Climate Change

C3S status on Essential Climate Variables

Joaquín Muñoz Sabater

- with contributions from data providers and C3S technical officers -

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CCI 9th Co-location Meeting, 25-28 March 2019 ,St. Hugh's College, Oxford

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Objective

- o To provide users with full and timely access to observational records of essential climate variables derived from satellite observations

which are

- o State-of-the-art products
- o Long-term, consistent , complete (CDR)
- o Regularly extended in time (ICDR)
- o Gridded, aggregated
- o *Accessible & Tracible*
    - ✓ *Access through the Climate Data Store*
    - ✓ *Documentation*
    - ✓ *Evaluation and Assessment*
    - ✓ *User support*

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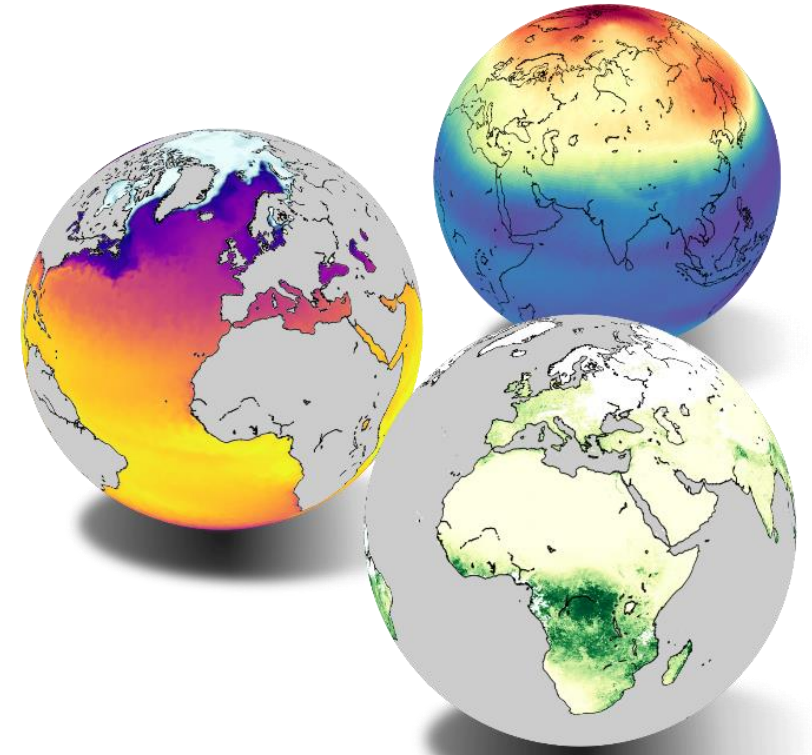
ECVs evolution in C3S

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Gridded datasets

C3S_312a	ECV products from satellite observations	9 contracts, 12 ECVs	Started 2016Q4 Ended 2018Q4
C3S_312b	ECV products from satellite observations	Additional 10 ECVs Organized in 5 Lots	Started 2018Q3 Will end 2021Q2
C3S_311a	In situ observations (Lot 4)	High-resolution ECV products for Europe	Started in 2017Q2 Will end 2021Q2

← *Proof of Concept*

← *Operations*

← *Based on E-OBS*

Reanalysis

ERA5	Global atmospheric reanalysis	Atmosphere, land, sea state	Started 2016Q1 1979-NRT completed
ERA5-Land	High-resolution global land reanalysis	Land	Started 2018Q1 2000-NRT completed
ORA5	Global ocean reanalysis	Ocean, sea ice	Complete

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	GCOS	C3S_312a 2017	C3S_312b 2018	2019	2020	2021	
Atmospheric physics							
Precipitation	4.3.5						
Surface Radiation Budget	4.3.6			Lot 1			Coordination with CM-SAF / ROM SAF / ESA CCI / Uni. Maryland / NASA / NOAA
Water Vapour	4.5.3						
Cloud Properties	4.5.4						
Earth Radiation Budget	4.5.5						
Atmospheric composition							
Carbon Dioxide	4.7.1	Lot 6					
Methane	4.7.2	Lot 6		Lot 2			Coordination with ESA-CCI and other national projects
Ozone	4.7.4	Lot 4					
Aerosol	4.7.5	Lot 5					
Ocean							
Sea Surface Temperature	5.3.1	Lot 3					
Sea Level	5.3.3	Lot 2		Lot 3			Coordination with ESA-CCI
Sea ice	5.3.5	Lot 1					
Ocean Colour	5.3.7						
Land hydrology & cryosphere							
Lakes	6.3.4						
Glaciers	6.3.6	Lot 8		Lot 4			Coordination with ESA-CCI, GloboLakes, Arc-Lake, HydroWeb
Ice sheets and ice shelves	6.3.7						
Soil moisture	6.3.16	Lot 7					
Land biosphere							
Albedo	6.3.9	Lot 9					
Land Cover	6.3.10						
Fraction of Absorbed Photosyntheti	6.3.11	Lot 9		Lot 5			Coordination with ESA-CCI, CGL, QA4ECV, LSA-SAF
Leaf Area Index	6.3.12	Lot 9					
Fire	6.3.15						
		2017	2018	2019	2020	2021	

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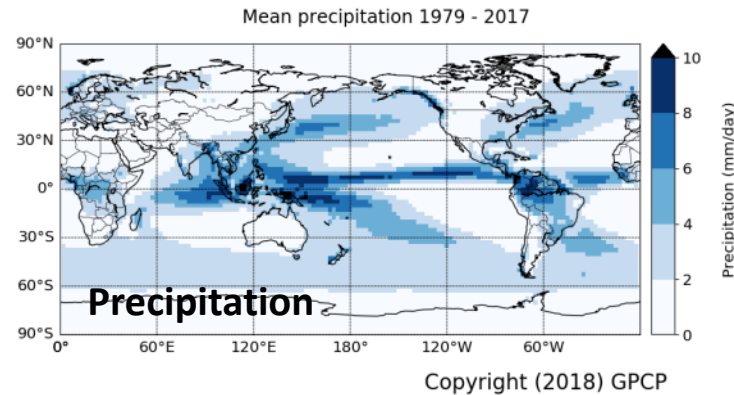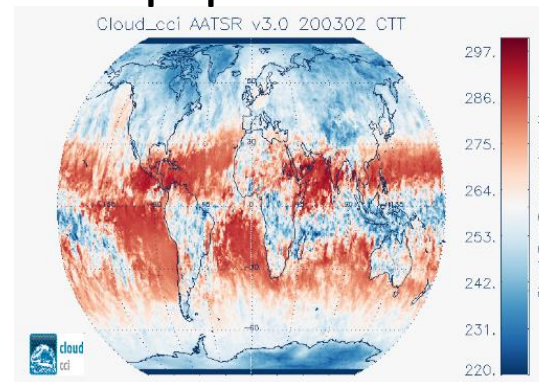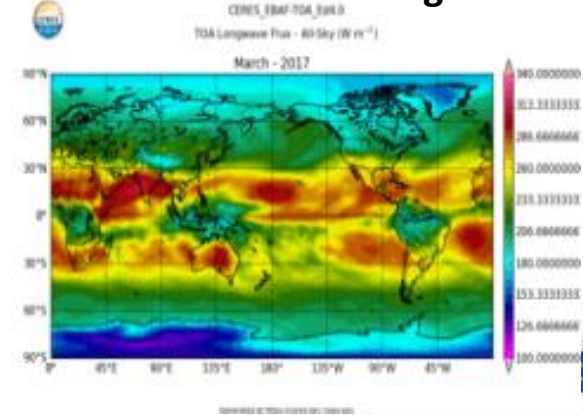**Climate Change**

- Combination of CDR/ICDR from several sensors for 5 ECVs.
- Currently in year 1 of Phase 1 (KO in May 2018)
- The consortium, led by DWD, has strong connections with ESA CCI (Cloud), EUMETSAT (CM SAF, ROM SAF), and USA (NOAA, NASA, University of Maryland).

Mean precipitation 1979 - 2017
Precipitation
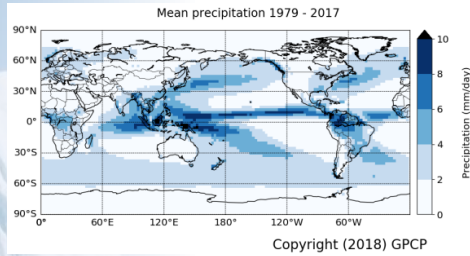Copyright (2018) GPCP

Surface Radiation Budget
Monthly Mean of Surface Downwelling Longwave Radiation for July 1992

Water Vapour
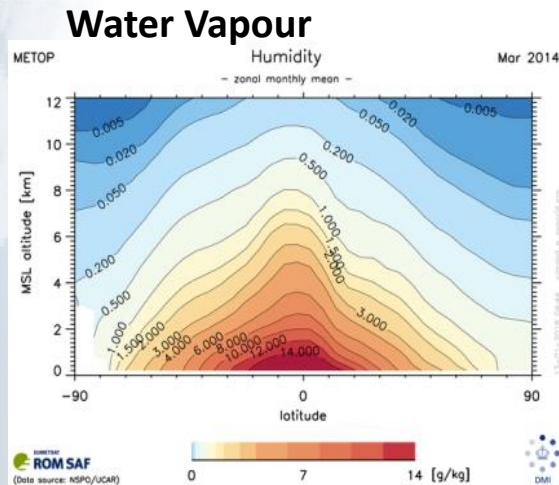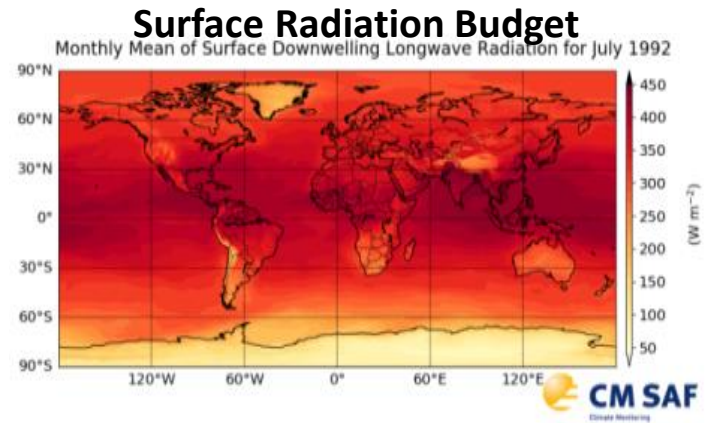
Cloud properties

Earth Radiation Budget

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Precipitation

Mean precipitation 1979 - 2017

Copyright (2018) GPCP

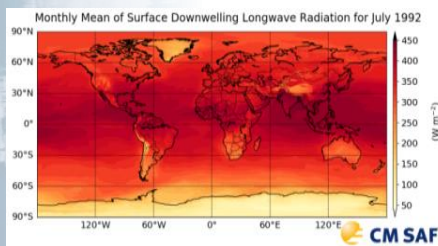**Service active since May 2018**→ Currently brokering existing precipitation datasets (GPCP) to CDS.

Products:

Global (CDR/ICDR) precipitation rates brokered from GPCP in the form of daily and monthly mean products, available from Oct 1996 onwards.

Next:

ICDR production. Use of MW data. CDR version 2 (in-house) will be based on the integration between microwave imager and sounders precipitation rate estimates to provide a global precipitation product on a regular grid.

Surface Radiation Budget

Monthly Mean of Surface Downwelling Longwave Radiation for July 1992

CM SAF

Service active since May 2018→ Currently brokering existing AVHRR-based datasets (CMSAF CLARA) to CDS.

Products:

Monthly means for **surface incoming shortwave radiation** (SIS), **surface outgoing shortwave radiation , surface downward longwave radiation**, **surface outgoing longwave radiation**, and daily means for **SIS** covering the period 1982-2015.
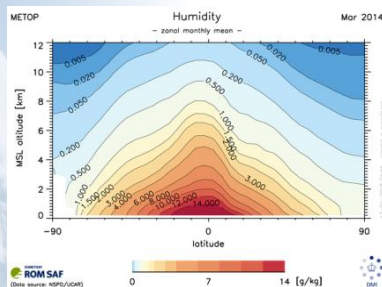
Next:

ICDR production. Complement the AVHRR CLARA product brokered from CM SAF with the CCI_Cloud (A)ATSR data record, and include S3 SLSTR.

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Water Vapour

Service active since May 2018→ Currently brokering existing datasets from ROM SAF, CM SAF and ESA DUE GLOBVapour to CDS.

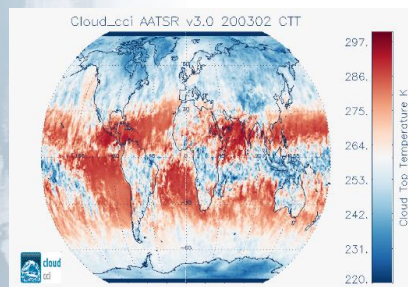**Products:**

CDR/ICDR of monthly mean of total column water vapour (TCWV), **specific humidity** (below 12km) from GPS RO and **upper tropospheric humidity** (UTH) from MW instruments, available from Oct 1996 onwards.

Next:

ICDR production. Heritage from the ESA Due GLOBVapour, CCI+ WV for TCWV product.

Cloud properties

Service active since May 2018→ Currently brokering existing datasets from AVHRR (CMSAF CLARA) and (A)ATSR (Cloud_CCI) to CDS.

Products:

Daily and monthly means for **cloud amount**, **cloud-top**, **cloud optical thickness**, and **cloud water path** covering the period 1982-2015 from AVHRR and 1995-2012 from (A)ATSR.
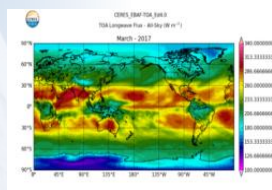
Next:

ICDR production. Complement the AVHRR CLARA product brokered from CM SAF with the CCI_Cloud (A)ATSR data record, and include S3 SLSTR.

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Earth Radiation Budget

Service active since May 2018→ Currently brokering existing ERB datasets (NASA CERES and Univ. of Maryland/NOAA HIRS, ESA Cloud_CCI (A)ATSR) to CDS.

Products:

CDR/ICDR of **TOA outgoing longwave radiation**, **TOA Reflected shortwave radiation**, **incoming solar radiation** provided as monthly mean for the periods: 2000-onwards for the NASA CERES, from 1979-onwards from HIRS, 1995-2012 from (A)ATSR. Daily **Total Solar Irradiance** (TSI) will be generated as a multi-sensor composite product from 1984 to 2017.

Next:

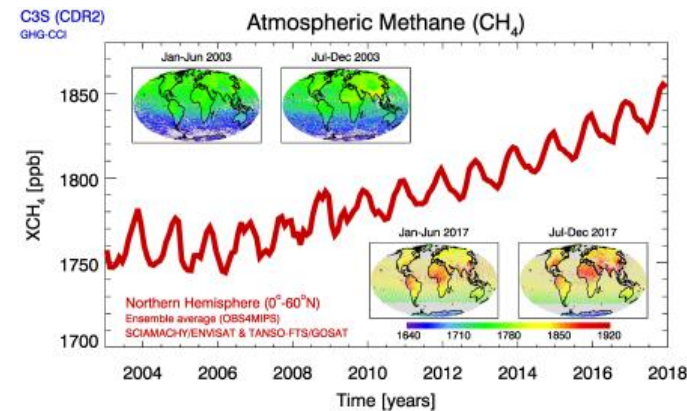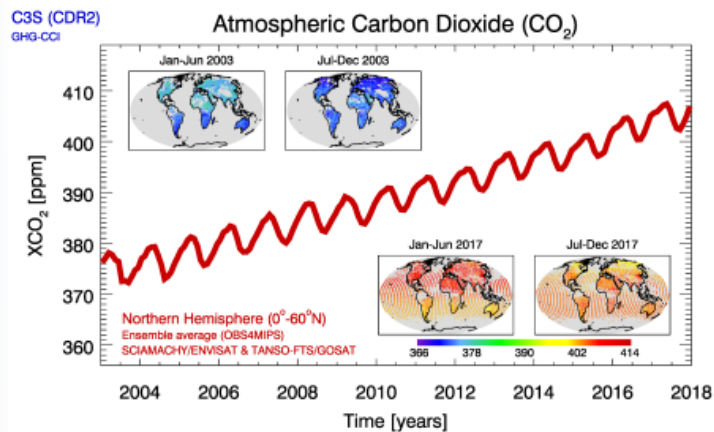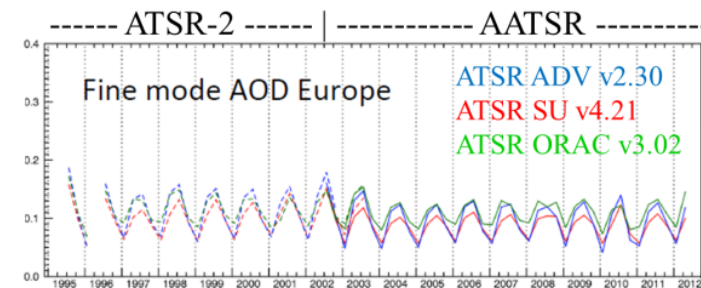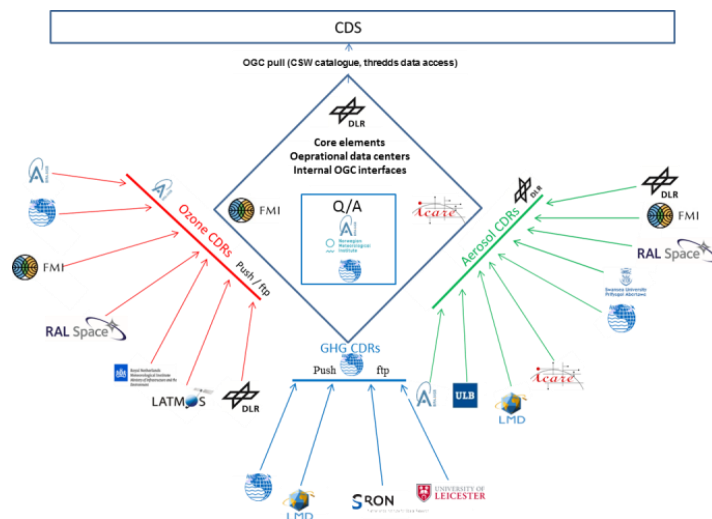ICDR production. Incoming radiation and ICDR of TOA fluxes derived from SLSTR (Cloud_CCI).
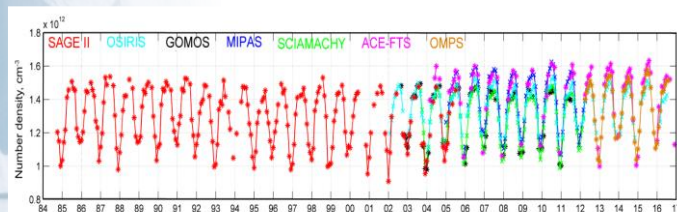
System based on a distributed ECV production, archive and data access.
Deliver to the Climate Data Store a suite of Satellite-based datasets on atmospheric composition covering four Essential Climate Variables: **ozone**, **aerosol properties**, **carbon dioxide (CO_2)** & **methane(CH_4)**
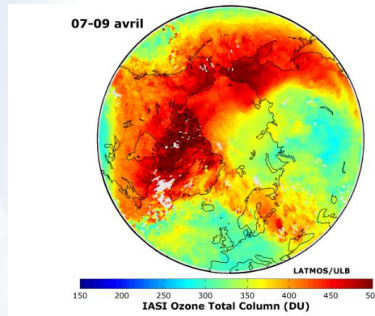
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Ozone

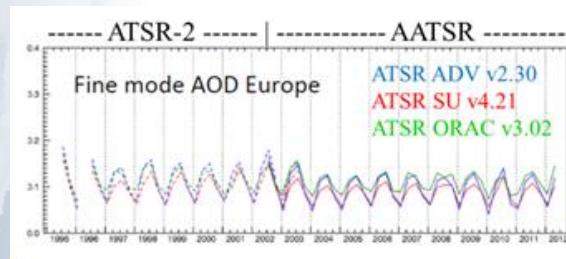**Service active since 2016**– Responsible entity: DLR

Products:

Total ozone columns, ozone profiles from limb and nadir sensors and multi-sensor reanalysis from past and present sounders.

Next:

Semi-annual extension into near real time.

Aerosol Properties

Service active since 2016– Responsible entity: DLR

Products:

Aerosol optical depth, layer height, single scattering albedo

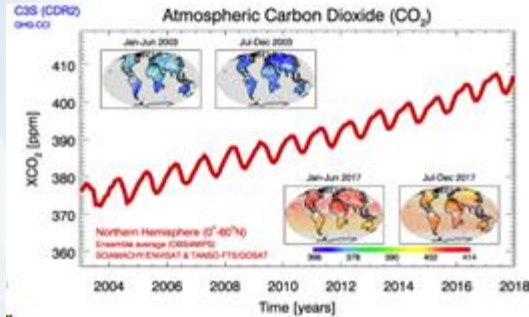**Next:**

Recently added observation from SLSTR on Sentinel 3; regular updates of records into near real time

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Carbon Dioxide

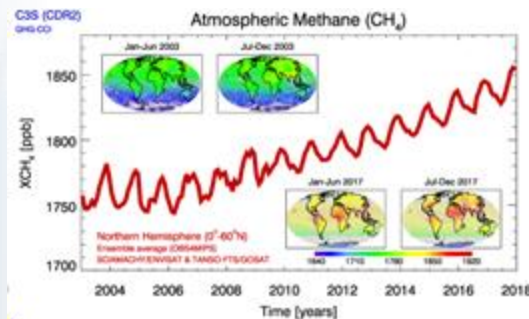**Service active since 2016** – Responsible entity: DLR

Products:

Level 2 column average carbon dioxide from individual sensors and merged

Next:

Yearly reprocessing of entire data record

Methane

Service active since 2016 – Responsible entity: DLR

Products:

Level 2 column average methane from individual sensors and merged

Next:

Inclusion of Sentinel 5p TROPOMI observations; Yearly reprocessing of entire data record

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Change
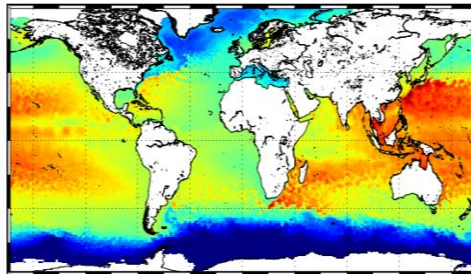
Sea Level

SST
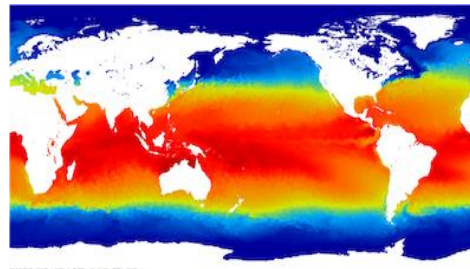
Sea Ice

Ocean Color

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Sea Level

Service active since 2016 – Responsible entity: CLS
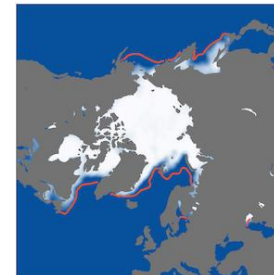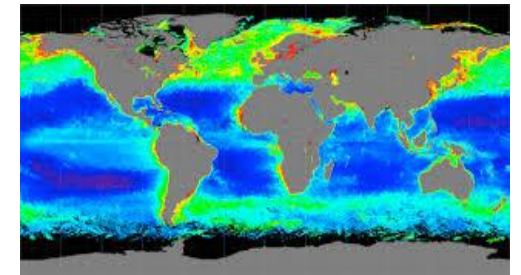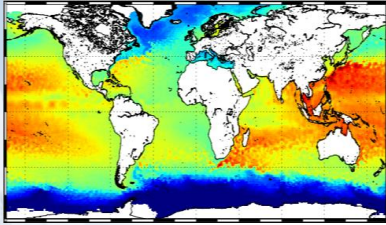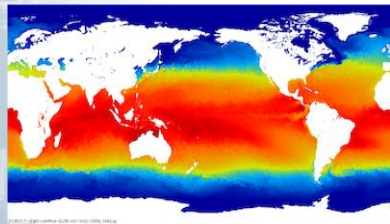
Products:

Ocean Dynamic topography and **ocean geostrophic velocities** (CDR/ICDR)
3 regions: Global ocean (0.25°), Mediterranean Sea (0.125°), Black Sea (0.125°)
Daily products from 1993 onward updated every 6 months

Next:

Integration of Sentinel-6/Jason-CS mission in production system to begin in 2020
Fully reprocessed record planned for 2021 in cooperation with CMEMS
Higher-resolution L4 gridded products for Medit. and Black Sea planned for 2021

SST

Service active since 2016
Responsible entities: UoReading and MetOffice (ICDR) + brokerage from SST CCI (CDR)

Products:

Global sea surface temperatures (CDR/ICDR)
Daily L3 and L4 products, 0.05° grid, from 1991 onward, ICDRs available within 5 days
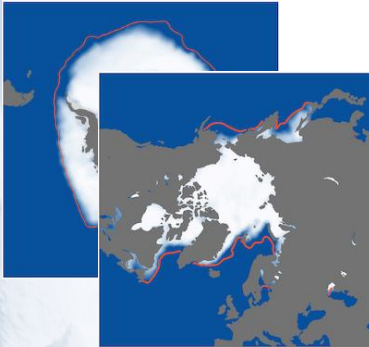
Next:

Upgrade of MetOp input stream to full resolution (1 km) planned for 2019
Use of MetOp-C and Sentinel-3B/SLSTR will be considered (currently AVHRR data from NOAA-19 and MetOp-A are used).

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Sea Ice

Service active since 2016

Responsible entities: Met Norway/DMI/AWI + brokerage from OSI-SAF for sea ice conc.

Products:

SI concentration (CDR/ICDR)**:** daily, 1978 onward, 12.5-km grid, N. and S. Hemis.
SI edge (CDR/ICDR)**:** daily, 2011 onward, 12.5-km grid, N. and S. Hemis.
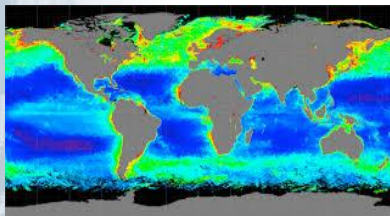**SI type** (CDR/ICDR): daily, 1991 onward, 25-km grid, N. Hemis. only
SI thickness (CDR/ICDR): monthly, 2002 onward, 25-km grid, N. Hemis. Only

Next:

Thickness: Extension of CDR back to 1993 using ERS-1/2 in cooperation with ESA CCI+
Edge/Type: Fully reprocessed records planned for 2021

Ocean Color

Service active since May 2018 – Responsible entity: PMLApps

Products:

Chlorophyll-a (CDR/ICDR)
Surface reflectance (CDR/ICDR)
Daily products on 4-km grid updated every 4 months
ICDR from 2017 onwards to extend CDR product from Ocean Color CCI (1997-2016)

Next:

Potential integration of Sentinel-3A/OLCI in production system
Potential increase in spatial resolution from 4km to 1km

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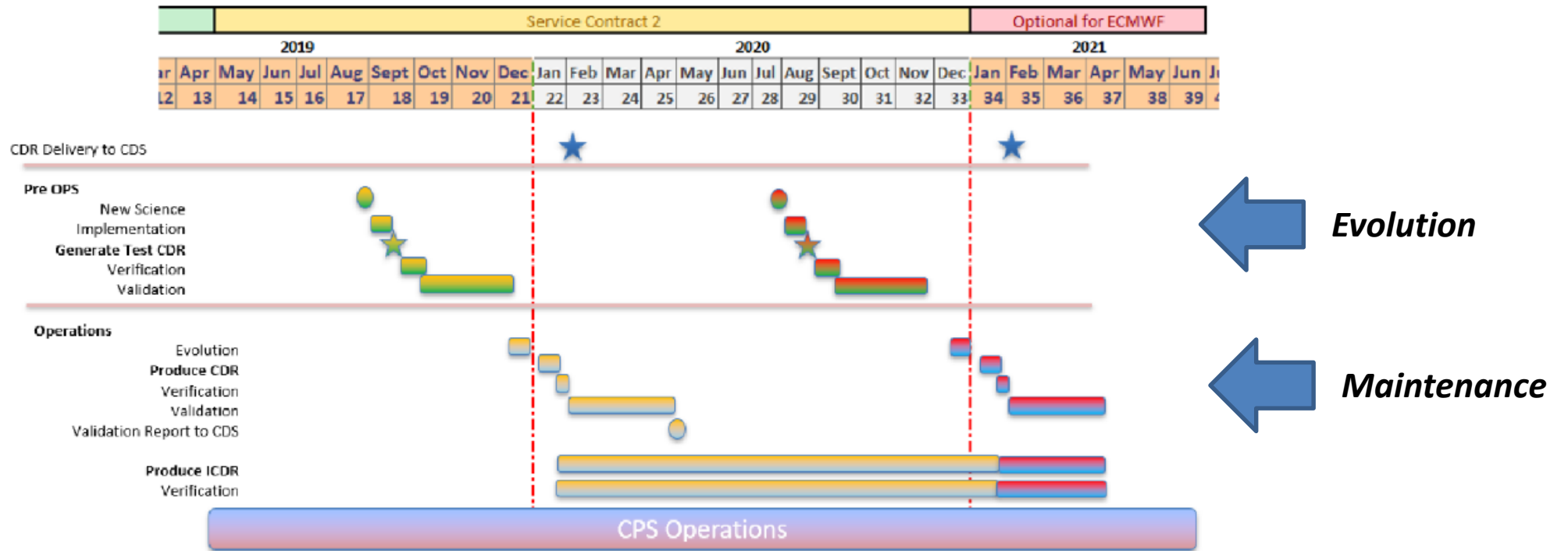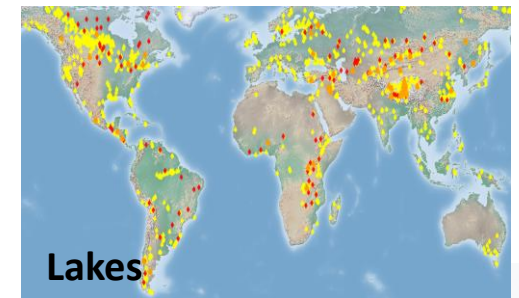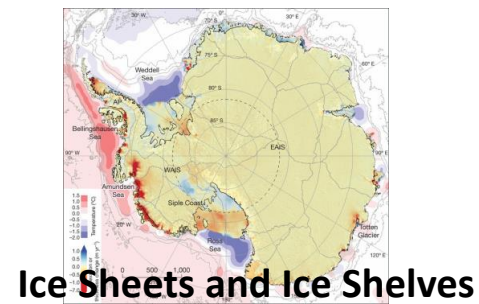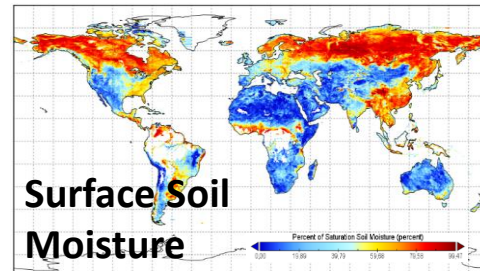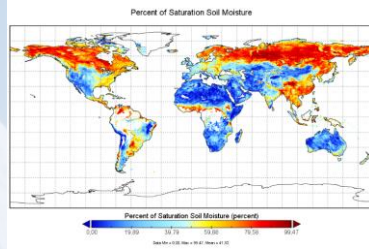

Figure 1: Service Timeline showing CPS set Up and CPS operations

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Soil Moisture

(Second phase) Service active since Nov 2018→ Timely generation of the ICDR within the 10 day production window.
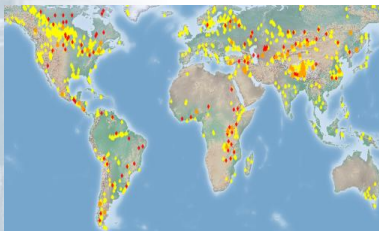
Products:

    3 Global products as CDR: **Passive** Sensors from 1978, **Active** sensors from 1991, **Combined** from 1978

Next (CCI dependent):

    Inclusion of SMAP in the CPS, update of L2 retrieval methods, improved error characterization, consistent use of GLDAS-Noah scaling reference

Lakes

Service active since Apr 2018→ CPS has been completed for both, LSWT & LWL and current transition to operations

Products:

    Lake Surface Water Temperature (CDR/ ICDR), Targets 1000 lakes worldwide, from 1995, daily monitoring

    Lake Water Level (CDR/ ICDR), Targets 155 lakes world wide, from 1992, daily to decadal monitoring

Next (Synergy with CCI+):

    LSWT: brokering of the Globolakes CDR (v4.0) and its evolution to include Metop B AVHRR.

    LWL: Evolution with inclusion of SLSTR (S3-A). Assessment of S3B SLSTR and SRAL.
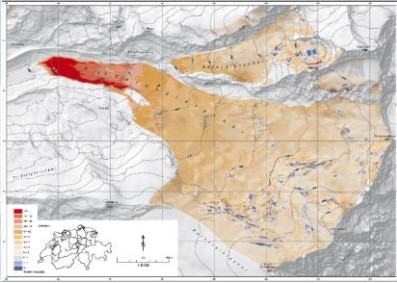
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Glaciers

(Second phase) service active since Jan 2019

Products:

**Glacier Area** CDR/ICDR - globally complete glacier outlines, > 30 years monitoring
Elevation Change CDR /ICDR –CDR from 1900 to present, ICDR focus on 2000-15
Mass Change CDR Annual update brokered from WGMS FoG database

Next:

New glacier inventories for around 2015 using S2A/B & Landsat 8, and from around 1985 from historic LTM data, improve RGI inventory around 2000. High-quality glacier elevation changes from DEMs & better assessment of glacier melt contribution to sea-level rise.

Ice Sheets
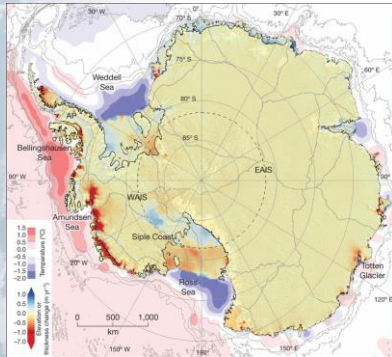
Service active since Apr 2018

Products:

Surface Elevation Change (CDR/ ICDR), Antarctic and Greenland from 1992, Monthly Updates
Ice Velocity (CDR/ ICDR), high resolution coverage, from 2014 for Greenland Ice Sheet
Gravimetric Mass Balance (CDR), Antarctic and Greenland from 2002 to 2017, Monthly basin values

Next:

Delivery of 25+ consistent dataset, addition of S3A to CPS, refined previous work with ENVISAT and CryoSat-2 datasets, cross-calibration between missions, possible brokering of GRACE data, 2018 map of IV Greenland
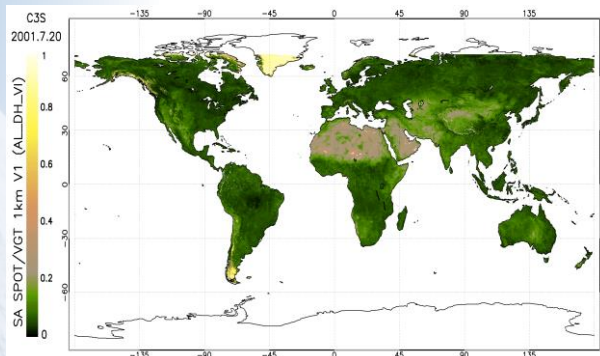
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Leaf Area Index

fAPAR

Fire Burnt Areas

Surface Albedo

Land Cover

Fire Radiative Power

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Albedo

(Second phase) service active since Apr 2018

- Continuous brokering v0 product from CGLS service & delivery of single-sensor CDRs v1.0 based on NOAA-AVHRR & SPOT-VGT, ICDR based on PROBA-V.
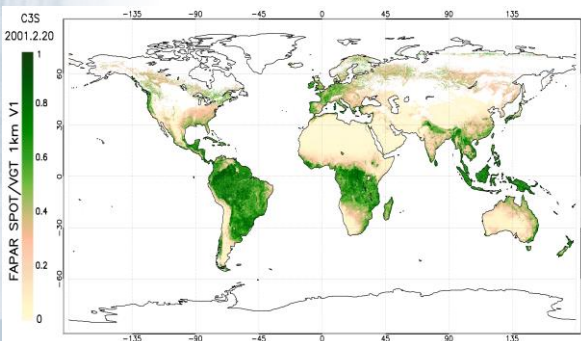
Products:

Albedo (broadband/Spectral directional & hemispherical) CDR/ICDR - global product based on NOAA-AVHRR, SPOT-VGT & PROBA-V

Next:

Pre-processing harmonization, consolidate CDRs towards multi-sensor approach (BRDF), Transition to S-3, ICDR provision with uncertainty and error propagation (1982-present)

LAI/fAPAR

(Second Phase) Service active since Apr 2018.

- Continuous brokering v0 product from CGLS service, delivery of single-sensor CDRs v1.0 based on NOAA-AVHRR & SPOT-VGT, ICDR v2.0 based on PROBA-V and TIP model .

Products:

LAI CDR/ ICDR, global product based on NOAA-AVHRR, SPOT-VGT & PROBA-V
fAPAR CDR/ ICDR, global product based on NOAA-AVHRR, SPOT-VGT & PROBA-V
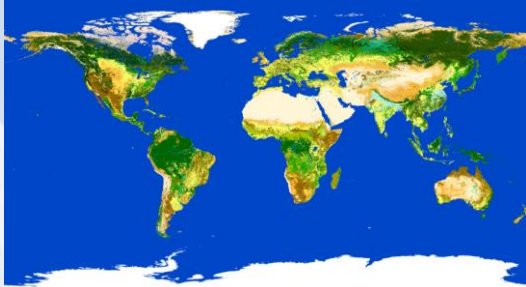
Next:

Pre-processing harmonization, consolidate CDRs towards multi-sensor approach, transition to S-3, ICDR provision with uncertainty and error propagation

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Land Cover

Service active since Apr 2018 → Sustained production and operationalisation of the process developed in ESA-CCI. No full dataset reprocessing is planned for this contract.
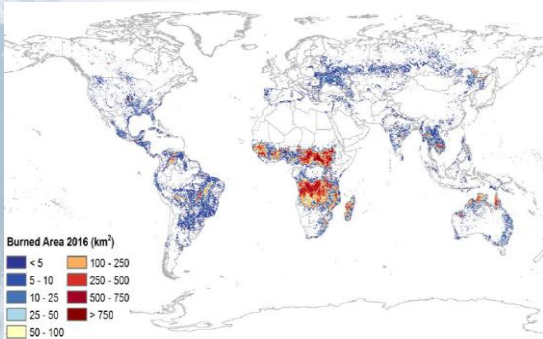
Products:

> **Land Cover map** CDR/ICDR - brokered maps at 300 m resolution (1992-2015). CDR completed for the years 2016-2019.

Next:

> Transition to S-3, Build further the validation reference database, Pre-processing of surface reflectance 2019.

Fire

Service active since Apr 2018 → Sustained production and operationalisation of the process developed in ESA-CCI. No full dataset reprocessing is planned for this contract.

Products:

> **Burned Area LAI** (CDR/ ICDR), brokered MODIS BA data set (2000-2016)
> **Fire Radiative Power** (ICDR) based on the algorithm of the operational FRP product of Sentinel-3 ground segment

Next:

> Brokering MODIS Fire CCI v5.1 Burned Area, adapting chains to S3 OLCI sensors. Extension of the reference perimeters to 2018- 2019, bring FRP into the service and prepare a strategy for its further evolution in C3S, intercomparison with CGL products.

Burned Area 2016 (km²)

< 5	100 - 250
5 - 10	250 - 500
10 - 25	500 - 750
25 - 50	> 750
50 - 100	

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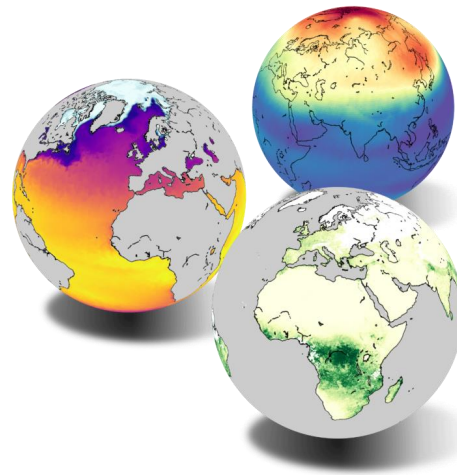**Climate Change**

With products that are

- o State-of-the-art products
  - o **Coordination with ESA CCI, EUMETSAT, etc., & other Copernicus services**
- o Long-term, consistent , complete (CDR)
  - o **Single/Multi sensor approach**
- o Regularly extended in time (ICDR)
  - o **Frequent updates of data records**
- o Gridded, aggregated
  - o **Meeting user requirements**

- o *Accessible & Tracible*
  - ✓ *Access through the Climate Data Store*
    - ✓ **Creation of adaptors, integration in CDS Toolbox**
  - ✓ *Documentation*
    - ✓ **Frequently supporting documentation produced in C3S (ATBD, PQAD, …)**
  - ✓ *Evaluation and Assessment*
    - ✓ **EQC, own QC procedures, benchmarking, evaluation of cross-ECV consistency**
  - ✓ *User support*
    - ✓ **Service desks opened for many services**
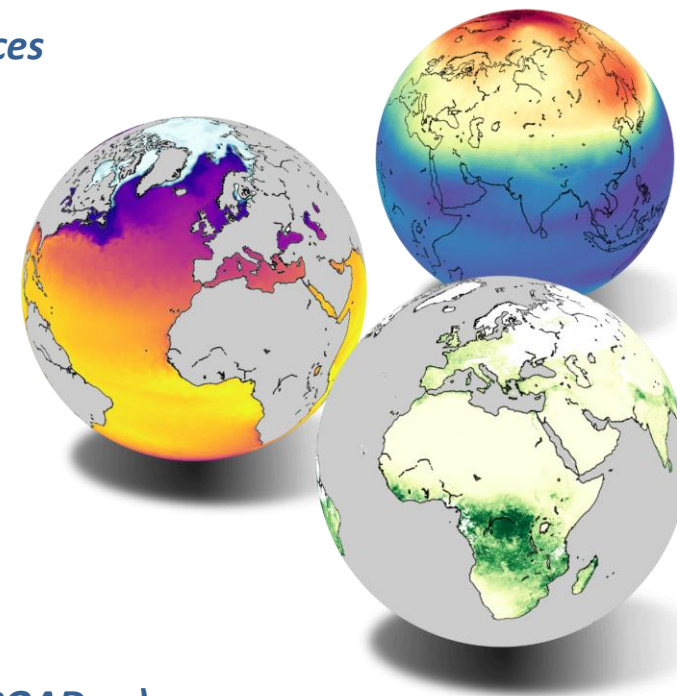
A n d   b e y o n d …

o   *Provision of datasets with estimation of uncertainty*

o   *Creation of use cases on-going*

o   *Promotional activities (Conferences, press releases, education events, workshops)*

o   *Contribution to the European State of climate; demonstrate the effectiveness of the inclusion of CDRs in climate monitoring*

o   *Contribution to the next IPCC AR6 report*

o   *Already providing key climate information to key stakeholders and policy makers*

Climate Change

Joaquin Munoz Sabater   Logout

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Soil moisture gridded data from 1978 to present

The system session is complete. Please report any issues to user support.

Overview   **Download data**   **Documentation**

This dataset provides estimates of **soil moisture** over the globe from a large set of satellite sensors. It is based on the ESA Climate Change Initiative soil moisture version 03.3 and represents the current state-of-the-art for satellite-based soil moisture climate data record production, in line with the "Systematic observation requirements for satellite-based products for climate" as defined by GCOS (Global Climate Observing System). Data are on a regular latitude/longitude grid expectedly with gaps in space and time.

When dealing with satellite data it is common to encounter references to Climate Data Records (CDR) and interim-CDR (ICDR). For this dataset, both the ICDR and CDR parts of each product were generated using the same software and algorithms. The CDR is intended to have sufficient length, consistency, and continuity to detect climate variability and change. The ICDR provides a short-delay access to current data where consistency with the CDR baseline is expected but was not extensively checked. The dataset contains the following products: "active", "passive" and "combined". The "active" and "passive" products were created by using scatterometer and radiometer soil moisture products, respectively. The "combined" product results from a blend based on the two previous products.

More details about the product are given in the Documentation section.

Volumetric Soil Moisture Uncertainty

Volumetric Soil Moisture Uncertainty (m3 m-3)
0,00   0,01   0,02   0,03   0,04   0,05

Contact

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License

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Publication Date

2018-10-25

Landing page
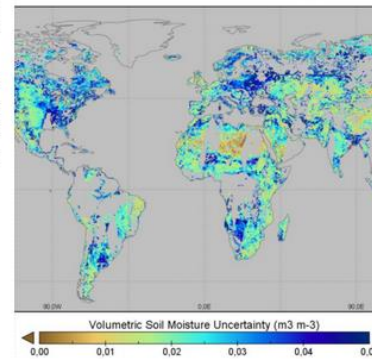
DATA DESCRIPTION	
Horizontal coverage	Global
Horizontal resolution	0.25°x0.25°
Temporal coverage	1978 to present
Temporal resolution	Day, 10-day and month
Update frequency	Depends on the product: 10-day for the ICDR and 6 month for the CDR.
File format	NetCDF
Data type	Grid

MAIN VARIABLES		
Name	Units	Description
Surface soil moisture	%	Content of liquid water in a surface soil layer of 2 to 5 cm depth expressed as the percentage of total saturation.
Volumetric soil moisture	$m^3 m^{-3}$	Content of liquid water in a surface soil layer of 2 to 5 cm depth expressed as m^3 water per m^3 soil.

Record updated 2019-03-21 11:41:04 UTC

European Commission

Europe's eyes on Earth

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Soil moisture gridded data from 1978 to present

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Overview   **Download data**   **Documentation**

- **Algorithm theoretical baseline document v2.2 (3.2M PDF)**

  Provides in-depth documentation on the algorithms used to derive the dataset(s).

- **Product user guide and specification document v2.3 (1.9M PDF)**

  Summarizes the characteristics of the dataset(s) in a concise manner with focus on: space and time extent and resolution; data formats, metadata and flags; description of variables, strengths and limitations.

- **Product quality assurance document v1.1 (2.5M PDF)**

  Describes the data quality assurance process applied by the data producer before release of the dataset(s).

- **Product quality assessement report v1.1 (3.4M PDF)**

  Provides the latest report on data quality obtained according to methodologies described in the product quality assurance document

- **Target requirements document v1.0 (845.7K PDF)**

  Summarises the minimum requirements identified for the dataset(s) regarding,among others, data quality, timeliness and data format.

- **Gap analysis document v1.0 (1.4M PDF)**

  Discusses identified gaps of the dataset(s) with respect to their target requirements.

- **System quality assurance document v1.1 (1.1M PDF)**

  Describes the processing chain and procedures in place at the data provides.

Documentation

ECVs in ESA-CCI & C3S

CCI	CCI+	C3S
	AG-Biomass	
Aerosol		Aerosol
Albedo		Albedo
Clouds		Clouds
		Earth Radiation Budget
		fAPAR
Fire		Fire
GHG		GHG
glaciers		Glaciers
Ice sheets		Ice Sheets
Land cover		Land Cover
	HR Land Cover	
		LAI
	Lakes	Lakes

CCI	CCI+	C3S
	LST	
Ocean colour		Ocean Colour
Ozone		Ozone
	Permafrost	
		Precipitation
	Salinity	
Sea ice		Sea Ice
Sea Level		Sea Level
	Sea State	
	Snow	
Soil Moisture		Soil Moisture
SST		SST
		Surface Radiation Budget
	Water vapor	Water Vapour

Both in CCI and C3S

In CCI/CCI+ and not in C3

In C3S and not in CI/CCI+