

Climatic change with nuclear war

SIR—In August 1984, I pointed out in *Nature*¹ that the article by Turco and others² on nuclear winter did not arrive at a firm scientific conclusion, and is subject to numerous doubts. Fourteen months later, one of the authors, Carl Sagan³, moderated his statement, which had been reiterated in publications as diverse as *Parade*⁴ and *Foreign Affairs*⁵, that nuclear winter is a robust conclusion. His acknowledgement that the question must be further investigated is welcome. Unfortunately, the current article⁶ contains ambiguous and inaccurate statements.

As an example, Sagan³ quotes from the recent analysis by the International Council of Scientific Unions⁷. He fails to mention the conclusions of this study: that no nuclear winter is to be expected in the Southern Hemisphere, that considerable temperature declines could occur only in the northern latitudes in the summer and

the mid-continental areas. In mid-summer the effect will not be worse than those in fall or early winter. By contrast, the original TTAPS report, which Sagan calls a "valid first-order assessment", predicted a minimum hemispheric average temperature of -23°C .

To escape the danger of nuclear winter, Sagan suggested the reduction of stockpiles, which unfortunately requires faith in the reliability of Soviet compliance. Sagan has published in *Foreign Affairs*⁸

gave rise to soot, the darkening of the sky and to the consequent biological catastrophe.

The survival of approximately half the living genera witnesses the toughness of life on Earth. A reasonable estimate of both the energy released and the smoke

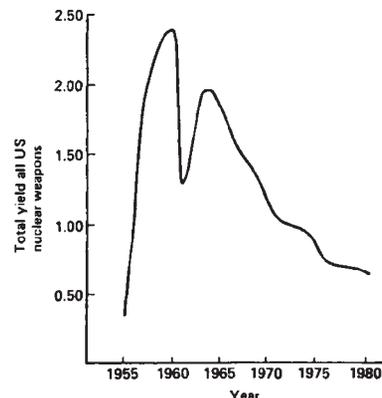


Fig. 3 The reduction in the total yield of US nuclear weapons over the years. Relative scale. 1972 = 1.00.

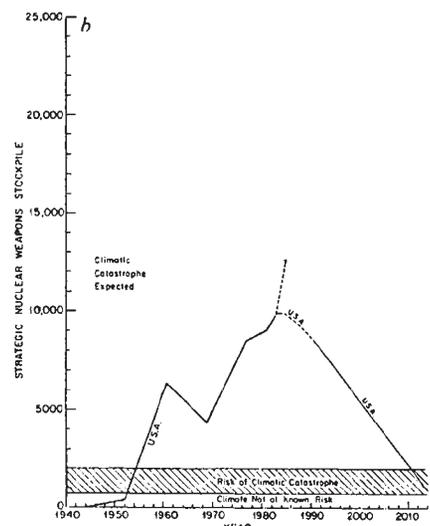
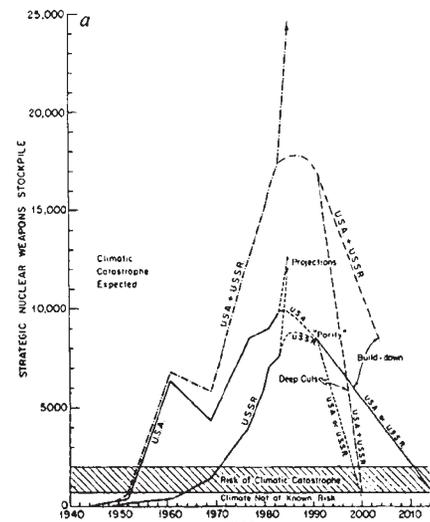


Fig. 1 a, Sagan's estimate of numbers of US and Soviet strategic nuclear weapons. b, An adaptation of Sagan's estimate of the numbers of US and Soviet strategic nuclear weapons.

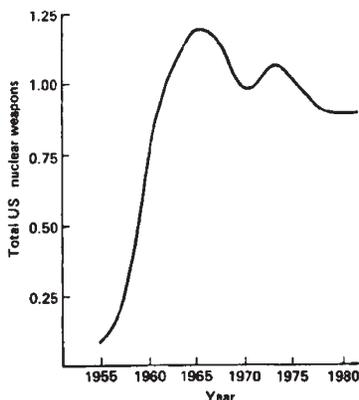


Fig. 2 The history of the relative numbers of US nuclear warheads. There has been a clear reduction in the total numbers. The scale is relative, with 1972 = 1.00.

data on the past and future numbers of nuclear weapons in the various stockpiles (Fig. 1). By contrast, the US government published⁹ relative figures on the time dependence of the American stockpile in regard to number of explosives and in regard to megatons (Figs 2, 3). It will be noted that the former have declined in the past two decades by 30 per cent, the latter by 75 per cent. This latter value is particularly significant in predicting worldwide effects. All of this was independent of disarmament negotiations.

To diminish the likelihood of the catastrophic impact of warfare, one should give most serious consideration to defensive measures. These may not only deter war but, in the horrible case of actual hostilities, the effect of nuclear war would be substantially reduced.

A basis of Sagan's claims is the work published by Alvarez and colleagues^{8,9} which adduces the presence of an iridium layer deposited 65 million years ago as evidence that an asteroid several miles in diameter hit the Earth. The subsequent dust excluded sunlight and led to the extinction of the saurians and many other species. On 11 October 1985, an additional paper was published¹⁰ where deposition of a terrestrial carbon layer was found to coincide with the iridium layer. The authors offer the plausible explanation that approximately 10^{31} erg was set free by a collision with an asteroid. This killed much of the vegetation, set forest fires and

emitted following the impact of an asteroid surpasses the total energy and smoke released in a nuclear war by a factor of 1,000. In this scenario the massive amount of smoke may well have overcome the effects of atmospheric moisture.

By contrast, in a nuclear war, as was pointed out¹, the mass of smoke is 10^{-4} times the mass of H_2O in the atmosphere at the corresponding latitudes. Thus an "asteroid" winter seems plausible but hardly a nuclear winter.

Both Sagan and I are rightly worried and are rightly considering the damage a nuclear war may produce. We differ in many respects, but most particularly in my concern about the direct and the intended effects of nuclear war, including the local effects of prompt radiation, while Sagan has concentrated on side effects. These side effects are obviously dwarfed by an event for which there is geological evidence.

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