Flächendifferenzierte Modellierung des Wasserhaushalts im Nationalpark Berchtesgaden

Harald Kunstmann

Modellierung Wasserhaushalt Nationalpark BGL

Ziele

- Berechnung & Abschätzung der Wasserhaushaltskomponenten in der Region des NP (470 km²) mittels WaSiM

  Wimbach, Klausbach, Königsseer-, Ramsauer- und Bischofswiesener Ache

- Prozessverständnis Interaktion Oberflächenwasser & Grundwasser & Schneedynamik im NP

- Verbesserung der Schneemodellierung in WaSiM:

  Integration von AMUNDSEN und/oder ESCIMO

- Validierung des Schneemodells (Stationsdaten, MODIS)

- Erwartete Änderung des Wasserhaushalts unter Klimaänderung

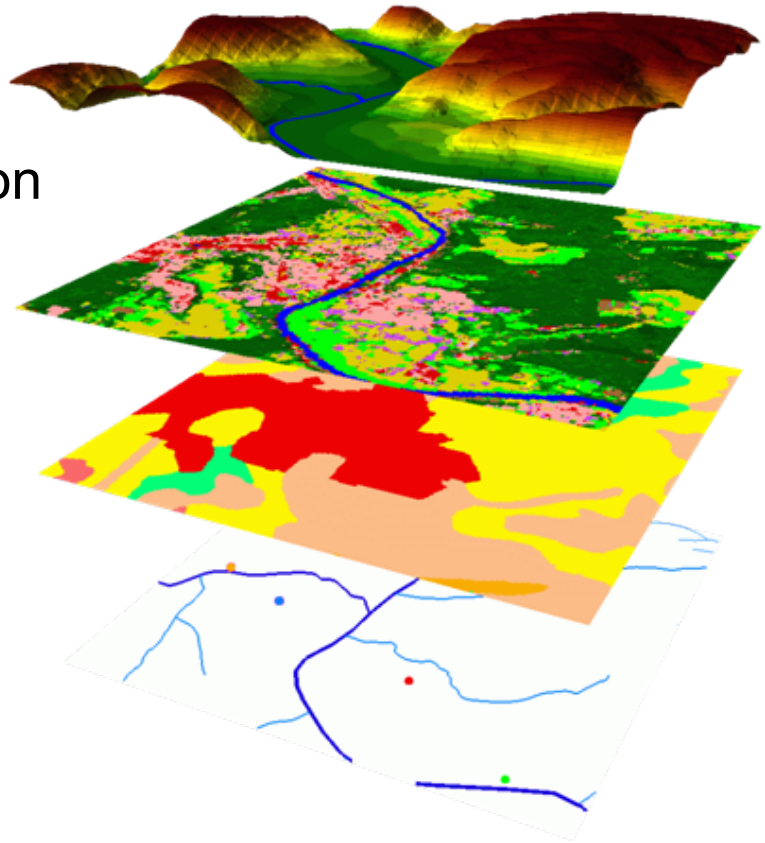
Distributed Hydrological Model WaSiM

Physically based algorithms for vertical water fluxes & groundwater:
- Evapotranspiration: soil and vegetation specific (Monteith)
- Flow through unsaturated zone (Richards)
- Suction head & hydraulic conductivity (van Genuchten)
- 2-dim groundwater model dynamically coupled to unsaturated zone

Conceptual approaches for lateral runoff aggregation
- Traveltime approach folded with linear storage
- Discharge routing: cinematic wave

Snow: day-degree approach

Setups so far at IMK-IFU
- spatial resolution: 90x90m² till 1x1 km²
- temporal resolution: hourly-daily
- subdivision into sub-catchments



Distributed Hydrological Model WaSiM

- Well-established tool for investigating the spatial and temporal variability of hydrological processes in complex river basins.
- Reasonable compromise between detailed physical basis and minimum data requirements.
- Previous applications demonstrated that WaSiM-ETH is able to address successfully very different hydrological problems on a wide range of scales.
- Is used by over 50 institutions (universities, research centres, regional authorities and engineering offices).

Distributed Hydrological Model WaSiM

Special features (incomplete):

- Variable Cell Sizes
- Dynamic Simulation of Vegetation Development (LAI Dynamics)
- Advanced Landuse Table
- Advanced Soil Table
- Macropore Runoff
- Exfiltration and Re-Infiltration of Groundwater
- Irrigation Management
- Considering (artificial) Drainage
- Considering Ponds
- Modelling of Glacier Runoff
- Considering Reservoir Management
- Considering external Abstractions and Inflows
- Online Coupling with external Models
- Coupling of sequential Model Runs
- Coupling of Substance Transport (-> Tracer) with Water Flow

Distributed Hydrological Model WaSiM

Data requirements

- **Geographical data:**
  minimum: digital elevation model, land use and soil grid →
  further spatial distributed data (slope, river network, subcatchments,…)

- **Meteorological data**
  minimum: temperature and precipitation
  standard: global radiation, wind speed, relative humidity
  → require spatial interpolation on regular WaSiM-grid

- **Hydrological Data**
  river discharge time series
  water management data (e.g. abstractions)
  if available: groundwater heads, tracer, aquifer properties (hydr. conduct., porosities, colmation resistance, aquifer thickness)

Water Balance Modelling NP BGL

- **Subcatchments**
  Wimbach, Klausbach, Königseer, Ramsauer, Bischofswiesern Ache

- **Resolution**
  Δx=100-500m, Δt=1h

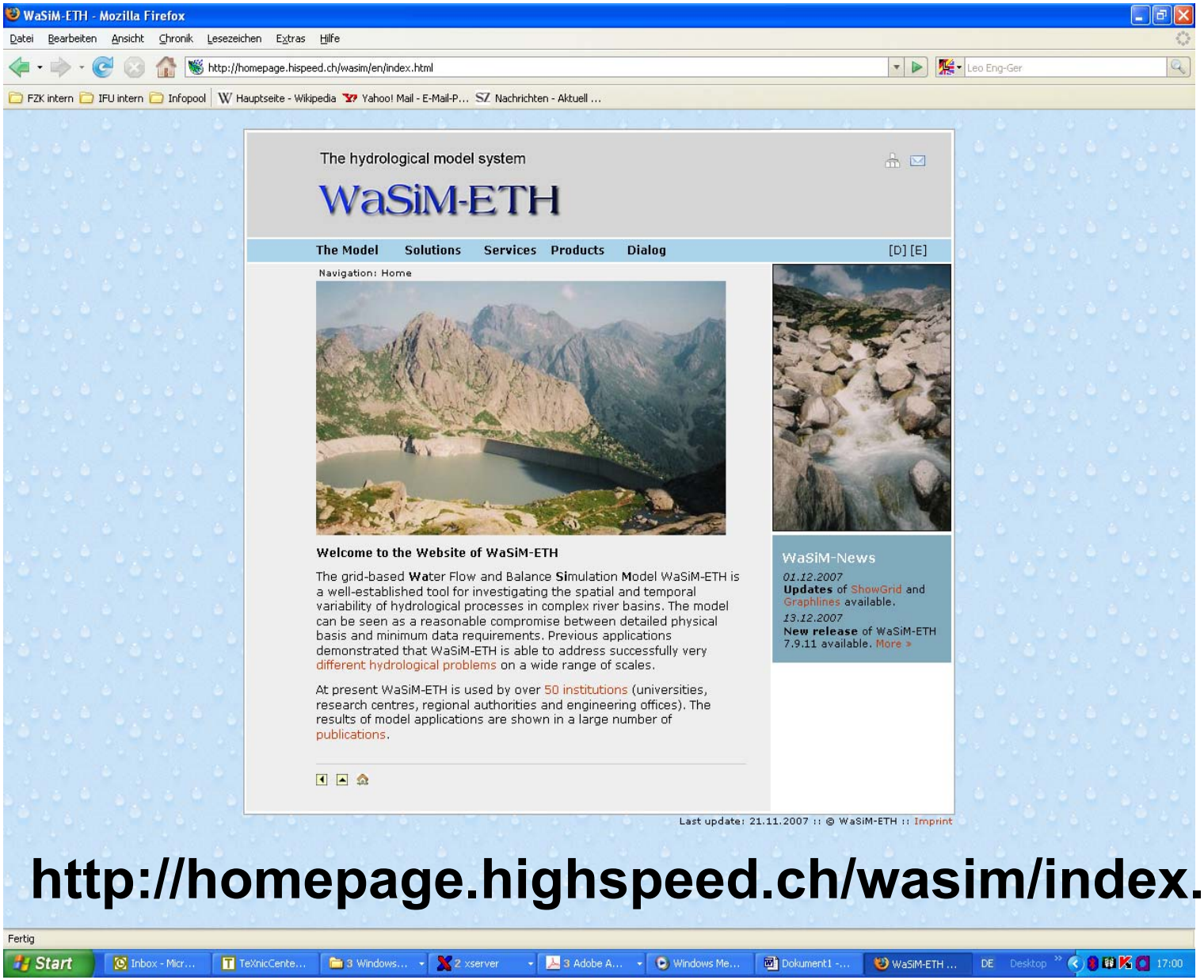
- **Approach**
  Richards-eq., Penman-Monteith, 2-dom groundwater model, etc.
  New snow module

- **Calibration/validation**: from 1990 on

- Validation of areal **snow cover dynamics** using MODIS satellite data

- **Finally**: climate change impact analysis (→ RCM driven WaSiM)

Water Balance Simulation Model ETH



http://homepage.highspeed.ch/wasim/index.html

Beispiel 1

Ammer Einzugsgebiet

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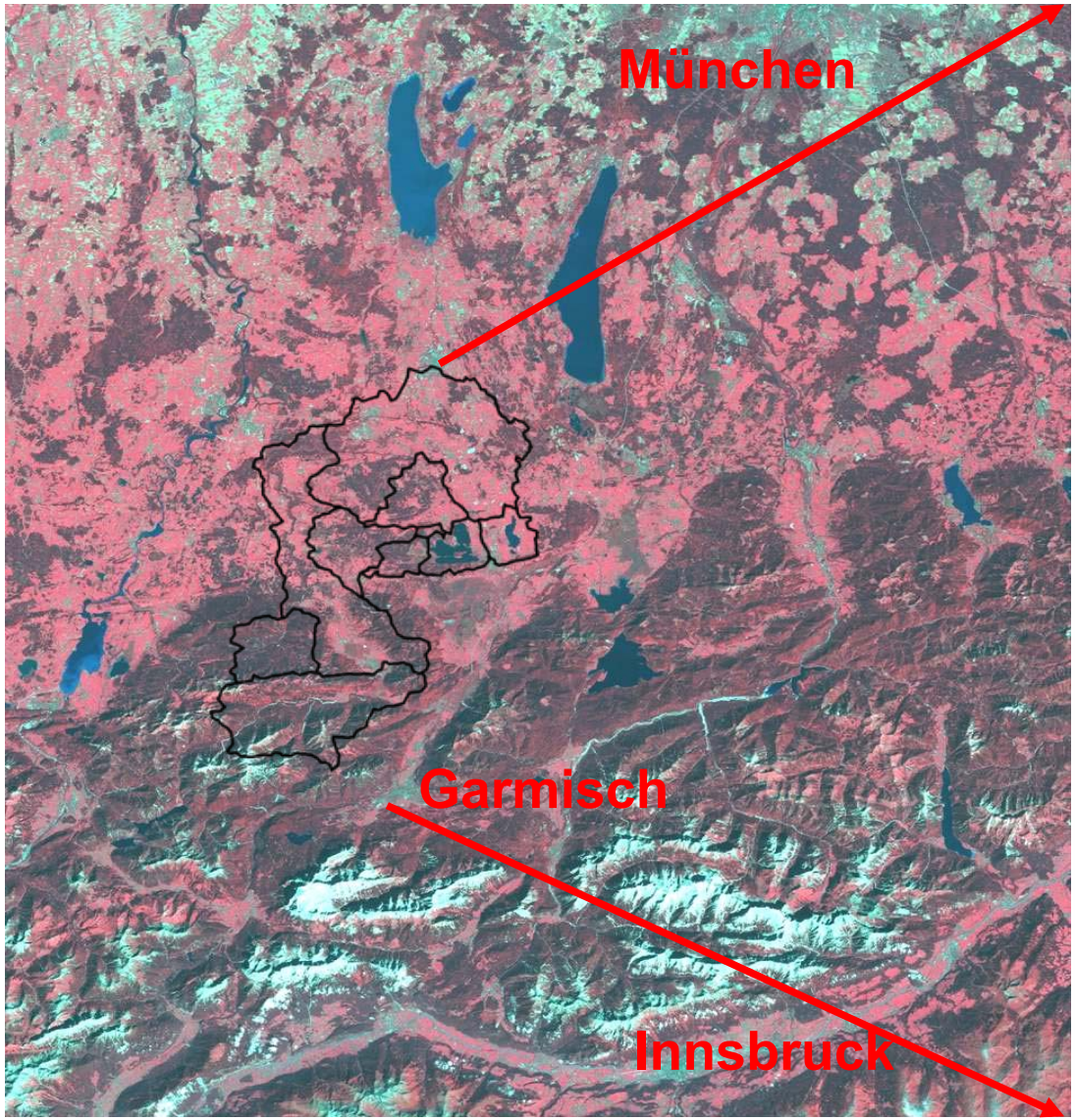
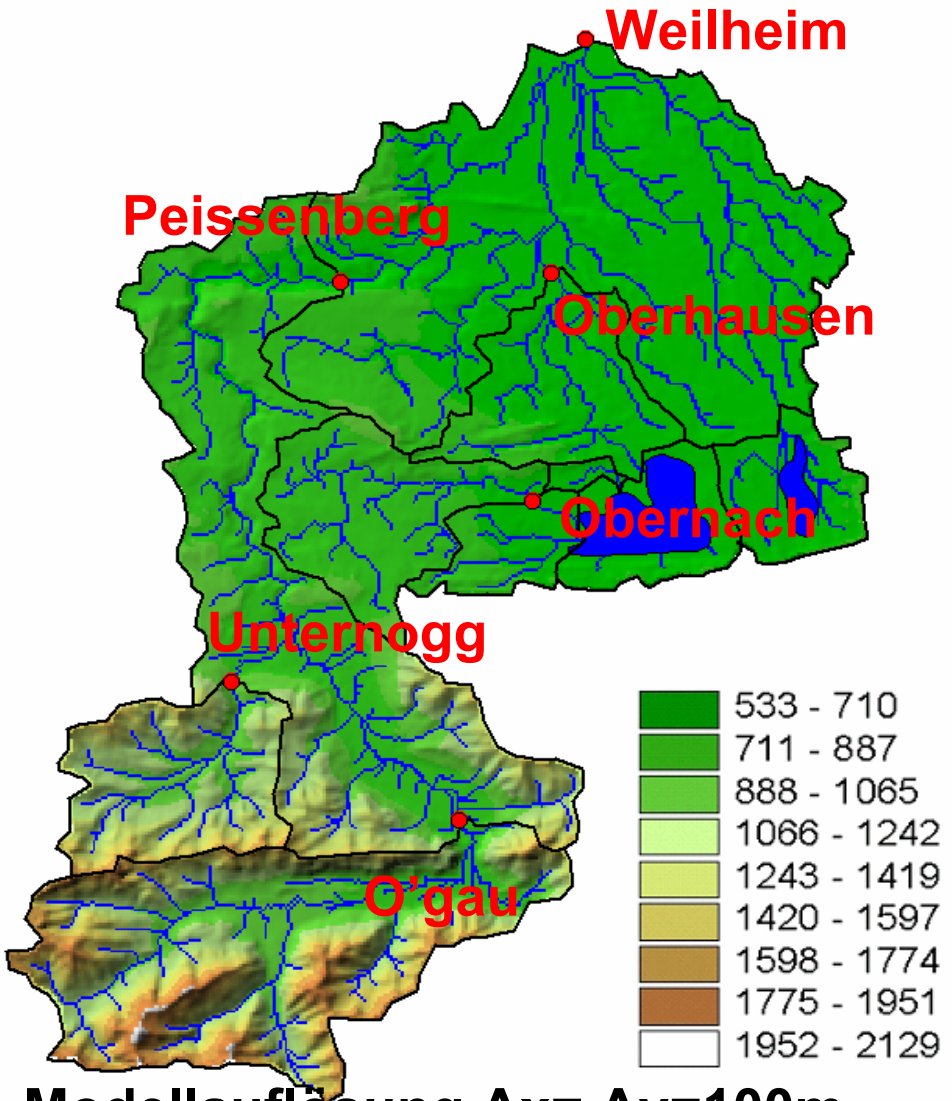
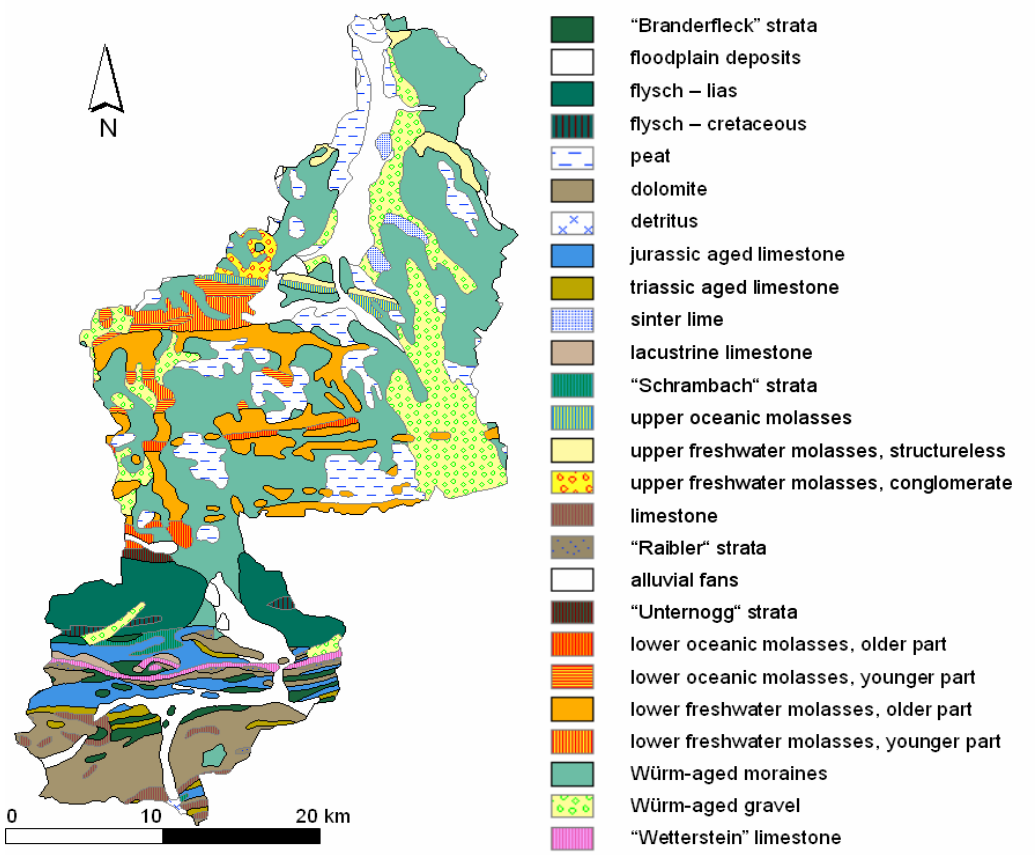
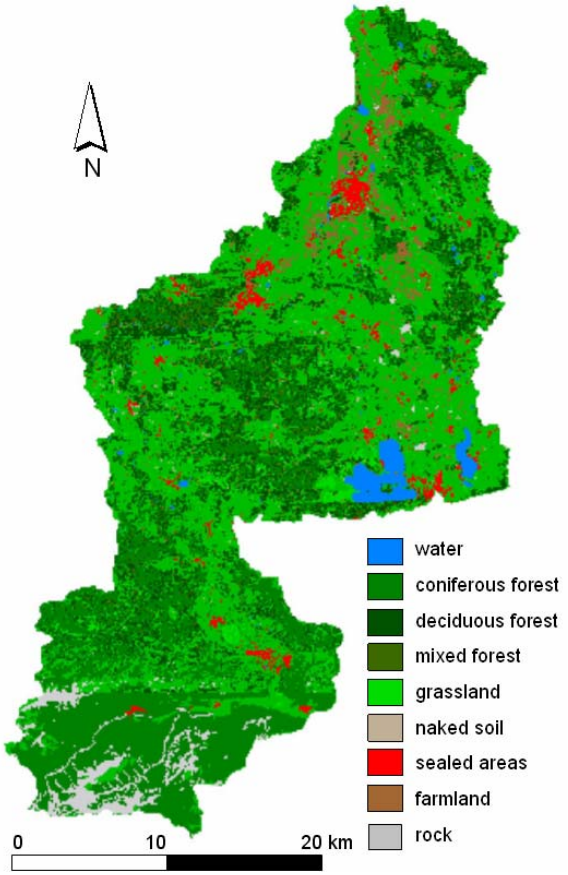




Modellauflösung Δx= Δy=100m

Ammer Einzugsgebiet





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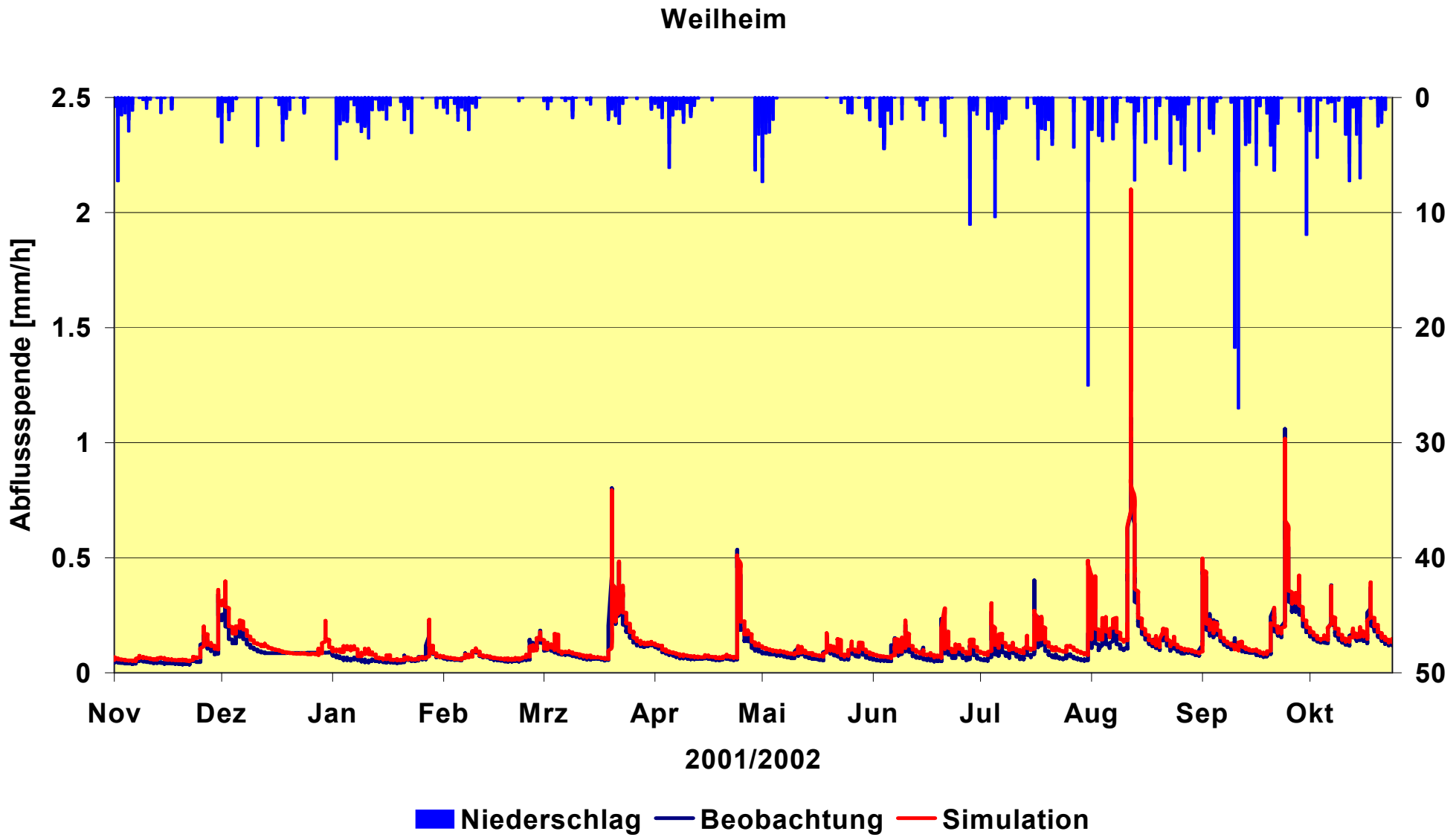

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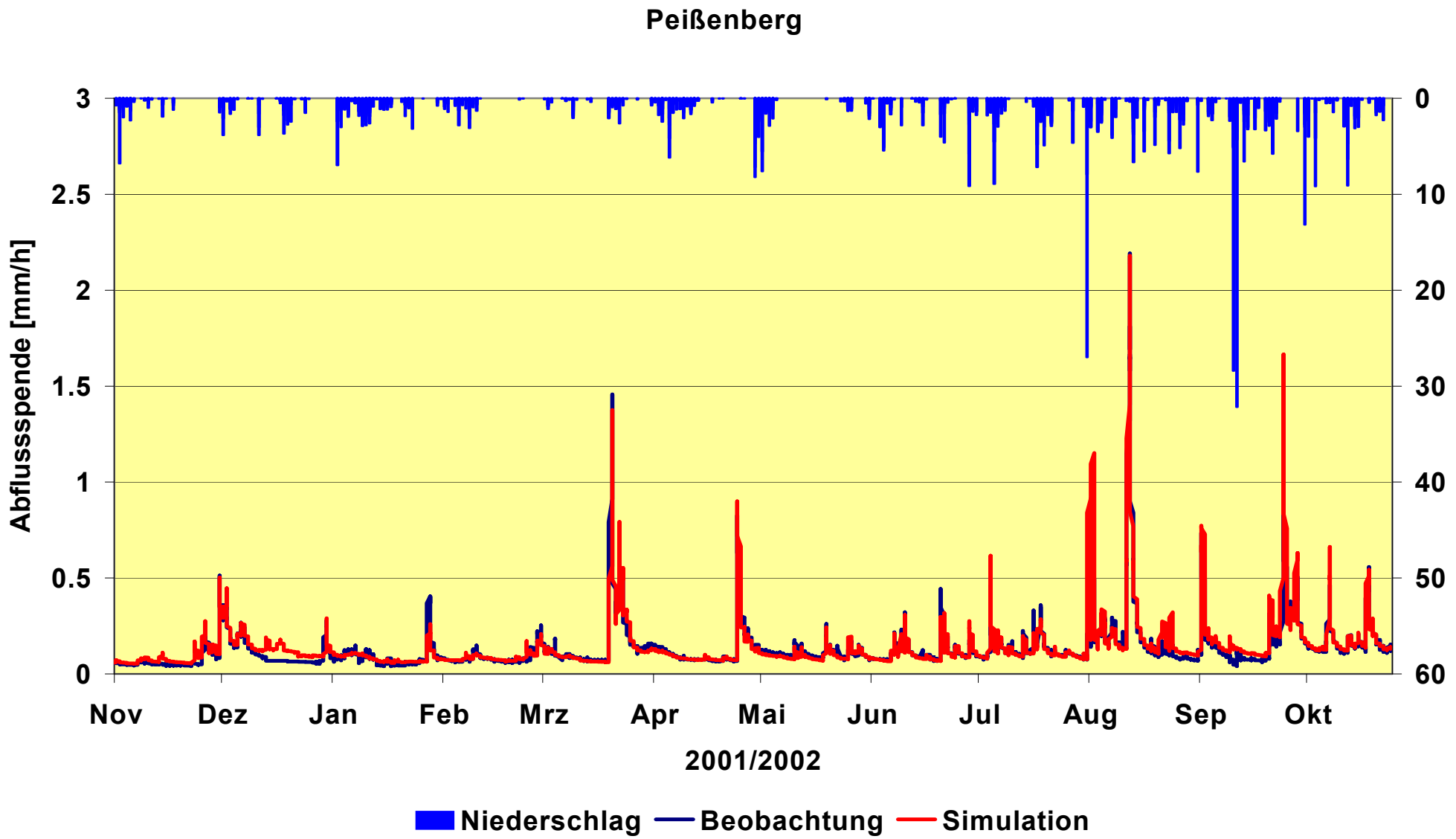
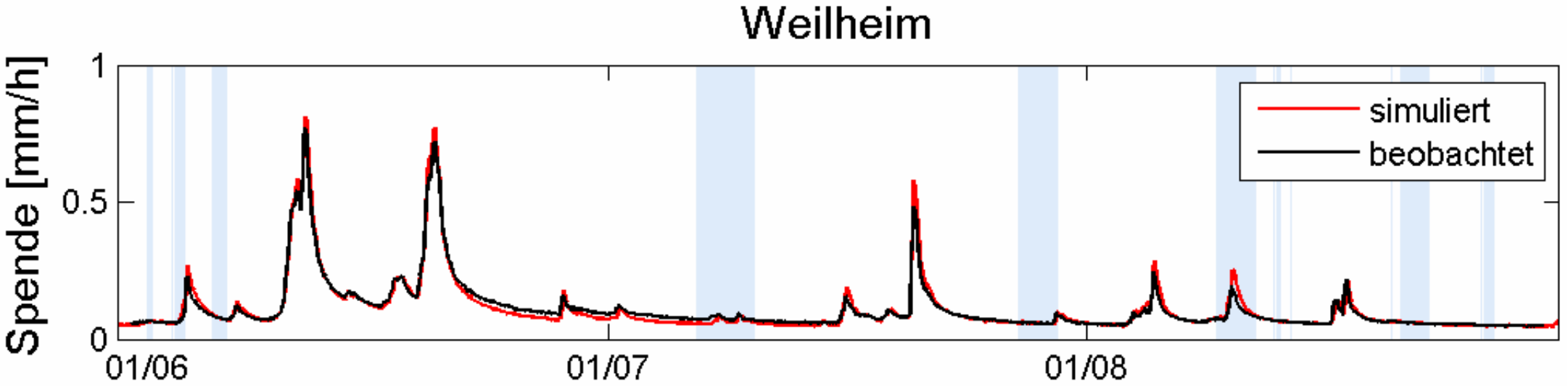
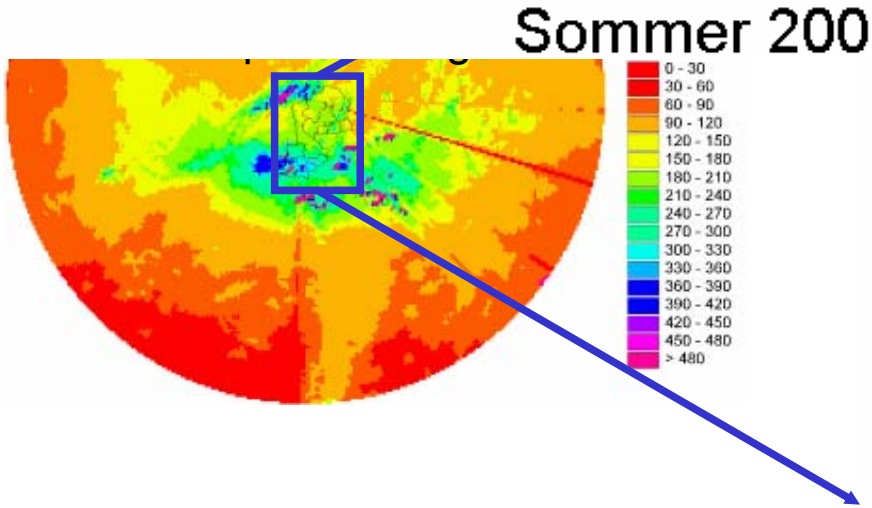
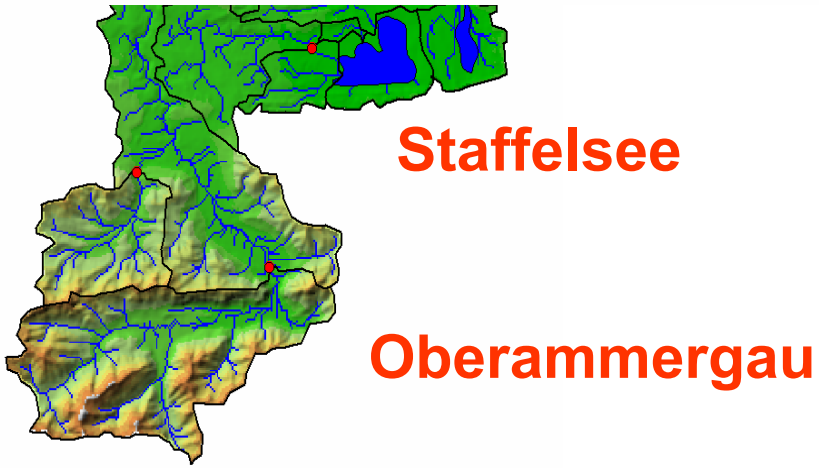


Ammer Einzugsgebiet

Erfassung der räumlichen Niederschlagsvariabilität im alpinen Terrain zur verbesserten Abfluss-Simulation



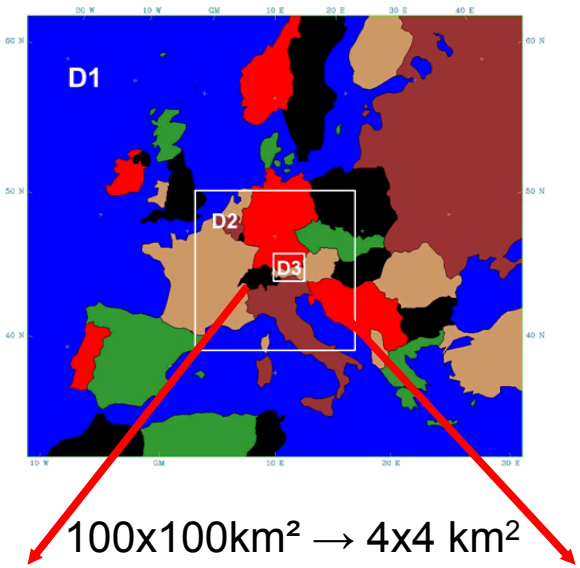




Regionale Klima-Hydrologie Modellierung

- Temperatur
- Niederschlag
- Wind
- Relative Feuchte
- Globalstrahlung

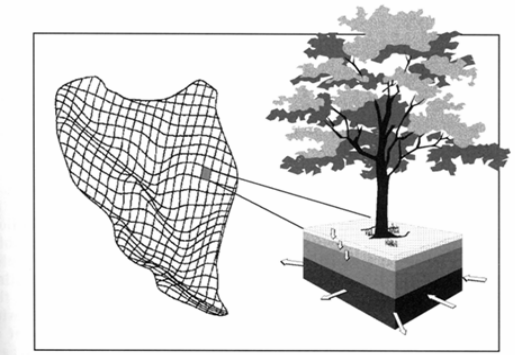
3-dim. atmosphärisches Modell



100x100km² → 4x4 km²

Hydrologisches Modell

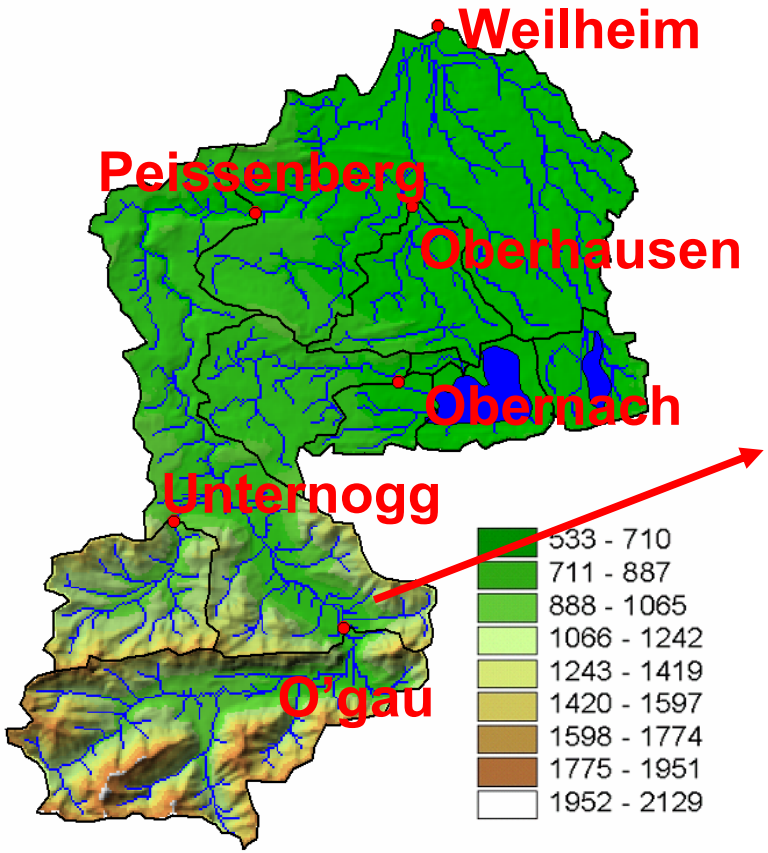
- Orographie
- Landnutzung
- Bodeneigenschaften
- Aquifereigenschaften
- Flussnetz



100x100 m² Auflösung

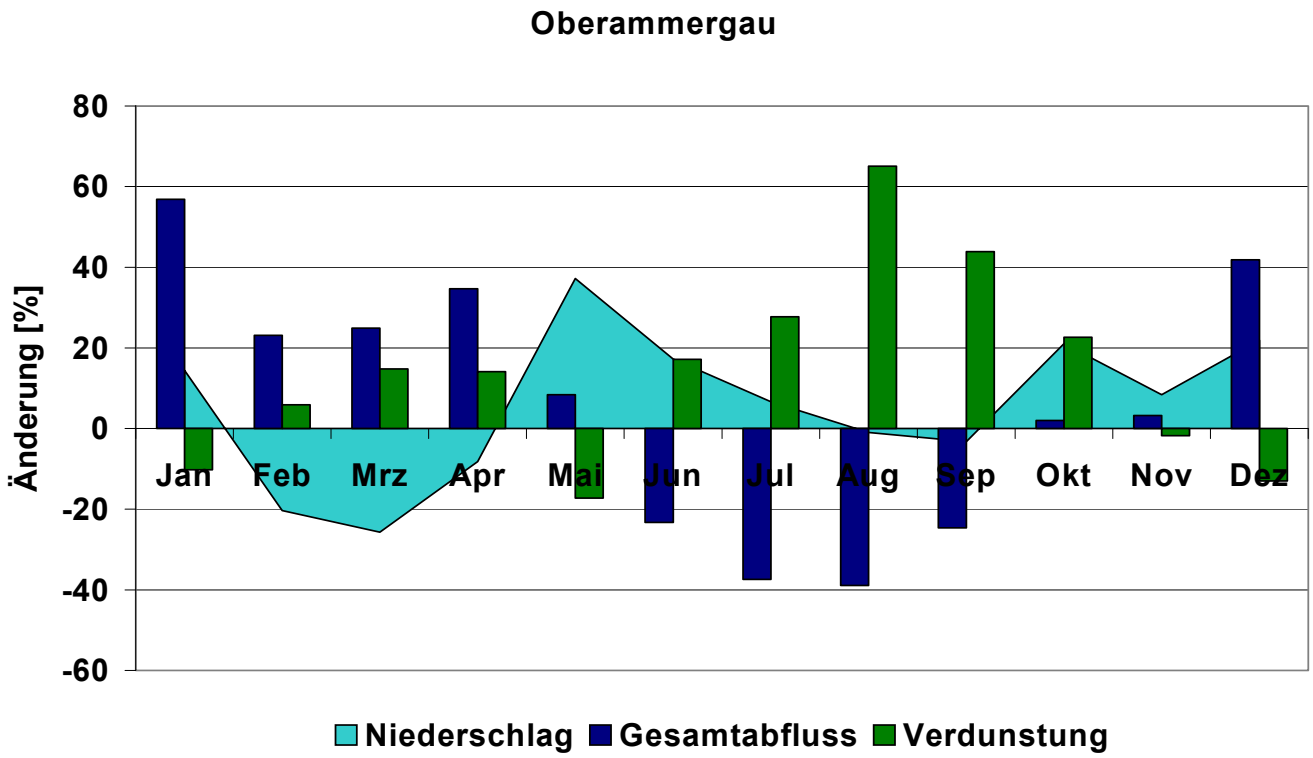
Evapotranspiration Infiltration Abfluss Grundwasser

Klimaänderung & Wasserverfügbarkeit Ammer



Modellkaskade ECHAM4 – MM5 – WaSiM

Änderung 1990-99 vs. 2030-39

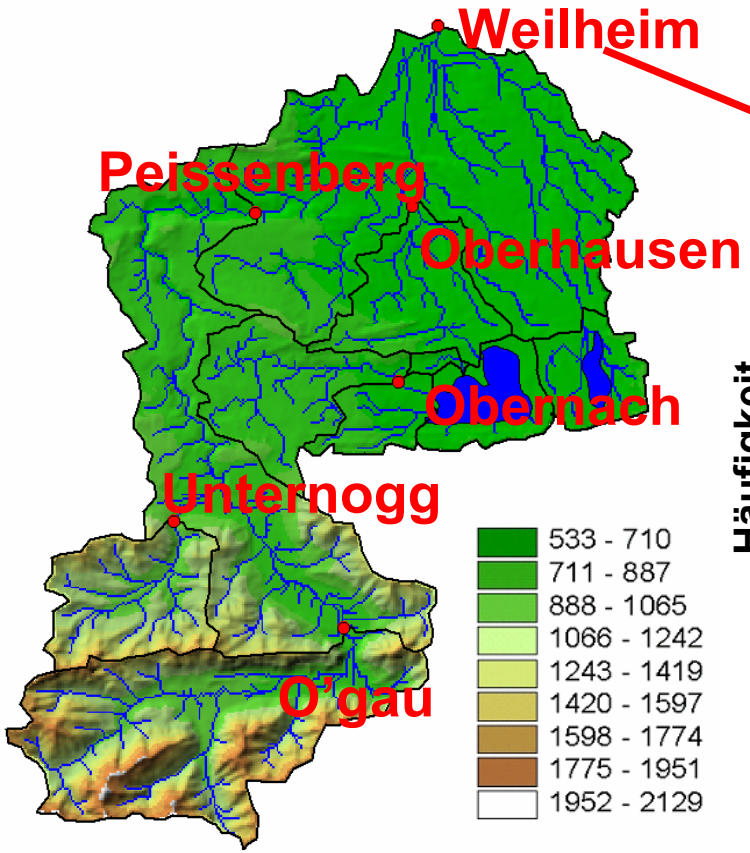


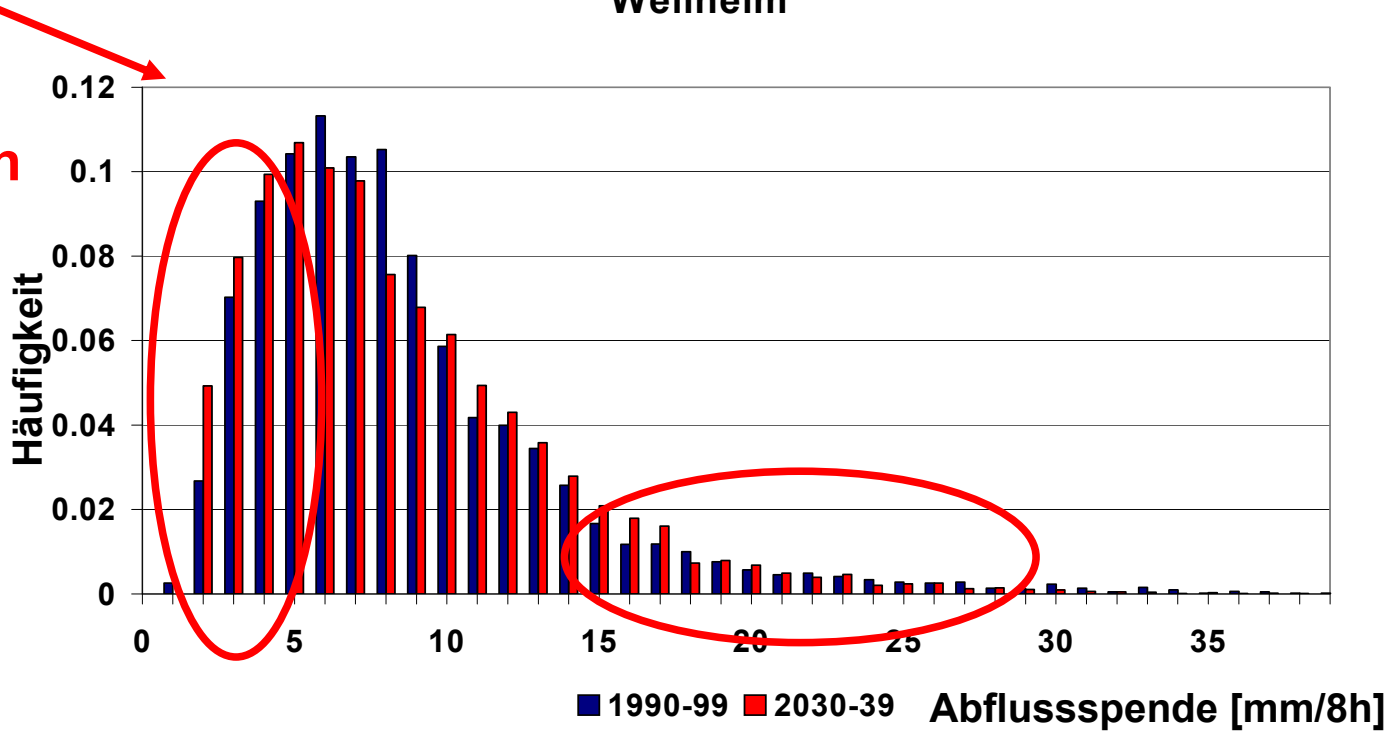
Zunahme Winter-, Verminderung der Sommerabflüsse

Klimaänderung & Wasserverfügbarkeit Ammer

Modellkaskade ECHAM4 – MM5 – WaSiM

Änderung 1990-99 vs. 2030-39





Veränderung der Häufigkeiten: Zunahme von Hochwasser & Niedrigwasser!

Beispiel 2

Weißer Volta

West Africa

encarta world atlas

- 94000 km²

ke Volta

e

lay - October

vember – April

ecol. zones:

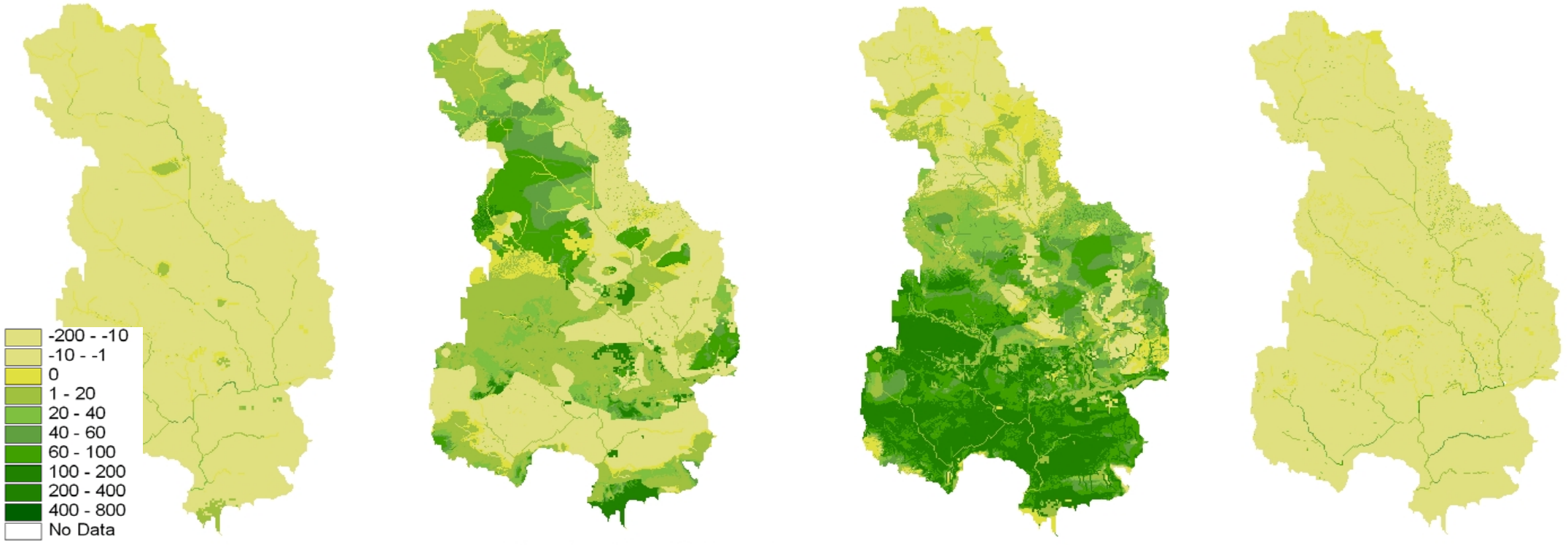
n Savanna

White Volta (Ghana & Burkina Faso)

Quantification of water balance variables: spatial distribution

Groundwater recharge (monthly sums)

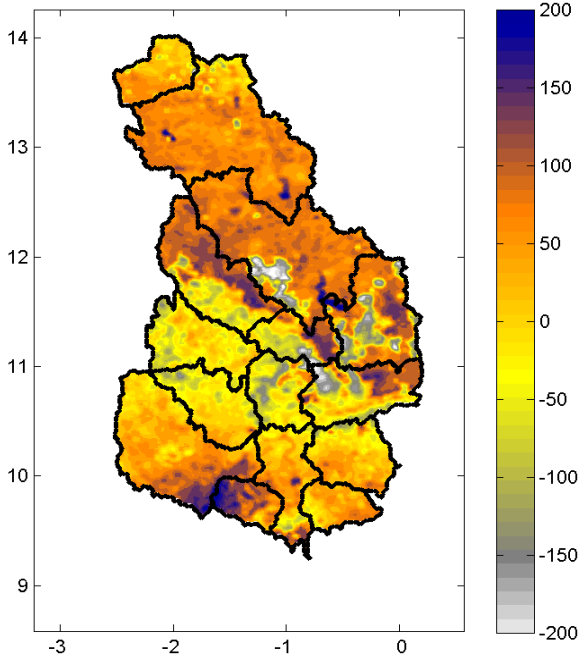
Apr 04 | Jul 04 | Sep 04 | Nov 04



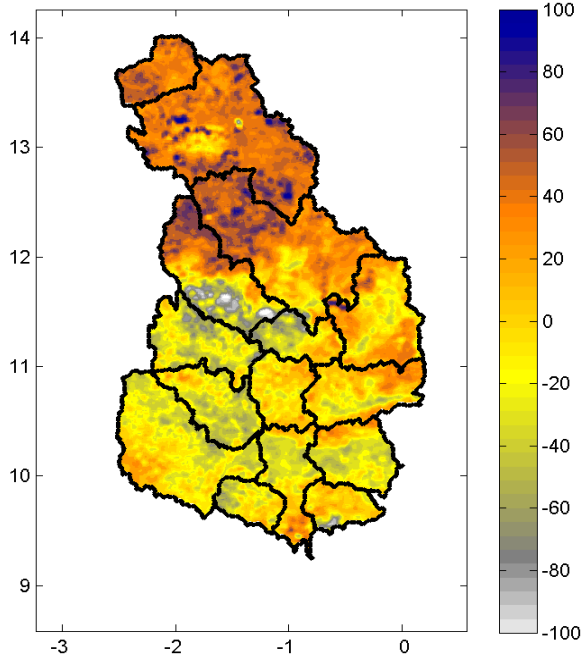
Assimilation of MODIS albedo and LAI in WaSiM

Spatial distribution using MODIS albedo & LAI of annual

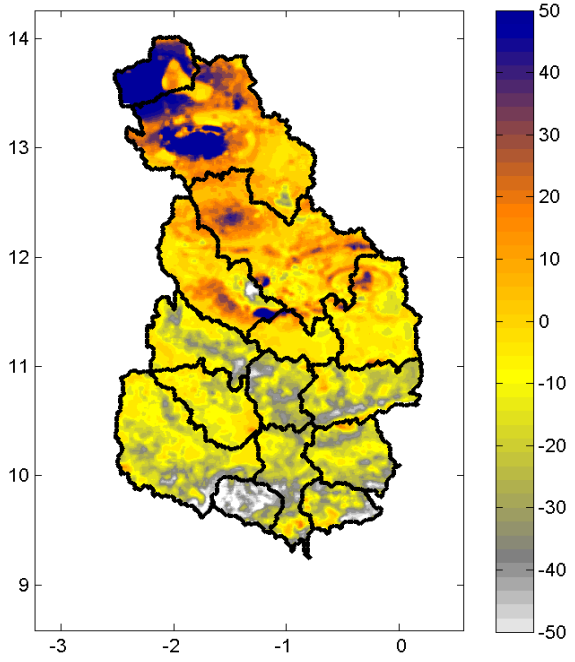
Potential ET



Actual ET



Total runoff




Vielen Dank für die Aufmerksamkeit