AVISO+ Satellite Altimetry Data

11

June 2015

Users Newsletter

Project News

Prepared by E. Bronner and CNES project managers

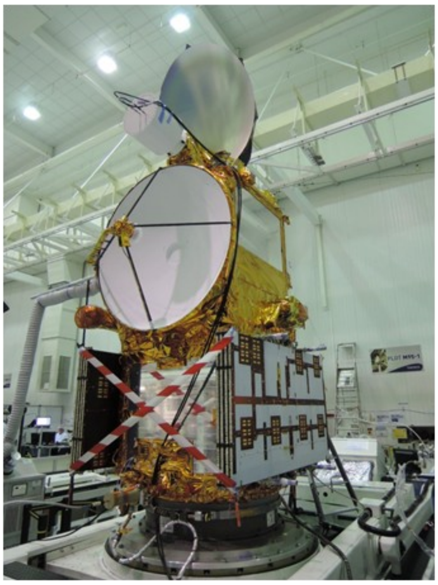
Missions in operation

The French-Indian **SARAL** mission is run jointly by CNES and ISRO (Indian Space Research Organisation), with participation from EUMETSAT. SARAL was launched on 25 February 2013. Two verification workshops, in August 2013 and April 2014, officially validated the quality of Near Real Time and Offline products. Except for a short Safe Hold Mode in October 2014, the mission was resumed successfully and provided valuable and promising results for Ka-band altimetry. The high quality of products was shown during the SARAL/AltiKa workshop in Constanz (Germany) in late October 2014.

HY-2A, launched in August 2011, is a Chinese mission that includes a French-Chinese partnership between CNES and CNSA/NSOAS for altimetry (DUACS) and orbit determination products (IDS). The mission and the altimeter are working well and altimetry products have been available through SSALTO/DUACS since mid-2014.

Seven years after launch, the CNES/NASA/EUM/NOAA **Jason-2** mission continues to provide high-quality products to the altimetry community. Jason-2 is still the reference mission in the multi-mission SSALTO/DUACS system. In May 2015, the 4 partners met during the annual and successful exploitation review. The next important step for Jason-2 will be to move to an interleaved orbit about 6 months after Jason-3 launch.

ESA's **CryoSat-2** mission, launched on 8 April 2010, is dedicated to ice monitoring. The third CryoSat user workshop took place in Dresden, Germany, from 12 to 14 March 2013. Cryosat-2 also contributes to the multi-mission SSALTO/DUACS system as a complementary mission for value-added products (Levels 3 & 4). Cryosat-2 data will be reprocessed in 2015 (Baseline C).



View of the Jason-3 satellite Credits Thales Alenia Space

On-going developments

Jason-3 is the successor to Jason-2 and assumes its principal characteristics (orbit, instruments, accuracy of measurements, etc.). This mission has been jointly developed with close international cooperation by EUMETSAT, NOAA, CNES and NASA. Jason-3 continues the story of the altimetry constellation Topex/Poseidon, Jason-1 and Jason-2. The Qualification Review of the satellite and the "Jason-3 Performance and CAL/VAL" Key Point meeting took place successfully at the end of 2014. The four partners also held the "Operational Readiness Review" to qualify the ground system and the operations at the end of January 2015. A dress-rehearsal for the satellite's beginning-of-life took place on mid-March with all the teams involved. The satellite is currently in storage on the premises of Thales Alenia Space pending its shipment to the Vandenberg (California) launch base in mid-June. The countdown campaign will then take place and the launch is foreseen for summer 2015.

Sentinel-3 is an ESA mission. Its main objective is to measure sea-surface topography, sea- and land-surface temperature and ocean- and land-surface colour.

For more than 18 months, engineers have been carefully piecing together the many components that make up ESA's Sentinel-3A satellite. Now hosting an array of instruments that will provide a wealth of information about the Earth's oceans and land, the satellite is complete, standing proud and ready for testing. Scheduled for launch at the end of 2015, Sentinel-3A is set to play a key role in Europe's Copernicus programme. CNES provides its expertise in altimeter, radiometer and POD data processing and will play an important role during the in-orbit validation of the altimetry user products.

As one of the fleet of satellites built for the world's largest environmental monitoring initiative, Sentinel-3A will join Sentinel-1A and Sentinel-2A in orbit.

The Sentinel-1A radar satellite was launched last April and the multispectral imaging Sentinel-2A is planned to be launched on June 23rd, 2015.

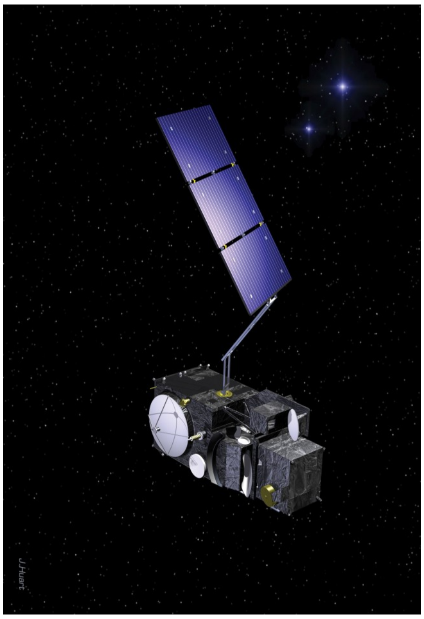
CFOSAT is a French-Chinese oceanographic mission (CNES/CNSA) devoted to ocean surface wind and wave observation, to be launched in mid-2018. After an interruption lasting a few months, project development is now under way again. A CFOSAT open science meeting took place in Guangzhou (China) from 3 to 5 February 2015. A Preliminary Definition Review of the French ground segment is planned for September 2015.

SWOT (Surface Water and Ocean Topography) is a French-American mission run jointly by CNES and NASA, with the participation of UKSA and CSA, for the study of oceanic and inland water surfaces. The mission is currently in Phase B, with its NASA/CNES Preliminary Definition Review scheduled for January 2016. On 6 January 2015, CNES and Thales Alenia Space signed an agreement for the development of the platform and the building of the satellite. The integration and testing activities will take place over the next few years on the TAS site in Cannes. This contract has received significant funding from the PIA (French Program of Investment for the Future), as part of the "Development of satellites with extensive application potential". Designed by TAS, the platform is unlike most satellites in low Earth orbit due to the exceptional "wingspan" of its solar panels (required by the power consumed by the radar), its stability and pointing requirements and the need to avoid microvibrations. SWOT will carry a radar interferometer in the Ka band (KaRin), designed by the JPL, which constitutes a technological breakthrough compared with conventional altimetry. CNES's other contributions to SWOT are the DORIS instrument, a POSEIDON-3 nadir altimeter, the ground control segment and a mission ground segment, including the centre for processing high-resolution data on continental surfaces. Delivery of SWOT to NASA is scheduled for 2020, with launch at the end of that year.

Credits D. Ducros

Past missions

The CNES/NASA **Jason-1** mission provided good quality data for 11.5 years (10 years on a repetitive orbit + a full 406-day geodetic cycle). The satellite was passivated and decommissioned on 1 July 2013. The entire mission will be reprocessed in 2015 to benefit from new geophysical models and orbits, new algorithms (ICE-1 retracking, time tag and altimeter range bias corrections), recomputation of radiometer-derived parameters and finally the NetCDF format.

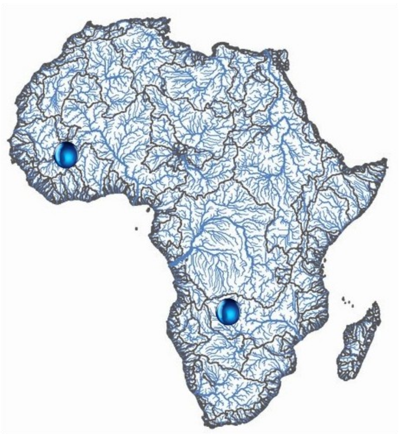


Credits J.Huart

Hydrology from Space

Prepared by C. Maheu

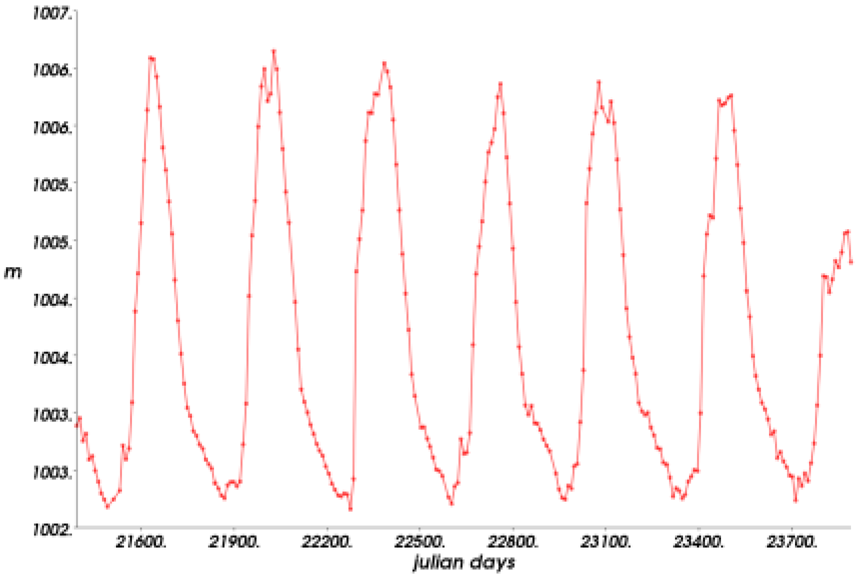
Because it is a source of life, water is an essential resource. It is also much more than a simple molecule; it needs to be fresh, clean and accessible too if it is to quench the basic needs of each one of our planet's inhabitants.



By 2050, the demand for water is expected to have increased by 55%, not only under the pressure of population growth, but also because consumption is increasing hugely: both industrial and agricultural needs are exploding. Whether to avoid shortages or flooding, water needs to be managed rationally and comprehensively: it is therefore of fundamental importance that we keep these resources under close observation.

By removing territorial borders and providing regular, spatial and temporal monitoring of inland waters, satellite remote-sensing techniques can make a major contribution to this resource management objective. Although initially developed for studying ocean surfaces, satellite altimetry rapidly broadened its scope to include monitoring of ice sheets and the levels of major inland waters such as the American Great Lakes and other inland seas. Such relatively large bodies of water lend themselves to good quality observations, as the measurement conditions are close to those of the open ocean.

Gradually, the increasing mastery of the altimetry technique, the application of processing and correction techniques which are specific to inland conditions, and the development of algorithms which attempt to improve the discrimination between signals reflected off land and signals reflected off water, have enabled smaller features to be monitored and measurement quality to be improved. This is crucial because, whereas for the ocean the altimeter only measures a homogeneous surface (the water), for land, it must



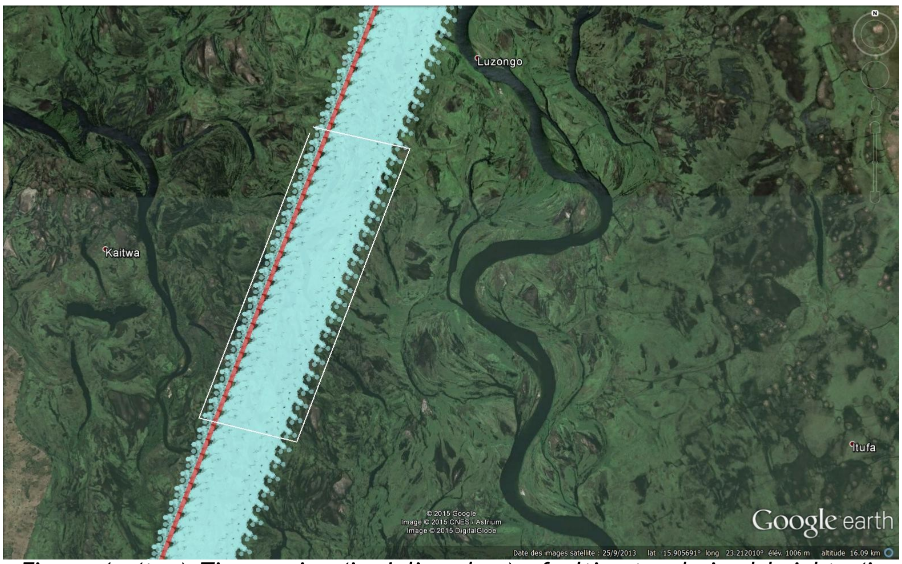


Figure 1: (top) Time series (in Julian days) of altimetry-derived heights (in meters) in the Barotse floodplain, near the Zambezi river. (bottom) These measurements were extracted from the Jason-2 data under pass 133 between 2008/07/17 (cycle 001) and 2015/05/30 (cycle 254). One track is shown in red, with all individual measurements for the entire period shown as blue points. The data are provided by the [Pistach project](#) (IGDR products with a specific treatment adapted to continental waters).

also deal with considerable topographical or textural contrasts which could unbalance it and cause it to lose lock. Another constraint is due to the radar altimetry technique itself. The altimeter provides measurements precisely at the satellite's nadir, i.e. for a limited area along the satellite's ground track, which restricts spatial sampling and rules out any global, systematic monitoring of inland waters.

As early as 2008, Jason-2 was enabling space hydrology to anticipate topographic contrasts, to better calculate the timestamp for the return of the radar echo, to define land/water transitions and therefore to provide reliable data more quickly. Multiple time series of water surface heights can be plotted on segments of rivers that are sometimes quite narrow (see figures).

CNES and NASA, in partnership with the Canadian Space Agency and the United Kingdom Space Agency, propose a space mission using a new technical concept: interferometric wide-swath altimetry. This mission, SWOT (Surface Water and Ocean Topography), whose launch is planned for 2020, will be capable of measuring slopes and water levels of rivers, lakes and flooded areas of a minimum width in the region of a few hundred meters.

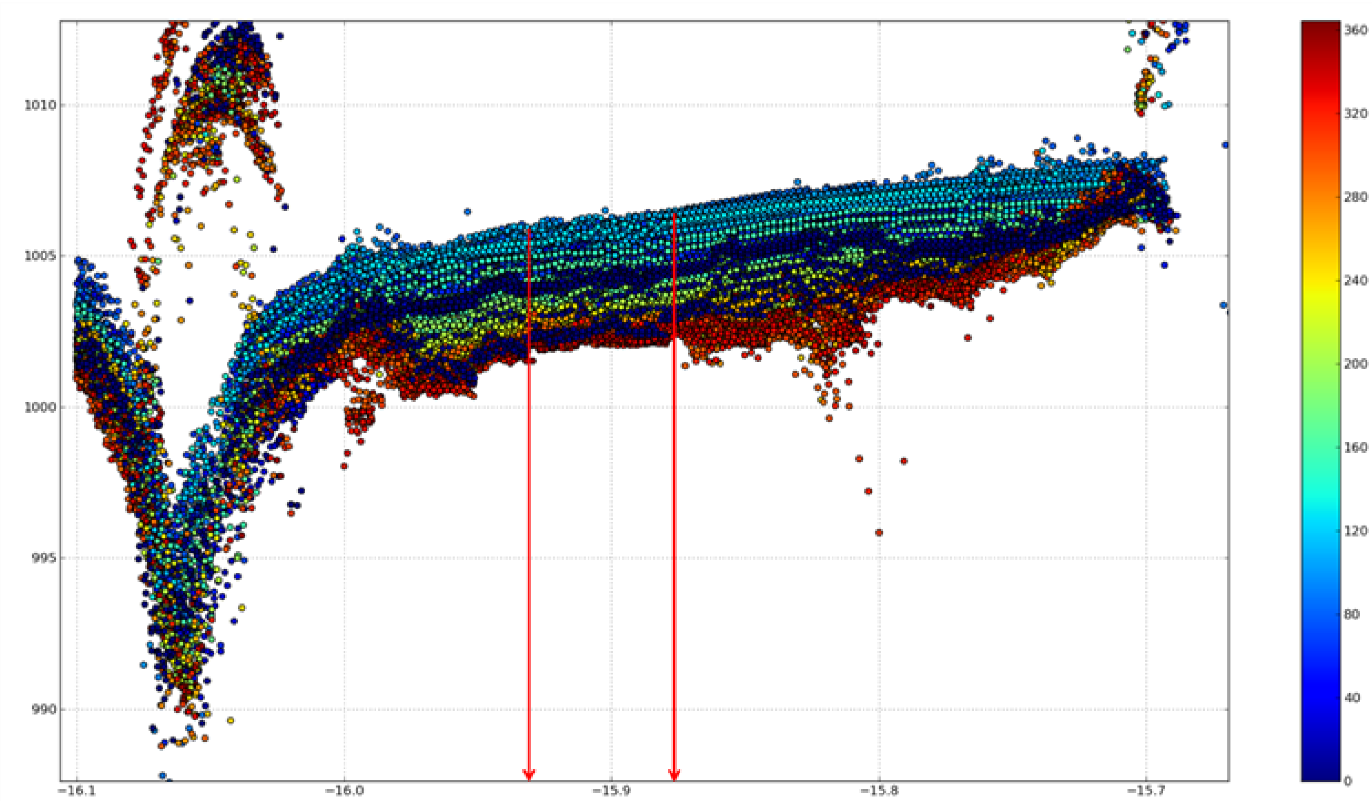


Figure 2: Altimetric heights along track No.133 (in meters) in the Barotse floodplains. All measurements from Cycle 001 to Cycle 254 are shown here. The colours of the dots indicate the day of the year (between 1 and 365). All points with the same colour therefore correspond to a measurement performed at the same time of the year, for all the years between 2008 and 2015. This representation makes it possible to locate areas with variations of heights and to refine the latitudinal limits on which the time series is calculated. The red arrows indicate the selection made for the series represented in Figure 1.

Online Data Extraction Service: a quick and easy-to-use interface

Prepared by C. Maheu

The Online Data Extraction Service ([ODES]) is a new service to extract along-track data from altimetry datasets. Here, we present the main steps through the interface adapted to a wind/wave selection over the Western Pacific to visualize the progress of Typhoon Noul.

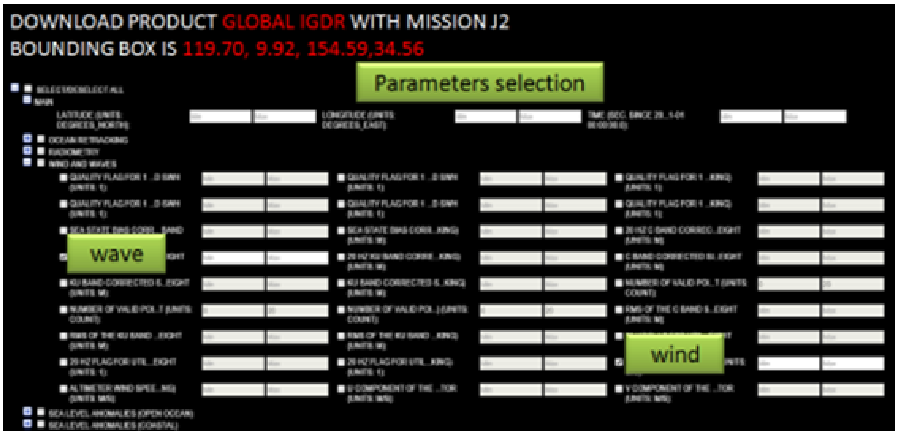
ODES is an interactive web portal providing users and applications with a wider range of altimetry-derived data, including high-resolution and experimental data:

- GDR native or enhanced GDR (GDR products with up-to-date corrections and models),
- Pistach (hydrology/coastal dedicated products),
- Peachi (SARAL/AltiKa new algorithms and parameters for coastal areas, surface hydrology, ice),
- CorSSH (corrections and geophysical parameters for ocean studies)
- and X-TRACK (specific processing for coastal studies).

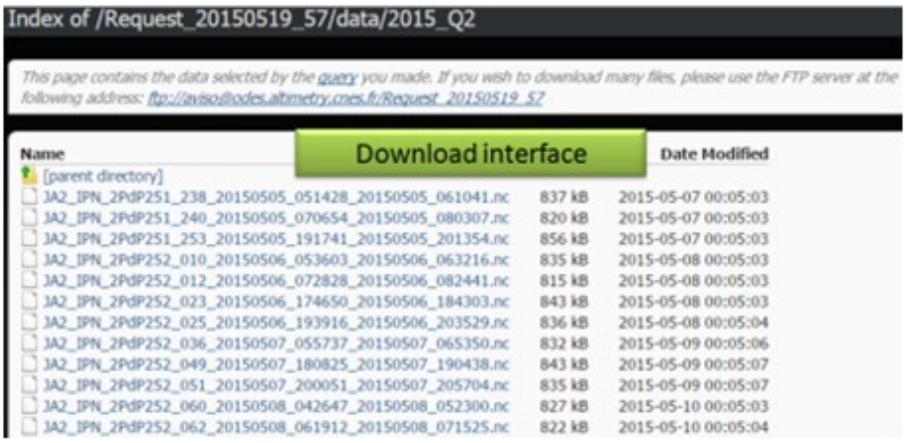
The user-friendly map interface enables users to extract data according to temporal or geographical criteria, and fast and interactive data exploration. The login/password requested when downloading is your Aviso FTP login/password, if you're already registered. If you're not yet registered, you can subscribe by filling in the registration form

The example below shows the main steps through the interface adapted for wind/wave selection over the Western Pacific to visualize Typhoon Noul. Cyclones are characterised by very high waves and strong winds, which can be measured by altimeters (provided that the satellites fly close enough to the area affected by the cyclone) and assimilated in real-time in some forecasting

First screen: Select Dataset, Mission, Period and Area and then log-in. Here we choose Native IGDR>Global IGDR>J2>2015-05-05 to 2015-05-12 over the Western

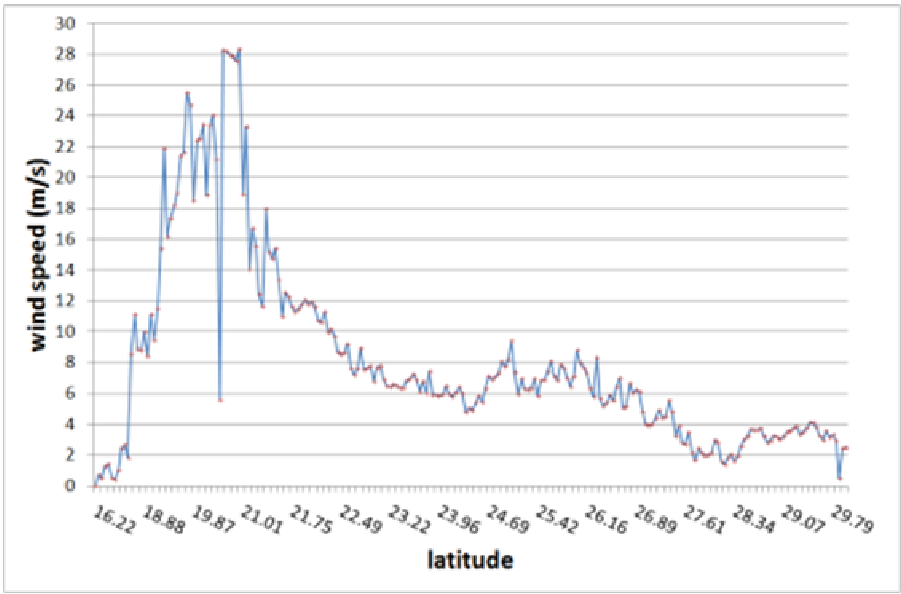


Second screen: the entire list of variables is presented for the given dataset. If there is any doubt concerning a parameter, a tooltip appears when the cursor hovers over the name. Here we are interested in the Wave and Wind fields. Click on Download.



The last screen appears rapidly, and you can download the data requested by your query. Use this interface or your preferred FTP software.

Typhoon Noul started as a tropical depression early in May and increased through the Western Pacific up to Category 5 on the Saffir-Simpson scale with wind speeds of more than 270 km/h and gusts as strong as 315 km/h. It hit the North-eastern tip of the Philippines when the sustained wind speeds were at their highest, on 9-10 May. The significant wave heights measured by altimetry closest to the typhoon's path reached more than 10 m.



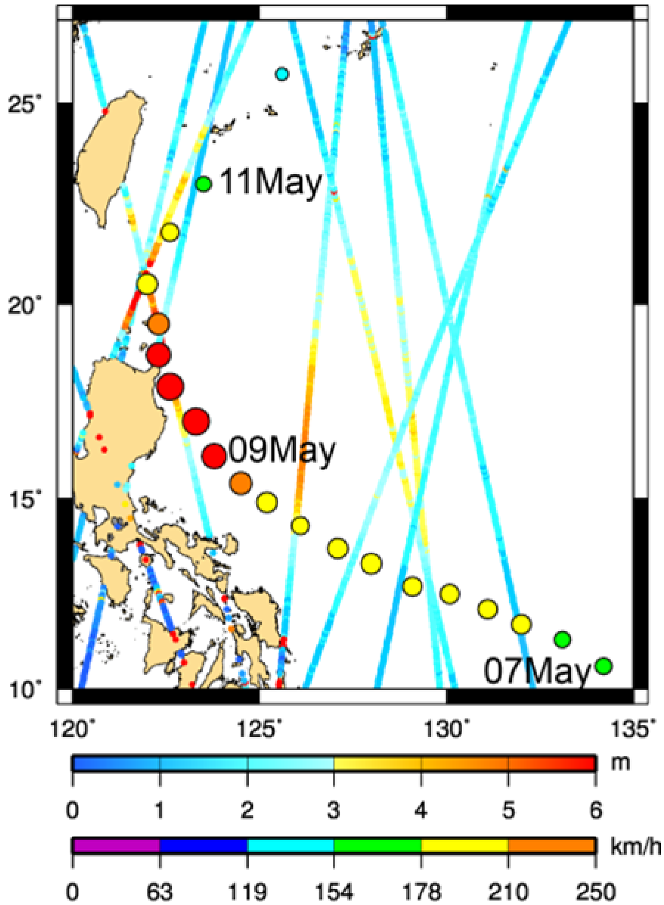
Altimeter wind speed (in m/s) measured along-track for Jason-2 pass 127. The strongest wind speed is about 28 m/s (more than 100 km/h) when Jason-2 was closest to the typhoon path.

Map of Significant Wave Heights (SWH, in meters) measured along-track.

All the satellite missions are plotted between 2015/05/09 and 2015/05/11: Jason-2 (passes 88, 101, 112 and 127); HY-2A (passes 9, 24 and 37); Cryosat-2 (passes 6 and 831) and SARAL/AltiKa (passes 464, 477 and 492).

The typhoon's path is shown by coloured circles (the intensity scale measures the wind speed of the typhoon in km/h): purple for a tropical depression, blue for Category 1, green for Cat. 2, yellow for Cat. 3, orange for Cat.4 and red for Cat. 5. The dates near the path indicate the date when the hurricane passed.

The Jason-2 pass 127 measured the highest SWH at 2015-05-10 19:51, when the typhoon was about 100 km further East.



New mapplet using altimetry to assess the performance of tide gauge networks

Prepared by G.Valladeau, P.Prandi

The Aviso+ website displays a new mapplet with geolocalised, coloured, cross check indicators for tide gauge networks. These indicators provide comparability information for each tide gauge station with altimetry data from one to four satellite missions. Some key metrics are available through a "light" version in an information card for each tide gauge, whereas a full version provides more information on the agreement between altimetry and tide gauge records.

To complete the global assessment of altimeter data where in-situ measurements are used as independent sources of comparison, tide gauge networks are compared to altimeter SLA time series
This section highlights potential anomalies in in-situ time series:

- from the detection of structural changes in in-situ time series
- from comparisons with all available altimetry data

The traditional method for assessing the quality of sea level time series recorded by tide gauges is to compare the results with those from satellite altimetry missions. Performing such comparisons systematically for each station in the network enables the detection of drifts and jumps in in-situ time series. For each station, the results of this quality assessment process are provided thanks to a dedicated mapplet which rapidly displays the performance of the in-situ sensor with respect to satellite altimetry (see figure on the right)

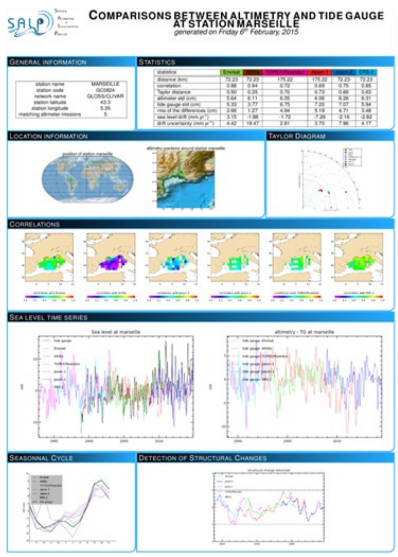
This map thus displays the cross check indicators relative to the comparison between altimetry and tide gauges for the different in-situ networks: for each tide gauge, the criteria defined below can be used to determine the relevance of an altimetry mission in the estimation of the quality of the in-situ time series:

- correlation of altimetry/tide gauge > 0.7 within 150 km around the tide gauge
- rms of the differences between the altimetry and the tide-gauge time series < 10 cm

Consequently, a green indicator indicates the relevance of a tide gauge time series for comparison with altimetry (at least 4 satellites meeting the criteria). Conversely, a black indicator indicates that no altimetry data can be used to assess the quality of the given tide gauge, which will thus not be considered in the assessment of altimetry data (see the performance of the Marseille tide gauge in the following figure).

<u>Further information:</u>

Data > CalVal > [Tide Gauge Network on the Aviso+ website]().



Key metrics, specific tests and results for a given tide gauge. Credits CNES/CLS.

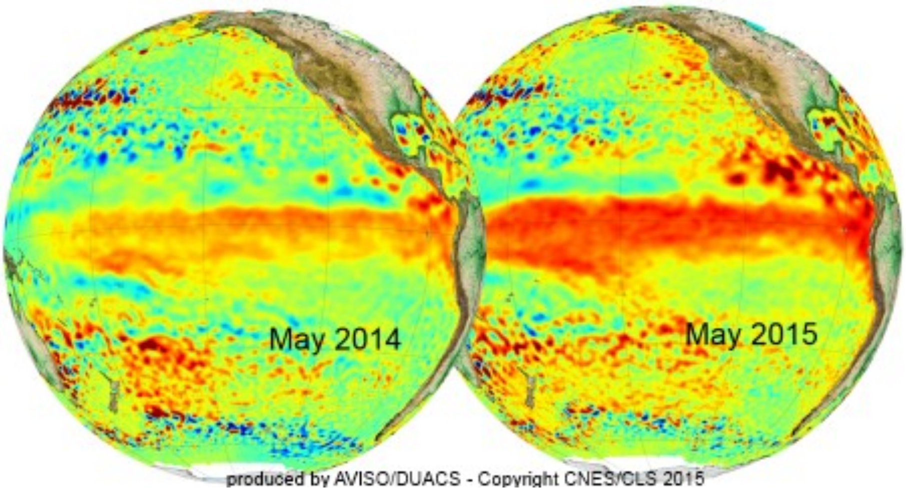
Mapplet with the cross check indicators for each tide gauge.

El Niño weak, moderate or strong in 2015?

Maps of Sea Surface Anomalies averaged over May 2015 (MSLA are computed from Ssalto/Duacs data) show large areas across the equatorial Pacific with above-average. Sea Surface Temperature (not showed here) are also above-average on May 2015. Those conditions are as high as observed during 1987 El-Niño, and thus forecasts are close to that episode.

Nevertheless, in February - March 2014 and up to May 2014, an El Niño was announced, possibly a strong one. Sea surface temperature was high all over Tropical Pacific, with few or no temperature gradient. So it aborted early in June because a lack of winds: no winds, no "southern oscillation", and El Niño disappeared.

Satellite altimetry, which measures sea surface height (which rises with higher temperatures during El Niño or falls with colder temperatures during La Niña), is vital for the early detection, analysis and close monitoring of these phenomena. An ocean indicator enables to follow the situation on the Aviso+ website. So, what about the El Niño in 2015: will it be weak, moderate or strong ?



Monthly mean of Sea Level Anomalies (annual and seasonal cycles removed) over the Pacific for May 2014 (left) and May 2015 (right). Credits CNES/CLS

Events

1-4 Sept. 2015, Lisbon, Portugal: 4th GODAE OceanView Coastal Oceans and Shelf Seas Task Team

15-17 Sept. 2015, Frascati, Italy: 3rd Space for Hydrology workshop: Surface Water Storage and Run-off: *Modeling*, In-Situ data and Remote Sensing

21-25 Sept. 2015, Toulouse, France: 2015 Eumetsat Meteorological Satellite Conference

13-16 Oct., 2015, Koblenz, Germany: Water Resources Assessment & Seasonal Prediction

18-19 Oct. 2015, Reston, VA, USA, Coastal Altimetry Workshop

19-23 Oct. 2015, Reston, VA, USA: OSTST (Ocean Surface Topography Science Team) meeting

19-23 Oct. 2015, Goa, India: 14th Global Sea Level Observing System-Group of Experts (GLOSS-GE) and Indian Ocean Sea Level Science Workshop (dedicated session on *Saral*/AltiKa mission)

20-23 Oct. 2015, ESA-ESRIN, Frascati, Italy: Earth Observation for Water Cycle Science 2015

4-6 Nov. 2015, Brest, France: 2nd GlobCurrent User Training and development meeting

30 Nov. -11 Dec. 2015, Paris, France: COP21/CMP11, 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change.

14-18 Dec. 2015, San Francisco, CA, USA: AGU Fall meeting

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