WAVE◦TURBULENCE
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High-Resolution Modeling of Internal Gravity Waves over the Complex Terrain of Central Pennsylvania on 14 April 2011

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The development and evolution of internal gravity waves and their interactions with surface cold pools are examined through a combined observation and high-resolution modeling study located over the valleys and ridges of central Pennsylvania. Terrain-induced internal gravity waves, often observed over complex topography under clear skies and weakly-forced nocturnal conditions, can contribute to the evolution or even the destruction of valley cold pools. Intermittent bursts of turbulence within the stable boundary layer (SBL) can occur through the modification of momentum and thermal fluxes as well as nonlinear phenomena. These complex interactions contribute to highly variable sub-mesoscale wind and temperature fluctuations (scales < 2000 m) in the SBL.

High-resolution (0.444-km horizontal grid spacing, 10 vertical layers in lowest 50 m AGL) Weather Research and Forecasting model (WRF) forecasts are compared to tower and sodar observations from a special data network located at Rock Springs, PA. Daily model forecasts and observations were used to identify cases where calm, clear nights presented wave-like structures. A non-stationary, internal-gravity wave case was observed on 14 April 2011. WRF forecasts suggest that changes in the wind shear and stability profile throughout the night resulted in a characteristic wavelength shortening that impacted the underlying cold pool. The sensitivity of these wave/cold pool interactions to initial conditions / data assimilation and model physics is assessed through a series of nested-grid WRF experiments. The Rock Springs observational data are used to evaluate the accuracy of the forecasts and our understanding of the physical processes.

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