



## **Ensemble assimilation of ARGO temperature profile, sea surface temperature and Altimetric satellite data into an eddy permitting primitive equation model of the North Atlantic ocean**

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Sea surface height, sea surface temperature and temperature profiles at depth collected between January and December 2005 are assimilated into a realistic eddy permitting primitive equation model of the North Atlantic Ocean using the Ensemble Kalman Filter. 60 ensemble members are generated by adding realistic noise to the forcing parameters related to the temperature. The ensemble is diagnosed and validated by comparison between the ensemble spread and the model/observation difference, as well as by rank histogram before the assimilation experiments. Incremental analysis update scheme is applied in order to reduce spurious oscillations due to the model state correction. The results of the assimilation are assessed according to both deterministic and probabilistic metrics with observations used in the assimilation experiments and independent observations, which goes further than most previous studies and constitutes one of the original points of this paper. Regarding the deterministic validation, the ensemble means, together with the ensemble spreads are compared to the observations in order to diagnose the ensemble distribution properties in a deterministic way. Regarding the probabilistic validation, the continuous ranked probability score (CRPS) is used to evaluate the ensemble forecast system according to reliability and resolution. The reliability is further decomposed into bias and dispersion by the reduced centred random variable (RCRV) score in order to investigate the reliability properties of the ensemble forecast system. The improvement of the assimilation is demonstrated using these validation metrics. Finally, the deterministic validation and the probabilistic validation are analysed jointly. The consistency and complementarity between both validations are highlighted. High reliable situations, in which the RMS error and the CRPS give the same information, are identified for the first time in this paper.