

Improving the disaggregation of daily rainfall into hourly rainfall using hourly soil moisture

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Abstract For various applications in hydrology, rainfall in short time steps (hourly) is needed. As direct measurements of sub-hourly rainfall are hardly possible in practice (especially in developing and under-developed countries), a potential alternative may be to try to derive such data from the available daily data through a disaggregation procedure. Random multiplicative cascade (RMC) models appear as an appealing solution to disaggregate the daily rainfall into sub-hourly rainfall. The RMC model provides a number of ensembles of hourly rainfall; taking the ensemble average one can get the hourly rainfall. This model is reasonably good in providing the magnitude of hourly rainfall, but fails to give the exact time of occurrence of hourly rainfall. Improvements can be made in the time of occurrence of hourly rainfall with the help of variables, which are sensitive to hourly rainfall. Soil moisture is one such a variable, which is directly sensitive to hourly rainfall. This paper deals with the potential of using hourly soil moisture in the improvement of hourly rainfall. Using this RMC model, ensembles of time series of hourly rainfall are generated. Among these ensembles of hourly rainfall, best ensembles are identified using generalized likelihood uncertainty estimate (GLUE) approach combined with the soil moisture model. The RMC model is applied and the performance is tested on several station data in the semi-arid and humid regions of South India. The model is able to capture the magnitude of hourly rainfall. Further, the RMC model is combined with a soil moisture data at a station in a semi-arid zone having hourly soil moisture profile data over a monsoon season. A soil moisture model was developed based on the Richards equation, and parameters of the model were calculated through laboratory experiments. The hourly rainfall is modelled through the calibration of soil moisture data at this station. It is shown that using the hourly measured soil moisture, improved estimates of hourly rainfall is feasible.

Key words rainfall disaggregation; soil moisture; multiplicative random cascade; GLUE