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Venus Aerosol Properties from Modelling and Akatsuki IR2 Observations

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1. Introduction

The global cloud cover at Venus is perhaps its most obvious attribute upon a first glance at the planet. Despite being analyzed by means of polarimetry, planetary emitted and reflected radiation, and in situ probes and balloons, many properties of the Venusian aerosols remain insufficently characterized. Three modes of particles were observed by in situ probes [4], though internal inconsistencies in the data from various instruments have left the identity and particulars of these three modes uncertain [6]. Analyses of the emitted near infrared radiation from Venus tend to attribute most of the observed variation to changes in the number concentrations of the third and largest mode of sulfuric acid droplets in the Venus clouds, despite that their existence and physical characteristics remain uncertain [1, 3]. Remote observations of the upper hazes have long suggested that the primary constituent is one micron radius spherical particles of a solution of sulfuric acid and water [2]. But the frequent and persistent co-existence of an additional submicron mode of particles in the upper haze is difficult to explain if both modes are composed of sulfuric acid.

2. Plan of Attack

The parameter space of radiative effects of the aerosols tends to be large enough to be difficult to adequately sample by means of a purely radiative transfer analysis. Changes in the peak, width, and shape of the particle size distribution, as well as changes in the composition, and even possible phase changes all can contribute to changes in the radiative properties. Considering all of these parameters at sufficient resolution to confidently characterize the aerosol properties is almost prohibitive unless some limiting assumptions are made. By exploring the phase space of microphysical properties, we can potentially eliminate regions of the phase space of radiative effects.

In this work, we employ the Community Aerosol and Radiation Model for Atmospheres (CARMA), version 2.3 in order to simulate the microphysics of the Venusian aerosols. We investigate the effect of changes in the microphysical properties of the aerosols and changes in the photochemical production rates by comparing the mass loading and particle size distributions of the clouds in a suite of simulations. We then compute the upwelling top of atmosphere radiance that would result from the cloud profiles so generated, and compare these predicted radiance variations with those that have been observed with the IR2 camera on the Akatsuki spacecraft.

3. Preliminary Results

Initial results indicate that temperature dependent coalescence efficiency, such as might be expected from a transition to a glass like phase [5], can lead to rapid changes in the particle size distributions on the timescale of days to weeks. In Figure 1, we show the mass loading and effective radius plotted as a function of time over the four year duration for such a simulation. In this profile, simulating the aerosols between 75° and 90° latitude, we see 50% excursions in mass loading and factor of two changes in effective radius, both occurring on timescales of around 1-3 weeks.

4. Summary and Conclusions

Large changes in the aerosol size distribution are being observed in microphysical simulations of the Venus clouds. One driver of these changes appears to be coagulation efficiency. The observed changes will have significant effects in the emitted near infrared radiance. We will attempt to show whether these simulated variations are consistent with those observed in the Akatsuki IR2 data.

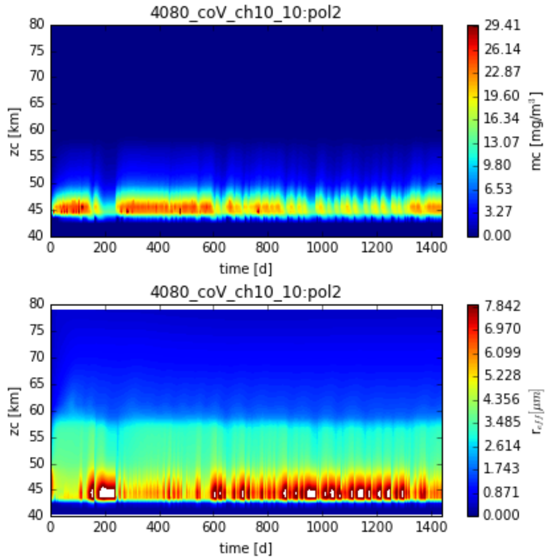

Figure 1: Mass loading (top) and effective radius (bottom) for a simulation in which coagulation efficiency is reduced when temperatures are lower than the nominal freezing point of sulphuric acid.

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References

[1] Grinspoon, D. H. et al.: Probing Venus's cloud structure with Galileo NIMS, Planetary and Space Science, Vol. 50(7), pp. 515-542, 1993.

[2] Hansen, J., E. and Hovenier, J. W.: Interpretation of the polarization of Venus, Journal of the Atmospheric Sciences, Vol. 31, pp. 1137-1160, 1974.

[3] Haus, R., Kappel, D., and Arnold, G.: Atmospheric thermal structure and cloud features in the southern hemisphere of Venus as retrieved from VIRTIS/VEX radiation measurements, Icarus, Vol. 232, pp. 232-248, 2014.

[4] Knollenberg R. and Hunten, D.: The microphysics of the clouds of Venus: Results of the Pioneer Venus Particle Size Spectrometer Experiment, Journal of Geophysical Research, Vol. 85(A13), pp. 8038-8058, 1980.

[5] McGouldrick, K., Toon, O. B., and Grinspoon, D. H.: Sulfuric acid aerosols in the atmospheres of the terrestrial planets, Planetary and Space Science, Vol. 59(10), pp. 934-941, 2011.

[6] Toon, O. B., et al.: Large, solid particles in the clouds of Venus: Do they exist?, Icarus, Vol. 57(2), pp. 143-160, 1984.