Global Hydrology and Remote Sensing Working Group
co-Chairs: Aaron and Dennis Lettenmaier

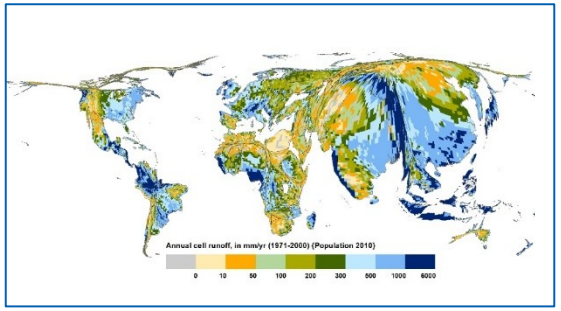
Projects:

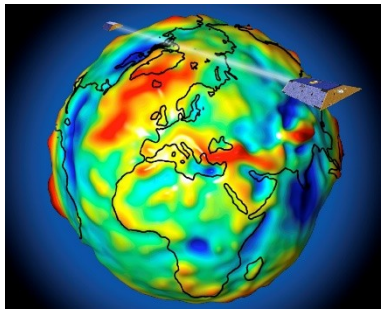
- Aaron Boone et al: Towards a better understanding of the global hydrological cycle with SWOT
- Petra Döll and Jürgen Kusche: GlobalCDA: Understanding the global freshwater system by combining geodetic and remote sensing information with modelling using a calibration/data assimilation approach
- Dennis Lettenmaier et al: Development of spatiotemporally continuous runoff using SWOT discharge data products
- Christian Schwatke and Denise Dettmering: SWOT for Monitoring Terrestrial Water Storage Changes: Quality Assessment and Combination with other Remote Sensing Data
- Jida Wang et al: Integrating reservoirs into SWOT's global surface water storage and discharge monitoring

GlobalCDA

Understanding the global freshwater system by combining geodetic and remote sensing information with modelling using a calibration/data assimilation approach

Research unit funded by German Research Foundation, 2018-2021 (probably prolonged until 2024)





Petra Döll (Goethe University Frankfurt) and **Jürgen Kusche** (University of Bonn)

Andreas Güntner (GFZ), Annette Eicker (HafenCity University Hamburg), Denise Dettmering (TU Munich), Nico Sneeuw and Mohammad Tourian (University of Stuttgart), Claudia Künzer (DLR), Tonie van Dam (University of Luxembourg), Maike Schumacher (Aalborg University)

GlobalCDA research approach

- streamflow
- TWSA
- snow cover
- **Area-volume-elevation of swb**

Variants of **global hydrological model** WaterGAP

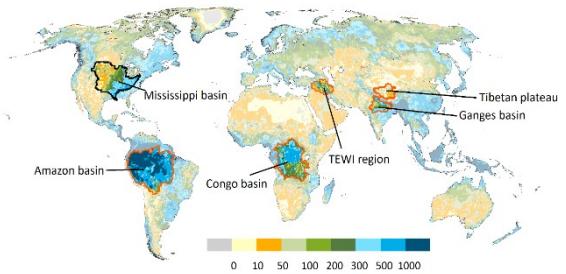
Optimized observations of model **output variables**

Ensemble-based multi-observation C/DA for adjusting parameters *(C)* and/or states *(DA)* *incl. sensitivity analysis*

Ensemble of WaterGAP output constrained by observational data (ensemble mean plus **uncertainty**) plus calibrated sets of spatially distributed model parameters

Analysis and evaluation leading to improved understanding of global freshwater system

Globally and in ‚critical regions'



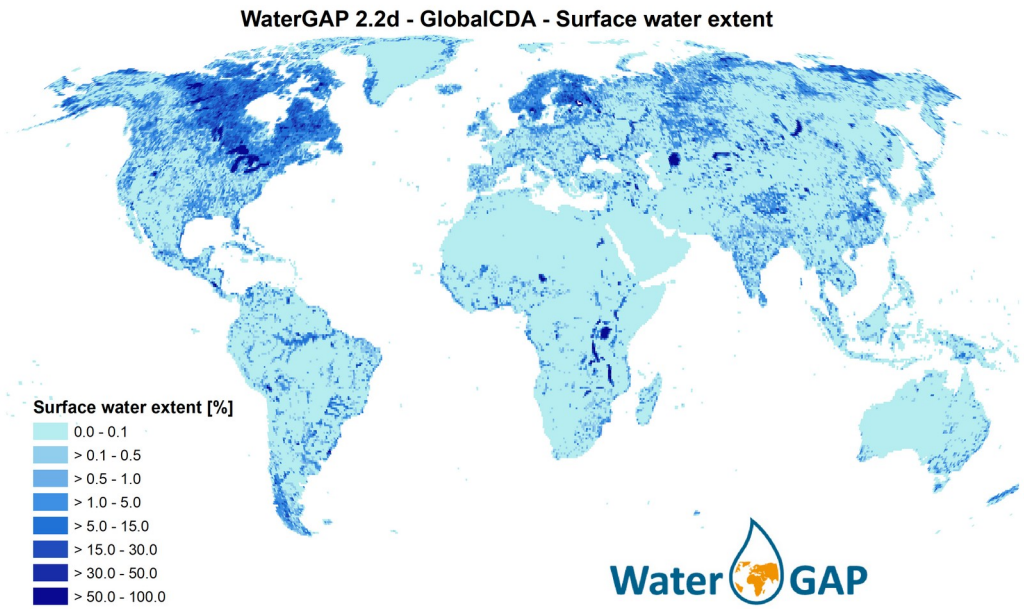
Role of SWOT in GlobalCDA

Provide time series of observed area-volume-elevation functions of surface water bodies for calibration/data assimilation of the global hydrological model WaterGAP

Specific reseach groups working producing SWOT-based observations:

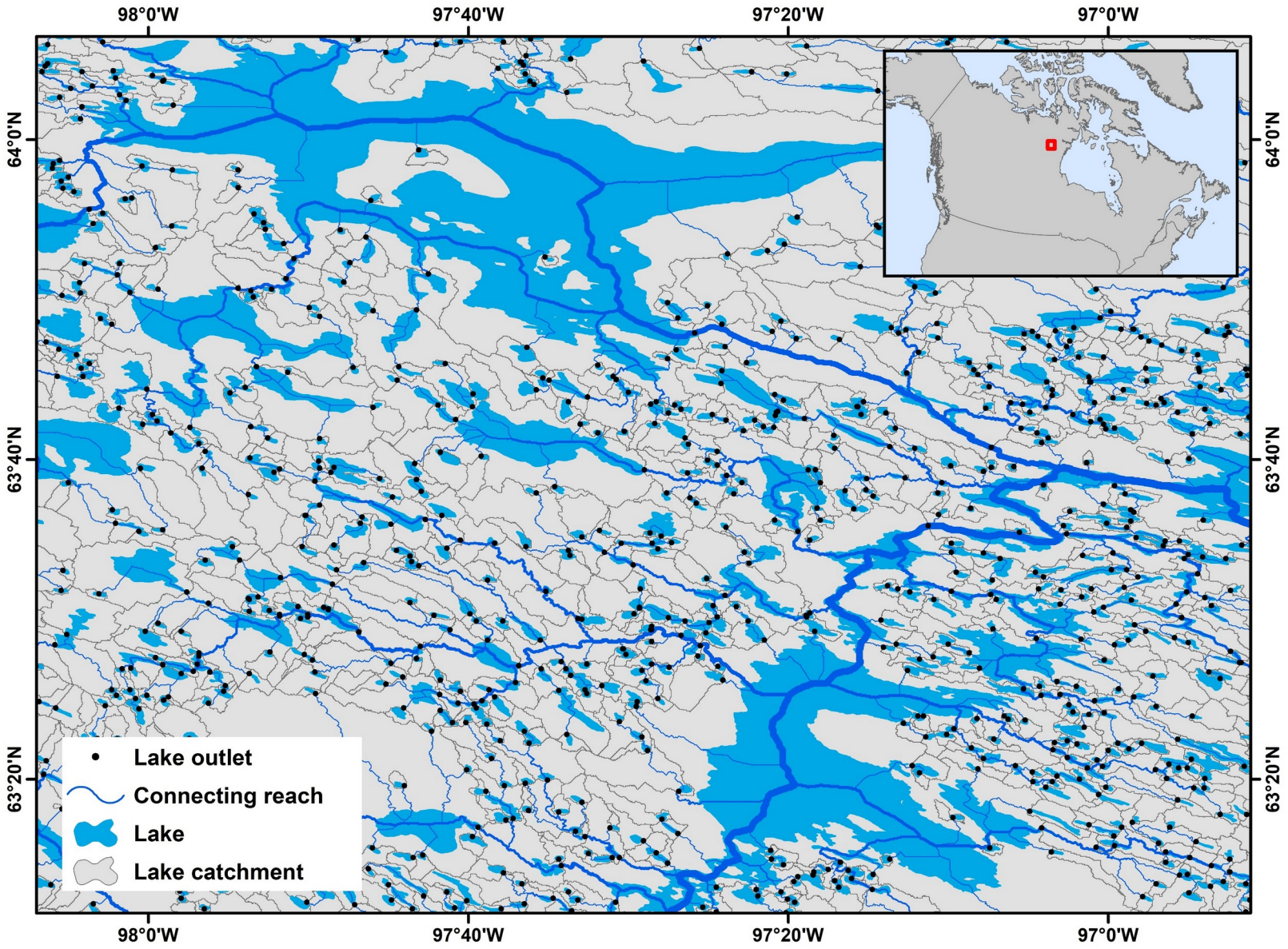
Denise Dettmering/Christian Schwatke, Munich;

Nico Sneeuw/Mohammed Tourian, Stuttgart (also estimating streamflow)



Rectifying a priori lakes and reservoirs to routing networks

(S. Sikder, J. Wang, Y. Sheng, G. H. Allen, D. Yamazaki, T. M. Pavelsky)



Topology attributes

Lake outlets
Downstream outlet
Downstream lake
Downstream river
Distance to dw outlet
Upstream lake count
Catchment area
Distance to sink/coast
…

River reaches
Downstream river
Up/down lakes/outlets
Node elevations
Reach length & slope
Accum up lake count
Stream order
…

Lake catchments
Associated outlet
Associated lake
Catchment area
Downstream river
…

Lakes
Outlet count
Up/down lake count
Catchment area
Accum catchment area
Lake type (order)
…

Rectifying a priori lakes and reservoirs to routing networks

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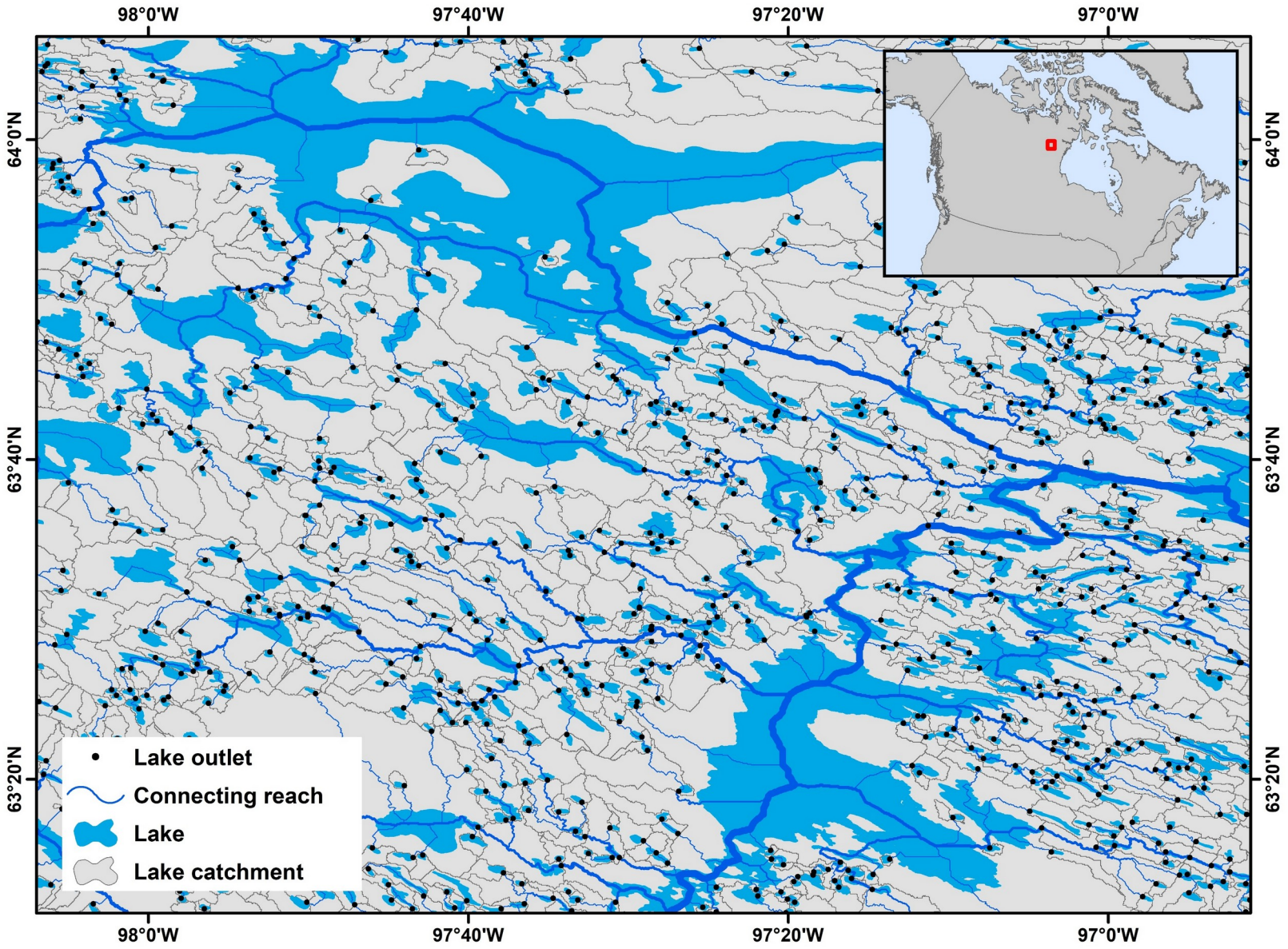


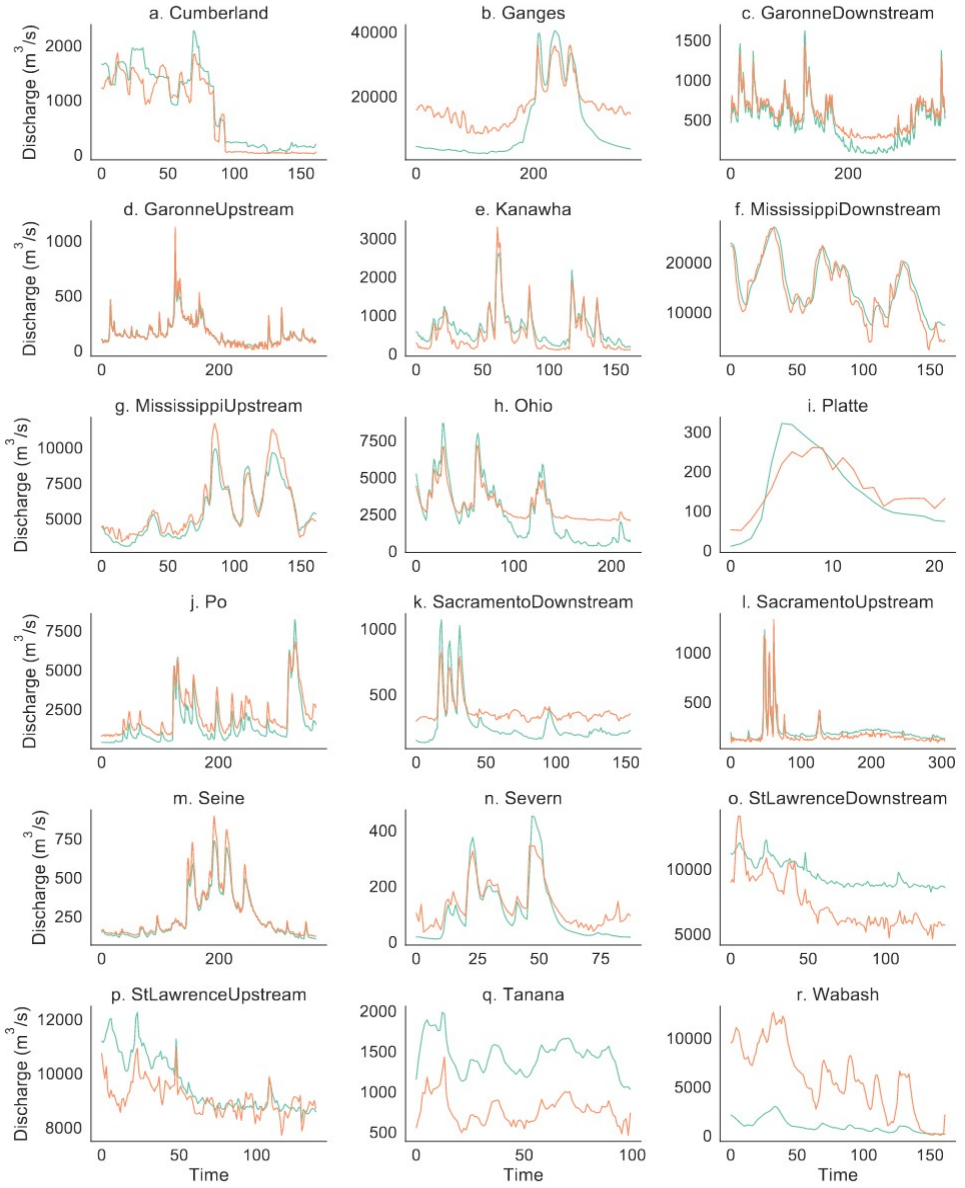
This prepared drainage topology considers lake bifurcation (i.e., one lake draining to multiple reaches and lakes).

This new lake topology allows for an intergradation of SWOT's lake and reservoir observations into global hydrological models.

Integrating SWOT-measured lake storage variations into routing models will improve not only model performance, but also our understanding of the roles of water stores (particularly reservoirs) in regulating discharge.

Improvements in continuous discharge estimates

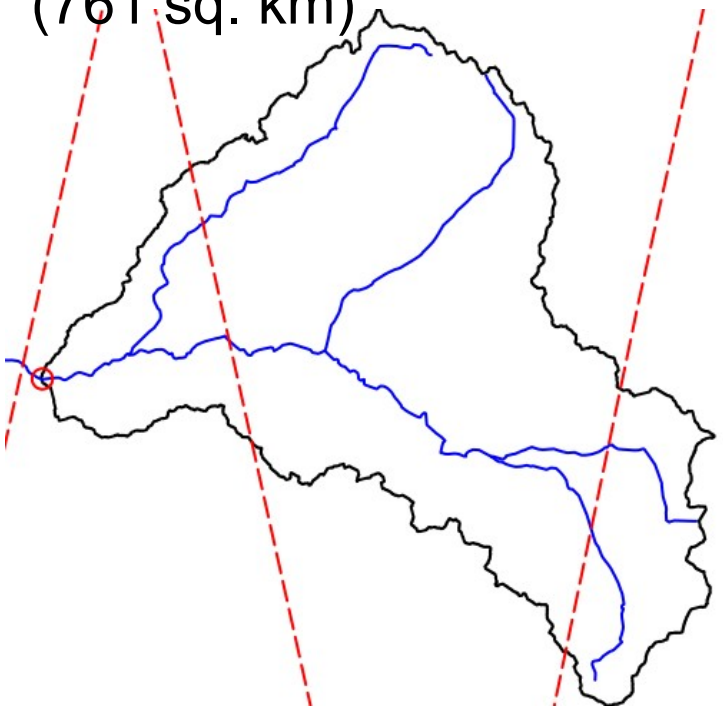
Kostas Andreadis (U Mass) and Dongyue Li (UCLA)



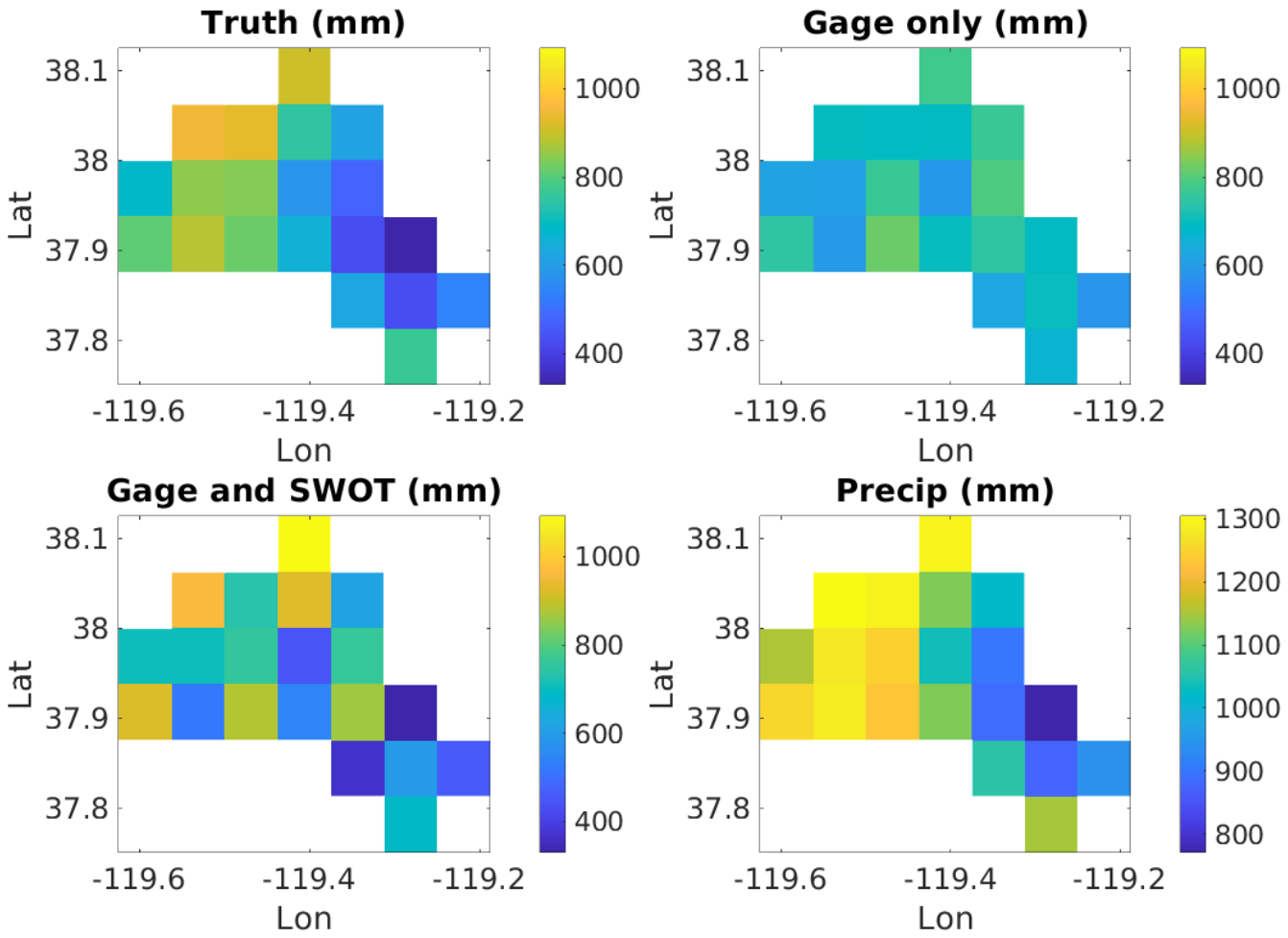
- Adapts one of the discharge algorithms that performs assimilation to run over river network (1-D)
- Initial results with “Pepsi challenge” rivers
- Compare with 2-D hydraulic/hydrologic assimilation for trade-offs between accuracy and computational time for global implementation
- Evaluate predicted uncertainty (important for the ISR and hydrologic model calibration)

Use of inverse routing can estimate runoff from SWOT-observed downstream discharge (Jacob Schaperow, Steve Margulis, Dongyue Li, and Dennis Lettenmaier, UCLA)

California's Hetch Hetchy watershed (761 sq. km)

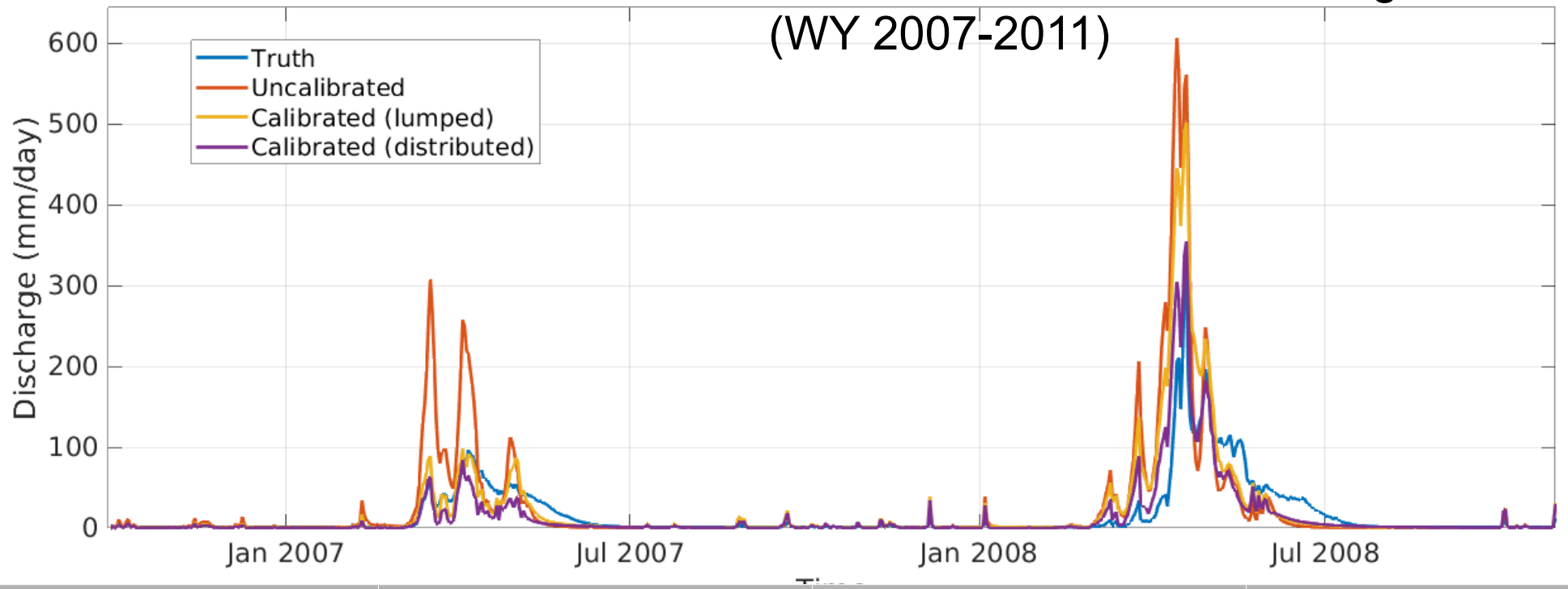


Average annual runoff estimates



Runoff (as contrasted with streamflow) estimates can be used to calibrate a spatially distributed hydrologic model

Runoff calibration vs. discharge calibration (WY 2007-2011)



	Uncalibrated	Discharge calibration	Runoff calibration
Cal. NSE	-2.2	0.80	0.64
Val. NSE	0.60	0.79	0.90

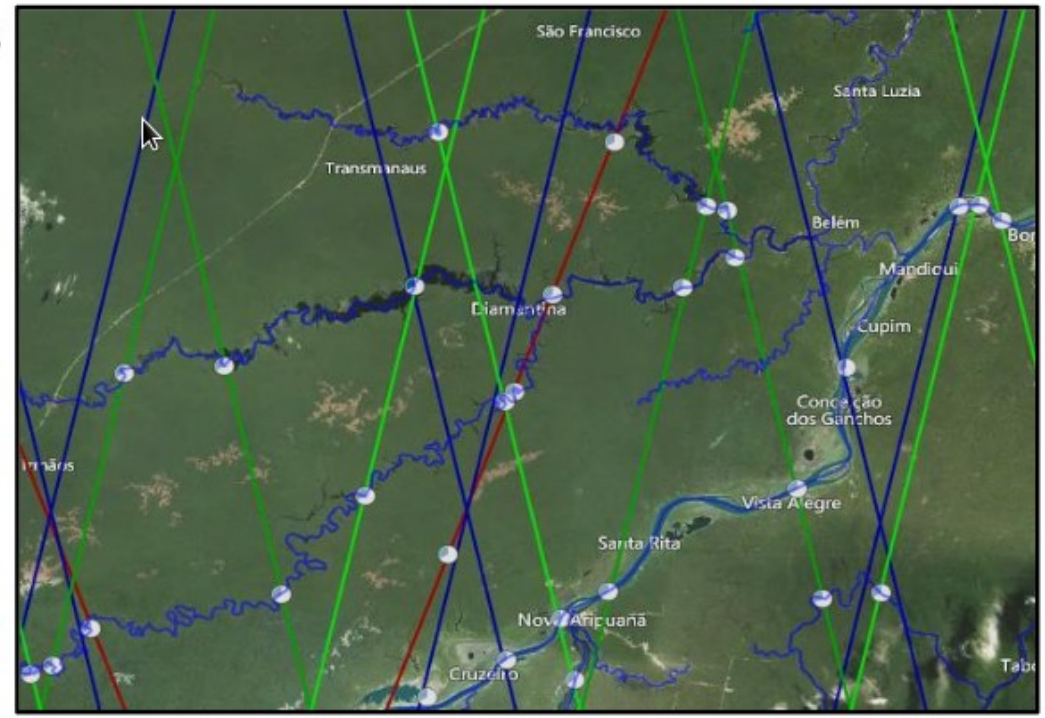
Deutsches Geodätisches Forschungsinstitut
Fakultät für Luftfahrt, Raumfahrt und Geodäsie
Technische Universität München

SWOT for Monitoring Terrestrial Water Storage Changes: Quality Assessment and Combination with other Remote Sensing Data

Christian Schwatke, Denise Dettmering

Preparation of DAHITI for the upcoming SWOT mission includes currently the integration of the SWORD dataset (v1.1)

- All DAHITI targets were assigned to reach ids and river km
- SWORD dataset is used to connect water level time series along rivers for an improved quality assessment without in-situ data
- SWORD dataset is also used for the automated creation of new virtual stations in DAHITI
- DAHITI contains currently more than 20.000 new targets which have been already computed. However, a quality assessment still has to be carried out before releasing the water level time series to the public.



Map with SWORD dataset, altimeter tracks and DAHITI targets

Additionally, the processing of new surface area data sets of lakes and reservoirs based on Landsat and Sentinel-2 is still ongoing. In future, this product will be used for the quality assessment of the SWOT surface data set

Improved river flow modeling with the integration of dams-reservoirs using SWOT

M. Sadki, S. Munier, A. Boone

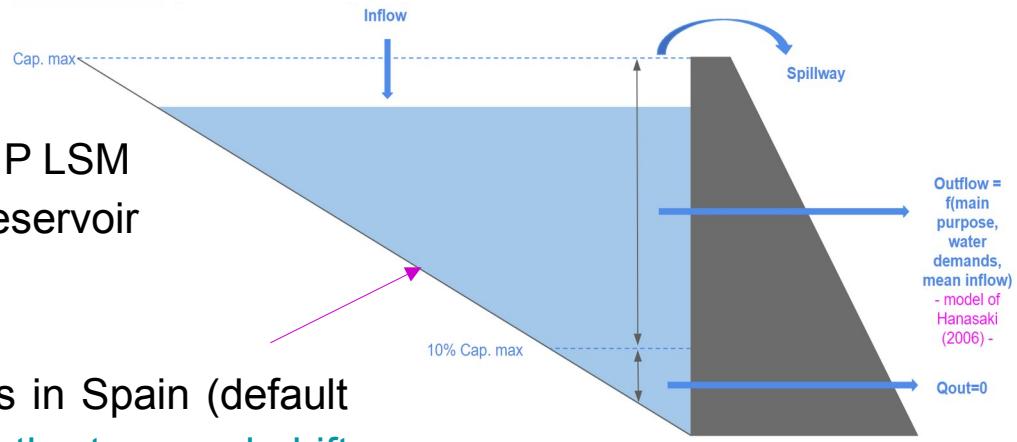
What are the contributions of SWOT observations in representing the impact of dams-reservoirs on water resources at large scales?

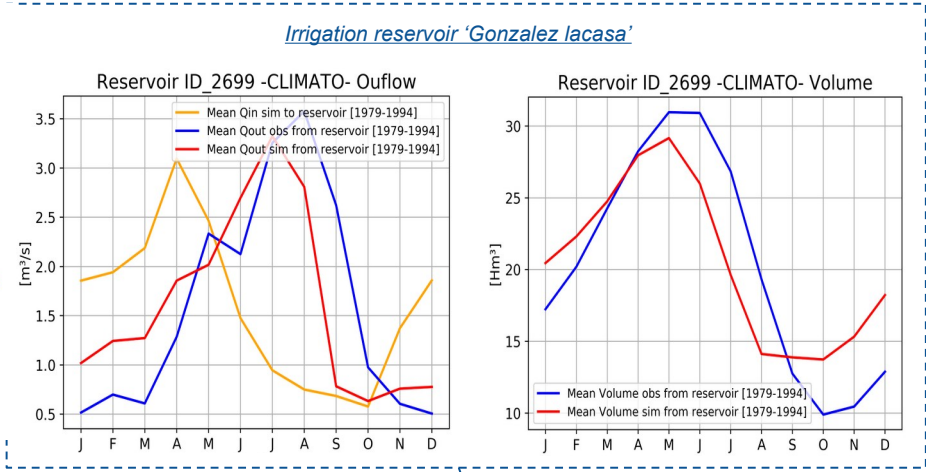
- Implemented within the CTRIP LSM routing scheme. Based on reservoir model → Hanasaki (2006)

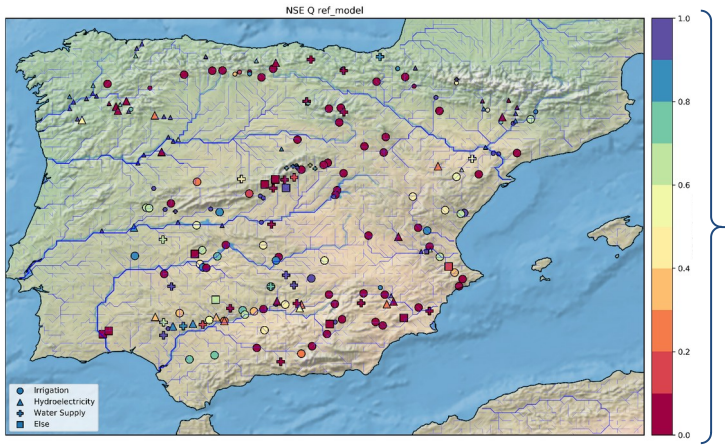
- Application on 215 reservoirs in Spain (default parameters) → Reproducing the temporal shift between upstream/downstream flow for irrigation reservoirs ; median NSE = 0.67 (+25% improvement)

- Currently: Sensitivity analysis of the model parameters

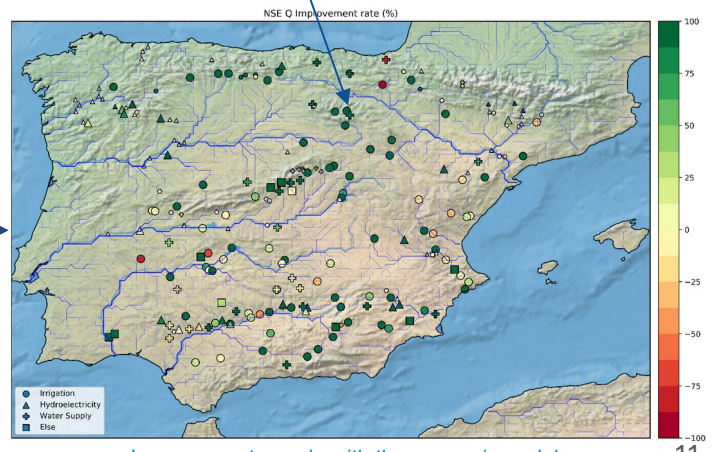
- Upcoming : Reservoir Model calibration with SWOT data assimilation tools in CTRIP







Reference Model (Reservoirs effects not taken into account)



Improvements made with the reservoir model

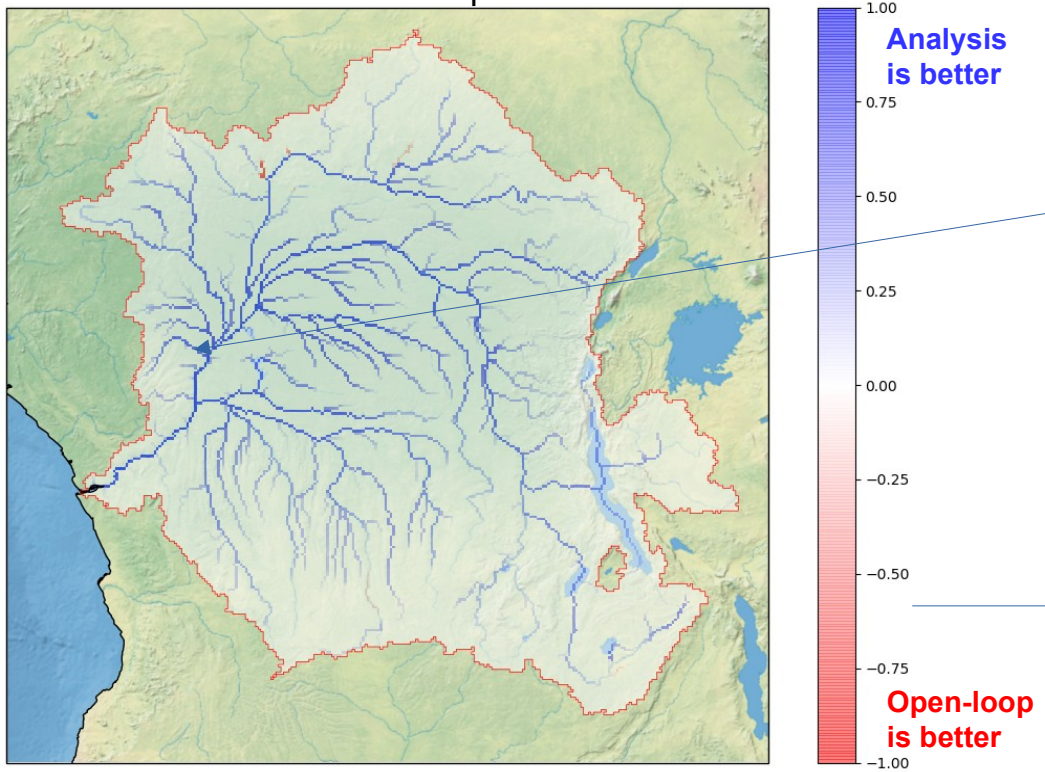
Towards a better understanding of the global hydrological cycle with SWOT

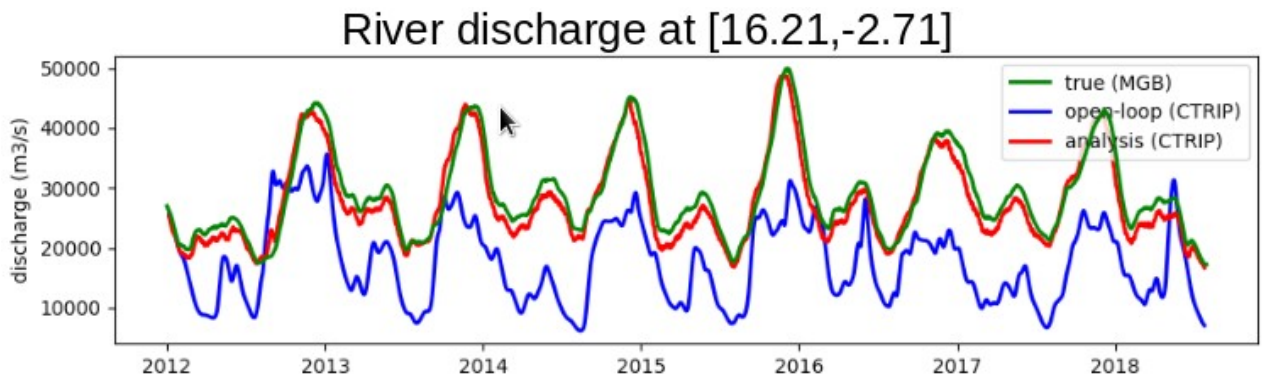
Can SWOT data assimilation into global hydrological models (1/12° resolution) help us to improve the understanding and representation of rivers and groundwater dynamics at the large to global scale?

(A. Boone, **S. Munier**, P. Le Moigne, C. Ottlé, D. Yamazaki)

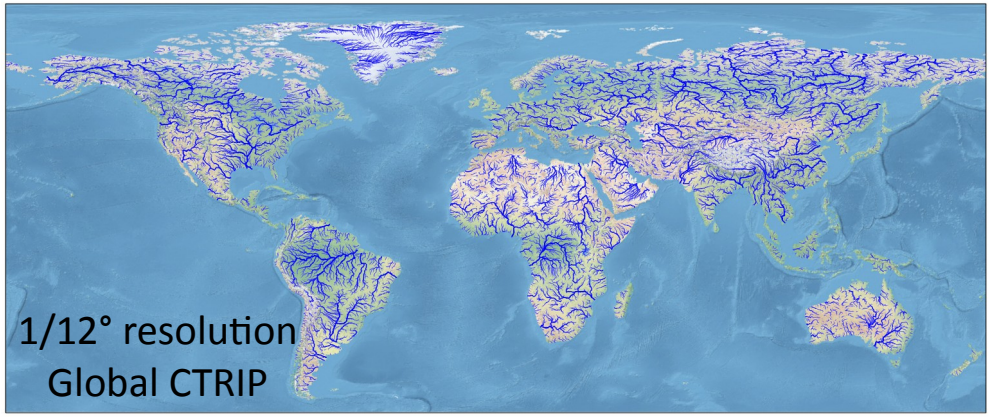
- Method: Test case over the Congo Basin → OSSE-like with independent model (MGB) and meteorological forcing to simulate the *truth*

CTRIP: Assimilation improvement





- Next step: extension to global scale



This work is an extension of the study presented at AGU (2019) and EO for Water Cycle Science 2020 (ESA, GEWEX)
S. Munier, A. Boone, S. Biancamaria, P. Le Moigne, 2020. Assimilation of SWOT discharge into CTRIP-12D over the Ebro Basin.

Collaborative Efforts:

Congo basin has been selected as a common case study among several of the different WG members

An interest in developing methods for assimilating products from other groups

Work to harmonize river networks and connections to lakes/reservoirs

Facilitate exchanges on using the large scale simulator

Discussions on data assimilation and calibration methods, experiences….

Next Steps:

Planning for a meeting in November → also possibly separate sub-groups working on rivers and lakes

Further discussions on common work for the Congo basin, and other sites (lakes in Canada….), and common datasets

Global DA results before launch!?