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ABSTRACT How, and when, does it become possible to conceptualize a truly planetary crisis? The Cold War nuclear arms race installed one powerful concept of planetary crisis in American culture. The science enabling the US nuclear arsenal, however, also produced unintended byproducts: notably, a radical new investment in the earth sciences. Cold War nuclear science ultimately produced not only bombs, but also a new understanding of the earth as biosphere. Thus, the image of planetary crisis in the US was increasingly doubled during the Cold War – the immediacy of nuclear threat matched by concerns about rapid environmental change and the cumulative effects of industrial civilization on a fragile biosphere. This paper examines the evolution of (and competition between) two ideas of planetary crisis since 1945: nuclear war and climate change. In doing so, the paper offers an alternative history of the nuclear age and considers the US national security implications of a shift in the definition of planetary crisis from warring states to a warming biosphere.

Keywords biosphere, climate change, earth sciences, Hurricane Katrina, national security, nuclear war, nuclear winter, radioactive fallout

Bad Weather:

On Planetary Crisis

Joseph Masco

Within the visual culture of the nuclear age, a very few sequences of film now stand as the core American cultural memory of the atomic bomb. The sequence of a forest experiencing nuclear blast, for example, has attained a kind of iconic status, reproduced repetitively in documentary and fiction films for the past half century to demonstrate the power of the exploding bomb (see Fig. 1). In presenting a forest bent to the breaking point, the intellectual value of these 3 seconds of film is to introduce viewers to an experience of the nuclear sublime.[1] The power of the blast, when mapped against one's own locality, also provides a rare point of physical reference in US nuclear footage, a recognizable human scale that has informed official statements, anti-nuclear activism, and Hollywood productions alike. In the slow-motion footage of a dense forest blown back like a thicket of grass, viewers are confronted with a moment of pure ecological devastation, a kind of fury that is at once unprecedented, uncontrollable, and yet also oddly familiar. It is this notion of ecological risk mediated by national security concerns that I interrogate in this essay. For the iconic status of these

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FIGURE 1
The trees of Operation Upshot-Knothole (stills taken from the DoD film, *Operation Upshot-Knothole*)

bent and broken trees addresses multiple registers of American insecurity. Uncannily mirrored in the video footage of recent natural catastrophes from the tsunami that hit Indian Ocean states in 2004 to the hurricanes that submerged New Orleans in 2005, this traumatized forest also allows us to

interrogate the relationship of 'national security' as a state project to the biosphere as the ultimate domain of security. For this sequence is undoubtedly a depiction of crisis, but of what kind? It is a military experiment involving a weapon of mass destruction (WMD), but it is also a military test of a specific ecosystem – it appears as both a tool of war and as a war on nature – a crisis of the future and of the now.

We live in an age of crisis – multiple overlapping crises, in fact, involving war, capital, law, public institutions – and have witnessed in recent years an extraordinary normalization of violence in everyday life via the 'war on terror'. This cinematic depiction of ecological fury contains within it a basic question about how to identify crisis, as well as expressing the conceptual power of war to override all other concerns. Revisiting these trees from a perspective of environmental risk reveals, I think, both the technoscientific contribution the Cold War arms race made to our understanding of the planet as an ecosystem, but also the power of the bomb to block collective thought and action. For when, and under what conditions, does it become possible for citizens to imagine a truly planetary crisis? I argue here that the Cold War nuclear project enabled a new vision of the planet as an integrated biosphere, but that it is precisely the security state's reliance on nuclear weapons to constitute US superpower status that blocks action on non-militarized planetary threats, and specifically, on climate change.

As we shall see, the Cold War nuclear arms race produced an unprecedented commitment to research in the earth sciences, enabling a new vision of the globe as integrated political, technological, and environmental space. The US nuclear project was linked very early on to concerns about weather and climate, enabling new public fears and visions of planetary threat. But, by elevating nuclear fear to the core instrument of state power, the Cold War arms race established a nationalized vision of planetary danger on very specific terms. In the early 21st century, the security state's effort to monopolize risk under a discourse of 'nuclear terror' came into direct confrontation with the scientific evidence of rapid ecological change. For the George W. Bush administration, the 'terrorist' armed with a 'WMD' trumps global warming as a planetary threat, underscoring the extraordinary politics involved in defining both 'terror' and the 'state of emergency'. The burnt and breaking limbs of this post-nuclear forest, however, not only offer an alternative genealogy of the nuclear age, but also allow an assessment of the distorting effects of the bomb on contemporary American ideas of threat.

In this essay, I examine three moments (in 1953, 1983, and 2003) in which nuclear crisis and ecological crisis are brought into mutual focus, and then assess the acts of political translation that enable diverse forms of risk to be configured as a singular national security problem, one supporting the geopolitics of the US security state. I begin with the formal linkage between the atomic bomb and weather in the early Cold War sciences; then explore how climate change was mobilized to effect nuclear policy in the 1980s; and finally, discuss how nuclear discourse has been mobilized in the 2000s to influence perceptions of global warming. Attending to the ecological coordinates of the nuclear revolution in this way fundamentally challenges

contemporary American ideas about planetary risk; it also reveals the conceptual and practical limits of a strictly 'national' form of security.

Part I: Militarizing Nature (1953)

While seeming to portray an alpine forest, the film footage is actually taken from the desert surroundings of the Nevada Test Site (see Fig. 2). Part of a nuclear test series known as Operation Upshot-Knothole in 1953, the forest was constructed out of Ponderosa Pines, which were cut and transported from California to Nevada. Each of the 145 trees was then sunk into concrete at the desert test site, creating a perfectly symmetrical, grid formation forest. This synthetic forest was loaded with sensors, and photographed from a variety of angles during the atomic blast. The goal, according to the once top-secret project report (US Department of Defense, 1953a), was:

> To determine effects of blast wave and association winds on trees – in terms of tree breakage, branch breakage and defoliation – located in a forest area of such stand density that the shock front and its accompanying winds are influenced by the presence of the stand.

As part of a larger effort to produce a comprehensive predictive capability for nuclear warfare, this synthetic forest was constructed by the US Department of Agriculture in order to be destroyed. Here is how the Department of Defense (DoD) originally presented the experiment to nuclear war planners and government officials in its once classified documentary film, *Operation Upshot-Knothole* (US Department of Defense, 1953b):

> A study of tactical importance: one hundred and forty-five ponderosa pines set in concrete, approximately 6400 feet [1950 m] from shot nine's zero. Instrumentation was thorough. A few major types being: pressure gauges at three heights, time-recording anemometers, phenotype dynamic pressure detectors, and snubber-wire arrangements to measure deflections. Pendulums were substituted for the lollipops of former operations, to provide mechanical simulation of tree response. As on many of these projects, cameras stations were set up to provide high-speed motion picture coverage of blast effects. Thermal input: 18 calories [75 J] per square centimeter – resulting in only mild char on tree trunks since the normal ground litter that will ignite at around three calories was lacking. Static pressures around four psi. Post-blast surveys indicated that approximately twenty percent of the trees were broken and the missile hazard from falling trunks and limbs would be substantial.

A study of tactical importance. As a military science experiment, this event was part of a larger US project to test the bomb against machinery and a variety of animal and human populations, as well as elements of the land, ocean, and atmosphere (Masco, 2004a). Part war fighting, part civil defense, part weapons science, the above-ground experiments conducted between 1945 and 1962 not only engineered the US nuclear arsenal, but they also produced and fixed American visual understandings of the technology on film. The technoaesthetics of the bomb were established for the American

FIGURE 2
Building the Test Forest at the Nevada Test Site (US National Archive Photograph)

public in this period, as the nuclear test regime went underground after 1963 eliminating most visual evidence of the blasts (Masco, 2004b). The visual record of the above-ground test period is thus not only an illustration of the logics of the security state – and the technoscience of producing atomic and thermonuclear explosions – but it remains a primary conceptual means of understanding the destructive power of the bomb.

Above-ground nuclear experiments were labeled 'tests' but the destruction was real, making each detonation an event with large-scale environmental consequences. The blast wave that bent this synthetic forest, for example, was only the most immediate of its environmental effects, as fallout from the explosion traversed the continental US. Indeed, the 11 atomic detonations of Operation Upshot-Knothole produced substantial radioactive fallout within the US, making it one of the most dangerous Nevada test series in terms of public health (Miller, 1986).[2] Today, the remnants of this synthetic forest exist in a series of symmetrically aligned stumps in the Nevada desert, a cryptic marker of a moment when the US Department of Agriculture was also a nuclear war-fighting agency (Johnson et al., 2000: 102). At its very

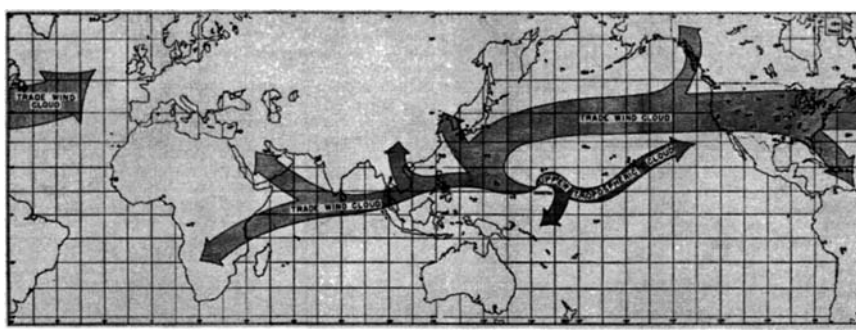
most basic, the lesson of 'Project 3.19: Effects of Atomic Explosion on Trees in Forest Stands' was that a nuclear blast could profoundly damage a forest (US Department of Defense, 1953a). The study did not investigate other kinds of nuclear effects on the trees, from radiation levels to potential mutation rates over time, as this forest was dead at the moment of its fabrication. Lost in the history of the Cold War – and specifically the technoscience of megatons and missiles that informed the nuclear 'balance of terror' – is, however, this extraordinary new state commitment to atmospheric and earth sciences. In test ranges across the continental US to Alaska and the Marshall Islands, the development of the bomb not only produced unprecedented environmental damage, but also inaugurated a newly comprehensive scientific effort to understand the global biosphere as a post-nuclear environment (Doel, 2003). This synthetic forest is important not only because it reveals the official nuclear imagination in 1953, but also because it registers an early effort to study ecological effects, and because the film footage remains to this day an iconic image of atomic devastation.

Indeed, the first decades of the Cold War turned the entire world into an experimental nuclear theater. The 215 above-ground and underwater nuclear detonations the US conducted between 1945 and 1962 produced a vast range of environmental effects that transformed both the globe and the earth sciences.[3] In the South Pacific, for example, two of the largest thermonuclear explosions – 'Mike' in October of 1952 (a 10.4-megaton blast [see Fig. 3]) and 'Bravo' in February of 1954 (a 15-megaton explosion that was the single largest US nuclear detonation of the Cold War, measuring more than 1000 times the explosive power of the Hiroshima bomb) – delivered vast radioactive material into the upper stratosphere. Noting that 'for centuries meteorologists have thought of exploring large-scale atmospheric circulations by means of tracers', meteorologists Machta, List, and Hubert mobilized the fallout to study global wind patterns in their 1956 *Science* paper 'World Wide Travel of Atomic Debris'. Using data from the Mike and Bravo detonations, the researchers demonstrated that fallout entered the upper stratosphere and circled the earth, distributing fallout across the northern hemisphere. In the process, they mapped stratospheric wind patterns (see Fig. 4). Their work was part of a wide range of new research mobilizing the effects of atmospheric nuclear testing to study ecological transport and circulation (see also Hare [1962] and Kroening [1965]). For example, in the following year, Comar, Russell, and Wasserman (1957) tracked the global distribution of strontium-90 from nuclear tests through the food chain, demonstrating that fallout deposited in the soil could be traced through plant and animal vectors into human beings.

By tracking the distribution of radioactive elements produced by atomic testing through the global atmosphere and across plant, animal, and human populations, Cold War scientists were able to document the integration of the global biosphere. Mapping biology against geography and global wind patterns, for example, the Rand Corporation (1953) tracked the planetary distribution of strontium-90 from thermonuclear atmospheric weapons tests explicitly to determine its biological effects on people.

FIGURE 3
'Mike' Thermonuclear Detonation (1 November 1952, Enewetak Atoll, 10.4 megatons) (Department of Energy photograph)

FIGURE 4
Illustration of Atmospheric Transport of Radioactive Materials From 'Mike' (Machta et al., 1956)



Known publicly as 'Operation Sunshine' to dispel its gruesome implications, the Rand study found that fallout from the Marshall Islands' nuclear tests were recorded at '44 stations in the United States' and '49 stations worldwide'; it also noted that there were 'still large areas in the polar regions and the south of the equator, and of course, behind the Iron Curtain, that were not sampled'. Not only was the nuclear complex now a

global enterprise, with US laboratories stretched from the continental US to Alaska and the South Pacific, but the effects of nuclear explosions were increasingly recognized to be global in scope, creating unprecedented health risks as well as new multi-disciplinary cartographic opportunities. In an early moment in what was to become human genome science, Rand initiated a global project to collect human bones (with a focus on children) to study strontium absorption rates and thus to study genetic damage; it also argued for a global project to monitor soils (as a central vector in spreading strontium-90 into the food chain), and contemplated the effects of nuclear testing on global weather patterns. Early Cold War scientists began to map the effects of radioactive fallout on human cells, plants, animals, landmasses, water systems, jet stream patterns, and the atmosphere with increasing precision, mobilizing the bomb as health threat, economic resource, and experimental lens. In other words, the military commitment to understanding the full range of nuclear effects generated unprecedented levels of funding for the earth and atmospheric sciences.

Throughout the above-ground test period, Americans voiced increasing concern about the health effects of radioactive fallout, generating both anti-nuclear and nascent environmental movements.[4] Reading across the scientific literatures on fallout from this period, one discovers a constant concern about atomic tests changing the weather and destabilizing the seasons.[5] Indeed, the public responded to the widely publicized US nuclear testing and civil defense programs (which were an explicit effort to psychologically and emotionally mobilize citizens as Cold Warriors) by attributing all manner of unusual natural phenomena – earthquakes, drought, floods, changes in agricultural cycles, hurricanes, insect plagues, changing animal migrations, and strange weather patterns – to the bomb. The Atomic Energy Commission formed a 'Committee on Meteorological Aspects of the Effects of Atomic Radiation' in 1956 to address these public concerns; their report concluded:

> No statistically significant changes in the weather during the first 10 years of the atomic age have been found, yet careful physical analysis of the effects of nuclear explosions on the atmosphere must be made if we are to obtain a definite evaluation of this problem. Although it is not possible to prove that nuclear explosions have or have not influenced the weather, it is believed that such an effect is unlikely. (Committee on Meteorological Aspects of The Effects of Atomic Radiation, 1956)

In the first 10 years of the atomic age. Despite the Committee's declaration, the mounting evidence from biological, earth, and atmospheric sciences was that nuclear testing had a vast range of effects. These effects not only traversed state territories (implicating non-nuclear states in the US nuclear program) but also damaged ecological systems around the globe.

While previous generations of scientists imagined the experimental laboratory as a model of the world, in the early Cold War the world itself became the laboratory. Experiments across a wide range of disciplines

demonstrated that each biological being on the planet was increasingly marked by the trace elements of the US nuclear testing program, as the earth was transformed into an experimental zone for nuclear science. Consider for a moment Shot Teak of the Hardtack test series conducted at Johnston Atoll on 31 July 1958. To study how the bomb would affect the upper atmosphere, Los Alamos scientists detonated a 2.4-megaton warhead at 250,000 feet (76.2 km) at 23.30 hours. The resulting nuclear flash was capable of producing flashblindess in people for 435 square miles (1126 km^2); it also disrupted the Van Allen Belt, producing a borealis that could be seen throughout the Pacific rim. This 'test' knocked out electrical power stations from Hawaii to Australia, demonstrating both a new war fighting tool – the electromagnetic pulse – and inaugurating a new generation of US weapons research devoted to 'hardening' military equipment against electrical disruption in nuclear warfare (see Hoerlin, 1976). The first years of the Cold War were, in short, a period in which the global biosphere was quite literally militarized by the US nuclear state, but it was also positioned as a comprehensive object of scientific research in the earth, atmospheric, and biological sciences (cf. Oreskes, 2003). Ecological threat was publicly recognized by these projects, even if the arms race with the Soviet Union was prioritized at each step in US Cold War policy. A nascent understanding of the impacts of technology on the biosphere was established, formulating the research questions that would ultimately inform a theory of climate change.

Producing experimental evidence of climate change, however, requires more than the accumulation of data sets in specific scientific disciplines; it requires a systematic means of measuring environmental conditions over time and of integrating diverse and huge data sets into a collective portrait of the biosphere. The early Cold War period is the moment many of the key scientific institutions were established that would ultimately provide the evidence for climate change.[6] The World Meteorological Association was formed in 1951 to regularize weather data collection across nation-states (Miller, 2001; Edwards, 2006). The World-Wide Network of Standard Seismographic Stations was established to listen for nuclear explosions and support international treaties; it revolutionized seismology by creating the first real-time system for measuring movement in the earth, enabling new understandings of continental drift, plate tectonics, and the constitution of the sea floor (see Oliver & Murphy, 1971; Barth, 1998, 2003). The first ice core samples were taken from the arctic poles by the US military in the early Cold War period, as bombers and intercontinental missiles transformed the arctic zones into highly militarized spaces (see Roucek, 1983; Doel, 2003). Similarly, concerns about biological and chemical warfare funded new research in oceanography, meteorology, and space sciences, and supported the longstanding military investment both in predicting weather patterns during combat and in weather modification as a potential weapon (see Harper, 2003).[7] (The DoD today describes weather as a 'force multiplier', considers the value of weather modification as not unlike 'the splitting of the atom', and desires to 'own the weather' via the development

of a 'global, precise, real-time, robust, systematic weather modification capability' [House et al., 1996].)

A central contribution of the Cold War state to a future theory of climate change was its focus on cartography – on measuring and mapping all aspects of planet earth, from the oceans to the landmasses and the ice caps to the airflows (Cloud, 2002; Hall, 2002; Hamblin, 2005). After 1960, the Corona satellite system provided a 'top secret' new level of resolution to mapping operations, replacing the illegal and highly dangerous covert U-2 spy plane flights over the Soviet Union (Ziegler & Jacobson, 1995). Satellite surveillance systems increased exponentially in resolution and data collecting power over the Cold War, ultimately measuring weather, temperature, and ozone, as well as nuclear silos, military bases, and troop movements (see, for example, Mason, 1968). Finally, the integration of these data sets into a comprehensive portrait of global climate was enabled by the long-term military investment in super computing (Edwards, 1996, 2000, 2006: 245). The history of supercomputing in the US is a history of the nuclear weapons programs. The complexity of modeling nuclear weapons explosions is perhaps only exceeded by the complexity of modeling global environmental change. In sum, weather, ice caps, atmospheric and space sciences, satellite cartography, and supercomputing all derive their initial funding and substantial support through the 20th century via the security logics of the nuclear state and its commitment to building the bomb – establishing the early data sets and infrastructure for climate science.[8]

Nonetheless, throughout the first decade of the Cold War there was a structural confusion installed in American culture about how to define 'national security' in relation to 'planetary threat'. The atomic bomb was the core technology in producing two rival notions of security – one in the form of a nuclear arsenal supported by deterrence theory, the other in the form of the closed world earth sciences producing increasing evidence of radiological damage from the nuclear test program itself. Key scientists who called for an end to nuclear detonations as a matter of public health were, at this moment, positioned as enemies of the state, and subject to intimidation (Wang, 1999; Hamblin, 2007). In other words, those who offered an alternative definition of security based on recognition of the accumulating industrial effects of the global nuclear complex were positioned as national security threats. Both enabled by Cold War funding and rejected by national security ideology, Cold War biological and earth scientists were both a resource and a threat to the evolving logics of the nuclear arms race. As a consequence, the regulation of military and non-military planetary science was increasingly determined less by funding than by where scientists published – in the open or classified literatures. As Doel (2003: 653) concludes:

> By the 1960s, two distinct 'environmental sciences' had emerged: one biology-centered, focused on the problems in ecology and population studies, and funded in part by agencies and managers concerned about human threats to the environment; the other geophysics-centered,

> focused on the physical environment, and responsive to the operational needs of the military services that support it. Studies by biological environmental scientists often appeared in the open literature, while significant results from the physical environmental sciences were often 'born classified'.

I would suggest that within these two sciences were also two different concepts of planetary threat, one focused increasingly on issues of global environment and the cumulative effects of industrial civilization, while the other continued to focus on how nature could be militarized for the benefit of the US national security state.

Thus, if a concept of the biosphere was shaped by the technoscience of the early Cold War state, the nuclear arsenal also severely distorted and limited the biopolitical lessons of the trees of Upshot-Knothole, Project Sunshine, or the Teak Shot. The nuclear state continued to privilege the military threat of state actors over that posed by a fragile biosphere. Nuclear policymakers did so by privileging a specific 'worst case' scenario form of military planning. Narratives of a sudden nuclear attack by the Soviet Union were supported by fantasies of bomber gaps, missile gaps, and other forms of US technological weakness. Predictions of large-scale genetic defects from radioactive fallout, contaminated food chains, and environmental damage on an unprecedented scale from the combined effects of nuclear industry and atomic tests were not constructed as 'national security' problems, except as they threatened nuclear production. Both discovered as an object of state interest and repressed as a political project, the damaged biosphere was ultimately contained by early Cold War geopolitics. The 'worst case' scenario mode of official thinking was limited, in other words, to the realm of state actors (and thus located in international relations) not radical environmental change (the biosphere), even as Cold War technoscience was developing a portrait of the planet as a fragile and integrated system.

Perhaps the purest illustration of this structural linkage between the bomb and biosphere in American political culture is that the first nuclear arms control treaty is also the first international environmental protection treaty. The 1963 Limited Test Ban Treaty (LTBT) eliminated nuclear detonations in the oceans, on land, in the air, and in outer space. Sold in the aftermath of the Cuban Missile Crisis as a means of reducing international nuclear tension, the LTBT was also a means of quieting public concerns about the effects of atmospheric fallout while continuing nuclear weapons production. The LTBT is now remembered at Los Alamos predominantly as a 'public health' initiative, one that took nuclear testing underground, and stabilized its experimental regime from 1963 to 1992 (Masco, 2004b). Without the visual evidence of new nuclear tests, as well as the protests over fallout, the move to underground testing also secured the bomb at the center of US national security logics for the remainder of the 20th century. The LTBT marks an important achievement for the environmental sciences as well: it demonstrated that industrial processes could damage the global biosphere, that negative environmental effects could be both cumulative

and transnational, and that international agreements could be forged to limit future damage. Thus, while insuring 30 more years of the arms race, the LTBT also implicitly recognized a post-national form of security, one that was planetary in scope.

The early Cold War nuclear program thus enabled a changing understanding of the planet. Radioactive fallout, as well as intercontinental ballistic missiles, transformed specific kinds of threat into a global phenomenon, even as Cold War earth scientists were documenting the fragility of ecosystems within a collective biosphere. This notion of a planet under ecological threat achieved a new kind of visual coherence with the first Apollo mission photograph of planet earth rising above the moon in 1968 (see Jasanoff, 2001) and with the first NASA satellite portrait of the global biosphere in 1980.[9] Within US security culture, however, a basic conflict was established between nuclear threats and climate threats, between the bomb as a state technology and the cumulative effects of industrial civilization on the biosphere. As we shall see, an evolving notion of planetary threat would eventually pit the national security logics of the state against a new, post-national view of security focused on a fragile biosphere.

Part II: A Nuclear Winter (1983)

> Unlike most earlier studies, we find that a global nuclear war could have a major impact on climate – manifested by significant surface darkening over many weeks, subfreezing land temperatures persisting for up to several months, large perturbation in global circulation patterns, and dramatic changes in local weather and precipitation rates – a harsh 'nuclear winter' in any season. (Turco et al., 1983: 1290)

After nearly four decades of life in the nuclear age – during which the US rebuilt its economy, geopolitical strategy, military, and citizen-state relationship around the bomb, weaving potential annihilation into the routine of everyday life – Americans discovered in the 1980s that they did not yet understand the full planetary costs of nuclear war. A research team headed by Louis Alvarez, a former Manhattan Project physicist and Nobel Prize winner, theorized in 1980 that the mass extinctions witnessed during the Cretaceous Period were caused by an asteroid impact, a collision so violent it flooded the atmosphere with debris, blocking sunlight and radically cooling the global environment (Alvarez et al., 1980; see also Davis, 2001; Mellor, 2007). The theory, which seemed to explain the sudden extinction of the dinosaurs 65 million years ago, became a subject of enormous debate both within and outside the academy. Crutzen and Birks (1982) soon pointed out that the massive fires ignited during a nuclear war might produce enough smoke to similarly affect the global atmosphere. The multidisciplinary team of Turco, Toon, Ackerman, Pollack and Sagan (known as TTAPS) followed in 1983 with both an elaborated theory, and an international research program, devoted to what they called 'nuclear winter'.

Published in two parts in *Science*, the first paper depicted a theory of radical climate change brought on by the combined planetary load of burning cities in a nuclear war, while the second paper was devoted to the 'long-term biological consequences of nuclear war' (Ehrlich et al., 1983). An intervention into the Reagan Administration's nuclear policy – which included a massive arms build up, renewed confrontation with the Soviet Union, and a discussion of 'winnable' nuclear wars – the 'nuclear winter' concept fundamentally challenged the nuclear security logics of the Cold War state (Badash, 2001). If establishing the 'closed world' sciences of the early Cold War state militarized the weather, the 'nuclear winter' debate of the 1980s explicitly mobilized a radically changing climate to promote nuclear disarmament.

The 'nuclear winter' *Science* papers began with an assessment of nuclear war (Ehrlich et al., 1983: 1293):

> Recent studies of large-scale nuclear war (5000- to 10,000-MT yields) have estimated that there would be 750 million immediate deaths from blast alone; a total of about 1.1 billion deaths from the combined effects of blast, fire, and radiation; and approximately an additional 1.1 billion injuries requiring medical attention. Thus, 30 to 50 percent of the total human population could be immediate casualties of nuclear war. The vast majority of the casualties would be in the Northern Hemisphere, especially in the United States, the USSR, Europe and Japan. These enormous numbers have typically been taken to define the full potential catastrophe of such a war. New evidence presented here, however, suggests that the longer term biological effects resulting from climatic changes may be at least as serious as the immediate one.

Climactic effects at least as serious. This portrait of mass death relies on an understanding of nuclear war built up over nearly four decades of US military planning and civil defense, a security discourse that frequently identified nuclear war itself as 'unthinkable'. Two decades after Herman Kahn (1960) first asked, 'if the survivors would envy the dead', the nuclear winter studies offered a portrait of a 'post-war' environment almost as traumatic as the initial nuclear firestorm. Erhlich et al. summarized their report this way (1983: 1293):

> Subfreezing temperature, low light levels, and high doses of ionizing and ultraviolet radiation extending for many months after a large-scale nuclear war could destroy the biological support systems of civilization, at least in the Northern Hemisphere. Productivity in natural and agricultural ecosystems could be severely restricted for a year or more. Postwar survivors would face starvation as well as freezing conditions in the dark and be exposed to near-lethal doses of radiation. If, as now seems possible, the Southern Hemisphere were affected also, global disruption of the biosphere could ensue. In any event, there would be severe consequences, even in the areas not affected directly, because of the interdependence of the world economy. In either case the extinction of a large fraction of the Earth's animals, plants, and microorganisms seems possible. The population size of *Homo sapiens* conceivably could be reduced to prehistoric levels or below, and extinction of the human species itself cannot be excluded.

Nuclear war could destroy the biological support systems of civilization. Placing humanity firmly on the path of the dinosaurs, the exploding bomb is positioned here to not simply as a military tool but as a transformational event for the planet. There is a direct line of research connecting the early 'tracer' studies of strontium-90 from above ground nuclear detonations to this depiction of 'nuclear winter'.[10] However, the political coordinates of the research have been inverted: while the fallout studies of 1950s were directly harnessed to the military expansion of the nuclear state, the 'nuclear winter' concept was mobilized to reduce nuclear arsenals and diminish the geopolitical reliance on the bomb for the sake of environmental security.

Basing their models on the current US and Soviet arsenals (59,959 total nuclear weapons in 1983), as well as likely war-fighting scenarios, TTAPS produced a series of computer simulations of the climactic effects of nuclear wars.[11] They modeled the effect of nuclear wars with total loads of 100 to 25,000 megatons (the combined conventional explosive force used in World War II is estimated to be 3–4 megatons, now achieved in a single thermonuclear weapon). The study concluded that a few hundred nuclear detonations producing a combined 100 megatons of force could produce change to the global climate, and offered a detailed portrait of what a 5000-megaton nuclear exchange would likely do to the biosphere. Cities would be transformed into soot and injected into the stratosphere, blocking sunlight for months. Temperatures would drop dramatically and low light levels would impact photosynthesis, leading to widespread crop failures. Violent storms, unpredictable weather, and radioactive fallout would challenge life in all parts of the globe. A key finding of the study was that these effects would not be limited to the northern hemisphere – thus primarily affecting the nuclear powered states in North America and Europe – but would have worldwide consequences. Calling for nuclear powers to recognize their mutual dependence on a biosphere that is capable of being both damaged and radically destabilized, the TTAPS project sought to render national security an obsolete (and dangerously misguided) concept, rightfully superseded by a concern about a transnational, ecological, and planetary sustainability.

With Carl Sagan as its public face, the TTAPS project addressed not only the scientific community and policymakers, it also communicated the science of 'nuclear winter' directly to the American public.[12] Sagan published an article in *Parade Magazine* (the Sunday supplement to most US newspapers) on 20 October 1983, laying out in layman's terms the argument about nuclear warfare and climate change (Sagan, 1983). His mass media strategy continued with the published proceedings of a 1983 conference: *The Cold and the Dark: The World After Nuclear War,* which presented readers with a new graphic image of atomic conflict (Ehrlich et al., 1984). Subverting the aesthetic perspective offered by the Apollo mission photographs of the earth, the cover image presents a soot-blackened planet in which only the southern tip of South America remains visible to sunlight. Sagan and Turco (1990) extended this visual strategy in their book, *A Path Where No Man Thought: Nuclear Winter and the End of the Arms Race*, in a

four-panel illustration of nuclear war and winter. Emphasizing the planetary scope of nuclear war, this pictorial sequence offered an extraterrestrial point of view, looking down first at the North Pole and then at the equator. What is immediately striking about the sequence is its temporal focus: nuclear war is presented in one frame (representing perhaps two hours of actual nuclear conflict given the state of US and Soviet weapons systems) while nuclear winter continues on for weeks, gaining in intensity. In their captions, Sagan and Turco underscore that from a polar perspective it is impossible to conclude who started the conflict. Indeed, they ground their assessment in the scientific effects of nuclear war rather than the politics of Cold War. Each subsequent image is removed in time, marking the atmospheric effects of thousands of nuclear explosions on the biosphere over several weeks. Ten days after the war, the soot has covered the northern Hemisphere, and in the final image all but the southern-most continental spaces are covered in smoke – blocking out sunlight.

By deploying an extraterrestrial image of the globe, instead of a portrait of the nation-state, as the visual icon of nuclear winter, Sagan and Turco sought to change the terms of Cold War security debates. Relying on their computer simulations, they argued that the nuclear powers should reduce the total number of nuclear weapons in their arsenals to beneath the threshold for a nuclear winter effect (Sagan & Turco, 1993: 371):

> If we define a city as having more than 100,000 people, then there are some 2,300 cities on the planet. This means that after START II is fully implemented, the USA or Russia could destroy every city on the planet and have 2,300 weapons left over .... If we wish to arrange a world in which no miscalculation, no technological error, no misunderstood orders, no fit of ethnic or religious passion, and not even a conspiracy of madmen could bring about a global environmental catastrophe, then we must arrange a world with fewer than several hundred nuclear weapons.

No conspiracy of madmen could bring about a global environmental catastrophe. Here, we have a new definition of climate crisis mobilized to enable nuclear disarmament. The 'nuclear winter' research undercut 'national security' in favor of a new kind of planetary security, producing vigorous scientific and political debate.[13] A coalition of 200 scientists (the Scientific Committee on Problems of the Environment of the International Council of Scientific Unions [SCOPE]) from 30 nations participated in a nuclear winter study that re-affirmed the global threat of smoke induced climate change from nuclear warfare.[14] The SCOPE study also became a prototype of the kind of multidisciplinary, multi-national scientific collaboration that has enabled recent science on CO_2 emissions and global warming. What the original 'nuclear winter' theorists ultimately sought was a de-militarization of the biosphere by replacing an international nuclear confrontation with a planetary notion of security – in effect, using one kind of catastrophe to critique another. Revising the dream of many Manhattan Project scientists that atomic weapons would make war obsolete, these researchers sought to

FIGURE 5
New York Frozen, *The Day After Tomorrow* (2004, 20th Century Fox)

mobilize the science of climate change, as well as images of a damaged and destabilized biosphere, to promote global nuclear disarmament and an end to the Cold War arms race.

Part III: Global Warming as Nuclear War (2003)

Utilizing the full commercial power of the Hollywood blockbuster formula, director Roland Emmerich gave audiences in 2004 an illustration of a biosphere radically out of balance. Avowedly a film to both entertain and 'raise consciousness', *The Day After Tomorrow* revisits the now longstanding link between nuclear war and ecological crisis, but does so to highlight the threat of climate change. In the film, global warming produces sudden and severe ecological effects, which are detailed with the latest computer-generated imaging technology and Hollywood panache: Los Angeles is destroyed by multiple tornadoes, while New York is both flooded by rising ocean currents and then frozen solid (see Fig. 5) as the upper-third of the US is trapped in a new ice age, and surviving US citizens are forced to flee across the Rio Grande into Mexico. A Hollywood response to early Bush administration claims that the industrial contribution to global warming was only a theory: the film drew openly on the tropes and history of Cold War atomic cinema to make a different kind of security argument.

In atomic cinema, the apocalypse is harnessed directly to the power of the nation-state, promoting a perverse kind of nation-building through images of collective sacrifice and death. For 60 years now Hollywood has produced big budget, special effects-driven stories about nuclear warfare (often allegorized), playing off of the Civil Defense promises and nuclear fears of the Cold War state.[15] The cinematic destruction of New York – often

FIGURE 6
Postnuclear New York, *The Planet of the Apes* (1968, 20th Century Fox)

codified in a ruined Statue of Liberty – has become an almost annual project in Hollywood and one that provides a precise genealogy of US nuclear fears, from *When Worlds Collide* (1951) to *The Planet of the Apes* (1968) (see Fig. 6) to *The Day After Tomorrow* (2004). The producers of *The Day After Tomorrow* are particularly attuned to this filmic register, having established their careers by revisiting Cold War atomic cinema (in *Independence Day* and *Godzilla*). *The Day After Tomorrow* (a play on the title of the 1983 American nuclear war film, *The Day After*) is a loose remake of the 1961 feature *The Day the Earth Caught Fire*. In this British production, an aggressive series of thermonuclear tests by the US and Soviet Union knock the earth off its axis, causing the planet to spin closer to the sun, producing a nearly apocalyptic planetary heat wave. *The Day After Tomorrow* ultimately uses the devices of atomic cinema – a focus on the destruction of cities, collective sacrifice, and militarized response – to address a form of catastrophe larger than the national politics of the security state: radical climate change. Bringing in more than $500 million in global box office, *The Day After Tomorrow* was the seventh most successful movie of 2004 and was widely credited with increasing audience recognition of climate change as a social issue (Leiserowitz, 2004).[16]

The Pentagon, perhaps not surprisingly, was thinking along very similar lines about the military implications of global warming in 2003–2004, despite its focus on the 'war on terror'. The DoD contracted futurologists Peter Schwartz and Doug Randall (2003) to write a report on the 'national security' implications of abrupt climate change. Positioning their report as an effort to 'imagine the unthinkable', Schwartz and Randall not only project an extreme vision of abrupt climate change into the next decade, but they also deploy almost all of the tropes of Cold War post-nuclear planning to do so. The 'unthinkable' as a national security discourse originates in

the Cold War nuclear standoff, exemplified by Rand nuclear analyst Herman Kahn (1960), who encouraged Americans to 'think about the unthinkable' and plan for life in a post-nuclear environment. In their scenario, Schwartz and Randall imagine a 'de-stabilized' world reorganizing itself around radical scarcities of food and water. Arguing that 'human civilization began with the stabilization and warming of the Earth's climate', they offer a sobering portrait of the 'national security' threat posed by global warming:

> Violence and disruption stemming from the stresses created by abrupt change in the climate pose a different type of threat to national security than we are accustomed to today. Military confrontation may be triggered by a desperate need for natural resources such as energy, food and water rather than by conflicts over ideology, religion, or national honor. The shifting motivation for confrontation would alter which countries are most vulnerable and the existing warning signs for security threats. (Schwartz & Randall, 2003: 14)

Climate change will thus redraw the geopolitical map on new terms, as states compete not just for prestige and power, but also for food and energy. This new world of unpredictable weather will present both opportunities and challenges to the US, calling for a new focus on national defense.

In this future history, the ecological crisis leads some nations to build 'virtual fortresses around their countries' in an effort to protect resources, while other nations fight one another for remaining global stocks of food, water, and energy. Thus, the futurologists present nothing less than an internationalized version of the early Cold War fallout shelter debate: shelter owners were taught that their first act in a post-nuclear world would likely be that of defending their property from their less prepared and highly traumatized neighbors (Grossman, 2001). 'Preparation' for disaster, rather than prevention, is the assumed role of government in this scenario, mimicking domestic nuclear emergency planning (cf. Oakes, 1994). Indeed, while detailing a radically destabilized biosphere, the primary problem addressed by the 'Abrupt Climate Change Scenario' is how to manage people and resources, not the causes of global warming. As in the 1950s civil defense programs, public panic is highlighted as the central problem, not nuclear warfare or the industrial origins of climate change. US 'national security', in other words, does not include preventing climate change, only responding to it on terms maximally beneficial to the security state.

In their report, Schwartz and Randall consider a radically changed, increasingly insecure world by 2020:

> As famine, disease, and weather-related disasters strike due to the abrupt climate change, many countries' needs will exceed their carrying capacity. This will create a sense of desperation, which is likely to lead to offensive aggression in order to reclaim balance. Imagine eastern European countries, struggling to feed their populations with a falling supply of food, water, and energy, eyeing Russia, whose population is already in decline, for access to its grain, minerals, and energy supply. Or, picture Japan,

> suffering from flooding along its coastal cities and contamination of its fresh water supply, eyeing Russia's Sakhalin Island oil and gas reserves as an energy source to power desalination plants and energy-intensive agricultural processes. Envision Pakistan, India, and China – all armed with nuclear weapons – skirmishing at the borders over refugees, access to shared rivers, and arable land. Spanish and Portuguese fishermen might fight over fishing rights – leading to conflicts at sea. And, countries including the United States would be likely to better secure their borders. With over 200 river basins touching multiple nations, we can expect conflict over access to water for drinking, irrigation, and transportation. The Danube touches twelve nations, the Nile runs through nine, and the Amazon runs through seven. (Schwartz & Randall, 2003: 18)

Needs will exceed carrying capacity. As hungry populations redraw political alliances and state borders in the competition over basic resources, the US DoD is presented with a new universe of state-based security threats. Megadroughts in northern Europe produce huge waves of emigration, North America is hit by high-intensity storms producing soil loss and decreased agricultural production, Asia is hit by massive famine producing 'chaos and internal struggles as a cold and hungry China peers jealously across the Russian and Western borders at energy resources'. Deaths from war, starvation, and disease increase globally with shortened growing seasons and intense weather. The US and Australia become defensive fortresses to protect their natural resources, while North and South Korea become a new combined nuclear power, and other nations pursue the bomb. In short, by 2020 it is a world of massive realignments of peoples and interests, increased warfare, and chronic shortages. As Schwartz and Randall (2003: 14) put it: 'Modern civilization has never experienced weather conditions as persistently disruptive as the ones outlined in this scenario.'

In *The Day After Tomorrow* the disastrous effects of climate change are attributed, in part, to the failure of the security state to listen to climate scientists about the dangers of global warming. Schwartz and Randall, however, demonstrate that climate change can still be appropriated by the national security state to promote a militarized response – a bunker society – rather than a fundamental rethinking of the terms of the industrial economy.[17] Working from within a classic military perspective, it becomes a category error for the futurologists to suggest that the US Department of Defense needs to mobilize against the threat of global warming – to prevent this coming chaos. Schwartz and Randall can only argue that more nuclear weapons will be set loose among states more inclined to warfare, with fewer resources and greater desperation. Rather than transforming the Environmental Protection Agency (EPA) into a chief agency for national defense (and perhaps drawing on the Cold War history of the US Department of Agriculture and the trees of Operation Upshot-Knothole), in this scenario the only possible outcome is a greater militarization of the US. Global threat is mobilized here to underscore the need for a nuclear arsenal, just as it was throughout the Cold War. The military–industrial complex is positioned as the answer to global instability, rather than as a

significant contributor to greenhouse gases with its network of more than 735 foreign military bases.[18]

Indeed, climate change was treated within the Bush administration as a threat not to the earth, but to its national security policies. Across a spectrum of government agencies devoted to studying the environment, news of the industrial contribution to greenhouse gases and climate change was stalled and at times actively repressed. Mirroring the initial security state reactions to scientific studies of the health effects of fallout in the 1950s, or of nuclear winter in the 1980s, climate change has been positioned as a threat to US military policy (see Kopp, 1979; Wang, 1999; Badash, 2001). This is most powerfully revealed in the protestations of NASA scientist James Hansen, Director of the Goddard Institute for Space Studies, who accused the Bush administration of trying to regulate his public speaking on climate change (Revkin, 2006).[19] As one of the most prominent US scientists to advance a theory of global warming as imminent threat, Hansen was subjected to handlers that listened to his phone interviews and reviewed his public presentations. This is the kind of treatment once reserved for nuclear weapons scientists, those whose every utterance was believed to affect the stability the 'free world'.[20] Similarly, government reports on climate change were edited by federal officials to downplay evidence of human contributions to global warming and to emphasize uncertainty in climate models.[21] Reports by government scientists pursuing a link between climate change and intensifying hurricanes were restricted, and the nationwide system of technical research libraries run by the EPA was closed due to 'federal budget cuts' – an act that drew protests from 10,000 scientists in 2006.[22] In 2008, a survey of EPA scientists found that the majority had felt political pressure from political appointees within the Bush administration to distort or censor environmental assessments (Union of Concerned Scientists, 2008). Thus, while climate scientists debated the 'tipping point' in global warming – the date in which massive environmental changes are unstoppable due to green house gases – the Bush administration largely portrayed climate change as a 'theory' and worked to delay any serious regulatory action at home or abroad (Eilperin, 2006a).[23] This struggle over the politics of planetary danger was about nothing less than the security state's ability to monopolize definitions of threat and security.

For despite the security state's efforts to designate terrorism as the ultimate existential threat, there has been an extraordinary amount of scientific evidence across disciplines, species, and ecosystems of climate change (Oreskes, 2004). Recent scientific studies have attributed to global warming fundamental changes in habitats, ecologies, and weather: birds are changing their migratory patterns in North America,[24] bears have stopped hibernating in Spain (*Independent*, 2006), two-thirds of the harlequin frog species in Central and South America have become extinct, polar bears are headed for the endangered species list due to loss of habitat,[25] the warming of the ocean is both bleaching coral reefs and melting the polar ice caps.[26] The extinction rate for species is accelerating (Parmesan, 2006), and the

oceans are losing the biodiversity that maintains ecological resilience to disease (Stokstad, 2006; Worm et al., 2006). If current melt rates continue, the polar ice caps could be gone in the summer of 2040.[27] The warming of the Atlantic Ocean and Gulf of Mexico may be contributing to larger and more violent hurricanes (Schwartz, 2006). And yet, the US remains the largest cumulative contributor to greenhouse gases (Marland et al., 2006), the country that has enabled and conducted much of the research on climate change, and the primary state in resistance to an international response. As a recent study from the British treasury department has argued, the financial cost of this delay could be enormous:

> Climate change will affect the basic elements of life for people around the world – access to water, food production, health, and the environment. Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms. Using the results from formal economic models, the Review estimates that if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risk and impact is taken into account, the estimates of damage could rise to 20% of GDP or more. In contrast, the costs of action – reducing greenhouse gas emission to avoid the worst impact of climate change – can be limited to around 1% of global GDP each year. (Stern, 2007: 643)

Hidden within these numbers are some of the most profound security issues any state has ever faced – from floods, to famine, to droughts, to violent storms – a 9/11 attack and a Katrina storm every year.[28]

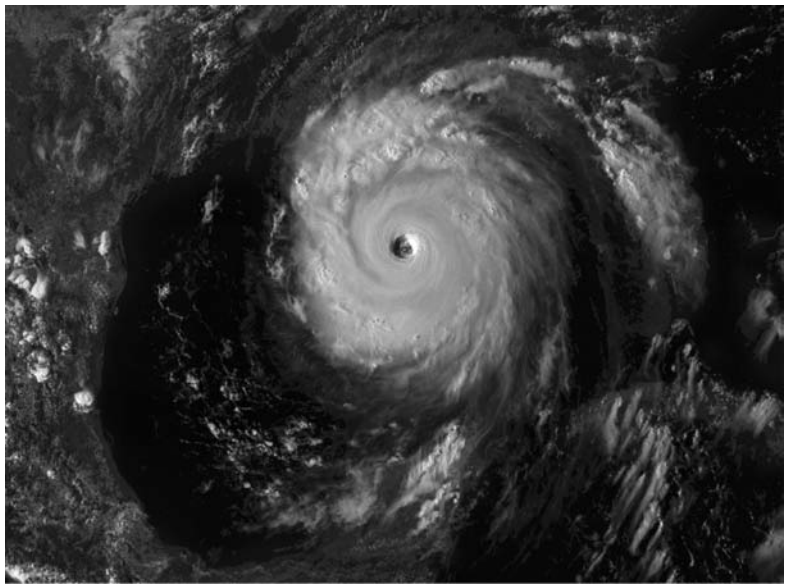
Conclusion: Katrina as Hiroshima

> It's as if the entire Gulf Coast were obliterated by a – the worst kind of weapon you can imagine. (President George Bush surveying the wreckage left by Hurricane Katrina in Alabama, 2 September 2005)

> I can only image this is what Hiroshima looked like 60 years ago. (Mississippi Governor Haley Barbour on Katrina damage in Mississippi)

Surveying the wreckage left by Hurricane Katrina on his first visit to the storm ravaged Gulf Coast in 2005, President George Bush invited Americans to think of the event *as if* it were a nuclear attack.[29] Mississippi Governor Haley Barbour was more specific, presenting the unprecedented wind and flood damage in his state as equivalent to the atomic bombing of Hiroshima (Martel, 2005). For Barbour, Katrina produced 'nuclear destruction'. He declared in a wide range of media interviews: 'The coast is just the greatest devastation I've ever seen. It's as if they set off a nuclear weapon there.'[30] Officials, rescue workers, and victims involved along the Gulf recovery similarly relied on nuclear imagery to transform a Category-4 hurricane and failed levy system into a de facto act of nuclear warfare (see Fig. 7).[31] Thus, Hurricane Katrina was, in the first case, only understandable to America's political leadership, and many of its citizens, in terms of nuclear catastrophe.

FIGURE 7
Hurricane Katrina Hitting the Gulf Coast (NOAA photograph)



Indeed, for many media commentators in the US, the first issue raised by Hurricane Katrina was not about violent weather – and the potential linkage of increasing hurricane strength to climate change – but rather about the national security state's ability to respond to a nuclear attack. Even as stranded residents of the Gulf Coast awaited rescue, cable news talk was significantly devoted to the failures of the Federal Emergency Management Agency (FEMA), not in response to an unfolding natural emergency but to an imagined nuclear one. On *MSNBC*, Chris Mathews asked FEMA and Department of Homeland Security officials what would we be facing if 'it was a bomb that went off, rather than a thunderclap of God's will?'[32] In addition to marking the failures in governmental emergency response, cable television used Katrina to rehearse 'WMD' preparedness, focusing not on floods, levy systems, and environmental change, but on biological warfare, chemical weapons, and terrorists armed with nuclear weapons. Commentators from across the political spectrum asked what the disaster revealed about the state of US civil defense, using the destruction left by Katrina to foment an image of future nuclear devastation in other cities. Not surprisingly, citizens of the gulf coast states called on the government to respond as promised in a state of nuclear emergency.

These responses to a devastating storm reveal how embedded nuclear concepts are in US political culture, and underscore the strange reliance Americans now have on nuclear threat to organize politics and experience – both foreign and domestic. Informing each of these comments is not only the trauma of Hurricane Katrina but also the powerful psychosocial effects of the atomic bomb on American security culture. For how is it that so many

Americans, from so many different social positions, could understand this non-nuclear, non-military event, in decidedly nuclear terms? What does it mean that a natural catastrophe could so immediately be transformed into an act of nuclear warfare in the public imagination? And what other logics about nature and security are blocked by this nuclear discourse?

I have outlined in this essay the multi-generational imbrications of nuclear weapons and climate change in the US, arguing that the advent of the atomic bomb enabled a new understanding of the global biosphere but also installed a specific set of ideas about catastrophic risk within American security culture. For, after rehearsing for generations the loss of an American city to the atomic bomb (in civil defense programs, nuclear war planning, and in Hollywood films), the US all but lost a city in 2005. However, New Orleans was not lost to the atomic bomb but to violent weather, a storm perhaps energized by the cumulative effects of greenhouse gases. The 'nuclear discourse' attached to Hurricane Katrina reveals that Americans have been conditioned to approach mass destruction on very specific terms. However, it also reveals that they have little actual understanding of the explosive power of the bomb: for even the smallest atomic bombs in the current US nuclear arsenal are 30 to 40 times more powerful than the weapon that obliterated Hiroshima (and thus capable of completely destroying a city the size of New Orleans). Nevertheless, the turn toward nuclear discourse to explain a natural catastrophe reveals the power of the nuclear project in America, and the multigenerational linkages between nuclear weapons and climate. The Cold War policy of containment involved not only producing bombs but also more detailed maps of the earth, global systems for monitoring air for radioactive trace elements, seismic monitoring systems listening for the distinct signatures of a nuclear explosion, and ultimately, supercomputing and satellite systems, which provided increasing sophistication in weather modeling. This 'closed world' of Cold War military planning, as Paul Edwards (1996) has put it, encapsulated the earth in military, command, control, and surveillance systems, and in doing so, it also created new understandings of the earth, sea, and sky, and of the biosphere itself as an integrated ecological space.

The Cold War nuclear arms race, however, also installed an idea of apocalyptic destruction, one that has been deployed by the national security state for generations to enable a variety of state projects. Indeed, the 'balance of terror' during the Cold War – the minute-to-minute possibility of a global exchange of thermonuclear warheads – transformed a specific image of apocalyptic destruction into an intimate space of state- and nation-building (see Masco, 2008). The Cold War arms race taught Americans that they could live on the knife's edge of total war, and do so in perpetuity. The national–cultural effects of this project are evident in many domains of everyday life, but are clearest in the contemplation of planetary risks that are not nuclear, and not subject to a policy of deterrence. To linguistically transform Hurricane Katrina into an atomic explosion is in part to evoke mass destruction in its ultimate form, but it is also a way of capturing the event on terms historically useful to the national security state. A week after the

storm, President Bush promised a thorough review of the emergency response effort, stating 'We want to make sure that we can respond properly if there is a WMD attack or another major storm.'[33] In doing so, he again inserted the nuclear terms of the 'war on terror' into a natural disaster. Mass death and destruction has meaning when framed within a nuclear discourse in the US precisely because the Cold War arms race turned the bomb into an organizing principle in American society.

In other words, the Katrina as Hiroshima discourse is an act of translation, rather than misrecognition. As we have seen, the 1950s, 1980s, and 2000s have all witnessed politically charged moments in the US in which the dangers posed by climate change and nuclear weapons were transposed. The designation of the US as a 'superpower' largely depends on the ability of the state to monopolize a discourse of risk, and to this end the atomic bomb has been an extraordinary instrument of state power. In declaring war on 'terror' in 2001, the Bush Administration did not declare war on all terror but rather expressed a more specific fear of the 'WMD'. Today, climate change directly competes with the 'WMD' as primary planetary threat, and demands a different political response. The tools for fighting climate change are in fact diametrically opposed to those informing the 'war on terror' – for a global response to CO_2 emissions requires a new kind of political cooperation, innovative economic and technological change, a shared vision of ecological sustainability, and above all, a willingness to substitute global concerns for national interests. Rather than sustaining a military–industrial economy, engaging climate change requires a new form of global governance.

Returning to the synthetic forest of 1953 (see Fig. 1), we can see in the fury of the nuclear blast a possible counter-narrative to the national security state, one grounded not in weapons but in a relationship towards the biosphere. For the lesson of these bent and broken trees is that if enough industrial force is applied to nature, it will break. The value of the 1953 synthetic forest is that it marks not only the power of the bomb, but also the fragility of even an artificially reinforced nature; it marks not only a new global effort to mediate international relations via nuclear technologies, but also the effects of industry on the biosphere. The mistaken lesson from Operation Upshot-Knothole is that war fighting and civil defense were all that were at stake in these experiments; for indeed, the nuclear blast that transformed 145 ponderosa pines into blades of grass blowing in an unnatural wind is but the most explicit manifestation of an industrial transformation of the natural world. The power of the bomb has been not only to link science and the state in a way that recognizes this fact, but also, to distort American political culture so that only international state threats are currently capable of mobilizing collective social action.

In the early 21st century, the imbrications of nuclear weapons and planetary threat remain so profound as to block both thought and action, allowing the security implications of a warming planet to elude the national security state. However, the ties between the bomb and climate change remain ever present: today, the same supercomputers that maintain the US

nuclear stockpile at the national laboratories are also modeling climate, even as the cars traveling the interstate highway system (designed by the Eisenhower administration as a part of a nuclear civil defense program) contribute to global warming every second of the day. Moreover, the increasing calls for a 'Manhattan Project' to deal with climate change still embed the biosphere within a purely militarized and nationalized logic, while presuming that a single state actor can remedy a global climate crisis.[34] But to attend to the shrinking artic ice caps or the intensifying weather patterns is to reject the idea of a national security and replace it with a planetary vision of sustainability. The technoscientific questions of biospheric sustainability are profound, requiring the integration of states and diverse environmental problems as objects of collective responsibility, a proposition that offers a new means of coordinating global order. Today 'security' remains embedded within an extremely narrow concept of threat and national advantage in US political culture, both legacies of Cold War state- and nation-building. But the lessons of the synthetic forest from 1953 – reiterated in the disappearing frogs, the melting ice caps, the intensifying hurricanes, and the dying coral reefs of today – are that more profound changes are at hand, and that securing the biosphere requires nothing less than a post-national vision of American power.

Notes

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1. The nuclear sublime involves a cognitive confrontation with the power of a nuclear detonation. The result is first a flooding of the senses with overwhelming information, which is followed by an effort to restore cognitive control through a naming of the thing. Thus, the nuclear sublime does not end in comprehension but rather in an intellectual compensation for the inability of the mind to fully comprehend the power of the exploding bomb; see Masco (2004b).
2. See US Defense Nuclear Agency (1982) for a detailed description of 'Shot Encore' and the variety of experiments and personnel involved in the test, as well as US Department of Defense (1953a).
3. From 1945–1992, the US (in addition to Hiroshima and Nagasaki) detonated 1054 nuclear devices, the vast majority at the Nevada Test Site. See Makhijani et al. (1995), Advisory Committee on Human Radiation Experiments (1996), Makhijani and Schwartz (1998), and Masco (2004a).
4. See Rojecki (1999) and Katz (1986), as well as Wittner (1993, 1997, 2003).
5. For example, see Machta and Harris (1955), Hare (1962), Bentz et al. (1957), Kroening (1965), and Hammond and Maugh (1974). These fears were powerfully expressed in Nevil Shute's 1957 novel, *On The Beach*, in which post-nuclear survivors gather in Australia to await the arrival of a deadly radioactive cloud; see also Stanley Kramer's award-winning 1959 filmic adaptation.

6. See Doel (2003), Edwards (2006), Miller and Edwards (2001), and also Leslie (1993) for discussions of the foundational logics of the Cold War sciences, and Weart (2003) on the discovery of global warming.
7. Peter Sloterdijk (2005: 225) has noted the essential linkage between modern war and the environment:

   > The true discovery of the environment was by gas warfare in the trenches of World War I. This type of war no longer kills by direct fire but by destroying the environment the enemy needs to survive. The art of killing with the environment is one of the big ideas of modern civilization. It contains the nucleus of contemporary terror: to attack not the isolated body of the adversary, but the body in its 'Umwelt'.

   From this perspective, what is unique about the radioactive fallout studies of the 1950s is the global scope of this new weapon, and its cumulative genetic effects.
8. The early Cold War sciences thus produced the first comprehensive efforts to build planetary data sets, engendering what Paul Edwards (2006) has called 'infrastructual globalism' at the level of earth sciences information. See also Edwards (forthcoming) for detailed analysis of the development of climate models.
9. See Poole (2008) for a history of the widely circulated Apollo 'earthrise' photograph (available from the NASA media archives at <www.nasa.gov/images/content/54428main_MM_image_feature_102_jwlarge.jpg> [accessed 15 June 2008]), as well as the prior images produced by satellites. See Jasanoff (2001) and Cosgrove (2001) for detailed analysis of efforts to conceptualize the planet as a whole, as well as the important cognitive shift produced by the move from drawing Earth to directly photographing it. For the first color portrait of the global biosphere, see the NASA project page at <http://dayton.hq.nasa.gov/ABSTRACTS/GPN-2003–00027.html> (accessed 15 June 2008).
10. For example, Lawrence Livermore National Laboratory in addition to being a nuclear weapons design laboratory also maintains a real-time global system for monitoring atmospheric releases of radioactive and other hazardous materials; see Sullivan et al.(1993) and <http://narac.llnl.gov/>. In 2002, scientists at Lawrence Livermore completed the first global climate simulation with a resolution of 30 miles (48 km); this was accomplished on the same supercomputers used to maintain the US nuclear stockpile.
11. See National Resources Defense Council (n.d.). In 2006, the US maintained an arsenal of about 10,000 nuclear weapons, while Russia had close to 9000.
12. See Carl Sagan (1983/4), Turco et al. (1990), and also Clemens (1986), Rubin & Cummings (1989), Badash (2001), and Demeritt (2001) for assessments of the 'nuclear winter' debate and media response.
13. For critiques of nuclear winter studies, see Thompson & Schneider (1986), and Rueter & Kalil (1991). See Hobbs & Radke (1992) for an assessment of the climate effects produced by smoke from Kuwait oil fires in 1991. Eden (2004) offers a detailed assessment of fire in nuclear warfare and discusses the politicization of US nuclear warfare models; see Glasston and Dolan (1977). Robock et al. (2007) and Toon et al. (2007) present updated nuclear winter studies focusing on regional conflict, each concludes that 100 Hiroshima-sized bombs (13 kilotons) on cities could produce climactic change. See Cockell and Stokes (1999) for an assessment of polar winter, the resulting 'ecosystem chaos', that might be applied to either nuclear winter or global warming.
14. The Scientific Committee on Problems of the Environment of the International Council of Scientific Unions (SCOPE) report 28 was published as *The Environmental Effects of Nuclear War* (Pittock et al., 1986); see also National Research Council (1985) and Peterson (1983). See Bumstead (1985) and Grinspoon (1986) for socio-cultural and psychological studies of the likely effects of a nuclear winter.
15. See Sontag (1965), Derrida (1984), Evans (1998), and Edwards (1996).
16. Online information about the film is available at the 'Box Office Mojo' site: <http://boxofficemojo.com/movies/?id=dayaftertomorrow.htm> (accessed 29 December 2006).
17. A recent report prepared by a group of retired Generals and Admirals, chaired by General Gordon R. Sullivan, identifies climate change as a 'threat multiplier for

instability in some of the most volatile regions of the world' and called for a restructuring of military strategy, acquisitions, and global basing to account for climate change, see CNA Corporation (2007: 6). Following Schwartz and Randall, the retired generals and admirals assembled for the report assume a primarily militarized response to climate change (including relocating military bases around the world that are vulnerable to rising sea levels), but do also call for the US to take a global leadership role in the effort to reduce greenhouse gases.

18. According to a recent DoD report on energy security (Crowley et al., 2007: 2–4):

> In FY05, the United States consumed about 20 million barrels per day. Although the entire federal government consumed a mere 1.9 percent of the total US demand, DoD, the largest government user of oil in the world, consumed more than 90 percent of all the government's petroleum (liquid fuel) use.

For analysis of the geostrategic effects of the military oil consumption, see Klare (2007); for analysis of US global military bases, see Johnson (2006: 139).

19. Also see Rick Piltz (2005) 'Censorship and Secrecy: Politicizing the Climate Change Science Program', available on the internet at the 'ClimateScienceWatch' website: <www.climatesciencewatch.org/index.php/csw/details/censorship-and-secrecy/> (accessed 3 May 2009).
20. Similarly, texts like the 'strategic plan for the US climate change science program' have been edited to emphasize uncertainties about climate change, and to construct global warming as a process that may or may not be caused by industrial effects. Thus, the goal of some of the official statements on climate change is not to mobilize a response but to control its image, to raise ambiguities in the scientific record, and challenge calls for immediate global governance of greenhouse gases. See *New York Times* (2005), and Grimaldi and Trescott (2007). For the most detailed account of the politicizing of climate change research by the Bush administration, see Donaghy et al. (2007) and Maassarani (2007). A report on 'political interference' with climate change science by the Committee on Oversight and Government Reform (2007) concludes there was a 'systematic effort' by the Bush administration to limit the discussion of climate change by censoring the testimony of federal scientists and government officials, editing scientific and governmental reports on climate change, and by resisting the application of environmental laws; see also Dickinson (2007).
21. See Thacker (2006), Revkin (2005), and *Nature* (2006). See also Eilperin (2008a). For an illustration of the edits to the *Strategic Plan for the US Climate Change Science Program*, see *New York Times* (2005).
22. See Giles (2006), Heilprin (2006), Daley (2006), and Lee (2006); and also Bearden & Esworthy (2007).
23. Also see Demeritt (2001) and Antilla (2005) for assessments of media coverage of climate change in the US. See Jacques et al. (2008) for a study of the experts behind 'environmental skepticism'.
24. See The Smithsonian Migratory Bird Center discussion at <http://nationalzoo.si.edu/Conservationandscience/Migratorybirds/Research/Climate_Change/default.cfm> (accessed 30 December 2006).
25. See Eilperin (2006b). The Bush administration changed the regulatory process for the Endangered Species Act, adding dramatically fewer species to the list than any other Presidency in the 35-year history of the law (Eilperin, 2008b).
26. On frog extinctions, see Blaustein and Dobson (2006); on coral reefs, see Buddemeier et al. (2004); on polar bears, see Roach (2006).
27. See National Center for Atmospheric Research and the UCAR Office of Program, 'Abrupt Ice Retreat Could Produce Ice-free Arctic Summers by 2040', *News Release* (22 December 2006). Available at <www.ucar.edu/news/releases/2006/arctic.shtml> (accessed 30 December 2006). See also Revkin (2006). For a summary of the unprecedented weather in 2007, see Borenstein (2007).
28. The US currently spends more on its military than the rest of the world combined. From 2002 to 2007, the US spent roughly $3.5 trillion on military affairs while allocating $37 billion to climate stabilization (a 97 to 1 ratio); see Pemberton (2008: 5).

29. 'President Arrives in Alabama, Briefed on Hurricane Katrina' (2 September 2005), available at <www.whitehouse.gov> (accessed 30 December 2006).
30. See Pettus (2005); and transcript from *CNN Larry King Live*, 'Hurricane Katrina's Aftermath (31 August 2005).
31. The Reverend Nina Russell of Louisiana completed this circuit of nuclear fantasy, telling the Baton Rouge *Advocate* a year after the storm:

    > Having just returned from hometown of Gulfport, Miss, I found out that Katrina did not do the damage. What really happened was that the Enola Gay went through a space warp and a 60-year time warp. Instead of dropping the bomb on Hiroshima, it dropped the bomb on Gulfport. The bomb was dropped in August 1945. Katrina happened in August 2005. And if you saw the destruction – you would believe that story!

    See an article in *The Advocate* by Anders (2006). *The Advocate* also ran a headline 'Katrina deal Miss. an Atomic Blow', on 31 August 2005.
32. Transcript from Chris Mathews, *Hardball*, MSNBC (31 August 2005).
33. *ABC News Online*, 'US to Dissect Katrina Response' (7 September 2005). Available at <www.abc.net.au/news/newsitems/200509/s1454669.htm> (accessed 3 May 2009).
34. In July 2008, as part of his continuing efforts to mobilize the public to engage climate change, Al Gore called on the US to produce '100 percent zero carbon electricity in 10 years'. He compared this national project to John F. Kennedy's challenge to land a man on the moon within a decade, and explicitly linked climate change to national security; for a transcript see <www.wecansolveit.org/pages/al_gore_a_generational_challenge_to_repower_america/> (accessed 30 December 2006). However, the costs of the Manhattan Project ($21 billion), or the Apollo Program ($96 billion), are likely to pale in comparison with the scale of investment needed to both understand and manage the global climate, as well as create a renewable energy regime; see Stine (2008).

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