

# Validation and impact assessment of Aeolus observations in the DWD modelling system

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- Introduction
- Impact on analysis cycle
- Forecast impact
- Recent performance
- Summary

# Recent Aeolus experiment

## Data denial experiment

### NWP model:

deterministic version of ICON based on R3B07  
grid ( $\Delta x \approx 13$  km)  
ensemble version ICON-EPS based on R2B6  
grid ( $\Delta x \approx 40$  km)

### Time period:

July 2020 – September 2020

### Bias correction:

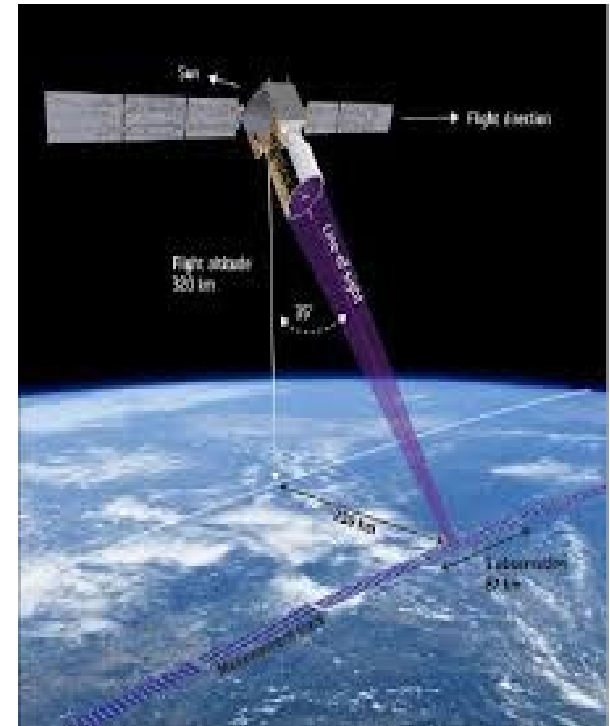
function of latitude for different height levels,  
separated for ascending/descending orbits

### Forecast experiment:

experiment with Rayleigh clear and Mie cloudy  
wind observations (EXP AEOLUS)

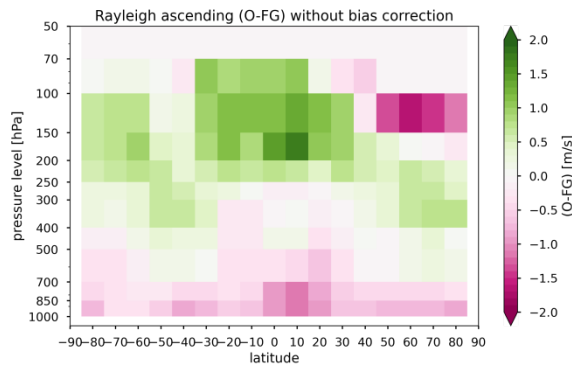
### Crtl run:

without Aeolus observations (DENIAL)

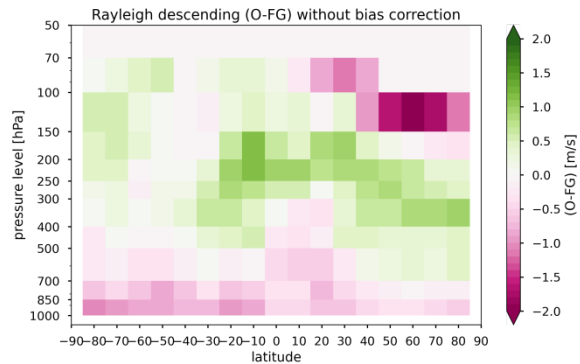
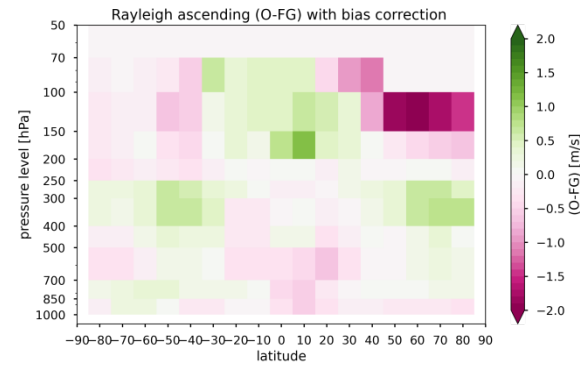


## 1) Data Quality

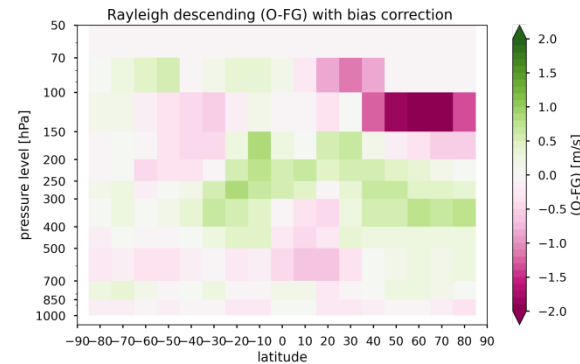
## Bias Correction – function of latitude and height



→ bias  
correction



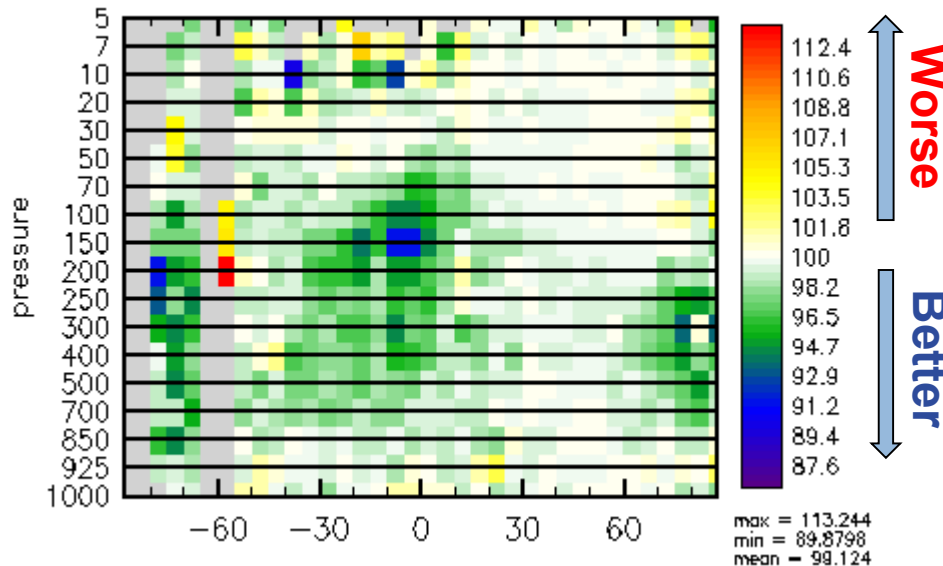
→ bias  
correction



01 July – 30 Sept. 2020

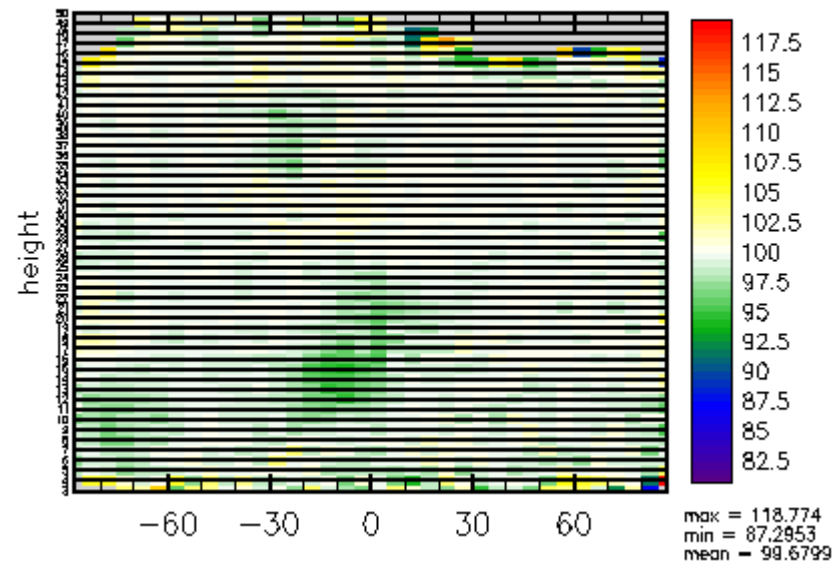
## Radiosondes

stddev(o-f)



## Radio Occultationen

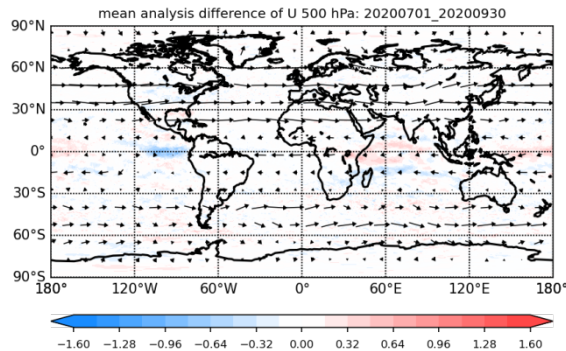
stddev(o-f)



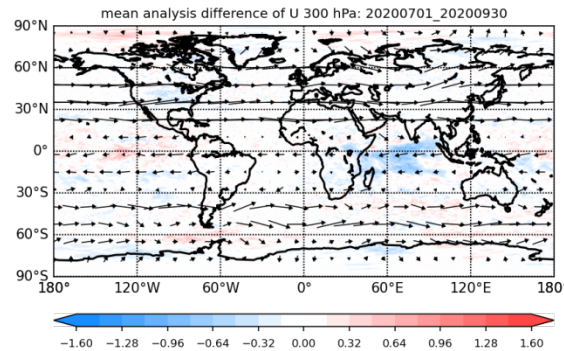
- Use of Aeolus HLOS data improve the use of other observation systems
- Improvement can be as high as 10 % in the tropics and polar regions
- Only small improvements on the Northern Hemisphere

## 2) Analysis Differences – mean changes in zonal wind U

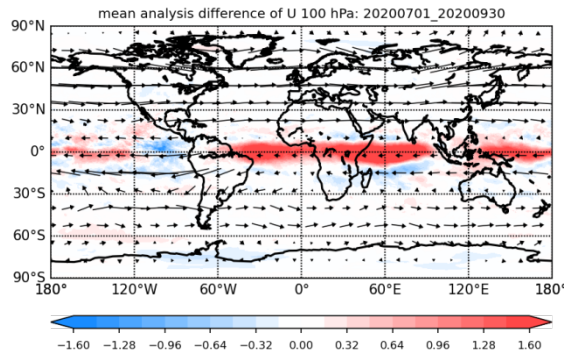
500 hPa



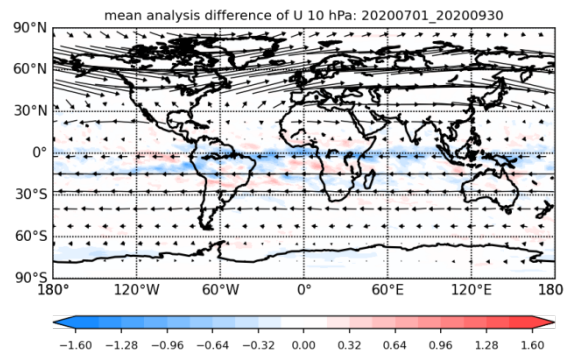
300 hPa



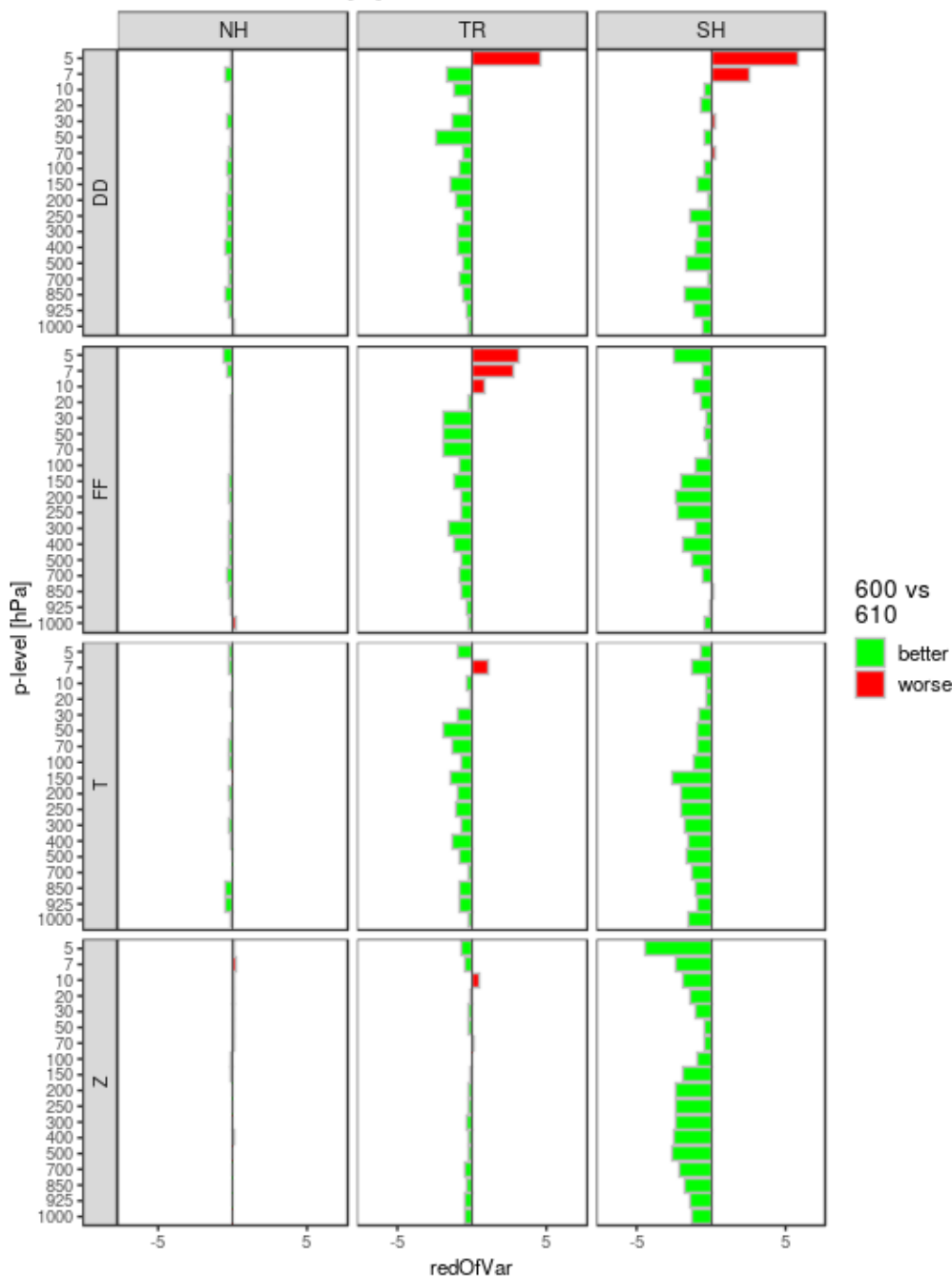
100 hPa



10 hPa



- the largest influence of Aeolus occurs in convectively active areas in the upper troposphere/lower stratosphere
  - mainly along the intertropical convergence zone (ITCZ)
- at 100 hPa - around the tropical tropopause - Aeolus tends to make the zonal component much larger (more westerly), in the stratosphere on average more easterly
- at 300 hPa – around India and Africa (Tropical Easterly Jet) - Aeolus tends to make the zonal component more easterly
- analysis differences also occur in the east Pacific region and the polar region of the southern hemisphere in upper levels



## Score Card

Forecast verification against radiosondes  
01 July. 2020 – 30. Sep. 2020

600: Control Experiment + HLOS winds

610: Control

Green: Forecast improvement using Aeolus

Red: Forecast degradation using Aeolus

Positive impact on all Hemispheres.

Largest impact in tropics and Southern Hemisphere in the upper troposphere/ lower stratosphere

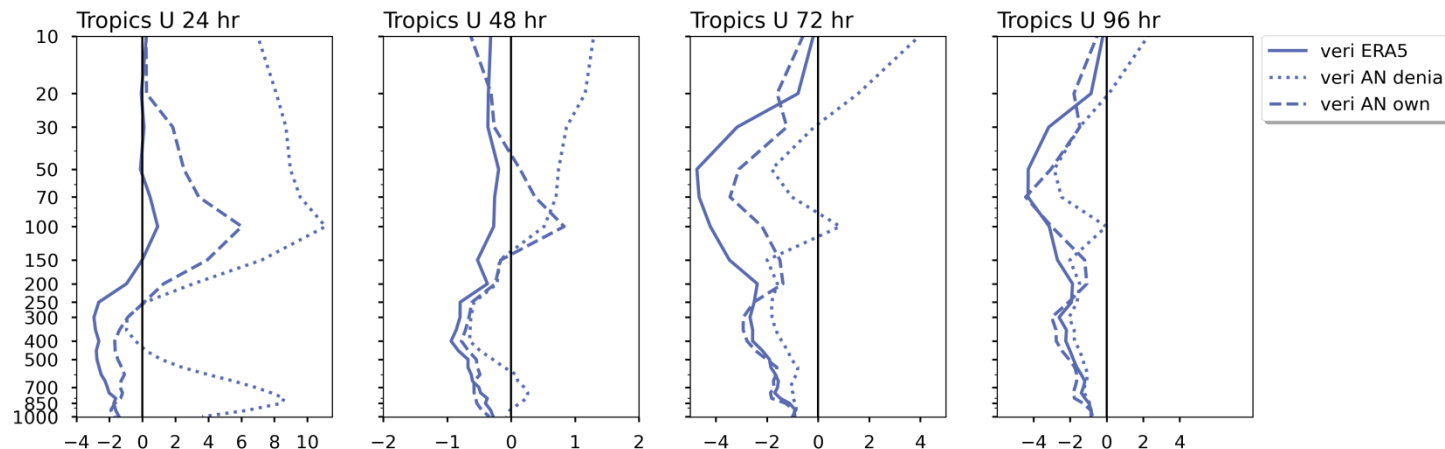
Small put positive impact in Northern Hemisphere

#### 4) RMSE reduction – which verification analyses?

Short-range forecast up to 48 hr – 72 hr impact when evaluated against analyses should be treated with some caution!

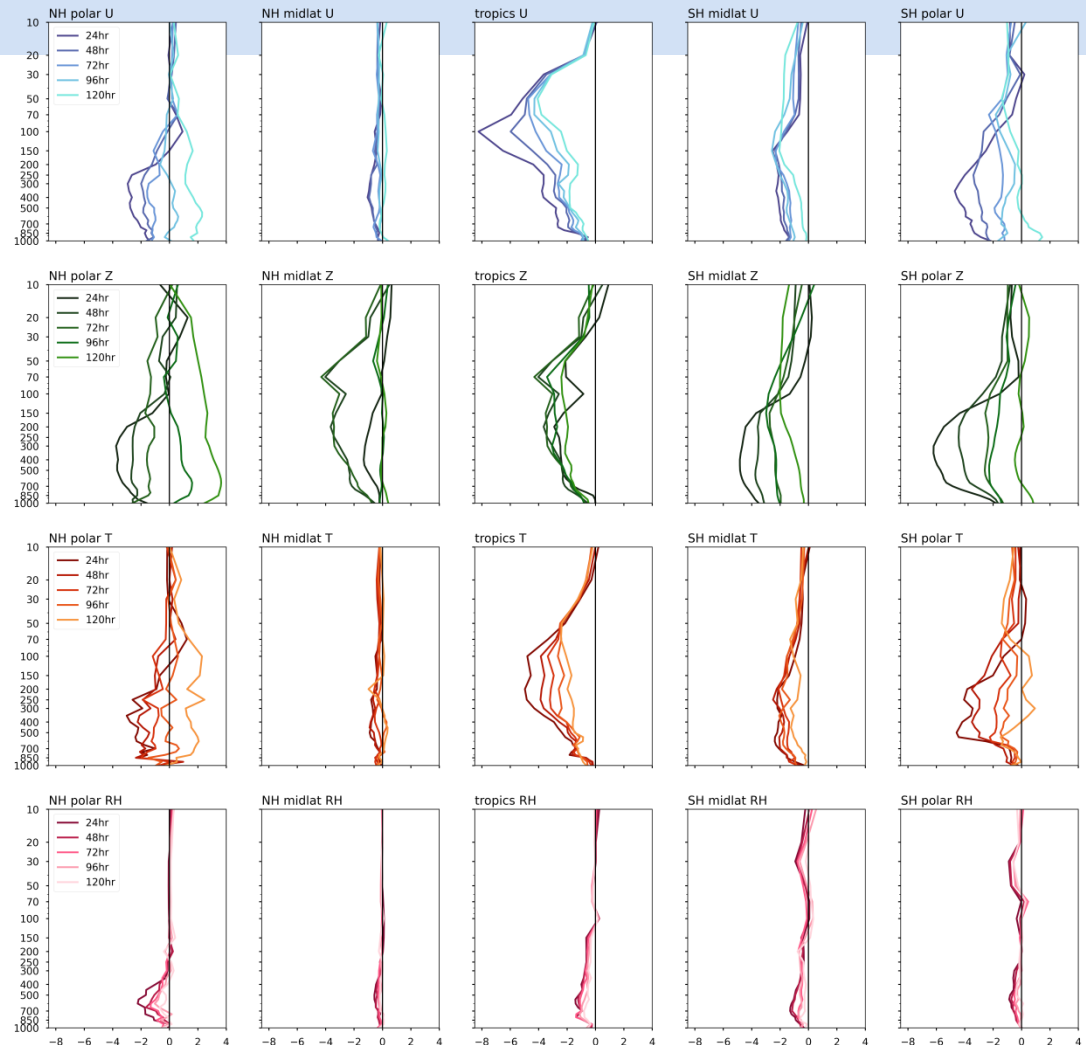
➔ contribution from analysis errors is more significant

- RMSE reduction when verifying against the analysis of the denial experiment (...) can lead to contrary results
- Better: using the independent ERA5 reanalysis data ( ) or the own analysis (---) for the verification



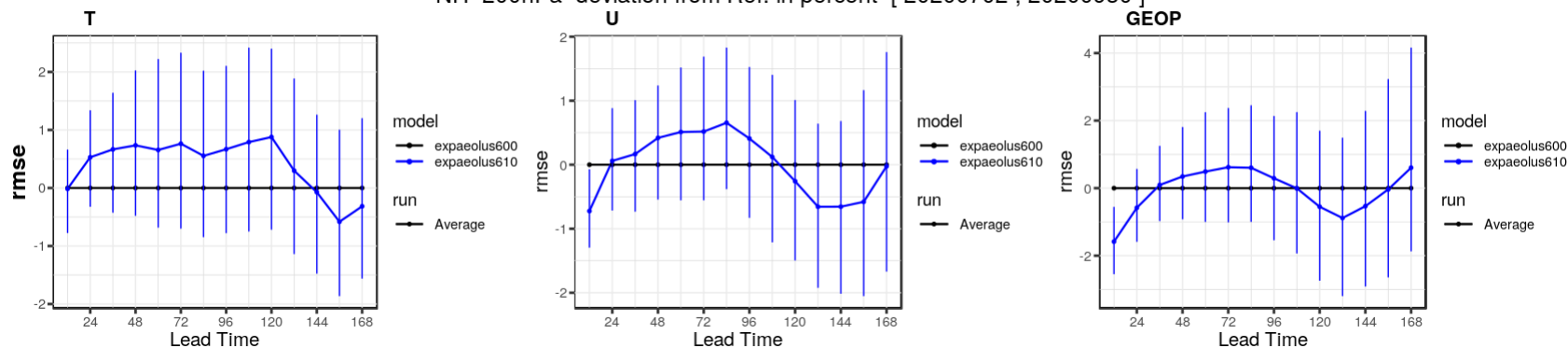
## 4) RMSE Reduction (normalised)

- verified against ERA5 analysis data
- >
- largest positive impact occurs in tropics around the tropopause for zonal wind, geopotential and temperature
- improvements in forecast (up to 3 days) of geopotential are large in the troposphere on the SH and the polar region of the NH
- 4 and 5 day forecasts show negative impact in the polar region of the NH – for wind, geopotential and temperature
- forecast of relative humidity is mainly improved in the lower troposphere in the tropics and polar region of the NH
- smallest impact of Aeolus winds occur in the midlatitudes of the NH for all variables

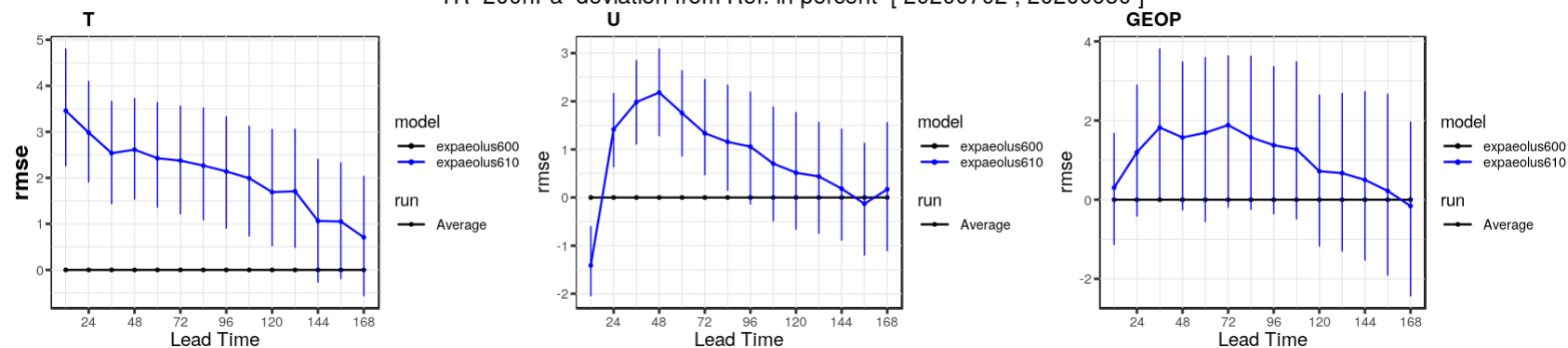




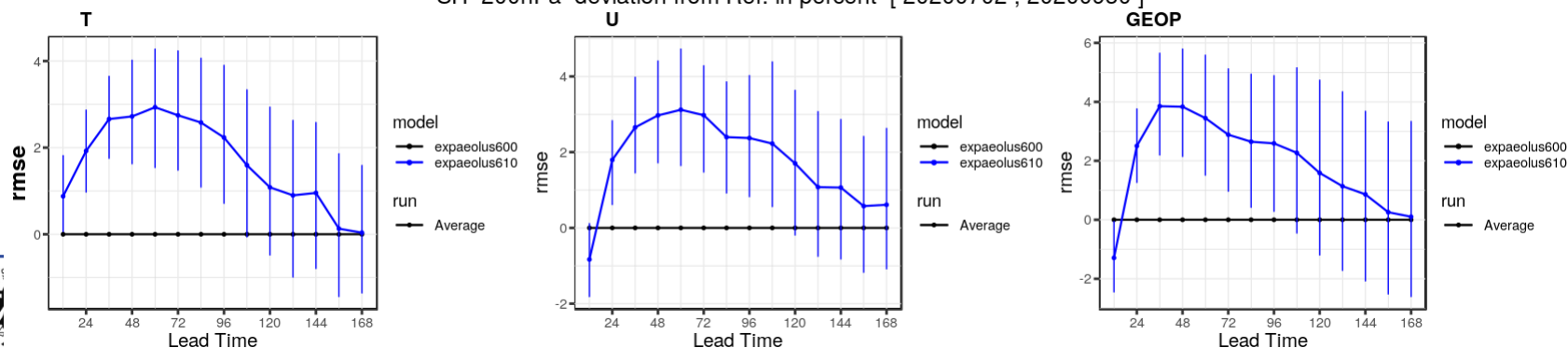
NH 200hPa deviation from Ref. in percent [ 20200702 ; 20200930 ]



TR 200hPa deviation from Ref. in percent [ 20200702 ; 20200930 ]

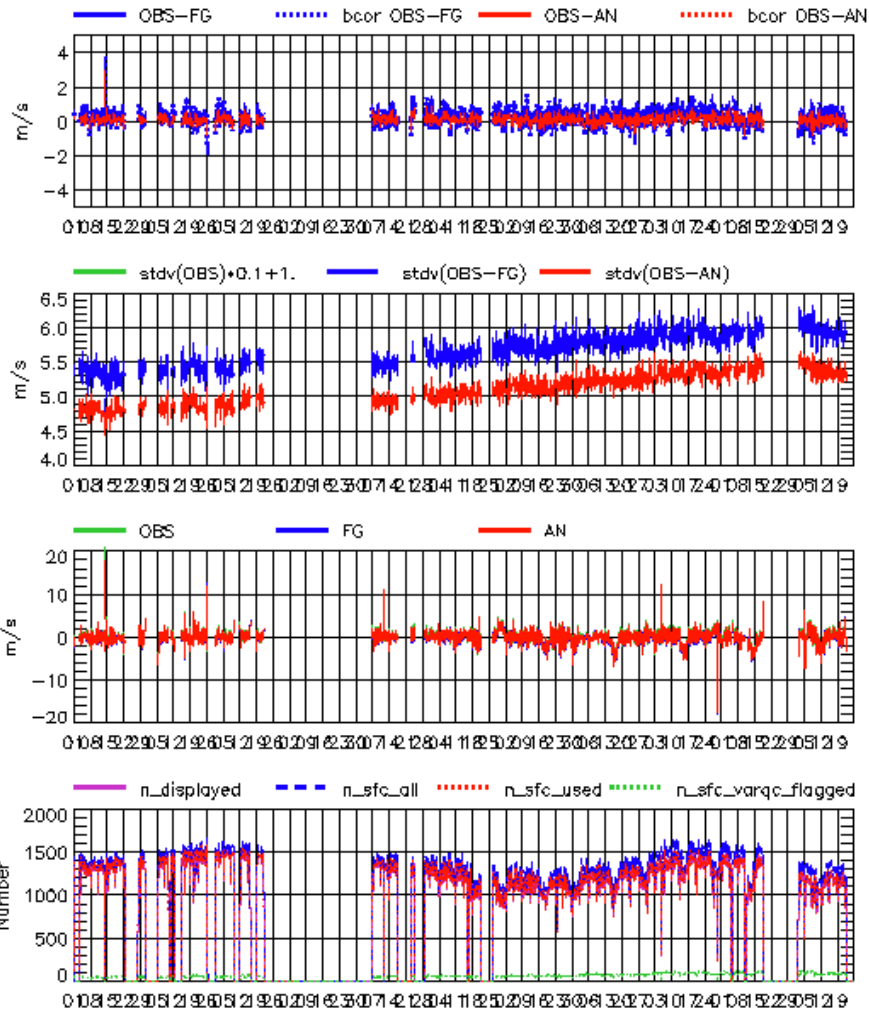


SH 200hPa deviation from Ref. in percent [ 20200702 ; 20200930 ]



# Wind Lidar performance January – Nov 2021

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



**Time series of obs-fg statistics for  
Rayleigh winds 1<sup>st</sup> of Jan.- 20<sup>th</sup> Nov. 2021**

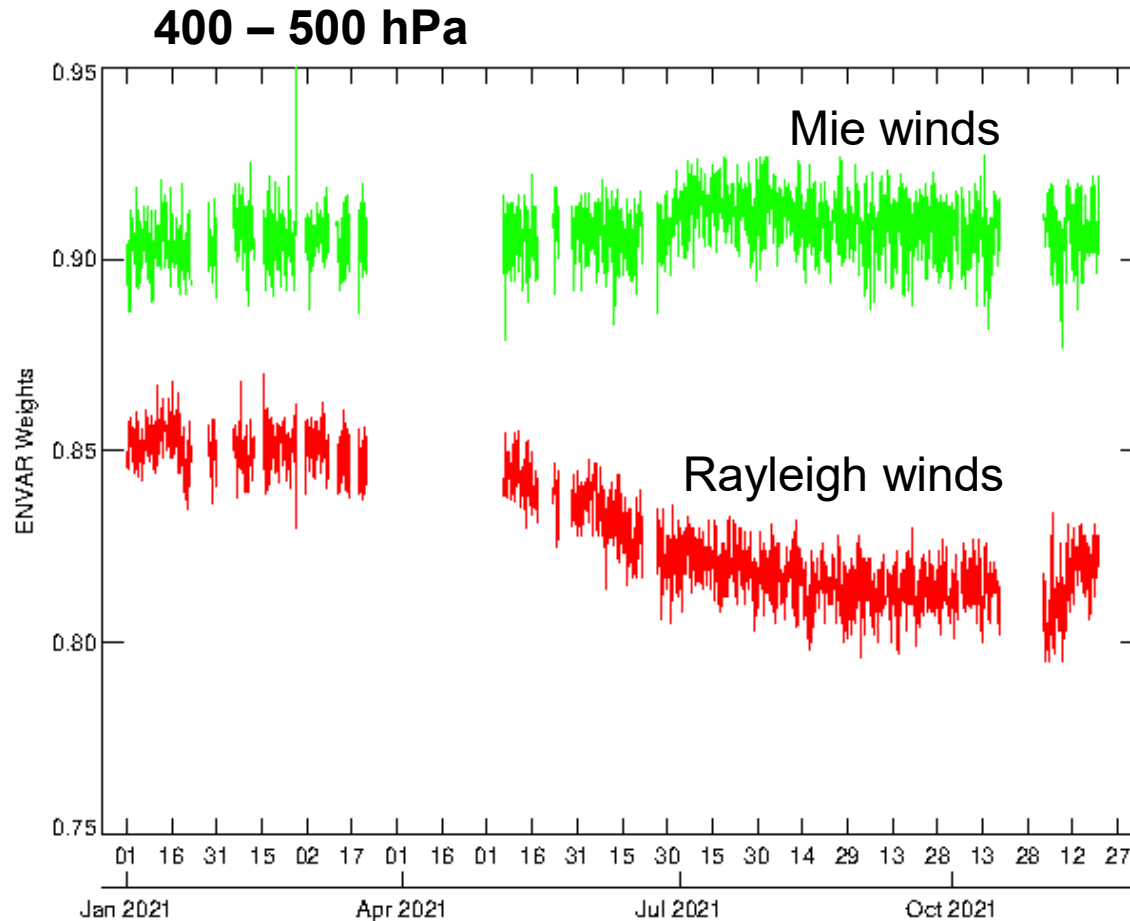
**Bias for Rayleigh and Mie winds stable**

**Increase of standard deviation over the  
Year 2021 for the Rayleigh winds through  
the whole atmosphere**

**For Mie winds the std is stable (no trend)**

**Number of used rayleigh winds minimum  
In summer 2021**





3dvar Observation weights in  
Middle troposphere

01 of Jan – Nov. 2021

Mie winds with const weights

Mie winds larger weights than  
Rayleigh winds

Rayleigh winds show some  
degradation

**Low weights indicate problems with the observations**

**Aeolus HLOS winds data denial experiment conducted for Jul.-Sep. 2020**

**Data selection followed recommendations by ECMWF and extensive data monitoring**

**Fit to first guess of independent observations in assimilation cycle improved by using Aeolus HLOS winds**

**Positive forecast impact up to 6 days on all hemispheres**

**Strongest impact in the upper troposphere/lower stratosphere of the Tropics**

**In 2021 the Rayleigh winds show some degradation in quality**

**Within the German Aeolus project EVVA several impact experiments using reprocessed data are planned**

**Further investigations concerning the tropical stratospheric winds (QBO), the interaction between stratosphere and troposphere, convection->precipitation, tropical cyclone forecast**