Interreg Co-funded by the European Union

Alpine Space

MOSAIC

Deliverable 1.2.1 - Catalogue of data sources relevant for analyzing past and future trends of climate change-related impacts

Version	Date	Author(s)/Coordinator	Changes
1.0	31 Oct 2023	Shelby Corning	First version
1.1	31 Oct. 2023	Frederic Berger & Clément Lattelais	Second version

Contents

Summary

This report in Work Package (WP) 1 serves to catalogue the data to be provided by partners in the scope of the MOSAIC project to achieve the objectives of the project; namely, to analyze past and future trends of climate-change related impacts. The contents of this report, as part of D.1.2.1, are current as of the most recent version date. Changes to data availability are expected throughout the course of the project, which runs for 36 months.

The data sets in this catalogue and report have been surveyed or identified by partners of the project consortium and have been or will be provided for analysis and eventual visualization on the web GIS atlas to be produced as the pinnacle of WP1. The available data are comprised of a combination of open-source, closed-source, and visualization-only data sets, and are marked as such.

As of the publishing date of this version of the report, there are a total of 48 maps, layers, or other data identified for the project and thus included in this report. Categories have been identified and defined to help group data sets. The identified categories include:

- climate and weather;
- topography;
- land use and land cover;
- forests, functions, and tree species;
- socio-economic; and
- disturbances and hazards.

The work for this report has been supervised by the MOSAIC Project Partner 7 (IIASA) to encompass the requirements of A1.1 – Data collection and assessment, and to netter prepare and structure tasks related to A1.2 – Data harmonization and processing.

Note to the reader: This deliverable will be regularly updated between now and the end of the project in order to take account of new sources and available data (e.g., updating of satellite data, the EU Copernicus site, cartographic productions of the project, etc.). To this end, data mining and harvesting is an ongoing activity of the MOSAIC project consortium, covering all of its workpackages.

Data Formatting and Requirements

Geographic Coordinate Systems (GCS)

To promote ease of harmonization and merging of data sets, data on the scale of the alpine space (as defined by Interreg Alpine Space, seen in Figure 1) are to be provided in the projection system WGS84 whenever possible. They may optionally be provided in a local GCS at a future point for inclusion into the web GIS atlas knowledge hub. Data on a local/regional scale may be provided in a local GCS to account for improved projection on a finer scale.

Extent and Alpine Space (AS) Boundary

Data which are available for the entirety of the alpine space or beyond are to be clipped to the alpine space boundary defined in the scope of the ALPTREES project, to promote and ensure ease of collaboration and continuity of Interreg AS projects and their output. Data available on a smaller scale (eg at the city, county, province, or country level) will be provided as-is. Anytime the AS is referred to, such as in the extent of a data set, this is what it is referring to.

Data Categories

Surveyed and identified data has been separated first by category, then by time frame: historical, current, and future (projected). In instances where multiple data sets are available for one variable, all data sets are listed. The categories are as follows:

- climate and weather (table 1, 2);
- topography (table 3);
- land use and land cover (table 4);
- forests, functions, and tree species (table 5, 6);
- socio-economic (table 7); and
- disturbances and hazards (table 9, 10)

A complete (non-separated) list of data is found in the appendix.

Climate and weather data

Both climate data sets in table 1 contain daily data related to temperature at noon (C), relative humidity at noon (%), 24-hour accumulated precipitation (mm), and wind speed (m/hr at 10m). These data sets provide a baseline for historical and recent weather conditions and are necessary to calibrate and validate various models which depend on weather data. Further, they allow for comparison of projected future climate conditions.

Table 1. Historical climate and weather data

Data set	CHELSA climate data	ERA5 dynamic downscaled climate data
Format	netcdf	netcdf
Spatial Resolution	1km x 1km	2.2km x 2.2km
Temporal Resolution	Daily	Daily
Extent	Interreg Alpine Space	(34.8° - 48.59° N; 3.91° - 19.93° E)
Time Range	2001-2020	1981-2022
Geographic Coordinate System (GCS)	WGS84	WGS84
Source	CHELSA	CMCC

Several future climate data sets have been provided for this project and are described in further detail in table 2. They include both RCP and SSP scenarios, which provide essential information on possible future weather conditions in the alpine space and partner countries. There is larger uncertainty as to which future scenario may play out; therefore, having multiple scenarios available in the scope of this project allows for users to consider multiple possibilities and make their own judgement. Further, where projections overlap with their predictions, we can ascertain that the likelihood of this overlap is more likely.

Table 2. Future (projected) climate and weather data

Data set	CMIP5 HadGEM2
Scenario(s)	RCP 2.6, 4.5, 6.0, 8.5
Format	netcdf
Spatial Resolution	1km x 1km
Temporal Resolution	Daily
Extent	Interreg Alpine Space
Time Range	2050, 2070
Geographic Coordinate System (GCS)	WGS84
Source	CHELSA

Topography

For topographic data, initial DEM is provided in the form of radar data from NASA's Shuttle Radar Topography Mission (SRTM). Pending availability across the alpine region and within countries, LiDAR data with higher resolution may be included at a later date. This will allow for calculations related to slope, aspect, and elevation. An experimental raster layer will be provided, which converts these variables into a per-pixel hours of daylight map, important especially for disturbances such as bark beetle but also for eg snow stability and avalanches due to changes in the crystallization process due to temperature and sunlight exposure.

Table 3. Topographic data

Data set	DEM	Hours of daylight/pixels
Format	Raster (.tif)	Raster (.tif)
Spatial Resolution	30m x 30m	100m x 100m
Temporal Resolution	Annual	Unknown
Extent	Alpine space	Alpine space
Time Range	2014	Unknown
Geographic Coordinate System (GCS)	WGS84	WGS84
Source	NASA - SRTM	IIASA

Land use and land cover

One land use and one land cover map have so far been identified for this project. For the alpine space, Copernicus Global Land Cover data is available for land cover information, which is necessary for calculations related to hazards such as erosion and wildfires, as well as consideration of ideal protection forest placement in relation to human developments. A land use map is available for Italy, which details land use by area (ha) and can be used to highlight interactions between human activity and natural hazards and disturbances. Details can be seen in table 4.

Table 4. Historical land use and land cover data

Data set	Land use map	Copernicus land cover map
Format	Shapefile	Raster (.tif)
Spatial Resolution	1:10000	100m x 100m
Temporal Resolution	Static	Annual
Extent	Italy	Alpine space
Time Range	2018	2015-2019
Geographic Coordinate System (GCS)	Monte mario Italy1 EPSG 3003	WGS84
Source	ARPA Veneto	Copernicus

Forests, functions, and tree-species (non-land cover based)

Forest and tree-species data have been separated based on observed data (table 5) and modeled/projected data (table 6). Forest characteristics for Slovenia include tree species, regeneration type, volume (m3), forest functions, protection forests (ha), and more. The location and areas of protection forests (as defined by each partner country) are available for Austria, France (state-owned forests in the French alps), and Switzerland. These are essential to understand where protection forests are located, what hazards and disturbances they have faced or will face, and to understand the impact of compounding and cascading climate hazards and events on protective forest functionality. This is in line with the project aim to identify hotspot regions, eg areas of current and future concern, to promote efficient and effective interventions.

Table 5. Historical and current forest data

Data set	Forest characteristics	Protection forest area	Forest vitality	Post-disturbance regeneration
Format	Shapefile, CSV	Raster (.tif)/Raster (.tif)/Shapefile	Raster (.tif)	Shapefile, CSV
Spatial Resolution	Unknown	10m x 10m/10m x 10m/Unknown	10m x 10m	100m x 100m
Temporal Resolution	Unknown	Annual/Unknown/Unknown	Annual	TBD
Extent	Slovenia	Austria/Switzerland/French Alps (state-owned)	Switzerland	Alpine space
Time Range	Unknown	2023/Unknown/2023	2015-2023	TBD
Geographic Coordinate System (GCS)	D96:EPSG 3794	Unknown/Unknown/EPSG 2154	Unknown	ETRS89-extended / LAEA Europe (EPSG: 3035)
Source	SFS data	BML/WSL/ONF	HAFL	MOSAIC (WP2)

For future forests, multiple partners will provide models for tree species suitability under various global warming conditions (table 6). This includes maps for the alpine space that describe binary suitability (yes/no), the probability of species presence, species distribution and suitability, and future potential species spread and probability of suitability. In addition, there is information available for future forest and vegetation belts in Switzerland. The species suitability maps are useful to understand how locations of protective forests may change in the future, and how to best approach recharacterization and regeneration of forest species makeup to promote resilient, sustainable forests.

Table 6. Tree-species (suitability) maps – alpine space

Data set	Binary suitability	Forest/vegetation belts	Probability of species presence	Tree species suitability

Format	Raster (.tif)	Raster (.tif)	Raster (.tif)	Raster (.tif)
Spatial Resolution	1km x 1km	Unknown	250m x 250m	1km x 1km
Temporal Resolution	Annual	Annual	Annual	Annual
Extent	Alpine space	Switzerland	Alpine Convention Perimeter	Alpine space
Time Range	Current, 2050, 2070	2085	1989-2060	Unknown
Geographic Coordinate System (GCS)	ESPG 2154	Unknown	ETRS89-extended / LAEA Europe (EPSG: 3035)	Unknown
Source	ClimEssences	Zischg et al. 2021	UNITO	ALPTREES

Socio-economic

Thus far, the only identified socio-economic data to be provided is a raster of gridded population density. This is helpful to assess human risk, and essential for some of the models used in the project to analyze the influence of humans on probability of natural hazards (both their occurrence and their management).

Table 7. Socio-economic data

Data set	Population density
Format	raster
Spatial Resolution	1km x 1km
Temporal Resolution	5-year intervals
Extent	Interreg Alpine Space
Time Range	2000-2020
Geographic Coordinate System (GCS)	WGS 84
Source	Gridded Population of the World

Disturbances and hazards

There are many possible definitions of disturbances and natural hazards. The current definitions used in this project can be found in the glossary, located in the appendix of this document. For this sub-section, unless specified otherwise, “disturbance(s)” will be used to describe both disturbances and natural hazards.

Based on listed data, the disturbances have been split into 3 tables: disturbed forests/mapped forest disturbances (table 8), forest fire data (table 9), and debris flow (table 10). The data on disturbances and hazards are necessary to establish past and current conditions of forests in the alpine zone. These data will be used to establish baseline conditions, as inputs or calibration/validation for disturbance models, and to develop a repository of alpine disturbances as promised in the MOSAIC proposal.

Data for general forest disturbance mapping is available to some capacity in most partner countries: Slovenia, Italy, and Switzerland. Maps/data are likely to become available for France and Austria in the coming months. The data found in table 8 provide a general overview of forest disturbances (location and severity), which are necessary to evaluate disturbance regimes over time and to understand the role of disturbances in protective forests (now and under climate change). This data will further be used by partners in modeling activities in WP2/3.

Table 8. Disturbed forests

Data set	Sanitary fellings (area)	Blowdown forests	Bark beetle damages	Disturbed forest patches (occurrence, severity, agent)	Disturbed forests (area)	Disturbed forests (severity)
Format	CSV	Shapefile	Shapefile	Raster (.tif)	Raster (.tif), Shapefile	Raster (.tif)
Spatial Resolution	forest compartment , coordinates	1:10000	1:10000	30m x 30m	Unknown	10m x 10m
Temporal Resolution	Annual	Annual	Annual	Annual	Annual	Annual
Extent	Slovenia	Italy	Italy	Alpine space	Switzerland	Switzerland
Time Range	1995-2022	2018	2021-2022	1985-2022	1990, 2000	2015-2023
Geographic Coordinate System (GCS)	D96:EPSG 3794	Monte mario Italy1 EPSG 3003	Monte mario Italy1 EPSG 3003	ETRS89-extended / LAEA Europe (EPSG: 3035)	Unknown	Unknown
Source	SFS data	Veneto Region geoportal	Veneto Region geoportal	UNITO	Swiss Office for Environment (Vivian & Lothar)	HAFL

Fire-specific forest data is available for the entire alpine zone (table 9). This includes historical burned area, emissions, and hotspot/risk areas (historical and future). The historical and current data will be used to understand past and current fire regimes, and the roles and impacts of forest fires in alpine protective forests. Projections provide insight into possible forest fire hotspots across the alpine zone, which are necessary for the project goals of singular and overlapping disturbance hotspot identification.

Table 9. Forest fires - historical fires and risk maps

Data set	Slovenia forest fires	Italy forest fires	Italy forest fire risk	Hotspot map	Burned area and emissions
Format	CSV	Shapefile	Raster (.tif)	Raster (.tif)	Raster (.tif)
Spatial Resolution	forest compartments, coordinates	Unknown	20m x 20m	1km x 1km	1km x 1km
Temporal Resolution	Annual	Annual	Static	Annual	Annual
Extent	Slovenia	Italy	Italy	Austria	Alpine space
Time Range	1995-2022	1981-2022	2018	2001-2100	2001-2100
Geographic Coordinate System (GCS)	Unknown	Monte mario Italy1 EPSG 3003	Monte mario Italy1 EPSG 3003	WGS 84	WGS 84
Source	SFS data	Unknown	Unknown	IIASA	IIASA

Data pertaining to debris flow (including soil erosion, landslides, rock falls, and avalanches) are compiled in table 10. By the end of the project, debris flow maps of at least one type are expected to be available for the entire alpine zone. Notably, many partner countries do not differentiate between debris flow type (such as the ALPTREES map). This data is essential to identify hotspots for debris flow under current and future conditions, and to provide a map of overlapping disturbance hotspots.

Table 10. Debris flow – soil erosion, landslides, rock falls, avalanches

Data set	Soil erosion	Rockfalls	Avalanches	Natural disturbances (agent, area)
Format	Shapefile	Shapefile	Shapefile	Raster (.tif)
Spatial Resolution	Unknown	25*25m	Unknown	Unknown
Temporal Resolution	Annual	According to the EU-DEM updating	Annual	Unknown
Extent	Italy	Alpine space	Italy	Alpine space
Time Range	2023	2019	Unknown	Unknown
Geographic Coordinate System (GCS)	Monte mario Italy1 EPSG 3003	WGS84-G1150 (EPSG 4326)	Monte mario Italy1 EPSG 3003	Unknown

		(DGED & DTED format)		
Source	ARPA Veneto	RockTheAlps	ARPA Veneto	ALPTREES

Appendix

Full list of data

Partner #	Partner Name	Variable/map/data type
1	INRAe	Forest fire: Forest Weather Indexes
1	INRAe	Accessibility to forest
1	INRAe	Protective forests (Rockfall, snow avalanches)
2	ONF	Tree species suitability
2	ONF	Protective forests
3	UNITO	Tree species suitability
3	UNITO	ERA5 dynamic downscale (climate data)
3	UNITO	Post-disturbance regeneration
3	UNITO	Disturbed forest patches (occurrence)
3	UNITO	Disturbed forest patches (severity)
3	UNITO	Disturbed forest patches (agent)
5	DPC/SPL	Land use
5	DPC/SPL	Forest fires
5	DPC/SPL	soil erosion
5	DPC/SPL	avalanches map
5	DPC/SPL	blowdown forests
5	DPC/SPL	Bark Beatle damages
5	DPC/SPL	Forest fire risk
6	BFW	Protective function
7	IIASA	Population density
7	IIASA	FLAM output - burned area, emissions
7	IIASA	fire hot spots
7	IIASA	CHELSA climate data (daily temperature, relative humidity, precipitation, wind speed)
7	IIASA	Hours of daylight/pixel
7	IIASA	Tree species suitability
7	IIASA	Natural disturbances

7	IIASA	Land cover (Copernicus Global Land Cover)
7	IIASA	DEM
9	SFS	Sanitary felling (disturbances)
9	SFS	Forest fires
10	HAFL	Disturbed forest Vivian & Lothar
10	HAFL	Protective function
10	HAFL	Future forest type / vegetation belts
10	HAFL	Disturbed forest
10	HAFL	Forest vitality

Glossary

When more than one definition is present, the definition which appears first is the preferred definition.

Adaptation - the process of adjustment to the actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities (IPCC).

Alpine space/alpine region - the Alps and their surrounding lowlands (Interreg).

Cascading event - extreme events, in which cascading effects increase in progression over time and generate secondary events of strong impact (MOSAIC).

- occur when an extreme hazard generates a sequence of secondary events in natural and human systems that result in physical, natural, social or economic disruption, whereby the resulting impact is significantly larger than the initial impact. Cascading impacts are complex and multi-dimensional, and are associated more with the magnitude of vulnerability than with that of the hazard (IPCC).

Climate-related disaster - Climate-related disasters include disasters categorized as meteorological, climatological, or hydrological (UN).

CMIP 5, 6 - Coupled Model Intercomparison Project Phase 5 and Phase 6 (IPCC).

Compound event - When two or more extreme events occur simultaneously, often with different causes, and resulting in multiplicative damages and losses (MOSAIC).

Disaster Risk Reduction (DRR) - Denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience (IPCC).

Disturbance - Short-term disruptive event; well-defined in space and time (MOSAIC).

Drought/drought event - Well-defined in space and time; period with extremely elevated temperatures and (optionally) long periods of minimal to no precipitation (MOSAIC).

- An exceptional period of water shortage for existing ecosystems and the human population (due to low rainfall, high temperature and/or wind) (IPCC).

Ecosystem services - Ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as (1) supporting services such as productivity or biodiversity maintenance, (2) provisioning services such as food or fibre, (3) regulating services such as climate regulation or carbon sequestration, and (4) cultural services such as tourism or spiritual and aesthetic appreciation (IPCC).

Ecosystem-based solutions (Eco-DRR) - sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim to achieve sustainable and resilient development (GreenRisk4Alps).

End user - person or entity that consumes or makes use of the goods or services produced; students, researchers, policy makers, forest managers, etc (MOSAIC).

Exposure (IPCC) - The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected (GreenRisk4Alps).

Forest Living Lab (FLL) - Forest living lab is an open-innovation ecosystem set in forest area. It is used for research and development, innovation processes and knowledge transfer in field of forestry. It involves different stakeholders and active users to help co-create products, services and innovations related to forestry (MOSAIC).

Hazard - The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or damage and loss to property, infrastructure, livelihoods, service provision and environmental resources (GreenRisk4Alps).

Heat waves - A period of abnormally hot weather, often defined with reference to a relative temperature threshold, lasting from two days to months. Heatwaves and warm spells have various and, in some cases, overlapping definitions (IPCC).

Hotspot - A hotspot is an accumulation of vulnerabilities towards disturbances and natural hazards in (protective) forests, considering the impact and risk of compound events, leading to a reduction of their protective functions. Hotspots are only considered as such in the event of 2 or more known/modeled/ predicted vulnerabilities under current or future climatic conditions. These areas are those which should be of priority when considering intervention and management strategies (MOSAIC).

Living labs - user-led open innovation ecosystems, which engage all stakeholders in the form of a public-private-people partnership (PPPP) to cocreate products, services, social innovations. They are set in real-life environments (e.g. forest, city, agglomeration, region, campus) (ENoLL).

Marteloscope - Silvicultural training sites of usually one hectare in which all trees are numbered, mapped and recorded. In combination with evaluation and simulation software, virtual tree selection exercises can be performed (Informar).

- Training areas for the selection of trees for felling, tending and other silviculture measures (MOSAIC).

Mitigation - A human intervention to reduce risk or loss from the occurrence of any undesirable event (GreenRisk4Alps).

Nature-based/forest-based solutions - actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively (GreenRisk4Alps).

Protective forest - forests that mitigate or prevent the impact of a natural hazard, including a rockfall, avalanche, erosion, landslide, debris flow or flooding on people and their assets in mountainous areas. A protection forest generally covers the sloping area between a hazard potential (e.g. an unstable rock cliff or an avalanche release zone) and the endangered or exposed assets; to protect soil and to prevent it from eroding or blowing away (Wikipedia).

Public-private-people-partnership - Public-Private-People Partnership (4P) is a cross-sector collaboration combining “people” with a traditional Public-Private Partnership (PPP). The term “people” encompasses civil society organizations, academia, professional organizations, media, and others. 4P was proposed to compensate for the shortcomings in conventional PPPs regarding a lack of residents' viewpoints, clarification of civil engagement, and incorporation of bottom-up strategies, especially in disaster management (Kobashi 2022).

- Public-Private-People Participation (PPPP/4Ps) is a people (end-users) oriented approach where all stakeholders including government, donor agencies, private sector and civil society work together. It includes the end-users' perspective into the PPP (SSWM).

Regeneration - Renewal of a forest stand (i.e. establishment of new young trees) by natural or artificial means (FAO).

Rehabilitation - the reparation of ecosystem processes, services, and productivity; however not necessarily to the same pre-existing condition (USFS).

Residual risk - the risk remaining after adaptation and risk reduction efforts (IPCC).

Resilience - a measure of the forest's adaptability to a range of stresses and reflects the functional integrity of the ecosystem (GreenRisk4Alps).

- The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (IPCC).

Restoration - the process of recovering an ecosystem that has been damaged, degraded, or destroyed; an attempt to return it to its historical trajectory (USFS).

- In the environmental context, restoration involves human interventions to assist the recovery of an ecosystem that has been previously degraded, damaged or destroyed (IPCC).

Risk - The potential for consequences where something of value is at stake (GreenRisk4Alps).

Scenarios - A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts but are used to provide a view of the implications of developments and actions (IPCC).

Severity - The component of disturbance magnitude expressed by the effects on vegetation and soil characteristics (MOSAIC).

Socio-ecological systems - Social-ecological systems are complex adaptive systems in which people and nature are inextricably linked, in which both the social and ecological components exert strong influence over outcomes. The social dimension includes actors, institutions, cultures and economies, including livelihoods. The ecological dimension includes wild species and the ecosystem they inhabit (IPBES).

Vulnerability - The propensity or predisposition of a (protective) forest to be adversely affected in a way which impedes its protective functions (GreenRisk4Alps).

Web GIS atlas - Interactive web-based GIS knowledge hub, containing a collection of alpine space data and related links and projects; as well as maps, figures, and graphics to visualize the data, and tools to interact with or analyze the data (MOSAIC).

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Annex 1: examples of COPERNICUS Data catalogue relevant for the Alpine Space.

This document presents a list of available datasets from EU-Copernicus relevant for the AS interreg project MOSAIC.

This document is meant to evolve in order to update the datasets and providers lists that are relevant for the AS interreg project MOSAIC.

The datasets are briefly presented, for more information it is recommended to follow the link to the data website included in every description.

Table of Content

Copernicus

https://www.copernicus.eu/en

Copernicus is the Earth observation component of the European Union's Space programme, looking at our planet and its environment to benefit all European citizens. It offers information services that draw from satellite Earth Observation and in-situ (non-space) data.

The European Commission manages the Programme. It is implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium-Range Weather Forecasts (ECMWF), EU Agencies and Mercator Ocean.

Vast amounts of global data from satellites and ground-based, airborne, and seaborne measurement systems provide information to help service providers, public authorities, and other international organisations improve European citizens' quality of life and beyond. The information services provided are free and openly accessible to users.

Agrometeorological indicators from 1979 to present derived from reanalysis

https://cds.climate.copernicus.eu/cdsapp#!/dataset/sis-agrometeorological-indicators?tab=overview

This dataset provides daily surface meteorological data for the period from 1979 to present as input for agriculture and agro-ecological studies. This dataset is based on the hourly ECMWF ERA5 data at surface level and is referred to as AgERA5. Acquisition and pre-processing of the original ERA5 data is a complex and specialized job. By providing the AgERA5 dataset, users are freed from this work and can directly start with meaningful input for their analyses and modelling. To this end, the variables provided in this dataset match the input needs of most agriculture and agro-ecological models.

Data description

Data type	Gridded
Projection	Regular latitude-longitude grid
Horizontal coverage	Global
Horizontal resolution	0.1° x 0.1°
Vertical coverage	Variables are provided on a single level which may differ among variables
Temporal coverage	From 1979 to present
Temporal resolution	Daily
File format	NetCDF-4
Conventions	Climate and Forecast (CF) Metadata Convention v1.7
Versions	1.0, 1.1
Update frequency	Monthly

Main variables (selection)

Name	Units	Description
Snow thickness	cm	Mean snow depth over the period 00h-24h local time measured as volume of snow (cm^3) per unit area (cm^2).
Snow thickness LWE	cm	Mean snow depth liquid water equivalent (LWE) over the period 00h-24h local time measured as volume of snow (cm^3) per unit area (cm^2) if all the snow had melted and had not penetrated the soil, runoff, or evaporated.
Solid precipitation duration fraction	Dimensionless	The number of hours with solid precipitation (freezing rain, snow, wet snow, mixture of rain and snow, and ice pellets) over the period 00h-24h local time divided by 24 hours and per unit of area.

Alpine gridded monthly precipitation data since 1871 derived from in-situ observations

https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-gridded-observations-alpine-precipitation?tab=overview

This dataset, also known as the Long-term Alpine Precipitation Reconstruction (LAPrec), provides gridded fields of monthly precipitation for the Alpine region (eight countries). The dataset is derived from station observations and is provided in two issues:

- LAPrec1871 starts in 1871 and is based on data from 85 input series;
- LAPrec1901 starts in 1901 and is based on data from 165 input series.

Data description

Data type	Gridded
Projection	Lambert Azimuthal Equal-Area projection (ETRS89)
Horizontal coverage	Alpine region (approximately 43–49°N, 4–17.5°E, land area only)
Horizontal resolution	5 km
Vertical coverage	Surface
Vertical resolution	Single layer
Temporal coverage	1871 to 2020
Temporal resolution	Monthly
File format	NetCDF4
Conventions	Climate and Forecast Metadata Convention v1.6 (CF-1.6)
Versions	1.1, 1.2
Update frequency	Every second year

Main variables

Name	Units	Description
Precipitation	kg m-2	Precipitation in the Earth's atmosphere means precipitation of water in all phases. The data represents the accumulated monthly precipitation calculated as the sum of daily precipitation measured between 07:00 CET of the respective day and 07:00 CET of the following day.

CERRA sub-daily regional reanalysis data for Europe on single levels from 1984 to present

https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-cerra-single-levels?tab=overview

The Copernicus European Regional ReAnalysis (CERRA) datasets provide spatially and temporally consistent historical reconstructions of meteorological variables in the atmosphere and at the surface. There are four subsets: single levels (atmospheric and surface quantities), height levels (upper-air fields up to 500m), pressure levels (upper-air fields up to 1hPa) and model levels (native levels of the model). This entry provides reanalysis and forecast data on single levels for Europe from 1984 to present. Several atmospheric parameters are common to both reanalysis and forecast (e.g. temperature, wind), whilst others are produced only by the forecast model (e.g. 10m wind gust, radiative fluxes).

Data description

Data type	Gridded
Projection	Lambert conformal conical grid
Horizontal coverage	Europe. The model domain spans from northern Africa beyond the northern tip of Scandinavia. In the west it ranges far into the Atlantic Ocean and in the east it reaches to the Ural Mountains.
Horizontal resolution	5.5 km x 5.5 km for CERRA high-resolution reanalysis 11 km x 11 km for CERRA ensemble members
Vertical coverage	From below the surface to the top of the atmosphere
Vertical resolution	Single level
Temporal coverage	September 1984 - June 2021
Temporal resolution	Analysis data: 3-hourly for high-resolution, 6-hourly for ensemble members Forecast data: hourly for forecast range 1 - 6 (high-resolution and ensemble members), 3-hourly for forecast range 6 - 30 (high-resolution only)
File format	GRIB2
Update frequency	New data will be added towards the end of 2023

Main variables (selection)

Name	Units	Description
Evaporation	kg m-2	Evaporation is the amount of moisture flux from the surface (ground and water) into the atmosphere. It is given as a mean for the grid area. The mean is a weighted average over all tile types present in the grid point. By model convention downward fluxes are positive. Hence, evaporation is represented by negative values and positive values represent condensation. It is an accumulated parameter meaning that it is accumulated since the last analysis. For instance, values extracted for 14 UTC reflect accumulated values since 12 UTC (the previous analysis).
Liquid volumetric soil	m3 m-3	The liquid volumetric soil water is the amount of non-frozen water in a cubic metre soil valid for the grid area in the corresponding soil

moisture (non-frozen)		layer. The parameter is available for analysis and forecast time steps. The value is instantaneous meaning that it is valid for the last time step of the integration at the issued time step. The soil model has three layers but only data for the top layer, closest to the surface, are provided. Deeper layers are affected by spin-up effects at the seams of the production streams. Users interested in soil parameters are recommended to use CERRA-Land data.
Snow density	kg m-3	Snow density is the snow mass per unit of volume. It is given as the mean for the grid area. Grid points without snow have missing values. Given values are instantaneous.
Snow depth	m	Snow depth is the average snow height for the grid area. Given values are instantaneous.
Snow depth water equivalent	kg m-2	Snow depth water equivalent expresses the snow depth in kg of snow over one square metre. The unit corresponds to 1 mm of water equivalent. It is given as the mean for the grid area. Given values are instantaneous.
Snowfall water equivalent	kg m-2	Snowfall water equivalent expresses the snowfall in kg of snow over one square metre. The unit corresponds to 1 mm of water equivalent. It is given as the mean for the grid area. It is an accumulated parameter meaning that it is accumulated since the last analysis. For instance, values extracted for 14 UTC reflect accumulated values since 12 UTC (the previous analysis).
Soil temperature	K	The soil temperature is the model temperature valid for the grid area at the corresponding soil layer. The parameter is available for analysis and forecast time steps. The value is instantaneous meaning that it is valid for the last time step of the integration at the issued time step. The soil model has three layers but only data for the top layer, closest to the surface, are provided. Deeper layers are affected by spin-up effects at the seams of the production streams. Users interested in soil parameters are recommended to use CERRA-Land data.
Total precipitation	kg m-2	Total precipitation is the amount of precipitation falling onto the ground/water surface. It includes all kind of precipitation forms such as convective precipitation, large scale precipitation, liquid and solid precipitation. The amount is valid for the grid area. The total precipitation is available only for the forecast time steps. It is an accumulated parameter meaning that it is accumulated from the beginning of the forecast. For instance, the 24h-forecast has the accumulated precipitation over 24 hours.
Volumetric soil moisture	m3 m-3	The volumetric soil moisture is the sum of the liquid and frozen water in a cubic metre soil valid for the grid area in the corresponding soil layer. The parameter is available for analysis and

		forecast time steps. The value is instantaneous meaning that it is valid for the last time step of the integration at the issued time step. The soil model has three layers but only data for the top layer, closest to the surface, are provided. Deeper layers are affected by spin-up effects at the seams of the production streams. Users interested in soil parameters are recommended to use CERRA-Land data.

CERRA-Land sub-daily regional reanalysis data for Europe from 1984 to present

https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-cerra-land?

The Copernicus European Regional ReAnalysis Land (CERRA-Land) dataset provides spatially and temporally consistent historical reconstructions of surface and soil variables at the same horizontal resolution as the CERRA high-resolution reanalysis.

Data description

Data type	Gridded
Projection	Lambert conformal conical grid
Horizontal coverage	Europe. The model domain spans from northern Africa beyond the northern tip of Scandinavia. In the west it ranges far into the Atlantic Ocean and in the east it reaches to the Ural Mountains.
Horizontal resolution	5.5 km x 5.5 km
Vertical coverage	From surface to a soil depth of 12m
Vertical resolution	Single level for surface parameters 14 layers for soil parameters. The vertical discretisation (bottom depth of each layer in meters) is 0.01, 0.04, 0.1, 0.2, 0.4, 0.6, 0.8, 1, 1.5, 2, 3, 5, 8, and 12m
Temporal coverage	September 1984 to April 2021
Temporal resolution	Analysis: daily (24-h) for total precipitation Forecasts: hourly
File format	GRIB2
Update frequency	New data are expected to be added towards the end of 2023

Main variables (selection)

Name	Units	Description
Name	Units	Description
Evaporation	kg m-2	Evaporation is the amount of water that has evaporated from the earth's surface from the initial time of the forecast to the forecast time step. It is given as a mean for the grid area between the three surface types in the grid - inland water, natural land and urban. Hence, evaporation is represented by negative values and positive values represent condensation. By model convention downward fluxes are positive. It is an accumulated field.
Fraction of snow cover	dimensionless	It represents the fraction of natural land covered by snow. It is an instantaneous variable and takes values between 0 and 1.
Liquid volumetric soil moisture (non-frozen)	m3 m-3	The volume concentration of liquid water only. The vertical discretisation (bottom depth of each layer in metres) is as follows - 0.01, 0.04, 0.1, 0.2, 0.4, 0.6, 0.8, 1, 1.5, 2, 3, 5, 8, and 12 m. A liquid

		volumetric soil moisture is available for each soil layer. It is an instantaneous field.
Percolation	kg m-2	The mass per unit area of water that drains below the deepest soil level in the model. The drainage is accumulated from the initial time of the forecast to the forecast time step. This variable is calculated for the natural land, including soil, vegetation and snow (not for urban and water bodies fraction). It is an accumulated field.
Snow density	kg m-3	The mean snow density is calculated as the ratio of snow depth water equivalent by the snow depth. It is an instantaneous field.
Snow depth	m	Snow thickness on the ground. It is an instantaneous field.
Snow depth water equivalent	kg m-2	The mass of liquid water obtained from melting the snow per unit area. This is equivalent to the depth of the liquid water in units of mm. It is an instantaneous field.
Snow melt	kg m-2	Melting of snow. This variable is accumulated from the beginning of the forecast time to the end of the forecast step. It is an accumulated field.
Soil heat flux	W m-2	The soil heat flux is the energy receive by the soil to heat it per unit of surface and time. The soil heat flux is positive when the soil receives energy (warms) and negative when the soil loses energy (cools). It is an instantaneous variable.
Soil temperature	K	The model has 14 soil layers. The vertical discretisation (bottom depth of each layer in metres) is as follows - 0.01, 0.04, 0.1, 0.2, 0.4, 0.6, 0.8, 1, 1.5, 2, 3, 5, 8, and 12 m. The soil temperature is available for each soil layer.It is an instantaneous field.
Surface latent heat flux	J m-2	The surface latent heat flux is the accumulated exchange of latent heat (due to phase transitions - evaporation, condensation) with the surface (ground and water) through turbulent diffusion from the initial time of the forecast to the forecast time step. It is given as a mean for the grid area between the three surface types in the grid - inland water, natural land and urban. By model convention downward fluxes are positive. It is an accumulated field.
Surface net solar radiation	J m-2	The surface net solar radiation is the accumulated solar short-wave radiation that is absorbed at the surface from the initial time of the forecast to the forecast time step. It is calculated as the difference between the downward solar energy and the upward solar energy at the surface. By model convention downward fluxes are positive. It is an accumulated field.
Surface runoff	kg m-2	The mass per unit area of water at the surface when saturation occurs. This variable is calculated for the natural land, including soil, vegetation and snow. It is an accumulated field.

Surface sensible heat flux	J m-2	The surface sensible heat flux is the accumulated exchange of heat (no phase transition) with the surface (ground and water) through turbulent diffusion from the initial time of the forecast to the forecast time step. It is given as a mean for the grid area between the three surface types in the grid - inland water, natural land and urban. By model convention downward fluxes are positive. It is an accumulated field.
Surface solar radiation downwards	J m-2	The surface solar radiation downward is the accumulated total (direct and diffuse) solar short-wave radiation reaching the surface from the initial time of the forecast to the forecast time step. By model convention downward fluxes are positive. It is an accumulated field.
Surface thermal radiation downwards	J m-2	The surface thermal radiation downward is the amount of thermal (long-wave) radiation reaching the surface accumulated from the initial time of the forecast to the forecast time step. By model convention downward fluxes are positive. It is an accumulated field.
Temperature of snow layer	K	Mean temperature of the 12 snow layers. It is an instantaneous field.
Total precipitation	kg m-2	Total daily precipitation is the amount of precipitation falling at the surface. It includes all kind of precipitation forms as convective precipitation, large scale precipitation, liquid and solid precipitation. The total precipitation is available only for the analyses at 06h00 UTC. It is an accumulated field from the previous day at 06 UTC to the present day at 06 UTC.
Volumetric soil moisture	m3 m-3	The volume concentration of liquid and ice water. The vertical discretisation (bottom depth of each layer in metres) is as follows - 0.01, 0.04, 0.1, 0.2, 0.4, 0.6, 0.8, 1, 1.5, 2, 3, 5, 8, and 12 m. The volumetric soil moisture is available for each soil layer. It is an instantaneous field.
Volumetric transpiration stress-onset (soil moisture)	m3 m-3	The soil moisture is the water content of a soil after gravitational drainage. When the water content of the soil reaches this value, the water cannot drain any more by gravity. The vertical discretisation (bottom depth of each layer in metres) is as follows - 0.01, 0.04, 0.1, 0.2, 0.4, 0.6, 0.8, 1, 1.5, 2, 3, 5, 8, and 12 m. It is a static variable.
Volumetric wilting point	m3 m-3	Model soil water content at which the vegetation wilts and can no longer recover. When the soil moisture reaches the wilting point, the vegetation is not able to extract the soil water. The soil moisture content is too low to be absorbed by the vegetation. The vertical discretisation (bottom depth of each layer in metres) is as follows - 0.01, 0.04, 0.1, 0.2, 0.4, 0.6, 0.8, 1, 1.5, 2, 3, 5, 8, and 12 m. It is a static variable.

Crop productivity and evapotranspiration indicators from 2000 to present derived from satellite observations

https://cds.climate.copernicus.eu/cdsapp#!/dataset/sis-agroproductivity-indicators

The evapotranspiration indicators provide the actual and potential vegetation and soil evapotranspiration. This is the sum of water vapor fluxes from soil evaporation, wet canopy evaporation and plant transpiration at the dry canopy surface. The product provides insight into regional and interannual variability in vegetation water use (actual and potential) and water stress. It can be used as an indicator to determine the impact of water stress on crops and vegetation in general. The evapotranspiration indicators are not suitable for field-scale analysis.

Data description

Data type	Gridded
Projection	Regular latitude-longitude grid
Horizontal coverage	Global
Horizontal resolution	0.1° x 0.1°
Vertical coverage	Surface
Vertical resolution	Single level
Temporal coverage	2000 to 2018
Temporal resolution	Dekadal (3 dekads per month, 36 per year)
File format	NetCDF4
Versions	1.0
Conventions	Climate and Forecast (CF) Metadata Convention v1.6
Update frequency	No updates expected

Main variables

Name	Units	Description
Potential evaporation	mm	The evaporation and transpiration (through vegetation) as it would occur if not limited by water availability but only by atmospheric demand (i.e. radiation, temperature) and the properties of the Earth's surface (mainly vegetation fractional coverage).
Actual evaporation	mm	The evaporation and transpiration (through vegetation) that actually occurrs, regulated by the minimum of supply (water availability in the soil) and demand (potential evapotranspiration).

ERA5 hourly data on single levels from 1940 to present

https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels

ERA5 is the fifth generation ECMWF reanalysis for the global climate and weather for the past 8 decades. Data is available from 1940 onwards. ERA5 replaces the ERA-Interim reanalysis.

Data description

Data type	Gridded
Projection	Regular latitude-longitude grid
Horizontal coverage	Global
Horizontal resolution	Reanalysis: 0.25° x 0.25° (atmosphere), 0.5° x 0.5° (ocean waves) Mean, spread and members: 0.5° x 0.5° (atmosphere), 1° x 1° (ocean waves)
Temporal coverage	1940 to present
Temporal resolution	Hourly
File format	GRIB
Update frequency	Daily

Main variables (selection)

Name	Units	Description
2m temperature	K	This parameter is the temperature of air at 2m above the surface of land, sea or inland waters. 2m temperature is calculated by interpolating between the lowest model level and the Earth's surface, taking account of the atmospheric conditions. This parameter has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.
Evaporation	m of water equivalent	This parameter is the accumulated amount of water that has evaporated from the Earth's surface, including a simplified representation of transpiration (from vegetation), into vapour in the air above. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time. The ECMWF Integrated Forecasting System (IFS) convention is that downward fluxes are positive. Therefore, negative values indicate evaporation and positive values indicate condensation.
Leaf area index, high vegetation	m2 m-2	This parameter is the surface area of one side of all the leaves found over an area of land for vegetation classified as "high". This parameter has a value of 0 over bare ground or where there are no leaves. It can be calculated daily from satellite data. It is important for forecasting, for example, how much rainwater will be

		intercepted by the vegetative canopy, rather than falling to the ground. This is one of the parameters in the model that describes land surface vegetation. "High vegetation" consists of evergreen trees, deciduous trees, mixed forest/woodland, and interrupted forest.
Leaf area index, low vegetation	m2 m-2	This parameter is the surface area of one side of all the leaves found over an area of land for vegetation classified as "low". This parameter has a value of 0 over bare ground or where there are no leaves. It can be calculated daily from satellite data. It is important for forecasting, for example, how much rainwater will be intercepted by the vegetative canopy, rather than falling to the ground. This is one of the parameters in the model that describes land surface vegetation. "Low vegetation" consists of crops and mixed farming, irrigated crops, short grass, tall grass, tundra, semidesert, bogs and marshes, evergreen shrubs, deciduous shrubs, and water and land mixtures.
Potential evaporation	m	This parameter is a measure of the extent to which near-surface atmospheric conditions are conducive to the process of evaporation. It is usually considered to be the amount of evaporation, under existing atmospheric conditions, from a surface of pure water which has the temperature of the lowest layer of the atmosphere and gives an indication of the maximum possible evaporation. Potential evaporation in the current ECMWF Integrated Forecasting System (IFS) is based on surface energy balance calculations with the vegetation parameters set to "crops/mixed farming" and assuming "no stress from soil moisture". In other words, evaporation is computed for agricultural land as if it is well watered and assuming that the atmosphere is not affected by this artificial surface condition. The latter may not always be realistic. Although potential evaporation is meant to provide an estimate of irrigation requirements, the method can give unrealistic results in arid conditions due to too strong evaporation forced by dry air. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time.
Precipitation type	Dimensionless	This parameter describes the type of precipitation at the surface, at the specified time. A precipitation type is assigned wherever there is a non-zero value of precipitation. In the ECMWF Integrated Forecasting System (IFS) there are only two predicted precipitation variables: rain and snow. Precipitation type is derived from these

		two predicted variables in combination with atmospheric conditions, such as temperature. Values of precipitation type defined in the IFS: 0: No precipitation, 1: Rain, 3: Freezing rain (i.e. supercooled raindrops which freeze on contact with the ground and other surfaces), 5: Snow, 6: Wet snow (i.e. snow particles which are starting to melt); 7: Mixture of rain and snow, 8: Ice pellets. These precipitation types are consistent with WMO Code Table 4.201. Other types in this WMO table are not defined in the IFS.
Runoff	m	Some water from rainfall, melting snow, or deep in the soil, stays stored in the soil. Otherwise, the water drains away, either over the surface (surface runoff), or under the ground (sub-surface runoff) and the sum of these two is called runoff. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time. The units of runoff are depth in metres of water. This is the depth the water would have if it were spread evenly over the grid box. Care should be taken when comparing model parameters with observations, because observations are often local to a particular point rather than averaged over a grid box. Observations are also often taken in different units, such as mm/day, rather than the accumulated metres produced here. Runoff is a measure of the availability of water in the soil, and can, for example, be used as an indicator of drought or flood.
Skin reservoir content	m of water equivalent	This parameter is the amount of water in the vegetation canopy and/or in a thin layer on the soil. It represents the amount of rain intercepted by foliage, and water from dew. The maximum amount of "skin reservoir content" a grid box can hold depends on the type of vegetation, and may be zero. Water leaves the "skin reservoir" by evaporation.
Skin temperature	K	This parameter is the temperature of the surface of the Earth. The skin temperature is the theoretical temperature that is required to satisfy the surface energy balance. It represents the temperature of the uppermost surface layer, which has no heat capacity and so can respond instantaneously to changes in surface fluxes. Skin temperature is calculated differently over land and sea. This parameter has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.
Snow density	kg m-3	This parameter is the mass of snow per cubic metre in the snow layer. The ECMWF Integrated Forecasting System (IFS) represents

		snow as a single additional layer over the uppermost soil level. The snow may cover all or part of the grid box. This parameter is defined over the whole globe, even where there is no snow. Regions without snow can be masked out by only considering grid points where the snow depth (m of water equivalent) is greater than 0.0.
Snow depth	m of water equivalent	This parameter is the amount of snow from the snow-covered area of a grid box. Its units are metres of water equivalent, so it is the depth the water would have if the snow melted and was spread evenly over the whole grid box. The ECMWF Integrated Forecasting System (IFS) represents snow as a single additional layer over the uppermost soil level. The snow may cover all or part of the grid box.
Snow evaporation	m of water equivalent	This parameter is the accumulated amount of water that has evaporated from snow from the snow-covered area of a grid box into vapour in the air above. The ECMWF Integrated Forecasting System (IFS) represents snow as a single additional layer over the uppermost soil level. The snow may cover all or part of the grid box. This parameter is the depth of water there would be if the evaporated snow (from the snow-covered area of a grid box) were liquid and were spread evenly over the whole grid box. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time. The IFS convention is that downward fluxes are positive. Therefore, negative values indicate evaporation and positive values indicate deposition.
Snowfall	m of water equivalent	This parameter is the accumulated snow that falls to the Earth's surface. It is the sum of large-scale snowfall and convective snowfall. Large-scale snowfall is generated by the cloud scheme in the ECMWF Integrated Forecasting System (IFS). The cloud scheme represents the formation and dissipation of clouds and large-scale precipitation due to changes in atmospheric quantities (such as pressure, temperature and moisture) predicted directly at spatial scales of the grid box or larger. Convective snowfall is generated by the convection scheme in the IFS, which represents convection at spatial scales smaller than the grid box. In the IFS, precipitation is comprised of rain and snow. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble

		mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time. The units of this parameter are depth in metres of water equivalent. It is the depth the water would have if it were spread evenly over the grid box. Care should be taken when comparing model parameters with observations, because observations are often local to a particular point in space and time, rather than representing averages over a model grid box.
Snowmelt	m of water equivalent	This parameter is the accumulated amount of water that has melted from snow in the snow-covered area of a grid box. The ECMWF Integrated Forecasting System (IFS) represents snow as a single additional layer over the uppermost soil level. The snow may cover all or part of the grid box. This parameter is the depth of water there would be if the melted snow (from the snow-covered area of a grid box) were spread evenly over the whole grid box. For example, if half the grid box were covered in snow with a water equivalent depth of 0.02m, this parameter would have a value of 0.01m. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time.
Soil temperature level 1	K	This parameter is the temperature of the soil at level 1 (in the middle of layer 1). The ECMWF Integrated Forecasting System (IFS) has a four-layer representation of soil, where the surface is at 0cm: Layer 1: 0 - 7cm, Layer 2: 7 - 28cm, Layer 3: 28 - 100cm, Layer 4: 100 - 289cm. Soil temperature is set at the middle of each layer, and heat transfer is calculated at the interfaces between them. It is assumed that there is no heat transfer out of the bottom of the lowest layer. Soil temperature is defined over the whole globe, even over ocean. Regions with a water surface can be masked out by only considering grid points where the land-sea mask has a value greater than 0.5. This parameter has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.
Soil temperature level 2	K	This parameter is the temperature of the soil at level 2 (in the middle of layer 2). The ECMWF Integrated Forecasting System (IFS) has a four-layer representation of soil, where the surface is at 0cm: Layer 1: 0 - 7cm, Layer 2: 7 - 28cm, Layer 3: 28 - 100cm, Layer 4: 100 - 289cm. Soil temperature is set at the middle of each layer, and heat transfer is calculated at the interfaces between them. It is assumed that there is no heat transfer out of the bottom of the

		lowest layer. Soil temperature is defined over the whole globe, even over ocean. Regions with a water surface can be masked out by only considering grid points where the land-sea mask has a value greater than 0.5. This parameter has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.
Soil temperature level 3	K	This parameter is the temperature of the soil at level 3 (in the middle of layer 3). The ECMWF Integrated Forecasting System (IFS) has a four-layer representation of soil, where the surface is at 0cm: Layer 1: 0 - 7cm, Layer 2: 7 - 28cm, Layer 3: 28 - 100cm, Layer 4: 100 - 289cm. Soil temperature is set at the middle of each layer, and heat transfer is calculated at the interfaces between them. It is assumed that there is no heat transfer out of the bottom of the lowest layer. Soil temperature is defined over the whole globe, even over ocean. Regions with a water surface can be masked out by only considering grid points where the land-sea mask has a value greater than 0.5. This parameter has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.
Soil temperature level 4	K	This parameter is the temperature of the soil at level 4 (in the middle of layer 4). The ECMWF Integrated Forecasting System (IFS) has a four-layer representation of soil, where the surface is at 0cm: Layer 1: 0 - 7cm, Layer 2: 7 - 28cm, Layer 3: 28 - 100cm, Layer 4: 100 - 289cm. Soil temperature is set at the middle of each layer, and heat transfer is calculated at the interfaces between them. It is assumed that there is no heat transfer out of the bottom of the lowest layer. Soil temperature is defined over the whole globe, even over ocean. Regions with a water surface can be masked out by only considering grid points where the land-sea mask has a value greater than 0.5. This parameter has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.
Soil type	Dimensionless	This parameter is the texture (or classification) of soil used by the land surface scheme of the ECMWF Integrated Forecasting System (IFS) to predict the water holding capacity of soil in soil moisture and runoff calculations. It is derived from the root zone data (30-100 cm below the surface) of the FAO/UNESCO Digital Soil Map of the World, DSMW (FAO, 2003), which exists at a resolution of 5' X 5' (about 10 km). The seven soil types are: 1: Coarse, 2: Medium, 3: Medium fine, 4: Fine, 5: Very fine, 6: Organic, 7: Tropical organic. A value of 0 indicates a non-land point. This parameter does not vary in time.

Sub-surface runoff	m	Some water from rainfall, melting snow, or deep in the soil, stays stored in the soil. Otherwise, the water drains away, either over the surface (surface runoff), or under the ground (sub-surface runoff) and the sum of these two is called runoff. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time. The units of runoff are depth in metres of water. This is the depth the water would have if it were spread evenly over the grid box. Care should be taken when comparing model parameters with observations, because observations are often local to a particular point rather than averaged over a grid box. Observations are also often taken in different units, such as mm/day, rather than the accumulated metres produced here. Runoff is a measure of the availability of water in the soil, and can, for example, be used as an indicator of drought or flood.
Surface latent heat flux	J m-2	This parameter is the transfer of latent heat (resulting from water phase changes, such as evaporation or condensation) between the Earth's surface and the atmosphere through the effects of turbulent air motion. Evaporation from the Earth's surface represents a transfer of energy from the surface to the atmosphere. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time. The units are joules per square metre (J m-2). To convert to watts per square metre (W m-2), the accumulated values should be divided by the accumulation period expressed in seconds. The ECMWF convention for vertical fluxes is positive downwards.
Surface runoff	m	Some water from rainfall, melting snow, or deep in the soil, stays stored in the soil. Otherwise, the water drains away, either over the surface (surface runoff), or under the ground (sub-surface runoff) and the sum of these two is called runoff. This parameter is accumulated over a particular time period which depends on the data extracted. For the reanalysis, the accumulation period is over the 1 hour ending at the validity date and time. For the ensemble members, ensemble mean and ensemble spread, the accumulation period is over the 3 hours ending at the validity date and time. The units of runoff are depth in metres of water. This is the depth the

		water would have if it were spread evenly over the grid box. Care should be taken when comparing model parameters with observations, because observations are often local to a particular point rather than averaged over a grid box. Observations are also often taken in different units, such as mm/day, rather than the accumulated metres produced here. Runoff is a measure of the availability of water in the soil, and can, for example, be used as an indicator of drought or flood.
Temperature of snow layer	K	This parameter gives the temperature of the snow layer from the ground to the snow-air interface. The ECMWF Integrated Forecasting System (IFS) represents snow as a single additional layer over the uppermost soil level. The snow may cover all or part of the grid box. This parameter is defined over the whole globe, even where there is no snow. Regions without snow can be masked out by only considering grid points where the snow depth (m of water equivalent) is greater than 0.0. This parameter has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.
Volumetric soil water layer 1	m3 m-3	This parameter is the volume of water in soil layer 1 (0 - 7cm, the surface is at 0cm). The ECMWF Integrated Forecasting System (IFS) has a four-layer representation of soil: Layer 1: 0 - 7cm, Layer 2: 7 - 28cm, Layer 3: 28 - 100cm, Layer 4: 100 - 289cm. Soil water is defined over the whole globe, even over ocean. Regions with a water surface can be masked out by only considering grid points where the land-sea mask has a value greater than 0.5. The volumetric soil water is associated with the soil texture (or classification), soil depth, and the underlying groundwater level.
Volumetric soil water layer 2	m3 m-3	This parameter is the volume of water in soil layer 2 (7 - 28cm, the surface is at 0cm). The ECMWF Integrated Forecasting System (IFS) has a four-layer representation of soil: Layer 1: 0 - 7cm, Layer 2: 7 - 28cm, Layer 3: 28 - 100cm, Layer 4: 100 - 289cm. Soil water is defined over the whole globe, even over ocean. Regions with a water surface can be masked out by only considering grid points where the land-sea mask has a value greater than 0.5. The volumetric soil water is associated with the soil texture (or classification), soil depth, and the underlying groundwater level.
Volumetric soil water layer 3	m3 m-3	This parameter is the volume of water in soil layer 3 (28 - 100cm, the surface is at 0cm). The ECMWF Integrated Forecasting System (IFS) has a four-layer representation of soil: Layer 1: 0 - 7cm, Layer 2: 7 - 28cm, Layer 3: 28 - 100cm, Layer 4: 100 - 289cm. Soil water is defined over the whole globe, even over ocean. Regions with a water surface can be masked out by only considering grid points where the land-sea mask has a value greater than 0.5. The

		volumetric soil water is associated with the soil texture (or classification), soil depth, and the underlying groundwater level.
Volumetric soil water layer 4	m3 m-3	This parameter is the volume of water in soil layer 4 (100 - 289cm, the surface is at 0cm). The ECMWF Integrated Forecasting System (IFS) has a four-layer representation of soil: Layer 1: 0 - 7cm, Layer 2: 7 - 28cm, Layer 3: 28 - 100cm, Layer 4: 100 - 289cm. Soil water is defined over the whole globe, even over ocean. Regions with a water surface can be masked out by only considering grid points where the land-sea mask has a value greater than 0.5. The volumetric soil water is associated with the soil texture (or classification), soil depth, and the underlying groundwater level.
Zero degree level	m	The height above the Earth's surface where the temperature passes from positive to negative values, corresponding to the top of a warm layer, at the specified time. This parameter can be used to help forecast snow. If more than one warm layer is encountered, then the zero degree level corresponds to the top of the second atmospheric layer. This parameter is set to zero when the temperature in the whole atmosphere is below 0℃.

ERA5-Land hourly/monthly averaged data from 1950 to present

https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land?tab=overview

https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land-monthly-means?tab=overview

ERA5-Land is a reanalysis dataset providing a consistent view of the evolution of land variables over several decades at an enhanced resolution compared to ERA5. ERA5-Land has been produced by replaying the land component of the ECMWF ERA5 climate reanalysis. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. Reanalysis produces data that goes several decades back in time, providing an accurate description of the climate of the past.

Data description

Data type	Gridded
Projection	Regular latitude-longitude grid
Horizontal coverage	Global
Horizontal resolution	0.1° x 0.1°; Native resolution is 9 km.
Vertical coverage	From 2 m above the surface level, to a soil depth of 289 cm.
Vertical resolution	4 levels of the ECMWF surface model: Layer 1: 0 -7cm, Layer 2: 7 -28cm, Layer 3: 28-100cm, Layer 4: 100-289cm Some parameters are defined at 2 m over the surface.
Temporal coverage	January 1950 to present
Temporal resolution	Hourly / Monthly averaged
File format	GRIB
Update frequency	Monthly with a delay of about three months relatively to actual date.

Main variables

Name	Units	Description
Evaporation from the top of canopy	m of water equivalent	The amount of evaporation from the canopy interception reservoir at the top of the canopy. This variable is accumulated from the beginning of the forecast time to the end of the forecast step.
Evaporation from vegetation transpiration	m of water equivalent	Amount of evaporation from vegetation transpiration. This has the same meaning as root extraction i.e. the amount of water extracted from the different soil layers. This variable is accumulated from the beginning of the forecast time to the end of the forecast step.
Leaf area index, high vegetation	m2 m-2	One-half of the total green leaf area per unit horizontal ground surface area for high vegetation type.
Leaf area index, low vegetation	m2 m-2	One-half of the total green leaf area per unit horizontal ground surface area for low vegetation type.
Potential evaporation	m	Potential evaporation (pev) in the current ECMWF model is computed, by making a second call to the surface energy balance

		routine with the vegetation variables set to "crops/mixed farming" and assuming no stress from soil moisture. In other words, evaporation is computed for agricultural land as if it is well watered and assuming that the atmosphere is not affected by this artificial surface condition. The latter may not always be realistic. Although pev is meant to provide an estimate of irrigation requirements, the method can give unrealistic results in arid conditions due to too strong evaporation forced by dry air. Note that in ERA5-Land pev is computed as an open water evaporation (Pan evaporation) and assuming that the atmosphere is not affected by this artificial surface condition. The latter is different from the way pev is computed in ERA5. This variable is accumulated from the beginning of the forecast time to the end of the forecast step.
Runoff	m	Some water from rainfall, melting snow, or deep in the soil, stays stored in the soil. Otherwise, the water drains away, either over the surface (surface runoff), or under the ground (sub-surface runoff) and the sum of these two is simply called 'runoff'. This variable is the total amount of water accumulated from the beginning of the forecast time to the end of the forecast step. The units of runoff are depth in metres. This is the depth the water would have if it were spread evenly over the grid box. Care should be taken when comparing model variables with observations, because observations are often local to a particular point rather than averaged over a grid square area. Observations are also often taken in different units, such as mm/day, rather than the accumulated metres produced here. Runoff is a measure of the availability of water in the soil, and can, for example, be used as an indicator of drought or flood. More information about how runoff is calculated is given in the IFS Physical Processes documentation.
Skin reservoir content	m of water equivalent	Amount of water in the vegetation canopy and/or in a thin layer on the soil. It represents the amount of rain intercepted by foliage, and water from dew. The maximum amount of 'skin reservoir content' a grid box can hold depends on the type of vegetation, and may be zero. Water leaves the 'skin reservoir' by evaporation.
Skin temperature	K	Temperature of the surface of the Earth. The skin temperature is the theoretical temperature that is required to satisfy the surface energy balance. It represents the temperature of the uppermost surface layer, which has no heat capacity and so can respond instantaneously to changes in surface fluxes. Skin temperature is calculated differently over land and sea. Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.

Snow cover	%	It represents the fraction (0-1) of the cell / grid-box occupied by snow (similar to the cloud cover fields of ERA5).
Snow density	kg m-3	Mass of snow per cubic metre in the snow layer. The ECMWF Integrated Forecast System (IFS) model represents snow as a single additional layer over the uppermost soil level. The snow may cover all or part of the grid box.
Snow depth	m	Instantaneous grib-box average of the snow thickness on the ground (excluding snow on canopy).
Snow depth water equivalent	m of water equivalent	Depth of snow from the snow-covered area of a grid box. Its units are metres of water equivalent, so it is the depth the water would have if the snow melted and was spread evenly over the whole grid box. The ECMWF Integrated Forecast System represents snow as a single additional layer over the uppermost soil level. The snow may cover all or part of the grid box.
Snow evaporation	m of water equivalent	Evaporation from snow averaged over the grid box (to find flux over snow, divide by snow fraction). This variable is accumulated from the beginning of the forecast time to the end of the forecast step.
Snowfall	m of water equivalent	Accumulated total snow that has fallen to the Earth's surface. It consists of snow due to the large-scale atmospheric flow (horizontal scales greater than around a few hundred metres) and convection where smaller scale areas (around 5km to a few hundred kilometres) of warm air rise. If snow has melted during the period over which this variable was accumulated, then it will be higher than the snow depth. This variable is the total amount of water accumulated from the beginning of the forecast time to the end of the forecast step. The units given measure the depth the water would have if the snow melted and was spread evenly over the grid box. Care should be taken when comparing model variables with observations, because observations are often local to a particular point in space and time, rather than representing averages over a model grid box and model time step.
Snowmelt	m of water equivalent	Melting of snow averaged over the grid box (to find melt over snow, divide by snow fraction). This variable is accumulated from the beginning of the forecast time to the end of the forecast step.
Soil temperature level 1	K	Temperature of the soil in layer 1 (0 - 7 cm) of the ECMWF Integrated Forecasting System. The surface is at 0 cm. Soil temperature is set at the middle of each layer, and heat transfer is calculated at the interfaces between them. It is assumed that there is no heat transfer out of the bottom of the lowest layer. Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.

Soil temperature level 2	K	Temperature of the soil in layer 2 (7 -28cm) of the ECMWF Integrated Forecasting System.
Soil temperature level 3	K	Temperature of the soil in layer 3 (28-100cm) of the ECMWF Integrated Forecasting System.
Soil temperature level 4	K	Temperature of the soil in layer 4 (100-289 cm) of the ECMWF Integrated Forecasting System.
Sub-surface runoff	m	Some water from rainfall, melting snow, or deep in the soil, stays stored in the soil. Otherwise, the water drains away, either over the surface (surface runoff), or under the ground (sub-surface runoff) and the sum of these two is simply called 'runoff'. This variable is accumulated from the beginning of the forecast time to the end of the forecast step. The units of runoff are depth in metres. This is the depth the water would have if it were spread evenly over the grid box. Care should be taken when comparing model variables with observations, because observations are often local to a particular point rather than averaged over a grid square area. Observations are also often taken in different units, such as mm/day, rather than the accumulated metres produced here. Runoff is a measure of the availability of water in the soil, and can, for example, be used as an indicator of drought or flood. More information about how runoff is calculated is given in the IFS Physical Processes documentation.
Surface latent heat flux	J m-2	Exchange of latent heat with the surface through turbulent diffusion. This variables is accumulated from the beginning of the forecast time to the end of the forecast step. By model convention, downward fluxes are positive.
Surface net solar radiation	J m-2	Amount of solar radiation (also known as shortwave radiation) reaching the surface of the Earth (both direct and diffuse) minus the amount reflected by the Earth's surface (which is governed by the albedo).Radiation from the Sun (solar, or shortwave, radiation) is partly reflected back to space by clouds and particles in the atmosphere (aerosols) and some of it is absorbed. The rest is incident on the Earth's surface, where some of it is reflected. The difference between downward and reflected solar radiation is the surface net solar radiation. This variable is accumulated from the beginning of the forecast time to the end of the forecast step. The units are joules per square metre (J m-2). To convert to watts per square metre (W m-2), the accumulated values should be divided by the accumulation period expressed in seconds. The ECMWF convention for vertical fluxes is positive downwards.

Surface net thermal radiation	J m-2	Net thermal radiation at the surface. Accumulated field from the beginning of the forecast time to the end of the forecast step. By model convention downward fluxes are positive.
Surface pressure	Pa	Pressure (force per unit area) of the atmosphere on the surface of land, sea and in-land water. It is a measure of the weight of all the air in a column vertically above the area of the Earth's surface represented at a fixed point. Surface pressure is often used in combination with temperature to calculate air density. The strong variation of pressure with altitude makes it difficult to see the low and high pressure systems over mountainous areas, so mean sea level pressure, rather than surface pressure, is normally used for this purpose. The units of this variable are Pascals (Pa). Surface pressure is often measured in hPa and sometimes is presented in the old units of millibars, mb (1 hPa = 1 mb = 100 Pa).
Surface runoff	m	Some water from rainfall, melting snow, or deep in the soil, stays stored in the soil. Otherwise, the water drains away, either over the surface (surface runoff), or under the ground (sub-surface runoff) and the sum of these two is simply called 'runoff'. This variable is the total amount of water accumulated from the beginning of the forecast time to the end of the forecast step. The units of runoff are depth in metres. This is the depth the water would have if it were spread evenly over the grid box. Care should be taken when comparing model variables with observations, because observations are often local to a particular point rather than averaged over a grid square area. Observations are also often taken in different units, such as mm/day, rather than the accumulated metres produced here. Runoff is a measure of the availability of water in the soil, and can, for example, be used as an indicator of drought or flood. More information about how runoff is calculated is given in the IFS Physical Processes documentation.
Surface thermal radiation downwards	J m-2	Amount of thermal (also known as longwave or terrestrial) radiation emitted by the atmosphere and clouds that reaches the Earth's surface. The surface of the Earth emits thermal radiation, some of which is absorbed by the atmosphere and clouds. The atmosphere and clouds likewise emit thermal radiation in all directions, some of which reaches the surface (represented by this variable). This variable is accumulated from the beginning of the forecast time to the end of the forecast step. The units are joules per square metre (J m-2). To convert to watts per square metre (W m-2), the accumulated values should be divided by the accumulation period expressed in seconds. The ECMWF convention for vertical fluxes is positive downwards.

Temperature of snow layer	K	This variable gives the temperature of the snow layer from the ground to the snow-air interface. The ECMWF Integrated Forecast System (IFS) model represents snow as a single additional layer over the uppermost soil level. The snow may cover all or part of the grid box. Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.
Total evaporation	m of water equivalent	Accumulated amount of water that has evaporated from the Earth's surface, including a simplified representation of transpiration (from vegetation), into vapour in the air above. This variable is accumulated from the beginning of the forecast to the end of the forecast step. The ECMWF Integrated Forecasting System convention is that downward fluxes are positive. Therefore, negative values indicate evaporation and positive values indicate condensation.
Total precipitation	m	Accumulated liquid and frozen water, including rain and snow, that falls to the Earth's surface. It is the sum of large-scale precipitation (that precipitation which is generated by large-scale weather patterns, such as troughs and cold fronts) and convective precipitation (generated by convection which occurs when air at lower levels in the atmosphere is warmer and less dense than the air above, so it rises). Precipitation variables do not include fog, dew or the precipitation that evaporates in the atmosphere before it lands at the surface of the Earth. This variable is accumulated from the beginning of the forecast time to the end of the forecast step. The units of precipitation are depth in metres. It is the depth the water would have if it were spread evenly over the grid box. Care should be taken when comparing model variables with observations, because observations are often local to a particular point in space and time, rather than representing averages over a model grid box and model time step.
Volumetric soil water layer 1	m3 m-3	Volume of water in soil layer 1 (0 - 7 cm) of the ECMWF Integrated Forecasting System. The surface is at 0 cm. The volumetric soil water is associated with the soil texture (or classification), soil depth, and the underlying groundwater level.
Volumetric soil water layer 2	m3 m-3	Volume of water in soil layer 2 (7 -28 cm) of the ECMWF Integrated Forecasting System.
Volumetric soil water layer 3	m3 m-3	Volume of water in soil layer 3 (28-100 cm) of the ECMWF Integrated Forecasting System.
Volumetric soil water layer 4	m3 m-3	Volume of water in soil layer 4 (100-289 cm) of the ECMWF Integrated Forecasting System.

Fire burned area from 2001 to present derived from satellite observations

https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-fire-burned-area?tab=overview

The Burned Area products provide global information of total burned area (BA) at pixel and grid scale. The BA is identified with the date of first detection of the burned signal in the case of the pixel product, and with the total BA per grid cell in the case of the grid product. The products were obtained through the analysis of reflectance changes from medium resolution sensors (Terra MODIS, Sentinel-3 OLCI), supported by the use of MODIS thermal information. The burned area products also include information related to the land cover that has been burned, which has been extracted from the Copernicus Climate Change Service (C3S) land cover dataset, thus assuring consistency between the datasets.

Data description

Data type	Gridded
Horizontal coverage	Grid product: Global Pixel product: Continents
Horizontal resolution	Grid product: 0.25° latitude x 0.25° longitude Pixel product: 250m (v5.0cds and v5.1.1cds); 300m (v1.1)
Vertical coverage	Surface
Vertical resolution	Single level
Temporal coverage	From 2001 to 2016 for v5.0cds From 2001 to 2019 for v5.1.1cds From 2017 to present for v1.1
Temporal resolution	Grid product: 15 days (v5.0cds); 1 month (v5.1.1cds and v1.1) Pixel product: Month
File format	NetCDF4
Conventions	Climate and Forecast (CF) Metadata Convention v1.6 and ESA CCI Data Standards [DSWG 2015]
Versions	Versions 5.0cds and 5.1.1cds provide data from the European Space Agency Climate Change Initiative Version 1.1 is the first burned area product developed especifically for the Copernicus Climate Change Service. Version 5.1cds and 1.0 have been deprecated, and replaced by versions 5.1.1cds and 1.1, respectively. Versions v5.1cds and 1.0 are kept for traceability, transparency and reproducibility. All versions are produced with the same processing chain.
Update frequency	Yearly

Main variables

Name	Units	Description
Burned area (Grid product)	m2	Total burned area within each pixel in the 15-days or monthly period.

Burned area in vegetation class (Grid product)	m2	Sum of burned area by land cover classes; land cover classes are from CCI Land Cover (for version 5.0cds) or C3S Land Cover (for the rest of the versions).
Confidence level (Pixel product)	%	Probability of detecting a pixel as burned. Possible values: 0 when the pixel is not observed in the month, or it is not burnable; 1 to 100 probability values when the pixel was observed. The closer to 100, the higher the confidence that the pixel is actually burned.
Flag of pixel detection (Pixel product)	Dimensionless.	Day in which the fire was first detected. Possible values: 0 if the pixel is not burned; 1 to 366 day of the first detection when the pixel is burned; -1 when the pixel is not observed in the month; -2 when pixel is not burnable: water bodies, bare areas, urban areas and permanent snow and ice.
Fraction of burnable area (Grid product)	Dimensionless	The fraction of burnable area is the fraction of the cell that corresponds to vegetated land covers that could burn. The land cover classes are those from CCI Land Cover for version 5.0cds or C3S Land Cover for the rest of the versions.
Fraction of observed area (Grid product)	Dimensionless	The fraction of the total burnable area in the cell that was observed during the time interval and was not marked as unsuitable/not observable. The latter refers to the area where it was not possible to obtain observational burned area information for the whole time interval because of lack of input data (non-existing images for that location and period), cloud cover, haze or pixels that fell below the quality thresholds of the algorithm.
Land cover of burned pixels (Pixel product)	Dimensionless	Land cover of the burned pixel, extracted from the CCI LandCover v1.6.1 for version 5.0cds or C3S Land Cover for the rest of the versions. Possible values: 0 when the pixel is not burned in the month, either because it was observed and not classified as burned, or because it is non burnable or was not observed; 10 to 180: land cover code when the pixel is burned
Number of patches (Grid product)	Dimensionless	Number of contiguous groups of burned pixels.
Standard error (Grid product)	m2	Error on the estimation of burned area in each grid cell, based on the aggregation of the confidence level of the pixel product.

Global land surface atmospheric variables from 1755 to 2020 from comprehensive in-situ observations

https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-observations-surface-land?tab=overview

This set of data holdings provides access to data collected from land surface meteorological observations across the globe. Data are available at the observational level and also at daily and monthly aggregations. Data have been collated and harmonised and quality control checks have been performed, but no attempt has been made to assess for potential biases. Data are provided for a range of commonly observed variables.

Data description

Data type	Point observation
Horizontal coverage	Global land (75,247 daily stations, 72,667 monthly stations, 19,587 sub-daily stations)
Horizontal resolution	Variable
Vertical resolution	Surface
Temporal coverage	1755 to 2020, start date and period of record is station dependent
Temporal resolution	Sub-daily, daily, monthly
File format	CSV
Versions	Current version - 1
Update frequency	Yearly

Main variables (selection)

Name	Units	Description
Accumulated precipitation	mm	Accumulated precipitation over specified period. (Available at frequencies: daily, monthly)
Fresh snow	mm	New snow accumulated between consecutive observations or over reporting period. (Available at frequencies: daily, monthly)
Snow depth	cm	Vertical distance from the snow surface to the underlying surface (ground, glacier ice or sea ice). (Available at frequencies: daily)
Snow water equivalent	mm	Surface snow amount. (Available at frequencies: daily)

Leaf area index and fraction absorbed of photosynthetically active radiation 10-daily gridded data from 1981 to present

https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-lai-fapar?tab=overview

Fraction of absorbed photosynthetically active radiation: FAPAR corresponds to the fraction of photosynthetically active radiation absorbed by the canopy. The FAPAR value results directly from the radiative transfer in the canopy which is instantaneous. It depends on canopy structure, vegetation element optical properties and illumination conditions. FAPAR is very useful as input to a number of primary productivity models based on simple efficiency considerations. FAPAR is relatively linearly related to reflectance values and is little sensitive to scaling issues. Note also that the FAPAR refers only to the green parts of the canopy.

Data description

Data type	Gridded
Projection	Plate Carrée
Horizontal coverage	Global land surface
Horizontal resolution	AVHRR: 1/30° (~4 km) VGT: 1/112° (~1 km) Sentinel-3: 1/336° (~300 m)
Vertical coverage	Top of the canopy
Temporal coverage	AVHRR: September 1981 to December 2005 SPOT-VGT: April 1998 to May 2014 PROBA-VGT: October 2013 to June 2020 Sentinel-3: July 2018 to April 2019
Temporal resolution	10 days
File format	NetCDF
Conventions	Climate and Forecast (CF) Metadata Convention v1.6
Versions	There are 5 product versions available, please refer to the overview text and/or documentation for further details on the differences between these versions.
Update frequency	Monthly updates

Main variables

Name	Units	Description
Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)	Dimensionless	It is a dimensionless quantity varying from 0 (over deserts) to 1 (for large, deep, homogeneous canopy layers observed by medium- to low-resolution sensors) quantifying the aumount of solar radiation in the spectral range 400–700 nm, known as photosynthetically active radiation (PAR), absorbed by the plants relatively to the total amount of energy available at that spectral range. The maximum value is never witnessed in

		practice because some of the incoming light is always reflected back by the canopy or the underlying ground.
Leaf Area Index (LAI)	Dimensionless	Leaf Area Index of a plant canopy or ecosystem, is defined as one half of the total green leaf area per unit horizontal ground surface area. It measures the area of leaf material present in the specified environment. This dimensionless variable (sometimes expressed in terms of square metres of leaf material per square metre of ground) varies between 0 and values of about 10 or so, depending on local conditions.

Precipitation monthly and daily gridded data from 1979 to present derived from satellite measurements

https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-precipitation?tab=overview

The analysis of the Global Precipitation Climatology Project (GPCP) provides global estimates of precipitation as monthly means since 1979 (GPCP monthly v2.3) and as daily means since 1996 (GPCP daily v1.3), based on estimates using microwave imagers on polar-orbiting satellites and infrared imagers on geostationary satellites. The monthly product also includes information from rain-gauge observations analyzed by the Global Precipitation Climatology Centre (GPCC). The GPCP daily product is tied to GPCC indirectly via its calibration with the GPCP monthly product.

Data description

Data type	Gridded
Horizontal coverage	Global
Horizontal resolution	1.0°x1.0° for daily mean values 2.5°x2.5° for monthly mean values
Vertical coverage	Surface
Vertical resolution	Single level
Temporal coverage	January 1979 to present for monthly mean values October 1996 to present for daily mean values
Temporal resolution	Monthly and daily
Temporal gaps	No gaps
File format	NetCDF4
Conventions	Climate and Forecast (CF) Metadata Convention v1.6, Attribute Convention for Dataset Discovery (ACDD) v1.3
Versions	2.3 (monthly) and 1.3 (daily)
Update frequency	Quarterly

Main variables

Name	Units	Description
Precipitation	mm day-1	This variable represents the water-equivalent volume rate per area and per day of atmospheric water in liquid or solid phase reaching the Earth's surface

Soil moisture gridded data from 1978 to present

https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-soil-moisture?tab=overview

This dataset provides estimates of surface soil moisture over the globe from a large set of satellite sensors. It is based on the methodology developed in the ESA Climate Change Initiative for Soil Moisture 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.

Data description

Data type	Gridded
Projection	Regular latitude-longitude grid
Horizontal coverage	Global
Horizontal resolution	0.25° x 0.25°
Temporal coverage	1978 to present
Temporal resolution	Daily, 10-day, Monthy
File format	NetCDF
Conventions	Climate and Forecast (CF) Metadata Convention v1.8
Versions	v201706: First release of the dataset. Equivalent to CCI version 3. v201812: Algorithm updates (merging, signal to noise ratio gap filling, uncertainties, masking), sensor updates (SMOS included). Equivalent to CCI version 4. v201912: Deprecated. Temporal extension of v201812 to 2019-12-31, updates in passive data pre-processing. Equivalent to CCI version 3. v201912.1: Correction to v201912 v202012: Algorithm updates (passive sensors processing, matching, sensor updates (SMAP included). Equivalent to CCI version 5. v202212: Algorithm updates (error estimates, flagging), sensor updates (ASCAT-C, FengYun 3B/C/D and GPM). Equivalent to CCI version 7
Update frequency	ICDR: produced on a 10-day cycle with 10-day latency. CDR: annually updated.

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	m3 m-3	Content of liquid water in a surface soil layer of 2 to 5 cm depth expressed as m3 water per m3 soil.

UERRA regional reanalysis for Europe on soil levels from 1961 to 2019

https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-uerra-europe-soil-levels?tab=overview

The UERRA dataset provides estimations of the climate in Europe based on model data combined with observations using the UERRA-HARMONIE system and MESCAN-SURFEX system.

Data description

Data type	Gridded
Projection	Lambert conformal conic grid with 565 x 565 grid points for the UERRA-HARMONIE system. Lambert conformal conic grid with 1069 x 1069 grid points for the MESCAN-SURFEX system.
Horizontal coverage	Europe: The domain spans from northern Africa beyond the northern tip of Scandinavia. In the west it ranges far into the Atlantic ocean and in the east it reaches to the Ural.
Horizontal resolution	11km x 11km for the UERRA-HARMONIE system. 5.5km x 5.5km for the MESCAN-SURFEX system.
Vertical coverage	From the surface to a depth of 12m for the MESCAN-SURFEX system. For the UERRA-HARMONIE system the vertical coordinates have no precise depth values. They are defined in terms of a time constant determining how quickly they adjust and restore. Please, see the documenation section for more information.
Vertical resolution	3 levels of the soil model for the UERRA-HARMONIE system. 14 for the MESCAN-SURFEX system: 0.01m, 0.04m, 0.1m, 0.2m, 0.4m, 0.6m, 0.8m, 1m, 1.5m, 2m, 3m, 5m, 8m, 12m.
Temporal coverage	January 1961 to July 2019.
Temporal resolution	Analysis are availabe each day at 00, 06, 12 and 18 UTC.
File format	GRIB2
Update frequency	No expected updates.

Main variables

Name	Units	Description
Soil temperature	K	Model temperature valid for the grid cell at the corresponding soil level. The value is instantaneous meaning that it is valid for the last time step of the integration at the issued model time step.
Volumetric soil moisture	m3 m-3	Amount of water in a cubic meter soil valid for the cell grid at the corresponding soil level. The value is instantaneous meaning that it is valid for the last time step of the integration at the issued model time step. To interpret soil water and to compare different models

		the Soil Wetness Index (SWI) is used: SWI = (soil_water - wilting_point) / (field_capacity - wilting_point).
Volumetric transpiration stress-onset	m3 m-3	Soil water content after the soil has been saturated and allowed to drain freely. The values are valid for the cell grid at the corresponding soil level.
Volumetric wilting point	m3 m-3	Model soil water content at which plants wilt and can no longer recover. It is given for a grid cell in the corresponding soil level.

Copernicus DEM - Global and European Digital Elevation Model (COP-DEM)

https://spacedata.copernicus.eu/collections/copernicus-digital-elevation-model

The Copernicus DEM is a Digital Surface Model (DSM) that represents the surface of the Earth including buildings, infrastructure and vegetation. The Copernicus DEM is provided in 3 different instances: EEA-10, GLO-30 and GLO-90. Data were acquired through the TanDEM-X mission between 2011 and 2015. The datasets were made available for use in 2019 and will be maintained until 2026.

Data description

Data type	Gridded
Horizontal projection	- DGED & DTED format: WGS84-G1150 (EPSG 4326) - continental Europe and UTM: EPSG 3035 - French DOMs (INSPIRE format): EPSG 32740, 32622, 32738, 32620)
Vertical projection	EGM2008 (EPSG 3855)
Horizontal coverage	- EEA-10: European coverage: 6M km² - GLO-30: Global coverage: 149M km² - GLO-90: Global coverage: 149M km²
Horizontal resolution	0.3 to 3.0 arc seconds
Vertical unit	meter
Vertical accuracy	< 4m (90% linear error)
Temporal coverage	2019-2023
File format	GeoTIFF (fully compliant with TIFF version 6.0) and DTED
Conventions	The GLO-90 dataset is available worldwide with a free license. The GLO-30 dataset is available worldwide with a free license available here. ESA – EU users who use the Copernicus DEM in their research are requested to use the following DOI when citing the data source in their publications: https://doi.org/10.5270/ESA-c5d3d65
Releases	2019_1, 2019_2, 2020_1, 2020_2, 2021_1, 2021_2, 2022_1, 2023_1
Update frequency	At least once a year