



Climate Change

# Science innovation for climate services

Anca Brookshaw

and colleagues from the Copernicus Climate Change Service  
ECMWF



European  
Commission



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## A large number of topics

- meteorological reanalysis
- multi-system climate predictions (e.g. seasonal)
- prototype services for climate timescales (decadal)
- attribution (of observed events to climate change)
- environmental predictions and other applications to economic and societal sectors (energy, hydrology, fire risk, insurance, agriculture, etc)
- infrastructure in support of data services and analysis, with emphasis on need of climate service developers

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## C3S seasonal forecast multi-system



Since October 2019:

ECMWF SEAS5  
UK Met Office GloSea5  
Météo-France System7  
CMCC SPSv3  
DWD GCFS2.0  
NCEP CFSv2

New in 2020:  
contributions from

ECCC  
JMA  
BoM

- **6-month forecasts issued every month on the 13<sup>th</sup>**
- *Large ensembles (members: ~50 forecast, 25-40 hindcast)*
- *Common reference period (1993-2016)*
- *Common horizontal resolution (1-degree)*
- *~30 surface variables*
- *5 variables on 11 pressure levels (from 925hPa to 10hPa)*
- **Graphical products through C3S webpage**  
[https://climate.copernicus.eu/charts/c3s\\_seasonal/](https://climate.copernicus.eu/charts/c3s_seasonal/)
- **Data service through CDS**  
<https://cds.climate.copernicus.eu/cdsapp#!/search?type=dataset>

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## Decadal prediction prototype

### ***Standardization and recommendations for best practice:***

- data encoding
- post-processing
- verification
- product generation and multi-model

### ***Case studies:***

- water management in river catchment (Germany)
- agriculture: crop planning
- insurance risks in N Atlantic
- renewable energy in Europe

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## Extreme events and attribution service

A contract to develop a prototype **Extreme events and attribution** component for C3S has just started (team led by KNMI). It will address:

- Communication of extreme events in the context of a changing climate;
- ‘Slow’ attribution of past events, to refine protocols and standards;
- Inclusion of data and tools in the CDS;
- Quality Assurance (QA) of methodology, including contribution from an Advisory Board
- Possibly ‘fast’ attribution of current events, if QA sufficient
- Service evolution





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# Reanalysis: ERA5, ERA5-T

The ERA5 global reanalysis ingested many reprocessed and additional observations, compared to its predecessor ERA-Interim

ERA5 is available in the C3S climate data store (CDS): 1979 onwards, 2-3 months behind real time

NEW!: timely updates, ERA5T, 5 days latency

In 2020: Extension to 1950-1978

Atmospheric motion vectors providing information on wind speed and direction

Radio occultation observations providing information on atmospheric temperature and humidity with very high vertical resolution

Satellite altimetry providing information on wave height

- NOAA 19 AVHRR IR AMV
- NOAA 18 AVHRR IR AMV
- NOAA 17 AVHRR IR AMV
- NOAA 16 AVHRR IR AMV
- NOAA 15 AVHRR IR AMV
- NOAA 14 AVHRR AMV
- NOAA 12 AVHRR AMV
- NOAA 11 AVHRR AMV
- NOAA 10 AVHRR AMV
- NOAA 9 AVHRR AMV
- NOAA 7 AVHRR AMV
- METOP-B AMV
- METOP-A AMV
- AQUA MODIS AMV
- TERRA MODIS AMV
- NPP AMV
- Dual-Metop AMVs

- GOES 16 AMV
- GOES 15 AMV
- GOES 13 AMV
- GOES 12 AMV
- GOES 11 AMV
- GOES 10 AMV
- GOES 9 WV AMV
- GOES 8 AMV
- GOES 6 AMV subtype 83
- GOES 6 AMV subtype 82

- METEOSAT 11 AMV
- METEOSAT 10 AMV
- METEOSAT 9 AMV
- METEOSAT 8 AMV
- METEOSAT 7 AMV
- METEOSAT 6 AMV
- METEOSAT 5 AMV
- METEOSAT 4 AMV
- METEOSAT 2 AMV

- Himawari 8 AMV
- MTSAT-2 AMV
- MTSAT-1R AMV
- GMS 5 AMV
- GMS-4 AMV
- GMS-3 AMV
- GMS-2 SATOB-AMV
- GMS-1 AMV

- FY-3C GPSRO
- Tandem-X GPSRO
- METOP-B GPSRO
- METOP-A GPSRO
- SAC-C GPSRO
- TerraSAR-X GPSRO
- COSMIC-6 GPSRO
- COSMIC-5 GPSRO
- COSMIC-4 GPSRO
- COSMIC-3 GPSRO
- COSMIC-2 GPSRO
- COSMIC-1 GPSRO
- GRACE A GPSRO
- CHAMP GPSRO

- NESDIS IMS

- SARAL RALT WAVE
- CRYOSAT 2 RALT WAVE
- JASON 2 RALT WAVE
- ENVISAT RALT WAVE
- JASON 1 RALT WAVE
- ERS 2 RALT WAVE
- ERS 1 RALT WAVE

- METOP-B ASCAT
- OceanSat-2 Scatterometer
- METOP-A ASCAT
- QuickSCAT seaWind
- ERS 2 Scatterometer
- New ERS 1 Scatterometer

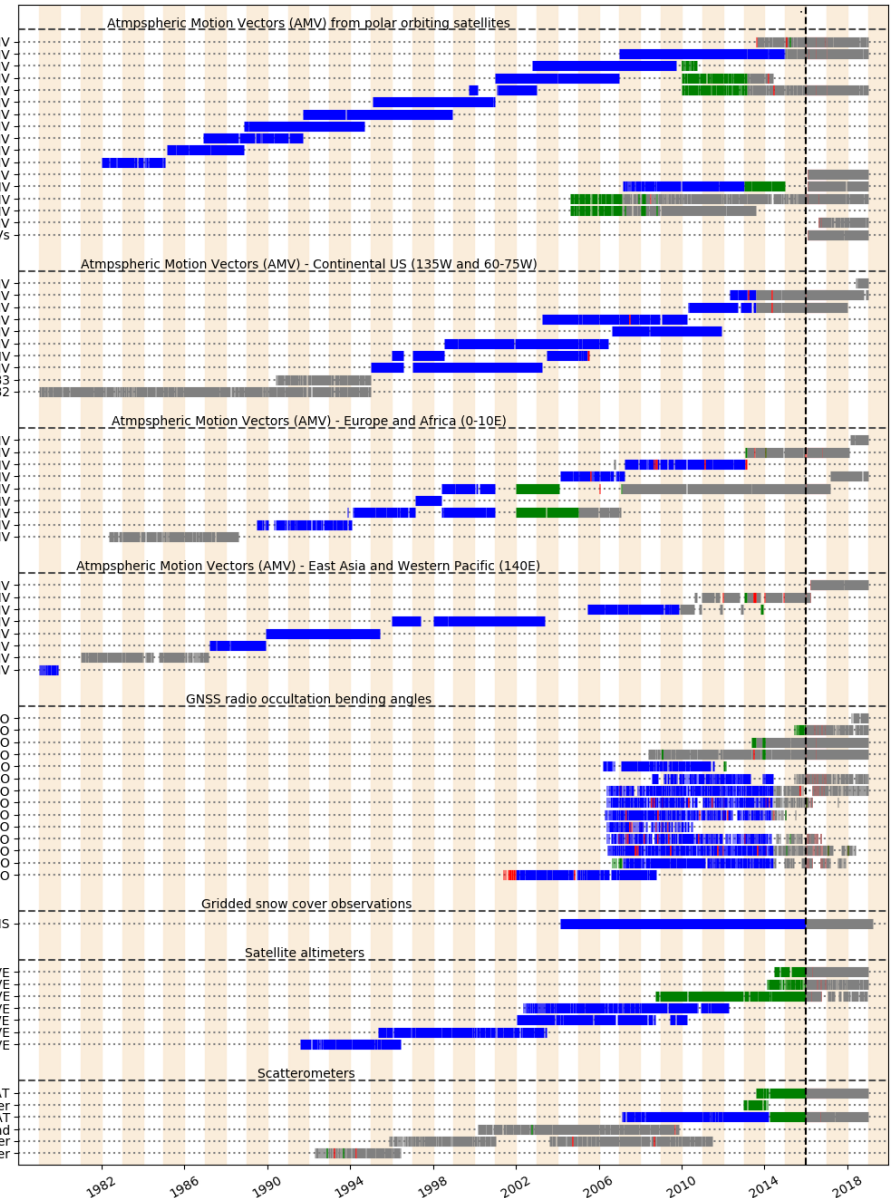


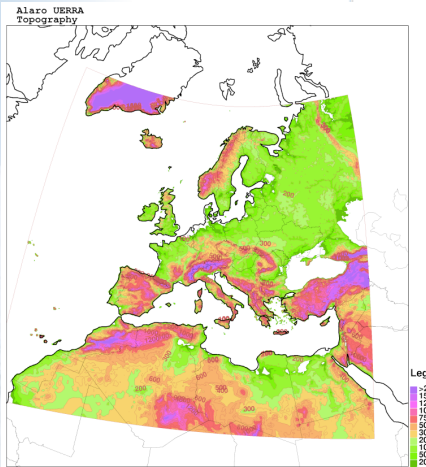
Figure: Hersbach et al, QJRM, 2019, in review



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# Reanalysis: ERA5-Land, regional reanalyses

## European area



**5.5 km**, 106 levels, Harmonie/Aladin, hydrostatic  
Surface analysis at 5.5 km – no downscaling  
Plus 10 ensemble members at 11km  
Will start from the early 1980s

SMHI, Météo-France - MET Norway

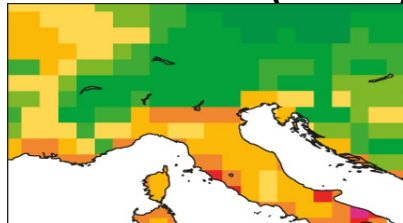
## Arctic area



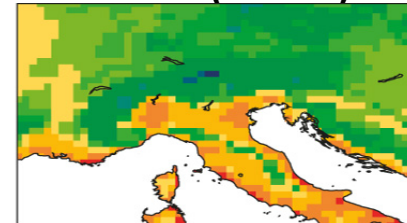
**2.5 km**, 65 levels, Harmonie/Arome non-hydrostatic  
Reanalysis period July 1997 – June 2021 (24 years)  
Special emphasis on handling of “cold surfaces”: snow, sea ice, glaciers

Met Norway, the Nordic countries and Météo-France

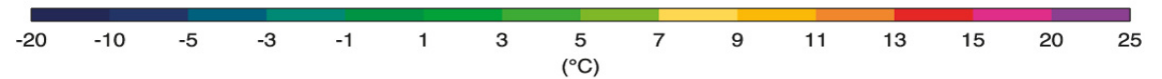
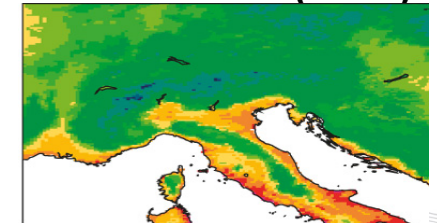
### ERA-Interim (79 km)



### ERA5 (31 km)



### ERA5-Land (9 km)





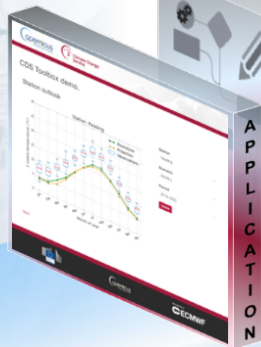
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# Climate Data Store and toolbox

END-USER

EXPERT

DEVELOPER



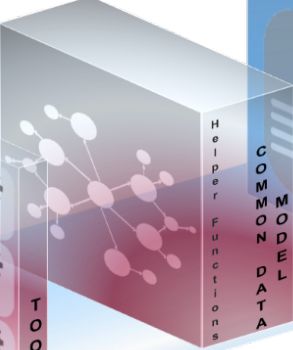
INFORMATION

Kilobytes



WORKFLOW

Compute Layer



Helper Functions  
COMMON DATA

Climate Data Store Infrastructure



INTEROPERABILITY

DATA

Petabytes



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Thank you



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