# Impact of Aeolus L2B winds in the regional model Harmonie-Arome

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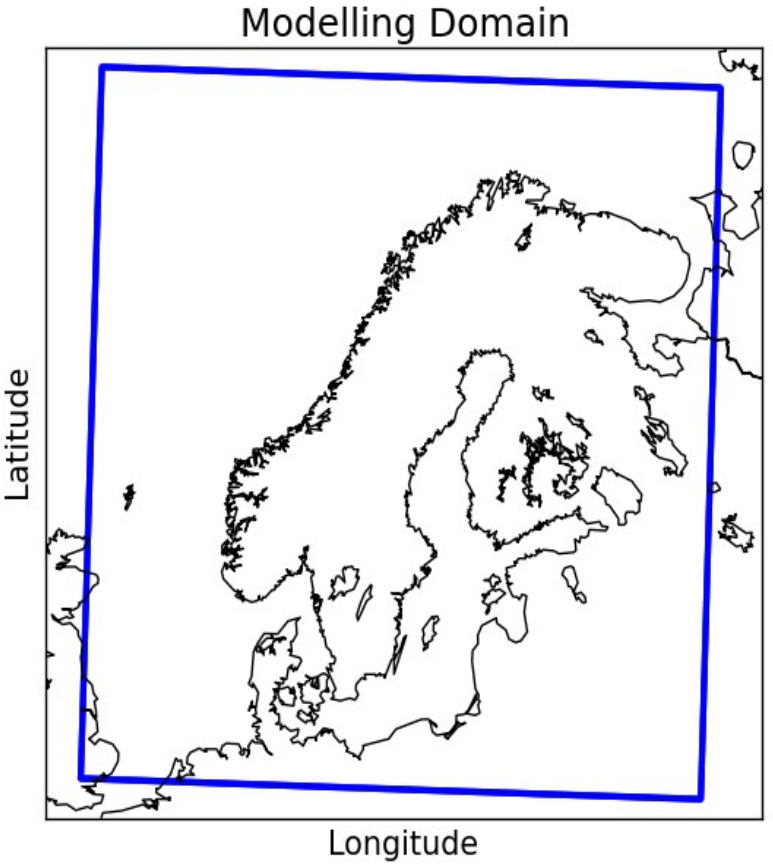
# HARMONIE-AROME NWP configuration

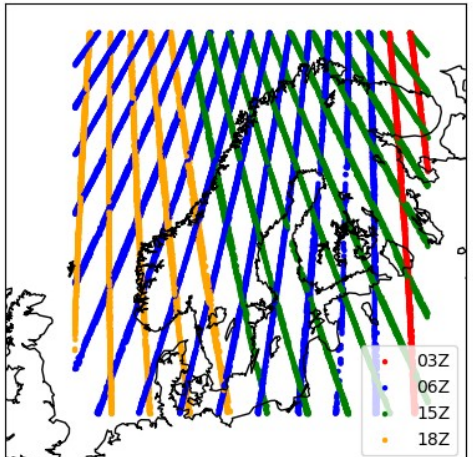
- MetCoOp is a non-hydrostatic forecast model.
- 2.5 km grid size and 65 vertical levels. (960 x 600 x 65 points)
- Initial and boundary conditions from ECMWF IFS
- 3D-Var data assimilation with 3h DA cycle.
- Assimilated obs:
  - Conventional observations
  - AMSU-A and MHS satellite radiances
  - Aeolus HLOS (Horizontal Line Of Sight) L2B winds from the ALADIN Doppler wind lidar which gives a vertical wind speed profile

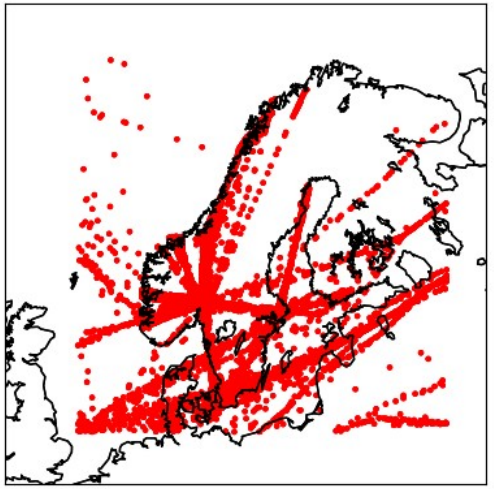
- Two experiment periods: 14 Sep to 15 Oct 2018 (laser A data) and 20 April to 19 May 2020 (laser B data, with M1 temperature bias corrected, see slide 5)

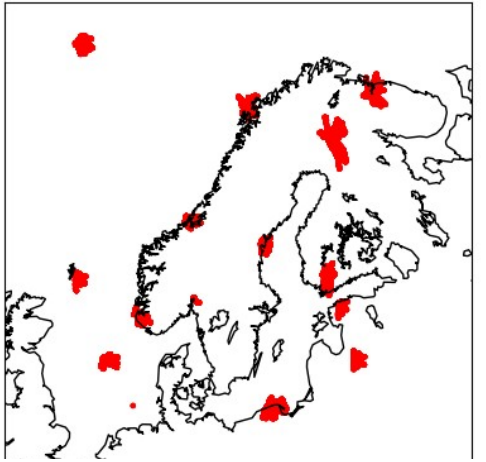
- Set of 4 experiments run for each period
  - No Aeolus data
  - All Aeolus data
  - Only Rayleigh data (clear sky, lower resolution)
  - Only Mie data (cloudy sky, higher resolution)

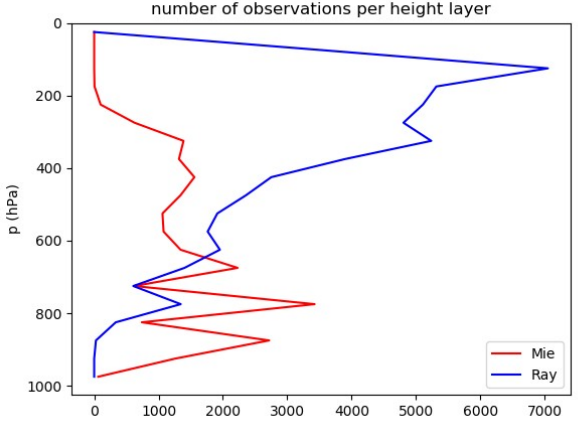


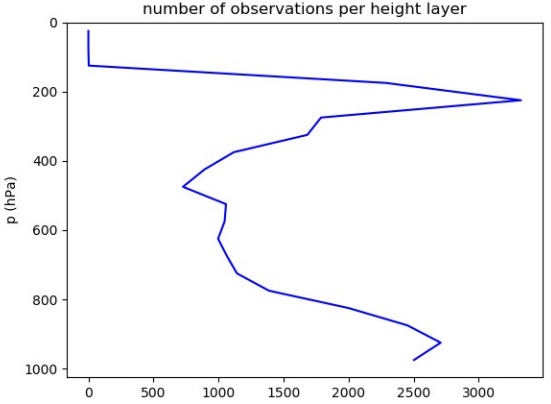
# Available upper air data (laser B period)
# (Aeolus, aircraft, radiosonde)

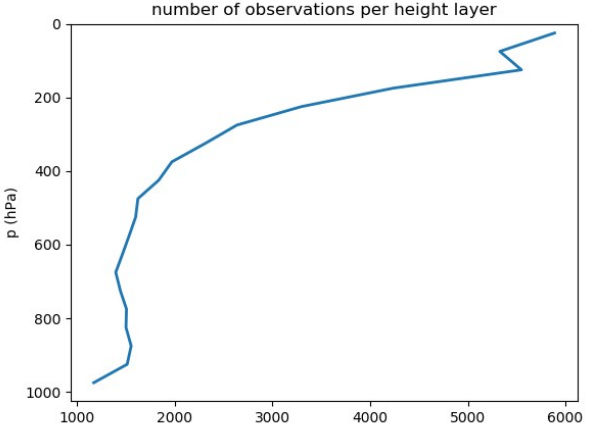


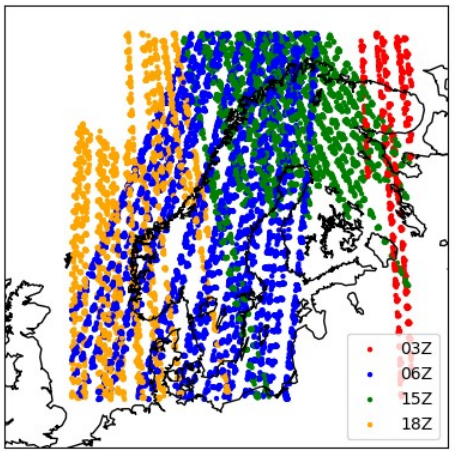




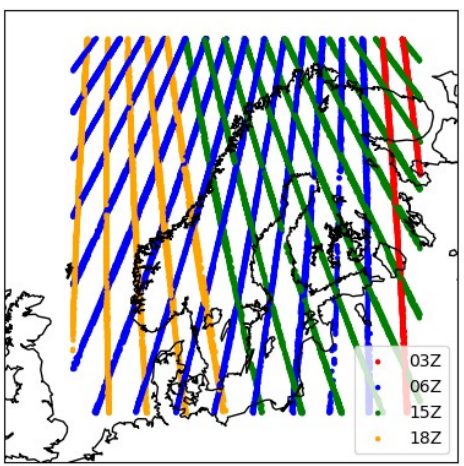



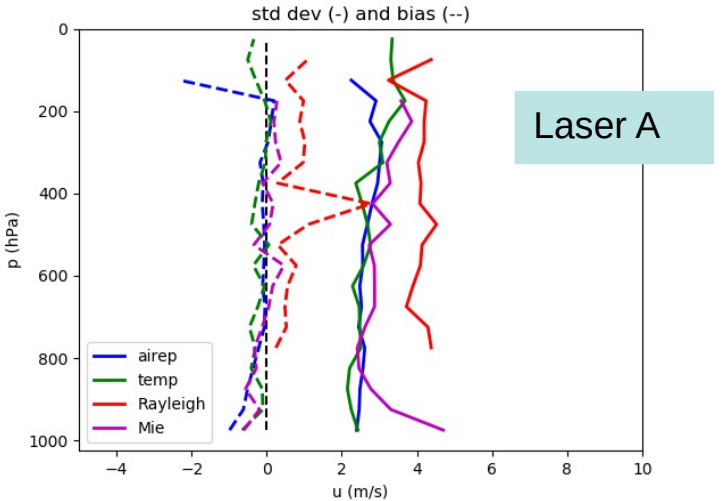
# Data availability and quality



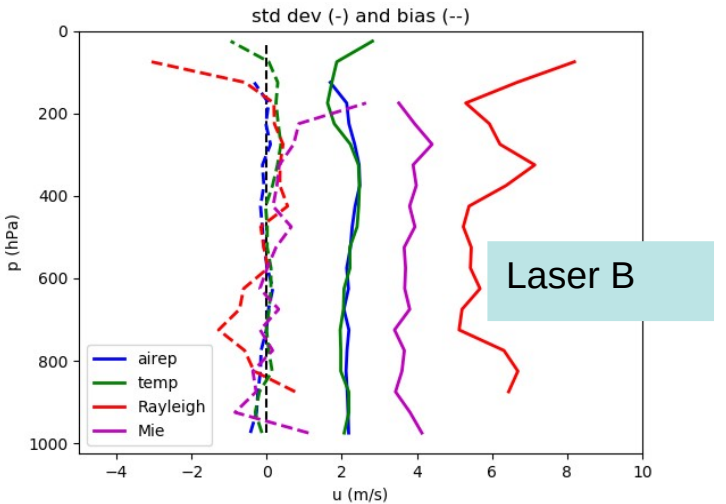

Aeolus coverage during laser A period (top) and laser B period (bottom)
- Usually two or three overpasses per day.




Comparing Aeolus STDV of O-B (observation minus background) to radiosondes and aircraft data
- Laser A: Mie similar quality to RS and aircraft, Rayleigh somewhat worse
- Laser B: Aeolus quality degraded



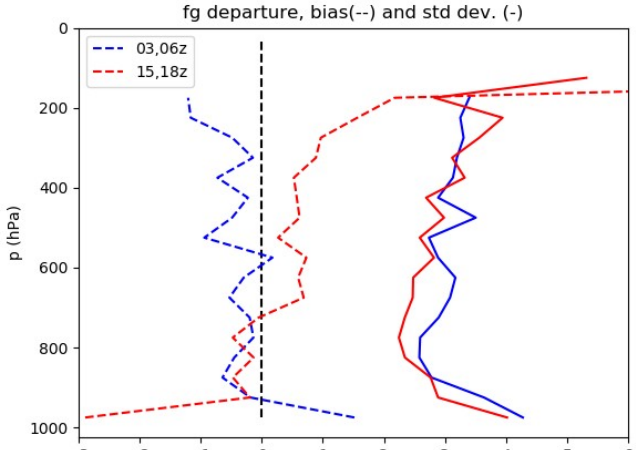

Laser A



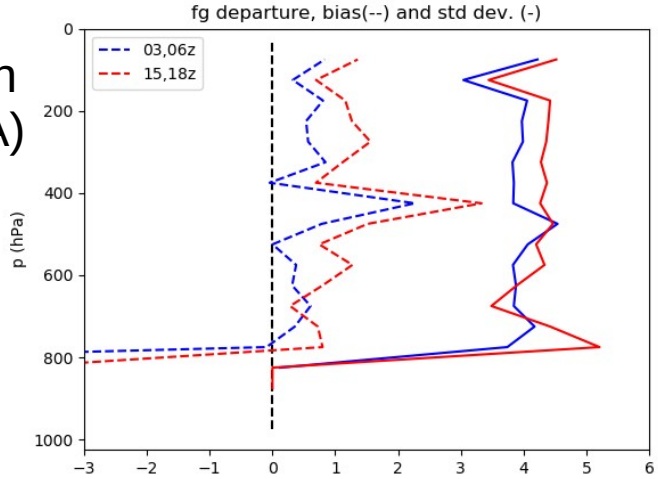

Laser B

# Separating ascending and descending orbits

Mie (Laser A)



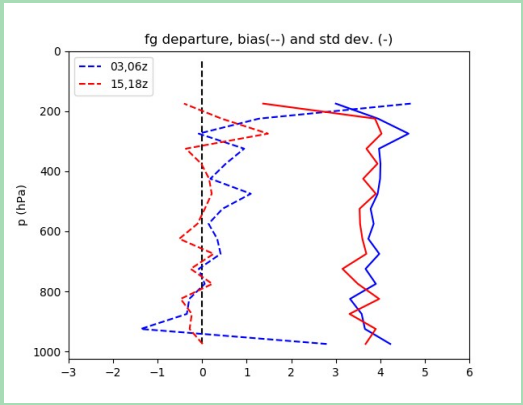

Rayleigh (Laser A)



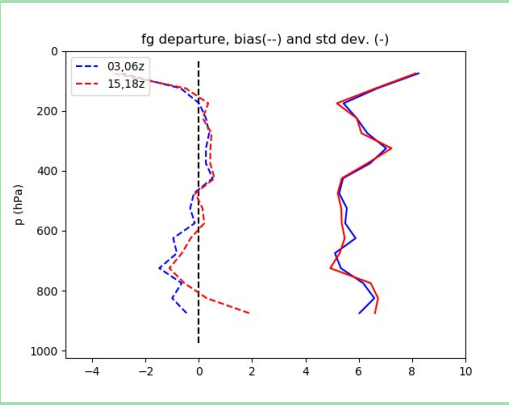

- Over MetCoOp domain, 03 and 06 UTC orbits are descending and 15 and 18 UTC are ascending
- O-B statistics - smaller bias for descending orbits, std dev. opposite trends for Mie and Rayleigh data

M1 mirror temperature bias correction available

Mie (Laser B)




Rayleigh (Laser B)



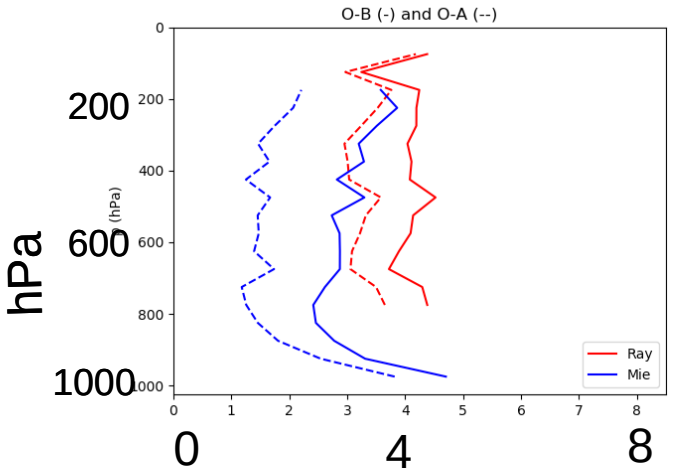
# Do the Aeolus observations change the model analysis?

O-B (-) and O-A (--)
Ray
Mie

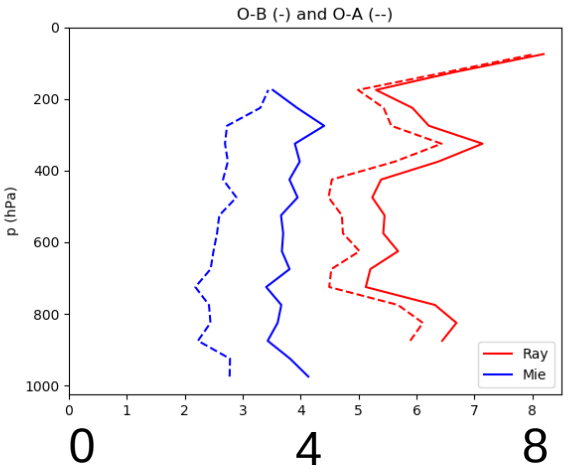
Observation error
Ray, Mie

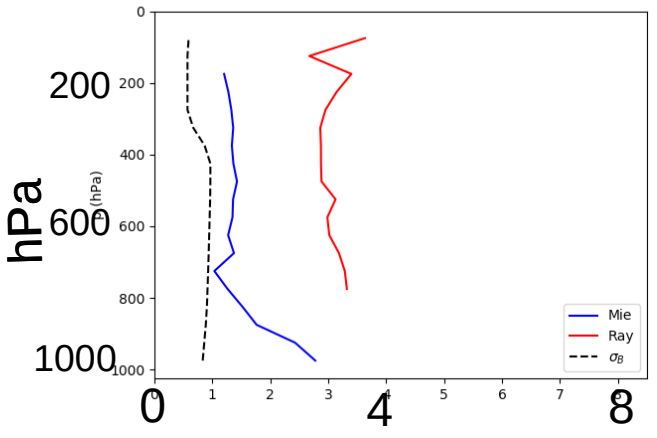
Background error
(--)

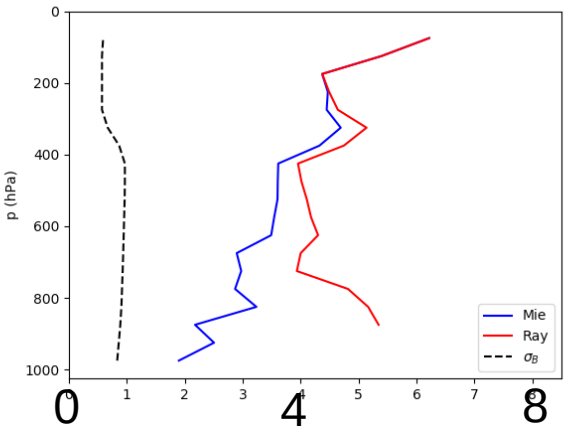
Laser A




Laser B



# Impact on modelling system
# - Degrees of Freedom of Signal (DFS)

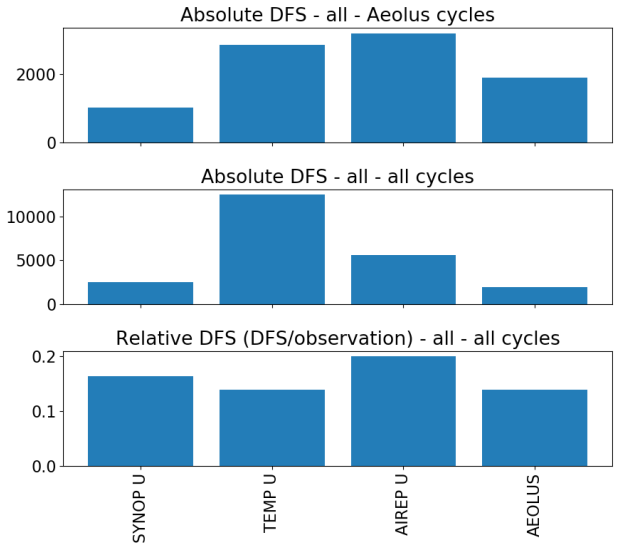
Laser B

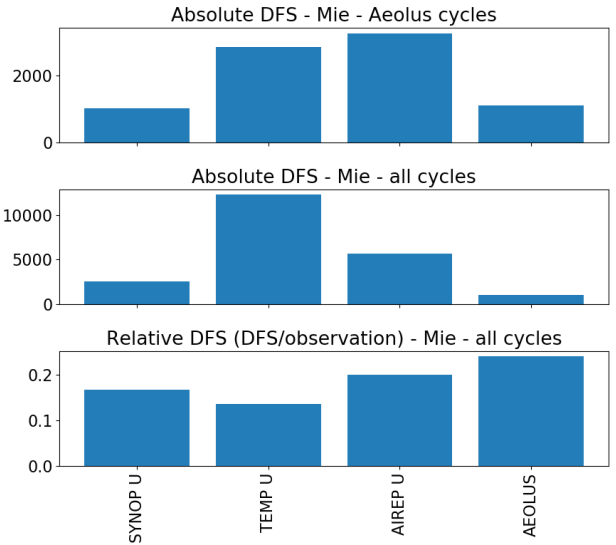
- Figures show the impact different types of observations of the wind speed, but not whether the impact is good or bad
- Synop stations (hourly), radiosondes (twice per day), aircraft (mostly daytime) and Aeolus (03, 06, 15 and 18 UTC)

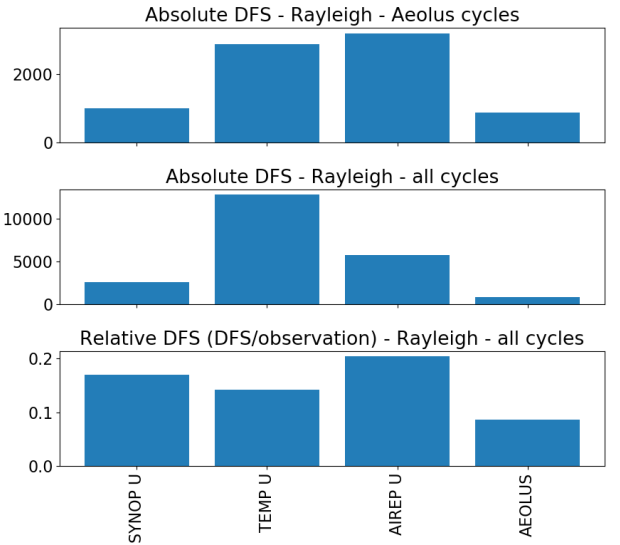
Abs. all A

Abs.

Rel.




SYNOP RS Aeolus

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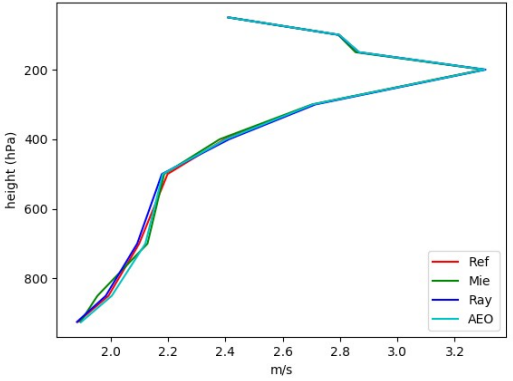
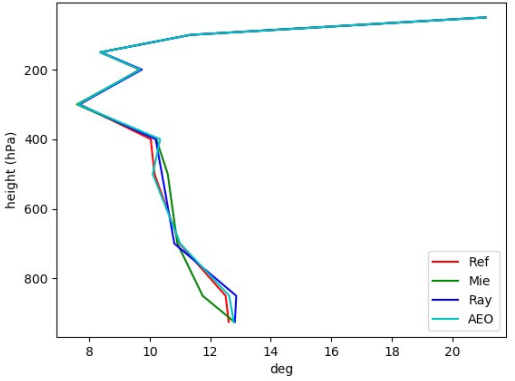
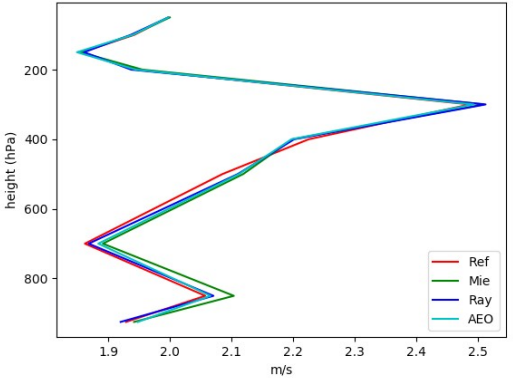
# Verification against radiosondes
## (6h forecasts)

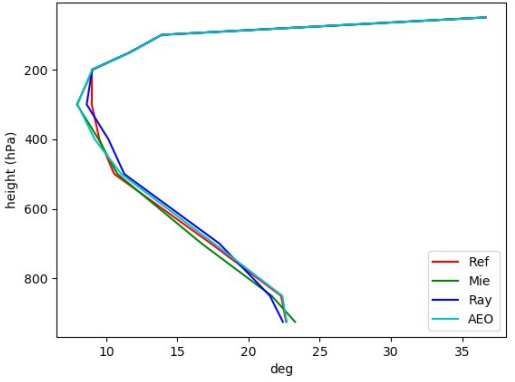
Laser A – wind speed and direction STDV




Laser B – wind speed and direction STDV

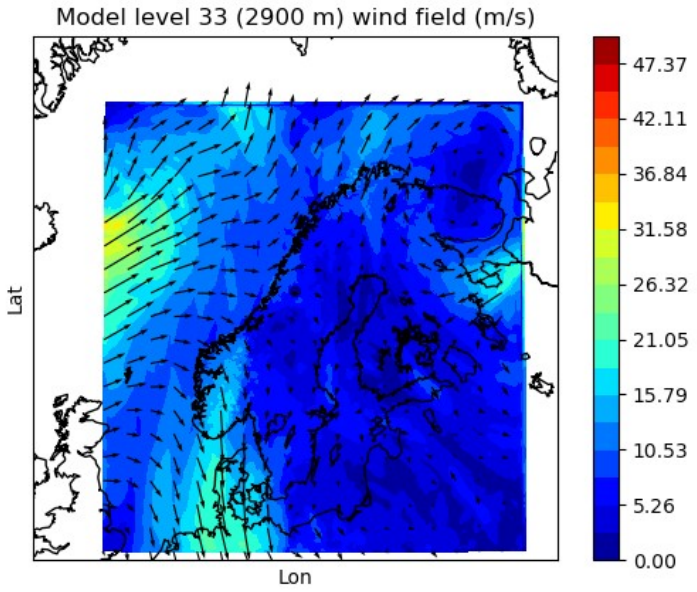


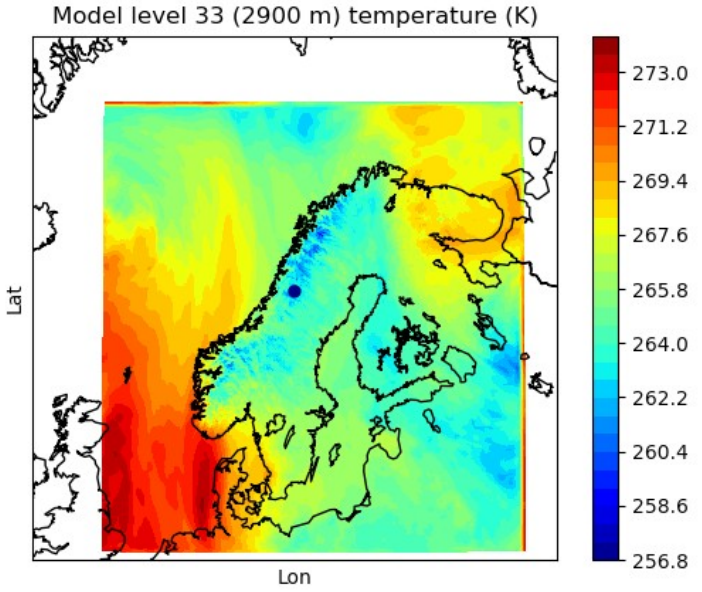




Cntr
Mie only
Ray only
Mie and Rayleigh

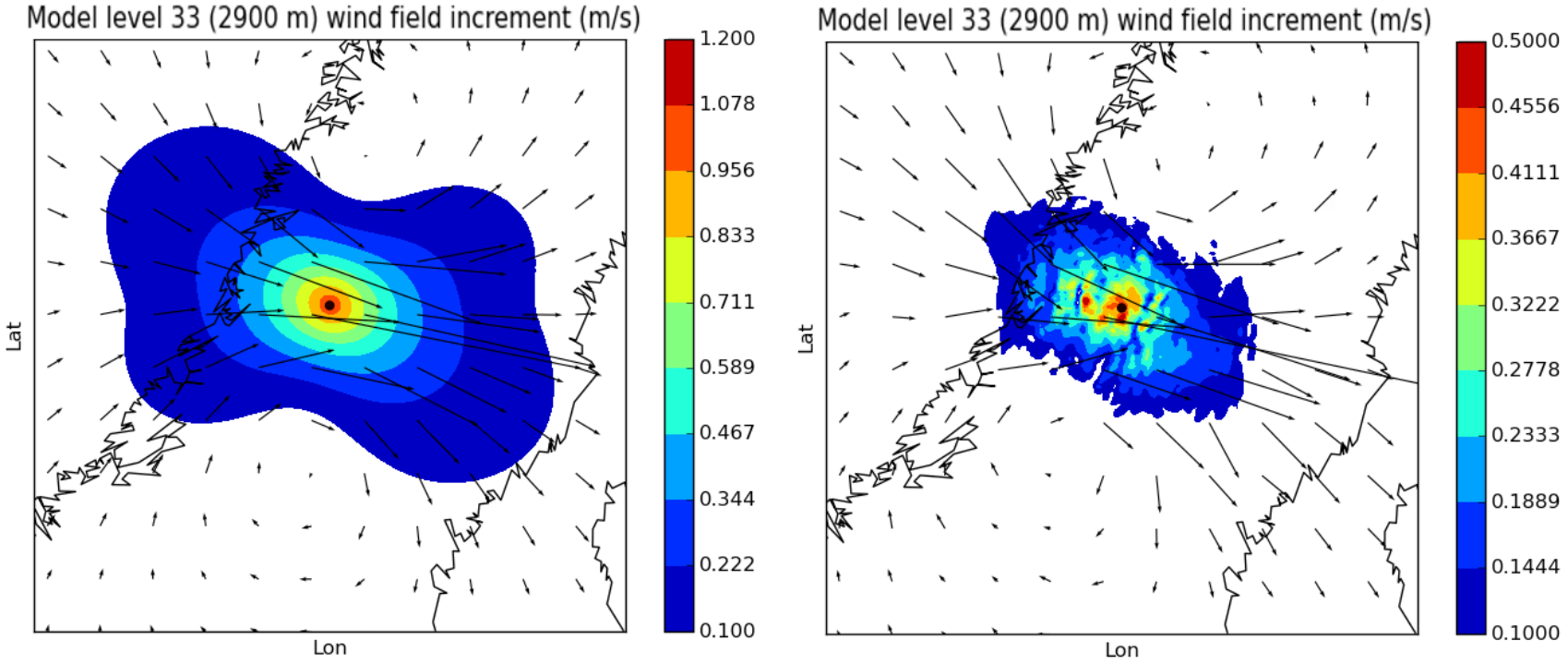
# 4D-Var – single obs test

- A single Mie observation is added to a Harmonie-Arome simulations using either 3D-Var or 4D-Var data assimilation
- - 7 m/s HLOS (Horizontal Line Of Sight) wind valid at 20200526 06.50 UTC



# Analysis increments of wind speed




Differences due to the better handling of time information in 4D-Var and better use of model information creating flow dependent analysis increments

# Conclusions

- Aeolus data successfully used in data assimilation for Harmonie-Arome in 3D-Var
- Laser A period
  - most impact on analysis from using Mie data, impact in analysis also seen with Rayleigh data
  - neutral forecast scores
- Laser B period
  - similar results in analysis and verification scores
  - larger observation errors
- 4D-Var shows promising result

For more details, see
https://doi.org/10.5194/amt-14-5925-2021