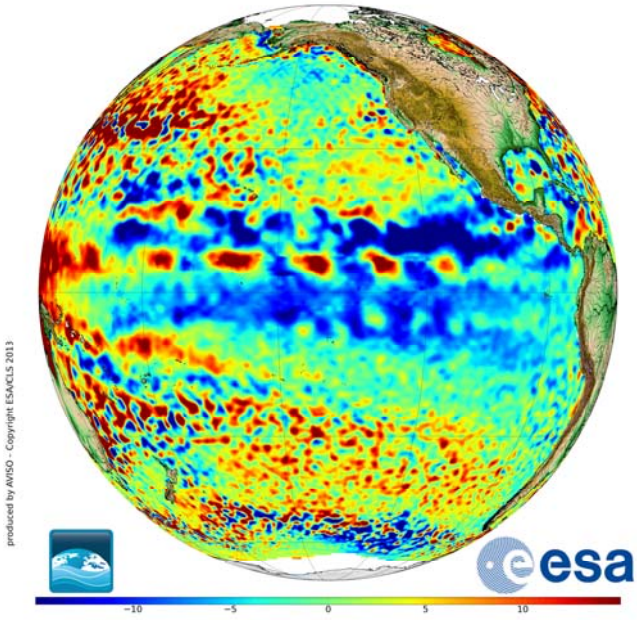
climate change initiative

→ SEA LEVEL NEWSLETTER

Issue 6 | December 2014



The Pacific sea level anomalies in December 2010 during the 2010-2011 La Niña.

In this issue:

The Sea Level ECV is now available over the 1993-2013 period!

The phase I of the Sea Level Climate Change Initiative project is now completed and these first 3 years (2011-2013) were the opportunity to involve the climate research community and define the user requirements for climate applications. New algorithms were developed to improve the altimeter data and a formal validation protocol was used for the estimation and the validation of their performances. An international panel of experts contributed to the selection of the best algorithms for climate applications. More than 50 years of cumulated altimeter data were processed, leading to the production of an 18 year-long time series (1993-2010) of sea level maps with associated climate indicators. Last, climate modelling groups contributed to the assessment of the products through assimilation and comparison with models and sea level closure budget studies.

The evolutions performed in phase I which have the most significant impact on the quality of the sea level ECV products are the altimeter wet troposphere correction, the use of the ERA-Interim reanalysis for the atmospheric corrections, the orbit solution and an improved instrumental correction for some missions.

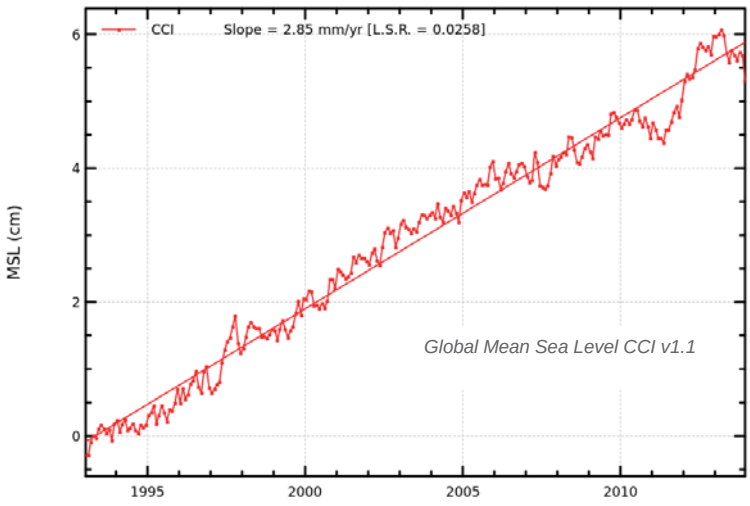
The work performed contributed to homogenize altimeter time series (Topex/Poseidon, Jason-1, Jason-2, ERS-1, ERS-2 and Envisat) in terms of sea level trends and to better characterize and reduce altimetry errors at climate scales.

However, the user requirements have not been reached at all temporal and regional scales and a lot of things remain to be explored. During phase II (2014-2016), some altimeter standards are evaluated and the altimetry errors will be reduced in some specific areas (coastal, Arctic).

Above all, an update of the sea level ECV is now released so that the 1993-2013 period is available (see in this newsletter). Access is provided by request at info-sealevel@esa-sealevel-cci.org. As required for climate studies, the ECV will be extended again in 2015 and a full v2 reprocessing of the product will be delivered in 2016, including the best algorithms developed during phase II.

More info on the project website: ***http://www.esa-sealevel-cci.org***

Temporal extension of the Sea Level ECV: a 1993-2013 climate record



The global Mean Sea Level (MSL) of the oceans is one of the most important indicators of climate change. Precise monitoring of changes in this MSL is crucial for understanding the climate but also the socio-economic consequences of any rise in sea level.

The first version of the Sea Level ECV covered an 18 years-long period and was released during phase I in 2012. The ECV consists in monthly gridded maps of averaged sea level anomalies combining all the altimeter missions available at a given time.

One of the major objectives of phase II is to better answer the users' needs and thus to provide time series as close as possible to the present. This requires the processing of recent additional years using the standards of the existing time series (orbit solutions, geophysical and instrumental corrections). This work has been performed in 2014 and the Sea Level ECV extension is now released. The product is available over the 1993-2013 period by request at info-sealevel@esa-sealevel-cci.org.

Climate / ocean indicators are derived from the products and are also available for the users:

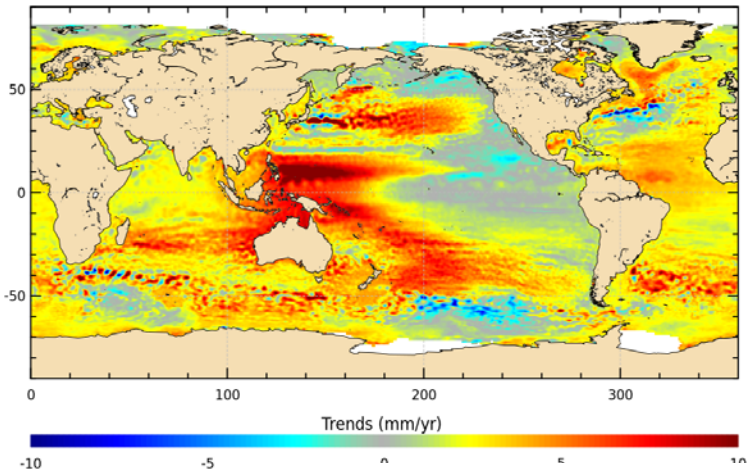
- the temporal evolution of the MSL over the global ocean and the associated trend over 1993-2013,
- the map of the regional distribution of the MSL trends over the period,
- the map of the amplitude and phase of the annual signal of the sea level.

The global MSL trend derived from the gridded merged altimeter sea level maps is presented on the figure above. It reveals that the mean level of the global ocean is rising by 2.85 mm/yr over the last two decades. At inter annual timescales, the impact of the 1997 El Nino event is detected with an increase of the global MSL of 10 mm. Similarly, the 2010 La Nina event is also observed at global scale with a drop of the sea level of ~4 mm.

The mean sea level of the global ocean is rising but large discrepancies can be found at regional scales. This is illustrated in the figure below which displays the regional distribution of the MSL trends. A stationary sea level and some negative values can be found in some regions, reflecting a decreasing mean sea level over the period, whereas positive trends are observed in large areas. In particular, the largest increase of the MSL is located in the western tropical Pacific Ocean (10 mm/yr).

During phase I of the project, the uncertainties of the altimeter sea level estimations have been determined when possible at global and regional scales for the long-term drift, the inter-annual and annual signals. The error on the global mean sea level trend has been determined to be lower than 0.5 mm/yr and during phase II, a specific task is dedicated to the assessment of the ECV products by the Climate Research Group: a confidence envelope of the ECV time series has been characterized (Zawadzki et al., OSTST 2014) and the work now focuses on reducing the uncertainty at regional scales. In addition, the ECV validation is done through assimilation and comparison with ocean models outputs and the ECV errors will be characterized through sea level closure budget analyses and international inter comparison exercises.

These elements clearly demonstrate that satellite altimetry is fundamental for the analysis of the evolution of the Sea Level Essential Climate Variable.



Regional Mean Sea Level trends (v1.1 ECV 1993-2013)

Access to products:
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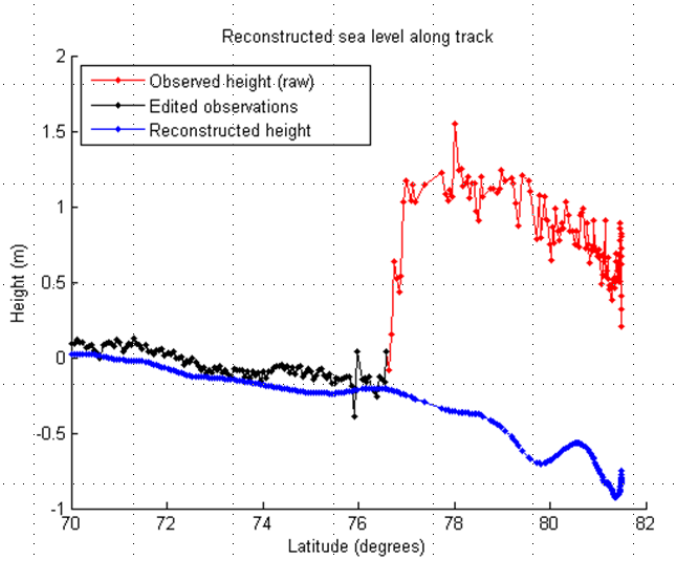
The Sea Level estimation in the Arctic Ocean

One of the major objectives of phase II is to better answer the users' needs and thus to reduce the uncertainty of the sea level measurements. In particular, a specific work focuses on improving the sea level estimation in the Arctic Ocean. Through phase I of the CCI project methods for re-editing and reprocessing the ERS and ENVISAT data significantly enhanced the data coverage providing more than twice as many quality ensured sea level observations in the Arctic Ocean.
In phase II DTU will work on extending the time-series to ingest the Cryosat-2 data in the Arctic, but also work on an experimental reconstructed sea level product for the ENVISAT and Cryosat-2 period to extend the time-series as shown in the Figure 1. Here the four year weekly sea level products from Cryosat-2 has been used to derive the spatial pattern of sea level change in the Arctic in an Empirical Orthogonal Function reconstruction. The figure shows an Envisat track crossing the Arctic Ocean into the ice. The reconstruction (blue curve) is shown along with the observed Envisat sea level timeseries in validated points (black curve) to extend the Envisat sea level time-series into regions where the Envisat observations are rejected as bad (red color).



Reconstructed Envisat along-track sea level crossing the Arctic Ocean into the ice.

2014 Publications

A publication that describes the SL_cci project and the main results of phase I in now available:
Ablain M., A. Cazenave, G. Larnicol, M. Balmaseda, P. Cipollini, Y. Faugere, M.J. Fernandes, O. Henry, J.A. Johannessen, J. Legeais, B. Meyssignac, N. Picot, M. Roca, S. Rudenko, M.G. Scharffenberg, D. Stammer, G. Timms, P. Knudsen, O. Andersen, and J. Benveniste: Improved Sea Level record over the satellite altimetry era (1993-2010) from the Climate Change Initiative project, Ocean Science, 2014.

Find below the other peer-reviewed articles published by the SL CCI team in 2014.

- Cazenave A., Dieng H.B., Meyssignac B., von Schuckmann K. Decharme B. and Berthier E., The rate of sea level rise. Nature Climate Change, vol 4, 358-361, DOI: 10.1038/NCLIMATE2159, 2014.
- Couhert A.; L. Cerri; J.-F. Legeais; M. Ablain; N. Zelensky; B. Haines; F. Lemoine; W. Bertiger; S. Desai; M. Otten; Towards the 1 mm/y Stability of the Radial Orbit Error at Regional Scales, Advances in Space Research, 2014.
- Dieng, H.B., Palanisamy H., Cazenave A., Meyssigac B. and von Schuckmann K., The sea level budget since 2003; Inference on the deep ocean heat content, submitted Surveys in Geophysics, 2014.
- Feng, X., M. Tsimplis, G. Quartly, M. Yelland, 2014, Wave height analysis from 10 years of observations in the Norwegian Sea, Cont. Shelf. Res. 72, 47-56. doi: 10.1016/j.csr.2013.10.013
- Feng, X., M. Tsimplis, M. Yelland , G. Quartly, 2014, Changes in significant and maximum wave heights in the Norwegian Sea, Glob. Plan. Change. 114, 68-76. doi: 10.1016/j.gloplacha.2013.12.010
- Henry O., Ablain M., Meyssignac B., Cazenave A., Masters D., Nerem S., Leuliette E. and Garric G., Investigating and reducing differences between the satellite altimetry-based global mean sea level time series provided by different processing groups, J. of Geodesy, 88:351–361, doi: 10.1007/s00190-013-0687-3, 2014.
- J. A. Johannessen, R. P. Raj, J. E. Ø. Nilsen, T. Pripp, P. Knudsen, F. Counillon, D. Stammer, L. Bertino, O. B. Andersen, N. Serra and N. Koldunov (2014) Toward Improved Estimation of the Dynamic Topography and Ocean Circulation in the High Latitude and Arctic Ocean:The Importance of GOCE, Survey in Geophysics, Springer, DOI 10.1007/s10712-013-9270-y.

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- Legeais, J.-F., Ablain, M., and Thao, S.: Evaluation of wet troposphere path delays from atmospheric reanalyses and radiometers and their impact on the altimeter sea level, Ocean Sci., 10, 893-905, doi:10.5194/os-10-893-2014, 2014.
- Palanisamy H., Cazenave A., Meyssignac B., Soudarin L., Woppelmann G. and M. Becker, Regional sea level variability, total relative sea level rise and its impacts on islands and coastal zones of Indian Ocean over the last sixty years, Global Planetary Change, 2013,doi: 10.1016/j.gloplacha.2014.02.0001.
- Palanisamy, H. Cazenave A., Delcroix T. and Meyssignac B., Spatial trend patterns in Pacific Ocean sea level during the altimetry era: the contribution of thermocline depth change and internal climate variability, Ocean Dynamics, in revision, 2014.
- Rudenko, S., Dettmering, D., Esselborn, S., Schöne, T., Förste, C., Lemoine, J.-M., Ablain, M., Alexandre, D., Neumayer, K.-H. (2014): Influence of time variable geopotential models on precise orbits of altimetry satellites, global and regional mean sea level trends. Advances in Space Research, in press, http://dx.doi.org/10.1016/j.asr.2014.03.010.

See http://www.esa-sealevel-cci.org/node/177 for a complete list since 2011

Sea Level CCI promotion – Events

The SL_cci project was represented at the following colloquia and meetings:

EGU Annual General Assembly, 27th April – 2nd May 2014, Vienna, Austria.
http://www.egu2014.eu/
The 40th COSPAR Scientific Assembly 2nd -10th August 2014, Moscow, Russia
http://cospar2014moscow.com/
The EUMETSAT Meteorological Satellite Conference, 22nd – 26th September 2014, Geneva, Switzerland
https://www.eumetsat.int/website/home/News/ConferencesandEvents/DAT_2076129.html
The 2014 Climate Symposium, 13th – 17th October 2014, Darmstadt, Germany
http://www.theclimatesymposium2014.com
CCI Collocation meeting, 20th – 24th October 2014, ESRIN, Frascati, Italy
SAR Altimetry Training Course, 21st – 22nd October 2014, Constance Lake, Germany
Please visit the dedicated web page in the 8th Coastal Altimetry Workshop site: http://www.coastalaltimetry.org
8th Coastal Altimetry Workshop, 23–24 October 2014, Constance Lake, Germany: http://www.coastalaltimetry.org/
Ocean Surface Topography Science Team meeting, 28th – 31st October 2014, Constance Lake, Germany
http://www.ostst-altimetry-2014.com
The extension of the Sea Level ECV is now available and promoted at the **AGU 2014 Fall meeting** 15th – 19th December, San Francisco, California, USA, http://fallmeeting.agu.org/2014/
The **first annual review** of the project (phase II) will take place in Toulouse, France on 29-30th January 2015.

All the developments performed within the project on altimeter standards and errors reduction will provide us with the opportunity to increase the synergy between the altimeter experts and the "atmosphere" and "sea ice" communities in particular. This will also enhance the link with other ECVs (SST, Sea Ice and Ice Sheets). In this context, several workshops are planned wand in particular:
ISSI workshop (International Space Science Institute), 2-5 February 2015, Bern, Switzerland: "Sea Level and associated climate components at global and regional scales as inferred from the ESA Climate Change Initiative (CCI)".

The Sea Level CCI consortium:

The production of SL_cci extensive results has been made possible by the coordinated work of a pan-European organization (the ESA Sea Level CCI project consortium). The project team is composed of 11 European partners from the Earth Observations community (CLS, GFZ, IsardSat, DTU, LEGOS, FCUP, NOC and PML) and partners from the Climate modelling community (LEGOS, UoH, ECMWF, NERSC and CLS), all which hold internationally acknowledged expertise in their respective fields. The consortium is led by CLS, which is responsible for the overall project management (together with CGI) and the technical activities that are related to the development and testing of the algorithms as well as the sea level ECV production.

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