Organizing Committee

J. Shukla (chair)

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World Modelling Summit for Climate Prediction

European Centre for Medium-Range Weather Forecasts, Reading, UK, May 6-9, 2008

Background:

The reality of climate change has been accepted by the world. Thanks to the sustained, comprehensive and objective assessments by the Intergovernmental Panel on Climate Change (IPCC), a consensus, with a high degree of confidence, has emerged in the scientific community that human activities are contributing to climate change. A systematic program of numerical experimentation with climate models during the past 40 years has played a crucial role in creating this scientific consensus, and in its acceptance by the world.

The nations of the world have therefore begun, with great urgency, discussion about mitigation and adaptation to climate change, the inevitability of which is now beyond doubt. The climate models will, as in the past, play an important, and perhaps central, role in guiding the trillion dollar decisions that the peoples, governments and industries of the world will be making to cope with the consequences of changing climate.

The climate modeling community is therefore faced with a major new challenge: Is the current generation of climate models adequate to provide societies with accurate and reliable predictions of regional climate change, including the statistics of extreme events and high impact weather, which are required for global and local adaptation strategies? It is in this context that the World Climate Research Program (WCRP) and the World Weather Research Programme (WWRP) asked the WCRP Modelling Panel (WMP) and a small group of scientists to review the current state of modelling, and to suggest a strategy for seamless prediction of weather and climate from days to centuries for the benefit of and value to society.

A major conclusion of the group was that regional projections from the current generation of climate models were sufficiently uncertain to compromise this goal of providing society with reliable predictions of regional climate change. Therefore, a major recommendation by the group was that, to meet the expectations of society, it is both necessary and possible to revolutionize climate prediction. It is necessary because adaptation strategies require more accurate and reliable predictions of regional weather and climate extreme events than are possible with the current generation of climate models. It is possible firstly because of major advances in scientific understanding, secondly because of the development of seamless prediction systems which unify weather and climate prediction, thus bringing the

insights and constraints of weather prediction into the climate change arena, and thirdly because of the ever-expanding power of computers.

Climate models are also useful tools for analyzing observations in a consistent physical framework. Analysis and prediction from past observations helps in interpreting the observed historical changes in the climate system and develop confidence in projections of future change.

The group further declared that the scientific expertise to realize this revolution resides in no single nation or scientific discipline, and therefore, a strong collaboration among the nations and among disciplines is required.

Realizing the profound and far-reaching implications of these suggestions, the WCRP, WWRP, and the International Geosphere Biosphere Program (IGBP) decided to organize a World Modelling Summit for Climate Prediction. It is expected that the Summit will provide valuable input to the World Climate Conference – 3. The primary emphasis of the summit will be on simulating and predicting the physical climate system. Since the prediction of regional climate change is strongly influenced both by weather fluctuations on short time scales and bio-geo-chemical processes on long-time scales, the summit includes important elements of the WWRP and the IGBP.

The underlying goal of the summit is no less than to prepare a blueprint to launch a revolution in climate prediction.

Themes:

The Summit will be organized around the following five themes:

1. Overview: societal drivers; current status of weather and climate modeling; strategies for seamless prediction; crucial hypotheses
2. Strategies for next-generation modelling systems: balance between resolution and complexity; balance between multi-model and unified modeling framework; issues of parameterizing unresolved scales and regional models
3. Prospects for current high-end computer systems and implications for model code design
4. Strategies for model evaluation, modelling experiments, and initialization for prediction of the coupled ocean-land-atmosphere climate system
5. Strategies for revolutionizing climate prediction: enhancing human and computing resources; requirements and possible organizational frameworks

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Expectations:

The Summit is expected to:

- Bring together leading scientists from all over the world to rigorously assess and discuss the capabilities of current model systems to fulfill the great expectations society has in them for guiding future adaptation and mitigation activities.
- Develop a visionary strategy that will enable and accelerate progress in the modelling and prediction of regional climate change and variations from days to decades.
- Recommend a realistic roadmap how this revolution in climate prediction can be achieved for the benefit of society.

In order to achieve these goals, it is expected that the Summit will address important scientific and organizational questions related to each theme as for example:

- Current generation climate models have serious limitations in simulating regional features, for example, rainfall, mid-latitude storms, organized tropical convection, ocean mixing, and ecosystem dynamics. What is the scientific strategy to improve the fidelity of climate models?
- Is the low resolution of current climate models due to limitations of scientific understanding or lack of powerful computers and scientific staff?
- Several current operational Numerical Weather Prediction (NWP) centers are using global models with resolutions of 25-50 km. During the next 3-5 years, it is expected that several global NWP models will have spatial resolution of about 10 km. Should the next IPCC assessment include at least a few climate models at about 10 km resolution for oceans and atmosphere?
- What is the strategy to ensure enhanced and sustained modeling efforts and computing power at the existing modeling centers of the world? Or, is the scale of the challenge so large that in addition to the current national efforts, a far more comprehensive, and internationally coordinated approach is needed?
- A large body of evidence based on modeling experiments suggests that as models improve their parameterizations and increase their spatial resolution, the model's ability to simulate the current climate as well as the model's skill in predicting daily and seasonal fluctuations improves. What is the likelihood that if the spatial resolution of climate models is sufficiently increased so that deep convective cloud systems, ocean

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overflows and mesoscale eddies, and heterogeneous land surface processes can be explicitly resolved, and therefore, do not need to be parameterized, the fidelity of climate models in simulating the current climate will improve?

Likewise, how can we ensure that if we replace the traditional strategy of parameterizing unresolved small scale processes (viz deep convection in the atmosphere and mesoscale eddies in the oceans) by resolving the unpredictable scales, the rapid growth of the inherently unpredictable small scale systems does not overwhelm the predictable large-scale flow?

- Will a major enhancement in computing power and dedicated scientific staff to develop data assimilation systems for very high resolution models enhance the value of space observations that are being made at a significant cost?
- It is well recognized that if the global models, from which lateral boundary conditions for regional models are prescribed, do not have reliable simulation of planetary waves and the statistics of tropical and extratropical storms, blocking and other regional phenomena, the use of high resolution regional models to downscale regional climate change is questionable. Is there a less questionable alternative? Are time-slice experiments using very high resolution (as high as regional models) global atmospheric models with surface boundary conditions from global change experiments, less questionable than regional downscaling? How important is coupling with the ocean and land at time and space scales commensurate with those of the atmosphere model? Are there more effective techniques available, perhaps in other disciplines, that could be employed to resolve the relevant features of the climate system?
- How accurate must simulations of the physical climate system be to justify the extension of climate models to include additional complexity due to chemical and biological processes? What time and space scales of coupling are fundamental to the system? What are the appropriate metrics to evaluate climate models?
- What are the current trends in computing? What is the best strategy to foster collaboration and interaction among the weather and modelling community, computational fluid dynamics community and computer (and chip) manufacturers to achieve a million fold increase in the effective computing power for climate and weather modelling and prediction?
- What is the best strategy to foster collaborations among modelling centers around the world? Has the time come for the climate modeling community of the world to establish a dedicated supercomputing facility and a collaborative research framework for climate and weather modelling and prediction that is beyond the capability of a single nation?

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Organization:

The summit will be held over four days, with the first half day featuring high-level invited speakers who will set the general tone for the meeting. This will be followed by 1.5 days of scientific talks related to the five themes and another 1.5 days of discussions in breakout groups. The summit will end with a plenary discussion and a declaration of the outcome of the meeting.

Place:

The summit will take place from 6-9 May 2008 in Reading, UK, hosted by the European Centre for Medium-Range Weather Forecasts (ECMWF).

International Organizing Committee:

An international organizing committee (OC) consisting of scientists from WWRP, WCRP, and IGBP has been formed to develop the themes for the summit. In addition to the members of the OC listed to the left, WCRP and WWRP are represented by:

WCRP

- Dr. J. Church
- Dr. V. Satyan
- Ms. A. Chautard
- Ms. C. Michaut

WWRP

- Dr. L. Barrie
- Dr. D. Burridge

Local Organizing Committee:

Members of the local organizing committee are:

- Dr. R. Hagedorn (chair)
- Dr. M. Miller
- Dr. T. Palmer

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Sponsors:

The summit is sponsored by the following organizations:

- Center for Ocean-Land Atmosphere Studies (COLA), USA
- Cray Inc.
- European Centre for Medium-Range Weather Forecasts (ECMWF)
- IBM
- International Council for Science (ICSU)
- International Geosphere Biosphere Programme (IGBP)
- Intergovernmental Oceanographic Commission (IOC)
- National Aeronautics and Space Administration (NASA), USA
- NEC
- Natural Environmental Research Council (NERC), UK
- National Oceanographic and Atmospheric Administration (NOAA), USA
- National Science Foundation (NSF), USA
- US Department of Energy (DOE), USA
- World Climate Research Programme (WCRP)
- World Meteorological Organization (WMO)
- World Weather Research Programme (WWRP)