Long-term validation of the Aeolus L2B product above Germany

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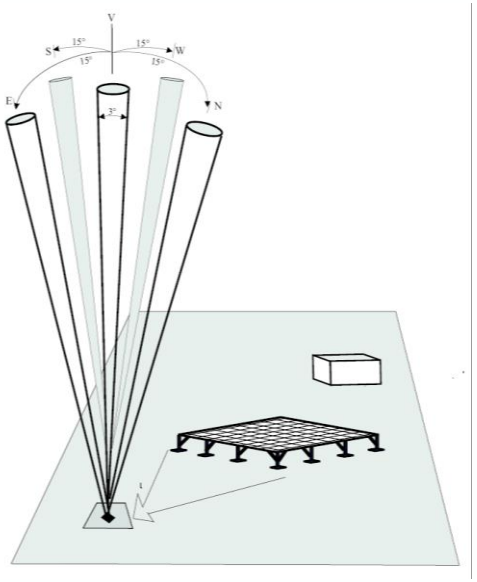
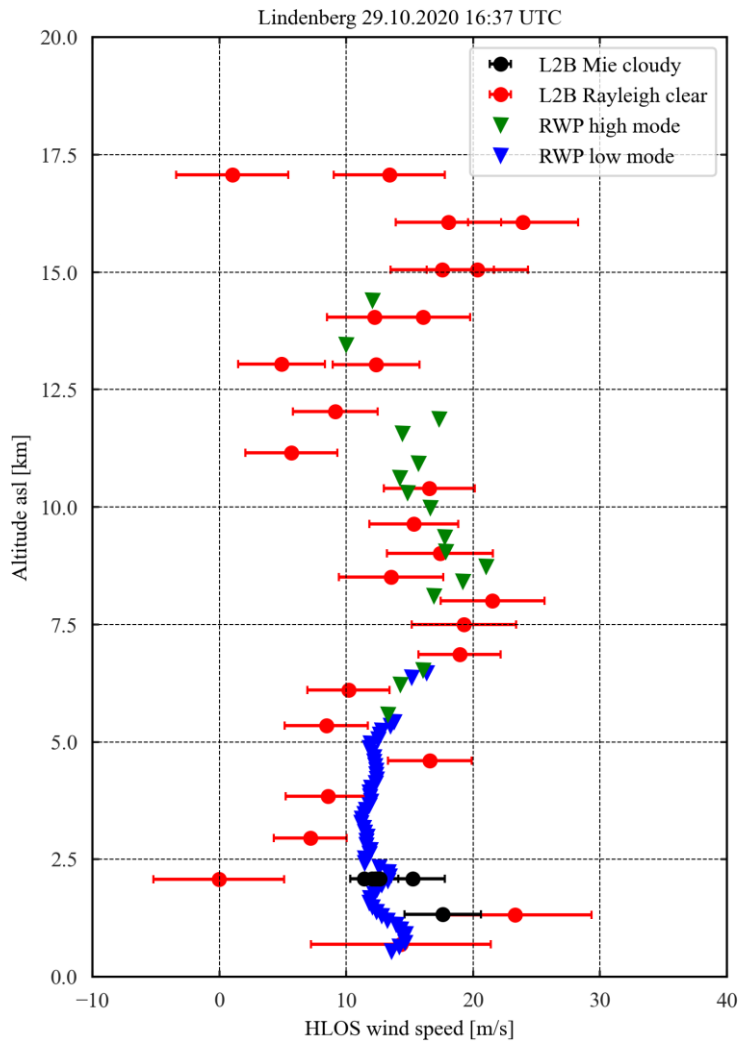
Experimental method applied

ALADIN and Tropospheric Radar Wind Profiler

ALADIN	RWP (482 MHz)
Coverage	
Particles / clear air	Particles/ clear air
Vertical range	
0 – 30 km	Low mode 0.5–9 km High mode 5.5-16 km
Vertical resolution	
250 – 2000 m	Low mode 94 m (145 m) High mode 315 m (485 m)
Temporal/Horizontal resolution	
90 km or less	Low mode 13 min (12 min) High mode 14 min (12 min)
Range bins	
24	Low mode 96 (70) / High mode 35 (22)
Wind components	
HLOS	u, v, (w)





German radar wind profiler network

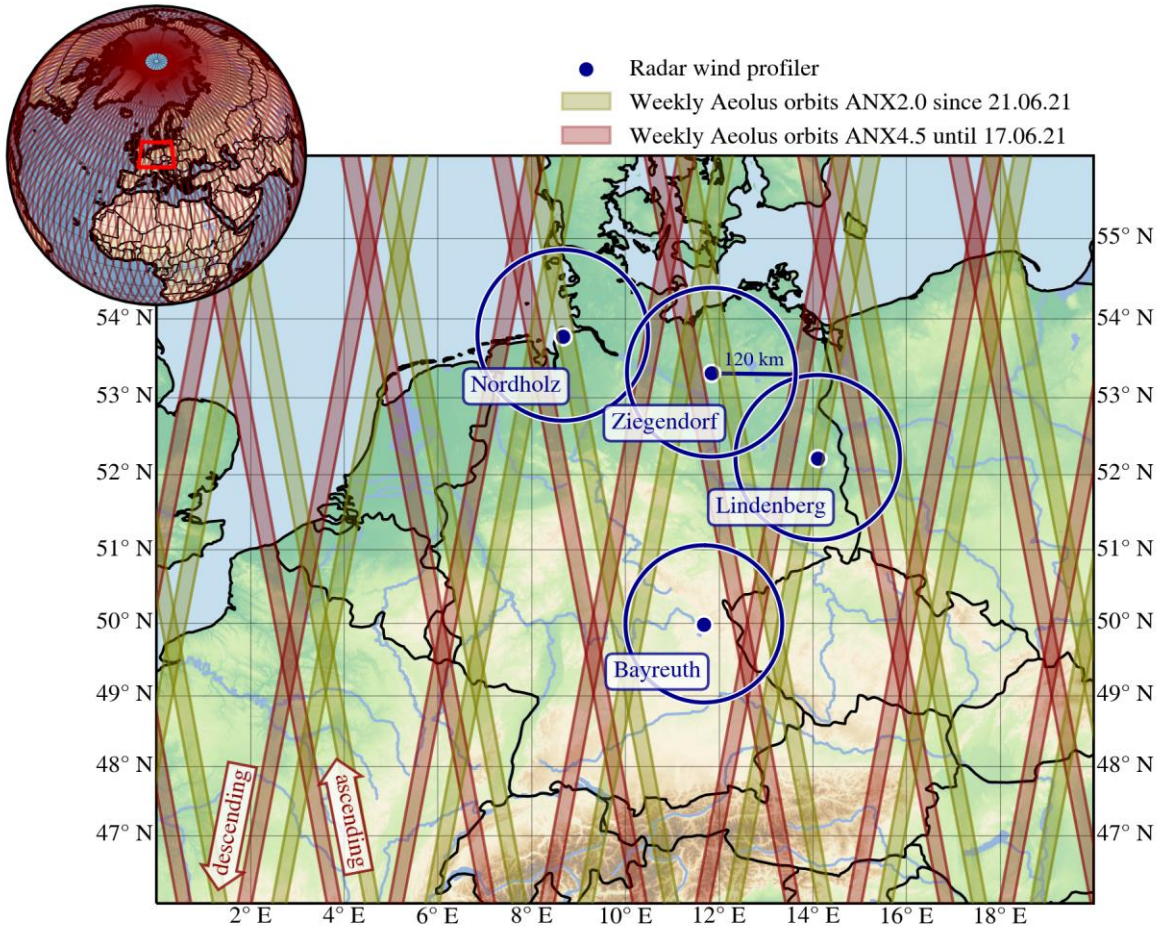
German radar wind profiler sites

- Ziegendorf (53.31N 11.84E) since 2003
- Nordholz (53.78N 8.67E) since 2004
- Bayreuth (49.98N 11.68E) since 2005
- Lindenberg (52.21N 14.11E) since 2009

Radar wind profiler data

- 01.09.2018 – 25.11.2021 from all sites
- Ziegendorf, Bayreuth and Nordholz are operated at lower vertical resolution
- No high mode data available for Nordholz
- All RWPs are operated continuously and fully automated

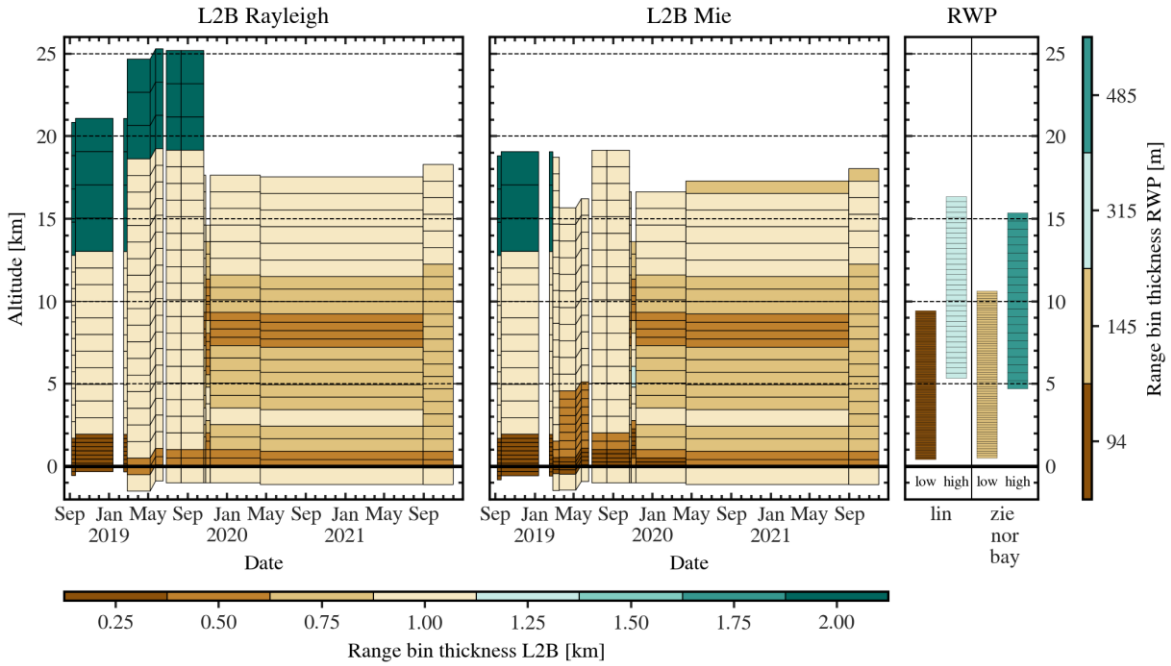
→ Radar wind profilers provide us with high quality reference wind data close to Aeolus' overpasses in time and space

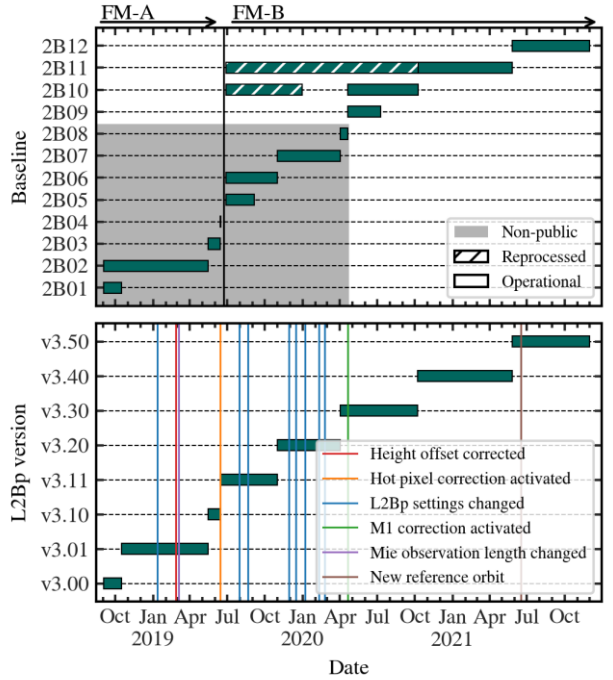


Aeolus data and its collocation

Aeolus L2B data

- Rayleigh-clear and Mie-cloudy from 07.09.2018 – 25.11.2021 covering Baselines B02–B12
- 1st reprocessed data set from 28.06.2019 – 31.12.2019 with Baseline B10
- 2nd reprocessed data set from 28.06.2019 – 10.10.2020 with Baseline B11
  Missing data for 22.06 – 28.06.2020 on the ADDF server
- Only valid winds which are not part of the blacklisted data
- Range bins with hot pixels are excluded for data before 14.06.2019





Collocation criteria

- Horizontal: 120 km radius around RWP (see previous slide)
- Temporal: Weighted average of two consecutive RWP-profiles
  → max 15 minutes difference
- Vertical: All RWP range bins within an Aeolus range bin are averaged → max 400 m difference
- Range bins with hot pixels are excluded for data before 14.06.2019
- Estimated error threshold: Mie < 4 m/s and Rayleigh < 8 m/s

Temporal evolution of the systematic and random error

Rayleigh-clear observations

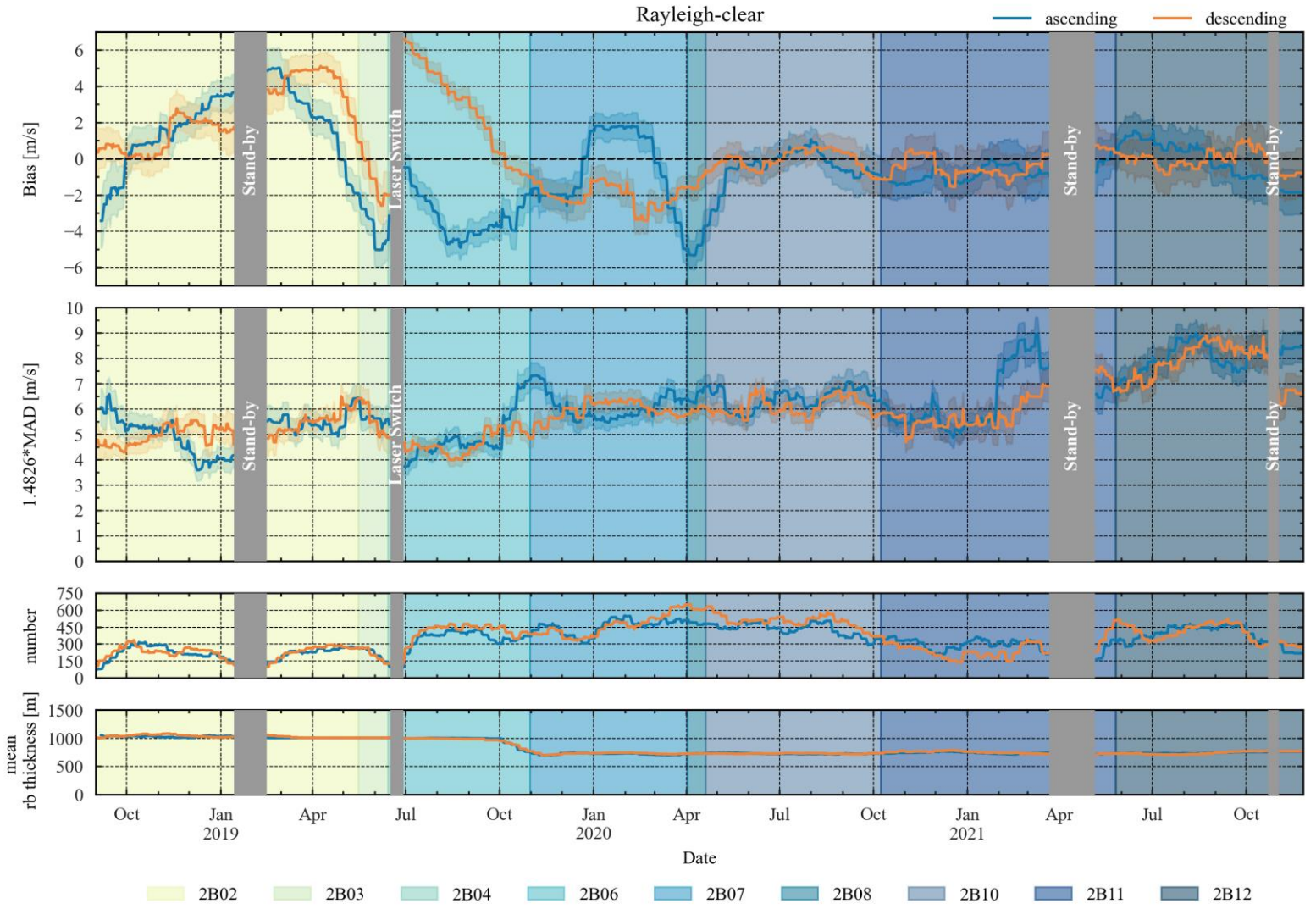
Moving statistics with 21-day window

Systematic error

- Strong variations until the M1 bias correction
- Slight variations after the M1 bias correction
- Differences between ascending and descending orbits
- Strong drift towards negative values with regular corrections during FM-B period until M1 bias correction

Random error

- Steady increase for FM-A and FM-B periods caused by decreasing laser energy
- Stronger increase since Jan 2021
- Thinner range bins lead to higher random error (change in range bin settings Oct 2019)



Temporal evolution of the systematic and random error

Mie-cloudy observations

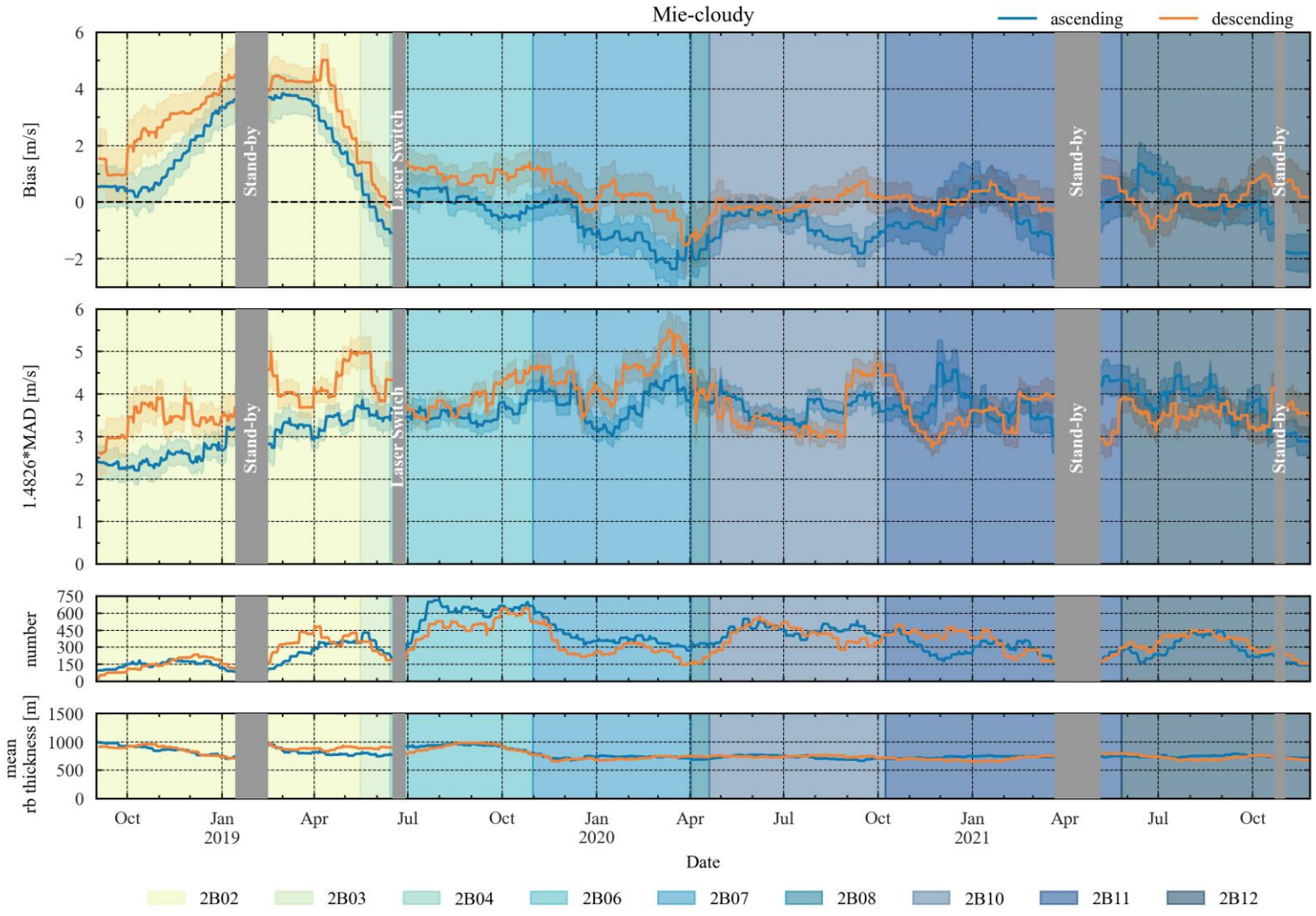
Moving statistics with 28-day window

Systematic error

- Strong variation for FM-A period
- Small differences between ascending and descending orbits
- Impact of M1 bias correction is less significant compared to Rayleigh winds
- Still some bias left after M1 bias correction

Random error

- Steady increase for FM-A and FM-B periods until April 2020
- Almost constantly varying between 3-4 m/s since April 2020

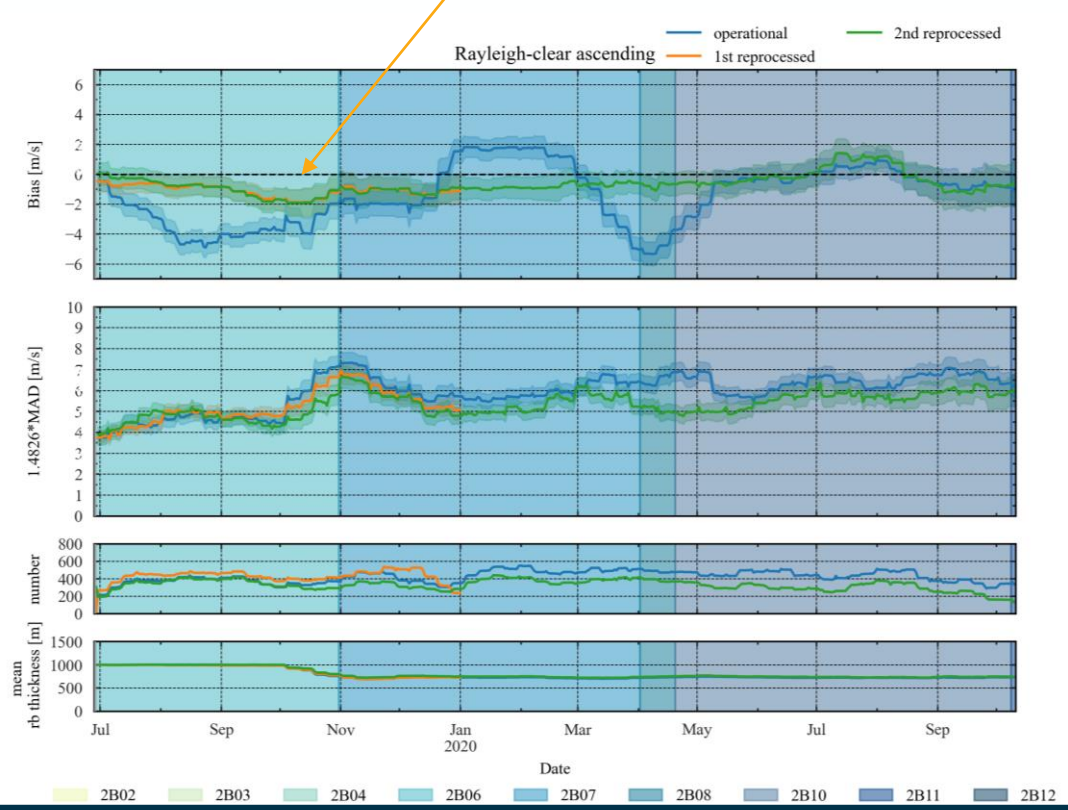


Reprocessed data set analysis

Comparison of the temporal evolution of the systematic and random error

Rayleigh-clear

- From 28.06.2019 – 10.10.2020 covering Baseline B06–B10 (operational), B10 (1st reprocessed) and B11 (2nd reprocessed)
- Both reprocessed data sets implement the M1 bias correction and thus improve the bias before April 2020
- In Oct-Nov 2019 a negative bias (ascending) and a positive bias (descending) is still visible in the reprocessed data

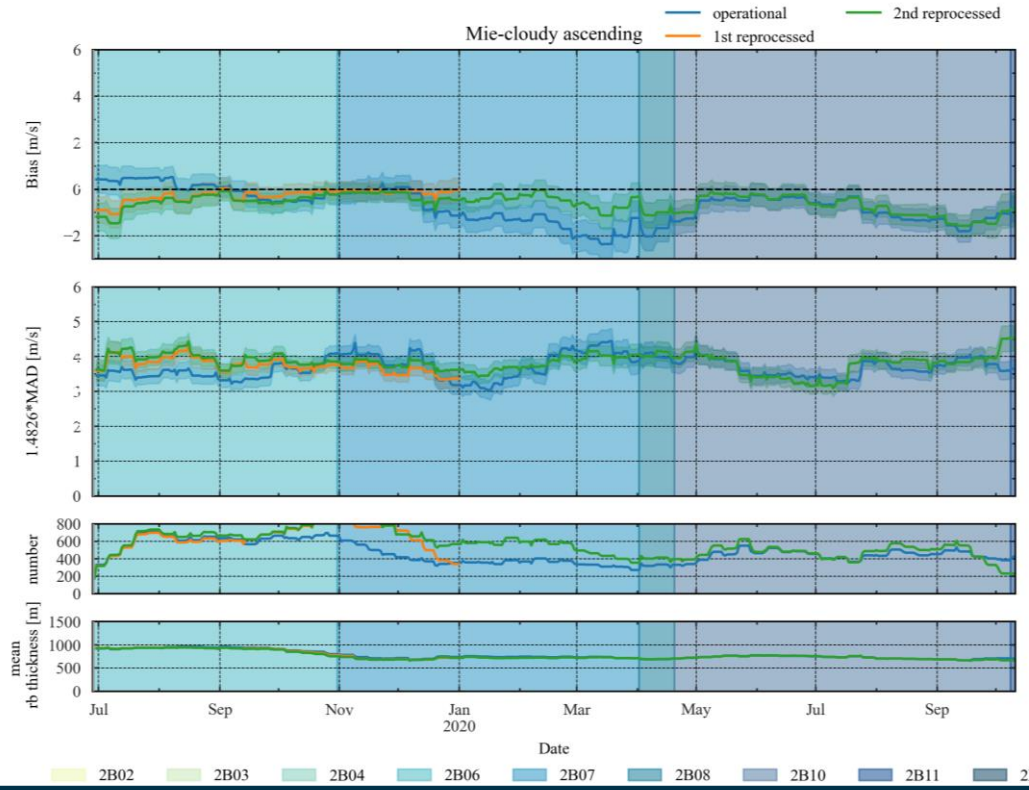


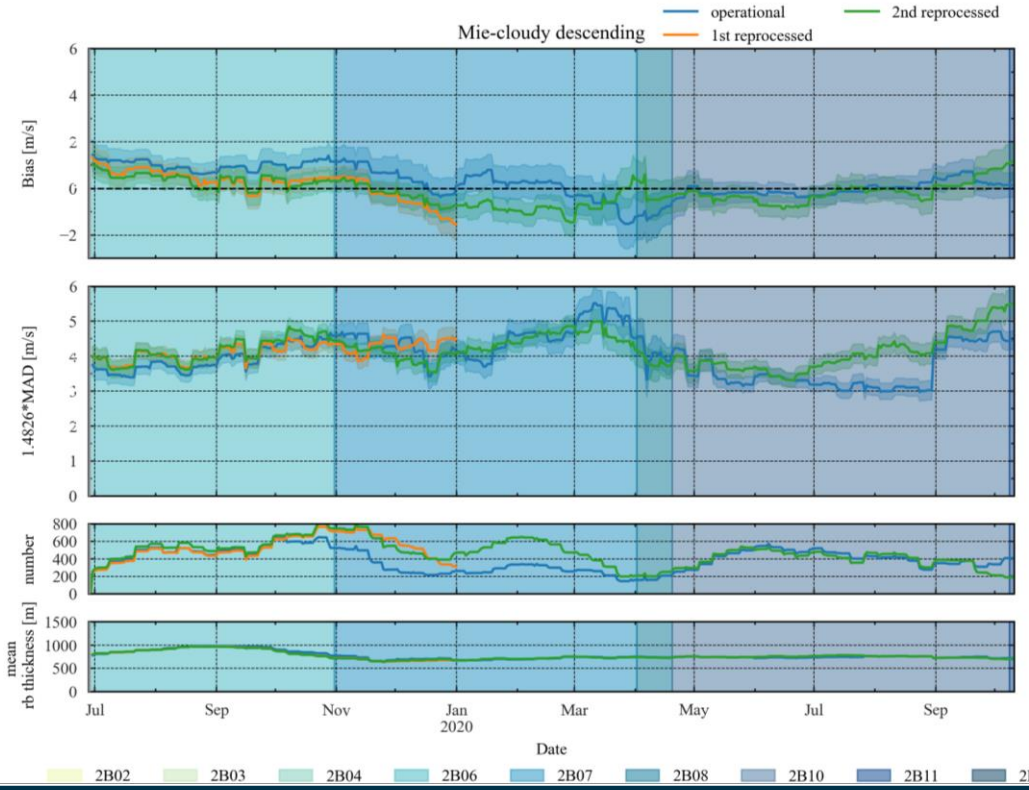
Reprocessed data set analysis

Comparison of the temporal evolution of the systematic and random error between data sets

Mie-cloudy

- From 28.06.2019 – 10.10.2020 covering Baseline B06–B10 (operational), B10 (1st reprocessed) and B11 (2nd reprocessed)
- Between Jan-May 2020 a slight bias improvement for ascending and a worsening for descending orbits
- The number of available wind measurements for comparison with RWP is higher for the reprocessed data

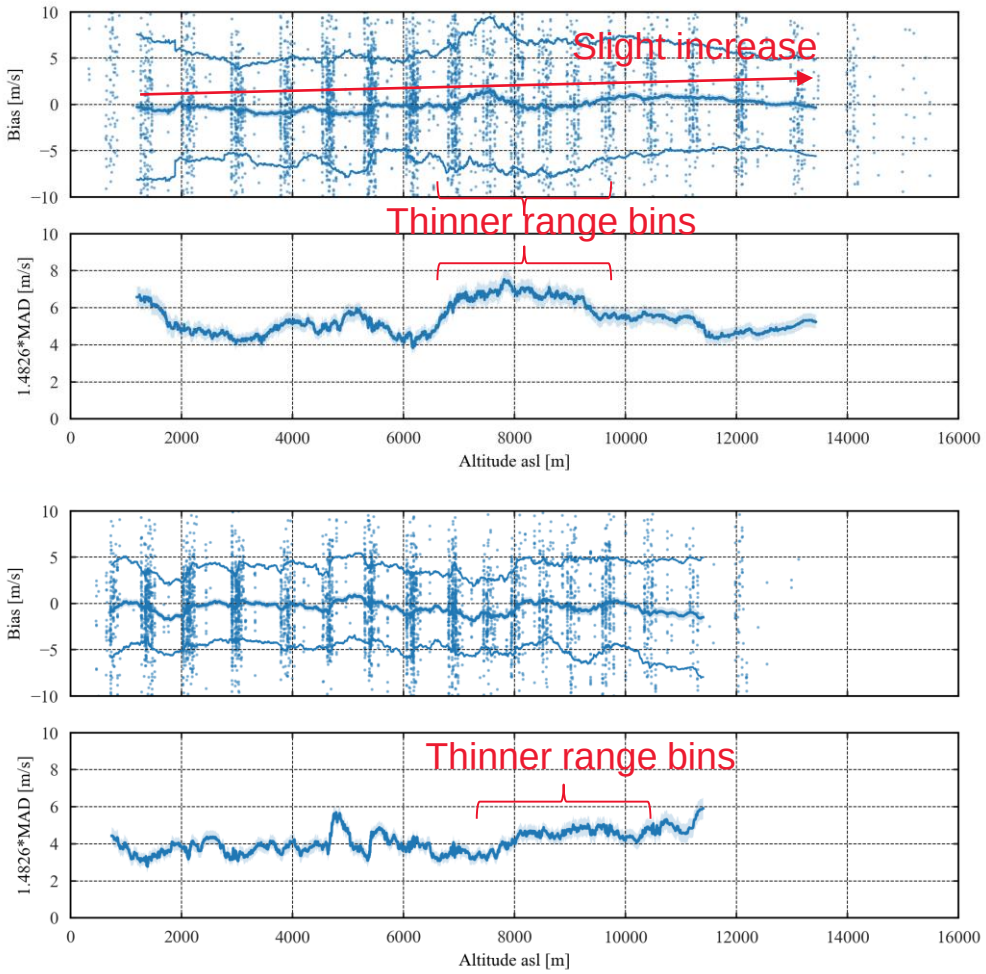




Dependencies of the systematic and random error

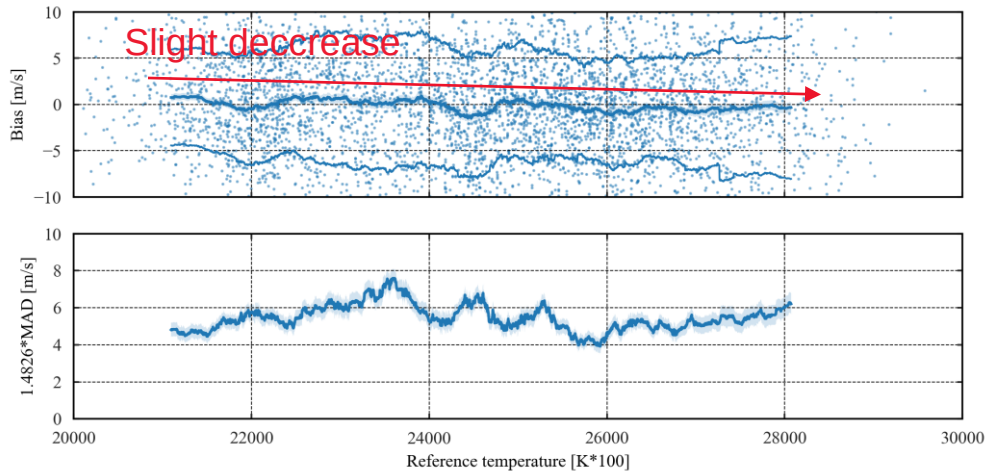
2nd reprocessed data set (only 01.01.2020 – 10.10.2020)

Altitude



Correlation possible

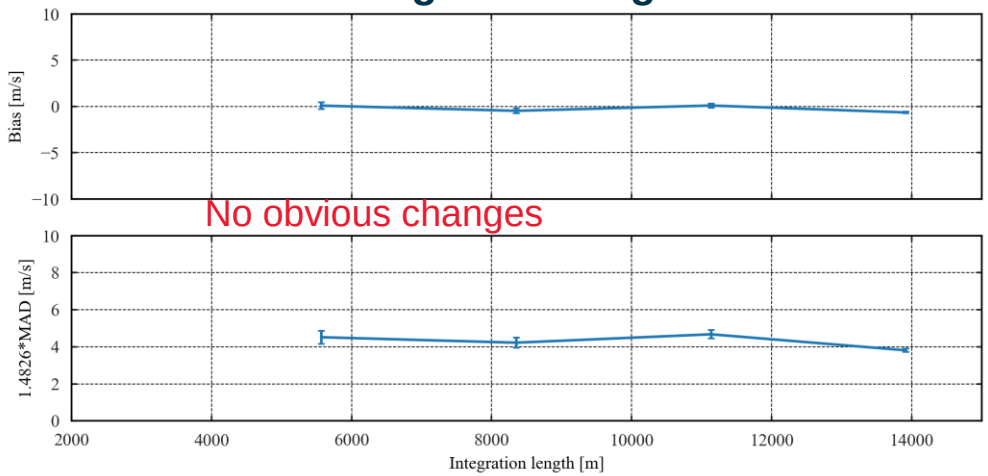
Reference temperature



Rayleigh-clear

Mie-cloudy

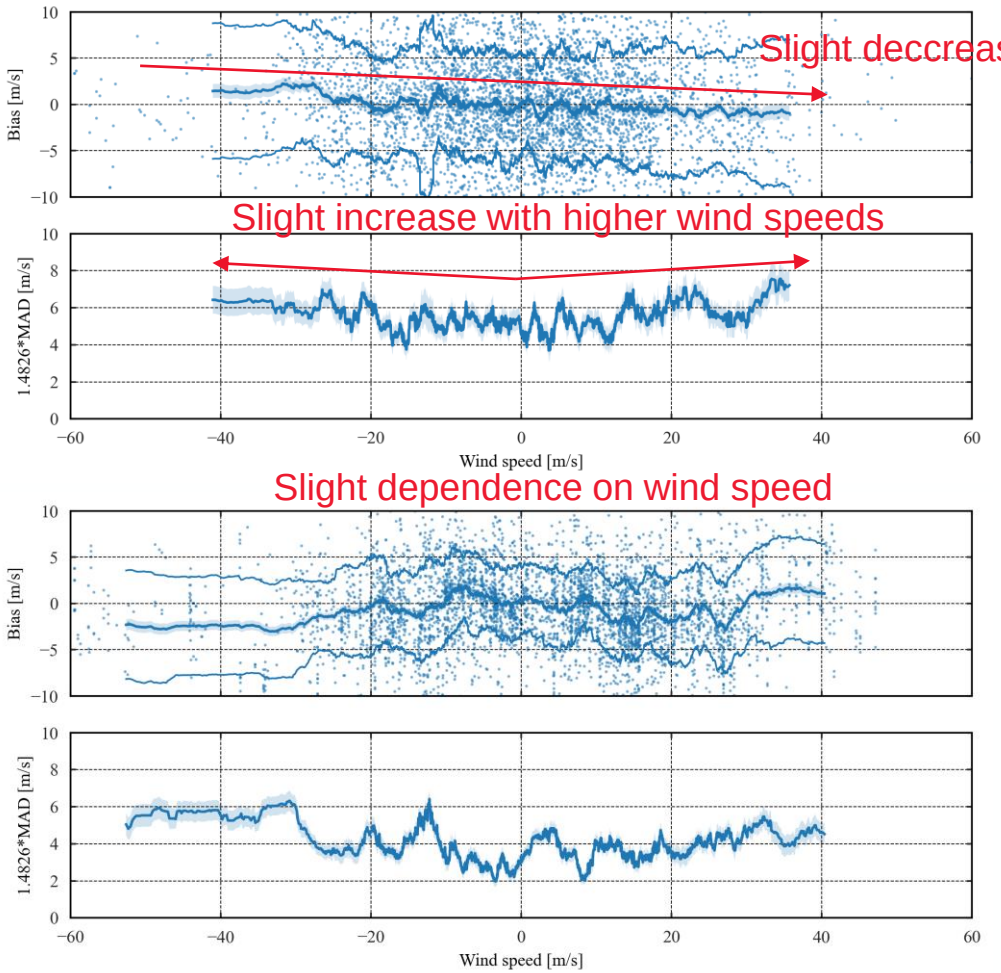
Integration length



Dependencies of the systematic and random error

2nd reprocessed data set (only 01.01.2020 – 10.10.2020)

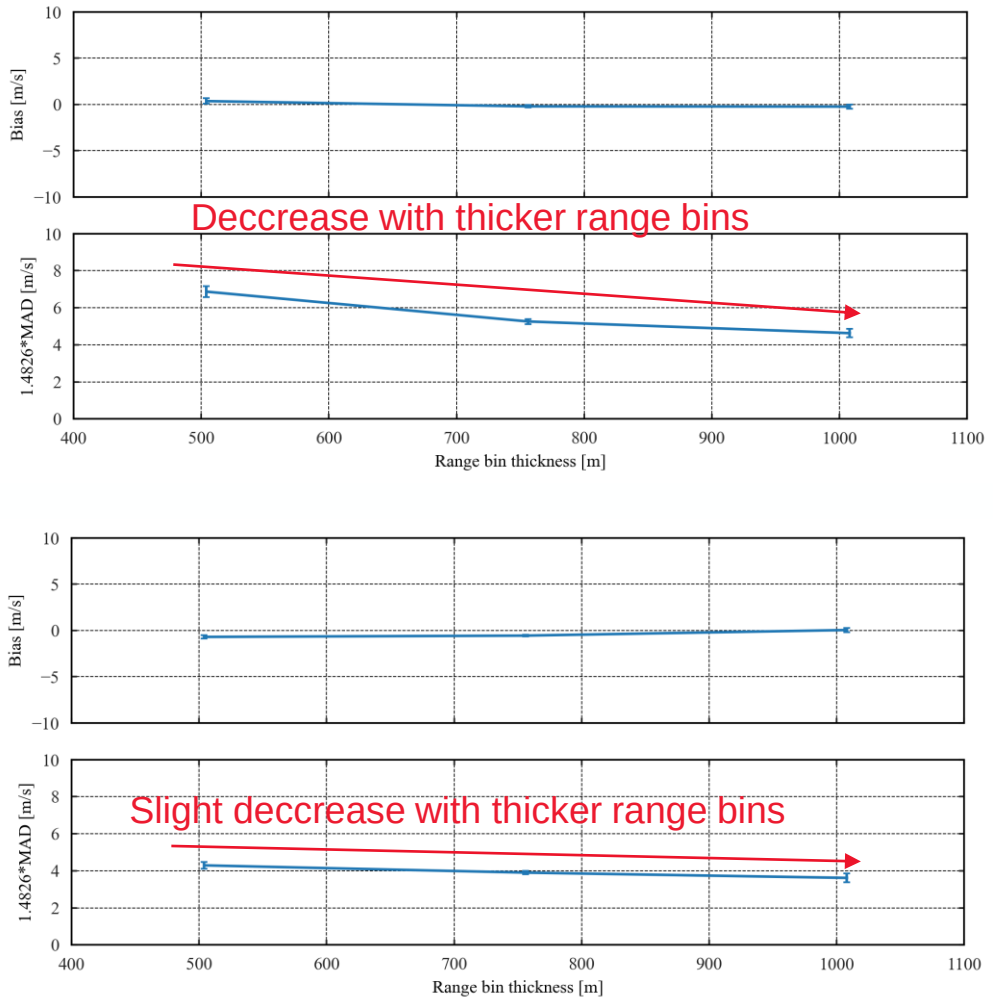
Wind speed



Rayleigh-clear

Mie-cloudy

Range bin thickness



Summary

- Analyzed Rayleigh-clear and Mie-cloudy data from launch until now, covering all baselines
- Analyzed Rayleigh-clear and Mie-cloudy data from reprocessed data sets
- Appropriate collocation and QC-criteria were applied and winds were filtered for blacklisted data
- Temporal evolution of systematic and random errors shows strong variations during the mission and differences between ascending and descending orbit types
  → Mission requirements are not met for random error
- With the implementation of the M1 telescope temperature bias correction the bias improved significantly
- Overall increasing random errors can be observed for Rayleigh-clear and Mie-cloudy winds with a stabilization of Mie random errors since April 2020
- Error dependencies on altitude, wind speed and range bin thickness are analyzed
  → Keep in mind that thinner range bins lead to higher random errors
  → Altitude/temperature dependent bias

VirES Virtual Research Environment (VRE)

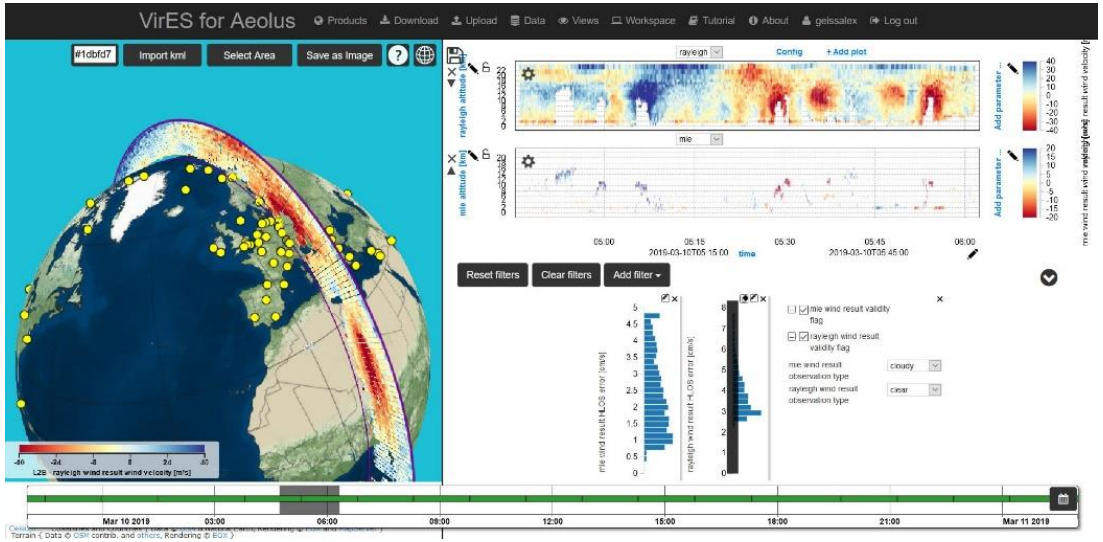
VirES for Aeolus Service

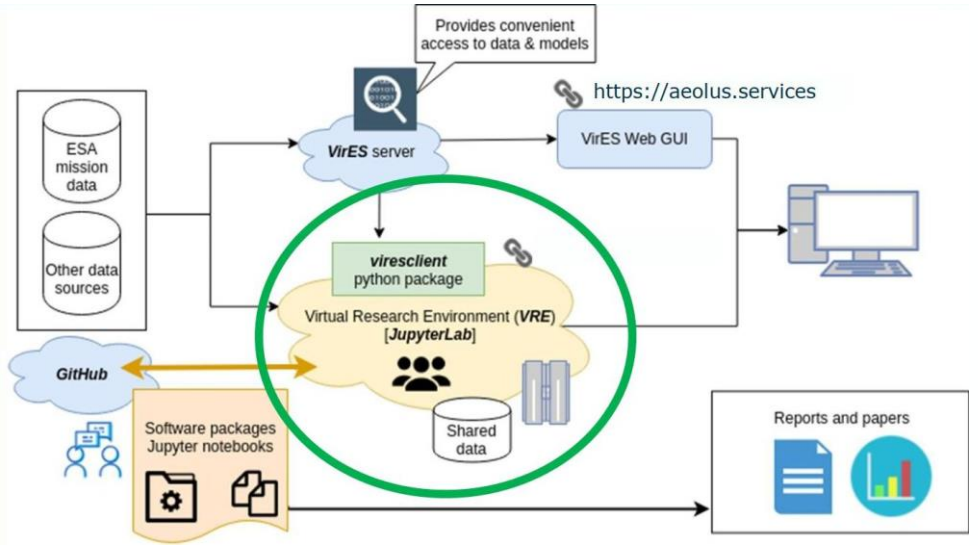
Virtual Workspace for Earth Observation Scientists

- Available at https://aeolus.services
- Highly interactive data exploitation and retrieval interface for access to latest available data
- Service operational since launch with public access to some products on 12 May 2020
- Several new features added since start
- Different panels for visualization and analysis
- Data download in raw- or NetCDF-format

Limitations

- Limited data set periods
- Data can not be modified in Vires web client
- Plots are not fully customizable
- No option for data upload and comparison





VirES Virtual Research Environment (VRE)

VirES Virtual Research Environment (VRE)

- JupyterLab environment with Python notebooks
- All necessary dependencies are set up within a cloud – here JupyterHub
  → can be run from anywhere in just a browser and data is processed server-side
- Viresclient for requesting data can also be used “offline” in a local environment
- Aeolus data can easily be extracted and loaded as pandas.DataFrame or xarray.Dataset
- Larger data set periods can be handled
- Own data can be uploaded
  → independent validation possible
- Validation algorithms can be shared between users#
- Several jupyter notebooks are already available and more are being developed

Pre-operational version soon available for Cal/Val teams with latest Aeolus data → contact Daniel Santillan from EOX to get access (daniel.santillan@eox.at)

https://vre.aeolus.services/

https://notebooks.aeolus.services/