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Lidar Atmospheric Measurements on Mars and Earth

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The LIDAR instrument operating from the surface of Mars on the Phoenix Mission measured vertical profiles of atmospheric dust and water ice clouds. The dust loading was distributed evenly through the planetary boundary layer (PBL) to heights of about 4 km and decreased at greater heights. Nighttime clouds were observed within the PBL after the air temperature started to drop in mid-summer. Two cloud layers were detected: one at the top of the PBL and the other near the surface. The cloud thickness and extent increased toward late summer.
An equivalent lidar system was also utilized for measurements in the atmosphere of earth where the conditions are similar to Mars. Coordinated aircraft in situ sampling provided a verification of the lidar measurement and analysis methods and also insight for interpretation of observations on Mars in terms of the dust and cloud microphysical properties. It was found that the vertical distribution of airborne dust above the Australian Desert is quite similar to what is observed in the PBL above Mars. Comparison with the in situ sampling is used to demonstrate how the lidar derived optical extinction coefficient is related to the dust particle size distribution. Airborne lidar measurements were also conducted to study cirrus clouds that form in the Earths atmosphere at a similar temperature and humidity as the clouds observed with the lidar on Mars. Comparison with the in situ sampling provides a method to derive the cloud ice water content (IWC) and this was applied to the Mars lidar measurements.