



HAL
open science

Sulphur oxides in Venus mesosphere detected from SPICAV/SOIR VEX solar occultation

Denis Belyaev, Franck Montmessin, Jean-Loup Bertaux, Oleg Korablev, Anna Fedorova, Emmanuel Marcq, A. Mahieux, X. Zhang

► **To cite this version:**

Denis Belyaev, Franck Montmessin, Jean-Loup Bertaux, Oleg Korablev, Anna Fedorova, et al.. Sulphur oxides in Venus mesosphere detected from SPICAV/SOIR VEX solar occultation. EPSC-DPS Joint Meeting 2011, Oct 2011, Nantes, France. hal-00666254

HAL Id: hal-00666254

<https://hal.science/hal-00666254>

Submitted on 9 Jun 2024

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.

Sulphur oxides in Venus mesosphere detected from SPICAV/SOIR VEX solar occultation

D. Belyaev (1,2), F. Montmessin (1), J.-L. Bertaux (1), O. Korablev (2), A. Fedorova (2), E. Marcq (2), A. Mahieux (3), X. Zhang (4)

(1) LATMOS, CNRS/INSU/IPSL, Guyancourt, France, (2) IKI RAS, Moscow, Russia, (3) BIRA/IASB, Brussels, Belgium, (4) CalTech, Pasadena, USA, (Denis.Belyaev@latmos.ipsl.fr)

Abstract

New measurements of sulfur dioxide (SO₂) and monoxide (SO) in the atmosphere of Venus by SPICAV / SOIR instrument onboard Venus Express orbiter provide powerful statistics to study the behavior of gases above Venus' clouds. The instrument (a set of 3 spectrometers) is capable to sound atmospheric structure above the clouds at several regimes of observations (nadir, solar and stellar occultations) either in UV or in near IR spectral ranges. In this paper we present results from solar occultations in the ranges of SO₂ absorption (190-230 nm, 4 μm) and SO (190-230 nm). The dioxide was detected by spectrometer SOIR at altitudes 65-80 km in the IR and by spectrometer SPICAV at 85-105 km in the UV. The monoxide's absorption was measured only by SPICAV UV at 85-105 km.

1. Generalities

Sulfur compounds are key components of Venus' atmosphere because this planet is totally covered by H₂SO₄ droplets clouds at altitudes 50-70 km. Any significant change in oxides SO_x above and within the clouds can affect the photochemistry in the mesosphere. Moreover, it may be an indicator of geological activity on the planet – a single volcanic event can disturb concentrations of atmospheric species that may affect SO_x behavior in the cloud top. Sulfur oxides actively participate in photochemical life around Venus' clouds (Mills et al., 2007). SO₂ photo-dissociates by absorption of solar radiation and, reversely, is formed by SO oxidation; further oxidation leads to SO₃ formation. Finally, in combination with H₂O it gives concentrated liquid sulfuric acid (~75% H₂SO₄).

In the present work, we describe a new set of SPICAV / SOIR sulfuric explorations from the VEX orbiter with some update of the previous SOIR results (Belyaev et al., 2008) and first SO_x observations made by SPICAV spectrometer in UV range. SPICAV-UV is sensitive to sulfur oxides' absorption band at 190-220 nm and able to sound altitudes 85-110 km in solar occultation mode. SOIR is sensitive to SO₂ absorption band around 4 μm and able to sound altitudes 65-80 km. Boresights of SPICAV and SOIR spectrometers are oriented identically in the occultation mode that gives us possibility to perform simultaneous measurements. Thus, we acquired vertical profiling of SO and SO₂ in Venus' mesosphere and compared it with very recent observations and modeling.

2. Results

In the lower layer (65-80 km) SO₂ mixing ratio varies around 0.02-0.5 ppmv, and in the upper layer (90-105 km) it increases with altitude from 0.05 to 2 ppmv, while [SO₂]/[SO] ratio is around 1 to 5. The presence of the SO_x abundance at high altitudes is analyzed on the basis of H₂SO₄ photodissociation and temperature conditions in Venus mesosphere. At levels 90-100 km the content of sulfur dioxide was found to increase with temperature from 0.1 ppmv at 165-170 K to 0.5-1 ppmv at 190-192 K. This behavior confirms a concept about SO₂ production in this altitude region by the evaporation of H₂SO₄ from droplets and its subsequent photolysis around 100 km (Zhang et al., 2010).

Acknowledgements

We thank our collaborators at LATMOS/France, BIRA/Belgium and IKI/Russia for the design and

fabrication of the instrument. We thank CNRS and CNES for funding SPICAV/SOIR in France, the Belgian Federal Science Policy Office, the European Space Agency (ESA, PRODEX program), Roskosmos and the Russian Academy of Sciences. Russian colleagues Oleg Korablev and Anna Fedorova acknowledge support from the Russian Foundation for Fundamental Research (RFFI, # 10-02-93116). One of us (Denis Belyaev) acknowledges support from CNES for a post-doc position at LATMOS. Xi Zhang was supported by NASA grant NNX07AI63G to the California Institute of Technology.

References

- [1] Belyaev, D., Korablev, O., Fedorova, A., Bertaux, J.-L., Vandaele, A.-C., Montmessin, F., Mahieux, A., Wilquet, V., Drummond, R.: First observations of SO₂ above Venus clouds by means of Solar Occultation in the Infrared, *J. Geophys. Res.*, Vol. 13, E00B25, doi:10.1029/2008JE003143, 2008.
- [2] Mills, F.P., Esposito, L.W., Yung, Y.L.: Atmospheric composition, chemistry, and clouds. *Exploring Venus as a Terrestrial Planet*, Geophysical Monograph Series, vol. 176, pp. 73–100, 2007.
- [3] Zhang X., Liang M.-C., Montmessin F., Bertaux J.-L., Parkinson C., Yung Y.L.: Photolysis of sulphuric acid as the source of sulphur oxides in the mesosphere of Venus, *Nature Geoscience* #3, Vol. 12, pp. 834-837, 2010.