First Results from Atmospheric Observations of CO2, H2O, and CO from SuperCam on Mars2020-Pereverance Rover

Franck Montmessin, T. Mcconnochie, T. Fouchet, C. Royer, Elise Wright Knutsen, T. Bertrand, O. Forni, P. Pilleri, O. Gasnault, Gaetan Lacombe, et al.

To cite this version:

Franck Montmessin, T. Mcconnochie, T. Fouchet, C. Royer, Elise Wright Knutsen, et al.. First Results from Atmospheric Observations of CO2, H2O, and CO from SuperCam on Mars2020-Pereverance Rover. Seventh International Workshop on the Mars Atmosphere: Modelling and Observations, Jun 2022, Paris, France. obspm-03903673

HAL Id: obspm-03903673

https://hal-obspm.ccsd.cnrs.fr/obspm-03903673v1

Submitted on 19 Dec 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

First Results from Atmospheric Observations of CO_2, H_2O, and CO from Super-cam on Mars2020-Pereverance Rover

F. Montmessin, *LATMOS, Guyancourt, France*, *(franck.montmessin@latmos.ipsl.fr)*, **T. McConnochie**, *Space Science Institute, Boulder, USA,* **T. Fouchet**, *LESIA, Paris Observatory, France*, **C. Royer**, *LESIA, Paris Observatory, France*, **E. W. Knutsen**, *LATMOS, Guyancourt, France,* **T. Bertrand**, *LESIA, Paris Observatory, France*, **O. Forni**, *IRAP, CNRS, Université de Toulouse, UPS-OMP, Toulouse, Franc,e* **P. Pilleri**, *IRAP, CNRS, Université de Toulouse, UPS-OMP, Toulouse, France,* **O. Gasnault**, *IRAP, CNRS, Université de Toulouse, UPS-OMP, Toulouse, France,* **G. Lacombe**, *LATMOS, Guyancourt, France*, **J. Lasue**, *IRAP, CNRS, Université de Toulouse, UPS-OMP, Toulouse, France,* **C. Legett**, *Los Alamos National Laboratory, Los Alamos, NM, USA, [6]University of Maryland, College Park, MD, USA,* **M. T. Lemmon**, *Space Science Institute, Boulder, USA*, **T. Newell**, *Los Alamos National Laboratory, Los Alamos, NM, USA, [6]University of Maryland, College Park, MD, USA,* **D. M. Venhaus**, *Los Alamos National Laboratory, Los Alamos, NM, USA, [6]University of Maryland, College Park, MD, USA*, **S. Maurice**, *IRAP, CNRS, Université de Toulouse, UPS-OMP, Toulouse, France*, **R. C. Wiens**, *Los Alamos National Laboratory, Los Alamos, NM, USA, [6]University of Maryland, College Park, MD, USA,* **and the SuperCam team.**

Introduction:

The SuperCam instrument onboard the Mars2020-Perceverance rover [1, 2] has the capability of performing several active and passive techniques. Passive spectroscopic measurements of the atmosphere are possible in the 0.4-0.85 (VIS) and the 1.3-2.6 (IR) micron ranges [3, 4]. Since landing in Jezero crater in February 2021, SuperCam has performed numerous atmospheric observations.

The technique used is called "passive sky", and has already been successfully conducted by ChemCam on the Mars Science Laboratory rover [5]. SuperCam extends on the Capabilities of ChemCam, by also being able to probe the atmosphere in the critical IR window which includes absorption and scattering characteristics of gases and aerosols of particular interest.

Passive sky measurements have typically been carried out every two weeks, providing a consistent monitoring of key quantities such as CO_2, O_2, H_2O and CO abundances along with cloud and aerosol properties. Particular attention was given to joint measurements of O_2 and CO, as they provide unique insights into the Martian chemical cycle and have never before been measured at the same time from the surface. The results presented here will focus on the retrieval of CO_2, H_2O and CO volume mixing ratios.

Primary science objectives. CO has been observed [6] to follow the expected seasonal cycle of a chemically-inert non-condensable trace gas. To resolve the expected seasonal cycle of CO, our target measurement precision is +/- 100 ppm. Near-surface abundances of water vapor are notoriously difficult to obtain, but are particularly valuable for assessing possible surface-atmosphere exchange processes. Our primary objective for water vapor is therefore to routinely sample the daytime H_2O column, for direct comparison with nighttime mixing ratio measurements made by the Mars 2020 Mars Environmental Dynamics Analyzer (MEDA) humidity sensor [7], but also to help connect in-situ measurement by MEDA with measurements from orbit. We target a precision for precipitable water column of +/- 1 precipitable microns, comparable to ChemCam [8].

Method:

The SuperCam instrument suite consists of a ChemCam-heritage reflection spectrometer, 385–465 nm ("violet"), < 0.2 nm res. [3], an intensified transmission spectrometer, 536–853 nm, 0.3 – 0.7 nm res. [3], and an acousto-optic-tunable-filter (AOTF) -based IR spectrometer, 1300 – 2600 nm, 20 – 30 cm^{-1} res. [2, 4].

The passive sky observing strategy is the same as the ChemCam MSL approach, where SuperCam is pointed to the sky at two different elevation angles thus yielding two different path lengths through the absorbing gas of interest. By ratioing the two obtained spectra, one removes most instrument response and solar spectrum uncertainties that are ~10x and ~100x larger than the signals of interest for the IR AOTF and transmission spectrometers, respectively. Due to sun-safety constraints, all sky spectra are effectively out of focus yielding an effective field of view of ~3° diameter. To obtain the desired sensitivities for O_2 and H_2O vapor, we use ~20 minutes of total integration time to provide multiple visits to each pointing position.

First results:

Initial results include several retrievals of water vapor mixing ratios along with a tentative determination of CO abundances in a limited number of measurements. H_2O was found to vary between 24 and 147 ppmv with a 5 ppmv uncertainty from H_2O and CO_2 infrared signatures, in rough agreement with previous

MEDA RH measurements [9].

CO mixing ratios range between 900 and 1700 ppmv, values which correspond well with concentrations observed from orbit, such as with the ACS instrument onboard the ExoMars Trace Gas Orbiter [10].

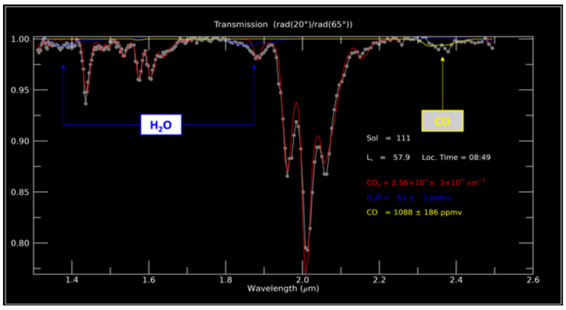

Figure 1: Fitting attempt of CO, CO_2 and H_2O in the IR. Data collected on Sol 111.

References:

[1] Wiens, R.C., et al. , 2021. Space Sci Rev 217, 4.

[2] Maurice, S., et al., 2021. Space Sci Rev 217, 47.

[3] Royer, C., et al.., 2020. Review of Scientific Instruments 91, 063105.

[4] Fouchet, T., et al., 2021, Icarus, 373, 114733.

[5] McConnochie T. H et al., 2018. Icarus 307, 294.

[6] Smith M. D. et al. (2018), Icarus 301, 117.

[7] Rodriguez-Manfredi et al. (2021) Space Sci Rev, 217, 3, 48.

[8] Trainer M. G. et al. (2019), JGR 124, 3000.

[9] Tamppari et al. (2021), AGU fall meeting, New Orleans P251-2253.

[10] Fedorova et al. (2022), in prep.