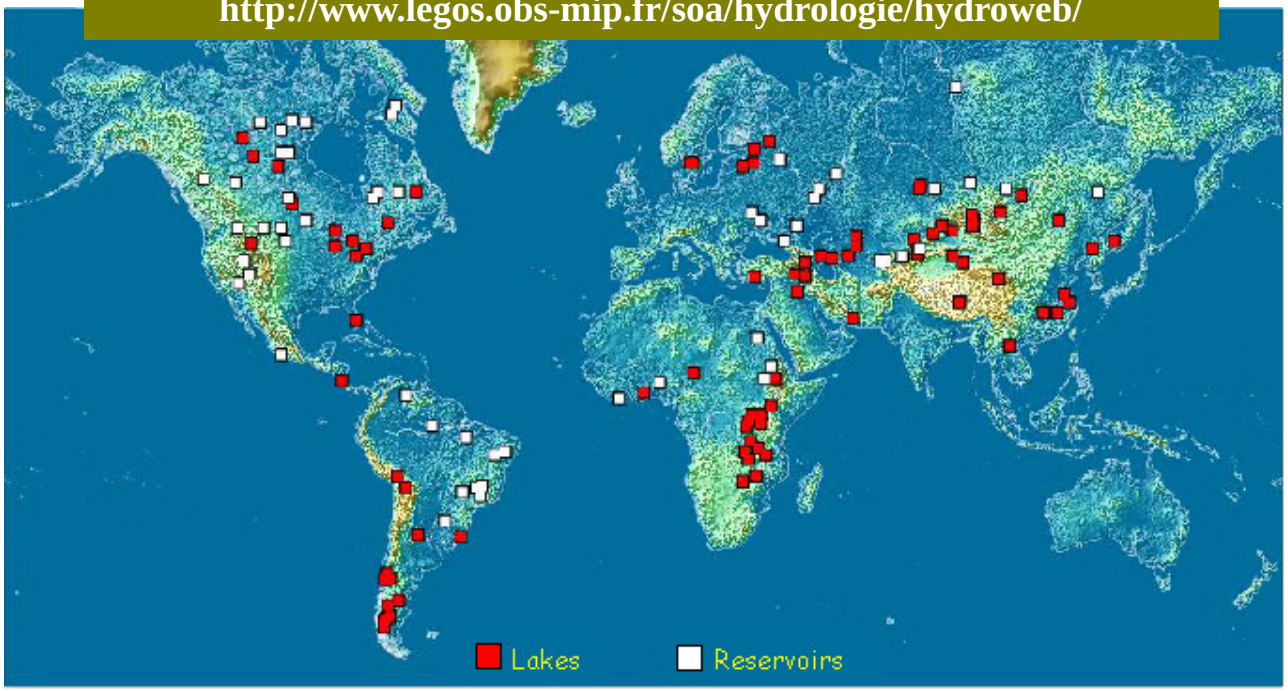
# Lakes surface and level variations from satellite altimetry and remote sensing: towards an international lake data centre.

**J-F. Crétaux, W. Jelinski, M. Bergé-Nguyen  S. Calmant, M-C Gennero, F Nino, P. Maisongrande & A. Cazenave**

**http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/**




**Lakes rivers and reservoirs level variations from satellite altimetry**

150 lakes & reservoirs, ~300 river's virtual stations
Update every year

## GCOS requirements

ECV for large open lakes, highly ephemeral lakes, close basin lakes

### Products T1.1: maps of lakes in the Global Terrestrial Network for Lakes (GTN-L)

Gridded georef maps of 250 m spatial resolution on monthly basis for 150 lakes
With accuracy of 5% (mainly reachable from RS imagery: MODIS, Landsat etc ..)

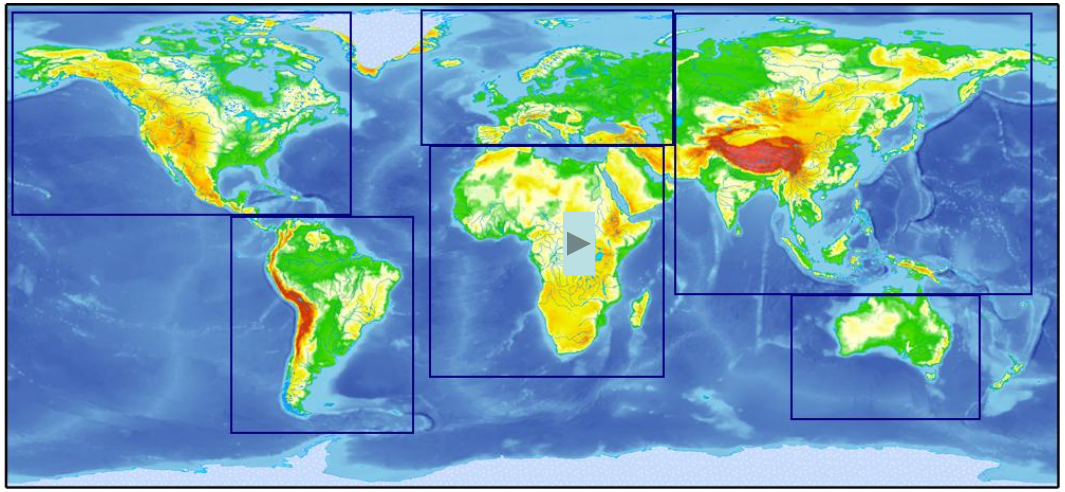
### Products T1.2: Lake levels of all lakes in the GTN-L list

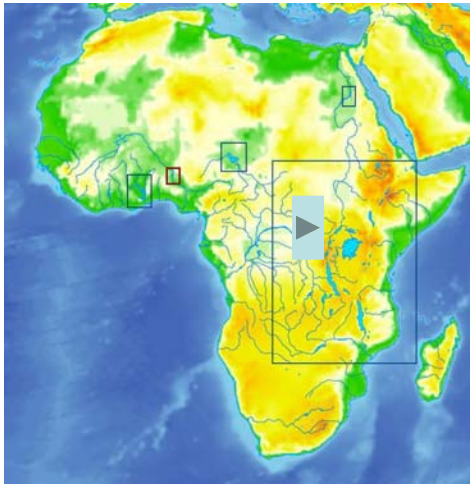
10 cm of accuracy and stability on weekly/monthly basis
Time series based on radar altimetry and in-situ gauges

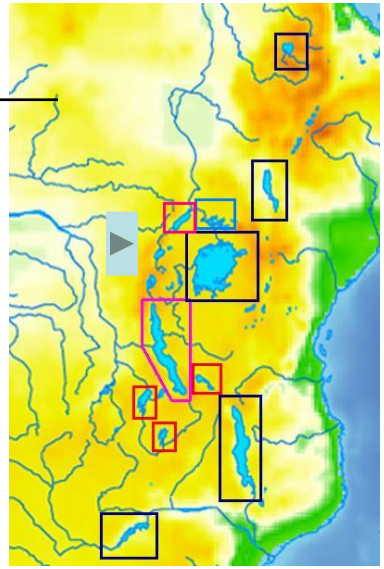
### Products T1.3: Surface temperature of all lakes in the GTN-L list

Daily 0.2° accuracy and 0.1° stability with 1 km spatial resolution

# Current use of Hydroweb

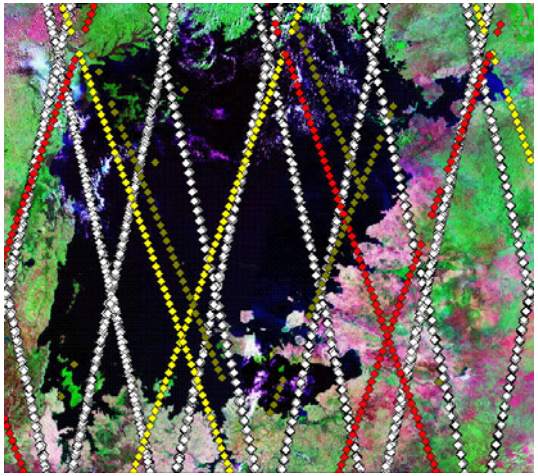


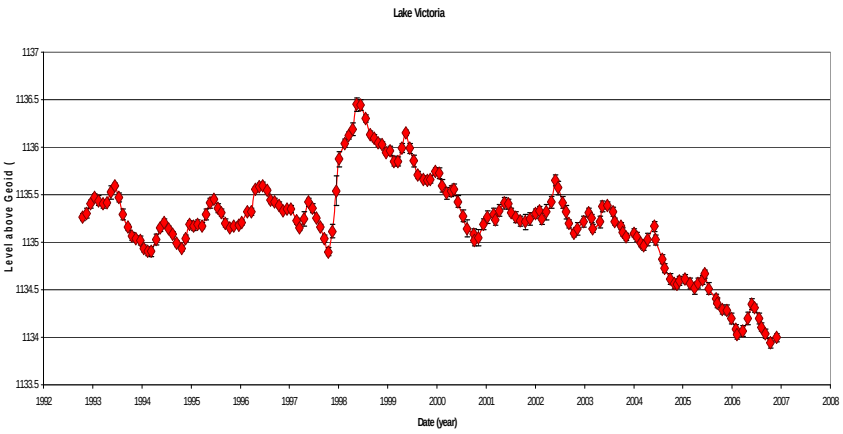




Lake Victoria

Download





# Extended Hydroweb (SOLS), current status

## Products T1.1

20 lakes surface water extent has been collected from:
ASAR, MODIS, LANDSAT, CBERS, Bathymetry maps, and SRTM
Only 4-5 images per lakes from min value to max value over historical evolution of each lake
Calibration & comparison has been performed

## Products T1.2

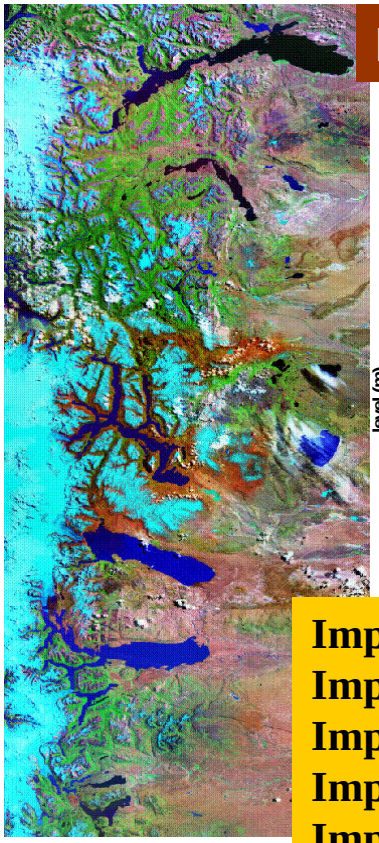
Radar altimetry over 150 lakes with 5 to 50 cm of accuracy depending
Of size of the lake including ~40 lakes of the GTN-L
Calibration through GPS campaign made over Caspian Sea and Issykkul Lake, and through comparison with In-Situ data (~10 lakes)

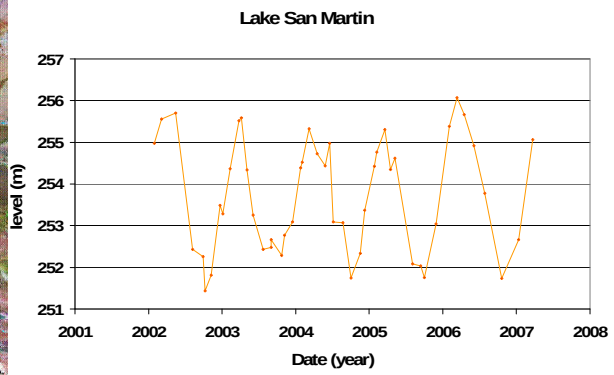
## Products T1.3

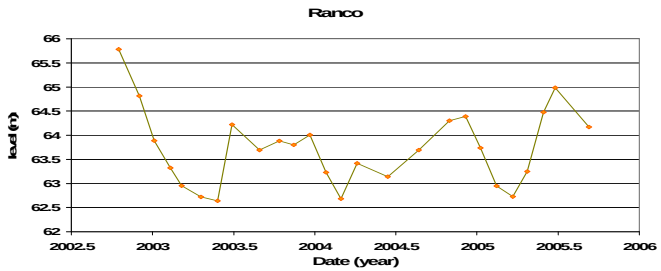
Not planed to be calculated

Selection of maps + level from altimetry => hypsometry curve (dh/dS)
=> Reconstruction of past surface variation on weekly/monthly basis through altimetry

# Lakes from radar altimetry in South America

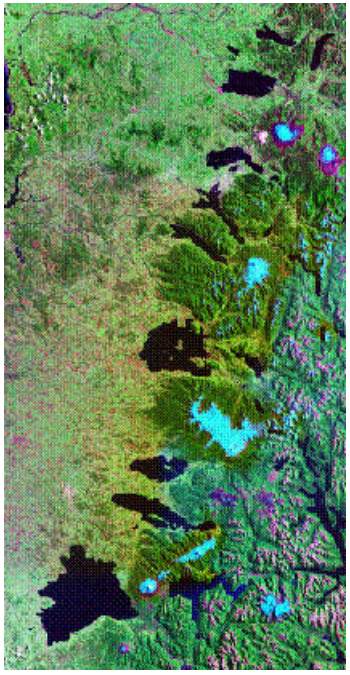


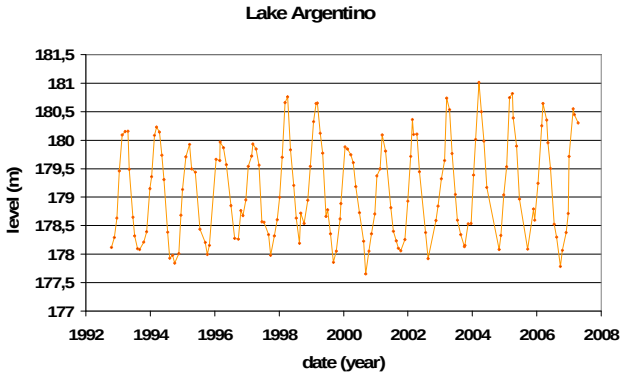


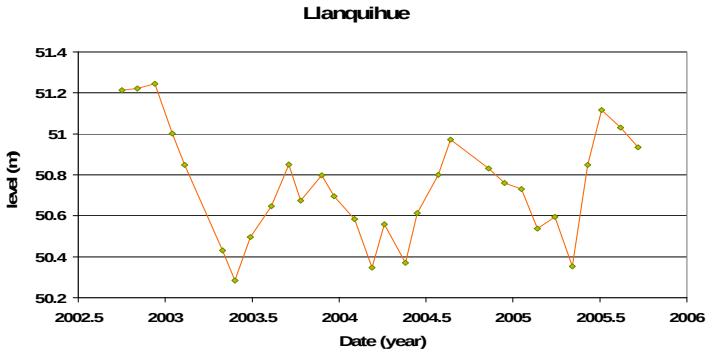




**Impact of Southern Oscillation ?**
**Impact of El Nino ?**
**Impact of PDO ?**
**Impact of Glaciar melting?**
**Impact of Precipitation?**

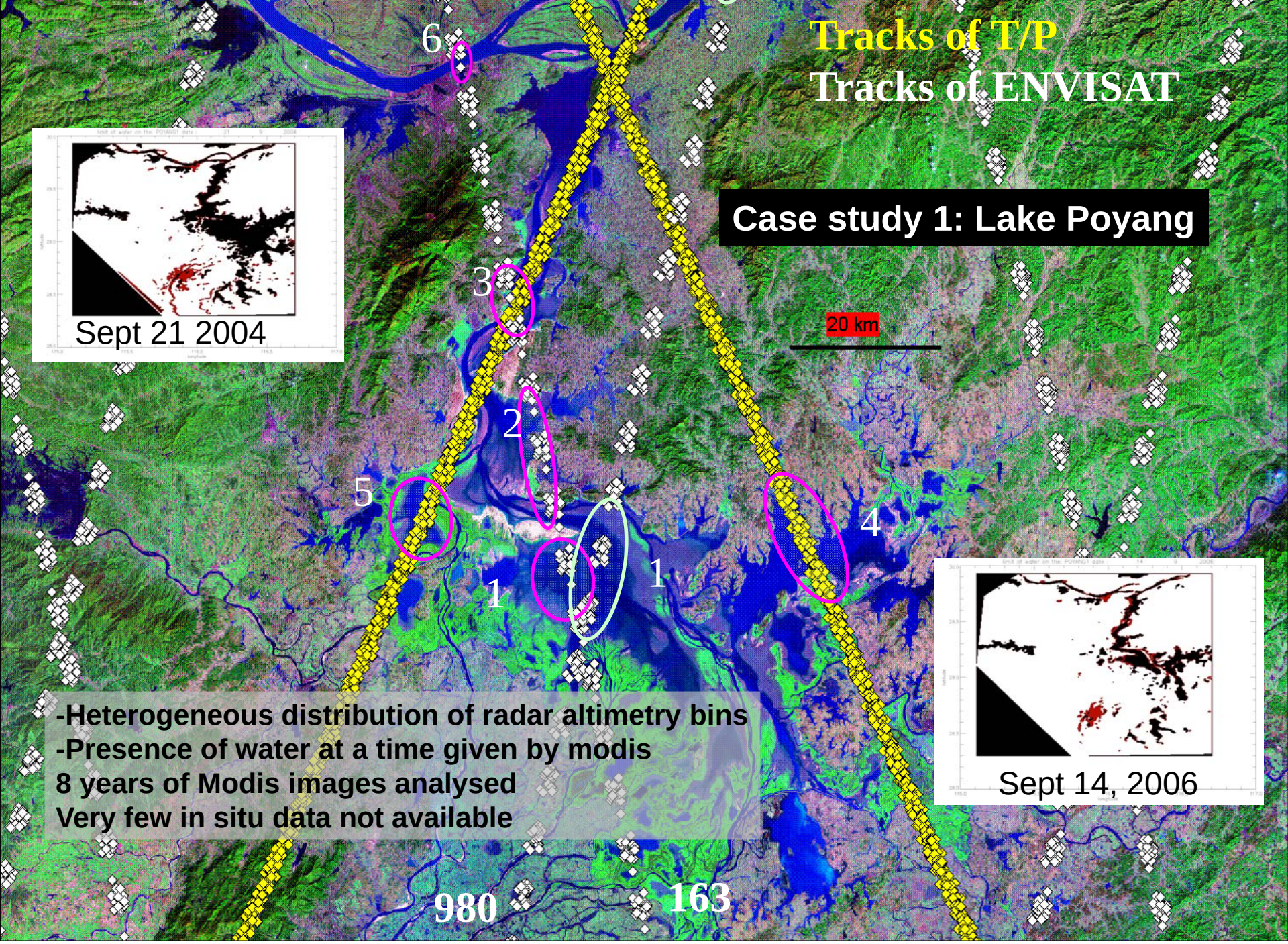
Radar altimetry allows to monitor level variations of ~10 lakes in the Andea



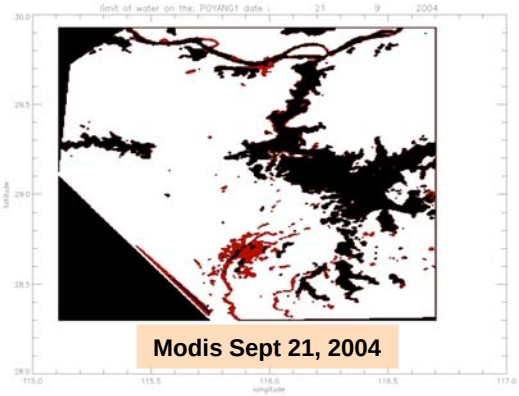


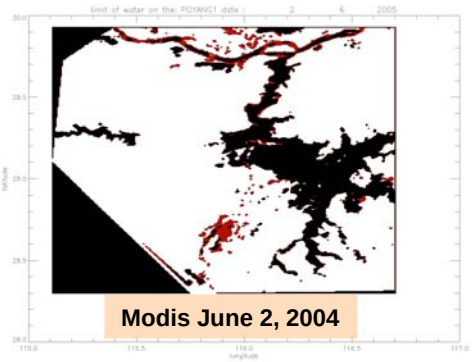



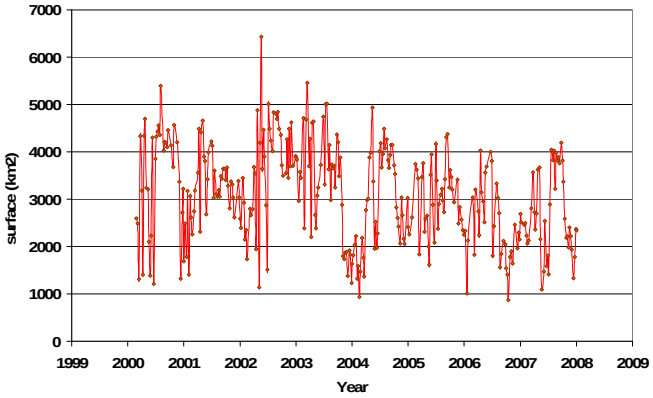

Lake level monitoring is a first step towards understanding the climate impact on terrestrial water storage variability: needed to use additionnal RS information


Tracks of T/P
Tracks of ENVISAT
Case study 1: Lake Poyang
20 km
6
3
2
5
1
1
4
Sept 21 2004
Sept 14, 2006
-Heterogeneous distribution of radar altimetry bins
-Presence of water at a time given by modis
8 years of Modis images analysed
Very few in situ data not available
980
163

# Modis multispectral images

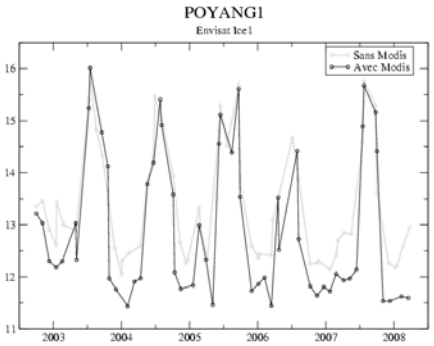


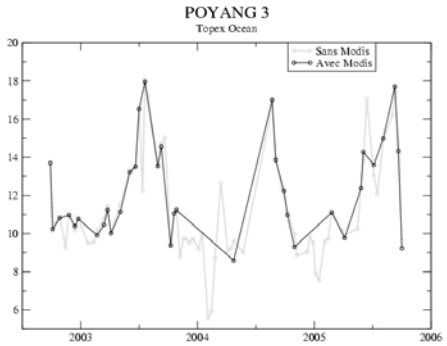



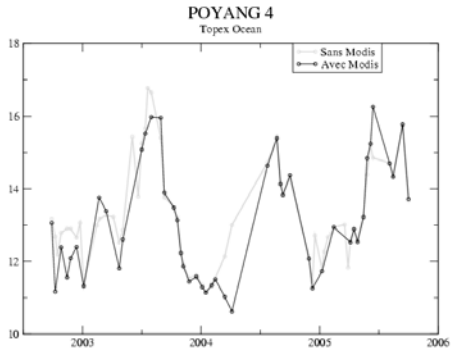




+

# radar altimetry

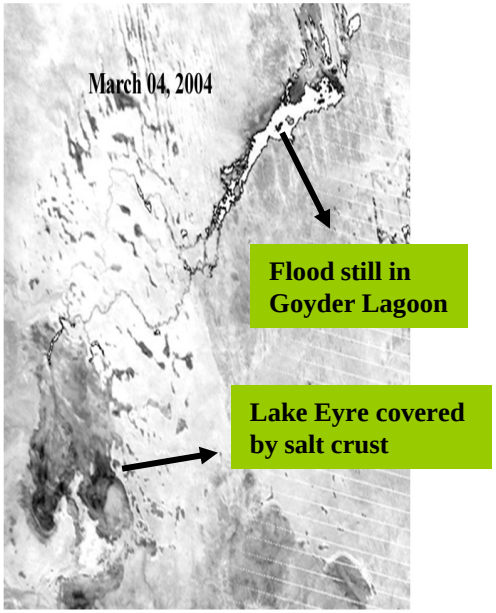


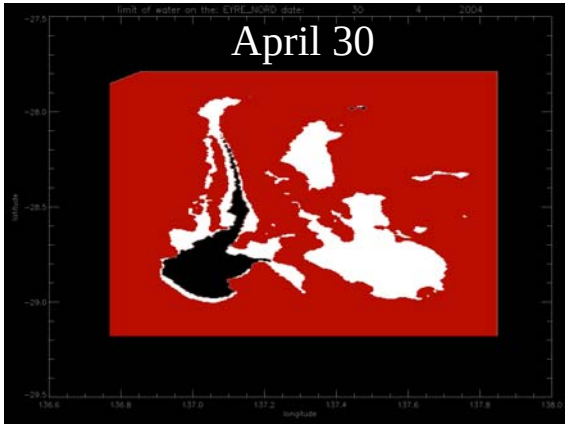

**Possibility to estimate sub basin level and surface and determination of volume variation**
**Comparison with in-situ in process through Dragon-II project**

# Sequence of 2004's flooding on Lake Eyre

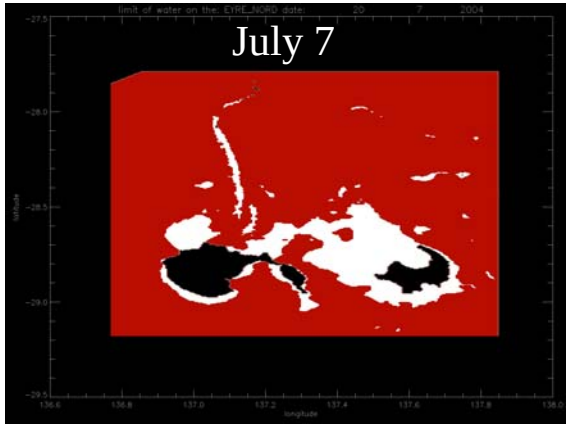



## Case study 2: Lake Eyre

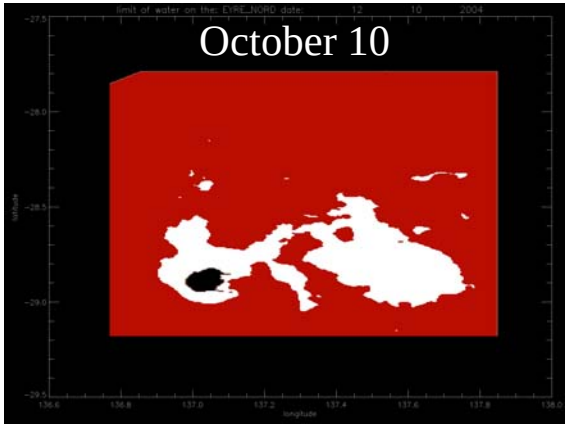


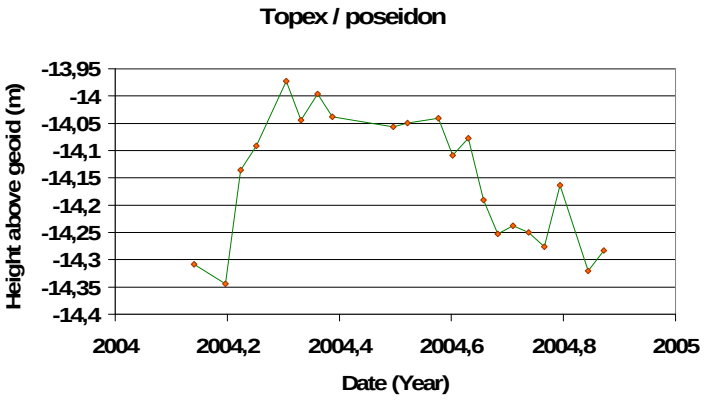


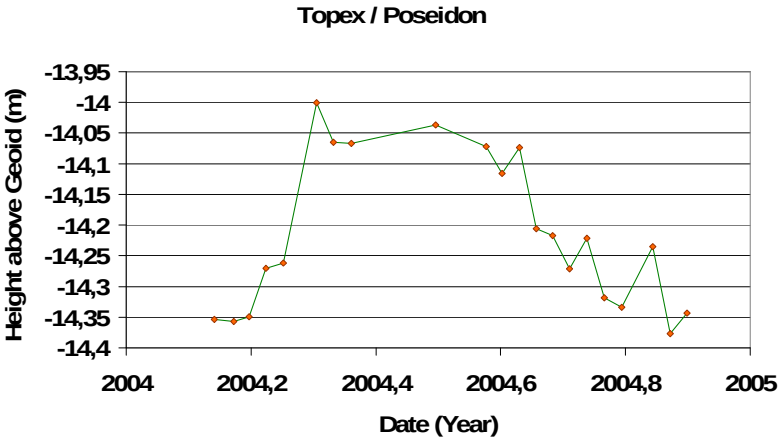


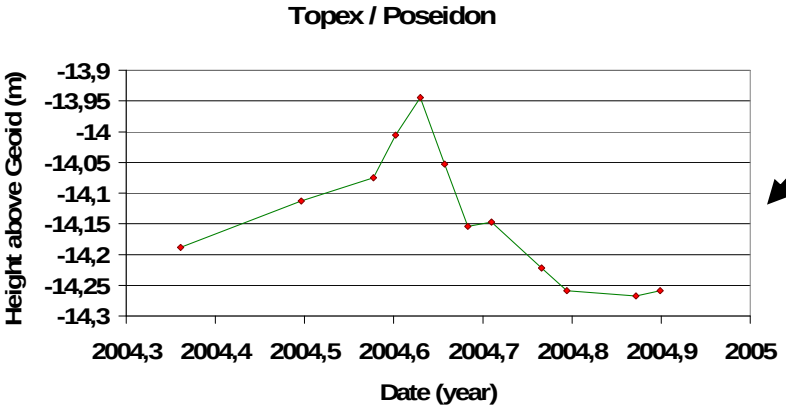


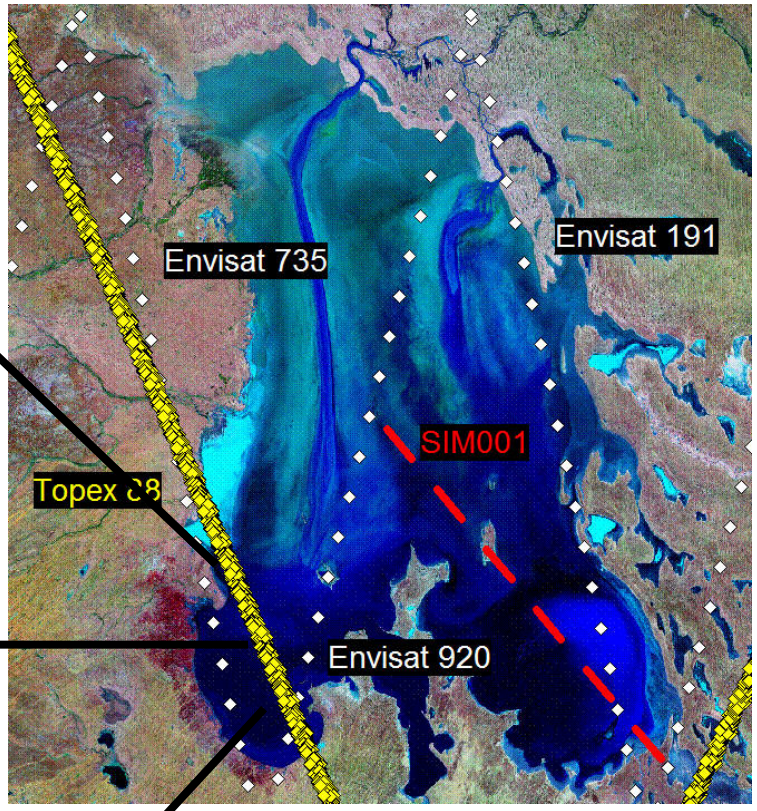


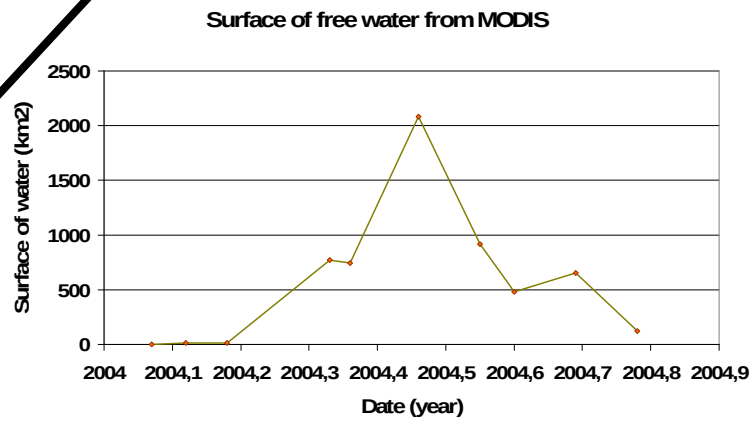




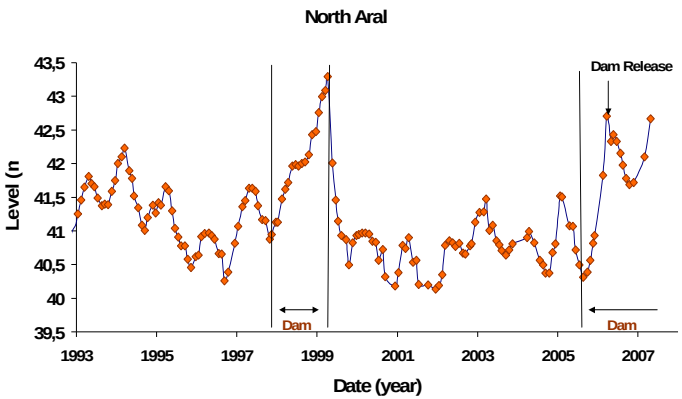



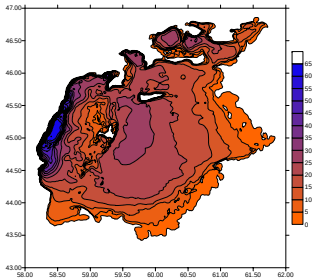



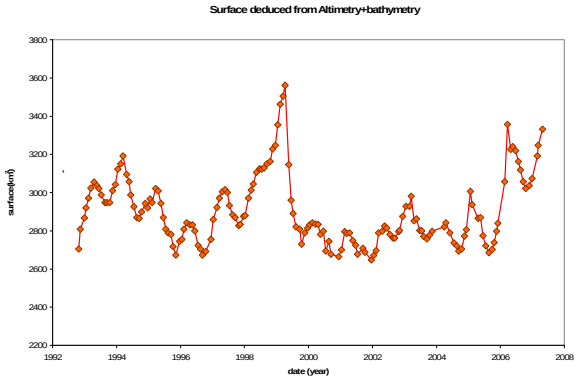

**ΔV on lake Eyre ~0.5 km$^3$**

# Case study 3: Aral Sea

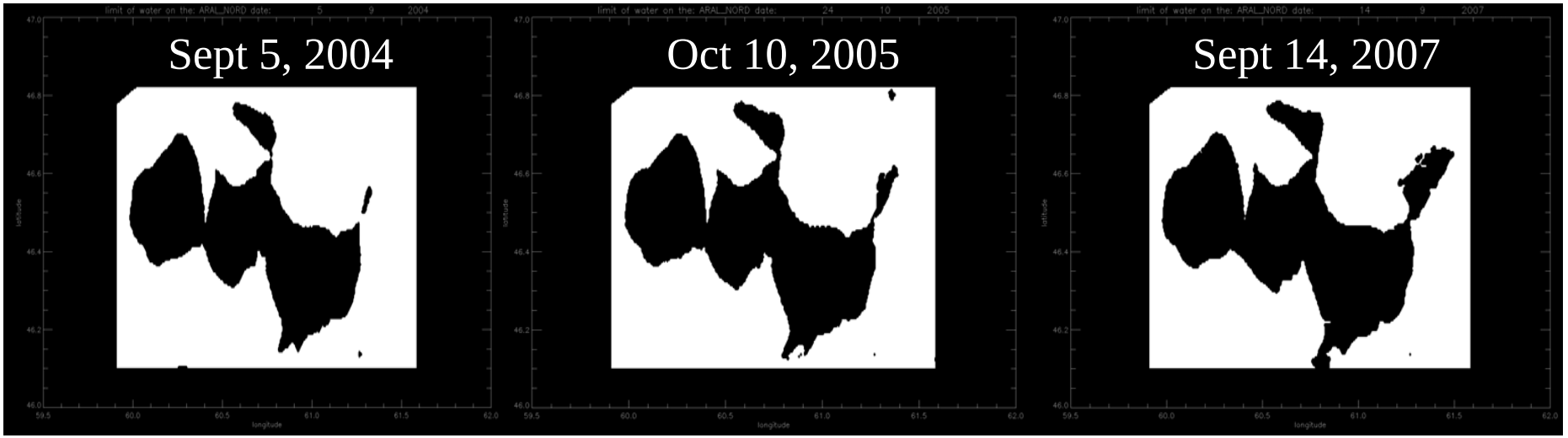
From altimetry + bathymetry => variation of surface



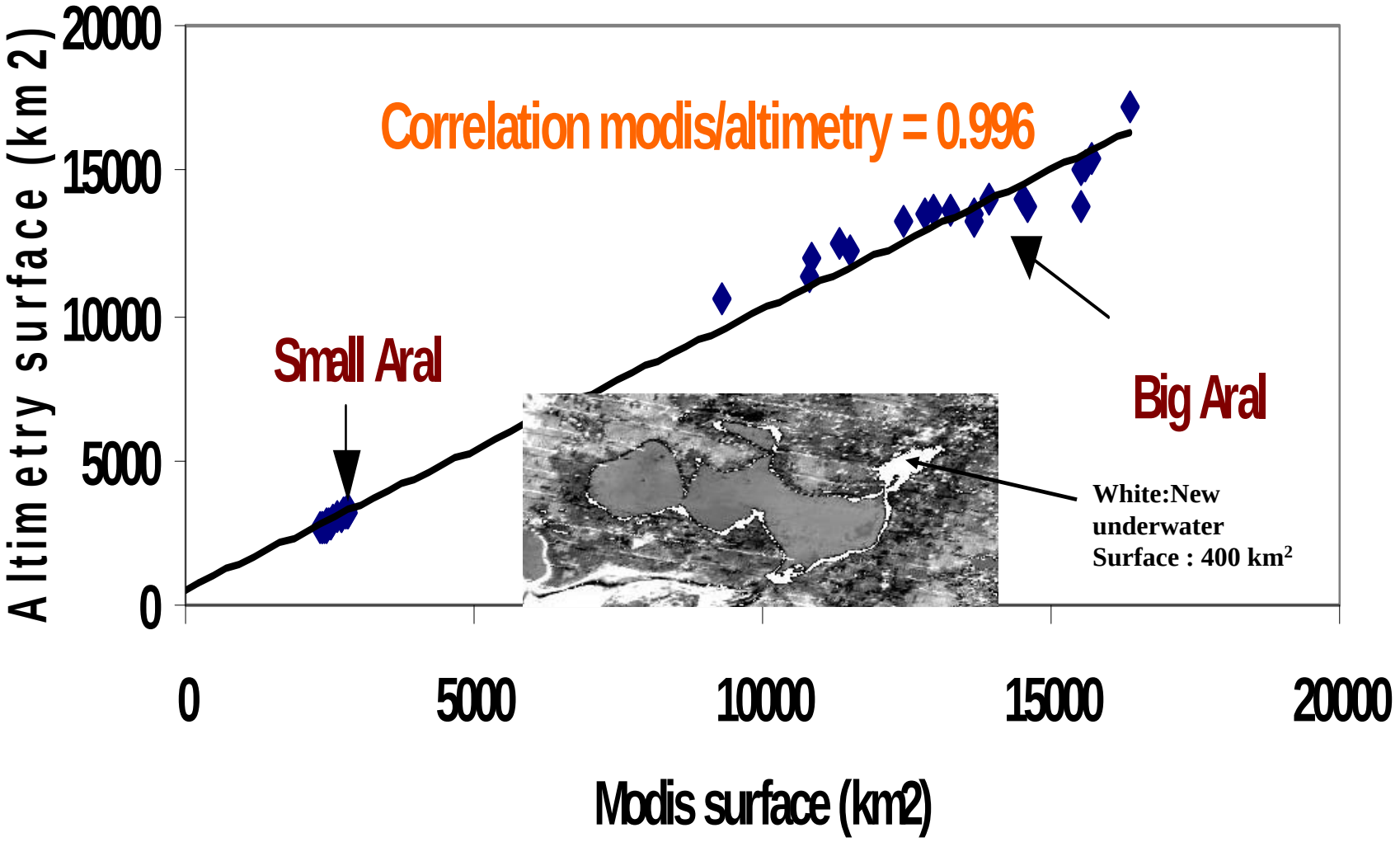






Direct measurement from analysis of the Modis images

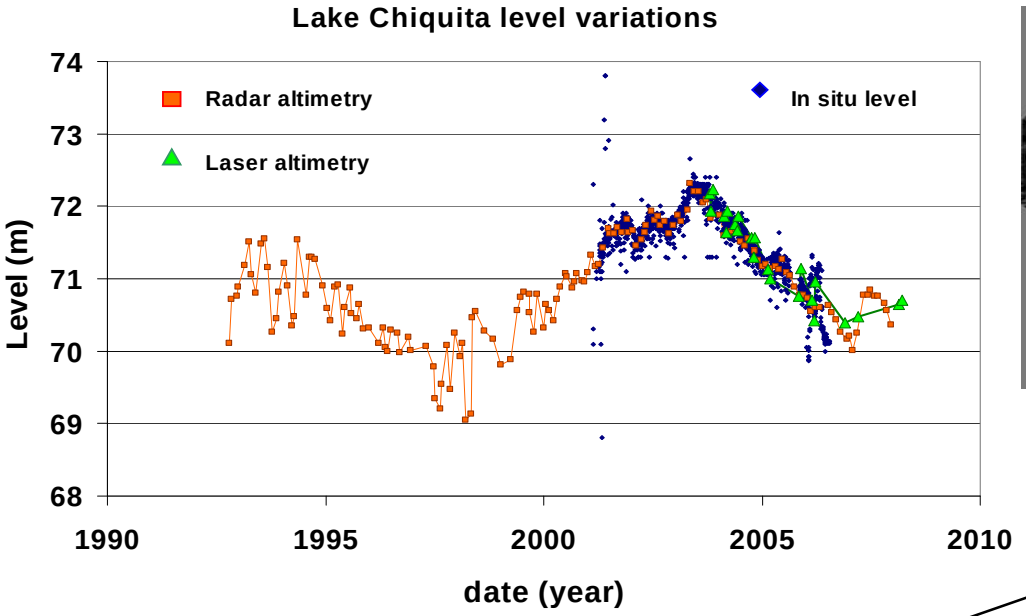


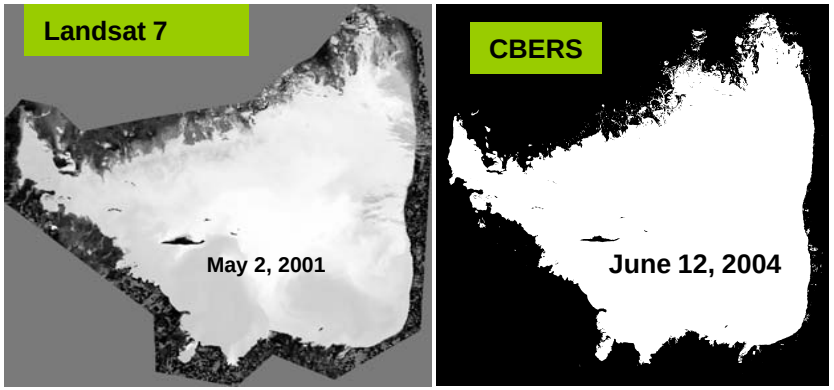
# Modis / altimetry Aral surface variations



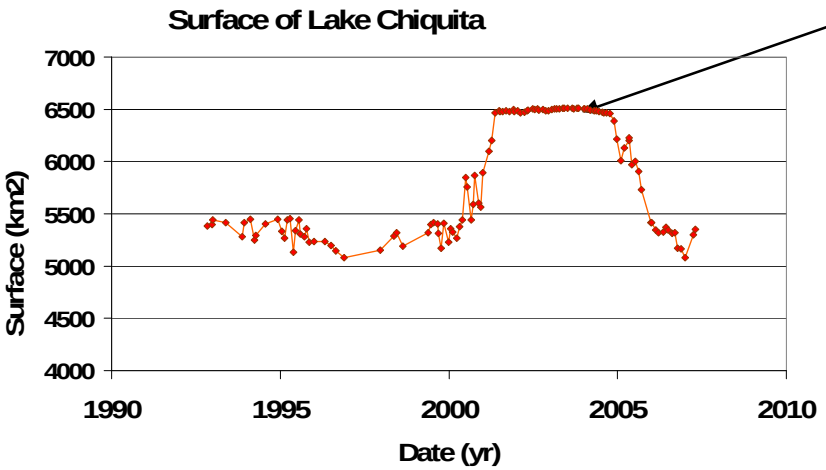
# Case study 4: Lake Chiquita

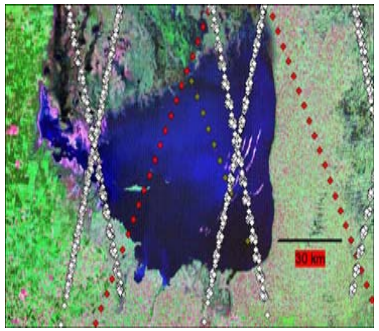
Landsat, CBERS, and modis images, In situ level,
radar altimetry over 15 years and laser altimetry over 5 years (Icesat)

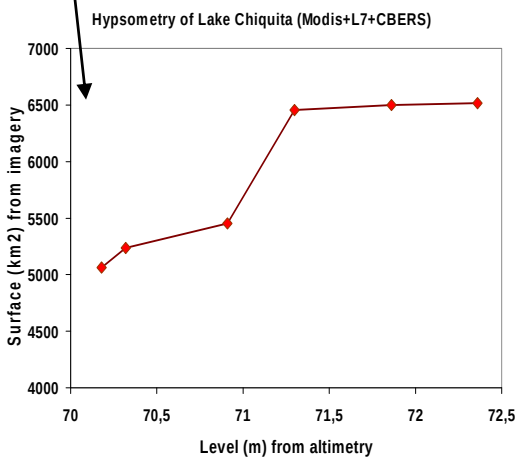


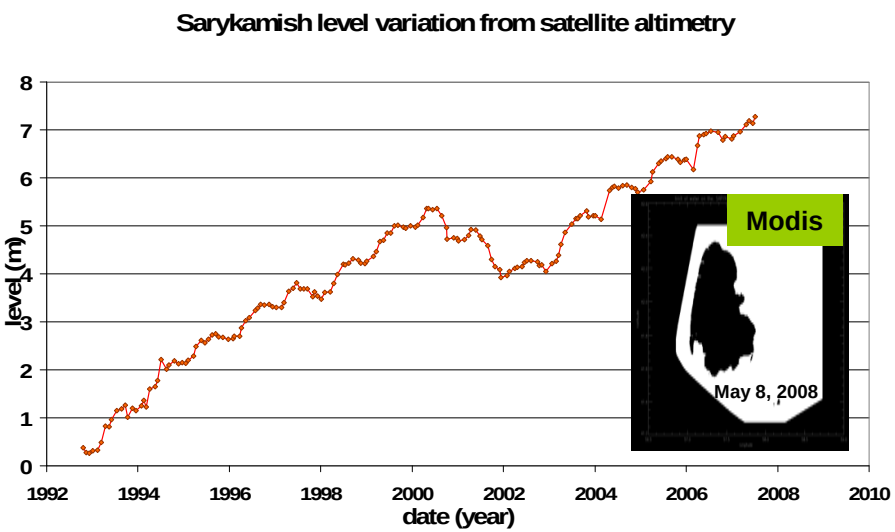

**For some lakes the relation dh/dS (hypsometry) is not linear which Explains for Mar de Chiquita the different shape of level and surface variation's plots**

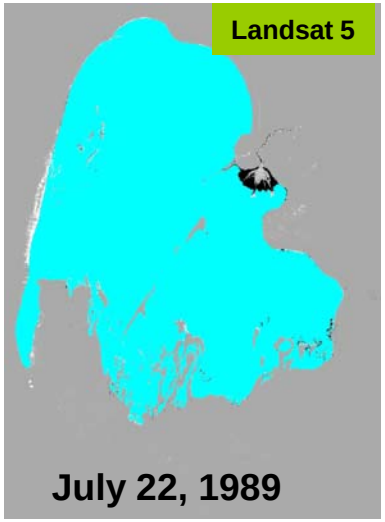


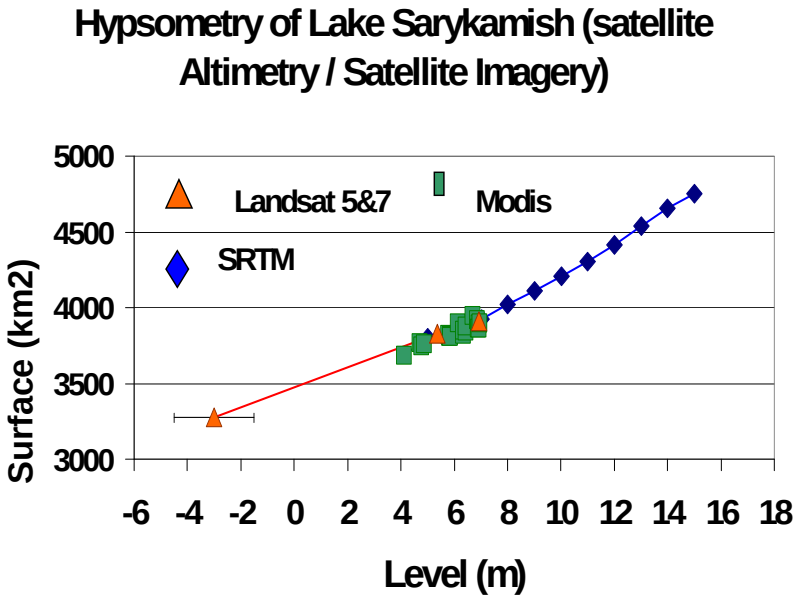



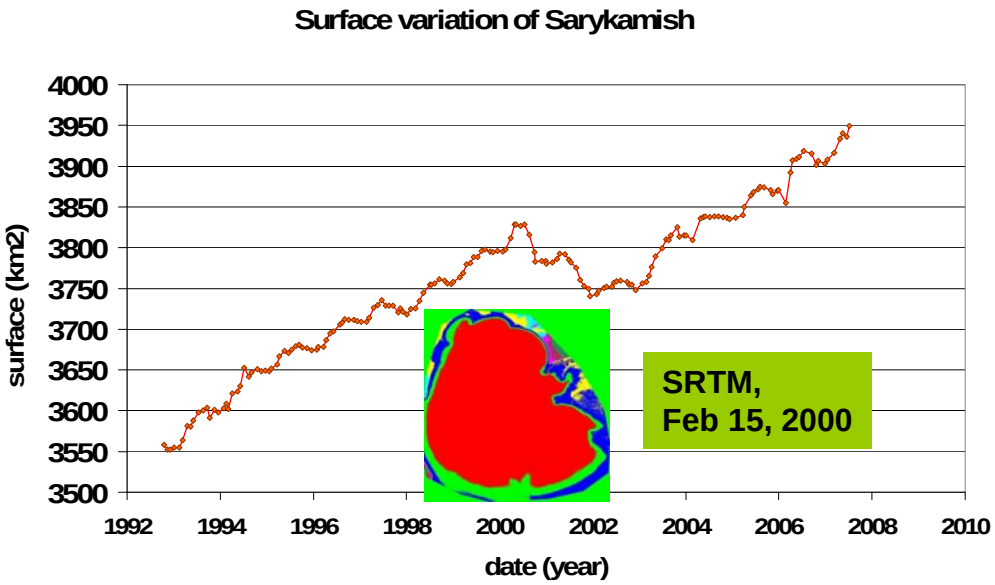
# Case study 5: Sarykamish lake (Turkmenistan)

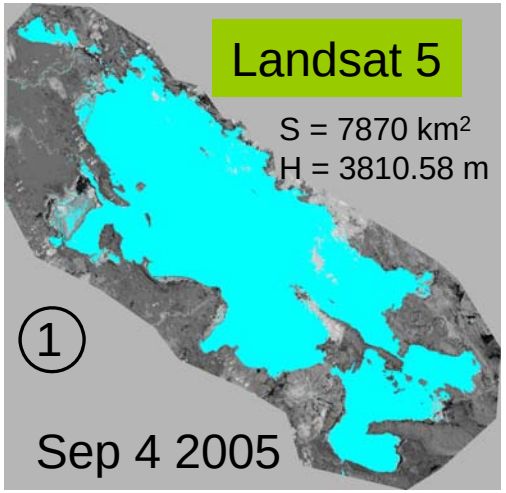


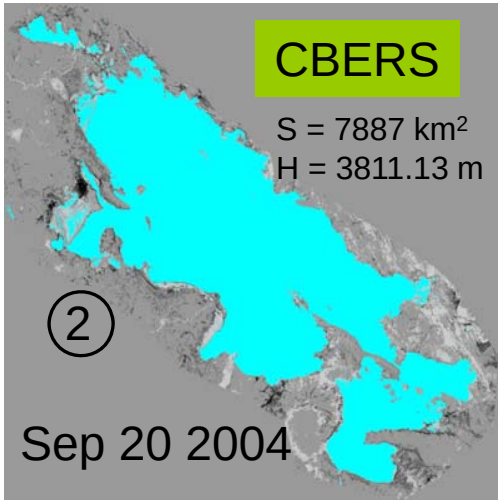



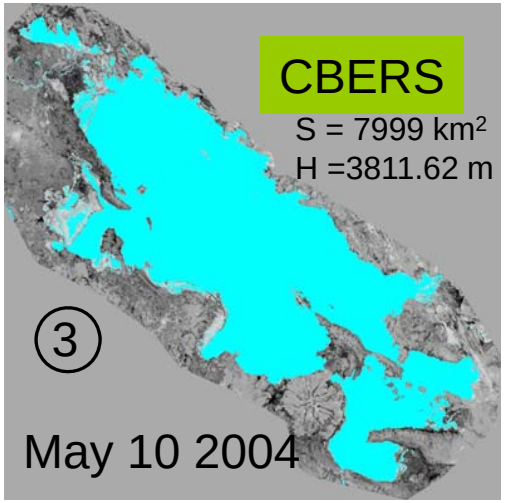


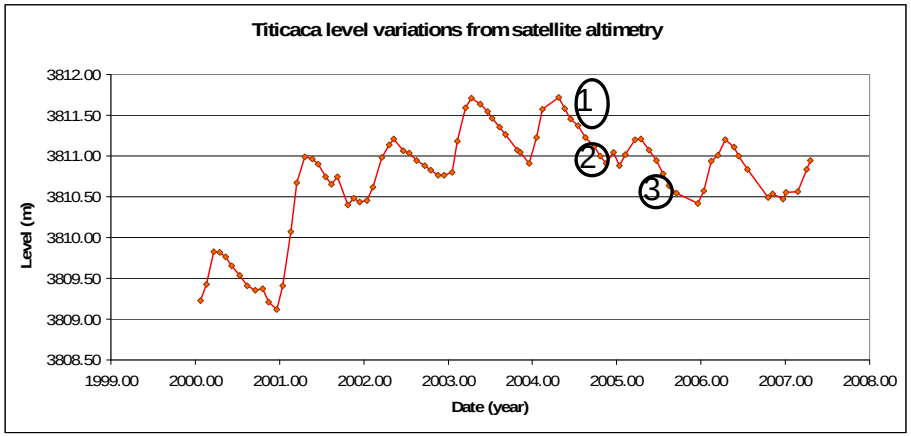




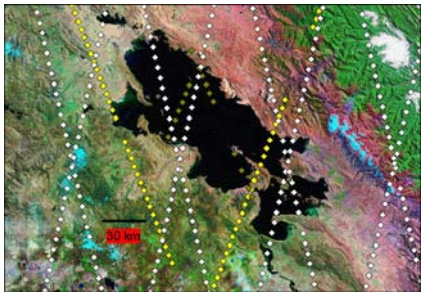



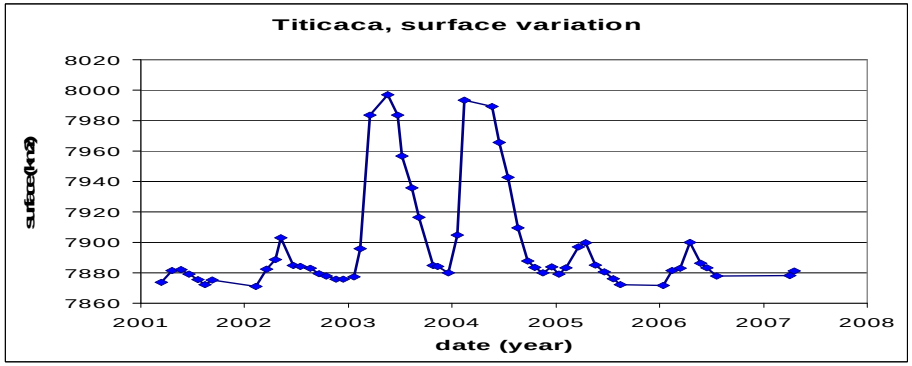



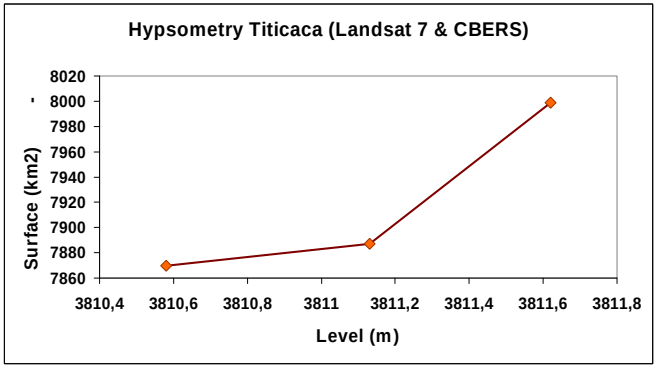




# Lake Titicaca

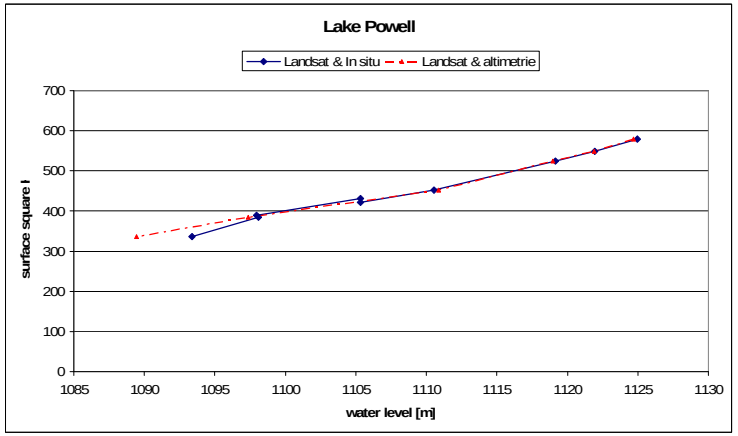
Data download





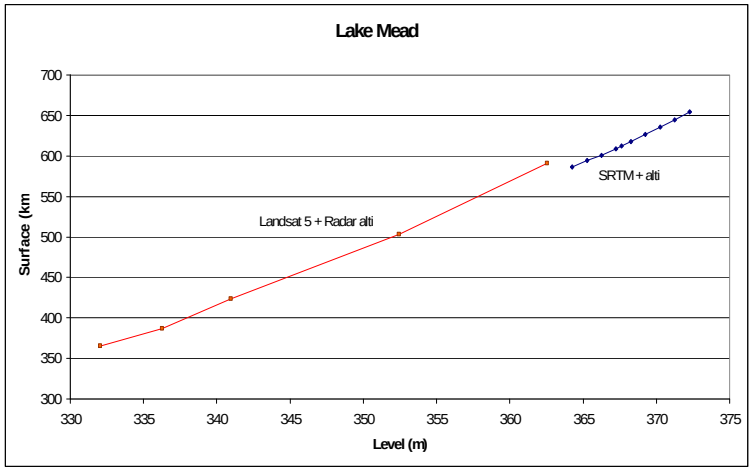



# Next phases of implementation




➢Hypsometry curve has been estimated for 20 lakes & reservoirs
➢150 lake levels are currently updated in Hydroweb
➢An in situ data base is under development at SHI in St Petersburg for the Hydrloare Project (level, surface temperature, phenology of lake ice, etc.)

⇒ Extraction of RS images for all lakes in the GTN-L list
⇒ Comparison of in situ level in the frame of cooperation with Official Hydrolare data centre (under the support of WMO)
⇒ Estimation of hypsometry of each lake
⇒ Participation in the Hydrolare steering comitee
⇒ New pages on the web site and NRT product delivery for lakes level, surface, and volume variations




⇒ Regular Updating of data centre web pages in the frame of Hydrolare project:
Delivery of various products & information from RS and In situ Data, for each lakes of the GTN-L (and also others)