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Seasonal variations in Titan's middle atmosphere observed with Cassini/CIRS during northern spring

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Abstract

Since 2004, Cassini performed 127 close Titan flybys, observing its atmosphere with instruments including the Cassini Composite InfraRed Spectrometer (CIRS). We know from CIRS observations that the global dynamics drastically changed after the northern spring equinox that occurred in August 2009 ([1], [2], [3], [4]). The pole-to-pole middle atmosphere dynamics (above 100 km) experienced a global reversal in less than 2 years after the equinox [4], while the northern hemisphere was entering spring. This new pattern, with subsidence at the south pole, has resulted in an enrichment of almost all molecules inside the southern polar vortex from 2011. According to General Circulation Model calculations, this single circulation cell pattern should remain until 2025.

We will present analysis of CIRS limb observations during the entire northern spring up to the beginning of northern summer, in September 2017. We show that many species (C_2H_2, HCN, HC_3N, C_6H_6, C_4H_2, CH_3CCH, C_2H_4) experienced their highest enrichments near the south pole near 500 km in March 2015, with abundances similar to in situ results from INMS at 1000 km [5], suggesting that the air inside the confined polar vortex (observed at latitudes higher than 80°S) was very efficiently transported downward from very high altitudes. In September 2015, an extension of the polar vortex towards lower latitudes (~65°S) was observed, while the molecular abundances decreased by a factor of 10 at 500 km. Simultaneously, in the northern hemisphere, after the disruption of the north polar vortex following the equinox, the enriched air that was previously confined at very high latitude gradually expanded towards mid latitudes at altitudes higher than 300 km. Since the beginning of 2016, a zone depleted in molecular gas and aerosol is observed in the entire northern hemisphere between 400 and 500 km, suggesting some complex unknown dynamical effect combined with photochemistry loss. We also show that an enriched region persisted at high northern latitude below 350 km during the entire northern spring, probably due to the confinement of the enriched air by a small circulation cell.

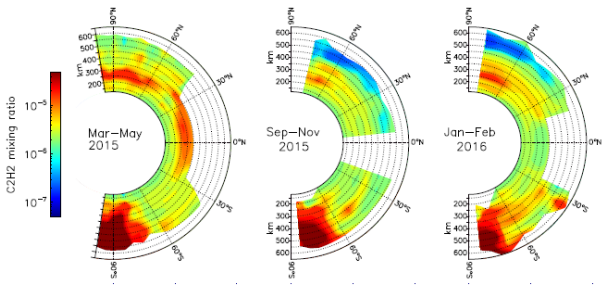

Figure 1: Example of C_2H_2 volume mixing ratio maps from 120 to 600 km between March 2015 and February 2016.

Acknowledgements

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References

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