Evaluation of ATLID aerosol products with AD-Net

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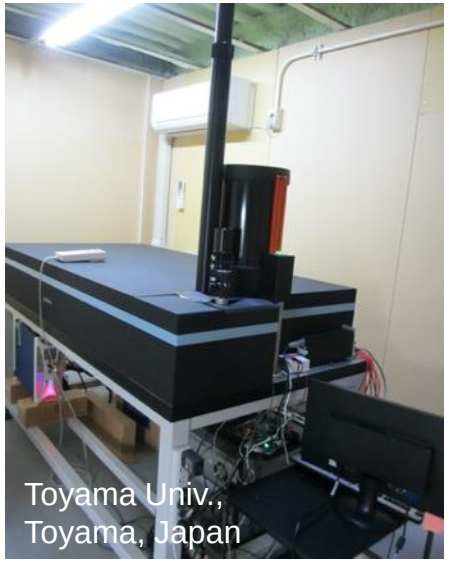
1st ESA-JAXA EarthCARE In-Orbit Validation Workshop

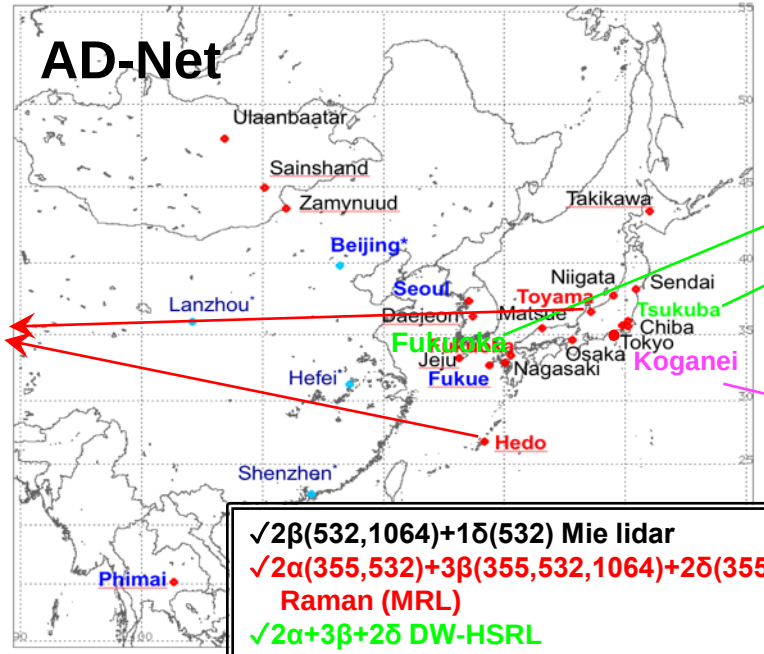
14 – 17 January 2025 | VIRTUAL EVENT

Validation of ATLID products using AD-Net ground-based lidars

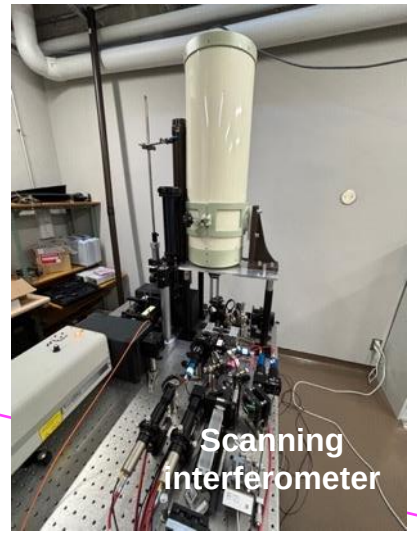
- Asian dust and aerosol lidar observation network (AD-Net) is one of the important lidar networks to validate ATLID products
- AD-Net has been upgraded by installing multi-wavelength HSRL and Raman lidars, which are useful for direct comparison of extinction and backscatter (Koganei, Tsukuba, Fukuoka, Toyama, and Hedo)
- As the first validation work, comparison analysis is carried out using HSRL at Tsukuba, Japan



MRL
(Toyama, Hedo)



✓2β(532,1064)+1δ(532) Mie lidar
✓2α(355,532)+3β(355,532,1064)+2δ(355,532) Raman (MRL)
✓2α+3β+2δ DW-HSRL
✓ 1α(355)+1β(355)+1δ(355) HSRL



DW-HSRL
(Tsukuba, 2024.08.15~)

355nm HSRL
(Koganei)

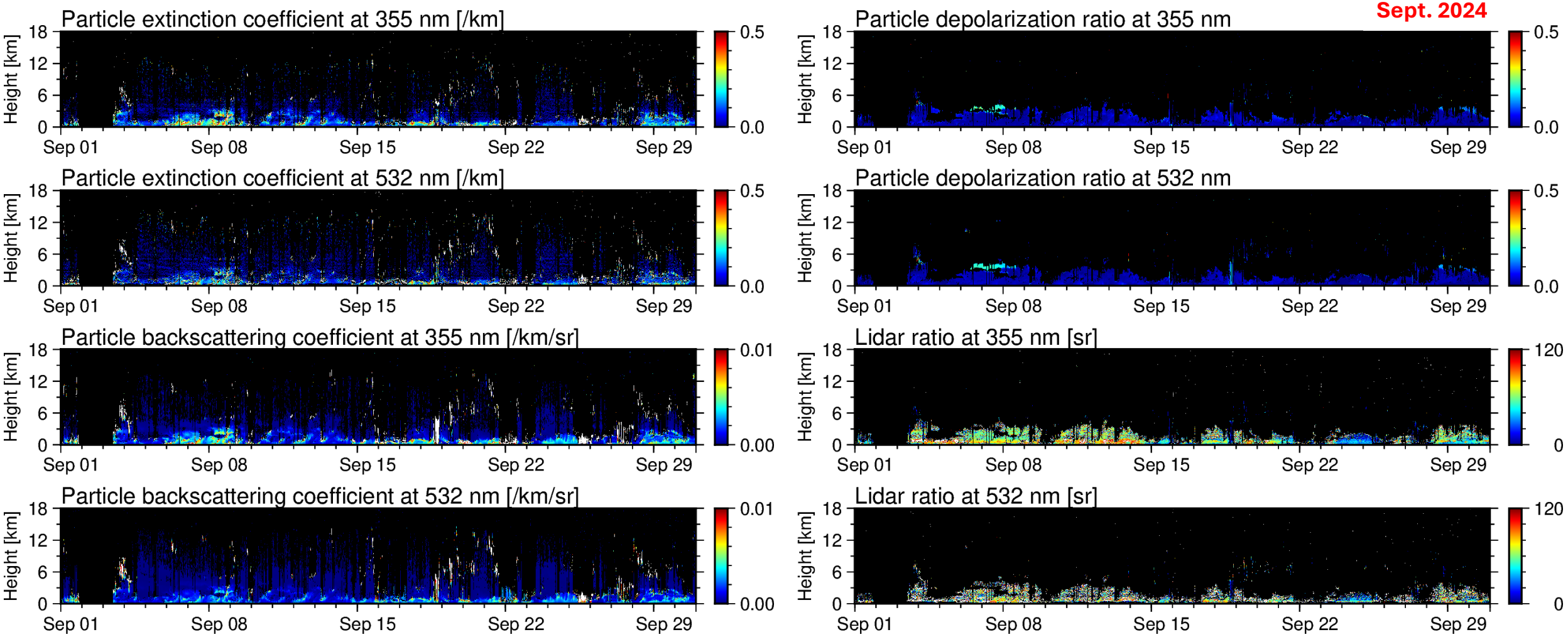
Data matchup between EarthCARE/ATLID and ground-based lidars

Observation site	Ground-based lidar type	EarthCARE overpass time (ASC/DESC) [UTC]	Number of overpass within 100 km distance (2024.10.09~)	Data availability of ground-based lidar during overpasses	Note
Koganei (NICT)	355-nm HSRL (1α+1β+1δ)	16:20 / 05:00	22	22/22 = 100%	
Tsukuba (NIES)	355 & 532-nm HSRL (2α+3β+2δ)	16:20 / 05:00	15	15/15 = 100%	Started from 2024.08.15 -
Fukuoka (Kyushu Univ.)	355 & 532-nm HSRL (2α+3β+2δ)	17:00 / 05:40	20	19/20 = 95%	355-nm HSRL from Mar. 2024
Toyama (Univ. of Toyama)	355 & 532-nm Raman lidar (2α+3β+2δ)	16:30 / 05:10	18	17/18 = 94%	
Hedo (NIES)	355 & 532-nm Raman lidar (2α+3β+2δ)	17:10 / 05:40	15	0/15 = 0%	Measurement stopped from 2024.10.09 util 2025.01.08

Number of overpasses is 5-8 per month for each site => expected to have 30-50 passes until the L2a validation report

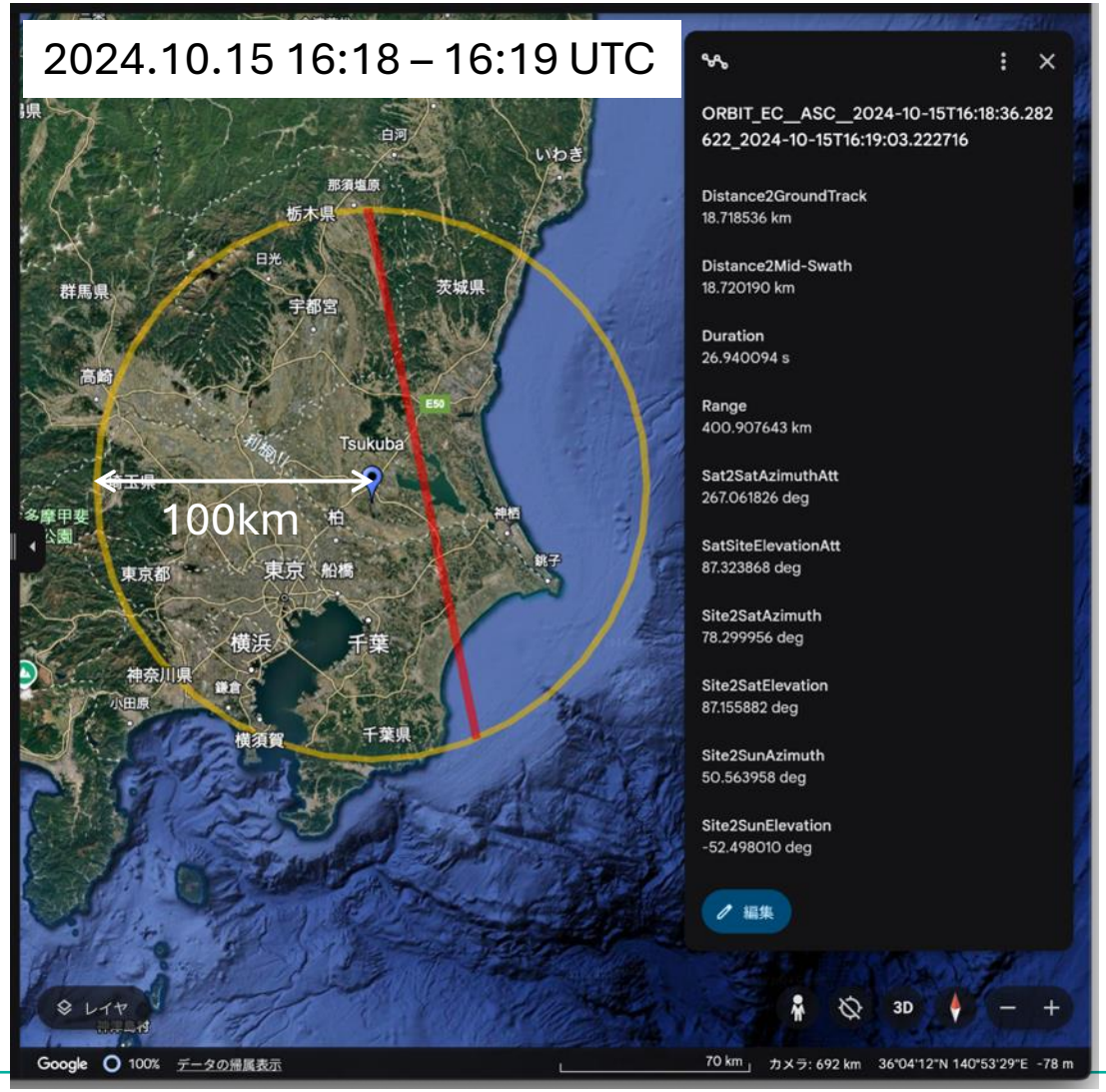
Dual-wavelength HSRL at Tsukuba

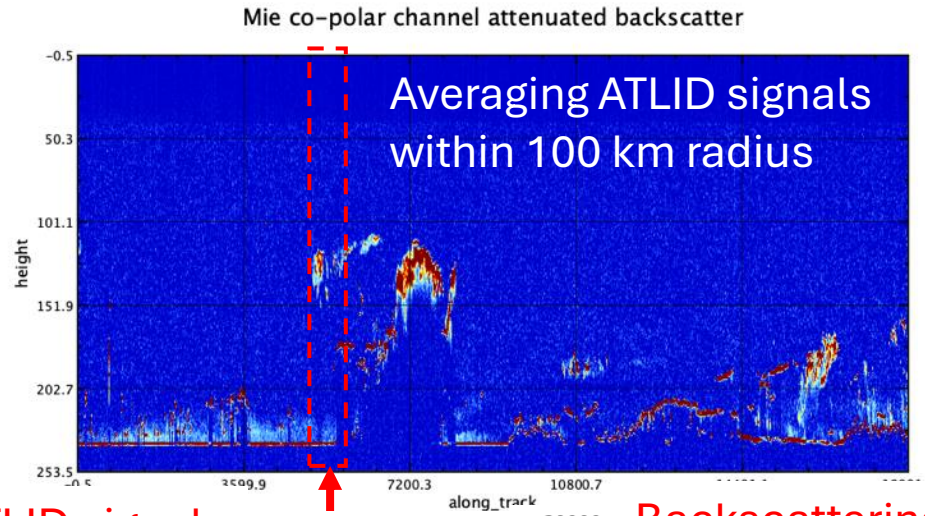
Sept. 2024



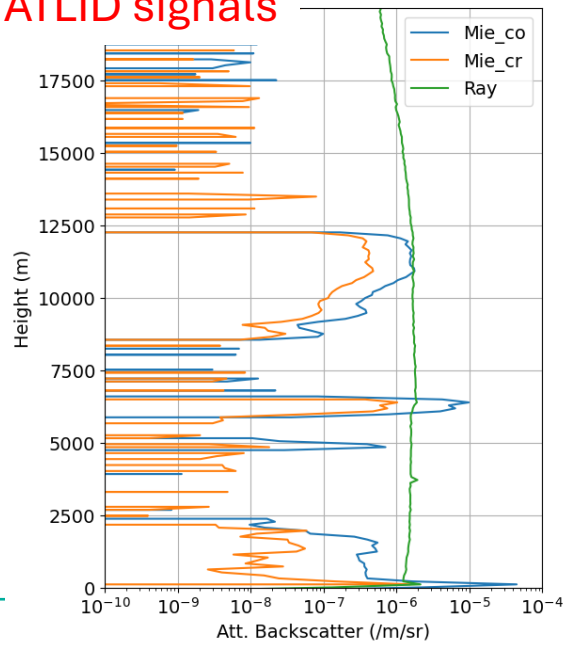
Continuous observation data of day and night aerosols/clouds by DW-HSRL are available at Tsukuba since Aug. 2024

First comparison between ATLID and NIES Lidar (HSRL)

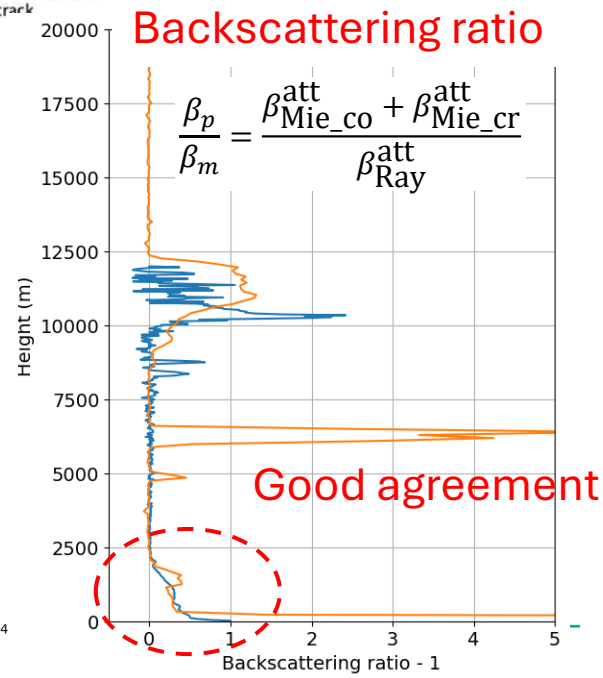




ATLID signals

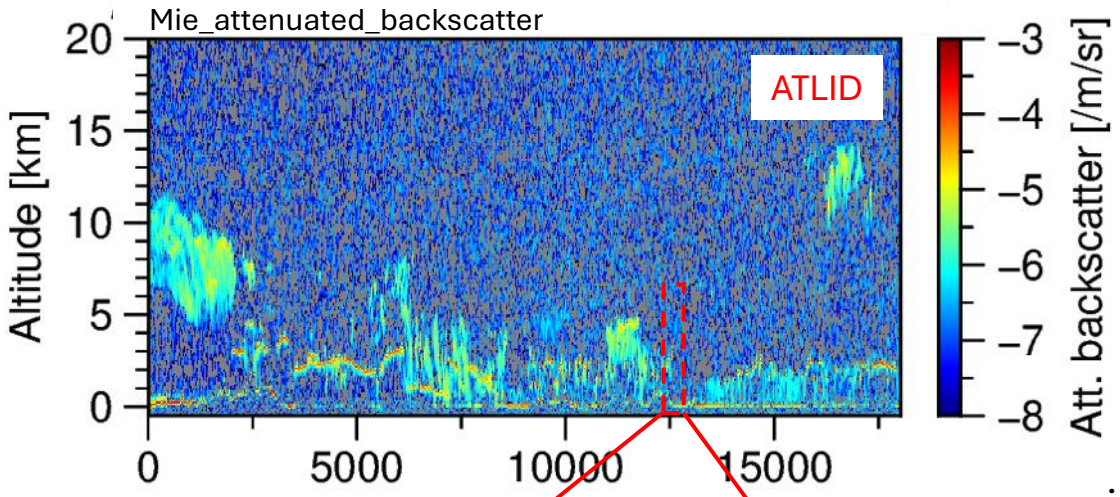


Backscattering ratio

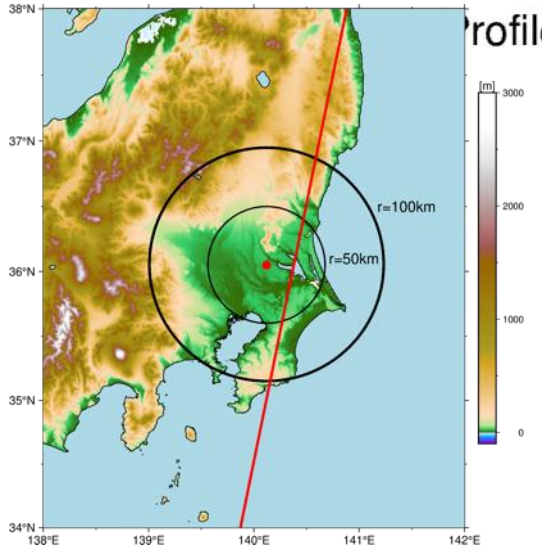


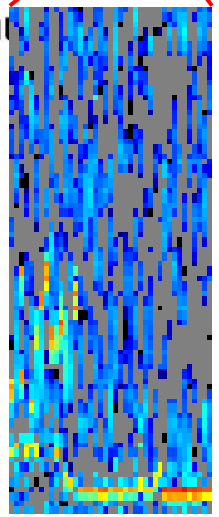
Averaging area of ATLID signals

ECA_E_ATL_NOM_1BS_20241223T0449_20241223T0501_03240D_vAc (daytime)



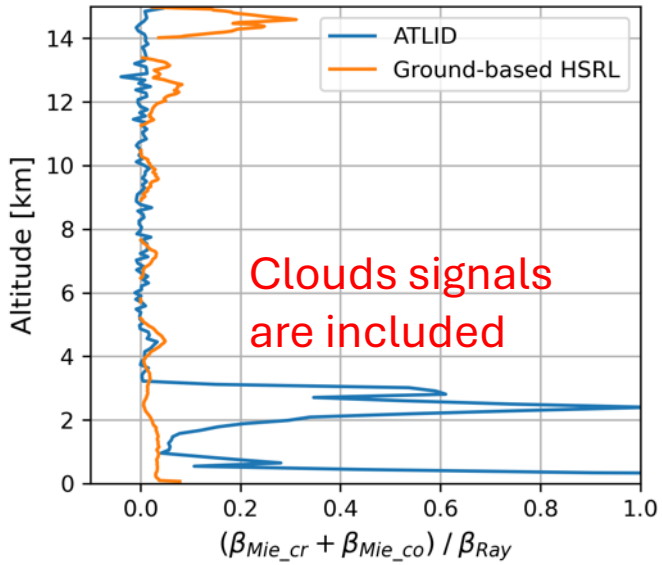
- Averaging over a wide area can improve the S/N ratio, but elevation differences and horizontal inhomogeneity of atmosphere (clouds) should be considered



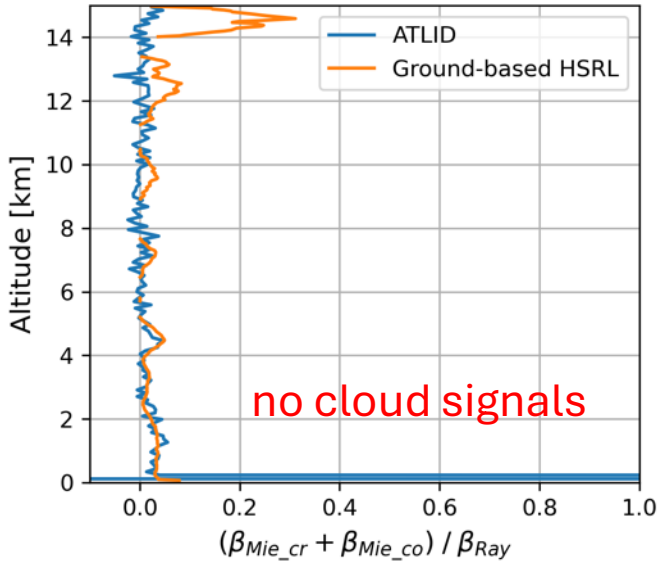


within 100 km

within 100km



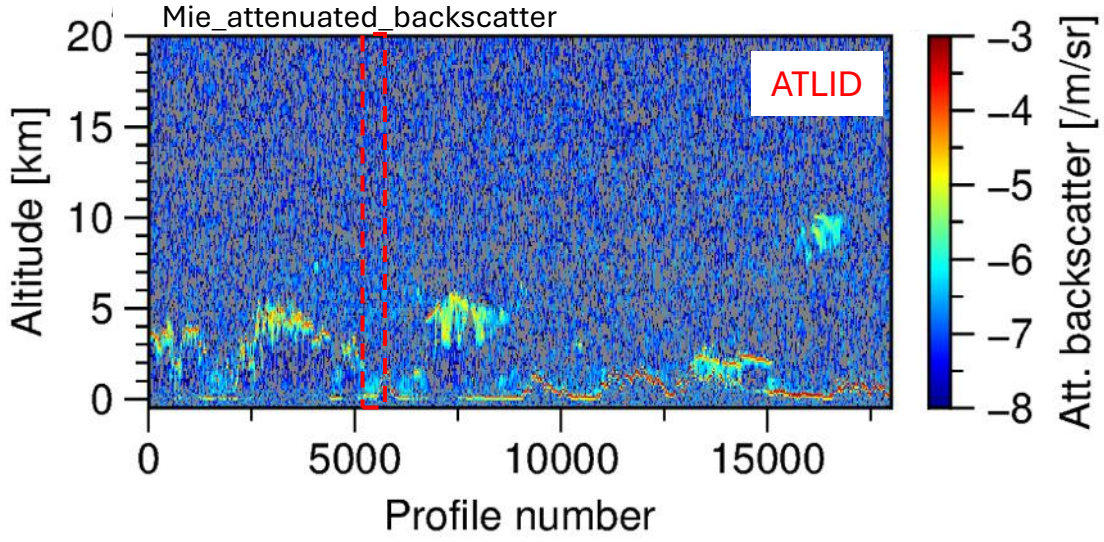
within 50km

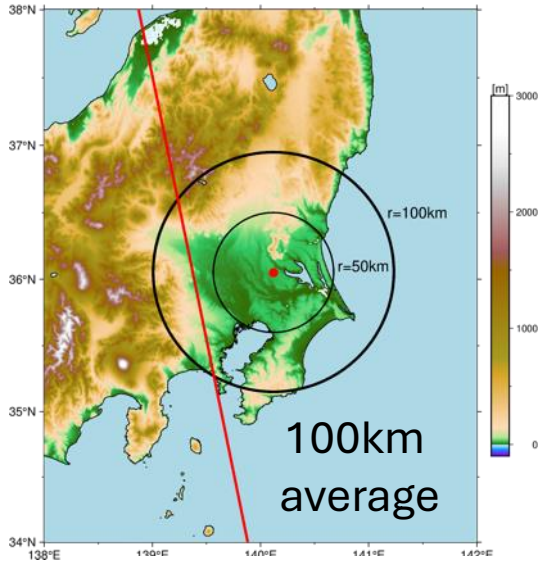


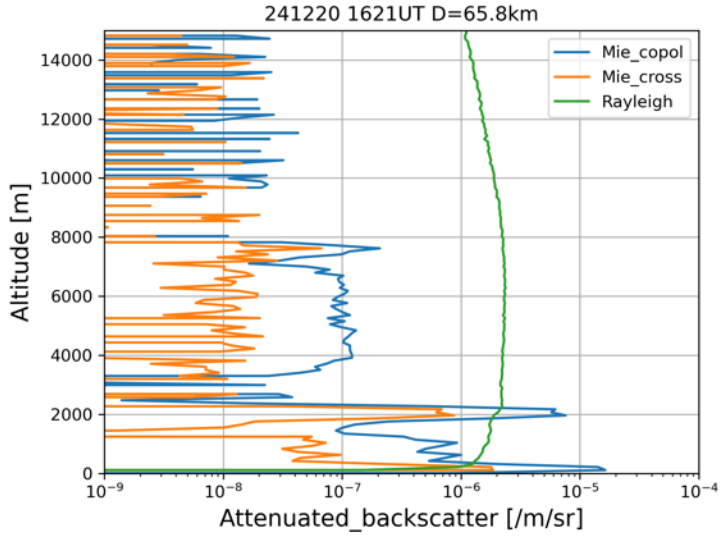
Transported aerosol layer case (low depolarization Asian dust)

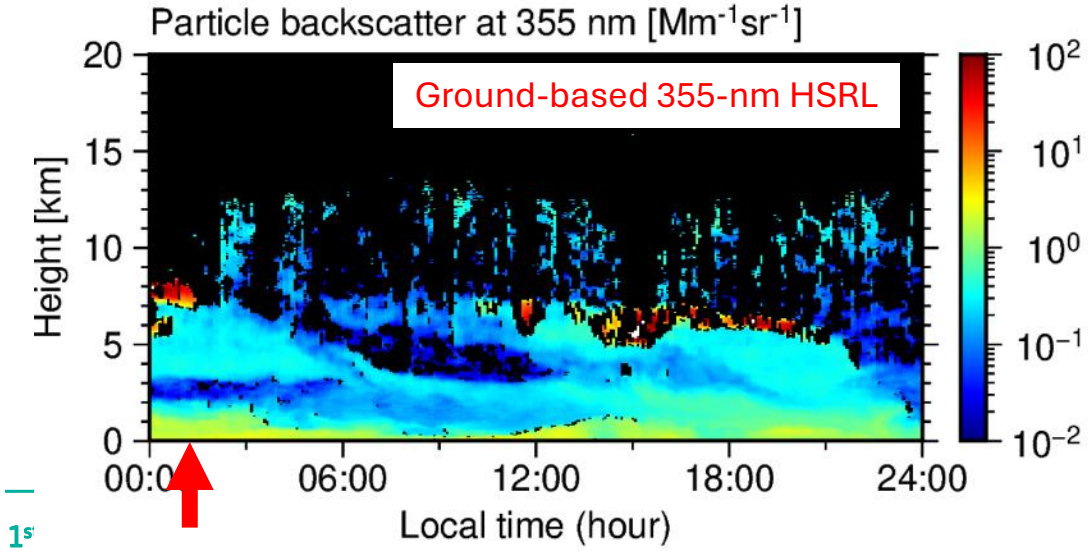
ECA_E_ATL_NOM_1BS_20241220T1617_20241220T1629_03201B_vAc (nighttime)

Minimum distance = 65.8 km

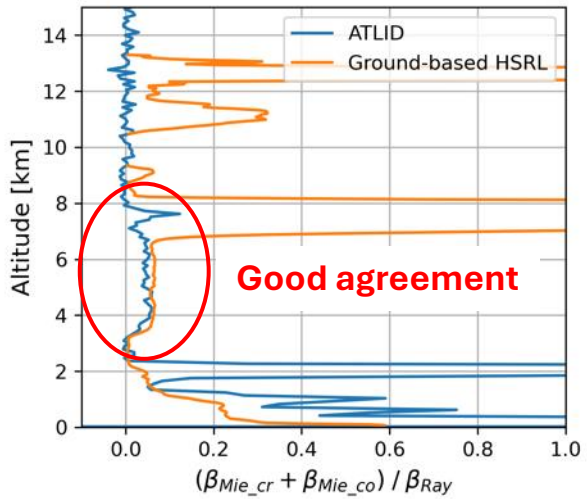




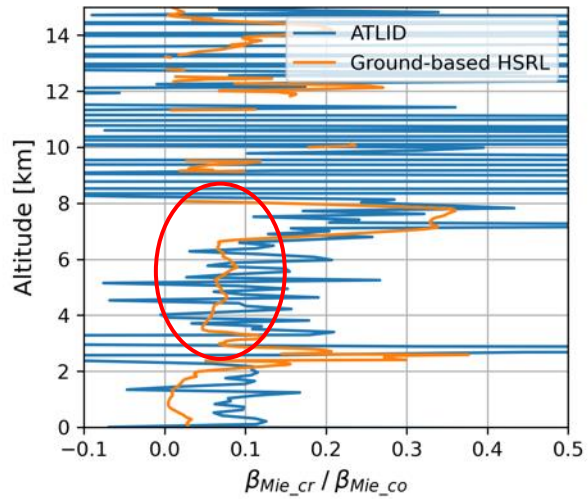




Backscattering ratio – 1



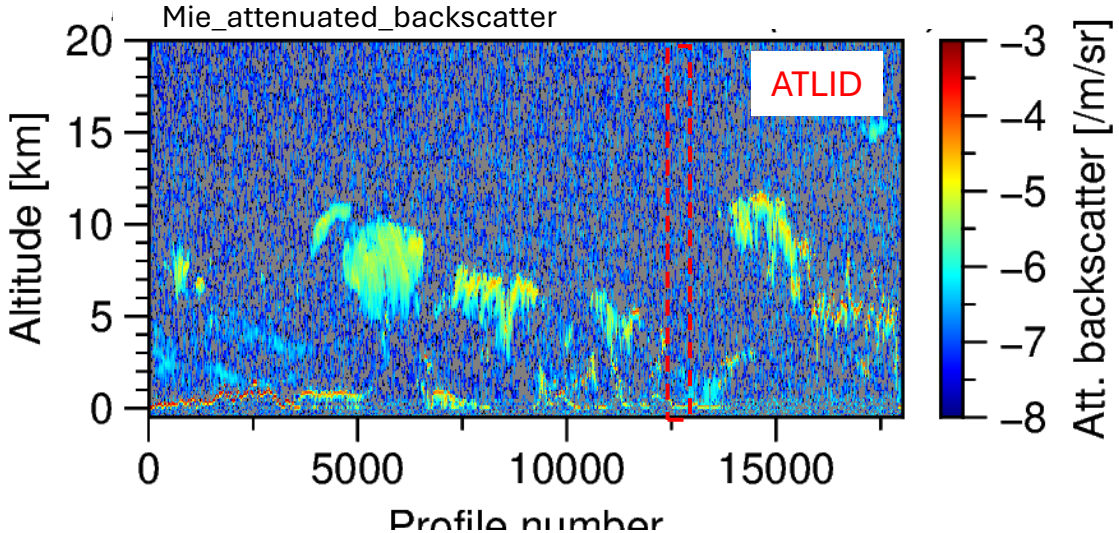
Particle depolarization ratio

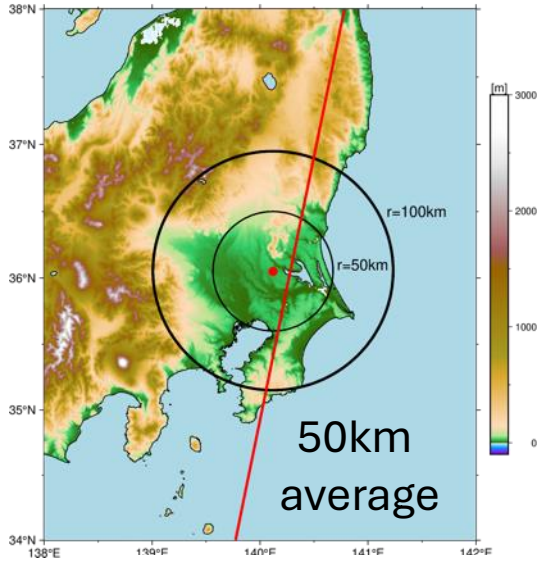


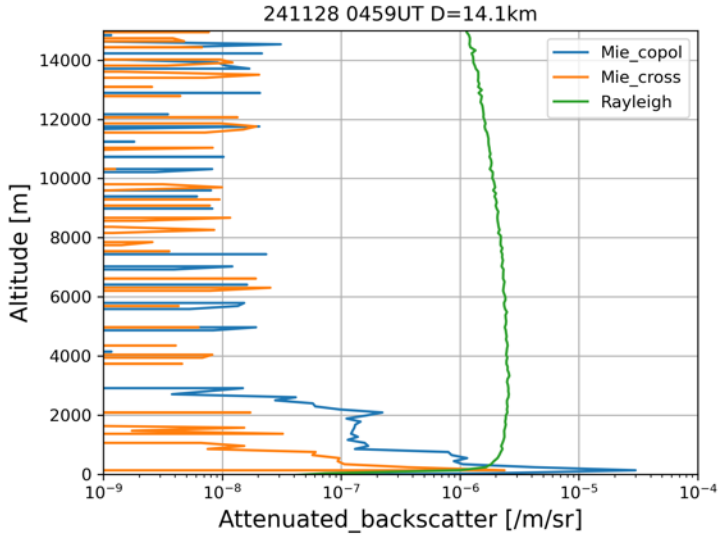
Boundary layer aerosol case (1)

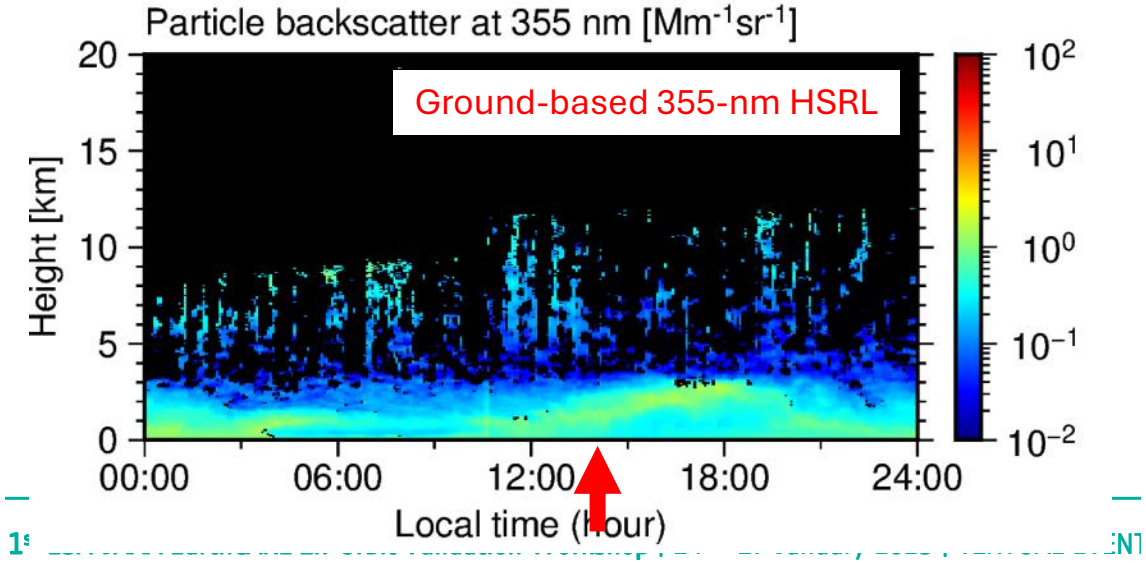
ECA_E_ATL_NOM_1BS_20241128T0450_20241128T0502_02851D_vAc (daytime)

Minimum distance = 14.1 km

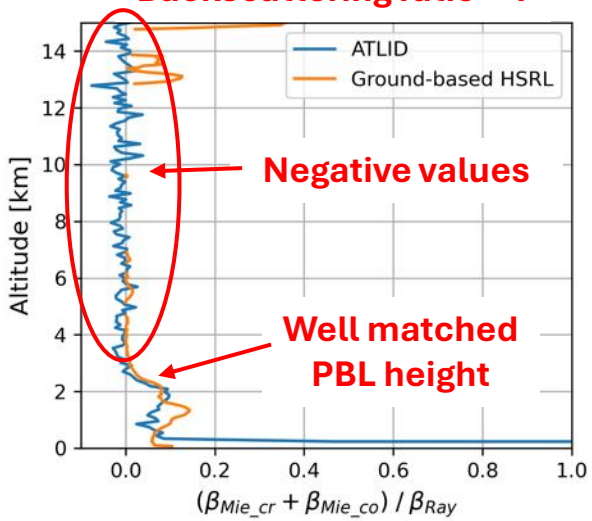




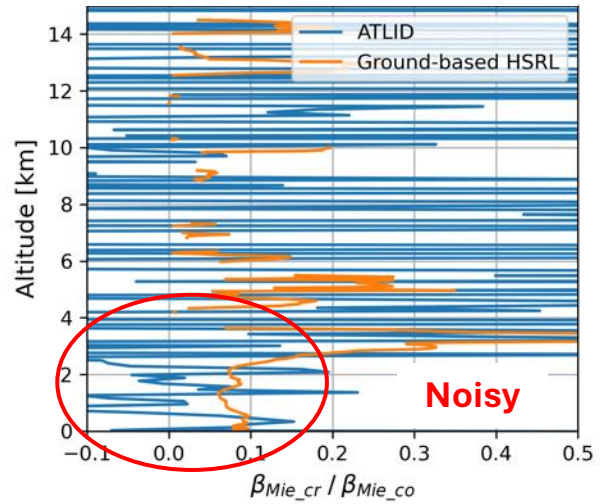




Backscattering ratio – 1

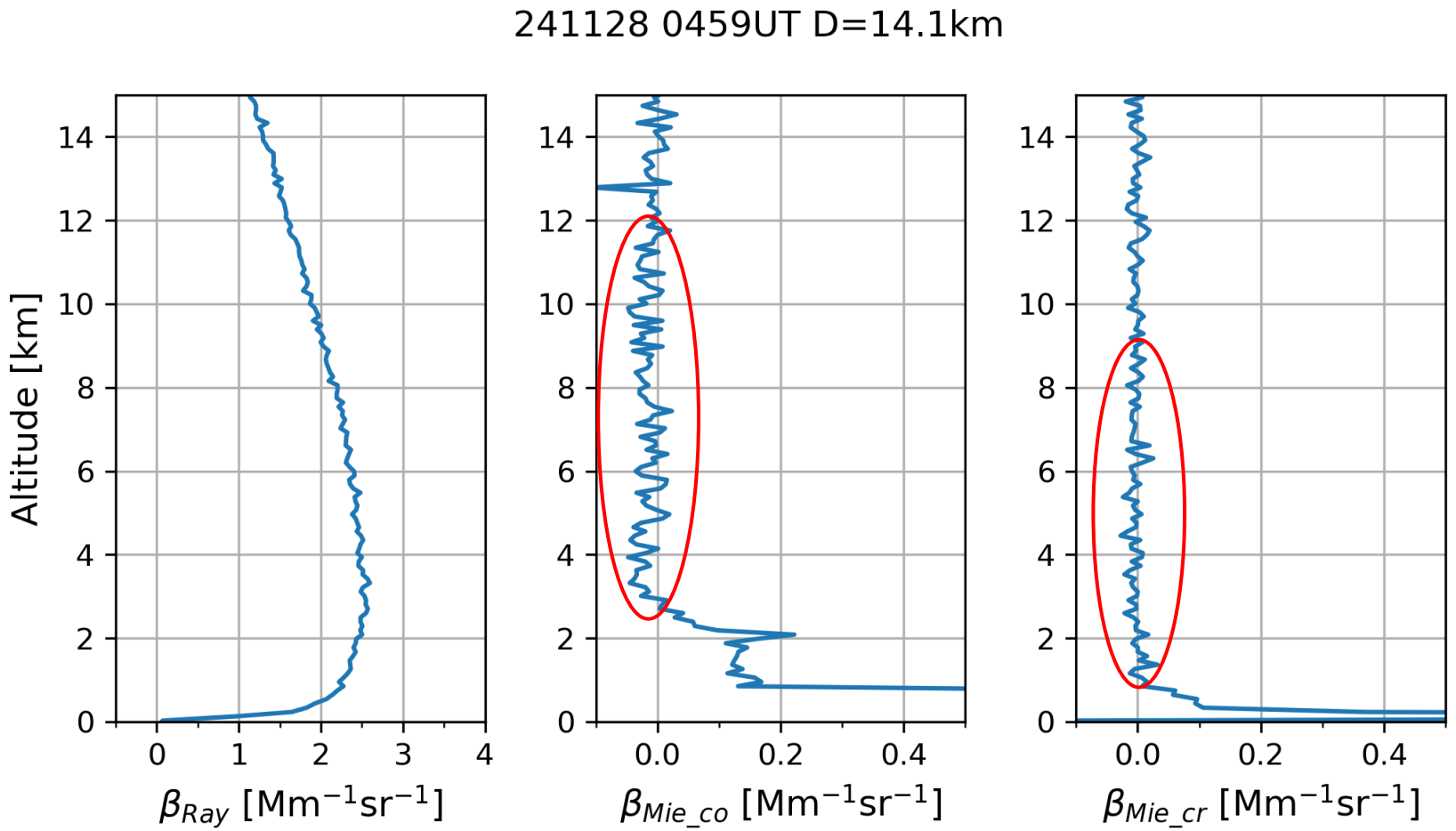


Particle depolarization ratio



Cause of negative backscattering ratio

ECA_E_ATL_NOM_1BS_20241128T0450_20241128T0502_02851D_vAc (daytime)

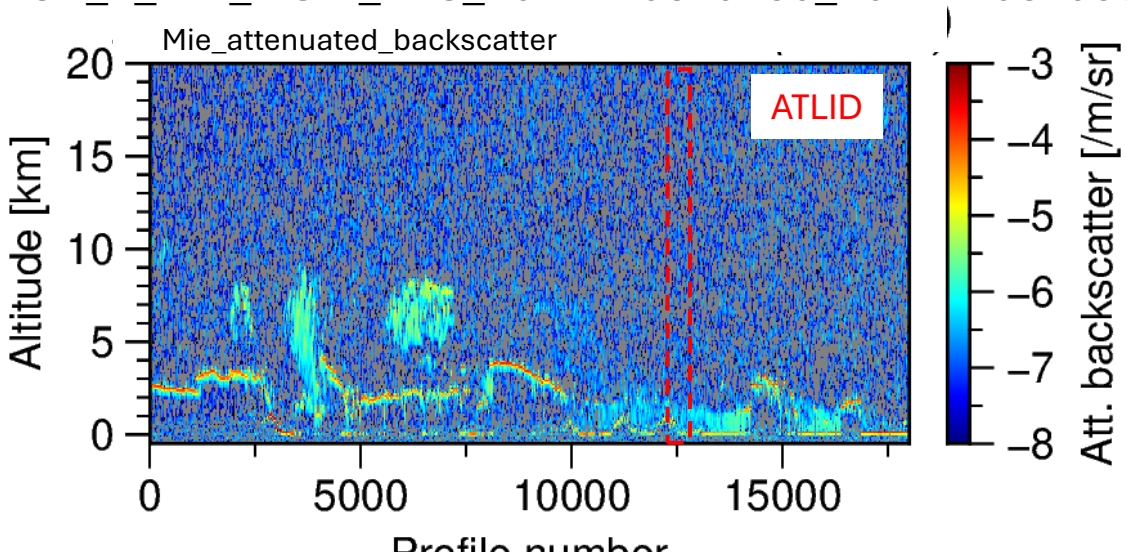


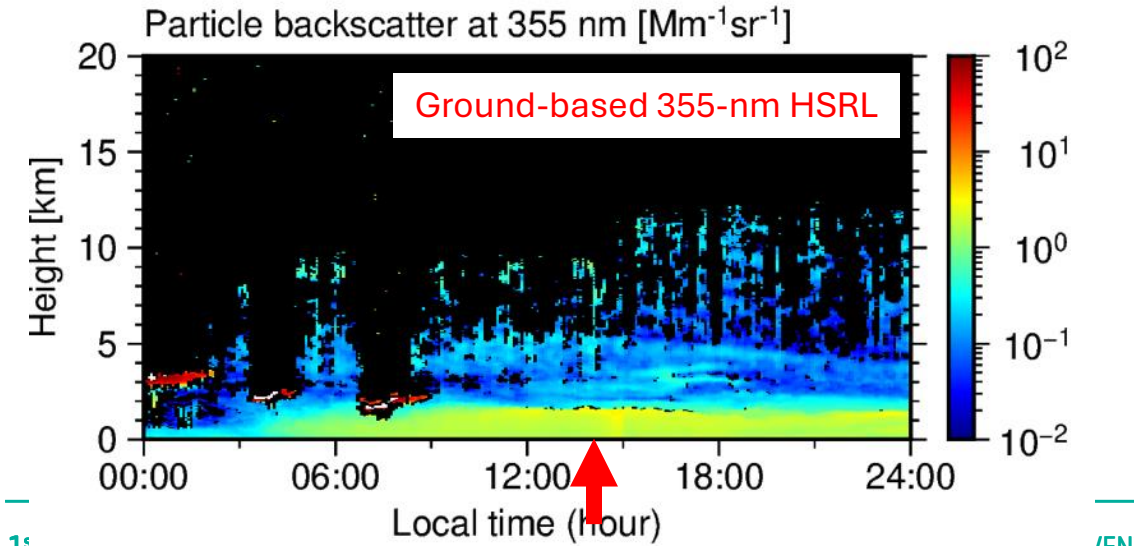
Mie attenuated backscattering coefficient (both copolar and crosspolar) have negative values

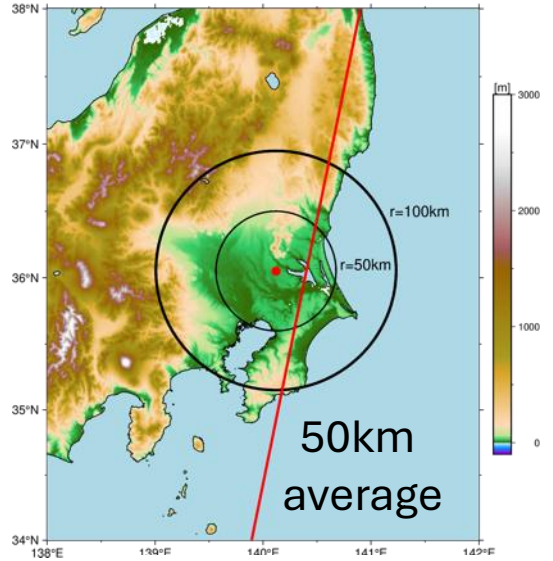
Boundary layer aerosol case (2)

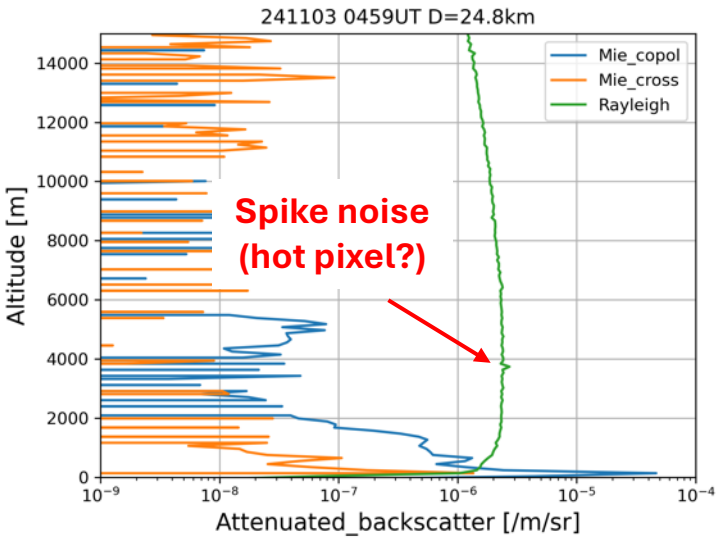
ECA_E_ATL_NOM_1BS_20241103T0450_20241103T0502_02462D_vAc (daytime)

Minimum distance = 24.8 km

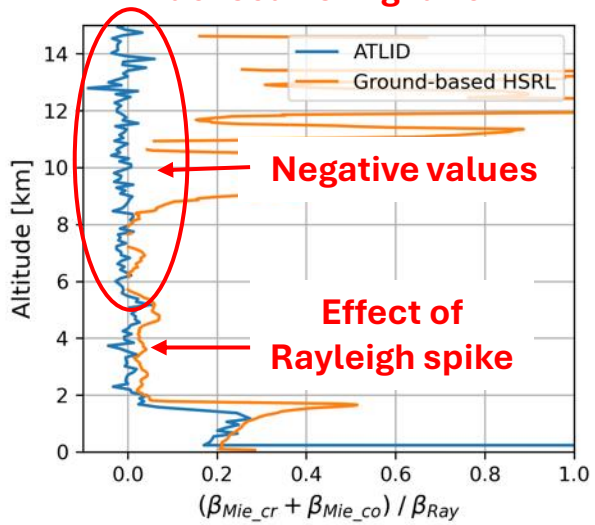




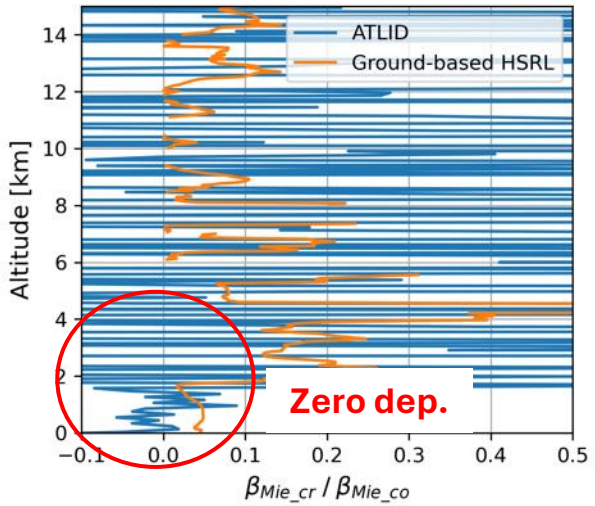




Backscattering ratio – 1



Particle depolarization ratio



Conclusions

- ATLID L1b products are evaluated using 355-nm ground-based HSRL at Tsukuba, Japan
- When averaging ATLID signals, surface elevation variations and atmospheric inhomogeneities should be considered
- Depolarization ratio during daytime is noisy and wide area averaging is needed and may have lower values than those measured by the ground-based lidar
- Backscattering ratio calculated from L1b signals has negative values for optically-thin aerosol cases (not all cases)
- We will extend the comparison analysis using other lidars (Koganei, Fukuoka, Toyama, and Hedo)

Thank you for your attention!