EPSC

EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

GEM-Mars GCM simulations with a Yin-Yang grid configuration: Impact on the polar regions

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Abstract

We present preliminary results from the updated dynamical core of GEM-Mars, which includes the option of a new horizontal discretization. In the Yin-Yang configuration, the domain is decomposed into two limited area sub-domains with an overlapping region. This eliminates any problems with the convergence of meridians at the poles and improves the computational load balance in message-passing interfaces. We examine the impact of this new configuration on model results, in particular, in the polar regions of Mars.

Introduction

Traditionally, both terrestrial and martian General Circulation Models (GCMs) using grid point methods have used latitude-longitude grids. More recently, there has been a shift to different types of grid definitions (see [5] for overview) to overcome some of the issues that arise with the latitude-longitude grid.

The GEM-Mars model ([3], [1]) is able to benefit from the improvements to GEM, the terrestrial version of the model used operationally by Environment and Climate Change Canada (ECCC). We have adopted the most recent version of the dynamical core (see [2], [4] for descriptions of some of the recent updates) to apply to the Martian atmosphere. One of the changes involves the new definition of the Yin-Yang grid, consisting of two identical latitude-longitude grids perpendicular to each other. The two domains have a static halo region similar to a limited-area piloting region where an interpolation is done to update the variables.

We present preliminary results with the new configuration and discuss the impact on the simulated fields.

Horizontal grid definition

Previous versions of GEM-Mars used a latitude-longitude grid definition with a horizontal resolution of 4°x4° or 90x45 grid points (~237 km at the equator). For testing the Yin-Yang grid, we have chosen the two domains to be 90x31 grid points each which leads to a maximum grid size of ~178 km. The central longitude of the domain covering the poles is chosen to pass through Hellas basin, so that it does not sit on the border of the sub-domains. Figures 1 and 2 show the new grid definition in orthographic and mercator projections, with interpolated MOLA topography and grid points shown.

Figure 3 shows the difference between the grid box sizes for the two configurations, with the latitude-longitude grid areas varying from 1,960 km^2 near the poles to 56,000 km^2 at the equator, while the Yin-Yang grid leads to a more uniform grid with a smaller range between 22,370 and 31,640 km^2.
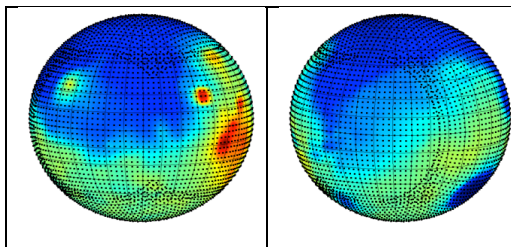
Figure 1 Orthographic projection of topography with grid points indicated by black points.
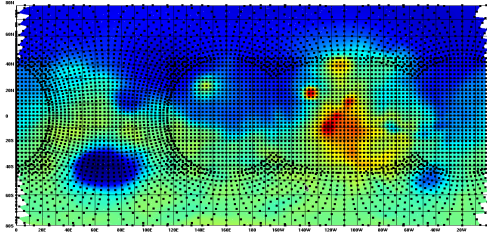
Figure 2 Same as Figure 1 but on a mercator projection.
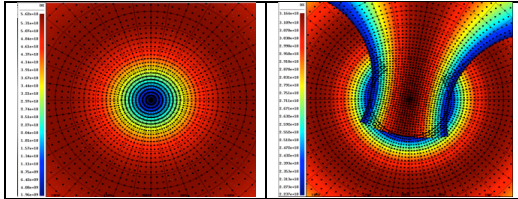
Figure 3 North polar stereographic projection of grid box area for 90x45 latitude-longitude configuration (left – colour scale ranges from 1,960 km^2 to 56,000 km^2) and the Yin-Yang configuration (right – colour scale ranges from 22,370 km^2 to 31,640 km^2).

Summary

We will present simulations using the new grid definition, comparing with previous model results, and discuss the impact on general circulation and the water cycle. Of particular interest is the release of water vapour from the polar caps during solstices, and its transport. Efficiency of the new core will also be discussed.

Acknowledgements

References

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