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Skill comparison between 3-D super-ensemble and ensemble Kalman Filter for short-term ocean prediction

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The capability of two data-assimilative prediction methods to forecast a regional ocean state in the short-term range (typically 0 to 72 hours) are compared.
The multi-model 3-D super-ensemble (3DSE, Lenartz et al. 2010) is first considered. Taking benefit of the increasing number of operational ocean models available for a given region, this approach optimally combines multiple forecasts (in the present study from ROMS, NCOM and MARS3D models) to provide a single prediction of an oceanic variable. Differing from usual ocean data assimilation techniques, the 3DSE "assimilates" past observations to optimize the spatially variable weights of the individual models. The 3DSE was found to outperform the individual models and their ensemble mean in terms of temperature forecast when a sufficient number of observations is available (Lenartz et al. 2010; Mourre et al. 2012). By contrast, the 3DSE prediction of ocean currents, which was operationally used in a glider adaptive sampling exercise in 2010, was found to contain significant errors. The method optimizes the model weights based on collected measurements, but does not prevent the possibility that the resulting model combination may significantly deviate from a physically consistent ocean state. In particular, errors increase in highly dynamical and/or poorly sampled areas.
The 3DSE predictive skills are compared to those of the ROMS model (Regional Ocean Modeling System) in which observations are assimilated through the more conventional ensemble Kalman Filter approach (EnKF, Evensen 2003). The EnKF exploits spatial and cross-variable covariances deduced from an ensemble of model simulations to consistently update ocean temperature, salinity and velocity fields throughout the modeling domain based on measurements of one or more of these variables.
An extensive set of observations collected in the Ligurian Sea in summer 2010 during the REP10 oceanographic experiment is used to carry out this skill assessment. A common dataset including CTD, glider and sea surface temperature observations is assimilated by means of both methods. Forecast skills are then evaluated against a common validation dataset. Statistical results of model-data comparisons are presented and advantages and drawbacks of both approaches are discussed.