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Observations for climate: The use of numerical models for ocean observing system evaluation and design

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Our use of ocean general circulation models to evaluate existing ocean climate observing systems and design new systems involves two research thrusts: (1) model sampling experiments, and (2) the use of Observing System Experiments (OSEs) to evaluate existing observing systems and Observing System Simulation Experiments (OSSEs) to evaluate new observing systems. Model sampling experiments have been used test the ability of in situ geostrophic velocity measurement systems supplemented by bottom velocity and wind information to test observing strategies for the Meridional Overturning Circulation (MOC) and meridional heat transport (MHT) in the extratropical South Atlantic. For example, an array of approximately 20 instruments deployed along 34.5^{o}S was found to reproduce the temporal evolution and vertical structure of the MOC and MHT and thus represents a potentially realistic strategy for monitoring these climate parameters at that latitude. Given that there is important mesoscale variability in the South Atlantic, analysis of the mooring data will need to be interpreted in concert with other existing observing systems with better zonal resolution but coarser temporal resolution (e.g., altimetry, cross-basin XBT transects, and ARGO). We have developed a prototype OSE/OSSE system at AOML with the goal of executing more rigorous ocean observing system evaluation and design studies. An OSSE is now being performed to evaluate observing strategies for the MOC throughout the Atlantic basin. This initial experiment uses a global HYCOM run with 0.72-degree resolution at the Equator from January 1948 through December 2010 forced by the NCEP reanalysis as the nature run. It also uses an Atlantic HYCOM domain extending southward to Antarctica run at 1/2 the resolution of the global model as the data assimilative model. The "fraternal twin" approach is employed where two different configurations of HYCOM are used for the nature run and for the second model used to assimilate the synthetic observations sampled from the nature run. We are employing a new data assimilation system, specifically the fixed basis variant of the Sequential Evolutive Extended Kalman (SEEK) filter. The experiments are now underway and results will be presented at the meeting. They are specifically designed to (1) evaluate the impact of extending ARGO profiles into the deep ocean, and (2) evaluate the impact of new cross-basin monitoring arrays.