



Users Newsletter

February 2010, #4

Project News

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In-orbit missions

The current missions by Jason-1, Jason-2 and ENVISAT continue to provide high quality data for the altimetry community. Currently, **ERS-2** is not used in SALP/AVISO products as this mission covers the same ground track as ENVISAT.

After a successful calibration with Jason-2 during the formation flight phase, Jason-1 was moved onto its new orbit (an interleaved orbit) in February 2009 and except for a Safe Hold Mode in mid-September 2009 and star tracker problems (with no scientific impact on

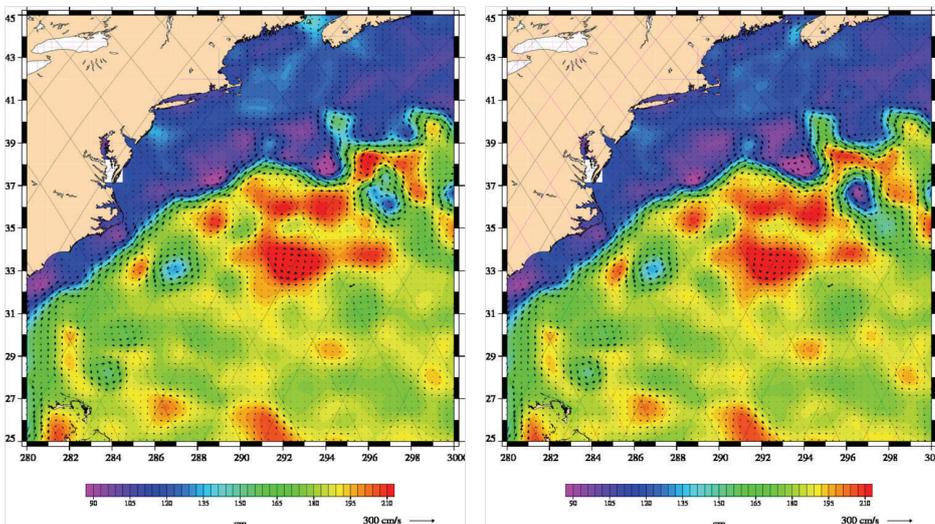
IGDRs), the satellite continues to perform very well. In association with other missions, it provides very useful data in time and space as shown in the figures of the Gulf Stream current, where meanders of mesoscale activities are now accessible.

Concerning reprocessing, the complete **Jason-1** reprocessing in GDR-C standard was completed in January 2010 and all data are available on the Aviso web site. The GDR-C standard benefits from a better orbit solution, a complete calibration for JMR parameters, improvements in dry troposphere and ionosphere range correction, a new SSB, a

new MDT, improved inverse barometer correction and non-tidal high frequency de-aliasing correction, an updated tide solution and new flags for rain and ice.

Routine GDR-C processing is nominal. Note however, that there was a processing delay after the recovery on September 09 due to the necessary recalibration of JMR.

In the summer of 2009, one year after its launch, **Jason-2** GDR products were disseminated to public users after a successful calibration-validation phase as recommended by the Ocean Surface Topography Science Team (OSTST) at their latest meeting in Seattle in June 2009. Several product upgrades are being planned to improve product quality for users. The upgrades include a new rain flag, a new tide model (GOT4.7), new calculation of radiometric parameters (Shannon Brown method), added parameters in SGDR products, corrections of minor bugs and the usual file updates (altimeter characterisation file, instrument correction tables, wind & SSB tables). As a result, a complete reprocessing of GDR-C Jason-2 products is being planned for mid-2010. A prototype intended to improve altimetry products in coastal and hydrological areas (PISTACH project) has been tested on Jason-2 data with encouraging results so far.



Dynamic topography in the Gulf Stream region. Left, as seen by Jason-2 only ; right, same region by Jason-2 and Jason-1. Significant meanders and eddies that are missed by one satellite alone are described by the tandem. (Credits CNES/CLS)

Concerning **ENVISAT**, the products are of very good quality (considering that ENVISAT altimetry S band is no longer available) and the consistency with the Jason-1/Jason-2 mission will be improved with the new standard (used for the reprocessing). Complete reprocessing of the ENVISAT mission should begin in early 2010. For the future, the ENVISAT mission has been extended to 2013 and the satellite should be moved to a drifting orbit in October 2010.

Ongoing developments

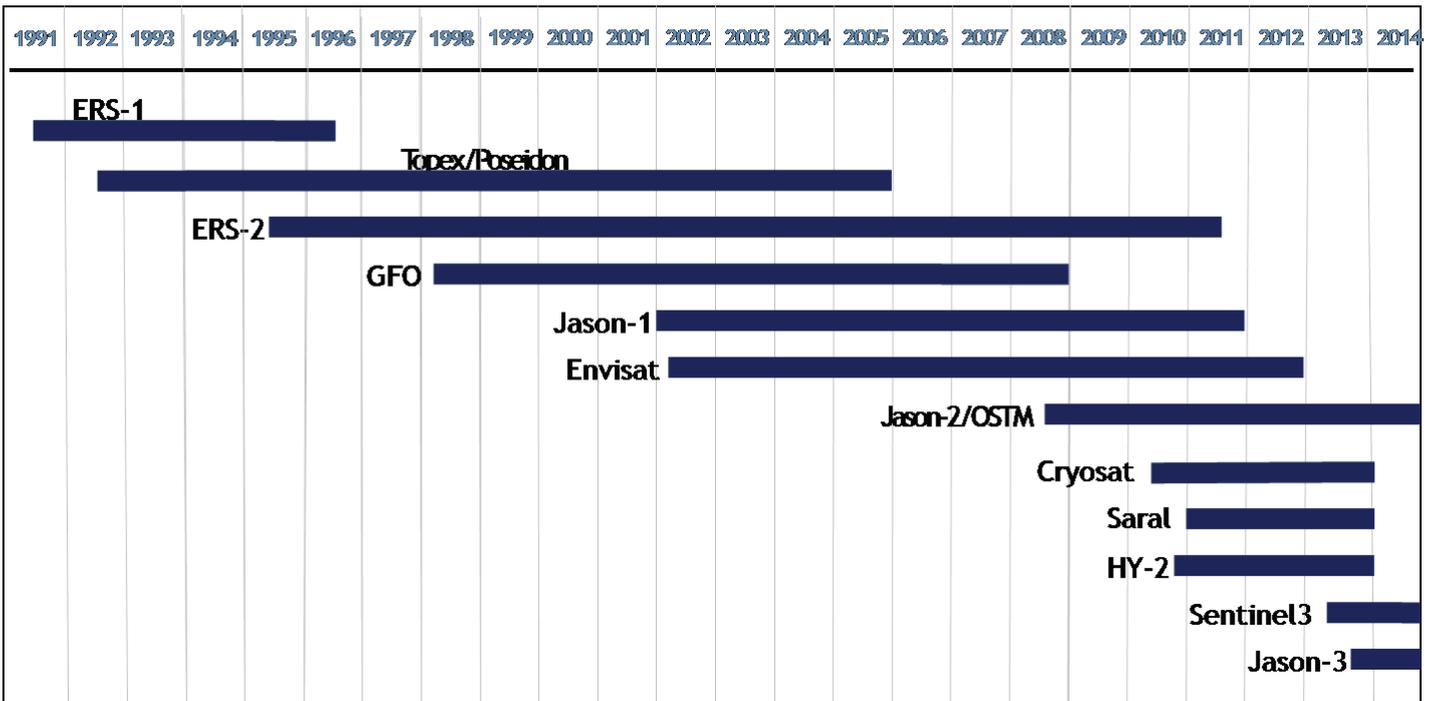
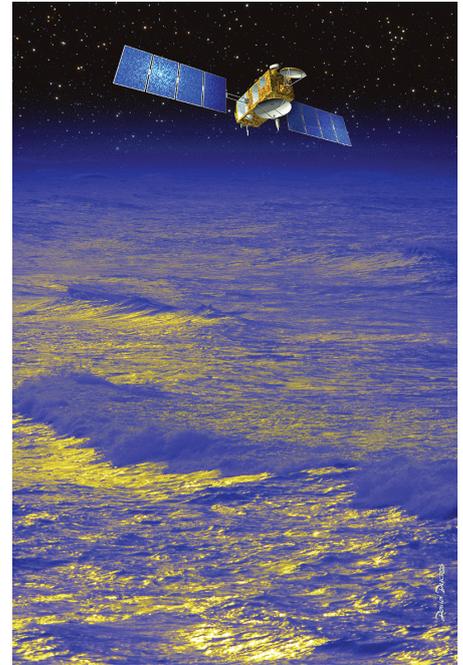
One of several programmes currently under development, **Cryosat-2** will be the next satellite to be launched in 2010. Cryosat-2, an ESA ice mission, will be launched on 25 February 2010 from Baikonur by a Dniepr launcher. The development phase is now over and system tests are nearing completion.

SARAL/AltiKa is a mission conducted jointly by ISRO and CNES. The satellite

is scheduled to be launched from India by the end of 2010. The system interfaces, performances and validation review was conducted successfully in October 2009. The different parts of the satellite are now entering the assembly and integration phase. Development of the ground segment is well underway and deployment continues at the different agencies.

HY-2A is a French-Chinese collaboration between CNES and CNSA/NSOAS for altimetry and orbitography products. The satellite is currently in its integration phase and the launch has been scheduled for the end of 2010.

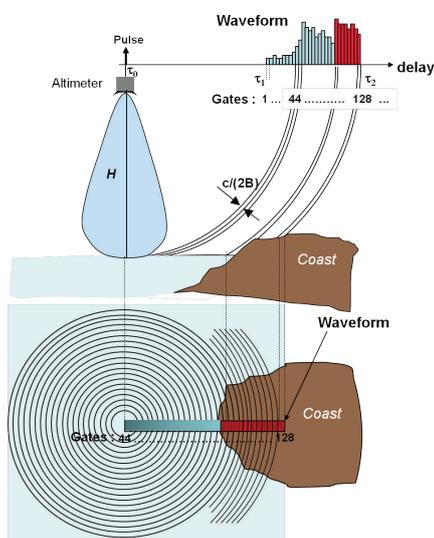
Concerning the **Jason-3** project, a joint CNES, EUMETSAT, NOAA and NASA programme, it has just received official approval for a beginning in early 2010 with a launch planned for mid-2013.



Pistach: Altimetry for coastal and hydrology applications

F. Mercier (CLS)

Many crucial issues for science, society or the economy arise in coastal zones and near continental waters. However, altimeter and radiometer instrument observations are perturbed by emerged lands (50 km off the coasts for radiometers, about 10 km for altimeters), which lead to absent or degraded data in the distributed datasets, mostly meant for open ocean studies. However, they do give measurements which contain useful information for areas between 50 km offshore and the coastline, over continental water bodies and over emerged land as well!



Schematic representation of a pulse-limited altimeter short pulse propagating from the altimeter to the sea surface in the case of an ocean to land transition (upper panel). The lower panel represents the footprint corresponding to each waveform gate. B is the bandwidth of the altimeter, c is the speed of light.

This is why CNES funded the PISTACH project (Prototype Innovant de Système de Traitement pour les Applications Côtières et l'Hydrologie, or Innovative Processing System Prototype for Coastal and Hydrology Applications), as part of the Jason-2 project, to improve satellite radar altimetry products over coastal areas and continental waters. For its part, ESA is supporting the Coastalt project (coastal ocean only) applied to ENVISAT and ERS datasets.

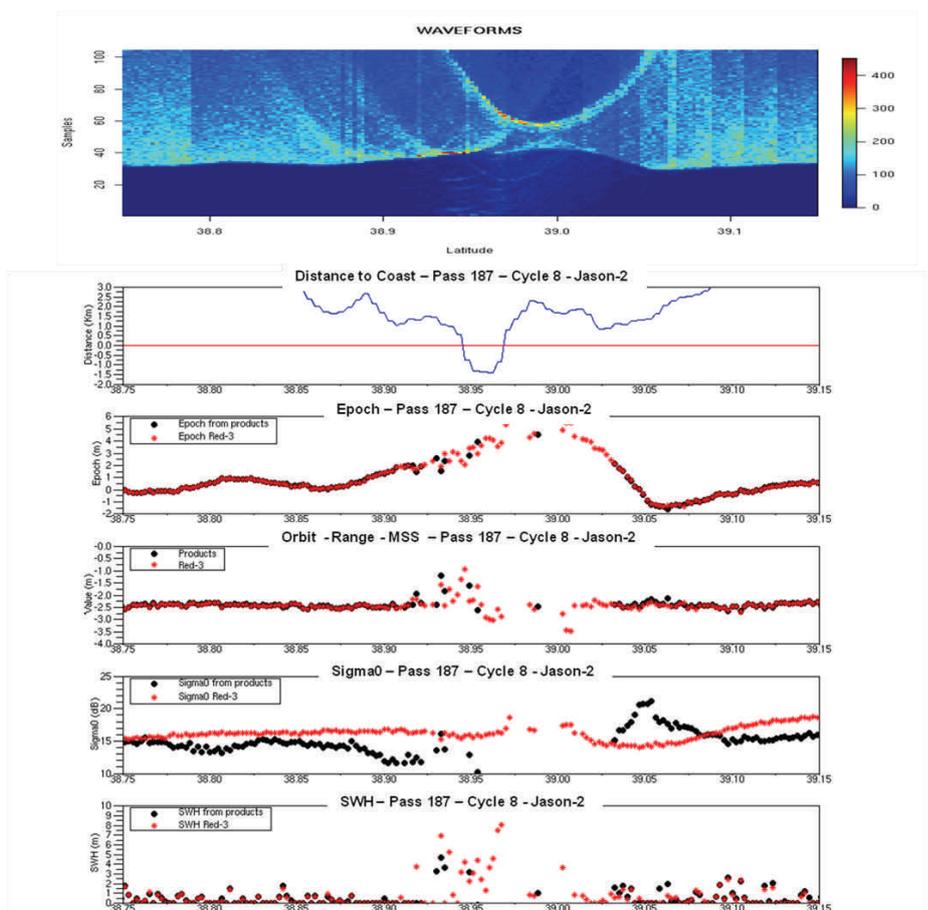
The input for the prototype consists of Jason-2 Level 2 S-IGDR altimeter products. The PISTACH products include new retracking solutions, several state-of-the-art geophysical corrections as well as higher resolution global/local models,

in addition to the content of standard Jason-2 IGDRs (NetCDF, with the nomenclature of variables and files similar to that for IGDRs). The prototype has now been commissioned and products are accessible through the Aviso web site. The products have the same format and structure as Jason-2 standard IGDR to facilitate their adoption and assessment by expert users, with data provided as high-resolution along-track products (20 Hz sampling rate, with fields which are either interpolated or copied), and about 80 extra fields. Two products are available, one for coastal applications, covering the whole ocean plus a 25-km fringe over land, the other for hydrology, with all emerged lands plus a 25-km fringe over oceans. Products that will be simpler and easier to use are already being envisioned for wider dissemination to non-expert users.

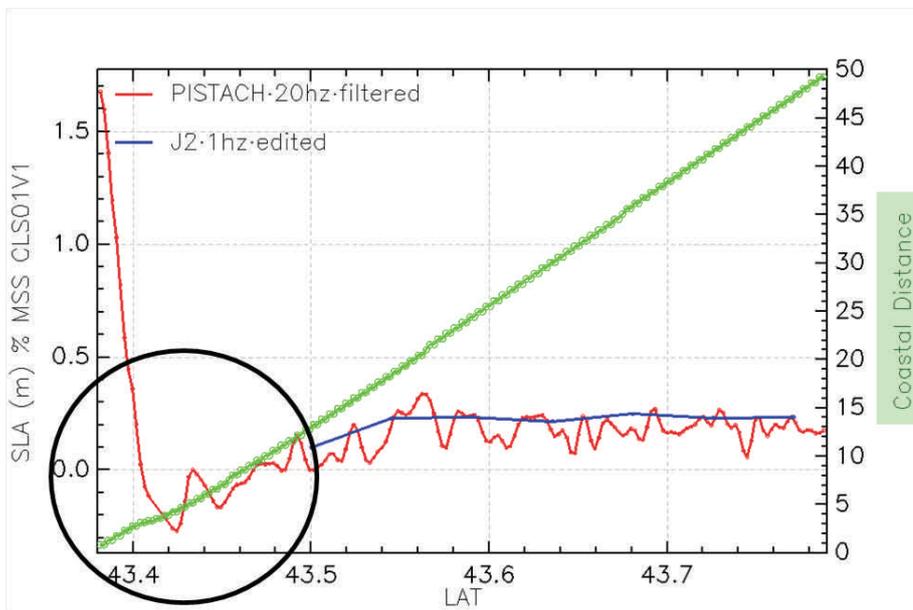
Waveform retracking

Over continental waters, the altimeter waveforms are highly perturbed by emerged lands within the radar footprint. Quasi-specular echoes are also frequently encountered. Thus dedicated retracking algorithms are required to retrieve the altimetric range correctly and, if possible, the other waveform parameters. The retracking strategy involves a classification of the waveforms, plus the application of four different retracking operations, in order to offer users several possibilities and enable them to choose the most appropriate for their case.

The waveforms are classified according to the shape of the waveform: Brown echoes (for ocean and ocean-like surfaces); peak echoes, linear, very noisy,



Results obtained in the frame of CNES/PISTACH project on Jason-2 data, cycle 10, pass 187 (ascending pass) when the satellite overflies the Ibiza Island. Parameters computed by the new retracking (red-3) and the parameters of the Jason-2 products (GDR: Geophysical Data Record) are plotted (black dots: values provided in the SGDR products (20Hz)). Red diamond, results of the new retracking. Are plotted successively, the Ku band waveforms, the distance to the nearest point of the coastline, the epoch achieved by the retracking, a simplified sea surface height (without any geophysical corrections), the sigma-0 coefficient and the significant wave height.



Comparison of PISTACH (red) along-track high-resolution altimeter products (Sea Level Anomaly) track 248 in the Bay of Biscay) with standard along-track altimeter products (blue) during Jason-2 cycle 24. The green curve indicates the distance to the coast in kilometers. Where the standard Jason-2 GDR stops at ~10km from the coast, the PISTACH processing allows recovery of reliable measurements up to 5 km from the shoreline.

etc. A number is assigned to each class, and included as a flag in the dataset, thus enabling users to automate their processing, for example by using a different retracking function depending on the class.

The 20Hz retracking outputs (ranges, sigma0, SWH, classes etc.) are included in the PISTACH products.

Coastal applications

Two different wet tropospheric corrections are implemented in the PISTACH prototype for coastal oceans:

- A composite correction, whereby the model correction (ECMWF) replaces the radiometer near the coasts (<50 km), or the ECMWF correction is shifted to the nearest valid radiometer value in the transition case. Interpolation and de-trending are also applied in complex cases.

- A decontamination correction, probably more suitable than the composite correction for areas where large and rapid fluctuations of air masses are observed, the composite correction being too smooth. On the contrary, decontamination may be less precise over areas with complex shorelines

A study was performed in order to assess the performances of empirical estimation of regional Sea State Bias (SSB) models. Three zones were selected: the Mediterranean Sea, Bay of Biscay and Gulf of Maine, because they represent different types of sea state regimes (dominated by young seas, short or long fetch etc.). Different SSB models were obtained on the three zones. It was shown that such estimations performed

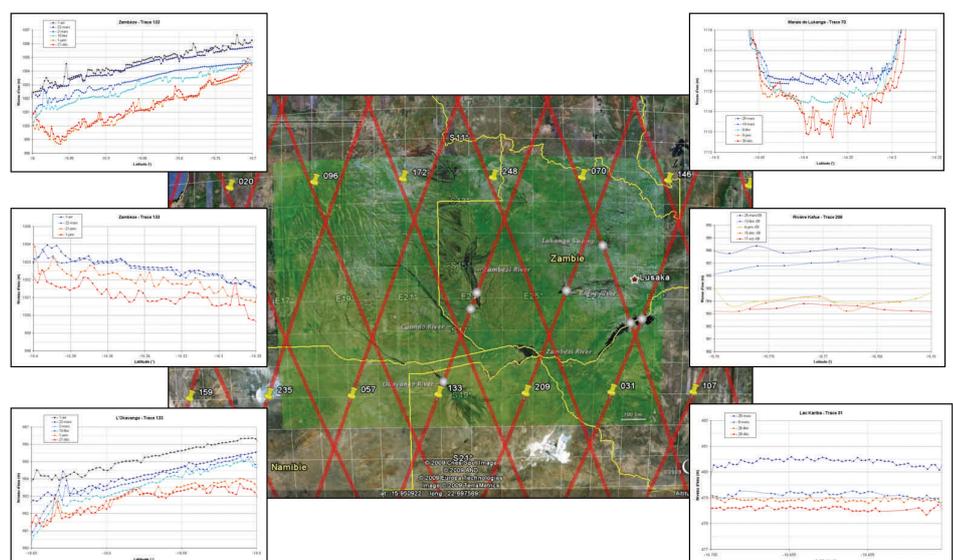
on very small regions are too affected by the oceanic signal, which prevents the real sea-state bias being retrieved. The PISTACH products will use the SSB model of Jason-2 GDR products.

Hydrology

The PISTACH “hydrological” products are enriched with state-of-the-art geophysical parameters (geoid, DEM, land cover class, Land/water mask, etc.).

The wet tropospheric correction, crucial over continental waters, cannot be computed from the onboard radiometer because the land emissivity drowns out the signal coming from water bodies. The model backup correction included in the standard altimetry products has proved to be insufficiently accurate over continental waters. For PISTACH we

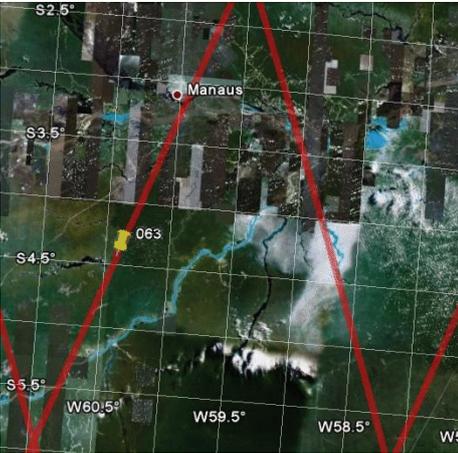
therefore developed a new wet tropospheric model correction based on a more accurate integration of the atmospheric parameters. Moreover, over land, the ECMWF model geometry does not reconstruct small-scale topography, especially over water bodies in mountainous terrains. The wet and dry tropospheric corrections are recomputed from ECMWF 3D meteorological fields with the bottom (and thus thickness) of the atmosphere column given by each altimetric measurement (to be included in the next version of the PISTACH products). See <http://www.avisioceanobs.com/en/data/products/sea-surface-height-products/global/coastal-and-hydrological-products/> for more information and access to the data.



Rise of the water level on several locations of the Zambezi river basins (river, lake, swamp, delta) from late 2008 to early April 2009, as measured by Jason-2 altimeter (data provided by an hydrology specific processing). Time series are presented from top to bottom and left to right (Credit CLS/CNES).

Data Use Case: using Pistach product over the Amazon

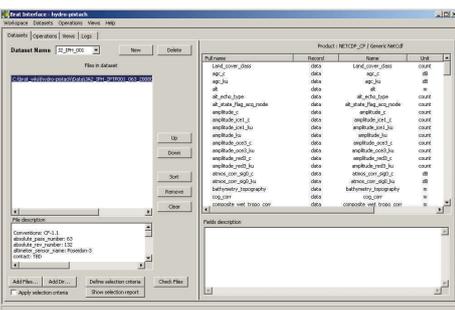
The Basic Radar Altimetry Toolbox is able to read and process the Pistach data. Here is an example over the Amazon River.



Amazon Basin around Manaus, with Jason-2 track 063 indicated

The Basic Radar Altimetry Toolbox (BRAT) is an "all-altimeter" collection of tools, tutorials and documents designed to facilitate the use of radar altimetry data. It is available at http://www.altimetry.info/html/data/toolbox_en.html. The first task when using BRAT is to create a new workspace. A workspace enables you to save and re-use all the choices, computation formulas etc. you use during a session. The first time it is run, the software should open on the "Datasets" tab. Click on "New" (next to "Dataset name"), then on "Add file" at the bottom. Choose the hydrology file for cycle 001, pass 063. This track passes over the junction between the Rio Solimoes and the Rio Negro, two of Amazon's tributaries.

BRAT works by creating intermediary files (NetCDF) to visualise altimetry data. You therefore need to select a field or to compose an expression including



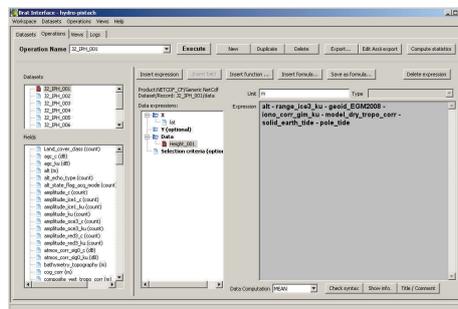
BRAT 'Datasets' tab, with a Pistach file loaded. Note the list of available fields right.

several fields and create the file (by executing an "Operation"). Only then will you be able to visualise your data.

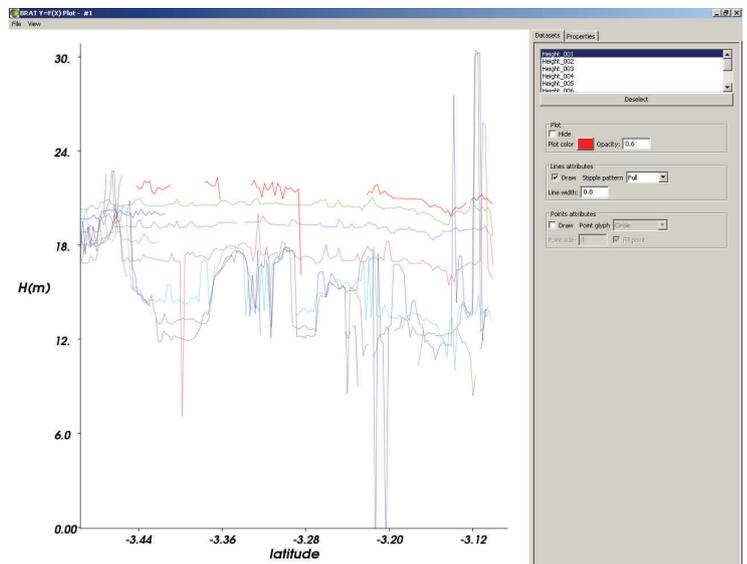
Click on the "Operations" tab. Click on "New". A default name is given (operation_1). You can then begin to define the expression you want to compute. Choose the dataset you have just defined. Below, you can see the list of available fields, with a short explanation in a popup tool-tip that appears when your mouse hovers over a field.

In the "Data expressions" box you can see four items:

- "X", to be filled with the latitude; choose "lat" in the list of fields, drag it and drop it in the "X" box.
- "Y" will stay empty
- Click on "Data expression", then on the "Insert expression" button. Type in or insert each field separately by dragging & dropping the expression: alt - range_ice3_ku - geoid_EGM2008 - iono_corr_gim_ku - model_dry_tropo_corr - solid_earth_tide - pole_tide (note that you have to type the "-" (minus sign) in both cases).
- Unit should be "m"
- Name the expression 'height_001'
- The last expression is "Selection crite-



Graphical output for Jason-2 cycle 001 to 010. Each color correspond to a different cycle. Some spurious data can be seen on this rough computation.



ria"; type in "is_bounded(-3.5, lat, -3.1)", in order to restrict the area to the Solimoes-Negro confluence.

Now, click on "Execute", The "Log" tab opens, to monitor the operation. For a single pass, execution should be fairly rapid. When the operation is finished ("ENDED"), the software switches automatically to the Operations tab (the tab from which the last operation was launched).

Go to the "Views" tab, and click on "New".

A list of available fields is given on the left (here, only one); drag & drop the selected field or use the arrows to move it to the right. Then click on 'Execute'. The visualisation window opens, and you should see a figure like this one (left, right, above or below).

You can go back to the Dataset tab, create several datasets, one for each cycle, and insert pass 063 into each of them. Then go to the Operation tab, click on "Duplicate", and change the datasets. You can thus have several similar operations, one for each cycle. (Note that an automated workflow is possible, if you want to process a number of files/cycles.) Execute them, and visualize them all on the same graph.

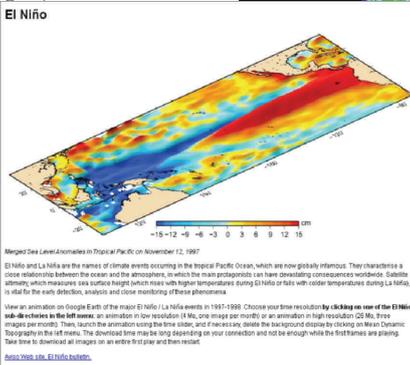
You then need to delete spurious data, before averaging all the points over the river for a given cycle, thus creating a unique level every ten days.

BRAT 'Operations' tab with the river height expression included. A click on 'Selection criteria' would show the restriction on latitude, which is the only one applied here.

Virtual globes: outreach tools for altimetry?

Virtual globes first appeared on the web in about 2003. While Google Earth is the best-known, there are others – NASA's World Wind, for example. However, Google Earth seems to be taking the lead, if not the whole 'market' these days. Their usefulness may seem debatable – the first thing most people do with them is to try and find their home. But use for Earth-related science outreach can go much, much further than trying to interpret satellite or aerial photography. Some teachers have been using these virtual globes as teaching aids for quite some time. In geography, of course, but also for geology and more generally the geosciences, even astronomy or history. And their novelty features are quite useful for public outreach: a globe that you can play with, turn around, zoom onto or click on to get more information is much more fun than a plain, flat, map. They are used by many people (and some geoscientists).

Aviso "Altimetry Applications" Google Earth file (with the example of the El Niño fact sheet and the animation overlaid on the globe)



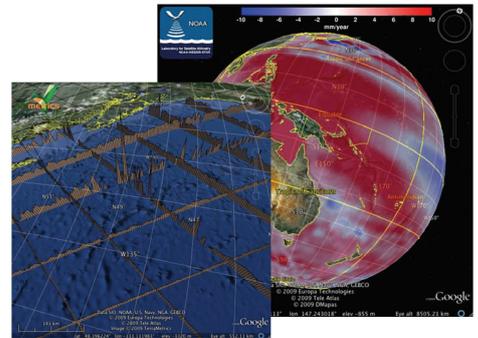
However, today no altimetry maps are referenced in Google Ocean (Aviso's altimetry applications are, but not in the 'Ocean' gallery)! There are some SST and ocean colour maps, etc. and the bathymetry includes some altimetry data, but there is no ocean topography as such in Google Earth's 'Ocean' Gallery.

However, even if they are not referenced in the proper gallery (or not referenced at all), several altimetry data applications (mostly with Google Earth) are available on the web. All the more so since an increasing number of display tools are interfaced with Google Earth, such as GMT or the Basic Radar Altimetry Toolbox.

The CNES Argonautica educational project produces Google Earth files each week for each of the buoys tracked in the project. This means that the different types of information provided can be overlaid (e.g. buoy location over current

velocities over ocean topography), and that the velocities of buoys can be computed (measuring the distance covered between two dates, then dividing by the time between the two measurements)

(<http://www.cnes.fr/web/CNES-fr/7161-argonautica.php>)



Example of Jason-2 Google Earth files made with GMT (courtesy Remko Scharroo, Altimetrics LLC)

NOAA/AOML proposes a hurricane and Tropical Cyclone Heat Potential module with animations of data on hurricanes and typhoons for 2008 and 2009. (http://www.aoml.noaa.gov/phod/cyclone/data/GE/TC_TCHP.kmz)

CCAR is conducting some tests with Google Earth fed by an Opendap/Thredds server through Web Maps Services (WMS). This should enable dynamic plotting of the data, with added scripts to dynamically define the resolution and colour scale.

Aviso uses Google Earth in several ways (<http://www-aviso.cnes.fr>, Data/Duacs, Data/Tools and NewsStand sections): our gridded near-real time maps of along-track data include maps of numbered ground tracks for all satellites, enabling users to locate a pass, or find the the number of a pass over a given area. There is also a Google Earth file for altimetry applications. IDS also shows the Doris stations (<http://www.ids-doris.org>).

Events

- **22-26 February 2010** AGU Ocean Sciences Meeting (Portland, USA)
- **25 February 2010** Cryosat-2 launch
- **29-31 March 2010** Marine Data and Information Systems (IMDIS 2010) (Paris, France)
- **26-30 April 2010** Ocean from space (Venice, Italy)
- **2-7 May 2010** EGU General Assembly (Vienna, Austria)
- **28 June - 2 July 2010** Esa Living Planet Symposium (Bergen, Norway)
- **8-12 September 2010** Eumetsat meeting (Córdoba, Spain)
- **18-20 October 2010** 2010 Ocean Surface Topography Science Team meeting (Lisbon, Portugal)
- **21-22 October 2010** International Doris Service Workshop (Lisbon, Portugal)
- **21-22 October 2010** Towards High-Resolution Remote Sensing of Ocean Dynamics and Terrestrial Surface Waters (Lisbon, Portugal)

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