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Inclusion of tide gauge sea level and filter improvements in the SODA reanalysis

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The Simple Ocean Data Assimilation (SODA) reanalysis of global ocean climate relies heavily on the historical hydrographic data set of some nine million temperature and salinity profiles, together with historical SST observations using OI-based sequential estimation. Here we describe two types of algorithm improvements. The first are the upgrades needed to include the 100 to 1000 historical coast and island tide gauge sea level time series in the reanalysis. The second are the upgrades associated with replacing the current OI-based sequential estimation with an ensemble filter.

Relative sea level is a mixed oceanographic-geophysical variable that includes effects of land motion and shifts in ocean mass as well as thermal expansion. The variable is of interest on its own because of the impact of sea level rise on coastal areas, but also because of the information it contains on the changing thermal structure of the ocean when combined with hydrography. In this study we are primarily interested in extracting the latter information. Inclusion of sea level time series in SODA is also complicated by the complex structure of the forecast error covariance whose spatial scale grows at periods longer than a year. Here we discuss the structure of the error covariance showing examples for particular gauge locations and estimate the impact of the observations through gauge comparisons to reanalyses in which the tide gauge time series are withheld. The results show that the greatest benefit from the inclusion of sea level observations will occur in the subtropical and midlatitude North Atlantic and Pacific where the gauges contain unique information about interannual to decadal variability. We propose an algorithm to handle the hydrographic and sea level data separately in order to take best advantage of their different characteristics.

In the second part of the talk we describe efforts to upgrade the assimilation algorithm used in SODA to an ensemble filter based on the Local Ensemble Transform Kalman Filter (LETKF). This type of upgrade is appealing for several reasons, not least of which is that it brings SODA into alignment with many atmospheric reanalyses, a prerequisite for coupled assimilation, and the presence of ensemble members provides a straightforward way to estimate uncertainty. Results are presented comparing parallel experiments with SODA-OI and SODA-LETKF, illustrating the tradeoffs between the old and new approach, along with a discussion of some of the outstanding problems. Finally we discuss the possible advantages of a hybrid approach.