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Radiative and dynamical modeling of Jupiter's atmosphere

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Jupiter's atmosphere harbours a rich meteorology, with alternate westward and eastward zonal jets, waves signatures and long-living storms. Recent ground-based and spacecraft measurements have also revealed a rich stratospheric dynamics, with the observation of thermal signatures of planetary waves, puzzling meridional distribution of hydrocarbons at odds with predictions of photochemical models, and a periodic equatorial oscillation analogous to the Earth's quasi-biennal oscillation and Saturn's equatorial oscillation.

These recent observations, along with the many unanswered questions (What drives and maintain the equatorial oscillations? How important is the seasonal forcing compared to the influence of internal heat? What is the large-scale stratospheric circulation of these giant planets?) motivated us to develop a complete 3D General Circulation Model (GCM) of Saturn and Jupiter. We aim at exploring the large-scale circulation, seasonal variability, and wave activity from the troposphere to the stratosphere of these giant planets.

We will briefly present how we adapted our existing Saturn GCM to Jupiter. One of the main change is the addition of a stratospheric haze layer made of fractal aggregates in the auroral regions (poleward of 45S and 30N). This haze layer has a significant radiative impact by modifying the temperature up to +/- 15K in the middle stratosphere.
We will then describe the results of radiative-convective simulations and how they compare to recent Cassini and ground-based temperature measurements. These simulations reproduce surprisingly well some of the observed thermal vertical and meridional gradients, but several important mismatches at low and high latitudes suggest that dynamics also plays an important role in shaping the temperature field.
Finally, we will present full GCM simulations and discuss the main resulting features (waves and instabilities). We will also and discuss the impact of the choice of spatial resolution and numerical dissipation on the tropospheric and stratospheric dynamical features.