2D tracer transport on Cartesian and icosahedral grids: scheme comparisons for idealized test cases

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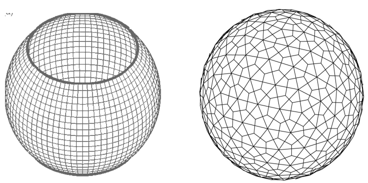
- We consider replacing the Cartesian mesh of the CHIMERE chemistry transport model with Voronoi meshes. Is this beneficial or detrimental?

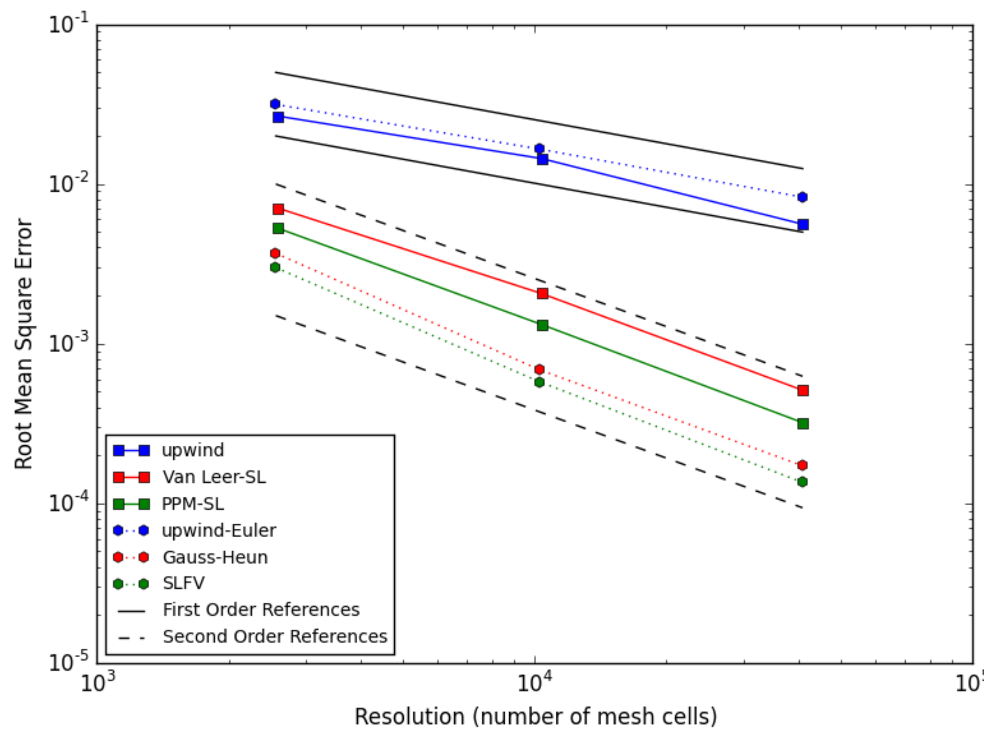
NUMERICS: Numerical schemes for solving the advection equation of orders 1 (upwind) and 2 (including SLFV [2]) are implemented on these meshes.



TEST CASES: We use tilted and vortex wind fields, not aligned with the mesh structures, to prevent biases (NL2010 [1], tilted rotating solid-body).

We use **metrics** including convergence and numerical diffusion to evaluate the mesh-scheme pairings.

METHOD: We start with a uniform Cartesian mesh between -45 and +45 degrees latitude, and an unstructured Voronoi icosahedral one, on a sphere with Earth radius.
For all schemes, we verify the monotonicity and stability for common Courant numbers (C). We then perform the simulations using the greatest common stable value, which is C = 0.8.



CONCLUSION:
Unexpectedly, we find that the Voronoi mesh (hexagonal symbols, dotted) does display better performance than the Cartesian (square symbols, solid) under some conditions.

Also, a 3D test case with real-life values is under study to assess performance with the realistic conditions of the Puyehue 2011 eruption.

References

[1] R. Nair and P. Lauritzen, A class of deformational flow test cases for linear transport problems on the sphere, *Journal of Computational Physics* 229(23):8868-888, Nov. 2010, DOI: 10.1016/j.jcp.2010.08.014

[2] S. Dubey, T. Dubos, F. Hourdin, and H. C. Upadhyaya. On the inter-comparison of two tracer transport schemes onicosahedral grids.*Applied Mathematical Modelling*, 39(16):4828 – 4847, 2015. ISSN 0307-904X. doi:https://doi.org/10.1016/j.apm.2015.04.015.