

General Circulation Modeling of the Jovian stratosphere

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Abstract

The middle atmosphere of Jupiter (1 bar to 1 μ bar) is primarily driven by the heat generated in the interior and by radiative heating and cooling. The stratosphere of Jupiter is less studied, and the mechanisms behind many observed phenomena (e.g., QJO) in the middle atmosphere as well as the stratospheric circulation patterns remain unknown. We have developed a new General Circulation Model (GCM) to simulate the middle atmospheres of gas giants, which can give important insights to the stratospheric circulation and to the physical and dynamical processes underlying the observed middle atmospheric phenomena.

1. Model description

This hydrostatic primitive equation model is based on the finite difference (grid point) dynamical core [1, 2]. In this version, we have parameterized the radiative effects by Newtonian cooling. The model physics also includes molecular viscosity, thermal conduction and Richardson-based turbulent diffusion. Unresolved sub-grid scale processes are parameterized by horizontal diffusion. The influence of interior forcing is implemented in the model by nudging the observed wind pattern at the lower boundary.

2. Summary and Conclusions

The simulations done with 360 x 180 grid points (longitude and latitude) and 41 vertical levels, show a large number of equatorial eddies which are vertically trapped. The horizontal diffusion coefficient affects the strength of the circulation, but the patterns remain unaffected. The model successfully reproduces “chevrons”-like [3] structures for the first time in the Jupiter’s equatorial atmosphere. It also reveals the vertical structure with the circulation cells imposed by the tropospheric zonal winds decaying with height. Eddies

dramatically alter the circulation, and wave-mean flow interactions destroy the multiple-band structure imposed at the lower boundary forming broader global-scale meridional cells at higher levels.

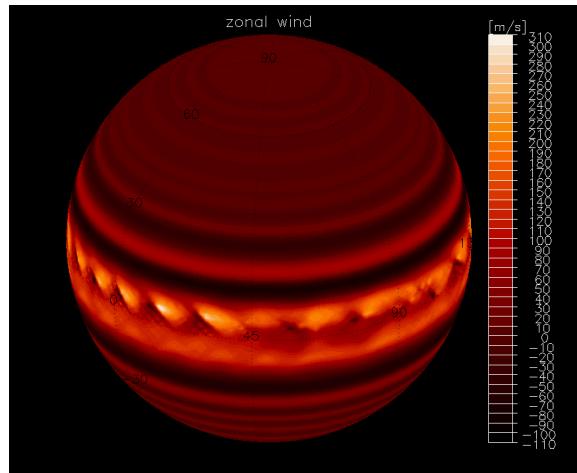


Figure 1: Eddies embedded in the zonal wind simulated with the GCM.

References

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