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Jupiter's cloud top altitude distributions estimated by spectral imaging in the 650-1000 nm range

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Jupiter is the fifth planet from the Sun and the largest planet in our solar system. Since Jupiter is a ball of dense gas and has no solid surface, it has many characteristic phenomena which are not observed on rocky inner terrestrial planets. A distinct feature of atmosphere is the boundary cloud pattern constructed by bright zones, dark belts, and polar regions. Another distinct feature is Great Red Spot (GRS). The physical processes of these phenomena remain matter for further investigation because the large optical depth of Jupiter's clouds prevent us from observing dynamics of the atmosphere under clouds directly. However, we can investigate dynamics of the atmosphere, if we get information on the altitude distribution of rugged cloud top. By taking Jupiter's images at a number of wavelengths and also by obtaining the spectra of atmosphere at methane absorption bands, we can reproduce the three-dimensional structures of cloud top and haze.

In this study, a new imaging system has been developed, which can take the cloud images of Jupiter with high wavelength resolution. The most important component of this system is a liquid crystal variable filter covering the wavelength range of 650 - 1100 nm with a bandwidth (FWHM) of 10 nm. A high speed cooled CCD camera (PixelVision, 652x494 pixels) has been attached to 60-cm telescope located at Iitate observatory, Fukushima, Japan. A number of images of Jupiter at 71 wavelengths were obtained in 10 minutes on April, 15 2005 and spectral maps were made over the whole disk of Jupiter. This is the first spectral imaging of Jupiter with such high wavelength resolution in visible and near-infrared wavelengths.

Assuming the n-layer model composed of a haze layer and n-th atmospheric layers, and ammonia cloud, we estimated cloud top altitudes which realize the measured spectra in two cases. In case 1, the optical depth of haze is fixed at 0.17 and only cloud altitude are estimated. In case 2, the optical depth and the cloud top altitude are estimated. In both cases, the vertical cloud structure which is consistent with previous studies was obtained. Although the largest difference in the cloud top altitude in EZ (Equatorial Zone) and SEB (South Equatorial Belt) is only 0.04 bar in case2, the model spectra show far better fitting to measured spectra in case 2. These results suggest that the optical depths of haze varied in each region and the difference of cloud top altitudes between EZ and SEB is not so large as suggested by previous studies.

The low latitude boundary of deep haze in NPR (North Polar Region) obtained in case 2 expands further equatorward than in SPR (South Polar Region). This shows a good agreement with the fact that the lowest boundary of the auroral main oval in northern hemisphere expands equatorward than that in the southern hemisphere. Furthermore, a comparison between the images at ammonia absorption bands and those at continuum wavelengths suggests extremely low ammonia column density in NEB.