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Evaluating the impact of different observing networks in the global ocean through ensemble simulations

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Assessing the relative impact of the main observing networks in the global ocean is a challenging problem for operational oceanography data exploitation and for future improvements of the observing networks themselves. In this study, we investigate the impact of different observing networks evaluated through ensemble variational data assimilation experiments. The ensemble members are generated by i) perturbing the observations within a three-dimensional variational data assimilation system, ii) perturbing the surface forcing (wind stress and net heat flux restoring) through the re-sampling of fields of differences between external datasets and iii) stochastically perturbing the ocean model parameterization tendencies in order to perturb the ocean model itself.
Since the forecast error variances are assumed proportional to the ensemble spread, the impact of each observational platform is represented by the relative ensemble spread increase of data-denial ensemble simulations with respect to an "all-observation" ensemble experiment, evaluated independently for each observing network. Our approach allows to determine the impact of the observing networks in model space, unlike traditional OSEs studies, and for different forecast ranges of the ocean general circulation model. Furthermore, no tangent-linear and adjoint coding is required. The impact is computed separately for sea-station reports (CTDs), XBTs, moorings (TAO/TRITON/PIRATA), Argo, sea-level anomaly observations (from all the altimetric missions available) and sea-surface temperature measurements from space-borne microwave instruments (TMI and AMSR-E) within the 3-year period 200301-200512.The results indicate that on the global scale altimetry exhibits the largest impact on near-surface temperature, sea-level height and zonal currents, the latter especially in subtropical gyres areas. Deep ocean results are, on the contrary, impacted mainly by Argo floats.
As expected, space-borne observations (SLA and SST) increase their impact in the Southern Ocean, due to the poorness of the in-situ observations network. For long forecast range (10 to 15 days), sea-station reports and expandable bathythermographs have an important impact, due to their larger-scale representativeness. The results of the impact on the salinity indicates the great importance of Argo floats, especially in the North extra-Tropics and within the top 200 m, while the impact of buoys and moorings becomes larger in deeper layers, especially in the Tropics.