EGU21-13687
https://doi.org/10.5194/egusphere-egu21-13687
EGU General Assembly 2021

Semi-Lagrangian advection models for quasi-uniform nodes on the sphere

Takeshi Enomoto[1] and Koji Ogasawara[2]
[1]Disaster Prevention Research Institute, Kyoto University, Uji, Kyoto, Japan (enomoto.takeshi.3n@kyoto-u.ac.jp)
[2]Graduate School of Science, Kyoto University, Kyoto, Japan (ogasawara@dpac.dpri.kyoto-u.ac.jp)

Radial basis functions enable the use of unstructured quasi-uniform nodes on the sphere. Iteratively generated nodes such as the minimum energy nodes may not converge due to exponentially increasing local minima as the number of nodes grows. By contrast, deterministic nodes, such as those made with a spherical helix, are fast to generate and have no arbitrariness. It is noteworthy that the spherical helix nodes are more uniform on the sphere than the minimum energy nodes. Semi-Lagrangian and Eulerian models are constructed using radial basis functions and validated in a standard advection test of a cosine bell by the solid body rotation. With Gaussian radial basis functions, the semi-Lagrangian model found produces significantly smaller error than the Eulerian counterpart in addition to approximately three times longer time step for the same error. Moreover, the ripple-like noise away from the cosine bell found in the Eulerian model is significantly reduced in the semi-Lagrangian model. It is straightforward to parallelize the matrix–vector multiplication in the time integration. In addition, an iterative solver can be applied to calculate the inverse of the interpolation matrix, which can be made sparse.