climate change initiative

→ SST NEWSLETTER

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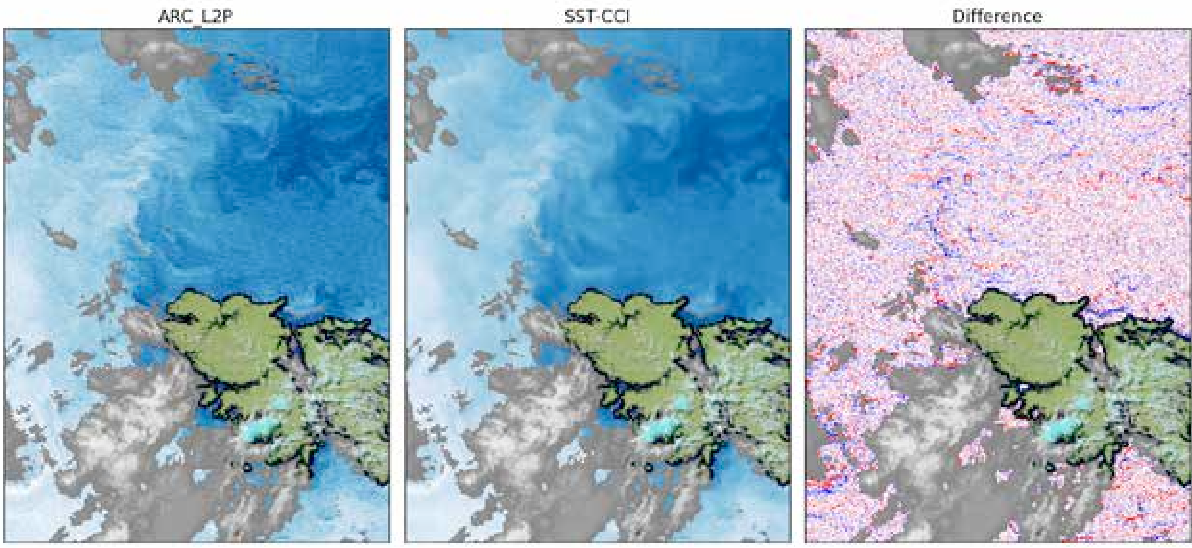

Figure 1: Left: full resolution (1 km) AATSR SST image from ATSR third reprocessing. Clouds over the ocean are rendered on a grey scale, and the green feature is land. The rendering of temperature is such that the warmest temperatures are deep blue and cooler temperatures are pale. Middle: new result, using new technique to reduce noise amplification in the process of retrieval. Right: noise removed. See Article 'New Reprocessing Method gives less noisy view of Ocean Temperatures' on page 2 for more information.

In this issue:

First SST CCI Products Generated in New Integrated Processing at Harwell

The computing power of the Climate and Environmental Monitoring from Space (CEMS/Jasmin) facility has been used to produce experimental products for SST CCI Phase 2. Previously, the climate data record (CDR) produced in Phase 1 had to be generated in three different locations.

In Phase 2, all processing for SST CCI is being integrated at a single location, greatly improving the sustainability of CDR generation. This is possible because of the rapid development of the CEMS/Jasmin facility over the past few years. SST CCI's use of the CEMS/Jasmin facility is substantially supported by the UK's National Centre for Earth Observation (NCEO).

The CEMS/Jasmin computing facility can directly see and write to the impressive storage capability of the Centre for Environmental Data Archival (CEDA). This means that all input datasets, both satellite data and auxiliary information, are rapidly accessible at a single location. Processing times are greatly enhanced over the previous distributed systems, and this allows researchers to get faster feedback on the scientific developments they implement.

The experimental products (versions EXPv1.x) span 1991 to 2013, and are presently being thoroughly validated. As well as testing the migration to a new computing infrastructure, the recent reprocessing includes some experimental new algorithms whose impacts on the SST CDR are being assessed (see next article 'New Reprocessing method gives less noisy view of Ocean Temperatures').

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New Reprocessing method gives less noisy view of Ocean Temperatures

New Sea Surface Temperature products were generated experimentally by SST CCI in March 2015. These included full resolution data from the Along Track Scanning Radiometers (ATSR) using a new retrieval method that reduces the noisiness of full resolution SSTs.

Although ATSRs are generally relatively low noise sensors, the process of low-bias SST determination using dual-view capability amplifies the sensor noise and creates images that look noisy. Smoothing of the SST could address this cosmetically, but this would degrade the feature resolution and real data quality, which is not satisfactory. Instead, a new theoretical development by SST CCI has been tested: namely, multi-channel smoothing of the atmospheric influence on observed ATSR brightness temperatures.

The conditions of the atmosphere vary more slowly with horizontal distance than the SST. The process of SST retrieval can be viewed as estimating the atmospheric influences on brightness temperatures and removing them to reveal the SST that underlies the atmosphere.

The new method estimates atmospheric influences across a wider area around a given image pixel, but treats the SST estimation at full resolution. Compared to older methods (left panel of Figure 1), the new SSTs are less noisy (middle panel), NOT because the SST has been smoothed (it has not), but because the new retrieval method amplifies noise less and gives a more faithful rendering of the true SST variation. The noise removed by the new method compared to the old method is shown in the right panel of Figure 1.

Atmosphere smoothing has been used elsewhere before, but the new SST CCI approach maximises the benefit using a new multi-channel approach.

Additional Microwave and Argo Research

Two new work packages (WP) are about to start. The Argo WP addresses the key challenge of establishing the stability of CCI SSTs on a global basis. The Microwave (MW) WP will focus on the development, assessment and therefore suitability of MW SST products from AMSR-E and AMSR-2, to be used with the longer-term IR record in the context of stable, accurate climate data records of SST.

The aim of the Argo WP is to address whether the Argo network offers a satisfactory stabile reference dataset in the 21st Century. This will be done by assessing the CCI SST dataset for artificial trends and step changes, through comparison with the moored buoy network, using near-surface observations from the Argo network of profiling floats as a stable reference data set. The results will be expressed as a statement as to whether any step changes are present in the CCI SST dataset, together with their magnitude. The long-term stability will also be expressed as a drift in K decade-1.

'Stability' is needed for comparability of SSTs over the long run. Establishing stability for the CDR requires comparison of CCI SSTs with a stable reference. Drifting buoys are not engineered to provide this. In Phase-I, tropical moored buoys (which are pre and post calibrated to SI standards) allowed stability assessment - but only for tropical regions. Now that the longevity of the Argo programme exceeds 10 years, it is timely to explore whether Argo can be used for global stability, at least since 2005. This is statistically more complex than for tropical moorings because Argo floats move around the ocean. For this reason, NOC has been added to the consortium to strengthen geo-statistical expertise.

The image below left shows the position and number of the Argo floats that have delivered data within the last 30days (as of 22/06/15). Source and picture credit: http://www.argo.ucsd.edu/

The aim of the Microwave WP is to develop an optimal estimation for AMSR MW SST and assess the impact of MW in L4 analysis relative to L4 analysis (including AVHRR GAC). This will be done by addressing the development of MW SST products from AMSR-E and AMSR-2, followed by validation and blending of the data set in a 0.05° resolution analysis together with infrared (IR) reference sensors (2002 to 2016). We will then assess the degree to which MW SST can be successfully used with the longer-term IR record in the context of stable, accurate climate data records of SST.

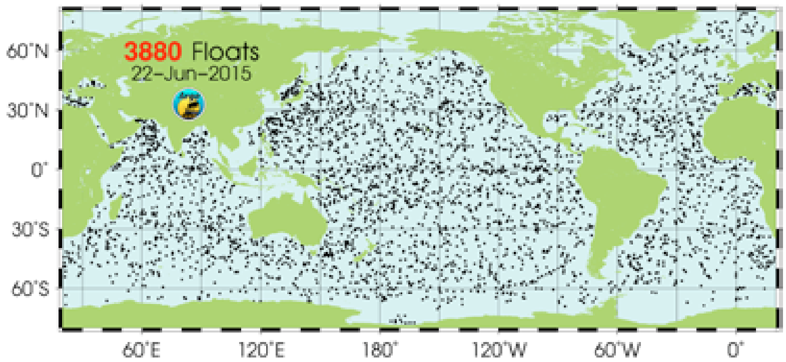

Figure 2: Global positioning of Argo floats.

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User Consultation on Representation of Uncertainty

The SST CCI project seeks to establish a method for communicating uncertainty in SSTs. This goal was the impetus for a workshop held in November 2014 in Exeter, UK, with participants from weather and climate research backgrounds.

One focus of the workshop was to clarify the distinction between error (mistakenness) and uncertainty (doubt, quantified as the standard deviation of an estimated error distribution). Earth observation data sets usually include errors on intermediate scales. These are generally related to ambiguity from atmospheric variability and therefore correlate on synoptic scales. The current SST CCI approach is to specify components of uncertainty from random, locally systematic, and systematic effects separately. In deriving uncertainty estimates across scales, these different components need to be propagated according to their correlation structure.

A few of the recommendations made by participants include:

- Full characterisation and clear documentation of the error model. Uncertainty components should be provided together with correlation information.
- Parameterised error covariance matrices, which can be large and difficult to use, to allow easy communication.
- Tools for appropriate uncertainty propagation, ensemble selection, or the creation of user-defined flags.
- Two major influences that govern how data is used are the scientific reputation of the producer and the precedent of successful exploitation. Because precedent is persuasive, data producers may be able to promote uptake of products by engaging trailblazer users with their improved uncertainty information.
- Data producers need to address uncertainty estimation in a rigorous, defensible manner by defining uncertainty traceability chains. Tracing an uncertainty budget through processing levels from instrumental measurement to geophysical product can be based on metrological norms.

The workshop concluded that uncertainty validation and verification are welcomed, but more reference data are needed.

Workshop recommendations are being used to update the SST CCI user requirements document. The organisers thank all participants for their enthusiastic contributions.

Figure 3 (below) shows an example day from a product of the SST CCI project. The inset shows a time series of SST from one location, together with an indication of its uncertainty (illustrative only). For the full article, see https://eos.org/meeting-reports/communicating-uncertainties-in-sea-surface-temperature from EOS.

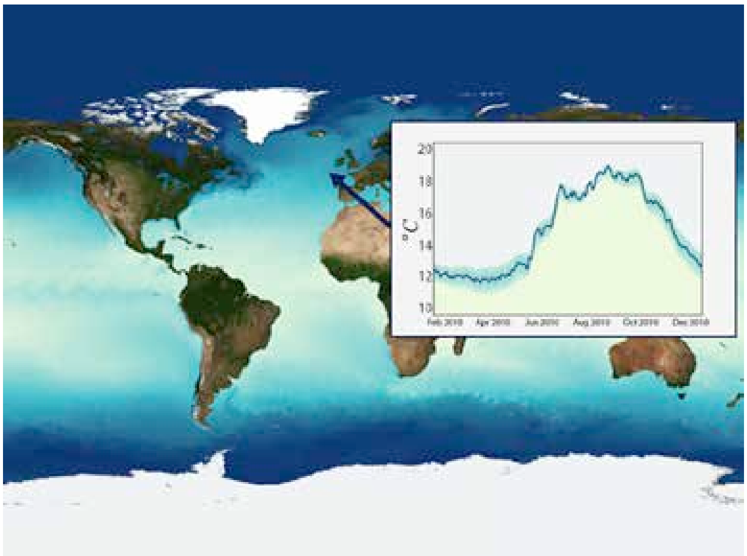

Figure 3. Sea Surface Temperature time series.

Global Area Coverage (GAC) Collection

The ESA SST CCI project has accumulated what we believe to be the most complete single archive of the AVHRR GAC Level 1B data, for the period 1978-2010, that exists anywhere.

To do this, we have taken data from the NOAA Center for Satellite Applications and Research (STAR) Advanced Very High Resolution Radiometers (AVHRR) Global Area Coverage (GAC) archive together with data from the NOAA Comprehensive Large Array-data Stewardship System (CLASS) archive and have added extra data from the AVHRR GAC archive held at the University of Miami. This archive contains some crucial overlap data taken when the operational status of one AVHRR satellite was switched to another. For many of the early AVHRRs these data are missing in the standard archives as they only kept data from sensors that were considered operational. Our new archive now includes these overlap data with approximately an extra one month of data during satellite switchovers for many of the earliest AVHRRs. This will provide much better continuity for sensor-to-sensor changes in the 1980s and 1990s.

We are continuing to extend the SST CCI AVHRR archive in order to cover the 2010-present period also. The plan is to continue to add to the AVHRR archive over the lifetime of the SST CCI project and to provide access to the full archive via the CEDA archive to the general community.

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SST CCI Lead Microwave SST Session

There was a session at the 16th Group for High Resolution SST (GHRSST) science team meeting, hosted by ESTEC in July 2015, on SST retrievals using Passive Microwave (PMW) sensors.

The purpose of the GHRSST science team meetings is to present, debate and decide on the best quality SST data for current and future work, by bringing together scientists who are working in the SST field from all around the world. The 16th meeting included talks by representatives from JAXA, RSS and SST CCI on their latest work in the PMW area.

This included work comparing retrievals from AMSR2 data with in situ measurements. The aim was to stimulate discussion during the session to address such questions as “What is limiting our ability to retrieve accurate SSTs from PMW sensors?” and “What is the most important step to move forward on to improve PMW data quality?”

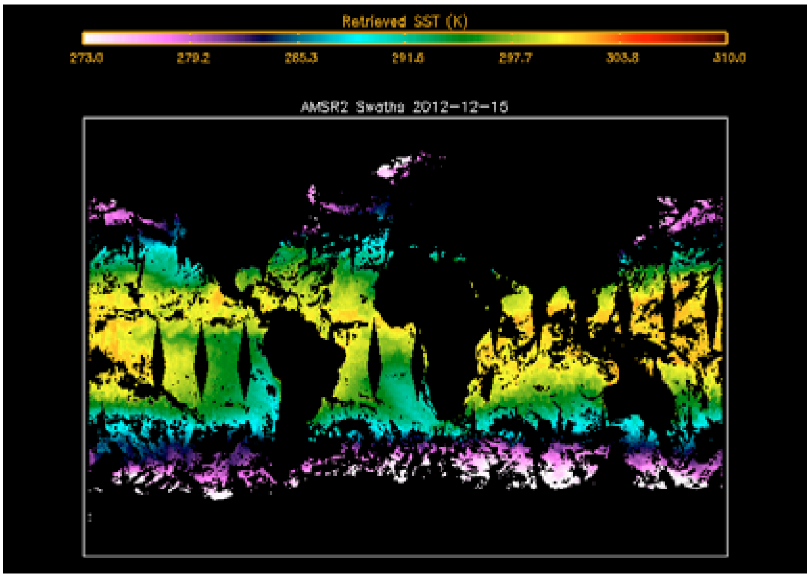

Figure 4. The X^2 screened SST from AMSR2, (credit Kevin Pearson).

Future Plans

The next major improvement of SST CCI capability will be the extension of the climate data record of sea surface temperature back to 1981, using the AVHRR meteorological sensors.

The future plans of the SST CCI project involve significant new scientific development to harmonise and stabilise satellite data prior to the era of stable dual-view reference instruments.

An experimental reprocessing covering 1981 to the ATSR era is due at the end of 2015, and will give important information to the team about how successful new methods have been and what challenges remain to achieve climate quality data. The newly integrated level 4 (spatially in-filled) processor will also be tested.

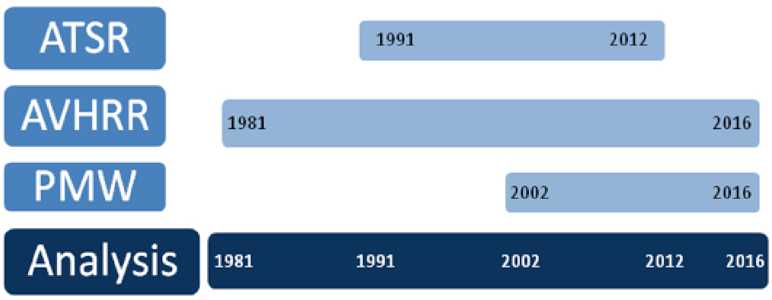

Figure 5. The era of satellite data due to be reprocessed in future work.

In parallel, preparations are underway for PMW remote sensing of SST within SST CCI (see above article ‘SST CCI Lead Microwave SST Session’). MW remote sensing is very different to thermal remote sensing using infra-red imagers. Fundamental work is ongoing to explore how much consistency with the standard SST climate data record can be achieved for MW.

During 2016 the consistency of MW for PMW remote sensing of SST with the standard SST climate data records will be tested in large scale processing. The final reprocessing of SST CCI in Phase-II is expected at the end of 2016, and will comprise satellite-specific products and a blended, daily, spatially completed SST product.

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