EPSC Abstracts
Vol. 12, EPSC2018-272, 2018
European Planetary Science Congress 2018

Ices, frosts and clouds on Mars observed by CaSSIS during the first months of TGO's primary science mission

A. Pommerol (1), N. Thomas (1), Z. Yoldi (1), V. Roloff (1), M. Almeida (1), P. Becerra (1), S. Tulyakov (2), L. Tornabene (3), F. Seelos (4), J. Bapst (5), C. J. Hansen (6), G. Portyankina (7), A. Lucchetti (8), M. Pajola (8), S. Douté (9), M. Patel (10) and G. Cremonese (8).
(1) Physikalisches Inst., University of Bern, Sidlerstrasse 5, CH-3012 Bern, Switzerland (antoine.pommerol@space.unibe.ch), (2) Ecole Polytechnique Federale de Lausanne, Switzerland, (3) Centre for Planetary Science & Exploration (CPSX), Western University, London, ON, Canada, (4) Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA, (5) LPL, University of Arizona, Tucson AZ, USA, (6) Planetary Science Institute, Tucson AZ, USA, (7) Laboratory for Atmospheric and Space Physics, University of Colorado, USA, (8) INAF-OAPD, Astronomical Observatory of Padova, Italy, (9) Institut de Planétologie et d'Astrophysique de Grenoble, Université Grenoble Alpes/CNRS, France, (10) School of Physical Sciences, The Open University, Milton Keynes MK7 6AA, UK.

Abstract

The CaSSIS (Colour and Stereo Surface Imaging System) [1] of the ExoMars Trace Gas Orbiter (TGO) has already acquired numerous images of Mars that show seasonal and diurnal ices and frosts at the surface as well as clouds and fog in the atmosphere. Simulations of the CaSSIS signal in all four colour filters from laboratory measurements with analogues and data from other missions will be helpful to interpret these new observations.

1. Introduction

The original 74°-inclination non-Sun-synchronous orbit of the TGO spacecraft coupled with the abilities of CaSSIS to image the surface:
- in up to four colour band
- with sufficient signal-to-noise to provide good quality images in low-light conditions
- with the possibility of quasi-simultaneous stereo acquisitions
provide new opportunities to study the seasonal and diurnal cycles of volatiles (H_2O and CO_2) at the surface of Mars. In particular, the regions around 70° latitude in both hemispheres are strongly affected by seasonal changes and can be studied in great details, with short revisit times and possibilities of observations at variable local time during all seasons.

In order to interpret the colour images in terms of ice properties relevant for our understanding of volatiles cycles, we have followed two types of approaches in preparation for scientific exploitation of CaSSIS data:

- Simulation of the CaSSIS spectral signal from laboratory experiments conducted with well-characterized analogues of Martian icy surfaces. This approach is detailed in a companion abstract [2].

- Simulation of CaSSIS spectral-images from data acquired by the HiRISE, CRISM and CTX imagers of MRO. The simulated data provide a thorough assessment of how the colour capabilities of CaSSIS address the relevant science and will be key for cross-calibration, comparison and change-detection with the actual CaSSIS images [3].

2. Observations

Since the beginning of the primary science phase in April 2018, CaSSIS has already acquired a large number of images, regularly increasing, showing the presence of H_2O and CO_2 ice and frosts at the surface and occasionally clouds and fogs in the atmosphere.

The first observations performed under low-light conditions have confirmed the ability of CaSSIS to provide high-quality images even under challenging illumination conditions. As expected, data from the BLU filter generally show a lower signal-to-noise than the other filters because of the low reflectance of the Martian surface at short visible wavelengths but excel at revealing the presence of even small amounts of ice at the surface or in the atmosphere because of their high reflectance. We are currently focusing our efforts on updating the laboratory calibration of data from the BLU and NIR filters [4] using in-flight data.

Colour composite images assembled from data acquired in the BLU filter combined with PAN and either RED or NIR filter can provide a wealth of information on the occurrence and properties of ices and the processes involved in their deposition and evolution. For instance, the RED-PAN-BLU image of the Northern rim of crater Korolev (73° North) shown by [5] and publically released on the 26th of April 2018 (http://exploration.esa.int/mars/60235-

exomars-images-korolev-crater/) was acquired at early local solar time (07:14 AM) with an incidence angle of 77°.

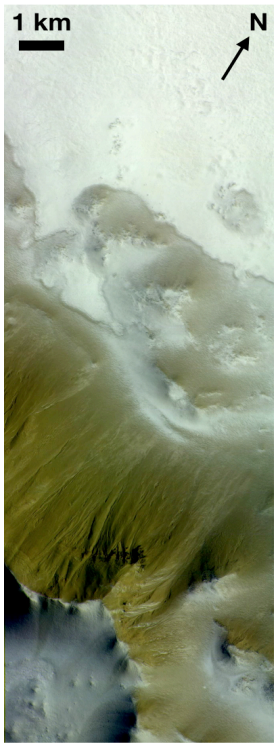

Figure 1: CaSSIS colour (RED-PAN-BLU) image of the Southern rim of crater Ross (252°E, 57°S). The image is 6 km wide, at a resolution of 4.5m/px. The north-facing slopes appear already defrosted at Ls=170°, with the exception of the channels of numerous gullies, whereas the floor of the crater and the southern facing slopes are still covered by bright seasonal CO_2 ice. CaSSIS image: CAS-M01-2018-05-05T19.25.42.020-RED-PAN-BLU.

This colour image shows icy terrains with a rich variety of albedo, colours and textures. Because the image was acquired shortly before the fall equinox in the northern hemisphere, it is likely that the ice seen at the surface consists of both perennial water ice deposits that have survived the entire summer and freshly deposited water frost. On-going comparisons with laboratory data [2] should help with the interpretation of observed colours and albedo in terms of ice properties.

In the other hemisphere, the external edges of the southern seasonal cap start sublimating as we approach spring equinox. Figure 1 shows an example of the sublimation of the seasonal ice on the North-facing slopes of the southern rim of crater Ross. TES temperature measurements at this location and season in previous Martian years [6] are compatible with the partial defrosting seen by CaSSIS. Of particular interest is also the observation of CO_2 ice inside the channels of gullies, as it has recently been hypothesized that the CO_2 cycle is associated to the gullies formation process [7].

3. Summary and future work

Many of the first images acquired by CaSSIS at the beginning of TGO's primary science missions show ices, frosts and clouds. In addition, the quality of the images, considering those acquired under challenging low-light conditions, prove the ability of the instrument to make a significant contribution to the understanding of volatiles cycles on Mars.

Simulations of CaSSIS spectral signal from both laboratory analogues and instruments on other missions are key for the interpretation of CaSSIS colour observations. Results obtained during the first moths of the primary science phase will guide future laboratory experiments.

Acknowledgements

The authors wish to thank the spacecraft and instrument engineering teams for the successful completion and operation of the instrument. CaSSIS is a project of the University of Bern and funded through the Swiss Space Office via ESA's PRODEX programme. The instrument hardware development was also supported by the Italian Space Agency (ASI) (ASI-INAF agreement no.I/018/12/0), INAF/Astronomical Observatory of Padova, and the Space Research Center (CBK) in Warsaw. Support from SGF (Budapest), the University of Arizona (Lunar and Planetary Lab.) and NASA are also gratefully acknowledged. The laboratory work has been carried out within the framework of the NCCR PlanetS supported by the Swiss National Science Foundation.

References

[1] Thomas, N. et al. (2017) Space Sci. Rev., 212, 1897
[2] Yoldi et al., this conference.
[3] Tornabene, L. L. et al. (2018) Space Sci. Rev., 214, 18.
[4] Roloff, V. et al. (2018) Space Sci. Rev., 214, xx.
[5] Thomas, N. et al., this conference.
[6] Bapst, J. et al. (2015) Icarus 260.
[7] Vincendon, M. et al. (2015) JGR, 120.