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Polarimetric study of Venus' cloud layers with SPICAV/VEx

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Abstract

1. Introduction

The study of Venus' cloud layers is important in order to understand the structure, radiative balance and dynamics of the Venusian atmosphere. Polarization measurements have given important constraints for the determination of the constituents of the clouds and haze. From ground based observations, Hansen and Hovenier[3], using a radiative transfer model with polarization, found that the main cloud layers between 50 and 70 km consist of $r \sim 1$ µm radius spherical droplets of a H_2SO_4-H_2O solution. In the early 1980s, Kawabata[4] used the polarization data from the OCPP instrument on the spacecraft *Pioneer Venus* to constrain the properties of the haze. They found that the haze layer is composed of smaller particles $r \sim 0.25$ µm with similar refractive indices.

Our work reproduces the method used by Hansen and Kawabata[3, 4]. We applied a radiative transfer model with polarization on the so far unexploited polarization data of the SPICAV-IR instrument on-board ESA's *Venus Express*. Our aim is to better constrain haze and cloud particles at the top of Venus's clouds, as well as their spatial and temporal variability.

2. SPICAV-IR observations

The SPICAV-IR spectrometer on *Venus Express* is based on an Acousto-Optic Tunable Filter (AOTF) working in the $0.65 - 1.7$ µm range, with two output beams linearly polarized in perpendicular directions, allowing us to measure the degree of linear polarization for different phase angles[6].

The data give a good latitudinal and phase angle coverage, mostly in the northern hemisphere. Latitudinal variations in polarization are visible in the observation data for orbits up to #1500 with a strong increase of polarization towards the north pole (Fig. 1). At lower latitudes, polarization is quite homogeneous and we observe the glory in polarization at low phase angles, in accordance with VMC observations in photometry.

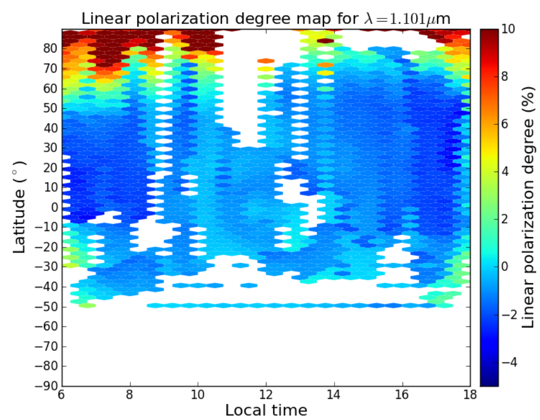

Figure 1: SPICAV data polarization map for orbits #400 to #1500.

3. Analysis

We use a radiative transfer model taking polarization into account in order to model the clouds[2, 1]. We consider a two layered model: an optically thick cloud layer of micrometric particles made of a concentrated sulfuric acid solution. Above lies the haze layer of $r \sim 0.25$ µm particles with a varying optical thickness τ_h.

3.1. Glory

At low phase angle, the main feature is the glory which gives information about the main cloud particles (Fig. 2). Our modeling yields good agreement with previous results with spherical particles with $r \sim 1$µm and $n_r \sim 1.42$ at $\lambda = 1$µm.

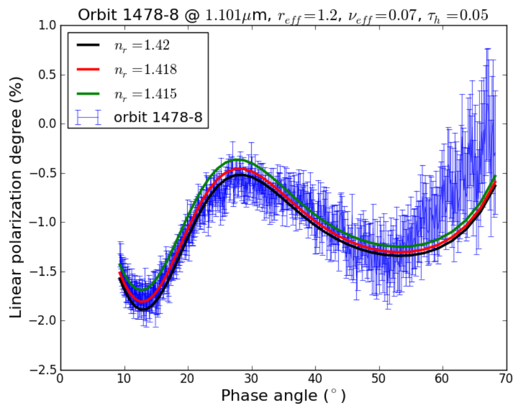

Figure 2: Glory as observed on orbit #1478-8 at $\lambda = 1.101$ nm with best model for $r_{\text{eff}} = 1.2$ µm, $\nu_{\text{eff}} = 0.07$, $n_r = 1.418$ and $\tau_h = 0.05$.

3.2. High latitudes

At higher latitudes, the main contributor to polarization is the submicrometric haze. The modeling allows us to measure the optical thickness of the haze layer. We observe an increase of τ_h with latitude. From 0.03 at $\lambda = 1.101$ µm at low latitudes, τ_h reach 0.07 at higher latitudes with an upper limit at 0.17.

4. Conclusion

SPICAV-IR provides global measurements of polarization of Venus clouds and allows us to retrieve the parameters of the cloud droplets, in agreement with previous measurements. We confirm that the clouds are made of spherical micrometric droplets of sulfuric acid while the haze are made of $r \sim 0.25$ µm particles. The optical thickness of the haze increases towards the pole, in agreement with other studies[5].

5. Perspectives

We aim to extend the modeling of the data to all the data set in order to build maps of cloud parameters. We also intent to investigate further the varibility with latitude, but also with local time. The long-term variations during the *Venus Express* mission and in comparison with OCPP will also be explored.

Acknowledgements

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