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Study of Venus' cloud layers by polarimetry with SPICAV/VEx

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Abstract

1. Introduction

The study of Venus's cloud layers is important in order to understand the structure, radiative balance and dynamics of the Venusian atmosphere. The main cloud layers between 50 and 70 km are thought to consist of $r \sim 1\,\mu\mathrm{m}$ radius droplets of a H_2SO_4-H_2O solution [1]. Nevertheless, the composition and the size distribution of the droplets are difficult to constrain more precisely. The polarization measurements have given important constraints for the determination of the constituents of the haze. In the early 1980s, Kawabata et al. [2] used the polarization data from the OCPP instrument on the spacecraft Pioneer Venus to constrain the properties of the haze. They obtained a refractive index of 1.45 ± 0.04 at $\lambda = 550\,\mathrm{nm}$ effective radius of $0.23 \pm 0.04\,\mu\mathrm{m}$, with a normalized size distribution variance of 0.18 ± 0.1.

Our work reproduces the method used by Kawabata. We developed a Lorentz-Mie scattering model and applied it to 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. Modelling

We introduce here the model that we have developed, based on the BH-MIE scattering model. Taking into account the same size distribution of droplets as Kawabata et al. (eq. 1), we obtain the polarization degree after a single Mie scattering by a haze at all phase angles given the effective radius and variance of the distribution and the refractive index of the droplets (fig. 1).

$$N(r) = C \cdot r^{-3+1/\nu_{eff}} \exp\left(\frac{-r}{r_{eff}\nu_{eff}}\right) \quad (1)$$

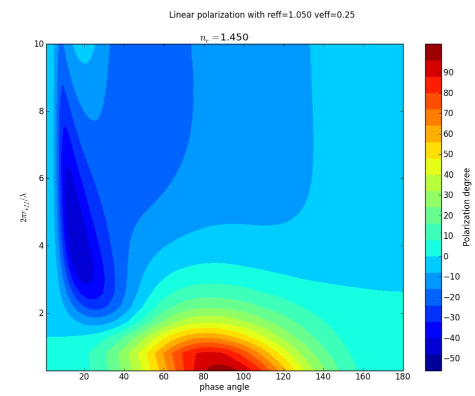

Figure 1: Polarization degree with respect to phase angle and size parameter for $n_r = 1.45$, $r_{eff} = 1.05\,\mu\mathrm{m}$ and $\nu_{eff} = 0.25$.

3. Observations analysis

We present the first application of our model to the SPICAV-IR data under the single scattering assumption.

3.1. SPICAV-IR data

The SPICAV-IR spectrometer on Venus Express is based on an Acousto-Optic Tunable Filter (AOTF), with two output beams linearly polarized in perpendicular directions, allowing us to measure the degree of linear polarization for different phase angles [3].

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 (fig. 2).

3.2. Study of glories

The glory is a strong polarization feature that appears at low phase angles, observed by both SPICAV and

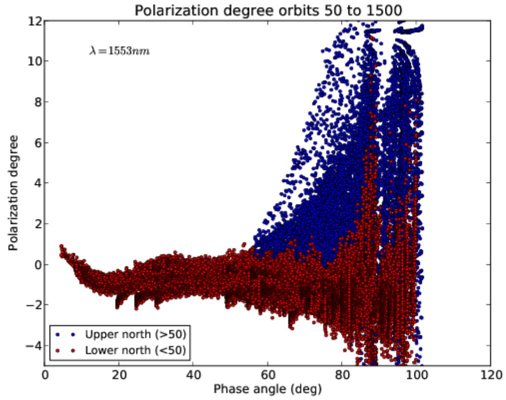

Figure 2: SPICAV data for orbits 50 to 1500 in northern hemisphere.

VMC. Because the multiple scattering does not change much the position of the main polarization features, we use the glory to make preliminary fits under a single scattering assumption, using the position and shape of the glory which depends on the cloud parameters.

4. Summary and Conclusions

The polarimetric data from SPICAV-IR is fully exploitable and the study of the glories will provide first estimates of the clouds parameters.

5. Perspectives

In the near future, we then aim to extend our study of the polarization data by integrating our model into a polarized radiative transfer model which will take into account the multiple scattering. Having more recent observations in wavelengths ranging from 650 to $1625\,\mathrm{nm}$, will put better constraints on the properties of both cloud and haze particles, with a primary focus on the cloud droplets characterization.

Acknowledgements

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