EPSC Abstracts
Vol. 13, EPSC-DPS2019-579-1, 2019
EPSC-DPS Joint Meeting 2019

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

High-Level Science Products of SPICAM (Mars Express) and SPICAV (Venus Express)

Nick Cox (1), Lucio Baggio (2), Jean-Loup Bertaux (2), Anna Fedorova (3), Gaetan Lacombe (2), Franck Lefèvre (2), Mikhail Luginin (3), Emmanuel Marcq (2), Franck Montmessin (2)
(1) ACRI-ST, France, (2) LATMOS, France, (3) IKI, Russia

Abstract

In this contribution we present new high-level science products derived from nadir and stellar/solar occultation observations obtained with the UV/IR spectrometers SPICAM and SPICAV on board the Mars Express and Venus Express spacecrafts. We describe the scope of the new level 2 processing and the data product content. We present examples of scientific results obtained with these data sets.

1. SPICAM/SPICAV UV/IR data

For the new level 2 processing of UV nadir and stellar occultation measurements all valid data obtained between orbits 0 and 13651 (SPICAM) and between 0 and 3151 (SPICAV) is used. Similarly for SPICAV all valid IR solar occultation measurements are processsed. For SPICAM, solar occultations until orbit 18550 are considered. Observations were reprocessed starting from the most recent level 1b data. We note that for the Venus stellar occultation observations particular care was taken to estimate and subtract the Nitric Oxide (NO) emission from the limb in order to reveal the true occultation signal.

The full details of the L2 processing are described in the Algorithm Theoretical Definition Documents (ATBDs) available through the PSA. The delivered products (Table 1) adhere to the PDS3 standard.

2. High-level science products

Nadir observations For the UV nadir observations of Mars and Venus the level 2a data products provide the absolute spectral radiances, radiance factors and geometrical parameters. When available, the associated level 2b data provide for Mars the columns of O_3, the UV-averaged surface albedo, the dust aerosol optical thickness and the geometrical data; and for Venus the mixing ratios of SO_2 and O_3, cloud top altitude, and the aerosol imaginary refractive index at 250 nm.

Table 1: SPICAM and SPICAV science products delivered to the ESA Planetary Science Archive (PSA).

Type of observation	Planet	Number of observations	Product level	Product type
UV-Nadir	Mars	2558	L2a	Radiance
		2558	L2b	Atmosphere
	Venus	1508	L2a	Radiance
		1508	L2b	Atmosphere
UV-Stellar occultation	Mars	2093	L2a	Transmittance
		1920	L2b	Atmosphere
	Venus	901	L2a	Transmittance
		901	L2b	Atmosphere
IR-Solar occultation	Mars	tbd	L2a	Transmittance
		tbd	L2b	Atmosphere
	Venus	648	L2a	Transmittance
		222	L2b	Atmosphere

Stellar occultation observations For the UV stellar occultation measurements the level 2a data products comprise the wavelength dependent transmission spectra as well as the spectral flux of the reference star spectrum. For the level 2b products we include the column (line) and local densities for CO_2/SO_2/O_3 (where applicable), as well as the atmospheric temperature profiles. The altitude sampling Δz is 1—3 km for Mars and 0.2–7 km for Venus.

Solar occultation observations For the IR solar occultation measurements the level 2a data products comprise the wavelength dependent transmission spectra as well as the reference flux of the reference solar spectrum. The level 2b products include aerosol opacities at 4 or 10 wavelengths from 1 to 1.55 μm for SPICAM and 10 wavelenghts from 0.65 to 1.55 μm for SPICAV. In addition for Mars the local density profiles of CO_2 and H_2O and aerosol size distributions and number density are included. For Venus the size distribution and number density of sulphur acid particles is given.

3. Scientific outcome (examples)

Mars: SPICAM-UV nadir The new dataset comprises Martian Years (MY) 27 to 32 (2004–2014) thus covering a time span appropriate for climatological studies of ozone and dust. As an example, Figure 1 shows the assimilated information on the ozone column (top) and dust opacity (bottom) ([1], [3]).

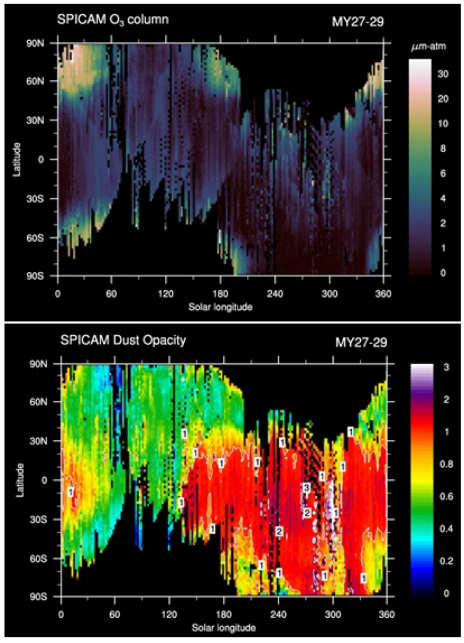

Figure 1: SPICAM retrieval of the ozone column (top) and the dust opacity (bottom) on Mars.

Venus: SPICAV-UV nadir For each orbit the radiance factor (200–320 nm) is given at different geometrical coordinates. Together with atmospheric radiative transfer models these are used to retrieve the levels [in ppbv] of O_3 and SO_2. An example is shown in Figure 2. SPICAV routinely detects O_3 at higher latitudes ([4]). At lower latitudes the cloud top is at 75±2 km. Venus is darker (UV dust opacity) at lower latitudes, consistent with known features (see [4]).

Stellar occultation on Venus/Mars Stellar occultations provide a radiography of the vertical distribution of CO_2, O_3 and aerosols. The CO_2 profile gives the vertical temperature profile. These data can then be compared with different global climate/atmosphere models (e.g. [2]).

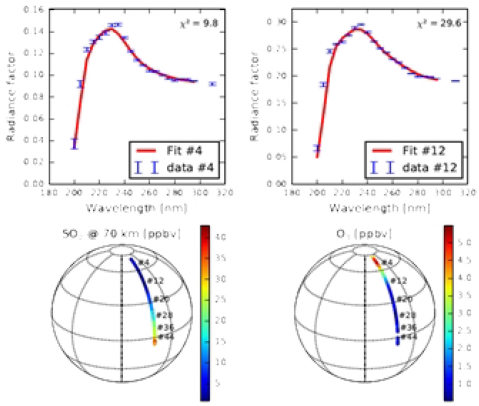

Figure 2: SPICAV nadir retrieval results. Example for orbit 0108A07 (from PSA FITS file).

4. Summary and Outlook

New high-level science products for the SPICAM and SPICAV UV and IR instruments have been delivered to the ESA PSA and will be available to the community (release is foreseen before the end of 2019). This contribution presents an overview of the delivered data products (level 2a and 2b) and provides some examples of the scientific content.

Acknowledgements

This project is supported by an EXPRO contract with ESA. EM acknowledges support from CNES and PNP.

References

[1] Montmessin, F., O. Korablev, F. Lefèvre, et al. “SPICAM on Mars Express: A 10 Year in-Depth Survey of the Martian Atmosphere”, 2017, Icarus, 297, 195-216

[2] Piccialli, A., F. Montmessin, D. Belyaev, et al. “Thermal Structure of Venus Nightside Upper Atmosphere Measured by Stellar Occultations with SPICAV/Venus Express”, 2015, Planetary and Space Science, 113, 321-335

[3] Willame, Y., Vandaele, A. C., Depiesse, C., et al. “Retrieving cloud, dust and ozone abundances in the Martian atmosphere using SPICAM/UV nadir spectra”, 2017, Planetary and Space Science, 142, 9-25

[4] Marcq E., Baggio L., Lefèvre F., et al. “Discovery of cloud top ozone on Venus”, 2019, Icarus, 319, 491-498