Background covariance of atmospheric duct properties based on ensembles

Neil D. Gordon*[1], Ana K. Ascencio[1], Ted Rogers[1], Tracy Haack[2], and Allen Zhao[2]

[1] Space and Naval Warfare Systems Center Pacific, San Diego, CA, USA

[2] Naval Research Laboratory, Monterey, CA, USA

In Refractivity Data Fusion (RDF), the Cartesian representation of refractivity calculated from the Numerical Weather Prediction (NWP) output is mapped into a set of 2-dimensional diagnostic variables which are surfaces over the NWP domain. The diagnostic parameters (e.g. duct base height, duct strength, duct thickness, evaporation duct height) include those generated by electromagnetic (EM) inverse problem solutions (e.g. refractivity-from-clutter or RFC). RDF produces an analysis of refractivity in the diagnostic space which is then mapped back into Cartesian coordinates for consumption in EM propagation assessment tools used by the Navy to gauge operational sensor performance. A companion presentation describes RDF in more detail.

Performance of RDF's objective analysis requires characterization of background error. The whole set of diagnostic variables used in RDF are not currently used in traditional variational data assimilation. The Wallops 2000 data set is being used to develop RDF. This data set includes radar clutter data, EM propagation loss measurements and a variety of in situ meteorological observations. We investigate the use of mesoscale NWP ensembles as a means to estimate a background covariance matrix (B) for the Wallops domain. An ensemble Kalman filter (EnKF) extension to the Naval Data Assimilation System (NAVDAS) is used to generate a 32-member ensemble that spans a 168 hour period beginning 28 April to 4 May 2000. Automated routines diagnose the above mentioned parameters from vertical profiles of refractivity calculated from the ensemble members.

Errors such as upward displacement (i.e., layers in the model appear to be upwardly displaced with respect to the observations), with otherwise unchanged air masses above and below the interfacial layer, should result in strong correlations in errors for parameters associated with height. The ensembles are used to calculate the zero-lag covariance values and those of the spatial correlation coefficients. For the most part, the values of the zero-lag correlation coefficients are close in magnitude and sign to heuristic estimates. However, the precise values are dependent on the underlying meteorology. The spatial correlation function has more rapid decorrelation in the direction normal to the coastline (and the Gulf-stream) than in the direction parallel to it. This is likely due to the change in sea surface temperature across the eastern edge of the gulfstream.