From Modeling to Laboratory Measurements: Simulated Microwave Radiometer Sensitivity to Water Vapor Abundance and a New High Pressure System to Measure Water Vapor under Jovian Conditions

Bryan M. Karpowicz*[1] and Paul G. Steffes[2]

[1] School of Earth and Atmospheric Sciences, Georgia Institute of Technology

[2] School of Electrical and Computer Engineering, Georgia Institute of Technology

Understanding the atmospheres of the outer planets is particularly important since they illuminate the history of the evolution of the solar system. We use a hybrid ray-tracing radiative transfer model (Hoffman, Ph.D. Thesis, Georgia Institute of Technology, 2001) combined with a thermo-chemical model (DeBoer and Steffes, *Icarus* , 123:324-335, 1996) to produce a simulated brightness temperature spectrum for future orbiting spacecraft missions equipped with microwave radiometers, and Earth-based microwave radio telescopes. We test sensitivities to the assumed microwave absorption model, water vapor distribution, and deep water vapor abundance.

Accurate retrieval of water vapor abundances in the deep atmospheres of the Jovian planets requires reliable information regarding the microwave absorption coefficients of both water vapor and ammonia. While there are many microwave absorption models for water vapor which have been used for remote sensing of terrestrial water vapor, there are only a few models that have been developed for a hydrogen-helium atmosphere under Jovian conditions (DeBoer, Ph.D. Thesis, Georgia Institute of Technology, 1995 with corrections from DePater et al., *Icarus*, 173: 425-447 2005; Goodman Ph.D. Thesis, University of Illinois, 1969). While these models are based upon limited laboratory measurements, neither are based upon laboratory measurements conducted in a hydrogen-helium atmosphere. We are currently developing a new system for laboratory measurement of water vapor (and ammonia) under Jovian conditions for pressures up to 100 bars, temperatures up to 550°K, and wavelengths from 6–20 cm. Using this system we will extend the work of Hanley and Steffes (see accompanying paper) so as to develop a reliable water vapor absorption model for a hydrogren-helium atmosphere over a wide range of temperature and pressure. The goal of this work is to more accurately model the sensitivities of microwave systems to detect water vapor in the outer planets.