climate change initiative

→ SEA LEVEL NEWSLETTER

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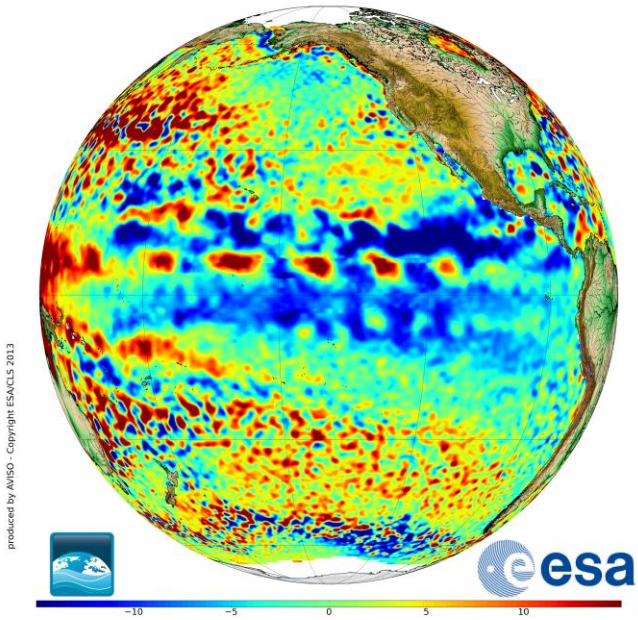


The Pacific sea level anomalies in December 2010 during the 2010-2011 La Niña.

In this issue:

A new chapter is underway...

It is an incredibly exciting time for the Sea Level CCI project team. The first 3 years (2011-2013) of the project are now completed and a new chapter is underway for the next 3 years.

The first phase of the Sea Level CCI project was 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. 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 for sea level closure budget studies (see following article).

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 and ERS-1 / ERS-2 / 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 the phase II will allow us to explore a lot of things: many altimeter standards remain to be evaluated and the altimetry errors should be reduced in some specific areas (coastal, Arctic). Above all, regular update of the sea level ECV should be provided, as required for climate studies. These updates should include the integration of new altimeter missions (CryoSat-2, SARAL-AltiKa, Sentinel-3 and Jason-3).

Sea Level CCI: transition to phase II

The global mean level of the oceans is one of the most important indicators of climate change. Precise monitoring of changes in the mean level of the oceans is crucial for understanding not just the climate but also the socio-economic consequences of any rise in sea level.

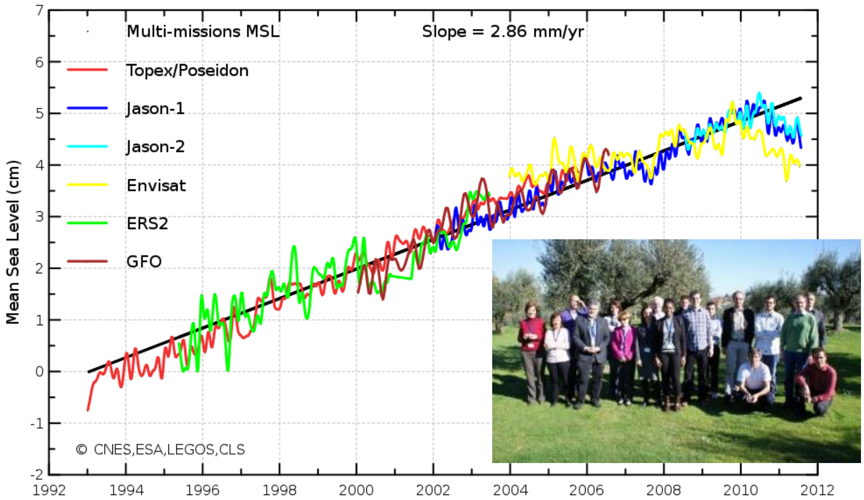
The Sea Level Essential Climate Variable (ECV) products produced during the ESA Climate Change Initiative phase I are Monthly gridded maps of averaged sea level anomalies (SLA) combining all the missions available at a given time, and oceanic indicators (global value and regional distribution of the Mean Sea Level trend).

The CCI phase I achievements have encouraged the continuation of the work by launching the phase II of the program. This new phase, started in 2014 for 3 additional years, will allow us to explore the new areas of improvement which arose in phase I.

Evolutions of the algorithms are central to the project since they affect the physical content of the Sea Level CCI ECV products. The strategy is thus to refine the user requirements and to focus on the improvement of the altimeter corrections which constitute the most important sources of errors with respect to the climate scales. The main challenges are:

- Altimeter and radiometer processing: use a multi-mission instrument expertise to enhance all the altimeter and radiometer calibration accuracy.
- Improved orbits: provide the best homogeneous solution for all missions.
- Sea Level corrections: homogeneous and stable time series using, for example, the most recent reanalyzed models.
- Arctic region: reduce the altimetry errors at high latitudes.
- Coastal areas: improve the sea level near the coasts.

All these developments will provide us with the opportunity to increase the synergy between the altimeter experts and other communities, particularly the atmosphere and sea ice communities.



One of the major objectives of phase II is to better answer the users' needs. This requires evolutions like the integration of new geophysical corrections (ocean tide, atmospheric corrections, Mean Sea Surface...) and new datasets (reprocessed Envisat, Jason-1 GDRs...). The processing will also have to be adapted to integrate new altimeter missions (CryoSat-2, Saral) and to improve the merging and mapping algorithms.

In addition, the users need time series as close as possible to the present. The main challenges of phase II concerning the system production will be to extend the coverage of the products temporally and geographically and to evolve from a prototype to a sustainable system. Thus, the production strategy in phase II is to provide extensions of the time series every year. This means processing recent additional years using the standards of the existing time series. In 2014, the available SL V1.1 ECV will be extended until December 2013. A full reprocessing of the ECV products will be performed in 2016, leading to a V2 dataset covering the 1993-2014 period. After each extension and the full reprocessing, an internal validation of the dataset will be performed, including internal consistency checks and comparisons with other products and with independent in-situ measurements.

A specific task will be dedicated to the assessment of the ECV products by Climate Research Group: this will first be done through assimilation and comparison with ocean models outputs. The error of the products will be characterized through sea level closure budget analyses and international inter comparison exercises. This work will be performed keeping in mind the phase I achievements. This will be the opportunity to increase the link with other ECVs (SST, Sea Ice, Ice Sheets).

The new ECV versions will be distributed on request to users.

The production of such 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.

Access to products:

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Validation of the SL-CCI products

Validation is one of the key features of the CCI project. This work is currently in progress within the Sea level CCI

The CCI 'Sea Level' products delivered at the end of Phase 1 have been validated and evaluated through two different approaches:

1. Assessment of the CCI 'Sea Level' ECV through its use in different ocean numerical models, ocean reanalyses and Earth system models
2. Assessment through the sea level closure budget

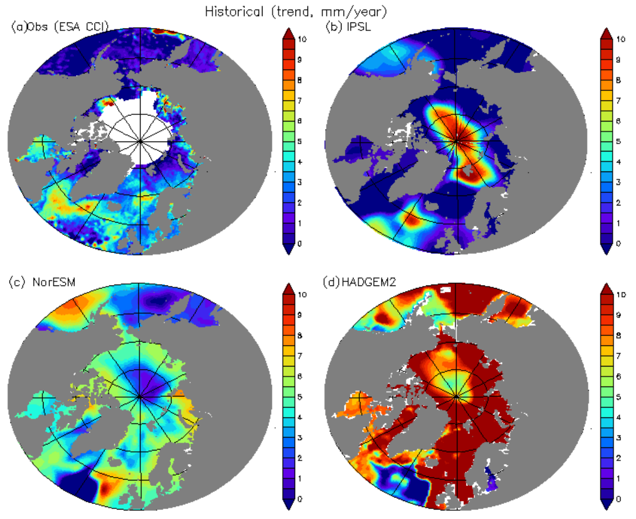
In approach (1), the impact of the CCI 'Sea Level' data are evaluated by quantifying changes of the model performances and robustness (compared to using a reference sea level data set, e.g., AVISO standard data) in representing a number of physical processes (e.g., the sea level drop associated with the 2011 La Nina, the Indonesian throughflow, changes in the Arctic circulation, effects of monsoon on sea level, regional sea level fingerprint due to wind stress, steric sea level trend patterns, etc.). For instance, left figure below indicates that the NorESM model provides the most similar sea level trends to altimeter measurements in the Arctic Ocean.

Approach (2) consists of comparing the global mean CCI 'Sea Level' trend and variability to the sum of the climatic and non-climatic components estimated independently: thermal expansion using XBT and Argo data, glacier melting from in situ and space-based observations, ice sheet mass balance from satellite altimetry, InSAR and Grace space gravimetry and land water storage change from GRACE and hydrological modeling. Additional 'solid Earth' effects such as 'Post Glacial Rebound' are also taken into account. The mass component (sum of land ice melt and land water storage) can also be estimated using GRACE space gravimetry data over the oceans. For the ice sheets and glacier components, results from other CCI projects will be integrated in the comparison.

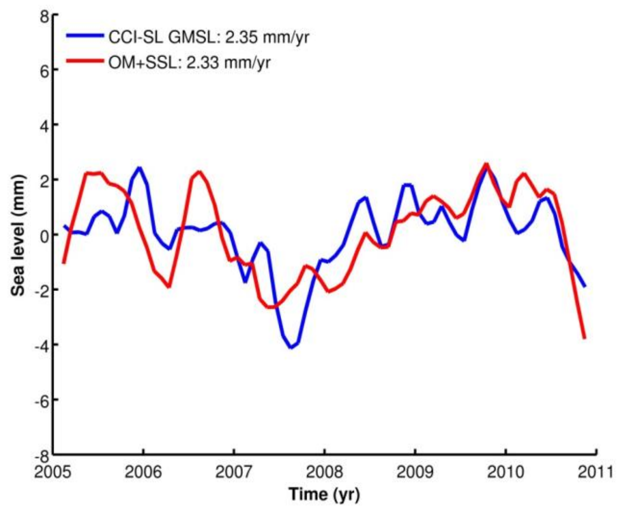
An example of approach 2 (inter annual variability only) is shown on the right figure below. The climatic contributions are estimated using Argo data for the steric effect and GRACE for the ocean mass component. Time series are detrended. This sea level closure budget approach reveals a particularly good correspondence between the SL-CCI dataset and external and independent measurements.

These two approaches have been implemented during the phase I of the SL-CCI project and it has been very interesting since it has provided a good overview of the quality of the CCI 'Sea level' products (global, regional, trends and inter annual variability). It also has allowed the ocean / climate modeling community to better analyze the sensitivity of the models and to highlight the difficulty of assessing the errors at climate scales.

During phase II of the project, in addition of the assessment of output products by the climate research group, the work will also focus on the error characterization and the inter comparison of the products with other datasets from international groups.



Derived high latitudes and sea level trends from CCI and three coupled climate models.



Global CCI Mean Sea Level inter annual evolutions (detrended) compared with the Ocean Mass plus the steric (Argo) sea level contributions.

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2014 Publications

Find below the 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, 2013, doi: 10.1038/NCLIMATE2159.
- 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, 2014, submitted to Advances in Space Research
- 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. and Garric G., Effect of the processing methodology on satellite altimetry-based global mean sea level rise over the Jason-1 operating period, 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.
- 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.
- 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

Upcoming events

The SL CCI project will be 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

Ocean Surface Topography Science Team meeting, 28th – 31st October 2014, Constance Lake, Germany
http://www.ostst-altimetry-2014.com

Prior to the « New frontiers of Altimetry" meeting, the 8th Coastal Altimetry Workshop will be held in Konstanz on 23–24 October 2014, so that delegates can conveniently attend all these related events. Please visit the dedicated web site for more information: http://www.coastalaltimetry.org/

AGU 2014 Fall meeting 15th – 19th December, San Francisco, California, USA
http://fallmeeting.agu.org/2014/

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