

C3S service offer on climate projection datasets



Climate Change

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Outline

- **What are climate projections?**
- **What is the C3S' Climate Data Store (CDS)?**
- **What climate projection datasets are published in the CDS?**



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WHAT ARE CLIMATE PROJECTIONS?



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Climate projections

Climate projections are numerical model simulations constrained by future evolution of greenhouse gas concentrations and also other factors as aerosol and land use changes for instance (projections are not forecasts or predictions)

- The Global Climate Models (GCMs) are coupled Earth system models, which describe the entire climate system (atmosphere, ocean, land, cryosphere, biosphere and their interaction)
- Regional Climate Models (RCMs) refine information for a specific region (the models are similar than that of the limited area models for NWP)
- Due to the underlining uncertainties in climate projections, they should be also evaluated in terms of ensembles in order to understand the robust climate change features, but also the uncertainties



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Climate projections: international cooperations

- **Climate projections are fostered by international cooperations on global and regional level (WMO WCRP)**
- **Global: CMIP (Climate Model Intercomparison Project), now CMIP5 and especially CMIP6 (5th and 6th phase)**
- **Regional: CORDEX (Coordinated Regional Climate Downscaling Experiment) project**
- **CMIP and CORDEX results are underpinning the IPCC assessments reports (AR6 is coming soon)**



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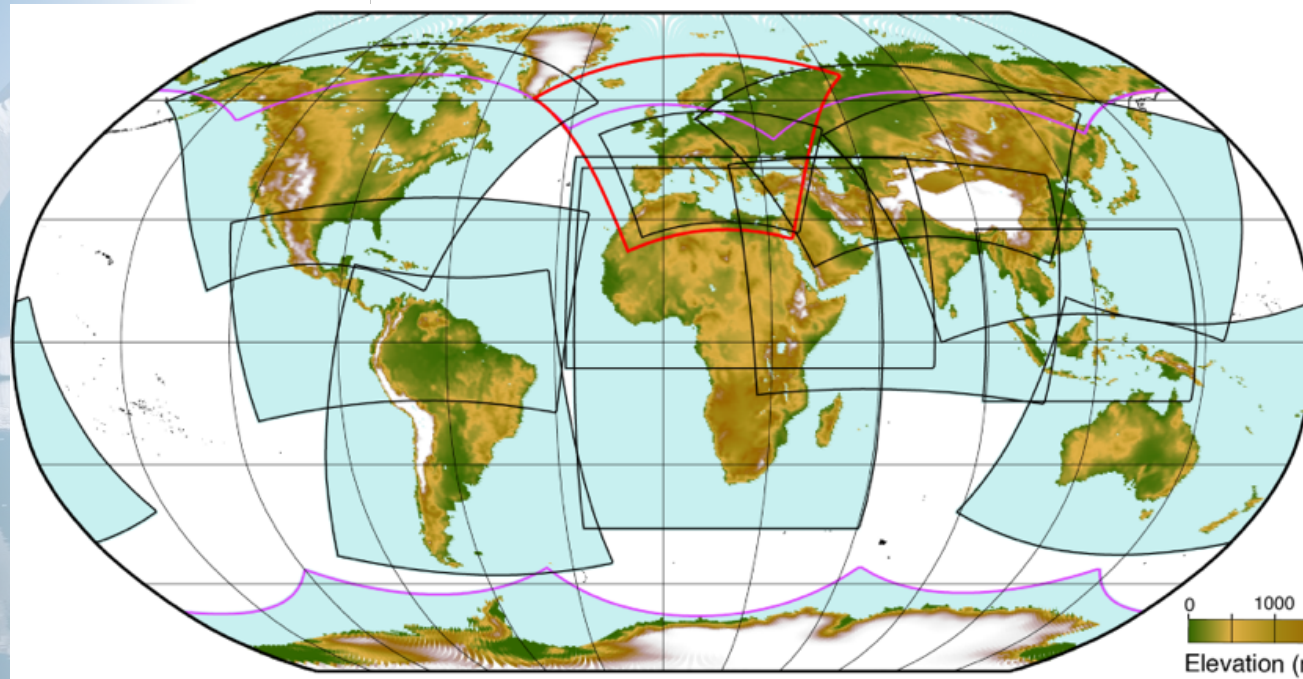
How C3S contributes to the international climate projection landscape?

- C3S supported to have additional RCM simulations for Europe (EURO-CORDEX, 12km resolution, more than 130 simulations altogether, being half of it funded by C3S) → significantly larger ensemble than usual for Europe
- C3S supported to curate and quality control simulations from all over the World (14 CORDEX domains covering the main land masses of the Globe)



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The 14 CORDEX domains (published in the CDS)



- 1: South America (SAM)
- 2: Central America (CAM)
- 3: North America (NAM)
- 4: Europe (EUR)
- 5: Africa (AFR)
- 6: South Asia (WAS)
- 7: East Asia (EAS)
- 8: Central Asia (CAS)
- 9: Australasia (AUS)
- 10: Antarctica (ANT)
- 11: Arctic (ARC)
- 12: Mediterranean (MED)
- 13: Middle East North Africa (MNA)
- 14: South-East Asia (SEA)



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COPERNICUS CLIMATE DATA STORE (CDS) AND TOOLBOX



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Climate Data Store (CDS) – free data access

cds.climate.copernicus.eu

The screenshot shows the homepage of the Climate Data Store. At the top, there are logos for the European Union, Copernicus, ECMWF, and Climate Change Service. A navigation bar includes links for Home, Search, Datasets, Toolbox, and Help & support. The main content area features a welcome message: "Welcome to the Climate Data Store" and "Dive into this wealth of information about the Earth's past, present and future climate." Below this is a search bar with a dropdown menu set to "All" and a "Search" button. Three featured tiles are visible: "Climate Data Store Toolbox" with a line graph, "Climate Data Store API" with a code snippet, and "Access climate reanalysis (ERA5)" with a map of Europe.

The CDS contains **observations**, global and regional **climate reanalyses**, global and regional **climate projections** and **seasonal forecasts**. It also contains generic and **sectoral climate indicators**.

The CDS is designed as a **distributed system**, providing improved access to **existing datasets** through a **unified web interface**.

Manual download forms and API requests

Toolbox for data manipulations!



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CLIMATE PROJECTION DATASETS PUBLISHED IN THE CDS



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Climate projection catalogue entries in the CDS

Raw climate projections:

- Global climate projections: CMIP5 and CMIP6
- Regional climate projections: CORDEX
- Plenty of derived sectoral datasets (📊) and applications (🏢) based on global and regional climate models; some examples:
 - Global (CMIP): Arctic route availability, Arctic sea ice content, ocean fronts data, *agroclimatic indicators*, marine biogeochemistry data, eutrophication indicators, fish abundance and catch data...
 - Regional (CORDEX): number of heatwave days and cold spells, temperature statistics, *hydrology* related indicators, ocean surface wave indicators, water level change, performance indicators for offshore *wind farms*, *energy* indicators, indicators for (mountain) *tourism*, fire danger indicators...



CDS (cds.climate.copernicus.eu): how to find?

projection

All Applications Datasets

Showing 1-41 of 41 results for projection x

Water sector indicators of hydrological change across Europe from 2011 to 2095 derived from climate simulations

CMIP

All Applications Datasets

Showing 1-14 of 14 results for CMIP x

CMIP5 monthly data on pressure levels

CORDEX

All Applications Datasets

Showing 1-20 of 23 results for CORDEX x

- CORDEX regional climate model data on single levels**
CORDEX regional climate model data on single levels
- The number of heat wave days for European countries derived from climate projections**
application makes use of two European-wide definitions: the Climatological EURO-CORDEX and Euroheat project
- Climatic suitability for the presence and seasonal activity of the Aedes albopictus mosquito for Europe derived from climate projections**
winter and summer or for the whole year, based on a bias-adjusted EURO-CORDEX dataset. Then, the
- Heat waves and cold spells in Europe derived from climate projections**
winter and summer or for the whole year, based on a bias-adjusted EURO-CORDEX dataset. Then, the
- Temperature statistics for Europe derived from climate projections**
-CORDEX dataset. The statistics are averaged for 30 years as a smoothed average from 1971 to 2100. This
- Hydrology related climate impact indicators from 1970 to 2100 derived from bias adjusted European climate projections**
Downscaling Experiment (EURO-CORDEX). The dataset contains Essential Climate Variable (ECV) data in the form
- European temperature statistics derived from climate projections**
bias-adjusted EURO-CORDEX climate projections dataset. Temperature statistics are typically used in



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Global climate projections: CMIP5

CMIP5: daily/monthly and single/pressure levels

CMIP5 monthly data on single levels

Overview | Download data | Quality assessment | Documentation

Experiment: Overview | Download data | Quality assessment | Documentation

At least one selection must be made.

AMIP

This is a new feature, work in progress. Should any inconsistency be found, please report to copernicus-support@ecmwf.int

Variable: The CDS datasets are assessed by the Evaluation and Quality Control (EQC) function of C3S independently of the data supplier. EQC encompasses a framework of processes aimed to assure technical and scientific quality harmonized across all dataset types available in the CDS. During the EQC process, the documentation provided with the dataset is scrutinized and data are checked for usability and reliability.

At least one selection must be made.

10m wind speed
 10m v-component of wind
 Eastward turbulent flux
 Maximum 2m temp
 Mean sea level pressure
 Near-surface relative humidity
 Northward turbulent flux
 Sea ice fraction
 Sea ice thickness
 Sea surface temperature
 Sea surface height
 Snow depth over sea
 Soil moisture content
 Surface sensible heat flux
 Surface solar radiation
 Surface snow amount
 TOA outgoing clear-sky radiation
 TOA outgoing shortwave radiation
 Total cloud cover

Variable: 2m temperature

Model: BNU-ESM (BNU)

Experiment: RCP 8.5 ✕

Variable:

Model:

At least one selection must be made.

Inmcm4 (INM, Russia)
 ACCESS1-3 (BoM-CSIRO)
 bccr-csm1-1-m (BCC, China)
 CCSM4 (NCAR, USA)
 CESM1-CAMS (NCAR, USA)
 CESM1-WACCM (NCAR, USA)
 CMCC-CM (CMCC, Italy)

CMIP5 monthly data on single levels

Overview | Download data | Quality assessment | Documentation

- CMIP5 data in the Copernicus Climate Data Store
- CMIP5 essential information (.html)

Specific information on how climate projections are served and presented in the CDS Catalogue with particular information on CMIP5 and CMIP6.

The link above provides simple and direct information on CMIP5. It also works as an entry point for more in-depth documentation on CMIP5 data and experiments.



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Global climate projections: CMIP6

CMIP6: one catalogue entry for everything (daily and monthly temporal resolution or single and pressure levels for instance, also temporal and spatial subsetting!)

CMIP6 climate projections

Overview Download data Documentation

Temporal resolution

At least one selection must be made

- Monthly Daily

Experiment

At least one selection must be made

- Historical SSP1-1.9 SSP1-2.6
 SSP4-6.0 SSP3-7.0 SSP5-8.5

Level

At least one selection must be made

- Single levels 1 hPa
 20 hPa 30 hPa
 100 hPa 150 hPa
 300 hPa 400 hPa
 700 hPa 850 hPa

Variable

At least one selection must be made

- Air temperature
 Daily maximum near-surface air temperature
 Eastward near-surface wind
 Grid-cell area for ocean variables
 Moisture in upper portion of soil column
 Near-surface relative humidity
 Near-surface wind speed

- SAM0-UNICON (South Korea)
 UKESM1-0-LL

TaiESM1

Temporal subset

- Whole available temporal range

With this option selected the entire available temporal range will be provided.

- Temporal range

Start:

1850-01-01

End:

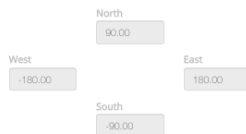
2300-12-31

Geographical area

- Whole available region

With this option selected the entire available area will be provided.

- Sub-region extraction



Format



Regional climate projections: CORDEX

CORDEX regional climate model data on single levels

Overview Download data Documentation

Domain ?

At least one selection must be made

- Africa
- Australasia
- East Asia
- Middle East and North America
- South-East Asia

- Antarctic
- Central America
- Europe
- North America
- South Asia

Experiment ?

At least one selection must be made

- Evaluation
- Historical
- RCP 2.6

Horizontal resolution

At least one selection must be made

- 0.11 degree x 0.11 degree
- 0.22 degree x 0.22 degree
- Interpolated 0.44 degree x 0.44 degree

Temporal resolution ?

At least one selection must be made

- Daily mean
- 3 hours
- Monthly mean
- 6 hours

Variable

At least one selection must be made

- 2m air temperature
- 2m surface specific humidity
- 10m v-component of the wind
- Maximum 2m temperature in the last 24 hours
- 200hPa temperature
- 200hPa v-component of the wind
- 850hPa u-component of the wind
- Evaporation
- Mean sea level pressure
- Orography
- Surface solar radiation downwards
- Surface upwelling shortwave radiation
- Total run off flux

- 2m relative humidity
- 10m u-component of the wind
- 10m wind speed
- Minimum 2m temperature in the last 24 hours
- 200hPa u-component of the wind
- 200hPa geopotential
- 850hPa v-component of the wind
- Land area fraction
- Mean precipitation flux
- Surface pressure
- Surface thermal radiation downward
- Total cloud cover

Global climate model ?

At least one selection must be made

- CCCma-CanESM2 (Canada)
- CSIRO-BOM-ACCESS1-0 (Australia)
- CSIRO-QCCCE-CSIRO-Mk3-6-0 (Australia)
- HIRSH-EC-EARTH (Ireland)
- IPSL-CM5A-MR (France)
- MDHC-HadGEM2-ES (UK)
- MPI-M-MPI-ESM-MR (Germany)
- NCC-NorESM1-M (Norway)
- NOAA-GFDL-ESM2M (USA)

- CNRM-CERFACS-CM5 (France)
- CSIRO-BOM-ACCESS1-3 (Australia)
- ERA-Interim (ECMWF)
- IPSL-CM5A-LR (France)
- MIROC-MIROCC5 (Japan)
- MPI-M-MPI-ESM-LR (Germany)
- NCAR-CCSM4 (USA)
- NOAA-GFDL-GFDL-ESM2G (USA)

Regional climate model

At least one selection must be made

- AWI-HIRHAM5 (Germany)
- BCCRM-RegCM4-3 (Turkey)
- CLMcom-BTU-CCLM4-8-17 (Germany)
- CLMcom-CCLM4-8-17-CLM3-5 (Germany)
- CLMcom-ETH-COSMO-crCLM (Switzerland)
- CLMcom-KIT-CCLM5-0-15 (Germany)
- CNRM-ALADINS2 (France)
- CNRM-ALADIN63 (France)
- CYI-WRF351 (Cyprus)
- ECHAM5-ENSEMBLES (Hungary)
- GBRICS-REM02015 (Germany)
- ICTP-RegCM4-3 (Italy)
- ICTP-RegCM4-6 (Italy)
- INM-REM-CM4-4 (India)
- IPSL-WRF381P (France)
- KNMI-RACMO21P (Netherlands)
- KNMI-RACMO22T (Netherlands)
- MGO-RRCM (Russia)
- MDHC-HadRM3P (UK)
- NMI-RegCM4-3 (Hungary)
- QUB-RegCM4-7 (USA)
- RMI-UGent-ALARO-0 (Belgium)
- SMHI-RCA4 (Sweden)
- UA-WRF (USA)
- UHDIH-WRF361H (Germany)
- Ulg-MAR36 (Belgium)
- UNSW-WRF360K (Australia)
- UQAM-CRCM5 (Canada)

- BCCR-WRF331 (Norway)
- CCCma-CanRCM4 (Canada)
- CLMcom-CLM-CCLM4-8-17 (EU)
- CLMcom-CCLM5-0-2 (Germany)
- CLMcom-HZG-CCLM5-0-15 (Germany)
- CMCC-CCLM4-8-19 (Italy)
- CNRM-ALADINS3 (France)
- CSIRO-CCAM-2008 (Australia)
- DMI-HIRHAM5 (Denmark)
- GERICS-REM02009 (Germany)
- GUP-CCLM4-8-18 (Germany)
- ICTP-RegCM4-4 (Italy)
- ICTP-RegCM4-7 (Italy)
- INPE-Eta (Brazil)
- ISU-RegCM4 (USA)
- KNMI-RACMO22E (Netherlands)
- LMD-LMDZANEMOMED8 (France)
- MDHC-HadREM3-GA7-05 (UK)
- MPI-CSC-REM02009 (Germany)
- NCAR-WRF (USA)
- OURANOS-CRCM5 (Canada)
- RU-COFE-RegCM4-3 (Thailand)
- SMHI-RCA4-SN (Sweden)
- UCAN-WRF3411 (Spain)
- Ulg-MAR311 (Belgium)
- UNSW-WRF360J (Australia)
- UNSW-WRF360L (Australia)
- UQAM-CRCM5-SN (Canada)



CDS: some user statistics for CMIP5, CMIP6 and CORDEX

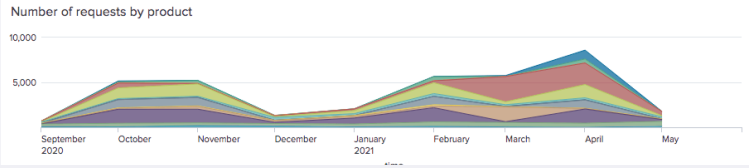
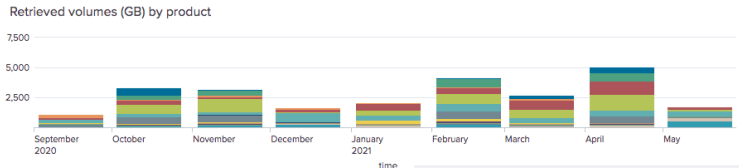
Active users
1,211

Number of completed requests
36,281

Number of failed requests
1,766

Retrieved volume in GB
24,911.85 GB

CMIP5



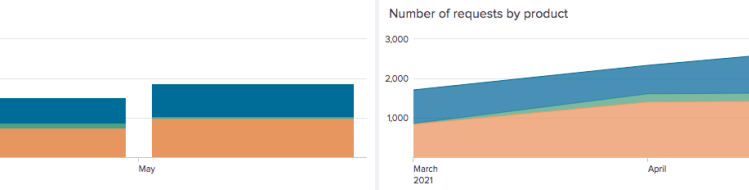
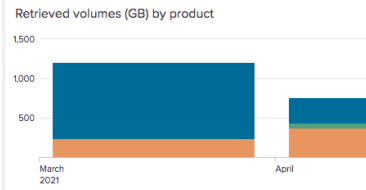
CMIP6

Active users
432

Number of completed requests
6,889

Number of failed requests
4,591

Retrieved volume in GB
2,901.49 GB



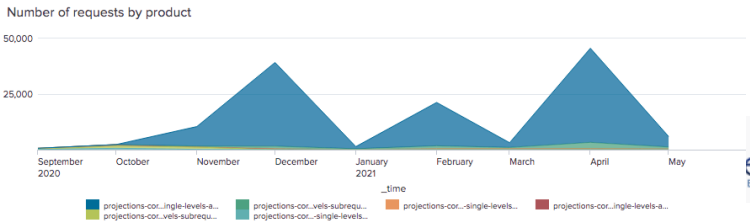
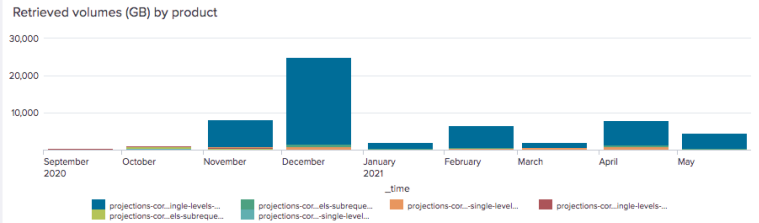
Active users
450

Number of completed requests
129,866

Number of failed requests
9,889

Retrieved volume in GB
57,888.43 GB

CORDEX





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FURTHER READING AND LISTENING



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Further reading and listening (1)

Recent web articles on the C3S website (climate.copernicus.eu)

- **CMIP6:** <https://climate.copernicus.eu/latest-projections-future-climate-now-available>
- **CORDEX:** <https://climate.copernicus.eu/worldwide-regional-climate-projections-now-available-through-c3s>
- **ECMWF Newsletter article: "New climate projection datasets in Copernicus" (p14, spring, 2021)**
<https://www.ecmwf.int/sites/default/files/elibrary/2021/19991-newsletter-no-167-spring-2021.pdf>
- **C3S webinars on regional climate projections for Europe (presentations, videos...)**
<https://climate.copernicus.eu/c3s-webinars-regional-climate-projections-europe>



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Further reading and listening (2)

Short videos about climate projections

- **What are climate models and projections? (Francisco Doblas-Reyes)**
https://climate.copernicus.eu/sites/default/files/2021-05/Francisco_Doblas_Reyes.mp4
- **EURO-CORDEX – The need for and use of additional simulations (Erik Kjellström)**
https://climate.copernicus.eu/sites/default/files/2021-05/Erik_Kjellstrom.mp4
- **What is the benefit having worldwide CORDEX information? (José Manuel Gutiérrez)**
https://climate.copernicus.eu//sites/default/files/2021-05/Manuel_Guiterrez.mp4



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**MANY THANKS FOR YOUR
ATTENTION!**