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Generation of soil moisture patterns at the catchment scale by EOF interpolation

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Abstract. Spatial patterns of soil moisture cannot be adequately characterized by direct measurement for most practical applications, so interpolation between observations is required. Interpolation of soil moisture is complicated because multiple hydrologic processes can affect soil moisture and these processes can introduce distinct modes of variation into the soil moisture patterns. In this paper, a new method to interpolate soil moisture data is presented. This method accepts a dataset of soil moisture at widely-spaced locations on multiple dates and produces fine-scale patterns of soil moisture on the same dates. The method first uses Empirical Orthogonal Function (EOF) analysis to decompose the dataset into a set of time-invariant patterns of covariation (EOFs) and a set of associated time series (called expansion coefficients or ECs) that indicate the importance of the patterns on each date. The method then uses a statistical test to retain only the most important EOFs, and these EOFs are interpolated to the desired resolution using a standard estimation or interpolation method. The interpolated EOFs are finally combined with the spatial averages and the ECs to construct the fine-scale soil moisture patterns. Using the Tarrawarra dataset, the EOF-based interpolation method is shown to outperform analogous direct interpolation methods, and this improved performance is observed when as few as two observation dates are available. The improved performance occurs because EOF analysis decomposes soil moisture roughly according to the controlling processes and the most important EOFs exhibit distinct but more consistent spatial structures than soil moisture itself. Less predictable variation is also separated into higher order EOFs, which are discarded by the method.

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