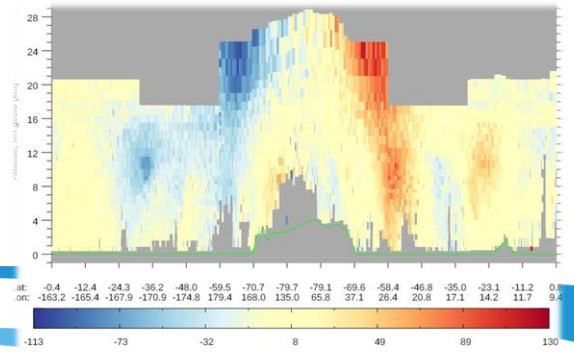
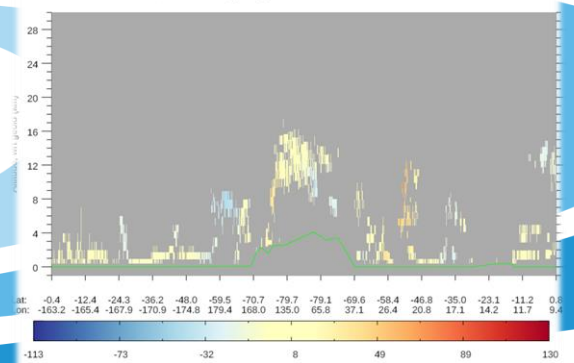
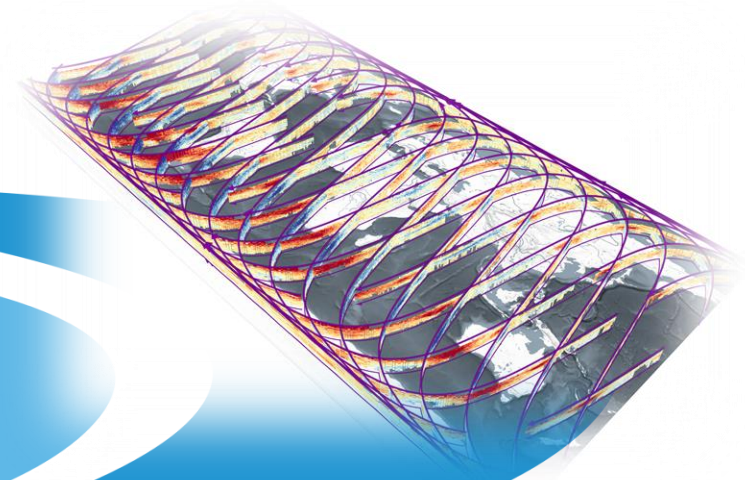
NRT L2B data quality monitoring

by Michael Rennie (ECMWF)
Acknowledgements to colleagues of: DISC, DAMI, ECMWF and ESA

Aeolus NWP Impact and L2B Product Quality Working Meeting
Day 1, Aeolus L2B product quality, 1 December 2021
On-line meeting

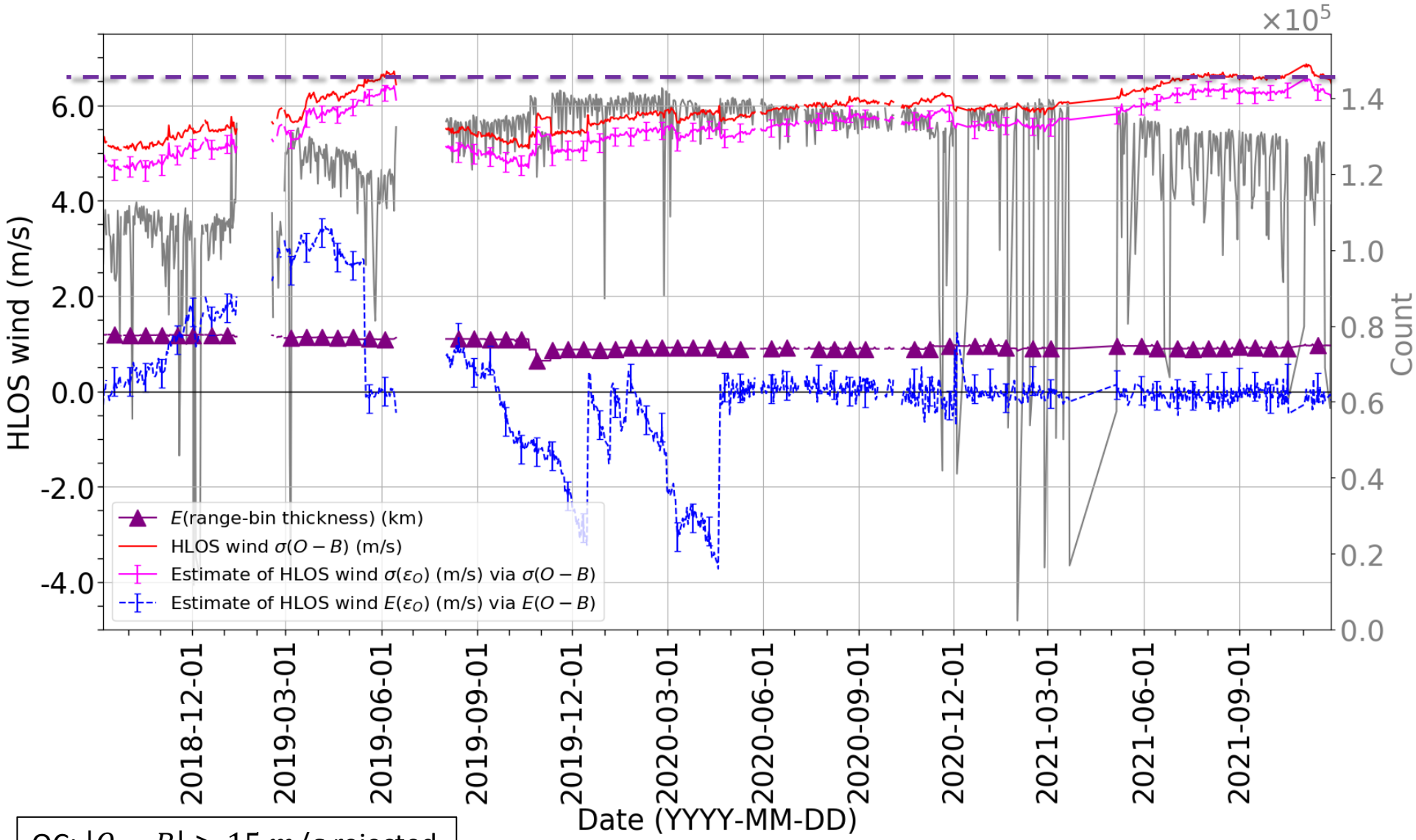

(a) L2B Rayleigh-clear HLOS winds


(b) L2B Mie-cloudy HLOS winds



Long-term L2B quality monitoring via O-B statistics

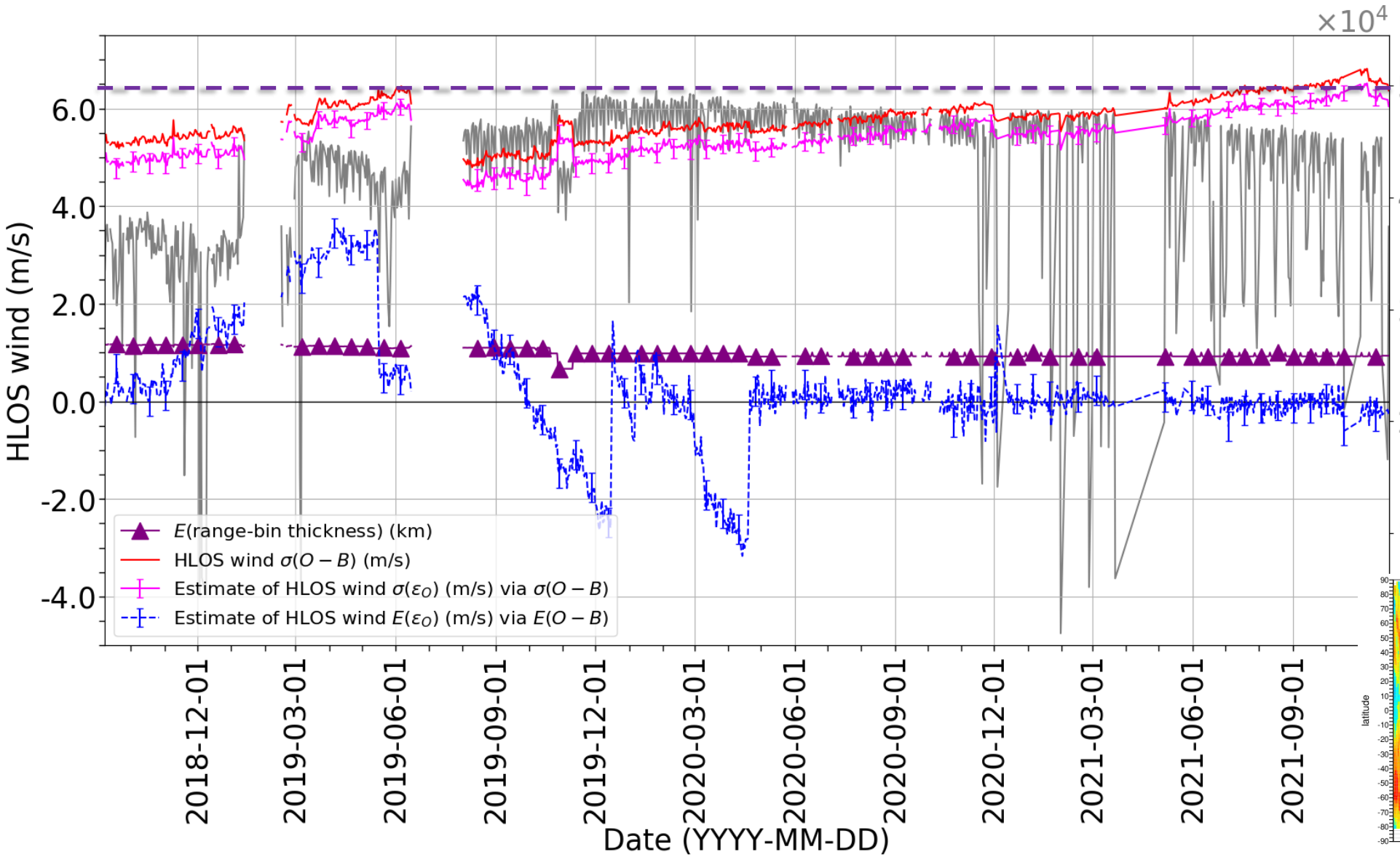
L2B Rayleigh-clear winds; **global**, whole profile



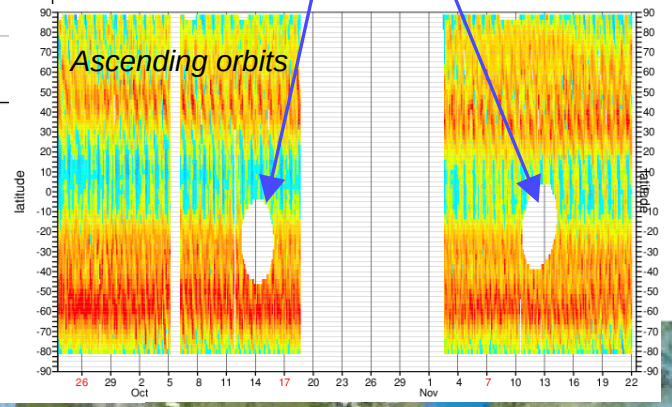
QC: $|O - B| > 15\ m/s$ rejected

- Random error at near record high (> 6 m/s), due to **atmospheric path transmission loss**
  - *Recent laser adjustments helped*
- Data counts passing QC decreasing – increasing noise with fixed quality control threshold
- Many data gaps due to *blocklisting* – for **instrument testing (bias risk)** and **laser switch-off/on** periods

L2B Rayleigh-clear winds; **tropics**, whole profile



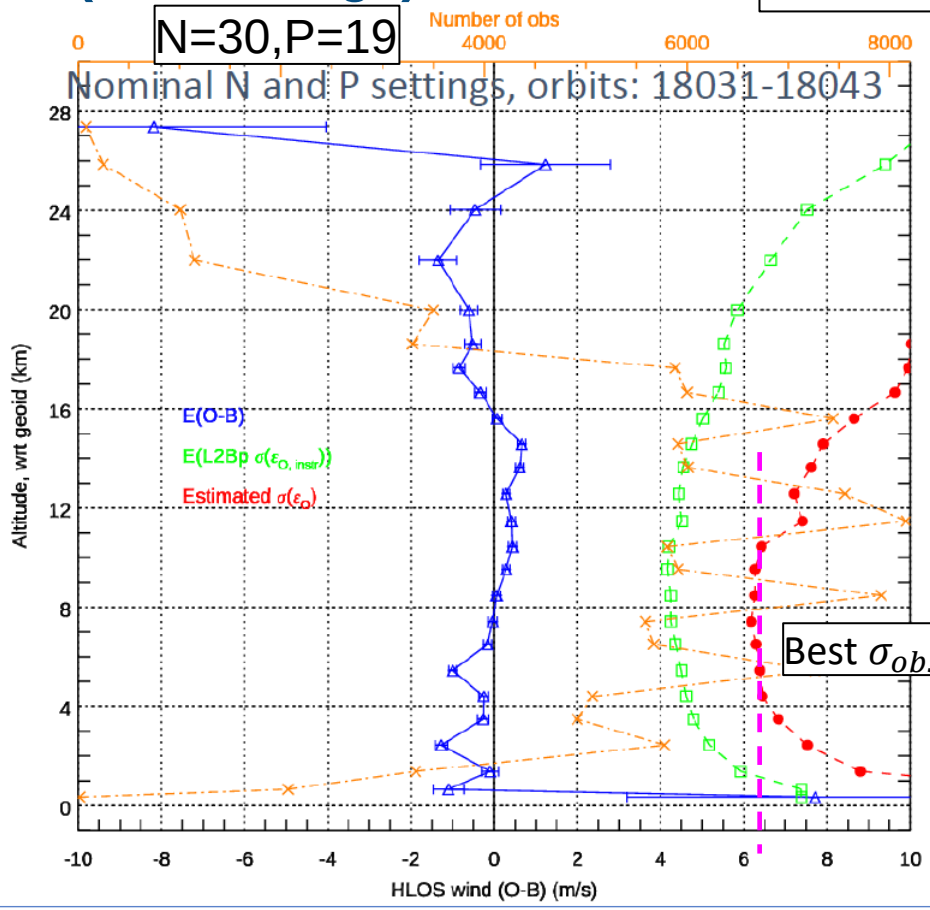
- Mostly increasing noise evident in **low solar background tropics**
- Decreasing data counts evident; modulated by data **flagged invalid during moon-blinding (every 2 weeks)** to avoid pointing related biases



An improvement in Rayleigh-clear noise by modifying how Aeolus accumulates laser shots on board (N/P settings)

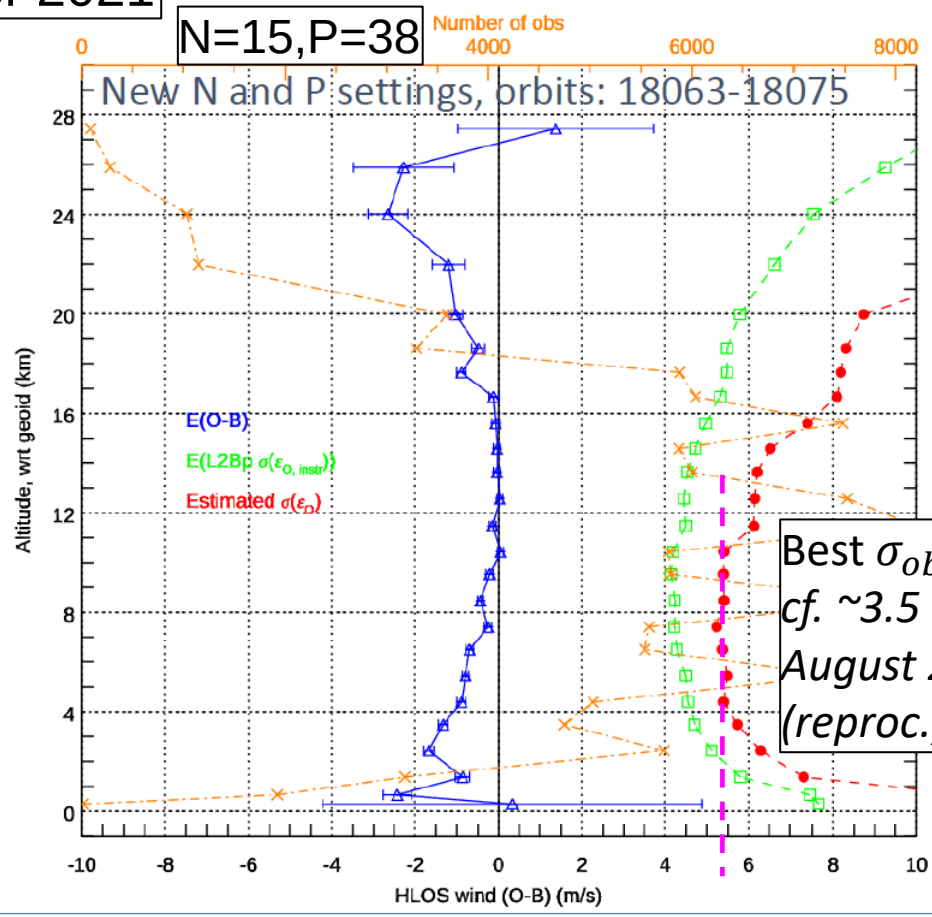
Tested on 5th October 2021

N=30,P=19



Best σ_{obs}~6.2 m/s

N=15,P=38



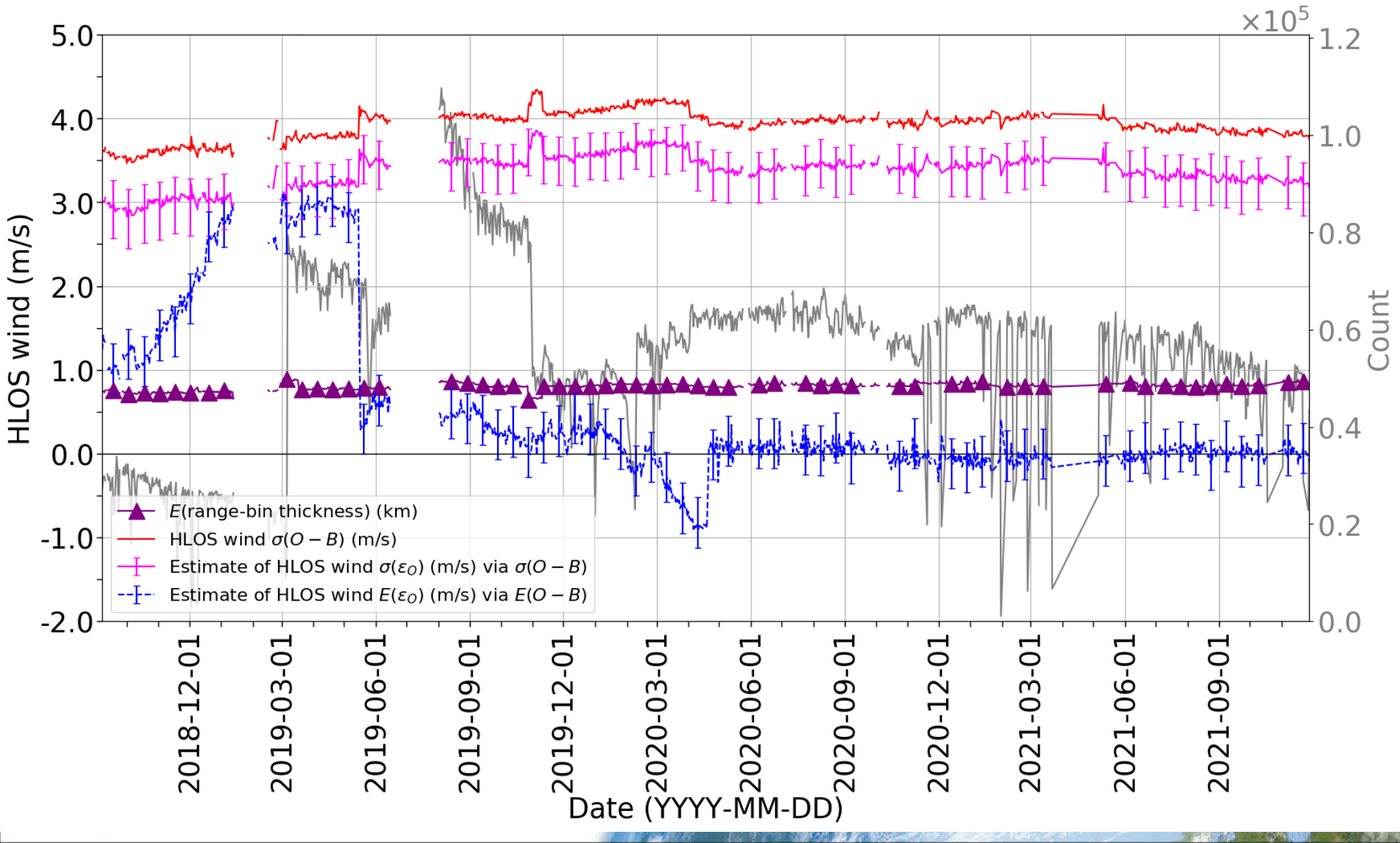
Best σ_{obs}~5.5 m/s; *cf. ~3.5 m/s in August 2019 (reproc.)*

- Rayleigh-clear scaled MAD (O-B) improved: 7.81 to 6.63 m/s i.e. **15% smaller random error** – needs ~32% more atmospheric path signal to achieve this normally. This is a very good result!
- Correlation coefficient (*r*) improved from 0.89 to 0.92 (not shown)
- Mie-cloudy random error also improved by a more modest ~0.11 m/s (not shown)

- Should go operational on 13 December 2021 (TBC); baseline 13 needs to be in place
- Measurement-scale doubled; higher SNR; L2B processor discards smaller % of measurement-bins, since **fewer missing L1B values**. Observation-scale remains same for Rayleigh-clear (1 BRC ~ 87 km) and similar for Mie-cloudy (~17 km, currently 14 km)

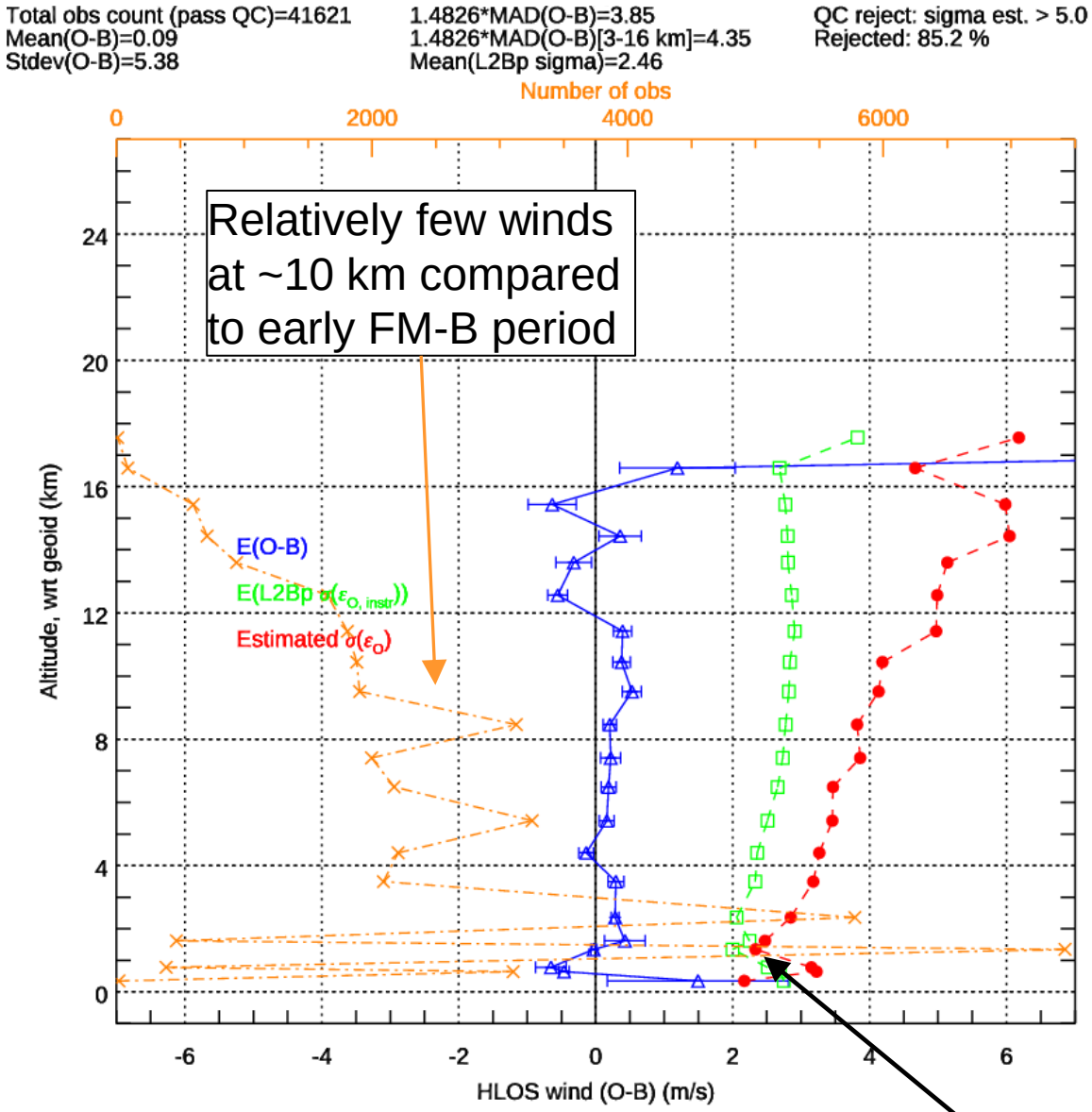
L2B Mie-cloudy; **global**, whole profile

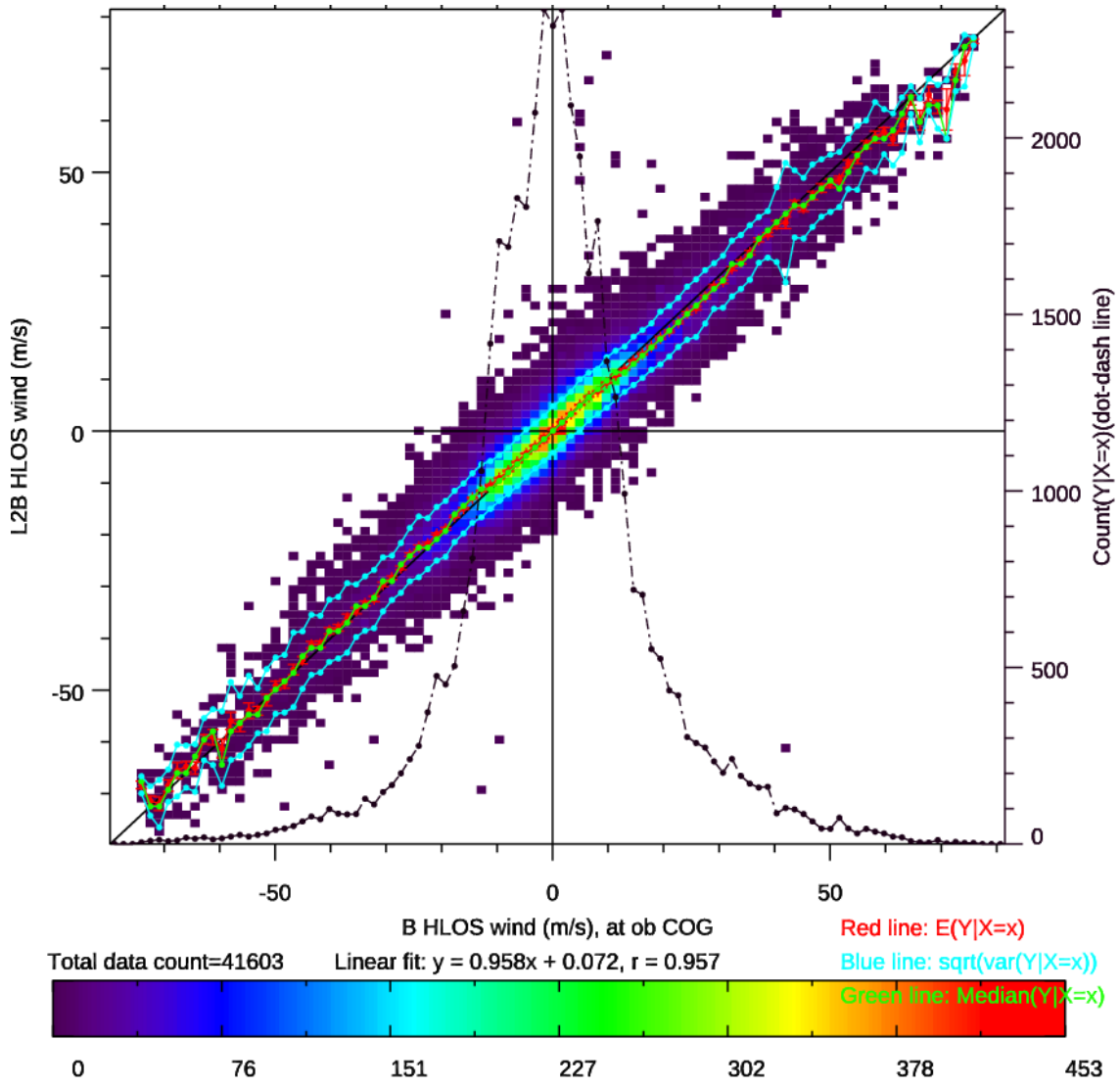
QC: $|O - B| > 10\ m/s$ rejected



- Random error fairly stable since May
  - 26 May 2021 improvement with baseline 12 L1B processing
- Wind-speed dependent bias improved since 1 July 2021 (see **Gert-Jan's talk**)
- Data counts decreasing – signal decrease + QC related and perhaps seasonal cloud coverage related dip

Example of L2B Mie-cloudy statistics in early October 2021



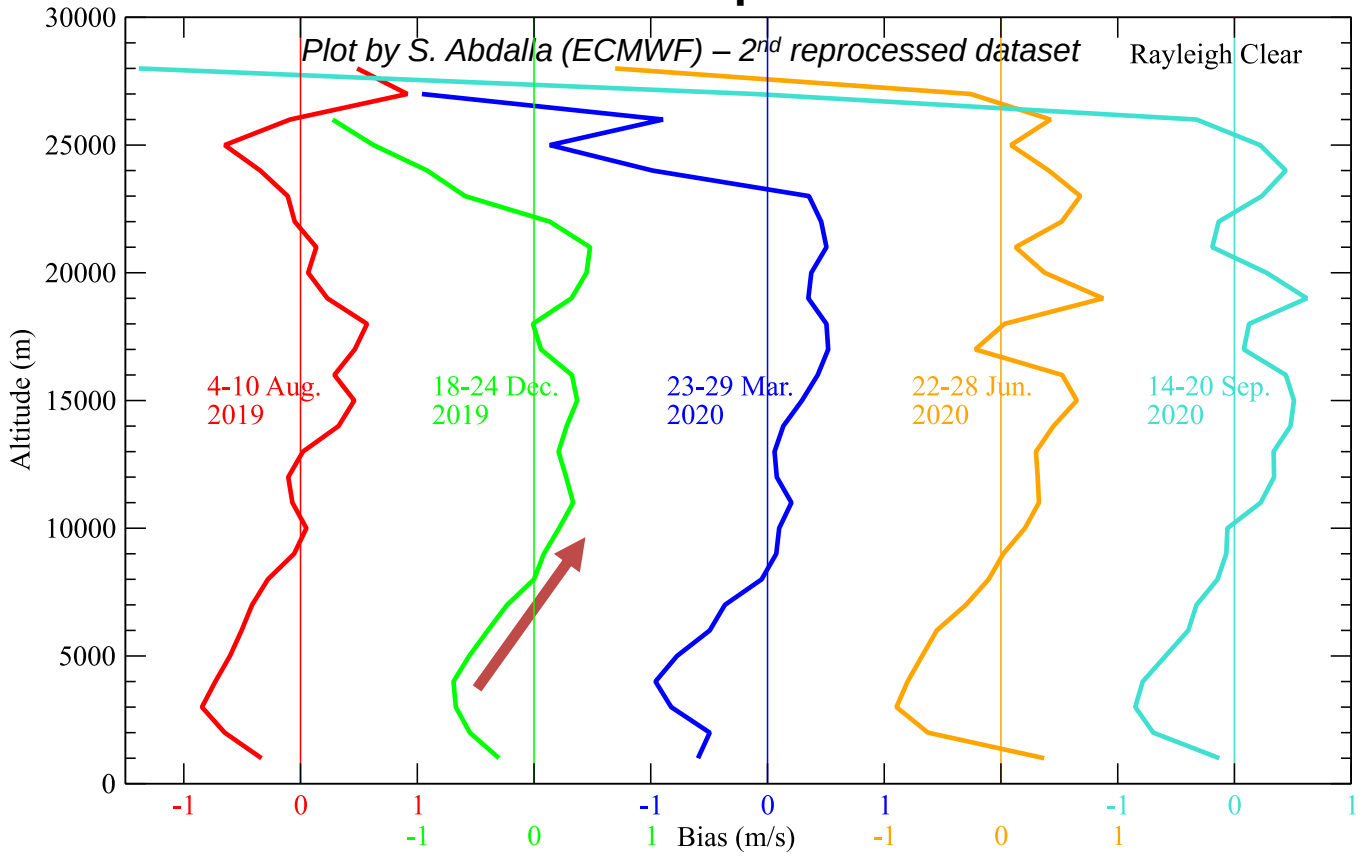


Best σ_{obs}~2.2 m/s

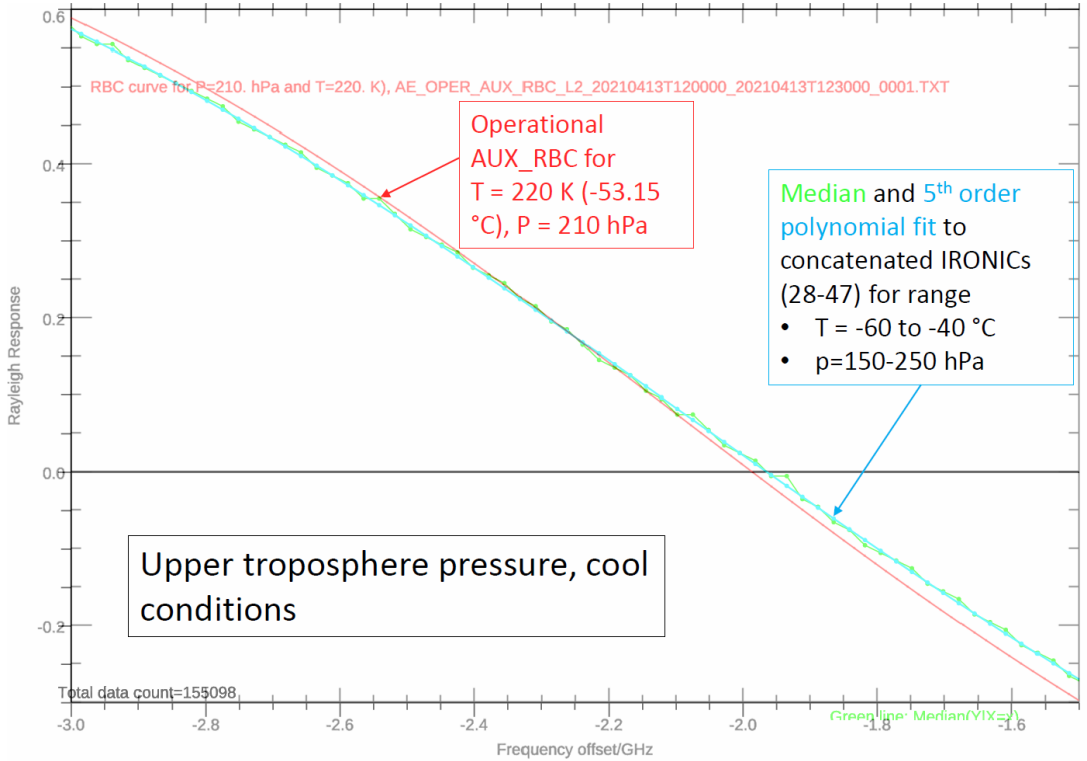
A Rayleigh-clear bias with altitude, which may affect NWP impact

L2B Rayleigh-clear "altitude"- dependent **bias**

- **In NRT and reprocessed data**

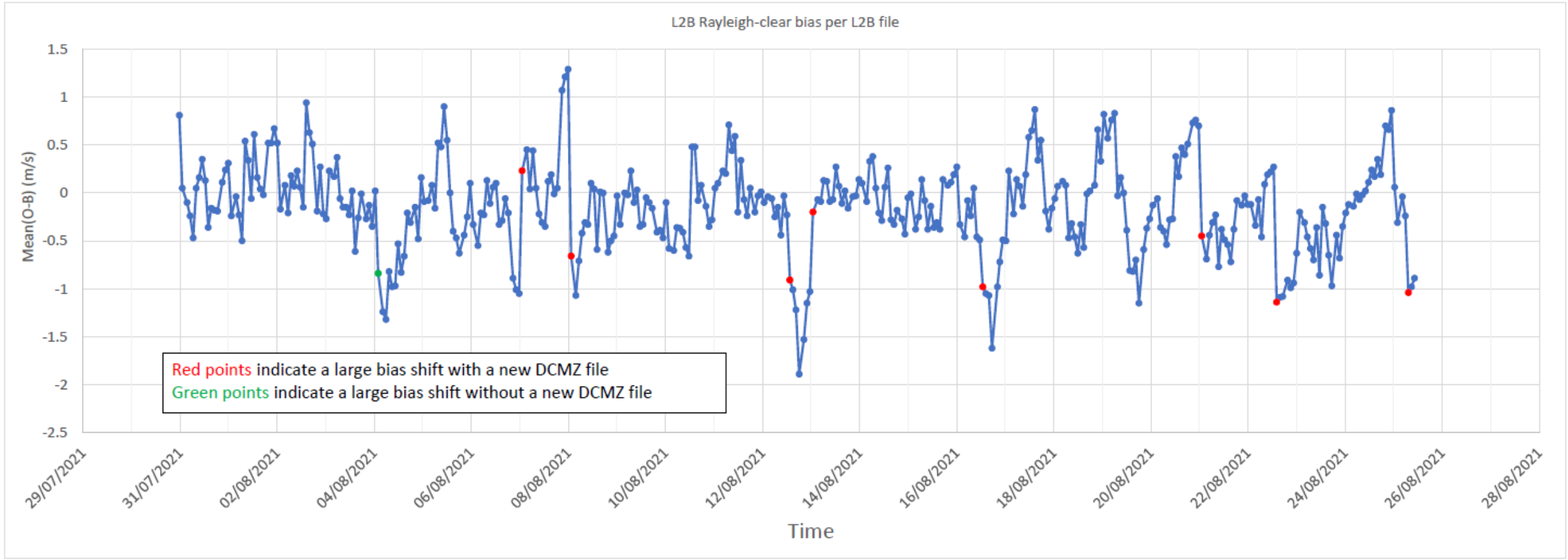


Investigations with special off-nadir calibrations (IRONICs) suggest imperfect Rayleigh response calibration curves



- Bias correlates with atmospheric temperature (hence altitude)
- Investigations (on-going) suggest imperfect Rayleigh-Brillouin Correction *response* as a function of *temperature*, *pressure* may cause the bias

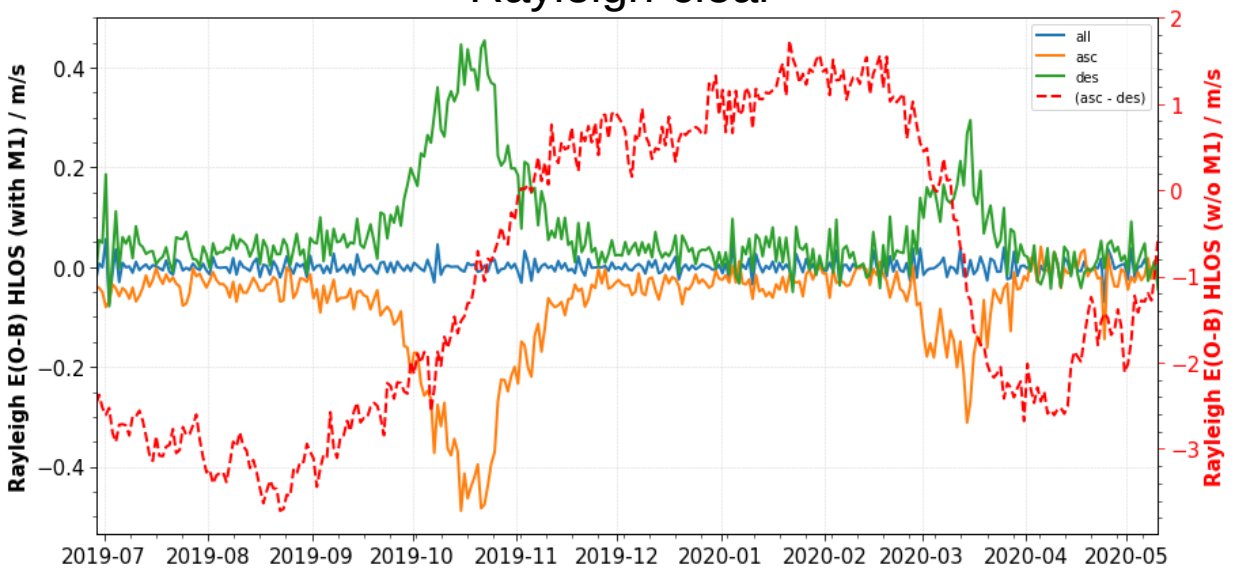
Rayleigh-clear bias jumps per L2B product due to hot-pixel fluctuations



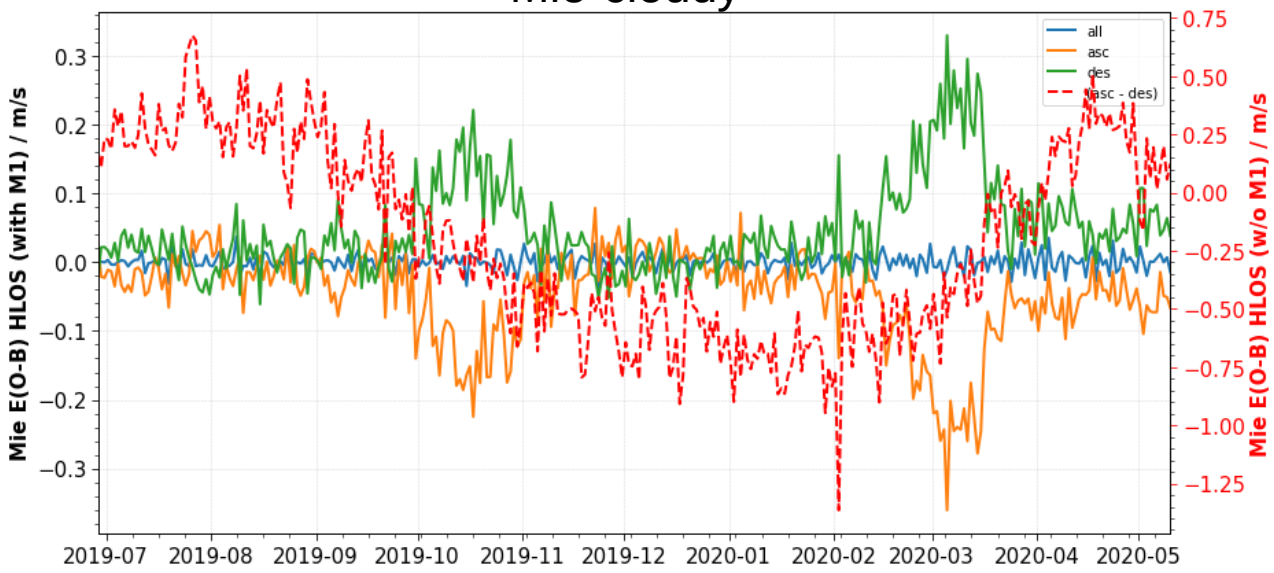
- Biases due to **typical fluctuations in existing hot pixel levels between DUDEs** (4 per day in August 2021) when combined with **increasingly low atmospheric useful signal levels** and **AUX_TEL bias correction**
- Mitigated to some extent by increasing number of **DUDEs per day to 8** (since 6 September 2021)
- Reprocessing should improve these dark current in memory zone related biases

A small bias which varies with ascending/descending orbits is evident in October/March – affecting both Rayleigh and Mie

Rayleigh-clear



Mie-cloudy



Plot by F. Weiler (DLR) – 2nd reprocessed dataset

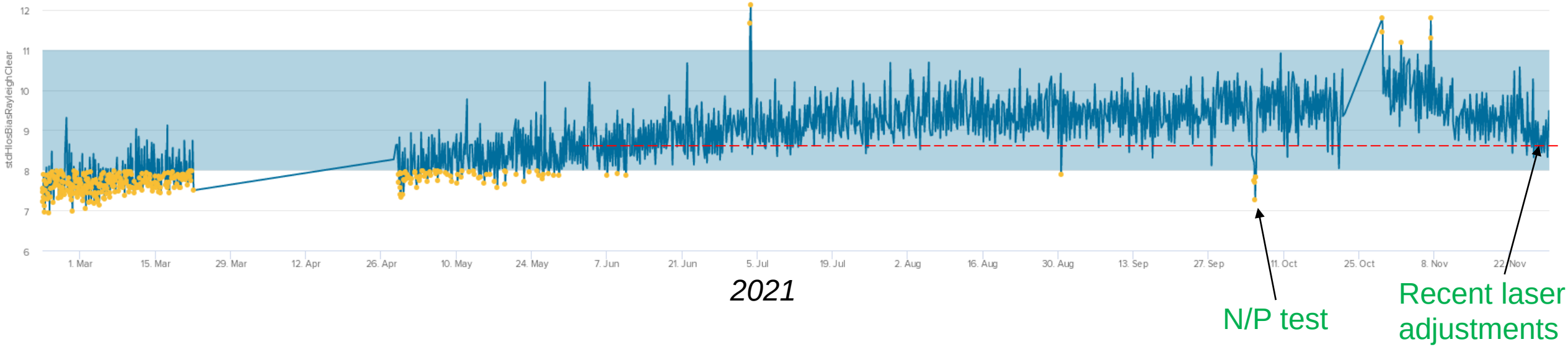
- Bias exist in **reprocessed** and **NRT data**
- Unknown what is causing this bias, but best guess (at the moment) is it is related to the M1 temperature-dependent bias correction in specific solar illumination conditions

Summary of L2B data quality as assessed via DISC NRT monitoring

- **Rayleigh-clear noise** near **record high** for mission due to ongoing **atmospheric path signal decrease**
  - However, expect noise to improve by ~15% soon via modified N/P settings
- **Mie-cloudy noise remains good** in strong cloud backscatter conditions, but gradually the **number of winds** passing QC is **decreasing e.g. cirrus**
- Several **remaining bias/product issues**:
  - **Rayleigh-clear:**
    - Altitude/temperature dependent bias ~±1 m/s
    - Bias jumps per L2B file ~±1 m/s due to fluctuations in levels of existing hot pixels (even higher biases on specific range-bins)
  - **Rayleigh-clear and Mie-cloudy:**
    - Ascending/descending bias differences ~±0.5 m/s in October/March – cause unknown, but likely related to M1-T bias correction for specific solar illumination conditions
    - Sporadic star-tracker moon-blinding induced pointing error biases (~4 m/s). We handle this by discarding all data with moon-blinding flag set, however this is *over-kill/wasteful*
    - A horizontal geolocation error (~5 km) due to a L1Bp bug, which shall be fixed with next delivery
      - Longitude incorrect by -0.075° – too far to the West

Thanks for listening, any questions?

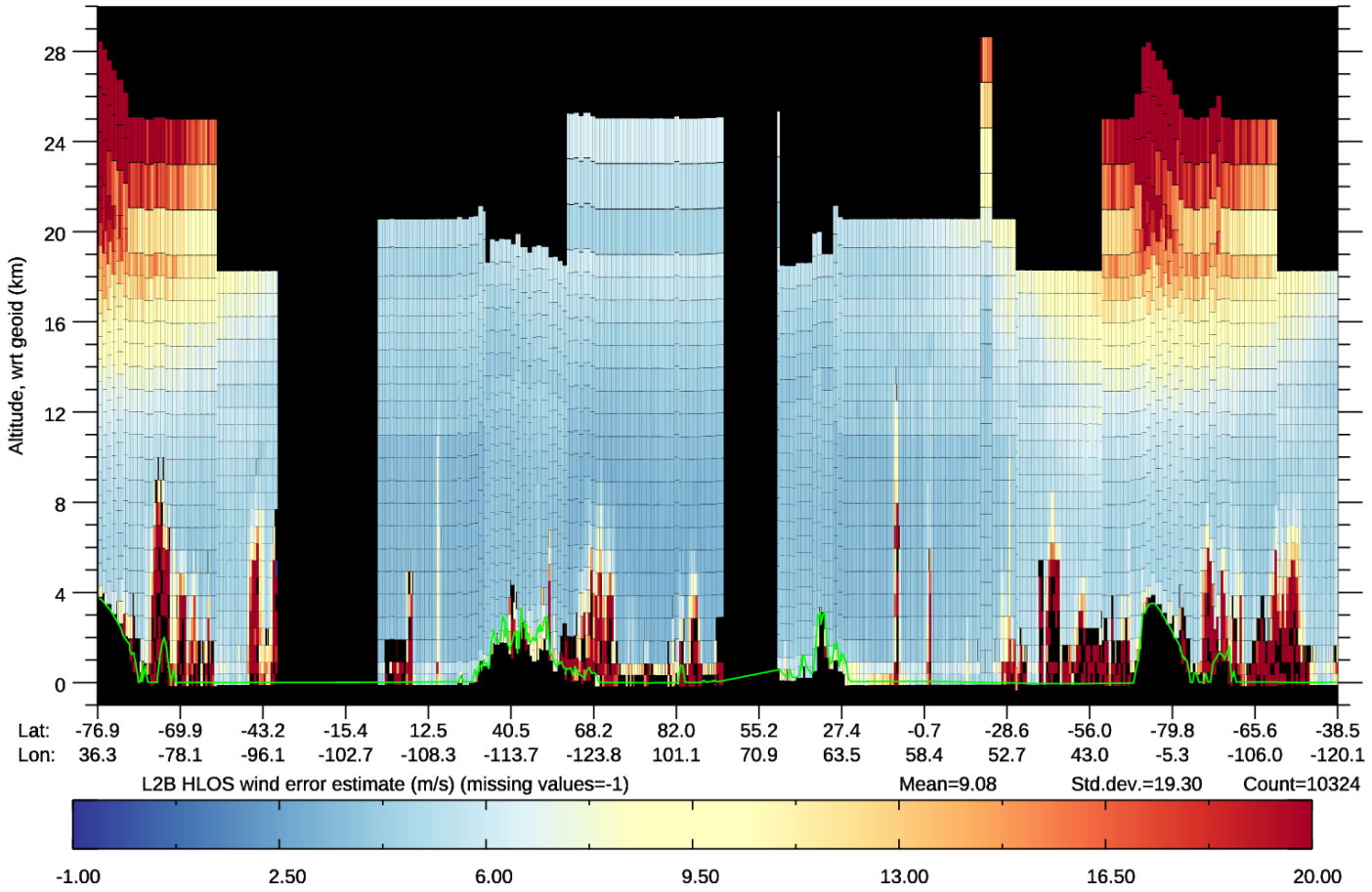
L2B Rayleigh-clear stdev(O-B) from past 280 days (ECWMF back-up server – no blocklist)



Similar random error now to early June 2021

With low Rayleigh atmospheric path useful signal solar background noise becomes a more dominant term in HLOS wind noise

L2B Rayleigh-clear $\sigma_{L2B,est}$ for orbit on 11 Nov 2021



Zonal average of $1.4\sigma_{L2B,est}$ (with ~17 m/s QC); 7-22 Nov 2021