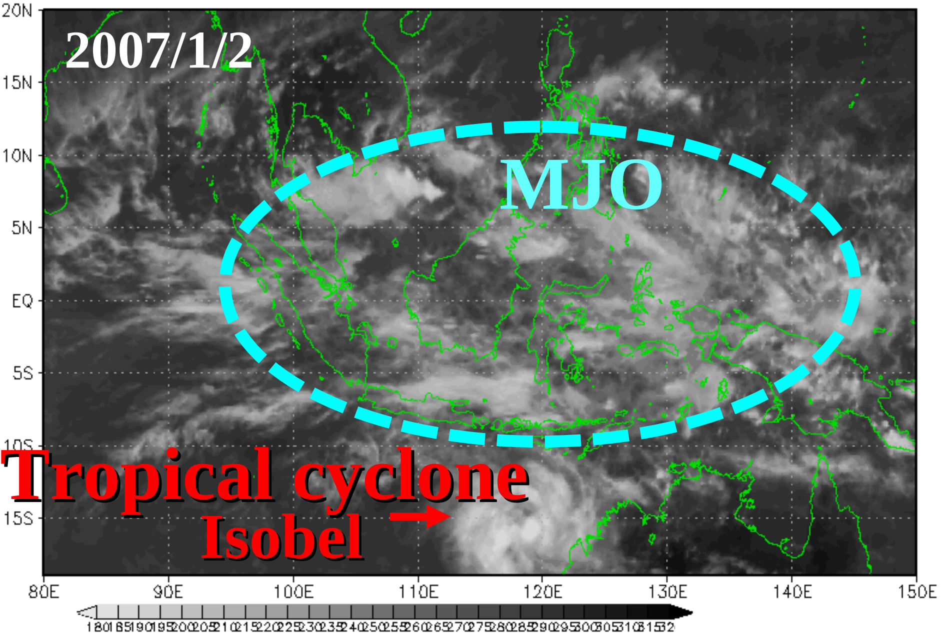
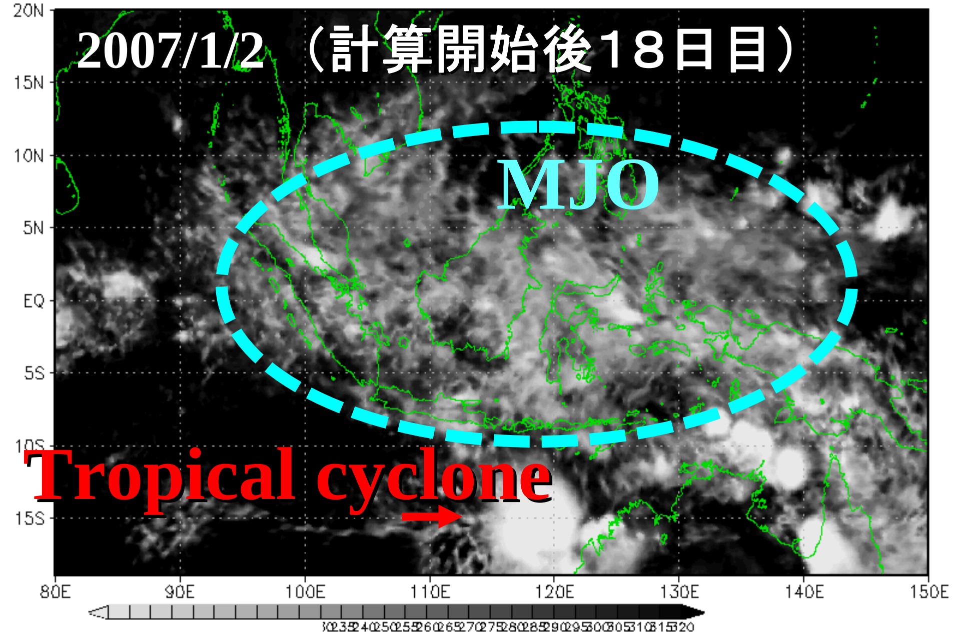
2週間先の台風が予測可能？

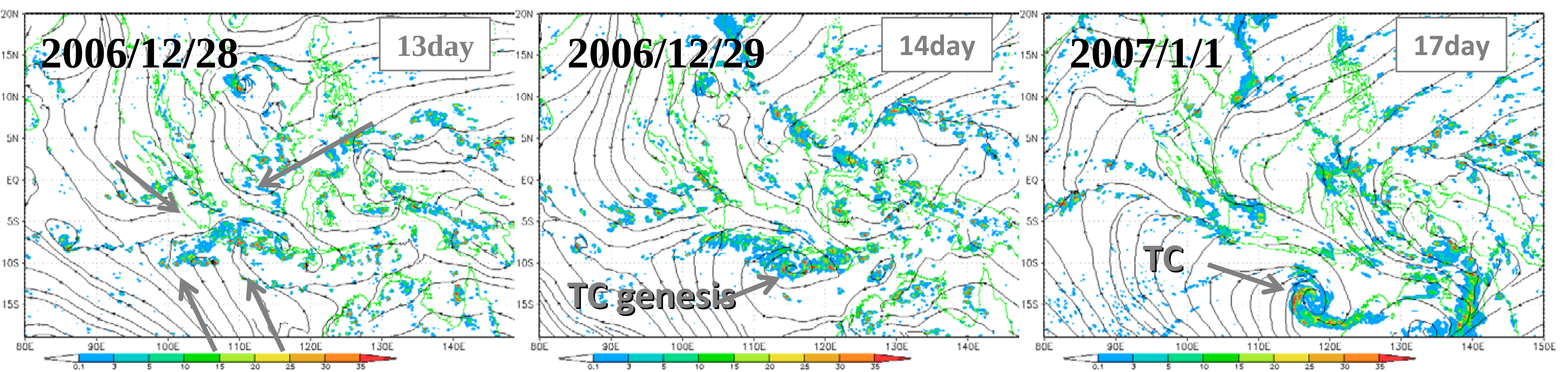
MTSAT Infrared Image



NICAM



Rain and streamlines



Fudeyasu & NICAM group

World Modelling Summit for Climate Prediction

ECMWF - Reading (UK), May 6-9, 2008

NEWS

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They say they want a revolution

Climate scientists call for major new modelling facility.

Climatologists have called for massive investment in computer and research resources to help revolutionize modelling capabilities. The eventual aim is to provide probabilistic climate predictions that are as useful, and usable, as weather forecasts.

At the end of a four-day summit held last week at the European Centre for Medium-Range Weather Forecasts in Reading, UK, the scientists made the case for a climate-prediction project on the scale of the Human Genome Project. A key component of this scheme, which would cost something up to, or over, a billion dollars, would be a world climate research facility with computer power far beyond that currently used in the field.

"We need to be breathtakingly bold." — Leo Donner

Questions on how severe the effects of global warming will be, and which regions will be hit in what ways, are beyond the capabilities of current climate science, at least in part because of computing constraints. Today's climate models are run on computers in the 10-teraflop range, meaning they are capable of 10 trillion operations a second. Despite this speed, models on these computers are still coarse-grained, cutting the world into cells more than 100 kilometres across.

Increasing computing power 10,000 times — to speeds in the hundreds of petaflops — would allow modellers to study simulations at the kilometre scale, enabling better predictions on the activity of hurricanes and, eventually, the local deep convection that transfers much energy into the upper atmosphere (see 'A real solution?'). This research could then be fed into operational models.

The scientists think they could answer at least some of the 'big' questions on the effects of global warming if the technology was available. But national climate-modelling efforts, such as those of the Met Office in Exeter, UK, or the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, aren't attracting the required level of funding. Although Japan's Earth Simulator in Yokahama was once the world's fastest computer, there are now 29 faster ones, with the first petaflop machines only months away.

"We need to be breathtakingly bold, frankly, in terms of some of the calculations that we're going to do in order to push the climate-prediction effort forward," says Leo Donner, a physical scientist at the Geophysical Fluid Dynamics Laboratory of Princeton University, New Jersey. Antonio Navarra, a climate modeller at the National Institute of Geophysics and Volcanology in Bologna, Italy, spells out the implication: "We're reaching the point where national resources are insufficient to answer the scientific questions."

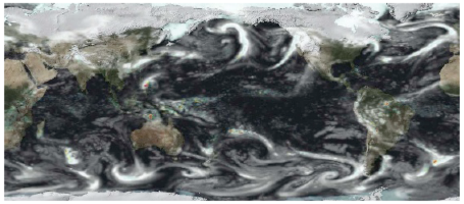
Researchers from around the world gathered in Reading, UK, for the summit.

More money and cutting-edge challenges would also provide some hope of retaining highly trained programmers with expertise in climate modelling. Conference chair Jagadish Shukla of the Institute of Global Environment and Society in Calverton, Maryland, says this resource is "decreasing faster than the sea ice" as staff are lured from research by the financial rewards and job security provided by companies such as Google.

Addressing the summit on its opening day, economist Jeffrey Sachs, the director of the Earth Institute at Columbia University, New York, said that there would be "a lot of interest among politicians in investing the hundreds of millions of dollars necessary, if scientists can provide answers to key questions... such as future food supply". Although governments are the obvious source of funding, Lawrence Gates, a now-retired climate scientist from the Lawrence Livermore National Laboratory in California, urged the attendees to explore philanthropic options.

How increased investment is divided between new facilities and existing ones is likely to be controversial. Some fear that a single global institute could threaten national centres, potentially taking the onus off governments to fund the institutions that are closest to stakeholders and could be expected to provide the predictions that have most real-world use. "Everyone is agreed that there needs to be a substantial investment in climate modelling, but whether a single centre is the solution is another question. There may be other ways," says John Mitchell, the chief scientist at the Met Office. Donner says that a sketch, presented on the conference's last day, of how the global facility might fit into the research world "seems to relegate national centres to little more than distributors of data".

However, Shukla was adamant that "every science breakthrough leads to the formation of an



State of the art: a model (left) from the UK National Centre for Atmospheric Science and the Met Office running on Japan's Earth Simulator.

a darwinian change in the way we are working and we shouldn't be afraid of that," says Navarra. The meeting could have come to grief on such differences, according to Julia Slingo, the director of the Centre for Global Atmospheric Modelling at the University of Reading, but in the end the level of consensus, she says, was "fantastic".

Various attendees expressed frustration at the fact that the new facility could not be funded purely on the basis of the world-class science it would do — and indeed the fact that it would produce great research might count against it, making it seem more like a "toy for the boys" than a policy-informing instrument.

"If we just ask for enhanced understanding, then we have very little chance of getting the necessary funding," warned Shukla. But as Mitch Moncrieff from NCAR put it "we need a quantum leap in research to provide better predictions, even if the politicians don't get that". And there was widespread agreement that they need to get it fast. "We need a revolution as it has got to be done extremely quickly", said Brian Hoskins, director of the Grantham Institute for Climate Change at Imperial College London, UK. ■

Olive Heffernan

A real solution?

Is the answer to climate prediction sitting in your pocket? Lenny Oliker, John Shalf and Michael Wehner of the Lawrence Berkeley National Laboratory in California think it could be. In a proposal discussed at the Reading climate-modelling summit (see main story) they suggest that the very small processors in mobile phones might be ideal components for very large climate computers — if 20 million of them could be wired together in the right way.

To run at the sort of kilometre-scale resolution that could accurately model cloud processes, they argue, a computer has to be able to run at a sustained speed of around 10 petaflops, and a peak speed of perhaps 20 times that or more. If built with traditional high-performance chips such as AMD's Opteron or Intel's Xeon, such a machine would be extremely expensive and power-hungry — perhaps requiring as much as 100 megawatts. Processors developed for cell phones are small — less than a square millimetre in area — and frugal in their power requirements, needing less than a tenth of a watt each. These advantages, the researchers argue, far outweigh the slower speed at which such processors work and would permit construction of a multi-petaflop computer that was much cheaper both to build and to run.

In some ways this is an extrapolation of the approach that IBM has taken to its successful Blue Gene line of supercomputers, which also rely on many relatively small and slow processors. But it goes further in the sheer number of processors and in an architecture designed specifically for the demands of climate calculations, rather than general-purpose computing.

Per Nyberg of Seattle-based supercomputer makers Cray — which, like rivals IBM and NEC, sent speakers to the summit with an eye to business opportunities — was understandably sceptical. "You can come up with back-of-an-envelope calculations about how cheaply you can build a computer but you have to be very, very careful." He argues that radical approaches can founder on software and on efficiency of usage, with a useful rate of number crunching far below the peak speed. And if the machine doesn't work as advertised, the expense of developing programs for it could be wasted. Wehner acknowledges the risks, but thinks careful prototyping and code development could minimize them. "We should build it and see," he says. **Oliver Morton**