



Validation of EarthCARE products under ACROSS activities

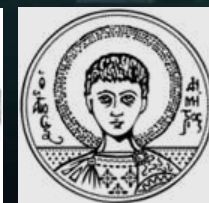
E. Marinou¹, K. Voudouri¹, M. Tsihla¹, P. Paschou¹, A. Karipis¹, G. Peletidou², I. Tsikoudi¹, I. Koutsoupi¹, K. Rizos¹, D. Balis², I. I. Serikov³, D. Kouklaki¹, V. Amiridis¹

¹National Observatory of Athens; ²Aristotle University of Thessaloniki; ³Max Planck Institute

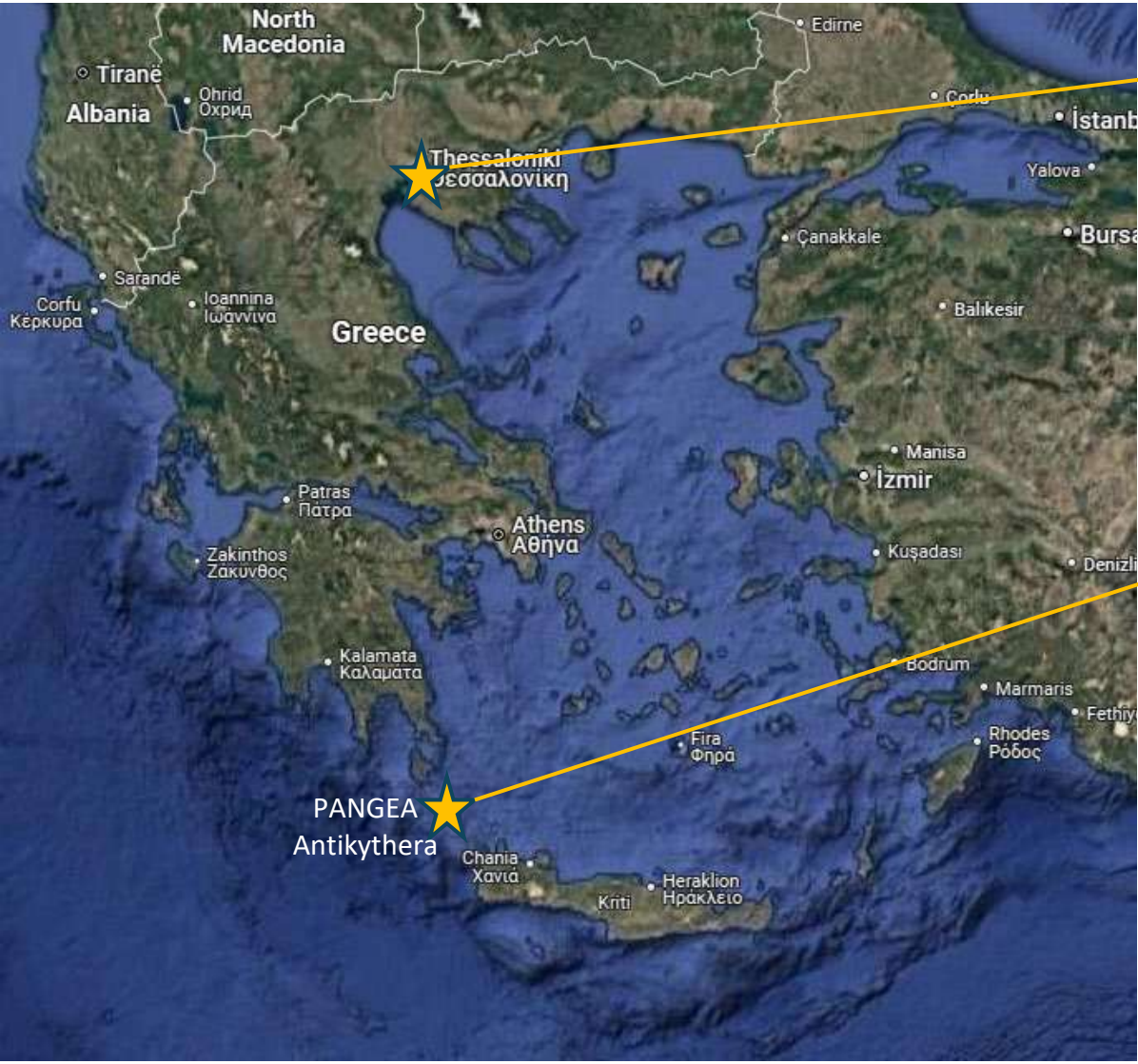
2nd ESA-JAXA EarthCARE In-Orbit Validation Works

17 – 20 March 2025 | Frascati

Funded by EU



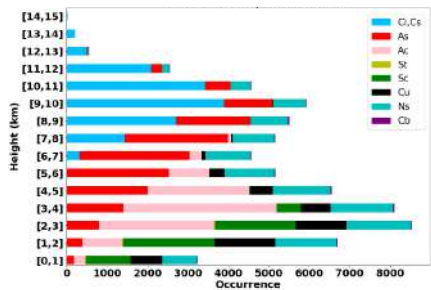
ACROSS Greek sites



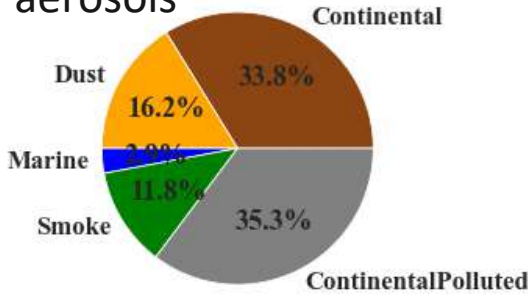
Thessaloniki Urban site

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

CloudSat Cloud Types occurrence (2007 – 2017)



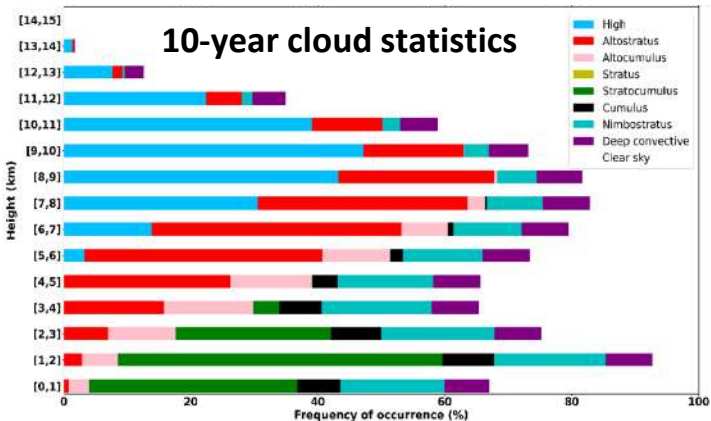
aerosols



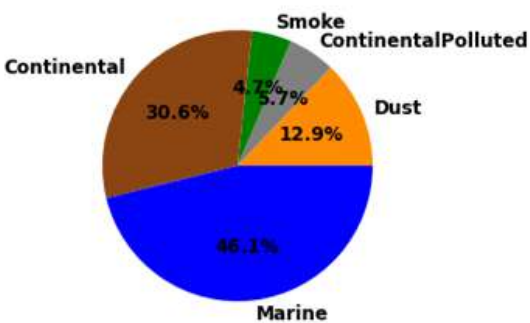
Antikythera background marine site

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

CloudSat Cloud Types occurrence (2007 – 2017)



aerosols



Antikythera measurements



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	
		no signal, window	
2024-09-28T00:09:03	yes	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	
		marine aerosols, but no	
2024-11-19T12:44:59	yes	EarthCARE data	
2024-11-26T00:04:12	yes	low clouds	
		mainly high clouds- big	
2024-12-05T12:48:21	yes	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	
2025-01-15T00:04:26	yes	low clouds	
2025-01-31T12:53:34	yes	low clouds	
2025-02-02T12:43:06	yes	low clouds	
2025-02-09T00:04:06	yes	low clouds	
2025-02-18T12:46:00	yes	low clouds	
2025-02-25T00:06:07	yes	low clouds	
2025-02-27T12:53:07	yes	low clouds	
2025-03-06T00:03:39	yes	dust	
2025-03-15T12:45:33	yes	dust mixture	

Antikythera Overpasses

3 golden nighttime cases & 4 daytime cases:

- 7/10/2024: Thin aerosol layer @ 5km
- 12/12/2024: Cirrus @ 6-9 km
- 6/3/2025: dust

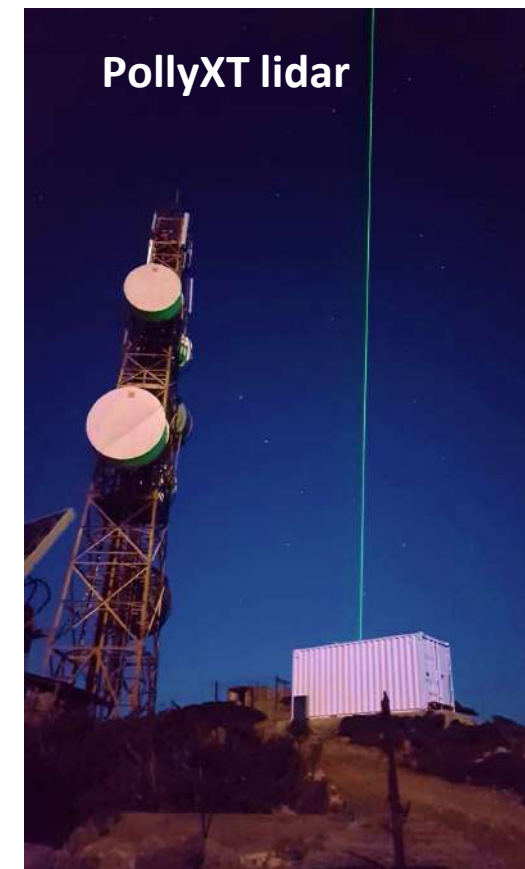
Measurements:

bp, ap, dp @355nm

bp, ap, dp @532nm

bp @1064nm

Full overlap @1km



Thessaloniki measurements



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 personnel	
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	Unhomogeneous vs Earthcare	41km
2024-11-10T12:47:42		clouds	
2024-11-17T12:54:52		instrument availability	
2024-11-26T00:05:24		lack of personnel	
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	
2025-01-15T00:04:26	no	low clouds	38km
2025-01-15T12:50:02	no	low clouds	13km
2025-01-24T00:00:43	no	low clouds	38km
2025-01-24T12:46:26	no	low clouds	90km
2025-01-31T12:53:34	10:59:08 - 13:31:37	aerosols up to 2km	63km
2025-02-09T00:04:06	no	low clouds	38km
2025-02-09T12:49:41	no	low clouds	13km
2025-02-18T00:00:16	no	low clouds	38km
2025-02-18T12:46:00	no	low clouds	90km
2025-02-25T12:53:07	no	low clouds	63km
2025-03-06T00:03:39	22:52:57 - 00:58:07	clear sky	38km
2025-03-06T12:49:15	11:39:11 - 13:42:46	clear sky	13km
2025-03-14T23:59:50	22:59:09 - 01:03:49	dust and cirrus clouds	38km
2025-03-15T12:45:33	08:32:57 - 14:32:49	dust and cirrus clouds	90km

Thessaloniki Overpasses

5 golden nighttime cases & 16 daytime cases:

- 18/8/2024: Cirrus 10-12 km
- 1/11/2024 & 6/3/2025: Clear sky
- 30/12/2024: Clouds at 7 km
- 14/3/2024: Dust & Cirrus

Measurements:

bp, ap @355nm

bp, ap, dp @ 532nm

bp 1064nm

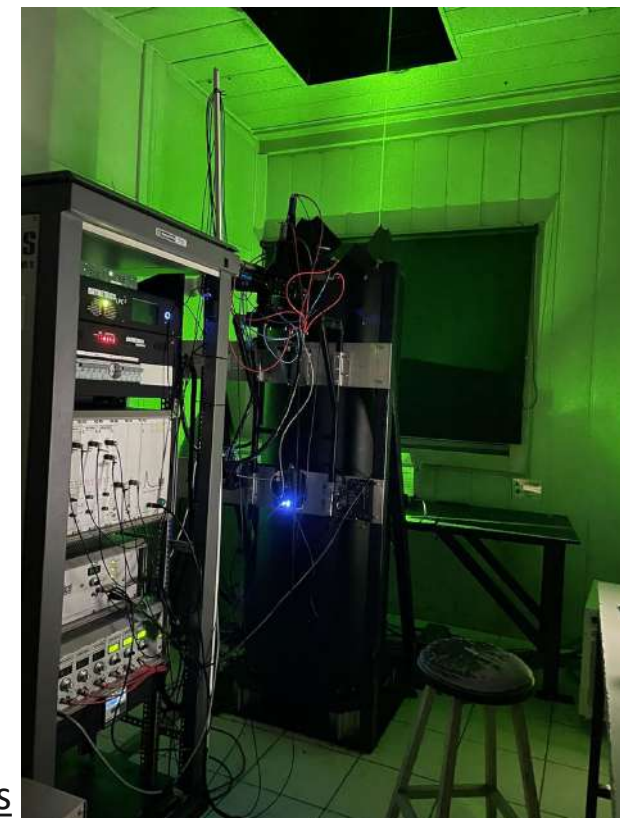
Depolarization measurements

@ 532nm -> converted to 355nm

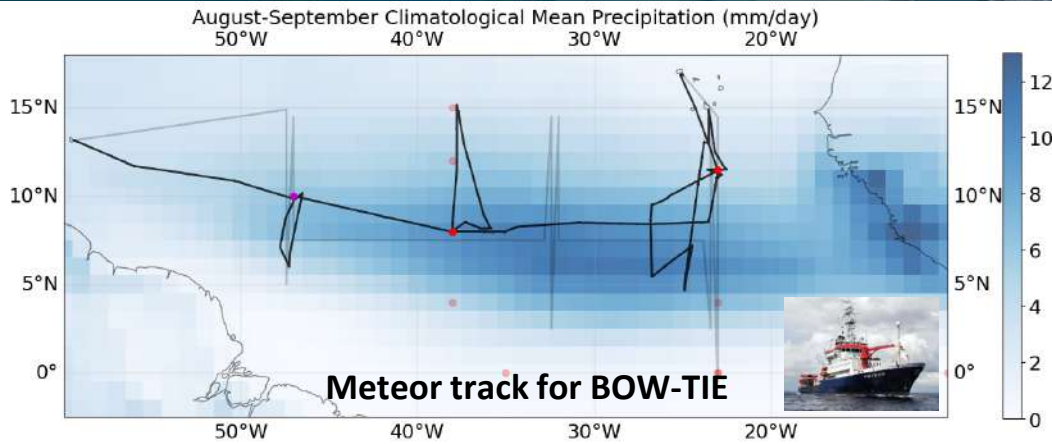
$Dp_{355} = Dp_{532} * 0.89$

reference:

DEDICATE EarthCARE-related conversion factors



BOW-TIE campaign



LIDAR	MPI-LICHT Raman Lidar		
PLATFORM	R/V Meteor		
TIME PERIOD	BOW-TIE (16 Aug - 23 Sep)		
PASS	OVERPASS_DATE	OVERPASS_TIME_UTC	Clouds presence
1	2024-08-20	15:52	no
2	2024-08-22	15:42	2 km
3	2024-08-30	03:29	5 km
4	2024-08-31	15:40	1 km
5	2024-09-03	16:10	2 km
6	2024-09-16	17:15	5 km

6 EarthCARE overpasses (5 daytime + 1 nighttime)

Measurements:

bp @355nm

bp, dp @532nm

WVMR, RH, T



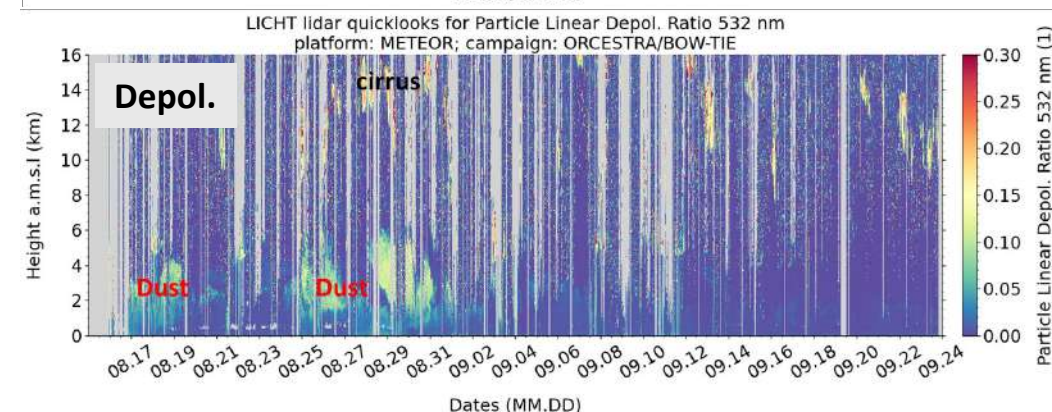
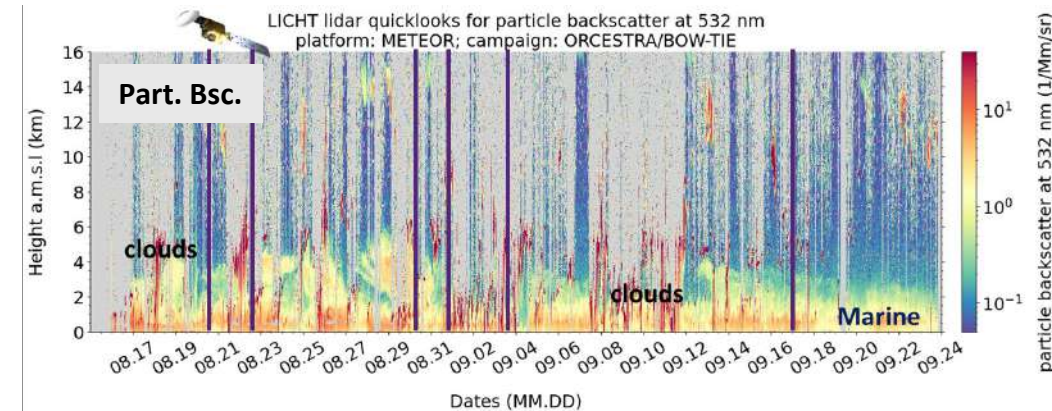
Depolarization measurements @ 532nm -> 355nm

$Dp_{355} = Dp_{532} \cdot 0.89$

reference: DEDICATE EarthCARE-related conversion factors

bp355 -> ap355

Pre-fixed LR based on EarthCARE classification (A-TC)



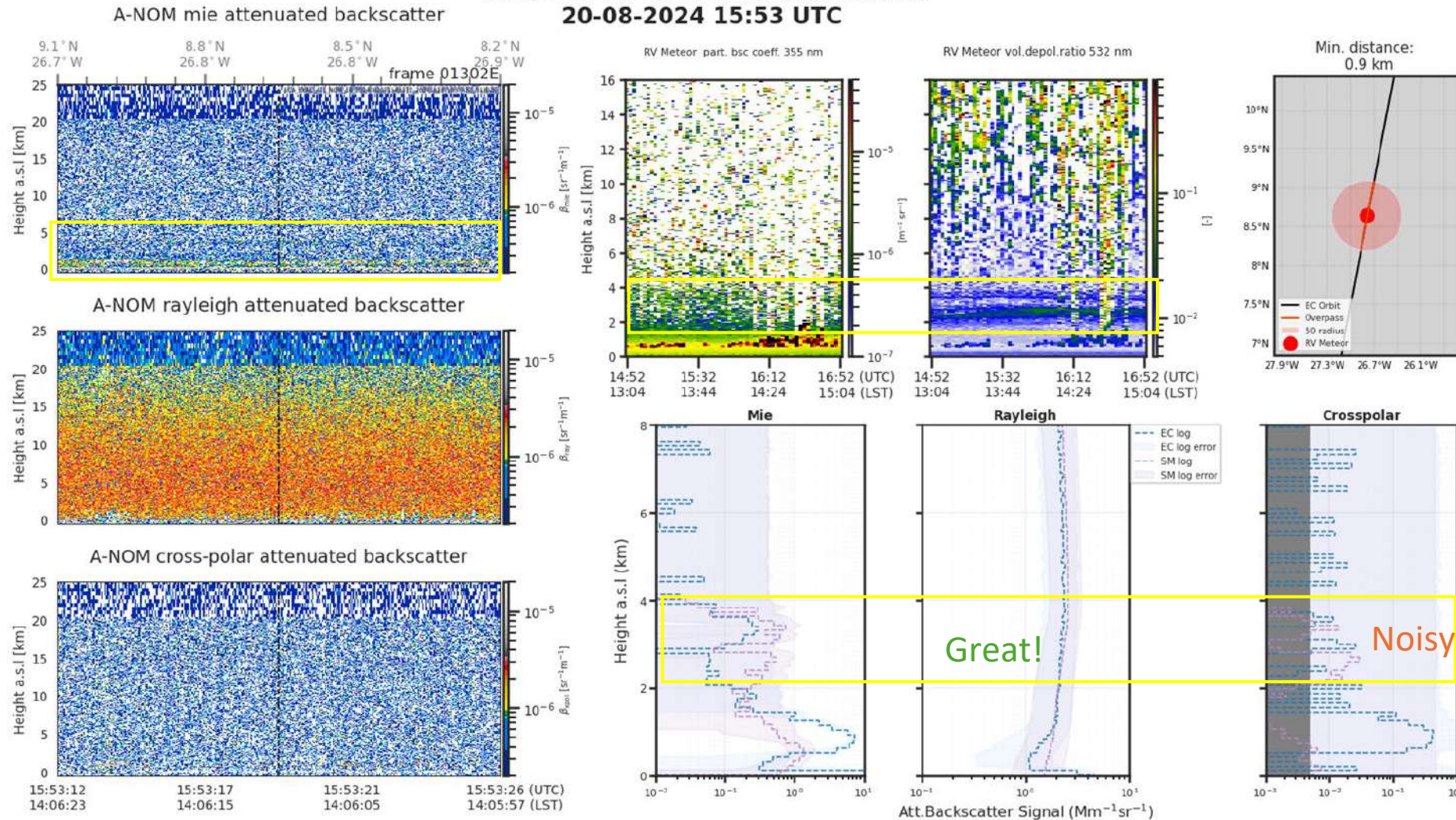
L1 intercomparisons

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

L1 A-NOM (AC) 20/8/2024 15:53 UTC – RV Meteor

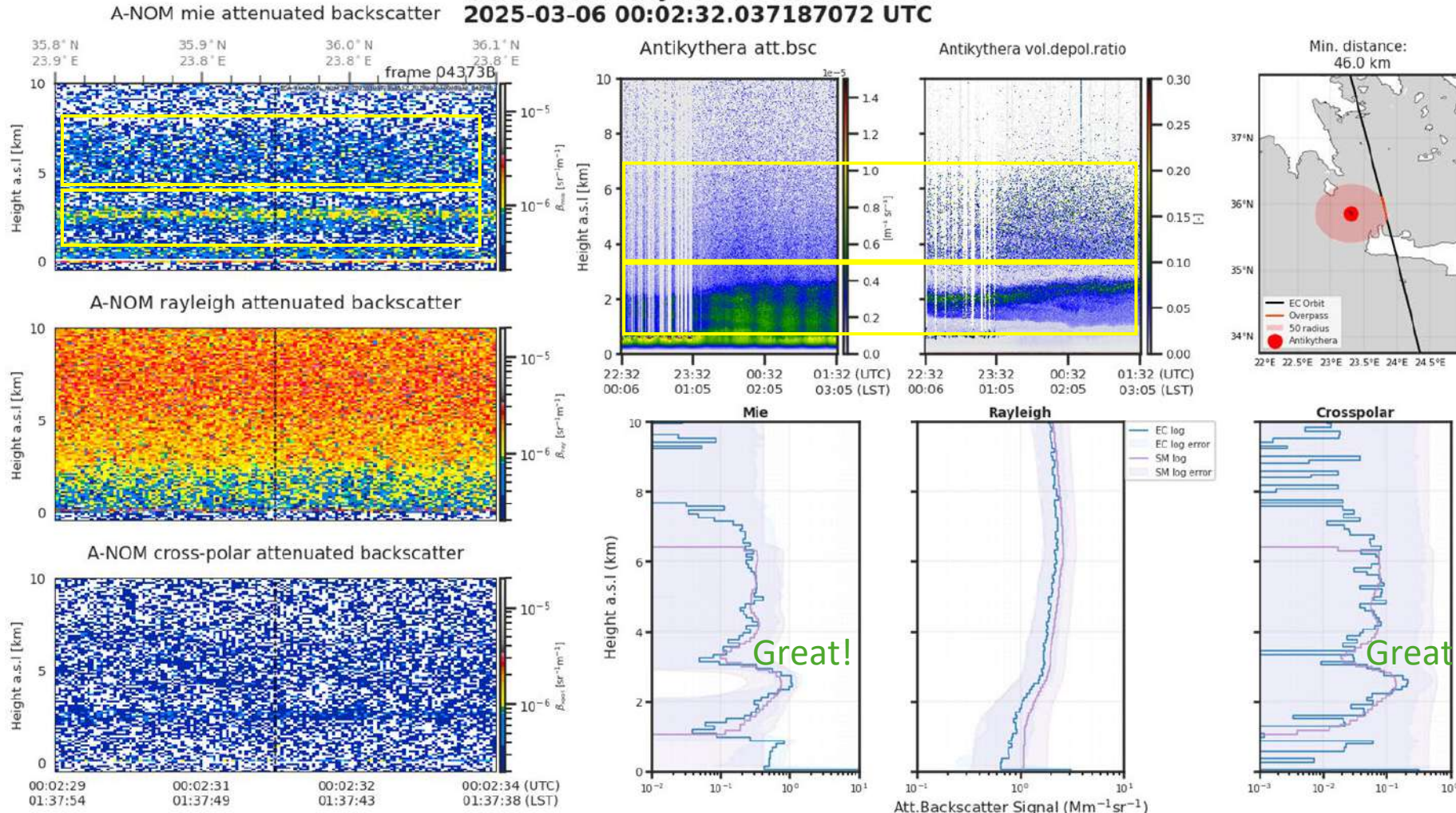


EarthCARE A-NOM (AC) Comparison with simulated data based on RV Meteor measurements 20-08-2024 15:53 UTC



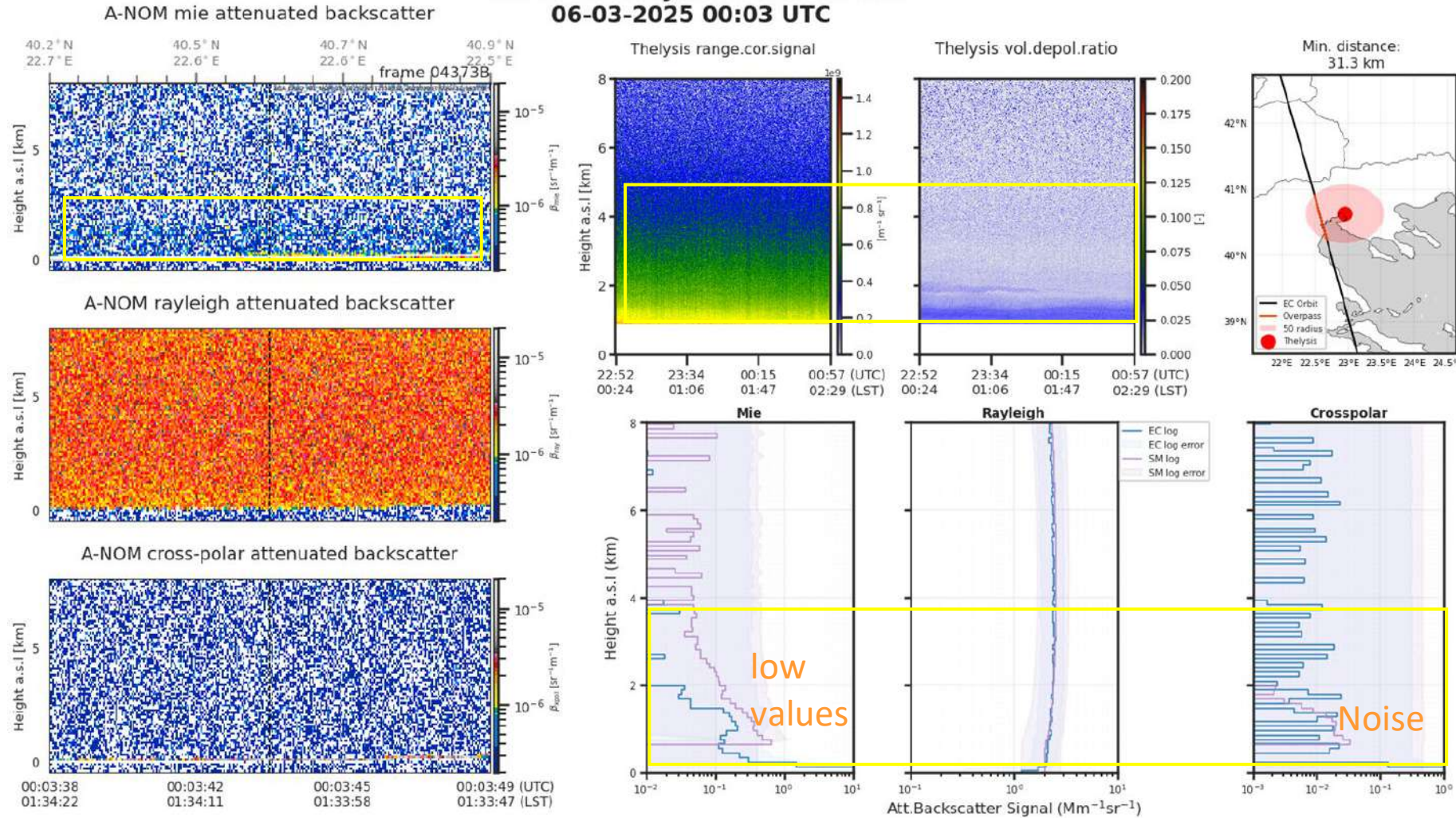
- 1 km overpass distance
- Very accurate layer detection!
- A-NOM Rayleigh: Great!
- A-NOM Mie: not so bad
- A-NOM crosspolar: noisy

EarthCARE A-NOM (AD) Comparison with simulated data based on Antikythera measurements 2025-03-06 00:02:32.037187072 UTC



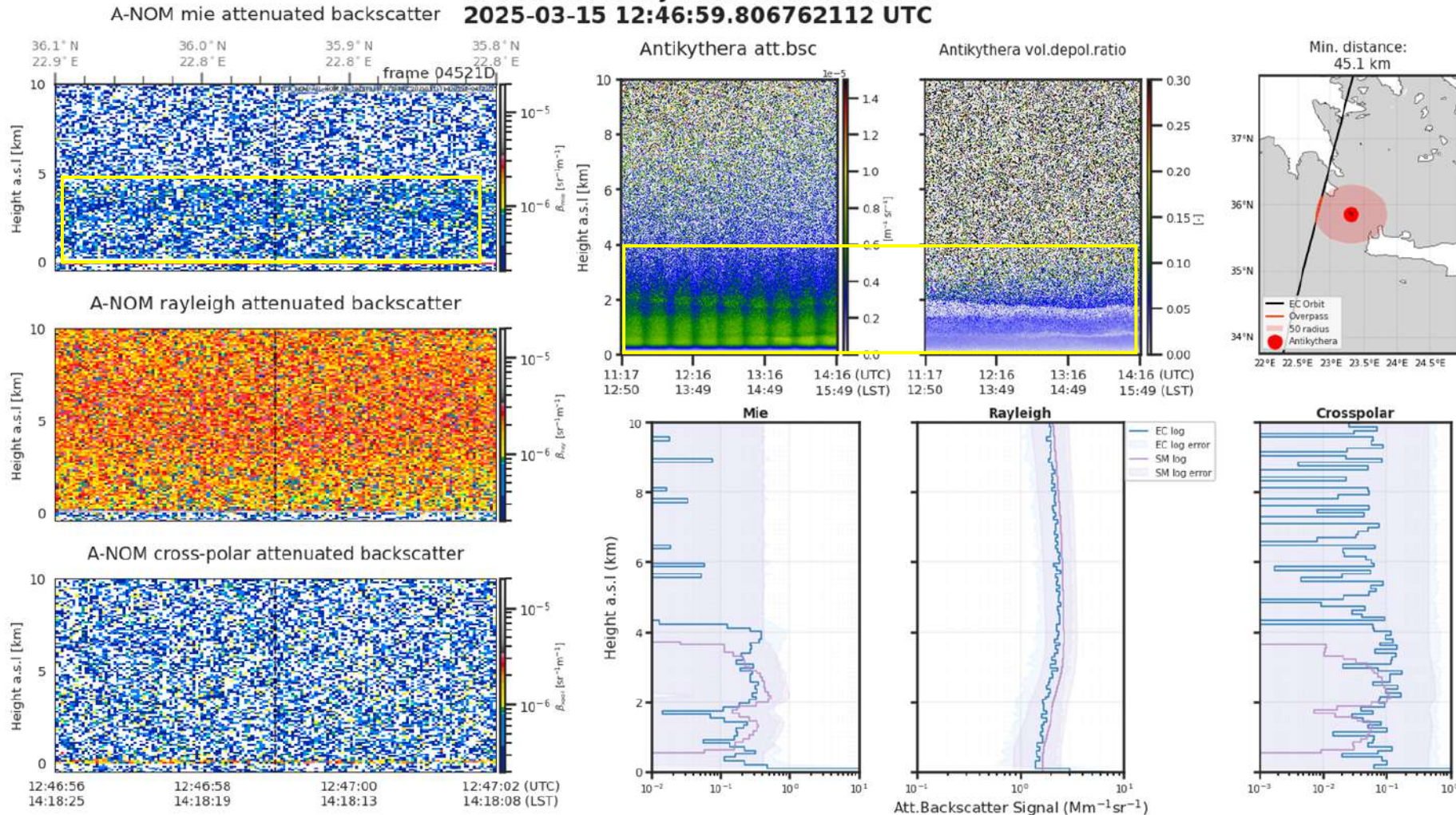
- 46 km overpass distance
- Dust layers
- Aerosol layer up to 5.5 km in both lidars
- A-NOM Mie and crosspolar profiles: Great!

EarthCARE A-NOM (AD) Comparison with simulated data based on Thelysis measurements 06-03-2025 00:03 UTC



- 31 km overpass dist.
- Aerosol layer: different heights
- Mie: lower values
- Crosspolar: Noise

EarthCARE A-NOM (AE) Comparison with simulated data based on Antikythera measurements 2025-03-15 12:46:59.806762112 UTC



- 45 km overpass distance
- Polluted Dust layers
- Aerosol layers detected nicely
- A-NOM Mie: lower values
- A-NOM crosspolar: higher values

L2 intercomparisons

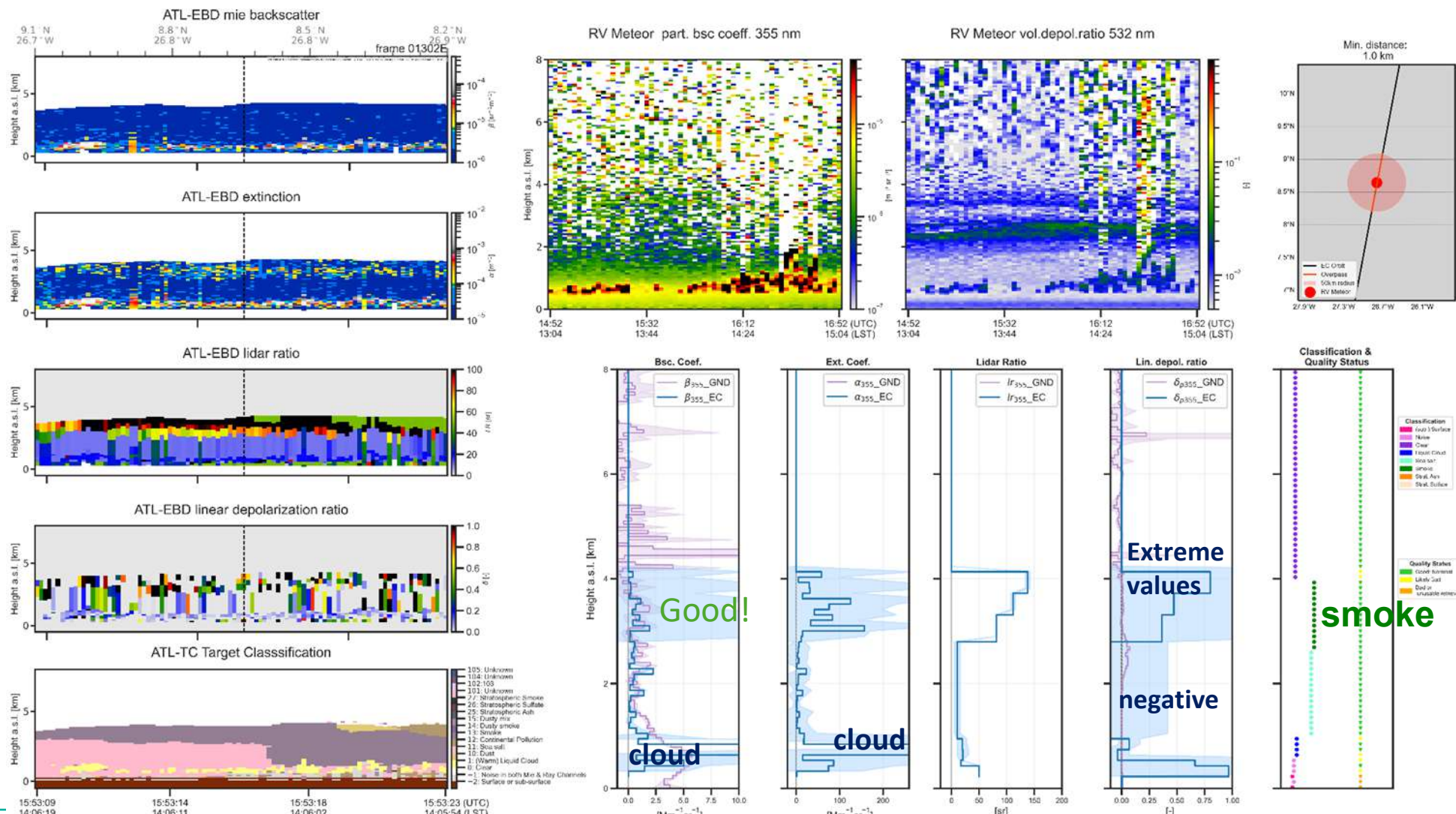
using single EC profiles at distance < 50 km

L2 A-EBD & TC (AC) 20/08/2024 15:44 UTC – RV METEOR



EarthCARE A-EBD(AC) & A-TC(AC) Comparison with RV Meteor Ground Station - MPI LICHT L2 Retrieval
 ECA: 20-08-2024 15:53:16.53 UTC - MPI LICHT: 20-08-2024 15:44:00.00 UTC

ATL-EBD Low
 res

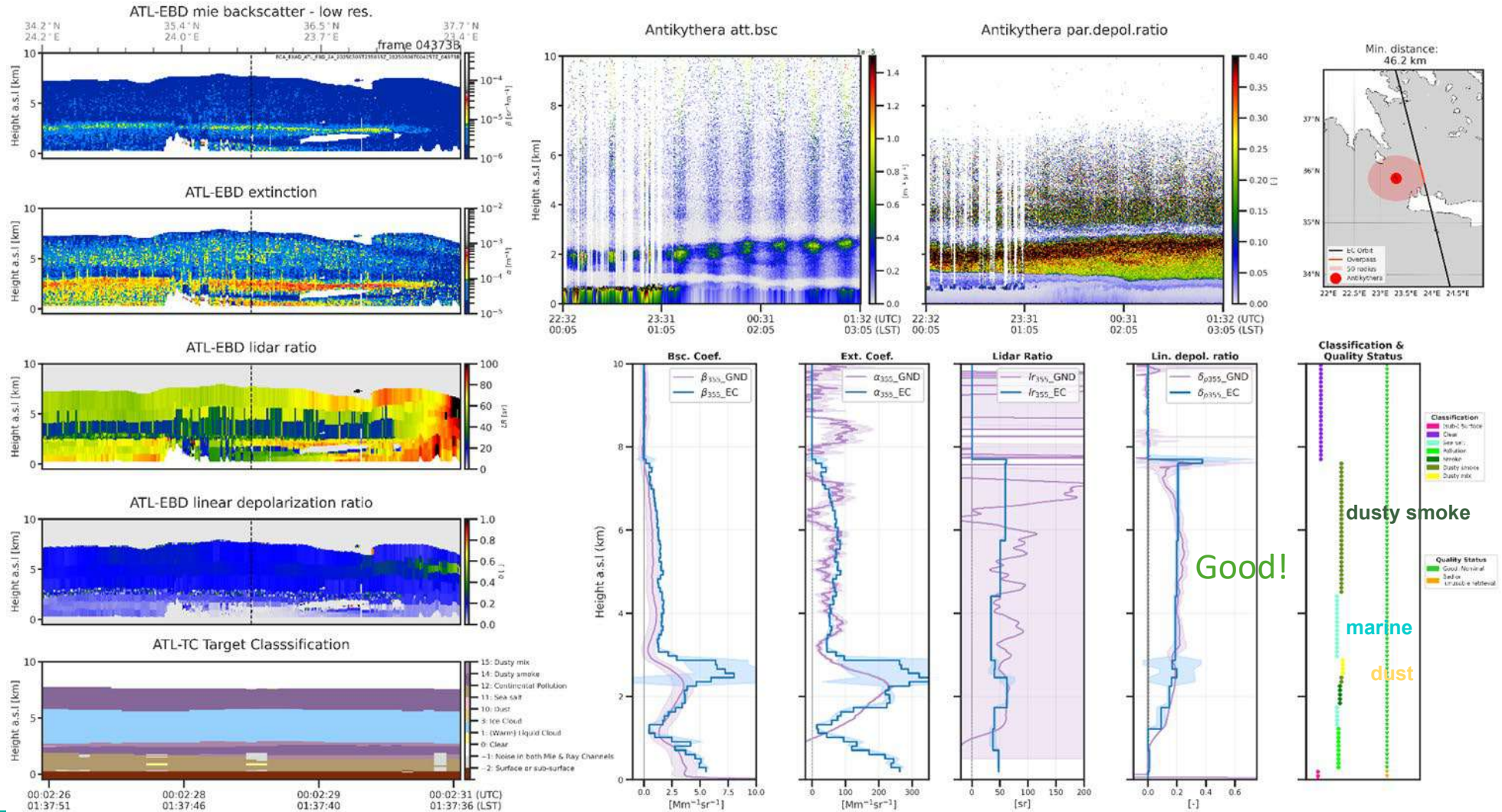


L2 A-EBD & TC (AD) 06/03/2025 00:02 UTC - AKY



ATL-EBD Low
res

EarthCARE A-EBD(AD) & A-TC(AD) Comparison with Antikythera Ground Station L2 Raman Retrieval
06-03-2025 00:02:29.32 UTC

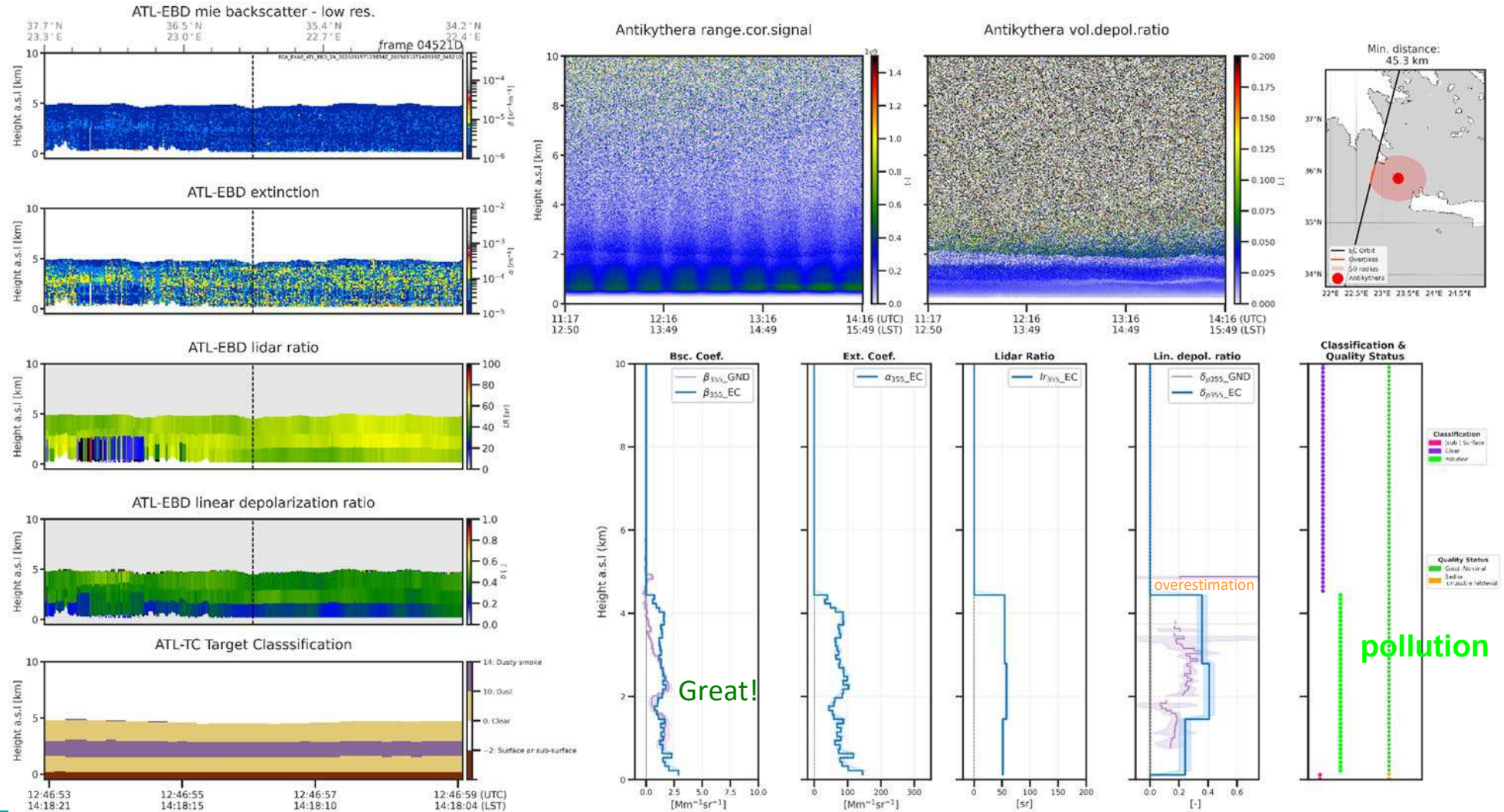


L2 A-EBD & TC (AD) 06/03/2025 00:02 UTC - AKY



ATL-EBD Low
res

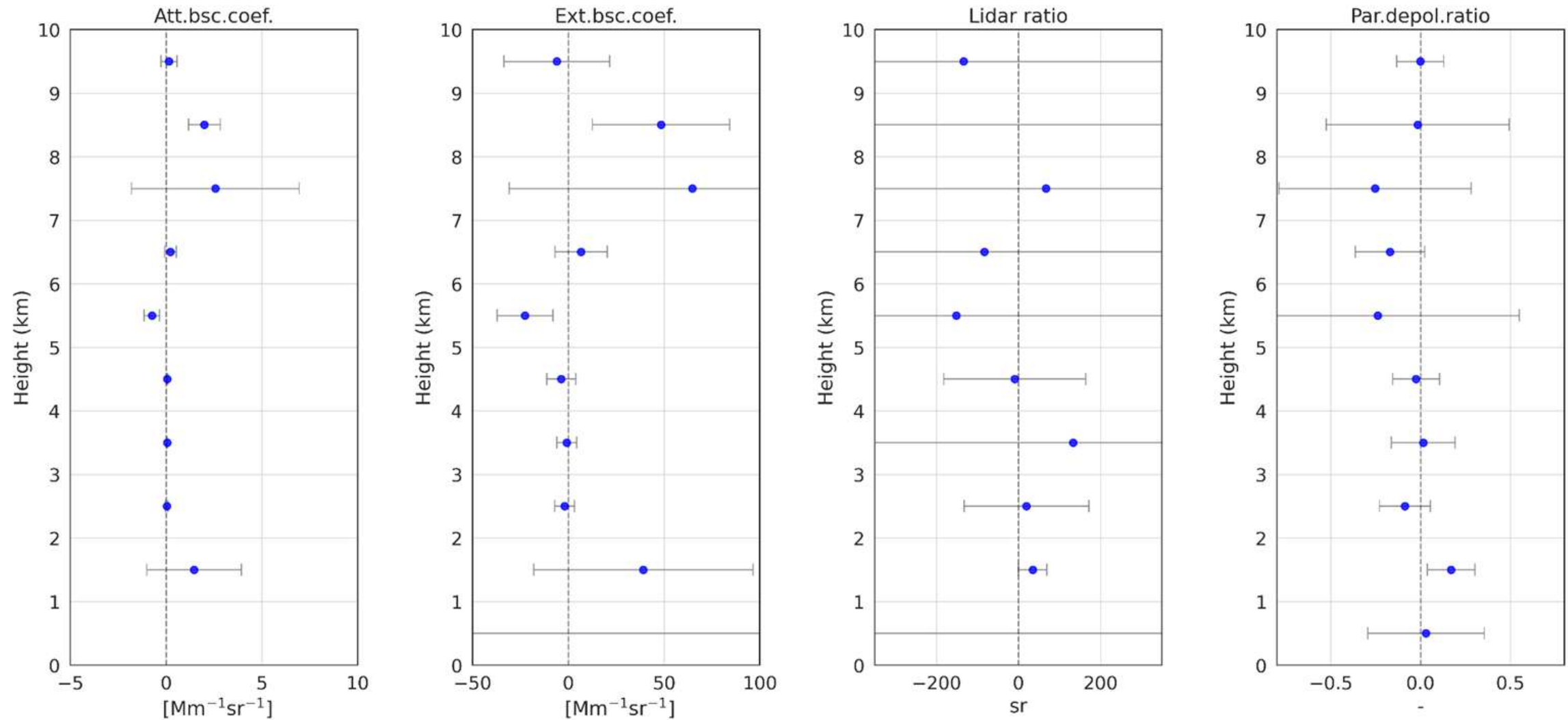
EarthCARE A-EBD(AE) & A-TC(AE) Comparison with Antikythera Ground Station L2 Klett Retrieval
15-03-2025 12:46:57.12 UTC



Statistical intercomparisons for L2 A-EBD (AC)

Mean Bias - AC baseline - Antikythera overpasses - 50km

Preliminary

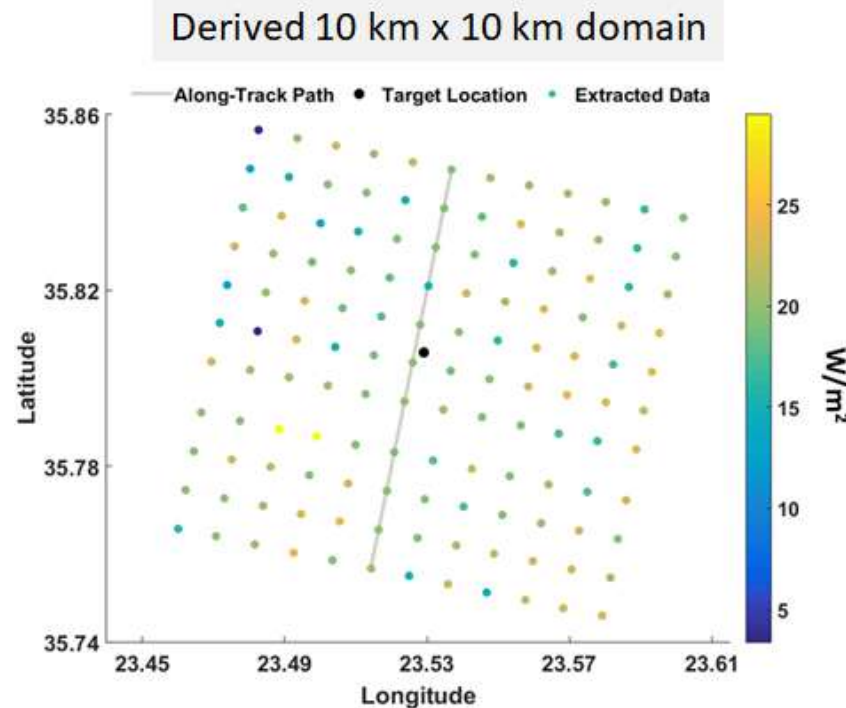


Radiation: Closure of BBR fluxes



Selected case study: 19/11/2024

EC and PERCUSION-HALO overpass - Antikythera, Greece



Methodology

- 1D RT simulations for each column:
 - (a) along track in 10km x 10km domain
 - (b) in the whole 10km x 10km domain
- Closure with BBR fluxes

BMA-FLX comparison with RT Average Along Track [10 km]

Abs. Diff: 19.26 W/m²

Rel. Diff: 21.81%

BMA-FLX comparison with RT Average Domain [10 km x 10 km]

Abs. Diff: 19.85 W/m²

Rel. Diff: 22.62%

Work in progress

Future work:

Closures with EC fluxes for more PERCUSION underpass cases – and larger variability in atmospheric observations

Closures with PERCUSION radiation measurements during EC underpasses



Summary

A-NOM

- Continuous suborbital measurements with Thessaloniki & Antikythera lidars
- BOW-TIE LICHT lidar measurements
- 29 usable collocated cases with ATLID
- L1 A-NOM intercomparison
 - Good agreement @ Mie and Rayleigh!
 - ATLID noisy Crosspolar signals
 - **Crosspolar Improvement in AD, higher values in AE ?**

A-TC

- L2 intercomparison
 - Very good layer detection!
 - **Depolarization ratio in AD better than in AE and AC ?**
 - Possibility for improvements in A-TC

Future work:

- Analyze all cases with same baselines after reprocess
- Evaluate other products
- Radiation closures with EarthCARE fluxes for PERCUSION underpass cases
- Radiation Closures with PERCUSION radiation measurements during EC underpasses

