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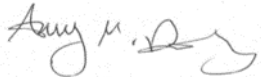
Report of CMUG Integration Meeting Nov 2023

ECSAT Centre, Harwell, Oxfordshire with hybrid participation via WebEx, 8-9th November 2023

Accepted by:	Institute / project	Signature
Amy Doherty	**Met Office / CMUG**	
Simon Pinnock	**ESA / CMUG**	

Version draft   1.0   December 2023

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Contents

1.   Introduction

The Integration Meeting (IM), held November 2023, was organised by the Climate Modelling User Group (CMUG) of ESA's Climate Change Initiative (CCI). The meeting was held in-person at ESA-ECSAT, Harwell, Oxfordshire, UK with hybrid capabilities, 8-9th November 2023. The Integration Meeting was held in conjunction with the CCI Colocation Meeting, which preceded the Integration Meeting 7-8th November 2023.

The meeting included participants from a range of communities, including CMUG project members, Science Leads, Climate Research Group (CRG) members, Climate Science Working Group (CSWG) members, ESA Technical Officers and other wider CCI personnel. There were at least 100 attendees, with many of the attendees from the CCI Colocation staying on to attend the following CMUG Integration Meeting.

Wednesday 8th November functioned as a transition between the CCI Colocation Meeting and CMUG's Integration Meeting with a session on joint CCI / CMUG topics: ESMValTool, obs4MIPs, CMIP, CORDEX, and CLIMATE-SPACE. Thursday 9th November began with the official introduction to the Integration Meeting, followed by brief overview presentations of CMUG's Phase 2 Work Packages, and then breakout sessions, for the Science study kick-off meetings. Not all studies held a kick-off meeting at this time, these will be scheduled at a later date. The kick-off meetings served to facilitate initial communication between the CMUG studies and the relevant ECV project personnel, which will continue through the course of the studies, feedback gathered during the breakout sessions will feed into study plans.

The meeting webpage is available on the CMUG website here, and includes links to the meeting agenda and presentations. A short summary of the CCI Colocation and CMUG Integration Meeting, produced by ESA, can be accessed here.

2.   Meeting aims

The aim of this meeting was to formally introduce the next phase of CMUG (CCI+ Phase 2), outline next phase activities, provide a space for ECV projects to discuss science study details with study leads during breakout sessions, and for most studies to hold their kick-off meetings. It was also a chance for CCI as a whole to investigate how links with the modelling community can be improved with CMIP and CORDEX presentations and discussions on tools and databases being a key aspect of this.

3.   Meeting agenda

The Integration Meeting agenda is outlined in the table below.

Nov. 08, 2023	Session 4: Joint CCI/CMUG – Observations / Model Intercomparisons	
13:30-17:30		
	ESMValTool – Latest Updates	Axel Lauer, DLR
	Obs4MIPs in CCI	Simon Pinnock, ESA
	CMUG Work Package on Future Evolution of Obs4MIPs	Amy Doherty, UK Met Office
	CMIP/CORDEX Discussion	Eleanor O'Rourke, CMIP IPO; Chris Lennard, CORDEX Africa; Irene Lake and Grisha Nikulin, CORDEX IPO/SMHI
	Outlook for EO Data Exploitation in CMIP7	Martin Juckes and Phil Kershaw, CEDA

	Discussion on Linking Observations with Models in CLIMATE-SPACE	Simon Pinnock, ESA
17:30-20:30	Poster Session	All projects to present latest scientific highlights
Nov. 09, 2023	**Session 5: CMUG Integration**	
09:00-10:00		
	Introduction to the Integration Meeting and Overview of CMUG Phase 2 (CCI+)	Richard Jones, UK Met Office
	Presentation of CMUG Plans for Phase 2 (CCI+) – 1 Slide per Study	Amy Doherty, UK Met Office / Study leads
10:00-11:00	First Breakout Session – Breakout Rooms by Science Study for joint Kick-off Meetings	WP5.1 Lisa Bock, DLR WP5.8 Rob Parker, NCEO (University of Leicester)
11:30-12:30	Second Breakout Session – Breakout Rooms by Science Study for joint Kick-off Meetings	WP5.3 Jean-Christophe Calvet, Météo-France WP5.6 Philipe Peylin WP5.7 Ulrika Willén, SMHI ESMValTool Drop-in Axel Lauer, DLR
12:30-13:00	Concluding Remarks and Meeting Close	Amy Doherty, UK Met Office

4.   Integration Meeting Day 1

4.1   ESMValTool: Latest Updates (Axel Lauer, DLR) – slides

ESMValTool activities in CMUG Phase 2 will focus on optimising treatment of uncertainty information within the tool and adding treatment of Snow, Above Ground Biomass and Permafrost. Other CCI datasets will also be updated where more suitable versions exist.

ESMValTool is widely used with diagnostics developed and applied for IPCC AR6.

The drop-in session on Day 2 was advertised as a good opportunity for participants to see ESMValTool in action, with a demonstration of the tutorial and explanation on the process for adding CCI data to the tool.

It was confirmed that the main ESMValTool engine is IRIS, developed by the Met Office, and it is this in combination with dask that does the 'lazy' processing. It is similar to XARRAY.

4.2   Obs4MIPs in CCI (Simon Pinnock, ESA) – slides

Obs4MIPs is an observations database, which is a WCRP initiative. Not all datasets can be added to obs4MIPs for various reasons including mismatch with CMIP defined variables. Obs4MIPs does not currently support uncertainty information but the team is trying to find ways to do this in the future.

The CCI CO_2 and methane datasets currently on obs4MIPs require updating.

A participant commented that there are currently multiple access points for different tools, such as obs4MIPs and ESMValTool etc., as well as specific requirements for how data should be prepared for these tools and platforms. Are there plans to harmonise and centralise access to all these products to reduce confusion? Simon Pinnock replied that data in obs4MIPs is already in a format compatible with ESMValTool. CCI has its own data portal, so obs4MIPs is an extra platform. Perhaps in the future they could be more connected to one another.

Action: AD to consider harmonisation between the data portal and obs4MIPs for D5.7f.

4.3   CMUG Work Package on Future Evolution of Obs4MIPs (Amy Doherty, UK Met Office) – slides

A participant asked what the priorities are for including all CMIP and CORDEX community requirements. Are there plans to include the extremes community? These communities have different observational needs. Amy Doherty responded that CMUG is looking to take all of these user requirements into account in the report (CMUG deliverable D5.7f). Amy is happy to gather all such information.

Richard Jones added that obs4MIPs sits under the WCRP activity Earth System Modelling and Observation (ESMO) which coordinates all modelling, data and observations activities across WCRP. Richard wondered where from the WCRP infrastructure people should go to get those additional requirements and areas of interest? Simon Pinnock answered noting he doesn't currently know and that is probably a question more for core project individuals.

Eleanor O'Rouke (CMIP IPO) confirmed there is no central mechanism. A cross-WCRP virtual meeting or something similar would be useful for this to coordinate between international projects to gather information from projects and lighthouse activities. It is definitely possible and it would be relatively straightforward.

Action: AD to follow up with WCRP activities to gather information for D5.7f.

Claire MacIntosh (ESA CCI) added that ESMO IPO is almost up and running from early next year (2024) when things can start to move towards that direction.

Action: AD to keep in contact with ESMO as it forms.

4.4   CMIP/CORDEX DISCUSSION (Irene Lake and Grisha Nikulin, SMHI; Chris Lennard, CORDEX Africa)

Obs4MIP does not currently contain regional datasets. It does accept higher resolution data if needed but this should be limited as very large datasets could cause issues when downloading. There is a requirement for a tool to subset data, which doesn't currently exist.

Action: AD to note requirement for tool in obs4MIPs which geographically subsets datasets.

Richard Jones noted that no one currently takes responsibility for accessibility of these tools and datasets. Accessibility is a big topic of discussion – can people actually access and use it? There are restrictions in many areas of the world, such as lack of space to download large datasets, power outages, lack of continuous access, etc. One possible solution could be to have the data stored centrally (e.g., cloud services, JASMIN). Whose responsibility is it to supply this?

Eleanor O'Rouke (CMIP IPO) added that in CMIP there is an 'access task team' which helps address such accessibility questions for CMIP. There are opportunities in the private sector, such as Google and Amazon. Sometimes there are free services but there are questions on sustainability of that, as well as quality assurance, etc. The CMIP 'access task team' is working on these questions. For tools / infrastructure, there are resource requirements. It is still a big question to be answered.

Action: AD to follow up with CMIP Access Task Team.

Simon Pinnock added that there should be high value in using satellite data in the context of CORDEX because this looks at much higher resolutions than global climate models. It should

be more useful in a CORDEX context. This is especially true if ESA want to use CCI data for adaptation, which usually requires working at a regional or local level. This would be a new community for CCI to liaise with.

Action: CMUG to facilitate meetings between CORDEX and CCI.

Irene Lake's presentation showed examples of flagship work that is being planned within CORDEX. Higher resolution for cities, high mountain areas, specific processes, etc. The move to very high resolution modelling (at the km scale) is ongoing. This could be very useful.

The flagship pilot studies are mostly carried out in Europe by Europeans which makes it difficult for other regions, especially in the Global South in terms of access and data handling. This comes back to the accessibility issue. Are there possibilities to download smaller amounts of data? Is subsetting possible / useful here? There are other domains across the globe, but these projects are also dominated by Europeans. To make it possible for other domains to do it themselves, which Irene and team would like, then accessibility requirements need to be addressed.

Chris Lennard (CORDEX Africa) added that a lot of products are taken for granted with the assumption that others know how to use them. What is the best way to use these products that are being produced? It might come as second nature to those familiar with the work / area but for others it may be new. If training programmes on using data products are planned then please advertise through CORDEX. Secondly, the question of capacity is important to consider, in an African context, but also South American and Southeast Asian – cloud computing has potential. Chris and team have worked with Amazon for the last eight months or so working on Amazon's infrastructure and 22km resolution looks possible. However, the data coming out of this would be very large (petabytes) so it cannot be downloaded easily (or at all). Chris and team used to have data physically transported on external hard drives from Europe to Cape Town, South Africa. Storing data in the cloud is a better option in the future due to the large data volumes.

Action: CMUG to specifically advertise ESMValTool training and tutorials to CORDEX projects.

It should be possible to run ESMValTool on Amazon servers – although the work would need to be funded by someone.

Action: CMUG to consider how to progress use of ESMValTool on Amazon servers.

Amy Doherty added that if this (solutions such as Amazon servers, etc.) is the future of how the Global South are going to access observation and model outputs then it is key to ensure compatibility with Amazon cloud servers (and the like). Chris Lennard added that access to ESMValTool analyses would be very useful in CORDEX Africa work. There are challenges, but challenges that should be solvable, and this looks like the best solution available at present.

Chris Lennard confirmed that CORDEX Africa would be interested in using satellite data for model evaluation and having all data in the same place would be very important. There is limited in situ data in large parts of Africa so satellite data are vital.

Amy Doherty suggested CCI ECV projects might need to think more on this topic. If CCI contacts could be shared then discussions can continue offline. CORDEX contact email addresses will be shared with CCI.

Action: AD to facilitate communication between CORDEX and CCI.

Claire Bulgin (LST_CCI) asked for information on where CORDEX already collects data and what the data requirements are. She confirmed for Chris that most CCI datasets are global in extent.

Tools that work for CMIP (ESMValTool, obs4MIPs) should also work with CORDEX, Grisha Nikulin confirmed that the formats are generally the same and some CORDEX grids are already supported by ESMValTool.

Action: CMUG to share information with CORDEX on which CORDEX domains are included in ESMValTool.

4.5   Outlook for EO data exploitation in CMIP7 (Phil Kershaw and Martin Juckes, CEDA) – slides

DataHub is available for all users, although it is a UK initiative.

Simon Pinnock noted that a dedicated observations MIP would be interesting and he would be interested to take this forward.

Action: SP to consider observations MIP.

Richard Jones suggested improved interaction with CMIP and IPCC. Links could be improved with other data repositories, such as the climate data store (CDS). The IPCC AR6 Interactive Atlas is being built into the Copernicus CDS so coordination with the UK DataHub would be beneficial. Phil confirmed that CEDA encourage the sharing of information, knowledge and data.

Axel Lauer (ESMValTool) asked how Phil and team picture access to cloud computing facilities. There are required resources for running a supercomputer and someone has to pay for this. How is this pictured in practice? Phil answered that there is a whole project plan looking at how charging and accounting could work. Ultimately, the service will need to be paid for but this could be done in different ways, such as a tiered system, grants, different charges for commercial users, etc.

4.6   Discussion on Linking Observations with Models in CLIMATE-SPACE (Simon Pinnock, ESA) – slides

Amy Doherty asked how the new ITT relates to CMUG. There is a large overlap between CMUG and these new projects, but ultimately these will replace CMUG, which will not be continued after this phase (2026). How will the non-science study aspects of CMUG be carried forward, the Integration meetings, the CSWG, the user requirements gathering and the contributions to tools? Simon said that this has not yet been decided.

Action: AD to follow up on possibility of CMUG comms activities being adopted in linking obs and modelling ITT or being absorbed into the KE activity.

4.7   17:30-20:30 Poster Session

Day 1 ended with an evening poster session. All projects presented their latest scientific highlights. CMUG's poster can be accessed on the CMUG website here.

5.   Integration Meeting Day 2

Introduction to the Integration Meeting and Overview of CMUG Phase 2 (CCI+) (Richard Jones, UK Met Office) – slides

No further comments or questions.

5.1   Presentation of CMUG Plans for Phase 2 (CCI+) – 1 slide per Study

Axel Lauer – WP4 CCI contributions to ESMValTool – slide

No further comments of questions.

Lisa Bock – WP5.1 Machine learning to advance climate model evaluation and process understanding – slide

There were two subsequent questions on the causal relations work. The first asked why aerosols are not included in this study. Lisa Bock answered that this study plans to start with cloud influencing factors and if that is successful in its approach then it would be useful to expand to include aerosols as well. The second question asked if there is any particular focus on parts of the climate system, such as tropical SSTs and clouds which would be interesting in terms of climate sensitivity? Lisa answered that the study would like to look at different cloud regimes, such as one for the tropical band.

Daniele Peano – WP5.2 Impacts and evaluation of vegetation phenology changes on observed and modelled land-atmosphere processes – slide

Land-atmosphere interactions are of interest for this study, such as CO_2 intake and those related to the interaction between Vegetation and Snow Cover in high latitude areas. Time constraints will limit what can be considered.

Amy Doherty added that the Kick-off Meeting for this study (which for other studies would be held in the following breakout sessions) would not be held during this Integration Meeting but will be held in about a years' time due to the later study start date.

Philipe Peylin – WP5.6 Snow dynamics impacts on temperature / high latitude climate – slide

No further comments or questions.

David Ford – WP5.4 ESA CCI data assimilation impact on seasonal predictability of ocean biogeochemistry – slide

David Ford was unable to attend to present this study, which he leads. Amy Doherty presented a brief summary in his place. No further comments or questions.

Kirsti Salonen – WP5.5 Cloud and aerosol analysis study – slide

Kick-off meeting to be held in December.

Ulrika Willén – WP5.7 Ice sheets and atmospheric drivers – slide

No further questions or comments.

Rob Parker – WP5.8 Using machine-learning to evaluate and understand our capability to model tropical wetland methane emissions – slide

Rob confirmed that Land Cover CCI will be used and this is interesting because the study will use wetland masking as well. The emissions from models with a wetland mask applied show vast differences in methane fluxes compared to when wetland masks are not included. This study will not focus on vegetation, but it can be explored in the future and will be of interest as vegetation potentially plays a large role in both methane emissions and as a transport mechanism. There are a lot of potential links for future work.

A participant asked Rob to briefly summarise how 'explainable AI' works as this term almost seems contradictory. How can an AI be explainable? Rob noted that this is due to the tree-based method which shows which way the AI has gone and why it went that way. The approach that they will use to build the Machine Learning-based emulator will allow them to explore the responses and sensitivity to specific input drivers (e.g., land surface temperature) using explainable AI methods such as SHAP. Furthermore, this approach should allow them to propagate uncertainty estimates (e.g., of CCI-LST) through the emulator to derive an envelope of uncertainty on the methane fluxes.

Jean-Christophe Calvet – WP5.3 How do LC and Snow uncertainties propagate? – slide

No further comments or questions.

5.2   Breakout Sessions

First Breakout Session: Scientific Study Discussions and Kick-off Meetings

      o   Room 1 = WP5.1 Machine learning for process understanding (Moon Room)

There are no notes from this session.

      o   Room 2 = WP5.8 Machine learning for wetland methane emissions (Mars Room)

Notes for this breakout session are available here.

Second Breakout Session: Scientific Study Discussions and Kick-off Meetings

      o   Room 1 = WP5.3 Land Cover (Moon Room)

This breakout session discussed both WP5.2 and WP5.3 with notes available here.

      o   Room 2 = WP5.6 Snow Dynamics (Mars Room)

There are no notes from this session.

      o   Room 3 = WP5.7 Ice Sheets (Main Conference Hall)

There are no notes from this session.

o   Room 4 = Drop in for ESMValTool Demo (ECSAT 013)

There are no notes from this session.

5.3   Concluding remarks and meeting close

Day 2 concluded with a brief wrap-up from Amy Doherty, who thanked all participants for attending. Amy sent a follow-up email the day after the Integration Meeting with a few key points and requested meeting feedback from partners. Such feedback will feed into future Integration Meeting planning.

Summary of actions:

- **Action: AD to consider harmonisation between the data portal and obs4MIPs for D5.7f.**
- **Action: AD to follow up with WCRP activities to gather information for D5.7f.**
- **Action: AD to keep in contact with ESMO as it forms.**
- **Action: AD to note requirement for tool in obs4MIPs which geographically subsets datasets.**
- **Action: AD to follow up with CMIP Access Task Team.**
- **Action: CMUG to facilitate meetings between CORDEX and CCI.**
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- **Action: SP to consider observations MIP.**
- **Action: AD to follow up on possibility of CMUG comms activities being adopted in linking obs and modelling ITT or being absorbed into the KE activity.**

All actions have been added to the CMUG Actions Database for monitoring.