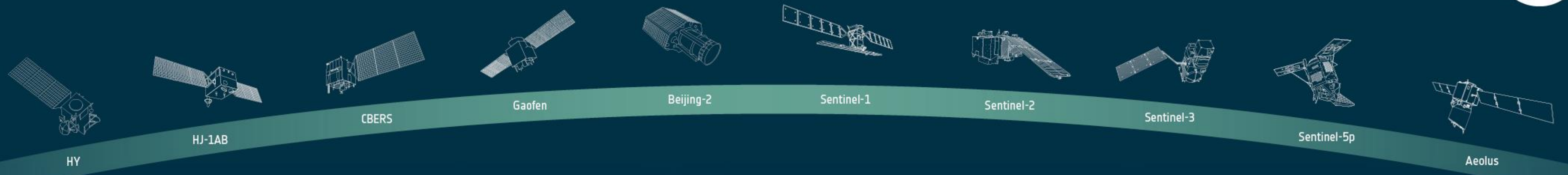

2022 DRAGON 5 SYMPOSIUM

MID-TERM RESULTS REPORTING

17-21 OCTOBER 2022

[PROJECT ID. 59089]

[LIDAR OBSERVATIONS FROM ESA´S AEOLUS (WIND, AEROSOL) AND CHINESE ACDL (AEROSOL, CO2) MISSIONS: VALIDATION AND ALGORITHM REFINEMENT FOR DATA QUALITY IMPROVEMENTS]

<FRIDAY, 21/OCT/2022>

ID. 59089

PROJECT TITLE: LIDAR OBSERVATIONS FROM ESA´S AEOLUS (WIND, AEROSOL) AND CHINESE ACDL (AEROSOL, CO_2) MISSIONS: VALIDATION AND ALGORITHM REFINEMENT FOR DATA QUALITY IMPROVEMENTS

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PRESENTED BY: Kangwen Sun

- **Objectives**
- Identify and correct the systematic error sources, guarantee and improve the performance of ALADIN (lidar instrument installed on Aeolus) and the data quality of the wind products
- Explore the application of Aeolus products
- **Topics**
- Calibration of ALADIN
- Validation of ALADIN L2B wind products
- Application of ALADIN products

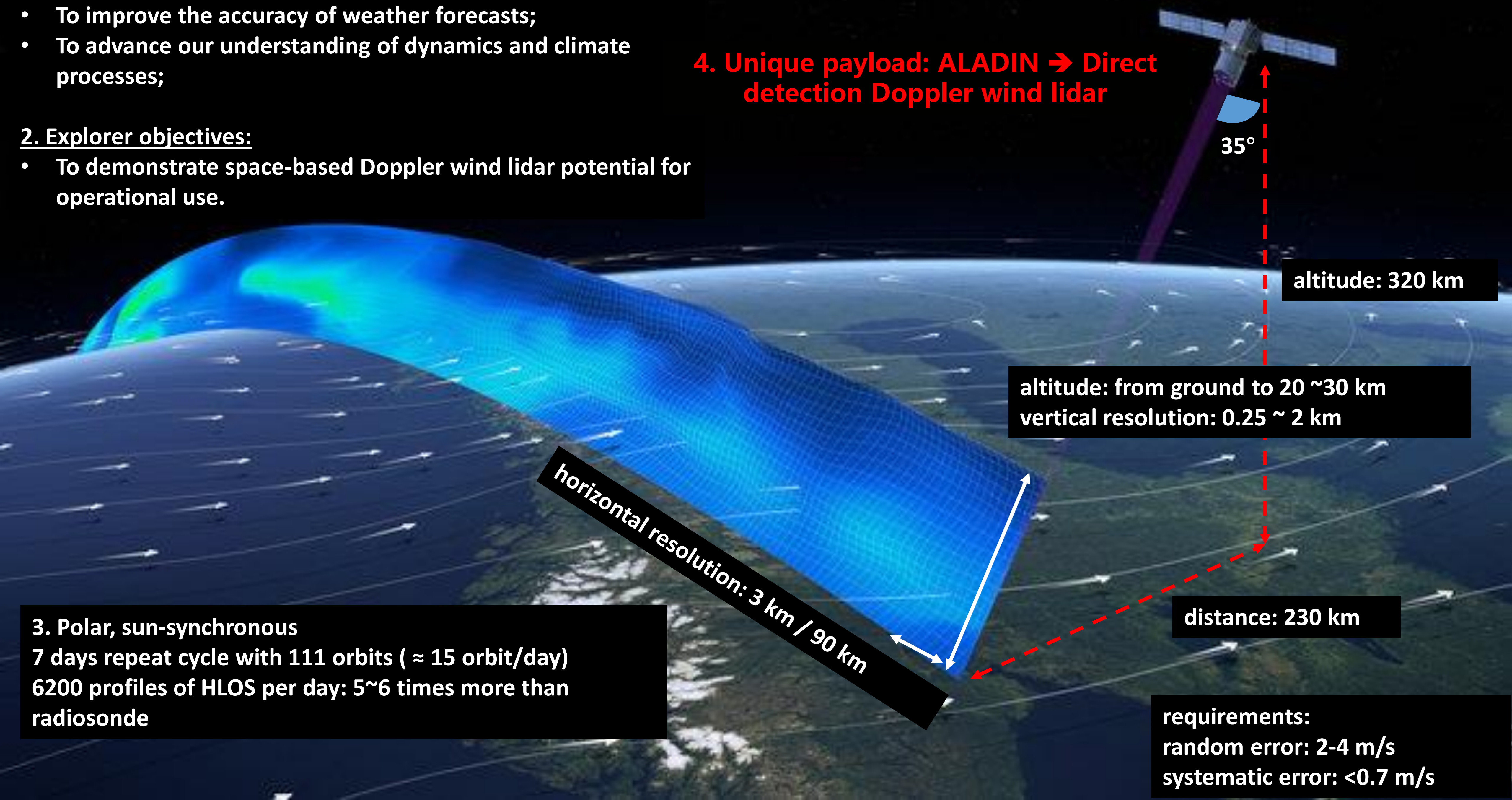
1. Scientific objectives:

- To improve the accuracy of weather forecasts;
- To advance our understanding of dynamics and climate processes;

2. Explorer objectives:

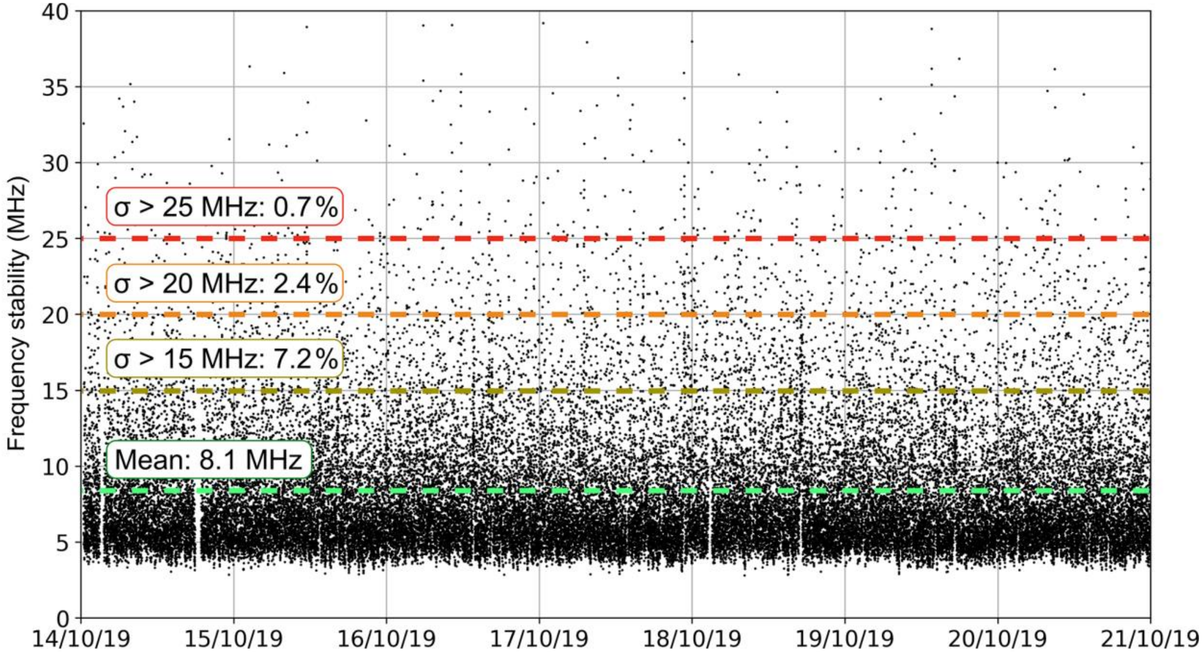
- To demonstrate space-based Doppler wind lidar potential for operational use.

4. Unique payload: ALADIN ➔ Direct detection Doppler wind lidar



3. Polar, sun-synchronous
7 days repeat cycle with 111 orbits (≈ 15 orbit/day)
6200 profiles of HLOS per day: 5~6 times more than radiosonde

Calibration of ALADIN: ALADIN laser frequency stability and its impact on wind measurement



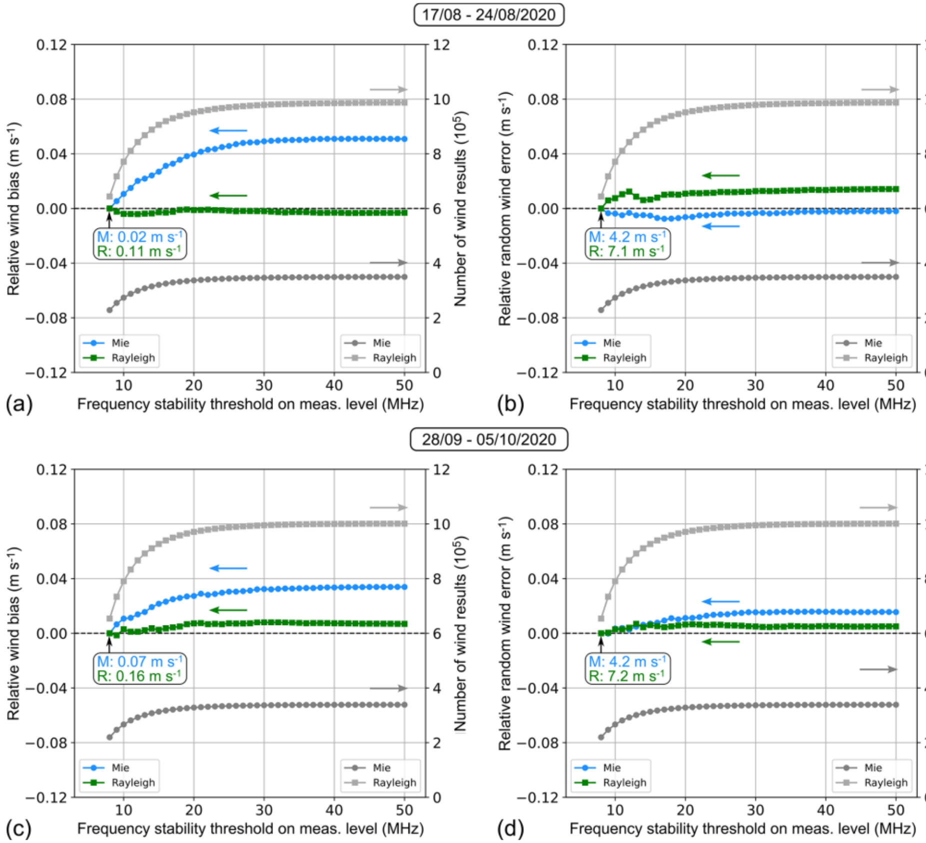
Time series of the laser frequency stability over 1 week from 14 to 21 October 2019

Monitoring the ALADIN laser frequency over more than 2 years :

- excellent frequency stability with pluse-to-pluse variations of about 10MHz
- the permanent occurrence of short periods with significantly enhanced frequency noise (> 30 MHz)

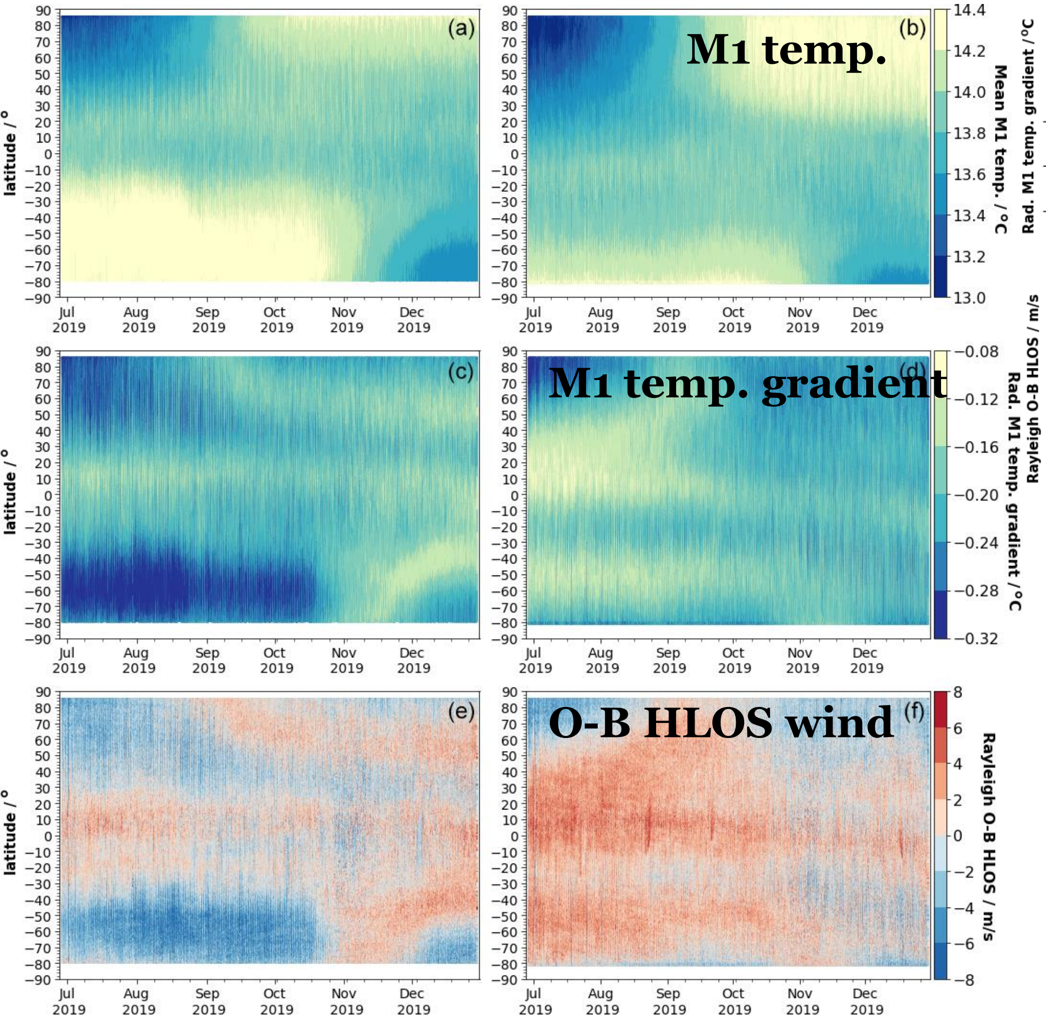
Analysis of the Aeolus wind error with respect to ECMWF model winds:

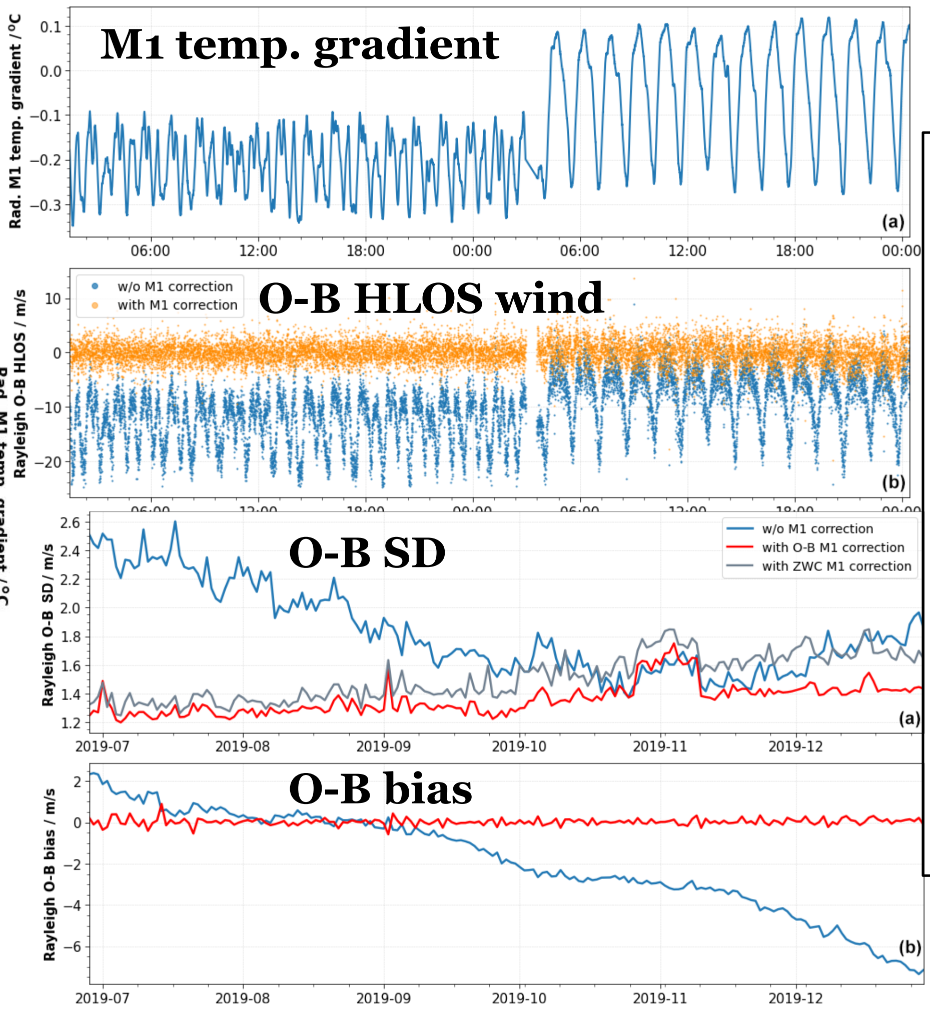
- frequency stability of the laser has a minor influence on the wind data quality on a global scale
- due to the small percentage of the frequency fluctuations are considerably enhanced



Wind bias (a) and random error (b) of the Mie (blue dots) and the Rayleigh channel (green squares) with respect to the ECMWF model background (O–B) depending on a frequency stability threshold for the period between 17 and 24 August 2020. Panels (c) and (d) show the corresponding data for the week between 28 September and 5 October 2020.

Calibration of ALADIN: correction of wind bias for ALADIN using M1 telescope temperatures



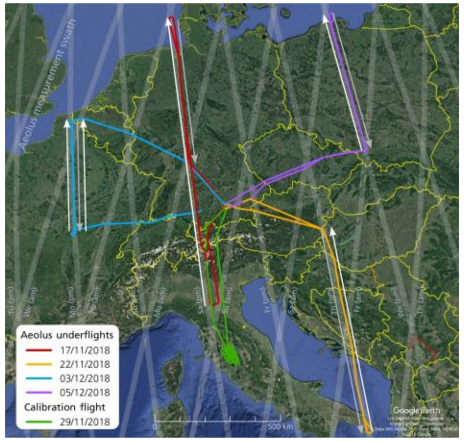


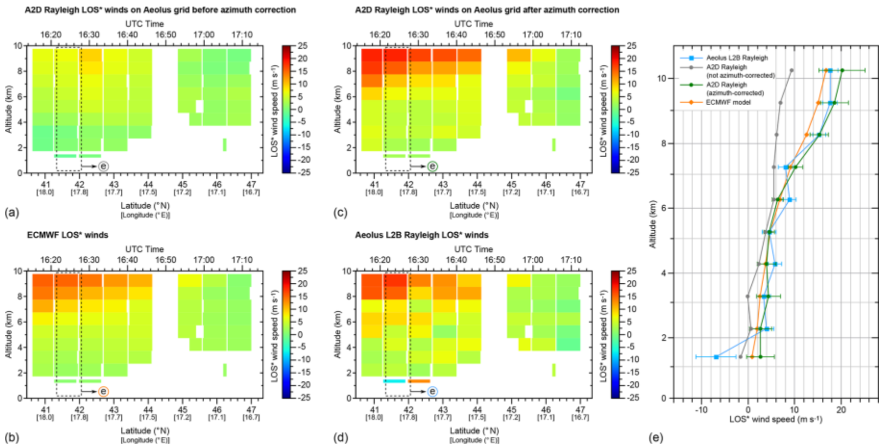
- small fluctuations of the temperatures across the 1.5 m diameter primary mirror of the telescope **cause wind biases of up to 8 m s−1**
- due to changes **in the top-of-atmosphere reflected shortwave and outgoing longwave radiation of the Earth** and the related response of **the telescope's thermal control system**
- ✓ **ECMWF model-equivalent winds** are used as a reference to describe the wind bias **to correct for this effect**

Dragon 5 Mid-term Results Reporting

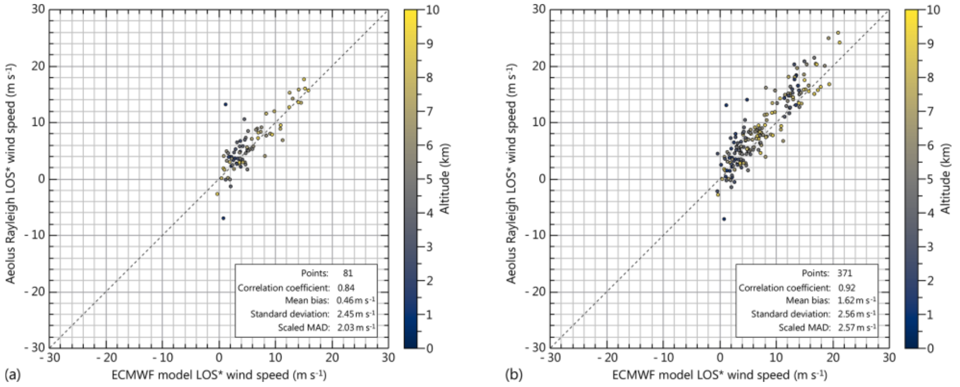
Validation of ALADIN: validation with co-located airborne wind lidar A2D observations

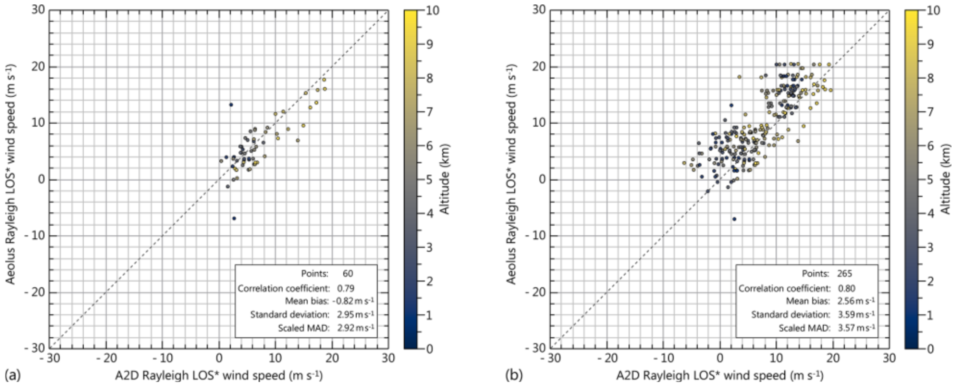
Flight no.	Date	Flight period (UTC)	Measurement period (UTC)	No. of A2D observations	Geolocation of DLR Falcon on Aeolus measurement track (start; stop)		No. of Aeolus observations
1	17/11/2018	15:14–19:14	A2D inoperable	No data	44.7° N, 10.6° E;	54.9° N, 7.8° E	12
2	**22/11/2018**	**14:29–17:56**	15:11–15:48	122	46.7° N, 16.8° E;	42.3° N, 17.7° E	7
			16:13–17:15	**176**	**40.5° N, 18.1° E;**	**47.2° N, 16.5° E**	**9**
3	29/11/2018	09:56–14:00			Calibration flight		
4	03/12/2018	15:48–19:31	16:48–17:13	82	47.8° N, 3.5° E;	50.5° N, 2.8° E	4
			17:22–17:48	87	50.1° N, 2.9° E;	46.8° N, 3.7° E	4
			17:53–18:29	117	47.1° E, 3.6° E;	50.6° N, 2.7° E	5
5	05/12/2018	14:56–18:22	15:53–16:45	173	50.3° N, 18.9° E;	54.9° N, 17.6° E	7
			16:55–17:18	78	54.0° N, 17.9° E;	50.8° N, 18.8° E	4





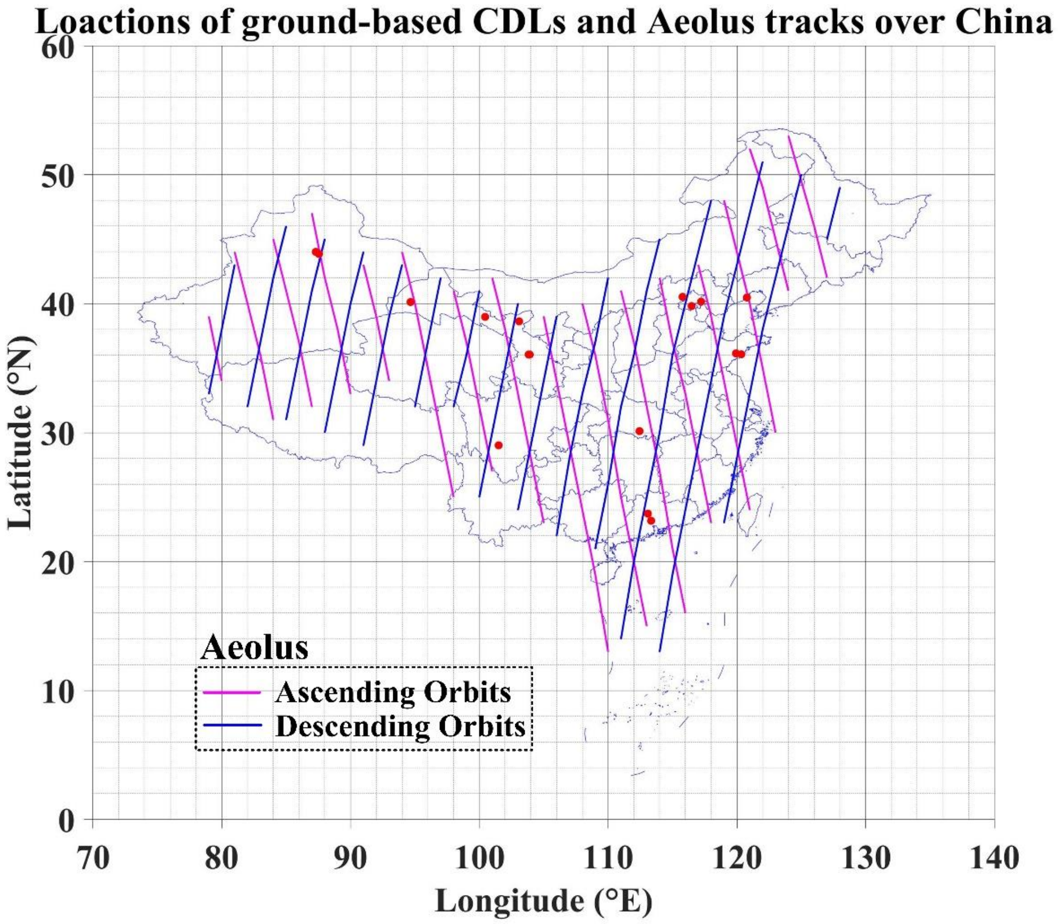
In the first airborne validation campaign after the launch and still during the commissioning phase of the mission, four coordinated flights along the satellite swath were conducted in late autumn of 2018, yielding wind data in the troposphere with high coverage of the Rayleigh channel.





Statistical parameter	A2D Rayleigh vs. 2 µm DWL	A2D Rayleigh vs. ECMWF	Aeolus Rayleigh vs. ECMWF	Aeolus Rayleigh vs. A2D Rayleigh
Number of compared bins	1301	524	371	265
Correlation coefficient (r)	0.83	0.89	0.92	0.80
Slope (A)	0.98 ± 0.02	1.03 ± 0.03	1.08 ± 0.02	0.83 ± 0.04
Intercept (B)	$-0.7\,\mathrm{m\,s^{-1}}$	$-1.2\,\mathrm{m\,s^{-1}}$	$0.9\,\mathrm{m\,s^{-1}}$	$3.8\,\mathrm{m\,s^{-1}}$
Mean bias	$-0.7\,\mathrm{m\,s^{-1}}$	$-0.9\,\mathrm{m\,s^{-1}}$	$1.6\,\mathrm{m\,s^{-1}}$	$2.6\,\mathrm{m\,s^{-1}}$
Standard deviation	$3.7\,\mathrm{m\,s^{-1}}$	$2.6\,\mathrm{m\,s^{-1}}$	$2.6\,\mathrm{m\,s^{-1}}$	$3.6\,\mathrm{m\,s^{-1}}$
Scaled MAD	$3.4\,\mathrm{m\,s^{-1}}$	$2.5\,\mathrm{m\,s^{-1}}$	$2.6\,\mathrm{m\,s^{-1}}$	$3.6\,\mathrm{m\,s^{-1}}$

Validation of ALADIN: validation with ground-based CDLs over China



Ground-based CDL observation sites of the VAL-OUC campaign since January 2020

Validation campaigns	Instrument type	Measurement mode	Location	Latitude, longitude, altitude	Measurement period
VAL-OUC	WindMast PBL	DBS*	Dunhuang	40.12° N, 94.66° E; 1.15 km	From 7 Jan to 29 Dec 2020
	WindMast PBL	DBS	Lanzhou	36.05° N, 103.91° E; 1.51 km	From 7 Jan to 29 Dec 2020
	WindMast PBL	DBS	Zhangye	38.97° N, 100.45° E; 1.46 km	From 5 Jan to 27 Dec 2020
	Wind3D 6000	DBS	Jingzhou	30.11° N, 112.44° E; 0.03 km	From 24 Jun to 22 Jul 2020
	Wind3D 6000	DBS	Pinggu, Beijing	40.15° N, 117.22° E; 0.05 km	From 21 Apr to 2 Jun 2020
	Wind3D 6000	DBS	Changji	44.01° N, 87.30° E; 0.58 km	3 Dec 2020
	Wind3D 6000	DBS	Jiulong, Sichuan	29.01° N, 101.50° E; 2.90 km	From 24 Oct to 29 Nov 2020
	Wind3D 6000	DBS	Jiaozhou, Shandong	36.14° N, 119.93° E; 0.02 km	21 Dec 2020
	Wind3D 6000	DBS	Qingyuan, Guangdong	23.71° N, 113.09° E; 0.03 km	From 12 May to 27 Aug 2020
	Wind3D 6000	DBS	Xidazhuangke, Beijing	40.52° N, 115.78° E; 0.91 km	From 7 Jan to 31 Mar 2020
	Wind3D 6000	DBS	Yizhuang, Beijing	39.81° N, 116.48° E; 0.04 km	From 7 Apr to 25 Aug 2020
	Wind3D 6000	DBS	Huludao	40.47° N, 120.78° E; 0.10 km	From 1 Nov to 28 Dec 2020
	Wind3D 6000	DBS	Wuwei	38.62° N, 103.09° E; 1.37 km	From 11 Apr to 26 Dec 2020
	Wind3D 6000	DBS	Lanzhou	36.05° N, 103.83° E; 1.53 km	From 4 Jan to 26 Dec 2020
	Wind3D 6000	DBS	South China University of Technology	23.16° N, 113.34° E; 0.03 km	From 13 Oct to 29 Dec 2020
	Wind3D 6000	DBS	Ürümqi	43.85° N, 87.55° E; 0.84 km	From 14 Oct to 24 Dec 2020
	Wind3D 6000	DBS	Qingdao	36.07° N, 120.34° E; 0.04 km	From 2 Nov to 28 Dec 2020

* DBS: Doppler beam swinging.

Validation of ALADIN: validation with ground-based CDLs over China

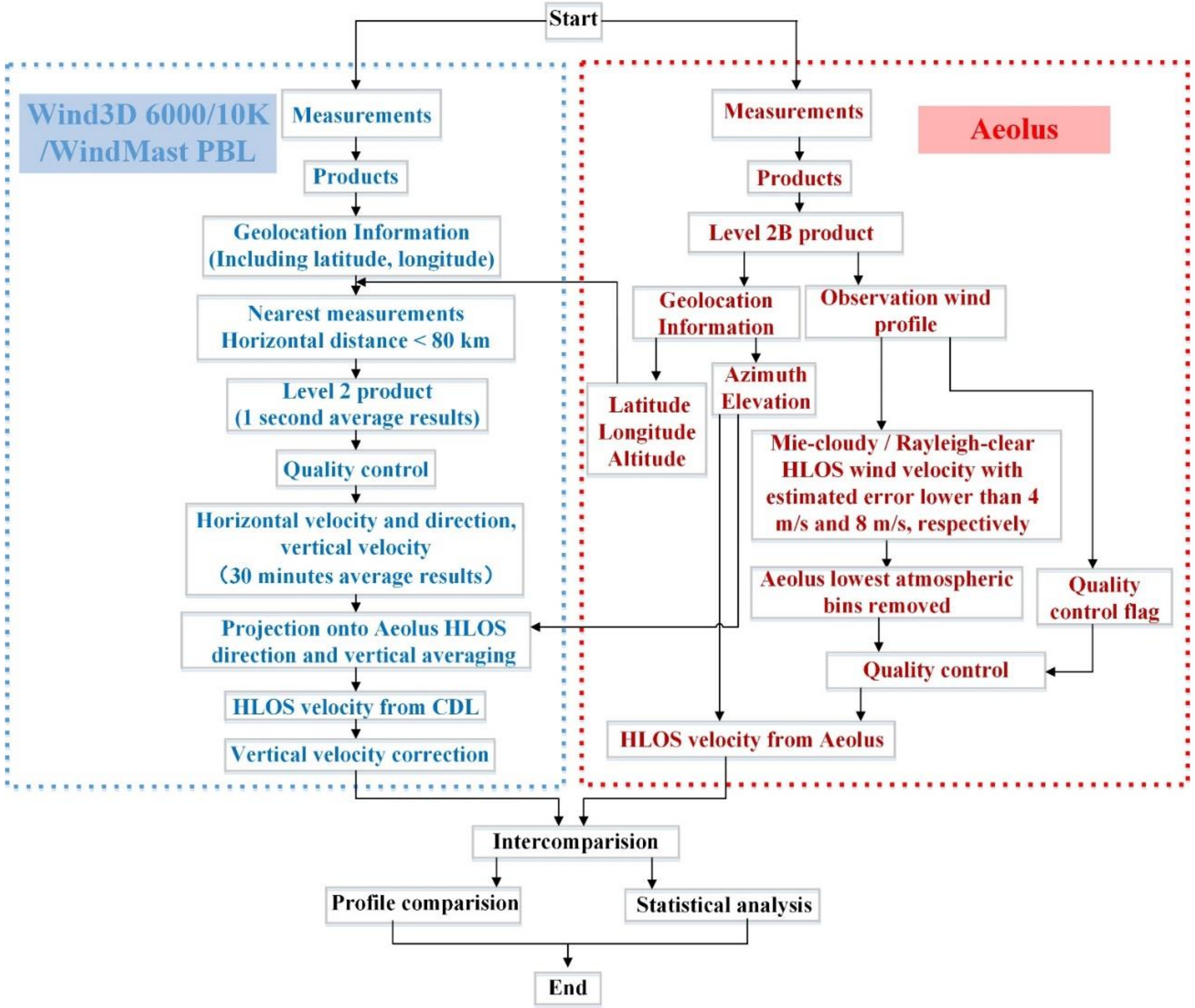
CDL introduction and observations over China

Wind3D 6000	
Wavelength	1550 nm
Repetition rate	10 kHz
Pulse energy	150 μJ
Pulse width	100 ns to 400 ns
Detection range	80 m ~ 6000 m (10km extended)
Data update rate	4 Hz (0.25 sec / measurement)
Range resolution	15 m ~ 30 m
Wind speed accuracy	≤ 0.2 m/s
Wind speed range	±75m/s
Wind direction accuracy	0.1°
Power consumption	200W (500W when cooling)
Operating temperature	-30 ~ +50 ℃
Housing classification	IP67
Size	746×764×1000mm
Weight	<80 kg
Data transfer	Ethernet, GPRS (optional)

WindMast PBL	
Wavelength	1550 nm
Repetition rate	10 kHz
Pulse energy	150 μJ
Pulse width	100 ns to 400 ns
Detection range	30 m ~ 4000 m
Data update rate	4 Hz (0.25 sec / measurement)
Range resolution	15 m ~ 30 m
Wind speed accuracy	≤ 0.1 m/s
Wind speed range	±75m/s
Wind direction accuracy	≤ 3°
Operating temperature	-30 ~ +50 ℃
Housing classification	IP65
Size	285×215×430mm
Weight	<30 kg
Data transfer	Ethernet, GPRS (optional)

Validation of ALADIN: validation with ground-based CDLs over China

Intercomparison: Strategy



CDL:

- SNR >-10dB

Aeolus:

- “validity flag” is ‘true’;
- Level 2B Rayleigh-clear error<8m/s
- Level 2B Mie-cloudy error<4m/s

➢ The Aeolus lowest atmospheric bins close to the ground are removed。

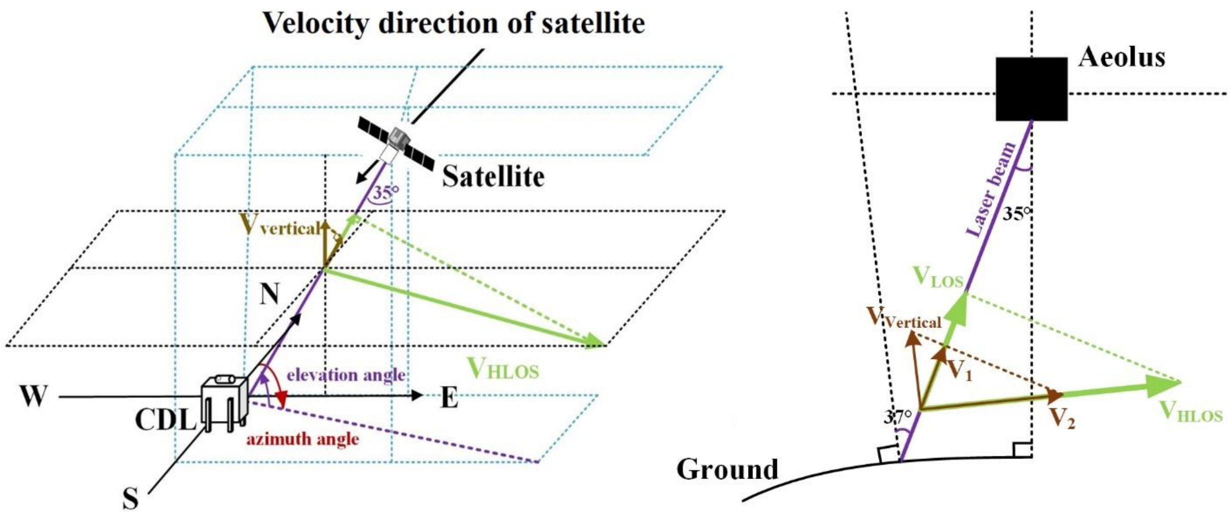
➢ The horizontal distance between the locations of CDLs and the Aeolus footprints must be less than 80 km

➢ Theoretically, there is no time difference between CDL and simultaneous Aeolus measurements.

➢ Vertical averaging of the CDL-produced wind measurements over Aeolus range bins is performed.

Validation of ALADIN: validation with ground-based CDLs over China

Intercomparison: vertical velocity correction



The schematic diagram of the vertical velocity impact on the HLOS velocity retrieval of Aeolus.

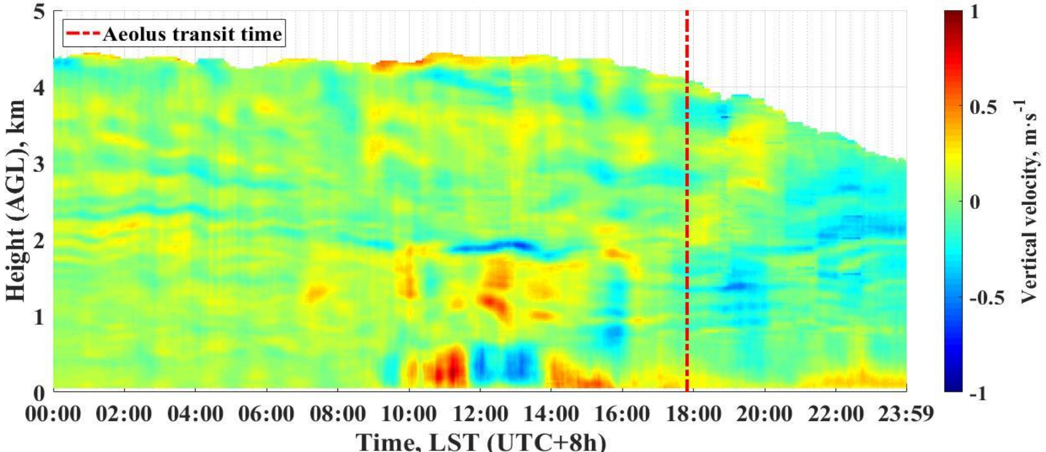
35° - The off-nadir angle of ALADIN.
37° - The viewing angle of the laser beam from ground (the curvature of the earth's surface).

According to the projection relationship, the vertical velocity impact on the HLOS is

$$V_2 = V_{vertical} \cdot \cot 37° \quad \text{Eq. (1)}$$

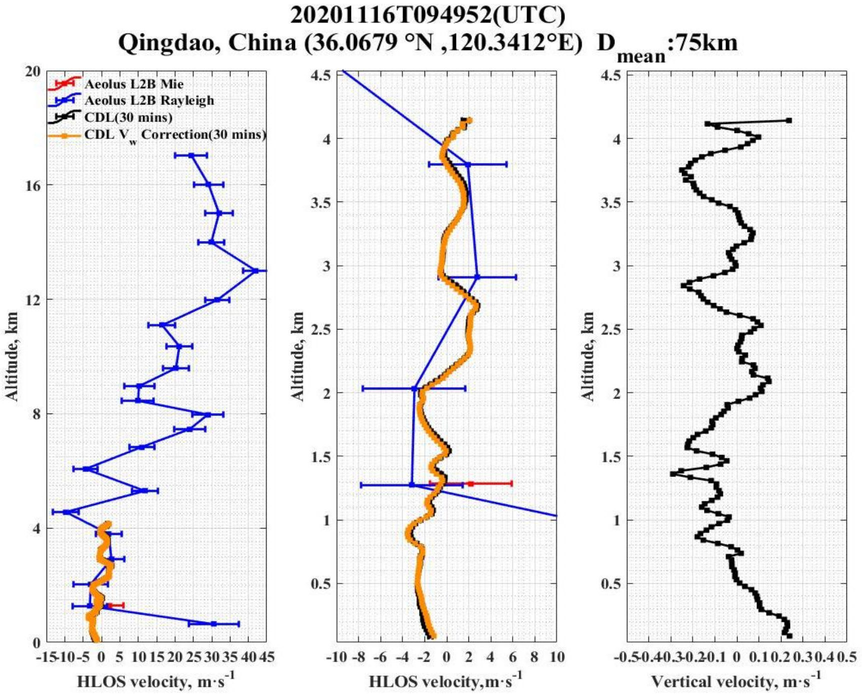
Hence the relationship between $HLOS_{Aeolus}$ and $HLOS_{CDL}$ should be

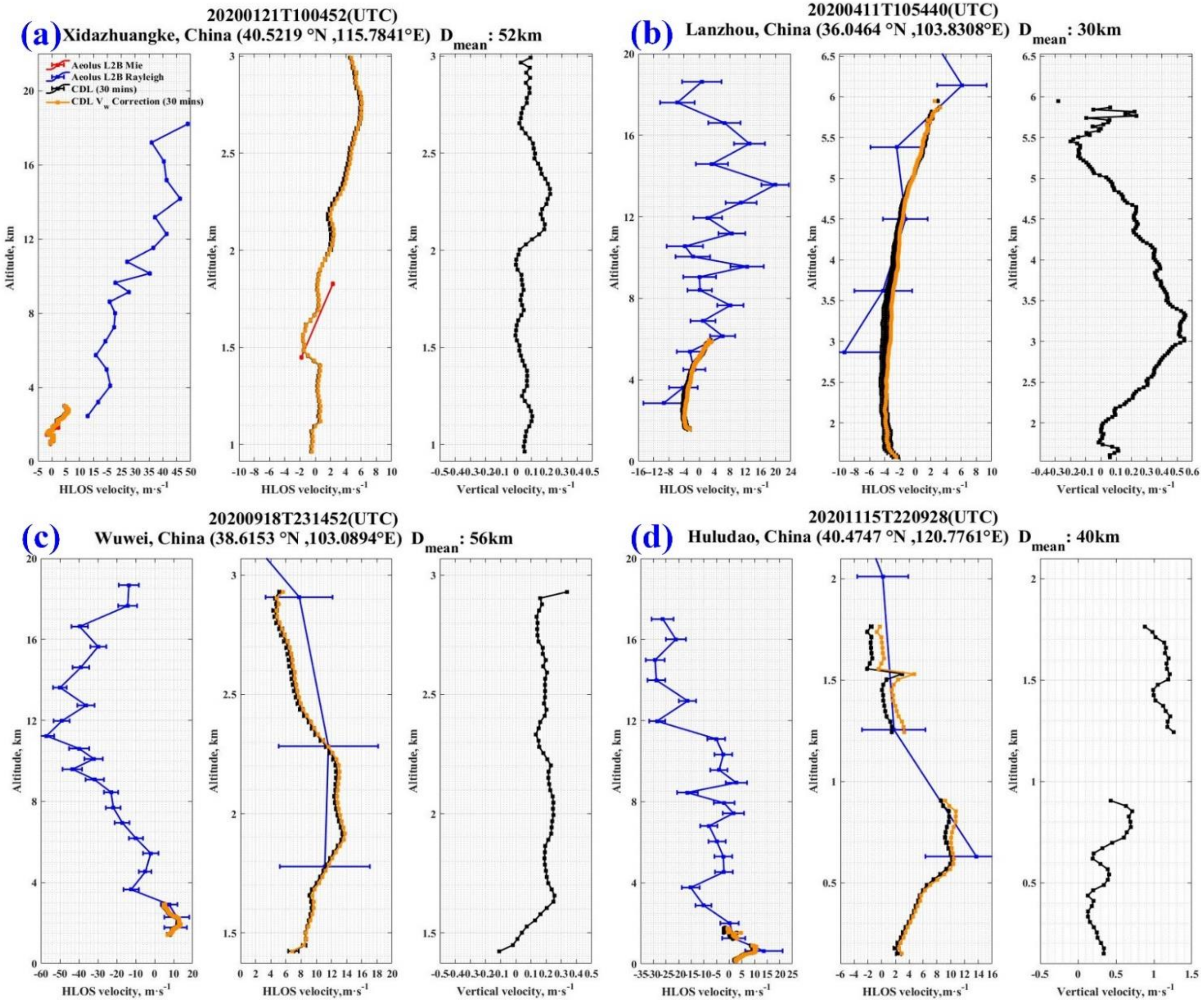
$$HLOS_{Aeolus} = HLOS_{CDL} + V_{vertical} \cot 37° \quad \text{Eq. (2)}$$



Validation of ALADIN: validation with ground-based CDLs over China

Results and discussion: measurement cases





Inter-comparison of HLOS wind velocities measured with CDL and Aeolus on 16 November 2020 at Qingdao (Shandong Province), China:

- **Red lines: Aeolus L2B Mie-cloudy HLOS profiles**;
- **Blue lines: Aeolus L2B Rayleigh-clear HLOS profiles**;
- **Black lines: CDL-retrieved HLOS profiles**;
- **Yellow lines: CDL-retrieved HLOS profiles after vertical velocity correction.**

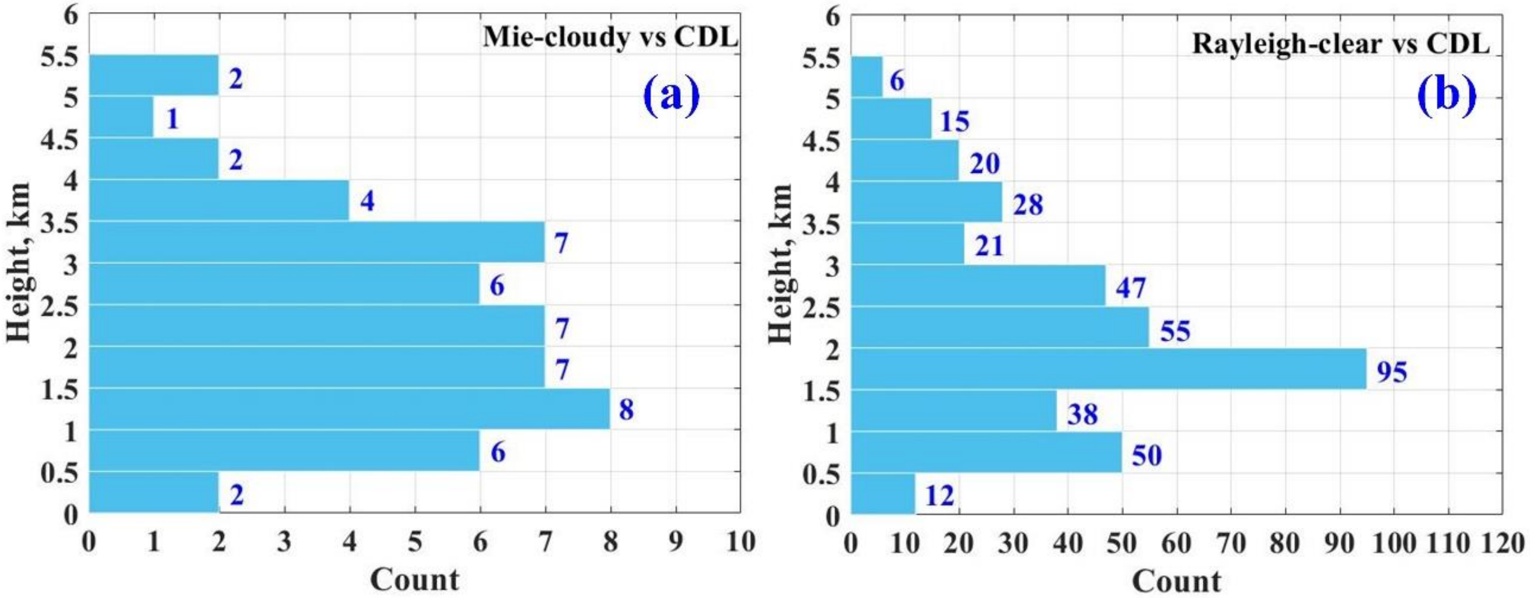
Validation of ALADIN: validation with ground-based CDLs over China

Results and discussion: statistical analysis

We compare the HLOS wind velocity results from Aeolus observations with the accompanying ground-based CDLs measurements within the VAL-OUC campaign.

- the time period of January to December 2020
- 52 simultaneous Mie-cloudy comparison pairs and 387 Rayleigh-clear comparison pairs
- at 17 stations

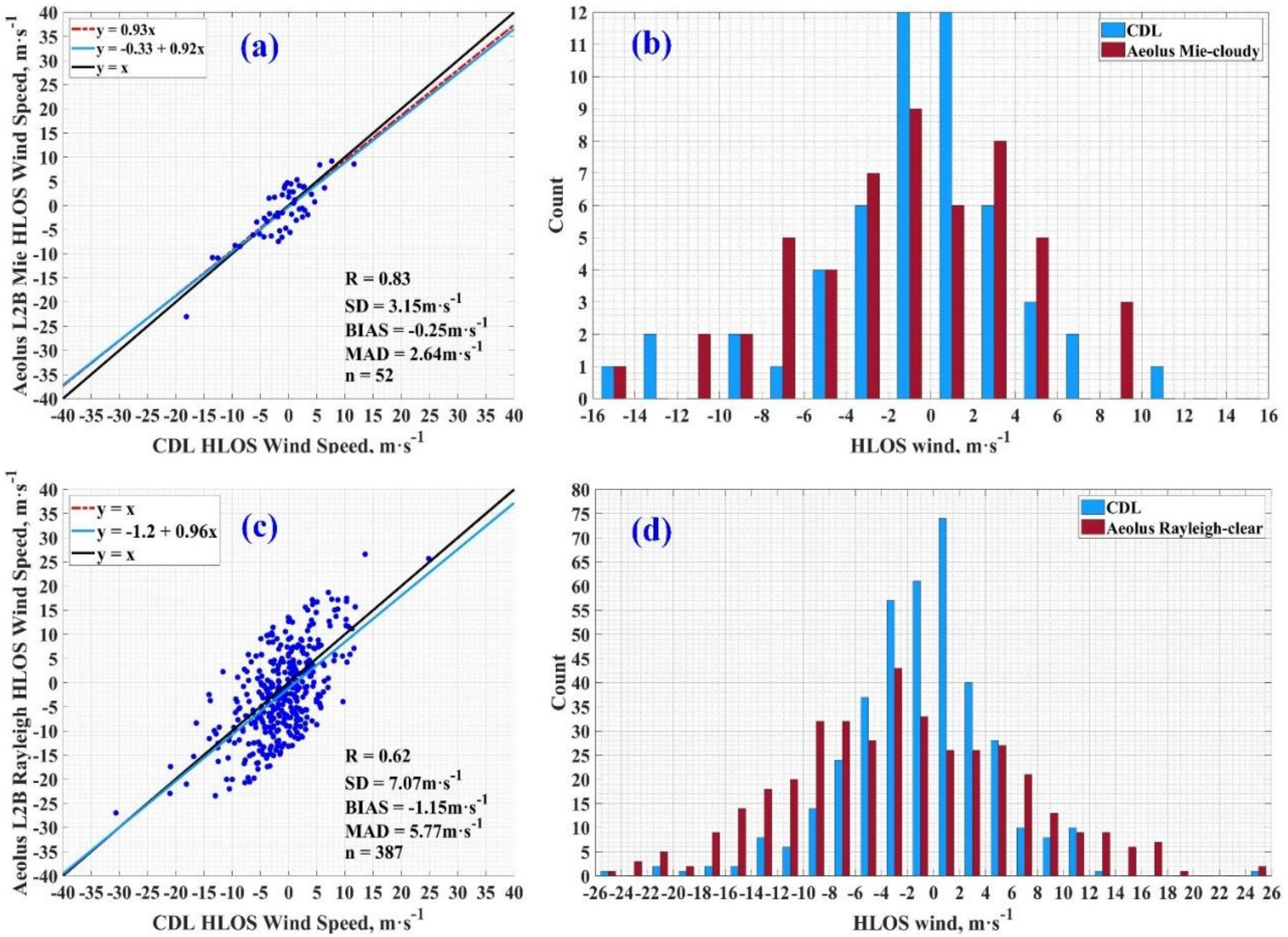
are acquired.



Counts of data pairs at different height ranges of (a) Mie-cloudy vs CDL and (b) Rayleigh-clear vs CDL

Validation of ALADIN: validation with ground-based CDLs over China

Results and discussion: statistical analysis



Comparisons of Aeolus L2B Rayleigh-clear HLOS wind velocities and Mie-cloudy HLOS wind velocities against that from CDL.

Statistical comparison of Aeolus HLOS winds and CDL-retrieved HLOS winds

Channel	Mie-cloudy	Rayleigh-clear
N points	52	387
Correlation	0.83	0.62
SD (m/s)	3.15	7.07
Scaled MAD (m/s)	2.64	5.77
BIAS (m/s)	-0.25	-1.15
"y=ax" Slope	0.93	1.00
"y=ax+b" Slope	0.92	0.96
"y=ax+b" Intercept (m/s)	-0.33	-1.20

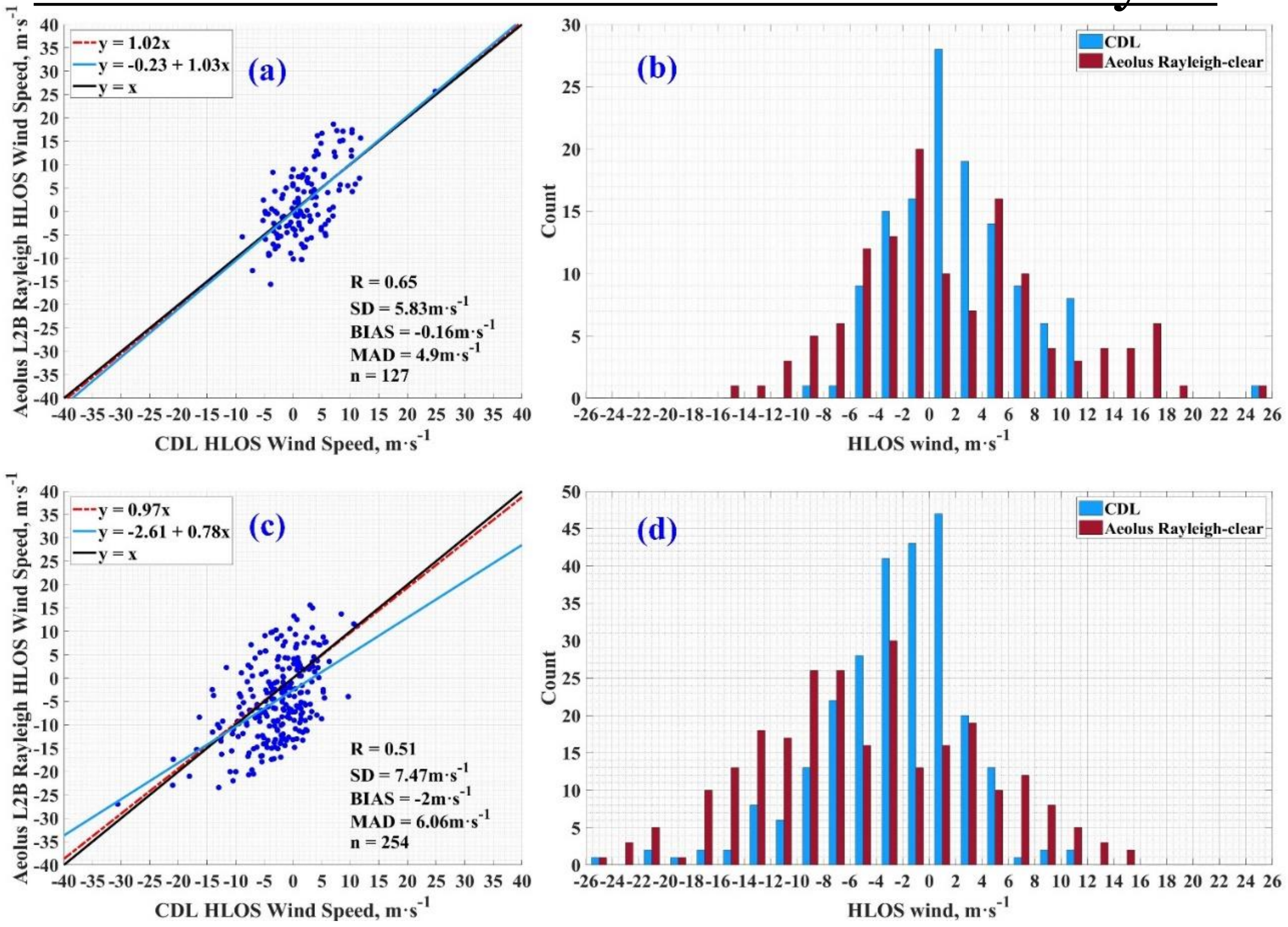
The data with HLOS differences larger than one standard deviation are removed and are not considered.

- 15 (22.39%) comparison pairs of Mie-cloudy HLOS
- 94 (19.54%) comparison pairs of Rayleigh-clear HLOS

are removed respectively.

Validation of ALADIN: validation with ground-based CDLs over China

Results and discussion: statistical analysis



Comparisons of Aeolus Rayleigh-clear HLOS against the CDL-retrieved HLOS according to the measurements made on (a)(b) ascending and (c)(d) descending tracks.

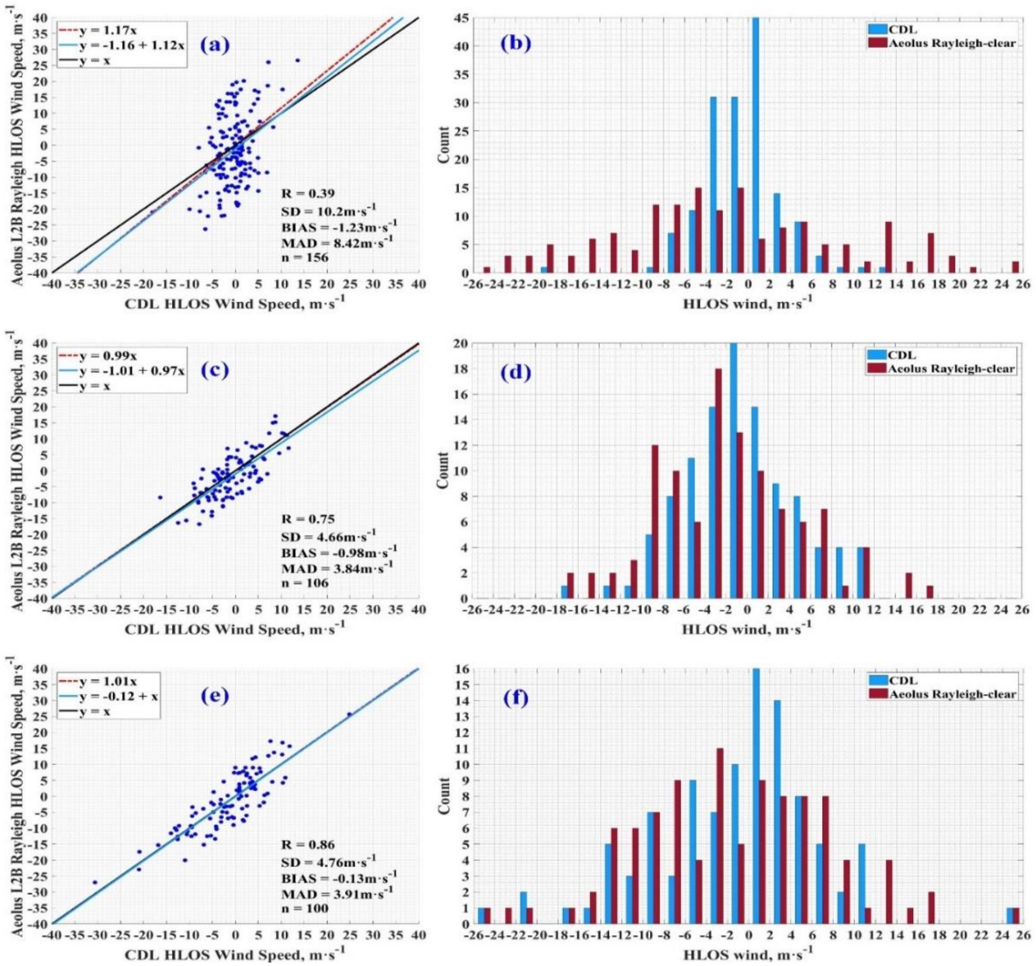
Statistical comparison of Aeolus HLOS winds and CDL-retrieved HLOS winds

Ascending/Descending	Ascending	Descending
N points	127	254
Correlation	0.65	0.51
SD (m/s)	5.83	7.47
Scaled MAD (m/s)	4.90	6.06
BIAS (m/s)	-0.16	-2.00
“y=ax” Slope	1.02	0.97
“y=ax+b” Slope	1.03	0.78
“y=ax+b” Intercept (m/s)	-0.23	-2.61

Consequently, the standard deviation, the scaled MAD and the bias on ascending tracks are slightly better than that on descending tracks.

Validation of ALADIN: validation with ground-based CDLs over China

Results and discussion: statistical analysis



The comparison between the Aeolus L2B Rayleigh HLOS data from (a)(b) Baseline 07 and 08, (c)(d) Baseline 09 and 10, and (e)(f) Baseline 11 against the CDL-retrieved HLOS data.

Statistical comparison of Aeolus HLOS winds and CDL-retrieved HLOS winds

Baselines	07 and 08	09 and 10	11
N points	156	106	100
Correlation	0.39	0.75	0.86
SD (m/s)	10.20	4.66	4.76
Scaled MAD (m/s)	8.42	3.84	3.91
BIAS (m/s)	-1.23	-0.98	-0.13
"y=ax" Slope	1.17	0.99	1.01
"y=ax+b" Slope	1.12	0.97	1.00
"y=ax+b" Intercept (m/s)	-1.16	-1.01	-0.12

- Baseline 07 / Baseline 08: Jan. to Apr. 2020
- Baseline 09 / Baseline 10: May to Sep. 2020
- Baseline 11： Oct. to the end of 2020

Thanks to the

- M1 mirror temperature correction
- different SNR thresholds for classification of Mie and Rayleigh
- Worldwide CAL/VAL team inputs

Baseline 09/10/11 improved significantly than that from Baseline 07/08.

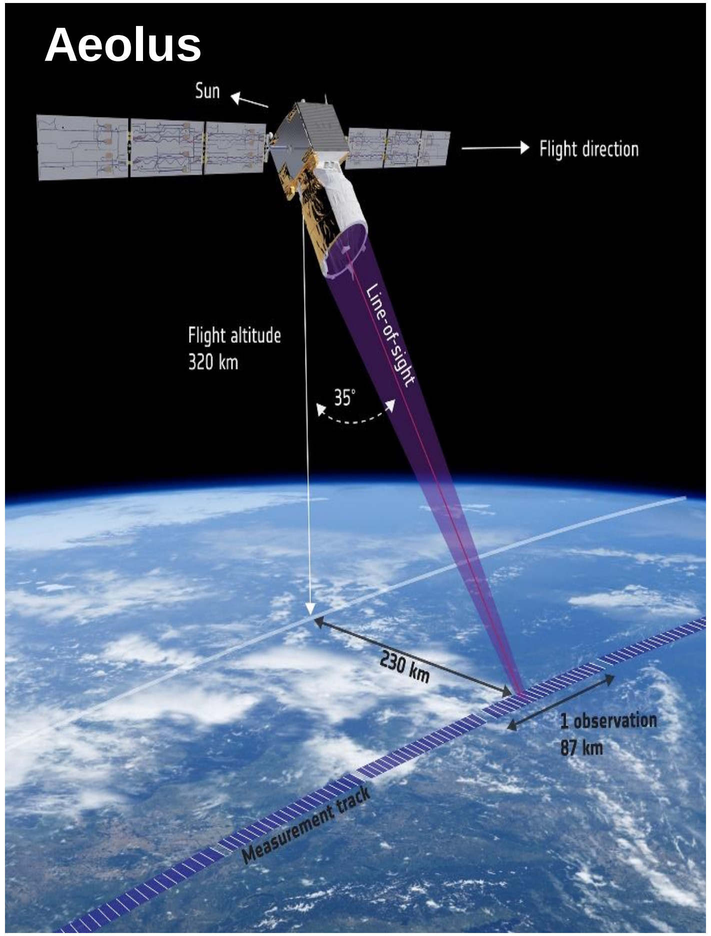
Validation of ALADIN: validation with ground-based CDLs over China

Campaigns/ Instruments		Rayleigh-clear					
		R	SD,	MAD,	Bias,	Slope	Intercept,
VAL-OUC (this study)		0.62	7.07	5.77	-1.15	0.96	-1.20
WindVal III/ A2D (Lux et al., 2020a)		0.80	3.6	3.6	2.6	/	/
WindVal III/ 2 μm DWL (Witschas et al., 2020)		0.95	4.75	3.97	2.11	0.99	2.23
AVATARE (Witschas et al, 2020)		0.76	5.27	4.36	-4.58	0.98	-4.39
AboVE-OHP (Khaykin et al., 2020)		0.96	3.2	/	1.5	/	/
RV Polarstern cruise PS116 (Baars et al., 2020)		/	/	4.84	1.52	0.97	1.57
MARA (Belova et al., 2021)	in summer	0.82	5.8	/	0.0	1.1	0.0
	in winter	0.81	5.6	/	-1.3	0.87	-0.8
ESRAD (Belova et al., 2021)	in summer	0.92	4.5	/	-0.4	1.0	-0.5
	in winter	0.88	5.2	/	-0.4	1.0	-0.6
WPR over Japan (Iwai et al., 2021)	Baseline 2B02	0.95	8.08	7.35	1.69	0.98	1.75
	Baseline 2B10	0.90	7.89	7.08	-0.82	0.94	-0.74
CDWL in Kobe (Iwai et al., 2021)	Baseline 2B02	0.98	6.17	4.92	0.46	1.05	0.61
	Baseline 2B10	0.96	5.69	5.21	-0.81	0.98	-0.88
CDWL in Okinawa (Iwai et al., 2021)	Baseline 2B02	0.93	6.57	5.68	1.08	0.99	1.07
	Baseline 2B10	0.79	6.53	5.58	-0.48	1.03	-0.52
GPS-RS in Okinawa (Iwai et al., 2021)	Baseline 2B02	0.99	4.55	4.77	1.00	0.99	1.00
	Baseline 2B10	0.99	4.43	3.97	0.45	1.01	0.38
RWP network over China (Guo et al., 2021)		0.94	4.2	/	-0.28	1.01	-0.41
RS over China (Guo et al., 2021)		0.90	/	/	0.09	0.92	-0.22

Campaigns/ Instruments		Mie-Cloudy					
		R	SD,	MAD,	Bias,	Slope	Intercept,
VAL-OUC (this study)		0.83	3.15	2.64	-0.25	0.92	-0.33
WindVal III/ A2D (Lux et al., 2020a)		/	/	/	/	/	/
WindVal III/ 2 μm DWL (Witschas et al., 2020)		0.92	2.95	2.24	2.26	0.96	2.7
AVATARE (Witschas et al, 2020)		0.91	3.02	2.22	-0.17	1.01	-0.21
AboVE-OHP (Khaykin et al., 2020)		/	/	/	/	/	/
RV PS116 (Baars et al., 2020)		/	/	1.58	0.95	0.95	1.13
MARA (Belova et al., 2021)	in summer	0.63 (Ascend); 0.72 (Descend)	6.8 (Ascend); 6.5 (Descend)	/	6.6 (Ascend); -0.5 (Descend)	1.0 (Ascend); 1.3 (Descend)	6.5 (Ascend); -2.4 (Descend)
	in winter	0.73 (Ascend); 0.70 (Descend)	5.7 (Ascend); 5.6 (Descend)	/	-1.0(Ascend); 0.9 (Descend)	1.1 (Ascend); 1.2 (Descend)	0.4 (Ascend); -1.2 (Descend)
ESRAD (Belova et al., 2021)	in summer	0.76 (Ascend); 0.90 (Descend)	4.7 (Ascend); 5.5 (Descend)	/	0.5 (Ascend); 0.7 (Descend)	0.8 (Ascend); 0.8 (Descend)	0.5 (Ascend); 0.2 (Descend)
	in winter	0.91 (Ascend); 0.85 (Descend)	3.9 (Ascend); 5.2 (Descend)	/	2.4 (Ascend); 0.9 (Descend)	1.0 (Ascend); 0.9 (Descend)	2.3 (Ascend); 0.5 (Descend)
WPR over Japan (Iwai et al., 2021)	Baseline 2B02	0.95	6.83	5.94	2.42	0.98	2.44
	Baseline 2B10	0.93	6.47	5.66	-0.51	0.96	-0.44
CDWL in Kobe (Iwai et al., 2021)	Baseline 2B02	0.98	4.80	3.55	1.63	1.05	1.76
	Baseline 2B10	0.97	5.15	3.92	0.16	1.02	0.22
CDWL in Okinawa (Iwai et al., 2021)	Baseline 2B02	0.97	3.64	3.76	2.38	1.01	2.37
	Baseline 2B10	0.86	4.74	3.86	-0.26	0.86	-0.04
GPS-RS in Okinawa (Iwai et al., 2021)	Baseline 2B02	0.97	4.52	4.14	2.15	0.97	2.07
	Baseline 2B10	0.95	5.81	3.99	-0.71	0.92	-0.22
RWP network over China (Guo et al., 2021)		0.81	6.82	/	-0.64	0.99	-0.67
RS over China (Guo et al., 2021)		0.92	/	/	-0.59	0.78	0.64

Application of ALADIN: dust transport observation with Aeolus and CALIPSO

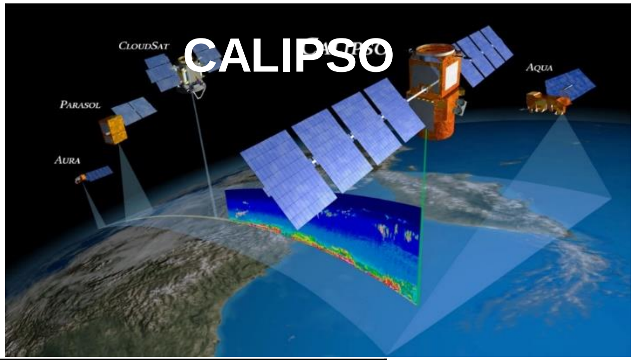
Aeolus/CALIOP and models introduction



Unit	Parameter	Value
Satellite	mean altitude	320 km
polar, sun-synchronous	mean orbital velocity	7.7 kms^{-1}
ALADIN instrument	slant angle at satellite	35 ° off nadir
direct-detection Doppler wind lidar	incidence angle at ground	37.6 ° wrt local zenith*
	vertical resolution	250 m – 2 km
	number of range gates	24 atmosphere and 1 background light
	range	ground to 30 km
	horizontal averaging length	90 km per observation
Laser Transmitter	wavelength	354.8 nm
Nd:YAG, frequency-tripled, diode-pumped	energy per pulse	80 mJ
	repetition rate	50.5 Hz
	linewidth	50 MHz FWHM
	pulse-to-pulse frequency stability	6-8 MHz rms
Telescope/Front Optics	primary mirror diameter	1.5 m
afocal Cassegrain, SiC structure	background light filter bandwidth	1 nm
	receive FOV	18.1 µrad
	transmit beam divergence	20 µrad (86% EE)**
Mie Spectrometer	Fizeau Free Spectral Range	0.91 pm / 2177 MHz
fringe imaging Fizeau interferometer	Fizeau Useful Spectral Range	0.66 pm / 1582 MHz
	Fizeau FWHM	67 nm / 159 MHz (atm.) 53 nm / 125 MHz (int.)
	total radiometric efficiency	0.71 % (BOL)
Rayleigh Spectrometer	Fabry-Perot Free Spectral Range	4.56 pm / 10913 MHz
double edge Fabry-Perot interferometer, 2 filters, sequential	filter separation	2.33 pm / 5547 MHz
	filter FWHM (direct/reflected)	1551 MHz / 1531 MHz
	total radiometric efficiency	6.4 % (BOL)
Detection Unit	Quantum efficiency	85 %
Accumulation CCD for Mie and Rayleigh receiver	Detection chain noise for each measurement / read-out	3.9 (Mie) – 4.7 (Ray) e$^-$ / pixel
	Dark current	1.9 e$^-$ / (pixel · s)
	Number of used pixels	16 lines * 25 rows

Data products：

- L2C wind vector
- Extinction coefficient@355nm



Type	Sun-synchronous
Altitude	705 km
Inclination	98.2°
Period	99 minutes
Repeat Cycle	16 days
Dimensions	1.49 m × 1.84 m × 2.31 m
Mass	600 kg
Power	562 W
Average Data Rate	34 Gb/day
Platform Pointing Requirements(3σ)	Control: 0.05° Knowledge: 0.04°

Data products：

- Extinction coefficient @532nm、1064nm
- Backscatter coefficient @ 532nm、1064nm
- Depolarization ratio@532nm

Application of ALADIN: dust transport observation with Aeolus and CALIPSO

Aeolus/CALIOP and models introduction

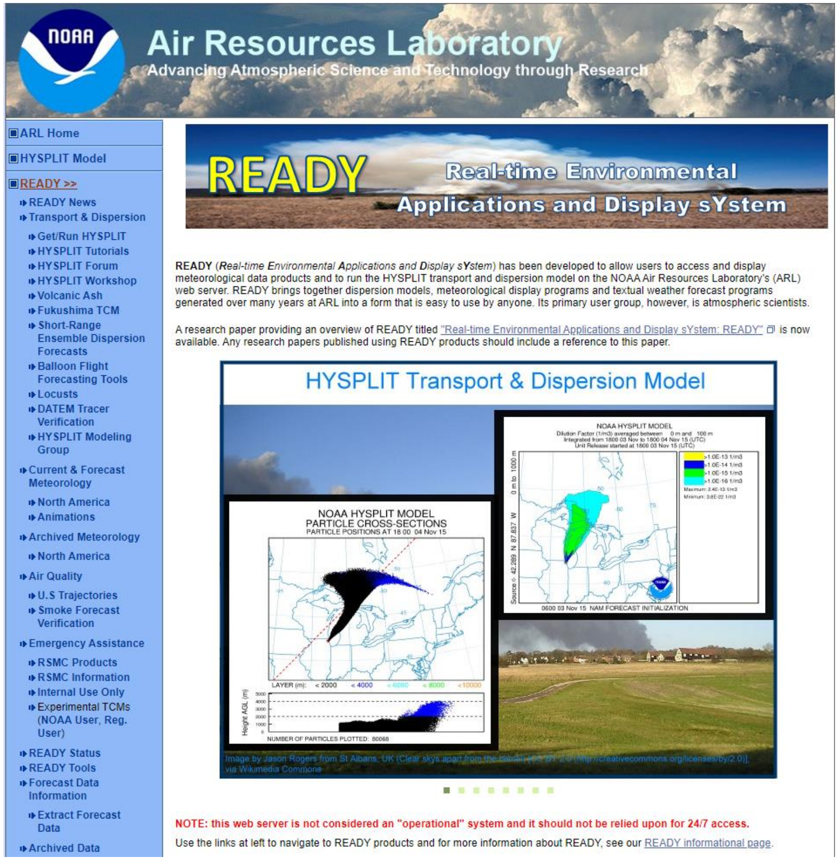
ECMWF

European Centre for Medium-Range Weather Forecasts, (https://www.ecmwf.int/)

4D-Var ERA5
0.25°×0.25° 31km hourly resolution 37 pressure levels

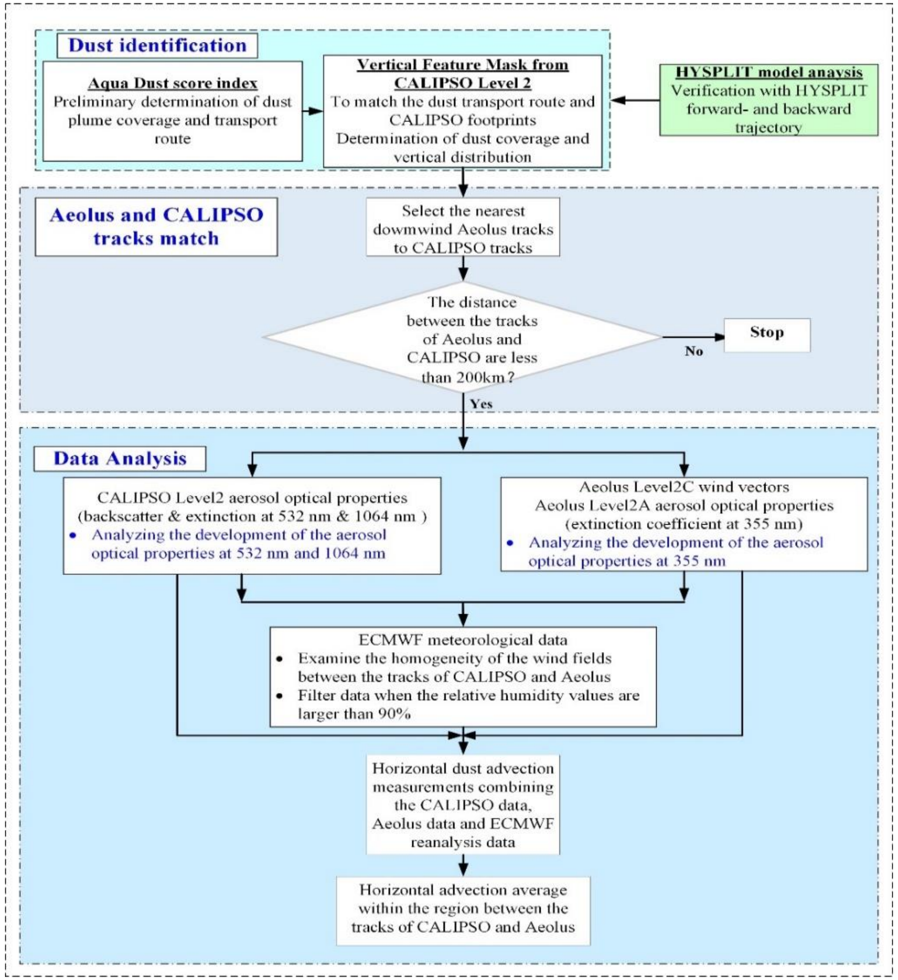
HYSPLIT

The Hybrid Single-Particle Lagrangian Integrated Trajectory model (https://www.ready.noaa.gov/index.php)

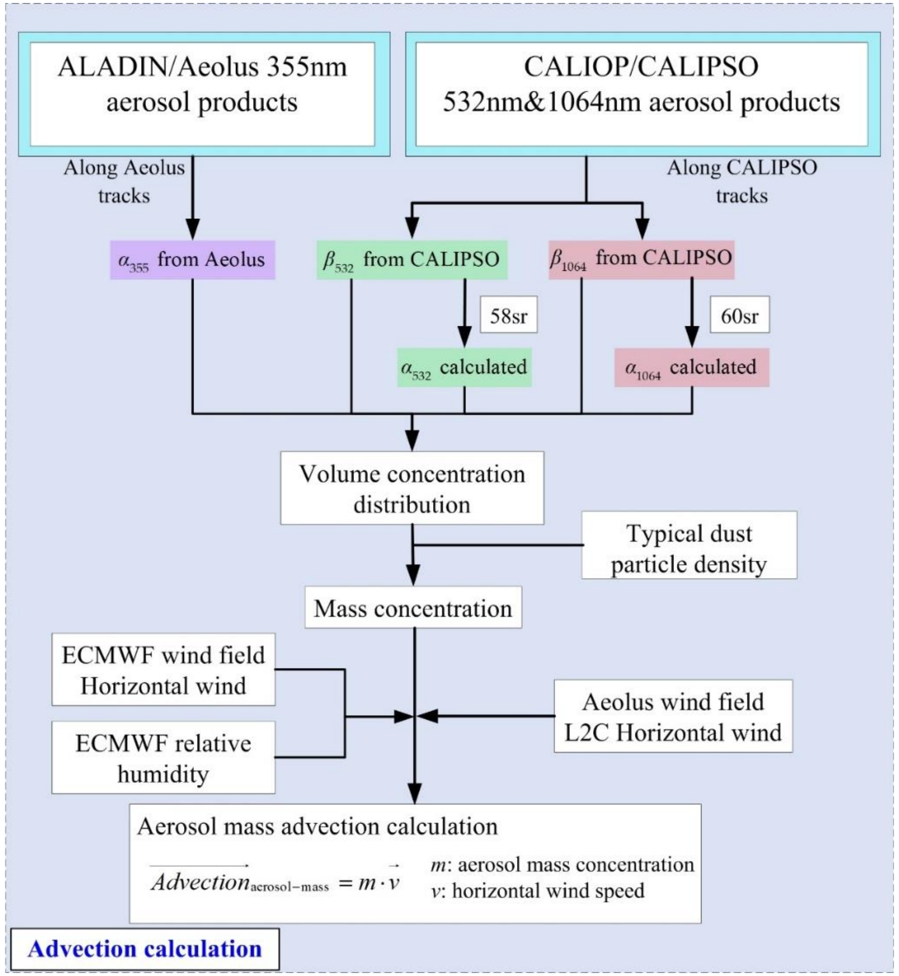


Application of ALADIN: dust transport observation with Aeolus and CALIPSO

Methodology



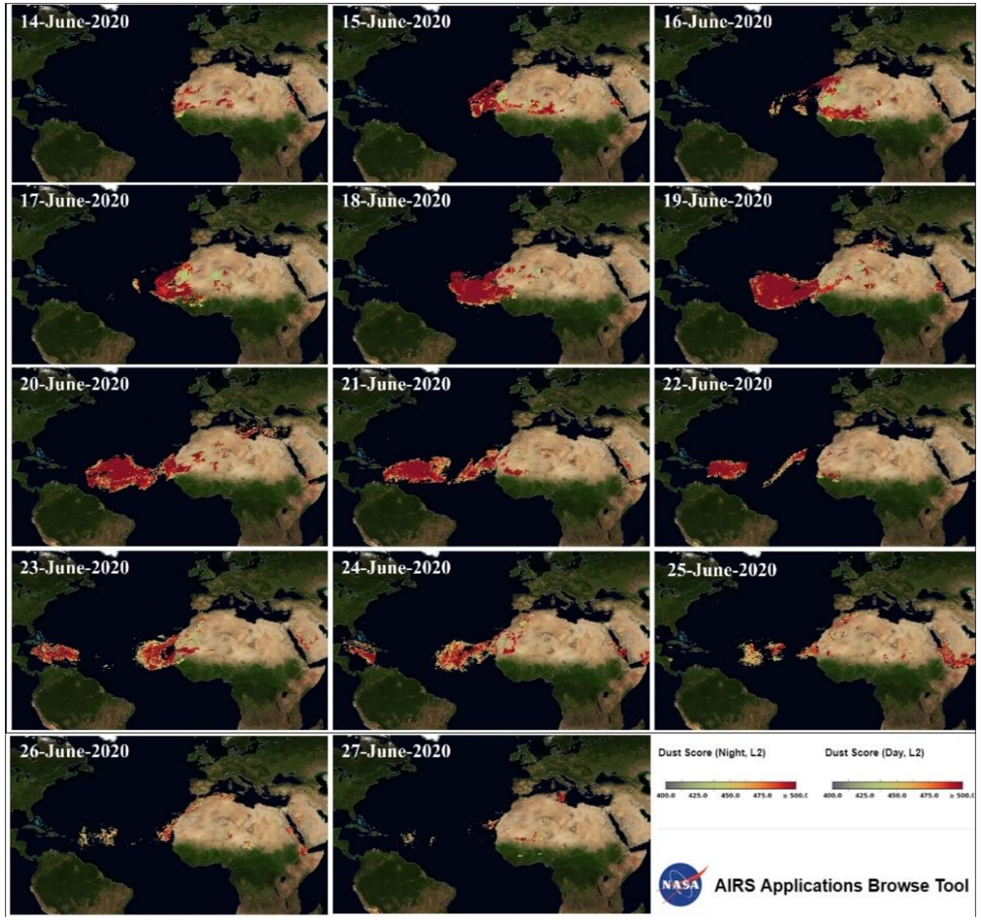
Dust identification, Aeolus and CALIPSO tracks match and data procedures



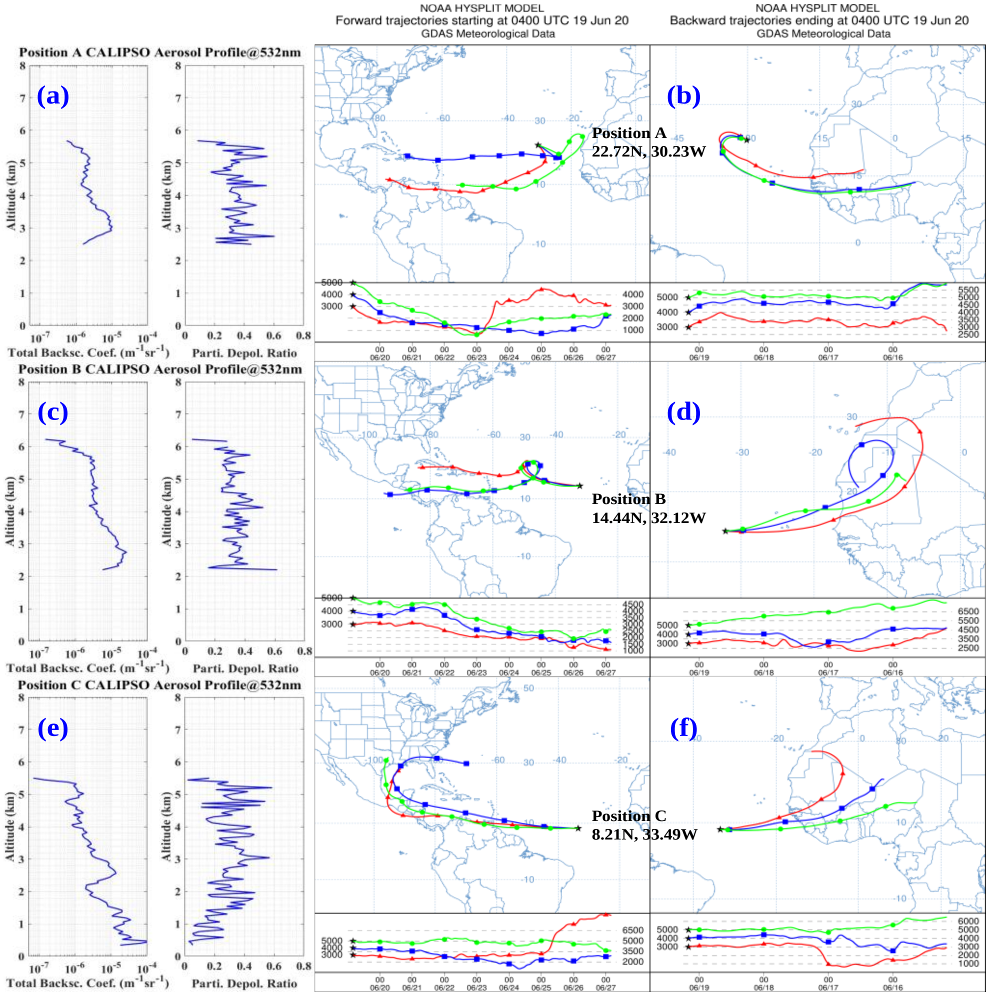
The flowchart of the dust mass advection calculation procedure

Application of ALADIN: dust transport observation with Aeolus and CALIPSO

Results and discussion



The Dust Score Index provided by AIRS/Aqua at different stages, including emission, transportation, dispersion and deposition

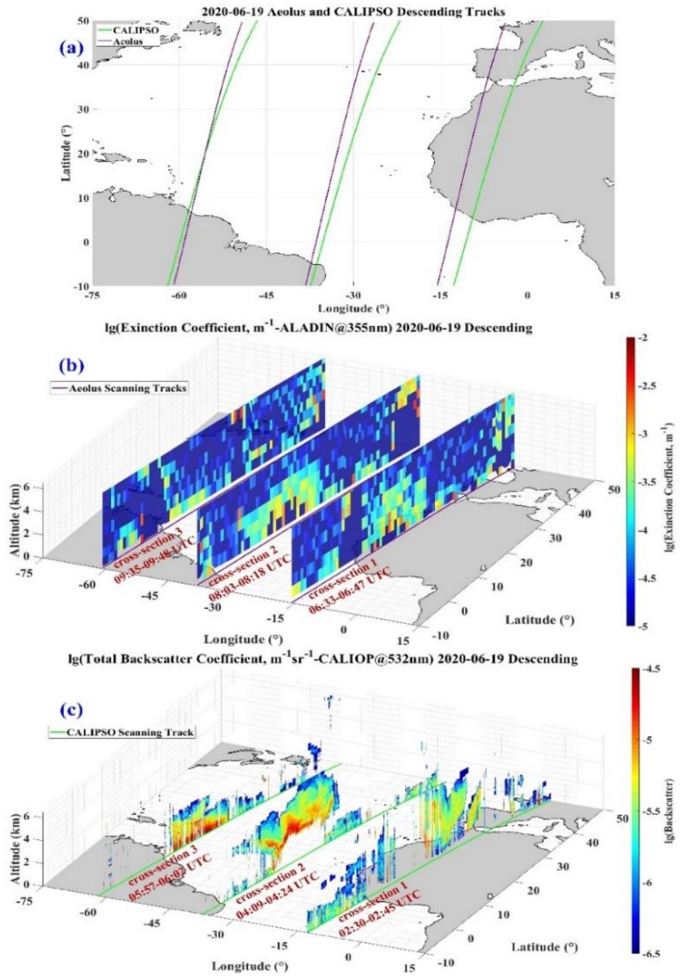


(a)(c)(e) CALIPSO total backscatter coefficient profiles and particle depolarization ratio profiles capturing dust layers at around 0400UTC 19 June 2020. (b)(d)(f) HYSPLIT backward trajectories and forward trajectories at different positions of corresponding CALIPSO profiles and different altitudes on 0400UTC 19 June 2020.

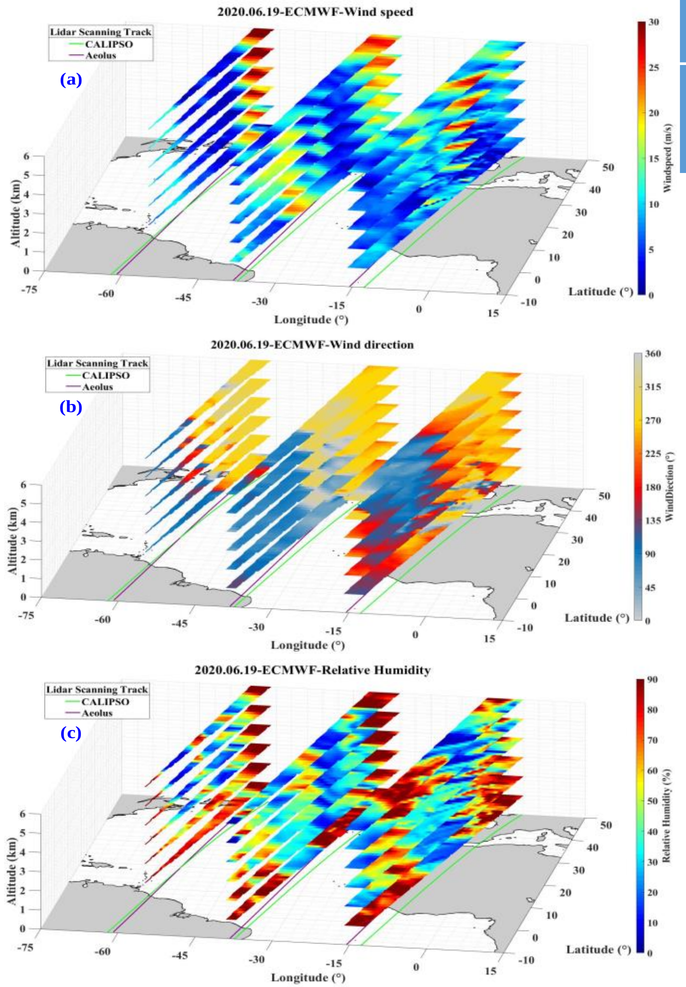
Application of ALADIN: dust transport observation with Aeolus and CALIPSO

Results and discussion: Measurement case

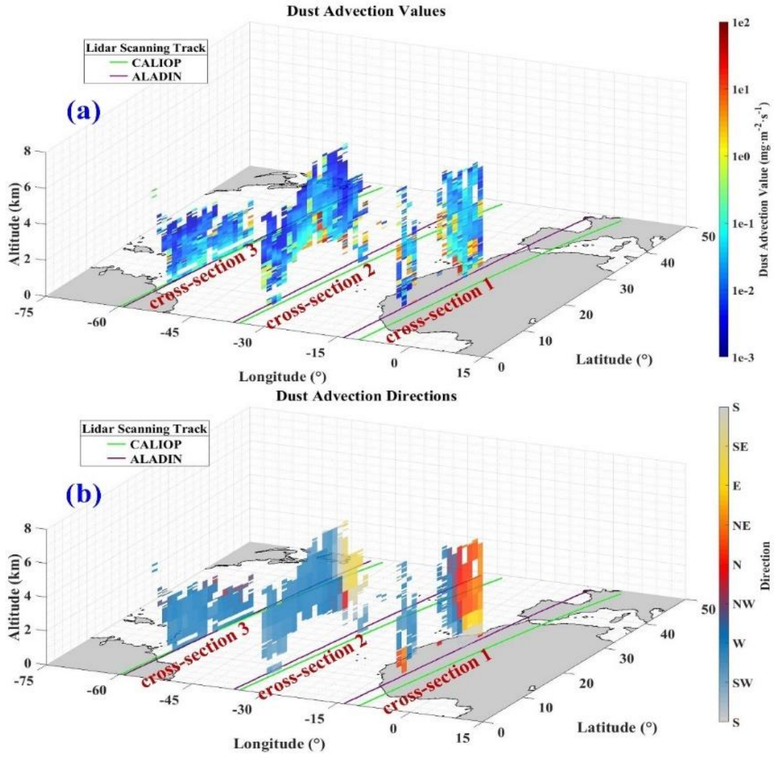
Cross-section	1	2	3
Mean mass concentration, mg/m³ (the retrieval method)	0.28±0.23	0.26±0.24	0.22±0.19
Mean mass concentration, mg/m³ (the factor method)	0.37±0.24	0.40±0.25	0.39±0.27



Observation cross-sections of Aeolus and CALIPSO on 19 June 2020



Wind fields and RH from ECMWF

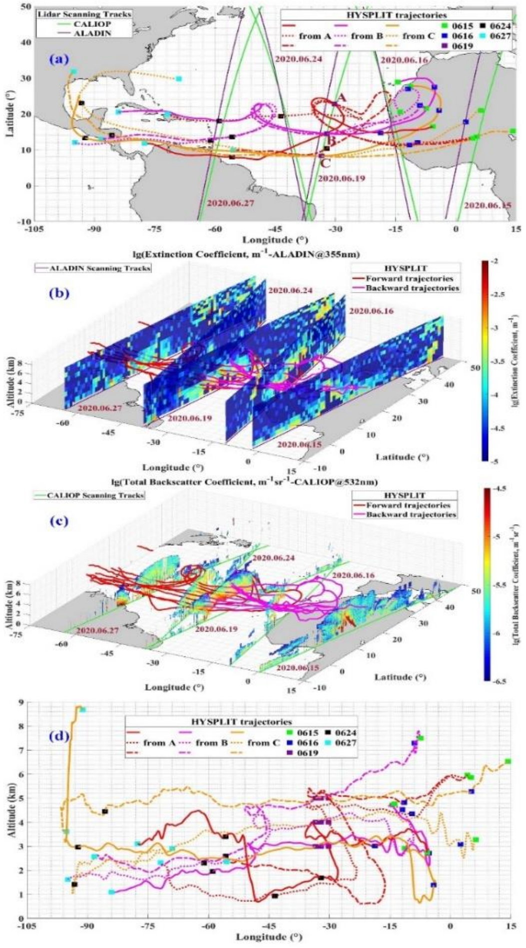


The dust advection calculated with data from ALADIN, CALIOP and ECMWF

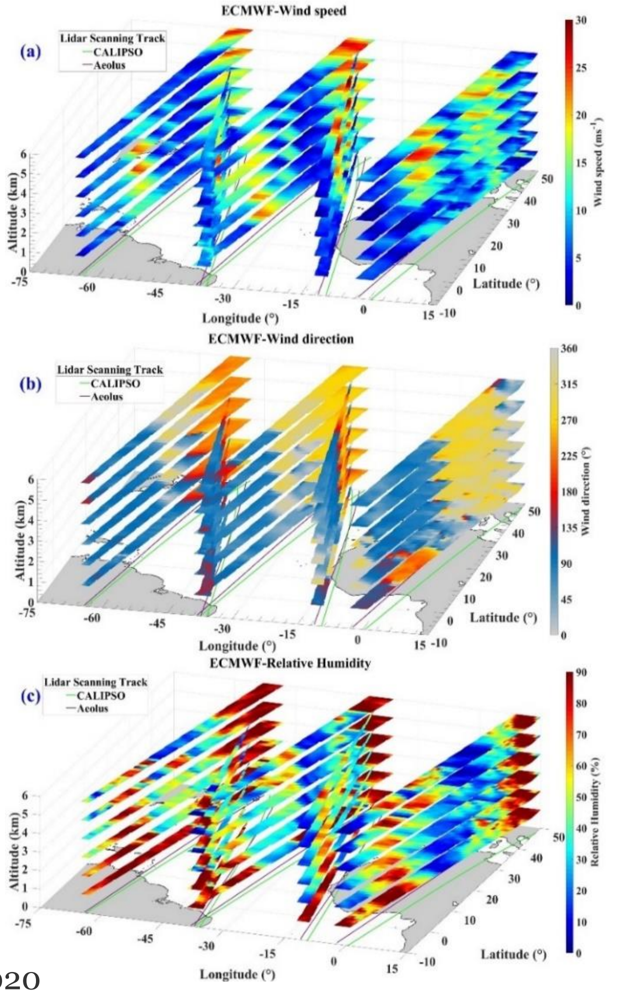
Application of ALADIN: dust transport observation with Aeolus and CALIPSO

Results and discussion: dust lifetime

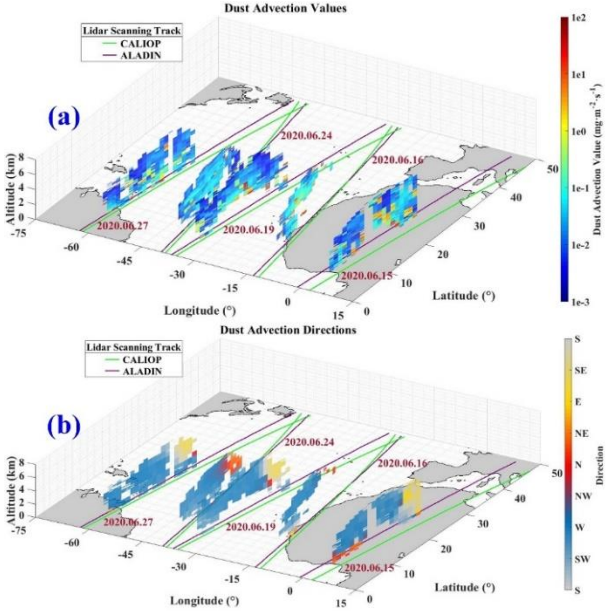
Date	15 June	16 June	19 June	24 June	27 June
Mean mass concentration, (mg/m³, the retrieval method)	0.30±0.23	0.27±0.24	0.26±0.24	0.27±0.24	0.22±0.19
Mean mass concentration, mg/m³ (the factor method)	0.26±0.17	0.39±0.24	0.40±0.25	0.42±0.21	0.34±0.20



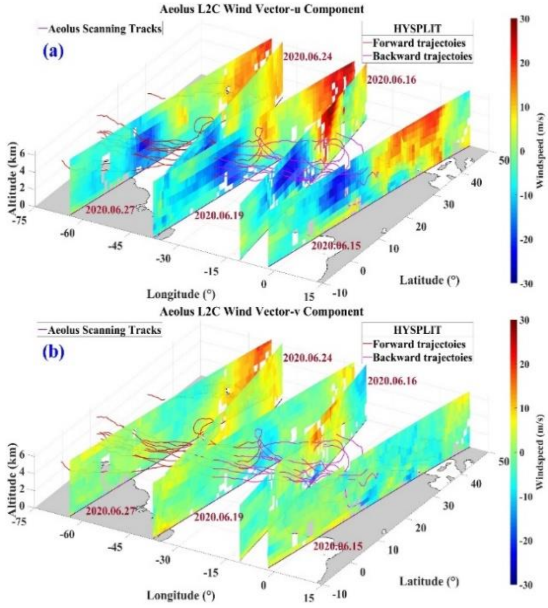
Observation of dust event during 15 and 27 June 2020 with ALADIN and CALIOP and the corresponding HYSPLIT trajectories



Wind fields and RH from ECMWF



The dust advection



The u and v components

The launch of ACDL

Chinese lidar mission **ACDL (Aerosol and Carbon dioxide Detection Lidar)** which was designed to measure CO_2 and aerosol from space – has been launched to space successfully on **16 April 2022**. The **commissioning phase of ACDL is scheduled to be 6 months**, during which the calibration and validation campaigns are implemented and the retrieval algorithms of column carbon dioxide concentration and aerosol optical properties profiles are improved. It is expected that with the calibrations and validations of ACDL and the updates of retrieval algorithms, the products of ACDL will be accurate and robust for science applications.

European Young scientists contributions in Dragon 5

Name	Institution	Poster title	Contribution
Oliver Lux	DLR		Aeolus calibration and validation
Fabian Weiler	DLR		Aeolus calibration and validation

Chinese Young scientists contributions in Dragon 5

Name	Institution	Poster title	Contribution
Kangwen Sun	OUC	Aeolus wind products validation with ground-based CDLs net over China and Aeolus products application on aerosol transport	Aeolus validation and application
Xiaoying Liu	OUC		Aeolus validation

- **Summary**

- **Calibration of ALADIN:** The ALADIN laser frequency stability and its impact on wind measurement was assessed and the correction of wind bias for ALADIN using telescope temperatures was conducted.

- **Validation of ALADIN L2B wind products:** Co-located airborne wind lidar observations were performed in central Europe, meanwhile ground-based coherent Doppler wind lidars (CDLs) net was established over China, to verify the wind observations from Aeolus.

- **Application of ALADIN products:** Based on the observation of ALADIN, combined with the data of CALIOP, ECMWF and HYSPLIT, a long-term large-scale Saharan dust transport event is tracked and the possibility of calculating the dust mass advection is explored.

THANK YOU!