HAL
open science

First global extraction of mesospheric Venusian O 3 and SO 2 concentrations from the entire SPICAV-UV/VEX stellar occultations dataset

Daria Evdokimova, Franck Montmessin, Denis Belyaev, Jean-Loup Bertaux

To cite this version:

Daria Evdokimova, Franck Montmessin, Denis Belyaev, Jean-Loup Bertaux. First global extraction of mesospheric Venusian O 3 and SO 2 concentrations from the entire SPICAV-UV/VEX stellar occultations dataset. EPSC-DPS Joint Meeting 2019, Sep 2019, Geneva, Switzerland. pp.EPSC-DPS2019-1469-2. insu-02264386

HAL Id: insu-02264386

https://insu.hal.science/insu-02264386v1

Submitted on 6 Aug 2019

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.

EPSC Abstracts
Vol. 13, EPSC-DPS2019-1469-2, 2019
EPSC-DPS Joint Meeting 2019
© Author(s) 2019. CC Attribution 4.0 license.

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

First global extraction of mesospheric Venusian O_3 and SO_2 concentrations from the entire SPICAV-UV/VEX stellar occultations dataset

Daria Evdokimova (1,2), Franck Montmessin (2), Denis Belyaev (1), Jean-Loup Bertaux (1,2)
(1) Space research institute (IKI) of the Russian Academy of Sciences, Moscow, Russia.
(2) UVSQ ; Sorbonne Universités, UPMC Université Paris 06; CNRS/INSU, LATMOS-IPSL, Guyancourt, France.
(evd.dar@yandex.ru)

Abstract

The SPICAV spectrometer was a part of the ESA's Venus Express spacecraft functioning on the Venus orbit in 2006-2014 [1]. Its UV channel worked in a spectral range of 118-320 nm that covered gaseous absorption bands of SO_2, O_3 and CO_2. Observations of stellar occultations in the UV allowed to study nighttime vertical distributions of these gases within altitude range of 80-110 km corresponding to Venus upper mesosphere. Temporal and spatial variations of the gaseous content are able to be analyzed considering the SPICAV dataset accumulated for the entire mission period.

In our work we present results of O_3 and reprocessed SO_2 retrievals based on the whole SPICAV UV dataset. The data processing pipeline was improved since the recent studies [2] that allowed to extend the number of considering observations.

1. Introduction

Minor gases (SO_2, O3, H_2O, etc.) have a great influence on chemical processes originated in the CO_2 atmosphere of Venus. An oxidation of the sulphur dioxide (SO_2) in the mesosphere produces the concentrated H_2SO_4 acid forming aerosol particles of a thick cloud layer (50-70 km). Moreover, SO_2 is a product of volcanic activity. Thus, variations of its abundance in the mesosphere may indicate the recent volcanic activity events on the Venus surface [3]. The high temporal and spatial variability of SO_2 volume mixing ratio (VMR) in the atmosphere over clouds was observed by SPICAV UV both on the day and night sides [4, 5]. Solar occultations measurements show the strong SO_2 variations from 10 to 200 ppb (one particle per billion) at the pressure level of 0.1 mbar (90-95 km) on the planet's terminator. In the night mesosphere the fluctuations behavior corresponds to one observed on the terminator, however the VMR values are 3-4 times higher due to the photolysis absence.

Ozone layer was discovered for the first time by SPICAV UV stellar occultations in 2006-2010 [6]. It was observed at the altitude about 100 km in nighttime atmosphere with corresponding VMR values of few tens in ppb. O_3 formation is a result of the Sub-Solar to Anti-Solar (SSAS) circulation bringing oxygen atoms to the anti-solar point.

Analysis of the temporal and spatial fluctuations of sulphur dioxide and ozone in the nighttime mesosphere may improve understanding of the SSAS circulation regime on Venus.

2. Data processing improvements

The stellar occultation method was implemented for the first time for Venus atmosphere by SPICAV UV. In this mode the planet is ascending or descending in the field of view of the spectrometer while the instrument is observing one star through the atmosphere. Spectra of stellar light partly absorbed in the atmosphere were measuring. However, the stellar spectra were superimposed by UV emissions of different extended sources around Venus (nitric oxide airglow, Lyman-α) in many cases.

Gaseous concentrations are retrieved from the atmospheric transmission spectra by resolving spectral and vertical inversion problems. Recently, the main improvements of the data processing algorithm for stellar occultation measurements were considered in details [2]. They combine a precise wavelength to pixel assignment based on the spectral features of measured stars and an extraction of emission spectra. Thus, the accuracy of conversion from the SPICAV raw data to the atmospheric transmission spectra is significantly increased. It

results in 20-40% better precision of gaseous concentration retrievals.

3. Preliminary results

The whole SPICAV-UV stellar occultation dataset is currently being processed taking into account the improvements of the pipeline described above. Thus, the number of statistically significant SO_2 detections is increased by 30% comparing with the previous study [5]. Moreover, the ozone absorption is considered in spectral inversion problem. The study of O_3 content were proceeded for the entire observational period of SPICAV UV.

Acknowledgements

Daria Evdokimova acknowledges a support of the Vernadski program of the French Embassy in Russia.

References

[1] Bertaux, J.-L. et al.: SPICAV on Venus Express: Three spectrometers to study the global structure and composition of the Venus atmosphere, PSS 55, pp. 1673-1700 (2006)

[2] Evdokimova, D.G. et al.: Improved retrieval of gaseous concentration profiles in Venus mesosphere using SPICAV-UV/VEX stellar occultation data, The ninth Moscow solar system symposium 2018, 8-12 October 2018, Moscow, Russia, 2018.

[3] Esposito, L.W.: Sulfur dioxide: Episodic injection shows evidence for active Venus volcanism, Science 223, pp. 1072–1074 (1984)

[4] Marcq, E. et al.: Variations of sulphur dioxide at the cloud top of Venus's dynamic atmosphere. Nat. Geosci. 6, pp. 25–28 (2013)

[5] Belyaev, D.A. et al.: Night side distribution of SO2 content in Venus' upper mesosphere, Icarus 294, pp. 58–71. (2017)

[6] Montmessin, F. et al.: A layer of ozone detected in the nightside upper atmosphere of Venus, Icarus 216 (1), pp. 82-85 (2011)