Craig Martin

CAUSATION IN DESCARTES' *LES MÉTÉORES* AND LATE RENAISSANCE ARISTOTELIAN METEOROLOGY

INTRODUCTION

Over seventy years ago, Étienne Gilson showed the parallels between Descartes' *Les météores* and the Coimbrans' textbook that was based on Aristotle's *Meteorology*. The topics treated in Descartes' work follow those found in the frequently-taught Jesuit textbook. They both discussed the formation of clouds, rain, rainbows and other lights in the sky, minerals and salts, and the cause of winds and earthquakes.[1] The similarities do not end at the structure and topics treated that Gilson pointed out but extend to large portions of the treatises' content. To be sure, differences appear, but many Aristotelian meteorological concepts are found throughout Descartes' treatise without being changed at all or only in a minor way. Descartes' *Les météores* was neither revolutionary, nor was it intended to be revolutionary.

Les météores was first published in 1637 together with the *Discours de la méthode, La géométrie,* and *La dioptrique.* Some recent studies on Descartes' physics and the *Les météores* have emphasized the eighth discourse where Descartes explained the rainbow through a geometrical analysis of refraction.[2] This emphasis has given the appearance that his study on meteorology was part of Descartes' larger goal of applying mathematics to natural philosophy as he did in the accompanying *La dioptrique*. Other studies, however, have emphasized the physical aspects of his account on the rainbow and how the deductive method Descartes used relies on observation and experience.[3] Moreover, while Descartes appeared to be rightfully proud of his treatment of the rainbow, it should be kept in mind that this discourse is meant to part of natural philosophy, not mixed mathematics, and is much different from the previous seven discourses, which rely on descriptive accounts of the movements of corpuscles.[4] Concentrating on the problem of the rainbow distorts the meaning of the entire treatise because most of *Les météores* is not an attempt to ground meteorology on mathematics but rather is a discussion of how a wide range of sublunary phenomena might be explained using only matter and local motion.

1 Gilson, "Météores cartésiens et météores scolastiques," pp. 102-137
2 For example, Gaukroger, *Descartes' System of Natural Philosophy*, pp. 25-28.
3 Garber, "Descartes and Experiment," pp. 94-104.
4 See Descartes, *Œuvres*, vol. I, p. 370.

In the first discourse of *Les météores*, Descartes announced his method for this subject. He would explain meteorological phenomena without recourse to substantial forms or real qualities, not because he denied their existence *tout court,* but because they were superfluous. He wrote:

> Then, know also that in order to keep my peace with the philosophers, I have no desire to deny that which they imagine to be in bodies in addition to what I have given, such as their *substantial forms,* their *real qualities* and the like; but it seems to me that my explanations ought to be approved all the more because I shall make them depend on fewer things.[5]

Here Descartes' unwillingness to reject outright the existence of substantial forms and real qualities was likely a matter of delicacy. In a 1642 letter to Regius, Descartes suggested that this tactic was meant to illustrate that these concepts were of no use without incurring the anger of Regius' colleagues by directly arguing against their existence.[6] Thus *Les météores* played a role in his attempt to eliminate substantial forms from physics.

This elimination is widely regarded as central to Descartes' critique of scholastic natural philosophy; for example, in *Le monde* and in the *Principia* he similarly suggested that matter and motion sufficiently account for the natural world.[7] Moreover, the reliance on matter and motion is a hallmark not only of Descartes' physics but an identifying feature of the new natural philosophies of the seventeenth century. What is not recognized, however, is that the removal of substantial forms and final causes was already common in some Aristotelian treatises on meteorology. Granted, in *Le monde* Descartes attempted to root out teleology and formal causation in all of physics, while Aristotelians were more likely to remove them just from the field of meteorology, leaving these kinds of explanation intact for psychology, biology, and other fields. Aristotelian commentaries were diverse; and it cannot be assumed that they slavishly followed Aristotle. For example, one contemporary commentator on Aristotle, the Jesuit Niccolò Cabeo, used the field of meteorology as paradigmatic for all of natural philosophy and thereby eliminated substantial forms from his explanations of all natural phenomena except for the human intellect. Understood in this

5 Descartes, *Œuvres*, vol. VI, p. 239. Translation in Descartes, *Discourse on Method, Optics, Geometry, and Meteorology*, p. 268.
6 Descartes, *Œuvres*, vol. III, pp. 491 f..
7 *Principia* IV 187, in Descartes, *Œuvres*, vol. IX, p. 309. On this point and on the possibility that portions of *Les Météores* came from early drafts of *Le Monde*, see Gaukroger, *Descartes: An Intellectual Biography*, pp. 226 f.

context, *Les météores* appears less a herald for the new sciences than a treatise that was participating in contemporary debates on explanation in meteorology.

Because of his tendency to deny the existence of influences, assessing Descartes' knowledge of his contemporaries' work is tricky. Nonetheless, we know that he learned some scholastic philosophy at the Jesuit college at La Flèche.[8] What impact his studies had on him is unclear. In a letter to Mersenne in 1640, three years after the publication of *Les météores*, Descartes requested the names of authors of Jesuit textbooks in philosophy because he could only remember those of the Coimbrans, Francisco Toletus, and Antonio Rubio.[9] Of those three, only the Coimbrans wrote on meteorology. In the same year he praised Eustachius a Sancto Paulo's *Summa philosophica*, a textbook on the entire range of philosophy including meteorology, which he said he had just recently purchased. Descartes' description of his limited memory of earlier readings may very well be true, but nevertheless should not be taken as proof of his total ignorance of contemporary Aristotelians in the 1630s. The correspondence between *Les météores* and other Aristotelian meteorological works is evidence of at least a minimal amount of familiarity with one or more of these books.

Furthermore, there is additional evidence that Descartes was familiar with the content of other treatises on meteorology, in particular ones that did not rely on formal causation. Soon after the publication of the *Discours,* Libert Froidmont (1587–1653), a professor of theology and philosophy at Louvain and author of the well circulated and frequently reprinted *Libri sex meteorologicorum* (1627), criticized Descartes on a number of grounds: his philosophy was too close to atomism, had unacceptable implications about the human soul, and did not utilize teleology.[10] In a lengthy letter to Plempius, Descartes responded to a number of Froidmont's points. With regard to *Les météores,* Froidmont had written that Descartes' description of the composition of bodies by their parts and shapes was "too gross and mechanical"[11] and he complained that Descartes "hopes he will explain too many things by position and local motion, which cannot be understood without some real qualities."[12] In sum, Descartes' meteorology suffered by its use of only matter and motion, without recourse to formal causation. Descartes defended himself not by arguing that "real qualities" were unnecessary or superfluous but by contending that his work treated similar problems as other

8 On Descartes and Jesuit instruction at La Flèche, see Rodis-Lewis, "Un élève du collège jésuite de La Flèche: René Descartes," pp. 25-36; Giard, "Sur la compagnie de Jésus et ses collèges vers 1600," pp. 199-225.
9 Descartes, *Œuvres*, vol. III, p. 185. For a discussion of this request see: Ariew, *Descartes and the Last Scholastics*, p. 26.
10 Armogathe argues that Descartes was familiar with observations found in Froidmont's *Meteorologica*. See Armogathe, "The Rainbow: A Privileged Epistemological Model," p. 252.
11 Descartes, *Œuvres*, vol. I, p. 406.
12 Ibid., p. 408.

3

meteorological tracts had done. He wrote:

> But if one should wish to list the problems which I explained only in the treatise *De meteoris,* and compare them with what has been done up until now by others on the same subject, in which he [Froidmont] is very versed, I am confident that he would not find such a great occasion for condemning my somewhat bloated and mechanical philosophy.[13]

Perhaps he was bluffing about his knowledge of contemporary works on meteorology. Nevertheless, in his defense of himself, Descartes maintained that his meteorology addressed the questions typical of the state of the field, thereby suggesting he had some idea what the state of the field was and that he was aware that others were not using formal and final causes as explanations, that they too were "gross and mechanical."

What Descartes and Froidmont meant by the word "mechanical" is unclear and it seems likely they did not share a similar definition for the word.[14] Nevertheless, a comparison of *Les météores* with the Aristotelian meteorological tradition shows that Descartes was to a certain degree correct about a number of his Aristotelian contemporaries if we accept that he meant "mechanical" to mean a reliance on material causation and a limited application of formal and final causation. An analysis of their work suggests that a debate over whether final and formal causes should be part of meteorological explanations had already begun before Descartes and continued into the middle of the seventeenth century. Aristotelian commentators on the meteorology cannot be thought of as a homogenous group of authors; rather, their views varied widely. The supposed novelty of eliminating substantial forms from meteorology, however, was in fact no novelty at all. Descartes' meteorological theories should not be understood as revolutionary but rather as a continuation of earlier debates. To understand why the field of meteorology differed from other parts of natural philosophy it is necessary to return to both Aristotle and his commentators.

ARISTOTLE'S METEOROLOGY

13 Ibid., p. 430. On this letter and the meaning of the word "mechanical" in Descartes and Froidmont, see Gabbey, "What was 'Mechanical' about 'The Mechanical Philosophy'?," p. 18. The last two lines of the above translation are taken from Gabbey.

14 See Gideon Manning's article in this volume for a discussion of the exchange between Froidmont and Descartes. See Daniel Garber's contribution for a general discussion of the term "mechanical philosophy" in the seventeenth century.

4

The seventeenth-century creators of new philosophies that competed against Aristotelian models prided themselves on their dependence on fewer causes. Even though few historians now trust the accuracy of claims of the complete independence of the promoters of such novel natural philosophies — they contain caricatures rather than portraits of scholastic thought — it is still generally accepted that Aristotelian natural philosophy privileged final and formal causation over material and efficient causation. This privileging is stated explicitly in the *Physics*, among other places, and is apparent in numerous treatises, such as the biological and psychological works.[15] For example, sensation and intellection are understood in terms of form and as actualities of potentialities; and the parts of living beings are considered with respect to their being "for the sake of something." Nevertheless, despite the overall emphasis on forms and ends, Aristotelian works also discussed material and efficient causation; and according to Aristotle it is possible to give explanations, perhaps not always complete explanations, of large portions of the natural world using just matter and motion. In fact Descartes was aware of the significant roles played by material and efficient causation in Peripatetic philosophy, as he contended that his use of shape, motion, and size in physics corresponded to some of the principles that Aristotle employed.[16]

For Aristotle there were limits to teleology just as there were limits to material explanations of nature. A detailed explanation of the varying virtues of the causes is found in *Meteorology* IV 12.[17] Contemporary scholars, as well as numerous medieval and early modern commentators, have considered this chapter as well as the entirety of *Meteorology* IV to be an introduction to biology, a bridge between discussions of the elements, qualities, and the formation of homeomerous substances to discussions of the functions that these substances have in animate beings.[18] Mary Louise Gill understands *Meteorology* IV 12 as delineating to what extent unqualified (*haplos*) necessity can explain the natural world. Gill equates Aristotle's "unqualified necessity" to a "material necessity [that] is grounded in the natures of materials and in general laws of material causation."[19] In *Meteorology* IV 12, Aristotle contended that there exists a hierarchy of substances, starting from the elements at the bottom, going to the homeomerous substances such as flesh and bone, to the

15 *Physics* II 9, 200a32-b3.
16 *Principia* IV 200, in Descartes, *Œuvres*, vol. VIII-1, p. 323.
17 The authorship of *Meteorology* IV has been and perhaps still is questioned. I treat the book as authentic. There were extremely few doubts expressed on its authenticity before 1915. For a summary and bibliography of most germane scholarship on this question see Baffioni, *Il IV libro dei "Meteorologica" di Aristotele*, pp. 34-44; 386-392.
18 Furley, "The Mechanics of *Meteorologica* IV: A Prolegomenon to Biology"; Gill, "Material Necessity and Meteorology IV 12."
19 Gill, "Material Necessity and Meteorology IV 12," pp. 146-147.

anhomeomerous substances such as organs, and finally to entire organisms at the top. The level of a substance within this hierarchy corresponds to the kind of causation that should be used to explain it. Thus, organs are known with respect to final causality, with respect to the "for the sake of something" *tou heneka,* that is, their function within an organism, even though they are simultaneously composed of an underlying matter and are the matter, which composes the entire organism. The characteristics of the homeomerous bodily parts — the flesh, blood, and bone, that is, the matter of these organs — however, can be known through what Gill calls material necessity because, "these things come to be by heat and cold and their combined motions."[20] The preceding eleven chapters to *Meteorology* IV discuss this material necessity, the motions caused by the hot and the cold. Similarly to Gill, David Furley stresses this book's reliance on matter and motion,[21] on "unqualified necessity," identical to Gill's "material necessity," as the primary explanation.[22]

Even though *Meteorology* IV 1-11 explores material properties as the result of matter and motion, the creation of primarily but not exclusively animate homeomerous substances is seen through the prism of teleology. The actions of the hot and cold participate in the process of concoction, whereby an unformed substance attains its perfected form, or, in the terms of medieval and Renaissance scholars, becomes a perfect mixture. Concoction is a type of *teleiōsis*, and although this book explains how the hot and the cold cause physical transmutation, these transmutations are often seen with regard to specific ends. The fact that even the "material necessity" of *Meteorology* IV is subordinate, at least partially, to final causes does not mean that there are no limits to Aristotelian teleology. Although *Meteorology* IV explains why and where there are limits to teleology, the three preceding books of the *Meteorology*, the three books that actually treat meteorological themes, are a better place to examine Aristotelian natural philosophy that has little recourse to final and formal causes.

The first three books of the *Meteorology* discuss changes in the sublunary region, a region that, according to Aristotle, is filled with irregular and episodic changes. Sublunary change results from the eternal motions of the celestial bodies that drive the transformation

20 390b2-14.
21 Furley, "The Mechanics of *Meteorologica* IV." Gill and Furley are by no means the first to emphasize matter and motion in *Mete.* IV. For example, Federico Pendasio (ca. 1600), a professor of philosophy at Padua and Mantua, claimed that the opinion that this book treated primarily matter and motion was widespread. See his *Lectiones in quartum librum meteorologicorum*, f. 1r: "Principium autem hoc statuo quod apud omnes est compertissimum, librum hunc, partem esse naturalis philosophiae, tractat enim quae concernunt materiam et motum."
22 Although Furley refers to *Meteorology* IV's "mechanics," I refrain from this label because Aristotle does not use machines or actual mechanisms as models or analogies. Calling this "mechanical" is anachronistic. For this precise definition of "mechanical philosophy" in antiquity, see Berryman, "Galen and the Mechanical Philosophy," pp. 235-253.

and cyclical motions of the four elements. Aristotle described the proximate cause of meteorological phenomena as being two exhalations that move in continual cycles between the surface of the earth and the uppermost limit of the terrestrial region. These two exhalations are a vaporous exhalation, which is wet and cold, and a smoky exhalation, characterized by dryness and heat. The movements of the dual exhalations provide a unity of explanation for Aristotle, as they give an account for a wide variety of phenomena, including many phenomena that are now considered to be beyond the scope of the atmospheric sciences, such as the apparently fiery paths of comets and the flickering light of the Milky Way. Additionally, according to Aristotle, an analogous pair of exhalations circulates beneath the surface of the earth and explains geological and hydrological phenomena such as volcanoes, earthquakes, hot springs, and the features of the sea and rivers.

As for most of Aristotle's natural philosophy, the purpose of meteorology is to provide causes. Aristotle did not rely on the supernatural to explain extreme examples of weather or other catastrophes and his naturalism was not subordinate to the ethical goal of removing fear of the Gods, as it was for Epicureans.[23] Rather the *Meteorology* is dedicated to explanations *via* material and efficient causation. The material cause of these atmospheric and subterranean changes are the elements and the two exhalations composed of them; the efficient cause is the motions of the celestial bodies, in this case the sun and the moon.[24] Final and formal causes are not part of his explanations for these subjects, because the matter of meteorological phenomena is perpetually imperfect, being partial transformations of the elements, as numerous medieval and Renaissance commentators noted. Moreover because these partially transformed elements are inanimate, as Olympiodorus argued, they do not participate in the formation of organs and organism, which have clear purposes and ends.[25] Thus it is perhaps not surprising that in Theophrastus' *Metaphysics*, where he attacks those who proclaim that "all things are for the sake of an end and nothing is in vain," his first counter example is meteorological, namely "the incursions and refluxes of the sea, or droughts and humidities, and in general, changes, now in this direction and now in that, and ceasings-to-be and comings-to-be."[26]

---

23 See Book 6 of Lucretius' *De rerum natura* and Epicurus' *Letter to Pythocles.*

24 *Meteorologica*, I 1, 339a20-33, trans. by E. W. Webster, in *The Complete Works of Aristotle*, vol. 1, p. 555.

25 On *Meteorology* I-III as about inanimate homeomerous substances see Olympiodorus, *In Aristotelis meteora commentaria*, p. 273, 20 f. For other discussions of the limits of teleology in Aristotle, see *De generatione animalium*, V 1, 778a29-778b7; *De partibus animalium*, I 1, 642a2-3.

26 Theophrastus, *Metaphysics*, IX 28-29. On the fact that meteorology was a prime example of dysteleology, see Vallance, "Theophrastus and the Study of the Intractable: Scientific Method in *De lapidibus* and *De igne*," pp. 28 f. For the view that Theophrastus' position on the limits of teleology was common to Aristotle, see Recipi, "Limits of Teleology in Theophrastus?," pp. 182-213; but, for the view that Theophrastus was attacking

7

Granted, some meteorological phenomena are endowed with purpose. Seasonal rains ensure the availability of crops; even though climatic and seasonal weather patterns exist,[27] specific rains, snows, earthquakes, and floods are without order or clear purpose. Moreover, Aristotle's meteorology, as nearly all ancient meteorology, emphasized rare and irregular phenomena, such as meteors, comets, various fires in the sky, volcanic eruptions, cyclones, and so forth. As a result, proper knowledge of these topics is difficult, he wrote: "Of these things some puzzle us, while others admit of explanation in some degree."[28] The arguments for intractability for the field of meteorology are even more pronounced in Theophrastus' *Meteorology*, where he provided not one cause but a multitude of possible causes.[29] In Aristotle's eyes and those of other ancient Peripatetics, because meteorology was a field dedicated to the part of the natural world that lacks clear order, being composed of the elements that have been partially but not completely transformed, it was best understood by material and efficient causes rather than formal and final ones, which in turn give us only probable or hypothetical knowledge when they provide any explanation at all. Because much of meteorology is distant and thus difficult to observe our knowledge of it is provisional, or as Aristotle wrote in *Meteorology* I 7, "we consider a satisfactory explanation of phenomena inaccessible to observation to have been given when our account of them is free from impossibilities."[30]

MEDIEVAL AND RENAISSANCE ARISTOTELIAN METEOROLOGY COMMENTARIES

For much of the Middle Ages and Early Modern period, the most common method to discuss meteorology was to write a commentary or textbook based on Aristotle's writings.[31] Because over 200 commentaries on meteorology were written during this period, I will limit my

---

Aristotle, see Lennox, "Theophrastus on the Limits of Teleology," pp. 143-151.

27 See *Physics* II 8, 198b16-21. Whether Aristotle actually endorsed a teleological position in this case has been a matter for debate. For a discussion of this issue see Furley, "The Rainfall Example in *Physics* II.8," pp. 115-120.

28 *Meteorologica*, I 1, 339a2-3.

29 Daiber, "The *Meteorology* of Theophrastus in Syriac and Arabic Translation," pp. 166-293, with an English trans. of treatise, pp. 261-271.

30 *Meteorologica*, I 7, 344a5-7, trans. by E. W. Webster, in *The Complete Works of Aristotle,* vol. 1, p. 562. Cynthia A. Freeland contends that *Meteorology* I-III relies on abduction rather than dialectics or syllogisms. See Freeland, "Scientific Explanation and Empirical Data in Aristotle's *Meteorology*," pp. 67-102. For a discussion of the lack of teleology in the *Mete*. see: Liba Taub, *Ancient Meteorology*, pp. 80-84. This lack is not always recognized, see Meinel, "Les *Météores* de Froidmont et les *Météores* de Descartes," p. 107.

31 By meteorology, I limit myself to the field that considered the causes of atmospheric and subterranean events and do not consider the prognostication of weather via signs. By limiting myself to this field, I am following Aristotle's definition of meteorology, which was understood as such by the large part of practitioners of natural philosophy in the Aristotelian tradition. For Aristotle's definition see *Meteorologica*, I 1, 338a19-339a5.

considerations to those of some of the most famed Renaissance Peripatetic authors, such as Agostino Nifo (1469–1538) and Pietro Pomponazzi (1462–1525); authors of text-books that might have been available to a young Descartes, such as the Coimbrans', Eustachius a Sancto Paulo's, John Poinsot's, and Daniel Sennert's; and the more significant works written in the years surrounding Descartes' composition of *Les météores*, including those of Libert Froidmont, Francesco Resta, and Niccolò Cabeo.

By the late Middle Ages the field of meteorology in these commentaries and textbooks became defined by its dysteleology. Averroes (1126–1198) retained the exhalations in his description of the scope of this work; whereby, in his view, the first three books treat the accidents of the dual exhalations and the final book homeomers in general.[32] Thus the four books, following the general schema of Aristotelian intellection, start with accidental particulars and end with universal statements. Albertus Magnus (1193–1280) believed that the first three books of the *Meteorology* treated substances that were in state of becoming simple mixtures and the final book discussed simple mixtures.[33] Thus for him, the *Meteorology* followed the priority implied in the act of becoming and the completion of this act. Later medieval scholars, such as Jean Buridan (1300–1358) and Blasius of Parma (ca. 1400) contended that the differing scopes of the first three books and the fourth one match the change from imperfect mixtures to perfect mixtures.[34] It was this view that was to dominate throughout the Renaissance and well into the seventeenth century.

During the Renaissance, the intractability and imperfection of meteorological phenomena was a basis for emphasizing the conjectural nature of natural science (*scientia*). Two of the most famed philosophers of the early sixteenth century, Nifo and Pomponazzi, put forth this position. Nifo, who was a professor of philosophy in several Italian universities, used meteorology and Aristotle's confession of the inability to understand all causes in order to distinguish the natural sciences from the mathematical. He wrote: "It must be said that natural science is not a science *simpliciter*, such as the mathematical sciences are, but is a science that explains the why (*propter quid*). It is the science of finding the causes which can be held through a conjectural syllogism that gives the *propter quid* of the effect." This account of the effect however is not definitive. He supported this position by his use of Aristotle's meteorology, and argued that, "Aristotle in the book of the *Meteorology* concedes that he does

32 Averroes, *In quartum librum meteorologicorum,* in *Opera,* vol. IV, f. 460r.
33 Albertus Magnus*, Liber quartus meteororum,* in *Opera omnia* vol. IV, p. 705.
34 Buridan, *Expositio libri meteororum*, f. 103r; Blasius of Parma, *Expositio in libros meteorologicorum*, ff.1r; 49r. This view was followed in the sixteeenth century by, among others, Agostino Nifo, Konrad Gesner, Francesco de Vieri, Agostino Pallavicini, Joannes Hawenreuter, Jacques Charpentier.

9

not provide the true causes of natural effects, but that which is possible through conjecture." [35] For Nifo, knowledge of meteorology is uncertain.

Nifo's contemporary and rival Pietro Pomponazzi's take on the intractability of meteorological phenomena led to an even more skeptical view of the nature of natural philosophy. According to his view, the idea of a complete science is held only by fools; meteorology is proof that we will never be able to have an accurate account of the entire natural world. Pomponazzi maligned both religious thinkers who argued that meteorological events, disasters in particular, were the result of the will of God, and those "stupid philosophers" and "Peripatetics," the latter being a category in which probably most of his contemporaries included him, who want to know everything, and proclaim that all events can be traced back to "movement of the heaven." [36] Moreover he contended that unlike Seneca, Aristotle did not believe that earthquakes and winds have final causes.[37] For Pomponazzi, meteorology is evidence for the absence of determinism and purpose in the universe and for the existence of limits for human knowledge.

DESCARTES AND SEVENTEENTH-CENTURY ARISTOTELIAN METEOROLOGY

While a number of medieval and Renaissance scholars tried to follow Aristotle's intention of leaving out final causation from meteorology, not all Early Modern Aristotelians followed this position. Throughout the sixteenth century and the first half of the seventeenth century, commentators on the *Meteorology* and authors of textbooks in natural philosophy and of other meteorological tracts became divided over the question if the field of meteorology relied only

35 "Dicendum, scientiam de natura non esse scientiam simpliciter, qualis est scientia mathematica, est tamen scientia propter quid: quia inventio causae, quae habetur per syllogismum coniecturalem, est propter quid effectus. per haec delentur obiectiones, quae contra haec fieri solent: Prima quidem delentur ex eo, quia non est circulus in demonstratione, cum primus processus sit tantum syllogismus, secundus vero demonstratio propter quid. deletur etiam Secunda obiectio, quia effectus semper est notior ipsa causa in genere notitiae quia est. nunquam enim causa potest esse ita certa quia est, sicut effectus, cuius esse est ad sensum notum. Ipsum vero quia est causae, est coniecturale, utrum tale esse coniecturale est notius ipso effectu, in genere notitiae propter quid. nam posita inventione causae semper scitur propter quid effectus. unde & Aristo., in libro Meteororum concedit se non tradidisse veras causas effectuum naturalium, sed quo erat sibi possibile coniecturabiliter" (Nifo, *Expositio super octo Aristotelis Stagiritae libros de physico auditu*, f. 6v).

36 "Peripatetici autem et alii stulti Philosophi qui volunt omnia scire, dicunt ex necessitate motus Coeli haec evenire" (Pomponazzi, *In libros meteororum,* f. 167r).

37 "Quoniam Aristoteles non posuit causam finalem terrae motus, Seneca autem in suis quaestionibus ponit finem, quia fiant terrae motus, et ego quia promisivo his in hoc libro dicturum de causa finali omnium effectuum, qui in his quatuor libris determinantur, ita etiam observabo. loquamur ergo de fine extrinseco, utrum terraemotus habeat utilitatem aliquam pro fine in universo propriam, et sic etiam de ventis; nulla enim res abstracta est in mundo quae non conveniat naturae ad aliquid, et propriam habeat utilitatem in universo, et in suo genere sit maxima bona: Deus enim secundum Philosophos est auctor optimus et sapientissimus, cum autem universum sit opus Dei, oportet ergo quod perfectissime hoc fecerit, ut Plato posuit in Thimeo [sic]" (Pomponazzi, *In libros meteororum,* f. 190v).

on material and efficient causes and could be explained through the motion of corpuscles and the processes of rarefaction and condensation. On the one hand, some commentators continued in the tradition of Nifo and Pomponazzi and explicitly denied that this subject could be explained by final and formal causes; and, on the other hand, several scholars introduced this field by giving its final and formal causes.

During the first decades of the seventeenth century, the role of formal and final causes distinguished meteorological treatises in much the same way that disputations about the location of comets and the division of the cosmos into distinct sublunary and supralunary regions did. There is even a partial correspondence between those scholars who did not use formal and final causes in meteorology and those who accepted the existence of the transmutation of the heavens, even though the two issues are not connected in terms of argument (see chart on p. XX). While the debates about causation in the meteorological world were neither as heated nor as potentially dangerous as ones regarding the possibility of change in the heavens, nevertheless they were divisive and included what might be characterized as extreme reformulations of Aristotelian physics, especially that of Niccolò Cabeo (1585–1650), which eliminated any role for metaphysical entities in the realm of physics.

At the start of *Les météores* Descartes followed the traditional distinction made in commentaries on Aristotle's *Meteorology* that substances can be classified as perfect or imperfect mixtures. Whereas in Aristotle's work, matter theory is not treated in depth until the final book, Descartes began his treatise with an exposition on the subject, making it the conceptual foundation for his exposition. He described the traditional elements as being composed of small irregular particles that join together, although never perfectly. Smaller particles that move more quickly than larger ones fill up any spaces between the pores of bodies made up of these larger particles, which move more slowly but have more impetus and thus can agitate other particles easily. The motions, combinations, shapes, and positions of these particles give rise to the various types of substances as well as their transformations. While rejecting traditional explanations of the elements, he retained the more typically Aristotelian terminology of vapors and exhalations. For Descartes, vapors are those bodies composed of fine material that are present within the pores of terrestrial bodies; exhalations are closely related to these vapors but are more regular in their shapes, being composed of particles with a shape similar to those which constitute water but are only finer. He likens exhalations to "spirits or brandies." The sun agitates the vapors and exhalations causing their

irregular but cyclical motion throughout the atmosphere.[38] These vapors and exhalations are a constant resource in the *Les météores* and are the composing matter of winds, clouds, and lightning, among other things.

Nearly all, if not all, early seventeenth-century meteorological treatises employed the terms vapor and exhalation to distinguish Aristotle's two exhalations. Typically *vapor* was the wet and hot exhalation, while *exhalatio* was hot and dry, as well as being frequently characterized as smoky. A number of authors of meteorological treatises, such as the Coimbrans, Eustachius a Sancto Paulo, Francesco Resta, John Poinsot, and Daniel Sennert divided the material cause of meteorology into proximate and remote causes: the former being the *vapor* and *exhalatio*, the latter the elements, or in the case of the Coimbrans just two elements, earth and water (see chart on p. XX). While Descartes did not use the term material cause and *a fortiori* did not distinguish between proximate and remote material causes, nonetheless there are parallels between his description of matter and those of the Aristotelians. In effect the irregular and fine particles correspond to the remote material cause while his vapor and exhalation are the proximate ones.

Moreover, Descartes' appeal to the sun as the cause of the motion of the vapor and exhalations mirrors Aristotelian positions. Granted, Descartes hedged his identification of the sun as the mover, by adding the phrase "or some other cause," and by making an analogy to light, which he argued was the result of the motion of fine particles as propelled by luminous bodies.[39] The Aristotelian textbooks for the most part state that the force and motion of the celestial bodies, particularly the sun, are the efficient causes of atmospheric change. Eustachius was an exception, as he believed that "Deus Optimus Maximus" is the efficient cause.[40] Alternatively, the Coimbrans distinguished the instrumental cause of the force and motion of the celestial bodies from their heat.[41] While Descartes did not employ a "quality" in his explanation, the concept of the heat of the sun as efficient cause does appear in Jean-Baptiste Duhamel's *De meteoris* (1660), a work that melded Aristotelian and Cartesian ideas with other novel philosophies.[42]

While the elaborate taxonomy of causes and explanations that is found in some of these texts books (proximate, remote, instrumental, *per se*, and *per accidens*) probably aggravated a number of thinkers who wished to leave behind Aristotelian philosophy, the

38 Descartes, *Œuvres*, vol. VI, pp. 239-241.
39 Ibid., p. 240.
40 Eustachius, *Summa philosophiae quadripartita*, p. 155.
41 Collegium Conimbricenses, *In libros meteorologicos,* pp. 4 f.
42 Duhamel, *De meteoris et fossilibus*, p. 11.

Deleted: .

work of John Poinsot (also known as John of St. Thomas, 1589–1644) might have given them cause to rethink their antagonism. His "Tractatus de meteoris" in his 1634 *Cursus philosophicus thomisticus* begins with the proclamation that he will not apply final and formal causes, only material and efficient ones.[43] The efficient cause is divided into two: *per se,* which is the power (*virtus*) of the sun, stars, and celestial bodies that comes in the form of heat, and *per accidens,* which is antiperistasis. Poinsot utilized corpuscular motifs to explain how heat acts as an efficient cause. According to Poinsot, *vapor* is composed of subtle aqueous parts. Heat causes evaporation by lifting these subtle parts to the higher regions, where they in turn fall, causing precipitation. The dry smoking *exhalationes*, however, are affected by the heat and *virtus* of the sun and stars, which cause them to rise and eventually flame up causing winds, thunder, lightning, and comets. The power of heat acts by thinning out (*subtilizando*) both of the exhalations and by separating (*segregando*) the more subtle parts from the thick ones. After these subtle parts have reached higher levels above the surface of the earth they either burst into flames or precipitate depending on whether they are smokey or watery.[44] Thus meteorological phenomena are caused by the separation and motion of small particles without recourse to final or formal causation.

Against Poinsot, a number of authors of meteorological treatises argued that meteorological phenomena could be understood by formal or final causes. The Coimbrans, in a lengthy discussion, concluded that the double exhalations do not have new substantial forms but retain the forms of the element. Eustachius contended that the formal cause of atmospheric change is located in the forms of the elements.[45] Libert Froidmont identified the substantial form of fire as the formal cause of meteors and maintained that the formal cause of wind was the form of the exhalations.[46] Francesco Resta divided formal causes into proximate and remote in his 1644 *Meteorologia*. For him, the remote formal cause of rain was the substantial form of water and the proximate the form of the drops.[47] In most of these treatises, once the formal cause was established there are few applications of it in further explanations, although it could be used to deduce the secondary properties of the exhalations; *vapor* has the properties of water, *exhalatio* has those of fire. Nevertheless, the paucity of applications of formal causes is justified by a strict reading of Aristotle. Thus, both Poinsot and Sennert, who denied that meteorological substances, being imperfect, have their own *forma misti*, seem

43 Poinsot, *Cursus philosophicus thomisticus: Tomus tertius philosophia naturalis*, p. 129.
44 Ibid., pp. 129 f.
45 Eustachius, *Summa philosophiae quadripartita*, p. 154.
46 Froidmont, *Libri sex meteorologicorum*, p. 41.
47 Resta, *Meteorologia de igneis aereis aqueisque corporibus*, p. 795.

more than reasonable in their interpretations. In this context, Descartes' contention that he did not utilize formal causes does not seem particularly bold.

If Aristotelian meteorology without formal causes is easy to imagine, the same can be true for final ones. Neither the Coimbrans mentioned them, nor did Sennert. Eustachius, however, wrote that the final cause of meteorology was the moderation of the weather, the perfection of the universe, and the manifestation of divine power and wisdom.[48] Froidmont argued that winds were useful to mankind by stopping putrefaction and making the world temperate.[49] Similarly, Resta contended that winds thin out the air and make the weather more temperate.[50] Given that much of the subject of meteorology was disaster-provoking weather and geological events, others followed Pomponazzi who lambasted those who thought everything had a purpose. This line of thought did not have to wait until Voltaire and the Lisbon earthquake of 1755. Furthermore, the conviction of those who held that there were entelechies for the weather does not appear to be strong. Froidmont, who wrote scholia on Seneca's *Naturales quaestiones*, a work that attempted to demonstrate the connectedness of the world to divinity through a number of meteorological examples, did not press particularly hard on this issue in his attack on *Les météores*. He took issue with the lack of teleology in Descartes' discussions of organisms but not in his polemics against his meteorology.[51]

CABEO'S METEOROLOGY

Although Descartes contested some aspects of the Aristotelian meteorological tradition and Froidmont was unhappy with his work, Gilson and Gaukroger reasonably point to the conservative nature of *Les météores* despite its novel treatment of the rainbow and the enumeration of an explicitly corpuscularian position.[52] The relative conservativeness of this work can be better appreciated by a close examination of Cabeo's commentary on the *Meteorology*. Cabeo, a Jesuit who lived in Northern Italy, is best known for his *Philosophia magnetica*, a work that attacked Gilbert and posited that corpuscular effluvia cause magnetic attraction. His interest in corpuscular philosophy continued in his *Commentaria in libros meteorologicorum* (1646), a four-volume tome to which Cabeo devoted much of the 1630s. Although Cabeo was familiar with the work of many proponents of novel natural

48 Eustachius, *Summa philosophiae quadripartita*, pp. 154 f.
49 Froidmont, *Libri sex meteorologicorum*, pp. 196-198.
50 Resta, *Meteorologia de igneis aereis aqueisque corporibus*, p. 363.
51 Descartes, *Œuvres*, vol. I, pp. 402-409.
52 See supra, p. XX [1].

philosophies, such as Galileo, Tycho Brahe, Paracelsus, and Kepler, he did not refer to the works of Descartes and does not appear to have been influenced by his writings.

The *Commentaria* is broad in scope and, although it includes a literal exegesis of Aristotle's text and maintained that Aristotle's writings are the starting place for the study of natural philosophy, the treatise went well beyond Aristotle's words and even the field of meteorology. It is in effect a comprehensive study of natural philosophy that delves into cosmology and chemistry as well as meteorology. For Cabeo, Aristotle's *Meteorology* was the ideal vehicle for investigating the natural world because it avoided the metaphysical speculation that dominated the rest of Aristotle's work. Most importantly, he thought that *physica* should avoid substantial forms as an explanation and rely only on truly physical causes and understood through the detailed observation of their physical effects, as Aristotle had done in the *Meteorology*.[53]

Cabeo separated *physica,* as he called it, from metaphysics and mathematics, both of which he considered speculative.[54] For him *physica* is concerned with the sensible, that is, "all of the effects of those things that can be perceived and are actually perceived," and "the sensible causes of all effects, which can be perceived by external sensation," while "those [causes] that cannot be perceived do not pertain to *physica*."[55] Because Aristotle was too occupied with metaphysics, dependence on his writings caused other Peripatetics to ignore sensible objects or to analyze nature using metaphysical concepts. Thus many of Aristotle's views were not authoritative because he was "more accustomed to metaphysical speculation, than physical observation." [56] Within the category of metaphysical speculation, he included abstractions and indiscriminate applications of logic that reduced things (*res*) into universal categories, differences, and divisions, all three of which he believed to have no physical reality. In his view, metaphysical entities are chimerical because they are not material,

53 Cabeo shared his concern over the non-physical nature of substantial forms with other contemporary Jesuits, namely Honoré Fabri. See Roux, "La philosophie naturelle d'Honoré Fabri (1607-1688)."

54 "Supponendum igitur est tres iam communiter ab omnibus distingui scientias totales speculativas Methaphysicam, Physicam, & Mathematicam, quae dicuntur scientiae totales," Cabeo, *Commentaria in libros meteorologicorum*, vol. I, p. 6.

55 "Omnes ergo illi effectus, qui sensu percipi possunt, & de facto sensu percipiantur horum omnium effectuum cognoscendi ratio spectabit ad Physicam, & ex complexione cognitionum harum proprietatum, & effectuum integrabitur Physica, quae tota versatur in hoc ut ostendat causas sensibiles omnium effectuum, qui sensu externo percipi possunt, & quae sic percipi non possunt non spectabunt ad Physicam," ibid., vol. I, p. 9.

56 "Sed etiam hic videtur Aristoteles magis metaphysicis speculationibus assuetus, quam physicis observationibus," ibid., vol. IV, p. 418; *Commentaria* IV, 79-80: "unde cum Aristoteles physicum agit, omnino antiquos sequitur, sed quia iste Philosophus maxime pollebat ingenio metaphysico, & apprime arridebat philosophari per metaphysicas abstractiones, reducendo semper res ad universalissimas, & metaphysicas rationes, ut constat in tota eius physica; imo & in tota morali, & poetica, & rhetorica ipsa; semper enim res deducit ad differentias, divisiones, & metaphysicas abstractiones" (ibid., vol. IV, pp. 79-80); "omnino Aristotel. ingenium erat ad subtilitates metaphysicas, & abstractiones: non concrescebat illa subtilitas ingenii, ut concrescunt physica," ibid., vol. IV, p. 351.

Formatted: Font:10 pt

sensible, or physical.[57] Thus he intended to correct the "many Peripatetics occupied in these metaphysical subtleties [who] do not read these books [i.e, the *Meteorology*]."[58] Cabeo commented on the *Meteorology* because it allowed him to create a natural philosophy based on physical bodies and not metaphysical concepts, while still maintaining allegiance to Aristotle.

Substantial forms were the main target of Cabeo's attack on metaphysics. The common conception of form as essence was mistaken, according to Cabeo; rather, forms are real, physical, material entities, namely spirits and vapors that have powers and virtues. He realized that this was not the accepted interpretation of Aristotle, as he wrote: "And thus perhaps the substantial form is a metaphysical essence and formula according to Aristotle; it is not a physical entity."[59] Nevertheless, because of substantial forms' non-sensible nature Cabeo believed they should have no place in natural philosophy. Moreover, he went on to reject the twin concepts of form and privation, a foundation of Aristotelian physics, because "one of which is nothing, the other which is metaphysical."[60] Instead, Cabeo defined form as active matter. He wrote:

> This is a form truly physical, this is a vapid and subtle spirit; for it is that, which gives determined being to each thing. For a thing is such because it is animated by this kind of spirit. From this [spirit], there is an active force, so great and of such kind; and just as the diversity of the sublunary objects comes from these diverse spirits, which are implanted in them, the diversity of faculties, properties and virtues comes from these. This spirit is true act, it is true form, not a metaphysical formula conceived in the mind, but a physical principle of a faculty.[61]

What Aristotle called form, and what some considered metaphysical, is in fact a specific type of body that unifies a substance. It is a spirit, a vapor that consists of small particles of matter

57 "sed videant ne physicam reliquant philosophiam, ut chimaeras sectentur metaphysicas," ibid., vol. I, p. 114; "illud est materia, non chimaerica, sed physica," ibid., vol. III, p. 406.
58 "Sed istos libros non legunt multi peripatetici occupati in illis subtilitatibus metaphysicis," ibid., vol. IV, p. 352.
59 "& sic fortasse forma substantialis, est essentia & ratio metaphysica apud Arist. Non entitas physica," ibid., vol. IV, p. 80.
60 "non forma, & privatio, quorum alterum nihil est, alterum quid metaphysicum," ibid., vol. I, p. 406.
61 "forma vero physica est ille, spiritus vapidus, & subtilis, ille enim est, qui dat rei unicuique determinatum esse. Ideo enim res est talis, quia tali spiritu animatur. Ab isto est vis activa, tanta, & talis; & sicuti diversitas harum rerum sublunarium provenit a diversis istis spiritus, qui rebus inditi sunt; ita diversitas facultatum, proprietatum, operationum, virtutum, ab iisdem prodit. Hic vero verus actus, haec vera forma, non metaphysica, mente concepta ratio, sed physicum principium facultatum," ibid., vol. III, p. 4.

and contains active forces that order the world.[62]

Cabeo's commitment to using only what he thought were physical entities greatly altered the traditional way of understanding causes not just for meteorology but for the entire natural world; in his account of substantial change, generation and corruption, and the nature of mixture both final and formal causes are conspicuously absent. For Aristotle, homeomerous substances were mixtures of the four traditional elements. When fully mixed, a new form either supervened upon or replaced the forms of the elements. Medieval and Renaissance scholastics thought mixtures were perfect, when the form was fully actualized and imperfect when only partially.[63] Cabeo, however, discussed generation, corruption, and the perfection of mixture in terms of the position and motion of three kinds of matter. Generation results when particles of spirit become fixed in a medium; destruction occurs when these particles disperse or fly away from the grosser particles, causing their binds to dissolve. "This," wrote Cabeo, "is a true physical mixture, and it becomes perfect, when there is a concoction of its wetness, by which the spirituous parts are joined with the fixed."[64] Perfection is not the realization of their form or end but rather the result of the power of the binding: "All of the perfect compositions [*perfecta compositio*] of sublunary substances are such because their parts are joined with a perfect link." The stronger the link, the more perfect the mixture.[65] Thus, the teleological principle becomes equivalent to a physical state. On the other hand, the corruption of substances comes from the weakening and dissolution of the links, which causes the "spirits and subtler parts to separate from the corporeal and the thick and still ones to fall, while the subtle ones go up into the air."[66] Neither generation nor corruption truly creates or destroys anything; generation and corruption are merely the division and union of parts.[67]

In his efforts to remedy the metaphysical tendencies of his Aristotelian predecessors and peers, Cabeo argued that *physica* should be based only on physical principles. These

62 Arnim, *Stoicorum veterum fragmenta*, § 439-462.
63 For Aristotle's theory of mixture and combination, see: Joachim, "Aristotle's Conception of Chemical Combination," pp. 72-86. For early modern debates over the distinction of these terms see Lüthy, "An Aristotelian Watchdog as Avant-Garde Physicist: Julius Caesar Scaliger."
64 "Haec est vera generatio physica, de quae hic Philosophi, quod nimirum partibus fixis; iterum volatiles aliae separatae adiungantur, & convenienti humore adglutinentur, & haec vera physica mixtio, & perficitur, ut constabit ex infra dicendis, concoctione illius humidi, quo partes spiritosae, cum fixis coniunguntur, & tota perfectio," Cabeo, *Commentaria in libros meteorologicorum*, vol. IV, p. 84.
65 "Tota rerum sublunarium perfecta compositio in eo consistit, ut partes sint perfecto vinculo copulatae, & quo magis coniunctae fuerint, & minus separabiles, etiam ab efficaciori agente, diceretur certe res magis perfecta, in ratione unius, & compositi; istam autem partium compositionem, seu colligationem, dixi iam saepe fieri in humido," ibid., p. 98.
66 "Dico ergo, ut saepe indicatum est, & non semel etiam fusius explicatum, rem aliquam corrumpi, nihil aliud esse, quam ex attentuatione humidi, quasi ex dissolutione vinculi separari spiritus, & partes subtiliores, a corporalibus: & crassas, & consistentes concidere, subtiles in auras abire," ibid., vol. IV, p. 80.
67 "ut in corruptione nihil deperditur, sed quae erant unita dividuntur; in generatione nihil producitur, sed quae erant divisa uniuntur," ibid.

principles largely came from the *Meteorology*. The spirits and vapors that traditionally explained aerial and subterranean change become the model for the entire natural world up to but not including the human soul.[68] Cabeo made the *Meteorology* a starting point in order to undermine metaphysical accounts of the natural world based on formal and final causes. These compositions, the linking, and the dissolution of the bindings of the elements explain the diversity of substances. Even though his philosophy used active principles, the place and position of elemental bodies were seen as crucial to creating new substances. His adoption of physical principles taken from his reading of the *Meteorology* ensured that substantial forms would have no explanatory role in his understandings of physical change, generation, and corruption.

CONCLUSION

While a number of followers of the Aristotelian tradition from antiquity until Cabeo's time understood meteorology as a field that relied on material and efficient causation, Cabeo went further and used Aristotle's *Meteorology* as a model for all of natural philosophy. Cabeo's interpretation is no more faithful to Aristotle than the Coimbrans' or Eustachius' that admits some role for substantial forms and final causes in meteorology. Nevertheless, his commentary shows that different directions could be pursued in interpreting Aristotle's primary work that does not use final and formal causation. Eustachius inserted God as the efficient cause and contended that the weather is the manifestation of divine wisdom. To the contrary, Poinsot explicitly denied entry to formal and final causes in his meteorological discussions, and Cabeo seized upon the fact that substantial forms are not involved in the *Meteorology* and thus made it the basis for a *physica* that did not rely on metaphysics. Aristotle and many of his followers recognized that formal and final causes were not needed for most of meteorology, but both Cabeo and Descartes did not limit themselves to this field. Rather, they thought they could use the material and physical principles of meteorology as a foundation for explanations of natural phenomena in general. The kinds of explanation previously held by meteorology became the model for all of physics.

Although it seems unlikely that Descartes and Cabeo influenced each other, their approaches demonstrate that in portions of physics, such as meteorology, both Aristotelians and their critics were capable of coming to similar conclusions regarding the insignificance of substantial forms in natural philosophy. For Cabeo, Aristotle's *Meteorology* with its emphasis

68 For his view on the soul, see ibid., vol. IV, p. 82.

on material and efficient causation became the basis of all of physics. Descartes' *Les météores* relied on similar tactics whereby the failure to use formal causation would not provoke anger among schoolmen, because the field traditionally utilized this kind of explanation only to a limited degree. Therefore meteorology was an ideal topic for Descartes to unfold his physics in a non-controversial manner. The innovations of *Les météores* are not to be found in Descartes' removal of substantial forms and real qualities, but in other areas, such as the use of images as a means of visual persuasion.[69]

Daniel Garber has argued that while the *Discours* was attacked, it was not perceived as revolutionary by conservative Aristotelians, such as Froidmont.[70] It does not appear that Descartes perceived it as revolutionary as well; he did not appear to expect anything but widespread acceptance of the contents of *Les météores* among those teaching in Jesuit colleges.[71] While Descartes suppressed *Le monde, Les météores*, focused on the inanimate terrestrial world, was a less controversial vehicle to present his larger goal of a physics that had no recourse to final and formal causes. Furthermore, because the subject matter of meteorology did not demand discourses on cosmology, which had proved dangerous to Galileo among others, and because a certain camp of Aristotelian natural philosophers — not just Cabeo, but Poinsot and Sennert as well — was already in agreement with his exclusive reliance on efficient and material causation, *Les météores* was a less dangerous vehicle than *Le monde* to provide a new model for natural philosophy.

Name and Date	Material	Efficient	Formal	Final	Place of Comet
The Coimbrans, 1608 [1592]	Proximate: Vapor & Exhalatio Remote: Earth & Water (p. 1)	Force and motion of Celestial bodies Instrumental: Heat (p. 4-5)	Does not have new substantial forms but retain forms of elements (p. 5)	No mention	Highest region of the air (p. 28)
Eustachius a Sancto Paulo, O. Cist., 1609	Vapor & Exhalatio (p. 154)	Deus Opt. Max. (p. 155)	Forms of the Elements (p. 154)	Moderation of the weather; perfection of universe; manifestation of divine power and	Sublunary

69 Christoph Lüthy, "Where Logical Necessity Becomes Visual Persuasion: Descartes's Clear and Distinct Illustrations," pp. 101-103; Claus Zittel, *Theatrum philosophicum: Descartes und die Rolle ästhetischer Formen in der Wissenschaft*, pp. 187-230.
70 Garber, "Descartes, the Aristotelians, and the Revolution that did not Happen in 1637," pp. 471-486.
71 Descartes, *Œuvres*, vol. I, p. 455.

				wisdom (p. 154-155)	
Libert Froidmont, 1639 [1627]	Vapor & exhalatio (p. 22)	The Sun (p.30)	Formal Cause of Meteors: Substantial form of fire (p. 41); Formal Cause of wind: substantial form of vapor and exalatio	Final Cause of wind: utility; fights disease by stopping putrefaction; makes world temperate (p. 196-198)	Some are sublunary (p. 116-117)
Francesco Resta, O. M., 1644	Proximate: Halitus (p. 1)	Sun, Celestial Bodies	Remote formal cause of Rain: substantial form of water Proximate: Division of water into drops; form of drops. (p. 795) Formal cause of wind: motion. (p. 360)	Final Cause of wind: Thins out air, makes weather more temperate. (p. 363)	Sublunary (p. 14)
Daniel Sennert, 1632 [1618]	Proximate: Vapor & exhalatio Remote: Four elements (p. 250)	The sun, subterranean heat, winds (p. 250)	Does not have *forma misti* (p. 251)	No mention	Some comets sublunary, some supralunary (p. 256)
John Poinsot (John of St. Thomas, O. P.), 1638 [1634]	Proximate: Vapor & exhalatio (p. 129-130)	Per se: Virtus of sun, stars, and celestial bodies. Per accidens: Heat that separates small particles from large ones. (p. 130)	Do not pertain (p. 129)	Do not pertain (p. 129)	Sublunary (p. 137)
Niccolò Cabeo, S. J., 1646	Earth, water, exhalations; mercury, sulfur, salt; wet medium, spirits, fixed parts	Power of heat, spirits	Do not pertain	Do not pertain	Supralunary
René Descartes, 1637	Vapor, exalatio	Sun	Unnecessary	Unknowable	Supralunary
Jean-Baptiste Du Hamel, 1660	Vapor, exhalatio, fumus (p. 2)	Heat of sun; subterranean heat	Unnecessary	No mention	Supralunary (Astronomia

		(p. 11)			physica, p. 70ff.)