Keeping supercomputers under control

SIR—The Purdue Water Resources Reseach Center in conjunction with the Office of Health and Environmental Research of the US Department of Energy recently co-sponsored a meeting on the current uses of, and future needs for, supercomputers in hydrology. 'Supercomputers in Hydrology: Future Directions', the first meeting of its kind, aimed to evaluate the need for large-scale vector and parallel processing machines and their peripherals in the hydrologic sciences, especially in subsurface hydraulics. While the charge of the seminar was to specifically deal with hydrologic applications of supercomputers, the conclusions drawn at the meeting apply equally well to many other fields of science and technology.

Almost all technical issues involving the use of supercomputers were presented either by a computer scientist, a programmer or an applied mathematician. Because the architecture of most supercomputers is radically different from scalar processing machines, this is no surprise. The real importance of this observation is the implied increase in need for multidisciplinary research teams to solve major ecological problems. Unfortunately, in the United States, many of the larger supercomputer funding initiatives do not address this issue at all.

This defect in the supercomputer initiatives leads to two major problems: scientists not doing 'science' and the inefficient use of supercomputers. If funds were available to support programmers with expertise on a machine of a certain architecture, the scientist would only need to communicate effectively with the programmer. The projected changes in architecture affect the programmer and not the scientist; hence the scientist is free to do science.

An alternative to long-run funding of programmer-consultants is for the initiatives to increase their effort in the development of very high level languages. Rice of Purdue's Computer Science Department gave a talk on projected advances in hardware and software over the next 10 years. From 1975 to 1985 computing speed increased by a factor of 25. Between 1985 and 1995 the speed is projected to increase by a factor of 2,000. On the other hand, from 1975 to 1985, computer languages have been improved by a factor of only 1.4. Unless more funding is made available for the development of high-level languages, improvement in ease of coding is not expected to increase nearly as fast as machine computational power. In fact, because of radical changes in architecture, programming may well become more difficult.

Another important point brought out at the seminar is that advances in science should not be overpowered by advances in computational capability. Do we really improve our fundamental understanding of science by looking at larger and larger computational problems? Many would argue that the understanding of complex chemical and physical interactions in the subsurface and the ability to estimate parameters is so poor that the large supercomputer models may in fact be totally incorrect. In this instance, supercomputer modelling efforts may turn out to be a greater obstacle to real progress than no model at all.

So there is clearly a role for supercomputers, but the extent of this role will depend on the availability of high level languages, expert programmer consultants working closely with multidisciplinary teams, exposure to different computational systems, and a judicious choice of problems with the aim of advancing our understanding of science.

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The real hazards of nuclear fallout

SIR—In his article "On minimizing the consequences of nuclear war"[1], Carl Sagan is misleading in his discussion of the dangers of radioactive fallout. Our remarks on this question are made in the spirit that the goal of scientists is to be as accurate and unbiased as possible in assessing the potential or alleged impacts of an event such as nuclear war, and that either minimizing or maximizing these consequences is a disservice to the general public and to decision makers who seek guidance. If scientists are not accurate, credibility is lost and messages from the scientific community will eventually be ignored.

To our knowledge, the serious consequences of local (or early) fallout, that which is deposited during the first 24 hours, have been accepted by the scientific community for over three decades. Projections of the intensity and extent of local fallout are highly sensitive to a number of variables, which helps explain why different assessments have produced widely different results. Uncertainties in these projections can be divided into three categories, those due to (1) the targeting scenario, (2) the fallout calculation model and (3) the selected meteorological conditions.

The targeting scenario contains variables such as numbers of weapons, the yield mix, fission fraction, height of burst and precise target locations. The height of burst (HOB) is of particular significance because air bursts do not produce significant local fallout, except for the possible rainout of debris from tactical yield weapons. Only when the fireball interacts with the ground (a ground level or near ground burst) does significant local fallout ensue. A reasonable assumption often made is that hardened military targets are targeted with ground bursts. For the 'softer' industrial and other military targets, maximum damage is accomplished by air bursts where the HOB can be optimized. The primary fires hypothesized in urban areas in 'nuclear winter' studies are assumed to be initiated by airbursts, because ground bursts have shorter range for initiating fires. Hence, maximizing smoke production implies minimizing local fallout. (2) Uncertainties in dose calculations in the best fallout models originate from several sources. These uncertainties are due to limited experimental calibration data, whether the modelled radioactivity is rigorously conserved, and whether time of arrival is properly accounted for. (3) Assumptions about selected meteorology — such as wind velocities, shears, precipitation patterns — affect the results. Hence local fallout assessments can vary greatly depending on these many assumptions.

In assessing the human impact of local fallout, additional factors must be considered. By far the most sensitive of these is the protection factor afforded by structures, such as homes, buildings, basements, and shelters. These structures can dramatically mitigate the unprotected dose assessments normally cited. An additional important consideration is the assummed lethal acute external whole body dose levels. Finally, for radiation exposure that is protracted in time, biological repair of the resulting damage is important in mitigating the effects[2]. This is especially important with regard to global fallout, where the dose is received slowly over many years. Dose effectiveness factors from 0.1 to 0.5 for chronic exposures have been suggested[2]. This means that a large chronic dose will have an effect equivalent to a much smaller acute dose. Any presentation that implies that our planet would be a radioactive desert of certain demise is not including these important factors in a balanced sense; hence, inaccurate and biased estimates can be created. Calculations of total fatalities produced by large-scale attacks on the continental United States undertaken by our group have produced estimates of fallout fatalities (after subtracting those already killed by blast and thermal effects) that range over almost two orders of mag-