

Likelihood of nitrogen condensation in Titan's present-day atmosphere

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The temperature in Titan's upper troposphere measured by the Huygens Probe is relatively close to the nitrogen condensation point. This poses the question as to whether seasonal nitrogen condensation might occur on Titan analogously to seasonal carbon dioxide condensation on Mars. The likelihood of nitrogen condensation in Titan's atmosphere is investigated using tropospheric temperature data obtained by Cassini radio occultations and simulation with a general circulation model (GCM). The observed tropospheric temperature generally decreases towards both poles but does not reach the nitrogen condensation point anywhere. However, Cassini may not have sounded the coldest season and area in Titan's troposphere. The GCM simulation shows that in the upper troposphere the variable solar distance associated with Saturn's orbital eccentricity has a larger impact on the seasonal polar temperature variation than the variable solar declination associated with Saturn's obliquity. In the upper troposphere relevant for nitrogen condensation the annual minimum polar temperature is predicted to occur around the northern autumnal equinox, approximately one season after aphelion. This temperature is then 1-2 K lower than in the season of the Cassini/Huygens mission. It is possible if not certain that some nitrogen condensation with cloud formation occurs in the northern and southern polar region in the upper troposphere around the northern autumnal equinox. Under the present orbital parameters of Saturn and Titan nitrogen condensation may occur more frequently near the south pole than near the north pole.