ENSEMBLES RT4 – Framework for coordinated experiments

Version: 29/4/05

Basic idea:
- Controlled experiments repeated with several different climate models to advance understanding of the factors/processes controlling future climate and related uncertainty in climate forecasts.
- A cross cutting activity in RT4, linking WPs 4.1, 4.2, 4.3 and 4.4

From the DoW:
"The experiments will be designed to investigate and understand factors controlling climate at selected time periods (e.g. 1850, 2000, 2050). The experiments will be conducted with both atmospheric and coupled GCMs. Specific experiments will be designed to investigate issues such as the role of specific feedbacks, sensitivity to resolution, and sensitivity to oceanic initial conditions."

Participating groups (6):
Reading, CERFACS, CNRM, INGV, NERSC, Kiel + (potentially) IPSL, ICTP

Broad aims:
- *Understanding climate, and climate forecast uncertainty (WP4.4), at a mechanistic/process level, particularly in terms of the role of specific feedbacks (WP4.1), the regional patterns of climate change (WP4.2), and the factors governing the frequency and characteristics of extreme events (WP4.3)*
- Add value to information available from core ENSEMBLES hindcasts, forecasts and scenario integrations
- Need a simple core set of computationally cheap experiments so that they can be done by all groups (including where possible different model resolutions etc).

Proposed Scientific Focus:
- With respect to climate forecast uncertainty focus on understanding *model uncertainty* (rather than scenario uncertainty or initial condition uncertainty) since this is where coordinated experiments can most obviously add value.
- Suggestion is that a major *but not exclusive* scientific focus should be *understanding the factors that determine the land sea-warming contrast*. The ratio of warming over land to warming over ocean varies between about 1.2 and 1.9 in IPCC TAR models. This level of uncertainty is comparable to that in global mean temperatures (i.e. climate sensitivity) and has significant implications for climate impacts. Analysis to date points to the potential importance of land surface and cloud feedbacks but the reasons different models give different ratios are not understood. This topic has clear relevance to all four workpackages in RT4. The relevance to WP4.1 and WP4.2 is obvious. For WP4.3 the focus could be understanding how patterns of mean change are related to changes in the frequency of extreme events such as heat waves and droughts. For WP4.4 the focus would be understanding and quantification of model uncertainty (WP4.4)

Proposed experiments:

a) AGCM experiments:
    a. Core set: Control and 2xC02 experiments using *common, time invariant, SST and sea ice fields* as lower boundary (probably taken

from a coupled experiment with one particular model). The purpose of using common lower boundary conditions is to remove some sources of inter-model variance (e.g. sea ice-albedo feedback) in order to better understand others. Experiments would be integrated for ~30 years (or 2*15 years). (**NB**: these experiments could obviously be used to look at many other aspects of climate besides the land/sea warming contrast, according to the interests of particular groups.)

b. Enhanced set: additional experiments could involve many perturbations, e.g., interfering with land-surface feedbacks, effect of SST or sea-ice anomalies etc. Which experiments would be most valuable to be decided through discussion.

b) Slab experiments:

a. A limitation of AGCM experiments is that prescribed SST allows no interactive response of the ocean to changing climate, and this limitation can sometimes give the wrong answer (e.g. Douville, Climate Dynamics, in press; Sutton and Mathieu, QJRMS, 128, 1259-1275, 2002). Some improvement, or at least understanding of sensitivity, can be achieved by using experiments in which the atmosphere model is coupled to a slab ocean. In this case the ocean heat flux convergence (aka Q-flux) must be specified. The core set of experiments could be repeated with some agreement as to how to specify the Q-flux (and possibly the change in Q-flux) in order to provide maximum insight. (Note that an ensemble of slab model experiments with perturbed model parameters has already been conducted at the Hadley Centre with versions of the HadCM3 model. The ENSEMBLES RT4 coordinated experiments would expand the scope of these experiments to include structural uncertainty.)

Proposed Process:

- Reading would supply boundary conditions for core set of time slice experiments. Individual groups responsible for interpolation onto their model grid (taking care over sea ice – lessons from PRUDENCE) and carrying out integrations. Alternatively, does anyone have a particularly good interpolation package and would be willing to at least coordinate this part to ensure consistent approach?
- WP leaders to supply list of diagnostics required. Consolidated list to be distributed by Reading.
- Output to be archived at a common centre (ENSEMBLES data centre?) in a common format (netCDF), accessible to all participating groups.
- Experimental details and status to be documented on RT4 www site.