

Cal / Val Over lakes

2 types of approaches can be adopted

- **Global Cal / Val**
 - Comparison with existing in situ network
 - Comparison with global satellite products
- **On site Cal / Val** 2 types of sites are proposed
 - “Gold standard” (High level of perennial and operational in situ measurements associated to field works): sites funded by the project?
 - “level-2”: opportunity site with limited in situ measurements and occasional field work. Funded from other projects (CCI, OSTST, etc ...)

2 Phases of cal/val

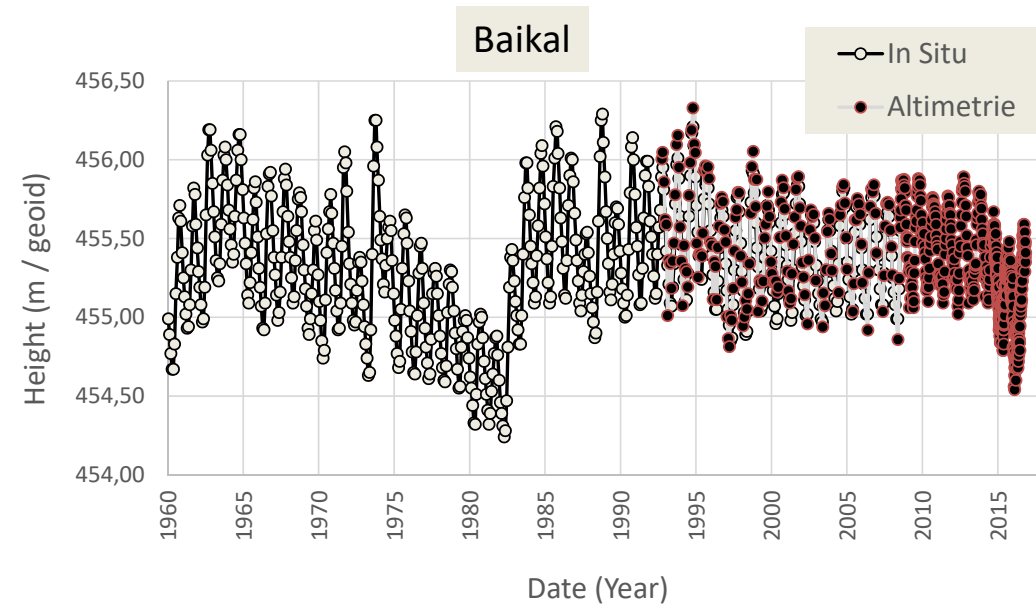
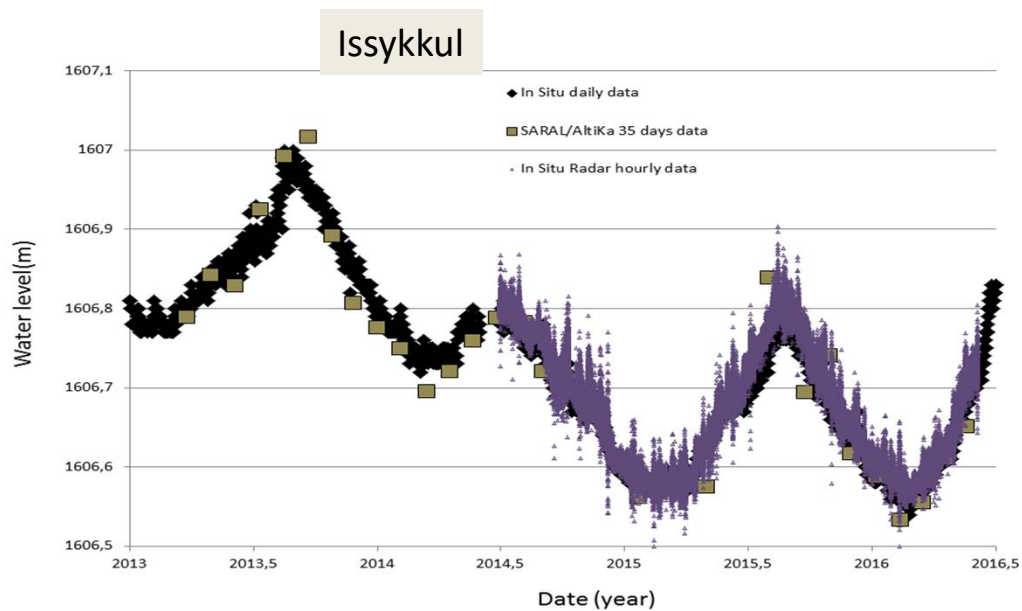
- 1D-Orbit during 3 months at the beginning of the mission
- Nominal Orbit at 21 days during the 36 months of lifetime



Global Cal/ Val : comparison to in situ data

Database available from different project and different sources:

- USGS, Canadian environment services, Hydrological services in Argentina, Chile and Brazil, Russian lakes from Hydrolare
- new projects over Caspian Sea region, Baikal, Issykkul and Chad lakes

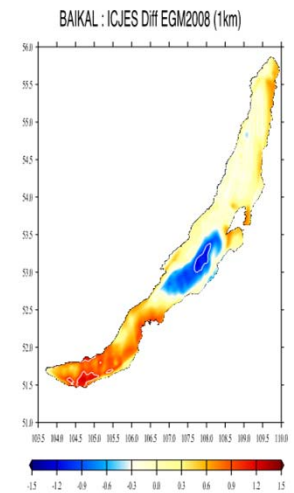
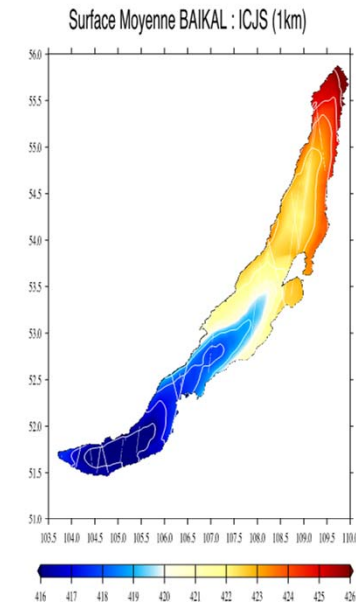
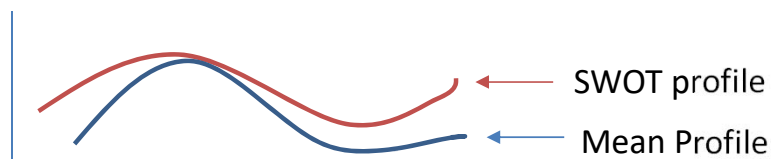
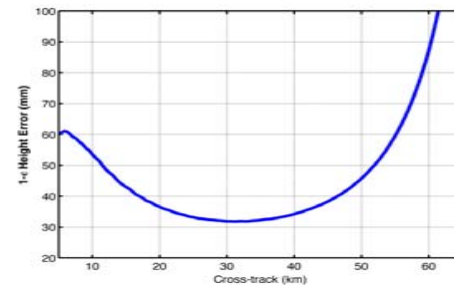
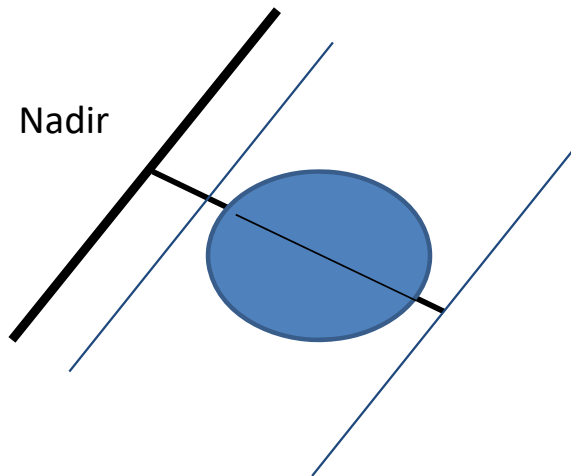


Global Cal/ Val : Generation of a priori mean lake surface

Objective:

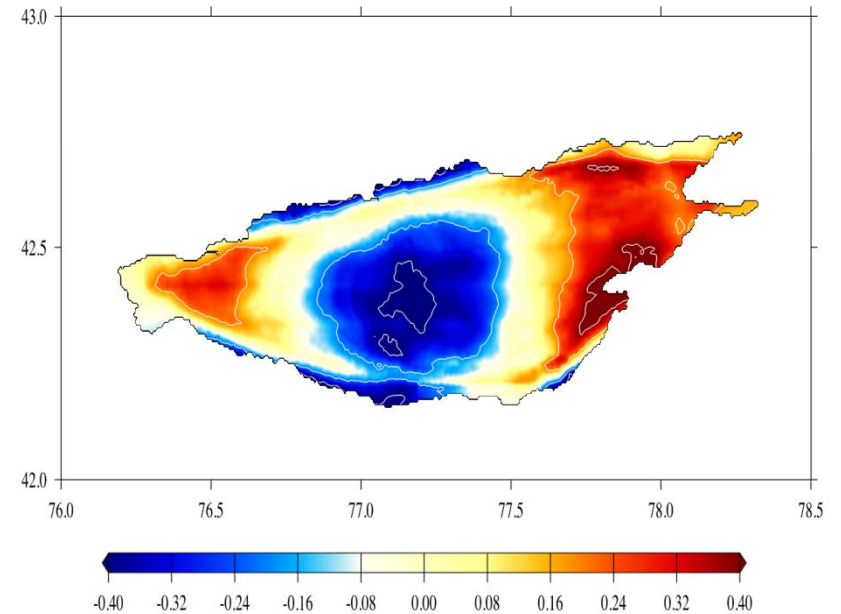
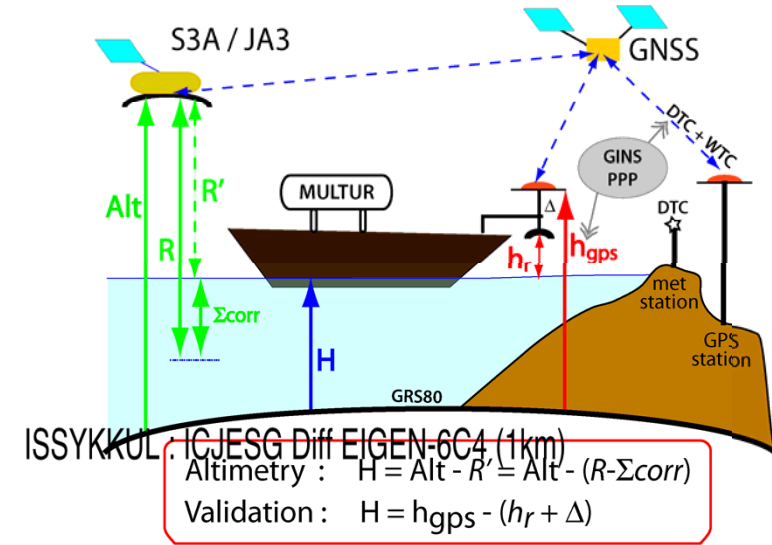
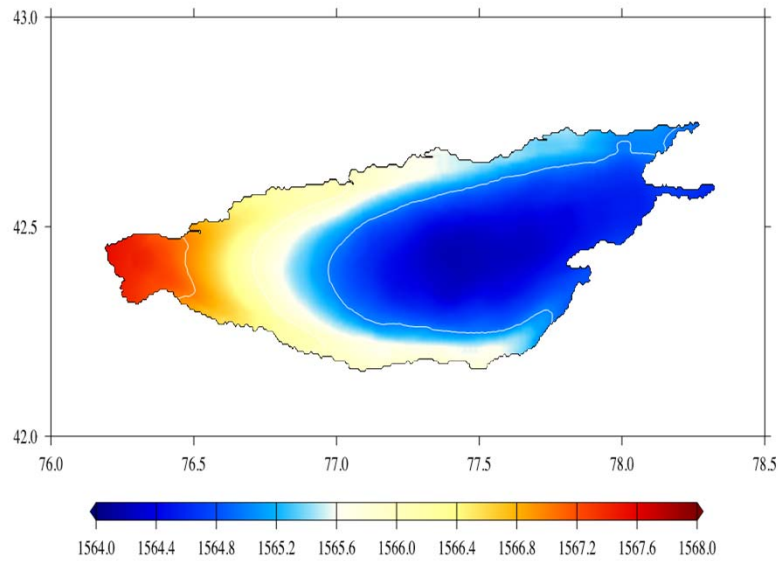
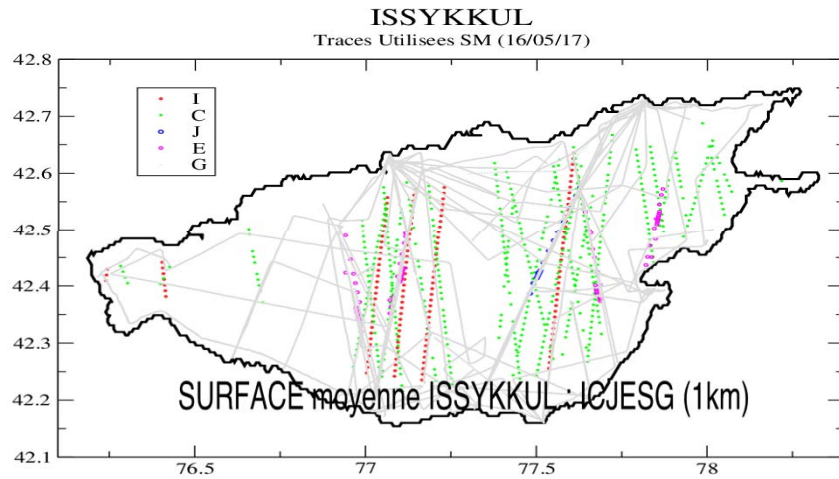
Calculation of accurate geoid from satellite altimetry over large lakes

- For Calibration of rolling effect
- For cross-track error budget validation

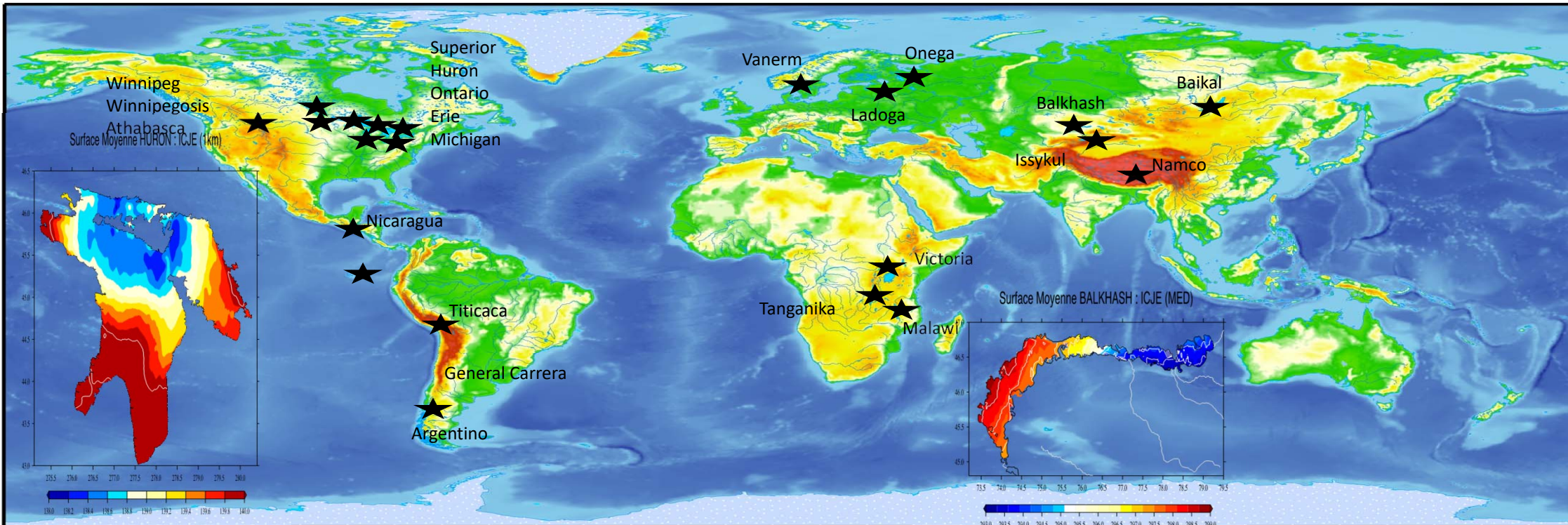


- Satellite altimetry repeat passes over fixed tracks are average to determine mean profile
- Dense coverage using Cryosat-2, Sentinel3A, Jason3, Saral AltiKa (nominal and geodetic orbit) and Icesat allow achieving high resolution (kilometer) geoid over large lakes

Merging of GPS profiles from several campaigns and altimeter track mean profiles



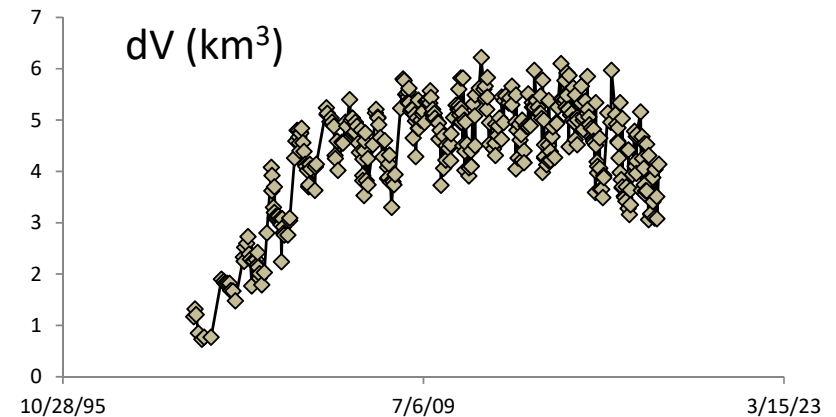
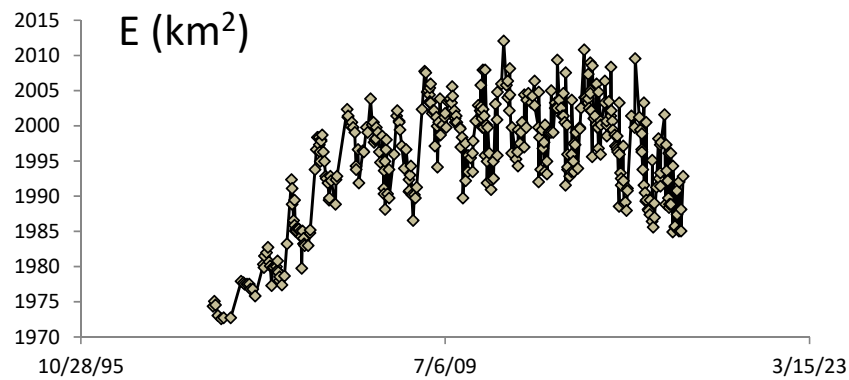
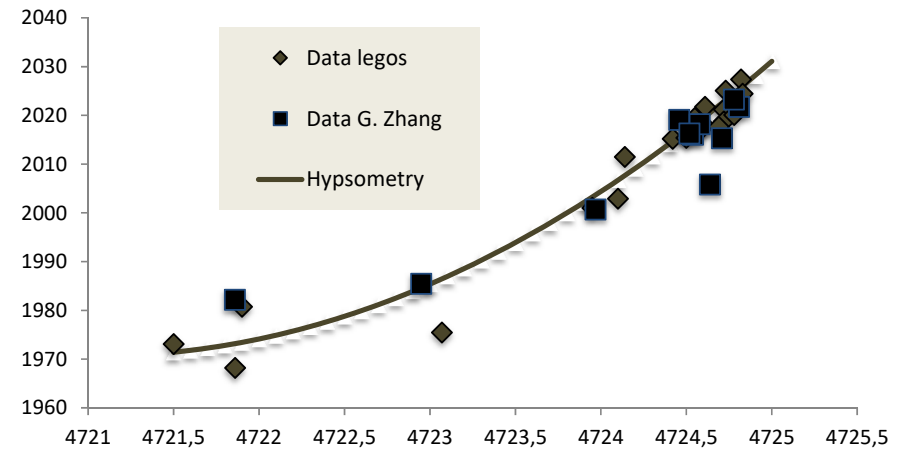
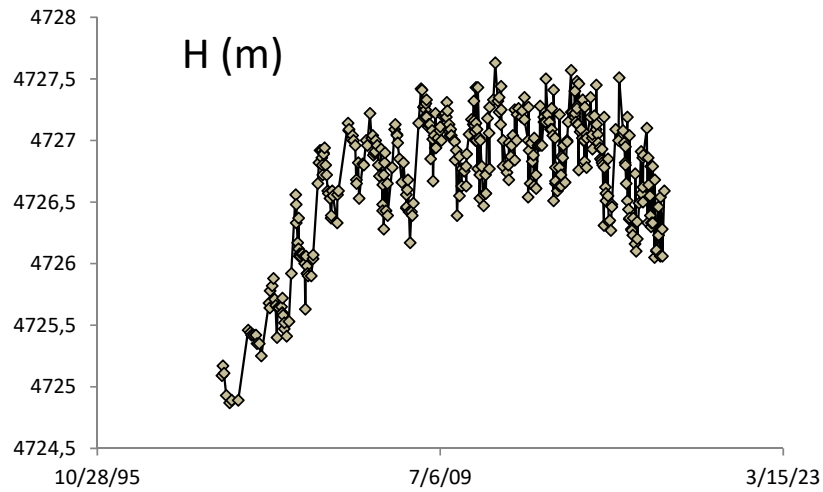
22 biggest world lakes with the following data:
Icesat, Jason1&2&3, Saral, Cryosat-2, Sentinel-3A & GPS campaigns (Issykkul)
Sentinel-3B and Saral geodetic mission (to be done in 2019)



~1000 altimetric profiles have been processed

Global Cal/ Val : Extent / Volume from comparison with hypsometric database from satellite (Hydroweb & lake CCI), and from In situ (Hydrolare)

The hypsometric curves on hundreds of lakes will be released for the validation of water extent and storage changes



On site Cal/ Val: some key points

- **Validation of storage change.**

No requirements on storage changes but :

Some bathymetries exist (Léman, Issykkul, others in USA) or generated using satellite imagery and laser altimetry (Lac Poopo, sobradinho reservoirs).

- **Validation of height and extent:**

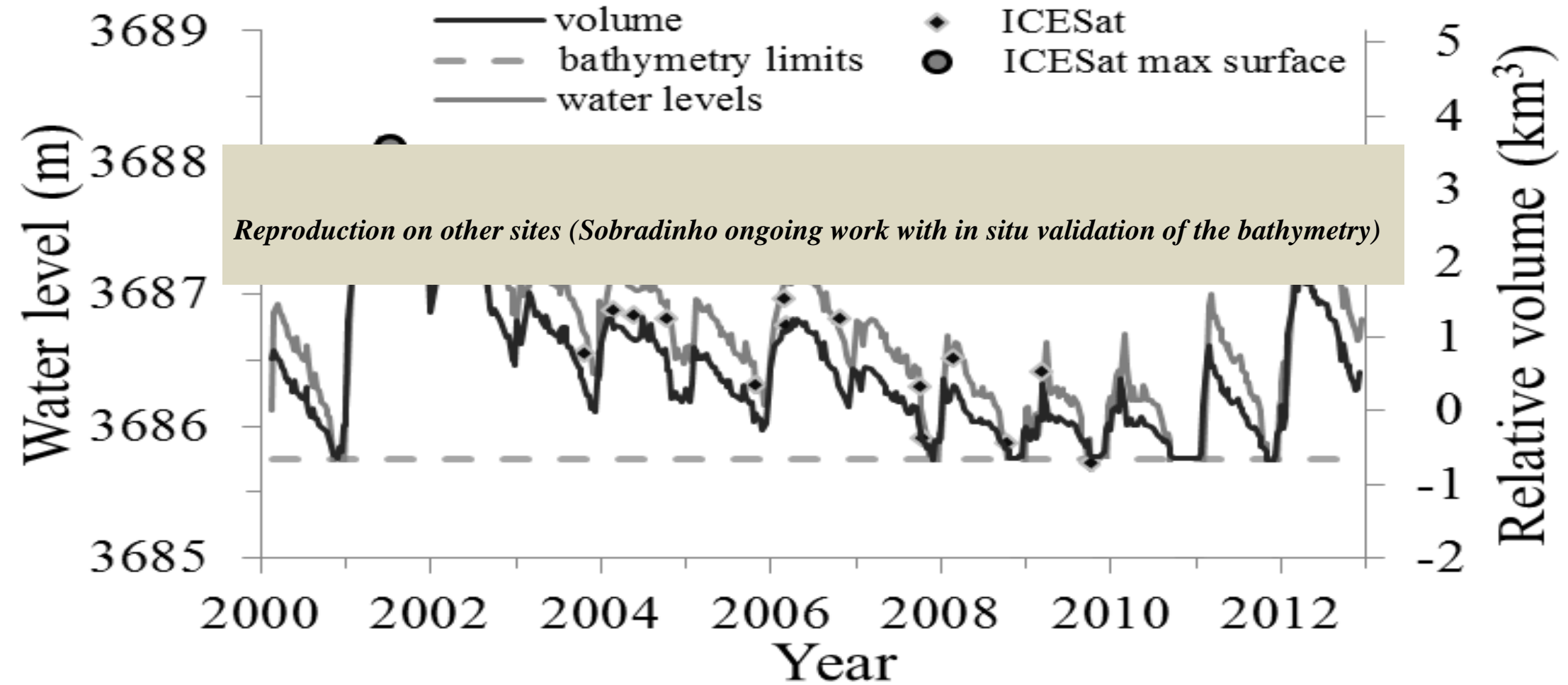
- GPS leveling, installation of limnigraphs
- Extent by aerial imagery or GPS mapping (experiment done in lake Chad in April 2019, under processing)
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- **Representativity of sites:**

- Boreal lakes (with ice cover), tropical (with dense vegetation), Arid lake (with shallow water and high variability)
- Size & morphology (distinction between close lakes, narrow ones, etc ...)

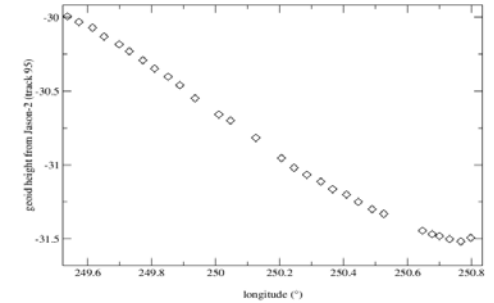
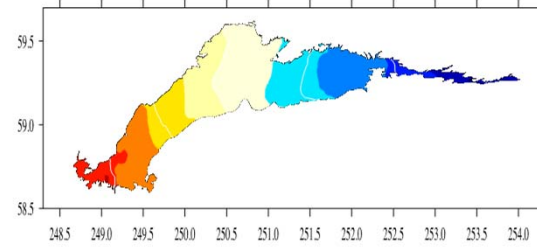
Validation of extent and storage change: example of lake Poopo

Lake Poopo water and volume variations

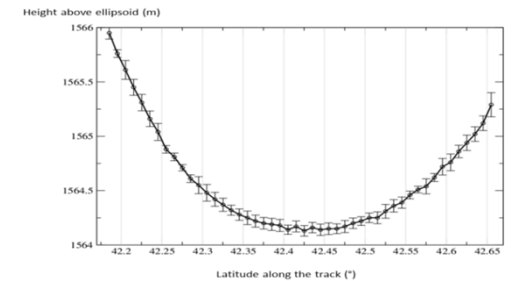
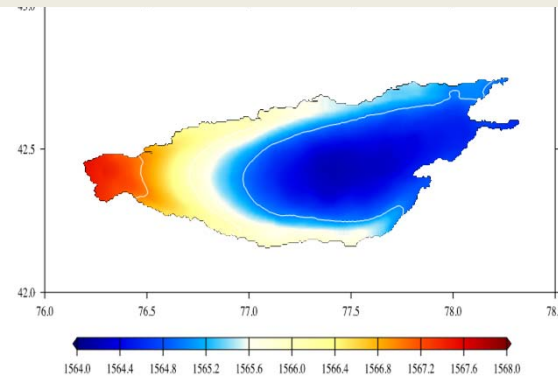
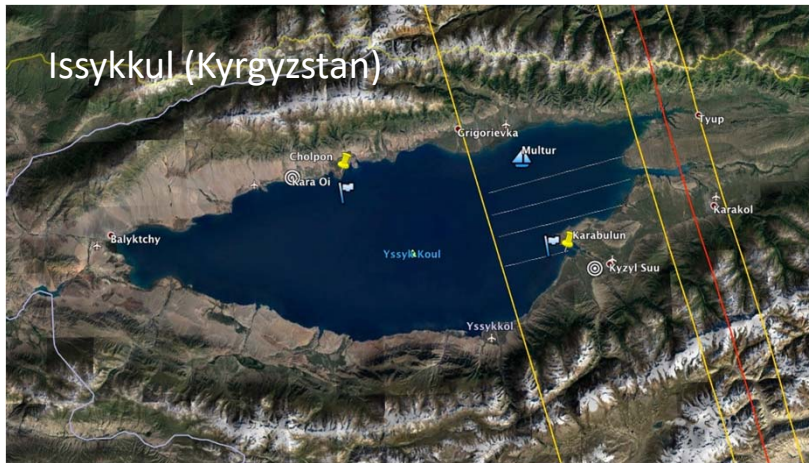


Cal/Val during the one-day orbit

Comparison of altimetric profiles and mean lake surface with equivalent from SWOT



Mean profile every day in the cross track direction.
 Comparison with hourly in situ water height
 Comparison with mean lake surface
 Tropospheric corrections using GPS receivers and weather stations
 Storm surges inferred from Tugo Model coupled with atmospheric data and bathymetry of the lake



On site Cal / Val: some proposals



Currently

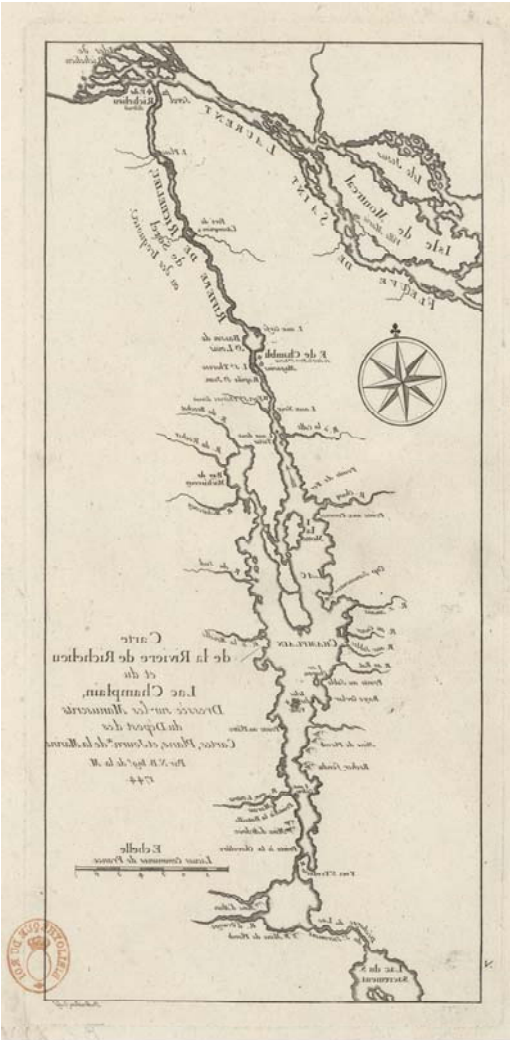
FOAM (nadir altimetry) => CNES (2007-)
FOAMS (SWOT) => CNES (2017-)

In preparation

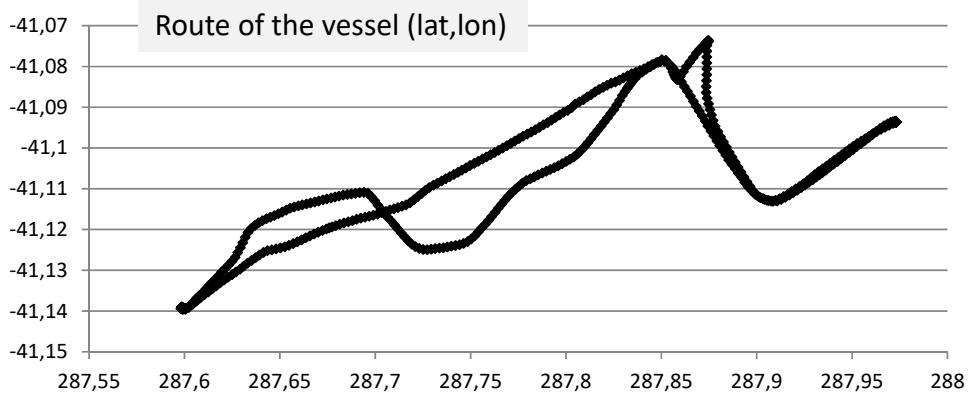
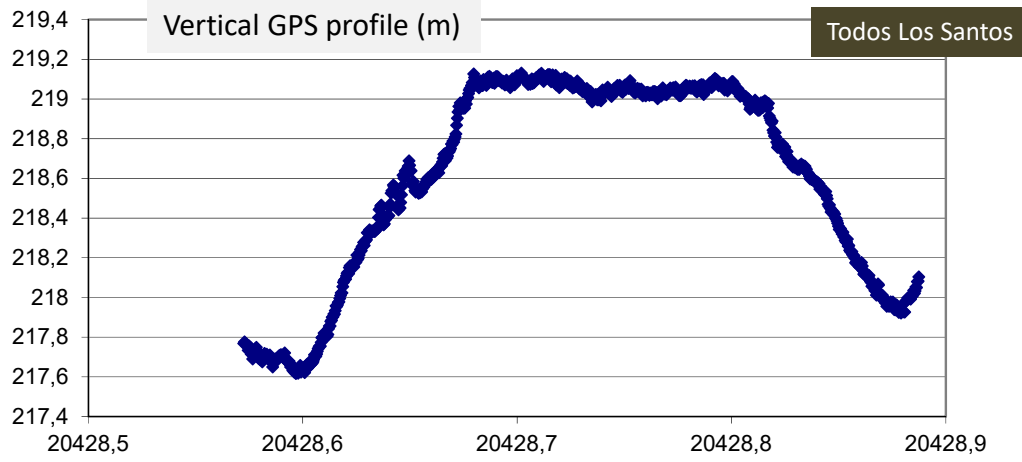
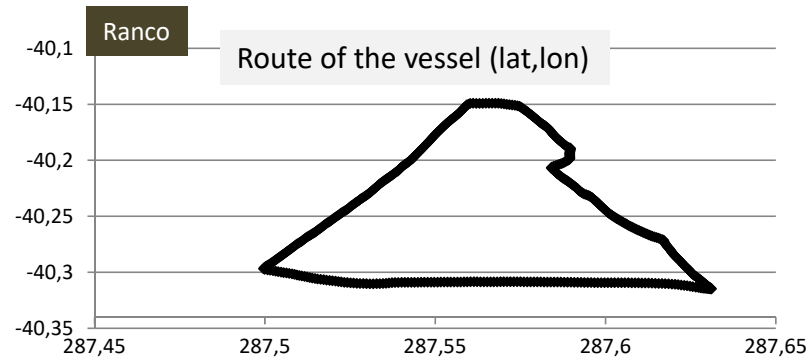
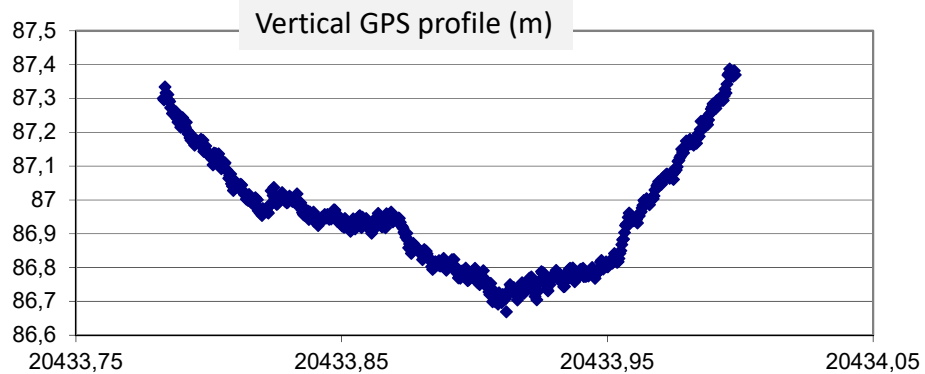
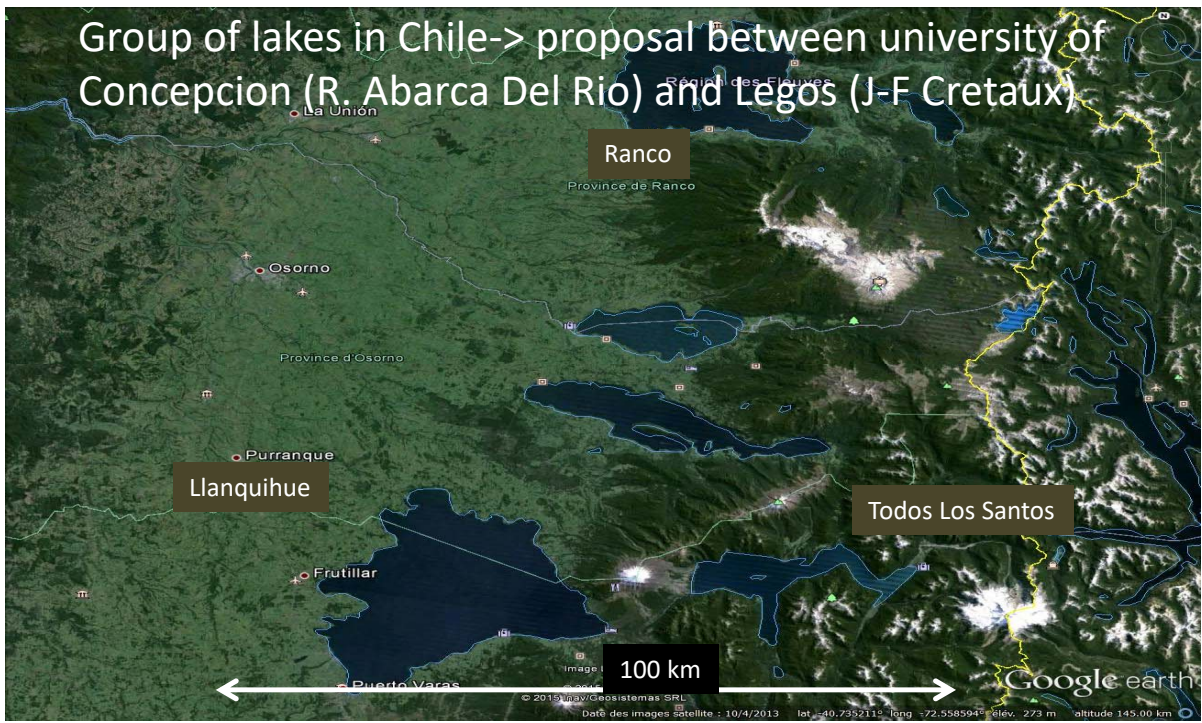
FOAM (SAR altimetry S3-like) => ESA program
CCI lakes (multi-variables) => ESA
Regional projects (Chad, Québec) => AFD?, CSA?

Possibility of coupling a river/lake/estuary cal/val site in Quebec?
 Champlain, Saint-Pierre, Saint-Laurent

Cooperation France-Quebec: Legos (S. Biancamaria) & university of Sherbrooke (R. Lecomte, M. Trudel)



Group of lakes in Chile -> proposal between university of Concepcion (R. Abarca Del Rio) and Legos (J-F Cretaux)



Conclusions

- **Global Cal / Val.**

Relying on past altimetry & imagery missions and global in situ database

- **On site Cal / Val**

Relying on different sources of funding (ESA CCI, ESA Cal/Val sentinel, OSTST, régional project, SWOT...) with a set of pre-existing cal/val sites (Issykkul) or in development (Baikal, Tchad) or to be setup specifically for SWOT (St Laurent, Tahoe, Chili)

Two phases of cal / Val

1D- orbit with particular efforts (in situ campaign) before and during the fast sampling phase
Nominal orbit with all sites and approaches proposed

Préparation for the next ST of a Cal/Val group for lakes: France/Chili/Canada/USA
In coordination with cal/val on rivers, JPL and CNES