GLOWA Volta

Water balance in a poorly gauged basin in West Africa using atmospheric modelling and remote sensing information

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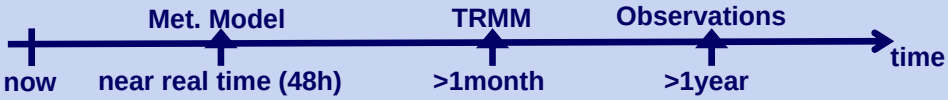
INTRODUCTION

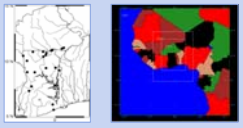
- Sustainable decisions in water resources management require scientifically sound information on water availability
- Central support in hydrological decision making arises from hydrological modelling which depends on meteorological input
- In poorly gauged basins (1) only little hydro-meteorological information is available and (2) station data are often only available with a considerable temporal delay and therefore unsuitable for near real time water management
- Hence, other near real time available meteorological data sources have to be used, which are in this study:



- Besides meteorological driving data, land surface properties are essential input data for distributed hydrological modelling
- Usually literature values of land surface properties are incorporated through tables depending on the land use
- Satellite derived land surface properties: increased level of detail in the spatial and temporal dimension
- MODIS products for albedo (Δt=16day, Δx=1km) and leaf area index LAI (Δt=8day, Δx=1km) are imported

Hydrological modelling using atmospheric modelling and remote sensing information

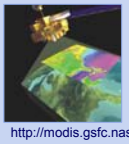
meteorological input
1. observation data
2. meteorological model: MM5
3. satellite data: TRMM 3B42



http://trmm.gsfc.nasa.gov/

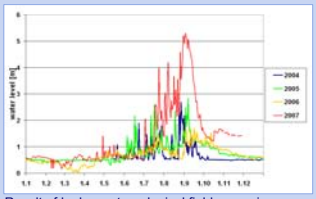
hydrological model: WaSiM
Δx = 1 km, Δt = 24 h

- digital elevation model
- real time discharge values @ unknown inflows
- soil & land use grid
- soil & land surface properties
- …



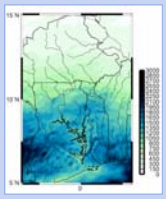
http://modis.gsfc.nasa.gov/

Information about spatial and temporal changes of water balance variables

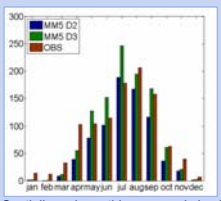


Result of hydro-meteorological field campaign: measured water level [m] at Yarugu from 2004 - 2007

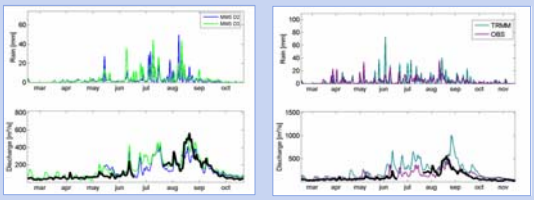
Results of the joint atmospheric-hydrological simulations



Simulated annual precipitation for 2004 [mm] for the Volta basin using MM5, 9x9km²



Spatially and monthly averaged simulated (MM5 D2 (27x27km²) and D3 (9x9km²)) vs. observed precipitation for 2004



Precipitation and routed vs. measured (black) discharge at Pwalugu using the gridded, near real time MM5 results D2 (27x27km²) and D3 (9x9km²) - left figure, and the scaled TRMM product 3B42 and observations –right figure, as meteorological data sources (2004)

- MM5 is able to provide the required meteorological input data for near real time hydrological simulations
- comparable/better performance to TRMM & OBS
- WaSiM provides moreover distributed information of actual evapotranspiration, groundwater recharge, soil moisture, total runoff, …
- support short-term sustainable decisions in water resources management

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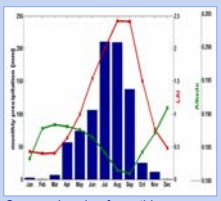
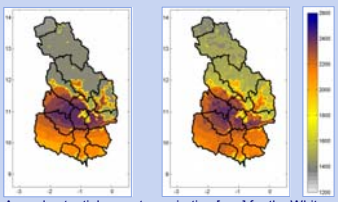
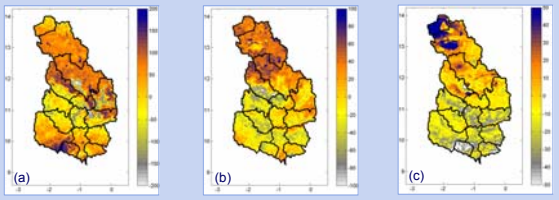
Assimilation of MODIS albedo and LAI



Seasonal cycle of monthly mean precipitation, LAI and albedo averaged over the White Volta basin (2004)



Annual potential evapotranspiration [mm] for the White Volta basin using static tabulated values (left) and dynamic MODIS estimates (right) for albedo and LAI (2004)



Differences [mm] of annual sums with MODIS albedo & LAI with respect to static tabulated for potential evapotranspiration (a), actual evapotranspiration (b), total runoff (c) for 2004

- MODIS albedo & LAI:
  - increased level of detail in spatial dimension & better representation of temporal development
  - all data are based on same data source & time
- hydrological simulation results: impact minor on time series, but clear on spatial distribution

References: Wagner, S., Kunstmann, H. Bárdossy, A., Conrad, C., Colditz, R., Water balance estimation of a poorly gauged catchment in West Africa using dynamical downscaling of meteorological fields and remote sensing information J. Phys.Chem. Earth (2008), doi:10.1016/j.pce.2008.04.002
Wagner, S., Kunstmann, H., & Bárdossy, A. 2006. Model based distributed water balance monitoring of the White Volta catchment in West Africa through coupled meteorological-hydrological simulations. Advances in Geosciences, 9, 39–44
Wagner, S. Water Balance in a Poorly Gauged Basin in West Africa Using Atmospheric Modelling and Remote Sensing Information, Dissertation