



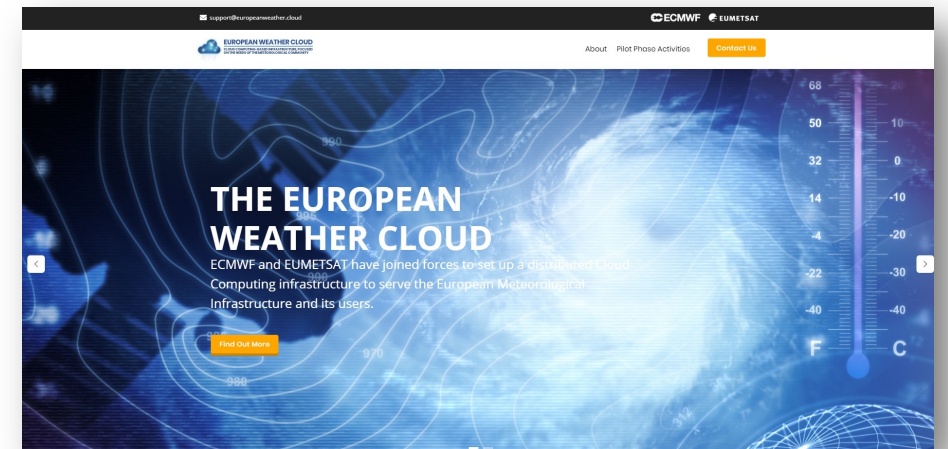
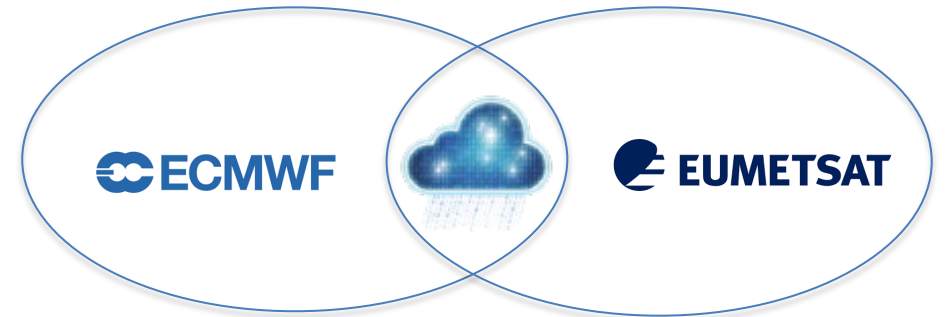
European Weather Cloud - Introduction

Online Computing Training Week
3 November 2023

Roberto Cuccu (ECMWF)

European Weather Cloud

- Pilot project started 2019 by ECMWF and EUMETSAT
- ECMWF new operational infrastructure in ECMWF Bologna Data Centre
- EUMETSAT running on public cloud infrastructure
- **Start of Operations on 26 September 2023**



www.europeanweather.cloud

Who is it for?

Member and Cooperating States

Research & Development

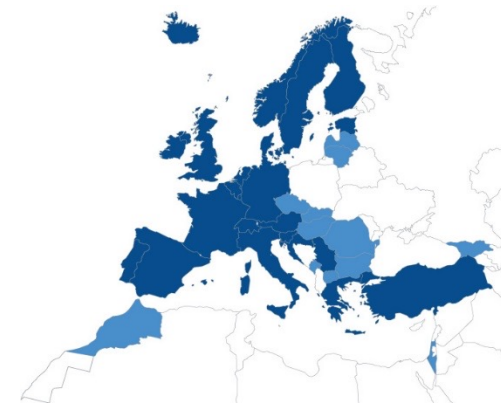
ECMWF Special Projects
EUMETSAT annual R&D calls

EMI Partners (e.g. EUMETNET)

Internal use at ECMWF and EUMETSAT

Member and Cooperating States usage authorized by Computing Representatives

- Access requests via Computing Representatives or EWC support



ECMWF

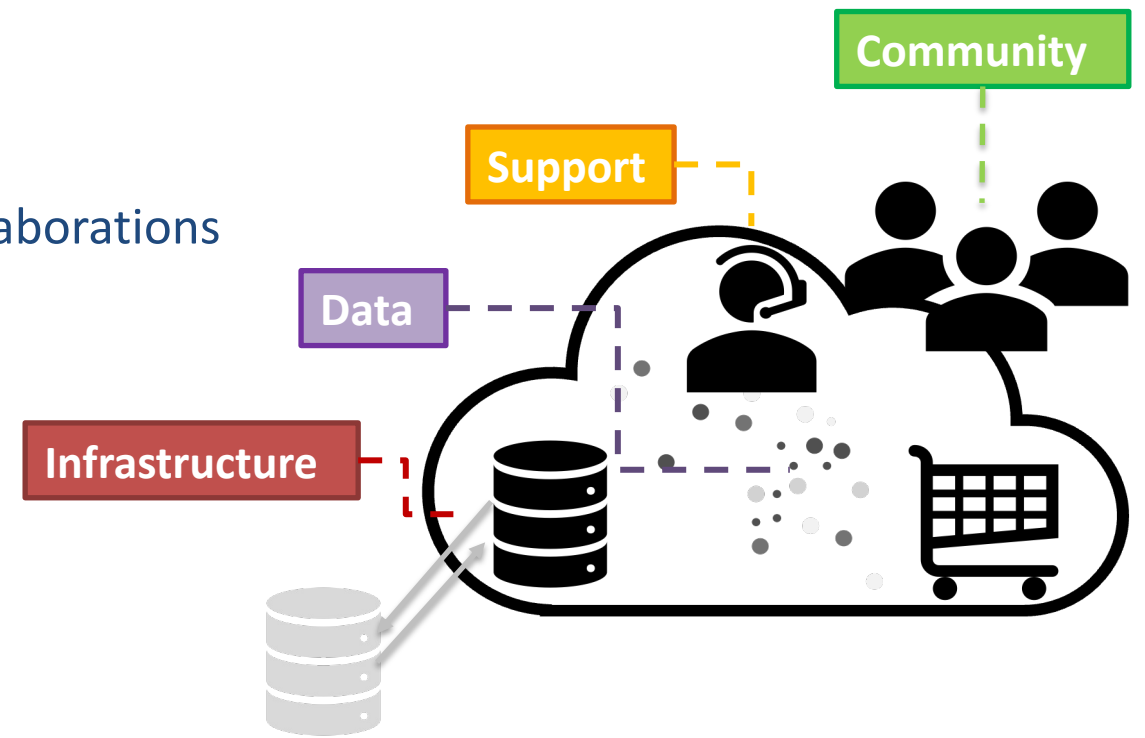


EUMETSAT

EWC provides compute capacity and access to ECMWF and EUMETSAT data holdings, additional external data sets and allows users to easily share their own data with others.

Benefits to the users

- Online access to the cloud computing resources
- Flexibility in provisioning, managing and deleting resources on-demand
- Data availability and data locality for processing
- Community : knowledge, applications, synergies, collaborations



Cloud Service Description

The service consists of cloud computing resources provided by ECMWF and EUMETSAT and controlled by cloud management software Morpheus.



Virtual Environments



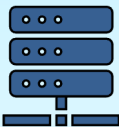
Isolated cloud tenancy



Virtual Machines



Block and Object Storage



Virtual Networking

.....

Resources Management



Blueprints and Instance types



Automation tools



Monitoring and Reporting



Metering and Accounting Service

.....

Support and Collaboration



Support Portal



Knowledge Base
Documentation



Discussion Platform

.....

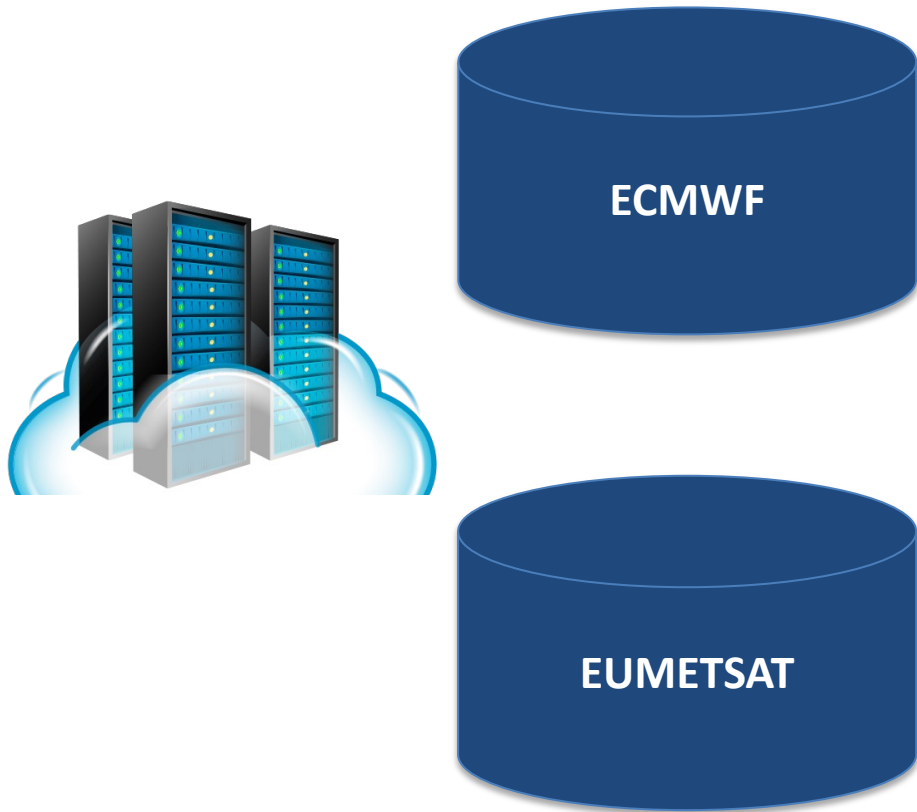


EUROPEAN WEATHER CLOUD
CLOUD COMPUTING-BASED INFRASTRUCTURE, FOCUSED
ON THE NEEDS OF THE METEOROLOGICAL COMMUNITY



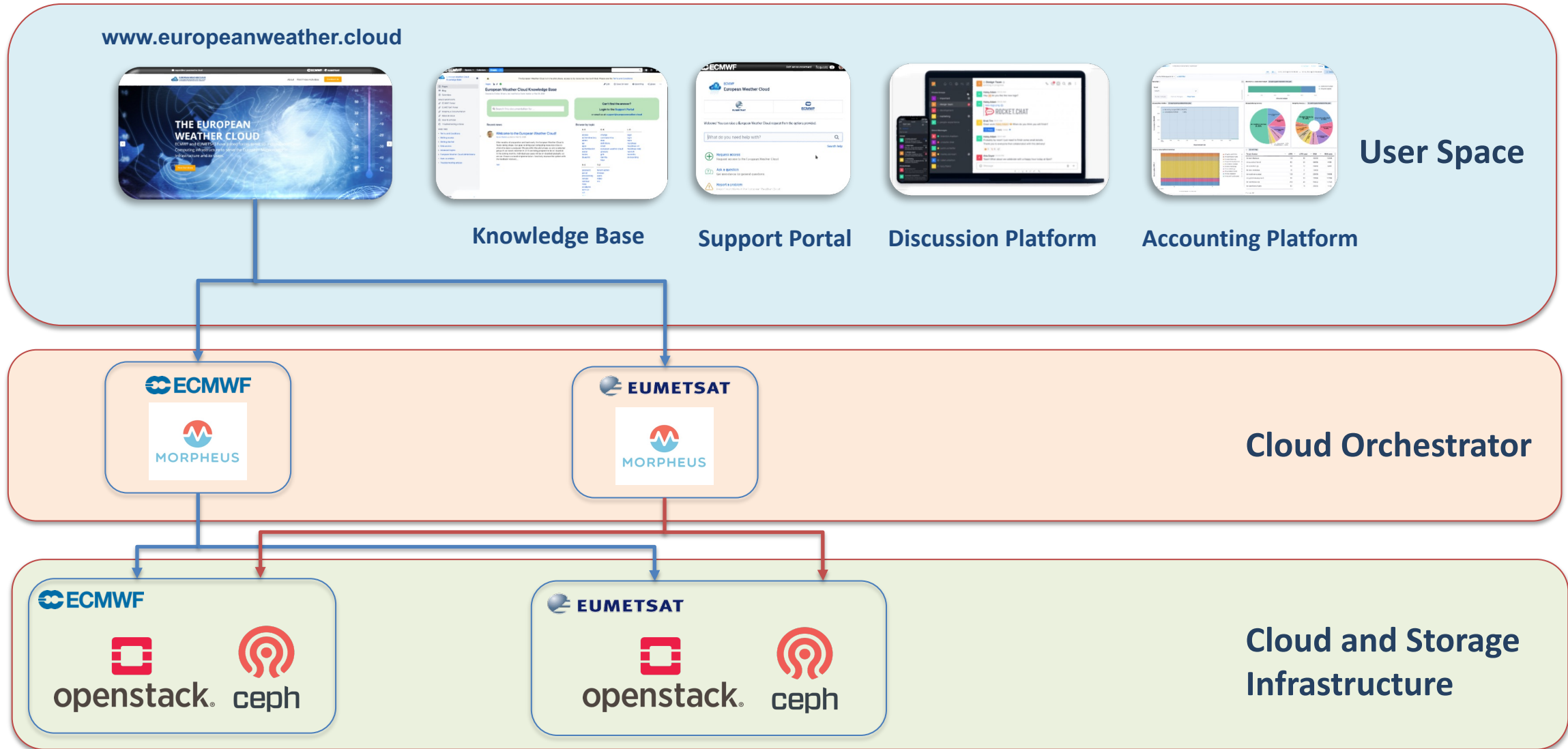
Data Access from EWC

Combined set of “pull” and “push” data access services:



- Meteorological Archival and Retrieval System (MARS)
 - ❖ ECMWF Petabytes-scale data archive providing APIs for data discovery and retrieval
- ECMWF Production Data Store (ECPDS)
 - ❖ Data dissemination service for customised data delivery
- Copernicus Climate and Atmospheric Data Stores (CDS/ADS)
 - ❖ Copernicus Climate Change (C3S) and Atmospheric Monitoring (CAM5) services data
- EUMETSAT Data Store & Data Tailor
 - ❖ Access to all EUMETSAT meteorological, climate and ocean data through a suite of APIs, and incorporating data tailoring capability
- EUMETCast Terrestrial
 - ❖ Near-real time data delivery via terrestrial network

High Level Design



ECMWF Operational infrastructure

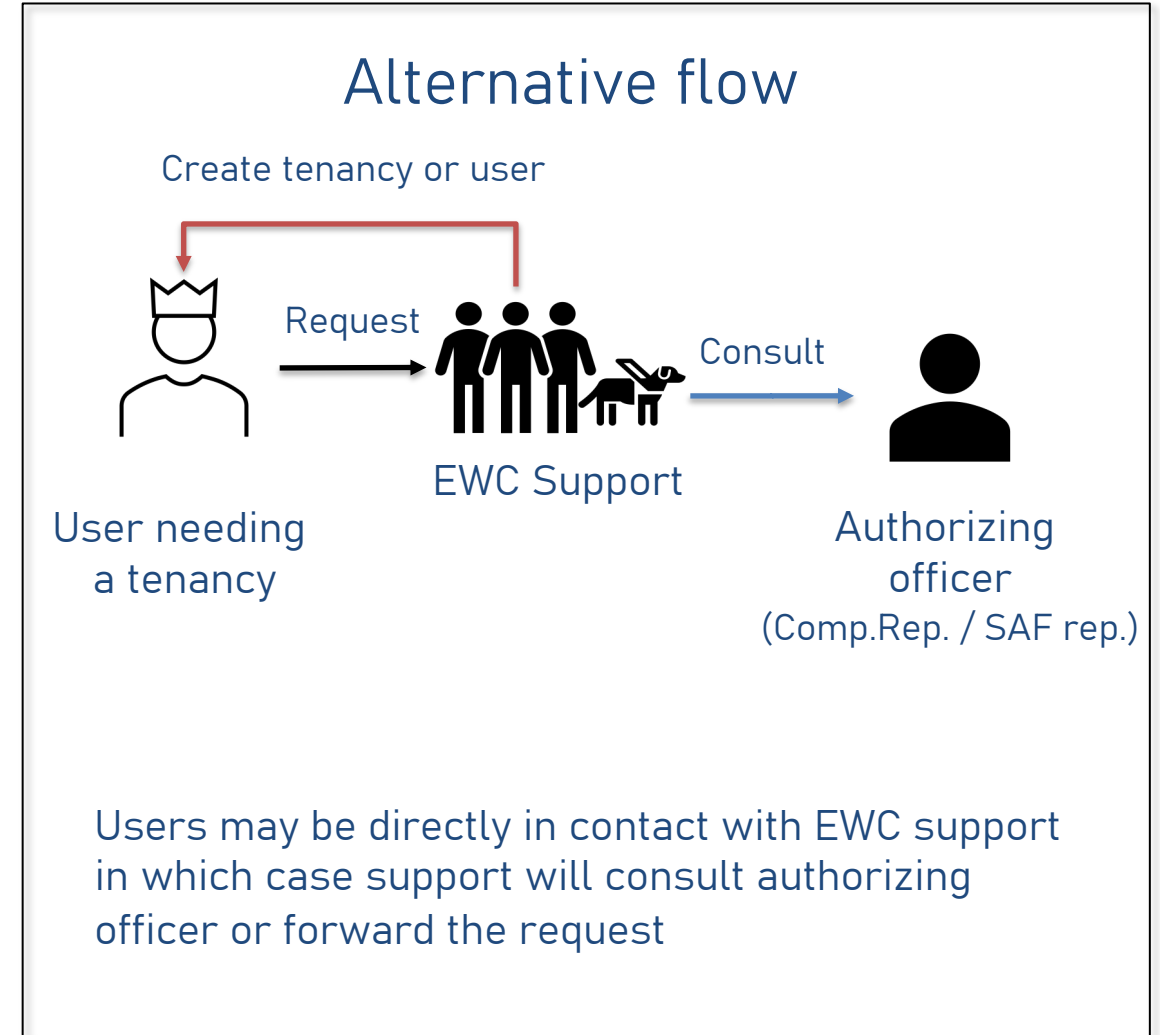
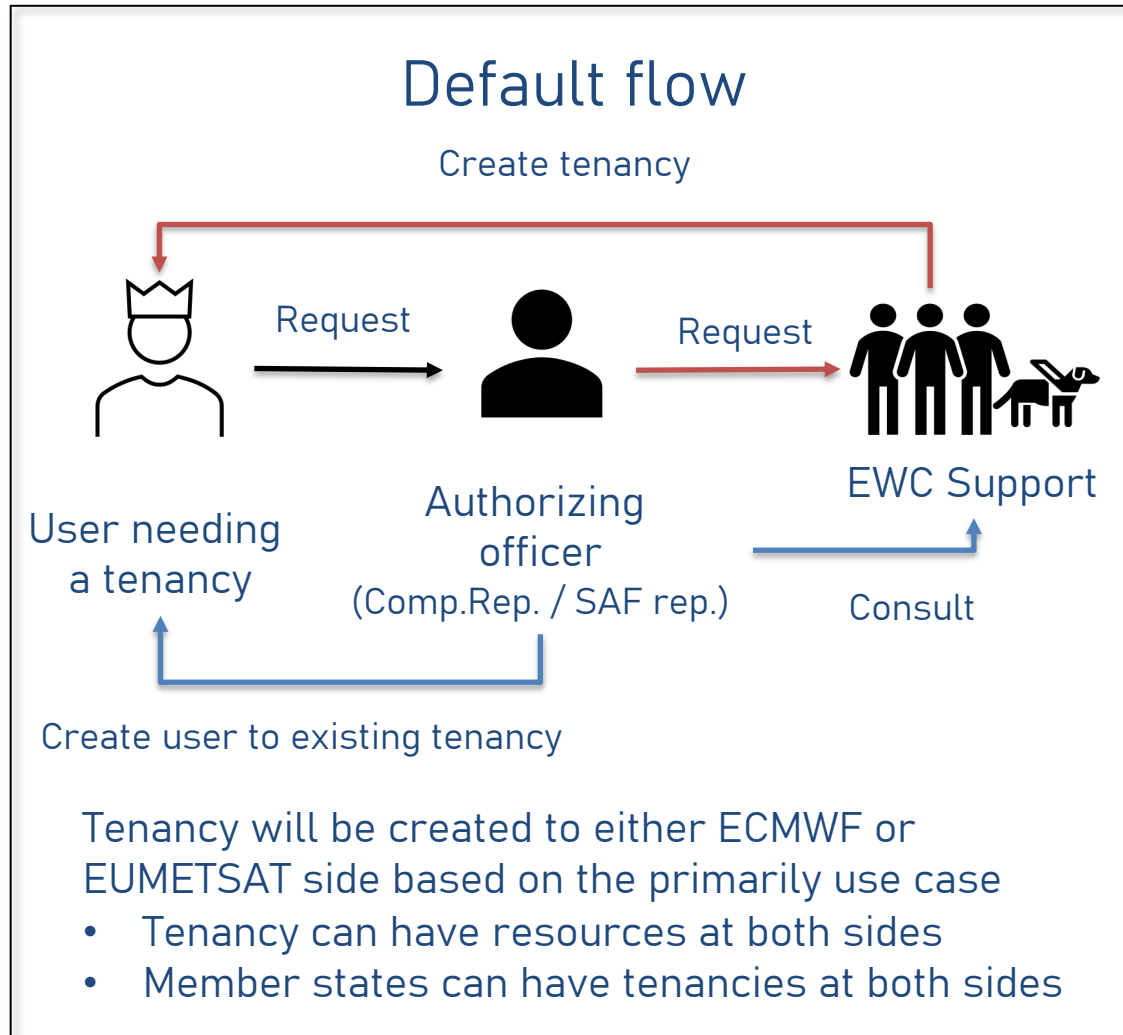
- New Cloud Infrastructure ready in ECMWF's Bologna Home
 - Collocated with other key ECMWF Computing and Data Services
- 2 Production clouds - one on each computer hall
 - Based on Openstack and Ceph

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



- Resources redistributed to the Member and Cooperating States
- Resources allocations managed by the Computing Representative

Getting a tenancy workflow



ECMWF Special Projects and EUMETSAT R&D Call



ECMWF Special Projects can also include EWC resources in their application, closes each year on 30 June

- The scope includes experiments or investigations of a scientific or technical nature, undertaken by one or more Member States, likely to be of interest to the general scientific community
- "Late request" possible after deadline



Annual **EUMETSAT Research & Development call** closes each year on 30 June

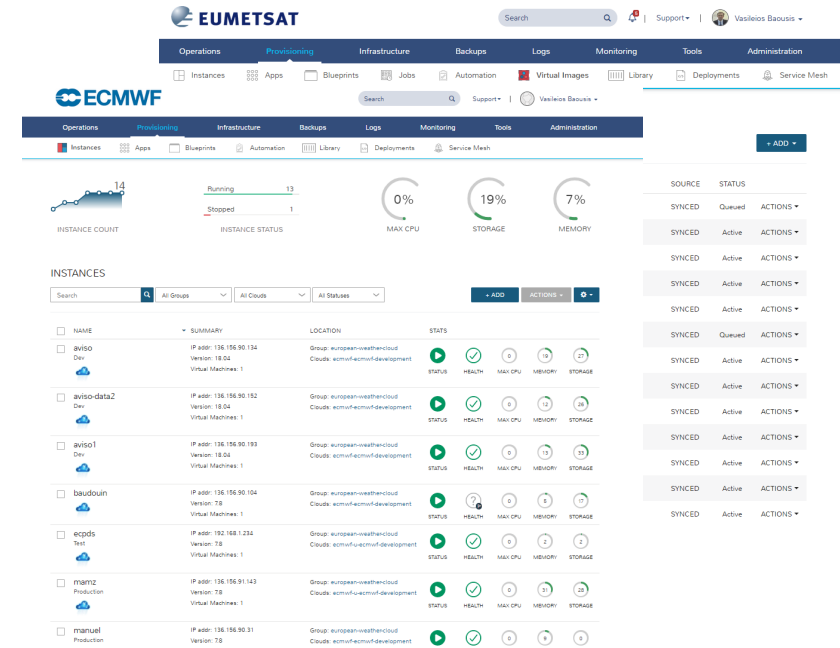
- Objectives on improving, development and using products in applications and using the cloud infrastructure
- Fast-track projects available anytime of the year for small projects

EWC Access – Morpheus Platform

Morpheus: the cloud management platform capable of orchestrating many clouds. Each member of the federation offers a Morpheus instance, to access the federated cloud infrastructures.

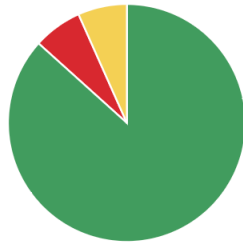
Tenants: each project with access to the European Weather Cloud is called a Tenant.

Clouds: Every partner in the European Weather Cloud Federation makes available their infrastructure to the users. Each one of them is seen as a Cloud in Morpheus.



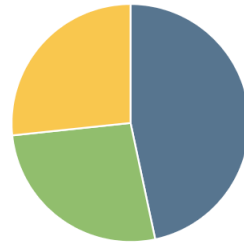
INSTANCE STATUS

15
instances



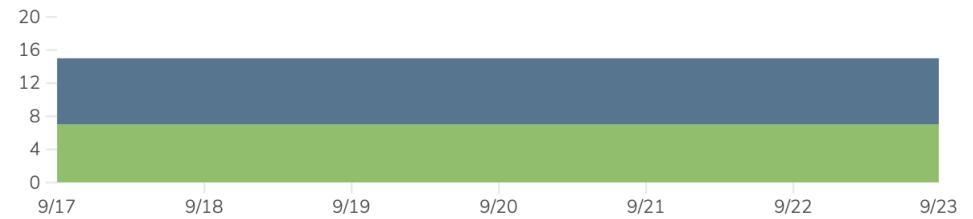
INSTANCES BY CLOUD

3
clouds

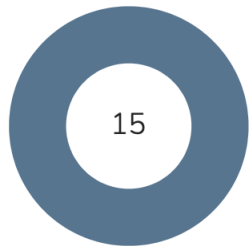


DAILY CLOUD INSTANCES

Week | Month

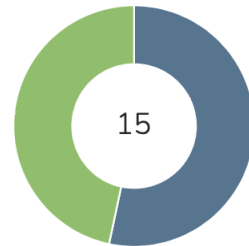


GROUP WORKLOADS



■ european-weather-cloud

CLOUD WORKLOADS

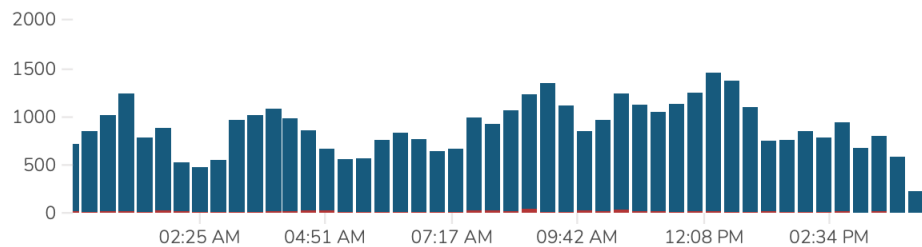


■ ecmwf-cci1-ms-nmhs-sandbo...
■ ecmwf-ms-nmhs-sandbox

CLUSTER WORKLOADS

NO DATA

LOG HISTORY



LOG TRENDS

All | Errors | Warnings


Received disconnect from port Bye Bye preauth
pod_workers.go Error syncing pod skipping err failed to StartContainer for openstack-...
I0923 scope.go RemoveContainer containerID
Disconnected from authenticating user root port preauth
I0922 scope.go RemoveContainer containerID

Virtual Machines provisioning

Provisioning-> Instances -> +ADD

The screenshot displays the ECMWF cloud management interface. At the top left is the ECMWF logo. A search bar and user profile (Demo User) are on the top right. A navigation bar includes: Operations, Provisioning (active), Library, Infrastructure, Backups, Monitoring, Tools, and Administration. Below this, a sub-menu shows 'Instances' (selected) and 'Apps'. The main dashboard features a line chart for 'INSTANCE COUNT' showing a value of 1. To the right, 'INSTANCE STATUS' shows 1 Running and 0 Stopped instances. Three circular progress indicators show resource usage: MAX CPU at 0%, STORAGE at 4%, and MEMORY at 10%. Below the dashboard is the 'INSTANCES' section with a search bar, filters for 'All Groups', 'All Clouds', and 'All Statuses', and a '+ ADD' button highlighted with a red box. At the bottom, a table header is visible with columns: NAME, SUMMARY, LOCATION, and STATS.

Virtual Machines provisioning



Operations Provisioning Library Infrastructure Backups

Instances Instances Apps

1

Running 1

Stopped 0

INSTANCE COUNT

INSTANCE STATUS

MAX CP

INSTANCES

Search All Groups All Clouds All Statuses

+ ADD ACTIONS

NAME	SUMMARY	LOCATION	STATS
------	---------	----------	-------

Instance Type selection

CREATE INSTANCE

GROUP CONFIGURE AUTOMATION REVIEW

Search

TECHNOLOGY

ROCKY
Rocky Linux is an open-source enterprise operating system designed to be compatible with Red Hat Enterprise Linux. It is under intensive development by the community. <https://rockylinux.org>

UBUNTU
Ubuntu is an open source software operating system that runs from the desktop, to the cloud, to all your internet connected things. <https://ubuntu.com/>

+ ADD ACTIONS

Virtual Machines provisioning

CREATE INSTANCE

AUTOMATION REVIEW

Configuration Options

VERSION

LAYOUT

PLAN
Cores: 4 Memory: 4 GB

RESOURCE POOL

VOLUMES +

NETWORKS DHCP +

AVAILABILITY ZONE

SECURITY GROUP

SERVER GROUP (AFFINITY)

FLOATING IP

▶ User Config

▶ Advanced Options

PREVIOUS NEXT

Instance configuration options:

- **Version** - linked to OS version: Rocky Linux 8.x ,9.x and Ubuntu 22.04
- **Layout** – instance configuration flavours :
 - <instance type>-<version>-**data** (pre-installed sw included)
 - <instance type>-<version>-**generic** (plain OS)
 - <instance type>-<version>-**gpu** (GPU drivers included)
- **Plan** – resources configuration : CPU, RAM and local Disk:
 - E.g. : 4cpu-4gbmem-30gbdisk => 4 CPU + 4GB RAM + 30GB disk
- **Volumes** – disks attached to the VM (local and extra disks)
- **Networks**
 - external-internet (public IP)
 - private-<tenancy name> (private network within the tenancy)
- **Security Group** – IP filter rules which define networking access
 - ssh
 - ssh-https
- **Floating IP** (public IP - alternative option to external-internet network!)

Virtual Machines provisioning

The screenshot displays the ECMWF cloud management interface. At the top left is the ECMWF logo. To its right is a search bar and a user profile for 'Training User'. Below this is a navigation bar with tabs for Operations, Provisioning (selected), Library, Infrastructure, Backups, Monitoring, and Tools. Under Provisioning, there are sub-tabs for Instances, Apps, and Code. The main content area shows the path 'Instances > traininguser-vm'. The VM 'traininguser-vm' is shown with a status of 'Running', environment 'Test', type 'Rocky', and plan '4cpu-4gbmem-30gbdisk'. A 'training' tag is attached to the VM. Below the VM details are seven performance metrics: Health (green checkmark), Last Backup (minus sign), Availability (100.000%), Response Time (N/A), Max CPU (0%), Memory (18%), and Storage (17%).

Operations Provisioning Library Infrastructure Backups Monitoring Tools

Instances Apps Code

Instances > traininguser-vm

traininguser-vm ★ EDIT ACTIONS DELETE

Running Env: Test Type: Rocky Plan: 4cpu-4gbmem-30gbdisk

training

HEALTH	LAST BACKUP	AVAILABILITY	RESPONSE TIME	MAX CPU	MEMORY	STORAGE
✓	—	100.000%	N/A	0%	18%	17%

S3 Object Storage

- Object storage is a computer data storage architecture designed to handle large amounts of unstructured data
- Data is stored as **objects** within resources called **buckets**
- **Benefits:** high scalability, flat structure, resilience, access protocol
- Supported access via the **S3 RESTful API** is compatible with the basic data access model of the Amazon Simple Storage Service (S3) which runs over HTTPS

<https://confluence.ecmwf.int/x/HINyEw>

S3 Object Storage - Access

Morpheus GUI

STORAGE

Buckets File Shares Volumes Data Stores Servers

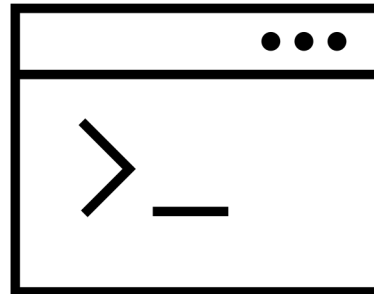
BUCKETS

Search

NAME	PROVIDER TYPE	BUCKET NAME
bucket_post	S3	postupdate
cci1-os	S3	vmbackup
Cloudy Bucket	S3	cloudybucket
Demo	S3	demo

Command Line Tools

- s3cmd
- rclone
- awscli

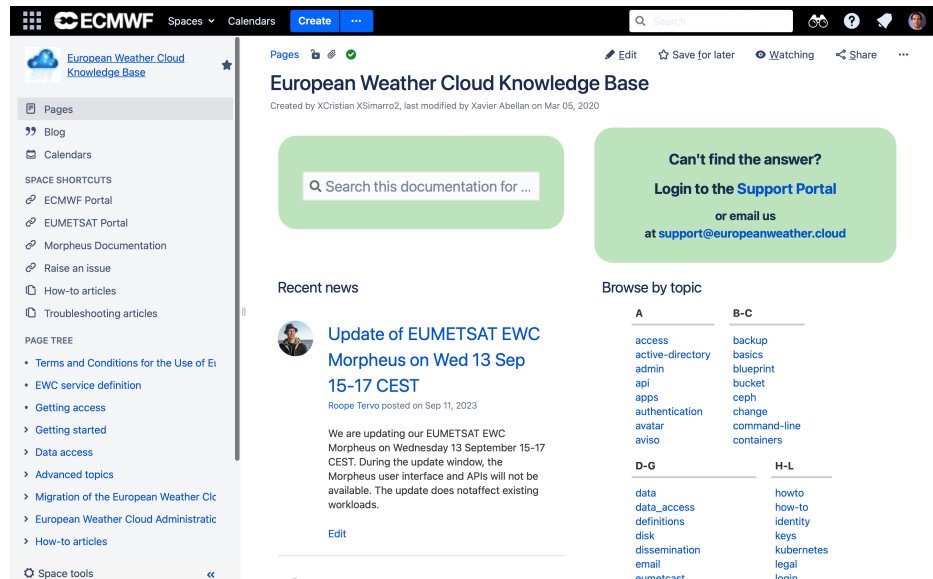


Python Libraries (boto3)



```
# Initialize the S3 client
s3 = boto3.client(
    's3',
    endpoint_url=S3_ENDPOINT_URL,
    config=Config(
        signature_version=UNSIGNED
    ))
```

Knowledge Base



The screenshot shows the Confluence interface for the European Weather Cloud Knowledge Base. The page title is "European Weather Cloud Knowledge Base", created by XChristian XSimarro2 and last modified by Xavier Abellan on Mar 05, 2020. A search bar is present with the text "Search this documentation for ...". A green callout box asks "Can't find the answer? Login to the Support Portal or email us at support@europeanweather.cloud". Below this, there is a "Recent news" section with a post titled "Update of EUMETSAT EWC Morpheus on Wed 13 Sep 15-17 CEST" by Roope Tervo, dated Sep 11, 2023. The post content states: "We are updating our EUMETSAT EWC Morpheus on Wednesday 13 September 15-17 CEST. During the update window, the Morpheus user interface and APIs will not be available. The update does not affect existing workloads." Below the post is an "Edit" link. To the right, there is a "Browse by topic" section with a grid of topics: A (access, active-directory, admin, api, apps, authentication, avatar, aviso), B-C (backup, basics, blueprint, bucket, ceph, change, command-line, containers), D-G (data, data_access, definitions, disk, dissemination, email, eumetcast), and H-L (howto, how-to, identity, keys, kubernetes, legal, login).

<https://confluence.ecmwf.int/x/6J83Cg>



KB Content



- Terms and Conditions
- Getting access
- Getting started
- Data access
- Advanced topics
- How-to articles
- Troubleshooting articles
- Discussion platform



Blog Posts

Support Portal

The screenshot shows the ECMWF user interface. At the top, there is a navigation bar with the ECMWF logo and a search bar. Below the navigation bar, there are several menu items: Dashboard, Reports, Costing, Approvals, and Administration. A dropdown menu is open, showing options: KNOWLEDGE BASE - EUROPEAN WEATHER CLOUD, SUPPORT PORTAL - EUROPEAN WEATHER CLOUD (highlighted with a red box), and ECMWF SERVICE STATUS. A red arrow points from the highlighted option to the right, towards the support portal page.

The screenshot shows the ECMWF European Weather Cloud support portal. At the top, there is the ECMWF logo and the text "European Weather Cloud". Below this, there are two logos: EUMETSAT and ECMWF. A welcome message reads: "Welcome! You can raise a European Weather Cloud request from the options provided." Below the welcome message, there is a search bar with the text "What do you need help with?". To the right of the search bar is a magnifying glass icon and the text "Search help". Below the search bar, there are three categories of help topics:

- General question**: Get assistance for general questions.
- Request access**: Request access to the European Weather Cloud.
- Report a problem**: Report a problem in the European Weather Cloud.

<https://jira.ecmwf.int/servicedesk/customer/portal/9>



EWC Accounting

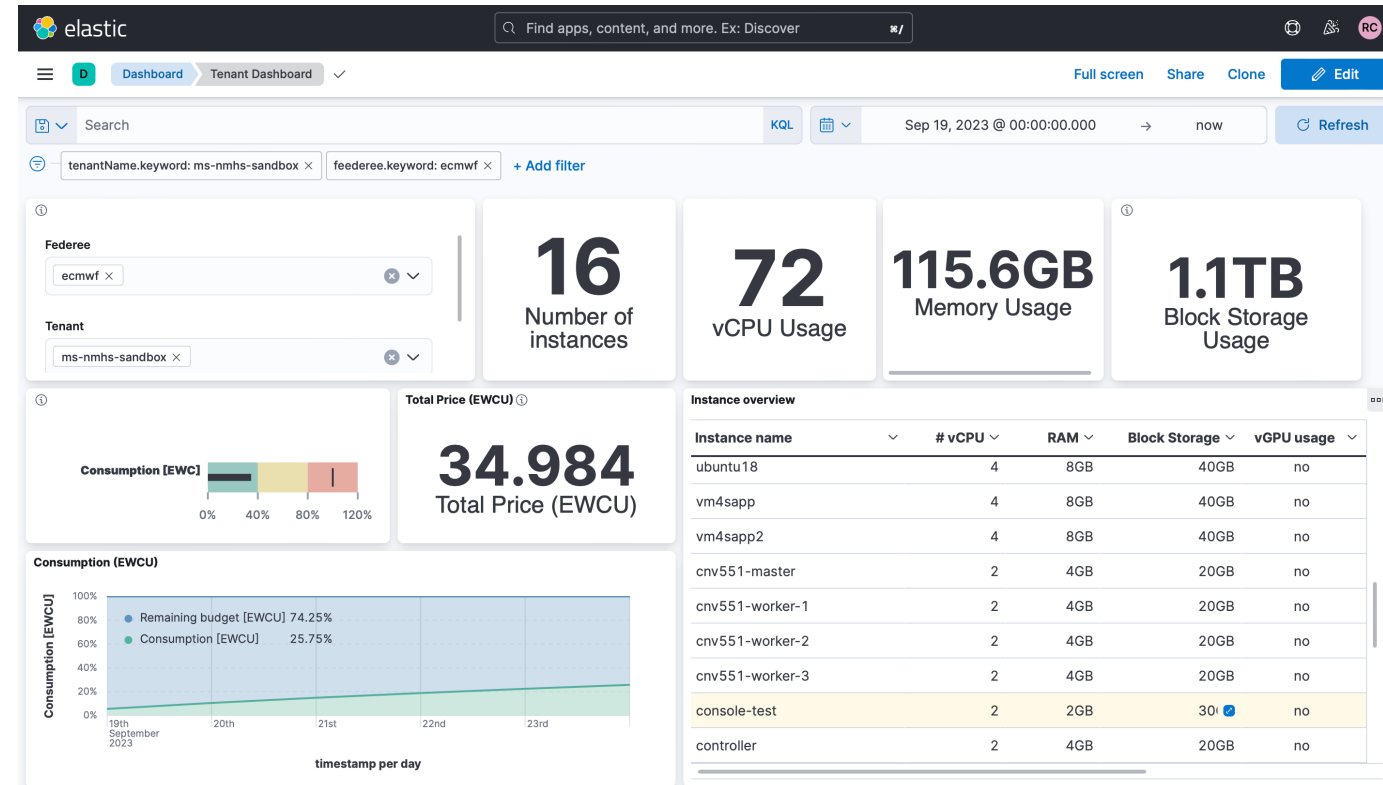
The **Accounting service** provides a cross-cloud overview of resource usage of the tenancies.

A web GUI provides metrics, time series, graphs, and dashboards displaying the accounting information.

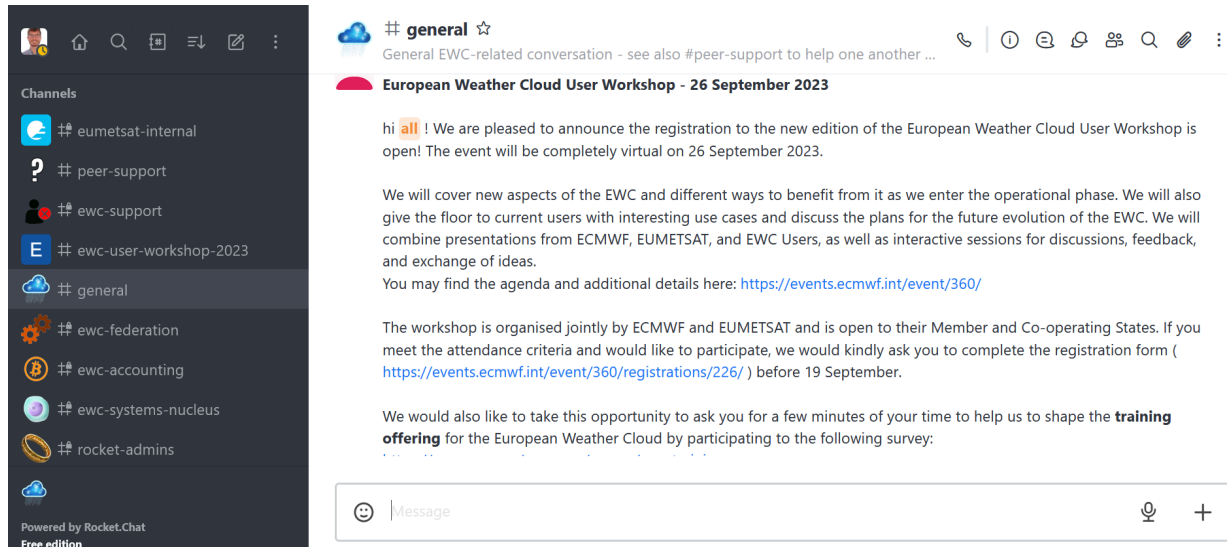
Accounted resources include:

- Virtual Machines
 - vCPU
 - Memory
 - Local Disks
- Object Storage (S3)
- vGPU usage

A **cloud billing unit** is adopted as virtual currency for the accounting of the consumed cloud resources.

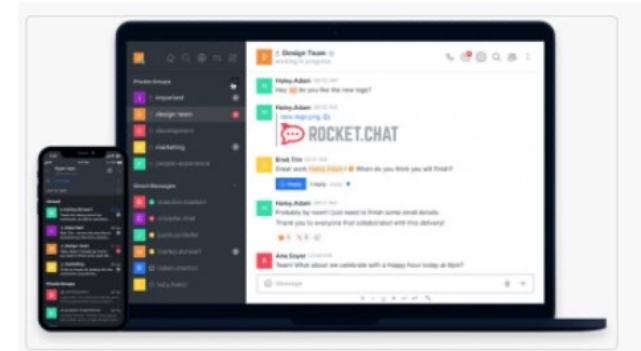


EWC Discussion Platform: Rocketchat



Installation

- Web based
- Desktop App
- Mobile



How do I join?

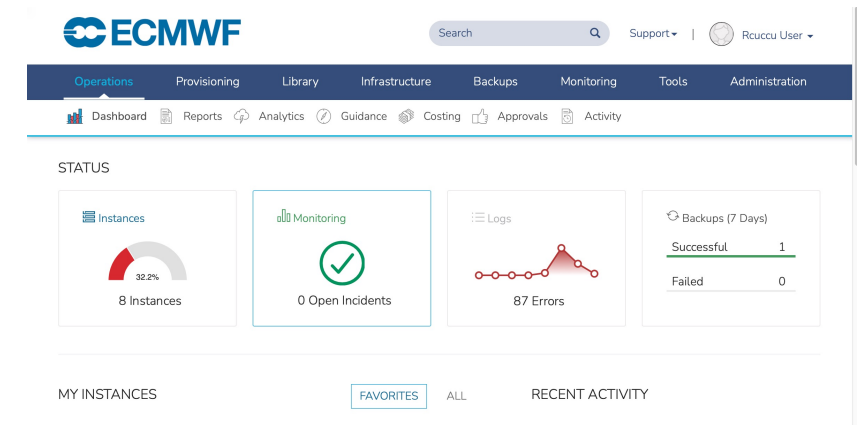
Member and Cooperating States users can self-register (based on email domain):

<https://chat.europeanweather.cloud>

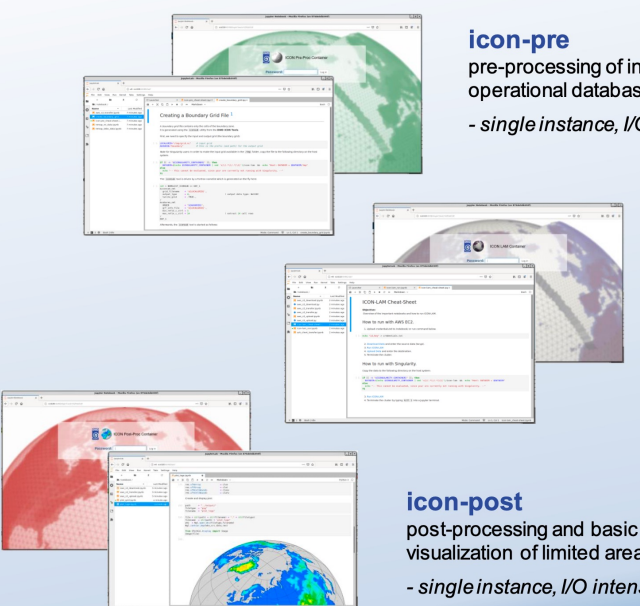
External users can't self-register but can be invited. They need to be accepted by admins.

Usage context examples

- ❖ Pre-operational / Operational usage
- ❖ Backup infrastructure
- ❖ Cloud “bursting” / elasticity
- ❖ Application development and testing support
- ❖ Systems architecture setup / testing
- ❖ Research / scientific activities
- ❖ Training activities
- ❖ Collaboration environments



Training

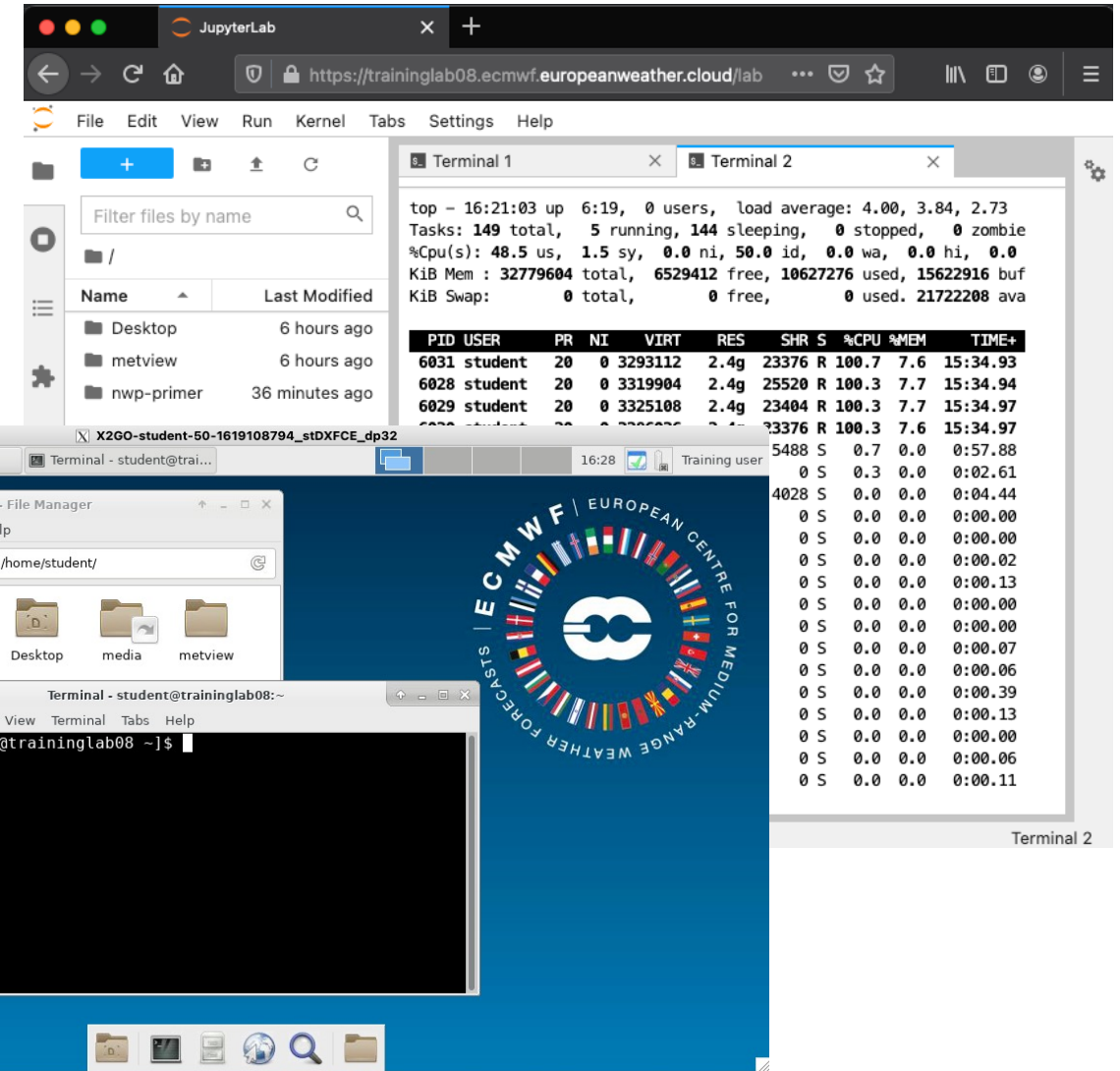


icon-pre
pre-processing of input data from DWD's operational database and other sources.
- *single instance, I/O intensive*

icon-lam
self-contained, MPI-parallel executable of the ICON limited area model. Ready-to-use for small and medium size setups.
- "virtual cluster" of multiple instances, CPU+network intensive

icon-post
post-processing and basic visualization of limited area ICON runs.
- *single instance, I/O intensive*

- ICON Lab by DWD
- ECMWF NWP Training labs
- EUMETSAT Training infrastructure



JupyterLab interface showing a file manager and a terminal window. The terminal displays system statistics:

```
top - 16:21:03 up 6:19, 0 users, load average: 4.00, 3.84, 2.73
Tasks: 149 total, 5 running, 144 sleeping, 0 stopped, 0 zombie
%Cpu(s): 48.5 us, 1.5 sy, 0.0 ni, 50.0 id, 0.0 wa, 0.0 hi, 0.0
KiB Mem : 32779604 total, 6529412 free, 10627276 used, 15622916 buf
KiB Swap: 0 total, 0 free, 0 used, 21722208 ava
```

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+
6031	student	20	0	3293112	2.4g	23376	R	100.7	7.6	15:34.93
6028	student	20	0	3319904	2.4g	25520	R	100.3	7.7	15:34.94
6029	student	20	0	3325108	2.4g	23404	R	100.3	7.7	15:34.97
6030	student	20	0	3325108	2.4g	23376	R	100.3	7.6	15:34.97
5488	S	0	7	0.0	0.0	0.0	S	0.7	0.0	0:57.88
0	S	0	3	0.0	0.0	0.0	S	0.3	0.0	0:02.61
4028	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:04.44
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.00
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.00
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.02
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.13
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.00
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.00
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.07
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.06
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.39
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.13
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.00
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.06
0	S	0	0	0.0	0.0	0.0	S	0.0	0.0	0:00.11

Artificial Intelligence / Machine Learning



- Oxford University & ECMWF collaboration
- ECMWF S2S AI/ML competition
- ESoWC/Code4Earth projects
- Exploratory activities by AEMET and DWD
- DWD Nowcasting with machine learning
- Italy post-processing with machine learning
- FUSEDCAST nowcasting using MTG/GOES data



Keras



PyTorch



EUROPEAN WEATHER CLOUD
CLOUD COMPUTING-BASED INFRASTRUCTURE, FOCUSED
ON THE NEEDS OF THE METEOROLOGICAL COMMUNITY



Data proximate computing in EWC with Dask

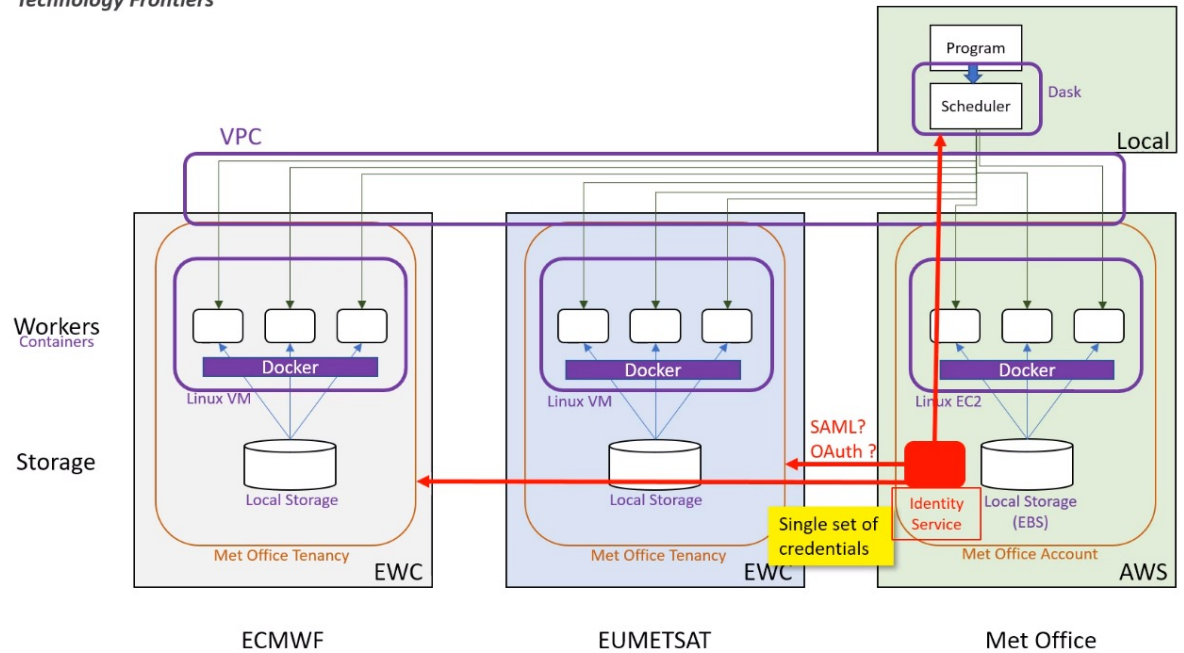


Image: Met Office

For more information:

<https://blog.dask.org/2022/07/19/dask-multi-cloud>

```
with in_org('metoffice'):
    dataset =
xarray.open_dataset('metoffice.nc').c
hunk({"latitude": 10})

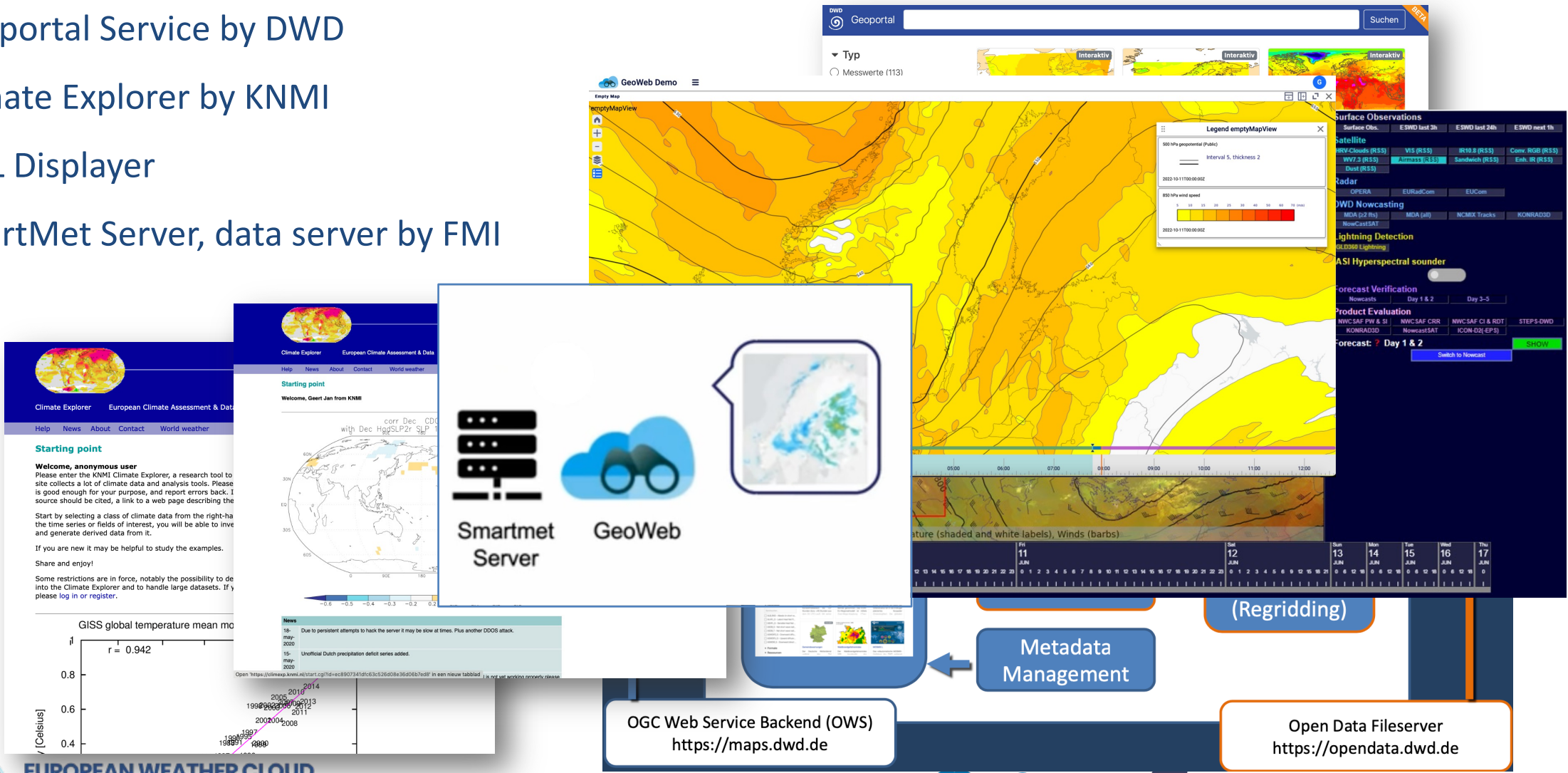
with in_org('eumetsat'):
    comparison_dataset =
xarray.open_dataset('eumetsat.nc').c
hunk({"latitude": 10})

averages =
dataset.mean('realization',
keep_attrs=True)
diff = averages.isel(height=5) -
comparison_dataset
differed =
diff.compute(optimize_graph=False)
```

Example simplified from: <https://dask.discourse.group/t/understanding-work-stealing/335/9>

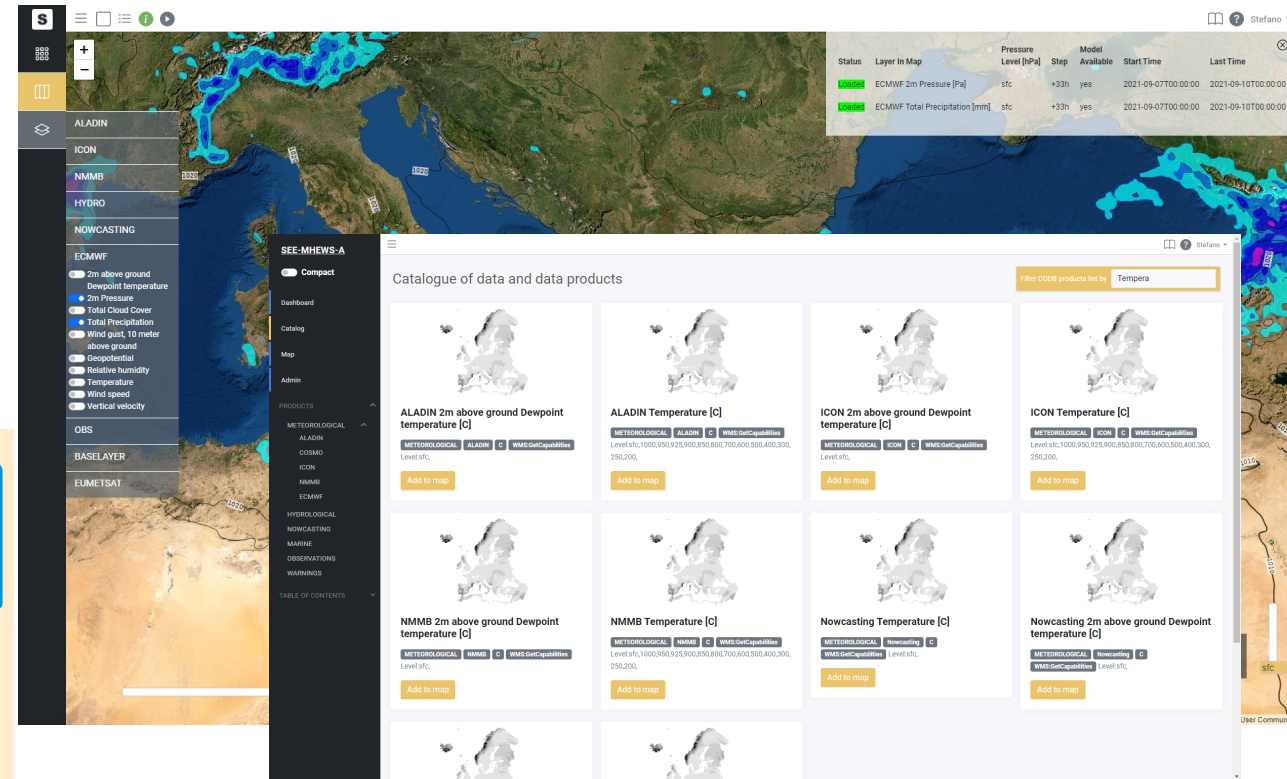
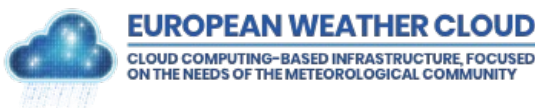
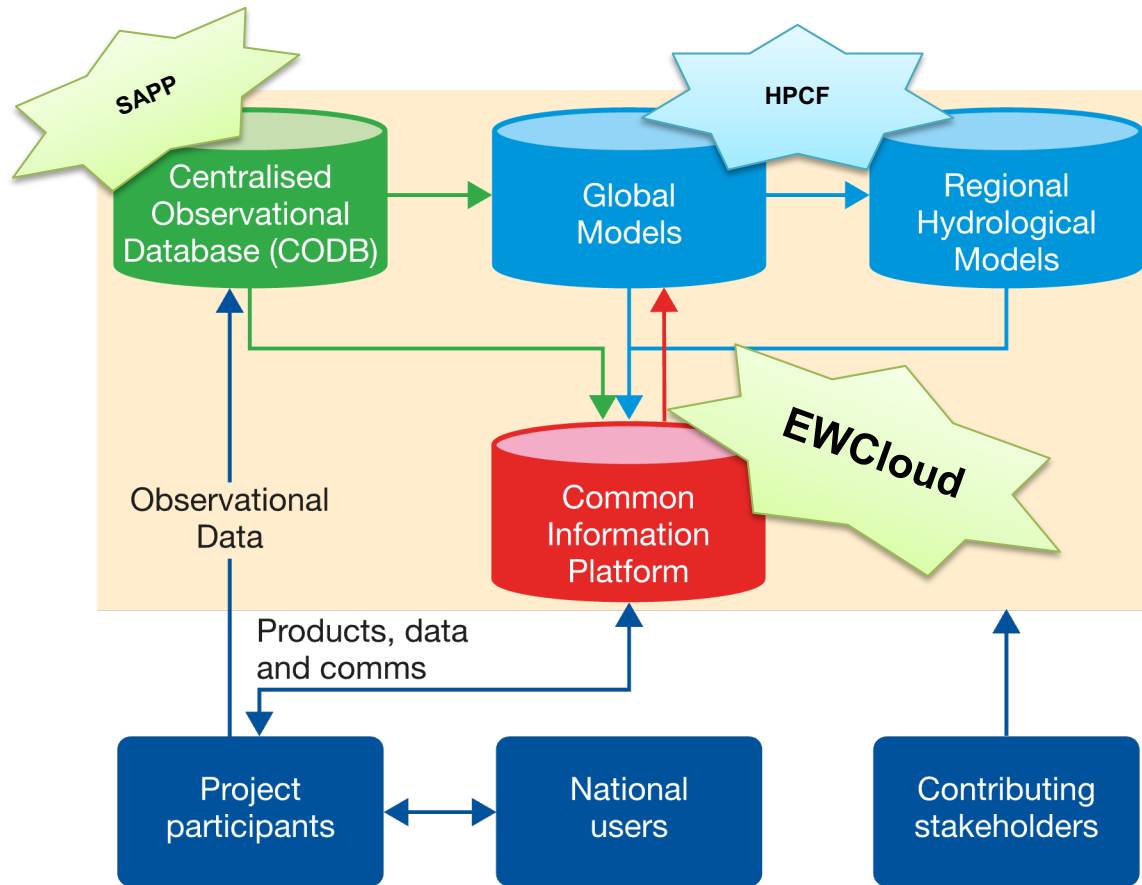
Data & visualisation services

- Geoportal Service by DWD
- Climate Explorer by KNMI
- ESSL Displayer
- SmartMet Server, data server by FMI



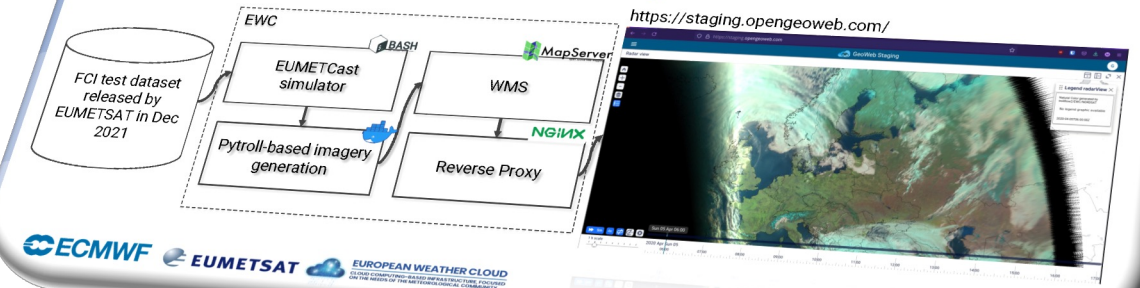
International collaboration projects

- SEE-MHEWS-A
- NordSat PyTroll MTG product generation



NordSat preparation for MTG product generation in EWC

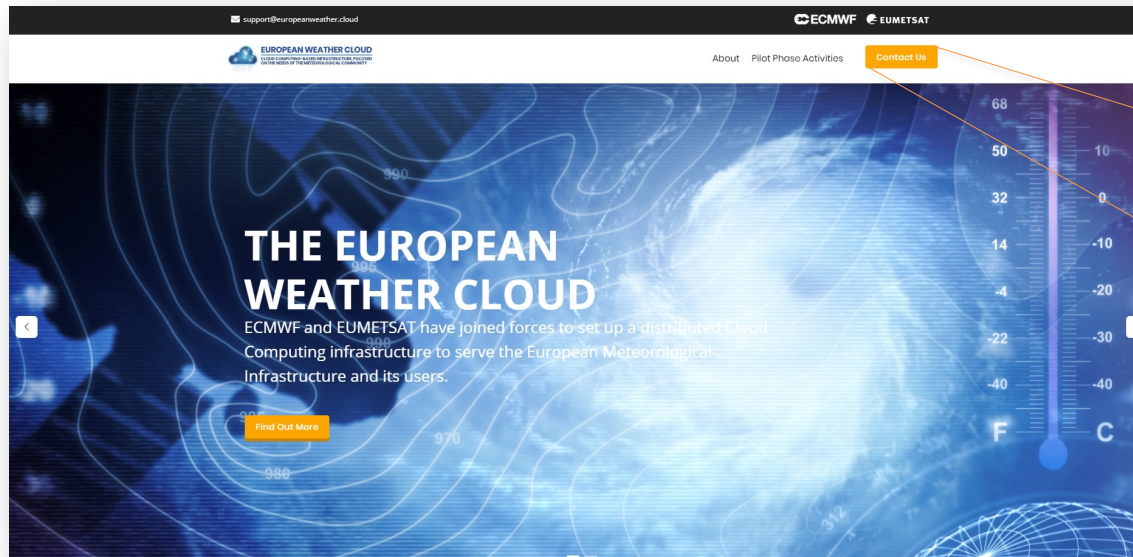
- NordSat (Iceland, Sweden, Norway, Denmark, Finland, Estonia, Latvia, Lithuania) is developing a central imagery production running in EWC for MTG/EPS-SG
- Imagery generation is operated in harmonised containers in a way that organisations can run the production in common EWC tenancy but also in other infrastructures (for resilience)
- The whole setup established in EWC in two days



Contact Us and Request Access



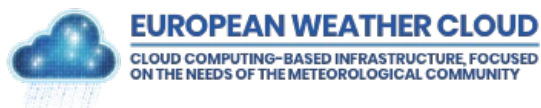
www.europeanweather.cloud



Contact Us



[support\(at\)europeanweather.cloud](mailto:support@europeanweather.cloud)





Questions?