Solubility of Methanol in Low-Temperature Aqueous Sulfuric Acid and Implications for Atmospheric Particle Composition

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Abstract

Using traditional Knudsen cell techniques, we find well-behaved Henry's law uptake of methanol in aqueous 45 - 70 wt% H_2SO_4 solutions at temperatures between 197 and 231 K. Solubility of methanol increases with decreasing temperature and increasing acidity, with an effective Henry's law coefficient ranging from 10^5 - 10^8 M atm^{-1}. Equilibrium uptake of methanol into sulfuric acid aerosol particles in the upper troposphere and lower stratosphere will not appreciably alter gas-phase concentrations of methanol. The observed room temperature reaction between methanol and sulfuric acid is too slow to provide a sink for gaseous methanol at the temperatures of the upper troposphere and lower stratosphere. It is also too slow to produce sufficient quantities of soluble reaction products to explain the large amount of unidentified organic material seen in particles of the upper troposphere.