ASSIMILATION OF TES DATA FROM THE MARS GLOBAL SURVEYOR SCIENTIFIC MAPPING PHASE.

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Introduction:

The Thermal Emission Spectrometer (TES) aboard Mars Global Surveyor has produced data which cover almost two Martian years so far (during its scientific mapping phase). Thermal profiles for the atmosphere below 40 km and total dust opacities can be retrieved from TES nadir spectra and assimilated into a Mars general circulation model (MGCM), by using the assimilation techniques described in detail by *Lewis et al.* (2002). This paper describes some preliminary results from assimilations of temperature data from the period Ls=141°-270° corresponding to late northern summer until winter solstice on Mars. Work in progress is devoted to assimilate both temperature and total dust opacity data for the full period for which they are already available (see figure 1).

Control Simulation and Data Assimilation:

The numerical model of Mars' atmosphere which is used for this study is the MGCM described by *Forget et al.* (1999) and by *Lewis et al.* (2002). With respect to this model, the only difference in this study is that we employed a new prescribed dust scenario which has been developed for the European Mars Climate Database (*Lewis et al.*, 1999). This scenario involves a horizontally and temporally varying dust field, by using prescribed functions to describe both the latitudinal and the temporal variations of the top of the dust layer and the optical dust opacity in the visible at 700 Pa. These are applied to calculate the vertical distribution of the dust according to the equation in *Forget et al.* (1999).

A model integration has been performed for several Martian years starting from rest, in order to achieve a consistent initial state of the Martian atmosphere to be used both for the control simulation and the data assimilation. For the assimilations, the model is initialized at Ls = 141.43°, which corresponds to the time of the year at which data of the MGS mapping phase begin to be available. In order to generate a set of different initial states, fields have also been taken at one, two and three day intervals from the principal initial point and similar control simulations and data assimilations have been performed.

Thermal profiles below 40 km, retrieved by TES nadir soundings, are assimilated by using a modified form of the analysis correction scheme (Lorenc et al., 1991) adapted for Mars (Lewis and Read, 1995, Lewis et al., 1996, 1997 and 2002). Work is in progress to assimilate both dust and temperature retrievals. Temperature retrievals have to undergo a quality control procedure and post-processing before being assimilated. These procedures, described in Lewis et al. (2002), filter out retrievals which could cause intermittent problems to the model physical schemes and to resample the data over pressure levels which reflect instrument resolution.

Assimilation experiments have been so far performed out to northern winter solstice, but almost two complete Martian years are now covered by data from TES mapping phase (see figure 1) and are being assimilated.

Preliminary Results on the Global Circulation:

Although data assimilation performed so far cover only late northern summer and autumn of the first year, interesting effects have been noticed in the global circulation. Zonal-means have been calculated for temperature, zonal wind and mean meridional circulation, time-averaging over five sols in order to filter out the high frequency modes.

Temperature differences between the data assimilation and the control simulation are mainly evident over the southern pole during southern late winter and the northern pole during northern late autumn, as can be seen in figure 2. Data assimilation seems to depict a colder atmosphere below 40 km over the poles, with differences up to 24 Kelvin. These differences are enhanced above 40 km, where no data are anyway available and changes in the variable fields are produced by the model in response to the changes in the lower atmosphere. Over the south pole during southern winter polar warming seems to be enhanced, whereas the corresponding polar warming over the north pole close to the northern winter solstice appears to be less intense. The enhanced polar warming over the south pole could be related to a better developed mean meridional circulation cell in the assimilation (see figure 3), leading to a warming mechanism as discussed by Forget et al. (1999).

In correspondence with the temperature differences between data assimilation and control simulation, the zonal wind shows differences larger than 50 m/s. The westerly wind over the south pole in southern winter is enhanced in the data assimilation, and the positions of the westerly jet at high northern latitudes and the easterly wind from the equator up to mid-latitudes are modified nearby the northern winter solstice (see figures 4 and 5).

The goal of the study is the assimilation and analysis of multi-annual MGS data with a focus not only on the zonal-means but largely on transient wave behaviour. Limb-sounding data will be included as they become available and there are plans to upgrade the assimilation procedure to assimilate the instrument radiances directly.

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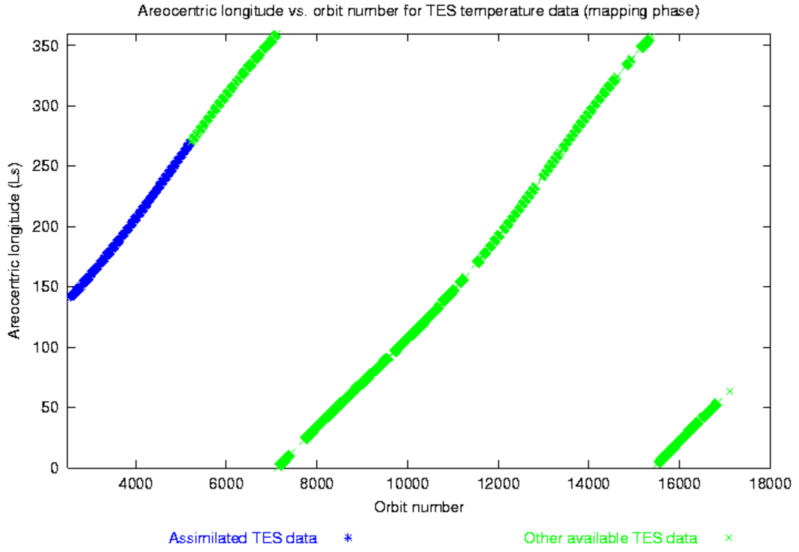
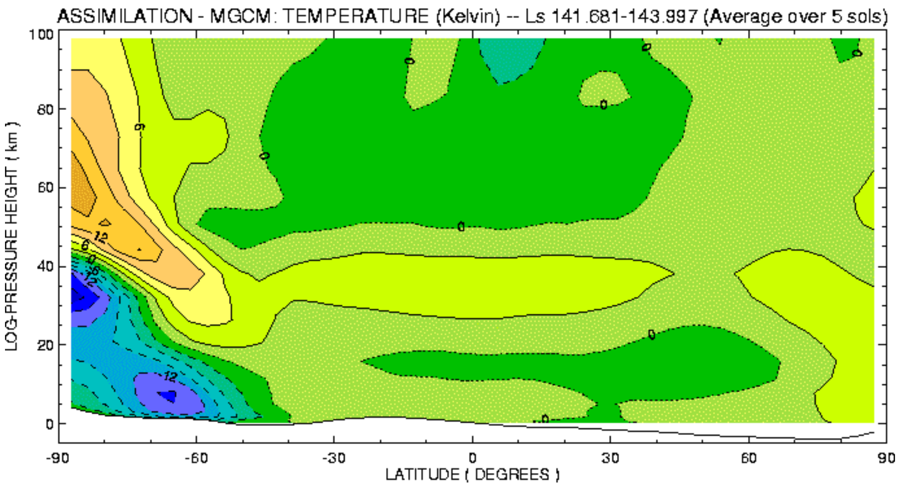


Figure 1: TES data



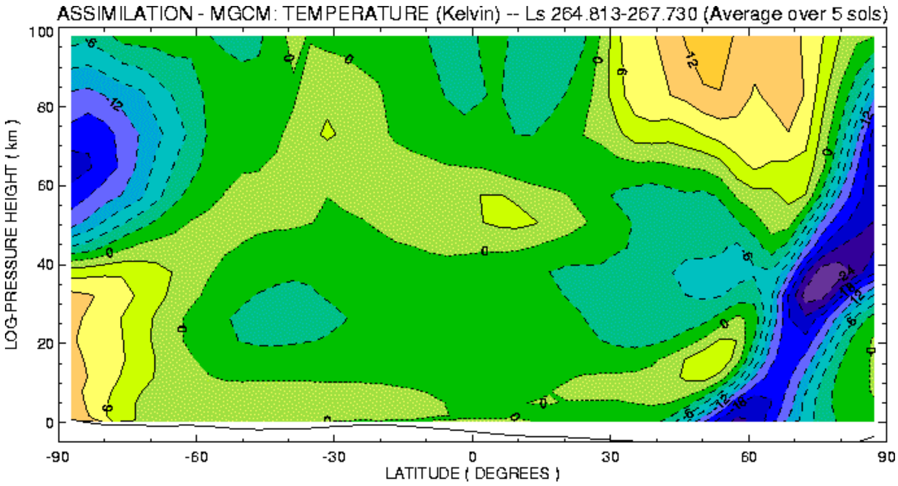


Figure 2: Differences between assimilation and control simulation for temperature at two different times.

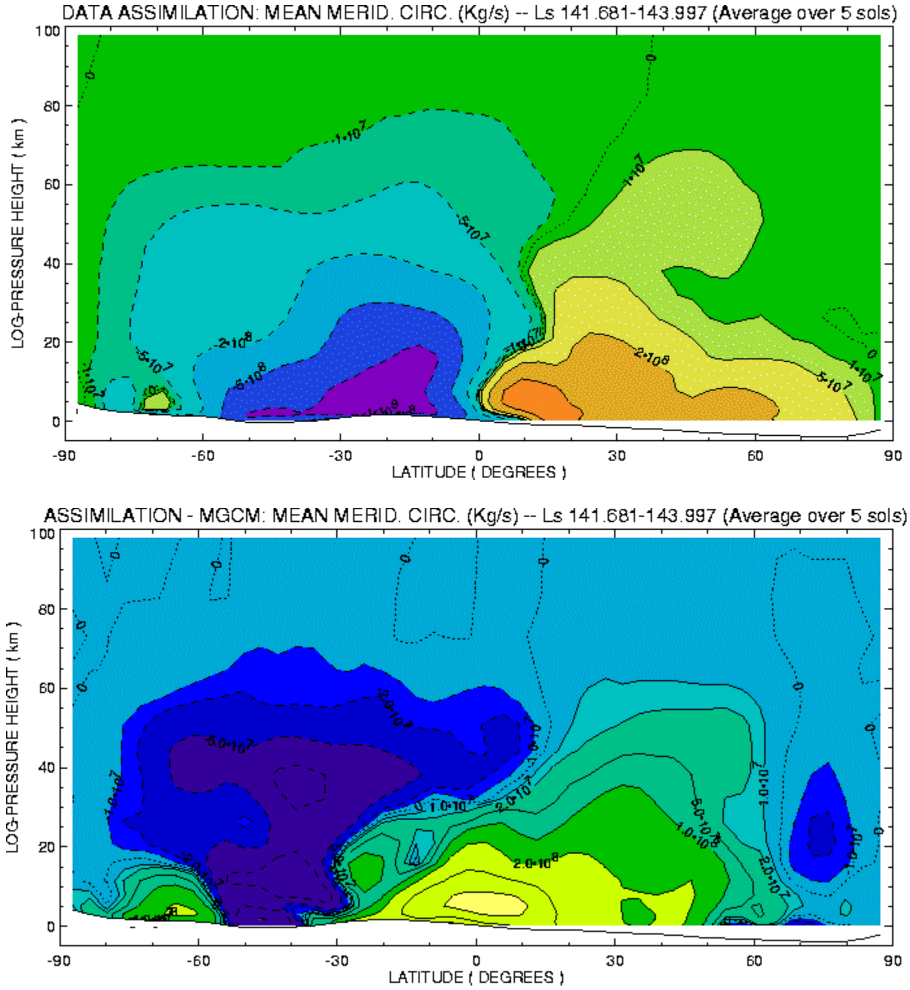


Figure 3: Mean meridional circulation in the data assimilation and difference between data assimilation and control simulation at Ls=142.8° (average)

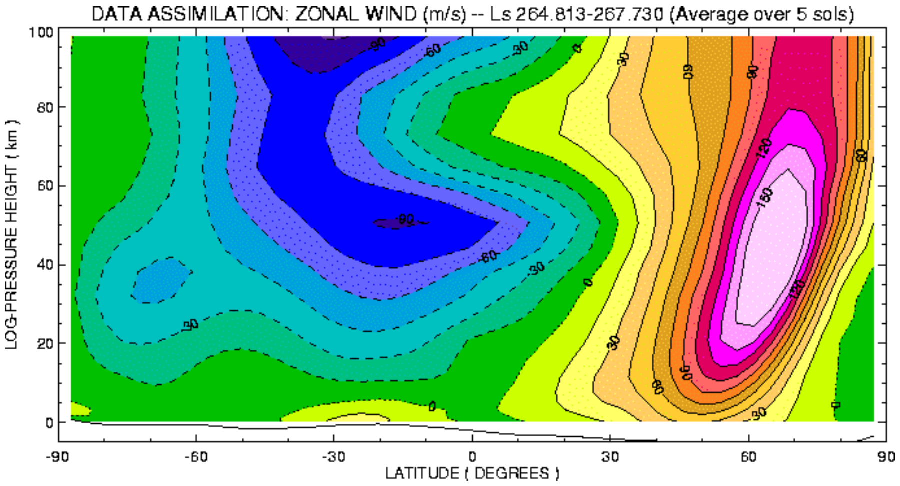


Figure 4: Zonal wind in the assimilation at Ls=266.3° (average)

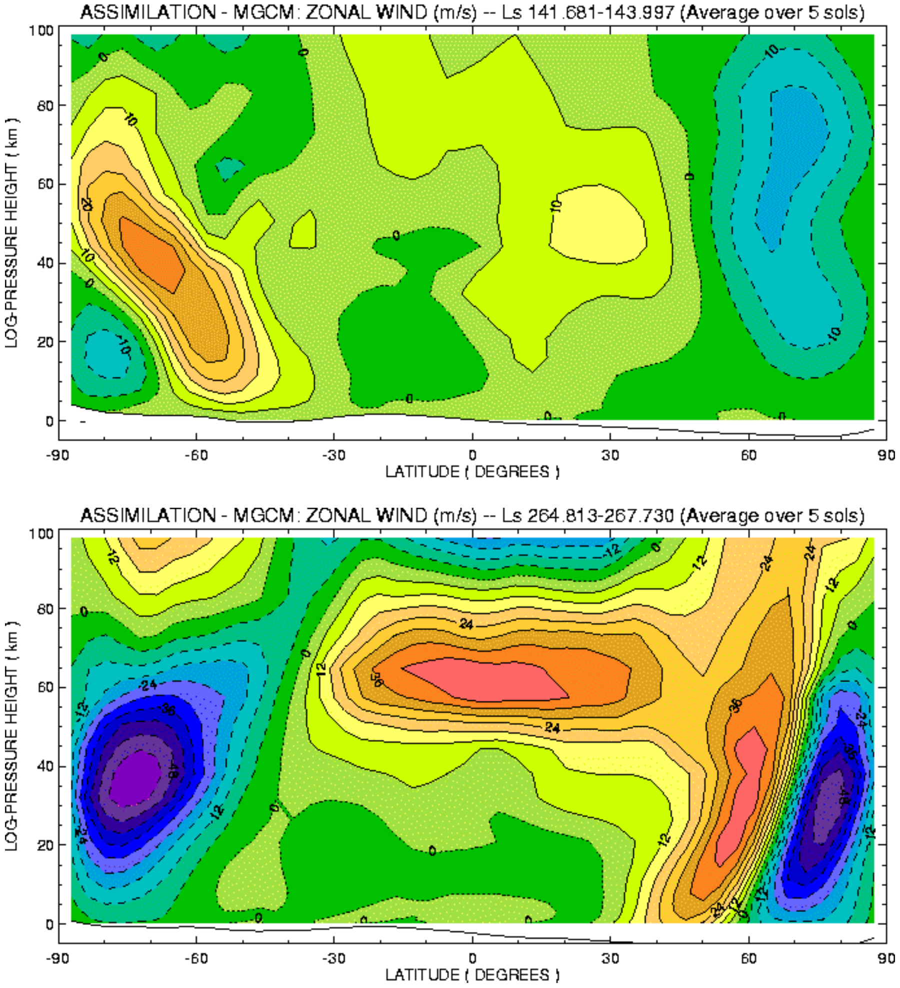


Figure 5: Differences between assimilation and control simulation for zonal wind at two different times.