Integrated IPY modeling effort for the Southern Ocean and Antarctic Marginal Seas

The IPY effort needs to ensure that the global ocean/climate modelling community is aware of the importance of Southern Ocean processes in correctly representing global ocean circulation and its variability.

Ideally IPY projects should incorporate modelling components ranging from regional scale and processes to circumpolar or global models. Within the projects it should be made a priority to improve the communication and information flux between these components and levels. Parametrizations specific to Southern Ocean and high latitude processes that were devised from observations and idealised process studies should be tested in larger scale applications to assess their large-scale importance and advise the global modelling community on how to incorporate them into their models.

An important IPY legacy will be the creation of much improved channels for the exchange of information amongst the Southern Ocean modelling community. Coordination of observational programmes in the Southern Ocean is underway to help scientists and program managers leverage resources (http://www.clivar.org/organization/southern/CLIVAR_CliC_Obs.html).
The panel will establish a similar website for Southern Ocean modelling efforts, whether they are connected to IPY or not. This will improve communications during IPY and form the basis for a coordinated modelling effort after IPY. In this context the panel endorses the establishment of a Southern Ice Ocean Modelling Intercomparison Project (formally SIOMIP, now known as SOPHOCLES which stands for Southern Ocean Physical Oceanography and Cryospheric LinkagES – see Section 2 *ix*).

Assimilation of extensive data sets from IPY cluster projects like CASO (http://www.clivar.org/organization/southern/CASO/index.htm) and its sister project SASSI (http://woceatlas.tamu.edu/sassi/) into either regional/circumpolar or global models is strongly encouraged. Ocean data assimilation (ODA) is developing fast, and, despite the fact that results are not yet completely satisfactory, progress is rapid and the outcome very promising. With ODA we encourage the analysis effort of the ocean state and variability more than the forecast framework. Indeed, ODA can provide the ocean four-dimensional multivariate fields that cannot be adequately resolved through observations. The effort of the oceanographic community to provide data in real or quasi-real time should be implemented during the IPY CASO/SASSI projects. This will allow a better enhancement of the unique observational effort that will take place during IPY. This effort should also include biogeochemical data.

Open scientific questions on which more significant progress should be made during IPY include a better constrained Southern Ocean fresh water budget and its variability. These challenges require a well coordinated modelling effort covering a wide range of processes. For sea ice these include the factors determining sea ice extent, particularly in summer, the use of the newly available database to constrain sea ice thickness and volume and thus northward fresh water export in the form of sea ice, as well as an improvement of the representation of dynamic deformation processes. A related issue is an improved estimate of precipitation over the ocean in the region due to the substantial volume of flooding and snow ice formation in the Southern Ocean.

A desirable goal for IPY is a collaborative modelling effort between the ocean and ice sheet modelling communities. A first step towards this has been the modelling of the interaction between ice shelf base and ocean and its inclusion in regional and circumpolar ocean models over recent years. Observational IPY efforts like that at Fimbulisen will help to constrain ice shelf basal mass fluxes and improve the existing database whose sparsity has prohibited rigorous model evaluation so far. Regional high-resolution models will allow investigations of the sensitivity of the smaller fringing ice shelf cavities to changes in inflow. Their results should be used to improve the representation of the smaller cavities in coarser circumpolar or global models.

The fresh water input by melting icebergs is one example of an active component in the Southern Ocean fresh water budget that is still poorly known. The panel encourages efforts to combine existing iceberg drift models and satellite data to a parameterization or climatology of iceberg fresh water input for use in sea ice-ocean models.

Global models should be used in combination with assimilation products of existing and IPY-planned data sets to investigate the net fresh water transport in the Southern Ocean and its variability. These complementary efforts will enable the modelling community to address standing questions posed through analysis of modern observations, e.g. to determine if the observed warming of the Circumpolar Deep Water is associated with the reported dramatic changes in the salinity of surface and bottom waters.

To understand ongoing changes in the characteristics of outflowing Southern Ocean water masses it is important to improve model representation of cross-shelf exchanges and down slope flows, particularly in models that are too coarse to represent the underlying processes explicitly. Important progress in this area has been made by the AnSlope study which focussed on the Ross Sea in recent years. Results from this programme have also been used by the Climate Process Team on Gravity Current Entrainment (CPT-GCE) which links US observational and modelling efforts in this area.

The Southern Ocean continues to be the area with the largest uncertainty within estimates of the oceanic carbon dioxide sink. The synoptic circumpolar snapshot of hydrographic and biogeochemical observations that will be obtained by CASO and related IPY programmes will help to reduce this uncertainty. It will also provide a comprehensive dataset for use in the evaluation of global ocean and coupled climate carbon cycle models in order to improve climate predictions.