Opportunistic weather observations in EUMETNET

Past, present and future

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EUMETNET

Introduction to EUMETNET and the Observations Capability Area

EUMETNET

EUMETNET is a General Partnership under Belgian law, which provides a collaborative framework for European National Meteorological and Hydrological Services.

- Collaborative (non-profit) organisation of **33 Members**
- Governed by the Assembly of Directors
- Supported by 4 Advisory Committees reporting to the Assembly
- **3 Capability Areas** (Observations, Capacity, Support)
  - 20 Programmes (6 mandatory)
  - 15 Modules (incorporated into Programmes)
- Expert Teams, Working Groups and Task Teams

1. Austria – GeoSphere
2. Belgium – RMI
3. Croatia – DHMZ
4. Cyprus – CYMET
5. Czechia – CHMI
6. Denmark – DMI
7. Estonia – ESTEA
8. Finland – FMI
9. France – Météo-France
10. Germany – DWD
11. Greece – HNMS
12. Hungary – HungaroMet
13. Iceland – IMO
14. Ireland – Met Éireann
15. Italy – ItAF-AVIAMM
16. Latvia – LEGMC
17. Lithuania - LHMS
18. Luxemburg – MeteoLux
19. Malta – MAMO
20. Montenegro – IHMS
21. Netherlands – KNMI
22. North Macedonia – HMS-RNM
23. Norway – MET Norway
24. Poland – IMGW-PIB
25. Portugal – IPMA
26. Romania - NMAR
27. Serbia – RHMSS
28. Slovak Republic – SHMU
29. Slovenia – ARSO
30. Spain – AEMET
31. Switzerland - MeteoSwiss
32. Sweden – SMHI
33. United Kingdom – Met Office

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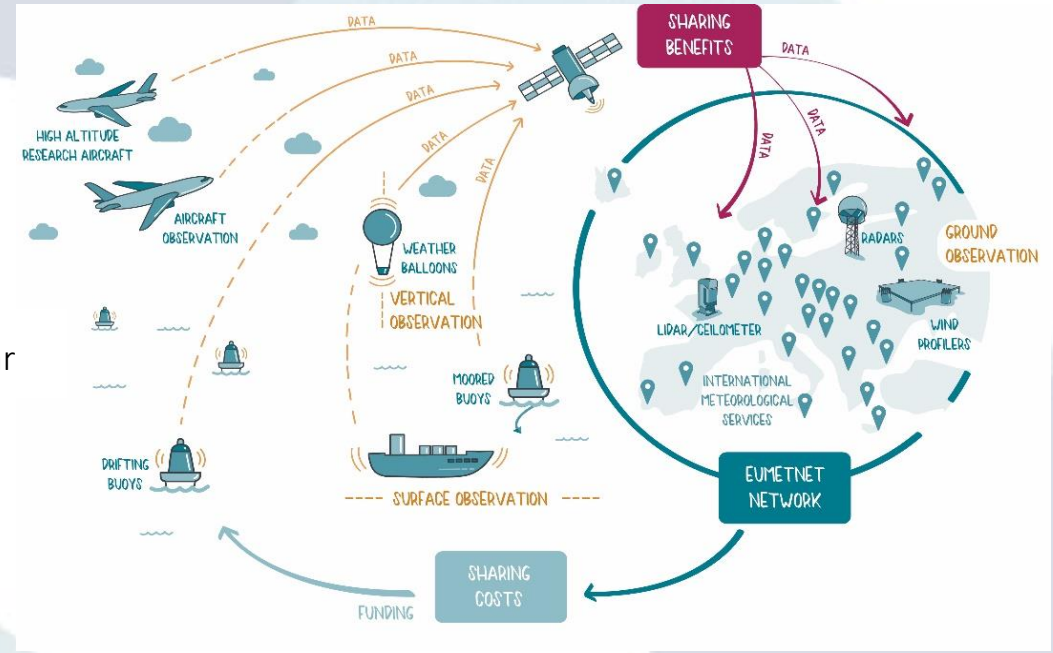
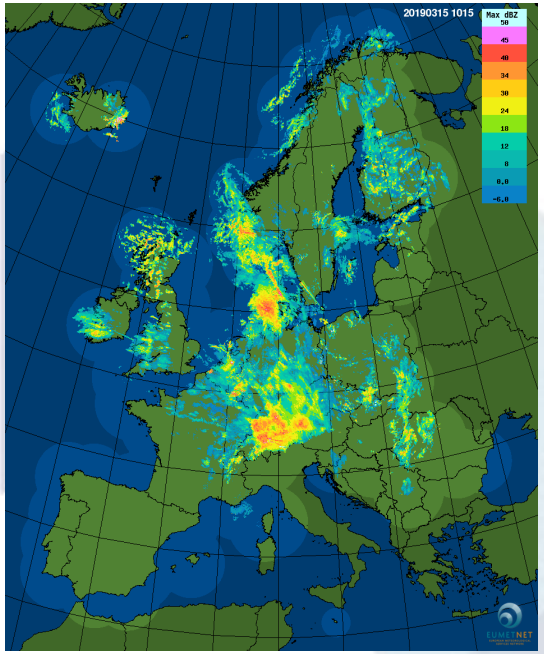
Observations Capability Area (OBS CA)

1. E-Profile – Obs from vertical profiling systems:

- Radar Wind profiler & Weather radar & Lidar Wind profiler
- Automatic Lidar & Ceilometer (aerosol, ash, cloud)
- Microwave Radiometer (humidity and temperature).



2. OPERA – Obs from Weather radar

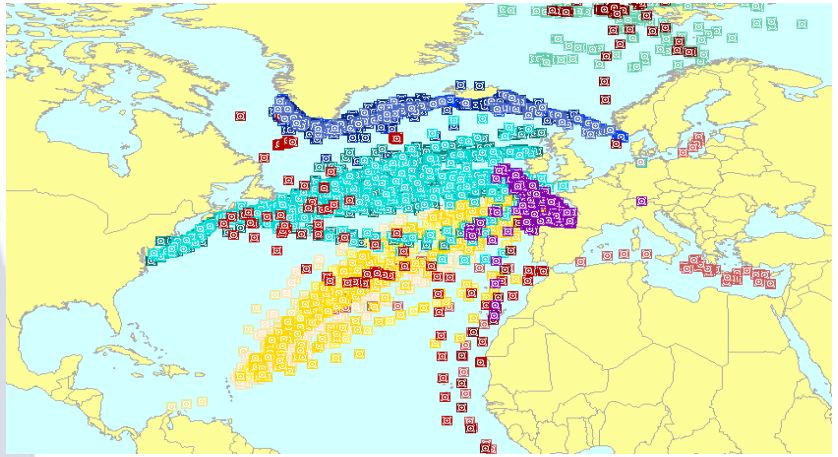


3. E-ABO – in-situ obs from aircraft:

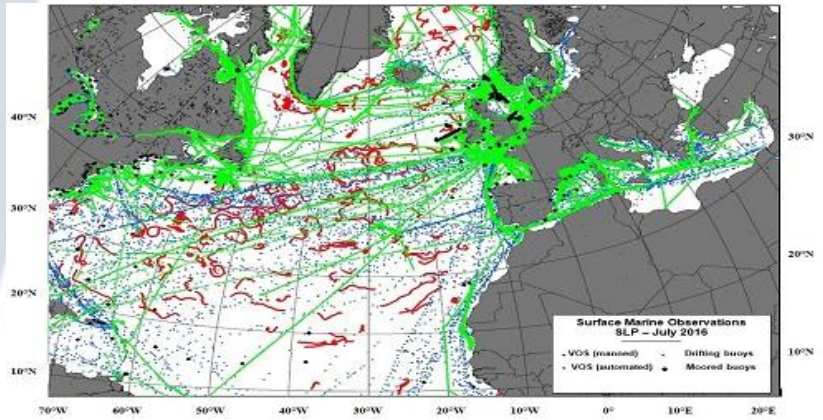
- AMDAR wind, temperature and humidity
- MODE-S wind and temperature
- and others e.g. ADS-C, TAMDAR, etc …

4. E-GVap – Obs derived from GNSS signals (humidity information).

5. E-ASAP – Radiosonde obs from marine vessels



6. E-SurfMar – Obs from marine vessels & buoys



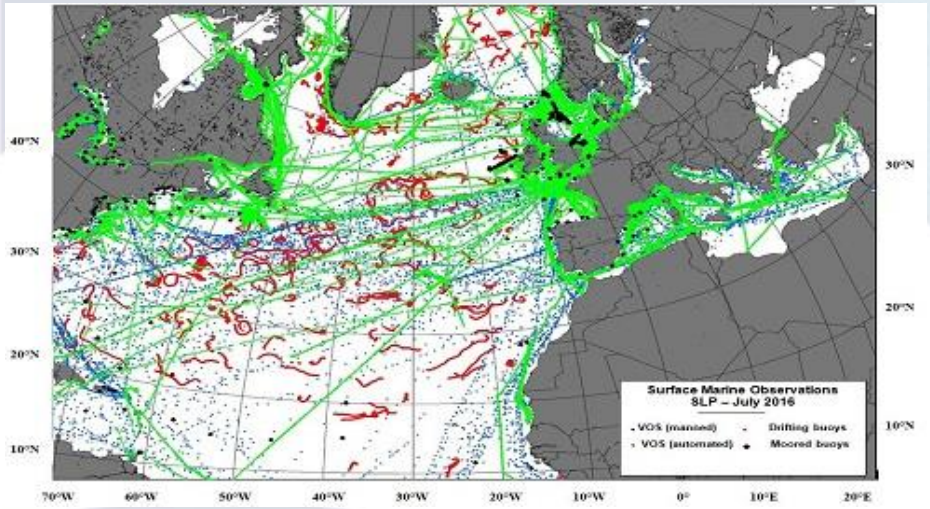
7. AutoPollen – Obs from Automatic Pollen monitoring systems.

8. OBS CA MP –

- Oversee the delivery of all eight OBS Programmes.
- Set and monitor performance standards for all EUCOS networks.
- Manage the development and delivery of a coordinated R&D plan.
- Deliver the Regional WIGOS Centre functions for EUMETNET Members.
- Manage the delivery (and then operation) of a new system to enhance data exchange (E-SOH).
- Manage the delivery of the *new* IoT module.

Marine programmes

are dedicated to performing observations at sea, mostly North Atlantic and Mediterranean Sea.

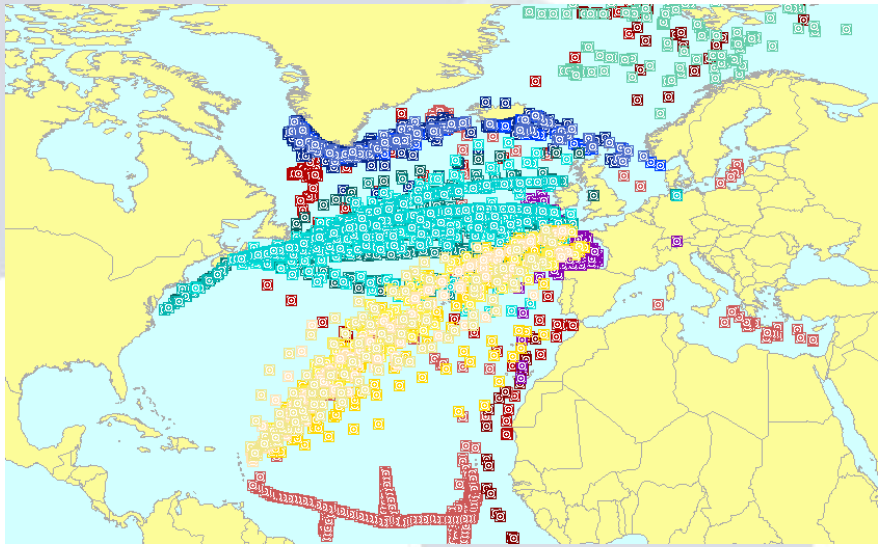


E-SURFMAR

Buoy
- ~ 150 daily operating drifting buoys;
- ~ 110 daily operating moored buoys.

VOS fleet

2000 vessels:
- 25% have an AWS, which produce 75% of the data ;
- 75% are manual systems, which produce 25% of the data.

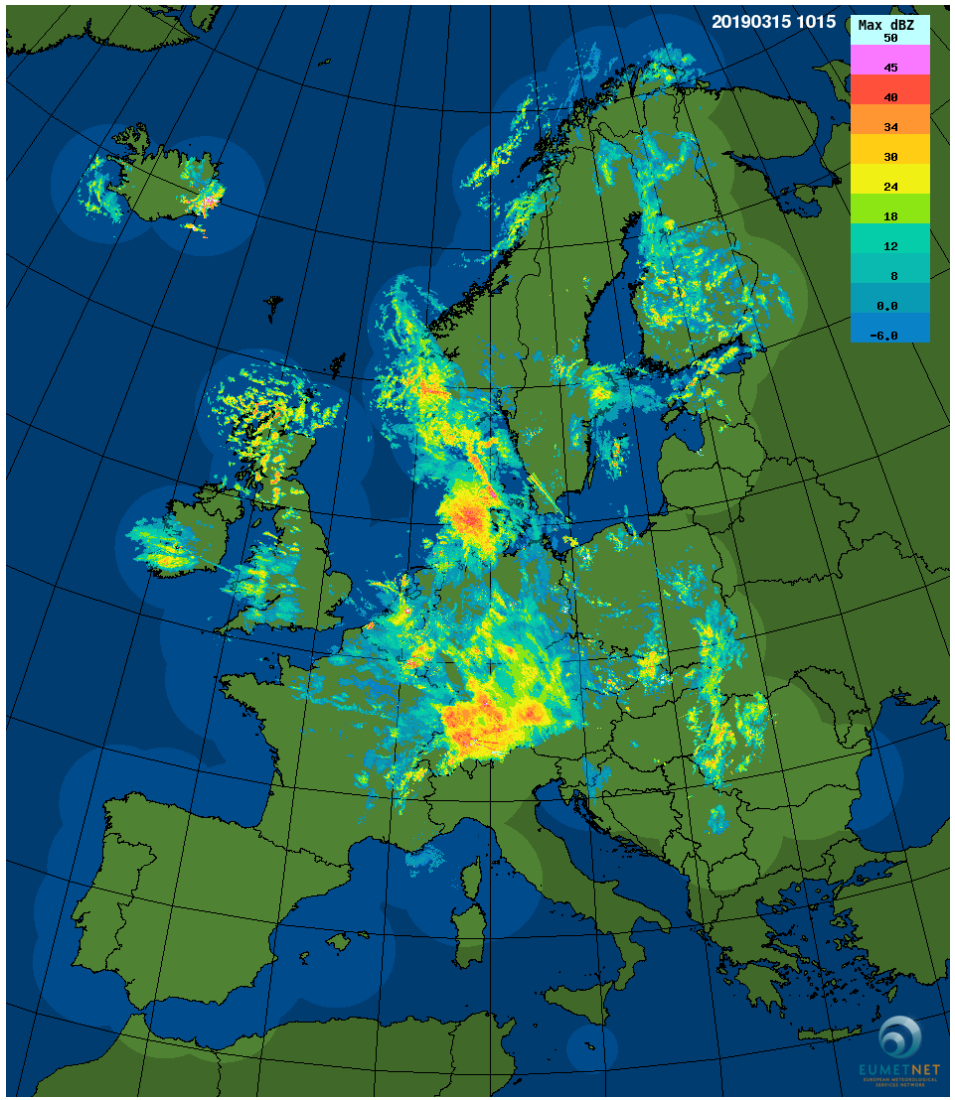


E-ASAP

16 units operated by E-ASAP (in collaboration with Météo France, DMI, and AEMET) distributing around 3000 soundings via GTS per year.

Upper air programmes

collect data acquired by Members nationally, provide calibration and quality control tools for these data and produce added-value products.



OPERA - Radar

FMI

Process data from around 180 weather radar in near-real time.

OPERA provides:

- Max reflectivity composite, 1km resolution, every 5 min.
- Precipitation composites (instantaneous rain rate and 1h accumulation), 2km resolution, every 15 min.

Upper air programmes

collect data acquired by Members nationally, provide calibration and quality control tools for these data and produce added-value products.

E-PROFILE

Wind profile network – process and share wind profiles in near–real time from wind profilers, weather radars and Doppler wind lidars

radar wind profilers WP Europe, Australia, Canada

precipitation radars WRWP

Doppler wind lidars

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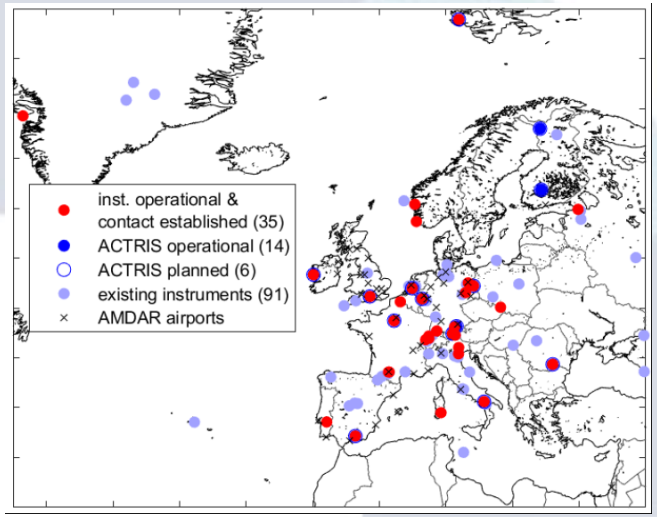
E-PROFILE

Ash and aerosol profiling network:

- Backscatter profiles from Automatic Lidars and Ceilometers (ALC) generated every 5 mins from a network of 400+ instruments.
- Information on the horizontal and vertical distribution of ash in the case of a volcanic eruption.



Temperature and humidity from microwave radiometer network:

- Pilot network with 10 stations
- Target by end of 2028: 40

Products: temperature and humidity profiles, brightness temperature.

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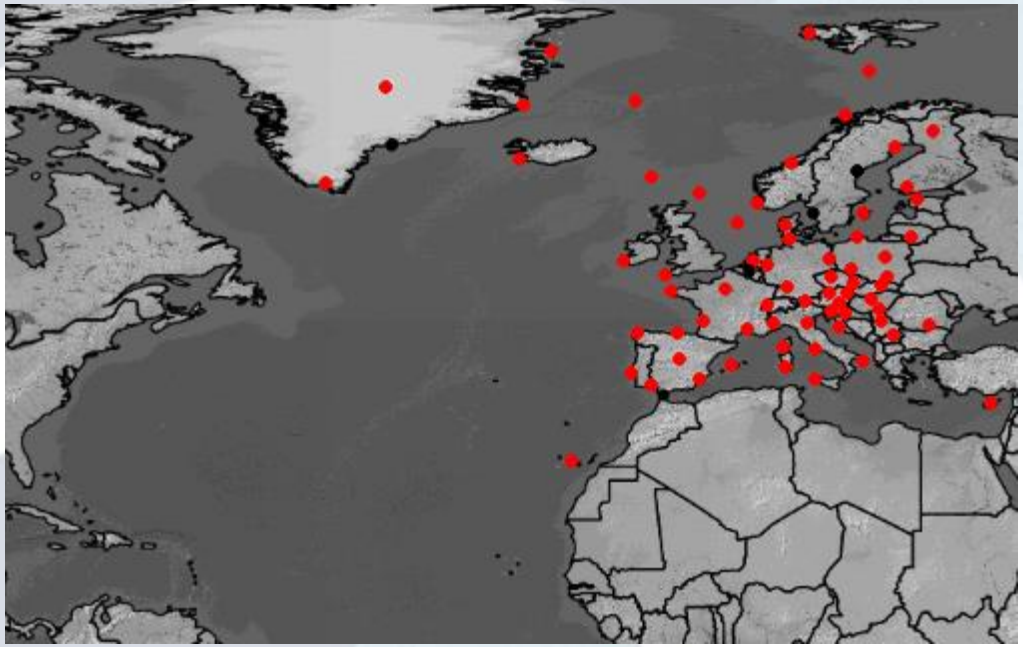
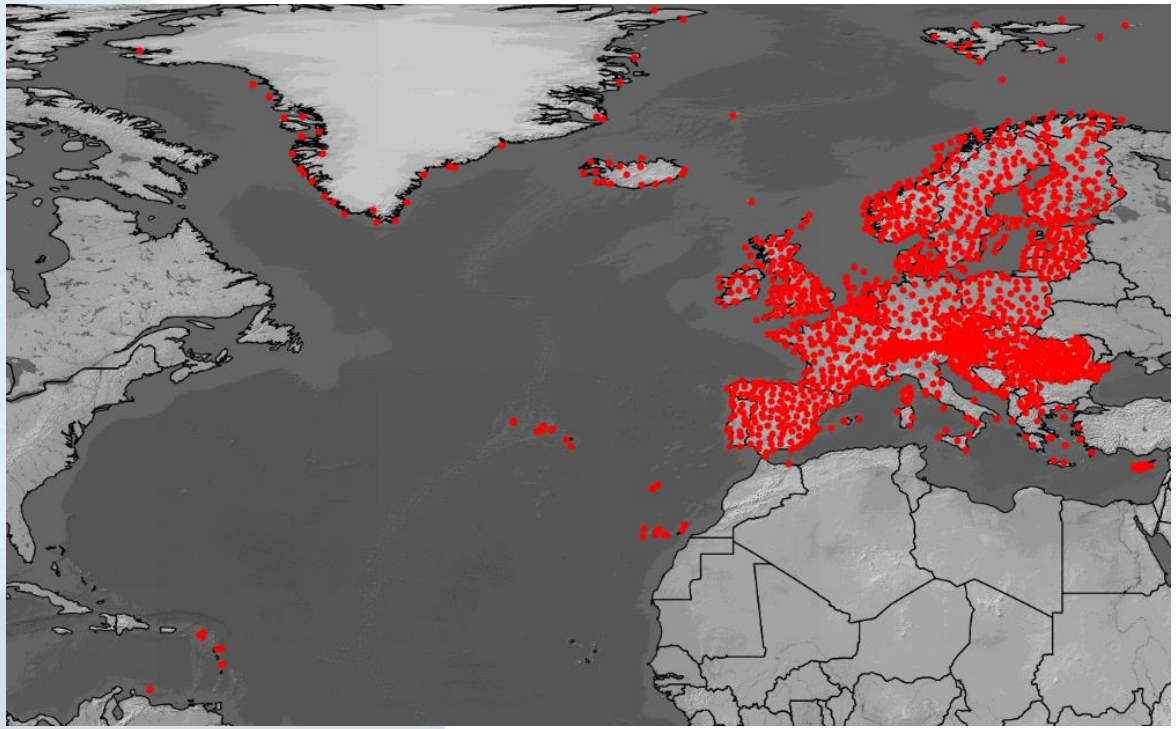
National programmes

Land Radiosondes



- ~ 74 GBON land stations based on a 500 km spacing,
- providing 1 to 2 sounding per day at 00UTC and 12 UTC (profiles of temperature, wind, pressure, and humidity),
- reaching 20-35km.

Land surface stations



- 1,938 GBON surface stations according to a 250 km spacing, providing hourly or 3-hourly reports.
- Reports generally contain wind speed and direction, air temperature, dew point temperature, humidity, pressure, snow depth, cloud height and type, max. gust, rainfall accumulation, solar radiation.

Bioaerosol programme

Partnerships with non-meteorological organisations to share non-conventional types of weather observations

AutoPollen

Operation.

There are now over 60 instruments in operation monitoring pollen across Europe.

Intercomparison Campaign.

Planning an intercomparison campaign, in 2025-2026.

Development.

Network expansion. Improving data quality using AI techniques (as part of the SYLVA project).

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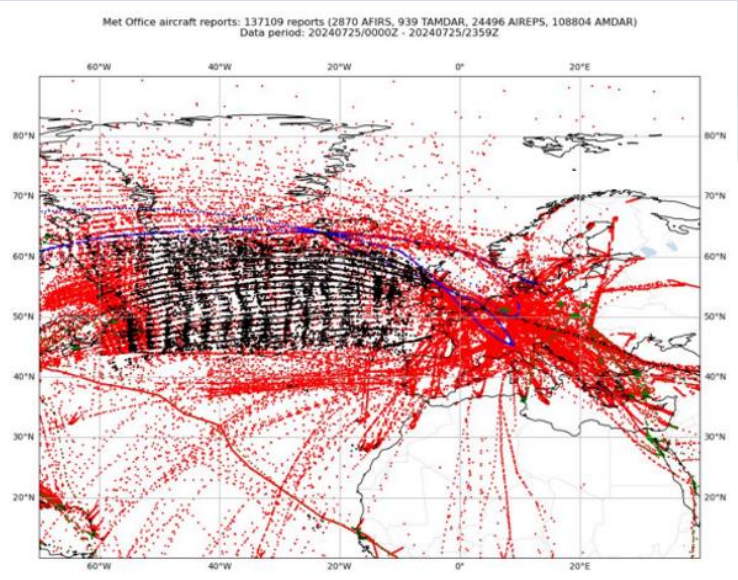
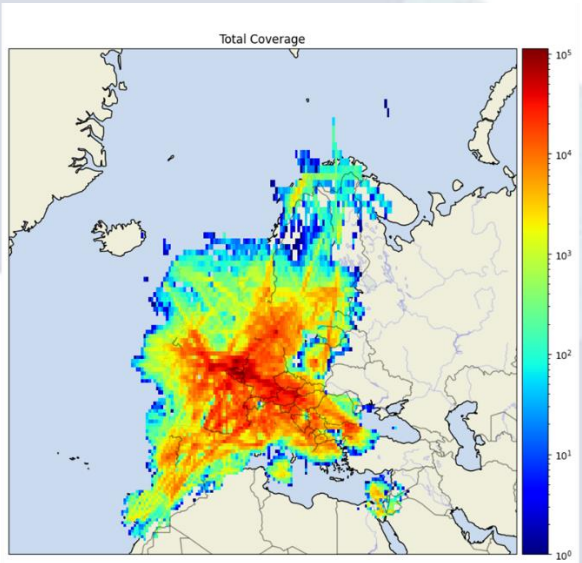
Upper air programmes

create partnerships with non-meteorological organisations to access non-conventional types of weather observations

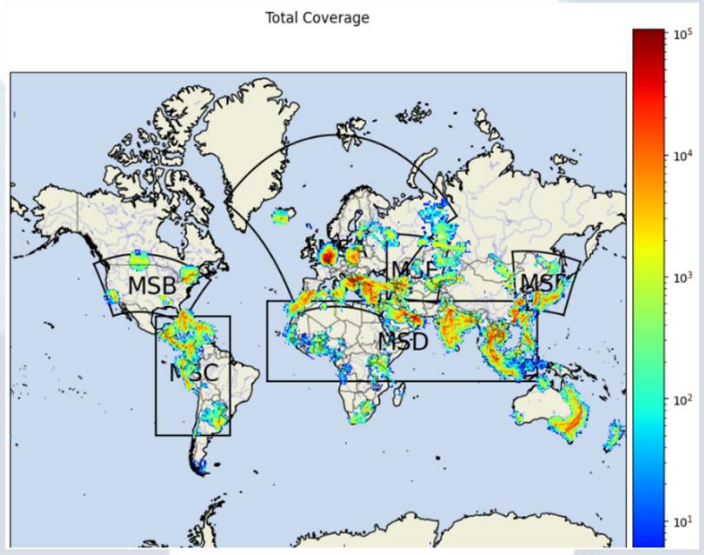


E-ABO

- AMDAR **temperature and wind** observations funded by EUMETNET including **humidity** data of 9 WVSS-II equipped aircraft,
- On average ~ 1,000 **temperature and humidity profiles** per day from 130 European airports.
- Huge amount of opportunistic Mode-S data collected (more on this in a minute)



European MODE-S Coverage – single day



Global MODE-S Coverage – single day

Network expansion.

New - KLM providing AMDAR data en-route to and over the Caribbean, Africa, and S. America, including GNSS height.

Global Mode S provided by the Met Office and EMADDC.

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Operational opportunistic observations

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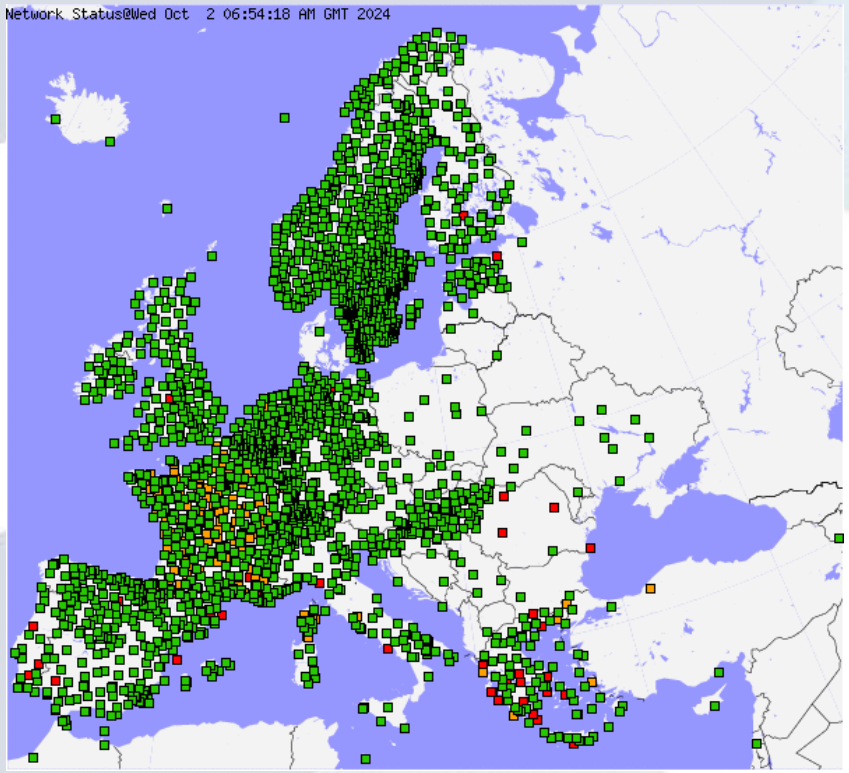
E-GVAP



E-GVAP provides:

- GNSS **zenith total delay** (ZTD) estimates and **integrated water vapour** (IWV) for more than 3500 unique sites, most of them in Europe, but also from other continents.
- In total about 25 million ZTDs are generated every month .

Main focus:

- Improving Data Timeliness.
- Improving Data Coverage.
- Sub-hourly ZTD data.

Partnership.

E-GVap provides a collaboration framework to access, free of charge, GNSS-derived products from geodetic institutions.

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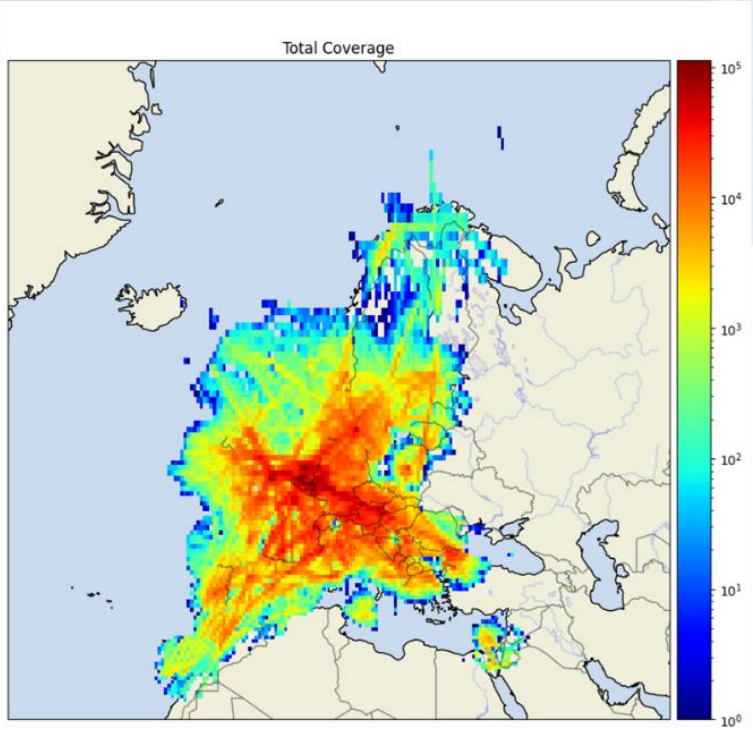
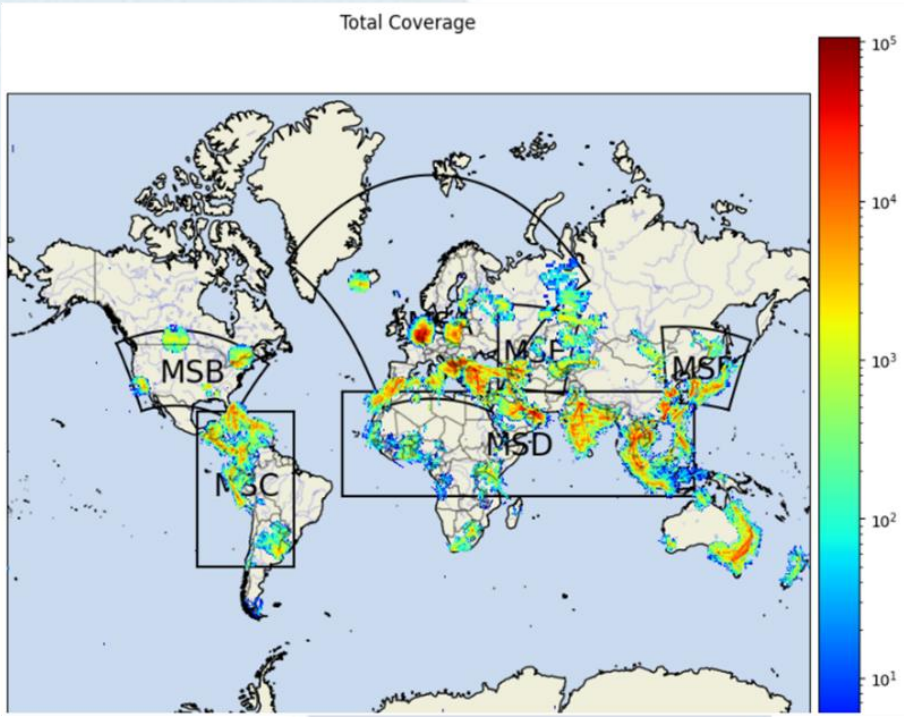
Mode-S



European MODE-S Coverage – single day



Global MODE-S Coverage – single day

Millions of wind and temperature from derived from air traffic control reports every day

Global Mode S provided by the Met Office and EMADDC.

Now assimilated in most global weather forecasting models, giving large impact on forecast skill

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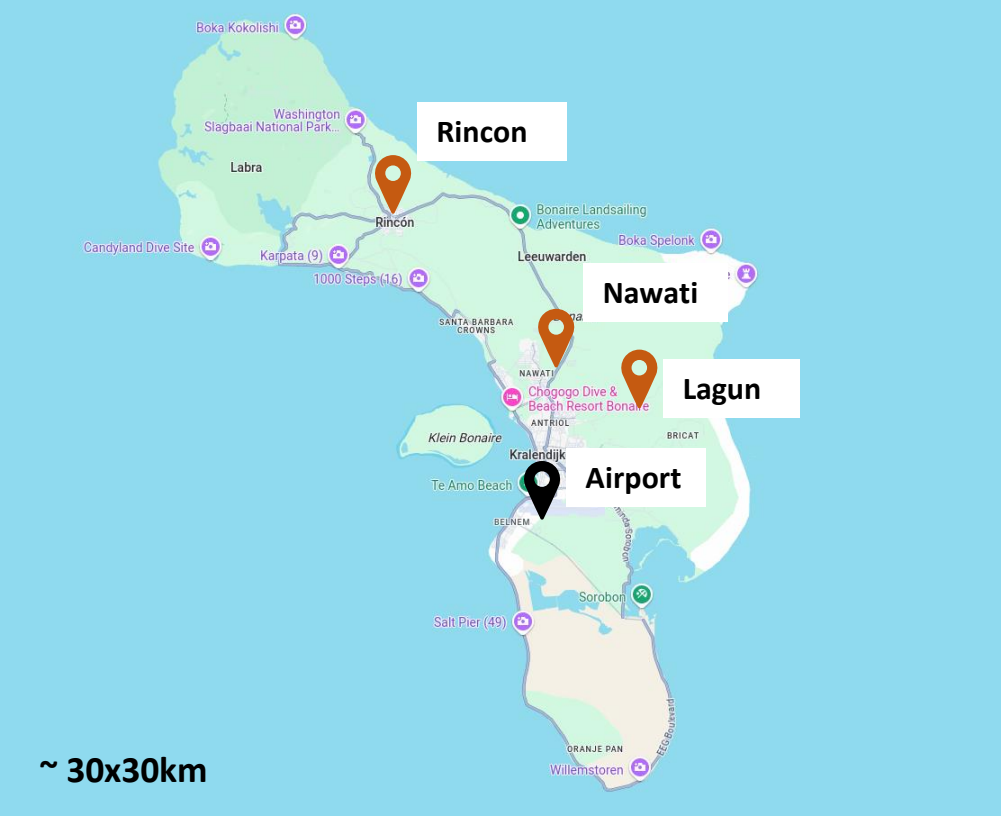
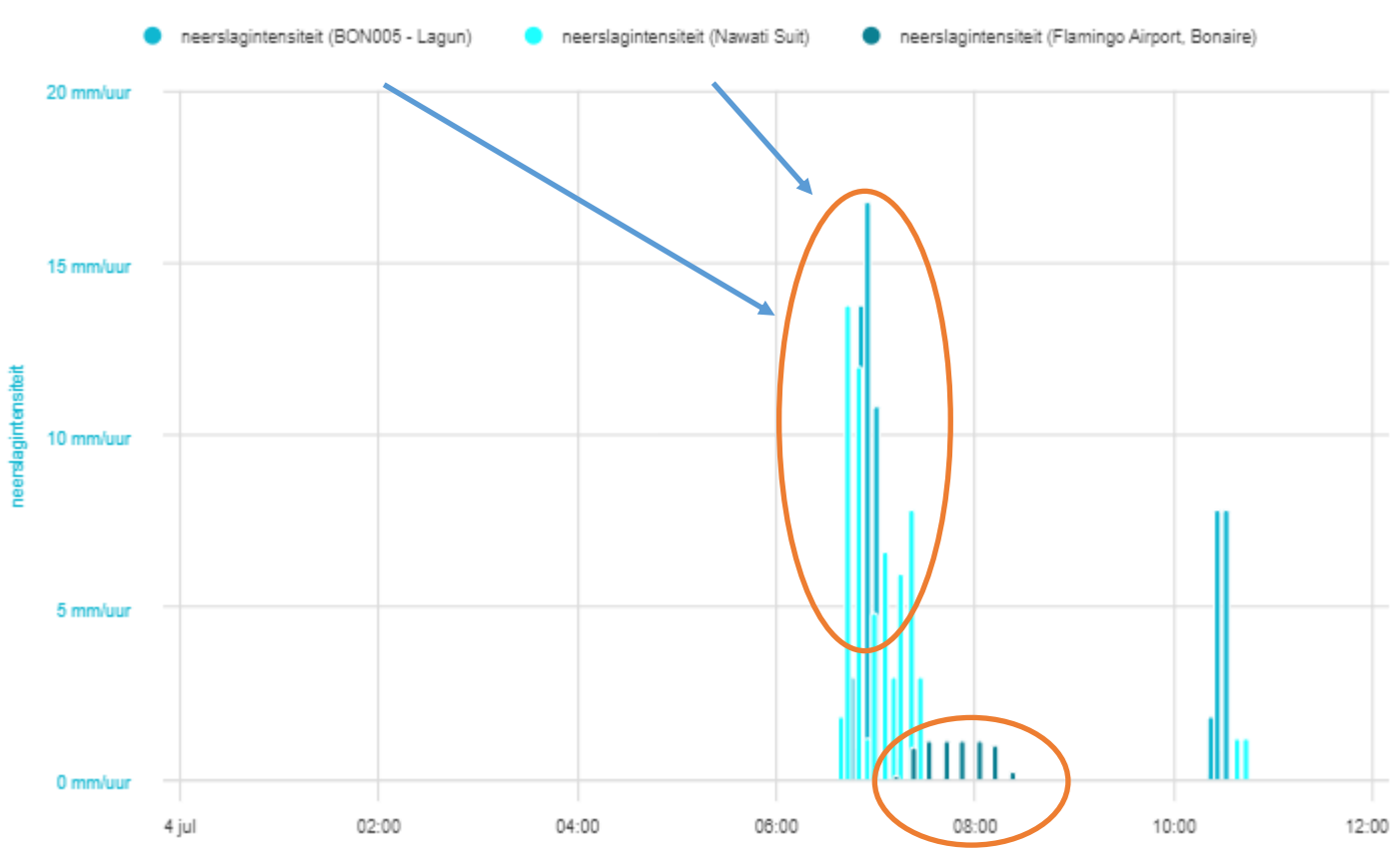


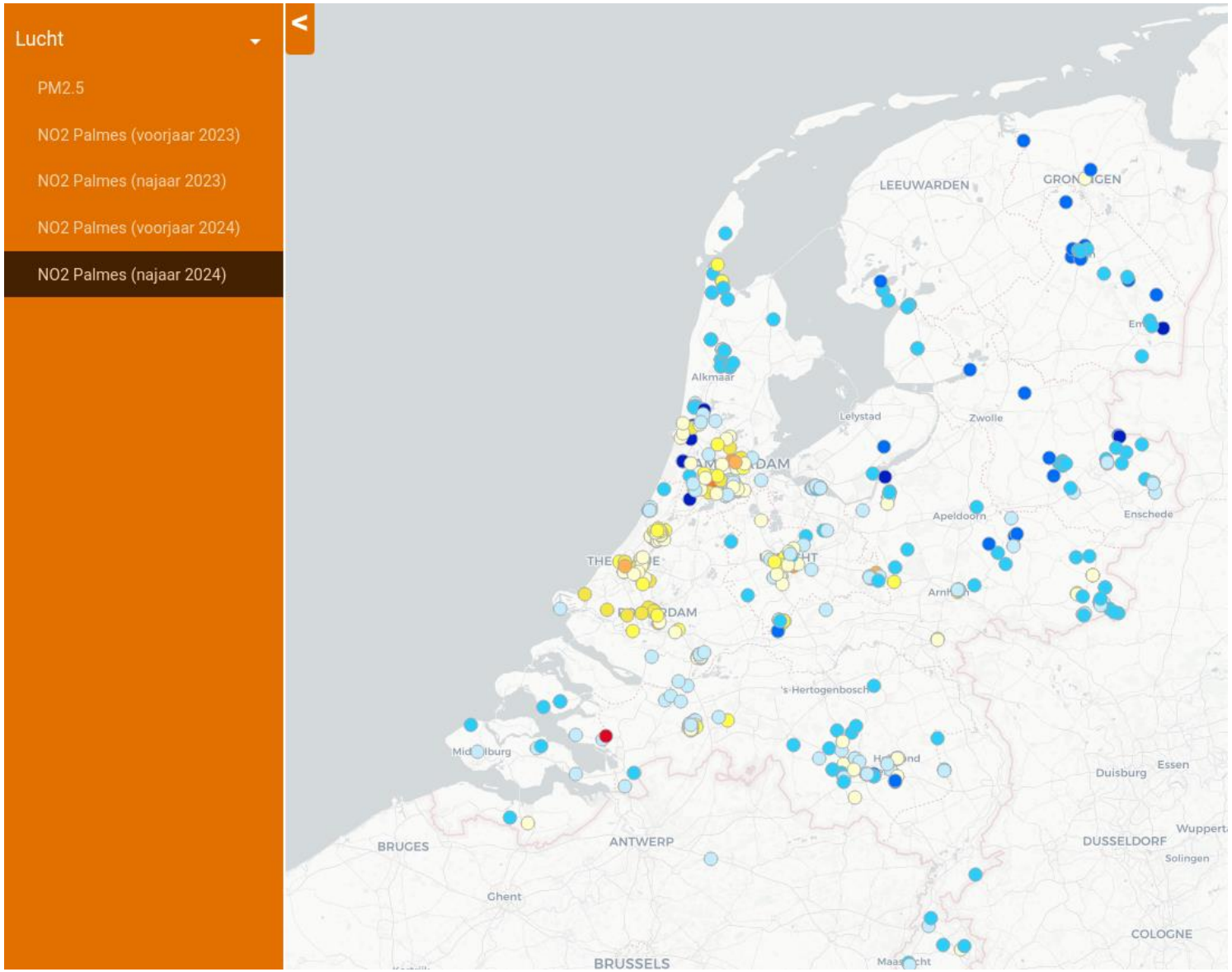


KNMI WOW data use

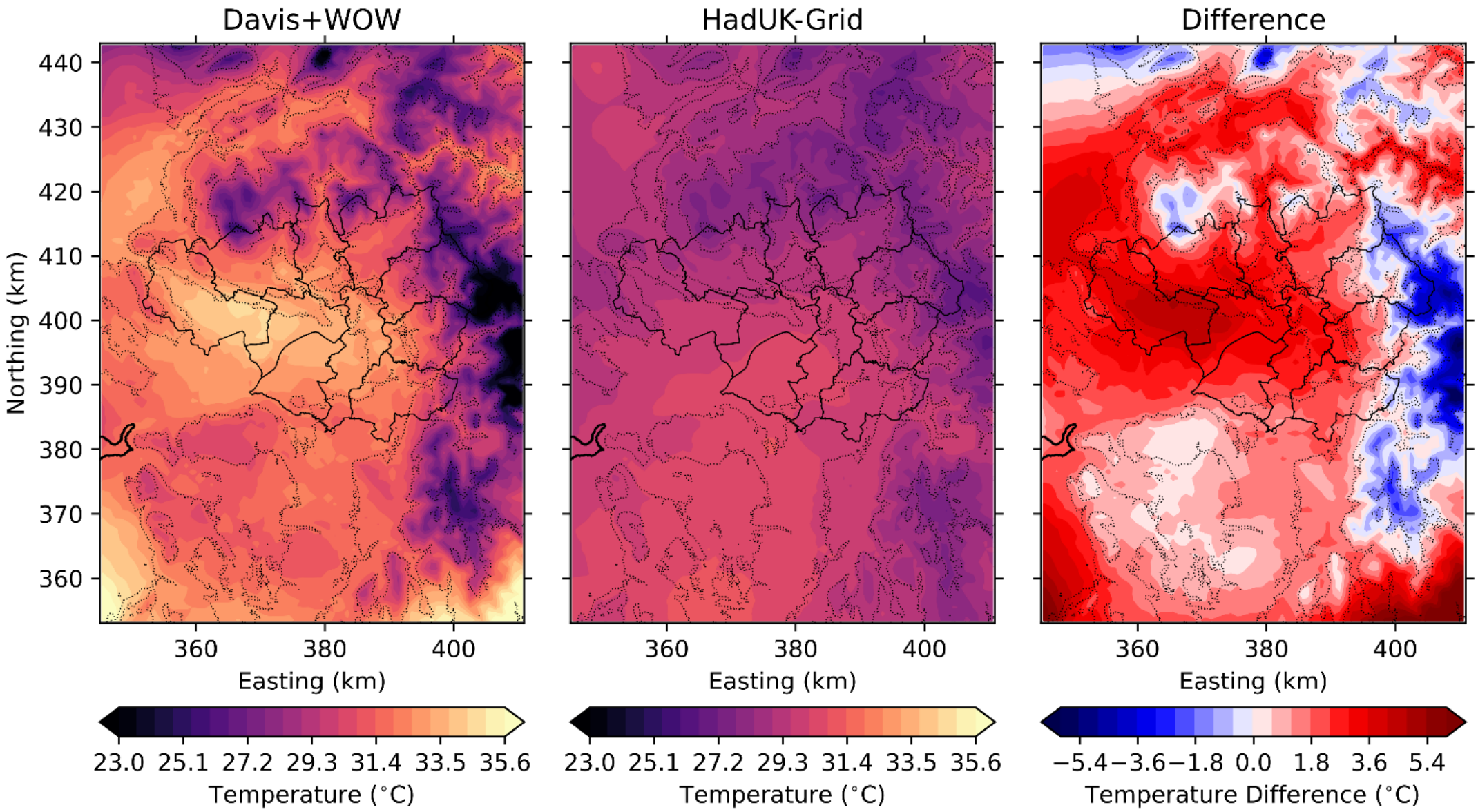
"WOW stations proved their added value during the passage of a shower. At 6:37 Dutch time, precipitation was measured at WOW station Nawati Suit. A shower developed quickly above the island and at 6:55 Dutch time, an intensity of 16.8 mm/hour was measured at WOW station Lagun. Showers of this intensity can cause local nuisance. If the meteorologist had only looked at the official KNMI station, this would have produced a completely different weather picture: at this station near the airport, only 1.1 mm/hour was measured"

KNMI crowdsourced air quality

“Twice a year, about 40 schools participate in a national air quality measurement campaign. Each school receives 10 air sample tubes. Students are free to choose measurement locations. The tubes measure for 4 weeks and are sent to a lab for analysis. I use this data for comparison against satellite measurements of NO2. Data quality control is here important of course, and I am experimenting with different strategies. Check: https://globenederland.nl/onderzoeksprojecten/stikstof/ “

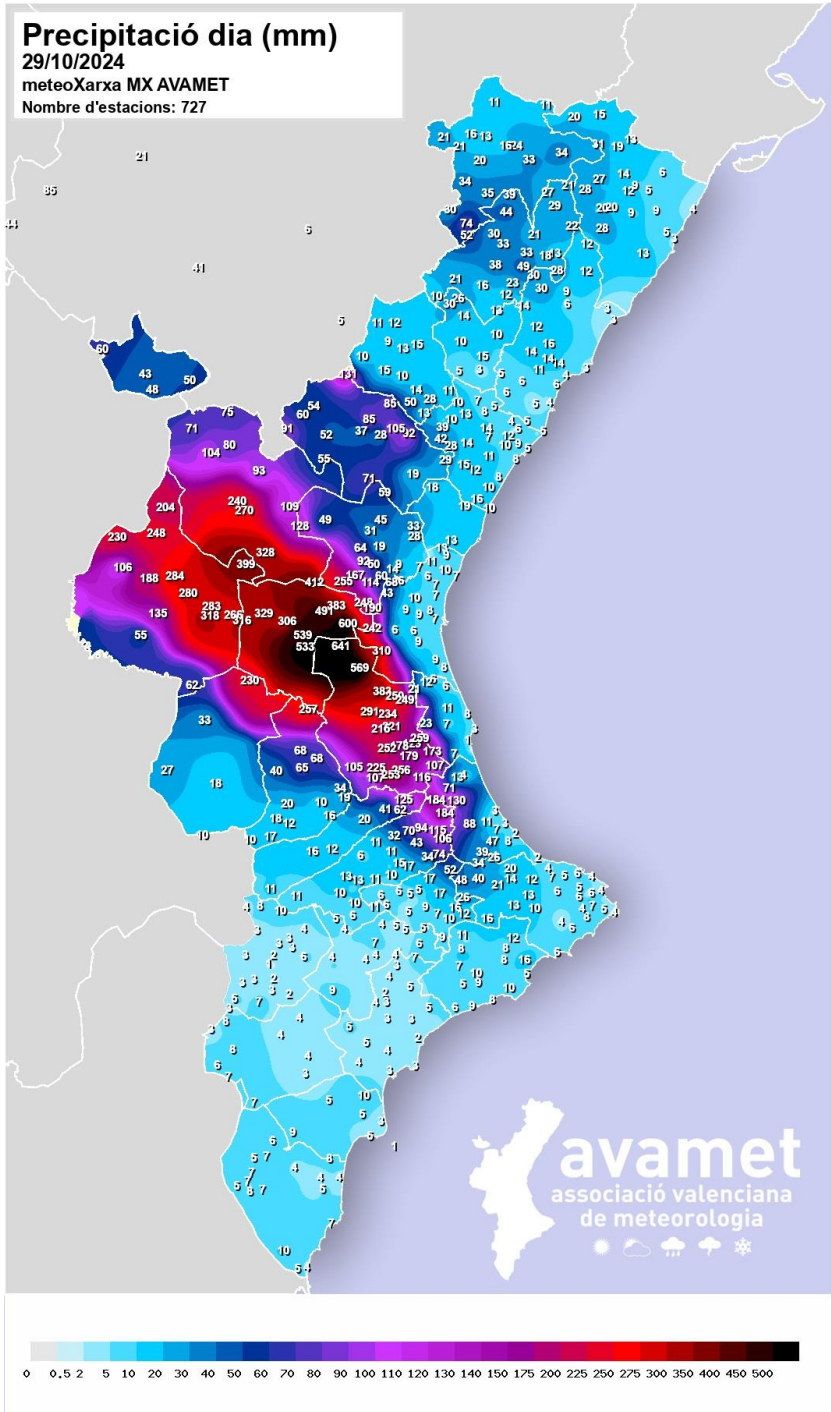


UK Met Office use – urban heat island climatology



Valencia floods October 2024

- PWS data proved invaluable during and after terrible storms in Valencia
- Over 600mm in 24h, much of that in only a few hours
- We are working with AVAMET to incorporate their data into our datahub (more on data access later…)



Previous R&D and collaboration across EUMETNET

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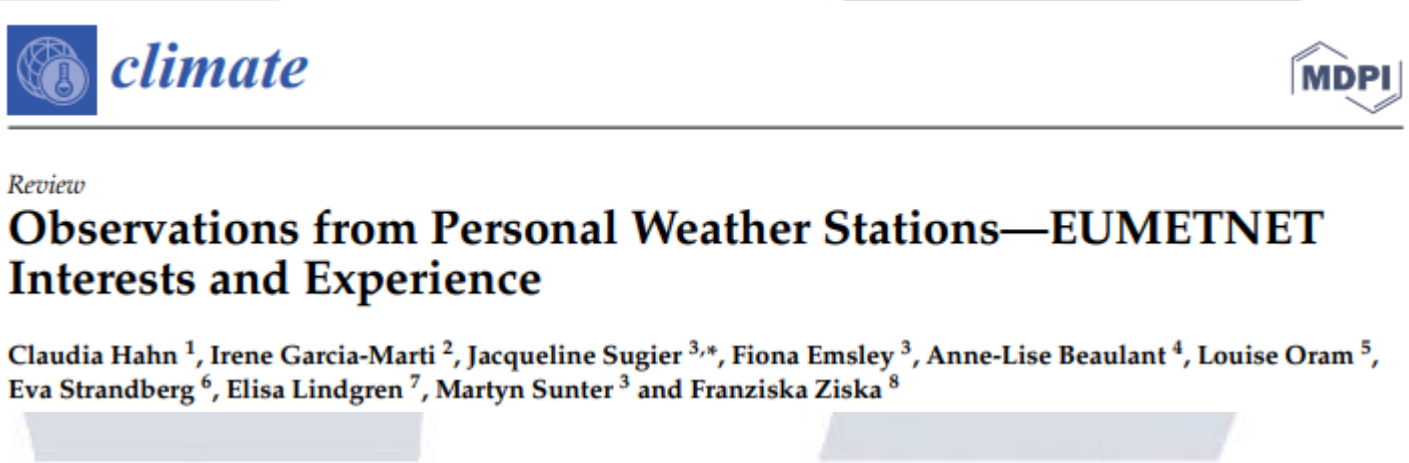
Working Group on crowdsourced observations

- Fostered close collaboration on 3rd party data
- Wide range of members, including several now involved with Opensense
- Helped EUMETNET understand 3rd party data use by Members at a strategic level
- Due to success, WG is now a full ‘module’ within the EUMETNET observations programme

EUMETNET paper on PWS data use

- Useful summary of PWS data use, and informed thinking for future strategy



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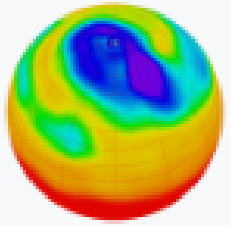
EUMETNET sandbox



Centre for Environmental Data Analysis

SCIENCE AND TECHNOLOGY FACILITIES COUNCIL
NATURAL ENVIRONMENT RESEARCH COUNCIL

2 archive PWS datasets for research and investigation by EUMETNET Members:

- WOW dataset open to all for 2020
- Netatmo dataset open to EMN Members for 2020

https://catalogue.ceda.ac.uk/uuid/e8793d74a651426692faa100e3b2acd3/

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R&D study: evaluation of automatic QC algorithms for PWS data

- Data available from Netatmo and WOW over EUMETNET Member countries
- Investigated validity of variety algorithms at European scale
- Conclusions showed how important processing and cleaning the data is

- This informed EUMETNET's strategy on IoT data, which evolved into the IoT Pilot project…

Current IoT and opportunistic observations work

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IoT observations for NWP pilot project

- Build the alpha version of a community platform to share IoT observations
- Ingest, pre-process, format and make accessible observations to all EUMETNET and ECMWF members
- Establish relationships with data providers
- Manage IoT data exploitation within GDPR legislation and business constraints
- Explore funding opportunities to sustain this activity in the long term

ECMWF

Danmarks Meteorologiske Institut

Met Office

Norwegian Meteorological Institute

Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat

FINNISH METEOROLOGICAL INSTITUTE

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IoT observations for NWP pilot project

- Initial focus will be on PWS and smartphone pressure data
- Project extension will look at webcam data

ECMWF

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Ministerie van Infrastructuur en Waterstaat

FINNISH METEOROLOGICAL INSTITUTE

Norwegian Meteorological Institute

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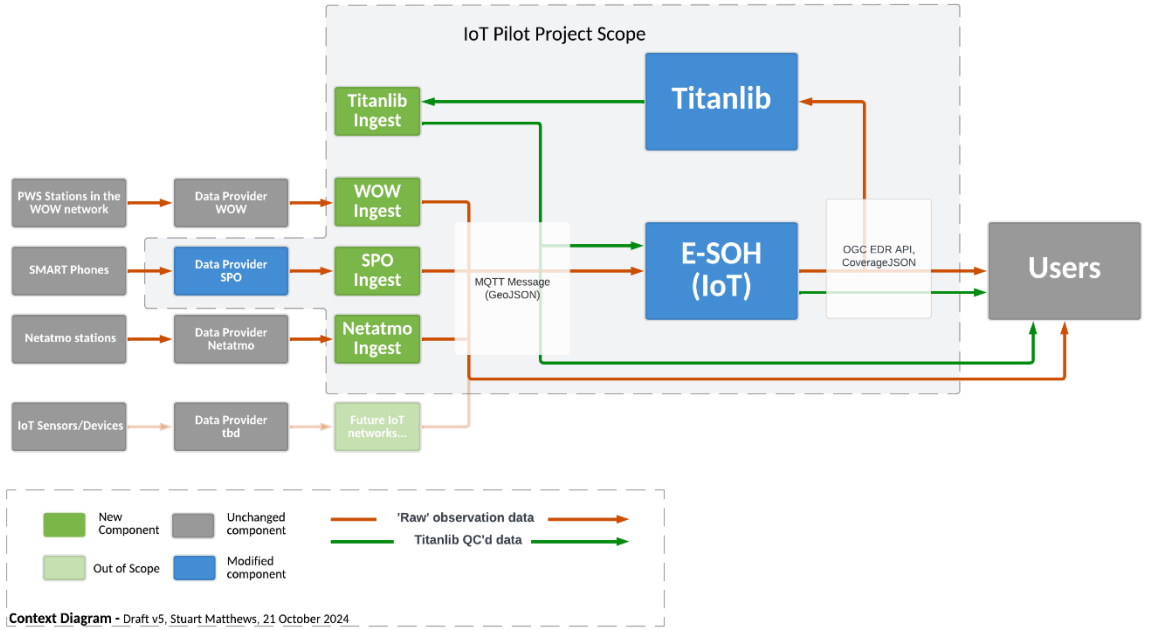
IoT datahub

- Based on E-SOH software with limited modifications:
- New ingestion components for each IoT network.
- Ability to record multiple versions of the same observation. i.e. pre- and post-QC.

TitanLib:

- TitanLib sits outside of ‘E-SOH-IoT’ and use standard OGC EDR APIs to access ‘raw’ IoT data from E-SOH-IoT.
- QCed data will be inputed to E-SOH-IoT via a new Titanlib Ingest component i.e. same method as other input to E-SOH.
- Other QC modules can be added



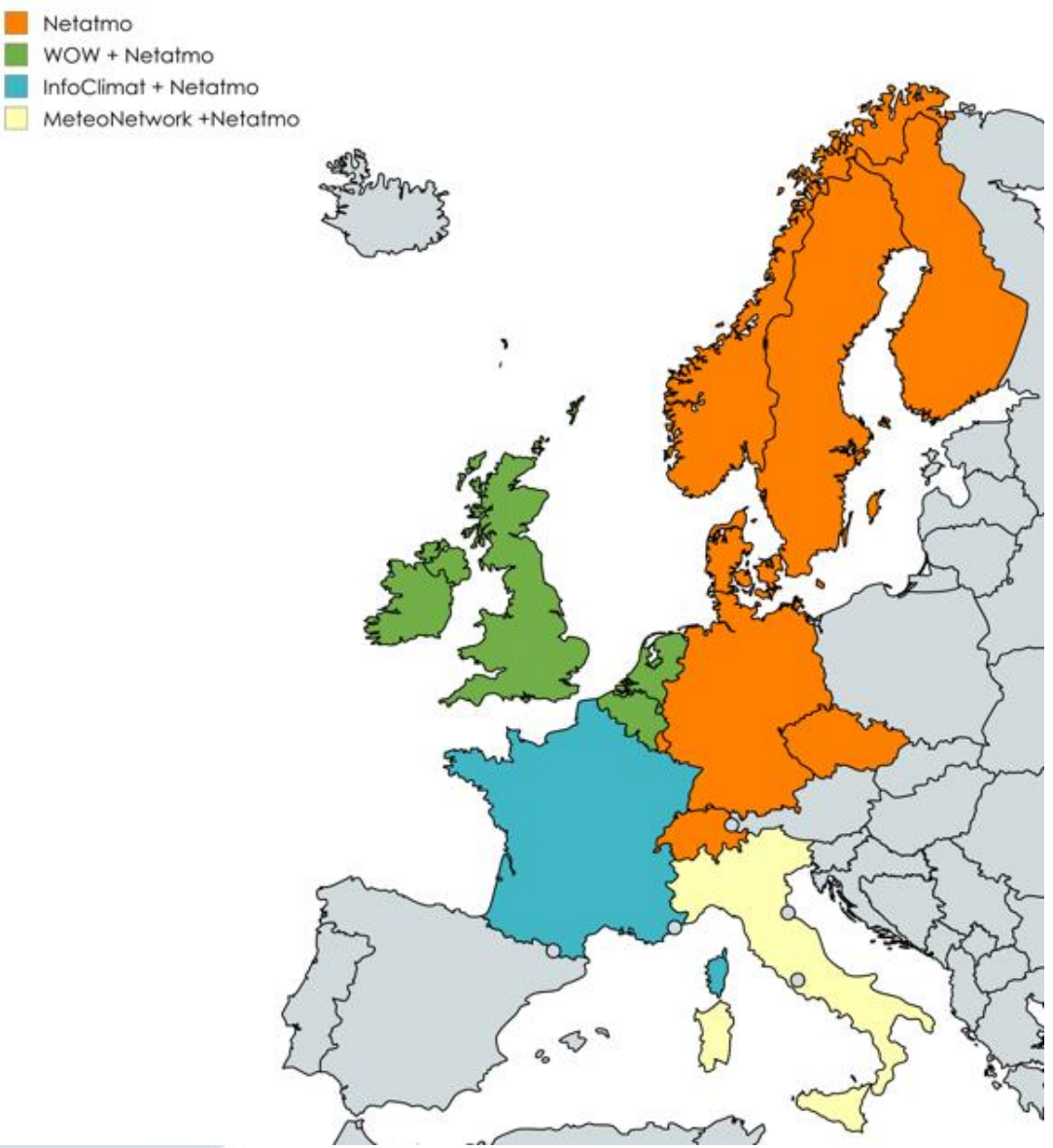
IoT pilot project data access

Data provision (free of charge for Pilot Project):

- Met Office for WOW data (mostly UK, Ireland, Belgium, Netherland).
- DMI for smartphone pressure data (mostly Denmark).

- Netatmo data for 14 countries
- MeteoNetwork (Italy).
- InfoClimat (France).

Providers and coverage of PWS data access for the Pilot Project



Future IoT and opportunistic data use in EUMETNET

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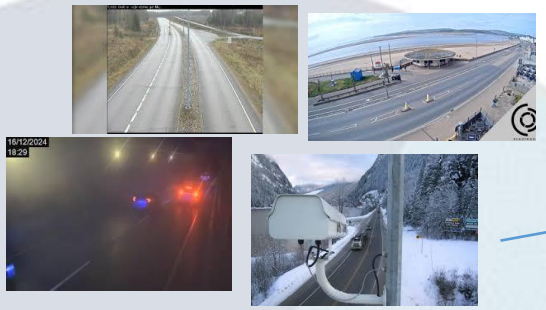
EUMETNET-ECMWF Pilot Project extension

- Incorporate additional IoT data types such as webcam images, increasing the dataset's diversity and demonstrating the system versatility.
- Create ML/AI tools to enhance the exploitation of IoT data, including image identification techniques for webcam data. This will improve the utility of visual data streams for environmental monitoring and forecast verification.



E-SOH-IoT webcam module

Return machine-readable information (numerical value) to categorise the image eg:

- sunny, cloudy, raining, foggy, dry ground, wet ground, snow cover…

ECMWF

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IoT datahub is ready for the next dataset…

- This could be more PWS, smartphone pressure data, webcams, impact data from apps, CML…
- Architecture is flexible and modular
- Can share openly, or restrict access, depending on dataset

What data strategy will we pursue?

Buy "data as a service" from providers? (e.g. Netatmo, Google, phone companies)

=> this can be expensive but has good coverage

Access PWS data for free from enthusiasts? (e.g. Infoclimat, Meteonetwork)

⇒ A lot of work to get coverage over all Members

⇒ Familiar data is easy to work with

Collect more data ourselves? (weather app impact data, smart phone pressure etc)

Our strategy is developing…and will very likely change due to the enormous changes happening with AI forecasting etc…but it's **likely to be a mix of all of the above!**

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Any questions?