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Development of an eddy-resolving reanalysis using the 1/12° global HYbrid Coordinate Ocean Model and the Navy Coupled Ocean Data Assimilation Scheme

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Multiple international agencies have performed atmospheric reanalyses using static dynamical models and assimilation schemes while ingesting all available quality controlled observational data. Some are clearly aimed at climate time scales while others focus on the more recent time period in which assimilated satellite data are used to constrain the system. Typically these are performed at horizontal and vertical resolutions that are coarser than the existing operational atmospheric prediction system. Multiple agencies have also performed ocean reanalyses using some of the atmospheric forcing products described above. However, only a few are eddy-permitting and none are capable of resolving oceanic mesoscale features (eddies and current meanders) across the entire globe. To fill this void, the Naval Research Laboratory is performing an eddy-resolving 1993-2010 ocean reanalysis using the 1/12° global HYbrid Coordinate Ocean Model (HYCOM) that employs the Navy Coupled Ocean Data Assimilation (NCODA) scheme.

A 1/12° global HYCOM/NCODA prediction system has been running in real-time at the Naval Oceanographic Office (NAVOCEANO) since 22 December 2006. It has undergone operational testing and will become an operational product by early 2013. It is capable of nowcasting and forecasting the oceanic "weather" which includes the 3D ocean temperature, salinity and current structure, the surface mixed layer, and the location of mesoscale features such as eddies, meandering currents and fronts. The system has a mid-latitude resolution of $\sim$7 km and employs 32 hybrid vertical coordinate surfaces. Compared to traditional isopycnal coordinate models, the hybrid vertical coordinate extends the geographic range of applicability toward shallow coastal seas and the unstratified parts of the world ocean. HYCOM contains a built-in thermodynamic ice model, where ice grows and melts due to heat flux and sea surface temperature (SST) changes, but it does not contain advanced rheological physics. The ice edge is constrained by satellite ice concentration. Once per day, NCODA performs a 3D ocean analysis using all available observational data and the 1-day HYCOM forecast as the first guess in a sequential incremental update cycle. Observational data include surface observations from satellites, including sea surface height (SSH) anomalies, SST, and sea ice concentrations, plus in-situ SST observations from ships and buoys as well as temperature and salinity profiles from XBTs, CTDs and Argo profiling floats. Surface information is projected downward using synthetic profiles from the Modular Ocean Data Assimilation System (MODAS) at those locations with a predefined SSH anomaly. Unlike previous reanalyses, this ocean reanalysis will be integrated at the same horizontal and vertical resolution as the operational system running at NAVOCEANO.

The system is forced with atmospheric output from the National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR) and the observations listed above. The reanalysis began in 1993 because of the advent of satellite altimeter data that will constrain the oceanic mesoscale. Significant effort has been put into obtaining and quality controlling all input observational data, with special emphasis on the profile data. The computational resources are obtained through the High Performance Computing Modernization Office.