Multivariate sea ice data assimilation in a global ¼° NEMO4.2/SI3 model

For more than a decade, Mercator Ocean International has been developing global real-time operational systems and producing Global Ocean Reanalysis. Based on the NEMO (Nucleus for European Modelling of the Ocean) modelling platform, observations are assimilated by a reduced-order Kalman filter. In-situ temperature and salinity profiles, altimetric data, sea surface temperature, and sea-ice concentration are jointly assimilated to constrain the coupled ocean and sea-ice model. Sea ice concentration passive microwave product is currently assimilated using a univariate and mono-data assimilation scheme. With the availability of satellite sea ice data (ice and snow thickness measurements), many efforts are being made by operational teams to set up multivariate and multi-data assimilation, and to try to control ice and snow volumes. Control of the ice volume is crucial in ice analysis, even if only sea ice concentration is assimilated. Performed with a configuration based on NEMO4.2 and the SI3 sea ice model at 1/4° horizontal resolution and driven by ERA5 atmospheric forcing, sensitivity experiments were first carried out without assimilation to determine parameter choices that would provide the best background for Arctic and Antarctic sea ice cover and to establish a reference experiment. Assimilation experiments were then carried out to measure the gradual impact of assimilating ice volume, freeboard (Cryosat-2) and snow depth information (CryoSat-2 and SARAL combined measurements) in a multivariate analysis context. The multivariate assimilation technique, successfully implemented, is able to constrain the sea-ice and snow volume on the regional patterns of the assimilated observations. We observe a particularly strong effect on the snow cover, with changes in the spatial patterns of snow depth in both hemispheres. These experiments show however different behaviour in the Arctic and Antarctic. The thermohaline properties of the oceanic upper layers in the Southern Ocean have proved to be a major factor in maintaining the sea ice cover and in representing the ice thickness distribution consistent with that provided by altimetry. Off shore regions in Antarctica revealed a high sensitivity to the implementation of the multivariate scheme, with the occurrence of polynyas related to changes in salinity and temperature of the mixed layer depth.

A. Chenal (1), G. Garric, C.-E. Testut, G. Ruggiero, M. Hamon - (1) CNES/Mercator, Mercator