An assessment of ocean climate reanalysis by the Data Assimilation System of KIOST applying Ensemble Optimal Interpolation

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Abstract

A data assimilation system has been developed to apply to a fully coupled climate model, CM2.1, in the Korea Institute of Ocean Science and Technology (KIOST). While the ocean observation data are assimilated into the ocean component model through the data assimilation system of the KIOST (DASK), the other component models are freely integrated. Here, we evaluated the variability of the ocean climate in the climate reanalysis by the DASK from 1947 to 2012. To assess oceanic processes and ocean climate variability as modeled by the DASK, we examined the North Pacific Intermediate Water, El Nino Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), Indian Ocean Dipole (IOD), upper 300 m heat content (HC300), Sea Surface Height (SSH), meridional heat transport, mean global temperature and salinity, and temperature and zonal velocity in the tropical Pacific. Furthermore, we compared these modeled features with various in-situ observations and with various other global reanalyses, such as the Simple Ocean Data Assimilation (SODA) and the GFDL Ensemble Coupled Data Assimilation systems (ECDA). The DASK represents global temperature and salinity well, not only at the surface but also at intermediate depths in the ocean. In addition, the DASK closely models the features of North Pacific Intermediate Water, a typical water mass in the North Pacific characterized by the salinity minimum layer. The DASK's ocean climate variability also matches well with observations of the ENSO, PDO and IOD. The HC300 of the DASK shows as good or better correlations with real-world observations compared to other reanalyses systems except in the tropics. In addition, the SSH variability of the DASK shows lower correlation in the tropics and north Atlantic rather than its HC300 correlation. It is suggested that the poor performance of the DASK in the tropics and north Atlantic is resulted from the bias of its low-resolution atmospheric model. Nevertheless, it is noteworthy that the DASK performs better or comparable particularly in the North Pacific and North Atlantic even though the DASK applies the Ensemble Optimal Interpolation, which is numerically more efficient than the Ensemble Kalman Filter applied by the ECDA, and a lower horizontal model resolution than that of the SODA. The validation suggests the high performance of the DASK in terms of ocean climate estimation and variability at a lower computational cost than the other two reanalyses systems we studied.

The DASK represents global temperature and salinity well, not only at the surface but also at intermediate depths in the ocean. In particular, the heat content of the DASK shows a good correlation with real-world observations. In this study, we use the reanalysis data from the DASK as an initial condition of our ENSO prediction system. To evaluate the ENSO prediction system, hindcast experiments have been conducted during 30 years from 1982 to 2011, which suggests that the ocean initialization significantly improve the ENSO prediction skill.