

# Overview of Computing Services

Introduction to ECMWF Computing Services

Online training course 2023

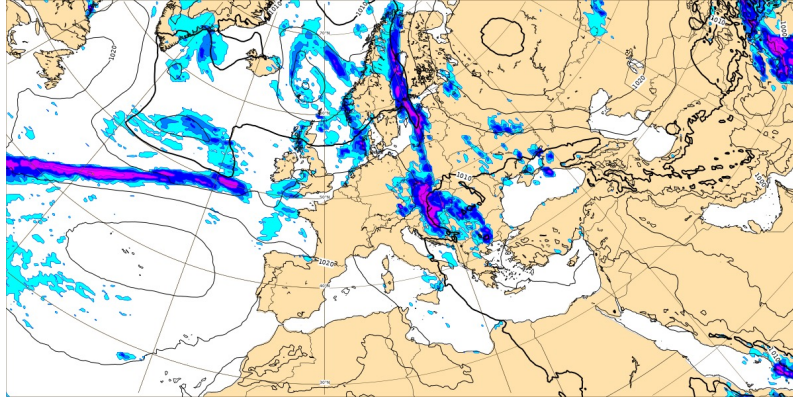
Paul Dando

Computing and Software Support Team



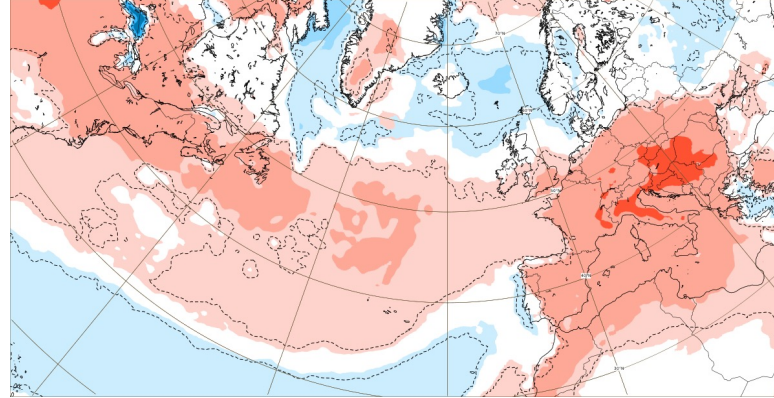
# ECMWF operational forecasting system

Medium range: up to 2 weeks



- ~9 km and 137 levels (T<sub>CO</sub>1279 / O1280 / L137)
- HRES:
  - to T+240h at 00 and 12 UTC
  - to T+90h at 06 and 18 UTC – “BC run”
- ENS: 50+1 members
  - to T+360h at 00 and 12 UTC
  - to T+144 at 06 and 18 UTC

Extended range: up to 6 weeks

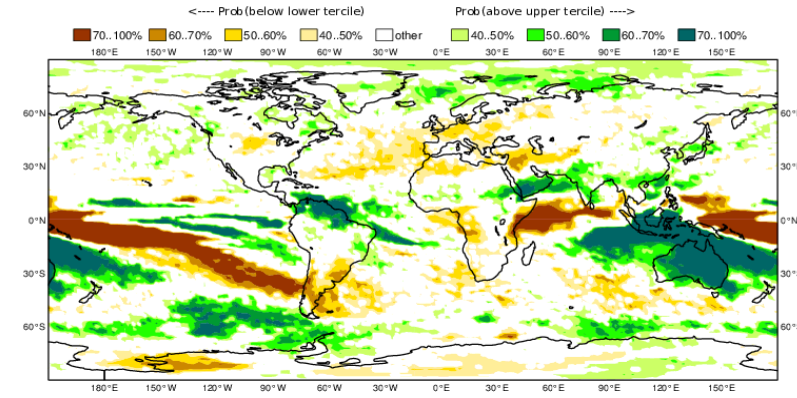


- ~36 km and 137 levels (T<sub>CO</sub>319 / O320 / L137)
- 100+1 members
- To 46 days (T+1104h) at 00 UTC every day

Ocean Waves

- WAM-HRES: ~14km coupled with HRES
- WAM-ENS: 50+1 members, ~14km coupled with ENS
- WAM-ENS-extended: 100+1 members, ~55km
- WAM-SEAS: 50+1 members, ~55km

Seasonal range: up to 7 months

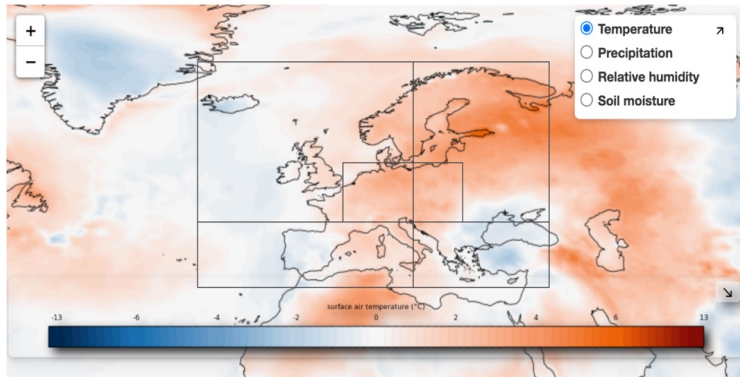


- ~36 km and 91 levels (T<sub>CO</sub>319 / O320 / L91)
- 50+1 members
- Once per month to 7 months ahead
- A sub-set of 15 members is run to 13 months ahead every quarter (Feb / May / Aug / Nov)
- 30 years of hindcasts

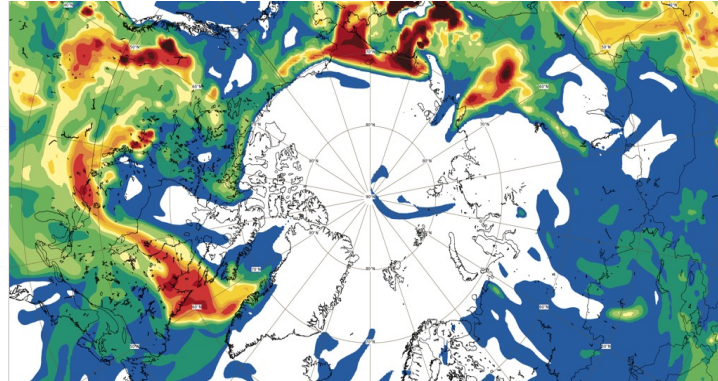
# Environmental modelling products

- [Copernicus Climate Change Service](#) – C3S
- [Copernicus Atmosphere Monitoring Service](#) – CAMS
- [Copernicus Emergency Management Service](#) - CEMS

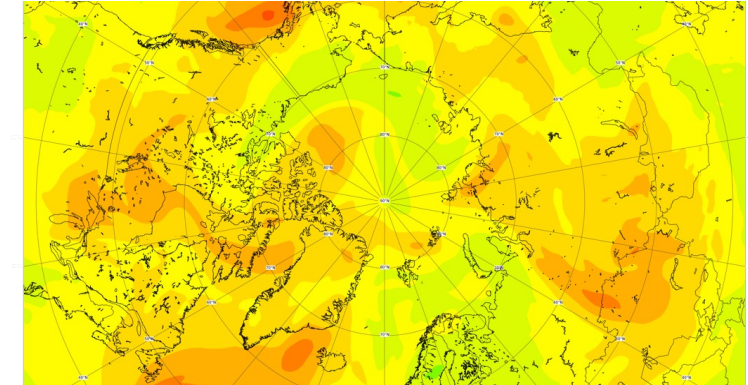
Monthly Copernicus climate monitoring



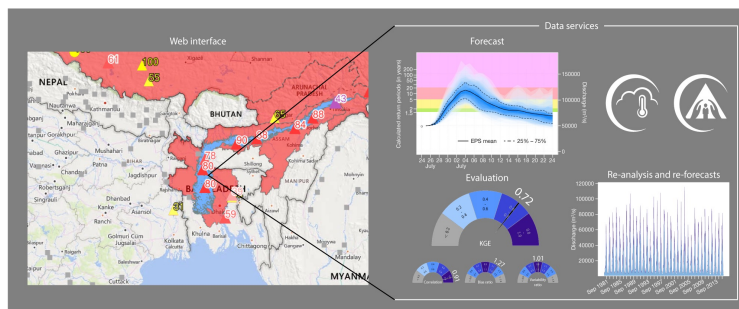
Carbon monoxide forecast



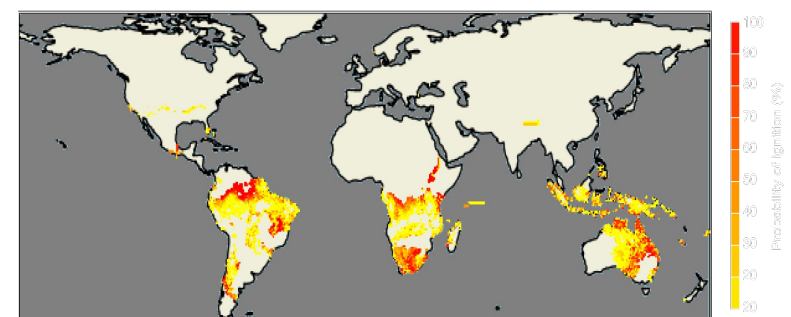
Ozone forecast



Using NWP to drive hydrological global forecasts

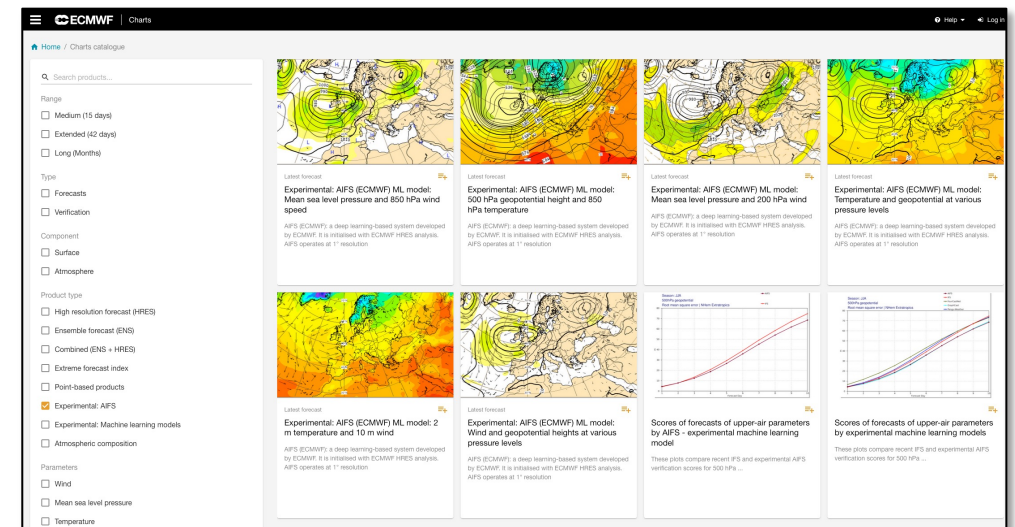
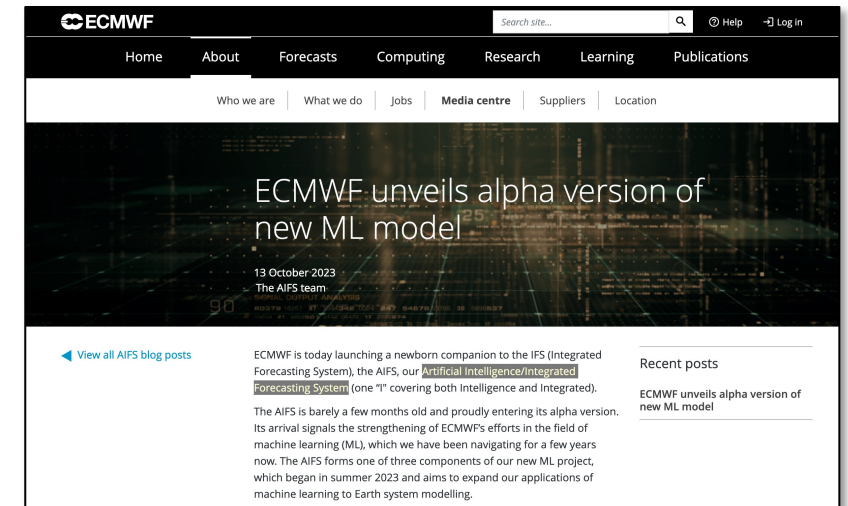


Probability of ignition by lightning 2016-02-01



# Artificial Intelligence/Integrated Forecasting System

- Alpha version of new machine learning model – AIFS
  - ~110 km ( $T_{CO95}$  / O96)
  - 13 pressure levels – U, V, W, T, Q and Z
  - Surface – MSL, SP, 10U, 10V, 2D, 2T
- Launched 13 October 2023
- Utilises the grid-flexibility and parameter efficiency of Graph Neural Networks
- Graphical products available
  - Charts catalogue
  - ecCharts



# Changes to the operational forecast systems

- ECMWF operational forecasts

- <https://confluence.ecmwf.int/display/FCST/Changes+to+the+forecasting+system>

- CAMS global forecasts

- <https://confluence.ecmwf.int/display/COPSRV/CAMS+Global>

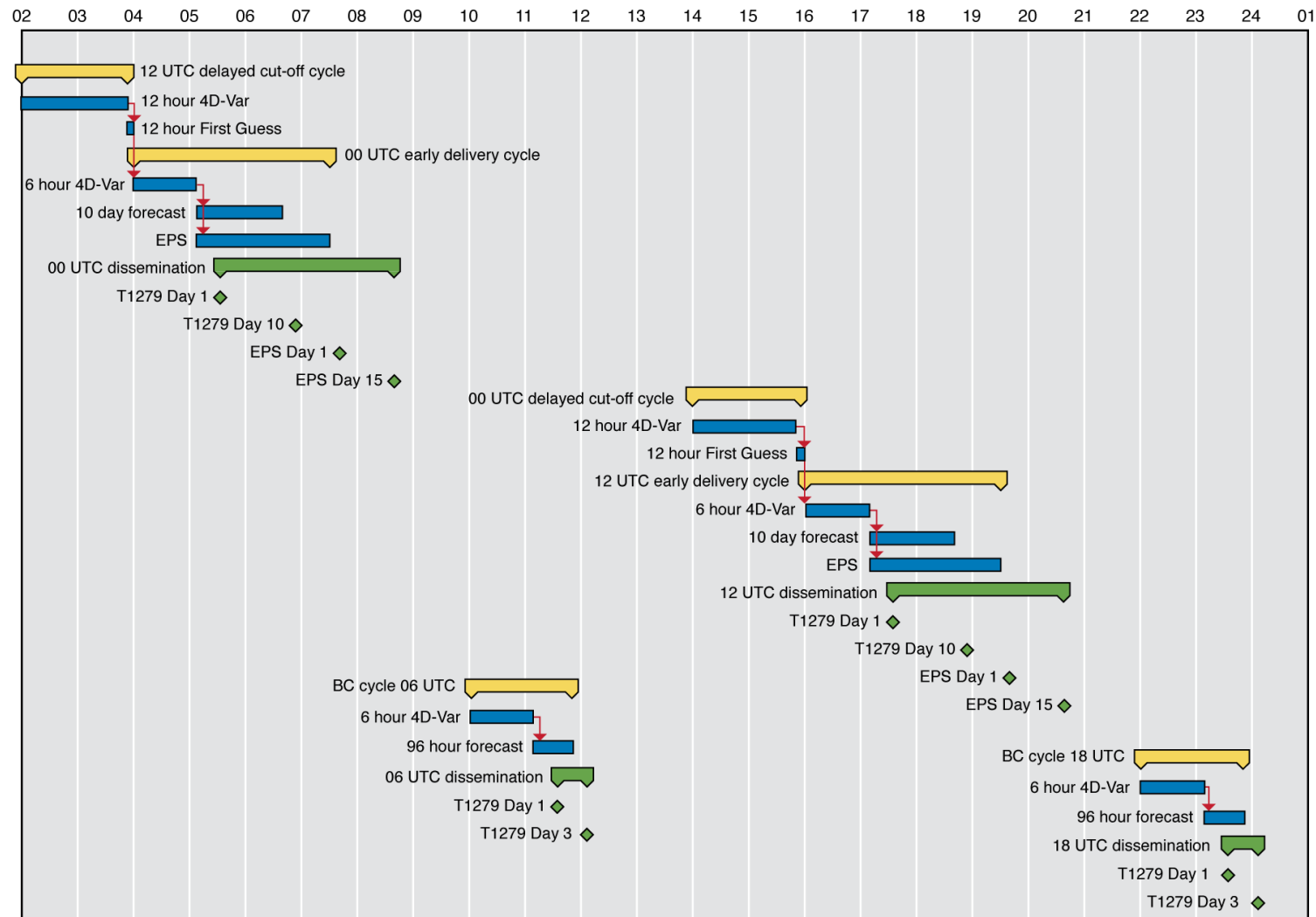
The screenshot shows the Confluence page titled "Changes to the forecasting system" under the "Forecast User Portal" space. The page content includes:

- Introduction:** On these pages you can find information about planned changes to the IFS forecasting system and documentation describing previous changes. Please note that for planned changes this information is subject to revisions as we proceed with experimentation.
- Formal announcements:** Formal announcements of the implementation schedules for new model cycles will still be made by email, and relevant information will then be posted on dedicated pages on the ECMWF web site, where you can also find information about previous changes to the ECMWF forecasting system. The terminology used is described in Terminology for IFS testing.
- Planned changes:**
  - Implementation of IFS Cycle 49r1 - Scheduled for Q2 2024 (TBC)
- Past changes:**
  - Implementation of IFS Cycle 48r1 - Implemented 27 June 2023
  - Implementation of IFS Cycle 47r3 on the Atos HPC - Implemented 18 October 2022
  - Implementation of IFS Cycle 47r3 - IFS Cycle 47r3 implemented 12 October 2021
  - Implementation of IFS Cycle 47r2 - IFS Cycle 47r2 implemented 11 May 2021
  - Implementation of IFS Cycle 47r1 - IFS Cycle 47r1 implemented 30 June 2020
  - Implementation of IFS Cycle 46r1 - IFS Cycle 46r1 implemented 11 June 2019
  - Implementation of IFS Cycle 45r1 - IFS Cycle 45r1 implemented 5 June 2018
  - Implementation of Seasonal Forecast SEAS5 - SEAS5 implemented 5 November 2017
  - Implementation of IFS Cycle 43r3 - IFS Cycle 43r3 implemented 11 July 2017
  - Implementation of IFS Cycle 43r1 - IFS Cycle 43r1 implemented 22 November 2016
  - Implementation of IFS Cycle 41r2 - IFS Cycle 41r2 implemented 8 March 2016
  - Horizontal resolution increase - IFS Cycle 41r2 implemented 8 March 2016
  - Boundary-Condition Programme ENS at 06 and 18 UTC - implemented 8 July 2015
- See also:**
  - Operational configurations of the Integrated Forecasting System (IFS)
- Mailing list:** A mailing list has been created to inform interested parties about IFS changes. To subscribe or unsubscribe, please send an email to `forecast_changes-request@lists.ecmwf.int` with either `subscribe` or `unsubscribe` as Subject.

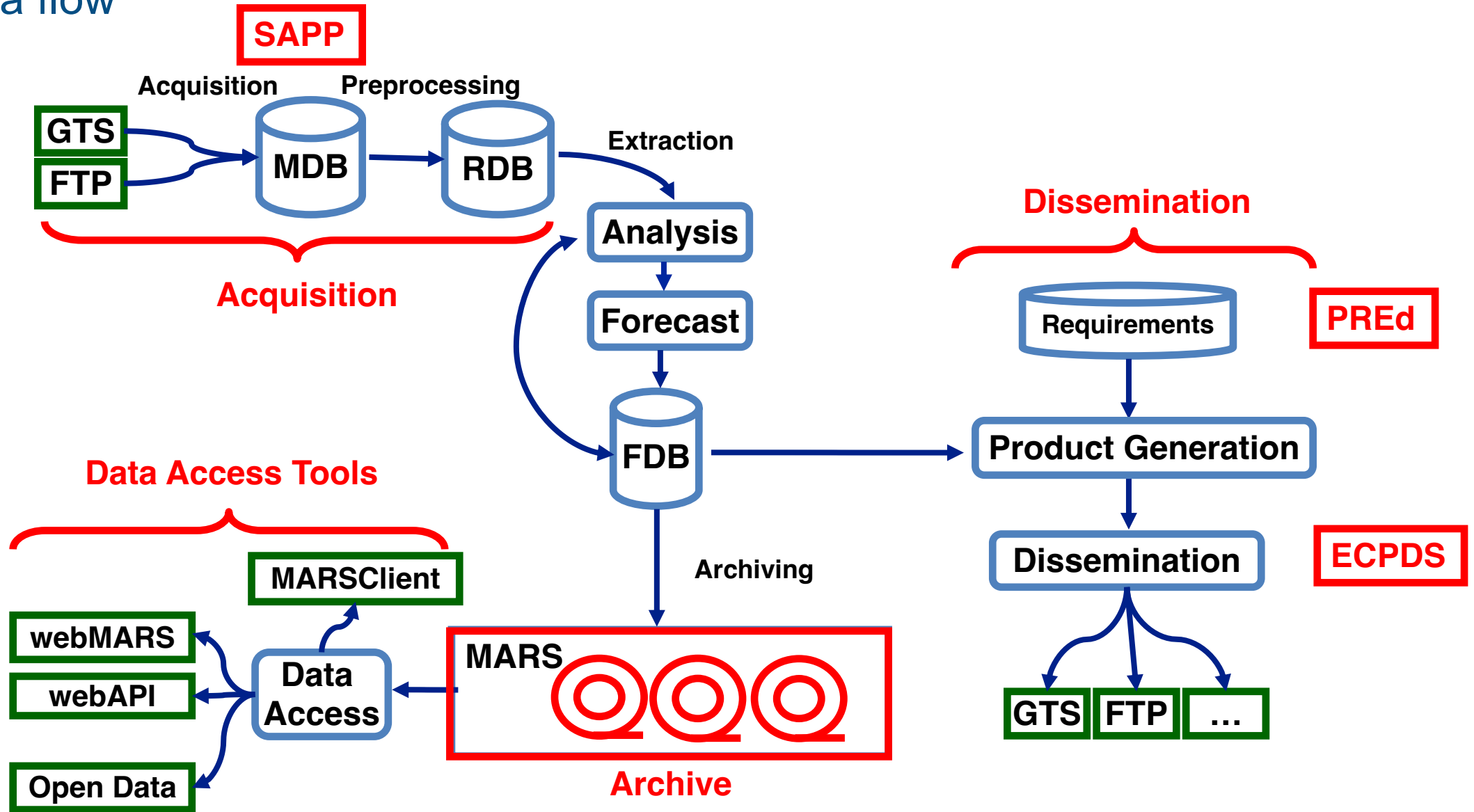
The screenshot shows the Confluence page titled "CAMS Global" under the "Production" space. The page content includes:

- Introduction:** Created by Miha Razinger, last modified by Richard Engelen on Apr 30, 2019.
- Implementation list:**
  - Implementation of IFS cycle 48r1 for CAMS
  - Porting of IFS cycle 47r3 to ATOS
  - Implementation of IFS cycle 47r3
  - Implementation of IFS cycle 47r2
  - Implementation of IFS cycle 47r1
  - Implementation of IFS cycle 46r1
  - Global production log files
  - Implementation of IFS cycle 43r3
  - Current global production suites
    - CAMS global NRT system upgrade 45r1 (26 Jun 2018)
    - CAMS global NRT system upgrade 43r3 (Sep 2017)
    - CAMS global NRT system upgrade (Jan 2017)
    - CAMS global NRT system upgrade (Q2 2016)
- Cycle 46r1:**
  - Accessing CAMS 46r1 test data
  - Implementation of IFS cycle 46r1
- Cycle 45r1:**
  - Accessing CAMS 45r1 test data
  - CAMS global NRT system upgrade 45r1 (26 Jun 2018)

# The main operational suites on ECMWF's HPCF



# Data flow





# Computing Services



# The Atos HPC Facility

- 4 Atos complexes (AA, AB, AC, AD)
  - HPC
  - ECS
- For serial and parallel workloads
- Slurm batch system (sbatch, squeue, scancel)
- Multiple storage options for different needs
  - HOME, PERM, HPCPERM, SCRATCH
- Software environment via modules



Atos Sequana XH2000	
Clusters (AA, AB, AC, AD)	4
Total number of compute nodes	7,680
Total number of GPIL nodes	448
Processor type	AMD EPYC Rome
Cores	64 cores / socket
	128 cores / node
Base frequency	2.25 GHz (compute)
	2.5 GHz (GPIL)
Memory/node	256 GiB (compute)
	512 GiB (GPIL)
Total memory	2.1 PiB
Total number of cores	1,040,384
Operational storage - SSD	1.3 PiB
Operational storage - HDD	12 PiB
Research storage	77 PiB

# HPFC – purpose

## Batch submission

- Slurm
- ECaccess Tools
- ecinteractive

## Time-critical applications

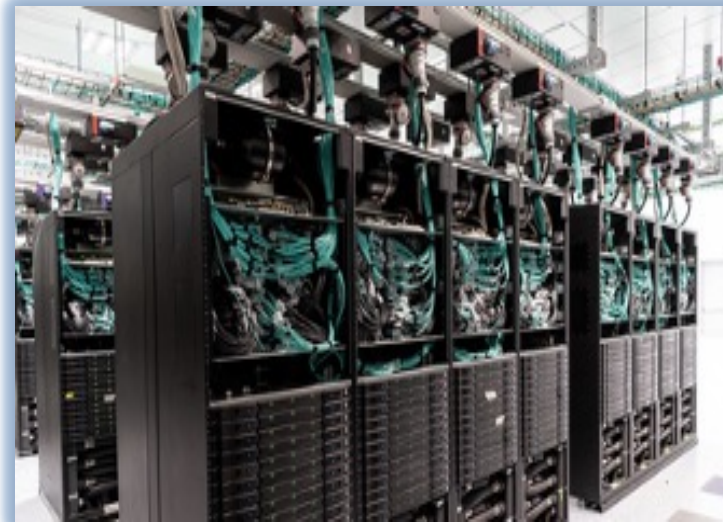
- Option 1
- Option 2
- Option 3

## Access to archives

- MARS
- ECFS

## Data transfer

- ftp / sftp
- ectrans



## Running meteorological models

- Member State models
- ECMWF's IFS

# Data Handling System

- Total amount of primary data: 628 PB
- Secondary data: 206 PB
- ~500 TB added per day
  
- Number of tapes:
  - 22,300 primary
  - 24,500 secondary
- Number of tape libraries: 10
- Number of Linux servers: 290
- Number of IBM 3592 tape drives: 396
- Number of LTO drives: 50
- Total amount of usable disk space: 28 PiB



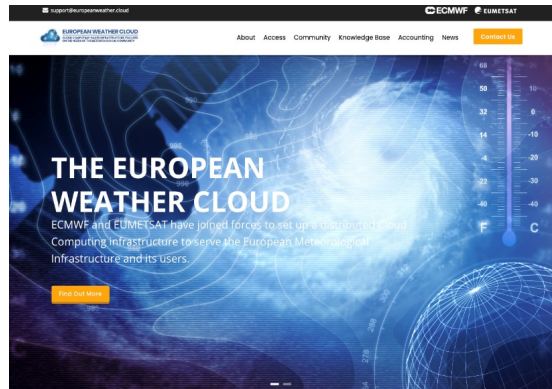
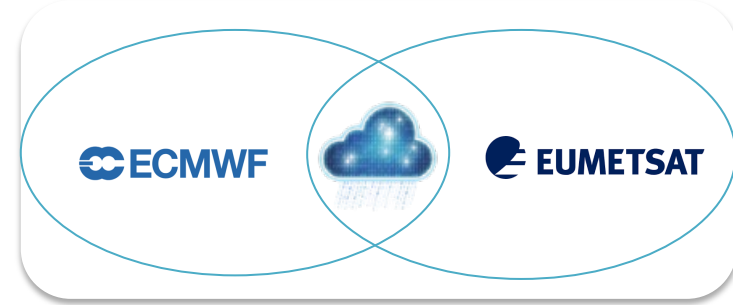
# Data Handling Services

- MARS – **M**eteorological **A**rchive and **R**etrieval **S**ystem
  - Data is accessed via a meteorological meta-language interface
  - Bulk of the data, few files (but holding billions of fields in total)
  - Relies upon excellent tape drive performance when retrieving lots of small parcels of data from tape
- ECFS – **E**CMWF **F**ile **S**ystem
  - HSM-like (Hierarchical Storage Management) service for “ad-hoc” files that are not suitable for storing in MARS
  - Data is accessed via an rcp-like interface
  - Millions of files, many very small
- HPSS – **H**igh-**P**erformance **S**torage **S**ystem
  - Both MARS and ECFS rely on HPSS as the underlying data management system that is used to store the data
  - Users do not have direct access to HPSS, only via MARS and ECFS

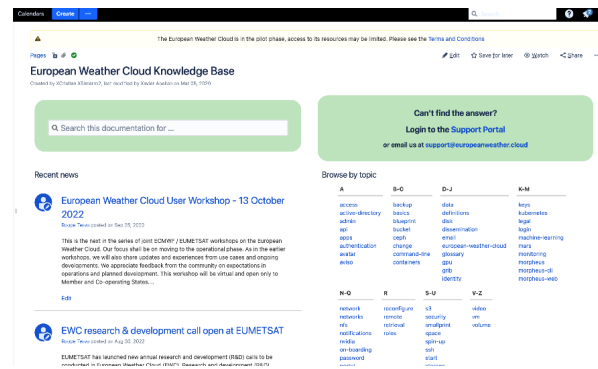


# European Weather Cloud

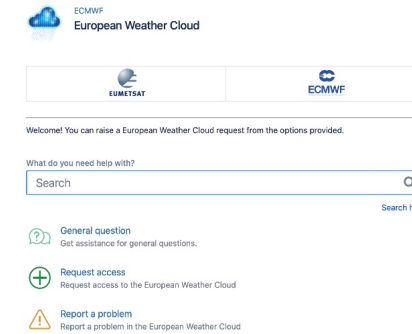
- Pilot project started in 2019 by ECMWF and EUMETSAT
- Operational since 26 September 20



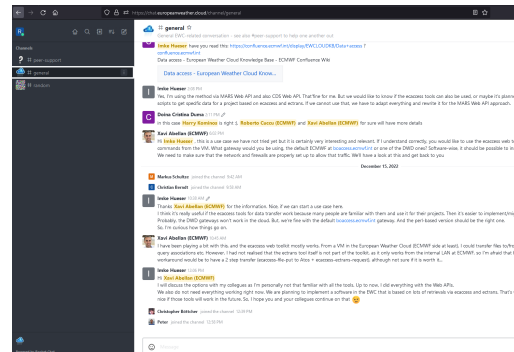
[Main Website](#)



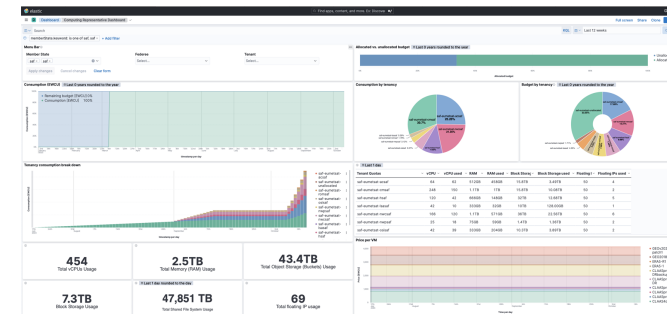
[Knowledge Base](#)



[User Support Portal](#)



[Discussion Platform](#)



[Accounting Platform](#)



# EWC – Operational Infrastructure



Cores	3830
Memory	30.7 TB
Storage	3.8 PB usable
GPUs	240 VGPUs (10 GB partitioning)

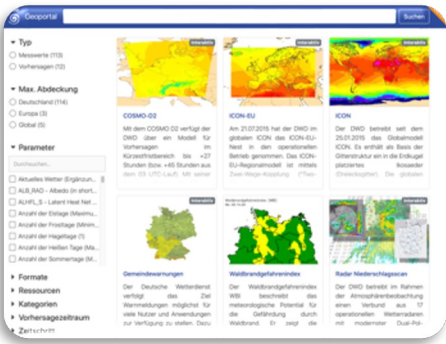
Cores	5632
Memory	53 TB
Storage	4.2 PB usable
GPUs	32 x A100 80 GB

- Hosted externally with 10 Gbps link to EUM
- Sizing may increase in future based on demand
- New Cloud Infrastructure ready in Bologna
- 2 Production clouds - one on each computer hall

• Resources allocated to each Member and Co-operating State  
• Managed by Computing Representatives



# EWC: What could you do with it ?



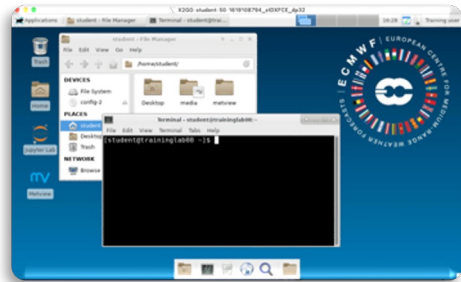
OGC web map services integrating maps in DWD's Geoportal



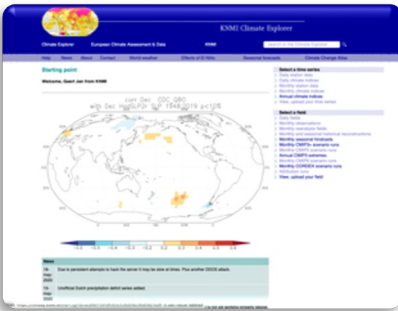
Forecast and climatology of cloud cover for Energy and Spatial sectors Météo-France Hosted on both ECMWF and EUMETSAT



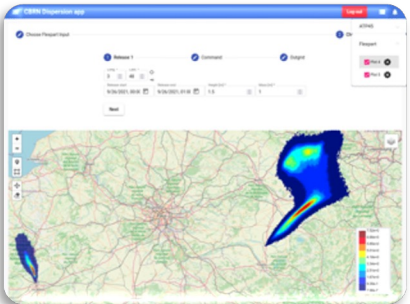
Oxford University Jupyter notebook environments for ML on weather & climate data sets



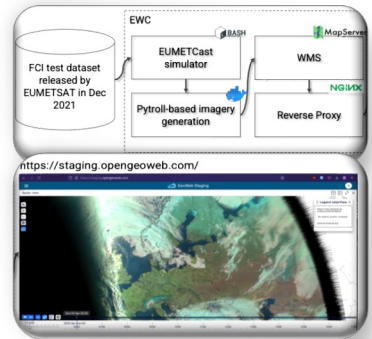
Virtual laboratories for training courses and workshops



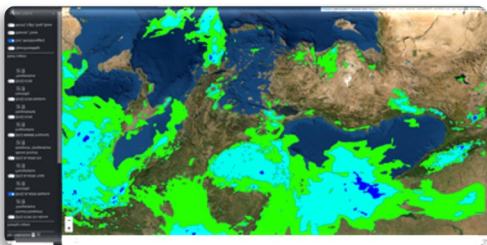
KNMI Climate Explorer setup on EWC



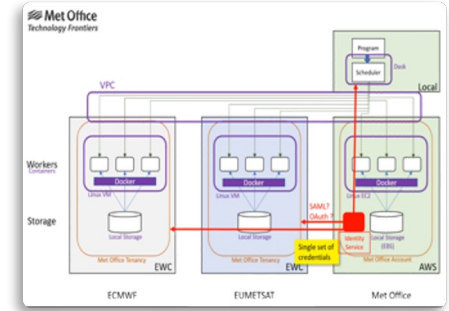
Atmospheric dispersion modelling from RMI



NordSat developing imagery generation tools for satellite products



South-East European Multi-Hazard Early Warning Advisory System Common Interface Platform

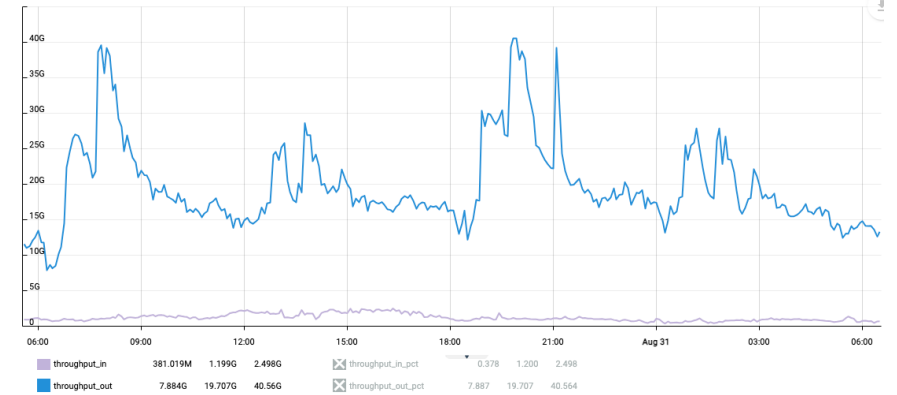


UK Met Office demonstrates Data Proximate Compute use case

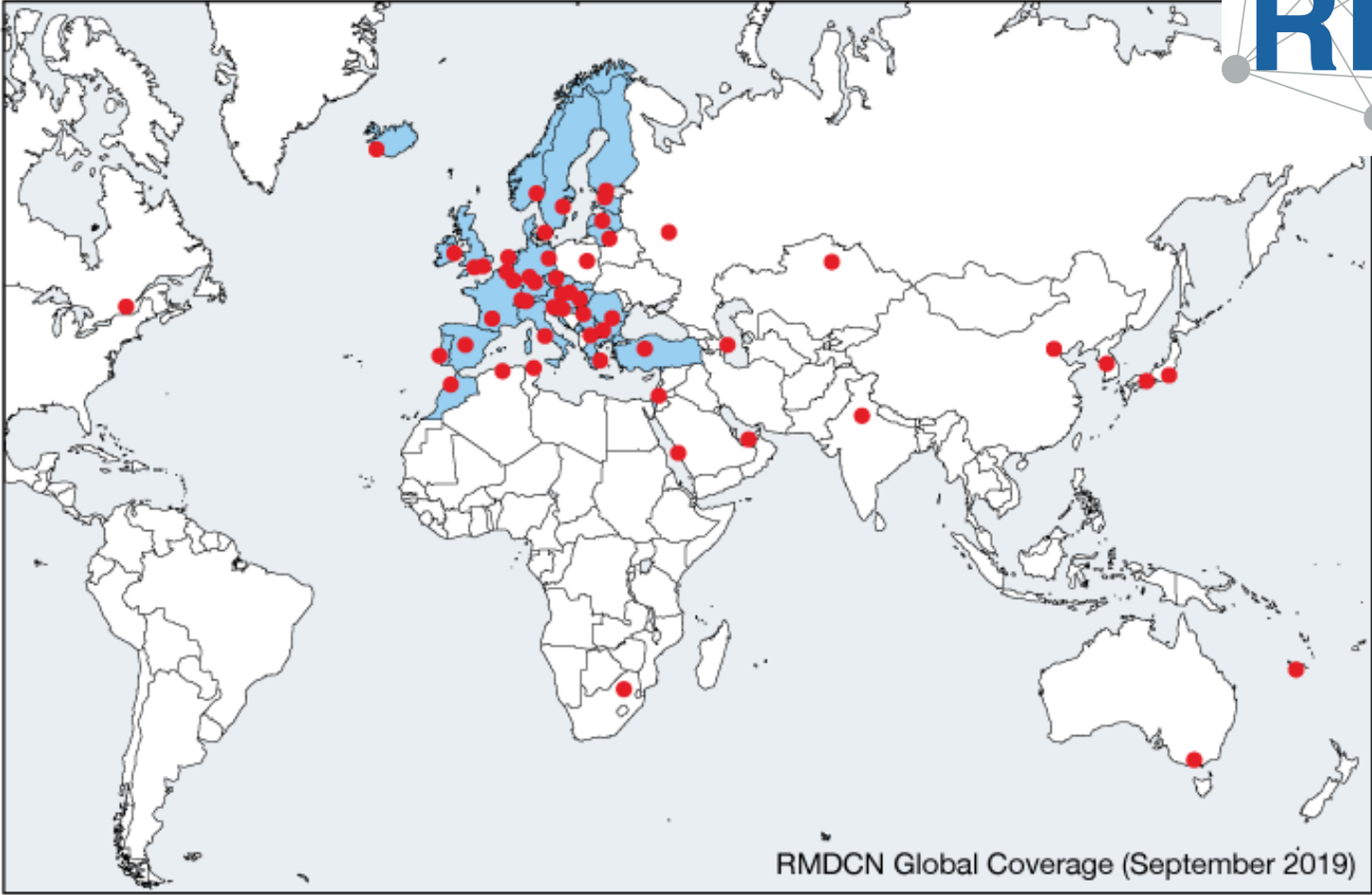


# Networks

- Internet
  - Dual links to local networks at each of ECMWF's sites
    - Jisc in the UK, GARR in Italy, and DFN in Germany
    - high-speed connections to the rest of the Internet, e.g. GÉANT
  - Bologna: 60Gbit/s uplink to GARR
    - Two routers on our side, each of which has a single connection to a separate GARR router
- RMDCN (Regional Meteorological Data Communications Network)
  - Secured VPN provided through MPLS (Multi Protocol Label Switching)
  - Supplied by Interoute Communications Limited
  - Bandwidth to Member States: 1 - 100 Mbps
  - Managed by ECMWF for WMO Region VI
- ECMWF is a participating organisation in the eduroam federation



# RMDCN connections

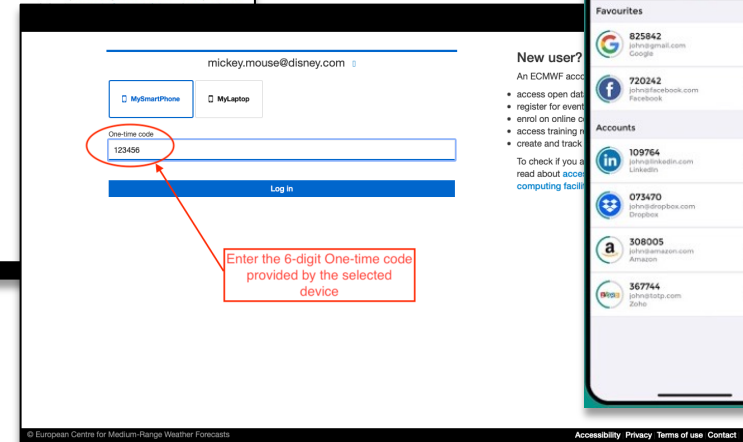
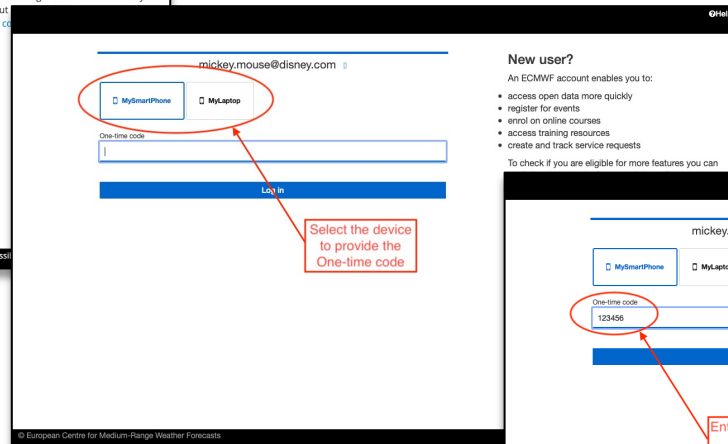
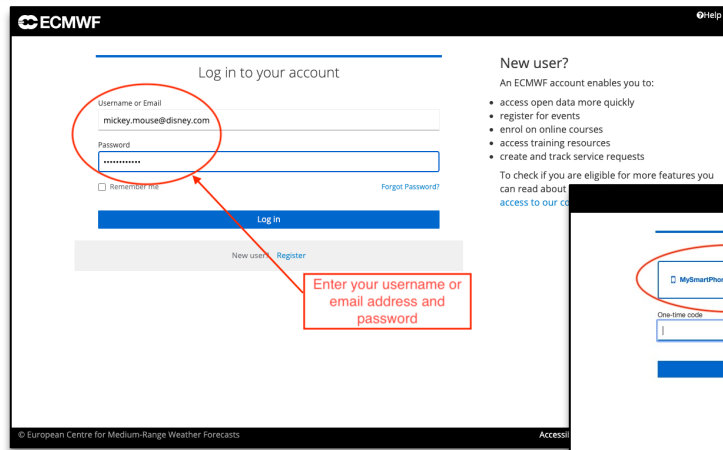


53 sites currently connected

# Access to ECMWF resources

All interactive login access to ECMWF's computing system requires Multi-Factor Authentication (MFA)

Password  
+  
One-Time Password provided by a Time-based one-time Password (TOTP) device



✓ See [Using Time-based One-Time Passwords](#)

# Remote access: the SSH service

```
usrc-> tsh login
> Profile URL:      https://jump.ecmwf.int:443
  Logged in as:    roberto.cuccu@ecmwf.int
  Cluster:         jump.ecmwf.int
  Roles:
  Logins:          usrc
  Kubernetes:     disabled
  Valid until:    2023-09-11 22:22:02 +0200 CEST [valid for 11h55m0s]
  Extensions:     permit-X11-forwarding, permit-agent-forwarding, permit-port-forwarding, permit-pty

usrc-> ssh hpc-login

#-----#
Welcome to ac6-100 of cluster ac!

## #####
# # # #
# # #
##### #
# # # #
# # #####

[IMPORTANT] Read carefully the following documentation:

https://confluence.ecmwf.int/display/UDOC/HPC2020+User+Guide

Have fun!

EC_GIT_TAG='commit e34fd29 deployed at 20230905_081008'
#-----#

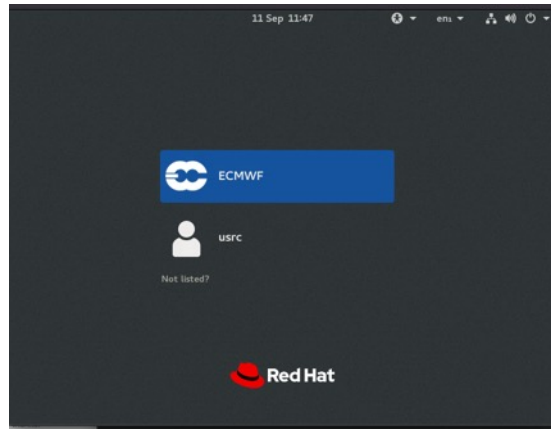
Last login: Mon Sep 11 08:25:37 2023 from 10.120.16.4
[ECMWF-INFO -ecprofile] /usr/bin/bash INTERACTIVE on ac6-100 at 20230911_082720.337, PID: 3058110, JOBID:
[ECMWF-INFO -ecprofile] $SCRATCH=/ec/res4/scratch/usrc
[ECMWF-INFO -ecprofile] $PERM=/perm/usrc
[ECMWF-INFO -ecprofile] $HPCPERM=/ec/res4/hpcperm/usrc
[ECMWF-INFO -ecprofile] $TMPDIR=/etc/ecmwf/ssd/ssd1/tmpdirs/usrc.3058110.20230911_082720.337
[ECMWF-INFO -ecprofile] $SCRATCHDIR=/ec/res4/scratchdir/usrc/6/ac6-100.3058110.20230911_082720.337
[usrc@ac6-100 ~]$
```

The screenshot shows the ECMWF user interface. At the top, there's a navigation bar with the ECMWF logo, a search bar, and several utility icons. Below the navigation bar, the page title is "Teleport SSH Access" and it's noted as being created by Oliver Gorwits and last modified by Xavier Abellan on Dec 16, 2022. The main content area describes Teleport as software for providing an SSH Jump Host service. It lists three key features: single SSH hop, re-authentication every 12 hours, and integration with standard tools. Below this, it explains the sign-on process using the "tsh" application. A list of configuration guides for various operating systems is provided, including Mac, Linux, Windows Terminal, Windows Subsystem for Linux (WSL), Windows MobaXterm, and Windows Cygwin. A callout box for system administrators provides additional information on network requirements.

✓ See [Teleport SSH Access](#) documentation

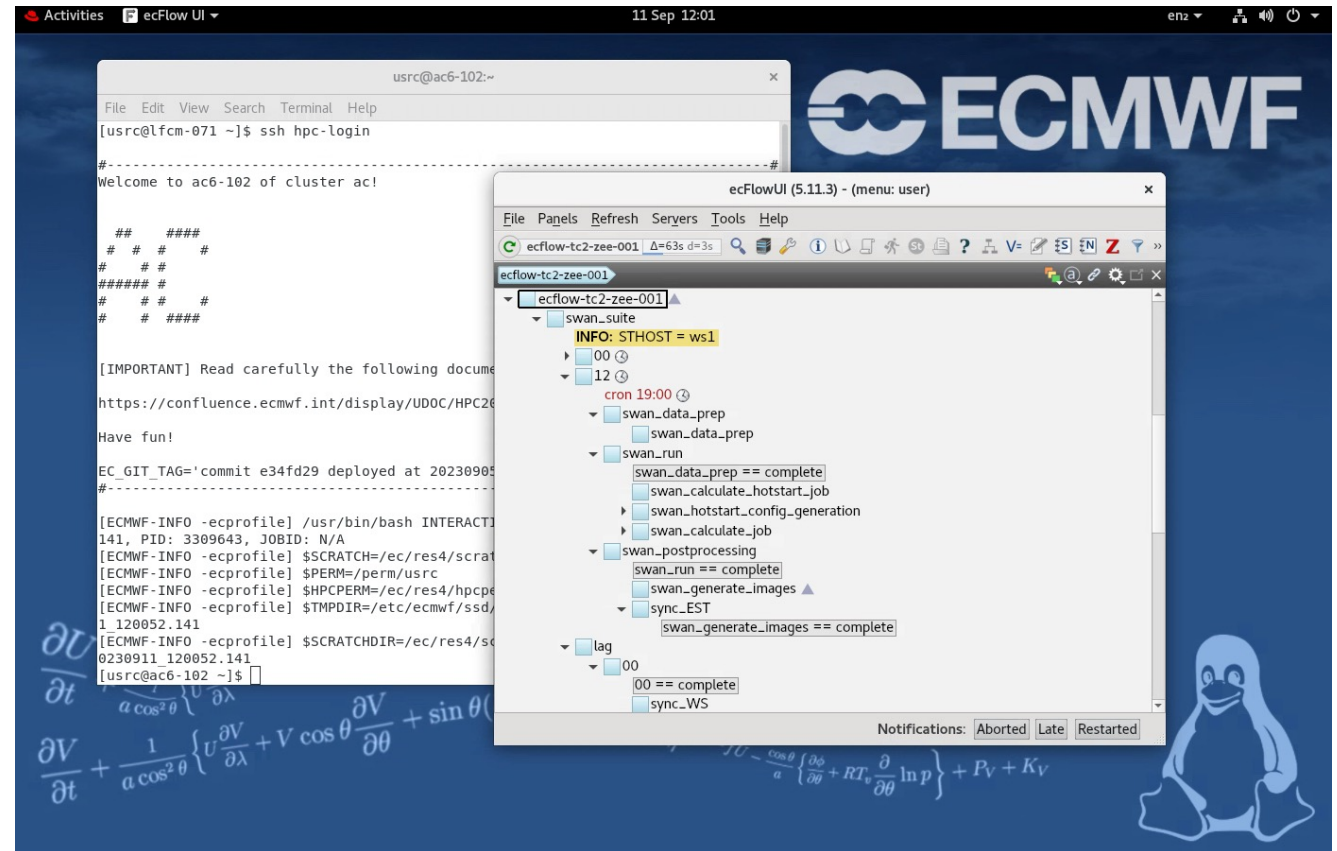
# Remote access: the Linux VDI service

<https://desktop.ecmwf.int/>



## Limited software installed

- No MARS
- No ECMWF software
- No 3<sup>rd</sup> party software
- No additional Python packages



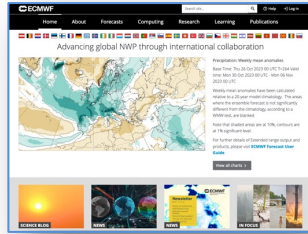
See [Linux Virtual Desktop – VDI](#) documentation

# Web Services

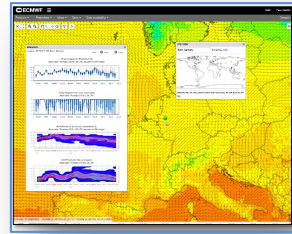


# Web services – overview

## Key service areas



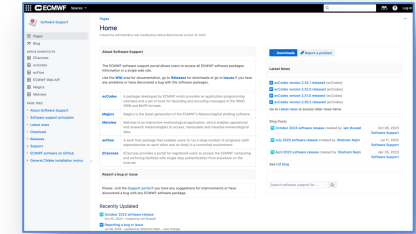
www  
Everyone



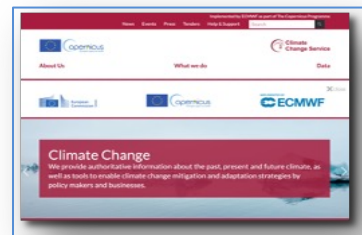
ecCharts  
Forecasters

A screenshot of the MARS Catalogue interface. It shows a list of data products available for download. The table includes columns for the product name, its operational status, and the date it was last updated. The products listed include various reanalysis and forecast data sets.

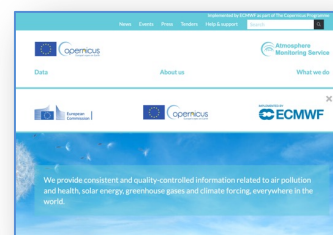
Apps  
Everyone



Atlassian  
Everyone



C3S  
Everyone



CAMS  
Everyone



EFAS  
EFAS Partners

# Web services – ECMWF Open Charts

<https://www.ecmwf.int/en/forecasts/charts>

- Charts published under a Creative Commons Attribution 4.0 International (CC BY 4.0)
- Open Charts API can be used to download charts by script

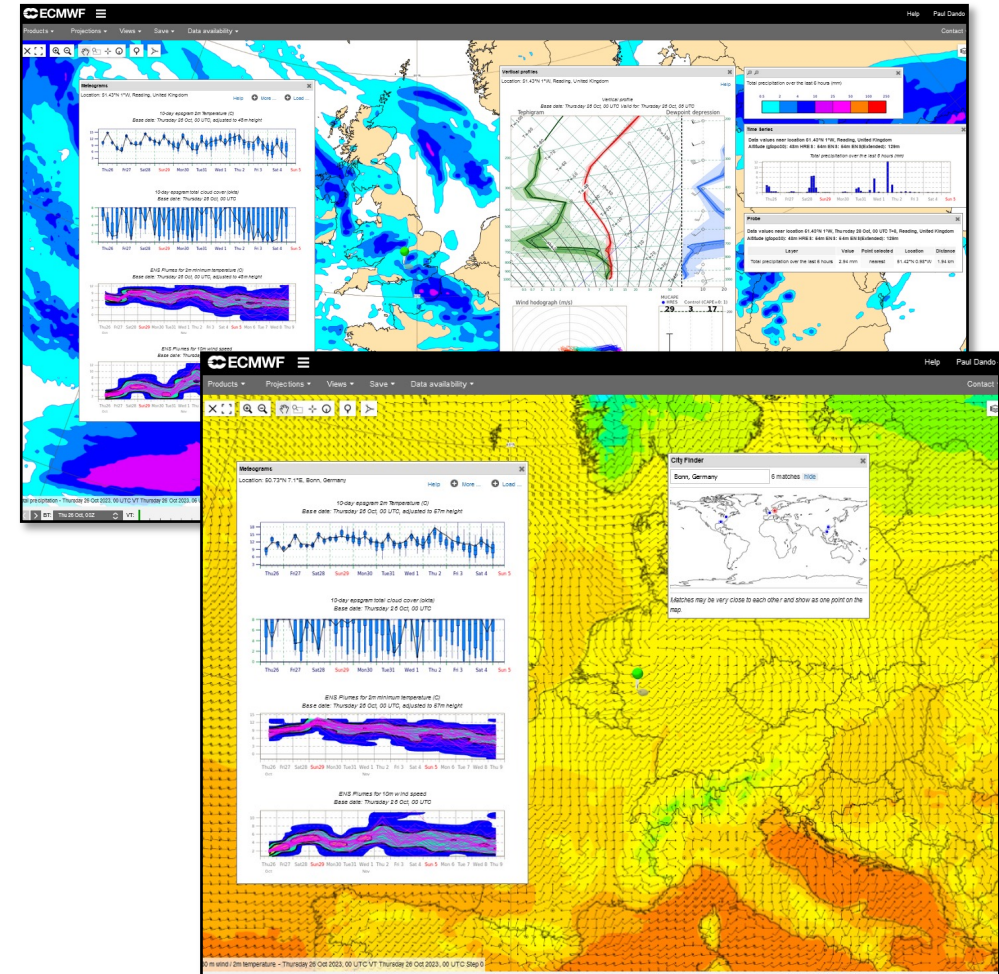
The screenshot displays the ECMWF Open Charts website. At the top, there is a navigation bar with links for Home, About, Forecasts, Computing, Research, Learning, and Publications. Below this is a secondary navigation bar with links for Charts, Datasets, Quality of our forecasts, About our forecasts, and Access to forecasts. A search bar is present in the top right corner. The main content area features a 'Charts' section with a search bar and a grid of various weather forecast charts, including maps and line graphs. A sidebar on the left contains 'Quick links' such as Chart Browser, Chart Dashboard, and ecCharts. A central filter panel allows users to select the range (Medium (15 days), Extended (42 days), Long (Months)), type (Forecasts, Verification), component (Surface, Atmosphere), and product type (High resolution forecast (HRES), Ensemble forecast (ENS), Combined (ENS + HRES), Extreme forecast index, Point-based products, Experimental: AIFS).

✓ See [Changes on web charts application](#)



# Web services – ecCharts: <http://eccharts.ecmwf.int/>

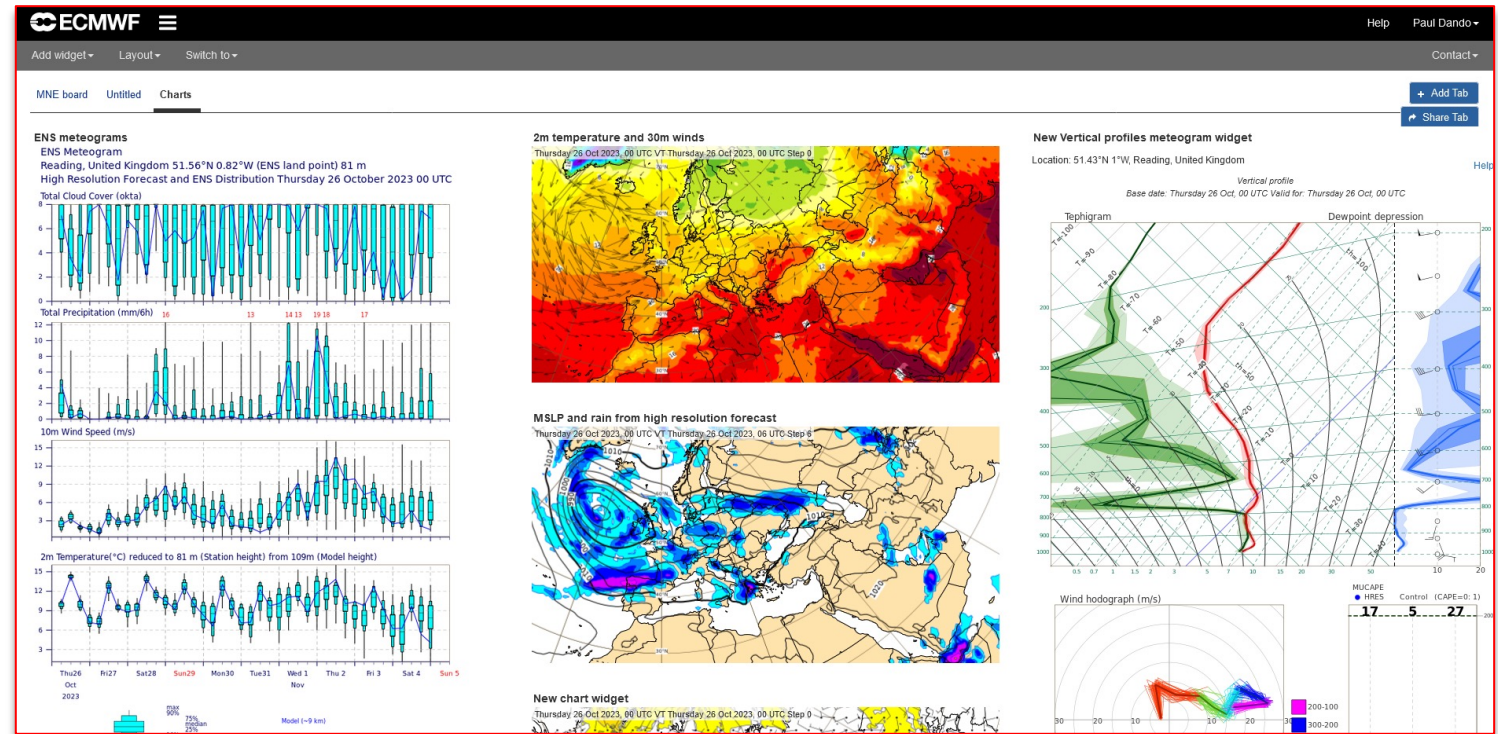
- Highly interactive (products created on-demand)
  - Interactivity (zoom-pan) and animation
  - Layer customisation (e.g. thresholds)
  - Charts with bespoke layers and optional styles
  - HRES, ENS, WAM products
  - Standard and bespoke ENS meteograms
  - Extreme Forecast Indices (EFI)
  - Point probing to explore data
- Highly available and operationally supported (24x7)
- Use of agreed dissemination schedule
- OGC WMS standards for machine-to-machine access



Access requested via your Computing Representative

# Web chart dashboard

- Documentation: <https://confluence.ecmwf.int/display/FCST/Chart+dashboard>
- Place to organise regularly accessed charts
- Shared with the ecCharts dashboard

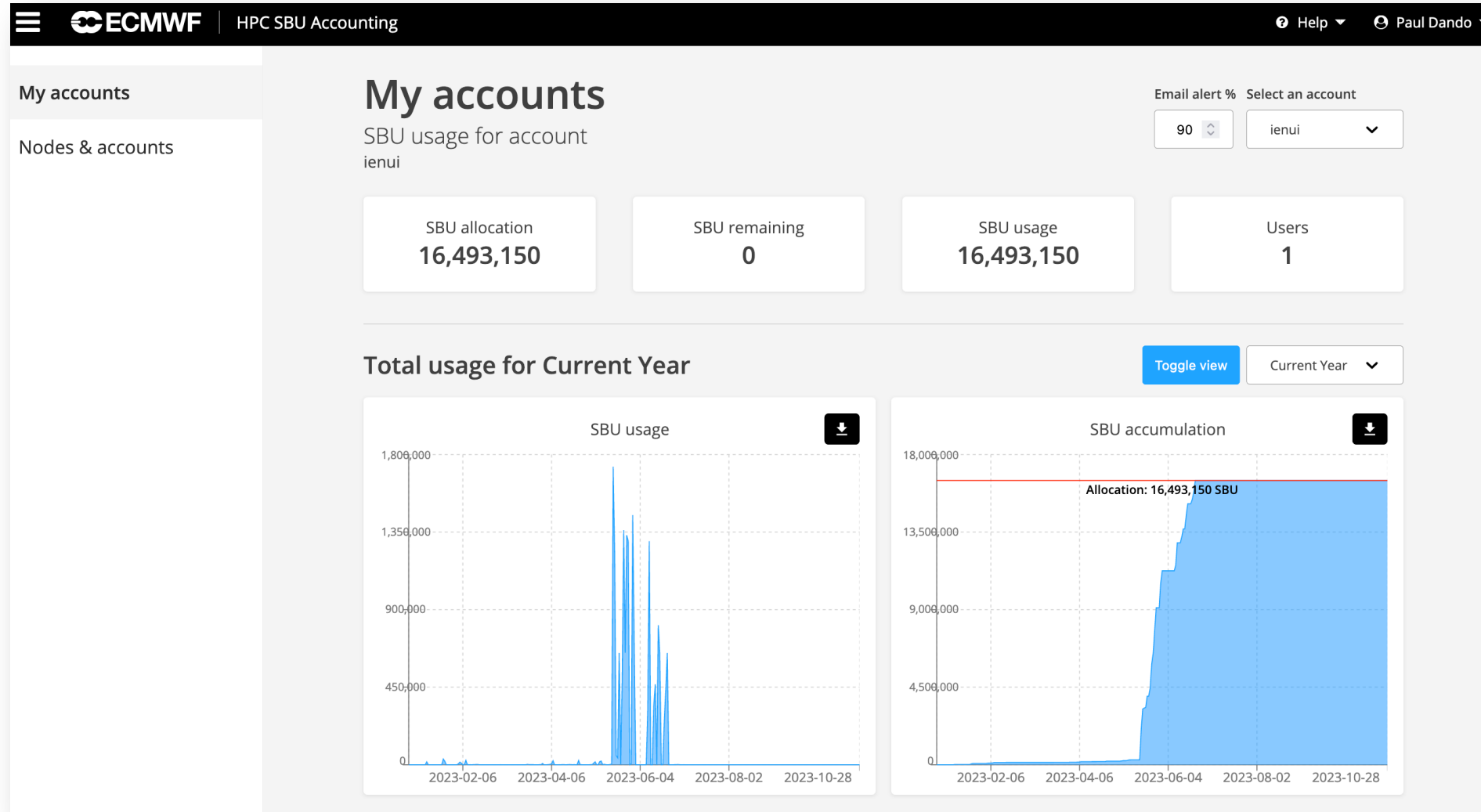


# Web Services – MARS <http://apps.ecmwf.int/services/mars/catalogue/>

- Web based interface to MARS
- Available to registered users only
- Retrievals (GRIB and NetCDF)
- Batch access with WebAPI (Python)
- View current activity
- Access documentation

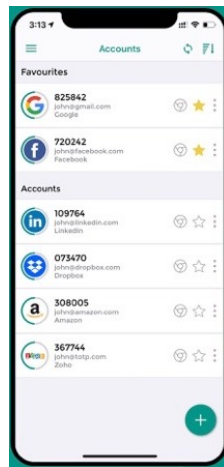
The image displays two overlapping screenshots of the ECMWF website. The background screenshot shows the 'MARS Catalogue' page, which includes a search bar, a list of data classes (Operational data, Operational archive, ECMWF Re-Analyses, Copernicus), and a 'Current activity' section. The foreground screenshot shows the 'Access MARS' page, which provides detailed information about the Web API, including an introduction, a step-by-step guide for installation, and various useful links and FAQs.

# Web services – HPC SBU accounting interface <https://hpc-usage.ecmwf.int/>

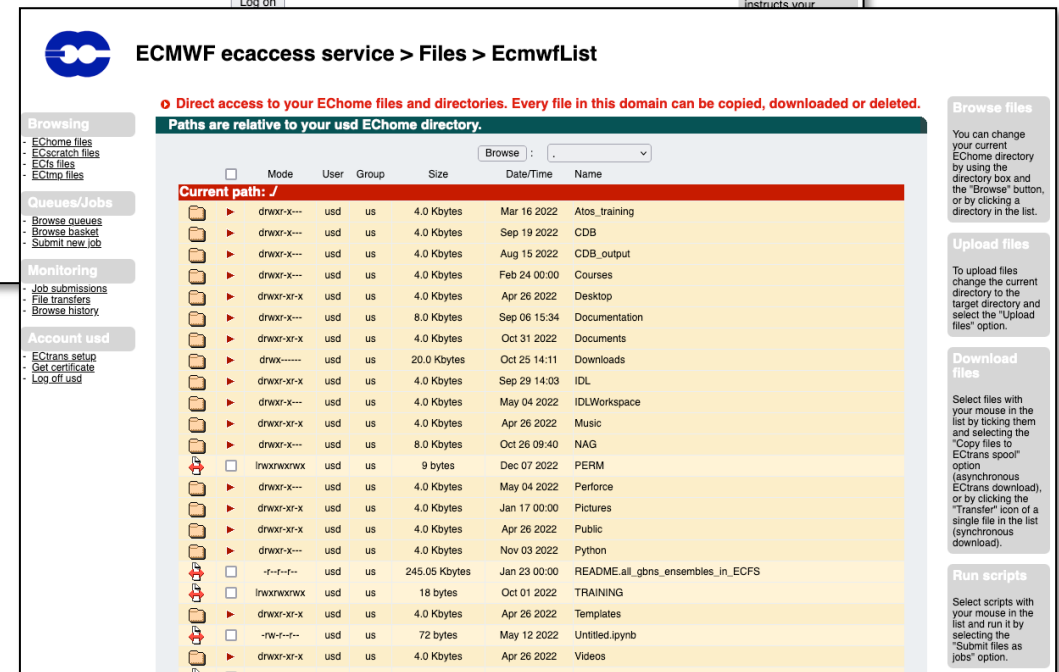
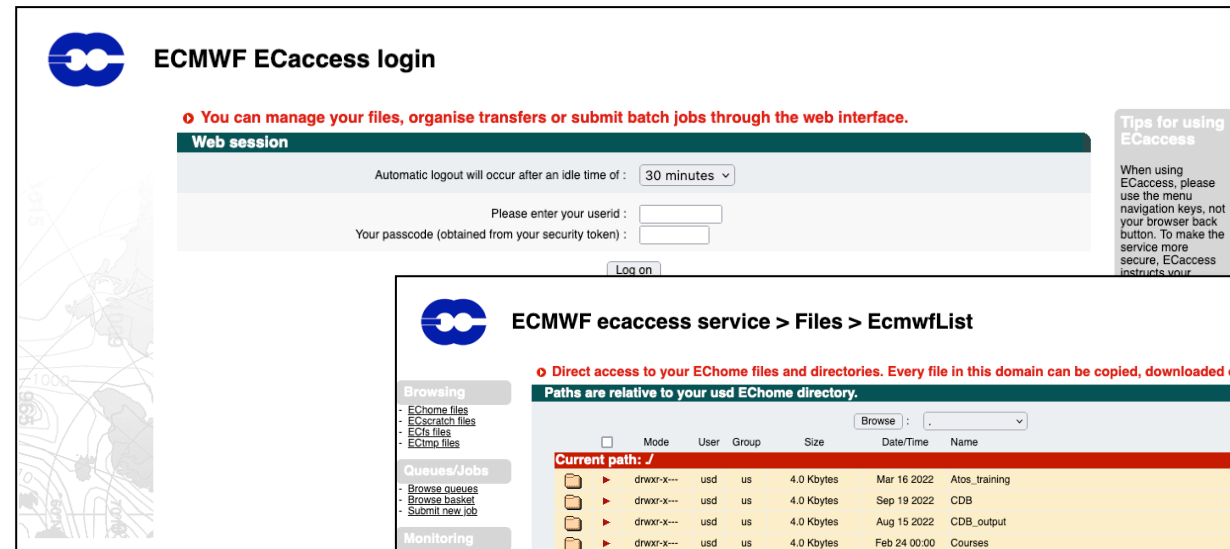


# Web Services – <https://boaccess.ecmwf.int>

- Interface to browsing, transfers, editing, submission of files to ECMWF
- Online help
- TOTP login needed



Only the code from the default TOTP device is accepted !



Mode	User	Group	Size	Date/Time	Name
drwxr-x---	usd	us	4.0 Kbytes	Mar 16 2022	Atos_training
drwxr-x---	usd	us	4.0 Kbytes	Sep 19 2022	CDB
drwxr-x---	usd	us	4.0 Kbytes	Aug 15 2022	CDB_output
drwxr-x---	usd	us	4.0 Kbytes	Feb 24 00:00	Courses
drwxr-xr-x	usd	us	4.0 Kbytes	Apr 26 2022	Desktop
drwxr-x---	usd	us	8.0 Kbytes	Sep 06 15:34	Documentation
drwxr-xr-x	usd	us	4.0 Kbytes	Oct 31 2022	Documents
drwx-----	usd	us	20.0 Kbytes	Oct 25 14:11	Downloads
drwxr-xr-x	usd	us	4.0 Kbytes	Sep 29 14:03	IDL
drwxr-x---	usd	us	4.0 Kbytes	May 04 2022	IDLWorkspace
drwxr-xr-x	usd	us	4.0 Kbytes	Apr 26 2022	Music
drwxr-x---	usd	us	8.0 Kbytes	Oct 26 09:40	NAG
lrwxrwxrwx	usd	us	9 bytes	Dec 07 2022	PERM
drwxr-x---	usd	us	4.0 Kbytes	May 04 2022	Perforce
drwxr-xr-x	usd	us	4.0 Kbytes	Jan 17 00:00	Pictures
drwxr-xr-x	usd	us	4.0 Kbytes	Apr 26 2022	Public
drwxr-x---	usd	us	4.0 Kbytes	Nov 03 2022	Python
-r--r--r--	usd	us	245.05 Kbytes	Jan 23 00:00	README.all_gbns_ensembles_in_ECFS
lrwxrwxrwx	usd	us	18 bytes	Oct 01 2022	TRAINING
drwxr-xr-x	usd	us	4.0 Kbytes	Apr 26 2022	Templates
-w-r--r--	usd	us	72 bytes	May 12 2022	Untitled.ipynb
drwxr-xr-x	usd	us	4.0 Kbytes	Apr 26 2022	Videos

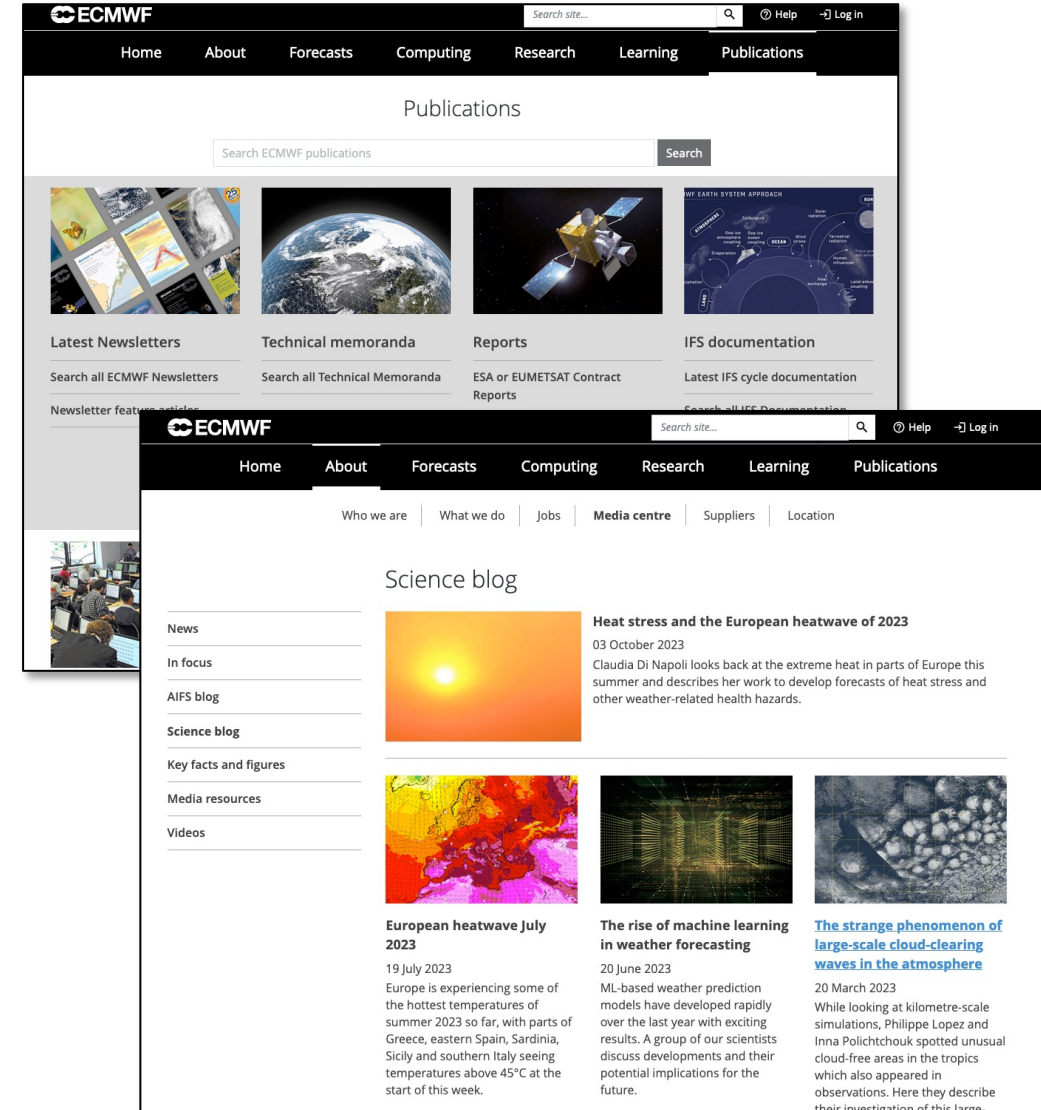
# User Documentation

<https://confluence.ecmwf.int/display/UDOC/User+Documentation>

The screenshot shows the ECMWF User Documentation page. The left sidebar contains a navigation menu with categories like 'Pages', 'Blog', 'SPACE SHORTCUTS', and 'Service status'. A red callout box labeled 'Browse by content' points to this sidebar. The main content area features a 'Welcome!' message and a search bar. A green callout box labeled 'Search' points to the search bar. Below the search bar, there are two columns: 'Browse by content' (highlighted with a red box) and 'Browse by topic' (highlighted with a blue box). The 'Browse by content' column lists various topics such as 'Support portal', 'Teleport SSH Access', and 'Atos HPCF and ECGATE services'. The 'Browse by topic' column lists keywords like 'slurm', 'batch', 'job', 'binding', 'grib', and 'hpc'. To the right, there is a 'Recent news' section with two articles. A blue callout box labeled 'Browse by topic' points to the 'Browse by topic' column.

# Web Services – documents and documentation

- Official documents (restricted access)
  - <https://www.ecmwf.int/en/about/who-we-are/governance>
- ECMWF publications
  - <https://www.ecmwf.int/en/publications>
- Research at ECMWF
  - <https://www.ecmwf.int/en/research>
- Computing Services
  - <https://www.ecmwf.int/en/computing>
- Science Blog
  - <https://www.ecmwf.int/en/about/media-centre/science-blog>
- And much more ...



# Operational Service Status

<https://www.ecmwf.int/en/service-status>

Email sent only when user action is required

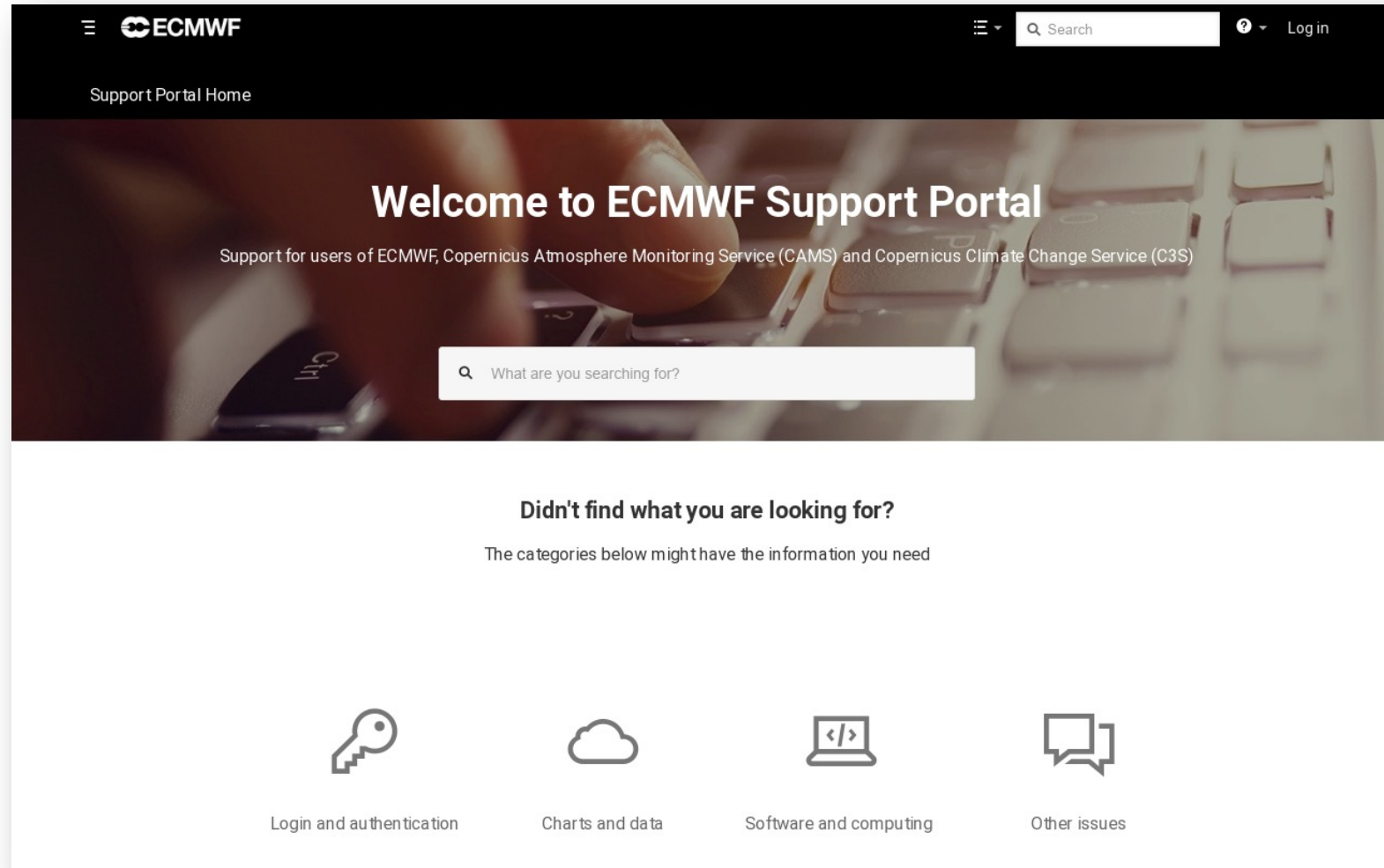
The screenshot shows the ECMWF Service Status page. At the top, there is a navigation bar with links for Home, About, Forecasts, Computing, Research, Learning, and Publications. Below this is a sub-navigation bar with links for Our facilities, Access to computing facilities, Software, and Service status. The main content area is titled 'Service status' and displays a grid of service indicators. Each indicator consists of a colored circle (green for 'OK', orange for 'Warning') followed by the service name. The services listed are: ACQUISITION, ECFS, MARS, TELEPHONY, ATOS, EFAS, MSACCESS, WEB-SERVICES, CADS, EMAIL, prepIFS, CONNECTIVITY, ENVIRONMENT, Product Requirements, DISSEMINATION, European Weather Cloud, RMDCN, ECACCESS, INTERNET, and Support Portal. Below the grid is a 'Notifications' section with a date range selector (Last 24h, Last 7 days, Last 30 days, All) and a search box. A table of notifications is displayed below, with columns for Date created, Service, Notification type, Title, and User action required. The table contains 9 entries, with the last three having a checkmark in the 'User action required' column.

Date created	Service	Notification type	Title	User action required
Thu 26/Oct/2023 13:30:02 UTC	WEB-SERVICES	Start	System Session Starts: eccharts, opencharts, intraplots: Routine update	✓
Thu 26/Oct/2023 12:54:19 UTC	WEB-SERVICES	End	System Session Ends: WebMARS: Redeploy frontend	
Thu 26/Oct/2023 12:30:08 UTC	WEB-SERVICES	Start	System Session Starts: WebMARS: Redeploy frontend	✓
Thu 26/Oct/2023 12:18:51 UTC	ATOS	In Progress	Atos HPCF - filesystem /lus/h2resw01 supporting \$HPCPERM and \$SCRATCH and /ec/fws4	
Thu 26/Oct/2023 10:17:46 UTC	ATOS	Start	\$SCRATCH/\$HPCPERM hanging on Atos HPCF	
Thu 26/Oct/2023 08:00:01 UTC	ECFS, MARS	Start	System Session Starts: Spectralib05 -Control path reconfiguration	✓
Thu 26/Oct/2023 00:21:10 UTC	RMDCN	End	RMDCN Acquisition and Dissemination service back to normal.	
Thu 26/Oct/2023 00:20:05 UTC	CONNECTIVITY	End	Instabilities on the RMDCN network resolved.	



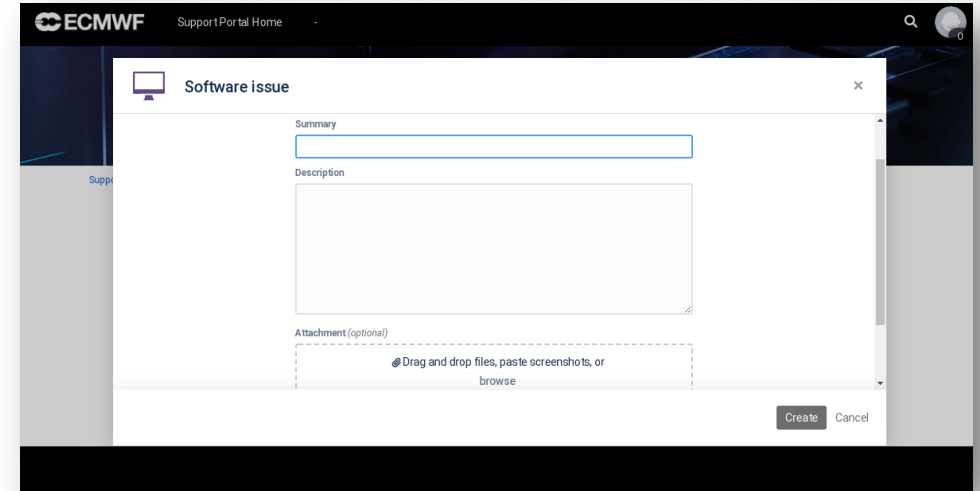
# Getting help and reporting problems

<https://support.ecmwf.int/>



# How to provide a good problem report

- Tell us which system you are using
- For problems with software, provide the version used
- Provide a good description of the problem
  - Actual Results: What happened when you got the bug?
  - Expected Results: What was supposed to happen?
  - The exact error message printed
- Provide a small example with data that shows how to reproduce the problem if possible
- For MARS issues, provide your retrieval request and all output

A screenshot of the ECMWF Support Portal interface. The page title is 'Software issue'. It features a 'Summary' field (a single-line text input), a 'Description' field (a large multi-line text area), and an 'Attachment (optional)' section with a dashed border and the text 'Drag and drop files, paste screenshots, or browse'. At the bottom right, there are 'Create' and 'Cancel' buttons. The background shows the 'Support Portal Home' header and a search icon.

**The better the problem report, the faster it will get fixed!**

# Questions ?



# Virtual tour of Data Centre



# The ECMWF Data Centre in Bologna



- Located in the Tecnopolo di Bologna
  - a former tobacco factory
  - designed by Pier Luigi Nervi
  - built in 1949 and closed in 1998

# How it looked in 2018



# How it looked in 2021



# How it looks in 2023





# Bologna Data Centre layout

