



Project News

Prepared by E. Bronner

Missions in operation

Saral: This joint mission is run by CNES, the French Space Agency and ISRO, the Indian Space Research Organization, with participation from EUMETSAT. Saral stands for SATellite for ARGos and ALtiKa. Saral/AltiKa follows the same ground track as ESA's ENVISAT mission but uses different technology, with the first Ka-band altimeter in orbit.

The satellite was launched on 25 February 2013 at 12:31 GMT by a PSLV (polar satellite launch vehicle) supplied by ISRO, from the

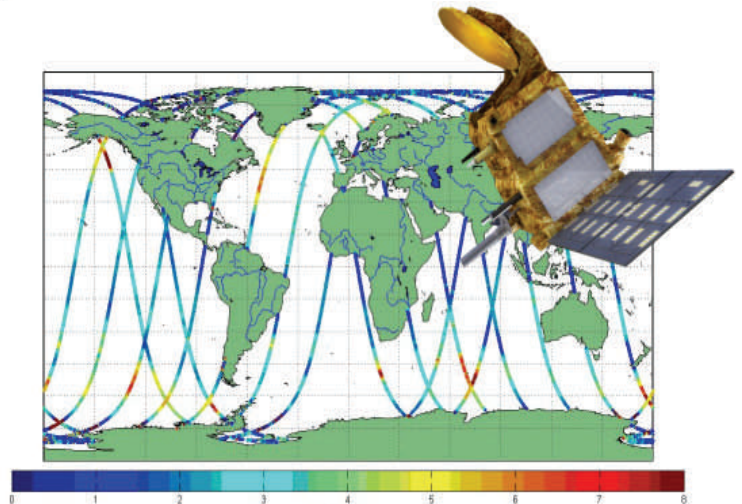


Saral launch on 2013/02/25 (Credits ISRO)

Satish Dhawan Space Centre, the main ISRO launch base at Sriharikota. The commissioning phase is under way and will last several months. For the moment, the satellite, instruments, ground segment and X-band stations are performing very well, and orbit quality is nominal.

CNES was responsible for supplying the first Near-Real-Time (NRT) products (Operational Geophysical Data Records, or OGDRs) until the satellite reached its nominal orbit. Since 18 March they have been produced by the official processing centres for NRT products at EUMETSAT and ISRO. Products that are not time-critical (Interim GDRs) are processed solely by CNES.

All systems are currently nominal and no major anomalies have been detected during processing. Offline products (GDRs) will be processed by CNES and ISRO. A panel of PIs will assess the quality of all Saral/AltiKa products before they are released for public use. The O/IGDRs data should be authorised for the AVISO data access service by the end of June 2013. The CAL/VAL phase will continue a few



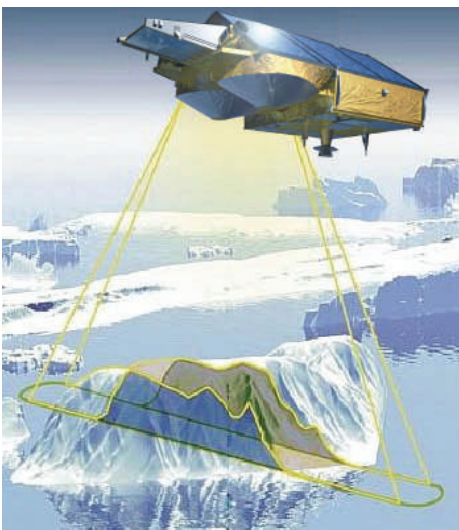
Along-track Significant Wave Heights provided by the first Saral OGDR products few hours after launch (Credits CNES)

months and will culminate with the NRT Verification Workshop (27-29 August 2013 in Toulouse, France). An AVISO newsletter on the first Saral/AltiKa scientific results will be published this summer.

Jason-1: The ageing Jason-1 mission has now started its 12th year of operation and is still providing good quality data to the geodetic and oceanography communities. Only one major anomaly has been observed: Jason-1 entered safehold mode (SHM) on 28 February 2013 at 16:13:37 UT, while traversing the South Atlantic Anomaly (SAA). The Jason-1 satellite recovered on 18 March and routine geodetic mission operations were resumed. The Jason-1 mission was interrupted during Geodetic Cycle 527 and cycle 528 was almost entirely lost. The origin of this SHM is not precisely known for the moment and investigations are being pursued. A request to extend the

mission for a further two years (2014-2015) has been submitted to CNES and NASA/JPL headquarters.

Jason-2: The Jason-2 spacecraft first entered a safhold mode on 25 March 2013 and then again on 30 March 2013, a few hours after the recovery. The mission was interrupted during cycle 174 then nominal science operations were resumed at the beginning of cycle 175 (5 April). Experts have not been able to identify a clear root cause due to a lack of information in telemetry data. Joint OPS teams from CNES and NOAA are carefully monitoring the spacecraft. Except for these 2 major events, the first SHM in the satellite's history, the satellite is delivering very good data. A complete reprocessing of all Jason-2 data (to the GDR-D altimetric standard) was completed in 2012 and products are available on the AVISO ftp server or through the AVISO CNES data centre and on NOAA server. (See further informa-



Cryosat-2 (Credits ESA/CLS)

tion on this new altimetric standard version "D" on the [Aviso website](#), in the [Public Release Document](#) or in the [Jason-2 Products Handbook](#)). A request for a 4-year mission extension has been sent to the headquarters of the four partners and is currently under evaluation by respective panels (CNES, NASA/JPL).

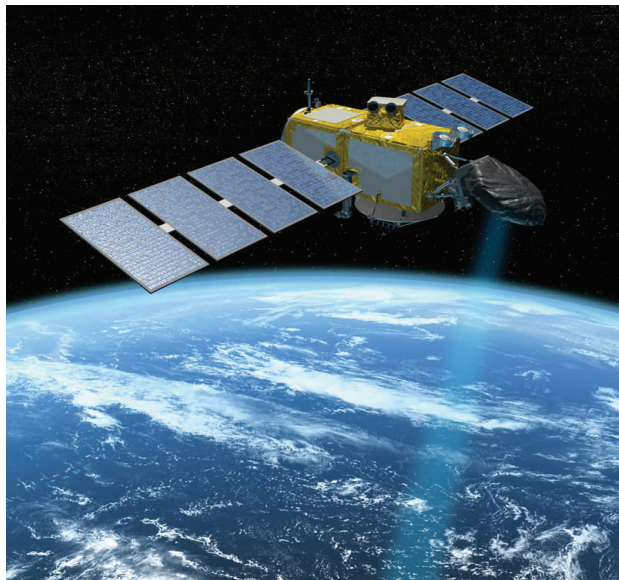
Cryosat-2: Everything is nominal on the Cryosat-2 mission. The third CryoSat User Workshop was held in

Dresden (Germany) in March 2013. Cryosat-2 data is still being reprocessed by CNES. Cryosat-2 contributes also to DUACS system as a complementary mission for level 3/4 products.

HY - 2 A : HY - 2 A , launched in August 2011, is a Chinese mission with French-Chinese collaboration between CNES and CNSA/NSOAS for altimetry (DUACS) and orbitography products (IDS). The mission appears to be performing nominally and the altimetric products are only distributed to PIs for the moment, in spite of great interest in the oceanographic community.

On-going developments

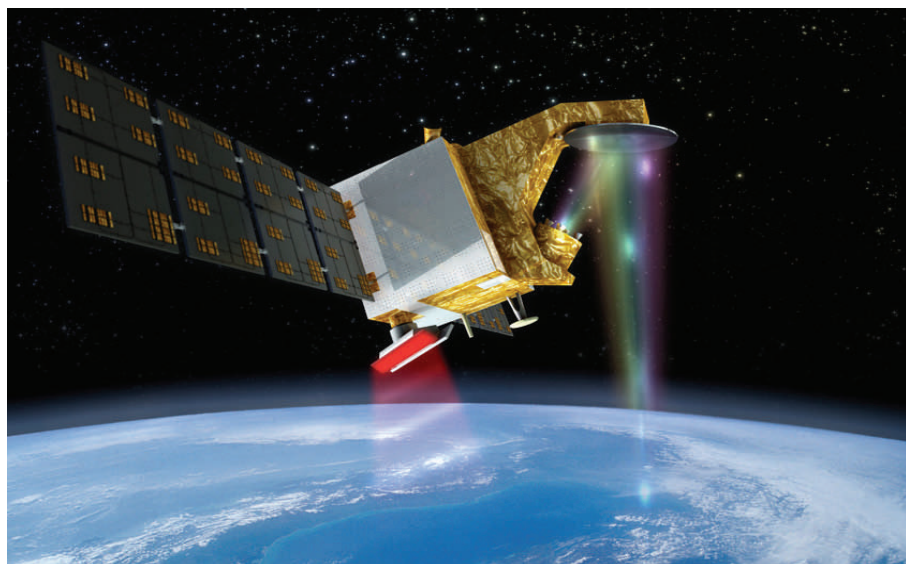
CFOSAT: The Chinese (CNSA) and French (CNES) Space Agencies have proposed a joint satellite mission devoted to monitoring of wind and waves on the ocean's surface, and related oceanic and atmospheric science and applications. This is the so-called CFOSAT project (Chinese-French Oceanic SATellite). A ground segment review was held for April 2013 to discuss system tests, interfaces and operations. A preparation meeting was held in China in March 2013.



Jason-3 (Credits NASA/JPL)

Jason-3: Development of the Jason-3 project (a joint EUMETSAT, NOAA, CNES and NASA mission) is continuing. A System Interface Review was held in Toulouse from 5 to 7 February 2013. The Jason-3 ground segment is still under development and no major concerns were raised during the review. A series of tests are to be held before the end of the year. The satellite launch has been slightly postponed to March 2015.

Sentinel-3A: Sentinel-3A is an ESA mission. Its development is going well with a launch date expected late 2014. A ground Segment Critical Review was held at ESRIN, in February 2013. The development is nominal and compatibility tests will soon begin.



CFOSAT (Credits CNES)

Change of the Ssalto/Duacs reference period

Prepared by C. Maheu, M.I. Pujol, Y. Faugère

As their name indicates, Sea Level Anomalies (SLA) are averaged for a given period of time, called the reference period. The Ssalto/Duacs Sea Level Anomalies products are historically referenced to the 7-year period from 1993 to 1999. For the past 20 years radar altimeters have been providing a huge amount of data, and the SLA products would obviously be more robust if the time scale were lengthened so that the Ssalto/Duacs reference period covers the period from 1993 to 2012.

After a brief description of the reference period and the way in which the mean profile is computed, this section describes the impact for users as well as the scheduling of the change in order to ensure a smooth transition.

What is measured by the altimeter?

An altimeter measures the sea surface height (SSH) above a reference ellipsoid which is the sum of the absolute dynamic topography (ADT) and the geoid above the same ellipsoid. The geoid is not yet known with enough precision to directly subtract it from the SSH and finally, to deduce the ADT. Alternatively, the SSH anomalies are used. The SSH anomalies are computed as the instantaneous SSH minus a temporal reference. This temporal reference can be a Mean Profile (MP) in the case of a repetitive orbit (T/P, Jason-1 before 2012/03, Jason-2, Envisat before 2010/10, etc.) or a gridded mean sea surface (MSS) for a non-repetitive orbit (this is the case for Jason-1G, Cryosat-2, ERS-1 or Geosat during their geodetic phases or for any future missions on a new ground track).

Computation of the Mean Profile

A mean profile is not a simple average of similarly co-located SSH data from the same ground track over a given period.

Indeed, as the instantaneous ground track is not perfectly controlled and varies within a ± 1 km band, it is necessary to use an ar-

bitrary and mission-consistent position for the co-location process. SSH measurements are then projected onto these co-location points. Precise cross-track projection and/or interpolation schemes and a good knowledge of the local cross-track geoid gradient are required to avoid errors.

The ocean variability is removed to minimize the seasonal/interannual aliasing effects. The mesoscale variability error is eliminated with

an iterative process using a priori knowledge from Sea Level maps derived from previous iterations or from other missions. Moreover, the inter-annual variability error is accounted for by using the MSS. This process enables us to reference the mean profiles for all missions to a common period for the sake of consistency with other missions. At this time, this reference period is [1993-1999] but it will be extended to [1993-2012].

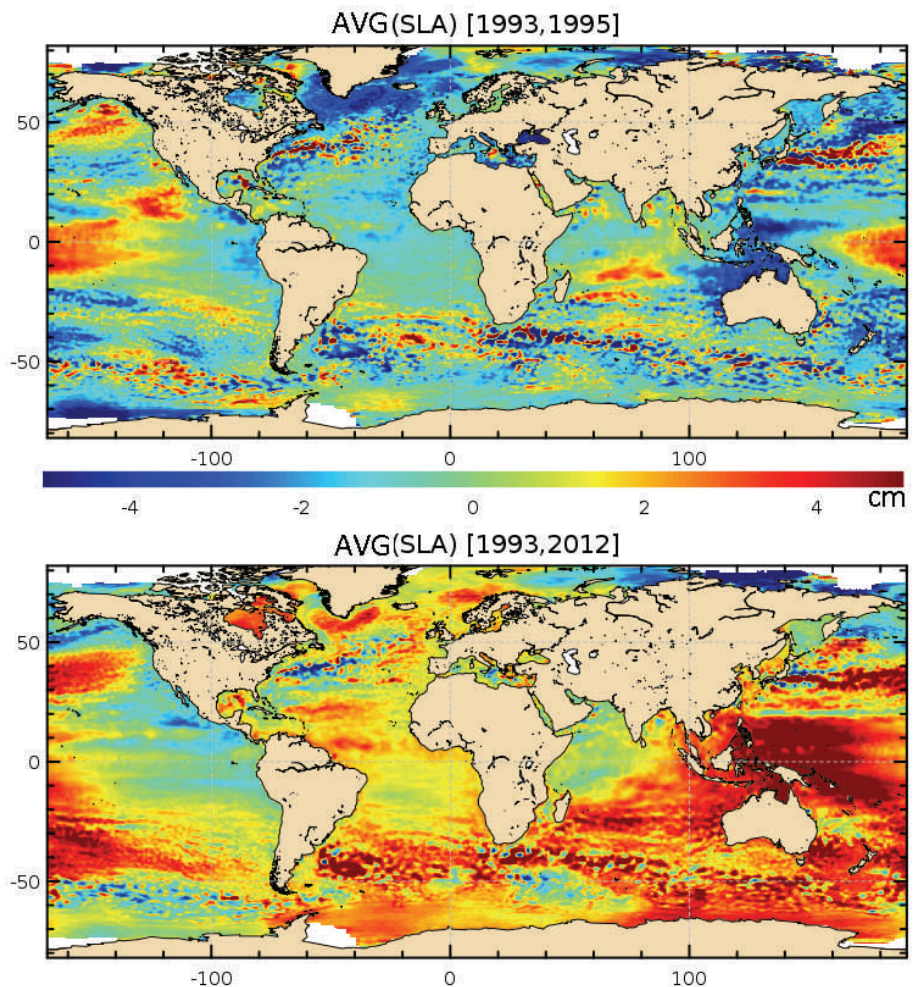


Figure 1: Averaged Maps of Sea Level Anomalies (in cm) for the periods [1993, 1995] (top) and [1993-2012] (bottom). The latter period [1993-2012] will be used to re-reference Sea Level Anomalies. (Credits CLS)

For example, the mean profile used for the repetitive mission, Jason-2, was computed in 2010 with 10 years of Topex/Poseidon data and 6 years of Jason-1 data and re-referenced a posteriori to the period [1993-1999]. The new reference period [1993-2012] will improve the mean profile by taking into account additional data acquired since 2010: the Jason-2 mean profile will then be computed with 10 years of Topex-Poseidon data, 6 years of Jason-1 data and 4 years of Jason-2 data.

Impacts on SLA but ADT unchanged

The change of the Ssalto/Duacs reference to the longer period [1993-2012] will affect the along-track and gridded **Sea Level Anomalies** in Delayed-Time and Near-Real Time but will not impact the **Absolute Dynamic Topography (ADT)**. Consider:

- A a reference period [ex : 1993-1999]
- B another reference period [ex : 1993-2012]
- Xy the variable X referenced over the Y period
- (X)_y the variable X averaged over the Y period

The Absolute Dynamic Topography (ADT) is unchanged

$$ADT = MDT_A + SLA_A = MDT_B + SLA_B$$

The Mean Dynamic Topography (MDT)

$$MDT_A = (ADT)_A = (MDT_B + SLA_B)_A$$

$$MDT_A = MDT_B + (SLA_B)_A$$

$$MDT_B = MDT_A + (SLA_A)_B$$

Along-track and gridded Sea Level Anomalies (SLA)

$$MDT_A + SLA_A = MDT_B + SLA_B$$

$$(MDT_B + (SLA_B)_A) + SLA_A = MDT_B + SLA_B$$

$$SLA_A = SLA_B - (SLA_B)_A$$

The reference change from the [1993-1999] period to the [1993-2012] period will affect the mean of the Sea Level Anomalies at regional scales. Changing the reference may also modify the instantaneous signature of the specific

structures of global surface circulation.

For example, in the Kuroshio current, the intensity of some eddies may be reduced by more than 20 cm when calculated according to the new reference period [1993-2012] than when they are referenced to the [1993-1999] period (see vertical arrow in Fig2). Likewise the position of some structures may be modified according to the reference period (see horizontal arrow in Fig2).

Schedule

For more than fifteen years, the multi-satellite DUACS system has been providing the altimetry community with Near Real Time and Delayed Time products. It is continuously evolving to improve reference surfaces, algorithms, corrections, standards in order to satisfy user needs. To insure a seamless transition during this change of the reference period, AVISO will provide several datasets such as the following:

- Early 2014: the new, entirely re-processed Delayed-Time data set will be released. All altimetry data

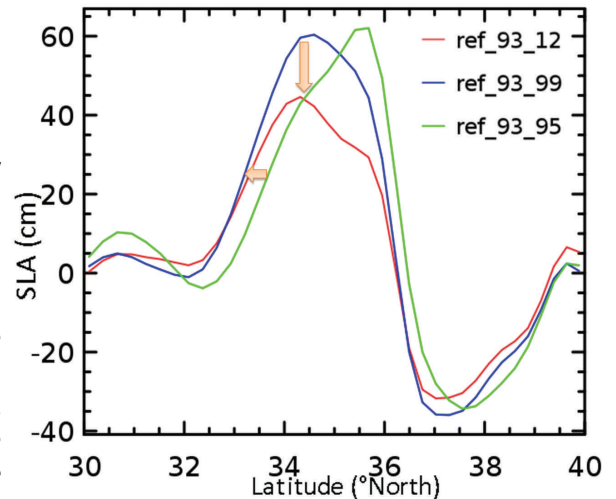


Figure 2 : Sea Level Anomalies (SLA) along a meridional section crossing the Kuroshio current in December 2011. SLAs referenced to the [1993-1995] period are in green, [1993-1999] period are in blue and [1993-2012] period are in red. (Credits CLS)

since 1992 will be upgraded (see “Duacs Upgrades in 2013-2014”, below) and updated with the new reference period [1993-2012]. The altimetry data referenced to [1993-1999] will be left on the servers to give you time to adapt to the change.

- At the same time, the Near-Real Time dataset will be duplicated; one based on the [1993-1999] reference period, and another based on the new [1993-2012] reference period.

Duacs Upgrades in 2013-2014

- ✓ Change of the reference period: Sea level anomalies will be computed using a mean estimated for the 20 years of altimetry data,
- ✓ New Mean Dynamic Topography (MDT_CNES-CLS13)
- ✓ Improvement of product content quality (along-track filtering, and merging parameterization),
- ✓ Reprocessing of the time series of Delayed-Time products for the new 20-year reference period, with homogeneous standards and processing,
- ✓ Daily gridded data will be regularly updated,
- ✓ Formal errors will no longer be expressed in % but in cm in the Level-4 gridded products,
- ✓ The spatial resolution of the maps for Level-4 gridded products will be delivered on a 1/4°x1/4° Cartesian grid (the lower resolution “lr” 1°x1°, and the 1/3°x1/3° grids with a Mercator projection will be removed). The corresponding geostrophic velocities will be homogenized,
- ✓ New format for Level-4 gridded products (NetCDF-CF format) as for the Level-3 along-track products.

Data Use Case: An example of how sampling can be improved

Prepared by C. Maheu

The main space and time scales of the ocean are enhanced with a combination of several satellites which greatly improves sampling. Here is an example of mapping with BRAT.

Developed under contract with ESA and CNES, 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.

The impact of merging 4 altimeters is analysed with respect to the formal mapping error (Figure 1) and the Eddy Kinetic Energy (Figure 2), in the Malvinas-Brazil confluence area considering:

- A single altimeter configuration (the reference mission “tpj1” series),
- A configuration with four altimeters (the merged series: Envisat/Jason-1/Topex-Poseidon tandem and GFO between 2002/05-2005/09; and with Jason-2/Jason-1/Envisat and GFO in 2008/07).

Formal mapping error

Figure 1 shows the error on the MSLA maps. This error represents the formal mapping error which is derived from the optimal interpolation processing used for the mission merging.

To plot Figure 1, first download the two series for a given date 2008/07/16 from the authenticated ftp server (see how to [access MSLA data from the Aviso website](#)):

- /donnees/ftpsedr/DUACS/global/dt/ref/msla/tpj1/err/dt_ref_global_tpj1_msla_err_20080716_20080716_20100503.nc for the “single altimeter” configuration
- /donnees/ftpsedr/DUACS/global/dt/ref/msla/merged/err/dt_ref_global_merged_msla_err_20080716_20080716_20100503.nc for the four altimeters configuration.

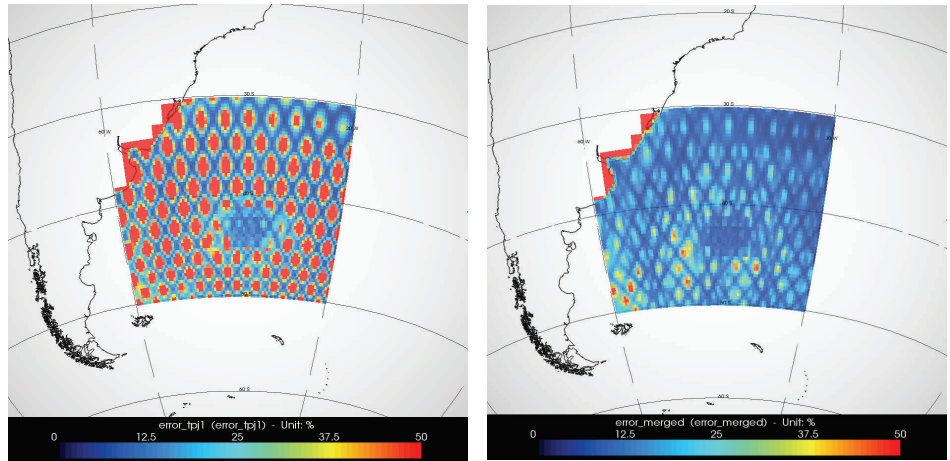


Figure 1: Maps of Formal Mapping Error (in %) for tpj1 series, for one satellite Jason-2 (left) and for a merged series (Jason-1&2, Envisat, GFO, right) in the Malvinas-Brazil confluence area, made from formal mapping error MSLA data on 2008/07/16. (Credits CLS)

With BRAT, first create the workspace: Menu File > Workspace > New. List the data files needed to create your Dataset: on the Dataset tab, click on “New”. A default name is given (Datasets_1), rename it with the corresponding series, (Dataset_tpj1_20080716, for tpj1 file). Click on “Add Files” at the bottom left. Retrieve the file previously loaded onto your computer. Do the same for the merged file: create the Dataset_merged_20080716 by including the four altimeters configuration file.

Create an operation

Click on the “Operations” tab. Click on “New”. A default name is given (Operation_1), rename it with the corresponding “tpj1” series (Operations_1altimeter). This is linked to the Dataset_tpj1_20080716, check it in the “Datasets” list just below the Operation Name. You can then start defining the expression you wish to compute. In the “Fields” box, you can see the list of available fields. In the “Data expressions” box (in the middle)

four items are displayed:

- “X”, to be completed with the longitude; choose “Longitude” from the list of fields on the left, drag and drop it into the “X” box, on the right.
- “Y” to be completed with “Latitude”
- “Data expression”: drag and drop “Grid_0001 (%)” from the Fields (which contains the formal mapping error values) into the “Data expression” box. Change the “Grid_0001 (%)” name by right-clicking on this name: “error_1altimeter”

Run (“Execute”) Operations_1altimeter.

On the basis of the Operations_1altimeter, create a new operation for the merged product by using the “Duplicate” button (when the Operations_1altimeter is selected). Carefully select the corresponding Dataset with the corresponding operation; rename the Operation (Operations_4 altimeters) and the Data (error_4 altimeters). Run (execute) the operation.

Display the maps

Go to the “Views” tab, and click on “New” to create a new view. Rename it “Display_1altimeter” for the single altimeter configuration view. A list of the available operations is given on the left; drag and drop the Operations_1altimeter to move it to the right. Finally, click on “Execute”. Do the same for the Operations_4altimeters. Set the min/max in the “Display Expression Properties” to compare both configurations (here we chose min=0; max=50, expressed in %)

With the single altimeter configuration (Figure 1, left) the areas between Jason-2 tracks suffer from a lack of sampling and reveal an important formal mapping error. The formal mapping error is greatly enhanced with improved sampling using the 4 altimeters configuration (Figure 1, right).

Eddy Kinetic Energy

Another way to demonstrate the advantages of combining several altimeters is to compute and plot the Eddy Kinetic Energy (EKE). The EKE is used in the study of mesoscale phenomena to assess the energy conveyed by eddies, currents, meander fronts or filaments. Download all the data files for the two following series between May 2002 and September 2005, from the authenticated ftp server (see how to [access MSLA data from the Aviso website](#)):

- single altimeter configuration: /donnees/ftpsedr/DUACS/global/dt/ref/msla/tpj1/dt_ref_global_tpj1_msla_h_20021002_*.nc
- four altimeters configuration: /donnees/ftpsedr/DUACS/global/dt/ref/msla/merged/h/dt_ref_global_merged_msla_20021002_*.nc

Follow the steps described in the Data Use Case in the [Newsletter#8](#) to see how to compute the EKE. Adjust for the current example to compute the mean EKE for the

whole time period for each altimeter configuration and plot Figure 2.

Jason-1 alone (Figure 2, top) shows a small area with intense signals, only where the Jason-1 tracks are

located. A clear improvement with the mean EKE can be seen when the four altimeters are merged (Figure 2, bottom).

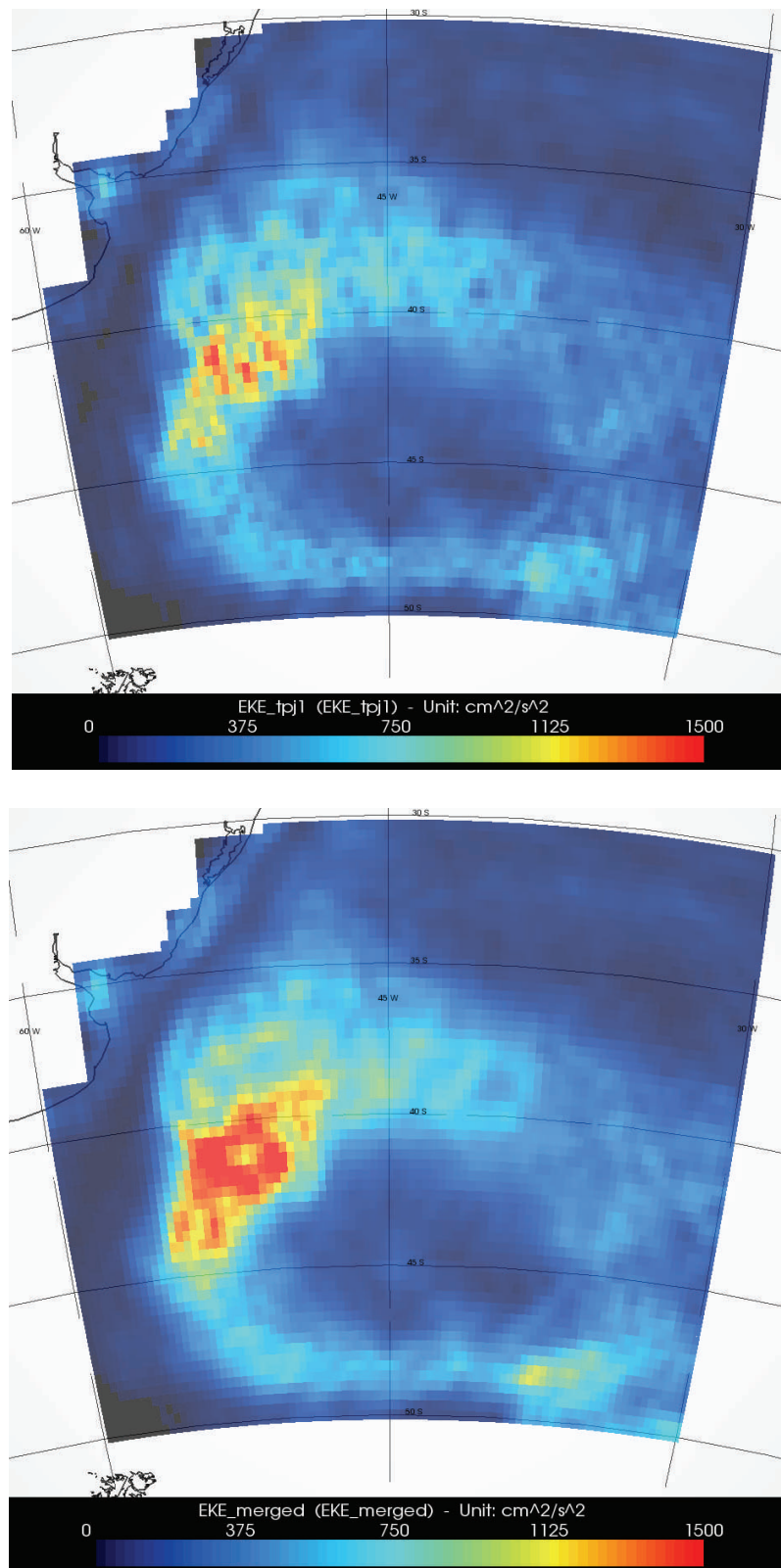
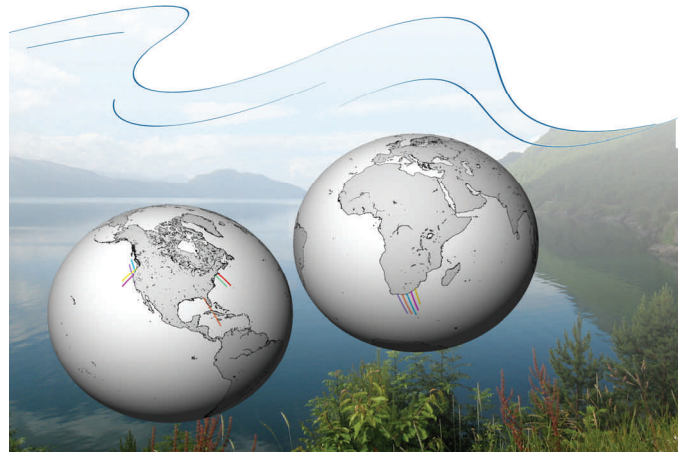


Figure 2: Maps of Eddy Kinetic Energy (in cm^2/s^2) averaged between May 2002 and September 2005 for tpj1 series (top), i.e. one satellite (Jason-1), and for the merged series (bottom), i.e. four satellites (T/P tandem, GFO, Jason-1, Envisat), in the Malvinas-Brazil confluence area. (Credits CLS)

PISTACH coastal altimeter product

An “easy to use” [coastal level-3 products](#) (Sea Level Anomalies) is delivered by Aviso for Jason-2, on four areas: Agulhas current, Florida Strait, Oregon, Mid Atlantic Bight.

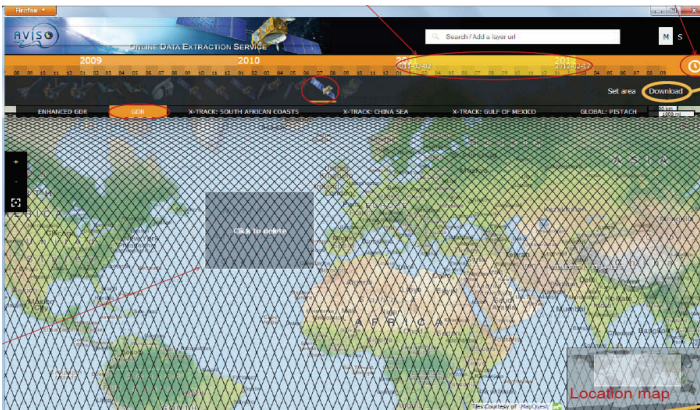
A new release of level-2 PISTACH products (available for Jason-1g, Jason-2 and Cryosat-2) is in preparation.



Aviso Online Data Extraction Service

A new interface to download altimetry data in an interactive and friendly interface.

The first online public version will be available by the end of the year.



AvisOcean

A new [application](#) on Iphone/Ipad to help you discover the oceans and altimetry.

More than 700 users have already downloaded the application! Join them!



Events

- 21 - 26 July 2013 : IGARSS, Melbourne, Australia
- 9 - 13 September 2013: The 2013 ESA Living Planet Symposium, Edinburgh, UK
- 16 - 20 September 2013: EUMETSAT Meteorological Satellite Conference, Vienna, Austria
- 7 - 11 October 2013: Coastal Altimetry and OSTST meetings, Boulder CO, USA
- 4 - 6 November 2013: GODAE OceanView Symposium, Washington DC, USA
- 9 - 13 December 2013: AGU San Francisco Fall Meeting, San Francisco, CA, USA
- 23 - 28 February 2014: AGU Ocean Sciences, Honolulu, Hawaii, USA

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