

# The Aeolus Data Innovation and Science Cluster (DISC)



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<sup>13</sup>LMU

<sup>14</sup>ABB

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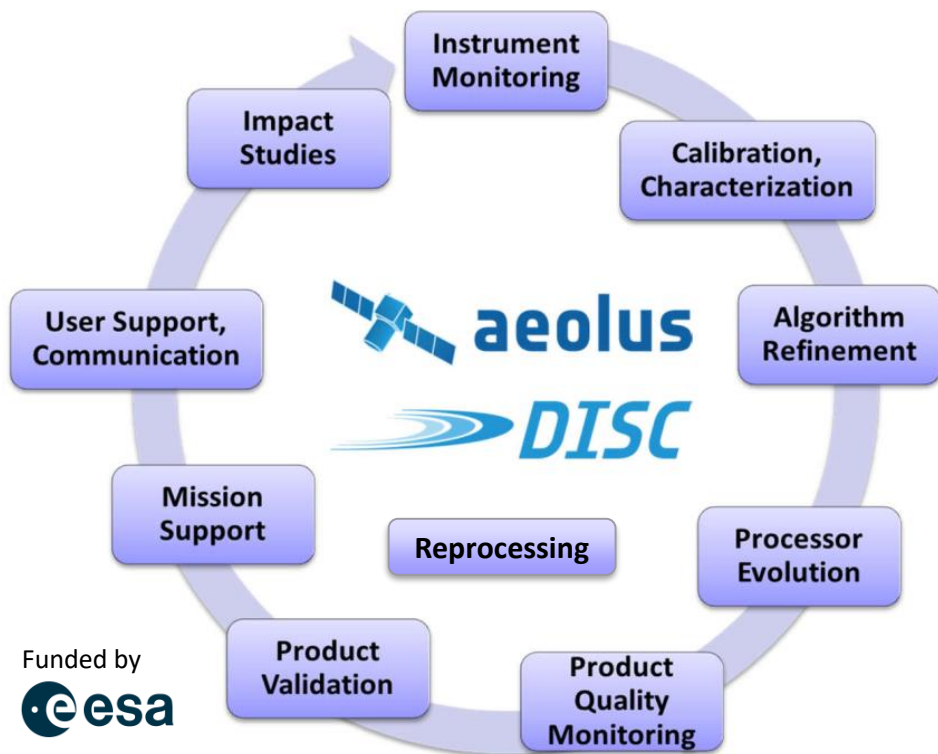
<sup>16</sup>IB Reissig

<sup>17</sup>OLA



Knowledge for Tomorrow

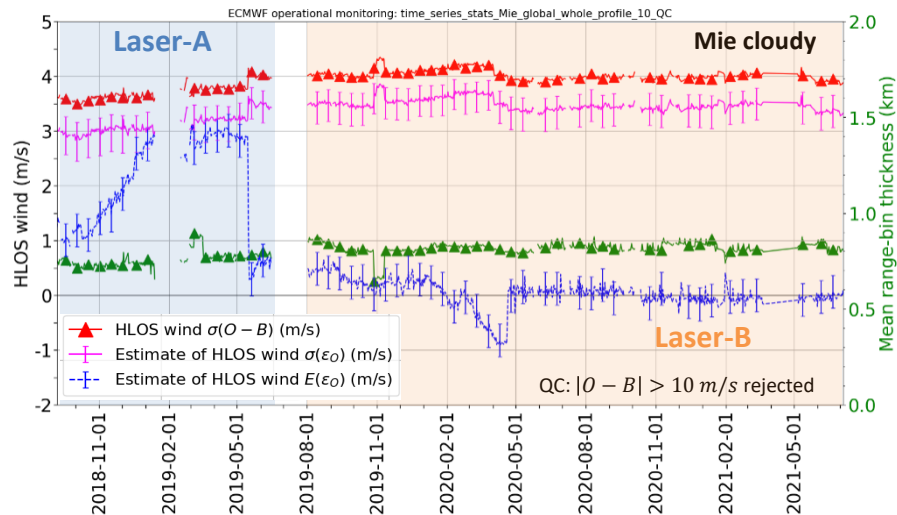
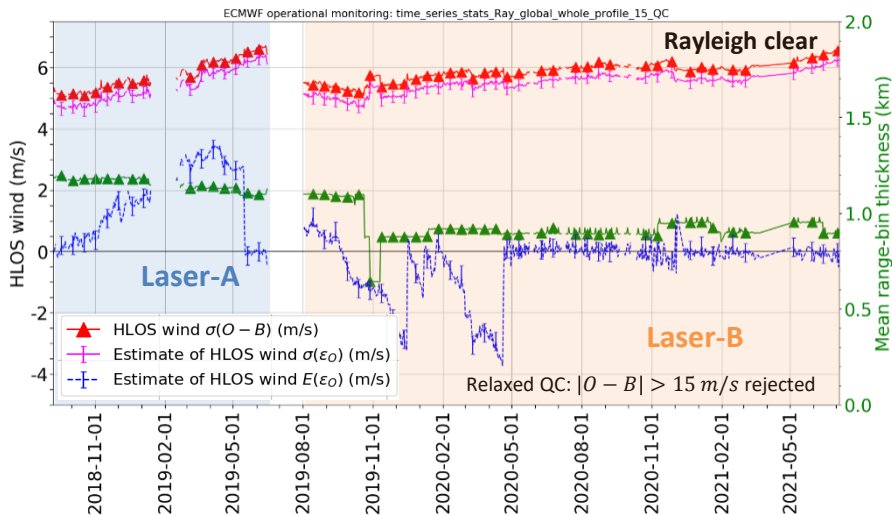
# The Aeolus Data Innovation and Science Cluster (DISC)



Funded by  
 **esa**



# Operational monitoring of Aeolus near-real-time data at ECMWF



- Aeolus is the first satellite mission to implement **operational monitoring at ECMWF directly after launch**. This operational monitoring is a **very strong tool** and helped to **identify several before launch unexpected error sources**.
- After launch, the **systematic errors (bias)** for both Mie and Rayleigh winds (several m/s) showed **strong slow drifts, orbital variations, differences for ascending and descending orbits**, and **stronger biases in single range-gates**.
  - Since 20 April 2020 **global mean bias** for both channels is **around 0 m/s**
- The Aeolus **random error** is currently in the order of **6 m/s for Rayleigh winds** and **3.5 m/s for Mie winds**

Figures by **M. Rennie (ECMWF)**.

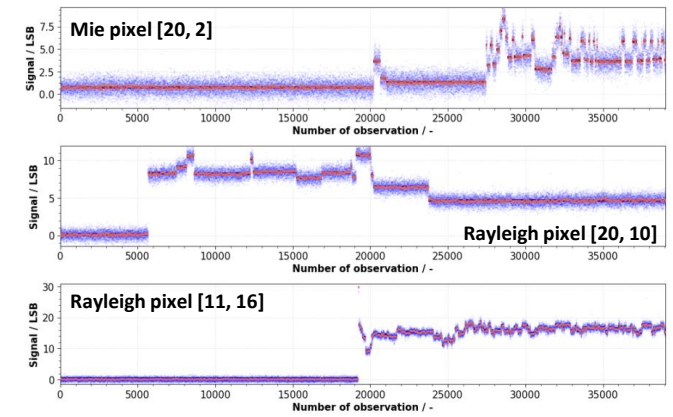
# What causes systematic errors?

Combination of several unexpected error sources with different temporal characteristics

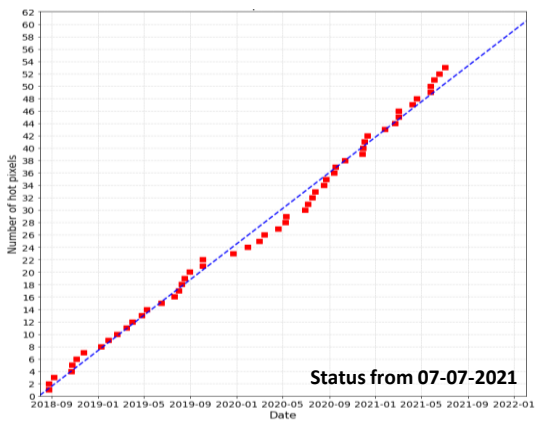
- ❖ Higher dark current rates for some “hot pixels”
  - ⇒ affects specific range gates; currently 54 pixels on Mie ACCD and 24 pixels on Rayleigh ACCD

All figures adapted from [Weiler et al., AMT 2021](#)

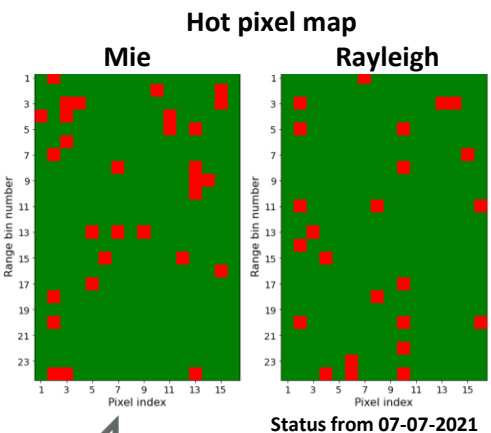
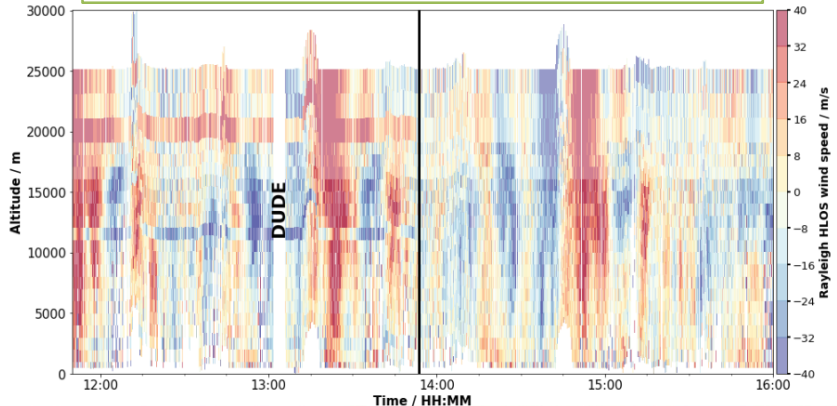
Systematic dark signal offsets with  $10^{-3}$  to  $10^{-4}$  of signal or 1% -10% of noise



Temporal evolution of hot pixel anomalies



Hot pixel correction implemented on 14-06-2019

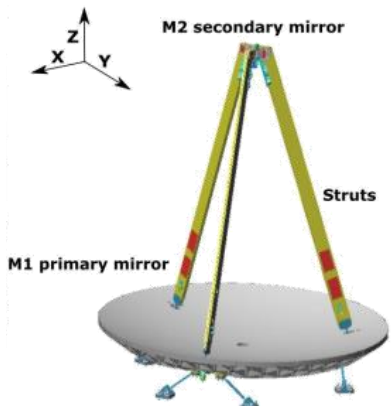




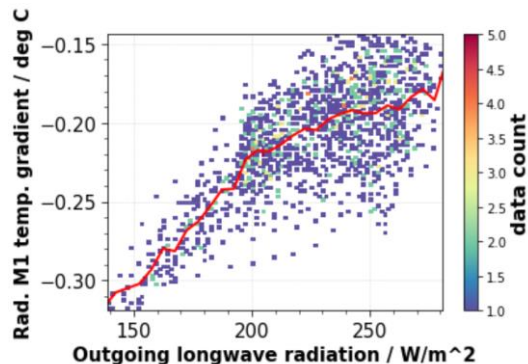
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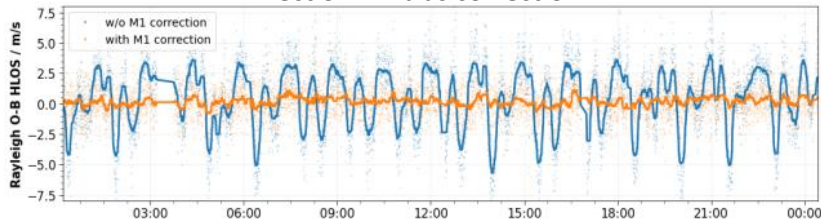
- ❖ Thermal variations of the **M1 telescope mirror**
  - ⇒ Corrected with Baseline 09 (20 April 2020)



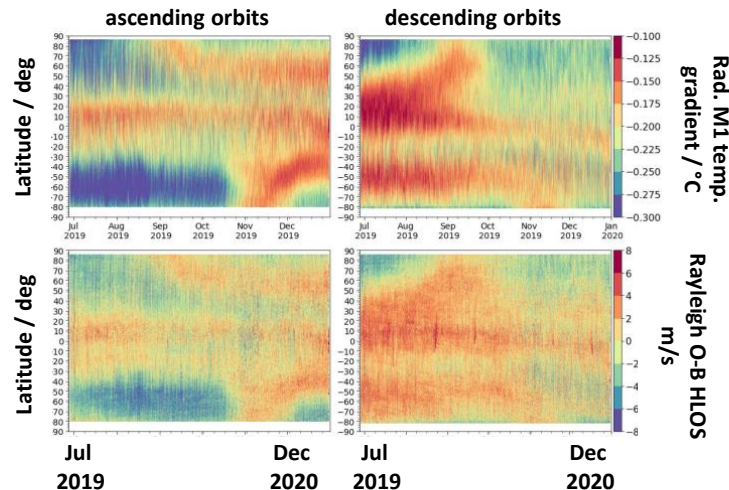
Thermal variations of M1 telescope mirror depend on outgoing longwave radiation



Effect of M1 bias correction



O-B bias strongly depends on thermal variations of M1 telescope mirror



# What drives the random errors?

## ❖ Laser emit energy

- ⇒ Lower than expected (factor 1-2)
- ⇒ Negative trend

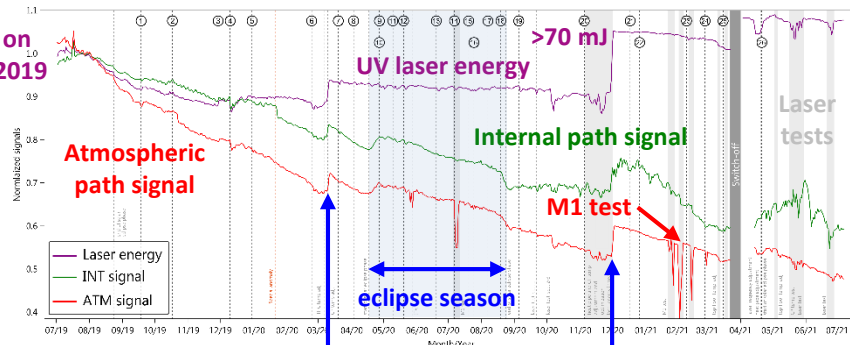
## ❖ Optical signal throughput in receive path for atmospheric signal

- ⇒ Lower than expected (factor 2-3)
- ⇒ Negative trend

## ❖ Solar background noise

- ⇒ Impact higher than expected due to lower atmospheric signal
- ⇒ Seasonal variation of solar background by factor 18: Rayleigh random errors of 7-8 m/s were obtained in summer months for polar regions

ALADIN atmospheric and internal path signal evolution for laser B



laser energy increase in March and December 2020

Figure by O. Lux (DLR).

Seasonal variation of Rayleigh solar background noise

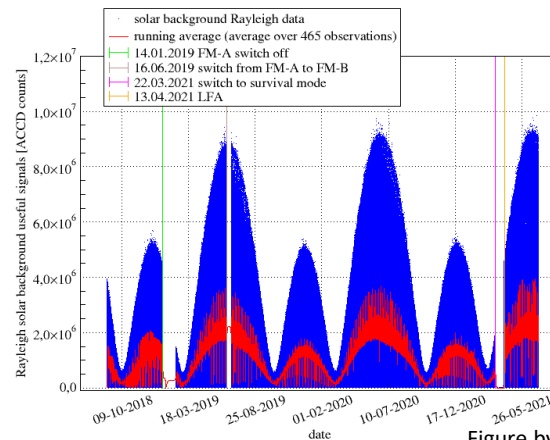


Figure by K. Schmidt (DLR).

# Aeolus processor evolution

- **New processor versions from DISC and baseline update for NRT** and reprocessing **every 6 months** with improvements in data quality for all products.
- **Current focus** is the further development of the **L2A processor** and products. Baseline 12 products (since May 2021) e.g. **include lidar ratios and a scene heterogeneity index**.
- Additionally, a new **feature mask** (based on EarthCare algorithms) is available since baseline 12 (beta version!) and a **new optimal estimation retrieval** for backscatter and extinction will be added with baseline 13 (autumn 2021).
- Recently, a **new correction for the Mie-cloudy winds** was introduced, which significantly **reduced the Mie systematic and random errors**.
- We are currently working on a Rayleigh-clear “altitude dependent” bias correction for the L2B wind products.

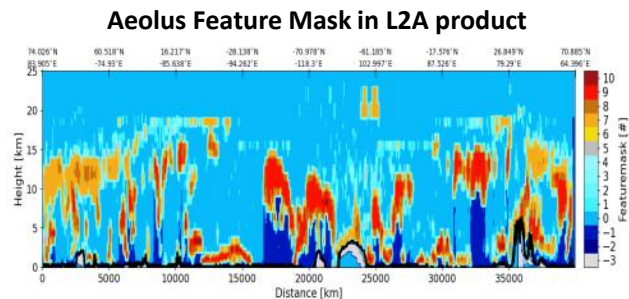
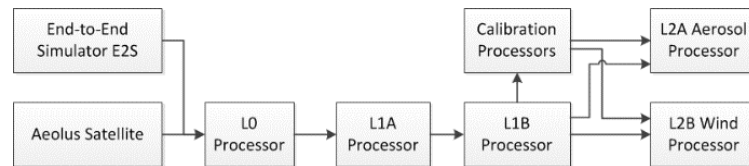


Figure by G-J. v. Zadelhoff (KNMI).

## “Altitude dependent” Rayleigh bias

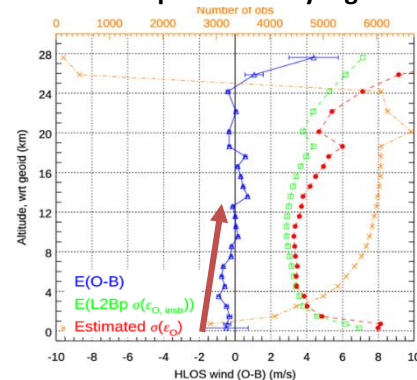


Figure by M. Rennie (ECMWF).

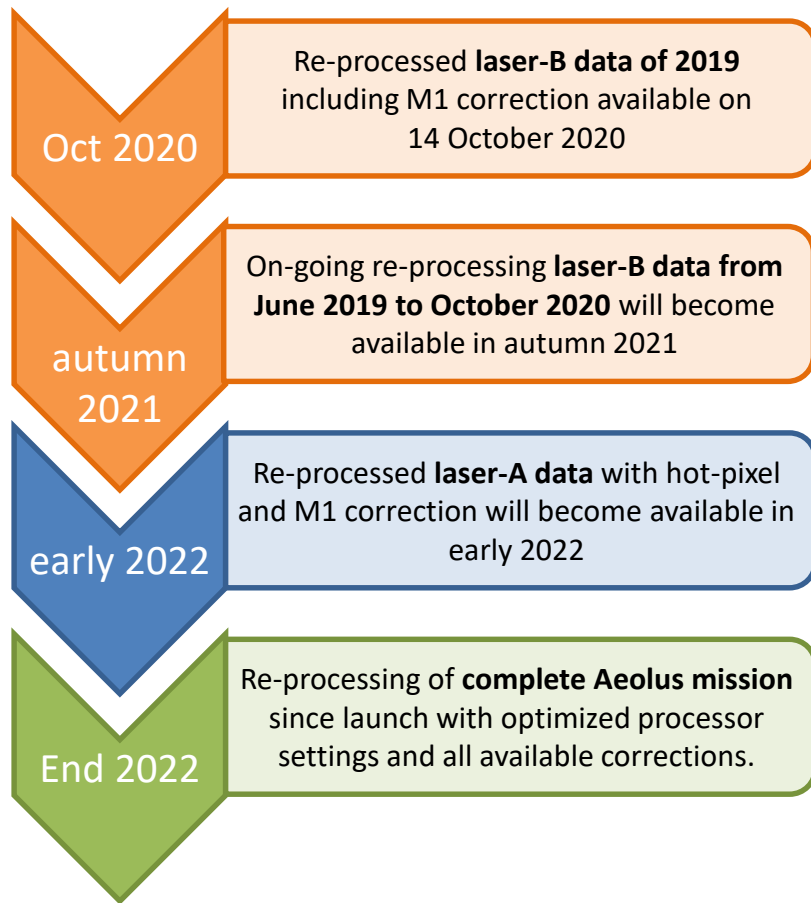


L1B+L2A processor by **D. Huber (DoRIT)**  
 L2B processor by **J. de Kloe (KNMI)**  
 ACMF calibration processors by **ABB+S&T**

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# Reprocessing of Aeolus data

- **1<sup>st</sup> reprocessing from June to December 2019** with baseline 10 product quality finished and **available since October 2020**.
- **2<sup>nd</sup> re-processing campaign is on-going** using baseline 11 processor versions (L1B 7.09, L2A 3.11, L2B 3.40) for period **June 2019 to October 2020**
  - fill gap in bias correction from Jan-May 2020 and consistent processing for 15 months of data
  - calibration of L2A product with varying  $K_{\text{ray}}$  and  $K_{\text{mie}}$  along the orbit
  - small improvements in bias correction for hot-pixel and M1
  - relaxed ground detection thresholds -> more ground returns available
- Plans for **2022**:
  - **Reprocessing of laser-A data** with baseline 13
  - **Reprocessing of complete Aeolus mission** with baseline 14

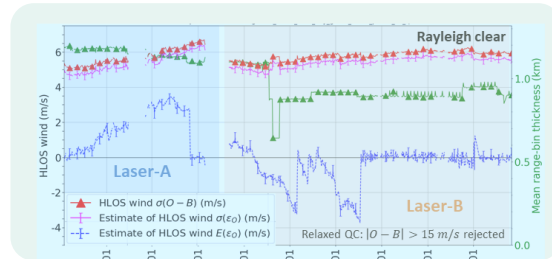




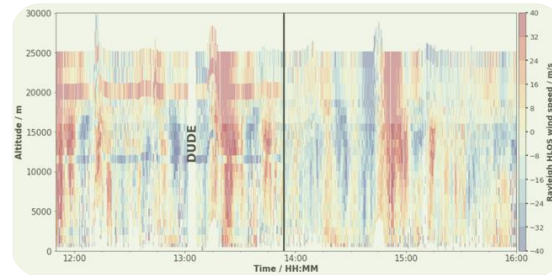
# Summary and Conclusion

- The **Aeolus DISC** consortium is responsible for **instrument monitoring, calibration, processor evolution, product quality, user support and impact studies**.
- **Aeolus wind data is monitored at ECMWF since launch**.
- This concept allowed a **fast detection and correction of multiple systematic biases**. Since 20 April 2020 **global mean bias** for both channels (Rayleigh & Mie) is **around 0 m/s**.
- The **random error is larger than expected before launch** and currently in the order of **6 m/s for Rayleigh winds and 3.5 m/s for Mie winds**.
- **New processor versions from DISC and baseline update for NRT and reprocessing** are provided **every 6 months** with improvements in data quality for all products.
- First **re-processed data (June – December 2019) available since Oct. 2020**. More to come in autumn 2021.

Aeolus data quality is constantly monitored at ECMWF



Several systematic errors have been corrected since launch



Reprocessing further enhances data quality

