Diagnostics for the Assimilation of Observations in the Boundary Layer

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In 4DVar information from observations is spread either by the background error covariances or by the linear model. We present diagnostics that allow us to separate the relative contributions of these two spreading mechanisms. The motivation for this work has been the sometimes poor assimilation of observations in the boundary layer (BL) in the Met Office's 4DVar system, particularly in temperature inversions and stratocumulus cloud cases. These problem cases have principally been attributed to inappropriate vertical covariances of the background error covariance matrix that have a tendency to spread the information from observations too much.

Here, we explore the role the physical parameterisations in the Met Office's 4DVar linear model in spreading the information from observations. To achieve this we have generated two sets of background error covariance statistics using the National Meteorological Center (NMC) method: a control set derived in the normal way and a modified set. For the modified covariance statistics the model errors of the moisture control variable at different levels are set to be artificially uncorrelated. Thus spreading of information will be due mainly to the physics and so the modified covariance statistics will allow us to see more clearly the influence of the physics.

We perform a set of single observation tests for four cases representing a range of meteorological situations. In these experiments, analysis increments are created from the insertion of a single observation of moisture. These diagnostics show that the background error covariance matrix tends to dominate the spreading of the information compared with the physical parameterisations. Therefore, the priority of further work is to improve the covariance statistics before we can gain the full potential from the physical parameterisations in linear model, particularly with respect to the boundary layer.