



CMUG Deliverable

Number: D6.1
Due date: 30 September 2020
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Climate Modelling User Group

Deliverable 6.1

Scientific Exploitation Report

Centres providing input: MOHC

Version	Date	Comment
0.1	30 September 2020	For ESA Review
1	TBC	Submission to ESA



METEO FRANCE
Toujours un temps d'avance



Max-Planck-Institut
für Meteorologie



Institut
Pierre
Simon
Laplace





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CMUG D6.1 Scientific Exploitation Report (SER)

Executive Summary

The Climate Modelling User Group (CMUG) project has been running since 2012. Phase 3 began in October 2018 coincident with the start of Phase 1 of CCI+. The SER describes the scientific engagement and outreach activities of CMUG. Some of the highlights of which are:

- Development of the CMUG website. The old CCI [CMUG website](#) has been transferred to a new location on an [ESA web server](#). See section 2.2 for more details.
- Refresh of the CMUG [Data Forum](#) which provides access to CCI datasets and allows CCI data users to interact and record user experiences. See section 2.3 for more details.
- Participation in meetings and workshops. These include CMUG Integration Meetings in Oct 2018 and Nov 2019, CCI Colocation Meetings in Mar 2019 and Sep 2020, Living Planet Symposium in Italy in May 2019, and CMIP6 Model Analysis Workshop in Spain in Mar 2019. See section 2.4 – 2.5 and Annex A1 for more details.
- CMUG has engaged with the wider scientific community through Twitter posts promoting CMUG, Obs4MIP, Open Data Portal and links to CCI, CMIP5/6 and ESA; and an EGU Ocean Science blog post on satellite data for ocean reanalysis. See section 2.6 for more details.
- There are a total of 27 CMUG peer-reviewed publications from all three phases. Some have an impressive number and increase of citations, with many reaching over 50 and one, (Hollman *et al.*, 2013), 255 (as of September 2020). See Annexes A4 to A6.



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1. Introduction

The Climate Modelling User Group (CMUG) project has been running since 2012 and Phase 3 of CMUG has been running since October 2018 when Phase 1 of CCI+ began. CMUG includes outreach and engagement activities for an audience including 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.

It is important to note that from late 2019 until mid-2020 there was a pause in many CMUG activities due to a significant change to CMUG staff, including the lead project manager and team science members, as well as the COVID-19 pandemic. As a result, there is an evident gap in some scientific exploitation activities during this time.

This report documents the scientific engagement, and exploitation activities and their outcomes/success for Phase 3 of the CMUG project. CMUG has been delivering the following engagement and exploitation activities:

1. Presentations on ESA CCI datasets at meetings during Phase 1 of the CCI+.
2. Continued development of the CMUG website to make the community aware of the CCI datasets, content, quality and availability.
3. High level awareness of the CMUG activities at the CMUG partner institutes.
4. Working level interactions with key scientists in climate modelling and reanalysis centres through the scientists in the CMUG institutes and CCI/CMUG meetings.
5. Work towards including selected ECV datasets on the Obs4MIPs site.
6. Link with GCOS activities through GCOS project office.
7. Link with relevant EU projects which require CCI data as input. The CMUG has a wide involvement with such projects (e.g. H2020 project APPLICATE, see section 2.1)
8. CMUG attendance and/or presentations at key climate modelling, reanalysis and satellite data meetings to promote the CCI ECV datasets (e.g. CMIP6 and relevant scientific conferences such as AMS, AGU, etc.)
9. Give inputs to the relevant WCRP as appropriate.
10. Coordinate outreach with CCI projects to ensure consistent message is given.
11. Advertise early use of CCI datasets in CMUG partner institutes.
12. 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.
13. Links to EUMETSAT's proposed activities on climate monitoring, ensuring complementarity and avoiding any duplication of effort.



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2. Engagement and Exploitation

2.1 Key engagement and exploitation activities

CMUG outreach and engagement activities to the climate modelling community (CMC), climate research community (CRC) and others (international bodies, scientific press, and the general public) were active throughout the CMUG Phase 1, became more focused in CMUG Phase 2 when the ECV datasets became available, and have continued as a focal point into CMUG Phase 3 and Phase 1 of CCI+.

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. An example of research uptake of CMUG promoted CCI data is the H2020 project APPLICATE (Advanced Prediction in Polar regions and beyond: modelling, observing system design and Linkages associated with a Changing Arctic climaTE) which used the Sea Ice ECV dataset.

The main means of communication to audiences outside the CCI is the CMUG project website (section 2.2.), which provides project reports, news bulletins and information on events (<https://climate.esa.int/en/projects/cmug/>). There is also the Climate Data Forum (CDF) (section 2.3) for user community participation that includes a blog, showcase and community pages, plus links to the CCI datasets and is complementary to the CCI Open Data Portal. CMUG maintains a list of contacts who are sent project information and updates on a regular basis (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 such as oral presentations, poster sessions, flyers, news bulletins, etc. 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. Outreach activity Oct 2018 – Sep 2020 is listed in Annex A2.

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2.2 CMUG website

The old CCI [CMUG website](#) (Figure 1) has recently been retired and a new page set up on an [ESA web server](#) (Figure 2). The landing page is now a [central ESA Climate Office website](#) with links to each of the CCI projects. The CMUG website content was evaluated in preparation for the transfer, including an update to all contact information and member biographies. A new flow chart (Figure 3), illustrating the structure of the CMUG project, has been produced and is included on the new CMUG website. Common website operations and tasks have been paused while the new website has been under development.

[CMUG's new website](#) is still under development, when completed it will provide information on project deliverables, scientific engagement, the scientific exploitation of CCI data, media outputs, and both past and forthcoming meetings and events. It includes papers for CMUG deliverables, project outputs, posters, flyers, and significant reports and presentations. It also includes links to the ESA CCI programme, individual ECV pages, and partner organisations. An example template of what a CCI CMUG project will look like on the new website is shown in Figure 4.

The website uses a common style with other CCI websites for easy navigation by users. In CMUG Phase 3 the CMUG website has been supplemented by the CMUG Data Forum which aims to provide an online discussion and information dissemination forum for the CCI. Such material disseminated through the forum includes short summaries of CMUG assessments of individual ECV datasets, key information about CCI datasets, a blog, and, if there is sufficient interest, a discussion forum.

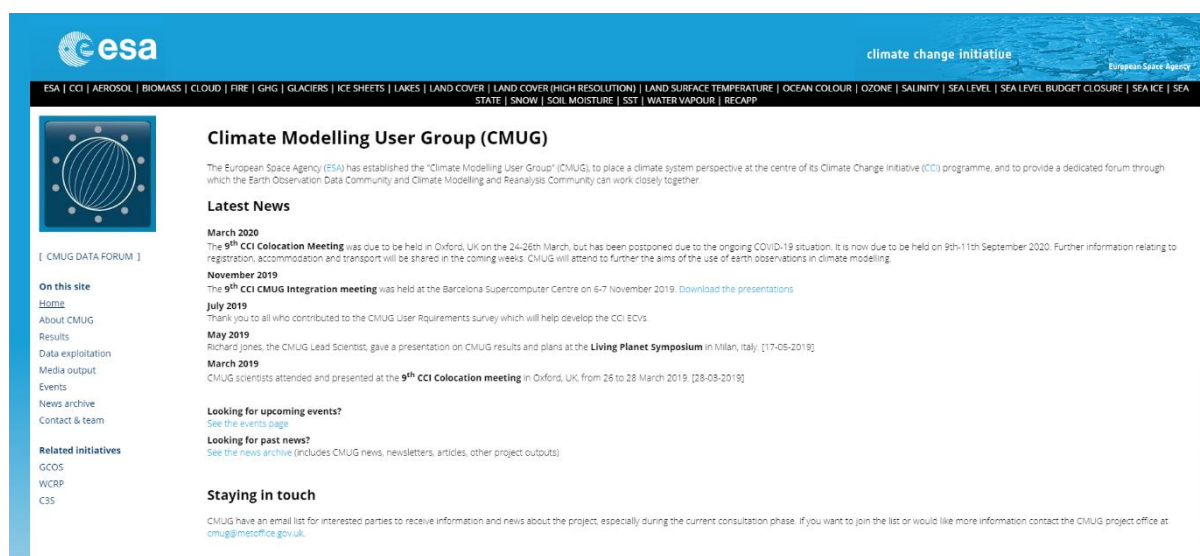


Figure 1: CCI CMUG website (old) front page screenshot (August 2020).

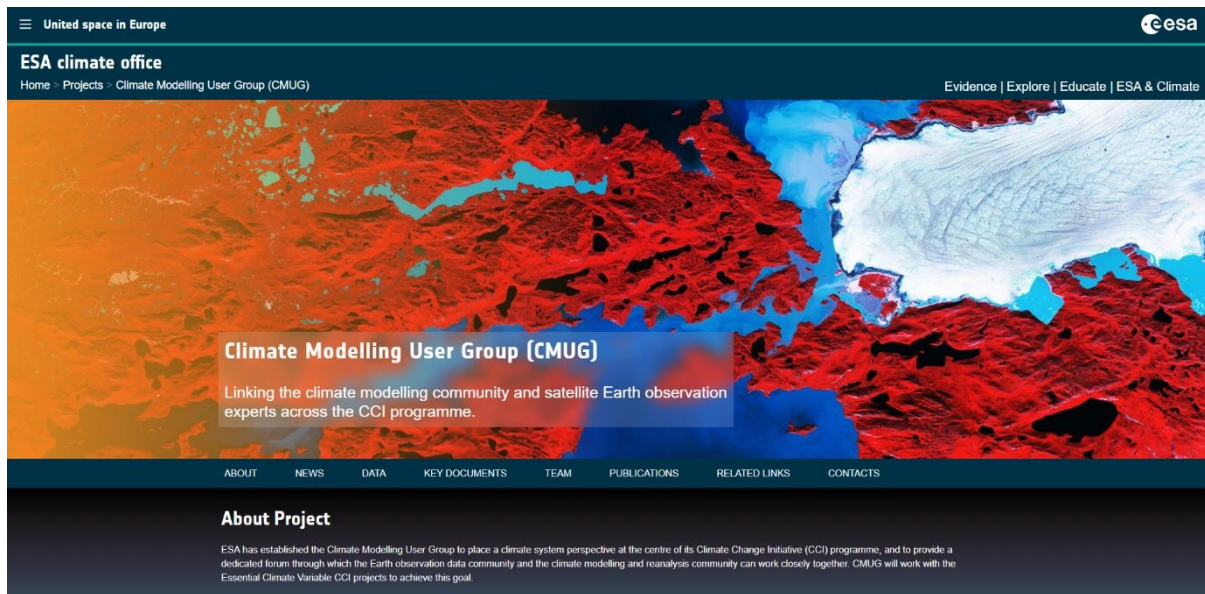
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Figure 2: CCI CMUG new website screenshot (September 2020).

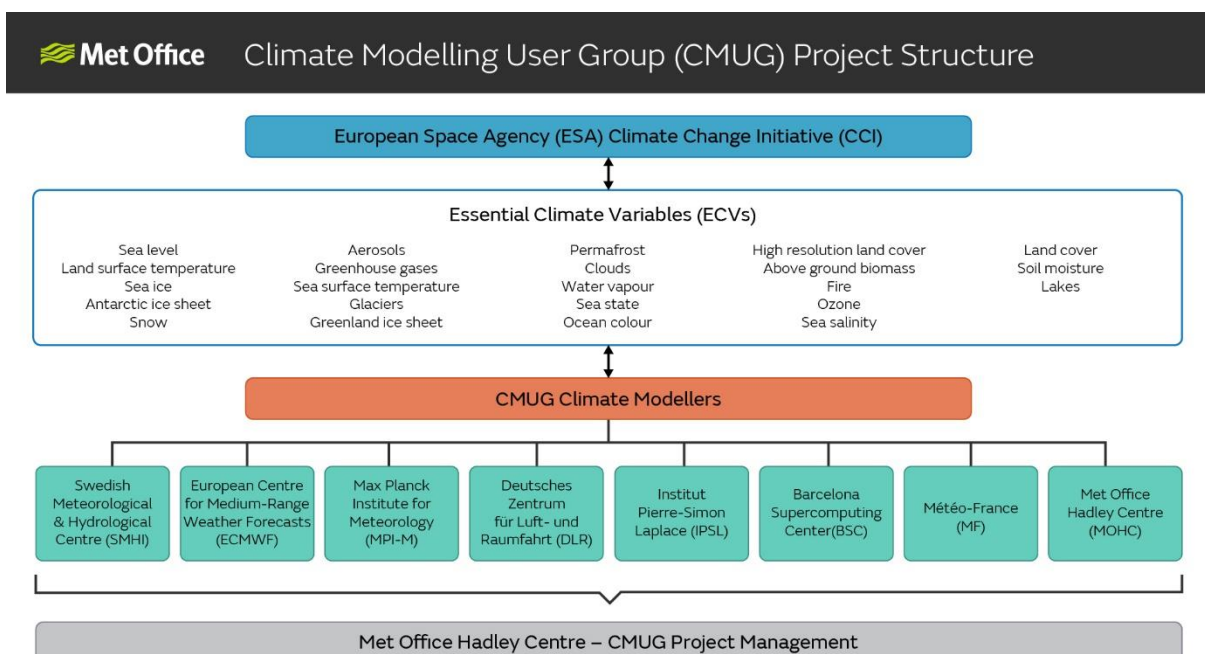


Figure 3: Flow chart diagram of CMUG's project structure.

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Figure 4: An example template of a CCI CMUG project on the new website.

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2.3 CMUG Data Forum

The CMUG [Data Forum](#) has once again been refreshed with a new look and feel (Figure 5). It continues to provide access to CCI datasets and provide a forum for CCI data users to interact and record user experiences. This forum website showcases work carried out by the CMUG user community with ESA's CCI datasets, and acts as a platform to share experience of using these datasets and to encourage collaboration between scientists and data users. Contributions are welcomed from modellers, scientists and others, with ideas, suggestions and potential applications for the datasets. The Data Forum complements the CCI Open Data Portal by providing an open forum for user discussion and feedback on CCI datasets.

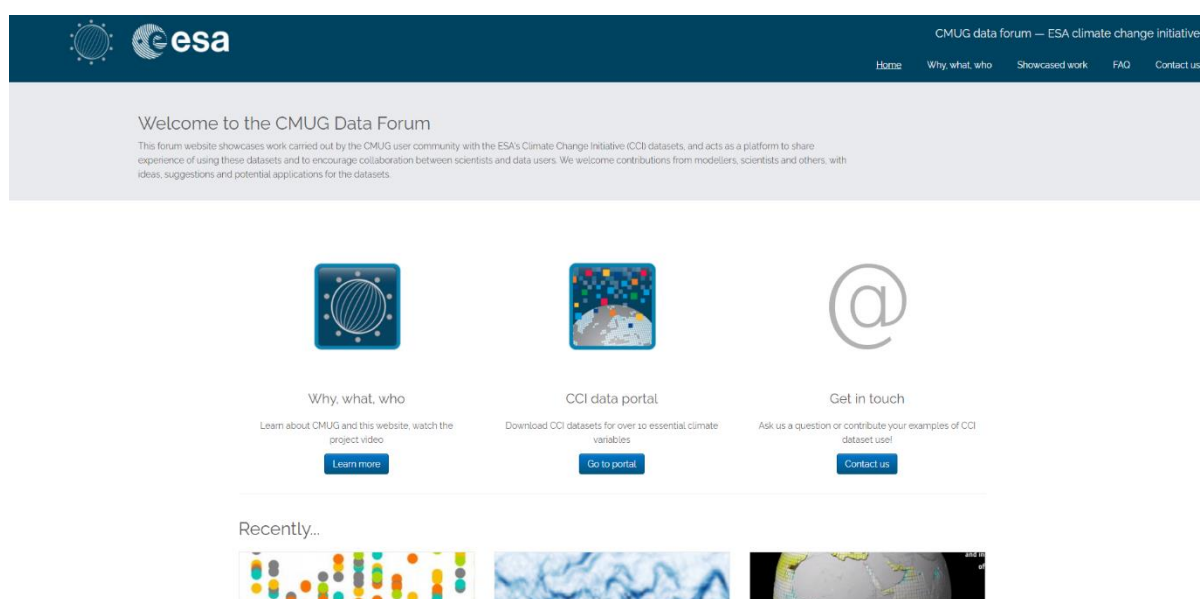


Figure 5: CCI CMUG Data Forum website screenshot (August 2020).

The Data Forum provides a link to a “[Why, what, who?](#)” webpage (Figure 6) which provides a brief account of CMUG’s history, the purpose of the Data Forum website, outlines ECVs, and provides a complementary video by former CMUG Chief Scientist Roger Saunders outlining the CMUG project aims and achievements. The Data Forum also links directly to the CCI [Open Data Portal](#) (Figure 7), providing access to downloadable CCI datasets for over 23 ECVs, as well as a ‘Get in touch’ option for those wanting to ask questions or contribute examples of CCI dataset use.



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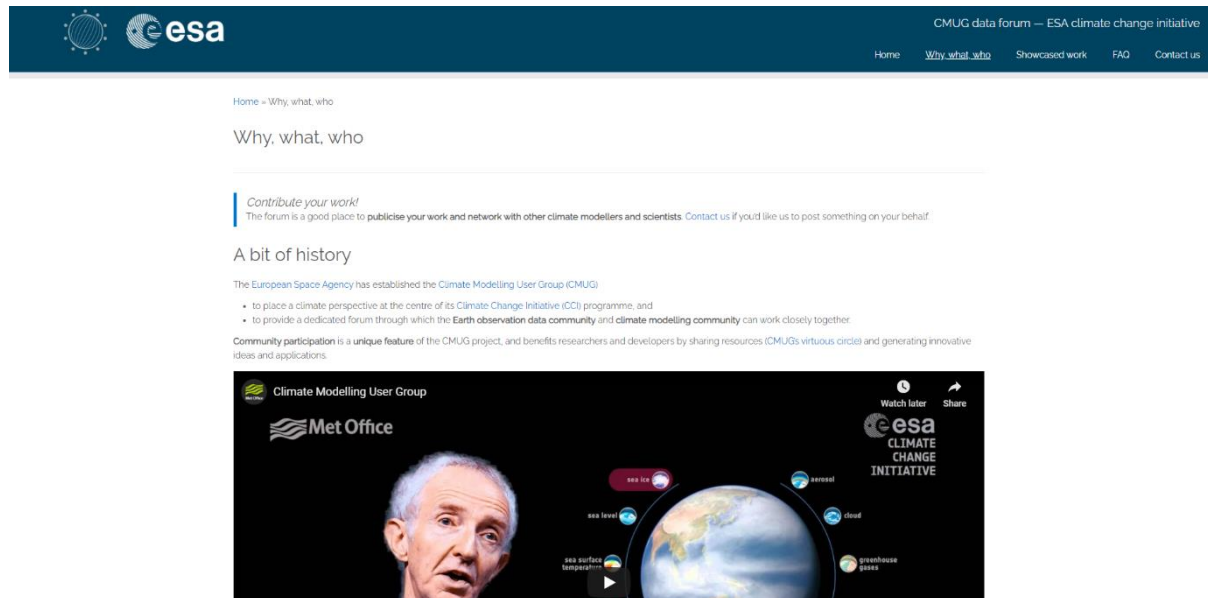


Figure 6: CCI CMUG Data Forum's "Why, what, who?" webpage screenshot (August 2020).

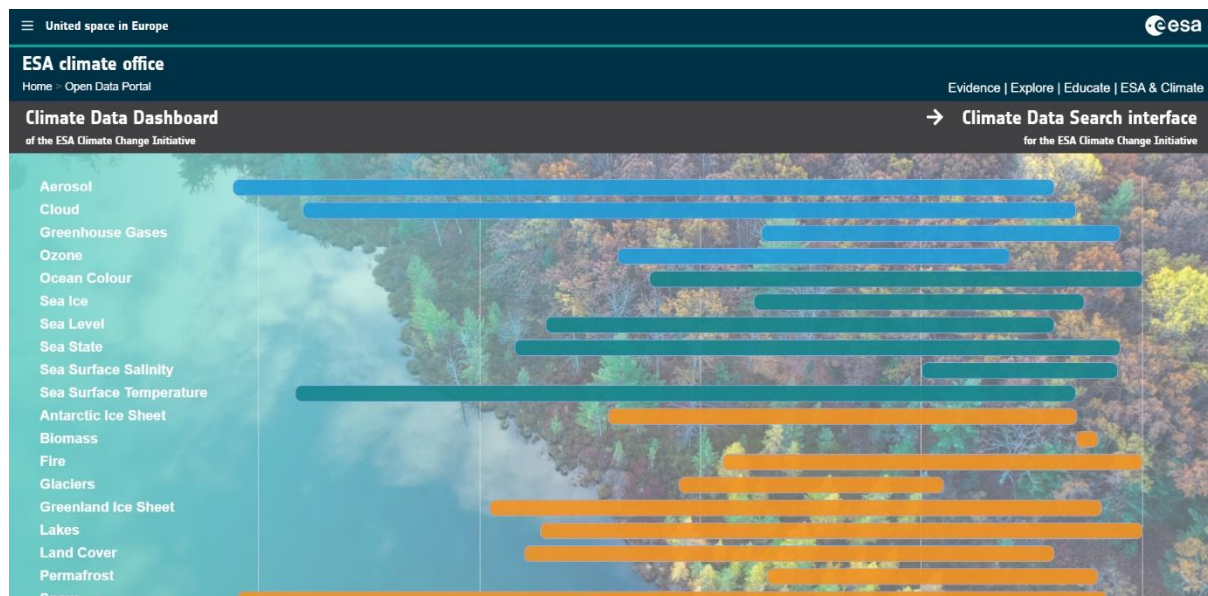


Figure 7: Open Data Portal screenshot (September 2020).

It is important to note that as the new ESA website and subsequent CCI CMUG website pages are revealed and come online, the Data Forum and Open Data Portal front ends may change in appearance, layout, and potentially in content.



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2.4 Meetings

Since the beginning of CMUG Phase 3 (October 2018), CMUG has organised or participated in a number of significant meetings, which are also listed in chronological order in Annex A1.

CMUG Phase 3 started with a CMUG Kick Off Meeting on 1st October 2018, held at ESA's European Centre for Space Applications and Telecommunications (ECSAT) and by videoconference. The aim of this meeting was to allow CMUG to describe the aims and actions in its work plan to ESA, including interactions with ECV teams. Priorities for CMUG in the near-term (following 6 months) and details for mid-term (following 12 months) CMUG activities and deliverables were clarified and agreed.

Following the 8th CCI Colocation Meeting at the end of CMUG Phase 2 in March 2018, CMUG organised and attended the 8th CMUG Integration Meeting in October 2018, held at the Met Office, Exeter, UK, and by videoconference. This was the first Integration Meeting of the CCI+ phase which saw nine new ECVs added to the initiative. The meeting provided forums (discursive and open discussions) for the new CCI+ ECV projects to explore the scope of their work and to agree common goals and actions with ESA and CMUG.

The 9th CCI Colocation Meeting was held in March 2019 at St. Hugh's College, Oxford, UK. This meeting consisted of presentations and discussions on CCI programme status and plans, ECV projects, AI for CCI, GCOS and CCI impacts on IPCC (AR6 and Special Reports), and cross-ECV activities and future opportunities.

In May 2019 CMUG participated in [ESA's 2019 Living Planet Symposium](#) at Milano Congressi, Milan, Italy. The event, which is held every three years, focuses on how Earth Observation contributes to science and society, and how disruptive technologies and actors are changing the traditional Earth Observation landscape, which is also creating new opportunities for public and private sector interactions. CMUG presented at this event, showcasing the project, its objectives, activities, workshops, legacy and continuity. CMUG's interactions with CCI ECV projects were also showcased, as well as CMUG's interaction with CMIP6 MIPs and CCI contribution to IPCC reports (e.g. AR6).

The 9th CMUG Integration Meeting was held in November 2019, at the Barcelona Supercomputing Center (BSC). This was the second Integration Meeting of the CCI+ phase. The aims of the meeting were broadly similar to the previous CMUG Integration Meetings. The meeting consisted of plenary talks reporting back on CMUG results for discussion, with the results of CCI experiments presented in a poster session. For example, there included plenary sessions which described the work and results of climate research projects and initiatives relevant to the CCI (such as EUMETNET, Future Earth, AIMES, FIDUCEO and GEWEX G-VAP) as well as sessions reporting on climate service-related activities relevant to planned CCI data outputs.

Also in November 2019, CMUG held its Annual Progress Meeting including project partners and ESA. The meeting raised priority actions for individuals and partners and provided a space



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for discussion on the evaluation of the project as a whole over the previous year and its direction for the year to come.

The 10th CCI Colocation Meeting was held in September 2020. This was the first time that the CCI Colocation had been delivered as an online meeting. The meeting consisted of a multitude and variety of talks and discussions as well as breakout sessions. Sessions focused on CCI's contribution to international climate initiatives, cross-ECV activities, Earth Observation for UNFCCC Paris Agreement, AI contribution to climate data and modelling, collaboration between CCI and C3S, and evolution of CCI into Phase 2 and beyond to a new ESA climate programme. CMUG produced and showcased a poster for a virtual poster session, highlighting CMUG's recent key achievements.

Since the beginning of CMUG Phase 3 there have also been several Climate Science Working Group (CSWG) and Data Engineering Working Group (DEWG) meetings. The CSWG mainly works to examine the climate quality and consistency of CCI ECV CDRs, refining scientific requirements of climate data users, provide feedback between ECV projects on common issues, and coordinate outreach plans to the climate research community.

The DEWG comprises one representative from each CCI project, a representative from ESA who is Chair of the working group, plus two members from ESA involved in ESA Climate Office Knowledge Exchange activities. Additional people are invited to attend meetings at the Chair's request. The objective of the DEWG is to ensure maximum usability of the datasets produced within CCI, and cultivate tools for their access, discovery and manipulation, through common CCI data standards.

CSWG meetings since October 2018 (current phase start):

- October 2018: CSWG discussions at 8th Integration Meeting
- November 2018: Discussions over Slack between CSWG and CMUG
- January 2019: CSWG Meeting
- May 2019: CSWG Meeting
- September 2019: CSWG Meeting
- November 2019: CSWG Meeting at 9th Integration Meeting
- February 2020: CSWG Meeting

DEWG meetings since October 2018 (current phase start):

- November 2018: DEWG Meeting
- March 2019: DEWG Meeting

CMUG also organises fortnightly internal management meetings and monthly meetings between CMUG and ESA. These meetings discuss any outstanding points, such as due deliverables or upcoming events. There are monthly financial meetings with CMUG's finance contact to discuss budgets and relevant points. Alongside these, CMUG members organise ad-hoc meetings where needed, such as to discuss an ongoing deliverable.

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2.5 Workshops

Since the beginning of CMUG Phase 3 (October 2018), CMUG has participated in some workshops, which are listed in chronological order in Annex A1.

CMUG attended the ‘Paving the way for Horizon Europe in the EO downstream sector: Fostering a competitive and sustainable European EO downstream sector’ workshop, 8th October 2019, held in Brussels, Belgium.

CMUG (Met Office, BSC, DLR) attended the CMIP6 Model Analysis Workshop from 25th – 27th March 2019 in Barcelona Spain. DLR presented on CMIP6 status and workshop goals. More information on this workshop and its outputs can be found [here](#).

In CMUG Work Package 3, Météo-France continued working on the implementation assimilation of snow products in the ISBA land surface model. Related to this, a Météo-France CMUG scientist attended the virtual LST CCI User Workshop meeting from 24th – 26th June 2020. A Met Office CMUG scientist also attended online and contributed to breakout groups on ‘Uncertainties in LST’ and ‘User requirements for Climate LST’. At IPSL, results produced from progress on LST were presented during this workshop.

2.6 Case studies

This section describes two activities where CMUG has engaged with the wider climate research community in this phase.

EGU Ocean Science blog post - Satellite data for ocean reanalysis

Following publication of a CMUG [paper](#) ‘Assessing the role and consistency of satellite observation products in global physical-biogeochemical ocean reanalysis’ (Ford, 2020; see Annex A4 for further details) the author was asked to write a [blog post](#) on the subject for the EGU Ocean Science blog (Figure 8). The target audience is early career oceanographers.

The blog post is titled ‘Satellite data for ocean reanalysis’ and also includes links to some CCI Planetary Visions videos by ESA. The blog post went live on the EGU Ocean Science blog on 22 September 2020 and was tweeted from EGU Ocean Sciences Twitter account and retweeted by EGU’s main Twitter account (Figure 9), including Met Office Science (Figure 10) and ESA Twitter accounts in the tags.

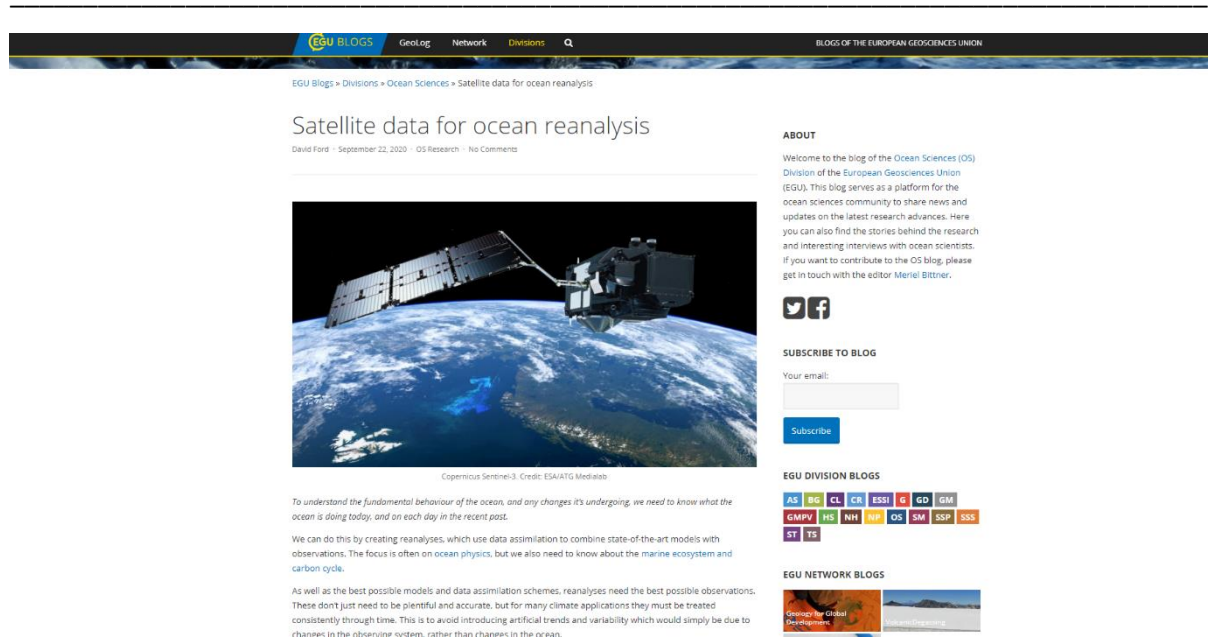
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Figure 8: EGU Ocean Science blog post 'Satellite data for ocean reanalysis'.



Figure 9: EGU retweets the Ocean Sciences Twitter post about the blog post in Figure 8.

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CMUG promotion on Met Office Science Twitter

CMUG has produced three Twitter posts ready to be published on the Met Office Science Twitter page (Figure 9) sometime in late 2020. This outreach activity took advantage of an ad-hoc opportunity presented to the wider team within the Met Office for a 'Twitter Takeover Month' whereby team projects are to be showcased over the period of a month.

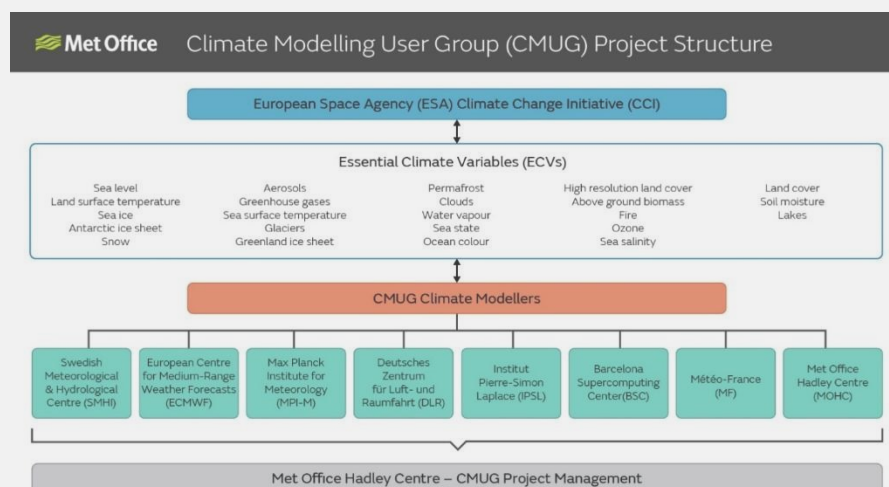


Figure 10: Met Office Science Twitter homepage.

The tweets introduce the CMUG project, including the new CMUG Organisational Structure Flowchart diagram in Tweet #1, introduce ESA's Climate Change Initiative (CCI) and advertise the Open Data Portal in Tweet #2 and advertise the use of the Obs4MIPs portal and how this work feeds into evaluation of CMIP5 and 6 in Tweet #3. The posts include links to ESA's Twitter and provide multiple links for users to follow out more information on each topic mentioned. These Tweets will be as shown as in Figure 11.

**CMUG Deliverable****Number:** D6.1**Due date:** 30 September 2020**Submission date:****Version:** 1.0*Tweet 1*

(1/3) The Met Office works with the European Space Agency @esaclimate on the Climate Modelling User Group (CMUG) which aims to improve communication between Earth Observation and Climate Modelling communities.

*Tweet 2*

(2/3) CMUG ensures a focus on the climate system is at the heart of the Climate Change

Initiative (CCI) <https://bit.ly/2ChTVME>. Essential Climate Variables produced by CCI can be accessed on @esaclimate's Open Data Portal, which is free and easy to use here <https://bit.ly/3keeHOI>

Tweet 3

(3/3) CMUG also works to process @esaclimate's Essential Climate Variable information which contributes to the obs4MIPs portal: <https://bit.ly/2PDqFTL>. This feeds into evaluation of Coupled Model Intercomparison Projects CMIP5 and 6 <https://bit.ly/33t5iwn>

Figure 11: CMUG promotion Tweets planned for Met Office Science Twitter.



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2.7 Other reports

The following documents for use in outreach and scientific engagement have been produced since October 2018:

- CMUG News Bulletin (January 2020)
- Quality Assessment Report (September 2019) accepted Feb 2020 v1
- Monthly and quarterly reports
- 10th Colocation Meeting poster (see Annex A3)

The 18 CMUG journal papers 2012 – 2018 are listed in Annex A6 and the nine 2018 – Sept 2020 in Annex A4.

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



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Annex A

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A1 Meetings and workshops attended by CMUG

This list describes the CCI programme and external science meetings since October 2018 (when Phase 3 of CMUG and Phase 1 of CCI+ began) to which there was a contribution by the CMUG team. Workshops with CMUG attendance or participation are also included. 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
2018			
1 Oct 2018	Kick-off meeting	ECSAT, Harwell, UK	CCI project meeting
8 Oct 2018	Paving the way for Horizon Europe in EO downstream sector	Breydel Auditorium, Avenue d'Auderghem 45, Brussels, Belgium	Attended workshop
29-31 Oct 2018	CMUG Integration 8	Exeter, UK	CCI project meeting
2019			
25-28 Mar 2019	CCI Colocation 9	Oxford, UK	CCI project meeting
25-29 Mar 2019	CMIP6 Model Analysis Workshop	Barcelona, Spain	CMUG attendance, DLR presentation
13-17 May 2019	Living Planet Symposium	Milan, Italy	CMUG presentation
6-7 Nov 2019	CMUG Integration 9	Barcelona, Spain	CCI project meeting
2020			
24-26 Jun 2020	LST CCI Workshop meeting	Virtual meeting	CMUG attendance, IPSL presentation, Met Office contribution to breakout groups
9-11 Sep 2020	CCI Colocation 10	Virtual meeting, WebEx	CCI project meeting

**CMUG Deliverable****Number:** D6.1**Due date:** 30 September 2020**Submission date:****Version:** 1.0**A2 Table of outreach activity**

The table below describes the main outreach and engagement activities for CMUG over the period October 2018 to September 2020.

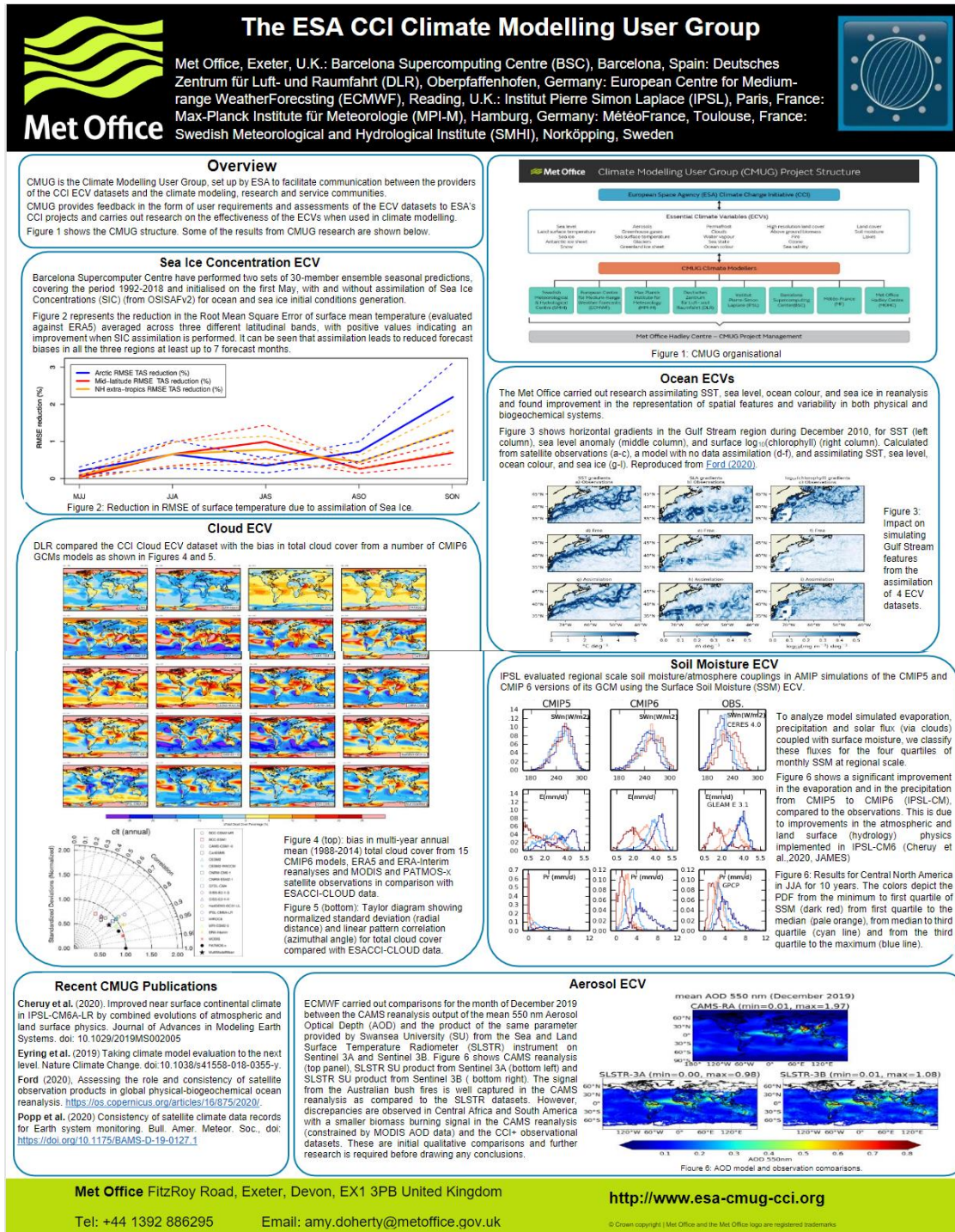
Date	Event	Participants	Location	Comment
2018				
8 Oct 2018	Paving the way for Horizon Europe in EO downstream sector	CMUG	Brussels, Belgium	Attended workshop
12 Oct 2018	SMHI Science meeting	UW / SMHI	CMUG poster	
29-31 Oct 2018	CMUG Integration Meeting 8	CMUG	Exeter, UK	CCI project meeting
2019				
16 Jan 2019	CCI CSWG meeting	CSWG	Remote attendance	
18 Jan 2019	CMUG Quarterly Progress Meeting	CMUG partners	Remote attendance	
25-28 Mar 2019	CCI Colocation Meeting 9	CMUG members	Oxford, UK	CMUG update to all, lead AR6 session
25-29 Mar 2019	CMIP6 Model Analysis Workshop	CMUG members	Barcelona, Spain	Poster by BSC: 'CCI sea ice concentrations to initialise seasonal predictions.'
8-12 Apr 2019	European Geosciences Union (EGU) General Assembly 2019	ECMWF	Vienna, Austria	CMUG interactions, Webpage link
3 May 2019	UKSA	Met Office	London, UK	Discussion of CMUG work
13-17 May 2019	CCI Living Planet Symposium	Met Office & Météo-France	Milan, Italy	CMUG presentation; CMUG on planet discussion (AR6); CMUG at CCI stand
29 May 2019	CCI CSWG meeting	CSWG	Online meeting	

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11-13 Jun 2019	UKESM Workshop	University of Leicester	Southampton, UK	Presentation about CMUG given on behalf of CMUG
9 Jul 2019	CMUG Quarterly Progress meeting	CMUG partners	Online meeting	
4 Sep 2019	CCI CSWG meeting	CSWG	Online meeting	
5 Nov 2019	CMUG Annual Progress meeting	CMUG partners	BSC, Spain	
6-7 Nov 2019	CCI CSWG meeting	CSWG	BSC, Spain	BOG within Integration Meeting
6-7 Nov 2019	CCI CMUG Integration Meeting	CSWG	BSC, Spain	Circa 70 participants
28 Oct – 1 Nov 2019	C3S GA	Met Office	Warsaw, Poland	CMUG interactions
2020				
27 May 2020	CMUG Quarterly meeting with ESA	CMUG, ESA	Online meeting	
9-11 Sep 2020	10 th CCI Colocation Meeting	CCI	Online meeting	
15 Sep 2020	WP Progress Meeting	Met Office, ECMWF	Online meeting	Meeting to discuss implementation of CMF inside C3S Toolbox, related to WP5

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A3 CMUG poster presented at 10th Colocation Meeting Sep 2020

Met Office FitzRoy Road, Exeter, Devon, EX1 3PB United Kingdom

Tel: +44 1392 886295

Email: amy.doherty@metoffice.gov.uk

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

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A4 CMUG peer-reviewed publications since October 2018

This list describes CMUG peer-reviewed publications since the beginning of the current phase (October 2018) until time of this report (September 2020). References are given as well as the number of citations, as sourced from Google Scholar (as of September 2020).

Paper	Citations *
Willén U. , et al., 2018: ENSO variability in multiple satellite observations and climate models. In prep.	-
Eyring, V. , Cox, P. M., Flato, G. M., Gleckler, P. J., Abramowitz, G., Caldwell, P., Collins, W. D., Gier, B. K., Hall, A. D., Hoffman, F. M., Hurtt, G. C., Jahn, A., Jones, C. D., Klein, S. A., Krasting, J. P., Kwiatkowski, L., Lorenz, R., Maloney, E., Meehl, G. A., Pendergrass, A. G., Pincus, R., Ruane, A. C., Russell, J. L., Sanderson, B. M., Santer, B. D., Sherwood, S. C., Simpson, I. R., Stouffer, R. J. & Williamson, M. S. (2019) Taking climate model evaluation to the next level. <i>Nature Climate Change</i> . doi:10.1038/s41558-018-0355-y. https://www.nature.com/articles/s41558-018-0355-y	74
Ford, D. A. (2020), Assessing the role and consistency of satellite observation products in global physical-biogeochemical ocean reanalysis. https://os.copernicus.org/articles/16/875/2020	-
Popp, T. , M I Hegglin, R Hollmann, F Arduin, A Bartsch, A Bastos, V Bennett7, J Boutin, C Brockmann, M Buchwitz, E Chuvieco, P Ciais, W Dorigo, D Ghent, R Jones , T Laverne, C J Merchant, B Meyssignac, F Paul, S Quegan, S Sathyendranath, T Scanlon, M Schröder, S G H Simis, U Willén . (2020) Consistency of satellite climate data records for Earth system monitoring. Bull. Amer. Meteor. Soc., doi: https://doi.org/10.1175/BAMS-D-19-0127.1	-
Waliser, D., Gleckler, P. J., Ferraro, R., Taylor, K. E., Ames, S., Biard, J., Bosilovich, M. G., Brown, O., Chepfer, H., Cinquini, L., Durack, P. J., Eyring, V. , Bathieu, P.-P., Lee, T., Pinnock, S., Potter, G. L., Rixen, M., Saunders, R., Schulz, J., Thépaut, J.-N., Tuma, M. (2020) Observations for Model Intercomparison Project (Obs4MIPs): status for CMIP6. <i>Geosci. Model Dev.</i> , 13, 2945-2958.	1
Albergel, C., Zheng, Y., Bonan, B., Dutra, E., Rodríguez-Fernández, N., Munier, S., Draper, C., de Rosnay, P., Muñoz-Sabater, J., Balsamo, G., Fairbairn, D., Meurey, C., and Calvet, J.-C.: Data assimilation for continuous global assessment of severe conditions over terrestrial surfaces, <i>Hydrol. Earth Syst. Sci.</i> , 24, 4291–4316, https://hess.copernicus.org/articles/24/4291/2020/ , 2020.	2
Bilbao, R., Wild, S., Otega, B., Acosta-Navarro, J., Arsouze, T., Bretonniere, P.-A., Caron, L.-P., Castrillo, M., Cruz-Gracia, R., Cvijanovic, I., Doblas-Reyes, F.J., Donat, M., Dura, E., Echevarría, P., Ho, A.-C., Loosveldt-Tomas, S., Moreno-Chamarro, E., Pérez-Zanon, N., Ramos, A., Ruprich-Robert, Y., Sicardi, V.,	

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Tourigny, E., Vegas-Regidor, J.: Assessment of a full-Field initialised decadal climate prediction system with the CMIP6 version of EC-Earth, https://esd.copernicus.org/preprints/esd-2020-66/ 2020	
Cheruy, F., Ducharne, A., Hourdin, F., Musat, I., Vignon, E., et al.: Improved near surface continental climate in IPSL-CM6A-LR by combined evolutions of atmospheric and land surface physics, Journal of Advances in Modeling Earth Systems, https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019MS002005 , 2020.	-
Zheng, Y., Albergel, C., Munier, S., Bonan, B., and Calvet, J.-C.: An offline framework for high-dimensional ensemble Kalman filters to reduce the time to solution, Geosci. Model Dev., 13, 3607–3625, https://gmd.copernicus.org/articles/13/3607/2020/ , 2020.	-

**Source: Google Scholar, September 2020*

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A5 Updated CMUG peer-reviewed publications from last SER (2015 – 2016)

This list describes CMUG peer-reviewed publications as listed in the previous SER, which was produced in CMUG Phase 2 and covered the period 2015 – 2016. These are included in this report to show any updates in citation numbers since 2016. Citations from the previous SER are the numbers in brackets, whilst the updated number of citations as of September 2020 is shown to the right of the brackets.

Paper	(Previous Citations*) Current 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, <i>Geosci. Model Dev. Discuss.</i> , 8, 7541-7661, doi:10.5194/gmdd-8-7541-2015, 2015.	(2) 54
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 <i>Ocean Sci. Discuss.</i> , 9, 687-744, 2012. doi:10.5194/os-8-751/2012/	(13) 51
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. <i>Bulletin of the American Meteorological Society</i> , 130313072241002. doi:10.1175/BAMS-D-11-00254.1	(58) 255
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. <i>Journal of Climate</i> 26(13):4758-4772 https://doi.org/10.1175/JCLI-D-12-00206.1	(3) 20
Loew, A. (2013). Terrestrial satellite records for climate studies: how long is long enough? A test case for the Sahel. <i>Theoretical and Applied Climatology</i> , 1–14. doi:10.1007/s00704-013	(6) 19
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. <i>Hydrology</i>	(31) 96

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<i>and Earth System Sciences</i> 17(9), 3523–3542. doi:10.5194/hess-17-3523-20130	
Loew, A. et al. (2016): Assessing surface solar radiation fluxes in the CMIP ensembles. <i>Journal of Climate</i> 29(20):7231-7246. https://doi.org/10.1175/JCLI-D-14-00503.1	(-) 7
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. <i>Journal of Geophysical Research</i> , 117(C12), C12013. doi:10.1029/2012JC008400	(15) 89
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. <i>Tellus A</i> , [S.I.], Nov. 2014. ISSN 1600-0870. doi:10.3402/tellusa.v66.23967	(3) 65
Dragani, R.: A comparative analysis of UV nadir-backscatter and infrared limb-emission ozone data assimilation, <i>Atmos. Chem. Phys. Discuss.</i> , doi:10.5194/acp-2016-96, 2016.	(-) 5

*Source: Google Scholar, September 2020

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A6 All CMUG peer-reviewed publications up to October 2018

This list describes all CMUG peer-reviewed publications until October 2018, when the current phase started, including citations (as of September 2020).

Paper	Citations*
Adloff F. , G. Jordà, S. Somot, F. Sevault, T. Arsouze, B. Meyssignac, L. Li, S. Planton (2017), Improving sea level simulation in Mediterranean regional climate models, <i>Climate Dynamics</i> , doi:10.1007/s00382-017-3842-3 https://link.springer.com/article/10.1007/s00382-017-3842-3	16
Bellprat, O. , F. Massonnet, S. Siegert, C. Prodhomme, D. Macias-Gómez, V. Guemas , F. Doblas-Reyes (2017) Uncertainty propagation in observational references to climate model scales. <i>Remote Sensing of Environment</i> . Volume 203, 15 December 2017, Pages 101-108. https://doi.org/10.1016/j.rse.2017.06.034	10
Dragani, R. : (2016) A comparative analysis of UV nadir-backscatter and infrared limb-emission ozone data assimilation, <i>Atmos. Chem. Phys. Discuss.</i> , doi:10.5194/acp-2016-96.	5
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, <i>Geosci. Model Dev. Discuss.</i> , 8, 7541-7661, doi:10.5194/gmdd-8-7541-2015, 2015.	54
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 <i>Ocean Sci. Discuss.</i> , 9, 687-744, 2012. doi:10.5194/os-8-751/2012/	51
Ford, D. A. and R. M. Barciela , (2017): Global marine biogeochemical reanalyses assimilating two different sets of merged ocean colour products. <i>Remote Sensing of Environment</i> 203. DOI: 10.1016/j.rse.2017.03.040.	27
Guemas, V., M. Chevallier, M. Déqué, O. Bellprat and F.J. Doblas-Reyes (2016). Impact of sea ice initialization on sea ice and atmosphere prediction skill on seasonal timescales. <i>Geophysical Research Letters</i> , 43, 3889-3896, doi:10.1002/2015GL066626.	25
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. <i>Bulletin of the American Meteorological Society</i> , 130313072241002. doi:10.1175/BAMS-D-11-00254.1	255

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Lauer, A., V. Eyring, M. Righi, M. Buchwitz, P. Defourny, M. Evaldsson, P. Friedlingstein, R. de Jeu, G. Leeuw, A. Loew , C.J. Merchant, B. Müller , T.Popp, M. Reuter, S. Sandven, U. Willén . 2017: Benchmarking CMIP5 models with a subset of ESA CCI Phase 2 data using the ESMValTool. Remote Sensing of Environment. Volume 203, 15 December 2017, Pages 9-39. https://doi.org/10.1016/j.rse.2017.01.007	24
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. <i>Journal of Climate</i> . 0880-6.	20
Loew, A. (2013). Terrestrial satellite records for climate studies: how long is long enough? A test case for the Sahel. <i>Theoretical and Applied Climatology</i> , 1–14. doi:10.1007/s00704-013	19
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. <i>Hydrology and Earth System Sciences</i> 17(9), 3523–3542. doi:10.5194/hess-17-3523-20130	96
Loew, A. , J. Trentmann and M. Schröder. (2016): Assessing surface solar radiation fluxes in the CMIP ensembles. <i>Journal of Climate</i> , https://doi.org/10.1175/JCLI-D-14-00503.1	7
Massonnet, F. , O. Bellprat , V. Guemas and F. J. Doblas-Reyes (2016). Using climate models to estimate the quality of global observational data sets. <i>Science</i> , 6311, 452-455, doi:10.1126/science.aaf6369.	36
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. <i>Journal of Geophysical Research</i> , 117(C12), C12013. doi:10.1029/2012JC008400	89
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. <i>Tellus A</i> , [S.I.], Nov. 2014. ISSN 1600-0870. doi:10.3402/tellusa.v66.23967.	65
Yue, C., Ciais, P., Cadule, P. , Thonicke, K., & van Leeuwen, T. T. (2015). Modelling the role of fires in the terrestrial carbon balance by incorporating SPITFIRE into the global vegetation model ORCHIDEE – Part 2: Carbon emissions and the role of fires in the global carbon balance. <i>Geoscientific Model Development</i> , 8(5), 1321–1338. http://doi.org/10.5194/gmd-8-1321-2015	36
Yue C., P. Ciais, P. Cadule , S. Kloster , et al., 2014, Modelling fires in the terrestrial carbon balance by incorporating SPITFIRE into the global vegetation model ORCHIDEE - Part 1: Simulating historical global burned area and fire regime. <i>Geoscientific Model Development Discussions</i> 7(2) DOI: 10.5194/gmdd-7-2377-2014.	8

*Source: Google Scholar, September 2020