EarthCARE ATLID Level 1 intercomparison with ACROSS lidars

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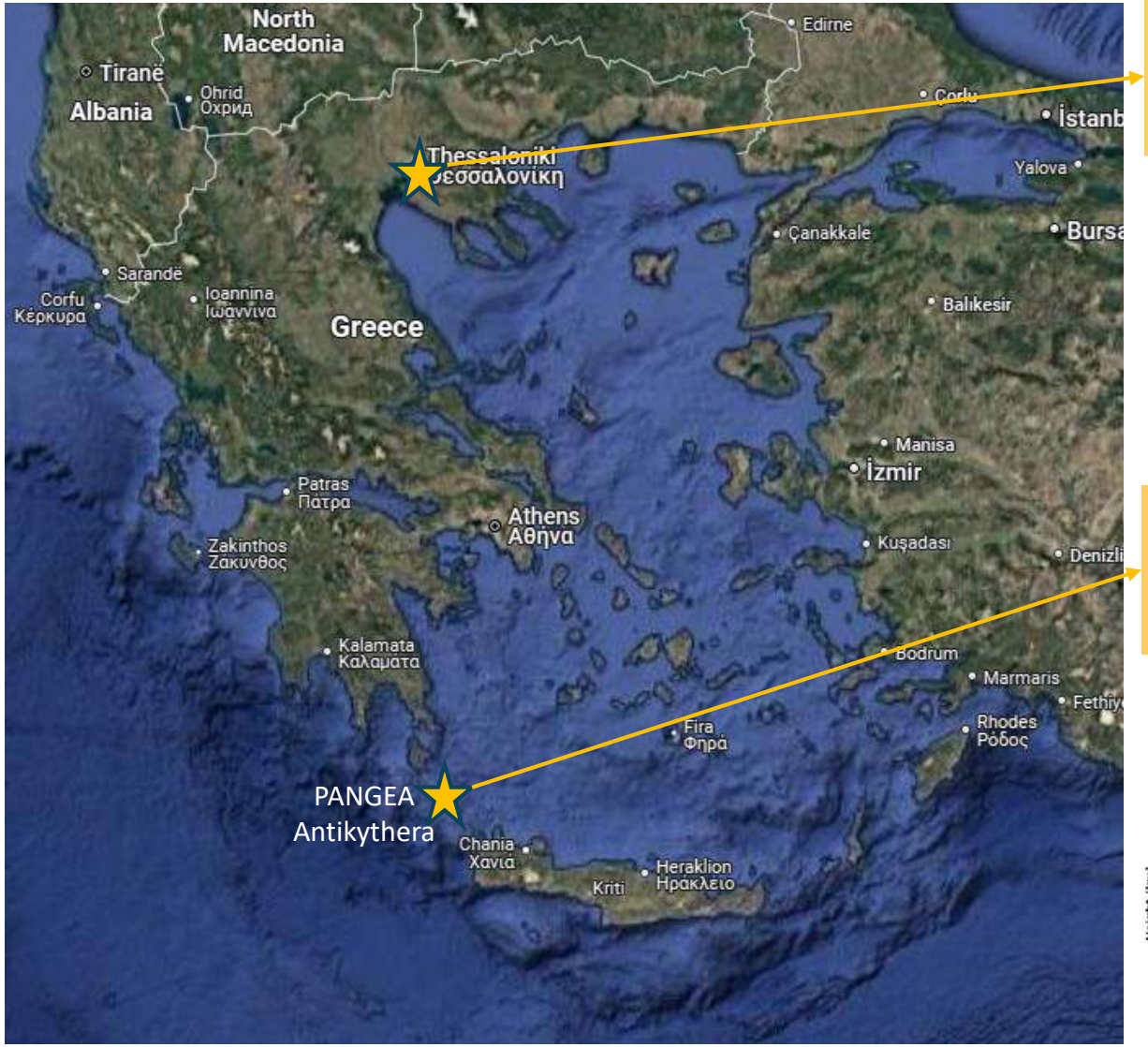
1st ESA-JAXA EarthCARE In-Orbit Validation Workshop
14 – 17 January 2025 | VIRTUAL EVENT

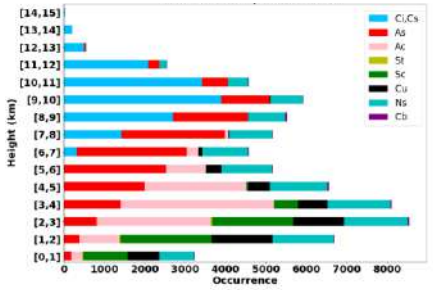
ACROSS Greek sites



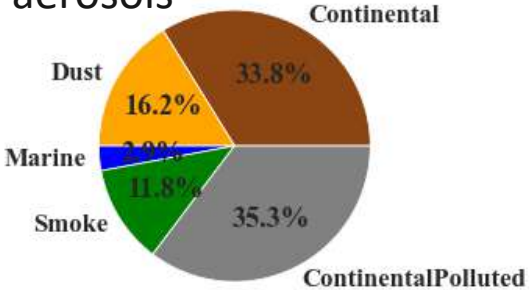
Thessaloniki Urban site

Typical obs.: aerosols: Continental + Polluted continental in PBL; other types elevated/transported

CloudSat Cloud Types occurrence (2007 – 2017)



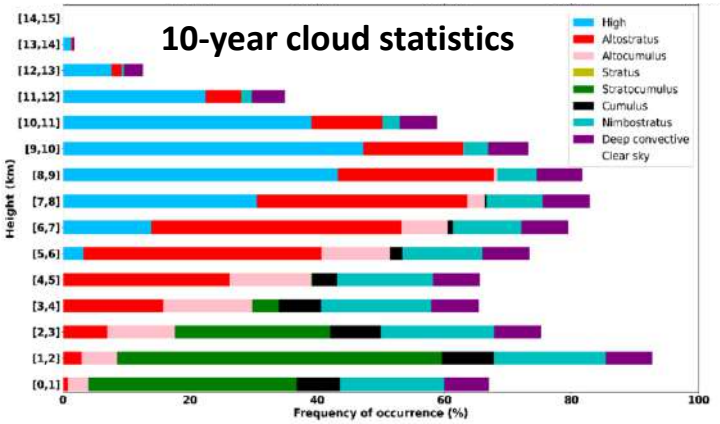
aerosols



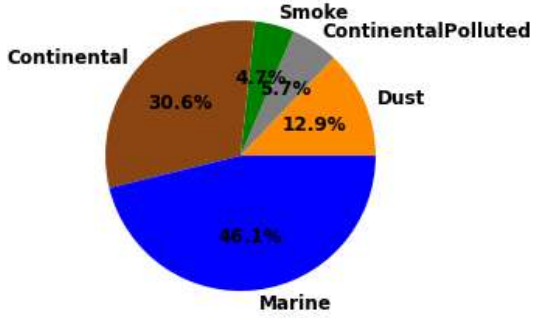
Antikythera background marine site

Typical obs.: clouds in the PBL;
aerosols: Sea salt in PBL; other types elevated layers

CloudSat Cloud Types occurrence (2007 – 2017)



aerosols



Thessaloniki dataset

Earthcare Overpass - THES Measurements			
DATE&TIME	MEASUREMENT	COMMENT	Distance
2024-07-16T00:07:02			
2024-07-16T12:53:34	12:25:13 - 14:00:45	aerosols up to 4km	
2024-07-29T00:03:14			
2024-08-07T00:09:31	10:17 - 10:43	clear sky	
2024-08-07T12:55:40	10:15:27 - 10:43:02	aerosols up to 3km	
2024-08-18T00:04:23	22:54:59 - 00:38:50	Cirrus clouds at 10- 12 km	36km
2024-08-18T12:50:25	10:49:30 - 12:28:38	dust 3-5km	
2024-08-27T00:06:26		lack of personel	
2024-08-27T12:52:11	08:10:20-10:19:15	aerosol layer 4-6km	
2024-09-03T00:08:37	22:02:59 - 01:09:41	not good grd retrieval	
2024-09-03T12:56:27	12:13:10 - 14:04:41	clouds at 8km	
2024-09-12T00:06:57		clouds	
2024-09-12T12:52:32	12:20:05 -13:31:19	clear sky	
2024-09-21T00:03:27		clouds	
2024-09-21T12:49:17		clouds	
2024-09-30T00:02:03	22:56:45 - 00:15:32	layer at 10km	267km
2024-10-07T00:06:23		clouds	
2024-10-07T12:51:59	12:02:10 - 13:49:57	clear sky	
2024-10-16T00:02:32	23:07:52 - 00:46:02	problem with trigger	
2024-10-16T12:48:14	12:22:19 - 13:55:59	cirrus at 13km	
2024-10-23T12:55:21	11:34:15 - 13:44:35	cirrus at 12km	
2024-11-01T00:05:51	22:58:03 - 00:42:24	clear sky - PBL aerosols	30km
2024-11-01T12:51:26	11:31:18 - 14:00:07	clouds above 8km	
2024-11-10T00:01:59	00:23:28 - 01:40:59	Unhomogeneus vs Earthcare	41km
2024-11-10T12:47:42		clouds	
2024-11-17T12:54:52		instrument availability	
2024-11-26T00:05:24		lack of personel	
2024-11-26T12:50:59	06:06:24 - 14:47:45	Cirrus clouds	
2024-12-05T00:01:34		clouds	
2024-12-05T12:47:17		clouds	
2024-12-12T12:54:24	11:57:31 - 14:01:29	clear sky	
2024-12-21T00:04:55		clouds	
2024-12-21T12:50:30		clouds	
2024-12-30T00:01:05	22:40:36 - 00:46:32	clear sky - PBL aerosols	34km
2024-12-30T12:46:48	11:53:45 - 14:02:41		
2025-01-06T12:53:55		clouds	

Thessaloniki Overpasses

3 golden nighttime cases & 13 daytime cases:

- 18/8: Cirrus 10-12 km
- 1/11: Clear sky
- 30/12: Clouds at 7 km

Measurements:

bp, ap @355nm

bp, ap, **dp @ 532nm**

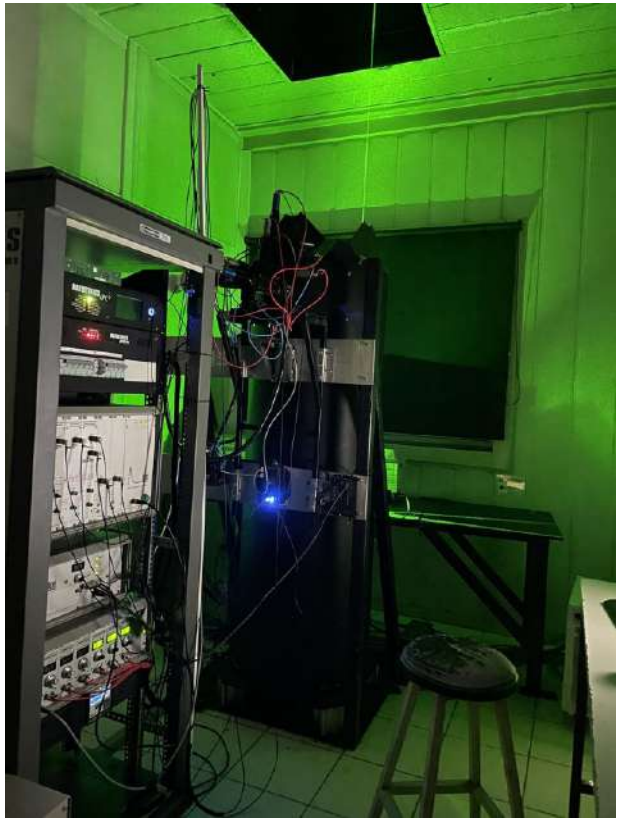
bp 1064nm

Depolarization measurements @ 532nm -> converted to 355nm

Dp_355= Dp_532*0.89

reference:

DEDICATE EarthCARE-related conversion factors



Antikythera dataset

Earthcare Overpass - AKY Measurements			
DATE&TIME	MEASUREMENT	COMMENT	Distance
2024-07-27T00:09:37	yes	no Earthcare	1 km
2024-07-29T12:50:3	yes	no Earthcare	
2024-08-07T00:08:15	no	UPS problem	
2024-08-09T12:48:02	no	UPS problem	
2024-08-16T00:12:43	no	UPS problem	
2024-08-18T12:51:09	no	UPS problem	
2024-08-25T00:11:58	no	UPS problem	
2024-08-27T12:48:50	no	UPS problem	
2024-09-03T00:07:21	no	UPS problem	
2024-09-05T12:44:10	no	UPS problem	
2024-09-12T00:03:48	no	UPS problem	
2024-09-12T12:50:42	no	UPS problem	
2024-09-19T00:09:33	yes	high level clouds	109 km
2024-09-21T12:50:25	yes	low clouds	
2024-09-28T00:09:03	yes	no signal, window condensation	
2024-09-30T12:45:59	yes	low clouds	
2024-10-07T00:05:11	yes	thin aerosol layer	43 km
2024-10-14T00:08:52	yes		113 km
2024-10-16T12:49:19	yes	Cirrus & thin aerosol layer	
2024-10-23T00:08:30	yes	low clouds	
2024-10-25T12:45:27	yes	thick low clouds	
2024-11-01T00:04:39	yes	low clouds	
2024-11-10T12:48:46	yes	thick low clouds	
2024-11-17T00:08:02	yes	low clouds	
2024-11-19T12:44:59	yes	marine aerosols, but no EarthCARE data	
2024-11-26T00:04:12	yes	low clouds	
2024-12-05T12:48:21	yes	mainly high clouds- big variability	
2024-12-12T00:07:33	yes	cirrus clouds	
2024-12-14T12:44:30	no	maintenance	
2024-12-21T00:03:43	yes	low clouds	
2024-12-30T12:47:52	yes	thick low clouds	
2025-01-06T00:07:05	yes	very clean day	
2025-01-08T12:44:01	yes	few low clouds	

Antikythera Overpasses

2 golden nighttime cases & 3 daytime cases:

- 7/10: Thin aerosol layer @ 5km
- 12/12: Cirrus @ 6-9 km
- 16/10 Daytime: Cirrus & thin aerosol layer @ 4km

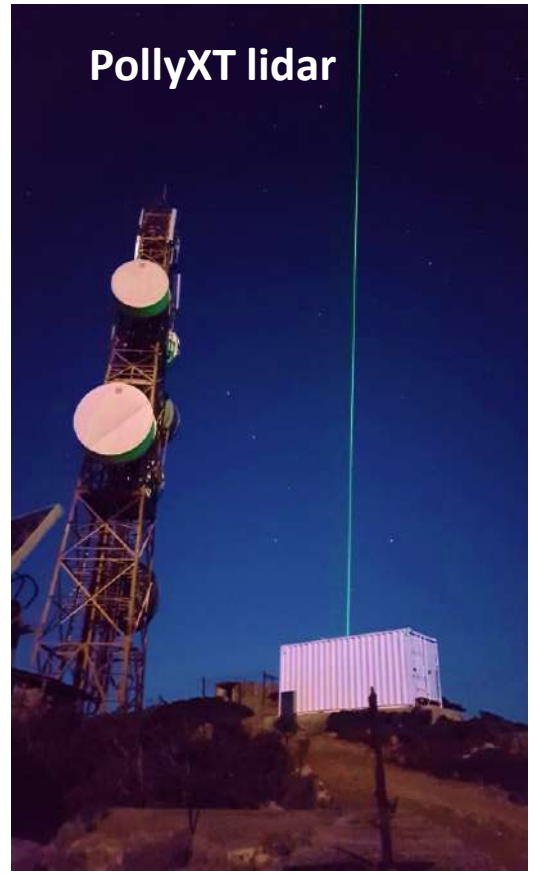
Measurements:

bp, ap, dp @355nm

bp, ap, dp @532nm

bp @1064nm

Full overlap @1km

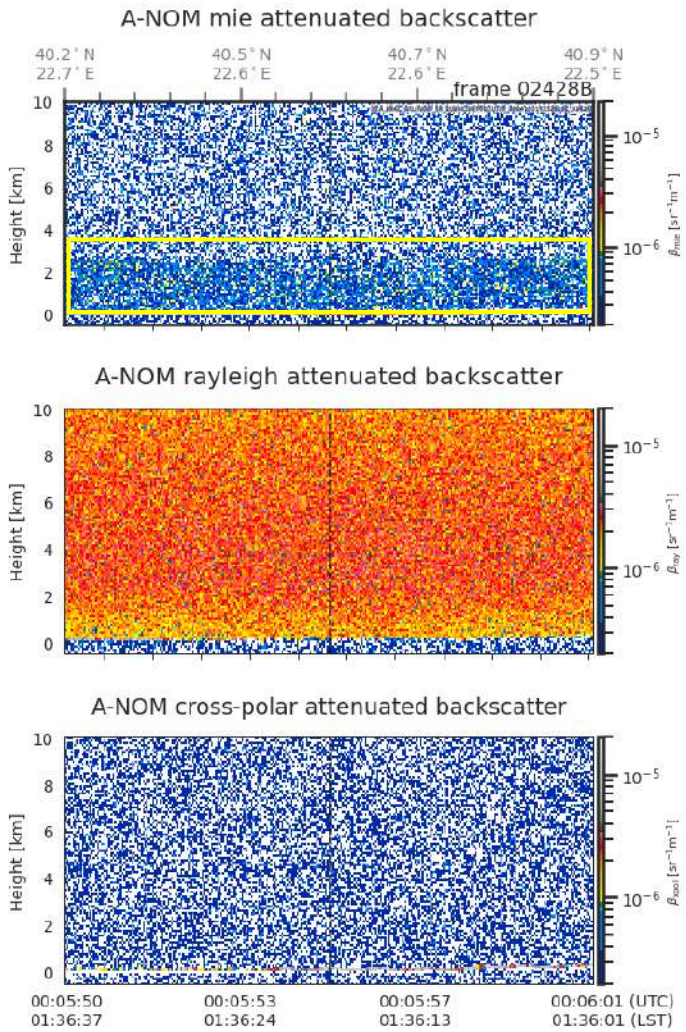


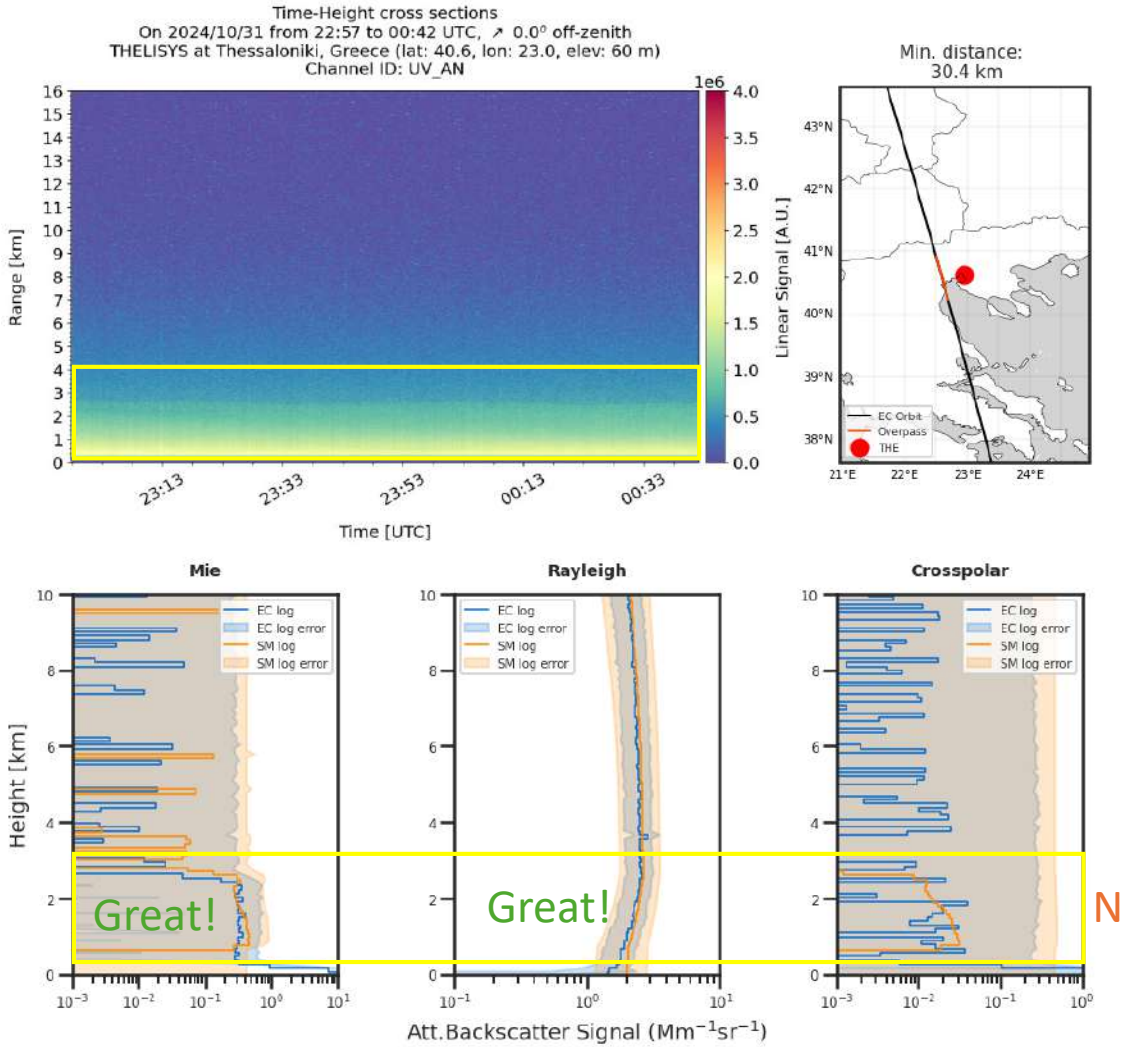
L1 intercomparisons

using averaged EC profiles at 50km radius & suborbital Raman retrievals through the ATLID CCT simulator

L1 A-NOM (AC) 1/11/2024 00:05 UTC - THES

EarthCARE A-NOM (AC) on 01-11-2024 00:01 UTC intercomparison with simulated data based on THE measurements

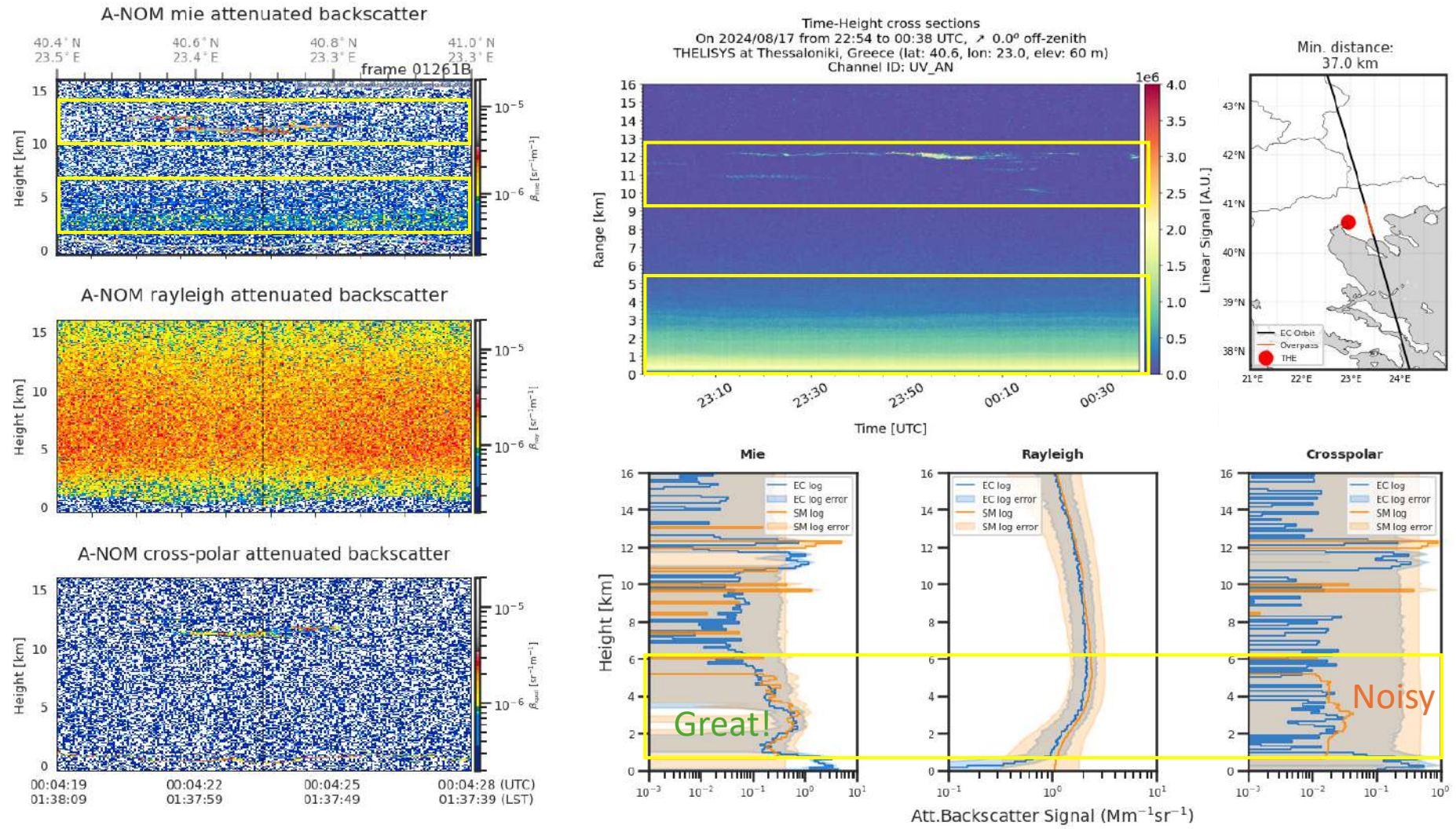




- 30 km overpass distance
- Aerosol layer up to 3 km observed in both lidars
- A-NOM Mie and Rayleigh profiles: Great!
- A-NOM crosspolar: noisy but of the same order

L1 A-NOM (AC) 18/08/2024 00:04 UTC - THES

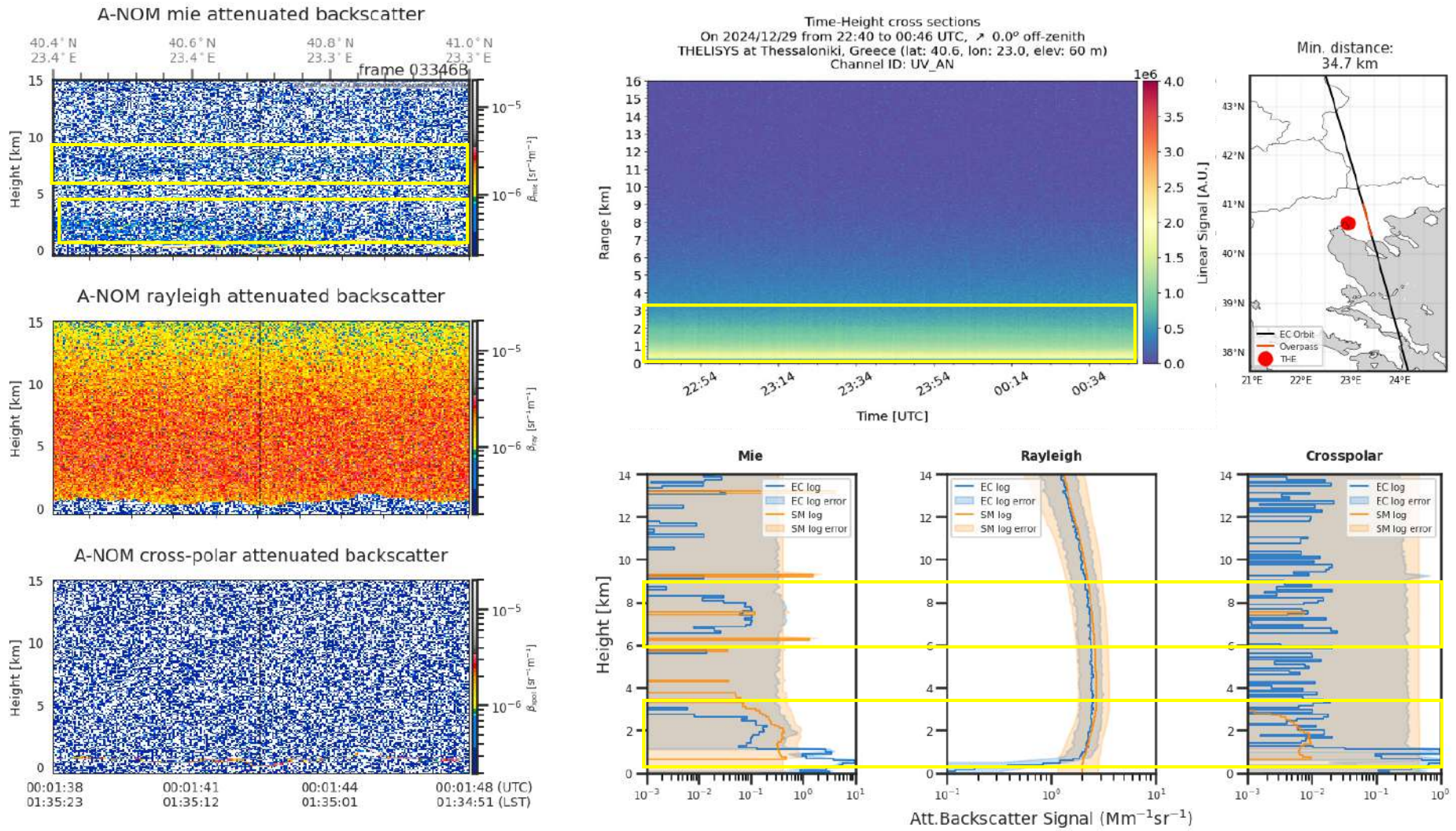
EarthCARE A-NOM (AC) on 17-08-2024 23:59 UTC intercomparison with simulated data based on THE measurements



- 37 km overpass distance
- Thin cirrus cloud detected from both lidar
- Aerosol layer up to 5.5 km in both lidars
- A-NOM Mie and Rayleigh profiles: Great!
- A-NOM crosspolar: noisy but of the same order

L1 A-NOM (AC) 30/12/2024 00:01 UTC - THES

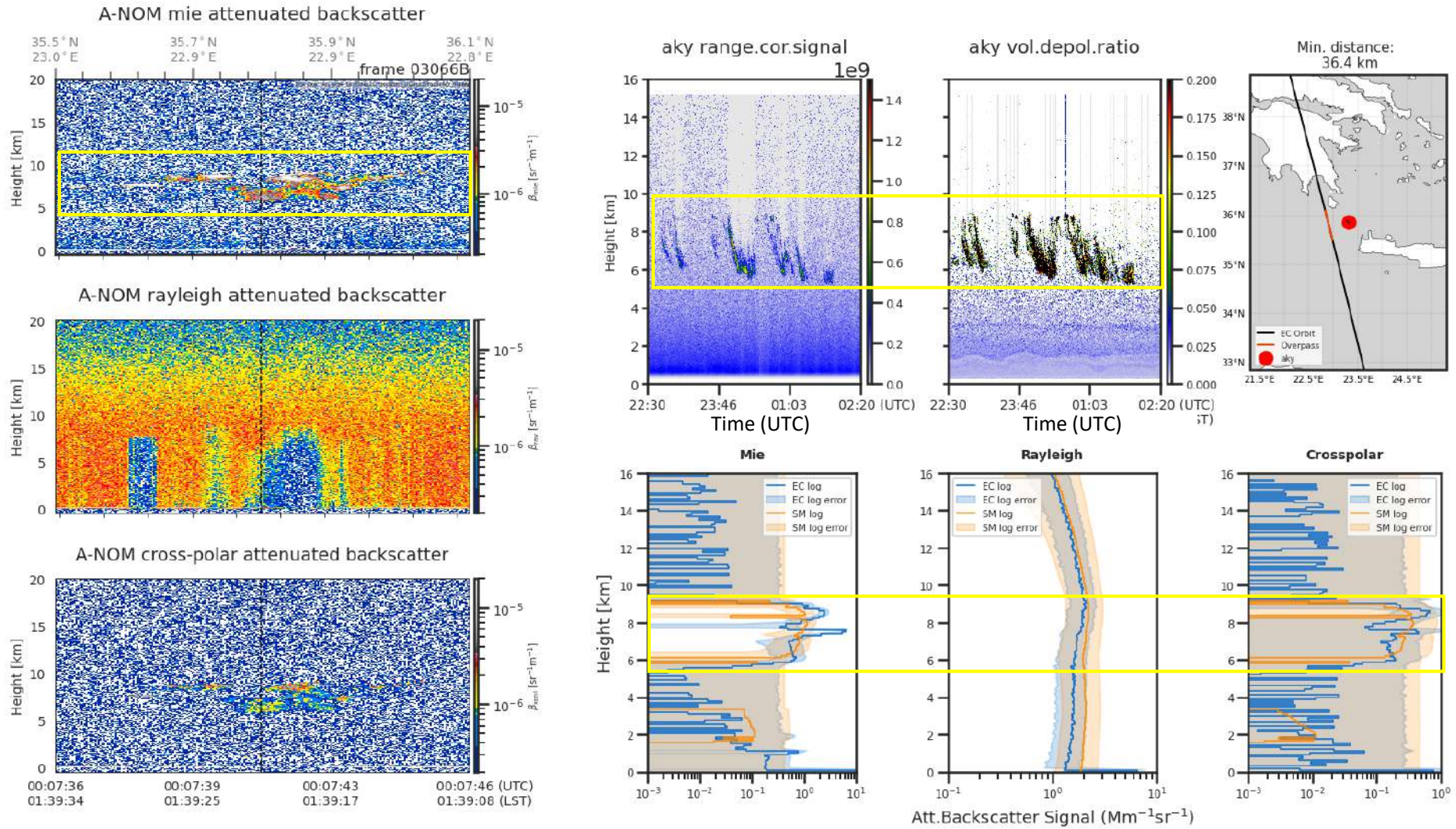
EarthCARE A-NOM (AC) on 29-12-2024 23:56 UTC intercomparison with simulated data based on THE measurements



- 35 km overpass distance
- EC aerosol layer at 7-9km not observed in THES
- Aerosol layer up to 3km observed from both lidars
- A-NOM Mie underestimation down to 1km, A-NOM Crosspolar noisy signals
- A-NOM Mie and Crosspolar: higher values bellow 1km. Possible due to overlap effect in THES lidar

L1 A-NOM (AC) 12/12/2024 00:07 UTC - AKY

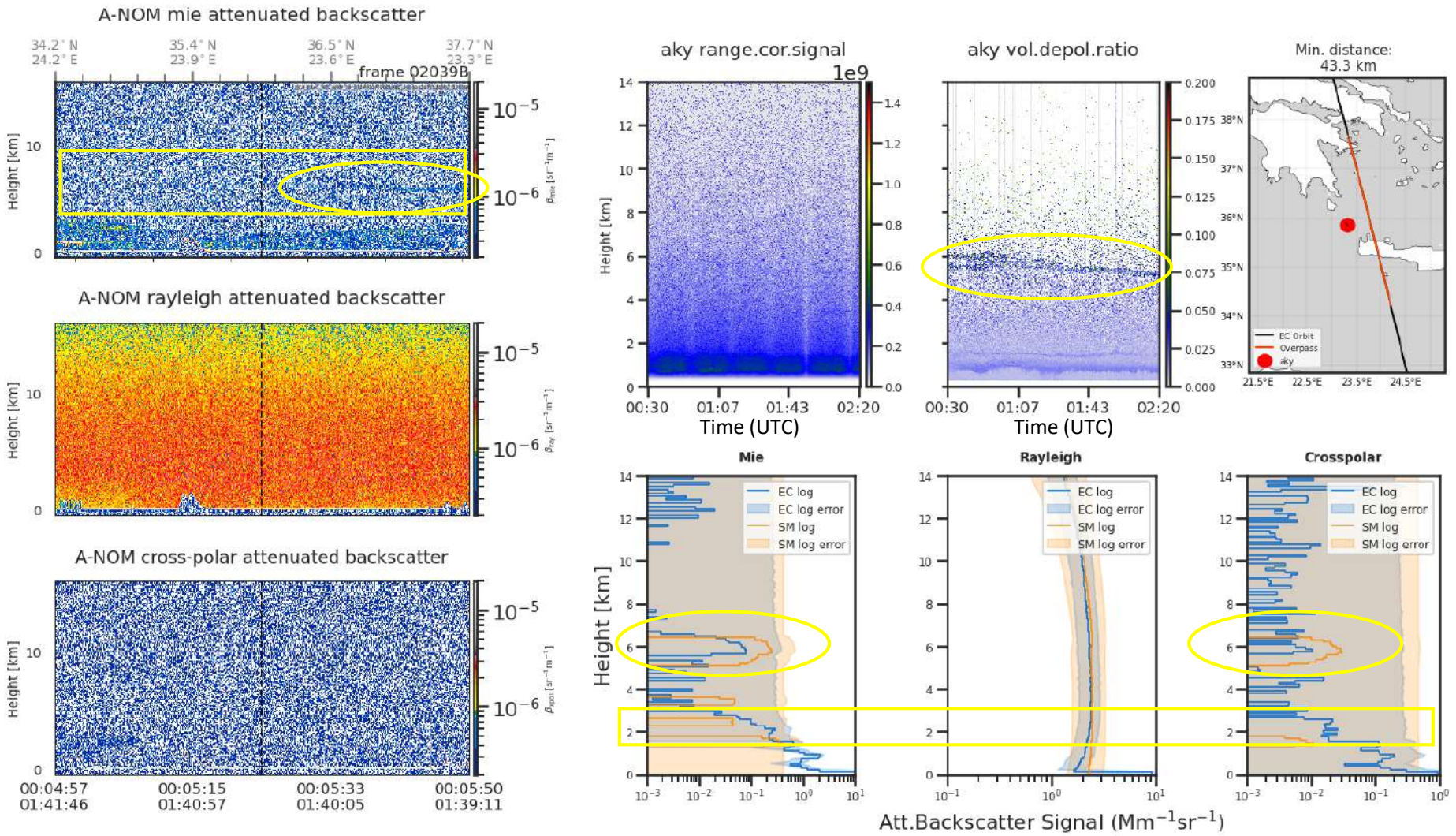
EarthCARE A-NOM (AC) on 12-12-2024 00:04 UTC intercomparison with simulated data based on aky measurements



- 36 km overpass distance
- Cirrus at 5 – 9.5 km detected from both lidars
- Mie & Crosspolar profiles: same order for 2 lidars, but differences due to cloud inhomogeneity
- Cloud effect on Rayleigh bellow cloud may be due to the cloud inhomogeneity
- Differences in the profiles of the aerosol layer bellow.

L1 A-NOM (AC) 7/10/2024 00:05 UTC - AKY

EarthCARE A-NOM (AC) on 07-10-2024 00:01 UTC intercomparison with simulated data based on aky measurements



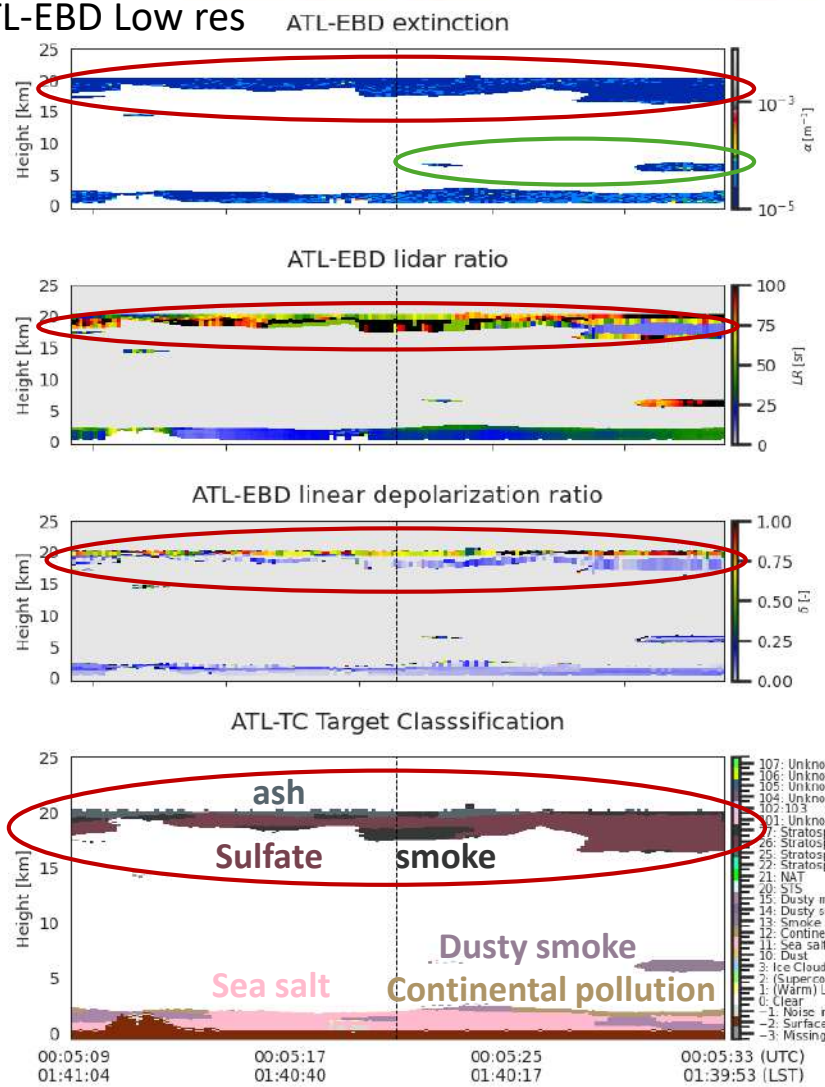
- 43 km overpass distance
- Thin pollution layer at 5-6.5 km
- The layer was detected from EC at 50-100 km radius from the site only (not closer vicinity profiles)
- Differences in Mie & Crosspolar -> layer inhomogeneity
- Bellow: higher EC Crosspolar values.

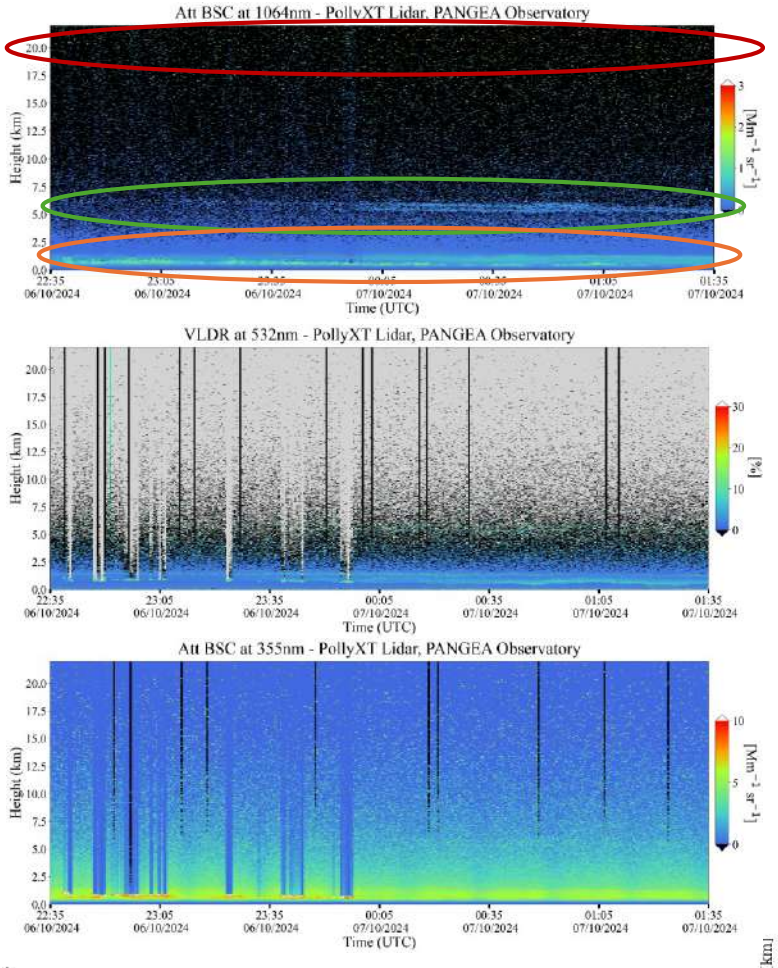
L2 intercomparisons

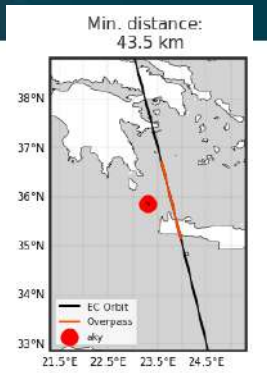
using single EC profiles at distance < 45 km

L2 A-TC (AC) 7/10/2024 00:05 UTC - AKY

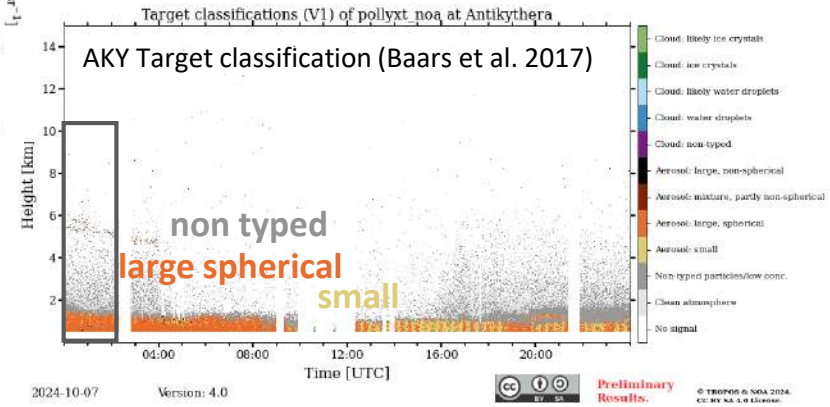
ATL-EBD Low res





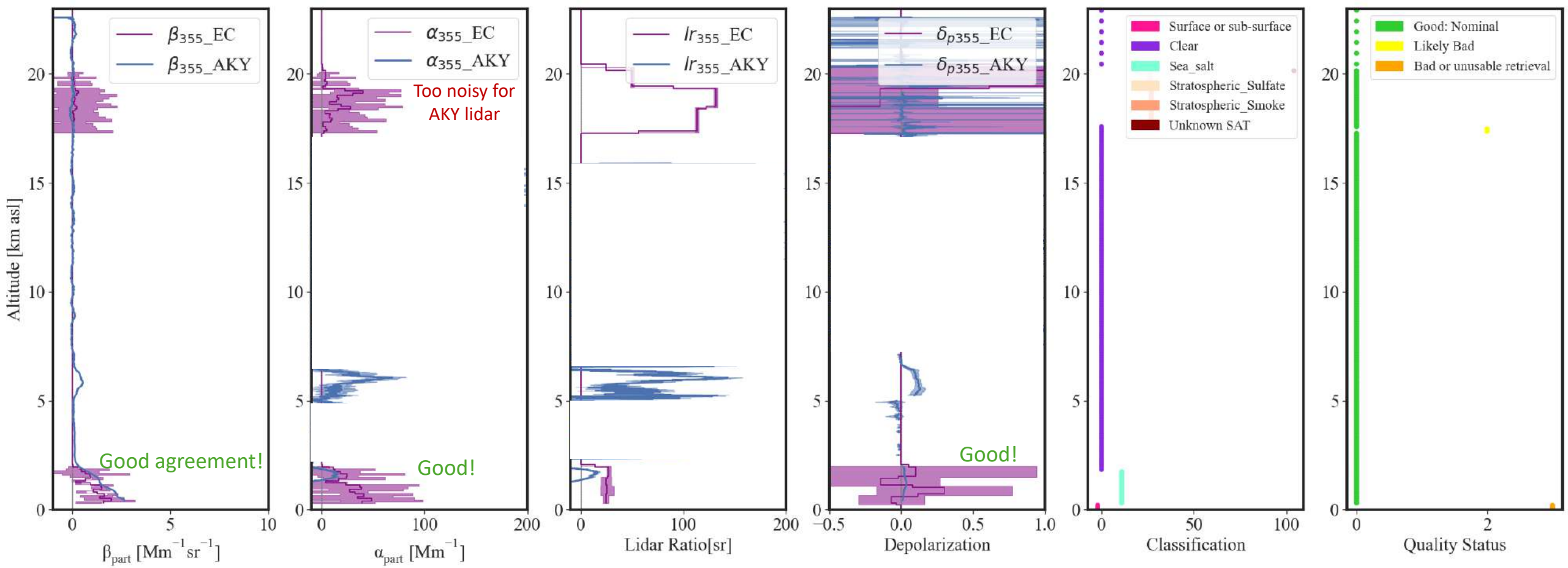


- Stratospheric aerosol layer not detected from ground -> real or possible artifact due to resolution step?
- **Thin aerosol layer at 6km: detected from both lidars!**
  TC: Dusty smoke
- **Layer <2km: Accurate target classification!**
  EC mainly Sea salt, + parts continental pollution & dusty smoke
  AKY mainly large spherical, + parts small & non typed



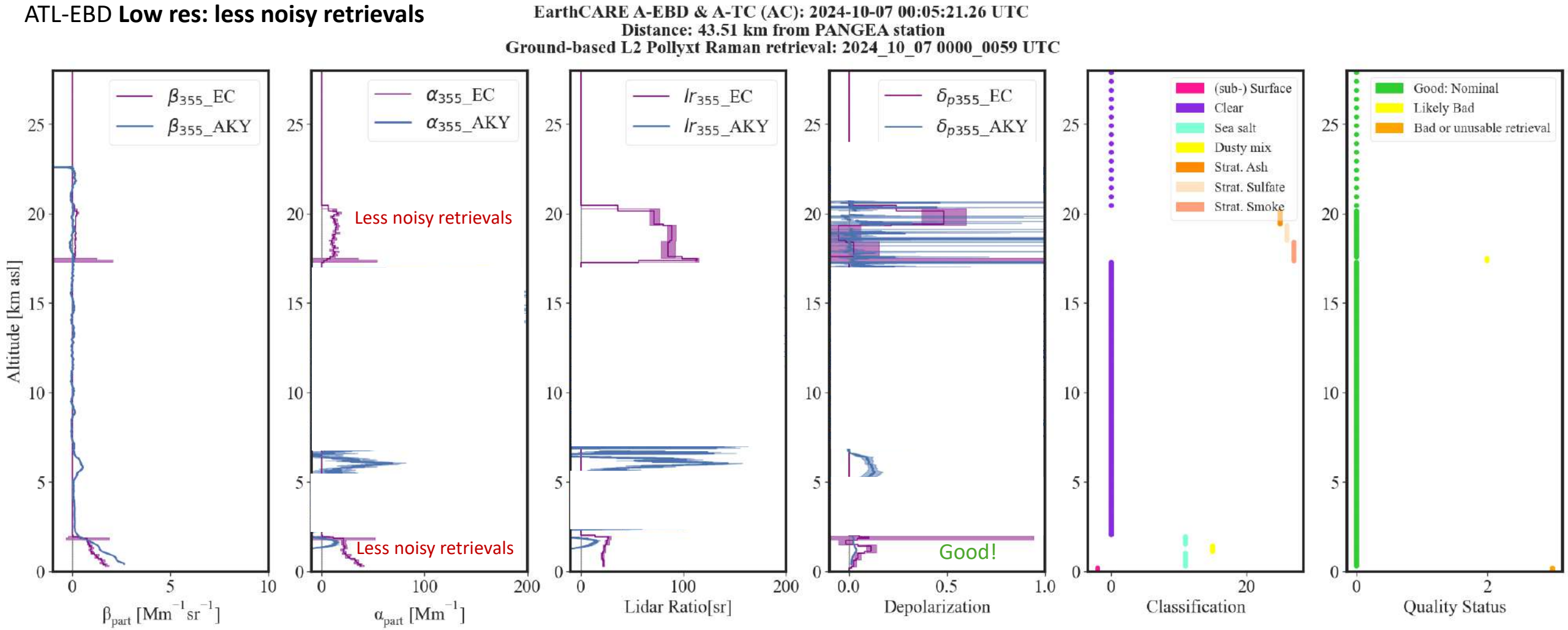
L2 A-EBD (AC) 7/10/2024 00:05 UTC - AKY

ATL-EBD **High res**



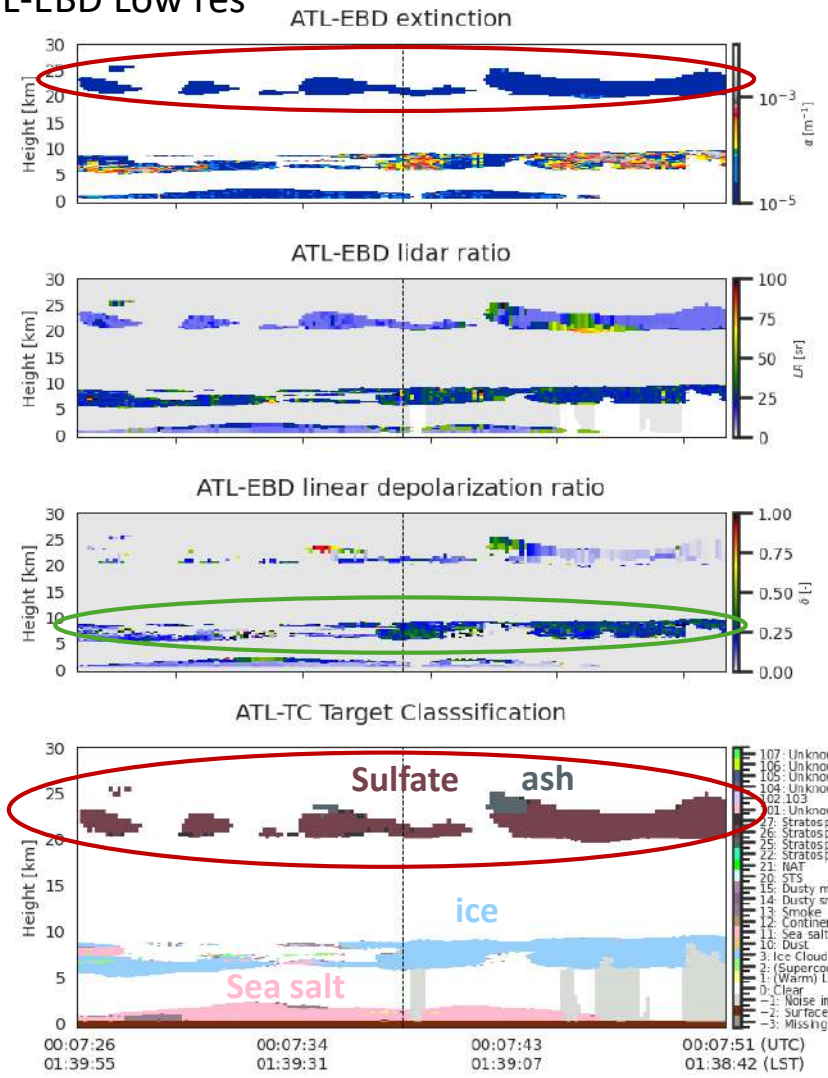
L2 A-EBD (AC) 7/10/2024 00:05 UTC - AKY

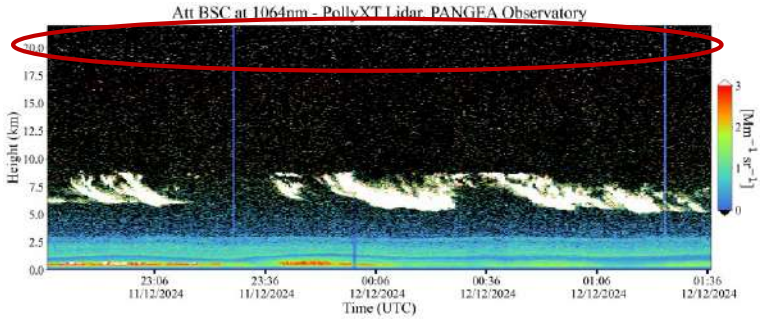
ATL-EBD **Low res: less noisy retrievals**

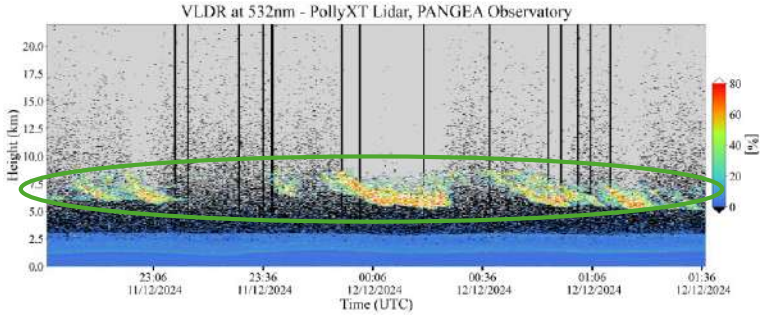


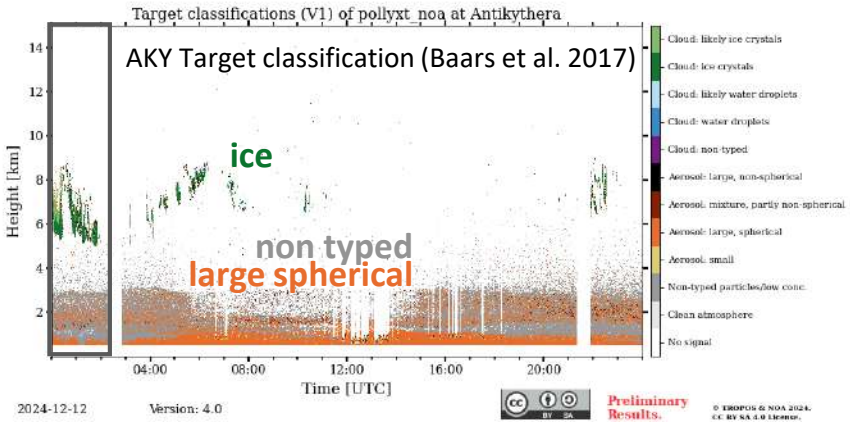
L1 A-TC (AC) 12/12/2024 00:07 UTC - AKY

ATL-EBD Low res

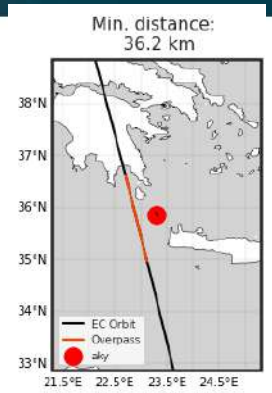






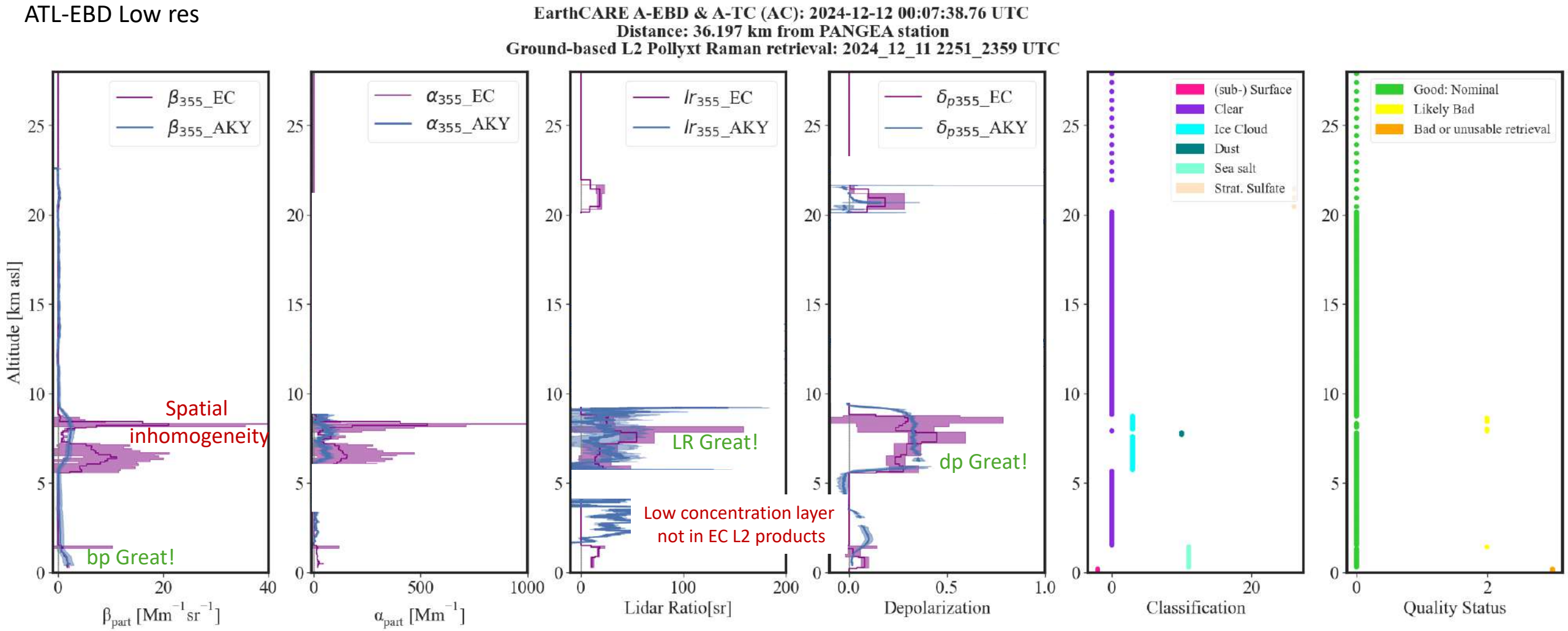


- Stratospheric aerosol layer not visible in AKY high resolution measurements
- **Cirrus at 6-9 km: Good Classification!**
- **Layer <3km: Accurate target classification!**
  EC mainly Sea salt
- **AKY mainly large spherical + noisy non typed**



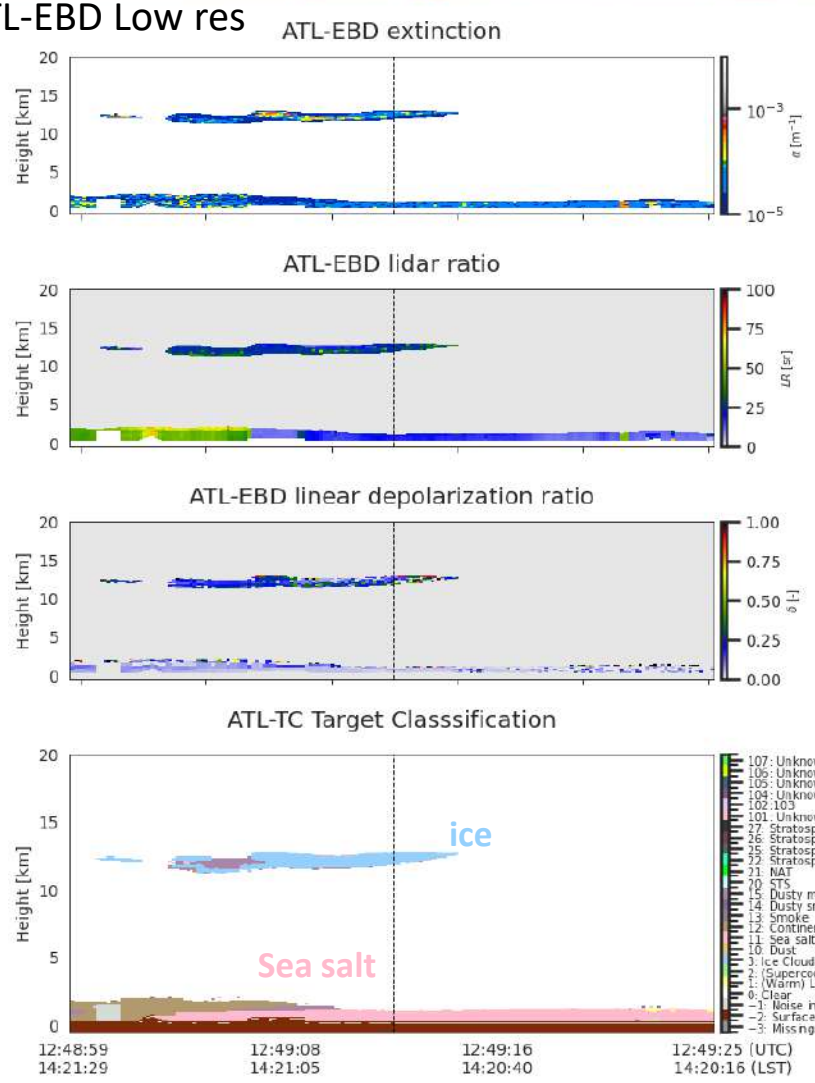
L1 A-EBD (AC) 12/12/2024 00:07 UTC - AKY

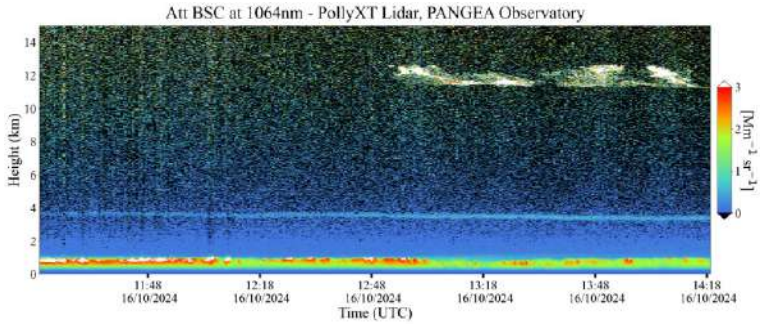
ATL-EBD Low res

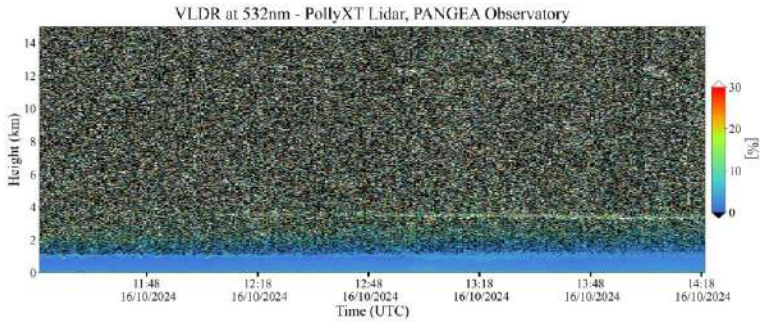


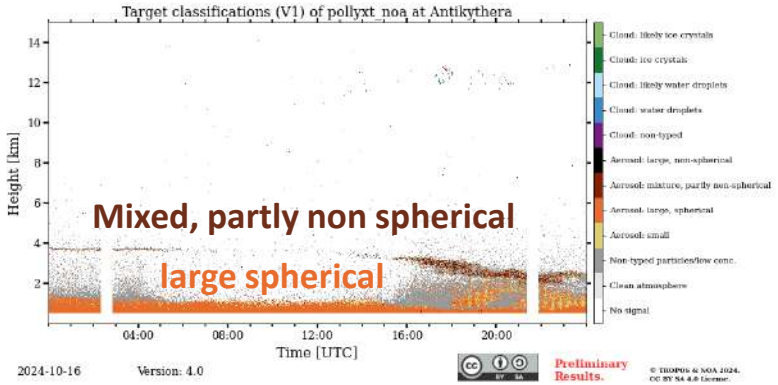
L2 A-TC (AC) 16/10/2024 12:49 UTC - AKY

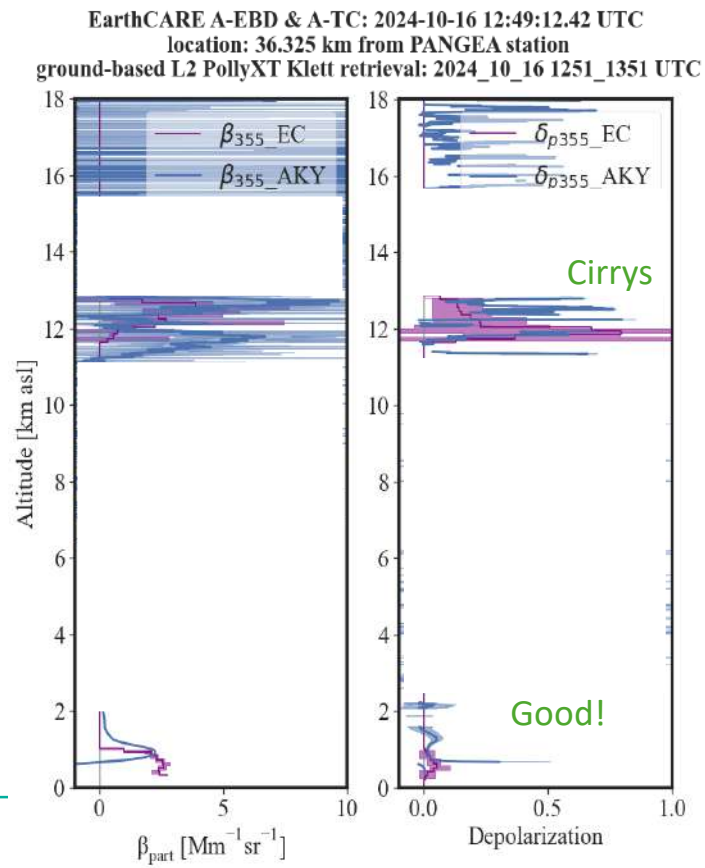
ATL-EBD Low res





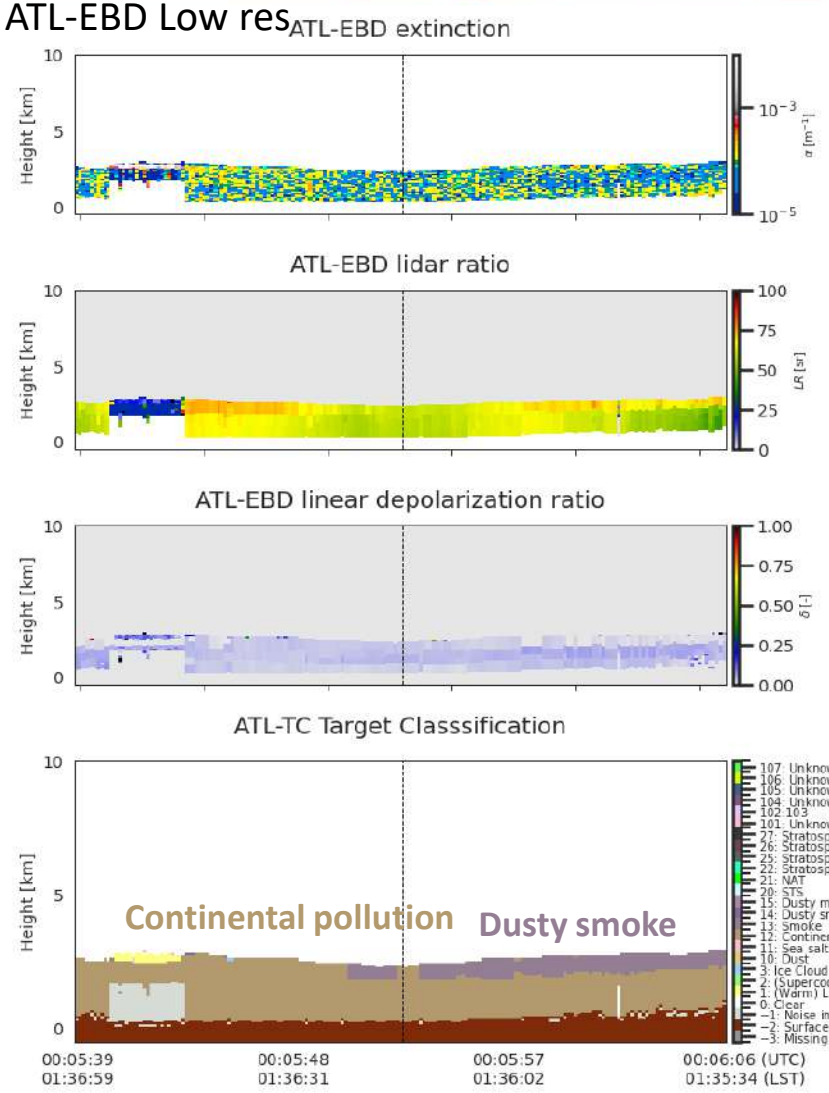


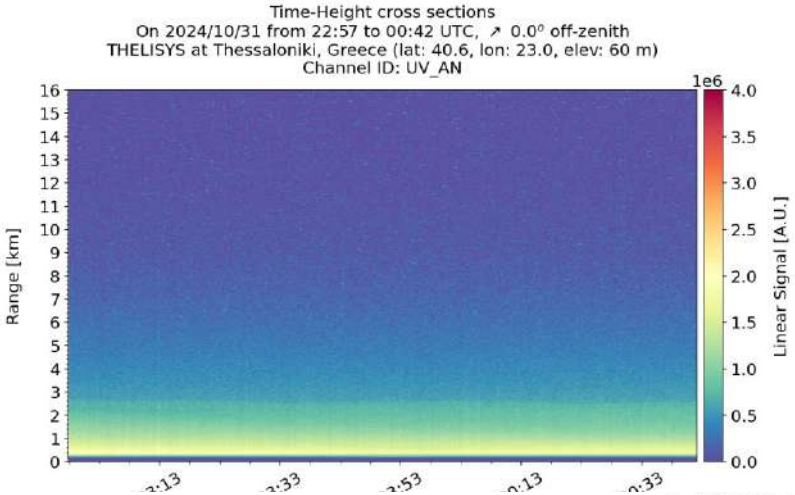


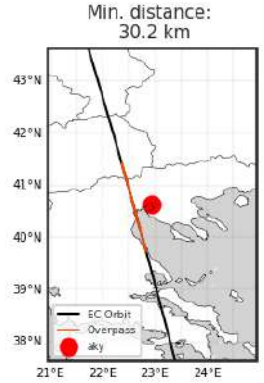


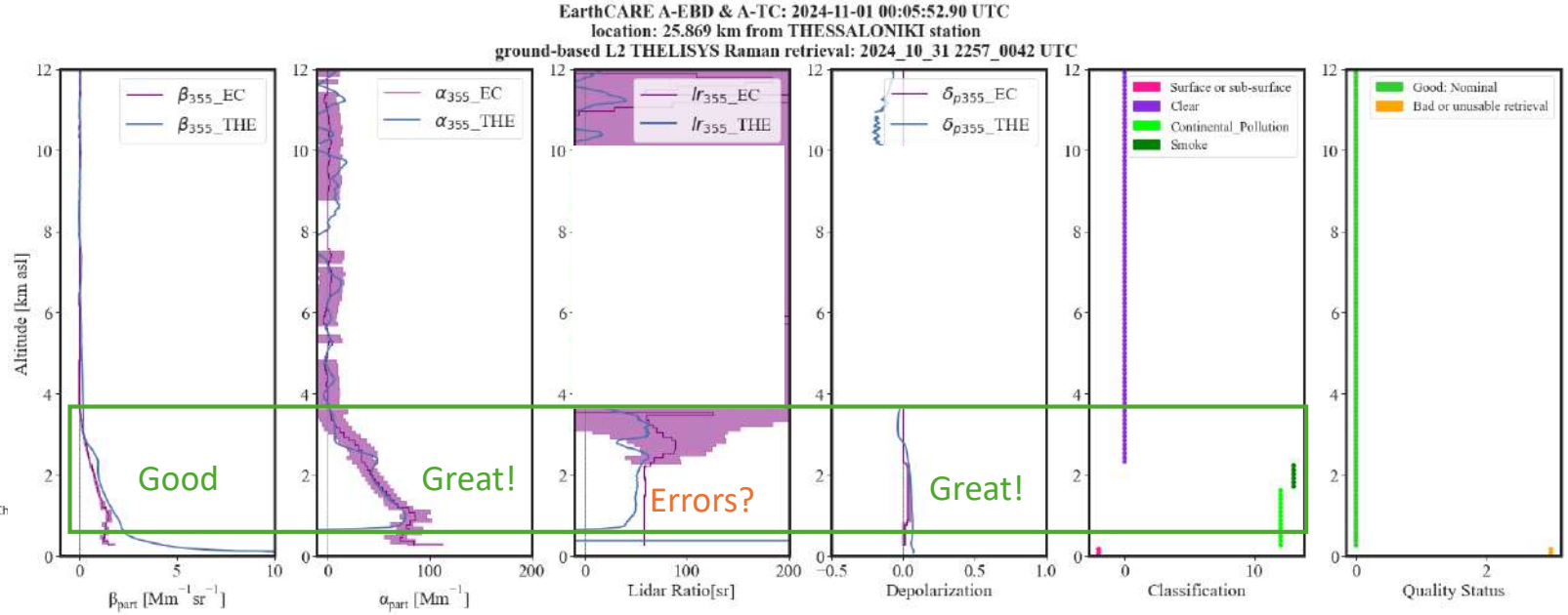
L2 A-EBD & A-TC (AC) 30/12/2024 01:40 UTC - THES

ATL-EBD Low res



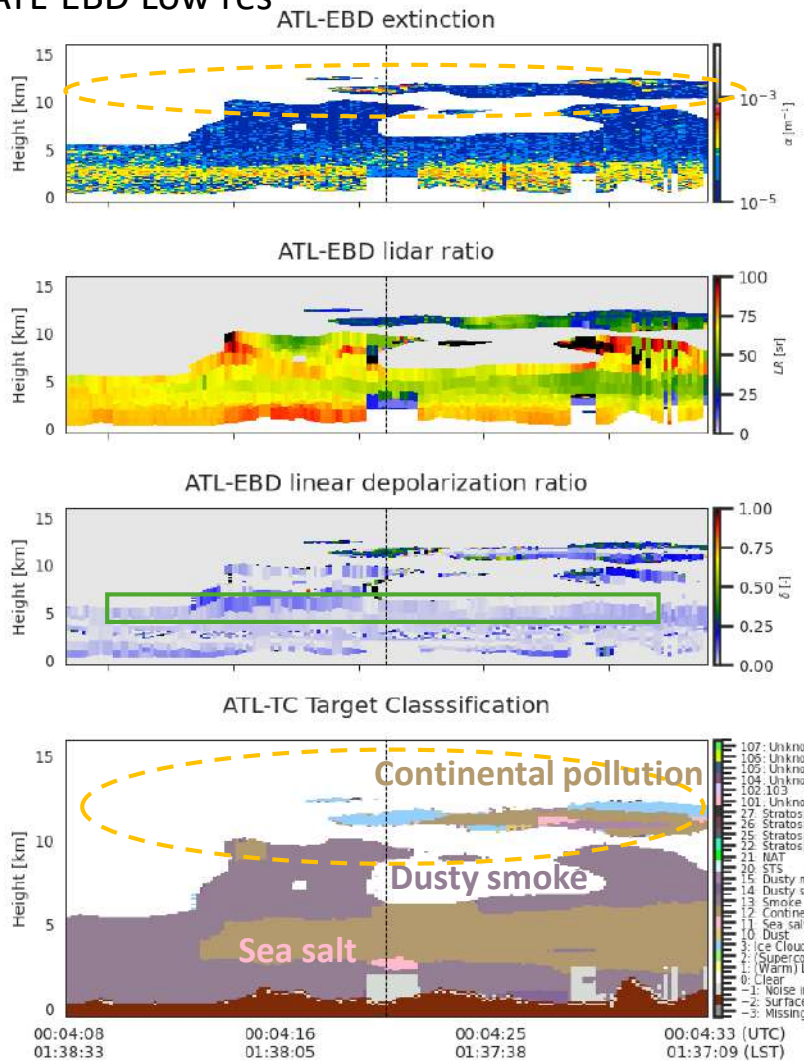


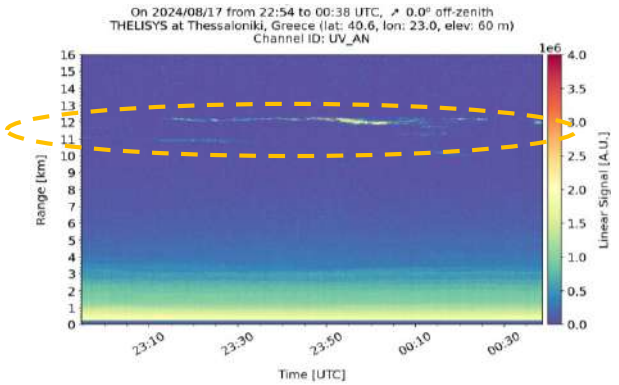




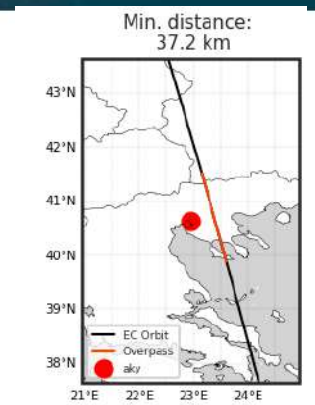
L2 A-EBD & A-TC (AC) 18/08/2024 00:04 UTC - THES

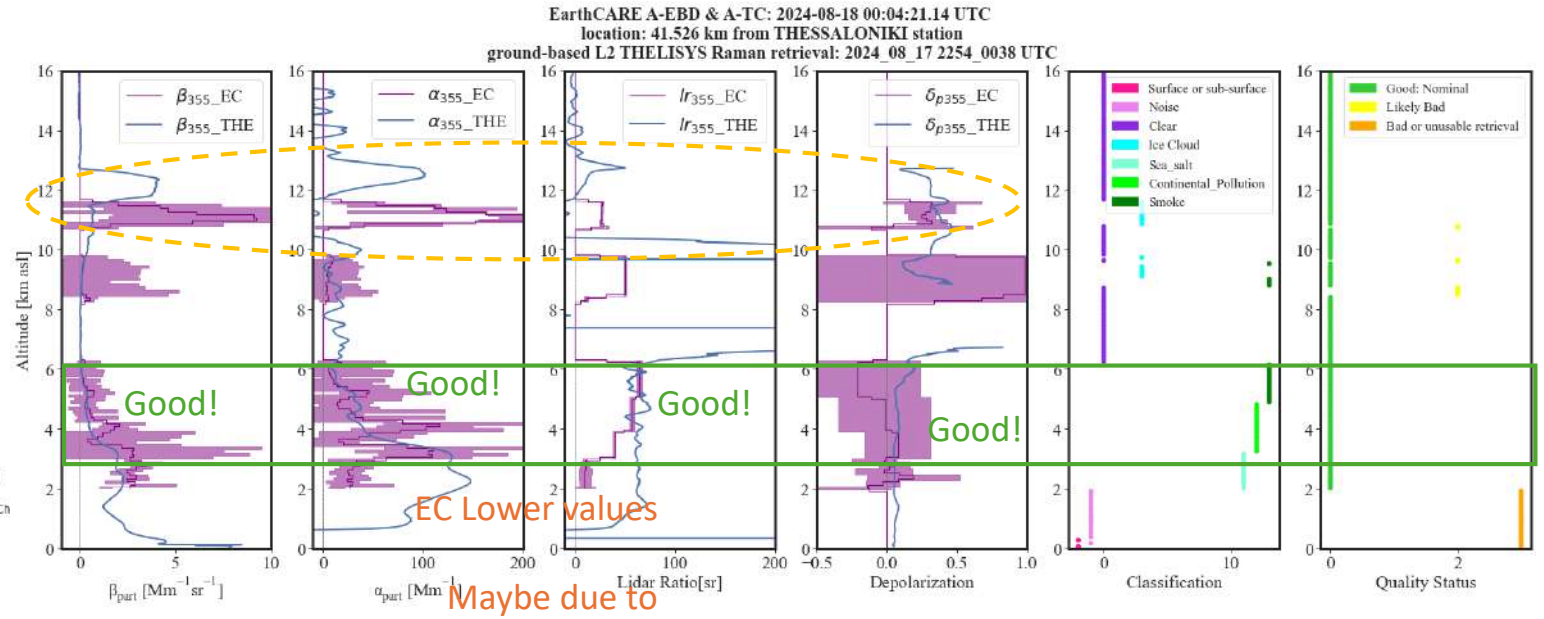
ATL-EBD Low res





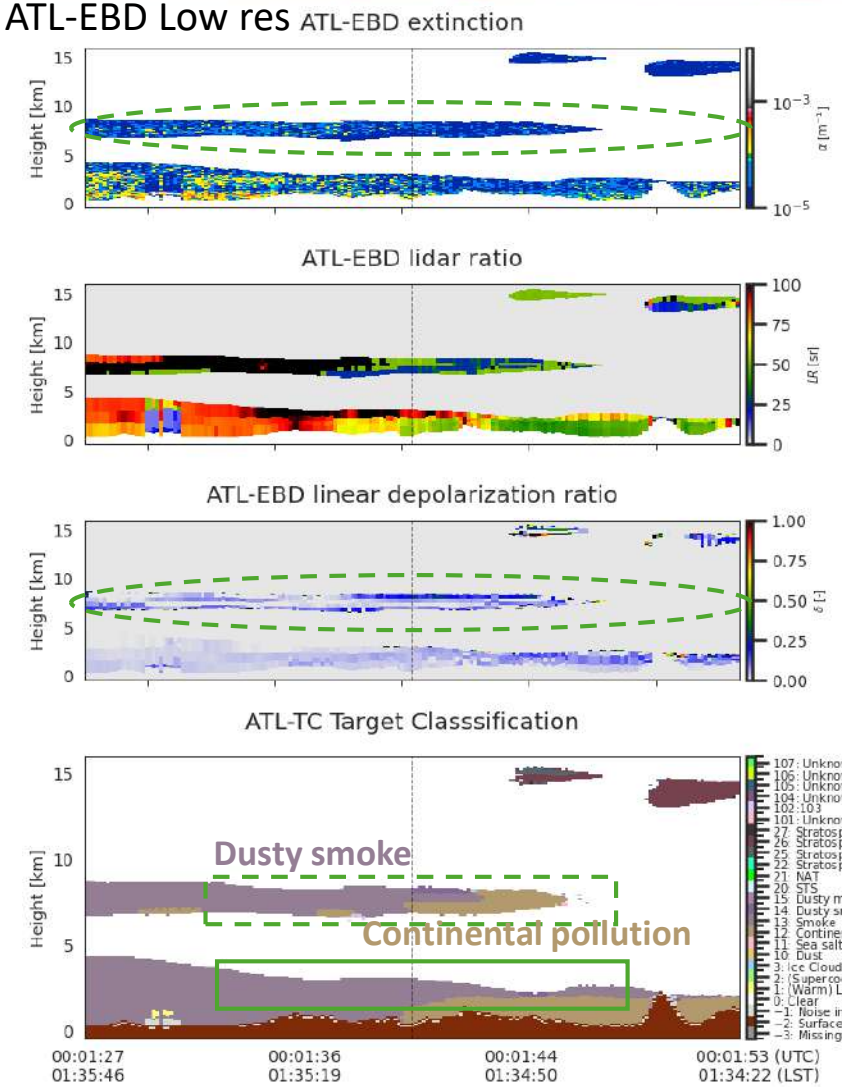
- **Aerosol layer with ice clouds: shift in altitude but depol is within EC uncertainties & Good Classification above site!**
- **Layer <6km: retrievals within errors**

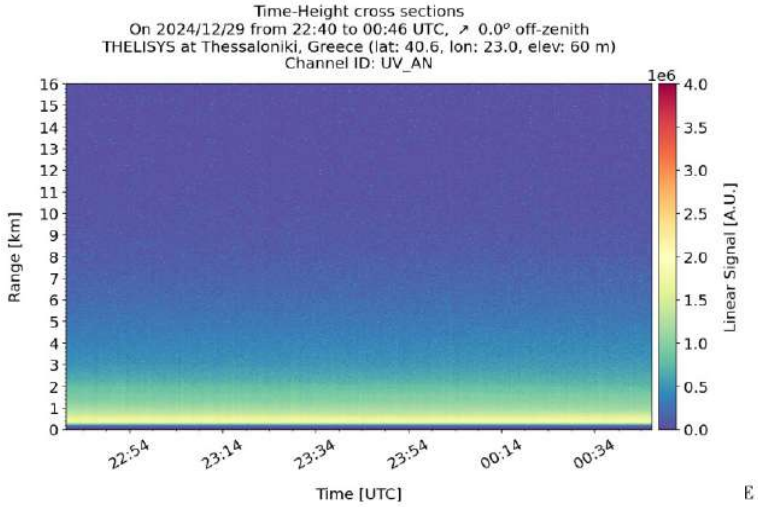




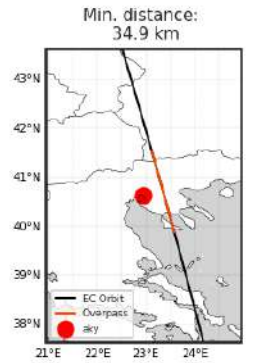
L2 A-EBD & A-TC (AC) 30/12/2024 01:40 UTC - THES

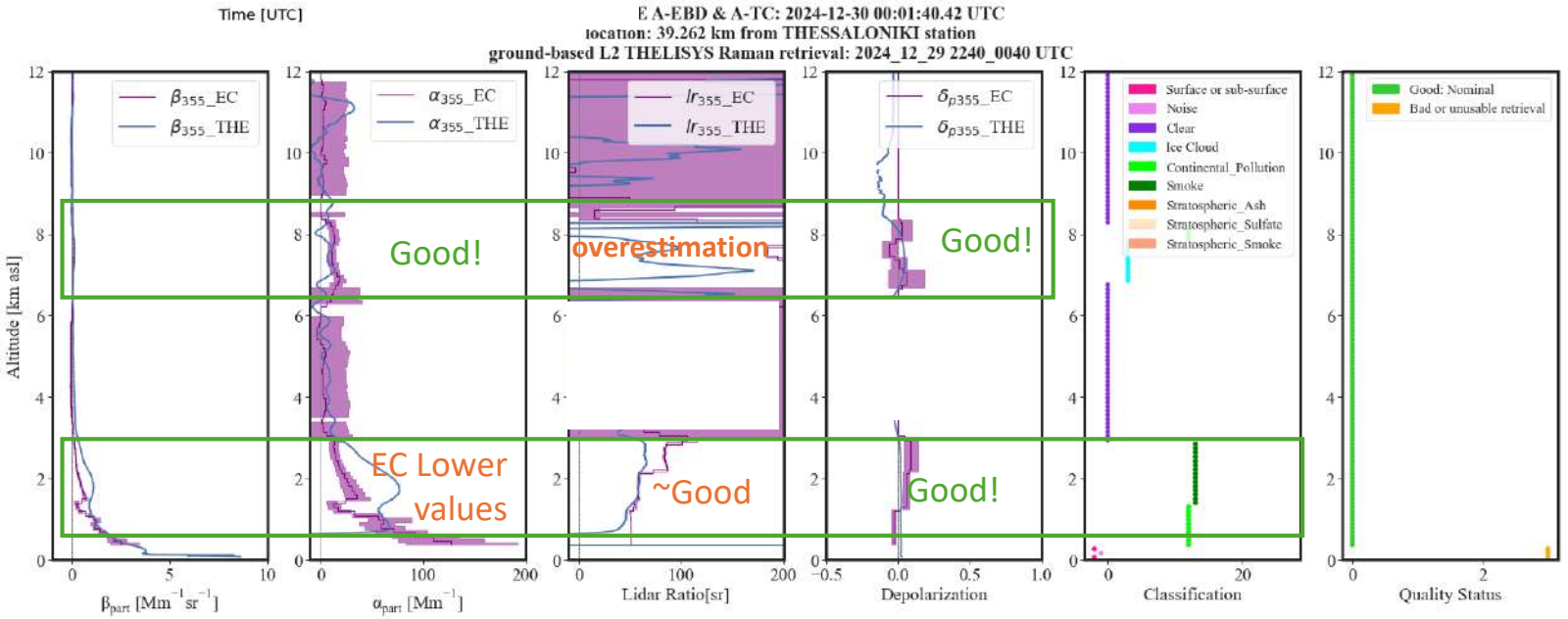
ATL-EBD Low res





- Elevated aerosol layer ~7.5km
- Aerosol Layer < 4km





Summary

A-NOM

- Continuous suborbital measurements with Thessaloniki & Antikythera lidars
- 21 usable collocated cases with ATLID: 5 nighttime cases & 16 daytime cases
- L1 A-NOM AC intercomparison with 5 nighttime overpasses:
  - **Good agreement @ Mie and Rayleigh for 2 cases!** Differences in 3 cases -> scene inhomogeneity
  - ATLID noisy Crosspolar signals

A-TC

- L2 AC intercomparison with 6 overpasses (5 nighttime & 1 daytime):
  - **A-TC is very sensitive in detecting stratospheric aerosol layers!**
  - Some thin / low-concentration layers in mid/low altitudes were not detected
  - Accurate classification of 3 ice clouds, 3 sea salt cases, and 1 dusty smoke case
  - **A-EBD: most features bp, ap, LR, dp were within the errors of the two datasets!**
- Future work:
  - Continue measurements & quantification of L2 product differences
  - Development of visualization python codes, provision to EarthCARE Cal/Val community in collaboration with EC DISC
  - Deployment of ESA's eVe lidar in Pyrgos site under a cross point
  - ACROSS community intense operations including radiation/cloud/in-situ measurements

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