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The relative abundance of vapor and condensed solids in protoplanetary disks

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Gas and ice are very unevenly distributed in a protoplanetary disk due to the wide range of prevalent temperatures and number densities. This diverse thermodynamic environment is caused by the Keplerian-rotation-induced viscous heating and by radiation from the central and nearby stars. A new condensation model is developed to account for the relative proportion of gas and ice at each point in the nebula. The method is based on computing the chemical evolution of selected abundant species until partial pressures are sufficiently high to desublimate the gaseous species into ice. The point at which this occurs relative to its steady state values determines final gas/ice ratios. It is found that the largest gradients occur near the spatial sublimation boundaries ("the snow line") and, depending on the volatility of the species. Significant differences occur in the inner high density planet forming regions and the lower density photospheric regions. Radial distributions of gas and ice highlight the large extent of water ice in the nebula and its vertical distribution. It is found that although ice dominates the mid and far nebula, water vapor is predominant in the centerplane region of the near nebula and above the disk photosphere. An interesting near nebula effect is the appearance of a cloud of water ice at the temperature inversion elevation surrounded by vapor above and below. We also consider the relative abundances of CO vapor and ice, a species amenable to observations in protoplanetary disks. Ref: Davis, S. 2007, ApJ, **660**, 1580. This work is partially supported by the NASA Astrobiology Institute.