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SAINT THOMAS AQUINAS

EXPOSITION
OF
ARISTOTLE'S TREATISE
ON METEOROLOGY

BOOK I - II (cc. 1-5)

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[The text of Aristotle precedes each lecture. The translation of Aristotle's *Meteorology* is drawn from *The Works of Aristotle*, ed. by W. D. Ross, trans. by E. W. Webster (Oxford: Clarendon Press, 1923).]

Complete Text of Aquinas and corresponding Aristotle, with appropriate text of Aristotle preceding each Lecture

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On Meteorology

Lecture 1 (Aristotle's Text)

338a19-339a9

METEOROLOGICA
BOOK I

1. [1] We have already discussed the first causes of nature, and all natural †1 motion, †2 also the stars ordered in the motion of the heavens, †3 and the physical elements—enumerating and specifying them and showing how they change into one another—and becoming and perishing in general. †4[2] There remains for consideration a part of this inquiry which all our predecessors called meteorology. [3] It is concerned with events that are natural, though their order is less perfect than that of the first of the elements of bodies. They take place in the region nearest to the motion of the stars. †5 Such are the milky way, and comets, and the movements of meteors. †6[4] It studies also all the affections we may call common to air and water, †7[5] and the kinds and parts of the earth and the affections of its parts. †8 These throw light on the causes of winds and earthquakes and all the consequences the motions of these kinds and parts involve. †9 Of these things some puzzle us, while others admit of explanation in some degree. [6] Further, the inquiry is concerned with the falling of thunderbolts and with whirlwinds and fire-winds, and further, the recurrent affections produced in these same bodies by concretion †10 [7] When the inquiry into these matters is concluded let us consider †11 what account we can give, in accordance with the method we have followed, of animals and plants, both generally and in detail. When that has been done we may say that the whole of our original undertaking will have been carried out.

Lecture 1 (Aquinas' Commentary)

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METEOROLOGY — BOOK I
Lecture 1

Aristotle's intent in this book. Enumeration of ground previously covered in preceding books, and yet to be covered in subsequent books.

p 1

1. Just as in natural things nothing is perfect so long as it is in potency, but is perfect absolutely only when it is in ultimate act, and just as, when it is midway between pure potency and pure act, it is perfect in a qualified sense but yet not absolutely, so too with science. Now the science which one has of a thing only

in a universal way is not science complete according to ultimate act, but is midway between pure potency and ultimate act. For someone who knows something in a universal way, does indeed know something in act of the things that are included in its proper notion; but he who thus knows in a universal way, knows the other things, not actually, but in potency only. For example, one who knows man only accordingly as he is animal, thus knows in act only a part of the definition of man, namely, the genus; but the differences constitutive of the species he does not yet know in act but potentially only. Consequently, it is plain that the completion of science requires that one not stop at what is common but go on to the species (individuals not falling under the consideration of art, since of them there is not intellectual understanding but sense knowledge).

p 1

2. For this reason, since Aristotle in the book, *On Generation,* has determined concerning the transmutation of elements in common, it was necessary, for the completion of natural science, to determine concerning the species of transmutations that affect the elements. And he determines concerning these in this book, entitled *Meteorology*.

p 1

It is his intention, therefore, in this book to determine concerning the transmutations that occur with respect to the elements, according to their several species. And in order to indicate his intention he presents an introduction, in which he does three things:

First, he enumerates the things already treated in the books of natural science that precede this book, at 3;

Secondly, he shows what is to be treated in this book, at 4;

Thirdly, he shows what remains to be discussed in books that follow, at 9.

p 1

3. Three books precede the present one, according to order, in natural science. Hence he does three things [†1].

p 1

First, he states what was treated in the book of *Physics*. As to the first two books, it is question of the causes of nature. This he alludes to, concluding from what has been determined in the books preceding [The Meteorology] when he says: "We have already spoken about the first causes of nature," meaning by "first causes of nature," the first principles, which are matter, form and privation, as well as the four genera of causes, namely, matter, form, agent and end. In the subsequent books of the *Physics* the discussion is of motion in general; hence he adds, "and of every natural motion."

p 1

The second book of natural science is the book, *On The Heavens,* in the first part of which, i.e., in its first two books, the discussion is about the heaven and the stars, which are moved with circular motion. This he alludes to when he says: "We have also discussed the superior movement of the well-appointed stars," meaning by "well-appointed," very beautifully arranged, and by "as to their superior motion," the circular motion by which all the heavenly bodies are moved. In the second part of that book, i.e., in the third and fourth books, he determines concerning the number of elements and their local motion. Alluding to this he says: "and about the bodily elements we have discussed their number and nature." He says "bodily" elements to distinguish them from the first principles, namely, matter and form, which are not bodies but the elements or principles of bodies, whereas fire and water and earth are bodies, and are the elements of other bodies.

p 2

The third book of natural science is the book, *On Generation,* wherein are treated the mutual transmutation of elements, in the second book; and generation and corruption in common, in the first book. This he subsequently alludes to when he says: "and of things that are mutually transmutable."

p 2

4. Then [†2] he shows what is to be discussed in the present book. About this he does two things:

First, he gives the usual name for this body of doctrine, at 4;

Secondly, he enumerates the things contained in this doctrine, also at 4.

p 2

He says therefore first that the remaining part of "this method," i.e., of natural science, which we have before us, is still to be treated. [What is now to be considered] is what all the earlier philosophers called "meteorology" — from *meteoron* which means "on high" or "elevated," and from *logos,* which is a "statement" or "explanation" — for in it are considered the things generated on high, such as falling stars, comets, rain, snow, and so on. This does not mean that other things, produced in the lower regions, such as lightning, earthquakes and the like, will not be discussed; but, because things generated on high are more marvelous and more desired, it is from them that this whole doctrine takes its name.

p 2

5. Secondly [†3] he enumerates the things to be considered in this doctrine. These are seen to be divided into four groups. For there are some things that are produced in the highest region, nearest to the heavenly body. Such things are, namely, those concerning which it still remains to be considered, things that happen indeed according to nature, but not an ordered nature and, as some claimed, by chance. This more irregular nature is not, however, the nature which belongs to the "first element of bodies," i.e., the celestial body, called "element," because it is a part of the whole corporeal universe, although it does not enter into the composition of mixed bodies, as do the elements. The nature according to which these things occur is more unordered than the nature of the celestial body, since the things in the celestial body always behave in the same way, whereas in the transmutations affecting the lower bodies much variation occurs. It was on this account that some have believed that these occurred, not by nature, but by chance, failing to consider that there is produced by nature, not only those things which happen always, but also those which happen for the most part. These, I say, occur in the region nearest the "carrying of the stars," i.e., the stars that are circularly moved. This he sets down to distinguish them from those that follow. As an example he mentions the "Milk," i.e., the milky circle called the "galaxy," and the stars called "comets," and the "phantoms," i.e., the apparitions, fiery and moving, called "falling stars" [meteors].

p 3

6. Secondly [†4], he enumerates the things which take place under the foregoing; namely, all things that are posited as phenomena common to air and water — for they are produced from aqueous matter in the region of air, when vapors are changed into water.

p 3

7. Thirdly [†5], he enumerates what takes place in the lowest region and says: "We must also talk about the parts of the earth," such as east, west, north, south, "and about its kinds," for example, that some earth is hot and sandy, and some cold and compact, "and about the properties of the parts" of the earth, for example, that some are sulphurous, some stony or in some way broken up. "From this knowledge" of the earth "we shall consider all the causes of 'spirits,'" i.e., winds, that differ according to the difference of the

earth. Likewise, "of earthquakes," the causes of which are attributed to the different type of earth, "and of all things that take place according to the motions of these," i.e., of winds and earthquakes. In these matters we cannot explain everything perfectly and according to certitude, but shall let some things remain doubtful, giving reasons for both sides; but in others we shall to some degree reach the truth.

p 3

8. Fourthly [†6], he enumerates the things which descend from on high as the result of winds. He says, therefore, that we shall also give an account of the falling of thunderbolts, and of whirlwinds (called "siphons") and of the burnings that accompany such whirlwinds, and of other circular phenomena that occur from congealing and are properties of those bodies, namely, the elements. He says this because whirlwinds are generated from compacted matter set rotating, and many other like things happen to whirlwinds as a result of matter compacted and set in circular motion. Or this could refer to the rainbow and halo (i.e., the corona surrounding the sun and moon and stars) which result from rays rebounding from thick matter.

p 3

9. Then at [†7] he mentions what remains to be treated in the books to follow and says that after we shall have finished with these matters enumerated above, we shall to the best of our ability, according to the method employed in earlier books (i.e., not by merely reciting others' opinions, but by inquiring into causes, speculate about animals and plants, both in a universal way and according to the individual species. And that will be almost the end of the natural science which we chose to discuss from the beginning. He says "almost," because not all natural things can be known by man.

Lecture 2 (Aristotle's Text)

339a10-339a10

[8] After this introduction let us begin by discussing our immediate subject.

339a11-339a33

2. We have already laid down that there is one physical element which makes up †1 the system of the bodies that move in a circle, and besides this four bodies owing their existence to the four principles, †2 the motion of these latter bodies being of two kinds: either from the centre or to the centre. These four bodies are fire, air, water, earth. Fire occupies the highest place among them all, earth the lowest, and two elements correspond to these in their relation to one another, air being nearest to fire, water to earth. The †3 whole world surrounding the earth, †4 then, the affections of which are our subject, is made up of these bodies. [9] This world necessarily has a certain continuity with the upper motions: consequently all its power and order is derived from them. (For the originating principle *of* all motion is the first cause. [10] Besides, that element is eternal and its motion has no limit in space, but is always complete; whereas all these other bodies have separate regions which limit one another.) †5 So we must treat fire and earth and the elements like them as the material causes of the events in this world (meaning by material what is subject and is affected), but must assign causality in the sense of the originating principle of motion to the influence of the eternally moving bodies.

Lecture 2 (Aquinas' Commentary)

p 4

Lecture 2

Principles of the natural changes to be considered in this book. Their relations to each other.

p 4

10. Having completed an introduction, in which the Philosopher has revealed his intention, he now begins to show his proposition. And this is divided into two parts:

In the first he restates facts necessary for knowing the principles of the transmutations to be treated in this book, at 11;

In the second part he begins to treat of them (L. 3).

p 4

About the first he does two things:

First, he enumerates the principles of these transmutations and their difference from one another, at 11;

Secondly, he shows how they are related to one another in causing, at 12.

p 4

11. He says therefore first [†8] that it has been previously determined both in the book, *On the Heavens,* and in the book, *On Generation,* that among the other corporeal principles that are principles of other bodies there is one which is the principle of those bodies from which is constituted the nature of the bodies circularly moved, i.e., of spheres and stars. This principle, out of which all such bodies are formed, he calls the "fifth essence." The other principles, of the lower bodies, are four in number, because of the primary tangible qualities, which are the principles of acting and of being acted upon. These are the hot, cold, moist and dry, of which there are but four possible combinations: for the hot and dry is fire, the hot and moist is air, the cold and moist is water, and the cold and dry is earth (that something should be hot and cold, or moist and dry, is impossible).

p 4

Of these four bodies there are two motions: one is upward from the middle [center] of the world, and this is the motion of light things, namely, fire and air; the other is to the middle [center], and this is the motion of heavy things, namely, earth and water. Accordingly, bodily motions are threefold: namely, to the middle for heavy bodies; from the middle for light bodies; and about the middle for the heavenly bodies, which are neither heavy nor light.

p 4

But notice should be taken of the differences in light and heavy. For there is something which is absolutely light, namely, fire, which is above all the others; there is something which is absolutely heavy, namely, earth, which is under all the others. But the other two are in a certain respect heavy and light — for air is light in relation to earth and water, but heavy in relation to fire; water, on the other hand, is light with respect to earth, but heavy with respect to air and fire. Consequently, these two are proportional to the other two that are extremes, i.e., as air is nearer to fire, so water is nearer to earth. Thus it is plain that the universe around the earth consists of four bodies. This is the world whose passions — which are the various transmutations found in the elements — we must consider in this book.

p 4

12. Then [†9] he shows how the aforesaid principles are related to one another in causing. And he says that it is necessary for the lower world to consist of the four elements thus in continuity with the "upper movements," i.e., with the bodies circularly moved (by "continuous" he here means "contiguous," in the sense that nothing lies between them). The reason why this is necessary is not only because no empty place can exist (hence bodies must be contiguous to bodies), but also because the end requires it — the end being that the whole power of the lower world be governed by the superior bodies, and this would not be, unless they touched — for a bodily agent must touch the thing acted upon and moved by it.

p 5

13. That the lower world is ruled and moved by the superior bodies he proves with two arguments. The first is this: The movent cause, i.e., the originative principle of motion, is necessarily the first cause. (This is to be understood in its relation to the formal and material cause. For matter is acted upon by the agent, which is by nature prior to the patient. The form, too, is an effect of the movent, which educes matter from potency to act. But the end is prior to the agent, because it moves the agent. Yet it is not always prior in the order of existence, but [sometimes] only in the order of intention.) Now it is plain that in the sphere of natural things the heavenly body is the first cause, and this is proved from its incorruptibility and nobility. Consequently, the heavenly body, with respect to these lower bodies, must be the originative cause of

Consequently, the heavenly body, with respect to these lower bodies, must be the originative cause of motion.

p 5

14. At [†10] he gives the second argument, which is this: The motion of the heavenly body is perpetual. This is apparent from the very disposition of place: for in the case of a straight line, one arrives at an end in act, namely, the terminus of the line, but in the case of a circle, one does not arrive at an end. He says, therefore, that circular motion does not have an end according to place. And lest anyone conclude from this that circular motion is imperfect, on the same ground that a straight motion is imperfect before reaching its end, he adds that a circular motion is always at an end — for any point you designate on a circle is both a beginning and an end, and circular motion is as perfect at any sector as a straight motion is at its end. Therefore it is plain, from the very disposition of place, that, to heavenly motions, perpetuity is congruent.

p 5

The motions of lower bodies, on the other hand, cannot be perpetual, because such bodies are moved with rectilinear motions, and a rectilinear motion remains one and continuous only according to the measure of the rectilinear magnitude along which the motion passes, and a reflected motion is not continuous, as was proved in *Physics* VIII. Hence, since all the lower bodies are a finite distance from one another, and no such body is infinite, as was proved in *Physics* III and in *On the Heavens* I, their motions must be finite and not perpetual. What is perpetual and always, consequently, is the movent of those things which are not always. Wherefore the lower elements, namely, fire and earth and the others which are "syngeneous," i.e., congenerable, with them, namely, air and water, and those things which are composed out of them, must be reckoned the causes of the things occurring in the lower world, "in the line of matter," i.e., after the manner of the material cause, because that is the way we speak of a subject and a patient being a cause of things. But their cause in the sense of "originative source of motion," i.e., their cause after the manner of movent cause, must be "sustained," i.e., held, to be that power which belongs to the "always moved," i.e., to the heavenly bodies, which are always in motion — for what is always in motion is compared to what is not forever in motion as agent is compared to patient.

Lecture 3 (Aristotle's Text)

339a34-339a35

3. [11] Let us first recall †6 our original principles and the distinctions already drawn and then explain the 'milky way' and comets and the other phenomena akin to these.

339a36-339b3

[12] Fire, †1 air, water, earth, we assert, originate from one another, and each of them exists potentially in each, as all things do that can be resolved into a common and ultimate substrate. †2

339b4-339b16

[13] The first difficulty is raised by what is called the air. What are we to take its nature to be in the world surrounding the earth? And what is its position relatively to the other physical elements. [14] (For there is no question as to the relation of the bulk of the earth to the size of the bodies which exist around it, since

astronomical demonstrations have by this time proved to us that it is actually far smaller than some individual stars. [15] As for the water, it is not observed to exist collectively and separately, nor can it do so apart from that volume of it which has its seat about the earth: the sea, that is, and rivers, which we can see, and any subterranean water that may be hidden from our observation.) [16] The question is really about that which lies between the earth and the nearest stars. Are we to consider it to be one kind of body or more than one? And if more than one, how many are there and what are the bounds of their regions?

339b17-339b19

[17] We have already described and characterized the first element, and explained that the whole world of the upper motions is full of that body. †3

339b20-339b26

This is an opinion we are not alone in holding: it appears to be an old assumption and one which men have held in the past, for the word ether has long been used to denote that element. Anaxagoras, †4 it is true, seems to me to think that the word means the same as fire. For he thought that the upper regions were full of fire, and that men †1 referred to those regions when they spoke of ether. In the latter point he was right, for men seem to have assumed that a body that was eternally in motion †2 was also divine †3 in nature; and, as such a body was different from any of the terrestrial elements, they determined to call it 'ether'.

339b27-339b28

For the same opinions appear in cycles among men not once nor twice, but infinitely often.

339b29-339b36

[18] Now there are some who maintain that not only the bodies in motion but that which contains them is pure fire, and the interval between the earth and the stars air: but if they had considered what is now satisfactorily established by mathematics, they might have given up this puerile opinion. For it is altogether childish to suppose that the moving bodies are all of them of a small size, because they seem so to us, looking at them from the earth.

339b37-339b38

This is a matter which we have already discussed in our treatment of the upper region, †4 but we may return to the point now.

340a1-340a3

If the intervals were full of fire and the bodies consisted of fire every one of the other elements would long ago have vanished.

340a4-340a16

[19] However, they cannot simply be said to be full of air either; [20] for even if there were two elements to fill the space between the earth and the heavens, †5 the air would far exceed the quantity required to maintain its proper proportion to the other elements. For the bulk of the earth (which includes the whole volume of water) is infinitesimal in comparison with the whole world that surrounds it. Now we find that the excess in volume is not proportionately great where water dissolves into air or air into fire. Whereas the *proportion* between any given small quantity of water and the air that is generated from it ought to hold good between the total amount of air and the total amount of water. [21] Nor does it make any difference if any one †6 denies †7 that the elements *originate from one another*, but asserts that they are equal in power. For on this view it is certain amounts of each that are equal in power, just as would be the case if they actually *originated from one* another. †1

340a17-340a18

340a17-340a18

[22] So it is clear that neither air nor fire alone †2 fills the intermediate space. †3

Lecture 3 (Aquinas' Commentary)

p 6

Lecture 3

Mutual transformation of the elements. Presence above of the heavenly body.

p 6

15. Having identified which are the active principles and which the material principles of the passions which he intends to treat, he now begins to determine concerning them. And this is divided into two parts:

In the first he determines concerning the particular transmutations of the elements, whereby they are transmuted according to themselves, at 15;

Secondly, he determines about their transmutations accordingly as they enter into composition to form a mixture, in Book IV.

p 6

The first part is divided into two parts:

In the first he determines concerning the transmutations or passions of the elements which occur on high;

In the second, about those which occur below, and this in Book II.

p 6

The first part is divided into three parts:

In the first he declares what his intention is;

In the second he states certain preliminaries necessary for determining what is to follow, at 16;

In the third he begins to determine concerning his main proposition (L. 6).

p 6

He says therefore first [†11] that we must speak of the "image of the milk," i.e., of the appearance of the milky circle, and of comets and of all other like things which are "syngeneous," i.e., generable along with them; but in doing so we shall [first] recall the positions laid down by us in the earlier books and the determinations already determined therein, so that we may, when necessary, use them to manifest the proposition.

p 6

16. Then [†12] he sets forth certain things needed for what is to follow. About this he does two things:

First, he premises something pertaining to the mutual transmutation of the elements, at 16;

Secondly, he speaks of the arrangement of the elements in the world, with special emphasis on air, at 17.

p 6

He says therefore first [†12] that fire and air and water and earth are produced from one another (even though Empedocles thought the contrary). And he restates this as proved in *On Generation* II. The reason for this which he assigns is that each element exists potentially in another, and that things so related can be generated one from the other. He assigns a further reason, which is that they all have the same common first matter which underlies each of them and into which, as into an ultimate, they are all resolved: for all things whose matter is one and common to all are so related that any one is potentially in any other — as, for example, a knife is potentially in a nail, and a nail potentially in a knife, because they have a common matter, iron.

p 6

17. Then [†13] he inquires into the order of the elements and into the case of air in particular. About this he does three things:

First he raises the question and says that our first problem is about the body called "air," as to what nature it has in the world surrounding the earth: i.e., is the whole air, and, if not, how it is related to the other elements?

p 7

Secondly [†14], he proposes certain evident facts about the order of the elements. The first fact concerns the earth, and it is that we are not entirely ignorant of the size of the earth in comparison to the surrounding magnitudes, namely, those of the heavenly bodies and of the other elements. For it is already plain from the considerations of astronomers that the earth is much smaller than certain stars, and that it is but the size of a point in comparison to the outermost sphere.

p 7

The second fact he proposes is about water [†15] and he says that we do not observe water to exist by itself and isolated from the body located about the earth, namely, from the sea and rivers, which we see, and from the bodies of water which some have asserted to exist hidden from us in the bowels of the earth. For it does not occur to water to be gathered together in this way — since the moistness which is water is contained by some alien terminus.

p 7

18. He further [†16] pursues the question he raised earlier, namely, as to what is the middle between the aforesaid [i.e., the earth and the farthest stars]. About this he does two things:

First, he shows [†16] that it is not the case that the entire space from the highest stars to the earth is filled with some one body such as fire or air or both, but that above there is an additional body besides these;

Secondly, he shows how the other bodies are related to that highest body with respect to position (L. 4).

p 7

Regarding the first he proceeds thus. First [†16] he says that there is a problem whether between earth and the farthest stars, which are called "non-wandering" and "fixed," we should posit, according to what is proper to nature, one body or more than one; and if more than one, how many, and where are the boundaries of their regions?

p 7

19. Secondly [†17], he repeats something already determined in *On the Heavens:* this is the condition, as far as its power is concerned, of the first element, namely, the celestial body; and that that entire world which is "about the upper motions," i.e., which is moved with a circular motion, is filled with that body — for all the heavenly bodies pertain to the nature of that first element. And since the philosophers supposed the contrary, he therefore, lest his opinion appear novel, adds that not only did he have this opinion, but it was also an ancient opinion of earlier men. For the body which is called "aether," and which we call the "heaven," has an ancient name.

p 7

But Anaxagoras seems to have supposed that it means the same as "fire" — for he took the word "aether" not to mean "always running," i.e., to be in continuous motion, but he derives it from *aethein,* which is "to burn," because he believed the superior bodies to be filled with fire. And although in this he spoke ill, nevertheless he was right in supposing the name "aether" to befit a corporeal potency over and above those bodies. For all the ancients are seen to have believed, and decided, that the name "aether" should be given to the body which always "runs," i.e., is always in motion, and which is a certain "divine," i.e., perpetual, something according to its nature. This they did as if that body were like no body that exists around us. Nor should it seem strange if this opinion, which we appeared to have adopted for the first time, was already held by the ancients. For we hold that the same opinions re-appear among men after dying out through neglect of study, not twice or thrice only, but an infinitude of times. Now he says this in keeping with his opinion that the world and human generation have been going on from eternity, as indicated in previous books. This being supposed, it is also plain that certain opinions and arts have begun from certain definite times; and thus it is necessary to say that these were in turn frequently, nay, an infinitude of times, destroyed by wars or other corrupting factors and again rediscovered.

p 8

20. Thirdly [†18], he shows that the circularly moved body is not any of the lower bodies. About this he does three things:

First, he shows this with respect to fire;

Secondly, with respect to air, at 21;

Thirdly, with respect to both, at 22.

p 8

With respect to the first [†18] it should be kept in mind that some have thought only the "carried" [moved] heavenly bodies, i.e., the sun, moon and stars, to have a fiery nature, and whatever exists between them to be of the nature of air; some on the other hand supposed the entire system to be of the nature of fire, as Anaxagoras said.

p 8

He says therefore that those who posited not only the moving bodies to be pure fire, but also the whole that surrounds them (i.e., all the spheres), and that which intervenes between earth and the stars to be air, i.e., from the earth to the moon's orb, and that whatever is above is all of it fire — whoever, I say, claim this, would, were they to consider the facts which have now been sufficiently proved by the mathematicians

would, were they to consider the facts which have now been sufficiently proved by the mathematicians concerning the sizes of bodies, probably give up this childish opinion. Only a simple and unschooled person would believe that the stars are small in size just because they appear small to us looking at them from afar.

p 8

This matter has been already discussed in the previous reasonings, i.e., in *On the Heavens* II; but we shall once more destroy the aforesaid position with the same argument. For, since the bodies of the stars and spheres are immeasurably greater than the size of the earth and of the things near the earth, then, if not only the bodies of the stars were of fire, but all the area between them were full of fire, every one of the elements would have long since been annihilated by virtue of the preponderance of fire over it.

p 8

21. Then [†19] he shows the same thing with respect to both. About this he does two things:

First, he gives the reason, at 22;

Secondly, he excludes a certain caviling objection, at 23.

p 8

He says therefore first [†20] that the due proportion among the elements is not kept, if the entire space between the earth and the outermost heaven is full of two elements, namely, fire and air. For the bulk of the earth, in which the whole quantity of water is also contained, is as no part at all compared to the total size of the bodies surrounding it, since, according to astronomers, even if compared only to the outermost sphere, it is as a mere point. But we see that when, as a result of separation or rarefaction, air comes to be from water, or fire from air, there is not such an immense excess in size. Now it is necessary, if the due proportion prevailing among the elements is to be preserved, that this small quantity of water maintain the same "reason," i.e., proportion, to the air made from it, as is maintained between the whole of water and the whole of air. In other words, the extent to which the quantity of air exceeds the quantity of water from which it is made must be proportional to the extent that all the air in the world exceeds all the water in the world.

p 9

23. Then [†21] he refutes a certain caviling objection and says that it is nothing against our position if someone should maintain, according to the opinion of Empedocles, that the elements are not generated from one another. For it is necessary, according to his opinion, that the elements be proportionally equal in power. Consequently, proportionate equality of power must be kept in the sizes of the elements if they are not generated one from the other, just as if they are.

p 9

Then he summarizes [†22] what has been said, and concludes that it is plain from the foregoing that neither does air fill the intermediate place between the earth and the highest stars, nor does fire; but, in addition to these two elements, there must be above them a heavenly body which is none of the lower elements.

Lecture 4 (Aristotle's Text)

340a19-340a24

[23] It remains to explain, after a preliminary discussion of difficulties, the relation of the two elements air and fire to the position of the first element, [24] and the reason why the stars in the upper region impart heat †4 to the earth and its neighbourhood. [25] Let us first treat of the air, as we proposed, †5 and then go on to these questions.

340a25-340b3

Since †6 water is generated from air, and air from water, why are clouds not formed in the upper air? They ought to form there the more, the further from the earth and the colder that region is. For it is neither appreciably near to the heat of the stars, nor to the rays reflected from the earth. It is these that dissolve any formation by their heat and so prevent clouds from forming near the earth. †7 For clouds gather at the point where the reflected rays disperse in the infinity of space and are lost. To explain this we must suppose either that it is not all air from which water is generated, or, if it is produced from all air alike, that what immediately surrounds the earth is not mere air, but a sort of vapour, and that its vaporous nature is the reason why it condenses back to water again. But if the whole of that vast region is vapour, the amount of air and of water will be disproportionately great. For the spaces left by the heavenly bodies must be filled by some element. This cannot be fire, for then all the rest would have been dried up. Consequently, what fills it must be air and the water that surrounds the whole earth—vapour being water dissolved.

340b4-340b29

[26] After this exposition of the difficulties involved, let us go on to lay down the truth, with a view at once to what follows and to what has already been said. The upper region as far as the moon †1 we affirm to consist of a body distinct both from fire and from air, but varying in degree of purity and in kind, especially towards its limit on the side of the air, and of the world surrounding †2 the earth. [27] Now the circular motion of the first element and of the bodies it contains dissolves, and inflames by its motion, whatever part of the lower world is nearest to it, and so generates heat. From another point of view we may look at the motion as follows. The body that lies below the circular motion of the heavens is, in a sort, matter, and is potentially hot, cold, dry, moist, and possessed of whatever other qualities are derived from these. †3 But it actually acquires or retains one of these in virtue of motion or rest, the cause and principle of which has already been explained. †4[28] So at the centre and round it we get earth and water, the heaviest and coldest elements, by themselves; round them and contiguous †5 with them, air and what we commonly call fire. It is not really fire, for fire is an excess of heat and a sort of ebullition; †6 but in reality, of what we call air, the part surrounding the earth is moist and warm, because it contains both vapour and a dry exhalation from the earth. But the next part, above that, is warm and dry. For vapour is naturally moist and cold, †1 but the exhalation warm and dry; and vapour is potentially like water, the exhalation potentially like fire.

Lecture 4 (Aquinas' Commentary)

p 10

Lecture 4

Three questions. The first, on the order of the elements, is solved.

p 10

24. After showing that neither fire nor air is the heavenly body called "first element" or "first body," he now intends to show how fire and air are related to that first body. Concerning this he does two things:

First, he raises this question, and two others necessary for his proposition, at 24;

Secondly, he answers them, at 26.

p 10

The first is divided into three parts, according to the three questions raised:

The second begins at 25;

The third at 26.

p 10

He says therefore first [†23] that after the above considerations there remains to be examined the relation of air and of fire to the first body, namely, the heavenly body, since it has been shown that it is something other than they.

p 10

25. Then [†24] he places the second question, namely, as to what cause is due the fact that from the upper stars heat is produced in the regions surrounding earth. This question, too, takes its rise from the foregoing considerations. For it seems to be according to nature that like should generate like: if, therefore, the heavenly body is not hot — for it is neither fire nor air, as was shown above — then there remains the problem of how heat can be caused by the heavenly body in these lower bodies.

p 10

26. Then [†25] he raises the third problem which also arises from the foregoing. For he had said previously that we must inquire how the nature of air in the universe is to be taken, and this for the reason that many of the things concerning which he is about to determine are generated in the air. He says therefore that, as we laid down above, we must first speak of air; then we shall have to discuss the other two questions proposed.

p 10

Hence he immediately begins to raise the difficulty on the nature of air. For it has been shown in *On Generation* II that water is produced from air and conversely. Thus, since the rains are generated from the condensings of the clouds, this is air being converted into water. He asks, therefore, if water comes to be from air, and air from water, why is it that, in the upper region of air, clouds are not condensed [thickened] to generate water?

p 10

And he gives a reason to show that such a thing should happen. For it is plain that condensation of clouds is due to coldness, for just as heat causes things to rarefy, so cold causes things to condense. Now it seems that a place should be colder the farther it is from earth, because in such a place the two causes of heating are lacking. One of these causes is proximity to the stars that cause heat; and this is referred to when he says that the upper region of air is not close enough to the stars which are hot, namely, as to effect, to allow the heat of the stars to prevent the thickening of clouds. The other cause of heat is solar rays bouncing back from the earth; this cause he refers to when he says that neither is that region of upper air near the rays "refracted," i.e., reverberated, from the earth, which rays prevent clouds from gathering close to the earth, inasmuch as their heat breaks down the consistency of the vapors. That this second cause does not prevent congregation he shows through a sign. For it is plain that the comings together of clouds occur where the rays reflected from the earth have already lost their power to heat through being immeasurably dispersed and are thus far distant from the rays that strike the earth; hence the cause of heat is not multiplied.

p 11

This last statement becomes plain if we keep in mind the fact that the rays coming from the sun to the earth are what cause heat. When a ray which comes from the sun to earth is reflected, there is now produced another ray as though moving upwards from the earth. The closer these two rays are to each other, the greater the heat produced, because the powers of both rays, i.e., that of the incident ray and that of the reflected ray, act on the same part of the air. Consequently, where a ray of the sun strikes the earth at a right angle, there a maximum of heat is produced, because the ray is reflected into the same direction; when a ray falling on some place strikes at an angle less than a right angle, the heat is by that much less, since, as repercussion takes place according to similar angles, a reflected ray, because of the wideness of the angle, is greatly distant from the ray which first falls. It is plain that the farther two lines containing an angle proceed, the greater becomes the distance between them. Hence, the farther one moves from the earth, where reflexion takes place, the farther the aforesaid two rays grow distant from each other, and there is less heat. Therefore, due to the immense separation of the aforesaid rays from one another in the upper region, the heat ceases, and clouds are formed there on account of the cold. And this what he says: "Gatherings of clouds are produced where the rays now cease because of immeasurable scatterings." Consequently, both causes that could prevent forming of clouds are absent in the upper region of air, as has been said. But since, notwithstanding this, clouds do not form there, it is necessary to say either that water cannot be formed from just any air, or, if all air is alike so far as being convertible into water is concerned, this air near the earth must not only be air, but as a vapor, and for this reason be gathered to generate water, while the upper air, which is pure air, cannot be condensed into water. But this cannot be: for if the totality of air near the earth, since it is such a great amount, is vapor, then it is seen to follow that the nature of air and of water would far exceed the other elements. Because the higher distances, between the stars, are filled with some body (for there is no such thing as a void, as was proved in *Physics* IV, and they cannot be filled with fire, for this would result in everything's drying up, as was proved above, consequently they must be filled with air, while the region near the earth is filled with water. But this air is vaporous, for vapor is a certain "disjoining of water," i.e., rarefied water.

p 11

Then, having presented the three questions, he adds, as though summarizing, that the problems concerning the aforesaid have been raised in this manner.

p 11

27. Then at [†26] he solves the questions proposed:

First, the question about the order of the elements;

Secondly, the one about generation of clouds (L. 5);

Thirdly, the one about heat produced in lower bodies by the stars (L. 5).

p 11

Regarding the first he does three things. First, he repeats what has been said about the nature of the first body and says that for an understanding both of the matters now in question and of matters to be stated later, we must state decisively that the highest body as far as the moon is other than fire and air, as has already been proved, and that there is in that highest body something more pure, and something less pure or sincere, without implying that there is present any composition or mixture of an extraneous nature. Rather "more pure" implies more noble, more virtuous, more formal. Hence it admits of differences both in power and in nobility. This difference is especially evident where it ceases at the air and the lower world surrounding the earth, for in the moon there appear defects of light, and, when it is full, certain dark areas appear.

p 12

28. Secondly, at [†27] he shows what effect the higher body has upon the lower ones. And he says that by means of the "first element," i.e., the heaven, circularly moved, and the bodies moved in it, namely, sun and stars, that part of the lower world nearest to it, dispersed or rarefied, as it were, by the motion of the superior body, becomes inflamed and heat is produced. And he gives the reason, saying that to understand this we must go back to the beginning.

p 12

For the entire bodily nature that exists under the circularly moved body is as a certain matter which is in potency to heat, cold, dryness, and wetness, and to the other passions and forms that result therefrom; and because matter is reduced to act by the first agent, bodily nature also becomes actually such and such by the fact that it participates in the motion, or does not participate but remains immobile, from the heavenly body, which we have previously declared to be the cause and originative principle of the motion in these lower bodies. This does not mean that the lower bodies receive such passions from the superior bodies, as it were, incidentally, and not according to nature, as when water becomes heated by fire; rather, the very nature or form according to which they are naturally hot or cold is received more principally from the superior body than from their generator, for the first principle of generation is the heavenly body.

p 12

28 bis. Thirdly [†28] he shows the order of the elements. For if heat originates in these lower bodies through participation in motion, and if, on the other hand, cold is due to distance from the heavenly motion, then, of necessity, that which is coldest and heaviest, namely, water and earth, is more removed from the heavenly motion and exists in the middle, as the earth does, or about the middle, as water does. Or else he says, "around the middle," because the middle, being indivisible, cannot be the place of a body, but rather, earth and water are "around the middle," i.e., the center of the world — for the center of the earth is in the center of the whole. "Around these," namely, earth and water, and "had to these," i.e., ordered in sequence after them, are air, and what is commonly called fire, in which [two] heat abounds.

p 12

He explains his statement that the fourth element, i.e., the one located above air, is not strictly called "fire." For "fire" signifies an excess of heat and is, as it were, a certain intensity and igniting. In the same way, ice is not an element but a certain superabundance of coldness producing congealed water. Now that to which fire is related in the way that ice is related to water has no name; so we call it by the name of fire. It is as though water should have no name and we should call the element of water, "ice."

p 12

But we must understand that in regard to that whole body we call "air," one part, the part nearest the earth,

is as though hot and moist on account of vapor, and exhalation from the earth. For the elements are arranged in a manner that befits their nature; therefore, because air is naturally hot and moist, it is disposed to receive vapor from the earth to preserve its heat and moisture. But that part of the body commonly called "air" which is higher, is hot and dry; and this upper part we call the element "fire." In this way the name "air" is common to two elements.

p 12

And because he had spoken about vapor and exhalation from the earth, he shows the difference between them and says that the nature of vapor is to be moist and hot, whereas the nature of an exhalation is to be hot and dry. As a result, vapor is, on account of its moistness, in potency to water; but an exhalation, on account of its dryness is, as it were, in potency to be ignited.

Lecture 5 (Aristotle's Text)

340b30-340b31

[29] So we must take the reason why clouds are not formed in the upper region to be this: that it is filled not with mere air but rather with a sort of fire.

340b32-341a4

[30] However, it may well be that the formation of clouds in that upper region is also prevented by the circular motion. For the air round the earth is necessarily all of it in motion, except that which is cut off inside the circumference which makes the earth a complete sphere. †2 In the case of winds it is actually observable that they originate in marshy districts of the earth; and they do not seem to blow above the level of the highest mountains. It is the revolution of the heaven which carries the air with it and causes its circular motion, fire being continuous with the upper element and air with fire. Thus its motion is a second reason why that air is not condensed into water.

341a5-341a8

But whenever a particle of air grows heavy, †3 the warmth in it is squeezed out into the upper region and it sinks, and other particles in turn are carried up together with the fiery exhalation. Thus the one region is always full of air and the other of fire, and each of them is perpetually in a state of change.

341a9-341a13

[31] So much to explain why clouds are not formed and why the air is not condensed into water, †4 and what account must be given of the space between the stars and the earth, and what is the body that fills it.

341a14-341a18

[32] As for the heat derived from the sun, the right place for a special and scientific account of it is in the treatise about sense, †5 since heat is an affection of sense, but we may now explain how it can be produced by the heavenly bodies which are not themselves hot.

341a19-341a28

[33] We see that motion is able to dissolve and inflame the air; indeed, moving bodies are often actually found to melt. [34] Now the sun's motion alone is sufficient to account for the origin of terrestrial warmth and heat. For a motion that is to have this effect must be rapid and near, and that of the stars is rapid but distant, while that of the moon is near but slow, whereas the sun's motion combines both conditions in a sufficient degree. [35] That most heat should be generated where the sun is present †1 is easy to understand if we consider the analogy of terrestrial phenomena, for here, too, it is the air that is nearest to a thing in rapid motion which is heated most. This is just what we should expect, as it is the nearest air that is most dissolved by the motion of a solid body.

341a29-341a31

This then is one reason why heat reaches our world. [36] Another is that the fire surrounding the air is often scattered by the motion of the heavens and driven downwards in spite of itself.

341a32-341a36

[37] Shooting-stars further suffice to prove that the celestial sphere is not hot or fiery: for they do not occur in that upper region but below: yet the more and the faster †2 a thing moves, the more apt it is to take fire. †3 Besides, the sun, which most of all the stars is considered to be hot, is really white and not fiery in colour.

Lecture 5 (Aquinas' Commentary)

p 13

Lecture 5

The remaining two questions solved.

p 13

29. Having solved the question about the order of the elements, he now solves the one about the thickenings which produce clouds. And he gives two solutions, the first of which he derives from the foregoing [†29], saying that the cause why clouds are not formed together in the upper region of the air must be considered to be the fact that this upper region, which is commonly called "air," is not only air but is something more akin to fire, as has been said. But because clouds are not formed even much below this region, it was necessary to present another solution.

p 13

30. Hence he presents a second solution [†30] and says that nothing prevents the air's motion in its circuit from inhibiting the gathering of clouds in the upper region; for it is necessary that all the air on the circumference of the earth flow with a circular motion. But he does not include in that flow the air trapped inside the "defined periphery," i.e., the circumference, namely, air enclosed within the parts of the earth, thus making a perfect sphere by virtue of the air enclosed between the parts. Therefore that air exceeding the height of all mountains flows in an orbit, while the air contained below the heights of the mountains is

the height of all mountains flows in an orbit, while the air contained below the heights of the mountains is prevented from this flowing, blocked by the immovable parts of the earth.

p 13

This is the reason why winds seem now to be generated "in stagnant areas of the earth," i.e., in air which is trapped between the parts of the earth, as though constituting pools of still air. For if the air where winds are born were moved circularly, it would be necessary that all winds accompany it along its circular orbit; but now we observe that winds blow out of diverse regions. And because winds are born not in the flowing air, but in the still air, they never exceed the high mountains; for it is said by the ancients that, when sacrifices were made on the loftiest mountains, the ashes, a year later would be found still in the same place intact. The fact that winds are not generated there is a sign, too, that clouds are not condensed into rain there. But why the air above the mountains flows he explains by saying that the reason it flows along in its course is that it is drawn along by the circling of the heaven; for fire is "continuous," i.e., contiguous, with the heavenly body, and air with fire.

p 13

Therefore, because the upper air flows along, its motion prevents its being gathered into water, for movement rarefies things and prevents coalescence. But whenever a portion of that air condenses in some way, or something denser is carried along in some way by some constrained motion, it will be carried downward, i.e., to the place of the air close to the earth; and if anything warm was in it, it would be carried upward. And the other part of that air, which did not become heavy, would be carried upward along with the exhaled fire. And so, while, of those things which are resolved out of earth and water, something remains in the region of air, and something is carried upward where fire is, one place continues to be filled with air and another filled with fire; but not in such a way that the same air and fire always remain incorrupt in number. What happens is, rather, that, as one portion of air or fire corrupts or is violently expelled toward the earth, another portion is always generated and rises upward from the earth and from the water. In this way, although there is always air in the region of air, and fire in the region of fire, yet there is always a continual turnover as a result of continuous generation and corruption. An analogy of this is seen in a flowing stream, in which there is always water, yet not the same numerical water, but as some flows on, other flows into its place.

p 14

31. Then [†31] he summarizes and says: "So much for what we have to say about the fact that in the upper region of air clouds do not form and no thickening of vapors into water takes place; and also about how we must think of the region between the highest star and the earth," i.e., as to what sort of body it is filled with.

p 14

32. Then [†32] he solves the third question. About this he does two things:

First, he states his intention and says that, as to the heat produced in these lower bodies by the sun, it would be more suitable to discuss this formally and "diligently," i.e., perfectly, among the matters to be discussed in the books dealing with sense; for "hot" is a certain passion of the senses, being the object of the sense of touch. But the sense and the sensible object are treated in the same science, for they are in a certain way referred to each other. However, since the matter at hand demands it, we must now discuss why it is that, though heavenly bodies are not hot as to their nature, yet heat is produced by them in these lower bodies.

p 14

33. Secondly [†33], he solves the question. And it is divided into two parts:

First, he presents the solution to the question;

Secondly, he proves what he had presupposed in the question, at 37.

p 14

The first is divided into two parts, according to the two causes assigned;

The second begins at 36.

p 14

With respect to the first he does three things. First [†33] he assigns the cause on account of which heat is generated in these lower bodies by heavenly bodies not themselves hot. And he says that by sense observation we see that movement, since it can separate and rarefy air, can also inflame it: for rarity and combustion go hand in hand, just as do cooling and thickening; and on this account, things borne along, such as arrows, if they include lead and wax, are often seen to melt, as though motion were making them hot. Hence it is not inconceivable that the heaven, by its motion, should heat these lower bodies.

p 14

34. Secondly [†34], he assigns the cause why heat is caused in these lower bodies more by the motion of the sun than by the motion of some other superior body. And he says that the sun by itself suffices to produce a burning heat in these lower bodies: for the heat produced from other heavenly bodies is almost imperceptible when compared to the heat caused by the sun. The reason for this is that if a motion is to cause vehement heat it must be rapid and close to us. Now the motions, both of the fixed stars, and of the five wandering stars [planets], which are, according to Aristotle, above the sun, namely, Saturn, Jupiter, Mars, Venus and Mercury, are indeed rapid, but they are far from us; on the other hand, the motion of the moon, although it is near, is, however, slow. But the motion of the sun has both, i.e., speed and nearness, in a manner sufficient to cause heat in these lower bodies.

p 14

What is said here about the velocity of the sun's motion is to be referred to its diurnal motion and not to the proper motions of the stars. For it is plain that all the stars complete their diurnal motion during the same period of time: but the closer a heavenly body is to the center, the smaller is the circumference of its orbit and the slower is it moved. But with respect to proper motions, the moon is moved most rapidly.

p 15

35. Thirdly [†35] he assigns the cause why heat is generated more by the motion of the body of the sun than by the motion of its sphere. And he says that it is reasonable for heat to be produced more by the solar body itself. Something akin to this can be discerned from what happens where we are [on earth]: for here also the air close to thick objects being moved along through violence becomes very hot. And it is reasonable that this should happen: because it is especially the motion of a solid body that dissolves air; hence, since the solar body is more solid than the other parts of its sphere, since it is not diaphanous, heat is generated more from its motion than from the motion of its sphere. This, therefore, explains why heat from the sun reaches this place, even though the sun itself is not hot.

p 15

Nor is any obstacle to this cause offered by the presence between us and the sun of the moon which cannot become hot; for although it is not heated by the sun, it is nevertheless influenced in a certain manner by the sun, for we observe that it is illuminated by the sun. Yet a medium and an extreme are not always changed with the same species of change: thus a ray of the sun does not ignite a [magnifying] glass filled with water, but the piece of flax placed beyond.

p 15

Also the reason is apparent why, where a shadow is, there is not as much heat as in a place where the sun's rays strike: it is because a shadow is caused by a body blocking the sun and interrupting the continuing transmutation deriving from the sun; however, the action of the sun does reach the place where a shadow is by a sort of reflexion.

p 15

Nor should it be supposed that the sun's motion, as motion only, causes heat; rather, it is in so far as it is the motion of such a body, i.e., of a body having in its nature the power to cause heat. For all the forms of the lower bodies are reduced back to the heavenly bodies as to certain principles: that is why diverse heavenly bodies produce diverse effects in bodily things, not only so far as heat is considered, but as far as other passions and forms are concerned.

p 15

36. Then [†36] he presents a proper cause of heat generated from the motion of the sun: yet not the universal cause but a particular cause. Hence he says that the fire which surrounds the lower parts of the world as a result of a heavenly body's motion is often violently thrust downwards and scattered through the air: because, as was said above, the upper part of the air and fire have a flow on account of the motion of the heaven.

p 15

37. Then [†37] he shows something which the question supposed, namely, that heavenly bodies are not hot or fiery; this he does by two signs. The first is that in that region we do not see the paths of those stars which seem to be falling [i.e., shooting stars], which are generated by combustion in the lower regions. This would not be the case if heavenly bodies were hot and fiery, because, wherever there is a greater and speedier motion, there something is ignited more readily.

p 15

The second sign is that the sun, which especially seems to be hot, considering its effects, is seen to be of a white, and not a fiery, color.

Lecture 6 (Aristotle's Text)

341b1-341b5

4. [38] Having determined these principles let us explain the cause of the appearance in the sky of burning flames and of shooting-stars, and of 'torches', and 'goats', as some people call them. All these phenomena are one and the same thing, and are due to the same cause, the difference between them being one of degree.

341b6-341b34

[39] The explanation of these and many other phenomena is this. When the sun warms the earth the evaporation which takes place is necessarily of two kinds, not of one only as some think. †4 One kind is rather of the nature of vapour, the other of the nature of a windy exhalation. That which rises from the moisture contained in the earth and on its surface is vapour, while that rising from the earth itself, which is dry, is like smoke. Of these the windy exhalation, being warm, rises above the moister vapour, which is heavy and sinks below the other. Hence the world surrounding the earth is ordered as follows. First below the circular motion comes the warm and dry element, which we call fire, for there is no word fully adequate to every state of the fumid evaporation: but we must use this terminology since this element is the most inflammable of all bodies. Below this comes air. [40] We must think of what we just called fire as being spread round the terrestrial sphere on the outside like a kind of fuel, so that a little motion often makes it burst into flame just as smoke does: for flame is the ebullition of a dry exhalation. †1[41] So whenever the circular motion stirs this stuff up in any way, it catches fire at the point at which it is most inflammable. The result differs according to the disposition and quantity of the combustible material. [42] If this is broad and long, we often see a flame burning as in a field of stubble: if it burns lengthwise only, we see what are called 'torches' and 'goats' and shooting-stars. Now when the inflammable material is longer than it is broad sometimes it seems to throw off sparks as it burns. (This happens because matter catches fire at the sides in small portions but continuously with the main body.) Then it is called a 'goat'. When this does not happen it is a 'torch'. But if the whole length of the exhalation is scattered in small parts and in many directions and in breadth and depth alike, we get what are called shooting-stars.

341b35-342a3

The cause of these shooting-stars is sometimes the motion which ignites the exhalation. At other times the air is condensed by cold and squeezes out and ejects †2 the hot element; making their motion look more like that of a thing thrown than like a running fire.

Lecture 6 (Aquinas' Commentary)

Shooting stars and meteors — their cause and difference.

p 16

38. Having laid down those things introduced to explain what is to follow, the Philosopher begins:

First, to determine concerning things generated on high out of dry matter;

Secondly, things generated on high from moist matter (L. 14).

p 16

The first is divided into three parts:

In the first he determines about falling stars and things having a like cause;

In the second about comets (L. 9);

In the third about the milky circle called the "galaxy" (L. 12).

p 16

About the first he does two things:

First, he determines about falling stars and other similar things;

Secondly, about certain other apparitions seen in the air (L. 8).

p 16

About the first he does two things:

First, he states his intention [†38] and says that, having determined the foregoing, we must explain the cause of the appearance in the heaven of burning flames and of shooting stars and of so-called *dali,* i.e., torches, and *aeges,* i.e., goats. They will be discussed at one and the same time, because they are all alike in kind and produced by the same cause, and differ only in degree, as will be clear below.

p 16

39. Secondly [†39], he determines his proposition, about which he does two things:

First, he states the causes generating the aforesaid, and says that the principle, both active and passive, of the aforesaid phenomena and of many others is what he will indicate. For when the earth has been warmed by the sun's motion, a certain exhalation is necessarily released from the earth. This is not of one sort, as some think, but is twofold: one is more vaporous and moist, the other more foam-like and dry — for from the aqueous moisture upon the earth's surface there is released and lifted on high a vaporous exhalation which is moist; from the earth itself, which is by nature dry, there is raised a fume-like or foam-like exhalation. Of these, the foam-like exhalation rises above the other on account of warmth which dominates in it and renders it more subtle: for the dry and warm is light — and fire is of this nature. But the vaporous exhalation, which is more moist, finds its place under the foam-like, being heavier, for it is not so fine: hot and moist pertain to the nature of the air, which is below fire, which is hot and dry.

p 16

The very order of the elements surrounding the earth attests to this. For under the circular motion of the heaven there is first located what is hot and dry and which is commonly called "fire," though that is not its

proper name, as has been said above: for, since the item common to every smoky exhalation has no name, and such is especially apt to burn, consequently, it was necessary to use words in keeping, and so such a fume-like evaporation comes to be called "fire." Under this fume-like exhalation is air. Thus we have posited both the effective cause of the aforesaid passions, which is the sun's movement, and the material cause, namely, the fume-like exhalation.

p 17

40. Secondly [†40], he determines concerning the generation of the aforesaid passions. About this he does two things:

First, he assigns the cause of their generation;

Secondly, the reason why certain things accompany them, at 47.

p 17

About the first he does three things:

First, he gives the cause of the aforesaid passions in common;

Secondly, their mutual differences, at 41;

Thirdly, he raises a question concerning what he has determined (L. 7).

p 17

He says therefore first [†40] that, in the light of the foregoing, we must understand what we have just now called "fire" to be as a certain "fuel," i.e., a combustible material, and that it is situated in the sphericity which is about the earth in the last place (beginning, that is, from the earth). Hence, on account of its proximity to the heavenly motion it often bursts into flame, being heated when only "slightly moved," i.e., when slightly stirred by the motion of the body above it, as happens in the case of smoke, when it is ignited and becomes flame: for a flame is nothing but the burning of a dry "spirit," i.e., smoke. Therefore the ignition of the above-mentioned fuel, commonly speaking, is responsible for the generation of the aforesaid passions, when matter which is prepared is placed in the proximity of the efficient cause.

p 17

41. Then [†41] he explains the differences among the aforesaid passions. About this he does two things:

First he shows what is the basis for the difference. And he says that from whatever source the aforesaid matter is had (regardless of how this "consistency" is obtained, namely, the aforesaid matter for burning), and when it is most perfectly disposed to be ignited, then it is so ignited in such a way by heating from the circular motion of the heaven: and the ignited passion varies according to the position and amount of the aforesaid matter.

p 17

42. Secondly [†42], he determines the differences among the aforesaid passions. And he says that if the aforesaid matter has great width and length, there appears to be a certain flame enkindled in the heaven, similar to stubble burning in a field [area]. But if it does not have great width, but only length, then "dali," i.e., torches, and "aeges," i.e., goats, and shooting stars are generated and appear there. For if the aforesaid matter is more in length than in width, and when it burns, the fire "scintillates," i.e., seems to leap and run about like "aeges," i.e., goats (which happens because not all the matter begins to be ignited at once but according to certain small sections, beginning from some starting-point in the matter), when, I say, this happens, it is called "aeges," i.e., a goat. But when the burning of the aforesaid matter takes place without

the aforesaid passion, i.e., without scintillation, because the entire material is ignited at once, then it is called a "dalus," i.e., a torch.

p 17

However, when the exhalation is not continuous, but frequent, and scattered in small areas, and in many ways, both according to length and according to width and even depth, then appear stars that seem to fly, because the material is rapidly consumed and ceased to be where it was previously burning, as happens with flax, if a small amount of it is laid down lengthwise and ignited: for the combustion seems to run along and seems similar to the movement of some fiery body. In this way, it is therefore plain that the burning flame has most material; a medium amount what are called "torches" and "goats," and least for shooting stars, which accounts for their rather frequent occurrence.

p 17

43. But because shooting stars have an additional cause of their generation, he adds that sometimes an exhalation ignited by the sun's movement generates them, but sometimes, too, when cold causes air to thicken, that which is hot within, being thickened, is forced out downward and is separated from the cold; this causes the thickened mass to ignite and a falling star is seen. That is also why the motion of stars falling in that way is not assimilated to a burning, but rather to a projecting.

Lecture 7 (Aristotle's Text)

342a4-342a15

[43] For the question might be raised whether the 'shooting' of a 'star' is the same thing as when you put an exhalation below a lamp and it lights the lower lamp from the flame above. For here too the flame passes wonderfully quickly and looks like a thing thrown, and not as if one thing after another caught fire. Or is a 'star' when it 'shoots' a single †1 body that is thrown? [44] Apparently †2 both cases occur: sometimes it is like the flame from the lamp and sometimes bodies are projected by being squeezed out (like fruit stones from one's fingers) and so are seen to fall into the sea and on the dry land, both by night and by day when the sky is clear. They are thrown downwards because the condensation which propels them inclines downwards. Thunderbolts fall downwards for the same reason: their origin is never combustion but ejection under pressure, since naturally all heat tends upwards.

342a16-342a26

[45] When the phenomenon is formed in the upper region †3 it is due to the combustion of the exhalation. When it takes place at a lower level it is due to the ejection of the exhalation by the condensing and cooling of the moister evaporation: for this latter as it condenses and inclines downward contracts, and thrusts out the hot element and causes it to be thrown downwards. [46] The motion is upwards or downwards or sideways according to the way in which the evaporation lies, and its disposition in respect of breadth and depth. In most cases the direction is sideways because two motions are involved, a compulsory motion downwards and a natural motion upwards, and under these circumstances an object always moves obliquely. Hence the motion of 'shooting-stars' is generally oblique.

342a27-342a32

So the material cause of all these phenomena is the exhalation, the efficient cause sometimes the upper motion, sometimes the contraction and condensation of the air. [47] Further, all these things happen below the moon. This is shown by their apparent speed, which is equal to that of things thrown by us; for it is because they are close to us, that these latter seem far to exceed in speed the stars, the sun, and the moon.

Lecture 7 (Aquinas' Commentary)

p 18

Lecture 7

Solution of problems concerning shooting stars.

p 18

44. Because he assigned two causes for the generation of shooting stars, he now raises a certain problem

about them. With respect to this he does two things:

First, he raises the problem [†43] which is this: whether the trajectory of shooting stars is the same as when the smoke-like exhalation of a lower candle is set afire by the flame of a higher candle or light (for in such a case the fire is seen to travel downward with marvelous speed and there appears to be the projection of one and the same fire instead of fire igniting in two distinct bodies); or whether the truth is that the trajectories of falling stars are the projections of some same falling body.

p 18

45. Secondly [†45], he solves this problem. Concerning it he does two things:

First, he says that the trajectories of falling stars seem to be due to both causes. For sometimes such a trajectory results from the continuous enkindling of matter, as was said of the smoke from lamps; but sometimes certain ignited substances are projected out as the result of being expelled by a higher coldness, much like a cherry pit squeezed out by one's fingers. Hence they are seen falling into the earth and sea, during the day as well as the night, when the sky is clear. He says, "during the day" and not at night only, because unless such a falling fire approached the earth through movement, it would not be visible during the day. Likewise he says, "when the sky is clear," because when it is cloudy, such fire would be snuffed out by the humidity of the clouds and air. But although those things expelled are on fire, and should, it would seem, on that account have to be light and therefore ascend, they are nevertheless cast downwards, because the condensation of cold driving them inclines them downwards. This is the reason why thunderbolts fall downwards even though ignited: for the generation of all things falling in this way is due, not to their being set afire by something hot which ignites them, but to their being detached by something cold which expels them — since by nature everything hot is borne aloft.

p 18

46. Secondly [†45], he explains the difference between the trajectories of the stars arising from these two causes. And he says that whatever shooting stars are generated more in the highest region, these are caused by the combustion of an exhalation; but the ones generated farther down are caused by the moister exhalation "mixing together," i.e., condensing and cooling. For this moist exhalation, now concentrated and inclining downwards, pushes and, as it were, thrusts downward the hot element, together with some condensed matter.

p 18

47. Then [†46] he explains certain phenomena accompanying these events. About this he does two things:

First, he explains the reason for the type of motion of such falling stars;

Secondly, he determines the place where they are generated, at 48.

p 18

He says therefore first that, depending on the different position of the exhalation with respect to the sides or depth [i.e., top or bottom], the falling star will be moved differently — either above or below, or to the side, of its point of ejection by the cold. For if the condensed cold matter which does the ejecting has come together above, the falling star is moved downward by the expulsion; but if the matter has collected below, then it is moved upward; if it comes together in neither place, then its [the star's] motion is sideways, as though obliquely or along the diameter. And this often happens: for the ejected hot mass is moved with two motions: by nature, as hot, it is moved upwards; but through the violence of the ejection, it is moved downwards. But all such things, whose motions are so combined, are moved "according to the diameter," i.e., obliquely, since such a motion is as though a mean between ascent and descent. As a result the motion of falling stars is most often oblique.

of falling stars is most often oblique.

p 19

Then he summarizes what has been set forth and says that the material cause of all the foregoing is an exhalation; but the movent cause is twofold: for sometimes it is the movement of a higher body, sometimes it is the condensing of air thickened by coldness, and subsequently forcing out the hot.

p 19

48. Then [†47] he determines the place where the aforesaid are produced and says that they are all produced below the moon. A sign of this is that they appear to us to be moving very rapidly, as do things we project, such as arrows and the like, which, for being close to us, seem to be travelling faster than the stars and sun and moon — although it is plain that, in truth, the higher bodies are moved much faster than anything here.

Lecture 8 (Aristotle's Text)

342a33-342b12

5. [48] Sometimes on a fine night we see a variety of appearances that form in the sky: 'chasms' for instance and 'trenches' and blood-red colours. [49] These, too, have the same cause. †1 For we have seen that the upper air condenses into an inflammable condition and that the combustion sometimes takes on the appearance of a burning flame, sometimes that of moving torches and stars. So it is not surprising that this same air when condensing should assume a variety of colours. For a weak light shining through a dense air, and the air when it acts as a mirror, will cause all kinds of colours to appear, but especially crimson and purple. For these colours generally appear when fire-colour and white are combined by superposition. Thus on a hot day, or through a smoky medium, the stars when they rise and set look crimson. The light will also create colours by reflection when the mirror is such as to reflect colour only and not shape. †2

342b13-342b14

These appearances do not persist long, because the condensation of the air is transient.

342b15-342b17

[50] 'Chasms' get their appearance of depth from light breaking out of a dark blue or black mass of air. When the process of condensation goes further in such a case we often find 'torches' ejected. When the 'chasm' contracts it presents the appearance of a 'trench'. †3

342b18-342b21

[51] In general, white in contrast with black creates a variety of colours; like flame, for instance, through a medium of smoke. But by day the sun obscures them, and, with the exception of crimson, the colours are not seen at night because they are dark. †4

342b22-342b24

[52] These then must be taken to be the causes of 'shooting-stars' and the phenomena of combustion and also of the other transient appearances of this kind.

Lecture 8 (Aquinas' Commentary)

p 20

Lecture 8

Cause of other phenomena appearing at night, and of certain that do not.

p 20

p 20

49. After assigning the cause of the conflagrations that are seen being moved in the air, the Philosopher here assigns the cause of certain other things that appear at night. About this he does two things:

First, he enumerates the things whose causes he intends to assign and says that sometimes at night, when it is clear, "phantoms," i.e., apparitions, are visible in the heaven: for instance, "crevices," i.e., gashes, as though the sky were open, and "bothyni," i.e., chasms, as though deep breaches, and also "blood-red colors."

p 20

50. Secondly, he assigns the causes of these things. About this he does two things:

First, he gives the cause of their appearance, at 50;

Secondly, why many other things occur that are not visible, at 52.

p 20

About the first he does two things:

First, he assigns the cause of the colors;

Secondly, the cause of the crevices and chasms, at 51.

p 20

He says therefore first [†49] that the causes of these apparitions and of the conflagrations discussed earlier are the same. For since it is plain that the upper air (which he earlier called "fuel") is so disposed as to be able to be ignited, so that sometimes a flame appears to burn, and sometimes it is ignited to give the appearance of moving torches and stars, it is not strange (since many varieties of ignitings occur in the air) that the upper air should appear colored with every variety of color.

p 20

For there are two ways in which air somewhat thickened comes to represent all varieties of colors: one way is when a feeble light, which is not enough to illuminate fully, shines through smoke or thick vapor; another way is when light is reflected off somewhat thickened air. From these two causes especially, there appears in the air a crimson and purple color, i.e., reddish and sub-red — for these colors appear especially when things fiery and white are mixed with black.

p 20

Such a mixture can occur as a result of the two above-mentioned causes: namely, by "superapposition" (described above as a feeble light shining through something fairly thick — as when the sun and the moon and other stars appear crimson when they rise and set, and as though sub-red when their light is not perfect). But I say this, if heat is present: because when it is cold, vapors are condensed and obscure the light of rising and setting stars more, so that it cannot get through; but when it is hot, the exhalations are finer and permit the light of the stars to pass through. Likewise, if the stars are seen through smoke, they have this color.

p 20

This mixture can also be produced by the other cause mentioned: namely, refraction, when the object from which the light is refracted (he here calls this object a "mirror"), whether it be a water-soaked cloud or something other of the same sort, is of such a nature as to reveal color but not shape. He will explain this, when it is question of the rainbow.

when it is question of the rainbow.

p 21

Then he explains why these colors quickly disappear and do not last long: it is because the cause of their appearance is "rapid," i.e., quickly passes — for air does not maintain a given state very long, and becomes thick or fine very easily.

p 21

51. Then [†50] he assigns the cause of "crevices" and "chasms" and says that when light visible in air is interrupted by something dark, due to thicker vapor than usual, depths and openings seem to exist in the heaven. A sign of this is that, when the vapor which interrupts the light becomes thicker still, fiery torches emerge or fall from these "crevices," as though something hot were ejected by the coldness which thickens the vapor. But when that dark vapor which interrupts the light becomes still more condensed and thick, it causes a greater depth to appear, because the white is overcome by black; when the situation is just the opposite, then only a crevice or opening appears.

p 21

It is plain, therefore, that both apparitions, i.e., that of colors and that of crevices, have a like cause, namely, black and white mixing together: but the purple or crimson color results from white shining through something black, whereas the crevices and chasms result from something black screening the white.

p 21

52. Then [†51] he shows that many things of this sort occur but are not visible. And he says that white joined with black produces many varieties of color, as appears with flame in smoke, which produces various colors depending on whether the smoke is thick or fine. But by day the sun's brightness prevents these colors from being seen: at night, however, only red appears, because the other colors, such as green and other darker colors, are on account of their darkness like the color of night.

p 21

Finally, he sums up what has been determined and says [†52] that these must be taken as the causes of shooting-stars and fire-stars and like apparitions "that make hasty appearances," i.e., that are seen to pass by without lasting very long.

Lecture 9 (Aristotle's Text)

342b25-342b26

6. [53] Let us go on to explain the nature of comets and the 'milky way', after a preliminary discussion of the views of others.

342b27-342b29

[54] Anaxagoras †1 and Democritus †2 declare that comets are a conjunction of the planets approaching one another and so appearing to touch one another.

342b30-342b35

[55] Some of the Italians called Pythagoreans †3 say that the comet is one of the planets, but that it appears at great intervals of time and only rises a little above the horizon. This is the case with Mercury too; because it only rises a little above the horizon it often fails to be seen and consequently appears at great intervals of time.

342b36-343a20

[56] A view like theirs was also expressed by Hippocrates of Chios and his pupil Aeschylus. †4 Only they say that the tail does not belong to the comet itself, but is occasionally assumed by it on its course in certain situations, when our sight is reflected to the sun from the moisture attracted by the comet. It appears at greater intervals than the other stars because it is slowest to get clear of the sun and has been left behind by the sun to the extent of the whole of its circle before it reappears at the same point. It gets clear of the sun both towards the north and towards the south. In the space between the tropics it does not draw water to itself because that region is dried up by the sun on its course. When it moves towards the south it has no lack of the necessary moisture, but because the segment of its circle which is above the horizon is small, and that below it many times as large, it is impossible for the sun to be reflected to our sight, either when it approaches the southern †5 tropic, or at the summer solstice. Hence in these regions it does not develop a tail at all. But when it is visible in the north it assumes a tail because the arc above the horizon is large and that below it small. For under these circumstances there is nothing to prevent our vision from being reflected to the sun.

Lecture 9 (Aquinas' Commentary)

p 22

Lecture 9

The opinions of others concerning comets.

p 22

53. After determining concerning falling stars and the like, the Philosopher now determines about comets.

p 22

First, he states his intention [†53] and says that we must speak now of comets and the milky circle, observing with respect to each the following order: first, we shall present the "doubts," i.e., the objections to what others have said, and then we shall state what we think.

Secondly [†54], he pursues his proposition in the order stated.

p 22

First, therefore, he presents what others thought of comets;

Secondly, he determines about them according to his own opinion (L. 11).

p 22

The first is divided into two parts:

In the first he presents the opinions;

In the second he disproves them (L. 10).

p 22

The first is divided into three parts according to the three opinions he presents.

p 22

54. First therefore [†54], he gives the opinion of Anaxagoras and Democritus who said that comets are "symphases," i.e., co-appearances of [planets] the wandering stars. These are five in number (namely, Saturn, Jupiter, Mars, Venus and Mercury), some of which, as they approach one another seem to touch, and there seems to be one star, and "flowing hair" appears [the coma, hence "comet"], due to the increase of light.

p 22

55. He presents the second opinion [†55], which was that of certain Pythagoreans living in Italy who said that a comet is one of the wandering stars [planets], but that the "phantasy," i.e., vision, of it occurs only after a long lapse of time, because it "exceeds," i.e., departs from the sun only slightly — as is the case with the star Mercury, which, because it only slightly "digresses from," i.e., moves away from, the sun, frequently does not appear, appearing only after a long time, having for a long time not appeared.

p 22

56. He presents the third opinion [†56], which was that of certain followers of Hippocrates, and of Aeschylus, his disciple. This opinion is similar to the second in supposing that a comet is one of the wandering stars; it differs in that the second opinion held the wandering star had a tail [coma] of itself, whereas this third opinion holds that it does not have a tail of itself, but, since it is wandering, sometimes acquires a tail by its position. According to this opinion a certain moisture is attracted by the star, and, since they assume that vision occurs by a beholder emitting visual rays, they posited that a visual ray reaches that moisture attracted by the star and is then reflected toward the sun. In this way the attracted vapor acts as a certain fiery mirror for the sun (for things are visible in a mirror because of reflection); and they say that it is thus that the tail is formed.

p 22

57. Then he assigns the cause regulating the time of its appearance and says that a comet star "appears at greater intervals than the other stars," i.e., is rendered invisible longer than the other stars, because time-wise it is very slow in getting clear of the sun, i.e., only when it has completed its entire cycle. He calls this "being left behind": for the wandering stars are said to be "left behind" with respect to the first motion, either because they are moved in a contrary direction and thus seem to retreat by their own motion, or because, as some say, they are moved more slowly than the first heaven which in its diurnal motion revolves everything else. So they said that a comet star is left behind by the sun to the textent of the whole of its orbit; and therefore, when it returns to the point where it first began to recede, it appears once more and remains in view until it again gets in conjunction with the sun. They also said that this star moves away from the sun not only according to longitude, but also according to latitude, declining to the north and south winds, i.e., to the north and to the south.

p 23

58. He also assigns the cause regarding the place of this star's appearance. And he says that this star does not appear in between the two tropics, namely, of Cancer and Capricorn; for the sun travels through that portion of the heaven and consumes the moisture, so that in that portion of the heaven this star cannot attract any water. But when it shifts to the south, receding from the sun's course, it finds there an abundance of moisture, because it had not been consumed by the sun. But because of the obliquity of the horizon, for us who live in the north the part of its parallel circle which is above the earth is small, whereas the part below is larger; consequently, the sun which, at night, when comets are visible, is under the earth, is so far from the moisture attracted by the star that a man's vision cannot be reflected from the moisture to the sun — whether the sun is near the "tropic," namely, that of Capricorn, or whether it is in the "summer turnings," i.e., in the summer tropic, which is that of Cancer. For no matter where the sun is under the earth, its distance from the contracted vapor is too great for reflection, either from the circle or from the latitude of the zodiac. But when that star is left behind by the sun toward the "boreal" [north wind], i.e., the north, then it can acquire a tail — because there is there much moisture, and the circumference of its circle above the horizon is large there, whereas the part below is small. Consequently it is easy for man's reflected vision to reach the sun.

Lecture 10 (Aristotle's Text)

343a21-343a22

[57] These views involve impossibilities, some of which are common to all of them, while others are peculiar to some only.

343a23-343b7

[58] This is the case, first, with those who say that the comet is one of the planets. For all the planets appear in the circle of the zodiac, whereas many comets have been seen outside that circle. Again more comets than one have often appeared simultaneously. [59] Besides, if their tail is due to reflection, as Aeschylus and Hippocrates say, this planet ought sometimes to be visible without a tail since, as they say, it does not possess a tail in every place in which it appears. But, as a matter of fact, no planet has been observed besides the five. And all of them are often visible above the horizon together at the same time. Further, comets are often found to appear, as well when all the planets are visible as when some are not, but are obscured by the neighbourhood of the sun. [60] Moreover the statement that a comet only appears in the north, with the sun at the summer solstice, †1 is not true either. The great comet which appeared at the time of the earthquake in Achaea †2 and the tidal wave rose due west; and many have been known to appear in the south. [61] Again in the archonship of Euclees, son of Molon, at Athens †3 there appeared a comet in the north in the month Gamelion, †4 the sun being about the winter solstice. Yet they themselves admit that reflection over so great a space is an impossibility.

343b8-344a1

[62] An objection that tells equally against those who hold this theory and those who say that comets are a coalescence of the planets is, first, the fact that some of the fixed stars too get a tail. For this we must not only accept the authority of the Egyptians who assert it, but we have ourselves observed the fact. For a star in the thigh of the Dog had a tail, though a faint one. If you fixed your sight on it its light was dim, but if you just glanced at it, †1 it appeared brighter. [63] Besides, all the comets that have been seen in our day have vanished without setting, gradually fading away above the horizon; and they have not left behind them either one or more stars. For instance the great comet we mentioned before †2 appeared to the west in winter in frosty weather when the sky was clear, in the archonship of Asteius. On the first day it set before the sun and was then not seen. On the next day it was seen, being ever so little behind the sun and immediately setting. But its light extended over a third part of the sky like a leap, so that people called it a 'path'. This comet receded as far as Orion's belt and there dissolved. Democritus however, insists upon the truth of his view and affirms that certain stars have been seen when comets dissolve. But on his theory this ought not to occur occasionally but always. [64] Besides, the Egyptians affirm that conjunctions of the planets with one another, and with the fixed stars, take place, and we have ourselves observed Jupiter coinciding †3 with one of the stars in the Twins and hiding it, and yet no comet was formed. [65] Further, we can also give a rational proof of our point. It is true that some stars seem to be bigger than others, yet each one by itself looks indivisible. Consequently, just as, if they really had been indivisible, their conjunction could not have created any greater magnitude, so now that they are not in fact indivisible but look as if they were, their conjunction will not make them look any bigger.

344a2-344a4

[66] Enough has been said, without further argument, to show that the causes brought forward to explain comets are false.

Lecture 10 (Aquinas' Commentary)

p 24
Lecture 10

Refutation of these opinions.

p 24
59. Having presented the opinions, he now disproves them.

First, he declares how they are to be disproved [†57] and says that he intends to present certain facts against all the opinions as a group, and certain facts against one or other of them in particular.

Secondly, he disputes against the opinions presented.

p 24
First, against the second one, which was that of the Pythagoreans;

Secondly, against the third, which was Hippocrates', at 61;

Thirdly, against the first, which was that of Democritus and Anaxagoras, 64.

p 24
60. As to the first [†58] he gives two arguments: the first of which is that all the wandering stars are "left behind," i.e., move as though being left behind, as already explained, in the circle of animals called the "Zodiac"; on the other hand, many comets are found outside this circle. Therefore, not all comets are wandering stars.

p 24
The second argument is this: more comets than one have often been seen together; hence a comet is not one of the wandering stars. The first of these arguments is against these opinions together; the second is specifically against the second and third opinions.

p 24
61. Then [†59] he disproves the opinion of Hippocrates with three arguments. As to the first of these he says that if a planet has a tail because of the reflection of the sight, as Hippocrates said, then it would have occasionally to appear without a tail. This is because it does not everywhere have a tail, as was said, but only when it is outside the tropics, receding to the north — for it is plain that it "falls behind" in other places as though receding from the sun; consequently it must sometimes appear without a tail. But no star is seen wandering without a tail other than the above-mentioned five. But occasionally all five are visible above the horizon at the same time; and when all are above the horizon, or some appear above and some are with the sun, comets nevertheless appear. Hence it is plain that a comet is not always one of the five wandering stars. And there is no other without a tail than these [five]. Therefore a comet is not a wandering

wandering stars. And there is no other without a tail than these [five]. Therefore a comet is not a wandering star, which on occasion appears with a tail — which would have to be the case, if it did not possess a tail of itself but from being in some determined place, as they claim.

p 24

62. He gives the second argument [†60] and says that it is not true to say that a comet occurs only in the region toward the north with the additional observation of the sun at the summer tropics [i.e., summer solstice], as though nearer to the comet. For the great comet which appeared at the time of the great earthquake and tidal wave in Achaia arose from the western equator; so it is plain that it occurred within the "tropics." Moreover, many have appeared in the south. It is therefore false to say that they occur only toward the north.

p 24

63. He gives a third argument [†61] and says that in the time of a certain Athenian ruler, a comet star was formed when the sun was near the winter tropics [solstice], i.e., near Capricorn and this was in the month of "Gamelion," i.e., December or January. Now as they themselves admit, it seems impossible for such a long reflection from our vision to the sun to occur, considering the distance to the sun then prevailing at night and considering the size of the section of the circle below the horizon. Therefore, their claim that a comet does not appear unless the sun is near the summer tropic [solstice] is false.

p 25

64. Then [†62] he disproves the first opinion with four arguments. The first of these is against all the aforesaid opinions that claim the comets are wandering stars — for even certain stars that are not wandering receive a tail. And this is to be believed not only on the authority of certain Egyptians devoted to mathematics, but Aristotle himself says that he saw one of the stars in the constellation of the Dog, in the thigh, to be exact, with a tail, although it was faint: this was evidenced by the fact that when you gazed at it intently, the light of the tail grew dim, but when one glanced at the star not too intensely but more moderately, more of the tail's light appeared.

p 25

65. In the second argument [†63] he says that all the comets that were seen in his time disappeared in a region above the horizon "without setting," i.e., without approaching the sun. For stars are said to "set" when they enter into the sun's rays; but the comets of his time disappeared without approaching the sun, still being above the horizon far from the sun. And they disappeared as if gradually wasting away without leaving behind the body of one star or of several. For the great star previously described, which was at the time of the earthquake in Achaia, in the Athenian archonship of Astius, appeared in winter during the evening when it was frosty and clear: on the first day, not the star, but only its tail, appeared, as though setting before the sun; but on the second day it was as visible as conditions permitted, because for a short time it remained behind the sun and then immediately set; but the light of that comet spread over a third part of the heaven which burst into light not gradually but all at once, so that the upward ascent of the light was called the comet's path; it did indeed ascend, receding from the sun toward the stars called "Orion's belt," where it was dissolved, not by approaching the sun, but by receding farther and farther from it.

p 25

This is also an argument against all the foregoing opinions that say a comet is one or more of the wandering stars. Consequently, it is plain from this argument that what Democritus said in support of his opinion was insufficient. For he said that when comets dissolved, there sometimes appeared certain remaining stars. This is an insufficient explanation because it devolved on him to prove that stars always, and not just occasionally, remained when comets were dissolved — which has been seen to be false from what has been said.

p 25

66. He gives a third argument [†64] which is this: Egyptians claim that the conjunctions of the planets with one another and with certain fixed stars take place. And he says that he himself saw Jupiter conjoin with a star in Gemini and make it invisible. Yet no comet was formed, as should have according to the opinion of Democritus and Anaxagoras.

p 25

67. The fourth argument [†65] is this: Although some stars seem to be larger and some smaller when compared to one another, yet each considered by itself appears to be as though a point and indivisible. But if they were in very truth indivisible, they could not produce a larger magnitude by merely touching one another, as was proved in *Physics* VI. Therefore, when they seem to be indivisibles, although they are not, they should not, when in conjunction, seem larger as far as their apparent size is concerned. Consequently, from the conjunction of stars a tail should not be visible as though produced by an increase of light. (These last two arguments are properly against Democritus' opinion). Finally, he summarizes what has been said — as is had in text [†66].

Lecture 11 (Aristotle's Text)

344a5-344a32

7. [67] We consider a satisfactory explanation of phenomena inaccessible to observation to have been given when our account of them is free from impossibilities. The observations before us †4 suggest the following account of the phenomena we are now considering. [68] We know that the dry and warm exhalation is the outermost part of the terrestrial world which falls below the circular motion. It, and a great part of the air that is continuous with it below, is carried round the earth by the motion of the circular revolution. In the course of this motion it often ignites wherever it may happen to be of the right consistency, and this we maintain to be the cause of the 'shooting' of scattered 'stars'. [69] We may say, then, that a comet is formed when the upper motion †1 introduces into a gathering of this kind a fiery principle not of such excessive strength as to burn up much of the material quickly, nor so weak as soon to be extinguished, but stronger and capable of burning up much material, and when exhalation of the right consistency rises from below and meets it. The kind of comet varies according to the shape which the exhalation happens to take. If it is diffused equally on every side the star is said to be fringed, if it stretches out in one direction it is called bearded. [70] We have seen that when a fiery principle of this kind moves we seem to have a shooting-star; similarly when it stands still we seem to have a star standing still. We may compare these phenomena to a heap or mass of chaff into which a torch is thrust, or a spark thrown. That is what a shooting-star is like. The fuel is so inflammable that the fire runs through it quickly in a line. Now if this fire were to persist instead of running through the fuel and perishing away, its course through the fuel would stop at the point where the latter was densest, and then the whole might begin to move. Such is a comet—like a shooting-star that contains its beginning and end in itself.

344a33-344b8

When the matter begins to gather in the lower region independently the comet appears by itself. [71] But when the exhalation is constituted †2 by one of the fixed stars or the planets, owing to their motion, one of

them becomes a comet. The fringe is not close to the stars themselves. Just as haloes appear to follow the sun and the moon as they move, †1 and encircle them, when the air is dense enough for them to form along under the sun's course, so too the fringe. It stands in the relation of a halo to the stars, except that the colour of the halo is due to reflection, whereas in the case of comets the colour is something that appears actually on them.

344b9-344b16

[72] Now when this matter gathers in relation to a star the comet necessarily appears to follow the same course as the star. But when the comet is formed independently it falls behind the motion of the universe, like the rest of the terrestrial world. It is this fact, that a comet often forms independently, †2 indeed oftener than round one of the regular stars, that makes it impossible to maintain that a comet is a sort of reflection, not indeed, as Hippocrates and his school say, †3 to the sun, but to the very star it is alleged to accompany —in fact, a kind of halo in the pure fuel of fire. †4

344b17-344b19

As for the halo we shall explain its cause later. †5

344b20-345a4

[73] The fact that comets when frequent †6 foreshadow wind and drought must be taken as an indication of their fiery constitution. For their origin is plainly due to the plentiful supply of that secretion. Hence the air is necessarily drier and the moist evaporation is so dissolved and dissipated by the quantity of the hot exhalation as not readily to condense into water.—But this phenomenon too shall be explained more clearly later when the time comes to speak of the winds.—So when there are many comets and they are dense, it is as we say, and the years are clearly dry and windy. When they are fewer and fainter this effect does not appear in the same degree, though as a rule the wind is found to be excessive either in duration or strength. For instance when the stone at Aegospotami fell out of the air—it had been carried up by a wind and fell down in the daytime—then too a comet happened to have appeared in the west. And at the time of the great comet †1 the winter was dry and north winds prevailed, and the wave was due to an opposition of winds. For in the gulf a north wind blew and outside it a violent south wind. Again in the archonship of Nicomachus †2 a comet appeared for a few days about the equinoctial circle (this one had not risen in the west), and simultaneously with it there happened the storm at Corinth.

345a5-345a10

[74] That there are few comets and that they appear rarely and outside the tropic circles †3 more than within them is due to the motion of the sun and the stars. †4 For this motion does not only cause the hot principle to be secreted but also dissolves it when it is gathering. But the chief reason is that most of this stuff collects in the region of the milky way.

Lecture 11 (Aquinas' Commentary)

Lecture 11

The cause, time and place of the appearance of comets according to Aristotle.

p 26

68. After refuting the opinions of others, the Philosopher here begins to give his own opinion on comets.

First, he explains the type of certitude to be sought in this matter [†67] and says that with respect to such things, not accessible to sense observation, one must not look for a certain and necessary demonstration, as found in mathematics and in phenomena accessible to sense. It is enough to demonstrate with an argument and present a cause, in such a way as to solve the problem with some possible solution from which nothing impossible follows, according to what here appears to sense. Accordingly, this is the method to be employed in the present case to obtain a cause.

p 26

69. Secondly, according to the aforesaid method he begins to assign a cause of the appearance of comets. About this he does two things:

First, he assigns the cause of the appearance of comets, at 70; Secondly, of the place and time of their appearance, at 76.

p 26

The first is divided into two parts:

In the first he gives the cause of the appearance of a comet, at 70;

Secondly, he manifests this through a sign, at 75.

p 26

Regarding the first he does two things:

First, he shows that there are two causes of comets appearing, at 70;

Secondly, he shows the differences between comets that arise from diverse causes, at 74.

p 26

70. About the first he does three things: First [†68], in order to manifest his proposition he re-introduces certain things already stated. And he says that we must maintain what has been said above to the effect that in the region of the lower world surrounding the earth, the first and highest part, below the bodies in circular motion, is the exhalation of the hot and dry. We must also suppose, as stated above, that this hot-dry exhalation, as well as a large portion of the air continuous with the fire, are revolved together around the earth, under the heavenly sphere, with a circular motion, as though carried and drawn along by the turning of the heaven. Thirdly, we must assume that the above-mentioned exhalation, thus moved, is frequently ignited in whatever way it happens to be disposed to allow fire to prevail well in it: this being, as was said, the cause of the shooting of certain stars.

p 26

71. Secondly [†69], he assigns a cause for the appearance of a comet and says that when such an exhalation condenses and when, as a result of the higher body's motion, a source of combustion falls into this exhalation and causes a flame to burst out in a certain area in such a way that the fire is neither large enough to consume all the material quickly, nor so weak as to quickly die out before a conflagration

enough to consume all the material quickly, nor so weak as to quickly die out before a conflagration occurs, but such as to last more and for a long time, in keeping with the size of the fire and the disposition of the condensed matter; and when along with this there continually rises from below an exhalation well disposed for this type of burning, i.e., sufficient to keep it burning for a long time, then it is that comets are formed. For the material already on fire appears to be a star, while the rest of the exhalation, which is not yet completely ignited but on the way to being ignited appears as a tail. The shape of the exhalation determines the shape that will appear: if the exhalation completely surrounds the "star," i.e., the origin or ignited part, there appears, as it were, a circle of tresses [coma], hence it is called "cometed"; but if it is disposed along the length of the ignited origin, then the exhalation appears as though the beard of the star, and is therefore said to be "pogoniated," i.e., bearded.

p 27

72. Thirdly [†70], he explains what was said about a comet by comparison with a falling star. For it was said above that the motion of fire ignited in such material, when it is moved by ejection, seems to be the motion of a star; similarly, the tarrying or state of rest of the fiery principle in this matter seems to be the tarrying or state of rest of a star. He says that a comet star is at rest so as to exclude the motion which appears in falling stars, but not so as to exclude the comet's motion as it is revolved along with the heaven. He will speak of this later. The reason why the above-mentioned principle tarries is that the material is not consumed at once, owing to the amount and thickness of the material and to the weakness of the fire, as well as to the other material that replaces it, as has been said.

p 27

It is as though someone threw a torch or other burning source into a large pile of chaff: the fire does not at once travel as though consuming the chaff, but the igniting seems to remain in one area for a long time. From this example properly understood one can see that the shooting of falling stars has a certain likeness to the appearance of a comet. For in shooting stars the fire travels quickly along the length on account of the disposition, namely, in the fuel, that permits it to be easily burned; but if the flame were to tarry and not pass along by consuming the matter, or if the material were very dense, so as not to be swiftly consumed, then, as though the intermediate trajectory had been taken away, there would only be the star standing, as is the case in the beginning and end of the trajectory.

p 27

Such is the comet. Thus we can imagine a comet as though it were a shooting star, as such a star is at the beginning and end of its course but with no shooting motion. He therefore concludes that when the source of its consistency was "in a lower place," i.e., under the lunar globe, a comet is said to appear by itself, without being accompanied by any star, either wandering or fixed.

p 27

73. Then [†71] he describes another way in which comets appear. And he says that when an exhalation is collected under some star, wandering or not wandering, on account of the motion of that star, then some such star becomes a comet — not that the star which appears is a fiery object in the air, as in the case cited above, but it is a true star, wandering or not wandering. Its "coma," however, does not come into existence in the heavenly region where the stars are, but under the heaven in the air.

p 27

And he gives the example of the "halo," i.e., of the air which sometimes is seen to surround the sun and moon, even though the sun and moon are in motion. Such a halo does not exist in the place where the sun and moon exist, though it accompany the sun and moon, even when the latter are moved. This passion comes into existence in the air condensed under the course of the sun and moon, as will be explained later. Therefore, just as a halo is to the sun and moon, so a "coma" is to the fixed stars and wanderers, whenever they appear with a "coma," which is a certain exhalation farther down, namely, in the upper region of the

they appear with a "coma," which is a certain exhalation farther down, namely, in the upper region of the air, deriving from the motion of those stars. Yet there is this difference between a halo and a "coma": the color of a halo is not in the vapor itself but is something that results from reflection toward a cloud, as will be explained later; but the color associated with a "coma" is properly a color belonging to the fumid exhalations themselves.

p 28

74. Then at [†72] he points out the difference between comets as appearing in these two ways. And he says that when the accumulation of an exhalation takes place in relation to a fixed or wandering star, it is necessary that there clearly appear in the comet the motion which belongs to the star to which the "coma" belongs; but when the comet star is fire existing *per se* in the air without any of the upper stars, then they seem to lag.

p 28

He explains this by the fact that the course of the lower world about the earth is such, namely, slower than the heavenly movement — for although fire and a large portion of the air are revolved by the motion of the firmament, they nevertheless cannot attain to the speed of the heavenly motion. Therefore the burning exhalation existing in the upper region of air is revolved along with the air and the fire. Because their motion is slower than that of the firmament, therefore the comet existing in the air remains behind the heavenly bodies, which are moving most rapidly. Consequently, from its slowness alone, it seems to have a movement contrary to the firmament, just as the planets do. Some indeed thought this of the planets — hence the aforesaid opinions posited that comets are planets.

p 28

But the very fact that a comet is often produced by itself, and this more frequently than in association with any of the "determinate," i.e., fixed, stars which have a fixed and determinate existence in the heaven, shows most plainly that a comet is not a reflexion produced in the exhalation (which he calls "hypeccauma" [fuel]) to the star to which the "coma" is attached, as is the case with a halo. But if it were as it is with a halo, the reflection of our vision would pass from the exhalation to the star, and not to the sun, as the followers of Hippocrates claim. But an account of the halo will be given later.

p 28

75. Then [†73] he manifests what he had said, through a sign. And he says that an argument to show that the stuff of comets is fiery, or so far as the fringe [coma] appears, is that a number of comets is a herald of winds and droughts. For it is plain that winds and droughts are the result of much dry exhalation being drawn from the earth; as a result, the air is quite dry and the moisture which evaporates from the seas is rarefied and dissolved by the abundance of hot exhalation; consequently, vapors are not easily condensed into water; rather, winds caused from the dry exhalations are generated. This will become clearer when winds are discussed. Thus, therefore, when frequent and numerous comets appear, which occurs as a result of the abundance of dry exhalation, the years are necessarily unusually dry and windy. But when the comets are less frequent, and not so large, the years are not notably dry and windy; yet frequently there is an excess of wind, either in duration because they last long, or in strength, because they blow furiously.

p 28

He gives examples. For sometimes a stone dropped into certain rivers from the air during the day, having been lifted by the wind; and then, that evening, a comet was formed. And the same is true of that large comet he referred to earlier: it was a dry winter with prevailing north winds, and because of contrary winds a tidal wave resulted and some cities are said to have been destroyed — for out on the sea a strong south wind was blowing, but in the bay a north wind prevailed. Likewise, under the rule of Nicomachus, a certain comet appeared and then a strong wind blew up in Corinth.

p 28

76. Then [†74] he assigns the cause for the place and time of a comet's appearance. And he says that the reason why comets are few and infrequent and occur more often outside the "tropics," i.e., outside the sun's path, than within, is that the motion of the sun and stars not only releases the hot exhalations resolved from the earth, but also breaks up any consistency and thickness that might be in them. In this way the cause of a comet's appearing is hindered except in cases when there is a superabundant accumulation of such exhalations, which happens rarely. The main reason why comets appear rarely is that most of the matter which causes the appearance of comets is accumulated in the region of the milky circle, as will be said later: hence it is rarely that enough exhalation accumulates to account for the appearance both of a comet and of the "milky circle."

Lecture 12 (Aristotle's Text)

345a11-345a13

8. [75] Let us now explain the origin, cause, and nature of the milky way. And here too let us begin by discussing the statements of others on the subject.

345a14-345a18

[76] (1) Of the so-called Pythagoreans †5 some say that this is the path of one of the stars that fell from heaven at the time of Phaethon's downfall. Others say that the sun used once to move in this circle and that this region was scorched or met with some other affection of this kind, because of the sun and its motion.

345a19-345a24

[77] But it is absurd not to see that if this were the reason the circle of the Zodiac ought to be affected in the same way, and indeed more so than that of the milky way, since not the sun only but all the planets move in it. We can see the whole of this circle (half of it being visible at any time of the night), but it shows no signs of any such affection †6 except where a part of it touches the circle of the milky way.

345a25-345a30

[78] (2) Anaxagoras, Democritus, and their schools say that the milky way is the light of certain stars. For, they say, when the sun passes below the earth some of the stars are hidden from it. Now the light of those on which the sun shines is invisible, being obscured by the rays of the sun. But the milky way is the peculiar light of those stars which are shaded by the earth from the sun's rays.

345a31-345b9

[79] This, too, is obviously impossible. The milky way is always unchanged and among the same constellations (for it is clearly a greatest circle), †1 whereas, since the sun does not remain in the same place, what is hidden from it differs at different times. Consequently with the change of the sun's position the milky way ought to change its position too: but we find that this does not happen. [80] Besides, if astronomical demonstrations are correct and the size of the sun is greater than that of the earth and the distance of the stars from the earth many times greater than that of the sun (just as the sun is further from the earth than the moon), then the cone made by the rays of the sun would terminate at no great distance

from the earth, and the shadow of the earth (what we call night) would not reach the stars. On the contrary, the sun shines on all the stars and the earth screens none of them.

345b10-345b11

[81] (3) There is a third theory about the milky way. Some say that it is a reflection of our sight to the sun, just as they say that the comet is. †2

345b12-345b25

[82] But this too is impossible. For if the eye and the mirror and the whole of the object were severally at rest, then the same part of the image would appear at the same point in the mirror. But if the mirror and the object move, keeping the same distance from the eye which is at rest, but at different rates of speed and so †3 not always at the same interval from one another, then it is impossible for the same image always to appear in the same part of the mirror. Now the constellations included in the circle of the milky way move; and so does the sun, the object to which our sight is reflected; but we stand still. And the distance of those two from us is constant and uniform, but their distance from one another varies. For the Dolphin sometimes rises at midnight, sometimes in the morning. But in each case the same parts of the milky way are found near it. But if it were a reflection and not a genuine affection of these regions, this ought not to be the case.

345b26-345b27

[83] Again, we can see the milky way reflected at night in water and similar mirrors. But under these circumstances it is impossible for our sight to be reflected to the sun.

345b28-345b30

[84] These considerations show that the milky way is not the path of one of the planets, nor the light of imperceptible stars, nor a reflection. And those are the chief theories handed down by others hitherto.

Lecture 12 (Aquinas' Commentary)

p 29

Lecture 12

Opinions of others on the Milky Way

p 29

77. After determining concerning falling stars and comets, the Philosopher here determines concerning the milky circle.

p 29

First, he states his intention [†75] and says that we must talk now of the milky circle: the how and why of

its appearance and what that milky brightness is. But we shall adhere to that order whereby we first discuss what others have said;

Secondly, he executes his proposition, at 78.

p 29

First he presents the opinions of others, at 78;

Secondly, his own opinion (L. 13).

p 29

The first is divided into three parts according to the three opinions he cited;

The second opinion begins at 80;

The third at 83.

p 29

78. Regarding the first he does two things. First, he presents the opinion at [†76] and says that some of the philosophers called "Pythagoreans" held that the milky circle is a certain path. But their opinions differed: for some asserted that it was the path of a certain star that passed through this part of the heaven after abandoning its own course when the heavens once went off the path — an event which the fables declare happened under Phaethon. Others say that the sun once travelled that path. Consequently, by the motion of the sun or of a star that area of the heaven was, so to speak, scorched, or affected in such a way that a patch of whiteness now appears there.

p 29

79. Secondly [†77], he rejects this opinion and says that it is an inconsistency for those who posited this opinion that they did not at the same time see that, if the journey of the sun or a star were the cause of this brightness in this region of the heaven, such a disposition has much more reason for appearing in the circle of the Zodiac than in the milky circle — for not only the sun, but all the wandering stars move through the Zodiac. Now the whole zodiacal circle is visible to us, at different times, because at night half of it always appears above the earth (for the earth has the status of a point compared to the sphere of the fixed stars: hence earth's largeness does not conceal anything in the Zodiac from us); but although the entire Zodiac is visible to us, no such disposition appears in it, save in the region where it is joined with the milky circle.

p 29

80. Then [†78] he presents the second opinion. First, he recites it and says that the followers of Anaxagoras and Democritus declared that the milky brightness which appears in the heaven is the light of certain stars. For when the sun is borne below the earth, they said, the earth's shadow reaches as far as the sphere of the fixed stars and covers some of them so that they do not receive the sun's rays; yet it does not cover all of them, because, due to the smallness of the earth, its shadow does not cover the entire heaven but only a small area. For they said that the brightness of the stars faced by the sun does not appear, because it is prevented from appearing by the sun's rays reaching them; consequently, no milky brightness surrounds them. But of the stars which the sun's rays do not reach, because the earth prevents this, their own light appears, which they identify as the milky brightness.

p 30

81. Secondly [†79], he rejects this opinion for two reasons. In presenting the first of them he says that what it claims is impossible. For the milky brightness always appears in the same stars — the milky circle

being seen to be one of the largest circles, which divide the sphere in half. But because the sun does not always remain in the same place in the heaven, other and other stars must always be being obscured from the sun's rays by the earth's shadow — since the shadow's motion must be imagined as opposite to the sun's course. Therefore, if the cause of the milky brightness' visibility were the earth's shadow blotting out the stars, then as the sun moved, the milky brightness would also have to shift. But this is not seen to happen, because it always appears in the same place and in the same stars, as was said. Consequently, the aforesaid theory is false.

p 30

82. He gives the second reason [†80] and says that astronomical arguments and considerations prove that the sun is larger than earth and that the fixed stars are much farther from the earth than the sun is, just as the sun is farther from us than the moon is. Now when a shining body is larger than the opaque body whose interposition produces a shadow, the shadow does not increase indefinitely, rather it ascends in pyramid form to a cone of a certain quantity which is proportionately less as the shining body is less distant from the opaque one, and the more the former's size exceeds the latter's. Hence it is plain that the cone of the earth's shadow is not projected very far with respect to the rays coming from the sun; neither does the earth's shadow, which we call "night," reach as far as the fixed stars. What has to happen is that the sun has a view of all the fixed stars and that the earth blankets none of them. The reason why it blankets the moon and eclipses it is that the moon is lower than the sun, as has been said. Consequently, it is plain that the theory under discussion presupposed something false.

p 30

83. He presents the third opinion [†81], and first he recites it, saying that there is a certain third theory about the milky circle. For some said that the milky brightness is due to our vision's being reflected from certain stars to the sun; as a result a brightness appeared around those stars striking our vision, so that they act as a certain mirror for the sun's brilliance, as Hippocrates also said when explaining the appearance of comets.

p 30

84. Secondly [†82], he rejects this theory for two reasons. He sets down the first of these and says that the above opinion posits something impossible. And he lays down this proposition: If "everything," i.e., the entire system, namely, the beholder, the mirror, and the object seen by means of the mirror, all remain at rest, then of necessity the same part of the "emphaseos," i.e., of the form appearing, will appear "on the same sign of the mirror," i.e., at the same point at which the reflection of the visual line took place. But if the mirror should move, and likewise the object seen by means of the mirror, while the beholder remains at rest, and if the two things in motion always remain at the same distance from the beholder, but with respect to one another are neither moving with equal speeds nor always at the same distance, then under these conditions it is impossible for the same appearance to occur in the same part of the mirror. For in practice it makes no difference whether the mirror and the thing seen are moving with unequal speeds, or one is in motion and the other at rest; and if this latter were the case, it is plain that the figure of the thing seen would appear now in one spot and now in another spot of the mirror, on account of the varying opposition according to position. And I say this, if the beholder is at rest: for if the beholder were to move, and the mirror remain at rest, while the object moved, then the figure of the thing seen could appear in the same spot on the mirror — since the beholder's motion could compensate for what was lacking due to the motion of the object seen, if they were thus proportionately moved. Hence, when the beholder remains at rest but the mirror and the thing seen are moved at unequal speeds, it is necessary that the figure not appear at the same spot on the mirror.

p 31

But the stars in the milky circle that are assumed to be a mirror, are in motion; moreover, there is motion of the sun, to which a reflection of our vision is assumed to take place (the sun therefore plays the role of the

the sun, to which a reflection of our vision is assumed to take place (the sun therefore plays the role of the thing seen); but we, the beholders, are at rest, because the earth is at rest (for the motion involved by our moving about on the earth makes no perceptible difference with respect to so great a size. Furthermore, the stars in question and the sun are equally moved in relation to us and their distance from us always remains the same. This does not mean that our distance from the sun is equal to our distance from the stars (for it has been previously said that the stars are higher than the sun), but that the sun, by its motion, does not increase or decrease its distance from us. And the same is true of a star. And by a "greater or less distance" is to be understood a distance that is significant with respect to the distance between the sun and the stars: we say this because of the smallness of the earth. But in relation to one another, the sun and the stars are not always equidistant: because "Delphis," i.e., the constellation of the Dolphin, which is in the milky circle, rises sometimes in the middle of the night and sometimes at dawn; and it is plain that this constellation is farther from the sun when it appears at night than when it appears at dawn. But the parts of the milky circle remain forever in the same place — which should not be the case if it were an appearance caused by a reflexion; for this brightness would not exist in the same place, as has been shown. Hence it is plain that the aforesaid theory is false.

p 31

85. He gives the second reason [†83] and says that at night the form of the milky circle appears in water and other such mirror-like bodies. But it is inadmissible to say that in these cases vision is reflected by the water to the sun — in other words, considering the distances involved, it seems most unacceptable that there should be two reflections: one, namely, from the water to the milky circle, and another from the milky circle to the sun.

p 31

Finally, in summary he concludes that the milky circle is neither the path of any of the planets, as the first opinion held; nor the light of certain stars not regarded by the sun, as the second opinion said; nor the reverberation of our vision from the stars to the sun, as the third opinion maintained. And before his time these were the prevailing opinions about the "galaxy" [Milky Way].

Lecture 13 (Aristotle's Text)

345b31-346b9

[85] Let us recall our fundamental principle and then explain our views. We have already laid down †1 that the outermost part of what is called the air is potentially fire and that therefore when the air is dissolved by motion, there is separated off a kind of matter—and of this matter we assert that comets consist. [86] We must suppose that what happens is the same as in the case of the comets when the matter does not form independently but is formed by one of the fixed stars or the planets. Then these stars appear to be fringed, because matter of this kind follows their course. In the same way, a certain kind of matter follows the sun, and we explain the halo as a reflection from it when the air is of the right constitution. [87] Now we must assume that what happens in the case of the stars severally happens in the case of the whole of the heavens and all the upper motion. For it is natural to suppose that, if the motion of a single star excites a flame, that of all the stars should have a similar result, †2 and especially in that region in which the stars are biggest and most numerous and nearest to one another. [88] Now the circle of the zodiac dissolves this kind of matter because of the motion of the sun and the planets, and for this reason most comets are found outside the tropic circles. †1 Again, no fringe appears round the sun or moon: for they dissolve such matter too quickly to admit of its formation. But this circle in which the milky way appears to our sight is the greatest circle, †2 and its position is such that it extends far outside the tropic circles. Besides the region is full of the biggest and brightest constellations and also of what are called 'scattered' stars (you have only to look to see this clearly). So for these reasons all this matter is continually and ceaselessly collecting there. [89] A proof of the theory is this: In the circle itself the light is stronger in that half where the milky way is divided, and in it the constellations are more numerous and closer to one another than in the other half; which shows that the cause of the light is the motion of the constellations and nothing else. For if it is found in the circle in which there are most constellations and at that point in the circle at which they are densest and contain the biggest and the most stars, it is natural to suppose that they are the true cause of the affection in question. The circle and the constellations in it may be seen in the diagram. †3 The so-called 'scattered' stars it is not possible to set down in the same way on the sphere because none of them have an evident permanent position; but if you look up to the sky the point is clear. For in this circle alone are the intervals full of these stars: in the other circles there are obvious gaps. [90] Hence if we accept the cause assigned for the appearance of comets as plausible we must assume that the same kind of thing holds good of the milky way. For the fringe which in the former case is an affection of a single star here forms in the same way in relation to a whole circle. So if we are to define the milky way we may call it 'a fringe attaching to the greatest circle, and due to the matter secreted'. This, as we said before, †1 explains why there are few comets and why they appear rarely; it is because at each revolution of the heavens this matter has always been and is always being separated off and gathered into this region.

346b10-346b15

[91] We have now explained the phenomena that occur in that part of the terrestrial world which is continuous with the motions of the heavens, namely, shooting-stars and the burning flame, comets and the milky way, these being the chief affections that appear in that region.

Lecture 13 (Aquinas' Commentary)

p 32

Lecture 13

The Milky Way, according to Aristotle

p 32

86. Having rejected the opinion of others about the milky circle, he now presents his own opinion. About this he does two things:

First, he recalls previous statements useful for explaining the proposition;

Secondly, he manifests the proposition, at 88.

p 32

He recalls two things: first, what was previously said about the location of the dry exhalation and of its kindling [†85]. Hence he says that he wants to recall what he previously laid down as a principle. For it has been previously said that everything between earth and the globe of the moon has the common name of "air," while the highest part thereof, although it cannot strictly be called "fire" (because fire denotes a superabundance of heat, just as does ice with respect to cold), yet that upper part of the air does have the virtue of fire, because it is hot and dry — with the result that, when the air is separated by the heavenly motion, a certain consistency of the exhalation already mentioned is collected from the earth and lower air and lifted upward; and we say that it is from this that comet stars appear.

p 32

87. Secondly [†86], he recalls what he previously said concerning one of the ways that account for the appearance of a comet. And he says that we should understand in the milky circle something akin to what takes place in comets when the comet is not an exhalation borne aloft and ignited, and existing by itself apart from any star, but is an apparition deriving from one of the fixed or wandering stars, as was said. For in those cases comets appear because such elevated exhalations accompany the course of the stars that appear as comets; just as the sun is accompanied by such a collected exhalation, from which, as a result of reflected rays, a halo appears, when the air is disposed for such.

p 32

88. Then [†87] he manifests the proposition, showing what is the cause of the appearance of the milky circle. About this he does three things;

First, he proposes the cause of the appearance of the milky circle;

Secondly, he introduces a sign to support what he said, at 90;

Thirdly, he concludes the proposition, at 92.

p 32

Regarding the first he does two things. First, he shows the cause of the appearance of the milky circle [†87] and says that what happens with respect to the appearance of one star should be understood as happening with respect to the entire heaven and its entire course — because it is reasonable, if the motion

of one star attracts and carries an exhalation along, that this should be all the more true of the motion of all the stars, and especially in that region of the heaven where there appears a very large collection of stars, greatest both in number and size.

p 32

89. Secondly [†88], he shows the cause why it is in that determinate part of the heaven that the brightness of the milky circle appears. And he says that the circle of the animals, called the "Zodiac," dissolves the accumulated mass of the above-mentioned exhalation, because of the fact that the sun and the other planets are moved through the Zodiac. This also explains why, for the most part, comets do not appear in the Zodiac, but outside the tropics, as was said. Moreover, this also is the cause why no fringe [coma] appears around the sun and moon: namely, because the motions of the sun and moon separate the exhalation (which we have said to cause the appearance of a comet and of the milky circle) faster than it can accumulate to cause these appearances. But that circle in which a milky brightness appears to us observers is both one of the greatest circles (for it divides the sphere in half), and is so located that in both directions it far exceeds both the tropic circles, namely, the winter and the summer one, even though it is intersected by the Zodiac. Moreover, this place of that circle is filled with bright stars so numerous and thick that they are called "sporadic," i.e., sowed in the heaven (this can be observed with the naked eye); as a result, an exhalation is always gathered together in such an area of the heaven, since, namely, there is in this region of the heaven stellar virtue powerful enough to attract the exhalation, and no vehement cause impeding its accumulating, as happens in the zodiacal circle. Accordingly, the exhalation accumulated in that region of the heaven causes a milky brightness to be seen there, just as the exhalation accompanying a star makes a fringe appear.

p 33

90. Then [†89] he shows what he has said with a sign, and says that a sign of the foregoing is that in the milky circle one of its semicircles is doubled and has more light. The reason for this is that in that semicircle there are more stars there and closer together than in the other semicircle, as though there were no other cause of the visible brightness than the movements of a great many clustered stars. For if a brightness appears in that circle in which there are more stars, and if more brightness appears in that section in which the stars are more numerous and closer together, it is reasonable that it is the multitude of stars that causes this appearance.

p 33

What was said of the circle itself, and of the stars existing in it, can be seen from the diagram — since the astronomers have drawn charts of the whole sphere and of the constellations in it.

p 33

91. Then he explains why the stars in the milky circle are called "sporadic," i.e., scattered like seeds: it is because they are scattered through that region of the heaven in such a way that they do not allow being grouped under some figure as do the stars existing in other regions of the heaven, since each of them does not have a fixed position so that they could be reduced into the likeness of some figure. This is plain to anyone looking at the heaven: because it is only in this circle that the areas between the major stars are filled with certain small stars; while in other regions of the heaven stars are manifestly lacking, so that the intervening spaces appear empty of stars.

p 33

92. Then [†90] he concludes his intention from the foregoing. And he says that if the cause assigned above of the comet's appearance is accepted as plausible (because it involves no manifest inconsistencies), the same should be accorded this explanation of the milky circle: because what, in the case of comets, is a fringe about one star, is here a corresponding passion affecting some one circle. Thus, the milky clarity, if

one were, so to speak, to define it, would be, as the milky way, nothing other than a fringe [coma] of the same greatest circle, appearing in the heaven on account of the "separating," i.e., the lifting from the earth, of an exhalation concentrated in that area. And therefore, as was already stated, many comets are not produced and they do not appear frequently, since such a gathering of the exhalation elevated from the earth is drawn up in accord with each revolution and brought together mostly in the region of the milky circle, in such a way that no surplus exhalation is left over from the milky circle which could be material suitable for the appearance of a comet.

p 33

93. Finally he sums up what has been said [†91] and says that we have spoken of the things that take place in the earth-environing world, which is subject, namely, to generation and corruption, as to that region which is "continuous," i.e., contiguous, to the heavenly movements: of the shooting of stars and of the burning flame and of comets and the milky circle, because such passions appear in that upper region.

Lecture 14 (Aristotle's Text)

346b16-346b19

9. [92] Let us go on to treat of the region which follows next in order after this and which immediately surrounds the earth. It is the region common to water and air, and the processes attending the formation of water above †2 take place in it. We must consider the principles and causes of all these phenomena too as before.

346b20-346b32

[93] The efficient and chief and first cause is the circle in which the sun moves. †3 For the sun as it approaches or recedes, obviously causes dissipation and condensation and so gives rise to generation and destruction. [94] Now the earth remains but the moisture surrounding it is made to evaporate by the sun's rays and the other heat from above, and rises. [95] But when the heat which was raising it leaves it, in part dispersing to the higher region, in part quenched through rising so far into the upper air, then the vapour cools because its heat is gone and because the place is cold, and condenses again and turns from air into water. And after the water has formed it falls down again to the earth. †1

346b33-346b35

[96] The exhalation of water is vapour: air condensing into water is cloud. Mist is what is left over when a cloud condenses into water, and is therefore rather a sign of fine weather than of rain; for mist might be called a barren cloud.

346b36-347a8

[97] So we get a circular process that follows the course of the sun. For according as the sun moves to this side or that, †2 the moisture in this process rises or falls. We must think of it as a river flowing up and down in a circle and made up partly of air, partly of water. When the sun is near, the stream of vapour flows upwards; when it recedes, the stream of water flows down: and the order of sequence, at all events, in this process always remains the same. So if 'Oceanus' had some secret meaning in early writers, perhaps they may have meant this river that flows in a circle about the earth. †3

they may have meant this river that flows in a circle about the earth. †3

347a9-347a12

[98] So the moisture is always raised by the heat and descends to the earth again when it gets cold. These processes and, in some cases, their varieties are distinguished by special names. When the water falls in small drops it is called a drizzle; when the drops are larger it is rain.

347a13-347a25

10. [99] Some of the vapour that is formed by day does not rise high because the ratio of the fire that is raising it to the water that is being raised is small. When this cools and descends at night it is called dew and hoar-frost. When the vapour is frozen before it has condensed to water again it is hoar-frost; and this appears in winter and is commoner in cold places. [100] It is dew when the vapour has condensed into water and the heat is not so great as to dry up the moisture that has been raised, nor the cold sufficient (owing to the warmth of the climate or season) for the vapour itself to freeze. For dew is more commonly found when the season or the place is warm, whereas the opposite, as has been said, is the case with hoar-frost. For obviously vapour is warmer than water, having still the fire that raised it: consequently more cold is needed to freeze it.

347a26-347a28

[101] Both dew and hoar-frost are found when the sky is clear and there is no wind. For the vapour could not be raised unless the sky were clear, and if a wind were blowing it could not condense.

347a29-347a35

[102] The fact that hoar-frost is not found on mountains contributes to prove that these phenomena occur because the vapour does not rise high. One reason for this is that it rises from hollow and watery places, so that the heat that is raising it, bearing as it were too heavy a burden cannot lift it to a great height but soon lets it fall again. A second reason is that the motion of the air is more pronounced at a height, and this dissolves a gathering of this kind.

347a36-347b12

[103] Everywhere, except in Pontus, dew is found with south winds and not with north winds. There the opposite is the case and it is found with north winds and not with south. [104] The reason is the same as that which explains why dew is found in warm weather and not in cold. For the south wind brings warm, and the north, wintry weather. For the north wind is cold and so quenches the heat of the evaporation. [105] But in Pontus the south wind does not bring warmth enough to cause evaporation, whereas the coldness of the north wind concentrates the heat by a sort of recoil, so that there is more evaporation and not less. †1 This is a thing which we can often observe in other places too. Wells, for instance, give off more vapour †2 in a north than in a south wind. Only †3 the north winds quench the heat before any considerable quantity of vapour has gathered, while in a south wind the evaporation is allowed to accumulate.

Lecture 14 (Aquinas' Commentary)

p 34

Lecture 14

The causes in general of phenomena generated by the moist exhalation in the lower part of the air. Of rain, dew and frost.

p 34

94. After determining concerning phenomena caused from the hot exhalation lifted to the highest place of the air, the Philosopher here determines about phenomena caused from the moist exhalation.

First, about phenomena caused above the earth from the moist exhalation;

Secondly, about those caused on the earth from the moist exhalation (L. 16).

p 34

95. Regarding the first he does two things: first, he shows what his intention concerns [†92] and says that we must now discuss the things which come to be in the region which, going downwards, is the second after the uppermost region of the air (where the phenomena already discussed take place), but which, going upward, is first, i.e., the region immediately around the earth: this region is the lower region of air. It is the region common both to water and to air; because in it air exists according to the natural order of the elements, and water is generated there from vapors borne aloft. Hence not only is it common to water and air, but also to the phenomena attending the generation of that water and air. These generations take place on high, when water is resolved into vapors (which pertain to the nature of air) and vapors are gathered into water. He also indicates the method for determining these matters and says that we should first take the common principles and causes of all these things that happen.

p 34

96. Secondly [†93] he determines the proposition.

First, he posits what pertains commonly to the cause of all passions of this kind;

Secondly, he determines concerning each of them separately, showing wherein they differ, at 101.

p 34

About the first he does three things: first, he sets down the efficient cause of these passions [†93] and says that all these passions have as their cause, in the sense of the movent, and primary, and first principle, the circle of the Zodiac in which the sun clearly moves, which both separates the vapors, by resolving them from earth, and unites them by its absence: for when coldness increases in the air on account of the sun's absence, clouds are condensed into water. Accordingly he adds that from its being at one time near us, and at another time away from us, the sun is the cause of generation and corruption. It gets near us, when by its own motion it approaches the northern signs; it is moved away from us, when it tarries in the southern signs.

p 34

97. Secondly [†94], he shows the material cause of these passions and says that, since the earth is at rest in the center, the aqueous humor surrounding it is, both through the agency of the sun's rays and through

other heat from the higher bodies, resolved into vapor and, being thus refined by the virtue of the heat, borne aloft.

p 34

98. Thirdly [†95], he shows the way in which the things under discussion are generated. About this he does three things: first, he states in general the way these passions are generated and says that the vapor borne aloft by the power of the heat is abandoned by the heat which bore it aloft. This happens in two ways: in one way by the fact that the finer and warmer elements in the vapor are raised higher still, to the upper region of the dry exhalation —consequently, the portion of vapor left behind remains cold; in another way by the fact that the heat in the vapor is quenched by having been lifted far from the earth, in the air above the earth where heat is feeble on account of the rays reflected from the earth being scattered far apart, as was stated above. Therefore, when the heat which warmed and elevated the moist vapor runs out, this vapor returns to its nature, with the coldness of the region condensing it; thus it becomes cool, and after being cooled, it is thickened, and once thickened, it falls to earth.

p 35

99. Secondly [†96] he shows what intermediates are involved in these transmutations. In the first transmutation, in which water is subtilized and raised up, the intermediate is vapor: for the very exhalation resolved from the water is called "vapor," which is intermediate between air and water. In that transmutation in which air is condensed into water, the medium is a cloud, which is a step toward the generation of water. But when the cloud is condensed into water, that which is left over in the cloud, i.e., whatever could not be condensed into water, is called the fog of mist. That is why mist is more a sign of clear than of rainy weather: for mist is, as it were, a "barren" cloud, i.e., devoid of rain, which is the natural effect of a cloud. However it sometimes happens that mist is carried up along with the vaporous exhalations before they are perfectly condensed into a cloud — and then mist can be a sign of rain.

p 35

100. Thirdly [†97], he shows how the above-mentioned transmutations bear an analogy to the first movent cause, i.e., to the circling of the sun. For a certain circling is discernible in the above-mentioned transmutations, as water is refined into vapors which are condensed into clouds, and the clouds into water, which falls to earth. He says therefore that this circular transmutation imitates the circular movement of the sun — for the sun is changed to diverse parts of the heaven (for example, to the north and to the south); and that cycle is completed in the fact that vapors ascend upwards and descend downwards. But we should understand this flow of ascending and descending vapors as a certain circular stream common to air and water: for the resolving of water into vapor pertains to the air, while the condensing of clouds into water pertains to the water. When, therefore, the sun is near, this river of vapors flows upward; when the sun is away, it flows downward; and this goes on without interruption in the order described. From this he concludes that perhaps the ancients, in speaking of Oceanus as a certain river surrounding the earth, were cryptically speaking of this river, which, as was said, flows circularly around the earth.

p 35

101. Then at [†98] he discusses the foregoing passions in detail, by pointing out their mutual differences. And it is divided into two parts:

In the first he determines about the generation of those phenomena whose cause is quite plain;

In the second about the generation of hail, concerning which there is greater difficulty (L. 15).

p 35

102. About the first he does two things: first, he determines about rain [†98] and says that when watery

moisture is elevated through the power of heat and is again brought down on account of cooling, different names, based on varying characteristics, are given to these passions of air. For when the vapors condensed into water in small parts fall, then they are called "psecades," i.e., drops, as occasionally happens, when small drops fall; but when the drops of a larger size generated from the vapors fall, this is called "rain."

p 36

103. Secondly [†99], he determines about dew and frost. First, he determines the manner in which they are generated. And he says that they arise from the fact that, when the sun is above the earth in daytime, something evaporates from the watery moisture because of the sun's heat, but this evaporation is not suspended or raised very high above the earth, for the simple reason that the "fire," i.e., the heat raising this vapor, is slight in comparison with the watery moisture elevated. Consequently, when the air cools at night, the vapor elevated during the day condenses and falls to earth and is called "dew" or "frost." The approach and departure of the sun in its diurnal course has the same relation to the generation of dew and frost as, in the generation of rain, its proper motion has according as it approaches and departs in summer and winter.

p 36

104. Secondly [†100], he points out their difference and says that frost occurs when the vapor is frozen before it is condensed into water: for this reason it occurs in winter and in "wintry," i.e., frigid, places. But dew occurs when the vapor is thickened into water and there is neither enough heat to dry out the vapor that has been raised, nor enough cold for the vapor to freeze. Hence dew must occur either during warm seasons or in warm places: because dew occurs always in temperate times or temperate places, but frost in times and places that are colder, as has been said. For since vapor is warmer than water (because some of the heat raising it is still in it) more cold is needed to freeze vapor than to freeze water: as a result, frost never occurs except where there is much cold.

p 36

105. Then [†101] he shows the conditions of disposed air under which dew and frost occur.

First, he shows this generally as to both, at 105;

Secondly, specially for dew, at 107.

p 36

About the first he does two things:

First, he shows what he is proposing, at 105;

Secondly, he gives a sign of the aforesaid, at 106.

p 36

He says therefore first [†101], that both dew and frost occur when the air is clear, without clouds and rain, and calm, without wind. Because if it is not clear, vapors cannot be lifted up during the day due to the lack of sufficient heat: if it is not calm, but windy, the vapors could not be condensed to form dew — for the wind, in agitating the air, prevents the vapors from massing together.

p 36

106. Then [†102] he gives a sign to support what he posited earlier about generation of dew and frost. And he says that a sign of the fact that dew and frost are caused by the fact that vapor is not lifted far above the earth is that frost does not appear on mountains, whereas it would seem that, on account of the cold there present, it should appear there even more. There are two reasons for this: First, because the vapor from which dew and frost are generated is raised from low, moist places, from which many vapors are

which dew and frost are generated is raised from low, moist, places, from which many vapors are generated and lifted up: hence the heat which elevates them, bearing, as it were, a burden too much for its power, cannot raise them to a very great height; hence, while still near the lowest places, the heat leaves the vapors, and dew and frost fall. That is why frost cannot form on high mountains. The second cause is that, as previously stated, the upper air above the mountains flows along, as though carried by the course of the heaven; and therefore, by its flowing it dissolves such gatherings of vapor that cause dew and frost. Now, more motion is needed for scattering large amounts of vaporous matter than small amounts: but the matter of rain and snow coalesces in large amounts, whereas the matter of dew and frost is, absolutely speaking, small, although it is large in relation to the small amount of heat elevating it: hence neither rain nor dew nor frost fall on the highest mountains, because of the greater flow of air; but on mountains that are not so lofty, rain and snow, but no dew or frost, fall, because of the lesser flow of air.

p 37

107. Then [†103] he shows under what circumstances dew in particular occurs. About this he does three things: first, he proposes a truth and says that dew forms in all places with south winds that are not strong enough to prevent vapors from gathering. It does not form with the blowing of the north wind except in the region of Pontus, which is very cold: there the opposite takes place, for dew forms there with northerly weather but not with southerly weather.

p 37

108. Secondly [†104], he assigns the cause of what generally happens and says that the cause of this is akin to what has been said: namely, that dew forms in temperate times but not in "winter," i.e., in very cold times. And he shows the point of similarity: the south wind brings mildness, but the north wind winter and cold, for it is a cold wind; and therefore, because of the "winter," i.e., because of the coldness, the warmth is extinguished from exhalations, and, as a result, the vapors cannot be elevated for dew to be formed.

p 37

109. Thirdly [†105], he assigns the cause of what happens in Pontus. The reason is that, because of the great cold there, the south wind is unable to produce sufficient mildness for vapors to be elevated: therefore no dew forms there during the time of the south wind. But the north wind, because of its coldness, collects the warm matter existing in damp places, "making a kind of anti-surrounding," i.e., by surrounding the warm matter with a certain contrariety — for when cold matter surrounds warm matter, if the former cannot completely quench the latter, it concentrates it. Thus, by the concentration of the hot, its effect is strengthened — and, as a result, more vapor is resolved.

p 37

This occurs not only in Pontus but is frequently observed in other places: wells evaporate more with a north wind than with a south wind, because of the heat trapped in them by the surrounding cold. However, in other places the coldness of the north wind quenches the vapor's heat before any can be concentrated in amounts large enough to generate dew; but when there are south winds, they do not impede the accumulation of vapors needed for generating dew. Even in Pontus there are times when, because of the north wind, the heat of the vapors is quenched and, therefore, do not rise; but sometimes, because of the greatness of the cold, much warmth is enclosed within the earth and a large amount of vaporous exhalation forms, in such a way that, for a brief time, it resists the air's coldness, but only long enough for an amount sufficient for the generation of dew to be accumulated.

Lecture 15 (Aristotle's Text)

347b13-347b15

[106] Water, †4 once formed, does not freeze on the surface of the earth, in the way that it does in the region of the clouds.

347b16-347b22

11. From the latter there fall three bodies condensed by cold, namely rain, snow, hail. Two of these correspond to the phenomena on the lower level and are due to the same causes, differing from them only in degree and quantity.

347b23-347b27

Snow and hoar-frost are one and the same thing, and so are rain and dew: only there is a great deal of the former and little of the latter. For rain is due to the cooling of a great amount of vapour, for the region from which and the time during which the vapour is collected are considerable. But of dew there is little: for the vapour collects for it in a single day and from a small area, as its quick formation and scanty quantity show.

347b28-347b33

The relation of hoar-frost and snow is the same: when cloud freezes there is snow, when vapour freezes there is hoar-frost. Hence snow is a sign of a cold season or country. For a great deal of heat is still present and unless the cold were overpowering it the cloud would not freeze. For there still survives in it a great deal of the heat which †1 caused the moisture to rise as vapour from the earth.

347b34-347b35

Hail on the other hand is found in the upper region, but the corresponding phenomenon in the vaporous region near the earth is lacking. For, as we said, to snow in the upper region corresponds hoar-frost in the lower, and to rain in the upper region, dew in the lower. But there is nothing here to correspond to hail in the upper region. Why this is so will be clear when we have explained the nature of hail.

347b36-348a14

12. [107] But we must go on to collect the facts bearing on the origin of it, both those which raise no difficulties and those which seem paradoxical.

348a15-348a36

Hail is ice, and water freezes in winter; yet hailstorms occur chiefly in spring and autumn and less often in the late summer, but rarely in winter and then only when the cold is less intense. And in general hailstorms occur in warmer, and snow in colder places. [108] Again, there is a difficulty about water freezing in the upper region. It cannot have frozen before becoming water: and water cannot remain suspended in the air for any space of time. [109] Nor can we say that the case is like that of particles of moisture which are carried up owing to their small size and rest on the air (the water swimming on the air just as small particles of earth and gold often swim on water). In that case large drops are formed by the union of many small, and so fall down. [110] This cannot take place in the case of hail, since solid bodies cannot coalesce like liquid ones. Clearly then drops of that size were suspended in the air or else they could not have been so large when frozen.

348a37-348b1

[111] Some †1 think that the cause and origin of hail is this. The cloud is thrust up into the upper atmosphere, which is colder because the reflection of the sun's rays from the earth ceases there, †2 and upon its arrival there the water freezes. They think that this explains why hailstorms are commoner in summer and in warm countries; the heat is greater and it thrusts the clouds further up from the earth. [112] But the fact is that hail does not occur at all at a great height: yet it ought to do so, on their theory, just as we see that snow falls most on high mountains. [113] Again clouds have often been observed moving with a great noise close to the earth, terrifying those who heard and saw them as portents of some catastrophe. Sometimes, too, when such clouds have been seen, without any noise, there follows a violent hailstorm, and the stones are of incredible size, and angular in shape. This shows that they have not been falling for long and that they were frozen near to the earth, and not as that theory would have it. [114] Moreover, where the hailstones are large, the cause of their freezing must be present in the highest degree: for hail is ice as every one can see. Now those hailstones are large which are angular in shape. And this shows that they froze close to the earth, for those that fall far are worn away by the length of their fall and become round and smaller in size.

348b2-348b31

It clearly follows that the congelation does not take place because the cloud is thrust up into the cold upper region.

348b32-349a4

[115] Now we see that warm and cold react upon one another by recoil. Hence in warm weather the lower parts of the earth are cold and in a frost they are warm. The same thing, we must suppose, happens in the air, so that in the warmer seasons the cold is concentrated by the surrounding heat and causes the cloud to go over into water suddenly. †1(For this reason rain-drops are much larger on warm days than in winter, and showers more violent. A shower is said to be more violent in proportion as the water comes down in a body, and this happens when the condensation takes place quickly,—though this is just the opposite of what Anaxagoras says. He says that this happens when the cloud has risen into the cold air; whereas we say that it happens when the cloud has descended into the warm air, and that the more the further the cloud has descended). But when the cold has been concentrated within still more by the outer heat, it freezes the water it has formed and there is hail. [116] We get hail when the process of freezing is quicker than the descent of the water. For if the water falls in a certain time and the cold is sufficient to freeze it in less, there is no difficulty about its having frozen in the air, provided that the freezing takes place in a shorter time than its fall. The nearer to the earth, and the more suddenly, this process takes place, the more violent is the rain that results and the larger the raindrops and the hailstones because of the shortness of their fall. For the same reason large raindrops do not fall thickly. [117] Hail is rarer in summer than in spring and autumn, though commoner than in winter, because the air is drier in summer, whereas in spring it is still moist, and in autumn it is beginning to grow moist. It is for the same reason that hailstorms sometimes occur in the late summer as we have said. †2

349a5-349a9

[118] The fact that the water has previously been warmed contributes to its freezing quickly: for so it cools sooner. Hence many people, when they want to cool hot water †1 quickly, begin by putting it in the sun. So the inhabitants of Pontus when they encamp on the ice to fish (they cut a hole in the ice and then fish) pour warm water round their reeds that it may freeze the quicker, for they use the ice like lead to fix the reeds. Now it is in hot countries and seasons that the water which forms soon grows warm.

349a10-349a11

It is for the same reason that rain falls in summer and not in winter in Arabia and Ethiopia too, and that in torrents and repeatedly on the same day. For the concentration or recoil due to the extreme heat of the country cools the clouds quickly.

country cools the clouds quickly.

349a12-349a16
[119] So much for an account of the nature and causes of rain, dew, snow, hoar-frost, and hail.

Lecture 15 (Aquinas' Commentary)

p 38
Lecture 15
On the place of the generation of hail and snow.

p 38
110. After determining about the generation of rain, dew and frost, the Philosopher here begins to determine about the formation of hail. About this he does three things:

First, he shows where hail is generated;

Secondly, he enumerates certain phenomena accompanying hail that raise a difficulty about its formation, at 111;

Thirdly, he assigns the cause of its generation, at 115.

p 38
He says therefore first [†106], that although vapor freezes in this lower air near the earth, yet water does not coagulate here to form hail as it coagulates in the region of the clouds. For three bodies condensed by cold come from that region: namely, rain water, snow and hail. But in the case of two of these bodies, certain proportionate things take place in the lower region near the earth, and which are generated from the same causes, but differ from rain and snow according to more and less, depending, namely, on whether they are produced more quickly or more slowly, and on largeness and smallness [of amount].

p 38
For snow and frost are proportionately the same, and likewise rain and dew: they differ according to abundance and scarcity. For rain comes to be from the cooling of an abundance of vapor — the cause of this abundance being a large and spacious region and a long time in which the vapor is being united and collected, and also a large place from which it is collected. For, since rains are generated on high, vapors collect there from many regions. Dew, on the other hand, has little vapor, because the time is short during which it is collected (for the consistency of that vapor is "ephemeral," i.e., of a single day), and the region is small in which it is collected, for it is collected close to the earth — and this becomes plain from the fact that the generating of dew is swift and its amount is small. And as it is with dew and rain, so with snow and frost: for when an entire cloud is frozen, snow comes to be; but when some small vapor near the earth freezes, frost comes to be. Therefore, both of them are a sign of cold weather or of a cold region — for, since some heat still abides in both the vapor and the cloud, they would not freeze, unless there were

present a vast coldness overwhelming that heat: there being in the cloud still a large residue of the heat which made the watery moisture evaporate from the earth, and in the vapor still more. Thus, as rain and snow come to be in the upper region, so dew and frost in the lower. But although hail comes to be in the upper region, nothing below corresponds to it: the reason for this will be plain, when the cause of the generation of hail is explained.

p 38

111. Then [†107] he proposes certain phenomena that occur with respect to hail and create a difficulty as to its generation;
And he proposes two difficulties with respect to generation of hail;

The second one is mentioned at 112.

p 38

He says therefore first [†107], that with respect to the generation of hail we must consider the facts which are thought to be reasonable, and not false. And first he proposes that hail is, as it were, "crystal," i.e., water solidly frozen; he further proposes that water freezes especially in winter. But the contrary is seen to happen: for hailstorms occur mainly in spring and autumn; and after this, during the time of fruit, i.e., in summer and around the onset of autumn; but less often in winter, and, in that case, when the cold of winter has been less. Generally speaking, hail occurs in more temperate places; snow in colder places and times. From all this it would seem that hail, in which a larger amount of freezing is involved, ought rather to occur in places and times that are cold.

p 39

112. Then at [†108] he presents a second difficulty, about which he does three things. First, he presents the difficulty and says that it appears inconsistent that water should freeze on high — for it cannot freeze before it is formed, nor after it is formed, can it remain aloft, since it falls immediately. Hence it does not appear that there can be time for it to freeze and generate hail.

p 39

113. Secondly, he gives an apparent solution of this difficulty [†109]. For one could say that the water, separated into minimal parts, remains in the air as though mingled with it, and does not fall at once, but abides in the air. This is what happens when "psecades" [droplets] fall, about which we spoke earlier. And a like thing is true of earth in respect to water, which is to earth, as air is to water: for often gold or earth float on water because of the minuteness of their particles; but if those particles of earth or gold coalesced, they would fall to the bottom of the water. Hence as a result of the small particles that abide in the air congregating, large drops are formed and, in this way, the drops are brought down. In like manner, one could say that it is not impossible for water permeating the air to freeze and form hail.

p 39

114. Thirdly [†110], he rejects this solution and says that what happens to occur in droplets does not occur in the case of hail. For bits of frozen water, if small, could not consolidate to form something large like hailstones in the way that the parts of water, as moist, coalesce: for hard objects, such as ice, do not unite the way more moist things do. Hence a quantity of water equal to the size of the hailstone would have had to be hanging above in the air without falling: this is evident, for it could not be the size it is after freezing, if it had not been that size before freezing — since from many small things cannot be formed many large continua. But that such an amount of water should remain above without falling seems impossible.

p 39

115. Then [†111] he assigns the cause of the generation of hail

119. Then [†115] he assigns the cause of the generation of hail.

p 39

First, he presents the opinions of others, at 115; Secondly, his own opinion, at 119.

p 39

About the first he does two things: first, he presents the opinions of others [†111] and says that it seems to some that when a large quantity of heat pushed a cloud into the upper region, which is very cold because the rays reflected from the earth do not reach there, the water arriving there is frozen on account of the region's being cold. And therefore the reason why hail occurs during the summer and in warm regions is that vast heat greatly pushes clouds into the upper region far from earth.

p 39

116. Secondly [†112] he attacks this position on three scores. First, we see that hail does not occur on lofty mountains — but it should, if hail is formed by vapor lifted into very high places, just as we see snow, which is generated on high, on lofty mountains.

p 39

117. He gives the second argument [†113] and says that clouds are often seen moving with a great noise close to the earth so that some people hearing it fall down in terror, as though it augured a great prodigy. At other times, when such clouds are seen near the earth without any noise, a great hailstorm occurs, with hailstones of incredible size and non-round shape. Now, these phenomena, namely, that the hail is not round in shape and that the stones are large, are due to the fact that the freezing of the hail took place near the earth; consequently its fall is of short duration — for if it had fallen a long time, the size of the hail would have been reduced and the shape rounded, because the descending motion would especially have dissolved the angled edges cleaving the air very strongly and offering it greater resistance. Therefore, it is not true that hail is generated very far from the earth.

p 40

118. He gives the third argument [†114] and says that it is necessary that the size of the hail be due to the vigor of the cause freezing it: because hail is something congealed after the manner of crystal, as everyone can see. But the size of hail is greater when the stones are not round; from which it can be concluded that hailstones which are not round have vigorous cause of their freezing. But the very fact that the stone is not round is a sign that it froze close to the earth; because if the stones came from a great distance, their surface would have been worn down all over because of motion from a distance, and thus they would be round in shape and smaller in size. Hence he concludes that the freezing of hail is not due to vapors being pushed up into a highest cold region far from the earth.

p 40

119. Then [†115] he assigns the cause of the generation of hail.

First, he excludes one difficulty raised earlier;

Secondly, he excludes another one, at 120.

p 40

He says therefore first [†115] that from frequent experience we observe that the hot and the cold being contrary surround each other and cause gathering. And this is evident in the case of the earth. For in the hot weather the interior of the earth is cold, due to the fact that the heat of the air surrounds earth's coldness; hence it congregates together within. On the other hand, when it is cold, the interior of the earth is warm, because the cold encloses inside the warmth which was in the earth. That is why in summer the water from

because the cold encloses inside the warmth which was in the earth. That is why in summer the water from fountains is cool but warm in winter. The same thing must be supposed to take place in the upper region also. Therefore, when the weather is warm, the cold, shut in by the contrariety of the warmth surrounding, acts with greater force — as a result, the coldness sometimes can form water very quickly from a cloud. And, for this reason, much larger drops are formed on hot days than in winter, and the rains are "labroterae," i.e., more violent. The size and violence are due to the fact that a whole sheet of rain descends very suddenly, which is due to the rapidity of condensation.

p 40

Therefore, what happens is the very contrary of Anaxagoras' theory, which held that this happens when the vapor, from which rain forms, rises into air which is very cold; but we, on the contrary, maintain that this happens when the vapor descends into warm air — and so much the more so according as the warmth is greater. Therefore, from the hot which surrounds and gathers together the cold, are due the large drops and the violence of the rain. But when the cold is still more gathered together as a result of being surrounded by an external warmth, not only are the clouds condensed into water suddenly but what is more, the water is frozen by the vehement power of the trapped coldness: then hail is formed. From this is plain the solution to the first difficulty: namely, why is water congealed into hail in warm weather more than in winter?

p 40

120. Then [†116] he solves the second difficulty. About this he does three things:

First, he solves the difficulty;

Secondly, he gives an explanation for the season in which hail is formed, 121.

Thirdly, he lays down something that contributes to the speed with which hail is formed, at 122.

p 40

The second difficulty arose from the fact that there did not seem to be able to be any time for the water on high to freeze into hail — for as soon as water is formed, it falls, and it cannot freeze before it has formed. To solve this difficulty, therefore, he says [†116] that the generation of hail occurs when the freezing of water is more rapid (on account of the vigor of the cold gathered together) than the downward motion of the water.

p 41

That this is possible he now shows. For since every instance of local motion is in time, it is plain that the rain water is traveling downward for some definite period of time; but it happens that the coldness, because of its vigor, freezes the water in less time than the time of descent. Hence there is nothing to prevent the freezing from occurring in less time than it takes the water to descend, if the cold is very vigorous and intense. This is why, the nearer to us the generation of water or hail takes place, the faster it freezes, since the heat is stronger near the earth and more vigorously expels and encloses the cold. In these circumstances the water of the rain must become more violent, and both the drops of rain and the hailstones larger, because they travel a shorter distance and less is dissolved away. For the same reason the raindrops do not fall thickly, for, since they suddenly condense into large drops at one time, they are not divided into many parts, and also fall very quickly — and that is why the stuff of rain and hail does not fall so thickly.

p 41

121. Then [†117] he assigns a reason for the time when hail is generated, and says that hail falls less in summer than in spring and autumn, but more than in winter: less in summer than in spring and autumn, because in summer the air is drier; but in spring the air is still moist on account of the preceding winter, while in autumn, it is already beginning to grow moist. Hence in summer there is not as much moist vapor

for generation of hail as in spring and autumn, although there is more heat. But in winter, although there is an abundance of material, there is lack of heat to concentrate the cold that generates hail. Also hail occurs at harvest time, i.e., in late summer, for the same reason: because the heat is then still potent and the air is beginning to get moist.

p 41

122. Then [†118], because he had solved the difficulty raised above by citing the speed with which hail is generated on account of the vigorous cold, he now posits something else that contributes to this same speed. And he says that a contribution to the speed of the coagulating process is the fact that the water is pre-heated (the vaporous stuff aiding the season's heat) and therefore freezes more quickly, because the cold acts upon it more vigorously and can penetrate farther into water that has been rarefied by the heat. This is the reason why many people, when they want to cool warm water, first place it in the sun, And fishermen in the region of Pontus, when they make huts during the ice season to fish (they catch the fish through holes cut in the ice of the sea or river), pour hot water around the poles they use for fishing, so that it will freeze faster; in this way they use the frozen water, as though it were lead, to keep the poles firmly fixed. But in warm regions and in warm seasons, hot water cools quickly, because it gets dense quickly, for the reason given. Hence, in Arabia and Ethiopia, rains occur in summer and not in winter, because the vapors are quickly cooled by reason of the contrariety of the heat surrounding them, since this region is very hot.

p 41

Finally [†119] he summarizes what has been said — and this is plain in the text.

Lecture 16 (Aristotle's Text)

349a17-349b2

13. [120] Let us explain the nature of winds, and all windy vapours, also of rivers and of the sea. But here, too, we must first discuss the difficulties involved: for, as in other matters, so in this no theory has been handed down to us that the most ordinary man could not have thought of.

349b3-349b14

[121] Some †2 say that what is called air, when it is in motion and flows, is wind, and that this same air when it condenses again becomes cloud and water, implying that the nature of wind and water is the same. So they define wind as a motion of the air. Hence some, wishing to say a clever thing, assert that all the winds are one wind, because the air that moves is in fact all of it one and the same; they maintain that the winds appear to differ owing to the region from which the air may happen to flow †3 on each occasion, but really do not differ at all. This is just like thinking that all rivers are one and the same river, and the ordinary unscientific view is better than a scientific theory like this. If all rivers flow from one source, and the same is true in the case of the winds, there might be some truth in this theory; but if it is no more true in the one case than in the other, this ingenious idea is plainly false. What requires investigation is this: the nature of wind and how it originates, its efficient cause and whence they derive their source; whether one ought to think of the wind as issuing from a sort of vessel and flowing until the vessel is empty, as if let out of a wineskin, or, as painters represent the winds, as drawing their source from themselves.

out of a wineskin, or, as painters represent the winds, as drawing their source from themselves.

349b15-349b19

[122] We find analogous views about the origin of rivers. †1 It is thought that the water is raised by the sun and descends in rain and gathers below the earth and so flows from a great reservoir, all the rivers from one, or each from a different one. No water at all is generated, but the volume of the rivers †2 consists of the water that is gathered into such reservoirs in winter. Hence rivers are always fuller in winter than in summer, and some are perennial, others not. Rivers are perennial where the reservoir is large and so enough water has collected in it to last out and not be used up before the winter rain returns. Where the reservoirs are smaller there is less water in the rivers, and they are dried up and their vessel empty before the fresh rain comes on.

349b20-349b27

[123] But if any one will picture to himself a reservoir adequate to the water that is continuously flowing day by day, and consider the amount of the water, it is obvious that a receptacle that is to contain all the water that flows in the year would be larger than the earth, or, at any rate, not much smaller.

349b28-350a13

Though it is evident that many reservoirs of this kind do exist in many parts of the earth, [124] yet it is unreasonable for any one to refuse to admit that air becomes water in the earth for the same reason as it does above it. If the cold causes the vaporous air to condense into water above the earth we must suppose the cold in the earth to produce this same effect, and recognize that there not only exists in it and flows out of it actually formed water, but that water is continually forming in it too.

350a14-350a18

[125] Again, even in the case of the water that is not being formed from day to day but exists as such, we must not suppose as some do that rivers have their source in definite subterranean lakes. On the contrary, just as above the earth small drops form and these join others, till finally the water descends in a body as rain, so too we must suppose that in the earth the water at first trickles together little by little, and that the sources of the rivers drip, as it were, out of the earth and then unite. This is proved by facts. When men construct an aqueduct they collect the water in pipes and trenches, as if the earth in the higher ground were sweating the water out. [126] Hence, too, the head-waters of rivers are found to flow from mountains, and from the greatest mountains there flow the most numerous and greatest rivers. Again, most springs are in the neighbourhood of mountains and of high ground, whereas if we except rivers, water rarely appears in the plains. For mountains and high ground, suspended †1 over the country like a saturated sponge, make the water ooze out and trickle together in minute quantities but in many places. They receive a great deal of water falling as rain (for it makes no difference whether a spongy receptacle is concave and turned up or convex and turned down: in either case it will contain the same volume of matter) and they also cool the vapour that rises and condense it back into water.

350a19-350b17

Hence, as we said, we find that the greatest rivers flow from the greatest mountains. This can be seen by looking at itineraries: what is recorded in them consists either of things which the writer has seen himself or of such as he has compiled after inquiry from those who have seen them.

350b18-350b22

In Asia we find that the most numerous and greatest rivers flow from the mountain called Parnassus, †2 admittedly the greatest of all mountains towards the south-east. When you have crossed it you see the outer ocean, †3 the further limit of which is unknown to the dwellers in our world. Besides other rivers there flow from it the Bactrus, †1 the Choaspes, †2 the Araxes: †3 from the last a branch separates off and flows into lake Maeotis †4 as the Tanais. †5 From it, too, flows the Indus, the volume of whose stream is greatest

into lake Maeotis †4 as the Tanais. †5 From it, too, flows the Indus, the volume of whose stream is greatest of all rivers. From the Caucasus flows the Phasis, †6 and very many other great rivers besides. Now the Caucasus is the greatest of the mountains that lie to the north-east, both as regards its extent and its height. A proof of its height is the fact that it can be seen from the so-called 'deeps' †7 and from the entrance to the lake. †8 Again, the sun shines on its peaks for a third part of the night before sunrise and again after sunset. Its extent is proved by the fact that though it contains many inhabitable regions which are occupied by many nations and in which there are said to be great lakes, yet they say that all these regions are visible up to the last peak. †9 From Pyrene †10(this is a mountain towards the west in Celtice) there flow the Istrus †11 and the Tartessus. †12 The latter flows outside the pillars, †13 while the Istrus flows through all Europe into the Euxine. Most of the remaining rivers flow northwards from the Hercynian mountains, †14 which are the greatest in height and extent about that region. In the extreme north, beyond furthest Scythia, are the mountains called Rhipae. †15 The stories about their size are altogether too fabulous: however, they say that the most and (after the Istrus) the greatest rivers flow from them. So, too, in Libya there flow from the Aethiopian mountains the Aegon and the Nyses; †16 and from the so-called Silver Mountain the two greatest of named rivers, the river called Chremetes †17 that flows into the outer ocean, and the main source of the Nile. Of the rivers in the Greek world, the Achelous flows from Pindus, the Inachus from the same mountain; the Strymon, the Nestus, and the Hebrus all three from Scombrus; many rivers, too, flow from Rhodope.

350b23-350b35

All other rivers would be found to flow in the same way, but we have mentioned these as examples. Even where rivers flow from marshes, the marshes in almost every case are found to lie below mountains or gradually rising ground.

350b36-351a18

[127] It is clear then that we must not suppose rivers to originate from definite reservoirs: for the whole earth, we might almost say, would not be sufficient (any more than the region of the clouds would be) †1 if we were to suppose that they were fed by actually existing water only and it were not the case that as some water passed out of existence some more came into existence, but rivers always drew their stream from an existing store. Secondly, the fact that rivers rise at the foot of mountains proves that a place transmits the water it contains by gradual percolation of many drops, little by little, and that this is how the sources of rivers originate. [128] However, there is nothing impossible about the existence of such places containing a quantity of water like lakes: only they cannot be big enough to produce the supposed effect. To think that they are is just as absurd as if one were to suppose that rivers drew all their water from the sources we see (for most rivers do flow from springs). So it is no more reasonable to suppose those lakes to contain the whole volume of water than these springs.

351a19-351b4

That there exist such chasms and cavities in the earth we are taught by the rivers that are swallowed up. They are found in many parts of the earth: in the Peloponnesus, for instance, there are many such rivers in Arcadia. The reason is that Arcadia is mountainous and there are no channels from its valleys to the sea. So these places get full of water, and this, having no outlet, under the pressure of the water that is added above, finds a way out for itself underground. In Greece this kind of thing happens on quite a small scale, but the lake at the foot of the Caucasus, †1 which the inhabitants of these parts call a sea, is considerable. †2 Many great rivers fall into it and it has no visible outlet but issues below the earth off the land of the Coraxi †3 about the so-called 'deeps of Pontus'. This is a place of unfathomable depth in the sea: at any rate no one has yet been able to find bottom there by sounding. At this spot, about three hundred stadia from land, there comes up sweet water over a large area, not all of it together but in three places. And in Liguria a river †4 equal in size to the Rhodanus †5 is swallowed up and appears again elsewhere: the Rhodanus being a navigable river.

Lecture 16 (Aquinas' Commentary)

p 42
Lecture 16

The cause of the generation of rivers.

p 42
123. After determining concerning things generated on high from the moist exhalation, the Philosopher here determines about things generated on earth from the same material — namely, about springs and rivers. It is divided into two parts:

In the first he determines concerning the cause of the generation of rivers;

In the second concerning their duration (L. 17).

p 42
As to the first, he does three things: first, he states his intention [†120] and says that the discussion is about winds and everything caused by winds, and about rivers and the sea. These will be treated in the following order: we shall first propose problems of our own; then we shall declare the true answer to the problems to ourselves and not others: since on these matters we have received no opinions from others that anybody could not have conceived, unlike that which was the case in regard to the other matters.

p 42
124. Secondly [†121], he presents the opinions of certain others about winds. And he says that some have declared that the body called "air," when it flows along and is in motion, is wind; but when it halts and condenses, it is cloud and water — as though the natures of water, air and wind were identical, and wind were nothing more than air and water. And because the whole of air is one, some, wishing to speak very wisely, have asserted that there is but one wind, and that if winds seem to differ, it is only because of the different places whence they move. This is like saying that all rivers are one river, and that all water is one: which is plainly false. Hence the generality of mankind, who speak as do the uneducated and without philosophic enquiry about the winds, speak with more truth than these, who in such an inquiry erred. For if it were true that all rivers flowed from one source, then it could also be somehow true that all winds were from one source: but it is plain that, for winds as well as for rivers, what they said is frivolously and deceitfully said.

p 42
It is appropriate to discuss in a tract proper to it what wind is, and how it is generated, and what moves it, and from what do winds derive their source, and whether we must consider the wind as though flowing from some receptacle, and continuing to flow until it is emptied, as though wind were squeezed out of a wineskin as Homer's fable pretended; or whether it comes, not from one, but from many sources, as the

painters depict the various winds puffing from out of themselves the source of breezes.

p 42

125. Thirdly [†122], he presents like opinions about the generation of rivers: this was the reason he introduced what he said concerning winds. About this he does three things:

First, he presents the false opinion of certain ones, at 125;

Secondly, he rejects it, at 126;

Thirdly, he rejects a certain argument of their, at 130.

p 42

He says therefore first [†122], that to some, the same things seem to be true of the generation of rivers as was said of the generation of winds. For they say that when water is raised aloft through evaporation and then re-descends, it collects under the earth and thus flows on to generate springs and rivers. It is as if they were understood to emerge from some "great womb," i.e., from some large depth where a great amount of water is gathered. It makes no difference to their theory whether all rivers flow from one such source or various rivers from various sources of this sort. According to this theory water is not newly generated under the earth to cause the flow of springs and rivers: what happens is that the water previously collected in the aforesaid receptacles is the source of the amount of waters and rivers.

p 43

And they said that a sign of this is the fact that in winter there is more river-flow than in summer. From this they assign the cause why some rivers are unceasing and some not. For when, because of the size of the depth, a sufficient amount of water gathers under the earth to assure continuity of flow, in such a way that the flowing water does not run out before returning again the next winter, then the river is made perpetual to the end. But if the reservoir is small, then, because of the smallness of the amount of water, the river's source runs dry (as an emptied vessel) before water again flows from the sky. That is why such a river does not flow perennially.

p 43

126. Then [†123] he rejects this position for four reasons: First, he says that if one were to take into consideration the vast amount of water that continually flows through rivers in the entire world, the subterranean reservoir, or reservoirs, feeding these rivers, would have to be larger, or at least almost as large, as the earth. This would require that the whole interior of the earth be hollow, in order to hold such a vast amount of water; and even that would not be a sufficiently large container.

p 43

Now this is plainly false: for, since earth is by nature in the middle [center], and its parts naturally tend to the middle, it cannot be said that the earth is hollow enough within to hold the water — although it is not inadmissible that there be certain receptacles of water in many parts of the earth.

p 43

127. Secondly [†124], he gives a second argument and says that it is inconsistent for one not to suppose that water comes to be within the earth from evaporated air, for the same reason that it is produced above the earth in the air. Hence, if evaporated air is condensed into water in the air above the earth on account of coldness, one must believe that the same is produced by reason of the coldness of the earth. And so, not only water existing separated in the earth as in a reservoir, flows through rivers, but water is also being continually generated within the earth by the refrigeration of vapors, and this will flow out through rivers.

p 43

128. But because someone could say that a certain water is generated within the earth from vapors, but that the whole is collected together into certain reservoirs, whence rivers flow, which theory would be similar to, and practically the same as, the previous position, therefore, thirdly, he rejects this by means of a sign at [†125]. And he says that it is even not to be supposed that water indeed is generated within the earth but remains there from day to day while rivers flow, as though there were certain pools of water under the earth, as some say. But one must understand that things take place in the same way within the earth, as above the earth. For above the earth, when vapor is first being condensed, small drops form and coalesce with others and in this way the flowing water easily descends in a certain quantity. The same thing takes place within the earth: for first small drops are generated; and thus the sources of rivers are springs gushing little by little below the earth.

p 43

An indication of this is what is done — for people who wish to bring out water, e.g., who dig wells or the like, collect the water in low and excavated places, as though the earth perspired water from elevated areas to lower areas. From which it appears that water flows drop by drop from the earth to produce rivers and springs, rather than that in the earth are places acting as pools of actually existing water.

p 44

129. Fourthly [†126], he supports the same view with another sign, based on the natural flow of waters: for the previous sign was based on a [human] work. And he says that for the same reason, the "discharge," i.e., the flow of rivers, seems to be from the mountains, and the largest rivers flow from the largest mountains; moreover, most springs are close to mountains and high places, whereas on the plains there are few springs apart from rivers. The reason is that mountainous and high places are like certain thick sponges (because the rocks are hard) as to ejecting water; and they are suspended [elevated], so that the water can flow: consequently, they produce water in many places and also collect water that comes down from above as rain. But this occurs in small sections of the mountains and not in the sense that within the mountains there are depths in which water is gathered. That is why he says that they collect water, for they receive a great abundance of water coming as rainfall. The shape of mountains is well-adapted for this, for a round shape is the most capacious of shapes.

p 44

So far as holding a great amount of water is concerned, it makes no difference whether the circumference is disposed above in a concave way, or according to a convex swelling — for in either case the capacity is equal. Hence, although mountains are not concave, but more convex, nevertheless they can receive a vast amount of water. And they not only hold a great amount of water as received from elsewhere, because of their shape, but also bring it forth as water born within because of the cold: for the vapor of earth, drawn out of the earth, and rising because of its inherent warmth, is coagulated within the earth by the coldness of the earth, so that it is again condensed into water. And that is why, as was said, the largest rivers flow from the largest mountains.

p 44

And this is plain, if one examines a traveler's description of the earth: for those who so described the earth have either themselves seen the rivers and regions, or learned of them from others. He therefore presents first the example of Parnassus which is in Asia at the winter rising [i.e., the southeast], and of the Caucasus, at the summer rising [north east]: since these are very large mountains, many and very large rivers rise from them. In Europe he gives the example of the Pyrenees located in the equinoctial setting [equatorial west], as well as of certain other mountains, which lie toward the north in Scythia: large rivers rise from them too. Then in Africa or in Libya he gives the example of certain other large mountains from

which other great rivers flow. And he says the same is true of other mountains and rivers, and that, whatever other rivers flow from marshes, these marshes are located near mountains; and thus is the same thing true. — From these examples, therefore, he concludes to his proposition [†127] and repeats what was said above: thus the text is plain.

p 44

130. Then [†128] he refutes the argument of those who posit the opinion under discussion. And he says that it is not inadmissible that places should be found actually containing a vast amount of water after the manner of lakes: but this is not sufficient to account for the flow of rivers. For we can no more say that the waters which may exist collected under the earth or in the mountains, contain all the water of rivers, than we can say that the springs, which plainly appear outside the earth, actually contain all the water of rivers: for most rivers flow from springs (which he says, because some flow from marshes, as has been said). Hence to think that those subterranean collections of water contain the entire body of waters that flow through rivers is like supposing that those collections of water found outside the earth in springs contain all the water found in rivers. Hence, since it is plainly false to suppose this of the springs we can see, then it can be known by analogy that it is also false to suppose it of the collections of water under the earth. But that such collections of water do exist under the earth can be made manifest by the fact that many streams are absorbed by the earth. This he explains with many examples that are plain in the text.

Lecture 17 (Aristotle's Text)

351b5-351b8

14. [129] The same parts of the earth are not always moist or dry, but they change according as rivers come into existence and dry up. And so the relation of land to sea changes too and a place does not always remain land or sea throughout all time, but where there was dry land there comes to be sea, and where there is now sea, there one day comes to be dry land. But we must suppose these changes to follow some order and cycle. [130] The principle and cause of these changes is that the interior of the earth grows and decays, like the bodies of plants and animals. Only in the case of these latter the process does not go on by parts, but each of them necessarily grows or decays as a whole, whereas it does go on by parts in the case of the earth. Here the causes are cold and heat, which increase and diminish on account of the sun and its course. It is owing to them that the parts of the earth come to have a different character, that some parts remain moist for a certain time, and then dry up and grow old, while other parts in their turn are filled with life and moisture. Now when places become drier the springs necessarily give out, and when this happens the rivers first decrease in size and then finally become dry; and when rivers change and disappear in one part and come into existence correspondingly in another, the sea must needs be affected.

351b9-352a17

If the sea was once pushed out by rivers and encroached upon the land anywhere, it necessarily leaves that place dry when it recedes; again, if the dry land has encroached on the sea at all by a process of silting set up by the rivers when at their full, the time must come when this place will be flooded again. †1

352a18-352b15

[131] But the whole vital process of the earth takes place so gradually and in periods of time which are so

immense compared with the length of our life, that these changes are not observed, and before their course can be recorded from beginning to end whole nations perish and are destroyed. Of such destructions the most utter and sudden are due to wars; but pestilence or famine cause them too. Famines, again, are either sudden and severe or else gradual. In the latter case the disappearance of a nation is not noticed because some leave the country while others remain; and this goes on until the land is unable to maintain any inhabitants at all. So a long period of time is likely to elapse from the first departure to the last, and no one remembers and the lapse of time destroys all record even before the last inhabitants have disappeared. In the same way a nation must be supposed to lose account of the time when it first settled in a land that was changing from a marshy and watery state and becoming dry. Here, too, the change is gradual and lasts a long time and men do not remember who came first, or when, or what the land was like when they came. This has been the case with Egypt. Here it is obvious that the land is continually getting drier and that the whole country is a deposit of the river Nile. But because the neighbouring peoples settled in the land gradually as the marshes dried, the lapse of time has hidden the beginning of the process. However,†1 all the mouths of the Nile, with the single exception of that at Canopus, are obviously artificial and not natural. And Egypt was nothing more than what is called Thebes, as Homer, too, shows, modern though he is in relation to such changes. For Thebes is the place that he mentions; which implies that Memphis did not yet exist, or at any rate was not as important as it is now. That this should be so is natural, since the lower land came to be inhabited later than that which lay higher. For the parts that lie nearer to the place where the river is depositing the silt are necessarily marshy for a longer time since the water always lies most in the newly formed land. But in time this land changes its character, and in its turn enjoys a period of prosperity. For these places dry up and come to be in good condition while the places that were formerly well-tempered some day †2 grow excessively dry and deteriorate. This happened to the land of Argos and Mycenae in Greece. In the time of the Trojan wars the Argive land was marshy and could only support a small population, whereas the land of Mycenae was in good condition (and for this reason Mycenae was the superior). But now the opposite is the case, for the reason we have mentioned: the land of Mycenae has become completely dry and barren, while the Argive land that was formerly barren owing to the water has now become fruitful. Now the same process that has taken place in this small district must be supposed to be going on over whole countries and on a large scale.

352b16-353a5

[132] Men whose outlook is narrow suppose the cause of such events to be change in the universe, in the sense of a coming to be of the world as a whole. †1 Hence they say that the sea is being dried up and is growing less, because this is observed to have happened in more places now than formerly. But this is only partially true. It is true that many places are now dry, that formerly were covered with water. But the opposite is true too: for if they look they will find that there are many places where the sea has invaded the land. But we must not suppose that the cause of this is that the world is in process of becoming. For it is absurd to make the universe to be in process because of small and trifling changes, when the bulk and size of the earth are surely as nothing in comparison with the whole world. [133] Rather we must take the cause of all these changes to be that, just as winter occurs in the seasons of the year, so in determined periods there comes a great winter of a great year and with it excess of rain. But this excess does not always occur in the same place. The deluge in the time of Deucalion, for instance, took place chiefly in the Greek world and in it especially about ancient Hellas, the country about Dodona and the Achelous, a river which has often changed its course. Here the Selli dwelt and those who were formerly called Graeci and now Hellenes. [134] When, therefore, such an excess of rain occurs we must suppose that it suffices for a long time. We have seen that some †2 say that the size of the subterranean cavities is what makes some rivers perennial and others not, whereas we maintain that the size of the mountains is the cause, and their density and coldness; for great, dense, and cold mountains catch and keep and create most water: whereas if the mountains that overhang the sources of rivers are small or porous and stony and clayey, these rivers run dry earlier. We must recognize the same kind of thing in this case too. Where such abundance of rain falls in the great winter it tends to make the moisture of those places almost everlasting. †1 But as time goes on places of the latter type dry up †2 more, while those of the former, moist type, do so less: until at last the

beginning of the same cycle returns.

353a6-353a14

Since there is necessarily some change in the whole world, but not in the way of coming into existence or perishing (for the universe is permanent), it must be, as we say, that the same places are not for ever moist through the presence of sea and rivers, nor for ever dry. [135] And the facts prove this. The whole land of the Egyptians, whom we take to be the most ancient of men, has evidently gradually come into existence and been produced by the river. This is clear from an observation of the country, and the facts about the Red Sea suffice to prove it too. One of their kings tried to make a canal to it (for it would have been of no little advantage to them for the whole region to have become navigable; Sesostris is said to have been the first of the ancient kings to try), but he found that the sea was higher than the land. So he first, and Darius afterwards, stopped making the canal, lest the sea should mix with the river water and spoil it. So it is clear that all this part was once unbroken sea. For the same reason Libya—the country of Ammon—is, strangely enough, lower and hollower than the land to the seaward of it. For it is clear that a barrier of silt was formed and after it lakes and dry land, but in course of time the water that was left behind in the lakes dried up and is now all gone. Again the silting up of the lake Maeotis by the rivers has advanced so much that the limit to the size of the ships which can now sail into it to trade is much lower than it was sixty years ago. Hence it is easy to infer that it too, like most lakes, was originally produced by the rivers and that it must end by drying up entirely.

353a15-353a24

Again, this process of silting up causes a continuous current through the Bosporus †1 and in this case we can directly observe the nature of the process. Whenever the current from the Asiatic shore threw up a sandbank, there first formed a small lake behind it. Later it dried up and a second sandbank formed in front of the first and a second lake. This process went on uniformly and without interruption. Now when this has been repeated often enough, in the course of time the strait must become like a river, and in the end the river itself must dry up.

353a25-353a26

[136] So it is clear, since there will be no end †2 to time and the world is eternal, that neither the Tanais nor the Nile has always been flowing, but that the region whence they flow was once dry: for their effect may be fulfilled, but time cannot. And this will be equally true of all other rivers. But if rivers come into existence and perish and the same parts of the earth were not always moist, the sea must needs change correspondingly. And if the sea is always advancing in one place and receding in another it is clear that the same parts of the whole earth are not always either sea or land, but that all this changes in course of time. [137] So we have explained that the same parts of the earth are not always land or sea and why that is so: and also why some rivers are perennial and others not.

Lecture 17 (Aquinas' Commentary)

Lecture 17

The duration and change of rivers.

p 45

131. After showing the cause of the generation of rivers, the Philosopher here determines about their duration. About this he does two things:

First, he presents his own opinion [†129] and says that the same parts of the earth are not always moist or dry, but they vary according as rivers are newly formed or decay. As a result, changes occur affecting the earth, so that what is now dry, later becomes a sea and vice versa; and sea or dry land are not always present in the same part of the earth. But this takes place, not by chance, but according to a certain order and according to a certain turning of the heavens, just as all changes taking place in these lower regions are regulated according to the movement of the heaven.

p 45

132. Secondly [†130], he explains what he has said. About this he does two things:

First, he assigns one cause of what has been said, at 132;

Secondly, he rejects a cause held by others, at 134.

p 45

About the first he does two things:

First, he assigns the cause of the transmutation just mentioned, at 132;

Secondly, he explains why such transmutations escape our notice, at 133.

p 45

He says therefore first [†130], that the cause and source of the above-mentioned transmutation is that the energy of the earth has its own kind of coming to a stop and old age, just as do bodies of animals and plants. But there is this difference: animals and plants suffer a stopping and old age, not successively with respect to different parts, but all at one time with respect to the whole, while, in the earth, this change is part by part, depending on the influence of heat and cold — for one part increases in heat or coldness, while another decreases, depending on the course of the sun and on other cycles of the heavenly bodies.

p 45

Hence, depending on their differing position as to the aspects toward the sun and stars, the parts of the earth receive diverse power. As a result, some parts of the earth can continue being moist and watery for a long time according to a definite period — and this is, as it were, their youth or full state; later, they dry up and exist in what is for the earth old age, which naturally is accompanied by dryness, because of the absence of moisture. While these portions of the earth are drying up, other regions of earth are being vivified and become in part watery. This is indicated by the fact that in the spring of the year all things become, so to speak, young again by moisture; but in winter the same things grow old because of the excessive dryness. Moreover, in spring our part of the earth is alive, while elsewhere everything is already dried up. From this it is plain that old age and youth do not affect the earth as a whole (as animals and plants are affected) but one part at a time.

p 45

According to this, therefore, in certain areas of the earth, the springs that are dried up in this way cease to

According to this, therefore, in certain areas of the earth, the springs that are dried up in this way cease to function. As a result, rivers that were once large become small, and finally dry up entirely; because the springs from which they originated are dry. Thus, in one part of the earth now grown old, the springs are dry, but in another part that has become watery, a corresponding number of new springs and rivers arise. Hence, because of these changes which affect streams, so that in one portion of the earth they perish and in another portion new ones arise, the sea too is changed as a consequence. Once the rivers dry up, the sea falls back and dry land appears where the sea was once swollen by the overflow of rivers. But where the sea has been dried up by accretions of earth deposited by rivers, it again is under water when a quantity of water has gathered.

p 46

133. Secondly [†131], he explains why these transmutations escape our notice, and says that these transmutations of sea and dry land escape us, because every natural change takes place not all at once but bit by bit — and the transmutations under discussion, which affect large sectors of the earth occur over long periods of time; and all nations die and pass away before a memory remains of such a change from its beginning to its end. For if the same peoples always remained in the same areas of the earth, some remembrance, even of things most ancient and of transmutations, could remain — but when one people is destroyed and a new one inhabits their land, no memory of the antiquities of the first remains among the second, much less among the third and fourth.

p 46

Now the disappearances of nations closest to our times are brought on by wars, but some also by diseases and epidemics, and some by sterility: of these destructions some occur all at once on a large scale, and some gradually. Furthermore, the migrations of peoples from place to place go unnoticed, because some forsake a region from the start because the earth is becoming barren or weak, or because of wars; while others remain as long as they can find sustenance there. Hence, the time between the first departure and the last is sometimes long, and there is no memory of the first migration, even if the men do not die, but migrate. And as it is with forsaking lands, so with their settling: because of the length of time, there is no record when and by which races the land first began to be settled and when it was first changed from swamp into dry land and made habitable — this taking place little by little and over long periods of time. And he gives the example of Egypt, whose land was gradually drained dry, as though by the river. He mentions other lands, too, that have been transmuted and drained dry of moisture, and vice versa, as is plain in the text.

p 46

134. Then [†132] he dismisses an explanation that some have suggested. About this he does three things: first, he dismisses the false explanation and says that some, by looking at some slight thing, want to make a judgment about the entire heaven: for they think that the cause of such transmutation is that the whole world is changing in the sense that the heaven and the world are being newly formed. They say that the sea gets smaller, because it was beginning to be dried up by the sun from the very beginning: that is why many places formerly moist are now dry. But this is partly true, partly not. For it is true that certain places formerly filled with water are now dried out; but the opposite is also true, because in some places the sea is found to have invaded areas that were formerly dry land. But it is false that the cause of this change is due to a generation of the earth. For it is ridiculous to postulate transmutations in the whole because of transmutations in small areas. Moreover, the size of the earth is almost as nothing compared with the heaven as a whole, for it takes on the status of a point.

p 46

135. Secondly [†133], he restates the true cause, and says that the true cause of those transmutations is this: just as a year is divided by different seasons, namely, by winter and summer and the customary seasons, so also a certain great cycle is divided according to established sequences by a great winter,

wherein there is an excess of storms, and a great summer, in which there is excessive dryness; but not in the sense that these great excesses of storms and dryness occur at the same time over the entire earth or always over the same regions: they occur in different regions. And he gives the example of the deluge in one definite region of Greece in the time of Deucalion.

p 47

136. Thirdly [†134], from the foregoing he assigns a cause why rivers last, and says that when excessive storms occur in some region, the earth is saturated with enough moisture to generate rivers for a long time. This is a detail common to various explanations: whether the perpetuity of rivers is explained by large subterranean depths containing much water, as claimed by some, as cited earlier; or whether, according to our own opinion already given, the cause of their perpetuity is the size and thickness and coldness of mountains, by which they can receive and contain vast stores of water as well as generate it. But those places where the substance of the mountains is small and they are not very high, or where they are, so to speak, spongy [porous] so that moisture cannot be preserved in them, and are rocky, so as not to be able to receive water, and are clayey, so as not to be able to generate it, in such places, I say, the flow of rivers diminishes until the region again becomes moist. Therefore, one must believe that in whatever places an abundance of water falls during a great winter, the moisture of such places will be more "perpetual," i.e., long-lasting. Yet, as time goes on, such places dry up and some become less moist until the return again of that period in which there is an excess of rain.

p 47

And so he concludes finally that, since change must take place in the whole universe (but not in the sense that the whole comes into being and is destroyed), if the world as a whole is perpetual, then it is necessary, as was said, that the same places be not forever moist, because of the sea or rivers, or dry, either — but places that previously were wet, become dry, and vice versa.

p 47

137. Then [†135] he manifests what he has said with examples. About this he does three things: First, he gives three examples, the first of which concerns the land of Egypt, which is found to be below the surrounding sea; for this reason certain of their kings were hindered from linking the two seas, when they saw that this would destroy the flow of the river water.

p 47

The second example concerns Lake Maeotis [Sea of Azov], in which the river flow produces so much silt that in his time it could only take boats much smaller than 60 years earlier.

p 47

The third example concerns the Bosphorus, which divides Europe from Asia. This strait is found smaller, and always tending to narrow, for the same reason.

p 47

138. Secondly [†136], he draws the conclusion that was chiefly intended and says that since there is no end to time and since the entire universe is eternal (according to his opinion presented in the *Physics* and in *On the Heavens*) it follows that neither the Tanais [Don] nor the Nile, which are very large rivers, have always been flowing, but the place whence they flow was once dry: because their "work," i.e., their flow, has a limit. The same is true of other rivers. And if this is true of rivers, it must be true also of the sea into which rivers flow: that is why, at different times, sea and dry land are reversed.

p 47

However, his supposition that the world and time are eternal is erroneous and opposed to the faith; nor are the arguments used to support these suppositions, demonstrations, as was shown elsewhere.

p 47

Thirdly [†137], he summarizes what he has said, and the text is clear.

Lecture 1 (Aristotle's Text)

353a27-353a28

BOOK II

1. [138] Let us explain the nature of the sea and the reason why such a large mass of water is salt and the way in which it originally came to be.

353a29-353b17

[139] The old writers who invented theogonies say that the sea has springs, †3 for they want earth and sea to have foundations and roots of their own. Presumably they thought that this view was grander and more impressive as implying that our earth was an important part of the universe. For they believed that the whole world had been built up round our earth and for its sake, and that the earth was the most important and primary part of it. [140] Others, †1 wiser in human knowledge, give an account of its origin. At first, they say, the earth was surrounded by moisture. Then the sun began to dry it up, part of it evaporated and is the cause of winds and the turnings back of the sun and the moon, †2 while the remainder forms the sea. So the sea is being dried up and is growing less, and will end by being some day entirely dried up. †3 Others †4 say that the sea is a kind of sweat exuded by the earth when the sun heats it, and that this explains its saltness: for all sweat is salt. Others †5 say that the saltness is due to the earth. Just as water strained through ashes becomes salt, so the sea owes its saltness to the admixture of earth with similar properties.

353b18-353b30

[141] We must now consider the facts which prove that the sea cannot possibly have springs. The waters we find on the earth either flow or are stationary. All flowing water has springs. (By a spring, as we have explained above, †6 we must not understand a source from which waters are ladled as it were from a vessel, but a first point at which the water which is continually forming and percolating gathers. †7 Stationary water is either that which has collected and has been left standing, marshy pools, for instance, and lakes, which differ merely in size, or else it comes from springs. In this case it is always artificial, I mean as in the case of wells, otherwise the spring would have to be above the outlet. Hence the water from fountains and rivers flows of itself, whereas wells need to be worked artificially. All the waters that exist belong to one or other of these classes.

353b31-353b34

On the basis of this division we can see that the sea cannot have springs. For it falls under neither of the two classes; it does not flow and it is not artificial; whereas all water from springs must belong to one or

other of them. Natural standing water from springs is never found on such a large scale.

354a1-354a6

[142] †1 Again, there are several seas that have no communication with one another at all. The Red Sea,†2 for instance, communicates but slightly with the ocean outside the straits †3 and the Hyrcanian †4 and Caspian seas are distinct from this ocean and people dwell all round them. Hence, if these seas had had any springs anywhere they must have been discovered.

354a7-354a10

[143] It is true that in straits, where the land on either side contracts an open sea into a small space, the sea appears to flow. But this is because it is swinging to and fro. In the open sea this motion is not observed, but where the land narrows and contracts the sea the motion that was imperceptible in the open necessarily strikes the attention.

354a11-354a31

The whole of the Mediterranean does actually flow. The direction of this flow is determined by the depth of the basins and by the number of rivers. Maeotis flows into Pontus †1 and Pontus into the Aegean. After that the flow of the remaining seas is not so easy to observe. The current of Maeotis and Pontus is due to the number of rivers (more rivers flow into the Euxine and Maeotis than into the whole Mediterranean with its much larger basin), and to their own shallowness. For we find the sea getting deeper and deeper. Pontus is deeper than Maeotis, the Aegean than Pontus, the Sicilian sea than the Aegean; the Sardinian and Tyrrhenic being the deepest of all. (Outside the pillars of Herakles the sea is shallow owing to the mud, but calm, for it lies in a hollow.) †2 We see, then, that just as single rivers flow from mountains, so it is with the earth as a whole: the greatest volume of water flows from the higher regions in the north. Their alluvium makes the northern seas shallow, while the outer seas are deeper. [144] Some further evidence of the height of the northern regions of the earth is afforded by the view of many of the ancient meteorologists. †3 They believed that the sun did not pass below the earth, but round its northern part, and that it was the height of this which obscured the sun and caused night.

354a32-354a33

[145] So much to prove that there cannot be sources of the sea and to explain its observed flow.

Lecture 1 (Aquinas' Commentary)

p 1

METEOROLOGY — BOOK II
Lecture 1

Opinions of the ancients on the origin of the sea and of its saltness

p 1

139. After determining concerning things generated on high, from either a dry evaporation or a moist vapor, and after adding a discussion about the generation of rivers on account of its similarity to the generation of rains, the Philosopher now begins to determine concerning things that come to be in the lower region from a dry exhalation. And it is divided into two parts:

In the first he determines about certain principal passions, at 140; In the second about certain things which accompany them (Book III).

p 1

The first is divided into two parts:

In the first he determines about the sea, whose saltness is caused by dryness, at 140;

In the second about winds and the things caused by them (L. 7).

p 1

140. The order which the Philosopher observes seems quite suitable. For after determining about things generated in the upper region of air from dry exhalation, namely, falling stars, comets, the milky circle and like things, he secondly determined about things generated in the lower region from moist exhalation, namely, rains and so on: and because rivers have a cause of their generation in the earth in the same way as rain in the air, after rains he determined about rivers. After this he determines about the sea, into which all rivers flow.

p 1

Concerning this, therefore, he first declares his intention [†138] and says that we must speak now of the sea: namely, as to what its nature is, whether it is the natural place of water or is it by accident that water is gathered there; as to what is the cause of such an abundance of water's being salty; and of the primal generation of the sea, i.e., does it have a source of its generation and how?

p 1

141. Secondly [†139], he pursues his proposition, about which he does two things:

First, he presents the opinions of others about the sea, at 141;

Secondly, he investigates the truth, at 143.

p 1

Concerning the first he does two things:

First, he gives the opinions of ancient theologizers, at 141;

Secondly, of the philosophers of nature, at 142.

p 1

Regarding the first [†139] one must know that before the times of the philosophers there were men called theologizing poets (such as Orpheus, Hesiod and Homer), because under the guise of fables they declared divine things to men. Concerning them, therefore, he says that they posited the sea to have springs of its own from which it is caused. They postulated this so as to avoid attributing to earth and sea extraneous principles not their own: for they believed the earth and sea to be most worthy of reverence, as though they

were a great part of the whole universe; and they said that the whole heaven exists for the sake of earth and water and that that is why earth and water are surrounded by other bodies and by the heaven itself, as though this part were most worthy of honor and the first principle among all the bodies of the universe.

p 1

142. Then [†140] he presents the opinions of the natural philosophers concerning the sea and gives three opinions. The first concerns the generation of the sea and he says that those wiser in "human wisdom" than the aforesaid poets (he says this because the naturalists dealt not with divine things, as did they, but with natural things, which is proper to human wisdom, i.e., conformed to the human intellect), said that the sea has generation. This is because from the beginning the entire region surrounding the earth was wet and full of water, but became dried out by the sun's evaporating the moisture: what evaporated, according to them, caused air and winds (and from this, they say, are caused the movement of the sun and moon and stars); what was left not yet dried up, is the sea. Hence they believe that by a continuous drying-up it is always shrinking, so that finally it will all be dried up and the sea exist no more. This is said to have been the opinion of Anaxagoras and Diogenes.

p 2

The second opinion is about the salt of the sea. For Empedocles said that the earth, warmed by the sun, exudes a certain sweat which, he believed, is the water of the sea. For this reason, so he says, the sea is salty, since the sweat of animals also is found to be salty.

p 2

The third opinion, that of Anaxagoras, also concerns the salt of the sea. He said that the earth through which the water passes, or which is mingled with the water, causes the salt of the sea: for just as something strained through ashes becomes salty, so the water of the sea becomes salty by an admixture of earth.

p 2

143. Then [†141] he searches for the truth regarding these opinions.

First, about the opinion of the theologizing poets at 143;

Secondly, about the opinions of the philosophers of nature (L. 2).

p 2

About the first he does two things:

First, he shows that the sea has no springs, as they said, at 143;

Secondly, he gives an answer to something seemingly contrary to his own argument, at 145.

p 2

Concerning the first [†141] he presents two arguments. The first is that among the waters surrounding the earth, some can flow and some are stationary. Of those that flow it is plain that all are derived from springs. But this does not mean that the springs have as their source, as it were, a container holding a vast store of water, from which rivers are derived: it means, as already stated, that from the many places where it is formed little by little [drop by drop], the water comes together, and that it is by such confluence that it for the first time comes to be in so great a quantity. But with regard to stationary waters, some are collected and held in one place by something artificial or natural that obstructs the flow, and are called marshes or ponds. These differ by reason of largeness or smallness: for if a large store of water has been thus collected, it is called a pond; if a little, a marsh. Now, some stationary waters are "fountainous," i.e., they subsist in their own source; all such are man-made, for example, wells. For all such waters thus stationary

subsist in their own source, all such are man-made, for example, wells. For all such waters thus stationary through art must have a spring, which would make them flow unless they were artificially prevented. Hence it is plain that all water from fountains and rivers flows of itself according to the inclination of nature, or, if it is to be stationary, must be made so artificially.

p 2

In the light of the foregoing it is plain that the water of the sea does not come from springs, because it falls within neither of the groups mentioned: it does not flow, as river water does, and we cannot say that it is man-made, as a well is. But all waters that come from springs either flow or are stationary by art — unless you include small bodies of water that stand of themselves and not artificially, as when flowing water finds its way into a hollow or meets an obstacle. But such water cannot exist in large amounts: because when the flowing water increases, it must either run over the obstacle and start to flow again, or be submerged within the earth, as, we have said, happens in many places. Hence it cannot be said that such a quantity of water as the water of the sea could be standing of itself, if it arose from springs. The conclusion, therefore, is that the sea does not have springs.

p 3

144. He gives the second argument [†142] and says that there are many seas that have no communication with any other. For the Red Sea joins but slightly with the Ocean Sea beyond the columns of Hercules: from which sea the Hyrcanian and Caspian (which is the sea of Pontus) are far removed. If they had springs, the people who live along all the sides of the sea would not have failed to discover them. It is therefore not true that springs of the sea exist.

p 3

145. Then [†143] because a common flow is apparent in some seas, lest it be supposed that the sea can flow, as if proceeding from springs, the contrary of which he had supposed in the first argument, he assigns the cause of the flow seen in the sea. About this he does three things:

First, he shows why some sea flows, at 145;

Secondly, he manifests what he supposed with a sign, at 146;

Thirdly, he summarizes at end of 146.

p 3

Now he assigns three causes of the sea's flowing [†143]. The first is that the sea flows because of its narrowness, where, from being a vast flood, it is confined into a small place because of being narrowed by adjacent land. Now the water of the sea is often moved back and forth, especially as a consequence of the movement of the moon, whose proper nature it is to agitate the moist: but this commotion of water in a large open sea goes unnoticed, but where it occurs in an area rendered small by the narrowness of the land it becomes more noticeable.

p 3

The second cause is that the sea which is contained within the columns of Hercules and does not communicate with any other sea (as was already said of the Sea of Pontus), that sea, I say, flows on account of the large number of rivers. And, for the same reason, one sea flows into another: for Maeotis flows into the Sea of Pontus and the Pontus into the Aegean. In other seas this is not so evident; but in the ones mentioned this happens on account of the number of rivers, for many rivers flow into them.

p 3

The third reason for the flow is that a sea covers a great deal of earth, in keeping with the quantity of the

The third reason for the flow is that a sea covers a great deal of earth, in keeping with the quantity of the water, and one sea is not as deep as another; but the one that is not so deep always flows to the deeper one. Hence that sea to which another flows is always seen to be deeper: as, for example, the Pontus is deeper than Maeotis, the Aegean than the Pontus, and the sea of Sicily deeper than the Aegean; but the Sofian and the Etruscan are the deepest of all. The sea beyond the Columns, however, is not deep, as is evident from the mud in the water flowing out of it. An indication of this is that it is calm, as though it were in a hollow. Therefore, just as individual rivers are seen flowing from higher to lower places, so in the sea, the flow is from the loftier places of the earth, which are in the north: consequently, the northern seas, from which water flows, are not as deep as those in the south which receive it.

p 3

146. Then [†144] through a certain sign he manifests what he had said, namely, that the earth is higher toward the north. He takes as an indication of this the fact that some of the ancients believed that the sun did not go below the earth but only around it and that it became invisible at night because the northern heights obscured it. — Then [†145] he summarizes what he had said — and it is plain in the text.

Lecture 2 (Aristotle's Text)

354b1-354b3

2. [146] We must now discuss the origin of the sea, if it has an origin, and the cause of its salt and bitter taste.

354b4-354b19

[147] What made earlier writers consider the sea to be the original and main body of water is this. It seems reasonable to suppose that to be the case on the analogy of the other elements. Each of them has a main bulk which by reason of its mass is the origin of that element, and any parts which change and mix with the other elements come from it. Thus the main body of fire is in the upper region; that of air occupies the place next inside the region of fire; while the mass of the earth is that round which the rest of the elements are seen to lie. So we must clearly look for something analogous in the case of water. But here we can find no such single mass, as in the case of the other elements, except the sea. River water is not a unity, nor is it stable, but is seen to be in a continuous process of becoming from day to day. It was this difficulty which made people regard the sea as the origin and source of moisture and of all water. And so we find it maintained that rivers not only flow into the sea but originate from it, †1 the salt water becoming sweet by filtration.

354b20-354b23

[148] But this view involves another difficulty. If this body of water is the origin and source of all water, why is it salt and not sweet? [149] The reason for this, besides answering this question, will ensure our having a right first conception of the nature of the sea.

354b24-354b32

The earth is surrounded by water, just as that is by the sphere of air, and that again by the sphere called that of fire (which is the outermost †2 both on the common view and on ours). Now the sun, moving as it does,

sets up processes of change and becoming and decay, and by its agency the finest and sweetest water is every day carried up and is dissolved into vapour and rises to the upper region, where it is condensed again by the cold and so returns to the earth. This, as we have said before, †3 is the regular course of nature.

354b33-355a32

[150] Hence all my predecessors †4 who supposed that the sun was nourished by moisture are absurdly mistaken. Some †5 go on to say that the solstices are due to this, the reason being that the same places cannot always supply the sun with nourishment and that without it he must perish. For the fire we are familiar with lives as long as it is fed, and the only food for fire is moisture. †1[151] As if the moisture that is raised could reach the sun! [152] or this ascent were really like that performed by flame as it comes into being, and to which they supposed the case of the sun to be analogous! Really there is no similarity. A flame is a process of becoming, involving a constant interchange of moist and dry. It cannot be said to be nourished since it scarcely persists as one and the same for a moment. This cannot be true of the sun; for if it were nourished like that, as they say it is, we should obviously not only have a new sun every day, as Heraclitus †2 says, but a new sun every moment. [153] Again, when the sun causes the moisture to rise, this is like fire heating water. So, as the fire is not fed by the water above it, it is absurd to suppose that the sun feeds on that moisture, even if its heat made all the water in the world evaporate. [154] Again, it is absurd, considering the number and size of the stars, that these thinkers should consider the sun only and overlook the question how the rest of the heavenly bodies subsist. [155] Again, they are met by the same difficulty as those †3 who say that at first the earth itself was moist and the world round the earth was warmed by the sun, and so air was generated and the whole firmament grew, and the air caused winds and solstices. The objection is that we always plainly see the water that has been carried up coming down again. Even if the same amount does not come back in a year or in a given country, yet in a certain period all that has been carried up is returned. This implies that the celestial bodies do not feed on it, and that we cannot distinguish between some air which preserves its character once it is generated and some other which is generated but becomes water again and so perishes; on the contrary, all the moisture alike is dissolved and all of it condensed back into water.

355a33-355b19

[156] The drinkable, sweet water, then, is light and is all of it drawn up: the salt water is heavy and remains behind, but not in its natural place. For this is a question which has been sufficiently discussed (I mean about the natural place that water, like the other elements, must in reason have), and the answer is this. The place which we see the sea filling is not its natural place but that of water. It seems to belong to the sea because the weight of the salt water makes it remain there, while the sweet, drinkable water which is light is carried up. The same thing happens in animal bodies. Here, too, the food when it enters the body is sweet, yet the residuum and dregs of liquid food are found to be bitter and salt. This is because the sweet and drinkable part of it has been drawn away by the natural animal heat and has passed into the flesh and the other parts of the body according to their several natures. Now just as here it would be wrong for any one to refuse to call the belly the place of liquid food because that disappears from it soon, and to call it the place of the residuum because this is seen to remain, so in the case of our present subject. This place, we say, is the place of water. Hence all rivers and all the water that is generated flow into it: for water flows into the deepest place, and the deepest part of the earth is filled by the sea. Only all the light and sweet part of it is quickly carried off by the sun, while the rest remains for the reason we have explained.

Lecture 2 (Aquinas' Commentary)

p 4
Lecture 2

The sea is shown to be the natural place of all water.

p 4
147. Here he begins to search into the truth about the opinions which the ancient natural philosophers held about the sea.

p 4
First, he shows what his intention is about [†146] and says that it is about the generation of the sea: if it was made, and of its savor — as to what is the cause of its salty and bitter taste;

Secondly, he pursues the proposition, at 148.

p 4
This is divided into three parts:

In the first he determines about the nature of the sea: whether it is the natural place of water, at 148;

In the second about its generation: whether or not it was made (L. 4);

In the third about its savor: why it is salty (L. 5).

p 4
The first part is divided into two parts:

In the first he shows the opinion of the ancients about the nature of the sea, at 148;

In the second he objects against it, at 149.

p 4
148. He says therefore first [†147] that the ancients thought the sea to be the source of all water, and that it is the substance and body of the totality of water, as though the sea were the natural place of water. And the cause which led them to this was that it seemed reasonable that, just as the main bulk of all other elements is gathered into one place, and there is one source from which are derived those portions of that element which mingle with other elements, due to the size of the elemental substance, so too with water. For we observe that the main body of fire exists in the upper region of this lower world, which is its natural place; likewise, the main body of air exists under the region of fire, as though gathered together in its appropriate place; and it is plain that the body of earth is in the center, around which all other bodies are ordered. Hence it is plain that according to the same reasoning, it is also necessary that there be a place where the main bulk of water be congregated, as in its proper and natural place.

p 4
Such a place can be naught but the sea: because the waters of streams are not all of them together, whereas for one element there must be one continuous place. Further, the water of rivers is not stationary but

flowing, whereas every element must be stable in its proper place — for the water of rivers flows so as to seem to be forever coming into existence and not remaining in the same place.

p 4

On account of this problem they thought that the sea was the source of all water and of all moist things. On which account they thought that all rivers not only flow into the sea, but from it as well — since the natural place of an element seems to be the source and terminus of the movements of all things that possess its nature, for all things naturally tend to their own place. And according to the ancients it was also the source since they held the elements to be ungenerated and incorruptible — hence water was not newly generated. Thus, wherever water might be found outside its proper place, it would have had to have flowed from the natural place of water.

p 4

And because one could object that the sea is salty, whereas the water of rivers is sweet, and consequently does not seem to flow from the sea, they add, to dismiss this objection, that when something salty is filtered, it becomes sweet; and so sea water, when filtered through earth, becomes drinkable in rivers.

p 5

149. Then [†148] he raises certain doubts about these previous determinings:

First, a doubt against the sea's being the natural place of water, at 149;

Secondly, against the sea's being the terminus of running waters (L. 3).

p 5

About the first he does two things:

First, he raises this doubt [†148], which is as follows: If the sea is the source of all water as though it were the natural place of water, why is sea water not sweet and drinkable but salty? For every element in its primal place is seen to be untransformed and in its natural state — while saltness is not a natural property of water but is due to some transmutations.

p 5

150. Secondly [†149], he solves this doubt. In connection with this, he does three things:

First, from matters already determined he takes something necessary for the solution;

Secondly, from what was proposed he dismisses a certain false opinion, at 151;

Thirdly, he settles the doubt, at 153.

p 5

He says therefore first [†149], that in assigning the cause of this doubt, not only will it be solved, but it will be necessary through it to obtain the correct opinion about the sea. He recalls, therefore, that water is positioned around the earth, as the sphere of fire above the air, and as the sphere of air above the water. For fire is the highest of the elements, whether fire be taken as the heavenly body, as very many hold, or as a body situated under the heavenly body, as he held above. Now, since generation and corruption, and all changes affecting lower bodies, are caused by the movement of the sun, what is finest and sweetest in rarefied water must be, as evaporated continually, brought to an upper region, where it is again condensed by the power of the cold and carried downward to earth. And this is always happening by nature, as already stated

already stated.

p 5

151. Then [†150] he uses this to dismiss a false opinion. First, he cites the opinion and says that from the foregoing it is plain that those ancients should be laughed at who said that the sun was fed by the watery moisture, and that it moved about because the same place cannot always offer this nourishment which it must have or be destroyed by not having it. For they thought that the sun was of a fiery nature. Now it is plain that fire lasts only so long as it is fed, and that the moist alone is its food. Consequently, when the moisture is totally consumed, the fire dies out.

p 5

152. Secondly [†151], he assails this opinion with five reasons. The first is that vapor which is lifted upward does not ascend as far as the sun's place, so as to be its food. This is plain enough from what has been already said.

p 5

Then [†152] he presents the second reason which is that those who held that opinion seemed to think that the rise of vapor to the sun is as the rise of smoke to a flame: from the latter they took their basis for thinking as they do about the sun. But there is no similarity. For a flame never remains the same individual but is continually becoming a new thing by the fact that other and other material is continually enkindled: the matter, originally moist and suitable for combustion, is completely dried up by the fire and ceases to be inflamed, and is then succeeded by other matter. And so it is plain that a flame is not fed, because what is fed must retain its identity, as is plain in animals and plants, whereas a flame persists as though for no time at all, as has been said. Now such a state of affairs cannot be true of the sun: for if it were fed in the way they claim, it would be re-born continually and not just once every day, as Heraclitus postulated.

p 6

He presents the third reason [†153] and says that the rising of moist vapor to the sun is akin to the boiling of water in pans over a fire. But the fire burning under the pan is not fed by the evaporating water. Therefore, neither is the sun, if it should cause so much water to evaporate.

p 6

He presents the fourth reason [†153] and says that it is inconsistent to postulate food for the sun only and not for the other stars, if they are to remain healthy, since they too are assumed by them to be of a fiery nature. Indeed, these stars are so many and so large that the totality of water would not be enough to feed them.

p 6

He presents the fifth reason [†155] and says that this argument is both against this position and against those who held that in the beginning the entire earth was covered with water, but that later, as the water was evaporated by the sun's heat, air was formed; and as a consequence, the whole heaven grew by the fact that air, being more rarefied, occupies more place than the water from which it is generated; what has been thus resolved out of water is the cause of winds and of the heaven's movement. Both, therefore, of these opinions are destroyed by the fact that we plainly see the return to earth of whatever has been lifted upward from the water. And if it does not return to the same place and equally in all places (for in some regions there is more evaporation than rainfall), yet in various places, according to a certain order of time, all the matter that has been borne aloft returns again to earth. And so it is plainly not so that higher bodies are fed by vapors or that one portion of the vapors remains air and another returns to water.

p 6

153. Then [†156] he concludes the solution of the aforesaid doubt, and says that since vapor is borne aloft, that which is sweet and drinkable is wholly carried up because of being lighter, whereas that which is salty, being heavier, remains below as in its proper place. For it seems to be reasonably and fittingly held in the difficulty previously set down that the sea is the natural place of water — for it is unreasonable that water should not have a proper natural place as do the other elements. But the solution of the difficulty raised against this from the saltness of the sea is that the place occupied by the sea is the natural place of water *qua* water; whereas it seems to be the natural place of sea water only, because that which is salt remains below because of its heaviness, while the sweet is evaporated aloft, because of its lightness.

p 6

He gives an example based on what happens in the bodies of animals. Although the food taken in is sweet and moist, the residue that remains of the food, as well as the superfluous nutriment, appears bitter and salty, because the sweet element has been drawn to flesh and to every part of the body by natural heat, according as each several part is naturally apt to be nourished. By analogy to this, he concludes that, just as it would be strange for a person to suppose that the belly is not the place of food but only of the residue, on the ground that when the members are being nourished, the matter of the food is forthwith removed from the belly and the residue remains, and such a person would not be judging wisely, because, as we have already said, it is the natural place of food *qua* food, and not just of the food present in the belly, so too at present, the place occupied by the sea is the natural place of water. Indeed, all water moves toward the sea as to its proper place; for the flow of water is toward what is more concave, as is the place of the sea. But although this is the natural place of water, yet what is sweet is forthwith borne aloft, because of the sun raising the vapor, while what is salty remains below for the reason already given.

Lecture 3 (Aristotle's Text)

355b20-355b32

[157] It is quite natural that some people should have been puzzled by the old question why such a mass of water leaves no trace anywhere (for the sea does not increase though innumerable and vast rivers are flowing into it every day). [158] But if one considers the matter the solution is easy. The same amount of water does not take as long to dry up when it is spread out as when it is gathered in a body, and indeed the difference is so great that in the one case it might persist the whole day long while in the other it might all disappear in a moment—as for instance if one were to spread out a cup of water over a large table. This is the case with the rivers: all the time they are flowing their water forms a compact mass, but when it arrives at a vast wide place it quickly and imperceptibly evaporates.

355b33-356a14

[159] But the theory of the Phaedo †1 about rivers and the sea is impossible. There it is said that the earth is pierced by intercommunicating channels and that the original head and source of all waters is what is called Tartarus—a mass of water about the centre, from which all waters, flowing and standing, are derived. This primary and original water is always surging to and fro, and so it causes the rivers to flow on this side of the earth's centre and on that; for it has no fixed seat but is always oscillating about the centre. Its motion up and down is what fills rivers. Many of these form lakes in various places (our sea is an instance of one of these), but all of them come round again in a circle to the original source of their flow, many at the same point, but some at a point opposite to that from which they issued; for instance, if they started from the other side of the earth's centre, they might return from this side of it. They descend only as far as the centre, for after that all motion is upwards. Water gets its tastes and colours from the kind of earth the rivers happened to flow through.

356a15-356a31

[160] But on this theory rivers do not always flow in the same sense. For since they flow to the centre from which they issue forth they will not be flowing down any more than up, but in whatever direction the surging of Tartarus inclines to. But at this rate we shall get the proverbial rivers flowing upwards, †2 which is impossible. [161] Again, where is the water that is generated and what goes up again as vapour to come from? For this must all of it simply be ignored, †3 since the quantity of water is always the same and all the water that flows out from the original source flows back to it again. [162] This itself is not true, since all rivers are seen to end in the sea except where one flows into another. Not one of them ends in the earth, but even when one is swallowed up it comes to the surface again. [163] And those rivers are large which flow for a long distance through a low-lying country, for by their situation and length they cut off the course of many others and swallow them up. †1 This is why the Istrus and the Nile are the greatest of the rivers which flow into our sea. Indeed, so many rivers fall into them that there is disagreement as to the sources of them both. †2[164] All of which is plainly impossible on the theory, and the more so as it derives the sea from Tartarus.

356a32-356b3

[165] Enough has been said to prove that this is the natural place of water and not of the sea, and to explain why sweet water is only found in rivers, while salt water is stationary, and to show that the sea is the end rather than the source of water, analogous to the residual matter of all food, and especially liquid food, in animal bodies.

Lecture 3 (Aquinas' Commentary)

p 7
Lecture 3

Why the sea does not increase. Rejection of Plato's Tartarus

p 7
154. Here the Philosopher raises another doubt, against the position that the sea is the terminal of rivers. About this he does three things:

First, he raises the doubt which he says is an old one [†157]: namely, why is it that, whereas rivers without number and of immense size enter the sea every day, it does not seem to grow and gives no evidence that such a vast amount of water is flowing into it?

p 7
155. Secondly [†158], he solves the problem and says that, although it is not unfitting that some should be puzzled at this, yet, after careful consideration, it is not difficult to see the solution. Thus, if an amount of water is poured over a certain surface, and the same volume is poured out in different areas, then, if the size of the surface is not the same, the time required for the drying-up of the water poured out is not equal, but there will be a difference arising from the difference of surface on which the water is poured, so that sometimes the water remains and does not dry up for a whole day, while sometimes it dries up under one's very eyes. For example, if someone should pour a cup of water upon a large table, all the water would dry up at once; but if the same amount were poured into some small place, it would be preserved for a long time. This is what happens with rivers and the sea: for the total water coming from the rivers to the sea is spread out over an area of the greatest latitude, and is forthwith imperceptibly dried up by the continuous evaporation of water, concerning which we spoke above.

p 7
156. Thirdly [†159], he excludes a certain false solution to this problem. First, he gives the solution and says that what Plato says about the sea and rivers in his book entitled the *Phaedo,* cannot be true. For he says there that all rivers and the sea meet at a source under the earth, as though the earth were perforated by the sea and rivers. This source, which according to him, is the source of all waters, is called "Tartarus," a certain vast body of water existing about the center of the world: from it, he says, come all the waters that do not flow, such as the sea and ponds, and waters that do flow, such as springs and rivers. He says further that Tartarus flows in every direction "to each of the rheums," i.e., to each of the streams of water. This happens because that source of all waters is forever in motion, for it has no fixed place in which to rest but is forever in motion about the center, as though wandering to and fro. Thus, when it is surging upward, it produces the "flowing out of rheums," i.e., the streaming of seas and rivers, not only toward that portion of the earth we inhabit; but from many other parts of the earth it pours out other bodies of still water, akin to the sea which exists among us.

p 7

p 7

But all seas and rivers are brought back by a certain cycle to that source whence they emerged, but in various ways. For some return according to the same place whence they flowed out, by a kind of reflex movement; others return along a route contrary to the one along which they emerged, so that, for example, if they emerged from beneath, they would flow back from above. We should not so think of "above" and "beneath" as to think that something could be beneath with respect to the center in which the primal source of waters is postulated: for from the surface of the earth to the center, there is a descent; but further, if the water should proceed beyond in a straight line, the course would be upward — movement from the center being the same as movement upward.

p 8

And according to this it is easy to assign a cause for the various colors and tastes of water: because the flowing water acquires its color and taste from the type of earth through which it flows out.

p 8

157. Secondly [†160], he disposes of the aforesaid position with five reasons. The first is that, since sometimes the rivers return by the same route and sometimes by a contrary one, it follows, according to this position, that the flow of rivers is not consistently in the same direction. For since they return to the center from which they flowed, they will not flow "below" any more than "above," if you compare the surface of the earth to the center, as is always understood. But in relation to the surface of the earth something is "up," and something "down," depending on height and depth. If the movement of rivers is caused from Tartarus' overflow and this overflow is in every direction, it follows that the water, impelled, as it were, by Tartarus, flows indiscriminately in every direction, just as Tartarus in its fluctuation goes in every direction. Consequently, what is said in the proverb will come to pass, namely, an "up" of rivers, i.e., rivers that are higher than the springs or that flow uphill — which is impossible.

p 8

He presents the second reason [†161], namely, that, according to the aforesaid position, it is seen that it would be necessary that an equal amount of water be always preserved — for he posits that as much water as flows from Tartarus returns to the source. Consequently, one must entirely exclude generation of water in the air and elevation of water from the earth by vaporizing — which is plainly false.

p 8

He presents the third reason [†162], namely, that all rivers end at the sea which do not terminate at other rivers, and no river so ends in the earth as though perforating the earth and going to Tartarus. Indeed, if there are any rivers entering into the concavity of the earth, they emerge again at some other spot. Consequently, it is not seen to be true that rivers return to Tartarus.

p 8

The fourth reason which he presents [†163] is this: if the course of rivers is caused by what flows out of Tartarus, it would be necessary that rivers have a vast abundance of water from the very start. But this we do not observe: among rivers, those are found to be large which flow a long course, since they receive the flowings of many rivers and cut off their route both as to place, because they are deeper and more concave, and as to length, because they follow a longer course. This is why the Ister, i.e., the Danube, and the Nile are the largest rivers flowing into the Mediterranean Sea, and concerning their sources different ones say different things, because of the variety of rivers that enter them.

p 8

He presents the fifth reason [†164], namely, that over and above the unacceptable aspects already indicated, there is also the fact that it would follow that the sea has its source from Tartarus. And this is not fitting,

because, as has been said, the sea is seen to be the natural place of water.

p 8

158. Thirdly [†165], he brings together what has been said above. And he says that so much has been said about the fact that the place which the sea occupies is the natural place of water and not just the natural place of the "sea," i.e., of salt water. And it has been stated why what is drinkable and sweet does not show up in the sea but does in flowing water: what is salty subsides in the sea, being, as it were, the residue from the evaporation of what is drinkable and sweet. Furthermore, it has been said that the sea is rather the end than the source of waters: since, namely, water is generated outside the sea, both in the air above (as was said of the generation of rain), and within the earth (as was said of the generation of springs and rivers); nevertheless, no matter where it is generated, water flows to the sea, unless it is prevented. And thus, salt water is akin to the residue of food in the bodies of animals: for the residue of food is salty and bitter. This is true of the residue of any food, but especially of moist food, as in the case of urine, which is more undigested and therefore more bitter and salty, as is evident.

Lecture 4 (Aristotle's Text)

356b4-356b6

3. [166] We must now explain why the sea is salt, and ask whether it eternally exists as identically the same body, or whether it did not exist at all once and some day will exist no longer, but will dry up as some people think.

356b7-357a4

[167] Every one admits this, that if the whole world originated the sea did too; for they make them come into being at the same time. It follows that if the universe is eternal the same must be true of the sea. [168] Any one who thinks like Democritus †3 that the sea is diminishing and will disappear in the end reminds us of Aesop's tales. His story was that Charybdis had twice sucked in the sea: the first time she made the mountains visible; the second time the islands; and when she sucks it in for the last time she will dry it up entirely. Such a tale is appropriate enough to Aesop in a rage with the ferryman, but not to serious inquirers. [169] Whatever made the sea remain at first, whether it was its weight, as some even of those who hold these views say (for it is easy to see the cause here), or some other reason—clearly the same thing must make it persist for ever. They must either deny that the water raised by the sun will return at all, or, if it does, they must admit that the sea persists for ever or as long as this process goes on, and again, that for the same period of time that sweet water must have been carried up before-hand. So the sea will never dry up: for before that can happen the water that has gone up beforehand will return to it: †1 for if you say that this happens once you must admit its recurrence. If you stop the sun's course there is no drying agency. If you let it go on it will draw up the sweet water as we have said whenever it approaches, and let it descend again when it recedes. [170] This notion about the sea is derived from the fact that many places are found to be drier now than they once were. Why this is so we have explained. †2 The phenomenon is due to temporary excess of rain and not to any process of becoming in which the universe or its parts are involved. Some day the opposite will take place and after that the earth will grow dry once again. We must recognize that this process always goes on thus in a cycle, for that is more satisfactory than to suppose a change in the whole world in order to explain these facts. But we have dwelt longer on this point than it deserves.

Lecture 4 (Aquinas' Commentary)

p 9

Lecture 4

Whether the sea always was, and always will be

p 9

159. After determining the nature of the sea, showing that it is the natural place of water, the Philosopher here inquires into its generation.

First, he indicates his intention [†166], and says that we must speak about the salt of the sea, and furthermore, about whether the sea is eternal or whether there was a time when the sea was not, and there will be a time when the sea will not be, but will completely cease.

p 9

160. Secondly, he pursues the proposition by disproving the theories of others on this matter:

First, he disproves the theories of the ancients;

Secondly, he excludes their reason, at 163.

p 9

About the first he does two things:

First, he disproves the theories of the ancients about the sea's coming into existence [†167] and says that some have thought that the sea has not always existed but began to exist at some time. They also posited that the entire world began to exist as the result of some process of generation and stated that the sea began with the world. This was not unreasonable, since, the sea being in a sense the place of water, which is one element, it must be among the principal parts of the world. Hence, whenever the world existed, the sea did. And therefore, just as they argue that, because the world was generated, the sea was generated, so we can argue conversely, that if the world is perpetual, so too is the sea. But that the world is perpetual, he presupposes from what he proved in the *Physics* and in *On the Heavens* — although this is false and alien to the faith, as was said above.

p 9

161. Secondly [†168], he disproves the opinions of the ancients about the disappearance of the sea. First he compares this theory to fables. And he says that to think that the sea will diminish in size and at length disappear, as Democritus said, is no different than the ideas in the fables of Aesop, who stated in a fable that Charybdis, a certain deep chasm in the sea, has twice absorbed the sea, in such a manner that previously water covered the entire earth, and this chasm imbibed enough water for the mountains to appear, having been uncovered from the water, and also the land between them; the second time it took in enough for islands to appear; the final time, it will swallow all the water of the sea, and thus there will everywhere remain dry land without the sea. But although to compose such a fable befits Aesop, the inventor of fables, who uttered this one when perhaps in a fit of anger with a "porthmeum," i.e., some harbor or seashore, so that, being angry with the waters, he pretended that all waters were destined to be swallowed up, yet, the utterance of such tales is less fitting for philosophers seeking the truth.

p 9

162. Secondly [†169], he disproves the aforesaid theory with a reason. And he says that whatever be the cause on account of which water first surrounded the earth, it will necessarily remain forever: whether it be said that this happens on account of the heaviness of water, whose weight makes it abide beneath the air and above the earth (which, indeed, is the true and manifest cause), or whatever else the cause may be, nevertheless, because of this, it must be that, if the water of the sea was at some time on the earth, it remain forever. For otherwise, if this were not so, they would have to say that the evaporated water borne aloft by the sun, does not return again to earth (the opposite of which is plain in the case of rain). Or, if the elevated water returns, it must needs be either that the sea always abide, if water is forever borne aloft and returns, or that it abide so long as the phenomenon of water returning shall continue. Further, it will be necessary for that which is drinkable in water to be borne aloft by evaporation. Consequently, the sea will never grow

dry in such an alternation — since the water will return once more to the sea.

p 10

And it makes no difference whether this happens once, namely, that the elevated water descend again, or a number of times: for in either case, no water is lost. Because it could, however, be claimed that this alternating process will not last forever, if the movement of the sun were to cease, he therefore adds that if anyone should say that the motion of the sun will cease, there will be nothing left to cause the sea's drying up; but if the motion of the sun abides forever, then it will always be necessary that the sun, as it approaches some region of the earth, lift up water by evaporation, and, when it departs from that region, that the water should fall, by reason of the cold. And so it cannot be said that the sea will entirely dry out, whether the motion of the sun continues or ceases.

p 10

163. Then [†170] he dismisses the reason moving them to posit their theory. And he says that they took up this theory (namely, that the sea would become wholly dry, and that it began at some time to exist), because there are many places that seem drier now than formerly. But the cause of this passion has not been given before, namely, the fact that at certain determinate times an excess of water is produced, and not because the universe as a whole is in the process of becoming — although its parts are. Then, at other determinate times, the contrary will come to pass, namely, there will be an excessive drought. When this shall have come about, the land will again be dried out which had been covered with water by the previous excess of water. And it is necessary that this proceed always in a cyclic way, namely, that after an excess of water there be, at a definite time, an excess of dryness, and vice-versa. This is more reasonable than the theory that the whole heaven is undergoing change just because of certain particular changes taking place around the earth.

p 10

And because this theory against which he has spoken appears reasonable on the surface, he remarks that his discussion has lingered longer on this point than it deserves.

Lecture 5 (Aristotle's Text)

357a5-357a14

[171] To return to the saltness of the sea: those who create the sea once for all, or indeed generate it at all, cannot account for its saltness. It makes no difference whether the sea is the residue of all the moisture that is about the earth and has been drawn up by the sun, or whether all the flavour existing in the whole mass of sweet water is due to the admixture of a certain kind of earth. Since the total volume of the sea is the same once the water that evaporated has returned, it follows that it must either have been salt at first too, or, if not at first, then not now either. If it was salt from the very beginning, then we want to know why that was so; and why, if salt water was drawn up then, that is not the case now.

357a15-357a23

[172] Again, if it is maintained that an admixture of earth makes the sea salt (for they say that earth has many flavours and is washed down by the rivers and so makes the sea salt by its admixture), it is strange that rivers should not be salt too. How can the admixture of this earth have such a striking effect in a great quantity of water and not in each river singly? For the sea, differing in nothing from rivers but in being salt, is evidently simply the totality of river water, and the rivers are the vehicle in which that earth is carried to their common destination. †1

357a24-357b6

[173] It is equally absurd to suppose that anything has been explained by calling the sea 'the sweat of the earth', like Empedocles. †2 Metaphors are poetical and so that expression of his may satisfy the requirements of a poem, but as a scientific theory it is unsatisfactory. Even in the case of the body it is a question how the sweet liquid drunk becomes salt sweat—whether it is merely by the departure of some element in it which is sweetest, or by the admixture of something, as when water is strained through ashes. Actually the saltness seems to be due to the same cause as in the case of the residual liquid that gathers in the bladder. That, too, becomes bitter and salt though the liquid we drink and that contained in our food is sweet. If then the bitterness is due in these cases (as with the water strained through lye) to the presence of a certain sort of stuff that is carried along by the urine (as indeed we actually find a salt deposit settling in chamber-pots) and is secreted from the flesh in sweat (as if the departing moisture were washing the stuff out of the body), then no doubt the admixture of something earthy with the water is what makes the sea †3 salt.

357b7-357b21

Now in the body stuff of this kind, viz. the sediment of food, is due to failure to digest: but how there came to be any such thing in the earth requires explanation. [174] Besides, how can the drying and warming of the earth cause the secretion of such a great quantity of water; especially as that must be a mere fragment of what is left in the earth? [175] Again, waiving the question of quantity, †4 why does not the earth sweat now when it happens to be in process of drying? †1 If it did so then, it ought to do so now. But it does not: on the contrary, when it is dry it grows moist, but when it is moist it does not secrete anything at all. How then †2 was it possible for the earth at the beginning when it was moist to sweat as it grew dry? Indeed, the theory †3 that maintains that most of the moisture departed and was drawn up by the sun and that what was left over is the sea is more reasonable; but for the earth to sweat when it is moist is impossible.

Lecture 5 (Aquinas' Commentary)

p 11
Lecture 5

The saltness of the sea according to the opinions of others

p 11
164. After determining about the nature of the sea and about its generation, the Philosopher now determines about its saltness.

First, he inquires about it according to the opinions of others;

Secondly, he presents his own opinion (L. 6).

p 11
With respect to the first he continues with the salt of the sea according to the three opinions of the natural philosophers presented in the beginning of this treatise on the sea.

p 11
165. He says therefore first [†171] that those who declared that the sea was at one time generated, or posit its generation in any way, cannot assign a reason for its saltness. For they say that in the beginning water surrounded the entire earth and that the sun raised aloft a great portion of the water, leaving a large area of the earth no longer covered with water, and that the residue, not yet dried up by the sun, became the sea. Now, if the cause of salt in the totality of the sea's water (which according to its nature ought to be sweet), came about because of earth's mixing with the water that remained, which was able to convert the sweet into so great saltness, then, since, with the return in the form of rain of the evaporated water, there necessarily results an equal amount of water's being preserved on earth, as was said, it is necessary that even in the first place, before the sun began its drying process, that the sea be salty; or if it was not salty before, it will not be salty later, because all the evaporated water returns. Consequently, it cannot be said that mixing with earth makes the water salty because now it exists in a smaller amount, while it could not make the total amount salty — since the amount both now and before is equal. But if the sea was salty from the start, it will remain to assign a cause of its saltness. Moreover, one should state why, if water was not borne aloft by evaporation from the very beginning, this happens now.

p 11
166. Then [†172] he continues with the second opinion, and says that they who declared that mixing with earth to be the cause of the sea's saltness fail to explain sufficiently why the sea is salty. For they claim that the earth has many tastes according to its various areas, so that the earth which the rivers transport to the sea mingles with the sea and makes it salty.

p 11
But this seems unacceptable, namely, that the sea become salty through mixing with earth, while the rivers, which are smaller, are not salty. Indeed, if the vast quantity of the water of the sea is changed to salt by

mixing with earth, the water of every river should, with even greater reason, be changed. For it is plain that the sea is an assemblage of all river waters — for the water of the sea differs from the water of rivers only by its saltness — something that does not occur in the waters of rivers, but only in the place where all the rivers come together. And this does not seem possible, if the sole mixing of earth transported by the rivers were to be the cause of saltness.

p 11

167. Thirdly [†173], he disproves the third opinion with three arguments. The first of these is taken from the fact that it assigned a non-evident cause of the saltness. And he says that it is ridiculous for someone to think he is speaking plainly, when he says that the sea is the earth's sweat and is for that reason salty, as Empedocles said. This perhaps satisfies the demands of metaphorical utterances according to the manner of poets — for to speak in metaphors pertains to poets, and it is probable that Empedocles, who wrote in meter, so they say, uttered many things metaphorically. But such a manner of speaking is not sufficient for knowing the nature of a thing; because a natural thing is not revealed by the comparisons employed in a metaphor. For how does it come about that what a man drinks is sweet, whereas the sweat generated therefrom will be salty? The metaphor does not make it clear whether the sweat remains salty because of the separation of something that was very sweet in the drink, or by a mixing with something, as happens when water is strained through ashes, for by mixing with ashes it is made salty or bitter. And the same cause seems to be at work in the taste of urine, which is a superfluity collected in the bladder: for this residue becomes bitter and salty, although the moisture imbibed was sweet.

p 12

Now, if it is true that water becomes bitter because it is strained through lime, and likewise if along with urine is carried something of such virtue as to make it salty (for when urine is kept standing in chamber-pots a certain salty sediment is found to settle); and likewise with sweat, something similar adheres to it when the sweat is exuded from the flesh, which makes it salty, as though the moisture leaving the body in the form of sweat washed from the flesh a residue which makes the sweat salty; if, I say, this is so in these three cases, and if the metaphor about sweat is rightly taken, then it is plain that also in the case of the sea, the cause of saltness will be something earthy mixing with the waters. But we know the cause of salt in the body of an animal, in sweat and in urine: it is the "hypostasis of food," i.e., the subsisting residue from what is appropriated as food by anything fed. The reason why it is salty is that it has not been digested. But what it is that can in like manner produce salt in the sea Empedocles has yet to say, since this is not manifest. And so it is plain that Empedocles sinned in this: that he did not clearly indicate the cause.

p 12

168. He presents the second argument [†174]; namely, that in spite of the drying up and warming of such a vast amount of water as is taken from the sea, nevertheless the whole water of the sea still remains salty. Now the portion raised away from the earth by evaporation is a submultiple of the water left on the earth (that is called "submultiple" which is to another as 1/2 is to double, or 1/3 to triple, and so forth). Hence it does not seem that the water of the sea, since it is a greater amount than the water borne up by evaporation can become salty from this, for sweat and urine, both of which are salty, are much less in volume than the moisture remaining in the body.

p 12

169. He presents the third argument [†175], and says that Empedocles must be asked why it is that after being dried out in various small or large areas by the sun, the earth does not now sweat with a sweat that seems bitter: for if it was true in the beginning that the earth sweated a bitter moistness, it should be doing so even now. But this is not seen to be happening now: for we see that the earth, when moist, can be dried out, and after it is dried out, it does not undergo anything like this, i.e., sweating. Neither, therefore, was it possible in the primal generation of the world, when the earth was moist (because it was covered with

water), for it to sweat through being dried out. Closer to the truth is the theory upheld by those who said that the sea is not the sweat of the earth but is water left after some portion of the earth did dry out. However, that the earth should sweat when moist, seems impossible.

p 12

And so he finally concludes that the causes alleged for the saltness of the sea are seen to elude reason.

Lecture 6 (Aristotle's Text)

357b22-357b24

[176] Since all the attempts to account for the saltness of the sea seem unsuccessful let us explain it by the help of the principle we have used already. †4

357b25-357b26

Since we recognize two kinds of evaporation, one moist, the other dry, it is clear that the latter must be recognized as the source of phenomena like those we are concerned with.

357b27-358a3

But there is a question which we must discuss first. Does the sea always remain numerically one and consisting of the same parts, or is it, too, one in form and volume while its parts are in continual change, like air and sweet water and fire? All of these †5 are in a constant state of change, but the form and the quantity †6 of each of them are fixed, just as they are in the case of a flowing river or a burning flame. The answer is clear, and there is no doubt that the same account holds good of all these things alike. They differ in that some of them change more rapidly or more slowly than others; and †7 they all are involved in a process of perishing and becoming which yet affects them all in a regular course.

358a4-358a28

[177] This being so we must go on to try to explain why the sea is salt. There are many facts which make it clear that this taste is due to the admixture of something. First, in animal bodies what is least digested, the residue of liquid food, is salt and bitter, as we said before. All animal excreta are undigested, but especially that which gathers in the bladder (its extreme lightness proves this; for everything that is digested is condensed), and also sweat; in these then is excreted (along with other matter) an identical substance to which this flavour is due. The case of things burnt is analogous. What heat fails to assimilate becomes the excrementary residue in animal bodies, and, in things burnt, ashes. [178] That is why some people say that it was burnt earth that made the sea salt. To say that it was burnt earth is absurd; but to say that it was something like burnt earth is true. We must suppose that just as in the cases we have described, so in the world as a whole, everything that grows and is naturally generated always leaves an undigested residue, like that of things burnt, consisting of this sort of earth. All the earthy stuff in the dry exhalation †1 is of this nature, and it is the dry exhalation which accounts for its great quantity. Now since, as we have said, the moist and the dry evaporations are mixed, some quantity of this stuff must always be included in the clouds and the water that are formed by condensation, and must redescend to the earth in rain. This process must always go on with such regularity as the sublunary world admits of, and it is the answer to the question how the sea comes to be salt.

question how the sea comes to be salt.

358a29-358b7

[179] It also explains why rain that comes from the south, and the first rains of autumn, are brackish. The south is the warmest of winds †2 and it blows from dry and hot regions. Hence it carries little moist vapour and that is why it is hot. (It makes no difference even if this is not its true character and it is originally a cold wind, for it becomes warm on its way by incorporating with itself a great quantity of dry evaporation from the places it passes over.) The north wind, on the other hand, coming from moist regions, is full of vapour and therefore cold. It is dry in our part of the world because it drives the clouds away before it, but in the south it is rainy; just as the south is a dry wind in Libya. So the south wind charges the rain that falls with a great quantity of this stuff. Autumn †1 rain is brackish because the heaviest water must fall first; so that that which contains the greatest quantity of this kind of earth descends quickest.

358b8-358b11

This, too, is why the sea is warm. Everything that has been exposed to fire contains heat potentially, as we see in the case of lye and ashes and the dry and liquid excreta of animals. Indeed those animals which are hottest in the belly have the hottest excreta.

358b12-358b23

[180] The action of this cause is continually making the sea more salt, but some part of its saltness is always being drawn up with the sweet water. This is less than the sweet water in the same ratio in which the salt and brackish element in rain is less than the sweet, and so the saltness of the sea remains constant on the whole. [181] Salt water when it turns into vapour becomes sweet, and the vapour does not form salt water when it condenses again. This I know by experiment. The same thing is true in every case of the kind: wine †2 and all fluids that evaporate and condense back into a liquid state become water. They all are water modified by a certain admixture, the nature of which determines their flavour. But this subject must be considered on another more suitable occasion.

358b24-358b33

[182] For the present let us say this. The sea is there and some of it is continually being drawn up and becoming sweet; this returns from above with the rain. But it is now different from what it was when it was drawn up, and its weight makes it sink below the sweet water. †3 This process prevents the sea, as it does rivers, †1 from drying up except from local causes (this must happen to sea and rivers alike). On the other hand the parts neither of the earth nor of the sea remain constant but only their whole bulk. For the same thing is true of the earth as of the sea: some of it is carried up and some comes down with the rain, and both that which remains on the surface and that which comes down again change †2 their situations.

358b34-359a16

[183] There is more evidence to prove that saltness is due to the admixture of some substance, besides that which we have adduced. Make a vessel of wax and put it in the sea, fastening its mouth in such a way as to prevent any water getting in. Then the water that percolates through the wax sides of the vessel is sweet, the earthy stuff, the admixture of which makes the water salt, being separated off as it were by a filter. †3 It is this stuff which makes salt water heavy (it weighs more than fresh water) and thick. The difference in consistency is such that ships with the same cargo very nearly sink in a river when they are quite fit to navigate in the sea. This circumstance has before now caused loss to shippers freighting their ships in a river. That the thicker consistency is due to an admixture of something is proved by the fact that if you make strong brine by the admixture of salt, eggs, even when they are full, float in it. It almost becomes like mud; such a quantity of earthy matter is there in the sea. The same thing is done in salting fish.

359a17-359b4

Again, if, as is fabled, there is a lake in Palestine, such that if you bind a man or beast and throw it in it

Again if, as is fabled, there is a lake in Palestine, such that if you bind a man or beast and throw it in it floats and does not sink, this would bear out what we have said. They say that this lake is so bitter and salt that no fish live in it and that if you soak clothes in it and shake them it cleans them. The following facts all of them support our theory that it is some earthy stuff in the water which makes it salt. In Chaonia there is a spring of brackish water that flows into a neighbouring river which is sweet but contains no fish. The local story is that when Heracles came from Erytheia driving the oxen and gave the inhabitants the choice, they chose salt in preference to fish. They get the salt from the spring. They boil off some of the water and let the rest stand; when it has cooled and the heat and moisture have evaporated together it gives them salt, not in lumps but loose and light like snow. It is weaker than ordinary salt and added freely gives a sweet taste, and it is not as white as salt generally is. Another instance of this is found in Umbria. There is a place there where reeds and rushes grow. They burn some of these, put the ashes into water and boil it off. When a little water is left and has cooled it gives a quantity of salt. †1

359b5-359b23

Most salt rivers and springs must once have been hot. Then the original fire in them was extinguished but the earth through which they percolate preserves the character of lye or ashes. Springs and rivers with all kinds of flavours are found in many places. These flavours must in every case be due to the fire that is or was †2 in them, for if you expose earth to different degrees of heat it assumes various kinds and shades of flavour. It becomes full of alum and lye and other things of the kind, and the fresh water percolates through these and changes its character. Sometimes it becomes acid as in Sicania, a part of Sicily. There they get a salt and acid water which they use as vinegar to season some of their dishes. In the neighbourhood of Lyncus, too, there is a spring of acid water, and in Scythia a bitter spring. The water from this makes the whole of the river into which it flows bitter. †3 These differences are explained by a knowledge of the particular mixtures that determine different savours. †4 But these have been explained in another treatise. †5

359b24-359b27

[184] We have now given an account of waters and the sea, why they persist, how they change, what their nature is, and have explained most of their natural operations and affections.

Lecture 6 (Aquinas' Commentary)

p 13

Lecture 6

Cause of the sea's saltness according to Aristotle

p 13

170. Having rejected these theories about the salt of the sea, he now presents his own opinion. About this he does three things:

First, he prefaces some things needed for manifesting the proposition;

Secondly, he assigns the cause of the sea's saltness, at 171;

Thirdly, he manifests what he had said through signs, at 177.

p 13

In regard to the first he does two things [†176]. The first item he repeats from the foregoing is that exhalations are of two kinds: one is moist and the other dry; and this must be regarded as the source of these, i.e., of the sea's saltness.

p 13

Secondly, he raises a problem whose true solution must be seen before the proposition is manifested. The problem is this: do the parts of the sea always remain numerically the same or are they changed in number while remaining the same according to quantity, as happens in air and in the drinkable water of rivers and in fire? For in all these the parts become other and other in number, but the species or form of the aggregate of these parts remains the same; and this is especially evident in flowing waters and in a burning flame, which is forever being renewed by successively new fumes, as was said above, and yet the flame always remains the same numerical one. Hence it is probable that all these cases are not exactly the same, for there is at least a difference so far as the rapidity of change is concerned: for it is plain that the parts of a flowing stream are exchanged more rapidly than the parts of the earth. Yet in all these cases there is a generation and corruption according to parts, following a certain order.

p 13

171. Then [†177] he assigns the cause of the sea's salt. About this he does two things:

First, he shows in general from what source a salty savor is produced;

Secondly, from what source is derived the saltness of the sea, at 172.

p 13

He says therefore first [†177] that, since the above are as described, there is need to set forth the cause of the sea's saltness. For it is plain by many signs that the salty taste is caused by an admixture of something. For we see that, in the bodies of animals, what is most undigested is salty and bitter: this is especially the residue of food, and more especially the residue collected in the bladder. That this is least digested is indicated by the fact that it is the most refined of all the residues, whereas all digested things are seen to be thickened by heat. And as with urine, so with sweat: for likewise with sweat, something undigested is separated which gives it this taste. So too with burnt things: because whatever is left after the action of the heat, that the heat cannot overcome, becomes a residue in the bodies of animals, and ash in burned objects, which, if mixed with water, makes it salty and bitter.

p 13

172. Then [†178] he assigns the specific cause of the sea's saltness. About this he does three things:

First, he does what is said;

Secondly, he manifests this through certain signs, at 173;

Thirdly, he excludes some objections, at 174.

p 13

He says therefore first [†178] that since a salty and bitter taste is found to be caused by the admixture of

something undigested or burnt, some have said that the sea was formed out of charred earth. But this is unacceptable if taken in a literal sense; taken as a metaphor, however, namely, in the sense that the saltness in the sea is caused by a mixing with something akin to charred earth, then it is true. For just as it occurs in the aforesaid, namely, in urine, sweat and ashes, so it must be understood even in regard to the earth as a whole: just as burning objects leave a residue of certain items that the fire was unable to dissolve, so too we must understand something to be left with respect to the earth by the action of heat, akin to the ash left by the action of fire. An example of this is the exhalation arising out of dry land, the magnitude of which the earth shows. Now when a dry exhalation of this sort mixes with the moist exhalation that is condensed into clouds and rain, it is necessary that in that moist exhalation there be contained something of the power of that dry exhalation; as a consequence, both mixed together re-descend when it rains. But this always occurs in a definite order: the mingled exhalations are borne aloft and re-descend in the form of rain. I say that this takes place in a definite order, i.e., to the extent that things occurring in the lower regions can participate in order: for they do not participate in order so perfectly as to occur always in the same way as do the heavenly bodies, but so as to occur for the most part. And thus he concludes that this sets forth whence there is generation of salt in the water of the sea.

p 14

173. Then [†179] he manifests what he had said through certain signs. And he says that because the dry exhalation mixes with the moist evaporation, southern waters and the first waters to fall in autumn are brackish, i.e., heavy and more on the salty side.

p 14

First he explains this with respect to "southern" waters, i.e., which fall with the south wind blowing. For the south wind in its blowing and in its size is very warm: for it blows from regions that are hot and dry and have little moisture — that is why it is a hot wind. But because one could say that it blows from a cold region, namely, from the antarctic pole, which must be cold on account of its distance from the sun, he adds that, even supposing that it blows, not from the hot, but from the cold places, nevertheless it must travel toward us through regions close to us that are hot and dry, as to proximate regions: hence it is hot. But the north wind, which comes to us directly from cold regions, collects many moist and cold vapors along with it: therefore, it is a cold wind. Yet for us it brings clear weather, because it drives these vapors in the opposite direction; but in places and regions in the south it is a wet wind, because that is where it drives the vapors. Conversely, a south wind is clear for those who live in the south, namely, around Libya, but for us it is rainy. And so, because a south wind collects a large quantity of dry exhalation, such a wind contributes a great deal to the falling of water that is salty. Thus is made plain the reason for one of the statements, namely, why rains from the south are brackish.

p 14

But because the same was said of the first rains of autumn, he also assigns a cause for this: it is necessary that the heaviest constituents of the vapors carried aloft descend first; but the heaviest are those containing the most earth; and that is why the first waters to fall in autumn after the summer are brackish and have a great deal of what is earthy.

p 14

He gives another sign in support of the reason assigned as the cause of saltness, namely, that the reason why the sea is warm and the regions near the sea are comparatively warmer is due to the abundance of the above-mentioned exhalation mixed with the water of the sea. For things previously afire are seen to possess within themselves the virtue of heat even after the fire has gone out: this is plain in ashes and lime and the excrement of warm-bellied animals. The reason for this is that the virtue of the alterating heat remains in them along with the dry exhalation. Hence, since he had said that the cause of the saltness of the sea was the dry exhalation resolved from dried-out earth, it follows that the sea will also derive an abundance of warmth therefrom.

abundance of warmth therefrom.

p 15

174. Then at [†180] he excludes some doubts on the aforesaid. About this he does two things:

First, he excludes the doubts;

Secondly, from what has gone before he concludes to the cause of the saltness of the sea, at 176.

p 15

The first is divided into two parts according to the two doubts solved; [The second one is solved at 175.]

p 15

The first doubt [†180] is that since the water of the sea does not continue to have numerically the same parts but evaporates and re-descends, it does not seem that the cause of the saltness of the sea is the mixed-in dry exhalation, but rather an evaporation from salt water.

p 15

To remove this doubt he says that the water of the sea is forever becoming other and other as to its parts, and each part has in its generation the aforesaid cause of saltness, namely, the admixture of the earthy exhalation. Now it is also true that some part of the salt water is always being borne aloft with the sweet through evaporation — but since something refined evaporates more quickly than something dense, and the sweet is more refined than the salty, necessarily less of the salty than of the sweet is elevated; but through being mixed with the dry exhalation the sweet again grows in saltness, and thus the sea is forever maintained constant both in quantity and in salt. And this is said of the sea "as a whole," i.e., so far as the whole sea is concerned, it is kept constant or practically so — for the aforesaid quantity is not always kept absolutely exactly.

p 15

175. The solution of the second doubt is at [†181]. The doubt is this: since the water of the sea is salty, what accounts for the fact that sweet water is generated from the vapors resolved from the waters of the sea?

p 15

To answer this he says that we must repeat that what evaporates in the sea becomes, when it is condensed, drinkable and sweet; therefore, it is not converted back into "sea," i.e., into salt water, but into fresh water. This happens to other things: wine and all liquids, when they are condensed, are turned into simple water: for when they evaporate, their condensed vapors are turned into water. The reason for this is that the principle of all moisture is water, and all things are resolved into their principles. Now all other liquids are generated from water which is affected or altered in some way, which affections vary according to the ingredients, and the savor depends on what is mixed in. This explains why, in the process of being generated, water varies and becomes salty. But because each thing is resolved into its principle absolutely, as has been said, the consequence is that whether it is salty sea water, or any liquid whatsoever of any vapor [savor?] you wish, the product of evaporation is simple water.

p 15

176. Then [†182] from all the foregoing he gathers the cause of the salt of the sea. And he says that we must now say that some portion of the water of the sea is forever being raised aloft by evaporation and becomes drinkable when it is condensed; and further, that with the falling water there descends something terrestrial which was borne aloft, not from the water of the sea, but from dry land. And this terrestrial

element because of its weight, sinks below the drinkable and sweet portion, with the result that the finer portion evaporates more. And therefore, as a result of continuous generation and evaporation, neither the sea nor rivers disappear: unless they happen to disappear in certain regions according to certain definite cycles, as mentioned earlier. Moreover, neither do the same parts of the sea or of the earth always remain, but only the whole bulks of both. Thus, we must think of the earth as we do of the sea, namely, that one part is borne aloft through exhalation and another part descends and, furthermore, that the parts on the surface exchange places with those that descend: as a result, every part of both can be corrupted and generated.

p 16

It should be noted that Aristotle, in assigning the cause of the saltness of the sea when treating of the natural place of water above, stated that the saltness of the sea is caused by the evaporation of what is fine and sweet. But this would not be a cause, if nothing foreign were mixed in the sea water — since it would be necessary that what remained be sweet and drinkable, according to the nature of simple water. Consequently, in order to show how the water of the sea is salty, he shows that something foreign is mixed in it, which sinks (after the sweet potable water is elevated) and makes the water of the sea salty. On this account he says that burnt earth is mixed with the vapors from which water is generated. Hence, since each part of the sea is thus generated, it follows that a terrestrial adjunct of this sort is mixed with every part of the sea, and generally sinks below the sweet and fine, the major portion of which is elevated.

p 16

And because sweet water is generated out of what evaporates, and all the water of springs and rivers is generated out of what evaporates, either on the surface of the earth or below the earth, it follows that the water of springs and rivers is sweet, simply because they are close to the source of generation; but the water of the sea is salty, being both the residue of vapors elevated by the sun and the final terminus into which the generated water is collected.

p 16

177. Then [†183] he manifests that the salty savor is caused from a terrestrial mixture. And he gives many signs. The first of these concerns a waxen container sealed and set in water. Whatever seeps in becomes sweet, as though the terrestrial stuff were filtered out by the wax. Another sign is that sea water is heavier than the sweet. A third sign is that sea water is denser than river water, so that ships laden with cargo sink deeper in rivers than in the sea. The fourth sign is that eggs, if full, float in water to which salt has been added and even float in the sea. Hence the sea seems to be like mud on account of its density. Those who make brine take as a sign that the salt has been well mixed with the water, when eggs float on it. Therefore, sea water, too, is dense on account of an admixture of some gross earthy stuff. The fifth sign is that in the lake in Palestine which is salty or bitter, if anyone should immerse a man or ass, it does not sink; and clothing dipped in it becomes fetid.

p 16

The sixth sign concerns a spring of "broad," i.e., salt, water in the province of Chaonia. This spring flows into a river of fresh water in which are no fish, but on account of the mixture contributed by this spring, salt is sometimes found instead of fish. When this water is boiled, salt is left after what is hot and liquid has evaporated. These salts are not coarse but fine as snow; they are weaker than other salts and give greater pleasure in foods.

p 16

The seventh sign is that there is a region in which reeds and rushes are burned. When their ash is cooked in water and cooled, it becomes salty to a degree depending on the proportion of burned earthy matter, which he had said is the cause of saltness. Hence, both in the water of these ashes, as well as in the water of the

sea, there must be a combustion which causes saltness. This is why universally any flowing water of springs and rivers which is salty, was once hot, as though proceeding from ignited earth. Afterwards the fire is extinguished within the earth, which, by the burning, having become sulphurous or something of the sort, still retains the marks of having been burnt, as lime and ashes do — so that water passing through it becomes salty. Indeed, such water not only becomes salty and receives saltness from the earth through which it passes, but also other savors, as he explains with examples (and this is plain in the text). — Finally, he sums up what has been said — and this is also plain in the text.

Lecture 7 (Aristotle's Text)

359b28-360a18

4. [185] Let us proceed to the theory of winds. Its basis is a distinction we have already made. †1 We recognize two kinds of evaporation, one moist, the other dry. The former is called vapour: for the other there is no general name but we must call it a sort of smoke, applying to the whole of it a word that is proper to one of its forms. The moist cannot exist without the dry nor the dry without the moist: whenever we speak of either we mean that it predominates. [186] Now †2 when the sun in its circular course approaches, it draws up by its heat the moist evaporation: when it recedes the cold makes the vapour that had been raised condense back into water which falls and is distributed through the earth. †3(This explains why there is more rain in winter and more by night than by day: though the fact is not recognized because rain by night is more apt to escape observation than by day.) But there is a great quantity of fire and heat in the earth, and the sun not only draws up the moisture that lies on the surface of it, but warms and dries the earth itself. [187] Consequently, since there are two kinds of evaporation, as we have said, one like vapour, the other like smoke, both of them are necessarily generated. That in which moisture predominates is the source of rain, as we explained before, †4 while the dry evaporation is the source and substance of all winds. [188] That things must necessarily take this course is clear from the resulting phenomena themselves, †5 for the evaporation that is to produce them must necessarily differ; and the sun and the warmth in the earth not only can but must produce these evaporations.

360a19-360a34

[189] Since the two evaporations are specifically distinct, wind and rain obviously differ and their substance is not the same, as those say who maintain that one and the same air when in motion is wind, but when it condenses again is water. †1 Air, as we have explained in an earlier book, †2 is made up of these as constituents. Vapour is moist and cold (for its fluidity is due to its moistness, and because it derives from water it is naturally cold, like water that has not been warmed): whereas the smoky evaporation is hot and dry. Hence each contributes a part, and air is moist and hot. [190] It is absurd that this air that surrounds us should become wind when in motion, whatever be the source of its motion—on the contrary the case of winds is like that of rivers. We do not call water that flows anyhow a river, even if there is a great quantity of it, but only if the flow comes from a spring. So too with the winds; a great quantity of air might be moved by the fall of some large object without flowing from any source or spring. †3

360a35-360b27

[191] The facts bear out our theory. It is because the evaporation takes place uninterruptedly but differs in degree and quantity that clouds and winds appear in their natural proportion according to the season; and it is because there is now a great excess of the vaporous, now of the dry and smoky exhalation, that some

is because there is now a great excess of the vaporous, now of the dry and smoky exhalation, that some years are rainy and wet, others windy and dry. Sometimes there is much drought or rain, and it prevails over a great †4 and continuous stretch of country. At other times it is local; the surrounding country often getting seasonable or even excessive rains while there is drought in a certain part; or, contrariwise, all the surrounding country gets little or even no rain while a certain part gets rain in abundance. The reason for all this is that while the same affection is generally apt to prevail over a considerable district because adjacent places (unless there is something special to differentiate them) stand in the same relation to the sun, yet on occasion the dry evaporation will prevail in one part and the moist in another, or conversely. Again the reason for this latter is that each evaporation goes over to that of the neighbouring district: for instance, the dry evaporation circulates in its own place while the moist migrates to the next district or is even driven by winds to some distant place: or else the moist evaporation remains and the dry moves away. Just as in the case of the body when the stomach is dry the lower belly is often in the contrary state, and when it is dry the stomach is moist and cold, so it often happens that the evaporations reciprocally take one another's place and interchange.

360b28-361a4

[192] Further, after rain wind generally rises in those places where the rain fell, †1 and when rain has come on the wind ceases. These are necessary effects of the principles we have explained. After rain the earth is being dried by its own heat and that from above and gives off the evaporation which we saw to be the material cause of wind. Again, suppose this secretion is present and wind prevails; the heat is continually being thrown off, rising to the upper region, and so the wind ceases; then the fall in temperature makes vapour form and condense into water. †2 Water also forms and cools the dry evaporation when the clouds are driven together and the cold concentrated in them. These are the causes that make wind cease on the advent of rain, and rain fall on the cessation of wind.

361a5-361a21

[193] †3 The cause of the predominance of winds †4 from the north and from the south is the same. (Most winds, as a matter of fact, are north winds or south winds. †5 These are the only regions which the sun does not visit: it approaches them and recedes from them, but its course is always over the west and the east. Hence clouds collect on either side, and when the sun approaches it provokes the moist evaporation, and when it recedes to the opposite side there are storms and rain. So summer and winter are due to the sun's motion to and from the solstices, and water ascends and falls again for the same reason. †1 Now since most rain falls in those regions towards which and from which the sun turns and these are the north and the south, and since most evaporation must take place where there is the greatest rainfall, just as green wood gives most smoke, and since this evaporation is wind, it is natural that the most and most important winds should come from these quarters. (The winds from the north are called Boreae, those from the south Noti. †2

Lecture 7 (Aquinas' Commentary)

On the generation of winds

p 17
178. After determining about the sea, whose saltness is caused from an admixture of the dry earthy exhalation, the Philosopher subsequently determines about the winds, which are caused by the same dry exhalation. And it is divided into two sections:

In the first he determines about the winds themselves, at 179;In the second about certain phenomena caused from winds (c. 7).

p 17
The first is divided into two parts:

In the first he determines about winds in general;

In the second about the species of winds (c. 6).

p 17
The first is divided into three parts:

In the first he determines about the generation of winds, at 179;

In the second about their local motion (L. 8);

In the third about their increase and abatement (L. 9).

p 17
Regarding the first he does three things:

First, he lays down the principles of the generation of winds, at 179;

Secondly, he describes the manner of their generation, at 181;

Thirdly, he manifests what has been said, at 182.

p 17
179. Regarding the first he does two things: first he assigns the material principle of winds [†185] and says that, since "spirits," i.e., winds, are to be discussed, it is necessary to recall this principle, already enunciated, namely, that there are two kinds of exhalation: one, indeed, is the moist, which is called "vapor"; the other is the dry, which, having no common name, is called "smoke" from one of its forms: for smoke is, strictly speaking, the dry exhalation of burning wood. Now these two exhalations are not so independent of each other that the moist is without the dry, and the dry without the moist — rather they are denominated one or the other by that which is predominant in a given case.

p 17
180. Secondly [†186], he mentions the efficient principle, which is the motion of the sun. And he says that when the sun in its course approaches a given region of the earth, its warmth elevates the moist; as the sun recedes, this raised vapor is condensed into water on account of the cold. This is why there is more rain in winter than in summer, and more at night than during the day, although night-rains go unobserved because of sleep. The rain water is divided up in the earth and drunk in by it. In the earth much heat exists, caused

by the action of the sun and other heavenly bodies. And the sun overhead, heating the earth, not only draws aloft the moisture resting on the surface of the earth — for example, the water of the sea, rivers and ponds — but also dries out the earth itself and draws up the moisture drunk by the earth. Consequently the exhalation it produces from the moisture resting on the earth is called "vapor," but the exhalation that results from its drying out the earth is called "smoke," just as in a parallel case, the exhalation from heated wood is called "smoke."

p 17

181. Then [†187] he determines the generation of winds and says that since exhalations are of two kinds, as has been said, one vaporous and one smoky, it is necessary that, from the sun's motion, both should come about. The one with more moisture is the source of rain water, as said above (which he says, because he had previously stated that some dry exhalation is mixed with it); but the dry exhalation is the source of winds.

p 18

182. Then [†188] he manifests what has been said about the generation of winds. About this he does three things:

First, he manifests it with an argument;

Secondly, from what has been said, he excludes false opinions about winds, at 183;

Thirdly, he manifests this with signs, at 185.

p 18

He says therefore first [†188] that since exhalations are of two kinds, on account of the two sources from which they are derived, namely, earth and water, it is possible, even necessary, that the sun and the heat which environs the earth can cause the resolution of both exhalations.

p 18

183. Then [†189] he dismisses false theories about the winds. First, the opinion of those who said that the natures of wind and of rain are the same. This he excludes by the fact that the effects of diverse things are themselves diverse: hence, since the exhalations differ on the basis of dry and moist, it is necessary that the nature of wind and of rain water be not the same, as some supposed who said that it is the same air which, when moved, is wind, and when condensed, becomes water.

p 18

But as stated in *On Generation,* air has something of vapor and of smoke. Its vapor is cold and moist and well-definable by its density; and this belongs to air in so far as it is moist. Thus also vapor, which is borne up from water, is cold by its very nature, as also is unwarmed water: just as warmed water remains cold according to nature, so also vapor. But smoke is hot and dry: because of the earth, it is dry; because of fire, it is hot. Hence it is manifestly plain that the upper air, which is hot and moist, bears a likeness to both.

p 18

184. Secondly [†190], he dismisses the false opinion as to its tenet that wind is nothing more than air in motion. And he says that it is unacceptable for anyone to suppose that the air which surrounds each of us is, when in motion, wind; or that every movement occurring in air is wind; just as also we do not suppose any water at all that flows, even if it be a large amount, to be a river, but only when it flows from some determinate source, which is a spring gushing from the earth. The same applies to winds: it is not a wind, if air, even in large amounts, is moved in some chance way, but only when it has as its source, as though its

spring, a raised dry exhalation. Consequently, it is not true that air in motion is wind: both because sometimes a small amount of air is in motion, and because it does not have a starting-point.

p 18

185. Then [†191] he manifests through signs what has been said about the generation of winds. And it is divided into three parts according to the three signs he gives:

The second part begins at 186;

The third part at 187.

p 18

He says therefore first [†191] that the phenomena attending winds and rains support what has been said about their generation. For because exhalations are continually occurring, now more, now less, clouds producing rain, and winds are forever being generated according to the nature of the season: for according to the varying condition of the season more occurs at one time and less at another. And because more vaporous exhalation is sometimes lifted up and more of the smoky at other times, depending on the diverse effects of the sun and stars, the consequence is that sometimes the years are more rainy and wet, and sometimes more windy and dry.

p 19

Now this happens in two ways: in one way, with respect to some whole continuous region, where at one time there are many rainstorms and at another many winds; in another way, with respect to various parts. For sometimes in one area of one region many rainstorms occur, and in another area of the same region there is a great drought; at other times the opposite occurs, namely, that the entire surrounding region has middling rain or even drought, while the other has an excessive rainfall. And he assigns the reason, saying that the cause of this is that it is reasonable that the same passion of dryness or dampness should extend often to a whole region, because places that are close to one another have the same position in relation to the sun, which is the cause of rain or of winds — unless one place happens to have a special characteristic which changes its disposition, such as mountains or bodies of water. But although it most frequently happens that an entire region shares the same weather passion, yet it sometimes happens that one locality of a region has an abundance of dry exhalation to generate winds, whereas another abounds in the moist to generate rains; or the opposite happens, i.e., a region that once abounded in rain now abounds in wind.

p 19

The reason for this diversity is that both types of exhalation can cross over into the exhalation of a "had," i.e., following [adjacent] region: for example, the dry exhalation sometimes blows up a wind in the very region from which it was elevated, but the moist exhalation is blown to a region next to the windy one; while sometimes the moist exhalation may remain and the dry migrate. For, just as in the body of an animal the upper flatulence which exhales from the stomach is in a condition contrary to the lower which exhales from the intestines, so, with respect to places, it happens that from the interchanging of exhalations, they undergo a certain counter-state, so that while dryness prevails in the region from which the moist exhalation is transported, moisture abounds in the region to which it is carried.

p 19

186. Then at [†192] he gives the second sign, and says that in the places in which it has rained, a wind often arises after the rain; and conversely, the winds stop when it rains. And this occurs because of what has been said about the sources of rain and winds, namely, that the one is from the dry exhalation and the other from the moist. For when the rain has fallen and wet the earth, the dry exhalation, which is the stuff of winds, is once more exhalated from the earth dried out by its own inherent warmth or by that of the sun

above. And this is the cause of winds occurring after rains: namely, since winds are increased by the separation of such elevation from the earth. But they cease because the vigor of heat once more separates the warm vapor from the earth, and it is elevated to a higher place where the cold condenses it and forms rain — which is the reason for rains occurring after winds. Rains not only succeed winds but destroy them: for, when clouds are pushed together by a wind into one place, the surrounding cold condenses them and water is generated; the water then cools and dampens the dry exhalation which was the stuff of the winds. Hence it is plain that flowing waters make winds cease, and that, when they cease, the rain succeeds them, for the reasons given. And he takes this as a sign that wind and rain come from contrary causes.

p 20

187. Then [†193] he gives a third sign that winds are generated from the dry exhalation. For this is the cause why winds blow mostly "from the Bear," i.e., from the north (described as "from the Bear," because the two "bears," Big and Little, circle closely around the North Pole) and from the south — for it is a fact that most winds are boreal, i.e., from the north, or austral, i.e., from the south.

p 20

The reason for this is that the sun is not moved over those places but approaches them and then departs. The closest it gets to the north pole is the beginning of Cancer; then it departs farther and farther, until it reaches the beginning of Capricorn, which is its maximum approach to the contrary pole, from which, departing once more, it cyclically returns to the beginning of Cancer. For this reason, these two points, namely, the beginnings of Cancer and of Capricorn, are called "tropics," i.e., turning-points: when the sun is in the beginning of Cancer, the summer turn occurs; when it is in the beginning of Capricorn, the winter turn. Beyond these points the sun gets no closer to either pole. But it is always moving over the east and west. And therefore, in the places lateral to the sun's course many clouds gather, because, as the sun approaches, a moist exhalation is formed on account of the heat; after the sun recedes to its opposite place, rains and wintry cold arise.

p 20

And so, depending on whether the sun is approaching the tropics or departing, summer and winter are produced, and water is raised aloft by evaporation and once more descends. For when the sun in the heavens attains the beginning of Cancer, our summer is produced, and an abundance of vapors are elevated on account of the heat produced by the nearness of the sun; but when it comes to the beginning of Capricorn, cold and winter are produced for us, and many rains come, because of the distance of the sun from us. But the opposite is occurring in that part of the earth situated at the other pole. Since in those regions to the south and north the most water falls, the greatest amount of exhalation must also occur there, just as more smoke is produced from wood green and damp than from dry. Hence, since an exhalation of that type is the source of winds, it is reasonable that more winds and the strongest ones blow from the south and are called "austral," and from the north and are called "boreal."

p 20

It should be noted that Aristotle here says that the south wind blows from the other pole according to the opinions of others; but later on he will give the opposite as his own opinion and will assign a different cause of the vigor of this wind.

Lecture 8 (Aristotle's Text)

361a22-361a36

[194] The course of winds is oblique: for though the evaporation rises straight up from the earth, they blow round it because all the surrounding air follows the motion of the heavens. †3[195] Hence the question might be asked whether winds originate from above or from below. The motion comes from above: before †4 we feel the wind blowing the air betrays its presence if there are clouds or a mist, for their motion shows that the wind has begun to blow before it has actually reached us; and this implies that the source of winds is above. But since wind is defined as 'a quantity of dry evaporation from the earth moving round the earth', it is clear that while the origin of the motion is from above, the matter and the generation of wind come from below. The oblique movement of the rising evaporation is caused from above: for the motion of the heavens determines the processes that are at a distance from the earth, and the motion from below †5 is vertical and every cause is more active where it is nearest to the effect; †6 but in its generation and origin wind plainly derives from the earth.

361b1-361b8

[196] The facts bear out the view that winds are formed by the gradual union of many evaporations just as rivers derive their sources from the water that oozes from the earth. Every wind is weakest in the spot from which it blows; †1 as they proceed and leave their source at a distance they gather strength. Thus the winter in the north is windless and calm: that is, in the north itself; but the breeze that blows from there so gently as to escape observation becomes a great wind as it passes on.

361b9-361b13

[197] We have explained the nature and origin of wind, the occurrence of drought and rains, the reason why rain stops wind and wind rises after rain, the prevalence of north and south winds and also why wind moves in the way it does. †2

Lecture 8 (Aquinas' Commentary)

p 21

Lecture 8

On the local motion of the winds

p 21

188. After determining about the generation of winds, the Philosopher now determines about their movement. About this he does two things:

First, he describes their movement, at 188;

Secondly, he inquires into the source of their movement, at 189.

p 21

He says therefore first [†194] that although the exhalation which is the principle of winds is lifted on high in a straight line, yet the motion of winds is not in a straight line: for the winds blow around the earth from one direction to the other, as from east to west, or vice versa. The cause of such a course is that, as previously stated, the upper region of air is moved circularly according to the motion of the heaven; and although winds do not blow in that upper air, as stated above, but in the lower air which is below the altitude of the highest mountains, yet this air also participates somewhat in the motion of the higher, although this circling is not completed. From this it comes about that the exhalations moving the air do not move it up or down (which the subtlety of the warmed exhalation or the cold of the condensed seem to demand); rather they move the air obliquely, as though the air were being affected by both motions. Hence, a wind's course need not be always westward, as is the course of the heavens, but in a direction opposite to that of the exhalation impelling it; which impulsion, however, becomes oblique on account of the influence exerted by the movement of the heaven.

p 21

However, the fact that its obliqueness is caused by the motion of a heavenly body does not make the wind's motion unnatural. This is so both because motions caused in lower bodies by the heavenly body are called natural, though they may not be according to the nature of the lower body, as is plain in the ebb and flow of the sea — since the lower bodies are by nature subject to the higher, and because whatever results in a thing from the cause of its generation is natural to it. Hence, since the agent cause of winds is the motion of the sun, as was said above, it follows that the obliqueness of the motion, since it is caused by the motion of the heaven, is natural to it.

p 21

189. Then [†195] he inquires about the starting-point of the movement of the winds:

First, as to whence they begin their movement, at 189;

Secondly, as to how they proceed from that starting-point, at 190.

p 21

He says therefore first [†195] that because the course of a wind is not straight up or down, but oblique, someone will wonder whence the starting-point of a wind's movement is, whether from above or below. That the starting-point of the movement of winds is above, is manifested by the air itself, in which the wind's movement appears before the wind blows on earth. For if a cloud or mist is seen in the sky, it is seen to be moved by the wind already present in the air even before it manifestly reached the earth, as a wind having its source of movement from above. But because a wind is generated from the mass of dry exhalation resolved from the earth, it is plain that, although the source of its motion is from above, nevertheless the material principle of its generation is from below. The reason for this is that the motion of a wind originates from that place toward which the elevated dry exhalation tends, just as rain begins to descend from the place whither the vapor has ascended. And this is evident from the fact that the motion of a wind is more vigorous in places high above the earth; moreover, since the exhalation in a straight line is borne upwards, it is from there that the motion originates; and in a place more approaching that beginning, there is more of a chance for wind. However, it is plain that the principle of the generation of a wind is from the earth.

p 22

p 22

190. Then [†196] he shows how the winds come forth from their principle. And he says that just as the sources of rivers are collected together little by little from various sectors of the earth, so too a wind is gathered together bit by bit from exhalations that are blended together. And he manifests this with two signs. One of these is that winds appear feeblest in the places in which they arise, but take on strength as they move along. The other sign is that, in northern regions, in winter there is calm and there are no boreal winds there; but as you leave those northern regions, the wind gradually increases and becomes very strong.

p 22

Finally he summarizes what has been said — and it is plain in the text at [†197]. But it should be noted that the winds which he here calls "Noti" are the ones he above called "austral."

Lecture 9 (Aristotle's Text)

361b14-361b24

5. [198] The sun both checks the formation of winds and stimulates it. When the evaporation is small in amount and faint the sun wastes it and †3 dissipates by its greater heat the lesser heat contained in the evaporation. It also dries up the earth, the source of the evaporation, before the latter has appeared in bulk: just as, when you throw a little fuel into a great fire, it is often burnt up before giving off any smoke. In these ways the sun checks winds and prevents them from rising at all: it checks them by wasting the evaporation, and prevents their rising by drying up the earth quickly. Hence calm is very apt to prevail about the rising of Orion †4 and lasts until the coming of the Etesiae and their 'forerunners'.

361b25-361b29

[199] Calm is due to two causes. Either cold quenches the evaporation, for instance a sharp frost: or excessive heat wastes it. In the intermediate periods, too, †5 the causes are generally either that the evaporation has not had time to develop or that it has passed away and there is none as yet to replace it.

361b30-361b33

[200] Both the setting †1 and the rising †2 of Orion are considered to be treacherous and stormy, because they take place at a change of season (namely of summer or winter; and because the size of the constellation makes its rise last over many days †3 and a state of change is always indefinite and therefore liable to disturbance.

361b34-362a10

[201] The Etesiae blow after the summer solstice and the rising of the dog-star: †4 not at the time when the sun is closest nor when it is distant; and they blow by day and cease at night. [202] The reason is that when the sun is near it dries up the earth before evaporation has taken place, but when it has receded a little its heat and the evaporation are present in the right proportion; so the ice melts and the earth, dried by its own heat and that of the sun, smokes and vapours. [203] They abate at night because the cold of the nights checks the melting of the ice. What is frozen gives off no evaporation, nor does that which contains no dryness at all: it is only where something dry contains moisture that it gives off evaporation under the

influence of heat.

362a11-362a30

[204] The question is sometimes asked: why do the north winds which we call the Etesiae blow continuously after the summer solstice, when there are no corresponding south winds after the winter solstice? [205] The facts are reasonable enough: for the so-called 'white south winds' do blow at the corresponding season, though they are not equally continuous and so escape observation and give rise to this inquiry. The reason for this is that the north wind blows from the arctic regions which are full of water and snow. The sun thaws them and so the Etesiae blow: after rather than at the summer solstice. (For the greatest heat is developed not when the sun is nearest to the north, but when its heat has been felt for a considerable period and it has not yet receded far. The 'bird winds' blow in the same way after the winter solstice. They, too, are weak Etesiae, but they blow less and later than the Etesiae. They begin to blow only on the seventieth day because the sun is distant and therefore weaker. They do not blow so continuously because only things on the surface of the earth and offering little resistance evaporate then, the thoroughly frozen parts requiring greater heat to melt them. So they blow intermittently till the true Etesiae come on again at the summer solstice: for from that time onwards the wind tends to blow continuously.)

Lecture 9 (Aquinas' Commentary)

p 23

Lecture 9

On the increase and diminishing of winds.

p 23

191. After determining about the generation and motion of winds, the Philosopher here determines concerning their increase and decrease. And it is divided into two parts:

In the first he determines about the decrease of winds, at 191;

In the second about their increase, at 193.

p 23

About the first he does two things:

First, he shows how the sun is the cause of winds' diminishing;

Secondly, he collects under one general heading the causes from which winds happen to cease or diminish, at 192.

p 23

He says therefore first [†198] that just as the sun moves the winds, so also it makes them cease. For when exhalations are few and feeble, the heat of the sun draws out what is more hot in the exhalation, absorbing it and dissolving the exhalations, just as a larger flame destroys a smaller one by consuming its matter. And so the winds cease. Moreover, the sun not only makes them cease when already existing, but also prevents them from being formed: namely, when by drying out the earth it anticipates the massing together of the exhalation, which is the matter of winds (and this happens especially in those seasons and places that are hot and dry). It is as though, if someone should throw a small bit of fuel into a large fire, the strength of the fire were to dry out the moisture in the fuel before smoke could issue forth from it.

p 23

Therefore the sun both makes winds to cease by consuming the material already collected, and prevents them from forming by quickly drying out the earth. That is why, around Orion's rising, i.e., before the time when the constellation of Orion begins to appear, coming out from under the sun's rays, during the time of summer's heat, a great calm from the winds prevails in the air, until the "Etesiae," which are the annual winds that are accustomed to blow annually in the summer, and the "prodromes," i.e., the "forerunners" — because certain winds sometimes arrive before the Etesiae, due to suitable matter's being sometimes quickly prepared.

p 23

192. Then [†199] he brings together the causes of winds' ceasing and says that a calm due to the absence of winds comes about from two causes: either from great cold quenching the warmness that resolves exhalations, as happens at the time of a sharp frost — since it has been said above that frost is prevented by winds, and therefore, when there is great cold and frost, there are no winds; or from excessive heat, which chokes and quenches the exhalation, as was said above. But even in intermediate seasons, i.e., between periods of maximum heat and maximum cold, there are very many calms: either when an exhalation has not yet been formed after heat and cold no longer block them, or when some exhalation has already been formed and has passed, and another has not yet come, after winds have been generated from the one now past.

p 23

193. Then [†200] he determines about the increase of winds.

First, about the increase which accompanies the rising of Orion, at 193;

Secondly, about the increase occurring after the rising of the Dog Star, 194.

p 24

He says therefore first [†200] that the configuration of Orion in its rising and setting, i.e., when it begins to appear and when it begins to disappear, is "undiscerning," i.e., intolerable, and "difficult," i.e., has severe and stormy winds. Nor is this contrary to his previous statement, for, before the rising of Orion, there is calm, but in the period of its rising and setting there is stormy weather. The cause of this is that its rising occurs when summer is changing to fall, and its setting when fall is changing to winter. Both times, i.e., that of its rising and that of its setting, cover a number of days because of the constellation's size, which does not appear all at once and disappear all at once. But when seasons are changing, many disturbances occur, for when a season is not determined to one, it inclines now in one direction, now to its contrary. That is why many rains and winds are produced on account of the exhalations.

p 24

194. Then [†201] he determines about the increase of wind after the rising of the Dog Star. About this he does three things:

First, he proposes the proposition, at 194;

Secondly, he assigns the cause, at 195;

Thirdly, he raises a doubt on this point, at 197.

p 24

He says therefore first [†201] that the "Etesiae," i.e., certain annual winds, blowing, as it were, always at the same time, blow after the "conversions," i.e., after the summer solstice — and not only right after the solstice, but also after the rising of the Dog Star. This is so because they do not blow when the sun is most close to us, namely, in the first turning [solstice], i.e., in the beginning of Cancer, nor when it is far away, as for example, when it is in the southern signs. Moreover, the Etesiae blow by day but stop at night.

p 24

195. Then [†202] he assigns the cause of the aforesaid. First, why it is that the Etesiae blow during the day, and particularly in the morning and around evening. And he says that when the sun is closest, it dries out any moisture from which wind material might be assembled, if it could be resolved; but when it recedes a bit, then an exhalation is resolved in a moderate amount; the heat, likewise, is moderate, so that frozen waters liquefy; and the earth, being dried both by the sun's heat and by its own inherent warmth, begins to swell, as it were, and, as the resolved moisture accumulates, to exhale — and in this way winds are generated.

p 24

196. Secondly [†203], he shows why the Etesiae abate at night and says that the reason this happens is that the night cold freezes the liquefying humors, so that the exhalation stops. For it is plain that neither does what is frozen exhale, nor what is dry, having no moisture, but the dry which has moisture exhales when heated. Consequently, the Etesiae do not blow either when the sun is nearest us on account of the drying, nor at night, on account of the freezing. However, there is another explanation that could be given, namely, that at night the sun is most distant from us and therefore cannot lift exhalations.

p 24

197. Then [†204] he raises a doubt about what was just determined. About this he does three things:

First, he raises the doubt, at 197;

Secondly, he solves it, at 198;

Thirdly, he dismisses something seemingly contrary to the solution (L. 10).

p 24

He says therefore first [†204] that some wonder why the north winds blow as they do continuously after the summer solstice, while the "Noti," i.e., the south winds, do not blow the same way after the winter solstice. For it seems that just as after the sun's approach to the north pole, winds blow from there, so after its approach to the opposite pole, winds should blow from the opposite direction.

p 25

198. Then [†205] he solves this problem and says that at the corresponding season, winds do blow, called the "leuconoti," so called because they blow in fair weather (*leucos* in Greek means "white"); but since they do not blow uninterruptedly, as do the Etesiae from the north — and therefore, because latent, it is the fact of their not being noticed that causes the present problem. Now the cause why they do not blow

continuously is this: the north wind blows from places under the arctic pole where abound water and snow, which are melted by the sun more after the summer solstice than in the beginning of the turning, although the sun is then closest to us; and that is why it is after and not during the summer solstice that the Etesiae blow. Similarly, the greatest stifling heat occurs, not when the sun is nearest us in the north, but the greater heat comes later, because of the continuing of the warming process over a long time.

p 25

For first, when the sun approaches the tropic, it finds matter disposed, then, beginning to dominate it little by little, it imprints its effect more after it begins to recede, but while it is nevertheless still near. That is why after the rising of the Dog Star, i.e., during the dog-days, there is more heat than before the solstice, or during it. Water and snow melt more then also; for which reason more exhalations occur and more winds blow then. But it is true that at the solstice, when the sun is nearer, it causes more drying, as he said above, and disposes the matter more for exhalation; but the greater exhalation occurs after the rising of the Dog Star, and it is then that the Etesiae blow without interruption. And similarly, after the winter solstice the "ornithiae" blow (so called from a bird or hen), because they blow as some constellation of the "Bird" rises, just as the Etesiae blow after the rising of the Dog Star. (The "ornithiae" are the winds he previously called "leuconoti.") And he says that the Ornithiae are weak, because they are minor winds and blow later than the Etesiae: for they begin to blow on the seventieth day after the winter solstice, as though around the beginning of spring.

p 25

The reason for this is that the sun is more remote and less strong, so that it does not totally heat that region (from which the south winds blow) and enable exhalations to be lifted up to form winds. And the reason why they do not blow continuously is this: certain moistures, that are on the surface of the earth and are weak, exhale from that region of the earth, the sun being at a distance, but from these a continuous wind cannot be generated; the other moistures, being more frozen, need a greater heat, before they vaporize, whereas the heat which the sun then affords is slight, because it is so far away. That is why those winds do not blow continuously, but in fits, until the Etesiae blow again from the north after the summer solstice: for these northern winds are better suited for continuous blowing, for the cause stated above.

Lecture 10 (Aristotle's Text)

362a30-362a31

[206] But the south wind blows from the tropic of Cancer and not from the antarctic region. †1

362a32-362b9

[207] There are two inhabitable sections of the earth: one near our upper, or northern †2 pole, the other near the other or southern pole; and their shape is like that of a tambourine. If you draw lines from the centre of the earth they cut out a drum-shaped figure. The lines form two cones; the base of the one is the tropic, of the other the ever visible circle, †3 their vertex is at the centre of the earth. Two other cones towards the south pole give corresponding segments of the earth. These sections alone are habitable. Beyond the tropics no one can live: for there the shade would not fall †4 to the north, whereas the earth is known to be uninhabitable before the sun is in the zenith or the shade is thrown to the south: and the regions below the

Bear †1 are uninhabitable because of the cold.

362b10-362b11

[The Crown, too, moves over this region: for it is in the zenith when it is on our meridian]. †2

362b12-362b27

[208] So we see that the way in which they now describe the geography of the earth is ridiculous. They depict the inhabited earth as round, but both ascertained facts and general considerations show this to be impossible. If we reflect we see that the inhabited region is limited in breadth, while the climate admits of its extending all round the earth. For we meet with no excessive heat or cold in the direction of its length but only in that of its breadth; so that there is nothing to prevent our travelling round the earth unless the extent of the sea presents an obstacle anywhere. The records of journeys by sea and land bear this out. They make the length far greater than the breadth. If we compute these voyages and journeys the distance from the Pillars of Heracles to India exceeds that from Aethiopia to Maeotis and the northernmost Scythians by a ratio of more than 5 to 3, as far as such matters admit of accurate statement. Yet †3 we know the whole breadth †4 of the region we dwell in up to the uninhabited parts: in one direction no one lives because of the cold, in the other because of the heat.

362b28-362b29

But it is the sea †1 which divides as it seems the parts beyond India from those beyond the Pillars of Heracles †2 and prevents the earth from being inhabited all round.

362b30-363a18

[209] Now since there must be a region bearing the same relation to the southern pole as the place we live in bears to our pole, it will clearly correspond in the ordering of its winds as well as in other things. So just as we have a north wind here, they must have a corresponding wind from the antarctic. †3 This wind cannot reach us since our own north wind is like a land breeze †4 and does not even reach †5 the limits of the region we live in. †6 The prevalence of north winds †7 here is due to our lying near the north. Yet even here they give out and fail to penetrate far: in the southern sea beyond Libya east and west winds are always blowing alternately, like north and south winds with us. †8 So it is clear that the south wind is not the wind that blows from the south pole. [210] It is neither that nor the wind from the winter tropic. For symmetry would require another wind blowing †9 from the summer tropic, which there is not, since we know that only one wind blows from that quarter. So the south wind clearly blows from the torrid region. Now the sun is so near to that region that it has no water, or snow †10 which might melt and cause Etesiae. [211] But because that place is far more extensive and open the south wind is greater and stronger and warmer than the north and penetrates farther to the north than the north wind does to the south. †11

363a19-363a20

[212] The origin of these winds †1 and their relation to one another has now been explained.

Lecture 10 (Aquinas' Commentary)

p 26

Lecture 10

The south wind not from the antarctic but from the summer tropic.

p 26

199. Because in solving the foregoing doubt the Philosopher had posited that the south winds do not blow uninterruptedly after the winter solstice, as do the northern winds after the summer solstice, and because the reason he assigned supposed that southern winds do not blow from regions of much water and snow (which would be false, if the south wind should blow from the other pole, where there is also an abundance of such matter, as has been said above), he therefore now intends to show that the south wind does not blow from the other pole but from a place under the summer tropic. About this he does three things:

First, he proposes what he intends, at 199;

Secondly, he outlines the disposition of the habitable earth, to enable one to better understand what he intends, at 200;

Thirdly, he manifests what he proposes, at 202.

p 26

He says therefore first [†206] that the south wind blows toward us "from the summer turning," i.e., from the place under the summer tropic, namely, under Cancer, and not "from the other Bear," i.e., from the other pole, concealed from us. He uses this terminology because the arctic pole, which is visible to us, is the one around which the constellations of the Bear, Big and Little, rotate.

p 26

200. Then [†207] he shows the disposition of the habitable earth.

First, he shows that the shape of the habitable earth is as a drum, at 200;

Secondly, he dismisses a contrary opinion which some held, at 201.

p 26

He says therefore first [†207] that there are two zones that can be inhabited: one toward the upper, arctic, pole, in which we live; the other, toward the opposite pole, south of us, just as our habitable area is south to them. But whether that land is inhabited, he leaves unclarified. The shape, however, of both areas resembles a drum. How this is to be imagined must be gathered from the facts he gives.

p 26

For it is plain that a certain portion of the heavenly sphere is always visible to us, namely, from the arctic pole to a zone which is less and less the closer one gets to the opposite pole. Another portion of the heaven is forever invisible to us, namely, from the opposite pole to a certain amount, whose size increases the closer one gets to the arctic pole. Midway between the two poles is the equinoctial circle [equator] intersected by the Zodiac declining toward each region. Where, therefore, the Zodiac declines most from the equinoctial circle toward the arctic pole is the summer tropic, i.e., the beginning of Cancer; where it declines most toward the pole invisible to us is the winter tropic, i.e., the beginning of Capricorn.

p 26

This, then, is the third region of the heavenly sphere, namely, the one between the two tropics. Two other parts are considered: one between the summer tropic and that which is always visible to us, and the one between the winter tropic and that which is hidden to us of the heaven. And because the whole earth is spherical, and located in the center of the heavenly sphere, it is necessary that under each part of the heavenly sphere there be considered individual parts of the terrestrial sphere. Let A mark the terrestrial point under the arctic pole; let B mark the point under the limit of the part always visible to us; let C represent the point under the summer tropic; let D mark the point under the winter tropic, let E represent the point under the limit of the part always hidden; let F mark the point under the antarctic pole, and Z the point in the center of the earth. Now draw straight lines from the center of the earth, Z, to B and to C. [The lines ZB and ZC] form two angles with a line drawn on the surface of the earth, which angles he here calls "cones." Because the line on the surface of the earth is curved — for the earth is spherical — it is plain that the two aforesaid lines [ZB and ZC] produce the figure of a drum, cutting the surface of the earth in a non-circular figure. This is what he [Aristotle] says: "Such a shape," i.e., "that of a drum," for the inhabitable earth, "is cut out by two lines proceeding from the center of it," i.e., of the earth, "and they form two cones," i.e., two angles, with a line traced under the surface of the earth, "the base of one angle being the tropic," i.e., having its base in the tropic point, "and the base of the other, the ever visible," i.e., the other angle is at the limit of the part of the heavens always visible; "the vertex, however," i.e., the top of the triangle ZBC, whose base is BC, "is produced in middle of the earth," i.e., in the center.

p 27

In the same way, in the other direction, toward the lower pole, two lines cut that part, drawn, namely, from the center to D and E.

p 27

And these two are the only zones that are habitable. For the zone between the two tropics seems uninhabitable because of the immense heat, as the sun passes, as it were, directly over it and over the tops of the heads of the inhabitants, if it should be inhabited. As for the other two zones, under the part of the heaven always visible and under that always hidden from us, near both poles, these are uninhabitable because of the immense cold, due to distance of the sun.

p 27

That the zone beyond [i.e., below] the summer tropic is not inhabited, he shows from the fact that, if it were, it would not be true that for all men living toward the arctic pole, shadows fall toward the north. For if the sun should sometimes be between them and the north, a shadow would fall sometimes towards the south. But if anyone lived beyond [below] the summer tropic, toward the arctic pole, then, when the sun is in the summer tropic, it would be between them and the arctic pole; hence a shadow would fall for them toward the south. But it is not found in inhabitable regions either that a shadow disappear or shift to the south. For there is no shadow where the sun is directly overhead, so that no shadow can be produced in any direction, while a shadow falls to the south in places where the sun declines more to the north. And he says that such places are uninhabitable, because even though someone should live there on account of some favorable combination of waters or mountains, yet such dwellings are rare and oppressive.

p 27

Just as these places are uninhabitable on account of the excessive heat, so the regions under the constellation of the Bear [which is the part of the heaven always visible to us] are uninhabitable on account of the cold caused by the sun being far away. Hence that part of the earth in which we live is between the two circles, i.e., between the one that passes through the summer tropic and the one which bounds that part of the heaven always visible to us. And this is plainly evident from the fact that the constellation of the Crown, which, indeed, is between both these circles, appears directly over our heads, when it is in the

"meridian" circle, i.e., in the circle that passes through the poles of the world and the point directly overhead.

p 27

201. Then [†208] he dismisses a false theory upheld by some. And he says that the foregoing account shows how ridiculous they are who describe the inhabited earth as circular: for such a thing is seen to be impossible, both according to reason and according to evident signs. For reason shows that the inhabited portion of earth is limited to a width, bounded on one side by a zone uninhabitable on account of the heat, and on the other by a zone uninhabitable on account of the cold. But along its length a circle could be joined, in such a way that all the aforesaid area would be inhabited, on account of the temperate climate; for no excess of heat and cold is found in the directions of east and west — according to which the earth's length is measured — but only according to width, which is reckoned according to the distance from the pole to the equinoctial circle [equator], since, on a surface the greater dimension is called the length, and the smaller one the width, and from east to west there is designated a whole semicircle, while from the arctic pole to the equator, a quarter part of a circle.

p 28

It is reasonable also that a distance to east and west should not cause differences of heat and cold, because this does not produce a greater or lesser approach to the sun's path as is produced by distance in latitude. Hence, if the mass of the sea did not somewhere prevent it, the whole course from west to east, and again from east to west, would be traversable, since the whole appears temperate. However, we find the earth inhabited only in a semicircular zone running from east to west; the extent of the sea preventing our access to the other semicircle. Thus does reasoning sufficiently show that the habitable surface of the earth is not circular or spherical.

p 28

And this is also made evident from manifest signs based on sea and land journeys: there is a great difference in quantity between longitude and latitude; consequently, the surface area that is habitable is not in the shape of a sphere. That there is such a great difference is plain: for from the Pillars of Hercules, which are at the final confines of Spain, as though at the last border of the west, to the Tanais in India, the distance (which is longitude) exceeds in size the distance from the last borders of Ethiopia to the extreme regions of Scythia (which is the latitude of our habitable earth), by a ratio of more than 5 to 3. If anyone were to analyze sea and land voyages in the proper way, he would have no doubt about these distances.

p 28

But the habitable earth has the following differences respecting longitude and latitude — for we know that all of the inhabitable area of the earth according to latitude is inhabited up to the uninhabitable areas, which are not inhabited either on account of the cold or on account of the heat; but this is not so of the longitude, because the area around the Indian limit to the east, and that around the Pillars of Hercules to the west, do not seem to be able to be conjoined so as to return in another direction, making the whole of this portion of the earth continuously habitable, because access is forbidden by the sea. That is why we cannot know whether people live there or not.

p 28

202. Then at [†209] he proves his proposition about the source of the south wind. About this he does three things:

First, he shows that the south wind does not blow from the other pole;

Secondly, that it does not blow from the winter tropic, but from the summer tropic, at 203;

Thirdly, he accounts for the vehemence of the south wind, at 204.

p 28

He says therefore first [†209] that just as the area of the earth in which we live is related to the arctic pole, so must some other be related to the opposite pole. Hence the blowing of winds in that area must be analogous to their blowing here. Hence just as the north wind blows from the arctic pole, so a wind must blow there from the opposite pole (which he calls "the other Bear"). But the wind which blows from the other pole cannot reach to here, because the north wind not only cannot reach the other inhabitable part of the earth, but it cannot even reach all of our habitable area: for the north wind is "apogeious," and cannot advance very far. But since our habitable area is to the north, very many north winds blow upon us; but just as many north and south winds blow here, so beyond the Sea of Libya, which is to the south, blow many east and west winds. Consequently, it is plain that the south wind does not blow from the other pole.

p 29

203. Then [†210] he shows that it does not blow from the winter tropic, because if the south wind blew from the winter tropic, there would have to be another wind blowing from the summer tropic, since those two places proportionately correspond. But this does not happen: for only one wind blows on us from that direction. For this reason it is necessary that the south wind is a wind blowing from the summer tropic, where the region is torrid.

p 29

204. Then [†211], because he had previously assigned the cause of the vehemence of the north and south wind by assuming that they blew from the opposite poles, according to the opinion of others, which he has just assailed, therefore he now gives the true cause of the south wind's vehemence according to his own opinion.

p 29

He says, therefore, that, although in that region, i.e., under the summer tropic, there is a scarcity of smoking matter in comparison to the pole, because the nearness of the sun forbids the presence of much water or "pastures," i.e., grassy and moist places from which Etesiae, i.e., continuous winds can arise, yet that region is so vast that it receives from various localities a collection of material suitable for a south wind, which wind is stabler and stronger than the north wind, on account of the size of the places from which its abundant matter has been collecting for a long time. As a consequence, this wind can last longer and reach the place of the north wind, more than the north wind can reach there, i.e., the place of the south wind.

Here the exposition of St. Thomas terminates.

Footnotes

†1 i.e. neither purposive nor constrained.

†2 Physics.

†3 *De Caelo*, esp. i and ii.

†4 *De Gen. et Corr.*, and perhaps *De Caelo*, iii, iv.

†5 i.e. just below the sphere of the moon.

†6 Bk. i. 4-8.

†7 Bks. i. 9-12, iii. 2-6. 378a 14.

†8 Bks. i. 13-ii. 3.

†9 Bk. ii. 4-8.

†10 Bks. ii. 9, iii. 1.

†11 *De An., Parv. Nat., H.A., P.A., I.A., G.A.*

†1 Read {exes} in l. 12 with Vicomercato.

†2 Hot, cold, dry, moist.

†3 Read commas for colons in ll. 15, 17, 18, and a colon for the full stop in l. 19, where the apodosis begins.

†4 The sublunary world.

†5 {hothen . . . allelon} (ll. 23-27) is parenthetical.

†6 The argument of this confused chapter seems to be as follows: 339a 33-b 2 introductory; 339b 2-16 the main question is stated to be the nature of air and its relations to the other elements: 339b 16-340a 18 a preliminary question about the nature of the element in the celestial sphere is discussed. Two views are dismissed, *(a)* that the stars and the interval between them are of fire, while the space from the earth to the moon is air, 339b 30-340a 3, *(b)* that the whole world from the earth to the stars, including the intervals between them, is of air, 340a 3-18. 340a 19-24 the original question is restated; it now appears in two parts, *(a)* relation of fire and air to the celestial element, *(b)* question about the origination of heat by the celestial bodies (now recognized as not themselves hot) on earth. This change in the formulation of the question is due to the answers given to the preliminary question. 340a 24-b 3 a preliminary discussion about the nature of air and difficulties raised about the formation of clouds in it: 340b 4-341a 12 question *(a)* is answered and the difficulty about clouds solved: 341a 12-end question *(b)* solved.

†1 Read {de} with JFHN and Thurot in l. 36.

†2 Cp. *De Gen. et Corr.* ii. 4, *De Caelo*, iii. 6 and 7.

†3 *De Caelo*. i. 3.

†4 Ibid. i. 270b 24.

†1 Read {kakeinous} (Thurot) in 1. 24.

†2 {theon}.

†3 {theion}

†3 {theion}.

†4 *De Caelo*, ii. 298a 15 (the smallness of the earth).

†5 The outermost heaven.

†6 Empedocles.

†7 Read {phesi} with E1JF in l. 13.

†1 *De Gen. et Corr*. ii. 6. A. there argues that if the elements are comparable a common substrate and transmutation are implied. But Empedocles says the elements are 'equal' while denying their transmutation. If he means *(a)* 'equal in quantity', there is something common to them in virtue of which they are measured, and transmutation follows. If he means *(b)* 'equal in power', e.g. 1 c.c. water has as much refrigerating power as 10 c.c. air, the water and the air must have something in common in virtue of which they refrigerate, and transmutation follows again. A. might prove on the same principle that since gold and lead can both be weighed they must be transmutable.

†2 Nor both together.

†3 Between the earth and the outermost heaven. The conclusion, which is not expressed, is: therefore there must be a fifth element in the celestial region.

†4 As soon as the stars and the upper region are not considered to be of fire, this requires explanation.

†5 This is misleading if it refers back to 339b 3, since it is not so much the aporetic discussion about the clouds in the air 340a 24-b 3, as the two discussions in 340b 4-341a 36, especially the first 340b 3-341a 12, which answer the original question.

†6 This passage 340a 24-b 3 is purely aporetic. No account is taken of results already arrived at.

†7 For A.'s conception of the stratification of the air, cp. Gilbert, *Meteor. Theorien d. gr. Altertums*, 476 sqq. (doubtful on some details), *Meteor*. 340b 29, 361a 22, 373a 23 and note.

†1 i.e. the region between the air properly so called and the moon.

†2 i.e. immediately surrounding.

†3 *De Gen. et Corr*. ii. 2.

†4 Ibid. ii. 10.

†5 Omitting {ta} in l. 21, with JF Al.

†6 Cp. 341b 21.

†1 Read {psychron} in l. 27 with E1 and cod. Par. suppl. 314, cp. 360a 22 sq.

†2 i.e. up to the height of the highest mountains. But cp. with the whole passage 361a 22, 373a 23, 340a 25 above.

†3 i.e. becomes {atmis}.

†4 In the upper air.

†5 No such account is to be found in the *De Sensu*.

†1 i.e. by day.

†2 Read {ta mallon kinoumena kai thatton ekpyroutai thatton} in l. 34 with JF and the lemma in Philoponus.

†3 And the outer sphere moves fastest.

†4 Perhaps Plato, *Timaeus*, 56 D.

†1 Cp. 340b 23.

†2 Read {ekthlibetai kai ekkrinetai} with JFHN and the lemma in Philoponus.

†1 Read {tou autou tinos} in l. 7 with JF2HN Ol. (lemma).

†2 Om. {de} in l. 8 with all the MSS.

†3 Omit {mallon} and read {ano} in l. 17 with E and the lemma in Olympiodorus. {mallon} and the superlative {anotato} are explanations of {ano}.

†1 As the phenomena described in c. 4. The obscurity of this chapter is due to the attempt to assimilate these phenomena of cloud coloration to the meteorites, &c., of c. 4. Ar. seems entirely to neglect the most obvious causes of these {phasmata} e.g. the sun, and obscures the fact that the phenomena of c. 4 are {kath hypostasin}, in the language of later writers, while those of c. 5 are {kat emphasin} Cf. Gilbert, *Meteor. Theorien d. gr. Altertums*, pp. 594 sqq.

†2 Cp. 372a 29 sq.

†3 Read in l. 17 {synion de «bothynos einai to» chasma dokei} after Thurot.

†4 Read {homochroian} in l. 20 with all the MSS.

†1 Diels, *Frag. d. Vorsokratiker*, 46 A 81.

†2 Ibid. 55 A 92.

†3 Diels, 30. 5.

†4 Ibid.

†5 Read {noto} for {tropiko} in l. 14 with E1 and perhaps Al. (The lemma in Philoponus has {notio topo}.)

†1 Cp. b 9. This condition was not stated in a 10 sq. Thurot would introduce it there by emendation. Probably Aristotle is at fault and not the text.

†2 Cp. b 18, 344b 34, 368b 6. The date is 373-2 B.C.

†3 427-6 B.C.

†4 Jan.-Feb.

†1 The peripheral parts of the retina are more sensitive to illumination than the central. Wundt, *Phys.*-

†2 The peripheral parts of the retina are more sensitive to illumination than the central. Wundt, *Phys. Psych.*@5, ii. 181, 502.

†2 b 1.

†3 Omitting {dis} in l. 31 with E1JFHN Al Ph Ol.

†4 {hypokeitai} (l. 8) {. . . diadromas} (l. 15) is a parenthesis. The apodosis of the main sentence is {aster touto gignetai}. (l. 20).

†1 Omitting {ton} in l. 16 with JHN, and Philoponus.

†2 345a 7, b 34.

†1 Omit {ton astron} in l. 4 with EJHN and the lemmata in Philoponus and Olympiodorus.

†2 Comma after {pollakis} in l. 16, with Philoponus.

†3 342b 36.

†4 Comma after {katharo}, in l. 14.

†5 iii. 2.

†6 Omit {oi} in l. 20 with the MSS., Alexander, and Philoponus.

†1 Cp. 343b 1.

†2 341-40 B.C. Omit {Athenesin} in l. 2 with E1JFHN.

†3 346a 14.

†4 344a 35.

†5 Diels, 45 B. 37c; 29. 10.

†6 Read {peponthos} in l. 23 with EFH Al.

†1 346a 17 and note.

†2 342b 35; Diels, 30. 6.

†3 Reading {me . . . mede} in l. 17 with E, Alexander (citation), and Philoponus.

†1 340b 4-32.

†2 Fobes inserts after {ekripizein} (l. 9) the following words from FHN—{aera te kai diakrivein dia to tou kyklou megethos}, and the following lemmata from Ol.—{ananke toinyn ton auton megiston kyklon malista ten mellousan touto poiesein phoran . . . chre gar touto, hina polle kinesis e dia to megethos gignomene kai pleiona ten exapsin poiese}. Al. Phil. seem to have had our text without these additions.

†1 345a 6.

†2 It is difficult to understand what is meant by 'the greatest circle'. Cf. 345a 33 and 346b 6. The meaning cannot be 'a great circle of the celestial sphere' in the ordinary sense; for, (1) this would not justify the article here and in 346b 6, (2) the fact that a circle is a 'great circle' in the ordinary sense does not involve

article here and in 340b 6, (2) the fact that a circle is a 'great circle' in the ordinary sense does not involve any part of it, except the points at which it cuts the equator, moving fastest; unless it happens to be the equator, and Ar. does not suppose that the milky way is. Vicomercatus suggests that {megistos} refers to the *breadth* of the band, but this is unsatisfactory. We are forced to assume that Ar. was thinking in a confused way of the outermost *sphere*, that of the fixed stars. Every point of this does, of course, move faster than every corresponding point on an interior sphere. This will also justify the article. It also explains 345a 33: 'the milky way is in the sphere of the fixed stars and cannot therefore move about, as the hypothesis would require'. It is true that the theory still does not work, even on its own presuppositions. But it could only work if we supposed the milky way to rotate on an axis at right angles to its own plane; and Ar. certainly did not think it did that.

†3 Aristotle must be supposed to have illustrated his theory here by a diagram of the milky way, but the Greek commentators have not preserved any tradition of the particular diagram used.

†1 345a 7.

†2 As distinguished from its formation on and under the earth, cc. 13-ii. 3.

†3 Cp. *De Gen. et Corr.* ii. 10; esp. 336b 15 sqq.

†1 Cp. 359b 34 sq.

†2 i.e. north and south on the ecliptic; cp. 361a 4 sq.

†3 Cp. 359b 34.

†1 As you might expect from the coldness of the wind.

†2 Read {atmizei} in l. 8 with the MSS.

†3 i.e. in places other than Pontus.

†4 As contrasted with vapour. Ar. is thinking merely of the lack of an analogue to hail.

†1 Omit {pyros} in l. 28 with E1 and (apparently) Alexander.

†1 i.e. Anaxagoras, cp. b 12, Diels, 46 A 85.

†2 Cp. 340a 27 sqq.

†1 Omit {hote de chalazan} in l. 8, with all the MSS. except N corr. {hote men} is answered by {hotan d} below and the intervening lines {dio kai . . . hotan malista} are parenthetical and should be printed accordingly.

†2 a 1.

†1 Read {to thermon} in l. 33 with all the MSS. except F corr.

†2 Hippocrates {peri physon} (Opp., vol. i, 571. 12, ed. Kühn).

†3 Read {rheon} in l. 24 with the MSS.

†1 Cp. Anaxagoras, Burnet, *Early Greek Philosophy*, § 135 == Diels, 46 A. 42 § 5.

†2 Read {to ton} in l. 7 with J ({touton} E).

†1 Read {epikremamenoi} in l. 8 with EJF2HN.

†2 Paropamisus or Hindu Kush.

†3 Indian Ocean.

†1 Balch-âb.

†2 Kunar.

†3 A. probably means the Oxus or Amu-Darya.

†4 Sea of Azov.

†5 Don.

†6 Rion

†7 Cp. 351a 11.

†8 Maeotis.

†9 This is unintelligible: our text, though it goes back to Alexander, must be corrupt.

†10 Pyrenees.

†11 Danube.

†12 Baetis or Guadalquivir.

†13 of Heracles.

†14 The mountains of Bohemia, Silesia, Moravia, and northern Austria.

†15 A mythical northern range to which no definite locality can be assigned.

†16 Read {Nyses} in l. 12 with the MSS.

†17 Sagiet el Hamra.

†1 i.e. any more than the region of clouds could be supposed to contain ready-made all the water that falls as rain.

†1 Caspian Sea.

†2 {phanera} (l. 9) is certainly wrong—it makes indifferent sense and is omitted by all the MSS. except S rec. Thurot thinks that a word (such as {megale}) or words expressing the contrast to {mikra} above are wanted, but this is not certain.

†3 On the east coast of the Black Sea, about the modern Abkasia.

†4 Perhaps the Eridanus (Po). Pliny alleges (falsely) that it flows underground (Pliny iii. 16).

†5 Rhône.

†1 Read a comma after {epleonazen} in l. 6, {apiousan} with E2J2FHN, and {plethyousi}. The version given implies this line of thought: rivers fall into the sea at *A* and push it out (by silting) so that it floods the land at *B*; when those rivers dry up the sea will recede from *B*. Again, a river fills up its estuary with silt and so land encroaches on the sea; when the river dries up the sea will return.

The two {hopou} clauses are concerned with one and the same process, but the first considers the effect on the place *B*, the second the effect on the place *A*.

The general principle seems to be that when wet predominates in a place rivers rise there: this makes the sea recede from the mouth of the rivers (by silting) and *ipso facto* encroach elsewhere; when dry predominates in the place the rivers shrink, then the sea returns there and *ipso facto* leaves the other place which it had invaded, dry.

Aristotle is hampered by the fact that from the nature of the case he is really familiar, as his examples show, with one side of the process only, the encroaching of land on sea.

†1 i.e. though there is no record of the beginning of this process the facts alleged prove the thesis.

†2 Read {pote} in l. 8 with EJF1HN.

†1 Cp. *De Caelo*, 279b 12; Cp. 352b 16, 353b 10, 356b 10.

†2 349b 3.

†1 Read {oiesthai dei} (l. 11) with cod. Par. suppl. 314 and Bag., and punctuate with {outoi . . . poiousin} in a parenthesis and commas after poiousin and proapoleipein}. Also in l. 13 omit {mallon}, probably introduced from the next sentence (Par. 2032 and Ol. (lemma) have {ton potamon without mallon}.

†2 Omit {gignomena} in l. 14 with Ideler (Alexander seems not to have read it) and read {elatton} (so probably Al.). The version given follows Vicomercato in making {tauta} and {thatera} refer to {hosois de} and {outoi gar}, respectively. But text and interpretation of the whole passage are doubtful.

†1 The Cimmerian and not the Thracian Bosporus is meant: cp. Reclus *Nouv. Géog. Universelle*, v, p. 788 sqq.

†2 Read {hypoleipsei} in l. 15 with JFHN Al. Ol. (lemma).

†3 e.g. Hesiod., *Theog*. 282.

†1 Alexander refers this to Anaximander (Diels, 2. 27) and Diogenes of Apollonia (Diels, 51 A. 9, 17); but it would fit almost any of the 'Milesians', e.g. Thales (cp. Burnet, § 9); Anaximenes (Diels, 3 A. 7, § 5).

†2 Cp. 354b 33 sqq. The 'turnings back' were explained as due to the resistance of compressed air by Anaximenes (Diels, 3 A. 15) and Anaxagoras (Diels, 46 A. 42, § 9); as due to a lack of the moisture that nourished them, according to Alexander (on the authority of Theophr.) on 354b 33 sq. below, by Anaximander and Diogenes. Zeller I@5. p. 223, n. 3, and Heath, *Aristarchus*, p. 33, refuse to attribute the view to Anaximander and interpret {tropai} as 'revolutions'.

†3 Cp. 352a 19.

†4 Empedocles, cp. 357a 24. Diels, 21 B. 55, A. 25 and 66, cp. 55 A. 99@a (Democritus) and 80 B. 32 (Antiphon).

†5 Cp. Diels, 11 A. 33 (Xenophanes); 57 A. 19 (Metrodorus of Chios); 46 A. 90 (Anaxagoras).

†6 349b 27.

†7 Read {tamieuomenon} in l. 21 with E2 and Cod. Par. Suppl. 314, {eis hen} in l. 22 with E1HN and Alexander, and {apanta} with E1HN and Alexander.

†1 Omit {epei} in l. 35 with Bon. *Ar. St.* iii.

†2 i.e. the Indian Ocean, cp. Partsch, 'Ar. über d. Steigen des Nil,' *Abh. d. kön. Sächs. Ges. d. Wiss.*, 1909, p. 569.

†3 i.e. the Atlantic.

†4 If this is not the Aral, which A. can hardly have known, we must explain the plural thus: 'Hyrcanian' is used to denote the Caspian, e.g. in Hecataeus; A. does not seem to have noticed that one and the same lake was meant and imagines the Hyrcanian distinct from the Caspian by a mere blunder. Or he may have thought of the two as different parts of the same sea in the way in which the Aegean and Adriatic might be called distinct seas by a writer who knew they were one in a sense. Cp. Bolchert, *Aristoteles' Erdkunde v. Asien u. Libyen*, p. 10.

†1 Black Sea.

†2 i.e. it is shallow, yet the water does not flow back (as you might expect on the analogy of Maeotis, &c.), because the sea lies in a hollow as is proved by the calm (Alexander). This seems the best that can be made of this suspicious sentence. The 'mud' is an echo of the Sargasso Sea.

†3 e.g. Anaximenes, Diels, 3 A. 7 (§ 6), 14. Aristotle is not endorsing the view about the sun, and there is no need to condemn this passage in consequence as Berger does.

†1 e.g. Xenophanes, Diels, 11 B. 30.

†2 Read {touton} in l. 25 with JFHN and Alexander, for {panton},

†3 I. 9.

†4 Cp. 353b 5. Cp. Burnet, § 9 (Thales); Diels, 3 A. 7, § 5 (Anaximenes).

†5 Perhaps Anaximander and Diogenes; cp. 353b 6 and 355a 22.

†1 {kai dia tout . . . monon} is a parenthesis (Thurot).

†2 Diels, 12 B. 6.

†3 Diels, 51 A. 9 refers this specially to Diogenes. Alexander identifies the doctrine with that of 353b 6 and refers it to Anaximander and Diogenes (on the authority of Theophrastus). It seems impossible to distinguish the {enioi} of 354b 34 and the {oiphaskontes} here, 355a 22. It looks as if the real distinction was that between those who explained the 'turnings' by compressed air and those who explained them by lack of nourishment. But in that case Aristotle, Theophrastus, and Alexander are all confused and have failed to maintain the distinction.

†1 *Phaedo*, III C sq.

†2 Eur. *Med.* 410.

†3 Read {exairein} in l. 20.

†1 Whereas on the theory these conditions would be unnecessary.

†2 Omit {aitias} in l. 30 with Alexander and Thurot.

†3 Diels, 55 A. 99a and 100. Cp. 352a 19.

†1 Omitting {ten} in l. 26.

†2 l. 14.

†1 And it is therefore absurd that they should not be salt.

†2 Diels, 21 A. 66; B. 55. Cp. 353b 11.

†3 Read {kan} in l. 6.

†4 Read {pleion} (with J1F1) and {elatton} in ll. 13, 14; 'waiving the point of quantity raised in the preceding argument'.

†1 Omit {he gar . . . pikros} in l. 14 with (apparently) some MSS. of Alexander. The point is not that the earth secretes moisture but not salt moisture; but, as the following lines show, that it does not secrete anything at all under the conditions supposed. The addition may be due to the idea that A. had admitted in the account of rivers (l. 13) that the earth did secrete moisture.

†2 Read {oun} in l. 17 with JFHN Al. for {d oun}.

†3 Cp. 353b 6, 356b 9.

†4 341b 6 ff.

†5 {aei . . . rheuma} (ll. 30-32) is a parenthesis (Bonitz). The apodosis begins with {phaneron} l. 32.

†6 Read {to d eidos kai to plethos} in l. 31 with Bonitz.

†7 Read {te} for {te kai} in l. 1 with JFHN.

†1 Read {anathymiasei} in l. 20 with Thurot. {anathymiasin} is read by all the MSS. and by Alexander. The mistake may be due to the failure to recognize that the {anathymiasis} may be charged with earthy particles.

†2 Omit {kai to megethei kai to pneumati} (l. 29), which make no sense in connexion with {aleeinotatos}. Al. does not seem to have read the words. Ol. does, but the {gr}. "{alethinotatos}" which he records suggests that the received text was seen to be nonsense.

†1 {kai} (b 4) corresponds to {te} (a 29) (Thurot).

†2 It is not true of wine.

†3 Cp. b 5.

†1 Cp. 359b 22.

†2 Read {metaballei} in l. 33 with EJFHN2.

†3 Cp. *Hist. An.* viii. 590a 24. Diels, 21 A. 66. Facts do not bear out this statement; cp. Diels, *Hermes*, xl, p. 310.

†1 Cp. *John Boyes, King of the Wa-Kikuyu*, p. 108. 'They (the Kikuyu) used to burn large quantities of green papyrus reed, mixing the ashes with their food instead of salt.'

†2 Read {engenomenen} l. 10 with J Al.

†3 Cp. Herod. iv. 52, 81.

†4 Read {delai, poioi} in l. 20; omitting {de} after {poioi} with E1JFHNl Al. and keeping {de} after {eiretai} with E (original reading) JFHN.

†5 Perhaps *De Sensu* c. 4; though Ol. (and more doubtfully Al.) refers to a treatise {p. chymon}.

†1 341b 6 ff.

†2 Punctuate with Bonitz-{dio; . . . mallon} (ll. 2-4) in a parenthesis, commas after {mallon} and after{gen} (l. 5), and colon after {thermainon} (l. 8).

†3 Cp. 346b 21, 35.

†4 1. 9.

†5 i.e. rain and wind.

†1-1 The connexion of thought would be easier if this passage were transposed (as by Thurot), to follow {pegen} a 33. If the traditional order is kept this passage must be treated as a sort of parenthesis.

†2 *De Gen. et Corr.* ii. 4.

†3 And we should not call it a wind.

†4 Read {kata pollen syneche} in l. 6 with E. If either {pollen} or {syneche} must go it should be {syneche} as a gloss on {pollen}. Al. certainly read {pollen}.

†1 Read {genesthai} in l. 28 with JFHN.

†2 Cp. 346b 26. Thurot would read {nephos} for {hydor} in l. 35. Then the next sentence would not give an alternative mode of the formation of water but complete the account given in this. Against this is the fact that in the account given in 346b 20 there is no mention of the driving together of clouds or of {antiperistasis}.

†3 The doctrine of the south wind here is irreconcilable with that in c. 5, 362a 31. Berger, *Gesch. der wissensch. Erdk. d. Griechen*, 280, n. 2.

†4 Read {apo te tes} in l. 5 with JFHN Al.

†5 Cp. 363a 3, 364a 5.

†1 Cp. 346b 35.

†2 This sentence informs us of what was assumed to be known in a 6 above, and is singularly pointless

†2 This sentence informs us of what was assumed to be known in a–b above, and is singularly pointless even for a gloss.

†3 But cp. 340b 33.

†4 Read comma after {anothen} (l. 27), no stop after {pnein} omit {d} (J corr. Al. Bag.), no stop after {epidelos}, {an} for {kan}, {kinoumene} for {kinoumenen} (J corr. and perhaps Al.).

†5 There is nothing to answer {men} in l. 35. There should be a colon at least after {engys}.

†6 Therefore the circular motion of winds cannot be attributed to the earth or it would begin at its surface and not at a height.

†1 But cp. 364b 5.

†2 i.e. obliquely, round the earth.

†3 Transpose {kai} to follow {marainei} (ll. 16, 17). So perhaps Ol.

†4 The morning rising, about July 13.

†5 Delete comma after {horais} (l. 28).

†1 The morning setting, about mid-November.

†2 The morning rising. There is no contradiction between this and l. 23 above. Both statements are vague and each may be referred to a different time, especially as in a constellation like Orion the date may vary according to the star chosen for observation. The time referred to in l. 23 must be earlier than that indicated here. For the latter cp. Polyb. i. 37.

†3 This is suspicious. The times meant are the change from early summer to late summer ({opora}) and from late summer to winter (cp. Theoph. *De Lap*. ix. 55); Eudoxus supposed {opora} to begin with the rise of Sirius (about the end of July). But this is expressed very unsymmetrically in {therous e cheimonos}. {ginetai} too suggests a gloss; if the clause is kept we must read {ginesthai} or insert {dioti} before {dia to} (Ideler's conjecture).

†4 About 28 July.

†1 And therefore we cannot expect any south winds to correspond to the trade winds.

†2 Contrast *De Caelo* 285b 14.

†3 i.e. that of the circumpolar stars. This is relative to latitude and so does not serve the purpose of delimiting zones at all well; though no doubt Aristotle meant the ever visible circles of a given place, e.g. Athens. Poseidonius criticizes Aristotle accordingly, cp. Strabo ii. 95, Berger *Geschichte*, p. 306, n. 1. It would be more consonant with the principles on which Aristotle determined the torrid zone if he meant here the arctic circle == that determined by a longest day of 24 hours, and Ideler supposes that this is the meaning, and the facts about the southern hemisphere support this. For Aristotle cannot have thought that the base of the corresponding cone there was the {aei aphanes kyklos} of any place in his own hemisphere. If this view is correct the phrase {dia pantos phaneros} is singularly unfortunate. Cp. 363b 32, and Berger, *Eratosthenes*, 74, n. 4.

†4 The sense required is 'always fall'; and Ideler would insert {aei} after {ouk} in l. 6. But Aristotle may have written carelessly.

†1 i.e. where the Bear is in the zenith when it is on the meridian.

†2 The Crown is in the zenith on the meridian of Athens, and the Bear marks the limit of the circumpolar stars at Athens. Therefore at a place where the Bear is in the zenith the Crown will be circumpolar. 'This region' then is the place where the Bear is in the zenith.

This is taken to be Aristotle's meaning here by Müllenhoff, *Deutsche Altertumskunde*, i, p. 235 n.: cp. Berger, *Geschichte*, p. 305.

Al. and Ol. take the statement to be a proof that we live in the northern temperate zone. 'The Crown is obviously between the circle of the Bear and the summer tropic; it is in the zenith on our meridian, therefore we are in the zone between the Bear and the summer tropic.' Then 'this region' == Greece.

Both explanations fail to give any point to the remark, which must be a learned interpolation.

†3 The connexion of thought is: 'our inhabitable zone is not round the ascertained width is to the ascertained length as 3:5; and the excess of length over breadth is really greater than that since the 3 represents the whole breadth, the 5 not all the length'.

†4 Read {platos} in l. 25 with the MSS.

†1 And not the climate.

†2 Delete the comma before {to) (l. 29).

†3 Omit {on} in line 34 with E1N1 Al.

†4 i.e. it has a short range.

†5 Omit {estin} in l. 1 with E1 and supply {diekei} from {dynaton diekein}.

†6 Omit {heos . . . pnei) (l. 2) with E1H1N1 Al. Whoever put it in missed the point of {apogeion}.

†7 Cp. 364a 5, 361a 4.

†8 Punctuate: {deoi . . . topon} (ll. 10-12) a parenthesis: colon after {apodosei}: colon after {topon} (Bonitz). Read {ho noto} (JHFN) in l. 8.

†9 i.e. southwards.

†10 Read {chionas} (comp. Partsch, p. 586n) in l. 14 and {texin} corr. HN), cp. 362a 18, 364a 8-10.

†11 But cp. 364a 5.

†1 i.e. north and south winds.