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Diagnostics of Titan's stratospheric dynamics using GCM simulations and CIRS data

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The dynamics of Titan's stratosphere is discussed in this presentation, based on a comparison between observations by the CIRS instrument on board the Cassini spacecraft and the results of the General Circulation Model developed at the Institute Pierre-Simon Laplace (Laboratoire de Météorologie Dynamique and Service d'Aéronomie), available at *http://www.lmd.jussieu.fr/titanDbase*.

The CIRS/Cassini observations of Titan's stratosphere are providing new data on its composition, at a different season from Voyager 1 (25 years ago) or ISO (10 years ago). They bring important information on vertical and latitudinal contrasts and enrichments of chemical species in the winter polar region, and therefore give more constraints on the dynamics of the atmosphere. Together with recent ground-based observations, they also provide information on the seasonal evolution of the stratospheric composition.

A detailed analysis is presented to evaluate how the model helps interpret the dynamical and chemical observations : (1) vertical profiles and meridian maps of the stratospheric temperature obtained by CIRS/Cassini and a vertical profile of the zonal wind at the Huygens landing site obtained by DWE/Huygens; (2) vertical and latitudinal profiles of the stratospheric composition deduced from the CIRS/Cassini dataset as well as meridional maps of the stratospheric composition from a CIRS/Cassini low resolution dataset.

We found that the thermal structure is strongly constrained by the structure of the haze layers. Designed to reproduce the haze structure observed at the Voyager 1 epoch, our GCM has a fixed haze production region located around the 1 Pa pressure level (roughly 400 km altitude). In these conditions, the haze structure and the stratospheric thermal structure are well reproduced. The situation is quite different at the Cassini epoch, since observations have shown that the detached haze layer moved upward, from 300-350 km during the Voyager 1 flyby to approximately 500 km. The influence of this change has been tested, though we are currently limited by the vertical extension of the GCM. The modification of the thermal structure is coupled to modifications on the meridional circulation and polar vortex horizontal mixing, and therefore affects the chemical distributions (impact on winter pole abundances). The intensity of the meridional circulation is weaker when the haze production source is elevated, and the vertical and horizontal mixing due to polar vortex is less extended in latitude.

There is an overall good agreement between GCM chemical distributions and observations in equatorial regions. The enrichment of ethylene in the low stratosphere at 15°S is explained by dynamical transport since this compound doesn't condense. Near the winter pole (80°N), some compounds (C_4H_2, C_3H_4) exhibit a minimum in the observed vertical profiles, whereas GCM profiles are well mixed all along the atmospheric column. This is discussed as a diagnostic of the strength of the meridional circulation, linked to the spatial extention of the polar vortex descending region. In the summer hemisphere, observed stratospheric abundances are globally uniform in latitude, whereas, in the model, the signature of a secondary meridional cell is obvious which maintains a residual enrichment over the summer pole. This may be related to meridional circulation, and to possible misrepresentation of horizontally mixing processes, due to the restricted 2-dimensional nature of the GCM.