

# ERA-CLIM2 M48 Review meeting

December 2017

## WP5: Service Developments

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## WP5 Service Development

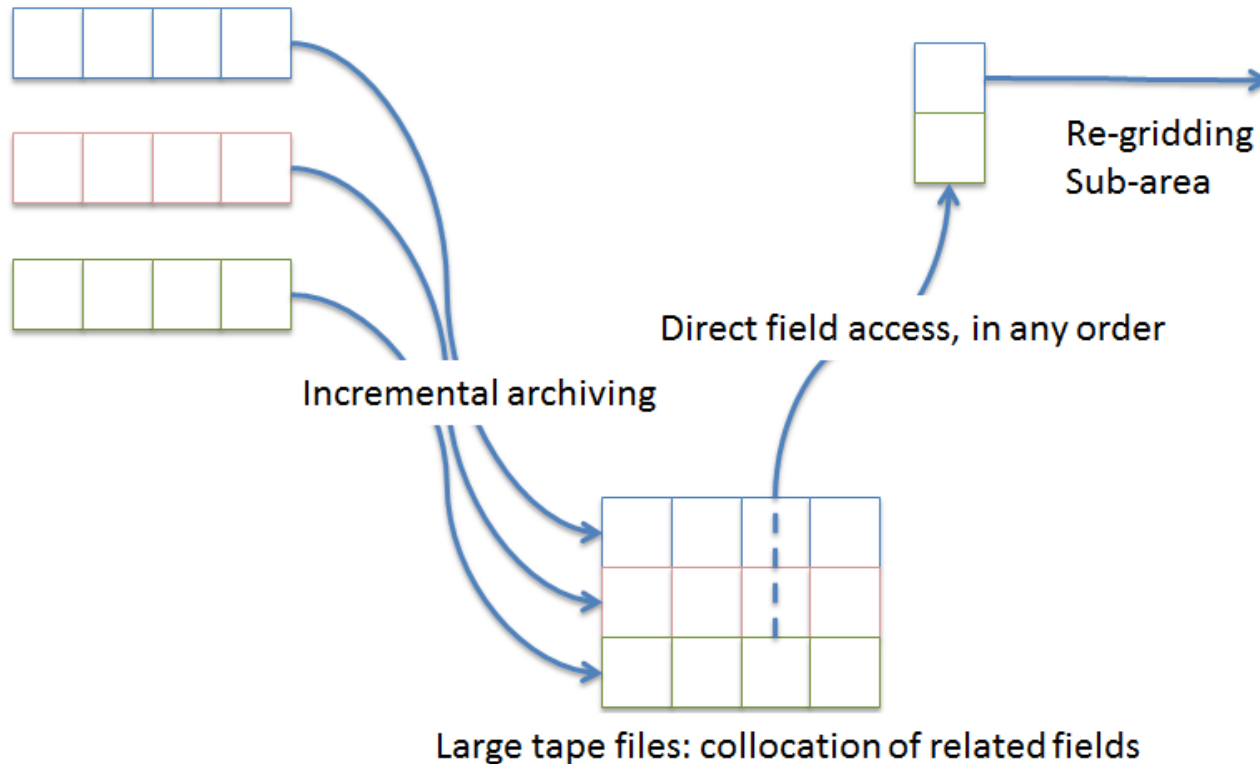
- Development of data services and visualisation tools for coupled reanalysis output.
- Identification of user requirements; monitoring and analysis of usage statistics.

*This work package addresses development of efficient and sustainable data and web services that are essential to the provision of full and open access to the data and information products developed in the project.*

## WP5 Deliverables

- D5.1 : Technical developments in MARS to **support archiving and retrieval of data in NetCDF** format. This is needed to allow use of MARS for the ocean component of the coupled reanalysis output. [**M36**]
- D5.2 : Implementation of **public data services** for gridded output from coupled climate reanalyses (CERA) [**M48**]
- D5.3 : Report on **data services usage** and requirements for climate reanalysis [**M48**]

# Service offered by MARS



- MARS archives atmospheric field of CERA-20C (handles 2D fields in GRIB)
- MARS scans archived files, extracts metadata from GRIB headers and keeps an index that tracks where each GRIB field is
- GRIBs are reorganised into larger files, to minimise the total number of files and collocate related fields to speed up retrievals
- On retrieval, MARS find the required fields, reads them from tape, and re-assembles them according to the user's request

## D5.1 Support for NetCDF in MARS

Original NEMO output files contain many variables (2D, 3D), feedback files, restart files, ocean observations, all annotated with NEMO's own convention

### Solution considered:

- NetCDF files are split into individual NetCDF files, 2D or 3D
  - Resulting NetCDF files must follow an agreed convention based on CF
  - Resulting NetCDF files are annotated with MARS specific information. These attributes are used by MARS to index the NetCDF files, and treat them as simple binary records
- On retrieval, those records will be assembled in a single NetCDF file to be delivered to the user

### Challenges:

- Define what variables to archive, focusing on user service
  - not all output above is interesting to users
- Find CF standard names
  - About 60% variables have a CF standard name
- Find sound metadata to enable assembling records on retrieval

# CERA20C Ocean data in NetCDF: Challenges for an archive

- Define what variables to archive, focusing on user services:
  - 53 Variables from the monthly means
- Many variables did not have an official CF standard name
  - Requested to the CF list Sep 2016, approved June 2017
- No adequate description of time in CF: monthly means of daily means
  - Nothing found in the literature
  - Experts of the CF community still debating how best to encode them
- Finding an accurate description of the tripolar ORCA grid
- During 2017, engaged with CF-NetCDF experts to produce metadata recommendations for encoding NetCDF products using the CF convention
  - Using examples from CERA20C ocean, UERRA, C3S products
  - Forms the basis of the Common Data Model for the CDS Toolbox
  - ... and many other datasets: S2S, HRES, ENS, ORAS4, ORAS5, C3S seasonal,
- Finally! Ready to start consolidation

## D5.2 Data Services

### Consolidation of CERA-20C into user version

- After production completes and quality of data is checked, the various CERA-20C streams are consolidated into a single version:
  - Retrieve all relevant data (GRIB Fields, ODB feedback)
  - Re-label headers with the user version (0001), filtering out un-wanted parameters/steps/cycles
  - Archive back into MARS

### Extend Public Data Server

- Public interface to data stored in MARS

# CERA-20C Consolidation

- Done in stages, priority given to most popular data, in order to facilitate access to data
  - First all monthly means
  - Then all Analysis, Ensemble means and stddev (surface, pl)
  - All Analysis, Ensemble means and stdev (ml, isentropic levels)
  - Forecast pressure level
  - Forecast surface
  - Forecast model level
  - Observation feedback
- 1 Pbyte of gridded data in GRIB (atmospheric + ocean wave fields)
- 20 Tbytes Observational feedback in ODB
- Consolidation took 5 months (Dec 2016 - Apr 2017)



# CERA-SAT Consolidation

- 450 Tbytes of gridded data in GRIB (atmospheric + ocean wave fields)
- 11 Tbytes Observational feedback in ODB
- Started November 2017
- On-going:
  - Monthly means
  - Observation feedback

# Public Datasets



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[Home](#)  
[Public Datasets](#)  
[Web-API Activity](#)  
[Job list](#)

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[Access Public Datasets](#)  
[General FAQ](#)  
[Web-API FAQ](#)  
[Accessing forecasts](#)  
[GRIB decoder](#)

## Public Datasets

Access to these datasets is provided free of charge. Terms and conditions may apply, please check with each individual dataset.

### Global Reanalyses

- ▶ [ERA5 \(Jan 2010 – Dec 2016\)](#)
- ▶ [CERA-20C \(Jan 1901 – Dec 2010\)](#)
- ▶ [ERA-20C \(Jan 1900 – Dec 2010\)](#)
- ▶ [ERA-Interim \(Jan 1979 – present\)](#)
- ▶ [ERA-Interim/LAND \(Jan 1979 – Dec 2010\)](#)
- ▶ [ERA-20CM \(Jan 1900 – Dec 2010\) Final](#)
- ▶ [ERA-40 \(Sep 1957 – Aug 2002\)](#)
- ▶ [ERA-15 \(Jan 1979 – Dec 1993\)](#)
- ▶ [CERA-SAT \(Jan 2008 – Dec 2016\) \(New\)](#)

### Regional Reanalysis

- ▶ [UERRA \(New models added on 22-11-2017\)](#)

### Multi-model

- ▶ [C3S Seasonal \(New\)](#)
- ▶ [S2S](#)
- ▶ [TIGGE](#)
- ▶ [TIGGE LAM](#)

### Atmospheric composition

- ▶ [MACC Reanalysis \(2003–2012\)](#)
- ▶ [CAMS Near-real-time \(July 2012 – present\)](#)
- ▶ [CAMS Global Fire Assimilation System \(2003 – present\)](#)
- ▶ [MACC GHG flux inversions \(1997 – 2014\)](#)
- ▶ [CAMS GHG flux inversions \(1997 – 2016\) Will be extended](#)
- ▶ [CAMS Climate Forcing Estimates \(2003 – 2012\) Will be extended](#)

# Public Datasets: CERA-20C



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## Type of level

[Model levels](#)  
[Potential temperature](#)  
[Potential vorticity](#)  
[Pressure levels](#)

## ► Surface

## Type

[► Analysis](#)  
[Forecast](#)

## CERA-20C sets

[Daily](#)  
[Synoptic Monthly Means](#)  
[Monthly Means of Daily Means](#)  
[Invariant](#)  
[Ocean Wave Daily](#)  
[Ocean Wave Invariant](#)  
[Ocean Wave Synoptic Monthly Means](#)  
[Ocean Wave Monthly Means of Daily Means](#)

## About

[Conditions of use](#)

## CERA-20C, Synoptic Monthly Means

### Select a year

☐ 1901 ☐ 1902 ☐ 1903 ☐ 1904 ☐ 1905 ☐ 1906 ☐ 1907 ☐ 1908 ☐ 1909 ☐ 1910 ☐ 1911 ☐ 1912 ☐ 1913  
☐ 1914 ☐ 1915 ☐ 1916 ☐ 1917 ☐ 1918 ☐ 1919 ☐ 1920 ☐ 1921 ☐ 1922 ☐ 1923 ☐ 1924 ☐ 1925 ☐ 1926  
☐ 1927 ☐ 1928 ☐ 1929 ☐ 1930 ☐ 1931 ☐ 1932 ☐ 1933 ☐ 1934 ☐ 1935 ☐ 1936 ☐ 1937 ☐ 1938 ☐ 1939  
☐ 1940 ☐ 1941 ☐ 1942 ☐ 1943 ☐ 1944 ☐ 1945 ☐ 1946 ☐ 1947 ☐ 1948 ☐ 1949 ☐ 1950 ☐ 1951 ☐ 1952  
☐ 1953 ☐ 1954 ☐ 1955 ☐ 1956 ☐ 1957 ☐ 1958 ☐ 1959 ☐ 1960 ☐ 1961 ☐ 1962 ☐ 1963 ☐ 1964 ☐ 1965  
☐ 1966 ☐ 1967 ☐ 1968 ☐ 1969 ☐ 1970 ☐ 1971 ☐ 1972 ☐ 1973 ☐ 1974 ☐ 1975 ☐ 1976 ☐ 1977 ☐ 1978  
☐ 1979 ☐ 1980 ☐ 1981 ☐ 1982 ☐ 1983 ☐ 1984 ☐ 1985 ☐ 1986 ☐ 1987 ☐ 1988 ☐ 1989 ☐ 1990 ☐ 1991  
☐ 1992 ☐ 1993 ☐ 1994 ☐ 1995 ☐ 1996 ☐ 1997 ☐ 1998 ☐ 1999 ☐ 2000 ☐ 2001 ☐ 2002 ☐ 2003 ☐ 2004  
☐ 2005 ☐ 2006 ☐ 2007 ☐ 2008 ☐ 2009 ☐ 2010

### Select time

☐ 00:00:00 ☐ 03:00:00 ☐ 06:00:00 ☐ 09:00:00 ☐ 12:00:00 ☐ 15:00:00 ☐ 18:00:00 ☐ 21:00:00

[Select All](#) or [Clear](#)

### Select number

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

[Select All](#) or [Clear](#)

### Select parameter

<input type="checkbox"/> 2 metre dewpoint temperature	<input type="checkbox"/> 2 metre temperature
<input type="checkbox"/> 10 metre U wind component	<input type="checkbox"/> 10 metre V wind component
<input type="checkbox"/> 10 metre wind speed	<input type="checkbox"/> 100 metre U wind component
<input type="checkbox"/> 100 metre V wind component	<input type="checkbox"/> Albedo
<input type="checkbox"/> Boundary layer height	<input type="checkbox"/> Charnock
<input type="checkbox"/> Convective available potential energy	<input type="checkbox"/> Forecast albedo
<input type="checkbox"/> Forecast precipitation	<input type="checkbox"/> Forecast surface pressure

# Public Datasets: CERA-SAT



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[Potential temperature](#)  
[Potential vorticity](#)  
[Pressure levels](#)

## ► Surface

## Type

[Analysis](#)  
[► Ensemble mean](#)  
[Ensemble standard deviation](#)  
[Forecast](#)

## CERA-SAT sets

[Daily](#)

## About

[Conditions of use](#)  
[Documentation](#)

## Navigation

[Home](#)  
[Public Datasets](#)  
[Web-API Activity](#)  
[Job list](#)

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## CERA-SAT, Daily

### Select a month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2009	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2010	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2011	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2012	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2013	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2014	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2015	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2016	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

### Select time

☐ 00:00:00 ☐ 03:00:00 ☐ 06:00:00 ☐ 09:00:00 ☐ 12:00:00 ☐ 15:00:00 ☐ 18:00:00 ☐ 21:00:00

[Select All](#) or [Clear](#)

### Select step

☐ 0 ☐ 3 ☐ 6 ☐ 9 ☐ 12 ☐ 15 ☐ 18 ☐ 21 ☐ 24 ☐ 27

[Select All](#) or [Clear](#)

**!** Forecasts are integrated daily, from 18:00UTC, for +step hours. For more information see the [documentation](#).

### Select parameter

- |  |  |
|--|--|
| <input type="checkbox"/> 2 metre dewpoint temperature                        | <input type="checkbox"/> 2 metre temperature                                   |
| <input type="checkbox"/> 10 metre U wind component                           | <input type="checkbox"/> 10 metre V wind component                             |
| <input type="checkbox"/> 10 metre wind gust since previous post-processing   | <input type="checkbox"/> 100 metre U wind component                            |
| <input type="checkbox"/> 100 metre V wind component                          | <input type="checkbox"/> Accumulated Carbon Dioxide Ecosystem Respiration      |
| <input type="checkbox"/> Accumulated Carbon Dioxide Gross Primary Production | <input type="checkbox"/> Accumulated Carbon Dioxide Net Ecosystem Exchange     |
| <input type="checkbox"/> Albedo  | <input type="checkbox"/> Boundary layer dissipation                            |
| <input type="checkbox"/> Boundary layer height                               | <input type="checkbox"/> Brightness temperature                                |
| <input type="checkbox"/> Charnock  | <input type="checkbox"/> Clear sky surface photosynthetically active radiation |

# Public Datasets: ECMWF WebAPI

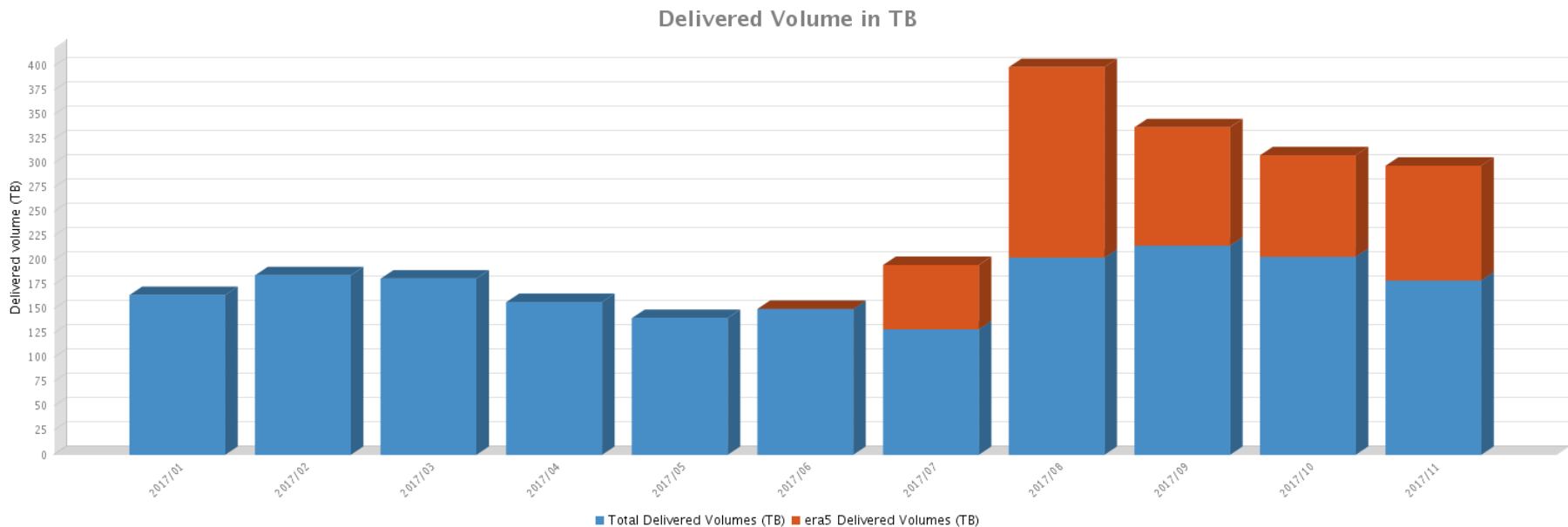
- Simple API to services using HTTPS
  - Install a simple library + token
  - Download data via batch scripts

```
#!/usr/bin/env python
```

```
from ecmwfapi import ECMWFDataServer
server = ECMWFDataServer()
server.retrieve({
    'dataset' : "cera20c",
    'stream'   : "edmm",
    'levtype'  : "sfc",
    'date'     :
"19010101/19010201/19010301/19010401/190105
01/19010601/19010701/19010801/19010901/1901
1001/19011101/19011201",
    'time'     : "00",
    'param'    : "2t",
    'grid'     : "1/1",
    'format'   : "netcdf",
    'target'   : "data.nc"
})
```

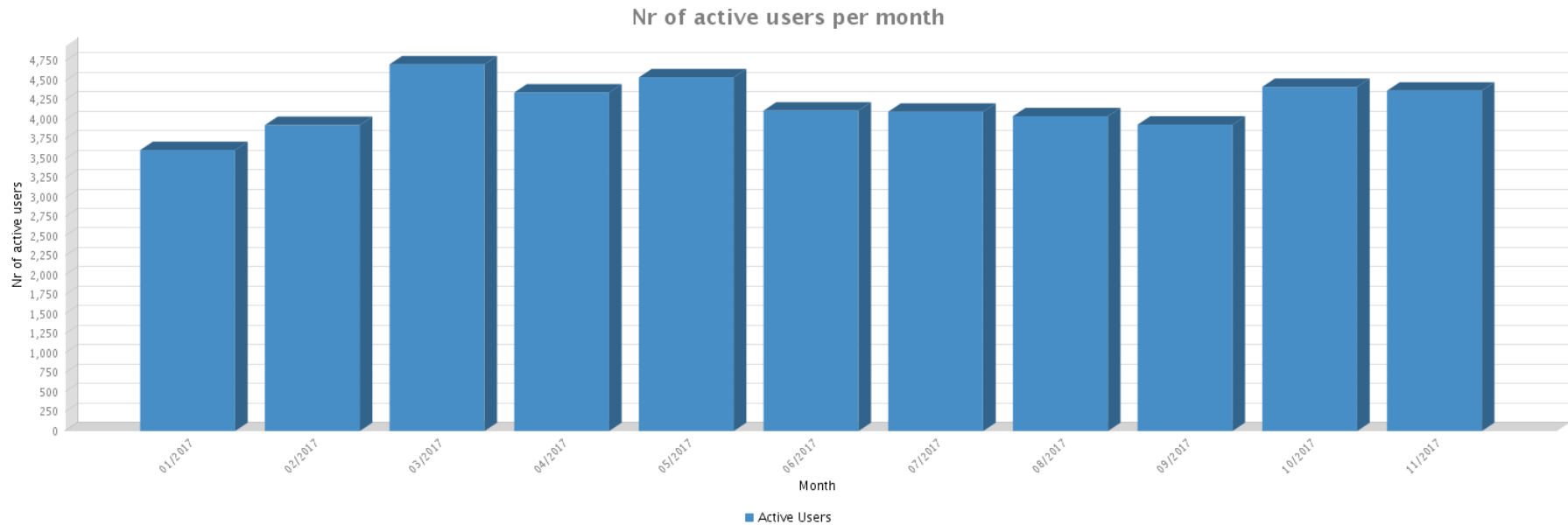
## D5.3 Report on data services usage: Statistics Framework

- Statistics on Public Data Servers
  - Stored all requests in a database, for further analysis
  - Performed statistics on popular datasets (ERA-Interim, etc...)
- Comparison of delivered volumes to users per month for ERA5 vs all other datasets for the year 2017
  - Clear impact of ERA5 (2010-2016) release in July 2017



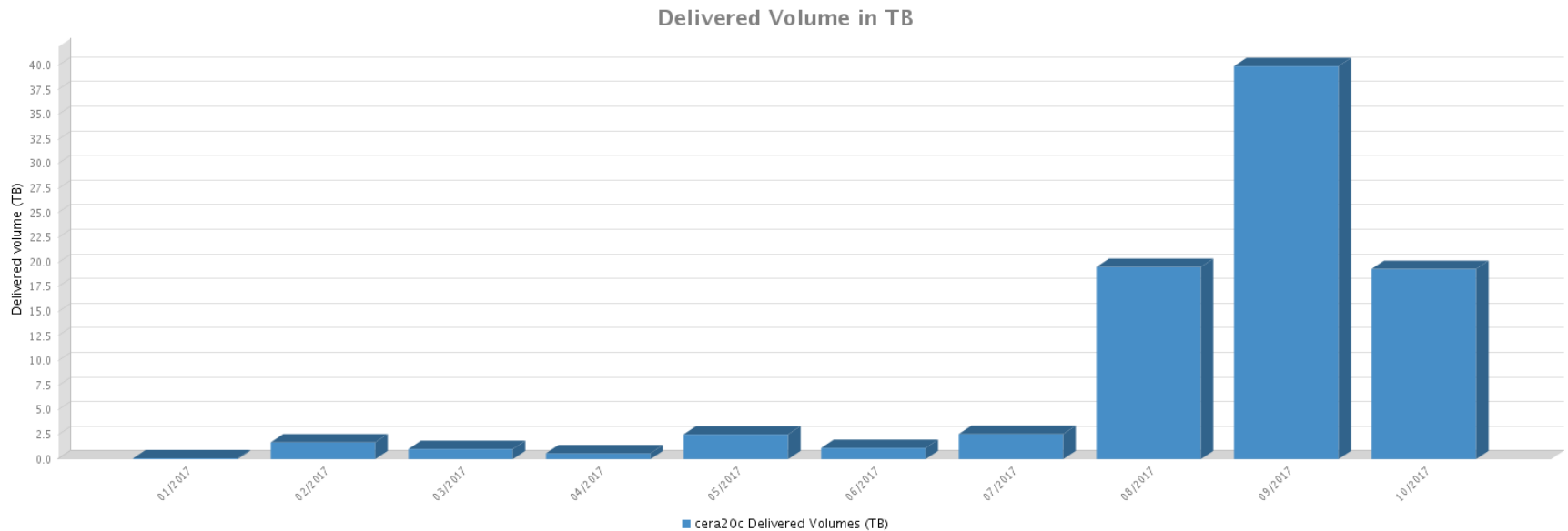
# Statistics Framework: Total number of users

- Total number of active users per month for all datasets
  - Active user: executes 3 or more retrievals



# CERA-20C Data Service Usage: delivered data

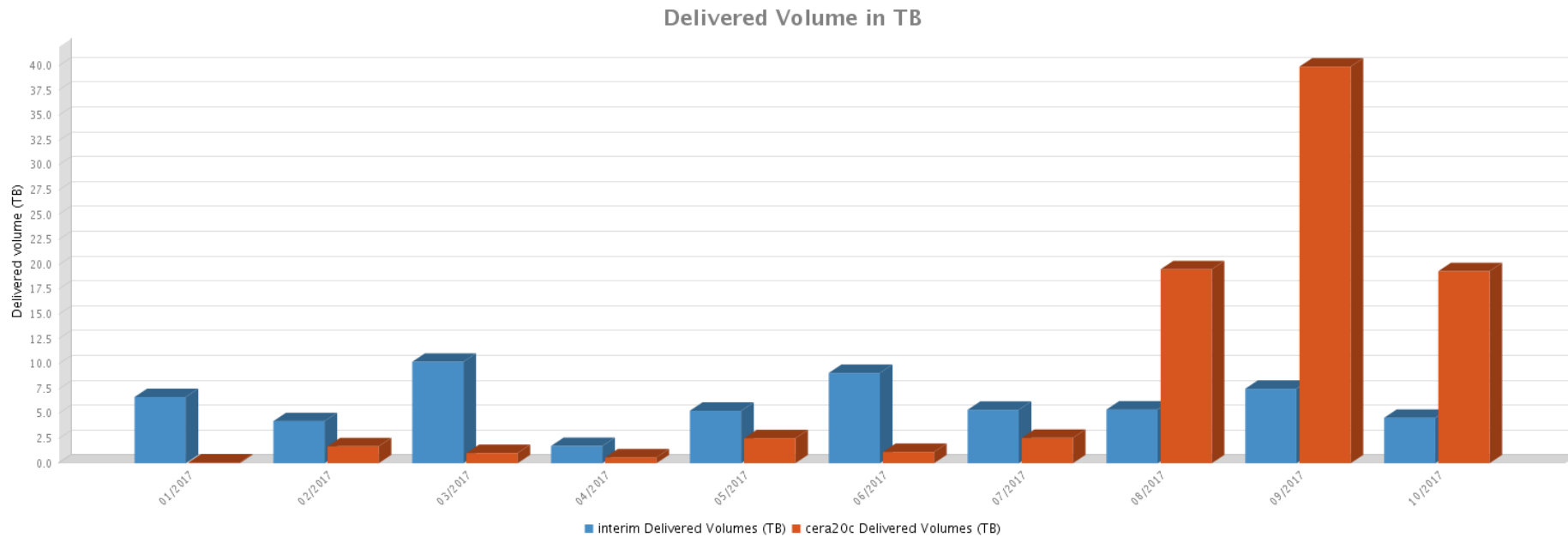
- Good uptake of CERA-20C by users
- Almost 40 TBytes delivered to users in September 2017





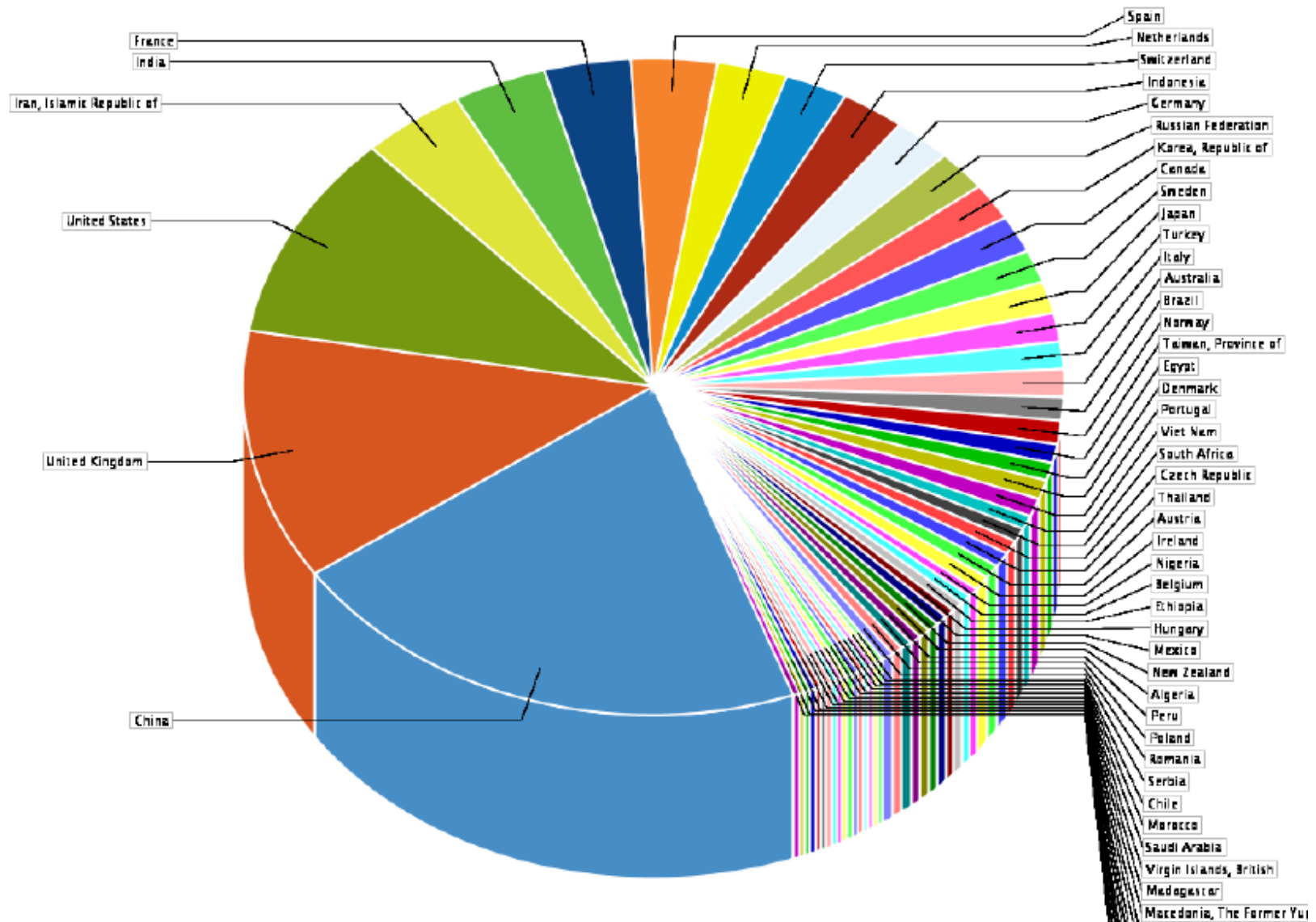
# CERA-20C Data Service Usage vs ERA-20C

- Compared with ERA-20C, first indications show CERA-20C is more popular



# CERA-20C Data Service Usage: User distribution by country

- Total number of users registered to CERA-20C: **259**




# Data Services usage: Study on popular parameters

- Project that aims to improve the description of reanalysis parameters archived in MARS. Start by the top 90 parameters, with a review process including internal and external review (15 reanalyses users)
  - Find the most retrieved parameters for popular datasets (eg, ERA-Interim)
  - The following 8 variables represent more than 6% (out of ~12,000 variables)

parameter	acronym	%
10 metre u-wind component	10u	1.25 %
10 metre v-wind component	10v	1.19 %
2 metre temperature	2t	1.17 %
total precipitation	tp	0.70 %
mean sea level pressure	msl	0.52 %
u-wind component at 850 hPa	u	0.50 %
v-wind component at 850 hPa	v	0.47 %
t at 850 hPa	t	0.43 %

# Data Services usage: Improve parameter description



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## Parameter details

GRIB parameters

[Full list](#)

Manuals

[GRIB API Documentation](#)

[ecCodes Documentation](#)

■ Parameter ID: 130

■ Name: Temperature

■ Short Name: t

■ Units: K

■ Description:

■ Documentation:

■ Insert date: 2010-09-10

■ Update date: 2010-09-10

■ Contact:

GRIB Edition 1GRIB Edition 2

rjtd

Key	Value
indicatorOfParameter	11
table2Version	200

WMO

Key	Value
indicatorOfParameter	11





Parameter name	Parameter ID
Temperature	130
<b>Draft Definition (FH, Version 5, 5 December 2017)</b>	
The temperature in the atmosphere. This parameter is available at all model levels, from close to the Earth's surface to the top of the atmosphere. This parameter has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15.  Units: kelvin (K)	
<b>Keywords:</b> TEMPERATURE, HEAT, COLD	

# ERACLIM2 WP5: Service Development - Summary

- WP5 Deliverables:
  - D5.1 MARS support for NetCDF (M36)
    - Technical development
  - D5.2 CERA Data Servers
    - CERA-20C (M40)
    - CERA-SAT (M48)
    - Ocean component Q1 2018
  - D5.3 Data services usage (M48)
    - CERA-20C
    - Framework to build customised reports

# ERA-CLIM2 Data Services: Not the end, but the beginning!

- Two Coupled Earth System Re-analyses available for the scientific community
- Foundations for Copernicus Climate Change Services

En Fr De    Contact  Manuel Fuentes ▾

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Charts | **Datasets** | Quality of our forecasts | Documentation and support | Accessing forecasts

## Browse reanalysis datasets

Reanalysis datasets

ERA5

ERA-Interim

ERA-Interim/Land

ERA-20C

ERA-20CM

CERA-20C

CERA-SAT

Archive catalogue

Real-time catalogue

Public, WMO & ACMAD

Dataset	Archive	Time period	Atmosphere	Atmospheric composition	Ocean waves	Ocean sub-surface	Land surface	Sea Ice	Observation Feedback Archive
ERA5	<a href="#">Download guide</a>	2010-2016	✓		✓		✓		
ERA-Interim	<a href="#">Download</a>	1979-present	✓		✓		✓		Expected soon...
ERA-Interim/Land	<a href="#">Download</a>	1979-2010					✓		
CERA-SAT	<a href="#">Download</a>	2008-2016	✓		✓	✓	✓	✓	✓
CERA-20C	<a href="#">Download</a>	1901-2010	✓		✓	✓	✓	✓	✓
ERA-20CM	<a href="#">Download</a>	1900-2010	✓		✓		✓		
ERA-20C	<a href="#">Download</a>	1900-2010	✓		✓		✓		✓
ERA-20CL	Expected soon...	1900-2010					✓		
ERA-40	<a href="#">Download</a>	1957-2002	✓		✓		✓		



Thank you for your attention!

# Prototype of NetCDF Ocean output in MARS



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## Navigation

[Public Datasets](#)

[Job list](#)

[< Return to selection](#)

## Additional filtering

### Current request

*Stream:* Atmospheric model

*Parameter:* Ocean salinity

*Year:* 1900

*Number:* 1

*Month:* February

*Version:* 2366

*Type of level:* Depth

*Time:* 00:00:00, 03:00:00, 06:00:00, 09:00:00, 12:00:00, 15:00:00, 18:00:00, 21:00:00

*Date:* 19000203

*Type:* Analysis

*Class:* ERA-CLIM2 coupled reanalysis of the 20th-century (CERA-20C)

The request will be done using the following attributes:

**Area:** Default (as archived) ([change](#))

**Grid:** 1x1 ([change](#))

[▲ Top of page](#)

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# ECMWF's commitment to support NetCDF

- Other projects require NetCDF support
  - All data being served from ECMWF Data Portals
  - Sub-seasonal to Seasonal project (S2S) requires archiving in MARS of Ocean output from 11 production Centres (near real-time + reforecast)
  - Other forecasting systems producing ocean output (HRES, ENS, ....)
  - Seasonal forecast being delivered in NetCDF to the C3S (real-time + reforecast), and will need to be served by the Climate Data Store (CDS)
  - Climate Predictions (CMIP6) will be part of the C3S, will be served by the CDS
- Define common metadata that will allow tools to seamlessly handle all the above
  - Define a MARS/NetCDF convention, on top of CF, CMIP5/6, SPECS
- ERA-CLIM2 D5.1 will enable support for NetCDF at ECMWF
  - Transfer the development outcomes into preoperational phase of C3S