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On the Recovery of the Environmental Pasts of Early Modern Plays

This article outlines some initial findings from the "Playing Conditions" research project, which seeks to improve our understanding of the role climate played in the rise of the Elizabethan playhouse industry. In the course of this research I have found it necessary to rethink several prevailing assumptions about the Little Ice Age.[1] The project involves the accumulation of as many data points as possible from which to form a fine-grained picture of weather patterns, weather variations, and climate shifts at a time now classified by climate historians as a crisis period, during which the northern hemisphere underwent significant cooling for several hundred years. Although there is still a great deal of primary source material to wade through at a moment when unfettered research time in the academy is a preciously rare commodity, a recent partnership formed with Madeline Bassnett to have the data sets incorporated into the *Weather Extremes in England's Little Ice Age, 1500-1700* ArcGIS database marks a turning point in the life cycle of the project and an opportunity to present initial observations based on the accumulated data, albeit in raw form.[2] While the project is primarily oriented towards theatre history and Shakespeare studies more generally, the proxy weather data accumulated to date points to significant new insights about the English Little Ice Age. Among the most important of these insights is an observation that the seasonal weather phenomena normally associated with the climate of the Little Ice Age, including long frozen winters and cold, wet summers, did not fully develop in England until the first decade of the seventeenth century. Yet the English climate of the sixteenth century was not what might be described as typical of this country either. While continental Europeans encountered Little Ice Age conditions during the sixteenth century, the English population faced volatile seasonal variations with extremes of drought and severe storm weather and violent tidal surges.

I shall explain that one of the reasons this shift in English climate has gone unnoticed despite a prominent eco-critical turn in Shakespeare Studies in the last three decades is that climate historians have focused on describing the Little Ice Age in long timescales and to a hemispheric or even global extent. Climate scientists base their identification of hemispheric cooling on data from dendrochronological studies, ice core sampling, and related techniques from numerous locations in Europe, northern Asia, and North America, but very few locations provide reliable data from within the British Isles. For observations about climate change at a hemispheric level, scientists extrapolate out from these disparate data points, so the relative absence of supportive data from a small land area is insignficant. Historians then look for corroborating documentary evidence to validate or disqualify these claims, although this can sometimes lead to a second wave of generalisations, with illustrative examples used to describe what is assumed to be widespread phenomena. I shall begin, however, with one illustrative example that casts some doubt on the principle that documented weather from the European continental mainland can be used as a proxy for weather across the Channel.

To avoid the sense that this is merely a tit-for-tat exchange of illustrative examples, I offer summaries of findings from accumulated documentary weather observations from early chronicles and contemporary sixteenth-century witnesses to life in England during the time the playhouse industry emerged. The uploading of these records to the database is an ongoing process, but I hope this stocktake of initial findings makes it clear why the process remains a necessary one in correcting abiding assumptions undergirding eco-criticism in Shakespeare Studies but also the climate history of England in general. For theatre historians, especially, an accurate picture of sixteenth-century climate in England is an important tool in improving understanding of playhouses and playing business. Yet I will conclude with a brief account of some of the points of resistance this research has faced in recent years. Even as climate scientists have repeatedly called for exactly this kind of research to add local textures and details to otherwise general claims about an "age," there are political and institutional voices on both sides that may prefer to maintain a one-dimensional picture of the past that can be leveraged for their immediate purposes.

The Difference a Day Makes: Remarkably Fine Weather in February, 1575

On 22 February 1575, shipmaster Francis Johnson wrote to Nathaniel Bacon that a shipment of goods bound from the Low Countries for Great Yarmouth was stuck fast by ice in the port at Dordrecht: "I trust in God that I shall come as haest as I cane and we shall at Yermuyth so soene as the iis [ice] is gone."[3] Johnson himself was stranded in Brielle, thirty miles (48 km) from his ship, where it was "frossin so hard" that his transport to Dordrecht was impossible via either road or waterway.[4] Such a scenario is highly uncommon in the modern era, as the Maas, Merwede, and Waal rivers, which meet at Dordrecht, usually flow with such volume as to avoid a total freeze in even the most severe Dutch winters. In 2021, for example, as the Netherlands experienced a deep freeze and people rediscovered their love of skating on frozen ponds and lakes across the country, the Merwede did not ice over.[5] Even in 1940, during the terrible winter that saw Second World War hostilities halted throughout Northern Europe due to extreme conditions, "huge snowdrifts on the roads" were reported in the Netherlands, "immobilising transport," and "train and tram services were practically suspended," but only one of the three rivers ceased flowing altogether: "The River Maas is completely frozen, and ice-floes fill the Rivers Waal and Merwede."[6] Yet to climate historians and indeed to lovers of Dutch art, images of frozen

waterways throughout the Netherlands might seem altogether unremarkable, with Jan van Goyen's portrayal of "Skating on the Merwede near Dordrecht" (1646; Figure 1) being typical of a visual genre that has become associated with the Dutch Republic in the Little Ice Age.[7] During the period that climate historians associate with intensive cooling across the northern hemisphere from around 1450 to 1830, frozen rivers became a frequent reality for the merchants of Dordrecht and other Dutch harbor cities, leading to significant pressures on their traditional water-based trade routes.[8]Johnson's experience in 1575 was thus far from unusual.

Figure 1. Jan van Goyen, "Skating on the Merwede near Dordrecht (1646)." With permission, courtesy Fondation Custodia, Collection Frits Lugt, Paris.

I begin with this relatively unremarkable example of a frozen Dutch port because it is worth comparing Johnson's experience in the Low Countries with that of his interlocutor. At the time that Johnson was writing to Bacon, there is no item to be found among the papers of Nathaniel Bacon of Stiffkey, near Wells-next-the-Sea in Norfolk, to indicate that he would be aware his goods might be delayed at their point of departure due to frozen conditions.[9] By all accounts, in fact, conditions throughout Norfolk were fine. For that matter, the whole of England seems at this time to have been untroubled by extreme cold. There was, as it happens, a series of earthquakes of

varying intensities that shook parts of England from York to Bristol after 4 pm on 26 February, but records indicate that it passed unnoticed in London and was not felt at all in Norfolk.[10] It is certainly also the case that Queen Elizabeth's court enjoyed a full calendar of court revels from Christmas right through to 15 February, after which planning began in earnest for the progress of 1575 that would include the famed entertainments at Kenilworth, with no sign that plans were slowed by any concerns over conditions throughout the realm.[11]

In case anybody suspects Nathaniel Bacon of simply being an unreliable barometer, disinclined to pass comment on the weather, it should be noted that as a new owner of farmlands linked to the Stiffkey estate, he is known to have documented concerns about his sheep and their pastures, as he did two years earlier during the winter of 1572–1573, when he wrote to Sir Nicholas Bacon, Lord Keeper, in December:

I enquired of Stringar what number of lambes one yeare with another *for one 100 ewes* the sheprive of Merston accompted for to Sir Thomas Gresham. He tolde me that the number was commonly about fowr score, but more often under than over. Yet upon talke had with other, I finde that yf it were not in respect of these hard winters ther might be loked for of 6 score ewes 5 score lambes, the shepe beinge well loked to at the time of yealdinge ther lambes, & the grounde not over laied.[12]

In 1575, we find nothing of this sort. Looking further afield for any record of a "hard" winter in this year, England's record yields nothing. The Privy Council met regularly throughout the 1574–1575 winter, and in the week of 22 February we find them in session five times, discussing matters related to skirmishes in the north, the assizes in Oxfordshire, minor legal squabbles, and even issuing licences to eat flesh in Lent but no concerns about extreme cold.[13] The court correspondence is also quiet for this week, save for a letter of condolence to Henry Sidney on the death of his daughter Ambrosia, inviting him to send his sole surviving daughter, Mary (later Countess of Pembroke), to live at court under her charge.[14] In short, when it comes to the search for proxy evidence of severe conditions in the English winter of 1574–1575, this may well be one of those times when absence of evidence does indeed mean evidence of absence: England's weather was unremarkably moderate.

What may seem unremarkable is quite the opposite when we recall that this was the period in which the frozen harbor at Dordrecht was considered to be the norm. When the "fine" conditions across England happen at exactly the same time that English goods are frozen in at a port just across the Channel, it might even be worth considering this weather in England to be *remarkably* fine rather than unremarkably so. This stark contrast in conditions on either side of the Channel might therefore provide some initial grounds for questioning the validity of claims made about the English Little Ice Age based on Northern European climate indicators, which I shall discuss in the next section. Yet I am careful here not to present one anecdote and treat it as representative of a wider pattern of contrasting conditions. Is it likely that the vast difference between the Dutch and English conditions on this date is merely an outlier? From the perspective of the climate scientist, seeking to extrapolate from multiple data points across numerous locations, evidence for a relatively widespread temperature drop across the entire northern hemisphere is unlikely to be compromised by one such outlier. In the search for decadal or even centuries-long trends, one day of remarkable difference will appear all but inconsequential. From the perspective

of the theatre historian, on the other hand, a day can make all the difference when it comes to trying to understand the primary drivers for some of the key milestones in the rise of the Elizabethan professional playing industry and the era of the great London playhouses. It should not go unnoticed here that just eight days before Johnson wrote his letter to Bacon during the great freeze in Dordrecht, the Earl of Warwick's Men played at court towards the end of the revels season, on 14 February, an honour which may have prompted the company's leading player Jerome Savage to invest in the development of a playhouse at Newington Butts, which may in turn have precipitated the decision by James Burbage to build the first of the great open-air theatres, the Theatre, in Shoreditch.[15]

For theatre historians, the thought that the climate of the Elizabethan Golden Age was the same as the one in which the Dutch Republic flourished poses pressing questions for the received histories of early touring companies and the emergence of the London playhouses. According to the prevailing theory, touring companies eventually gravitated toward London when crown policies such as the Vagabond Act of 1572 forced them to seek noble patronage in order to be viable, and then their patrons sought to use the very best companies to gain favor through entertainment at court revels. To be ready to play at court at short notice, the companies needed to stay close to London for extended periods, which eventually prompted the rise of the playhouses.[16] Could it be, however, that exposure to conditions associated with the Little Ice Age forced touring companies to abandon life on the road? As a corollary to this question, it seems worth asking further why, in the midst of this Little Ice Age spanning several centuries, it took so long for this change to come about? Perhaps more perplexing is the realisation that if the Little Ice Age could be dated to around 1430, then it quite possibly predated the emergence of touring companies. If the Little Ice Age prompted players to abandon the road, it must surely also have been in some degree what prompted them to take to the road in the first place. Puzzling, indeed. Another possibly more pressing question should also be apparent once we stop and properly think about life in a Little Ice Age. Why was the players' response to being exposed to cold, wet conditions on the road to take up playing in one of the great cultural innovations of the Elizabethan age: large, uncovered, open-air amphitheatre playhouses?

These questions and conundrums were the initial drivers of the "Playing Conditions" project, but it should already be clear that these questions were based on the assumption that conditions in Europe would generally be mirrored in England, just across the Channel. This anecdote from February 1575, at almost precisely the moment when the leading professional playing companies of the day decided to establish permanent playhouses outside London, put the proverbial cat among the pigeons. Before we could even ask these questions, then, it was going to be necessary to recalibrate our understanding of English climate during the Little Ice Age or, at the very least, to determine the extent to which the differences between conditions in Dordrecht and Norfolk on 22 February 1575 might be indicative of different climates over longer timescales even within this period. In short, it was going to be necessary to determine whether this one day in what was a particularly monumental year for the rise of the English playhouses represented an outlier at all.

Spot the Glacier: Shakespeare Studies and the Little Ice Age

Scientists have known for several decades that a drop in temperatures of more than 1 degree Celsius took place across the northern hemisphere from the 1400s to the early 1800s, based on tree

ring analysis, ice core sampling, and other biological and geological evidence.[17] The term "Little Ice Age" was used by François Matthes in 1939 in a report on evidence for historical change in the spread of glaciation in the United States, but the definition was extended by Hubert Lamb in 1966 to cover the whole of the northern hemisphere.[18] The scientific case for a Little Ice Age was never wholly reliant on proxy data such as the growth rate indicated in tree rings, but also drew on corroborating evidence from both contemporary written accounts and artistic representations. Jean Grove's *The Little Ice Age* (1988), for example, supplements the author's expertise in glaciology by including textual and visual evidence supporting the scientific proxy data, such as paintings of glaciers contemporary with dates that proxy data indicated glacial growth within specific regions.[19] Cultural historians have eventually realized that artistic representations of this kind were doing more than merely documenting the climate of their time, and were themselves the cultural signs of invention, a part of the human response to this extreme climate shift. Wolfgang Behringer's *A Cultural History of Climate* (2010, first published in German in 2007) therefore includes two chapters on the Little Ice Age, the second being an examination of the "cultural consequences" of this period of global cooling.[20]

In Shakespeare studies, scholars eventually began to follow suit, with descriptions of Shakespeare's plays as responses to or records of the Little Ice Age appearing in books and journals from 2006 onwards. Robert Markley's oft-cited "Summer's Lease: Shakespeare in the Little Ice Age," was published in 2008 in an ecostudies book edited by Thomas Hallock, Ivo Kamps, and Karen Raber, and cites Brian Fagan's *The Little Ice Age: How Climate Made History* to demonstrate that England's climate during Shakespeare's lifetime was typified by more than just the drop in temperature that gives the Little Ice Age its name.[21] Markley notes, based on Fagan's work, the importance of the North Atlantic Oscillation (NAO), related to changes in the differential between typically high pressure systems above the Azores and a persistent low above Iceland. Fagan explains that a high NAO state indicates that strong westerly winds bring warm air from the Gulf Stream to northern Europe, and a low index resulting from higher pressure above Iceland reduces these westerlies.[22] As a result, the high index brings milder winters and moderate rainfall, and the low index results in weather typified by harsher winter conditions and wetter summers overall. As Markley notes, paraphrasing Fagan, "The basic weather patterns were particularly volatile over southern England during the Little Ice Age," during which period the NAO "characteristically registered in what climatologists call its low index state."[23] The period was thus typified not only by severe winters but also by volatile conditions during the rest of the year, which Markley finds exemplified in Shakespeare's references to storms as indices of madness (such as we find in *King Lear*) and unstable weather as signs of conflict amongst the gods (as in *A Midsummer Night's Dream*).

There is, however, an issue with Markley's reliance on Fagan to describe the weather patterns over southern England. It is important to remember that the climate science used to establish the temperature drop across the northern hemisphere was based on proxy indicators in multiple locations across Northern America, China, Europe and elsewhere, but British data sources were not typically central to their evidence. It so happens that dendrochronology or tree-ring analyses are notoriously unreliable for English conditions due to deforestation in the medieval and early modern periods from increased demand for woodcrafts and shipbuilding, the housing explosion, and the enclosures of the sixteenth century, as well as the boom in metals industries, which initially relied on wood being used to stoke the fires for smelting and metalworking.[24] Since temperature

is not the only factor in the changing growth rates of trees, it has also been observed that dendrochronology alone is insufficient for providing seasonal, annual, or even decadal temperature change indications, and is therefore best used only for broader time scales of a century or more.[25] Peat bogs have offered some corroborating evidence for the drop in temperature in the British Isles during the fifteenth to sixteenth centuries, based on pollen, microfossils, and insect residues trapped at different layers, but a glance over the studies that produced this evidence reveals that they all focus on bogs either in Scotland or in the northern parts of England.[26] Importantly, none of the scientific proxy data available to Fagan related specifically to southern England, but Fagan's discussion of the volatile weather patterns in this period do not relate to southern England either. In the pages that Markley cites, Fagan is merely explaining the NAO and its impact on weather in its low and high states across all of Europe and the North Atlantic. Elsewhere, Fagan does describe a spike in storm activity "throughout Europe" in the 1560s to 1600s, which he discusses in relation to the defeat of the Spanish Armada in 1588, but he does not provide any evidence of storm activity in England itself.[27]

What then of Markley's claim that Fagan refers to NAO indices "characteristically" registering in a low state throughout the Little Ice Age? This, too, is not what Fagan writes. He writes instead about the low index state primarily shaping conditions across Europe in the seventeenth century, with particular confidence about this claim only after 1675, since this is the first year covered by the historical NAO reconstructions published by a team of climate scientists led by Jürg Luterbacher in September 1999.[28] As it was, Fagan encountered this research late in the process of writing a book that was published in 2000, so the references he makes to the NAO data are deployed sparsely and mainly in support of his argument for the "climatic seesaw" that culminated in the gradual cooling cycle of a Little Ice Age.[29] Given that Fagan relies on reconstructions dating from 1675, it would be incorrect to claim that the NAO was "characteristically" in its low index state for the whole of the Little Ice Age. More to the point, Fagan knows to be cautious about overstating the importance of the NAO, since Luterbacher's team concluded their 1999 paper with an observation that weak indications are present for oscillatory NAO behaviour in winter, suggesting that the systems responsible for the NAO appear to be "decoupled" at times and may therefore be "not always the dominant mode for the European climate."[30] Luterbacher's team published another set of historical reconstructions two years later, dating back to 1500, but they reported even greater levels of uncertainty in the results, calling for more research and additional documentary evidence to strengthen any NAO reconstructions.[31]

While Markley is right to point out that Little Ice Age climate was typified not only by cold conditions, he makes the mistake of assuming that scientific claims about Little Ice Age climate should also apply characteristically to England for the same period. There are other Shakespeare scholars who have made similar assumptions while nevertheless tending to focus more generally on the drop in temperatures associated with an "ice age," as a way to shift thinking of Shakespeare's world away from the "green world" envisioned by a former generation of critics inspired by Northrop Frye. Daryl Palmer's 2006 essay on the "northern lineage" of Hamlet, for example, pictures the "chilly era that engulfed the whole of Europe" as the context in which Shakespeare could imaginitevely construct a hero who will become the "supreme representative of his age" through familial connections to the "frozen north."[32] More recently, Chloe Fairbanks has argued that the "global" drop in temperature provides the broad-scale context in which the "political doctrine of good husbandry" came under scrutiny in terms of the ability of rulers to

practically respond to the environmental crisis and declines in harvest yields in England, with Shakespeare's representations of gardens in *Richard II* and *Henry V* examined here as literal expressions of this practical need.[33]

I should stress that these are not examples of poor criticism. On the contrary, I cite these scholars here because of the clarity of their arguments, linking plays to real-world contexts and to real-world effects. My concern is that in making these links, the scholars who put Shakespeare's plays in such close contact with Little Ice Age environments run the risk of treating the plays rather too much like the pictures of glaciers that Grove saw as corroborating evidence for scientific claims of glacial expansion in Europe. For the literary critic, the goal should be to avoid having Shakespeare's characters merely bearing witness to real-world weather phenomena, and there are indeed a good many skilled eco-critics already developing more nuanced readings of the plays in conversation with climate history.[34] Yet it is also a simple fact of Shakespeare scholarship that wide public interest in the playwright's life and work invariably forces our more nuanced arguments into direct tension with the demand for simple facts. The result can be rather like an echo chamber, especially when the climate histories cited by these critics also quote Shakespeare as "evidence" for historical claims. For example, Fairbanks cites historian Geoffrey Parker's 2013 book *Global Crisis: War, Climate Change & Catastrophe in the Seventeenth Century* and journalist Philipp Blom's 2019 book, *Nature's Mutiny: How the Little Ice Age Transformed the West and Shaped the Present* for the description of the global temperature drop, and in both books we find Shakespeare's work also being cited as evidence for broad climate claims.[35] Parker cites *A Midsummer Night's Dream*, just as Markley did, to illustrate the widespread failures of crops throughout Europe as a result of the severe cold and excessive rainfall of the 1590s, and Blom observes that Richard III's line, "the winter of our discontent," is a literal description of the difficult winters the English endured in the same decade.[36] Building on such sources, literary critics interested in understanding Shakespeare's response to the climate crisis of the Little Ice Age will of course find crisis and ice in the plays. What might it mean for Shakespeare Studies if we find that the ice was more common across the Channel, and that the climate in which he lived and wrote was different? The difference a day makes, once more.

The Big Thaw: Changing the Landscape of the English Little Ice Age

I noted previously that Fagan's *The Little Ice Age* does not describe an upsurge in storm activity for southern England, but it does detail evidence of violent storms elsewhere in Europe during the sixteenth century and specifically in the Channel in 1588. Where Fagan does single out southern England, it is in relation to the series of poor harvests documented by numerous sources throughout England in the 1590s. It should be added that he views these crop failures as resulting from the cold weather, describing the 1590s as "the coldest decade of the sixteenth century."[37] Importantly, closer scrutiny of this section of Fagan's book shows that he offers no direct evidence for this observation about temperatures in this decade; rather, he details the fluctuations of grain prices and evidence of famine as the proof that the weather was cold. Parker does something very similar when citing Shakespeare from *Midsummer* in the context of his discussion about the impact of extended cold spells on agriculture and food production across Europe. While Parker mentions heavy rainfall as one of the types of weather produced by these cold spells, his argument hinges on the claim that the decade was a particularly cold one, for which he immediately finds support not from Shakespeare but from "Ottoman chroniclers in Hungary

and the Balkans [who] also recorded unusually severe winters that froze the Danube solid."[38] Blom also buffers his claims about the ubiquity of discontented winters in the sixteenth centruy with claims about the prevailing cold conditions in England during both the "sixteenth and seventeenth centuries," when the argument is based on his assumption that seventeenth century frost fairs are indicative of the Thames freezing over frequently also in the century before.[39]

Viewed together, the work of Blom, Fagan, and Parker, as well as others like them, appears to present a consensus on English climate across both the sixteenth and seventeenth centuries, and there is agreement that the 1590s represented a particularly cold decade that resulted in widespread famine. Yet one need only look at any one of these studies in isolation to find that the case for a cold sixteenth century and for an extremely cold final decade is based on inference from evidence either across the Channel or from the next century. As a counterpoint to this pattern of inference in relation to English conditions, I turn to a landmark work by Dagomar Degroot, *The Frigid Golden Age: Climate Change, the Little Ice Age, and the Dutch Republic*, *1560–1720*, a book exploring how the golden age of the Dutch Republic emerged in response to a period usually understood by historians only in terms of famine, hardship, or decline: "Little Ice Age weather encouraged social spaces and technologies that contributed to the resilience of the republic in the face of climate change."[40] It is fair to say that in this respect Degroot's argument is similar to the claims made by Blom, Fagan, Parker, and others about the climate crisis being a driver for cultural, economic, political, and social change. What sets this study apart from the others is its author's refusal to rely on inference or generalisation. While Degroot frames this investigation in terms of decade-scale climate trends, with particular focus on the two periods that climate scientists had already singled out as the coldest extremes of the Little Ice Age – the Grindelwald Fluctuation (1560–1628) and the Maunder Minimum (1645–1720) – he also seeks more closely to examine reported local responses to short-term weather patterns. He notes that climate histories have had a tendency to emphasise large-scale shifts through studies that he describes as "a mile wide but an inch thick": only briefly covering a large number of changes or (usually negative) effects of catastrophic climate stress.[41] Degroot is instead interested in detailed studies of a few aspects of Dutch culture to closely examine "the ways in which global climate change really affected people on the level of transient local activities that ultimately shape human history."[42]

Degroot's method is instructive since it relies almost exclusively on local activities or observations, and it should be no surprise that there is ample evidence of the frigid climate in the Dutch Republic. But his study also shows that a deeper dive into the archive can reveal a host of local and seasonal variations within these broader climate patterns. It is not the case, for example, that the Merwede was constantly frozen over throughout the Little Ice Age, even though the images of communities gathering on the frozen river have become part of the iconography of the Dutch Little Ice Age. By shifting attention to the years in which the waterways did freeze over at Dordrecht, Degroot is able to examine more closely the frequency of such events and identify the pressure points that prompted innovations or changes in the management of trade via the harbour. The fact that Blom and others arrive at assumptions about the cold sixteenth century in England by way of inference rather than from a similar abundance of detail makes me want to find the detail from specific locations and times within England to produce a case study of English sixteenth-century climate that is thicker than it is wide. From this it is hoped that we will identify those pressure points that made the great innovations of the golden age of Shakespearean theatre seem necessary at the time.

The first question should be whether there is in fact an abundance of examples of cold weather documented in English records of the sixteenth century but which have been largely overlooked by studies that focus instead on the most visible examples, like communities on a frozen river Thames. Such a study was attempted by William Andrews, whose book *Famous Frosts and Frost Fairs in Great Britain: Chronicled from the Earliest to the Present Time* was published in 1887.[43] Based on the records Andrews sourced, there is evidence of a severe cold spell across much of England (lasting at least several weeks) in 38 out of the 270 years from 1019 to 1288 (or one in every 7.1 years), and a further eleven from 1288 to 1523 (one in every 21.4 years), but from 1523 to 1607 Andrews identifies just the one year of significant freezing: the winter of 1564/5. From 1608 onwards, England had severe frozen spells in seven out of the next 27 years. Admittedly, this study is very old and needs therefore to be treated with some caution. Yet the sources on which Andrews relied for the chronicling of frosts and frost fairs are the same ones that subsequent scholars have been citing: John Stow's *Annales*(1605), for example, and Thomas Short's detailed *A General Chronological History of the Air, Weather, Seasons, Meteors, &c.* (1749), which draws from Stow and supplements that history with additional records from the Bills of Mortality, almanacs, calendars, treatises on the causes of diseases and plagues, and "a great Number of Authors," who he deems too many to name.[44] If Andrews had missed a string of severe freezing events for the sixteenth century, it must have been because Short also missed them and, more importantly, that Stow had not recorded them even though he would have lived through them during the eight decades of his own life (1524 to 1605).

Even accepting the principle that there is surely more primary documentary evidence to be unearthed, the relative infrequency of longer frozen spells in the sixteenth century must give us pause. Closer examination of Short and Stow make it clear that Andrews was relying on criteria that disqualified some references to extreme cold in this century, especially the requirement that the conditions included thick snow or frozen waterways for longer than several weeks. Without this condition, there are several records in the accounts of Short and Stow that point to shorter but still severe winter conditions, such as the "great Frost" recorded by Short for the last days of 1536 and early 1537, during which the Thames is reputed to have frozen over, or the "great and deep" snows reported by both for the winter of 1572–1573 (and which Bacon mentions in a letter that I have already considered here), or a deep snow lasting about a week in February 1579.[45] Including these other harsh winters adds several data points for this period, but we still only end up with four such seasons in 84 years, a rate of one every 21 years and on par with the rate at which Andrews records severe winters for the previous 235 years. The caveat here is of course that the previous period would undoubtedly have had more winters that fit the revised criterion by which these three events can be added to the count for the sixteenth century, so four events in 84 years would still represent a slowing down rather than an increase in frequency of severe winter events.

It is perhaps worth adding that the first of the early modern London frost fairs, in which the Thames froze over so deep and for such long duration that stalls and markets were erected on the ice for many weeks, was in 1608, nearly three years after Stow's death. Those who describe the Thames frost fairs of the seventeenth and eighteenth centuries in painting a typical picture of London in the Little Ice Age are thus also presenting a phenomenon foreign to the author of the *Annales*of 1605. Delving into contemporary documents such as letters, diaries, almanacs, and prognostications, I have spent several years compiling more evidence to supplement Stow's and

Short's histories, to see if the historical record backs up a frozen English landscape dominating the Little Ice Age. In addition to Stow and Short, then, I note the precise recordings made by John Dee in his diaries, as he sought to determine the optimal conditions to summon demons or practice alchemy.[46] At the beginning of his *Diaries*, which commence in 1577, for example, Dee records a number of weather events such as the "Great wind SW, close cloudy, raining" on 19 February, or the "Cold and wet weather" over the two days of 7 to 8 May, and "Circa 10, a shower of hail and rain" on 8 June.[47] Importantly, while I have compiled hundreds of contemporary observations or comments on the weather from dozens of sources, none have given me reason to suspect that Stow or Short failed to record any extended winter freezes.

Conversely, weather observations drawn from Short, Stow, and many other sources reveal at least twelve years in the sixteenth century that were marked by drought, and many more in which excessive heat was recorded.[48] The most spectacular example of this is from 1592, just before Shakespeare wrote Richard's "winter of our discontent" speech, in which year there is evidence not of extended frost (not even of winters of discontent) but of a hot spell so severe that at its most extreme the Thames completely dried up for the space of three days, at which point the briny seawater backed up into the river channel past London bridge at the next high tide. Thomas Short wrote of the event, "an excessive Drought, and great Death of Cattle from want of Water; Springs and Brooks were dried up; Horsemen could ride the *Thames*."[49]This was in late August to early September, when temperatures would normally start dropping; instead, they spiked upwards, resulting in drought well into the latter part of the year. Fagan's claim that the 1590s represented the coldest decade of the sixteenth century seems to run up hard against such local weather reporting. Indeed, when Parker attributes the crop failures of 1594 to 1597 to excessive rainfall, there is an abundance of local material to back him up, but his assumption that the rainfall is linked to the cold, wet summers associated with Little Ice Age climate does not match with the local evidence. The first of these consecutive years of failed harvests was a particularly bad year for widespread flooding throughout southern England, about which I shall say more in the next section, but it should be noted that the floods of 1594 followed hard upon a period of intense heat and dry winds which resulted in, among other things, a fire in Shakespeare's hometown of Stratford-upon-Avon on 13 May, when "there was burnt by mischance of fire above 100 houses and barns."[50] By attending to such local observations with greater focus, it becomes evident that the assumptions about sixteenth-century English climate require some recalibration.

Staying High and Dry: Climate Change and Early Modern Cultural Innovation

I have in recent years been drawing upon the evidence of extreme weather events to examine their potential impact on players, playhouses, and playing business in general, but I remain mindful that any extreme weather event viewed in isolation might not account for a threat to long-standing practices, and any such event might even reinforce existing beliefs or practices. The pamphlets reporting "strange news" of extreme phenomena or weather were popular in the early modern period because they helped to reassure populations that adhering to church-sanctioned rules of conduct would stave off catastrophe, with townships affected by extreme events seen as having incurred divine retribution by straying from the path of the righteous.[51] Frequency of extreme weather thus becomes a factor in determining where pressure might be exerted on cultural or social norms. In previous research, I have for example demonstrated that a series of inundations in the Thames floodplain in the decades before 1575 go some way to explain the decision by Jerome

Savage to choose a plot of commercial land in Newington Butts a mile south of the river for the location of his Playhouse.[52]The selected location was one of the two highest points of land in the whole of the southern floodplain, and even the highest flood in human memory prior to the establishment of the Playhouse, in 1555, saw the Newington Butts plot remain on high ground. Yet the 1555 flood was also the first of a series of high water events in the floodplain, with five recorded floods or tidal surges in the decade from 1564 to 1574 alone.[53]

I have since established that a similar scenario played out with public playhouses built on Wine Street in Bristol, the highest point in the city and one of the few places to remain dry during the Great Flood of 1607 (Figure 2), and in Prescot, Lancashire.[54] The Rose playhouse built on London's Bankside in 1587 was, however, poorly situated and experienced several closures for flooding, and it is likely that the famous redevelopment of 1591, while ostensibly lengthening gallery spaces to increase audience capacity, also included repairs and mitigation specifically against water damage. The establishment of the Rose in this location and then the Globe nearby in 1599 suggests that the relationship between playhouse location and relatively low flood vulnerability was never absolute. As I argued in my work on Newington Butts, the flooding of 1594 explains why the Lord Admiral's Men were forced to abandon the Rose for eleven days in June to perform at the Playhouse on higher ground a mile to the south, and it very likely explains why the first recorded performance of the Lord Chamberlain's Men was when they too appeared at Newington Butts alongside the Admiral's players during the same brief performance run.[55] The Chamberlain's players had been touring, as the Earl of Derby's Men, but the earl's death in April saw them appointed to a new patron during their return leg at around the time they were visiting Southampton in May, when flooding south of London forced them to temporarily align with the Admiral's Men on safe, dry ground. That the same company would choose in 1599 to build at the Globe site near the south bank of the Thames would seem to be in direct defiance of any flood-based rationale, especially when the records show that there was flooding of the river again in 1596 and 1599.

Front cover image. “A true report of certaine wonderfull ouerflowings of Waters.” Artist unknown. Printed by William Jaggard for Edward White, 1607. STC22916. Reproduction: Microfilm. Ann Arbor, Mich.: University Microfilms International, 1957. Courtesy National Library of Australia, Bib ID 1170927. Public Domain, Out of Copyright [Created Date + 70 years].

The Globe decision nevertheless appears to have been remarkably serendipitous, with the 1599 flood taking place several months before the Globe began hosting performances by the Chamberlain’s Men. No other flood event was recorded for London during its four decades of operation to 1642. This observation throws into sharp relief the rather neat division between the prevailing conditions in southern England between the sixteenth and seventeenth centuries. Rather than assuming that illustrative examples of phenomena from one century can be unproblematically applied to the other, the accumulated documentary materials from the “Playing Conditions” project point instead to a need to demarcate the two centuries with near precision. The final decade of the sixteenth century may well have been the coldest one in some parts of Europe, but this was not the

case in England. The excessive rainfall that produced widespread flooding and famine was linked to unduly hot weather in the same period. This was not a period of predictable alternation between cold winters and cold, wet summers. The conditions in which the Lord Chamberlain's Men decided to build their primary playhouse on the Southside of the Thames came at the tail end of what was the most volatile decade of England's sixteenth century climate, marked by extremes of hot, dry weather on one hand and violent storms and flooding on the other. Then, seemingly as if the Little Ice Age switch was flicked at the turn of the century, England's climate fell more into line with the conditions deserving of the name "ice age," with more frequent cold spells and relatively moderate summers.

More work needs to be done to corroborate this phenomenon, of course, but this is at least currently what the data is telling me. If this picture means that I am as yet unable to see more clearly the rationale for the establishment of the Globe in a flood-prone zone just as this very risk was on the verge of dissipating in the face of a big freeze, I have been able to stake a much stronger claim on the impact of another volatile decade on the players. In my recent study of the early touring habits of the Earl of Leicester's Men, I have argued that flooding was a major factor in the formation of what would become the standard touring circuits of the era's most important playing companies. Thanks to the expansion of knowledge of company touring practices generated by the Records of Early English Drama (REED) project, theatre historians now generally accept that there were seven touring circuits used by Shakespearean companies, identified by Scott McMillin and Sally-Beth MacLean in *The Queen's Men and their Plays*.[56] Yet McMillin and MacLean assumed that these circuits followed ancient trade routes and were therefore not an invention of the playing companies. When I recreated the trajectories of the earliest tours undertaken by Leicester's Men in 1559 and 1560, however, it became apparent that they followed different paths, which were less circuit-like and more destination-oriented, exactly matching the routes mapped out in the printed itineraries of the sixteenth century, such as William Smith's *Particular Description of England*.[57] These were ancient trade routes that linked major port and market towns, but not in the form of what we could call "circuits."

The first innovation in touring by Leicester's Men was to connect two of these ancient trade routes by cutting through the low flat landscape of Lincolnshire. For several years, they favored a long route that proceeded from London to Norwich, then headed west to the Great North Road, north into Yorkshire, and finally back to London via the same central route. Scrutiny of the official reports of the management of the waterways of Lincolnshire (or Holland, as it was called then) shows that in the years from 1564 to 1570 the region was frequently inundated by flood and tidal surges, including reports of roads being rendered unusable between towns in which Leicester's Men are known to have performed. There are also numerous other reports of extreme weather and flooding in this decade, such as the great clown Richard Tarleton's early effort at broadsheet reporting, the *Lamentable and Woeful Discourse of the Fierce Floods*, 1570.[58] What this means is that the company developed the East Anglican circuit initially as a way to curtail a much longer tour due to flooding in the lowland region on which they relied beforehand. Rather than double-back through Norwich, they simply looped back to London via Cambridge and headed south. In later years, this East Anglian circuit would be their most frequently used shorter touring route, as it would also become for the Queen's Men and other major companies.

There were also important flow-on effects of using these shorter circuits. With fewer miles to travel, the players were able to increase their personnel on the road, resulting in larger company sizes overall, and this resulted in turn in the ability to stage longer and more spectacular plays for provincial audiences, such as *The Cradle of Security*, described by a witness in Gloucester in 1572 as employing a large cradle stage property and elaborate costumes and devices.[59] I argued that the increasing theatrical capital that these more elaborate productions generated for playing companies also created the problem of storage and maintenance of company assets, thereby creating a need for something like the development of permanent playhouses to serve both as storehouses and performance venues. Yet if flooding precipitated the establishment of new touring circuits in the 1560s and then the rise of the playhouses in Newington Butts and in Shoreditch in 1575 to 1576, it may be that the establishment of the Rose on Bankside in 1587 can be chalked up to complacency. From the documentary records, it appears that the volatile decade from 1564 to 1574 represented almost the last period of heavy rainfall and flooding until the volatile 1590s. The only flood recorded in that interval was in 1579, caused by the sudden thaw of a deep snow that fell in February: as Short recorded the event, there was a heavy frost for several days and "then a Thaw, with continual Rains a long time after: hence such high Waters, and great Floods, as drowned Marshes and low Grounds, *Thames* so flooded *Westminster-hall*, that Fishes were left in it."[60] Relatively more moderate conditions in the 1580s could have given Henslowe cause to think less of the threat of flooding and to focus instead on purely economic factors linked to situating his playing venue so close to the river and, more to the point, closer to the paying audiences. The salient lesson here, then, is to not always be looking for the impact of extreme weather as a catalyst for change. Change sometimes arises when conditions are the most favorable for a new venture.

The Climate of Opinion and the Opinion on Climate

I shall end this set of preliminary findings from the recovery of weather observations and records with some reflections on the recovery process itself and the challenges posed by the politics of climate change research at this current time. Just as the realities of global warming and the extreme weather this warming precipitates are denied by some on the basis of those very extremes, so too there may be some expediencies in wanting to portray the Little Ice Age as characterized by a big freeze alone.[61] Some readers may already be familiar with the global headlines this project unwittingly and unwillingly attracted in 2021 when an application for funding under the Australian Research Council Discovery Program (ARC-DP) scheme was successful in obtaining a recommendation to be funded. This was scuppered when it was announced on Christmas Eve that the then acting federal minister for Education, Stuart Robert, had opted not to fund six out of the 593 projects recommended for funding; "Playing Conditions" was one of the six.[62] I also want to reflect here on some of the more disconcerting aspects of the experience of trying to garner support for this project within the academy. The ministerial veto in 2021, while galling, was not altogether unexpected. Would I have believed that a minister of a government with a track record of climate change denial could so transparently have singled out a climate-based project for a purge of this kind? Absolutely, of course. The point of resistance that I did not at first expect came instead from among fellow academics.

When an earlier ARC-DP attempt failed in 2020, it was largely on the back of one low score from an assessor who vigorously dismissed the project as "silly" and insisted that, instead of further

work needing to be done on reconstructing the climate of the period, it was "Far better to […] focus on the richness of Shakespeare's language, drawing attention to his use of weather and references to climate's unpredictability to create atmosphere, build character, and drive the play's action."[63] Here, it seems, was one scholar who believed the only worthwhile use of climate studies was indeed to play spot-the-glacier in Shakespeare's works and, under secure cover of this anonymous procedure, saw to it that no funds would be made available. The assessor who castigated the project team for not wanting to focus on Shakespeare's language seems to have approached the application with an expectation that English scholars should stick to words, words, words, and forget the clouds, except perhaps only insofar as Polonius describes their shapes. I cannot say that the report was written by a climate change denier, but the assessor did seem to me to be singing from a song sheet that would have been music to the ears of the previous government.

Even disregarding the government of the day there is also a powerful, and dare I say disproportionate, section of the global mainstream and social media committed to denying the reality of anthropogenic climate change. It is in this severe climate of opinion that funding decisions are made, and research priorities are codified. When it comes to the recovery of the environmental past, these issues are exacerbated by the fact that the textual traces of the past are simply a proxy for climate and weather phenomena. I need not rehearse here the extensive methodological considerations that climate historians and climate scientists have raised about the value of cross-referencing scientific proxy evidence (comparing ice core samples, tree ring analysis, and similar geological and biological data sources) with recorded human observations, but I will direct the reader to the excellent summaries by Sam Brönnimann, Christian Pfister and Sam White of the sources of evidence from the "archives of nature" and the "archives of societies" that are necessary in equal measure for climate reconstructions of the pre-instrumental era.[64] The difficulty that we face in the humanities is that there is a growing mistrust of the value of recovering human observations on the grounds that it involves subjective interpretation of the textual record. Even from academic assessors within the humanities, we encounter persistent scepticism about the potential for additional documentary evidence to improve historical climate reconstructions by scientists. Yet as I noted above, the scientists responsible for constructing the most reliable NAO historical reconstructions openly call for corroborating evidence from archival sources. Outside the humanities, the critics on social media or in some pockets of the press in the wake of the 2021 ministerial veto in particular have been downright dismissive of this humanities project tackling questions that scientists alone should, in their opinion, be asking.

By having the records that I have already accumulated incorporated into a database, I hope that other researchers will be able to explore the variations of England's climate in the sixteenth and seventeenth centuries with greater precision. For my part, the payoff will be the ability to identify when weather extremes may have contributed to changes in how plays were staged or in the ways companies conducted the business of playing. Degroot observes that the patterns with which populations become comfortable are what make weather extremes stand out in the imagination. Much has been written about the ways that early modern and late medieval cosmology accommodated extreme phenomena as signs of divine retribution, and as John Emrys Morgan points out, printers would often use one generic image to refer to multiple iterations of the same kind of event, such as in the use of the same front page image from the report of the Bristol flood of 1607 in several reports of other flood events.[65] I am therefore inclined to want also to map the mundane conditions, which as I indicated from the outset must surely present as somehow

remarkable when they are experienced by people whose world we see as being marked by frequent extremes and volatility and who saw these extremes as somehow part of a divine plan. While the database of extremes represents a timely opportunity for me to put a dormant body of data to good use, there will undoubtedly be a need in the future to aid the recovery of the climate of the period through a rather more banal extension of this same resource, with a "Fair to Middling Weather" category range, an adjustment that I am happy to report is being incorporated. Along lines such as these, and with a frigid Little Ice Age no longer dominating our sense of the English climate in this period as too characteristically cold or wet, I believe we are beginning to make better sense of the environmental factors driving innovations that we associate with Shakespearean drama.

Notes

[1] This article presents data obtained during a Folger Shakespeare Library Fellowship, February to April 2019, and research supported by a Vice-Chancellor's Strategic Research Initiative grant internal to the University of Southern Queensland, 2022 to 2023. I also wish to thank the "Playing Conditions" project team (Heather Knight, Matthew Steggle, Elizabeth E. Tavares, and Madeline Bassnett). While the article relates to our collaborations, much of the focus is also on my individual data sets and some personal reflections of conducting this research within the current academy and for this reason I have opted to present this as a sole-authored article.

[2] Access at https://weather-extremes-in-englands-little-ice-age-westernu.hub.arcgis.com/

[3] Johnson to Bacon, from Brielle, 22 February 1575, in *The Papers of Nathaniel Bacon of Stiffkey*, *Vol. I, 1556–1577*, edited by A. Hassell Smith, Gillian M. Baker, and R.W. Kenny (Centre of East Anglian Studies, University of East Anglia, 1979), 157.

[4] Hassell Smith et al, 156.

[5] "In Pictures: Netherlands deep freeze revives national obsession," *Aljazeera* 10 February 2021 <https://www.aljazeera.com/gallery/2021/2/10/in-pictures-deep-freeze-stirs-ice-skating-hopes-in-netherlands>.

[6] "Freeze in Europe. Both Wars at Standstill. Ships Blocked," *The Mercury* 19 January 1940 Front page. https://trove.nla.gov.au/newspaper/article/25764489.

[7] "Dose of Art #182: Jan van Goyen – Skating on the Merwede near Dordrecht (1646)," Size of Art weblog, 2021 https://sizeofart.com/dose-of-art-182-jan-van-goyen-skating-on-the-merwede-near-dordrecht-1646/.

[8] Adriaan M.J. de Kraker, "Ice and Water. The Removal of Ice on the Waterways in the Low Countries, 1330–1800," *Water History* 9 (2017): 109-28, 125.

[9] From the Papers of Nathaniel Bacon at the Folger Shakespeare Library, a letter from Sir Christopher Heydon dated 21 January 1574/5 makes a representation to Bacon on behalf of the bearer, Edward Balyston, whose passage from Baconsthorpe was thus evidently not hindered

(X.d.502.3); and a letter from Edward Bacon to his brother from Gray's Inn, dated 7 February 1575, records among other things the Earl of Oxford's departure for a tour of the continent "with licence," indicating no concerns over the sailing conditions out of London (Hassell Smith et al, *Papers*, 1.185).

[10] The event is featured in several contemporary accounts, including John Stow, *The Annales of England* (London, 1605), 1149. For discussion, with evidence of there being no impact in London or Norfolk, see R.M.W. Musson, "The Seismicity of the British Isles to 1600," in *British Geological Survey, Earth Hazards and Systems Internal Report*OR/08/049 (Keyworth: British Geological Survey, 2008), 463-69.

[11] E.K. Chambers, *The Elizabethan Stage*, 4 vols. (Oxford: Clarendon, 1923), 4.91; see also "County Index of Visits by the Queen" (*Folgerpedia, Elizabethan Calendar Day-by-Day*, including "Proposed Progresses") for planned visits in 1575 https://folgerpedia.folger.edu/mediawiki/media/images_pedia_folgerpedia_mw/4/4c/ECDbD_County_Hosts_Proposed_Progresses.pdf.

[12] Hassell Smith et al, *Papers*, 1.49.

[13] John Roche Dasent, ed. *Acts of the Privy Council of England*, vol. 8, 1575–1577 (London: Her Majesty's Stationery Office, 1894), 344–50.

[14] M.W. Wallace, *Life of Sir Phillip Sidney* (Cambridge: Cambridge University Press, 1915), 149–50.

[15] See William Ingram, *The Business of Playing: The Beginnings of the Adult Professional*

Theater in Elizabethan London (Ithaca: Cornell University Press, 1992), 172; Laurie Johnson, *Shakespeare's Lost Playhouse: Eleven Days at Newington Butts* (London and New York: Routledge, 2018), 75-81.

[16] For a recent summary and critique of this narrative, see Laurie Johnson, *Leicester's Men and Their Plays: An Early Elizabethan Playing Company and its Legacy* (Cambridge: Cambridge University Press, 2023), 4–13.

[17] See O. Paasche and J. Bakke, "Defining the Little Ice Age," *Climate of the Past Discussions* 6 (2010): 2159–75.

[18] F. Matthes, "Report of Committee on Glaciers," *Transactions of the American Geophysical Union* 20 (1939): 518–23; H.H. Lamb, *The Changing Climate* (London: Methuen, 1966), 101.

[19] Jean M. Grove, *The Little Ice Age* (London: Methuen, 1988).

[20] Wolfgang Behringer, *A Cultural History of Climate* (Cambridge: Polity Press, 2010), 121–67.

[21] Robert Markley, "Summer's Lease': Shakespeare in the Little Ice Age," in *Early Modern Ecostudies: From the Florentine Codex to Shakespeare*, eds. Thomas Hallock, Ivo Kamps, and Karen L. Raber (New York: Palgrave Macmillan, 2008), 131–42, 135.

[22] Brian Fagan, *The Little Ice Age: How Climate Made History, 1300–1850* (New York: Basic Books, 2000), 24–28.

[23] Markley, "'Summer's Lease,'" 135.

[24] John U. Nef, "An Early Energy Crisis and its Consequences," *Scientific American* 237 no. 5 (1977): 140–51; Julia C. Webb and Anne E. Goodenough, "Questioning the Reliability of 'Ancient' Woodland Indicators: Resilience to Interruptions and Persistence Following Deforestation," *Ecological Indicators* 84 (2018): 354–63.

[25] Keith R. Briffa, Philip D. Jones, Fritz H. Schweingruber, Wibjörn Karlen, and Stepan G. Shiyatov, "Tree-ring Variables as Proxy-climate Indicators: Problems with Low Frequency Signals," in *Climatic Variations and Forcing Mechanisms of the Last 2000 Years*, edited by Philip D. Jones, Raymond S. Bradley, and Jean Jouzel, NATO ASI Series. Series I: Global Environmental Change, vol. 41 (Berlin and Heidelberg: Springer, 1996), 9–41.

[26] See Julia C. Webb, Julia McCarroll, Frank M. Chambers, and Tim Thom, "Evidence for the Little Ice Age in Upland Northwestern Europe: Multiproxy Climate Data from Three Blanket Mires in Northern England," *The Holocene* 32 no. 5 (2022): 451–67.

[27] Fagan, *Little Ice Age*, 90–94.

[28] Fagan, *Little Ice Age*, 27; Jürg Luterbacher, Christoph Schmutz, Dimitrios Gyalistras, Eleni Xoplaki, and Heinz Wanner, "Reconstruction of Monthly NAO and EU Indices Dating Back to AD 1675," *Geophysical Research Letters* 26 no. 17 (1999): 2745–48.

[29] Fagan, *Little Ice Age*, 23.

[30] Luterbacher et al, "Reconstruction," 2748.

[31] Jürg Luterbacher, Eleni Xoplaki, Daniel Dietrich, Philip D. Jones, Trevor Davies, Diane Portis, J. Fidel González-Rouco, Hans von Storch, Dimitrios Gyalistras, Carlo Casty, and Heinz Wanner, "Extending North Atlantic Oscillation Reconstructions Back to 1500," *Atmospheric Science Letters* 2 no. 1-4 (2002): 114–124.

[32] Daryl W. Palmer, "Hamlet's Northern Lineage: Masculinity, Climate, and the Mechanician in Early Modern Britain," *Renaissance Drama* 35 (2006): 3–26, 21.

[33] Chloe Fairbanks, "'Maister of the earth?' Reassessing the Monarch-as-Husbanman Metaphor in Shakespeare's Histories," *Green Letters: Studies in Ecocriticism* 27, no. 4 (2023): 402–17, 403.

[34] In particular, eco-critical readings of Shakespeare and his contemporaries based on a knowledge of Little Ice Age climates can be found in works by scholars such as Todd A. Borlik, *Ecocriticism and Early Modern English Literature: Green Pastures* (New York: Routledge, 2011); Simon C. Estok, *Ecocriticism and Shakespeare: Reading Ecophobia* (New York: Palgrave Macmillan, 2011); Randall Martin, *Shakespeare & Ecology* (Oxford: Oxford University Press, 2015); and Sophie Chiari, *Shakespeare's Representation of Weather, Climate and Environment* (Edinburgh: Edinburgh University Press, 2018).

[35] Fairbanks, "Maister of the earth?" 403.

[36] Geoffrey Parker, *Global Crisis: War, Climate Change & Catastrophe in the Seventeenth Century* (New Haven and London: Yale University Press, 2013), 111–12; Philipp Blom, *Nature's Mutiny: How the Little Ice Age Transformed the West and Shaped the Present* (Basingstoke: Pan Macmillan, 2019).

[37] Fagan, *Little Ice Age*, 94.

[38] Parker, *Global Crisis*, 112.

[39] At least one reviewer calls Blom out on factual errors when referring to seventeenth-century events as being from the eighteenth-century. It may be that Blom is just careless with the enumeration of centuries, but it remains that his readers can thus be mistaken for thinking that he is accurately describing events or phenomena of one century when they belong more correctly to another. See Peter N. Miller, Rev. of *Nature's Mutiny* by Philipp Blom, *The New York Times* 5 March 2019, https://www.nytimes.com/2019/03/05/books/review/philipp-blom-natures-mutiny.html.

[40] Dagomar Degroot, *The Frigid Golden Age: Climate Change, the Little Ice Age, and the Dutch Republic, 1560–1720*(Cambridge: Cambridge University Press, 2018), 6.

[41] Degroot, 9.

[42] Degroot, 9.

[43] William Andrews, *Famous Frosts and Frost Fairs in Great Britain: Chronicled from the Earliest to the Present Time* (London: George Redway, 1887).

[44] Stow, *Annales*; Thomas Short, *A General Chronological History of the Air, Weather, Seasons, Meteors*. 2 vols. (London: T. Longman and A. Millar, 1749), 22.

[45] See Short, *Chronological*, 215, 245–46, 259; and Stow, *Annales*, 1140, 1160.

[46] John Dee, *The Diaries of John Dee*, ed. Edward Fenton (Oxfordshire: Day Books, 1998).

[47] Dee, *Diaries*, 1–2.

[48] Examples include Dee, *Diaries*, 256; Short, *Chronological*, 200, 206, 211, 216, 226, 233, 268, 272, 274; Stow, *Annales*, 804, 848, 977, 1062, 1117, 1173, 1271; Heather Wolfe, ed. *The Trevelyon Miscellany of 1608: An Introduction to Folger Shakespeare Library MS V.b.232* (Folger Shakespeare Library, 2007), f.324v.

[49] Short, *Chronological*, 274.

[50] Shrewsbury School, "Dr. Taylor's Manuscript," f.196v-197; cited in Robert Bearman, "Stratford's Fires of 1594 and 1595 Revisited," *Midland History* 25, no. 1 (2000): 181–90, 185.

[51] See, for example, the argument that extreme weather would not represent a problem for states or rules since they were easily accommodated by belief in divine punishment and the absolute power of the monarchy, in William M. Cavert, "Winter and Discontent in Early Modern England," in *Governing the Environment in the Early Modern World: Theory and Practice*, edited by Sarah Miglietti and John Morgan (London and New York: Routledge, 2017): 114–33, 116.

[52] Laurie Johnson, *Shakespeare's Lost Playhouse: Eleven Days at Newington Butts* (London and New York: Routledge, 2018), 86–88.

[53] See Short, *Chronological*, 228, 232, 233, 243, 251; Stow, *Annales*, 1113, 1115, 1117, 1130, 1147.

[54] *A true report of certaine wonderfull ouerflowings of Waters, now lately in Summerset-shire, Norfolke, and other places of England* (London: Edward White, 1607).

[55] Johnson, *Lost Playhouse*, 136–37; 143–45.

[56] Scott McMillin and Sally-Beth MacLean, *The Queen's Men and Their Plays* (Cambridge: Cambridge University Press, 1998), 18–22, 39–41.

[57] Johnson, *Leicester's*, 74–81.

[58] Johnson, 109–11.

[59] Johnson, 151–52.

[60] Short, *Chronological*, 259.

[61] For research into the effect of snow events on climate change attitudes, see for example, David M. Konisky, Llewellyn Hughes, and Charles H. Kaylor, "Extreme Weather Events and Climate Change Concern," *Climatic Change*134 (2016): 533–47.

[62] Daniel Hurst, "Federal government's Christmas Eve veto of research projects labelled 'McCarthyism,'" *The Guardian* 24 December 2021 <https://www.theguardian.com/australia-news/2021/dec/24/federal-governments-christmas-eve-veto-of-research-projects-labelled-

mccarthyism>; Julieanne Lamond, "Ministerial interference is an attack on academic freedom and Australia's literary culture," *The Conversation* 4 January 2022, < https://theconversation.com/ministerial-interference-is-an-attack-on-academic-freedom-and-australias-literary-culture-174329>; Jack Grove, "Australian scientists join outcry over humanities research veto," *Times Higher Education* 10 January 2022 < https://www.timeshighereducation.com/news/australian-scientists-join-outcry-over-humanities-research-veto>.

[63] Assessor's Report, Australian Research Council Discovery Program DP210102141, 7 July 2020.

[64] Sam Brönnimann, Christian Pfister and Sam White, "Archives of Nature and Archives of Societies," in *The Palgrave Handbook of Climate History*, eds. Sam White, Christian Pfister, and Franz Mauelshagen (London: Palgrave Macmillan, 2018), 27–35.

[65] John Emrys Morgan, "Understanding Flooding in Early Modern England," *Journal of Historical Geography* 50 (2015): 37–50, esp. 41–42.