THE PAST, THE PRESENT AND THE FUTURE OF GLOBAL WEATHER AND CLIMATE MODELLING

WEDNESDAY 25 APRIL 2007

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The emergence of weather and climate modelling: Richardson's dream – Prof Peter Lynch, School of Mathematical Sciences, University College Dublin
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The basic ideas of numerical forecasting and climate modelling were developed about a century ago, long before the first electronic computer was constructed. However, there were several major practical obstacles to be overcome before numerical prediction could be put into practice. In this presentation, we will trace the history of numerical weather prediction from the work of the early pioneers, Abbe, Bjerknes and Richardson, to the first computer forecast on the ENIAC computer in 1950 by Jule Charney et al. and the first simulation of the general circulation by Norman Phillips. A reconstruction of the ENIAC forecasts will be described.

Global weather and climate modelling expands to cover the globe – Prof Tony Slingo, Environmental Systems Science Centre, University of Reading
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This talk will focus on the period when several groups around the world started work in numerical weather prediction and climate modelling, while at the same time the models became global in coverage. This was made possible by advances not only in computers but also in the development of efficient numerical algorithms. Parameterisations were developed to deal with the unresolved processes; some highlights will be discussed. The very different trajectories followed by weather forecast and climate models in dealing with model resolution, complexity and ensembles illustrates the different priorities in the two applications. Despite some divergence between the two types of model, the ECMWF weather forecast model was turned into a successful climate model, while the ultimate example of NWP and climate model convergence is of course the Met Office Unified Model.

Global NWP over the last 15 years – Dr Philippe Bougeault, European Centre for Medium-Range Weather Forecasts Philippe.Bougeault- at -ecmwf.int
The talk will review the landmarks of global NWP development over the last 15 years at ECMWF and other global prediction centres. The three major factors of progress have been the increase in model and data assimilation resolution (made possible by the regular

increase in computing power), the increase in the number, quality and diversity of satellite data (made possible by the large investments in meteorological satellites in Europe and North America) and the improvements of the forecasting systems, i.e. the model physical and numerical aspects and the data assimilation methods - e.g. the 4D-Var (made possible by the investments of meteorological services in NWP research and development). Examination of the forecast skill from recent re-analyses is one possible method to determine how much each of the three factors above have contributed to the current good forecast skill. Another major development has been the start of the operational ensemble prediction in most global NWP centres, which is now culminating in the on-going TIGGE project, which aims to exchange operational ensemble forecasts from ten global NWP centres in real-time. An important question for any global prediction centre nowadays is therefore how to split computing resources between deterministic and ensemble forecasts. The talk will offer some considerations relevant to this question.

Global climate modelling: the last 10 years – Ms Catherine Senior, Hadley Centre, Met Office cath.senior- at -metoffice.gov.uk
This talk will cover the period that Arakawa has called the 'Great challenge third phase of numerical modelling'. I will focus on the challenge for climate modelling by considering progress on the three axes of uncertainty; Resolution, Complexity and Ensembles. At the Met Office, we started to use the Unified Forecast and Climate model in 1991 and this has enabled benefits to be gained across time and space scales within the UM system. Benefits of progress in resolution and atmospheric and ocean physics will be described through use of examples of methods of improvement. The substantial increases in complexity throughout the period will be covered and examples of their impact on simulations of both present day climate and future climate changes will be highlighted. Finally, this era has marked the start of the use of ensembles in climate prediction and has enabled the application of robust methods of detection and attribution of climate change and the move towards probabilistic climate prediction.

Future global NWP – is high resolution the answer? – Dr Richard Forbes, Joint Centre for Mesoscale Meteorology, Met Office richard.forbes- at -metoffice.gov.uk
The relentless increase in computing power over the last few decades has led to a corresponding increase in the resolution (and accuracy) of operational global NWP models, with resolutions of around 10 km feasible within the next decade. Operational limited area models are already approaching kilometre scale resolutions and can provide an insight into the possible future of convective-scale global modelling if trends continue. But do we keep on and on increasing the resolution, from 10 km to 1 km, from 1 km to 100m? What about predictability? We will never get away from uncertainty in NWP and the time-scales and space-scales of predictability are intimately linked. A vital component of any future global NWP system will be an appropriate method to address the uncertainty in the prediction problem at all time and space scales. This talk will use examples from kilometre-scale limited area modelling to discuss some of the issues surrounding high resolution modelling and predictability for the future of global NWP.

Future climate modelling: bringing together climate and weather processes – Dr Pier-Luigi Vidale, NCAS Climate p.l.vidale- at -reading.ac.uk

Weather and climate modelling has always had to contend with limited resources, especially computing power and data storage, forcing us to compromise between resolution, duration of the simulation and/or size of the ensemble. What if we were suddenly given access to a virtually infinite amount of computing power? The Earth Simulator supercomputer, with its 5120 SX6 processors and peak performance of almost 40 TFlops, became available to the UK climate research community in 2005. Recognising that the typical limitation of current climate simulations is that weather elements, the building blocks of climate, are not properly represented, we set out to build a matrix of climate models to systematically explore the role of resolution in modelling the climate system. We have ported and operated versions of the Hadley Centre's HadGEM1a climate model, with atmospheric resolutions of 135, 90 and 60km and oceanic resolutions of 1 and 1/3 degree, completing several multi-decadal simulations. We will show examples of phenomena that are missing and/or poorly represented in current climate models (coupled and uncoupled), together with their impacts on the mean model climatology. Results of Japanese groups who pursue similar research on the Earth Simulator will also be included.