EPSC Abstracts
Vol. 14, EPSC2020-284, 2020
https://doi.org/10.5194/epsc2020-284
Europlanet Science Congress 2020

Simulations of convective storms in Jupiter with an updated version of a three-dimensional model of moist convection

Peio Iñurrigarro, Ricardo Hueso, and Agustin Sánchez-Lavega
Departamento de Física Aplicada I, UPV/EHU, Bilbao, Spain (peio.inurrigarro@ehu.eus)

Moist convective storms powered by the release of latent heat in rising air parcels are a key element of the meteorology of the Gas Giants [1] and are suspected to play also an important role in the atmospheric dynamics of the Ice Giants [2]. In Jupiter convective storms of different spatial scales occur with different frequencies, from short-lived localized storms [3] to longer-lived storms able to trigger planetary-scale disturbances that develop in cycles of several years [4].

Several models with different approaches have been developed to study moist convection in Jupiter and other planets [5-8]. Three-dimensional cloud resolving models are computationally expensive but have the advantage of allowing the study of the motions generated in the storm and they can also take into account the effects of the three-dimensional Coriolis force in the evolution of the storm. We have used an updated version of a three-dimensional Anelastic Model of Moist Convection [9-11] to explore the development of convective storms in Jupiter. We have improved the dynamical core of the model increasing the stability of the model, which allows us to simulate the dynamics of the development of the storms for longer time ranges than previous simulations presented with this model.

Here we will present results of new simulations of moist convective storms in Jupiter. We simulated the onset and initial development of the storms in a series of different scenarios of condensables abundances to study under which conditions it is possible to trigger convective storms. We tested different abundances of the condensables, relative humidities and fractions of condensates carried by the storm. We play particular attention to the capacity of the storm to generate convective downdrafts with the potential to desiccate the volatiles of the upper atmosphere [12, 13].

References:

[1] A. P. Ingersoll et al. Moist convection as an energy source for the large-scale motions in Jupiter's atmosphere, Nature 403, 2000.

[2] R. Hueso and A. Sánchez-Lavega. Atmospheric Dynamics and Vertical Structure of Uranus and Neptune's weather layers, Space Science Reviews, 215:52, 2019.

[3] P. Iñurrigarro et al. Observations and numerical modelling of a convective disturbance in a large-scale cyclone in Jupiter's South Temperate Belt, Icarus 336, 2020.

[4] A. Sánchez-Lavega et al. Depth of a strong jovian jet from a planetary-scale disturbance driven by storms, Nature 451, 2008.

[5] C. R. Stoker. Moist Convection: A Mechanism for Producing the Vertical Structure of the Jovian Equatorial Plumes, Icarus 67, 1985.

[6] Y. Yair et al. Model interpretation of Jovian lightning activity and the Galileo Probe results, Journal of Geophysical Research 103, 1998.

[7] K. Sugiyama et al. Numerical simulations of Jupiter's moist convection layer: Structure and dynamics in statistically steady states, Icarus 229, 2014.

[8] C. Li and X. Chen. Simulating Nonhydrostatic Atmospheres on Planets (SNAP): Formulation, Validation and Application to the Jovian Atmosphere, The Astrophysical Supplement Series 240, 2019.

[9] R. Hueso and A. Sánchez-Lavega. A Three-Dimensional Model of Moist Convection for the Giant Planets: The Jupiter Case, Icarus 151, 2001.

[10] R. Hueso and A. Sánchez-Lavega. A three-dimensional model of moist convection for the giant planets II: Saturn's water and ammonia moist convective storms, Icarus 172, 2004.

[11] R. Hueso and A. Sánchez-Lavega. Methane storms on Saturn's moon Titan, Nature 442, 2006.

[12] T. Guillot et al. Storms and the Depletion of Ammonia in Jupiter: I. Microphysics of "Mushballs", Journal of Geophysical Research, in press, 2020.

[13] T. Guillot et al. Storms and the Depletion of Ammonia in Jupiter: II. Explaining the Juno observations, Journal of Geophysical Research, in press, 2020.