Session: B4 Oral presentation

## Observations for climate: Comparative analysis of upper ocean heat contentvVariability from ensemble 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 anthropogenic trends. Since HC variability is also associated with SST variability, a better understanding and monitoring of HC variability can help us understand, monitor, and forecast, major SST modes such as El Niño and Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), Pacific Decadal Oscillation (PDO), Tropical Atlantic Variability (TAV) and Atlantic Multidecadal Oscillation (AMO). An accurate initialization of HC variability in coupled climate models will also play a crucial role in emerging decadal climate prediction efforts. The availability of multiple operational ocean analyses (ORA) that are routinely produced by operational and research centers around the world provides an opportunity to assess uncertainties in the HC analysis, to help identify gaps in observing systems as they impact the quality of ORAs and therefore climate model forecasts, and help identify deficiencies in data assimilation schemes. Multiple ORA also provide the basis for development of real-time multi-model ensemble HC monitoring products. We have analyzed ten ORAs, two objective analyses (OA) based on in-situ data only and eight model analyses based on ocean data assimilation systems (ODAS). The two OAs are the monthly temperature analysis of the UK Met Office (EN3) and the seasonal temperature analysis of the National Oceanographic Data Center of NOAA (NODC). The eight ODASs are the ocean reanalyses from NCEP, ECMWF, MERCATOR/France, JMA/Japan, GFDL/NOAA, GMAO/NASA, BOM/Australia. The mean, annual cycle, interannual variability and long-term trend of upper 300m HC (HC300) in 1980-2009 are compared between various ORAs. The spread among ORAs can be taken as a measure of uncertainty in our knowledge of the climate, and the consistency among ORAs provides a tool to monitor the state of the climate. The consistency among ORAs tends to increase with time, i.e., during the latter period of the analysis, particularly in the tropical Pacific, the tropical Indian Ocean and extra-tropical southern oceans due to constraints of observations from tropical mooring arrays and Argo floats. The consistency of mean HC300 is generally high north of 30oS except near western boundary currents, in the tropical Atlantic and some regional seas. The consistency of HC300 anomaly, measured by anomaly correlation with EN3, is generally high in the tropical Pacific, tropical Indian Ocean, North Pacific and North Atlantic, but it is low in the tropical Atlantic and extra-tropical southern oceans, indicating large uncertainties in our knowledge of HC300 variability there. The linear trends of HC300 in 1993- 2009 show a consistent and strong warming in the western tropical Pacific and subpolar North Atlantic, a consistent and moderate warming (cooling) in the central North Pacific (near the west coast of North America and eastern subtropical Pacific). HC300 anomaly has also been linked to SST anomaly. The lead/lag correlation between HC300 and SST anomaly associated with ENSO, IOD and Atlantic Nino are further analyzed. Implications of accurate HC300 analysis on the predictions of ENSO, IOD and Atlantic Nino are discussed.