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ÉmerGéantes: a new Global Climate Model to study the dynamics of Saturn's stratosphere – and beyond

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Recent observational programs, both spatial and ground-based, have revealed the complexity of the middle atmospheres of giant planets. In particular, maps of the temperature and of the distribution of trace species in the Saturn stratosphere have been obtained by the Cassini spacecraft with unprecedented details. These maps exhibit puzzling anomalies, which cannot be explained by current photochemical and radiative models (none of them includes dynamics), and which have been interpreted as the signature of large-scale or seasonal dynamical motions. Yet Saturn's global circulation remains weakly characterized. Furthermore, on Saturn and Jupiter, equatorial oscillations in the zonal wind and temperature field have recently been discovered and are reminiscent of the Earth's Quasi-Biennial Oscillation, a fundamental dynamical phenomenon. These oscillations thus appear to be a common dynamical phenomenon in very different planetary atmospheres.

We will present the development of "ÉmerGéantes", a new global climate model for giant planets. This new model is based on the LMDz dynamical core, which has been successfully adapted to terrestrial planets and moons: the Earth, Mars, Venus, Titan, Triton/Pluton. Details on the numerical challenges, the adaptations needed to simulate gas giants, and the optimization of the radiative transfer computations will be presented, along with preliminary results.

The aim of this project is study in detail the atmospheric circulation of giant planets by resolving atmospheric circulations in their stratosphere (and, possibly, in the future, the coupling between their troposphere and stratosphere). It will serve as a new tool to address fundamental questions in geophysical fluid dynamics, explore the giant planets circulation patterns, and better interpret current and future observations. This new GCM will first be focused on reproducing Saturn's climate, following the harvest of observations obtained by the Cassini mission. We plan to also study Jupiter in the future, both in the frame of future missions (Juno, JUICE) and a comparative planetology approach with Saturn. Another area of fruitful application of our model is extrasolar planets, such as " hot Jupiters ", that act as natural laboratories to broaden our knowledge of atmospheric dynamics in extreme environments.