DWD, NUG, NEC – some personal remarks

NUG meeting XXXVI, Osaka, May 13 2025

Manuel Reiter, Deutscher Wetterdienst

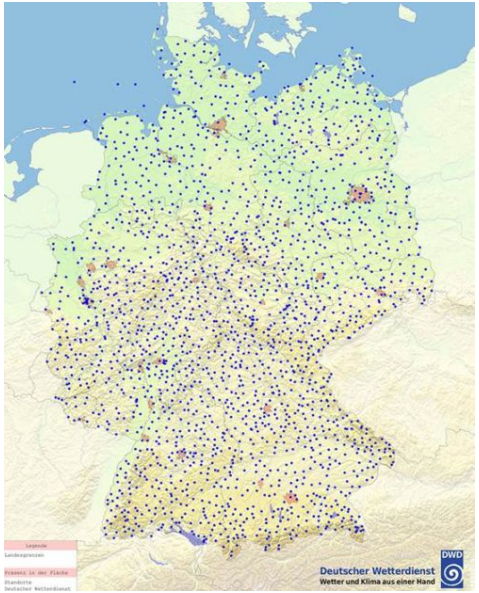
Deutscher Wetterdienst (DWD)

Germany's National Meteorological Service – an overview

- Founded in 1952
- Authority under the Federal Ministry for Transport (BMV)
- Headquarters in Offenbach am Main
- 6 branch offices in Hamburg, Potsdam, Leipzig, Essen, Stuttgart and Munich
- Around 2,150 staff members
- Provider of scientific and technical services and with a duty to undertake research
- Represents Germany in international meteorological and climatological organisations

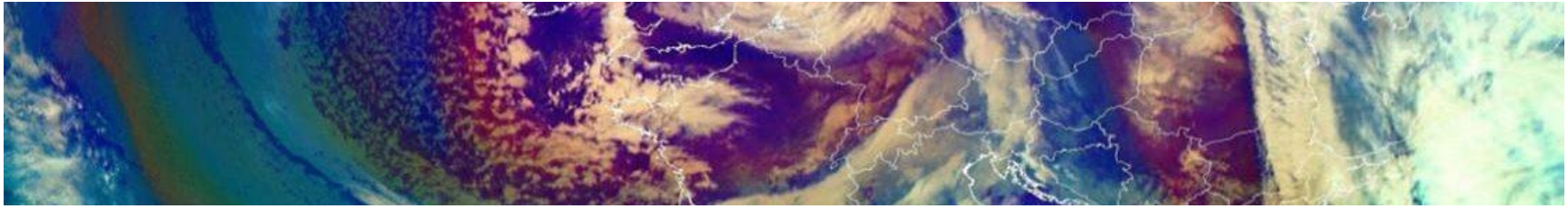
Regional presence throughout Germany for the collection of all kinds of weather- and climate-related data

- 181 main weather stations (staffed and automatic)
- 48 stations for measuring radioactivity
- 1,726 voluntary measuring stations
- 1,070 phenological observation sites
- 18 weather radar sites
- 2 meteorological observatories
- 10 upper-air stations
  (around 7,000 radiosonde launches every year)
- 2 main shipboard weather stations (staffed)
- 150 automated shipboard weather stations
- 448 ships at sea participating in the
  WMO Voluntary Observing Ships (VOS) programme



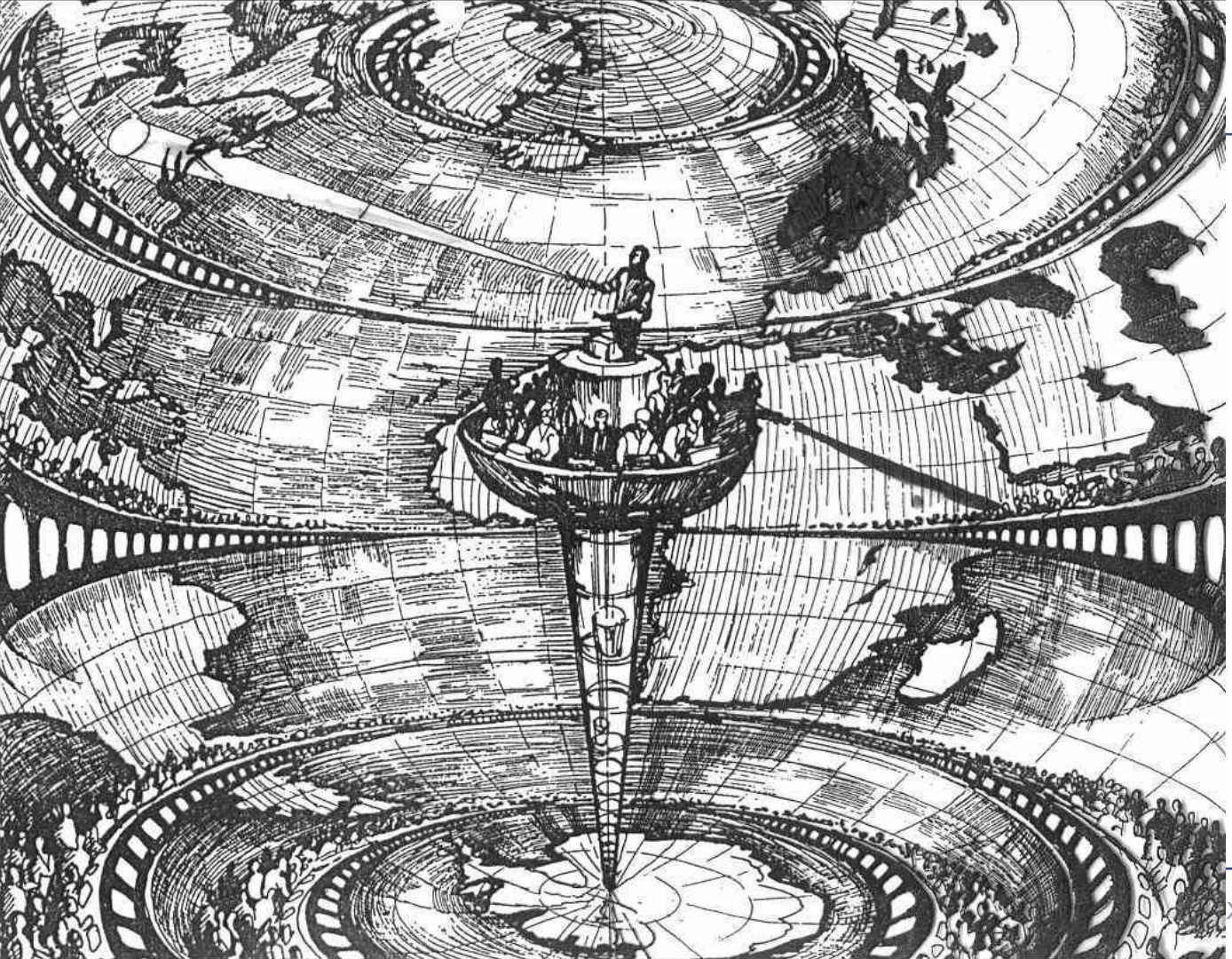
Our core tasks are

- to observe and forecast the weather
- to issue weather and severe weather warnings
- to monitor and study the climate in Germany
- to evaluate climate change and climate variability
- to predict and project future climate conditions
- to provide early warnings, situation reports and information on prevention against the risks of natural hazards
- to provide advice on climate change adaptation
- to monitor radioactivity in the air and in precipitation
- to represent Germany in international organisations
- to operate the necessary measuring and observation systems



How do we do that?

(among others…)



Numerical Weather Prediction (NWP)

Lewis Fry Richardson
1916 / 1922

High Performance Computing (HPC)

Since 1966

1 PetaFLOP/s

1 TeraFLOP/s

1 GigaFLOP/s

1 MegaFLOP/s

CDC-3800

Cyber 76

Cray YMP

Cray T3E

IBM pSeries

NEC SX-9

Cray XC40

NEC SX-Aurora

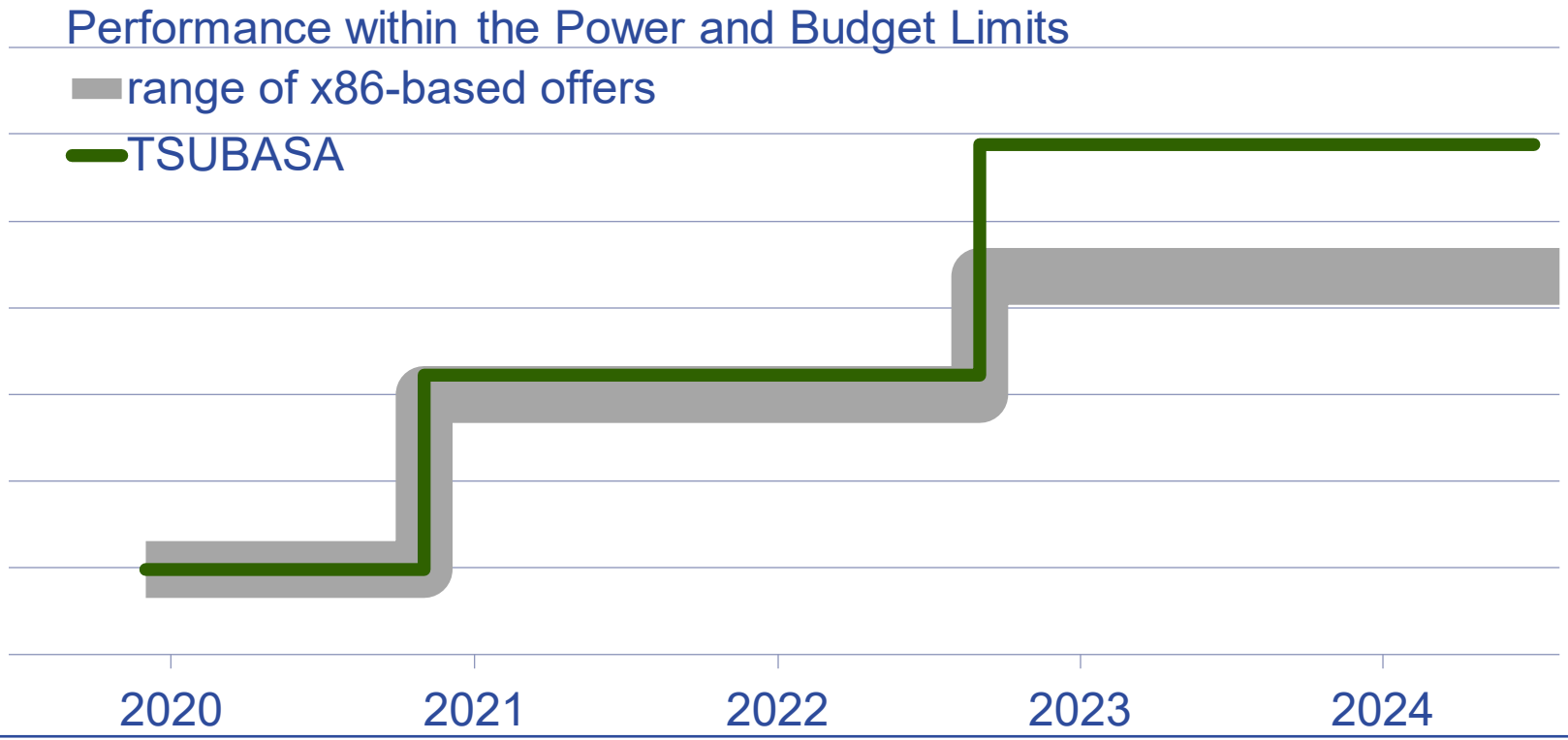
1966 1971 1976 1981 1986 1991 1996 2001 2006 2011 2016 2021 2026

Toulouse 2010: My first NUG

SX 9 Phase 2

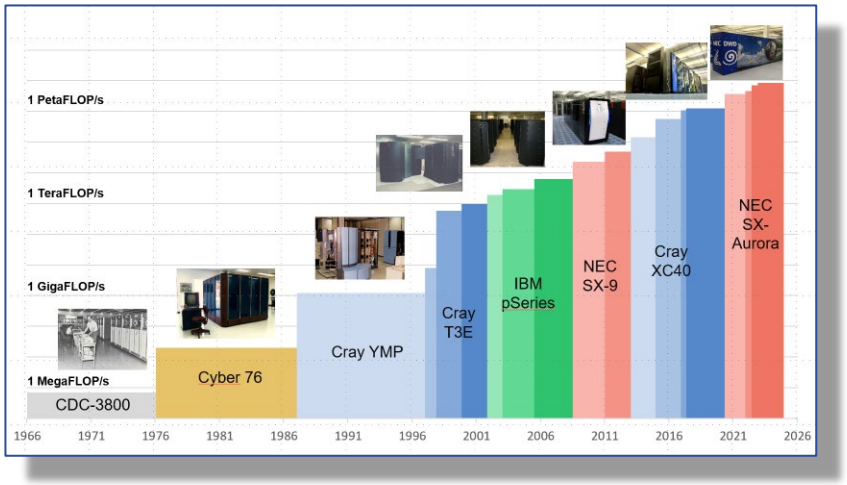
February 2011

2019: Procurement of SX-Aurora TSUBASA



2024: Aurora Phase 3

- ➔ Expansion of **HPC** in Offenbach and Ludwigshafen by 50%
- ➔ contract extended into 2027 (+1y optional)
- ➔ **16,6 PFlop/s for Climate and Research**
  12,8 PFlop/s for NWP



Operational NWP System

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

ICON Global
Non-Hydrostatic

Det 13 km
EPS 26 (20) km
120 level
40 member

Analysis (3h)

EnVAR + LETKF
40 member

Forecasts
180h: 00, 12 UTC
120h: 06, 18 UTC
51 (75)h: 03, 09, 15, 21 UTC

ICON-EU
2-way-nest

Det 6.5 km
EPS 13 (10) km
74 level
40 member

Analysis (3h)

EnVAR + LETKF
40 member

Forecasts
120h: 00, 06, 12, 18 UTC
51 (75)h: 03, 09, 15, 21 UTC

ICON-D2 LAM
Convective Scale

Det 2 km
EPS 2 km
65 level
20 (40) member

Analysis (1h)

KENDA / LETKF
40 member

Forecasts
48 (72)h: 00, 03, 06, 09, 12, 15, 18, 21 UTC

ICON-D05 LAM
2x 2-way-nest

Det 2 | 1 | 0.5 km

65 level

ICON-D2 LAM

Nests are started during forecast

Forecasts
48h: 00, 03, 06, 09, 12, 15, 18, 21 UTC

ICON-D2 RUC
Convective Scale

Det 2 km
EPS 2 km
65 level
20 (40) member

Analysis (1h)

KENDA / LETKF
40 member

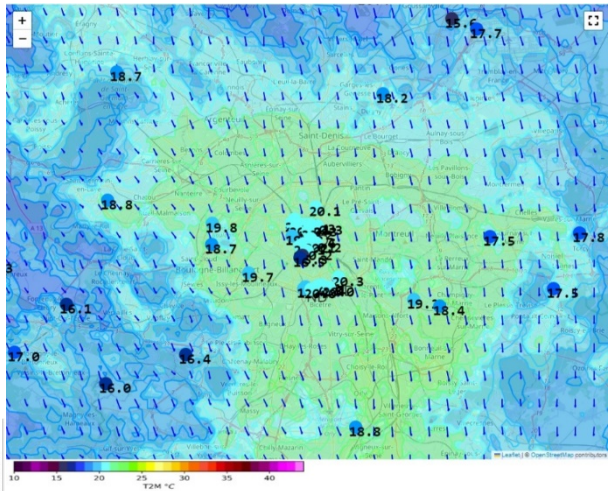
Forecasts
14h: 00-23 UTC

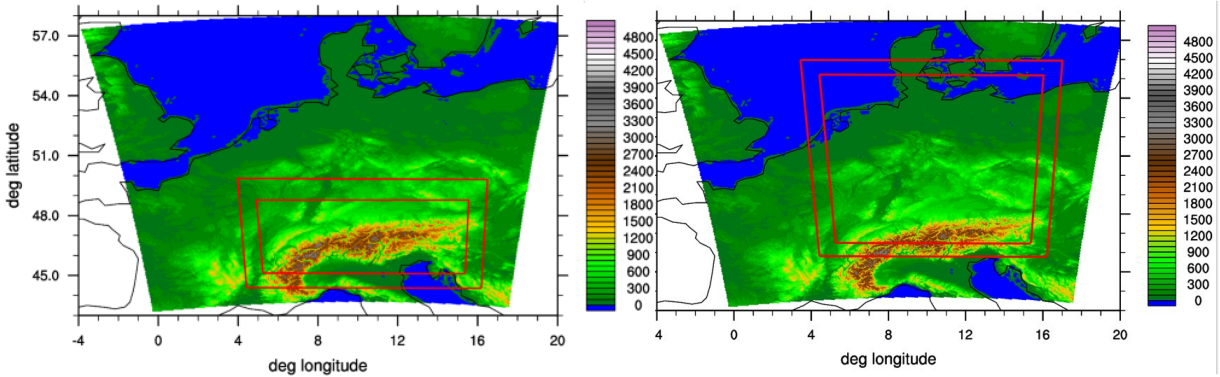
Green text: Realization later this year (depending on storage system)
Red text: Under consideration

All systems will be supplemented by AI-based predictions.

Since February 2025: ICON with 500 m Nest

- Refining the mesh size from 2 km to 500 m tends to improve the model skill in various aspects.
- First planned for dedicated high-resolution forecasts for the TEAMx observational campaign over the Alps.
- Tested for the Summer Olympic Games with a 500 m nest over Paris.
- Now running for a configuration over Germany.



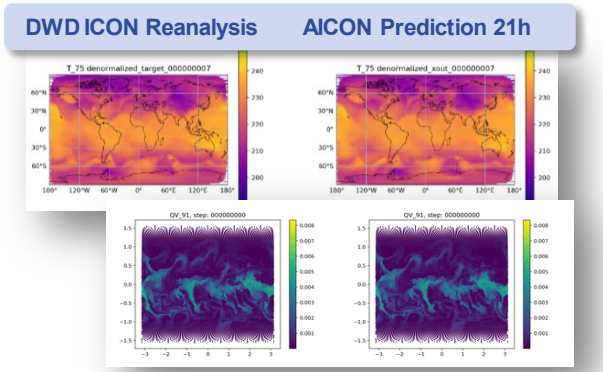


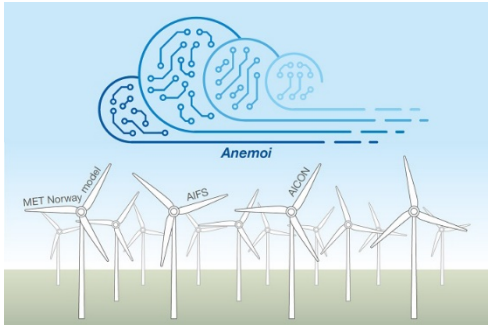
Highly demanding for strong scaling and all kinds of HPC hardware:

48 hours of forecast have to run in 30 minutes!

Rapid development of AI based NWP

- 02/2022: FourCastNet (NVIDIA)
- 11/2022: Pangu-Weather (HUAWEI)
- 12/2022: GraphCast (Google)
- 10/2023: AIFS (ECMWF)





© ECMWF

Anemoi

- several packages written in python and addressing different aspects of AI/ML weather forecasting pipeline:
- Datasets, Training, Models, Inference, Graphs.
- Main tool is pyTorch.
- Benchmark will be available from ECMWF.

Developments at DWD

- ICON-DREAM: Dual Resolution (13|6.5 km) Reanalysis for Machine learning.
- First tests together with KIT based on Pangu Weather ⇒ KANGU
- Together with ECMWF and several european weather services: joined development of Anemoi (framework for weather forecasting based on ML).

AICON will be: Anemoi Framework + Settings to apply special neural network + weights trained on ICON Reanalysis

2024/2025: Market survey for next HPC

- Difficult market, prices have risen significantly
- Indicative offers for replacement of current system with identical performance:
  - CPU and GPU offers (and vector)
  - GPU: Various levels of optimisation (CUDA)
  - No offer to fit into current budget (even **without performance increase**)
  - Only aggressively optimised GPU solutions offer power efficiency comparable to SX-Aurora
- Applied for budget increase, outcome uncertain
- We will closely watch future vector development

Thank you! Questions? Remarks?

Manuel.Reiter@dwd.de