FUSING OBSERVATIONS OF ATMOSPHERIC REFRACTIVITY WITH BACKGROUND FIELDS FROM A NUMERICAL WEATHER PREDICTION MODEL

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The authors present a new approach for fusing observed modified refractivity, $M(z)$ where z is the height, with a background refractivity diagnosed from a numerical weather prediction (NWP) model. A key aspect of the approach is implementing a non-linear observation operator for handling differences between observed and modeled refractivity that are explained by vertical displacement as well as differences that can be characterized using linear methods.

The observation operator relies on a two-stage mapping. Let z be an array of height values. A Markov process is used to generate an array of perturbed heights z'. Thus $M(z')$ possesses random displacements with respect to $M(z)$. A second mapping takes the form of $M'(z') = M(z') + \epsilon$ where ϵ is too created via a Markov process. The random mappings $M(z) \longrightarrow M'(z')$ can be generated *ad nauseum* and because of their Markov orgins, an *a priori* probability (p_a) can be associated with each one. Out of an ensemble of these mappings, we choose the subset that provide "good" fits to the observed data when the background field at the location of the observation is mapped through them; all subset members are assumed to have identical experimental probabilities (p_e's) that sum to 1. All other mappings (those outside of the subset) have $p_e = 0$. Assuming the *a posteriori* probability p_p is the product $p_p = p_a \dot{p}_e$, it is clear that the mapping having the highest *a priori* probability that is in the subset of good fits is the MAP estimator.

The non-linear observation operator is inserted in the (otherwise) familiar minimum variance optimal interpolation (MVOI) data assimilation scheme. Inserting the non-linear operator in this manner results in a sub-optimal estimation scheme but one that is quite practical. Real data are used to show that: (a) the scheme improves the handling of mismatches where vertical displacements of features are major factors, and (b) that the cost of the sub-optimality is not necessarily excessive.

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