Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PPS020-28 Room:103 Time:May 24 17:45-18:00

An attempt to estimate the stability of Jupiter's atmosphere based on the vertical structure of large-scale disturbances

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1. introduction

The vertical structure of Jupiter's atmosphere, namely the composition in far below the visible cloud, remains as an unresolved issue presently, because the only direct observation, which is done by the Galileo Probe in 1995, presumably did not succeeded in obtaining the global properties. Thermodynamics calculations (e.g., Weidenschilling and Lewis, 1973; Sugiyama et al. 2006) can estimate the atmospheric structure once a hypothetical composition in the deep levels is employed, but the results must be verified by observation.

Allison (1990) argued that the large-scale disturbances observed in the North Equatorial Belt may serve as a clue. Stratospheric temperature profiles obtained by the Voyager radio occultation suggest the existence of vertically propagating waves (Lindal et al. 1981). Assuming that the wave are equatorial Rossby waves, Allison(1990) compared the vertical wavelength of the observed waves and that of the vertical eigenmodes of a simplified atmosphere consisting of 4 layers, one of which is cloud layer, and estimated the thickness and stability of the cloud layer. In this study, we generalize the approach of Allison so that we can consider more complex atmospheric structure and try to estimate the deep atmospheric composition.

2. Method

We numerically solve the vertical structure equation as a forced problem and search the values of the equivalent depths at which the response in the stratosphere become resonantly large, and compare those values with the equivalent depth of the vertically propagating waves found by the radio occultation. We employ three types of the atmospheric structure, which are based on the Jupiter's atmospheric static stability profiles with solar, 5 times solar and 10 times solar abundance of condensible components obtained by Sugiyama et al.(2006). The forcing is a vertically localized layer of heating in the water cloud level.

3. Results

We found a set of discrete values of equivalent depths that are related to the resonant excitation with all of the three atmospheric profiles. The value of the equivalent depth of the first mode, which is the largest equivalent depth of resonance, is 0.4km, 1.9km, and 3.9km for solar, 5 times solar and 10 times solar abundance of condensible components, respectively. The waves found in Lindal et al (1981) has the equivalent depth of 2.2km (Allison,1990) and is explained best with 5 times solar abundance of condensible gasses.

Keywords: Jupiter's Atmosphere