Evaluating Methods to Downscale Multiple Coarse-Resolution Grid Cells of Soil Moisture

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Abstract. Many applications require maps of soil moisture that have fine resolutions (10-30 m) and span large spatial extents (100-300 km). Coarse-resolution soil moisture (1-25 km) can be obtained over large extents from remote-sensing methods and land-surface models, but such estimates must be downscaled to reach the required resolutions. The *Equilibrium Moisture from Topography, Vegetation, and Soil* (EMT+VS) model is a tool to downscale coarse-resolution soil moisture using fine resolution topographic, vegetation, and soil data. However, all previous testing of the EMT+VS model has considered small catchments that would fit within a single coarse-resolution soil moisture grid cell. The objective of this research is to generalize the EMT+VS model to accept multiple grid cells of coarse-resolution soil moisture, which would allow the method to be applied to much larger spatial extents. Two approaches are implemented and compared. The first one (the block method) is a direct extension of the original EMT+VS model and downscales each coarse grid cell independently. The second approach (the windowing method) replaces the coarse grid cell values in the EMT+VS model with values that are calculated from windows that are centered on each fine-resolution grid cell. The window's values are based on weighted averages of the coarse grid values that occur within the window. Three weighting methods are considered: box, disk, and Gaussian. To compare the different methods, they are applied to the Cache la Poudre (8 ha) and Tarrawarra (10 ha) catchments which have detailed soil moisture observations available. The results show that the block method typically provides the most accurate estimates of soil moisture, but it produces abrupt changes in the soil moisture at the coarse grid boundaries, which might be problematic for some applications. The three windowing methods are similar in performance relative to each other, and on average produce lower values of the Nash-Sutcliffe Coefficient of Efficiency (NSCE), 0.01 to 0.05 lower, than the block method. With little cost to performance, the windowing method resolves the abrupt changes at the coarse grid boundaries, making it better suited for many applications.