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Second Only to Nuclear War: Science and the Making of Existential Threat in Global Climate Governance

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Climate change moved rapidly up the international political agenda between 1979 and 1988. What explains this shift? Existing explanations focus on how an international epistemic community built a scientific consensus that informed state interests by reducing uncertainty. However, in 1988 scientists actually heightened uncertainty about the future consequences of climate change by depicting it as a security threat "second only to a global nuclear war." To account for this, I integrate insights from science and technology studies and securitization theory. In doing so, I theorize how scientists speak the grammar of security and construct existential threats. I argue that scientists catalyzed political action in the climate case by drawing on ideas about time, technology, and humanity's place in the universe. I conduct a discourse analysis of key scientific texts in the 1980s to uncover the frames and discourses scientists used to place climate change on the international political agenda.

Why did the climate emerge as a problem on the global environmental governance agenda in the late 1980s? The "greenhouse effect" had been well known since the nineteenth century, but modern climate science only developed an image of the climate as a global geophysical system in the 1950s. In 1979, two major scientific events depicted climate change as an important political problem. In February, the World Climate Conference concluded that the burning of fossil fuels and changes in land use had increased carbon dioxide levels in the atmosphere and that this would lead to global warming. Later that year, a US National Academy of Sciences study group chaired by Jules Charney found that a doubling of CO_2 would increase global temperature by 3°C (+/−1.5°C). Charney's report provided the first quantitative prediction of global warming aimed directly at policymakers.[1] A series of international meetings and conferences then culminated in the 1988 Toronto Conference on the Changing Atmosphere, which placed climate change on the agenda of states. The Toronto conference was remarkable not because it presented authoritative new evidence, but because it depicted climate change as an existential threat to human life "second only to a global nuclear war" (World Meteorological Organization [WMO] 1989, 292). The conference catalyzed the creation of the core institutions of global climate governance, the Intergovernmental Panel on Climate Change (IPCC), and the United Nations Framework Convention on Climate Change (UNFCCC).[2]

What explains how and why climate change moved up the global agenda? Existing explanations for agenda-setting in the climate case contend that scientists convinced policymakers to take climate change seriously by reducing uncertainties in their models and presenting the evidence for global warming in a series of authoritative meetings and reports (Bodansky 1993; Rowlands 1995; Paterson 1996; Franz 1997; Haas and McCabe 2001; Torrance 2006). Indeed, scientists increased confidence in their findings by improving climate models and collecting new data over the course of the 1980s. But they did not eliminate large uncertainties concerning the magnitude, timing, and consequences of global warming. Moreover, the point predictions introduced by the Charney report remained stable through the 1990s, and no new quantifications were presented in 1988 (Franz 1997; van der Sluijs, van Eijndhoven, and Shackley 1998; Torrance 2006; Edwards 2010). Indeed, at Toronto and other meetings, scientists sought to raise the political profile of climate change by arguing that the consequences of climate change were highly uncertain and potentially catastrophic. This is the inverse of the mechanism laid out in the epistemic communities and rationalist literatures.

How did scientists and other members of the epistemic community frame climate change so as to move it up the international agenda? I integrate insights from science and technology studies (STS) and securitization theory to argue that scientists politicized climate change by framing it as a security problem. This framing drew on ideas about time, knowledge, technology, and humanity's place in the universe to portray climate change as a threat to human existence. I reconstruct the discursive and institutional history of international climate governance in the 1980s through close readings of primary documents. This analysis reveals that scientists proved influential in setting the agenda not necessarily because they reduced uncertainties by converting them into calculable risks, but because they articulated climate change as a security problem with uncertain, potentially catastrophic consequences.

In the first phase, from 1979 through 1984, scientists outlined the likely negative effects of climate change for sea levels, agricultural production, and extreme weather events. This period saw a vigorous transnational debate about whether climate change constituted a threat significant enough to warrant strong, immediate political action. The debate hinged less on technical questions than on assumptions about humans' capacity for adaptation, the reliability of technological progress, the divergent time scales of human and natural systems, and the ability to model or anticipate climatic change. A central question here was whether rapid changes to unstable natural systems

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[1] See Charney, Arakawa, Baker, Bolin, Dickinson, Goody, Leith, Stommel, and Wunsch (1979).

[2] On my recounting, the scientific consensus on anthropogenic climate change emerges much earlier, around 1990, than commonly thought. This is supported by Shwed and Bearman's (2010) quantitative study of the climate change literature, which shows a large increase in the number of publications and the degree of consensus after 1988.

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would overwhelm the adaptive capacities of human societies. In the second phase, culminating in the 1988 Toronto conference, scientists combined the ideas introduced in the earlier phase with Cold War themes that recalled the possibility of human extinction. The discursive frames underlying these claims had been developed and deployed in earlier atmospheric controversies over nuclear winter and the ozone hole. The Toronto conference catalyzed political action by constructing an image of an uncertain future in which humans might find themselves unable to adapt to unanticipated changes in unstable natural systems. Thus, scientists depicted climate change as a security threat by drawing on what I call "cosmological ideas" about humanity's relationship with nature.

My argument matters for ongoing policy debates and understanding the role of uncertainty in international-relations theory. First, efforts to securitize the climate in the 1980s failed to mobilize strong international action. This calls into question ongoing efforts to combat climate change through the same general strategy. Second, the theoretical section introduces a new mechanism to explain how scientists wield agenda-setting power—one distinct from the epistemic communities and rationalist arguments. Rather than focusing on uncertainty reduction, my account reveals how scientific knowledge can generate political attention by depicting uncertain futures. I demonstrate that uncertainty is not, as many international-relations theories assume, an ontological condition of world politics. Rather, the extent—and even existence—of uncertainty is shaped by the contingent, contested politics of knowledge.

Science and Agenda-Setting in Global Climate Governance

Two broad approaches might explain how scientists placed global warming on the international agenda.[3] First, the epistemic community literature argues that science is powerful when scientists form authoritative communities that, in turn, produce consensual knowledge (Haas 1992; Haas and McCabe 2001). This consensual knowledge, the argument goes, defines and clarifies state interests under conditions of uncertainty. Second, approaches in both STS and international-relations theory highlight the symbolic or discursive power of scientific knowledge to constitute political order and shape political action (Litfin 1994; Jasanoff 2004; Gupta 2006).[4]

Haas and McCabe (2001, 327, 332) employ the epistemic community framework to explain the emergence of climate change. They argue that "a small transnational network of experts" led the process of identifying and framing climate policy. They show how a dedicated group of scientific and political elites led by Mostafa Tolba and Bert Bolin organized a series of United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO) conferences in the 1980s. In this account, the conferences created an authoritative community of scientists who forged scientific consensus, synthesized the scientific literature, and produced policy-relevant knowledge that persuaded states to govern greenhouse gas emissions.

This is a necessary part of the explanation, but as Paterson argues, it does not explain "how an epistemic community can get its viewpoint across and influence state action" (1996, 155). One possibility is that epistemic communities succeed in setting the political agenda because they offer quantified risk assessments. These persuade states to define their interests or calculate costs and benefits in particular ways (Haas 1992, 223; Rowlands 1995, 153–55). However, precise risk assessments are rarely available to policy-makers.[5] In the climate case, climate modeling improved over the course of the 1980s and a better understanding of non-CO_2 greenhouse gases implied that temperature increases might come sooner than previously thought. However, the central findings of climate science remained stable over the course of the 1980s. From 1979 on, climate models consistently predicted 3°C (+/−1.5°C) of warming (Franz 1997; van der Sluijs et al. 1998; Torrance 2006, 37–38; Edwards 2010, 378). Scientific reports warned of negative effects on agriculture, precipitation, sea level rise, and weather extremes. Thus, a number of analysts conclude that the emergence of scientific knowledge alone cannot explain the rise of climate change onto the political agenda of states (Hecht and Tirpak 1995; Franz 1997; Weingart, Engels, and Pansegrau 2000; Bodansky 2001; Torrance 2006).

Another possibility is that the introduction of a specific form of policy-relevant knowledge drove the changes between 1979 and 1988 (Paterson 1996, 34; Franz 1997, 23–24; Hughes 2015, 91–92). For Franz (1997, 24), the central shift between 1985 and 1988 was the "attempt to transform scientific facts into political facts." Paterson (1996, 34) suggests that what made Toronto unique was that it offered specific policy recommendations such as emissions cuts, energy efficiency targets, and research and development funds. This is also an important part of the story; however, it does not explain why policy-makers were motivated to address the problem in the first place. As Edwards (2010, 357) points out, policy-makers will only devote scarce political resources to an issue if they believe there is a crisis and someone has explained the causes of the crisis and offered a resolution. Existing explanations have focused on the latter two elements. However, they have not yet shown how scientists conveyed that there was a crisis demanding resolution.

Scholars working in the STS tradition represent the emergence of global climate governance as a process of discursive production and contestation (Agarwal and Narain 1991; Shackley and Wynne 1995; Paterson 1996; Demeritt 2001; Miller 2004; Oreskes 2004; Hulme 2008; Edwards 2010; Jasanoff 2010; Lövbrand 2011; Hughes 2015; Allan 2017).[6] For example, Miller (2004, 54) argues that we cannot explain the emergence of climate change in international politics without attending to the construction of "climate" as an "ontologically unitary whole." The use of computer models to construct a truly global climate beyond existing local and regional weather patterns helped authorize governance of the climate at the global level. By constructing the climate as a global risk, scientists articulated "a vision of natural order that made clear the necessity for, and possibility of, a global politics of climate" (Miller 2004, 55). On this view, science is a powerful, productive force that shapes the central categories within which international politics plays out.

[3] For general theories of agenda-setting in international-relations, see Carpenter (2007, 2010) and Hafner-Burton and Pollack (2002).

[4] There is also a skeptical or instrumental argument on which science is powerful because it is used by states to fulfill their interests. This perspective cannot explain agenda-setting but is well suited to explaining the role of science in the later stages of climate governance (Paterson 1996, 153–54; Edwards 2010, 406–11).

[5] Thus, rationalist arguments that posit precise cost-benefit analysis as a mechanism are unrealistic. For example, Sprinz and Vaahtoronta (1994) operationalize interests precisely, but without explaining why we should expect policy-makers to have access to such evidence. Nonetheless, policy-makers do "fight for what they understand to be their preferred outcome" (Rowlands 1995, 158).

[6] For important precursors to this argument in other environmental domains, see Litfin (1994) and Epstein (2008).

This is an important insight, but it cannot explain the timing or specific mechanisms of agenda-setting in the climate case.

The insights of STS have not been translated into a theory that explains how and when scientists effectively translate their epistemic authority into agenda-setting power in the short run.[7] Nonetheless, as Paterson (1996, 155) points out, a discursive, STS-influenced approach is well suited to explaining agenda-setting. It encourages us to investigate how scientific discourses interrelate and combine with other discourses in the course of political action. Indeed, a focus not on communities of scientists but on discursive acts enables us to see the power of science in a new light.

From this perspective, Edwards (2010) shows how scientists built the discursive resources to set the agenda in global atmospheric politics. He argues that climate models were translated into policy tools in a number of political controversies: supersonic transport, the *Limits to Growth* report, the ozone hole, acid rain, and nuclear winter (Edwards 2010, 358). In these debates, scientists did not simply present technical, scientific findings, but embedded those details in broader Cold War themes concerning science and technology, catastrophe, and danger.[8]

Of particular importance was the nuclear winter debate in the early 1980s. The idea of nuclear winter arose from geological studies that suggested that the cause of the Cretaceous-Tertiary extinction event 65 million years ago was a dust cloud produced by a gigantic meteor. Analogously, scientists inferred that a nuclear war would generate dust clouds and fires that could induce a nuclear winter (Edwards 2010, 382). Crutzen and Birks' seminal paper argued that the effects of nuclear war would last for months:

> Fires would strongly restrict the penetration of sunlight to the earth's surface and change the physical properties of the earth's atmosphere…. Under such conditions it is likely that agricultural production in the Northern Hemisphere would be almost totally eliminated, so that no food would be available for the survivors of the initial effects of the war. (Crutzen and Birks 1982, 124)

Similarly, Carl Sagan's review concluded that "pyrotoxins, low light levels, radioactive fallout, subsequent ultraviolet light, and especially the cold are together likely to destroy almost all of Northern Hemisphere agriculture" (1983/1984, 270). Sagan warned that these and other effects "would imperil every survivor on the planet. There is a real danger of the extinction of humanity" (1983, 292). The nuclear winter debate depicted climate change as an existential threat endangering the survival of the species.

The nuclear winter debate and other controversies developed an atmospheric politics situated within broader Cold War discourses about the power of science and technology. In these debates, scientists portrayed humans as a global force that could alter the operations of nature. In so doing, they drew both on a modernist belief in the power of science and technology and pessimistic narratives about the negative effects of scientific and technological civilization. These controversies increased political attention to global atmospheric problems. In addition, they provided scientists with political experience in securitizing environmental issues. Finally, and most importantly for our purposes, they set the discursive frames within which the climate problem was later embedded.

Securitizing Moves and Agenda-Setting Processes

The STS perspective highlights how scientific knowledge operates as a productive form of power that shapes the categories and representations of political discourses (Jasanoff 2004). However, this perspective has not been translated into a theoretical framework that can map or explain short-term agenda-setting processes. In this section, I integrate the STS perspective with insights from securitization theory to theorize how scientists exercise agenda-setting power by constructing problems as existential threats. This shifts the explanatory focus away from the preexisting attributes of scientists toward the dynamic processes of constructing and framing problems.

Securitization theory argues that security problems are not objectively given, but constructed by processes of political contestation (Waever 1995; Buzan, Waever, and de Wilde 1998). A securitizing move is a speech act that defines a phenomenon as an existential threat to the survival of some referent object such as the state, an identity group, or an ecosystem (Buzan et al. 1998, 24–25; Taureck 2006, 54–55; Waever 2009, 23). If successful, securitizing acts justify the removal of the problem from normal politics and necessitate "emergency measures" to neutralize the threat (Buzan et al. 1998, 21). Buzan et al. (1998, 32–33) outline two sets of conditions for securitization. First, an authorized political actor who speaks the "grammar of security" must "construct a plot that includes existential threat, point of no return, and a possible way out" (Buzan et al. 1998, 33). Second, an audience must accept or authorize the securitizing claim. Both sets of conditions depend on broader epistemic, ontological, normative, and aesthetic structures that contain the resources securitizing actors draw on to speak the grammar of security and shape the background conditions for the acceptance of securitizing acts (Huysmans 1998, 228; Williams 2003, 525; Balzacq 2005, 177; Sjöstedt 2013; Van Rythoven 2015).

Buzan et al. (1998, 83) analysis of environmental securitization concludes that most environmental problems remain in the domain of normal political debate. This is because environmental threats unfold in an "unspecified, relatively remote future" and therefore do not invoke "panic politics." Nonetheless, as a number of studies focusing on climate politics after 2007 have shown, the securitization framework can be effectively used to explain the emergence of new practices and actors (Trombetta 2008; Detraz and Betsill 2009; Floyd 2010; Detraz 2011; Oels 2012; Mayer 2012).[9] In the language of Buzan et al. (1998, 23–25), even if securitizing moves fail to generate emergency measures, they can be effective tools in the politicization of issues.

To effectively apply securitization theory to the case of climate governance in the 1980s, I draw on a reading of securitization as a contested political and social process that unfolds over time (Williams 2003, 521; Balzacq 2005, 193; Oren and Solomon 2015, 314).[10] A processual focus on

[7] A number of studies in international-relations aim to, consistent with STS arguments, move beyond the linear model of science and politics in the climate case (Rowlands 1995; Paterson 1996; Torrance 2006; Hughes 2015). However, none of these accounts provides a theory or methodology for the study of discursive frames in agenda-setting processes. Moreover, though Rowlands and Paterson critique the sufficiency of the epistemic communities argument, they nonetheless conclude that consensus formation and uncertainty reduction explain the power of science in agenda-setting (Rowlands 1995, 94; Paterson 1996, 144–47).

[8] See Hulme (2008) for a complementary analysis.

[9] For an important critique of this literature, see Corry (2012).

[10] Oren and Solomon (2015) criticize the "instantaneity" of securitization theory, but as Hansen (2012) argues, the Copenhagen School has always contained a processual dimension in its conceptualization of politics as "a continuous struggle

securitizing moves and their indeterminate, contingent effects can be applied to cases like the climate where scientists used security claims to try to elevate the issue. In the climate case, scientists were able to raise awareness of the problem of climate change and place the issue on the international political agenda. But the central question remains, how did scientists construct climate change as an existential threat deserving of scarce political attention? Existing studies of science in the securitization literature have suggested that scientists can use their epistemic authority to securitize objects, but have not theorized how and why scientists speak the grammar of security (Buzan et al. 1998, 72–73; Berling 2011, 392).

The Cosmological Grammar of Existential Threat

Despite its importance to the securitization framework, there has been relatively little analysis of what constitutes the grammar of existential threat.[11] However, an important early intervention by Huysmans (1998) provides a theoretical starting point for explaining how and why scientists securitize issues. For Huysmans (1998, 231), a securitizing move hails a "metaphysics of life" that "defines our relations to nature, to other human beings and to the self." In particular, Huysmans argues that security claims invoke the uncertainty of the future and the possibility of death to represent humans as fragile beings. This calls on religious, political, and epistemic actors to act as authorities that will protect people from the uncertainty and insecurity of death (Huysmans 1998, 237–39). Securitizing acts do not actually succeed in reducing the "impression of chaos." Nonetheless, they create a constant demand for knowledge and political practices that promise to neutralize danger (Huysmans 1998, 245–47).

Building on Huysmans, Aradau and van Munster (2011) argue that scientific and expert knowledge can be used to fashion "catastrophic futures." The modes of knowledge used in catastrophic thinking are distinct from those used to produce risk assessments: "If risk and probability introduce an array of finite possibilities for the future, catastrophe challenges the limits of possibility" (Aradau and van Munster 2011, 10). That is, catastrophic thinking expands the bounds of the possible by depicting a future that has not arrived. Doing so requires imaginative and aesthetic modes of thought that motivate efforts to "tame the possibility of a calamitous future" (Aradau and van Munster 2011, 19). Far from reducing uncertainty, catastrophe narratives invoke and produce uncertainty by imagining fragile humans overcome by nuclear war, drought, hurricanes, and rising seas. These calamitous futures construct existential threats because they describe a world in which the survival of civilization or the human species is in question.

In Huysmans' account, experts are persistently called upon to reduce the uncertainty created by security claims, but they never foreclose that uncertainty. Instead, as Aradau and Munster show, uncertainty is a powerful element of security claims. Here, the role of scientific and expert knowledge in catastrophic thinking is the inverse of that portrayed in the epistemic community literature (Haas 1992; Clark, Mitchell, and Cash 2006). Scientists do not only inform state interests by reducing uncertainty, they also invoke uncertainty to raise awareness and mobilize action. Scientists can weave together narratives about security, nature, and the fragility of life that create, rather than reduce, the impression of chaos.

The invocation of uncertainty then helps to constitute scientists as authorities because their expertise is needed to avert catastrophe. In the linear view of science and politics, scientists produce authoritative risk assessments due to their attributes or position in society (Haas 1992; Clark et al. 2006). Most accounts of the role of science and expertise in securitization theory adopt this model (Buzan et al. 1998; Berling 2011). Sending critiques this static model, arguing that authority is "not produced by legitimate belief or by a social contract" (2015, 11). Rather, authority is constructed and defined in processes of political contestation, when "some actors succeed in presenting their interests and attendant categories as natural and universal rather than arbitrary and particular" (Sending 2015,11). Actors become authoritative when they differentiate themselves so as to construct and occupy a privileged position in a social-political field.

In securitization processes, experts and scientists construct the ground of their own authority by positing a new governance object and constructing a sense of crisis around it. In cases such as climate change, where the crisis lays in the future, providing a scientific account of the crisis is not an effort to relieve ongoing confusion. Rather, it is an effort to generate fear of a partially unknown future. Before scientists tell policy-makers that greenhouse gases may disrupt agricultural production or that the use of antibiotics may encourage antibiotic-resistant bacteria, policy-makers are ignorant of these possible states of the world. By providing knowledge in these instances, scientists portray an uncertain future filled with potential threats. In the case of catastrophic securitizations, uncertainty is constructed as a fear of future possibilities.[12] In some instances, experts offer point predictions about the likelihood of crisis outcomes, defining pockets of risk within the uncertain future. However, the motivational force of an image of the future is derived from the possibility that the negative effects of a catastrophe will outstrip our imagination.

On the STS view, scientists are politically powerful because scientific ideas produce the categories and values that structure political orders. Integrating this insight with securitization theory suggests that scientists are powerful securitizing agents because they have authoritative access to ideas about nature, humanity, and the cosmos. In Huysmans' account, these are the central elements of securitizing claims. Because scientists have the power to wield these ideas, they have a unique ability to define security problems. Moreover, their causal knowledge and modeling techniques allow them to create vivid, calculable images of the future.

In speaking the grammar of security to set the international agenda, scientists draw on broader cultural and cosmological discourses that circulate through the international system. In the context of the global Cold War, the cosmological backdrop for the grammar of security was structured by the ambivalences of the nuclear age (Hulme 2008; Edwards 2010). On one hand, nuclear weapons demonstrated that humanity had harnessed science and technology to control the most powerful forces in the universe. On the other hand, nuclear weapons posed an existential threat to the survival of the human species. As we saw in the nuclear winter debate, these ideas both constituted scientific knowledge as an authority and served as a reservoir of

to establish the quasi-permanence of an ordered public realm" (Buzan et al. 1998, 144, quoted in Hansen 2012, 528). As Waever puts it, the focus of the theory is on the "*processes* of securitization and desecuritization" (1995, 57, emphasis in the original).

[11] Although, see Waever (2009, 21–23).

[12] On fear as uncertainty, see Rathbun (2007, 538–41).

discursive and affective resources that could be drawn upon by securitizing actors.

These ideas are cosmological, rather than merely epistemic or ontological. Cosmologies unite epistemic claims about the foundations of knowledge and ontological claims about what exists into a narrative that defines the role of humanity in the cosmos. For example, a central cosmological issue in the analysis that follows is whether humans are masters over nature or fragile in the face of nature. Narratives of humans harnessing the power of science and technology to fuel progress give the sense that humans have conquered nature. Conversely, the invocation of natural disasters and the possibility of death recalls the fragility of humanity. The fact that, in the case of climate change, scientific and technological civilization may cause catastrophe undermines the ideal of control over nature.

The integration of STS and securitization theory explains how scientists speak the grammar of security in order to persuade policy-makers to devote scarce political resources to an issue. This account theorizes an alternative mechanism by which scientific actors can influence political action: constructing uncertain futures. This mechanism is compatible with the epistemic community literature's emphasis on uncertainty reduction and community formation. However, my processual focus on discursive acts helps account for how scientific groups constitute and mobilize their authority in context. In what follows, I show that scientific securitizing acts played an important role in the emergence of climate governance.

Setting the Climate Agenda, 1979–88

Over the course of the 1980s, climate change went from being an inchoate problem to a high-level concern on the international agenda. To reveal how scientists placed the issue on the agenda of states, I conduct a discourse analysis of the frames used to portray climate as a security problem.[13] Through an analysis of primary documents, I recover the concepts and beliefs that scientists deployed to construct climate change as a meaningful political problem. My approach incorporates elements of poststructuralist discourse analysis in attending to the often hidden epistemic, ontological, temporal, and cosmological themes in discursive frames. However, I step outside the poststructuralist perspective by presupposing that these frames can operate as mechanisms in the international political process (Banta 2012). Following Balzacq (2010, 66), I combine discourse analysis with process-tracing of the key institutional developments in the United States and Europe to demonstrate the importance of these frames as mechanisms in the agenda-setting process. The analysis shows how scientists deployed securitizing frames in the decisive year 1988.

Climate Policy Discourse in the United States and Europe, 1979–85

A 1979 National Academy of Sciences report chaired by Jules Charney provided the first authoritative declaration that climate change was an important policy problem. The Charney report concluded that a doubling of atmospheric CO_2 would generate a 3°C warming (+/−1.5°C). This conclusion remained a stable scientific fact throughout the 1980s and into the 1990s (van der Sluijs et al. 1998; Torrance 2006; Edwards 2010). The same 1.5°C to 4.5°C temperature range was the basis of the 1983 Environmental Protection Agency (EPA) report, the 1985 Villach report, and the 1988 Toronto report (EPA 1983; WMO 1986; WMO 1989).

In February of the same year, the consequences of global warming for human agricultural, economic, and political systems had been presented at the First World Climate Conference. Delegates reported that the findings presented were "scary" (Torrance 2006, 34). One speaker expressed concern that there would be "irreversible" changes to an "inherently unstable" system (WMO 1979a, 19–20). The conference declaration stated that it was "urgently necessary" to improve knowledge of the climate and prevent manmade changes because of the "all-pervading influence of climate on human society" (WMO 1979b, 3). While the conference declaration did not provide a quantitative prediction for the amount of warming to expect, it stated that the "long-term survival of mankind" depended on "achieving a harmony between society and nature" (WMO 1979b, 6). These pronouncements stopped short of depicting climate change as an existential threat to humanity. However, they foregrounded the fragility of humanity in the face of an unstable nature.

A 1980 Department of Energy report on the implications of climate change provided clear evidence that global warming would negatively affect agricultural productivity and accelerate sea level rise (Department of Energy [DoE] 1980, 221). The consequences of credible sea-level rise were vividly displayed in an image of possible flooding on the East Coast of the United States (Figure 1). These changes, the report warned, would disrupt economic and political systems:

> Just as random mutations almost always decrease the fitness of a finely tuned genetic system, sudden man-made environmental disruptions of ecosystems, agriculture, and society will probably outweigh particular benefits. (DoE 1980, 225)

The report suggested that humans are fragile because they depend on precisely balanced human-natural systems. It further argued that changes in human and ecological systems could not be addressed by "technological fixes" (DoE 1980, 226). The report concluded that if continued use of fossil fuels was deemed to be so useful as to obviate alternatives, then "a minimal obligation would seem to include planning to cope with the uncertainties and the worst possible set of outcomes" (DoE 1980, 226). This conclusion rested on cosmological representations of a fragile nature and humanity's capacity to harness science and technology.

Thus, by 1980 the core elements of the argument that policy-makers needed to govern climate change were already in place. Climate scientists had made clear predictions about the magnitude and timing of climate change (3°C, +/−1.5°C by the middle of the next century) and laid out the expected effects on ecosystems and societies (rising sea levels, agricultural disruption, altered weather patterns). Scientists did not significantly reduce uncertainty about or alter these scientific details between 1979 and 1988 (Franz 1997, 10–16; Torrance 2006, 37–38). Climate scientists did make their models more realistic and improved their understanding of non-CO_2 greenhouse gases over the course of the 1980s (Bodansky 1993, 458–59; Paterson 1996, 29; Franz 1997, 15). These changes were important because they increased scientists' confidence in their findings and emboldened them to politicize climate change. However, subsequent reports did not alter point predictions or introduce more precise risk assessments or cost-benefit analyses. So, it is difficult to explain the shift to agenda-setting and institutionalization with reference to uncertainty reduction

[13] My understanding of interpretivist discourse analysis follows Hopf (2007). I relied on existing secondary accounts to guide my text selection of the central scientific reports in the agenda-setting process.

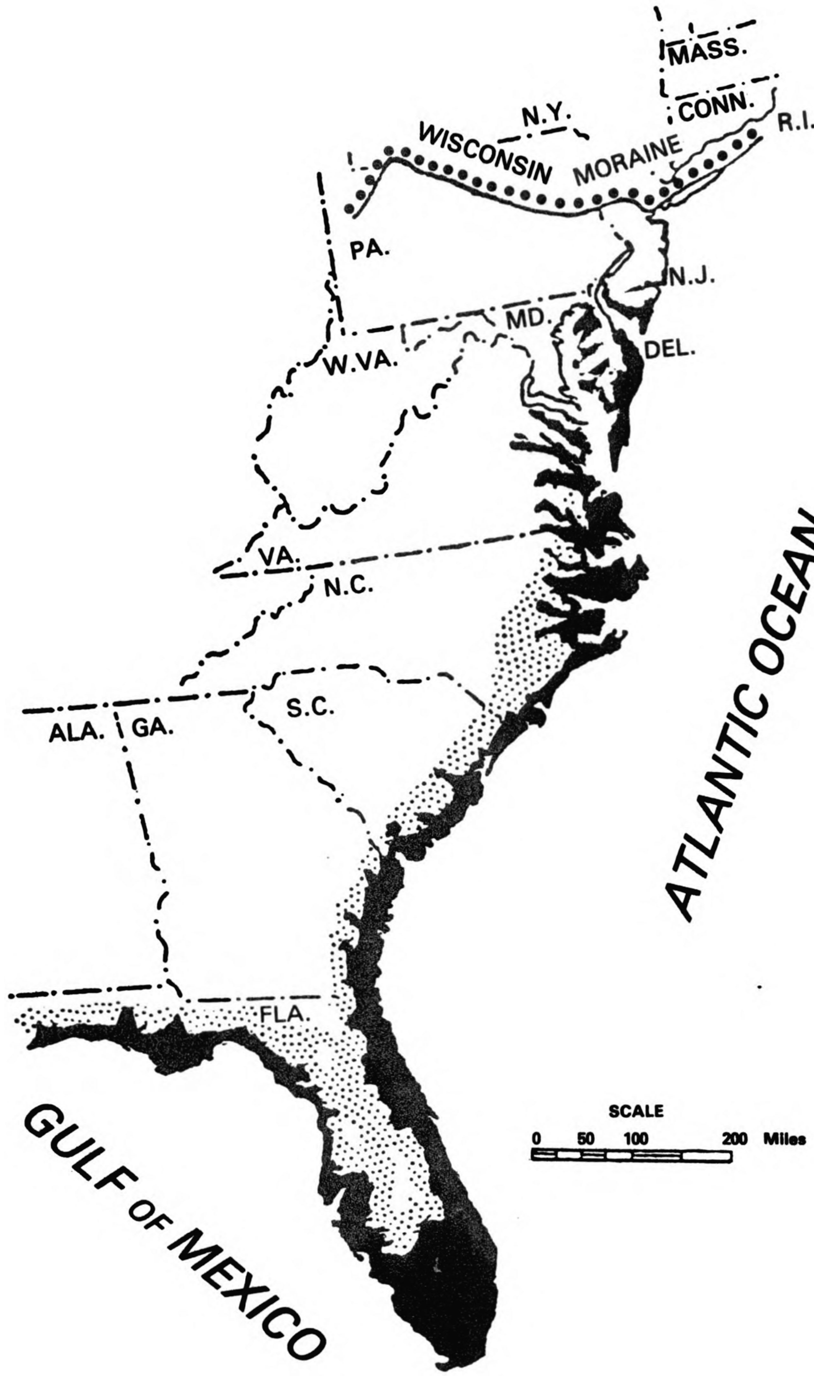

Figure 1. Credible shoreline changes based on geological evidence; source: DoE 1980, 224

alone. What changed after 1980 was that scientific actors in Europe and the United States drew on ideas about time, nature, and humanity's place in the universe to construct climate change as an existential threat. In doing so, they drew a portrait of an uncertain future that needed to be secured.

In the United States, the National Academy of Sciences, Environmental Protection Agency (EPA), and Department of Energy studied climate change throughout the 1980s (Hecht and Tirpak 1995). In 1982 and 1983, the National Academy of Sciences organized the first economic analyses of the problem (Clark 1982; Carbon Dioxide Assessment Committee 1983). These early economic analyses focused on estimating when CO_2 would double and thus when the predicted warming was likely to occur (Nordhaus and Yohe 1983). Thus, they were not focused on providing a precise assessment of the costs and benefits of mitigation and adaptation. Nonetheless, the 1983 Carbon Dioxide Assessment Committee report argued that while climate change was a potentially grave problem, there was too much uncertainty surrounding its effects and the costs of prevention to warrant strong action. However, this conclusion was not built on quantitative analyses, but on cosmological ideas about time and humanity.

The Carbon Dioxide Assessment Committee's conclusion that strong immediate action was unwarranted rested principally on the analysis by economist Thomas Schelling

(Oreskes, Conway, and Shindell 2008, 125). Schelling's (1983, 453) chapter highlighted uncertainties about the levels and effects of carbon dioxide and uncertainties "about what the world will look like." Schelling (1983, 471–73) suggested that most rich countries would be able to effectively adapt because human societies have a long history of adjusting to changing conditions in weather and climate. As Oreskes et al. (2008, 126) put it, Schelling "implied that that while climate change was uncertain, technological improvement was not." The certainty of human progress would prove more important than the vagaries of nature. Thus, Schelling invoked the creativity of humans in the face of environmental change to argue that climate change did not necessitate urgent political action.

American policy elites never reached a consensus on the implications of climate change. Instead, there was vigorous debate about whether prevention or adaptation was the appropriate policy response. Schelling and the Carbon Dioxide Assessment Committee advocated adaptation while others argued that consideration of time and human history demanded a precautionary approach. A 1983 EPA report written by Stephen Seidel and Dale Keyes clearly outlined the "adverse consequences" of climate change. It stated that climate warming would lead to "increases in temperature, changes in precipitation, changes in storm patterns, and increases in sea level" (EPA 1983, 1–7). These changes would require "significant adjustments" in agricultural and land use practices. Furthermore, if the changes wrought by warming were unanticipated, they could have "catastrophic" consequences (EPA 1983, 1–7). The report also considered possible benefits, such as increases in CO_2 enhancing photosynthesis. It concluded:

> The magnitude of these effects, and whether they are positive or negative, depends to a large extent on how quickly these changes occur—or on our ability to delay climatic change—and how successfully global society anticipates and adjusts to them. (EPA 1983, 1–10)

So the determination of the costs and benefits of climate change would depend on how fast the changes occurred and whether or not those changes were anticipated. The report presented two clear policy options: prevent climate change or adapt to changing conditions. The report argued that "the large uncertainty in projecting likely climatic changes and resulting socioeconomic effects" meant that a cost-benefit analysis of the two strategies would be "little more than guesswork" (EPA 1983, 1–12). Nonetheless, the report suggested that the sooner countries moved away from fossil fuels, the cheaper and easier that shift would be (EPA 1983, 1–14).

European scientists came to similar conclusions. A 1984 report sponsored by the European Commission concluded that increases in climate variability would cause problems for European agriculture in the short run even if "European agriculture could almost certainly learn to adapt" in the long run (Flohn and Frantechi 1984, 314). This report also placed climate change in long-term historical perspective but drew the opposite conclusion that Schelling did. It stated that humans have been interfering in the climatic system for 8000 years, but noted that human influence is growing, causing "serious consequences" such as "deforestation, desertification, overgrazing, bushfires, and soil degradation" (Flohn and Frantechi 1984, 5). As in the EPA report, the temporal dimension of the problem was in the foreground: if warming happens rapidly, it is likely to cost more and be more problematic for European agriculture (Flohn and Frantechi 1984, 10–11).

Cosmological beliefs about nature, time, and scientific and technological progress supported each position in these debates. Schelling argued that humanity's long history of migration and adjustment indicated that adaptation to climate change was feasible. The EPA report, by contrast, concluded that a strategy premised on adaptation could have catastrophic consequences. Schelling's analysis was rooted in an understanding of time and humanity that stressed the ability of human societies to develop and adapt. Schelling emphasized the plasticity and technological creativity of humanity over the long run and thereby downplayed the costs of adaptation. The EPA report reasoned that the capacity to adapt depends on the ability to anticipate changes. This in turn depends on the availability of social resources and forecasting tools. Thus, it contested the idea that humans can limitlessly adapt to a changing environment by stressing the high costs of unanticipated changes. Here, the analysis rests on the assumption that there are limits to human knowledge and mastery that should induce caution.

In addition, Schelling and the EPA authors drew different conclusions in the face of long time horizons with high uncertainty. While Schelling marginalized uncertainty by invoking the scientific and technological capabilities of humans, the EPA authors used uncertainty about the future to foreground the fragility of humanity in the face of an open, unpredictable future. Likewise, researchers in Europe concluded that rapid short-term change would cause serious problems even if long-term adaptation would be possible. In short, the political debate over whether it would be better to spend on mitigation in the short run or on adaptation in the long run was built on a cosmological grammar. Thus, it makes sense that precise quantitative statements of costs and benefits would not resolve the underlying disputes. At this point, scientists and experts did not explicitly aim to securitize climate change. However, they had put in place the discursive resources to do so later.

The Internationalization and Securitization of Climate Policy Discourse

International developments accelerated in the mid-1980s as a dedicated epistemic community of scientists and international organization officials organized a series of meetings and conferences. International groups of scientists had been studying the climate since the 1960s under the auspices of Bert Bolin and the International Concerned Scientists Union (ICSU). In the mid-1980s, the ICSU, the United Nations Environmental Program, and the World Meteorological Organization convened scientific meetings to synthesize the existing science and create pressure for a climate convention (Haas and McCabe 2001).

The 1985 meeting at Villach declared that climate change was a significant political problem that would have "profound effects on global ecosystems, agriculture, water resources, and sea ice" (WMO 1986). The Villach report advocated for a treaty modeled on the recent Vienna Convention for the Protection of the Ozone Layer (WMO 1986; Hecht and Tirpak 1995). In substance, the conclusions of the Villach report were broadly similar to the evidence presented at the 1979 World Climate Conference (Franz 1997, 10–11; Torrance 2006, 34). As Franz (1997, 10–15) shows, the most significant change in the science leading up to Villach was the quantification of the greenhouse effects of non-CO_2 gases including methane and ozone. The central finding was that these other gases accounted for about half of existing warming. This forced a downward revision in the lower bound of the estimate for when a doubling of

CO_2-equivalent emissions might occur. It was now possible that CO_2-equivalent concentrations could double as early as 2030. Scientists found this significant because they "finally realized that significant warming could occur within their lifetime (or at least the lifetimes of their children)" (Franz 1997, 15).

The transmission of these findings at Villach was important, but it does not explain the rise of climate change up the international agenda. First, the downward revision of the lower bound for the timing of CO_2-equivalent doubling was a relatively arcane, technical finding that, while important to scientists, was neither widely reported in the media nor part of the political discussions (Franz 1997, 12–16). In the end, the actual projected date for CO_2-equivalent doubling remained unchanged (Franz 1997, 11). Second, the actual content of climate discourse in the late 1980s bore little resemblance to the frames used at Villach (Franz 1997, 3; WMO 1986). While the new understanding of non-CO_2 gases was important in motivating scientists, it does not explain why policy-makers accepted that climate change was a significant political problem.

Nonetheless, as Haas and McCabe (2001) argue, the formation of a transnational epistemic community was central to the internationalization of climate science, and Villach was a central site of community formation. It led to the creation of the Advisory Group on Greenhouse Gases that organized further scientific meetings in Villach and Bellagio in 1987 (Paterson 1996, 31). Together, these meetings forged an international consensus, which was important for the emergence of climate governance in the late 1980s and early 1990s. Following Villach, this scientific community promoted scientific evidence of anthropogenic warming and advocated for change. But it was the use of security frames in Europe, the United States, and international forums that catalyzed political attention. These frames drew on the cosmological grammar deployed in earlier reports, but now made the security implications of climate change explicit.

In Europe, there was a rapid increase of attention to climate change after 1985. Villach and other scientific reports boosted media attention devoted to climate change and raised the political salience of the problem (Weingart et al. 2000; Schreurs, Clark, and Dickson 2001). In West Germany, for example, politicization proceeded rapidly. In 1986, the German Physical Society framed the problem in dramatic terms as a potential "climate catastrophe" (Weingart et al. 2000, 268). In 1987, the Bundestag established the Enquete Commission, composed of both scientists and politicians, which recommended a 30 percent reduction in greenhouse gases (Weingart et al. 2000, 269). The invocation of catastrophe imported a cosmological, apocalyptic tone that motivated strong action. Consistent with Aradau and Munster (2011), the Commission combined scientific knowledge with an imaginative, catastrophic aesthetic to depict an uncertain future full of risks. In the face of high uncertainty regarding the costs and benefits of climate change mitigation, the Enquete Commission and other scientific reports pressed for strong, early action (Weingart et al. 2000).

However, this security frame did not necessarily depict climate change as an existential threat to the survival of the state, Europe, or civilization. Nonetheless, it increased the political salience of the climate problem and stimulated the European Commission to develop climate change policy and support an international convention (Haigh 1996). The European Commission decided to advocate a preventive approach consistent with the precautionary principle and defined itself as a leader with a "special responsibility" to encourage international action (Haigh 1996, 163). In short, the European Commission took up the call for strong action even in the absence of a clear cost-benefit analysis or precise risk assessment. By 1990, it had committed to stabilizing emissions at 1990 levels by the year 2000.

In the United States, the Villach report was the subject of a fierce interagency debate. While the EPA and State Department supported initiating a convention process, the Department of Energy argued "that the Villach report was inadequate because it was not prepared by government officials" (Hecht and Tirpak 1995, 380–81). Instead, the Reagan Administration supported the creation of an intergovernmental scientific body, led by governmental representatives, to assess and synthesize climate research (Hecht and Tirpak 1995, 381). However, a group of Senators disappointed with this decision spearheaded the 1987 Climate Protection Act, which funded research and directed the State Department and the EPA to prepare policy options for addressing climate change (Hecht and Tirpak 1995, 383).

In 1988, the building political momentum culminated in a flurry of international activity. In March, spring flooding in the Rhine area was linked to increased precipitation caused by global warming (Weingart et al. 272). In the United States, Congress held high-profile hearings amidst the hottest, driest summer since the 1930s. At the hearings, James Hansen, lead climate modeler at the Goddard Space Institute, testified that climate change caused heat waves, droughts, floods, and storms (Paterson 1996; Bodansky 2001). After the hearings, Hansen told the media that it was "time to stop waffling so much and say that the evidence is pretty strong that the greenhouse effect is here" (Shabecoff 1988). Hansen in effect advocated a change in the temporal orientation of climate science—from warning that warming would come to stating that the effects had arrived.[14] In June, the ICSU, UNEP, and WMO hosted another major scientific meeting, the Toronto Conference on the Changing Atmosphere. The Toronto Conference recommended a 20 percent cut in greenhouse gas emissions by 2005 (WMO 1989, 296). In December, the UN General Assembly passed resolution 43/53 endorsing the establishment of the Intergovernmental Panel on Climate Change.

While the secondary literature points to the report of the 1988 Toronto Conference as the central global statement of scientific consensus on climate change that catalyzed political action, the Toronto report contained no new hard evidence or precise statements of costs and benefits (Paterson 1996; Bodansky 2001; Torrance 2006). Instead, it pursued a discursive strategy of securitizing climate. The report opened by starkly declaring that the consequences of humanity's ongoing "experiment" with the global atmosphere "could be second only to a nuclear war" (WMO 1989, 292). Rapid, unprecedented changes to the atmosphere would constitute "a major threat to international security." The scientists and policy-makers at Toronto framed climate change as a security problem by drawing on the grammar of security that had been introduced in Cold War debates over the supersonic transport jet, the limits to growth, and nuclear winter (Edwards 2010). By arguing that climate change was a threat akin to nuclear weapons, the Toronto report represented climate change as a specific kind of catastrophe—an existential threat to the survival of the human species.[15]

[14] I am indebted to an anonymous reviewer for highlighting this shift in the presentation of time.

[15] Importantly, the referent object here is not the state but humanity as a whole, which suggests that the report's authors were influenced by the human security movement in the 1980s (see Waever 1995; Floyd 2007).

The Toronto declaration was distinct from previous articulations of climate catastrophe because it directly connected climate change to cosmological themes and Cold War security discourses. In this vein, it highlighted the ambivalent relationship that climate change has to science and technology. On the one hand, anthropogenic climate change is only possible because humans have harnessed science and technology to build industrial civilization. On the other hand, like nuclear weapons, climate change foregrounds the possibility that industrial civilization is out of control, creating problems that cannot be contained. The Toronto report drew on pessimistic Cold War beliefs to suggest that humanity's industrial-technological experiment with the atmosphere was to be feared in the same manner as the destructive power of nuclear weapons. Thereby, climate change was linked to the radical uncertainty of the Cold War, in which the possibility of catastrophe was ever-present. Thus, the uncertainty of a potentially catastrophic future was used to represent climate change as a threat to humanity (Huysmans 1998; Aradau and Munster 2011).

The Toronto report also constructed climate change as a threat by explicitly making the case that changes in the atmosphere were a threat to international security. The report issued warnings about a litany of negative effects: "rising sea-level, altered precipitation patterns and changed frequencies of climatic extremes" (WMO 1989, 292). These and other changes, the report concluded, would "imperil human health and well-being," "diminish global food security," "increase political instability and the potential for international conflict," and "generate the extinction of animal and plant species upon which human survival depends" (WMO 1989, 293). Thus, the report hailed climate change as a threat to a variety of valued referent objects.

As in earlier texts, temporal conceptions were central to this framing. The Toronto report argued that climate change is difficult to manage because the "time lag" between emissions and their consequences necessitates early and prompt action (WMO 1989, 294). Thus, "If rapid action is not taken now by the countries of the world, these problems will become progressively more serious, more difficult to reverse, and more costly to address" (WMO 1989, 293). The background paper for the conference warned that if atmospheric and ecological effects were allowed to occur, a return to earlier climactic conditions would be "virtually impossible" because the complexities, path dependencies, and interaction effects in the system make climactic changes "irreversible" (WMO 1989, 386). This warranted a strategy of mitigation rather than adaptation (WMO 1989, 386–87).

However, as in the EPA report, the more significant temporal issue was an epistemic problem: "unanticipated and unplanned change" undermines the ability of political, economic, social, and agricultural systems to adapt (WMO 1989, 295). Since global food systems were already inadequate and precarious, it was imperative to do everything possible to allow the international community to sustain existing agricultural and marine resources (WMO 1989, 295). Rapid changes in climate would undermine the existing global food system and cause social and economic dislocation. But the epistemic concern was that scientific knowledge would not be able to anticipate all change, thereby undermining comprehensive planning. Thus, strong, early, internationally coordinated action to reduce CO_2 emissions and increase energy efficiency would be necessary (WMO 1989, 297–98).

Climate science and climate governance developed rapidly from 1988 through the creation of the UNFCCC in 1992.[16] The discourse of climate governance in this period drew on the policy frames introduced at the Toronto conference. For example, the 1988 report to the European Council on the Greenhouse effect, which galvanized European support for the UN negotiations, quotes the Toronto report's declaration of global warming as a security threat at length (European Commission 1988, 34). In a speech to the Royal Society in September of 1988, UK Prime Minister Margaret Thatcher depicted climate change as an "experiment" that would cause "accelerated melting of glacial ice and a consequent increase in the sea level of several feet over the next century."[17] Thatcher (1988) also expressed concern that "climatic instability" that "would greatly exceed the capacity of our natural habitat to cope." The UN General Assembly resolution (1988) that endorsed the creation of the IPCC also deployed the language of the Toronto report, declaring global warming "a threat to, inter alia, human health, agricultural productivity and animal and marine life."

Similarly, the text of the UNFCCC (1992) has the same temporal underpinnings as the 1983 EPA report and the 1988 Toronto report. The stated objective of the convention is to

> prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. (UN 1992, Art. 2)

The UNFCCC text suggested that it is not realistic to avoid any interference with the climate. Instead, the stated goal was avoid "dangerous" or rapid changes to the climate that would produce a threat to human agriculture and economic life. On this view, the convention intends only to slow climate change, such that ecological and human systems have a chance to adapt "naturally." Thus, the stated intent of the UNFCCC and global climate governance as it unfolded over the course of the 1990s was rooted in the discourse articulated in the 1988 Toronto report: climate change is a threat to human society because it will produce unanticipated changes into human agricultural and economic systems that cannot be adapted to quickly.[18]

Conclusion

This article raises important questions about climate politics today and how to integrate science into international-relations theory. First, while securitizing moves in the 1980s raised awareness of climate change and catalyzed institutionalization in the climate domain, they did not produce robust international action. Nor did they drive the adoption of emergency measures. Securitization theory suggests that environmental securitizations are unlikely to succeed. After all, it is difficult to maintain a sense of existential threat when the worst consequences of inaction lie in the future. Indeed, securitizing strategies may backfire because such images become "increasingly untenable if the expected climate catastrophe does not rapidly materialize" (de Goede and Randalls 2009, 873). We need further research to fully

[16] On the rapid growth of climate science in this period, see Shwed and Bearman (2010).

[17] I would like to thank an anonymous reviewer for this citation.

[18] Notably, at some point the temporal targets featured in earlier reports (such as 0.1°C per decade in the Villach report) were dropped for an absolute 2°C target.

understand and assess the wider effects of climate securitization after 1992. Such research could inform strategies of climate advocacy today by identifying whether and how securitizing moves lost their effectiveness. As it stands, the long history of efforts to securitize the climate suggests that ongoing efforts to portray climate change as an existential threat are unlikely to fare any better.

However, the history here also suggests that more scientific facts will likely do little to clear the difficult political obstacles in climate governance. If we can count on neither securitization nor uncertainty reduction to drive international action, what strategies should advocates of climate policy deploy? They might draw on the power of scientific cosmologies to construct positive visions of a sustainable future. Put differently, the problem in climate discourse may be the emphasis on the problem rather than on generating images of the solution. Thus, advocates could harness the power of cosmological ideas to explain how actions today will lead to a neutralization of the threat.[19]

Second, my account introduces a new mechanism through which scientists generate political influence: they can catalyze political action by drawing on cosmological discourses to frame problems and issues. Whereas the STS-inspired literature focuses on how scientific knowledge produces the conceptual landscape of international politics, I outline how scientific actors can catalyze political action in a more direct form of political contestation. This form of influence complements, but remains distinct from, the central mechanisms in the epistemic community literature. Whereas the epistemic community literature argues that authoritative international groups define interests by reducing uncertainty, the climate case shows that scientific groups can also project the uncertainty of an open future to construct security threats. In other words, the political power of epistemic communities and knowledge-based actors rests not on the ability to reduce uncertainty alone, but also on the capacity to draw on cosmological grammars to heighten uncertainty. This form of uncertainty cannot be resolved or translated into risk by more information or better calculations because it concerns a future that has not yet arrived (de Goede and Randalls 2009, 867).

Indeed, international-relations scholars usually depict uncertainty as an ontological condition in which actors find themselves. However, the construction of uncertainty in the climate case shows that actors' epistemic orientations are not objectively given. Rather, they are shaped by processes of political contestation and social construction. From this perspective, the types of uncertainty that Rathbun (2007), for example, identifies—fear, ignorance, confusion, and indeterminacy—all exist in the world, but their existence, salience, and relative importance become subjects of empirical inquiry.

Along the same lines, Hom (2010) shows that the arrangement of time is not objectively given. Rather, it is produced by discourses and technologies that divide the world up into temporal units. He focuses on the construction of Western clock time as a means of spreading and enforcing hegemony, but in the case of climate debates, perceptions of time played a different role. Scientists sought to construct long-time horizons so that they could cultivate a sense that humans simply could not adjust to some changes in the natural environment. That is, the problem of climate change rests ultimately on a fundamental disjuncture between the differing temporalities of human life and the planet. Thus, engagement in the politics of the environment requires contesting representations and technologies of time.

[19] Optimistic visions of the future might emerge from the social sciences, but they also might arise from popular culture. See, for example, the optimistic science fiction collected in Finn and Cramer (2014), especially Newitz (2014). I am grateful to Dan Nexon for this suggestion.

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