Covariance operators on the equiangular gnomonic cubic grid

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1. Introduction

The next operational global forecasting system at NCEP will employ the FV3 dynamical core developed at NASA/GSPC and NOAA/GFDL by Lin and his colleagues (Lin and Rood, 1996; Putman and Lin, 2007) and it will become necessary to adapt NCEP's existing Global Statistical Interpolation (GSI) data assimilation system to the new grid framework employed by the FV3. The most challenging part of this task will be the reformulation of the spatial covariance operators. The grid framework is that of the gnomonic cubed sphere, shown schematically in the figure. The attractive properties of the grid are that, in each of its six tiles, it is free of singularities or significant curvature, and its resolution is almost uniform. But a characteristic feature of that grid that needs to be taken into account in the course of formulating suitable spatial covariance operators is its inherent obliquity, varying with distance from the median lines of each tile and becoming as large as 120° at the grid corners.

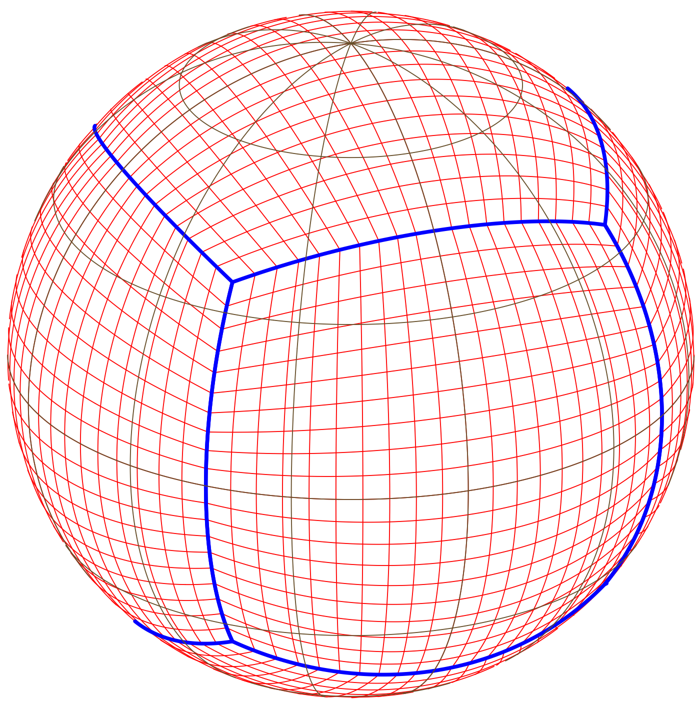

Figure 1. Schematic illustration of the equiangular gnomonic cubed-sphere grid, showing its characteristic weak nonorthogonality.

At present the global GSI covariances are generated on overlapping orthogonal grids (two polar stereographic, sandwiching one nonpolar cylindrical) using the method of sequential spatially-recursive filter as described in, for example, Purser et al. (2003). In the new configuration, a single type of grid suffices, but six copies of it entails some additional interpolation and blending. The nonorthogonality can be accommodated by augmenting the set of line directions of the one-dimensional smoothers to include the principal grid diagonals as well as just the two main grid directions in the horizontal; essentially this method is already used in NCEP's operational Real Time Mesoscale Analysis (RTMA, see de Pondeca et al., 2011) to achieve general horizontal anisotropy in an orthogonal grid, whereas we now seek, conversely, to achieve isotropy from a grid that is oblique.

We intend to take the opportunity to investigate whether the recursive filters, with their inconvenient infinite impulse-response, can be replaced with alternative quasi-Gaussian smoothers based on B-splines (de Boor, 1978), whose contrasting finite impulse-response should obviate the need for the massive and non-scalable data motion that the present methods of parallelization involves. Another opportunity suggested by the geometrical simplicity and regularity of the new grid is to adopt an explicitly "multigrid" approach to the additive synthesis of the covariances from many isotropic Gaussian components covering a broad range of scales. By suitably weighting each such component, we gain more flexible control over the covariance profile shape than is feasible in the GSI as presently formulated.

References

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