An analysis of the orthogonal terrain-following vertical grids on reducing the advection errors in the terrain-following coordinate

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Abstract

An orthogonal terrain-following coordinate (OS coordinate) was proposed by Li et al. (2013) to reduce the advection errors in the classic σ-coordinate. The OS coordinate can smooth the vertical layers above the steep terrain as well as create the orthogonal terrain-following grids in the vertical. The idealized advection experiments in Li et al. (2013) validated that the OS coordinate can significantly reduce the advection errors in the high level above the steep terrain. In this study, we further investigate the distinct effect of the orthogonal grids created by the OS coordinate in term of the advection errors near the surface. First, we use the OS coordinate to implement a modified idealized advection experiment from Schär et al. (2002) by moving the tracer right down to the top of terrain. And then we compare the results obtained by the OS coordinate with those of the corresponding hybrid σ-coordinate near the surface. Finally, we investigate the stability of the OS coordinate above the steep terrain. The experimental results show that the orthogonal grids created by the OS coordinate can reduce the advection errors, and the stability of the OS coordinate can be similar as that of the classic σ-coordinate above the steep terrain.