

CCI+ Implementation Plan

UK Space4Climate – January 26th, 2017

Evolution of CCI over the period 2017-2024:

- CCI+ enables EO and climate research communities in Member States to develop the ECV data products required by climate science (e.g. IPCC, CMIP, CoP-21) and for use in climate services (e.g. C3S).

Taking account of:

- new GCOS Status Report (2015) and new GCOS-IP (2016)
- new EO capabilities (e.g. Sentinels, Earth Explorers)
- new programmatic landscape (e.g. C3S, H2020, EUMETSAT CDOP-3, CMIP-6)

Background – CCI ECVs



- Original proposal for 21 ECVs (170M€) was undersubscribed by 77M€.
- Selection criteria were adopted by Member States to prioritise available resources
- Projects addressing 13 ECVs were subsequently started in CCI

	Atmosphere	Ocean	Terrestrial
GCOS ECVs started in CCI so far	Aerosol Properties Carbon Dioxide and Methane Ozone Cloud Properties	Sea Surface Temperature Sea Level Sea Ice Ocean Colour	Land Cover Fire Disturbance Soil Moisture Glaciers and Ice Caps Ice Sheets
GCOS ECVs considered within scope, but not started in CCI so far	Long-lived Greenhouse Gases	Sea State Sea Surface Salinity	Snow Cover Albedo Leaf Area Index FAPAR Lakes Above Ground Biomass

Table 1.

The list of ECVs defined by the GCOS Report "Systematic Observation Requirements for Satellite-Based Products for Climate" (GCOS-107, September 2006) that were considered to be within scope at the start of the CCI, and those that were selected for implementation.



CCI+ Objectives and Scope



CCI+ Objectives:

- **research, development, qualification** and **delivery to users** of pre-operational ECV products
- **definition, sizing** and **demonstration** of ECV processing systems
- **transfer** of ECV production to operational entities outside ESA

Driven by **climate user requirements** defined by GCOS, under authoritative advice from CSAB, and strong coordination with the international Space Agencies response to GCOS via the Joint CEOS/CGMS Working Group on Climate (WGClimate).

CCI+ Scope:

- i. Development of new ECVs (i.e. ECVs that were not started in CCI so far)
- ii. New R&D on ECVs that were started in CCI
- iii. Cross-ECV scientific exploitation (demonstration)
- iv. Knowledge Exchange

NB: CCI+ will not build operational processing systems



(i) New ECVs in CCI+

Selection will be based on criteria already defined by Member States [ESA/PB-EO(2009)32, rev. 1]:

- Response to GCOS requirements (revised in 2016)
- Availability, quality, uniqueness and importance of the satellite data
- Maturity of retrieval algorithms
- Ability to capitalise on European scientific expertise
- Prospects for transition to an external operational context

Taking into account:

- Overall level of Member States contributions
- Need for complementarity with other ECV activities in Europe (C3S, CDOP-3, H2020, etc.)

List of new ECVs will be selected in early 2017, after CM-16.

- CSAB meeting in early 2017 to support ESA in formulating...
- CCI+ Implementation Plan to be presented to PB-EO in Feb 2017

Preliminary analysis of new ECVs in CCI+



Atmosphere	Ocean	Terrestrial
Composition	Surface	
Aerosols Properties	Sea Surface Temperature	Land Cover
Carbon Dioxide & Methane	Sea Level	Fire Disturbance
Ozone	Sea Ice	Soil Moisture
Long-Lived Greenhouse Gases	Ocean Colour	Glacier and Ice Caps
Precursors (for Aerosols and Ozone)	Sea State	Ice Sheets
Upper Air	Current	Snow Cover
Cloud Properties	Sea Surface Salinity	Albedo
Temperature	Carbon Dioxide Partial Pressure	Leaf Area Index (LAI)
Water Vapour	Phytoplankton	FAPAR
Wind Speed and Direction	Ocean Acidity	Lakes
Earth Radiation Budget	Sub Surface	Above Ground Biomass
Surface	Carbon	Permafrost
Surface Air Pressure	Current	Ground Water
Surface Air Temperature	Nutrients	River Discharge
Surface Precipitation	Ocean Acidity	Soil Carbon
Surface Radiation Budget	Oxygen	
Water Vapour (Surface humidity)	Salinity	
Near-Surface Wind Speed, Dir	Temperature	
	Tracers	
	Global Ocean Heat Content	
Within CCI Scope	Started in CCI	



Preliminary analysis of new ECVs in CCI+



Atmosphere	Ocean	Terrestrial
Composition	Surface	
Aerosols Properties	Sea Surface Temperature	Land Cover - High Resolution
Carbon Dioxide & Methane	Sea Level	Fire Disturbance
Ozone	Sea Ice	Soil Moisture
Long-Lived Greenhouse Gases	Ocean Colour	Glacier and Ice Caps
Precursors (for Aerosols and Ozone)	Sea State	Ice Sheets
Upper Air	Current	Snow Cover
Cloud Properties	Sea Surface Salinity	Albedo
Temperature	Carbon Dioxide Partial Pressure	Leaf Area Index (LAI)
Water Vapour	Phytoplankton	FAPAR
Wind Speed and Direction	Ocean Acidity	Lakes
Earth Radiation Budget	Sub Surface	Above Ground Biomass
Surface	Carbon	Permafrost
Surface Air Pressure	Current	Ground Water
Surface Air Temperature	Nutrients	River Discharge
Surface Precipitation	Ocean Acidity	Soil Carbon
Surface Radiation Budget	Oxygen	Land Surface Temperature
Water Vapour (Surface humidity)	Salinity	
Near-Surface Wind Speed, Dir	Temperature	
	Tracers	
	Global Ocean Heat Content	
Within CCI Scope	Implemented in CCI	Proposed in CCI Extension



(i) New ECVs: Sea-Surface Salinity

Sea Surface Salinity

Surface salinity is a key indicator of changes in the global water cycle under a warming climate, and a key factor in the sequestration of heat and carbon from the atmosphere to the sub-surface ocean layers.

Satellite Instruments

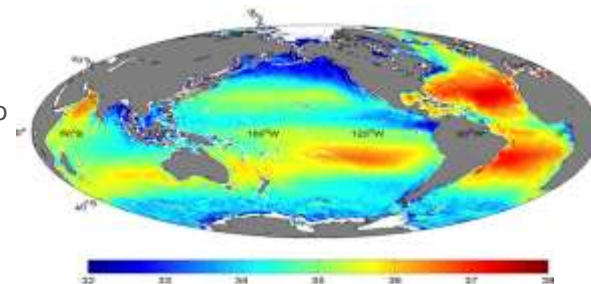
SMOS, Aquarius, SMAP,
AMSR-2, AMSR-E, TMI

Expertise

SMOS Science Team
STSE SMOS+ SOS
STSE Pathfinders Ocean Acidification
SMOS-MODE (EC COST Action)
New ESA SMOS Pi-MEP

The expected delta of CCI+

- Until the launch of ESA's SMOS in 2009, global coverage of SSS was not available.
- SMOS Level-2 salinity products (ver.6) are now reaching maturity, and there is good potential to develop a long term multi-mission salinity CDR based on a combination of SMOS data with NASA's L-band Aquarius (launched 2011) and SMAP satellites (launched 2015).
- Explore the possibility to extend ECV back in time using prototype salinity retrievals applied to AMSR and TMI.
- Fully exploit the potential information on ocean acidity.



Ocean salinity from ESA's SMOS Earth Explorer (ESA/IFREMER)

GCOS Requirement (GCOS-200)

ECV	Res.	Frequency	Uncertainty	Stability (10yr)
Sea Surface Salinity	1-100 km	Hourly to monthly	0.01 psu	0.001 psu

(i) New ECVs: Sea State



Sea State (Waves)

Waves affect ocean-atmosphere coupling (heat, momentum, mass fluxes) and are a driver of change in coastal zones (floods, extremes, erosion), but there is little understanding of the influence of climate change on waves. Changes in wave climate also provide an indicator of changes in ocean surface winds and storms.

Satellite Instruments

Altimeter: ERS-1, ERS-2, Envisat, Sentinel-3

Topex/Poseidon, Cryosat, Jason-1/2/3, Sentinel-6, AltiKa, CFOSAT

SAR: ERS-1, ERS-2, Envisat, Sentinel-1

Expertise

DUE GlobWave

STSE CoastAlt

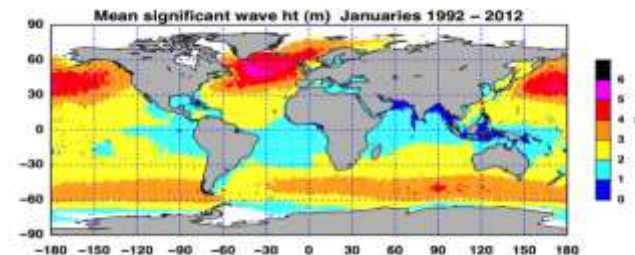
AVISO

JCOMM Coordinated Ocean Wave Climate Projections community

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The expected delta of CCI+

- Development of a sustained coordinated international capacity to deliver high quality sea-state observations for climate.
- Assessment of competing SAR and altimeter retrievals.
- Assembly of a quality-controlled reference data set of wave-buoy measurements.
- Development of a harmonised multi-mission ensemble of intercalibrated satellite wave data, and a CDR with the required long term stability.
- Full exploitation of ESA's SAR-based archive of directional wave spectra products from 1991 onwards.
- Improved uptake of satellite wave measurements in climate research.



Example SAR wave parameter time series (top) and multi-mission altimeter global mean significant wave height (GlobWave/ESA/Ifremer/CLS)

GCOS Requirement (GCOS-200)

ECV	Res.	Frequency	Uncertainty	Stability (10yr)
Wave Height	25 km	3 hourly	10 cm	5 cm



(i) New ECVs: Biomass

Above-Ground Biomass

Global monitoring of vegetation biomass and its dynamics is essential for understanding carbon sequestration and emission, to accurately model the response of vegetation to climate warming, and to plan mitigation and adaptation strategies.

Satellite Instruments

ERS-1, ERS-2, Envisat, Sentinel-1
 ALOS-2, NOVOSAR, GLAS-2, NISAR,
 GEDI, TerraSAR, COSMO-SkyMed
 BIOMASS Earth Explorer (P-band SAR)

Expertise

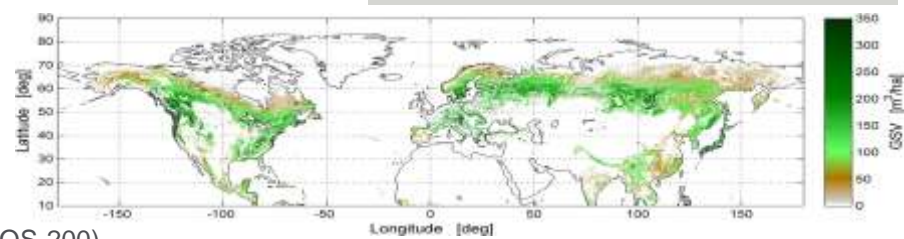
PolInSAR & BIOMASS Science Workshops
 International BioGeoSAR Symposia
 BIOMASS Earth Explorer science team
 Forest Biomass Network
 Global Carbon Project
 DUE GlobBiomass, STSE BIOMASAR

The expected delta of CCI+

- International assessment of forest biomass retrieval algorithms, and improved algorithms exploiting new satellite instruments.
- Development of methods for determining non-forest biomass.
- Development of tomographic capabilities, combined use of satellite and airborne lidar and on understanding signals and ecology.
- Coordination and consolidation of in situ observations including ground-based lidar, allometry and wood density.
- Provision of global estimates of wood density, tree ecology, deforestation and forest degradation.
- Characterization of uncertainty and long-term stability of ECV products.



Santoro et al. RSE, 2015 (STSE BIOMASAR)



GCOS Requirement (GCOS-200)

ECV	Res.	Freq.	Uncertainty	Stability (10yr)
Above-Ground Biomass	500m to 1km	Annual	20% (>50 t/ha) 10 t/ha otherwise	10%

(i) New ECVs: Snow



Snow

Snow has a major influence on the Earth's radiation balance, its high reflectivity driving the ice-albedo positive feedback. It is a sensitive and compelling indicator of climate warming, and an important source of water for agriculture.

Satellite Instruments

ATSR-2, AATSR, Sentinel-3 SLSTR, AVHRR, MODIS, VIIRS

Envisat ASAR, Sentinel-1 SAR

Sentinel-2, Landsat, etc. for validation

SMMR, SSM/I, AMSR, SMOS

Expertise

DUE GlobSnow and GlobSnow-2,

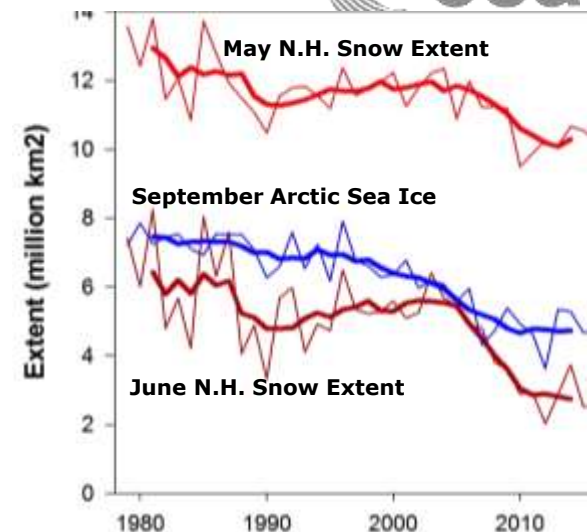
GSE PolarView, SnowPEX,

EC Cryoland, Sen3App,

H-SAF, CryoClim

The expected delta of CCI+

- Build on novel retrieval approaches developed in Europe to provide a snow cover CDR combining AVHRR, (A)ATSR, MODIS, VIIRS and Sentinel-3
- Improve quality of GlobSnow precursor SWE CDR (e.g. investigate possibility to retrieve snow density from SMOS)
- Investigate the potential for a CDR of wet snow derived from ASAR and Sentinel-1 over Europe
- Fully exploit Sentinel-2 for retrieval/validation, particularly in complex terrain.
- Strengthen international snow retrieval community built up by ESA's SnowPEX and NASA's iSWGR.

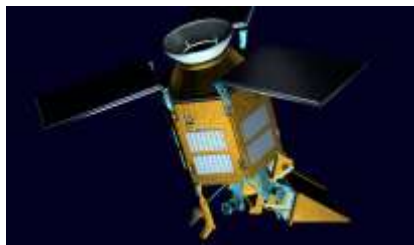


N. Hemisphere snow cover compared with arctic sea-ice decline (NASA/NOAA)

GCOS Requirements (GCOS-200)

ECV	Res.	Freq.	Uncertainty	Stability (10yr)
Snow Area	1km/100m	Daily	5%	4%
Snow Depth	1km/100m	Daily	10mm	10mm
Snow Water Eq.	1km	Daily	10mm	10mm

(i) New ECVs: Precursors of Ozone and Aerosol



ESA Sentinel-5P

Precursors of Ozone and Aerosol

Observations of precursors of ozone and aerosols improve the ability to detect and attribute changes in ozone and aerosol in both the troposphere and the lower stratosphere, and to validate emission databases. They are industrial pollutants either directly or indirectly harmful to human health.

Satellite Instruments

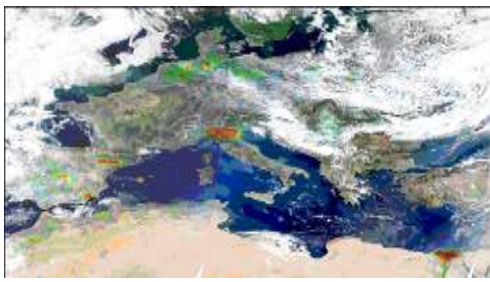
GOME, SCIAMACHY, GOME-2, OMI, Sentinel-5P, Sentinel-4/5, IASI, IASI-NG, MOPITT

Expertise

DUE TEMIS, GlobEmission GSE PROMOTE EC GEMS/MACC, QA4ECV

The expected delta of CCI+

- Advance beyond the existing precursor work to establish NO₂, HCHO and CO CDRs and apply to Sentinel-5P, -4 and -5 data.
- Develop GOME, SCIAMACHY, GOME-2 and OMI SO₂, and IASI NH₃ CDRs and apply to Sentinel-5P (and later Sentinel 4/5 and IASI next generation instrument)
- Validation and intercomparison with in-situ and other satellite measurements (e.g. MOPITT)
- Improved characterisation of retrieval uncertainties, necessary for inverse modelling
- Reduced uncertainties in emissions databases and source attribution



Distribution of ammonia measured using MetOp IASI (Credit: LATMOS)

ECV	Res.	Freq.	Uncertainty	Stability (10yr)
NO ₂ column	5-10km	4hr	max(20%; 0.03 DU)	2%
SO ₂ , HCHO col.	5-10km	4hr	max(30%; 0.04 DU)	5%
CO column	5-10km	4hr	max(20%; 20 DU)	2%
CO profile	5-10km	4hr	20%	2%

[NH₃ – no GCOS req. yet]

(i) New ECVs: Long-Lived Greenhouse Gases

Long-Lived Greenhouse Gases

Beside CO₂ and CH₄, other powerful anthropogenic GHGs are: N₂O, CFCs, HFC's, HCFCs, PFC's and SF₆. These gases will continue to be responsible for stratospheric ozone loss for many years to come. Environmental policies on emissions depend on accurate knowledge of the stratospheric lifetimes of these GHGs and ozone depleting substances.

Satellite Instruments

MIPAS, IASI
ACE-FTS, Odin SMR
MLS, HIRDLS

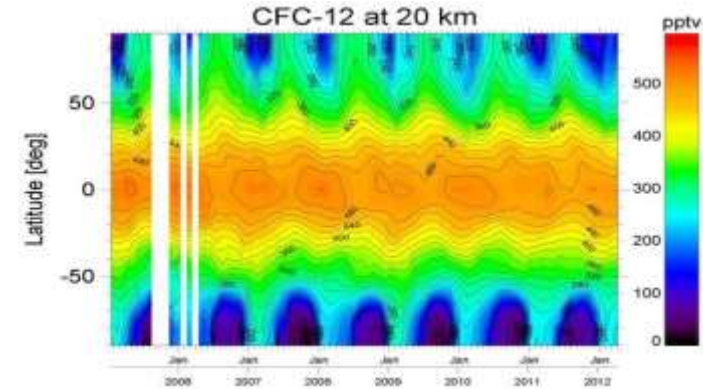
Expertise

Several European & Canadian scientific studies have demonstrated retrievals of a series of GHGs beside CO₂ and CH₄ based on MIPAS, ACE and SMR measurements.

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The expected delta of CCI+

- Develop MIPAS, ACE-FTS, and Odin SMR N₂O, CFC, HCFC, HFC, SF₆ and PFC CDRs from existing research-level retrievals.
- Investigate competing retrievals
- Merge products from different satellites to build consistent CDRs, and link European CDRs with MLS and HIRDLS products.
- Develop IASI long-lived GHG CDRs and apply to the IASI next generation instrument.
- Better monitoring of Montreal and Kyoto protocols, and better predictions of stratospheric processes under a changing climate.



CFC-12 retrieved from MIPAS (credit: IMK)

GCOS Requirements (GCOS-200)

ECV	Res.	Freq.	Uncertainty	Stability (10yr)
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No quantitative requirements yet.

(i) New ECVs: Water Vapour



Water Vapour

The strongest GHG. Changes in tropospheric water vapour are a positive feedback to CO₂ increases. In the upper atmosphere water vapour is a major uncertainty in radiative forcing, the source of chemically-active hydroxyl radicals, and a sensitive indicator of changes in the Brewer-Dobson circulation.

Satellite Instruments

GOME, SCIAMACHY, GOME-2, OMI, IASI, MERIS

Sentinel-5P, Sentinel-3 OLCI

Expertise

DUE GlobVapour

GEWEX G-VAP

O3M- and CM-SAFs

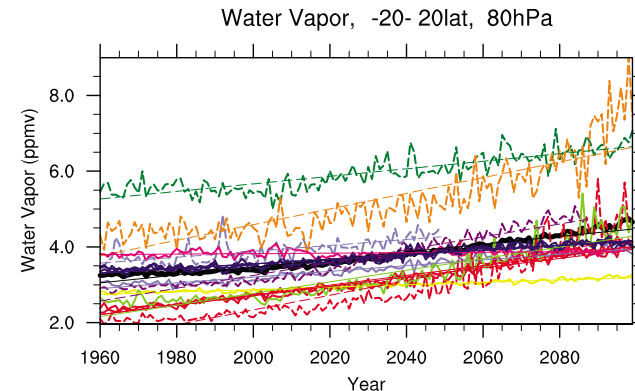
The expected delta of CCI+

Total column water vapour:

- Advance beyond the precursor work done in the DUE GlobVapour project in order to improve quality of SSM/I and MERIS CDR and apply to OLCI and MODIS data.
- Develop multi-mission GOME, SCIAMACHY, GOME-2, and OMI w.v. CDR and apply to Sentinel-5P, -4 and -5.

Stratospheric w.v.

- Develop MIPAS, SCIAMACHY, IASI, and ACE, w.v. CDR, and intercompare via SPARC SDI.



Model uncertainty in stratospheric water vapour (Gettelman et al., 2010)

ECV	Res.	Freq.	Uncertainty	Stab. (10yr)
Total column	25 km	4 hr	2%	0.3%
Trop. profile	25km/2km	4 hr	5%	0.3%
Strat. profile	100-200km/2km	Daily	5%	0.3%
Upper trop. humidity	25 km	1 hr	5%	0.3%

(i) New ECVs: High Resolution Land Cover

High Resolution Land Cover

Changes in land cover affect surface albedo, evapotranspiration, sensible heat flux, and sources and sinks of aerosols and trace gases. Kilometre-scale classifications are sufficient to characterise surface heterogeneity for the purposes of climate models, but adequate detection of changes requires higher resolution.

Satellite Instruments:

Sentinel-2, SPOT series
Landsat archives
ASAR, Sentinel-1

Expertise:

GLC-2000, GlobCover, LandCover_cci
GOF-C-GOLD, REDD, GFOI, FAO-FRA,
GEO-GLAM

The expected delta of CCI+

- Delivery of a HR global landcover changes for the Sentinel-2 epoch (12-22 classes)
- Produce high-resolution map of permanent/temporary water bodies
- Take advantage of the new Sentinel-2 spectral bands to improve accuracy to better than the current level of 10-15%
- Confront the challenge of processing the massive volume of Sentinel-2 data required
- Develop internationally accepted validation strategy
- Tailored products supporting reporting under UN conventions (e.g. REDD+, GFOI, FAO-FRA)



LandCover_cci has delivered moderate resolution landcover maps for the epochs 2000, 2005, and 2010

GCOS Requirements (GCOS-200)

ECV	Res.	Freq.	Uncertainty	Stability (10yr)
Maps of HR land cover	10-30m	5 yr	5%; 1/3 IFOV	5%
Maps of key IPCC LU changes and land management types	10m-1km	1-10y	20%; 1/3 IFOV	20%

(i) New ECVs: Lakes

Lakes

Lakes are reliable indicators of regional anthropogenic impacts and climate change. They also have a profound impact on surface-atmosphere exchanges.

Satellite Instruments

ERS, Envisat, Sentinel-3 altimeters

ERS, Envisat, Sentinel-1 SARs

MERIS, OLCI, (A)ATSR, MODIS, SLSTR

Sentinel-2, Landsat, ...

Expertise

SST_cci, Landcover_cci,

GlobTemperature, GlobDiversity, CoastColour

ESA's Rivers and Lakes project

Global Lakes Sentinel Service (GLaSS)

ARC-Lake, GloboLakes, GLOWABO,

HYDROWEB, HYDROLARE

The expected delta of CCI+

- Development of a consistent and tailored set of long term geophysical variables characterising lake dynamics globally.
- Improve existing precursor products on LSWT, lake colour, lake area, lake level, lake ice, and adapt to new satellite infrastructure, such as the Sentinels and Cryosat-2.
- Coordinate US, Russia, Europe activities to provide products to the WMO Data Centre.
- Develop derived products on lake ice freeze-up and break-up dates.



LandCover_cci
global water
bodies and
zoom over
Russian lakes

ECV	Res.	Freq.	Uncertainty	Stab. (10yr)
Water level	100m	Daily	lg.3cm / sml.10cm	1cm
Water extent	20m	Daily	lg.5% / sml. 10%	5%
Water temp.	300m	Weekly	1K	0.1K
Ice thickness	100m	Monthly	1-2cm	-
Ice cover	300m	Daily	10%	1%
Water colour	300m	Weekly	30%	1%

(i) New ECVs: Land Surface Temperature

Land Surface Temperature

Satellite LST provides accurate, global, spatially continuous information complementary to the established point-based and globally sparse 2m air temperature databases used extensively in climate research.

Satellite Instruments

ERS-1, ERS-2, Envisat, (A)ATSR
Sentinel-3 SLSTR, MODIS, VIIRS, AVHRR
SEVIRI, MVIRI, GOES, MTSAT
SSM/I, AMSR

Expertise

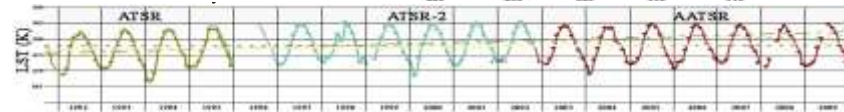
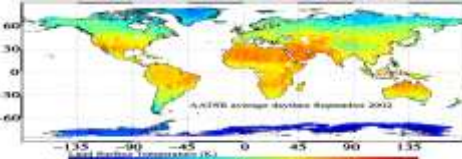
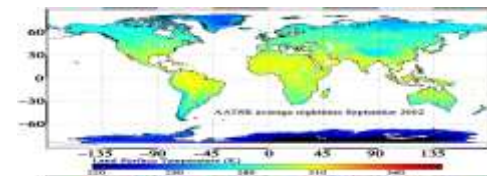
SST heritage
DUE GlobTemperature
Unique in-situ validation infrastructure (KIT)
EarthTemp Network, ILSTE
Land SAF
In-situ T_{sfc} expertise: CRUTEM, ISTI, ...
H2020 EUSTACE

The expected delta of CCI+

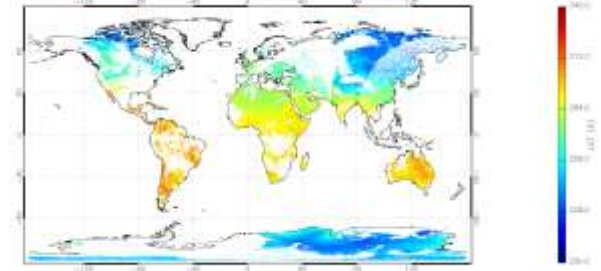
- Advance beyond the precursor work in GlobTemperature to provide a long-term global multi-mission (LEO + GEO + PMW) LST CDR with full characterisation of the diurnal cycle, uncertainties, and IR clear-sky bias.
- Develop full exploitation of satellite LST in climate model verification, and for improving the quality of in-situ surface temperature record construction.
- Continue to strengthen the international LST expert and user community via European participation in ILSTE.

GCOS Requirements (GCOS-200)

ECV	Res.	Freq.	Uncertainty	Stab. (10yr)
Maps of LST	1 km	3 hr	1 hr	< 0.1 K



(A)ATSR nighttime LST from 1991-2009 (U. Leicester)



Merged global polar + geo LST (GlobTemperature)

(ii) New R&D on ECVs already started in CCI



Further R&D on ECVs is needed in CCI+ to:

- Improve **quality** of ECV products closer to meeting GCOS goals (e.g. accuracy, spatial resolution, long term stability), and improve cross-ECV **consistency**.
- Develop algorithms for "difficult" **ECV variables** required by GCOS, e.g. regional sea-level, coastal ocean colour, aerosol absorption, sea-ice drift, ...
- Extend ECV **length** by developing methods to bring older less well-calibrated satellite instruments into the time series (e.g. ATSR-1, AVHRR), and develop **corrections** for future instrument degradation.
- Fully exploit the **new capabilities** of Sentinel and Earth Explorer instruments, e.g. new types of measurement, new spectral bands, wider swaths, higher resolution.
- Develop climate-quality methods to join-up **multi-mission time series**, especially where there are **gaps**, e.g. Envisat to Sentinel-1 & -3.
- Increase maturity of ECV product **uncertainty estimates**.
- Develop better **merged** ECV products (e.g. polar + geostationary)
- Perform **algorithm round-robins** to objectively assess promising new ECV retrieval techniques.



(iii) Cross-ECV Activities



Cross-ECV activities are a key strength of CCI and CCI+

CCI has succeeded to build an active multi-disciplinary community fostering dialogue and cooperation between the EO and climate science – as recommended by both CSAB and ESAC.

1. CCI+ CMUG-type activity providing

- an integrated climate user perspective across all ECVs
- demonstration exploitation of the CCI+ ECV products
- feedback to the CCI+ teams on ECV quality and consistency
- outreach to the wider climate modelling community

2. CCI+ Cross-ECV targeted scientific studies

- Demonstrate the value of the CCI and CCI+ ECVs and to strengthen uptake by the wider climate community.
- Permafrost ECV building on combined & tailored data sets from Snow, Land Cover, Lakes, LST, and other ECV projects.
- E.g. Analysis of multiple ECVs for IMBIE, sea-level budget closure, carbon-cycle research, *etc.*

3. CCI+ Young Scientist Research Fellowship Scheme

- To stimulate exploitation by the next generation of climate scientists.



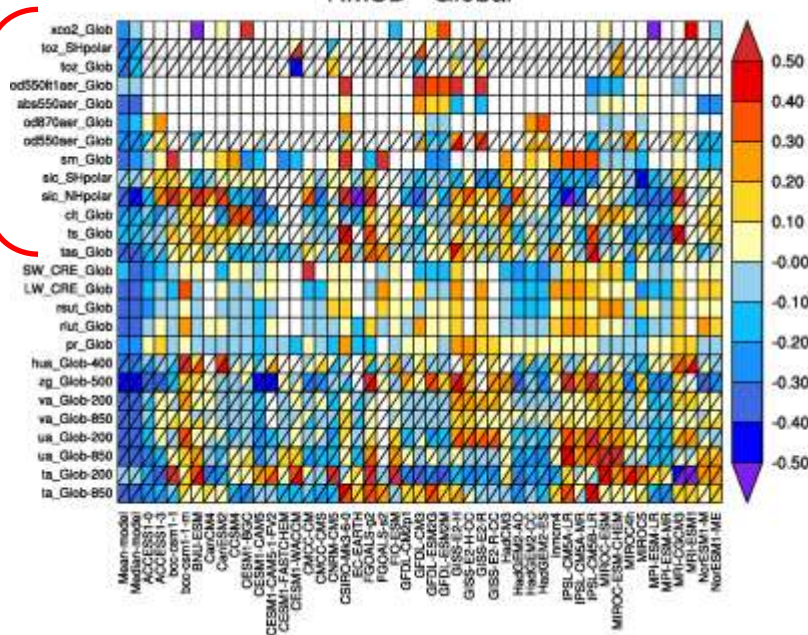


ESA CCI datasets

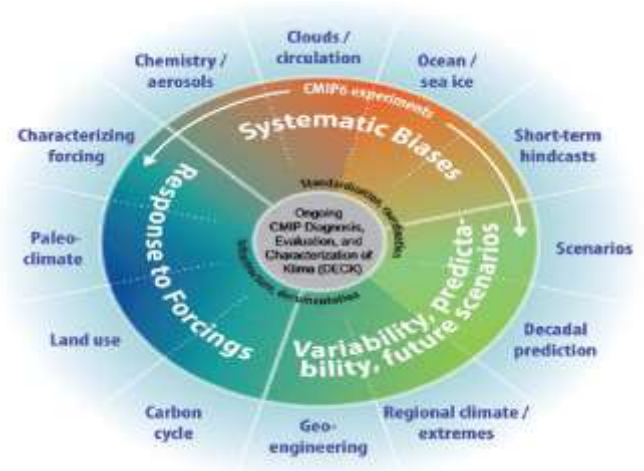
- greenhouse gases
- ozone
- aerosol
- soil moisture
- sea ice
- cloud
- SST

'climate research scientists can now access good datasets to evaluate their models thanks to the ESA CCI'

RMSD - Global



Assessment of climate models using ESMVal tool for several CCI datasets



Schematic of the proposed experiment design for phase 6 of the Coupled Model Inter-comparison Project (CMIP6) Meehl et al., 2014



(iii) Cross-ECV Activities: Permafrost

Permafrost

A clear warming trend in permafrost temperatures has been observed since the early 1980s across boreal and Arctic terrestrial ecosystems. Thawing permafrost is likely to release large amounts of CO₂ and CH₄ gas, amplifying global warming.

Satellite Instruments

ERS-1, ERS-2, Envisat, (A)ATSR, SAR,
MERIS, Sentinel-3 SLSTR, OLCI,
MODIS, VIIRS, AVHRR
SMOS
SSM/I, AMSR

Expertise

DUE PERMAFROST and GlobPermafrost
CCI ECV projects: Land Cover, Soil Moisture,
Fire, GHG
NSIDC CALM

The expected delta of CCI+

- Construction of a suite of EO-based products to provide enhanced analysis of long term changes in permafrost ecosystems: land cover, snow, land surface temperature, soil moisture, lakes, etc.
- Product and algorithm intercomparisons focussing on performance at high latitudes.
- Tailoring of above products to adapt them for use in permafrost change analysis.
- Development of high resolution terrain assessment in key areas of change.
- Intercomparison with permafrost models

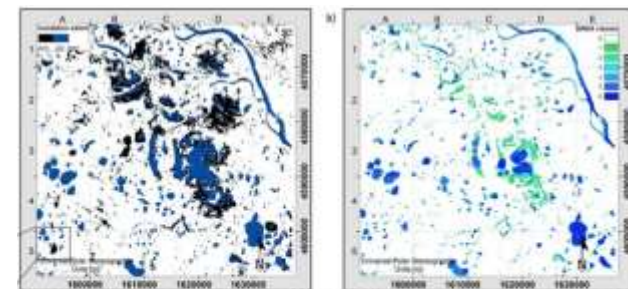
GCOS Requirements (GCOS-200)

ECV	Res.	Freq.	Uncertainty	Stab. (10yr)
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No satellite product requirements specified yet



Permafrost underlies nearly a quarter of the N.H.



Seasonal changes in lakes as proxy information

H2020

- R&D exploiting ECVs
- Some complementary work on developing ECVs

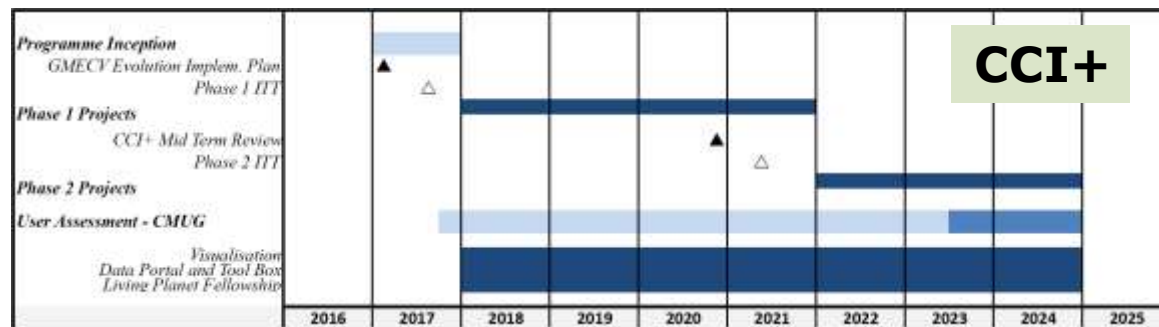
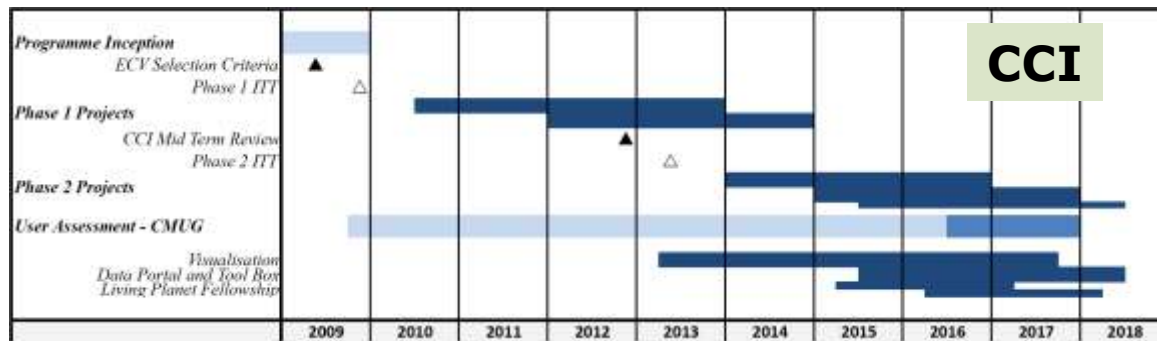
Copernicus Climate Change Service

- Operational production of ECVs, but no R&D
- First call for 9 ECVs announced on 13 Jan 2016 (sea ice, sea level, sea surface temperature, ozone, aerosol, CO₂ and CH₄, soil moisture, glaciers and ice caps, albedo-LAI-FAPAR)
- Expect further C3S calls for operational production of ~20 more ECVs by end 2017
- At a practical level ESA works closely with ECMWF for the transfer of CCI R&D into C3S operations.

EUMETSAT Satellite Application Facilities

- New SAF CDOP-3 programme starts 2017 (approved in mid-2016)
- ESA is working closely with EUMETSAT to ensure full complementarity on the development of ECVs, on a case-by-case basis (e.g. WG-DRG, mutual participation in tender evaluations, joint workshops, etc.).

CCI schedule



CCI+ Summary



- CCI+ is a proposal for the evolution of CCI over the period 2017-2024 to develop new ECV data products required by **climate science** and **climate services**.
- As for CCI, the objective is to **transfer the R&D results into an operational context** outside ESA once the ECV algorithms and pre-operational processing systems are sufficiently mature.
- CCI+ will enhance the contribution of European EO science to future **UNFCCC IPCC assessments**, as part of the international coordinated action on climate observations through CEOS and GCOS.
- Both **new ECVs** as well as **new R&D on ECVs already started in CCI** are included, complemented by supporting activities providing an integrated climate user perspective, on cross-ECV exploitation, Knowledge Exchange.
- The proposed CCI+ activities are **complementary** to other activities on ECVs in Europe (e.g. C3S, H2020, EUMETSAT SAFs) , and will be closely linked with international climate science programmes.



CSAB Recommendations



Of 11 new ECV activities (10 plus Permafrost) proposed for CCI+, the Board recommends four - Water Vapour, Sea Surface Salinity, Snow Cover and Permafrost - as highest priority.

The Board recommends five others - Land Surface Temperature, Above Ground Biomass, Lakes, Sea State, and High Resolution Land Cover - as worthy candidates for CCI+ funding.

With respect to High Resolution Land Cover, the Board recognised the likely stronger interest in local to regional (rather than global) versions of these products, suggesting the need for some partnerships to establish the design and application of data and services based on such very high resolution products.



CSAB Recommendations



Atmosphere	Ocean	Terrestrial
Composition	Surface	
Aerosols Properties	Sea Surface Temperature	Land Cover - High Resolution
Carbon Dioxide & Methane	Sea Level	Fire Disturbance
Ozone	Sea Ice	Soil Moisture
Long-Lived Greenhouse Gases	Ocean Colour	Glacier and Ice Caps
Precursors (for Aerosols and Ozone)	Sea State	Ice Sheets
Upper Air	Current	Snow Cover
Cloud Properties	Sea Surface Salinity	Albedo
Temperature	Carbon Dioxide Partial Pressure	Leaf Area Index (LAI)
Water Vapour	Phytoplankton	FAPAR
Wind Speed and Direction	Ocean Acidity	Lakes
Earth Radiation Budget	Sub Surface	Above Ground Biomass
Surface	Carbon	Permafrost
Surface Air Pressure	Current	Ground Water
Surface Air Temperature	Nutrients	River Discharge
Surface Precipitation	Ocean Acidity	Soil Carbon
Surface Radiation Budget	Oxygen	Land Surface Temperature
Water Vapour (Surface humidity)	Salinity	
Near-Surface Wind Speed, Dir	Temperature	
	Tracers	
	Global Ocean Heat Content	
Within CCI Scope	Implemented in CCI	Proposed by the CSAB for the CCI Extension



- Two Invitations to Tenders
 - New ECVs – One SoW with 9 Annexes – Open Tender
 1. Water Vapour
 2. Salinity
 3. Sea State
 4. HR Land Cover
 5. Snow
 6. Lakes
 7. Above Ground Biomass
 8. Permafrost
 9. Land Surface Temperature
 - Climate Modelling User Group – One SoW – Direct Negotiation

- Procurement of the three other activity lines
 - New R&D in existing ECVs
 - Cross-ECV activities
 - including CCI Research Fellowship (calls in 2019, 2021 and 2023)
 - Knowledge Exchange Activities
 - Open Data Portal
 - CCI Tool Box
 - Visualisation
 - Other Knowledge Exchange activities

- The procurement process and exact content still to be defined:

QUESTIONS