Experimental Validation and Evaluation of Aeolus Winds using Radiosonde and Radar Wind Profiler Observations & Model Equivalents

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AS1.35 Aeolus data and its application - 5 May, 2020

EVAA

German Project for the **E**xperimental **V**alidation and **A**ssimilation of **A**eolus

Project coordinated by: LMU MIM

Project partners: TROPOS Leibniz-Institut für Troposphärenforschung; Deutscher Wetterdienst Wetter und Klima aus einer Hand DWD

Funded by: DLR Raumfahrtmanagement

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WIND VALIDATION

AEROSOL VALIDATION

NWP IMPACT

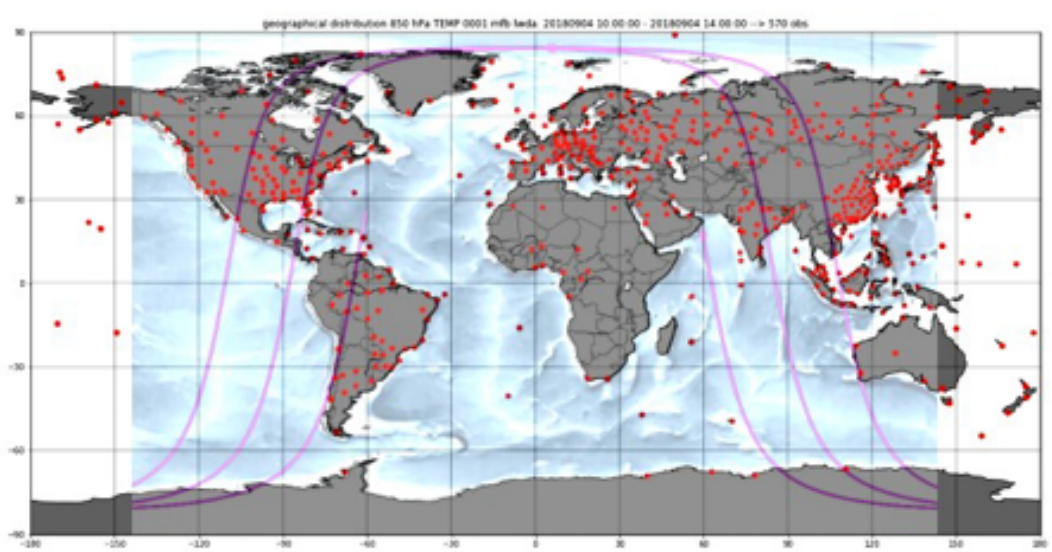
Data and method

Aeolus Level 2B product

- Rayleigh clear winds: estimated error < 6 m/s
- Mie cloudy winds: estimated error < 4 m/s
- 800 - 80 hPa
- (all data used for the statistics are preliminary data)

Radiosonde data

- global observational database ECMWF (~ 1200 RS obs/day)
- rare coverage SH and polar regions → focus on NH
- HLOS = - u sin(φ) - v cos(φ)



Location Radiosondes, Aeolus Orbit 2018/09/04 10:00 – 14:00 UTC

Collocation criteria:

temporal distance < 90 min

horizontal distance < 120 km

vertical distance < 500 m

Model equivalents

First guess departure (O-B) from the global model ICON from DWD and the ECMWF model serve for further comparisons and systematic error investigations

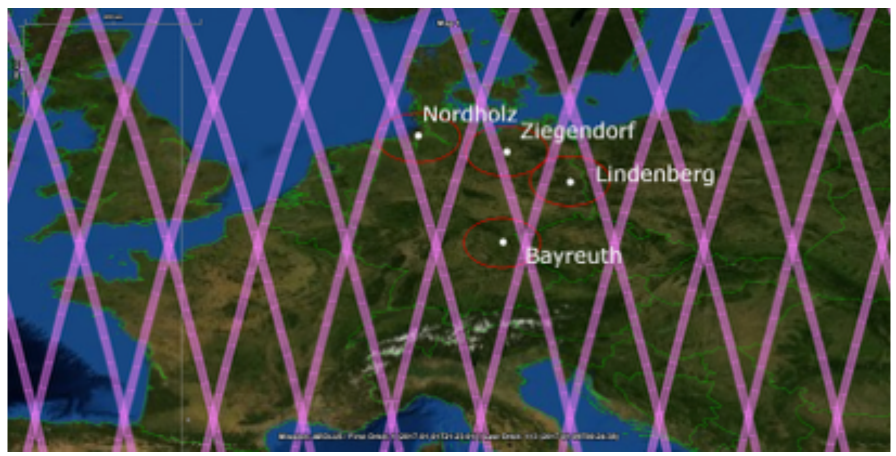
Data and method

Aeolus Level 2B product

- Rayleigh clear winds: estimated error < 6 m/s
- Mie cloudy winds: estimated error < 4 m/s

Tropospheric Radio Wind Profiler

- 4 locations in Germany (DWD), running 24/7
- HLOS = - u sin(φ) - v cos(φ)

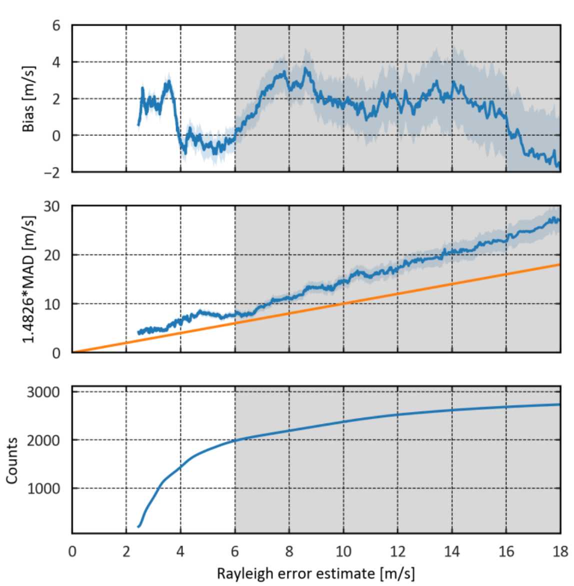


Collocation criteria:

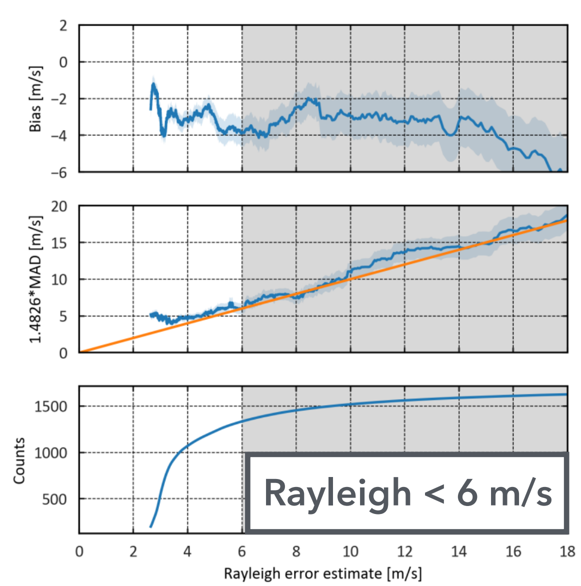
temporal distance	< 14 min
horizontal distance	< 120 km
vertical distance	< 500 m

Error estimate thresholds: © Alexander Geiss (LMU)

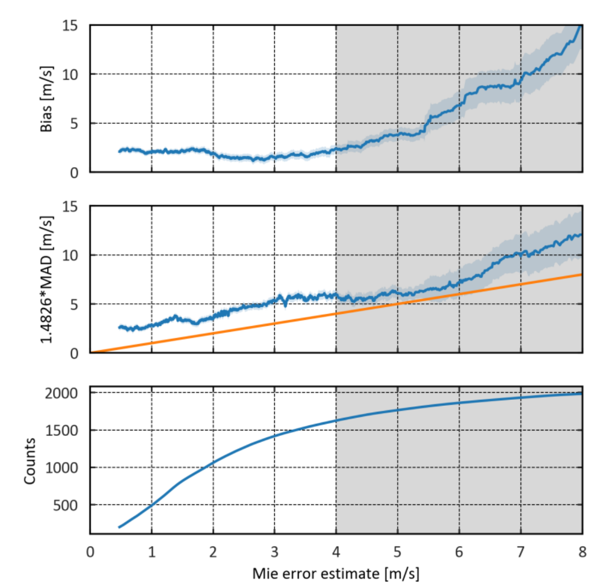
Rayleigh FM-A ascending



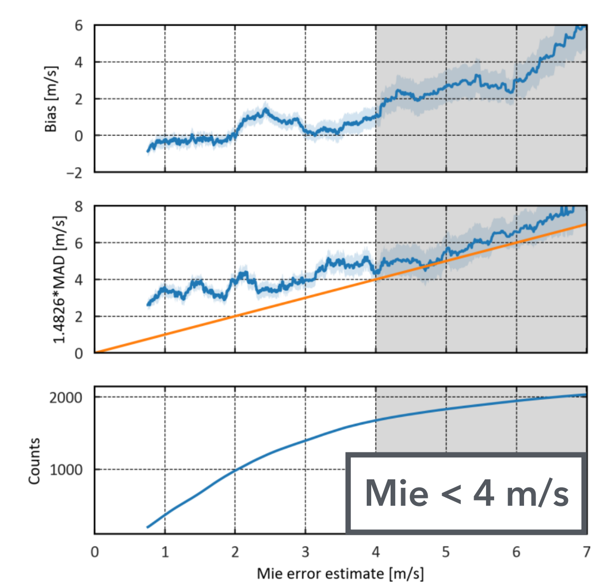
Rayleigh FM-B ascending



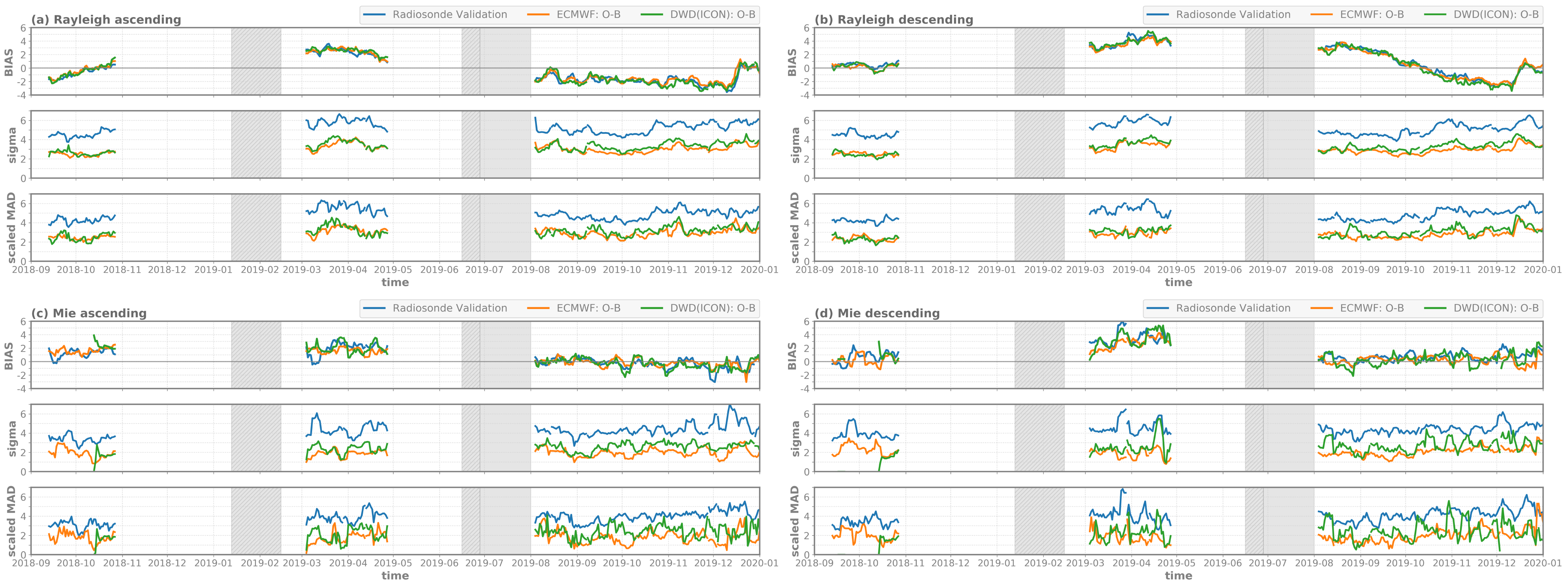
Mie FM-A ascending



Mie FM-A descending



Validation - temporal evolution of systematic and random error



Time evolution from September 2018 to January 2020 of the systematic and random error of Aeolus HLOS winds for the northern hemisphere using collocated radiosonde observations and model equivalents (O-B) of the ECMWF model and the ICON model of DWD. Statistics for one day based on 7 days.

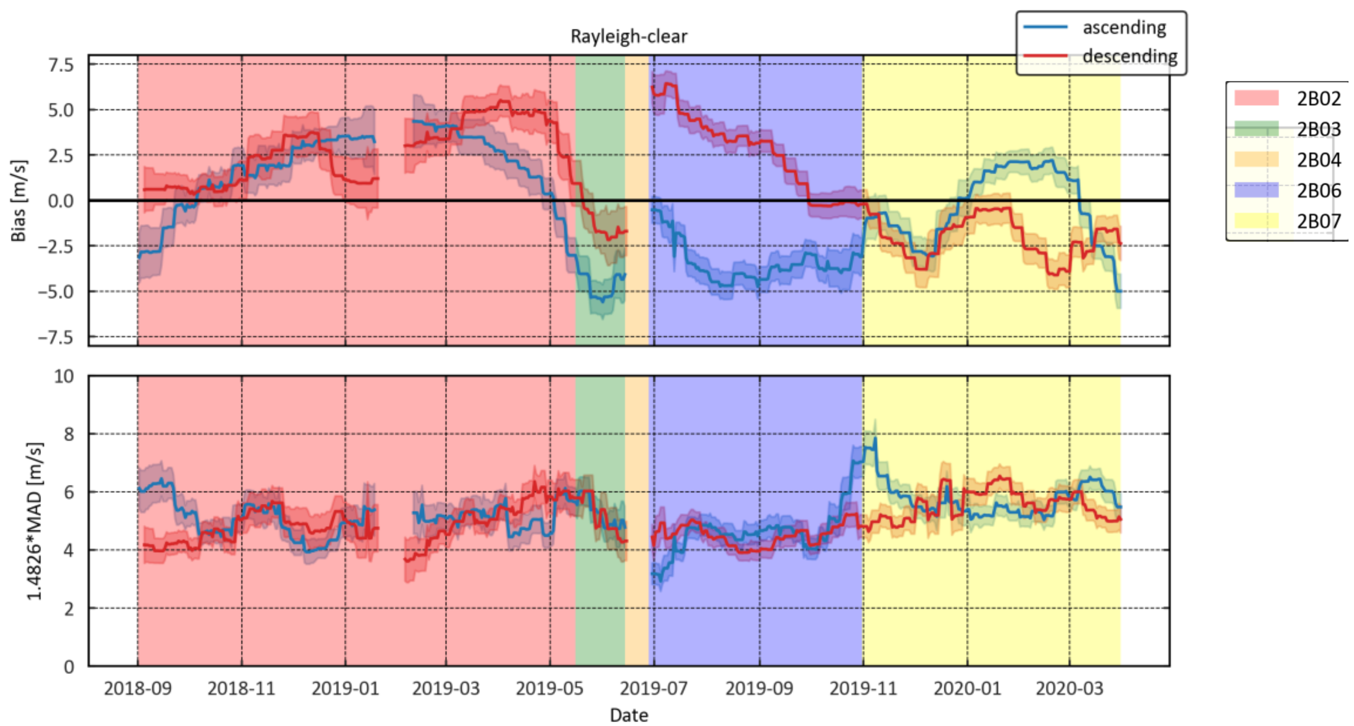
(a) Rayleigh channel, ascending orbit **(b)**: Rayleigh channel descending orbit

(c) Mie channel, ascending orbit **(d)** Mie channel, descending orbit

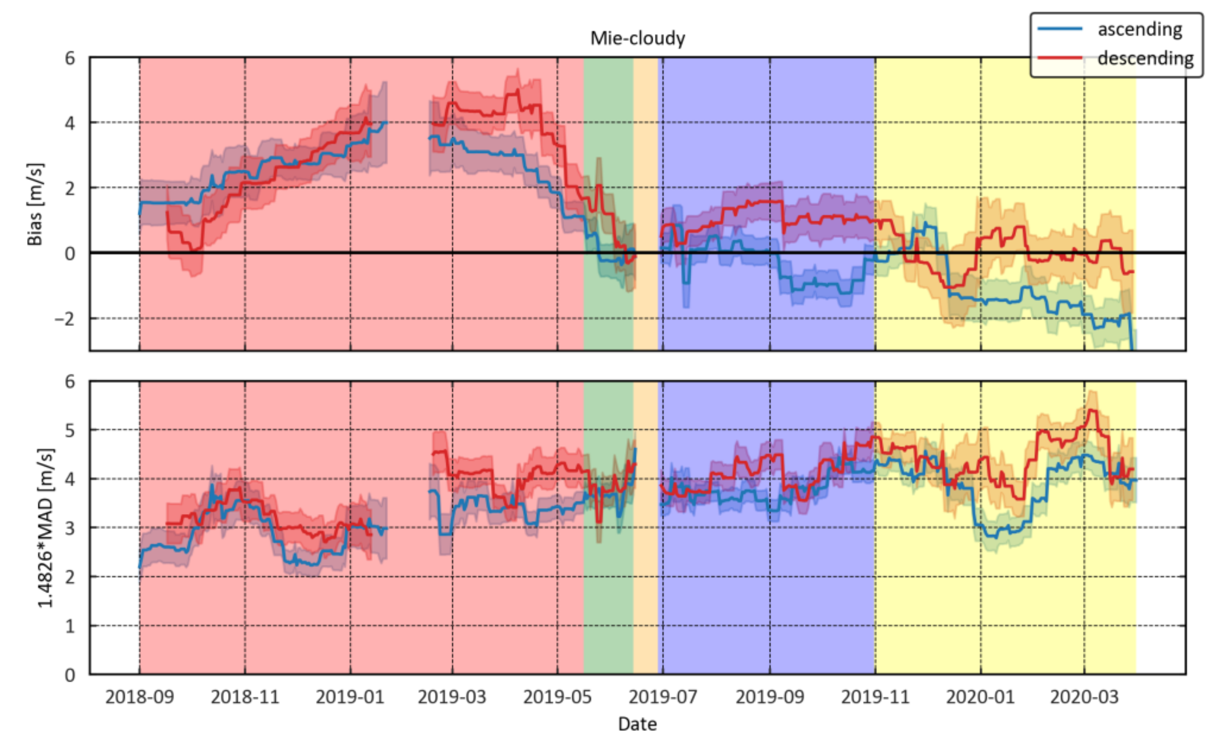
Note: some parts are missing because of ongoing, not yet finished monitoring at DWD (will be completed soon)

Validation - temporal evolution of systematic and random error

Rayleigh



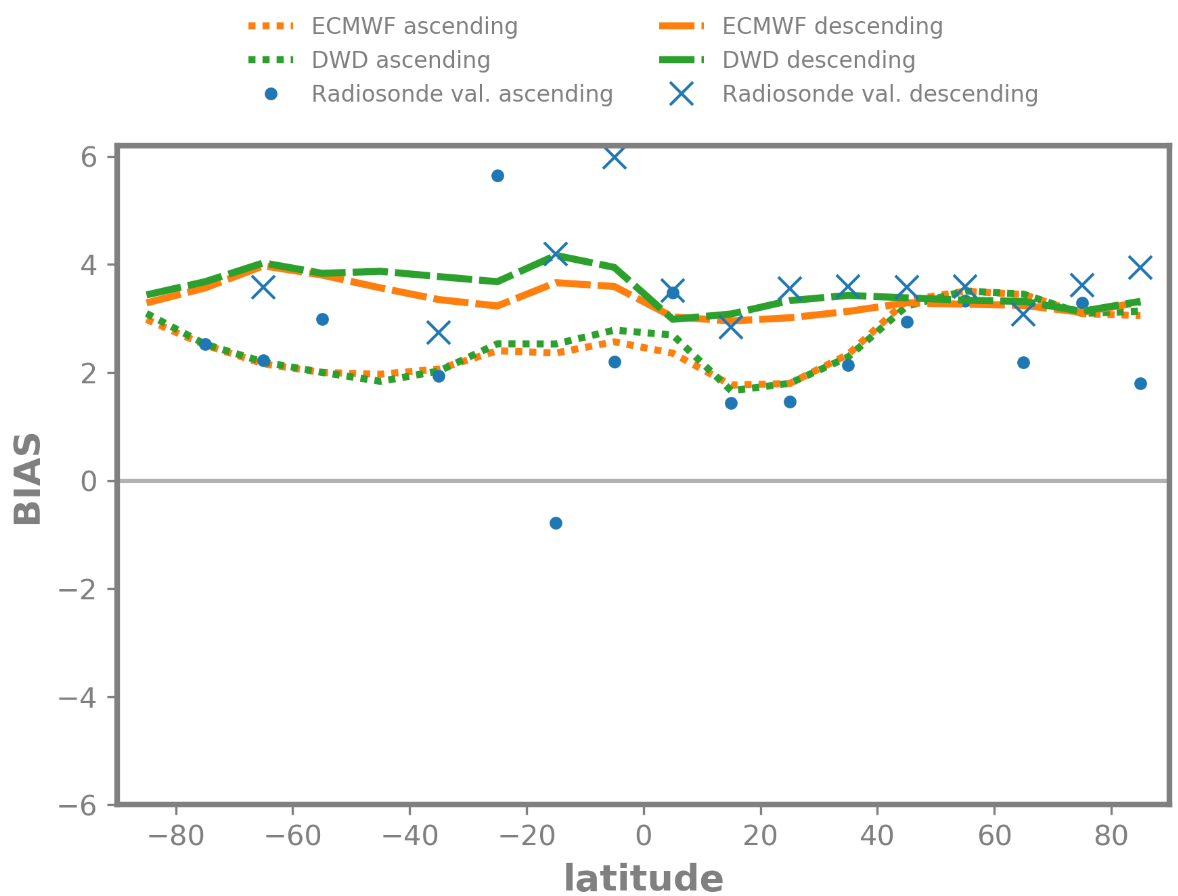
Mie



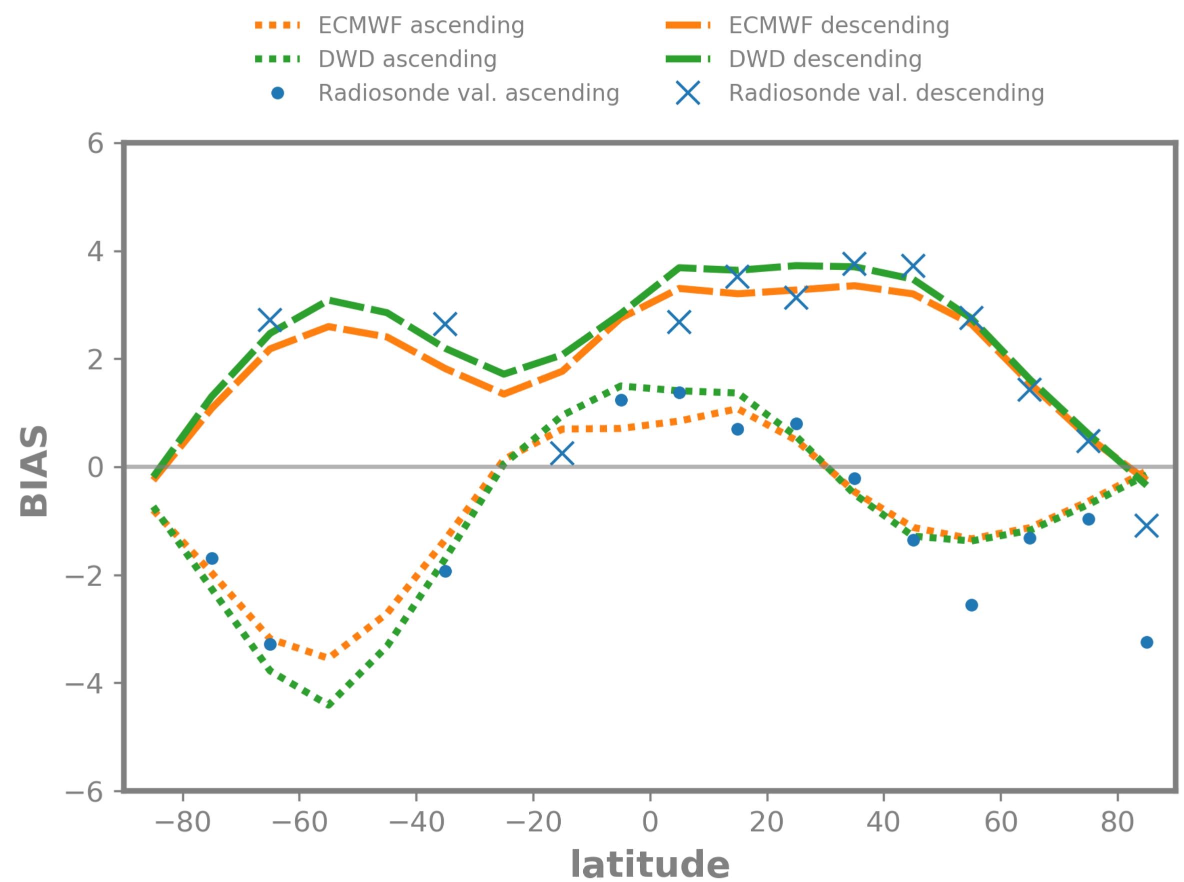
Time evolution from September 2018 to 15 March 2020 of the systematic and random error of Aeolus HLOS winds using collocated radar wind profiler observations.

Statistics for one day based on 21 days.

Systematic error dependencies - Rayleigh orbit phase bias



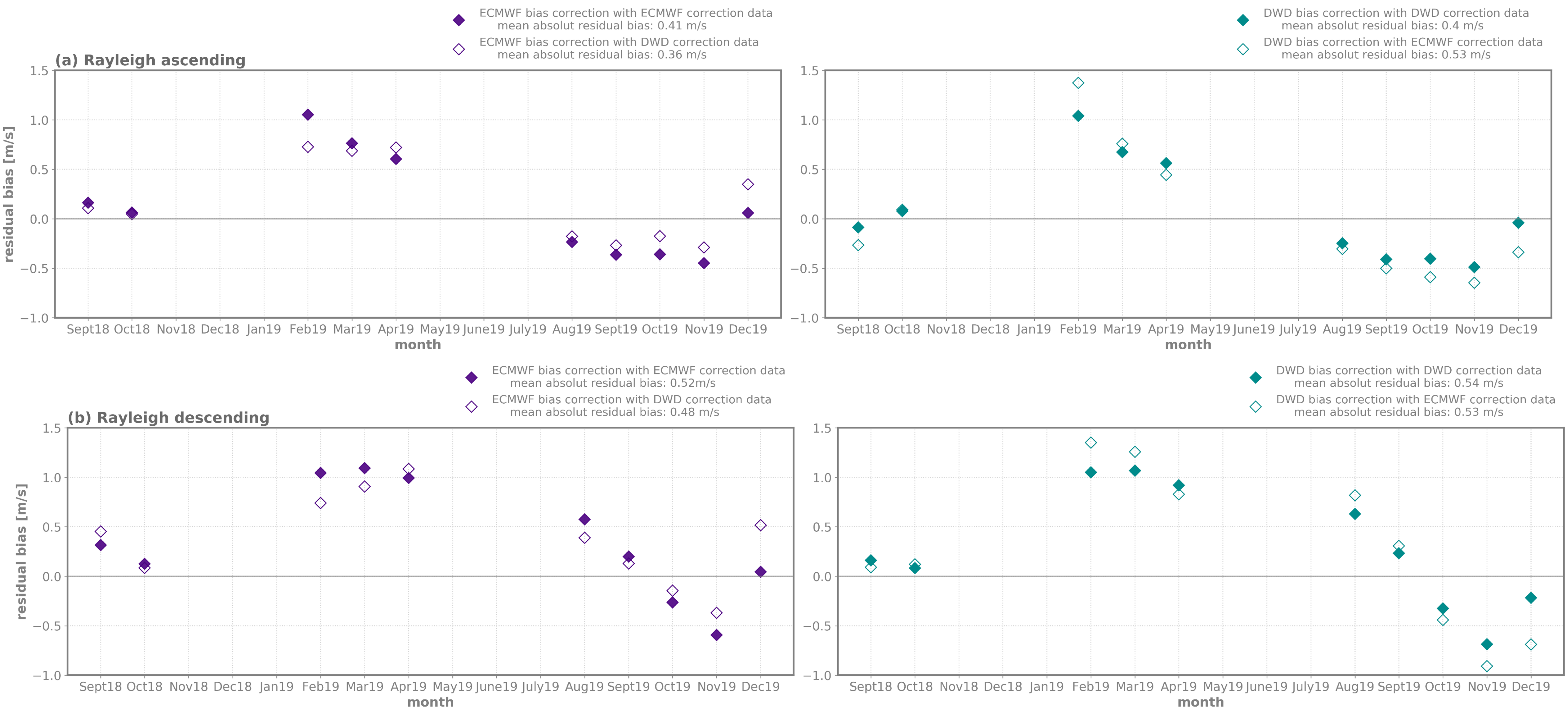
March 2019: BIAS as function of latitude for ascending and descending orbit



August 2019: BIAS as function of latitude for ascending and descending orbit

- summer and autumn months: strong differences between asc and desc orbit, fluctuations with latitude
- spring and winter months: less differences between asc and desc orbit, bias seems more constant with latitude
- good accordance between the two models
- bias dependence also visible with radiosonde data (outliers mainly caused by small sample size)

Rayleigh orbit phase bias - correction approach

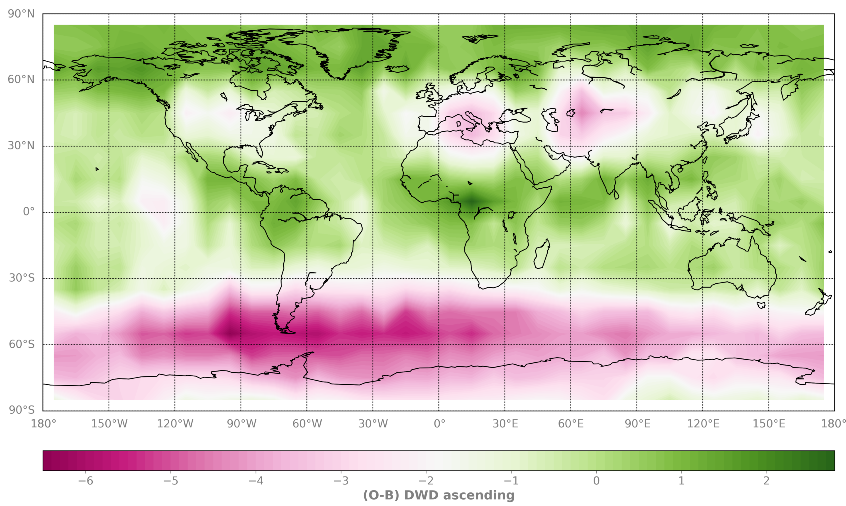


Residual after orbit phase bias correction approach - ECMWF and DWD model. Correction values are calculated using the past seven day's O-B bias (weighted) as function of latitude for asc and desc orbit. Unfilled markers show the residual when the correction values of the other model are used.

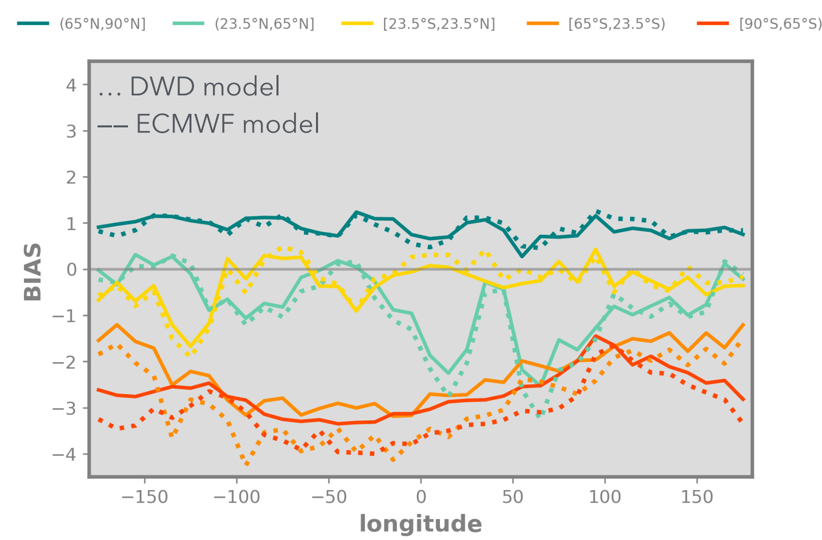
→ Overall, still mean absolute residual bias of around 0.5 m/s

Systematic error dependencies - Rayleigh orbit phase/longitude bias

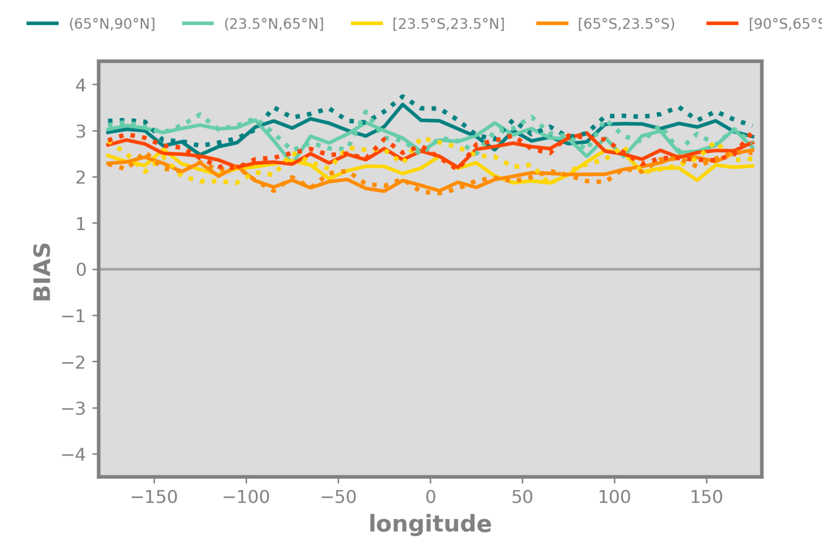
Sept19 - Rayleigh ascending (DWD)



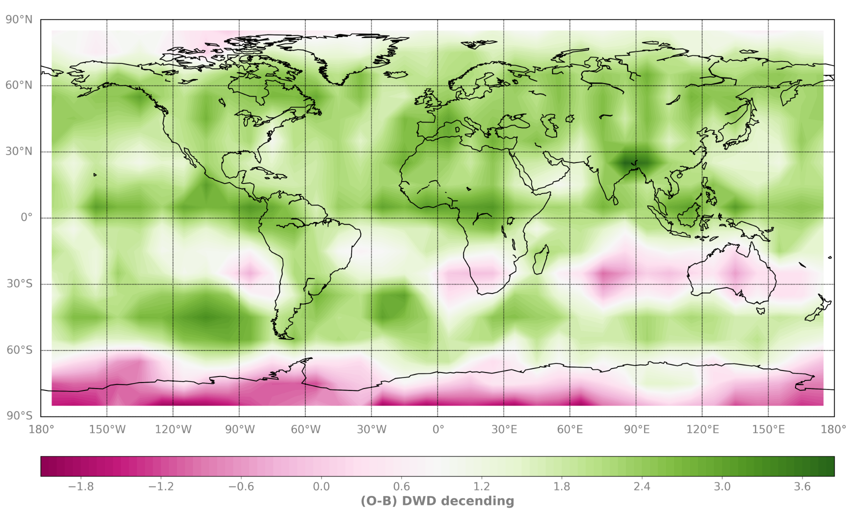
Sept19 - Rayleigh ascending (ECMWF, DWD)



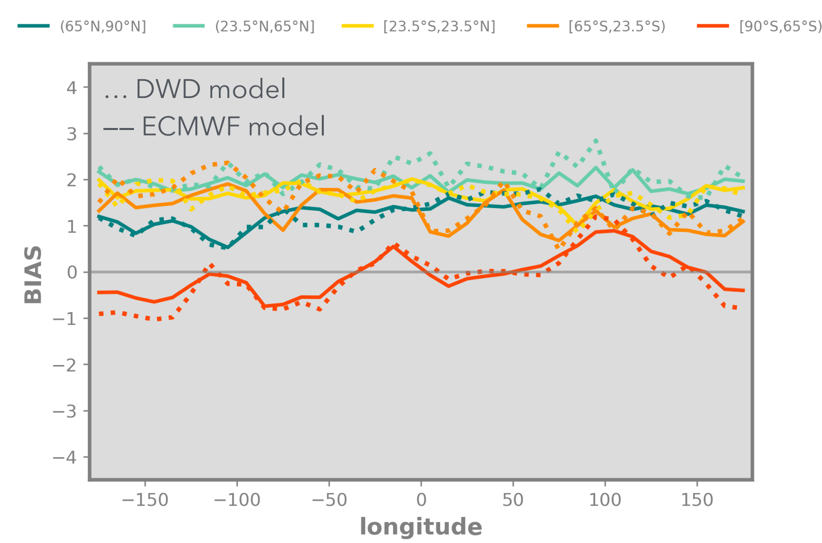
Mar19 - Rayleigh ascending (ECMWF, DWD)



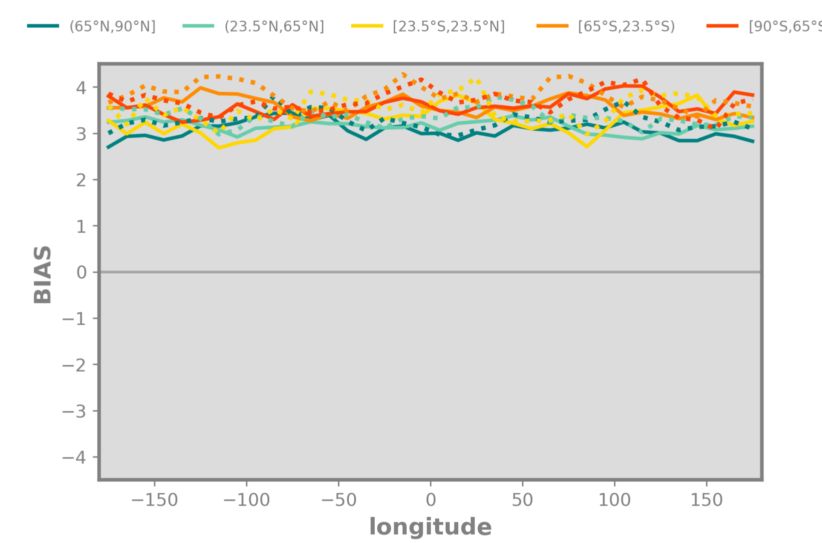
Sept19 - Rayleigh descending (DWD)



Sept19 - Rayleigh descending (ECMWF, DWD)



Mar19 - Rayleigh descending (ECMWF, DWD)

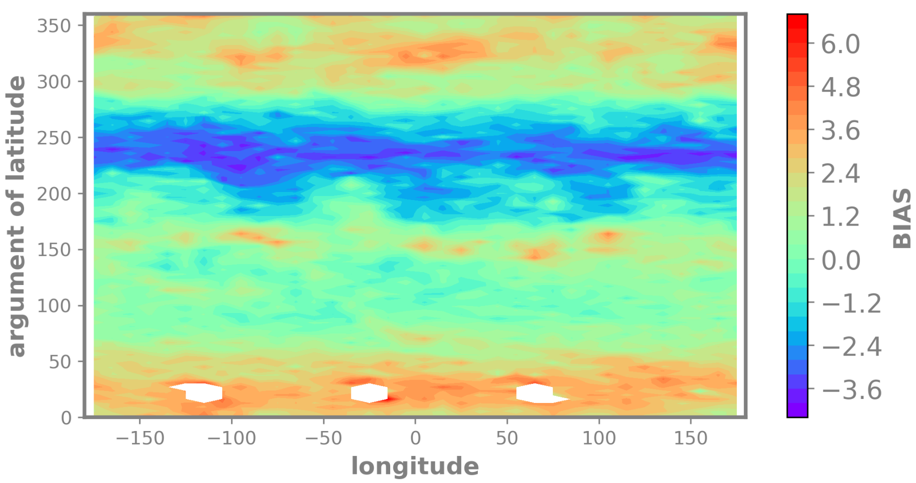


- for ascending orbit strongest fluctuations on NH - mid latitudes
- for descending orbit strongest fluctuations on SH - mid latitudes

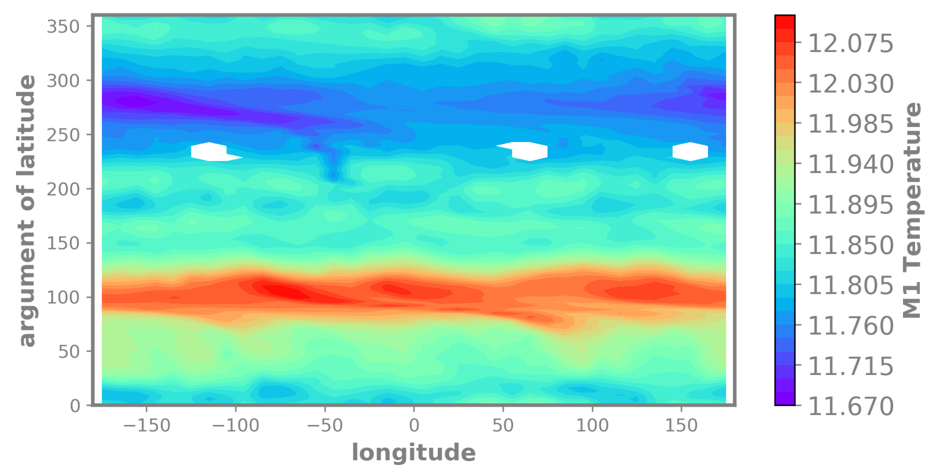
- longitude bias more present in autumn months, than in spring
- largest differences between ECMWF an DWD model in the mid latitudes (SH), but overall good agreement

Systematic error dependencies - Rayleigh orbit phase/longitude bias

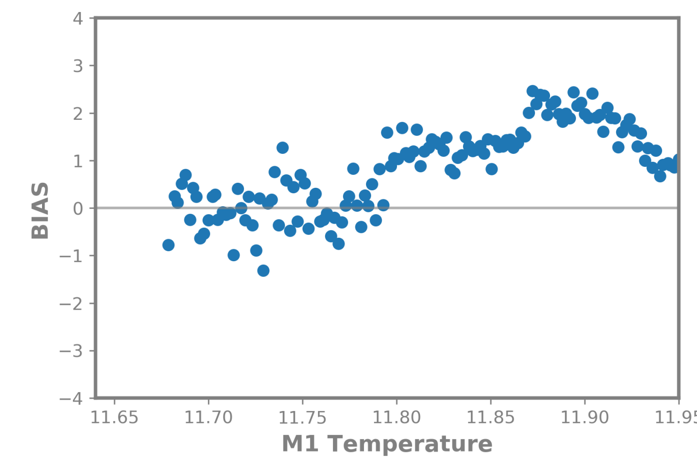
May19 - BIAS



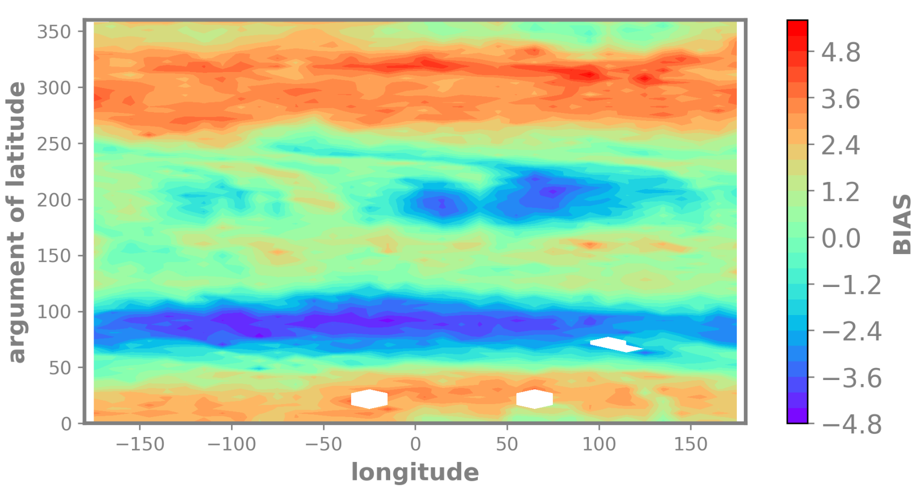
May19 - M1 Temperature



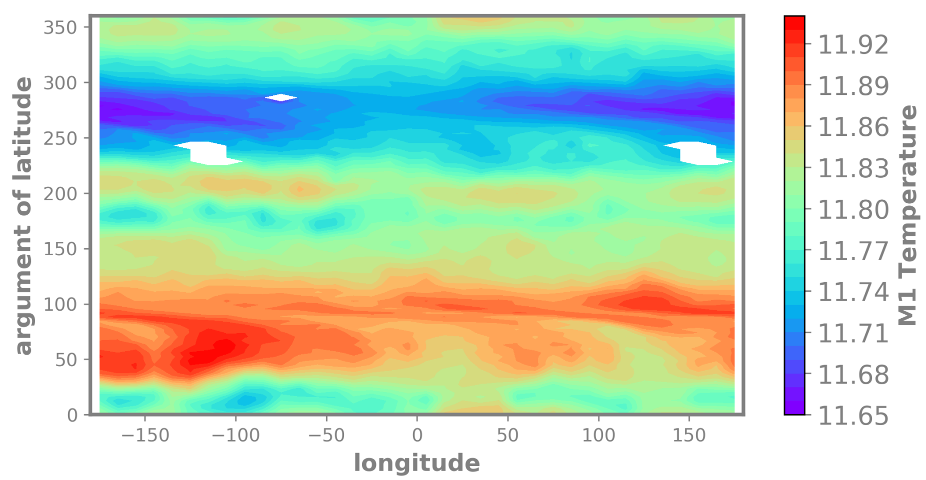
May19 - BIAS vs M1 Temperature



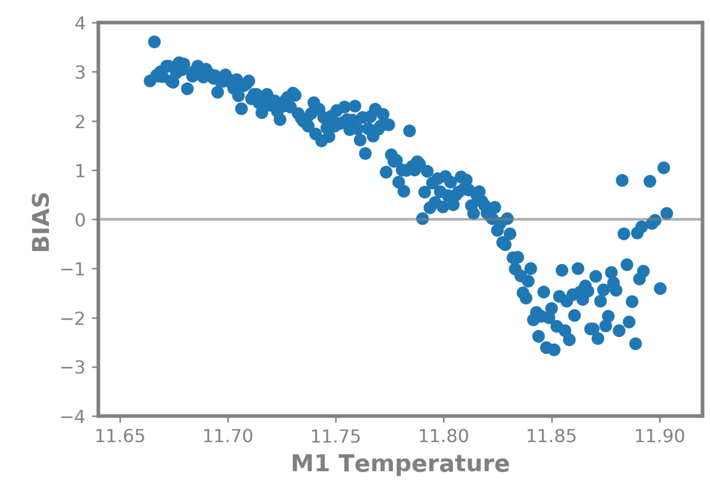
Aug19 - BIAS



Aug19 - M1 Temperature



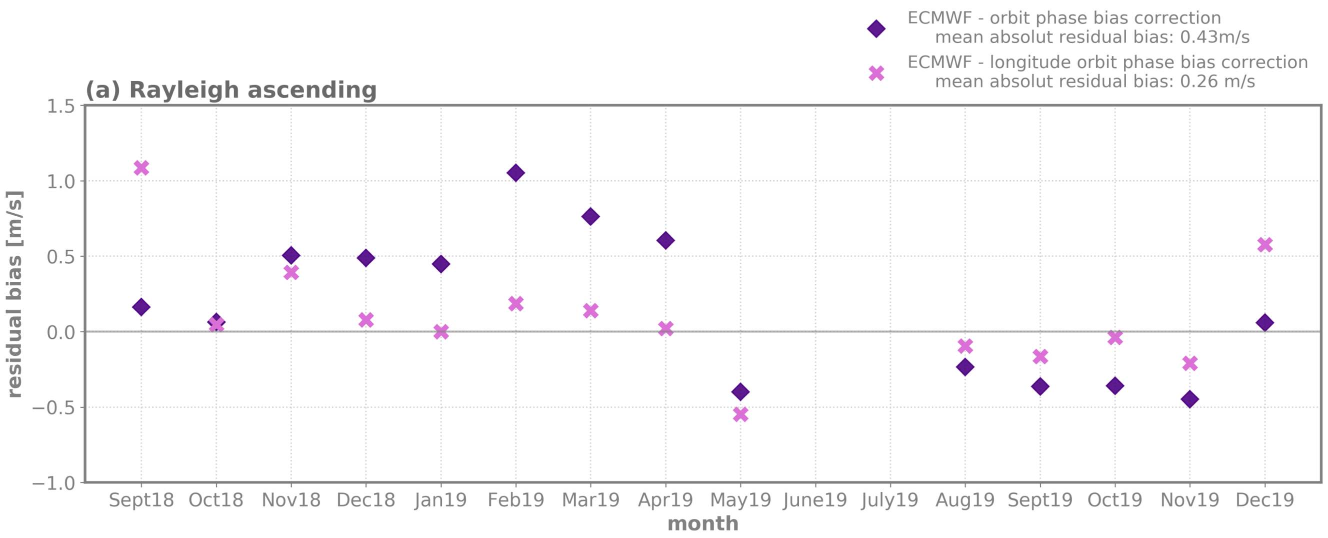
Aug19 - BIAS vs M1 Temperature

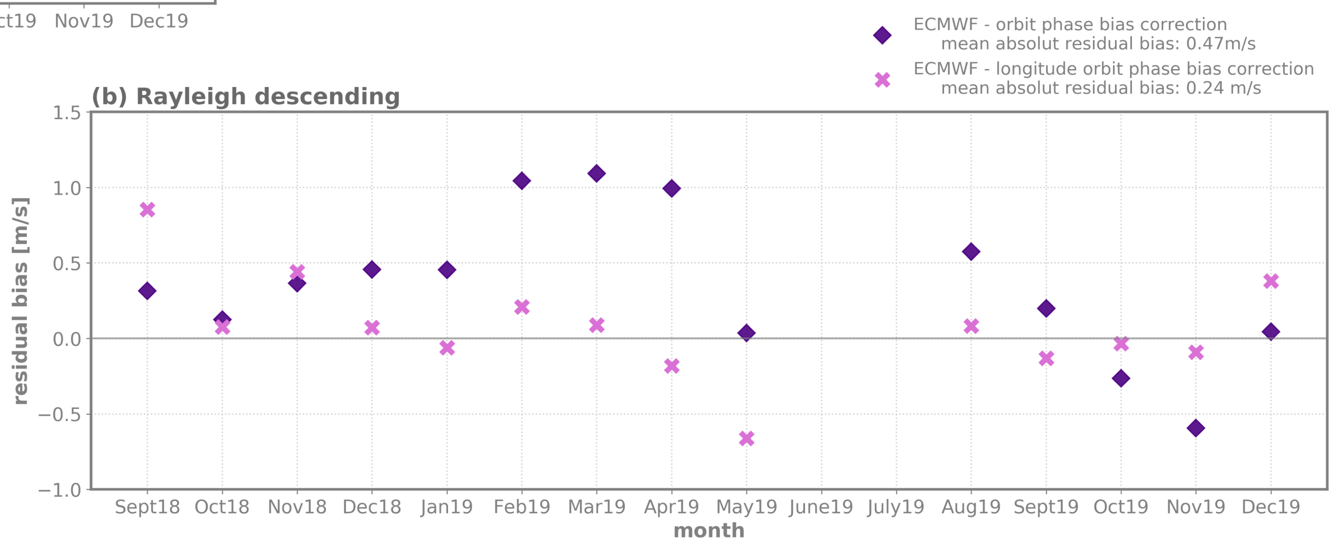


- for some periods, like August 2019, significant relation between mean M1 Temperature and BIAS
- for some periods, like May 2019, the relation is not that clear
- mean M1 Temperature only shows approximately a correlation

Data M1 Temp: L1A - Fabian Weiler (DLR)

Rayleigh orbit phase/longitude bias - correction approach





Residual after orbit phase bias correction approach (slide 5) and after an orbit phase and longitude bias correction approach. For the new correction approach correction values are calculated using the past seven day's O-B bias (weighted) as function of latitude and longitude for asc and desc orbit.

→ Overall, improvement of around 0.2 m/s when considering orbit phase and longitude bias dependence for correction

Summary/Conclusion

- independent radiosonde and radar wind profiler measurements are used as reference for the evaluation of the Aeolus L2B product
- error estimate thresholds based on radar wind profiler validation
- good agreement for L2B wind comparisons using radiosonde observations and model equivalents from DWD (ICON) and ECMWF model
- in summer and autumn strong differences between Rayleigh ascending and descending orbit and fluctuations with latitude occur
- in spring and winter orbit phase dependence is less significant
- after an orbit phase bias correction still a residual bias of around 0.5 m/s remains
- in addition to the orbit phase dependence a longitude bias component exists, also more significant in summer/autumn (relation to mean M1 Temperature visible for some periods)
- with a few exceptions, a bias correction approach considering orbit phase and longitude shows smaller residuals