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Bivariate sea-ice assimilation for Global Ocean Analysis/Reanalysis

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Recent intercomparison studies among ocean/sea-ice Reanalyses (such as ORA-IP) have shown large discrepancies in many sea-ice-related fields, despite a rather general agreement in the sea-ice extension. The low accuracy of sea-ice thickness measurements together with the highly non-gaussian distributions of related uncertainty, made multivariate sea-ice data assimilation (DA) strategies still at an early stage, although nearly twenty years of thickness observations are now available. In a standard multivariate scheme, the break of Gaussianity can generate un-realistic corrections due to the poor linear relationship driven by the B matrix.

One approach to solve the problem is the implementation of anamorphous transformations that modify the probability density functions of ice anomalies into Gaussian ones (Brankart et al. 2012). In this study, a 3DVar DA scheme (called OceanVar), employed in the routinely production of global/regional ocean reanalysis CGLORS (Storto et al, 2016), has been recently extended to ingest sea-ice concentration (SIC) and thickness (SIT) data. An anamorphous operator, firstly developed and made freely available within the SANGOMA project (http://www.data-assimilation.net/), has been updated and adapted for the bivariate assimilation of SIC/SIT within the OceanVar framework.

We present the comparison among several sensitivity experiments that were performed assimilating different observation datasets and using different DA configurations at 1/4 degree global resolution. Specifically, we assess the impact of ingesting different SIT products, such as SMOS and CRYOSAT-2 data or the merged product CS2SMOS.

We show that the sole assimilation of SIC improves the spatial representation of SIT with respect to a free run. The inclusion of thickness correction, determined by empirical relations, appears to improve the sea ice characteristics in the Atlantic sector and degrade them in the Siberian region; therefore a refined tuning could probably be beneficial. The spatial error reduces sharply only once CRYOSAT-2 data are assimilated jointly with SIC data. In the present set up, all the experiments generally tend to overestimate the sea-ice volume in the case SMOS data are not assimilated. However, observational errors associated with SMOS data are generally too small, leading to jumps in the volume time series at the beginning of the accretion period if not calibrated correctly.

The proposed approach is suitable to be used for covarying ocean/sea-ice variables in future coupled ocean/sea-ice DA.

Storto, A. and Masina, S. (2016), Earth Syst. Sci. Data, 8, 679, doi: 0.5194/essd-8-679-2016

Brankart, et al. (2012), Ocean Sci., 8, 121, doi: 10.5194/os-8-121-2012