climate change initiative

→ CMUG NEWSLETTER

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The new Met Office supercomputer, and inset, illustrative model output of surface temperature, wind and air pressure.

In this issue:

The Climate Modelling User Group (CMUG)

The CMUG mission is to place a climate perspective at the centre of ESA's Climate Change Initiative (CCI). Previously, the climate data record (CDR) produced in Phase 1 had to be generated in three different locations.

CMUG is a consortium of major European climate modelling and reanalysis centres including the Met Office, Météo-France, the European Centre for Medium Range Weather Forecasts (ECMWF), the Max Plank Institute for Meteorology (MPI-M), Institute Pierre-Simon Laplace (IPSL), the German Aerospace Centre (DLR) and the Swedish Meteorological and Hydrological Institute (SMHI).

CMUG has four main objectives:

- Assessment of climate model simulations and reanalyses using CCI climate data records
- Providing independent feedback on the quality of the CCI datasets to the CCI ECV teams
- Demonstrate the added value of ECVs above current state of the art
- Engage with climate research community (CRC) to promote the value of using CCI datasets

CMUG started by establishing the user requirements of the climate modeling and reanalysis communities for ECV Earth observation datasets. User needs of other groups (GCOS, climate change impact modelers and Climate Services) were also included.

In Phase 1 CMUG assessed the climate quality of 12 CCI ECV datasets with a climate system and modeling perspective. This independent assessment was fedback to the CCI ECV teams through reports, meetings, presentations and journal papers. This assessment continues in Phase 2 with more detailed, integrated and robust experiments to fully test the CCI ECV data.

The CMUG also provides an integrating approach by providing consistency analyses between different ECV datasets, and estimating the uncertainty using climate models and reanalyses. The ECV datasets will have longer time series, reduced bias, and provide more metadata for users, such as better uncertainty characterisation, in Phase 2.

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CMUG Validation and Verification of ECVs

The CMUG provides an independent user perspective of ECV data.

CMUG provides independent verification of CCI data by comparing CCI data with existing global climate datasets and reanalyses, and by applying the CCI data in global and regional climate model simulations. Validation of CCI data by climate models can be through assimilation; by using the data as boundary conditions to drive the model; or by comparison with other datasets and models.

In each case specific information is learned about the climate quality of the data, the robustness of the climate model and the climate processes involved. In Phase 2 CMUG is running a dozen model-based experiments with CCI data.

As well as assessments for individual ECVs, cross-assessments will be completed for particular groupings of related ECVs which have direct or indirect climate system interactions to evaluate their relative effects. One example is the assimilation of marine ECVs (sea surface temperature, ocean colour, sea surface height and sea ice) in to the Met Office FOAM ocean model to assess the individual and joint impact that these data have on the model (see Fig. 1). Another is the cross assessment of CCI glacier, land cover and sea level being conducted by SMHI for the Arctic region to help understand the climate processes at work there.

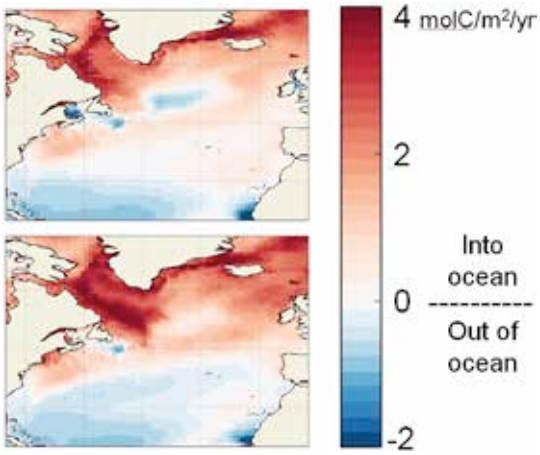

Figure 1: Simulations of ocean chlorophyll in the FOAM ocean model without (top) and with (bottom) assimilation of CCI Ocean Colour data. The bottom simulation closely matches the real world state as known from in-situ measurements (not shown).

CMUG scientific achievements

In Phase 1, CMUG developed methods and techniques for assessing the quality of CCI datasets, for example using the Climate Monitoring Facility (CMF) at ECMWF. The CMF is an interactive interface that facilitates the evaluation of multi-year variability of statistical averages computed from climate data records (CDRs). The CMF was used to assess the long-term homogeneity and consistency of CDRs, and this work continues in CMUG Phase 2. For the Ozone and Greenhouse Gases ECVs, monthly area mean quantities were compared with available reanalyses such as ERA-Interim and MACC. Climate variability was assessed by comparing the standard deviation of the data with the spread of the reanalysis ensemble. An assessment of modelled ozone data from the MACC model shows good agreement with CCI and ERA-Interim datasets for the period 1996-2012.
In another example, good spatial and temporal agreement was observed between CCI data and the JSBACH land surface model data (at MPI-M) for global mean soil moisture, especially over semi-arid areas, with good characterization of the Sahel's interannual anomalies (see Figure 2).

Future CMUG Phase 2 validation studies

In Phase 2, cross-assessments of CCI datasets are being performed to establish the sensitivity of individual ECVs and consistency between CCI datasets. A cross assessment of aerosols, clouds and radiation budget will use the ESMVal tool to show agreement between CCI Aerosol data, AERONET in-situ observations and MISR-MODIS model for the calibration period 1996-2012.

A cross assessment of clouds, water vapour, radiation and soil moisture (SM) aims to validate CCI data against modelled SM using the ALARO-HARMONIE regional climate model. This is examining the physical limitations of SM and cloud cover CCI data because satellite instruments are known to measure SM only in the top layer of soil. However, agreement between modelled SM in the top layer and deeper soil layers indicate that satellite data might be a reasonable proxy for deeper soil moisture dynamics.

CCI datasets are also being evaluated through a model intercomparison project using the CNRM Arpege and IPSL atmospheric models. CCI greenhouse gas data for carbon dioxide and methane are looking to better capture the spatial and temporal patterns observed in the in-situ data.

Climate model evaluation tools, including CMF and the ESMVal tool, are being developed for use with CCI data and are proving valuable for model verification and validation. The ESMVal tool supports the CMIP initiative which in turn validates the models used in the IPCC assessment reports. All this adds confidence when using CCI datasets more widely for benchmarking Earth system models.

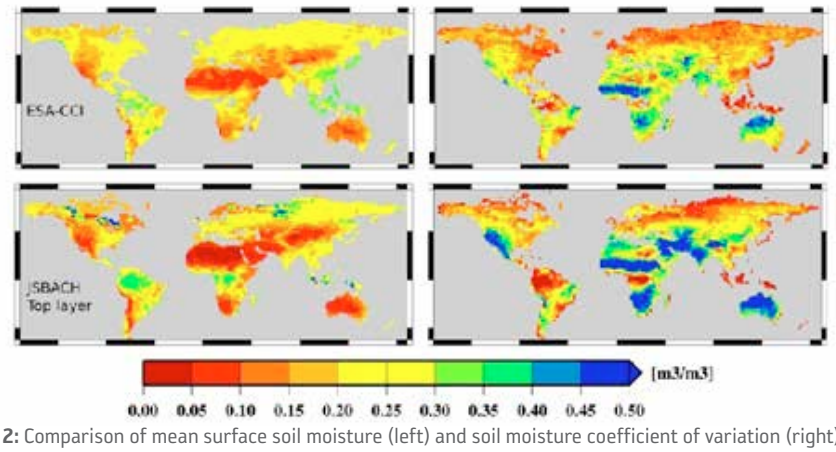

Figure 2: Comparison of mean surface soil moisture (left) and soil moisture coefficient of variation (right), across the ESA-CCI observational dataset (top row) and JSBACH model results (bottom row), for 2003-2009.

CMUG Feedback to ECV Data Teams

A key component of the CMUG project is to provide feedback to ECV teams on user requirements and data quality.

In addition to the CMUG modelling validation work which is discussed with the ECV climate research teams the CMUG also provides information on user requirements from across the climate research community to the CCI ECV teams.

User requirements were canvassed from seventy five experts across Earth system research. The requirements included the following considerations:

- To provide long term monitoring datasets to ascertain decadal and centennial climate change and variability
- to compare modelled with measured parameters from hourly to decadal timescales to assess (and constrain) internal processes and biases
- to initialise seasonal and decadal forecasting models and evaluate their forecast skill for short term climatic variations e.g. El Niño to identify biases in models and deficiencies in the observing network
- to provide homogenous data with good estimates of random errors and bias correction, in combination with independent in-situ observations.

CMUG interfaces with several key climate initiatives, for example the Global Climate Observing System (GCOS), World Climate Research Programme (WCRP), Working Group on Coupled Modeling (WGCM) and Copernicus Climate Change Services (C3S) - see Box on page 4.

CMUG provides an independent assessment of CCI data which is transparent and openly available. The feedback from CMUG to CCI ECV research teams takes an iterative approach for continuous development and improvement - see Figure 3.

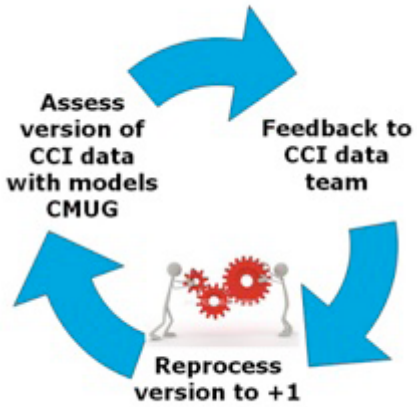

Figure 3. The virtuous circle of assessment, feedback and improvement.

CMUG demonstrates the value of CCI ECV data

CMUG demonstrates the value of CCI ECV datasets to the climate research community through:

- Demonstrating the climate quality
- Showing the consistency of the data across ECVs
- Suggesting improvements to the datasets
- Publicising and promoting their use to the climate research community
- Helping to enable access through the emerging climate services

CMUG has published five academic papers on the evaluation and validation of CCI ECV datasets and their impact on climate research. See for example Sevault et al., 2014, on the design evaluation of the ocean component of a fully coupled Mediterranean regional climate system model, and Ford et al., 2012, on assimilating observed ocean colour data into a FOAM-HadOCC physical-biogeochemical model. These make the validation methodologies and results available for scrutiny and demonstrate scientific rigour. One paper, published in the Bulletin of the American Meteorological Society (BAMS) gives an overview of the CCI

CMUG is working with research centres and projects outside the CCI on using CCI ECV data, for example, the Barcelona Supercomputing Centre (BSC), within the EC FP7 funded project on seasonal to decadal climate predictions for the improvement of European Climate Services (SPECS) is now using CCI ECV data.

The Obs4MIPs initiative makes observational products available for climate validation studies of the Climate Model Intercomparison Project (CMIP) – a major component of IPCC (Inter-governmental Panel on Climate Change) assessment reports. The CMUG works as an intermediary between the CCI ECV projects and Obs4MIPs advising on data preparation and submission.

CCI datasets have been actively promoted by CMUG to the climate research community through outreach and engagement with relevant European research projects, for example, EUPORIAS, EUCLEIA, IS-ENES2, CLIP-C, EURO-CORDEX, CORE-CLIMAX and PRIMAVERA.

References:

Sevault et al., 2014, A fully coupled Mediterranean regional climate system model: design and evaluation of the ocean component for the 1980-2012 period. Tellus 11/2014; 66.

Ford et al., 2012, Assimilating GlobColour ocean colour data into a pre-operational physical-biogeochemical model. Ocean Sci., 8, 751–771, 2012

Hollmann et al., 2013, The ESA climate change initiative: Satellite data records for essential climate variables. BAMS 94, 10, p. 1541-1552.

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Engaging with the Climate Research Community to promote CCI datasets

CMUG members have attended several key climate science conferences and publicised CMUG and CCI results in presentations and poster sessions. For example, in October 2014, CMUG co-chaired with ESA and presented the CCI project at the Earth Observations and CCI session at the 2014 European Climate Symposium.

CMUG also attended major multidisciplinary environmental science conferences such as the Living Planet Symposium 2013, and a CMUG poster was presented at Planet Under Pressure, London, 2012 (see picture).

In 2013, the Met Office hosted the 4th Working Group on Numerical Experimentation (WGNE) workshop on systematic errors in weather and climate models, where CMUG results were presented. CMUG's fourth integration meeting in 2014 was held at the Met Office and was attended by many of the climate scientists who work there.

In July 2015, CMUG organised a session at the UK Space conference in Liverpool to promote the UK's role in 'Space Enables Futures' and included a talk on the CCI.

CCI data are highly valuable for monitoring environmental conditions and are contributing to IPCC's Climate Assessment Reports. These comprise full scientific and technical assessments of climate change, together with authoritative summaries for policy makers.

CMUG regularly attends the EUMETSAT conferences, this year in Toulouse, and the European (EGU) and American (AGU) Geophysical Union conferences to promote the CCI ECV datasets.

CMUG and other CCI scientists at the 2015 Integration meeting at SMHI, Sweden.

Copernicus Climate Change Services (C3S) and CMUG

CCI datasets will be made available to Copernicus Climate Change Service (C3S) to support their operational service delivering climate services and products for the benefit of society. Currently under development C3S will make many Earth observation datasets, including many CCI ECV datasets, available to users. C3S is building a European knowledge base of reliable information on current, past, and future climate projections. The initiative is led by ECMWF and involves institutes across Europe.

Copernicus combines observational and model data using the latest science techniques to develop authoritative, quality assured information about the past, current and future states of the climate in Europe and worldwide.

CMUG is developing and validating state of the art climate models using CCI ECV data, and this model output could be of use to Copernicus. Such model data would include seasonal, inter-annual and decadal projections.

Provision of climate observations and model data is contributing to improvements in climate forecasts, research studies, and to policy and planning for climate change adaptation and mitigation. Copernicus will make such data available online with supporting tools and services.

Copernicus provides data to a wide user group including water management, energy, agriculture & forestry, health, transport, tourism, insurance and disaster risk reduction. CMUG science is therefore underpinning the use of CCI datasets for critical social and economic applications.

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