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The Energy and Momentum Balance of Titan's Stratospheric Polar Vortex as Simulated in a General Circulation Model

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Titan's stratospheric polar vortex is a prominent phenomenon of Titan's global wind field, consisting of a westerly jet achieving speeds of nearly 200 m s^{-1} [1, 2]. The strong westerly winds have been hypothesized to serve as a mixing barrier to molecules transported to the high winter latitudes by Titan's stratospheric meridional overturning circulation [2]. Similar to Earth's stratospheric polar vortex, the vortex on Titan is primarily driven by diabatic cooling at high winter latitudes, resulting in a steep meridional temperature gradient and, via the thermal wind relation, a strong vertical wind shear [3]. While the existence and evolution of the vortex has been constrained for one half of a Titan year by observations from the Cassini spacecraft, a rigorous analysis of the potential mechanisms that give rise to the strong stratospheric jet has not yet been performed.

Here, using simulations from the Titan Atmospheric Model [4], which has recently been updated to better simulate Titan's stratosphere [5], we study the temporal evolution of processes proposed to be responsible for the evolution of Titan's stratospheric polar vortex, including: solar shortwave heating (largely controlled by the presence of stratospheric aerosols), adiabatic heating from the descending branch of the meridional overturning circulation, and molecular longwave cooling [3].

References

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