Merging a high-resolution meteorological distribution model (MicroMet) with a detailed snow-evolution model (SnowModel)

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A snow evolution modeling system (SnowModel; Liston and Elder 2006a) was used to simulate seasonal snow evolution across three, 30-km by 30-km, simulation domains that included the Cold Land Processes Field Experiment (CLPX) meso-cell study areas (MSAs) in Colorado, U.S.A. These three MSAs have distinctly different topography, vegetation, meteorological, and snow-related characteristics. The simulations were performed using a 30-m grid increment and a 3-hour time step, and spanned the period 1 October 2002 through 1 April 2003, generally the snow accumulation season for this region. Meteorological forcing was provided by 27 meteorological stations and 75 atmospheric analysis grid points that were distributed across the model simulation domains using a micrometeorological distribution model (MicroMet; Liston and Elder 2006b). The simulations included a data assimilation sub-model (DataAssim; Liston and Hiemstra 2006) that forced the simulated snow water equivalent (SWE) distributions towards a collection of ground-based and airborne SWE observations. The observations consisted of area-averaged SWE over three, 1-km by 1-km intensive study areas (ISAs) for each MSA, and a collection of NOAA airborne observations that each integrated an area covering a length of approximately 10 km and a width of 300 m.

The simulated SWE distributions displayed considerably more spatial variability than that available from the observations alone. This is the result of SnowModel’s relatively fine-scale representations of orographic precipitation, low-elevation melt, wind redistribution (snow drifts above treeline), and snow-vegetation interactions. Intuitively, the general distribution patterns simulated by the model were considerably more realistic than those defined solely by the observations. The combined modeling and data assimilation system produced high-resolution SWE distributions that closely fit both our understanding of snow evolution processes and the magnitude of the snow observations.