MARS MESOSPHERIC WINDS AROUND NORTHERN SPRING EQUINOX - COMPARISON OF OBSERVATIONS AND MODEL.

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Introduction

During the last decade due to the input of many successfull space missions to Mars and advances in computational capacity general circulation models (GCM) for the Martian atmosphere have evolved to a state that allows detailed predictions of atmospheric dynamics [Wilson(1997), Haberle et al.(1999), Forget et al.(1999), Hartogh et al.(2005), Moudden and McConnell(2005), Richardson et al.(2006), Takahashi et al.(2003)]. Wind speeds are a key variable in the models and need to be validated by observations. We present a detailed comparison between observations of mesospheric winds on Mars around northern Spring Equinox and predictions of these winds from a general circulation model.

Observations

We put a focus on studying the evolution of dynamcis in the upper atmosphere of Mars around northern Spring Equinox (L_S = 0). Model calculations predict the global circulation around 50 to 100 km altitude to change from a dominant northern jet configuration during northern winter to a dominant southern jet configuration in early northern summer (see Fig. 1). Data was gathered using

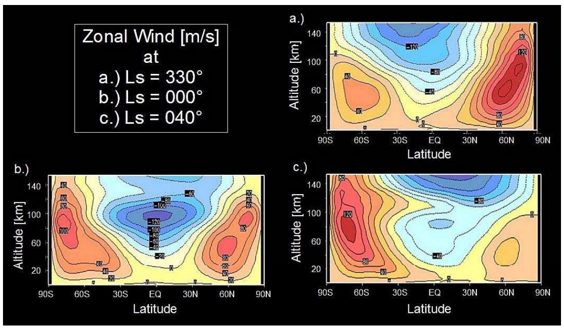

Figure 1: Model predicted zonal wind field for the Martian atmosphere for three season (L_S=330,000,040), matching the times of the conducted observations. The predicted transition from dominant northern to southern latitude jet is nicely visible.

ground based ultra-high spectral resolution observations of non thermal (non-LTE) CO_2 features around 10 μm wavelength. These measurements probe an altitude of ~80 km. A typical spectrum from the atmosphere of Mars is presented in Fig. 2. Observations were car-

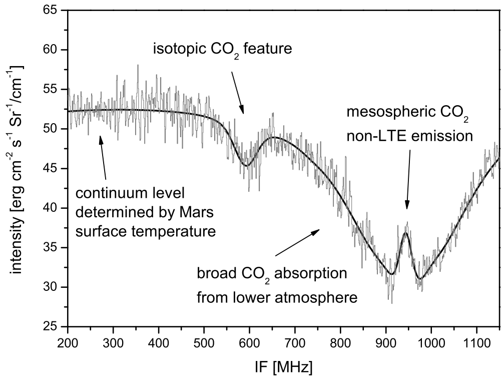

Figure 2: A typical spectrum of absorption and emission features of the P(2) CO_2 transition to retrieve Doppler-shifted wind velocities on Mars. In black the best fit of a full atmospheric radiative transfer model to the spectrum is shown.

ried out during three seasons (L_S=335 (season 1), 357 (season 2), 040 (season 3)) using the Cologne Tuneable Heterodyne Infrared Spectrometer (THIS) at the McMath-Pierce Solar Telescope on Kitt Peak, Arizona (season 1 and 2) and the NASA InfraRed Telescope Facility on Mauna Kea, Hawaii (season 3). Season 1 was observed in November 2005 and two additional observing campaigns were conducted in November 2007 and March 2008 to match the seasons 2 and 3.

Heterodyne techniques allow a spectral resolution of more than 10^6 and thus the observation of fully resolved molecular features and the retrieval of Doppler shifts down to 1 MHz. In the case of our observations the high accuracy in the retrieved Doppler-shifts corresponds to an accuracy of 10 m/s. In addition the high spatial resolution on the planetary disk intrinsic to infrared wavelengths especially compared to existing sub-

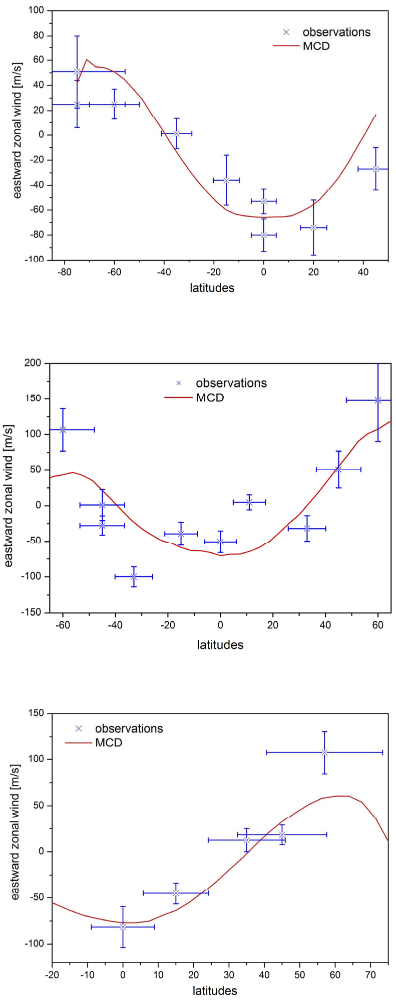

Figure 3: Retrieveals and quick comparison to GCM for all three seasons. From top to bottom: L_S=335, L_S=357, L_S=40

mm observations enables unique ground-based studies of latitudinal variations.

We retrieved values from 100 m/s retrograde to 100 m/s prograde depending on the observed latitude. An overview of retrieved values is given in Fig. 3.

The observations provide the first seasonal study of zonal winds on Mars at high spatial resolutions. For more information on the instrument and the heterodyne technique see [Sonnabend et al.(2008)].

Comparison to GCM

The model prediction were composed from the Mars Climate Database (MCD) [Millour et al.(2008)]. Due to the complex observing geometry the GCM data needs to be extracted from the database in such a way that it reconstructs the field-of-view of the telescope. In addition, since the altitude of the observed winds cannot be determined from the data directly we use the Granada non-LTE radiative transfer code [Lopez-Valverde et al.(2010)] to estimate the altitude distribution of emission in our observed spectra. In the past only a quick comparison to longitudinally, altitudinally and temporally averaged GCM output was performed (see Fig. 3). The results from all seasons are in reasonable agreement to the model predictions [Sonnabend et al.(2006)]. Some deviations were found for higher latitudes (>45 degrees). At the conference we will present the detailed comparison to the extracted GCM predictions. Details on the method of the data extraction will be presented in a companion talk [Lopez-Valverde et al.(2011)].

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