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

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Abstract

New measurements of sulfur dioxide (SO_2) 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 SO_2 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 H_2SO_4 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). SO_2 photo-dissociates by absorption of solar radiation and, reversely, is formed by SO oxidation; further oxidation leads to SO_3 formation. Finally, in combination with H_2O it gives concentrated liquid sulfuric acid (~75% H_2SO_4).

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 SO_2 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 SO_2 in Venus' mesosphere and compared it with very recent observations and modeling.

2. Results

In the lower layer (65-80 km) SO_2 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 $[SO_2]/[SO]$ ratio is around 1 to 5. The presence of the SO_x abundance at high altitudes is analyzed on the basis of H_2SO_4 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 SO_2 production in this altitude region by the evaporation of H_2SO_4 from droplets and its subsequent photolysis around 100 km (Zhang et al., 2010).

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