Multivariate data assimilation across ocean and sea-ice interface

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Ocean and sea-ice play a fundamental role within the Earth system model at several timescales: the ocean has a huge capacity to store heat, driving Earth system inertia, while sea-ice influences surface heat, moisture and freshwater fluxes, modulating the Earth's temperature. Despite the recent availability of multiple satellite-based datasets that monitor the ocean interface, present state-of-the-art global ocean/sea-ice reanalyses are generally limited by the ingestion of few data types, mostly treating the ocean and sea-ice sectors separately and with univariate assimilation schemes in the latter.

In the present study we start from the CMCC global ocean reanalysis system (C-GLORS), that is routinely employed to produce up-to-date global eddy-permitting reanalyses for diverse purposes and part of the ocean reanalysis ensemble product in the Copernicus Marine Service catalogue. The latest version, C-GLORSv8, is based on the OGCM NEMO4.2 coupled to CICE6. The sea-ice sector includes a 3Dar scheme that covaries sea-ice concentration and thickness based on Gaussian anamorphism (i.e., quantile mapping), while the ocean is corrected through OceanVar, a 3Dar scheme that assimilates T, S, SLA. Here we present a further development of C-GLORSv8 that introduces cross-covariances between ocean and sea-ice variables through joint ocean-ice background-error EOFs, allowing the assimilation of sea-ice observations to correct ocean variables and vice versa. While the technical aspects are interesting in their own right, we will mainly focus on the comparison among several 1-year-long assimilative experiments looking at the interface between ocean/sea-ice. The impact of ingesting different observation types will be studied in different DA configurations (strongly coupled, weakly coupled) using several metrics (sea ice volume, Integrated Ice Edge Error, surface salinity, etc). We discuss the potential growth of biases in the ocean sector caused by systematic biases in sea-ice departures and possible solutions, including ML-assisted unbiasing.