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Combining Patch-Scale Modeled Output with Spatial Statistics to Estimate Evapotranspiration Across the Landscape

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Difficulty in closing the water balance of a watershed, specifically in mountainous regions, has been sustained for decades despite its importance for downstream water security and environmental maintenance. At the watershed scale, evapotranspiration, ET, can be generalized as $ET = P - Q$, where Q is runoff, and P is precipitation. ET is often considered the most uncertain parameter to quantify, as it is difficult to measure directly, and is generally approximated as a function of potential evapotranspiration. Eddy covariance flux towers provide physical measurements of evapotranspiration, but these towers are relatively new, providing a limited time series, have high installation and maintenance costs, and are few and far between. Physically based models have the capacity to quantify each component of the water balance equation individually with a high spatiotemporal resolution. However, simulations are computationally and time-intensive, and their accuracy strongly depends on model parameterization, which requires accurate spatiotemporal information of the modeled area, calibration and validation. This study will combine patch-scale modeled estimates of ET from the Community Land Model (CLM) with spatial statistics to improve the accuracy and efficiency of ET estimation across the East River watershed, Colorado. More specifically, the CLM model is being used at strategically selected meteorological stations within the watershed to simulate patch-scale ET, which will then be spatially distributed using a suite of readily available spatial data, including, but not limited to, Landsat Normalized Difference Vegetation Index (NDVI), Parameter-elevation Regression on Independent Slopes Model (PRISM) precipitation and temperature, and the National Land Cover Database (NLCD) land-cover product. The results will be initially validated by estimating watershed ET using PRISM precipitation and measured streamflow at a USGS gauge, located at the pour point of the watershed, and then with flux- tower measured ET once available. The questions driving this research include: i) What is the optimal size and number of patches to be modeled to receive good agreement with annual watershed-scale modeled ET?; and ii) How do the statistically based approach and the watershed-scale model compare with ET estimated as the difference of PRISM precipitation and measured streamflow? The proposed approach will provide spatial estimates of ET, improving our ability to more accurately close the water balance, as well as lead to a better understanding of how ET varies with climate extremes, by vegetation type, along an elevational transect, and provide insight for the implications of climate change.