Session: C22 Poster: T253A

A set of global ocean re-analyses for climate applications

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This work is intended to provide the description of a set of global ocean re-analyses produced over the last few years at the authors' institutes with the purpose to show the applicability of these products for studies of climate change and variability. The first re-analyses were conducted with an Optimal Interpolation (OI) assimilation scheme which assimilates only temperature and salinity taken from the EN3 and previous versions of the data set (http://www.metoffice.gov.uk/hadobs/en3) which did not implement any kind of time varying XBTs corrections. On the other way a 3D-Variational approach (3DVAR) was used more recently to produce another set of re-analyses. In 3DVAR, besides the above mentioned hydrographic EN3_v2a data set but with the a time-dependent fall rate correction applied to the XBTs, along-track sea-level anomaly (SLA) observations were also assimilated from 1992 onward via a local hydrostatic adjustment scheme. Within this scheme, the sea-level increment is assumed proportional to the water-column integrated density increment, and split into thermo- and halo- steric contributions according to the local structure of the bivariate background-error vertical covariances. We have investigated in particular the impact of the altimeter data and the use of different Mean Dynamic Topographies (MDT) by comparing the re-analyses with observed temperature, salinity and velocity observations. All the above re-analyses have been validated against a set of high quality in situ observations and independent data. Differences among the re-analyses are evaluated in terms of improvements in the method used to assimilate the data and the quality and amount of observations themselves with the purpose to detect possible sources of uncertainty of the long-term changes of climate indicators, such as the integrated ocean heat content, heat and fresh-water transports and the meridional overturning circulation. Finally, we highlight the most recent developments along with the future directions of an eddy-permitting re-analysis system.