**Experimental Studies of the Exchange of Water Between the Atmosphere and Surface of Mars**

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**Lidar Remote Sensing (LIDAR) Measurements of Clouds and Precipitation from the Surface of Mars**

The LIDAR instrument on the Phoenix mission observed water ice clouds in the atmosphere of Mars that were similar to cirrus clouds on Earth. Fall streaks in the cloud structure traced precipitation on ice crystals toward the ground. Measurements of atmospheric and surface temperatures indicated that the planetary boundary layer (PBL) was well mixed up to 5 km in height, and convective clouds were observed on the surface and in the PBL. The PBL was observed both during the day and at night, with ice crystals in the PBL observed at night.

**LIDAR Measurements of Clouds and Precipitation**

The outline and internal structure of the cloud that had formed above the surface of Mars was imaged by the LIDAR instrument. The LIDAR pattern was consistent with ice crystals precipitating from the cloud, and eventually sublimating in the dry atmosphere. Fall streaks are a well-known feature of cloud observation on Earth, and such streaks were observed in the Phoenix mission. The LIDAR measurements show that ice crystals were generated by the LIDAR instrument, and that precipitation occurred during the mission.

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**Laboratory Investigation of Perchlorate and Water at the Surface of Mars with Laser Raman Scattering**

A major discovery during the NASA Phoenix Mars mission was the identification of perchlorate (ClO₄⁻) in the surface regolith by the Wet Chemistry Laboratory instrument (Hecht et al., 2009). More recently, the Sample Analysis at Mars instrument on the Phoenix mission observed perchlorate and other brine-like substances in the surface regolith (Smith et al., 2009). The liquid Brines remained as liquid until the eutectic temperature was reached and then freezing occurred. The resulting liquid Brine was observed at the surface, and the PBL was observed during the day and at night, with ice crystals in the PBL observed at night.

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**Conclusions**

- A major discovery during the NASA Phoenix Mars mission was the identification of perchlorate (ClO₄⁻) in the surface regolith by the Wet Chemistry Laboratory instrument (Hecht et al., 2009).
- More recently, the Sample Analysis at Mars instrument on the Phoenix mission observed perchlorate and other brine-like substances in the surface regolith (Smith et al., 2009).
- The liquid Brines remained as liquid until the eutectic temperature was reached and then freezing occurred. The resulting liquid Brine was observed at the surface, and the PBL was observed during the day and at night, with ice crystals in the PBL observed at night.

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**References**

- Whiteway et al., Science, 305, 2004
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