



Subject: WCRP Community-Wide Consultation on Model Evaluation and Improvement

To:

- NWP and Seasonal Forecasting Centers
- World Climate Modeling Centers
- WGCM and associated MIPs (PMIP, CFMIP, C4MIP, etc)
- CLIVAR modeling groups (WGOMD, WGSIP)
- CLIVAR regional and monsoon panels
- US CLIVAR panels and working groups, CPTs
- WCRP Task force on Regional Climate Downscaling
- WCRP Projects (CLiC, SPARC, GEWEX)
- THORPEX, WWRP
- IGBP/AIMES

From:

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Errors in climate (ocean-atmosphere-land-ice) and NWP general circulation models substantially limit the skill of climate and weather predictions on a wide range of space and time scales. Identifying these errors and understanding their root cause constitutes a prerequisite for the planning of model improvement activities. On the other hand, translating the wealth of results from process studies, observational campaigns etc. to model improvements is a non-trivial issue for the modeling community.

For this purpose, we propose to initiate a "bottom-up survey" about the key deficiencies of regional and global NWP and climate models. This survey includes problems identified in operational NWP and seasonal prediction centers as well as deficiencies that climate modelers and analysts of CMIP3 simulations have identified for the current generation of models. The priorities identified by the survey will be the basis of model development/improvements across the entire WCRP Projects and activities, and also through its partnership with WWRP, IGBP and ESSP. WCRP is also currently examining the scope and structure of its modeling activities and the outcome of this survey will also inform these decisions/discussions.

We are asking modelers, analysts and process-orientated panels and international projects six targeted questions – see the template overleaf. The success of the survey in identifying priorities and opportunities depends on the involvement and enthusiasm of the participants in the survey either by sharing results and/or identifying actions to be taken.

The main purpose of the survey is to provide input to the strategic planning for model improvement activities that could be coordinated through the various working groups, projects and panels of WCRP. Suggestions for such coordinated activities are welcome. Results from this survey will be reviewed and discussed at the next WGCM and WGNE meetings. The information collected by this survey, including details, links and references on relevant ongoing and new activities (regional observational studies, observations, process modeling studies, theory, etc) will be made available by means of a community resource website and a white paper will synthesize the outcomes of this survey and make recommendations on where international coordination is needed for the development of the next generation of models.

Please complete the survey by 15 September 2009 and submit your response electronically to Anna Pirani at apirani@princeton.edu

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Please complete the following template by writing your answers into the boxes below the questions, sending any supplementary material such as clearly labeled figures in a separate file. Please submit your response electronically by **15 September 2009** to Anna Pirani at apirani@princeton.edu.

Q1: Please state your particular area of interest, e.g. global or regional climate or NWP modeling, seasonal prediction, sea-ice feedbacks, monsoons, troposphere-stratosphere exchanges, etc. Global climate of the late 19th to early 21st centuries; now including seasonal to decadal time scales plus prediction. Tendered on behalf of the International CLIVAR Climate of the Twentieth Century project plus personal thoughts of the co-chairs.

Q2: Given your interest, what would you consider/identify as the KEY uncertainties/deficiencies/problems of current models? What do you think should be evaluated/improved as a priority in models in terms of parameterization and/or interactions among processes? (Give references and/or one key figure where possible)

2.1 Representation of clouds; convective processes - particularly tropical

2.2 Representation of land surface processes, especially vegetation - this may be a vital component of multidecadal variations in the Sahel, for instance, as SST is a necessary but seemingly not sufficient condition (see Ref 1 below); also there is an urgent need for real data on soil moisture for model land surface development and initialization for seasonal forecasts. The Soil Moisture Active and Passive satellite mission targeted for launch in 2014 should be strongly supported.

2.3 Double ITCZ, annual cycle, ENSO structure in tropical Pacific. These likely relate in part to high spatial model resolution to include the subseasonal, seasonal and ENSO variability properly.

2.4 Troposphere-stratosphere interactions. This particularly needs a well-resolved stratosphere and a high model lid into the mesosphere. Ref 2 below. Recent unpublished research also indicates the change in the stratospheric Brewer-Dobson circulation under anthropogenic warming may have important tropospheric effects.

2.5 Air-sea coupling, where higher spatial resolution seems essential to make progress in correctly representing atmosphere-ocean processes in the extratropics for correctly simulating atmospheric circulation (ref 3 below)

2.6 Better complex chemical processes, particularly the ozone cycle and the carbon cycle

2.7 Limited knowledge of the past climate (i.e. beyond 100 years back and especially the last millennium). Need more coordination on proxy paleodata, including the integration of proxy and instrumental data, a neglected subject.

2.8 Parameterization of urban areas to provide indications of heat stress etc. Do the rapidly increasingly, large and sometimes diffuse urban areas (megalopoli) have an increasing influence on regional climate more widely?

Q3: Do you see a particular gap (in knowledge, in observations or in practice) that would need to be filled, or a particular connection between different modeling communities or between modeling, process studies and observations that should be made a priority?

3.1: Understanding of why different models have different systematic errors and how to reduce them. One way forward is to bring together much more comprehensively internationally NWP and climate model expertise as many model errors/biases are visible on weather forecasting time scales.

3.2 Related to this, how best to initialize climate models with biases e.g. anomaly initialization or model adjustment to observed data, etc? A key topic for seasonal to decadal prediction.

3.3: Little idea of how to relate observations to model parameterizations or how to improve model parameterizations. There is an opportunity to explore new methodologies applied to the recent great increase in highly resolved satellite data (clouds, radiation etc)

3.4: Atmospheric vertical temperature and moisture profiles and their trends which are very important for climate change and remain poorly understood e.g as discussed in the US Climate Change Science Program Report No. 1.

3.5: Observations and understanding of boundary layer over land and oceans. This relates to 2.2, 2.3, and 5.3

Q4: Do you see any particular resource or opportunity within the modeling/process study/observational/theoretical community (e.g. new results, new observations) that would be particularly useful and should be exploited to tackle this problem?

4.1: Need to reduce fragmentation in modeling community, to make results from one model applicable to another. Requires a major effort to understand why models differ. Current practice is to try to understand why models behave similarly, which is avoiding the major issue.

4.2: Homogenized high-resolution satellite radiances. For process studies, relatively short but very high resolution satellite data sets can be used. For studies of the trends in radiative forcing, homogenisation of sometimes less detailed including legacy data is key.

Q5 What would best accelerate progress on the topics raised in questions 1-4? Do you have suggestions for new initiatives (new process studies, field campaigns, or new collaborative approaches, eg international Working Groups, Climate Process Teams)?

5.1: Support to GRUAN including international radiosonde comparisons

5.2: GSICS

5.3 Experimentally-based WCRP-WGSIP working group to thoroughly look at increasing model spatial resolution for the accurate representation of air-sea interaction and its effects through the depth of the atmosphere (e.g ref 4). This project would have the initial goal of maximizing seasonal predictability in the extratropics (and possibly the tropics) for a variety of carefully selected model structures, e.g. using the perturbed physics approach and multiple models. It should feed back more generally on the key topic of understanding and reducing model biases

5.4 Strengthen SPARC efforts to explore the impact of highly resolved stratosphere/lower mesosphere on the tropospheric climate (a) for the current climate - are there effects in the Southern Hemisphere as well as ENSO/sudden warming effects in the Northern Hemisphere? Also for seasonal to interannual prediction, there may be significant untapped model skill from a lack of accurate representations of the QBO or the ability to retain initialised information about the QBO e.g. ref 5. (b) for the future climate e.g. through the expected Dobson-Brewer circulation changes

Q6: Any other suggestions/issues to be raised?

References:

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2. Ineson, S. and A. A. Scaife, 2009: The role of the stratosphere in the European climate response to El Niño. *Nature Geoscience*, 2, 32-36, doi:10.1038/ngeo381

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4. Minobe S. et al, 2008: Influence of the Gulf Stream on the troposphere. *Nature*, 452, pp206-209

5. Marshall, A. G., and A.A. Scaife. Impact of the Quasi-Biennial Oscillation on seasonal forecasts. *J. Geophys. Res.* (in press)