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Correlations of control variables for horizontal background error covariance modeling on cubed-sphere grid

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Background error covariance matrix is very important for variational data assimilation system, determining how the information from observed variables is spread to unobserved variables and spatial points. 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. It is assumed that the forecast errors in the control variables chosen are statistically independent. We used the cubed-sphere geometry based on the spectral element method which is better for parallel application. In cubed-sphere grids, the grid points are located at Gauss-Legendre-Lobatto points on each local element of 6 faces on the sphere. The two stages of the transformation were used in this study. The first is the variable transformation from model to a set of control variables whose errors are assumed to be uncorrelated, which was developed on the cubed sphere-using Galerkin method. Winds are 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 balance operator. The second is spectral transformation which is to remove the remaining spatial correlation. The bases for the spectral transform were generated for the cubed-sphere grid. 6-hr difference fields of shallow water equation (SWE) model run initialized by variational data assimilation system were used to obtain forecast error statistics. In the horizontal background error covariance modeling, the regression analysis of the control variables was performed to define the unbalanced variables as the difference between full and correlated part. Regression coefficient was used to remove the remaining correlations between variables.