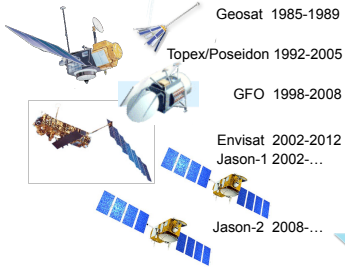# CTOH:
> 20 years of Altimetry Data Service

R. Morrow, F. Birol, F. Niño, S. Fleury

with CTOH team : F. Blarel, D. Blumstein, C. Delebecque, M.-C. Gennero, L. Roblou, 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.
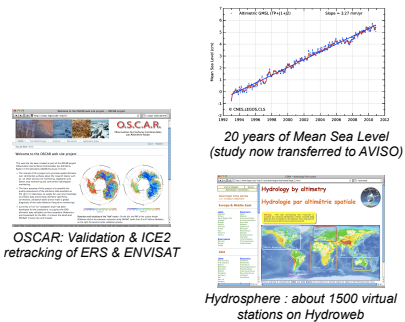
Historical Timeline

Satellite altimeters at CTOH

Geosat 1985-1989
Topex/Poseidon 1992-2005
GFO 1998-2008
Envisat 2002-2012
Jason-1 2002-…
Jason-2 2008-…

CTOH Major Developments

1989 CTOH established : Analysis of Geosat data

1992 Topex/Poseidon launch : Start of Mean Sea Level studies
(J.F. Minster, C. Le Provost, A. Cazenave)

2000 Extension of altimeter service to continental surfaces:
- Cryosphere (OSCAR, F. Remy, B. Legresy)
- Hydrosphere (Hydroweb, A.Cazenave, JF Cretaux)

2005 Development of Coastal altimetry products
(F. Lyard, F. Birol, L. Roblou)

2008 Development of Multi-mission ocean products:
- Surface currents, Southern Ocean fronts, FSLE filaments
(R. Morrow, S. Fleury, J. Sudre, J-B Sallée, F. D'Ovidio)

20 years of Mean Sea Level
(study now transferred to AVISO)

OSCAR: Validation & ICE2 retracking of ERS & ENVISAT

Hydrosphere : about 1500 virtual stations on Hydroweb

Today: Continuity of Service and Innovative Products

Along-track: 20 years of data over all surfaces

CTOH maintains homogeneous altimetric GDR data bases for :
- Topex/Poseidon (1992 – 2005);
- GFO (2000 – 2008);
- ENVISAT (2002 – today);
- Jason-1 (2002 – today);
- Jason-2 (2008 – today).

Both 1 Hz and 18-20 Hz data available over all oceanic and continental surfaces.
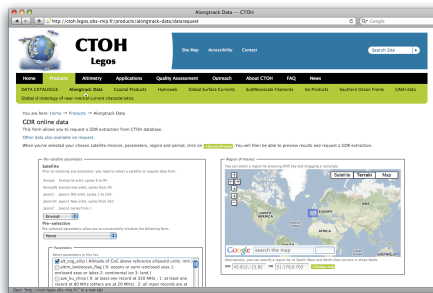
CTOH Scientific Users Community

Users can **interactively select alongtrack data** using spatio-temporal criteria and visualize the different corrections before downloading.

Higher level altimeter products can also be accessed via our website : coastal, multi-mission, hydrology, …

Web Service
http://ctoh.legos.obs-mip.fr

Coastal products with X-Track

Coastal processing of 1Hz alongtrack SLA are available in 20 regions for the different altimetric missions, based on CTOH alongtrack data. The product includes MSSH, geophysical corrections and distance to the coast. High frequency coastal SLA products (20hz J1&2, 10hz T/P) are available for 3 test regions.

Since June 2012 **alongtrack tidal constants** (amplitude, phase lags and accuracy) are available every 7 km alongtrack for the 20 regions, based on the ~20 year time series from T/P and Jason.
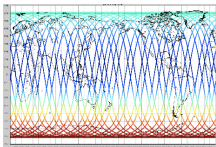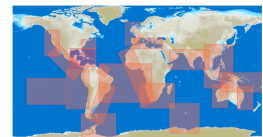

Corrections added to all GDR data-bases by CTOH :
- GIM ionospheric correction
- Wet Tropo (CLS 01, Brown 2010)
- Tide models (FES04, GOT47)
- Inverse barometer (ECMWF, MOG2D)
- Mean Dynamic Topo (RIO05, RIO09)
- Mean Sea Surface: (CLS_01, CNES_10)
- Geoids (GGM02, EGM2008, GOCE2010, EIGEN_6)
- Bathymetry (Gridone)
- Dist. to nearest coast (Leuliette, Stump)

Surface currents

Weekly ¼° surface currents combining geostrophic current anomalies (from AVISO – DT–2010), Ekman (from QuikScat) and the mean geostrophic circulation (from CNES CLS 09) are available up to 2009.
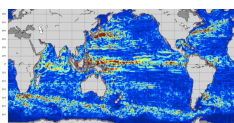
Filaments

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.
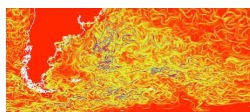
Hydrosphere : Hydroweb

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 (☞)

Cal/Val

The CTOH disseminates the Quality Assessment on cryosphere for the re-processed Envisat GDR v2.1
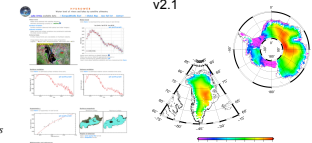
Near Future: New Missions and High Level Products

New altimeter missions

Cryosat
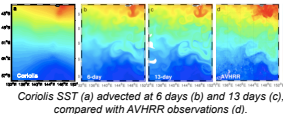Saral-Altika
Jason-3
Sentinel-3

The CTOH provides expertise for the space agencies (CNES, ESA) for new altimetric applications over all surfaces. This includes developing and validating new corrections, and providing expertise on coastal, hydrology, cryosphere and fine-scale ocean applications.

Upcoming missions data at CTOH :
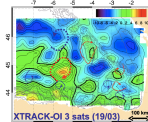SARAL/AltiKa, Sentinel-3, Jason-3, Jason-CS, SWOT.

SWOT
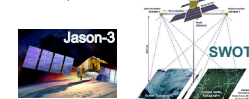
New ocean products

Tracer Advection by Altimetry

Coriolis SST (a) advected at 6 days (b) and 13 days (c), compared with AVHRR observations (d).
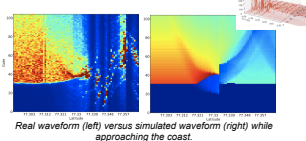
Stirring by altimetric currents can induce finer-resolution structures in low-resolution 2D tracer fields, such as SST or SSS fields.
10 years of fine-resolution SST and SSS fields are now available south of Australia across the Antarctic Circumpolar Current. Other regions are being tested & validated before distribution.

Regional mapping

Regional maps of sea level anomalies are derived from 1-Hz multi-satellite coastal altimetry data (X-TRACK) for 2002-2005 in the Bay of Biscay. The methodology allows to maintain small scales (50-100km) to better represent local scales of variability. Maps were validated using in-situ currentmeters & lagrangian drifters. Frontal detection using SST images compare well to Lyapunov Exponents (FSLE) computed from the maps (Dussurget et al., 2011 and 2012).

XTRACK-OI 3 sats (19/03)

Retracking Waveforms

Real waveform (left) versus simulated waveform (right) while approaching the coast.

An approach to waveform inversion by genetic algorithms and massively parallel computing is underway to tackle hydrological altimetry data. Because of non-ocean-like reflective surfaces which mix echoes of different materials, regions with hydrological interest are difficult to interpret. The inversion problem by the evolutionary approach allows to find some approximate solutions to the fundamentally ill-posed problem.

LEGOS • OMP • esa 20 years of progress in radar altimetry 24-28 September 2012, Venice, Italy • cnes • IRD Institut de recherche pour le développement • CLS • CNRS INSU Observer & comprendre • Université Paul Sabatier TOULOUSE III