Ammonia-Water Low Temperature Vapor-Liquid Equilibrium: Applications to the Atmospheres of Outer Planets

Dr. Nimmi C. Parikh
Richard Stockton College of New Jersey

Dr. John Zollweg
Cornell University

Knowledge of atmospheres of other planets is important not only for its intrinsic value but also for the insights which this knowledge can provide to us about the atmosphere of our own planet, the origins of our solar system, and perhaps even the origins of life on earth. Accurate interpretation of remote sensing data and high quality atmospheric models require thermodynamic data on the condensible trace constituents which are expected to form clouds in these planetary atmospheres. Specifically, for studies of Jupiter's atmosphere, a good thermodynamic model of Vapor-Liquid Equilibrium (VLE) in the ammonia-water system under conditions relevant to Jupiter (below 20C) is of vital importance for understanding the composition of condensing ammonia-water clouds, constraining ammonia gas phase abundances, and reducing extrapolation uncertainties in atmospheric models. While there is substantial VLE data on the ammonia-water system at high temperatures, low temperature VLE data in general use are old, sparse, and inconsistent between different investigators. We have obtained experimental data on temperature, pressure, and liquid composition of ammonia-water mixtures from 20C to 0C. We have combined these data with select, carefully evaluated, literature data to create an updated maximum-likelihood model of the ammonia-water system which takes into account experimental uncertainties in all measured data. From the temperature-dependent model parameters we have calculated new cloud profiles (mole fraction of ammonia in condensing droplet versus altitude) for potential condensing ammonia-water clouds on Jupiter.

References:

Nimmi C. Parikh. Vapor-Liquid Equilibrium in the Systems Argon-Oxygen and Ammonia-Water: Measurements and Modeling for Industrial and Planetary Applications. Ph.D. Dissertation, Cornell University, 1997.

S. Skjold-Jorgensen. On Statistical Principles in Reduction of Thermodynamic Data. Fluid Phase Equilibria, 14, p. 273, 1983

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