ESA CLIMATE CHANGE INITIATIVE PHASE 1

CLIMATE MODELLING USER GROUP (CMUG)

STATEMENT OF WORK

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reference/*réference* EOP-DTEX-EOPS-SW-09-0002
issue/*édition* 1
revision/*révision* **2.2**
date of issue/*date d'édition* 16-11-2009
status/*état* **Approved**
Document type/*type de document* SOW

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1. INTRODUCTION

1.1 Scope of the Document

This document is the "Statement of Work" (SoW) specifying the work to be performed under the contract for the "Climate Modelling User Group" (CMUG) project initiated within the framework of the ESA "Climate Change Initiative" (CCI).

The CMUG project will be led by a dedicated team of leading modelling centres in Europe, including the "Met Office Hadley Centre", the "Max Planck Institute for Meteorology", "Meteo France" and the "European Centre for Medium-Range Weather Forecasts", which together bring world-leading expertise in developing and operating Climate Models, Numerical Weather Prediction models, Data Assimilation Systems and Re-analysis.

This document presents the background of the CCI, the objectives and structure of the CMUG, the tasks to be undertaken to achieve these objectives, the deliverables to be developed, and the schedule of milestones to be achieved.

It also describes how CMUG will provide (i) a *forum* for the "Climate Modelling Community" (being the main user group for this project) and (ii) *feedback* to the "CCI Projects" delivering "Global Satellite Data Products" meeting some of the needs of the "Global Climate Observing System" (GCOS).

1.1 Terminology

Terms used in this document are to be understood as follows:

"Climate Change Initiative" (CCI) refers for simplicity to the "ESA Earth Watch Programme Element on Global Monitoring of Essential Climate Variables", which aims to "systematically generate, preserve and give access to long-term data sets of some of the "Essential Climate Variables" (ECVs) required to meet the needs of the Parties to the "United Nations Framework Convention on Climate Change" *(*UNFCCC).

"Climate Modelling User Group" (CMUG) refers to the cross-cutting project of the CCI programme and including the following leading modelling centres: the Hadley Centre, the Max Planck Institute for Meteorology, MeteoFrance, and the European Centre for Medium-Range Weather Forecasts.

"CCI Project" refers to each one of the eleven individual projects delivering "Global Satellite Data Products" to be implemented as part of the first phase of the CCI.

"Climate Modelling Community" refers to the wider climate modelling community, including the CMUG partners, as well as many other research groups, existing networks (e.g. CM-SAF – Climate Modelling Satellite Application Facility, ENES – European Network for Earth System Modelling), scientific bodies, that are involved in the exploitation of *coupled* models of the climate system for global / regional climate change modelling, long-term climate projection and seasonal / decadal climate forecast. The CMUG project will provide a forum for this particular modelling community.

"Global Satellite Data Products" refers here to the time-series of consistent global products derived mainly from satellite data (together with their metadata and traceable error characterisation) associated with ECVs. These products are delivered by the CCI Projects as a contribution to the Climate Data Records needed by GCOS.

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1.4 Reference Documents

RD-0 Statement of Work of CCI projects. EOP-SEP/SOW/0031-09/S

RD-1 Implementation Plan for the Global Observing System for Climate in support of the UNFCCC, 1992. (WMO/TD No.1219). [GCOS-92].

RD-2 Systematic Observation Requirements for Satellite-based Products for Climate: Supplemental Details to the satellite-based component of the GCOS-IP, 2006. (WMO/TD No.1338). [GCOS-107].

RD-3 Guideline for the Generation of Satellite-based Datasets and Products meeting GCOS Requirements, 2009. (WMO /TD No.1488). [GCOS-128]

RD-4 Satellite Observation of the Climate System – the CEOS response to GCOS IP, 2006.

RD-5 Elements of a Programme Proposal: ESA initiative on Climate Change, 2008. [ESA PBEO(2008)56].

RD-6 Global Monitoring of ECV: Draft Implementation Approach, 2009. [ESA PBEO(2009)32].

RD-7 ESA Climate Change Initiative: First Implementation Steps, 2009. [ESA PBEO(200969].

RD-8 GLOBMODEL reports [http://www.globmodel.info/]

RD-9 Variational bias correction in ERA-Interim, ECMWF newsletter, 2009.

RD-10 Implementation Plan for Global Space Based Intercalibration System (GSICS), 2006.

RD-11 Satellite instrument calibration for measuring global climate change - Report of a Workshop, Ohring G, Wielicki, B; Spencer, R; Emery, B; Datla, R: Bulletin of American Meteorological Society, 2005., 86 (9), 1303– 1313 [DOI:10.1175/BAMS–86–9-1303].

RD-12 AISIC3 workshop report, Achieving Satellite Instrument Calibration for Climate Change [http://www.asic3.sdl.usu.edu/]

RD-13 Quality Assurance Framework for Earth Observation (QA4EO) [http://www.qa4eo.org/]

RD-14 A summary of the CMIP5 experiment design, Taylor, K.; Stouffer, R. ; Meehl, G., 2008.

RD-15 European Research Framework Programme on Climate Change, 2009. EUR2369.

1.6 Acronyms & Abbreviations

CCI Climate Change Initiative

CMUG Climate Modelling User Group

CMIP5 Coupled Model Intercomparison Project (Phase 5)

ECV Essential Climate Variable

GCOS Global Climate Observing System

IPCC Intergovernmental Panel on Climate Change

UNFCCC United National Framework Convention on Climate Change

2. BACKGROUND & OBJECTIVES

2.1 Scope & Objectives of CCI

The overall objective of the CCI, as laid out in the Programme declaration approved by ESA member states is:

"To realize the full potential of the long-term global "Earth Observation" archives that ESA together with its Member states have established over the last thirty years, as a significant and timely contribution to the ECV databases required by UNFCCC".

In particular, the CCI programme aims to deliver a set of "Global Satellite Data Products" as a contribution to the establishment of a long-term Climate Data Record meeting the needs of the GCOS [RD-1-7]. Within the first phase, the CCI will focus on the following sub-set of eleven "Essential Climate Variable" (ECVs) defined by GCOS [RD-2],

	ECV
	Oceanic Domain
O.1	Sea-Ice
O.2	Sea-Level
O.3	Sea-Surface Temperature
O.4	Ocean Colour
	Terrestrial Domain
T.2.1	Glaciers & Ice caps
T.5.1	Land Cover
T.9	Fire Disturbance
	Atmospheric Domain
A.4	Cloud Properties
A.7	Ozone
A.8	Aerosol Properties
A.9	Greenhouse Gases

Table 1: List of Essential Climate Variables targeted within the first phase of CCI and associated climate products.

and be implemented via a series of twelve parallel contracts, each targeting a specific user community, comprising:

- Eleven contracts for production of Global Satellite Data Products (one per ECV), referred here as "CCI Projects", addressing the thematic needs of "Climate Research Groups".

- One integration contract, referred here as "Climate Modelling User Group" (CMUG), established to bring a *climate system perspective* within the programme and to provide a *forum* platform for the "Climate Modelling Community" and data community to work closely together.

2.2 Scope & Objectives of CMUG

The rationale for CMUG lies in the need for ***integration*** across thematic projects focussing on one single ECV, which was recommended by the CCI "Climate Scientific Advisory Body" and the "ESA's Earth Science Advisory Committee".

The overall objectives of CMUG are threefold:

(1) Support integration within the CCI programme by providing ESA and CCI Projects with (i) requirements and user assessment from the Climate Modelling Community and (ii) feedback from a "climate system" perspective (e.g. examining consistencies across ECVs, synergies / overlap within production system, climate constraints to be ensured).

(2) Foster the exploitation of Global Satellite Data Products within the Climate Modelling Community by (i) promoting the use of CCI data sets to climate modellers and (ii) by building partnership and links with existing research organisations, networks and scientific bodies of the Climate Modelling Community.

(3) Assess quality and impact of individual/combined Global Satellite Data Products in Climate Model and Data Assimilation context by (i) assessing suitability of products for climate applications (e.g. climate modelling, decadal prediction, reanalysis, etc), and by (ii) quantifying their incremental value on model performances in an objective manner.

2.3 Logic of the Work

CMUG activities ***shall*** contribute to the overall integrated approach of the CCI by building appropriate two-ways interfaces between CCI Projects and the Climate Modelling Community as illustrated in Figure 1.

In particular, CMUG ***shall*** provide *feedback* to ESA and CCI Projects at various levels including at least:

- Data requirements and priority needs from the Climate Modelling Community (reflecting a consensus view of the whole community) and ensuring that specifications of products delivered by CCI Projects meet user needs.
- Validation activities, providing additional *scrutiny* on the process through an integrated "climate system" view, and providing complementary consistency check through models.
- User assessment activities, providing also quantitative information on the impact of Global Satellite data Products within Climate Models.
- Synergy with existing climate research activities and networks.

This feedback ***shall*** be provided through a series of technical notes described in Appendix 1 along a sequential approach described in Appendix 2. It is worth stressing that the feedback provided by CMUG has *no contractual* implications for CCI Projects (e.g. it is not part of a formal review for approval of CCI Project's deliverables).

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Also, CMUG ***shall*** design and implement mechanisms to link with the whole Climate Modelling Community, including organisations, networks, international modelling programmes like “Coupled Model Intercomparison Project Phase 5” (CMIP5) and scientific bodies and the “Intergovernmental Panel for Climate Change” (IPCC), in order to:

- Gather their *requirements* for Global Satellite Data Products and tools to exploit these data sets within Climate Models.
- Provide a *forum* to the whole community to foster the exploitation of Global Satellite Data Products within Climate Models.
- Assess the *value* of Global Satellite Data Products for the community and impact of performances of models.

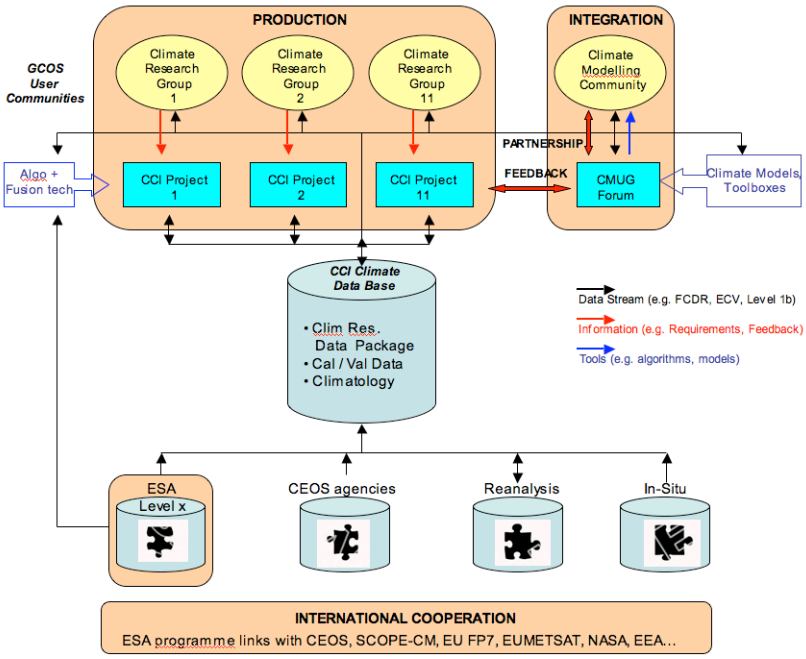

Figure 1: Schematic describing the contribution of the CCI programme to the establishment of long-term stable Climate Data Record. To ensure integration, CMUG will incorporate within the CCI organisational framework (i) an element of feedback from user communities, and (ii) an element of partnership with the key actors in the climate change research community, by building links and interfaces to enable them to work closely with the data community. The black, red and blue arrows correspond to flow of data (e.g. Global Satellite Data Products, validation data), information (e.g. review, feedback, requirements), and tools (e.g. toolboxes), respectively.

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3. WORK TO BE PERFORMED

In order to achieve the objectives of CMUG, the following tasks ***shall*** be executed:

1. *Scientific Requirements Analysis*
2. *Support Technical Feedback*
3. *Integration and Assessment of Global Satellite Data Products in Model context*
4. *Scientific Exploitation by the Climate Modelling Community*
5. *Project Management*

Each task detailed below addresses variables of Table 1 and is associated with a set of deliverables detailed in Appendix 1 (underline deliverables shall be revised during the project) and a schedule detailed in Table 2.

The methodology and modelling tools used in Task 3 shall first be "proofed" in the beginning of the second year by using existing "Precursor Products" addressing at least 2 ECVs of Table 1 (e.g. data sets from GLOB series for Ocean Colour, Aerosol, or other climate satellite-based data sets).

3.1 Task 1: Scientific Requirements Analysis

OBJECTIVES:

- Provide a high-level description of the main structure and data needs of the Climate Modelling Community.
- Specify in details the requirements of the Climate Modelling Community in terms of observational climate products related to ECV of Table 1. This will be used as input to CCI Projects for production of Global Satellite Data Products.
- Specify requirements for data exploitation tools, such as Observation Operators, needed to facilitate the integration of Global Satellite Data Products within Climate Models.

INPUTS:
RD-0, RD-8.

TASKS:

- Identify the main user groups, networks, scientific bodies representing the Climate Modelling Community and their high-level needs in terms of data for *all* ECV with significant satellite components.
- Specify in details the data requirements of the Climate Modelling Community based on GCOS requirements and assess their feasibility.
- Specify in details Observation Operators needed to enable modellers to compare Climate Model outputs with observations.
- Conduct interviews / surveys with key climate modelling centres to ensure that requirements reflect the view of the whole community (and not only CMUG).
- Organise workshops with key climate modelling actors to get community endorsement of requirements.
- Provide CCI Projects with access to reanalysis data they need as input to generate the Global Satellite Data Products (e.g. input to retrieval scheme, atmospheric correction).

OUTPUTS:
D1.1 Profile and Needs of the Climate Modelling Community.
D1.2 Requirement Baseline Document.

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3.2 Task 2: Support Technical Feedback

OBJECTIVES:

- Provide a climate-system perspective to the CCI programme.
- Support technical review of some outputs from CCI Projects.

INPUTS:
RD-0, D1.2, CCI Project's deliverables identified in Appendix 2.

TASKS:

- Review some of the deliverables of *all* 11 CCI Projects (identified in Appendix 2), and provide feedback to ESA with regard to user specifications, data definitions, reference data sets, data output products, validation activities, user manual, and impact assessment activities.
- Attend key meetings (identified in Section 5) to provide feedback to CCI Projects science team.
- Convene and organise integration meetings with the 11 CCI Project's teams to discuss issues and opportunities for synergy in production and validation activities of Global Satellite Data Products, and climate constraints to ensure between individual products, and opportunities for synergy with existing activities in climate research in Europe.

Please note that the "Technical Notes" are feedback and have no contractual implications for CCI Projects. Also, although the deliverables of this task address only CCI Project documents identified in Appendix 2, the CMUG team has access to *all* CCI Projects' documents and is therefore free to comment on any of them if deemed useful (e.g. algorithms development, round robin protocol).

OUTPUTS:
D2.1 Technical Note on User Requirement and Specifications.
D2.2 Technical Note on System Prototyping.
D2.3 Technical Note on Final Product Validation and User Assessment.

3.3 Task 3: Integration and Assessment of Global Satellite Data Products in Model context

OBJECTIVES:

- Foster the use of Global Satellite Data Products within Climate Models.
- Assess suitability of individual / combined satellite products for climate applications (e.g. consistency, stability, quality).
- Validate methodology to assess suitability on a data set of Precursor Products.
- Quantify impact and usefulness of individual/multiple satellite products for Climate Modellers.

INPUTS:
Satellite Data Precursor Products, CCI Projects' Climate Data Package.

TASKS:

- Foster integration of Global Satellite Data Products within Climate Models, with particular focus on model evaluation, and CMIP-5 [RD-14].
- Assess *consistency* of Global Satellite Data Products in *time* (e.g. stability, issue of bias error) and *across ECVs* (e.g. Cloud, Aerosol, fire disturbance), in particular by checking they reproduce properly the main climate *processes* (e.g. Enso, Ozone hole, volcanic eruption), and are able to capture climate variability and small climate change signals (e.g. observed trends). The assessment shall be performed with a holistic climate system view (e.g. checking feedback processes, El Nino Southern Oscillation tele-

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connections) and follow best-practices / guidelines for validation of climate data sets [RD-10/13].
- Characterize quality of Global Satellite Data Products in Model and Data Assimilation System context (when possible).
- Proof methodology for suitability check on "Precursor Products" taken from existing data sets addressing at least 2 ECVs of Table 1.
- Gather feedback from climate modellers on the use of products.
- Quantify sensitivity of models to the Global Satellite Data Products (individual and multivariate data sets) by performing Observing System Experiments.

OUTPUTS:
D3.1 Quality Assessment Report.
D3.2 User Assessment Report.

3.4 Task 4: Scientific Exploitation by the Climate Modelling Community

OBJECTIVES:
- Foster take-up of Global Satellite Data Products by the Climate Modelling Community.
- Increase awareness about climate products generated by the CCI and their value for modellers.

INPUTS:
D1.1, D1.2, D3.1, D3.2, CCI Projects' deliverables, RD-15.

TASKS:
- Promote the use of Global Satellite Data Products to the research community worldwide, with particular focus on European community modelling framework (e.g. NEMO – Nucleus for European Modelling of the Ocean), and community inter-comparison initiatives (e.g. CMIP-5) in order to maximise outreach.
- Design and Implement appropriate mechanisms / interfaces to link to the wide Climate Modelling Community and key actors to foster wide use of data sets into models.
- Promote actively results to the IPCC in support of their future assessment.
- Organise workshop with key climate modelling actors to promote the CCI and foster the use of Global Satellite Data Products within models.
- Propose new routes for enhanced exploitation of Global Satellite Data Products, including activities in Data Assimilation, impact assessment and exploitation of ECV outside Table 1.

OUTPUTS:
D4.1 Scientific Exploitation Plan.
D4.2 Scientific Exploitation Report.
D4.3 Promotion Package.

3.5 Task 5: Project Management

OBJECTIVE:
- Ensure the project is implemented in a coherent and effective manner.
- Ensure that effective links / interfaces are properly built with the relevant actors.

INPUTS:
Proposal.

TASKS:

- Manage the overall activity to ensure that the Tasks are executed in a coherent, consistent and efficient manner.
- Monitor progress of each Task, identify potential delays and ensure adequate mitigation measures are put in place, ensure timely submission of all deliverables.
- Provide monthly progress reports to ESA and Minutes of meeting.
- Attend progress meetings and ensure attendance by all necessary project team members.
- Coordinate with all relevant partners and actors of the wider community.
- Ensure feedback mechanisms with the Climate Modelling Community.
- Provide work plan to achieve the objectives of the CMUG.

OUTPUTS:
D5.1 Monthly Progress Report.
D5.2 Quaterly Progress Report.
D5.3 Minutes of Meetings.
D5.4 Project Management Plan.
D5.5 Project Web Site.

4. MANAGEMENT

The Contractor shall nominate a “Project Manager” who will be the sole interface with ESA for the duration of the project.

The Project Manager ***shall***:

- Manage the *overall activity* to meet the objectives of CMUG and ensure that all tasks are executed in a coherent, consistent and efficient manner and all deliverables are provided to ESA. He shall be responsible for the implementation of Task 6, monitor progress of each task, ensure timeliness and quality of all deliverables and organize and attend progress meetings.

- Be responsible for the *coordination* of appropriate *interfaces* and *linkages* with the Climate Modelling Community, making sure that the CMUG team operates as a forum platform and captures the views of the whole community (and not only the view of the CMUG team). The interactions of CMUG with the CCI projects will be performed through ESA.

- Ensure that the necessary expertise is available in the consortium to perform all the tasks, if some specific competencies (e.g. models, communications), or tools are deemed to be missing in the team, the Project Manager shall pro-actively bring them to the consortium through dedicated consultants.

- Lead the organisation of workshops with the Climate Modelling Community and dedicated integration meetings with the CCI Projects.

5. MEETINGS

5.1 Meeting Types

At least one representative of the CMUG consortium ***shall*** participate in the following types of meetings during the duration of the project:

- *Contract Progress Meeting with ESA*
  - Status review
- *Scientific Workshops*
  - Exchanging views with the Climate Modelling Community
- *Integration Meetings*
  - Exchange with key personnel from all CCI Projects
- *Co-location Periods*
  - Orientation, information exchange & coordination with key personnel from all CCI Projects

The role, duration and locations of meetings are further described below. The number, dates and place of meetings, and participation are to be interpreted as an *indicative baseline*, which can be adapted according to needs emerging during the project (e.g. revised schedule of integration meetings). The team ***shall*** optimise meeting timing (e.g. getting meeting back to back) and locations in order to minimise travel and use video-conferencing, teleconferencing, and internet-based-meeting facilities (e.g. wiki, webex) as much as possible, and make *carbon-neutral* travel (e.g. compensation of emissions). All arrangements (e.g. venue, logistics, agenda, participants) for the contract meetings, workshops and integration meetings will be made by the Project Manager subject to approval from ESA. The Project Manager ***shall*** chair all progress and integration meetings, provide all minutes, ensure all actions raised during the meetings are promptly recorded in the Actions Database of the Project Management Plan, provide a report for scientific workshops and post it for comments on the web site.

5.2 Contract Progress Meetings

The Project Manager ***shall*** organise the following contract meetings of *one day* every *three* months between ESA and the whole CMUG team in order to assess status of deliverables and contract milestones:

- Kick-Off meeting in ESRIN.
- Progress Meeting 1 by teleconference.
- Progress Meeting 2 at contractor premises.
- Progress Meeting 3 by teleconference.
- Annual Review 1 in ESRIN.
- Progress Meeting 4 by teleconference.
- Progress Meeting 5 at contractor premises.
- Progress Meeting 6 by teleconference.
- Annual Review 2 in ESRIN.
- Progress Meeting 7 by teleconference.
- Progress Meeting 8 at contractor premises.
- Progress Meeting 9 by teleconference.
- Final Review in ESRIN.

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Based on the outcome of the annual review, the contractor shall update the Project Management Plan and Scientific Exploitation Plan, which will form the basis to move the following year.

5.3 Scientific Workshops

The Project Manager and the team ***shall*** organise the following scientific workshops of *one to two days* with key representatives of the *international* Climate Modelling Community (travel expenses of key experts / speakers ***shall*** be supported by CMUG project):

- Scientific Workshop 1, (year one) addressing issues related to the exploitation of Global Satellite Data Products within Climate Models and getting the endorsement of requirements of the community.
- Scientific Workshop 2, (year three) addressing the value and impact of ECV data set for the community.

These workshops will be held in contractor premises or in conjunction with other international Earth Science meetings (e.g. European Geophysical Union) in order to optimise attendance and minimise cost.

5.4 Integration Meetings

The Project Manager and the team ***shall*** organise the following *bi-annual* Integration Meetings of *one day* in order to bring together the relevant representatives of the CCI Projects (travel supported by the CCI Projects) and discuss issues from a climate perspective:

- Integration Meeting 1, in the process of the requirement phase.
- Integration Meeting 2, in the end of the requirement phase.
- Integration Meeting 3, in the process of the algorithm development phase.
- Integration Meeting 4, in the conclusion of the algorithm development phase.
- Integration Meeting 5, for preparation of the next stage.
- Integration Meeting 6, to review exploitation activities.

These meetings will be held according to needs at the contractor facilities.

5.5 Co-location Working Periods

At least one representative of the CMUG team ***shall*** attend the four co-location periods of *three days* (including *one day* for communication to stakeholders) held in ESRIN in order to meet with key personnel from all CCI Projects (in particular from the Science Teams), get information on progress and provide feedback. The co-location period bring all the CCI Projects together to firmly establish the scientific coherency between the projects, and to ensure inter-consortia coordination, consolidate common approaches, and mobilize the multi-disciplinary scientific expertise available within the various teams. They also play a key role of communication to ESA delegates and climate stakeholders.

- Co-location 1, address consistency in requirements and specifications.
- Co-location 2, address achievable performance with existing algorithms and algorithms selection.
- Co-location 3, assessment of performance of ECV products.
- Co-location 4, assessment of climate trends and model outputs.

6. SCHEDULE

The project shall be carried out within 36 months from the Kick-Off date, associated with the following the *indicative* schedule (assuming CMUG Projects start early 2010). Several Tasks shall be run in parallel.

6.1 Schedule for Deliverables

Ref	Name of CMUG Deliverable	m01	m02	m03	m04	m05	m06	m07	m08	m09	m10	m11	m12	m13	m14	m15	m16	m17	m18	m19	m20	m21	m22	m23	m24	m25	m26	m27	m28	m29	m30	m31	m32	m33	m34	m35	m36
Task 1	***Scientific Requirement Analysis***																																				
D1.1	Profile & Needs of the Climate Modelling Community	X																																			
D1.2	Requirement Baseline Document		X																																		
Task 2	***Support Technical Feedback***																																				
D2.1	Tech Note on User Req & Specifications					X																															
D2.2	Tech Note on System Prototyping																				X																
D2.3	Tech Note on Validation & User Assessment																																			X	
Task 3	***Integration & Assessment of Satellite Products in Model context***																																				
D3.1	Quality Assessment Report															X																					X
D3.2	User Assessment Report																																				X
Task 4	***Scientific Exploitation by Climate Mod Community***																																				
D4.1	Scientific Exploitation Plan			X								X												X													
D4.2	Scientific Exploitation Report											X												X													X
D4.3	Promotion Package																	X												X						
Task 5	***Project Management***																																				
D5.1	Monthly Progress Report	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
D5.2	Quaterly Progress Report						X						X						X						X						X						X
D5.3	Minutes of Meeting	X	X	X	X		X			X		X	X			X			X			X			X	X	X				X			X			X
D5.4	Project Management Plan	X										X												X													
D5.5	Project Web Site			X														X												X						X

Table 2: Schedule of Tasks and Deliverables

6.2 Schedule for Meetings

Duration	Meeting Type	m01	m02	m03	m04	m05	m06	m07	m08	m09	m10	m11	m12	m13	m14	m15	m16	m17	m18	m19	m20	m21	m22	m23	m24	m25	m26	m27	m28	m29	m30	m31	m32	m33	m34	m35	m36
	Contract Meetings with ESA																																				
# 4 / 1d	KickOff / Annual / Final meeting in ESA premises	X										X												X													X
# 6 / 1d	Progress Meeting by Teleconf			X						X						X						X						X						X			
# 3 / 1d	Progress Meeting at contractor premises						X												X												X						
	Meetings with Climate Modelling Community																																				
# 1 / 2d	Workshop 1 at contractor premises or int conference				X																																
# 1 / 2d	Workshop 2 at contractor premises or int conference																																			X	
	Meetings with CCI Projects																																				
# 6 / 1d	Integration Meeting at contractor premises						X					X							X			X					X									X	
# 4 / 3d	Colocation meeting in ESRIN			X												X												X							X		

Table 3: Schedule of Meetings.

6.3 Schedule for Milestones

Date	Milestone	Milestone Description
KO	M1	Contract Kick-Off
KO+6	M2	Delivery and acceptance of D4.1 (v1), D1.1, D1.2, D2.1
KO+12	M3	Delivery and acceptance of D4.1 (v2), D4.2 (v1), D5.4 (v1)
KO+18	M4	Delivery and acceptance of D3.1 (v1), D4.3 (v1)
KO+24	M5	Delivery and acceptance of D4.1 (v3), D4.2 (v2), D5.4 (v2), D2.2
KO+30	M6	Delivery and acceptance of D4.3 (v2), D5.5
KO+36	M7	Delivery and acceptance of D2.3, D3.1 (v2), D3.2, D4.2 (v3)

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APPENDIX 1: DELIVERABLES of CMUG

All deliverables ***shall*** be *concise,* clear, comprehensive, and self-contained documents and be delivered to ESA. In addition, some of the documents ***shall*** also be delivered to CCI Projects and/or Climate Modelling Community as specified below. The schedule of delivery is described in Table 2. *Note that some deliverables (underlined below)* ***shall*** *be updated several times.* The list of deliverables from CCI Projects is presented in Table 3 and the interactions between CMUG and CCI Projects described in Table 4 of Appendix 2.

All deliverables ***shall*** be subject to approval by ESA. Any documents rejected by ESA ***shall*** be revised by the Contractor, addressing all problems raised, and an updated version delivered to ESA within one month. Documents to be reviewed at progress meetings shall be delivered to ESA, at least one week in advance of the meeting.

D1.1 Profile & Needs of the Climate Modelling Community

This document ***shall*** provide a high-level description of the key and relevant actors of the Climate Modelling Community, the models they use and their needs in terms of data sets (in particular addressing *all* ECV with significant satellite component). This document is intended to provide ESA with the *big picture* of the Climate Modelling Community structure and needs, a baseline to measure future take-up of Global Satellite Data Products, and a way to quantify of the relative role and importance of ECVs for climate modelling (providing a basis for future activities).

The document ***shall*** include at least:

- A breakdown and profile of the Climate Modelling Community, and any other actor deemed relevant for the CMUG project, including CMUG partners and other main climate modelling groups (Europe and worldwide), the IPCC, scientific bodies (e.g. WMO – World Meteorological Organisation), programmes (e.g. WCRP – World Climate Research Programme, with focus on particular working groups like WOAP and WGCM, CMIP5, IGBP – International Geosphere-Biosphere Programme), and networks (e.g. CM-SAF - EUMETSAT Satellite Application Facility for Climate Monitoring, IS-ENES – Infrastructure for the European Network for Earth System Modelling, METAFOR - Common Metadata for Climate Modelling Digital Repositories, CLMC - Climate Limited Modelling Community, CLISAP - Integrated Climate System Analysis and Prediction), and other relevant EC projects on Climate Change [RD-14]).
- A mailing list of key experts – namely climate modellers in charge of managing, operating or designing Climate Models - from the main climate modelling centres, from which feedback will be gathered.
- A brief description (including a synthetic table) of the main *European Climate Models*, used for global and regional climate modelling, their components, resolution, community usage (e.g. model/ platform shared by different groups) and relative importance regarding contribution to IPCC.
- A high-level description of the *data needs* (e.g. parameters, sampling requirements) of the Climate Modelling Community for all ECVs (not only of Table 1), describing briefly their use (e.g. initialisation, model evaluation, forcing, boundary condition), existing data sets (e.g. HOAPS - Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data), relative impact (e.g. setting priorities for ECV portfolio) and critical data gaps.
- A copy of the interviews and surveys performed to gather the necessary information (and complementing existing surveys such as the one performed by the WCRP).

Target: Climate Modelling Community

D1.2 Requirement Baseline Document

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This document ***shall*** provide a *detailed* description of the requirements of the Climate Modelling Community in terms of data needs (associated with the 11 ECVs of Table 1) and data tools (mainly Observation Operators). It is intended as an input to CCI Projects and includes two main parts:

- Part I on data requirements ***shall*** be integrated by the CCI projects during Phase 1 (user requirement) to complement and refine their specifications of the satellite products they deliver.
- Part II on data tools requirements is more of an informative nature and, could be used either by CCI Projects during Phase 2 (algorithms development) to optimise their software and turn them into an Observation Operator, or simply form the basis for future algorithm development activities (outside CMUG but where CMUG could play a role of integration within the framework of "Cloud Feedback Model Intercomparison Project Observational Simulator Package" (COSP).

In particular, Part I of the document ***shall*** specify the following attributes of for Global Satellite Data Products, taking GCOS requirements as a starting point:

- Parameters of interest, their level of processing (e.g. radiance, geophysical variable),
- Required (and minimum acceptable) accuracy, stability and error characteristics.
- Expected and minimum resolution and coverage in time (observation cycle) and space.
- Required format, metadata, grid and projection.
- Quality flags and indicators.
- Traceability of information (e.g. which user, for which application).

and include a brief discussion of the:

- Methodology for setting up requirements (in particular regarding stability and accuracy which are essential for climate studies), by providing quantitative information on the climate signal to be observed and model noise, and by discussing the process of translation of requirements from the parameter (to estimate) to the observable (measured by the instrument) along the line of [RD-11/13].
- Feasibility of achieving these requirements with satellite observations.

Part II of the document ***shall*** provide specifications of a set of "Observation Operators" (i.e. software providing a model equivalent of the satellite observations), which would be needed by the Climate Modelling Community to better integrate the data streams into their models.

Target: CCI Projects

D2.1 Technical Note on Requirement Analysis & Product Specifications

This document ***shall*** provide comments, technical advise on some of the CCI Projects Task 1 deliverables, including "User Requirement Document" and "Product Specification Document". This document is intended as a feedback to CCI Projects (not part of a formal review).

Some of the questions to be addressed are:

- Are the user requirements complete and representative of the wide community?
- Do they build on GCOS requirements? Are they feasible?
- Do the specifications of the products reflect the needs of user communities?
- How sound is the methodology to gather requirements and transform them into specifications of ECVs?

Target: CCI Projects

D2.2 Technical Note on System Prototyping & ECV Production

This document ***shall*** provide comments, technical advise on the "Product User Guide". This document is intended as a feedback to CCI Projects (not part of a formal review).

Some of the questions to be addressed are:
- Is the system delivering sensible products meeting the needs of user communities?
- Is the Product User Guide comprehensive and rigorous?
- Is the software usable as an Observation Operator? If not, what needs to be developed ?

Target: CCI Projects

D2.3 Technical Note on Final Product Validation and User Assessment
This document ***shall*** provide comments, technical advise on some of the CCI Projects Task 4 deliverables, including the "Product Validation Protocol", "Product Validation and inter-comparison Report", and "Climate Assessment Report". This document is intended as a feedback to CCI Projects (not part of a formal review).

Some of the questions to be addressed are:
- Are the error characteristics provided by CCI Projects compatible with D3.1 (v2)?
- What are the different components of the uncertainty?
- Is the user assessment complete and representative of the wider community?
- What is the impact of the CCI programme for the community?
- Is the user assessment from CCI Projects consistent with the user assessment from CMUG?

Target: CCI Projects

D3.1 Quality Assessment Report
This document ***shall*** describe the assessment of suitability of the Global Satellite Data Products for climate applications, such as Climate Modelling, Decadal Prediction and Reanalysis, including at least quantitative information on:
- Consistency and stability of individual and multivariate data sets (e.g. trend analysis).
- Ability to capture climate variability and climate change signal.
- Quality of the products, and associated error characteristics provided by CCI Projects.

Two versions ***shall*** be provided including:
- Version 1 addressing "Precursor Products" taken from existing data sets (e.g. Glob series, other climate data sets), and providing a *quick* analysis of the suitability and value of products for at least 2 ECVs of Table 1 (to be defined by the team). This is a light report mainly intended as a proof the methodology.
- Version 2 addressing the "Final Products" delivered by the CCI Projects, and providing a *comprehensive* analysis for all 11 ECVs of Table 1.

Target: CCI Projects

D3.2 User Assessment Report
This document ***shall*** describe the and include at least the following information:
- Feedback of users from the Climate Modelling Community on the products (e.g. utility assessment form, quotes from a variety of users), and their contribution to potential improvement of model performances.
- Results of sensitivity tests and Observing System Experiments providing a quantitative analysis of the incremental impact of (single and combined) data streams.

Target: CCI Projects, Climate Modelling Community

D4.1 Scientific Exploitation Plan
This document ***shall*** briefly including the following plans:
- *"Science Plan"* describing the scientific activities to be undertaken to foster use of Global Satellite Data Products (e.g. publication, organization of workshops, participation in advisory board, list of events to

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attend, material to produce, special report of IPCC on observations). In particular, a list of events to be organised by the Project Manager to address the Climate Modelling Community and promote the use of products within Climate Models.

- *"Forum Strategy"* describing the links, and mechanisms of interaction and consultation (e.g. interview, surveys) between CMUG and the wide Climate Modelling Community, identified in D1.1 to ensure that CMUG acts as a true "forum" to the wider community. Suggestion shall be made on the most effective mechanism for interacting with the community (e.g. through WCRP working groups).
- *"Experiment Design"* describing all the model experiments, including assimilation and sensitivity experiments to be performed to quantify error and impact, and discussion of the impact measure / metrics.
- *"Quality Assessment Plan"* describing the actions to be performed to assess the suitability of Global Satellite Data Products for climate applications, consistency in *time* and *across* ECVs (with particular interest in the bias error) and the exploitation of Precursor Products to validate the methodology and tools exploited by CMUG (e.g. description of the Precursor Data set addressing at least two variables of Table 1).
- *"Exploitation Roadmap"* for possible future activities to be performed (in Stage 2) to foster exploitation of the wide ECV portfolio (including *all* ECVs with strong satellite component and usefulness for Climate Models, also outside the ECVs of Table 1) to the Climate Modelling Community, including data assimilation studies (e.g. study to be described), development of data toolboxes (e.g. design of new observation operators), new federation or promotional activities (e.g. working group on satellite observations in support of IPCC). This section shall provide (by the end of year 1) *detailed* requirements towards future activities in the CCI programme.
- *"Communication Plan"* containing all communication actions towards the Climate Modelling Community in general, and key actors in particular the IPCC (e.g. IPCC Education Office), including generation of brochures, peer-reviewed publications, web sites, presentations, list of events to attend (e.g. conferences), training to organise, list of promotional and e-learning material to generate (including a video podcast).

This document is a living document revised on an annual basis, taking account of progress in CMUG and CCI Projects activities.

D4.2 Scientific Exploitation Report

This document ***shall*** contain a summary report describing the activities of CMUG, and provides a quantitative analysis the status of uptake of the ECV portfolio by the Climate Modelling Community. It is a living document to be revised on a regular basis.

D4.3 Promotion Package

This deliverable ***shall*** include all the promotional & e-learning material generated according to the Communication Plan. This material shall be made available on the public web site. Various versions shall be delivered according to development of new material.

Target: Climate Modelling Community, CCI Projects

D5.1 Monthly Progress Report

This document ***shall*** include a summary of progress during the reporting period (e.g. progress in each Work Package, description of any difficulties, list of events attended, publications), management activities, the status of deliverables, and actions being implemented and indication of activities to be completed.

D5.2 Quaterly Progress Report

This document ***shall*** briefly summarise (maximum 2 pages) for a non-expert audience, the major progress (e.g. results, achievements, highlight, publications, communication activities, international cooperation activities) and problems within the project over the previous three months and the plan for the next upcoming three months.

D5.3 Minutes of Meetings.
The Minutes of Meetings (fo all meetings described in section 5) ***shall*** be prepared by the project Manager and be made available to ESA no later than 7 days after the meeting.

D5.4 Project Management Plan
This document ***shall*** include a description of the project organisation (e.g. work breakdown structure, Gantt charts, work package descriptions including task leaders and level of effort per work package, resources, travel plan and budget, communications, data base of actions, document review cycle, analyses of risk factors and mitigation strategies), to be undertaken to meet the objectives of the project and address challenges. A full and revised version of this plan shall be prepared and presented at least one month before the annual review, and shall be finalised after the annula review taking account of comments made at the review.

D5.5 Project Web Site
A project web site ***shall*** be set up (reserving web address such as www.cci-cmug.org or similar) and maintained for at least the duration of the project, including the following parts:

- Public web site providing general information about the project (e.g. objectives, project description, schedule, consortium members, Climate Modelling Community, deliverables, mailing list), links to access CCI data, links to access data exploitation tools (for manipulation, analysis of long-term climate satellite data records and confrontation with model outputs).
- Private web site (password protected) used as a management tool to store and access document deliverables (all versions), Minutes of Meeting, Monthly Reports, including comments raised by ESA and users and provide access to collaborative tools (e.g. wiki, webex) if needed.

Target: Climate Modelling Community, CCI Projects

APPENDIX 2: DELIVERABLES of CCI PROJECTS & INTERFACES

The CCI Project contracts ***shall*** be carried out in 36 months in three Phases along the schedule described in Table 4 below.

Task	Code	Deliverable	Stage 1: Requirements analysis & specs, algo development, inter-comparison & selection				Stage 2: System prototyping and ECV production				Stage 3: Final product validation & user assessment			
			Year 1				Year 2				Year 3			
		Title	KO +3	KO +6	KO +9	KO +12	KO +15	KO +18	KO +21	KO +24	KO +27	KO +30	KO +33	KO +36
Requirements Analysis & Prod. Specs	D1.1	User Requirements Document	*											
	D1.2	Product. Specification Document		*										
	D1.3	Data Access Requirements Doc.	*											
Algorithm Development, Intercomparison and Selection	D2.1	Product Validation Plan		*										
	D2.2	Database for Task 2		*										
	D2.3	ATBD v0		*										
	D2.4	Round-Robin Data Package			*									
	D2.5	Prod. Val. & Algo Selection Rep			*									
	D2.6	ATBD v1					*							
	D2.7	DPM v1					*							
	D2.8	IODD v1					*							
System Protoyping & ECV Production	D3.1	System Prototype Description						*						
	D3.2	System Verification Report						*						
	D3.3	Database for Task 3						*						
	D3.4	Product User Guide								*				
	D3.5	Climate Research Data Package								*				
	D3.6	ATBD v2							*					
	D3.7	DPM v2							*					
	D3.8	IODD v2							*					
Final Prod. Val & User Assess.	D4.1	Prod. Val. & Intercomp. Report											*	
	D4.2	Climate Assessment Report												*
System Specification	D5.1	System Requirements Document			*									
	D5.2	System Specification Doc V0				*								
	D5.3	System Specification Doc V1							*					

Table 4: List of deliverables of CCI Projects where deliverables relevant for CMUG are highlighted in yellow.

All CCI Projects deliverables ***shall*** be made available to CMUG, which is free to provide rapid comment on any of them. However, CMUG ***shall*** provide detailed technical notes on the following subset of deliverables:

- D1.1: User Requirement Document
- D1.2: Product Specifications
- D3.5: Product User Guide
- D4.1: Product Validation & Inter-comparison Report
- D4.2: Climate Assessment Report

It is worth noting that these technical notes have no contractual implications for CCI Projects.

The sequential approach of exchange of document is illustrated in Table 5. The data stream are not taken into account here, it is assumed that CMUG will be given access to the main database including all Global Satellite Data Products.

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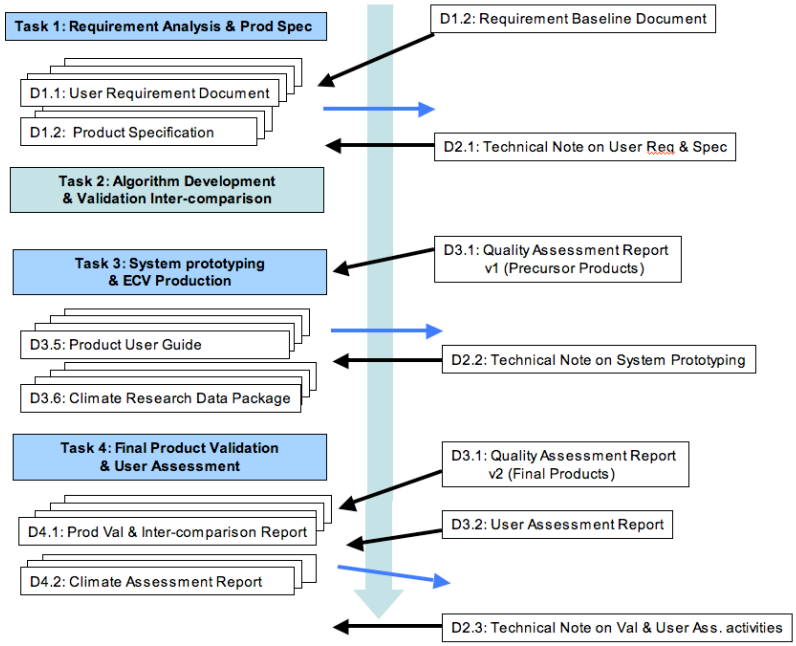

Table 5: Interfaces between CCI Projects (left panel) and CMUG (right panel) showing the sequence of deliverables exchange.