Geophysical Research Abstracts,
Vol. 11, EGU2009-9099, 2009
EGU General Assembly 2009

Satellite precipitation error propagation in the prediction of large-scale floods and soil moisture

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The study presents an evaluation of satellite-based precipitation estimates at high spatio-temporal resolution and precipitation error propagation in the simulation of hydrological processes over large continental areas. The La Plata basin in South America and the Mesonet network in the state of Oklahoma are the study regions selected for evaluating the satellite-rainfall uses in the prediction of daily-average streamflows and 3-hourly soil moisture fields, respectively. Two hydrological models are used to represent the prediction systems in this study: (1) the Variable Capacity Infiltration semidistributed model (VIC) applied in the La Plata basin for the prediction of basin processes at daily time scale; and (2) the Community Land Model (V3.5; CLM-V3.5) applied in the Oklahoma region for the simulation of one-dimensional land-atmosphere interaction processes at 3-hourly time step. Initially, both models were forced with 'reference' rainfall derived from in situ gauge measurements and evaluated against independent hydrological observations: namely, daily-average streamflow measurements for evaluation of the VIC application in the La Plata basin, and spatially interpolated soil moisture fields derived from the Mesonet stations in the Oklahoma region for the evaluation of the CLM-3.5 simulations. The models were subsequently forced by precipitation fields derived from the various remote sensing techniques. For the La Plata basin those include: the NASA Version 6 TRMM multi-satellite Precipitation Analysis (TMPA-V.6), and an ensemble-based error model correction of the technique. For the Oklahoma region the precipitation estimates are from: TMPA-V.6, the NOAA Climate Prediction Center's microwave satellite morphing technique, and the WSR-88D radar network. The study presents error analysis of the different satellite precipitation estimates for both regions and contrasts satellite techniques against the performance of radar rainfall estimates for the soil moisture prediction. The error propagation in the streamflow and soil moisture parameters is presented and evaluated for different scales, spatio-temporal resolutions, and remote sensing products. The relative contribution of modeling to precipitation input uncertainty in the overall hydrologic prediction error is discussed based on the findings of this data-based numerical experiment.