Increasing the spatial resolution of the CTRIP routing model: hydrological impacts over France

S. Munier (CNRM/GMME/SURFACE)
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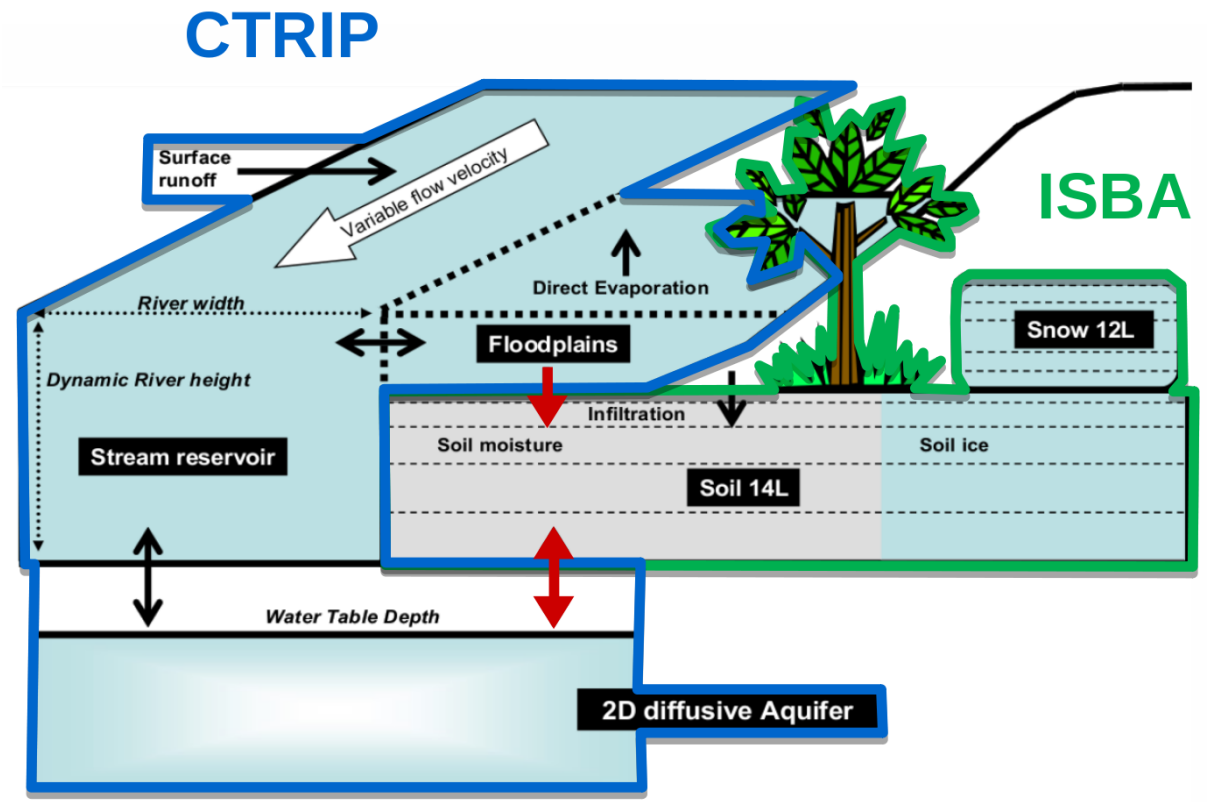
SURFEX-CTRIP hydrological system

- **CTRIP** : CNRM version of the TRIP based river routing system
  - ➔ variable flow velocity
  - ➔ flooding by river overflow
  - ➔ aquifers

  (Oki and Sud, 1998, Decharme et al., 2008, 2010)

- **ISBA-A-gs** : simulates the diurnal cycle of :
  - ➔ water and carbon fluxes
  - ➔ plant growth
  - ➔ vegetation variables

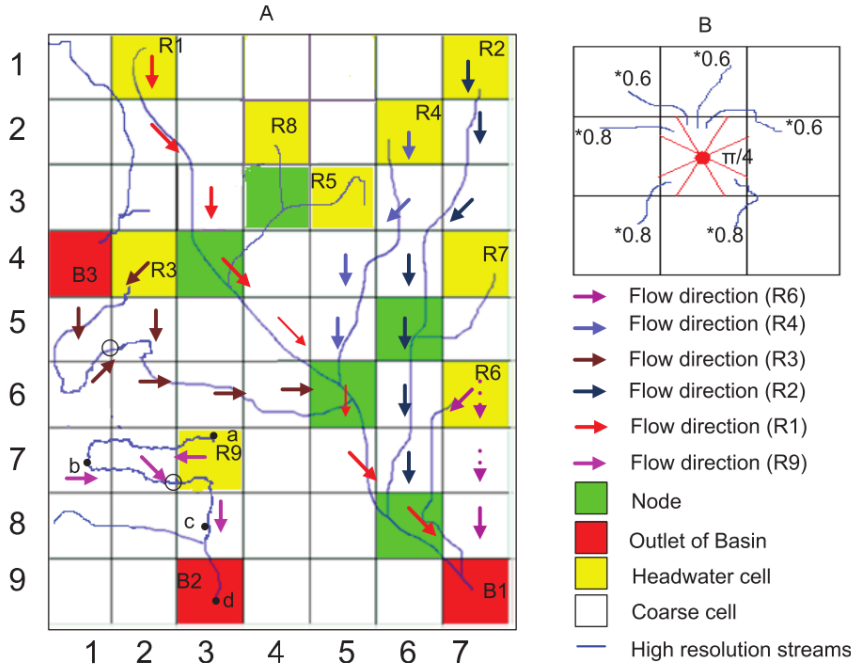
  (Calvet et al., 1998, 2007, Gibelin et al., 2006)



CTRIP 12D : a CTRIP version at 1/12° resolution

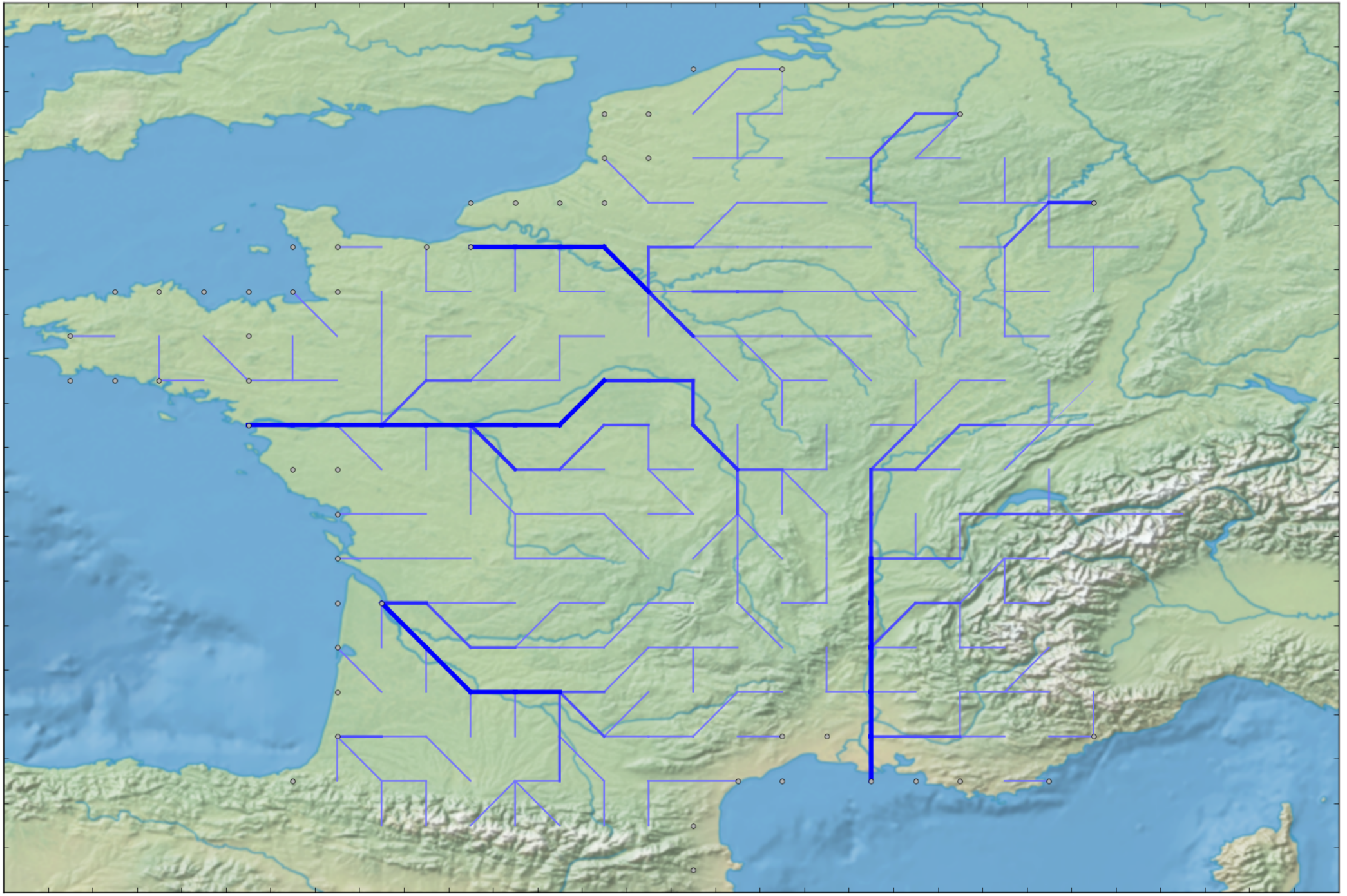
- Upscaling of the river network from MERIT DEM (Yamazaki et al., 2017)
  - high-accuracy global DEM at 3″ resolution (~90 m at the equator)
  - removal of major error components from existing DEMs
- Hierarchical Dominant River Tracing (Wu et al., 2011)
  - Extraction and upscaling of flow direction (D8)
  - Major rivers computed first
  - River diversion when necessary
  - Fully automated algorithm (no manual correction)

} ***river network structure preserved***



Wu et al., 2011

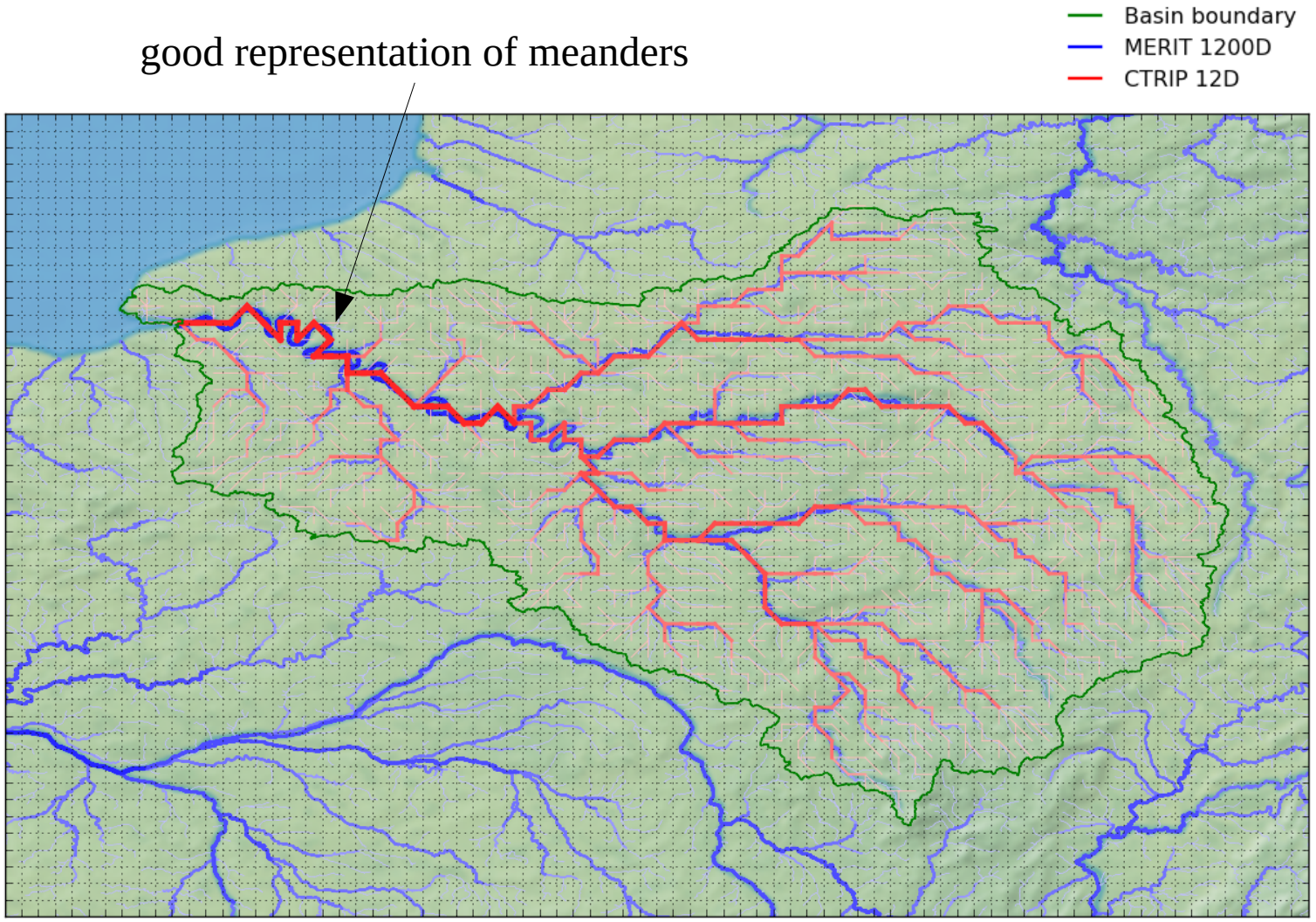
CTRIP 2D



CTRIP 12D

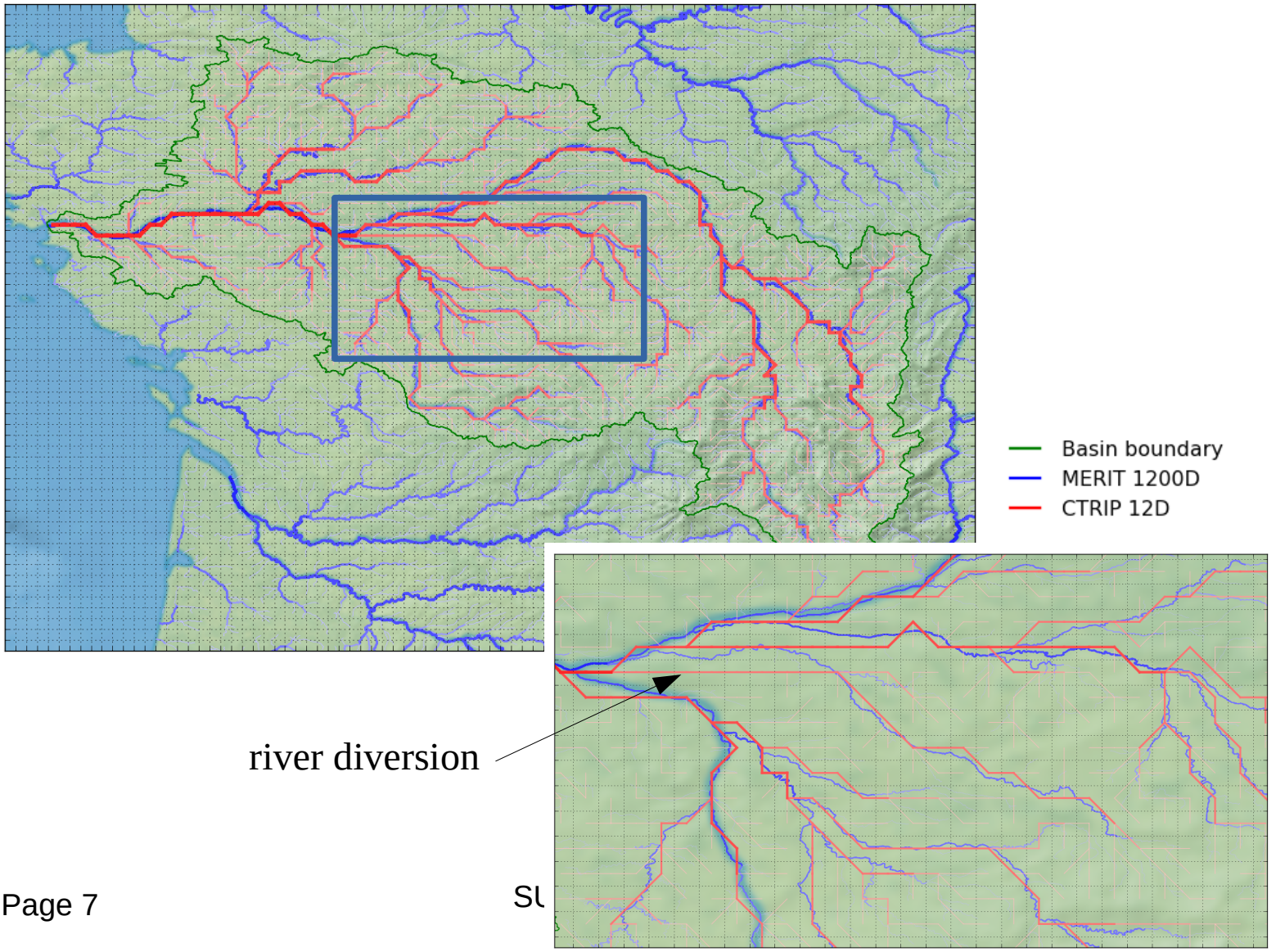
CTRIP 12D

- Some examples: Seine basin



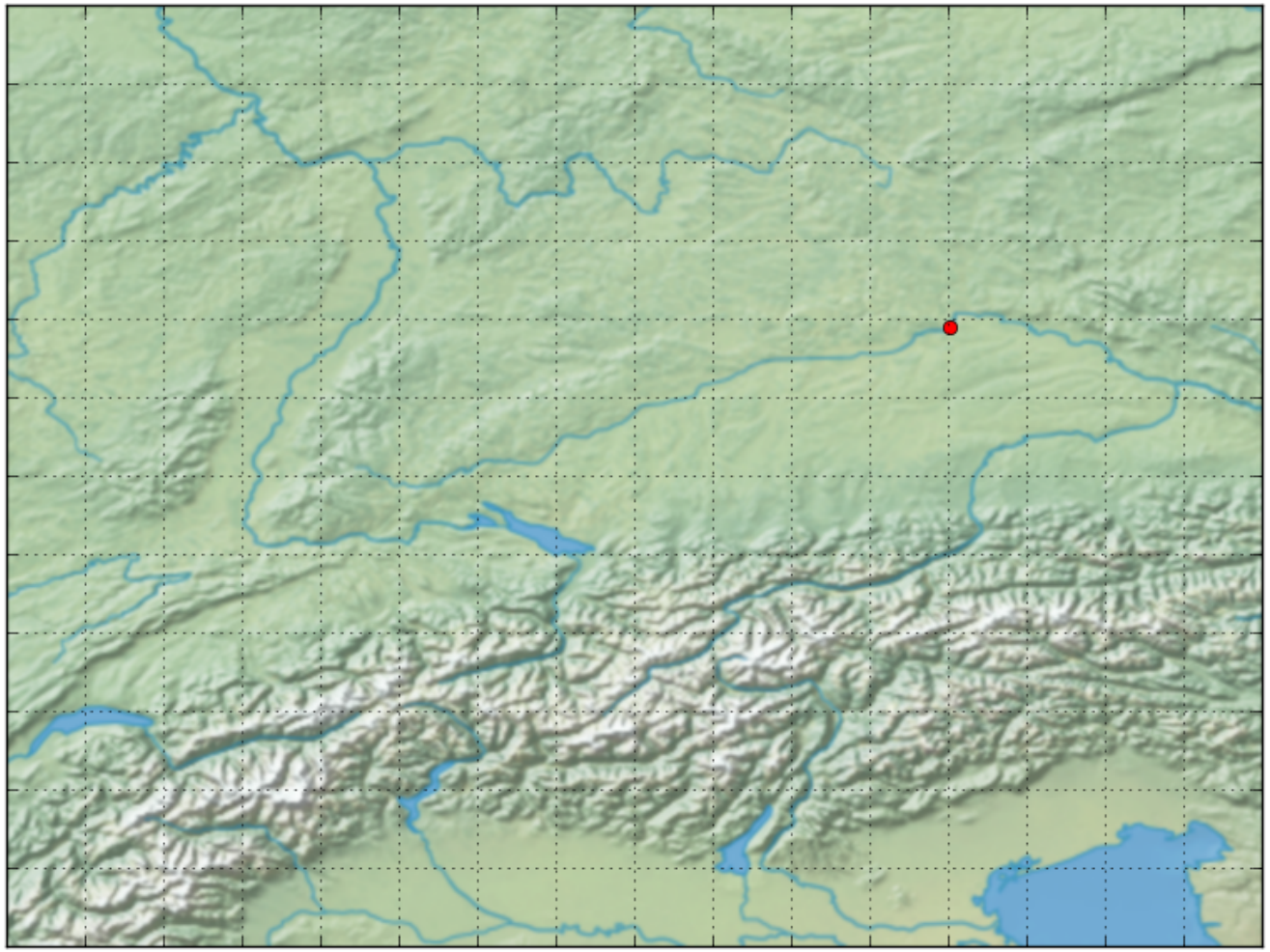
CTRIP 12D

- Some examples: Loire basin



Comparing CTRIP results with observations

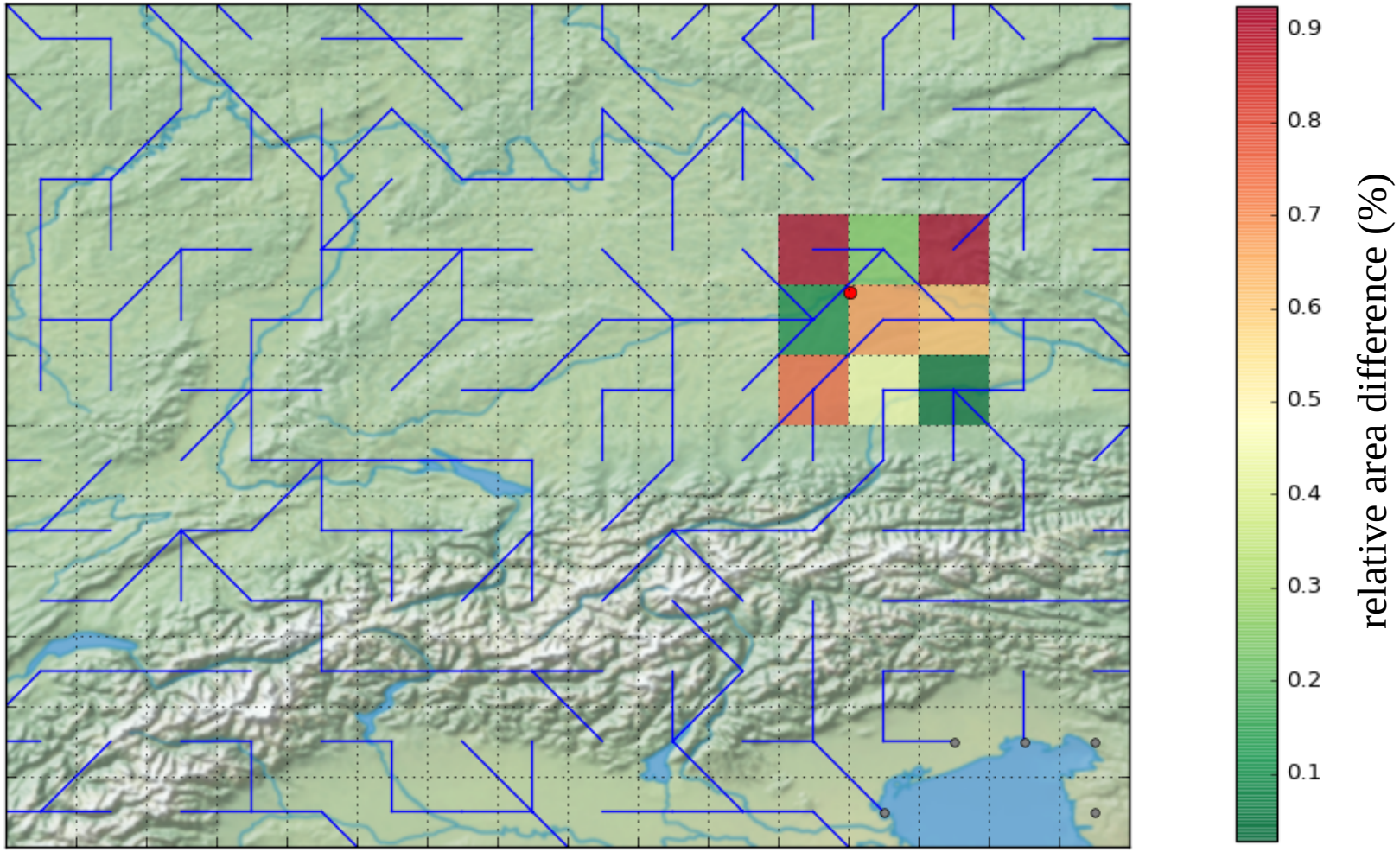
- What is the CTRIP pixel corresponding to a given gauge station?



id	4918
db	R2D2
nat_id	6342910
source	GRDC
name	OBERNDORF
river	DANUBE RIVER
country	DE
lon	12.0149
lat	48.947
area	26448
start	1925-11-01
end	2009-12-30
length	85

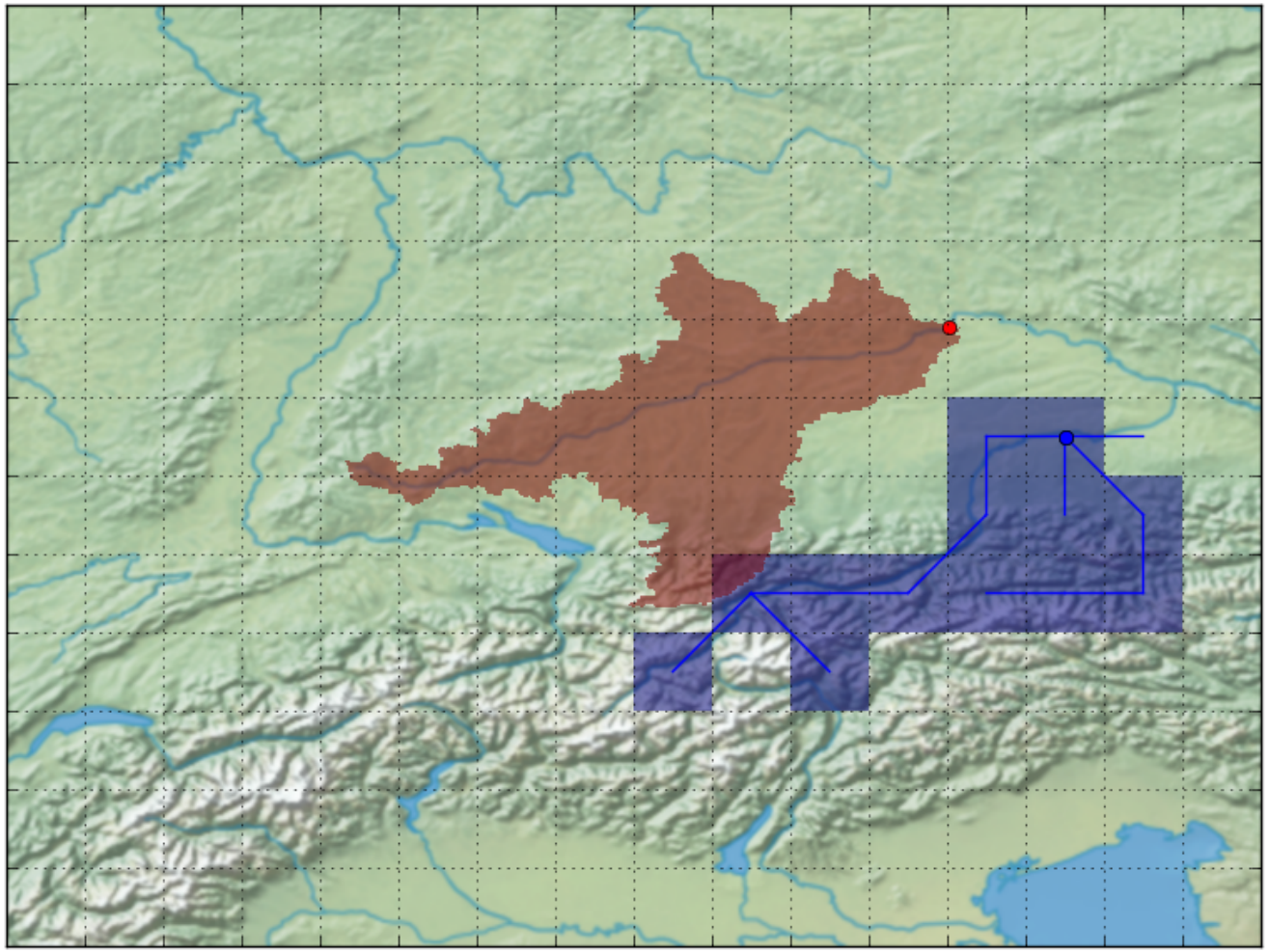
Comparing CTRIP results with observations

- What is the CTRIP pixel corresponding to a given gauge station?
  - ➔ Classical method: comparison of drainage area (station metadata)



Comparing CTRIP results with observations

- What is the CTRIP pixel corresponding to a given gauge station?
  - ➔ Advanced method: basin mask overlapping



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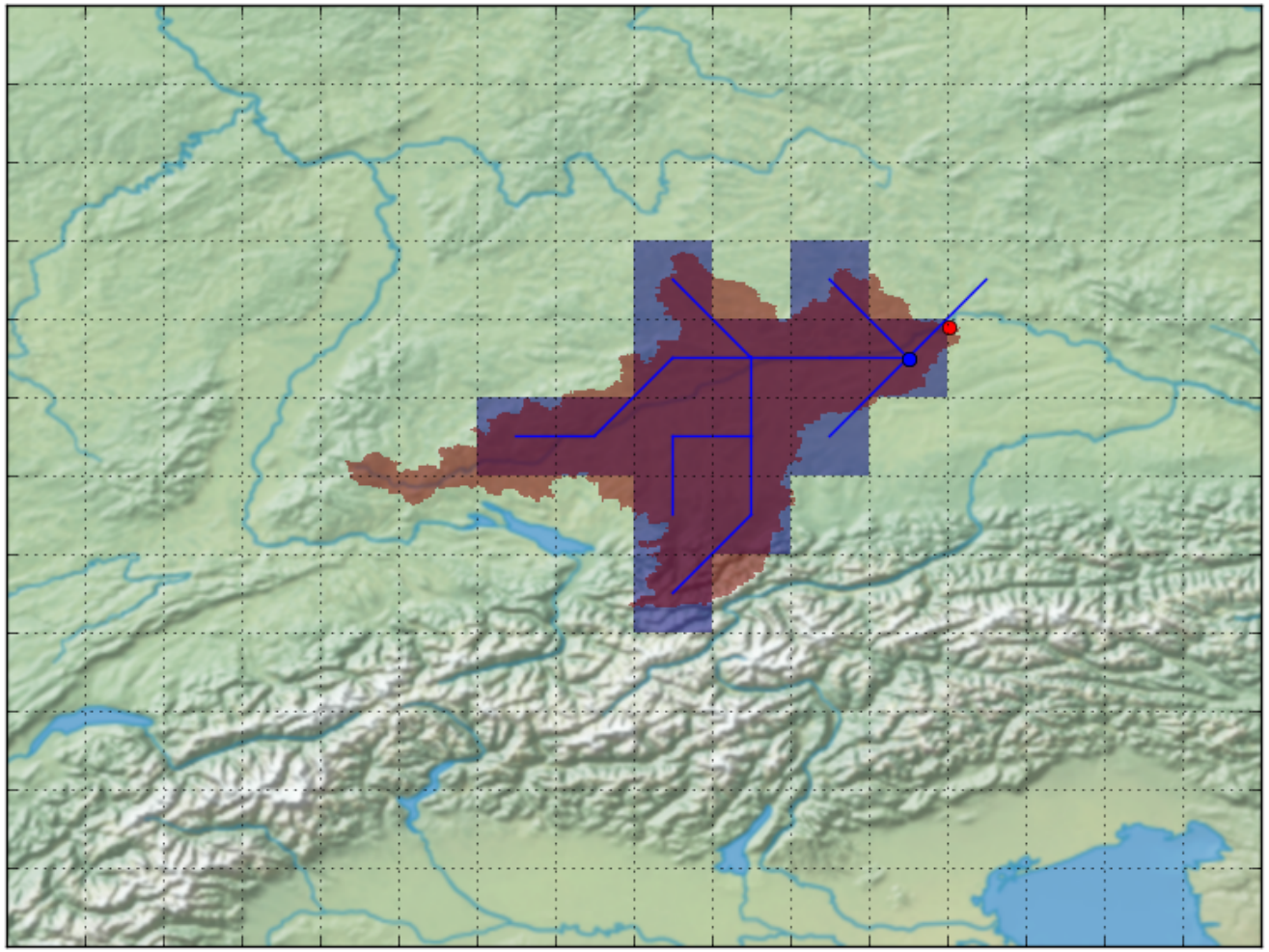

Comparing CTRIP results with observations

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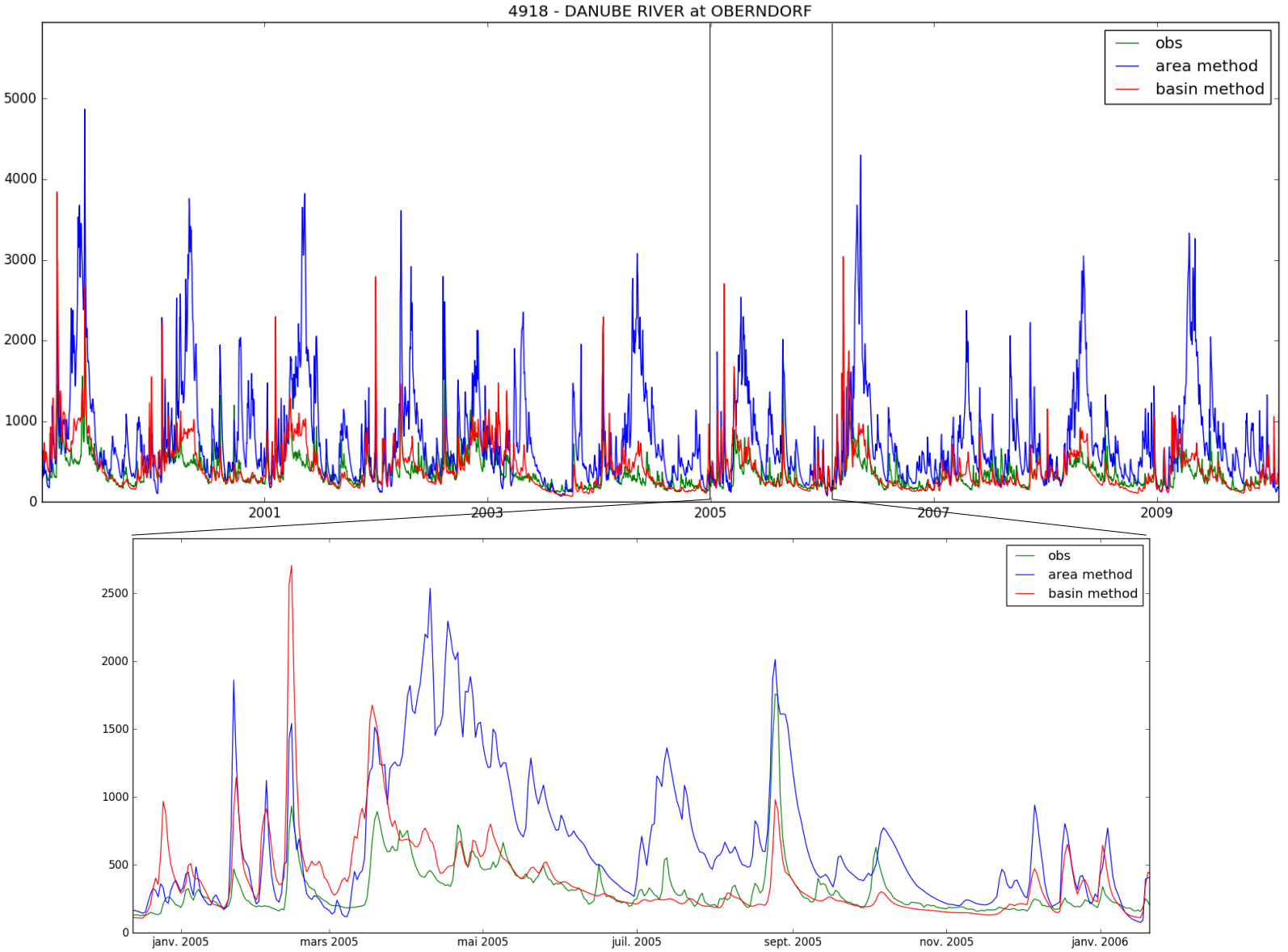
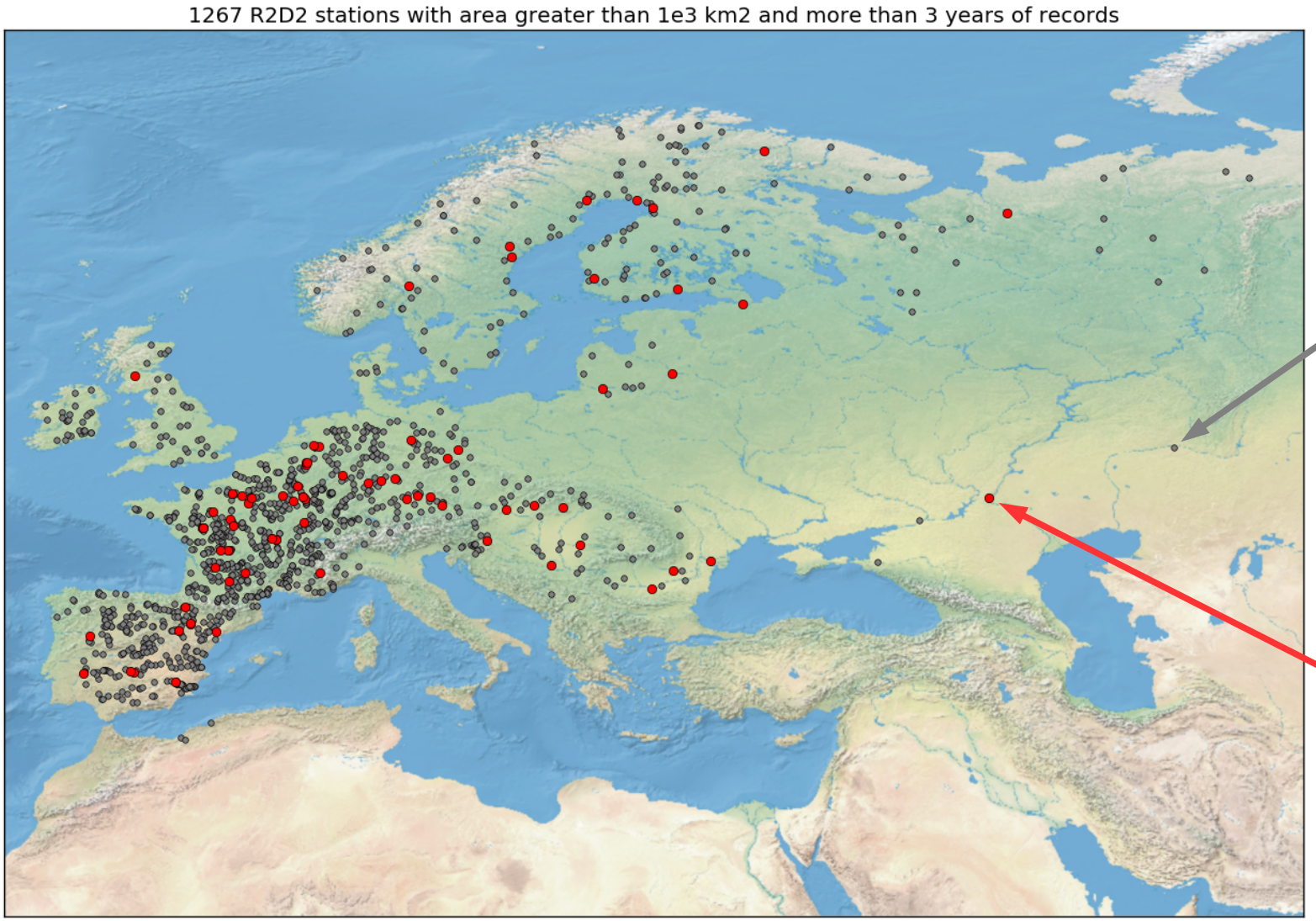
  - ➔ Advanced method: basin mask overlapping



NSE = -0.22

NSE = 0.50

Comparing CTRIP results with observations



Simulation results

- CTRIP simulation configuration
  - CTRIP forcing: SAFRAN – ISBA (8 km)
  - CTRIP 2D vs CTRIP12D
  - Modeling options:

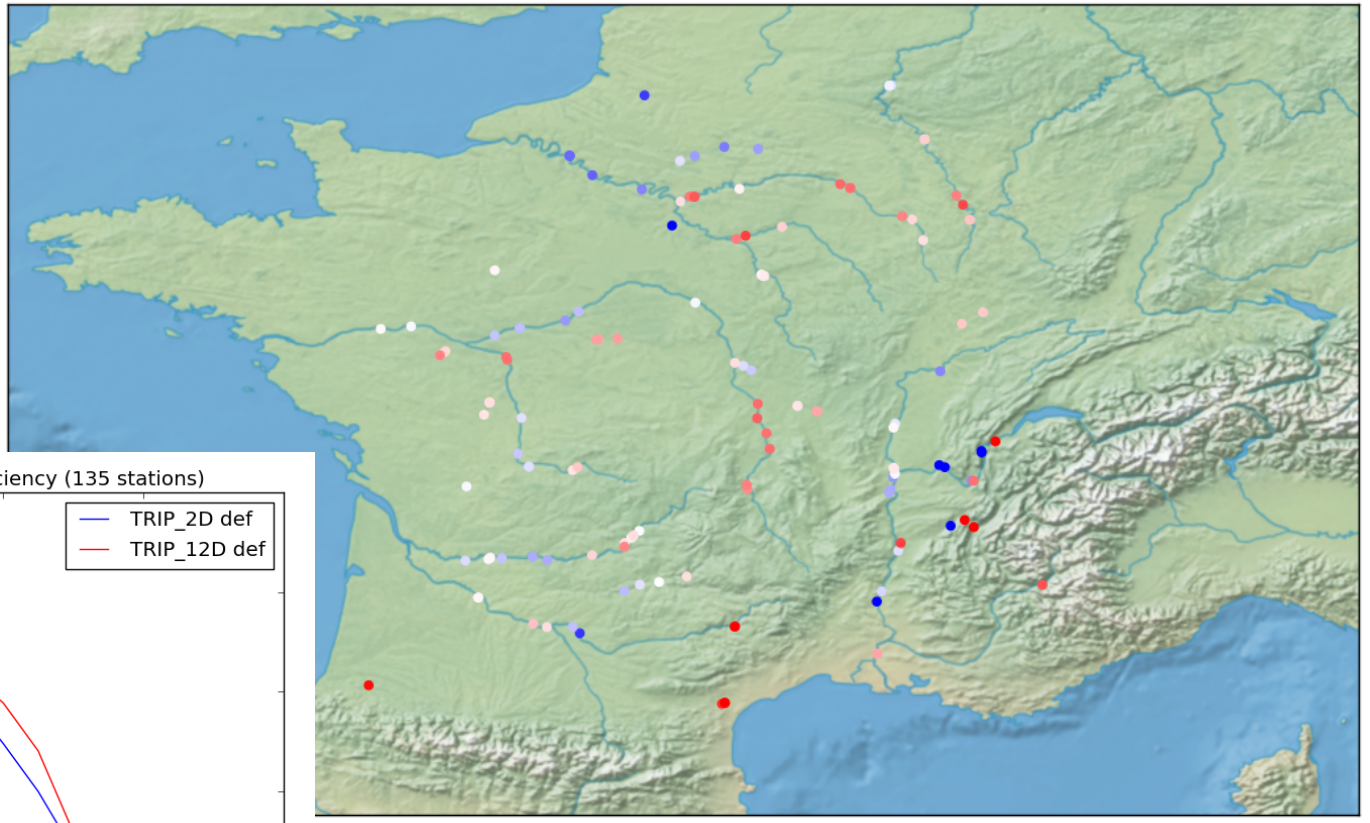
config	def	vit	vitgw
options	Manning	+ variable flow velocity	+ groundwater

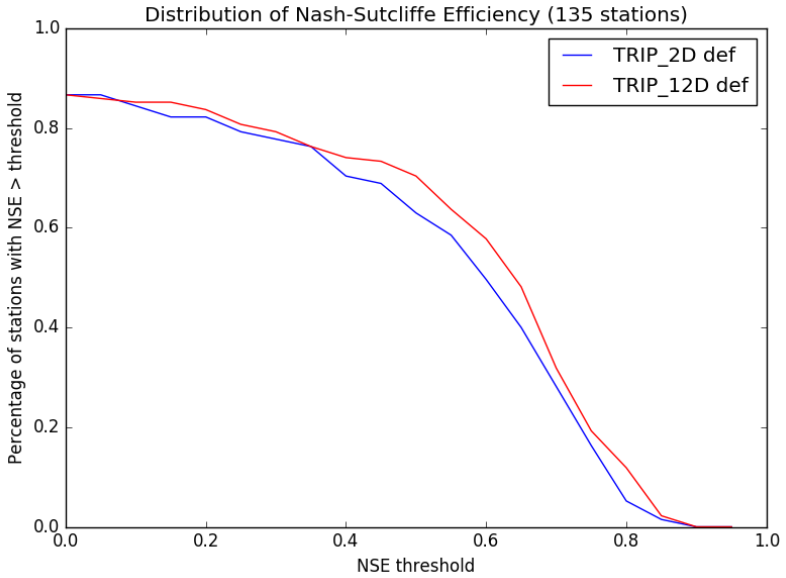
- Performances against discharge observations
  - NSE: Nash-Sutcliffe Efficiency
  - Discharge ratio (Qsim/Qobs)
  - Correlation

- Comparison with MODCOU (from the SIM2 operational chain)

Simulation results

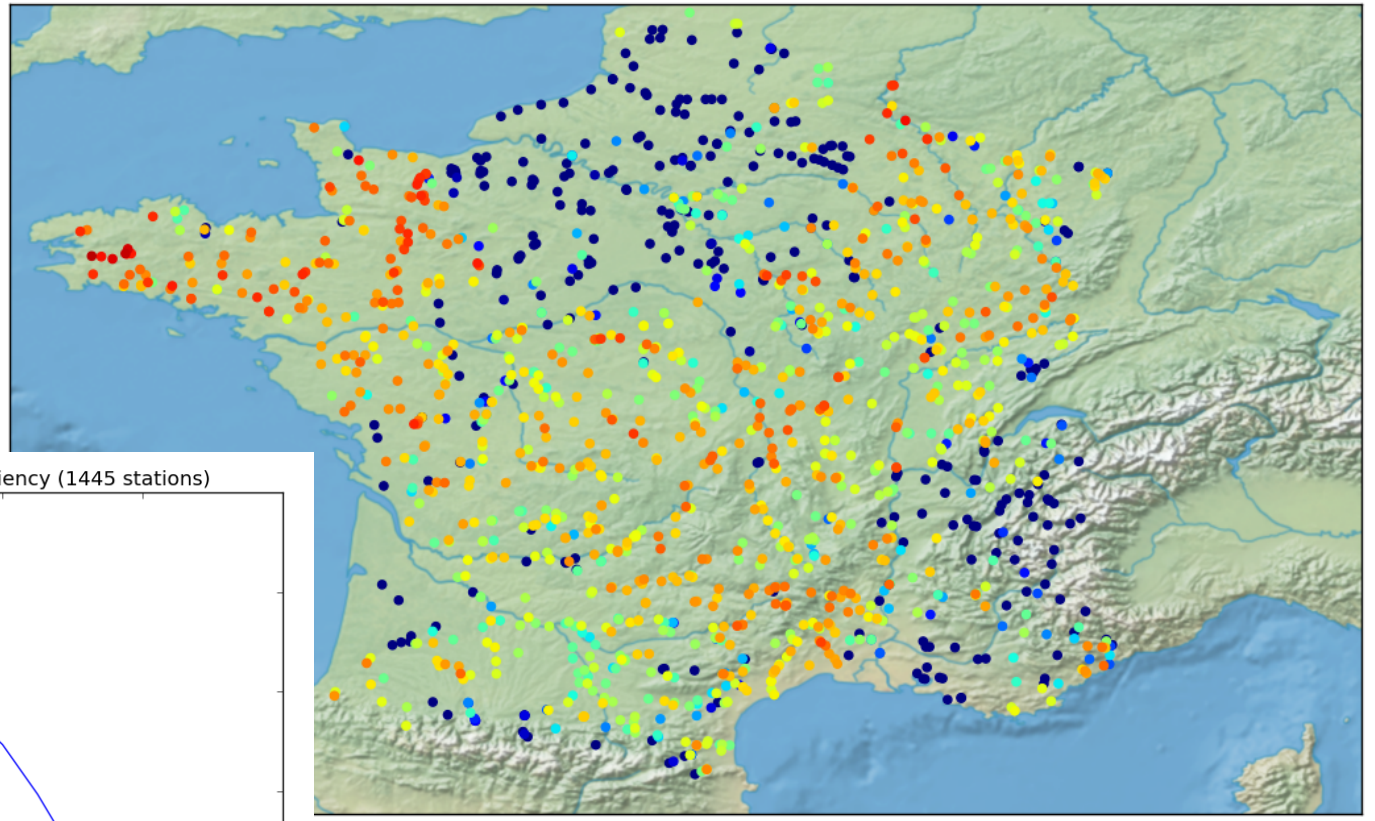
- **CTRIP 12D def** vs **CTRIP 2D def**: NSE

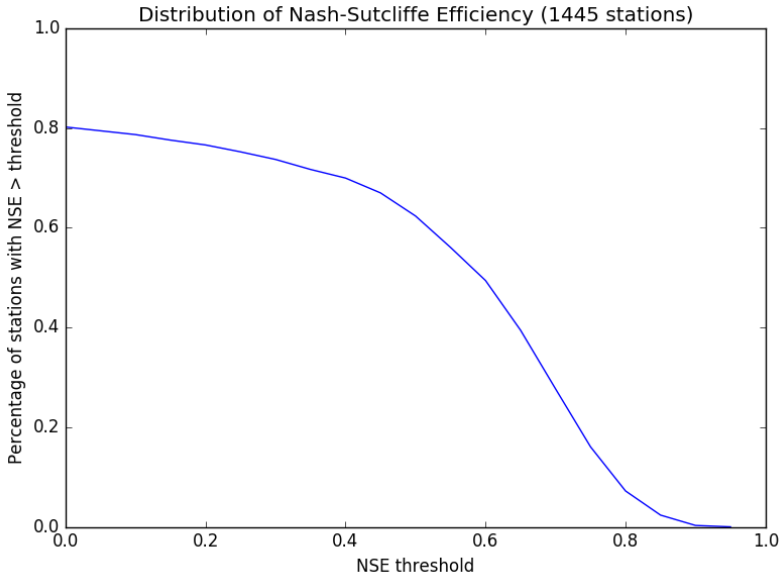




Simulation results

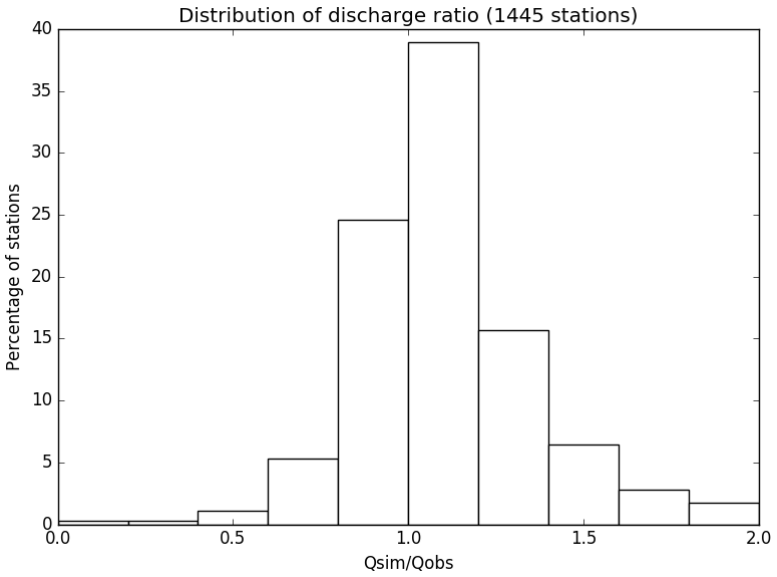
- **CTRIP 12D def**: NSE

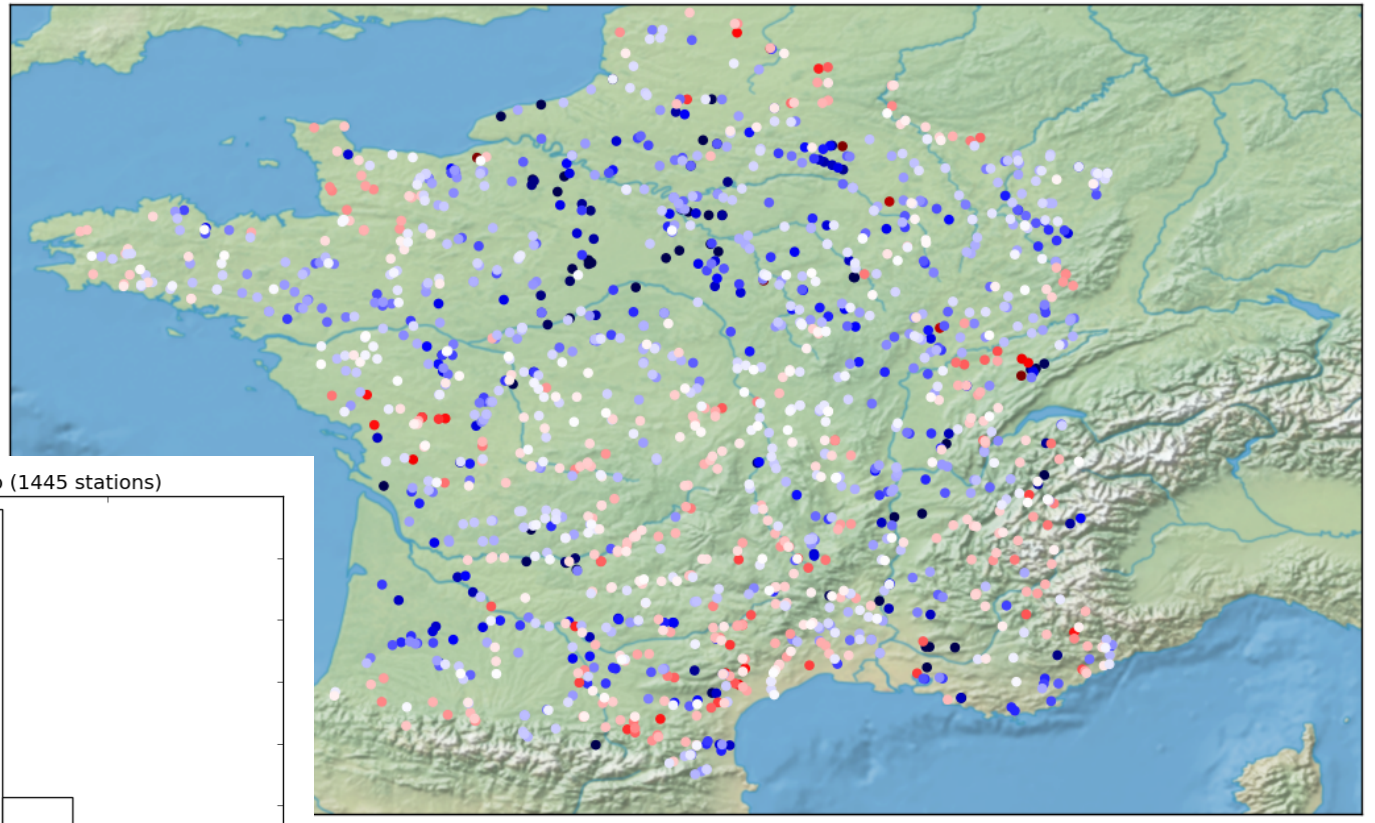


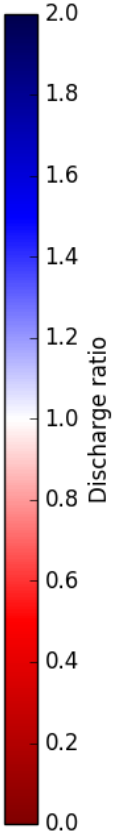


Simulation results

- **CTRIP 12D def**: ratio

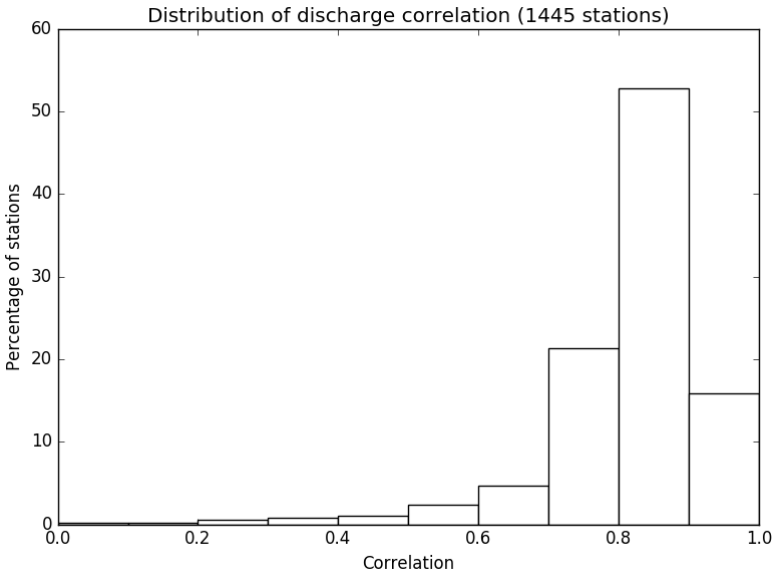


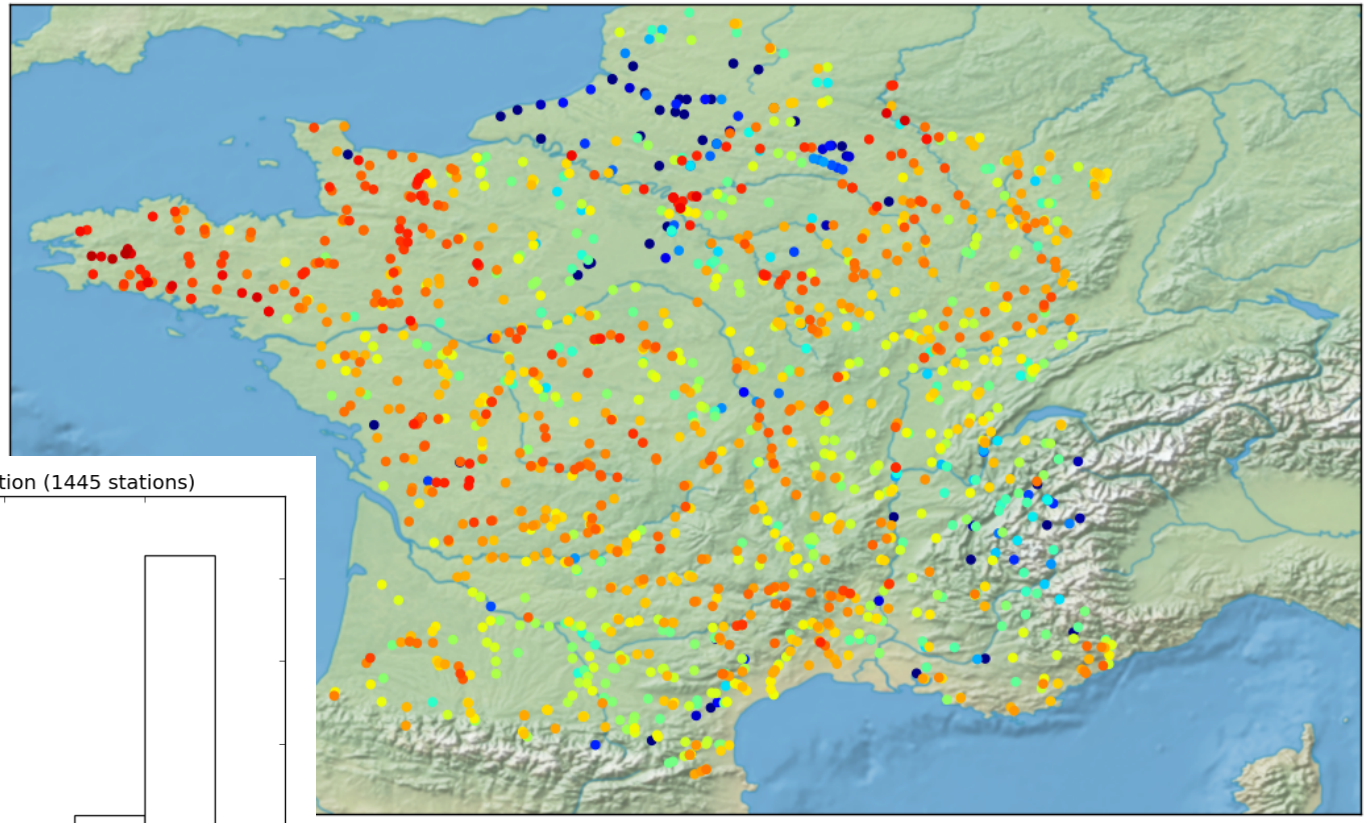


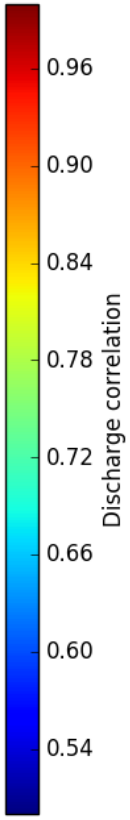


Simulation results

- **CTRIP 12D def**: correlation

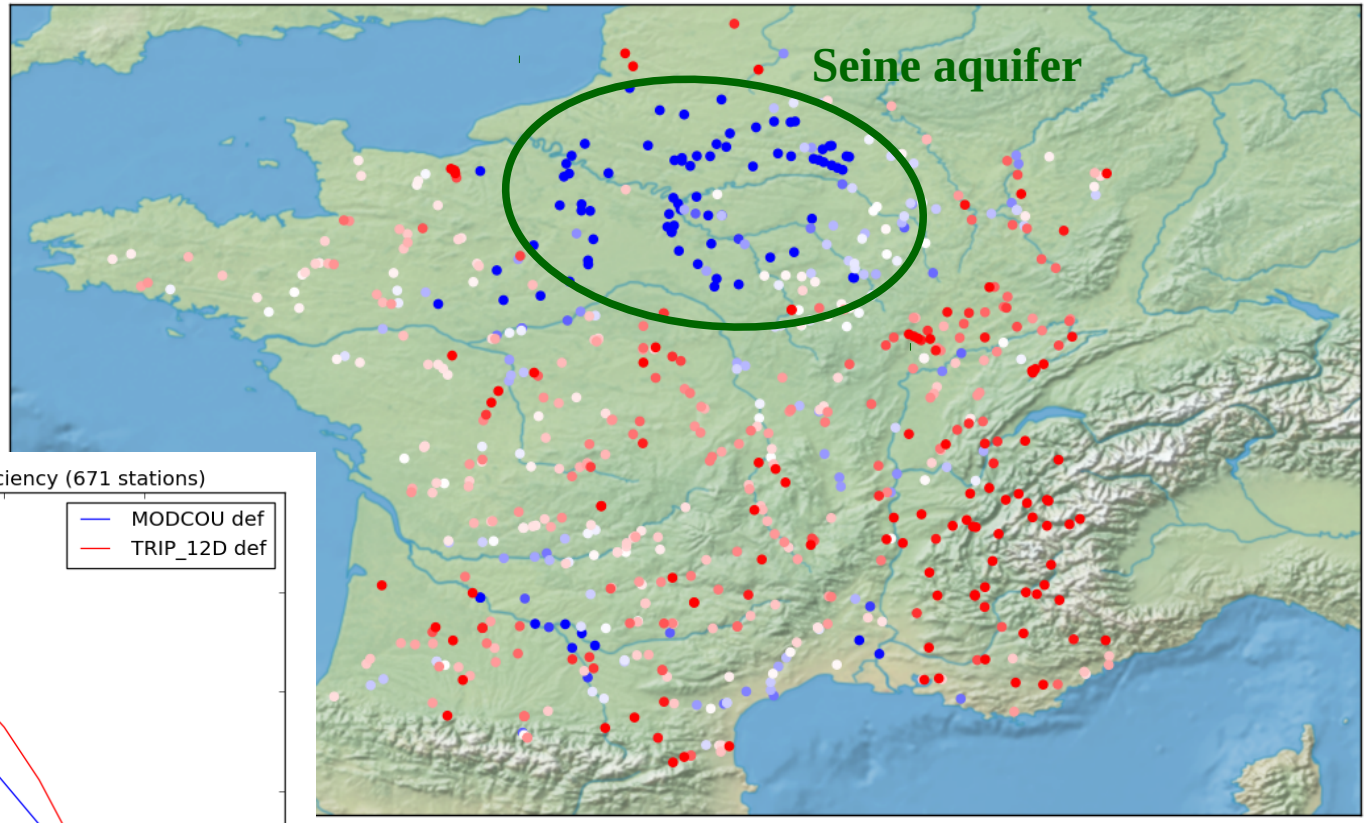


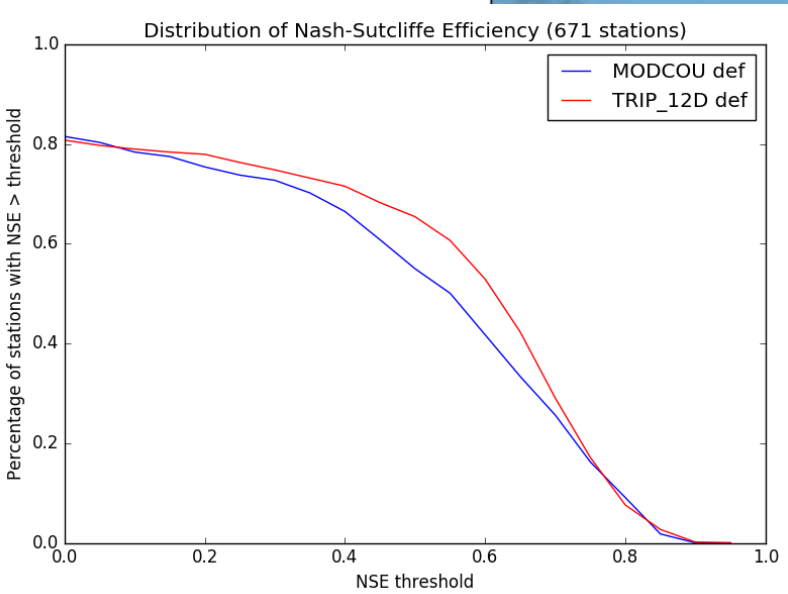


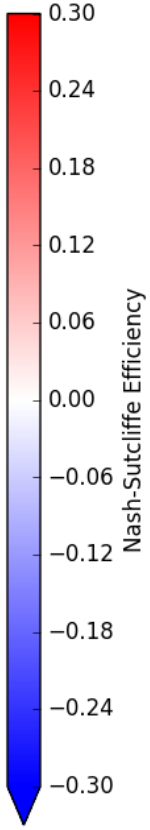


Simulation results

- **CTRIP 12D def** vs **MODCOU**: NSE







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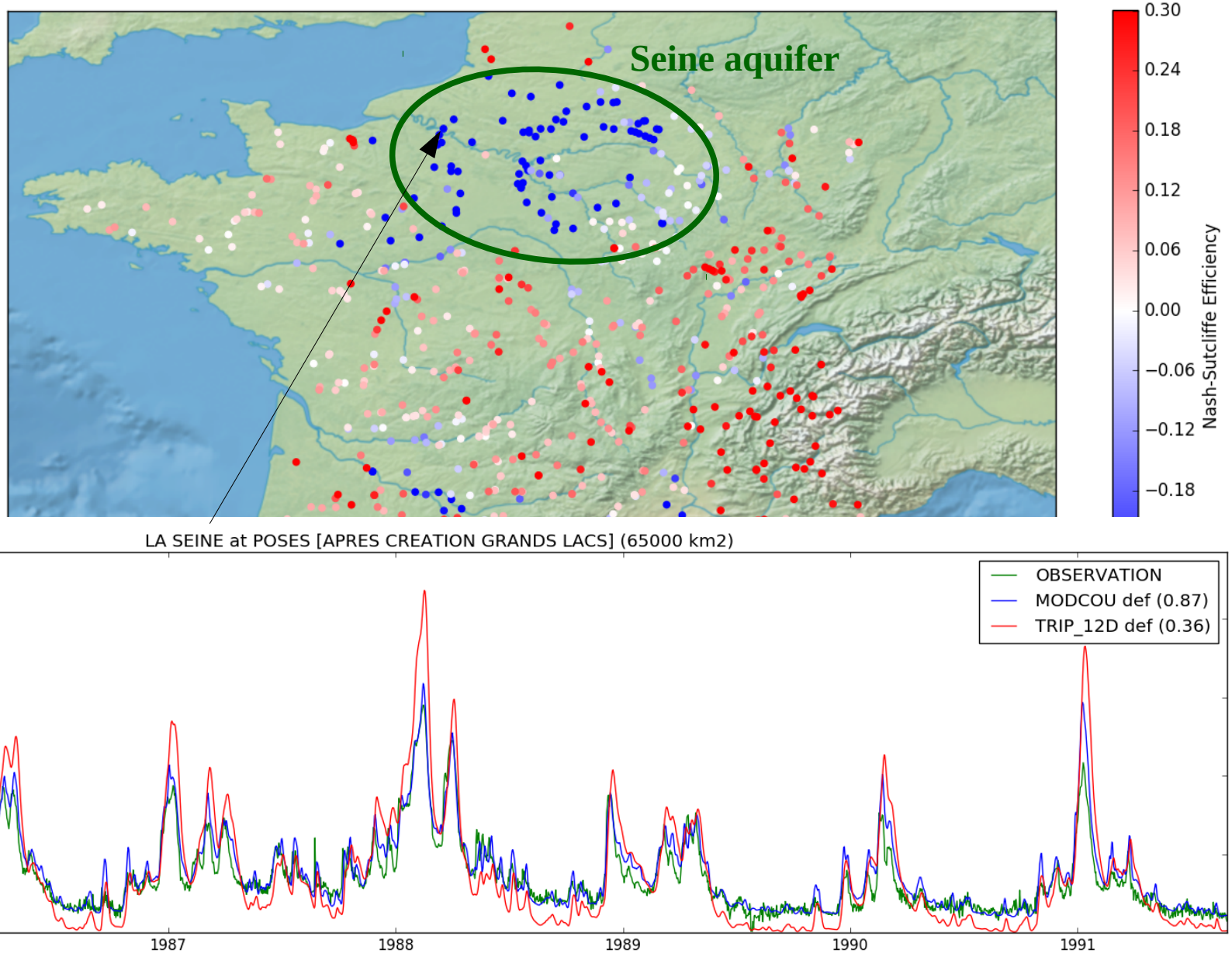

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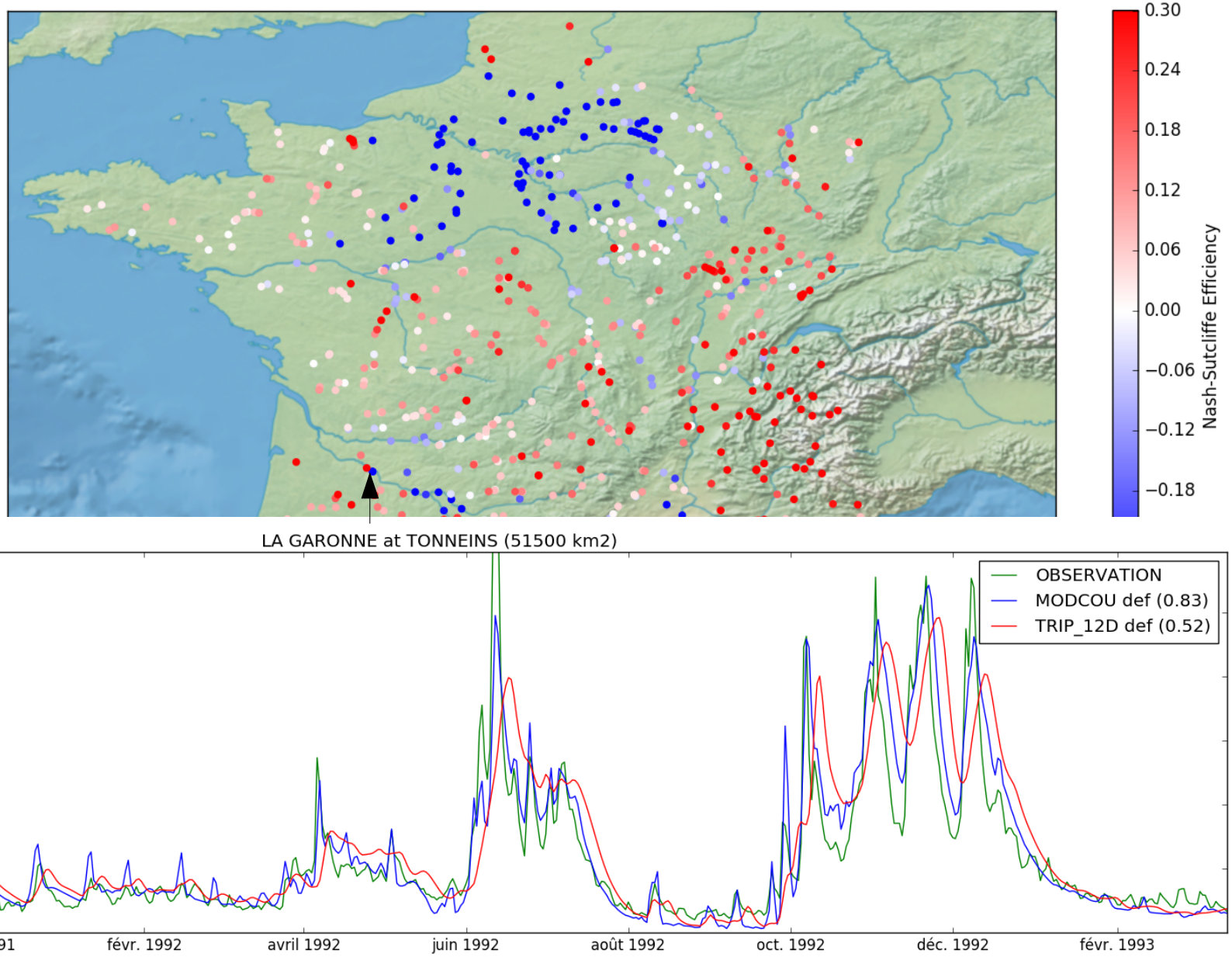
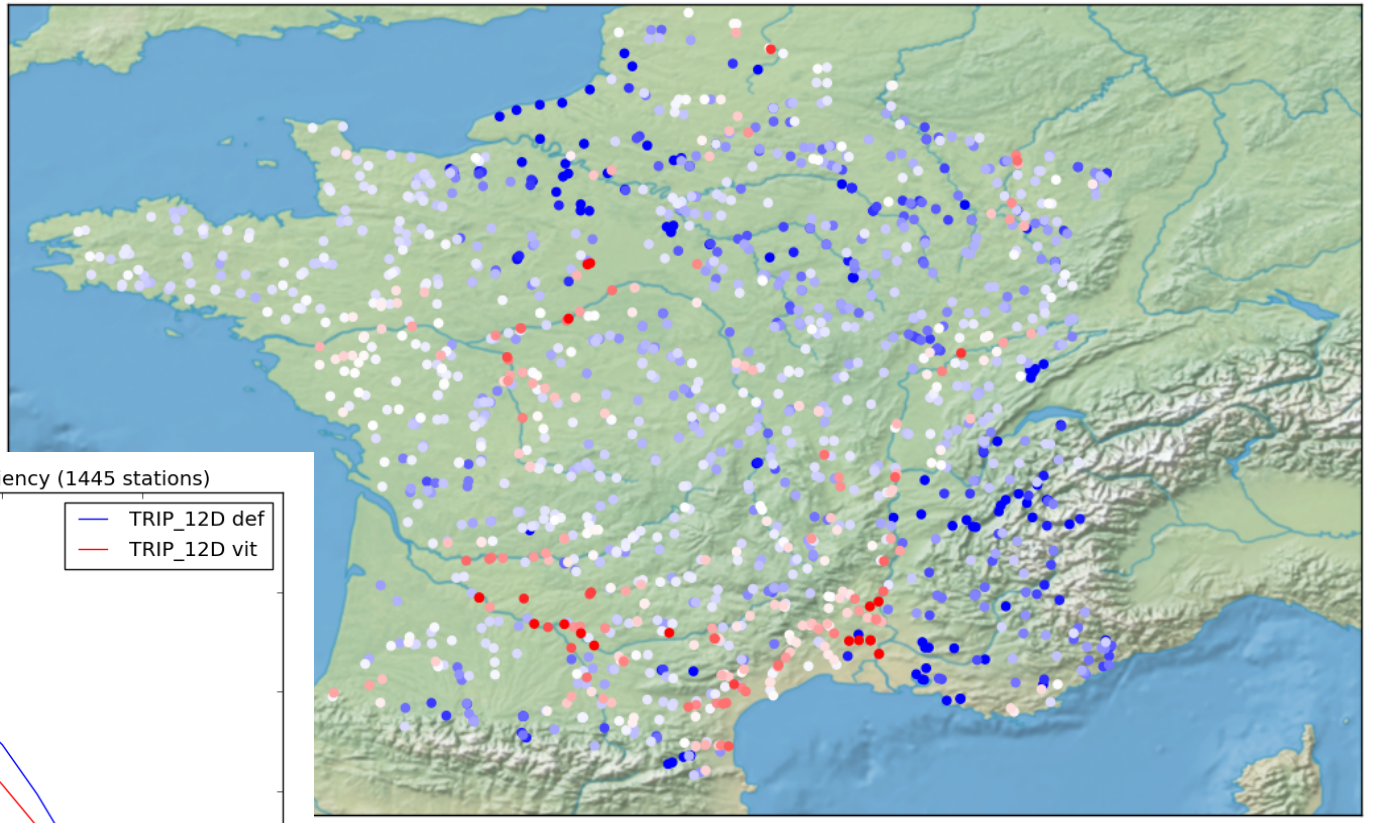
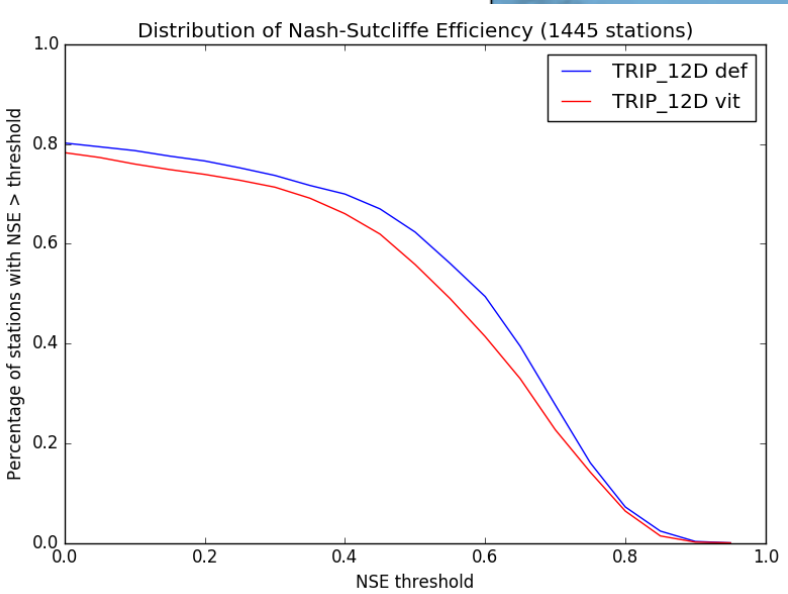


Simulation results

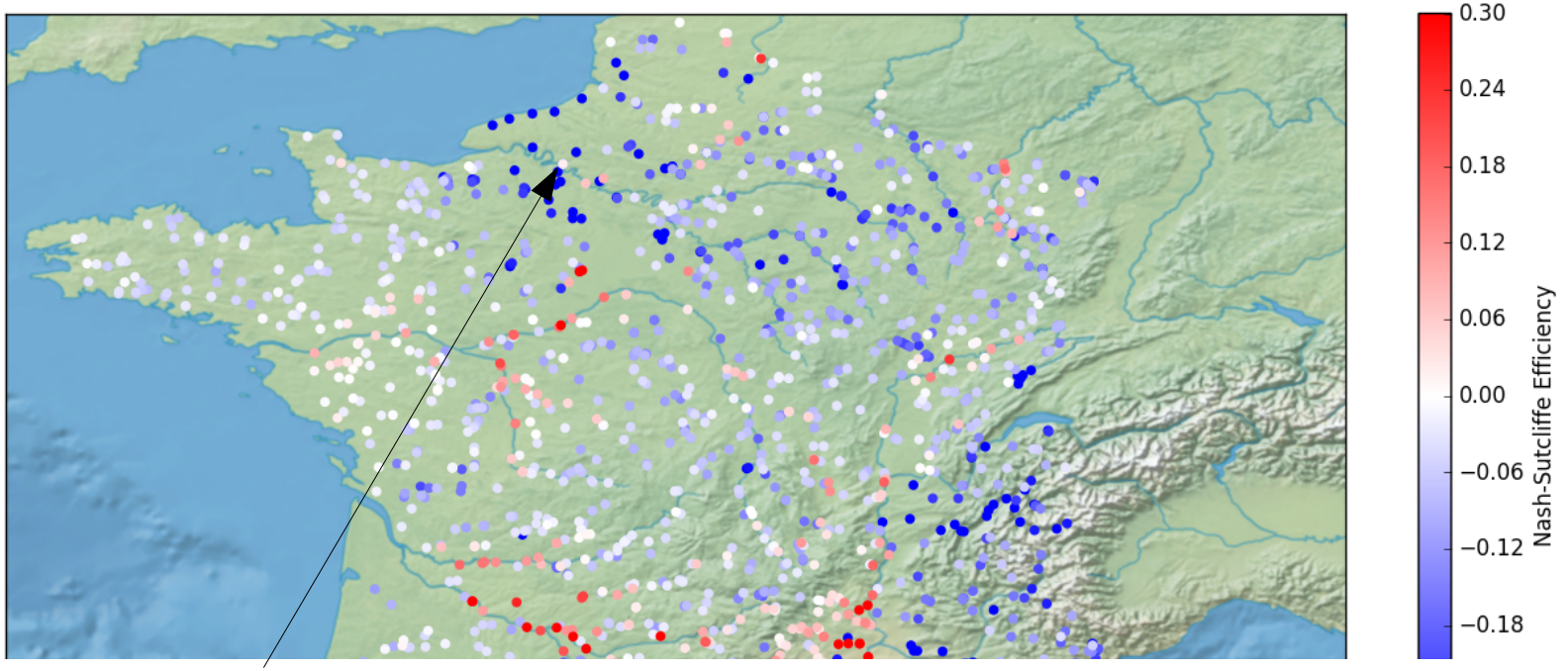
- **CTRIP 12D vit** vs **CTRIP12D def**: NSE

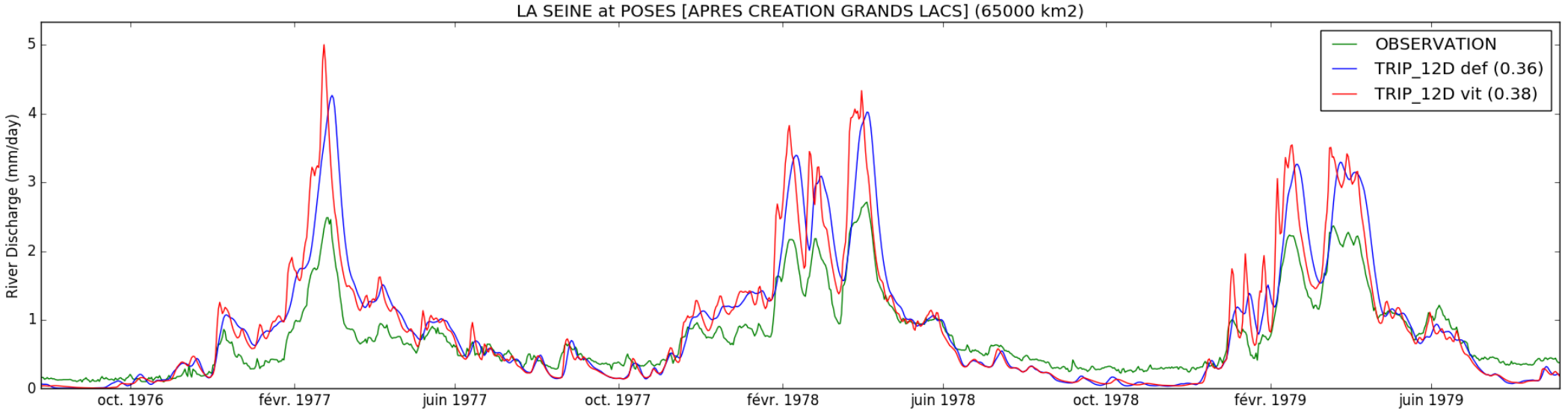




Simulation results

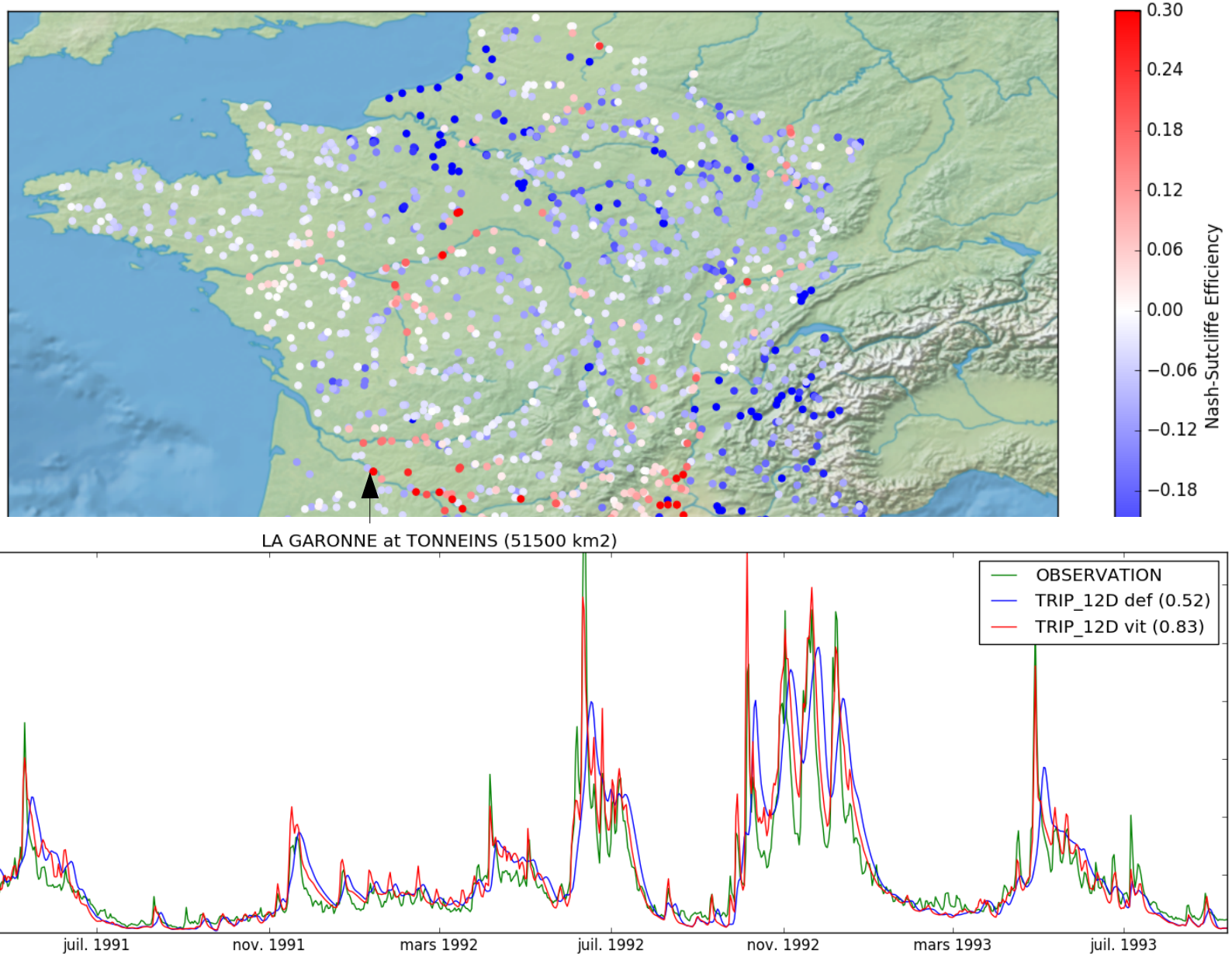
- **CTRIP 12D vit** vs **CTRIP12D def**: NSE





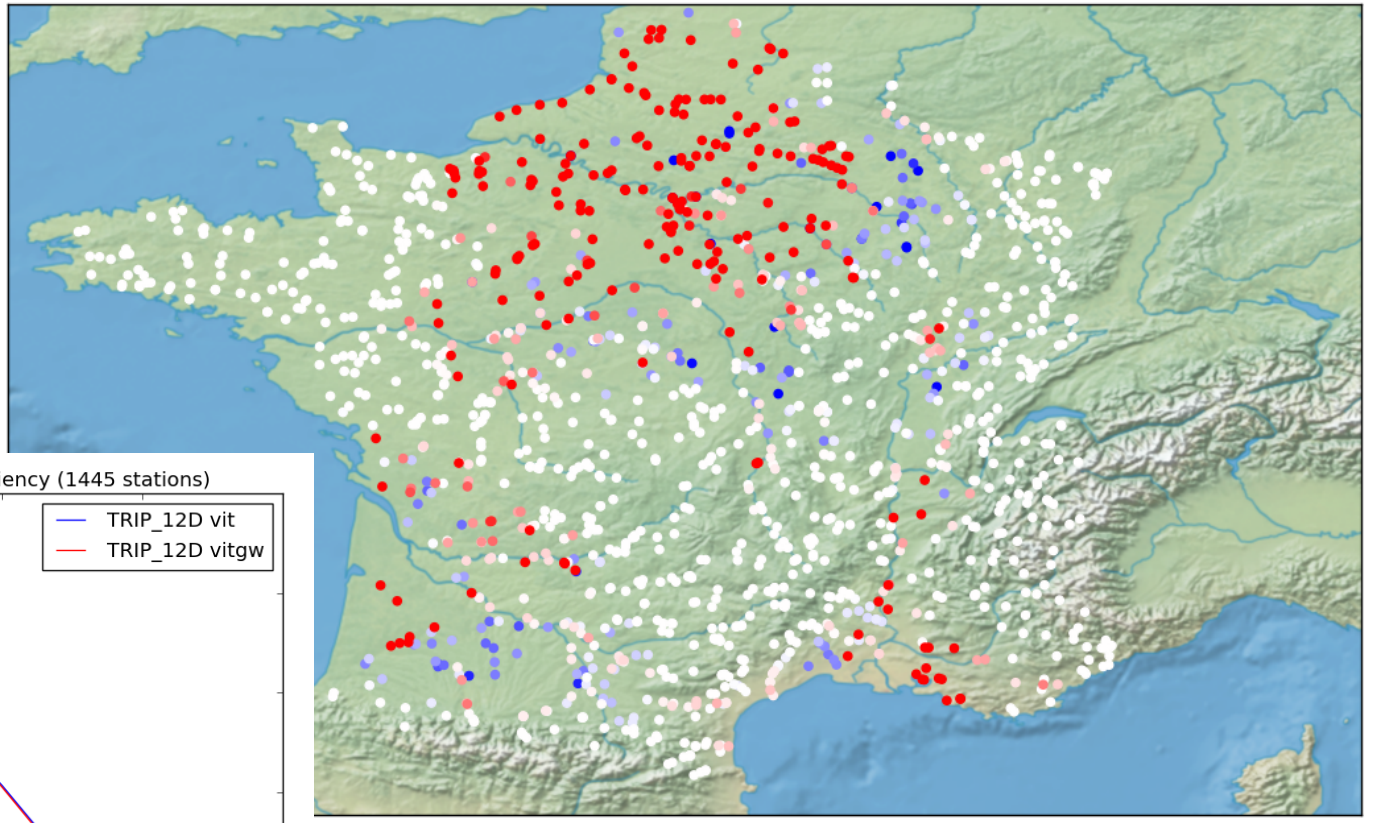
Simulation results

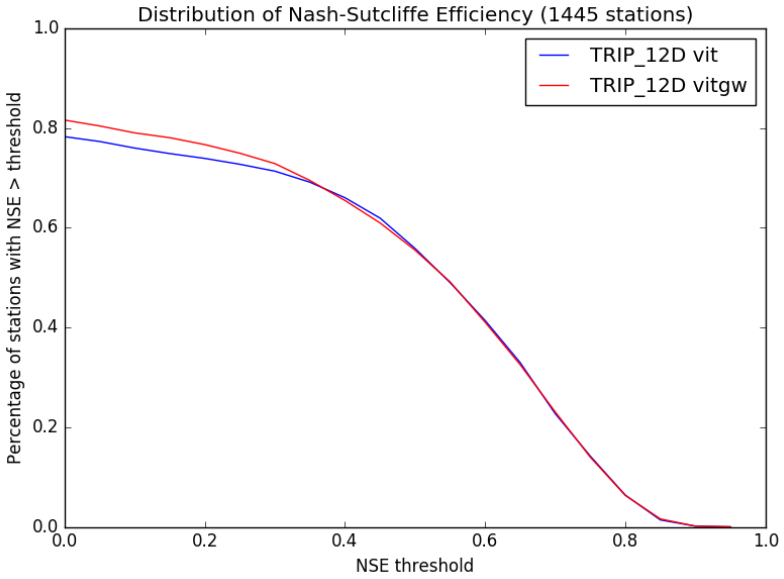
- **CTRIP 12D vit** vs **CTRIP12D def**: NSE



Simulation results

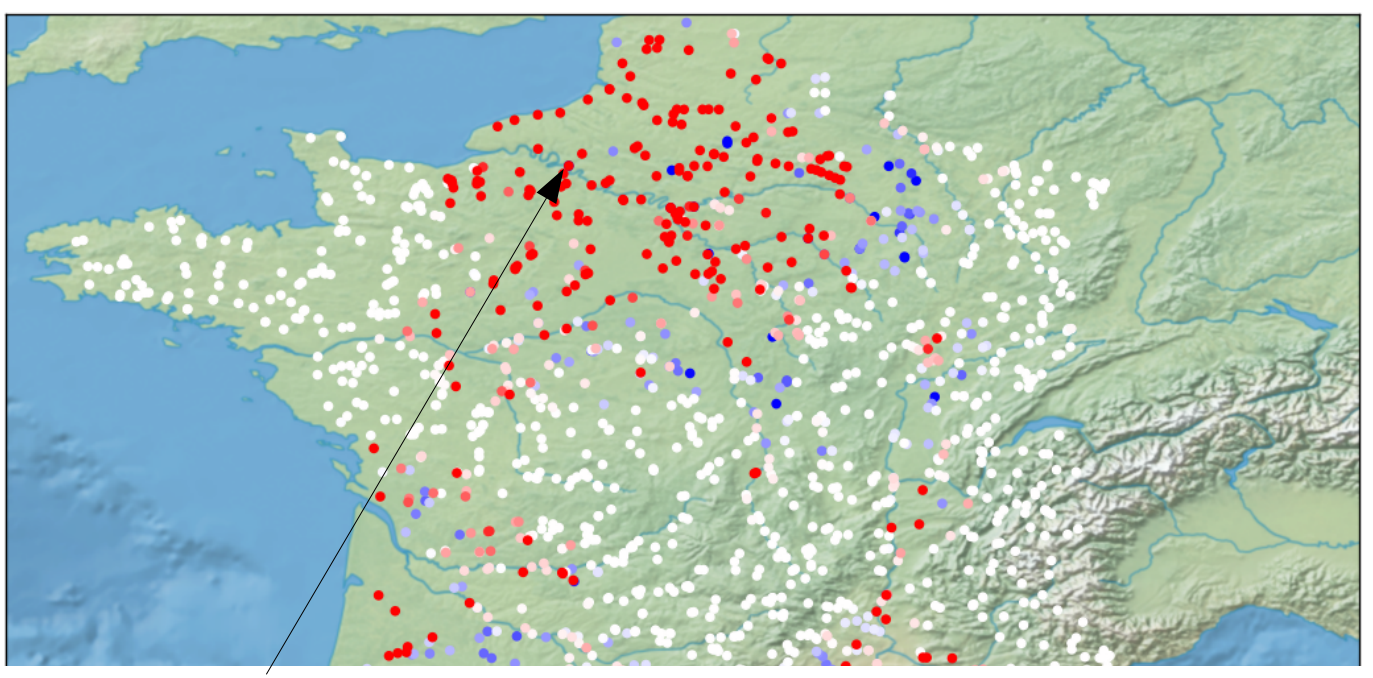
- **CTRIP 12D vitgw** vs **CTRIP12D vit**: NSE

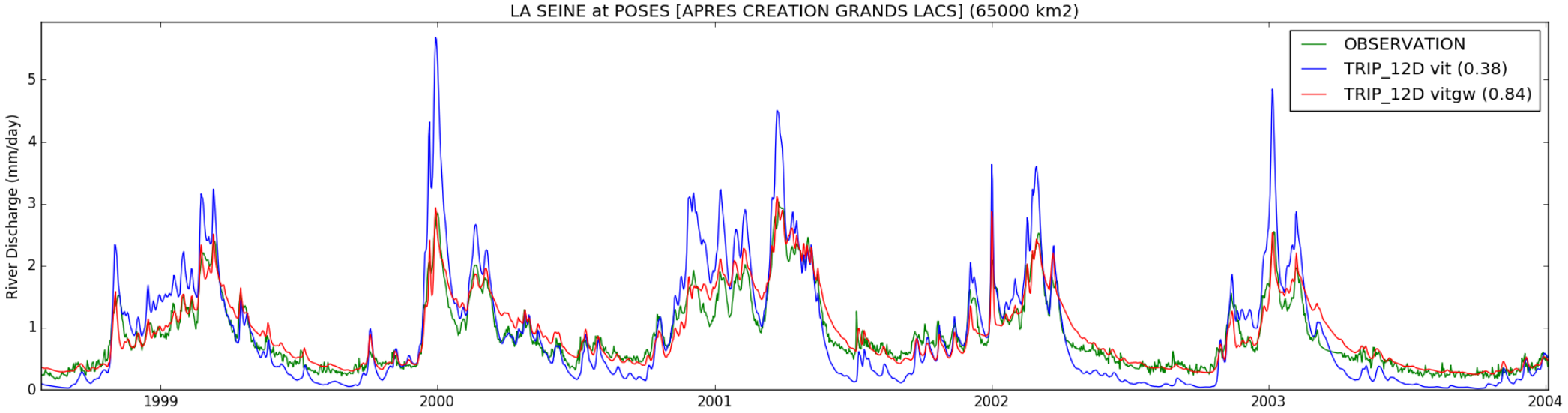




Simulation results

- **CTRIP 12D vitgw** vs **CTRIP12D vit**: NSE

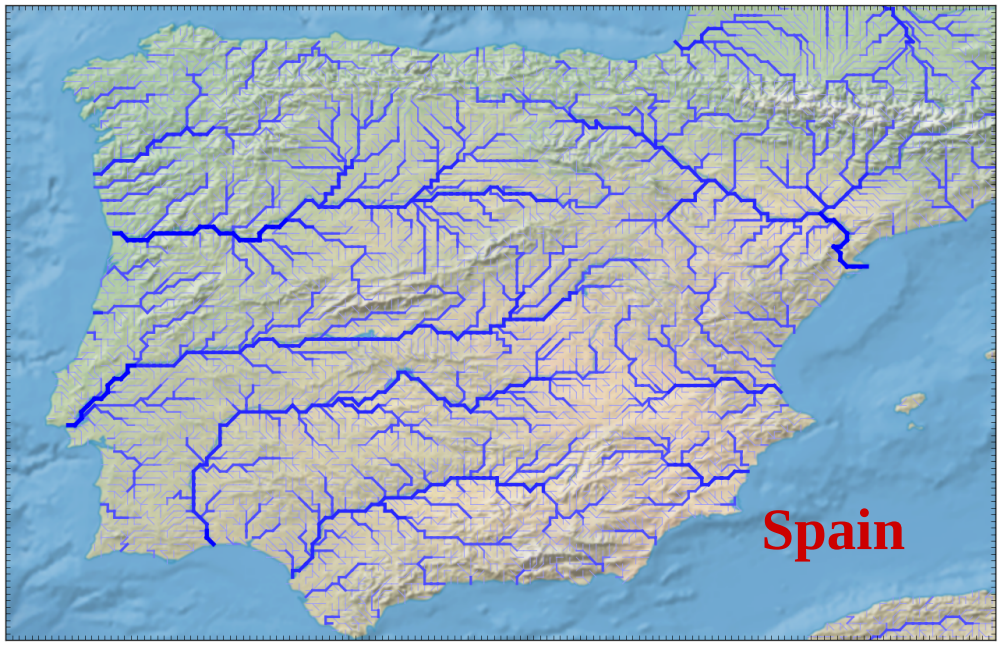




Next steps

- Parameterization
  - Improve empirical relationships
    (river width, roughness coefficient)
  - Sensitivity analysis
- ISBA-CTRIP coupling
  - Capillary raise
  - Floodplains
- Extension to global scale
  - Validation of the river network

Next steps



Thanks!

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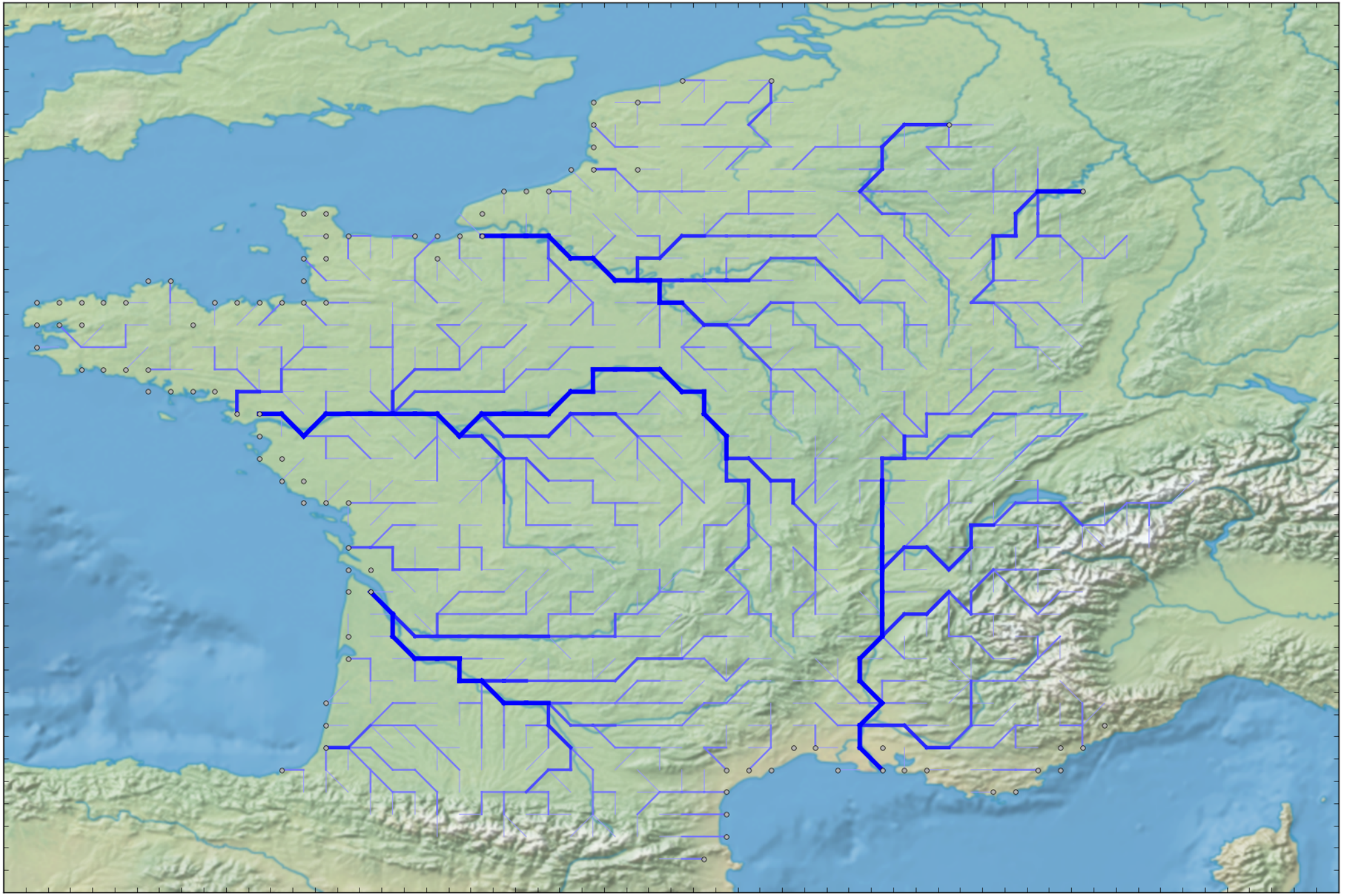
CTRIP 4D



CTRIP 120D