Climate Change

Copernicus Climate Change Service

Samantha N Burgess + many colleagues
Deputy Director, C3S

EUMETSAT – Remote Sensing for ocean-atmosphere interactions
3rd December 2021

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

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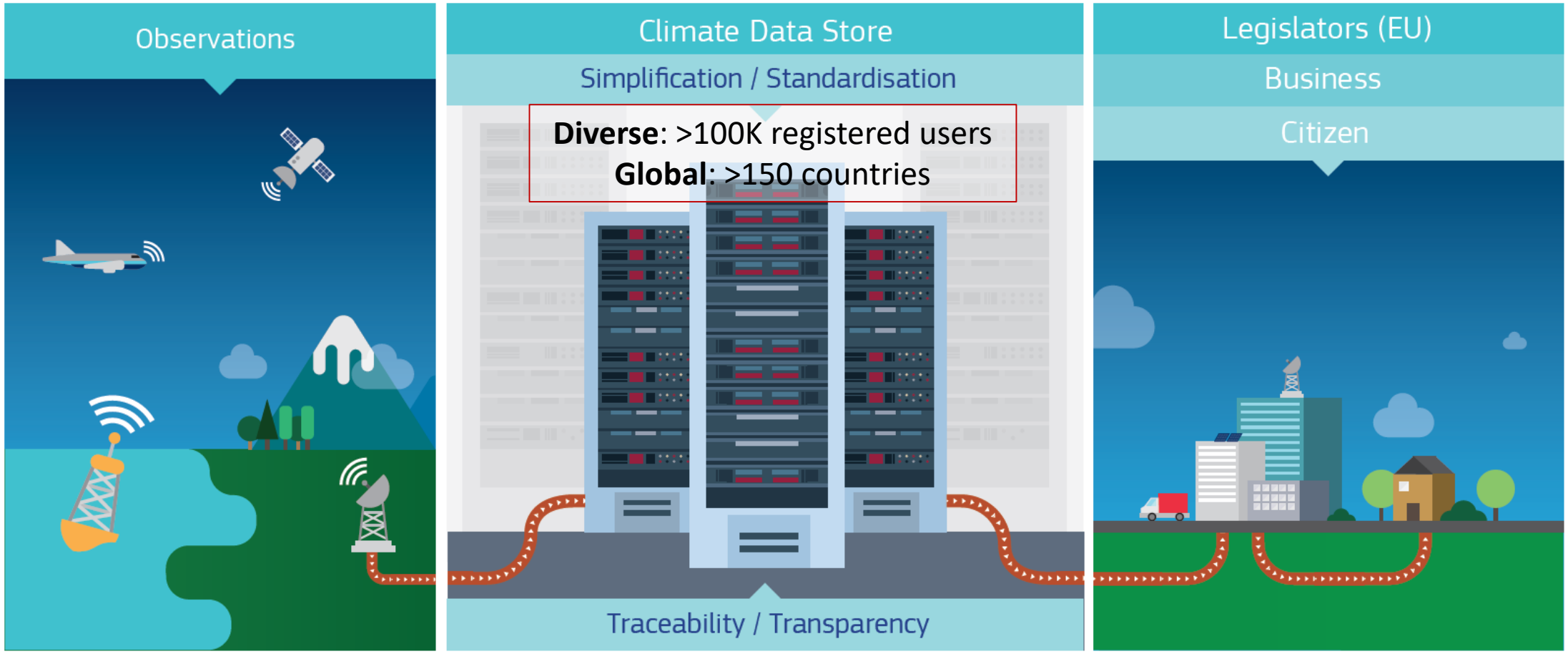
Copernicus Climate Change Service – the nexus between observations and society

https://cds.climate.copernicus.eu

DATA → INFORMATION



PETABYTES → KILOBYTES

Free and open data that is traceable and transparent

109 Catalogued Datasets

24 catalogued public applications
+ 19 available the European Climate Data Explore (EEA)

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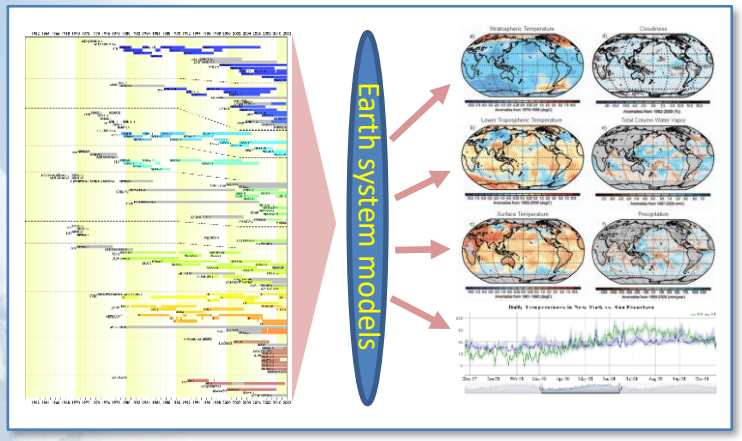
C3S portfolio: access to climate data for the past, present and possible futures

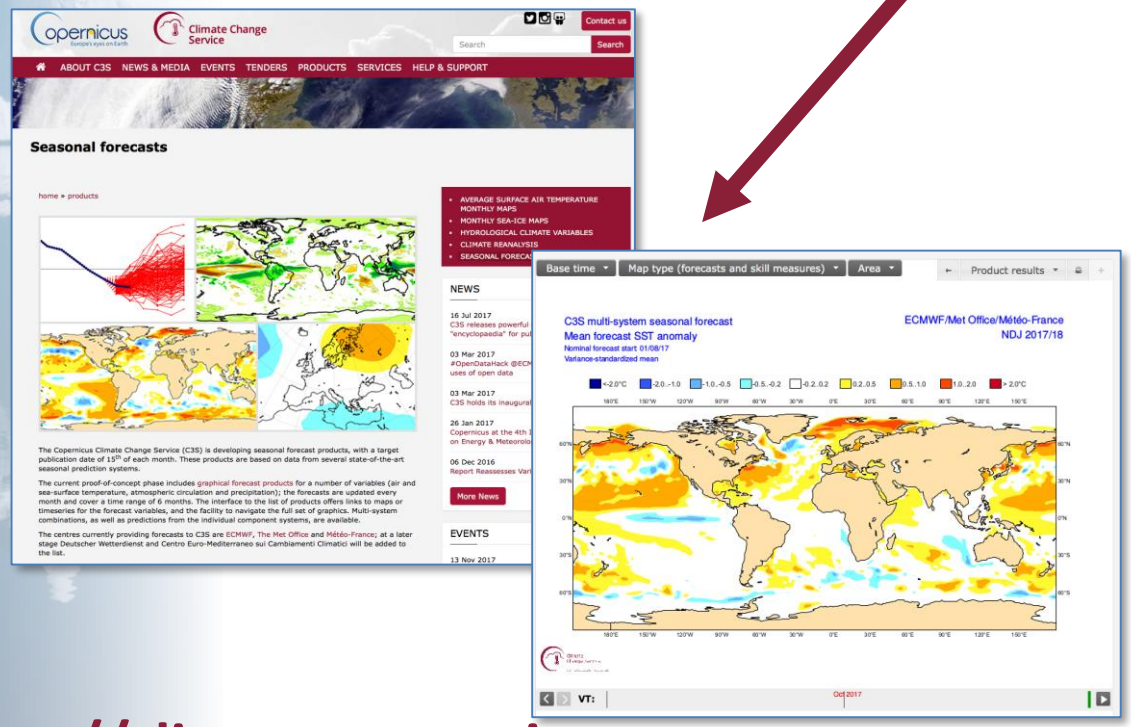


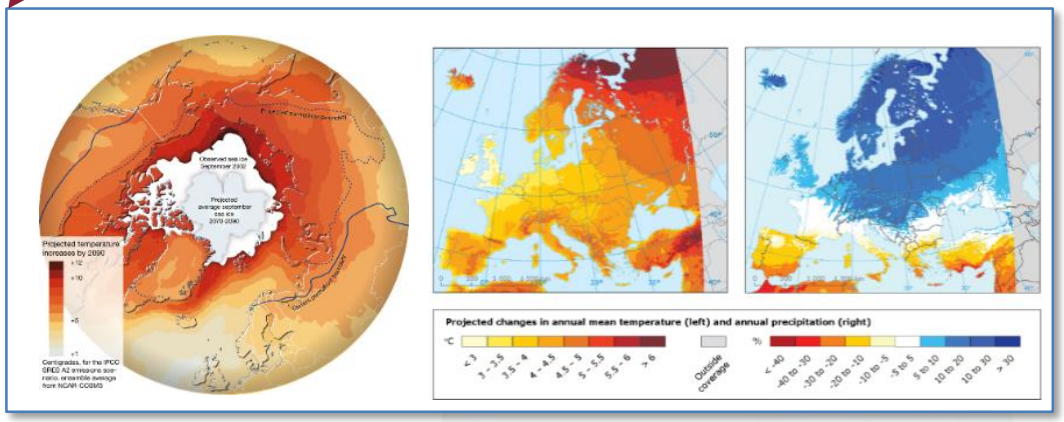
Observations, ECVs and climate reanalyses

Seasonal forecast data and products

Climate model simulations

Sectoral climate impact indicators





http://climate.copernicus.eu

The Climate Data Store

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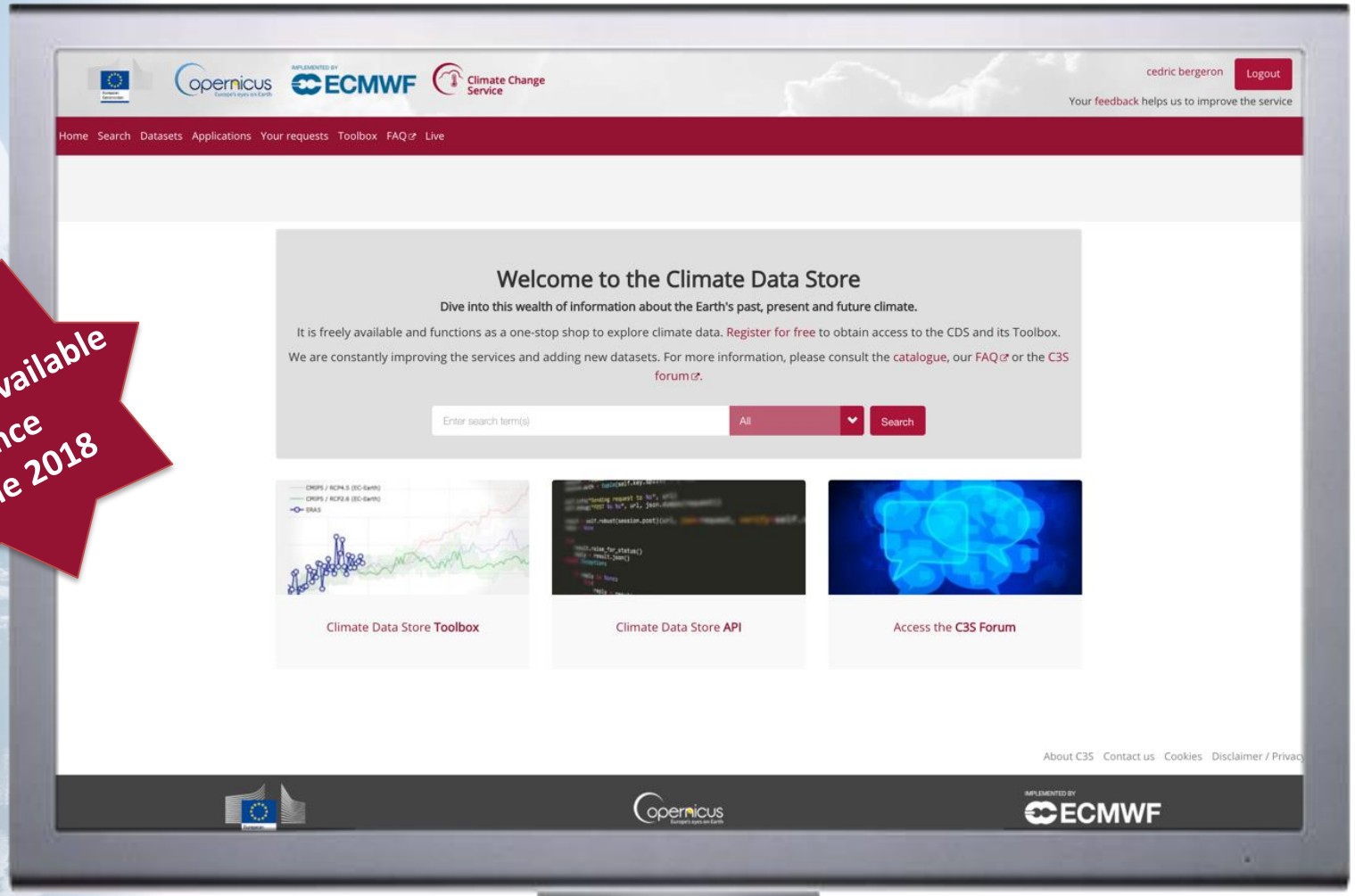

Publicly available since June 2018

https://cds.climate.copernicus.eu

The **Climate Data Store** also called CDS, is **an online open and free service**.

It allows users to browse and access the wide range of climate datasets via a searchable catalogue…

… It allows users to build their own applications, maps and graphs

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Climate data records of Essential Climate Variables (ECVs)

C3S supports 22 ECV services grouped in 5 thematic areas:

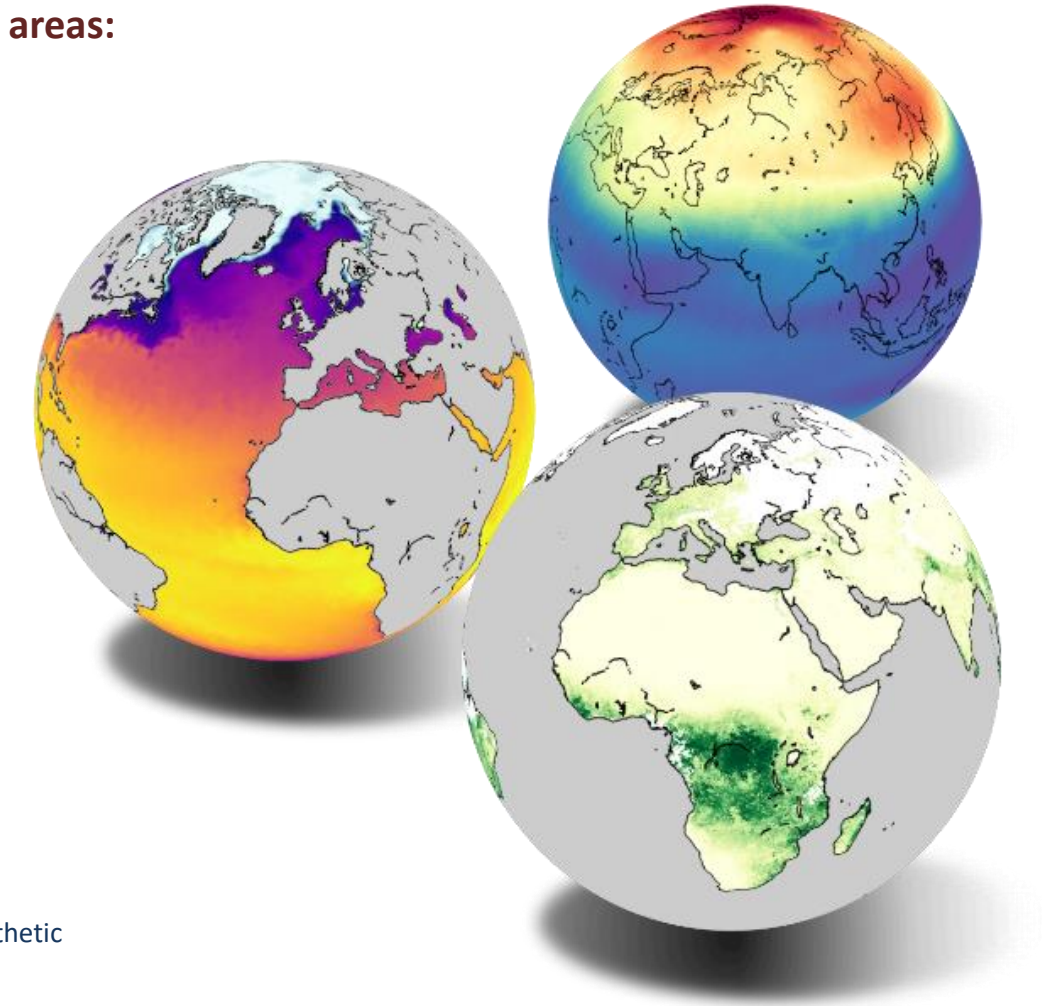
Atmospheric physics
- Precipitation
- Surface radiation budget
- Water vapour
- Cloud properties
- Earth radiation budget

Atmospheric composition
- Carbon dioxide
- Methane
- Ozone
- Aerosol

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

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

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



ECV products that are

- State-of-the-art
  - *Coordination with ESA CCI, EUMETSAT/SAFs & other Copernicus Services*
- Long-term, consistent , complete (CDR)
  - **Single/Multi sensor approach**
- Regularly extended in time (ICDR)
  - **Frequent updates of data records**
- Gridded, aggregated
  - **Meeting user requirements**
- *Accessible & Traceable*
  - *Access through the Climate Data Store*
  - *Documentation*
  - *Quality Assurance*
  - *User support*

Scientific requirements are based on Global Climate Observing System (GCOS) framework.

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C3S Ocean ECVs: Sea Ice

Sea Ice Thickness

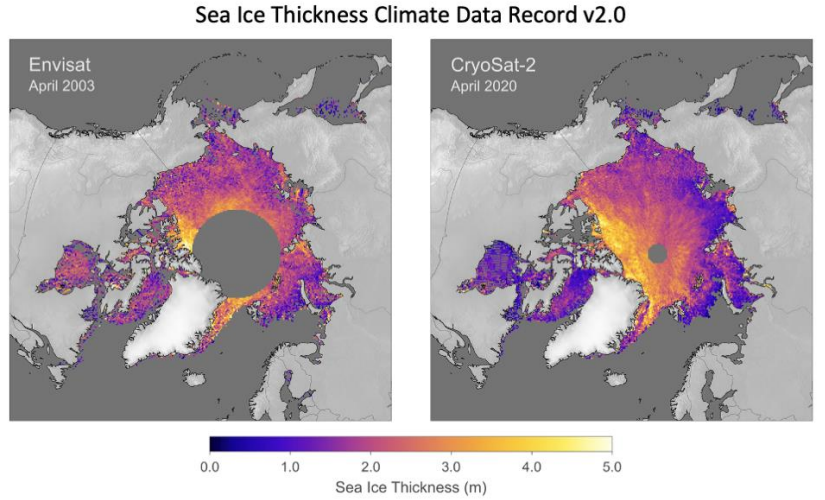
- ❑ Monthly product for the Northern Hemisphere
- ❑ Based on radar altimetry measurements from **Envisat** (10/2002 – 10/2020) and **CryoSat-2** (11/2010 – present)
- ❑ Resolution: 25 km
- ❑ Daily data available with 16-day latency behind real time
- ❑ Latest version: **v2.0** (released in Oct 2021)

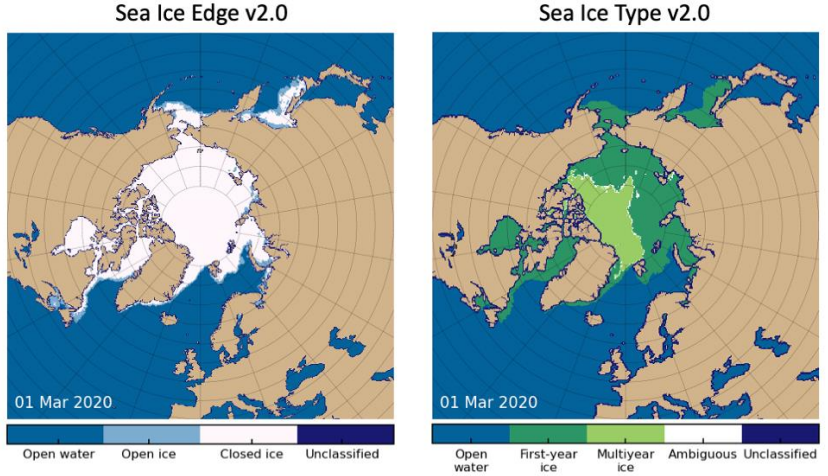
Sea Ice Type

- ❑ Daily classification of sea ice as **first-year ice** or **multiyear ice**
- ❑ Based on PMW measurements from SMMR-SSM/I-SSMIS
- ❑ Available for N. Hemisphere from October through April
- ❑ Resolution: 25 km
- ❑ Daily data available with 16-day latency behind real time
- ❑ Latest version: **v2.0** (released in Sept 2021)

Sea Ice Edge

- ❑ Daily classification of sea surface as **open water**, **open ice**, or **closed ice**
- ❑ Based on PMW measurements from SMMR-SSM/I-SSMIS
- ❑ Available for N. and S. Hemispheres
- ❑ Resolution: 12.5 km
- ❑ Daily data available with 16-day latency behind real time
- ❑ Latest version: **v2.0** (released in Sept 2021)





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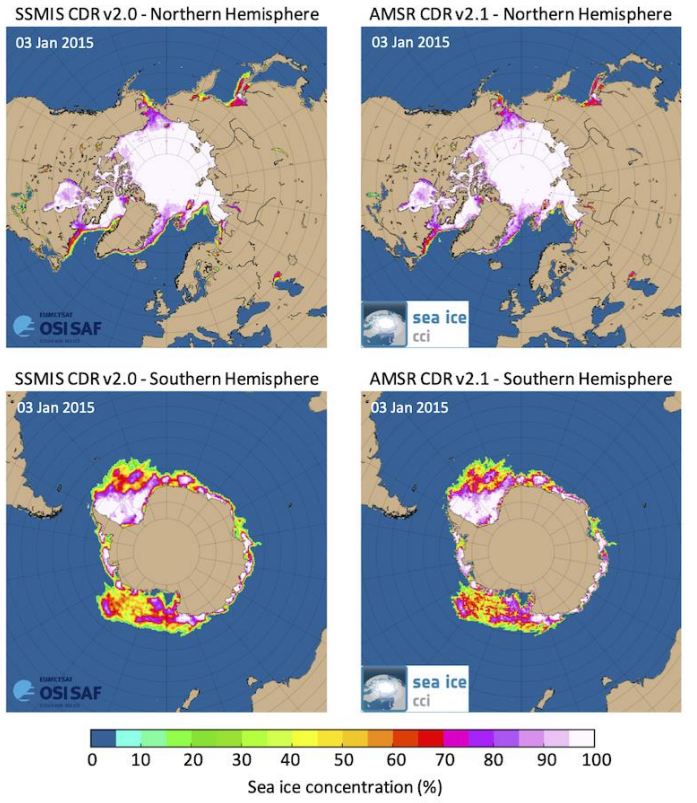
C3S Ocean ECVs: Sea Ice

Sea Ice Concentration

- Two brokered daily products:
  - **EUMETSAT OSI SAF v2** based on **SMMR-SSM/I-SSMIS** (1979 to present) with daily updates (16-day latency behind real time)
  - **ESA CCI v2.1** based on **AMSR-E and AMSR2** (2002-2017), without updates
- Regions: N. and S. Hemispheres
- Same 25-km EASE2 grid but different true spatial resolutions:
  - 15–25 km for AMSR vs 30–60 km for SSMIS
- **Complementary** products:
  - AMSR product provides much more detailed view of sea ice cover
    → best for studies of marginal ice zone
  - SSMIS product provides a long and consistent record with daily updates
    → best for climate change assessment



Coming soon in the CDS

Sea Ice Drift

- Daily data from 1991 to 2020
- Based on PMW observations from SSM/I and SSMIS sensors
- Resolution: 75 km

Sea Ice Surface temperature

- Daily data from 1982 onward
- Based on AVHRR observations
- Resolution: 5 km
- Timeliness: Updated with 1-month behind real time

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C3S Ocean ECVs: Sea Level & Ocean Colour

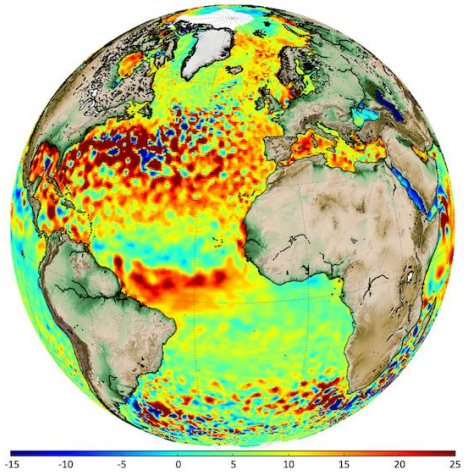
Sea Level

- Daily global estimates of **sea level anomaly**, **absolute dynamic topography**, and **geostrophic velocities**
- Available from Jan 1993 onward
- Based on altimetry measurements from a 2-satellite constellation:
  - **Reference mission** (T/P, Jason-1, Jason-2, Jason-3)
  - **Complementary mission** (ERS-1/2, Envisat, SARAL/Altika, Sentinel-3A)
- Products optimised for climate monitoring → focus on homogeneity and stability
- Resolution: 0.25° lat-lon
- Data updated 3x/year with 5-month latency behind real time
- Latest version: **vDT2021** (released in Oct 2021)

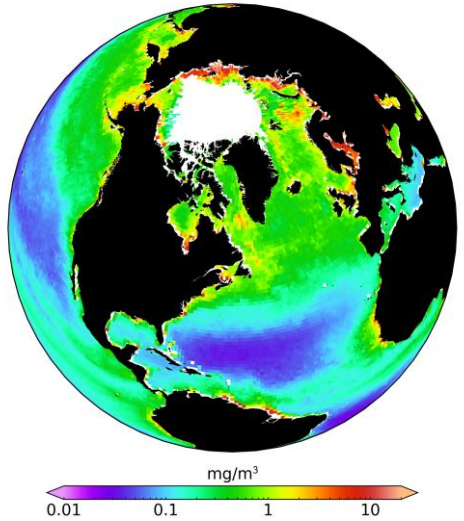
Ocean Colour

- Daily global estimates of ocean surface **chlorophyll-a concentration** and **remote sensing reflectance**
- Based on multiple sensors: SeaWiFS, MERIS, MODIS Aqua, VIIRS, and (from v5.0 onward) OLCI
- Processing chain software developed as part of **ESA OC CCI**
- Resolution: 0.042° lat-lon (4 km at Equator)
- Quarterly updates with 9-12 month latency behind real time
- Latest version: **v5.0** (released in Nov 2020)

Sea Level Anomaly (cm) for 01/09/2020 from CDR vDT2021



2018 annual mean chlorophyll-a concentration



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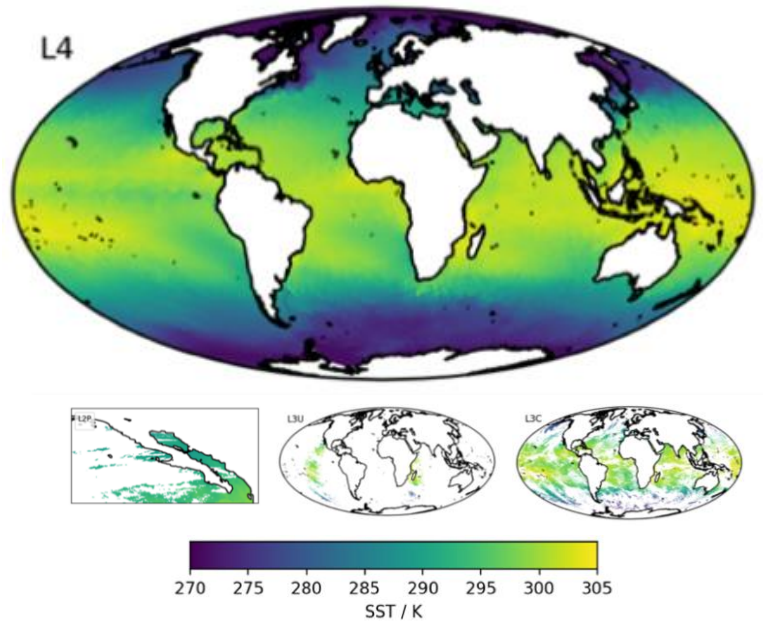
C3S Ocean ECVs: Sea Surface Temperature

Sea Surface Temperature

- ❑ Daily global product from 1981 onward
- ❑ Based on the series of AVHRR, ATSR, and LSTR sensors
- ❑ CDR (1981-2016) brokered **from ESA SST CCI**
- ❑ Extension of CDR (ICDRs) from 2017 onward produced by C3S
- ❑ Multiple processing levels: **Level-2**, **Level-3**, and **Level4**
- ❑ Resolution: 0.05° for L3 and L4
- ❑ Daily data available with 1-month latency behind real time
- ❑ Latest version: **v2.1** (released in Oct 2021)

SST for 7 Jan 2017



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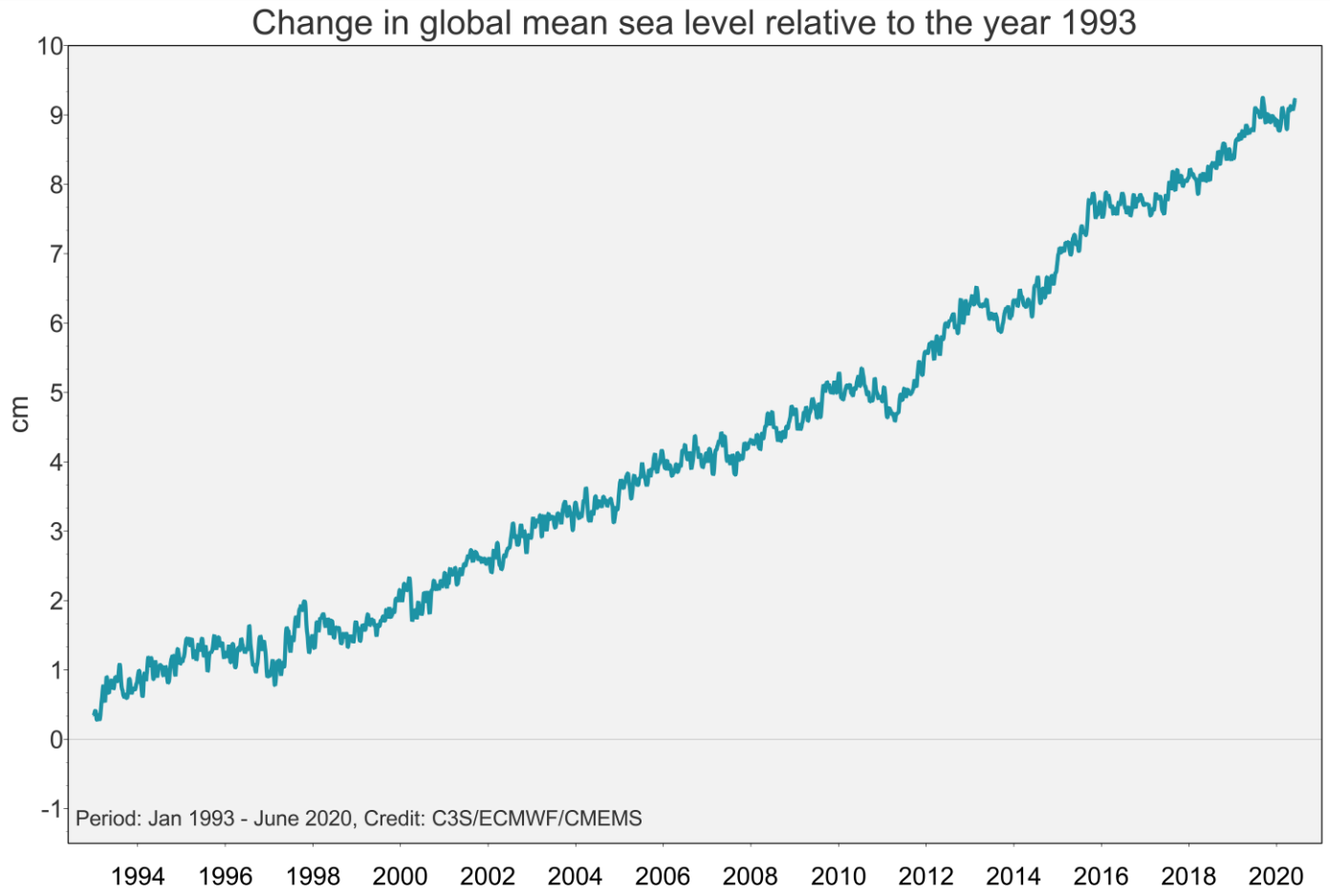
Climate applications of C3S Ocean ECV Climate Data Records



Global mean sea level time series used for **C3S Sea Level Climate Indicator**

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

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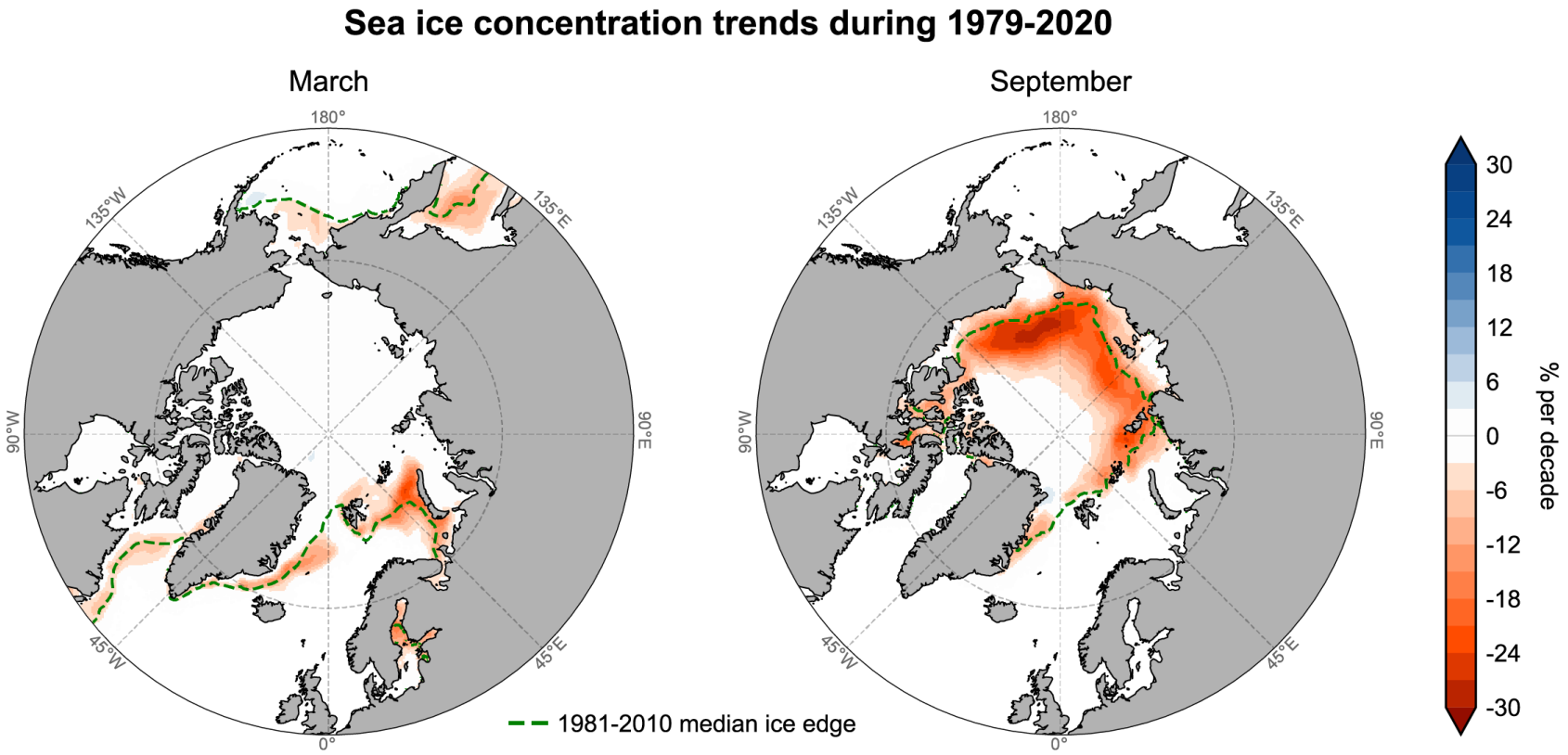
Climate applications of C3S Ocean ECV Climate Data Records



Data: OSI SAF Global Sea Ice Concentration CDR/ICDR v2, C3S Sea Ice Edge CDR v1. Credit: C3S/ECMWF.

Sea ice concentration trend maps used for **C3S Sea Ice Climate Indicator**

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

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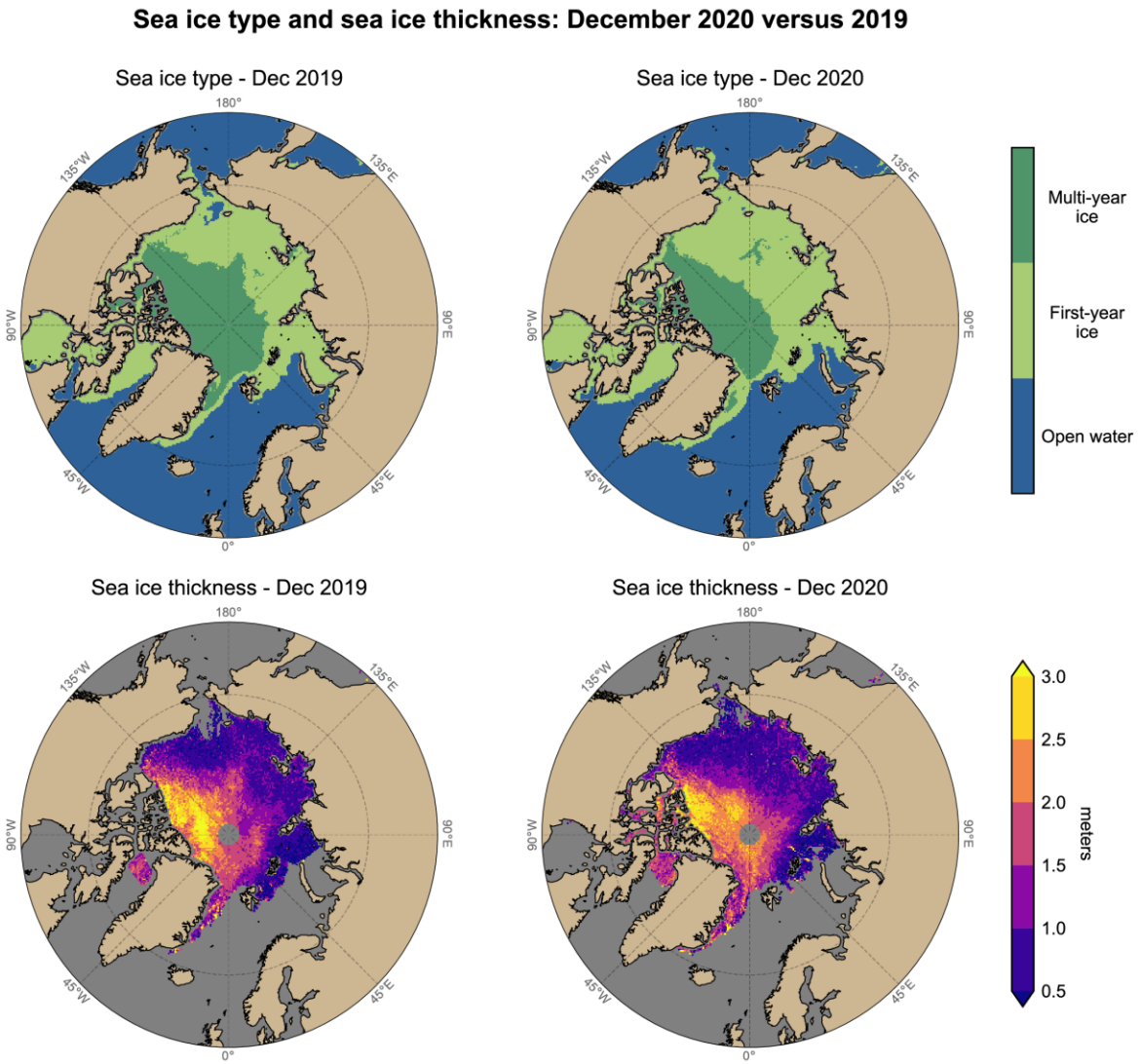
Climate applications of C3S Ocean ECV Climate Data Records



End-of-year comparison maps of sea ice type and edge used for the Arctic section of

C3S European State of the Climate Report

https://climate.copernicus.eu/esotc/2020/arctic-sea-ice

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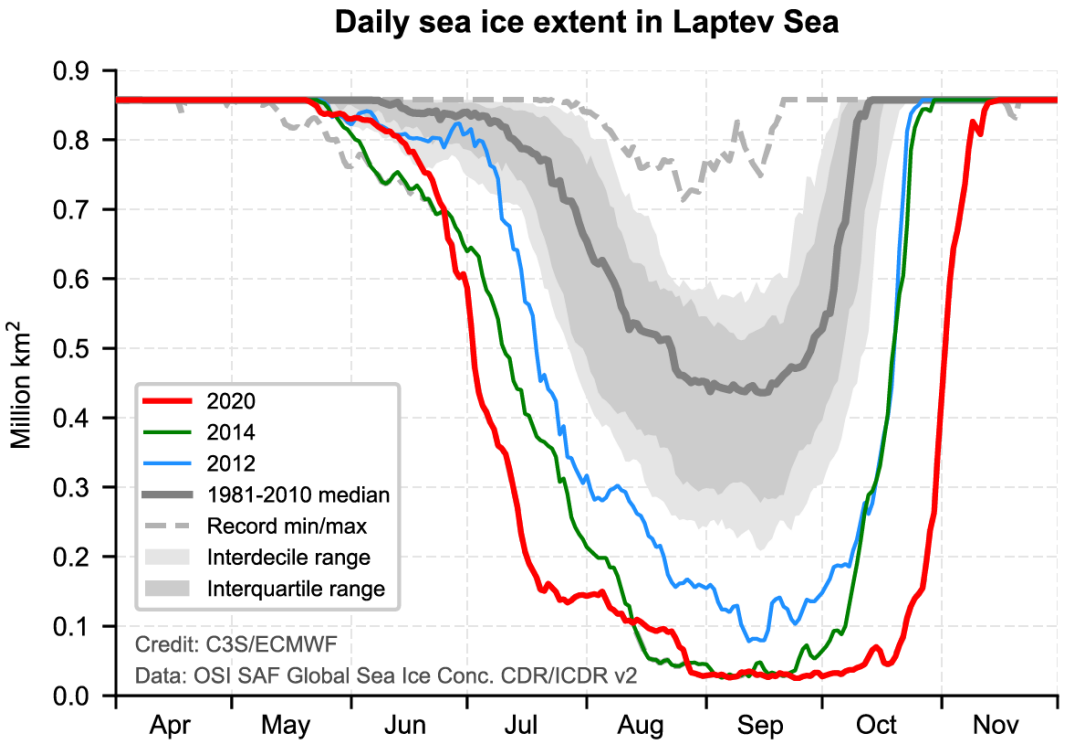
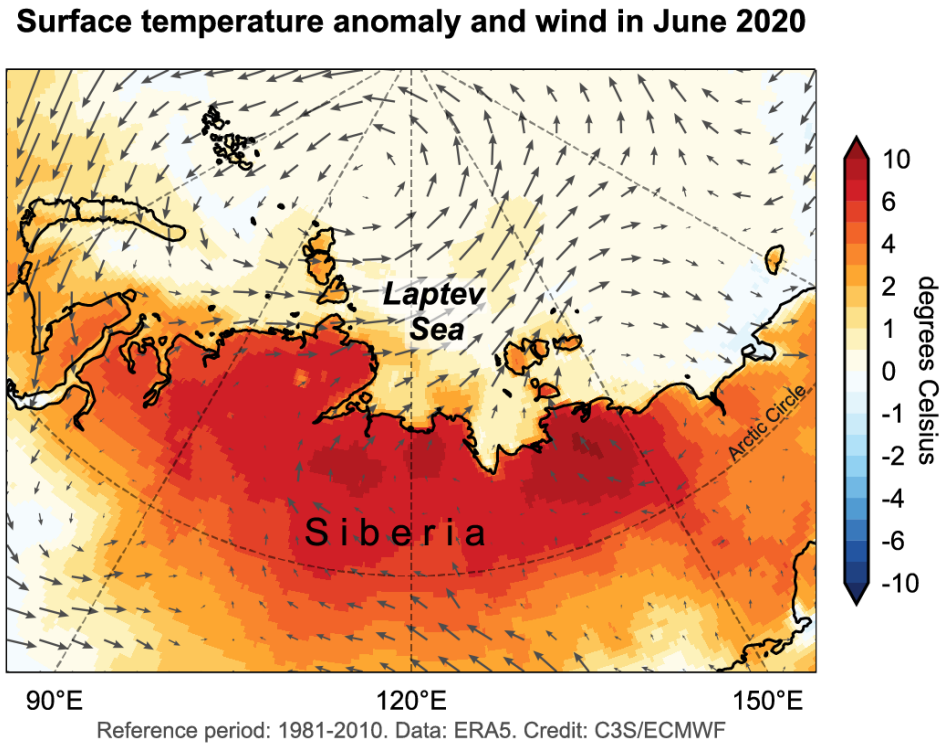
Climate applications of C3S Ocean ECV Climate Data Records





Analysis of the record low sea ice extent in the Laptev Sea in 2020
combining OSI SAF sea ice concentration data and ERA5 temperature and wind data
used in the Arctic section of the **C3S European State of the Climate Report**
https://climate.copernicus.eu/esotc/2020/arctic-sea-ice

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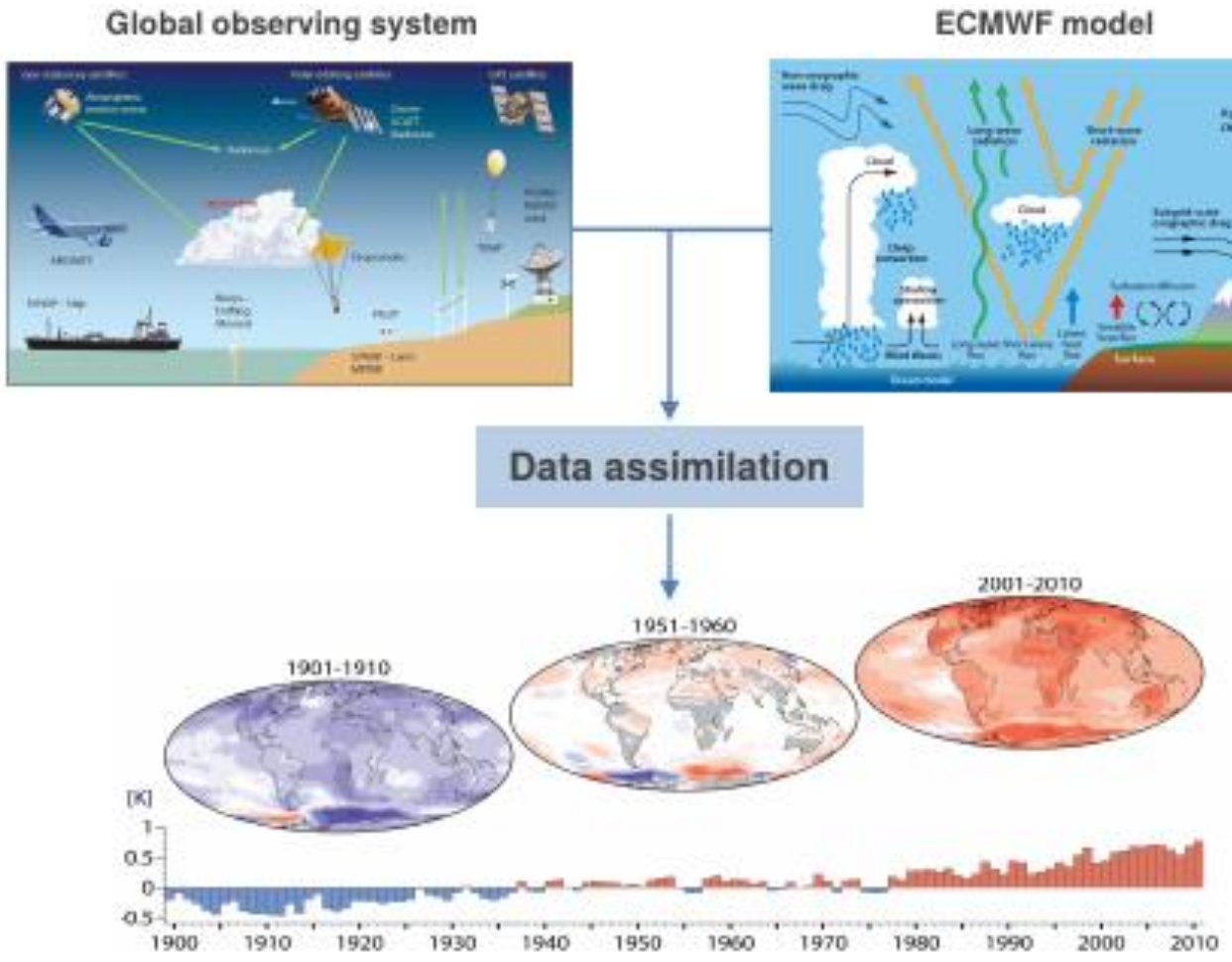
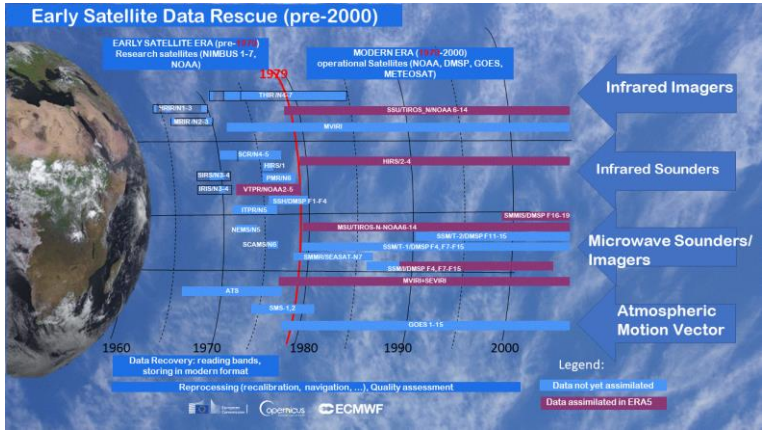
Reanalysis uses past observations with today's weather forecast model



- ✓ Complete: combining vast amounts of observations into (global) fields *"reanalysis is a smart machine"*
- ✓ Consistent: use the same physical model and data assimilation system throughout
- ✓ Convenient: "maps without gaps", always available in the same way
- ➢ provide an uncertainty estimate



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C3S Reanalysis: global (ERA5, ERA5-Land) and regional (Europe, Arctic)

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'maps without gaps' of weather and climate.

Popular datasets in the CDS

Global:

ERA5 (31km)

- Hourly, daily updates 5 days behind real time from 1979 onwards
- Preliminary back extension (1950-1978) is available in the CDS
- Final back extension is currently in production

ERA5-Land back extension (9km,1950-1980)

- Recently published in the CDS
- Has a good general consistency with ERA5 fields
- Full period is now 1950-present (> 7 decades)

Regional:

European reanalysis

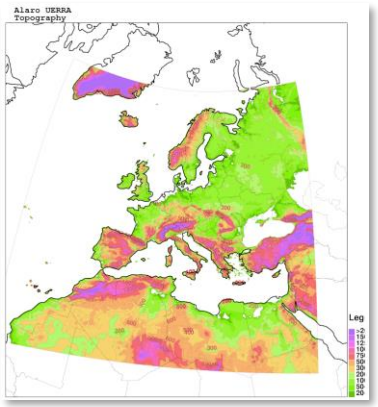
UERRA is available: 1961-2019, 6-hourly (11km and 5.5km land product),

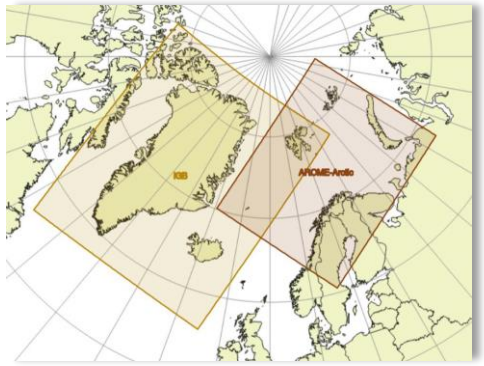
CERRA and CERRA-Land (5.5km) will be available in Q1 2022

Arctic reanalysis (CARRA, 2 sub-domains, 2.5km)

1998-2019 is available, hourly

A back extension from 1991 is produced and will be available until the end of the year





The ERA5 observing system

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Over 200 types of reported variables

Reprocessed data sets

Radiances: SSM/I brightness temp from CM-SAF
MSG from EUMETSAT

Atmospheric motion vector winds: METEOSAT, GMS/GOES-9/MTSAT, GOES-8 to 15, AVHRR METOP and NOAA

Scatterometers: ASCAT-A (EUMETSAT),
ERS 1/2 soil moisture (ESA)

Radio Occultation: COSMIC, CHAMP, GRACE, SAC-C, TERRASAR-x (UCAR)

Ozone: NIMBUS-7, EP TOMS, ERS-2 GOME, ENVISAT SCIAMACHY, Aura MLS, OMI, MIPAS, SBUV

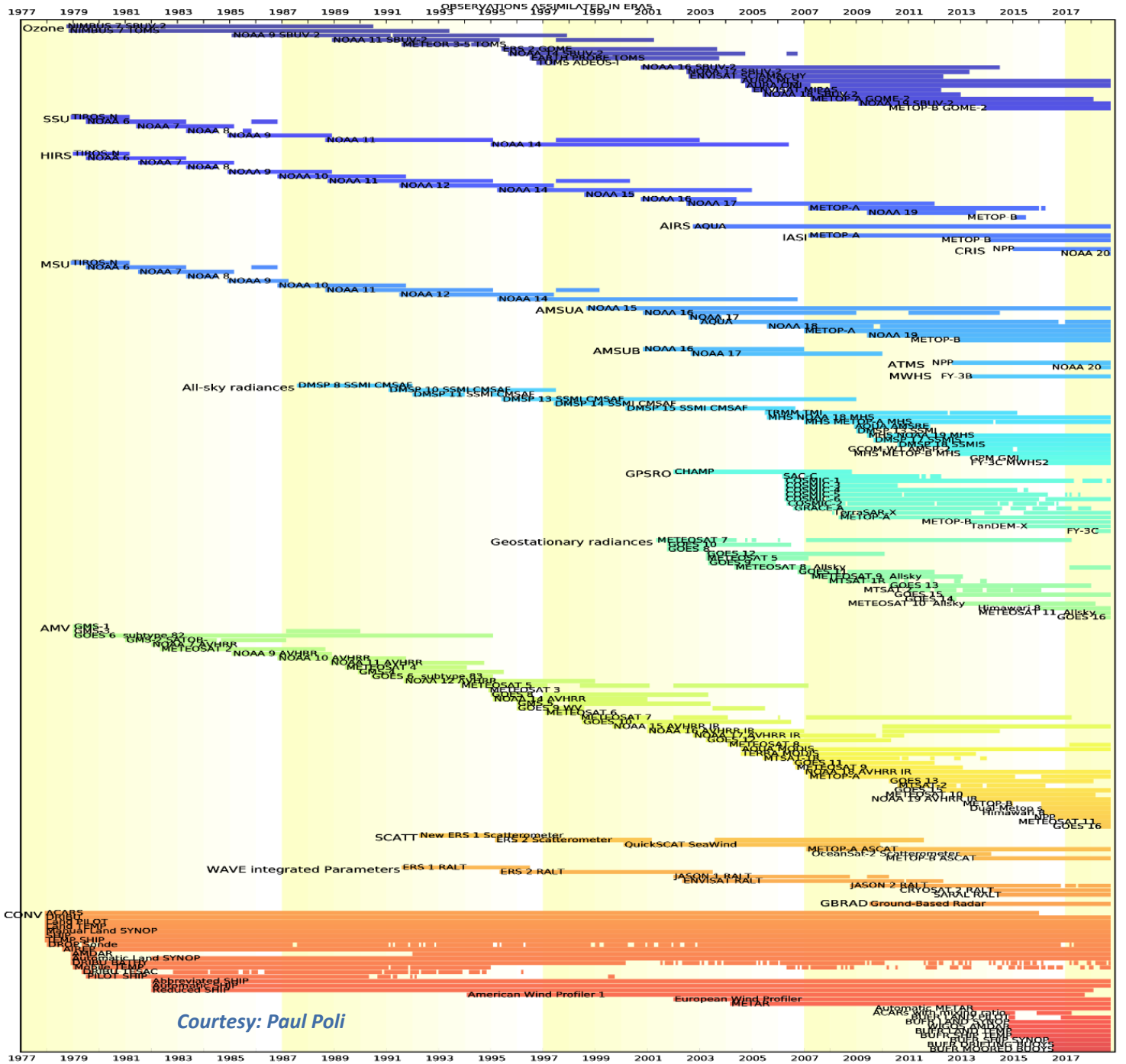
Wave Height: ERS-1,ERS-2, Envisat, Jason

Latest instruments

IASI, ASCAT, ATMS, CrIS, MWHS, Himawari, …

Improved data usage

all-sky vs clear-sky assimilation,
latest radiative transfer function, corrections,
extended variational bias control



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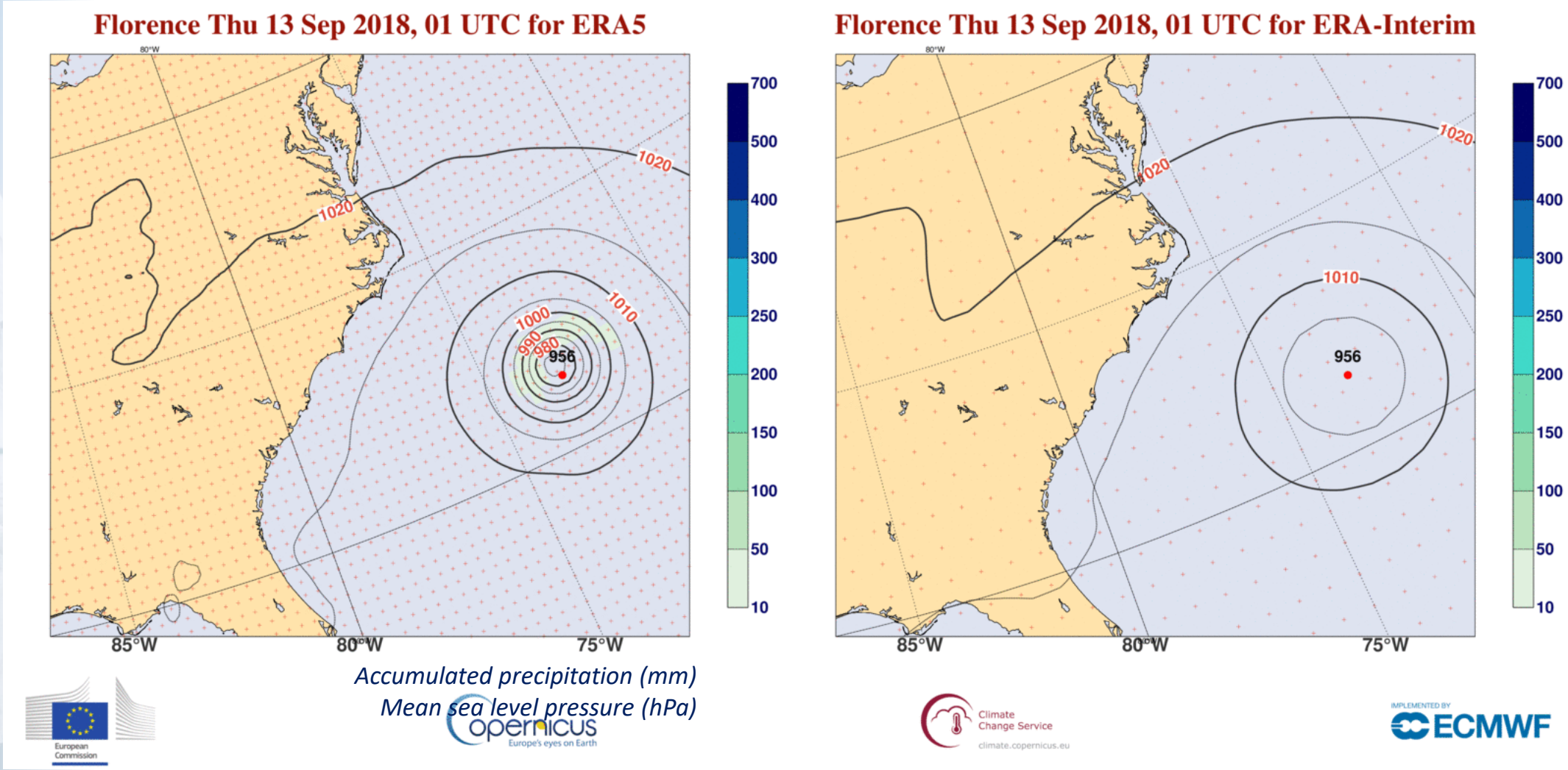
Better model, more and better observations, higher resolution, hourly output



Accumulated precipitation (mm)

Mean sea level pressure (hPa)

ERA5

ERA-Interim

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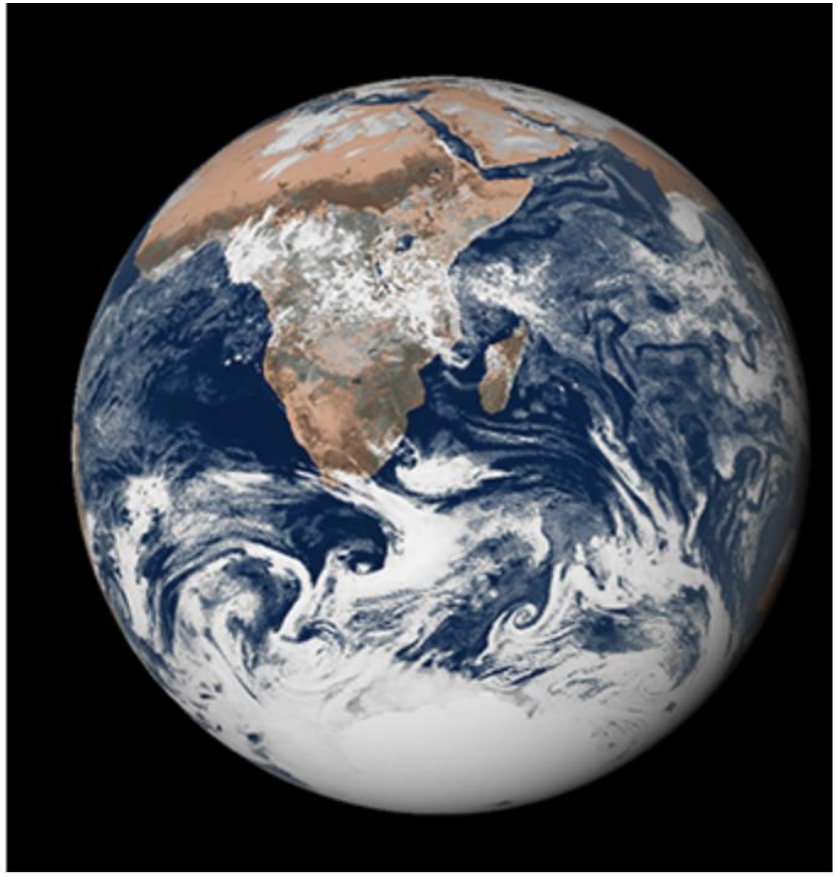
Future of reanalysis

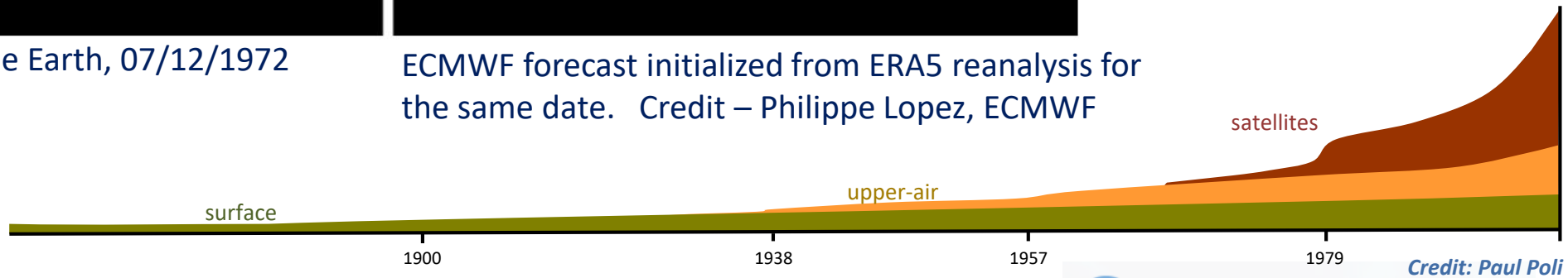
Apollo 17 image of the Earth, 07/12/1972
Credit - NASA



ECMWF forecast initialized from ERA5 reanalysis for the same date. Credit – Philippe Lopez, ECMWF

ERA6:

- Coupled ocean-atmosphere
- Better representation of key atmosphere-ocean processes and feedbacks
- C3S satellite data rescue
- ERA6L with enhanced land data assimilation



Credit: Paul Poli

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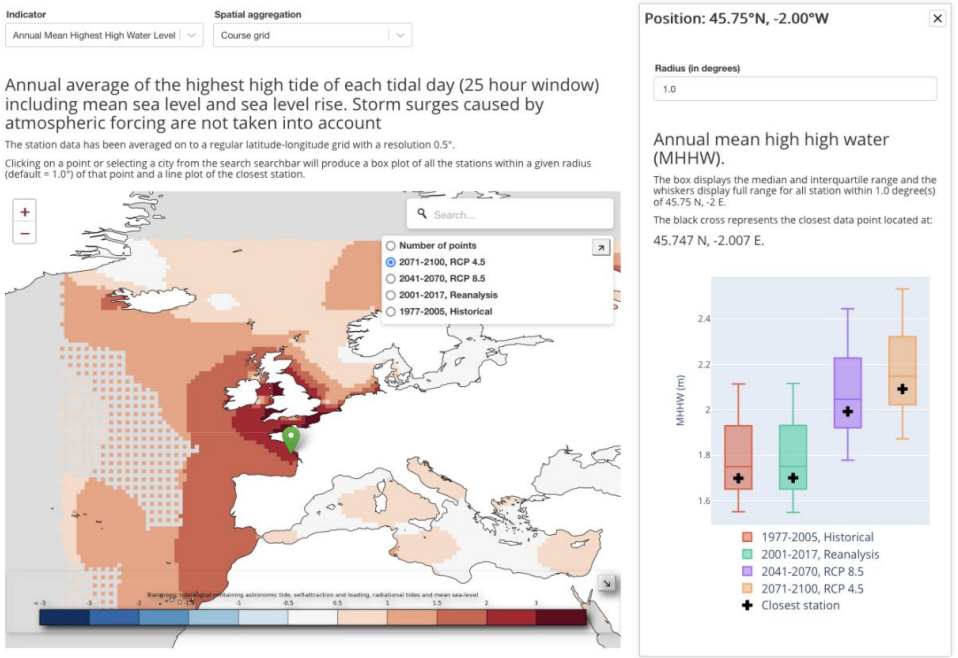
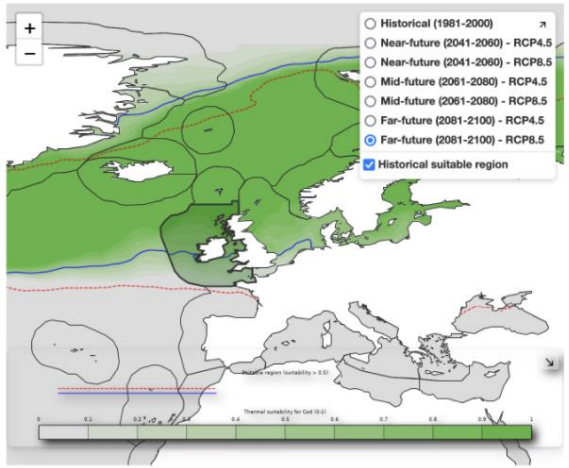
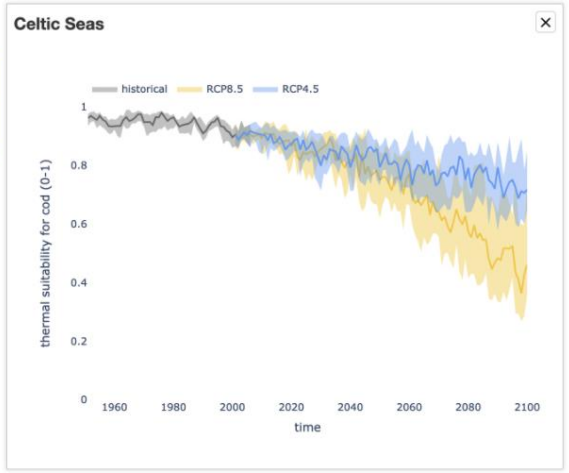
New sectoral applications and data to support ocean adaption

Indicators of water level change for European coasts:

- Range of European coastal indicators, including water levels, tidal ranges & ocean surface wave parameters under potential climate change impacts up to 2100
- Indicators are useful for various coastal sectors, for example assessing coastal flooding, coastal erosion, infrastructure planning and adaption studies







Thermal suitability of fish habitats:

- Explores the thermal suitability for selected fish species over the global ocean and regional seas, based on CMIP5 climate projections (bias-adjusted to ERA5) from 10 GCMs.
- Interactive maps show habitat-specific thermal suitability averages alongside SST for 20-year time frames (1981-2000 (historical), 2041-2060 (near future), 2061-2080 (mid future), 2081-2100 (far future)) for two differing possible climate scenarios

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Operational service for users….

https://climate.copernicus.eu/help-and-support 67% Search

Help and support

We provide a dedicated user support service to aid Climate Change Service data discovery, dissemination, understanding and use by all users. The user support service currently includes a Knowledge Base accessible 24/7 and a friendly manned helpdesk.

24/7 Knowledge Base

The Knowledge Base provides documentation and answers to frequently asked questions.

Forum

For users of the C3S services

Become part of the community, work together and support each other.

Contact us

Can't find the answer you're looking for? Get in touch!

Login to the **C3S Enquiry Portal**

User Satisfaction Surveys

We run user satisfaction surveys every year.

- 2020 Report
- 2019 Report
- 2018 Report
- 2017 Report

Your user story

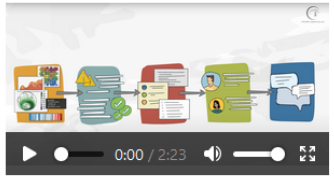
We collect user stories to show the diversity and wide-range usage of our data and services. You will find here some examples. Contact us directly to share your user story with us.

User Training

C3S User Learning Services offers free training in how to use the Climate Data Store platform and its content.

ECMWF SUPPORT GUIDELINES >

FINDING YOUR WAY TO THE RIGHT DATA:



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