Geophysical Research Abstracts
Vol. 18, EGU2016-6555, 2016
EGU General Assembly 2016

Rainfall-gauge density and performance of a process-oriented model in a semi-arid basin

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It is relevant for hydrologists to choose modelling strategies that extract as much information as possible from the available hydro-climatological parameters and data, especially precipitation. This is particularly relevant in semi-arid environments, where data are scarce. Such strategies have been assessed using the WASA-SED model (Water Availability in Semi-Arid Environments with Sediment Routines). It is a semi-distributed process-oriented hydro-sedimentological model, which simulates runoff and water availability in large dryland catchments in daily steps. The study area was the semiarid Upper Jaguaribe Basin (24,600 km^2), North-eastern Brazil, where precipitation is mainly generated by the Inter-Tropical Convergence Zone. We investigated three modelling strategies, in an attempt to enhance the model performance without the need of additional field data or calibration effort: (1) search for an optimal relation between rainfall-gauge density and model performance; (2) selection of the rainfall gauges, depending on their data completeness; and (3) division of each sub-catchment into several modelling units with neither parameter nor input-data addition. The results showed no direct correlation between rainfall-gauge density and model goodness. In fact, modelling units with many gauges tended to perform poorly in regular and dry years. The reason is that, in these years, the average hyetograph is flattened, lying often below the initial abstractions and leading to artificially low simulated runoff. The strategy of selecting rainfall gauges according to their completeness, despite valid, has proven to be very limited in improving model performance; whereas the division of the sub-catchments into several modelling units has proven to be very effective. For the present study, the optimal model performance has been obtained for a density of 4 rainfall gauges per modelling unit.