Climate Modelling User Group

Project Management Plan

Prepared by	**The Met Office**
Reference	**CMUG-3-PROJMGMT**
Version	**Issue 1 revision 3**
Issue date	**02 November 2020**

1 Contents

1 Introduction

The CMUG project in the ESA CCI+ programme is led by the Met Office which provides the interface to ESA and project manages the CMUG activities.

The following activities are included:

- Ensure the project is running on time and within budget (including maintaining the project plan and risk register and organising progress meetings with ESA)
- Ensure that CMUG project deliverables meet contractual requirements
- Prepare project and meeting reports for ESA
- Work closely with WP2 and WP6 to ensure effective communications and outreach
- Work with WP Leads to maintain active links with other CCI teams, the DEWG and CSWG
- Organise annual integration meetings and/or user workshops
- Lead the CSWG
- Facilitate interactions with relevant organisations (e.g. ESGF, Copernicus, GCOS, WGCM, WCRP, CLIVAR, Cordex etc)
- Ensure the CMUG consortium works under effective agreement
- Ensure payments are made by ESA to the Met Office, and from the Met Office to partners

2 Overview of Consortium

The consortium consists of the UK Met Office, Meteo-France, The European Centre for Medium Range Weather Forecasting (ECMWF), the Swedish Meteorologicl and Hydrological Institute (SMHI), Deutsches Zentrum für Luft (DLR), the Max Plank Institute – Meteorology (MPI-M), the Barcelona Supercomputer Center (BSC) and Institut Pierre-Simon Laplace (IPSL). The Met Office Hadley Centre leads and coordinates the project. The key staff from each institution are shown in Table 1.

Position	Name	organisation	Email
Science Leader	Richard Jones	Met Office	Richard.Jones@Metoffice.gov.uk
Project manager (science)	Amy Doherty	Met Office	Amy.doherty@metoffice.gov.uk
Project manager (admin)	Hannah Phillips	Met Office	Hannah.phillips@metoffice.gov.uk
Finance manager	Dom Lethem	Met Office	Dom.lethem@metoffice.gov.uk
Scientist	David Ford	Met Office	David.ford@metoffice.gov.uk
scientist	Debbie Hemming	Met Office	Debbie.hemming@metoffice.gov.uk
scientist	Rob King	Met Office	Rob.king@metoffice.gov.uk
scientist	Hannah Griffith	Met Office	Hannah.griffith@metoffice.gov.uk
Science lead	Veronika Eyring	DLR	Veronika.Eyring@dlr.de
scientist	Axel Lauer	DLR	Axel.Lauer@dlr.de
scientist	Björn Brötz	DLR	Bjoern.Broetz@dlr.de
scientist	Mattia Righi	DLR	Mattia.Righi@dlr.de
Admin/finance	Rolf Thiess	DLR	Rolf.Theiss@dlr.de
Scientist	Francisco Doblas-Reyes	BSC	francisco.doblas-reyes@bsc.es
Science lead	Pabol Ortega	BSC	portega@bsc.es
scientist	Louis-Phillippe Caron	BSC	louis-philippe.caron@bsc.es
scientist	Enza di Tomaso	BSC	enza.ditomaso@bsc.es
Admin/finance	Mar Rodriguez	BSC	Mar.rodriguez@bsc.es
Science lead	Rossana Dragani	ECMWF	rossana.dragani@ecmwf.int
scientist	Angela Benedetti	ECMWF	Angela.benedetti@ecmwf.int
Science lead	Dirk Notz	MPI-M	Dirk.notz@mpimet.mpg.de
scientist	Andreas Wernecke	MPI-M	andreas.wernecke@mpimet.mpg.de
Admin/finance	Martina Boether	MPI-M	martina.boether@mpimet.mpg.de
Science lead	Jean-Christophe Calvet	Meteo-France	Jean-Christophe.Calvet@meteo.fr
Science lead	Ulrika Willén	SMHI	Ulrika.Willen@smhi.se
scientist	Claus Zimmermann	SMHI	Klaus.zimmermann@smhi.se
Admin/finance	Madeleine Benderyd	SMHI	Madeleine.benderyd@smhi.se

Science lead	Frédérique Cheruy	IPSL	Frederique.cheruy@lmd.jussieu.fr
scientist	Jean-Louise Dufresne	IPSL	jean-louis.dufresne@lmd.jussieu.fr
scientist	Agnès Ducharne	IPSL	Agnes.Ducharne@upmc.fr
scientist	Yanfeng Zhao	IPSL	yanfeng.zhao@lmd.jussieu.fr

Table 1 : Key staff from each of the CMUG partner institutions, with position within CMUG and contact email addresses

Figure 1 shows the points of contact within those organisations and the direct reporting lines between the institutions in the project

This structure ensures that the work of the partners is carried out efficiently in an integrated way to effectively achieve the aims of the work packages and the goals of the project. The management structure which is supporting this work is also flexible enough to adapt to changes in the project should they arise. To date this approach has worked well and no reason can be seen to change it.

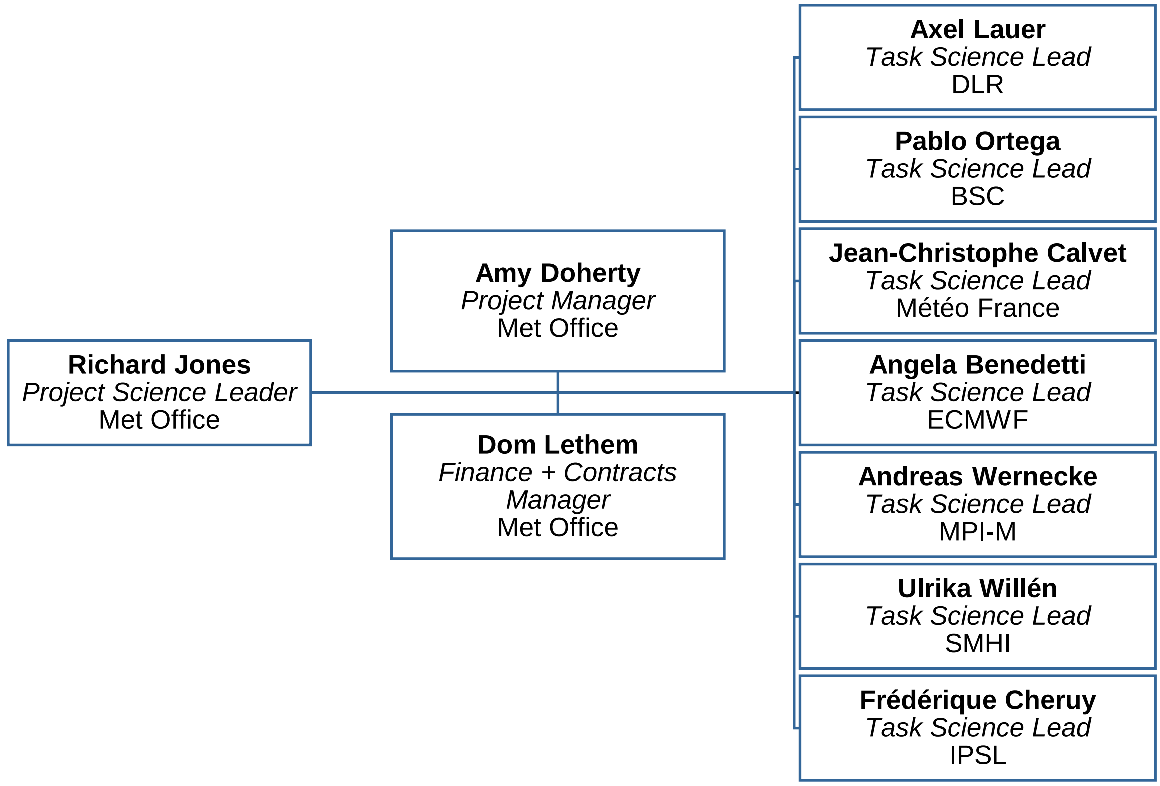

Figure 1. The organigram for the CMUG management structure.

3 Management team and governance

2.1 Management team

The Met Office Hadley Centre will be the **lead organisation** for the CMUG project and will be working in close cooperation and collaboration with the other members of the CMUG consortium. Governance of the project will continue from CMUG Phase 2 as an inclusive process whereby the strengths and individual skills of the partners in the consortium can be used to their maximum benefit.

The **Science Leader** of the project, from the Met Office Hadley Centre, will provide the intellectual direction for the project. They will work in collaboration and cooperation with the science leaders of the other institutions in the consortium. All decisions will be made with full agreement of all the Science Leads and the Project Manager.

The **Project Manager** is responsible for ensuring that the "programme board" (see below) functions effectively to conduct the project according to ESA's requirements, and conforms to relevant institutional directives and the consortium agreement. CMUG management will be conducted using industry standard best practice.

The Project Manager is supported by a Finance Manager who will work to support the financial functions of the project. Specialist communications directly between ESA's finance department and the Met Office Hadley Centre Finance Manager will take place for contractual financial matters. See the *Financial proposal* for more information about project finances.

The Science Leader and Task Leads from the project partners named in **Error! Reference source not found.** will constitute the CMUG **Programme Board** and they will meet in person or by teleconference at least once every quarter to ensure the project is run according to plan and is achieving its goals. Communications between consortium partners will be implemented through face-to-face meetings, teleconferences, e-mail and web-based information sharing (web pages, wiki pages and online documents).

Contact between ESA officers and the Task Leads of the project will also take place as needed to cover scientific and technical issues in a direct way. The Project Manager will be kept informed of such communications. Section 2.4 in this document describes the lines of reporting.

2.2 Governance

The Task Leaders from the project partners named in Figure 1 will constitute the programme board and they will meet in person or by teleconference at least every quarter to ensure the project is run according to plan and is achieving its goals. Communications between consortium partners will be implemented through face to face meetings, teleconferences, email and web-based information sharing (web pages, wiki pages and online documents).

The Science Leader of the project from the Met Office Hadley Centre will provide the strategic direction for the project in collaboration with the WP Leads. All decisions will be made with full agreement of all the science partners and the project manager.

The project manager is responsible for ensuring that the programme board functions effectively to conduct the project according to ESA's requirements, and conforms to relevant institutional directives and the consortium agreement. The project manager will be the main point of contact between the consortium and the Technical Officer nominated by ESA.

2.3 Tasks and responsibilities

2.3.1 PROJECT MANAGER'S KEY TASKS AND RESPONSIBILITIES

The Project Manager, Amy Doherty (Met Office), will support the Science Leader in the overall management of the project and ensure that all tasks are executed in a coherent, consistent and efficient manner. The Project Manager will provide the necessary administrative support to the Science Leader to ensure the project remains within schedule, within budget and achieves its objectives.

The Project Manager will be supported by a Finance Manager, Dom Lethem (Met Office).

The Project Manager's key tasks and responsibilities are as follows.

1. To provide at Kick-Off (KO) and implement the Project Management Plan (PMP) to achieve the objectives of the project (see *Technical Proposal*).
2. To monitor progress of each task and identify, follow up and close out all problems or underperformance.
3. To set up and maintain a project Actions Database, review it on a monthly basis, and chase up any actions outstanding.
4. To monitor progress of each task, ensure timeliness and quality of all deliverables and organize and attend progress meetings.
5. To lead the organisation of workshops and dedicated meetings with the CCI Projects.
6. To support the organisation of the working groups and to provide coordinated input to them.
7. To organise internal quality review and to ensure timeliness in submission of all deliverables.
8. To compile monthly progress reports and minutes of meetings.
9. To compile quarterly progress reports for a technically literate but non-expert audience.
10. To organize and attend progress meetings and ensure attendance by all necessary project team members.
11. To support the coordination of project activities with other relevant ongoing national, EC-funded and international projects.
12. To support the Science Leader
13. To coordinate the CSWG

2.3.2 WP LEADS' MANAGEMENT RESPONSIBILITIES

The WP Leads management responsibilities are:

1. At least one representative of CMUG from each institution shall participate in the following types of meetings during the duration of the project: Contract Progress Meeting with ESA, Scientific Workshops; Integration Meetings; Colocation Meetings.
2. Appropriate representation from CMUG for the colocation meetings of three days (including one day for communication to stakeholders) usually held in the Oxford area to meet with key personnel from all CCI projects.
3. To contribute to the overall integrated approach of the CCI by building appropriate two-ways interfaces between CCI projects, the Climate Modelling Community, and other international initiatives (e.g. WCRP, CMIP, Copernicus and H2020 climate projects).
4. To provide feedback to ESA and CCI projects at various levels (e.g. via technical notes and progress meetings).
5. Design and implement mechanisms to link with the whole Climate Modelling Community, including organisations, networks, international modelling programmes like "Coupled Model Intercomparison

Project Phase 6" (CMIP6), scientific bodies, European and other international initiatives and the "Intergovernmental Panel for Climate Change" (IPCC).

6. To provide input and direction, and to further the aims and objectives of the CSWG

The WP leads are as follows:

WP1	Meeting the evolving needs of the climate community	Richard Jones	Met Office
WP2	Providing an integrated view and feedback to ESA and the CCI Teams	Richard Jones	Met Office
WP3	Quality assessment of CCI products	Jean-Christophe Calvet	Meteo France
WP4	Exploiting CCI products in MIP experiments	Dirk Notz	MPI-M
WP5	Adaptation of community climate evaluation tools for CCI needs	Axel Lauer	DLR
WP6	Coordination and Outreach	Hannah Griffith	Met Office
WP7	Interface of CCI data to climate services	Angela Benedetti	ECMWF
WP8	Project Management	Amy Doherty	Met Office

2.3.3 OVERVIEW OF INTERNAL COORDINATION MECHANISM FOR CMUG

The main internal coordinating mechanism for CMUG management is the teleconference meeting held quarterly. This will be chaired by the Project Manager, with participation by WP leads, and CMUG partners as needed. These meetings will cover CMUG activity (progress and results) against Deliverables, and Milestones and consideration will be given to the integration of work and results. The meetings will also cover interactions with the CCI, interactions with the Climate Research Community and Financial and contractual matters. There will be discussion of near-term plans to cover the period up to the next meeting. Ideally these meetings will be timed to feed in to the quarterly reports due to ESA, and any progress or review meetings. Meeting actions and decisions will be recorded in a shared online document and reviewed at the start of each meeting. Quarterly progress meetings will be held with ESA, either in person or by videoconference.

2.4 Lines of reporting

Partner Institutions report to the Met Office project management team who, in turn, report to ESA. All deliverables are submitted through the Met Office and approved by the Project manager and science lead before submitting to ESA. The Met Office gathers and collates material for monthly and quarterly reports and the deliverables for which a cross-project response is required.

Science leaders and scientists working with each ECV are expected to contact the relevant ECV team directly to keep them informed of progress and facilitate ongoing communication. All such contact will be reported to the Met Office project management team for inclusion in the monthly reports to ESA, which will contain a table of all interactions between CMUG and the ECV teams.

4 Project Management

The start date for this plan is 1 October 2018, and the three-year duration gives a planned end date of 30 September 2021. However, after delays due to management changes and COVID-19 the new schedule has a planned end date of July 2022. Table 2 shows the new schedule for milestones and payments with the deliverables associated with each milestone listed. This table was taken from the contract payment plan.

Milestone + deliverables included	Due date (previous due date)
Milestone 1 (including provision for advance payment as identified hereunder): Upon acceptance of deliverables D1.1, D2.2 v1, and D2.3 v1, D5.7b v0	31 October 2020 (original date 31 March 2019)
Milestone 2: Upon successful year 1 review and acceptance of relevant deliverables D3.1 v1, D4.1 v1, D5.7a, D5.7b v1, D5.7c v0, D6.1 v1, D6.2 v1, and D7.1 v1	31 December 2020 (original date 01 October 2019)
Milestone3: Upon acceptance of deliverables D2.2 v2, and D2.3 v2	28 February 2021 (original date 31 March 2020)
Milestone 4: Upon successful year 2 review and acceptance of relevant deliverables D2.1, D3.1 v2, D4.1 v2, D5.6, D5.3 v1, D5.7b v2, D5.7c v1, D6.1 v2, and D6.2 v2	31 July 2021 (original date 01 October 2020)
Milestone 5: Upon acceptance of deliverables D1.2, D2.3 v3, D5.3 v2 and D7.1 v2	31 January 2022 (original date 31 March 2021)
FINAL: Upon successful year 3 review and acceptance of all deliverables including contract closure documentation	31 July 2022 (original date 01 October 2021)

Table 2: Milestones with deliverables for each and due dates

4.1 Project Management Plan (PMP)

This project management plan was constructed under the PRINCE methodology with planning of the resources, timeline, critical points, deliverable dates, dependencies, milestones and meetings. The gantt chart for the plan is shown in Table 2. The project plan incorporates points at which the need for revision, if any, will be formally examined. The PMP covers:

- The project organisation, i.e. timeline, gantt chart, governance;
- Resources and travel plan and budget;
- Description of work packages;
- Communications planning.
- Risk Register
- Actions database
- Governance structure, roles and responsibilities
- Reporting mechanisms

4.2 Actions Database

The Actions Database records and track all actions associated to the PMP, including those stemming out of meetings, and scientific-based issues. The Actions Database will include action reference numbers, a reference to the corresponding meetings (if relevant), actionee, action description, due date, status. The Actions Database will be shared in a Microsoft Excel format at management meetings. It is available at: https://docs.google.com/spreadsheets/d/1qj8ThI2a7hU8y_f6-Sx2jhjyFx4I-xqnCUQmcJWXjj8/edit#gid=0

A risk register is maintained and updated at the quarterly progress meetings. Vsn 2 is given in *Table* .

SEVERITY OF IMPACT	*LIKELIHOOD OF OCCURRENCE*	*PREVENTION*	*MITIGATION*	*OWNER*	*DATE*
Risk 1: CCI ECV projects not delivering data on time or to the required standard					
High	Medium to high	Liaise closely with ECV teams to know when this is happening	Negotiate with ESA for either a change in the CMUG deliverable or more time for the ECV to deliver required data	CMUG consortium, Project Manager	13 August 2020
Risk 2: Loss of key team members					
High	Medium	Re-negotiation of CMUG role	Recruitment of replacement	CMUG consortium, Project Manager	13 August 2020
Risk 3: CMUG not engaging with international initiatives					
Medium	Low	Identify the correct lead(s) of international initiatives of interest to CMUG	Draw in new experts to CMUG to take on this engagement work	CMUG consortium, CMUG Science Lead, Project Manager	13 August 2020
Risk 4: CMUG not engaging with the climate research community					
Medium	Low	Identify new lead(s) within CMUG partners to do this activity. Find new channels for engagement	Would need to discuss with ESA what actions could best be taken to mitigate.	CMUG consortium, Project Manager	13 August 2020
Risk 5: CMUG not understanding user needs					
Medium	Low	Use Climate Services to understand user needs	Use Climate Services to understand user needs	CMUG consortium, Project Manager	13 August 2020
Risk 6: CMUG climate models not available					
Medium	Low	Ensure models are capable and ready	Use previous version	CMUG consortium, Project Manager	13 Auguat 2020
Risk 7: Unforeseen impacts from Brexit (e.g. restrictions on computer sharing)					
Medium	Low	Have contingency resources in place	To be advised by CMUG management	CMUG consortium, Project Manager	13 August 2020
Risk 8: CMUG finances for non-Eurozone partners is reduced by exchange rate falls					
Low	Medium	Met Office to cover their shortfall in funding	To be advised by CMUG management	Met Office, SMHI, Project Manager	13 August 2020

Table 3. Risk register for the CMUG project, v2, 01-07-19)

5 Reporting

5.1 Monthly progress report

Monthly progress reports will be provided by the end of each calendar month for the full duration of the project. They will be communicated via e-mail to ESA and CMUG consortium.
Monthly progress reports will summarise progress during the last calendar month as:

- Progress made for each Task (see Technical Proposal), status of each deliverable, description of any difficulties, list of major events attended;
- A cumulative list of all publications (including conference presentations and posters);
- Actions from Actions Database raised, closed and outstanding;
- Report of problems and analysis of risk regarding slippage in the schedule (including planned actions to mitigate identified risks);
- Status of the fund for external experts to be invited to attend CMUG meeetings;
- Statistics on accesses and downloads from the CMUG website and CMUG Data Forum.
- List of past and upcoming project meetings
- Record of CMUG consortium meetings with CCI ECV project teams.

They will also include for the next calendar month:

- Summary of activities planned;
- Plan for communication activities, indicating events and conferences;

5.2 Quarterly project scientific highlights

Project scientific highlights will be provided quarterly, when available, by the Science Leader for public consumption and published on the CMUG website and CMUG Data Forum. The text will be 500 words long and accompanied by two illustrating images as well as appropriate links for more details.

5.3 Quarterly status report

Quarterly progress reports will be provided as required by ESA. The timing will depend on the schedule of the ESA Programme Board meetings, to which the CMUG quarterly report contributes. They will provide a 1-2-page summary of the following for a technically literate but non-expert audience:

- Project achievements in the previous three months (e.g. results, highlights, publications, communication activities, international cooperation activities);
- Progress made for each Task (see Technical Proposal), status of each deliverable, description of any difficulties, list of major events attended;
- A cumulative list of all publications (including conference presentations and posters);
- Major problems encountered and solutions adopted.
- Cooperation with international partners, European and national projects;
- Major planned project activities in the coming three months;

5.4 Final project report

A final report (D8.3) will be provided at the end of the project. It will describe the main achievements of the project as well as lessons learned (to be used to inform any future possible phase of the project). The Final Report will summarise CMUG activities, results and recommendations, and be 20-30 pages long including references and figures.

5.5 Other reporting

Minutes of the meetings (progress, integration, review, etc) will be taken by the Project Manager and circulated in draft no more than one week after the meeting. Comments on the minutes will be incorporated and a final agreed version circulated to ESA, project partners and other attendees as appropriate. The minutes will also be recorded on a password protected website for private access only by ESA or CMUG. Minutes will be used to document agreed actions required in the project which will be followed up by the project Manager.

6 Tasks and Deliverables

The tasks addressed in this proposal are:

Task 1: Meeting the evolving needs of the climate community
Task 2: Providing integrated view of CCI & feedback to ESA and CCI teams
Task 3: Assessing consistency and quality of CCI products across ECVs
Task 4: Exploiting CCI products in MIP experiments
Task 5: Adaptation of community climate evaluation tools for CCI needs
Task 6: Coordination and Outreach
Task 7: Interface to the European Climate Service
Task 8: Project Management

These tasks will be met by a set of deliverables to ESA, listed below, for which a set of work packages (WPs) contribute to. A breakdown of the individual Deliverables is shown in Table 4 which summarises the tasks and partners contributing to each of them and the Gantt chart showing timings is in Table 5. For Tasks 3 and 4 a more detailed breakdown of the contributing WPs is given in Section 8 of this document. The deliverables are structured to match those in the Statement of Work and listed in the table below:

Deliverable	**Description**	**Contributors**	**Type**
Task 1			
D1.1	User Requirement document	**MOHC**, All	Doc
D1.2	EO for climate foresight report	**MOHC**, All	Doc
Task 2			
D2.1	CCI Scientific impact report	**MOHC**, All	Doc
D2.2	Climate Data Forum v1 v2 v3	**MOHC, All**	Doc
D2.3	Product documentation assessment v1 v2 v3	**MOHC**, All	Doc
Task 3			
D3.1	Quality assessment report v1 v2 v3	**MOHC,** All (except MPI-M and SMHI)	Doc
Task 4			
D4.1	Reports on MIP impact assessment and benchmarking CMIP5 models v1 v2 v3	**MOHC,** All (except ECMWF, MF, DLR and SMHI)	Doc
Task 5			
D5.1	Release of enhanced version of the ESMValTool and user guide	**DLR**	ESM Community tool

Deliverable	Description	Contributors	Type
D5.2	CMF for CCI products and models evaluation	**ECMWF**	Data evaluation tool
D5.3	ESMValTool GitHub repository (V1) and Namelist (V2) v1 v2		ESM Community tool
D5.4	Report on CMIP6 global model evaluation with ESA CCI/CCI+ data from Task 5.3 and improvements compared to CMIP5 in support of IPCC AR6	**DLR,** BSC, MetO, SMHI	ESM Community tool
D5.6	Updated CMF with additional CCI ECVs	**ECMWF**	Data evaluation tool
D5.7	CCI contribution to Obs4MIPs a) Training material v1 b) Roll out schedule v0 v1 v2 c) Annual report v0 v1 v2 d) CCI Obs4MIPs data	**DLR**	ESM Community tool
Task 6			
D6.1	Scientific exploitation report v1 v2 v3	**MOHC,** All (except DLR)	Doc
D6.2	Promotion package v1 v2 v3	**MOHC,** All (except DLR)	Web
Task 7			
D7.1	Climate Service Interface Reqm't & R'map v1 v2	**ECMWF** All (except DLR)	Doc
Task 8			
D8.1	Quarterly progress reports	**MOHC** with input from partners	Doc
D8.2	Maintenance of CMUG web pages	**MOHC** with input from partners	Web
D8.3	Final Report	**MOHC** with input	Doc

Table 4. List of deliverables for CMUG, the partner who leads a deliverable is highlighted in bold.

Ref	Name of CMUG Deliverable	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Task 1	Meeting the evolving needs of the climate community																																				
D1.1	User requirements document			**V1**																																**V2**	
D1.2	EO for Climate Foresight report																												**V1**								
Task 2	Providing integrated view and feedback to ESA and CCI teams																																				
D2.1	CCI Scientific impact report																								**V2**												
D2.2	CCI Climate data forum						**V1**										**V2**																				**V3**
D2.3	Technical note on CCI product assessment						**V1**									**V2**															**V3**						
Task 3	Assessing consistency and quality of CCI CDRs across ECVs																																				
D3.1	Quality assessment report												**V1**												**V2**											**V3**	
Task 4	Explointing CCI products in MIP experiments																																				
D4.1	MIP impact assessment report												**V1**												**V2**											**V3**	
Task 5	Adaptation of community evaluation tools for CCI needs																																				
D5.1	Enhanced ESMValTool and user guide release																																				**V1**
D5.3	ESMValTool GitHub repository (V1) and Namelist (V2)																								**V1**				**V2**								
D5.4	Evaluating CMIP6 ensemble with CCI data & ESMValTool																																				**V1**
D5.2	CMF for CCI products and models evaluation																								**V1**												
D5.7	CCI contribution to Obs4MIPs																																				
a	Training material												**V1**																								
b	Roll out schedule						**V0**						**V1**												**V2**												
c	Annual report												**V0**												**V1**												**V2**
d	CCI Obs4MIPs data																																				**V1**
Task 6	Coordination and outreach																																				
D6.1	Scientific exploitation report												**V1**												**V2**												**V3**
D6.2	Promotion package												**V1**												**V2**												**V3**
Task 7	Interface to Climate services																																				
D7.1	Climate service interface requirements and roadmap										**V1**																				**V2**						

Task 8	Project management																																				
D8.1	Quarterly report			x			x			x			x			x			x			x			x			x			x			x			
D8.2	CMUG website																																				
D8.3	Final report																																				x
Milestone							M1						M2						M3						M4						M5						M6

Table 5. Project Gantt chart showing timings of deliverables and milestones.

7 Meetings

CMUG will organise meetings related to the CMUG activities as described in *Table* 6.

In general meeting minutes will be taken by the Project Manager and circulated in draft no more than one week after the meeting. Comments on the minutes will be incorporated and a final agreed and signed version circulated to ESA, CMUG consortium and other attendees as appropriate. The minutes will also be recorded on a protected website for private access only by ESA and CMUG. Actions associated with meetings will be recorded by the Project Manager in the Actions Database; reports of scientific workshops will be provided by the Project Manager and posted on the CMUG project website after approval by ESA.

The meetings will be as follows.

- **Progress meetings**: quarterly meetings with ESA, to monitor progress, via teleconference, at ECSAT or at a CMUG partner institution. WP Leads, the Science Leader and the PM will participate, and CMUG partners as needed. PM will report on these.
- **Annual Review meetings:** annual meetings with ESA at ECSAT to review progress status of the work, reporting of achievements, completion status of deliverables, management effectiveness and efficiency, identification of current/potential problems, consolidation of action plans for next project phase; these meetings may lead to a review of the PMP. WP Leads, Science Leader and the PM will attend, and CMUG partners as needed. PM will report on these.
- **Integration meetings:** annual meeting with key representatives of the CCI projects and Climate Research Groups, to discuss issues from a climate model perspective. CMUG partners to attend as needed. PM will report on these.
- **Colocation meetings:** annual meetings organised by the ESA Climate Office, to establish firmly the scientific coherency and coordination between the ECV projects. CMUG partners to attend as needed.
- **Meetings with CCI projects:** meetings with CCI projects, science leaders, and relevant working groups of CCI. PM will report on these in the monthly reports.
- **International Science meetings (scientific workshops with the climate research community):** as described in table 6, the PM will coordinate or manage as needed.

KO	DATE	EVENT	DAYS	LOCATION	ATTENDEES
+0	Oct 2018	KO meeting	1	Tele/videoconferencing	All partners
+1	**Oct 2018**	**Integration meeting**	**1**	**Met Office (UK)**	**All partners**
+3	Dec 2018	Progress meeting	1	Tele/videoconferencing	WP Leads
+6	Mar 2019	Progress meeting	1	Tele/videoconferencing	WP Leads
+6	Mar 2019	Collocation meeting	3	ECSAT (UK)	~4
+8	May 2019	Living Planet	3	Milan, Italy	~2
+10	Jul 2019	Progress meeting	1	Tele/videoconferencing	WP Leads
+14	Nov 2019	Integration meeting 9	3	BSC	All partners
+14	Nov 2019	Annual progress / Review meeting	1	With Integration meeting at BSC	WP Leads in person
+15	Dec 2019	Progress meeting	1	Tele/videoconferencing	WP Leads
+18	Mar 2020	Progress meeting	1	Tele/videoconferencing	WP Leads
+18	Mar 2020	Collocation meeting	3	Oxford (UK)	~4
+21	Jun 2020	Progress meeting	1	Tele/videoconferencing	WP Leads

+24	Sep 2020	Integration meeting 10	3	CMUG partner institute	All partners
+24	Sep 2020	Review meeting (for mid-term review)	1	With Integration meeting or at Oxford (UK)	WP Leads
+27	Dec 2020	Progress meeting	1	Tele/videoconferencing	WP Leads
+30	Mar 2021	Collocation meeting	3	Oxford (UK)	~4
+30	Mar 2021	Progress meeting	1	Tele/videoconferencing	WP Leads
+32	May 2021	User-foresight w'shop	1	WMO (Switzerland)	~4
+33	Jun 2021	Progress meeting	1	Tele/videoconferencing	WP Leads
+35	**Aug 2021**	**Annual review and final meeting**	**1**	**ECSAT (UK)**	**All partners** in person or by teleconf

DATE	MEETING	DAYS	LOCATION	ATTENDEES
2X	Obs4MIPs meetings	2	Europe, USA	~2
12X	Sience meetings (e.g. EGU, IS-ENES3)	3	Europe	~2
15X	CCI team meetings	2	Europe	~1

Table 6. CMUG meetings plan for CMUG project in ESA CCI+ programme.

8 Communications and Outreach

The Communications and outreach activities for CMUG are described in WPs 2.2 (Climate Data Forum) and 6.2 (Promotion Package). As part of the project management there is a coordinated oversight of communications and outreach for achieving the project's objectives, which the project manager leads in discussion with the management team. It is also recognised that there will be times when an unscheduled outreach activity is needed at short notice, and these will be met whenever possible. The CMUG website and Forum will record outreach activity, and where possible, effectiveness. This will also be recorded on the project sharepoint site when it has been set up.

8 Work packages

WP1: Meeting the evolving needs of the Climate Community (lead by Richard Jones)

WP: 1.1		Start / end	M1	M4
Title: Meeting the Needs of the Climate Community - Requirements				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM	0.25	0.5	0.15	0.25	0.05	0.5	0.5	0.5

Sum: **2.7**

Key personnel	**Lead : Amy Doherty**, Richard Jones, Jean-Christophe Calvet, Veronika Eyring, Jean-Louis Dufresne, Ulrika Willén, Rossana Dragani, Francisco Doblas-Reyes, Dirk Notz

CCI+ ECVs	WV	Salin	S-State	Lakes	Snow	PF	LST	HRLC	AGB				
	X	X	X	X	X	X	X	X	X				
ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS	Gla
	X	X	X	X	X	X	X	X	X	X	X	X	X

Objectives

The aim is to gather the latest requirements from climate modellers, impact modellers, GCOS, users of climate services and other users, and to build on the requirements gathered previously.

Questions to be addressed:

1. What are the observational requirements of the CMC and other climate researchers for the new ECVs?
2. What are the additional requirements of these users for this data (e.g metadata, quality indicators, supporting information, uncertainty characterisation, etc)?
3. What coordinating bodies are there for these users (e.g. Cordex, GCOS) and what are their requirements?
4. What is the best framework to provide satellite climate data to the user community?
5. Do the ESGF and Obs4MIPs comprise the best solution?

Output / Deliverables

- Report D1.1 on updated requirements in Months 4 and 35
- Update CMUG web pages of user requirements

WP1.2 Plan for D1.1 1. User Requirements Document

1. Start with CMUG Phase 2 user database, interaction list and relevant Deliverables [Month 1, Met Office]
2. Update users on list and add new users from new areas of research (projects, initiatives) by consulting CMUG partners, CCI CSWG, International branches in CMUG partners (especially with contacts from

C3S, JPI, GFCS, GCOS, WGCM, IPCC/CMIP, MIP initiatives]. [Month 1, all CMUG partners, Met Office to lead]

3. Engage with these contacts to identify and describe their data needs (for the new ECVs) which will be via, email, newsletter, presentation/meetings, online survey, telephone survey, feedback form. [Months 2 and 3, all CMUG partners, Met Office to lead]
4. Process and analyse the information to understand: key areas, dependencies, emerging needs, as well as user needs for uncertainty, accuracy target, threshold and breakthrough. Discuss findings with CCI CSWG and Science Leads at Integration Meeting (end Oct 2018). [Months 3 and 4, all CMUG partners, Met Office to lead]
5. Write report to inform both ESA and the CCI ECV teams [Month 4, all CMUG partners, Met Office to lead].
6. Revise report in the light of any comments from the ECV teams or ESA. Publish on CMUG website when finished. [Month 4, Met Office].
7. Update to D1.1 in Month 35. An update would be made at the end of the project that describes the new requirements which have emerged over the three years of the project. [Month 30, all CMUG partners, Met Office to lead].
8. The original 13 ECVs to be included in the report.

WP: 1.2		Start / end	M24	M28
Title: **Meeting the Needs of the Climate Community – EO for climate foresight report**				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM	0.25	0.5	0.15	0.25	0.05	0.5	0.5	0.5

Sum: **2.7**

Key personnel	**Lead : Richard Jones**, Paul van der Linden, Jean-Christophe Calvet, Veronika Eyring, Jean-Louis Dufresne, Ulrika Willén, Rossana Dragani, Francisco Doblas-Reyes, Dirk Notz

CCI+ ECVs	WV	Salin	S-State	Lakes	Snow	PF	LST	HRLC	AGB				
	X	X	X	X	X	X	X	X	X				
ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS	Gla
	X	X	X	X	X	X	X	X	X	X	X	X	X
Objectives													
To provide a foresight report for use of EO data for climate applications (e.g. monitoring, model validation, reanalysis)													

Questions to be addressed:
1. What are the future observational requirements of the CMC and other climate researchers for the existing and new ECVs?

2. Is there a need for additional new ECVs? If so, which ones, and for what applications? 3. What might be the future possible additional requirements from these users for this data (e.g metadata, quality indicators, supporting information, uncertainty characterisation, etc)? 4. What are the possible future interactions and requirements for international coordinating bodies (e.g. Cordex, GCOS)? 5. What is the best framework to provide satellite climate data to user communities? 6. What future role do the ESGF and Obs4MIPs have in this?
Output / Deliverables
1. Workshop/meeting with relevant experts 2. Foresight Report D1.2 3. Community white paper
WP1.2 Plan for D1.2 Foresight Report on Earth Observations
1. Identify relevant meeting (e.g. WGCM assembly, or C3S GA) to co-host a workshop, which is to be attended by relevant experts. [Month 20, Met Office]. 2. Develop the programme and desired outcomes for the (1 day) meeting in consultation with ESA. [Month 22-24, all CMUG partners, Met Office to lead]. 3. Engage with experts (who may or may not be attending the meeting) to understand current climate monitoring by satellite and evolving needs for the future (in the context of the Sentinel missions) [Month 24-26, all CMUG partners, Met Office to lead]. 4. Hold the workshop (which is conducted in a way that solicits the desired outcomes) [Month 26, Met Office to lead, other partners as needed]. 5. Write report D1.2 to address comments from ESA and develop and publish a community white paper (to be approved by ESA) [Month 28, Met Office to lead, other partners as needed].

WP2: Providing an integrated view and feedback to ESA and the CCI Teams (lead by Richard Jones)

WP: 2.1		Start / end	M1	M24
Title: Scientific Impact report				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM	0.15	0.7	0.1	0.15	0.03	1	0.7	0.3

Sum: **3.13**

Key personnel	**Lead : Amy Doherty**, Hannah Griffith, Richard Jones, Jean-Christophe Calvet, Veronika Eyring, Jean-Louis Dufresne, Ulrika Willén, Rossana Dragani, Francisco Doblas-Reyes, Dirk Notz

CCI+ ECVs	WV	Salin	S-State	Lakes	Snow	PF	LST	HRLC	AGB				
	X	X	X	X	X	X	X	X	X				
ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS	Gla
	X	X	X	X	X	X	X	X	X	X	X	X	X

Objectives

The aim is to document the scientific impact of the CCI on the climate research community at the end of CMUG phase 2.

Scientific questions to be addressed:

Document the Scientific Impact of the whole CCI programme in time for presentation at the CCI+ programme-level MTR (currently planned for Dec 2020)

Tasks to be performed

1. Gather input for report (as papers and presentations by climate scientists, but also on user statistics and interactions)
2. Compile report
3. Get feedback from CCI team CRGs
4. Provide as input to ESA for the 2020 mid-term review

Output / Deliverables

- Report D2.1 in M24

WP: 2.2		Start / end	M1	M33
Title: **Climate Data Forum**				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM	0.15	0.7	0.1	0.15	0.03	1	0.7	0.3

Sum: **3.13**

Key personnel	**Lead: Hannah Griffith**, Richard Jones, Amy Doherty, Jean-Christophe Calvet, Veronika Eyring, Jean-Louis Dufresne, Ulrika Willén, Rossana Dragani, Francisco Doblas-Reyes, Dirk Notz

CCI+ ECVs	WV	Salin	S-State	Lakes	Snow	PF	LST	HRLC	AGB				
	X	X	X	X	X	X	X	X	X				
ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS	Gla
	X	X	X	X	X	X	X	X	X	X	X	X	X

Objectives

Develop climate data forum web pages and be one-stop shop for information on satellite climate datasets. The forum will support the following:

1. Blogging about CCI data (scientists must register to do this)
2. Discussion groups on CCI data (scientists must register to do this)
3. Links to CCI (and allied) data sets
4. Links to supporting information on datasets (potentially this could be from the IS-ENES3, obs4MIPs or other projects)
5. Liaise with CCI Knowledge Exchange team

This WP will support also the outreach WP in achieving its objectives.

Scientific questions to be addressed:

N/A

Tasks to be performed

1. Gather information
2. Maintain forum site and seek comments (news, discussion, blog)
3. Promote the forum to the wider climate science community to secure their participation and engagement.
4. Update frequently during the project
5. Transfer content to the new CCI portal system (to be developed in 2019 under the KE project).

Output / Deliverables

Web pages
Interaction with climate modeling, research and reanalysis community
Significant updates at Months 6, 16 and 33.

WP: 2.3		Start / end	M1	M30
Title: **Technical Note on Product Assessment**				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM	0.15	0.7	0.1	0.15	0.03	1	0.7	0.3

Sum: **3.13**

Key personnel	**Lead: Richard Jones**, Amy Doherty, Hannah Griffith, Jean-Christophe Calvet, Veronika Eyring, Jean-Louis Dufresne, Ulrika Willén, Rossana Dragani, Francisco Doblas-Reyes, Dirk Notz

CCI+ ECVs	WV	Salin	S-State	Lakes	Snow	PF	LST	HRLC	AGB				
	X	X	X	X	X	X	X	X	X				
ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS	Gla
	X	X	X	X	X	X	X	X	X	X	X	X	X

Objectives
Provide feedback to ESA and CCI teams on their plans for product assessments.

Scientific questions to be addressed:

Ascertain fidelity of CCI datasets for climate research

Tasks to be performed

1. Gather CCI documents for ECVs as they become available
2. Review reports
3. Draft initial report
4. Update report during CCI+ Phase 1 as more plans become available

The timing of the reports will depend on the availability of the reports from the CCI teams.

Output / Deliverables

- Report D2.3v1, v2 and v3

Note on availability of ECV documents:
The Technical Note on Product Assessment is produced three times during the contract period, in months 6, 15 and 30, and CMUG will assess the documents available at those times. If an ECV project delivers its data or documents late, then CMUG will assess the material at the next date. As a starting point, CMUG will approach this assessment as it did in Phases 1 and 2, and assess ECV project outputs relevant to users, in this contract there needs to be the user requirements gathering before we know which aspects are most important.

WP3: Quality assessment of CCI products (lead by Jean-Christophe Calvet)

WP3.0 Leadership of WP3
Leader: Meteo-France: Jean-Christophe Calvet
Resources (man month/partner): 1
Activity: To coordinate the research of this WP within CMUG, to represent this WP to ESA and the CSWG as needed at management and progress meetings.

WP3.1 consistency between CCI LST, SM product and LAI products
Leader and associated partners: Meteo-France: Jean-Christophe Calvet
Resources (man month/partner): 4
Type of assessment: reanalysis
Model used (e.g. Earth System model, individual components): ISBA land surface model in the SURFEX open-source modelling platform LDAS-Monde open-source data assimilation system
ECVs involved, CCI products involved: LST, SM, C3S LAI product and/or equivalent products (e.g. AVH15C1)
Aim of the experiments: Assess the consistency between CCI LST, SM product and LAI products
Scientific question addressed: 1. How can land ECVs consistency can be verified ? 2. Are land ECVs represented well in climate and land surface models ? 3. Can EO data improve land reanalyses ? 4. Can EO data improve representation of extreme events (e.g. droughts) ?
Rationale (why important for the community): LST is a key land ECV for surface energy budget, water resource assessment, crop production, fire risk monitoring, etc.; related to LAI and SM
Use of the uncertainty information: assessment of the usefulness/consistency of the product through time
Value of the assessment and complementarity with CCI experiments: LDAS-Monde has the unique capability of sequentially assimilating vegetation and SM products, jointly.
Coverage in space/ time: daily (daytime, night time), global, 1°x1°
Metrics to analyse the performances/impact: Correlation Coefficient, Bias, Standard Deviation of Differences, Root Mean Square Difference for LST (with and without assimilation of SM and LAI)

Tasks to be performed (e.g. re-formatting, analysis):
Passive monitoring of LST associated to the assimilation of both SM and LAI. Assessment of model and analysis departures from the observations before and after the assimilation through time (seasonal and interannual variability, trends).

References:
Albergel, C., et al.: Sequential assimilation of satellite-derived vegetation and soil moisture products using SURFEX_v8.0: LDAS-Monde assessment over the Euro-Mediterranean area, Geosci. Model Dev., Geosci. Model Dev., 10, 3889–3912, https://doi.org/10.5194/gmd-10-3889-2017, 2017.

Deliverables:
A quality assessment report at M12, M24 and/or 36 for D3.1 (depends on CCI data availability and when the CMUG research takes place)

WP3.2 consistency between CCI Snow, SM product and LAI products

Leader and associated partners: Meteo-France: Jean-Christophe Calvet

Resources (man month/partner): 4

Type of assessment: reanalysis

Model used (e.g. Earth System model, individual components):
ISBA land surface model in the SURFEX open-source modelling platform
LDAS-Monde open-source data assimilation system

ECVs involved, CCI products involved: Snow, SM, C3S LAI product and/or equivalent products (e.g. AVH15C1)

Aim of the experiments: Assess the consistency between CCI Snow, SM product and LAI products

Scientific question addressed:
1. How can land ECVs consistency can be verified ?
2. Are land ECVs represented well in climate and land surface models ?
3. Can EO data improve land reanalyses ?
4. Can EO data improve representation of extreme events (e.g. droughts) ?

Rationale (why important for the community):
Snow is a key land ECV for water resource assessment, surface energy budget, etc.; related to SM and LAI through initial soil temperature profile conditions, and during and after melting

Use of the uncertainty information:
assessment of the usefulness/consistency of the product through time

Value of the assessment and complementarity with CCI experiments:
LDAS-Monde has the unique capability of sequentially assimilating vegetation and SM products, jointly.

Coverage in space/ time: daily, global, 1°x1°

Metrics to analyse the performances/impact:
Correlation Coefficient, Bias, Standard Deviation of Differences, Root Mean Square Difference for snow depth (if feasible to derive)
Correlation Coefficient, Bias, Standard Deviation of Differences, Root Mean Square Difference for SWE
Differences in areas covered by snow (after and before the assimilation of SM and LAI)
(with and without assimilation of SM and LAI)

Tasks to be performed (e.g. re-formatting, analysis):
Active monitoring of the SWE snow product associated to the assimilation of both SM and LAI. Assessment of model and analysis departures from the observations before and after the assimilation through time (seasonal and interannual variability, trends).

References:
Albergel, C., et al.: Sequential assimilation of satellite-derived vegetation and soil moisture products using SURFEX_v8.0: LDAS-Monde assessment over the Euro-Mediterranean area, Geosci. Model Dev., Geosci. Model Dev., 10, 3889–3912, https://doi.org/10.5194/gmd-10-3889-2017, 2017.

Deliverables:
A quality assessment report at M12, M24 and/or 36 for D3.1 (depends on CCI data availability and when the CMUG research takes place)

WP3.3 Consistency between SM, PERMAFROST, and LAI products

Leader and associated partners: Meteo-France: Jean-Christophe Calvet

Resources (man month/partner): 4

Type of assessment: reanalysis, benchmarking

Model used (e.g. Earth System model, individual components):

ISBA land surface model in the SURFEX open-source modelling platform

LDAS-Monde open-source data assimilation system

ECVs involved, CCI products involved: SM, Permafrost

C3S LAI product and/or equivalent products (e.g. AVH15C1)

Aim of the experiments:

Assess the consistency between CCI SM, CCI Permafrost and LAI products.

It is noted that the CCI Permafrost data will be produced in a permafrost model forced with CCI SM data (amongst other data inputs) thus comparisons will be made with and without CCI SM.

Scientific question addressed:

1. How can land ECVs consistency can be verified ?

2. Are land ECVs represented well in climate and land surface models ?

3. Can EO data improve land reanalyses ?

4. Can EO data improve representation of extreme events (e.g. droughts) ?

Rationale (why important for the community):

Permafrost is related to SM and LAI through initial soil temperature profile conditions, both during and after melting, it is important to understand and quantify these processes for future research and understanding climate change impacts in permafrost regions.

Use of the uncertainty information:

Specification of errors in the LDAS; assessment of the usefulness/consistency of the product through time; root-zone soil moisture can be analysed assimilating only LAI; since the planned Permafrost_cci ECV products (active layer depth, temperature, extent) will be derived from a permafrost model forced by CCI ECVs (LST, Snow, Soil Moisture and Land Cover) two assimilation experiments will be made, with and without CCI-SM.

Value of the assessment and complementarity with CCI experiments: LDAS-Monde has the unique capability of sequentially assimilating vegetation and SM products, jointly.
Coverage in space/ time: daily, global, 1°x1°
Metrics to analyse the performances/impact: Correlation Coefficient on both volumetric and anomaly time-series, Bias, Standard Deviation of Differences, Root Mean Square Difference, Normalized Information Contribution for SM Correlation Coefficient, Bias, Standard Deviation of Differences, Root Mean Square Difference, Normalized Information Contribution for LAI Differences in areas affected by soil freezing (after and before the assimilation of SM and LAI) (with and without assimilation of SM and LAI) SM and LAI analysis Increments
Tasks to be performed (e.g. re-formatting,analysis): Active monitoring of soil moisture through the assimilation of both SM and LAI. Passive monitoring of the permafrost product associated to the assimilation of both SM and LAI. Assessment of model and analysis departures from the observations before and after the assimilation through time (seasonal and interannual variability, trends). Analysis of trends in river discharge, evapotranspiration and carbon flux variables (GPP, NEE, NPP, autotrophic and heterotrophic respiration terms). Active monitoring of soil moisture through the assimilation of LAI only.
References: Albergel, C., et al.: Sequential assimilation of satellite-derived vegetation and soil moisture products using SURFEX_v8.0: LDAS-Monde assessment over the Euro-Mediterranean area, Geosci. Model Dev., Geosci. Model Dev., 10, 3889–3912, https://doi.org/10.5194/gmd-10-3889-2017, 2017.
Deliverables: A quality assessment report at M12, M24 and/or 36 for D3.1 (depends on CCI data availability and when the CMUG research takes place)

WP3.4 Propagation of CCI(+) observational uncertainties to climate models scales
Leader and associated partner: BSC: Louis-Philippe Caron
Resources (man month/partner): 4PM
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analysis
Model used (e.g. Earth System model, individual components): Coupled historical simulations Initialized seasonal prediction hindcasts

ECVs involved, CCI products involved:

Old ECVs: soil moisture, fire (burned area)   New ECVs: Land Surface Temperature

Aim of the experiments:

Observational uncertainties originate from a cascade of errors in the retrieval process, structural uncertainties in the algorithms, and statistical uncertainties in the spatio-temporal projections (Merchant et al., 2017). These errors are correlated in space and time, due to mesoscale systems, for instance, that impact satellite retrieval on a given spatio-temporal scale. Observational uncertainties cannot therefore be averaged and scaled by the square root of the number of independent samples as for uncorrelated errors, but require the consideration of the correlation of errors in space and time. A novel approach how to achieve this has been presented in Bellprat et al. (2018) and applied to the CCI sea-surface temperature (SST) dataset. This task will aim at expanding this effort to other CCI ECVs (all relevant to the study of wild fires) in order to disseminate propagated observational uncertainties at daily, monthly, decadal, climatological scales as well as for different grid resolutions, regions, hemispheric and global averages.

Scientific question addressed:

How can the observational uncertainty estimates provided by CCI(+) reference datasets be translated into different spatiotemporal scales to compare to climate model simulations?

Are there important differences relative to the nature of the products?

Rationale (why important for the community):

Uncertainties in climate models and observational references have been assessed thoroughly in the past. However, it has remained difficult to integrate these because of the lack of formal concepts that characterize uncertainties at common scales represented by both the models and the observations. Furthermore, methods of model evaluation and verification currently lack the ability to include observational uncertainties in metrics and statistical tests. The objective of this WP is to develop these missing concepts in order to use the observational uncertainty information developed in CCI(+) for CMUG and other future modelling users.

This work is linked to the work in the FIDUCEO project.

Use of the uncertainty information:

The central outcome of the WP will be to demonstrate the value of observational uncertainty assessment in CCI(+) and to illustrate the relevance of observational uncertainties in comparison to climate model uncertainties (structural and internal), revisiting the paradigm that model uncertainties exceed those from observations.

Value of the assessment and complementarity with CCI experiments:

This WP will operate as a communication node between the uncertainty work carried out in the CCI(+) teams and the different CMUG partners, ensuring that observational uncertainties are propagated adequately to the required scales of analysis. This effort will be central for all CMUG partners and other users aiming at climate model–observation comparison using the CCI data (Massonnet et al., 2016). Finally, this task will act as bridge between CMUG and CCI teams on matters of model and observational uncertainty.

Coverage in space/ time:

Period covered by ESA CCI ECVs

Metrics to analyse the performances/impact:

Seasonal forecast skill will be computed using the Pearson correlation of the ensemble mean prediction with the observations. Probabilistic properties that could be derived from the ensemble will be omitted

Tasks to be performed (e.g. re-formatting, analysis):

1) Apply method developed in Bellprat et al. (2018) to investigate how observational uncertainties propagate to space-time means.
2) Compare the propagated observational uncertainties from the ECV CCI product to that derived from differences in different observational products.

This task will require interaction with each of the CCI ECV teams to determine the best currently available knowledge of error correlation scales in space and in time for the different ECVs.

References:

Merchant, C. J., Paul, F., Popp, T., Ablain, M., Bontemps, S., Defourny, P., Hollmann, R., Lavergne, T., Laeng, A., de Leeuw, G., Mittaz, J., Poulsen, C., Povey, A. C., Reuter, M., Sathyendranath, S., Sandven, S., Sofeiva, V. F., and Wagner, W. (2017). Uncertainty information in climate data records from Earth observation, Earth Syst. Sci. Data Discuss., 9, 511-527.

Bellprat, O., Massonnet, F., Siegert, S., Prodhomme C., Macias-Gomez, D., Guemas, V., Doblas-Reyes, F. (2018). Uncertainty propagation in observational references to climate model scales. Remote Sensing of the Environment, 203, 101-108.

Massonnet, F., Bellprat, O., Guemas, V., Doblas-Reyes, F. (2016) Using climate models to estimate the quality of global observational data sets, Science, 6311, 452-455.

Deliverables:

Report on propagation of observational uncertainty for the D3.1 quality assessment report at M12, M24 and/or 36 for D3.1 (depends on CCI data availability and when the CMUG research takes place)

WP3.5: Document SM-atmosphere feedbacks in transition regions

Leader and associated partners:

IPSL: **Lead: F. Cheruy**, J.L. Dufresne, A. Ducharne

Resources (man month/partner): 4

Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis):

Process oriented evaluation

Model used (e.g. Earth System model, individual components):

Coupled Atmosphere-Land surface components of the IPSL-CM - nudged with winds

ECVs involved, CCI products involved:

LST, SM, turbulent fluxes, radiation , air temperature , precipitation

Aim of the experiments:

Can CCI(+) data be used to detect on observations the soil moisture /surface temperature feedback related to soil thermal inertia.

Scientific question addressed:

Can the co-variations of SM, LST and precipitation be used to document the soil moisture - temperature feedback (intra-daily time scale)

Rationale (why important for the community): Improve processes related to the land-atmosphere coupling in climate models.
Use of the uncertainty information: Construct the same diagnostics with other available products, use instrumented site information.
Value of the assessment and complementarity with CCI experiments: Try to detect with observational analysis a new SM related temperature feedback
Coverage in space/ time: Global analysis done at regional scales, multi-year
Metrics to analyse the performances/impact: Comparison of the diagnostics done with satellite derived products and instrumented site observations.
Tasks to be performed (e.g. re-formatting, analysis): Process oriented diagnostics
References: Cheruy F. , J.L. Dufresne, S. Ait Mesbah, JY Grandpeix, F Wang. Role of Soil Thermal Inertia in Surface Temperature and Soil Moisture-Temperature Feedback, 2017, JAMES; 9,8, 2906,2919 doi = {10.1002/2017MS001036} Seneviratne S. I., M. Wilhelm, T. Stanelle, B. Hurk, S. Hagemann, A. Berg, F. Cheruy, M. E. Higgins, A. Meier, V. Brovkin, M. Claussen, A. Ducharne, J.-L. Dufresne, K. L. Findell, J. Ghattas, D. M. Lawrence, S. Malyshev, M. Rummukainen, and B. Smith. Impact of soil moisture-climate feedbacks on CMIP5 projections: First results from the GLACE-CMIP5 experiment. Geophysical Research Letters, 40:5212--5217, October 2013
Deliverables: A quality assessment report at M12, M24 and/or 36 for D3.1 (depends on CCI data availability and when the CMUG research takes place) Scientific paper if the results are suitable.

WP3.6: Constraining the evapotranspiration at the scale of climate model grid-cell
Leader and associated partners: IPSL: **Lead: F. Cheruy**, J.L. Dufresne, A. Ducharne
Resources (man month/partner): 4
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Process oriented evaluation
Model used (e.g. Earth System model, individual components): Coupled Atmosphere-Land surface components of the IPSL-CM - nudged with winds
ECVs involved, CCI products involved: LST, SM, snow = CCI ECV data

Turbulent fluxes, radiation , air temperature, precipitation = non-ECV data

Aim of the experiments:

Our main goal is to explore the potential of multiple satellite derived products to better understand the land surface processes and land-atmosphere coupling, at the scale of climate model grid-cells. We will mostly focus on the water and energy budgets over land, and try to identify relationships between presumably related variables, including new ECs as snow cover and LST.

Scientific question addressed:

Can we better constrain the controls of evapotranspiration (ET) at the scale of climate model grid-cells? Do the corresponding stress functions (for soil moisture, incoming energy, atmospheric humidity, temperature) take a different form at the point and grid-cell scale?

Can large-scale differences between LST and air temperature provide additional information to document the behavior important parameterization for the near surface climate such as turbulence, heat conduction into the soil (Ait-Mesbah et al., 2015, Wang et al., 2016)) snow dynamics?

Rationale (why important for the community):

Improve processes related to the land-atmosphere coupling in climate models.

Use of the uncertainty information:

Construct the same diagnostics with other available products, use instrumented site information.

Value of the assessment and complementarity with CCI experiments:

Try to relate differences between air-temperature and LST to turbulence, heat conduction or snow dynamics parameterizations.

Try to constrain the controls of evaporation at the scale of the model

Coverage in space/ time:

Global analysis done at regional scales, multi-year

Metrics to analyse the performances/impact:

Comparison of the diagnostics done with satellite derived products and instrumented site observations.

Tasks to be performed (e.g. re-formatting,analysis):

Prepare relevant process oriented diagnostics (based on energy fluxes and ECV states) for the analysis (e.g. Cheruy et al. 2017, Cheruy et al. 2013)

References:

F. Cheruy, A. Campoy, J.-C. Dupont, A. Ducharne, F. Hourdin, M. Haeffelin, M. Chiriaco, and A. Idelkadi. Combined influence of atmospheric physics and soil hydrology on the simulated meteorology at the SIRTA atmospheric observatory. Climate Dynamics, 40:2251--2269, May 2013.

Cheruy F, Dufresne JL, Ducharne A, Passy P, Magand C, Ghattas J (2017). Diagnostics of the soil moisture / atmosphere coupling in numerical simulations and in global datasets derived from in situ or satellite passive and active remote sensing. Report to the ESA CCI CMUG project, 15 pages

Ait-Mesbah,S. F. Cheruy , J.L. Dufresne F. Hourdin, On the representation of surface temperature in semi-arid and arid regions, Geophys. Res. Lett., 42(18), pp. 7572–7580, 2015, doi:10.1002/2015GL065553

Wang,F., Cheruy F., Vuichard N., Hourdin, F., 2016 The impact of heat roughness length on surface meteorology in IPSL - CM model , AMA (Ateliers de Modélisation Atmosphérique), Toulouse, 18-22 Jan. 2016

Deliverables:

A quality assessment report at M12, M24 and/or 36 for D3.1 (depends on CCI data availability and when the CMUG research takes place)

Scientific paper if the results are suitable.

3.7 The effect of Lakes on local temperatures
Leader and associated partners: Met Office: **Lead: R. Jones**, G Redmond
Resources (man month/partner): 2
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Assimilation, process understanding
Model used (e.g. Earth System model, individual components): PRECIS Met Office Regional Climate Model
ECVs involved, CCI products involved: CCI ECVs: Lakes, LST, Other ECVs: Lake surface water temperature
Aim of the experiment: This activity aims to identify and describe the interactions and relationships between lakes and their surrounding land areas. Typically this would be around large lakes (e.g. Victoria, Great Lakes)
Scientific question addressed: What are the interactions between lakes and the surrounding land areas? What effect does lake temperature (or other parameter) have on the surrounding LST?
Rationale (why important for the community): A key use for LST data is as a driver for regional models in small scale processes. This work will validate the LST by using it to understand and estimate the effects of lake surface water temperature.
Use of the uncertainty information: As provided in the ECV data and model.
Value of the assessment and complementarity with CCI experiments: This work complements the LST work in WPs 3.1, 3.4 and 3.5. It should be able to include the work on uncertainty from WP4.
Coverage in space/ time: 12km resolution, time span for CCI data.
Metrics to analyse the performances/impact: Comparison of model fields to ECVs, time series analysis for processes involved and climate indicators, consistency of spatial and temporal features in model fields compared with ECVs.
Tasks to be performed (e.g. re-formatting, analysis): Run a simulation of Lake Surface water Temperature dependence on surface air temperature using satellite-era LSWT observations for about 4 major lakes and LST over that period. Testing the correlation of observations and simulation on a variety of timescales, and assess the degree of temporal consistency of observed and simulated mean and variability statistics. Interpret the usefulness of the results.

References: None, but has links to EUSTACE project
Deliverables: Contribution to CMUG D3.1 Quality Assessment Report.

WP3.8: Evaluation of the impact of an enhanced ESA Sea Ice reanalysis (EnESA-SIR) on initialization of seasonal prediction
Leader and associated partners: BSC, **Lead: Pablo Ortega**, Rubén Cruz-García, Juan Camilo Acosta
Resources (man month/partner): 4 person months
Type of assessment: Comparative analysis of the seasonal predictive skill for seasonal hindcasts initialized with different products/strategies.
Model used (e.g. Earth System model, individual components): EC-Earth v.3 under the same coupled configuration used for DCPP (Decadal Climate Prediction Project)
ECVs involved, CCI products involved: CCI/CCI+ ECVs: SIC, SST, SIT and clouds (and potentially salinity)
Aim of the experiments: To quantify the benefits on forecast skill related to an enhanced initialization of sea ice (based on a reanalysis that includes both assimilation of Sea Ice concentrations from ESA and nudging of SSTs). This is an improved strategy to the one previously used in CMUG2, which only included assimilation of sea ice concentrations. This approach produced a strong initial shock in the predictions due to inconsistencies with the initial conditions used for the ocean and the atmosphere. The EnESA-SIR should minimise the initial shock, and thus is expected to improve the prediction skill.
Scientific question addressed: What is the added-value of Initial Conditions from EnESA-SIR on the seasonal climate forecast quality? Are there any teleconnections/dynamical processes improving the skill in other regions than the Arctic?
Rationale (why important for the community): Numerous studies have reported important impacts of sea ice on climate variability over remote regions (e.g. North Atlantic, Tropical Pacific, California, Mediterranean Sea), via diverse teleconnection mechanisms (e.g. Deser et al 2010, Grassi et al 2013, Cvijanovic et al 2017). Therefore, an improved initialization of sea ice on the seasonal-to-decadal forecast systems can have a beneficial impact on the skill of the climate predictions on large areas of the world, and in particular over Europe.
Use of the uncertainty information: Uncertainty will be addressed by comparing the reanalysis with other Sea Ice products not directly used for the assimilation

Value of the assessment and complementarity with CCI experiments:

Several seasonal forecast systems with the same model, but not initialized with assimilated ESA SIC conditions will be additionally performed and analysed to determine the added-value of ESA products on skill. Also, the evaluation of the forecasts will be performed against other CCI products (such as SST, SIT and Clouds) to test the cross-consistency across the ECVs (and in particular if skill is improved when information of CCI SIC data is included in the ICs).

Coverage in space/time:

Global (with 50 km grid spacing or higher), daily resolution in the period 1993-2014

Metrics to analyse the performances/impact:

Forecast verification metrics in terms of bias and probabilistic (e.g. root- mean-square error skill and Rank Probability Skill Scores) and deterministic skill (e.g. Root mean Square Error, Anomaly Correlation Coefficient), and significance tests to attribute skill enhancements.

Tasks to be performed (e.g. re-formatting,analysis):

Evaluating the added-value of using the EnESA-SIR on seasonal prediction skill in:

1. Sea Ice changes across the Arctic and their linkages/impacts on mid-latitudes (e.g. precipitation/clouds in the Mediterranean Sea)
2. The North Atlantic ocean circulation, in particular its response to recent freshening of the Labrador sea and its subsequent impacts on the subpolar gyre (characterized by an unprecedented cooling)
3. The NAO, ENSO and their teleconnections

References:

Cvijanovic I, B Santer, C Bonfils, DD Lucas, JCH Chiang, S Zimmerman (2017) Nat Comms 8, 1947.

Deser C, Tomas R, Alexander M, Lawrence D (2010) The seasonal atmospheric response to projected Arctic sea ice loss in the late twenty-first century. J Climate 23: 333-351

Grassi, B., G. Redaelli, and G. Visconti, 2013: Arctic sea ice reduction and extreme climate events over the Mediterranean region. *J. Climate*, **26**(24), 10101–10110.

Deliverables:

A quality assessment report at M12, M24 and/or 36 for D3.1 (depends on CCI data availability and when the CMUG research takes place)

Scientific paper if the results are suitable.

WP3.9: Biophysical feedbacks in the global ocean

Leader and associated partners: Met Office, David Ford.

Resources (man month/partner): 3

Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Assimilation, reanalyses, hindcast

Model used (e.g. Earth System model, individual components): NEMO physics, MEDUSA biogeochemistry, and CICE sea ice models, which together form the ocean components of the state-of-the-art UKESM1 Earth system model, which will be used for experiments to be submitted to CMIP6. Data assimilation will be performed using the variational NEMOVAR system, used for operational ocean forecasting and reanalysis at the Met Office and ECMWF.

ECVs involved, CCI products involved:

CCI ECVs: OC, SST, SI, Sea level, sea surface salinity, Sea Surface State

Other ECVs: temperature, salinity, carbon dioxide, and ocean heat content

Aim of the experiments:

The distribution of chlorophyll in the ocean has an impact on light attenuation and therefore ocean heat uptake, changing the ocean physics and sea ice. However, this biophysical feedback is not yet commonly included in climate models or reanalyses. This activity will assess the suitability of CCI ocean colour products to constrain this process when assimilated into coupled physical-biogeochemical ocean reanalyses. Assimilating ocean colour data has been demonstrated to improve the accuracy of 3D model chlorophyll, and it is expected that this will lead to more accurate simulation of light attenuation and ocean heat uptake in reanalyses, when biophysical feedback processes are included. This should then improve consistency with other ECVs. Furthermore, air-sea CO_2 flux parameterisations typically used in climate models do not use sea surface state as an input, even though this is known to play a role. A further experiment will assess the impact on air-sea gas exchange of including sea state data as an input in the flux parameterisation.

Scientific question addressed:

Two equivalent reanalyses will be performed with NEMO-CICE-MEDUSA, assimilating CCI ocean colour products, and spanning a period of variability in the El Niño Southern Oscillation (ENSO), in which biophysical feedbacks are known to play a role. The first reanalysis will have no feedback from biology to physics, as in standard climate models. The second reanalysis will include the process.

The two runs will then be assessed against CCI sea surface temperature (SST), sea level and sea ice products (sea surface salinity could also be used if available), as well as in situ observations of temperature, salinity, carbon dioxide, and ocean heat content. This will assess the impact of including biophysical feedbacks, driven by assimilation of CCI ocean colour data, on the model representation of the physical ocean and cryosphere ECVs, the consistency of features between ECVs and processes, and the carbon cycle.

A further model run will include level 4 sea surface state data as an input to the model air-sea CO_2 flux parameterisation, and investigate the impact on the ocean carbon cycle compared with the standard parameterisation which just uses wind speed.

Rationale (why important for the community):

The WP will deliver an assessment of the suitability of CCI ocean colour and sea state products for constraining these processes in the ocean, and the resulting interactions and consistency between multiple ECVs. The impacts on sea ice and the carbon cycle each relate the results to WCRP Grand Challenges, as well as advancing understanding of how climate models and reanalyses can deliver improved representations of climate processes. Furthermore, the results will provide an initial indication of the potential importance of the feedbacks for seasonal and decadal forecasting, relating to the WCRP Grand Challenge of Near-term Climate Prediction.

This will build on prior work performed as part of the EC FP7 MyOcean2 project, the pre-operational phase of the Copernicus Marine Environment Monitoring Service (CMEMS).

Use of the uncertainty information:

The uncertainty information provided with the CCI ocean colour products will be used both in the quality control of the observations, and in the error covariances used in the data assimilation, in order to provide the best possible error estimates for the data assimilation. If possible, will producing joint statements on uncertainty with other WPs working on the same ECVs.

Value of the assessment and complementarity with CCI experiments:

Will coordinate activity with WPs 3.7 and 3.8 to include any uncertainty information on SI developed there in this work.

Coverage in space/ time:
Global Ocean, time span for CCI data.

Metrics to analyse the performances/impact:

Statistical comparison of model fields to ECVs, time series analysis of ocean heat content, ocean carbon and other climate indicators, consistency of spatial and temporal features in model fields compared with ECVs.

Tasks to be performed (e.g. re-formatting, analysis):

Two equivalent reanalyses will be performed with the NEMO-CICE-MEDUSA, ocean model, assimilating CCI ocean colour products, and spanning a period of variability in the El Niño Southern Oscillation (ENSO), in which biophysical feedbacks are known to play a role. The two runs will then be assessed against CCI sea surface temperature (SST), sea level and, sea ice products (sea surface salinity could also be used if available), as well as in situ observations of temperature, salinity, carbon dioxide, and ocean heat content. A further model run will be performed using level 4 sea state data as an input to the air-sea CO_2 flux parameterisation, and assessed against in situ carbon dioxide observations.

References: Builds upon earlier CMUG paper: Ford D. and Barciela R., Global marine biogeochemical reanalyses assimilating two different sets of merged ocean colour products, Remote Sensing of Environment, 2017, https://doi.org/10.1016/j.rse.2017.03.040.

Builds upon earlier EC FP7 MyOcean2 report: Ford D. and Barciela R., Biophysical feedbacks in a coupled physical-biogeochemical ocean model, Forecasting Research Technical Report 608, Met Office, Exeter, UK, 2015.

Deliverables:

A quality assessment report at M12, M24 and/or 36 for D3.1 (depends on CCI data availability and when the CMUG research takes place)

WP3.10: Assessment of the potential of CCI/CCI+ data to constrain mineral dust simulations at the regional scale.

Leader and associated partners: E. Di Tomaso (BSC)

Resources (man month/partner): 4 PM

Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis):

The assessment will consist of a statistical analysis of the CCI/CCI+ data before model integration, and of the evaluation of the impact of assimilating the data with an ensemble-based Kalman filter method over a regional domain.

Development and testing of the assimilation of CCI IASI dust data will be performed at the regional scale and at high spatial resolution. Additionally, once CCI+ high resolution land cover data will become available, simulations will be run also with enhanced information on land use type.

Model used (e.g. Earth System model, individual components),

Data assimilation experiments of mineral dust will be run with the NMMB-MONARCH model (Pérez et al. 2011) which uses of a LETKF DA scheme (Di Tomaso et al. 2017).

ECVs involved, CCI products involved:

The work will consider the following CCI/CCI+ ECVs: Aerosol dust, LC and where available and if relevant to dust sources, High Res LC.

CCI IASI dust data will be assimilated in model simulations, while CCI+ high resolution land cover data (once data will become available) will be used to enhance the NMMB-MONARCH's land use type, with a consequent impact on dust emissions.

Aim of the experiments:

This contribution aims at demonstrating the use of CCI/CCI+ data to produce dust analyses at the regional scale. Part of its findings will set the basis for the assessment activity 11 on the production of a pilot dust reanalysis, where the impact on dust cycles at different temporal scales will be evaluated. It also aims at assessing the synergy of CCI aerosol data (in particular when constraining atmospheric concentrations over dust source areas) with CCI+ land cover data (used for an enhanced characterization of dust emissions), with the goal to provide feedback on these ECVs to the ESA CCI/CCI+ teams.

Scientific question addressed:

· Are CCI (pixel-level) uncertainties realistic?

· Which is the added value of assimilating thermal infrared retrievals?

· Which is the impact of IASI data assimilation at the regional scale in high resolution simulations?

· Does enhanced land type information improve the first-guess of mineral dust tracers, and consequently dust analyses?

· Are the used CCI/CCI+ ECVs consistent?

Rationale (why important for the community):

Current aerosol (and dust) data assimilation is mainly based on retrievals in the visible part of the electromagnetic spectrum, and with no information on aerosol speciation. These retrievals have limitations over highly-reflective surfaces and rely on solar irradiance. CCI IASI retrievals in the thermal infrared have the potential to constrain dust simulations thanks to their sensitivity to silicate-based, large-size absorbers during both day and night, and over different surface types (both ocean and land, including deserts).

Use of the uncertainty information:

CCI pixel-level uncertainties will be taken into account to characterize the observation error statistics used by the data assimilation scheme.

Value of the assessment and complementarity with CCI experiments:

A data assimilation/modelling assessment of CCI/CCI+ data will be of added value to the standard CCI experiments as it will provide a different perspective to the evaluation efforts, and will allow to assess ECVs for cross-consistency.

Coverage in space/ time:

Data assimilation experiments will be run on a regional domain covering Northern Africa, Europe and the Middle East for specific dust events (usually lasting 1 to 10 days) during the active dust season.

Metrics to analyse the performances/impact:

The impact of ECVs will be assessed through data assimilation diagnostics based on first-guess and analysis departures, and through analysis validation with independent observations.

Tasks to be performed (e.g. re-formatting,analysis):

· processing IASI dust aerosol data to follow the assimilation cycles

· implementation of an observation operator for the thermal infrared

· identifying optimal assimilation settings for observation error statistics, observations' density and covariance localization

· implementation of the use of CCI+ high resolution land cover to characterize the model land type

· assessment of the impact of assimilating the data during relevant dust events and validation with independent observations

References:

Pérez, C., Haustein, K., Janjic, Z., Jorba, O., Huneeus, N., Baldasano, J. M., Black, T., Basart, S., Nickovic, S., Miller, R. L., Perlwitz, J. P., Schulz, M., and Thomson, M.: Atmospheric dust modeling from meso to global scales with the online NMMB/BSC-Dust model – Part 1: Model description, annual simulations and evaluation, Atmos. Chem. Phys., 11, 13001–13027, doi:10.5194/acp-11-13001-2011, 2011.

Di Tomaso, E., Schutgens, N. A. J., Jorba, O., and Pérez García-Pando, C. (2017): Assimilation of MODIS Dark Target and Deep Blue observations in the dust aerosol component of NMMB-MONARCH version 1.0, Geosci. Model Dev., 10, 1107-1129, doi:10.5194/gmd-10-1107-2017.

Deliverables:

Report on Assessment of dust assimilation at the regional scale, contributing to D3.1 Quality Report [BSC, month 35]

WP3.11: Production of a pilot dust reanalysis at the regional scale

Leader and associated partner: E. Di Tomaso (BSC)

Resources (man month/partner): 3 PM

Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis):

The assessment will consistent of the production and evaluation of a pilot dust reanalysis, with special emphasis on assessing the characterization of diurnal and seasonal cycles.

The production of a pilot dust reanalysis based on CCI/CCI+ ECVs will be performed during a 1 year period, and thoroughly validated with independent observations and other reanalyses. The experiment will capitalize on some of the results of the assessment activity 10 on the optimal configuration for an assimilation system for the ECVs considered.

Model used (e.g. Earth System model, individual components):

The dust reanalysis will be produced with simulations from the NMMB-MONARCH model (Pérez et al. 2011) coupled to a LETKF DA scheme (Di Tomaso et al. 2017).

ECVs involved, CCI products involved:

The work will consider the following CCI/CCI+ ECVs: Aerosol dust, LC and where available (and if relevant to dust sources) High Res LC.

CCI IASI dust data will be assimilated in model simulations for the reanalysis period. Simulations will make use also of CCI+ high resolution land cover data, once these will become available, in order to enhance the NMMB-MONARCH’s land use type.

Aim of the experiments:

This contribution aims at producing a pilot dust reanalysis based on CCI/CCI+ data, and at assessing whether their integration in model simulations can improve the monitoring of mineral dust and the characterization of dust cycles.

Scientific question addressed:

Can CCI/CCI+ data improve aerosol reanalysis?

Can CCI/CCI+ data improve in particular the characterization of dust cycles?

How well does the regional dust reanalysis compare to global reanalyses?

Rationale (why important for the community):

Aerosol (and dust) reanalyses provide valuable information to a range of different users, information which is also fed into aerosol-related climate services. A regional reanalysis with a dedicated focus on dust can aim at describing the fine spatio-temporal scales that meet the requirements of policy makers and stakeholders in sectors such as transport, energy and air quality.

Use of the uncertainty information:

CCI uncertainty information will be used to "weigh" in an optimal way the observations in the estimation of the reanalysis.

Value of the assessment and complementarity with CCI experiments:

A reanalysis assessment is able to showcase the potential of CCI/CCI+ data to contribute to the formulation of management and mitigation plans of different socio-economic sectors. A dust reanalysis in particular can be used to provide resources for studying the impact of dust on health, weather and climate.

BSC's strong links to specific user communities through its WMO SDS-WAS activities can guarantee the visibility of such potential for the data considered.

Coverage in space/ time:

The dust reanalysis will be produced for a regional domain covering Northern Africa, Europe and the Middle East over a 1 year period.

Metrics to analyse the performances/impact:

Statistical analysis based on innovations will be used to detect systematic (spatial and temporal) patterns of data impacts on the dust analysis. Dust reanalysis mean values, uncertainty and characterization of diurnal and seasonal cycles will be analysed through comparison with independent observations.

Tasks to be performed (e.g. re-formatting,analysis):

- production of a pilot reanalysis over the course of a specific year characterized by relevant dust events
- statistical analysis of innovations throughout dust cycles at different temporal scales
- reanalysis validation with independent observations
- comparison of the dust reanalysis with other reanalyses

References:

Pérez, C., Haustein, K., Janjic, Z., Jorba, O., Huneeus, N., Baldasano, J. M., Black, T., Basart, S., Nickovic, S., Miller, R. L., Perlwitz, J. P., Schulz, M., and Thomson, M.: Atmospheric dust modeling from meso to global scales with the online NMMB/BSC-Dust model – Part 1: Model description, annual simulations and evaluation, Atmos. Chem. Phys., 11, 13001–13027, doi:10.5194/acp-11-13001-2011, 2011.

Di Tomaso, E., Schutgens, N. A. J., Jorba, O., and Pérez García-Pando, C. (2017): Assimilation of MODIS Dark Target and Deep Blue observations in the dust aerosol component of NMMB-MONARCH version 1.0, Geosci. Model Dev., 10, 1107-1129, doi:10.5194/gmd-10-1107-2017.

Deliverables:

Report on Assessment of the pilot regional dust reanalysis, contributing to D3.1 Quality Report [BSC, month 35]

WP3.12: Integrated assimilation of the CCI+ Sentinel 3 AOD and Sentinel 5P ozone retrievals in the IFS
Leader and associated partners: ECMWF: **Lead: A. Benedetti**, R. Dragani, J. Letertre-Danczak
Resources (man month/partner): 9 PM (see cost per individual task below)
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Assimilation and feedback to reanalysis
Model used (e.g. Earth System model, individual components): The ECMWF IFS with enhanced chemistry
ECVs involved, CCI products involved: CCI Ozone and CCI Aerosol
Aim of the experiments: This work assesses the impact of assimilating the CCI+ ozone retrievals from Sentinel 5P and Aerosol Optical Depth (AOD) from the Sentinel 3 measurements to feed back to the Copernicus Climate Change Service (C3S) and Copernicus Atmosphere Monitoring Service (CAMS) reanalyses.
Scientific question addressed: • Suitability of the CCI+ ozone and aerosol data to constrain a global reanalysis • Appropriateness of the observation uncertainty via the data assimilation system • Consistency between the two CCI data records via a data assimilation system and with independent observations • Consistency of the produced reanalysis with existing global reanalyses.
Rationale (why important for the community): The investment in the Copernicus programme, particularly in the satellite component, is only worthwhile if datasets of high quality are produced and used by the scientific, and operational communities (especially the Copernicus Services) as well as by industry. To demonstrate the added value (above current state of the art datasets) we will assess the impact of Sentinel 5P ozone and Sentinel 3 aerosols, focusing on the aim of these datasets being used in future Copernicus operational reanalyses (which are widely used).
Use of the uncertainty information: The use of the uncertainty is an integral part of the data assimilation process, and will be communicated to other WPs and the CCI teams
Value of the assessment and complementarity with CCI experiments: This study aims at producing an integrated assessment of the impact of assimilating Ozone, and Aerosol CCI+ datasets retrieved from the Sentinel 5P and 3 measurements, respectively. The results are expected to feed into future Copernicus Climate Change Service (C3S) and Copernicus Atmosphere Monitoring Service (CAMS) reanalyses. Work within this proposal will examine how the ozone retrievals from S5P can be best exploited. The high horizontal resolution provided by this satellite represent a significant change compared with predecessors. This poses both technical and scientific challenges. From a technical point of view, efficient ways to manage within the IFS (e.g. Input/Output and processing) the wealth of data that will be delivered need to be found. From a scientific point of view, the horizontal resolution of the S5P is comparable with that

of the ECMWF operational suite. Can the information provided by the data at such a high spatial resolution be exploited successfully? Or perhaps unaccounted horizontal correlations degrade the resulting analyses? *This work exploits synergies with an activity currently under preparation for another CCI+ proposal.*
Coverage in space/ time: Global / 6 month of overlapping period between S3 and S5P
Metrics to analyse the performances/impact: Spatial and temporal comparisons with independent observations and existing global aerosol reanalyses will be performed and assessed in terms of e.g. mean and standard deviation of the differences, and RMSE.
Tasks to be performed (e.g. re-formatting,analysis): This work exploits synergy with the CCI+ Aerosol ECV project, hence the cost reported here only refers to what is needed for ozone: • S5P O3 data BUFR converter (1.0PM) • data preparation and testing (1.0PM) • S5P O3 IFS instrument implementation and data flow testing (1.0PM) • S5P data volume handling: Thinning vs. super-obbing choice assessment and implementation in IFS (2.0PM) • Bias assessment and implementation of a correction strategy (1.5PM) • Experiments set-up and monitoring (1.0PM) • Result assessment and reporting (1.5PM)
Deliverables: Report on the suitability of the CCI aerosol and ozone products from the Sentinels 3 and 5P to be assimilated in global operational reanalysis in the D3.1 Quality Report.

WP4: Exploiting CCI products in MIP experiments (lead by Dirk Notz)

WP4.0 Leadership of WP4
Leader: MPI-M Dirk Notz
Resources (man month/partner): 1
Activity: To coordinate the research of this WP within CMUG, to represent this WP to ESA and the CSWG as needed at management and progress meetings.

WP4.1 Evaluation of modeled system memory
Leader and associated partners: MPI-M, Dirk Notz
Resources (man month/partner): 4 PM
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analysis
Model used (e.g. Earth System model, individual components): MPI-ESM, CMIP6 archive
ECVs involved, CCI products involved: Use of CCI+ variables depends on respective progress, but might include sea surface salinity, snow, LST For CCI variables, we will focus on SST and SI for this exploratory study. Routine evaluation will then be possible based on the framework developed within this study. (which links to WP 5)
Aim of the experiments: To develop and apply a framework that allows one to evaluate the simulated memory (temporal correlation) of ECVs in a model-evaluation processing chain
Scientific question addressed: How can we evaluate the memory of climate variables as simulated by large-scale model simulations?
Rationale (why important for the community): Model evaluation studies are usually concerned with the evaluation of individual snapshots, which usually are averaged over time. However, a key requirement for example for realistic seasonal prediction studies relates to the evaluation of the modeled memory of the system. Errors in realistically simulating the memory of a system can for example give misleading results in the potential seasonal predictability as obtained in so-called perfect-model studies.
Use of the uncertainty information: The uncertainty information will be used to assess the robustness of the obtained estimate of system memory
Value of the assessment and complementarity with CCI experiments: This assessment will allow us to evaluate the memory of a given ECV in climate-simulation assessments
Coverage in space/ time: as long and as global as possible for individual ECVs

Metrics to analyse the performances/impact: Differences in analysed model quality with and without consideration of memory allows one to assess the importance of internal variability for model evaluation, including an assessment of statistical robustness given the possibly limited sample sizes involved
Tasks to be performed (e.g. re-formatting,analysis): 1. Transfer and further develop knowledge on the evaluation on temporal correlation during model evaluation 2. Develop processing chain to routinely consider temporal correlation 3. Link with task 5 to implement processing chain into standard benchmarking tools
References: none
MIP Interactions 1. The MIPs currently working with. - SIMIP 2. The nature of the WP4 research link to the MIP(s) named in point 1. - Use of SI and LST for model memory 3. The MIPs with a potential WP4 research fit / could interact with. - Possibly DCPP
Deliverables: A report on MIP impact asssessment and bench marking of CMIP5 models at M12, M24 and/or 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place) describing a possible processing chain, and highlighting examples of the evaluation of the temporal correlation

WP4.2 Evaluation of model results considering observational uncertainty
Leader and associated partners: MPI-M, Dirk Notz
Resources (man month/partner): 4 PM
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analysis
Model used (e.g. Earth System model, individual components): MPI-ESM, CMIP6 archive, possibly CORDEX
ECVs involved, CCI products involved: Use of CCI+ variables depends on respective progress, but might include sea surface salinity, snow, LST For CCI variables, we will focus on SST and SI for this exploratory study. Routine evaluation will then be possible based on the framework developed within this study. (which links to WP 5)
Aim of the experiments: To develop and apply a framework that allows one to include observational uncertainty information into a model-evaluation processing chain
Scientific question addressed: How can we take observational uncertainty into account when evaluating large-scale model simulations?

Rationale (why important for the community):
The primary reason why observational uncertainties remain weakly explored in the climate modeling community is that the uncertainties are thought to be orders of magnitudes smaller than those of the models. This paradigm holds arguably for many ECVs and for older generations of climate models. Along with heavy climate model development during the past decades and increased horizontal model resolution thanks to more powerful high-performance computing systems, this paradigm has been put in question (Massonnet et al., 2016). The minor role attributed to the uncertainty of observational references should be particularly questioned for new ECVs that are strongly depending on complex retrieval algorithms as for instance used for sea-ice thickness.

Use of the uncertainty information:
The uncertainty information will form the central part of this assessment

Value of the assessment and complementarity with CCI experiments:
This assessment will allow us to consider observational uncertainty information for climate-simulation assessments

Coverage in space/ time:
as long and as global as possible for individual ECVs

Metrics to analyse the performances/impact:
Differences in analysed model quality with and without consideration of observational uncertainties allows one to assess the importance of the observational uncertainties for model evaluation

Tasks to be performed (e.g. re-formatting,analysis):
1. Transfer and further develop knowledge on the use of observational uncertainty for model evaluation
2. Develop processing chain to routinely consider observational uncertainty for model evaluation
3. Link with task 5 to implement processing chain into standard benchmarking tools

References:
Massonnet et al., 2016: Using climate models to estimate the quality of global observational data sets, Science, 354, 452-455.
Notz D. 2015 How well must climate models agree with observations? Phil. Trans. R. Soc. A 373: 20140164. http://dx.doi.org/10.1098/rsta.2014.0164

MIP Interactions

1. The MIPs currently working with.
   - SIMIP
2. The nature of the WP4 research link to the MIP(s) named in point 1.
   - understanding the role of uncertainty in models vs obs
3. The MIPs with a potential WP4 research fit / could interact with.
   - possible relevance to CORDEX

Deliverables:
A report on MIP impact assessment and bench marking of CMIP5 models at M12, M24 and M36 for D4.1 (depends on CCI data availability and when the CMUG research takes place) describing a possible processing chain and highlighting examples of the evaluation of the temporal correlation.

WP4.3 Evaluation of model results considering the abstraction level of observational products

Leader and associated partners:
MPI-M, Dirk Notz

Resources (man month/partner): 4 PM

Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analysis
Model used (e.g. Earth System model, individual components): MPI-ESM, CMIP6 archive, possibly CORDEX
ECVs involved, CCI products involved: Use of CCI+ variables depends on respective progress, but might include sea surface salinity, snow, LST For CCI variables, we will focus on SST and SI for this exploratory study. Routine evaluation will then be possible based on the framework developed within this study. (which links to WP 5)
Aim of the experiments: To develop and apply a framework that allows one to estimate the ideal abstraction level at which a model evaluation should be carried out
Scientific question addressed: At which observational abstraction level should we evaluate large-scale model simulations?
Rationale (why important for the community): The retrieval algorithms of any ECV consists of various abstraction levels to convert the raw satellite data to the geophysical quantity of interest. At the various steps of the processing chain, assumptions are made which increase the observational uncertainty from one level to the next. This can cause substantial observational uncertainty in the highest-level product, which hence might not be the ideal choice for model evaluation. In this WP, we will examine procedures to define the ideal abstraction level for large-scale model simulations. We will for example examine how one can assess up to which level an instrument simulator in an ESM allows one to meaningfully reduce the impact of observational uncertainty. Links to the FIDUCEO project.
Use of the uncertainty information: The uncertainty information will form the central part of this assessment. Links to the FIDUCEO project.
Value of the assessment and complementarity with CCI experiments: This assessment will allow us to reduce the impact observational uncertainty information for climate-simulation assessments
Coverage in space/ time: as long and as global as possible for individual ECVs
Metrics to analyse the performances/impact: Differences in analysed model quality with and without consideration of the ideal abstraction level allows one to assess the importance of the observational uncertainties for model evaluation
Tasks to be performed (e.g. re-formatting,analysis): 1. Develop an overarching framework to define the ideal abstraction level for model evaluation 2. Develop processing chain to include various abstraction levels during model evaluation 3. Link with task 5 to implement processing chain into standard benchmarking tools
References: None
MIP Interactions 1. The MIPs currently working with. - SIMIP 2. The nature of the WP4 research link to the MIP(s) named in point 1.

- understanding the role of uncertainty in obs for model evaluation
3. The MIPs with a potential WP4 research fit / could interact with.
   - possible relevance to CORDEX

Deliverables:
A report on MIP impact assessment and bench marking of CMIP5 models at M12, M24 and 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place) describing a possible processing chain, and highlighting examples of the evaluation of the temporal correlation.

WP4.4 Optimal spatial and temporal scales for model evaluation
Leader and associated partners: MPI-M, Dirk Notz
Resources (man month/partner): 4 PM
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analysis
Model used (e.g. Earth System model, individual components): MPI-ESM, CMIP6 archive, possibly CORDEX
ECVs involved, CCI products involved: Use of CCI+ variables depends on respective progress, but might include sea surface salinity, snow, LST For CCI variables, we will focus on SST and SI for this exploratory study. Routine evaluation will then be possible based on the framework developed within this study. (which links to WP 5)
Aim of the experiments: To develop and apply a framework that allows one to estimate the ideal spatial and temporal time horizon at which a model evaluation should be carried out to minimize the impact of observational uncertainty
Scientific question addressed: At which time and space scale should we evaluate large-scale model simulations?
Rationale (why important for the community): A point-wise examination of observational uncertainty fails short in taking the often considerable temporal and spatial correlation of the uncertainty into account. Hence, a point-wise consideration of observational uncertainty might give misleading results regarding model quality in a model-assessment study. In this WP, we will develop and use a framework to identify the ideal spatial and temporal scale at which a climate-model evaluation should be carried out.
Use of the uncertainty information: The uncertainty information will form the central part of this assessment
Value of the assessment and complementarity with CCI experiments: This assessment will allow us to reduce the impact of observational uncertainty information for climate-simulation assessments
Coverage in space/ time: as long and as global as possible for individual ECVs
Metrics to analyse the performances/impact: Differences in analysed model quality with and without consideration of the ideal temporal and spatial scale allows one to assess the importance of these scales for model evaluation

Tasks to be performed (e.g. re-formatting,analysis): 1. Develop an overarching framework to define the ideal spatial and temporal scale for model evaluation 2. Develop processing chain to consider various spatial and temporal scales during model evaluation 3. Link with task 5 to implement processing chain into standard benchmarking tools
References:
MIP Interactions 1. The MIPs currently working with. - SIMIP 2. The nature of the WP4 research link to the MIP(s) named in point 1. - understanding the role of uncertainty in obs for model evaluation 3. The MIPs with a potential WP4 research fit / could interact with. - possible relevance to CORDEX
Deliverables: A report on MIP impact assessment and bench marking of CMIP5 models at M12, M24 and 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place) describing a possible processing chain, and highlighting examples of the evaluation of the temporal correlation

WP4.5 Evaluation of model results considering internal variability
Leader and associated partners: MPI-M, Dirk Notz
Resources (man month/partner): 4 PM
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analysis
Model used (e.g. Earth System model, individual components): MPI-ESM, CMIP6 archive, possibly CORDEX
ECVs involved, CCI products involved: Use of CCI+ variables depends on respective progress, but might include sea surface salinity, snow, LST For CCI variables, we will focus on SST and SI for this exploratory study. Routine evaluation will then be possible based on the framework developed within this study. (which links to WP 5)
Aim of the experiments: To develop and apply a framework that allows one to consider the impact of internal variability into a model-evaluation processing chain
Scientific question addressed: How can we take internal variability into account when evaluating large-scale model simulations?

Rationale (why important for the community):
Often, much of the difference between model simulations and any given observational record is explicable by internal variability, which describes the chaotic fluctuation of the observational record around the long term mean that is determined by the external forcing of the climate system (Notz, 2015). Hence, internal variability often hinders possible improvements in our observational capabilities to directly increase the fidelity (or lack thereof) of our model simulations. However, a systematic assessment of the role of internal variability for model evaluation is largely lacking. In addition, we lack a systematic analysis of observational records to obtain estimates of internal variability that can be used for detection and attribution studies, for example. Hence, these are usually based on estimates of internal variability as determined from large model ensembles. In this task, we will in close collaboration with CCI teams attempt to determine internal variability of existing and new ECVs directly from the observational record. These will then be compared to model-derived estimates. This allows us to more robustly quantify the relative role of internal variability versus anthropogenic drivers for explaining changes in observables related to the changing climate of our planet.

Use of the uncertainty information:
The uncertainty information will be used to assess the robustness of the obtained estimate of internal variability

Value of the assessment and complementarity with CCI experiments:
This assessment will allow us to consider internal variability for climate-simulation assessments

Coverage in space/ time:
as long and as global as possible for individual ECVs

Metrics to analyse the performances/impact:
Differences in analysed model quality with and without consideration of internal variability allows one to assess the importance of internal variability for model evaluation

Tasks to be performed (e.g. re-formatting,analysis):
1. Transfer and further develop knowledge on the use of internal variability for model evaluation
2. Develop processing chain to routinely consider internal variability
3. Link with task 5 to implement processing chain into standard benchmarking tools

References:
Notz D. 2015 How well must climate models agree with observations? Phil. Trans. R. Soc. A 373: 20140164. http://dx.doi.org/10.1098/rsta.2014.0164
Olonscheck, D. & Notz, D. (2017). Consistently estimating internal climate variability from climate model simulations. *Journal of Climate*, *30*, 9555-9573 , doi:10.1175/JCLI-D-16-0428.1

MIP Interactions

1. The MIPs currently working with.
   - SIMIP
2. The nature of the WP4 research link to the MIP(s) named in point 1.
   - understanding the role of internal variability in SI interactions in models
3. The MIPs with a potential WP4 research fit / could interact with.
   - possible relevance to CORDEX

Deliverables:
A report on MIP impact assessment and benchmarking of CMIP5 models at M12, M24 and/or 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place) describing a possible processing chain, and highlighting examples of the impact of internal variability for model evaluation.

WP4.6 Evaluation of model results considering a combination of sources of uncertainties

Leader and associated partners:
MPI-M, Dirk Notz

Resources (man month/partner): 4 PM
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analysis
Model used (e.g. Earth System model, individual components): MPI-ESM, CMIP6 archive, possibly CORDEX
ECVs involved, CCI products involved: Use of CCI+ variables depends on respective progress, but might include sea surface salinity, snow, LST For CCI variables, we will focus on SST and SI for this exploratory study. Routine evaluation will then be possible based on the framework developed within this study. (→Task 5)
Aim of the experiments: To develop and apply a framework that allows one to include both observational uncertainty and uncertainty arising from internal variability into a model-evaluation processing chain
Scientific question addressed: How can we take observational uncertainty and internal variability into account when evaluating large-scale model simulations?
Rationale (why important for the community): Any assessment of model quality based on a simple comparison of a model simulation with a given observational product is compromised both by uncertainties in the observations and uncertainties arising from internal variability. In this WP, we will combine the insights from parts 1 to 4 of this analysis into a joint framework, which then allows one to carry out a robust evaluation of model quality, taking observational uncertainty, internal variability, the ideal abstraction level and the ideal temporal and spatial scale into account.
Use of the uncertainty information: The uncertainty information will form the central part of this assessment
Value of the assessment and complementarity with CCI experiments: This assessment will allow us to consider observational uncertainty and internal variability for climate-simulation assessments
Coverage in space/ time: as long and as global as possible for individual ECVs
Metrics to analyse the performances/impact: Differences in analysed model quality with and without consideration of observational uncertainties and internal variability allows one to assess the importance of both sources of uncertainty for model evaluation
Tasks to be performed (e.g. re-formatting,analysis): 1. Develop a theoretical understanding for how best to combine the insights gained in parts 1 to 4 of this analysis. 2. Develop a processing chain to routinely consider observational uncertainty and internal variability 3. Link with task 5 to implement processing chain into standard benchmarking tools
References: Notz D. 2015 How well must climate models agree with observations? Phil. Trans. R. Soc. A 373: 20140164. http://dx.doi.org/10.1098/rsta.2014.0164
MIP Interactions 1. The MIPs currently working with. - SIMIP 2. The nature of the WP4 research link to the MIP(s) named in point 1.

- understanding the role of uncertainty and variability in models vs obs
3. The MIPs with a potential WP4 research fit / could interact with.
   - possible relevance to CORDEX.
4. Other ways of interacting with any of the MIPs
   - CMUG presentation at MIP meeting

Deliverables:
A report on MIP impact assessment and bench marking of CMIP5 models at M12, M24 and/or 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place) describing a possible processing chain, and highlighting examples of the combined impact of observational uncertainty and internal variability for model evaluation

WP4.7 Skill assessment of the DCPP decadal predictions
Leader and associated partners: BSC, Louis Philippe Caron
Resources (man month/partner): 4 man months
Type of assessment: Evaluation of probabilistic and deterministic skill in decadal predictions
Model used (e.g. Earth System model, individual components): Decadal predictions based on global Earth system models
ECVs involved, CCI products involved: CCI ECVs: Sea Level, SST and Clouds (Only products more than 20 years long are considered, to be able to assess with some confidence the skill at decadal timescales)
Aim of the experiments: To produce an extensive model skill assessment of the decadal hindcasts done within DCPP (Boer et al 2016; and thus contributing to CMIP6 initiative) using the longest CCI products as an independent source for validation, thus testing at the same time the consistency of CCI data with the reference datasets used for their initialization
Scientific question addressed: · Which are the regions/variables with more skill for decadal prediction across climate models? · Can CCI/CCI+ data help to identify if these are robust across datasets? · Does skill arise for different variables over the same region? · Can this help to identify the processes behind the skill?
Rationale (why important for the community): The combined analysis of several state-of-the-art decadal climate prediction systems will help to constrain which climate variables and regions have robust skill, covering timescales from seasons to decades, and thus provide robust valuable climate information for the development of climate services
Use of the uncertainty information: Uncertainties in the predictions will be illustrated through the use of probabilistic skill metrics, and by evaluating them against different reference datasets
Value of the assessment and complementarity with CCI experiments: This comprehensive assessment can be considered as a complementary way of contrasting the CCI data with other observational/reanalysed products, in this case by testing to what extent prediction skill is sensitive to the reference observational dataset.

Coverage in space/time:
Global,1982-2015

Metrics to analyse the performances/impact:
Forecast verification metrics in terms of bias and probabilistic and deterministic skill, and to attribute significant differences in skill

Tasks to be performed (e.g. re-formatting,analysis):

- Compilation of different observational products (CCI and non-CCI produced) to assess the skill of the variables of interest
- Extraction and preparation of the pertinent climate fields from the EUCP dataset
- Evaluation of the skill across the different models, variables and observational datasets
- Synthesis of the main results

References:
Boer J and Coauthors (2016), The Decadal Climate Prediction Project (DCPP) contribution to CMIP6, Geosci. Model Dev., 9, 3751–377.

MIP Interactions

1. The MIPs currently working with.
   - DCPP (Decadal Climate Prediction Project) BSC performed the equivalent experiment in CMIP5. We will perform experiments in components A, B and C of the DCPP plan. Also, we plan to investigate the impact of resolution by running component A at high resolution within the context of EUCP. Experiments are using the EC-Earth climate model:
   - DECK
   - ScenarioMIP

2. The nature of the WP4 research link to the MIP(s) named in point 1.
   - WP4.7 will evaluate the skill of the DCPP simulations.
   - The DECK and ScenarioMIP experiments will be used as reference to evaluate the impact of initialization, so they will be used as well, comparing these simulations with DCPP-A.

3. The MIPs with a potential WP4 research fit / could interact with.
   - HighResMIP - These simulations were performed in the context of the PRIMAVERA H2020 project.
   - PAMIP - The experiments will be performed in the context of the APPLICATE H2020 project.
   - VolMIP.

4. The expected results that the WP experiment could contribute to the MIP(s) in point 3.
   - Some experiments in VolMIP could be used to investigate the impact of volcanic eruptions on climate forecasting. On the other hand, the protocols for PAMIP and HighResMIP are not compatible with the DCPP experimental protocol.

5. Other ways of interacting with any of the MIPs (e.g. contribute to MIP newsletter, joint paper, CMUG presentation at MIP meeting,....)
   - Since WP4.7 will be done in the context of EUCP, there will be plenty of opportunities for collaborations and joint papers with EUCP partners. The results will also be presented at EUCP meetings.

Deliverables:
A report on MIP impact assessment and bench marking of CMIP5 models at M12, M24 and/or 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place)

WP4.8 Use LST products to develop and test simple models relating the LST versus air temperature (near surface) difference to vegetation moisture stress
Leader and associated partners: MO, **Lead: Rob King**, Debbie Hemming
Resources (man month/partner): 3 months (MO)
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analyses
Model used (e.g. Earth System model, individual components): JULES land surface model,
ECVs involved, CCI products involved: CCI: LST, AGBiomass, SM, LC Others: Temperature (near surface), Precipitation, FAPAR, LAI,
Aim of the experiments: - Use the differences between LST and Temperature (near surface) to assess spatial and temporal variations in vegetation moisture stress across biomes. SM will also be used to examine the vegetation moisture stress. The biomes will be characterised by AGBiomas and LC. - Understand relationships between LST and Temperature in the context of vegetation carbon exchanges across biomes and regions - Assess the potential for using LST versus Temperature relationships as a large-scale monitor of vegetation moisture stress
Scientific question addressed: Can LST versus Temperature relationships be used to monitor large-scale vegetation moisture stress across different biomes and regions? What quality information can be learned from the ancillary ECVs used in this study?
Rationale (why important for the community): This Activity will describe the temporal/spatial relationship between surface temperatures and biomes, allowing a better development of CCI+ LST for meeting user needs This research links with EUSTACE project to pull in and build on results from there.
Use of the uncertainty information: Spatial and temporal uncertainties in the LST and Temperature products will be characterized and used to estimate uncertainties in the proposed vegetation moisture stress indicator.
Value of the assessment and complementarity with CCI experiments: Links to WP4.10 and to other CMUG experiments on AGB, SM and LST.
Coverage in space/ time: Global at 5km / daily, currently available at: https://land.copernicus.eu/global/products/lst
Metrics to analyse the performances/impact: Average differences by biome and region in the LST versus Temperature relationship, Standard Deviation in the relationship spatially and temporally (intra and inter annual).

Tasks to be performed (e.g. re-formatting,analysis):

- Identify temporal and spatial relationships between LST and Temperature for different vegetation types and moisture regimes (using SM, LC and AGB)
- Assess relationships between LST vs Temperature and large-scale water and carbon flux observations over the range of vegetation types
- Conduct idealised JULES experiments to test simple theories relating LST versus air temperature to vegetation moisture stress. Using ESA CCI products (including SM, air temperature) to force the model experiments.

References:
None

MIP Interactions

1. The MIPs currently working with.
   - the CMUG team will consult with colleagues who are working on relevant MIPs, such as LS3MIP (Land Surface, Snow and Soil Moisture) as to how best to exploit links, data, and research results.
2. The nature of the WP4 research link to the MIP(s) named in point 1.
   - Understanding Land Surface processes
   - better understanding of the differences between uncertainty characterisations in models and those in obs.
3. The MIPs with a potential WP4 research fit / could interact with.
   - possible relevance to DCPP, LUMIP.
4. Other ways of interacting with any of the MIPs
   - CMUG presentation at MIP meeting

Deliverables:
Results will contribute to D4.1 report on MIP impact assessment and bench marking of CMIP5 models, Month 36 .
Benchmark of current LST vs Temperature relationships and methodologies to assess these using ESA CCI LST, as input to WP2.
Journal paper if results warrant it.

WP4.9 Use CCI+ products and simple models developed in WP4.8 to evaluate performance of modelled LST versus air temperature, using multiple up-to-date land surface and Earth System models

Leader and associated partners:
MO, **Lead: Debbie Hemming**, Rob King

Resources (man month/partner): 3 months (MO)

Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis):
Statistical analyses, use of available hindcast model data, multi-model comparison.

Model used (e.g. Earth System model, individual components):
JULES land surface model, UKESM1 model runs, other CMIP5 and (where available) CMIP6 runs

ECVs involved, CCI products involved:
CCI: LST, AGBiomass, SM, LC, and if available for regions of interest: HRLC (regions for HRLC to be defined in late 2018)
Other: Temperature (near surface),

Aim of the experiments:

- Evaluate how well the observed relationships between LST and Temperature across different vegetation types and moisture regimes are captured by the JULES land surface model, UKESM1 and other CMIP5 and 6 (where available) Earth System Models.

Scientific question addressed:

Can models capture the LST versus Temperature (near surface) relationships observed with satellite products across different vegetation types and moisture regimes?

Rationale (why important for the community):

This Activity will describe the temporal/spatial relationship between LST CCI and biomes, allowing a better understanding of the product for meeting user needs

Links with EUSTACE project to pull in and build on results from there.

This WP can also include some treatment of CORDEX data (which could simplify some of the analyses as these are driven by reanalyses) so can be compared more directly with the ECVs as they will share much of the same intra-interannual variability

Use of the uncertainty information:

Spatial and temporal uncertainties in the LST and Temperature products and the range of models used in this assessment will be characterized and compared

Value of the assessment and complementarity with CCI experiments:

Links to WP4.9 and to other CMUG experiments on AGB, SM and LST.

Coverage in space/ time:

Global at 5km / daily (will use what CCI LST produce)

Metrics to analyse the performances/impact:

Average differences by biome and region in the LST versus Temperature relationship between satellite and model data, Standard Deviation in the relationship spatially and temporally (intra and inter annual).

Tasks to be performed (e.g. re-formatting,analysis):

- Derive relationships between LST and Temperature (near surface) for historic model runs of JULES, UKESM1 and other CMIP5 and 6 (where available) models
- Evaluate the model LST vs Temperature relationships across different vegetation types and moisture regimes against observed relationships
- Summarise results by model, vegetation type, region and moisture regime, identifying key areas where models differ significantly from observations and possible reasons for these differences

References:

None

MIP Interactions

1. The MIPs currently working with.
   - the CMUG team will consult with colleagues who are working on relevant MIPs, such as LS3MIP (Land Surface, Snow and Soil Moisture) as to how best to exploit links, data, and research results.
2. The nature of the WP4 research link to the MIP(s) named in point 1.
   - better understanding of climate and land surface processes in models.
3. The MIPs with a potential WP4 research fit / could interact with.
   - possible relevance to DCPP, LUMIP, C4MIP, CORDEX
4. The expected results that the WP experiment could contribute to the MIP(s) in point 3.
   - better understanding of the CCI products being examined and how they could be useful to and used by these MIP projects
5. Other ways of interacting with any of the MIPs
   - CMUG presentation at MIP meeting

Deliverables: A report on MIP impact assessment and bench marking of CMIP5 models at M12, M24 and/or 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place) including statement on quality of ESA CCI LST and implications for model development. Journal paper if results warrant it.

WP4.10 Comparison of CCI products for studying vegetation variations with other satellite products and land surface models
Leader and associated partners: MO, Debbie Hemming
Resources (man month/partner): 3 months (MO)
Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis): Statistical analyses, cross-comparison, model evaluation metric development
Model used (e.g. Earth System model, individual components): JULES land surface model, UKESM1 model runs, other CMIP5 and (where available) CMIP6 runs
ECVs involved, CCI products involved: AGBiomass, LST, SM, LC, Temperature (near surface), Precipitation, FAPAR, LAI
Aim of the experiments: - Compare the seasonal timing and magnitude of vegetation-relevant CCI products with other satellite products (inc MODIS) and vegetation variables from existing historic model runs (of JULES, UKESM1, CMIP5/6). - Identify significant differences in the timing, location and vegetation types between CCI products and other satellite and model data. - Suggest key areas for model development to improve vegetation seasonality. - Contribute results to a multi-model evaluation conducted in the CRESCENDO project.
Scientific question addressed: Can the large-scale CCI ECV satellite products be used to improve representation of sensitivities and thresholds between vegetation productivity (and other carbon cycle processes) and climate in land surface/Earth System Models?
Rationale (why important for the community): This work will allow a better understanding of how the CCI+ products meet user needs Links with model evaluation work under the CRESCENDO project
Use of the uncertainty information: Spatial and temporal uncertainties in the CCI ECVs will be characterized and compared with a range of model estimates.
Value of the assessment and complementarity with CCI experiments: There is very good potential for
Coverage in space/ time: Global at 5km / daily

Metrics to analyse the performances/impact:
Phenology metrics – Start of Season, Peak of Season, End of Season, Length of Season. Timing and value of base data (i.e. LAI) for each metric, Standard Deviation of timing and value across key biomes and regions.

Tasks to be performed (e.g. re-formatting,analysis):
Analysis, cross-comparison, time series analysis,

References:
None

MIP Interactions

1. The MIPs currently working with.
   - the CMUG team will consult with colleagues who are working on relevant MIPs, such as LS3MIP (Land Surface, Snow and Soil Moisture) as to how best to exploit links, data, and research results.
2. The nature of the WP4 research link to the MIP(s) named in point 1.
   - better understanding of climate and land surface processes in models.
   - model evaluation using observations and statistics
3. The MIPs with a potential WP4 research fit / could interact with.
   - possible relevance to DCPP, LUMIP, C4MIP
4. The expected results that the WP experiment could contribute to the MIP(s) in point 3.
   - better understanding of the CCI products being examined and how they could be useful to and used by these MIP projects
5. Other ways of interacting with any of the MIPs
   - CMUG presentation at MIP meeting

Deliverables:
A report on MIP impact assessment and bench marking of CMIP 5 models at M12, M24 and/or 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place)
Paper on evaluation of model seasonality in vegetation.

WP4.11 Assess the land-surface interaction related biases in AMIP simulations with CCI and other products.

Leader and associated partners:
IPSL: **Lead: Frederique Cheruy**, Jean Louis Dufresne, A. Ducharne

Resources (man month/partner): 4

Type of assessment (e.g. statistical analysis, detection, attribution, assimilation, prediction, hindcast, budget analysis, reanalysis):
process oriented evaluation

Model used (e.g. Earth System model, individual components):
Atmosphere-Land surface component of IPSL-CM

ECVs involved, CCI products involved:
LST, snow, other: air temperature, turbulent fluxes (Jung, Gleam), meteorological analysis, MODIS data, CERES radiation fluxes, SM (CCI, SMOS, Gleam...)

Aim of the experiments:
Identify biases in the surface state and surface fluxes in AMIP simulations and understanding the origin of these biases in present day simulations (temperature, albedo, fluxes)

Scientific question addressed:
Our main goal is to explore the potential of multiple satellite derived products to try to relate existing and identified biases (surface state and surface fluxes) to missing or incorrectly represented processes, thus offering solutions for model improvement by revisiting the process representation.

Rationale (why important for the community):
Biases in present-day simulations cast doubts on the reliability of the future climate projections, and question the use of near-surface variables produced by numerical climate models for climate change impact studies.

Use of the uncertainty information:
check for consistency for the same diagnostics done with various data sources for ECV

Value of the assessment and complementarity with CCI experiments:
This experiment will take advantage of the experiments (and their results) in WP 3 where sensitivity studies using the nudging approach will be conducted on short time periods consistent with time period of the observations.

Coverage in space/ time:
Global/Multi-year and regional focus

Metrics to analyse the performances/impact:
AMIP Multi-model analysis of the near surface temperature biases will be performed, temperature biases will be evaluated with respect CCI observed variables (snow, SM, LST) and additional observed variables (Radiation budget, turbulent fluxes).

Tasks to be performed (e.g. re-formatting,analysis):
Correlation, surface energy budget analysis (Cheruy et al. 2014)

References:

Bellprat O, Kotlarski S, Lüthi D, Schär C (2013) Physical constraints for temperature biases in climate models. Geophys Res Lett 40:4042–4047. doi: 10.1002/grl.50737

F. Cheruy, J. L. Dufresne, F. Hourdin, and A. Ducharne. Role of clouds and land-atmosphere coupling in midlatitude continental summer warm biases and climate change amplification in CMIP5 simulations. Geophysical Research Letters, 41:6493--6500, September 2014

Jung T, Doblas-Reyes FJ, Goessling H, Guemas V, Bitz C, Buontempo C, Caballero R, Jokobsen E, Karcher M, Koenigk T, Matei D, Overland J, Spengler T, Yang S, 2015, Polar-lower latitude linkages and their role in weather and climate prediction. Bull. Amer. Meteor. Soc., 96, ES197-ES200, doi:10.1175/BAMS-D-15-00121.1.

Vogel, M.M., R. Orth, F. Cheruy, S. Hagemann, R. Lorenz, B.J.J.M. Hurk, and S.I. Seneviratne, 2017: Regional amplification of projected changes in extreme temperatures strongly controlled by soil moisture-temperature feedbacks. Geophysical Research Letters, 44(3), 1511-1519.

MIP Interactions

1. The MIPs currently working with.
   - LS3MIP (Land Surface, Snow and Soil Moisture)
   - SPMIP (Soil Parameter MIP)
   - AMIP
   - HighResMIP
   - SnowMIP
2. The nature of the WP4 research link to the MIP(s) named in point 1.
   - LS3MIP is specifically designed to assess the land atmosphere feedbacks. (See paper authored by Cheruy, Ducharne et al GMD-9-2809-2016).
   - will use the CCI+ ECV products to evaluate some of the model runs done for LS3MIP.
   - better understanding of climate and land surface processes in models.
   - better understanding of model biases using observations

3. The MIPs with a potential WP4 research fit / could interact with.
    - TBD
4. The expected results that the WP experiment could contribute to the MIP(s) in point 3.
    - TBD
5. Other ways of interacting with any of the MIPs
    - CMUG presentation at MIP meeting

Deliverables: A report on MIP impact assessment and bench marking of CMIP5 models at M12, M24 and/or 36 for D4.1 (depends on CCI data availability and when the CMUG research takes place) and contribution to scientific paper if enough results

WP5: Adaptation of community climate evaluation tools for CCI needs (lead by Axel Lauer)

WP5 is led by Axel Lauer (DLR).

Note that the workpackage components listed below do not include Tasks 5.5 or 5.6, and Task 5.6 from the original technical proposal has been renamed 5.2 to be consistent with the payment plan linked to the milestones (on page 16 of the signed contract). The original Task 5.2 and 5.5 were removed from an earlier version of the proposed project but the remaining tasks were not renumbered and an error was introduced into the signed contract referencing D5.2 linked to Milestone 4 (when it should have been D5.6 from the original technical proposal).

WP: 5.1, 5.3, 5.4		Start / end	1	36
ESMValTool				
Lead Partner	**Lead: Axel Lauer** (DLR) Veronika Eyring, Birgit Hassler, Sabrina Zechlau (DLR)			
Other CMUG partners	Javier Vegas, Kim Serradell (BSC) Debbie Hemming, Rob King (Met Office) Ulrika Willén, Klaus Zimmermann (SMHI)			

Model(s)	CMIP5 and CMIP6 models, Regional Models (CORDEX)
Experiment type	Historical simulations according to the CMIP protocol with fully coupled Earth System Models; regional model simulations
Period for experiment	Observational period for each ECV provided by CCI

NEW ECVs	Sea Salinity	Sea State	AG Biom	LST	Snow	Lakes	Hi-res LC	Water Vap.	Perma-frost					
	X			X				X						
OLD ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS –Arct	IS –Ant	Gla
	X							X						

Other data	Other observational data for comparison where available

Objectives
The aim of **WP 5** is to fully exploit ESA CCI and CCI+ data in the context of Earth system model (ESM) evaluation. The ESMValTool is a standardized community based evaluation and benchmarking tool that will be used for CMIP6 model evaluation and analysis. The goal is to enhance the ESMValTool with additional diagnostics and performance metrics that as tailored analysis for the evaluation of models with ESA CCI and CCI+ data. In **WP 5.1** we will release the enhanced version of the ESMValTool from the project including proper documentation of the code for users and developers. This task will also ensure that the work in ESA CMUG is well aligned with the work in other projects that support the ESMValTool development in order to fully exploit synergies. **WP 5.3** will integrate new versions of ESA CCI/CCI+ data into the tool and will develop new tailored

diagnostics and performance metrics. **WP 5.4 /** will then use the implemented diagnostics to evaluate new simulations from the CMIP6 ensemble with ESA CCI and CCI+ data.

The results of **WP 5** will lead to an enhanced use of ESA CCI/CCI+ data for climate model evaluation in CMIP and aim to make a substantial contribution to the analysis of CMIP6 data and to IPCC AR6.

Note: It is required that the ESA CCI and CCI+ datasets will be provided by the ESA CCI teams as best estimate plus uncertainty information in a format compliant with Obs4MIPs/CMIP standards ideally accompanied with a technical note similar to the Obs4MIPs descriptions.

Scientific questions to be addressed

1. How well can state-of-the-art Earth system models simulate climatological mean, variability and trends in the selected ECVs?
2. What is the progress that has been achieved in CMIP6 compared with CMIP5 in the selected ECVs?
3. Are the new observational time series of the ESA CCI complementing and changing global and regional model evaluation and benchmarking assessment of the models in comparison to other observations provided for example by obs4MIPs?
4. How can observational uncertainties and natural internal variability be integrated into the evaluation of climate models? (link to Task 3) OPTIONAL
5. What is the performance of global Earth system models for ESA CCI/CCI^{+} data compared to regional models? OPTIONAL

Tasks to be performed

Task 5.1 Coordination, support and documentation of ESMValTool CMUG activities

[DLR 2 PM; TOTAL 2 PM]

This Task ensures that the ESMValTool activities are well coordinated with other projects and releases the enhanced project version of the tool as open source software.

- Pull requests of new ESA CMUG contributions to the ESMValTool at the GitHub repository will be quality controlled.
- Tags will be included so that provenance is ensured in the final results and plots according to the ESMValTool standard. This will include information on e.g. input data, metadata, diagnostics, tool version, and doi's in the output files.
- Maximize synergies with other relevant projects, in particular with obs4MIPs, ESGF, CMIP, Copernicus projects like C3S-MAGIC and C3S-511, and EU projects like APPLICATE, CRESCENDO and PRIMAVERA.
- Release the enhanced ESMValTool and user's guide at the end of the project as open source software.

Task 5.3 Implementation of CCI and CCI+ products into the ESMValTool

[DLR 7 PM, BSC 3 PM, MetO 3 PM, SMHI 2 PM; TOTAL 15 PM]

In this task we will integrate new CCI+ data as well CCI data that have not yet been implemented (e.g. methane) into the ESMValTool. The starting point will be a generic namelist which will be enhanced by the CMUG partners who lead the implementation of a specific ECV with ECV specific diagnostics. Within the ESA CCI programme, the ESMValTool will be available to the Climate Research Groups for their work.

Specifically, the following CCI/CCI+ data will be included by the partners listed in parenthesis:

- Land surface temperature [MetO 3 PM]
- Long-lived GHGs (CH_4), water vapour [DLR 6 PM]

- Sea surface salinity [BSC 3 PM]
- Ocean colour [SMHI 2 PM]

Each partner will follow the ESMValTool coding rules and will submit a pull request upon finalization of the implementation of the ECV at the ESMValTool GitHub repository. The contributions will be combined into a project specific ESMValTool namelist similar to https://github.com/ESMValGroup/ESMValTool/blob/master/nml/namelist_lauer17rse.xml. [DLR 1 PM].

Task 5.4 Evaluating the CMIP6 ensemble with ESA CCI and CCI+ data using the ESMValTool

[DLR 3 PM, MetO 1 PM, BSC 1 PM, SMHI 1 PM; TOTAL 6 PM]

In this Task we will run the enhanced version of the ESMValTool with ESA CCI / CCI+ data on the CMIP5 and CMIP6 ensembles for ECVs defined in **Task 5.3**. Uncertainty provided for each ECVs will be used in the analyses of the results within the benchmarking framework. Total uncertainties on ECVs products on mean values (at a given location and at given spatial and temporal scales) will be considered in performance metrics and diagnostics. These uncertainties will provide bounds to compare with model simulations to determine if model errors are significant. A peer-reviewed publication will be written, which if the timing of results permits will be submitted before the IPCC AR6 WG I cut-off date for including papers (31 Jan 2020) which would ensure that the results of this WP can make a significant contribution to IPCC AR6.

Task 5.4.1 Evaluating the CMIP6 ensemble with ESA CCI and CCI$^+$ data

- Application of the ESMValTool to CMIP6 model results
- Assessment of CMIP6 model performance with a focus on the newly implemented variables from **Task 5.3**

Task 5.4.2 Assessment of progress in CMIP6

- Application of the ESMValTool to CMIP5 model results and comparison with CMIP6
- Evaluation of CMIP6 progress in comparison to CMIP5

Output / Deliverables

- D5.1 v1: Release of enhanced version of the ESMValTool and user guide released to wider community [DLR, month 36]
- D5.3.v1: Pull requests at the ESMValTool GitHub repository for specific ECVs of Task 5.3 [ECV leads of Task 5.3, month 24]
- D5.3.v2: Combined project specific ESMValTool namelist for global model evaluation released at GitHub for ECVs of Task 5.3 [DLR, month 28]
- D5.4.v1: Report on CMIP6 global model evaluation with ESA CCI/CCI+ data from Task 5.3 and improvements compared to CMIP5 in support of IPCC AR6 [DLR, BSC, MetO, SMHI, month 36]

WP: 5.2		**Start / end**	1	36
Title: Adaptation of the CMF and CMF database				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM		4						

Sum:4

Key personnel	Rossana Dragani, **Lead: Angela Benedetti**
Model(s)	• Climate Monitoring Facility (CMF) and CMF database

Experiment type	• Development of the operational CMF tool
Notes	http://apps.ecmwf.int/climate-monitoring/.

CCI+ ECVs	
	During CCI+, work is envisaged to maintain and extend the CMF Db to the new ECVs and the corresponding reanalysis fields as appropriate
Period for experiment	• As available

CCI data products	• Statistics computed from L3 SST, SSH, SI, Cloud, GHG, O3, SM, Aerosol, (possibly) OC
Other data	• **Statistics computed from available recent reanalyses and other available observations**

Objectives
To complete the existing datasets where their temporal coverage has been extended or new reprocessed versions become available.
Use of the Uncertainty information
The UI will make use of data ingested in a database that includes the CCI L3 (merged) uncertainties processed in area averaged statistics.

Scientific questions to be addressed:
Not Applicable

Tasks to be performed

The following activities are needed:

1. Download the original CCI and reanalysis datasets not available in the CMFDb for both the old and new ECVs as appropriate.
2. Write software to process the new ECVs in a suitable form (both observations and reanalyses).
3. Definition of metadata database for new ECVs (both observations and reanalyses).
4. Data processing, and quality control.

Complementarity with CCI experiments

Not applicable

Output / Deliverables

- D5.2 Updated CMFDb with additional CCI ECVs and corresponding reanalysis products as appropriate. Month 24

WP: 5.7		**Start / end**	1	36
Title:	**CCI Contribution to Obs4MIPs**			

CMUG participant	DLR	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM	12						

Sum:12

Key personnel	Axel Lauer, Mattia Righi, Birgit Hassler, Sabrina Zechlau (DLR)
Model(s)	ESMValTool

Summary	Support to the existing and new ECV projects in processing and uploading their data to the Obs4MIPs database in the correct format and configuration for CMIP5/6.
Notes	CMUG Note on Requirements on CCI datasets for inclusion in Obs4MIPs v0.3 https://earth.esa.int/documents/10174/1619046/RD04_obs4mips_req_cmug_v0.3.pdf

CCI+ ECVs	All the ECVs from CCI Phases 1 and 2 (where relevant, e.g. Glaciers have their own user community and are not submitting to Obs4MIPS). All the new ECVs, when their data becomes available. Include updates to ECV datasets, if appropriate. GlobAlbedo Dataset
Period for data	As provided by the ECV teams and the GlobAlbedo team
Product	Existing ECVs to be compliant with CMIP5, and if relevant/necessary with CMIP6 New ECVs to be to be compliant with CMIP6, and if relevant/necessary with CMIP5

Objectives
Obs4MIPs refers to a limited collection of well-established and documented datasets that have been organized according to the Coupled Model Intercomparison Project (CMIP5, CMIP6) model output requirements and made available on the Earth System Grid Federation (ESGF, http://esgf.org). Each Obs4MIPs dataset corresponds to a field that is output in one or more of the CMIP5 or CMIP6 experiments. This technical alignment of observational products with climate model output can greatly facilitate model data comparisons. Guidelines have also been developed for Obs4MIPs product documentation that is of particular relevance for model evaluation. This effort was initiated with support from NASA and the U.S. Department of Energy and has now expanded to include contributions from a broader community including CFMIP-OBS (http://climserv.ipsl.polytechnique.fr/cfmip-obs/) and products that rely on ESA satellites. To summarize, products currently available via Obs4MIPs are: • Directly comparable to a model output field defined as part of CMIP5 or CMIP6 • Open to contributions from all data producers that meet the Obs4MIPs requirements • Well documented, with traceability to track product version changes • Served through ESGF (and directly available through https://www.earthsystemcog.org/projects/Obs4MIPs/). To prepare ECV products for submission to Obs4MIPs, it is necessary to bin the ECV data set into time average products on a lat-lon grid. Additionally, the data set needs to be formatted as NetCDF, implementing CF metadata conventions, and compliant with CMIP model metadata (compliant with the Climate Model Output Rewriter API "CMOR"). A 5-8 page technical note describing the data set and following a uniform template also needs to be prepared. To avoid the unnecessary duplication of effort for the CCI teams to each learn the intricacies of the Obs4MIPs data file and metadata format, the Contractor shall take responsibility to provide Obs4MIPs technical support to all CCI teams. The CCI projects shall remain responsible for averaging their own ECV products onto the low spatial and temporal resolution grid required by Obs4MIPs, whereas CMUG shall be responsible for wrapping these low resolution ECV data sets in the Obs4MIPs-format NetCDF files with CMOR-compliant metadata, and publishing these data sets on the Earth System Grid Federation. The Contractor shall write training materials to assist CCI teams prepare their datasets for Obs4MIPs, in the cases where they are willing to do this unaided by the Contractor. The Contractor shall provide a total level of effort amounting to 12 person-months (*i.e.* 4 person-months per year) of a suitably qualified climate data scientist to provide the above Obs4MIPs support. This shall include

travel to allow the Contractor's scientist to attend one CCI meetings per year to coordinate the necessary work with each CCI project team.

Tasks to be performed:
Advice from CMUG on preparation of CCI datasets for Obs4MIPs is provided https://earth.esa.int/documents/10174/1619046/RD04_obs4mips_req_cmug_v0.3.pdf. The CCI ECV projects shall: • Consult with ESA, CMUG and their CRGs, to decide which of their ECV data sets are of most interest to the CMIP community, and therefore most appropriate for contribution to Obs4MIPs. • Perform the necessary spatial and temporal averaging/binning on their data sets • Liaise with the Contractor to convert these data sets into Obs4MIPs format • Write the required short technical note at graduate student level that accompanies an Obs4MIPs data set, and ask CMUG to evaluate it. The Contractor shall: • Plan a roll-out schedule for CCI Obs4MIPs data sets. • Develop a package of training material (manuals, presentations) to assist CCI teams to prepare their data sets in Obs4MIPs format. • Liaise with CCI ECV project teams and provide technical support to assist CCI project teams to prepare their (low-resolution) ECV data sets suitable for Obs4MIPs. • Convert the provided ECV data sets into Obs4MIPs format, including setup of all necessary CMOR-compliant metadata. • Publish and maintain the CCI Obs4MIPs data sets on the CCI ESGF Node/Project (working with the CCI Open Data Portal contract) • Ensure the CCI Obs4MIPs data is listed correctly in the global Obs4MIPs indexes.

Output / Deliverables		
D5.7a (DEL-12)	M12	Obs4MIPs training material
D5.7b (DEL-16)	ver. 0 at M06 ver. 1 at M12 ver. 2 at M24	Roll-Out Schedule for CCI Obs4MIPs data sets
D5.7c (DEL-18)	ver. 1 at M12 ver. 2 at M24 ver. 3 at M36	Annual report on CCI data sets prepared for Obs4MIPs
D5.7d (DEL-13)	*ad hoc*	CCI Obs4MIPs data sets

WP6: Coordination and Outreach (lead by Hannah Griffith)

WP6 is led by Hannah Griffith (Met Office).

WP: 6.1		**Start / end**	M1	M36
Title: Scientific exploitation report				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFranc	MetOffice	MPI-M	BSC
PM	0.0	0.7	0.1	0.1	0.1	2	1	0.4

Sum: **4.4**

Key personnel	**Lead: Hannah Griffith**, Richard Jones, Amy Doherty, Jean-Christophe Calvet, Jean-Louis Dufresne, Ulrika Willén, Rossana Dragani, Francisco Doblas-Reyes, Dirk Notz

CCI+ ECVs	WV	Salin	S-State	Lakes	Snow	PF	LST	HRLC	AGB				
	X	X	X	X	X	X	X	X	X				
ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS	Gla
	X	X	X	X	X	X	X	X	X	X	X	X	X

Objectives
The aim is to summarise the use of the CCI datasets through outcomes of integration meetings and results presented in other relevant conferences.

Scientific questions to be addressed:
How are the CCI datasets impacting on the latest climate research, in the following areas: 1. Scientific research funded by the EC 2. Scientific research funded at national level 3. Through CCI uptake in other initiatives (Obs4MIPs, CMIP) 4. Other uptake (EEA, JRC) 3. Applied or commercial research
Tasks to be performed
1. Gather feedback on the uses of CCI data 2. Compile reports from integration meetings
Output / Deliverables
Report D6.1 V1 in Month 8, v2 in month 20, v3 in month 32

WP: 6.2		Start / end	M1	M32
Title: **Promotion Package**				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFranc	MetOffice	MPI-M	BSC
PM	0.0	0.7	0.1	0.1	0.1	2	1	0.4

Sum: **4.4**

Key personnel	**Lead: Hannah Griffith**, Richard Jones, Amy Doherty, Jean-Christophe Calvet, Jean-Louis Dufresne, Ulrika Willén, Rossana Dragani, Francisco Doblas-Reyes, Dirk Notz

CCI+ ECVs	WV	Salin	S-State	Lakes	Snow	PF	LST	HRLC	AGB				
	X	X	X	X	X	X	X	X	X				
ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS	Gla
	X	X	X	X	X	X	X	X	X	X	X	X	X

Objectives

Promote CCI datasets and CMUG results to the climate modelling and reanalysis community, to the Copernicus programme, international bodies and climate researchers.

Scientific questions to be addressed:

Liaise with CCI Knowledge Exchange team

Tasks to be performed

Prepare material for promotion of CCI products which include:

- Newsletters (twice yearly, paper and email)
- Flyers / posters / presentations at conferences, workshops and meetings
- Website (kept up to date and relevant, with results and material promoting the CCI)
- Use the web forum (WP2.2) as a comms tool to increase profile of the CCI
- Journal papers illustrating the use of some of the CCI datasets
- Maintain an email group of interested researchers/research groups
- Horizon scanning for outreach opportunities
- Maintain within the project plan a section on communications and outreach
- Respond to ad-hoc requests for outreach activities

Output / Deliverables

Newsletters/Web pages/Flyers/Posters/Presentations/Journal Papers/Links with Web forum
Outputs at Months 8, 20, 32

WP7: Interface of CCI data to climate services (lead by Angela Benedetti)

WP: 7.1		**Start / end**	M1	M30
Title: Interface of CCI data to climate services				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM	0	1	0.2	0.2	0.2	1	0.3	0.5

Sum: **3.4**

Key personnel	**Leads: Richard Jones, Angela Benedetti**, Rossana Dragani Jean-Christophe Calvet, Jean-Louis Dufresne, Ulrika Willén, Francisco Doblas-Reyes, Dirk Notz, Amy Doherty Jean-Noel Thepaut at ECMWF and Chris Hewitt (Met Office) will provide input to CMUG on this topic when needed.

NEW ECVs	Sea Salinity	Sea State	AG Biom	LST	Snow	Lakes	Hi-res LC	Water Vap.	Permafrost				
	X	X	X	X	X	X	X	X	X				
ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	O3	Cld	Aer	IS	Gla
	X	X	X	X	X	X	X	X	X	X	X	X	X
Objectives													
Define interface of CCI data to climate services (i.e. Copernicus for Climate Change)													

Scientific questions to be addressed:

N/A

Tasks to be performed

1. Meet with Copernicus Climate Change Service co-ordinators, other national climate services and key stakeholders (ECMWF, EEA, JRC)
2. Refer to requirements obtained in D1.1
3. Prepare report based on their inputs. The report will provide information on how CCI data can support the aims and objectives of Copernicus. The information will cover relevant scientific features of the data, some technical aspects, and the process links needed at organizational level.

Output / Deliverables

- Report D7.1

WP8: Project Management (lead by Amy Doherty)

WP: 8		**Start / end**	M1	M36
Title: Project management				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	
PM	0	0	0	0	0	6	0	

Sum: **6**

Key personnel	**Lead: Amy Doherty**, Hannah Philipps, Richard Jones, Hannah Griffith

ECVs													
Objectives													
Manage the CMUG project													

Scientific questions to be addressed:

N/A

Tasks to be performed

1. Project manage the CMUG phase 2 project
2. Scientifically manage project
3. Liaise with project team
4. Be main point of contact between CMUG and ESA
5. Provide quarterly and monthly reports on project
6. Maintain risk register
7. Ensure deliverables fulfill their objectives and are delivered on time
8. Ensure maximum effectiveness for communications and outreach
9. Organize annual CMUG integration meetings
10. Act as point of contact in CMUG for DSWG and SEWG
11. Coordinate CSWG
12. Work with ESA on annual progress meetings
13. Manage the financial part of the consortium

Output / Deliverables

Integration Meeting reports

Workshop Reports (where meeting had significant CMUG input or organisation)

D8.1 Quarterly Progress reports to ESA

D8.2 Maintenance of CMUG web pages

D8.3 Final Report – Month 36 Final Report will summarise CMUG activities, results and recommendations, be 20-30 pages inc. refs and figs