Geophysical Research Abstracts,
Vol. 11, EGU2009-887, 2009
EGU General Assembly 2009

Downscaled TRMM Rainfall Time-Series for Catchment Hydrology Applications

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Hydrology in semi-arid regions is controlled, to a large extent, by the spatial and temporal distribution of rainfall defined in terms of rainfall depth and intensity. Thus, appropriate representation of the space-time variability of rainfall is essential for catchment-scale hydrological models applied in semi-arid regions. While spaceborne platforms equipped with remote sensing instruments provide information on a range of variables for hydrological modelling, including rainfall, the necessary spatial and temporal detail is rarely obtained from a single dataset.

This paper presents a new dynamic model of dryland hydrology, DryMOD, which makes best use of free, public-domain remote sensing data for representation of key variables with a particular focus on (a) simulation of spatial rainfall fields and (b) the hydrological response to rainfall, particularly in terms of rainfall-runoff partitioning. In DryMOD, rainfall is simulated using a novel approach combining 1-km spatial detail from a climatology derived from the TRMM 2B31 dataset (mean monthly rainfall) and 3-hourly temporal detail from time-series derived from the 0.25-degree gridded TRMM 3B42 dataset (rainfall intensity). This allows for rainfall simulation at the hourly time step, as well as accumulation of infiltration, recharge, and runoff at the monthly time step. In combination with temperature, topography, and soil data, rainfall-runoff and soil moisture dynamics are simulated over large dryland regions. In order to investigate the hydrological response to rainfall and variable catchment characteristics, the model is applied to two very different catchments in the drylands of North and West Africa.

The results of the study demonstrate the use of remote sensing-based estimates of precipitation intensity and volume for the simulation of critical hydrological parameters. The model allows for better spatial planning of water harvesting activities, as well as for optimisation of agricultural activities relative to realistic moisture fields. Future work will aim to understand how medium-term climate variability affects such activities.