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

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Upper ocean heat content (HC) is one of the key indicators of climate variability on many time-scales extending from interannual to long-term trends. The availability of multiple operational ocean analyses (ORA) that are now routinely produced around the world provides an opportunity for quasi-real time monitoring of this variable using the ensemble methodology. The ensemble can be used to assess uncertainties in the HC analysis, which may help to identify gaps in observing systems, and deficiencies in data assimilation schemes. 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 upper 300m HC from 1980 to 2009 are compared.

The quality of HC300 analysis tends to increase with time due to an increase in observations. The quality of HC300 anomalies is relatively high in the tropical Pacific, tropical Indian Ocean, North Pacific and North Atlantic, but low in the tropical Atlantic and extra-tropical southern oceans where observations are very sparse. Uncertainties in HC300 anomalies associated with ENSO, Indian Ocean Dipole and Atlantic Nino are further analyzed, and the roles of HC300 on potential predictability of those SST modes are discussed. HC300 has large multi-decadal variability and long-term trends. The consensus among ORAs suggests that the mean HC300 in 70^{o}S-70^{o}N has a brief cooling in early 1980s and 1992-1993 related to volcanic eruptions, a small warming in 1985-1991, a continuous, and a more robust, warming in 1994-2003, and a persistence or weak cooling in 2004-2009.

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