Building a European-wide hydrological model

2010 International SWAT Conference, Seoul - South Korea

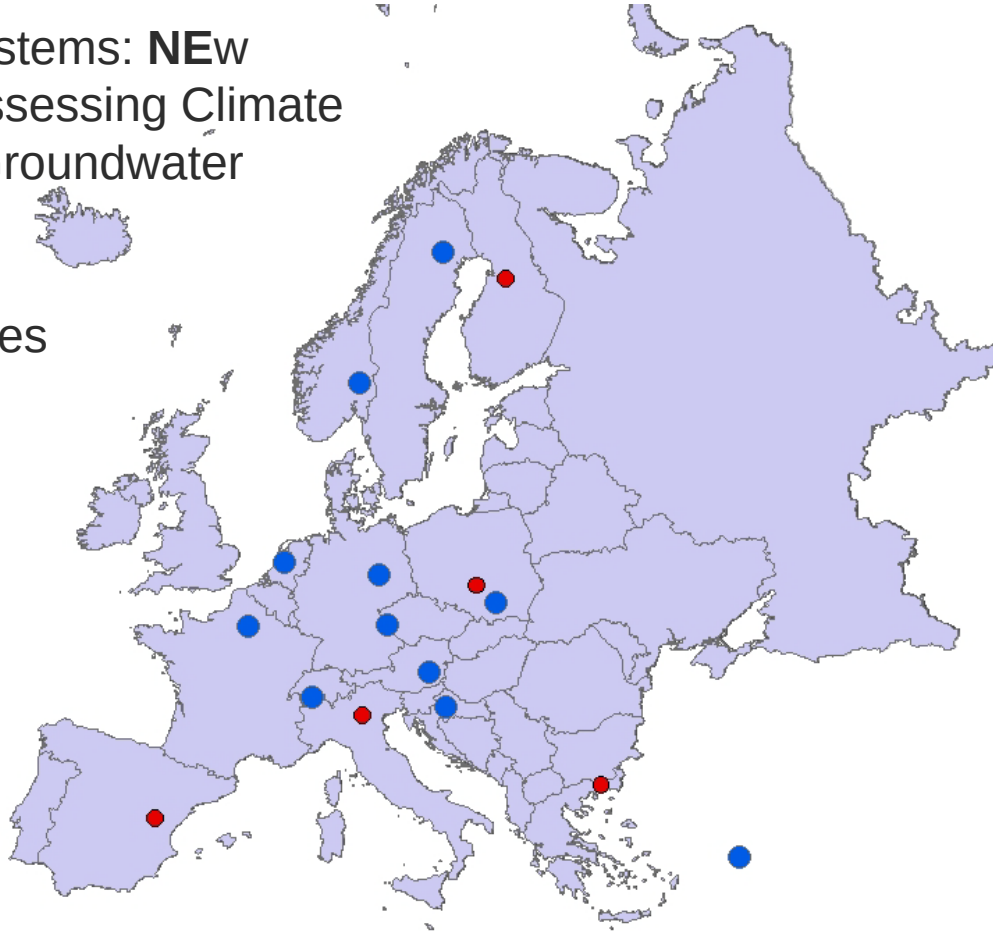
Christine Kuendig

Eawag: Swiss Federal Institute of Aquatic Science and Technology

Contribution to GENESIS – 7th Framework EU project

GENESIS
groundwater and dependent ecosystems

- **G**roundwater and Dependent **E**cosystems: **NE**w **S**cientific and Technical Bas**IS** for Assessing Climate Change and Land-use Impacts on Groundwater Systems
- 25 Partners from 17 different countries
- 9 Mio € budget
- 5 years until spring 2013
- 16 case study sites



Contribution to GENESIS – 7th Framework EU project

GENESIS
groundwater and dependent ecosystems

- Research topics comprised in 8 workpackages:
  - Hydrogeology, agricultural land-use and management, pollutant transport, microbiology, degradation, biogeochemistry, wetlands, ecology, hydrology, climate change, tracer use, modelling, water engineering, water economy, sociology and policy

- Our contribution:
  - Model the quantity and quality of groundwater recharge on a continental scale, application of land-use and climate change scenarios

Building a European-wide hydrological model

Main objectives

- Setup up of SWAT for the European continent
  - European Database
- Calibration and validation with focus on water quantity and quality, blue and green water flow
- Future scenarios of climate and land use change
- Assessment of input uncertainty (precipitation)
  - Comparison of station data vs. gridded interpolated observation data

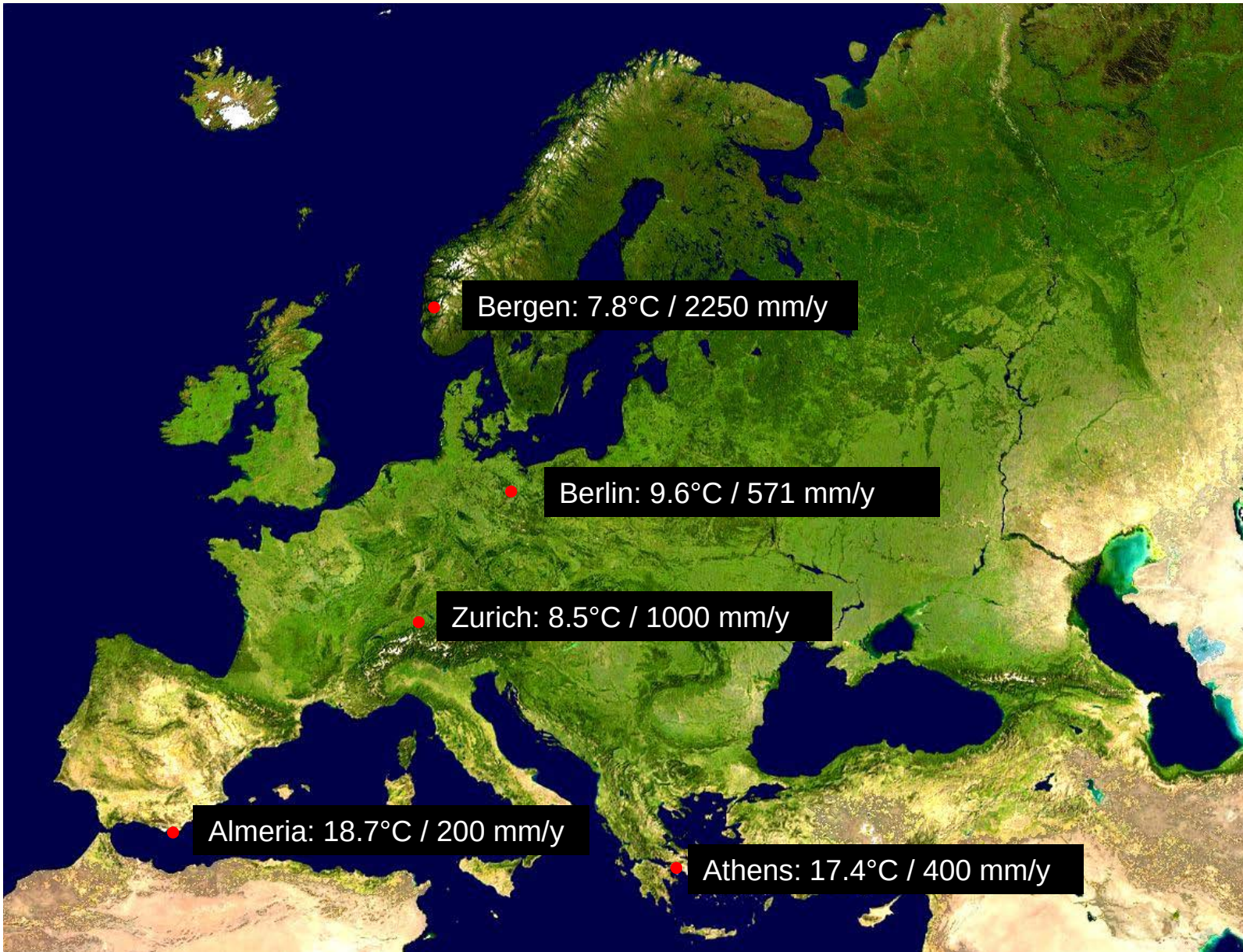
Building a European-wide hydrological model

Recent work

- Setup of SWAT on the European continent using the European Database
- Preliminary calibration results (40 runs using SUFI-2)
  - Nash Sutcliffe efficiency at around 150 discharge stations

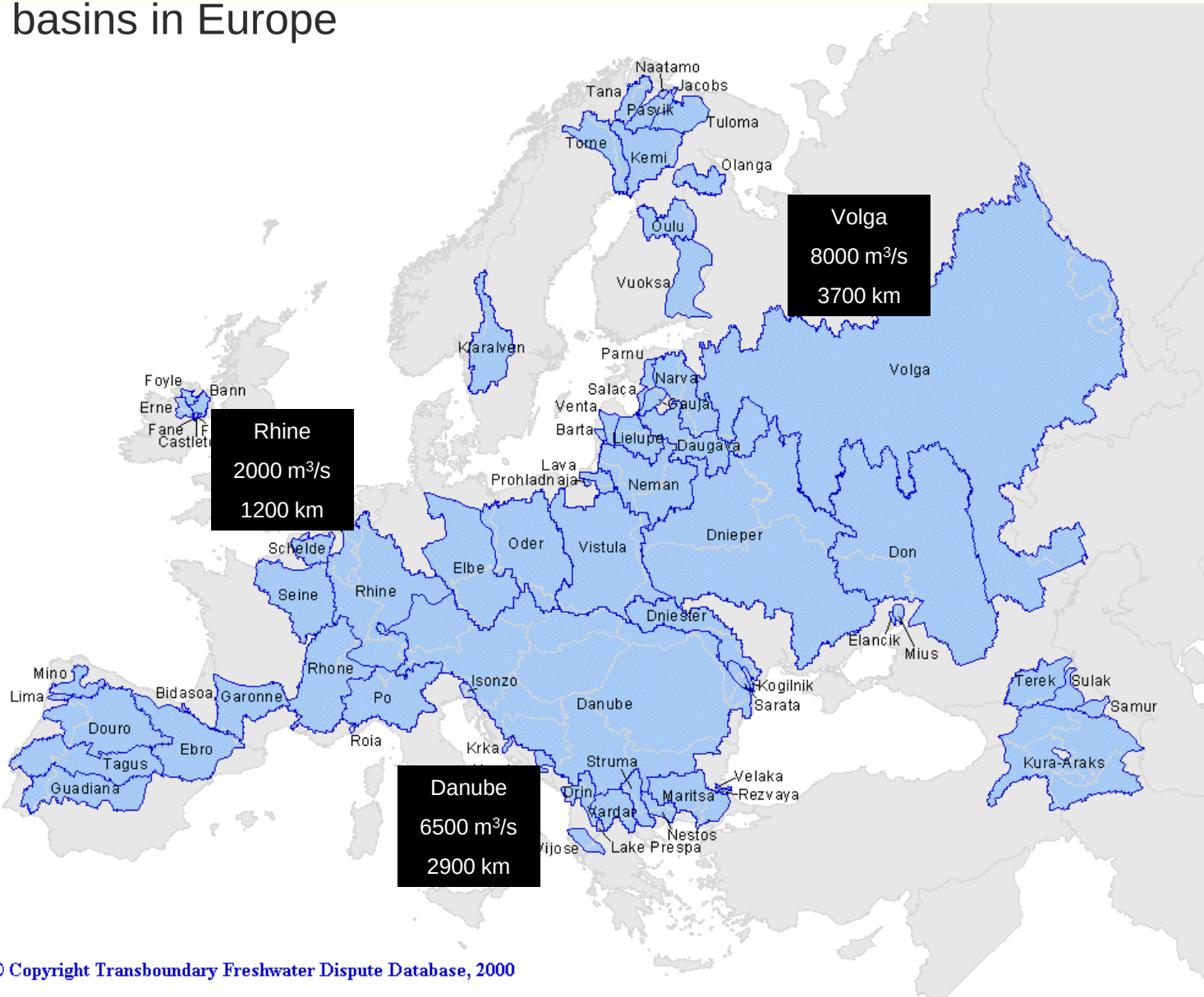
European Continent

European Continent



European Continent

Selection of river basins in Europe



European SWAT database

Data sources

- All datasets obtained from freely available sources on the internet
  - NASA (National Aeronautics and Space Administration)
  - USGS (United States Gelogical Survey)
  - NCDC (National Climatic Data Centre)
  - EEA (European Environmental Agency)
  - KNMI (Royal Netherlands Meteorological Institute)
  - GRDC (Global Runoff Data Centre)

European SWAT database

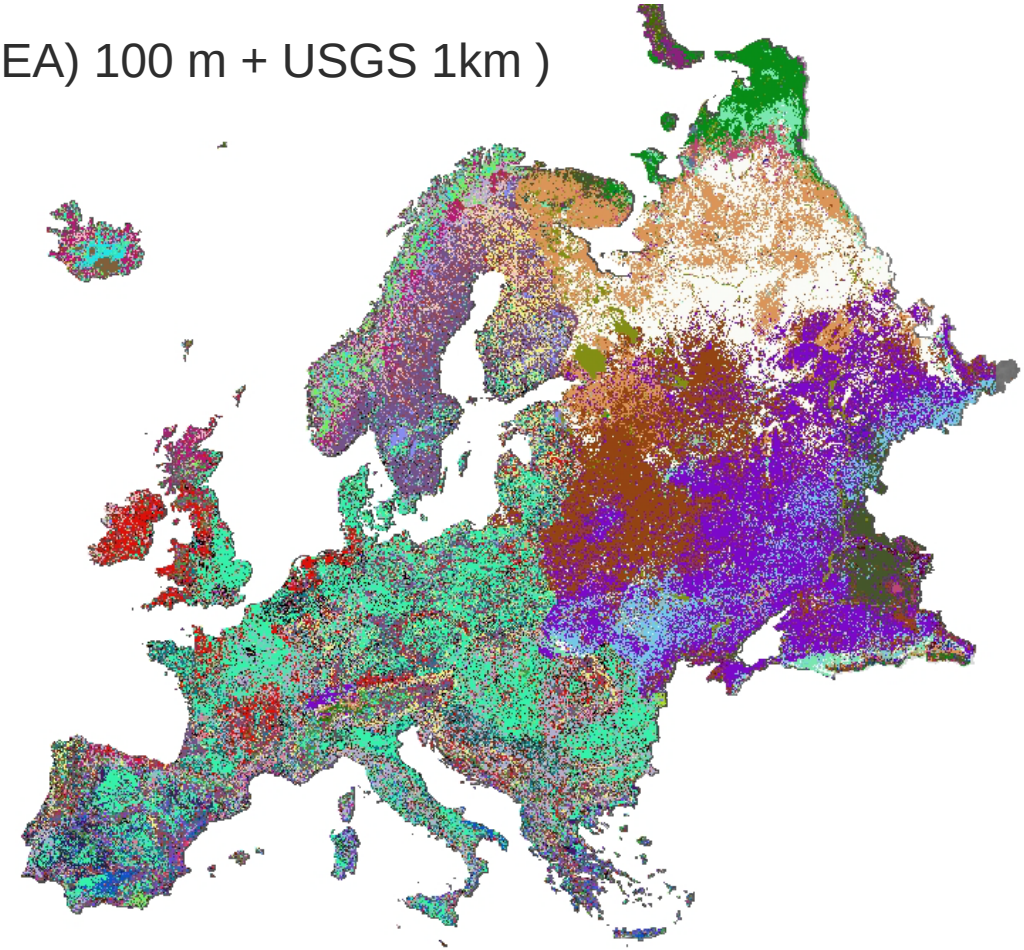
Spatial maps

- DEM (NASA, 1 km resolution)

European SWAT database

Spatial maps

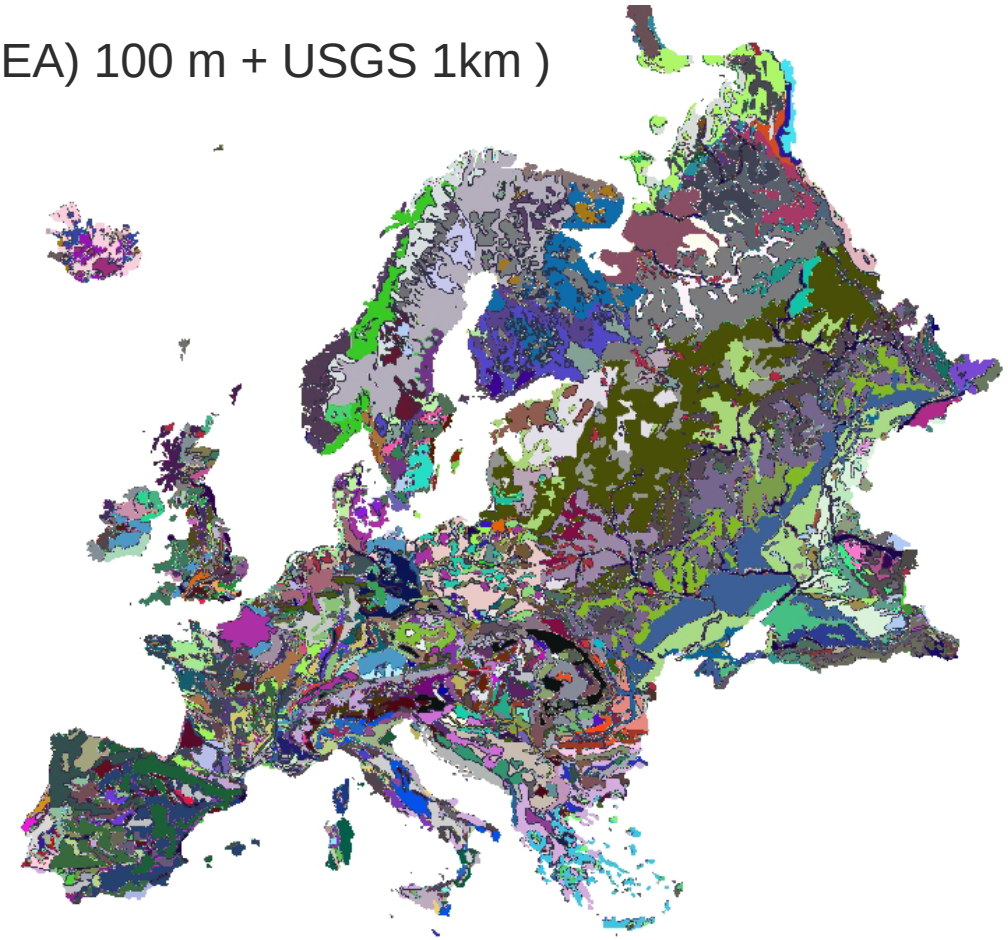
- DEM (NASA, 1 km resolution)
- Land cover (CORINE project (EEA) 100 m + USGS 1km)



European SWAT database

Spatial maps

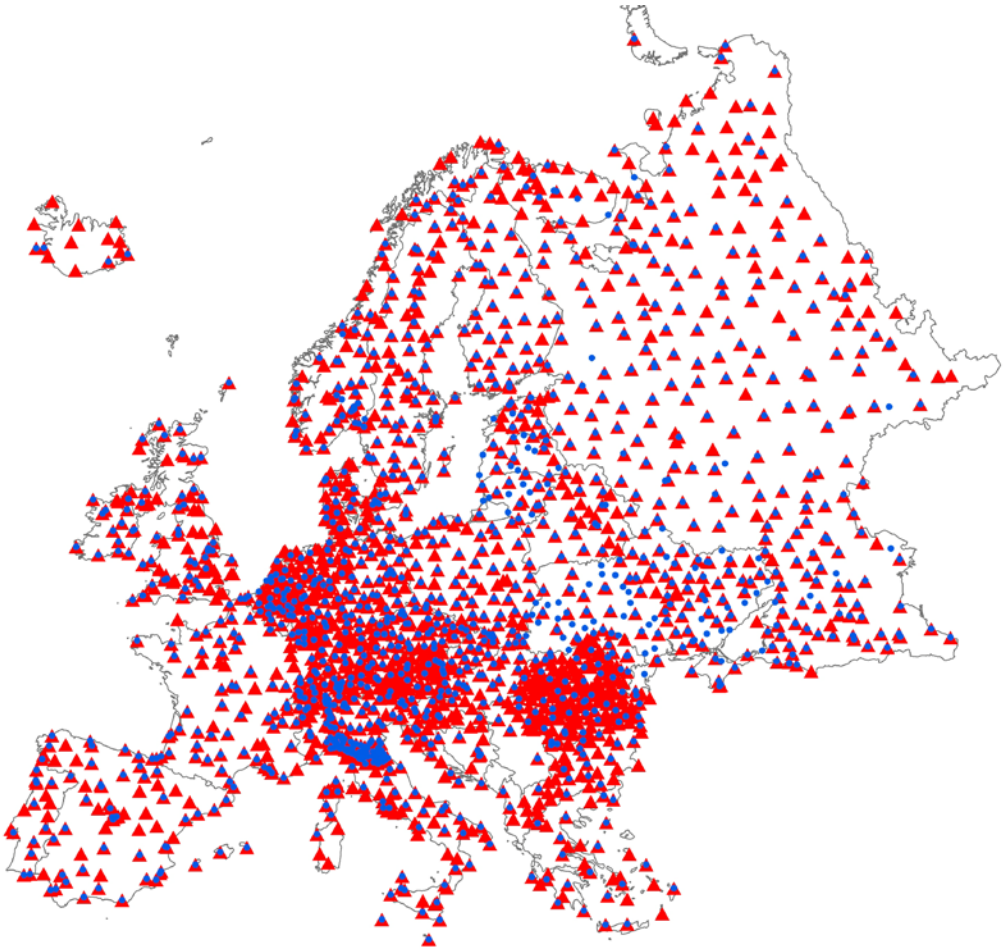
- DEM (NASA, 1 km resolution)
- Land cover (CORINE project (EEA) 100 m + USGS 1km)
- Soil (USGS 10km)



European SWAT database

Climate data

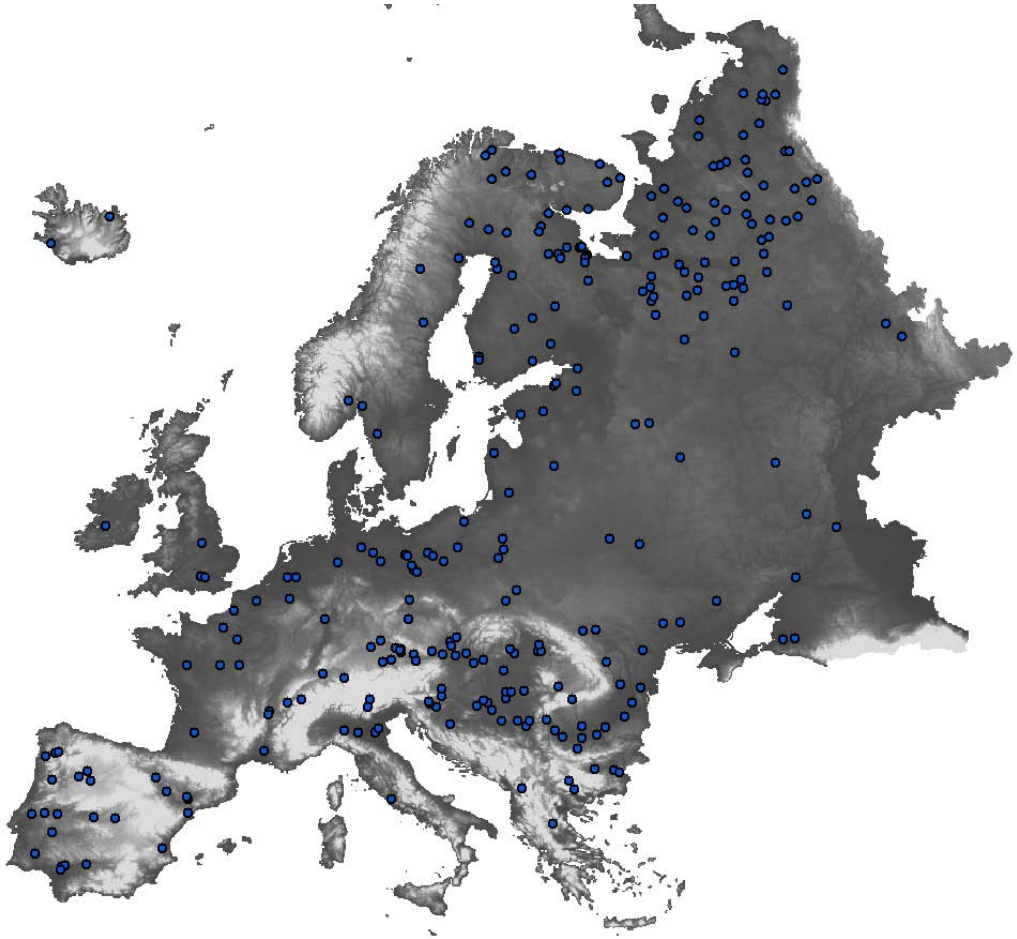
- Climate data from different sources:
  - NCDC
  - ECAD dataset (KNMI)
  - National Met Offices
- Daily temperature (red)
  - ~2000 stations
- Daily precipitation (blue)
  - ~1300 stations



European SWAT database

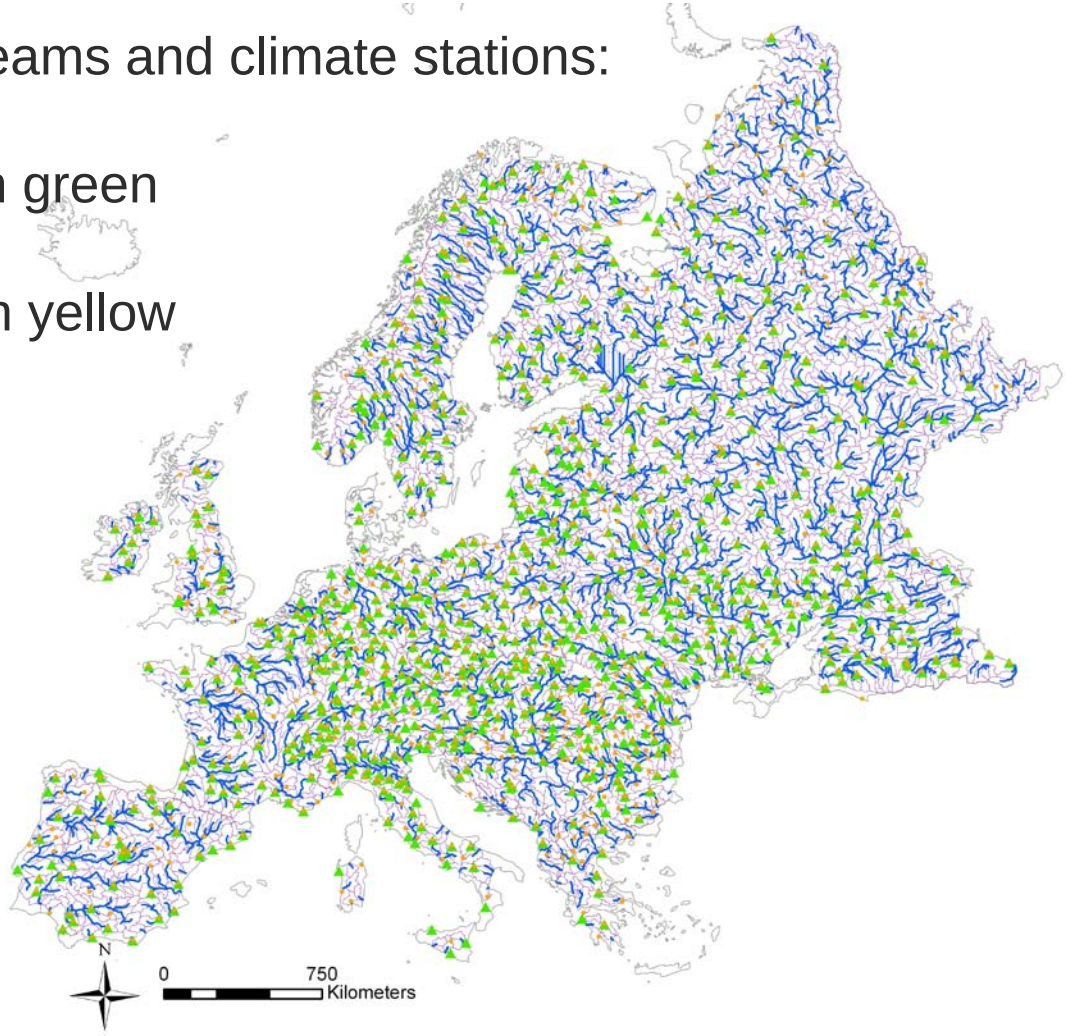
Discharge data

- Discharge, monthly means:
  - Global Runoff Data Centre



Setup of SWAT model

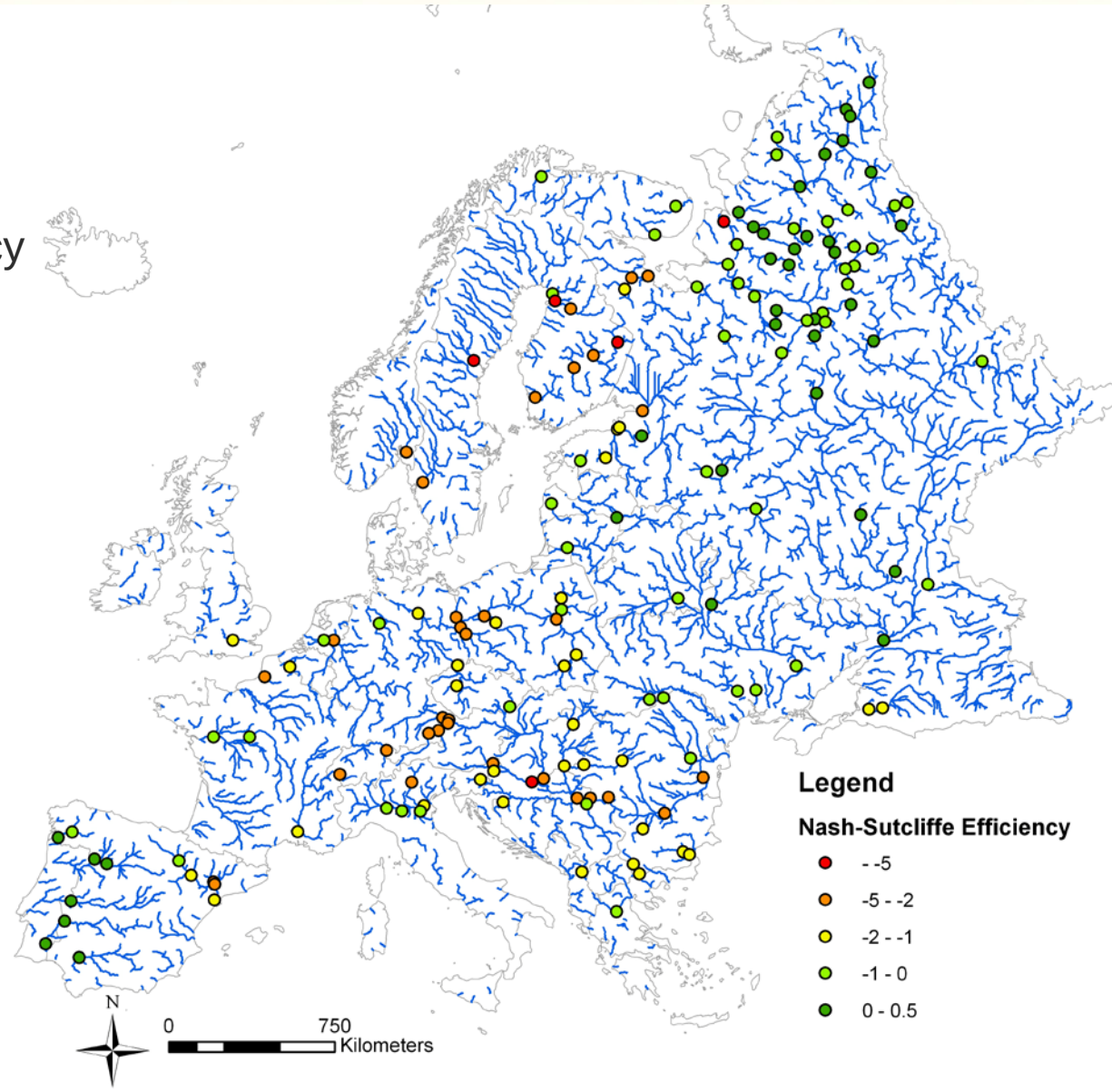
- Watershed delineation, streams and climate stations:
  - Precipitation stations in green
  - Temperature stations in yellow
- ~2000 subbasins
  using the option dominant
  land-use and soil type
  for HRU generation
- size of subbasins between
  1000 and 20‘000 km^2



Preliminary results

After 40 simulations

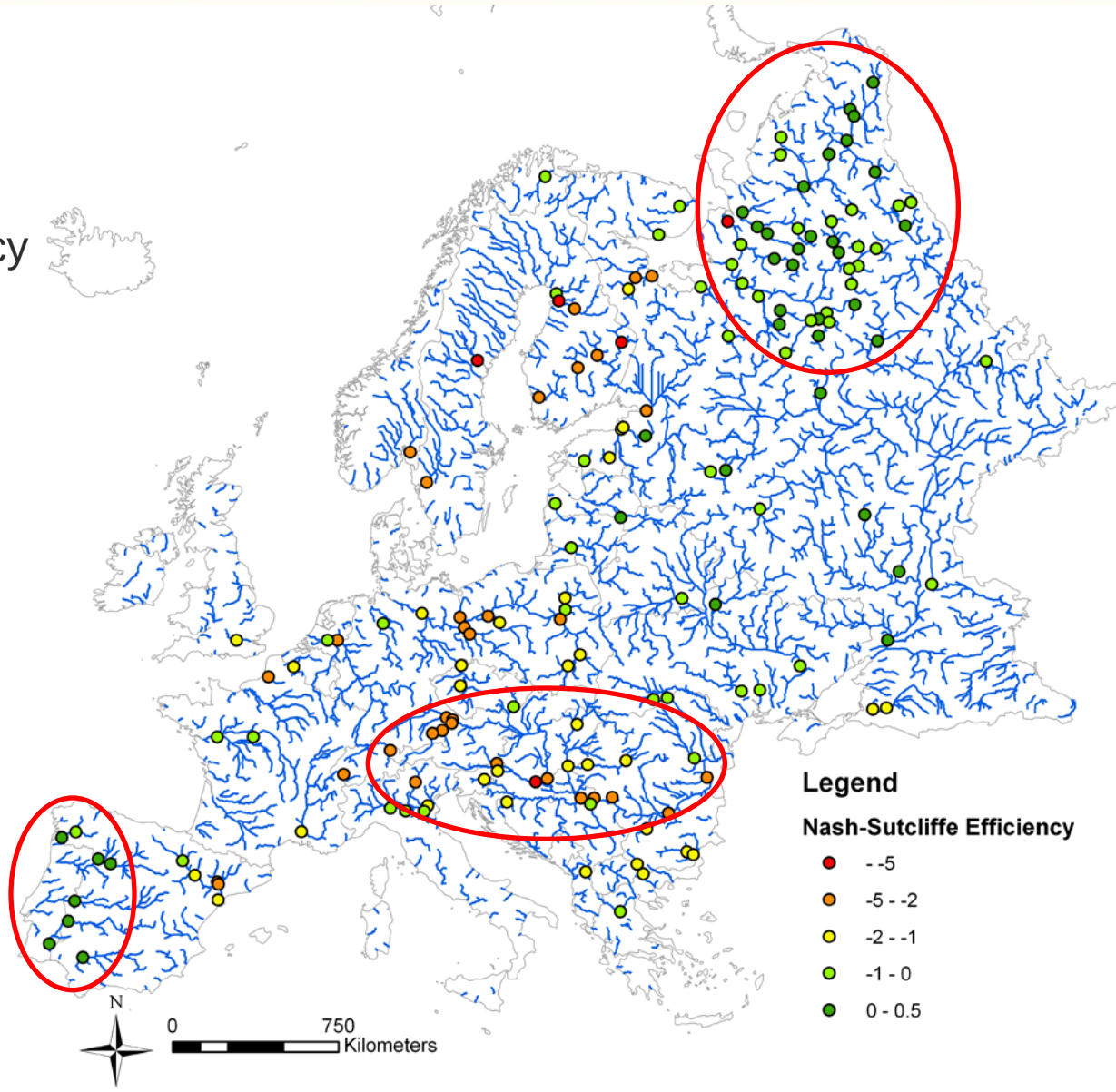
- Nash Sutcliffe Efficiency



Preliminary results

After 40 simulations

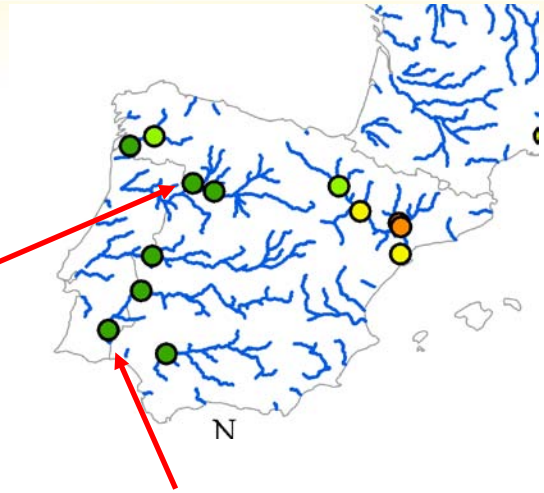
- Nash Sutcliffe Efficiency



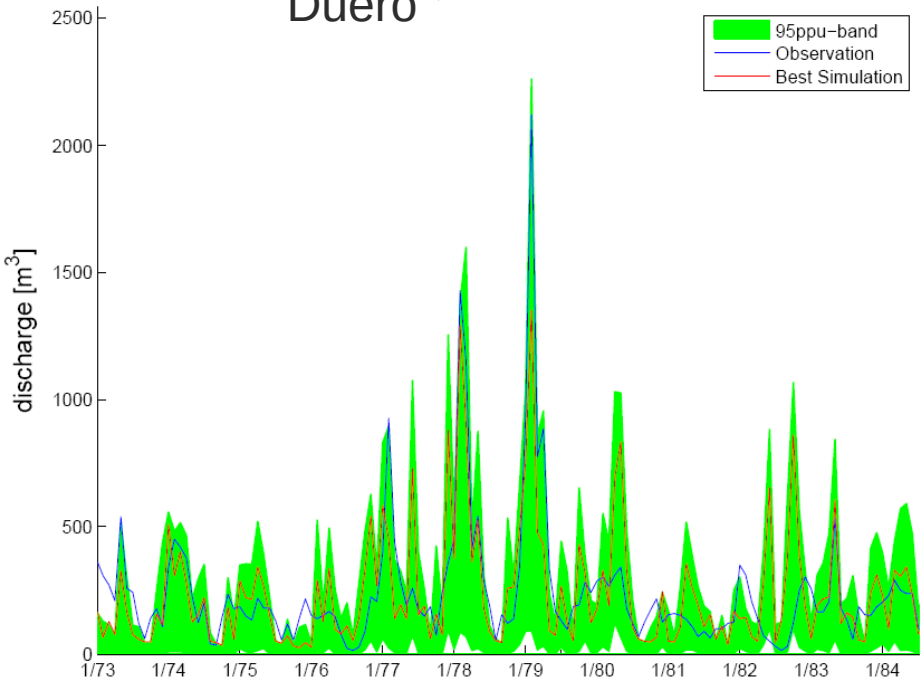
Preliminary results

Iberian Peninsula

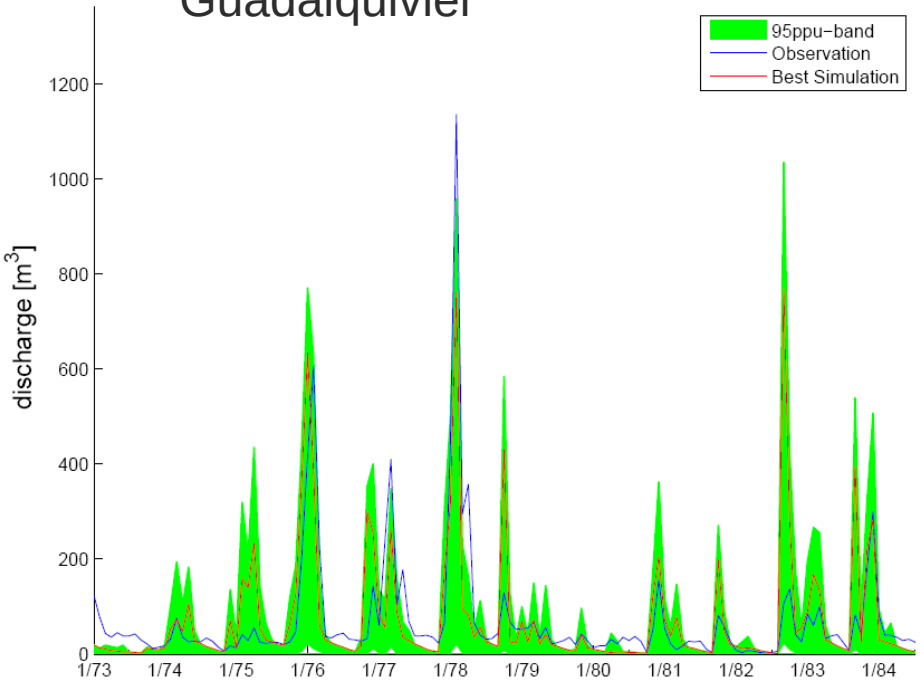
- Pattern well represented
- Calibration will improve with more runs



Duero



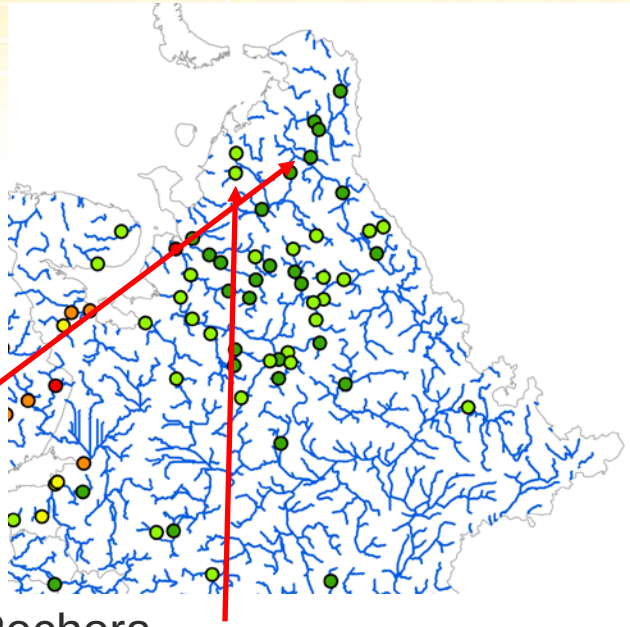
Guadalquivier



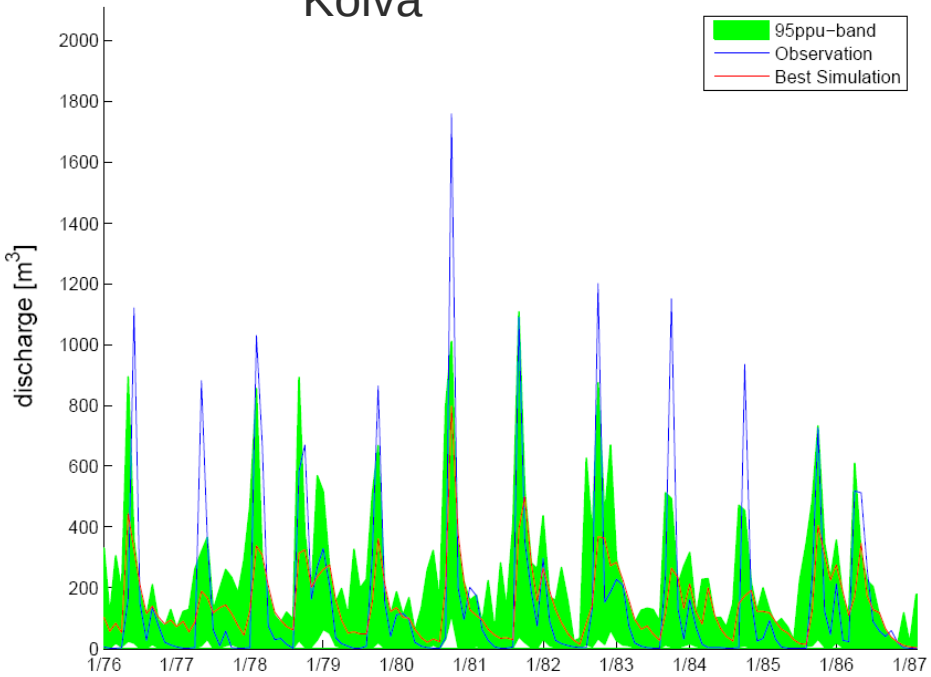
Preliminary results

North East Europe

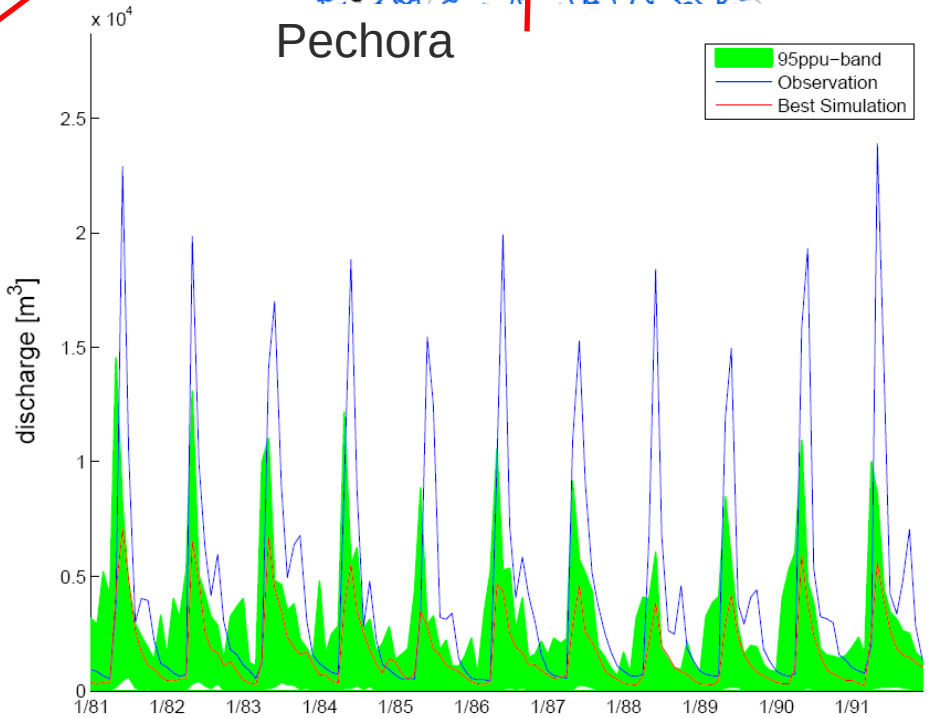
- Pattern well represented
- Height of peaks not captured
- Catchment under influence of snow cover



Kolva



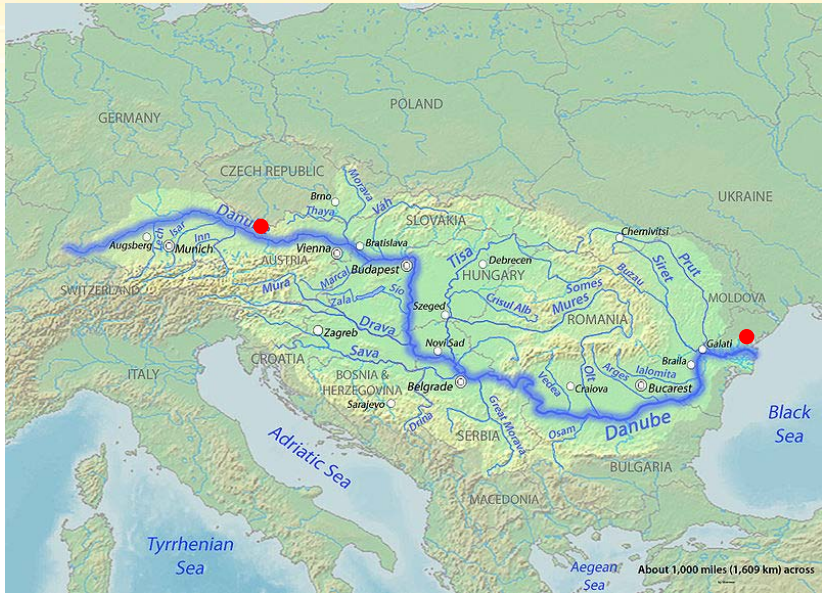
Pechora

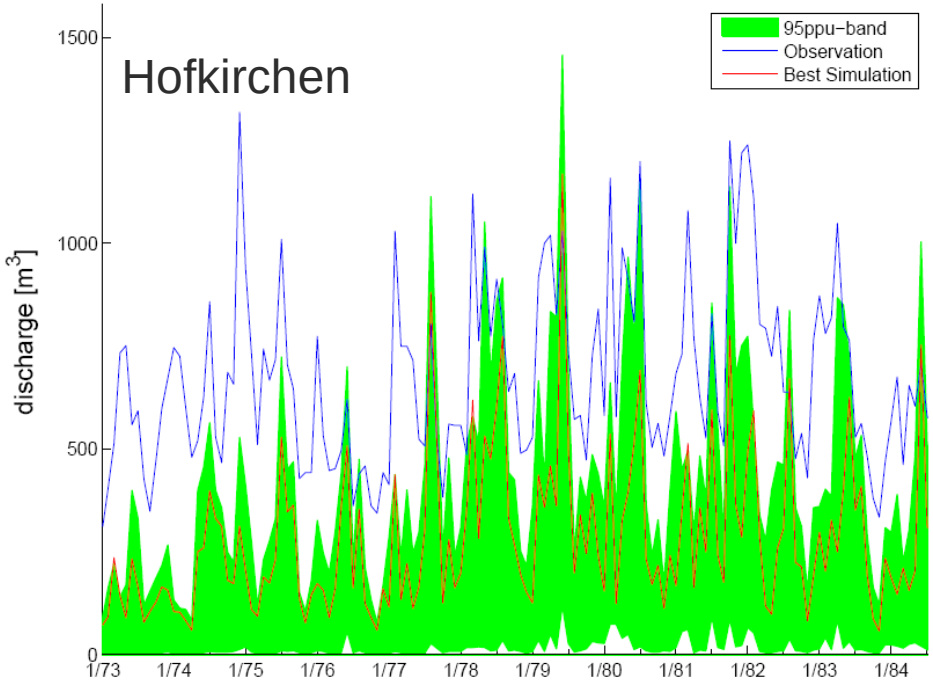


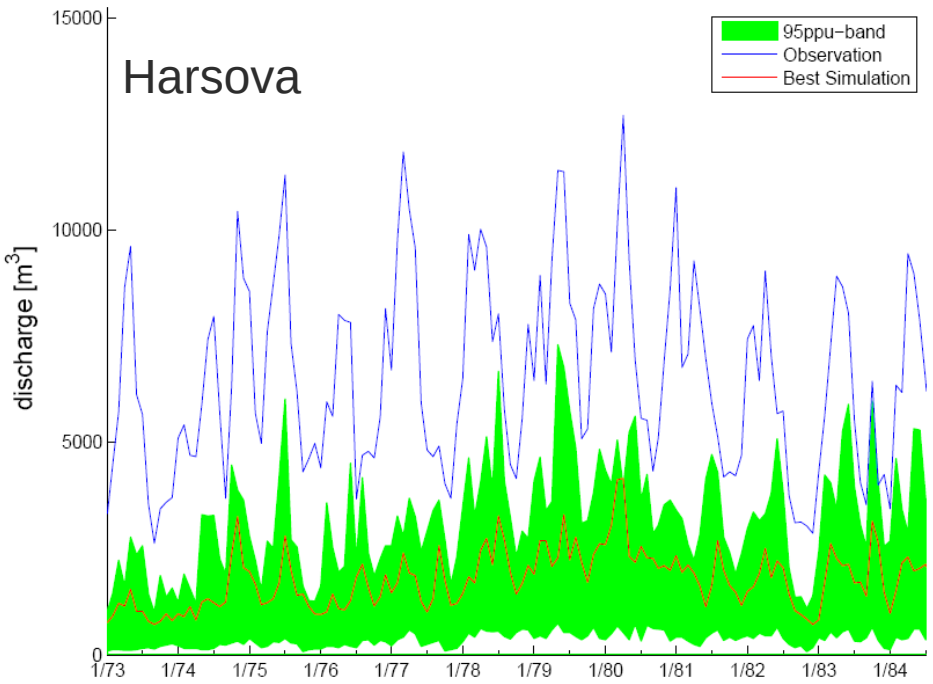
Preliminary results

Danube upstream and downstream

- Discharge underestimated
- Downstream station lacks more water
- Precipitation values ?







Conclusion

- In some regions results look promising for upcoming calibration
- Problems:
  - Local climate, snow cover
  - Climate data (precipitation)
  - River management, hydropowerplants and reservoirs
- Solution:
  - Clustering according to local characteristics, different calibration approaches for each region
  - Use of gridded climate data
  - Include reservoirs and inlets

Outlook

- Comparison of climate station data with gridded interpolated datasets (CRU, at 2.5° latitude by 3.75° longitude resolution and monthly time resolution, other datasets?)
- Calibration and validation
- Use of the calibrated model for future scenarios
    - Climate
    - Land use

Thank you for your attention!

Parameter ranges for calibration

r__CN2.mgt	-0.5	0.5
v__ALPHA_BF.gw	0.0	1.0
v__GW_DELAY.gw	0.0	100
v__GWQMN.gw	0	5000
v__GW_REVAP.gw	0.02	0.2
v__REVAPMN.gw	0	500
v__RCHRG_DP.gw	0	1
v__CH_N2.rte	0.0	0.3
v__CH_K2.rte	0.0	100
r__SOL_AWC(1).sol	-0.5	0.5
r__SOL_K(1).sol	-0.5	0.5
r__SOL_BD(1).sol	-0.2	0.2
v__SFTMP.bsn	-5	5
v__SMTMP.bsn	-5	5
v__SMFMX.bsn	0	10
v__SMFMN.bsn	0	10
v__ESCO.bsn	0.01	1
v__EPCO.bsn	0.01	1
v__SNOCOVMX.bsn	0	500
v__SNO50COV.bsn	0.01	0.99