Correlations of Control Variables for Representing Forecast Errors on Cubed-Sphere Grids

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The background error covariance is essential in data assimilation for spreading out information spatially especially in data-sparse areas, providing statistically consistent and dynamically balanced increments at the neighbouring grid points and levels of the model [1]. The full representation of the matrix is impossible because of the huge size, so the matrix is constructed implicitly by means of a variable transformation.

Background state is derived from a short numerical forecast, and so background errors share properties with forecast errors [2]. Forecast error statistics were based on Community Atmosphere Model-Spectral Element (CAM-SE) model runs every 6 hours for 31 days. CAM-SE is built upon the cubed-sphere grid, where the grid points are located at Legendre-Gauss-Lobatto (LGL) points on each local element of 6 faces on the sphere. We used the cubed-sphere geometry based on the spectral element method which is better for parallel application to apply control variable transform.

The variable transformation from model variables to a set of control variables whose errors were assumed to be uncorrelated was developed on the cubed sphere-using Galerkin method. The motivation of the control variable transform is to capture the properties of B without the need for an explicit matrix [2]. Winds were decomposed into rotational part and divergent part by introducing stream function and velocity potential as control variables. The dynamical constraint for balance between mass and wind were made by applying linear/nonlinear balance operators. The statistical structure of forecast errors will be presented for the basic model variables (T, u, v, etc.) and control variables (stream function, velocity potential and unbalanced geopotential height, etc.).

References

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