CMUG Deliverable

Number: D6.1
Due date: 10 May 2016
Submission date: 10 May 2016
Version: 2.0

Climate Modelling User Group

Deliverable 6.1

Scientific Exploitation Report

Centres providing input: MOHC

Version	Date	Comment
1	10 Jun 2015	Version 1
2	10 May 2016	Version 2

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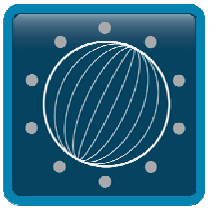

Contents

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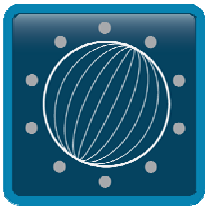
CMUG Scientific Exploitation Report

1 Introduction

Phase 2 of the CMUG project has been running since 2014 and includes engagement, exploitation and outreach activities for the climate research community (including reanalysis, climate impact studies and climate modelling), international coordinating bodies, scientific press, the general public and others with a general interest in the Earth climate system. This report documents the scientific engagement, and exploitation activities and their outcomes/success since the previous exploitation report (v1) of June 2015. CMUG has been delivering the following engagement and exploitation activities as described in the CMUG activity plan:

1. *Presentations on ESA CCI datasets during Phase 2 of the CCI.*
2. *Continued development of the CMUG web site to make the community aware of the CCI datasets content, quality and availability.*
3. *Maintain CMUG newsgroup where important announcements about the CCI datasets are sent out to registered users when CCI datasets become available.*
4. *High level awareness of the CMUG activities at the CMUG partner institutes.*
5. *Working level interactions with key scientists in climate modelling and reanalysis centres through the scientists in the CMUG institutes and invitations to CCI/CMUG meetings.*
6. *Ensure some of the CCI datasets are available from the Obs4MIPS site.*
7. *Link with GCOS activities through GCOS project office and AOPC.*
8. *Link with relevant EU projects which require CCI data as input. The CMUG has a wide involvement with such projects (e.g. IS-ENES2, SPECS, EUCLEIA, GAIA-CLIM…)*
9. *Attendance and/or presentations at key climate modelling, reanalysis and satellite data meetings by CMUG staff to promote the CCI datasets (e.g. CMIP5, WCRP Science conference, EUMETSAT Meteorological Satellite Conference, AMS, AGU, etc)*
10. *Give inputs to the WCRP GEWEX scientific steering group and sub-groups (e.g. WDAP, WGCM) as appropriate.*
11. *Co-ordinate outreach with individual CCI projects to ensure consistent message is given.*
12. *Advertise early use of CCI datasets in CMUG partner institutes.*
13. *By working with the CCI projects ensure that the CDRs (and associated observation operators) are easy to access and ingest in commonly used formats. In addition their error characteristics must be provided along with the datasets.*
14. *Links to EUMETSAT's proposed activities on climate monitoring – need to ensure complementarity and avoid any duplication of effort, etc.*



2 *Engagement and Exploitation*

2.1 Key engagement and exploitation activities

CMUG engagement and exploitation activities to the climate modelling and reanalysis communities (the CMC) and others (international bodies, business, and the general public) have continued through Phase 2 as updated versions of the ECV datasets have become available and have been assessed by CMUG and used by other research groups.

Various engagement and outreach activities are being carried out to publicise the CCI datasets to encourage their use and exploitation, and with the support of the CMUG validation reports. Such external data exploitation to date includes the use of CCI data for climate model initialisation, prescribing boundary conditions, assimilation, reanalysis, climate monitoring, and in-situ quality control. Examples of CMUG promoting CCI data externally where it is taken up in research are the SPECS-FP7 project, the Southern Ocean Observing System (SOOS) initiative, and a UK university, which are described in section 2.6.

The main means of communication to audiences outside the CCI is the CMUG project website (section 2.2), which provides project reports, newsletters and information on events (http://www.esa-cmug-cci.org). There is also a Data Forum (section 2.3) for user community participation that includes a blog, showcase and community pages, plus links to the CCI datasets (http://www.esa-data-cci.org/ecv.html) and is complementary to the CCI Open Data Portal. CMUG maintains a list of key contacts who are sent project information and updates on a regular basis (newsletters, email bulletins, etc)

CMUG attendance at national and international climate research events (conferences, unions, symposia, etc.) is another key channel through which information about the CCI reaches the scientific community and a wider set of stakeholders (scientific press, policymakers and 'interested' public). This work is supported by a range of media, (oral presentations, poster sessions, flyers, newsletters) including the recently produced CCI Visualisations that CMUG has shown at meetings on behalf of the CCI Visualisations project. A summary of meetings recently attended is given in Annex A1.

CMUG research results are also disseminated via peer-reviewed journals, and articles in programme bulletins. This is a specialist route to the climate science community and the scientific press. Activity in this arena and its outcomes are described in section 2.5.

Formal communication on CMUG outreach and engagement activities has been recorded in monthly and quarterly management reports and presented at CMUG management meetings and annual progress meetings with ESA. A listing of progress against planned events is given in Annex A2.

2.2 CMUG website

The CCI CMUG website (Figure 1) has been maintained with current information on project deliverables, scientific engagement, the scientific exploitation of CCI data, media outputs and events both past and

future. The CMC continues to be informed of CMUG news via electronic newsletters (Ten have been published in total to date). The site has also been updated with forthcoming CMUG events, posters, flyers, and significant reports and presentations. It also includes links to the ESA CCI programme website, to websites for CCI ECV projects, and partner organisations.

The CMUG website is supplemented by the CMUG Data Forum which provides an online discussion and information dissemination forum for the CCI. In January 2016 the Data Forum was refreshed with a different look and feel and new content described in section 2.3.

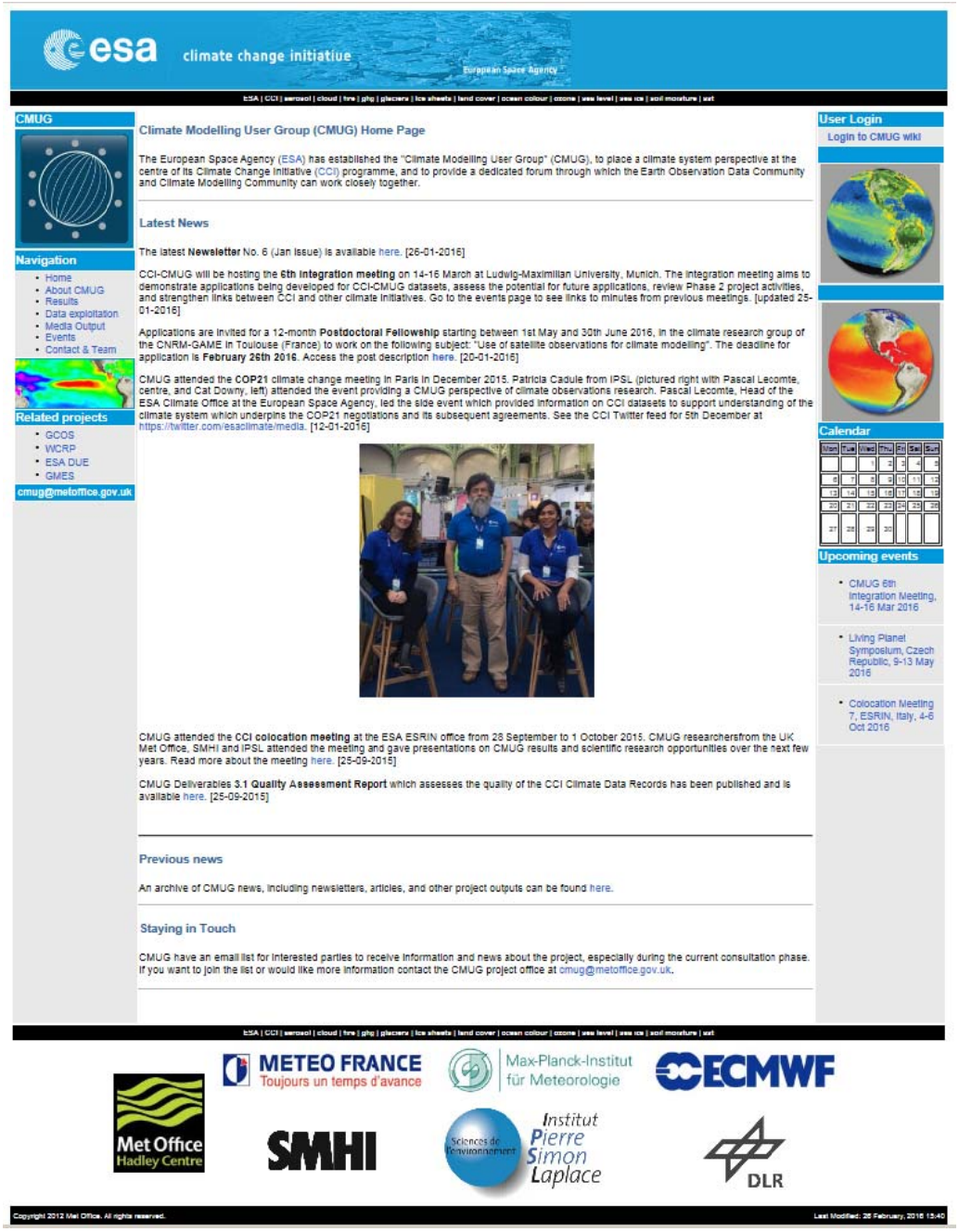


Figure 1: CMUG website front page (January2016).

Website traffic:

Web statistics were collected since May 2015 using Google Analytics. Figure 2 shows daily web traffic between May 2015 to Feb 2016. The data indicates a maximum number of visits between 10 and 20 per day, with peaks in visits in late May 2015 following the 5th CCI CMUG Integration Meeting and in June 2015. The summary pie chart shows that most traffic (58%) is from new visitors. Figure 3 shows CCI-CMUG website traffic (number of sessions) from May 2015 to Feb 2016 by location indicating that most visitors are located in UK, followed by Brazil, Germany, France and Italy.

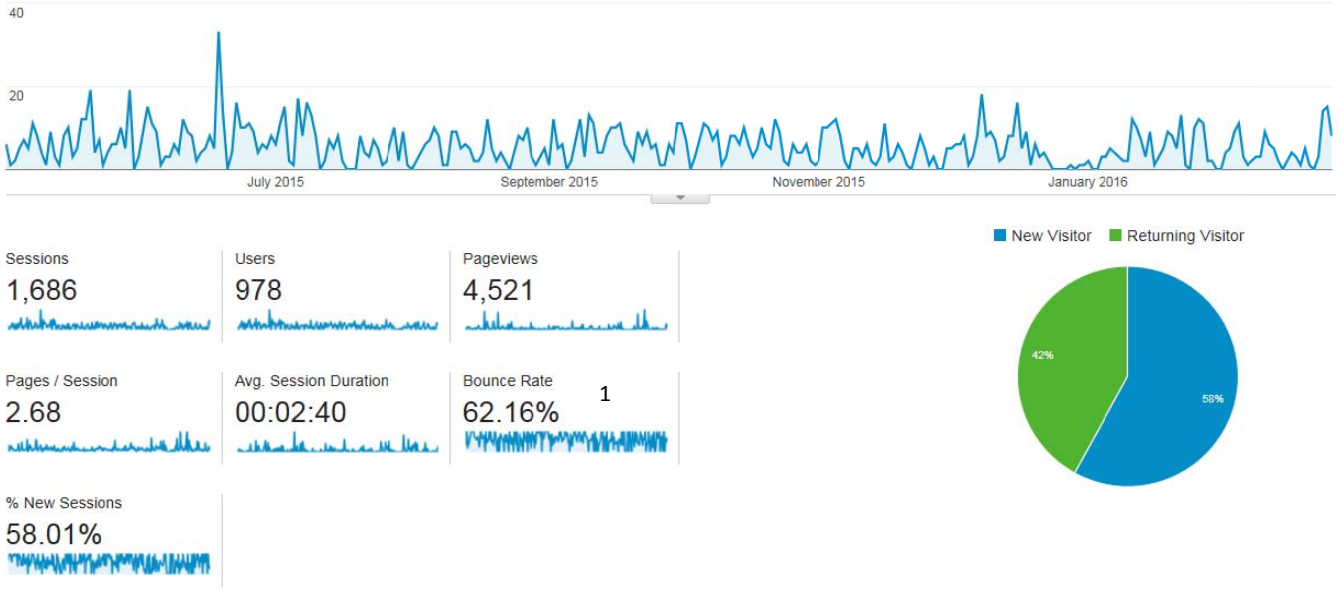


Figure 2: CCI-CMUG website traffic from May 2015 to Feb 2016 by new and returning visitor [1].

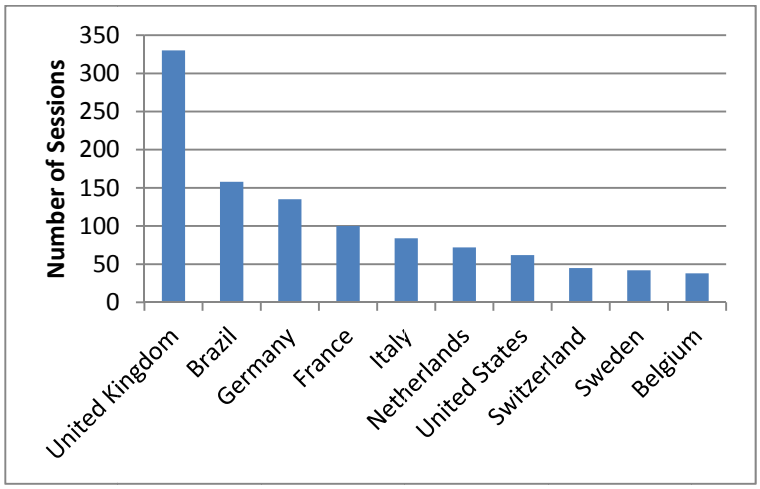


Figure 3: CCI-CMUG website traffic from May 2015 to Feb 2016 by location (UK visits have been adjusted for the influence of developer visits).

[1] Bounce Rate is the percentage of single-page visits (i.e. visits in which the person left your site from the entrance page without interacting with the page).

2.3 CMUG Data Forum

The CMUG data forum has been refreshed with a new look and feel (Figure 4). It continues to provide access to CCI datasets, and a forum for CCI data users to interact and record user experiences. The refreshed forum went live in January 2016, and includes links to CMUG data validation documents, metadata, individual ECV websites, and their data products (Figure 5). New content includes a video by CMUG chief scientist Roger Saunders outlining the CMUG project aims and achievements, and a blog by CMUG scientist Yoko Tsushima on her work with the CMUG global cloud datasets. The Data Forum complements the CCI Open Data Portal which went live in 2016, by providing an open forum for user discussion and feedback on CCI datasets.

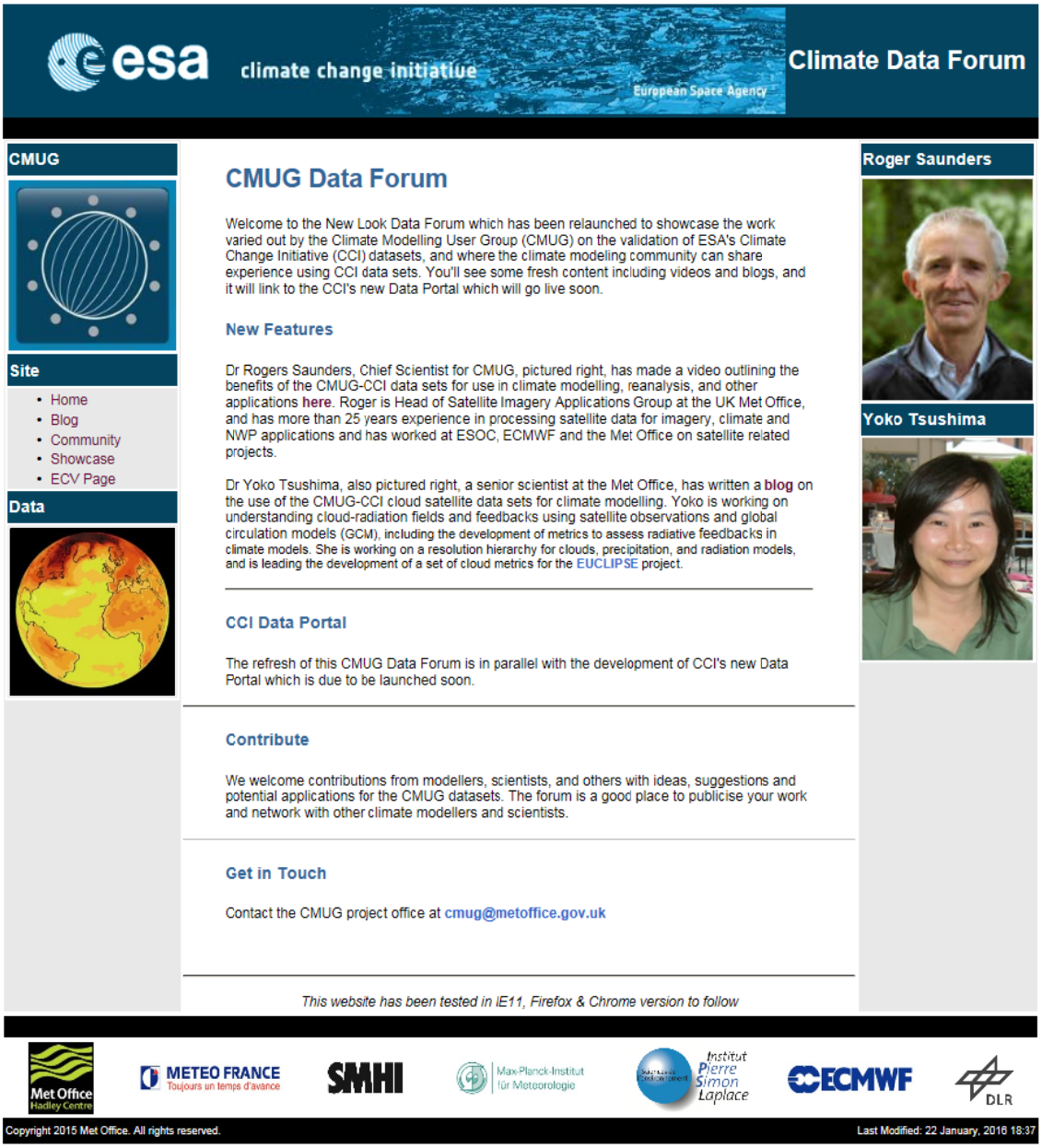
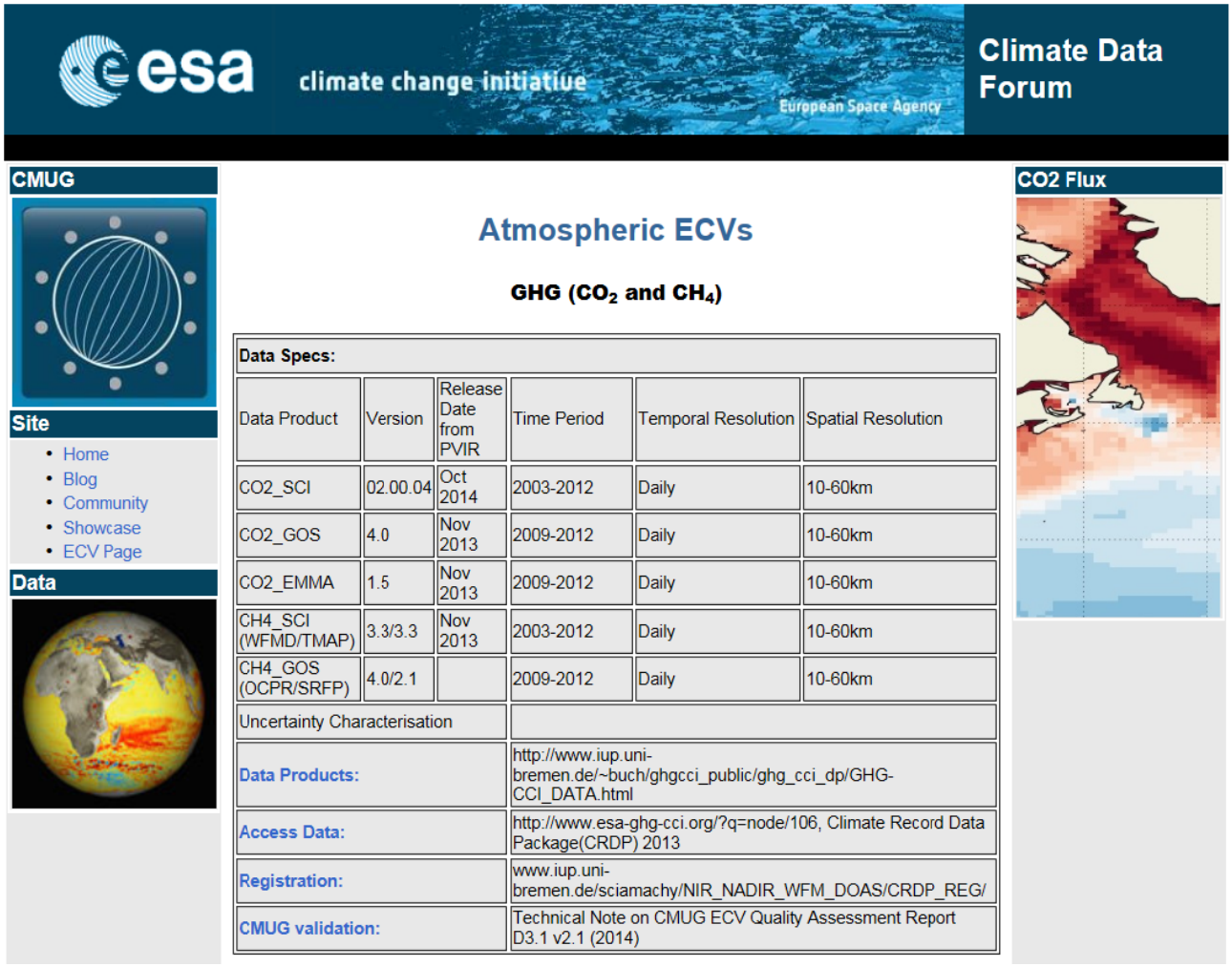


Figure 4: Front page of the refreshed CCI CMUG Data Forum.



Data Specs:					
Data Product	Version	Release Date from PVIR	Time Period	Temporal Resolution	Spatial Resolution
CO2_SCI	02.00.04	Oct 2014	2003-2012	Daily	10-60km
CO2_GOS	4.0	Nov 2013	2009-2012	Daily	10-60km
CO2_EMMA	1.5	Nov 2013	2009-2012	Daily	10-60km
CH4_SCI (WFMD/TMAP)	3.3/3.3	Nov 2013	2003-2012	Daily	10-60km
CH4_GOS (OCPR/SRFP)	4.0/2.1		2009-2012	Daily	10-60km
Uncertainty Characterisation					
Data Products:			http://www.iup.uni-bremen.de/~buch/ghgcci_public/ghg_cci_dp/GHG-CCI_DATA.html		
Access Data:			http://www.esa-ghg-cci.org/?q=node/106, Climate Record Data Package(CRDP) 2013		
Registration:			www.iup.uni-bremen.de/sciamachy/NIR_NADIR_WFM_DOAS/CRDP_REG/		
CMUG validation:			Technical Note on CMUG ECV Quality Assessment Report D3.1 v2.1 (2014)		

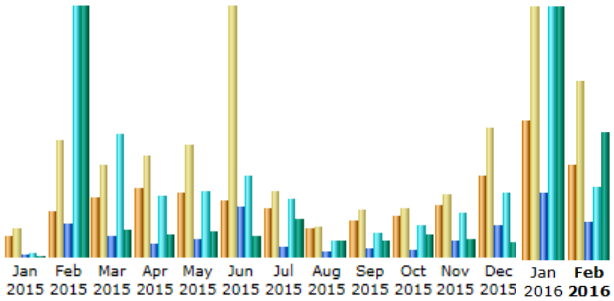
Figure 5: A page from the refreshed CMUG Data Forum, describing the data available for an ECV in the CCI, in this case the GHG data product range and key specifications are given.

The Forum provides links to key CMUG validation documents (Figure 5), especially the Technical Note on CMUG ECV Quality Assessment Report (Deliverable 3.1). This documents the details of the scientific evaluation of CCI datasets for quality and consistency.

Forum visitor statistics (Figure 6) show a total of over 11,000 hits in the period from Jan 2015 to date. Visits increased steadily from September last year with the number of visitors and the quantity of data downloaded peaking in February and dipping slightly in the summer holiday period. Peaks in the number of hits were recorded in February 2015 and at the end of May corresponding with the CCI CMUG 5th Integration Meeting.

Figure 7 shows the number of Forum visits from Jan 2015 to date by location. Most hits were from the UK, in part exaggerated by development activity, followed by the US, Ukraine (although this is not

easily explainable), Netherlands, Russia, Germany and France (Figure 7). These statistics provide a useful indicator of visitor numbers, but filtering by IP address would add definition in future.



Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2015	18	24	25	56	843.50 KB
Feb 2015	39	98	386	2,803	320.00 MB
Mar 2015	51	77	245	1,376	35.09 MB
Apr 2015	57	85	148	694	28.67 MB
May 2015	54	93	216	741	33.39 MB
Jun 2015	47	209	575	905	27.53 MB
Jul 2015	41	55	116	650	48.26 MB
Aug 2015	24	26	67	178	21.16 MB
Sep 2015	31	40	94	274	22.85 MB
Oct 2015	34	41	79	361	30.08 MB
Nov 2015	43	53	192	490	24.42 MB
Dec 2015	68	108	361	726	18.50 MB
Jan 2016	59	107	394	1,506	47.86 MB
Feb 2016	40	76	225	432	24.19 MB

Figure 6: CMUG data forum visitor statistics from Jan 2015 to date by month.

Locales (Top 25) - Full list

Locales		Pages	Hits	Bandwidth
Great Britain	gb	831	5,682	378.26 MB
Ukraine	ua	580	580	5.00 MB
United States	us	566	743	40.03 MB
Russian Federation	ru	119	183	6.13 MB
Netherlands	nl	78	569	53.93 MB
Germany	de	47	153	8.00 MB
France	fr	33	158	10.09 MB
China	cn	30	81	8.00 MB
Japan	jp	23	74	24.55 MB
Brazil	br	16	180	6.73 MB
Italy	it	16	73	7.60 MB
Czech Republic	cz	13	13	112.33 KB
Unknown	zz	13	13	98.04 KB
Spain	es	12	86	7.37 MB
Romania	ro	12	28	826.29 KB
Ireland	ie	12	12	192.66 KB
Switzerland	ch	11	69	3.93 MB
India	in	10	95	6.91 MB
Canada	ca	10	16	261.94 KB
Slovak Republic	sk	8	13	3.15 MB
Austria	at	6	33	1.58 MB
Mexico	mx	4	38	1.59 MB
Virgin Islands (British)	vg	4	4	61.71 KB
Portugal	pt	3	42	1.75 MB
Malaysia	my	3	23	1.28 MB
Others		44	293	33.40 MB

Figure 7: Data Forum visits by country.

2.4 Meetings & Workshops

Since the last report in June 2015, CMUG has organised or participated in several international meetings and workshops which are listed in Annex A1.

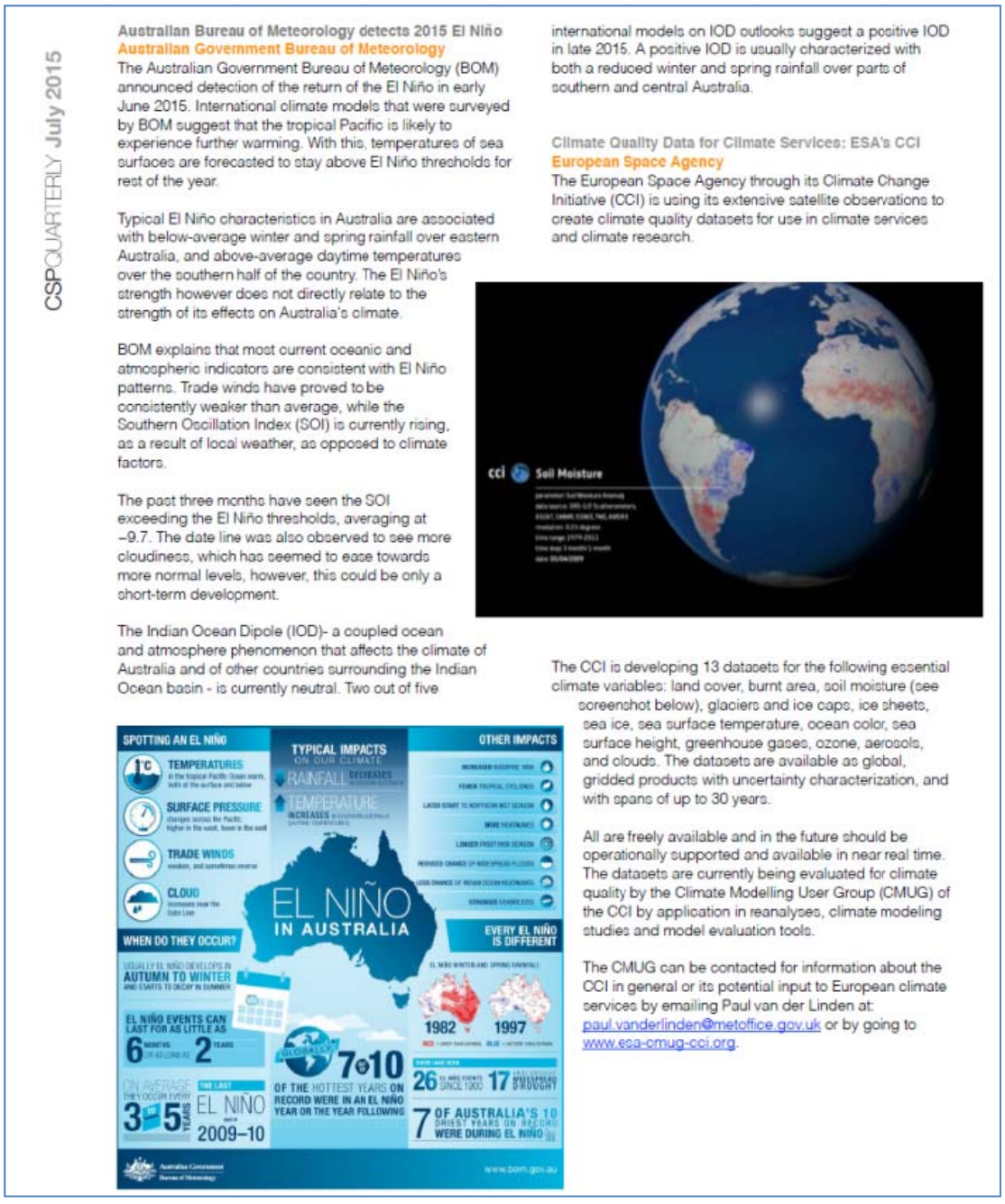
The 5th Project Integration meeting was held at SMHI Sweden in May 2015 and is reported in the previous version of this report. The **6th Project Integration Meeting** will be held 14-16th March at Ludwig Maximilians University (LMU) in Munich. The integration meeting will examine the current gridded climate observation datasets of the CCI programme, their validation by the CMUG climate modelling teams, their application in climate research, and their potential use in C3S.

There are annually a number of international climate conferences (e.g. EGU, AGU, AMS, EC funded project meetings) at which climate science research is presented and discussed. CMUG scientists have attended and presented CMUG results at these and other public events and conferences. CMUG participated in the AGU in San Francisco in December 2015 and a CMUG scientist gave a presentation the AMS conference in New Orleans in January 2016.

International coordinating bodies and programmes (WMO, WCRP, GRUAN, WOAP, EUMETSAT) hold regular meetings where CMUG scientists have presented programme information and results, either as members of these bodies, or by invitation as experts. Roger Saunders publicised CMUG activities in his presentation at the UK Space conference in July and at the EUMETSAT conference in September 2015. He also presented a poster at the Global Climate Observing System (GCOS) meeting in the Netherlands in March 2016 (See Annex A4). DLR gave a poster presentation on their development work with the ESMVal tool at the 14th Aerocom Workshop in Italy in October 2015.

A CMUG presentation was given at the UK Space conference in July 2015. UK scientists held a meeting *Climate Datasets from Space* on 1st February 2016 to capture the science successes and impacts of the current CCI programme, to discuss UK scientific contributions, and to look at future possible exploitation of CCI data sets. The meeting recognised the impact of CCI contributions to IPCC AR5 and the many potential applications for CCI data. It identified increased usage of CCI datasets by a wide range of users, particularly for SST, ocean colour, greenhouse gases, sea ice/cryosphere products and land cover, and acknowledged CMUG's contribution to the CCI programme. (*Source: Prof. John Remedios & Dr Sophie Hebden, Earth Observation Science group at the University of Leicester*).

In July 2015, CMUG was featured in the German Climate Service Center (GERICS)'s quarterly Climate Services Partnership (CSP) report. GERICS is the name since 2015 of the Helmholtz-Zentrum Geesthacht (HZG) climate services center, Hamburg. The article (see Figure 8) raises awareness of the ESA CCI datasets as well as CMUG evaluation activities.



CSPQUARTERLY July 2015

Australian Bureau of Meteorology detects 2015 El Niño
Australian Government Bureau of Meteorology

The Australian Government Bureau of Meteorology (BOM) announced detection of the return of the El Niño in early June 2015. International climate models that were surveyed by BOM suggest that the tropical Pacific is likely to experience further warming. With this, temperatures of sea surfaces are forecasted to stay above El Niño thresholds for rest of the year.

Typical El Niño characteristics in Australia are associated with below-average winter and spring rainfall over eastern Australia, and above-average daytime temperatures over the southern half of the country. The El Niño's strength however does not directly relate to the strength of its effects on Australia's climate.

BOM explains that most current oceanic and atmospheric indicators are consistent with El Niño patterns. Trade winds have proved to be consistently weaker than average, while the Southern Oscillation Index (SOI) is currently rising, as a result of local weather, as opposed to climate factors.

The past three months have seen the SOI exceeding the El Niño thresholds, averaging at −9.7. The date line was also observed to see more cloudiness, which has seemed to ease towards more normal levels, however, this could be only a short-term development.

The Indian Ocean Dipole (IOD)- a coupled ocean and atmosphere phenomenon that affects the climate of Australia and of other countries surrounding the Indian Ocean basin - is currently neutral. Two out of five international models on IOD outlooks suggest a positive IOD in late 2015. A positive IOD is usually characterized with both a reduced winter and spring rainfall over parts of southern and central Australia.

Climate Quality Data for Climate Services: ESA's CCI
European Space Agency

The European Space Agency through its Climate Change Initiative (CCI) is using its extensive satellite observations to create climate quality datasets for use in climate services and climate research.

The CCI is developing 13 datasets for the following essential climate variables: land cover, burnt area, soil moisture (see screenshot below), glaciers and ice caps, ice sheets, sea ice, sea surface temperature, ocean color, sea surface height, greenhouse gases, ozone, aerosols, and clouds. The datasets are available as global, gridded products with uncertainty characterization, and with spans of up to 30 years.

All are freely available and in the future should be operationally supported and available in near real time. The datasets are currently being evaluated for climate quality by the Climate Modelling User Group (CMUG) of the CCI by application in reanalyses, climate modeling studies and model evaluation tools.

The CMUG can be contacted for information about the CCI in general or its potential input to European climate services by emailing Paul van der Linden at: paul.vanderlinden@metoffice.gov.uk or by going to www.esa-cmug-cci.org.

Figure 8: CMUG publicity in GERICS's SCP journal, July 2015

Based on the success of the first ESMVal workshop at LMU-München in March 2015 in steering the technical development of the ESMValTool (reported in the previous Exploitation report), a follow-up AGCI workshop is being considered to be held in Aspen, US, in 2017. A second workshop is expected to further foster innovative research in the field of ESM evaluation and support CMUG's benchmarking activities. Its timing will depend on that of climate evaluation model activities e.g. IPCC, CMIP.

2.5 Documents and publications

The following documents for use in outreach and scientific engagement have been produced over the last 2 years:

- CMUG newsletters (June 2015, Aug 2015 and Jan 2016)
- User Requirements Report (December 2014)
- Scientific Impacts Report (May 2015)
- Technical Report on Product Assessment (June 2015, updated Dec 2015)
- Data Quality Assessment Report (June 2014, Sep 2015)
- Technical Note on Obs4MIPs
- MIP Impact Assessment Report (Jun 2015)

The number of CCI peer-reviewed journal papers published since 2012 now exceeds 200. The ten CMUG journal papers are listed in Annex A3.

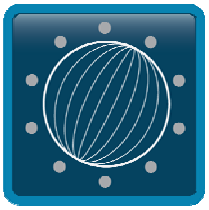
Several new CMUG papers are in preparation and some have been submitted for publication. Veronika Eyring and Mattia Righi et al. of DLR have submitted a paper on the use of ESMVal in CMUG for the journal Geoscientific Model Development *(Eyring, V. et al, 2016).* Alex Loew of LMU has submitted a paper to the Journal of Climate assessing surface solar radiation fluxes in the CMIP ensembles (*Loew et al., 2016, in press*). ECMWF is preparing two papers, one is a comparative analysis of the assimilation of UV nadir-backscatter and infrared limb-emission ozone data, and one assesses ozone round-robin assimilation experiments in preparation for the ERA5 reanalysis.

2.6 Case studies

This section describes three activities where CMUG has engaged with the wider climate research community which has allowed CCI data to be independently taken up in a research environment.

SPECS FP7 project

CMUG CCI is relevant to key European research projects, for example SPECS-FP7, Seasonal to Decadal climate Prediction for the Improvement of European Climate Services. SPECS-FP7 focuses on climate prediction capabilities at the seasonal to decadal time scales to strengthen European climate services. Precise observations are key in climate prediction to generate accurate initial conditions and to determine the level of prediction skill. The new CCI datasets are specifically relevant as they are (1) largely independent from previous observations which have been used to tune the models, (2) of very high-resolution necessary to cope with the increasing resolution of the models and (3) of high quality with an estimate of the observational uncertainty, currently not taken into account in climate forecasting. Within SPECS the CCI data has been used to explore the prospects of climate predictions with the highest resolution ever tested. New experiments from SPECS have also served to determine observational quality of the CCI data. Forecast quality of different model systems is systematically higher for ENSO when using the CCI sea-surface temperatures (SST) in comparison to other datasets which can be explained by a reduced level of observational noise (See Figure 9). Future studies will



further work on the generation of new initial conditions using modern assimilation techniques capable of considering observational uncertainty estimates provided by ESA CCI. (Source: Omar Bellprat, Barcelona Supercomputing Center).

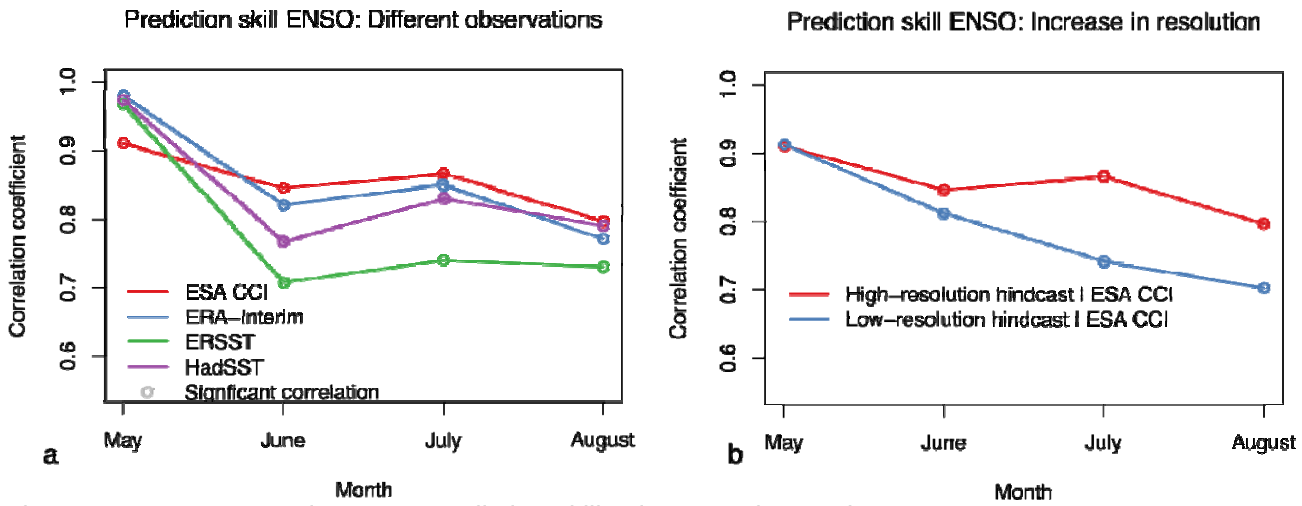


Figure 9: Improvements in ENSO prediction skill using CCI observations.

SOOS initiative

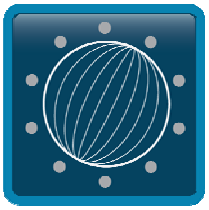
CMUG has been in contact with the Southern Ocean Observing System (SOOS) since Phase 1 and has provided information about relevant CCI datasets (SI, SST, OC, IS) that support their work. A sub-group of SOOS, the Southern Ocean Satellite Data Needs project conducted a community survey to find out the current status of Southern Ocean satellite data application and availability, including CCI datasets and products. A summary of the user requirements, available data to meet those needs and an analysis of how this will fulfil research needs is available in an Antarctic Science[2] paper.

Exeter University

This is a PhD research project in which CMUG OC and SST joint assessment modelling results are being used to determine the cause of biases in CMIP models.

The study is of CO_2 fluxes in the North Atlantic, and is comparing observations of the surface fugacity of CO_2 (fCO_2) from the SOCAT observation database, with output from CMIP5 climate models, over the period 2000-2013. In the observations, the trend in ocean fCO_2 goes up more slowly than the trend in atmospheric CO_2, causing a trend in the air-sea CO_2 flux. In all the CMIP5 models however, oceanic and atmospheric CO_2 increase at similar rates, so the trend doesn't match the observations. The hypothesis is that there is something common to all the models which is causing them to not capture the observed trend in the air-sea CO_2 flux. The CMUG multivariate ECV assessment better matches the trend in the observations than the CMIP model runs, and the work is now looking at whether the trend is better simulated with or without assimilation of CCI ocean colour only, CCI SST only, or both together. Initial results indicate that the assimilation affects the magnitude of the fCO2, but has little impact on the

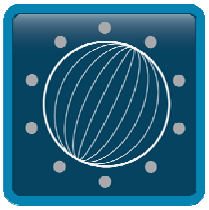
[2] Pope, A., P. Wagner, R. Johnson, J.D. Shutler, J. Baeseman and L. Newman. 2016: Community Review of Southern Ocean Satellite Data Needs, Antarctic Science.



trend. Additional sensitivity experiments are planned (with no data assimilation), in order to determine what the FOAM model simulates (e.g. realistic atmospheric forcing, realistic initial conditions) that the CMIP5 models don't, that is key to capturing this trend.

2.7 Other reports

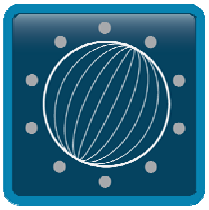
In the course of the CMUG project other documents were generated with a specific role or audience in mind. These are communication products (meeting reports, publications, etc) which are not formal deliverables, and thus not submitted to ESA for contractual acceptance. This document provides an archive for such material.



Annex A

Contents

- Meetings attended by CMUG
- Table of Outreach Activity 2015-2016
- CMUG Peer reviewed publications since 2013

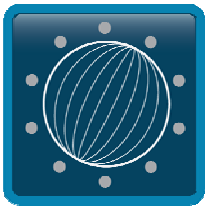


A1 Meetings attended by CMUG

This list describes the CCI programme and external science meetings since June 2015 (when outreach activities and their impact were last reported) to which there was a contribution by the CMUG team. It excludes CCI ECV project meetings which are part of the CCI and are also attended by CMUG team members as they are concerned more with science research than outreach.

Date	Meeting	Location	CMUG role
2016			
4-6 Oct 2016	CCI Colocation meeting 7	ESRIN	CCI project meeting
9-13 May 2016	Living Planet Symposium	Czech Republic	CMUG presentation
17–22 April 2016	EGU	Vienna, Austria	CMUG abstract submitted
14-16 Mar 2016	CMUG 6th integration meeting	Munich, Germany	CCI project meeting
2-4 Mar 2016	GCOS Conference	Netherlands	CMUG poster [3]
10-14 Jan 2016	AMS 2016 conference	USA	CMUG presentation
2015			
14-18 Dec 2015	AGU conference	San Francisco, USA	CMUG participation
29 Sep-1 Oct 2015	CCI Colocation 6	ESRIN	CCI project meeting
21-25 Sept 2015	EUMETSAT Met Satellite Conference	Toulouse, France	CMUG participation
13-15 Jul 2015	UK Space Conference	Liverpool, UK	Presentation of CCI and CMUG results
26-28 May 2015	CMUG 5th integration meeting	SMHI, Sweden	CCI project meeting
11 May 2015	MACC-III Copernicus User	UNICEF, Rome	CMUG participation
3-4 Mar 2015	ESMVal workshop	Munich	CMUG participation

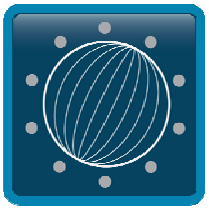
[3] See Annex A4.



A2 CMUG Outreach Activity 2015-2016

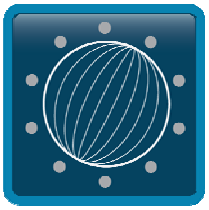
The table below describes the main outreach and engagement activities for CMUG over the period July 2015 to March 2016. It names the event, timing, location, planned type of outreach, steps taken to date, and audience for each outreach activity. Versions 3 of this report will cover the period February 2016 to June 2017.

	Event	Date	Location	Activity	Progress	Audience
1.	UK Space Conference	3-15 Jul 2015	Liverpool, UK	Presentation of CCI and CMUG results	Completed	Remote sensing and Earth observations experts in UK
2.	Overview CMUG newsletter	July 2015	NA	Showcase CMUG research in newsletter	Completed	Ministers and science funders
3.	CMUG article in CSP newsletter	July 2015	NA	Showcase CMUG research	Completed	Climate Services
4.	Monthly blog for data forum	August 2015	NA	Topic: uncertainty in the CCI	-	Climate modellers, reanalysis, climate researchers
5.	ESMValTool paper released for peer review	August 2015	NA	Journal paper	-	Climate modellers, reanalysis, climate researchers
6.	IPCC-Workshop "Regional Climate Projections and their Use in Impacts and Risk Analysis Studies"	15-18 Sept 2015	São José dos Campos, Brazil	CMUG scientist attended. Interaction	Completed	Regional climate modellers, and climate change impact modellers
7.	EUMETSAT Met Satellite Conference	21-25 Sept 2015	Toulouse, France	Presentation	CMUG participation	nowcasting and short-range NWP
8.	Restructure Data Forum to create three main pages.	Sept 2015	NA	Development	Completed	Climate Modelling Community
9.	Monthly blog for data forum	Sept 2015	NA	Topic: climate quality in the CCI	-	Climate modellers, reanalysis, climate researchers
10.	CCI Collocation meeting	29 Sept – 1 Oct	ESRIN, Italy	Two CMUG presentations and	Completed	CCI research teams



		2015		interactions		
11.	Develop CMUG Data Forum: forum and weblog	Oct 2015	NA	Launch forum and revised website	Completed in January 2016	Climate modellers, reanalysis, climate researchers
12.	Monthly blog for data forum	Oct 2015	NA	Topic: consistency in the CCI		Climate modellers, reanalysis, climate researchers
13.	AeroCOM/CCMI/ AerChemMIP meeting	7-9 Oct 2015	Frascati, Italy	CMUG Participation	-	Aerosol observations and modellers
14.	WGCM meeting / CMIP Analysis Workshop	18-23 Oct 2015	Dubrovnik Croatia	CMUG Participation	-	Global climate modellers
15.	CRESCENDO-PRIMAVERA Kick-Off Meeting	23-27 Nov 2015	Exeter, UK	CMUG Participation	Completed	H2020 project High resolution modellers
16.	Invite users to contribute to the weblog, science videos and/or webinar.	Nov 2015 & ongoing	NA	CMUG Outreach	Completed	Scientists and Developers
17.	Monthly blog for data forum	Nov 2015	NA	Topic: long data series in the CCI	None identified	Climate modellers, reanalysis, climate researchers
18..	COP-21	30 Nov - 11 Dec 2015	Paris, France	Attend side event with Pascal Lecomte	Attended side event	Climate change policymakers
19.	AGU	14-18 Dec 2015	San Francisco, USA	CMUG Participation	-	Climate researchers
20.	Publicise and create new links to the CCI Data Portal when it becomes available.	Nov 2015	NA	CMUG Outreach	CCI Data Portal not available	Climate Modelling Community
21.	Monthly blog for data forum	Dec 2015	NA	Topic: using CCI data in models	Blog prepared in Dec published in Jan 2016	Climate modellers, reanalysis, climate researchers
22.	CMUG newsletter	Dec 2015	NA	Showcase CMUG research in	Issue 6 published in Jan 2016	Climate research community

				newsletter		
23.	American Meteorological Society (AMS)	10-14 Jan 2016	New Orleans, USA	CMUG Presentation	Present-ation given	Earth System Science in Service to Society
24.	GCOS Conference	2-4 Mar 2016	Netherlands	CMUG poster See Annex A4	Poster presented	Climate researchers
25.	Paper submitted with CMUG O3 results	April 2016	NA	CMUG journal paper	-	Climate researchers



A3 CMUG peer reviewed publications, including number of citations

Paper	Citations*
Eyring, V., Righi, M., Evaldsson, M., Lauer, A., Wenzel, S., Jones, C., Anav, A., Andrews, O., Cionni, I., Davin, E. L., Deser, C., Ehbrecht, C., Friedlingstein, P., Gleckler, P., Gottschaldt, K.-D., Hagemann, S., Juckes, M., Kindermann, S., Krasting, J., Kunert, D., Levine, R., Loew, A., Mäkelä, J., Martin, G., Mason, E., Phillips, A., Read, S., Rio, C., Roehrig, R., Senftleben, D., Sterl, A., van Ulft, L. H., Walton, J., Wang, S., and Williams, K. D.: ESMValTool (v1.0) - a community diagnostic and performance metrics tool for routine evaluation of Earth System Models in CMIP, *Geosci. Model Dev. Discuss.,* 8, 7541-7661, doi:10.5194/gmdd-8-7541-2015, 2015. (*Under Review*).	2
Ford, D. A., K. P. Edwards, D. Lea, **R. M. Barciela**, M. J. Martin, and J. Demaria (2012): Assimilating GlobColour ocean colour data into a pre-operational physical-biogeochemical model Ocean Sci. Discuss., 9, 687-744, 2012. doi:10.5194/os-8-751/2012/	13
Hollmann, R., Merchant, C. J., **Saunders, R.**, Downy, C., Buchwitz, M., Cazenave, A., … Wagner, W. (2013). The ESA Climate Change Initiative: satellite data records for essential climate variables. *Bulletin of the American Meteorological Society*, 130313072241002. doi:10.1175/BAMS-D-11-00254.1	58
Lean, K. and **R. Saunders,** (2013): Validation of the ATSR Re-processing for Climate (ARC) dataset using data from drifting buoys and a three-way error analysis. *Journal of Climate.* -0880-6. http://www.hydrol-earth-syst-sci.net/17/3523/2013/hess-17-3523-2013.html	3
Loew, A. (2013). Terrestrial satellite records for climate studies: how long is long enough? A test case for the Sahel. *Theoretical and Applied Climatology*, 1–14. doi:10.1007/s00704-013	6
Loew, A., Stacke, T., Dorigo, W., de Jeu, R., & Hagemann, S. (2013). Potential and limitations of multi-decadal satellite soil moisture observations for selected climate model evaluation studies. *Hydrology and Earth System Sciences 17*(9), 3523–3542. doi:10.5194/hess-17-3523-20130	31
Loew, A. et al. (2016): Assessing surface solar radiation fluxes in the CMIP ensembles. *Journal of Climate, in press*)	-
Merchant, C. J., Embury, O., Rayner, N. A., Berry, D. I., Corlett, G. K., Lean, K., … **Saunders, R.** (2012). A 20 year independent record of sea surface temperature for climate from Along-Track Scanning Radiometers. *Journal of Geophysical Research*, *117*(C12), C12013. doi:10.1029/2012JC008400	15
Sevault, F., Somot, S., Alias A, Dubois, C., Lebeauoin-Brossier, C., Nabat, P., Adloff, F., Déqué, M., & Decharme, B. (2014): A fully coupled Mediterranean regional climate system model: design and evaluation of the ocean component for the 1980-2012 period. **Tellus A,** [S.l.], Nov. 2014. ISSN 1600-0870. doi:10.3402/tellusa.v66.23967	3
Dragani, R.: A comparative analysis of UV nadir-backscatter and infrared limb-emission ozone data assimilation, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-96, 2016.	-

**Source: Google Scholar March 2016.*

A4 CMUG poster presented at GCOS meeting 2016

The ESA Climate Modelling User Group assessment of satellite climate datasets

R. Saunders[1] and the Climate Modelling User Group [2,3,4,5,6,7]

[1]Met Office, Exeter, U.K., [2]ECMWF, Reading, U.K., [3]MétéoFrance, Toulouse, France, [4]Institut Pierre Simon Laplace, Paris, France [5]DLR, Oberpfaffenhofen, Germany, [6]Max-Planck Institute, Hamburg, Germany, [7]SMHI, Norköpping, Sweden

What is the Climate Modelling User Group (CMUG) ?

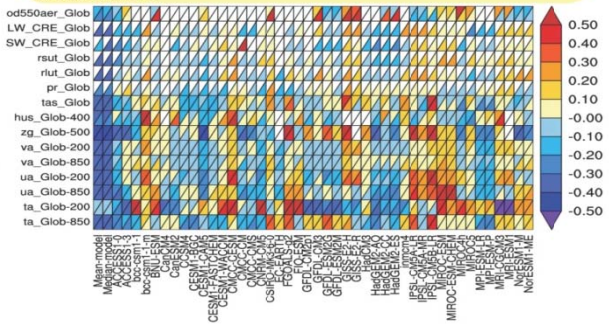
ESA's Climate Change Initiative (CCI) project is creating climate data records for 13 ECVs for climate monitoring, developing climate models and assimilation in reanalyses. The CMUG was set up as an independent group to assess the datasets for climate modellers and promote their use by them.

Model	SST	SSH	Seaice	OC	Cloud	Ozone	Aerosol	GHG	LC	BM	Fire	Glacier	Experiment Type
Ocean					**Atmosphere**					**Land**			
FOAM	X	X	X	X									Assimilation
NEMOVAR_ORA	X	X	X	X									Assimilation and Detection
ERA-Clim					X								Assimilation
MACC-II					X	X	X						Assimilation
JSBACH, TM3							X	X	X	X			Assimilation
EC-Earth/CMIP5	X				X	X	X		X				Assessment, evaluation
LMDz, ORCHIDEE							X	X	X	X			Boundary Condition
MPI-OM, MPI-ESM	X		X	X	X								Assimilation (Polar Regions)
EMAC-MADE					X		X						Comparison
RCAHARMONIE	X				X					X			Comparison/Eval (CORDEX Africa)
Arctic HYPE		X							X			X	Assessment
CNRM-RCM	X	X			X		X			X			Comparison (Med CORDEX)
CNRM-CM, Arpege	X		X				X		X	X	X		Boundary Cond
IPSL-ESM	X		X										Boundary Cond
EC-EARTH	X		X										Boundary Condition
ESMVal	X		X				X		X	X	X		Tech ESMVal CMIP6 + metrics
ESMValTool	X	X		X		X	X	X		X			ESMValTool + metrics
CMF	X	X	X	X	X	X	X	X					Web interface CMF
Benchmarking	X		X	X	X	X	X	X	X	X	X		ESMValTool + metrics

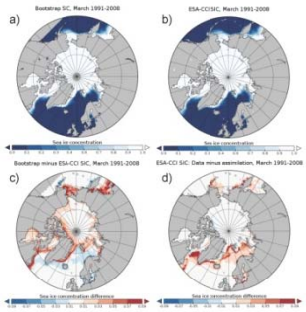
A summary of the assessments being carried out by the CMUG for each ECV and also the model evaluation tools being developed.

Assessing CMIP5 model simulations

The Earth System Model Evaluation (ESMVal) Tool is being developed by DLR to evaluate known systematic biases common to climate models, such as coupled tropical climate variability, monsoons, southern ocean processes and continental dry biases. It has been used to compare modelled aerosol optical thickness with the CCI aerosol climate data record. The plot below shows relative space-time root-mean square error (RMSE) calculated from the 1980–2005 climatological seasonal cycle of the CMIP5 historical simulations for variables listed for each row. The relative performance is displayed, with blue shading indicating performance being better and red shading worse, than the median of all the model results. White boxes are used when data is not available for the given model and variable.



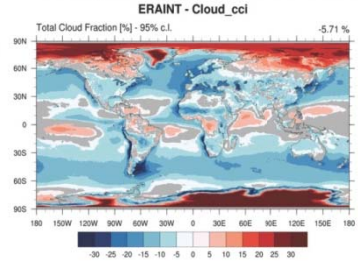
Assessing CCI Sea-Ice Fields for Models



March mean sea ice concentration for (a) NSIDC-Bootstrap and (b) ESA-SICCI sea ice products averaged over 1991-2008. Differences between data products (c) and between ESA-SICCI data before and after assimilation into the MPI-ESM model (d) show small spurious ice concentrations, e.g., north of Norway. These are related to weather effects which are not filtered out in ESA-SICCI, since there is no robust method to do so Ivanova et al[1]. In the next release of the ESA-CCI sea ice product a data layer with applied weather filter will be included.

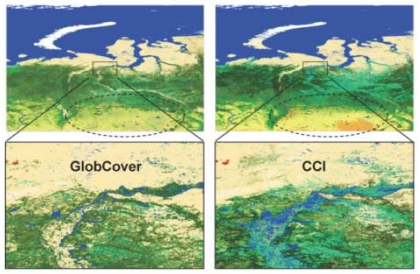
1. The Cryosphere, **9**, *1797-1817, 2015*

Comparisons of CCI Cloud and Model data



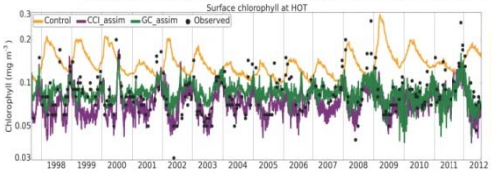
Cloud cover from the CCI has been added to the ESMVal tool, and metrics are being developed to assess climate variability by comparing CCI cloud fraction with CLARA-A2, ERA-Interim, NCEP and CMIP3 models. The figure shows a recent comparison between ERA Interim and CCI cloud fraction data, showing the difference to be most significant at the poles.

Assessment of CCI Land Cover



CCI Land Cover was found to include more surface water (about 6-20% more) than GlobCover over parts of Siberia which might be important for understanding Arctic hydrology dominated by large rvers and a large number of small and large lakes. Impacts in the model are still being analysed.

Assimilation of CCI Ocean Colour Data



Time series of modelled and observed chlorophyll concentrations in the surface 10m at the Hawaiian site with no assimilation, GlobColour and CCI ocean colour assimilation runs.

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http://www.esa-cmug-cci.org