EPSC Abstracts
Vol. 18, EPSC-DPS2025-1106, 2025, updated on 17 May 2026
https://doi.org/10.5194/epsc-dps2025-1106
EPSC-DPS Joint Meeting 2025

Dynamical sources of jovian moist convection

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Moist convection plays a key role in Jupiter's energy and mass transport [1, 2], yet its distribution and nature remain poorly understood due to conflicting observations from various space- and ground-based instruments. Juno MWR data reveal equatorial enrichment of water and ammonia [3, 4], suggesting strong upwelling, while lightning observations show minimal activity near the equator and increased activity toward the poles [5]. These discrepancies have led to competing theories involving the presence of strong deep wind shear [6], circulation cells [7, 8], and mixed-phase cloud formation [9]. Disentangling these requires detailed knowledge of Jupiter's deep atmospheric structure (such as the deep wind and thermal structure and the spatial distribution of condensing species), which is challenging to obtain via remote sensing alone.

In this work, we aim to address these degenerate results by simulating the jovian atmosphere using the Explicit Planetary hybrid-Isentropic Coordinate (EPIC, [10]) model. We use the new convective parameterization alongside the existing cloud microphysics scheme [11, 12] to model the convection across the planet. We vary the deep atmospheric wind shear and the water abundance to test how these parameters affect the nature and strength of convection in our model. Using these models, we investigate and compare the spatial distribution of convection in our models with those observed by both the Juno MWR and lightning data.

Our results (Figure 1) show that the locations of strong convection are driven by the presence of a "moisture front" [13], whereby the advection of moisture-rich air into a drier region results in an increase in convective potential, which leads to convection. This has been observed along meso-scale (or larger) convective storms [14] and is consistent with observations of strong convection tied to locations to steep volatile gradients. Increasing the deep wind shear increases the eddy mixing across the gradient through the generation of baroclinic instabilities.

Figure 1: Integrated water cloud density (left) and water vapor mixing ratio at 4 bars (right) along with the associated wind field at 4 bar and the water vapor convergence in red, at day 110 into the model. Note how both the turbulence and the meridional volatile gradient increases with wind shear (parameterized by *m* in our model), increasing the strength of convection in the atmosphere. Increased convection results in thicker and denser clouds in the zone (northern half of the region).

Here, we will present our results from varying the deep wind shear and the water abundance. We will derive constraints on the degenerate properties by comparing our modeled atmosphere to the observed data, and present possible theories to reconcile the contrasting observed nature of convection.

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