Climate Change

Copernicus Climate Change Service(C3S)

Land, Hydrology and Cryosphere Service

Richard Kidd and C3S 312b Partners

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European Commission

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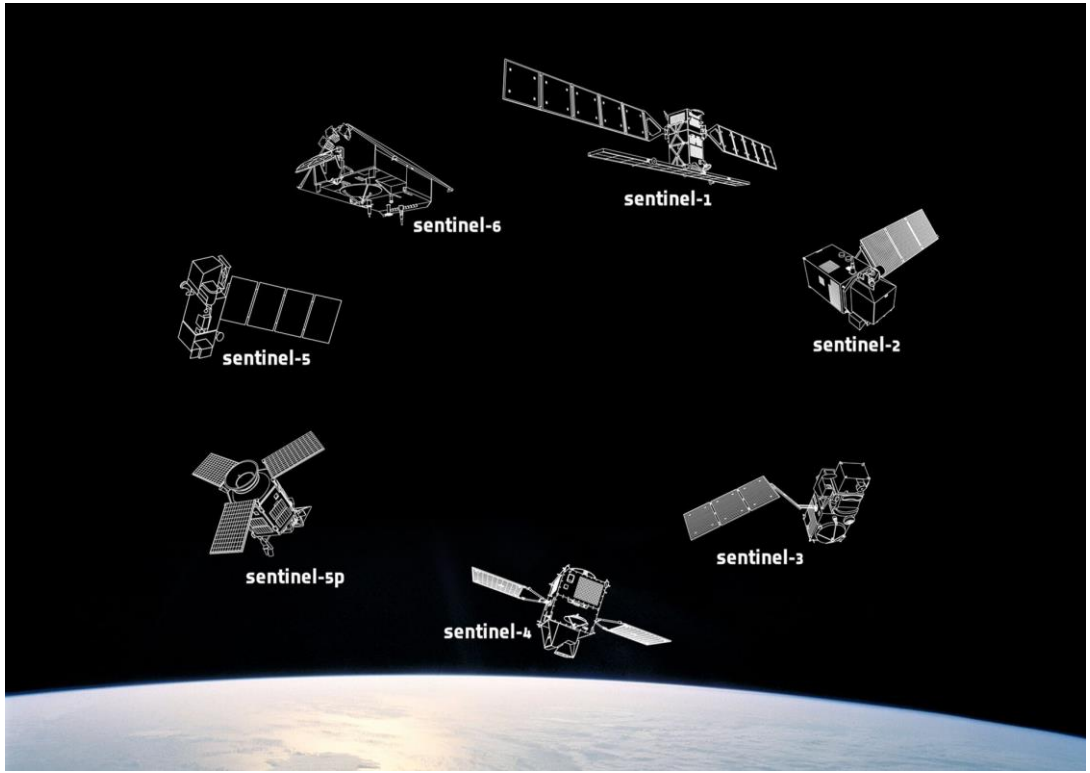
Copernicus: The Sentinel Family



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Copernicus Programme

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What is Copernicus Climate Change Service?

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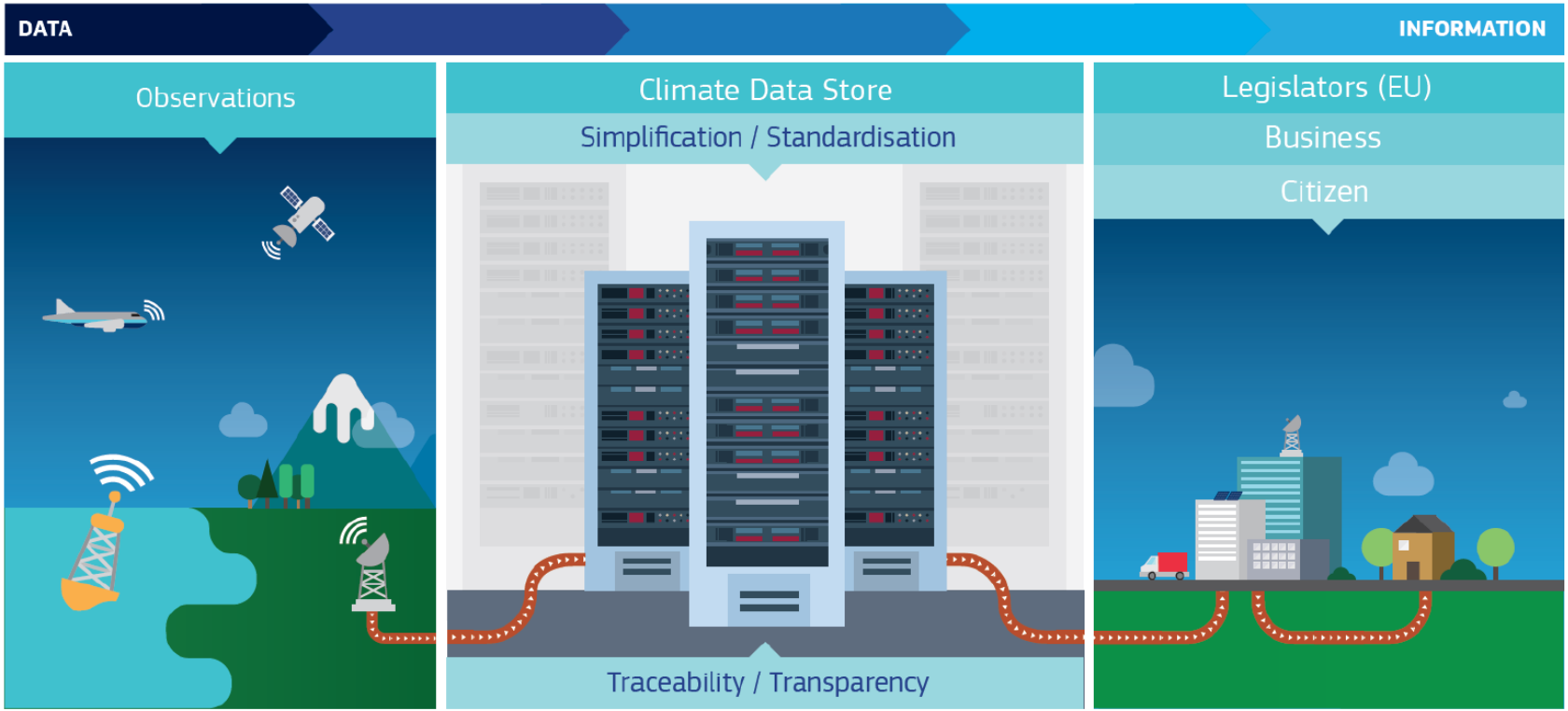

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The Climate Data Store (CDS)

Climate Change

C3S Goal: Reliable Access to high-quality Climate Data through the Climate Data Store

Climate datasets

The CDS provides a single point of access to a variety of climate datasets, including observations, reanalyses of past observations, seasonal forecasts and climate model projections.

Read more >

Browse the CDS data catalogue >

Tools for using climate data

The CDS features a powerful toolbox for processing and visualising data in the cloud, so that users can develop climate information suited to their needs.

Read more >

Browse the CDS toolbox >

Sectoral impacts

We provide real applications of CDS data and tools that demonstrate how businesses, governments and citizens can make informed decisions on how to mitigate the effects of climate change.

Read more >

Quality assurance

We provide quality assurance for all CDS data, tools and applications. We continuously engage with users and independent experts to evaluate our services and ensure that they are fit for purpose.

Read more >

https://climate.copernicus.eu/what-we-do

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The Climate Data Store (CDS)

What is on the CDS

- Over 87 datasets (May 2021)
- Satellite Observations (ECV's GCOS, currently 22 ECV's on CDS)
- Surface Observations
- Global Reanalysis (ERA5 and ERA5 Land)

Information from the CDS is:

- Used as a **Monitoring tool** – Monthly Bulletins (ESoTC), **Climate Indicators**
- Used for **Seasonal predictions** – to manage climate risks

Not just making information available

- Also – quality assessment – **Evaluation Quality Control**

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ECVs as Climate Indicators

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The European State of the Climate (ESoTC) uses C3S ECV products as climate indicators

Since 1957

Global loss of ice thickness of around

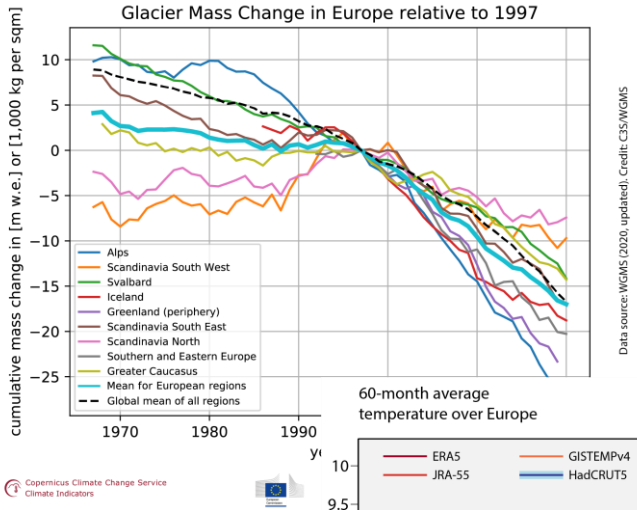
30 m ▼

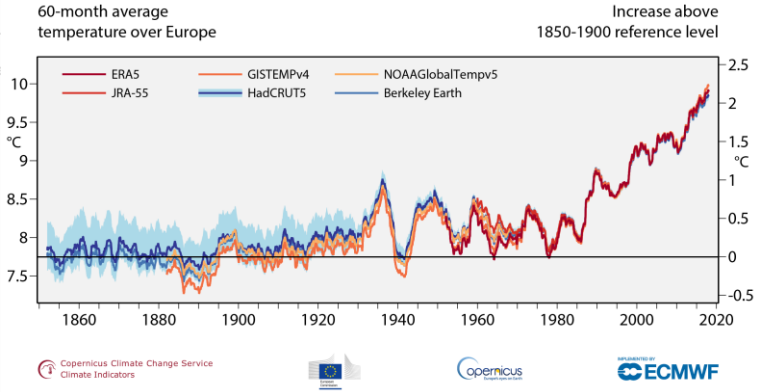
Since 1960s

European loss of ice thickness

4–35 m ▼

Southwestern Scandinavia and the Alps, respectively





Since 1850–1900, an increase

Globally, of around

1.2°C ▲

Europe, of around

2.2°C ▲

Arctic, estimate of around

3°C ▲

For five-year averages

https://climate.copernicus.eu/climate-indicators/

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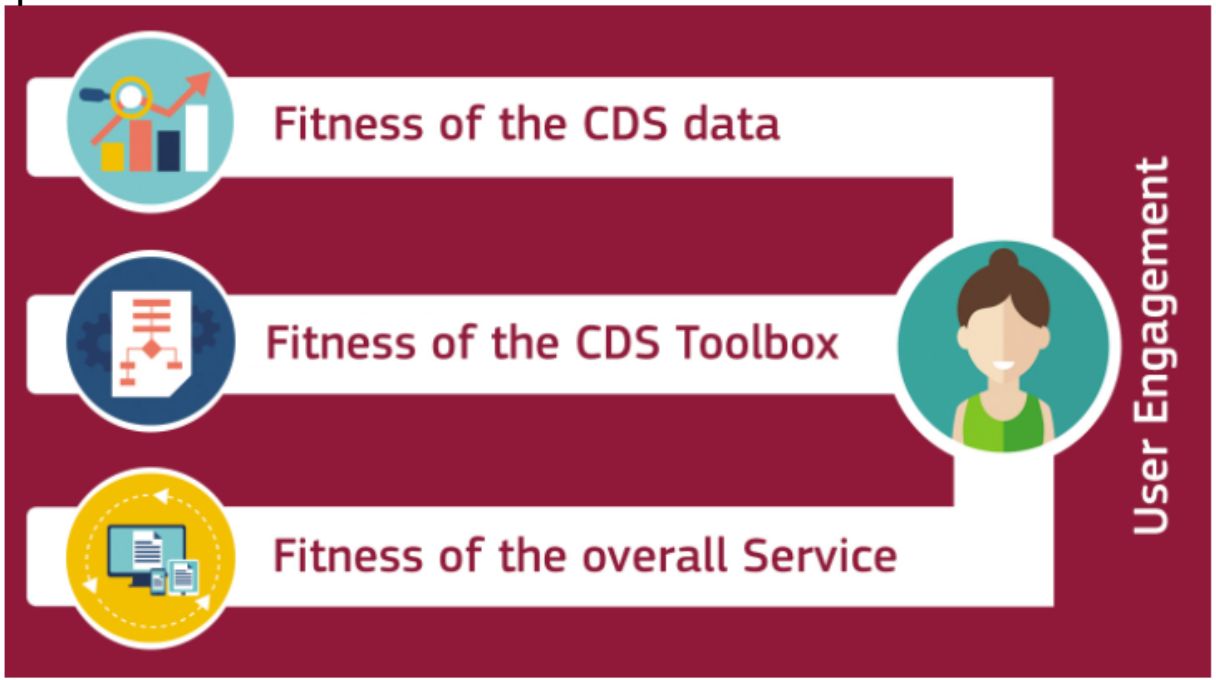
Evaluation and Quality Control (EQC)

As an operational service, CDS not only provides access to data and information, but also provides Quality Assurance on those products – Since Oct 2020 this is implemented via a framework that ensures an independent assessment of, and report On, the products



https://climate.copernicus.eu/quality-assurance-climate-data-store

Satellite-Based Essential Climate Variables

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Atmospheric physics
- Precipitation
- Surface radiation budget
- Water vapour
- Cloud properties
- Earth radiation budget

Coordination with CM-SAF / ROM SAF / ESA CCI / Uni. Maryland / NASA / NOAA

Atmospheric composition
- Carbon dioxide
- Methane
- Ozone
- Aerosol

Coordination with ESA-CCI and other national projects

Ocean
- Sea surface temperature
- Sea level
- Sea ice
- Ocean colour

Coordination with ESA-CCI / OSI-SAF

Land hydrology & cryosphere
- Lakes
- Glaciers
- Ice sheets & ice shelves
- Soil moisture

Coordination with ESA-CCI, GloboLakes, Arc-Lake, HydroWeb

Land biosphere
- Albedo
- Land cover
- Fraction of absorbed photosynthetic
- Leaf area index
- Fire

Coordination with ESA-CCI, CGL, QA4ECV, LSA-SAF

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ECV's for Land Hydrology and Cryosphere

Lot 4 Land Hydrology and Cryosphere ECVs
Led by **EODC**
Scientific Lead: **Wolfgang Wagner**
Service Manager: **Richard Kidd**

The **LHC service** provides **11 products** over the **four ECV** thematic areas of **Soil Moisture, Glaciers, Lakes**, and **Ice Sheets and Ice Shelves.**

Soil Moisture

TU WIEN DEPARTMENT OF GEODESY AND GEOINFORMATION

VanderSat

Science Lead: TU Wien
Wouter Dorigo
Service Manager: EODC
Christoph Reimer

Glaciers

University of Zurich[UZH]

enveo

Science Lead: Uni Zurich
Michael Zemp
Service Manager: Uni Zurich
Frank Paul

Lakes

University of Reading

CLS
COLLECTE LOCALISATION SATELLITES

Science Lead: Uni Reading
Christopher Merchant
Service Manager: Uni Reading
Laura Carrea

Ice Sheets and Ice Shelves

UNIVERSITY OF LEEDS

DTU Space
National Space Institute

enveo

Science Lead: Uni Leeds
Andrew Shepherd
Service Manager: UCL
Lin Gilbert

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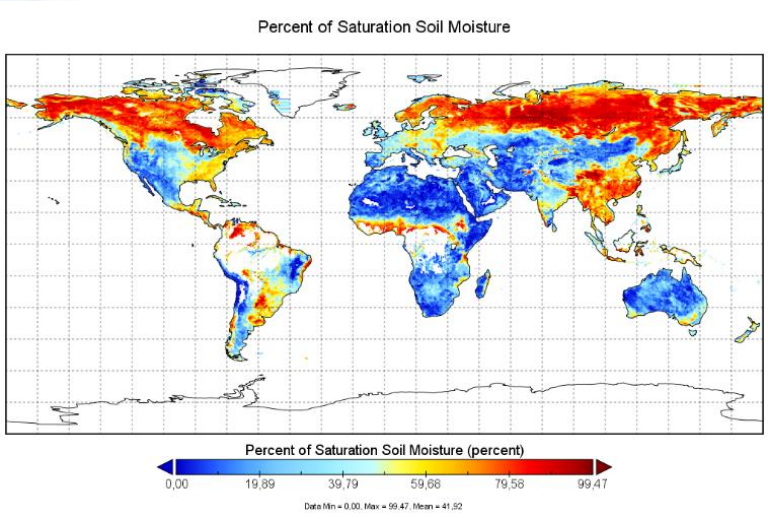
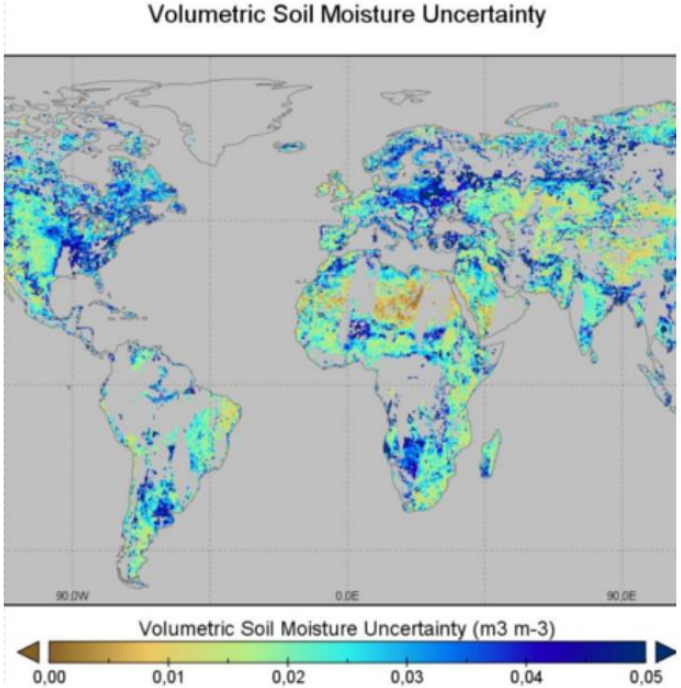
Surface Soil Moisture ECV

3 Global products as CDR **Passive** Sensors from 1978,
Active sensors from 1991, **Combined** from 1978
All also provided as ICDR in NRT on a decadal basis





ECV's for Land Hydrology and Cryosphere

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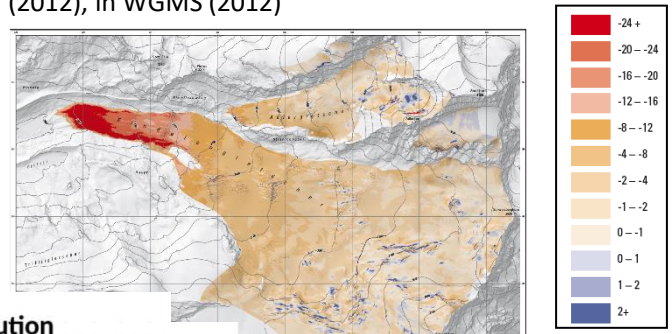
Glaciers ECV

Glacier Area CDR/ICDR - globally complete glacier outlines, > 30 years monitoring

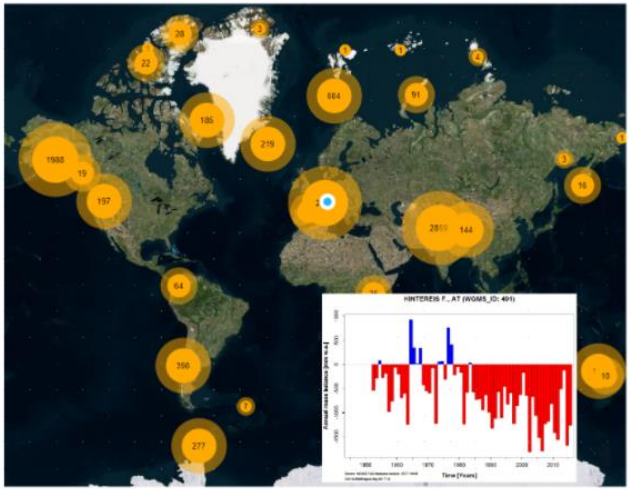
Elevation Change CDR /ICDR –CDR from 1900 to present, ICDR focus on 2000-15

Mass Change CDR Annual update brokered from WGMS FoG database

Findel Glacier, Zermatt (CH): Elevation Change 2005 to 2010: - 3.2m, Joerg et al. (2012), in WGMS (2012)

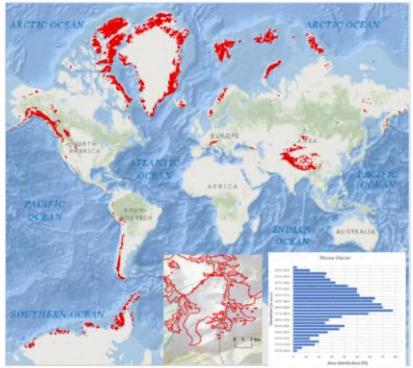


Glacier Elevation



Worldwide distribution of glaciological series. The blue dot refers to the location of the Hintereis Ferner glacier in Austria. Its glaciological serie is shown in the graph.

Glacier Distribution



Worldwide distribution of glacier outlines associated with individual glacier parameter including hypsometry. The inset figures show a close up of the outlines of the Rhone glacier in Switzerland and the corresponding hypsometry.

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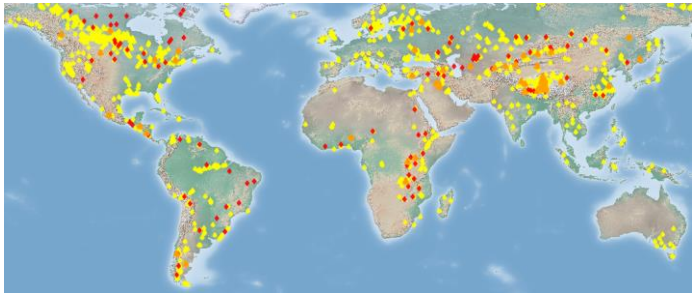
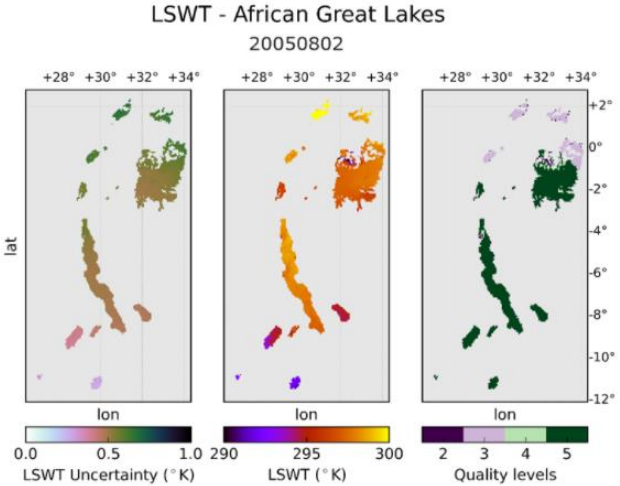
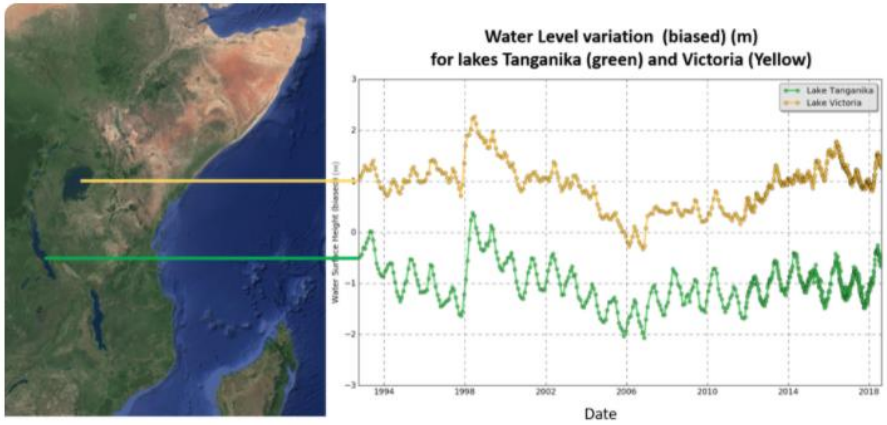
Lakes ECV

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 1993, daily to decadal monitoring



Lakes and Reservoirs monitored (Yellow: Lake Surface Water Temperature, Red: Lake Water Level : Orange (LSWT, LWL) both variables available





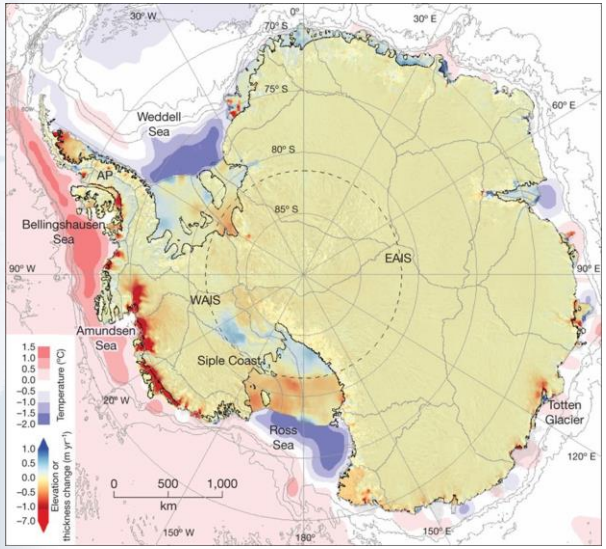
ECV's for Land Hydrology and Cryosphere

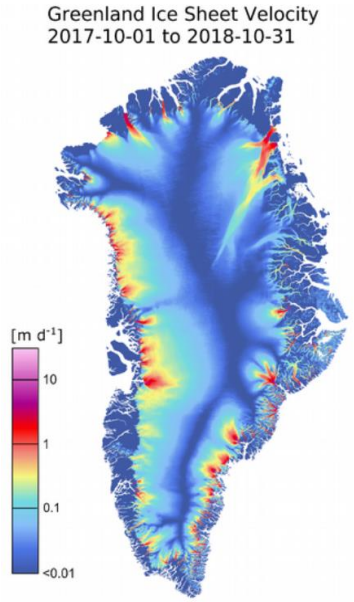
Ice Sheets and Ice Shelves ECV

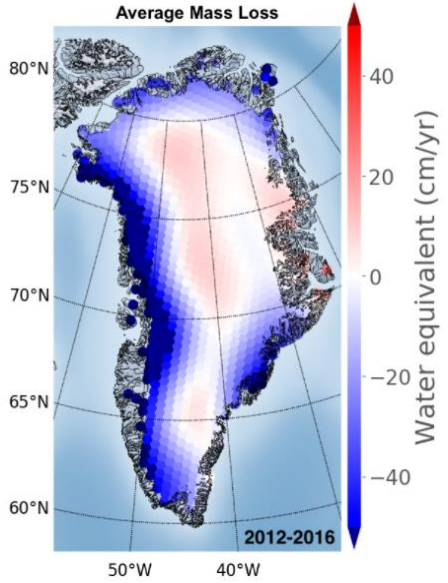
Surface Elevation Change (CDR/ ICDR), Antarctic and Greenland from 1992, Monthly Updates

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







*Surface Elevation Change: Shepherd, Fricker and Farrell, Nature **558**, 223-232, 13 June 2018*

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LHC on CDS – Soil Moisture

Home Search Datasets Applications Your requests Toolbox FAQ Live

Search results

Soil Moisture

All Datasets

Sort by
- **Relevancy**
- Title
- Type

- Product type
- Variable domain
- Spatial coverage
- Temporal coverage
- Sector
- Provider

Showing 1-20 of 29 results for **Soil Moisture** x

Soil moisture gridded data from 1978 to present

Soil **moisture** gridded data from 1978 to present

Reforecasts of river discharge and related data by the European Flood Awareness System

Soil **moisture** for three **soil** layers Snow water equivalent It also provides static data on **soil** depth

Seasonal forecasts of river discharge and related data by the European Flood Awareness System

once a month consisting of: River discharge **Soil** **moisture** for three **soil** layers Snow water equivalent

River discharge and related historical data from the European Flood Awareness System

time series of: River discharge **Soil** **moisture** for three **soil** layers Snow water equivalent It also

Seasonal reforecasts of river discharge and related data by the European

European Commission

LHC on CDS – Soil Moisture Overview

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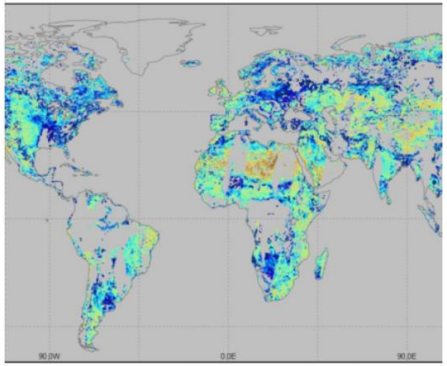
Soil moisture gridded data from 1978 to present

Overview | Download data | Quality assessment | 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

Volumetric Soil Moisture Uncertainty



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copernicus-support@ecmwf.int

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LHC on CDS – Soil Moisture Download

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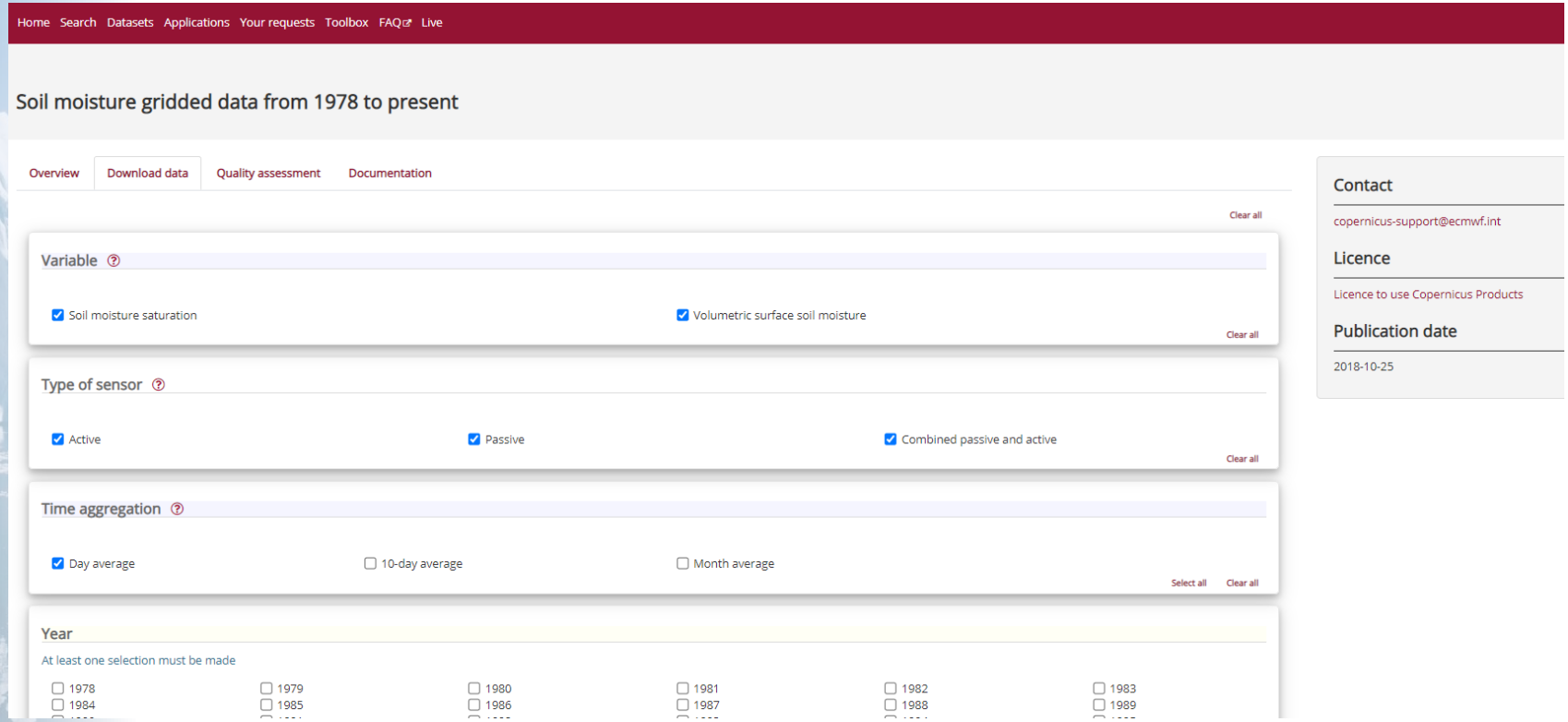

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LHC on CDS – Soil Moisture Documentation

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Soil moisture gridded data from 1978 to present

Overview | Download data | Quality assessment | Documentation

- Documentation for version 201706
- Documentation for version 201812
- Documentation for version 201912
- Documentation for version 202012

  - **Algorithm theoretical baseline document v3.0 (PDF)**

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

  - **Product user guide and specification document v3.0 (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 v3.0 (PDF)**

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

  - **System quality assurance document v3.0 (PDF)**

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

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Show API request Hide Toolbox request

Post to Toolbox API endpoint.

```
import cdstoolbox as ct

@ct.application(title='Download data')
@ct.output.download()
def download_application():
    data = ct.catalogue.retrieve(
        'satellite-soil-moisture',
        {
            'variable': [
                'soil_moisture_saturation', 'volumetric_surface_soil_moisture',
            ],
            'type_of_sensor': [
                'active', 'combined_passive_and_active', 'passive',
            ],
            'time_aggregation': 'day_average',
            'year': '2021',
            'month': '05',
            'day': [
                '01', '02', '03',
                '04', '05', '06',
                '07', '08', '09',
                '10', '11', '12',
                '13', '14', '15',
                '16', '17', '18',
                '19', '20',
            ],
            'type_of_record': 'icdr',
            'version': 'v201912.0.0',
        }
    )
    return data
```

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CDS Toolbox- Soil Moisture Anomalies

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Toolbox Editor

Applications Data Documentation

Search for app or example

- your workspace
  - LWL data
  - LSWT Data
- examples
  - 00 Hello World
  - 01 Retrieve data
  - 02 Plot map
  - 03 Extract time series and plot graph
  - 11 Calculate time mean and standard deviation
  - 12 Calculate climatologies
  - 21 Calculate regional mean and anomalies
  - 31 Calculate trends
  - 41 Calculate GDD

Satellite Soil Moisture Anom... Console Your queue Runtime profile

Layout Copy Run

```
import cdstoolbox as ct

layout = {
    'input_ncols': 1,
    'input_align': 'top'
}

product_sensor_variable = {
    'COMBINED': ('combined_passive_and_active', 'volumetric_surface_soil_moisture'),
    'ACTIVE': ('active', 'soil_moisture_saturation'),
    'PASSIVE': ('passive', 'volumetric_surface_soil_moisture'),
}


@ct.application(title='Monthly Satellite Soil Moisture Anomalies', layout=layout)
@ct.input.dropdown('product',
                   label='Satellite Soil Moisture Product:',
                   values=product_sensor_variable.keys(),
                   help="Select a Satellite Soil Moisture product")
@ct.input.text('lons',
               label='Longitude(s) (comma separated):', type=str,
               default='6.375, 147.375, -5.625',
               help="Pass list of WGS84 Longitudes (between -180 and 180) of points to plot (comma
separated)")
@ct.input.text('lats',
               label='Latitude(s) (comma separated):', type=str,
               default='50.625, -35.125, 41.375',
               help="Pass list of WGS84 Latitudes (between -90 and 90) of points to plot (comma separated)")
@ct.input.slider('clim_range', min=1992, max=2019, step=1,
                 default=(1992,2010), label='Climatology Baseline:',
                help="Select the baseline for calculation of the climatology.")
@ct.output.markdown()
@ct.output.livefigure()
@ct.output.livefigure()
def satellite_sm_anomaly(product, lons, lats, clim_range):

    """
    Application main steps:

    - Select and retrieve one of 3 available satellite Soil Moisture products from the CDS.
    - Extract monthly time series at all selected locations
```

Monthly Satellite Soil Moisture Anomalies

Satellite Soil Moisture Product:

COMBINED

Longitude(s) (comma separated):

6.375

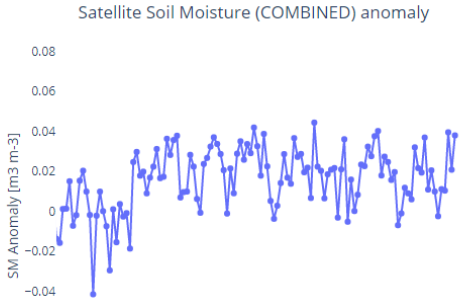
Latitude(s) (comma separated):

50.625

Climatology Baseline:

from 1992 to 2010

Satellite Soil Moisture Anomalies This application shows how to retrieve different Satellite Soil Moisture products from the CDS. It extracts monthly time series from the image stack to calculate and visualise climatologies and anomalies using the toolbox functions. The baseline for calculation of climatologies can be selected by the user. The number and location of visualised points can also be changed.



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Welcome to the Climate Data Store

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Free Full and Open Access to Data

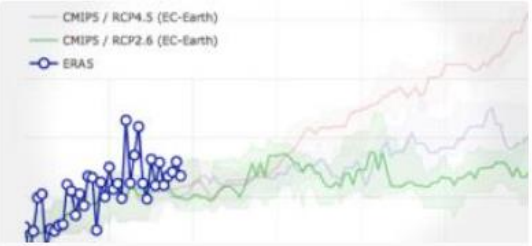
Welcome to the Climate Data Store

Dive into this wealth of information about the Earth's past, present and future climate.

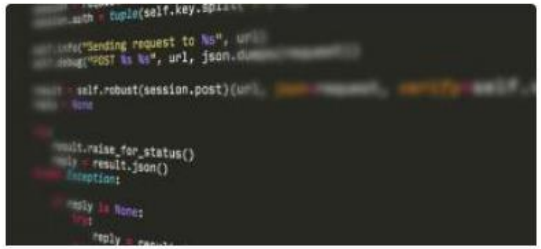
It is freely available and functions as a one-stop shop to explore climate data. Register for free to obtain access to the CDS and its Toolbox.

We are constantly improving the services and adding new datasets. For more information, please consult the catalogue, our FAQ or the C3S forum.

Enter search term(s) | All | Search



Climate Data Store **Toolbox**



Climate Data Store **API**

Access the **C3S Forum**

https://cds.climate.copernicus.eu/#!/home

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Acknowledgements

C3S 312b Lot 4: Land, Hydrology and Cryosphere Service implemented by:

eodc

VanderSat

In cooperation with

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University of Zurich[UZH]

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National Space Institute

Slides 3, 4 from:
C3S webinars on regional climate projections for Europe
https://climate.copernicus.eu/c3s-webinars-regional-climate-projections-europe

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