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Global climate modelling of Saturn's stratospheric equatorial oscillation

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The Composite InfraRed Spectrometer (CIRS) on board Cassini revealed an equatorial oscillation of stratospheric temperature, reminiscent of the Earth's Quasi-Biennial Oscillation (QBO), as well as anomalously high temperatures under Saturn's rings. To better understand these predominant features of Saturn's atmospheric circulation in the stratosphere, we have extended towards higher altitudes the DYNAMICO-Saturn global climate model (GCM), already used in a previous publication to study the tropospheric dynamics, jets formation and planetary-scale waves activity. Firstly, we study the higher model top impact on the tropospheric zonal jets and kinetic energy distribution. Raising the model top prevents energy and enstrophy accumulation at tropopause levels.
The reference GCM simulation with 1/2° latitude/longitude resolution
and a raised model top exhibits a QBO-like oscillation produced by resolved planetary-scale waves. However, the period is more irregular and the downward propagation faster than observations. Furthermore, compared to the CIRS observation retrievals, the modeled QBO-like oscillation underestimates by half both the amplitude of temperature anomalies at the equator and the vertical characteristic length of this equatorial oscillation. This QBO-like oscillation is mainly driven by westward-propagating waves; a significant lack of eastward wave-forcing explains a fluctuating eastward phase of the QBO-like oscillation. At 20°N and 20°S latitudes, the DYNAMICO-Saturn GCM exhibits several strong seasonal eastward jets, alternatively in the northern and southern hemisphere. These jets are correlated with the rings' shadowing. Using a GCM simulation without rings' shadowing, we show its impact on Saturn's stratospheric dynamics. Both residual-mean circulation and eddy forcing are impacted by rings' shadowing. In particular, the QBO-like oscillation is weakened by an increased drag caused by those two changes associated with rings' shadowing.

Field

Planetology (incuding small bodies and exoplanets)

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