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Aerosol and Cloud in the Atmosphere of Jupiter

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Abstract

We present the latitudinal and vertical distributions of Jovian stratospheric aerosols and cloud top levels retrieved from Cassini ISS (Imaging Science Subsystem) images. A nonlinear optimization approach is used to simultaneously obtain the aerosol and cloud information from three channels together: the cloud channel at 938 nm, the strong methane absorption band at 890 nm, and the UV channel at 258 nm, based on previous work (Banfield et al., 1998) in the near IR band (H and K bands). Large difference between the scattering properties of aerosols and clouds in the equatorial region and polar region indicate different types of aerosol and clouds in the two regions.

1. Method and Results

The retrieval method is based on the Bayesian approach from Rodgers et al. (2000). A multiple scattering model is used to calculate the top-of-atmosphere reflection spectra for the three ISS channels. The latest methane k-distribution parameters from Karkoschka and Tomasko (2010) and H_2-H_2 continuum absorption coefficients from Borysow et al. (2002) are used. Two types of aerosol are distinguished. Haze at low and middle latitude is optically thin and can be treated as Mie particles. The high latitude aerosols with large optical depth are modeled as aggregated particles using the multi-sphere method (Mackowski and Mishchenko, 1996). The aerosol concentration profile is scaled from the previous work (Banfield et al., 1998). Figure 1 shows the fitting results in the equator region for multiple phase angles. Figure 2 shows the results for the south polar region (South 65º). The retrieved aerosol phase functions and cloud phase functions (assumed as Henyey-Greenstein phase function) for equatorial and polar regions are shown in Figure 3.

2. Figures

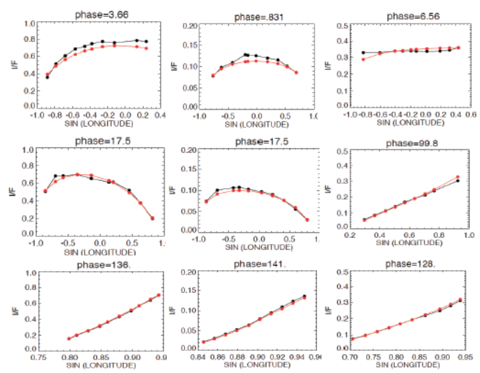

Figure 1: Fitting results (model: red; data: black) for the equatorial zone in multiple phase angles. The left, middle and right columns are for the CB3, MT3 and UV1 channels, respectively.

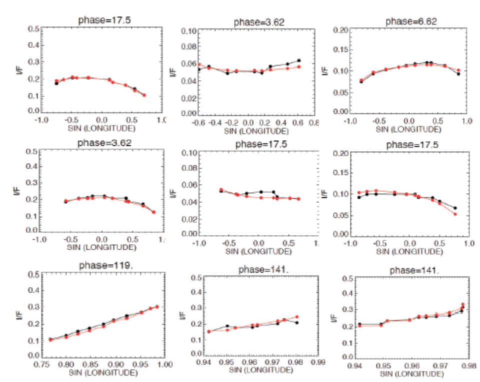

Figure 2: Same as Figure 1, for South 65º.

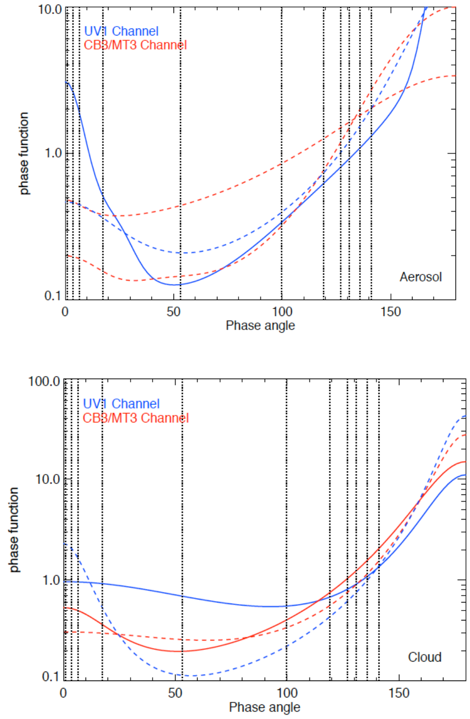

Figure 3: Comparison of the aerosol (top panel) and cloud (bottom) phase functions between the equatorial region (solid) and polar region (dashed). The vertical lines indicate the phase angles of the observations.

3. Conclusion

Jupiter aerosol distribution shows two components: a single sphere component with radius of 0.3-0.4 micron at low latitude and low altitude, and a fractal aggregated multisphere component with monomer radius of tens of nanometers at high latitude and high altitude. Asymmetry between south and north hemisphere exists. The difference of the aerosol properties between the equatorial and polar region may indicate different chemical production mechanisms (e.g., photolysis driven versus particle driven processes, Moses et al. 2005; Wong et al. 2000). The optically thick haze layer in the high latitude could have significant impact on the heating rates in the polar stratosphere of Jupiter.

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