Abstract

Understanding of the physical and chemical processes in planetary atmospheres is essential for the development of general circulation models (GCM) and meteorological forecast models. Adopting Earth models to the atmospheres of Mars and Venus has been improved substantially over the last few years due to constraints imposed by improved technology of ground-based observations and data that became available from several space missions.

Observational constraints of the models especially at high altitudes are needed for parametrization and validation. These data can only partially be provided by spacecrafts. Earth-based observations in other atmospheric regions or long term observations are a necessary and cost-efficient complementary observational method to constrain the models and to prepare for future space missions and landers.

An elegant method to measure high atmospheric winds is by observing infrared CO_2 absorption and emission lines with high spectral resolution heterodyne spectroscopy. From line frequency (Doppler)shifts velocities of the emitting and absorbing gas can be directly deduced. In contrast to microwave observations an adequate spatial resolution can be achieved in addition to the high spectral resolution with the infrared heterodyne observing technique. Therefore the retrieved wind velocities at each observed position on the planet are independent from additional assumptions like temperature or pressure profiles.

Such an infrared heterodyne instrument named THIS (Tuneable Heterodyne Infrared Spectrometer) has been developed at the I. Physikalisches Institut at the University of Cologne and has been improved within this work to a level where regular observations of the Martian and Venusian atmosphere are now possible.

Wind velocities measured in the atmospheres of Mars and Venus during four observation runs within a time period from 2005 to 2008 are presented in this work. Observations were accomplished in coordination with other observing techniques and results are compared with them as well as with output parameters of model calculations.

For Venus observations mainly comparison with results from other ground-based observations, in particular within the coordinated ground-based campaign 2007 to support Venus Express, are made due to a lack of reliable model results at higher altitudes. Measured wind values in general are lower than those from other observing techniques and compared to them only a moderate variability with time was observed.

The coordinated ground-based campaign generally showed that the dynamic in the Venusian atmosphere is much more complex than believed before. Hence additional data especially concerning temporal variability of wind velocities are needed. Further observing campaigns with THIS are already in preparation.

On the contrary global circulation models of the Martian atmosphere have already reached a high level and provide detailed information about various atmospheric parameters. The results of our wind observation validate the predictions of one models developed at the Laboratoire de Météorologie Dynamique du CNRS (Paris) over wide range. Data analysis and data interpretation emphasized exchange with modelers and it has been shown that measurements with THIS are a valuable tool for the future to validate and proof these models even in more detail.