ECMWF
The strength of a common goal

Conferenza GARR 2022
Matteo Dell’Acqua
European co-operation at its best: pooling resources
35 Member and Co-operating States
380 staff +
Coming from 30 countries
3 locations
Partnerships around the world …
Three sites: one unique role

ECMWF’s role is to address the critical and most difficult research problems in medium-range NWP that no one country could tackle on its own.
ECMWF new Data Centre in Bologna
Emboldening global collaboration
What do we do?
European co-operation at its best: **deliverables**

- Global numerical weather forecasts
- Supercomputing & data archiving
- Education & training programme

- EU activities: *Operating the Copernicus Climate and Atmosphere Services, contributing EFAS and FIRE to the Copernicus Emergency Management Service*, entrusted entities of DestinE
 Deliverables: Global NWP at all ranges

Medium-range prediction
High-resolution mean sea level pressure and ensemble spread

Monthly forecast plumes
Weekly anomaly – 2m temperature over Europe

Long-range prediction
El Nino SST anomaly plume
Working with the EU: Environmental information

Atmosphere Monitoring

Climate Change

Flood forecasting

Fire forecasting

Carbon monoxide forecast

Ozone forecast
Model performance: WMO comparison

![Graph showing model performance comparison](image)

- US National Centers for Environmental Prediction (NCEP)
- German National Meteorological Service (DWD)
- Korea Meteorological Administration (KMA)
- Australia’s Bureau of Meteorology (BoM)
- ECMWF’s high-resolution forecast (HRES)
- Copernicus Atmosphere Monitoring Service (CAMS)
- UK Met Office
- Canadian Meteorological Centre (CMC)
How do we do it?
CAPTURING THE WEATHER

To predict the future, we observe the present. Every day, we absorb 800 million observations to create a detailed snapshot of Earth’s weather.
BEYOND THE WEATHER FORECAST

ECMWF’s forecasting system is now giving us even more vital predictions about Earth’s environmental developments. These forecasts can protect infrastructure, promote economic development and save lives.
Increase realism in model
Machine Learning has been part of ECMWF forecasts for many years
And now planning to revolutionize the full NWP workflow...
Computing & Scalability
Numerical Weather Prediction workflow
HPC use of some of the largest supercomputers

2020 HPCwire Awards
Readers’ Best Use of HPC in Physical Sciences – ECMWF & ORNL

Wedi et al, 2020
Largest meteorological archive in the world

Total volume in archive:
350 PB

Ensemble output:

Predicted: 929 TiB

Today: 71.7 TiB

18km (2017) 9km (2020) 5km (2025)
The ECMWF data Archive

Every day the archive grows more than 250TB. This is approximately 1.75 Petabytes (PB) every week.

If this data was printed, the books produced could be put in a 11,372 km long row. This is about the distance travelling from Bologna to Nova Scotia, Canada and back again!
Data consumption scenarios
Data Dissemination

- A total of 1374 Destinations with 2121 Hosts across 79 countries:
  - Dissemination: 611 Destinations across 78 countries
  - Acquisition: 694 Destinations across 34 countries
  - Data Portal: 69 Destinations (mostly CAMS and MACC)
The European Weather Cloud aims to become the cloud-based collaboration platform for meteorological application development & operations in Europe and contributes to the digital transformation of the European Meteorological Infrastructure

“a community cloud”

- 3-year pilot project started in January 2019 until 2021
- Currently in Continued Pilot Usage and Preparation for Operations phase
- Use Case workshops every 6 months, currently 30 use cases
- Operationalisation in 2022
Destination Earth
digital twins of the Earth system

Core service platform
- User portal
- ML interface
- MyDestinE: cloud storage & compute

Data lake
- E2E data handling
- Data bridges
- User & external sources

Digital Twins
- Extremes & Climate change
- Extreme-scale software & ML
- HPC workflows

Simulation

Infrastructure

User

Observation
UNDERSTAND THE PAST, PREDICT THE FUTURE

Fed by real-world observations, these digital twins let us understand what has happened on Earth – and what will happen in the decades ahead.
WHAT WILL OUR PLANET LOOK LIKE IN 50 YEARS?

Earth’s digital twin can reveal the answers that we need to make a better world for all. This remarkable technology gives us…

**REVOLUTIONARY**
new detail and precision in our models of Earth’s systems

**FASTER AI-DRIVEN STUDIES**
and quicker access to world-changing information

**BETTER CONNECTIONS**
to energy, food and water than ever before

**UNRIVALLED FORESIGHT**
into the impact of climate events and our own policies
DIGITAL TWIN, REAL IMPACT

Giving us new insights on days or entire decades, Earth’s digital twin can provide huge benefits to many sectors.

CITIES
Smart cities can harness the digital twin for everything from traffic management to construction planning.

FARMING
The digital twin can aid agriculture’s key functions (irrigation, fertilisation, harvest) and its response to extreme weather.

ENERGY
We will have new knowledge to enable ambitious projects like harvesting Earth’s inner heat, converting this geothermal energy and storing it.

CLIMATE CHANGE
The digital twin’s unique insights will help drive Europe’s efforts to become the world’s first climate-neutral continent by 2050.
How to manage the dataflow

- **User**
  - Core service platform
  - User portal
  - ML interface
  - MyDestinE: cloud storage & compute

- **Infrastructure**
  - Digital Twins
    - Extremes & Climate change
    - Extreme-scale software & ML
    - HPC workflows
  - Data bridges
  - User & external sources

- **User data**
  - ~ O(1 GiB/request)

- **Data Lake**
  - E2E data handling
  - Data bridges

- **User Portal**
  - MyDestinE

- **Core Service Platform**
  - User portal
  - ML interface
  - MyDestinE: cloud storage & compute

- **Data Bridges**
  - User & external sources

- **Data Centre**
  - EuroHPC Site

- **DE Service Platform**
  - 1 server + port open to outside + storage
  - Query (Temp + Region)

- **FDB Service**
  - (Object protocol)
  - REST API

- **Storage (capacity)**

- **Data Bridge**
  - Parallel FS (speed)
  - FDB Object Storage

- **HPC/GPU**
  - ~ O(1-100 TiB/day)

- **HPC/CPU**
  - 1 PiB/day

- **ML Interface**

- **MyDestinE**
  - cloud storage & compute

- **EuroHPC Site**
  - Data Centre