Time Water Levels on Rivers and Lakes Using Jason-2 Altimetry Data

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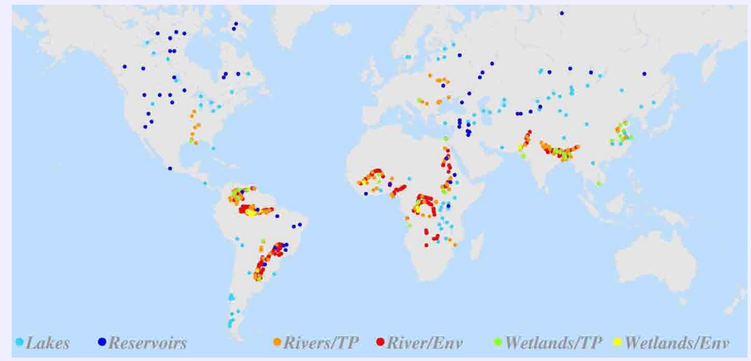
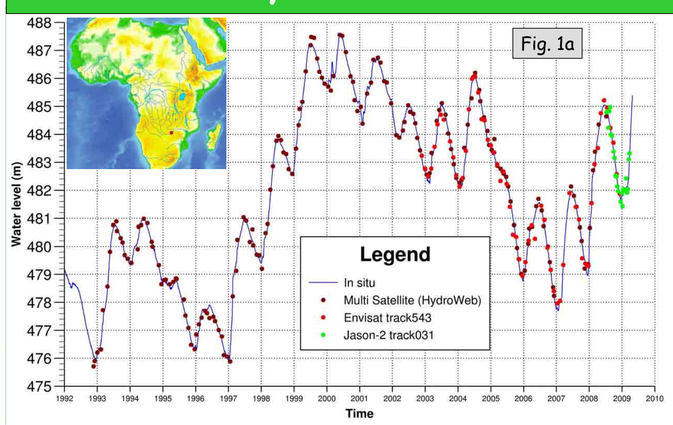
Summary :
In the recent years, we have developed the HYDROWEB data base (http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/) which provides offline water level time series on rivers, lakes and floodplains based on altimetry data from several satellites (Topex/Poseidon, ERS, Jason-1, GFO and ENVISAT). All valid data of a single satellite-river crossing are further averaged to provide a mean river water level at the time of the satellite crossing. At present time altimetry data from Jason-2 satellite are used to compute time series over major rivers. We present validation tests that have been done (Amazon, Congo Rivers) using in situ data when available and/or altimetry data from other missions. We also give results of comparisons between IGDRs and GDRs altimetry data of Jason-2.

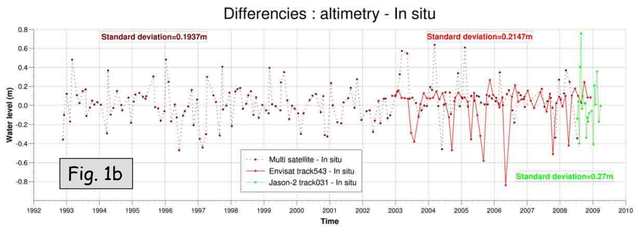
Moreover, additional remote sensing data, like satellite imagery, allow calculating surface variations of lakes. A lake data centre is under development at the Legos in coordination with State Hydrological Institute of the Russian Academy of Science. A prototype of this lake data centre, based on a selection of 20 lakes, already provides the level-surface-volume variations calculated through combination of various satellite images (Modis, Asar, Landsat, Cbers) and radar altimetry (Topex / Poseidon, Jason-1 & 2, GFO, Envisat, ERS2). The final objective is to propose a data centre fully operating in 2009 based on remote sensing technique and controlled by in situ infrastructure for the Global Terrestrial Network for Lakes (GTN-L) under the supervision of WMO and GCOS. (contact : marie-claude.gennero@cnes.fr)

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



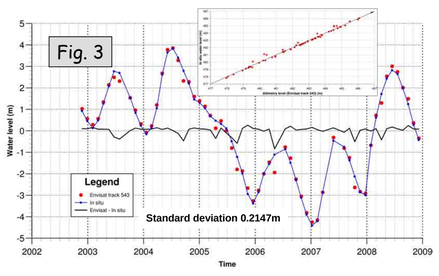
Altimetry validation on Lake Kariba (Zambezi river)

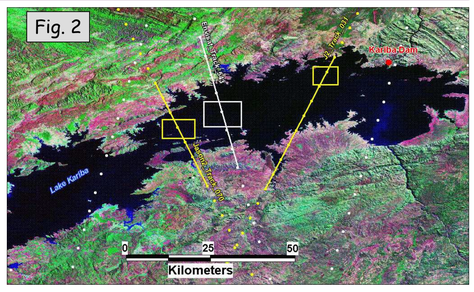




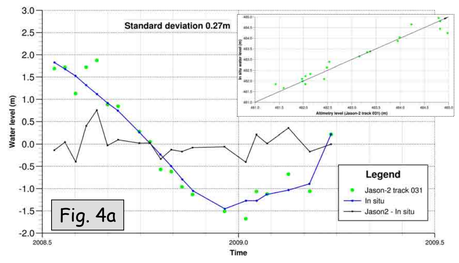
-**In Fig. 1a & 1b** : Time series obtained by altimetry from several satellite missions from 1992 until now, compared with in situ data.

-**In Fig. 3** : Results obtained with Envisat GDR altimetry data compared with the in situ data

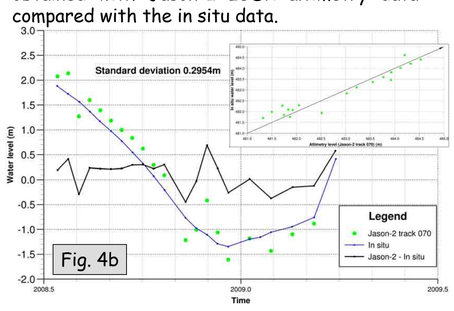




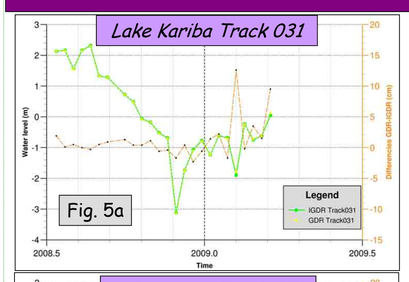
On the figures opposites we show the time series of water level in several places in the lake Kariba (Zambezi Basin in Western Africa - see Fig. 2), compared to the time series of in situ gauge located less than 50 km. The results show a standard deviation ranging from 20 to 30 cm depending on the mission and the distance to the station (Figures 1a and 1b).

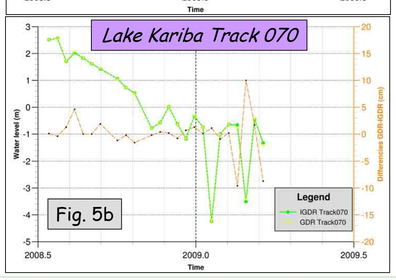


- **In Fig. 4a & 4b** : Preliminary results obtained with Jason-2 IGDR altimetry data compared with the in situ data.



First validation Jason-2 GDR

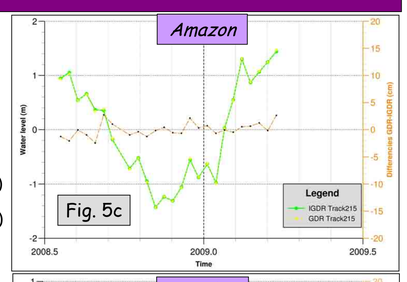


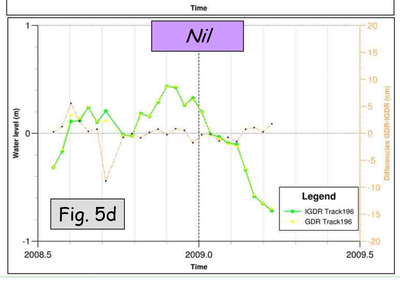


- **Fig. 5a,b,c,d** : Comparisons of the Jason-2 GDR and IGDR data until cycle 26.
- **Fig. 5a,b** : Over Lake Kariba (see fig. 2)
- **Fig. 5c** : Over Amazon river (see fig. 6a)
- **Fig. 5d** : Over Nil river (see fig. 9a)

- *IGDR are in green.*
- *GDR in yellow.*
- *Difference GDR-IGDR in orange.*

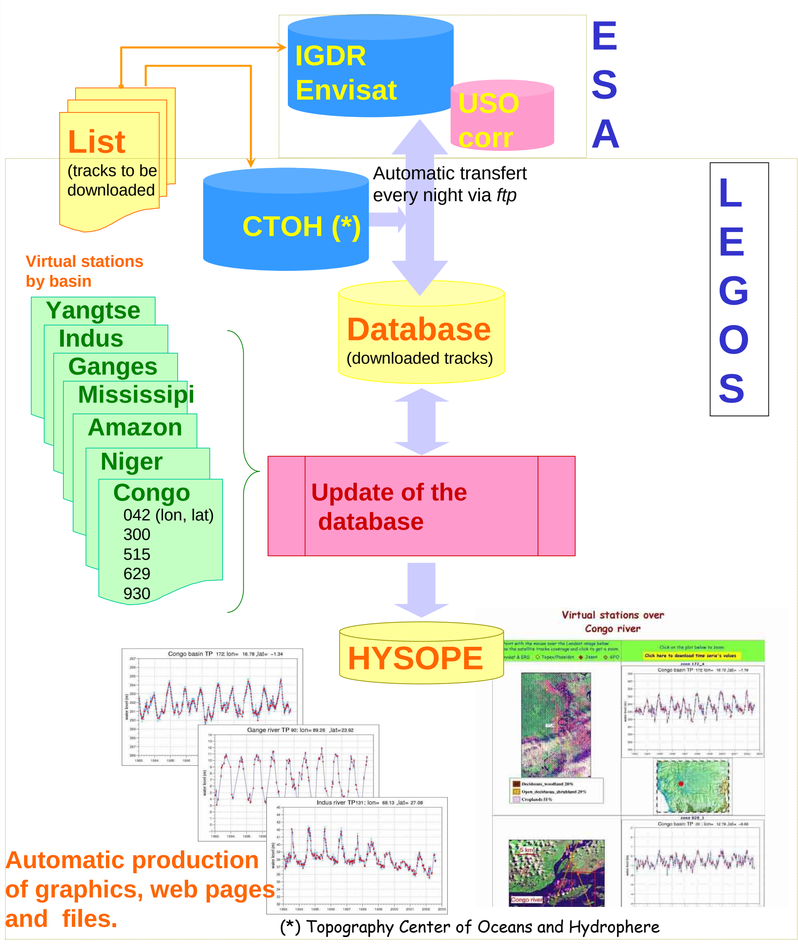
Some cycles seem to be wrong, specially on the Fig. 5a and 5b.





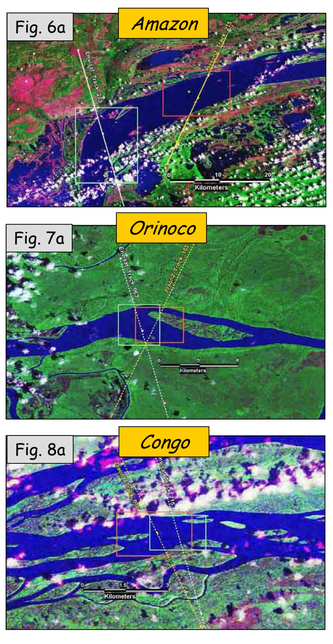
HySOpe : Near real time water levels from satellite altimetry

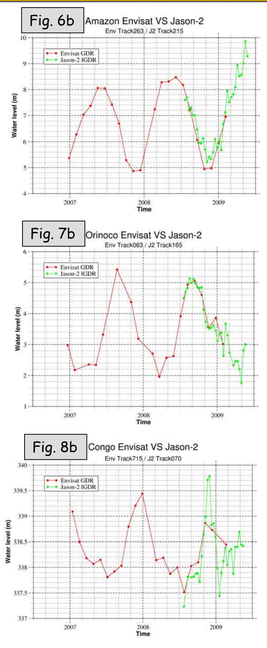
HySOpe is a machine for automatic updating of the database HydroWeb from IGDR data (Envisat, Jason-2), either directly from ESA or from the CTOH(*) database at LEGOS.

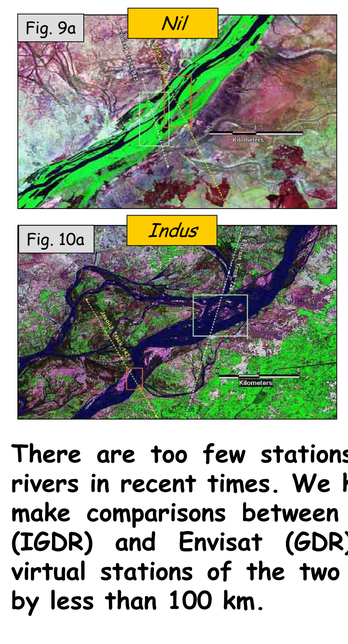


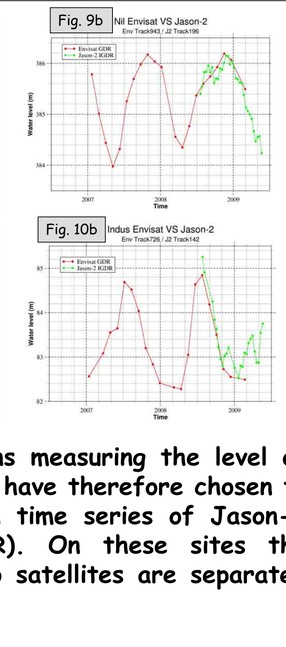
(*) Topography Center of Oceans and Hydrophere

First Validation Jason-2 (IGDR) with Envisat time series





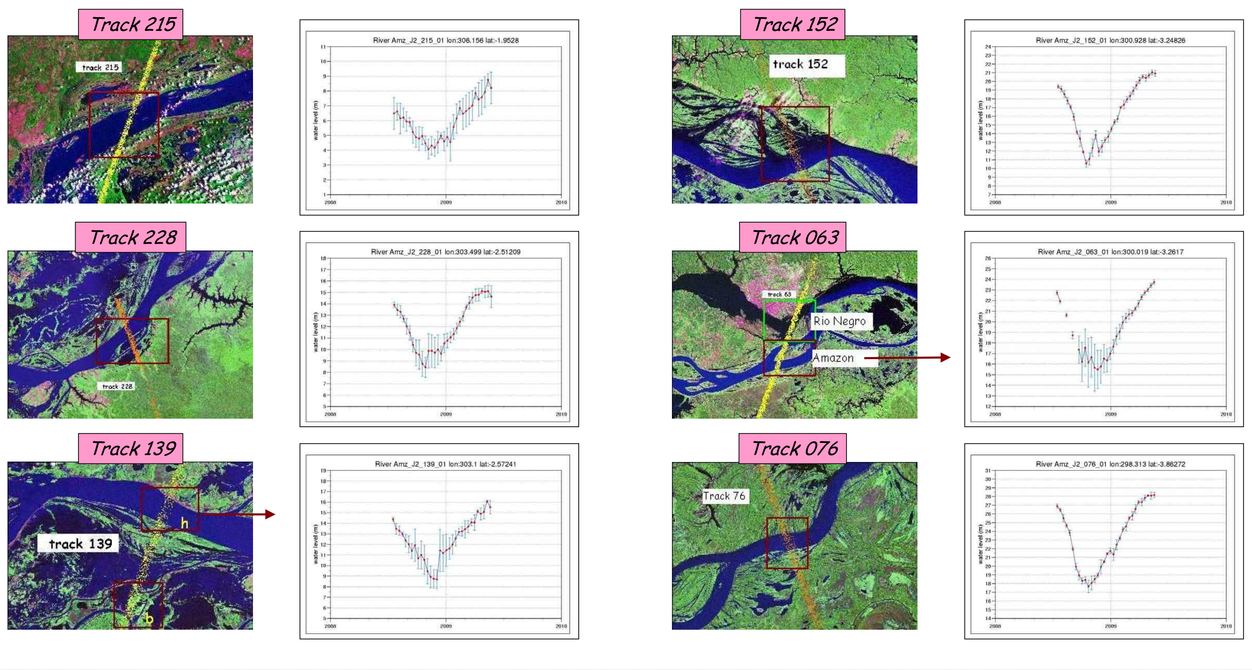




There are too few stations measuring the level of rivers in recent times. We have therefore chosen to make comparisons between time series of Jason-2 (IGDR) and Envisat (GDR). On these sites the virtual stations of the two satellites are separated by less than 100 km.

Jason-2 (IGDR) time series over Amazon river

Some examples of water level time series using IGDR Jason-2, all along Amazon river (cycles 1 until 32)



Informations related to the time series producted

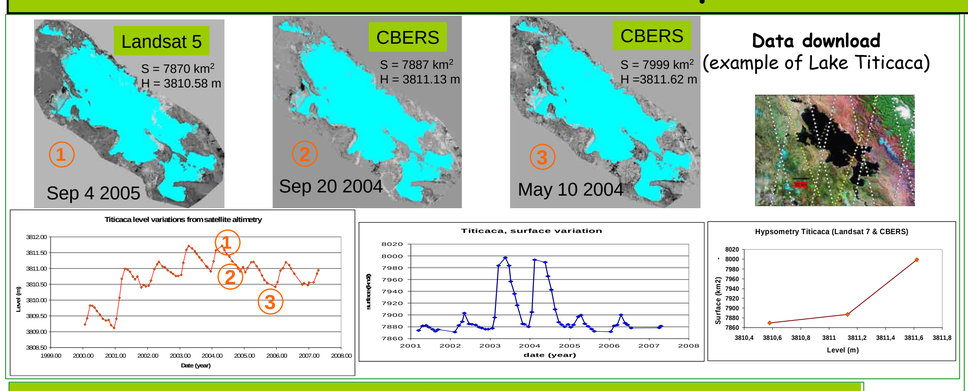
Products : *GDR (Geophysical Data Records)*
Electromagnetic spectrum : *Ku band*
Retracking used : *Ice1*
Geoid applied : *Grace (GGM02C)*
Corrections applied : *- wet tropospheric (model NCEP/ECMWF)*
- dry tropospheric
- ionospheric (radiometer) and gim model since cy65
- pole tide
- solid earth tide

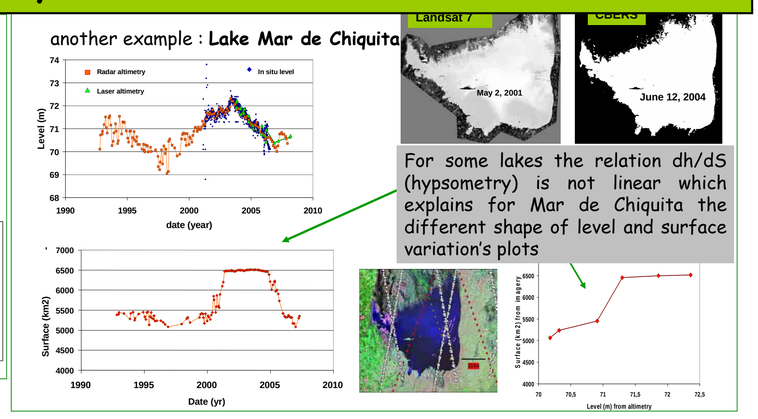
Envisat

Products : *IGDR (Interim Geophysical Data Records) and GDR*
Electromagnetic spectrum : *Ku band*
Retracking used : *Ice1*
Geoid applied : *Grace (GGM02C)*
Corrections applied : *- wet tropospheric (model ECMWF)*
- dry tropospheric
- ionospheric (radiometer) gim backup
- pole tide
- solid earth tide

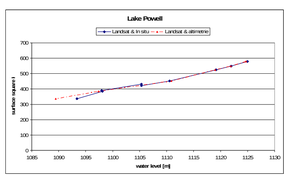
Jason-2

New improvements in HydroWeb

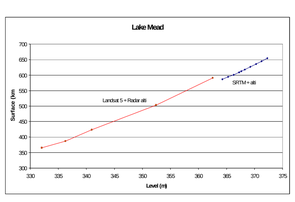




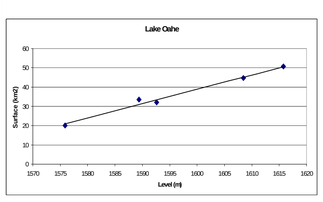
Next phases of implementation



➢ 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 GEO & 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).

Essential Climate Variable (ECV) defined by GCOS : a list of products.

➢ **Products T1.1**

Maps of lakes in the Global Terrestrial Network for Lakes (GTN-L). Gridded georeferenced maps of 250 m spatial resolution on monthly basis for 150 lakes with accuracy of 5%.

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**

(*Lake levels of all lakes in the GTN-L list*)

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

Selection of maps & level from altimetry

⇒ hypsometry curve (dh/dS)
⇒ Reconstruction of past surface variations on weekly/monthly basis through altimetry