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Exploring the North in a Changing Climate

The Little Ice Age and the Journals of
Henry Hudson, 1607–1611

ABSTRACT During its nadir between approximately 1565 and 1720, the Little Ice Age cooled the Arctic by 0.5° C relative to early twentieth-century averages. Historians of past climates often craft declensionist and even determinist narratives of the Little Ice Age in the far north. Conversely, social or cultural historians usually depict the early modern Arctic environment as unchanging. The journals kept by Henry Hudson and his crew during their voyages of Arctic exploration provide detailed information on environmental conditions and human responses that bridge these different historical perspectives and concerns. The journals reflect the influence of the Little Ice Age in the Arctic, but also demonstrate that voyages of northern exploration were affected by complex and even counterintuitive relationships between global climate change and its local environmental manifestations. These relationships can only be examined with a rigorous methodology that confronts issues of scale and causation that are still rarely considered by climate historians. Ultimately, the journals reveal that a shifting climate was a dynamic, but hardly determinist, agent in the early modern exploration and exploitation of the Arctic.

KEYWORDS Climate history, historical climatology, environmental history, early modern history, Henry Hudson, Northern Passage, methodology, spatial scale, temporal scale

In recent months, reports released by the Intergovernmental Panel on Climate Change have confirmed that anthropogenic climate change is dramatically altering Arctic and subarctic environments, with alarming consequences for their inhabitants (IPCC 2014: 7). While the scale and potential consequences of modern warming are unprecedented, natural climatic shifts have also shaped past relationships between people and Arctic environments in ways that provide critical context for climate change today. From approximately 1565 to 1720, sulfur released by volcanic eruptions and a decline in solar radiation cooled the world's climate. This nadir of a longer "Little Ice Age" (LIA) manifested in the Arctic as a 0.5° C decline in average temperatures, relative to the early twentieth-century norm. This superficially modest cooling in fact dramatically altered the distribution of sea ice, the frequency of storms, and the strength of ocean currents across the Arctic and Subarctic (Mann *et al.* 2009: 1257; White 2014: 327; Zeeberg 2002: 104).

Most historians interested in past climate change have approached the LIA by investigating how cool and often unpredictable weather across the northern hemisphere contributed to famine and provoked social unrest in agricultural societies. Since cold temperatures seem so hostile to human life, histories of the LIA in the Arctic have often repeated even more overtly declensionist narratives that reinterpret the disappearance or decline of Norse settlements in light of climatic cooling (Parker 2013: xix; Lamb 1995: 260; Brown 2001: 262; Behringer 2010: 141). By contrast, many historians of human experiences in, and representations of, the Arctic during the LIA depict the far north as a homogenous realm of unchanging cold: a stage for human drama, but not an actor in its own right (Regard & Lemercier-Goddard 2013: 11; Ryall 2014: 121). Even environmental historians of the North generally focus on "northscapes" transformed less by their internal dynamism than their malleability in the hands of human explorers and colonizers (Jørgensen & Sörlin (eds.) 2013: 3).

With their detailed descriptions of both human decisions and environmental conditions, accounts of early modern Arctic exploration can unite these very different approaches to the far north. This article introduces detailed journals kept by Henry Hudson and his crew during four expeditions to high latitudes undertaken between 1608 and 1611, during a particularly cold phase of the LIA that many historical climatologists today call the "Grindelwald Fluctuation." For climate historians, an analysis of the journals tests and refines interdisciplinary reconstructions of the LIA in the Arctic. It challenges declensionist or determinist narratives by emphasizing the agency of people who resisted constraints imposed by a shifting climate, and it highlights the complexity of local environmental conditions that

could respond in counterintuitive ways to global cooling. For historians of the Arctic and Subarctic, this examination of the journals demonstrates the agency of an environment that co-evolved with human activity to influence its own representation and exploitation. It cautions against the assumption that Arctic environments encountered and described by early moderns were homogenous and unchanging. It also offers new insights into expeditions that helped transform European understandings of the Arctic and Subarctic in ways that would affect its later colonization. Ultimately, a climate history of the Hudson expeditions requires methodologies for confronting issues of scale and causation that have relevance for all historical scholarship (Howkins 2014: 294).

The Grindelwald Fluctuation endured across the Northern Hemisphere from approximately 1565 until 1630 (Pfister 2007: 57). Journals kept by Hudson and his crew record sea ice in places, and at times, that clearly reflect the existence of contemporary cooling in the Arctic and Subarctic. However, they also reveal that unrelenting cold did not always doom voyages of Arctic exploration, even in the chilliest decades of the LIA. The Grindelwald Fluctuation was, in fact, distinguished by highly variable weather, and even in more stable climates annual fluctuations in meteorological conditions are especially pronounced in the Arctic. Indeed, the first journey led by Hudson pressed far into the Arctic in a year of relative warmth, while the second soon succumbed to particularly frigid conditions. The course of Hudson's third voyage was scarcely affected by sea ice, while his last expedition was likely influenced by temperatures that were only slightly cooler than the twentieth-century norm. For the explorers, the influence of climatic trends was occasionally reinforced, but often mitigated, by complex interactions between the regional atmosphere, hydrosphere, cryosphere, and biosphere (Walsh 2008: S3). These environmental conditions were, in turn, mediated both by the agency of the explorers and the characteristics of their society.

The Hudson voyages therefore reveal that historians of past climates should establish not one, but four distinct relationships while crafting their narratives, especially when they approach topics relevant to the Arctic or Subarctic. The first must firmly link the local or regional environmental phenomena to activities conducted by human beings. The second must plausibly connect short-term weather events to long-term climate change. The third must join these atmospheric fluctuations to relevant changes in the geosphere, hydrosphere, cryosphere, or biosphere. Only then can historians of climate consider the fourth and final relationship, that between climate change and human history. Working through these relationships can help climate historians develop less declensionist or determinist conclusions about the complex ways in which decadal climatic fluctuations



Fig. 1. Changing perceptions of the Arctic in response to journeys of exploration. Top: a map of the Arctic published in the Dutch Republic on the eve of Hudson's voyage (from Mercator & Hondius 1606). Bottom: a map drawn by Willem Barents just before his death near Novaya Zemlya, in 1597 (from Barents 1599). While older maps depicted a vast polar continent connected to Greenland, in these newer maps the polar continent has been at least partially replaced by open water, and Greenland is surrounded by ocean.



affected human activity (Degroot 2014: 239). But nuance also has its limits, for climate change can seem like a more direct influence in human history when satellite maps of Arctic ice cover today are compared to environmental records in the journals kept by Hudson and his crew. Ultimately, analyzing the environmental context of Hudson's journeys demonstrates both the value of nuancing, and the importance of acknowledging, climate change as an agent in northern history.

Human and Environmental Contexts for the Hudson Voyages

The Arctic environment was still largely unknown to the organizers and participants of the voyages led by Hudson. From Ptolemy's second-century *Geographia* to the world map drawn by Johannes Ruysch in 1507, most European representations of the Arctic had relied on the hazy and imprecise recollections of adventurers who had never reached the very high latitudes. That would change later in the sixteenth century. Merchants in Europe's increasingly prosperous north could only indirectly access the rich lands and trade routes newly claimed by Iberian powers. After 1530, they therefore funded expeditions that sought alternative passages to Asia through Arctic waters to the northeast and northwest. Knowledge of the Arctic expanded as explorers travelled deeper into its icy seas. For example, notions of inhabited polar continents gradually disappeared from maps published after the ill-fated voyages led by the Dutchman Willem Barents (Fig. 1). Still, European explorers had scarcely approached the pole, or entered the high latitudes of the Canadian Arctic and the Russian Arctic beyond the Kara Sea. For many merchants and cartographers, hopes for an ice-free passage to Asia therefore persisted (Zeeberg 2005: 57; Zeeberg 2007: 36; Hellinga 2007: 31; Unwin 1995: 4).

Hudson was the first explorer of the far north whose expeditions would be financed by both Dutch and English merchants. Little is known of his early life, and his participation in sixteenth-century voyages of northern exploration has never been firmly established. Certainly he was influenced by Arctic myths that had not yet been entirely disproven by previous expeditions. Many scholars in Amsterdam and London, foremost among them the Dutch cartographer-clergyman Petrus Plancius, still argued that sufficiently deep water could not freeze. Moreover, they believed that northern temperatures in the summer were nowhere lower than at 66° N, and actually rose at higher latitudes in the continuous sunlight of that season. If sufficiently deep water could be found in the icy band that surrounded this temperate Arctic, a passage to Asia in the east, west, or perhaps even across the pole should be possible. In their four voyages, Hudson and his crews would attempt every conceivable route (McCoy 2012: 95; Murphy 1909: 2; Thomson 1975: 62).

The first three expeditions led by Hudson entered the Arctic off the northwestern coast of Norway, before pressing into the high latitudes north of Europe. Unbeknownst to the explorers, environmental conditions there were, and are, largely shaped by the relatively warm remnant of the Gulf Stream, known as the North Atlantic Current, as it collides with the frigid Transpolar Drift that presses south through the Fram Strait, and with cold currents flowing west from the Kara Sea (Fig. 2). Prevailing westerlies interact with the North Atlantic current to bring warmth to northern Europe and its surrounding waters, while the mingling of currents provides rich nutrients that sustain abundant marine life. Perhaps the most significant characteristic of the Arctic environment is the presence of sea ice, which oscillates in area from $7 \times 10^6 \text{ km}^2$ in September to a high of $10 \times 10^6 \text{ km}^2$ in March. The annual thickness and extent of sea ice in the Arctic north of Europe is most importantly determined by regional temperatures, wind patterns, and currents. All of these are influenced both by regular shifts in atmospheric pressure at sea level (expressed, for example, in the different settings of the North Atlantic Oscillation), and by climatic trends like the natural cooling of the LIA or the more rapid anthropogenic warming of the present (Walsh 2008: S4; Polyak *et al.* 2010: 1760; Marchenko 2012: 5; National Snow & Ice Data Center).

Sea ice in this variable and extreme environment comes in so many varieties that 183 are listed in the sailing guide published by Fisheries and Oceans Canada. Critical distinctions can be made between old ice, which does not melt in the summer; new ice, which does; pack ice composed of broken ice crushed together by wind or current; icebergs broken from a mainland glacier and afloat at sea; and drift ice, which consists of ice pieces, or floes, that have separated from the pack. Every voyage led by Hudson was influenced by the unique characteristics of one or more of these ice types (Day 2006: 144; Savours 1999: vi).

The fourth expedition undertaken by Hudson and his crew sailed into very different seas. The waters of the eastern Canadian Arctic and Sub-Arctic, bereft of sufficiently warm currents flowing from the south, freeze more completely than the seas north of Europe. The Labrador Current transports cold water south from the High Arctic, and has a cooling influence on the coast north of Cape Cod. Icebergs calved from glaciers on Ellesmere Island, Devon Island, and particularly Greenland are ferried south by the current. Warmer currents do trickle into the Davis Strait, delaying ice formation in its eastern opening. Meanwhile, the Hudson Bay is a relatively closed system, connected to the oceans only through narrow channels at points along its northeastern boundary. Because many rivers flow into the Bay, it has a lower average salinity than ocean water, and it therefore freezes



Fig. 2. A map of the Arctic and Subarctic, depicting currents and relevant locations for the Hudson voyages. Warm currents are in red; cold currents are in blue (Polyak et al. 2010: 1758; "Arctic Ocean Currents Map," Arctic Portal Library; <http://library.arcticportal.org/1494>; access date 23 June 2014).

comparatively quickly. The Bay ices over completely in the winter, and the springtime breakup of the ice is shaped by the Bay's current, the pattern of rivers that empty into it, the dynamics of airflow sweeping over increasingly snow-free land, and the influence of advection. The consequence of these complex processes is counterintuitive: in the summer the last ice in the Bay lingers both at its extreme north, near Southampton Island, and its extreme south, in James Bay (Etkin 1991: 19; Catchpole 2003: 19; Pharand 1984: 2).

Many of these environmental realities influenced, and were influenced

by, the climatic fluctuations of the LIA. To obtain records of average seasonal temperatures across the Arctic during the LIA, historical climatologists have employed scientifically analyzed “proxy” sources that respond to climate change alongside model simulations and documentary observations. These reconstructions suggest that sea ice and glaciation in the Arctic north of Europe and the high Canadian latitudes generally expanded in the cooler temperatures of the Grindelwald Fluctuation (Crespin *et al.* 2009: 394; Crespin *et al.* 2013: 327; Lemke, Harder & Hilmer 2000: 278; Zeeberg 2002: 104; Funder *et al.* 2011: 750). However, these relationships were hardly straightforward. For example, the climatic trends of the LIA in the far north were at times reinforced, and occasionally interrupted, by the atmospheric pressure oscillations that accompanied changes in the North Atlantic Oscillation (NAO) and the Arctic Multidecadal Oscillation (AMO). Moreover, after 1600 CE the West Spitsbergen Current likely transported more heat northward into the Arctic, which in that region counteracted the cooling influence of a ten percent reduction in the strength of the Gulf Stream. Model simulations also suggest that Arctic temperatures in autumn, winter, and spring likely responded most dramatically to the climatic oscillations of the LIA, while summer temperatures remained relatively stable (D’Andrea *et al.* 2012: 1007; Grumet *et al.* 2001: 142; Crespin *et al.* 2009: 394; Crespin *et al.* 2013: 327; Zeeberg 2002: 104).

European journals of exploration do not provide a direct window into these environmental relationships. Hudson and his crew interpreted northern natures and peoples in light of the expectations and assumptions that informed not only English imperialism, but also the complex blend of Christian and Aristotelian concepts still central to contemporary natural philosophy. For the explorers, the far north was a purifying environment. It revealed and tested the virtue of those who entered it, and because it was bereft of accessible gold or silver, its exploration contrasted with the plunder carried out by the Portuguese and Spanish in the south. It was also an extreme wilderness, a place in which environmental norms and laws were seemingly reversed. Explorers who hazarded this realm were remembered in narratives that contributed to the strengthening collective identity of emerging nation-states, especially when their voyages ended in tragedy (Regard & Lemerrier-Goddard 2013: 11; Martin 2006: 6; Burstyn 1966: 169; Jorink 1999: 13).

On the other hand, journals kept by European Arctic explorers generally provide reliable environmental data, because the safety of the crews who kept them and the ultimate significance of the expeditions they recorded depended on their accuracy. Landscapes sketched by explorers approximately match the way they really appear, maps drawn after expeditions

were often remarkably accurate, and reports of fauna or flora were reliable enough to encourage the development of profitable whaling and fishing industries. Even fanciful descriptions of mermaids or other mythological beings can, for environmental historians, provide hints as to the kinds of animals explorers encountered but misinterpreted. Ultimately, most early modern journals of polar exploration, when read with an appreciation for historical context and expected audience, can provide dependable new data for climate historians. Among these journals, some of the most continuous and descriptive were kept by Hudson and his crew.

Climate Change and the Search for an Eastern Passage. The Expeditions of 1607 and 1608

In the early seventeenth century, Dutch merchants and mariners were swiftly outpacing their English rivals in the quest for greater access to Russian and Asian markets (De Vries & Van der Woude 1997: 377). In that context, the discovery of a northern passage offered hope to English merchants. Geographers estimated that such a route would be shorter than its southerly alternative, and securing it for England would upend the country's unequal commercial relationship with the Dutch Republic. Consequently, English merchants were only briefly daunted by the failures of English and Dutch explorers in the late sixteenth century to locate such a route. In 1607, the English Muscovy Company commissioned Henry Hudson to find a passage through the ice near the recently charted island of Spitsbergen, part of the Svalbard archipelago that lies halfway between Norway and the pole (Fig. 2). From there, Hudson and the organizers of his expedition hoped that warmer temperatures would allow an easy journey across the pole, and ultimately towards Asia (McCoy 2012: 95; Thomson 1975: 62).

According to the Julian calendar then used in England, on 1 May 1607 Hudson and eleven crewmen departed London aboard the little bark *Hopeful*. Struggling against contrary winds, by 30 May they had only reached approximately 61° 11' N, not far from the northern coast of Shetland Island. Thereafter progress was quicker. On 13 June they reached the eastern coast of Greenland, and their sails were coated in ice. They were soon engulfed in a dangerous north-easterly gale that threatened to wreck the *Hopeful* on Greenland's coast, but the weather moderated by 18 June. Two days later the explorers, now at 70° N, spotted sea ice for the first time. They set their course away from Greenland and towards Spitsbergen, sailing through fog amid great floes of drift ice driven south by the Transpolar Drift (Fig. 1 and Fig. 3) (Hudson & Playse 1860: 8; García-Herrera *et al.* 2003: 14; Thomson 1975: 63).

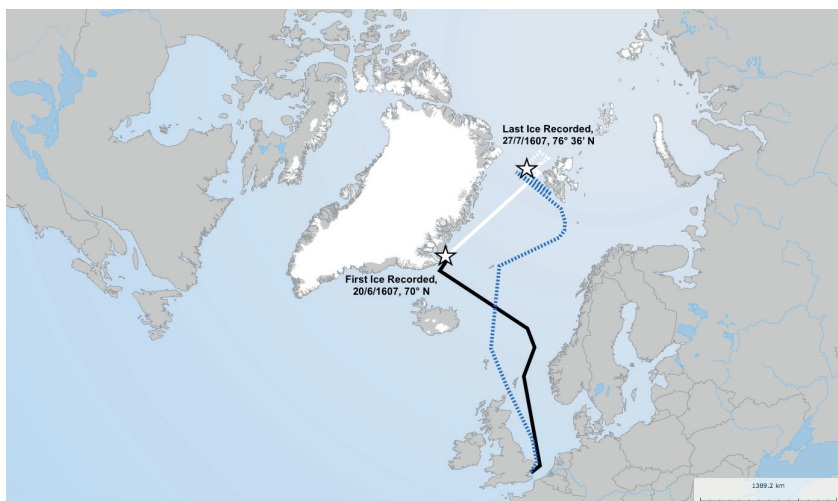


Fig. 3. The course of the first Hudson expedition to the Arctic. The outbound voyage is in black, while the return trip is shown in blue dashes. The portion of the voyage during which sea ice was either certainly or probably encountered is depicted in white (solid for the outbound journey, and dashed for the return trip). White stars denote when and where ice was first and last encountered ("Inter-Map," Arctic Portal Library; <http://library.arcticportal.org/1494>; access date 13 January 2015).

In a journal written jointly by Hudson and crewman John Playse, an entry on 27 June reported "ice laying very thick all along the shore" of Spitsbergen. On 28 June, they had manoeuvred the *Hopeful* between the ice and the shore, but on the following day they were again confronted with a ferocious storm. The storm had abated by the evening of 30 June, and thereafter the mariners slowly and haltingly pressed north, despite the continued presence of sea ice that, at times, surrounded their ship. On 12 July they had reached the northern coast of Spitsbergen at 80° N. That afternoon they were becalmed and in thick fog, as the current slowly drove them towards nearby pack ice. "It pleased God at the very instant to give us a [breeze]," their journal recounts, "which was the meanes of our deliverance." The explorers could not find passage through the ice, but they did record warm temperatures and many whales, as well as abundant fauna and flora on the shore. Hudson and his crew meandered south along the western coast of Spitsbergen, before bearing for England in late July. At 78° 82' N on 16 July, the mariners ceased to continuously describe visible ice, although their last encounter with sea ice took place on 27 July, at approximately 77° 36' N (Fig. 3). They returned to London on 15 September 1607 (Hudson & Playse 1860: 22).

The first expedition led by Hudson sailed further north than any voyage recorded by European explorers, and Hudson's descriptions of abundant

whales off Spitsbergen contributed to the rise of a large and destructive whaling industry. Hudson's expedition and its consequences were products of seventeenth-century cultural and economic structures leveraged by human agency, but they were also influenced by complex interactions between global, regional, and local environments. In Northwestern Europe, 1607 was unusually warm in the context of the generally cool Grindelwald Fluctuation, and the journal kept by Hudson and Playse suggests that unusually temperate conditions were also felt in the vicinity of Spitsbergen (Van Engelen, Buisman & Ijnsen 2001: 112). This meteorological anomaly was compounded by a peculiar manifestation of the Grindelwald Fluctuation in the far north. Relative to twentieth-century averages, its summers were not as cool as its other seasons, although the shift from the warmth of summer to the chilliness of autumn was more extreme. Moreover, although the Gulf Stream was, on average, ten percent weaker during the Grindelwald Fluctuation than it is today, the greater warmth of the West Spitsbergen Current likely also contributed to reduced sea ice near Spitsbergen (Zeeberg 2002: 66; D'Andrea *et al.* 2012: 1007; Crespin *et al.* 2009: 394; Crespin *et al.* 2013: 327). Accordingly, despite the cool climate, in 1607 counterintuitive but mutually constitutive relationships between the atmosphere, hydrosphere, and cryosphere near Spitsbergen favoured Hudson's deep incursion into the Arctic. On the other hand, very high or very low winds repeatedly imperilled the voyage of 1607, although shifts in the frequency of these conditions cannot yet be tied to LIA climate change in the Fram Strait.

The merchants of the Muscovy Company were hardly discouraged by the outcome of Hudson's voyage in 1608, but they did forego further exploration of the Arctic north of Spitsbergen in favour of an expedition to the seas around Novaya Zemlya (Fig. 2). Previous explorers financed by Dutch and English merchants had reached as far as the northeastern tip of the Novaya Zemlya and the Kara Sea, but despite braving great hardships they had uncovered no ice-free passage to Asia. Hudson therefore set sail earlier in the year than his predecessors, departing London aboard the *Hopeful* on 22 April 1608. Hudson and his financiers likely believed that greater time in the north would yield more opportunities to scour the ice for a passage, and more chances to avoid the failures of previous expeditions (Hudson 1860b: 23; McCoy 2012: 98; Day 2006: 137; Thomson 1975: 63).

Hudson was now the sole author of his journal. As the *Hopeful* sailed up and around the coast of Norway in late May, he described weather that, even for the high latitude, was persistently and unusually frigid. Hudson reported that "my carpenter was taken sicke [...] and three or foure more of our companie [...] I suppose by meanes of the cold." It was still abnormally cold when the ship rounded the North Cape, the northernmost point



Fig 4. The course of the second Hudson expedition to the Arctic. The outbound voyage is in black, while the return trip is shown in blue dashes. The portion of the voyage during which sea ice was either certainly or probably encountered is depicted in white (solid for the outbound journey, and dashed for the return trip). White stars denote when and where ice was first and last encountered ("Inter-Map," Arctic Portal Library; <http://library.arcticportal.org/1494>; access date 13 January 2015).

of Norway, and entered the Barents Sea. However, by the time the expedition encountered its first sea ice on 9 June, the crew had recovered (Fig. 4). According to Hudson's measurements, they had reached $75^{\circ} 29' N$, and were approximately 200 kilometres west of Novaya Zemlya. They pressed on until the ice would permit no further passage, and it was only with damage to the ship that they managed to retreat to open water (Hudson 1860b: 27).

Despite repeated attempts to sail around the north coast of Novaya Zemlya, the pack ice forced the *Hopeful* further south, until on 25 June Hudson concluded that "our hope of passage was gone [by] this way," owing to the "abundance of ice." Manoeuvring through the ice, the mariners reached the Strait of Proliv Kostin Shar, on the southwestern shore of Novaya Zemlya. They were more than 160 kilometres north of the entrances to the Kara Sea that had been charted in previous expeditions. Hudson and his crew braved the ice driving from the strait to explore whether a nearby river flowed into the Kara Sea. On 5 July, three days after nearly being crushed by ice, they discovered that the river led nowhere. Hudson concluded that he was now "out of hope to find passage by the north-east." Midway through June, the mariners left the pack ice behind, and they returned to London on 7 August (Hudson 1860b: 44; McCoy 2012: 98; Thomson 1975: 63).

In his second voyage, Hudson did not come close to entering the Kara Sea and repeating the accomplishments of his sixteenth-century predeces-

sors. This failure was influenced by very different environmental relationships than those that had contributed to his more promising first expedition. In Northwestern Europe, 1608 was an extremely cold year even in the context of the Grindelwald Fluctuation, and Hudson's journal indicates that unusually frigid temperatures also extended into the Arctic (Van Engelen, Buisman & Ijnsen 2001: 112). A winter that was among the coldest of the LIA was followed by a chilly summer, and these atmospheric conditions contributed to the sea ice that barred Hudson's way. The climate of the Grindelwald Fluctuation raised the likelihood of such extremely cold years. Interactions between climate, weather, and local Arctic environments were again mutually constitutive, but in 1608 that synergy was very different in the vicinity of Novaya Zemlya than it had been in the seas near Spitsbergen a year earlier. The influence of environmental conditions unfavourable for Arctic exploration was compounded by the second expedition's early departure. Despite the relative warmth of early summer, sea ice in the Arctic actually reaches its nadir in autumn, after many months of thawing. By leaving in spring, the mariners actually confronted far more sea ice than they would have, had they left later. In 1608, seemingly clear connections between a cooler climate, frigid weather, extensive sea ice, and Hudson's failure were therefore not so straightforward. The second voyage had no chance of charting a passage to Asia, but it could have reached deeper into Arctic waters had the explorers made different decisions. Overall, during Hudson's first two expeditions the different regional consequences of a generally cool global climate altered the course of northern exploration, and helped shape the future European exploitation of the Arctic.

Climate Change and the Search for a Western Passage. The Expeditions of 1609 and 1610

After the failure of Hudson's second voyage, the merchants of the English Muscovy Company had little interest in financing further expeditions. On the other hand, as early as 1603 the leaders of the much larger and more profitable Dutch East India Company had committed themselves to preventing foreign agents from discovering a northern passage to Asia. Merchants of the Company's Amsterdam chapter sought to hire Hudson in the winter of 1608–1609, thereby hoping to foil English attempts at finding a passage while possibly uncovering one for their own use. They were justifiably suspicious of Hudson's assurances that the Arctic climate had warmed after he travelled beyond 80° N in his first journey, but Plancius assuaged their fears. The VOC eventually hired Hudson to chart a northeastern passage, and on 25 March 1609 Hudson and his crew of 16 departed Amsterdam aboard the small ship *Halve Maan* ('Half Moon'). Their express orders were to seek a

route to Asia in the vicinity of Novaya Zemlya (Juet 1860: 45; Murphy 1909: 17; Thomson 1975: 66).

Hudson may never have had any intention of following these instructions. When the explorers reached the northernmost point of Norway in the third week of May, crewman Robert Juet, who kept the expedition journal, wrote that they had “much trouble, with fogges sometimes, and more dangerous of ice.” In a blizzard on 19 May, dissent bordering on mutiny erupted among the half-Dutch, half-English crew. Hudson responded by suggesting that they undertake what he had probably desired since leaving port: the search for a passage in milder latitudes, to the southwest (Fig. 5). The *Half Moon* ultimately sailed into what is now called the Hudson River in New York State. Its crew did not uncover a passage to Asia, but did chart the future site of New Amsterdam for the Dutch. Hudson was forced by his English crew to stop at Dartmouth on his return voyage to Amsterdam, and King James ordered him to remain in the country and cease his service to the Dutch (Juet 1860: 48; Murphy 1909: 33; Thomson 1975: 68; McCoy 2012: 99).

The course of Hudson’s third expedition reveals again that the influence of a generally cooler climate did not determine the outcome of early modern Arctic exploration. Documentary sources suggest that 1609 was an unusually warm year in the context of the Grindelwald Fluctuation in northern Norway (Van Engelen, Buisman & Ijnsen 2001: 112). Nevertheless, Hudson’s third expedition left very early in the year, and its crew verged on mutiny during a spate of cold, dangerous, and altogether discouraging weather. Relationships between local environmental circumstances and human agency therefore helped shape the outcome of the voyage, even if broader connections cannot be established between climate and the decisions of the explorers. Still, cold weather and ice had not daunted Hudson so easily in his previous voyages, and even after the mutiny Hudson was not obligated to propose a course he had secretly already wished to pursue.

While Hudson’s third expedition, like his first, failed to find a passage to Asia, it did yield valuable information that encouraged enterprising English merchants to fund subsequent voyages. In 1610, three wealthy and enthusiastic members of the English gentry commissioned Hudson to chart a Northwest Passage through the Canadian Arctic, in the ice that had foiled earlier attempts by Martin Frobisher, John Davis, and other explorers. Strong westerly currents encountered by Hudson’s predecessors in the channel between present-day Baffin Island and Quebec had convinced him that a great sea lay not far to the west (Fig. 2). On 17 April 1610, Hudson left London aboard the *Discovery*, a little ship of just 55 tons that would carry 20 crewmen and two boys. The expedition journal, which Hudson wrote himself, first recorded sea ice on 3 June, when the *Discovery* approached the

southeastern coast of Greenland (Fig. 6) (Hudson 1860a: 93; Savours 1999: 19; Thomson 1975: 71; Neatby 1958: 16; McCoy 2012: 99).

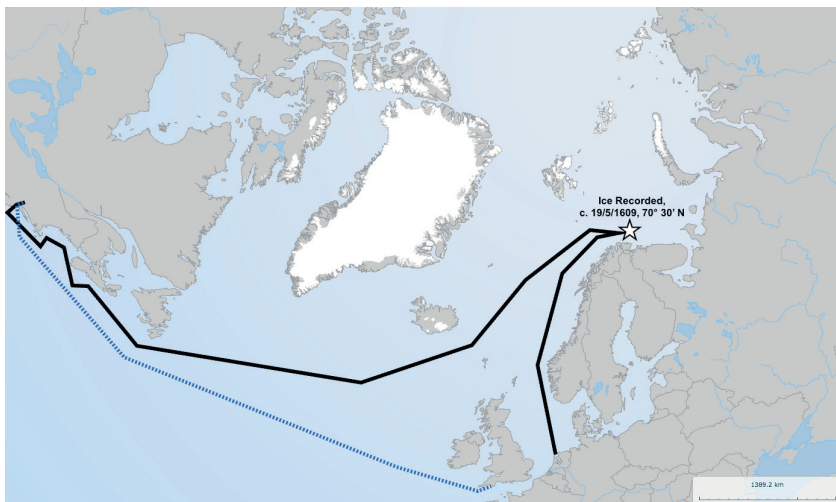


Fig 5. The course of the third Hudson expedition to the Arctic. The outbound voyage is in black, while the return trip is shown in blue dashes. The white star denotes when and where ice was encountered (“Inter-Map,” Arctic Portal Library; <http://library.arcticportal.org/1494>; access date 13 January 2015).

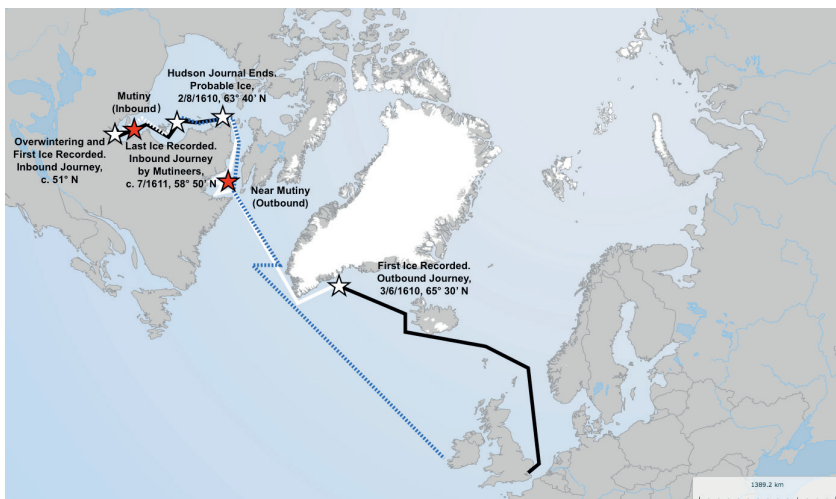


Fig 6. The course of the fourth and final Hudson expedition to the Arctic. The outbound voyage is in black, while the return trip is shown in blue dashes. The portion of the voyage during which sea ice was either certainly or probably encountered is depicted in white (solid for the outbound journey, and dashed for the return trip). White stars denote when and where ice was first and last encountered during the expedition under Hudson and the return trip by the mutineers. Red stars denote where mutinies or near-mutinies occurred (“Inter-Map,” Arctic Portal Library; <http://library.arcticportal.org/1494>; access date 13 January 2015).

Soon thereafter, as the *Discovery* entered what is now called the Hudson Strait, its crew was alarmed by perilous icebergs. In a storm the mariners sailed into pack ice near Akpatok Island, in the seas between Quebec and Baffin Island, and their plight seemed hopeless. The crew was now near mutiny, and only narrowly did a majority vote to press on. The current eventually allowed them to escape the ice, and thereafter they sailed through the passage between what Hudson called Cape Wolstenholme and Cape Dudley Digges, into what is now named the Hudson Bay. A landing party discovered preserved geese that had been stored by local Inuit, but Hudson, believing they had found their passage to Asia, insisted that they press south instead of wasting time to collect these victuals. They were now in uncharted seas. Sailing near the coast, they left the ice floes behind until they were abruptly confronted by the southern limit of Hudson Bay. By then it was October, and they had little choice but to find shelter for the winter. On 10 November they were frozen in, and after a winter of extreme hardship the crew mutinied in earnest when their food ran out. In June 1611, the mutineers abandoned Hudson, his son, and those too sick or too loyal to be of service, before sailing towards the geese they had encountered precisely a year earlier. They were ambushed while trading with Inuit at the entrance to Hudson Bay, and only eight crewmen returned to England (Hudson 1860a: 95; Pricket 1860: 113; Savours 1999: 19; Day 2006: 139).

The surviving crew were tried, but their experience in the Arctic made them valuable, and all were ultimately acquitted. Mysteriously, Hudson's journal ended on 2 August 1610. The only record of the rest of the expedition was written by Abacuk Pricket, one of the mutineers. Together, both documents record how environmental relationships influenced Hudson's last expedition. The winter of 1609–1610 had actually been mild in the Canadian Subarctic, and relatively warm temperatures may have influenced the melting of sea ice in the Hudson and Davis Straits. That might have helped the explorers enter Hudson Bay, although they were still confronted by sea ice. In each of Hudson's last three expeditions, crews either mutinied or were close to mutiny only when they encountered thick sea ice that endangered their journey (Hudson 1860a: 97; Thomson 1975: 84; de Champlain 1907).

In early 1610, Hudson overcame his crew's first expression of dissent. However, the rest of that year was probably unusually cold, and in October the expedition was confronted by a sharp transition between summer warmth and autumn chilliness. The salinity and currents of Hudson Bay both ensured that it froze over quickly, and that sea ice would linger in its southern waters. Had Hudson allowed his crew to gather geese at the entrance to Hudson Bay, he might have avoided a mutiny in the spring that was provoked both by the threat of sea ice and the prospect of starvation.

Clear relationships therefore existed between weather, local environments, and human agency during Hudson's final voyage, but the influence of the prevailing climate is more difficult to discern. Easier to detect is the historical significance of the mutiny amid sea ice, which prevented Hudson from charting the west coast of what was subsequently named Hudson Bay. That encouraged further expeditions by those seeking a western passage, and ultimately led English adventurers to the peoples and harbours that would support a regionally transformative fur trade. By affecting Hudson's third and fourth voyages, dynamic regional environments, shaped by complex interactions with global climatic trends, ultimately influenced the colonization of North America.

Conclusions. Broader Contexts and Modern Relevance

Because the world's climate today is unstable, interdisciplinary scholars usually reconstruct past climatic fluctuations with reference to the early twentieth-century climate. However, historians interested in the human consequences of climate change typically compare decade-scale climatic regimes in defined geographic spaces to the warmer or cooler climates that immediately preceded or followed them. In that context, this analysis of the Hudson expeditions has provided new insights into relationships between moderate climate change and human activity, which even in extreme environments were never straightforward.

However, climate histories of the Arctic also demonstrate that understandings of the connections between climate change and human history can take on a new light when the regional environmental manifestations of very different climatic regimes, often separated by centuries or millennia, are compared. The extent to which both "old" and "new" ice have retreated in recent decades is demonstrated by juxtaposing satellite measurements of modern Arctic sea ice with maps of sea ice recorded in Hudson's journals (Fig. 7, Figs. 3–6). In today's climate, the distribution of summer sea ice would not have prevented the traverse of a Northeast Passage in 1608, and would not have kept Hudson from leaving the bay that is his namesake in October 1610 (Fig. 7). In fact, the extent of summer sea ice between Greenland and Svalbard recorded by Hudson in his first expedition roughly matches regional sea ice extent in December 2014. That remarkable similarity demonstrates the scale of climate change since the Little Ice Age, considering the great difference between winter and summer sea ice extent in the Arctic. The Hudson expeditions therefore illustrate not only the possibilities but also the limitations of nuancing climate histories of the Arctic and Subarctic, given the extremity of environmental change in these regions in recent times.

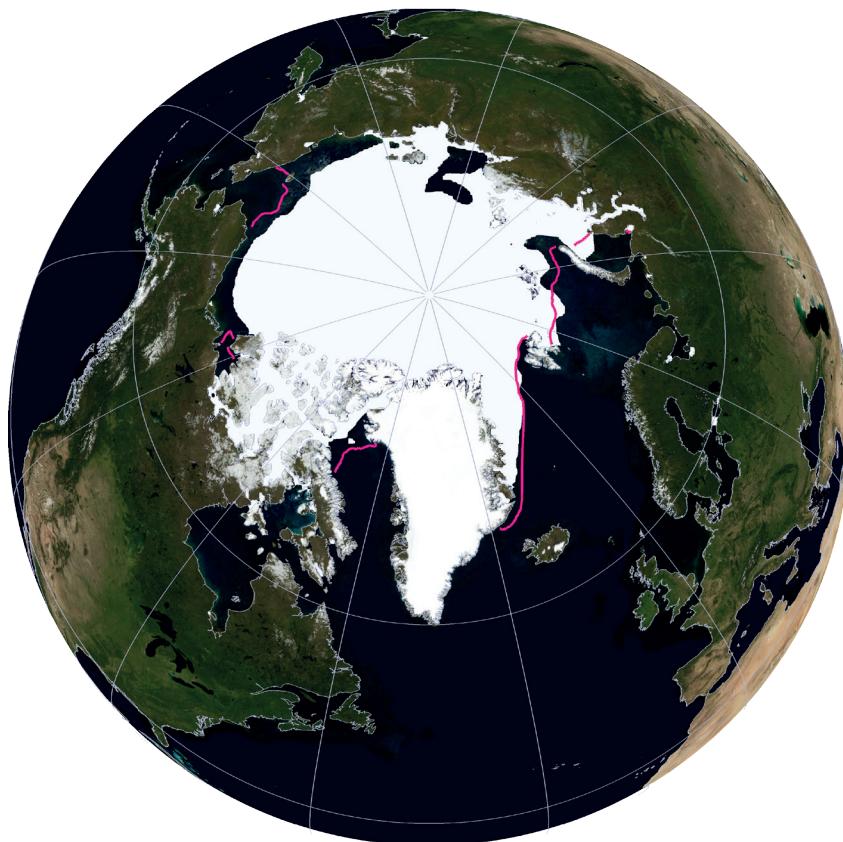


Fig. 7. Sea ice in October, 2014. The 1979–2000 mean sea ice extent is outlined in pink (National Snow and Ice Data Center).

Nevertheless, for climate historians journals kept during the Hudson expeditions show that relationships between climate change and human history were complex and often counterintuitive even in the most extreme environments. Broad constraints to human action existed in the context of the Grindelwald Fluctuation, but local or regional environmental expressions of a cooler climate could actually provoke polar discoveries. Moreover, warm years could interrupt even the coldest decades of the LIA, opening new environments for discovery and exploitation. Ironically, declensionist and determinist narratives are undermined by studying human history in an extreme environment that responds to climate change more dramatically than anywhere else on earth.

Historians of the Arctic and Subarctic have usually concluded that early modern journeys in search of a northern passage to Asia failed in a frigid

and therefore hostile environment. However, the Hudson journals show that dynamic regional environments could affect human action, enabling important discoveries that ultimately had great significance for the environmental and social history of the far north. A middle ground must be found between histories that examine human agency but ignore influential changes in the natural world, and narratives that privilege environmental forces over people who were always free to choose between different responses. This article demonstrates that such a middle ground can only be mapped by using a rigorous methodology for dissecting the relationships that bind climate change to human history. It reveals that this methodology is most effective when it is applied to detailed sources that, like Hudson's journals, were written in environments clearly shaped by climate change. Ultimately, this climate history of the far north highlights the importance of a balanced approach when projecting future climate change. Climate change is happening, but humans are free to choose how they will respond.

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