Interim Progress for SWOT Sciences of Lakes and Wetlands (SLeW) working group

2021 SWOT Science Team Meeting

09. 15. 2021

~~06. 19. 2010~~

Group objectives

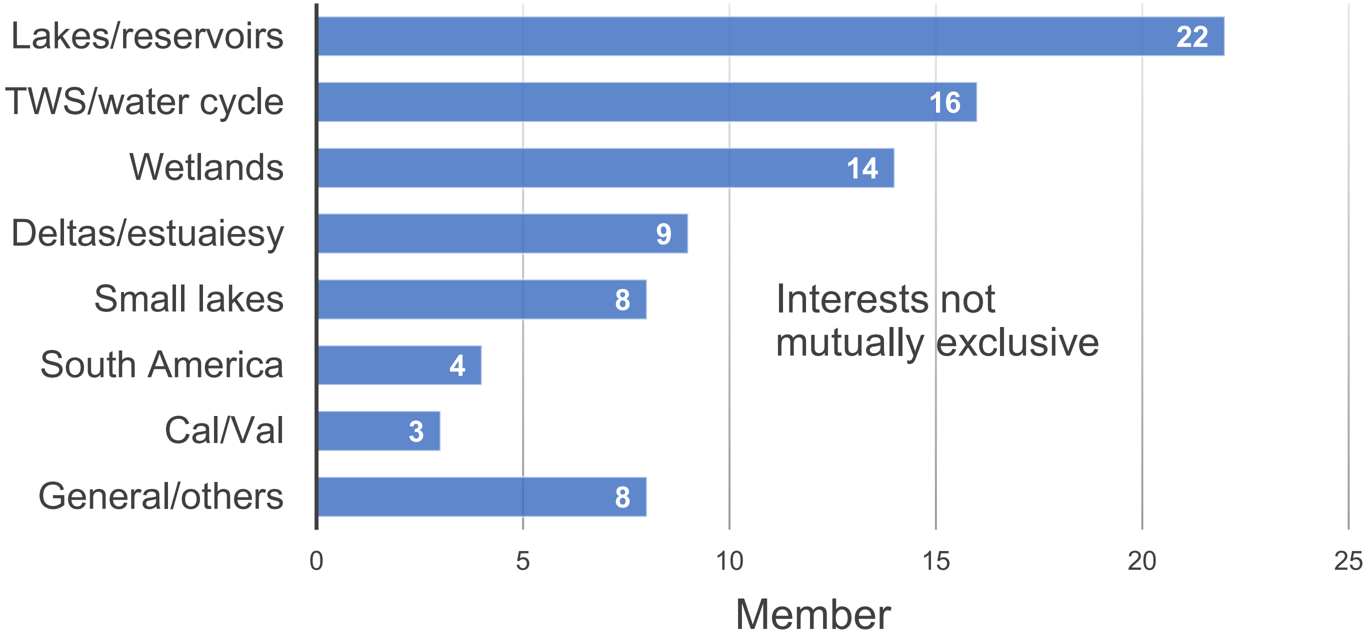
SLeW focuses on issues pertaining to SWOT measurements and data products of lakes, reservoirs and wetlands, and investigates new knowledge on these water bodies such as:

- Lake and wetland dynamics and mechanisms,
- Connectivity with rivers and floodplains,
- Feedback to the water and carbon cycles,
- Interactions with deltas and estuaries, and
- Impacts on the sea level budget.

Listserv: swot-slew@listserv.ksu.edu

Members

- 10+ ST projects
- 43 members:
    - North America: 18
    - Europe: 20
    - South America: 3
    - Japan: 2

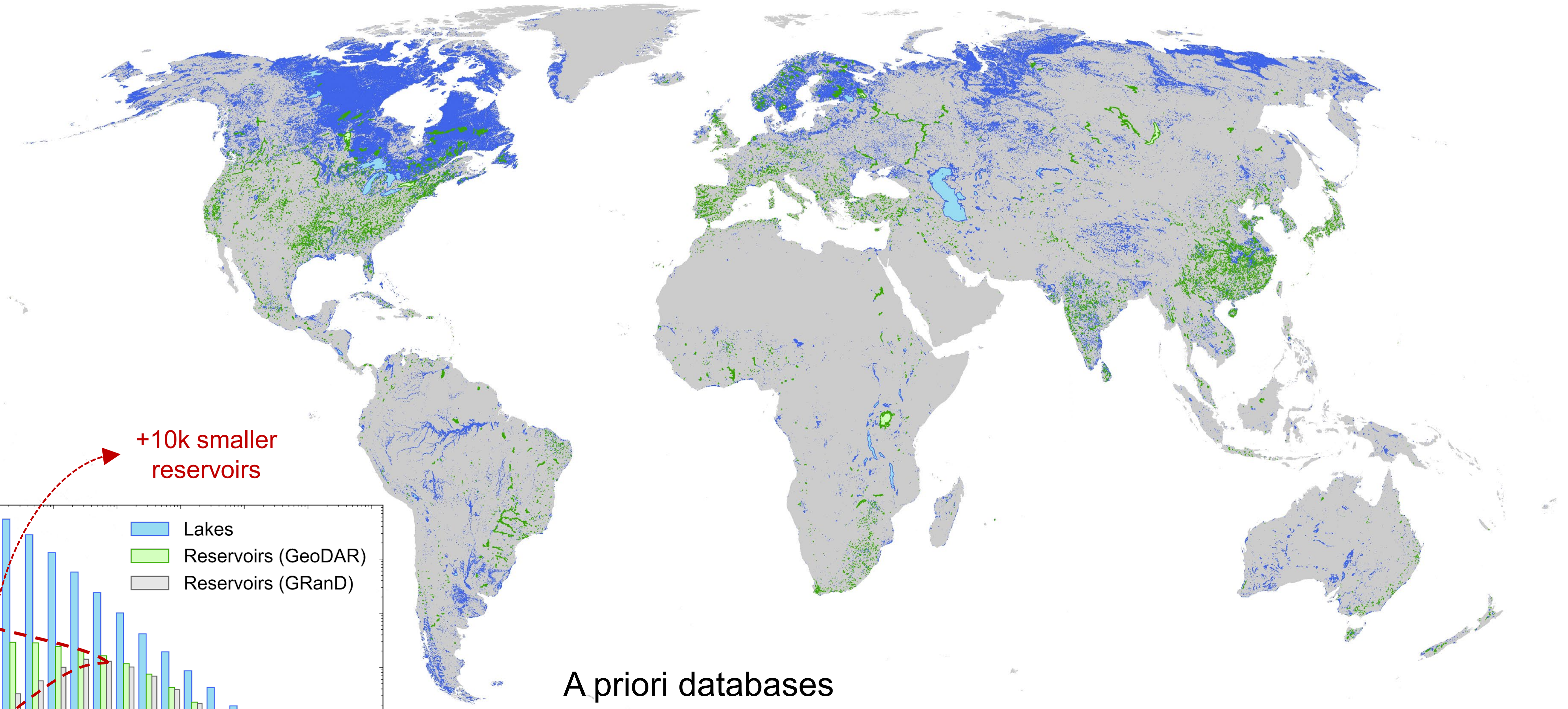


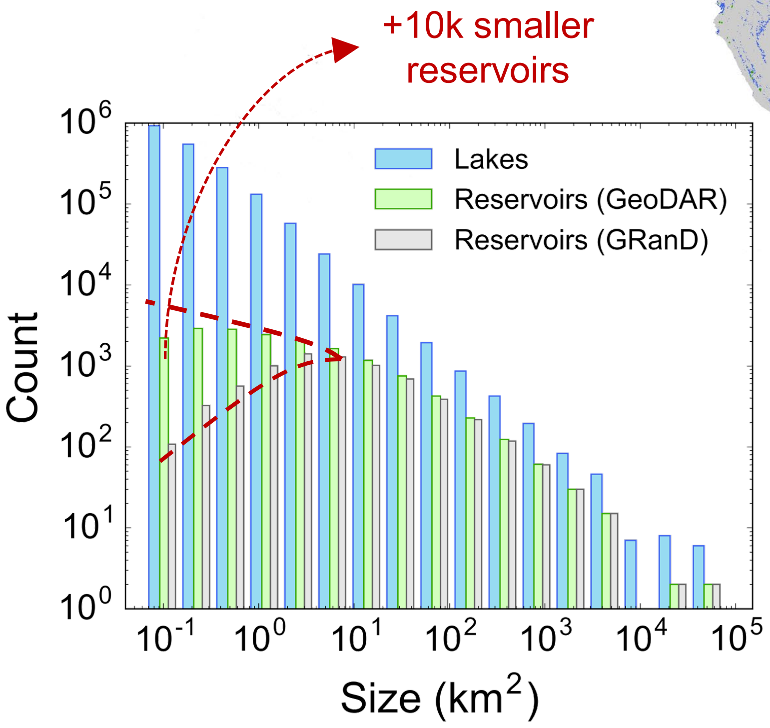
Discussions

- Meetings in year 1: Feb 1st and 2nd, May 17th, June 17th.
- Topics thus far: a priori lake database, lake product processing chains, lake volume algorithms. Next meetings: Wetlands

Science Team projects

- SPLASH : Small Ponds and Lakes in semi-Arid regions by SWOT and High resolution satellite sensors (PI: Manuela Grippa)
- SNORKS: SWOT and Northern laKeS (PI: Sylvain Biancamaria)
- SWOT for South America (PI: Fabrice Papa)
- Integrating reservoirs into SWOT's global surface water storage and discharge monitoring (PI: Jida Wang)
- SWHYM: Hydrology from SWOT – SWOT Wetlands HYdrological Monitoring (PI: Frédéric Frappart)
- Lake Issyk Kul Observatory – Validating SWOT (PI: Tilo Schöne)
- SWOT for Monitoring Terrestrial Water Storage Changes: Quality Assessment and Combination with other Remote Sensing Data (PI: Christian Schwatke)
- REFECCT: Rehearsal of EFfective Flood Early warning and decision-support system to strengthen Coping Capacity and adapTation in west Africa (PI: Luciana Fenoglio)
- ERDSWOT: Estimation of River Discharge using SWOT – Full catchment coverage with optimal space and time resolution (PI: Mohammad Tourian)
- COCTO-FO: Coastal Ocean Continuum in surface Topography Observations Follow-On (PI: Nadia Ayoub)
- …





A priori databases

- Lakes: v0.1 ready (*C. Pottier, Y. Sheng)*
- Reservoirs: in progress (*J. Wang, Y. Sheng, G.H. Allen, J.F. Cretaux, S. Sikder; doi:10.5194/essd-2021-58*)
- Wetlands: No designated a priori wetland data yet

SPLASH

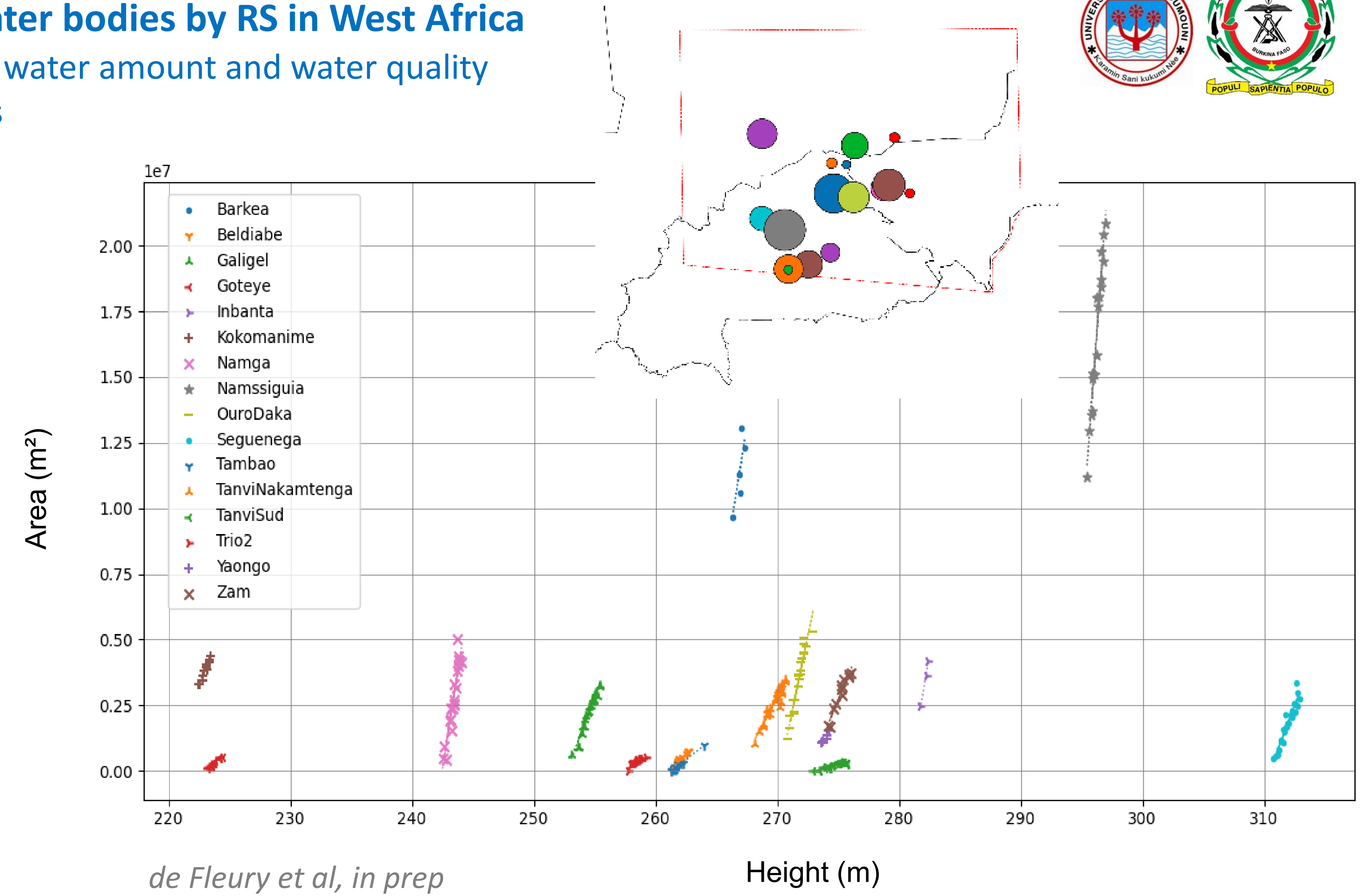
M. Grippa, M. de Fleury, M. Gosset,
A. Abdourhaman Touré, M. Boubacar Moussa,
H. Nikiema, J.M. Dipama E. Newall-Rochelle E. Robert , L. Kergoat

Integrated vision of small water bodies by RS in West Africa

Developing methods to monitor water amount and water quality indicators in small Sahelian lakes

Ongoing work: water balance estimations

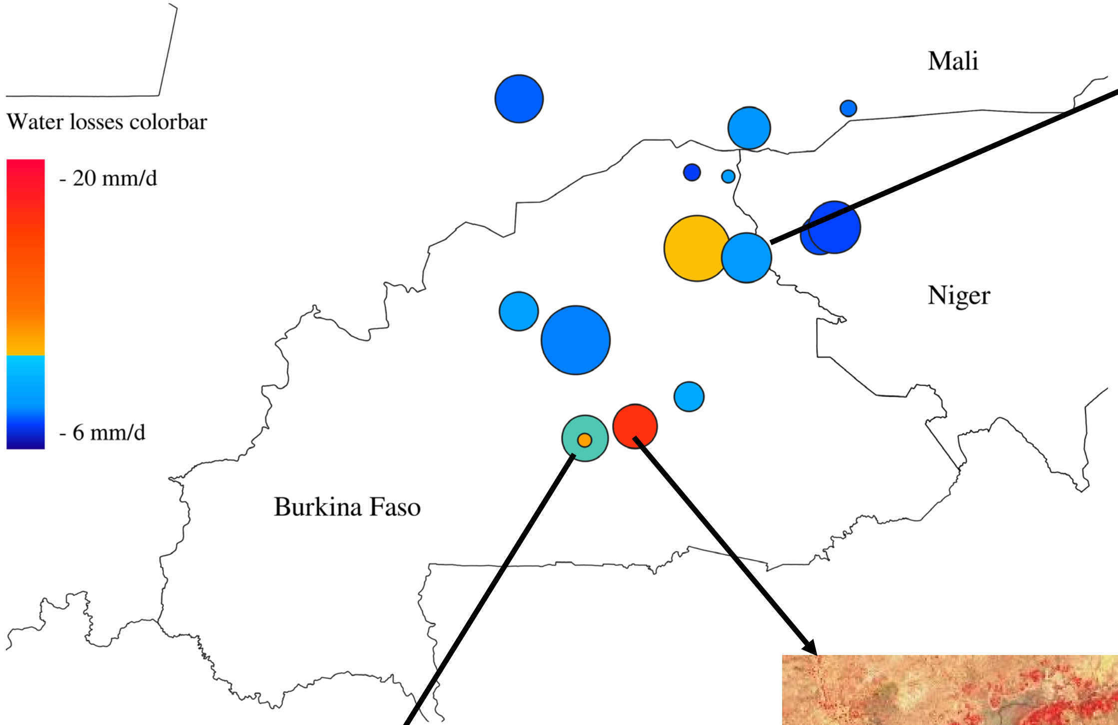
1- Area – height relationships (Sentinel2 +Sentinel3)



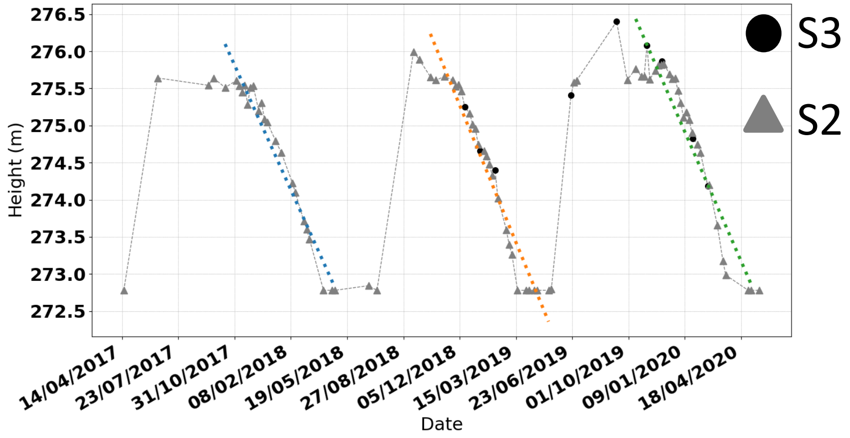
de Fleury et al, in prep

SPLASH

2- Water losses during the dry season



Ouro dam: water losses similar to evaporation rate

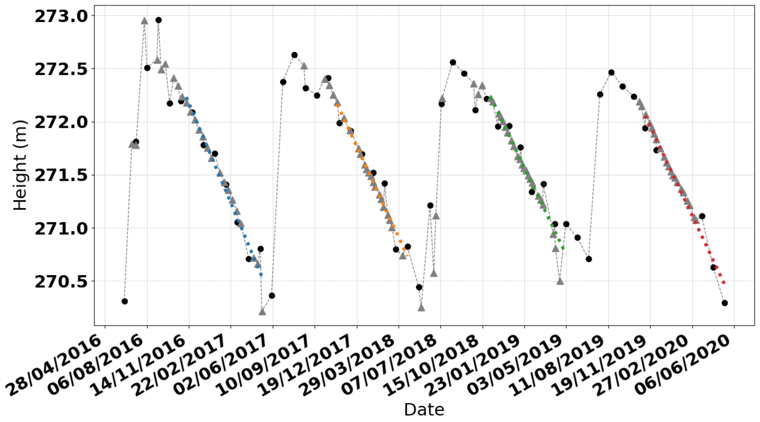


Tier sites

Tanvi 1

Tanvi 2

Mogtego dam: water losses much higher than evaporation rate: human withdrawal for irrigation



SPLASH

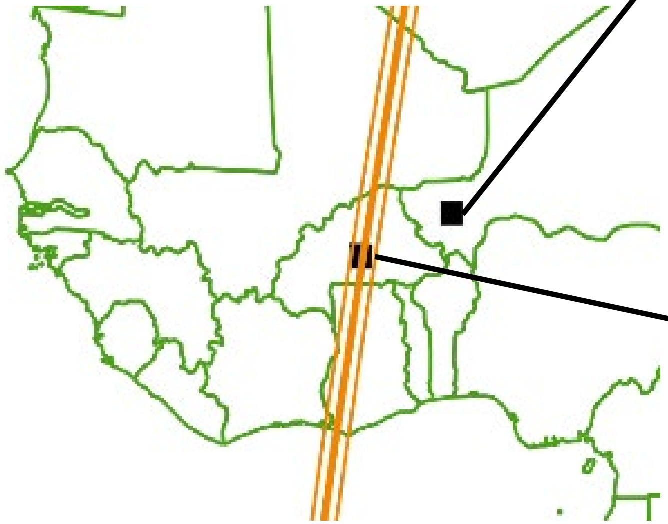
Sites tier2 SWOT: Ongoing work

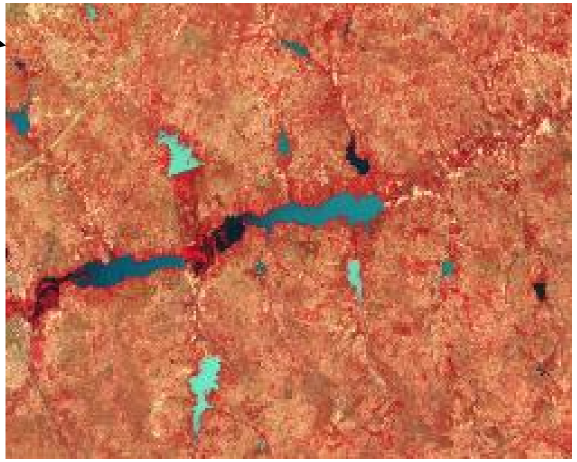
Bangou-Kirey, Niger

Small natural lake, extremely high reflectance , high SPM values, very small particles

Measurement set up in progress

- Water level and temperature
- (OTT, to be installed sept 2021)
- SPM weekly measurements since 2020
- Physico-chemical parameters





Tanvi dam, Burkina Faso

Medium size Dam, « relatively clear » water, on the S3 track

Estimations of surface, height and volumes by S2+S3 + water turbidity and MES by S2

Measurement set up in progress

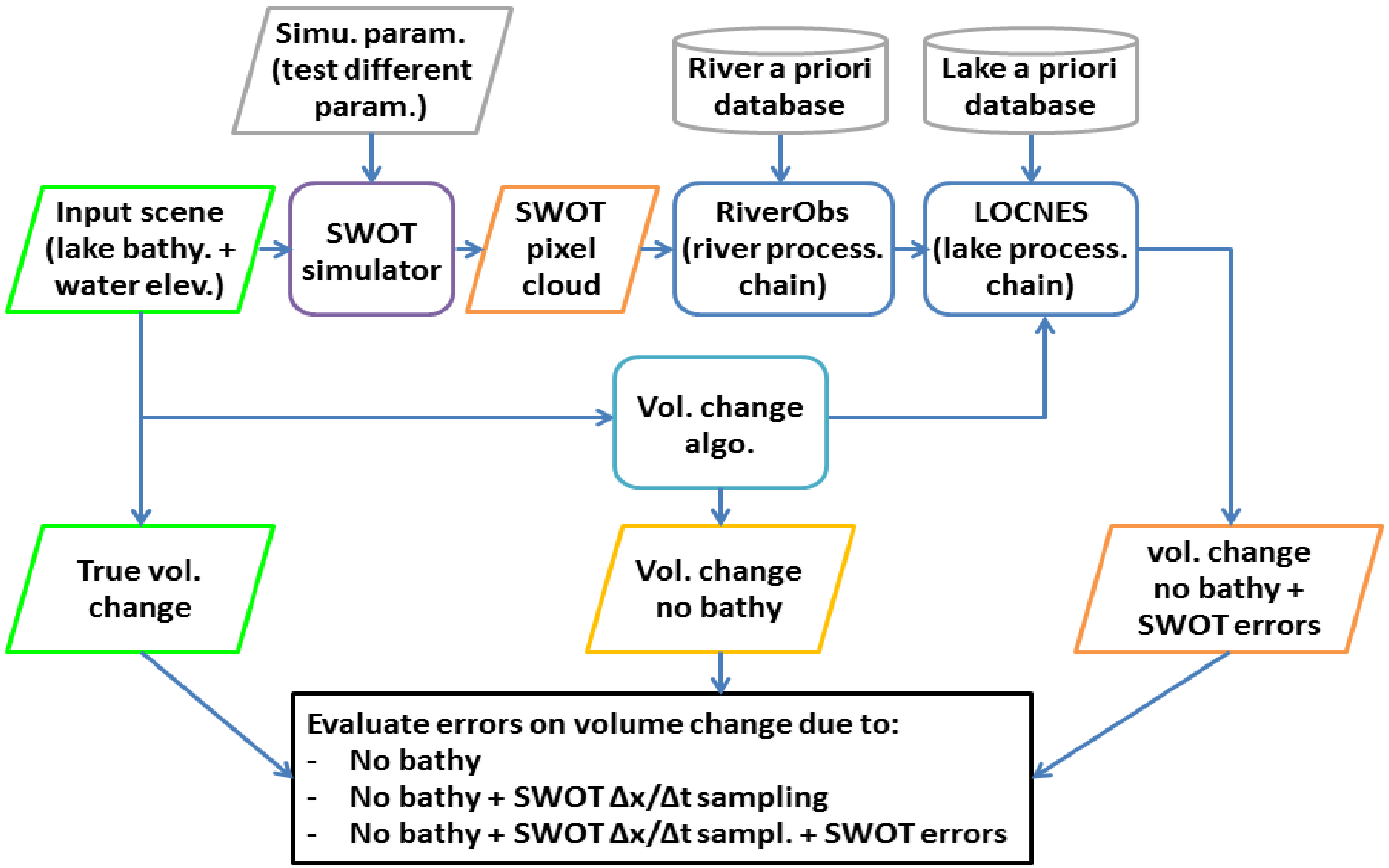
- Water level and temp (OTT to be installed end 2021)

SWOT and Northern laKeS (SNORKS)

(PI: Sylvain BIANCAMARIA & Mélanie TRUDEL)

- Project purpose: investigate errors expected from the official SWOT level 2 lake products (especially lake volume change) over Canada
- SWOT simulator input scenes for 15 lakes in Quebec (max area from 60ha to 11,000ha) and 1 lake in the Peace-Athabasca Delta (20,000ha):
  - Lake bathymetry from level lines maps merged with lidar DEM (freely available from Quebec government)
  - Lake water elevation time series from Canadian operational gages (14 lakes) or nadir altimetry (2 lakes)
- Virtual SWOT observations computed and LOCNES processing chain (to get lake volume change) ran and outputs analyzed for 4 lakes (more being processed)

Methodology



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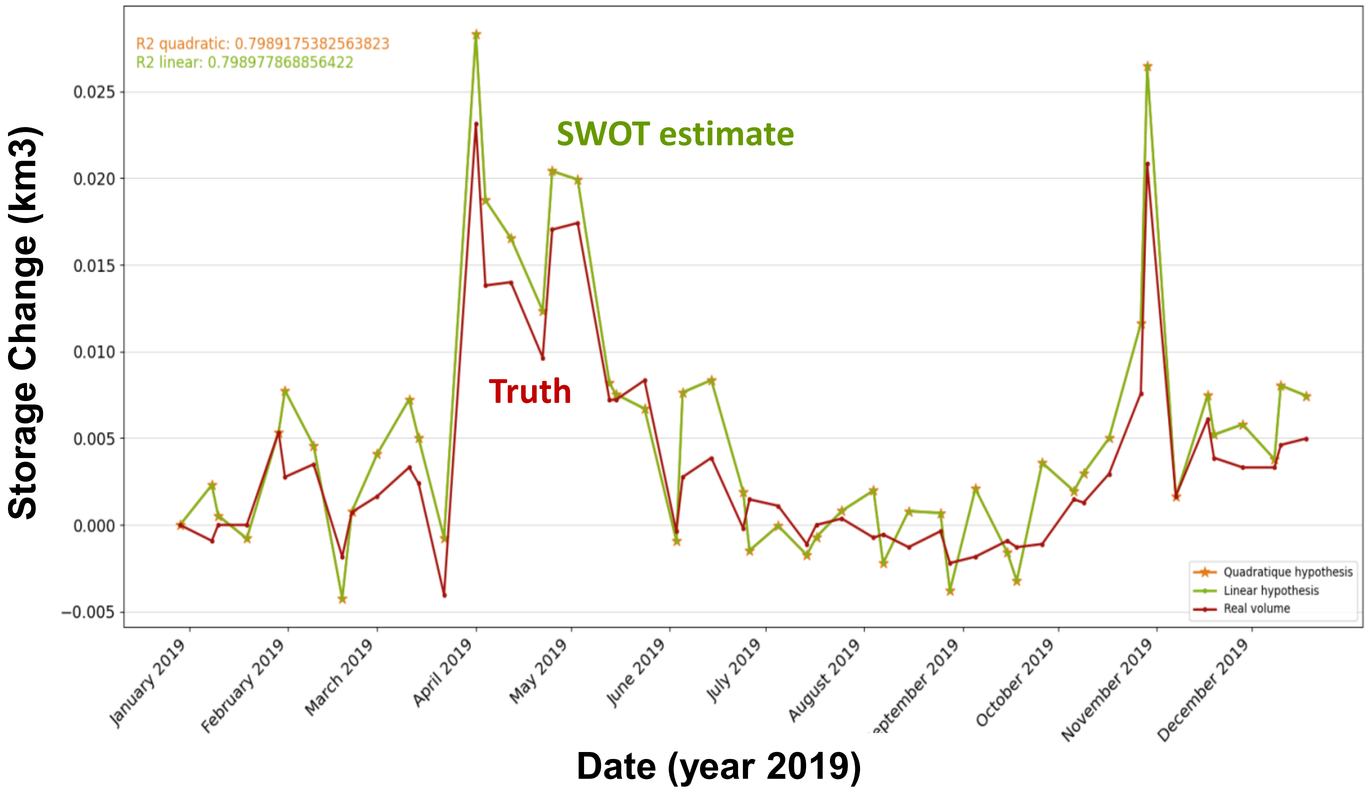
Massawippi lake (area ~1800 ha)



Decadal time scale storage variations on artificial reservoirs using Cryosat-2 radar altimetry:

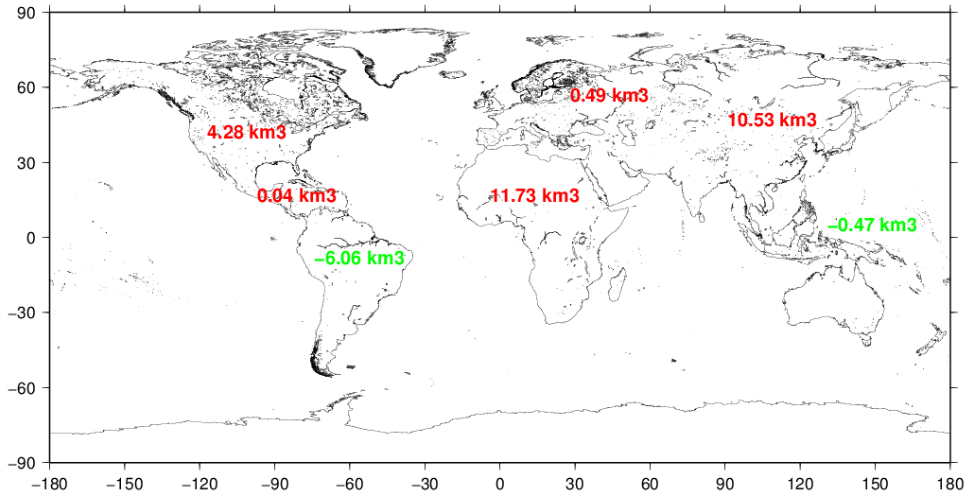
J.-F. Cretaux, M. Berge-Nguyen, and A. Blasquez (LEGOS); J. Wang (KSU); F. Yao (CU Boulder)

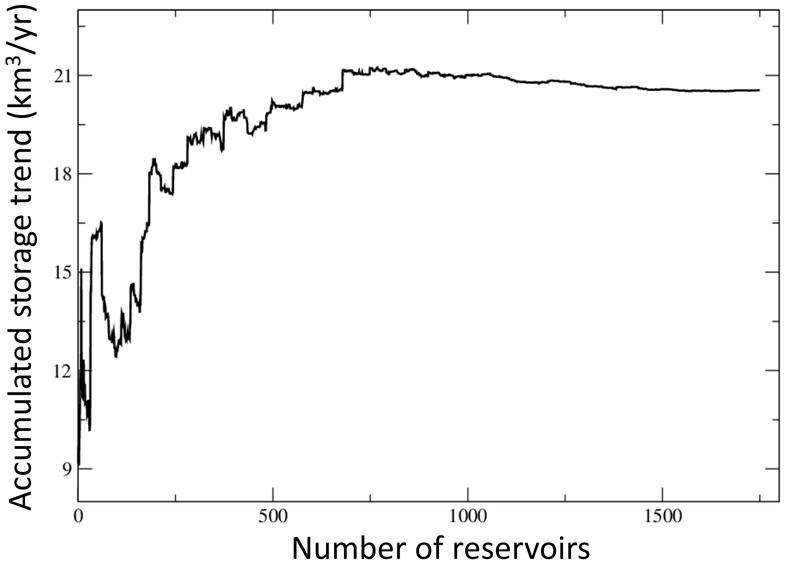
Data used

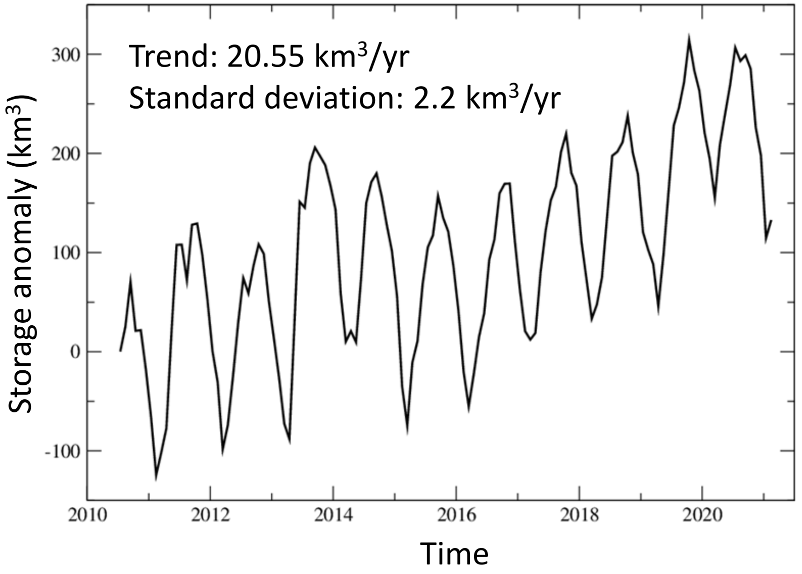
- 2010-2021 Cryosat-2 radar altimetry on 1750 largest reservoirs
- Landsat imagery & hypsometry on ~200 largest reservoirs
- GeoDAR database on reservoirs polygons

Main conclusion

- Equivalent GSLR of -0.05 mm/yr
- Strong impact of the 700 largest reservoirs and convergence to 20.55 km^3/yr
- Strong positive trend in Africa and Asia, negative in South America
- Interannual changes and seasonal cycle are marked
- Less new reservoirs => lower trend than in the past





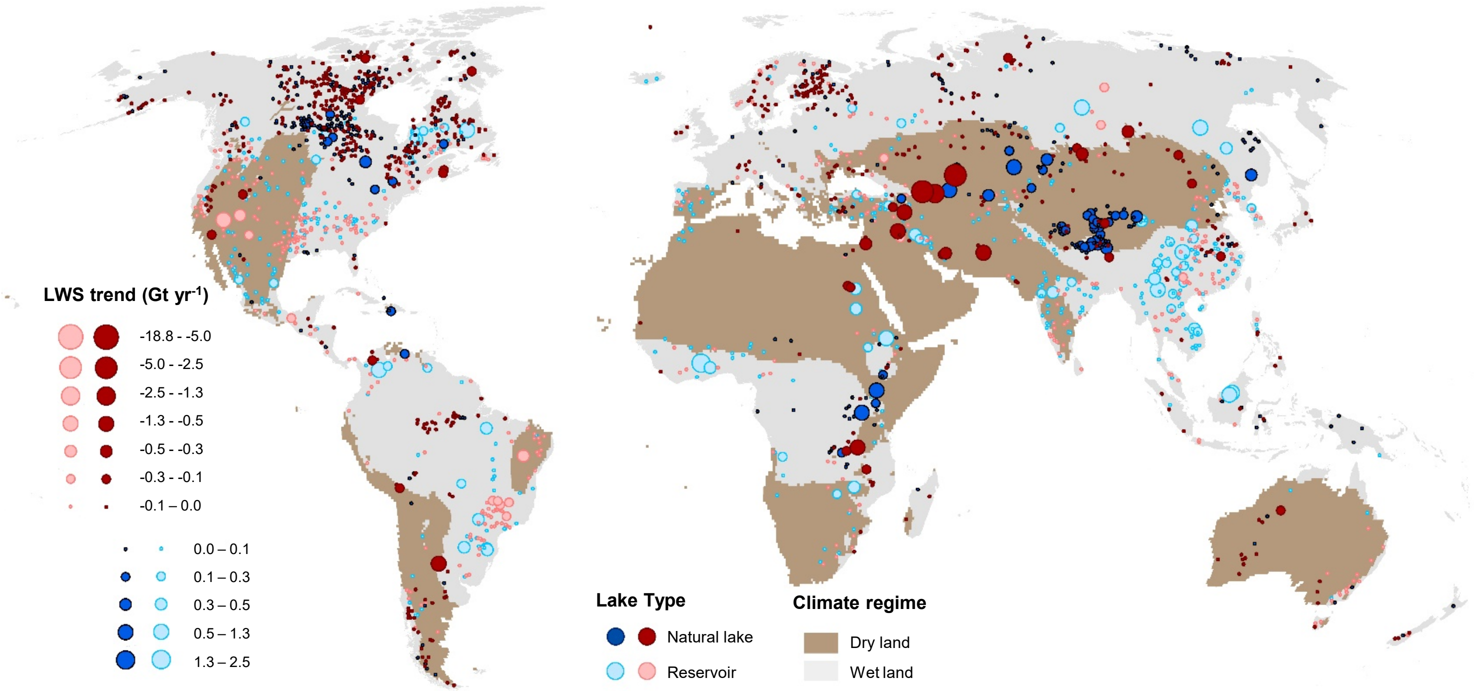


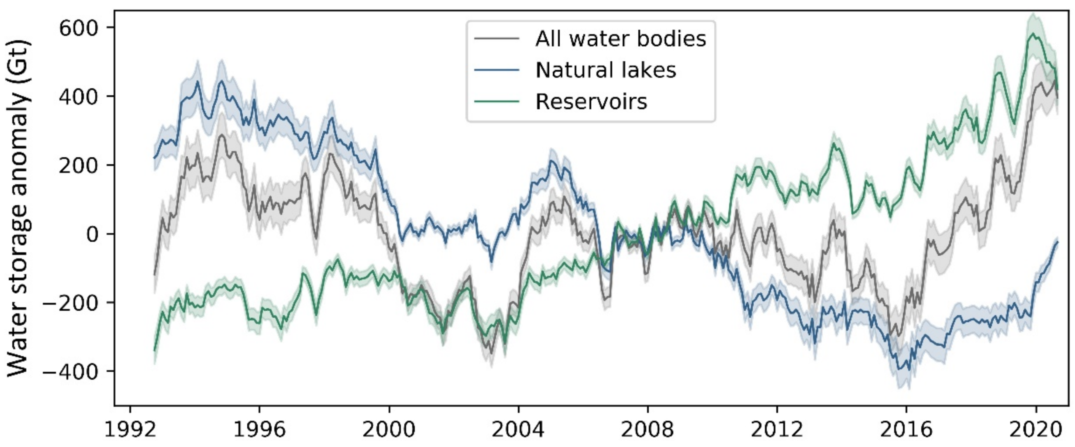
Future work

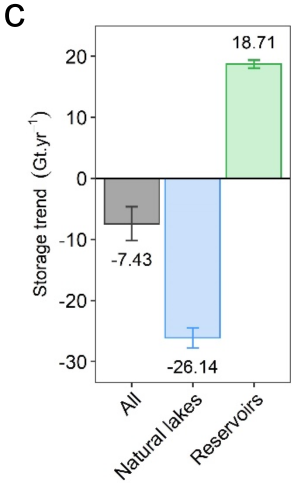
Implementation of an operational service based on:
Cryosat-2/ICESat-2/Sentinel3A&B/S6 and SWOT data

Understanding interannual storage variability in global lakes and reservoirs

CU Boulder: F. Yao, B. Livneh, B. Rajagopalan, L. Pitcher
Kansas State: J. Wang
LEGOS, CNES: J. Cretaux, M. Berge-Nguyen
IIASA: Y. Wada







Core datasets

- 30-m Landsat images (1992-now)
- Radar altimetry (1992-now)
- ICESat (2003-2009)
- ICESat-2 (2018-now)

Method

- Constructing high-frequency lake areas (Yao et al. 2019)
- Deriving lake hypsometry and volume changes (Wang et al. 2018)

Preliminary findings:

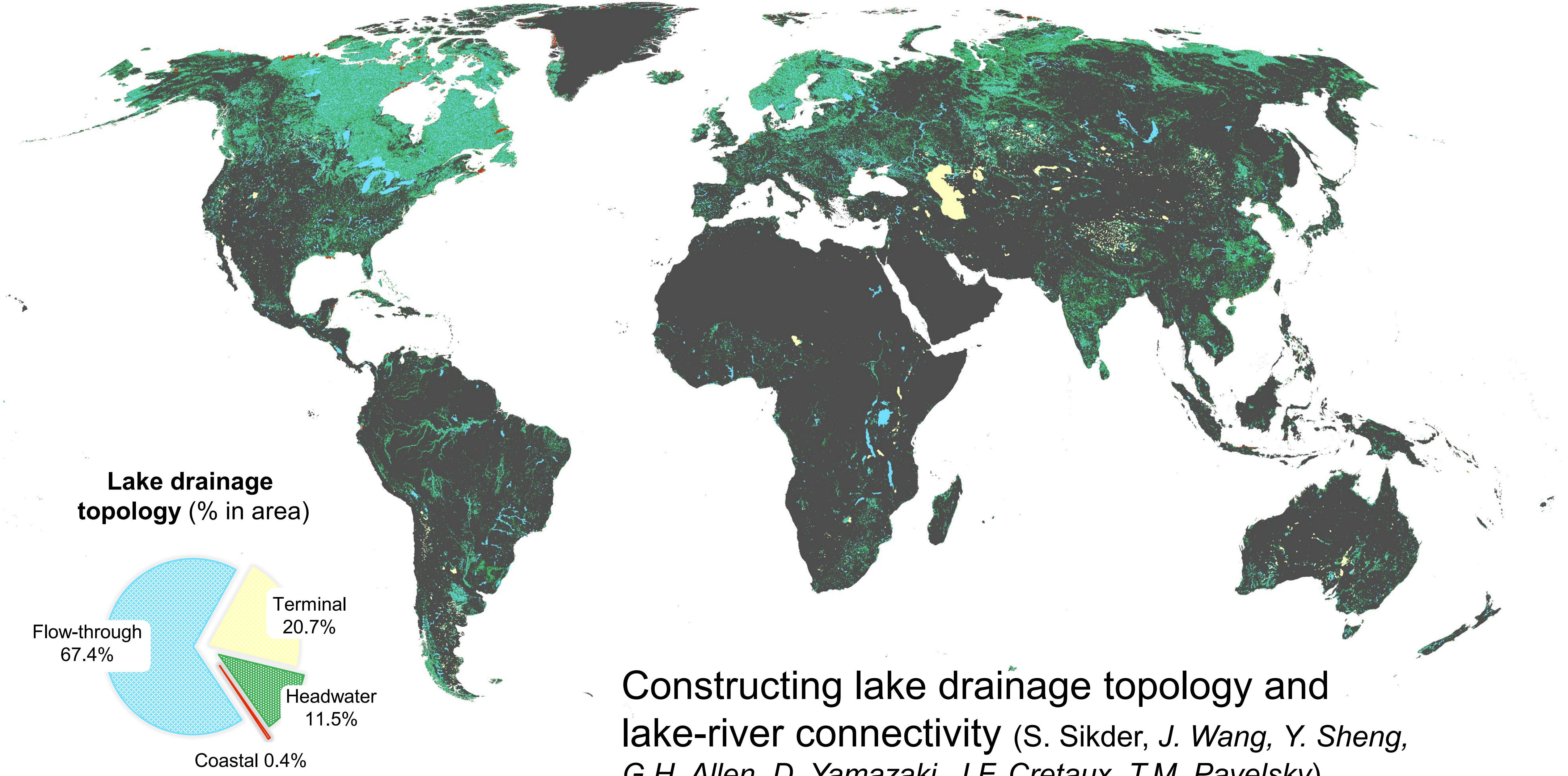
- Divergent storage trends in natural lakes and reservoirs

Data to be delivered:

- High-frequency lake volume time series for ~2,000 major lakes and reservoirs from 1992 to now

Ongoing/Future work:

- Attributing lake volume variability to natural variability, climate change, and human activities
- Comparing SWOT-based algorithms with existing alternatives on estimating lake volume change

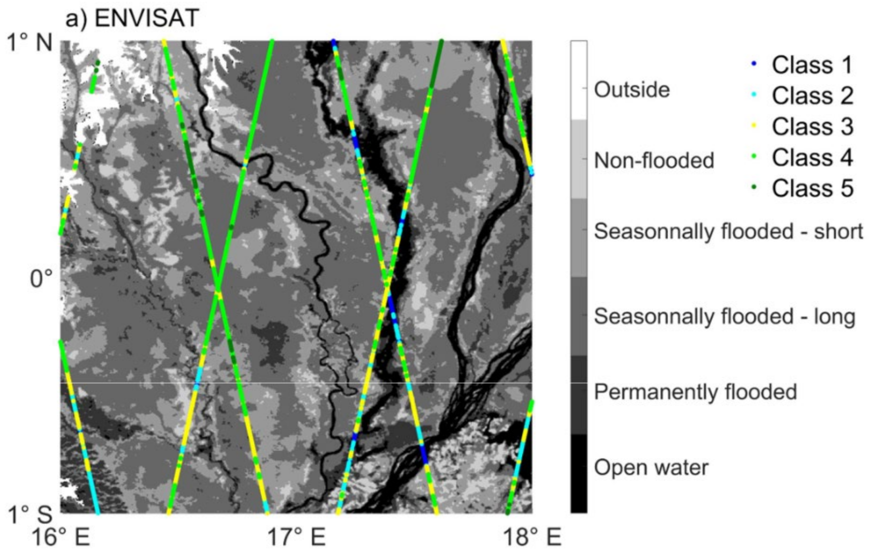


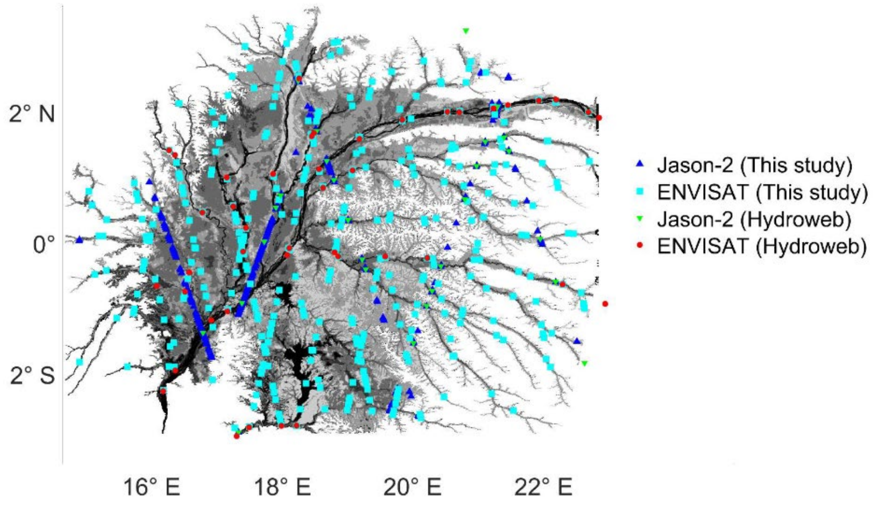
Constructing lake drainage topology and lake-river connectivity (S. Sikder, *J. Wang, Y. Sheng, G.H. Allen, D. Yamazaki, J.F. Cretaux, T.M. Pavelsky*)

SWHYM Surface water storage over extensive floodplains

F. Frappart and F. Papa

Unsupervised classification of σ_0 => automatic definition of virtual stations (VS) on water class. Tested in Congo (Frappart et al., Remote Sens., in revision)
and other sites (P. Enguehard training period at ESPACE-DEV)





MODIS + VS multimissions (see Normandin et al., HESS, 2018 for the method):
- Mekong (C. Normandin, Post-doc)
- Inner Niger Delta

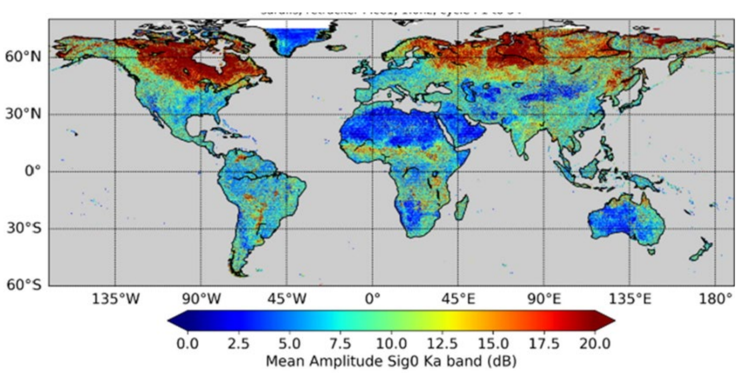
Sentinel-1 + VS multimissions in Tonle Sap (Mekong) (B. Pham-Duc, USTH)

Review paper on SWS (Papa & Frappart, Remote Sensing, in revision) invited

SWHYM Backscattering analysis at Ka-band over land surfaces

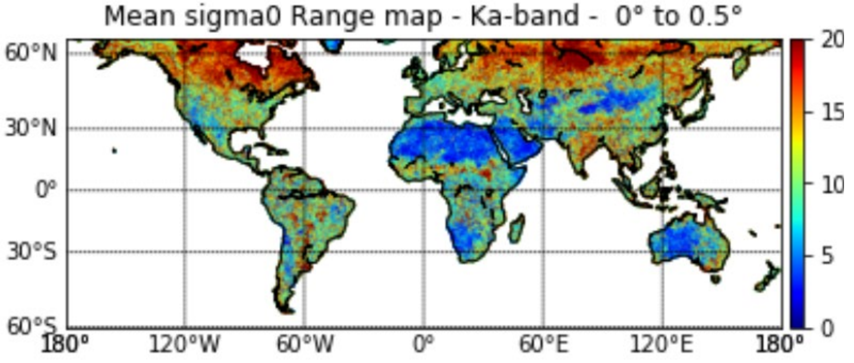
SARAL (Frappart et al., Adv. Space Res., 2021)

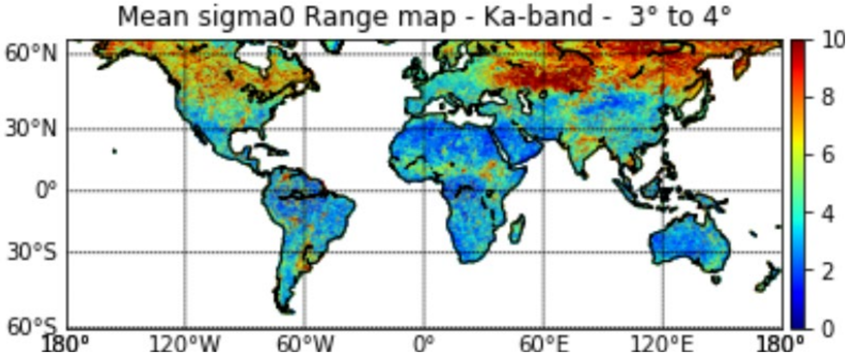
annual Amplitude



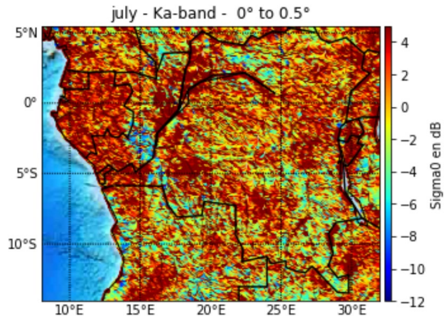
GPM (K. Guerouate – training period at LERMA)

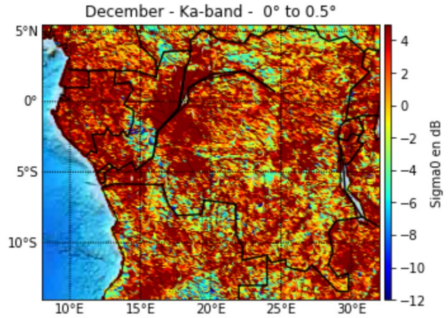
annual amplitude (dB)

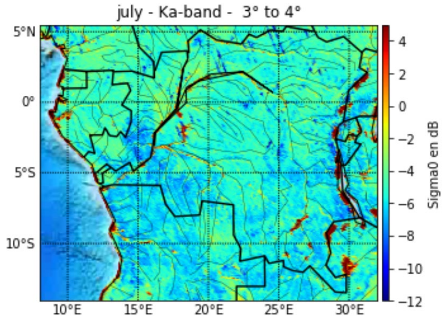


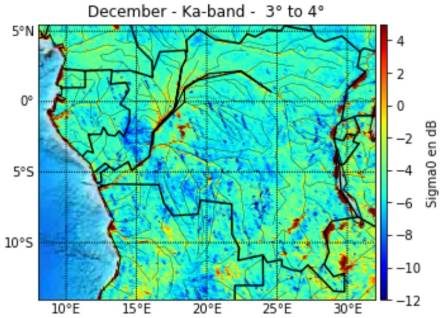


GPM over Central Africa





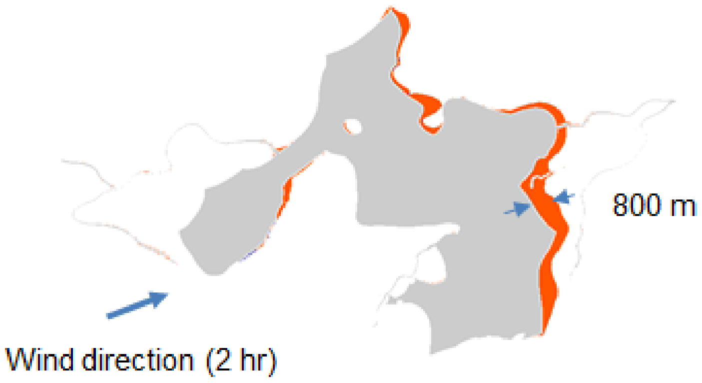




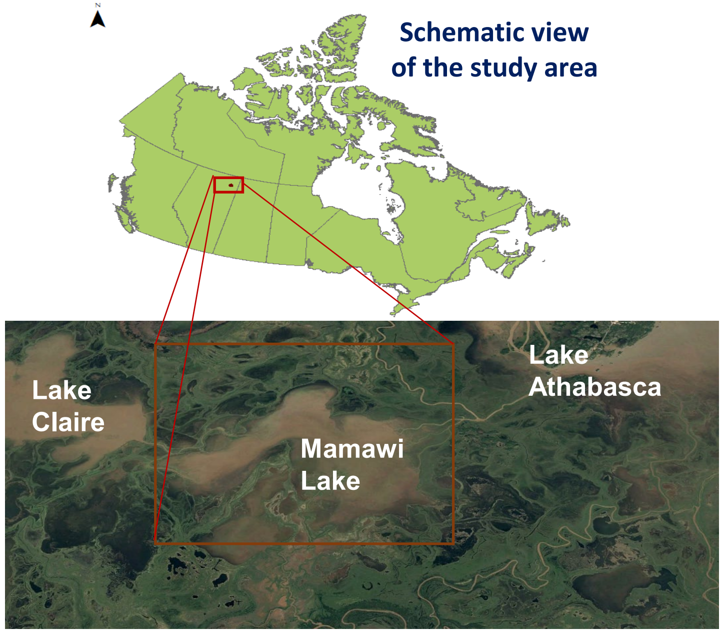
SWOT Mission Challenges with Wind-driven Water Surface in Low-slope topography shallow Lakes

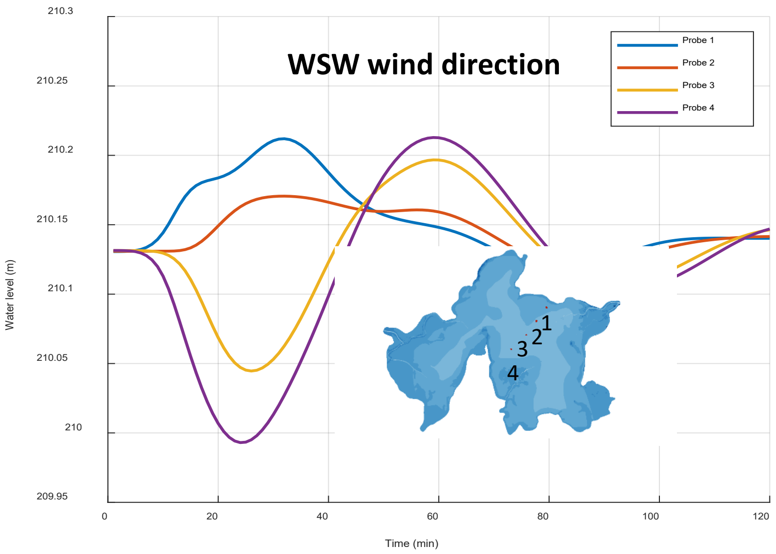
Parna Parsapour [1], Pascal Matte[1], Daniel Peters[1], Yves Secretan[2], Mélanie Trudel[3], Gabriela Llanet Siles[3]
[1] Environment and Climate Change Canada, [2] INRS, [3]Université de Sherbrooke

- Objective
  - Understanding the implications of wind on surface water levels for the SWOT mission
- Case study
  - Low slope topography shallow lake at heart of the PAD
- Method
  - H2D2 hydrodynamic model
  - Calibration of the model with the 2017 AirSWOT field data
- Preliminary results and thoughts
  - The model can replicate surface lake levels to within 5 cm
  - Important effects of wind on lake levels, extent, slope, and the reverse flow
  - Important implications for SWOT data if only a portion of lake captured by satellite
- Future work
  - Development of H2D2 model for Lake Athabasca for post launch cal/val

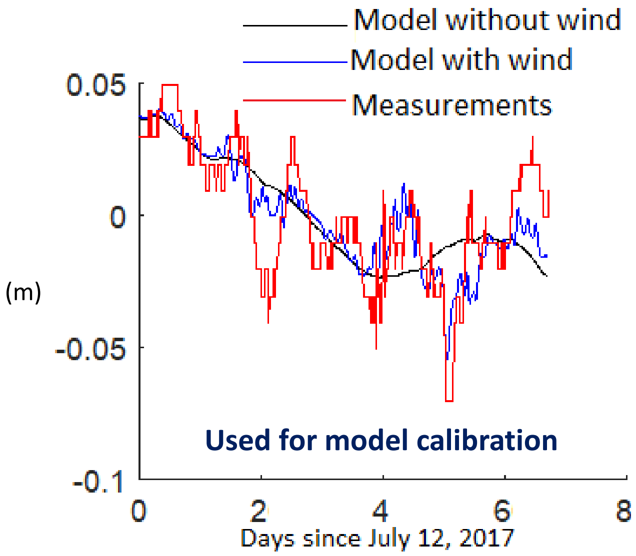


Change in the water extent due to WSW sustained wind





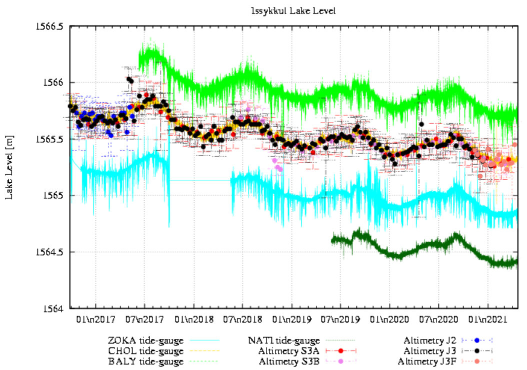
Water level variations along WSW wind



Water level fluctuations at the North station in Mamawi Lake during AirSWOT 2017 field data

Lake Issyk Kul SWOT Cal/Val

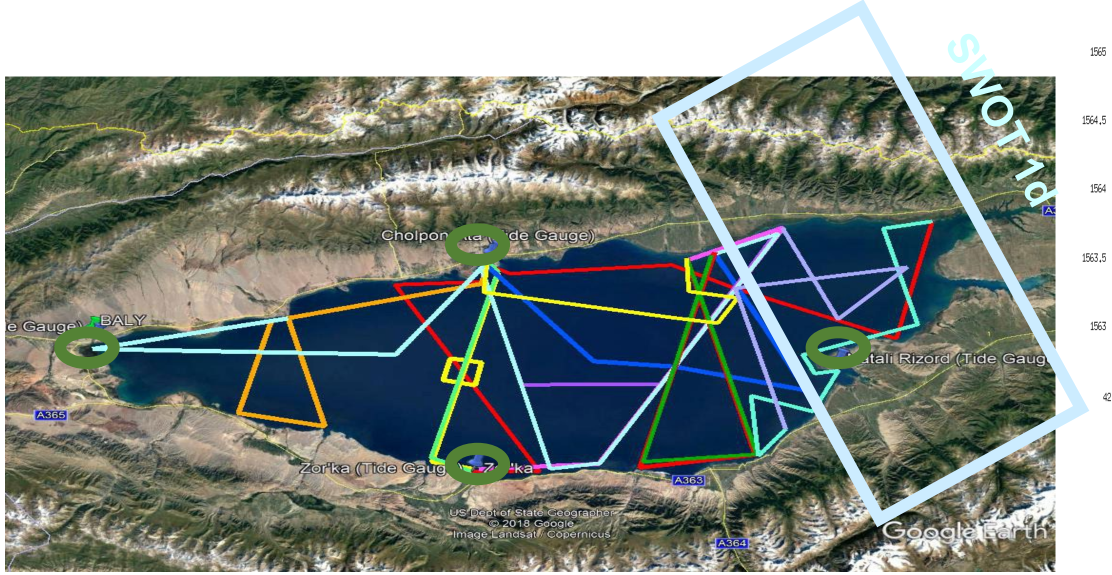
PI: Tilo Schöne

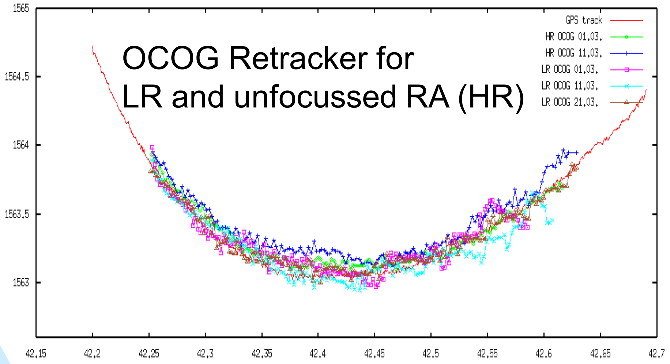


- 4 GNSS-controlled gauges
- 2 climate monitoring stations (West/South shore)
- Sea State control through wind and TG variability

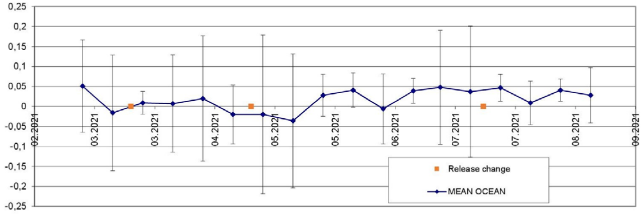
Continuous Monitoring since 2016


Profiling using a GNSS buoy and GNSS+radar gauge from a vessel to establish a lake reference surface for radar altimetry monitoring





In-situ lake level along the satellites path's GNSS survey is „reconstructed" using changes at the shore tide gauges



For each pass delta and RMS to the reference track is computed and compared
Quality can be estimated for each waveform (in case of Sentinel-3/6 and J3)

densification was planned for 2019/20 and is planned for 2021 + in situ trips during cal/val

Checklist of other generic priorities before launch

- A priori databases
  - Priori Lake Database (PLD)
    - V0.1 currently ready
    - V0.n: Ongoing improvement until launch (available after launch)
  - Reservoirs
    - To continue improving the inventory and metadata for medium-size and small reservoirs
  - Lake-river connectivity:
    - Lake drainage topology established
    - To harmonize a priori lake (PLD) and river (SWORD) databases.
  - Wetlands
    - No designated a priori wetland data yet
    - To investigate combination with already available satellite products

Checklist of other generic priorities before launch

- Algorithms
  - Algorithms for lake and reservoir products streamlined
  - To continue investigating impacts of riparian vegetation, surface wind, and other error sources
- Analysis tools
  - To identify tools that are still missing for analyzing level-2 products
  - To share codes to reduce duplication of efforts and increase our analytical capability
  - To share synthetic data from the simulator to facilitate additional analytical tool developments
- Cal/Val and accuracies
  - To understand water gradient impacts using in situ data and all active radar altimetry missions
  - To intercompare evaluations on different lakes within the working group
  - To establish a common minimum comparison methodology for data use and evaluation after launch