Impact of Data Assimilation on ECCO2 Equatorial Currents

David Halpern, Dimitris Menemenlis, and Ichiro Fukumori

Jet Propulsion Laboratory
NASA / California Institute of Technology
United States of America
david.halpern@jpl.nasa.gov

A component of the Estimating the Circulation and Climate of the Ocean (ECCO) consortium [1] is called ECCO2 [2], which introduced sea ice, the Arctic Ocean, and a 19-km horizontal grid that permits eddying motions in the global ECCO ocean circulation estimates. We use ECCO2 adjoint-method solutions over five years (2004, 2005, 2009-2011) to examine the impact of assimilation of in-situ observations on the Equatorial Undercurrent (EUC) and North Equatorial Countercurrent (NECC). ECCO2 solutions had nineteen 10- to 20-m layer thicknesses in uppermost 400 m and archived estimates with 3-day averages. In the equatorial central Pacific Ocean at 150°W where April and October are maximum and minimum times of the annual cycle of upper-ocean currents, the impacts of data assimilation were negligible for the EUC transport and slightly modest for the NECC transport. For example, the Optimized (with data assimilation) – minus – Baseline (with no data assimilation) difference (in absolute percentage value, |(Optimized-Baseline)/(Optimized+Baseline)/2)|) in EUC volume transports for 12-14 April 2004 and 12-14 October 2004 were -1.4 (or 2.5%) and 0.0 (or 0.0%) Sverdrups, respectively. One Sverdrup (Sv) equals 10^6 m^3 s^{-1}. Similarity of ECCO2 currents and National Oceanic and Atmospheric Administration in-situ measurements of upper-ocean currents on the equator at 147°E, 165°E, 170°W, 140°W, and 110°W will be discussed. For NECC transports, the 12-14 April and 12-14 October 2004 differences were -0.4 (2.7%) and -5.4 (or 17.9%) Sv, respectively. Throughout 2004, the largest such 3-day averaged differences between Optimized and Baseline solutions for EUC and NECC transports at 150°W were -12.0 (or 18.2%) and -17.6 (or 52.9%) Sv, respectively.

The ECCO2 methodology assimilated a vast quantity of observations [1], including satellite measurements of ocean surface topography, sea surface temperature, and ocean mass, and in-situ measurements of vertical profiles of temperature and salinity. No ocean current observations were assimilated. Unlike the satellite component of the observing system, the in-situ component had continuous spatial and temporal variations in data quantity and quality, which sometimes were substantial. To test the spatial-temporal impact of in-situ assimilated data on ECCO2 equatorial currents, the longitudinal distribution (including Atlantic and Indian oceans) of EUC and NECC transport differences between Optimized and Baseline solutions will be described relative to the quantity and quality of types of assimilated data. The 5-year ECCO2 time period encompassed a substantial reduction (increase) of measurements recorded in the equatorial Pacific (Indian) Ocean. The impact of data assimilation over a longer period from 1992 to the present will be examined with other ECCO products.

[1] Wunsch, C., et al. (2009) The global general circulation of the ocean estimated by the ECCO-Consortium. *Oceanography*, *22*, No. 2, 88-103.

[2] Menemenlis, D., et al. (2008) ECCO2: High resolution global ocean and sea ice data synthesis. *Mercator Ocean Quarterly Newsletter*, *31*, 13-21.