A Case Study of the Mechanisms Modulating the Evolution of Valley Fog

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Abstract—We present a valley fog case study in which radiation fog is modulated by topographic effects using data obtained from a field campaign conducted in Heber Valley, Utah from 7 January – 1 February 2015, as part of the Mountain Terrain Atmospheric Modeling and Observations (MATERHORN) program. We use data collected on 9 January 2015 to evaluate relationships between radiation fog, turbulence, and gravity waves associated with the surrounding topography. A very shallow (≈10 - 30 m) fog layer formed by radiative cooling was observed from 0720 to 0900 MST, which was likely triggered by local mountain circulations. Before the fog event, air temperatures were around -9 °C, relative humidity with respect to water and ice were ≈ 95% and 105% respectively, and the wind speeds were extremely low (mostly < 0.5 m s^{-1}). Observed particle concentrations indicate that fog particles (1.0 – 10.0 μm) were formed through the vapor condensation upon the cloud condensation nuclei (0.3 – 1.0 μm). The fog appears to be triggered by cold-air advection from the south (≈200 °). Quasi-periodic oscillations were observed before and during the fog event with a time period of about 14 minutes. These oscillations were detected in surface pressure, temperature, sensible heat flux, incoming longwave radiation, and turbulent kinetic energy. We hypothesize that the quasi-periodic oscillations were caused by atmospheric gravity waves with a time period of about 14 minutes based on wavelet analysis. Results suggested that atmospheric flow dynamics over mountainous terrain significantly affect fog formation, development, and dissipation.