CTOH altimetry products (L1 to L4) For Ocean and Continental Surfaces

S. Fleury, F. Birol, F. Blarel, D. Blumstein, N. Fuller, F. Frappart, M.-C. Gennero, B. Legresy, R. Morrow, F. Niño, M. Rogé

Established in 1989, the **Center for Topographic studies of the Oceans and Hydrosphere (CTOH)** is a French national observation service dedicated to satellite altimetry. The main objective of the CTOH is to develop and maintain altimetric data bases with homogeneous, up-to-date corrections for the long term monitoring of sea level, lake and river levels, and the cryosphere for climate studies. The CTOH aids scientific users in the development of new altimetric products and applications, and works in close relation with the CNES and ESA.

"In order to improve the transfer of expertise between the CTOH research service and the operational service at AVISO/CNES, a joint project has been conducted over the past years with the CNES. A common web portal for altimetry (AVISO +), based on the operational AVISO service and the research and development CTOH service is opened since February 2014 (http://www.aviso.altimetry.fr/en/home.html)."

L1/L2 Products … and R&D

Along-Track L1/L2 GDR Products

- Topex/Poseidon (1992-2005)
- GFO 1998-2008
- Envisat 2002-2012
- Jason-1 2002-2013
- Jason-2 2008-now
- Saral 2013-now
- Cryosat2 ESA 2010-now (LRM,SAR,SAR-IN)
- Cryosat2 CPP 2011-2012 (LRM,SAR)

Both 1 Hz and 18-20-40 Hz data available over all oceanic and continental surfaces. **All in netcdf format** (except T/P and GFO).

Corrections added to all GDR databases by CTOH :

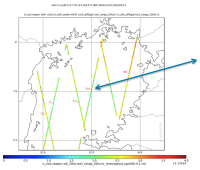
- Ionospheric correction (NIC08 and GIM)
- Wet Tropo (CLS 01, Brown 2010)
- Tide models (FES04, GOT47, GOT48)
- Inverse barometer (ECMWF, MOG2D)
- Mean Dynamic Topo (RIO05, RIO09)
- Mean Sea Surface: (CLS_01, CNES_10, CNES_11)
- Geoids (EGM2008, GOCE2010, EIGEN_6C3)
- Bathymetry (Gridone,)
- Dist. to nearest coast (Leuliette, Stump)
- Dry Troposphere
- Doppler Slope

ERS2 Reprocessing

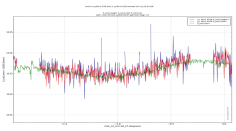
The CTOH has re-processed the ERS-2 mission for **continental applications**. Two retrackers are provided in this product: ice1 and a **reprocessed ice2**, with all required corrections. **See poster : *« A new ERS-2 level 2 product at CTOH"*** for a more detailed presentation of the product. It has been validated with Envisat.v21 during the one year tandem period (***see poster* « ERS2-ENVISAT cross-validation CTOH retracking of the tandem phase »**). It has been also compared with the new ERS Reaper's product for the same period on some specific surfaces.

Comparison over Victoria lake of ERS2-CTOH with ERS2-Reaper and Envisat.v21

The Victoria lake is over flight by six ERS2 or Envisat tracks (left figure bellow), representing about **2000** measurements at 20hz. We have computed the height level of the lake using the 3 products (right figure bellow for track 528), and compare the resulting Stdev for december 2002, i.e. cycle 80 of ERS2 and cycle 12 of Envisat (table on the right).



The six ERS2 and Envisat tracks that over flight the Victoria lake.



The Victoria lake water level along track 528 for the 3 products: ERS2-CTOH,ERS2-Reaper and Envisat.v21. The higher noise level for ERS2 is due to a lower PRF rate. At a first order the two ERS2 products (CTOH and Reaper) are very similar.

Stdev of the height measurements for three altimetry products: **ERS2-Reaper, ERS2-CTOH and Envisat.v21** over Victoria lake.

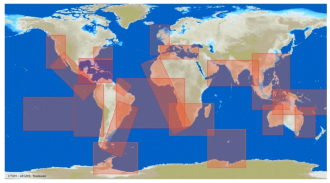
Stdev (mm)	ERS2 Reaper	ERS2 CTOH	Envisat.v21
H = alt - range_ice2	447.3	446.2	303.0
- geoid egm08	-195.3	-220.6	-157.0
- wet	-1.6	+0.2	-0.6
- dry	+0.5	-0.2	-0.2
- iono	-0.4 nic09	+0.1 -0.2 gim	-0.5
H_ICE2 RMS	**250.5**	**225.7**	**144.7**
(or, using geoid_eigen6c3*)	(225.6)	**196.4**	(92.9)

The first line is the height without correction: H = alt –range_ice2. The **ERS2 measurements are more noisy that Envisat'ones**. It is explained by a lower PRF frequency over lands for ERS2.
Each of the following lines shows the impact on the height Stdev of each correction added one after the other.
The second line, related to the **geoid** correction used the same egm08 model for the 3 products to ease the comparison. However we recommend the new and more accurate model **'eigen6c3'** available in all CTOH distributions (see last line).
The impact of the **wet and dry tropospheric and ionospheric** corrections (lines 3 to 5) are about 1mm for the 3 products.
The 'gim' ionospheric correction (line 5) is better than 'nic09' but, starting from year 2000, it does not cover all the ERS1&2 flying period. Thus both 'gim' and 'nic09' are included in the product.
Finally, the last-but-one line shows, for this very first evaluation over a lake, that the **ERS2-CTOH product, dedicated to continental applications, improves the Stdev of about 25mm** (or even **54mm with the geoid eigen6c3** – see last line).

L3 Products … and R&D

Coastal products with X-Track

Coastal processing of 1Hz alongtrack SLA are available in 20 regions for different altimetric missions (T/P, J1&2, Envisat, GFO) based on CTOH alongtrack data. High sampling rate coastal SLA are available for 3 regions *(see oral presentation Birol et. al, @ CAW2014)*.



Along-track tidal constants (amplitude, phase lags and accuracy), based on the ~20 years of T/P and Jason time series, are available every 6-7 km alongtrack for the 20 X-Track regions.

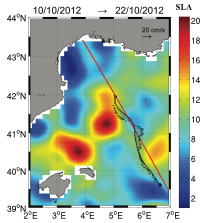
Hydrosphere : Hydroweb

Hydroweb provides near real-time time series of water level on the lakes (about 160), rivers and flooded plains (about 1300 virtual stations) using Topex, ERS-1&2, GFO, Envisat, Jason1&2 altimeters.

Hydroweb ( ) and new web pages for time series over lakes ( )

Along-Track Mesoscale Structures

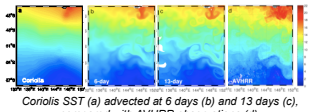
Investigation of the observability of mesoscale sructures in alongtrack data: Comparison between mesoscale structures observed from glider trajectories and the velocity fields obtained from alongtrack CTOH Jason-2 SLA.



L4 Products … and R&D

Tracer Advection by Altimetry

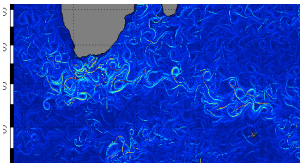
Stirring by altimetric currents can induce finer-resolution structures in low-resolution 2D tracer fields, such as SST or SSS fields.
10 years of fine-resolution SST and SSS fields are now available south of Australia across the Antarctic Circumpolar Current. Other regions are being tested & validated before distribution.



Coriolis SST (a) advected at 6 days (b) and 13 days (c), compared with AVHRR observations (d).

Filaments

FSLE position and strength based on analyses by F. D'Ovidio (LOCEAN, Paris) calculated from gridded AVISO surface current and using Finite-Size Lyapunov Exponents (FSLE), at 4km resolution, every 4 days from 1993 to today.



Sea Ice Lead Measurements using Saral/Altika

The Arctic sea-ice has expressed drastic changes during last decades which have strong impacts on the local and global climates. While seaice surface is well observed from space using VNIR and PMW images, its thickness and volume remain far too imprecise for the climate models. Only altimeters can measure these two Essential Climate Variables (or ECV, according to G-COS and CCI). The thickness is deduced from the seaice 'freeboard' which is the difference between the ice height and the free water height measured in the 'leads' (seaice fractures). The strong reflexivity of the still and icy water within the leads in Ka band eases the leads detection with Saral/Altika.

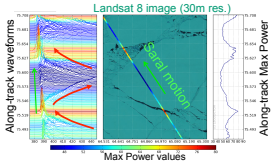
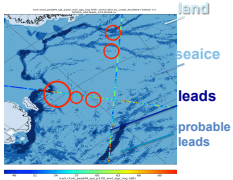


Figure on the left shows the Max Power parameter along a Saral track projected on a Landsat8 image. The peaky WF while crossing the leads.

Figure on right shows the good agreements (see red circles) between the Max Power criteria of Saral/Altika echos and the leads segmented within MODIS/ TIR images.



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