4DVAR with ensemble background error covariance estimation in a coastal ocean model

*Ivo Pasmans[1], Alexander Kurapov[1]

1. Oregon State University

Traditionally 4DVAR implementations for ocean forecasting proceed in a series of relatively short time windows and assume that the model background error covariance is static in time. Offshore Oregon/Washington (USA west coast) this static assumption on the background error covariance is unlikely to hold as the outflow of the Columbia River creates a fresh water plume of which the location and extent vary depending on wind direction and river outflow. To better capture the natural variability in the system we have implemented E4DVAR data assimilation in Oregon State University's ocean forecasting system. In this system the initial conditions at the beginning of each 3-day window are corrected by combining the previous 3-day model forecast from a 2-km ROMS (Regional Ocean Modeling System) model with observations of GOES sea-surface temperatures, high-frequency radar surface current observations and Jason satellite altimetry using 4DVAR. For the tangent linear and adjoint parts of the 4DVAR algorithm the system uses the in-house developed AVRORA codes. The background error covariance is estimated by localizing, using a new Monte-Carlo localization scheme, the sample covariance of a 50-member ensemble. The members of this ensemble are generated by running the system using different wind fields and perturbed observations. Results show that the new system provides better forecasts for the subsurface temperature and salinity fields and a more accurate representation of the temperature-salinity relationship. However, the surface salinity in the new system turned out to be overly sensitive to observation errors in sea-surface temperature. Interestingly, introduction of approximate salinity conservation in the assimilation scheme has been shown to suppress unrealistically large sea-surface salinity corrections and additionally modify the shape of the river plume. This indicates that implementation of data assimilation in models with tracers is non-trivial and should be handled with care.

Keywords: data assimilation, 4DVAR, coastal ocean, localization, river plume

