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Eigensolutions of Laplacian Operator on the sphere for geodesic grids

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Spherical Laplacian operator is solved as an eigen-problem for two geodesic grids of the cubed sphere grid and the icosahedral-hexagonal grid. To discretize the Laplacian operator, the spectral element method was used for the cubed-sphere grid, while the finite difference method was employed for the icosahedral-hexagonal grids. Matrix equations with respect to the unknown grid-point values on the global domain, obtained from the discretization, were solved numerically on a standard linear-system solver package. It was shown that the eigenvectors exhibited non lat-lon grid structure, unlike the spherical harmonics functions which are the eigenfuctions for the lat-lon grid. The eigenvalues were found to behave as a step-function-like behavior, i.e. 2n+1 identical eigenvalues for the degree of n. Implication of the eigenvalues and corresponding eigenvectors to the atmospheric dynamical core is discussed in the aspect of the phase speed of some basic dynamical mode as well as the time-step size.