Geophysical Research Abstracts
Vol. 21, EGU2019-15821, 2019
EGU General Assembly 2019

Modeling atmospheric dynamics and moist convection in Jupiter's troposphere

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Jupiter's tropospheric dynamics is characterized by the presence of about alternately 29 prograde and retrograde jet streams. These jets delimit longitudinal bands where wind shear is alternately anticyclonic and cyclonic which match respectively with the observed bright zones and brown belts. The equatorial jet is superrotating with an eastward velocity equal to 100 m s^{-1} In this large scale zonal structure we can see some vorticies (like the Great Red Spot or the white ovals) as well as convective storms and lightnings. Juno mission has revealed not long ago that this zonal structure disappear beyond 70 degrees latitude to become more turbulent near the poles.

In order to understand the physical processes that underlie these observations, we use the General Circulation Model (GCM) developed at the LMD to model gas giant. The dynamical core DYNAMICO, which solves the atmospheric primitive equations, uses an icosahedral grid to ensure good energy and momentum conservation as good scalability properties for massively parallel computing. Physical parametrizations include radiative transfer, vertical diffusion, constant internal heat flux and convective adjustment.

In high resolution simulations (0.5 degree resolution in longitude and latitude), we can see about ten jets alternately prograde and retrograde emerge from the baroclinic instabilities thanks to an inverse cascade of energy. Baroclinic instabilities develop in our simulations only because of the few Kelvin equator-to-pole temperature gradient present in our model runs. However, ground-based or space-based observations are consistent with a near zero meridional temperature gradient at the 1-bar pressure level. That is why we investigate one other possible source of instabilities: the convection. The simple convective adjustment used until then is not able to transfer momentum or consider latent heat release. We replace it by a thermal plume model originally developed for Earth but adjusted for gas giant. This new parametrization is able to transport momentum and tracers thanks to mass flux variations computed along the vertical. We will discuss its influence on the large scale circulation and potentially compare it to Juno observations.