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Nuclear winter

Towards a scientific exercise

from K.A. Emanuel

THE detonation of the first atomic bomb on 16 July 1945 changed the world in many ways, not least of which is the view some scientists have taken towards their profession. Many have come to feel that resposibility for the influence of their achievements rests partially with them and should not reside solely with politicians. While imparting certain benefits to political decision making, this attitude has at times tainted the objectivity that is crucial to scientific endeavour. Nowhere is this more apparent than in the recent literature on 'nuclear winter' research, which has become notorious for its lack of scientific integrity. Among the most serious criticisms levelled at this work has been the failure to quantify the large uncertainties associated with estimates of the war-initiated fires and their combustion products, the highly approximate nature of the global circulation models used in the calculations, and the appearance of the results in popular literature before being exposed to the rigours of peer review.

Although controversy continues to surround this work, serious research is beginning to qualify the earlier bold assertions. A good example appears on page 301 of this issue in the paper by B.W. Golding, O. Goldsmith, N.A. Machin and A. Slingo, which attempts to examine the physical factors affecting the disposition of a smoke plume shortly after its inception. These authors point out that previous estimates of the nuclear winter effect have relied either on one-dimensional models, which must assume a uniform distribution of smoke, or on three-dimensional models with grid intervals too large to resolve mesoscale (medium-scale) circulations very near recently initiated plumes. Yet it is likely that such circulations would result from the horizontal temperature gradients produced by radiative heating of the smoke.

Using a mesoscale numerical model, Golding *et al.* show that mesoscale ascent rates of 20 cm s^{-} are possible 12 h after plume initiation; such rates will rapidly lead to condensation of water vapour even in circumstances where the air is initially quite dry. Subsequent scavenging of the smoke by precipitation could substantially alter the characteristics of the plume before it diffuses into the continental-scale pall which is the starting point of most nuclear winter calculations.

The calculations presented by Golding *et al.* are themselves dependent on assumptions concerning the concentration, geometry and radiative characteristics of the smoke plume and the large-scale meteorological conditions in which it is released, and the model does not explicitly deal with the interaction of condensed water and snoke particles. The results do strongly suggest, however, that more attention must be paid to the mesoscale characteristics of the plume in the first day or so of its lifetime. The paper is a welcome step in transforming nuclear winter research from a means of political advocacy to a scientific exercise. □

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