New Dataset of Atmospheric Parameters Retrieved by PFS-MEx

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Introduction: More than 3,000,000 IR spectra returned by the Mars Express Planetary Fourier Spectrometer (PFS-MEx) have been used to build this new dataset of atmospheric parameters, covering the full range of season, latitude, longitude, and local time for more than 6 full MYs. By exploiting PFS/MEx capability to perform observations at different local times (LT), this dataset allows investigation of the daily cycles of suspended dust and ice. All parameters are successfully retrieved in the polar regions, including the polar nights. Retrieved surface and atmospheric temperatures, as well as integrated dust and ice opacity are used as input parameters for the self-consistent retrieval of water vapour and carbon monoxide.

PFS retrievals: The atmospheric parameters presented here are retrieved by means of the algorithm for the scientific analysis of individual calibrated PFS measurements originally developed by [1] and recently improved by [2]. The improved algorithm uses the optimal estimation method with the Bayesian approach [3].

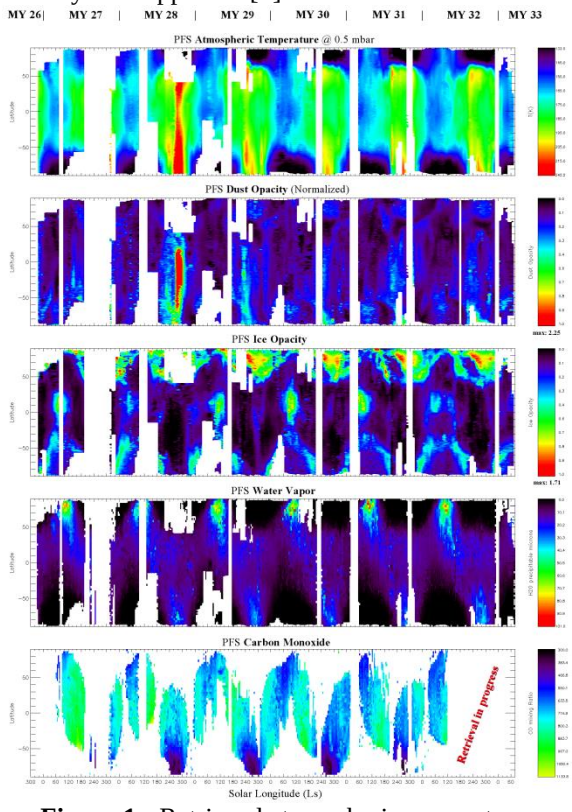

Figure 1: Retrieved atmospheric parameters as a function of latitude and Ls and for different Martian Years. From top to bottom: zonal-mean temperatures at 0.5 mbar; column-integrated dust opacity @ 1075 cm^{-1}; column-integrated ice opacity @ 825 cm^{-1}; water vapor (pr-μm); carbon monoxide (ppbv).

Daily cycles of dust and ice: Contrary to TES and MCS data, the PFS dataset presented here allow us to investigate the daily variation of both ice and dust. Exploiting the non-Sun-synchronous nature of Mars Express orbit, PFS performed observations of Martian atmosphere at all local times .

Dust. The mean values of dust opacity during non-dusty seasons and during the global dust storm observed in 2007 are shown in Figures below.

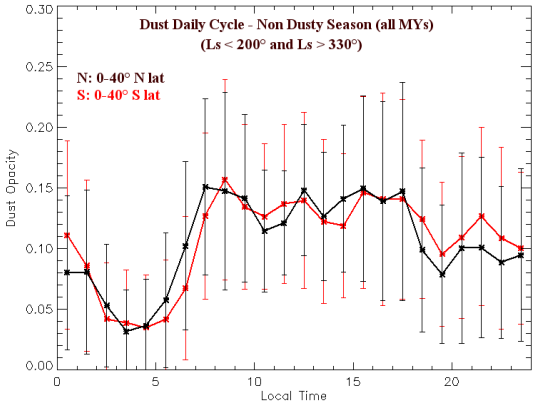

Figure 2: Dust daily cycle in non-dusty season

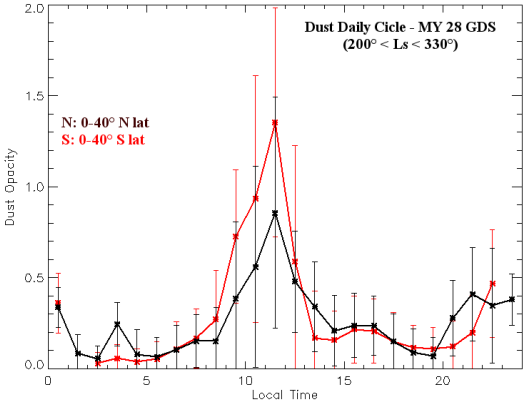

Figure 3: Dust daily cycle in non-dusty season

Ice. The daily variation of ice opacity in aphelion cloud belt is shown in the Figure below. The spatial distribution of nighttime and daytime ice clouds in the aphelion cloud belt as observed by PFS will also

be presented.

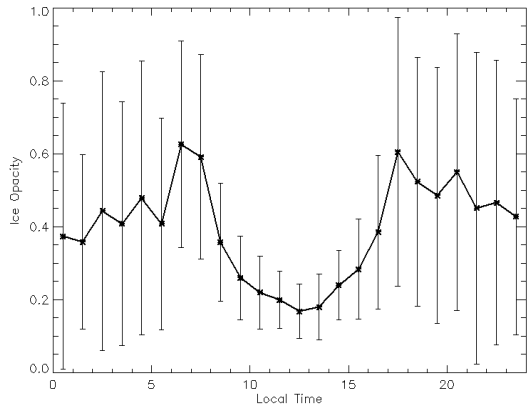

Figure 4: Dust daily cycle in non-dusty season

Climatology of dust, ice, water vapor and carbon monoxide: PFS observations allow the retrieval of atmospheric parameters in the polar regions, including the polar nights, where some of the most striking features are observed for the first time.

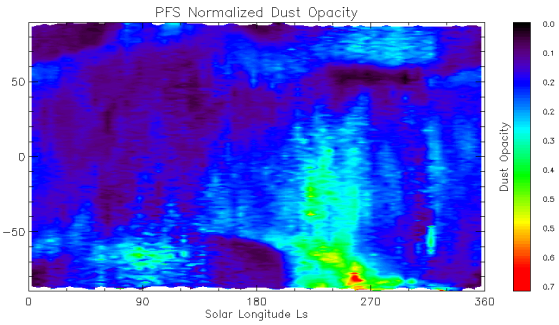

Figure 5: Seasonal evolution of dust opacity

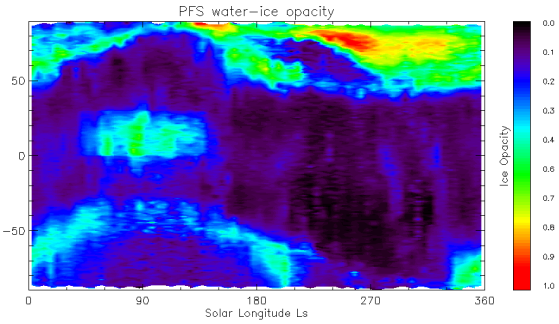

Figure 6: Seasonal evolution of ice opacity

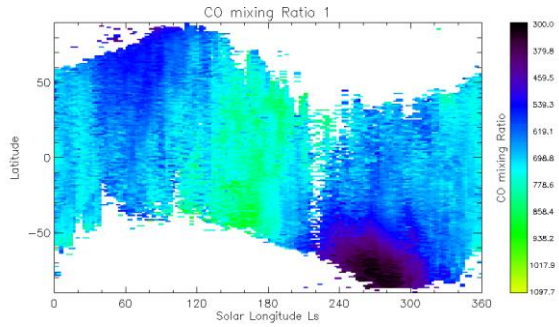

Figure 7: Seasonal evolution of carbon monoxide

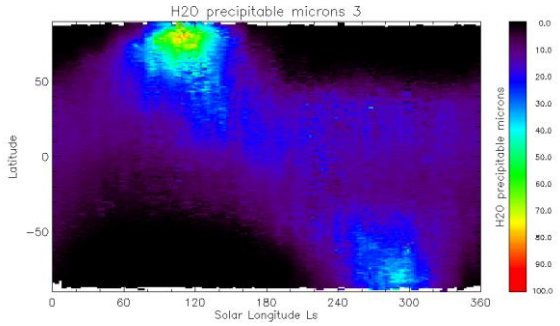

Figure 8: Seasonal evolution of water wapor

Discussion: With unprecedented spatial and temporal coverage and details revealed, this dataset offers new challenges to the GCMs and, at the same time, a new reference for the MYs complementary to those observed by MGS-TES. Most of the features observed by PFS, especially in the polar regions, were not observed in details before and cannot be reproduced by current GCMs. Current GCMs accurately predict water vapor and carbon monoxide climatology, although important discrepancies are observed in the polar regions. The new PFS dataset also allow first-time analysis of dust and ice daily cycles. Accurate modelling of these key parameters are indispensable for a comprehensive understanding of current martian climate, circulation and dynamics, and of the processes by which a dust storm on Mars is generated. The new PFS observations have the potential to improve the accuracy of current martian GCM and to address some of the current limitations of Mars DA.

References:

[1] D. Grassi, et al. (2005). Planet. Space Sci., 53, doi:10.1016/j.pss.2005.01.006.

[2] P. Wolkenberg, et al. (2017), Icarus, doi.org/10.1016/j.icarus.2017.10.045.

[3] C.D. Rodgers (2000). Inverse Methods for Atmospheric Sounding: Theory and Practice, World Scientific, Singapore.