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Instruments for Hydrometeorological Decision Support in Sustainable Water Management

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Problem

- Sustainable water use under changing climate conditions and increasing water demands has to be addressed by international cooperations for sustainable development, especially in climate sensitive regions.
- Sustainable decisions in water resources management require scientifically sound information of the
  1. current water resources and fluxes and
  2. future water availability due to climate change.
- In regions, where precipitation is limited to only a few months per year, the onset of the rainy season and the respective start of sowing time is of crucial importance for sustainable food production, which requires a
  3. reliable estimation of the onset of the rainy season.
- The instruments and methods to answer these questions should be world wide applicable, cost-effective and preferably public domain.

Hydrometeorological Decision Support for the Volta Basin

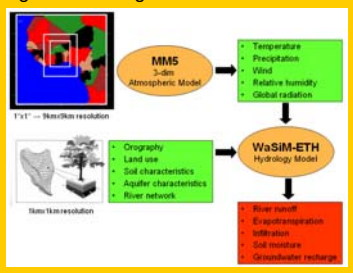
Long Term Planning

Climate Change Impact on Water Availability

• Climate changes on regional scale can differ significantly from the overall trend of global climate change
• Identify regions where changes in spatial or temporal distribution of water balance variables are expected
• Design adaptation and mitigation strategies

1. Coupling Strategy for Joint Atmospheric-Hydrological Simulations

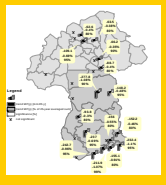
• Dynamical downscaling of global atmospheric fields: global climate scenarios, global (re-)analysis or forecast data
• Using simulated atmospheric information in hydrological modeling



Results:

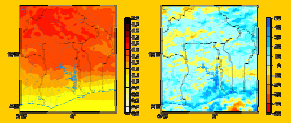
a) Footprints of Climate Change: Trend Analysis

• Annual precipitation trend [mm/25years]



b) Looking into the future: Regional climate simulations

• Change in mean annual temperature and rainfall (2030-39 vs 1991-2000)



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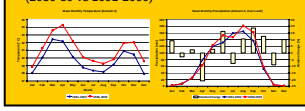
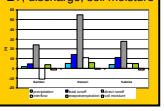


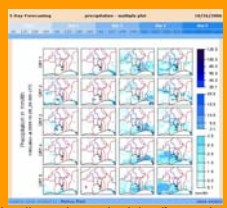
• Hydrological response: ET, discharge, soil moisture



Short/Mid Term Planning

Operational
- Weather Forecast (NWP)
- Model Based Water Balance Information System

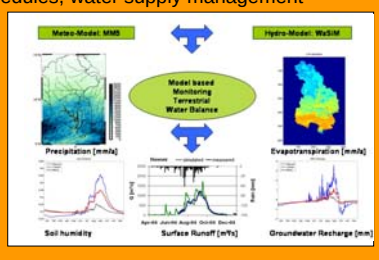
2. Operational 5-day Numerical Weather Prediction



http://www.glowa-volta.de/atm/forecast.htm

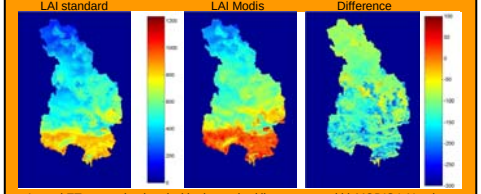
3. Operational Joint Atmospheric-Hydrological Simulations

• Simulation of spatially distributed water balance (48h delay)
⇒ Provides contemporary basin wide estimation of spatial and temporal changes of water balance variables
⇒ Important information for water resources management, e.g. power generation, irrigation schedules, water supply management



4. Assimilation of satellite derived land surface properties

• Hydrological simulations with spatially detailed information on land surface properties (MODIS)

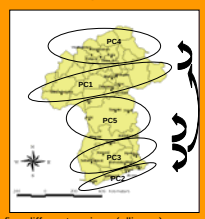


• Annual ET-maps simulated with a) standard literature - and b) MODIS LAI-values;

Prediction of Rainy Season's Onset
- Relying on Surface Parameters
- Using Atmospheric Parameters

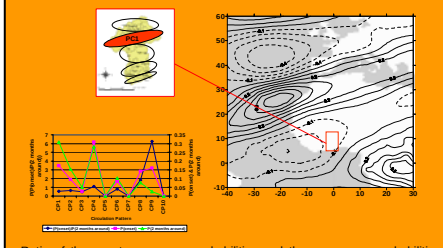
5. Prediction of the rainy season's onset using Linear Discriminant Analysis (LDA) and Linear Regression Analysis (LRA)

• Calculation of linear discriminant functions in order to classify each day into the classes 1.dry season, 2.transition, 3. onset of the rainy season and 4. wet season
• Estimating successively the regional onset dates of the current season knowing the onset date of that region where the rainy season commences at first by means of linear regression analysis (LRA)
⇒ Important information for farming management:
- sowing dates
- mobilization manpower, machines etc.



• Spatial location of the five different regions (ellipses) corresponding to the principal components. The arrows represent the direction for predicting the rainy season's onset of one region using the current onset date of another region;
e. g. ORS_PC5 = f(ORS_PC3)

6. Additional probabilistic information using atmospherically fields and circulation pattern analysis



• Ratio of the onset occurrence probabilities and the occurrence probabilities two months around the onset (left below); Mean horizontal wind speed anomaly in 500 hPa (1961-1999) corresponding to CP9 reliable for onset in PC1 (right)

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