GAME Documentation

GAME Development Team

The *speed* s of a model is defined by

$$s \coloneqq \frac{\Delta t}{\Delta \tilde{t}}, \tag{1}$$

where Δt is the time step of the model and $\Delta \tilde{t}$ is the duration it takes to integrate from one time step to the next.

1 NWP mode

In NWP mode, one wants to be able to integrate one day within 8.5 minutes, which corresponds to $s = \frac{24 \cdot 60}{8.5} = 169$. As a general rule, one can say that the computation time is in equal parts needed for data assimilation, the dynamical core and the processes involving moisture and radiation. Thus, the dynamical core has a mimimum speed of

$$s \geq 509. \tag{2}$$

1.1 Grid optimization

Hexagonal spherical grids need to be optimized for numerical modeling. Therefore, the Lloyd algorithm is used, which yields a *spherical centroidal Voronoi tesselation (SCVT)* after convergence [1]. [3] gives an overview of optimization alternatives and it seems to be that the SCVT is the most suitable for modeling. The procedure employed for executing the Lloyd algorithm is the one described in [2].

1.2 Parallelization

2 Radiation scheme

GAME employs the so-called `RTE+RRTMGP (Radiative Transfer for Energetics + Rapid and Accurate Radiative Transfer Model for General Circulation Model Applications-Parallel)` [4], [5] scheme. It is bound to the C code through the API `RTE-RRTMGP-C` [6].

References

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[2] Hiroaki Miura and Masahide Kimoto. A Comparison of Grid Quality of Optimized Spherical Hexagonal–Pentagonal Geodesic Grids. In: *Monthly Weather Review* 133.10 (Oct. 2005), pp. 2817–2833. ISSN: 0027-0644. DOI: 10.1175/MWR2991.1. eprint: https://journals.ametsoc.org/mwr/article-pdf/133/10/2817/4213997/mwr2991_1.pdf. URL: https://doi.org/10.1175/MWR2991.1.

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[4] Robert Pincus, Eli J. Mlawer, and Jennifer S. Delamere. Balancing Accuracy, Efficiency, and Flexibility in Radiation Calculations for Dynamical Models. In: *Journal of Advances in Modeling Earth Systems* 11.10 (2019), pp. 3074–3089. DOI: 10.1029/2019MS001621. eprint: https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2019MS001621. URL: https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019MS001621.

[5] *RTE-RRTMGP github repository*. June 22, 2020. URL: https://github.com/earth-system-radiation/rte-rrtmgp.

[6] *RTE-RRTMGP-C github repository*. June 22, 2020. URL: https://github.com/MHBalsmeier/rte-rrtmgp-c.