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Scattering Properties of Jovian Cloud Particles from Cassini/ISS: Mie Scattering Phase Function and Particle Size

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The three distinct cloud layers were predicted by an equilibrium cloud condensation model (ECCM) of Jupiter. NH_3cloud, NH_4SH cloud, and H_2O cloud would be based at altitudes corresponding to pressures of about 0.7, 2.2 and 6 bars, respectively. However, there are significant gaps in our knowledge of the vertical cloud structure, despite the continuing effort by numerous ground-based, space-based, and in-situ observations and theory.
$CH_4$is considered that its altitude distribution is globally uniform because it does not condense in Jovian atmosphere. Therefore, it is possible to derive the vertical cloud structure and the optical properties of clouds (i.e., optical thickness and single scattering albedo) by observing reflected sunlight in CH_4absorption bands (727, 890 nm) and continuum in visible to near-infrared (NIR). Since we need to consider multiple scattering by clouds for deriving information on the vertical cloud structure and the optical properties of clouds, it is essential to understand the scattering properties (e.g., the scattering phase function) of clouds. Observations at wide solar phase angles are required to determine the scattering phase function of cloud particles. However, the limitation of solar phase angle as viewed from Earth (small range of 0 to about 12 degrees) prevents us from determining the scattering phase function of clouds. Therefore, most studies have used the scattering phase function inferred from the Pioneer 10/Imaging Photopolarimeter (IPP) data (blue: 440 nm, red: 640nm, and solar phase angles: 12-150 degrees) [Tomasko et al., 1978].
To derive the vertical cloud structure using CH_4absorption bands in NIR, we have used the scattering phase function in red light as a substitute for the scattering phase function in NIR, although cloud particles should have wavelength dependency. In addition, the red pass band was so broad (595-720 nm) that this scattering phase function in red light only showed wavelength-averaged scattering properties of clouds. Therefore, the Pioneer 10/IPP data was not adequate for considering wavelength dependency. The uncertainty of this scattering phase function is one of the biggest weaknesses which prevent from understanding of vertical cloud structure.
To provide a new reference scattering phase function with wavelength dependency, we have analyzed the Cassini/Imaging Science Subsystem (ISS) imaging data obtained at BL1 (451 nm), CB2 (750 nm), and CB3 (938 nm) over wide solar phase angles (3-137 degrees) during its Jupiter flyby in 2000-2001.
We adopted a simple cloud model which consists of haze layer, Rayleigh gas layer and a semi-infinite cloud layer from above. We performed radiative transfer calculation to fit theoretical limb-darkening curves to observed ones at 11 solar phase angles for each wavelength, and optimized free parameters (e.g., particle size) of the scattering phase function of clouds approximated by Mie scattering phase function.
In this presentation, we will show detail model description and these results. Finally we discuss scattering properties of cloud through comparison with results of Tomasko et al. [1978].

Keywords: Jupiter, atmosphere, radiative transfer, Cassini