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


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

Date (year)
Level above Geoid

Download

Lake Victoria
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 planned to be calculated.

Selection of maps + level from altimetry => hypsometry curve (dh/dS) => Reconstruction of past surface variation on weekly/monthly basis through altimetry.
Impact of Southern Oscillation?
Impact of El Nino?
Impact of PDO?
Impact of Glacial 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 additional RS information
- 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

Case study 1: Lake Poyang

Sept 21, 2004

Sept 14, 2006
Modis multispectral images

Modis Sept 21, 2004

Modis June 2, 2004

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

Flood still in Goyder Lagoon

Lake Eyre covered by salt crust
\[ \Delta V \text{ on lake Eyre } \sim 0.5 \text{ km}^3 \]
Case study 3: Aral Sea

From altimetry + bathymetry => variation of surface

Direct measurement from analysis of the Modis images
Modis / altimetry Aral surface variations

Correlation modis/altimetry = 0.996

Small Aral

Big Aral

White: New underwater Surface: 400 km²
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)

Lake Chiquita level variations

For some lakes the relation $\Delta h/\Delta S$ (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)

Sarykamish level variation from satellite altimetry

Hypsometry of Lake Sarykamish (satellite Altimetry / Satellite Imagery)

Surface variation of Sarykamish
Lake Titicaca

Data download

Hypsometry Titicaca (Landsat 7 & CBERS)

Titicaca level variations from satellite altimetry

Titicaca, surface variation

S = 7870 km²
H = 3810.58 m

S = 7887 km²
H = 3811.13 m

S = 7999 km²
H = 3811.62 m

Landsat 5

Sep 4 2005

CBERS

Sep 20 2004

CBERS

May 10 2004

Surface (km²)        -
Next phases of implementation

- Hypsomotropy 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 Hydrolare 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)