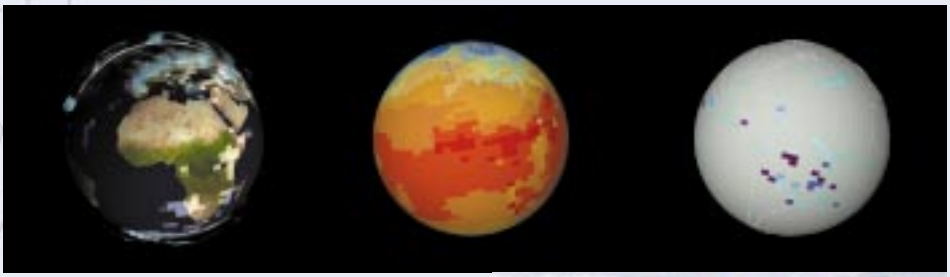
Brute force approach to Climate Prediction

Climatologists face a dilemma when making predictions with their current climate models. Most models predict significant changes to the Earth's climate in the coming century, but there is enormous variation in exactly what they predict. The Climate Prediction project hopes to help address this climatic uncertainty.

To tackle this problem, confidence in the predictions from climate models must be evaluated, say the developers. The current generation of atmosphere-ocean general circulation models (AOGCMs) can simulate many large-scale features of present-day climate and recent climate change with a high degree of accuracy. However, even with the incredible speed of today's supercomputers, climate models have to include the effects of small-scale physical processes (such as clouds) through simplifications (parameterisations). The many variables incorporated into these models are simply too poorly constrained by the available data. Any one variable could have a significant impact on climate simulation.

There are two complementary approaches to reducing this uncertainty. The first involves improving the parameterizations while narrowing the range of uncertainty in the parameters. This is a continuous process and requires building better models using the latest supercomputers. It also requires the gathering of more data on a wide range of atmospheric variables, wind speed, cloud cover, and temperature.

The second approach involves carrying out large numbers of model runs in which the parameters are varied within their current range of uncertainty. Those that fail to model past climate successfully are rejected and the successful ones used to study future climate. The problem boils down to varying the "underdetermined" parameters and repeating the simulation and forecast in order to obtain a spread of forecast climates that are consistent with recent climate change. This is the Climate Prediction approach.



By running hundreds of thousands of climate models with slightly different physics, the whole range of uncertainties in all the parameterizations can be tackled. This ensemble forecasting approach requires an enormous amount of computing power, far beyond the currently available resources of cutting-edge supercomputers, because the number of underdetermined parameters can be very large. The chaotic nature of AOGCMs precludes the use of linearisation techniques to identify "pathological" parameter-perturbations, and it has already been shown that the impact of multiple perturbations is not additive.

This leaves no alternative to a "brute-force" exploration and running very large numbers of long climate model integrations. The only practical solution is to appeal to distributed computing, which combines the power of thousands of ordinary computers, each computer addressing a small but key part of the global problem.

The project has already recruited 37,000 home and business personal computer users to provide a share of their unused computer power in a massive distributed system. By participating in the experiment, home users can help the researchers address the problem of uncertainty. Climateprediction.net will harness this distributed computing power to make the first fully probability-based fifty-year forecast of human-induced climate change using a full-scale 3-D atmosphere-ocean climate simulation model.

www.climateprediction.net
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