WCRP
World Climate Research Programme

WCRP Community-wide Consultation on Model Evaluation and Improvement

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 and regional climate modeling. Anthropogenic climate change. Monsoons and climate variability. Troposphere-stratophere interactions. Continental hydrology. Planetary atmospheres.

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)

Key model deficiencies or uncertainties :
- tropical biases in mean climate and in climate variability (diurnal cycle over tropical continents, e.g. Fig 17 of Dai, J. Climate, 2006, mid-level convection and transition from shallow to deep convection, intra-seasonal variability, e.g. Lin et al., J Climate, 2006): *deficiencies in the parameterization of atmospheric convection.*
- uncertainties in climate change cloud feedbacks, in climate sensitivity and in the simulation of present-day SSTs: *deficiencies and uncertainties in the parameterization of marine boundary-layer clouds* (e.g. Bony and Dufresne, GRL, 2005, Figs 2 and 3)
- uncertainties in regional climate change projections (and then changes in in hydrological changes, water ressources, extreme events, + prediction of carbon-climate feedbacks): *uncertainties in the response of tropical precipitation over continents, land surface-atmosphere interactions*

Missing processes (or very crude representations) in GCMs:
- High frequency ocean-atmosphere coupling (with enough physics/discretization in the ocean).
- Life cycle, organization and propagation of tropical convection.
- Influence of subgrid-scale orography on atmospheric convection, boundary layer, snow, run-off …
- Physical and microphysical processes controling humidity/temperature/clouds in the UTLS
- Tropical cyclones in climate models.

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?

Gaps in knowledge :
- Organization of tropical convection: what processes ? what role in climate ?
- Processes controlling the depth of atmospheric convection (e.g. the occurrence of intermediate convection).
- Processes controlling the subgrid-scale variability of water and cloud optical properties (matters for the prediction of cloud formation, radiation, onset of precipitation), and of rainfall (matters for the prediction of runoff and for climate change impacts); consistent representation of subgrid-scale variabilities in parameterizations (radiation, clouds, rainfall).
- “Grey zone” of parameterizations in models used at increasingly high resolution (pb of continuity between subgrid/resolved scales in models) : how to tackle this problem?

- Numerical oscillations/stability: lack of formalism and of appropriate numerical schemes.
- Physics of polar clouds and snow.

Gaps in practice :
- Facilitate the access and use of available observational datasets (common database for modelers, netcdf format, gridded fields, etc).
- Facilitate the access to simulations from high-resolution models (LES, CRMs) : would help the development of GCM parameterizations.
- Plan the development and the distribution of satellite simulators to the modeling community as an integral part of satellite missions (would facilitate the rapid and consistent use of satellite data for model evaluations)
- Encourage multiple methodologies of model-data comparison, including : the wider and more systematic use of satellite simulators, the understanding of the correspondance between satellite level 1 data and model variables, the complementarity of model evaluations through satellite simulators and geophysical data retrievals, etc.
- The evaluation of regional models, in particular in the tropics, should be more rigorous and more stringent (e.g. use satellite simulators to evaluate clouds) ; design protocols to better assess the added value of high resolution (more details or better physics?), assess the relative merits of the different techniques of regionalization (two-way nesting, stretched grids, etc).

Missing connections among modeling communities:
- Disconnection between water isotopic modeling communities (SWING community of GEWEX/CEOP), global climate modeling (WGCM) and process modeling (GEWEX modeling panels focused on deep convection or land-surface processes).
- Disconnection between communities modeling passive tracers/atmospheric chemistry (e.g. aerosols, ozone, CO2, etc) and communities involved in atmospheric processes (boundary layer, convection)
- Disconnection between polar climate modeling community (CLIC) and CFMIP (cloud feedbacks model interacomparison project) for the evaluation of clouds in models and the understanding of cloud-climate feedbacks.

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?
- *A-Train* constellation of satellites (including CALIPSO, PARASOL and CloudSat): revolutionary for the observation of clouds and their evaluation in models
- *YOTC* (Year of Tropical Convection): great ressource for the analysis and the evaluation of atmospheric convection in models, hopefully leading to the improvement of convective parameterizations
- *Megha-Tropics* : a tropical satellite (to be launched in March 2010) measuring water vapor, precip and radiation simultaneously with an unprecedented spatial and temporal sampling : will allow the study of convective organization, of the diurnal cycle of convection, humidity–convection–radiation interactions, etc)
- *New satellite observations of water isotopes* in the atmosphere (e.g. TES, Schiamachy, IASI) + *new laser technology* to make easier and more systematic in-situ measurements of water isotopes in precip, vapor, rivers, etc : allow new evaluations and new constraints on the model physics (e.g. atmospheric convection, microphysics of precipitation, land surface hydrologic processes, troposphere-stratosphere processes, etc).
- *Process-oriented intercomparison projects*: AMMA-MIP (framework for model evaluation using AMMA field campaign results), CFMIP (evaluation of model clouds using satellite observations, understanding of cloud-climate feedbacks), CGILS (GCSS-CFMIP intercomparison of LES models and single-column versions of GCMs focused on marine boundary-layer clouds and feedbacks)
- *Depository website of large-scale forcings and evaluation datasets* (from campaigns or instrumented sites) *for single-column versions of GCMs* : facilitates the process-evaluation of models on several types of meteorological situations (polar climate, tropical convection over land, tropical convection over ocean, shallow convection, etc). cf http://gcss-dime.giss.nasa.gov/
- Encourage the evaluation of climate models in climate and NWP mode (e.g. transpose-AMIP experiments on short time scales) and identify the role that model errors have on models' skill at different time scales (day-to-day, seasonal, decadal predictions).

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)?
- *Encourage the formation of young scientists in the area of model development (e.g. parameterizations)*, and their recrutment on permanent positions (experience is a key in this area !)
- *Organize more conferences/workshops on systematic errors in models* (aka the Feb 2007 WGNE workshop): great to share problems and remedies among model developers and analysts.
- *Make openly available* (and in a standard format) *3D LES/CRM simulations* of past and current GEWEX-GCSS case studies (for low-level clouds, convective clouds, polar clouds, etc) and outputs from global CRMs or super-parameterizations: would help the development of GCM parameterizations of clouds, convection, boundary layer by permitting the analysis of subgrid-scale variabilities of different variables (water vapor, temperature, wind..)
- *Encourage water isotopic measurements* in campaigns focused on tropical convection and in instrumented sites (e.g. ARM, CloudNet); encourage the GEWEX-GCSS WG on deep convection to include water isotopes in CRMs and SCMs (would help to assess the dynamical processes responsible for troposphere-stratosphere exchanges and some microphysical processes)
- *Encourage the development and the maintenance of a hierarchy of model configurations* in modeling groups (e.g. single-column versions, aqua-planets, slab ocean-atmosphere coupled models): helps to understand what complex models (GCMs, ESMs) predict; helps to identify the root cause of model biases; helps to understand the impact of modeling hypotheses on the simulated climate; facilitates bridges between GCMs, conceptual models/theories, the new generation of climate models (e.g. super-parameterizations, global CRMs).
- *Envisage a depository site of GCM parameterizations* (although parameterizations can rarely be used as plug-and-play, it would be a very useful ressource)
- *Enhance collaborations among the different projects or working-groups involved in the modeling of clouds and moist processes* (GEWEX/GCSS, WGCM/CFMIP, WGNE, SPARC/UTLS, GEWEX/SWING, CLIC/polar clouds)

Q6: Any other suggestions/issues to be raised?
- *Make the analysis of CMIP5 simulations useful for model developers!*
(1) the list of models considered in each study should be collected in a Table so that each modeling groups may know in which studies their model has been analyzed (not possible for CMIP3).
(2) encourage syntheses of the different analyses and evaluations performed on particular topics (e.g. ENSO, sea-ice, etc) . Should it be a role for the different CLIVAR panels and other international projects?
(3) encourage the analysts to make available their scripts/diagnostics on a depository website so that the diagnostics may be routinely used by the modeling groups within the model development process.