Wintry Doom

Visions of climate catastrophe drew upon a widespread fear that nuclear war could wreck the global environment. Scientific calculations, publicized in 1983, suggested that the bombs could pollute the air with enough dust and chemical smog to severely cool the planet—a "nuclear winter." The lesson about the atmosphere's fragility was meanwhile reinforced by evidence that such a climate catastrophe had actually happened long ago. Something, perhaps a single asteroid-bomb, had caused a global cooling that exterminated the dinosaurs.

In the 1950s, as the world's arsenals filled with hydrogen bombs, people worried about how a thermonuclear war might injure the entire global environment. Poignant novels and movies showed radioactive dust, borne on the winds, extinguishing all life on Earth.[1] Experts dismissed the scenarios as impossible. But secret studies supported by the U.S. military suggested that a war's effects on the atmosphere could be quite serious. In an openly published, but little noticed, 1958 review of climatology, a leading expert wrote that a nuclear war could throw up enough dust to alter the climate for a few years.The U.S.Weather Bureau had gone farther in an unpublicized 1956 study, saying it was conceivable that enough dust might be thrown into the stratosphere to launch a new "ice age." In the 1960s a few scientists tried to publicize the threat. The public scarcely noticed it, amid countless apocalyptic warnings about how nuclear weapons could bring the end of civilization or even all life on Earth.[2]

Most experts agreed that the effects of a nuclear war on climate deserved little attention. A National Academy of Sciences panel that reviewed the issue in 1975 concluded that a war could kick up as much dust and smoke as a large volcanic eruption. Scientists suspected that such eruptions in the past had cooled the Earth a degree or so for a year or two. Moreover, recent spacecraft observations of Mars had showed that a planet-wide dust storm could become

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[1] Weart (1988), chap. 12. Warning of a "Fimbulwinter" caused specifically by dust that blocked sunlight appeared on p. 68 of Poul Anderson and F.N.Waldrop, "Tomorrow's Children," *Astounding Science-Fiction,* March 1947, pp. 59-79, reprinted as first part of Poul Anderson, *Twilight World* (NY: Torquil, 1961), according to Bartter (1988), pp. 220-21.

[2] Landsberg (1958); I have only hearsay information on classified studies carried out by the RAND Corporation, probably as early as the mid 1950s. See Hecht and Tirpak (1995), p. 375. Weather Bureau study: Hewlett and Holl (1989), p. 369, referencing Atomic Energy Commission, Division of Biology and Medicine, "Summary Discussion of Effects on Humans, Agricultural Products, and Weather of a Projected Nuclear War," Oct. 9, 1956 (Washington, DC: AEC). Warnings: Lapp (1962), pp. 102-103; Commoner (1966), pp. 76-77, referencing Hudson Institute, "Special Aspects of Environment Resulting from Various Kinds of Nuclear Wars," Part II, H1303-RR, Jan. 8, 1964 (Harmon-on-Hudson, NY: Hudson Institute); Ehrlich and Ehrlich (1970), p. 192, speculating about smoke as well as dust. On nuclear apocalypse see Weart (1988).

self-sustaining. Still, the authors concluded that the effects "would probably lie within normal global climatic variability," and it seemed like a minor problem next to the other horrors of a nuclear war. The panel also pointed out that the nitrogen compounds (NO_x) created by the fireballs could sharply reduce the Earth's ozone layer, but again the damage would be only temporary. The authors did admit that little was known about climate, so that "the possibility of climatic changes of a more dramatic nature cannot be ruled out." A few scientists criticized the report for brushing aside possible calamities. Some pointed to the vast firestorms that a war could ignite, exclaiming that might pollute the atmosphere so severely as to "force *Homo sapiens* into extinction."[1] These scientists were in tune with a public attitude that grew strong during the 1960s and 1970s. For the first time, many people found it plausible that we could bring about an atmospheric catastrophe so terrible that it would destroy the human race.

This commonly held attitude may have helped scientists to admit into their thinking a new answer to an old puzzle. Geologist Walter Alvarez and his physicist father, Luis Alvarez, proposed that the fall of a huge asteroid had caused the extinction of the dinosaurs some 65 million years ago. They figured that the dust thrown into the air by an impact could have obscured sunlight long enough to kill much of the Earth's plant life through simple darkness, so that the dinosaurs perished of starvation. Stephen Schneider recalled that when he heard Luis Alvarez explain the new idea in a 1979 lecture, "I commented from the floor that such a cloud could have climatic effects, particularly a sharp, but short-term climatic cooling on land." Schneider was just then involved in studies that emphasized how smoke, smog, and other aerosols could cool the atmosphere and perhaps even precipitate an ice age. Calculations soon confirmed that an asteroid strike could indeed have brought on a global cooling severe enough to kill off the dinosaurs directly.[2]

Other scientists scoffed at the idea, especially geologists and paleontologists who stuck to their old theories about dinosaurs. These theories, however, failed to fit observations of world-wide peculiarities preserved in rock layers 65 million years old. Some geologists proposed that the damage to the atmosphere had not been due to an asteroid strike, but to CO_2 and other gases from an enormous, "paroxysmal" spate of volcanic eruptions. There was evidence of just such a volcanic outpouring at about the right time. Either way, the killer had been a shocking atmospheric change.[3]

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[1] National Academy of Sciences (1975), quotes p. 7; criticism, extinction: Ehrlich et al. (1977), pp. 690-91. Ozone effects were announced in 1974, see *New York Times,* Sept. 6, 1974, p. 1; Nov. 12, 1974, p. 38.

[2] Schneider and Londer (1984), p. 205n; Alvarez et al. (1980); cooling of up to 40°C for up to a year over continents was calculated by Pollack et al. (1983).

[3] McLean (1981); McLean (1985); Officer et al. (1987) ("paroxysmal" in their title); for the controversy, see Glen (1994); for a general discussion of issues, Palmer (1999); for a short summary, Huggett (1990), pp. 171-78.

The dinosaur-extinction debate became passionate, sometimes personal and embittered, carrying forward a tradition of geological controversy that stretched back to the 18th century. On one side had been traditional "catastrophists," whose historical roots connected them with Bible fundamentalists and Noah's Flood. They had argued ardently that vast cataclysms in the past had suddenly extinguished entire sets of species. By the late 19th century these views had been driven from the field of professional scientific discussion by the views of so-called "uniformitarians" (a more precise term would have been "gradualists.") These scientists had amassed convincing evidence that evolution acted over millions of years, responding to the slow rise of mountain chains or the parting of continents. By 1980, however, some paleontologists were beginning to be persuaded that species could evolve in a "punctuated" pattern. In short, the catastrophist viewpoint was raising its head again. Anyway that was how the opponents caricatured the movement—the actual scientific arguments were of course more complex.[1] Underneath the science, what mattered was a picture in which dinosaurs did not decline gradually over eons, but fell in their prime, struck down by a random doom. The unspoken and repugnant implication was that any species (maybe even our own) could be extinguished in an arbitrary moment.

The most likely way that could happen was through nuclear war. The effect of bombs on climate had been taken up again in 1981 by Paul Crutzen. A Dutch scientist interested in aerosols, Crutzen had helped set off the stratospheric transport controversy of the early 1970s by showing how airplane emissions could destroy ozone. After working at the Air Quality Division of the U.S. National Center for Atmospheric Research and was now employed in Germany. Crutzen had recently been in Brazil, collecting samples of smoke to check the contentious claim that slash-and-burn destruction of forests was a major source of atmospheric CO_2. Reviewing the 1975 National Academy report, Crutzen worried that the study group had focused on dust without taking full account of how much smoke, NO_x, and other smog could arise from the firestorms of industrial centers and forests torched by bombs. People had known for many decades that the smoke from great forest fires could dim the sunlight thousands of miles downwind. Crutzen concluded that nuclear war, much like the Alvarez asteroid, could send the world into a frozen twilight.[2]

Atmospheric scientists were well-placed to take up the question of smoke from a nuclear war. Measurements like Crutzen's of the effects of soot and the like had greatly advanced since the 1975 study. Richard Turco and others, working on the dinosaur extinction problem, had developed a computer model of a haze-filled atmosphere, and it had occurred to them that dust lofted by the explosions of a nuclear world war might have effects comparable to the dust from an asteroid impact. Meanwhile James Pollack and Brian Toon had been working with Carl Sagan on how the aerosol smoke from volcanoes could affect climate. Joining forces, the groups calculated that after an exchange of hydrogen bombs, the sooty smoke from burning cities could

[1] Huggett (1990); Palmer (1999).

[2] Crutzen and Birks (1982); on the history, see Levenson (1989), pp. 214-18; Davidson (1999), pp. 360-71.

bring on a "nuclear winter"—months or even years of cold so severe it would gravely endanger living creatures.[1]

The scientists did this work mainly for public consumption. When they announced their results in 1983, it was with the explicit aim of promoting international arms control. Surely the likelihood that all-out nuclear war was literally suicidal would persuade nations to reduce their arsenals? As a side effect, the studies helped to improve scientific understanding of how aerosols could affect climate.[2]

The computer models were so simplified, and the data on smoke and other aerosols were still so poor, that the scientists could say nothing for certain. Critics, mostly people opposed to nuclear disarmament, quickly pointed out the deficiencies. In the mid 1980s, detailed studies confirmed that a nuclear war would probably alter global climate temporarily. But as Schneider and a coauthor explained in a widely read article, it was not likely to bring an apocalyptic winter, but only a dangerous "nuclear fall."[3] There were so many variable factors that nobody could say with confidence what would happen. (More recent research has not changed the situation: the devastation wrought by a full-scale nuclear war would probably, but not certainly, include a severe but temporary degradation of climate.)

By the late 1980s, a wide variety of geological evidence supported the hypothesis that the doom of the dinosaurs had been a climate catastrophe. The cause perhaps included enormous volcanic outbursts, and certainly a great asteroid strike, which had shrouded the atmosphere not only with dust but with smoke from vast wildfires ignited by the asteroid's blazing descent. Accepting the idea, most geologists moved on to inquire whether exceptional asteroids or volcanic eruptions might have caused the other great extinctions in the geological record. The vociferous disputes over nuclear winter and dinosaur extinction had made scientists and the public more sensitive than ever to the way stuff emitted into the air could push a severe climate change.

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[1] A one-dimensional radiative-convective model. Turco et al. (1983); the biological consequences were discussed by Ehrlich et al. (1983), whose prestigious authors included Carl Sagan, George Woodwell, Stephen J. Gould, Ernst Mayr, etc.

[2] Poundstone (1999), pp. 292-319; Badash (2001).

[3] Thompson and Schneider (1986). See Sagan and Turco (1990).