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Spectral Representation of Spatial Correlations in Variational Assimilation and Application to Stratospheric Chemistry Data Assimilation

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One of the critical aspects of any assimilation system is the formulation of a background error covariance matrix (BECM) which is sufficiently compact to be implemented numerically and sufficiently complex to represent correctly the real error covariances of the first guess field. In the late nineties, meteorological centers have implemented relatively powerful BECM where the spatial correlation matrix is defined in the spectral space. In this configuration, the horizontal correlations are assumed to be homogeneous and isotropic. Moreover, non-separable vertical correlations can be implemented.

The goals of this study are numerous. First, it aims at presenting this method by focusing on a univariate assimilation and for global models. Usually, this method is implemented in meteorological spectral models with the physical grid being the (non-equally spaced) Gaussian grid. We will show that the method can be applied directly to equally spaced physical grid without operating a transformation from the Gaussian grid to the model grid, which necessarily degrades the analyses. This method has been implemented in the stratospheric chemistry data assimilation system BASCOE. Hence, the results from real test cases will be shown. In particular, the hypothesis of homogeneity and isotropy will be examined and way forward flow-dependent BECM will be discussed. Finally, a FORTRAN code has been developed and will be made available to the community.