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The Martian lower atmosphere as seen by the Radio Science Experiment MaRS on Mars Express

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Abstract

The Radio Science Experiment MaRS on Mars Express is sounding the Martian atmosphere and ionosphere using the spacecraft radio subsystem [1].

Within the atmosphere and ionosphere the atmospheric refraction alters the path geometry due to the radial variation of refractivity. The resulting frequency shift of the signal can be used to calculate the degree of bending, the ray periapsis, and the projection of the ray path onto the planetary surface. The refractivity of the atmosphere at the ray periapsis is obtained from the bending angle via an Abel transform [2]. The neutral number density is directly related to the refractivity profile through a constant factor C_1 which depends on the atmospheric composition of the atmosphere.

The temperature and pressure profiles follow in a next step covering the altitudes from the surface boundary layer up to ~50 km with a vertical resolution of only a few hundred metres.

The highly elliptical orbit of Mars Express allows to study a large range of local times and locations and can therefore be used to investigate latitudinal, diurnal, and seasonal variations. More than 500 profiles of temperature, pressure and neutral number density have been obtained in six occultation seasons so far, mostly in the northern hemisphere covering all latitudes during almost all seasons.

The high vertical resolution allows to investigate the strong variability of the surface boundary layer and to study temperature variations caused by eddies and waves.

Several temperature profiles are located in the polar regions of both hemispheres. MaRS could observe the southern winter hemisphere during the second occultation season (OCC 2) at the end of 2004 (Ls ≈ 130°) and in 2008 (OCC 8, Ls ≈ 94°).

The northern high latitudes were investigated during the third occultation season in 2005. 70 profiles covering all latitudes between 50° N and 76° N at solar longitudes between 259.6° and 289.5° were retrieved.

The data set shows the seasonal variations in the high latitude range on both hemispheres, caused by CO_2 condensation. The good latitudinal coverage during each occultation season gives information about the zonal circulation of the atmosphere. Figure 1 shows the pressure gradient at a geopotential surface of 10 km in the northern hemisphere for the third OCC season. A strong latitudinal pressure gradient and the influence of CO_2 condensation over the course of the winter season can clearly be seen. The MaRS data set complements the MGS Radio Occultation data who achieved a broad longitudinal coverage in the high latitude range. Both data sets will be used to study seasonal changes.

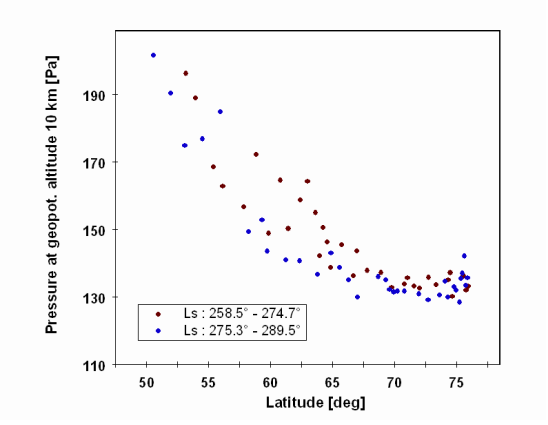

Figure 1: Pressure values at a geopotential altitude of 10 km for the third OCC season in 2005. Each dot indicates one measurement. The red dots show the first part of the OCC season, starting at mid latitudes and moving closer to the pole, the

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blue dots show the second part of the OCC season starting the high latitudes and coming closer to lower latitudes.

References

[1] Pätzold, M. et al. (1994), *ESA Special Publication*, SP-1240.
[2] Fjeldbo, G. et al. (1971), *Astron. J., 76*, 123-140.

Acknowledgements

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