WCRP Community-Wide Consultation on Model Evaluation and Improvement

Q1: *Please state your particular area of interest, e.g., global and regional climate or NWP modeling, seasonal prediction, sea-ice feedbacks, monsoons, troposphere-stratosphere exchanges, etc.*

A1: This response reflects views developed during deliberations of the US CLIVAR Process Studies and Model Implementation Panel (PSMIP). This panel provides input on US plans for improving parameterizations of critical climate processes and for better quantification of climate model uncertainties. Our activities have included a review of the CPT program, a BAMS 'best practices for process studies' article, and ongoing review of process studies seeking multi-agency funding. The views contained within this response are my own, however, and do not fully represent the wide range of the panel's expertise.

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).*

A2: This question is similar to a discussion the panel held in July, 2009, on new themes for US CLIVAR from the panel's perspective. At the time, we discussed high-latitude processes including clouds, ocean processes, and sea-ice interactions. We also discussed the representation of complex ecosystems in models, and of alpine/complex topography regions.

A longer response can be built around the topic of aerosol indirect effects. Aerosol indirect effects are still poorly represented in climate models. A recent observationally-based global energy balance calculation (Murphy et al., 2009, JGR) places an upper bound on aerosol direct and indirect effects at -1.1 W m^{-2} since 1950, calculated as a residual. This is less than the upper bounds of the IPCC AR4 aerosol direct+indirect forcing estimate. Another recent paper, by Stevens and Feingold (2009, Nature), points to processes that can act to buffer initial forcings of a system. A classic example is the cloud lifetime effect (Albrecht, 1989). 20 years after the publication of this paper, our understanding of how aerosol influences cloud liquid water paths has only become more complicated, with no one process unambiguously dominant. Meteorology can also affect the ultimate radiative impact of an aerosol forcing. An example is the observed dynamic compensation of the cloud albedo effect - increases in aerosol loading occurring within more stable environments encouraging lower liquid water paths, whose radiative impact then at least partially compensates for the cloud albedo (Twomey) effect (e.g., Matsui et al., 2006). More attention needs to be paid to the representation of meteorological/ synoptic processes in the climate models, and to the representation of already-identified compensatory processes. This is a more holistic approach than is being currently adopted, and is best implemented with a combination of active observational and model researchers working at a variety of scales, bringing in their own discipline's viewpoints. The Climate Process Teams may have represented one attempt at this, however, their short time frame and focus on results, of necessity narrow their focus. The GCSS approach, with its focus on case studies, greater independence from programmatic considerations, and a group definition based on participation rather than funding, may be better suited for more holistic assessments.

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 and between modeling process studies, and observations that should be made a priority?*

A3: A quantitative assessment of the 'cloud lifetime' effect and a holistic discussion of how it should be represented in climate models (appropriate autoconversion scheme + entrainment closure + response to large-scale environmental changes) is one. An assessment of what is needed to constrain best-estimates of the climate sensitivity from observations is another. An incorporation of the aerosol indirect effect for ice clouds into climate models, as well as a focus on the better representation of subgrid-scale vertical velocities are suggestions that are also already incorporated into this year's CPT announcement of opportunity in the US.

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

A4: One idea discussed at a recent Keck Institute workshop was to create a specialty dataset similar to that for the Year of Tropical Convection, but focusing on clouds, a 'Year of Cloud Appreciation' dataset as it were (liberty taken here with the naming). This could include efforts made at assimilation of satellite radiances specifically for improving the depiction of clouds. This would also include data from different sources on low cloud boundary layer depth, as operational retrievals of this important parameter are inaccurate, while the strengths and weaknesses of the newer datasets not completely documented.

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, e.g. international working groups, climate process teams) ?*

A5: see A4.

Q6: *Any other suggestions/issues to be raised?*

written by Paquita Zuidema, co-chair of US CLIVAR Process Studies and Model Implementation Panel.