Helmholtz Climate Initiative

# Regional Climate Change

# Towards Closed Regional Atmospheric and Terrestrial Water Balance Modeling with WRF-HMS (TP4)

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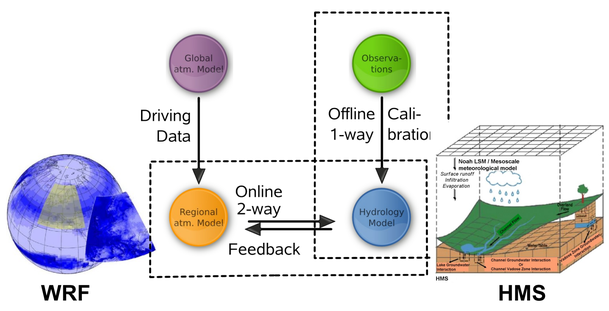
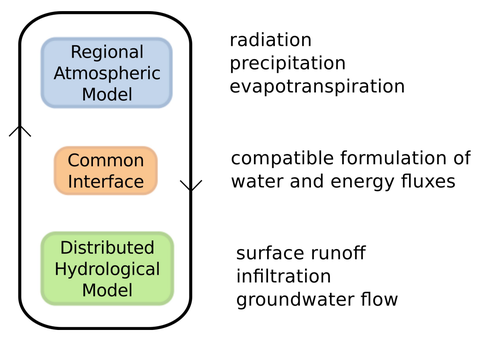
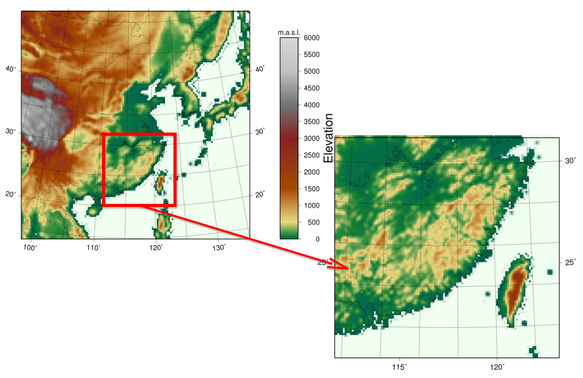
## Concept of Closed Regional Water Balance Modeling




*Compartment crossing coupled modeling system WRF-HMS*

## Water Budget Study for the Poyang Lake Region (China)




*Study region, model domains 1 & 2 (WRF)*

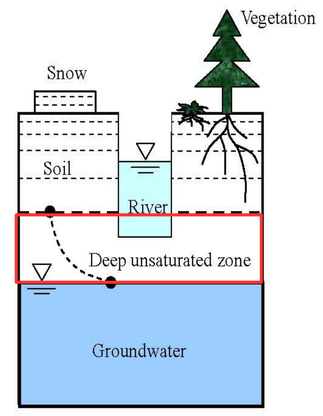
- Investigation of feedback mechanisms among land-surface and subsurface conditions with the atmosphere
- Assessment of the impact of land-use change scenarios on the regional water cycle in combination with climate change
- The Poyang Lake region features shallow groundwater levels that are in active exchange with the atmospheric boundary layers

## Technical Realization of the Coupling Scheme

- Introduce a deep unsaturated zone between the bottom of LSM and ground water level
- The soil moisture profile in this zone is determined by equating downward drainage with upward vertical diffusion assuming equilibrium soil moisture profile
- Soil hydraulic properties: Clapp and Hornberger approximation

**3 Coupling Modes:**

- NO COUPLING: No interaction between LSM and groundwater
- COUPLING METHOD 1: Soil moisture (θ) has a linear changing trend in deep unsaturated zone
- COUPLING METHOD 2: Pressure head (ψ) has a linear changing trend in deep unsaturated zone

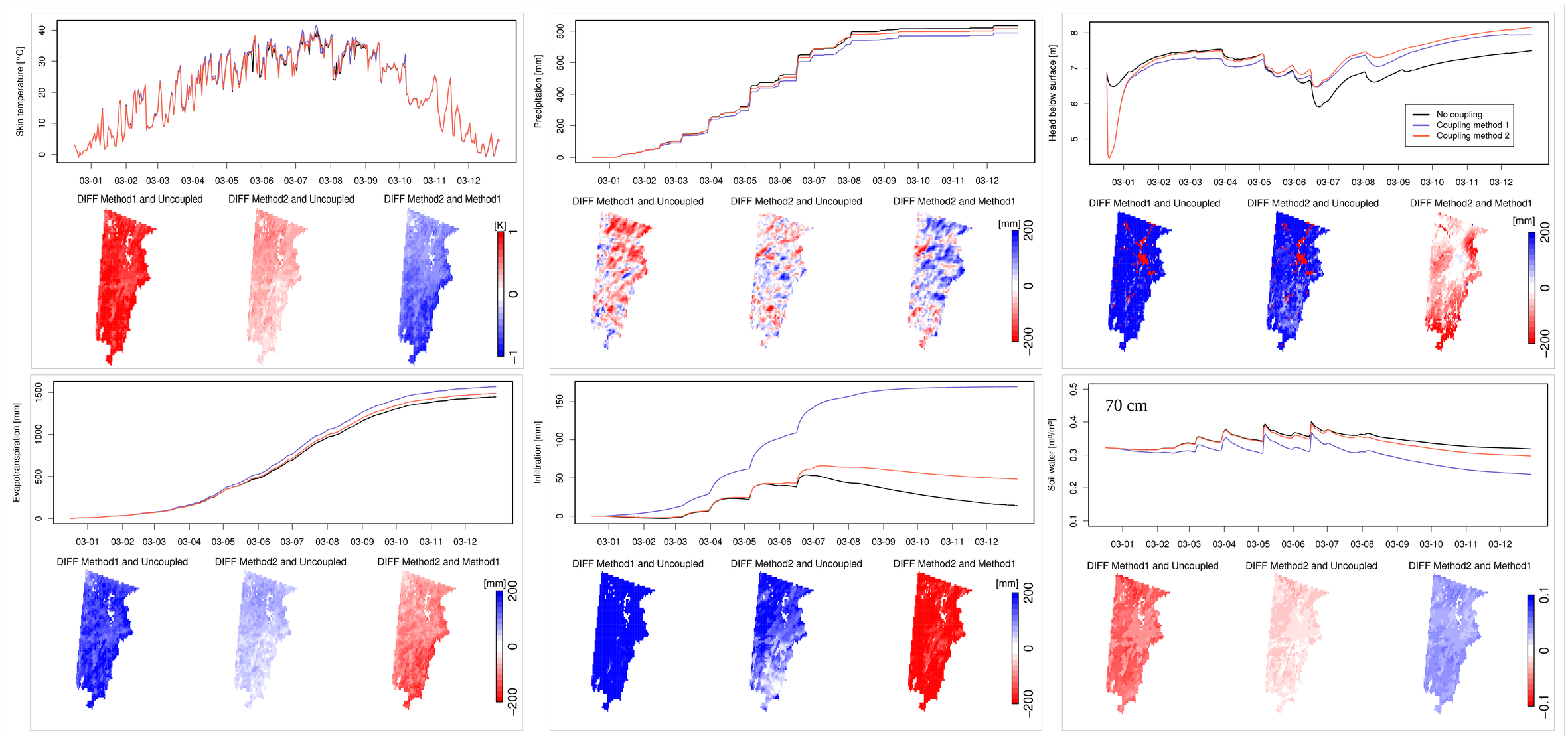



*Coupling scheme*

**Model configuration:**

- Resolution: 30 km (domain 1), 10 km (domain 2); Driving: ECMWF ERA-INTERIM
- Timestep: 60 sec WRF (domain 2), 1 hour HMS
- Domain 1: uncoupled Noah-LSM; Domain 2: coupled Noah-LSM-HMS

## Deviations in Water and Energy Fluxes between Coupled and Uncoupled simulations




*Water budget time-series for a single model grid cell and respective cumulative fluxes / differences of annual sums or means for the Poyang Lake Region, China.*

- The application of the two way fully coupled regional atmospheric / hydrological model WRF-HMS has a significant effect on the water and energy fluxes on regional scales
- The introduction of a deep unsaturated zone that interacts with the soil profile of the LSM and the groundwater enables the exchange of water from deeper and larger storage bodies
- Changes in water and energy fluxes are congruently experienced throughout the different compartments
- Significant alterations of precipitation and evapotranspiration are obtained when coupling is enabled
- The model remains stable, no imbalanced conditions of the water fluxes are experienced for the 2003 simulation