Distributions of the Jovian cloud-top altitude observed by multi-wavelength imaging spectroscopy

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Jupiter is a ball of dense gas and has no solid surface. It has many characteristic phenomena which are not seen in the terrestrial planets. Since this planet is covered with very thick clouds, their large optical depth prevents us from the direct observation of atmospheric dynamics under the clouds.

We regard the altitude distribution of rugged cloud top as tracers of atmosphere under clouds. The vertical distribution of clouds can be estimated from the spectroscopic observations. However, conventional observation systems have both merits and demerits. Spectroscopic observations don't have high spatial resolution, in contrast, imaging ones don't have high spectral resolution. In this study, we can obtain the spectral imaging of Jupiter (field of view : $160*151$ [arcsec]) with high wavelength resolution (5nm) in visible and near-infrared wavelengths with a Liquid Crystal Tunable Filter (LCTF).

We observed Jovian images several times from 2005 through 2007 at the Iitate observatory in Fukushima prefecture, Japan. In this study, we mainly analyzed the data set taken on April 14, 2005. Fitting observed spectral curve into that of 'N-layer radiative transfer model' [Matsuura 2005], We can estimate cloud-top altitude distribution. In this model, the term representing Mie scattering by cloud particles is approximated by 'Minnaert's law'. Since single scattering albedo of cloud particles and the optical depth of haze are assumed not to depend on wavelength, we couldn't decide their absolute values. However we could estimate the absolute value of cloud-top altitude because it was not dependent on them. Fitting model reflectance spectra to observed one was tried in two ways to decide which was better. Firstly, we used only CH_4 strong absorption band for fitting. Secondly, 47 wavelength range (including strong and weak CH_4 absorption bands) were taken into account. As a result, we have found the former is better as long as we use N-layered model because the latter has contained CH_4 weak absorption bands which had information of the deeper area than strong absorption band. Note that we can resolve the detailed vertical cloud structure from our data sets observed with LCTF by using multi-cloud layer model because they have information of not only the higher area but also the deeper one.

In this study, we have found that cloud-top altitudes (EZ : 0.90, NEB : 0.98, SEB : 1.14 bar) were deeper than previous results [e.g., West and Tomasko. 1980; Satoh and Kawabata 1994] (=0.30-0.60 bar). On the other hands, some previous results (1-2 bar) support ours [Irwin et al., 2005]. We also have confirmed that the haze distributions is consistent with previous results.