Assessment of Aeolus L2B products with the LATMOS RALI airborne platform

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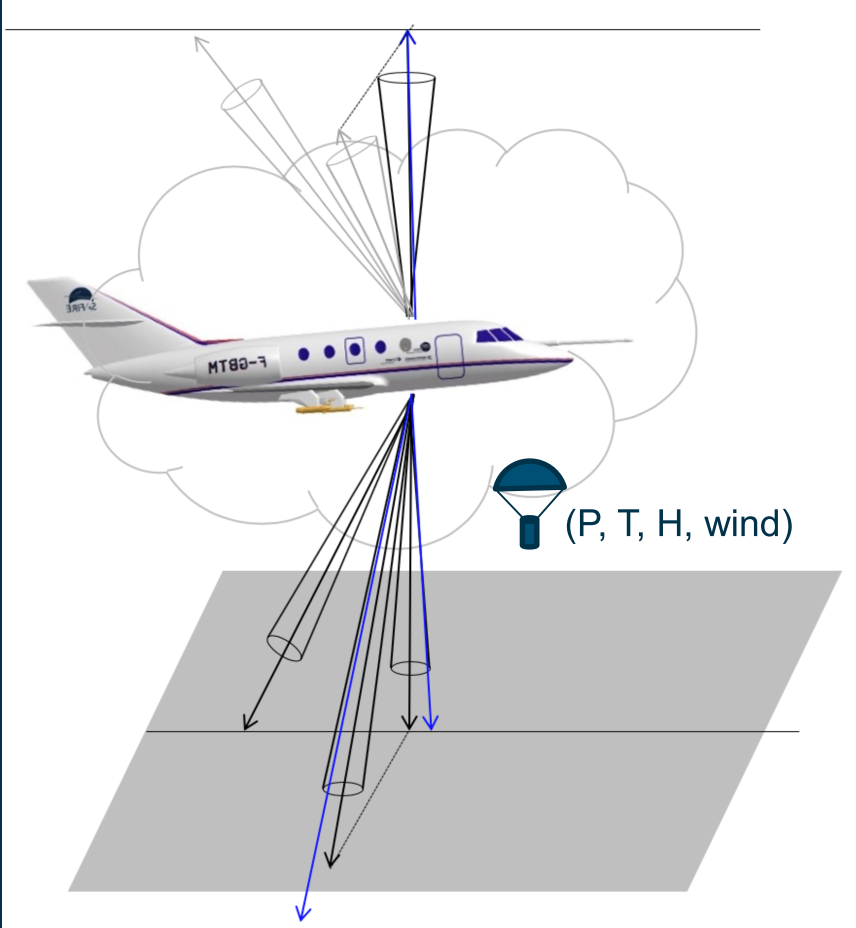
LATMOS – IPSL

3rd Aeolus NWP Impact and L2B product quality working meeting, Webex, 1 December 2021

The SAFIRE F20 payload for wind measurements



RASTA - 95 GHz
mono-static, pulsed system (1.6kW) : sensitivity ~-40dBZ@1km
4 antenna-system (1 up and 3 down)

Measurements (int 250 ms/every 1s/60m):
Z, **V**, Doppler spectrum
→ **Cloud wind below the aircraft** (combining the 3 antennas)

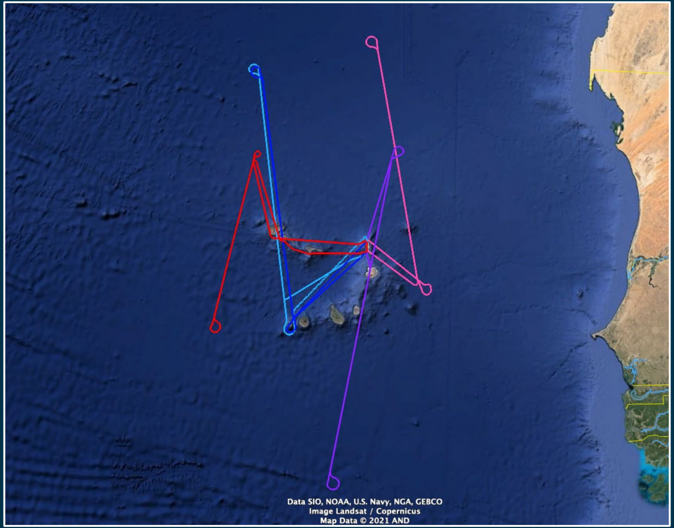
LNG lidar – 355/532/1064nm
High spectral resolution Doppler polarised lidar at 355nm
3 possible lines-of-sight: nadir, zenith or **37°off nadir (Aeolus-like)**

Measurements (5s-50s /6m):
Backscatter at 355/532/1064 nm, Polarisation at 355, **line of sight velocity of aerosol and cloud particles at 355nm**, Molecular backscatter at 355nm

Dropsondes (Vaisala, Aspen QC) → horizontal wind profiles

F20 in-situ wind at aircraft altitude

Datasets



CADDIWA, 8 – 19 Sept. 2021
Cape Verde (Sal International Airport)

5 flights with Aeolus underpasses
13 DS

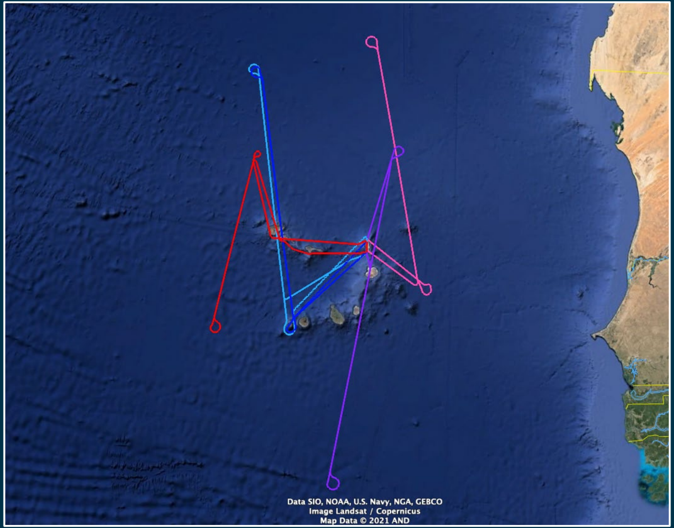
Aeolus B12, 3 ascending orbits and 2 descending orbits

08/09
The only case with RASTA

RALI targets: SAL, boundary layer clouds and aerosols, mid-level clouds

LNG 50s (~10km) resolution for higher SNR

Datasets



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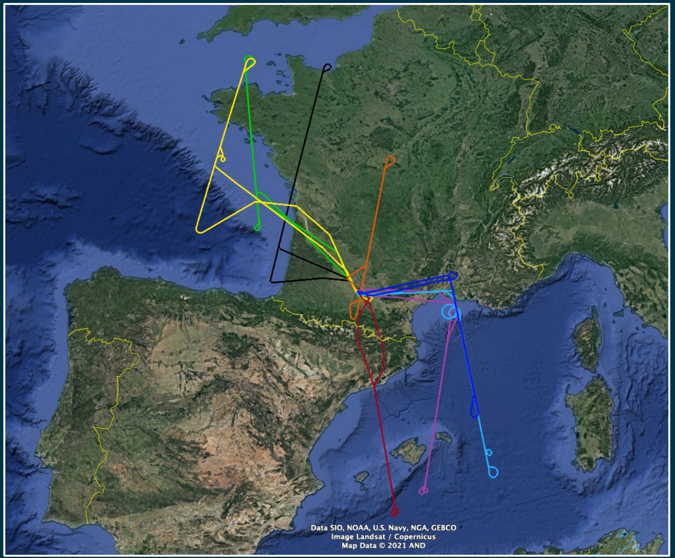


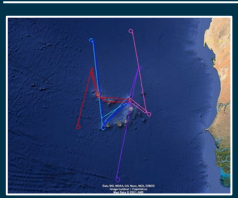
CALVAL Aeolus 2019, 16 – 27 Sept. 2019 & 5 – 7 Nov. 2019
France (Toulouse Francazal Airport)

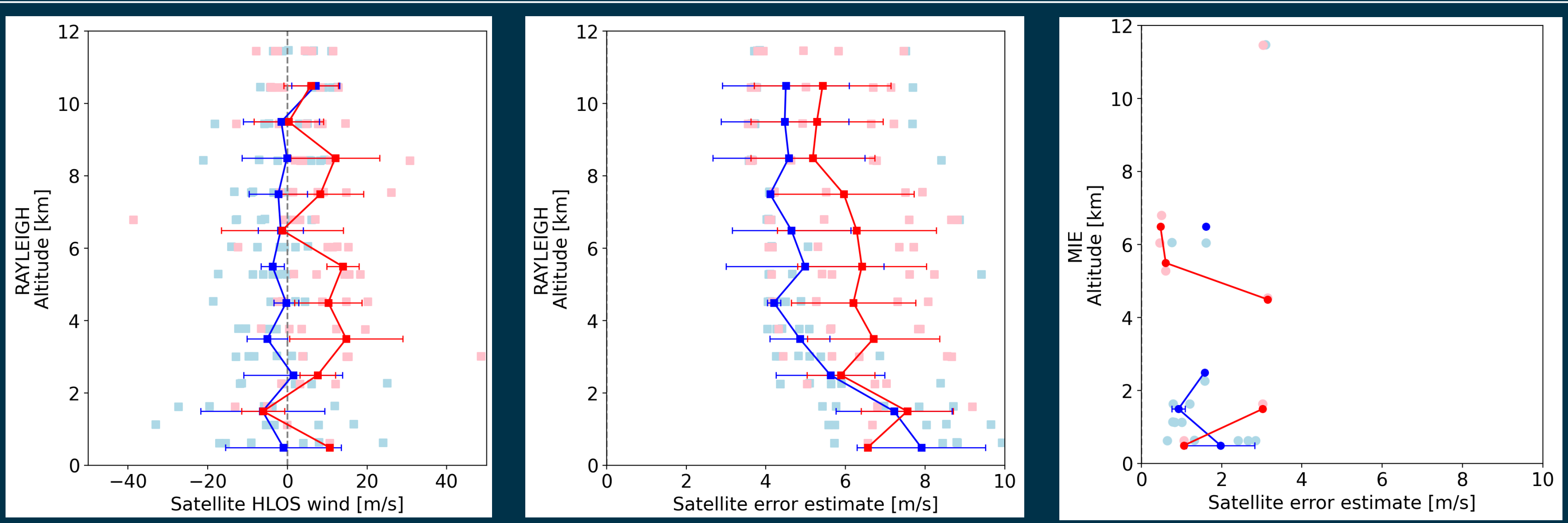
9 flights with Aeolus underpasses
5 exploitable flights for RALI – Aeolus Mie comparisons
22 dropsondes (DS)

Aeolus B06 and B10, 2 ascending orbits and 3 descending orbits

RALI targets: low-level, mid-level and high-level **clouds**

Datasets – a few statistics



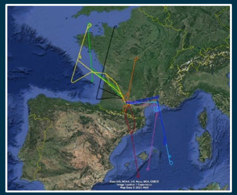


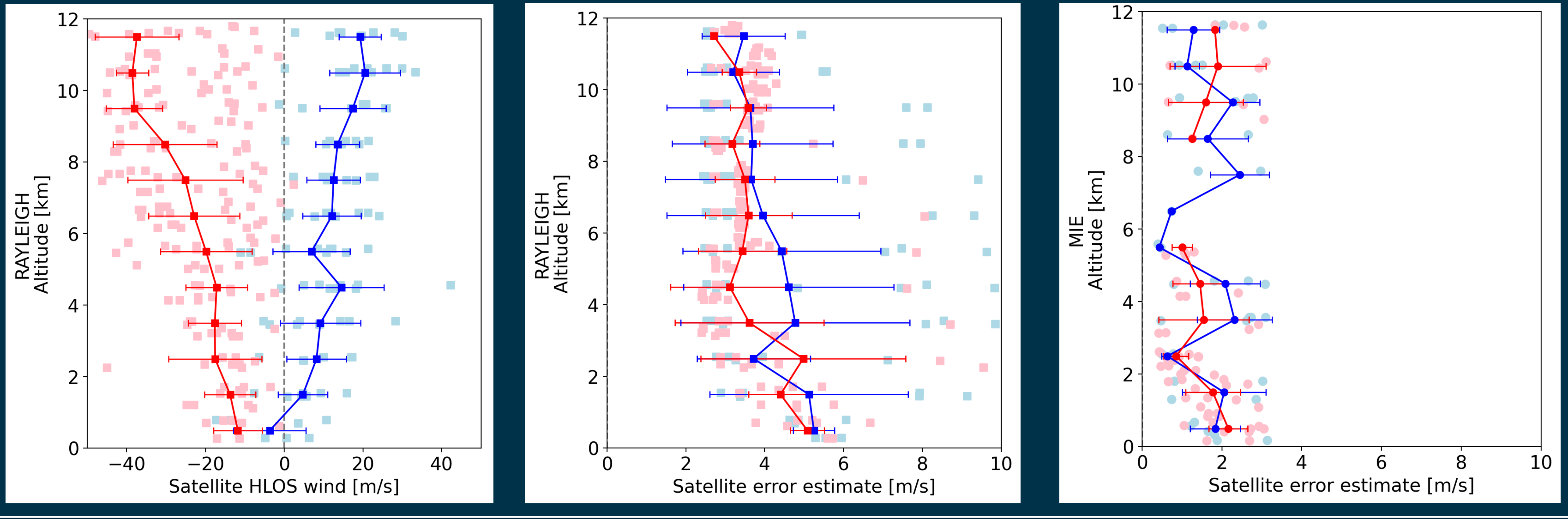
Asc.

Desc.

2021 campaign

A statistics of Aeolus L2B – B10 profiles used for comparison with DS





2019 campaign

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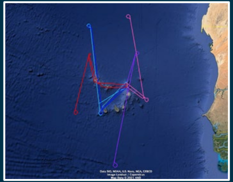
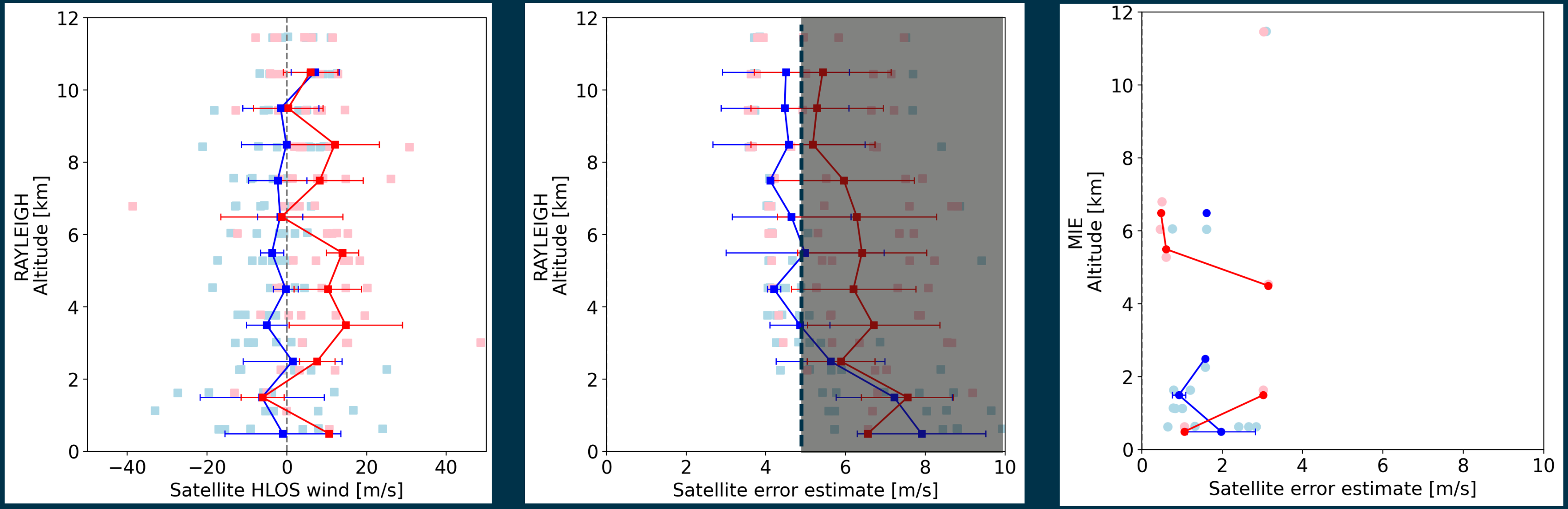
Datasets – a few statistics





2021 campaign

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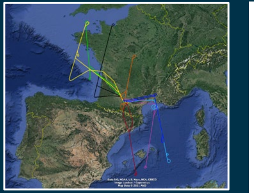

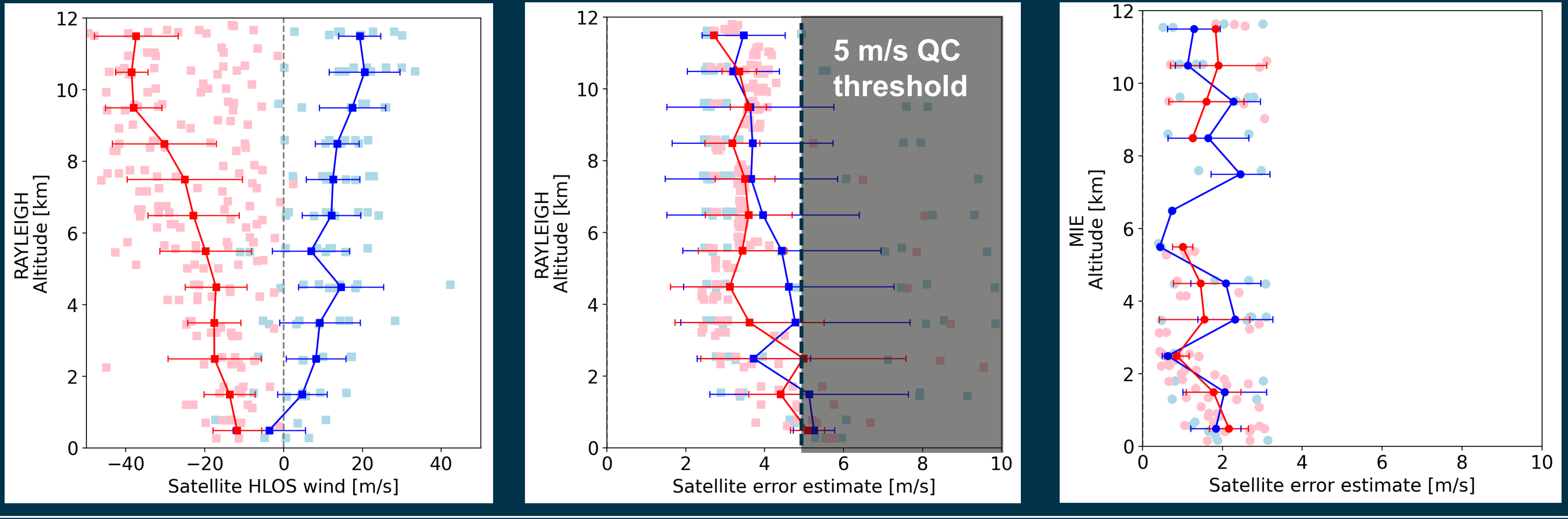

2019 campaign

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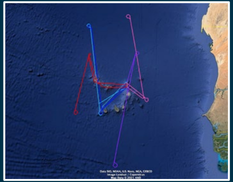
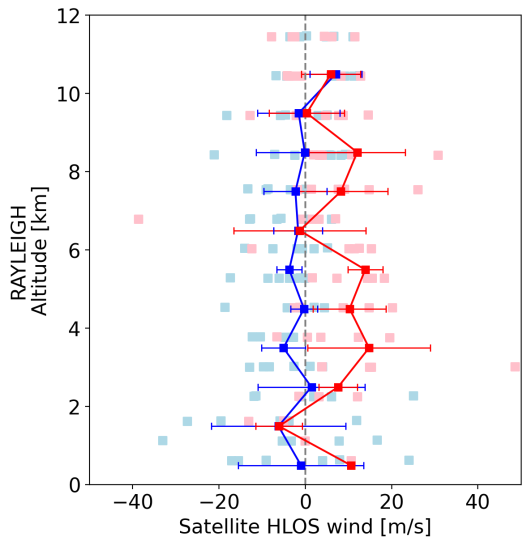
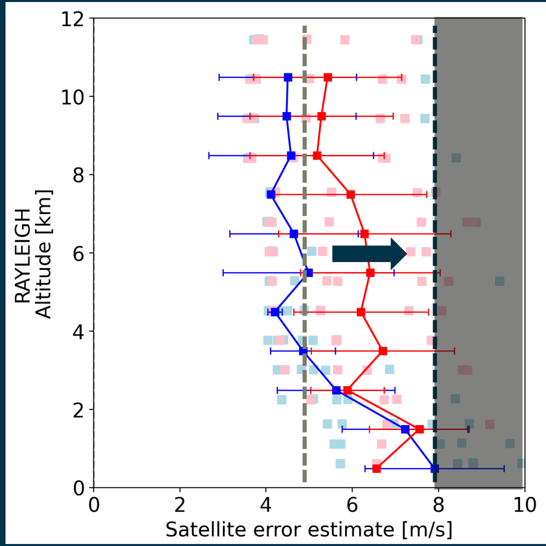
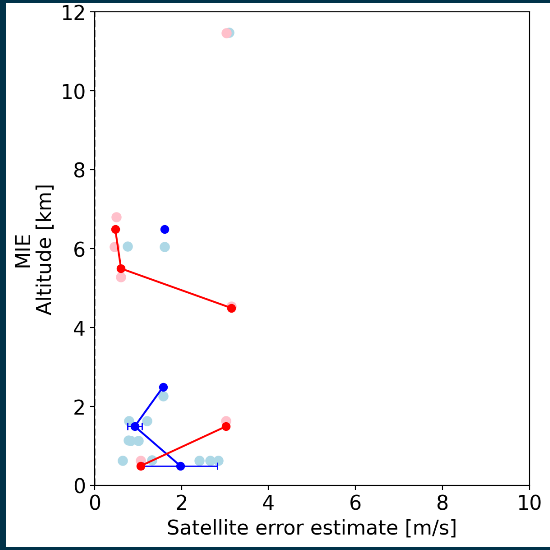


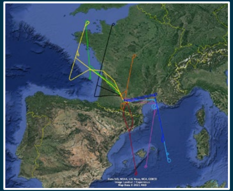


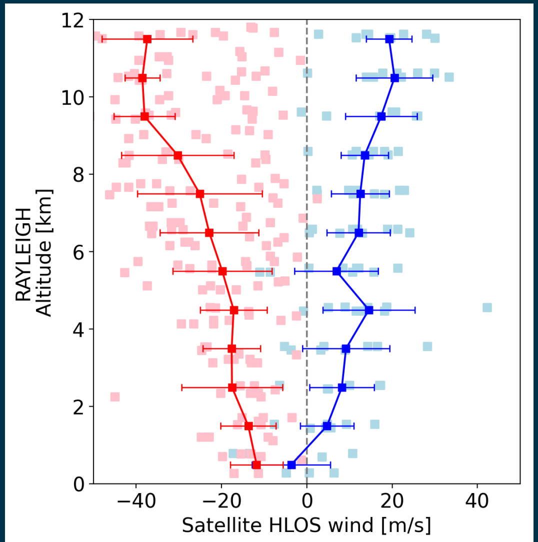


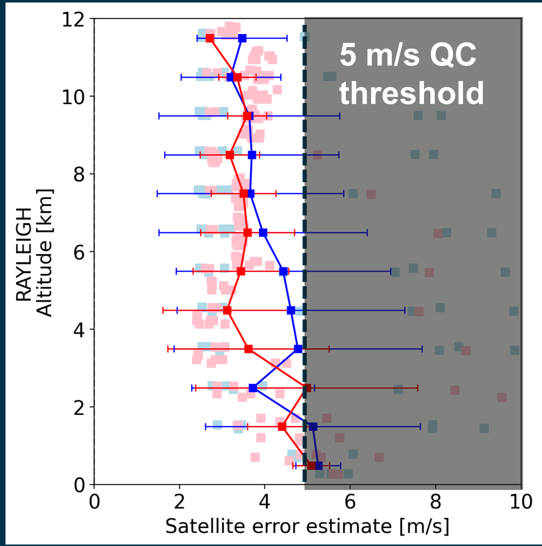


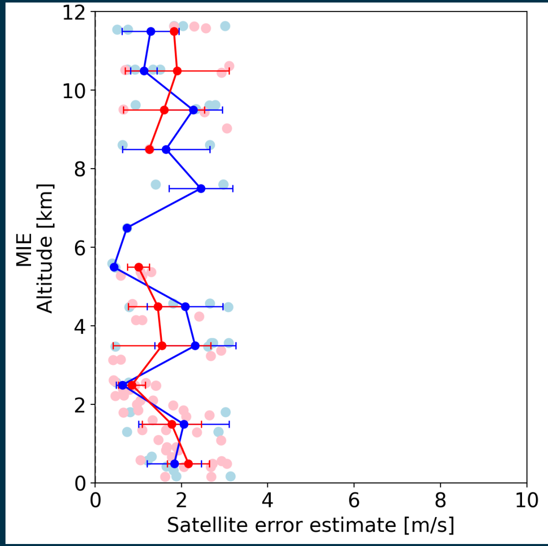
2021 campaign

A statistics of Aeolus L2B – B10 profiles used for comparison with DS





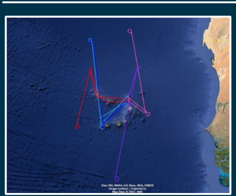




2019 campaign

A statistics of Aeolus L2B – B12 profiles used for comparison with DS

F20 payload cross-validation

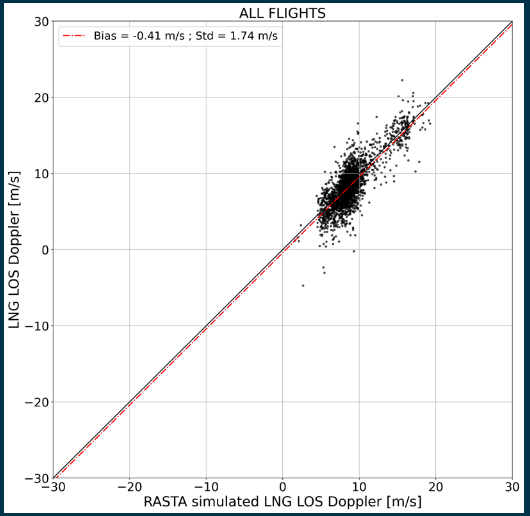


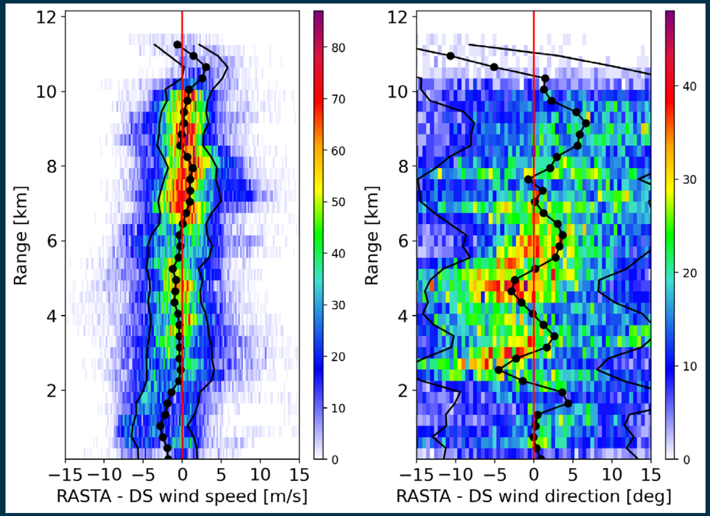
Statistics on 2 flights with good RALI overlap on Sept., 11th

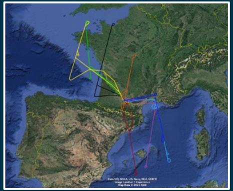
RASTA wind – DS wind – LNG LOS Doppler (slant viewing)
Filtered LNG data: Atmospheric contrast > 0.2 and Doppler random error < 3m/s

	Counts	Bias	Stand. Dev.	sMAD
RASTA - DS	61500	-0.22 m/s (5.7°)	3.7 m/s (37°)	3.3 m/s (21°)
LNG - RASTA	2800	-0.41 m/s	1.7 m/s	1.6 m/s

Scaled MAD = 1.4826 x MEDIAN(| (Aeous – DS) – MEDIAN(Aeous – DS) |)



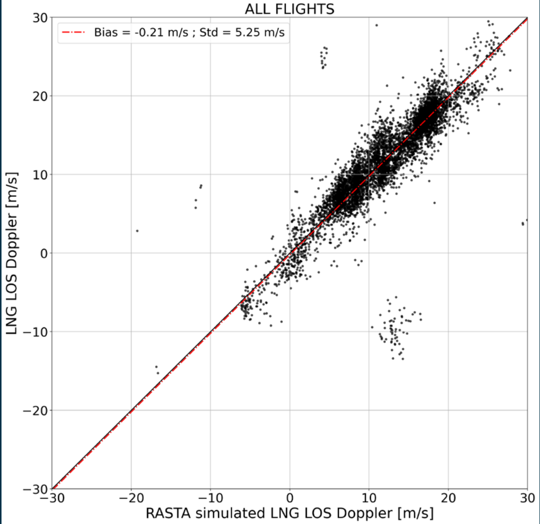


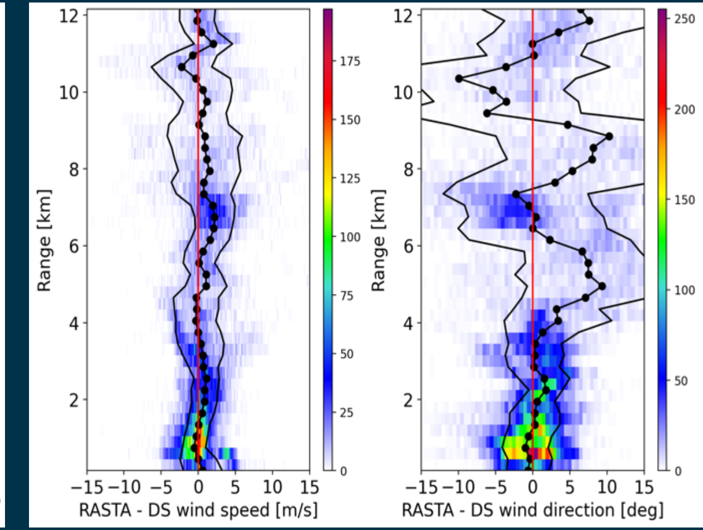


Statistics on all flights

RASTA wind – DS wind – LNG LOS Doppler (slant viewing)
Filtered LNG data: Atmospheric contrast > 0.2 and Doppler random error < 3m/s

	Counts	Bias	Stand. Dev.	sMAD
RASTA - DS	30000	0.6 m/s (0.85°)	3.4 m/s (8°)	2.2 m/s (4.3°)
LNG - RASTA	6100	-0.21 m/s	5.25 m/s	1.75 m/s





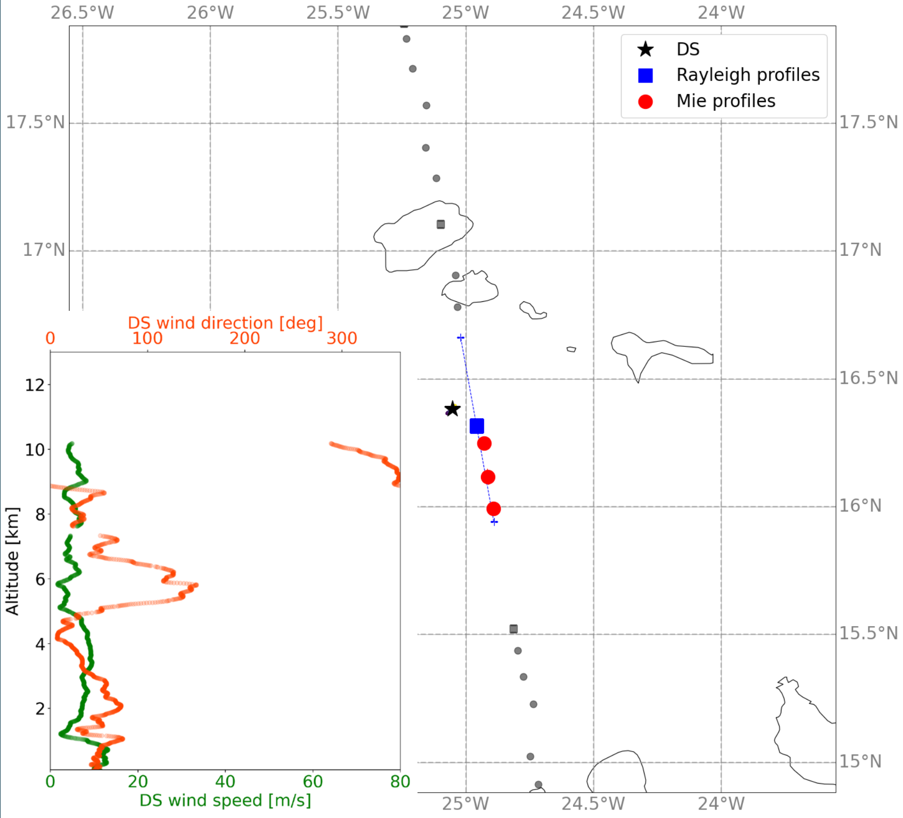
Comparison with DS – methodology example

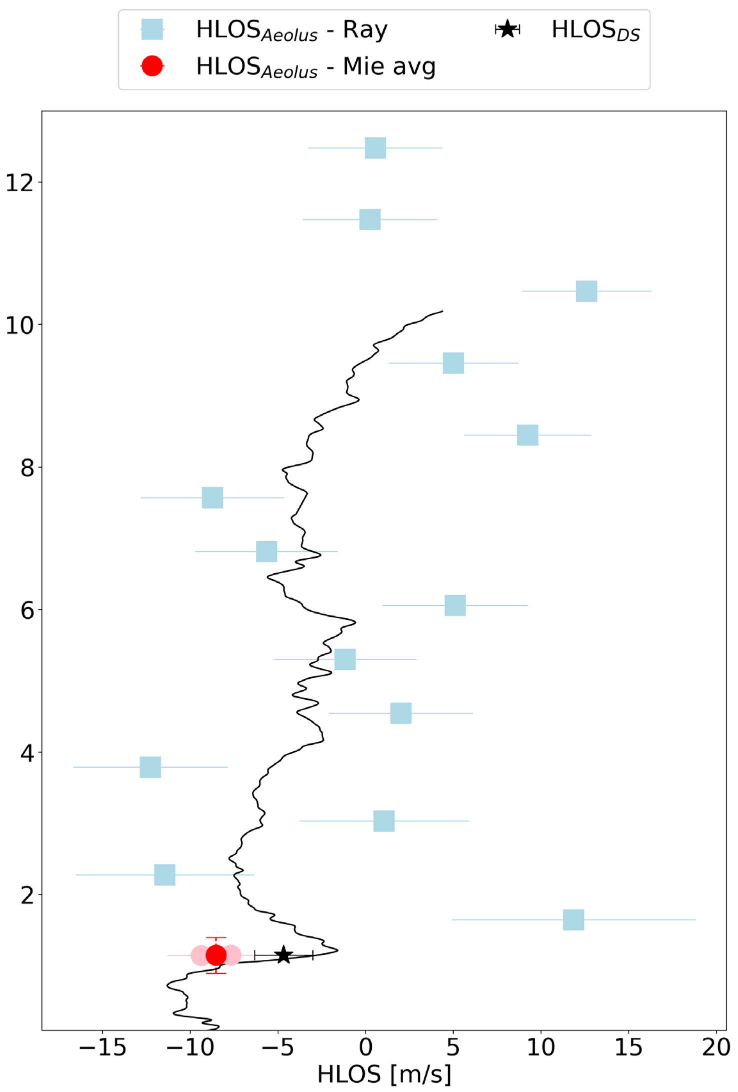
2021-09-17 Ascending

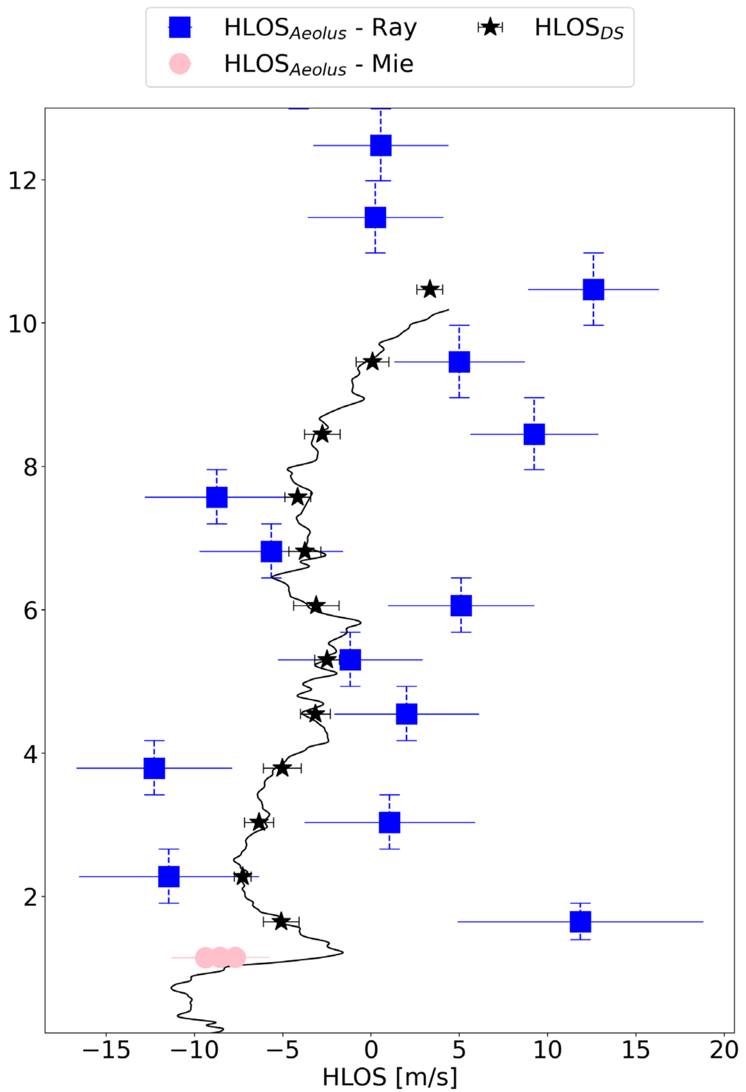
Time (UTC): Aeolus = 19:36:12, DS = [19:31:08 - 19:44:37]

Rayleigh profile distance to the dropsonde = 12 km

Mie profiles distance to the dropsonde = [19 km, 46 km]







Comparison with RALI – methodology example

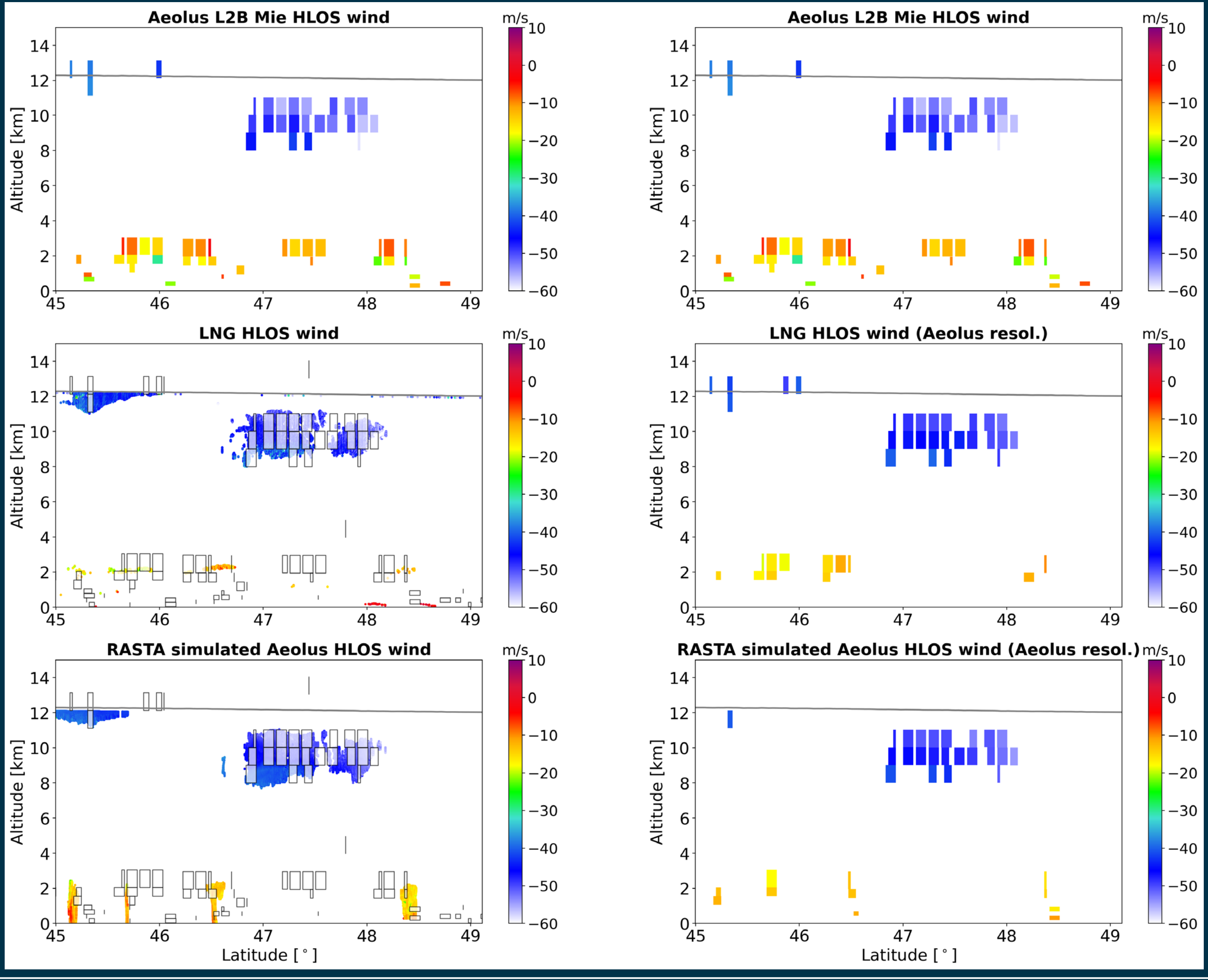
2019-09-27 Descending

LNG HLOS measurement corrected from difference with Aeolus azimuth angle (Lux et al. 2020):

$$\Delta HLOS = [\sin(Az_{LNG}) - \sin(Az_{Aeolus})] * u + [\cos(Az_{LNG}) - \cos(Az_{Aeolus})] * v$$

(u, v) → ERA5 hourly horizontal wind information

RASTA wind retrieval validation using F20 in-situ winds, DS and ERA5.



Comparison with RALI – methodology example (2)

2021-09-10 Ascending

LNG HLOS measurement corrected from difference with Aeolus azimuth angle (Lux et al. 2020):

$$\Delta HLOS = [\sin(Az_{LNG}) - \sin(Az_{Aeolus})] * u + [\cos(Az_{LNG}) - \cos(Az_{Aeolus})] * v$$

$(u, v) \rightarrow$ ERA5 hourly horizontal wind information

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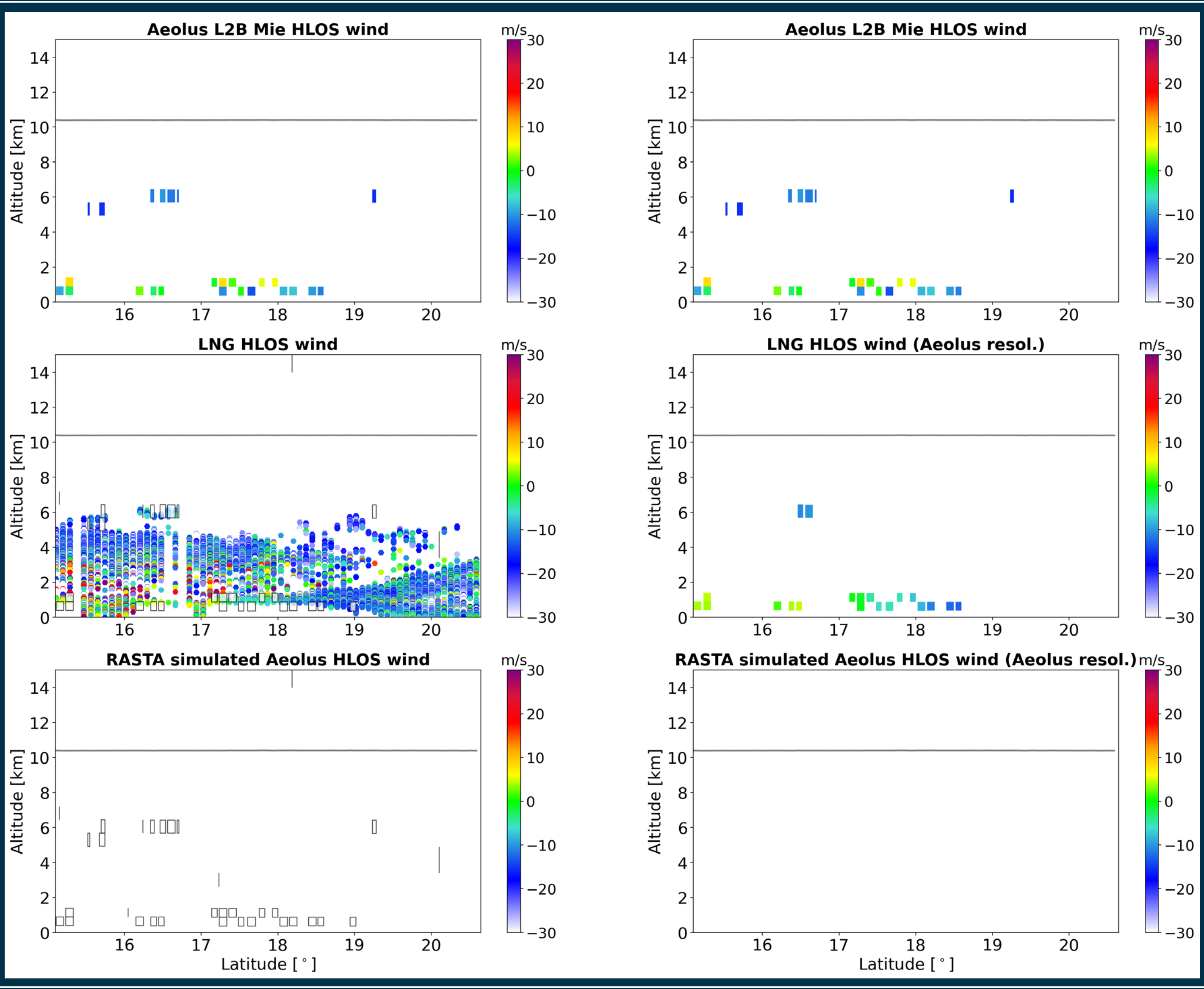
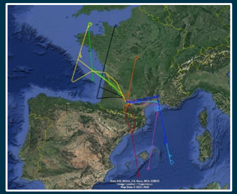


Main results from comparison with dropsondes



		Bias (m/s)		Standard dev. (m/s)		Scaled MAD (m/s)		Counts	
		B06	B10	B06	B10	B06	B10	B06	B10
RAY	asc.	**-3.03**	**-1.29**	3.57	4.23	3.64	3.84	**62**	**69**
	desc.	1.45	1.5	4.84	4.88	4.4	4.7	**94**	**100**
MIE	asc.	-0.21	-1.21	2.31	4.16	3	2.55	**18**	**24**
	desc.	0.99	0.25	3.59	3.51	2.43	3.56	**19**	**29**

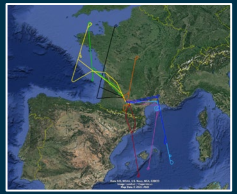
New baseline

- More data available ← reduction of estimated random error

- Reduction of bias for rayleigh ascending orbits

Scaled MAD = 1.4826 x MEDIAN(| (Aeous – DS) – MEDIAN(Aeous – DS) |)

Main results from comparison with dropsondes



		Bias (m/s)		Standard dev. (m/s)		Scaled MAD (m/s)		Counts	
		B06	B10	B06	B10	B06	B10	B06	B10
RAY	asc.	**-3.03**	**-1.29**	3.57	4.23	3.64	3.84	**62**	**69**
	desc.	1.45	1.5	4.84	4.88	4.4	4.7	**94**	**100**
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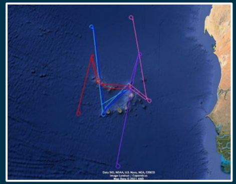


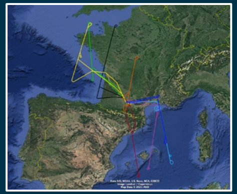
		Bias (m/s)	Standard dev. (m/s)	Scaled MAD (m/s)	Counts
		B12	B12	B12	B12
RAY	asc.	**0.73**	**7.67**	**8.51**	60
	desc.	**0.72**	**8.8**	**8.89**	38
MIE	asc.	-0.64	2.59	1.53	10
	desc.	1.4	4.12	4.63	4

New campaign and new baseline

- Reduction of bias for rayleigh

- Increase in standard deviation and scaled MAD

Main results from comparison with RALI (Mie only)



		Bias (m/s)		Standard dev. (m/s)		Scaled MAD (m/s)		Counts	
		B06	B10	B06	B10	B06	B10	B06	B10
LNG	asc.	-1.60	-1.32	4.20	3.61	3.52	3.97	**56**	**76**
	desc.	-0.08	0.45	4.42	5.42	4.15	4.92	**45**	**96**
RASTA	asc.	0.69	0.36	3.721	3.18	2.64	3.64	**45**	**72**
	desc.	2.88	2.32	8.98	8.41	3.36	5.34	**35**	**85**

New baseline

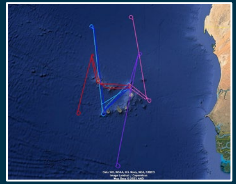
→ No significant improvement

Main results from comparison with RALI (Mie only)

		Bias (m/s)		Standard dev. (m/s)		Scaled MAD (m/s)		Counts	
		B06	B10	B06	B10	B06	B10	B06	B10
LNG	asc.	-1.60	**-1.32**	4.20	3.61	3.52	3.97	**56**	**76**
	desc.	**-0.08**	**0.45**	4.42	5.42	4.15	4.92	**45**	**96**
RASTA	asc.	0.69	0.36	3.721	3.18	2.64	3.64	**45**	**72**
	desc.	2.88	2.32	8.98	8.41	3.36	5.34	**35**	**85**

New baseline

→ No significant improvement

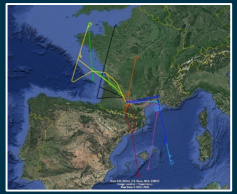


		Bias (m/s)	Standard dev. (m/s)	Scaled MAD (m/s)	Counts
		B12	B12	B12	B12
LNG	asc.	**1.92**	7.93	7.6	40
	desc.	**-0.79**	2.64	2.76	34
RASTA	asc.	/	/	/	0
	desc.	-1.3	1.32	1.75	4

New campaign

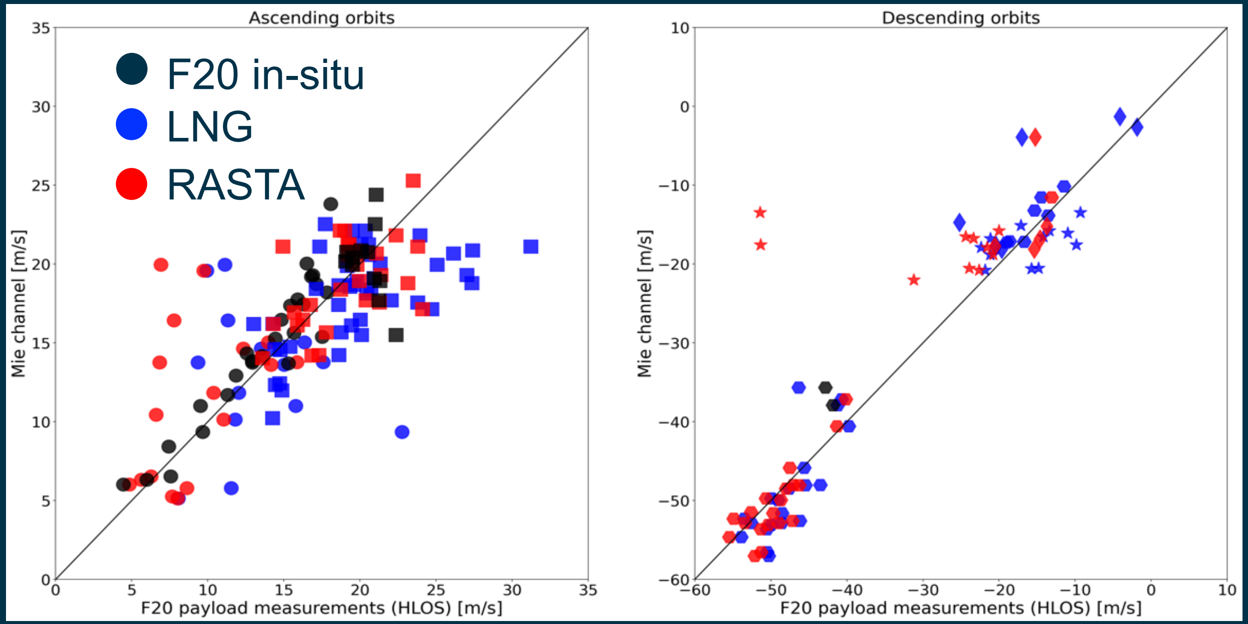
- Even less data
- Inconsistent bias values for ascending orbits
- Similarly low bias for descending orbits

Main results from comparison with RALI (Mie only)

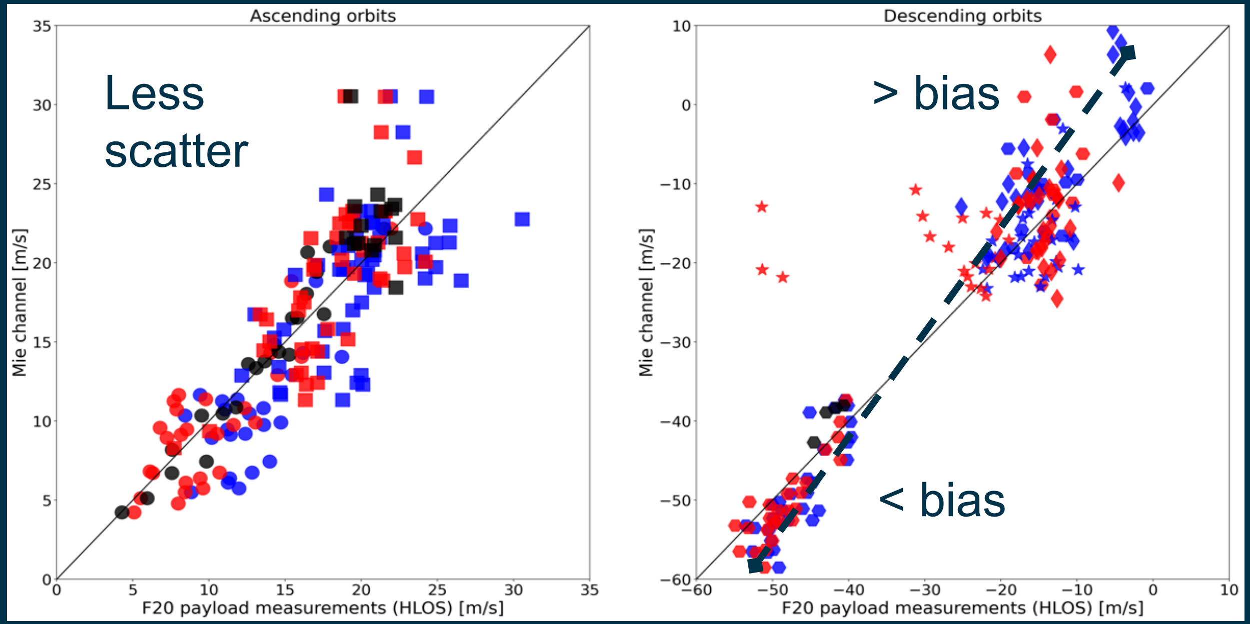


Comparing B06 and B10 on the 2019 data

B06

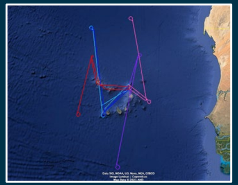


B10

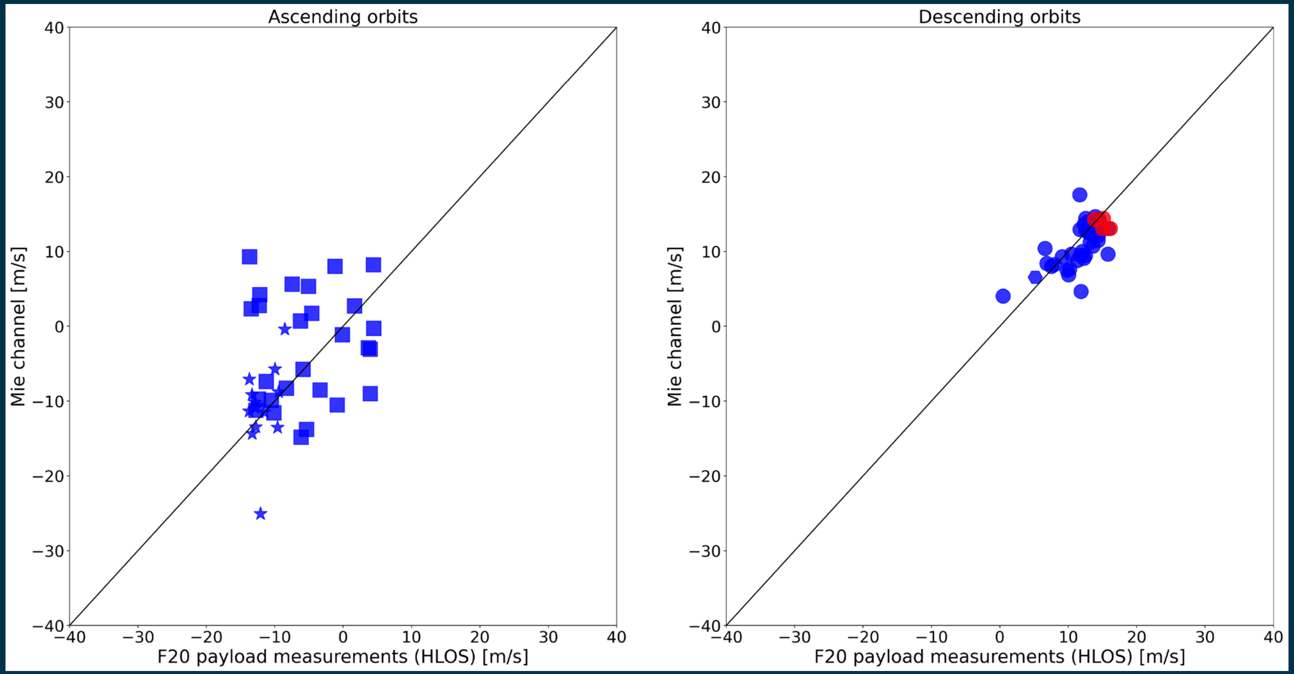


Different wind conditions between ascending and descending orbits → possible reason for the differences

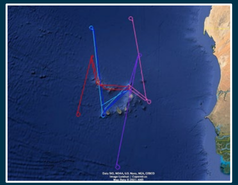
Main results from comparison with RALI (Mie only)



Same results for the Cape Verde dataset (2021)



Main results from comparison with RALI (Mie only)



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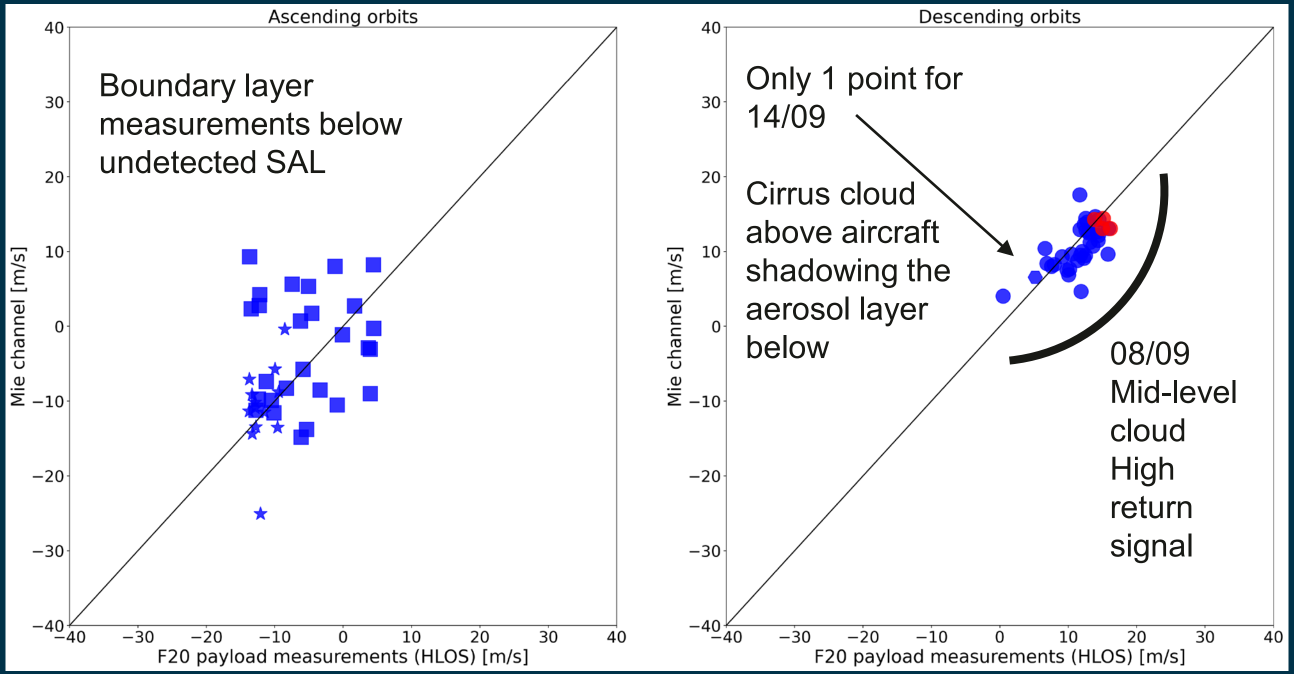

The flights performed during the CADDIWA campaign cannot provide sufficient data for quantitative Aeolus L2B assessment

Summary

- Bias reduction for Rayleigh channel with new baseline (but larger variability)
- No significant impact on Mie channel

- Probable influence of wind intensity on Mie channel performance (but not enough data to confirm this hypothesis)

- Atmospheric conditions during the CADDIWA campaign not satisfying to assess L2B Mie products
  - Aeolus not sensitive enough to detect aerosol layers at the Mie resolution
  - High altitude cirrus clouds shadowing the SAL, too high for the F20


esa
THANK YOU FOR YOUR ATTENTION

Seed questions for Aeolus L2B product quality working meeting 2021

I. Krisch, A. Geiss, S. Kheykin, S. Bley

Questions related to L2B product quality

- Did you recognize differences in the L2B data quality (systematic and random errors) throughout the mission lifetime (FM-A, FM-B)?
- Does your analysis indicates improvements after M1 bias correction (all datasets after B09, including reprocessed)?
- Did you assess the quality of the reprocessed dataset B11 from June 2019 – October 2020?
- Have you noticed range-bin dependent, orbital phase, geographical, temporal wind biases?
- Enhanced orbital dependent biases found in March & October (likely due to increased solar background noise)
  - → Evidence also found in comparison to measurements?
- What is the spatial representativness of Aeolus Rayleigh/Mie winds?
- Which QC filters have you used and did you change them during the mission?
- Have you compared the HLOS estimated error, provided in the product, to random errors (scaled MAD) found in your cal/val comparisons?
- Comparison to AMVs: Did you compare L2B Mie cloudy winds to AMVs for the special RBS period (November 2019)?

Recommendations for the future

- Do you have recommendations for future operations (for upcoming reprocessing campaigns, scene classification in clear, cloudy)?
- Do you have recommendations for special range bin settings?
- Are there any ideas/needs/potential for L3 products (different grids, global maps/statistics)?
- Recommendations for Aeolus follow-on mission?