Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG33-11 Room:202 Time:May 25 13:45-14:00

Scattering Properties of Jovian Aerosols from the Cassini ISS Limb-Darkening Observatioins

SATO, Takao M.[1*], SATOH, Takehiko[2], KASABA, Yasumasa[1]

[1]Department of Geophysics, Graduate School of Science, Tohoku University, [2]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency

This study provides new observational constraints on the scattering properties of aerosols in the Jovian upper troposphere and stratosphere. To achieve this objectives, we have analyzed imaging data during the Cassini flyby of Jupiter (October 2000-March 2001, solar phase angle coverage: 0-140 degrees) by utilizing its onboard Imaging Science Subsystem (ISS).

In this study, we present the analysis results of four sets of limb-darkening curves extracted along a bright zone (STrZ) and a dark belt (SEBn) from Jovian images in CB2 (750 nm) and BL1 (455 nm). To explain the solar phase angle behaviors of limb-darkening curves for each data set, we perform the radiative transfer calculations with a simple cloud model and the Mie theory applied to scattering of aerosols.

From these calculations, we find two important characteristics of cloud particles. One is the effective radius of cloud ($r_{eff,cloud}$). The best-fit $r_{eff,cloud}$ is obtained at 0.3 micron in CB2 and 0.2 micron in BL1. These values are in good agreement with those inferred from previous studies for the diffuse and ubiquitous layer of small particles in the upper troposphere as described in the synthesis works by West et al. (1986, 2004). The other is the real part of the refractive index of cloud ($n_{r,cloud}$). The best-fit $n_{r,cloud}$ for all data sets except for one data set ($n_{r,cloud}$ = 1.8) get a same value ($n_{r,cloud}$ = 1.85). Such values of $n_{r,cloud}$ are found to be much higher than previous experimental values of n_r for NH_3 ice particles (n_r ~ 1.4). Thus, we conclude that the best-fit combination of $n_{r,cloud}$ and $r_{eff,cloud}$ would strongly suggest the idea that the abundant small particle population in the upper troposphere is not composed of pure NH_3 ice. What actually eliminates the spectral signature of NH_3 ice around the 3-micron wavelength, despite the fact that significant depletion of NH_3 vapor has been observed for pressure levels of visible cloud layer, is unclear at this moment. The high real refractive index obtained in this study may hint at the composition of cloud particles for further studies.

As described above, the scattering properties of cloud particles for both the STrZ and the SEBn are found to show much the same characteristics, which suggests that the cloud particles themselves are less likely to be related to the visual difference between the zones and belts. We find that only the single scattering albedo of cloud shows a remarkable difference between two regions (this parameter gets a higher value for the STrZ than one for the SEBn), and is one key parameter which causes the visual difference. Our results support the idea proposed by West et al. (1986). Such difference in absorption would be likely to be due to chromophores (unknown coloring agents).

On the basis of these results, we compare our best-fit Mie phase functions for clouds obtained from all data sets with the phase functions derived by Tomasko et al. (1978) from the Pioneer 10 observations. The overall shapes of our Mie phase functions are found to be much flatter than those of their functions. Our Mie phase functions can reproduce the Pioneer 10 observations well. In contrast, Tomasko et al.'s function does not reproduce the Cassini observations. This is attributed to the fact that their phase function is under-constrained, primarily due to a considerable gap in observations for an intermediate solar phase angle (34-109 degrees).

A set of our new Mie phase functions has two advantages over Tomasko et al.'s functions:

1. since the Cassini data do not have a large gap in solar phase angle, the new Mie phase functions are better constrained;
2. the Mie phase function can easily be applied to different wavelengths.

With such characteristics, we now have a set of reliable baseline phase functions that can be used to interpret the ever-changing appearance of Jovian clouds as changes of the vertical cloud structure and/or distribution of chromophores in the atmosphere.

Keywords: Jupiter, atmosphere, aerosol, Cassini, radiative transfer