



Impact de la haute résolution pour la modélisation des processus en rivière à l'échelle continentale

S. Munier (CNRM/Météo-France)
15 novembre 2019

SURFEX-CTRIp hydrological system

- **CTRIP** : CNRM version of the TRIP based river routing system

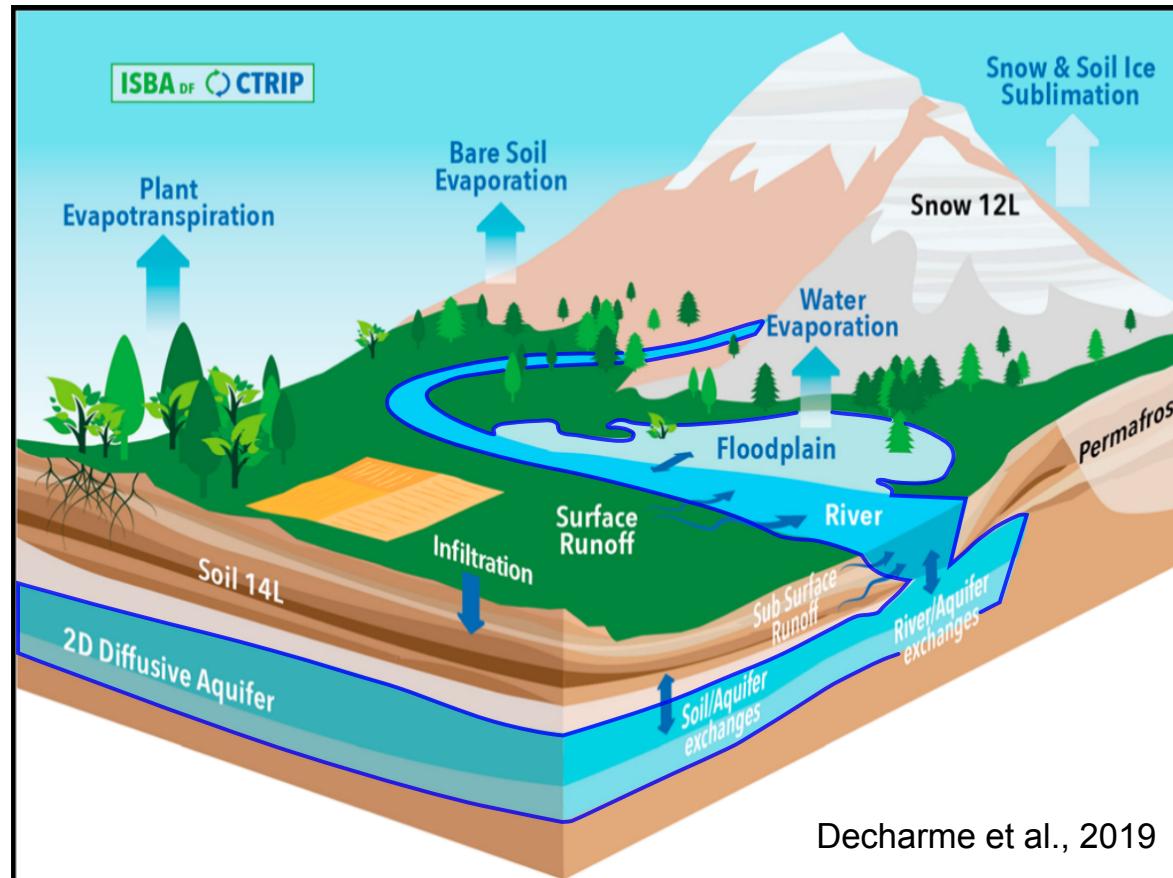
- variable flow velocity
- flooding by river overflow
- aquifers

(Oki and Sud, 1998, Decharme et al., 2019)

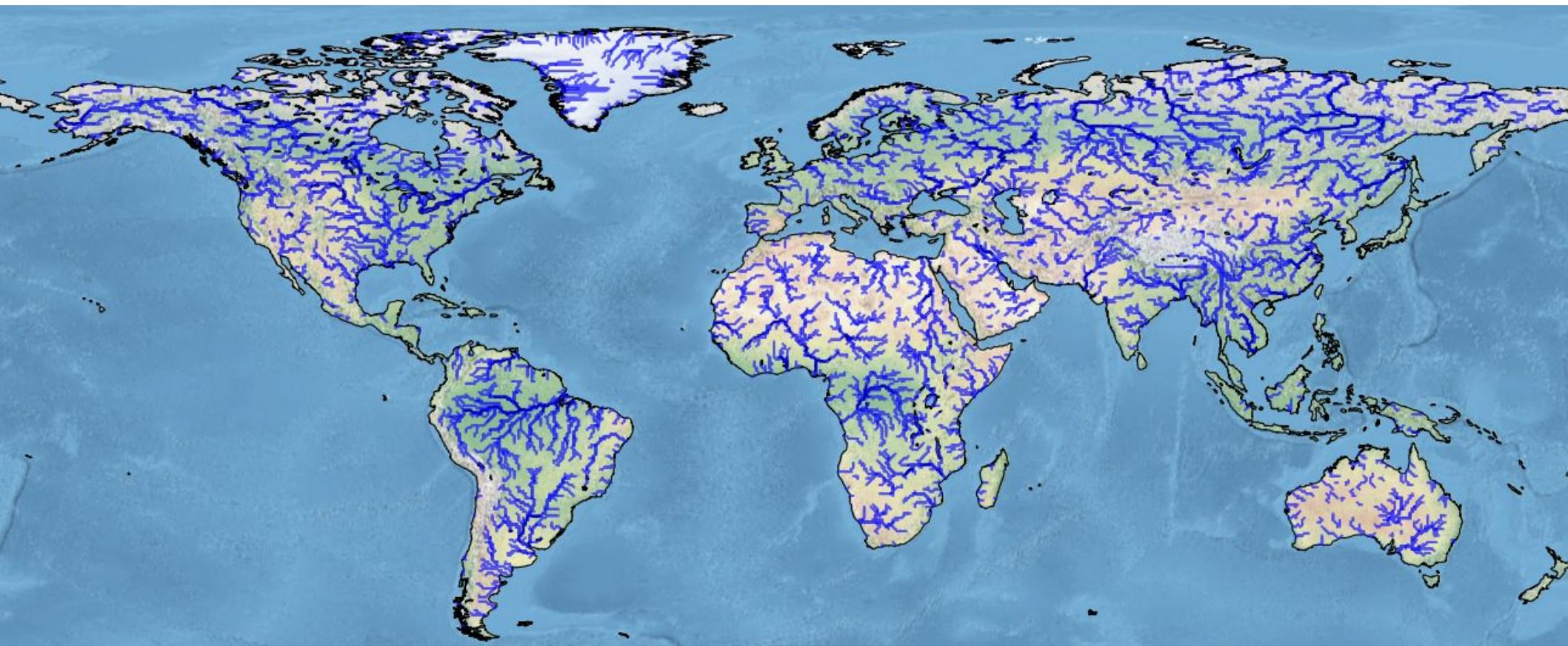
- **ISBA-A-gs** : simulates the diurnal cycle of :

- water and carbon fluxes
- plant growth
- vegetation variables

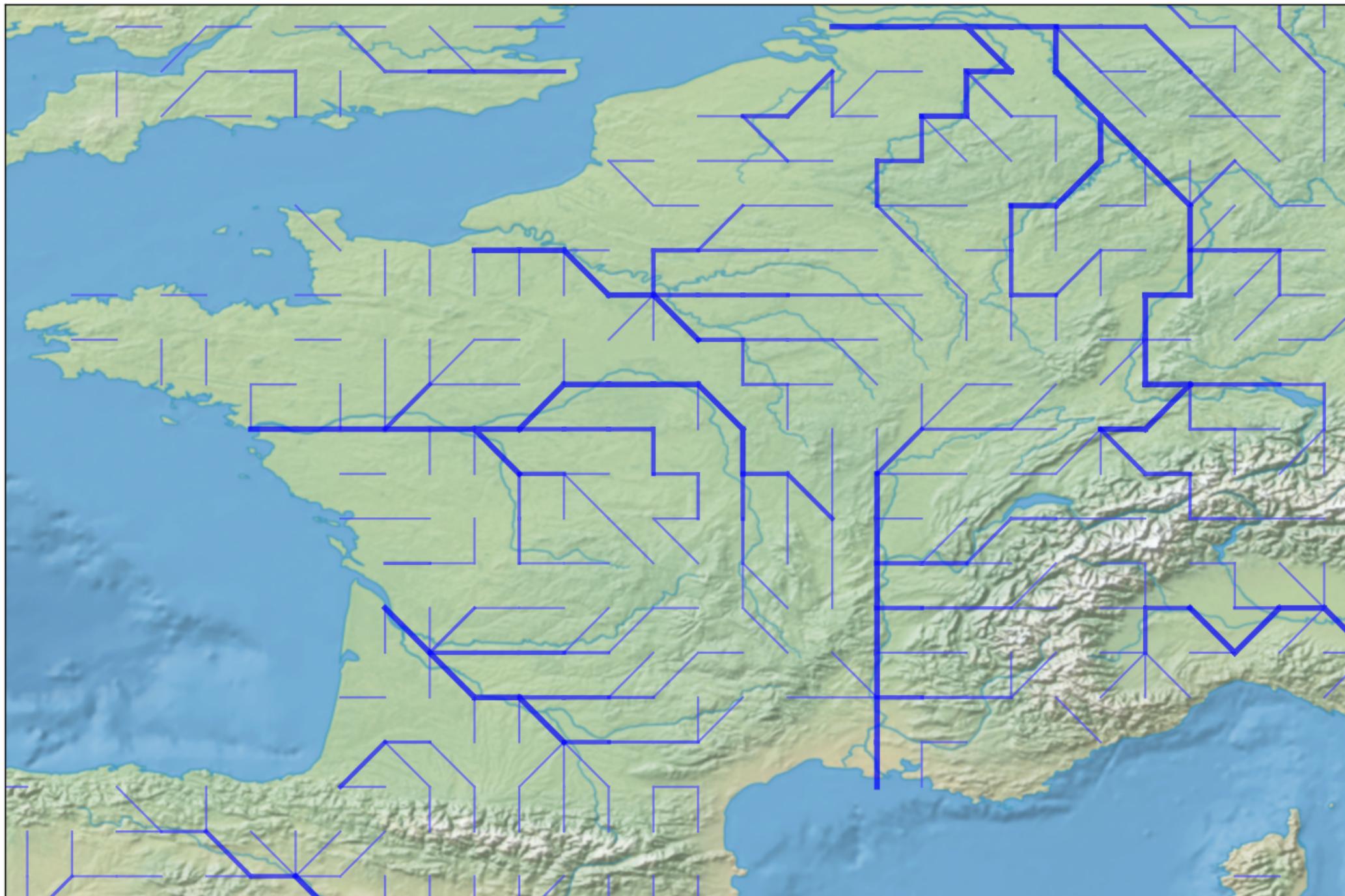
(Calvet et al., 1998, 2007, Gibeau et al., 2006)



CTRIP-2D: river network

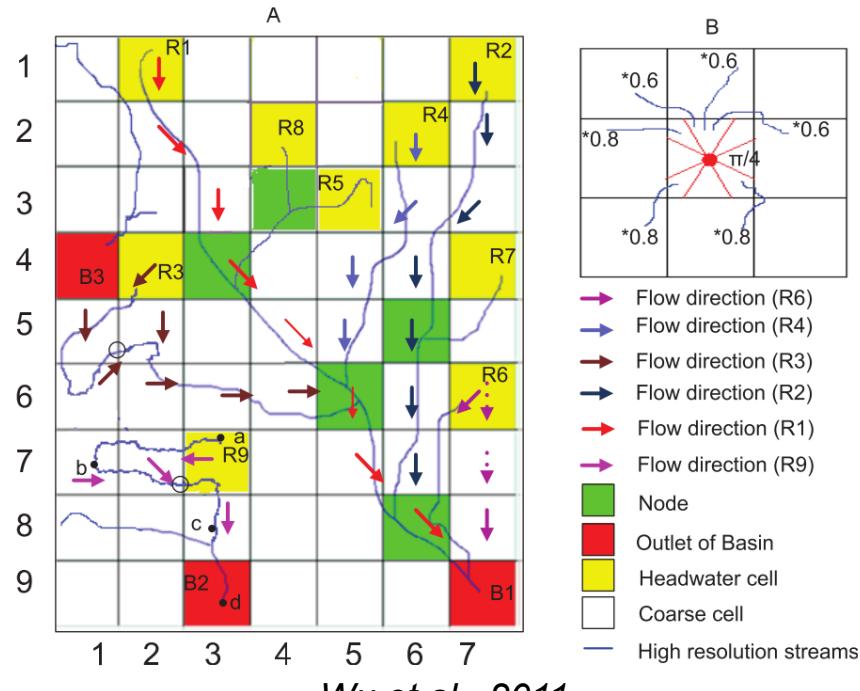


CTRIP-2D: river network



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)



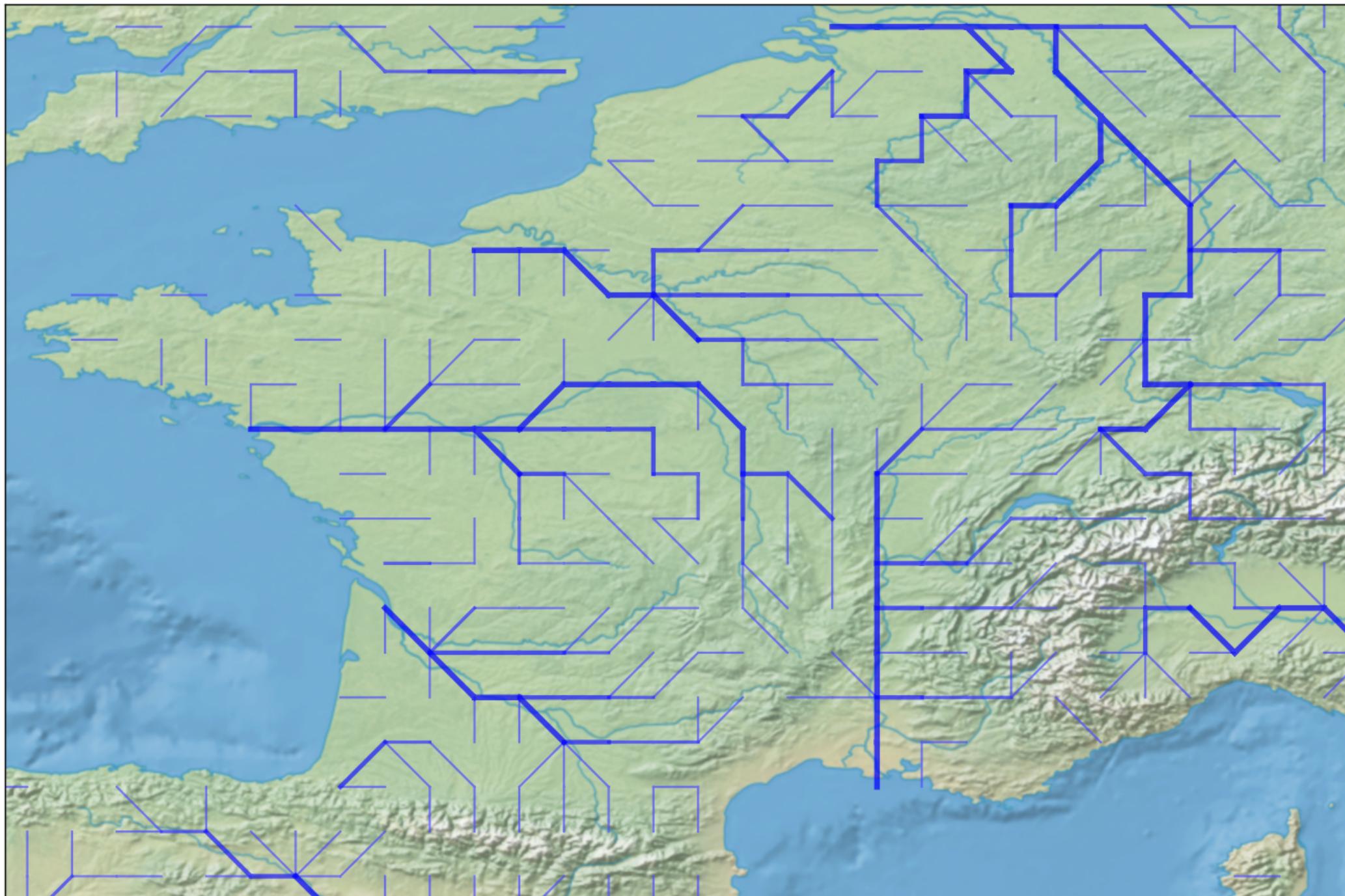
CTRIP-12D: a CTRIP version at 1/12° resolution

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- Quality check
 - Qualitative (mainly visual)
 - River network: CTRIP-2D (0.5°), DRT (1/12°), Google Earth
 - Basin boundary: CTRIP-2D, GRDC
 - Quantitative
 - Basin area, basin mask overlap, main river structures

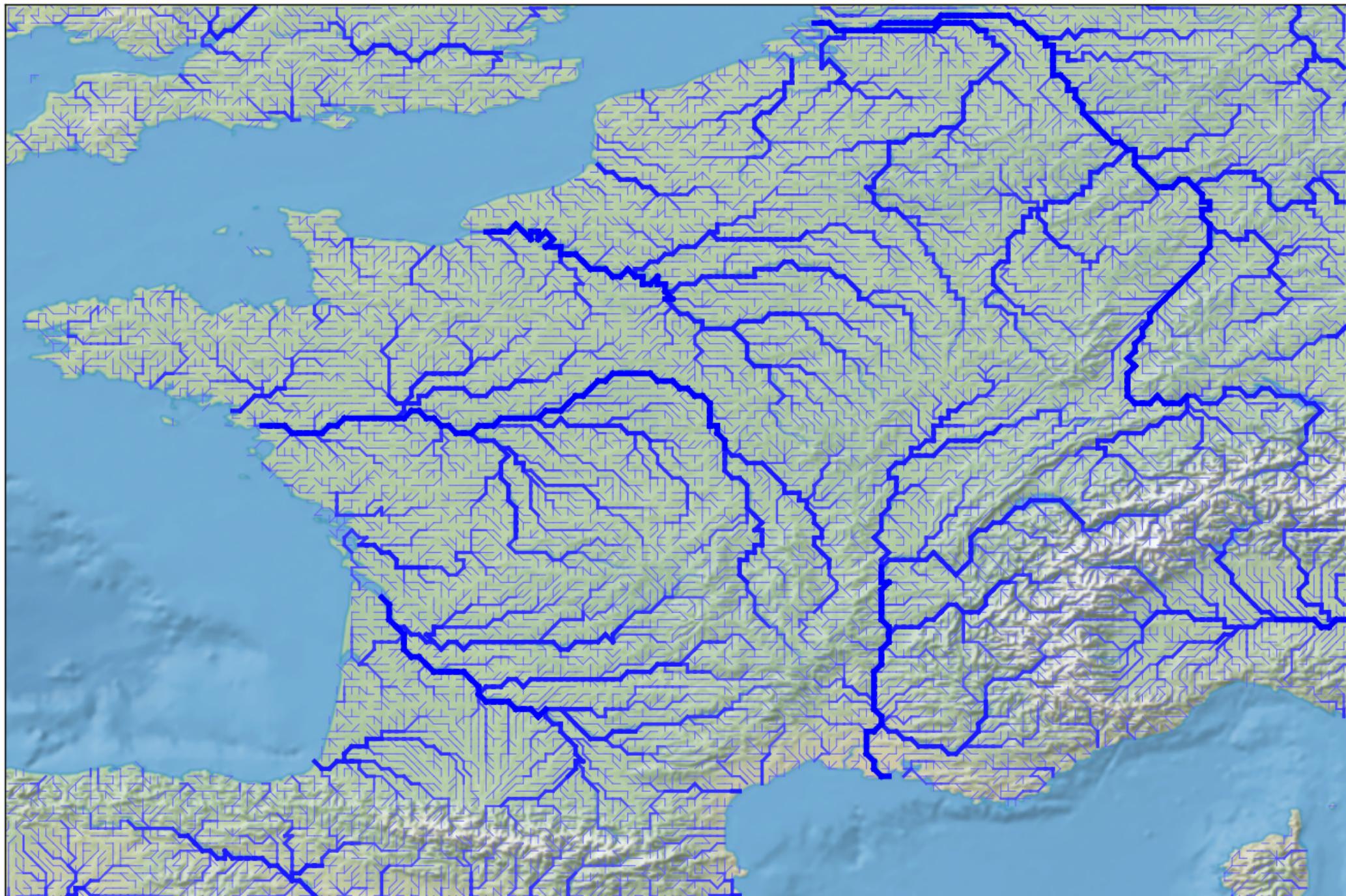
} *river network structure preserved*

=> reliable and consistent global river network

CTRIP-2D: river network



CTRIP-12D: river network



CTRIP-12D: river network



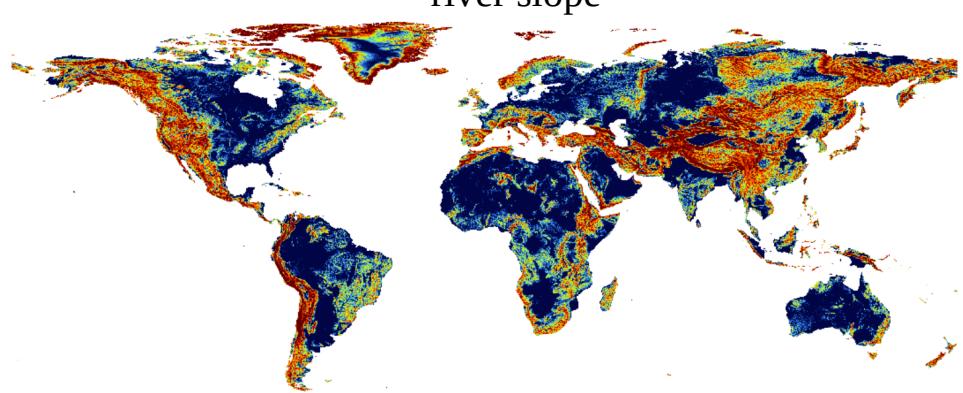
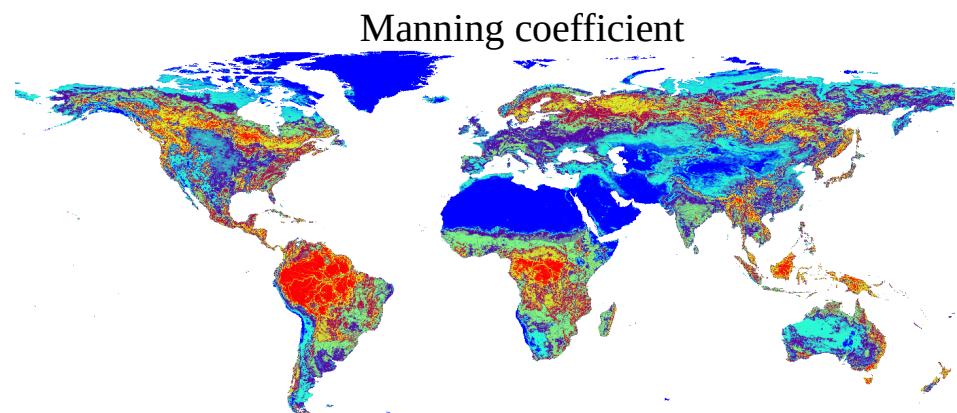
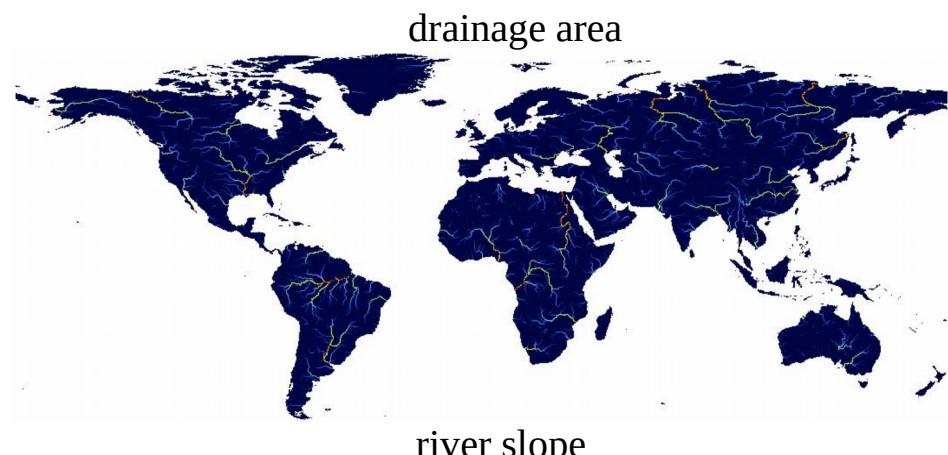
CTRIP-12D: river network

- Integrated into Google Earth Engine
 - <https://simonmunier.users.earthengine.app/view/ctrip-12d>
 - for visual check of major rivers



CTRIP-12D: parameters

- Derivation of main CTRIP parameters
 - from river network:
flow direction, river sequence, basin number, drainage area
 - from empirical relationships:
river length, river slope, river width, roughness coefficient (Manning)
(Decharme et al., 2019)



Simulation results

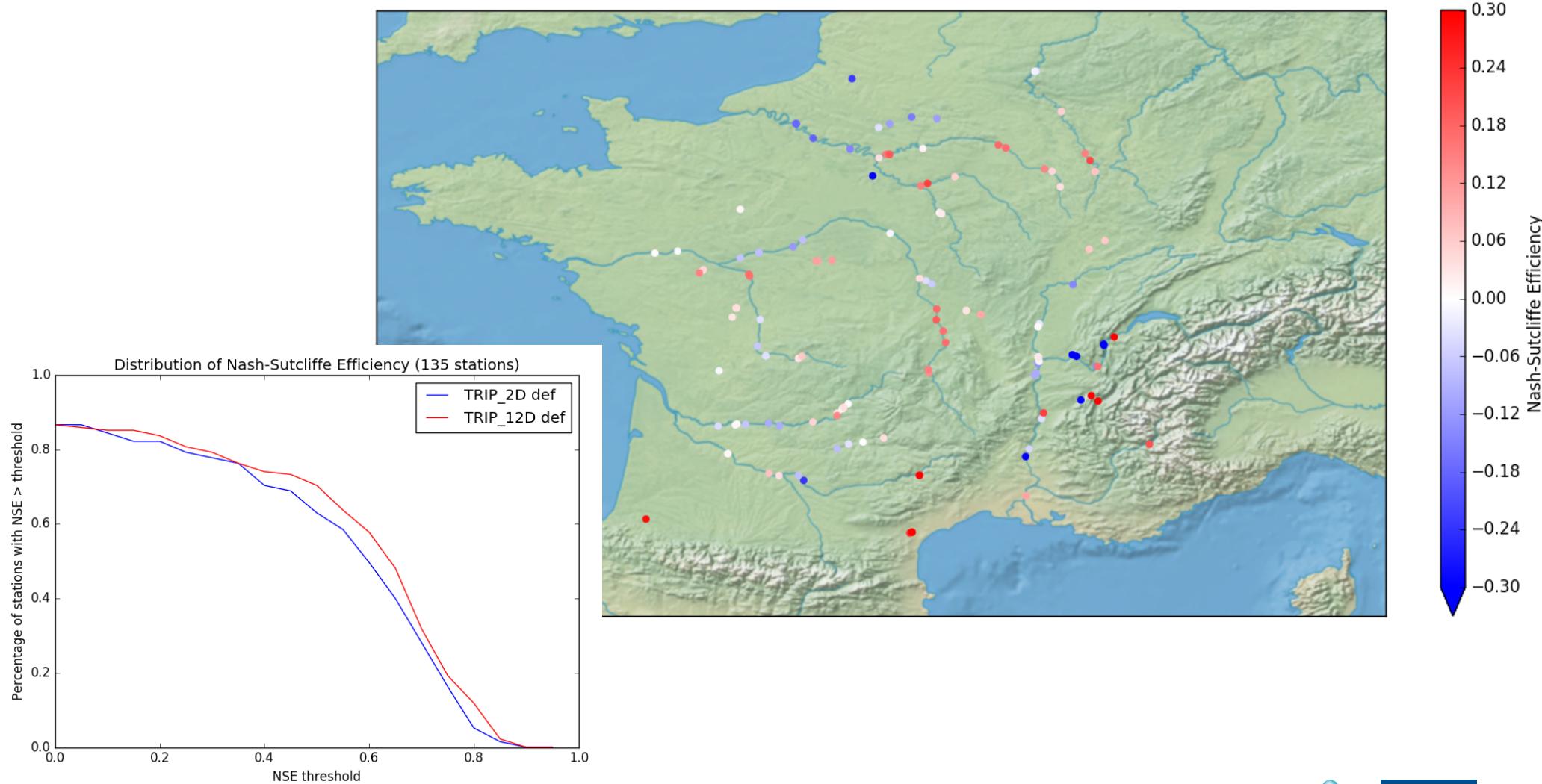
- CTRIP simulation configuration
 - ➔ CTRIP forcing: SAFRAN – ISBA (8 km)
 - ➔ CTRIP-2D vs CTRIP-12D
 - ➔ Modeling options:

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

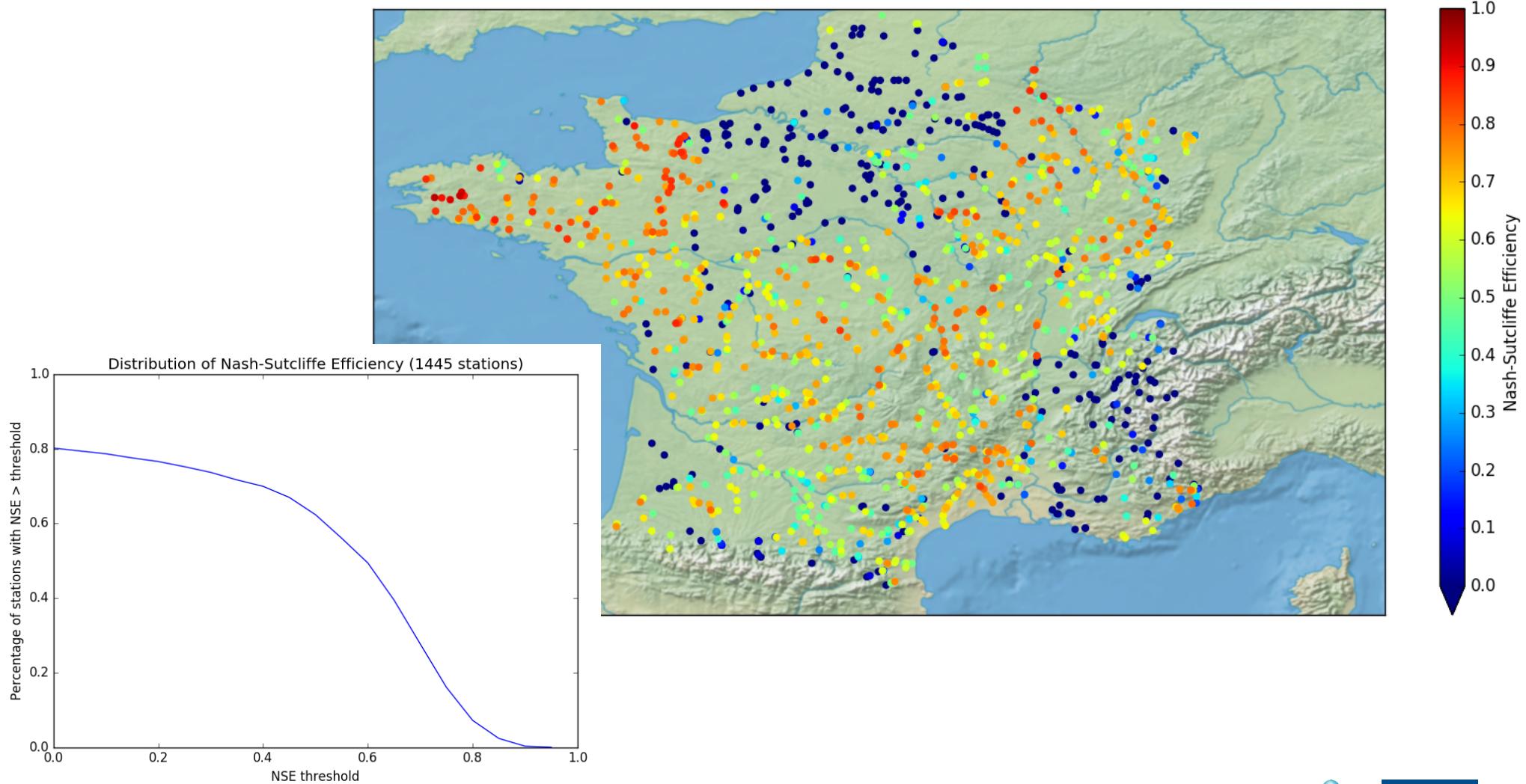
Simulation results

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



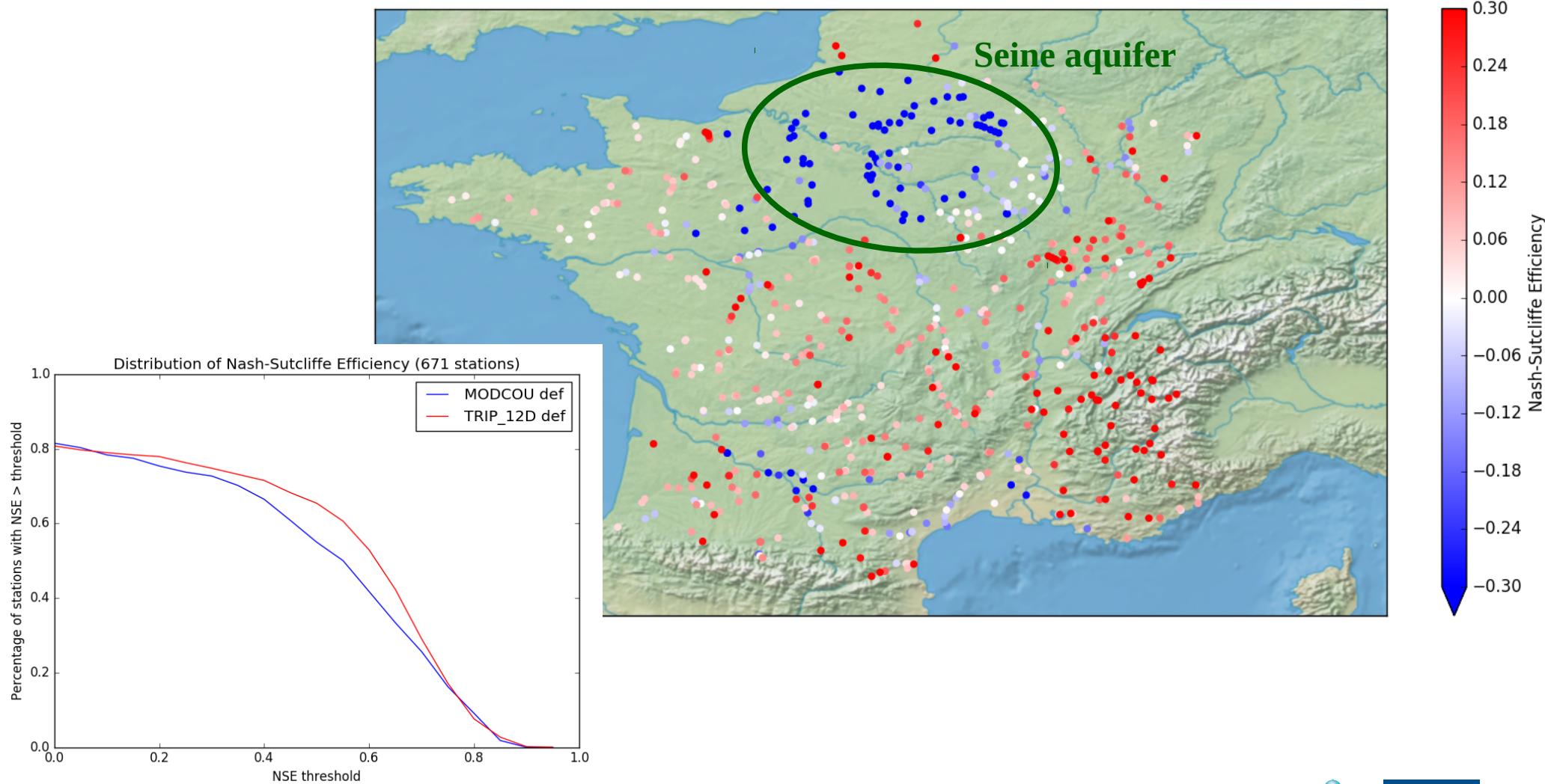
Simulation results

- CTRIP-12D def: NSE



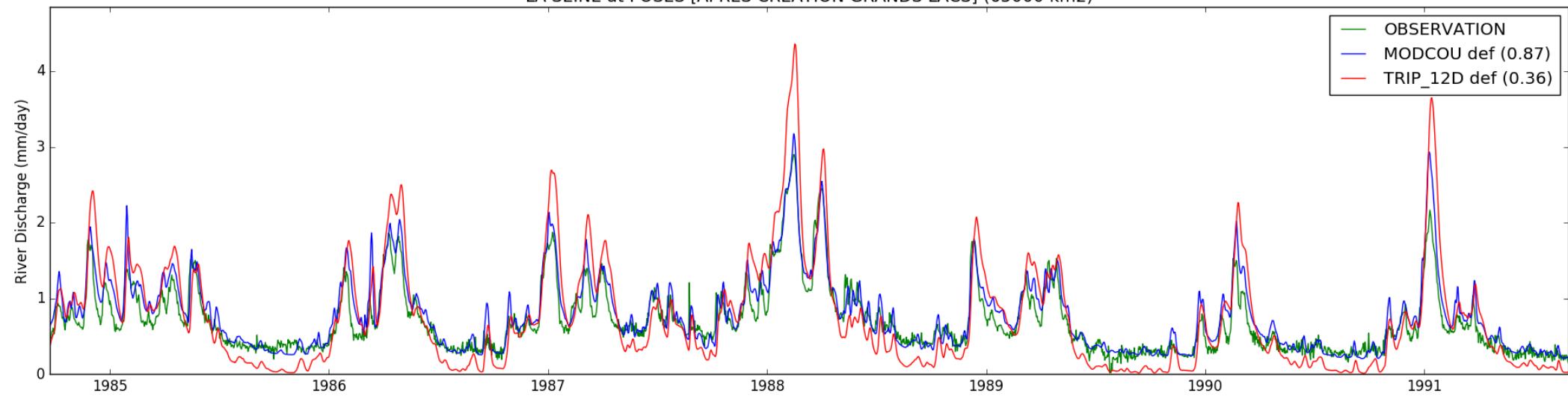
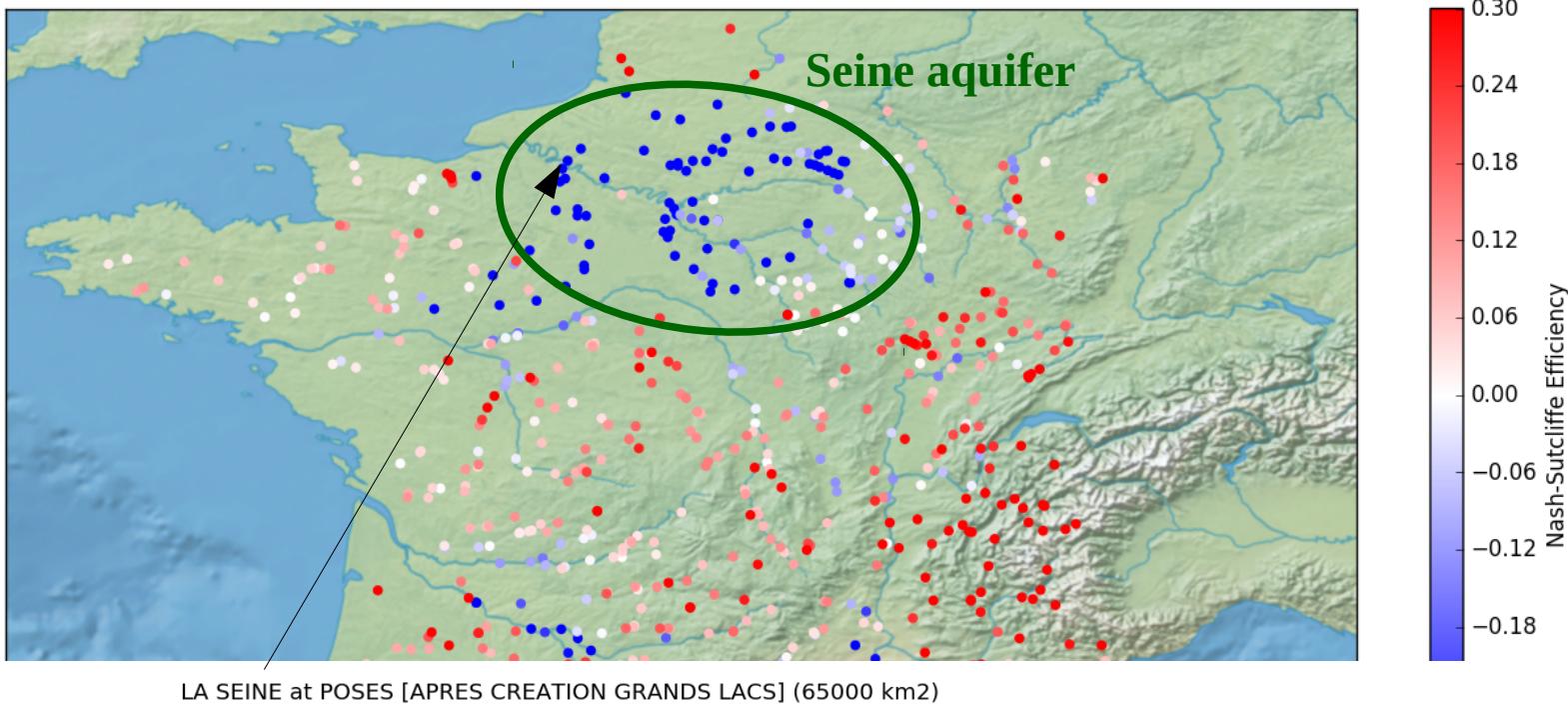
Simulation results

- CTRIP-12D def vs MODCOU: NSE



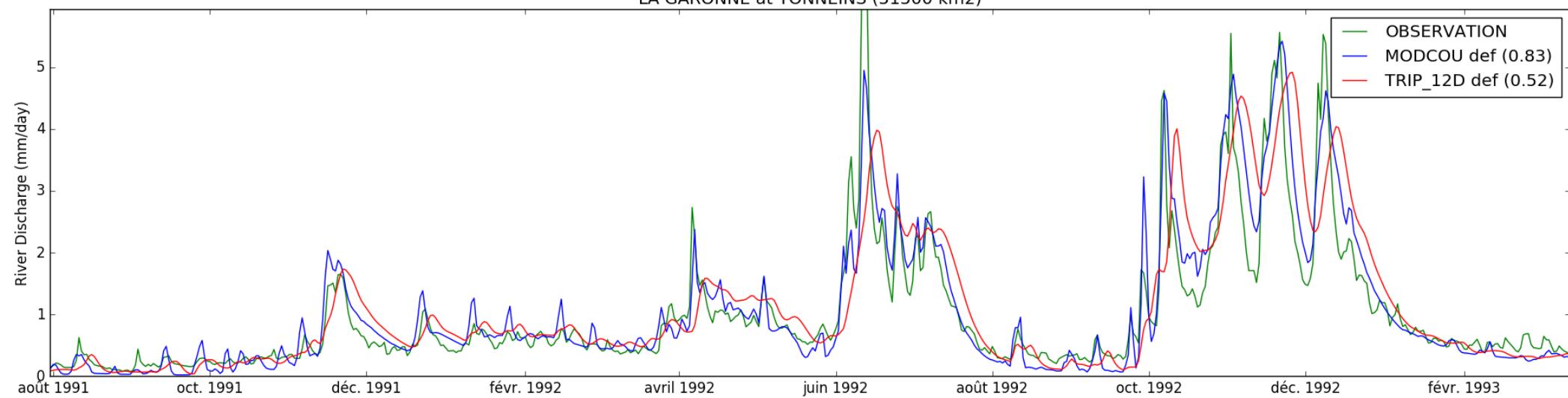
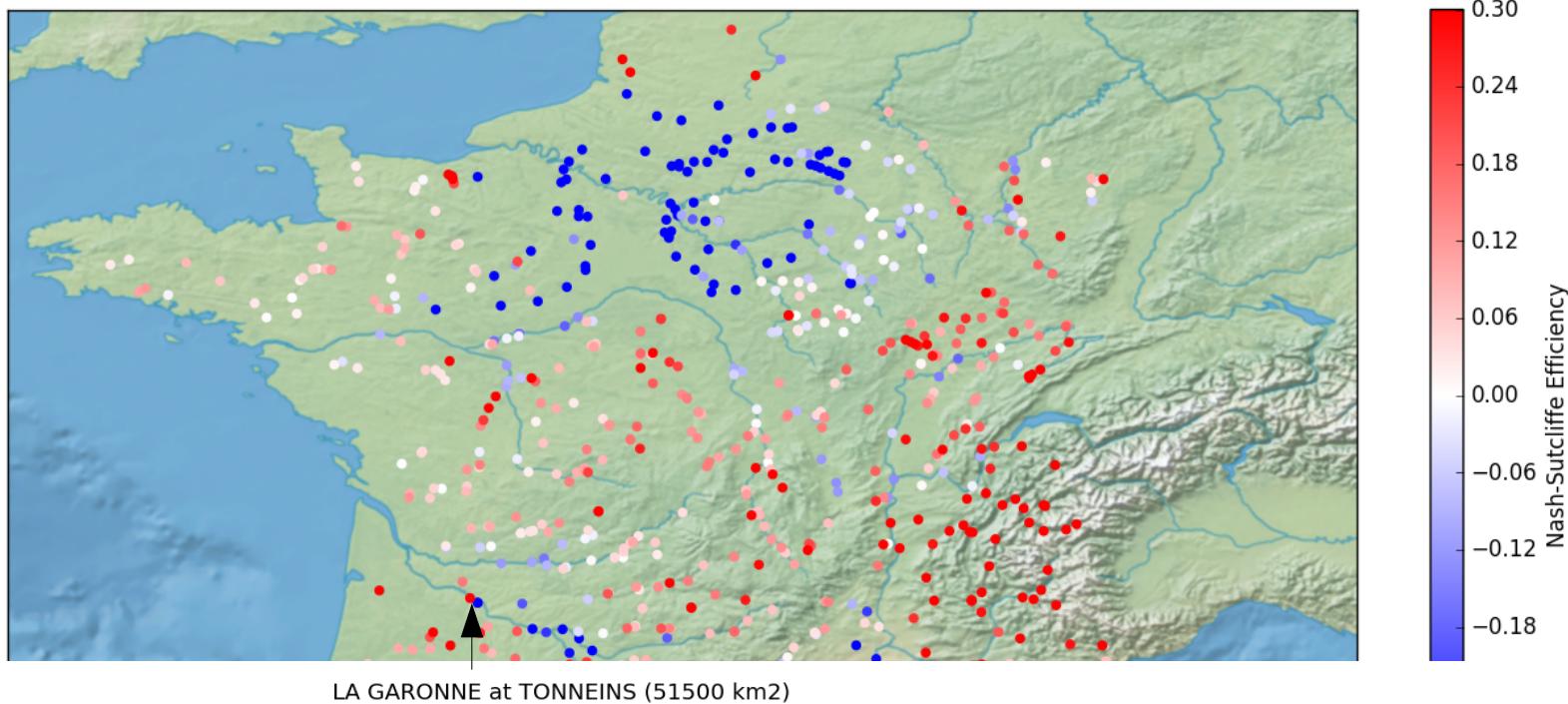
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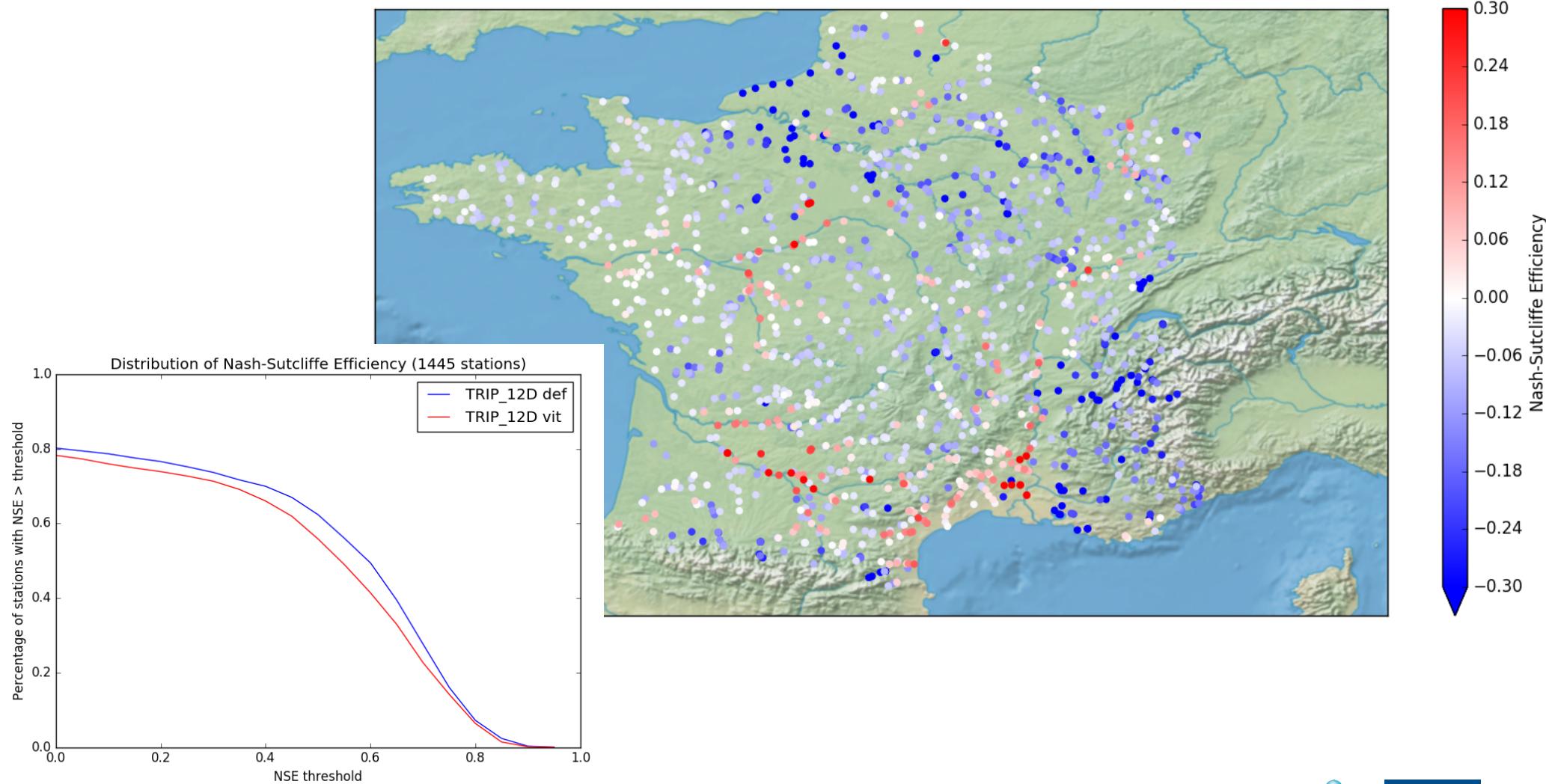
Simulation results

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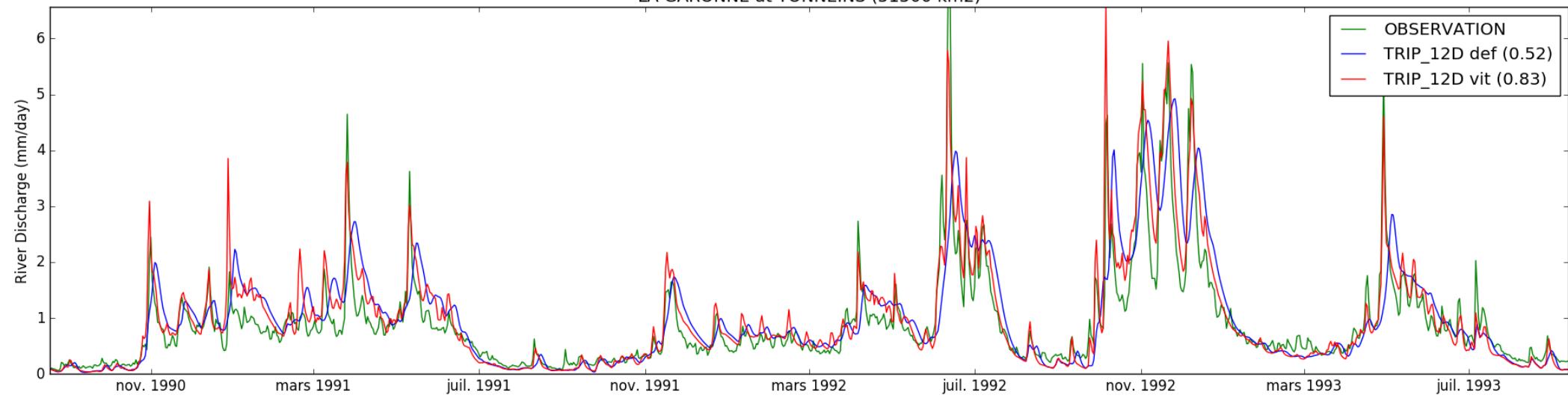
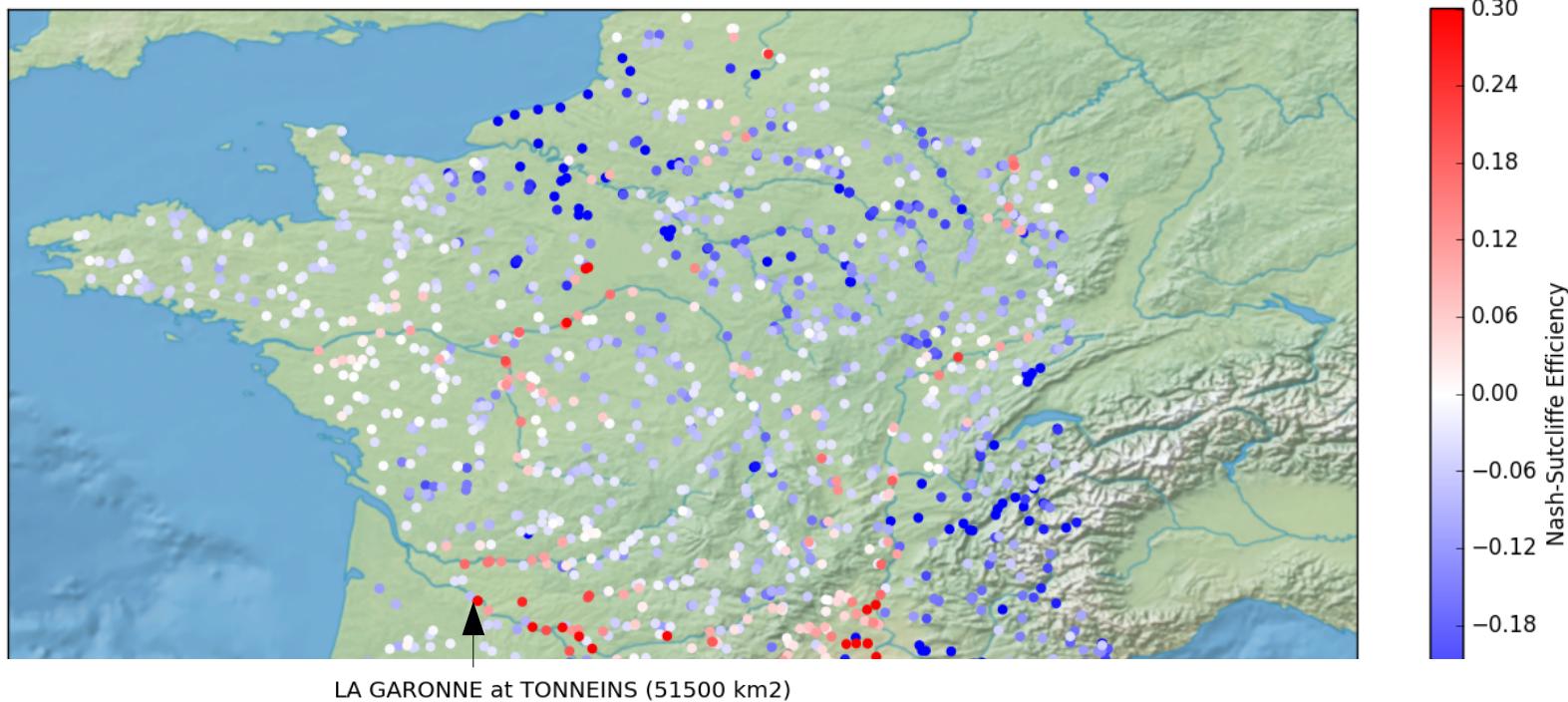
Simulation results

- CTRIP-12D vit vs CTRIP12D def: NSE



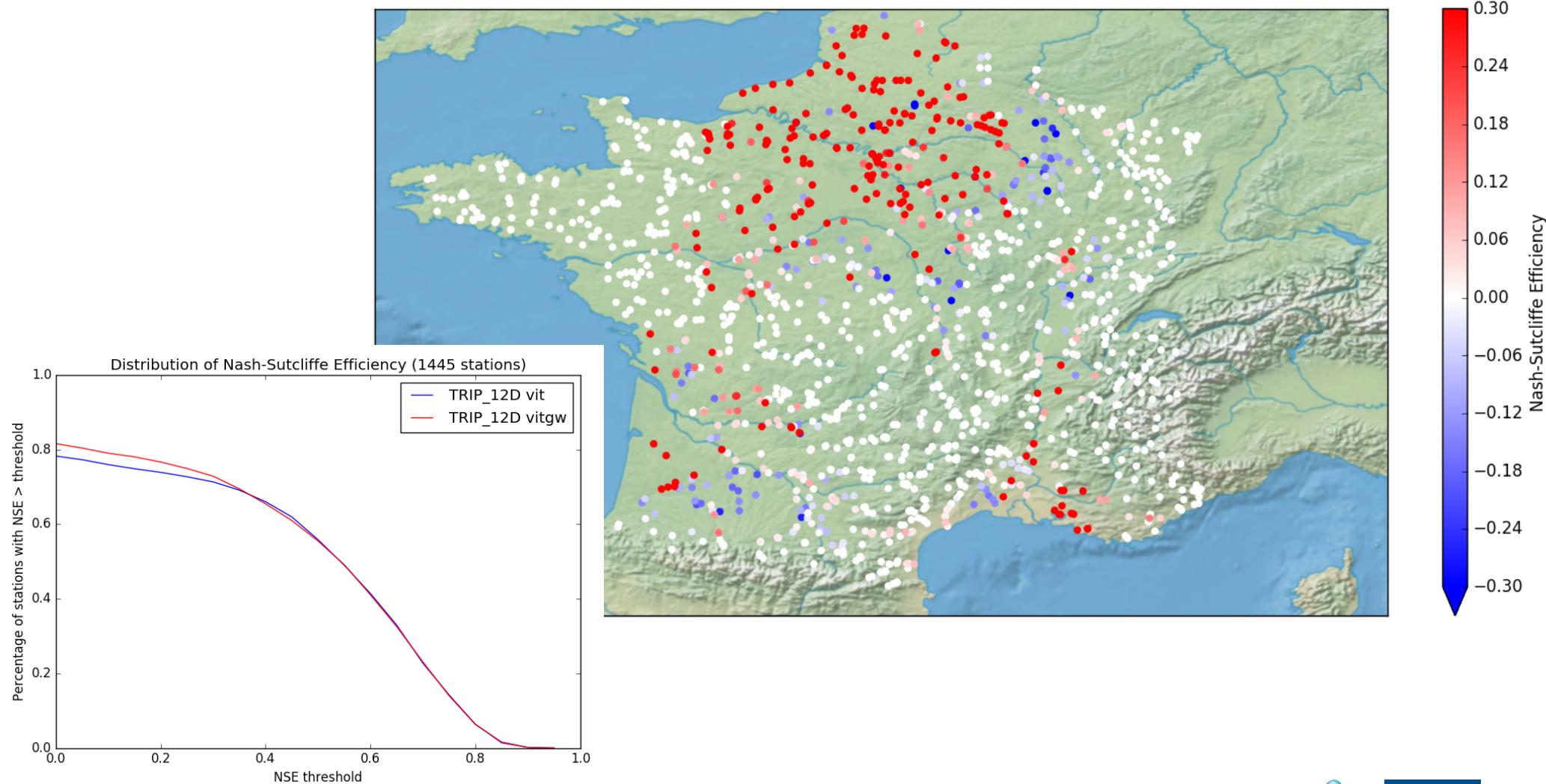
Simulation results

- CTRIP-12D vit vs CTRIP12D def: NSE



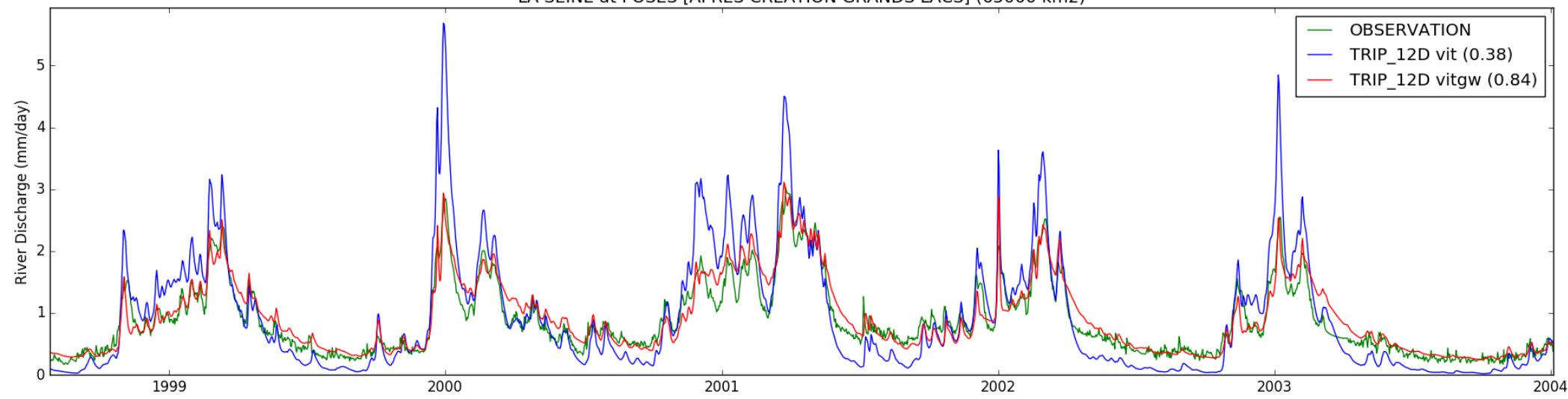
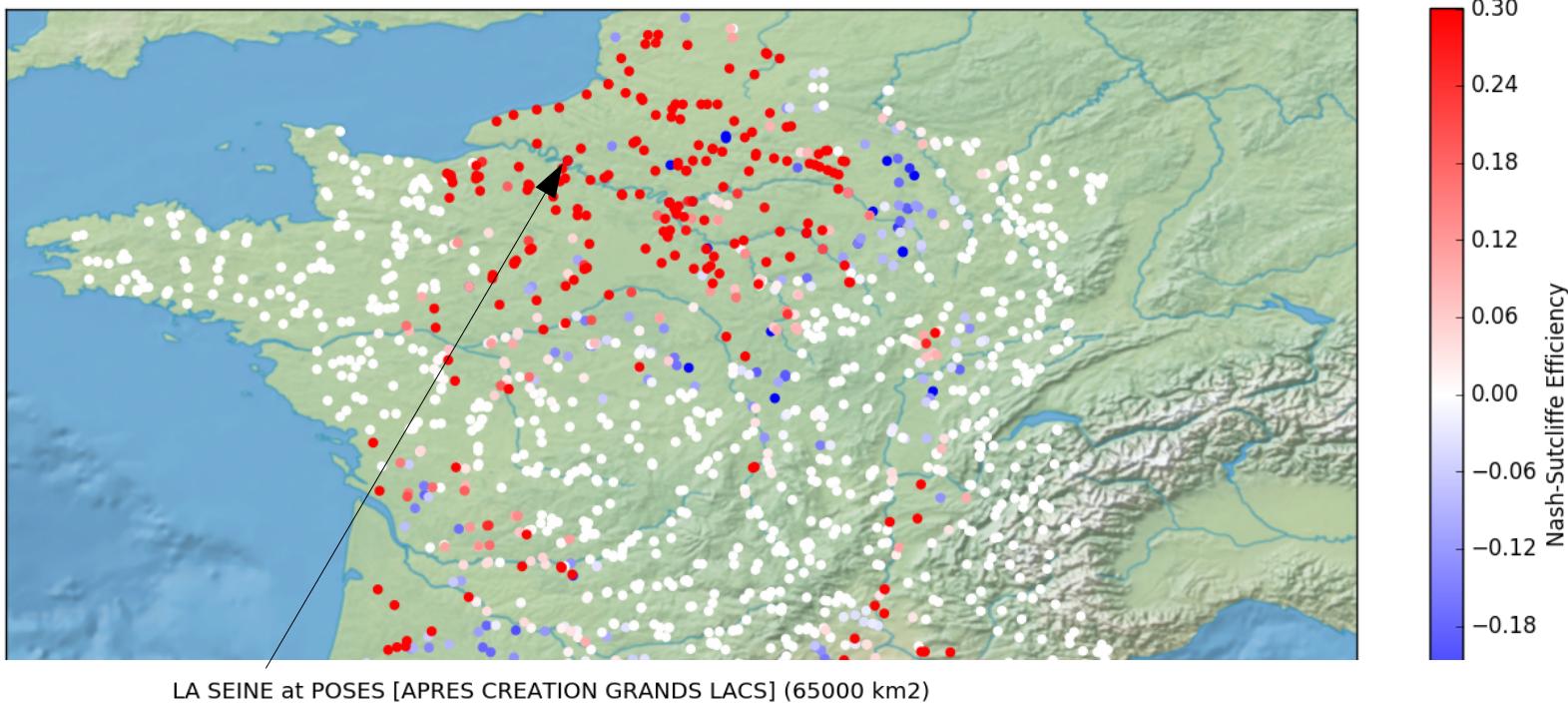
Simulation results

- CTRIP-12D vitgw vs CTRIP12D vit: NSE



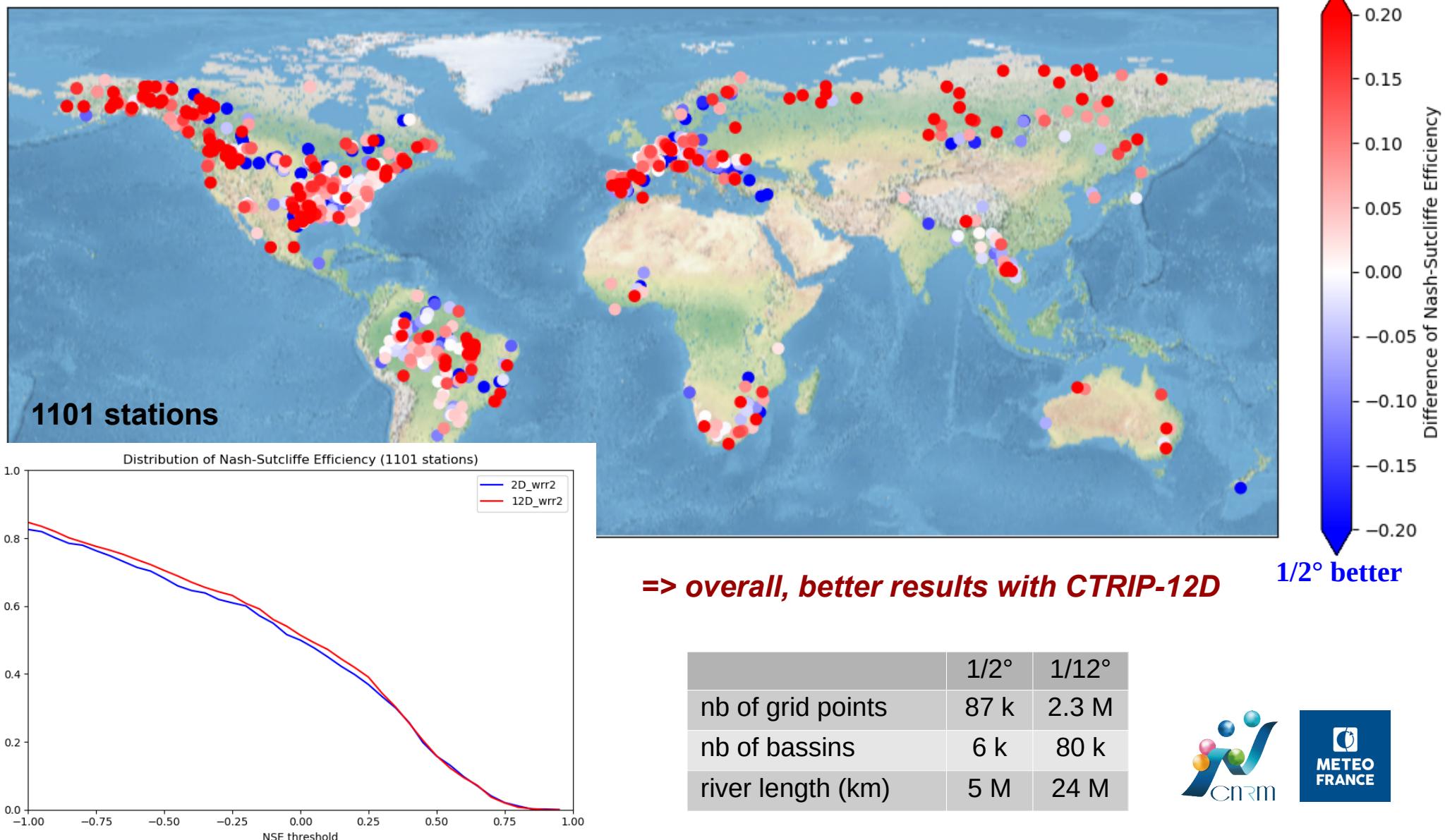
Simulation results

- CTRIP-12D vitgw vs CTRIP12D vit: NSE



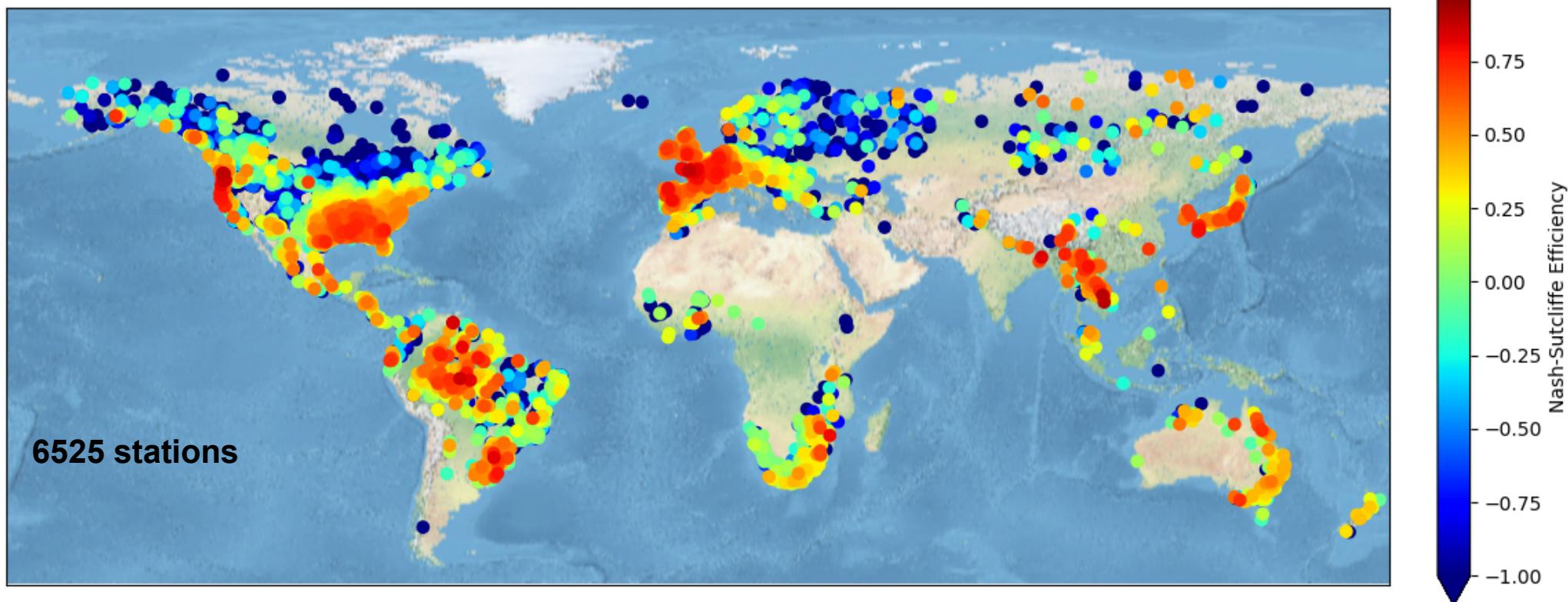
Global scale simulation

- Comparison of NSE for CTRIP-2D and CTRIP-12D



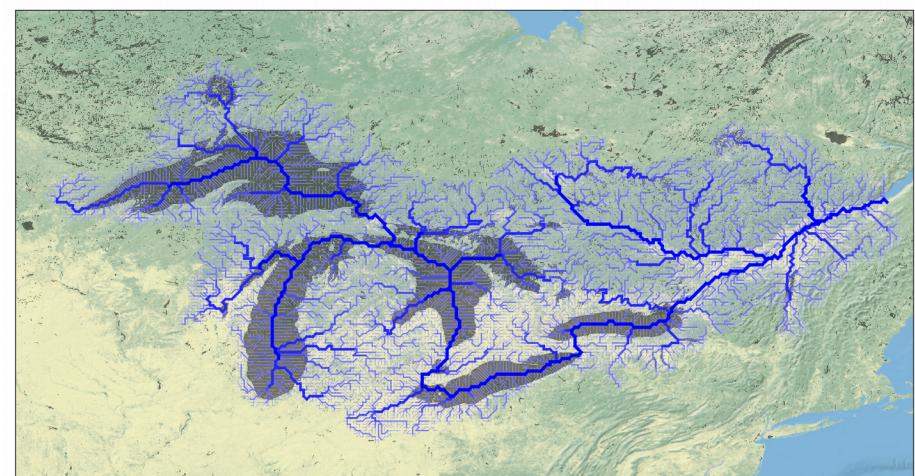
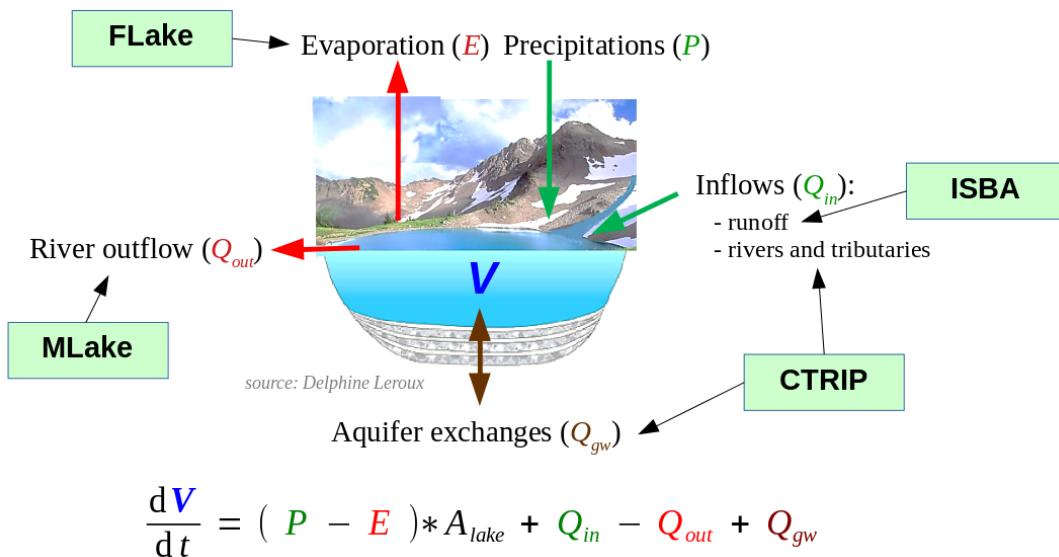
Global scale simulation

- Evaluation of CTRIP-12D at the global scale



Next steps

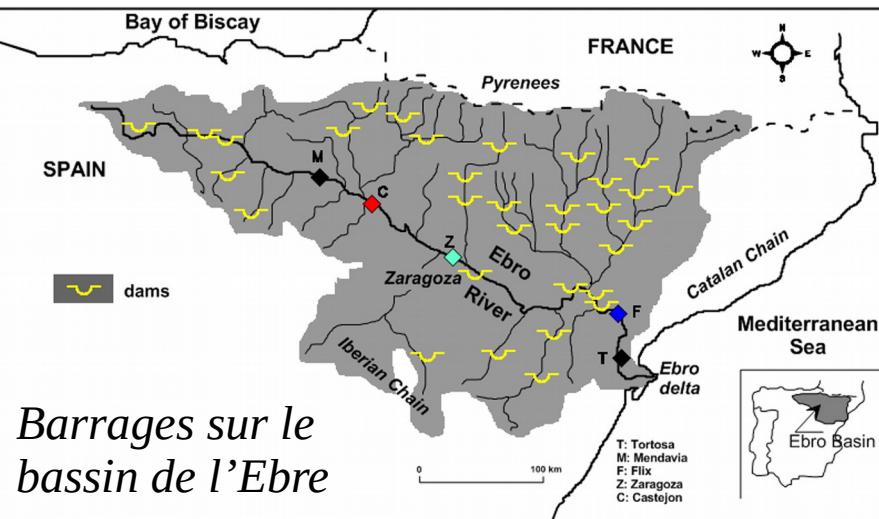
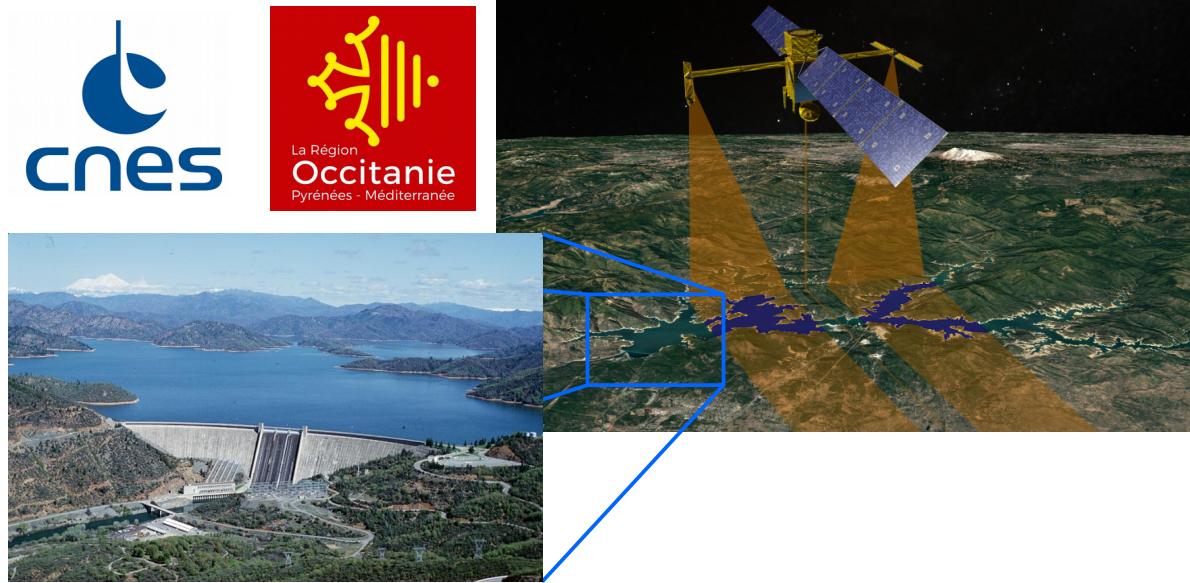
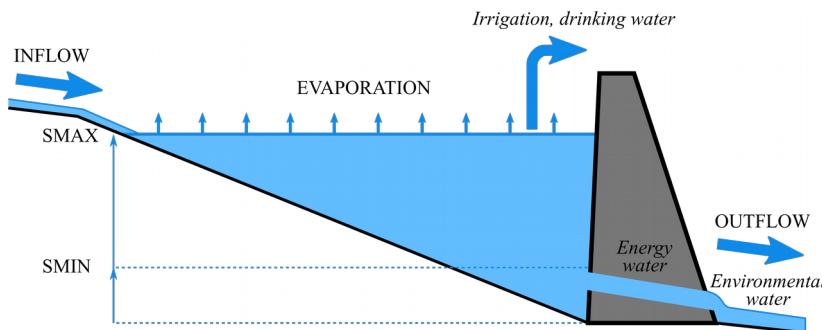
- ISBA-CTrip coupling
 - 2D-diffusive groundwater scheme (+ capillary raise)
 - Floodplains
- MLake (PhD Thibault Guinaldo, 2017-2020)
 - Water mass budget
 - Integrated into the river network
 - Fully coupled to SURFEX



Thèse de Malak Sadki (2019-2022)

Objectif scientifique :

Améliorer notre compréhension
de l'impact de l'anthropisation
sur les ressources en eau à
l'échelle régionale



- ▶ Réseau de rivières haute résolution (CTRIPI-12D)
- ▶ Développement d'un modèle barrage-réservoir
 - basé sur le modèle MLake en cours de développement
- ▶ Gestion des réservoirs et lâchers de barrages
 - hydro-électricité
 - soutien d'étiage
 - écrêtage des crues
 - irrigation
- ▶ Assimilation d'observations satellites
 - caractérisation des réservoirs
 - calibration des paramètres

*future mission
altimétrique SWOT*



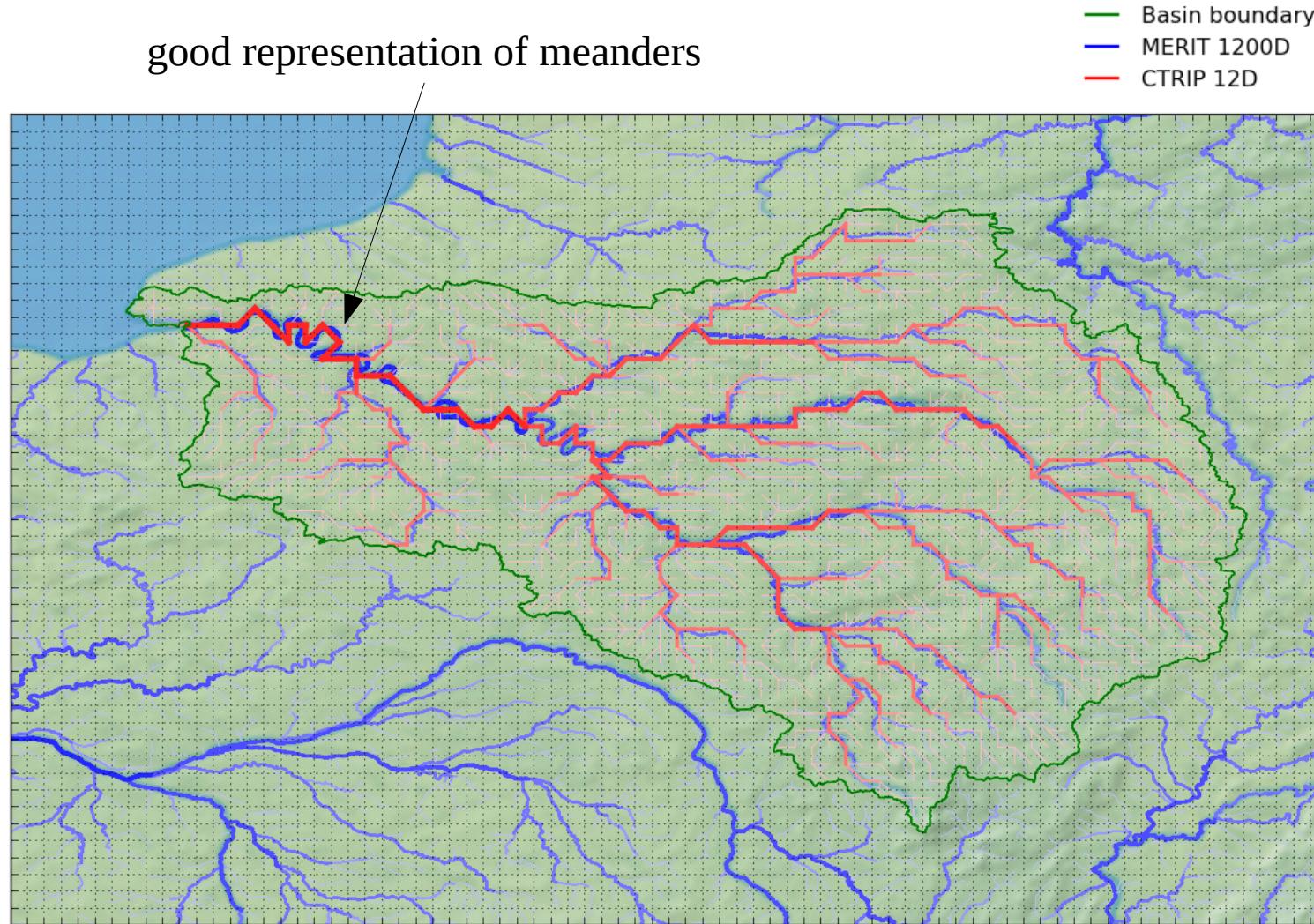
Thanks!

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CTRIP-12D: river network

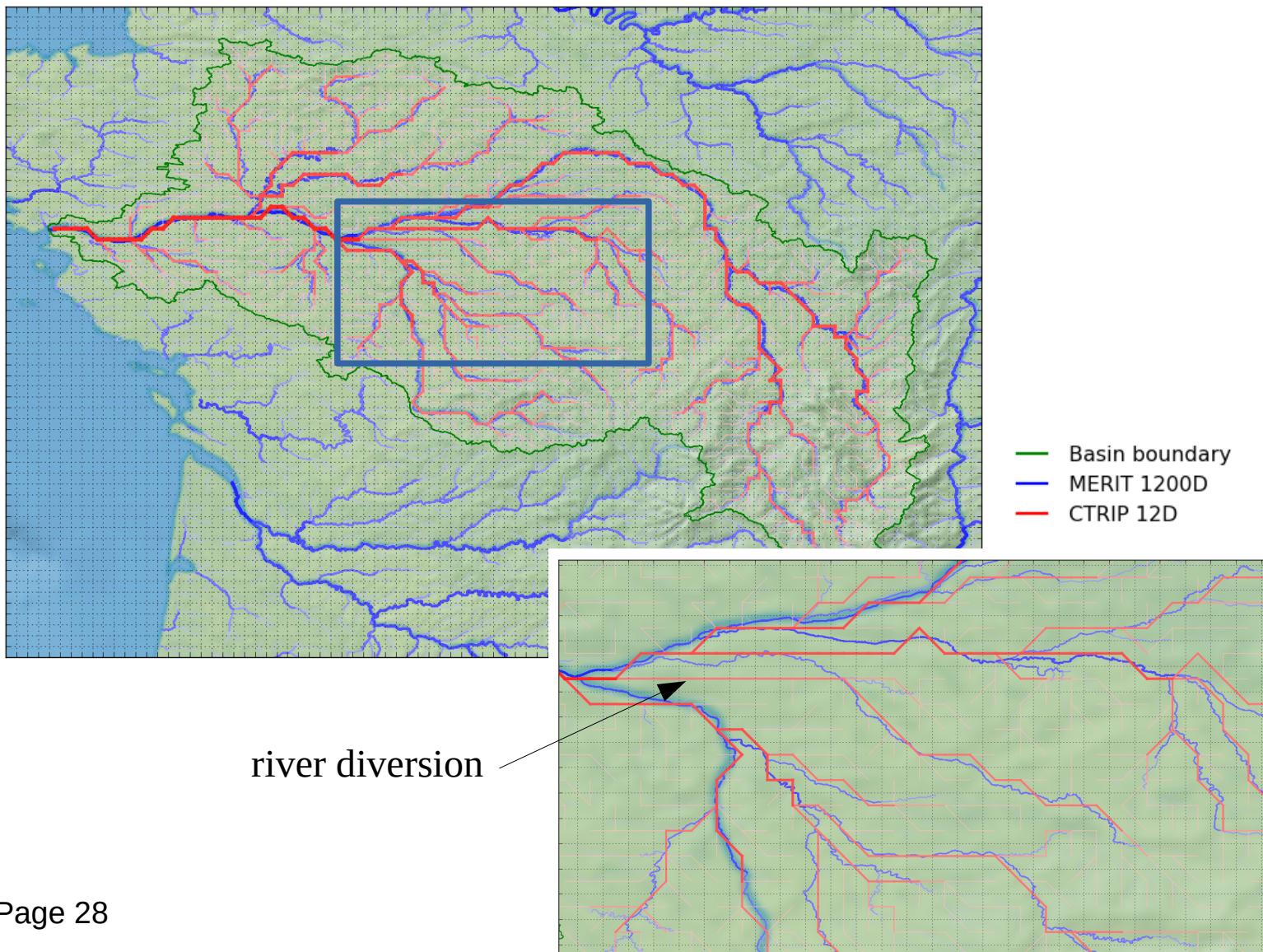
- Some examples: Seine basin

good representation of meanders



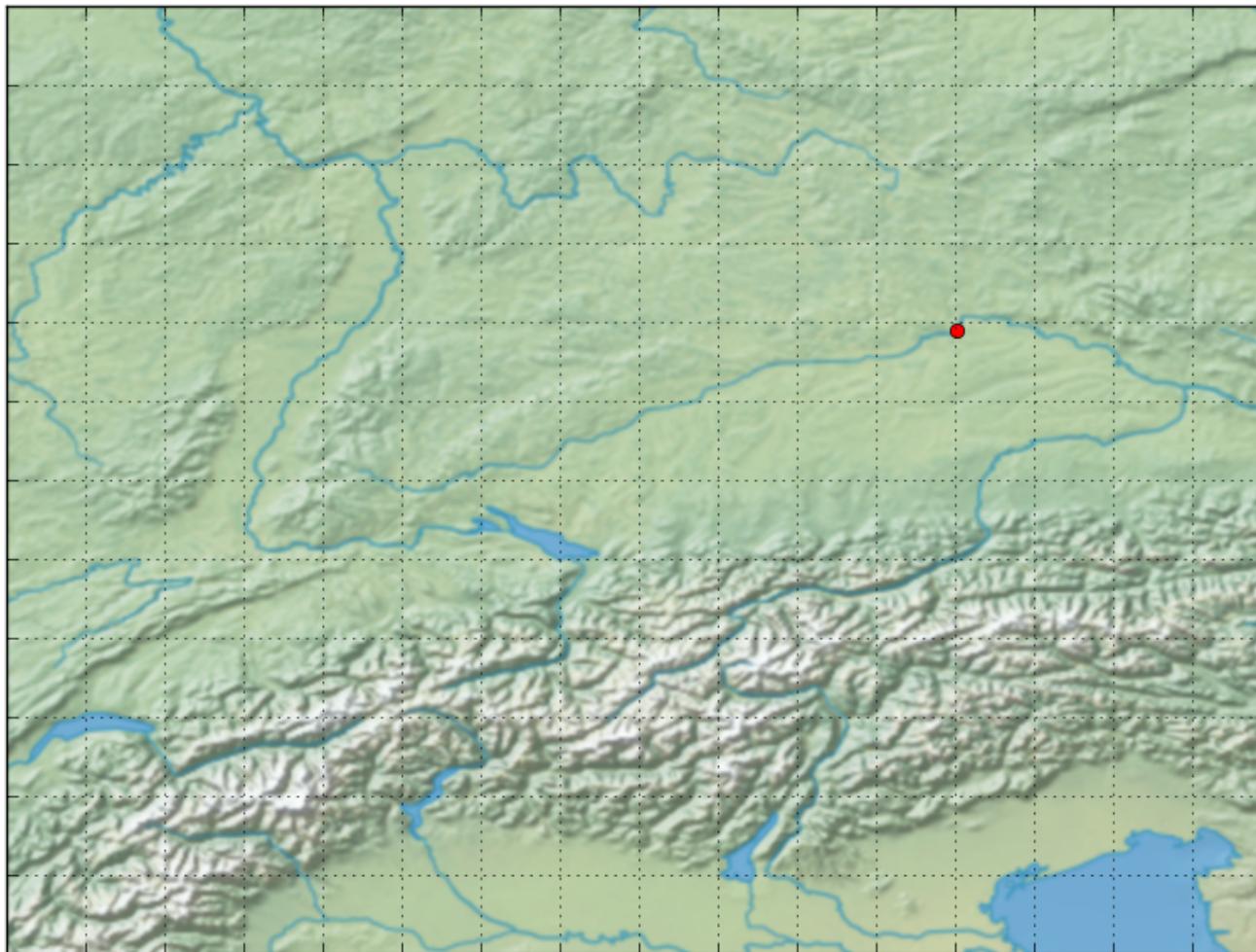
CTRIP-12D: river network

- Some examples: Loire basin



Comparing CTRIP results with observations

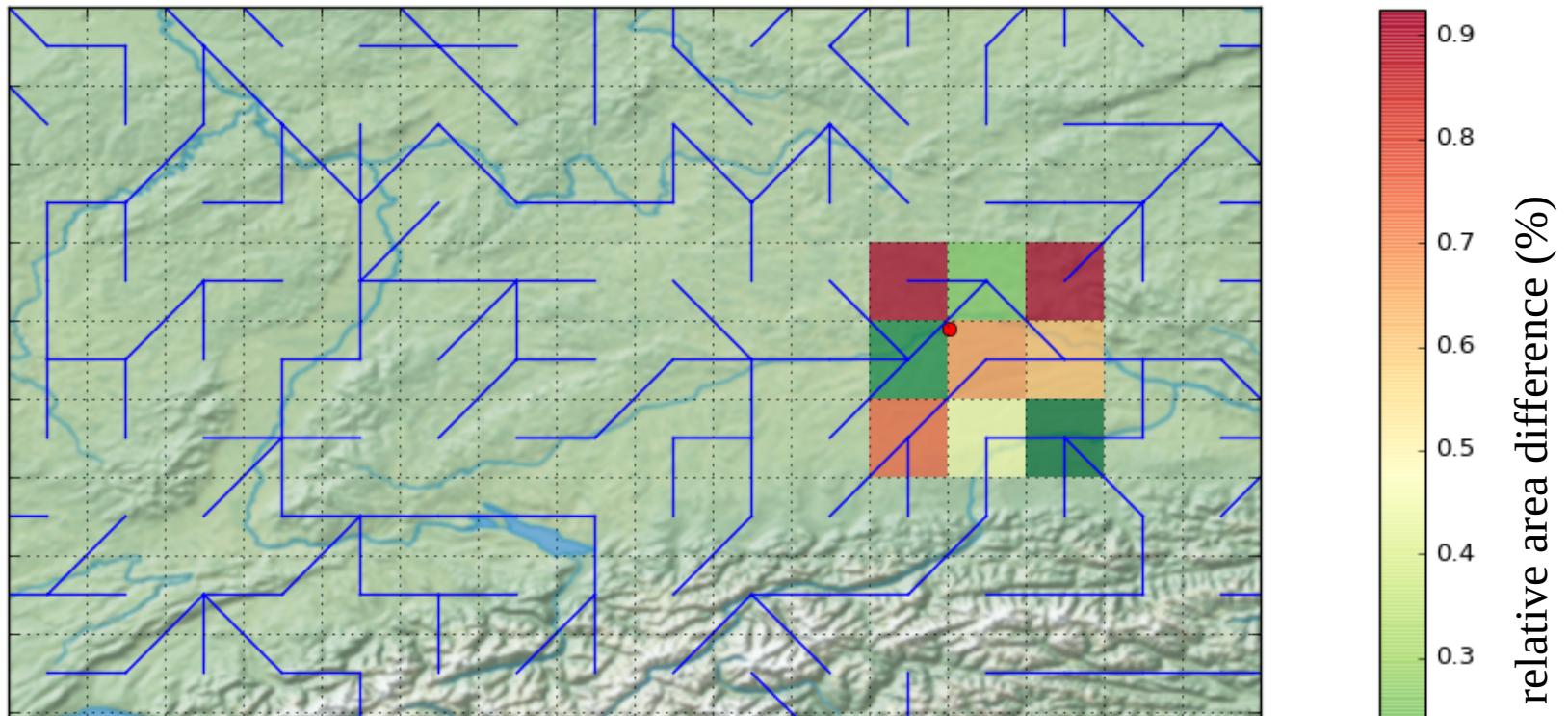
- What is the CTRIP pixel corresponding to a given gauge station?



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

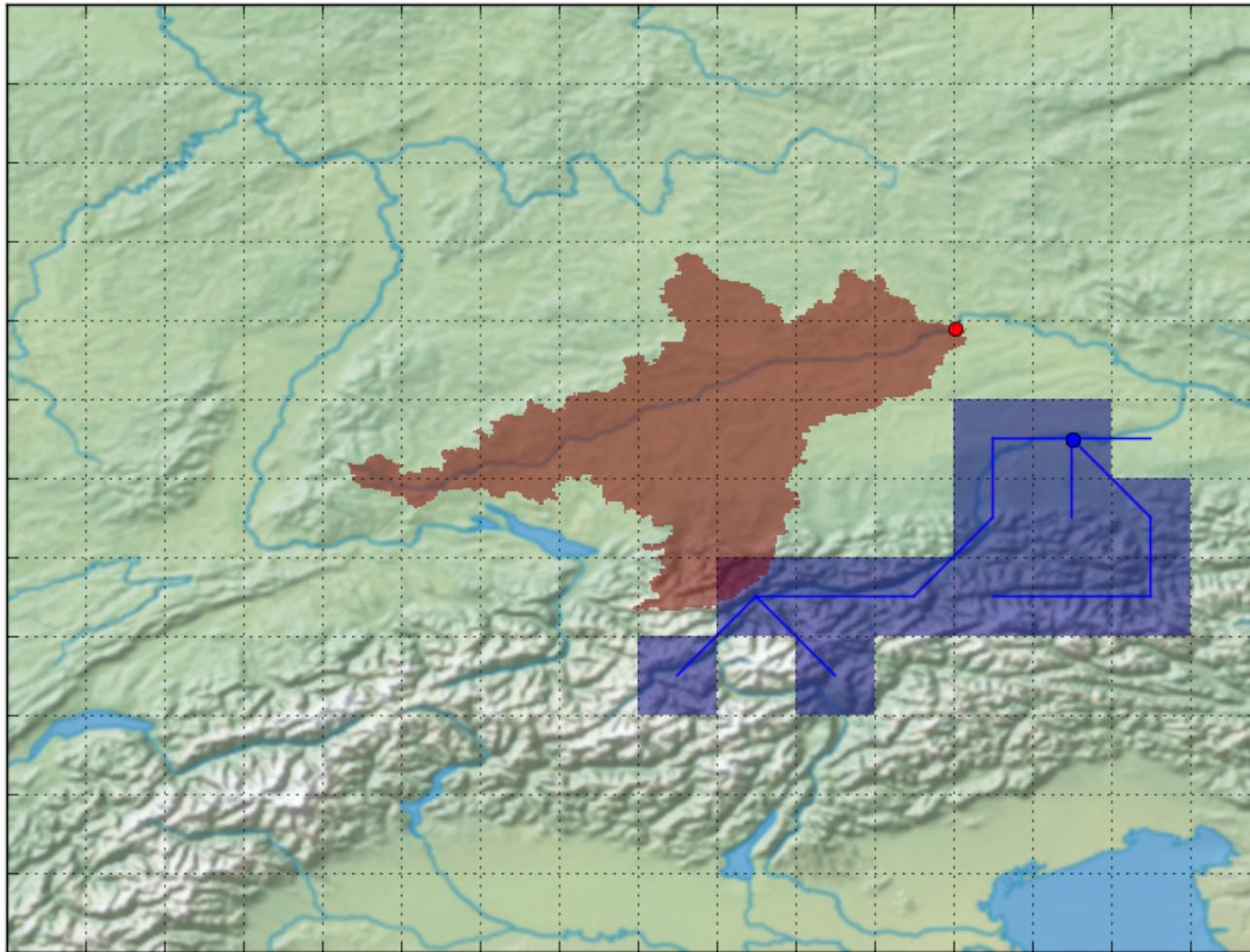
Comparing CTRIP results with observations

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



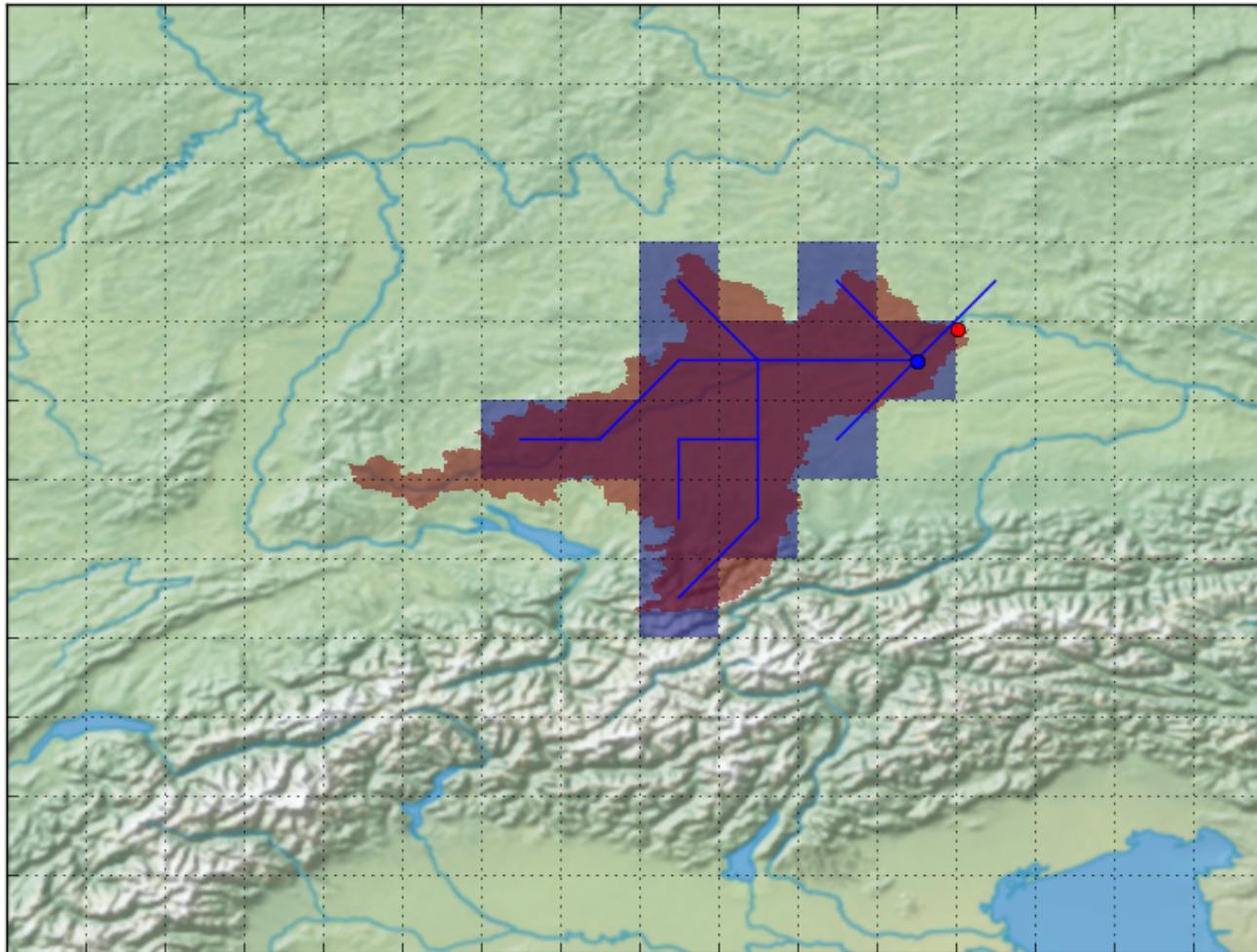
Comparing CTRIP results with observations

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



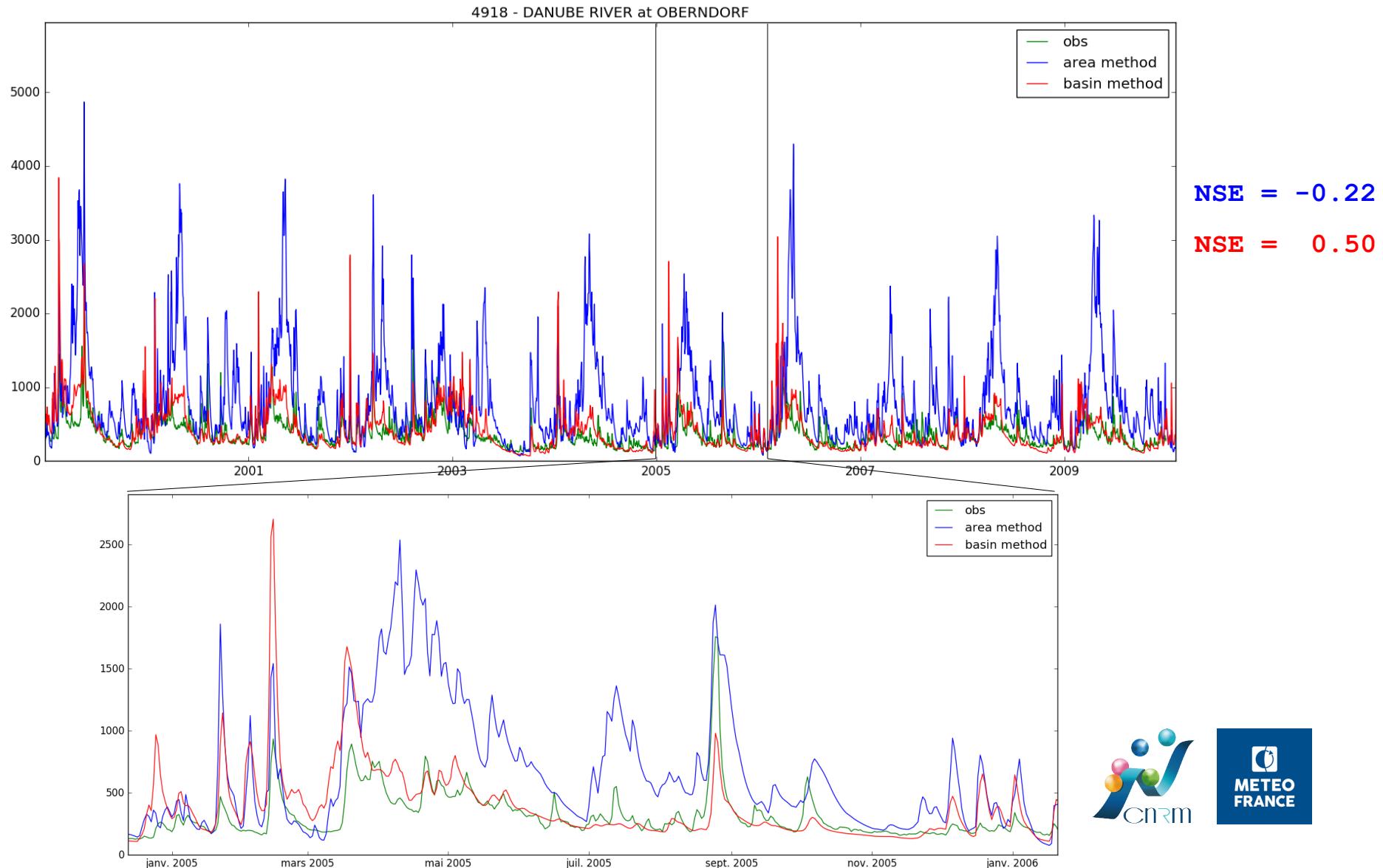
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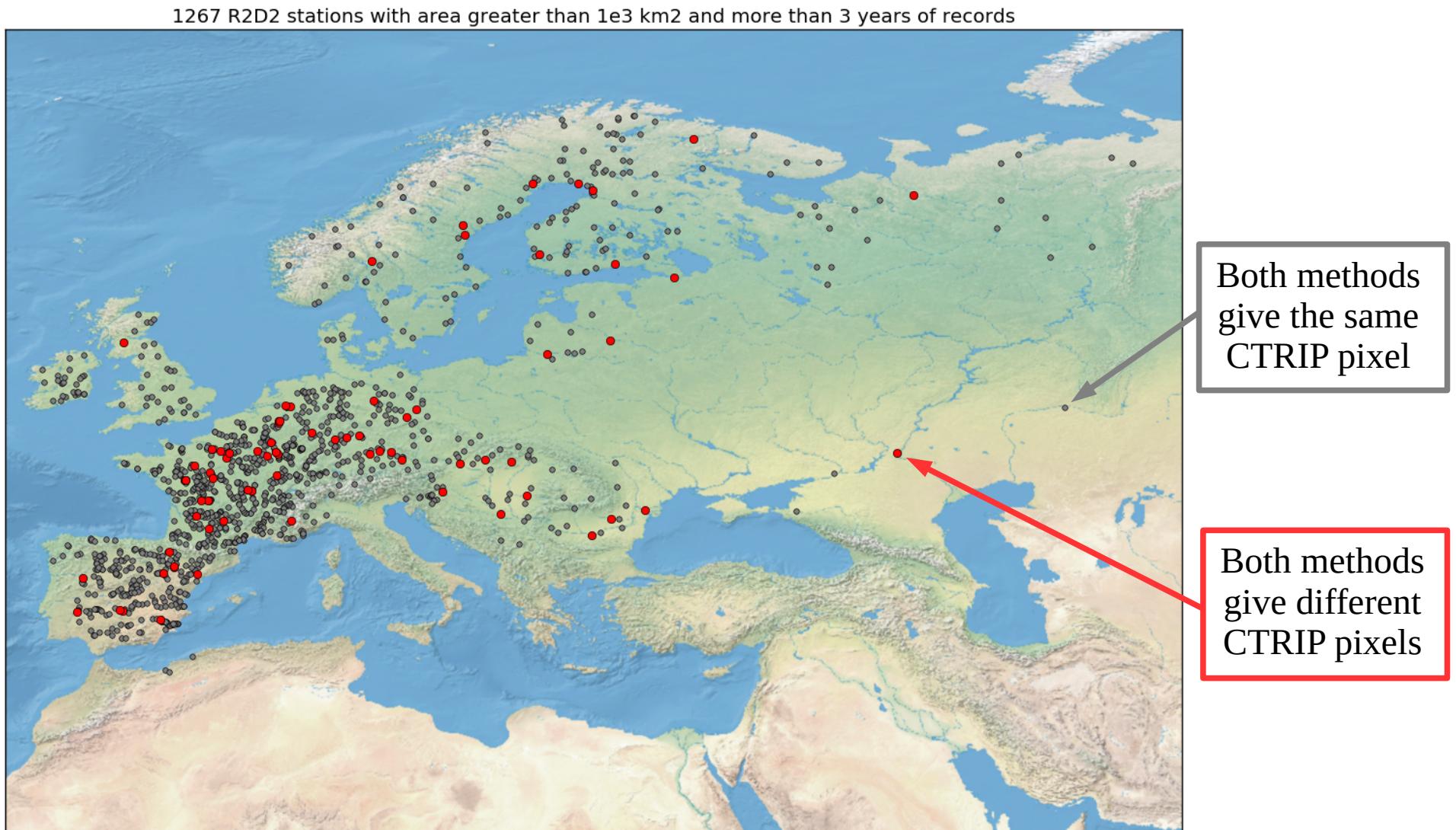


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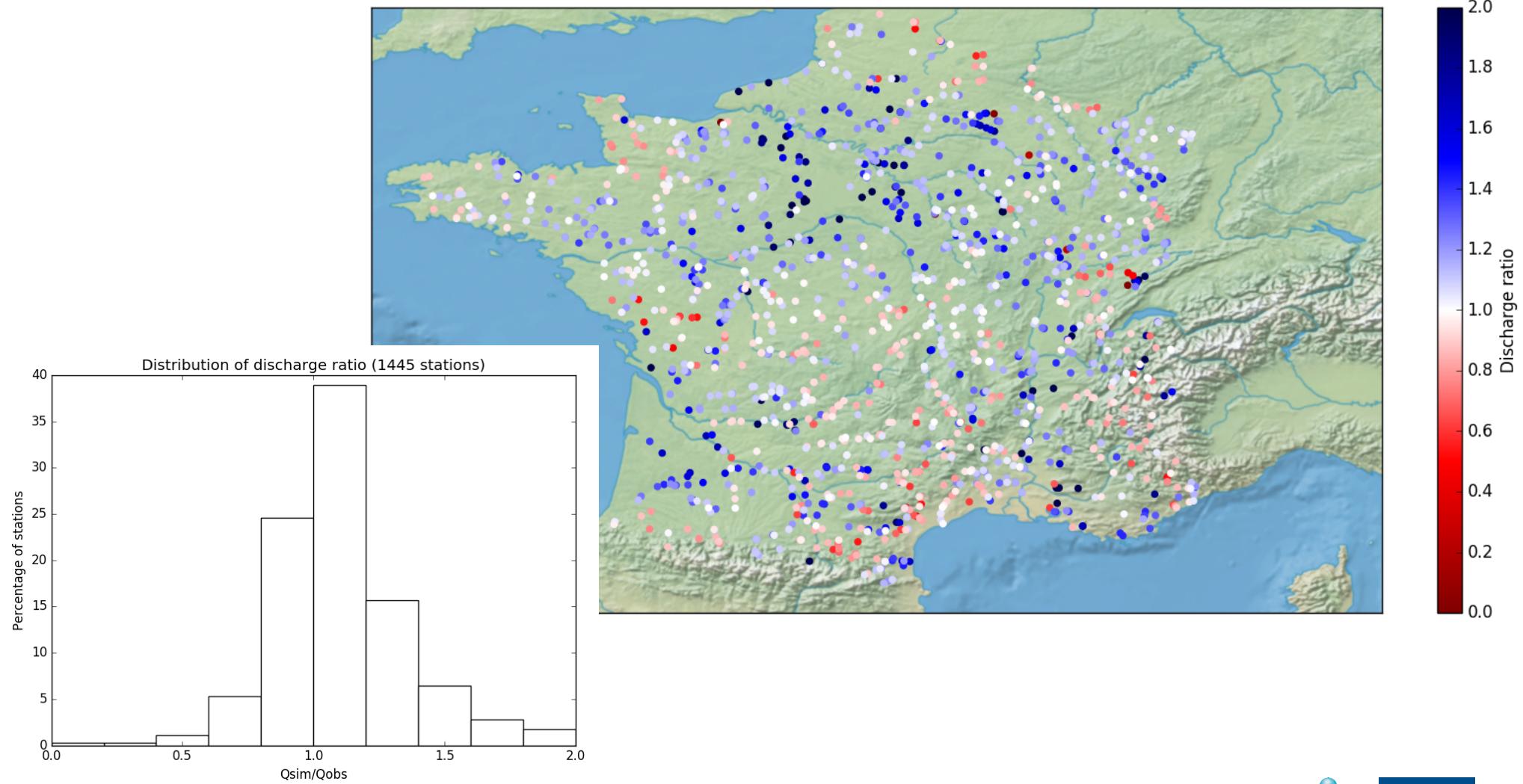


Comparing CTRIP results with observations



Simulation results

- CTRIP-12D def: ratio



Simulation results

- CTRIP-12D def: correlation

