A Comparative Analysis of Upper Ocean Heat Content Variability from an Ensemble of Operational Ocean Reanalyses

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Ocean heat content (HC) is one of the key indicators of climate variability and also provides ocean memory critical for seasonal and decadal predictions. The availability of multiple operational ocean analyses (ORA) now routinely produced around the world is an opportunity for estimation of uncertainties in HC analysis and development of ensemble based *operational* HC climate indices. In this context, the spread across the ORAs is used to quantify uncertainties in HC analysis and the ensemble mean of ORAs to identify, and to monitor, climate signals. Towards this goal, we analyzed ten ORAs, two objective analyses based on in situ data only and eight model analyses based on ocean data assimilation systems. The mean, annual cycle, interannual variability and long-term trend of HC in the upper 300m (HC300) from 1980 to 2009 are compared.

The spread across HC300 analyses generally decreased with time and reached a minimum in the early 2000s when the Argo data became available. There was a good correspondence between the increase of data counts and reduction of the spread. The agreement of HC300 anomalies among different ORAs, measured by the signal to noise ratio (S/N), is generally high in the tropical Pacific, tropical Indian Ocean, North Pacific and North Atlantic, but low in the tropical Atlantic and extratropical southern oceans where observations are very sparse. A set of climate indices were derived as HC300 anomalies averaged over the areas where the co-variability between SST and HC300 represents the major climate modes such as ENSO, Indian Ocean Dipole, Atlantic Nino, Pacific Decadal Oscillation, and Atlantic Multidecadal Oscillation. The ensemble of operational ocean reanalyses provides a tool to monitor *signals* and *uncertainties* in upper ocean heat content variability in near real time.