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Towards a Better Understanding of Water Stores and Fluxes: Model Observation Synthesis in a Snowmelt Dominated Research Watershed

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The hydrology of high-elevation, mountainous regions is poorly represented in Earth Systems Models (ESMs). In addition to regulating downstream water delivery, these ecosystems play an important role in the storage and land-atmosphere exchange of carbon and water. Water balances are sensitive to the amount of water stored in the snowpack (SWE) and the amount of water leaving the system in the form of evapotranspiration—two pieces of the hydrologic cycle that are difficult to observe and model in heterogeneous mountainous regions due to spatially variant weather patterns. In an effort to resolve this hydrologic gap in ESMs, this study seeks to better understand the interactions between groundwater, carbon flux, and the lower atmosphere in these high-altitude environments through integration of field observations and model simulations. We compare model simulations to field observations to elucidate process performance combined with a sensitivity analysis to better understand parameter uncertainty. Observations from a meteorological station in the East River Basin are used to force the integrated hydrologic model, ParFlow-CLM. This met station is co-located with an eddy covariance tower, which, along with snow surveys, is used to better constrain the water, carbon, and energy fluxes in the coupled land-atmosphere model to increase our understanding of high-altitude headwaters systems. Preliminary results suggest the model compares well to the eddy covariance tower and field observations, shown through both correct magnitude and timing of peak SWE along with similar magnitudes and diurnal patterns of heat and water fluxes. Initial sensitivity analysis results show that an increase in temperature leads to a decrease in peak SWE as well as an increase in latent heat revealing a sensitivity of the model to air temperature. Further sensitivity analysis will help us understand uncertainty of snow-related and forcing parameters. Through obtaining more accurate and higher resolution meteorological data and applying it to a coupled hydrologic model, this study can lead to better representation of mountainous environments in all ESMs.