Implementation of CCI+ phase 1 – status

Susanne Mecklenburg,
CCI+ mid-term review
26 November 2020
Focal point for climate activities in ESA

- Implement the **Climate Change Initiative (CCI) Programme** – our flagship programme
- Working on **international (policy) level** with EU, Copernicus Services, ECMWF, EUMETSAT, UNFCCC, IPCC, GCOS, CEOS, CGMS, WCRP, WMO, Future Earth, SCO etc
- Observer at **IPCC/UNFCCC**
THE MISSION
From ESA/PB-EO(2017)11, rev.2, CCI+ Implementation Plan

“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 Essential Climate Variable (ECV) databases required by the United Nations Framework Convention on Climate Change (UNFCCC).

It will ensure that full capital is derived from on-going and planned ESA missions for climate purposes, including ERS, Envisat, the Earth Explorer missions, relevant ESA-managed archives of Third-Party Mission data and, in due course, the [Copernicus] Space Component.

Retaining these same objectives, CCI+ aims to continue the successful achievements of CCI to date on the research, development and qualification of pre-operational ECV products and processing systems, and promote their transfer to operational production outside ESA.”

➔ FOCUS is on R&D: innovation & pre-operational developments

An example

1st merged (SMOS-SMAP-Aquarius) salinity dataset from space: 2010-2018

Unprecedented global view of salinity, crucial for modelling ocean circulation + monitoring the marine environment

ESA - NASA collaboration
THE DRIVERS

- **GCOS** as the primary source of requirements for ECV and their performance goals
- Climate Science Advisory Board (**CSAB**) providing advice on CCI+ implementation and the link to international climate science programmes
- International coordination with/ contribution to the international response of Space Agencies to GCOS via the Joint **CEOS/CGMS Working Group on Climate**
- Strong link to **operational climate services**, foster uptake of CCI in climate services
- **International collaboration and coordination**
  - International climate research and policy networks
  - EU and national research programmes
  - National space agencies
  - End-user organisations in ESA member states
- Close link to the **international climate modelling community**: Coupled Model Inter-comparison Project (CMIP)

Some representation on panel discussion this afternoon
THE IMPLEMENTATION: current status

WMO defined **54** Essential Climate Variables

**36** benefit from space observations

**21** generated by ESA Climate Change Initiative

climate.esa.int
THE IMPLEMENTATION: current contractual structure

THEME 1: New Essential Climate Variables
9 ECVs addressed: Water Vapour, Salinity, Sea State, Snow, Permafrost, HR Land Cover, Lakes, Biomass, Land Surface Temperature

THEME ii) Additional R&D on ECVs included in CCI
13 ECVs addressed: Aerosol, Cloud, Fire, Glaciers, GHG, Ice sheet Antarctica, Ice Sheet Greenland, Land Cover, Ocean Colour, Ozone, Sea Ice, Sea Level, Sea Surface Temperature Soil Moisture

THEME iii) Cross-ECVs
Climate Modelling User Group, IMBIE project office, SLBC, RECCAP-2, 1st CCI Fellowship call

THEME iv) Knowledge Exchange
Open data portal, communication, education, webpage and App, toolbox

Preparing the new climate programme
EO support for UNFCCC Paris Agreement

Scientific highlights and overview on activities in ...
Agenda #2.1: ocean – cryosphere – land – atmosphere; posters online
Agenda #2.2, posters online
Agenda #2.3, video on Climate from Space App
Agenda #3.1
## IMPLEMENTATION STATUS OF CCI+ PHASE 1

<table>
<thead>
<tr>
<th>Contract</th>
<th>CCI+ phase 1 Start</th>
<th>End</th>
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<tr>
<td>Theme i) New ECVs and additional activities</td>
<td>mid 2018</td>
<td>mid-2021</td>
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<td>Theme ii) R&amp;D for existing ECVs</td>
<td>Q2/3-2019</td>
<td>mid 2022</td>
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<td>Theme iii) Cross-ECV</td>
<td>CMUG 10-2018 04-2020 06-2020 Q1 2021 Q1 2024 TBC</td>
<td>IMBIE PO ITT in Q4 2020 2020 RECCAP-2 CCI fellowship 1st call (May 2020) 09-2022 03-2023 +2 years 12-2021 2 years 2 years</td>
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<tr>
<td>Theme iv) Knowledge Exchange</td>
<td>09-2019</td>
<td>08-2022</td>
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<tr>
<td>Preparing for new climate programme</td>
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![Diagram showing implementation status of CCI+ Phase 1](https://example.com/diagram.png)
Focus on …

From ESA/PB-EO(2017)11, rev.2, CCI+ Implementation Plan

- **Scientific Excellence** and cross-ECV research
- Strengthen link between **modelling** activities (CMUG) and individual ECVs
- **CCI+ best practice**
  - Consistency of satellite climate data records for Earth system monitoring, T. Popp et al., BAMS, 2020, [https://doi.org/10.1175/BAMS-D-19-0127.1](https://doi.org/10.1175/BAMS-D-19-0127.1)
  - CCI open data portal: free and open access, data standards, ancillary information
- Develop **Knowledge Exchange** strategy to raise awareness for CCI+ achievement
- Foster uptake of CCI+ R&D in **climate services**, maintain synergy with C3S
CCI PEER-REVIEWED PUBLICATIONS

Cumulative peer-reviewed publications by CCI projects

* to end of October
CCI IN NUMBERS

- 126 Institutions
- 21 ECVs
- 14 ECVs transferred to Copernicus
- c400 European scientists
- 640 Peer-reviewed articles
- 350 terabytes
- 180+ datasets
- 8 million files

Open data

Data centres
Industry
National weather services
Universities & Research Institutes

CCI
CCI+

2
24
9
72
3
37
10
76
IPCC CONTRIBUTION

IPCC Fifth Assessment Report

15 papers
60 citations
28 contributing authors

Special Report: The Oceans and Cryosphere in a Changing Climate

38 papers
162 citations
von Shuckmann (CRI), Kääb (CRI), Meyssignac (CRI), Marzeion (CRI)

IPCC Sixth Assessment Report

9 chapters with CCI authors

Sathyendranath (OC), Eyring (CMUG), Dufresne (CMUG), Notz (CMUG), Henson (OC), Jones (CMUG), Seneviratne (SLBC), von Shuckmann (SLBC), Racaultis (OC)
CLIMATE MODELLING USER GROUP

- Dedicated forum for collaboration between the Earth Observation Data and Climate Modelling Communities

- Improved interaction through
  - New cross-project Climate Science Working Group (CSWG)
  - Providing tailored satellite based ECV products for CMIP model evaluation activities
  - 50% of ECVs implemented into ESMValTool (Earth System model Evaluation Tool)
  - Support to WCRP’s Obs4MIPs (Observations for Model Inter-comparison Project)

Note: Close interaction with WCRP data advisory council through ESA representation and ESA currently co-chair for Obs4MIPs

Project team: Met Office, ECMWF, Météo France, MPI-M, SMHI, DLR, IPSL, BSC

See dedicated presentation on CMUG, agenda #2.2
WORKING WITH OPERATIONAL SERVICES

CCI-C3S cooperation agreement

- Provision of CDR
- Coordination of R&D activities
- Collaboration on pre-operational developments
CCI & C3S COLLABORATION

- Complementarity and synergy
- Collaborate on common R&D
- Provide pre-operational development for operational climate services: 16 ECVs transferred to operational climate services including C3S (and EUMETSAT)
- Further collaboration on
  - Interoperability
  - Quality Assurance
  - Data provenance
  - User Information

Representation on panel discussion this afternoon
CCI & C3S COLLABORATION

Dedicated workshops on
- R&D Gap Analysis and common interests
- Joint ESA-ECMWF Data Standards for Satellite-Based ECVs
- Dataset Mapping Between C3S & CCI
- Harmonising C3S & CCI Toolboxes Workflows

Main points of discussion for common R&D focus on
- Including experience from “new” ECVs: biomass, permafrost and LST
- Link to modelling: root-zone soil moisture, vegetation
- New topics: vegetation, biodiversity, terrestrial hydrology/river discharge
- Detailed summary note available, base for new C3S and CCI activities

→ Update on CCI-C3S co-operations agreement planned
CCI & EU EUMETSAT COLLABORATION

- **Coordination** between CCI and EUMETSAT’s Continuous Development and Operations Phase (CDOP) activities on-going as part of current CDOP review
- **Complementary and synergy**
- **Collaboration** on common ECV data sets, e.g. sea ice, soil moisture etc
- Working closely on the **ECV inventory** hosted by EUMETSAT through CEOS/CGMS WGClimate, https://climatemonitoring.info/ecvinventory/
- Regular coordination meetings, through ESA-EUMETSAT bilaterals and on working level

Close collaboration on algorithm development and extension of data records: OSI SAF (left) and CCI (right) sea ice concentration maps (Weddell Sea). Next versions of both data will be run by OSI SAF.

Representation on panel discussion this afternoon
The objective of CCI Knowledge Exchange is to maximise awareness, access, use and understanding of satellite data for climate research with an emphasis on promoting the CCI Programme.

Recent highlights
- New webpage climate.esa.int
- Updated Climate from Space Tool

More details on agenda #2.3
NEW Climate Office Webpage now available: climate.esa.int

Climate from Space App cfs.climate.esa.int
- Showcase ESA Climate (ECV) datasets
- Interactive 3D globes & maps
- For teaching & exhibitions
- Mobile | tablet | desktop
INTERNATIONAL COLLABORATION
**International climate landscape**

**STAKEHOLDERS (CCI)**
- Defining requirements for ECVs & scientific focus
  - International policy
  - Global Stocktake
  - Mitigation & Adaption
- National & regional interests

**USERS (CCI)**
- Climate Science and Modelling
- Climate services
- New user communities?

**ESA’s role**
- Addressing ECV requirements & associated science
- Providing expert input (data and science)
- Pre-operational development and R&D

**ESA’s role**
- Providing scientific evidence as input to policy decision
Achievements of CCI+ phase 1

- 21 Essential Climate Variables addressed
- Provision of high-quality, uncertainty characterised, validated climate data records
- Linking individual ECVs in cross-ECV approach: IMBIE, SLBC, RECCAP-2
- Supporting the uptake of climate data records in the climate modelling community: CMUG
- Working closely with the operational climate services, in particular C3S and EUMETSAT
- Contributing to the international climate landscape
- Providing the science base to IPCC assessment reports
- Extended outreach, communication and education
WHAT IS AN ESSENTIAL CLIMATE VARIABLE?

ECV datasets provide the long-term empirical evidence needed to understand and predict the key components of the climate.

They are required to support the work of the UNFCCC and the IPCC to guide mitigation and adaptation measures, assess risks and enable attribution of climate events to underlying causes, and to underpin climate services.

54 ECVs, 36 can be monitored from space.

21 ECVs are under development by ESA Climate Change Initiative
CCI FELLOWSHIPS 2020

26 applications received from 9 countries

- Terrestrial 12
- Ocean 7
- Atmosphere 3
- Cryosphere 4

Selected Proposals by Member State

- United Kingdom: 2
- Switzerland: 1
- Italy: 1
- Germany: 2
- France: 1
- Denmark: 2

11 proposal selected, to start in Q1/2 2021

- Terrestrial 4
- Ocean 4
- Atmosphere 1
- Cryosphere 2
UNCERTAINTY QUANTIFICATION

Uncertainty in Climate Data Records from Earth Observation, C. J. Merchant et al., 2017, (10.5194/essd-9-511-2017) - best practice across 11 CCI ECV projects (18 authors; land, atmos, ocean, cryosphere)

![MODIS CTH uncertainty ice cloud](image1)

![MODIS CTH uncertainty liquid cloud](image2)

Uncertainty validation using the distribution of differences between matched cloud top heights measured by Cloud_cci and CALIPSO. A correct estimation of the retrieval uncertainty should reproduce the dashed blue curve, with a FWHM of 2.35.

Reference will be made under agenda #2.1 and #2.2
Establish and define the concept of (technical, retrieval, scientific) cross-ECV consistency - 22 CCI co-authors, with 8 detailed examples from across the CCI, identifying also status of research into cross-consistencies

Example above shows co-variation between multiple ECVs: El-Nino region SST, sea level, sea surface salinity, chlorophyll-α, cloud fraction, water vapor, soil moisture, aerosol optical depth (credit: U. Willen, SMHI)

Reference will be made under agenda #2.1 and # 2.2
ECV DATA ACCESS – CCI OPEN DATA PORTAL

- Free and Open Access
- Global coverage (where applicable)
- Long timeseries (20-30 years)
- Gridded (at a usable resolution e.g. ¼ degree)
- Validated (by in situ observations) and tested
- Bias corrected (e.g. between different satellites)
- Uncertainty characterisation (per pixel, correlated…)
- Useful temporal resolution (daily, monthly…)
- Can be sourced back to algorithm choice
- Level 1, 2 or 3
- Consistency between CCI_ECV datasets
- Full documentation & version control
- Peer reviewed publications
- Available on CCI Data Portal, and Copernicus Services
- Supporting information, e.g. cloud masks

More detail under agenda #2.3
LIAISON LINK WITH FUTURE EARTH

FORMAL PARTNERSHIP

- Strategic link to major international research network for environmental and sustainability science.
- Widens use of ESA and CCI data products within Future Earth’s Global Research Projects and increases ESA involvement.
- Supports EO capacity building, awareness and communications e.g. 10 Climate Insights report launched at COP-25.
- Identifying opportunities for collaboration and potential ESA contributions in the international context – GEO, CEOS, UNFCCC.
- Joint Activity Programme helps set research priorities. Recent activities:
  - Global Mountain Biodiversity Assessment ECVs for Mountains workshop with GEO initiative GEO-GNOME, June 2019.
  - Future Earth Coasts Linking EO data and sustainable development across the Atlantic, 3-5 Dec 2019.
  - Research demonstrators for COP-26: To Demonstrate Benefits Of Long-Term Climate Records

Representation on panel discussion this afternoon