EPSC Abstracts
Vol. 13, EPSC-DPS2019-538-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Mars atmospheric parameters from PFS-MEx

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Abstract

The Planetary Fourier Spectrometer (PFS, [1]) on Mars Express (MEx, [2]) has been observing the Martian atmosphere since January of 2004, Ls = 331.18° of MY 26. It has now provided nearly continuous monitoring of conditions in the Martian atmosphere for over 15 years and it is still performing measurements at the time of writing. We present retrievals of atmospheric parameters, such as temperature vertical profiles, surface temperatures, and column-integrated optical depth of suspended dust and water ice, as well as column-integrated abundance of carbon monoxide (CO) and water vapor (H_2O), through radiative transfer modeling of thermal- and near-infrared spectra taken by the PFS. Joint observations between the Nadir and Occultation for Mars Discovery (NOMAD) and the Atmospheric Chemistry Suite (ACS) packages onboard ExoMars Trace Gas Orbiter (TGO), and the PFS are currently being planned and executed, allowing for intercomparison and intercalibration of spectra, as well as exploitation of synergies and complementarities for the retrieval of minor species, suspended aerosols, and other atmospheric parameters.

1. PFS Retrievals

PFS has two distinct spectral channels operating simultaneously and covering the wavenumber range between 200–2000 cm^{-1} (Long Wavelength Channel, LWC, [3]) and 2000–8300 cm^{-1} (Short Wavelength Channel, SWC, [4]). Both channels have a sampling step of 1 cm^{-1} and a spectral resolution of ~1.3 cm^{-1}.

Thermal-infrared spectra returned by PFS LWC are well suited for retrieval of the thermal structure of the atmosphere from the surface to about 60 km, as well as of the surface temperature and the column-integrated optical depth of suspended dust and water ice. Water vapor can also be retrieved by PFS LWC spectra (Figure 1), while carbon monoxide can be retrieved from the 1-0 fundamental band measured by the PFS SWC (Figure 2).

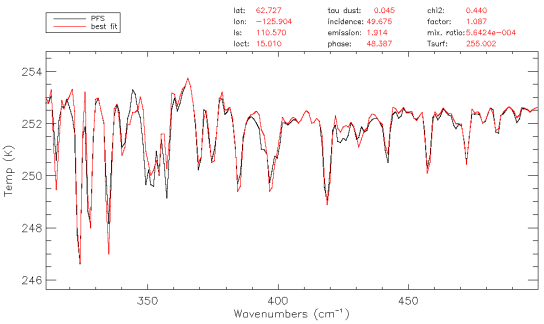

Figure 1: H_2O Retrieval. PFS LWC spectrum (black) compared to the best-fit synthetic spectrum (red).

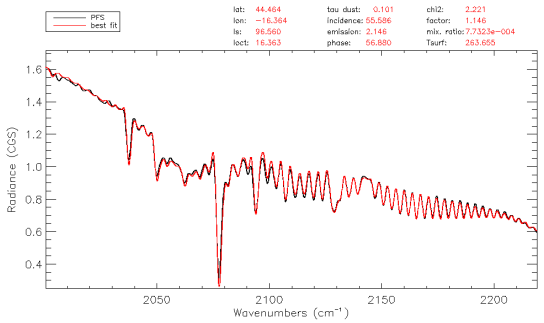

Figure 2: Retrieval of CO. PFS SWC spectrum (black) compared to the best-fit synthetic spectrum (red).

Atmospheric temperatures and aerosols opacity are also successfully retrieved over cold surface areas and in the polar regions, including the polar nights. PFS retrievals provide a detailed global description of the seasonal and spatial distribution of CO and H_2O in the Mars atmosphere and information about their interannual variability. We will give an overview of the results so far obtained.

2. MEx-TGO Joint Observations

Joint observations between NOMAD, ACS and PFS are currently being planned. Between 8th of June, 2018, and 10th of April, 2019, 65 joint observations have been executed, and more will be executed in the forthcoming months. Limb-limb joint observations will hopefully be planned and executed in the future. Two observations are considered "simultaneous" if their latitudinal and longitudinal distance is less than 5°, in a time-frame of ~5 minutes. Table 1 lists the MEx MTP, orbit and Date of the executed observations. We will present some preliminary comparison of data from the instruments.

Table 1: List of NOMAD+ACS+PFS joint observations (until 10th April, 2019).

MTP	Orbit	Date	MTP	Orbit	Date
183	18267_A	8/6/18 21.00		18862_B	28/11/18 22.10
	18269	9/6/18 10.33	**190**	18929_A	18/12/18 9.46
184	18344_A	1/7/18 3.33		18943	22/12/18 13.05
	18348	2/7/18 7.03	**191**	18968	29/12/18 20.04
	18355_A	4/7/18 7.56		18977	1/1/19 10.56
	18379_A	11/7/18 7.12		19002	8/1/19 17.48
185	18391	14/7/18 20.50		19011_B	11/1/19 8.40
	18423	24/7/18 5.45		19020_B	13/1/19 23.32
186	18580	7/9/18 20.38		19036	18/1/19 15.31
187	18589	10/9/18 11.34		19054	23/1/19 21.14
	18598	13/9/18 2.26		19056	24/1/19 10.59
	18607_A	15/9/18 17.18	**192**	19065	27/1/19 1.51
	18616	18/9/18 8.10		19072	29/1/19 2.58
	18625	20/9/18 23.02		19074	29/1/19 16.43
	18634	23/9/18 13.53		19083	1/2/19 7.35
	18652	28/9/18 19.37		19085	1/2/19 21.23
	18663	2/10/18 0.16		19092	3/2/19 22.27
	18674	5/10/18 4.55		19101	6/2/19 13.19
188	18685	8/10/18 9.34		19112	9/2/19 17.58
	18687	8/10/18 23.21		19114	10/2/19 7.45
	18695	11/10/18 6.27		19129	14/2/19 16.02
	18696	11/10/18 14.14		19140	17/2/19 20.43
	18704	13/10/18 21.19	**193**	19173	27/2/19 10.51
	18723	19/10/18 12.12		19202_A	7/3/19 21.25
189	18781	5/11/18 8.32		19211	10/3/19 12.21
	18790	8/11/18 22.27		19229	15/3/19 18.03
	18799	10/11/18 14.12		19238_A	18/3/19 8.54
	18817	15/11/18 19.54		19247	20/3/19 23.49
	18826	18/11/18 10.47	**194**	19261	24/3/19 22.51
	18835	21/11/18 1.20		19291	2/4/19 17.04
	18844_A	23/11/18 15.18		19316	9/4/19 23.55
	18853	26/11/18 7.55		19318	10/4/19 13.38
	18856_B	27/11/18 6.29			

Acknowledgements

The PFS experiment is funded by the Italian Space Agency (agreement number 2018-2-HH.0).

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