Climate Change

# Climate Change Service

Climate and water

Carlo Buontempo, Jean-Noël Thépaut, Cédric Bergeron

ECMWF

**@carlo_tuitter ; Carlo.Buontempo@ecmwf.int**

Copernicus Europe's eyes on Earth | European Commission | ECMWF

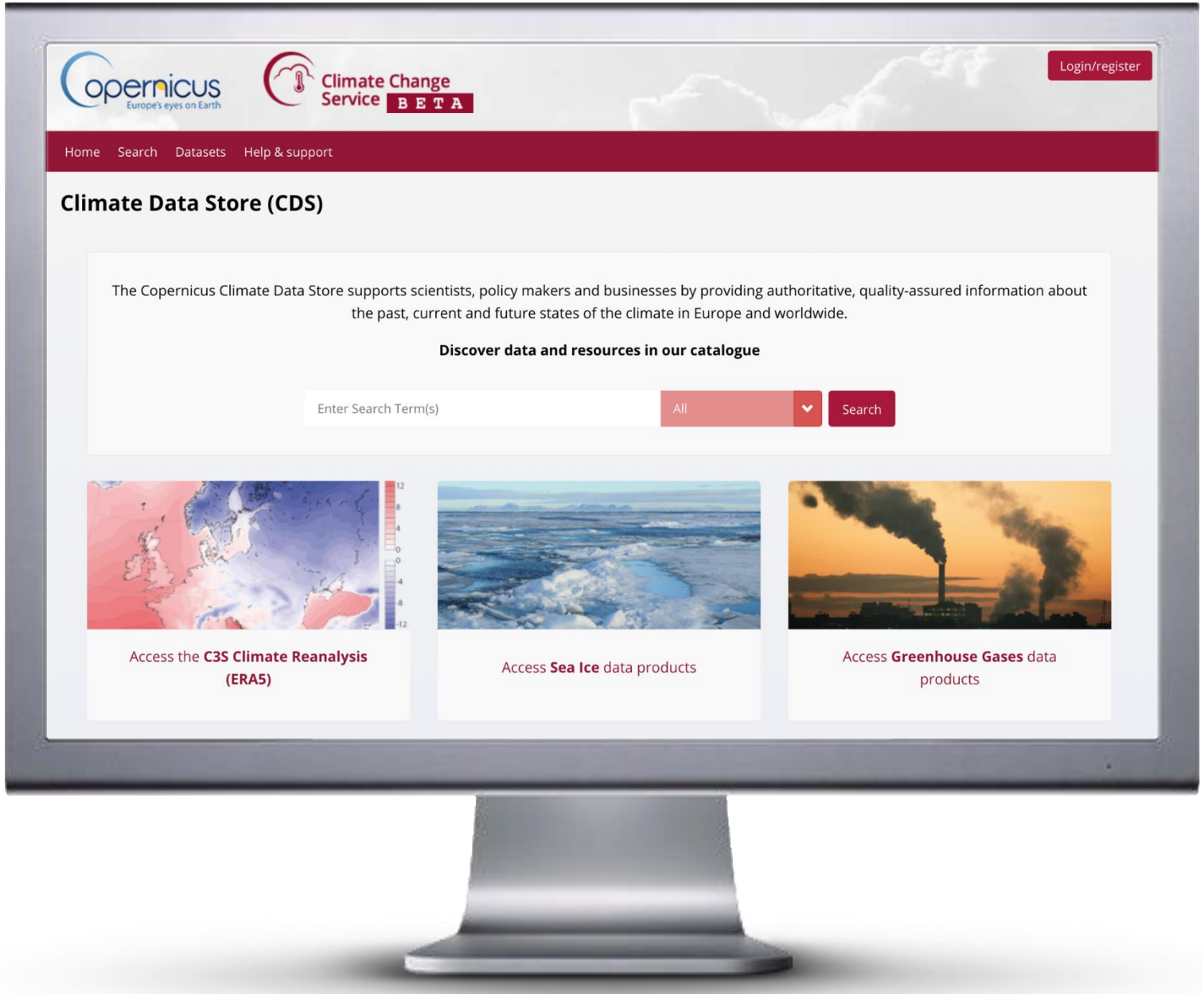
# Water and climate: an obvious link

Publié le 28 Mai 18 à 18:23 | Modifié le 29 Mai 18 à 9:29

Des pluies torrentielles se sont abattues sur la commune d'Isigny-le-Buat. (©Antoine Feugere)

Retrieved from: https://actu.fr/faits-divers/videos-orages-torrents-boue-inondent-routes-sud-manche_17004733.html
At 9:54 on May 29 2018

# Climate Data Store – CDS

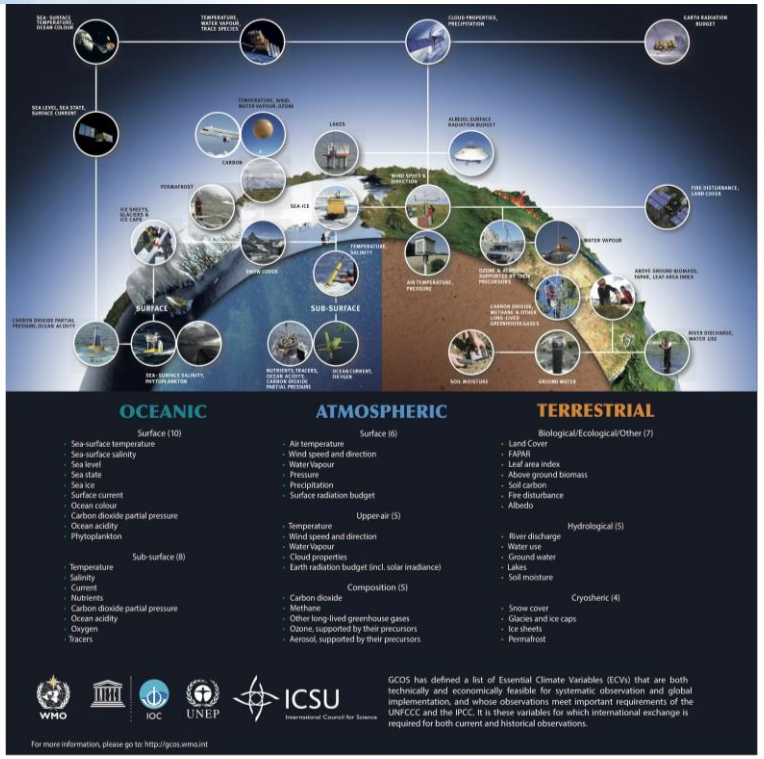



The CDS contains **observations**, global and regional **climate reanalyses**, global and regional **climate projections** and **seasonal forecasts.**

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

# C3S:

Atmosph
Monitori

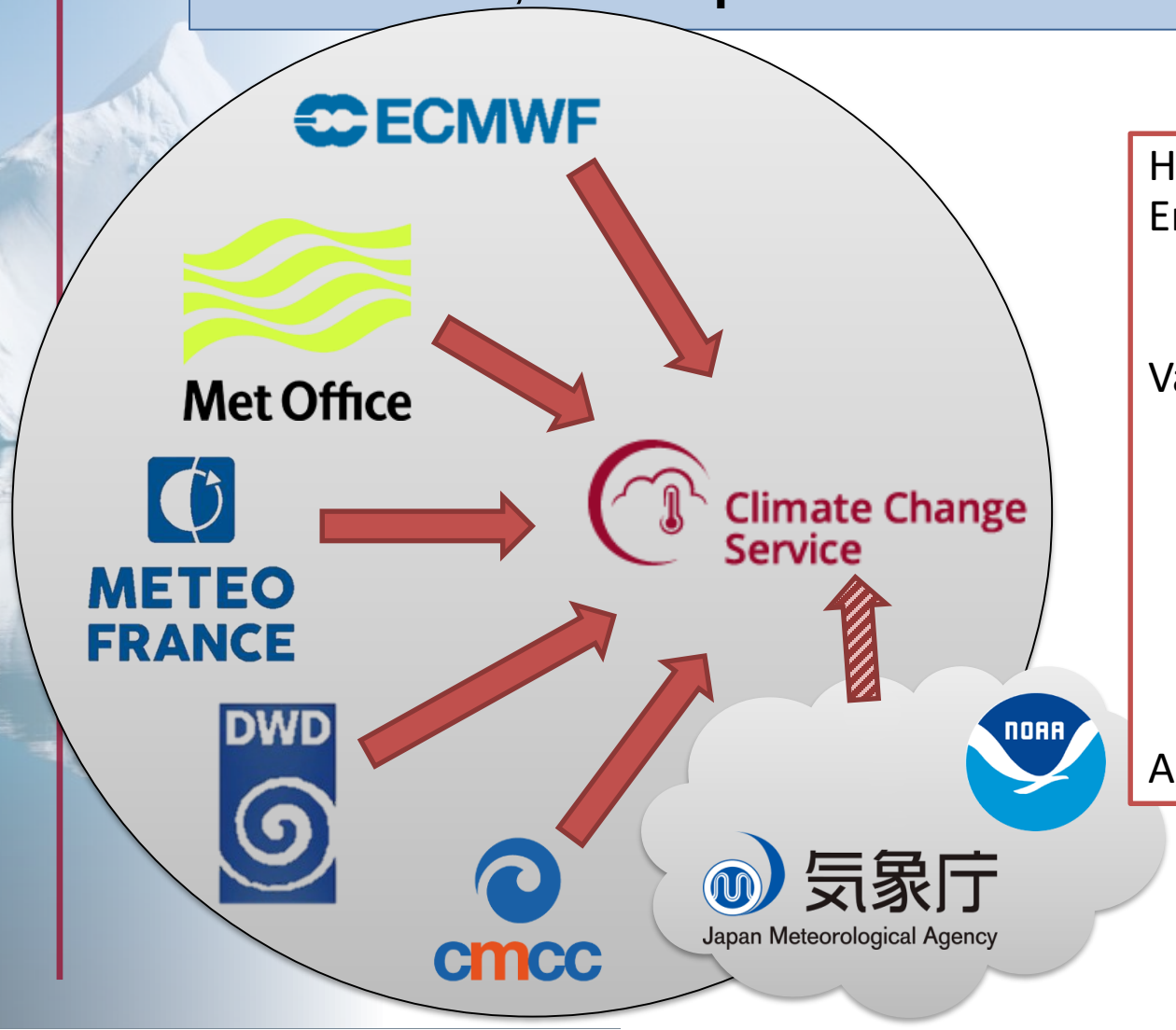



| | | | C3S_312a | | | | |
|---|---|---|---|---|---|---|---|
| | | | | C3S_312b | | | |
| | | GCOS | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Atmospheric physics** | | | | | | | |
| | Precipitation | 4.3.5 | | Lot 1 | | | |
| | Surface Radiation Budget | 4.3.6 | | | | | |
| | Water Vapour | 4.5.3 | | | | | |
| | Cloud Properties | 4.5.4 | | | | | |
| | Earth Radiation Budget | 4.5.5 | | | | | |
| **Atmospheric composition** | | | | | | | |
| | Carbon Dioxide | 4.7.1 | Lot 6 | Lot 2 | | | |
| | Methane | 4.7.2 | Lot 6 | | | | |
| | Ozone | 4.7.4 | Lot 4 | | | | |
| | Aerosol | 4.7.5 | Lot 5 | | | | |
| **Ocean** | | | | | | | |
| | Sea Surface Temperature | 5.3.1 | Lot 3 | Lot 3 | | | |
| | Sea Level | 5.3.3 | Lot 2 | | | | |
| | Sea ice | 5.3.5 | Lot 1 | | | | |
| | Ocean Colour | 5.3.7 | | | | | |
| **Land hydrology & cryosphere** | | | | | | | |
| | Lakes | 6.3.4 | | Lot 4 | | | |
| | Glaciers | 6.3.6 | Lot 8 | | | | |
| | Ice sheets and ice shelves | 6.3.7 | | | | | |
| | Soil moisture | 6.3.16 | Lot 7 | | | | |
| **Land biosphere** | | | | | | | |
| | Albedo | 6.3.9 | Lot 9 | Lot 5 | | | |
| | Land Cover | 6.3.10 | | | | | |
| | Fraction of Absorbed Photosyntheti | 6.3.11 | Lot 9 | | | | |
| | Leaf Area Index | 6.3.12 | Lot 9 | | | | |
| | Fire | 6.3.15 | | | | | |
| | | | | | | | |
| | | | 2017 | 2018 | 2019 | 2020 | 2021 |

Climate Change

# C3S seasonal forecasts - Introduction

Aim: to generate **seasonal forecast** products based on the **best information available**, to an **operational schedule**, and make them **publicly available**.



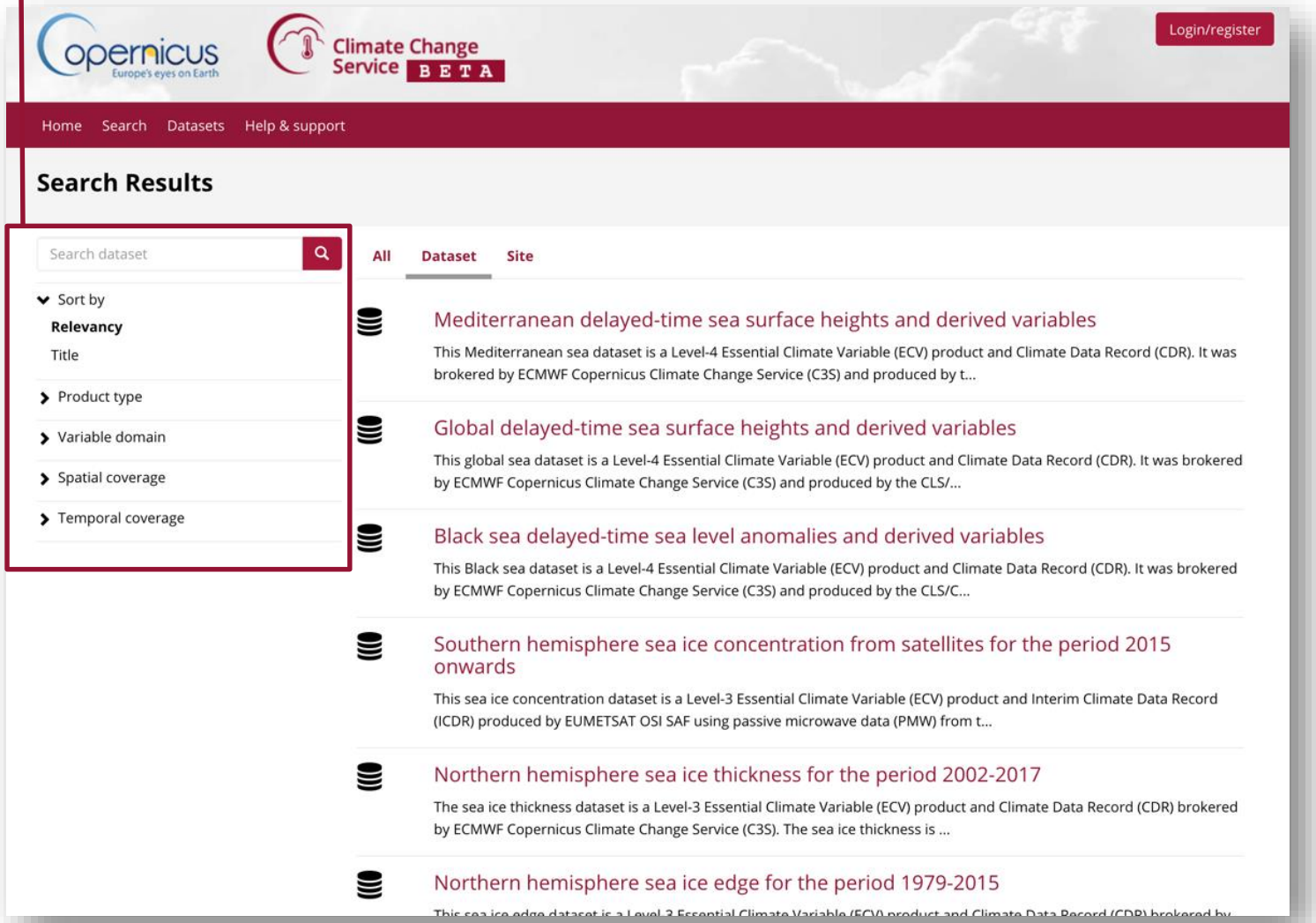

Horizontal grid: global 1deg x 1deg
Ensemble size:
- Forecasts: ~50 members
- Hindcasts: ~25 members x 24 years (1993-2016)

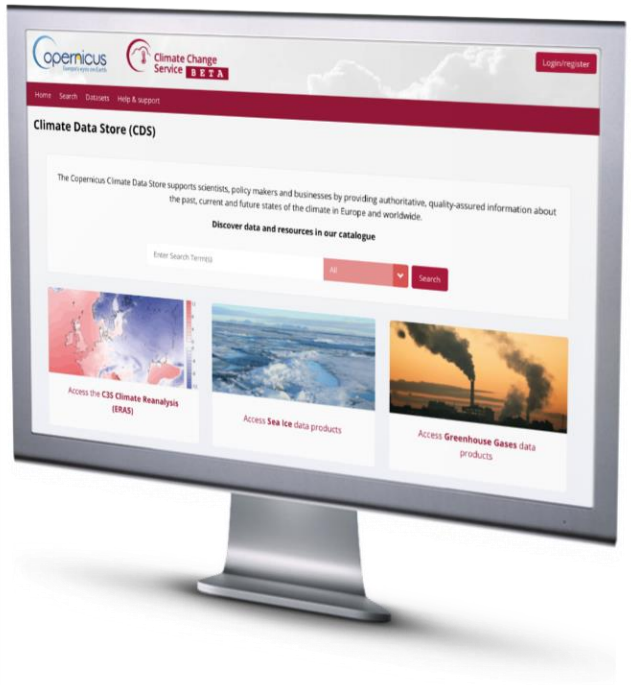
Variables
- Surface
  - 7 vars every 6h
  - +30 vars every 24h
- Pressure (11 levels, from 925 hPa to 10 hPa)
  - 8 vars every 12 h

Agreed NetCDF specification C3S-0.1 (based on CF)

IMPLEMENTED BY ECMWF Copernicus European Commission

# Searching and Browsing Functions



# Discovery and Retrieve Functions

Gridded Satellite Observation Example

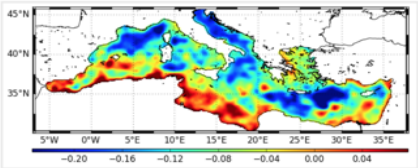
Copernicus Europe's eyes on Earth — Climate Change Service BETA — Login/register

Home Search Datasets Help & support

## Mediterranean delayed-time sea surface heights and derived variables

Overview | Download data | Validation and verification | Documentation | Sample application

This **Mediterranean sea** dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by ECMWF Copernicus Climate Change Service (C3S) and produced by the CLS/CNES DUACS satellite altimeter production system. Within the production process, the long-term stability and large scale changes are built upon the records from the reference missions (TOPEX-Poseidon, Jason-1, Jason-2 and Jason-3). The additional missions (ERS-1, ERS-2, Envisat, CryoSat-2, SARAL/AltiKa and Sentinel-3A) are homogenized with respect to the reference mission and contribute to improve the sampling of mesoscale processes, provide the high-latitude coverage and increase the product accuracy. The steady number of satellites used in the constellation contributes to the long-term stability of the sea level record.




**Sea level anomalies** and derived variables are computed with respect to a twenty-year mean reference period (1993-2012) where up-to-date altimeter standards are used to estimate the sea level anomalies with mapping algorithms dedicated to this region. Contrary to near-real time and interim sea level products, the stability and accuracy of the **delayed-time** product make it adapted to climate applications. This product is delayed about 4-5 months due to the timeliness of the input data, the centred processing temporal window and the validation process. Any modification of past input data, or of the processing chain, will provoke the issuing of a new version of the whole dataset. These products were previously distributed by AVISO+. Details on the altimeter and processing algorithms, validation results and uncertainties are available in the Algorithm Theoretical Basis Document (ATBD), the Product User Guide and Specification (PUGS) and the Product Quality Assessment Report (PQAR) in the Documentation section.

**Keywords:** Altimetry, Sea Level, Climate, Currents, Ocean Topography

| Metadata | |
|---|---|
| Horizontal coverage: | Mediterranean sea (cartesian projection) |
| Horizontal resolution: | 1/8 degree |
| Temporal coverage: | From January 1993 until present with a few months delay |
| Temporal resolution: | Daily |
| Data format: | NetCDF |
| Data type: | GRID |

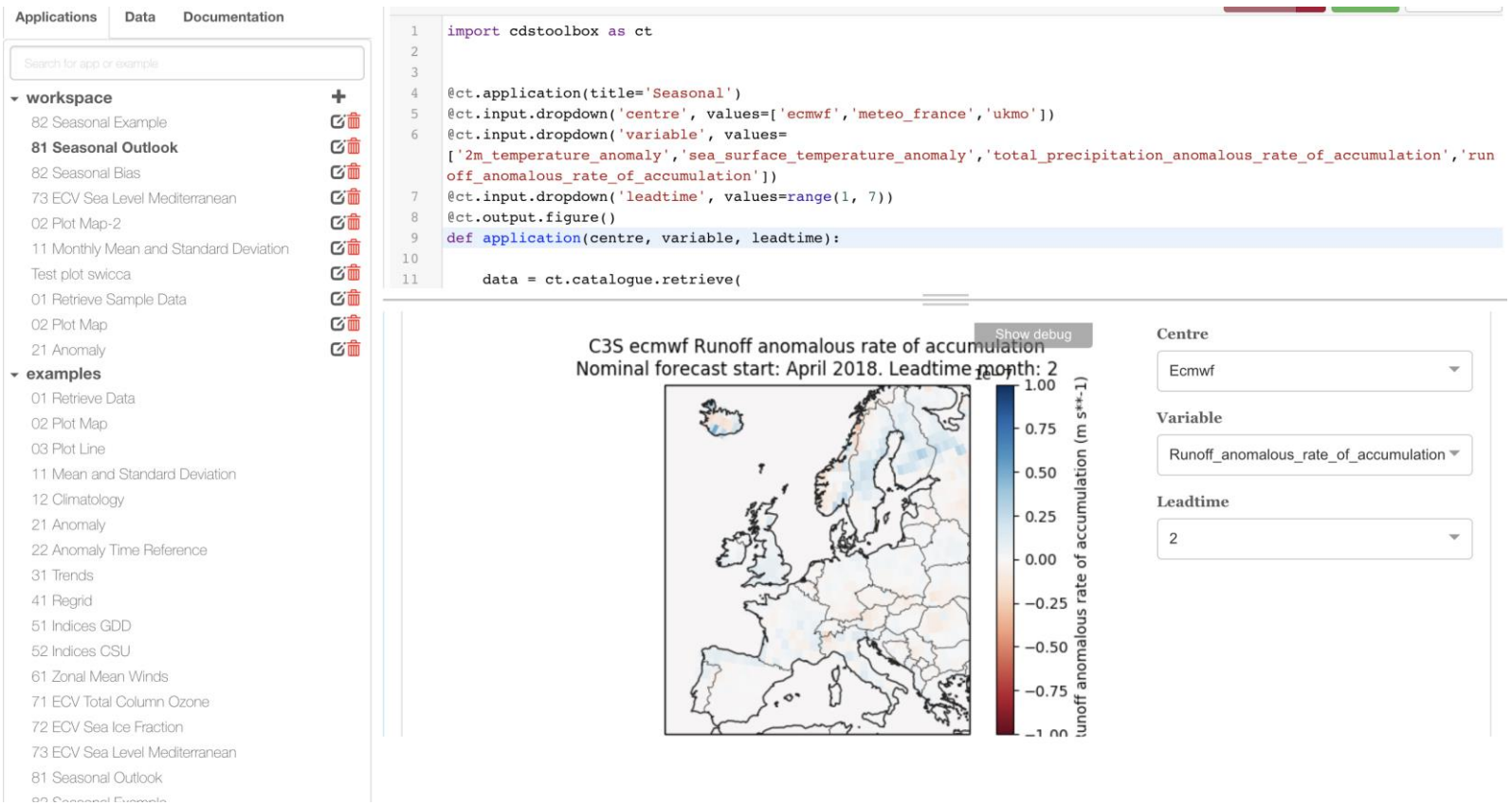
carlobuontempo — vi retrieve_era5.py — 80×24

```
#!/usr/bin/env python3
import cdsapi
c = cdsapi.Client()

c.retrieve("reanalysis-era5-pressure-levels",
{
"variable": "temperature",
"pressure_level": "1000",
"product_type": "reanalysis",
"date": "2008-01-01",
"time": "12:00",
"format": "grib"
},
"download.grib")

~
~
~
~
~
~
~
~
```

# Climate Data Store - implementation

- **Ongoing physical implementation**:
  - On-Premises Private **Cloud** :
    - CloudFerro
      - **34** compute servers x 2 cpu x 12 cores@ 2.2 GHz and 192 GB RAM per server
      - 4 compute server x 2 CPUs x 8 cores @ 2.6 Ghz and 64 GB RAM per server
      - **100** TB SSD and **900** TB HDD

# Climate Data Store - Toolbox

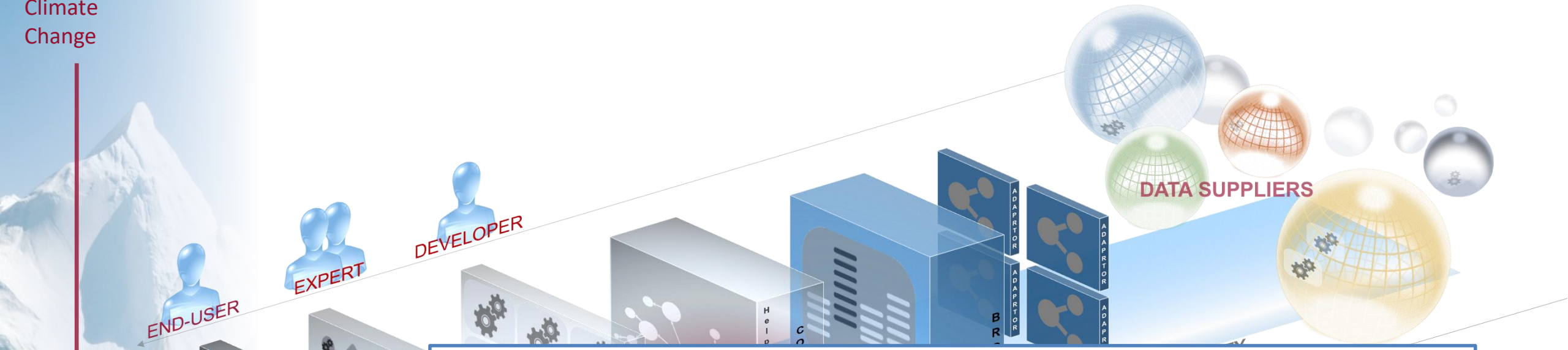



## Toolbox:

The CDS provides an **authoritative set of software** that will allow users to **develop applications** that will make use of the content of the CDS

Climate Change

# Climate data store




As an operational Service, **C3S** ambitions to become an **enabler** of **downstream climate services**, by providing or brokering **high quality** and sector relevant climate **data** and **indicators:**

1) to provide **practical examples** of how C3S in general and CDS in particular could deliver information of relevance to specific sectors.
2) To act as benchmarks of **good practice**.
3) To document **users needs**, and whenever possible address those.

*In particular SIS contract should develop and make available* ***sector-relevant indicators and tools*** *that were either unavailable or inaccessible before.*

Climate Change

# Data is not information without users and context: co-design in practice …

This is a small subset of the set of users SMHI have engaged with in one of our SIS contracts. We had so far 17 of those contracts. It is difficult to summarize all we learnt but:

1) Many users just want data: good data, easy to access and well characterised.
2) Our primary users are not necessarily the end-user but rather the intermediate ones

Berit Arheimer et al @SMHI

Copernicus Europe's eyes on Earth | European Commission | ECMWF

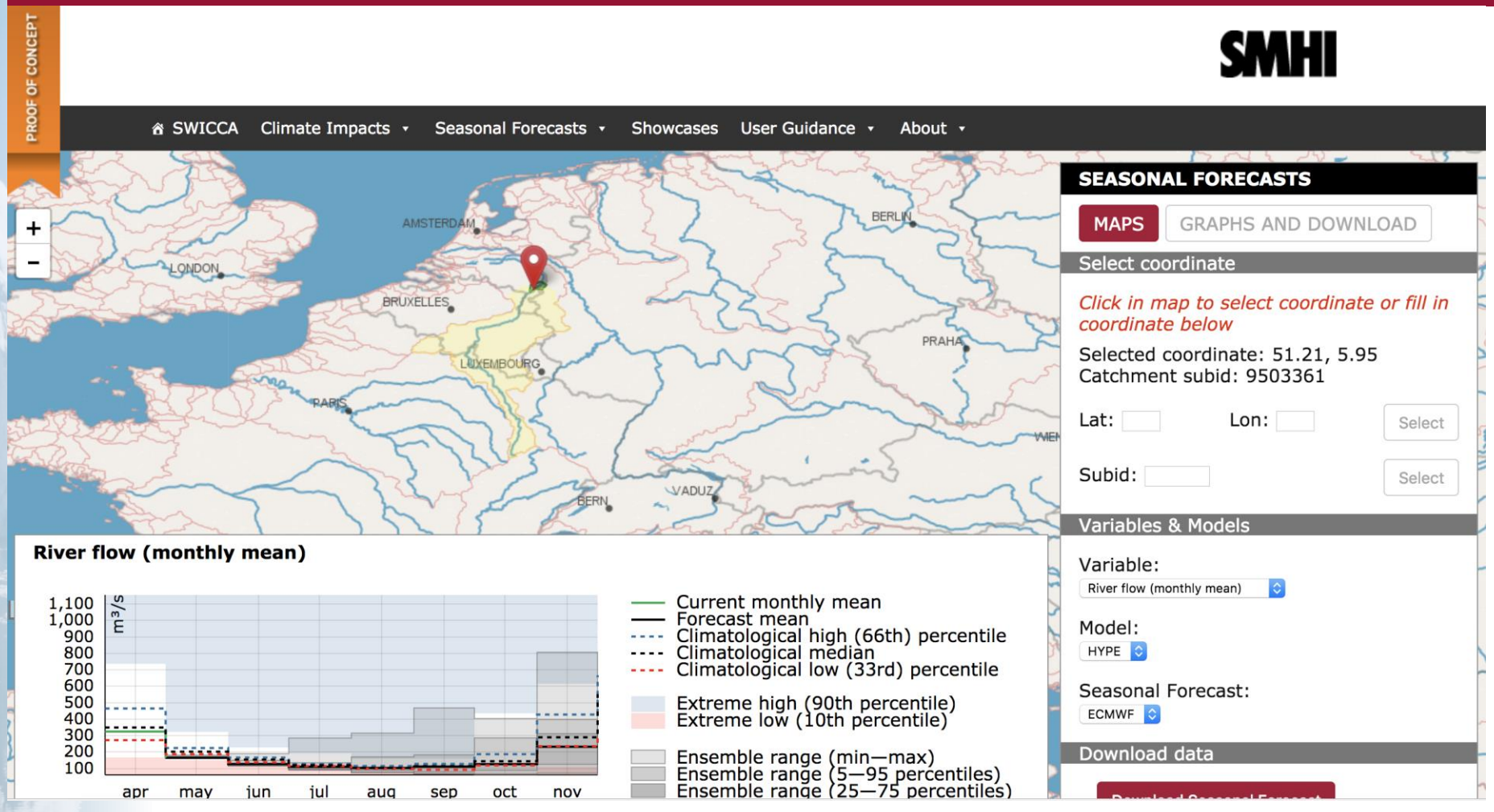
| C2 | C3 | C4 | C5 | CP1 |
|---|---|---|---|---|
| User Requirement (UR) description | UR class | Raw requirement | User sector | ECV |
| Free text.<br>Be specific and quantify statements where possible. | **Choose from:**<br>- **Product** (complete CP)<br>- **Variable** (complete CP)<br>- **General** (complete CG) | Original text.<br>Extract from project source material. | **Choose one or more sector from C3S Sectors:**<br>- **Agriculture and forestry** - **Coastal**<br>- **Disaster risk reduction** - **Energy**<br>- **Health** - **Infrastructure**<br>- **Insurance** - **Tourism**<br>- **Transport** - **Water management** | **Use terms fi** |
| Seasonal forecasts of precipitation for the insurance sector should be available before the underwriting/ renewal season | Variable | seasonal rainfall forecast: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season. | Insurance | Precipitatior |
| Seasonal forecasts of sea surface temperature for the insurance sector should be available before the underwriting/renewal season | Variable | seasonal forecast of ocean surface temperature: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season. | Insurance | Sea surface |
| Seasonal forecasts of surface temperature for the insurance sector should be available before the underwriting/renewal season | Variable | seasonal forecast of surface temperature: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season. | Insurance | Surface air t |
| Seasonal forecasts of tropical cyclone activity, specifically the number of storms, for the insurance sector should be available before the underwriting/ renewal season | Variable | seasonal forecast of tropical cyclone activity: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season. | Insurance | |
| Seasonal forecasts of tropical cyclone activity, specifically the Accumulated Cyclone Energy, for the insurance sector should be available before the underwriting/renewal season | Variable | seasonal forecast of tropical cyclone activity: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season. | Insurance | |
| Seasonal forecasts of precipitation for the insurance sector should cover the full upcoming year | Variable | seasonal rainfall forecast: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to cover the full upcoming year. | Insurance | Precipitatior |
| Seasonal forecasts of sea surface temperature for the insurance sector should cover the full upcoming year | Variable | seasonal forecast of ocean surface temperature: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to cover the full upcoming year. | Insurance | Sea surface |
| Seasonal forecasts of surface temperature for the insurance sector should cover the full upcoming year | Variable | seasonal forecast of surface temperature: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to cover the full upcoming year. | Insurance | Surface air t |
| Seasonal forecasts of precipitation should have more ensemble members to capture full level of uncertainty | Variable | seasonal rainfall forecast: More ensemble to represent uncertainty: There is an insufficient number of ensemble members in seasonal forecasts. Current ensembles do not capture the full level of uncertainty. | Insurance | Precipitatior |
| Seasonal forecasts of sea surface temperature should have more ensemble members to capture full level of uncertainty | Variable | seasonal forecast of ocean surface temperature: More ensemble to represent uncertainty: There is an insufficient number of ensemble members in seasonal forecasts. Current ensembles do not capture the full level of uncertainty. | Insurance | Sea surface |
| Seasonal forecasts of surface temperature should have more ensemble members to capture full level of uncertainty | Variable | seasonal forecast of surface temperature: More ensemble to represent uncertainty: There is an insufficient number of ensemble members in seasonal forecasts. Current ensembles do not capture the full level of uncertainty. | Insurance | Surface air t |
| Seasonal forecasts of precipitation should be available at a higher spatial resolution | Variable | seasonal rainfall forecast: Increasing spatial resolution | Insurance | Precipitatior |
| Seasonal forecasts of surface temperature should be available at a higher spatial resolution | Variable | seasonal forecast of surface temperature: Increasing spatial resolution | Insurance | Surface air t |
| Seasonal forecasts of precipitation should include forecasts of extremes | Variable | seasonal rainfall forecast: make forecast of extremes | Insurance | Precipitatior |

Already ~1400 entries!

Contract led by Uni. Reading

Climate Change

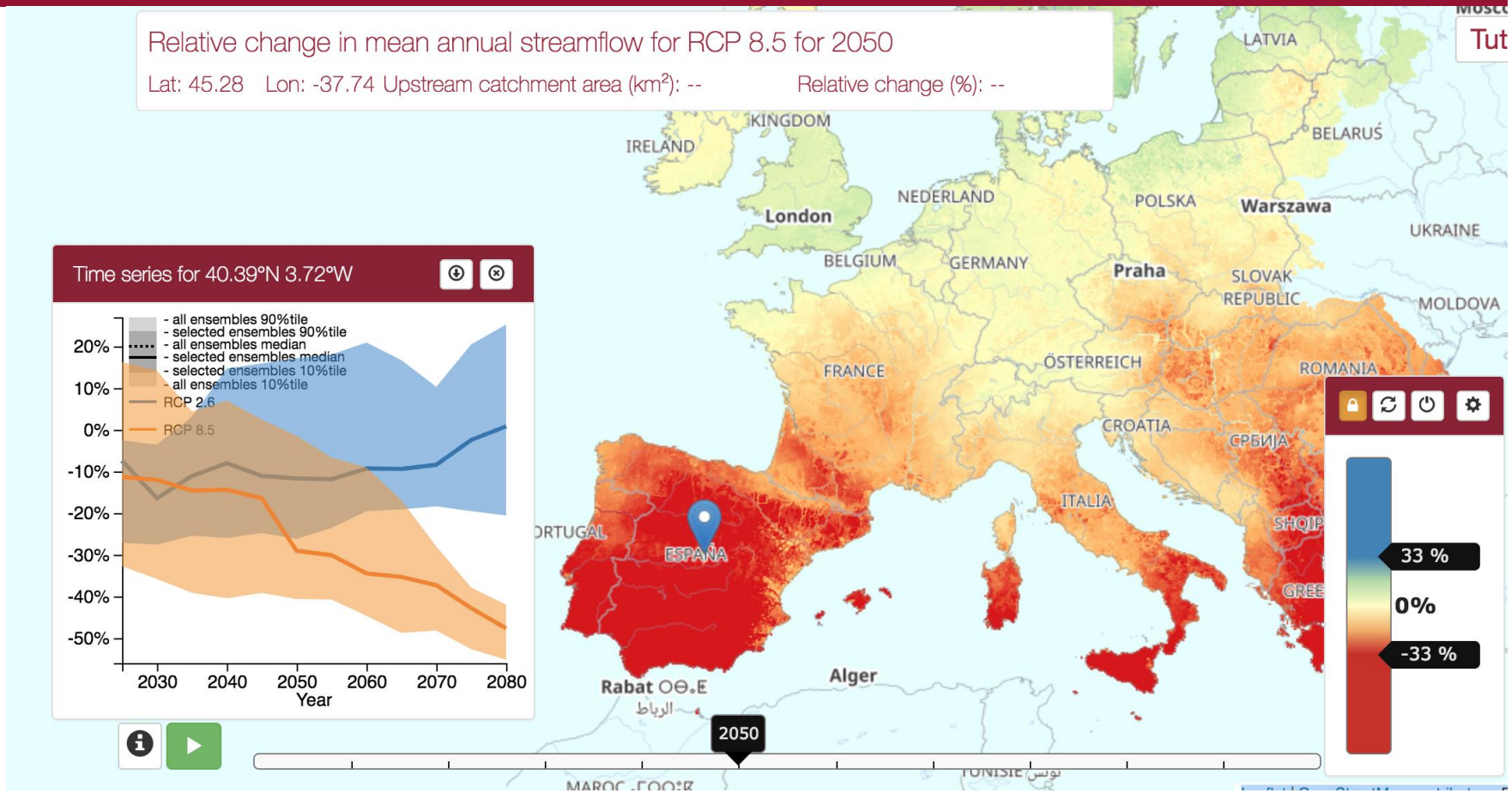
# swicca.climate.copernicus.eu




Pechlivanidis et al EGU2018-5194

Climate Change

# Water resources and drought



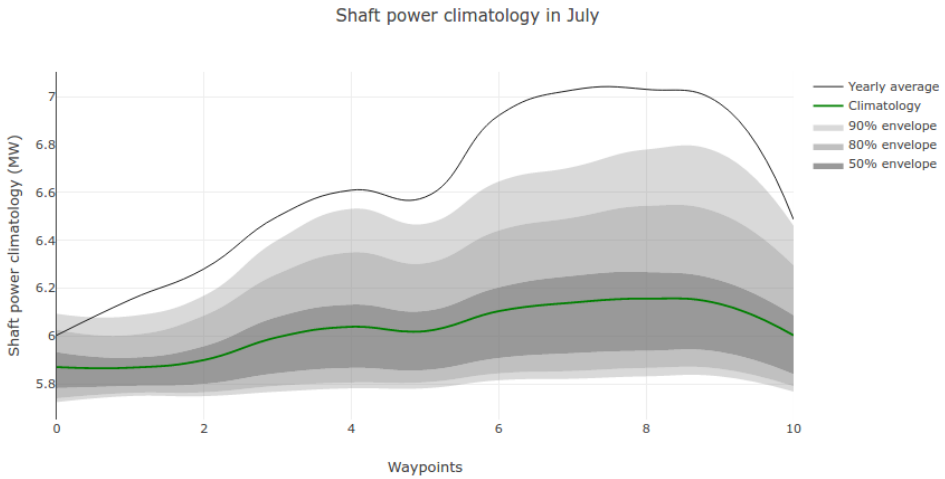

Using a combination of chain of models linking future climate scenarios with hydrological parameters it has been possible to produce an operational assessment of current and future conditions. The water-agriculture-energy nexus provide a good example of how climate mitigation and adaptation can be intertwined. Madrid, in the small plot faces significantly different hydrological futures depending on the mitigation strategy adopted.

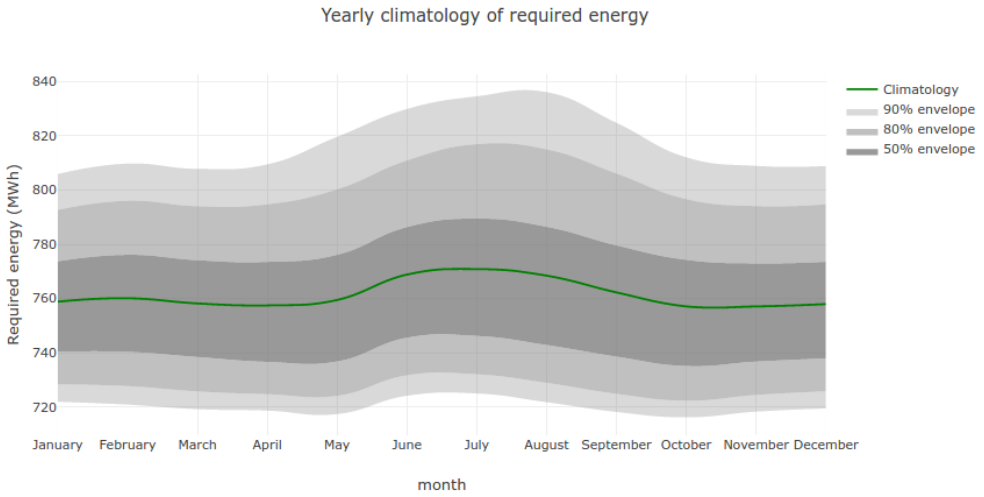
*Samaniego et al. Nature Climate Change* **volume 8**, pages421–426 (2018) doi:10.1038/s41558-018-0138-5

Climate Change

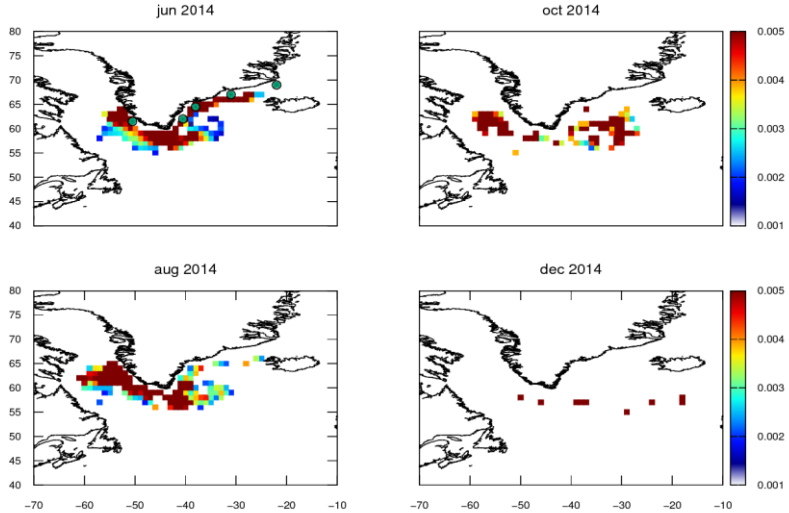
# Climate indicators related to Shipping

## Which part of the route/season is most likely to lead to overconsumption ?

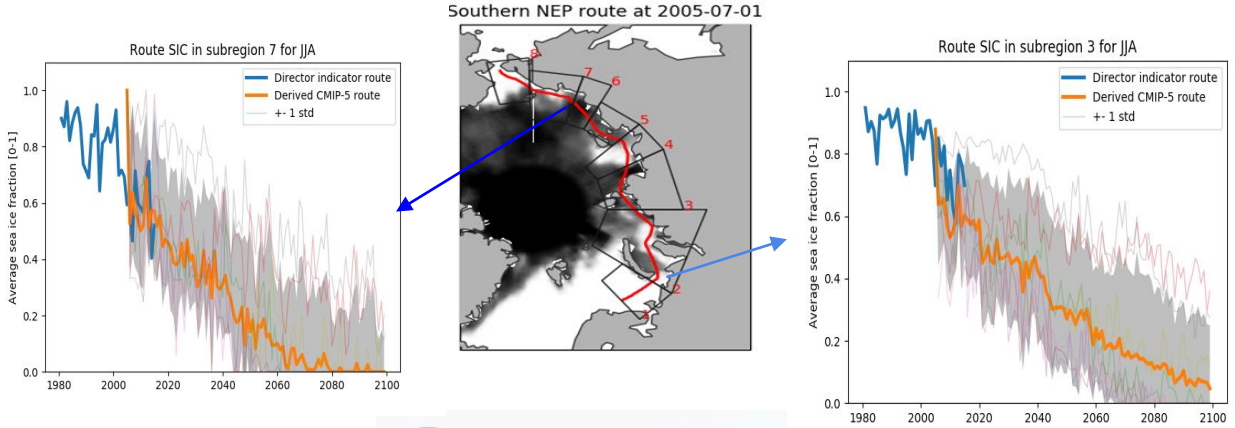



## Where/when will I find icebergs ?




## When will the Arctic route become commercially viable?



Climate Change

Copernicus Europe's eyes on Earth

Climate Change Service BETA

Carlo Buontempo Logout

Home Search Datasets Applications Your requests Help & support

# SIS SWICCA: Water Quantity

Water quantity indicators: Flood recurrences, fl
runoff, wetness.

Overview Download data Documentatior

**Copernicus SWICCA Sectoral Information System**
climate-impact data to speed up the workflow in cl
water management across Europe.

Available **water quantity indicators** are:

- **Flood recurrences** are given as daily river flows
periods of 2, 5, 10, 50, and 100 years. The return perio
a Gumbel distribution fitted to the yearly maximum ri
period. For the reference period (1971-2000) the abs
for the future periods the relative changes are provide

- **Flow duration curve (FDC)** gives information about
flow rates occur. The FDC is described through 13 per
90% in steps of 10%, 95%, 99 %. In case of the FDC fo
seasonality, it is based on all daily data for a 30-year

## Water quality indicator for European rivers

Overview Download data Documentation

### Variable

- [ ] Total phosphorous loads
- [ ] Total phosphorous concentrations
- [ ] Soluble phosphorous loads
- [ ] Particulate phosphorous concentrations
- [ ] Organic nitrogen concentrations
- [ ] Water temperature
- [ ] Organic nitrogen loads
- [ ] Particulate phosphorous loads
- [x] Total nitrogen concentrations
- [ ] Inorganic nitrogen loads
- [ ] Total nitrogen loads
- [ ] Soluble phosphorous concentrations
- [x] Inorganic nitrogen concentrations

Select all Clear all

### Emissions scenario

- [x] RCP 8.5
- [x] RCP 4.5
- [ ] RCP 2.6

Select all Clear all

### Time aggregation

- [ ] Means for each month
- [x] Mean over the whole period

Select all Clear all

### Contact

copernicus-support@ecmwf.int

### License

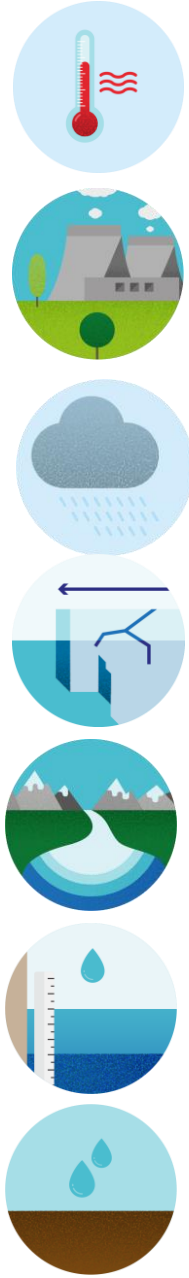
Licence to Use Copernicus Products

### Related data

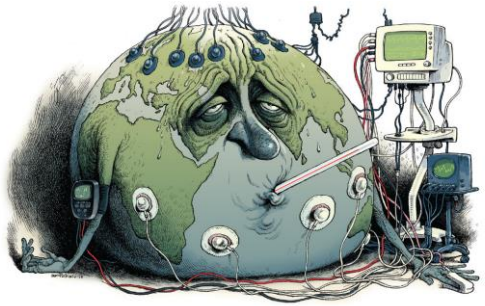
Water quantity indicators for European catchments

Contract led by SMHI

Copernicus Europe's eyes on Earth European Commission ECMWF



| | |
|---|---|
| Surface temperature | ↑ |
| Greenhouse gases | ↑ |
| Rain | – |
| Sea Ice | ↓ |
| Glaciers | ↓ |
| Sea Level | ↑ |
| Soil Moisture | ↓ |



***Credit: Victor & Kennel, Nature Climate Change, 2014.***

Climate Change

# SIS contracts

Proof of concept

- **The past** (2016-2018):
  - Energy (UEA, CEA), Water (CEH,SMHI), Insurance (CGI), *cities (SMHI), agriculture (TelespazioVega)*

Operational phase

- **The present** (2018-2019,..):
  - *European*: storm-surges (Deltares), fisheries (PML), tourism (TEC), cities/health (Vito)
  - *Global*: shipping (OSM), global impacts (SMHI), agriculture (WEnR)

- **The future** :
  - Recently signed: energy, water, insurance
  - quality assurance for SIS, biodiversity, forestry, cultural heritage, case studies, DRR, transport, …

Climate Change

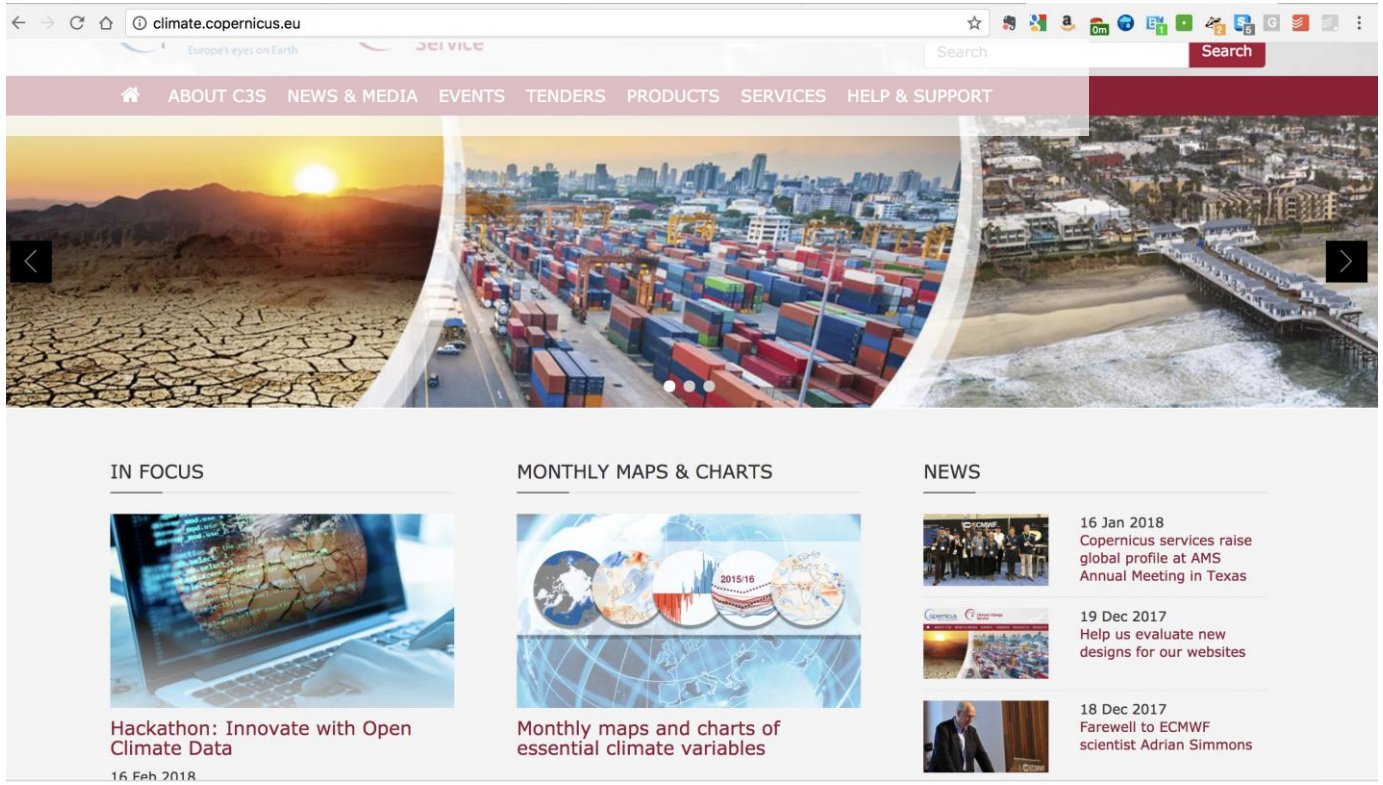
## Points for discussion

- A common framework to deal with  all terrestrial ECVs across time-scales: from historical reconstructions, to multi-decadal projections.
- A coordinated  approach to water across Copernicus Services.
- Improve the quality of the observational record for terrestrial ECVs
- Striking the right balance between the service provision and the requirements to maintain a lively downstream market of applications.

Climate Change

# climate.copernicus.eu

# THANK YOU




Carlo.Buontempo@ecmwf.int
@carlo_tuitter

Copernicus Europe's eyes on Earth | European Commission | ECMWF