Recent advances in global hydrology modeling at CNRM, Météo-France

CTRIP-12D

MLake

SWOT DA

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SWOT Science Team meeting - Bordeaux, 17-20 June 2019

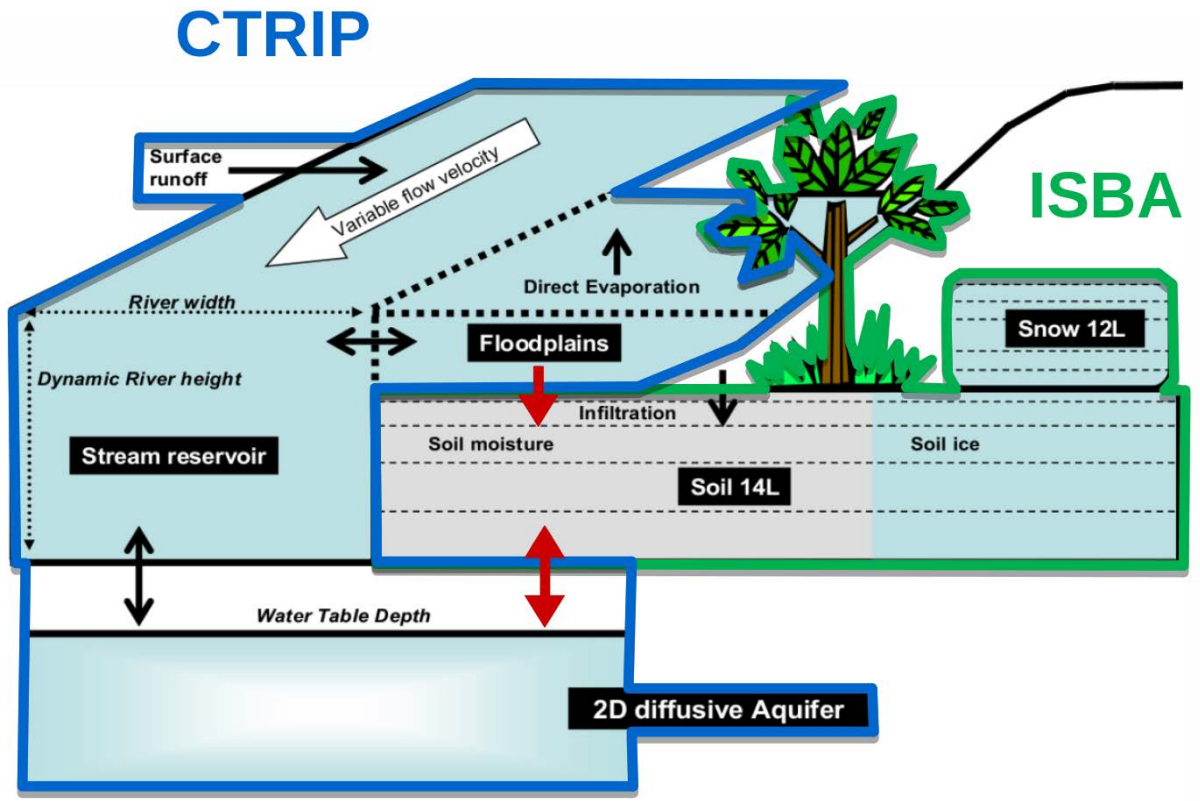
SURFEX-CTRIP hydrological system

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

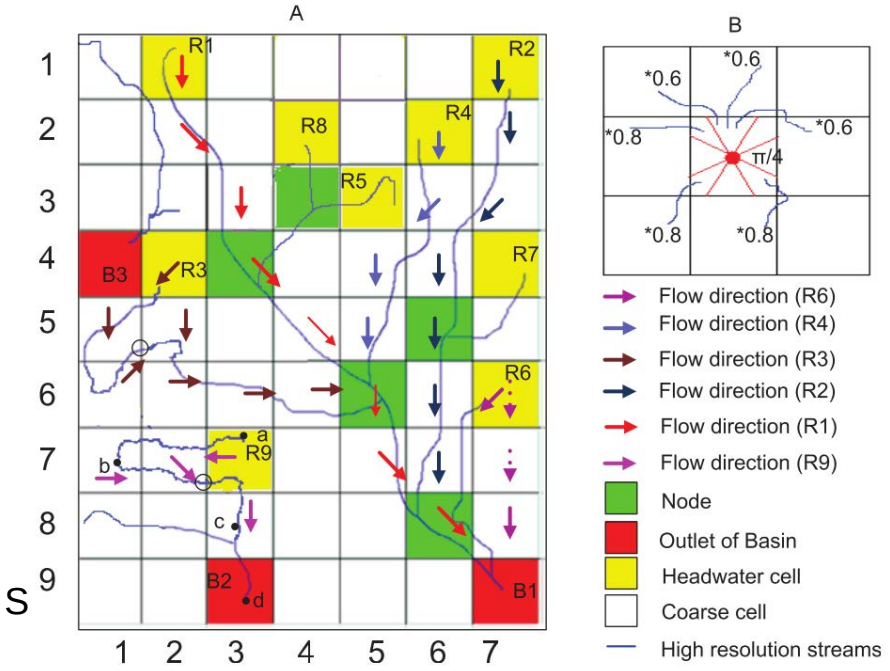
  (Calvet et al., 1998, 2007, Gibelin et al., 2006)



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

- Upscaling of the river network from MERIT Hydro (Yamazaki et al., 2019)
  - high-accuracy global DEM at 3″ resolution (~90 m at the equator)
  - removal of major error components from existing DEMs
- Hierarchical Dominant River Tracing (DRT, 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***

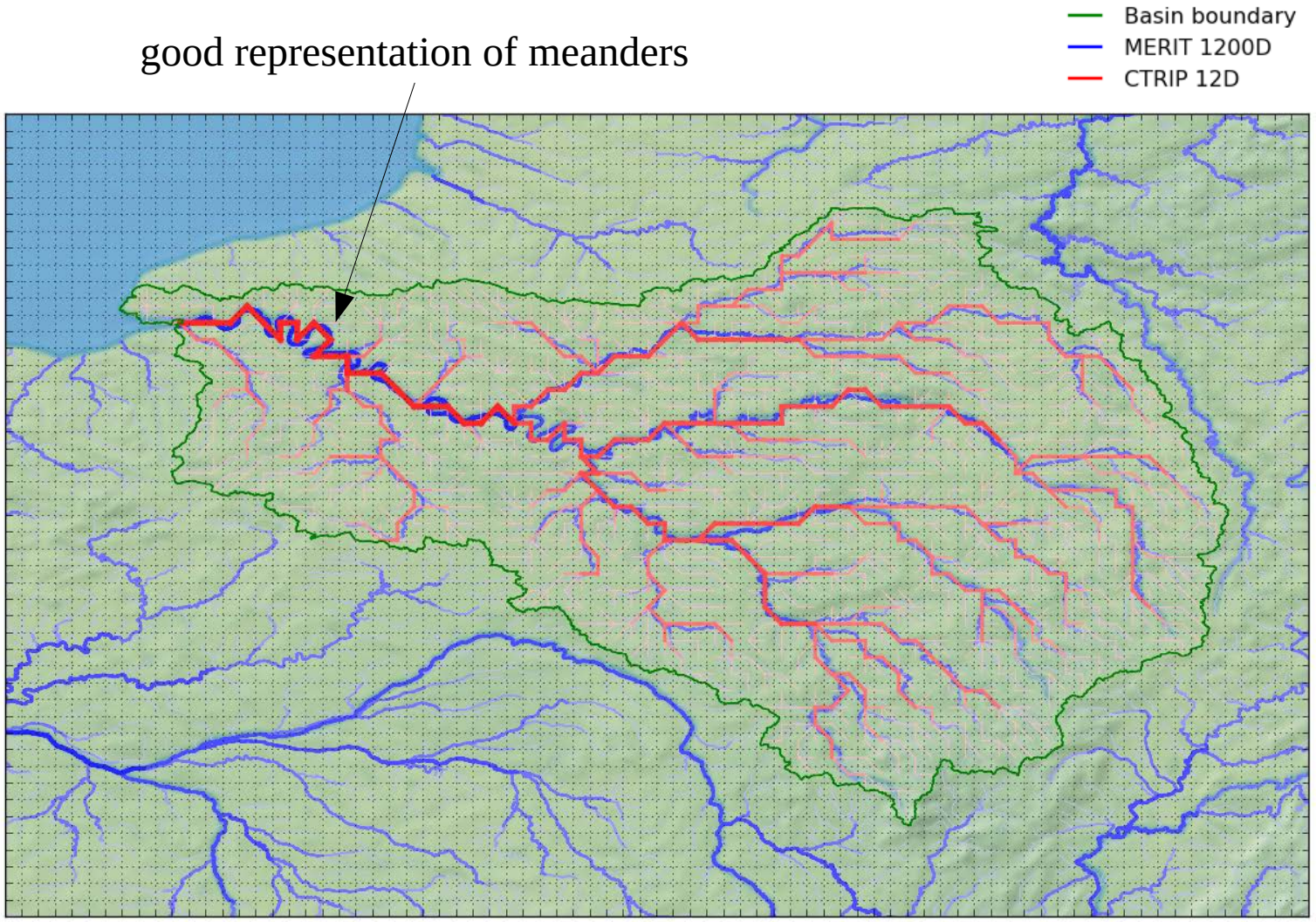


Wu et al., 2011

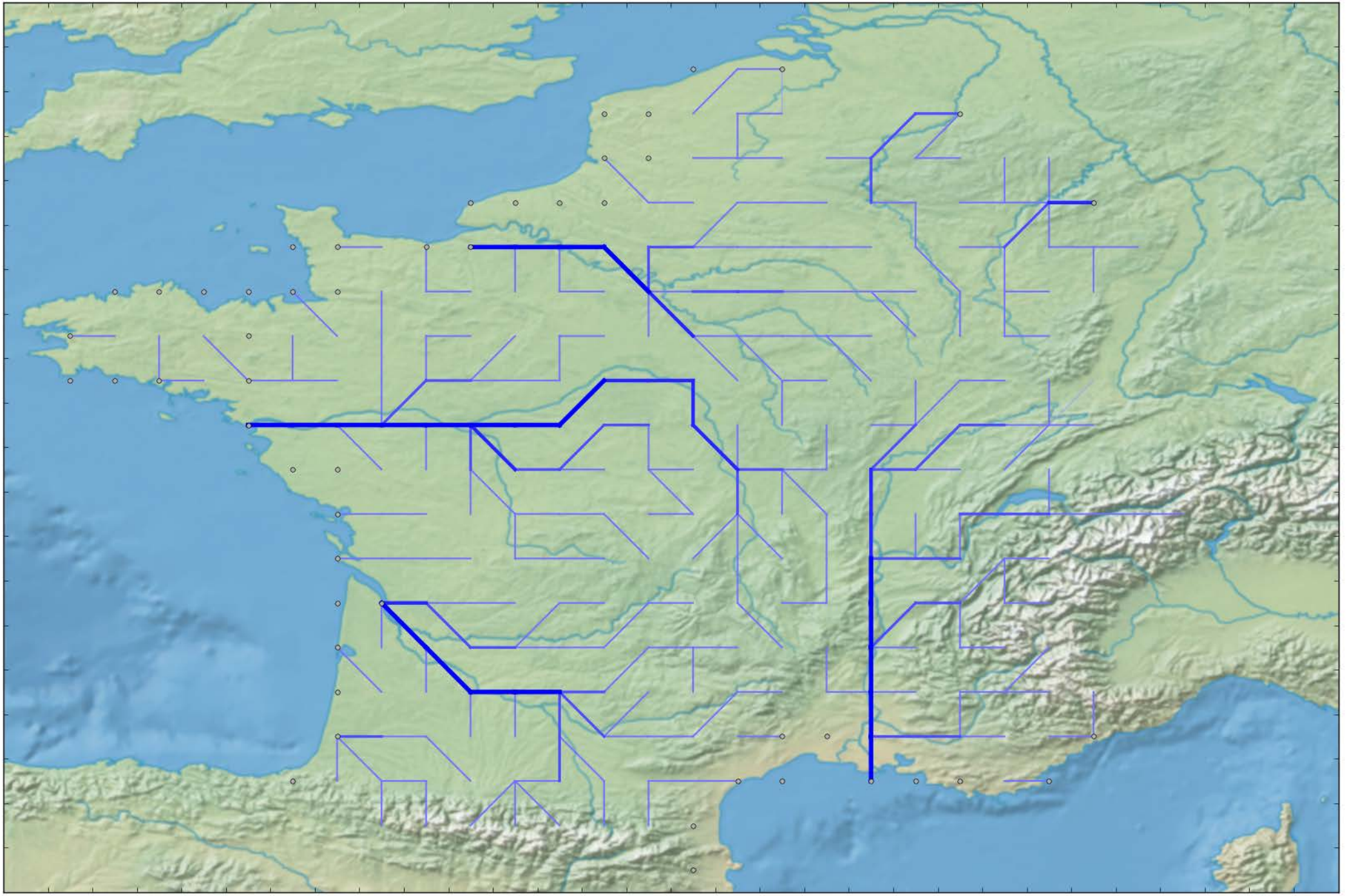
S … e 2019

CTRIP-12D

- Example of the Seine River basin



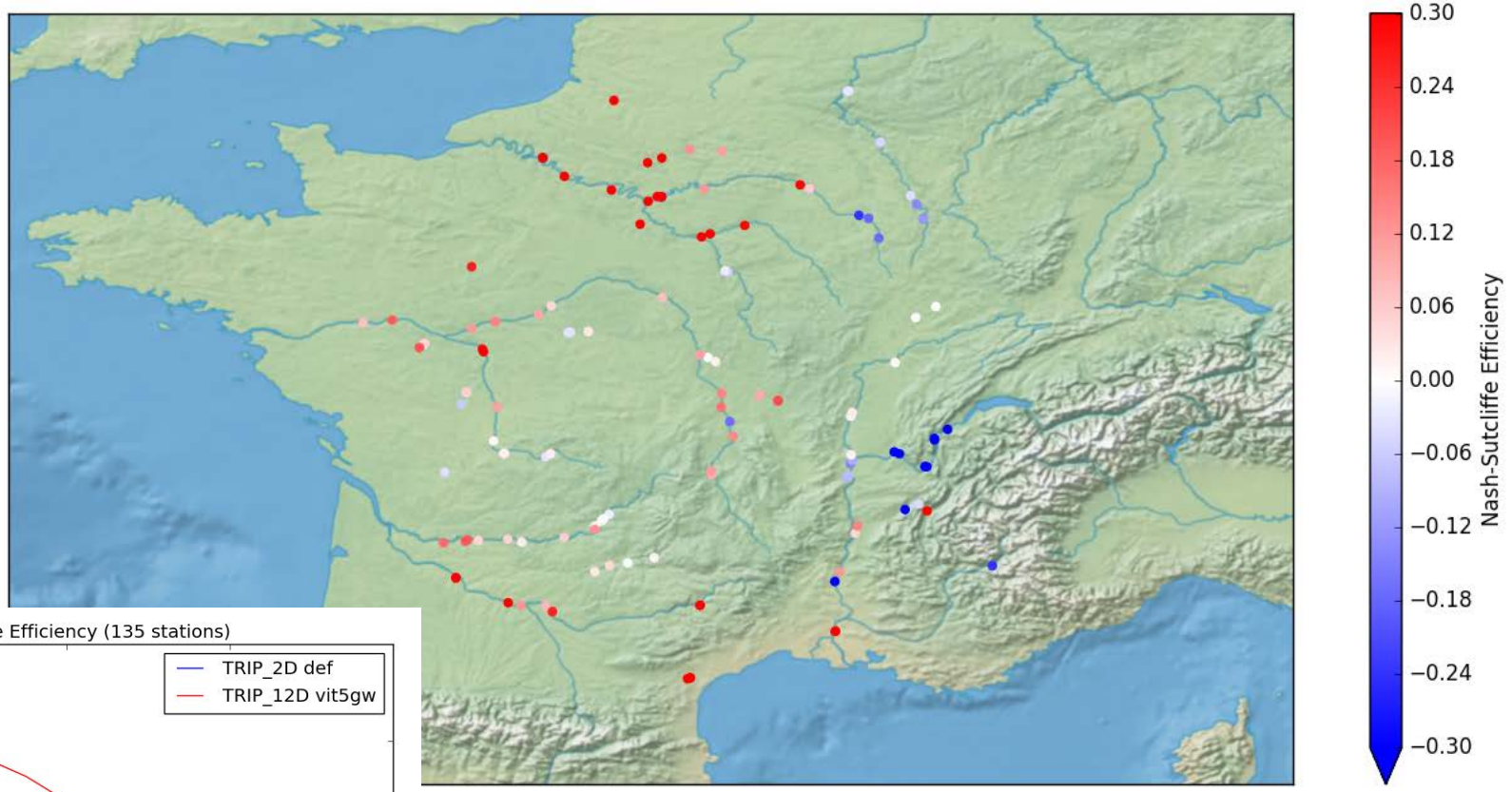
CTRIP-2D over France

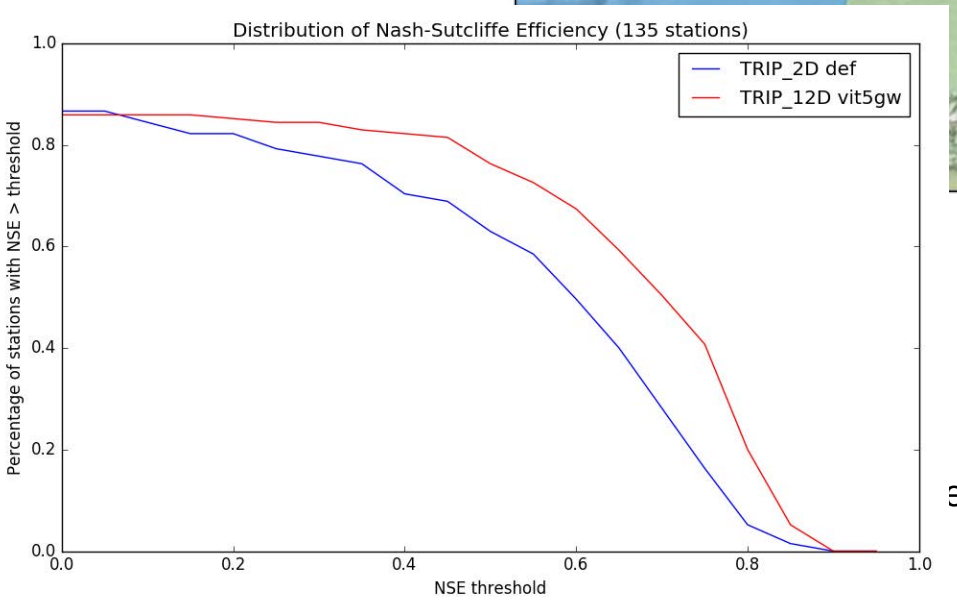


CTRIP-12D over France

CTRIP-12D: preliminary results

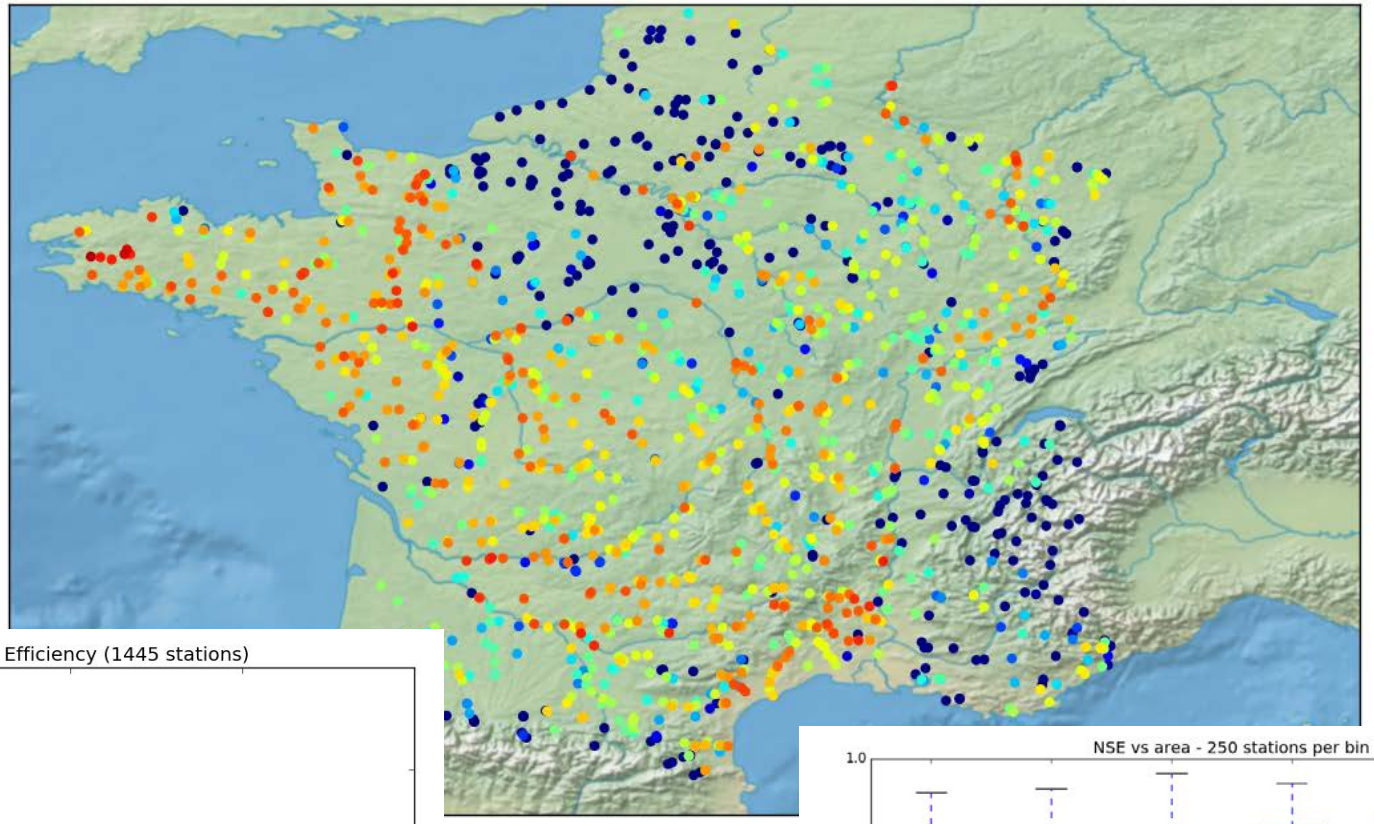
- **CTRIP-12D** vs **CTRIP-2D**: NSE

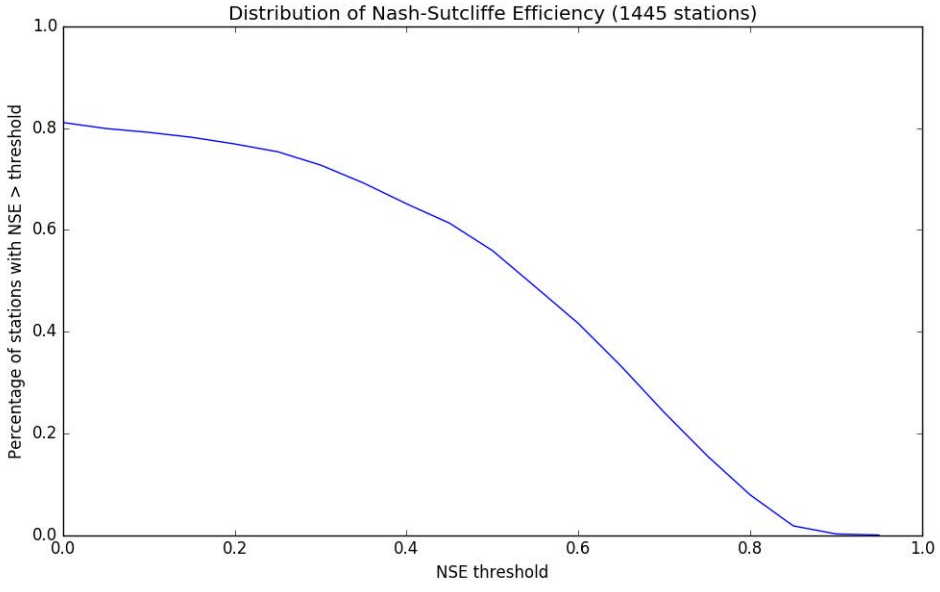




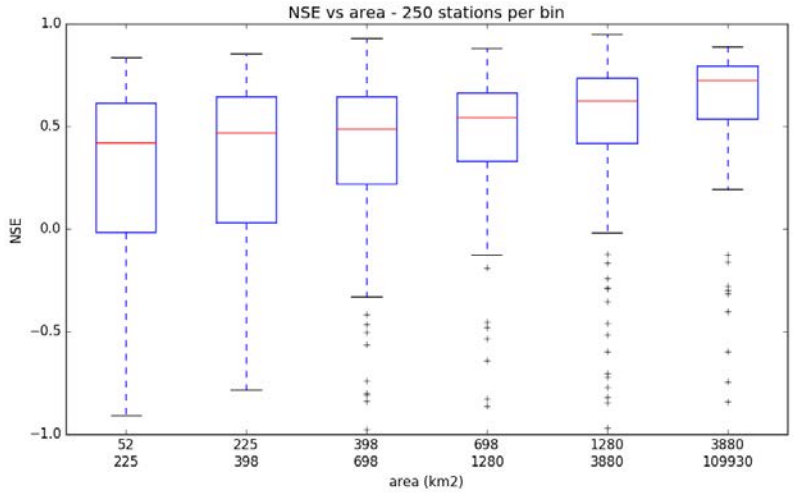
CTRIP-12D: preliminary results

- **CTRIP-12D**: NSE

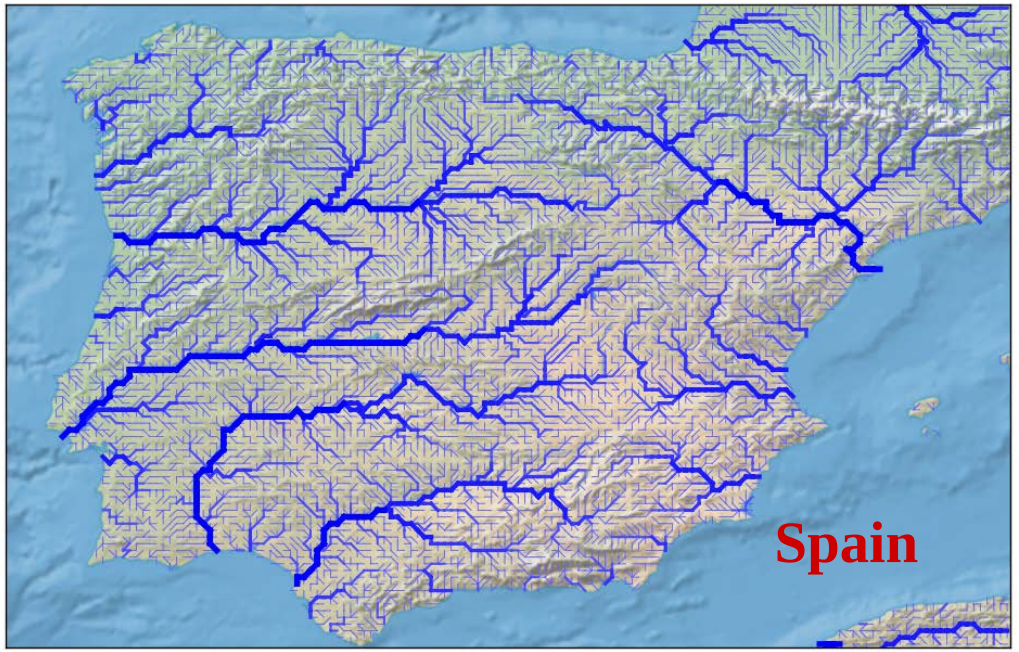




Munier et al., in prep



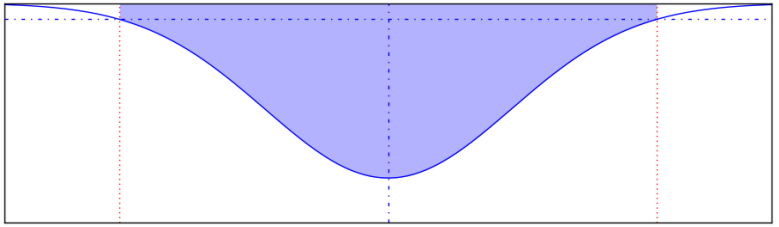
CTRIP-12D: examples

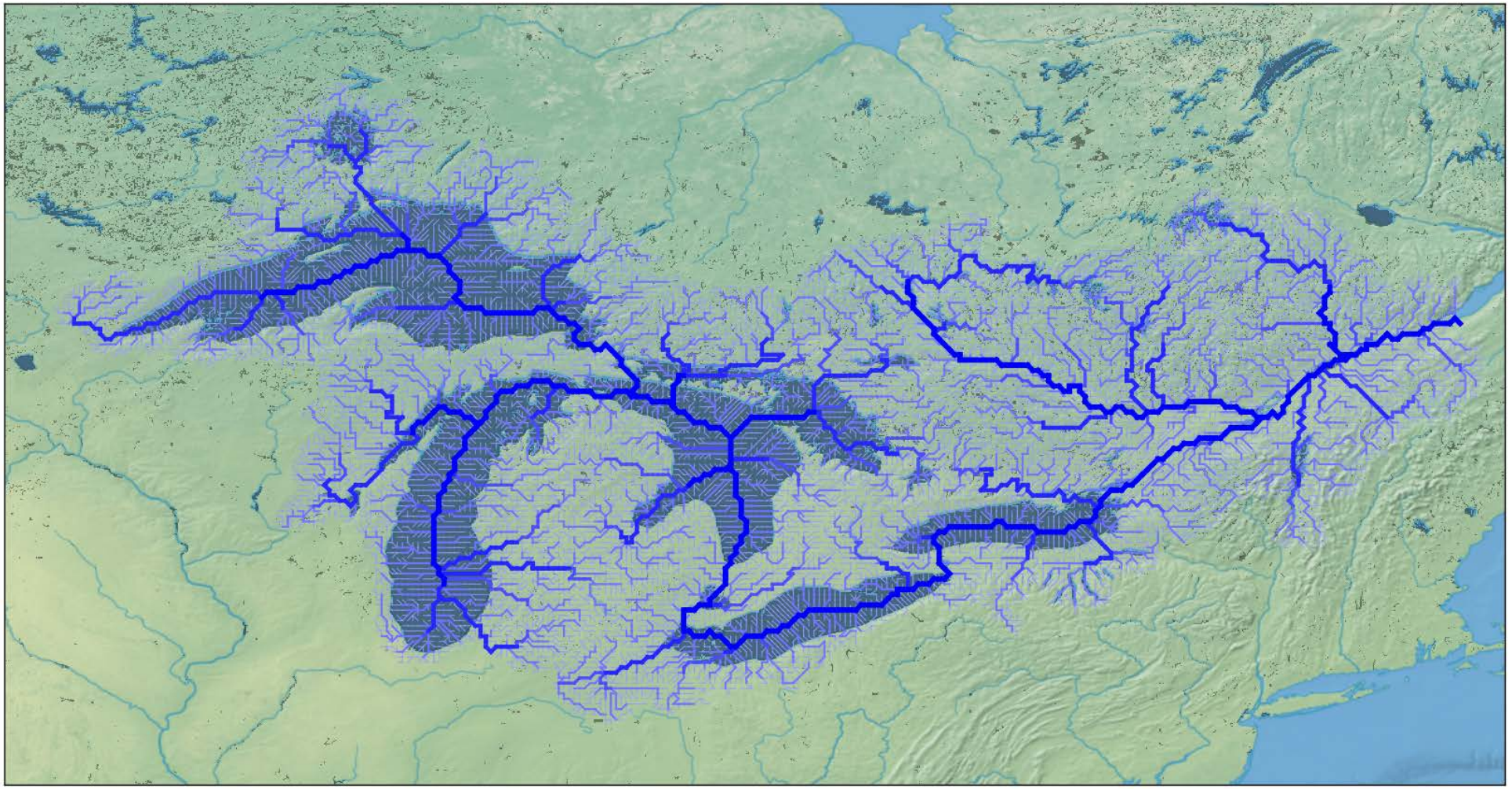


Munier et al., in prep

MLake: Water mass balance in lakes

- Global scale extraction of lakes (localization, area) from ECOCLIMAP-II (1 km resolution)
- Calibration of a Gaussian shape for bathymetry
- Clipping of lake mask over the CTRIP-12D river network





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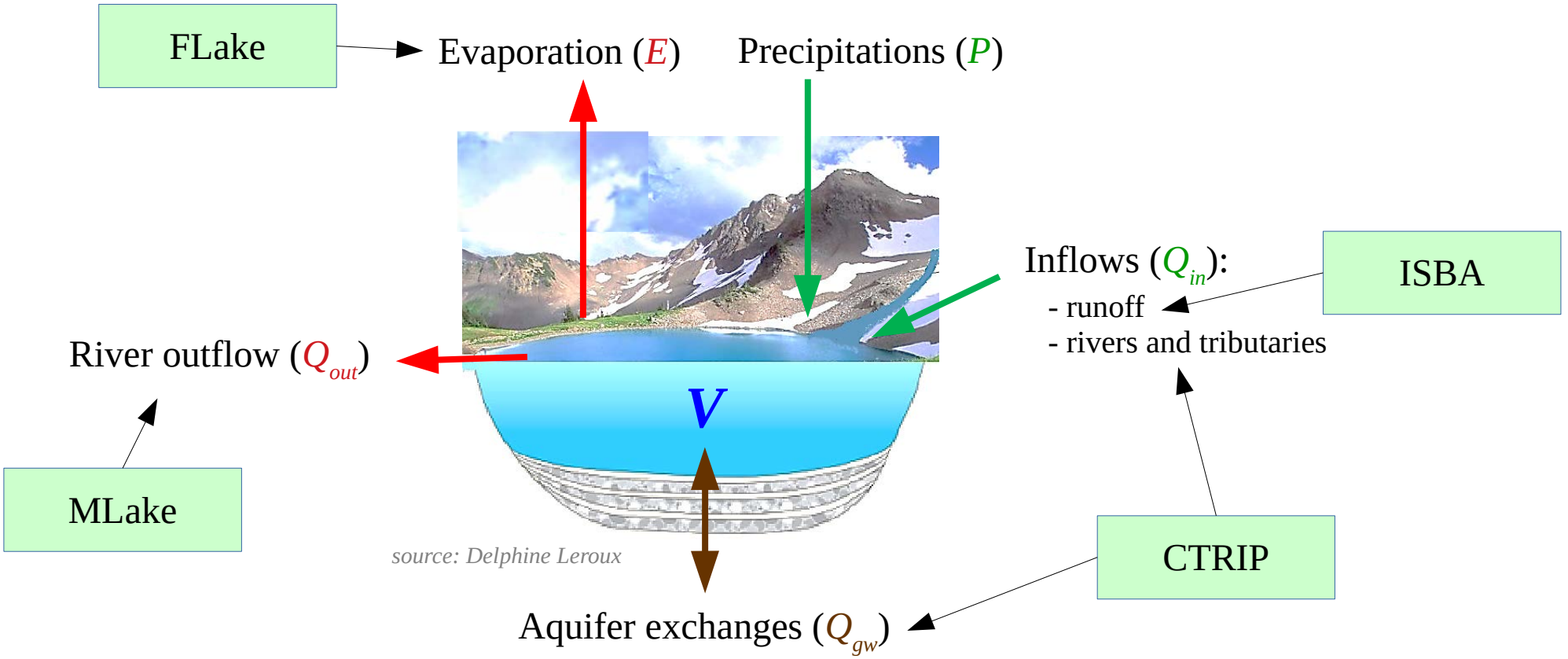


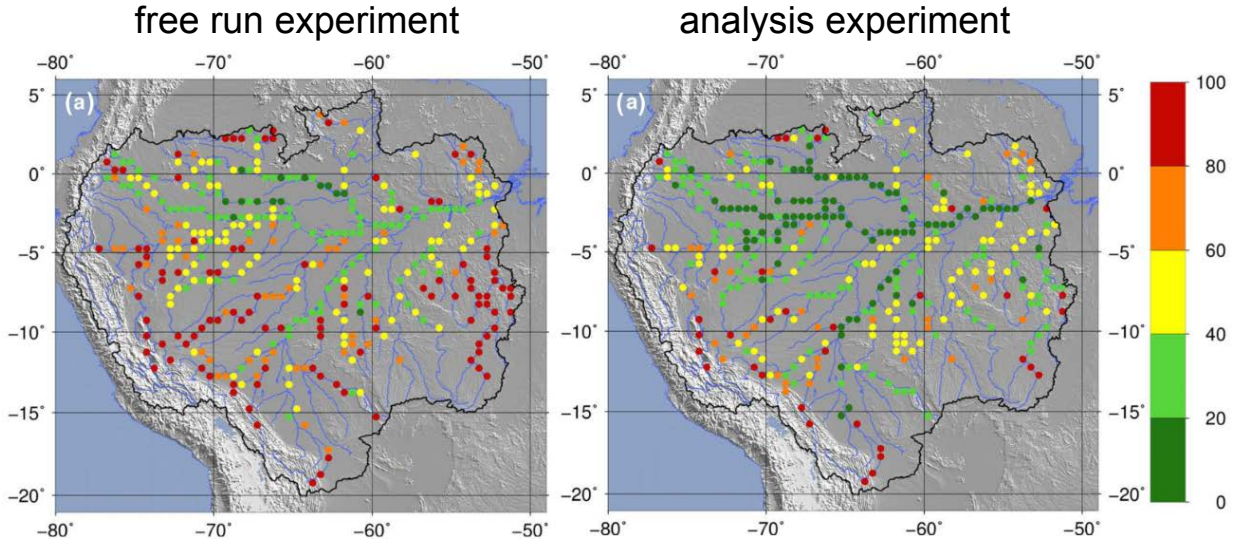
$$\frac{dV}{dt} = (P - E) * A_{lake} + Q_{in} - Q_{out} + Q_{gw}$$

Guinaldo et al., in prep

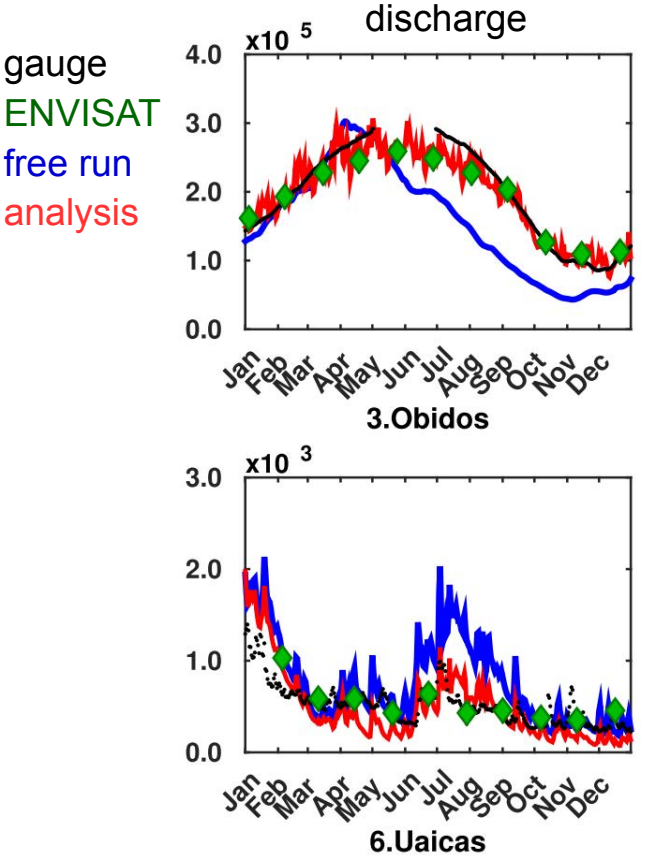
SWOT DA within CTRIP

- Based on previous work by Emery et al. (2018, 2019) over the Amazon basin

  Assimilation of ENVISAT observations within CTRIP for parameter estimation or state correction (river storage or discharge)



RMSEn of simulated/analyzed discharge with respect to the ENVISAT

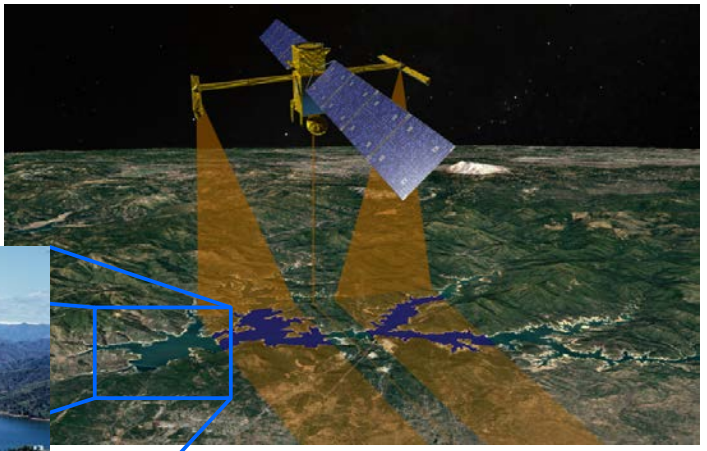


- On-going integration in the SURFEX code (TOSCA project)
  - Freely available from GIT repo
  - Possible extension for case studies over any basin around the world

Integration of dam-reservoirs

- New PhD starting in October 2019, funded by CNES

Improved river flow modeling with the integration of dams-reservoirs and the use of the future altimetry SWOT mission



Main objective:

Improve our understanding of the impact of anthropization on regional scale water resources

- New high resolution river network
- Development of a dam-reservoir model
- Reservoir management and dam releases
  - Hydropower
  - Irrigation
  - Low-flow sustainability
  - Flood control
- Assimilation of satellite observations
  - Characterization of reservoirs
  - Model parameter calibration

References

- Emery, C. M., A. Paris, S. Biancamaria, A. Boone, S. Calmant, P. A. Garambois and J. S. Da Silva (2018). **Large-scale hydrological model river storage and discharge correction using a satellite altimetry-based discharge product.** *Hydrology and Earth System Sciences*, 22(4), 2135–2162.

- Emery, C. M., S. Biancamaria, A. Boone, S. Ricci, M. Rochoux M. and V. Pedinotti (2019). **Correction of large-scale river routing model parameters using SWOT observations.** *Hydrology and Earth System Sciences*, submitted.

- Emery, C. M., A. Paris, S. Biancamaria, A. Boone, S. Calmant, P.-A. Garambois, J. Santos de Silva and C. David (2019). **Discharge estimation via assimilation of multi-satellite-based discharge products: case study over the Amazon basin.** *IEEE Geosci. and Remote Sens. Letters*, submitted.

- Häfliger, V., E. Martin, A. Boone, S. Ricci, and S. Biancamaria (2019). **Assimilation of Synthetic SWOT River Depths in a Regional Hydrometeorological Model.** *Water*, 11(1), 78.

- Guinaldo, T. et al. (2019). **MLake: a water mass balance model for the representation of lake dynamics within the SURFEX modeling plateform.** *In prep*.

- Munier, S. et al. (2019). **Increasing the spatial resolution of the CTRIP routing model: hydrological impacts over France.** *In prep*.

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