The E-PROFILE network for vertical profiling of wind, clouds and aerosols

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Acknowledgement: E-PROFILE team, COST TOPROF, ACTRIS

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Outline

- EUMETNET
- E-PROFILE
- Automatic Lidars and Ceilometers (ALC)
- Calibration, monitoring and validation
- Data access
- A case study
- Next steps
- Summary and Conclusions

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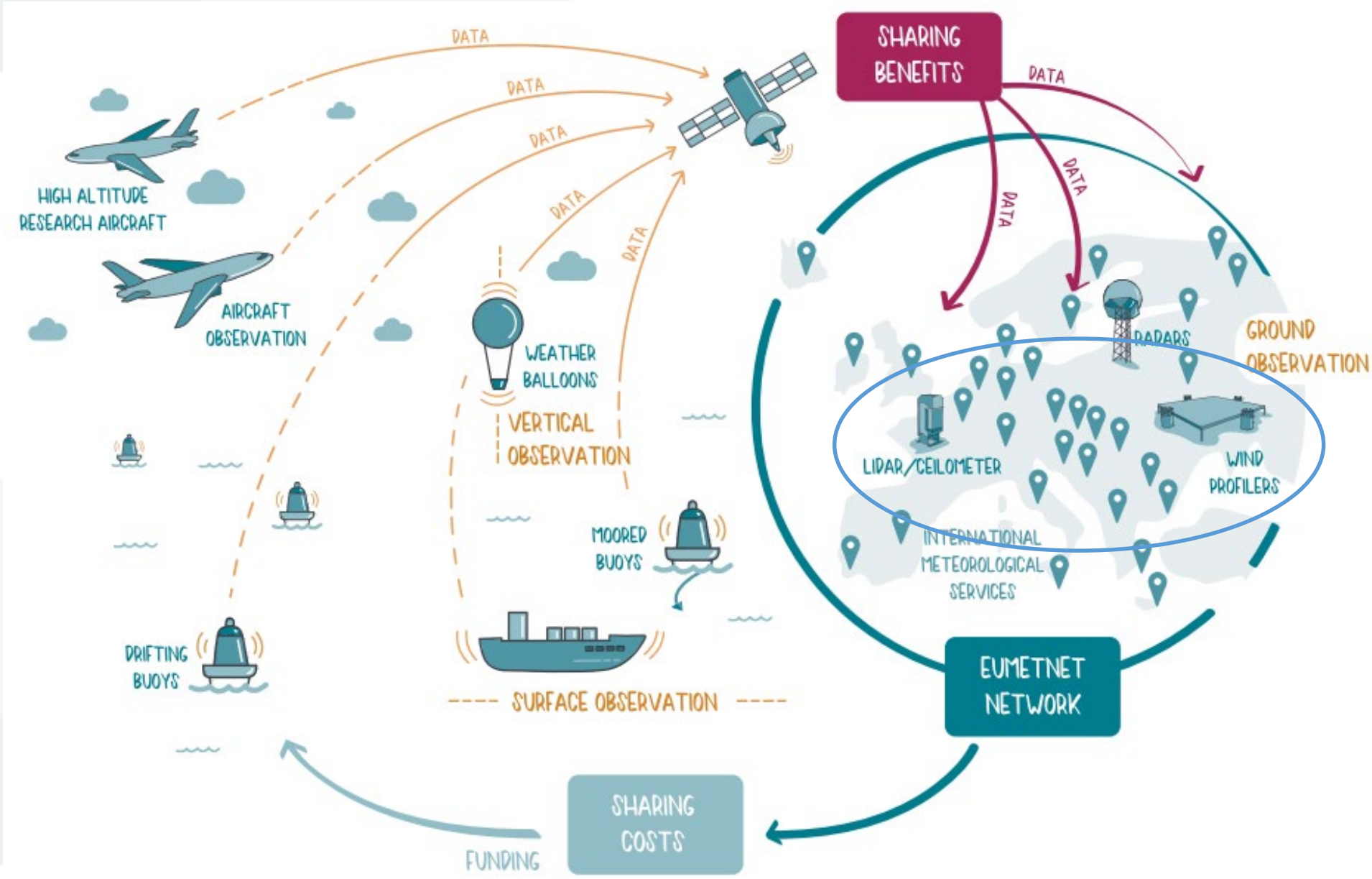
EUMETNET

- 31 Members
- Co-operation
- Sharing costs

In the domains of
- Observations
- Forecasting
- Climate
- Aviation
- R&D



E-PROFILE networks

Wind

- 40 radar wind profilers
- VAD from 96 weather radars
- Doppler lidars from 2022 onward

Ash, Aerosols and clouds

- >380 ALC currently active (still growing)
- Ash mass estimates and extinction coefficient by 2023

BL temperature profiles and humidity (upcoming)

- K- and V-band MWR
- pilot network by 2021/22
- network completed by 2023

The Wind network

- radar wind profilers WP Europe, Australia, Canada
- precipitation radars WRWP
- upcoming: Doppler lidars

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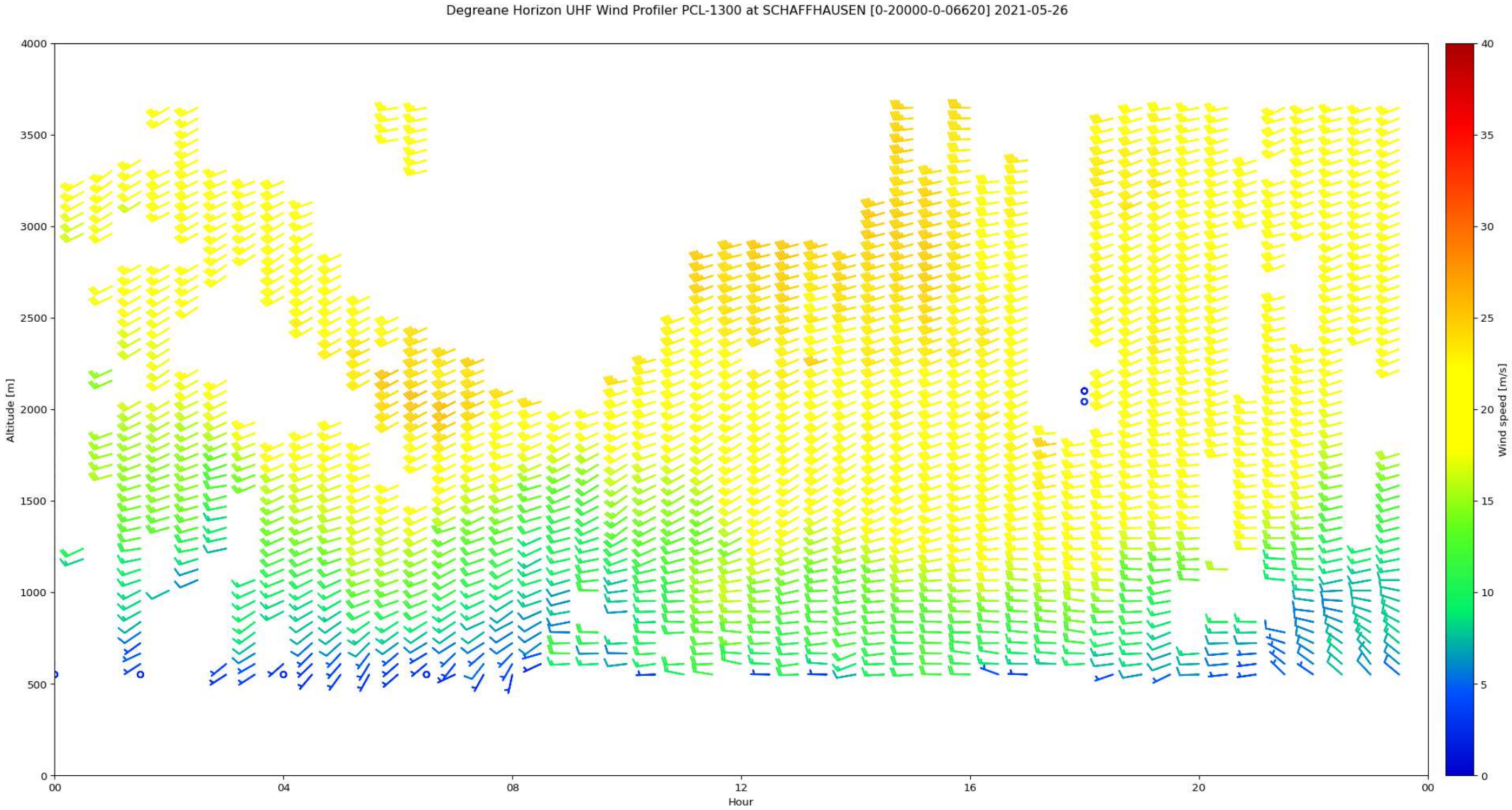
The Wind network



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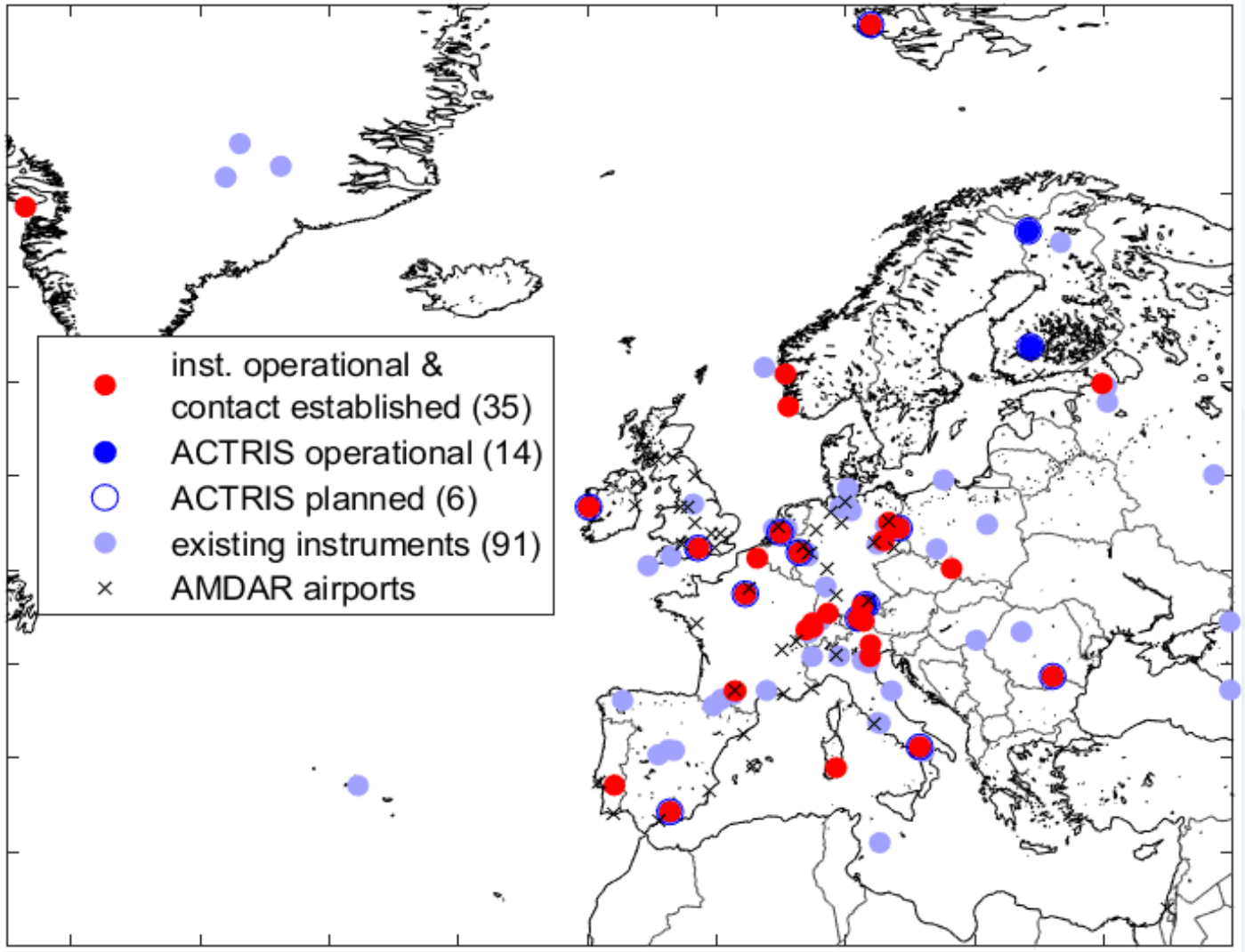
The Temperature and Humidity Network



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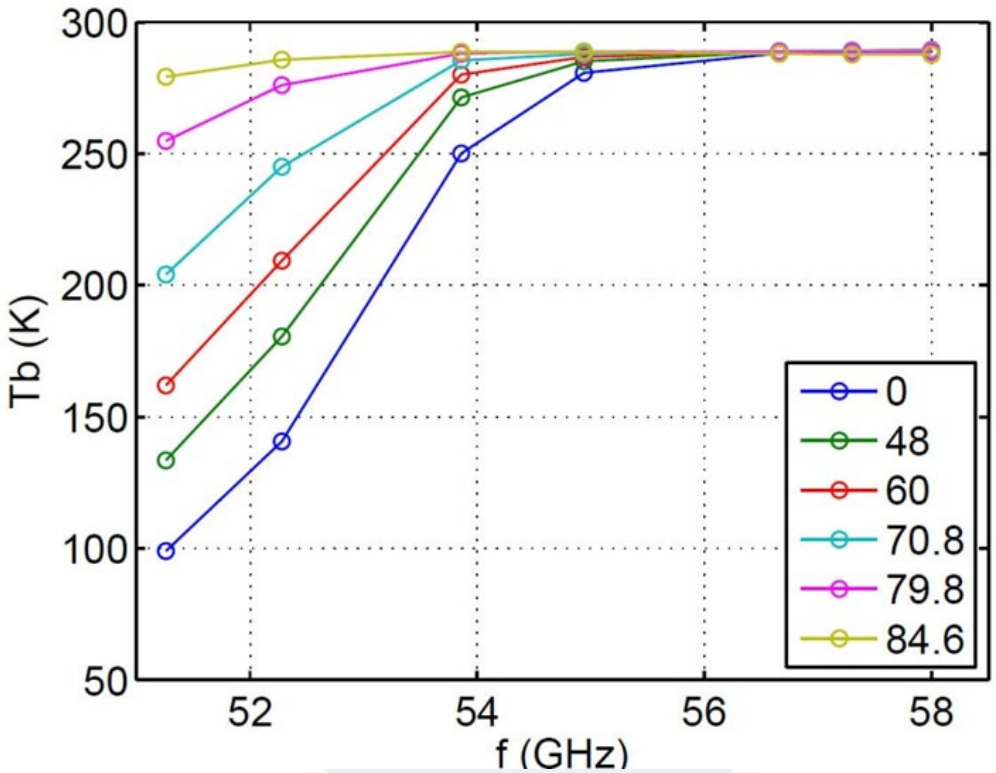
The Temperature and Humidity Network

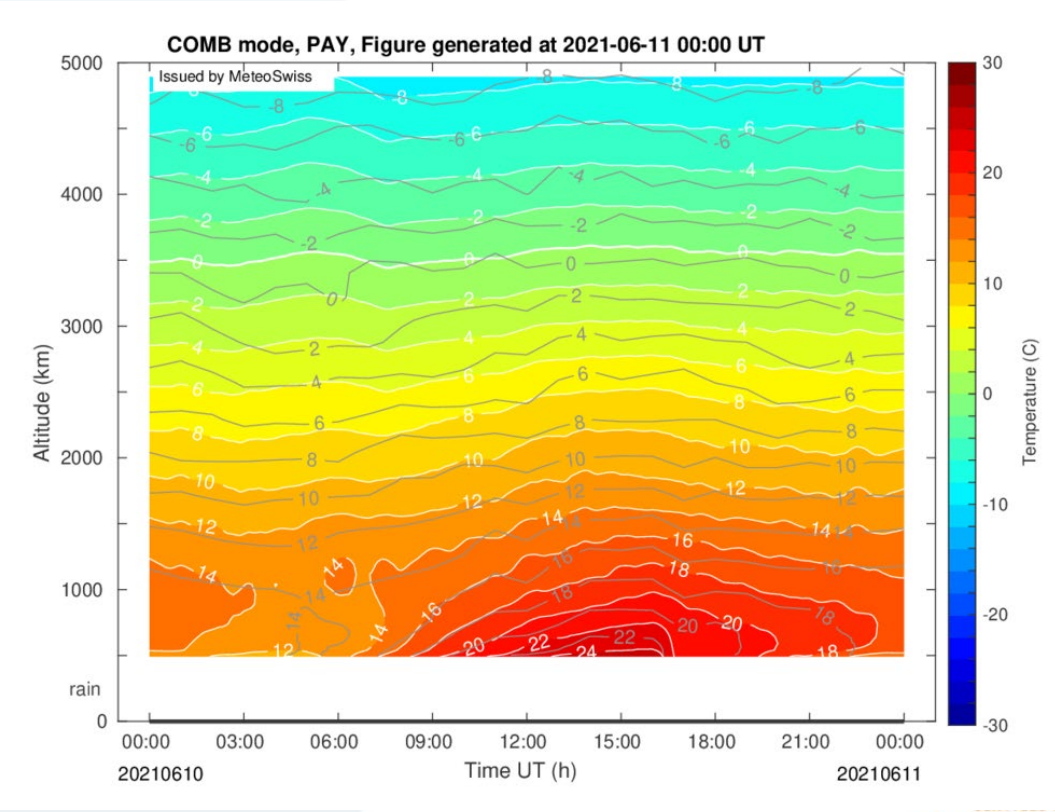
Level 1:

- Brightness Temperature



Level 2:

- Temperature profile
- Integrated Water Vapor
- Integrated Liquid Water



The Aerosol and Cloud Network

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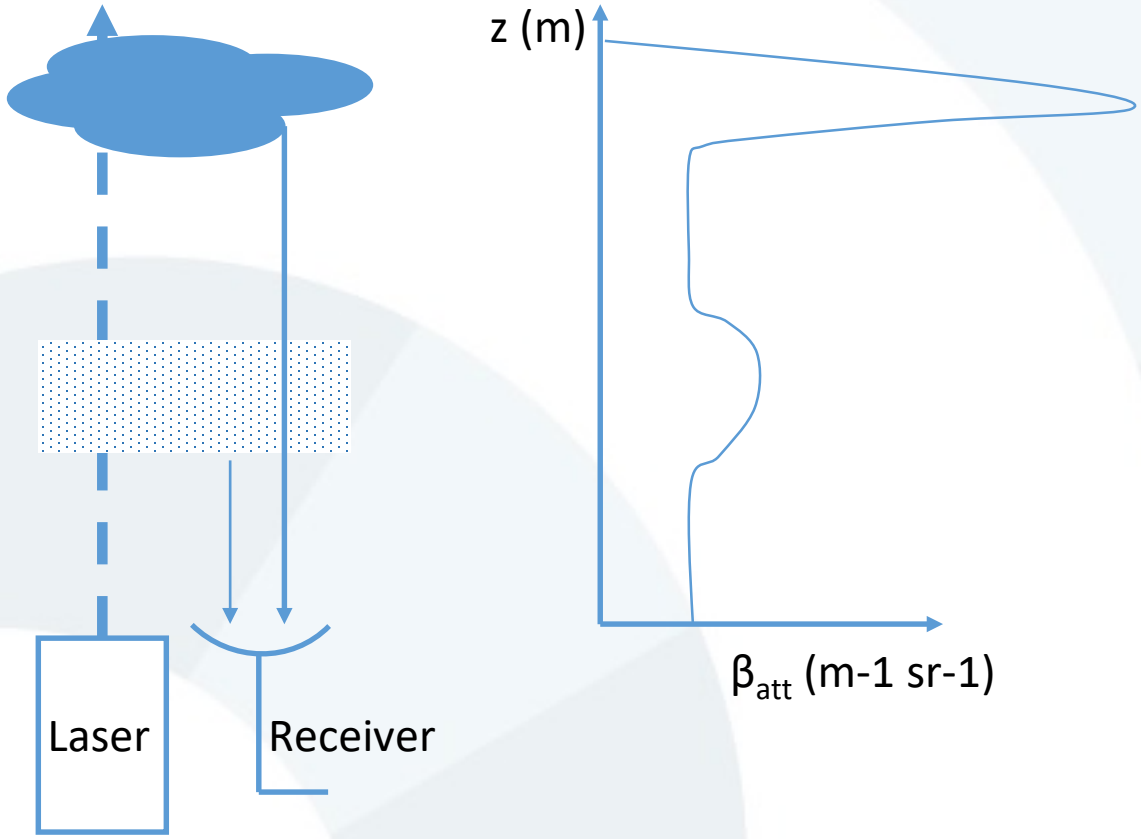
Automatic Lidars and Ceilometers (ALC)

The lidar principle



Three categories

Automatic Lidar

High SNR Ceilometer

Low SNR Ceilometer

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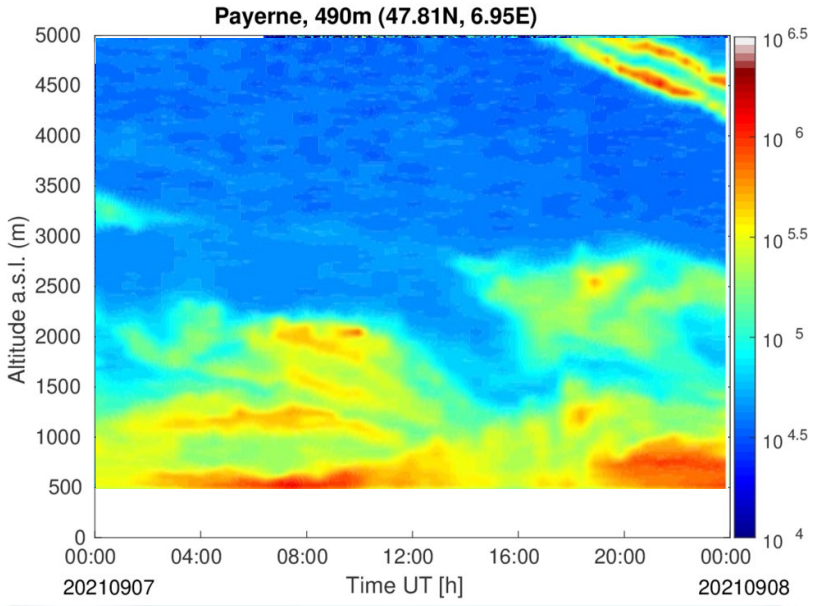
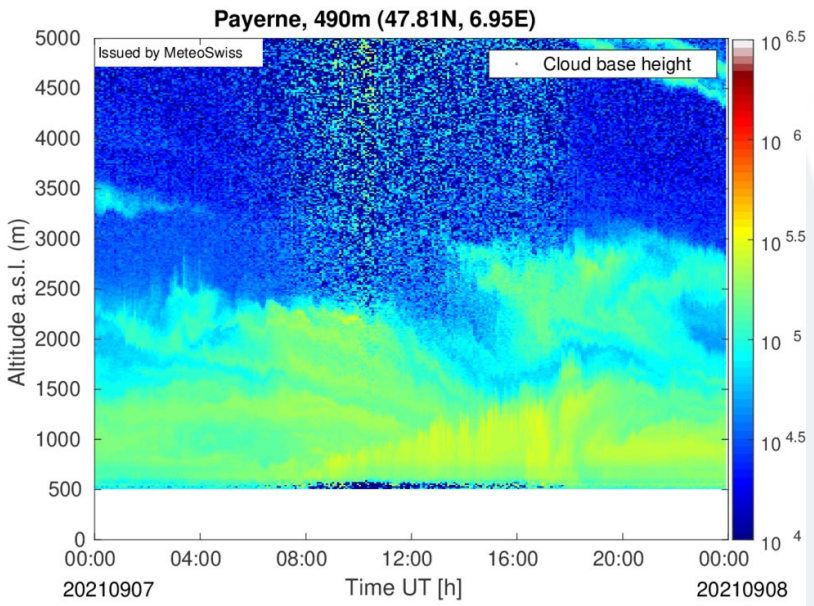
Performance differences

Automatic lidar



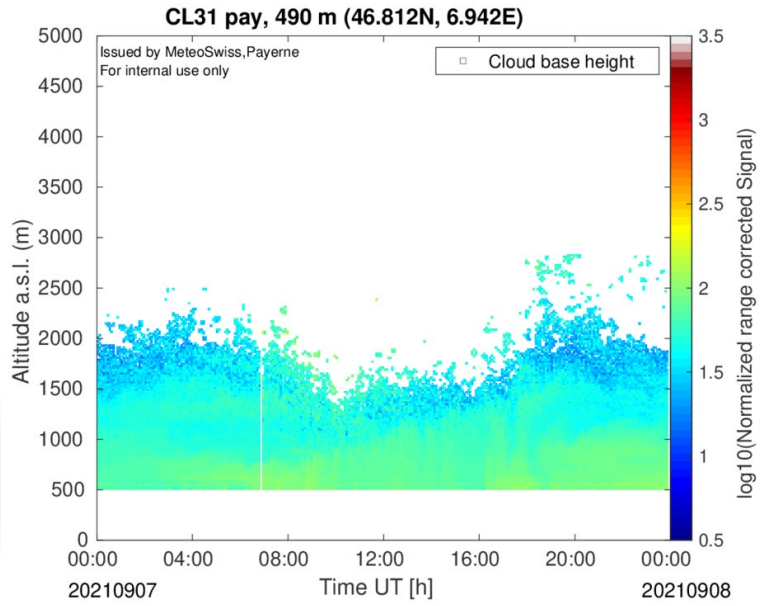
A few instruments.

High SNR ceilometer



1/3 of E-PROFILE

Low SNR ceilometer



2/3 of E-PROFILE

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Attenuated backscatter coefficient

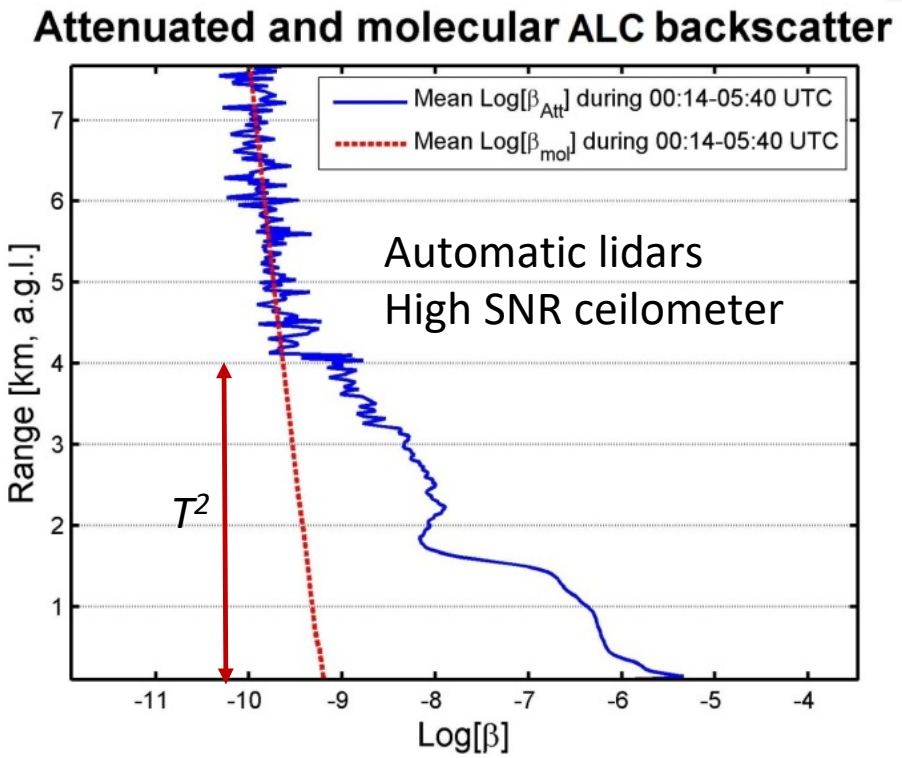
The product of the backscatter coefficient, β, and the two-way transmission between lidar and observed volume, T^2:

$$\beta_{att} = \beta \cdot T^2$$

β_{att} depends on the position of the lidar!

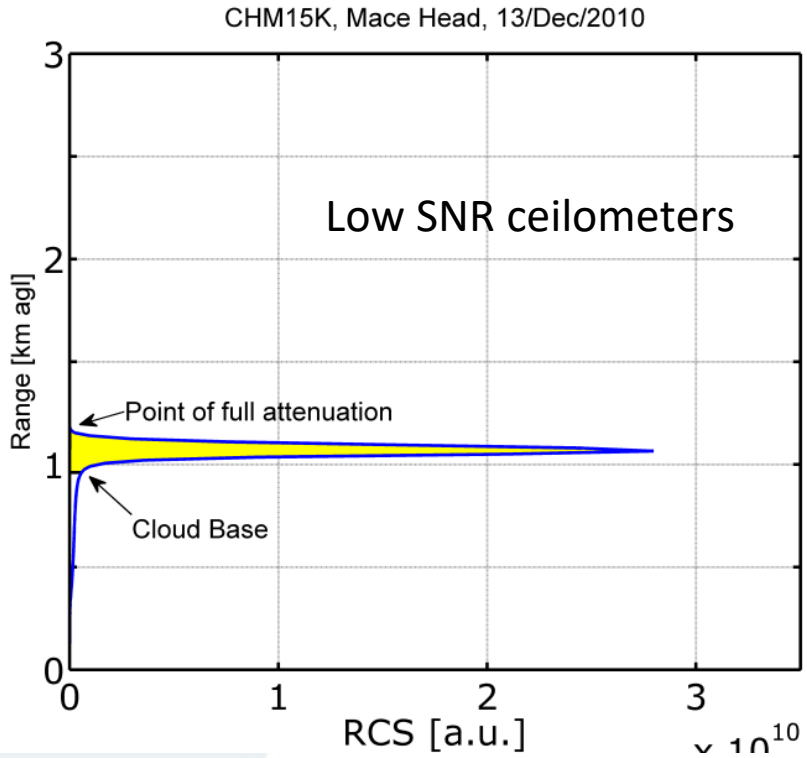
Calibration

Molecular calibration



[Wiegner and Geiß, 2012]

Liquid cloud calibration

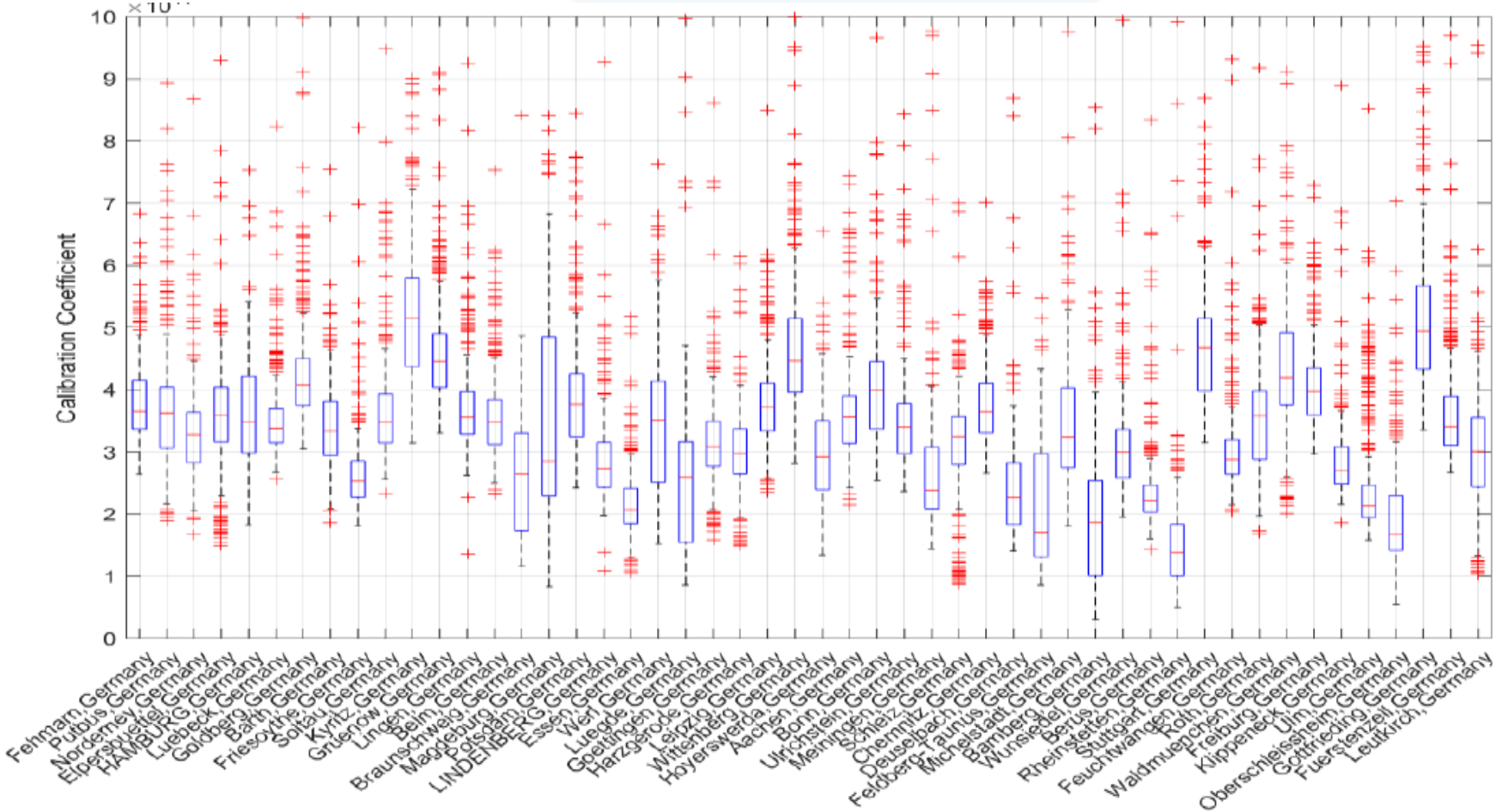


[O'Connor et al., 2004]

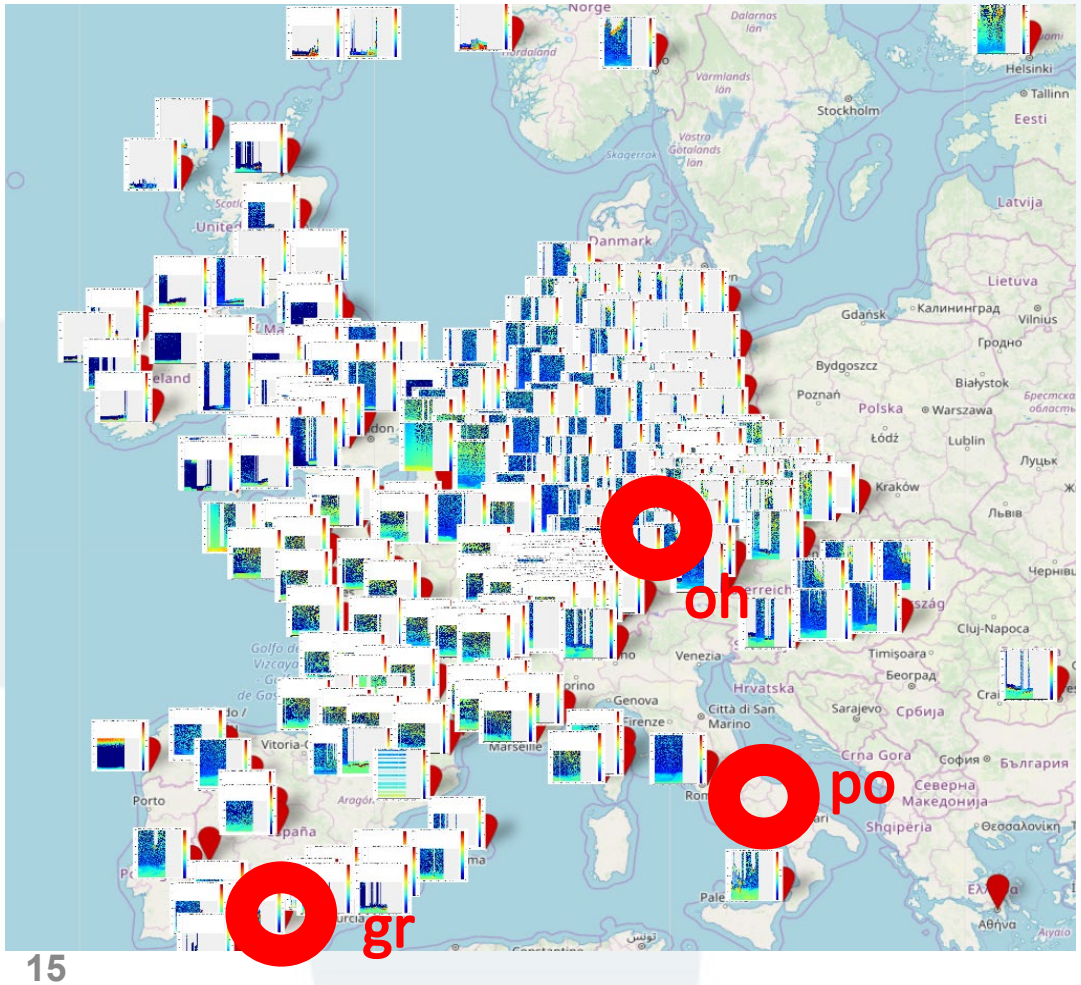
Calibration

- Calibration performed every night
- New calibration coefficient applied once per month

Monthly statistics of nightly calibration coefficients
High SNR ceilometers, Rayleigh calibration



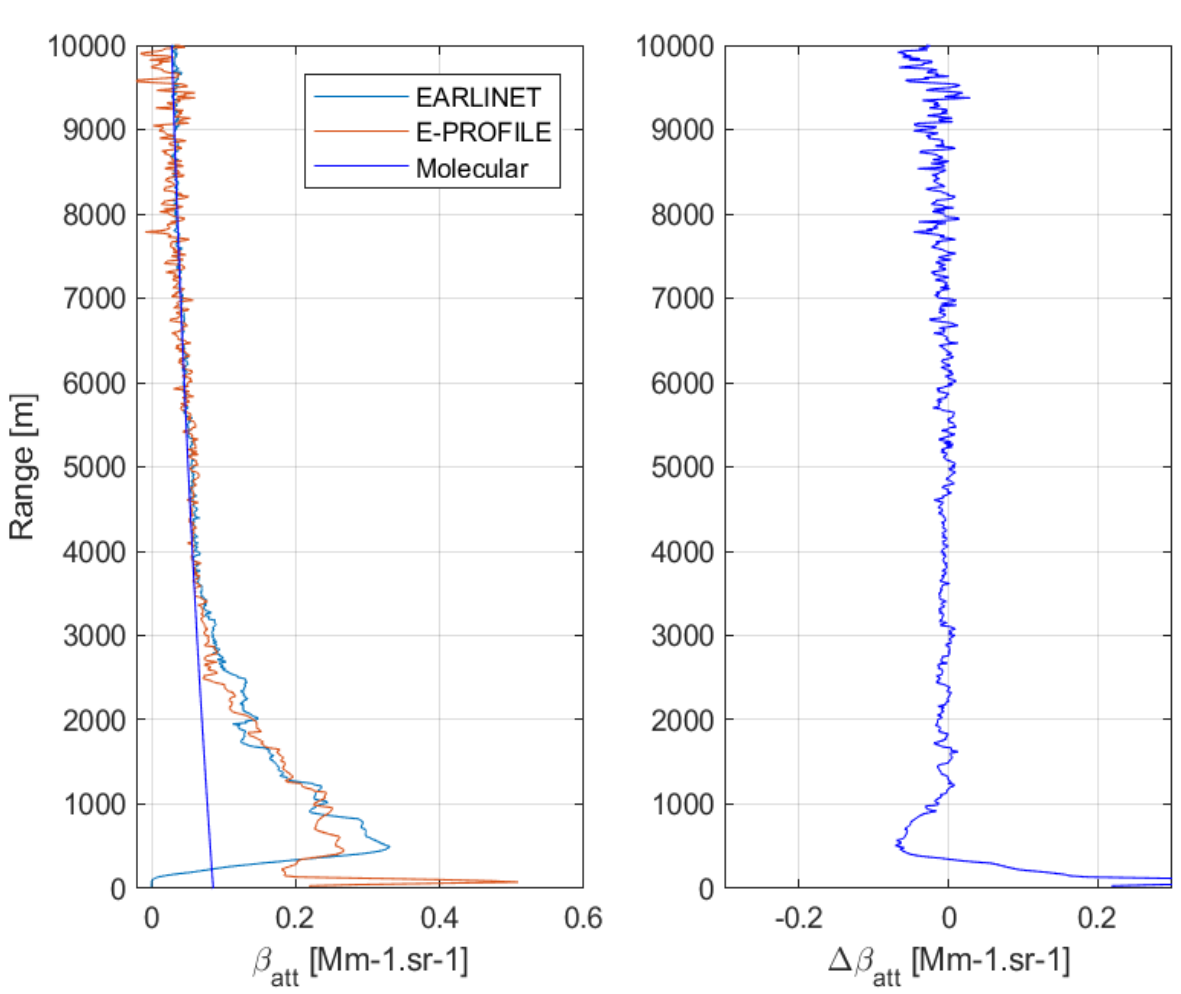
Validation wrt EARLINET research lidar

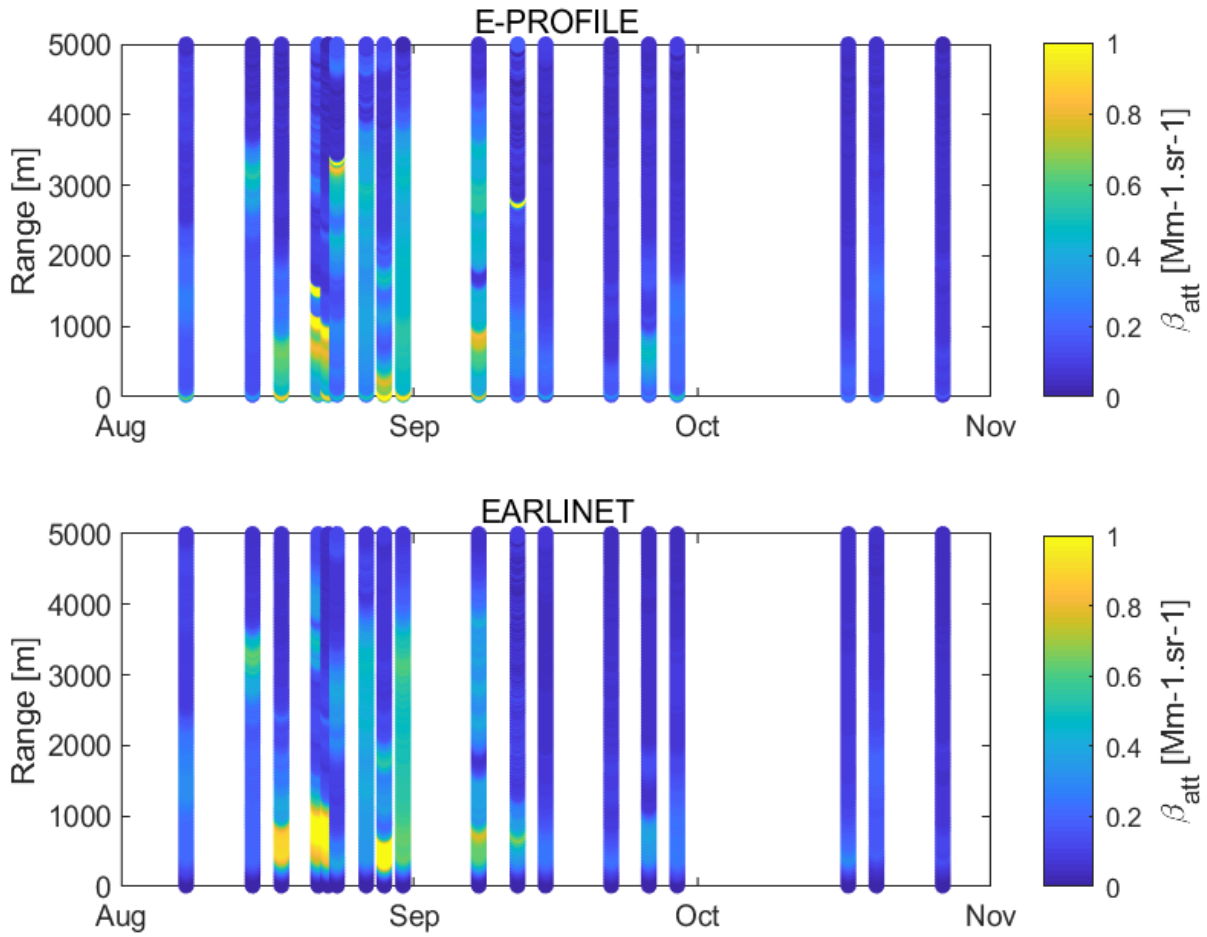


- 3 sites with co-location of ceilometers and lidars at 1064 nm
- routine att. backscatter from E-PROFILE
- att. backscatter from EARLINET SCC
- 3 months of data (1 year at the end)

Validation wrt EARLINET research lidar

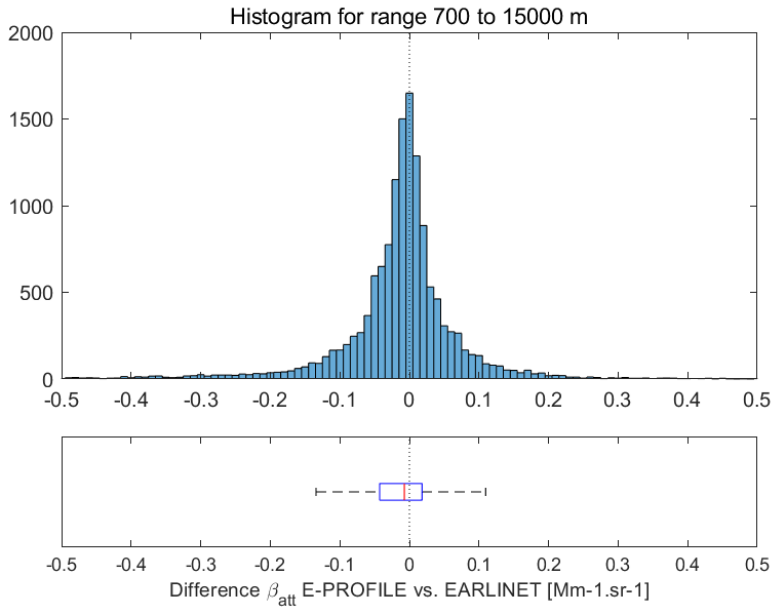
Attenuated backscatter profiles at Hohenpeissenberg, Germany



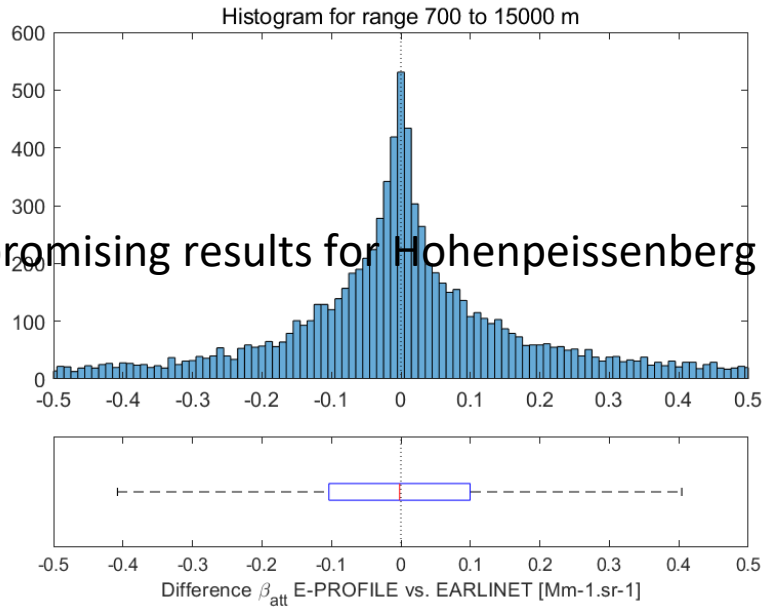


Comparisons at Hohenpeissenberg, Potenza and Granada

Hohenpeissenberg

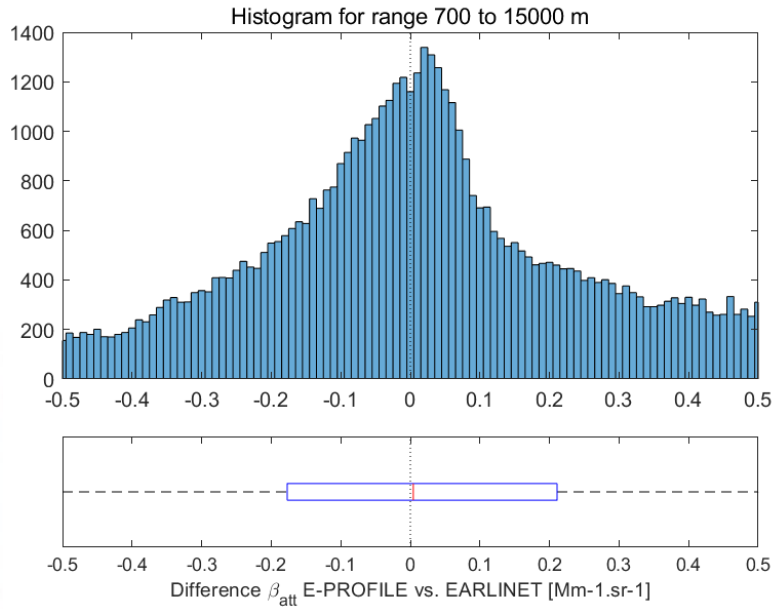


Potenza



promising results for Hohenpeissenberg

Granada



- Hohenpeissenberg: no bias
- Potenza: old ceilometer, more noise but no bias
- Granada: issue with overlap correction, under investigation

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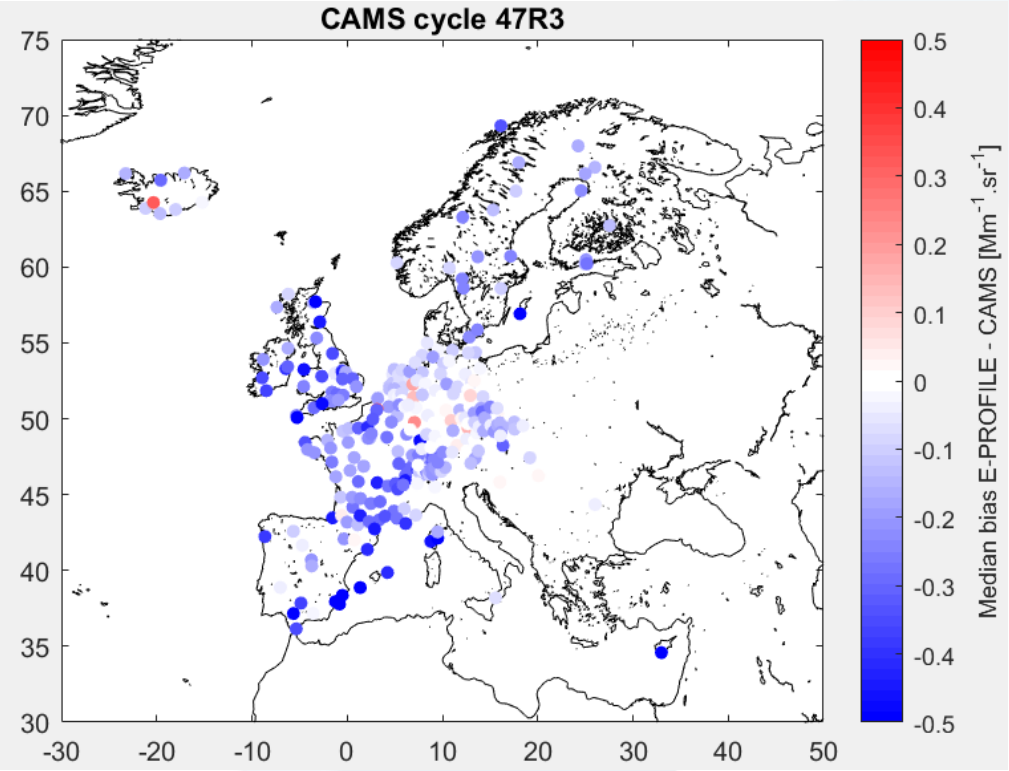
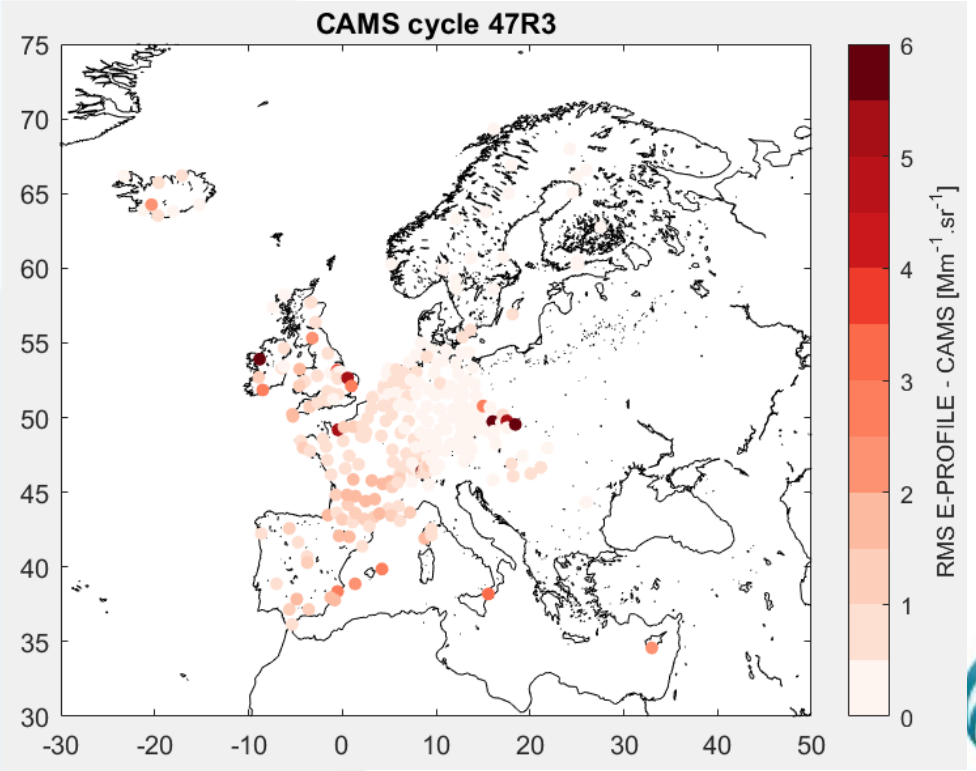
Monthly O-B statistics using CAMS

Median Bias
E-PROFILE - CAMS



RMSE
E-PROFILE - CAMS

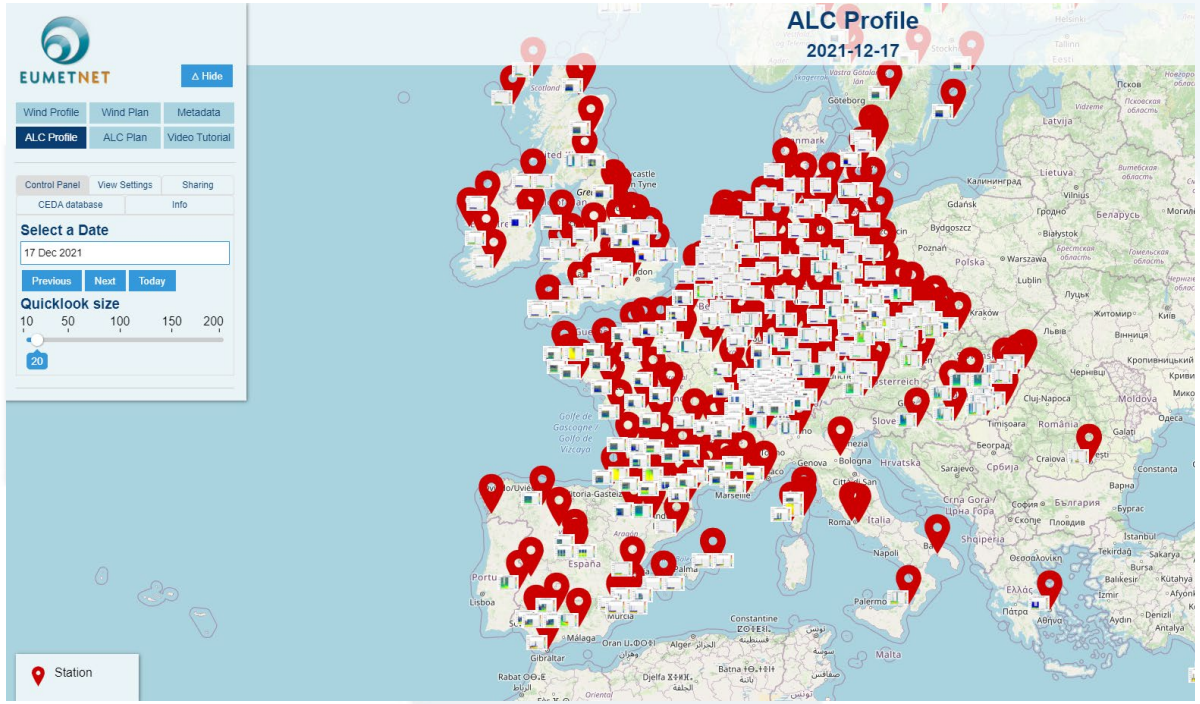


01-31 April, 2021 (N_stations = 370)

Data access

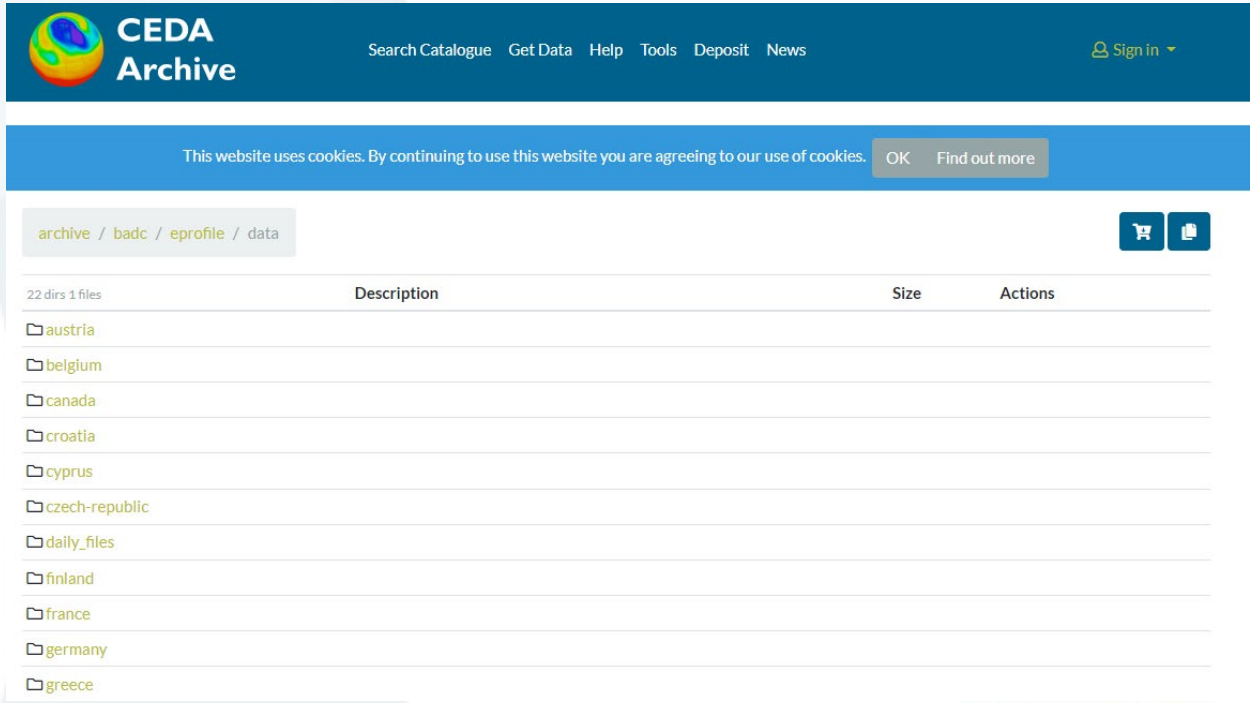
Visualized data on interactive web application:

https://e-profile.eu



Numeric data in netCDF:

https://data.ceda.ac.uk/badc/eprofile/data/



Profile view

EUMETNET

Δ Hide

Wind Profile | Wind Plan | Metadata

ALC Profile | ALC Plan | Video Tutorial

Control Panel | View Settings | Sharing

CEDA database | Info

Select a Date

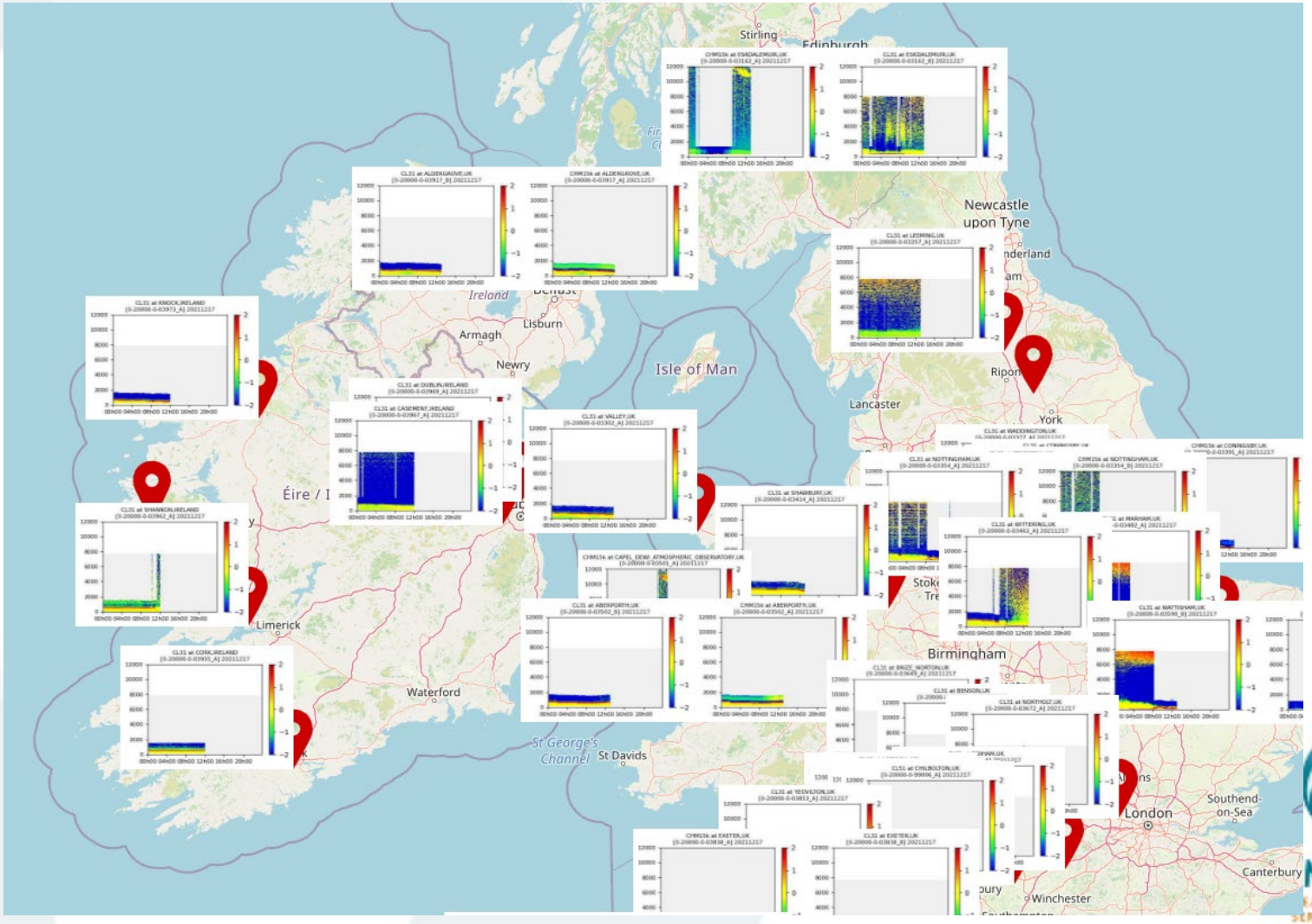
17 Dec 2021

Previous | Next | Today

Quicklook size

10 50 100 150 200

20



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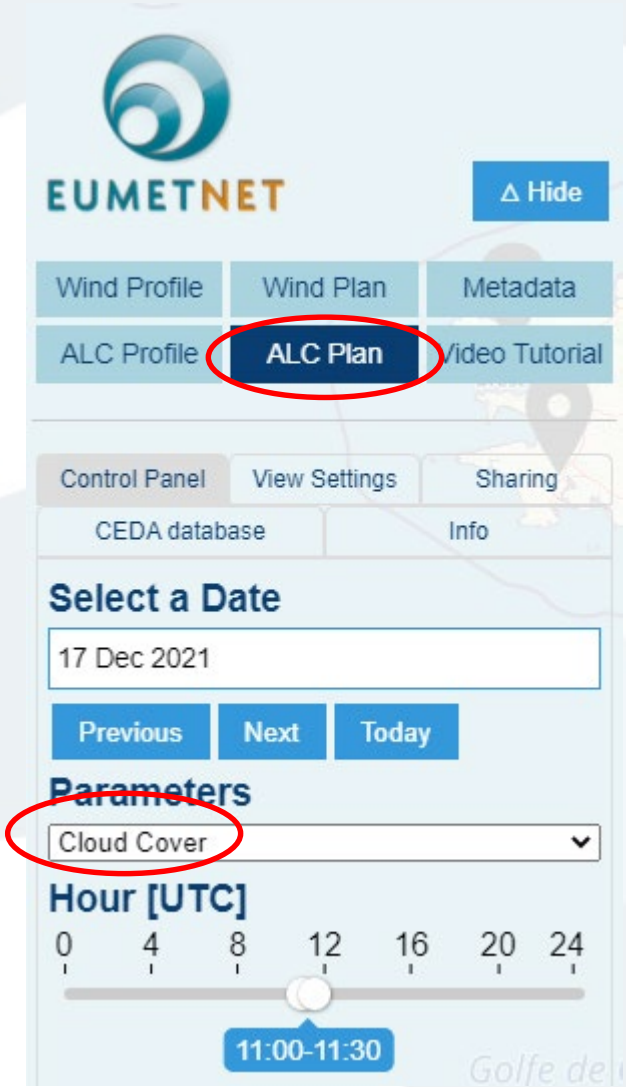
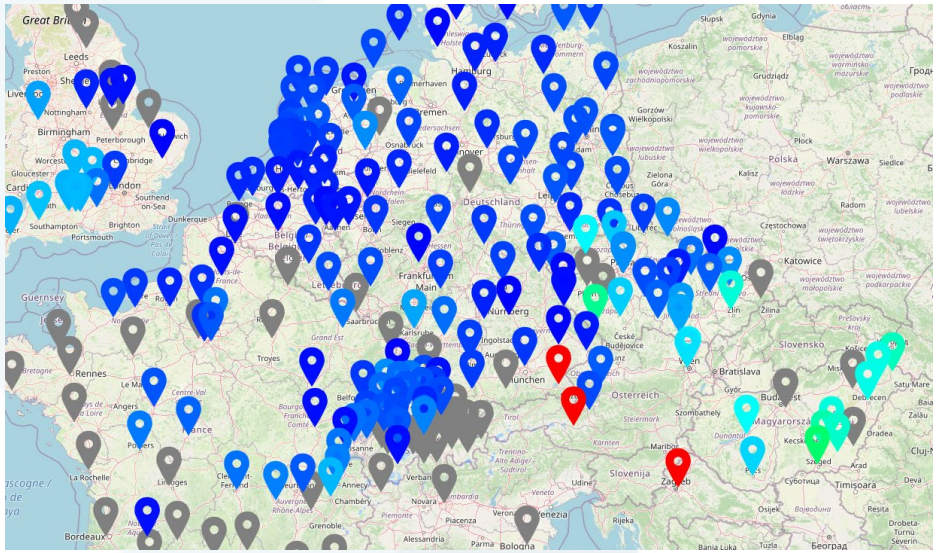
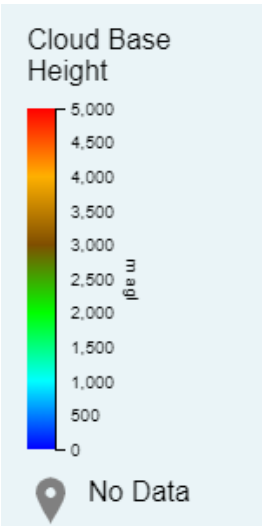
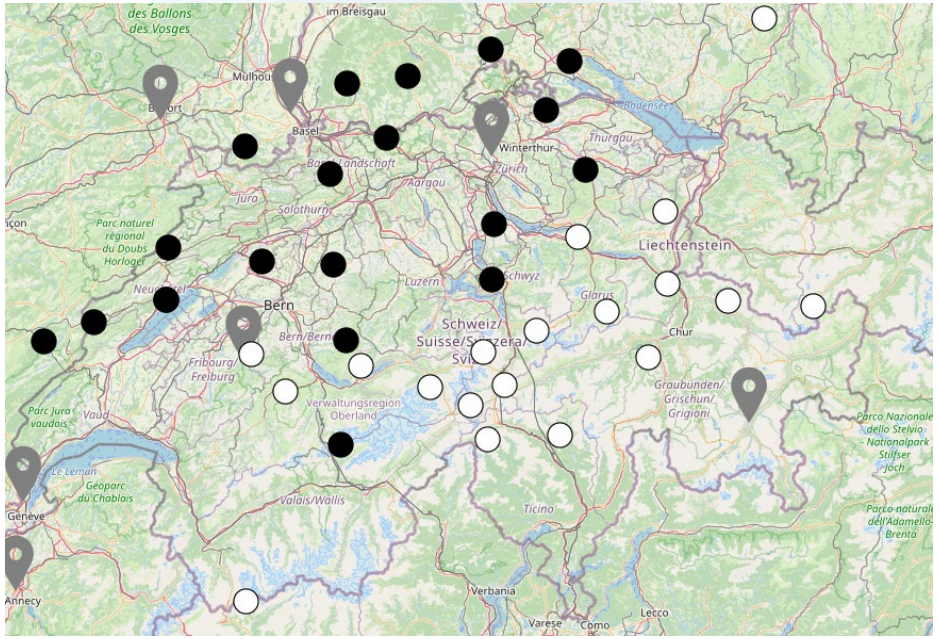
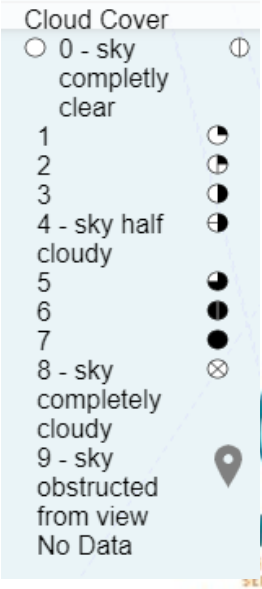
Plan view


EUMETNET
△ Hide
Wind Profile
Wind Plan
Metadata
ALC Profile
ALC Plan
Video Tutorial
Control Panel
View Settings
Sharing
CEDA database
Info
Select a Date
17 Dec 2021
Previous
Next
Today
Parameters
Cloud Cover
Hour [UTC]
0 4 8 12 16 20 24
11:00-11:30




Cloud Base Height
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
m agl
No Data




Cloud Cover
0 - sky completly clear
1
2
3
4 - sky half cloudy
5
6
7
8 - sky completely cloudy
9 - sky obstructed from view
No Data

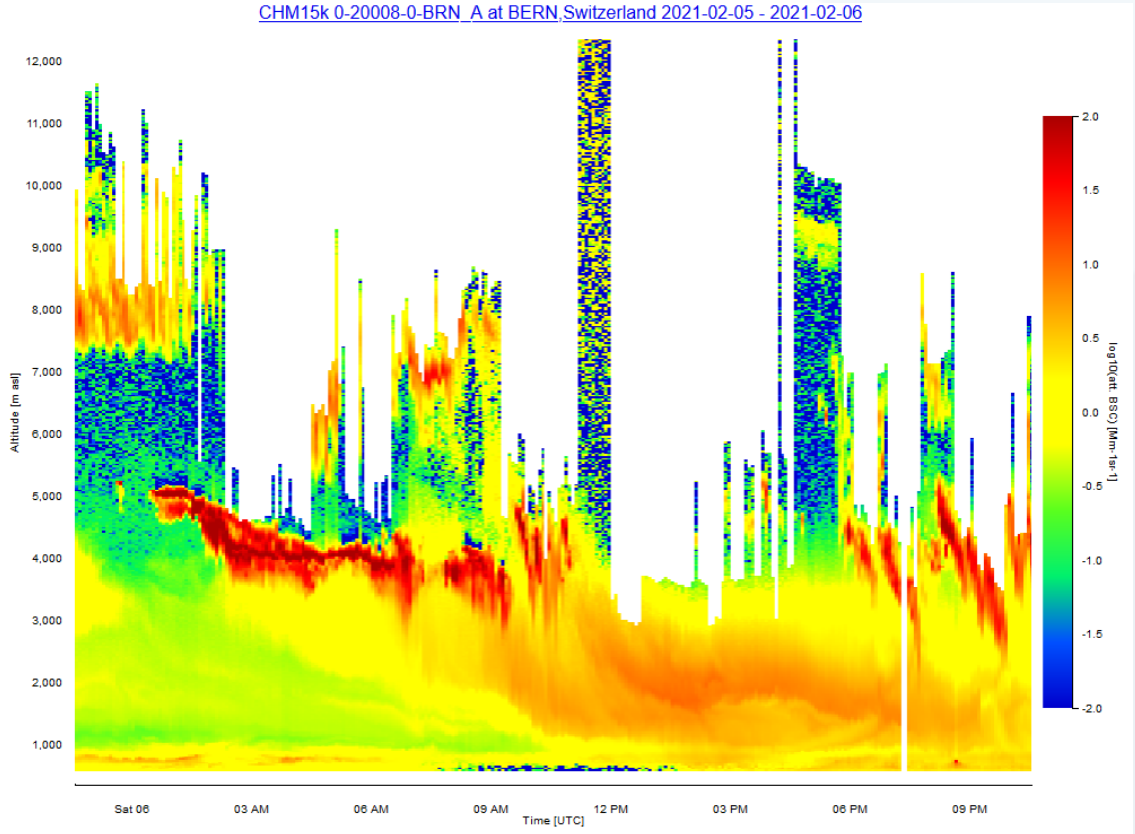
Case study: Saharan dust event, 5 – 7 February 2021

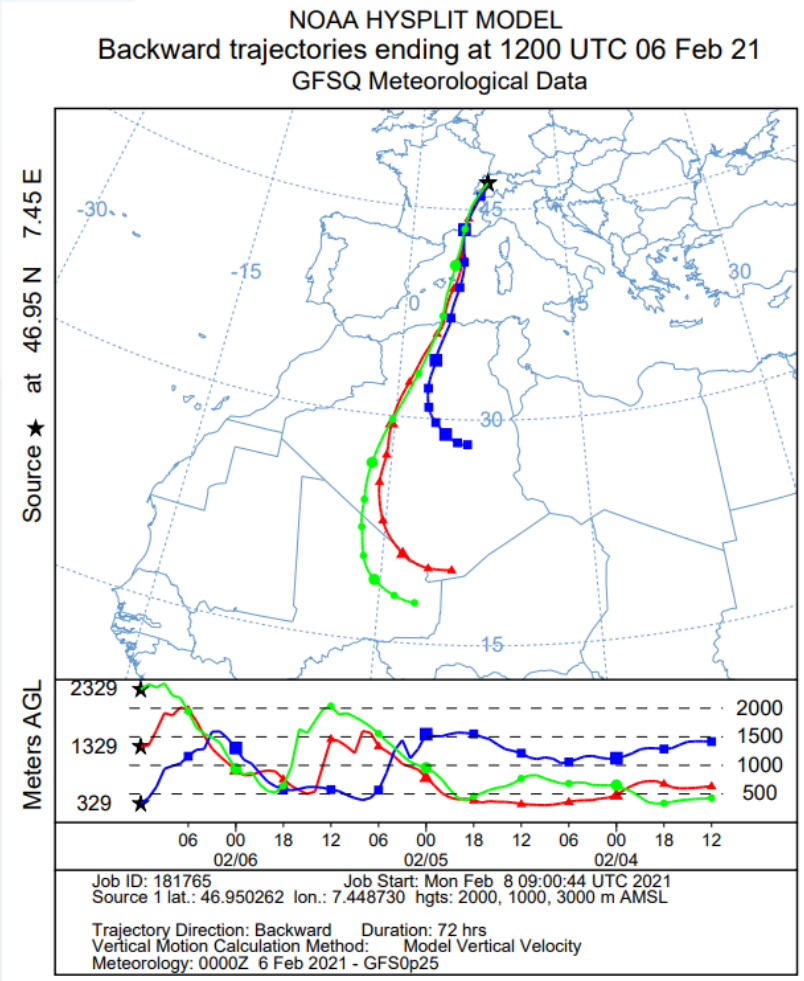
Photo: Alexander Haefele

Photos: Maxime Hérvo

Case study: Saharan dust event, 5 – 7 February 2021

High SNR ceilometer at Berne, Switzerland





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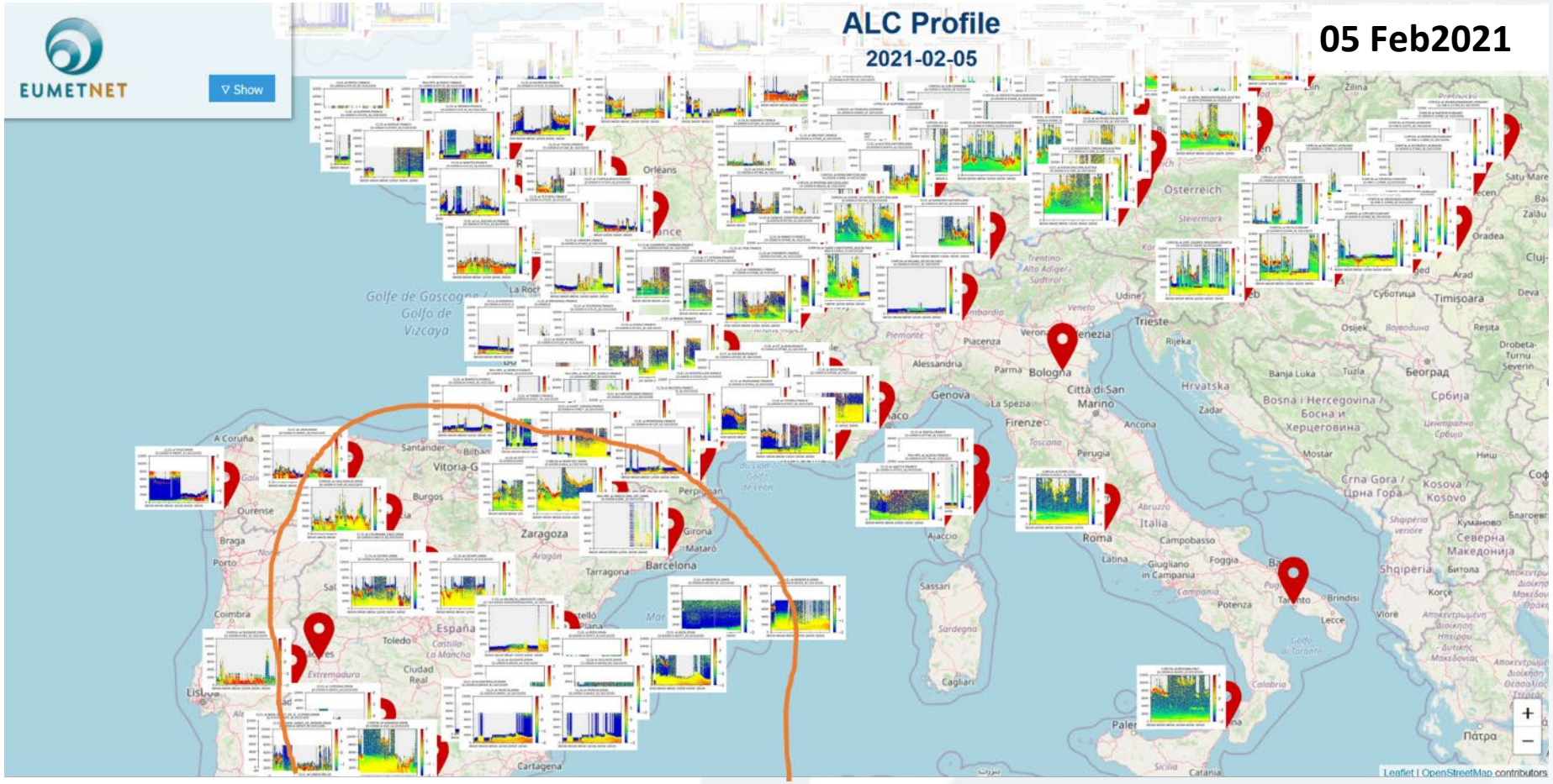
Case study: Saharan dust event, 5 – 7 February 2021

Massive Saharan dust outbreak touched large parts of Europe, 5-7 February 2021 (R. Rüfenacht)

→ Dense 24/7 European E-PROFILE ALC network proved useful to track the horizontal, vertical and temporal distribution of the Saharan dust plume…



Spatially distributed attenuated backscatter profiles of E-PROFILE ceilometers

Areas of high dust concentrations: morning afternoon

Source: https://e-profile.eu

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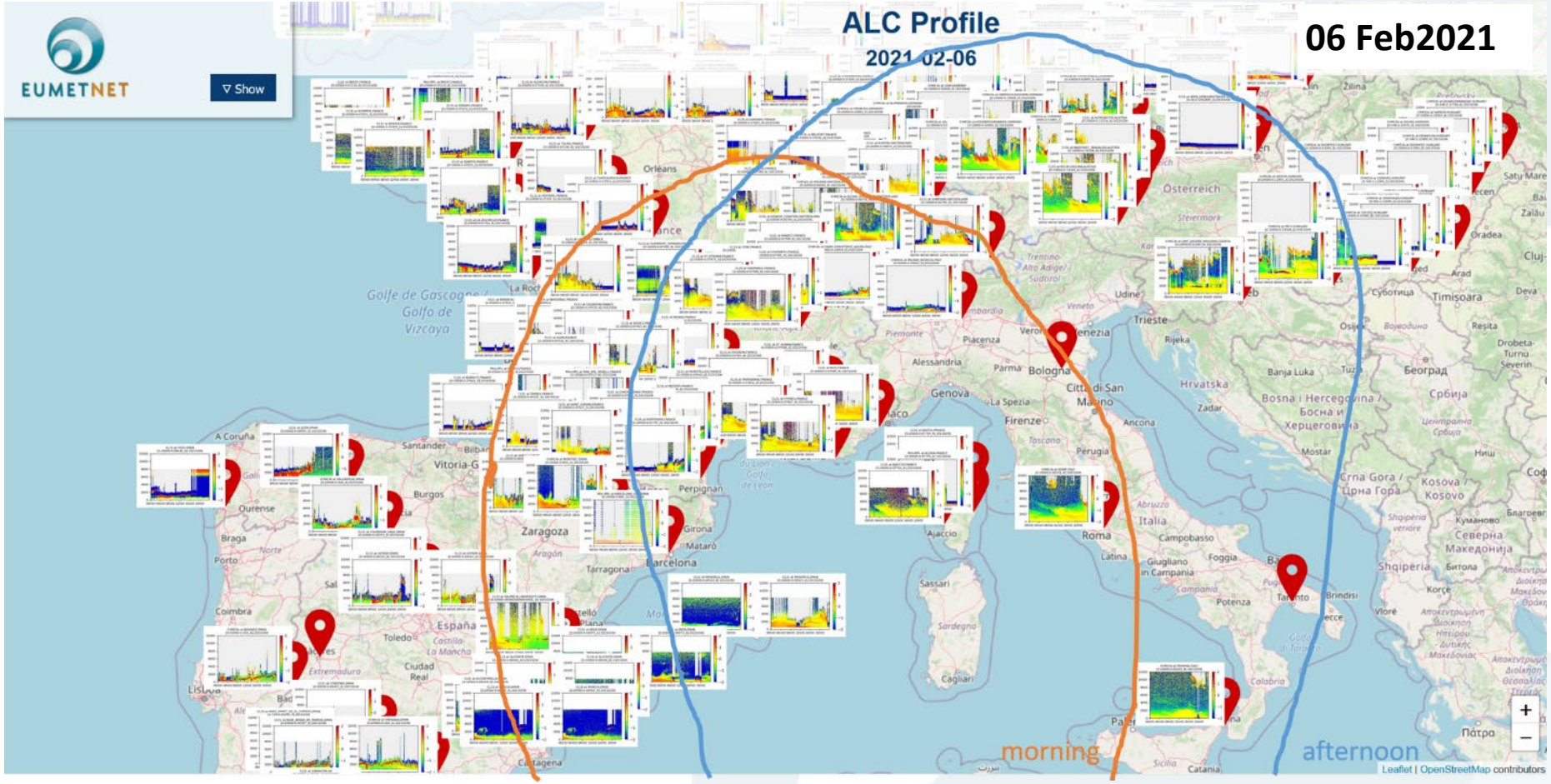
Case study: Saharan dust event, 5 – 7 February 2021

Massive Saharan dust outbreak touched large parts of Europe, 5-7 February 2021 (R. Rüfenacht)

→ Dense European E-PROFILE ALC network of continuous near-real time operation proved useful to track the horizontal, vertical and temporal dispersion of the Saharan dust plume…



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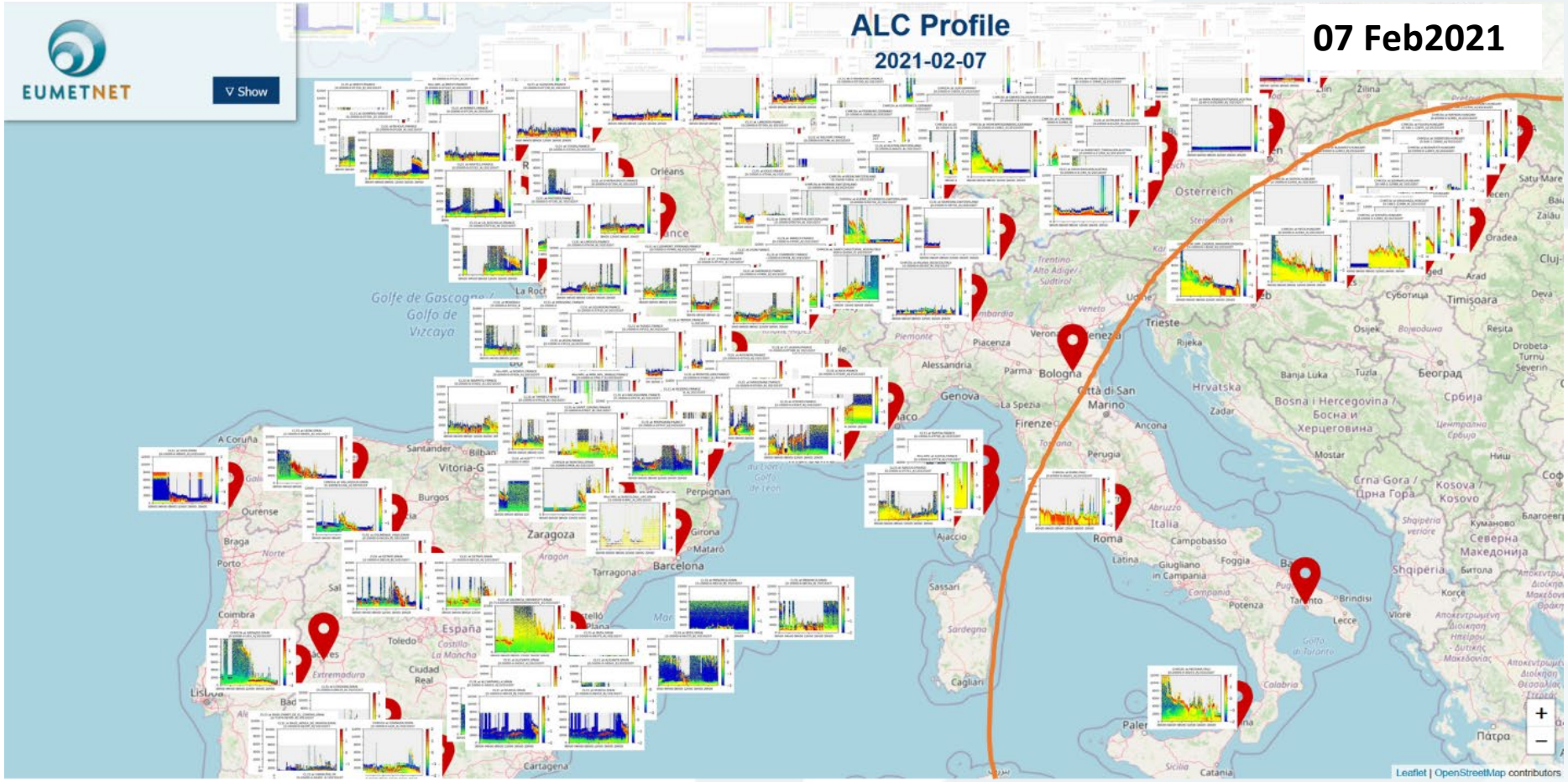

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Areas of high dust concentrations: morning afternoon

Source: https://e-profile.eu

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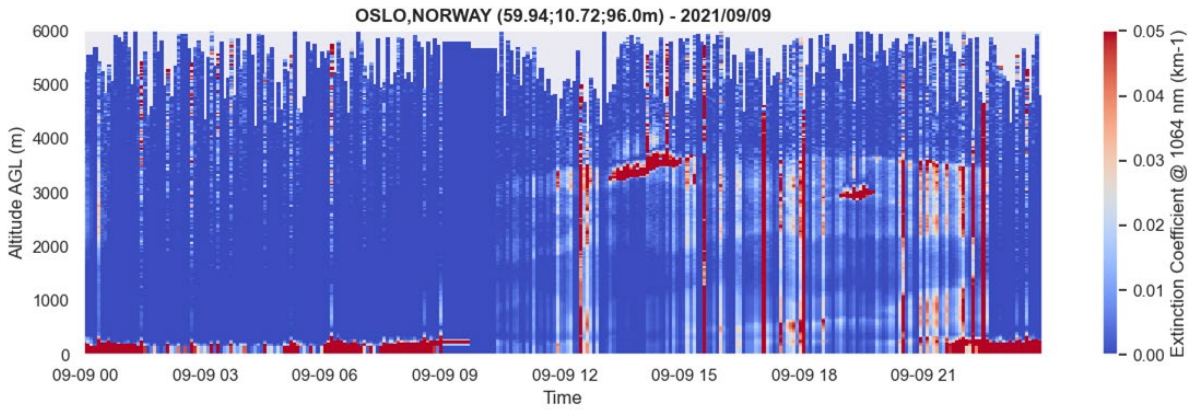
Next steps until 2023

- **Attenuated backscatter is useful, but not enough**
- **Strong requirement for**
  - Extinction coefficient
  - Mass estimates

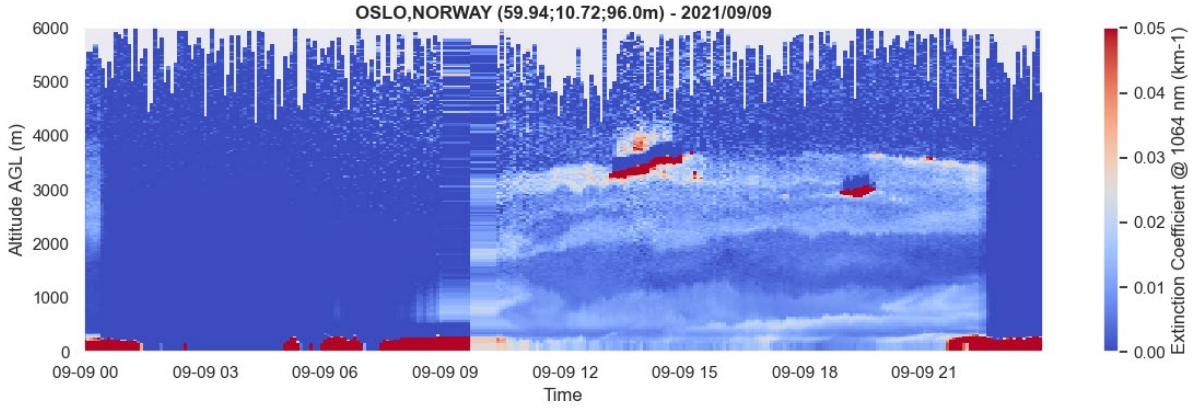
-> Implementation of new processing chain:

- **BASIC retrieval**
- **Forward Klett applied to calibrated profiles (β_{att})**

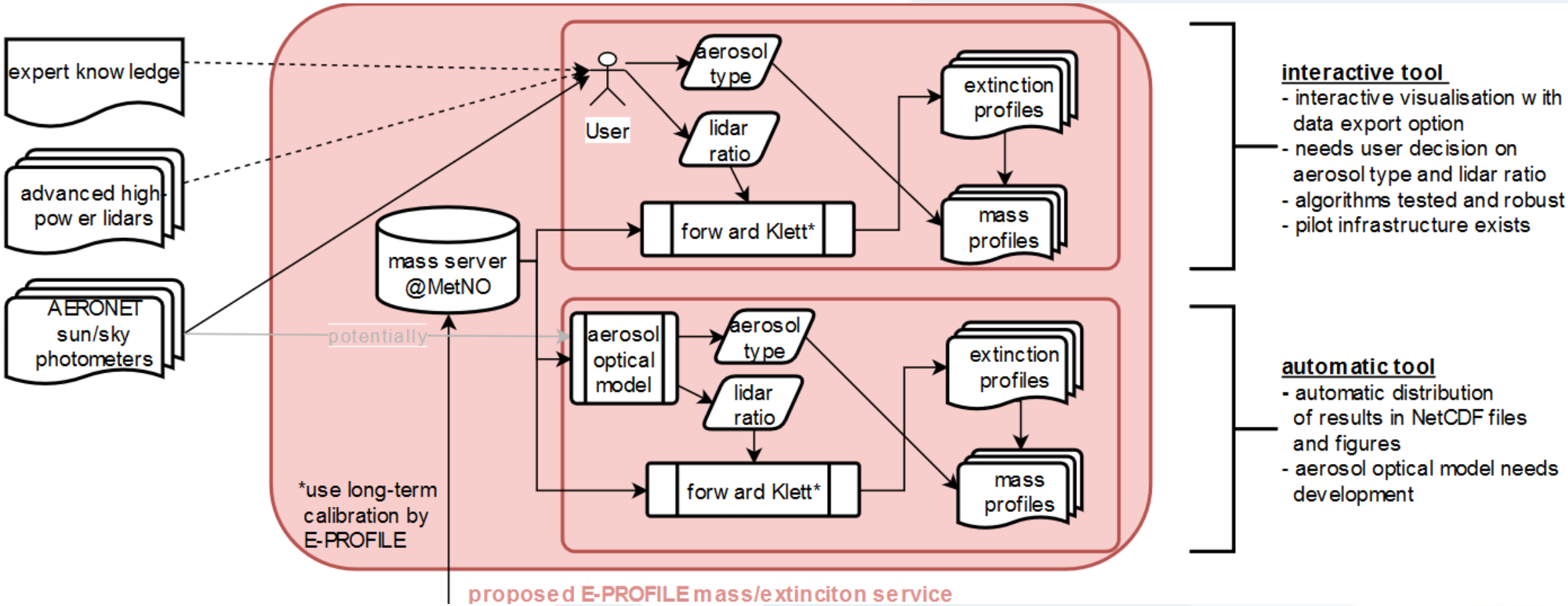
Backward Klett retrieval



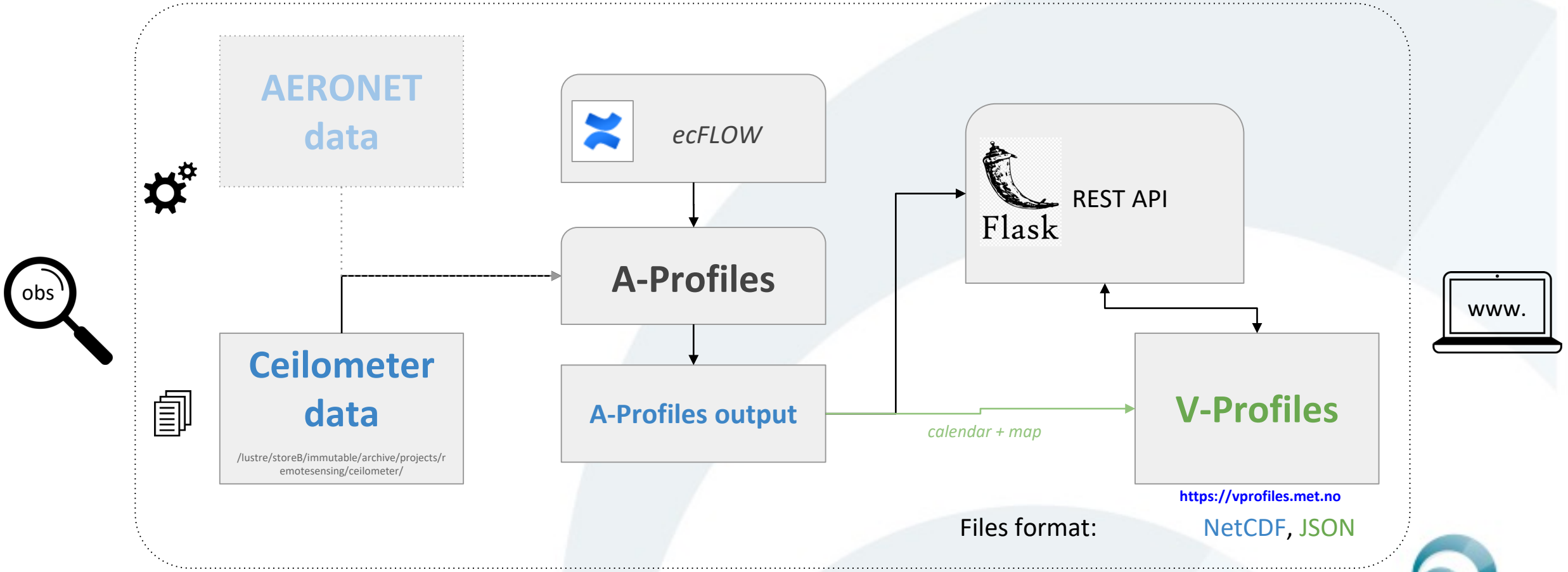
Forward Klett retrieval



Implementation of mass/extinction service



V-Profiles - new workflow: NRT in Europe



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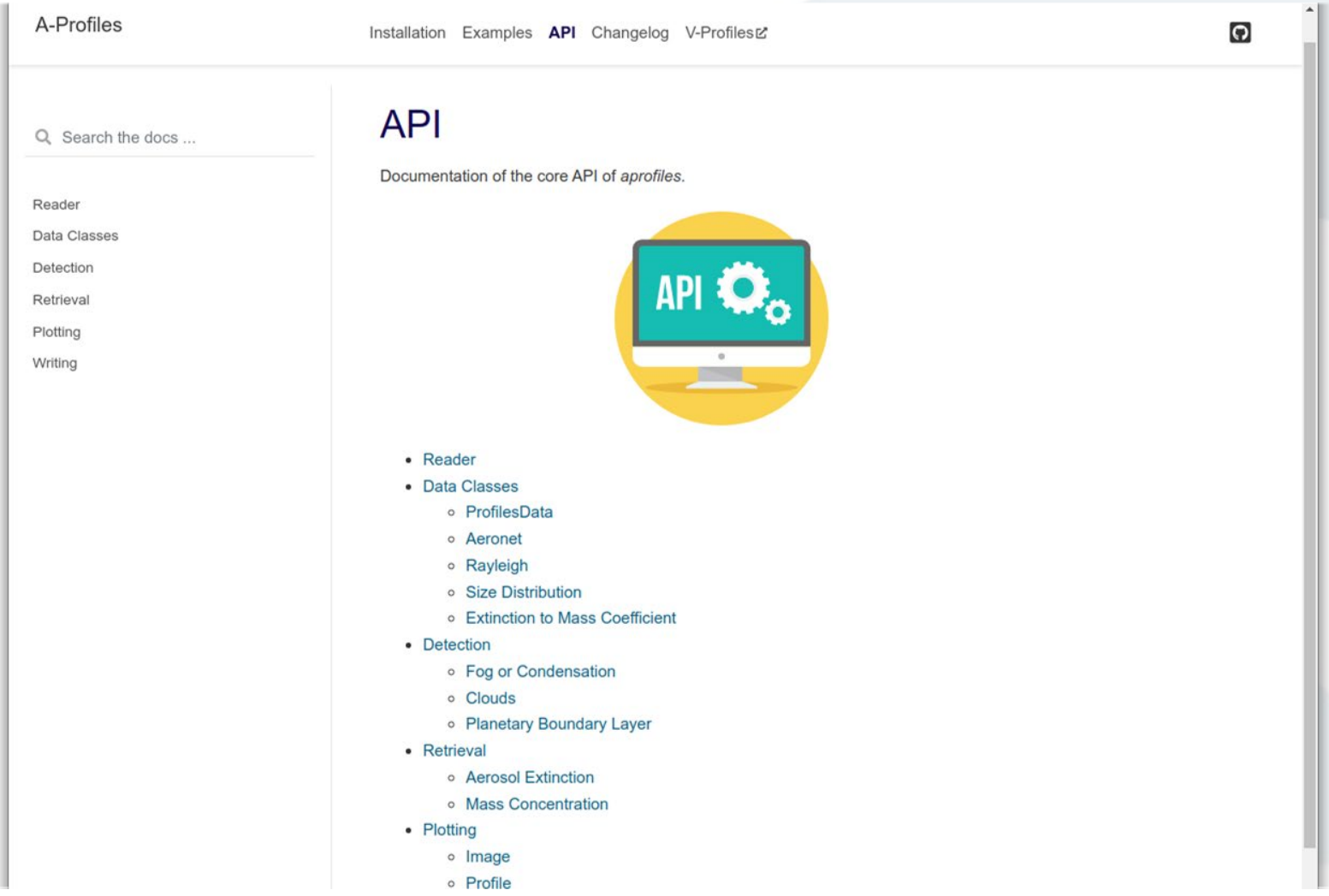
A-Profiles - Analysis of Aerosol Profiles

https://github.com/AugustinMortier/A-Profiles *(to be moved to github.com/Metno/)*



Summary and Conclusions

- **E-PROFILE coordinates 3 networks**
  - Wind
  - Aerosol and clouds
  - Temperature and humidity
- **Attenuated backscatter is the operational product**
- **Extensive QC and monitoring, including O-B statistics using CAMS**
- **A Web App supports easy data mining**
- **Data are available from CEDA**
- **Extinction coefficient and mass estimates under development**

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