



# ECMWF – Into the Future

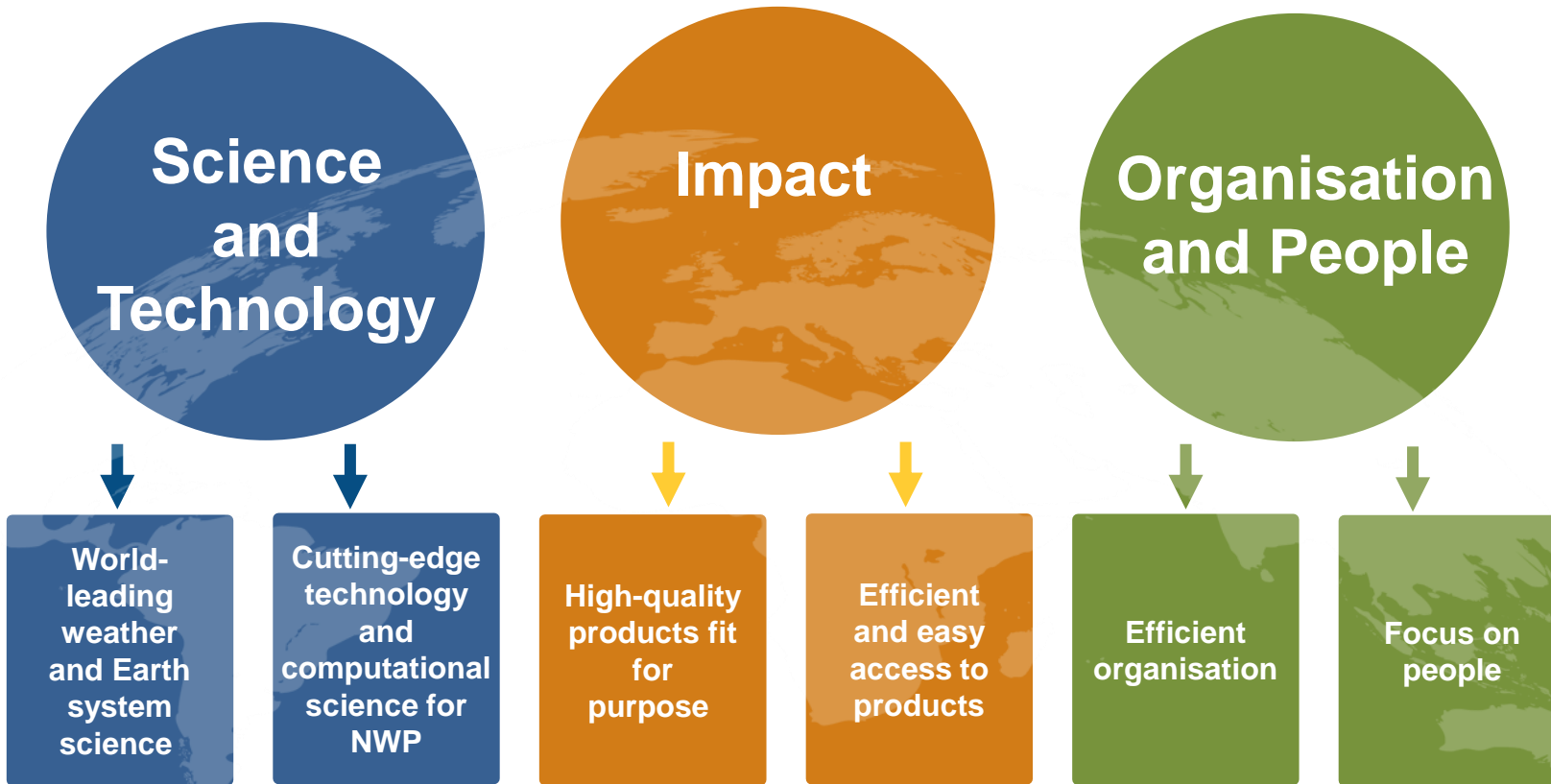
UEF2021

Florian Pappenberger, Director of Forecasts

@FPappenberger



# ECMWF Strategy 2021 - 2030



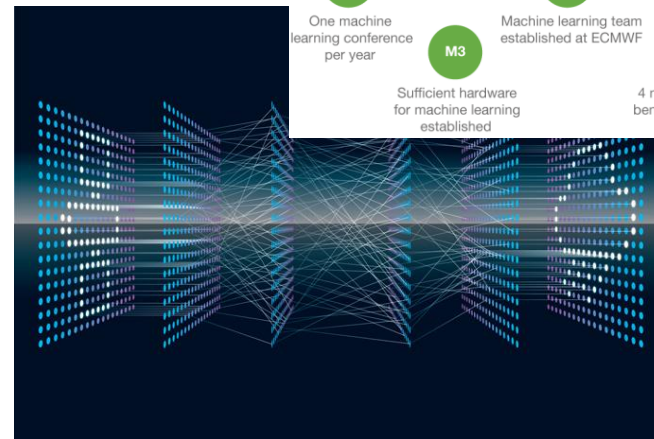
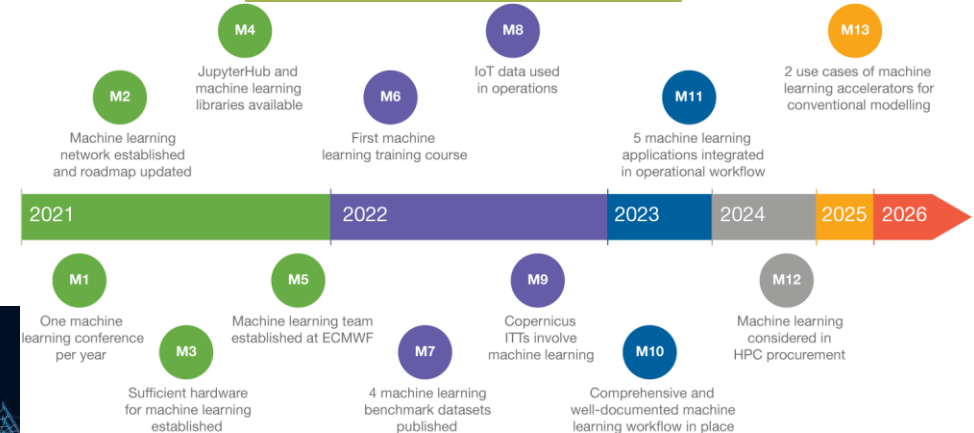
# Machine Learning

- Machine Learning has many application areas across ECMWF from Observations to Data Assimilation to NWP to Post-processing and dissemination
- It will also be used in a number projects ECMWF collaborate on including:
  - Centre of Excellence in Weather & Climate Modelling with ATOS and ECMWF supported by AMD, Mellanox, NVIDIA and DDN
  - European Weather Cloud
  - MAELSTROM
  - CliMetLab
  - DestinationE
- The roadmap has a number of milestones over next 10 years
- It also faces many challenges which the roadmap outlines

878

Machine learning  
at ECMWF:  
A roadmap for the  
next 10 years

Peter Dueben, Umberto Modigliani, Alan Geer,



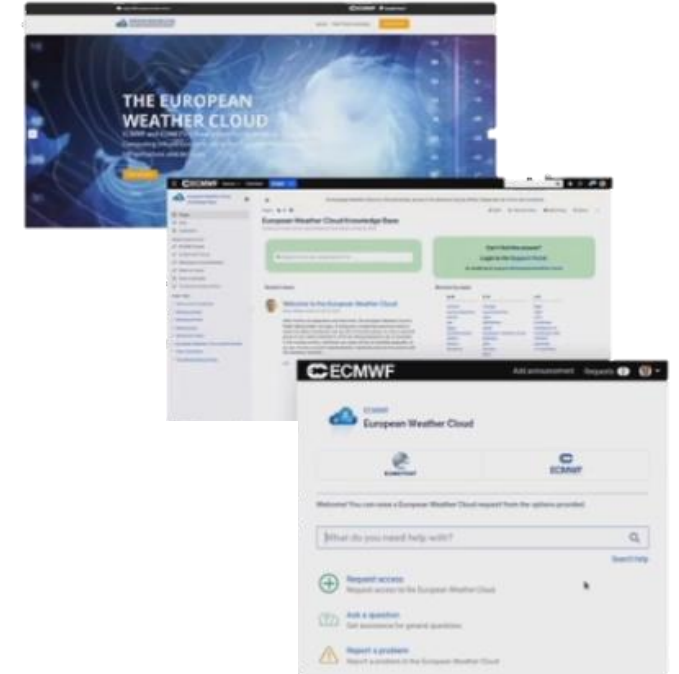


# EUROPEAN WEATHER CLOUD

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



- 3-year pilot project started in January 2019, extended until 2021
- Currently in Continued Pilot Usage and Preparation for Operations phase
- Use Case workshops every 6 months, currently 30 use cases
- Potential operationalisation in the near future



*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**”*



EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

[www.europeanweather.cloud](http://www.europeanweather.cloud)  
[View recent webinar](#)

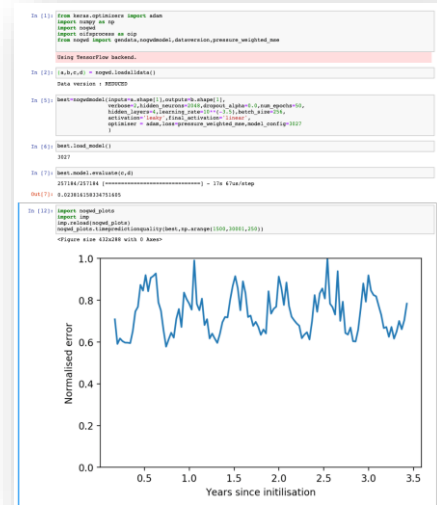
# Use cases - Demonstrating the new way of working with MS/CS

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

DWD use case on offering notebooks to train and develop the ICON model on the European Weather Cloud



Oxford University offering Jupyter notebook environments for Machine Learning on weather & climate data sets

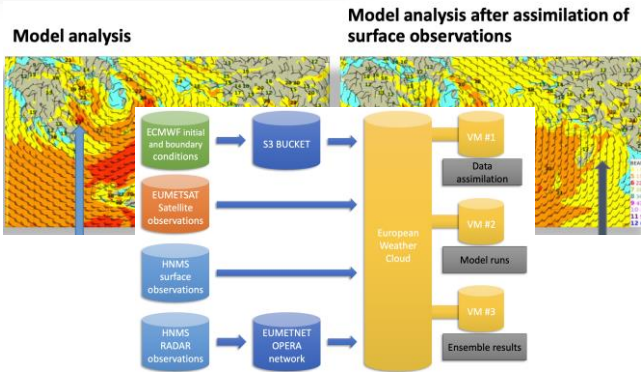


Forecast and climatology of cloud cover for Energy and Spatial sectors  
Météo-France

Hosted on both ECMWF and EUMETSAT

The screenshot shows the KNMI Climate Explorer web interface. It includes a search bar, a 'Starting point' section, and a 'Welcome, anonymous user' message. The interface is designed for exploring climate data and analysis tools.

KNMI Climate Explorer running on the European Weather Cloud



HNMS uses ECMWF forecast as boundary condition for model and assimilation trials

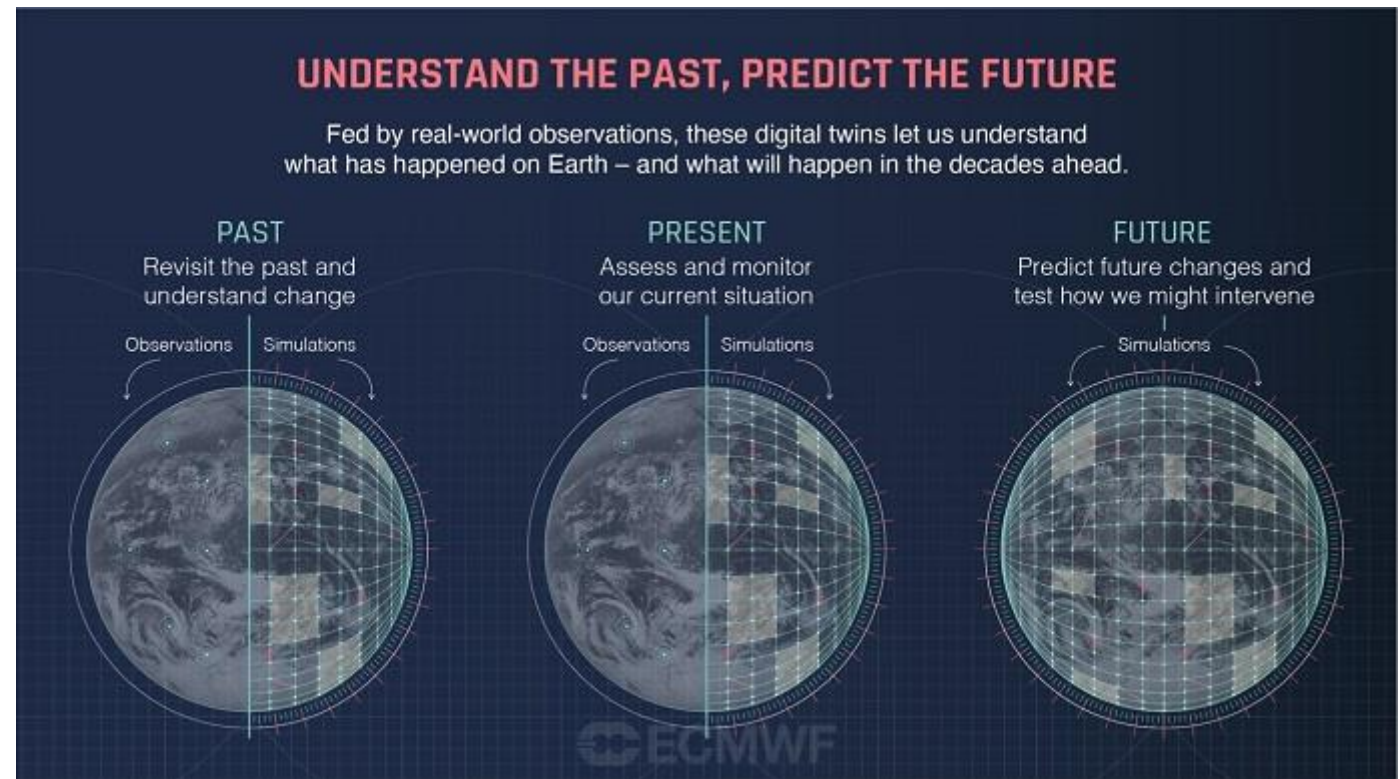
The screenshot shows the OGC web map services interface. It includes a search bar, a 'Typ' section, a 'Max. Abdeckung' section, a 'Parameter' section, and a 'Format' section. The interface is designed for exploring map services and data.

OGC web map services integrating maps in DWD's Geoportal

# Destination Earth (DestinationE)

*Aim: To create a digital twin of the Earth that will make it possible to interactively explore various natural processes and human activities*

- Programme to launch in 2021
- Implemented over 7-10 years
- ECMWF will manage the Digital Twin on Weather-Induced and Geophysical Extremes.
- This will provide capabilities and services for the assessment and prediction of environmental extremes



- ECMWF: entrusted entity for **C3S** and **CAMS**
- ECMWF: Contractor to Joint Research Centre (JRC) for operating:
  - **CEMS-EWS** (Flood)
  - **CEMS-EWS** (Fire)

2021-2027:  
New MFF and new Space Regulation  
New Budget  
New (3<sup>rd</sup>) Facility  
New Service Component (CO<sub>2</sub>)

Copernicus Day  
@ UEF2021  
Thursday 3<sup>rd</sup> June

# Open Data – what is next?

& WMO essential data (already free)

The collage features several overlapping elements: the top right shows a snippet of 'THE PARLIAMENT MAGAZINE' with the subtitle 'POLITICS, POLICY AND PEOPLE'; below it is a news article titled 'free and open weather data for all' with a sub-headline 'Centre for Medium-Range Weather Forecasts (ECMWF) is moving towards a policy of open data, writes Umberto Modigliani.'; in the center is a tweet from @ECMWF dated 7 October 2020, which reads: 'From today, all ECMWF graphical products are free and accessible to all! Medium-range, extended-range and long-range forecast charts of temperature, wind, precipitation, clouds and ocean waves are just some of the products available. [ecmwf.int/en/about/media...](https://www.ecmwf.int/en/about/media...) @CopernicusECMWF @WMO'; and on the left is a screenshot of the ECMWF website navigation menu with options like Home, About, Forecasts, Computing, Research, Learning, etc.

The screenshot shows the 'Charts catalogue' page on the ECMWF website. On the left, there is a search bar and filter options for 'Range' (Medium (15 days)) and 'Product type' (High resolution forecast (HRES), Ensemble forecast (ENS), Combined (ENS + HRES), Extreme forecast index, Point-based products). The main area displays a grid of 16 weather charts with labels such as 'Mean sea level pressure and wind speed', 'Geopotential 500 hPa and temperature at 8...', '2m temperature and 30m winds', 'Mean sea level pressure and wind at 200...', 'Rain and mean sea level pressure', 'Total cloud cover', 'Vorticity and wind at 700 hPa', and 'Simulated images - Infrared'.

New Chart Browser!



# Integrated Forecasting System (IFS) cycles

- **Cycle 46r1**

Continuous data assimilation and introduction of a 50-member Ensemble of Data Assimilations: weakly coupled data assimilation for sea-surface temperature in the tropics; improvements in the wave model, the convection scheme, the radiation scheme and the use of observations.

- **Cycle 47r1**

Improved treatment of observations. Improvements in the data assimilation and to the model. Quintic vertical interpolation in the semi-Lagrangian advection scheme has been introduced as well as the inclusion of a better surface albedo climatology making use of more data from the MODIS instrument.

- **Cycle 47r2**

Single precision and increased number of ENS model levels (91 to 137). New Tropical Cyclone tracks from 06/18 UTC forecast cycles made available as WMO essential products.

- **Cycle 47r3**

Moist physics upgrade, improvements to observation usage, improved stratospheric analysis (weak constraint 4DVar)

2019  
Q2

46r1

2020  
30 Jun

47r1

2021  
11 May

47r2

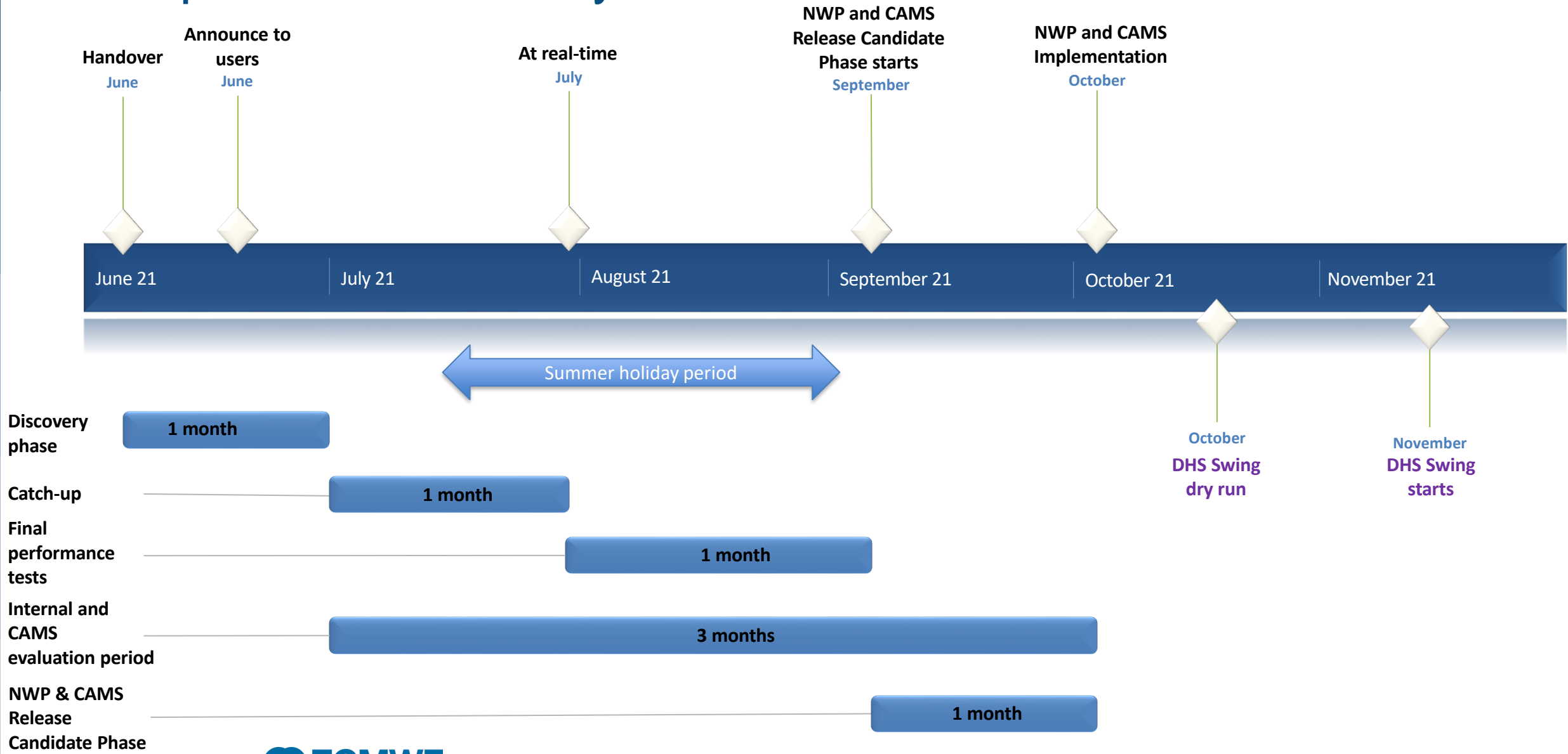
Oct

47r3

BOND

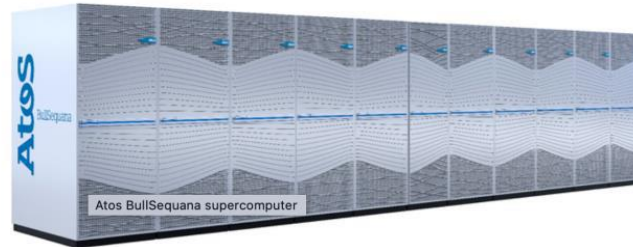
48r1

# Implementation of cycle 47r3



# BOND – Bologna Our New Datacentre

Our new premises are looking great!



The Atos BullSequana supercomputer. (Image: Atos)

The Atos HPC installation has begun after initial testing was successful

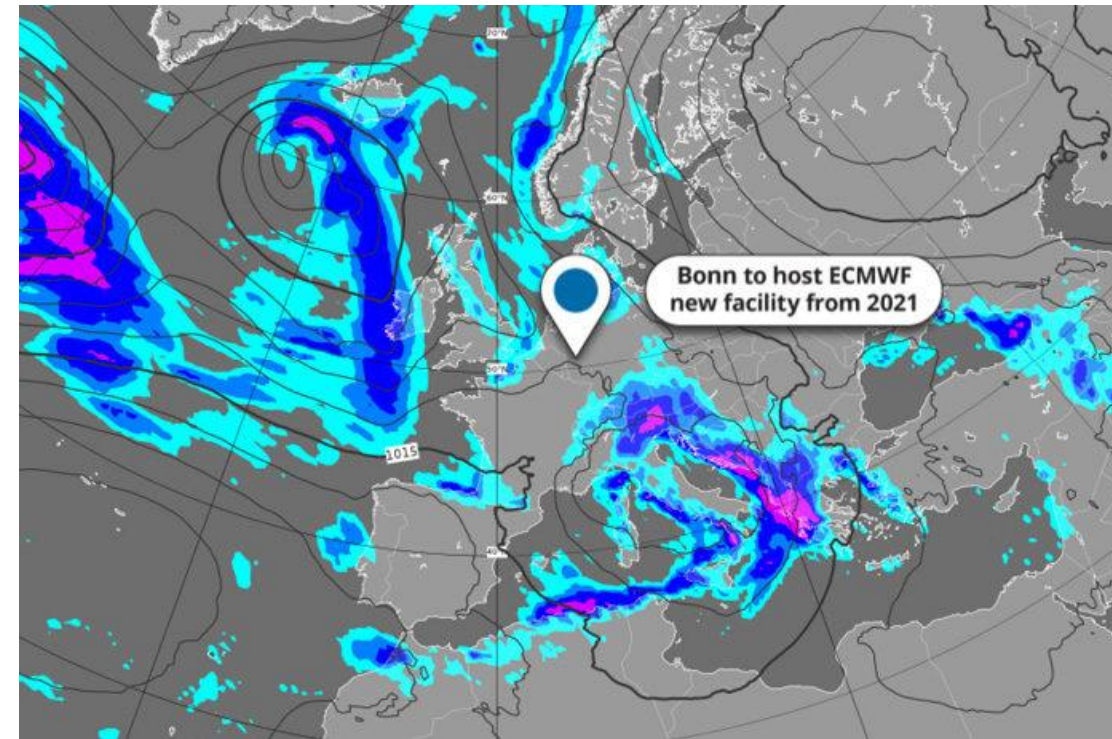
48r1 will be the first cycle on the Atos HPC

The Atos Test and Early Migration System (TEMS) is now available to some users for testing of code prior to the migration to the Atos HPC

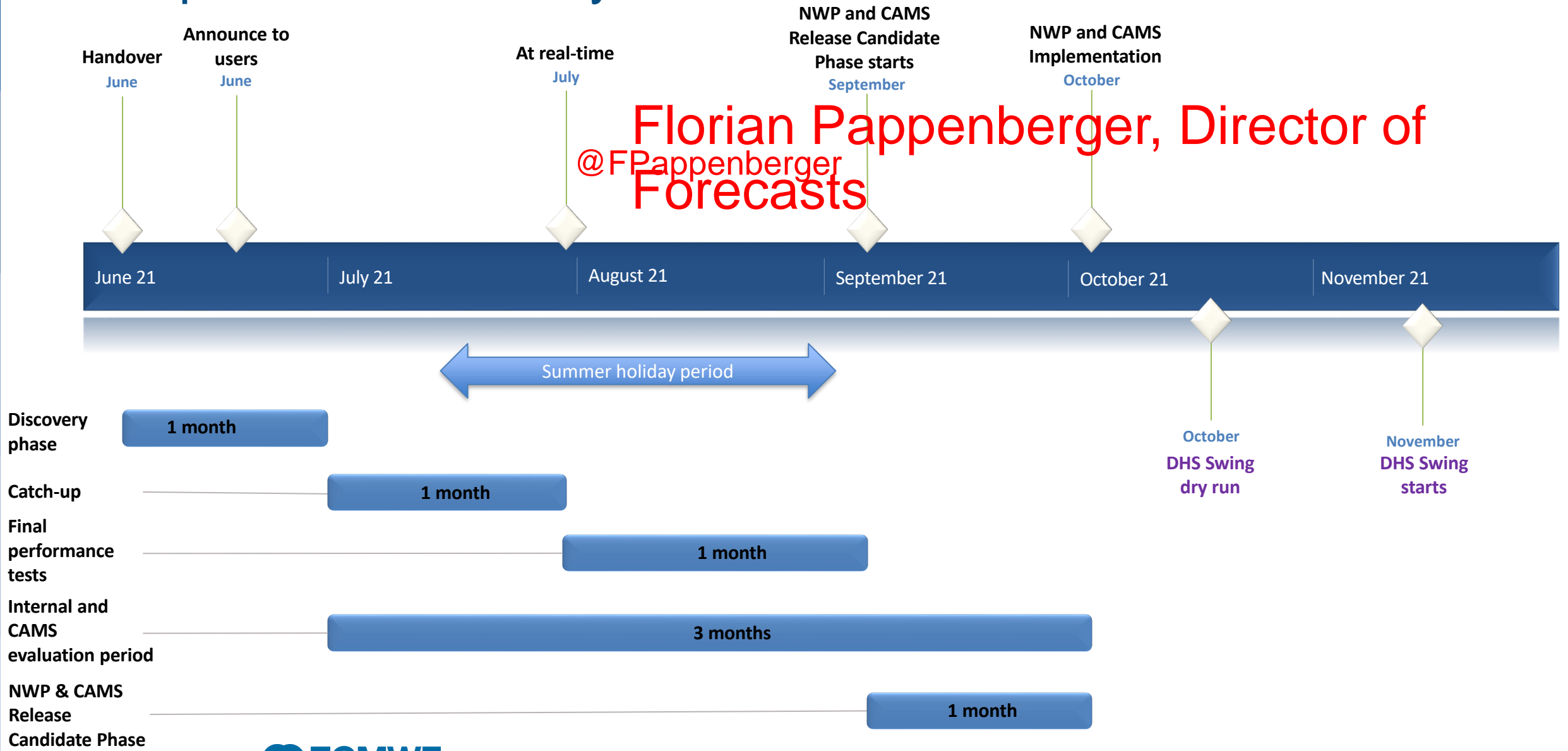


# Bonn, Germany to host new ECMWF facility – BRIDGE project

- Focus on activities that ECMWF conduct in partnership with the EU including:
  - Copernicus
  - Destination Earth
- Foster more collaboration across Europe
- First staff moving summer 2021
- Initially in temporary offices with permanent offices available in 2026
- ECMWF HQ will remain in Reading, UK



# Implementation of cycle 47r3



**Florian Pappenberger, Director of**  
**@FPappenberger**  
**Forecasts**



# Thank you!

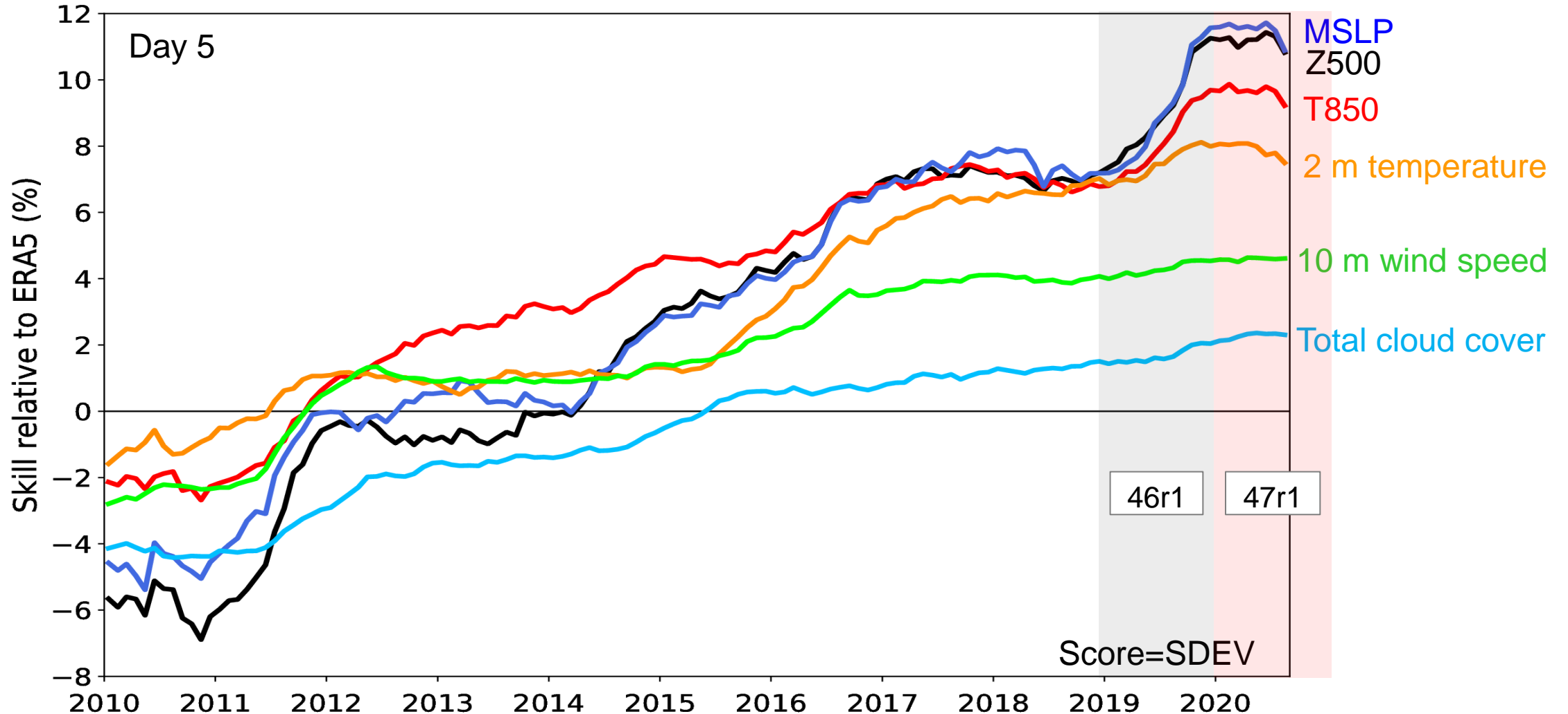
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# Forecast performance

*HRES Skill relative to ERA5 (score=SDEV)*



# Forecast performance

## Comparisons with other centres – Z500 Northern Extratropics

500hPa geopotential  
Anomaly correlation  
NHem Extratropics (lat 20.0 to 90.0, lon -180.0 to 180.0)

- DWD
- CMC
- JMA
- UKMO
- ECMWF
- ERA5
- BoM
- KMA
- NCEP

