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The Role of Clouds in Climate Change

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The role of greenhouse gases, predominantly CO_2, on climate has been understood since the work of Arrhenius in the late 1800's. The role of clouds on the Earth's radiative balance is far more uncertainty. It is known that small atmospheric particles act as the seeds on which water droplets and ice crystals form but projecting laboratory and field measurements of particles and clouds to climate projections remains the most uncertain aspect of climate change. Laboratory and field studies show that cloud formation occurs when the ambient water vapor exceeds the equilibrium saturation value. When the ambient temperature is above 0°C and the relative humidity above 100%, liquid water condenses on aerosol particles, known as cloud condensation nuclei. The spontaneous formation of ice within aqueous droplets of the size commonly found in the atmosphere does not occur until a level of supercooling exceeding -38°C, and a saturation near that of liquid water, is reached. Consequently, ice nucleation from 0 to -38°C requires the presence of a special particle, known as an ice nucleus. This talk will describe the current state of knowledge of cloud formation and what aspects remain uncertain. Information gained from laboratory and field studies will be compared to our understanding of Earth's current state and how climate is projected to change in the future.