

Touching the cold in the Little Ice Age

*Reason and fancy in Robert Boyle's
and Margaret Cavendish's writings on northern cold*

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Abstract

Climate change urges us to reconsider the very cold. Its natural manifestations – ice and snow – are today shrinking elements, and the gravity of melting glaciers and thawing polar regions is indeed deeply worrying for the planet as a whole. In this article questions will be raised concerning how cold was understood and imagined during the Little Ice Age, when the freezing cold was a regular part of the everyday life in large parts of Europe. The very cold became an object of enquiry for natural philosophers in unprecedented ways. The article focuses on Robert Boyle's *New Experiments and Observations touching Cold, or an Experimental History of Cold, begun* (London, 1665) and Margaret Cavendish's *Observations upon Experimental Philosophy* (London, 1666) and explores early modern English imaginaries of the polar regions, and how they join in the scientific debate on how to understand the cold.

Keywords

Robert Boyle, Margaret Cavendish, cold, ice, imaginary, the North, the Arctic

Introduction

The effects of global warming, such as thawing glaciers, unpredictable snowfall and shrinking ice sheets, have sparked growing research interest in the freezing cold from disciplines that normally left the study of these matters to natural scientists. “Ice humanities” is a newly established interdisciplinary field of research that explores freezing temperatures with the objective to understand how “people and societies invent, create, and narrate ice (including snow) so it becomes not just physical but embedded

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in our minds and identities”.¹ From a climatological perspective, ice is linked to our planetary future and permeates the existential and emotional dimensions of culture, arts, and language. Accordingly, making sense of our human predicament under climate change cannot be left to ice physics only. The initiators of ice humanities, Klaus Dodds and Sverker Sörlin, write that ice “is and will remain hyperpoliticized and culturalized” and they suggest that ice can be understood as a “crisis concept” parallel to the environment.² Following the ice is thus to critically engage in Euro-Western scientific knowledge of glaciers and the discovery of ice ages in history, as well as the long lasting and accelerating effects of the industrial revolution, the exploration of Arctic regions from early nineteenth century onward and up to today’s climate situation where the cryosphere has become a critical zone of global environmental change.³

In this article I wish to contribute to emerging scholarship in the ice humanities by calling attention to an earlier historical period in the northern hemisphere known for its low temperature, the so-called Little Ice Age which culminated 1570-1710.⁴ My interest focuses especially on mid seventeenth-century England due not only to the period’s recurring freezes affecting the country, but also to the fact that it was during this time that the very idea of “cold-ness” had become an object of enquiry for British natural philosophers in unprecedented ways. According to one of the first volumes of the Royal Society’s *Philosophical Transactions* (1665), the state, condition and properties of ice and cold temperatures had “hitherto bin almost totally neglected” as objects of knowledge.⁵ But, the journal continued, one of the society’s fellows, Robert Boyle, had since stirred up public interest and debate by publishing “near *Two hundred choice Experiments and Observations* [on the cold, ice and snow], that certainly the Curious and Intelligent Reader will in the perusal thereof find cause to admire both the Fertility of a Subject, seemingly so barren, and the Author’s Abilities of improving the same to so high a Degree”.⁶ Similarly, in 1666, the natural philosopher Margaret Cavendish declared that the dispute concerning the cold, ice and snow, was much “agitated among the learned”.⁷ It is in this context of “thinking with the cold” that several questions stand out for advancing current debates in the ice humanities: How were ideas about the cold imagined, created and narrated by early modern natural philosophers? How did the imaginary of the northern hemisphere play out in the production of knowledge about the cold? What can we learn from these early attempts to create scientific knowledge as well a philosophical imaginary of the cold, ice and snow?

I will look into Robert Boyle’s representation of the cold, ice and snow in *New Experiments and Observations touching Cold, or an Experimental History of Cold, begun* (1665).⁸ What is more, I will put Boyle’s thoughts in

play with his contemporary critic, Margaret Cavendish, who elaborated her contributions to the debate in *Observations upon Experimental Philosophy* (1666) and its companion novel *The Description of a New World, Called The Blazing world* (1666).⁹ For Boyle, experimental methods and measuring instruments applied to cold matter contributed original and local knowledge. His design was “to set down Matters of fact, not to write a complete and regular Treatise” on nature, as he declared in the preface to the book.¹⁰ Conversely, Cavendish, positioned questions about the cold in relation to her general theory of nature, which critiqued a mechanistic understanding of nature as well as experimental philosophers’ trust in scientific instrumentation. There is a considerable body of research on the natural philosophy of Cavendish and the experimental work of Boyle, but less has been written on their reasoning about the cold.¹¹ Therefore in comparing the two authors, and the particular image of the northern hemisphere in their work, Boyle and Cavendish offer important, contrasting vantage points to enlighten scientific debate on the production of knowledge about the cold, ice and snow in early modern England.¹²

Touching the cold

Boyle opened his *History of Cold* by declaring that the subject had generally been considered so barren that he was surprised by his own attempt to study it.¹³ Having said that, he hoped that his experiments and observations could “in some measure repair the Omissions of Mankinds Curiosity towards a subject so considerable, and so diffus’d”.¹⁴ A crucial task indeed, since nothing wise had previously been said about the cold by either the classic authors or modern natural philosophers. How could there be so little knowledge about something so commonly experienced in the North? Though claiming novelty, Boyle’s forerunner, Francis Bacon, had already pointed to the fact that the cold was worth examining, because it was nature’s main instrument besides heat.¹⁵ Furthermore, contemporary thinkers like Pierre Gassendi, René Descartes and Thomas Hobbes had before Boyle challenged scholastic Aristotelian natural philosophy by putting forward new theories of the cold, its causes and its different formations.¹⁶ So, Cavendish was right about the agitation. Heightened interest in the cold had decidedly to do with the general shift regarding knowledge of nature and the nature of knowledge, traditionally called the scientific revolution. This shift involved, in the words of Christiana Christopoulou, a “reconceptualization of the concept of cold”.¹⁷ Ice could thus be considered an early modern “crisis concept” accompanied by a plethora of contested queries: Was the existence of the cold the result of some positive quality or just a privation of heat, or both?

Did the cold originate from the northern regions or was there a “*primum frigidum*”? Was it produced by violent winds or by corpuscular “seeds of cold” (*frigorifick atoms*)? How could one best explain the process of freezing? Was there a difference between natural ice and artificially produced ice? Could the cold be measured – temperature, strength, weight – and with which scientific instruments? What generated icebergs and the expanse of sea ice? What explained the levity of ice? Etcetera.¹⁸

These questions were dealt with in different ways by both Boyle and Cavendish, but to understand their significance, I want to underscore the role played by the authors’ respective ideas about the North, their need for what I call a “northern imaginary” in order to conceptualise the cold and its various manifestations. As Dilip Gaonkar explains, a social imaginary refers to a shared sense of meaning, a setting “within which a people imagine and act as world-making collective agents”.¹⁹ Charles Taylor has framed the concept as a sort of mental horizon of tacit and pre-reflective social meaning.²⁰ So, what was this specifically northern imaginary of the cold in early modern England, and how did it affect popular as well as scientific renderings of it? During the Little Ice Age frosty winds, frozen rivers, and low temperatures were frequent and familiar experiences for the English, encompassing wondrous encounters as well as troubling situations. They could marvel at spectacular events like the big Frost Fairs on the frozen River Thames, but also suffer the bitter effects of frigid weather.²¹ In late 1650s, John Evelyn (an acquaintance of both Boyle and Cavendish) noted in his diary that recent winters had been so cold that “the *Crowes* feete were frozen to their prey: Islands of Ice enclosed both fish & fowl frozen, & some persons in their boates”.²² Yet, for the scientific investigation of the cold, English winters were often unpredictable; as a natural philosopher you could do nothing but wait for the freeze, or seek it out in caves or mountainous regions, as Bacon had stated in *Sylva Sylvarum*.²³ Artificially created cold was thus needed for the experiments Boyle set up, but such environments were difficult to create and maintain. He complained that,

[...] the Truth is, that I am plainly Tired with writing on this subject, having never handled any part of Natural Philosophy, that was so Troublesome, and full of Hardships, as this has proved; especially because, that not only the Experiments being New; and many of them subject to miscarriages, required to be constantly Watched, but being unable to *produce or intend* Cold as we can do Heat, nor command / the Experiments that concern Congelation [...] I was fain to Wait for, and make Use of a Fit of frosty weather (which has very long been a rarity) as solicitously as Pilots watch for, and improve a Wind.²⁴

Ironically, the printing of *History of Cold* was delayed by a freeze. The publisher Henry Oldenburg commented in his preface that “when the Frost began, which was late in the season, the Coldness did within a while arrive at that degree, that by its operation upon the moisten’d paper, it long put a stop to the Proceedings of the Press”.²⁵

To really grasp the cold, ice, and snow, gazing northward seemed necessary. Only in northern “countries cak’d with ice, where the pale Polestar in the north of heav’n sits high, and on the frosty winter broods”, as the Saxon magician phrased it just before the frost scene in John Dryden’s play *King Arthur* (1691) [act III, scene 2], nature revealed one of its instruments, the cold, in plain sight to be observed and examined. In the North, the cold was according to Boyle’s *History of Cold*, both stupendous and steadfast.²⁶ The northern hemisphere and Arctic region consequently functioned as a mental horizon that provided both imaginaries and knowledge of the cold, in contrast to southern Europe.²⁷ I will soon elaborate on how this mental horizon was played out, but first some thoughts on gazing north from an early modern English point of view.

Gazing north

Robert Boyle and Margaret Cavendish never travelled North, but their writings on the cold display spectacular northern sceneries, the shivers of freezing winters and the horrid noise of breaking ice. Their readers were indeed brought to polar landscapes and chilly temperatures, just as the fictional mariners and the abducted heroine in Cavendish’s *Blazing world* were “carried as swift as an arrow out of a bow, towards the North Pole, and in a short time reached the Icy Sea, where the wind forced it amongst huge pieces of ice”.²⁸ Certainly, ideas and fantasies about the Far North – Ultima Thule – had been circulating in Europe since Antiquity, and stories about a hyperborean utopia, a northern world of barbaric cruelty, sea monsters and harsh weather were without a doubt familiar to erudite persons like Boyle and Cavendish.²⁹ But in early modern England, a new type of literature with stories of lived experiences of the cold was published and spread, such as seamen’s journals and travel reports from the North.³⁰ Though sceptical towards the more fantastical content in these testimonies, Boyle made ample use of eyewitnesses from the North in his *History of Cold*.³¹ It is equally very likely that Cavendish was well informed about these contemporary hazardous travels in the Arctic region.³² In line with stories in circulation of English crews frozen to death (or near death), the villains in her *Blazing World* are caught in polar ice and die.³³ Her heroine, however, was not affected by the cold; she survived and wandered off to meet friendly northern creatures. It could be argued that the polar region

in Cavendish's narrative here functioned as a passage into an unknown world, a *Blazing World* beyond the constraints she experienced as an intellectual woman in early modern times. But in seventeenth century England this was hardly the common intention of gazing north.

Heightened curiosity about cold polar landscapes and northern climates were, as hinted above, not just a matter for natural philosophers of the time. From the late sixteenth century onward the prospect of conquering the northern hemisphere for English political and economic interests was explored with increasing intensity. In Matthew Dimmock and Andrew Hadfield's words: "From a barely understood and scantily charted icy wasteland looming of a mythic past, it rapidly became a place of imperial possibility, offering abundant natural resources and new commercial routes that would allow English mariners to traverse the globe and access eastern markets".³⁴ From a southern European point of view, England was often defined as a northern country, which suited the self-image of the English people.³⁵ In his book *The Dream of the North*, Peter Fjågesund brings this aspect to the fore. He points to the fact that early on, because of Britain's central geographical position in the North Atlantic and the strong Scandinavian presence in the country from the 800s onwards, the Arctic connection became a central and self-evident element in British cultural and political orientation.³⁶ British people experienced a cultural and geographical kinship with icy nature and the cold climate of the Far North, which contributed to the strengthening of their sense of northern identity and self-confidence.

In other words, despite the temperate climate, England's northward facing identity was cultivated alongside its colonial aspirations.³⁷ English intellectuals such as the court astronomer John Dee convinced his countrymen that the North was a lost British empire waiting to be rediscovered by Englishmen.³⁸ The blazing northern light would shine over the world again, but now under British flag. In line with this, the British Crown supported northbound expeditions.³⁹ The Muscovy Company (first known as the Mystery and Company of Merchant Adventurers for the Discovery of Regions, Dominions, Islands, and Places unknown) was founded in 1551 with the objective to find new northern trade routes for English commercial interests. These imperialistic dreams were to some extent hindered by other northern powers such as the Danish Crown and competing Dutch trading companies. Yet, when Boyle published *History of Cold* in 1665, regular shipping routes to Archangelsk by the White Sea, trade agreements and diplomatic contacts between the Russian Tsar and the English Crown had long been in place. While the northern passages were fraught with danger, the seamen of the Muscovy Company guaranteed safe trade routes to the north-east, tackling northern winds, icy waters, and frozen har-

bours.⁴⁰ Facilitating English travel northward, the Company also acted as eyewitness reporter of cold climates and thus became instrumental in the exchange of natural knowledge beyond that of trading wool and timber.

The Swedish bishop Olaus Magnus's *Description of the Northern Peoples* (1555), one of the most wide-spread sources of information on northern regions in early modern times and one of the references in Boyle's *History of Cold*, claimed that the bitter cold originated from the North and that physical experience was necessary to understand it: "The huge power which the frost, or cold, possesses in the North, as if this were its own native region can be demonstrated in many ways, through the sense of feeling rather than by authorities".⁴¹ Feeling the cold was thus crucial. Cavendish also stressed that the cold always appeared in, and could not be thought of without, some form of sensuous experience of "shaking, freezing, chilly, windy, numb, stiff, rare, dense, moist, dry, contracting, dilating, ascending, descending".⁴² Boyle too acknowledged that "Coldness being a Tactile Quality, it seems impertinent to seek for any other judges of It than the Organs of that sense, whose proper object it is".⁴³ Nevertheless, in relation to coldness he questioned the reliability of the senses. If the goal was to establish matters of fact about the cold, scientific measuring instruments were indispensable to distinguish subjective sensations from objective registrations.⁴⁴ Cavendish was on the contrary sceptical towards the value of these instruments and the ambition to grasp nature quantitatively, "since art is found out and practised by man, man conceits himself to be above nature".⁴⁵ For Cavendish, therefore, the method of rational inquisition guaranteed a truer understanding of nature, which led her to the conviction that nature in all its parts was perceiving and knowing – qualities that an instrument could never detect.⁴⁶ As she declared: "Matter, self-motion, and self-knowledge, are inseparable from each other, and make nature one material self-moving, and self-knowing body".⁴⁷ In her writings on the cold Cavendish thus introduces a "thinking with ice" that would consequently entail following the ice's own agency, a kind of relational reasoning that challenged the notion of human superiority and the objectification of the natural world by refusing to accept a privileged anthropocentric position in relation to knowledge.⁴⁸ Indeed, this is an abstract way of what Dodds and Sörlin frame as "staging an encounter with the temporality, materiality, and spatiality of ice",⁴⁹ but it might also be interpreted as a way to look upon the cold from a northern perspective, beyond instrumentalism and colonising desire.

Boyle was perhaps more in tune with British expansion and when considering the difficulties in setting up experiments on cold phenomena in England, he admitted that he "must either make use of other mens

Testimonies, or leave some of the Remarkablest *Phænomena* of Cold unmention'd".⁵⁰ In a later chapter devoted to ice he further recounted: "though we shall deliver some few Experiments of our own, such as we had opportunity to make, yet much greater part [...] be taken up by Collections out of Travellers, and Navigators, into those Colder Regions".⁵¹ Together with Olaus Magnus's book, mentioned above, Boyle consulted over forty printed testimonies from "Voyages into the Northern Countries" and travellers' lived experience of the bitter northern cold.⁵² Magnus had pointed to the difficulty of travelling in these parts, the power of the frost and the falls of snow were often so severe and "the weather with its thick, sudden mists, which darken the air, so dreadful, that travellers cannot even tell whether a person they meet at close quarters is friend or foe".⁵³ Many of the travel stories thus contained "little but melancholly Accounts of storms and distresses" Boyle wrote, but he also admitted that here and there useful information was provided of a great frost, or a great snow, or ice.⁵⁴ He considered some sources more reliable than others. Steven Shapin has discerned a system in Boyle's choice of sources: "direct testimony was preferred to hearsay testimony; multiple testimony to single; knowledgeable sources to vulgar".⁵⁵ Accordingly, the Dutchman Gerrit de Veer's famous and widespread eye-witness account of William Barents's three travels to Novaya Zemlya in the late sixteenth century was an obvious reference, as well as parts of Englishmen's explorations in the northern hemisphere included in Samuel Purchas's collection of travels.⁵⁶ Another trusted informant of the cold, ice and snow was *The Strange and Dangerous Voyage of Captain Thomas James* (1633), from which Boyle said he "borrowed more observations, then from those of any other Sea-man".⁵⁷ James, who had set out to discover the Northwest Passage, was regarded as an extra reliable source since he was both a gentleman and university educated.⁵⁸ In Boyle's view, James was "enabled to make far better use then an ordinary Sea-man would have done, of the opportunity he had to observe the *Phænomena* of Cold, being forced to Winter, in a place where he endured little (if at all) less extremity of Cold, then that of *Nova Zembla*".⁵⁹ In this context, Boyle considered eyewitness description by a person of James's calibre as empirical evidence of similar quality to the observations made during experimental sessions in England.⁶⁰ And while Boyle was more critical towards the descriptions made by Olaus Magnus, for the reason that his stories were often based on hearsay, his learning and lived experience of the fierce northern cold made his writings credible all the same.⁶¹ Finally, with regard to wider accounts of northern cold and ice, the trustworthiness of a testimony was more important than how recent the observations were. The cold did not change. Depictions of the northern Russian climate in *Of the Russe Commonwealth* (1591) by English

ambassador and Muscovy middleman Giles Fletcher was a case in point for Boyle, as well as information on the freezing cold in Russia collected by his friend Samuel Collins, during his time as personal physician to the Russian Tsar (1660–1669).⁶² Together these elements indicate that Boyle's notion of the freezing cold guiding his investigations was to a great degree informed by a "northern imaginary" formulated from retold British and Dutch encounters with Nordic landscapes.

Thinking with ice

Olaus Magnus considered the harshness of the cold a specifically northern experience. Margaret Cavendish was less sure. In the chapters devoted to the cold in *Observations* she spoke of "cold regions" and "cold climates" in the North, but her objective was not to explore the climates of these geographical areas, but to present philosophical arguments against any form of reduction of nature's actions. According to her own observations, animal perceptions of heat and cold were relative: A man can have fever in the coldest climate, and cold fits in the hottest climate.⁶³ She also maintained that,

[...] there are so many several sorts of heat and cold, that it is impossible to reduce them all to one certain cause or principle, or confine them to one sort of motions [...] some will apprehend cold weather sooner than others; the reason is, that in their perception of touch, the sensitive motions work quicker or slower in figuring or patterning out heat or cold.⁶⁴

Cavendish claimed that the most rational opinion about the cold was related to the fact that nature in its totality consisted of rational matter, sensitive matter, and inanimate matter. Matter moves in various ways, but it is never mechanically determined as Boyle tried to prove. All of nature's constituent parts are perceptive and this perception consists of ordering – or, in Cavendish's words "patterning" – exterior objects.⁶⁵ Feeling the cold, or heat, was therefore one aspect of this perceptive activity, which was related to and dependent upon sensory circumstances, "for it is not the air that makes all cold; no, not that cold which is called elementary [...] but the corporeal, figurative self-moving, perceptive, rational and sensitive parts of nature, which make all other creatures, make also heat and cold".⁶⁶ Cavendish thus explained freezing as a change of perception, and feeling the cold as a way of actively framing the world. This constant patterning of nature could not be reduced to something to already there or something exclusively human. A certain amount of creation and imagination was always involved in the production of knowledge in all parts of nature and geographical location, cold or not. This constant

preceptive activity implied that nature must be considered as self-knowing. The ice perceives us, patterns us. In one important passage she wrote:

[...] it is absurd to confine all perceptions of nature, either to pressure and reaction, or to the animal kind of perception; since even in one and the same animal sense, (as for example seeing) there are numerous perceptions: for, every motion of the eye, were it no more than a hairsbreadth, causes several perceptions: besides, it is not only the five organs in an animal, but every part and particle of his body, that has a peculiar knowledge and perception, because it consists of self-moving matter [and] a piece of wood, stone, or metal, may have a perceptive knowledge of man, yet it hath not a man's perception [...] no more than the eye patterning out a tree or stone, can be said to have a vegetable or mineral perception.⁶⁷

So, it is no wonder then that Cavendish's thoughts did not match the title page motto of *History of Cold*: "What Nature may do or bring forth is not to be contrived or imagined, but rather uncovered".⁶⁸ For Boyle, it made sense to acknowledge the relatively subjective perception of one's senses: the temperature experienced when dipping your body in cold water, for instance, varied depending upon how cold or warm the body was before touching the water. He called it a paradox.⁶⁹ But Boyle's aim was to uncover temperatures, relations and effects of the cold independently of human interference, to set a "Perfect Standard of Cold".⁷⁰ He wished it would be possible to perform experiments in those northern countries where the effects of cold were most remarkable, and envisioned weather-glasses and thermoscopes transported from one country to another to discover "the differing Degrees of Coldness in differing Regions, and know (somewhat near) how much the Air even of Muscovy, or Norway, or Greenland it self, is cold then that of England [...] The Instrument being accompanied with a memorial of the Degree, it stood at, when expos'd to such a Cold, as made water begin to freez".⁷¹ Unfortunately, the performance of the instruments at hand was still unreliable. It was a matter of improvisation, as Christopoulou has stated. The thermoscopes used by Boyle could measure variation in temperature, but he had no standard scale. Christopoulou also argues that Boyle did not use "a concept of temperature where degrees of the two qualities could belong to the same scale and explained by the same natural process".⁷² Nonetheless, Boyle found the information that the instruments delivered "preferable to those of our senses, because those Dead Engines are not in such cases obnoxious to the same causes of uncertainty with our Living Bodies".⁷³

The experiments performed in England dealt with measuring bodies and liquids capable of freezing and freezing others, degrees of coldness, and the tendency of the cold to move up or down, the expansive force of

freezing water and other liquids, the levity of ice and the weight of frozen bodies, etcetera. Boyle's fascination with ice – the essential effect of the cold and the qualitative proof of the highest degree of cold – was shown by the number of experiments he performed that dealt with freezing of all kinds of liquids (sea water, clear water, urine, ale and beer, milk, wines of different sorts and spiritous liquors, various oils, gum Arabic solutions, vitriol solutions). The chapter "Experiments and Observations touching ice" straightforwardly opens with the declaration that the "Great part of our present History, being employ'd about delivering the *Phaenomena* of Congelation".⁷⁴ Congealed water on a larger scale and in colder conditions was nevertheless found elsewhere, so the discoveries made in England were contrasted with, or confirmed by, credible eye-witnesses "that had travelled either to *Greenland*, *Terra Nova*, or other gelid Climates".⁷⁵ James had for instance noted that oil and wine found in the polar region would become "frozen as hard as a piece of wood, and we must cut it with a Hatchet",⁷⁶ while Collins reported from northern Russia that strong Claret wine did not freeze, while the beer froze easily and gave the ice the taste of hops.⁷⁷ Other experiments which dealt with the expansion of water, proved to be compelling. As Boyle explained:

We took a new Pewter-bottle, capable to contain, as we guess'd, about half a pint of water, and having fill'd it top full with that Liquor, we scru'd on the stopple, and exposed it during a very frosty night, to the cold Air, and the next morning the water appeared to have burst the Bottle, though its matter were metalline, and though purposely for this trial we had chosen it quite new, the crack appeared to be in the very substance of the Pewter.⁷⁸

This specific discovery was supported by a similar story from de Veer's description of the harsh period in Novaya Zemlya, when "the extreme Cold, both some of their other Barrels, and some of those that were hooped with Iron, were, as they speak, *frozen in pieces*, that is according to our Conjecture, burst together, with the Hoops, whether of Wood or Iron by the expansive force of the imprison'd Liquors brought to freez".⁷⁹ The frozen liquids referred to were without exception brought by the travellers from the South to the North. Such observations of southern matter reacting to northern climates can be seen as part of "the white, western vision of the North" – an empty space for European powers to conquer and exploit.⁸⁰ If not mastered, the Arctic cold threatened to metamorphose travellers and their gear into ice, which had happened to more than one crew.⁸¹

Even if Boyle was keen to prove that ice could be measured with the same accuracy in England as in the polar region, he could not avoid the strangeness of the northern ice. The dominant impression, as Christopher

P. Heuer points out in his book on the visual poetics of the Far North in early modern times, was “of intractability, strangeness, and the ‘perplexitie’ of matter”.⁸² The sublime quality of the Arctic landscape only came to be appreciated later.⁸³ For Boyle, the stupendous cold of the North represented a kind of wonder and strangeness that was not fit for experiments.⁸⁴ Yet, the experiments carried out using smaller pieces of ice in England (for instance, on the levity of ice) led to vague and imprecise results that did not match the reports from northern eye-witnesses.⁸⁵ The northern ice was puzzling, as for instance the strength of congealed seawater that had recently carried the Swedish king and the whole Swedish army over sea passages in Denmark. Ice-bridges of this magnificence had been described by Olaus Magnus, Boyle wrote, but they seemed so fantastic that had Charles X Gustav not in fact marched over the ice in 1658, he would not have believed the bishop’s words.⁸⁶ Furthermore, how credible were the many reports of mountains and vast sheets of ice floating throughout the Arctic Sea? Eye-witness testimonies seemed credible, but it was difficult to fathom the size of “those stupendously tall pieces of ice”, or if the ice mountains were free-floating or grounded.⁸⁷ Boyle chose to believe that the stories taken together, as told by Dutchmen and Englishmen (and one learned Frenchman), proved the accuracy of these natural ice manifestations “from being entertain’d with a Disbelief, which their strangeness would else tempt men to”.⁸⁸ Even for Boyle, then, imaginative faculties were needed to understand the facts of nature. In a repetitive manner his secondhand observations confirmed “the most stupendious Example”, “the vastness of single mountains of ice, the stupendiousness”, “the stupendiosest piece (for height and depth) of single Ice”, and so on. Language failed him, but the imaginative energy generated by the thought of icebergs, ice sheets and vanishing horizons was striking. Surprisingly, Cavendish was far more matter of fact when it came to explaining icebergs. In a short paragraph in *Observations*, she declared:

What produces those great precipices and mountains of ice which are found in the sea, and other great waters? I answer: that snow, as also thick fogs and mists, which are nothing but rarified water, falling upon the ice, make its outside thicker; and many great shelves, and broken pieces of ice, joining together, produce such precipices and mountains as mentioned.⁸⁹

It was as if she made the northern nature less foreign than Boyle did, or at least something less stupendous. In the same line of thought, the fictional Arctic landscape that the heroine in *Blazing World* encountered was surprisingly welcoming: It was “covered all with snow” and the big bears walking on the ice, at first frightening, “showed her all civility and kindness imaginable; for she being not able to go upon the ice, by reason of

its slipperiness, they took her up in their rough arms, and carried her”.⁹⁰ In the following story of the heroine (who quickly becomes Empress of this new world) local knowledge about ice, snow and frost was presented.⁹¹ The Empress did not always agree, but she listened carefully and learned.

Conclusion

In her essay, *The Library of Ice: Readings from a Cold Climate* (2019), Nancy Campbell calls Robert Boyle a poet.⁹² She finds his long list of experiments on various shapes and sizes of ice both imaginative and expressive. In her reading, Boyle is also a careful observer of the changing colours of the Arctic ice, a sensitive listener to ice breaking and his rendering of the northern cold creatively unsystematic. This does not sound like the dry scientist aiming to establish objective standards and matters of facts on coldness, but Campbell might be right. As I have shown in this article, freezing phenomena were invented, created, and narrated in *History of Cold* with a curiosity that included tales of Arctic travellers and imaginary polar landscapes. Boyle knew that he was dependent on observations and experiences from the North for the conceptualization of the cold. If credible in providing Boyle with detailed information about freezing temperatures, ice and snow, they were furthermore inscribed in a broader vision of England as a northern political power. Boyle stated that his scientific work attempted to reveal, not imagine, the qualities of natural phenomena. *History of Cold* however shows that the distinction was difficult to uphold. Did Boyle not after all, in Heuer’s words, let “the Arctic, environment and landscape [...] take on agency and become actors in their own right”?⁹³

In contrast to Boyle, Cavendish saw the relationship between reason and fancy in another way. As Susan James has rightly observed, “Cavendish stresses their interconnections. By presenting *Observations* and *Blazing World* as “two worlds” joined at their poles, she encourages the readers to move between philosophy and fiction”.⁹⁴ Every part of nature is perceptive according to Cavendish and she thus urges us to be humble, “since all Knowledge, by your Form, you gain/Then let not *Pride* above your *Reason* reign”.⁹⁵ My reading of Cavendish’s intentions is that she accordingly presented her imaginary of the Arctic region with its ice and snow, as a gateway to an intellectual journey that could help the reader to better grasp the fundamental actions of nature. In line with her natural philosophy, we should try to understand what the ice tells us. Indeed, the early modern European culture was “rich in ice-bound discourse” in which reality and the imaginary intermingled.⁹⁶ The cold experiences by north-bound travellers needed translation, as was fictionally demonstrated by

François Rabelais in his widespread adventures of Pantagruel. In one of the stories Rabelais let his hero sail between icebergs and freezing winds that turned sounds and speech to ice. However, the eerie silence of the frozen words was broken when they were caught by Pantagruel and melted on the ship's deck. The sounds – “hin, hin, hin, hin, his, tick, tock, crack, brededin, brededac, fr, frrr, frrrr, bou, bou, bou, bou, bou, bou, bou, bou, bou, tracc, tracc, trr, trrr, trrrr, trrrrr, trrrrrr, on, on, on, on, on, ououououon” – were in fact the frozen fragments of confusions in the Arctic region.⁹⁷ Whether or not Pantagruel's recordings can teach us something about how to listen to the ice melting in own time is of course another question. But what we can learn from both Boyle's scientific endeavours and Cavendish's vision of nature is that there is no escaping the imaginary aspect of human reason, and we need both ice physics and ice humanities to meet the climate change challenges today.

Notes

1. Klaus Dodds and Sverker Sörlin, “Ice Humanities – Living, Thinking and Working in a Melting World”, *Ice Humanities – Living, Thinking and Working in a Melting World*, eds. Klaus Dodds and Sverker Sörlin (Manchester: Manchester University Press, 2022), 2.
2. Dodds and Sörlin, “Ice Humanities”, 18; on ice as “crisis concept”, 8–14.
3. Dodds and Sörlin, “Ice Humanities”, 27.
4. The world experienced a significantly cooler climate between ca. 1300–1800, a period which now is called The Little Ice Age. For a thorough defence of the fact that this cooling trend was particularly acute in the northern hemisphere from the late sixteenth to the early eighteenth century, see Sam White, “The Real Little Ice Age”, *Journal of Interdisciplinary History* 44, no. 3 (2014); Fredrik Charpentier Ljungqvist, *Klimatet och människan under 12000 år* (Stockholm: Dialogos förlag, 2017), 287–308. On the political and cultural impact of the Little Ice Age see Brian Fagan, *The Little Ice Age. How Climate made History, 1300–1850* (New York: Basic Books, 2000), Geoffrey Parker, *Global Crisis. War, Climate Change & Catastrophe in the Seventeenth Century* (New Haven and London: Yale University Press, 2013) and Charpentier Ljungqvist, *Klimatet och människan*, 309–331.
5. *Philosophical Transactions of the Royal Society of London* 1, issue 3 (May 1665), 47. For a first public announcement of Boyle's experiments, see *Philosophical Transactions of the Royal Society of London* 1, issue 1 (March 1665), 8, <https://doi.org/10.1098/rstl.1665.0006>.
6. *Philosophical Transactions of the Royal Society of London* 1, issue 3 (May 1665), 47.
7. Margaret Cavendish, *Observations upon Experimental Philosophy*, ed. Eileen O'Neill (Cambridge: Cambridge University Press, 2001), 120.
8. Robert Boyle, *New Experiments and Observations touching Cold, or an Experimental History of Cold, begun* (London, 1665), henceforth referred to as *History of Cold*. A second edition was issued in 1683. Citations in the article are from the modern edition Robert Boyle, *The Works of Robert Boyle, Vol. 4, Colours and Cold, 1664–5*, eds. Michael

Hunter and Edward B. Davis (London: Pickering and Chatto, 1999). More cold experiments were later presented by Robert Boyle in *Experiments and Notes about the Mechanical Origine Or production of Heat and Cold* (London, 1675).

9. Margaret Cavendish, *Observations upon Experimental Philosophy, to which is added, The Description of a New World, Called The Blazing World* (London, 1666), henceforth referred to as *Observations*. Citations in the article are from the modern edition Margaret Cavendish, *Observations upon Experimental Philosophy*, ed. Eileen O’Neill (Cambridge: Cambridge University Press, 2001). The chapters analysed are mainly from part I: “XXV Of the Motions of Heat and Cold”, “XXVI Of the Measures, Degrees, and Different Sorts of Heat and Cold”, “XXVII Of Congelation and Freezing”, “XXVIII Of Thawing or Dissolving of Frozen Bodies”, “XXIX Several Questions Resolved Concerning Cold, and Frozen Bodies”, 95–124. The citations in the article to *The Description of a New World, Called The Blazing World* are from the modern edition Margaret Cavendish, *Political Writings*, ed. Susan James (Cambridge: Cambridge University Press, 2003), henceforth referred to as *Blazing World*.

10. Boyle, *The Works of Robert Boyle*, 210.

11. Reflections on Boyle’s take on coldness is found in Nancy Campbell, *The Library of Ice: Readings from a Cold Climate* (London: Scribner, 2019), 36–45. Interestingly, *History of Cold* is only mentioned once in the seminal work by Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985), 209. The reasoning around icebergs in *History of Cold* is however a case in point for the argument on the trustworthiness of travellers’ testimonies and what counted as reliable knowledge for Boyle in Steven Shapin, *A Social History of Truth. Civility and Science in Seventeenth-Century England* (Chicago and London: The University of Chicago Press, 1994), 247–258. Michael Hunter, *Boyle Between God and Science* (New Haven, Conn. and London: Yale University Press, 2009), 145–146, points to innovative aspects of the publication of *History of Cold*, such as the detailed presentation of the experimental findings under titles, the public expounding of experimental equipment, and precise citations of sources. Hunter does not, however, go into the phenomenon of the cold. For this I am indebted to the work by Christiana Christopoulou, “Early Modern History of Cold: Robert Boyle and the Emergence of a New Experimental Field in Seventeenth Century Experimental Philosophy” in *History of Artificial Cold, Scientific, Technological and Cultural Issues*, ed. Kostas Gavroglu (Springer, 2014), 21–51. E-book, DOI 10.1007/978-94-007-7199-4. Christopoulou’s article focuses on Boyle’s experiments on coldness. The testimonies of northern travellers used by Boyle to support the findings in England are only briefly mentioned. Michael Hunter, “Introductory notes” in *The Works of Robert Boyle*, xvii–xxiv, gives a thorough picture of the making of the book and he mentions Boyle’s work in relation to Cavendish’s *Observations*, xxiii. Even if the chapters in Cavendish’s *Observations* dealing with the cold have not yet earned much attention, there is an expanding literature on the natural philosophy of Cavendish in general and her critique of experimental philosophers. See for instance Lisa T. Sarasohn, *The Natural Philosophy of Margaret Cavendish. Reason and Fancy during the Scientific Revolution* (Baltimore: The Johns Hopkins University Press, 2010), 169–172; Emma Wilkins, “Margaret Cavendish and the Royal Society”, *Notes & Records of the Royal Society of London* 68, no. 3 (2014), 245–260.

12. Boyle and Cavendish are normally considered as incompatible figures in the field of science. This idea has been challenged by Emma Wilkins and Jo Wallwork

who argue that in terms of rhetorical and publication strategies, as well as the overall purpose of science, there are similarities between them. Jo Wallwork, “Disruptive Behaviour in the Making of Science: Cavendish and the Community of Seventeenth-Century Science” in *Early Modern Englishwomen Testing Ideas*, eds. Jo Wallwork and Paul Salzman (Farnham and Burlington: Ashgate, 2011), 41–53; Emma Wilkins, “Margaret Cavendish and Robert Boyle on the Purpose, Method and Writing of Natural Philosophy” in *Women, Philosophy and Science: Italy and Early Modern Europe*, eds. Sabrina Ebbersmeyer and Gianni Paganini (Springer, 2020), 81–104. E-book, DOI 10.1007/978-3-030-44548-5.

13. Boyle, *The Works of Robert Boyle*, 208.

14. Boyle, *The Works of Robert Boyle*, 209.

15. Francis Bacon, *Sylva Sylvarum: or A Naturall Historie*, published posthumously by William Rawley (London, 1628): “Producing of Cold is a thing very worthy the Inquisition; both for Use and Disclosure of Causes. For *Heat* and *Cold* are *Natures* two hands, whereby shee chiefly worketh”, 22–23.

16. For instance, René Descartes presented his theories about snow, rain and hail in the sixth discourse of *Les Météores* (1637) and Thomas Hobbes discussed the causes and effects of cold in chapter six of *Decameron Physiologicum, or, Ten dialogues of Natural Philosophy* (1677).

17. Christopoulou, “Early Modern History of Cold”, 21.

18. OED on early modern use of the term levity: “In pre-scientific physics, regarded as a positive property inherent in bodies in different degrees, or varying proportions, in virtue of which they tend to rise, as bodies possessing gravity tend to sink. Cf. GRAVITY N. 4A. *Obsolete* exc. *Historical* or *allusively*.” *Oxford English Dictionary*, s.v. “levity, n.¹, sense 1.b”, July 2023. <<https://doi.org/10.1093/OED/7878237548>>

19. Dilip Gaonkar, “New Imaginaries: An Introduction”, *Public Culture* 14, no. 1 (2002), 1.

20. Charles Taylor, *Modern Social Imaginaries* (Durham: Duke University Press, 2003).

21. Alvin Snyder, “Hard Frost, 1684”, *The Journal for Early Modern Studies* 8, no. 2 (2008), 20–23. Snyder shows how “weather and climate played a key role in forming English body worlds and a sense of English identity”, 9. He mentions Boyle’s work briefly in relation to the effects of the cold on human bodies.

22. John Evelyn, *The Diary of John Evelyn*, ed. E.S. de Beer (London: Oxford University Press, 1959), 388.

23. Bacon, *Sylva Sylvarum*, 184–186.

24. Boyle, *The Works of Robert Boyle*, 223.

25. Henry Oldenburg, “The Publisher to the ingenious reader” in Boyle, *The Works of Robert Boyle*, 206.

26. Boyle, *The Works of Robert Boyle*, 208.

27. Peter Fjågesund, *The Dream of the North: A Cultural History to 1920* (Amsterdam and New York: Brill, 2014), E-book: <https://brill.com/display/title/29986>, 15, 74–75. I find it surprising that Robert Boyle’s book on the cold is not mentioned in Fjågesund’s very detailed and nuanced depiction of northern imaginaries from Antiquity to the twentieth century.

28. Cavendish, *Blazing World*, 7.

29. Fjågesund, *The Dream of the North*, 33–116.

30. Matthew Dimmock and Andrew Hadfield, “The North” in *Amazons, Savages*,

and *Macchiavels: Travel and Colonial Writing in English, 1550–1630*, ed. Matthew Dimmock and Andrew Hadfield (Oxford: Oxford University Press, 2022) E-book: <https://academic.oup.com/book/43773/chapter/370667346>

31. Maija Jansson, “Eyewitnesses to the Phenomenon of Russian Cold: Robert Boyle and the Accounts of Early Travelers North”, *Quaestio Rossica* 10, no. 3 (2022), <https://doi.org/10.15826/qr.2022.3.716>. Jansson’s article focuses on the impact of England’s commercial and diplomatic relations with Russia on the early development of natural science in England, which plays out in Boyle’s *History of Cold*. Her analysis focuses on Boyle’s use of Giles Fletcher, *Of the Russe Commonwealth* (1591). Shapin, *A Social History of Truth*, 247–353, mentions Boyle’s use of Captain Thomas James’s *The Strange and Dangerous Voyage* (1633) and correspondence with Samuel Collins, physician to the Russian Tsar 1659–1666.

32. Line Cottegnies, “Utopia, Millenarianism, and the Baconian Programme of Margaret Cavendish’s *The Blazing World* (1666)” in *New Worlds Reflected. Travel and Utopia in the Early Modern Period*, ed. Chloë Huston (Farnham: Ashgate Publishing Limited, 2010), 74–76. Cottegnies argues convincingly for the influence of Bacon’s *New Atlantis* on Cavendish’s *Blazing World*.

33. Cavendish, *Blazing World*, 7–10.

34. Dimmock and Hadfield, “The North”, 103.

35. Snyder, “Hard Frost, 1684”, 12: “early modern Europeans tended to view Londoners as near neighbours to Muscovites and Laplanders”.

36. Fjågesund, *The Dream of the North*, 22.

37. The term “northernness” seems appropriate, though it was not used until nineteenth century according to OED. It denotes “the state or condition of being northern in situation”, *Oxford English Dictionary*, s.v. “northernness, n., sense 1”, July 2023. <https://doi.org/10.1093/OED/9774748266>, or “the quality of being from the north; northern character or tradition”, *Oxford English Dictionary*, s.v. “northernness, n., sense 2”, July 2023. <https://doi.org/10.1093/OED/6797104433>.

38. Dimmock and Hadfield, “The North”, 104; Fjågesund, *The Dream of the North*, 63.

39. Dimmock and Hadfield, “The North”, 103–105.

40. Jansson, “Eyewitnesses to the Phenomenon of Russian Cold”, 1071, 1076. The Muscovy company had a monopoly on trade between Russia and England until 1698.

41. Olaus Magnus, *Description of the Northern Peoples*, vol. 1 [1555], transl. Peter Fisher and Humphrey Higgins transl., ed. Peter Foote (London: The Hakluyt Society, 1996), 46. Peter Foote, “Introduction” in Olaus Magnus, *Description of the Northern Peoples*, lxx: “For two hundred years and more it served European scholars as their chief key to knowledge of Scandinavia”. The book, originally in Latin *Historia de Gentibus Septentrionalibus*, was quickly translated to several European languages. In 1658 an anonymous translation was published in English. Boyle’s own references are nevertheless to the Latin version. Fjågesund, *The Dream of the North*, 54.

42. Cavendish, *Observations*, “Of the Measures, Degrees, and Different Sorts of Heat and Cold”, 102.

43. Boyle, *The Works of Robert Boyle*, xxx.

44. For a defence of the use of tools in science see Boyle, *The Works of Robert Boyle*, 214–215.

45. Cavendish, *Observations*, 95.

46. Cavendish, *Observations*, 100: “for I see, that in this present age, learned men

are full of art, and artificial trials; and when they have found out something by them, they presently judge that all natural actions are made the same way [...] particular sensitive knowledge in man, which is built merely upon artificial experiments. Will never make him a good philosopher, but regular sense and reason must do it; that is, a regular, sensitive, and rational inquisition, into the various actions of nature”.

47. Cavendish, *Observations*, 137.

48. Cavendish, *Observations*, 98–99. Though not developed further in this article, in terms of non-human agencies and the relationality of matter, there are interesting intellectual synergies between Cavendish’s early modern natural philosophy and more recent new materialist and eco-feminist thought – such as Donna Haraway’s “becoming-with”, Karen Barad’s “agential realism”, and Jane Bennett’s “vibrant matter”. See Karen Barad, “Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter”, *Signs: Journal of Women in Culture and Society* 28, no. 3 (2003), 801–831; Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham and London: Duke University Press, 2010); Donna Haraway, *When Species Meet* (Minneapolis: University of Minnesota Press, 2008).

49. Dodds and Sörlin, “Ice Humanities”, 8.

50. Boyle, *The Works of Robert Boyle*, 218.

51. Boyle, *The Works of Robert Boyle*, 346.

52. Boyle, *The Works of Robert Boyle*, 220.

53. Olaus Magnus, *Description of the Northern Peoples*, 49.

54. Boyle, *The Works of Robert Boyle*, 218.

55. Shapin, *A Social History of Truth*, 249.

56. Boyle read Gerrit de Veer, *The True and Perfect Description of Three Voyages ... by the Ships of Holland and Zeeland* (1598; English translation 1609) as reprinted in Samuel Purchas, *Hakluytus Posthumus: or, Purchas his Pilgrimes: Contayning a History of the World in Sea Voyages and Land Travells by Englishmen and Others* (London, 1625).

57. Boyle, *The Works of Robert Boyle*, 221. Boyle is referring to Thomas James, *The Strange and Dangerous Voyage of Captain Thomas James in his intended Discouery of the Northwest Passage into the South Sea, Wherein the Miseries indured, both Going, Wintering, Returning & the Rarities observed, both Philosophicall and Mathematicall* (London, 1633).

58. Shapin, *A Social History of Truth*, 250–251.

59. Boyle, *The Works of Robert Boyle*, 221.

60. Shapin, *A Social History of Truth*, 252. Jansson makes the same reflection in relation to Fletcher’s eye-witness account of northern Russian climate, “Eyewitnesses to the Phenomenon of Russian Cold”, 1060.

61. Boyle, *The Works of Robert Boyle*, 220–221.

62. Jansson, “Eyewitnesses to the Phenomenon of Russian Cold”, 1068.

63. Cavendish, *Observations*, “Of the Measures, Degrees, and Different Sorts of Heat and Cold”, 103.

64. Cavendish, *Observations*, “Of the Motions of Heat and Cold”, 96–97.

65. On the concept of patterning see Deborah Boyle, “Margaret Cavendish on Perception, Self-Knowledge, and Probable Opinion”, *Philosophy Compass* 10, no. 7 (2015), 439–440, 10.1111/phc3.12232, and Kourken Michaelian, “Margaret Cavendish’s Epistemology”, *British Journal for the History of Philosophy* 17, no. 1 (2009), 31–53. DOI: 10.1080/09608780802548259.

66. Cavendish, *Observations*, “Of the Measures, Degrees, and Different Sorts of Heat and Cold”, 104.

67. Cavendish, *Observations*, “Of Knowledge and Perception in General”, 140–141.
68. In Latin: “Non fingendum, aut excogitandum, sed inveniendum, quid natura faciat aut ferat”. The quotation is attributed Francis Bacon, but the source has not been found according to the editor of *The Works of Robert Boyle*, 204.
69. Boyle, *The Works of Robert Boyle*, 229–230.
70. Boyle, *The Works of Robert Boyle*, 242.
71. Boyle, *The Works of Robert Boyle*, 284.
72. Christopoulou, “Early Modern History of Cold”, 29, on instrumentation, 28–35. The first reliable thermometer was invented by Daniel Gabriel Fahrenheit in 1714, using mercury as the thermometric substance. Boyle experimented with different liquids (distilled water, oil of aniseed, alcoholic mixtures etcetera) without finding long-lasting success with one that did not easily freeze or that could depict small variations in measurement.
73. Boyle, *The Works of Robert Boyle*, 234.
74. Boyle, *The Works of Robert Boyle*, 346.
75. Boyle, *The Works of Robert Boyle*, 346.
76. Boyle, *The Works of Robert Boyle*, 274.
77. Boyle, *The Works of Robert Boyle*, 300.
78. Boyle, *The Works of Robert Boyle*, 325.
79. Boyle, *The Works of Robert Boyle*, 329.
80. Fjågesund, *The Dream of the North*, 28.
81. Christopher P. Heuer, *Into the White. The Renaissance Arctic and the End of the Image* (New York: Zone Books, 2019), 163–164; Fjågesund, *The Dream of the North*, 57–58 (Willoughby expedition), 67–68 (Barents expedition).
82. Heuer, *Into the White*, 20.
83. Fjågesund, *The Dream of the North*, 27. Fjågesund describes the change in attitude, in which the Arctic landscape was soon considered sublime in a positive sense, “with its endless expanses, the various combinations of sea and ice, darkness and light, cold and emptiness, which exhibited natural forces beyond man’s imagination”, 137. On the sublime interpretation of the Arctic imposed upon by Western visitors during early nineteenth century, see Robert W. Rix, “The Arctic Sublime” in *The Cambridge Companion to the Romantic Sublime*, ed. Cian Duffy (Cambridge: Cambridge University Press, 2023), 154–165.
84. Boyle, *The Works of Robert Boyle*, 346–357.
85. Shapin, *A Social History of Truth*, 253–254.
86. Boyle, *The Works of Robert Boyle*, 350, 354–355. On the Swedish army’s march across the Belts see Lars Ericson Wolke, 1658: *Tåget över Bält* (Lund: Historiska Media, 2008).
87. Boyle, *The Works of Robert Boyle*, 322–323. On Boyle and icebergs, see Shapin, *A Social History of Truth*, 253–258.
88. Boyle, *The Works of Robert Boyle*, 352–354. Besides de Veer and James, polar stories of English travellers in Purchas’ collection (Mr W. Baffin and Captain James Hall) and the French hydrographer P.G. Fournier.
89. Cavendish, *Observations*, “Several Questions Resolved Concerning Cold, and Frozen Bodies”, 122.
90. Cavendish, *Blazing World*, 9.
91. Cavendish, *Blazing World*, 24–25, 34.
92. Campbell, *The Library of Ice*, 40.

93. Heuer, *Into the White*, 168.

94. Cavendish, *Blazing World*, “To the reader” 5–6; the editor Susan James’s comment, note 2.

95. Margaret Cavendish, “Of Humility” in *Poems, or, Several Fancies in Verse with the Animal Parliament in Prose* (London, 1668), 136.

96. Heuer, *Into the White*, 164.

97. Rabelais citation from Heuer, *Into the White*, 166. On the frozen words (*les paroles gelées*) in the context of early modern travel literature see Heuer, *Into the White*, 164–169; Kim Campbell, “Of Horse Fish and Frozen Words”, *Renaissance and Reformation*, 14, no. 3 (1990), 183–192.

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