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Planetary-scale waves and the meteorology of Titan's tropics

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Titan exhibits an active weather cycle involving methane. Equatorial and mid-latitude clouds can be organized into fascinating morphologies on scales exceeding 1,000 km. Observations include an arrow-shaped equatorial cloud that produced detectable surface accumulation, probably from the precipitation of liquid methane. An analysis of an earlier cloud outburst indicated an interplay between high- and low-latitude cloud activity, mediated by planetary-scale atmospheric waves. We present a combined analysis of cloud observations and simulations with a three-dimensional general circulation model of Titan's atmosphere providing a physical interpretation of observed storms, their relation to atmosphere dynamics and their aggregate effect on surface erosion. We find that planetary-scale Kelvin waves arise naturally in our simulations, and robustly organize convection into chevron-shaped storms at the equator during the equinoctial season. A second and much slower wave mode organizes convection into southern-hemisphere streaks oriented in a northwest–southeast direction, similar to observations. As a result of the phasing of these modes, precipitation rates can be as high as twenty times the local average in our simulations, possibly playing a crucial role in fluvial erosion of Titan's surface. We also present a forecast of the weather expected in the coming season on Titan.