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Elucidating how trace gases interact with ice surfaces

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The interaction between ice surfaces and trace gases plays a significant role in atmospheric chemistry, such as chemical and photochemical reactions contributing to ozone depletion and secondary aerosol formation. The molecular-level properties of the ice surface and small organic molecule adsorption are essential to understand the impact of hosting these molecules and further chemical reactions. In particular, acetone is a typical small-oxygenated organic molecule found in the troposphere, and a critical contributor to the formation of HO_x radicals. To capture a molecular understanding of the interface, a surface selective technique, such as sum frequency generation (SFG) spectroscopy, is crucial to probe ice surfaces and observe the adsorption of acetone on ice surfaces. We observe significant differences in the structure and reorientation of the water molecules for ice and water surfaces upon the addition of acetone. The distinct behavior of water molecules and acetone is linked to differences in reactivity and rates of photochemical reactions via overtone pumping on ice and water surfaces.