

Improved smoothness and homogeneity of icosahedral grids using the spring dynamics method

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An icosahedral grid that has both high smoothness and homogeneity is proposed (Iga and Tomita 2014). The grid-generation method is based on the combination of the spring dynamics (SPR) method with zero natural spring length (SPR0) and transformation by a smooth analytic function around the 12 vertices of an icosahedron. As a preliminary step, we first showed that the grid interval of the grid generated by SPR0 was inversely proportional to a Lambert conformal conic projection map factor, with a map angle of 300° around the vertices. Then, the transformation function was analytically determined, such that the resolution for the azimuthal direction became constant. In order to estimate cost-efficiency of numerical simulation with the newly proposed grid, we introduced an index defined as the ratio between the minimum grid interval and the squared maximum grid interval. It showed a 2.5 % improvement from a recursive grid, and a 0.3 - 12 % improvement from the best cases of the original SPR grid proposed by Tomita et al. (2002) dependent on global resolution. We also re-examined the original SPR method and found that the natural spring length proposed in Tomita et al. (2002) should be shortened to avoid instability when the global resolution is higher than grid-level 8. Finally, we examined the grids using advection / shallow water simulations.

Reference

- H.Tomita, M. Satoh, and K.Goto, 2002, An optimization of the icosahedral grid modified by spring dynamics, *J. Comput. Phys.*183: 307–331.
- S.Iga and H.Tomita 2014, Improved smoothness and homogeneity of icosahedral grids using the spring dynamics method, *J. Comput. Phys.*, 258:208-226