# A climate for better models

The biggest game in climate research today is building the best numerical models of the global atmosphere, and its players engage in intense competition. 'Model intercomparisons', as they're called among the researchers in the know, have begun to fill the scientific literature.

Computer-generated simulations of temperature or wind patterns are compared mercilessly with reality and discussed *ad nauseam*, in dispassionate but pointed language. If your model displays 'large RMS errors' or fails to 'capture the general large-scale' structure of the seasons — perhaps due to 'a particularly coarse horizontal resolution' — then basically it's back to the computer-aided drawing board. In an analysis of 16 global atmosphere models, organised in 1991 by the World Meteorological Organisation, the modellers received a capital 'C' for getting it right, a lower-case 'c' for getting it nearly right, and a 'B' for giving the other modellers something to laugh about.

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The validation of models is, of course, a serious business, especially as governments increasingly rely on them in making important and potentially costly policy decisions concerning abatement of climate change due to the enhanced greenhouse effect.

In a new study, CSIRO's climate impact group compared the performance over the southern and south-east Asian region of four leading models; these included the group's own model, CSIRO 9. In their analysis, the researchers looked for high 'pattern correlation coefficients' (that is, closely similar geographical patterns of variation between the simulation and the observations) and low 'root mean square or RMS errors' (that is, small differences at each geographical point between the simulated and actual values of a climatic factor).

For simulating mean sea-level pressure for all four seasons, the United Kingdom Meteorological Office high-resolution model (UKMOH) did best, scoring an average of 0·89 out of a possible 1 for pattern correlation and an average of 1·5 hPa for RMS error (zero is a perfect score). Second came CSIRO 9, scoring 0·77 and 2·7, followed by the Canadian Climate Centre model and the United States Geophysical Fluid Dynamical Laboratory high-resolution model.

On simulating temperature CSIRO 9 shared the top honours with UKMOH, but it was clearly the best for rainfall simulation (generally the hardest climatic factor to get right), scoring 0·58 for pattern correlation and 2·8 mm per day for RMS error. In total, CSIRO 9 was slightly more accurate than UKMOH, while the other two were well back.

The heartening result for CSIRO's climate modellers is that, although CSIRO 9 has a relatively low spatial resolution, it appears to perform as well as higher-resolution models for the southern Asian region. So what are they predicting for this extremely important region under enhanced greenhouse conditions? First of all, modellers hate the word 'prediction' — it makes them think of crystal balls and tarot cards. A climate model generates 'scenarios' that tell you how the climate may respond if we disrupt or perturb it — for example, by adding a few billion tonnes of $CO_2$ to the atmosphere each year.

The scenario for southern Asia is, basically, more rain. According to the models, a doubling of atmospheric $CO_2$ (or its equivalent from all greenhouse gases) would — as the atmosphere reached equilibrium — cause a 17 to 59% rise in rainfall during the wet season in northern India, Pakistan and Bangladesh and a change of between –5% and +18% in Indonesia, eastern Philippines, coastal Viet Nam, Sri Lanka and Malaysia. In addition, CSIRO 9 estimates that heavy rain events, which already cause widespread flooding throughout southern Asia, could increase in intensity by up to 20%, especially during the wet season.

Given that India and Pakistan, respectively, are likely to be the most and fourth-most populous nations on Earth by the middle of next century, that's bad news for humanity, but there is a highly significant caveat. The model's calculations are dependent on how far global air temperatures will rise for a given concentration of $CO_2$, and on how much $CO_2$ human activities will emit during the next 50–80 years.

If world population growth is kept to fewer than 6·5 billion by 2100, and economic growth for the next century is maintained at a low 1·2% a year, greenhouse emissions should decline and the estimated changes in rainfall intensity in the southern Asian region could be restricted to less than 5% (the precise estimate depends on the sensitivity of the climatic system) by 2070.

This is the relatively good news from the modellers.

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