MARS ATMOSPHERE DENSITY AND TEMPERATURE BETWEEN 50 AND 130 KM OBSERVED BY MARS EXPRESS SPICAM STELLAR OCCULTATION

F. Forget, S. Lebonnois, M. Angelats i Coll *Laboratoire de Météorologie Dynamique, ISPL, Paris, France (forget@lmd.jussieu.fr)* **E. Quemerais, J. L. Bertaux, F. Montmessin, E. Dimarellis, A. Reberac,** *Service d'Aéronomie, Verrière le Buisson, France* **M. Lopez Valverde, F. Gonzalez Galindo** *IAA Granada, Spain*

Introduction:

The observation of numerous stars rising or setting through the Martian atmosphere as seen by the SPICAM UV spectrometer aboard Mars Express allows to retrieve the atmospheric density and temperature from below 50 km to above 120 km (Bertaux et al. 2005). This part of the atmosphere was previously almost unknown since almost no measurements were available (a few entry profiles). Moreover, General Circulation Model simulations have shown that this part of the atmosphere should present a very active and interesting dynamic, but that simulation prediction are extremely model dependent. We present new results of inversion of 505 profiles obtained over the four Mars seasons (Ls= 332° - 270°). These profiles will be interpreted with the help of the LMD general circulation model (Forget et al. 1999) which has recently been extended up into the thermosphere (Angelats i Coll 2004) and is thus ideally suited for this analysis.

Data retrieval

The method used to estimate atmospheric density and temperature from the sequence of UV spectra of a star rising or setting through the Martian atmosphere is decribed in details in Quemerais et al. (2006). In practice the spectral transmission of the atmosphere is extracted from the raw data taking into account instrumental particular features. Then the spectral inversion retrieves the slant densities (local densities integrated along the line of sight) of CO2 for each measurement of the transmission $\tau(\lambda, z)$ during the occultation. Finally, the vertical inversion retrieves the vertical distribution of the local densities from the series of the slant density measurements produced by the spectral inversion. This vertical inversion includes a new scheme of Tikhonov regularization.

Density data analysis and comparison with predictions from atmospheric models.

When interpolated to reference altitude above the Mars geoid, the density exhibit meaningful variations correlated with season, latitude, etc... In many cases, these variations are well predicted by the LMD GCM allowing a detailed analysis of the origin of these variations. In some cases, however, the observations present some variations that are not predicted, suggesting the effect of processes not yet occuring in the model.

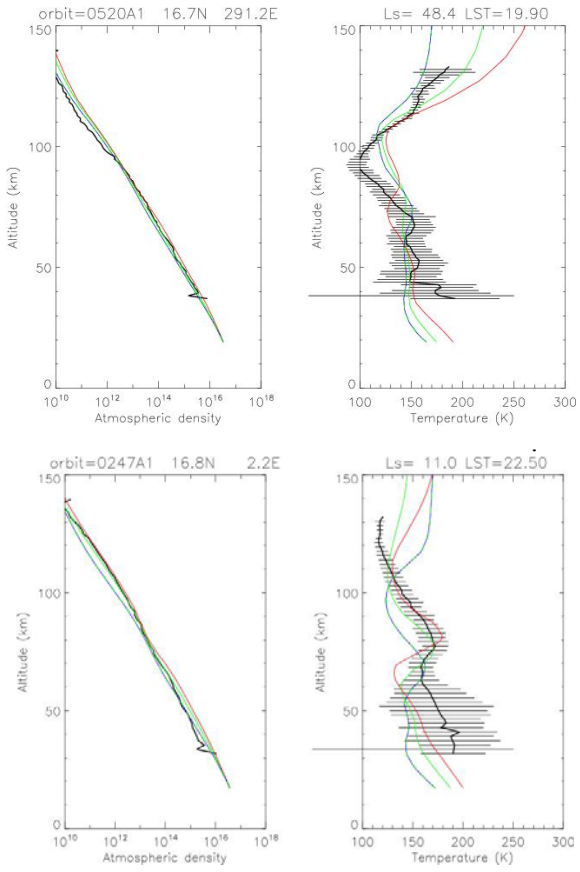

Figure 1. Examples of density and temperature profiles retrieved from Spicam stellar occultations. The observed profiles (black) are compared to LMD GCM predictions obtained with various dust scenarios (blue, green red) to represent the range of possible profiles in the model. Below 50 km, the observations are affected by the atmospheric dust and not reliable.

Temperature profiles

By integrating the hydrostatic equations from the density profile, it is possible to estimate the temperature profile with a reasonable accuracy. Figure 4 and 5 show examples of such results, compared to the model predictions.

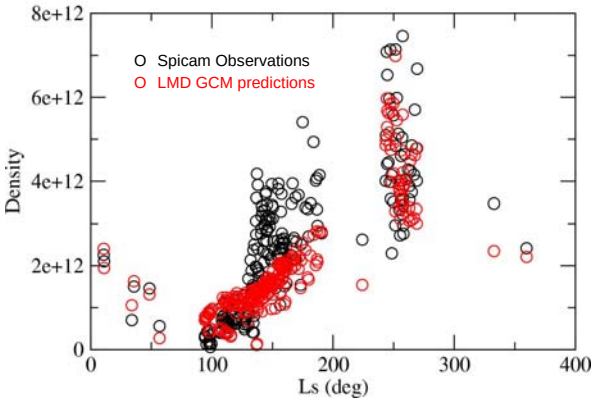

Figure 2 : density variation at 100 km above the Mars aeroid as a function of season as observed by Spicam and as predicted by the GCM at exactly the same location and time.

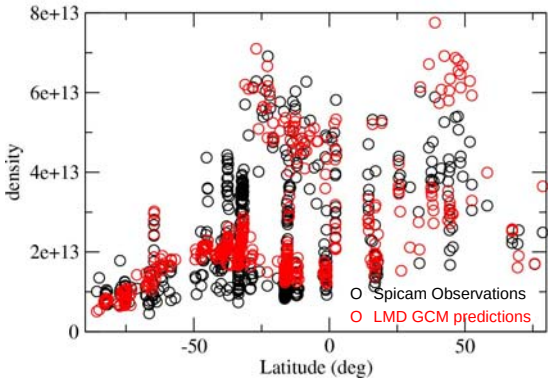

Figure 3 : Density variation at 80 km above the Mars aeroid as a function of latitude for observations obtained during late northern summer (Ls=130°-170°)

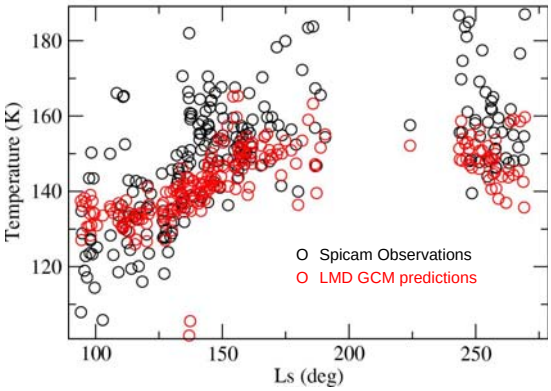

Figure 4. Temperature variations at 80 km above the Mars aeroid as a function of season as observed by Spicam and as predicted by the GCM at exactly the same location and time.

References

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