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Assimilation of simulated satellite altimetric data and ARGO temperature data into a double-gyre NEMO ocean model

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In recent years, data assimilation, adressing the problem of producing useful analyses and forecasts given imperfect dynamical models and observations, has shown increasing interest in the atmosphere and ocean science community. The efficiency of data assimilation in improving the model prediction has been proven by numerous work. However, it is still a challenge to design operational data assimilation schemes which can be operated with realistic ocean models, with reasonable quality and at acceptable cost.

In this work, several experiments, assimilating the simulated altimetry and temperature observations into a double-gyre NEMO ocean model, are performed with objective to investigate the impact of different assimilation setups, including changing the observation distribution, the ensemble size and the localisation scale, on the quality of the analysis. The double-gyre NEMO ocean model corresponds to an idealized configuration of the NEMO model: a square and 5000-meter deep flat bottom ocean at mid latitudes (the so called square-box or SQB configuration). The main physical parameters governing the dominant characteristics of the flow are the initial stratification, the wind stress, the bottom friction and the lateral mixing parameterization. The domain extends from 24N to 44N, over 30° in longitude (60W - 30W) with 11 vertical levels between 152 m and 4613 m in depth. The minimum horizontal resolution of the model is 1/4°.

The observations are generated from the model simulations (the truth) by adding spatially uncorrelated gaussian noise with given standard deviation. Two types of observation are considered : sea surface height (SSH) and temperature. The observation grid of the SSH is simulated from the ENVISAT and Jason-1 satellite tracks, and that of the temperature is generated in order to mimic the ARGO float profile. The observation localisation is performed in order to avoid spurious correlation at large distance. For this, the observations are weighted by the e-folding gaussian function depending on their distance from the water column under consideration. The initial field and error covariance is made through the model simulation itself. The initial ensemble is generated with 100 members. A second ensemble with 40 members is generated from the initial ensemble by Singular Value Decomposition (SVD) truncation.

The assimilation method is the square root analysis scheme of the Ensemble Kalman Filter (EnKF) included in the Ocean Assimilation Kit (OAK). Assimilation is performed in three cases :
1) ENVISAT SSH observations and ARGO temperature observations are assimilated with 100 ensemble members.
2) ENVISAT and Jason-1 SSH observations and ARGO temperature observations are assimilated with 100 ensemble members.
3) ENVISAT SSH observations and ARGO temperature observations are assimilated with 40 ensemble members.

The results obtained in different cases are analysed and assessed by means of the root mean square error (RMS) of the analysis compared to the truth and to the observations, as well as of the ensemble standard deviation (ensemble spread). The advantages and disadvantages of each case are highlighted through comparison.