First validation results from AECARE
including the ATMO ACCESS pilot activity

Holger Baars on behalf of the
ACTRIS, EARLINET, Cloudnet, and ATMO-ACCESS teams
with contributions from M. Sicard, M. Haarig, H. Gebauer, C. Papanikolaou

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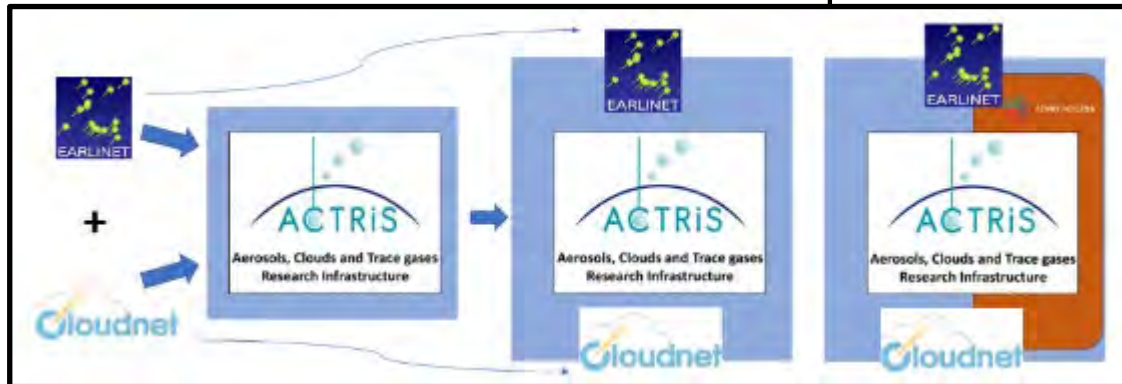14 – 17 January 2025 | VIRTUAL EVENT

What is AECARE?

AECARE=ACTRIS for EarthCARE L2 product evaluation

- ESA cal/val proposal (EVID05, AOID 38644)
- Initiative started years ago and evolved over the years due to research infrastructure developments:

- Involvement of ACTRIS central facilities with centralized QA/QC and data flows
- New stations, new instrumentation, changing partners
- Funding of operation secured, but very limited for data analysis
  → **concentrate on data delivery to EVDC**
- Use of ATMO-ACCESS pilot activity (Trans National Access) to prepare validation activities and get limited funding
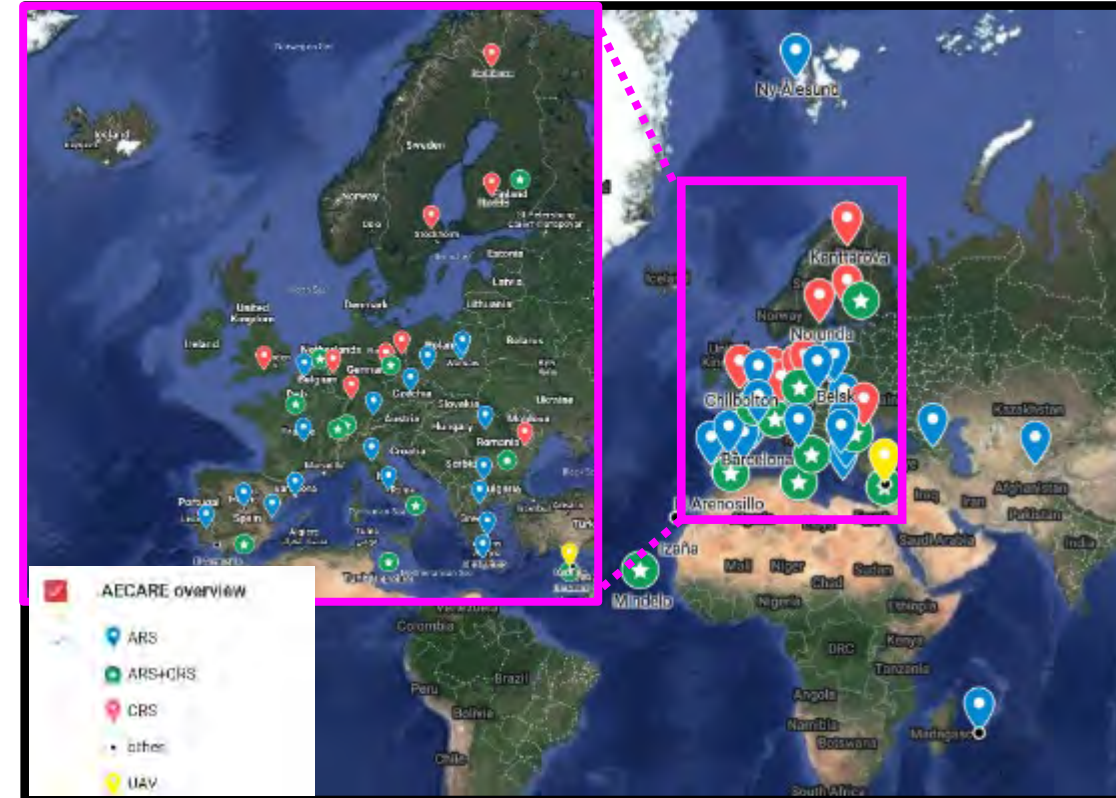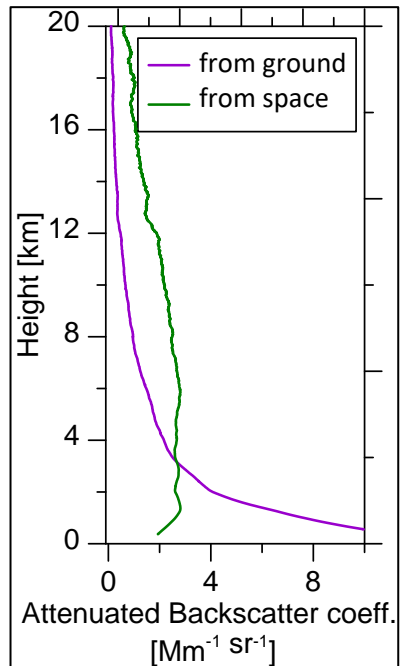

ARS = aerosol remote sensing (lidar+photometer)
CRS = cloud remote sensing (radar+MWR+ceilometer+disdrometer+..)

Level 1 data from ground and space are not the same!
(Attenuated backscatter coefficient for Mie, Ray, and cross)

→ Direct comparison not possible

Direct use of L1 data by using **ratios**

- Depolarization ratio

- Scattering ratio

Use of **simulator** tools

- CARDINAL ATLID simulator tool

- Prerequisite:
  Observing exactly the same atmospheric scene in the whole column

→the strength of network observations have to be used as direct overpasses are rare

1. Direct use of L1 data by using ratios

- Scattering ratio
- Depolarization validation example

2. Use of simulator tools

- ATLID simulator tool

The present work includes preliminary data (not fully calibrated/validated and not yet publicly released) of the EarthCARE ESA mission developed in collaboration with JAXA. The analysis has been performed in the context of the EarthCARE Validation Team and of the ATLID Integrated Commissioning Team
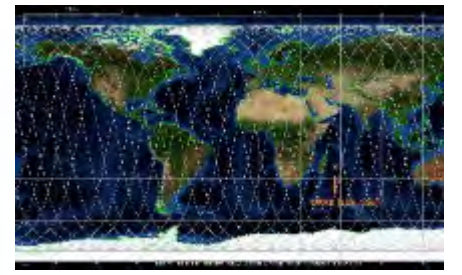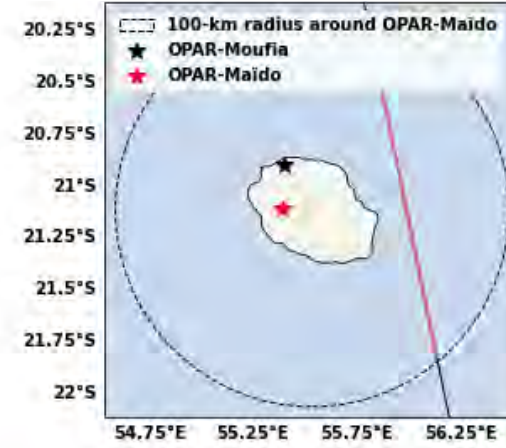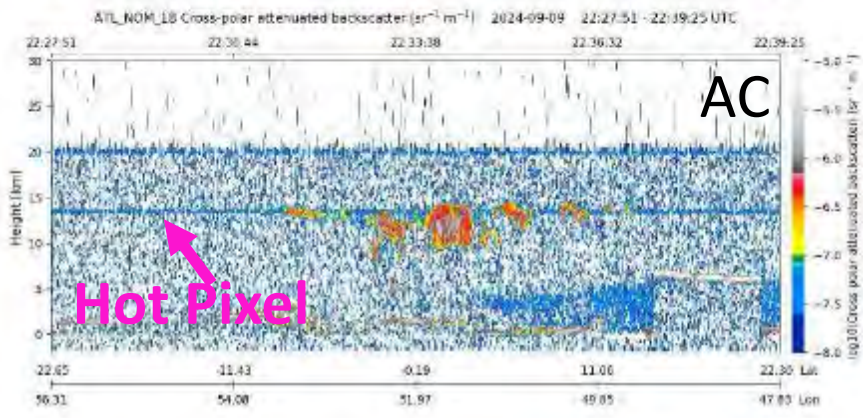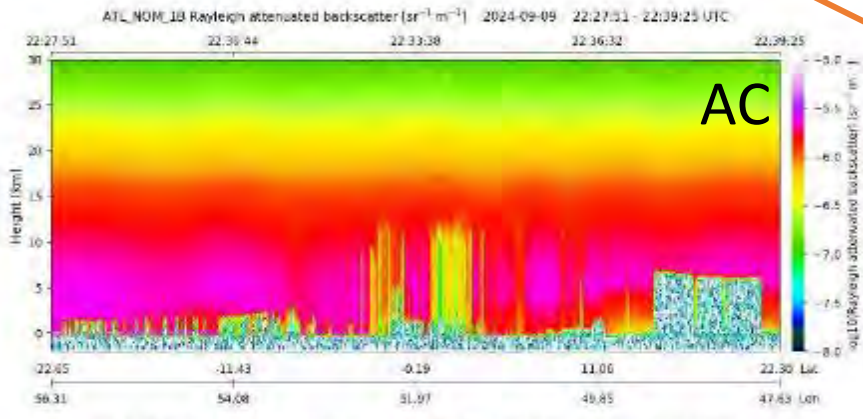
First comparisons ATLID/EarthCARE at Observatory of Atmospheric Physics of la Réunion (OPAR)

Michael Sicard, Dominique Gantois, Niels Groenen, Valentin Duflot, Guillaume Payen, Eric Golubic, Patrick Hernandez, Anne-Sophie Maillot, Yann Hello
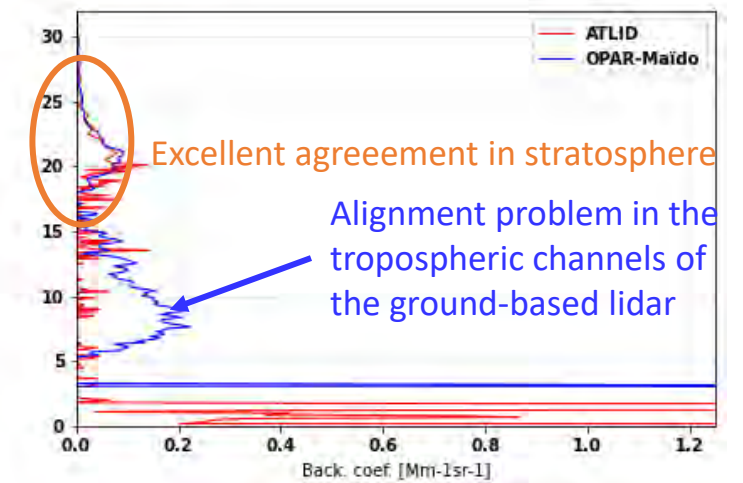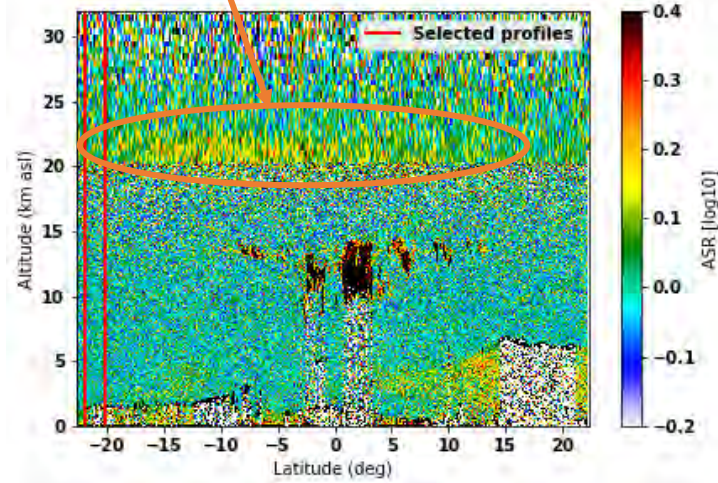
OPAR (21S, 55E)

Mission: EARTHCARE / First Orbit: 2583 (2024-11-10T22:59:54) / Last Orbit: 2612 (2024-11-12T21:16:12)
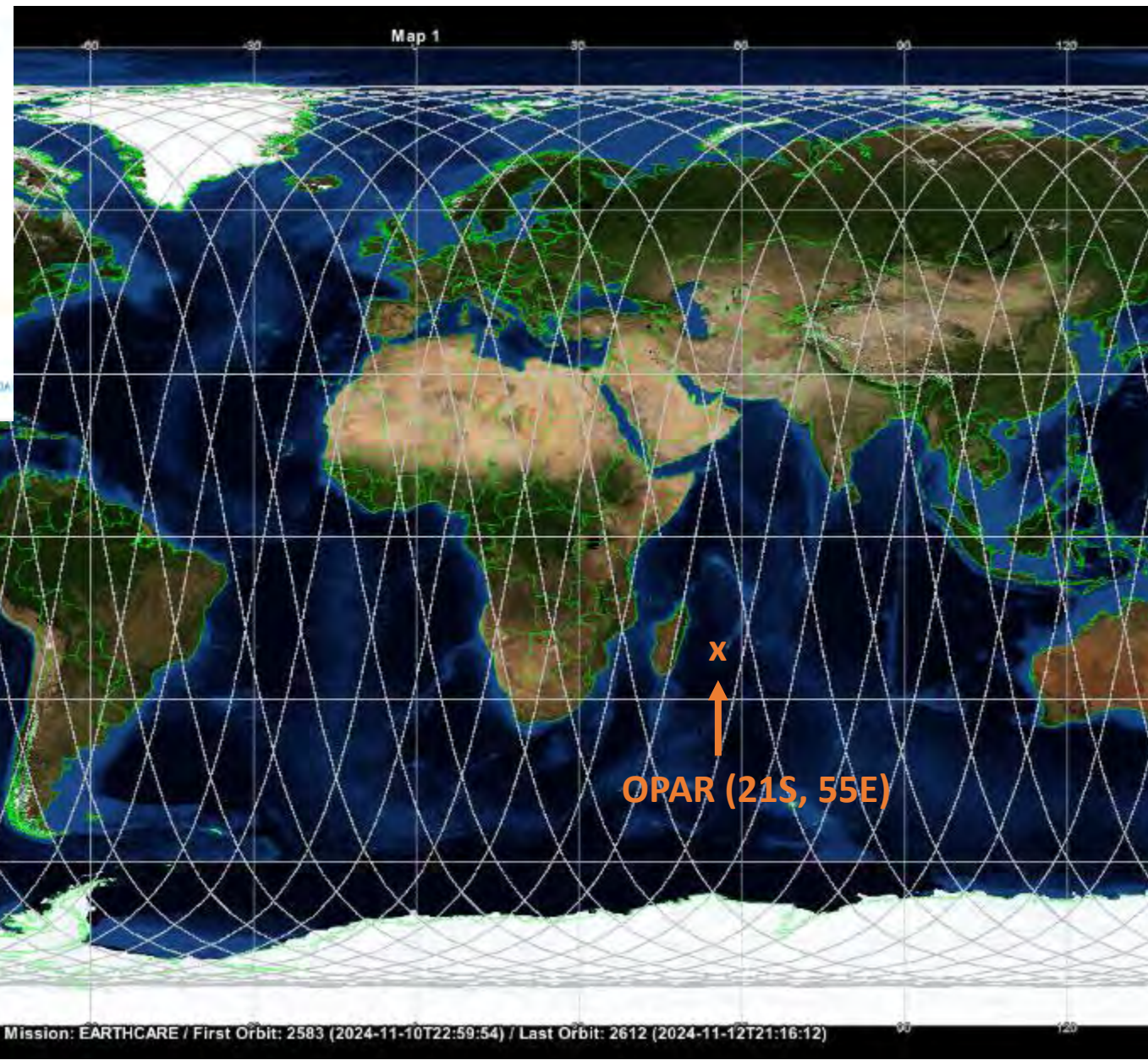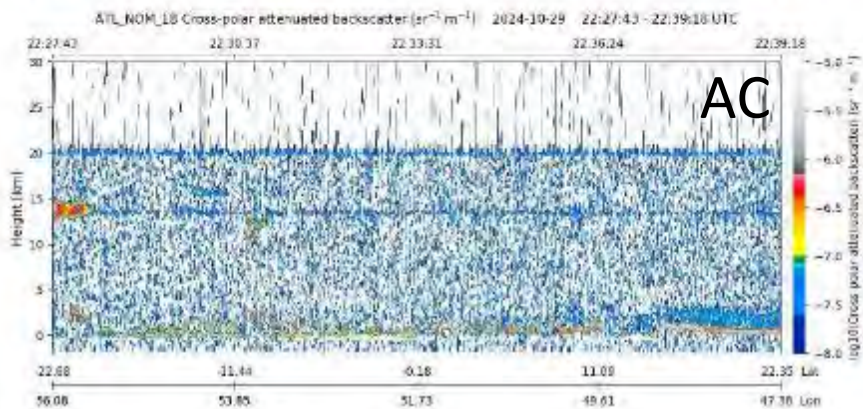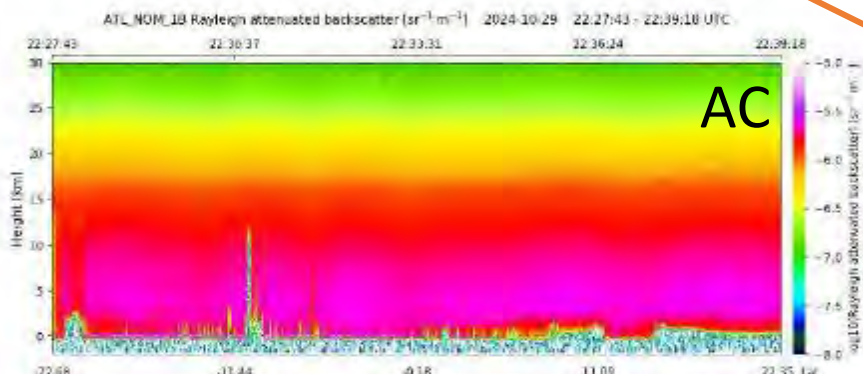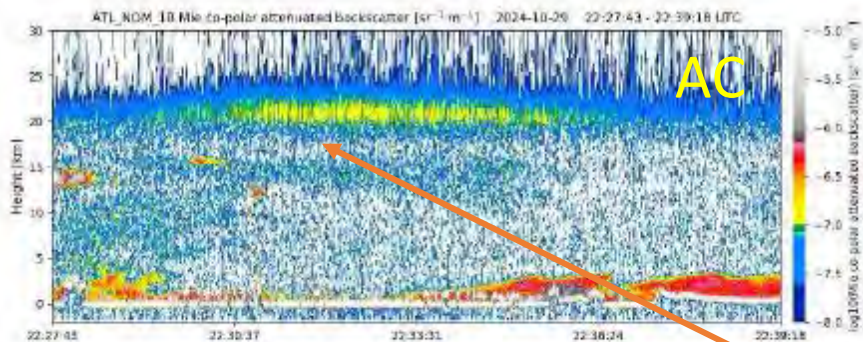
EarthCARE overpass 9 September 2024 @ 22:26UTC

Nighttime

Ruang volcano plume

Excellent agreeement in stratosphere

Alignment problem in the tropospheric channels of the ground-based lidar

AC

AC

AC

Hot Pixel
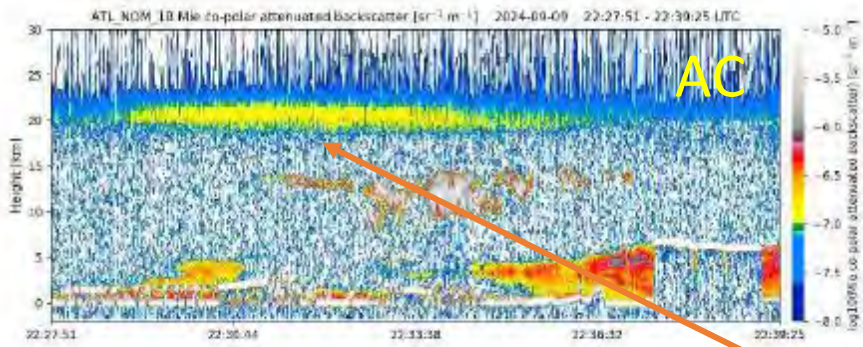
Stratospheric layer observed by ATLID since summer can be confirmed by ground-based lidar

Credits to M. Sicard

UNIVERSITÉ DE LA RÉUNION

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

EarthCARE overpass 29 October 2024 @ 22:28UTC

Nighttime

Ruang volcano plume
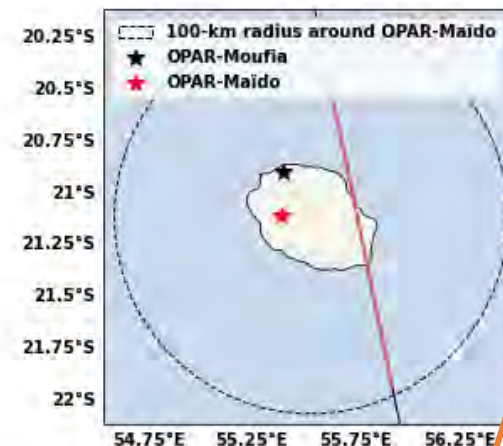
The agreement in stratosphere is not that good

Perfect height detection of this cirrus
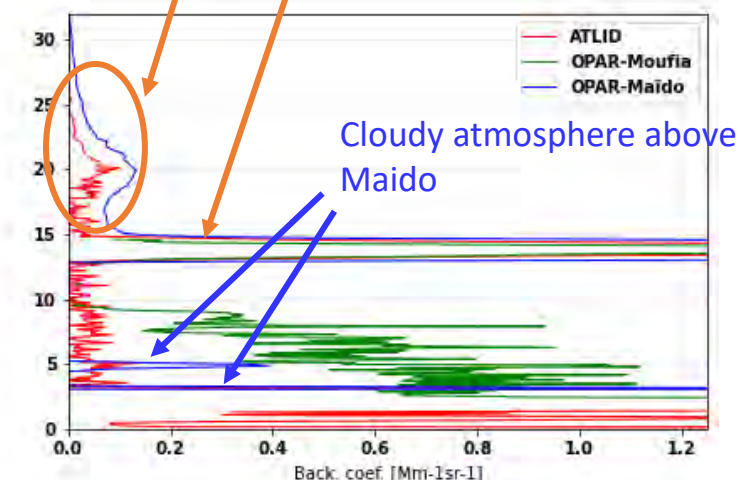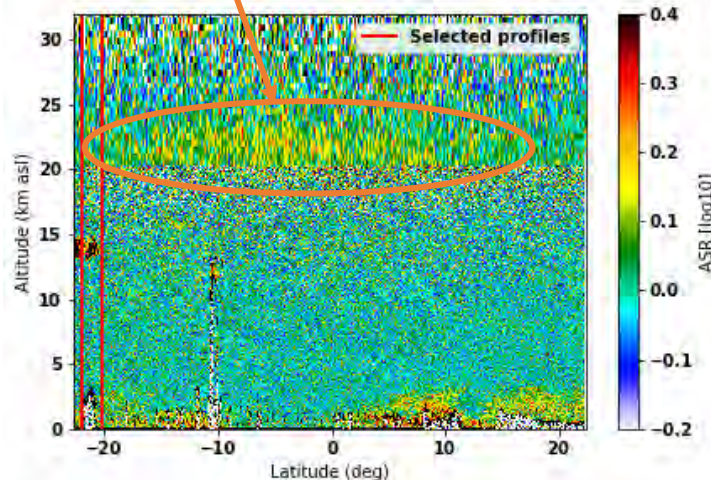
Cloudy atmosphere above Maido

- Cloudy conditions make comparison difficult
- Base cloud boundaries are in perfect agreement

Credits to M. Sicard

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Map 1

ATLID – Check of depolarization performance

Moritz Haarig
Leonard König, Julian Hofer, Ulla Wandinger

TROPOS
Leibniz Institute for
Tropospheric Research

X

Dushanbe,
Tajikistan

Mission: EARTHCARE / First Orbit: 2583 (2024-11-10T22:59:54) / Last Orbit: 2612 (2024-11-12T21:16:12)

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8
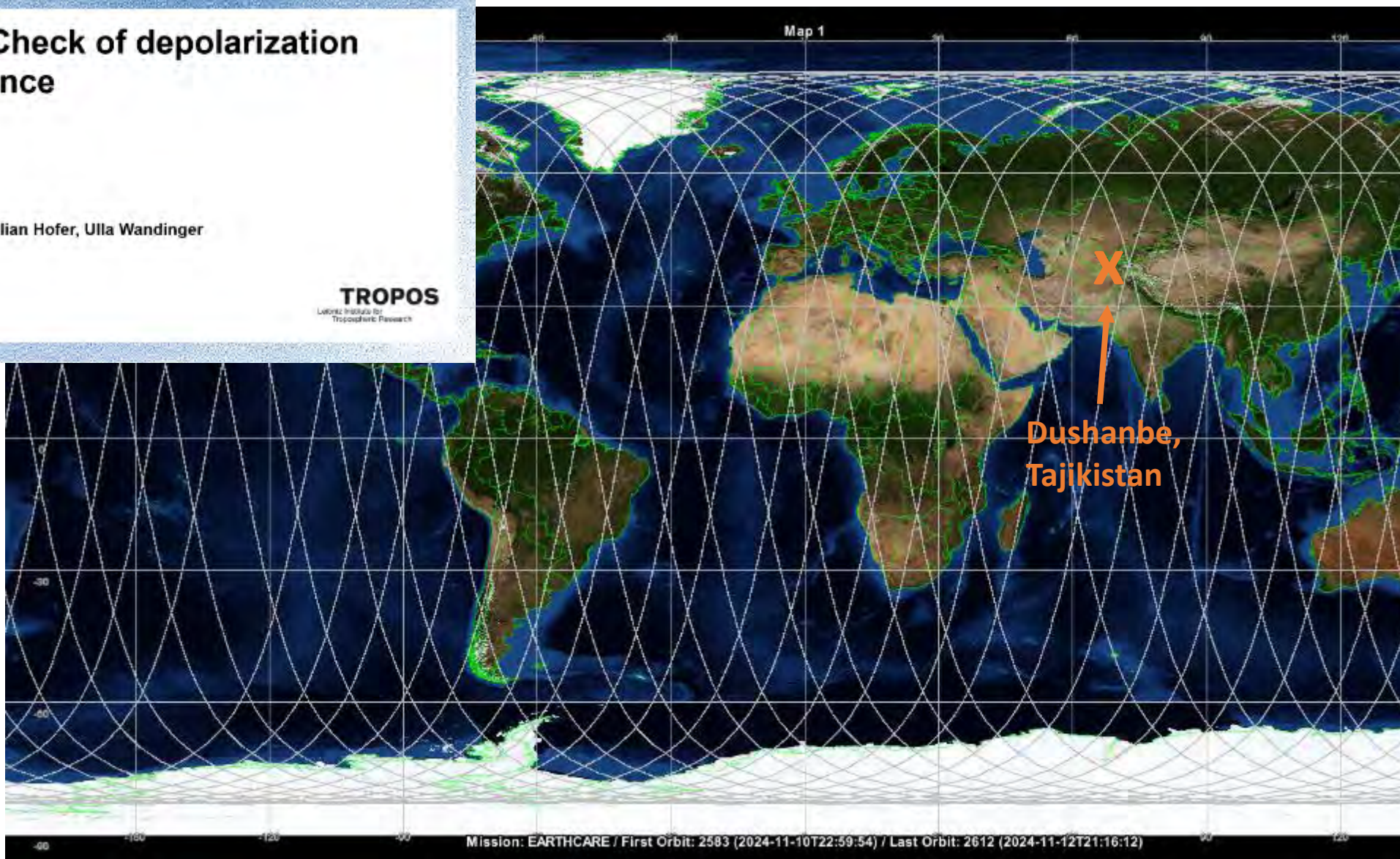
2024-09-02T21:02:59.418841
11.8 km

Attenuated backscatter (1064)

Volume depolarization ratio (532)
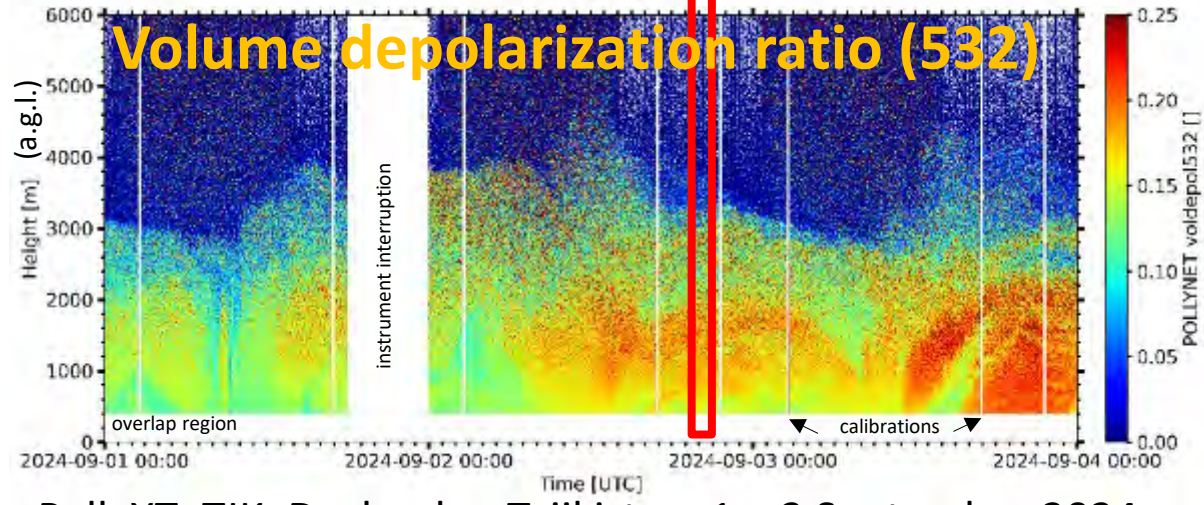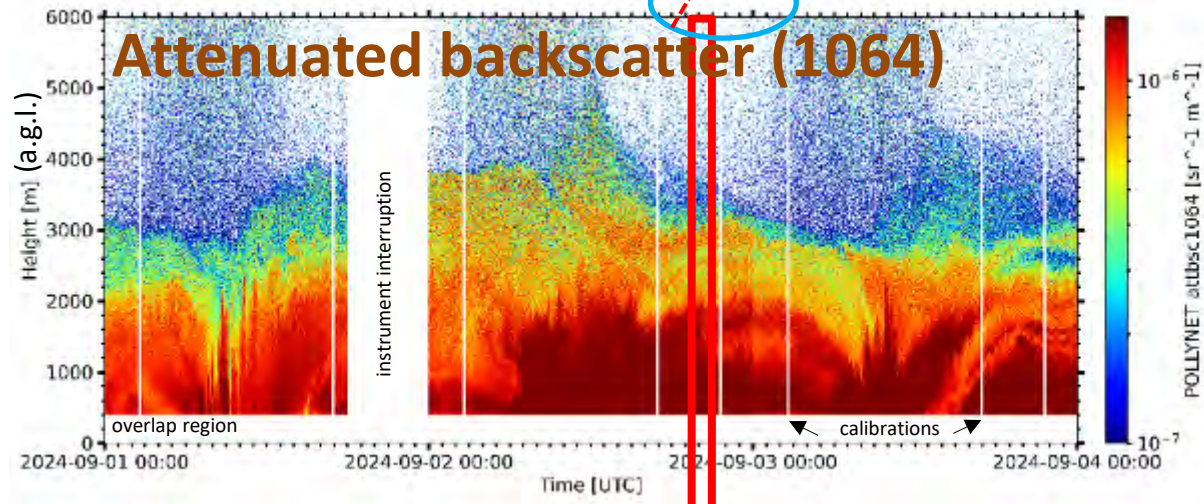
PollyXT_TJK, Dushanbe, Tajikistan, 1 – 3 September 2024

profile period

2 September 2024
20:00-21:30 UTC

PollyXT_TJK, Dushanbe, Tajikistan, 2 September 2024, 20:00-21:30 UTC

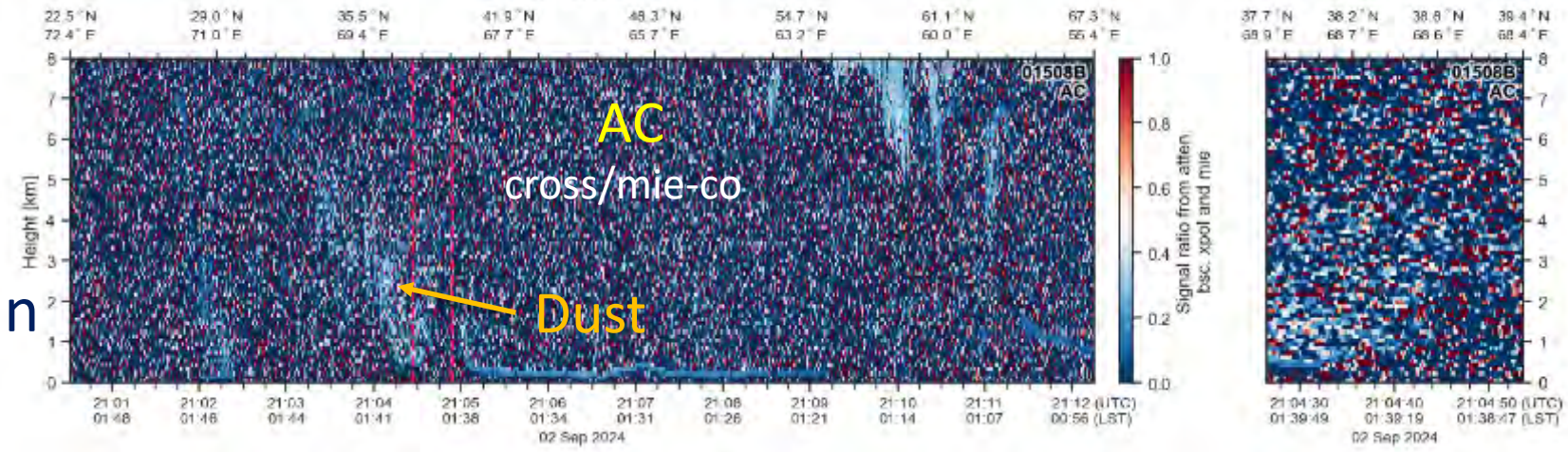Hofer et al., 2020
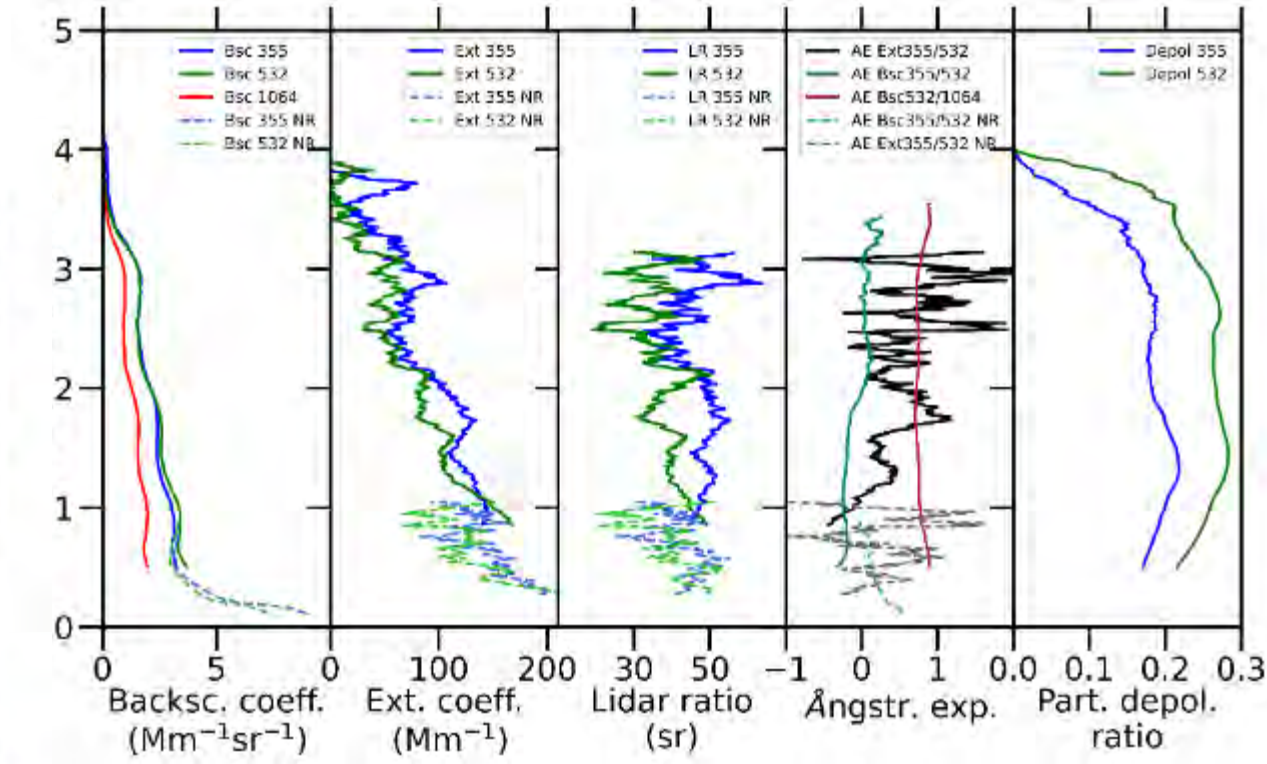
ATLID nicely observes the optically thick dust layer

Night time
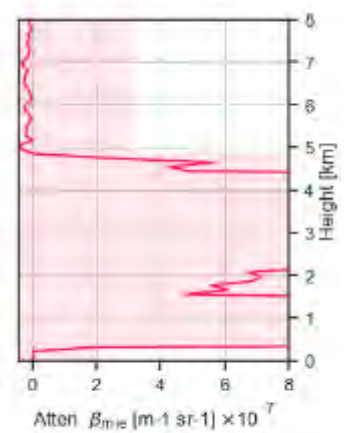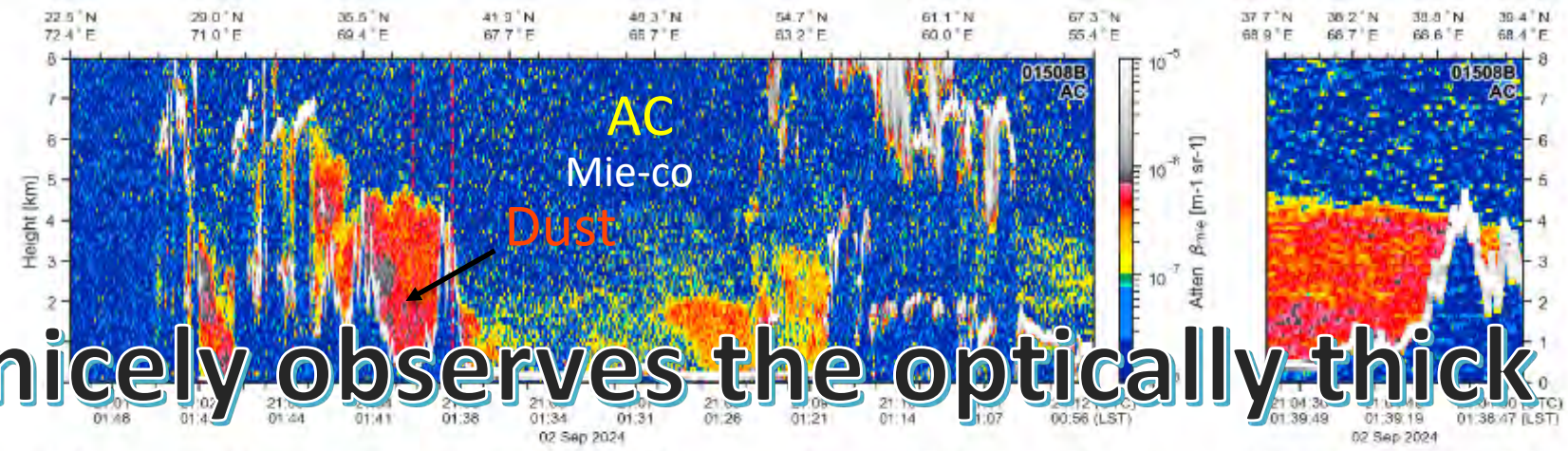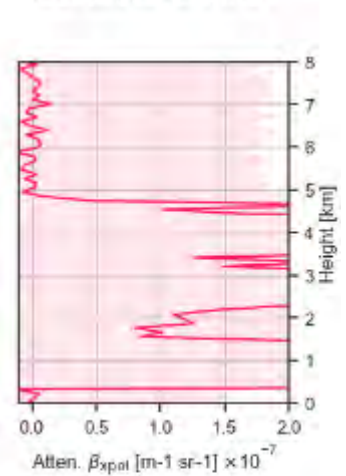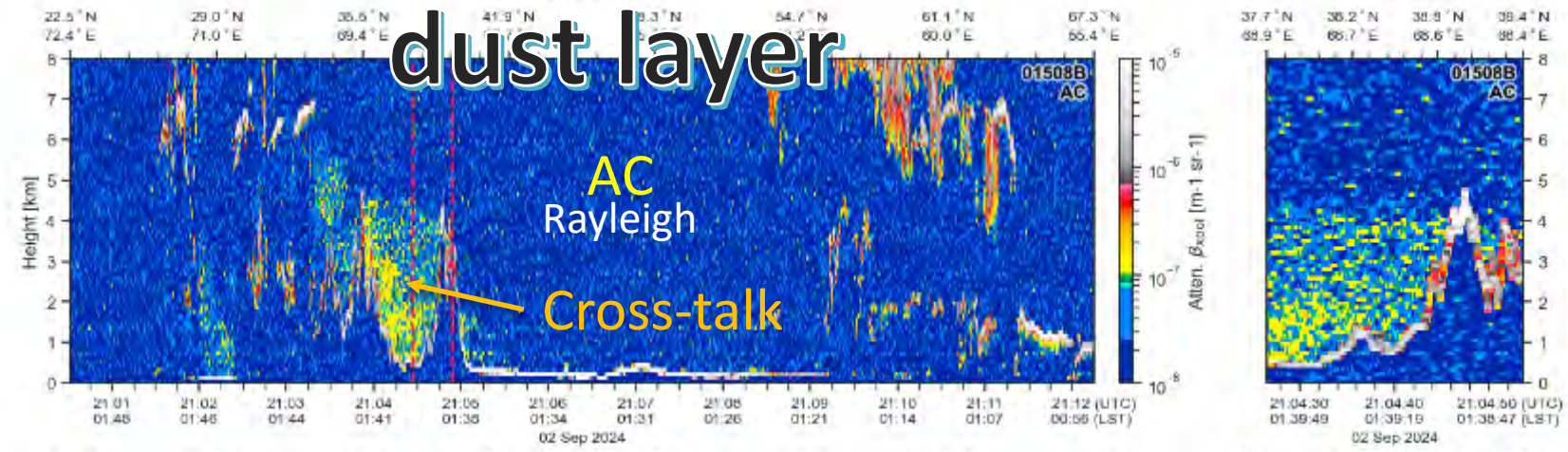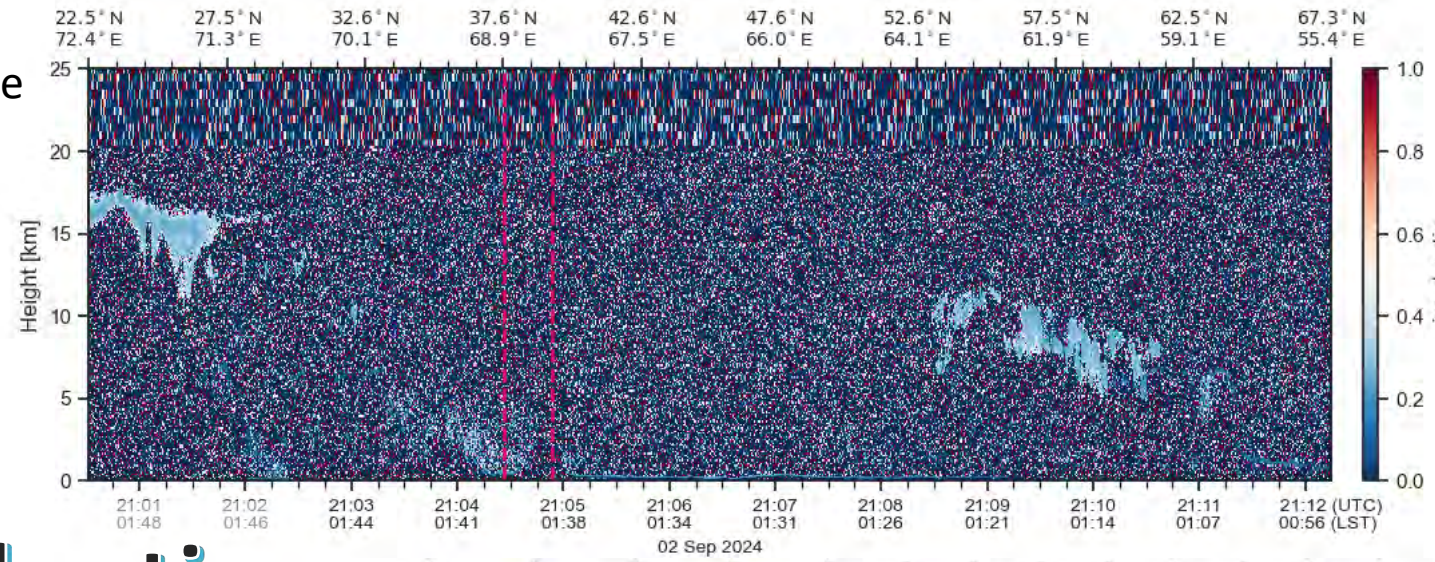
Frame 1508B

Overpass over PollyXT at Dushanbe, Tajikistan

10
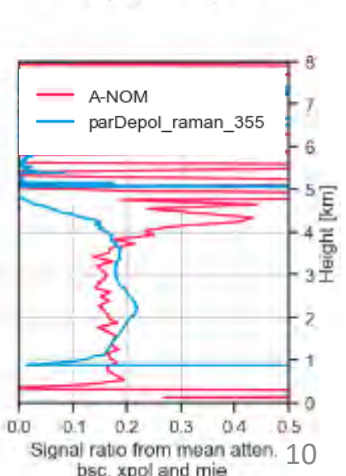
Signal Ratio (cross/co) → particle depolarization ratio
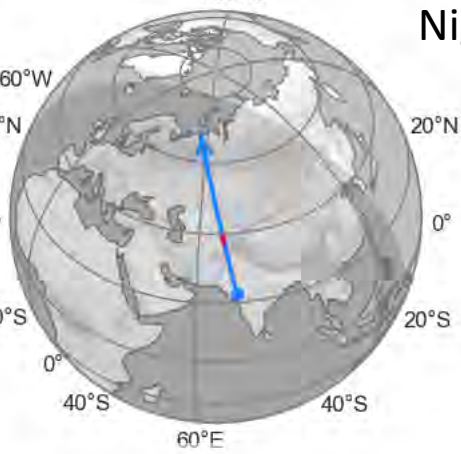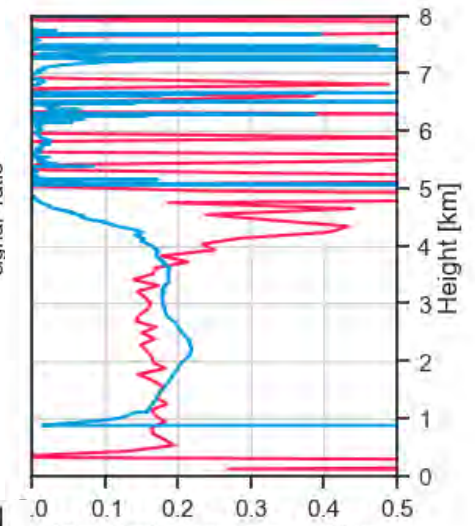
ATLID depol ratio from L1 signal ratios agrees with ACTRIS reference
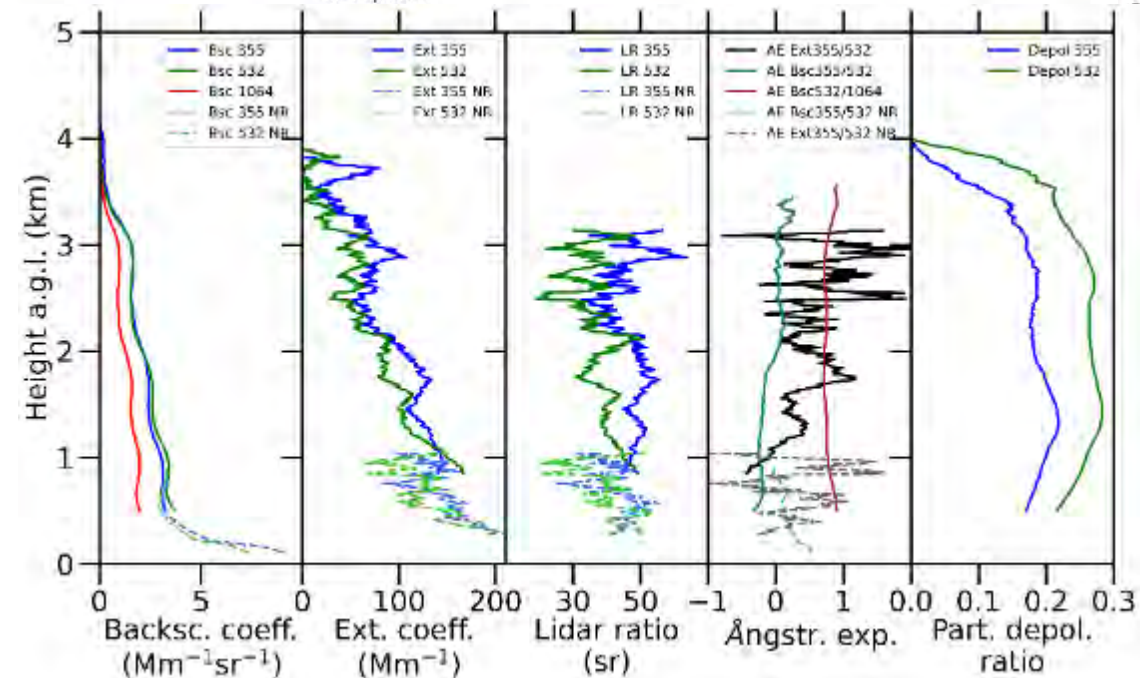
1. Direct use of L1 data by using ratios

- Scattering ratio
- Depolarization validation example

2. Use of simulator tools

- ATLID simulator tool

The present work includes preliminary data (not fully calibrated/validated and not yet publicly released) of the EarthCARE ESA mission developed in collaboration with JAXA. The analysis has been performed in the context of the EarthCARE Validation Team and of the ATLID Integrated Commissioning Team

First ATLID to ground comparison
at Mindelo (Cabo Verde)
using the L1 simulator tool

Henriette Gebauer, Leonard König, Athena Augusta Floutsi, Moritz Haarig, Ulla Wandinger, Holger Baars

X

Mindelo, Cabo Verde

Mission: EARTHCARE / First Orbit: 2583 (2024-11-10T22:59:54) / Last Orbit: 2612 (2024-11-12T21:16:12)

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TROPOS
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Tropospheric Research 13
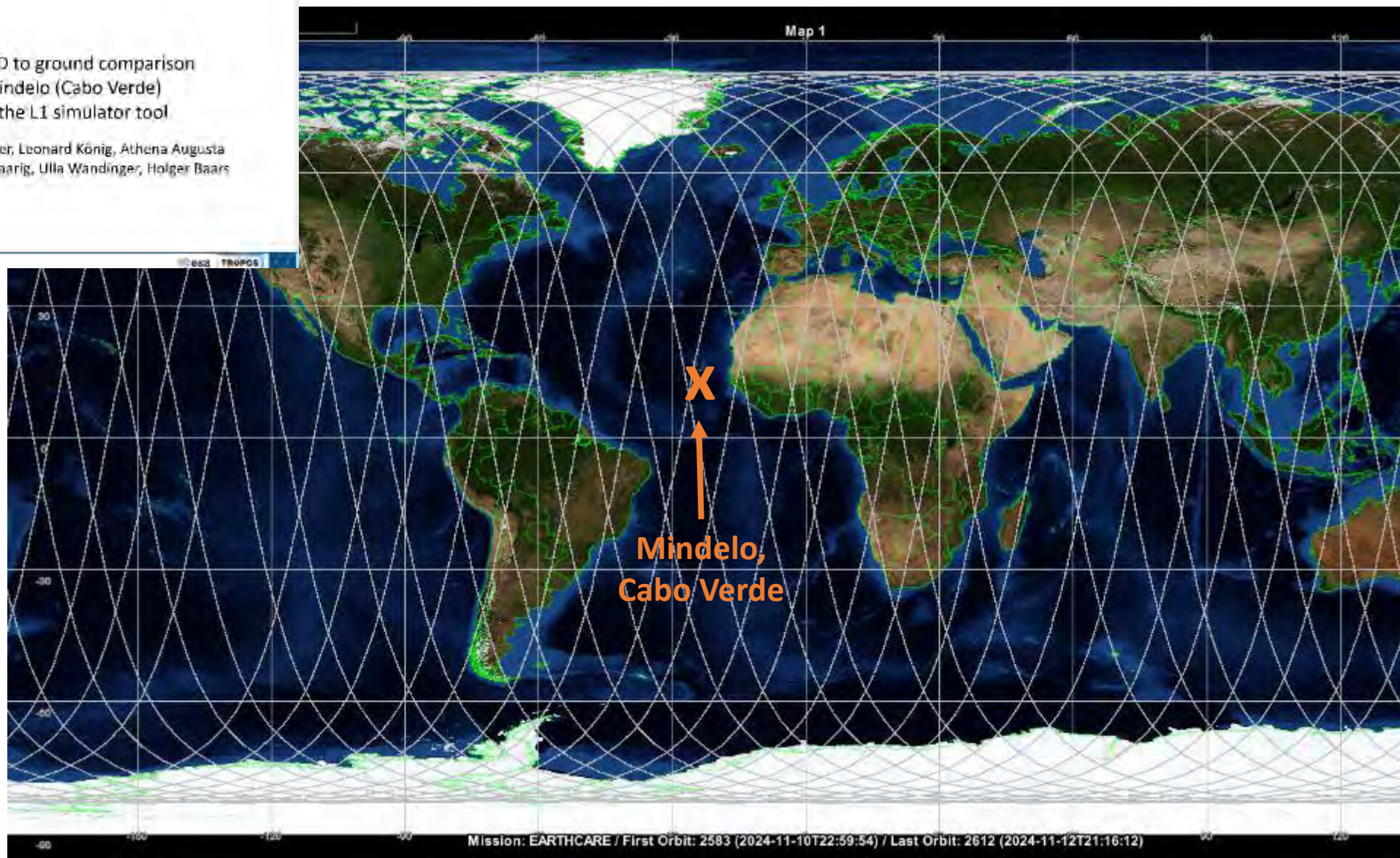
21. 08.2024 - nighttime

Early EarthCARE overpass over ACTRIS supersite at Mindelo, Cabo Verde during Orchestra Validation Campaign

21 km

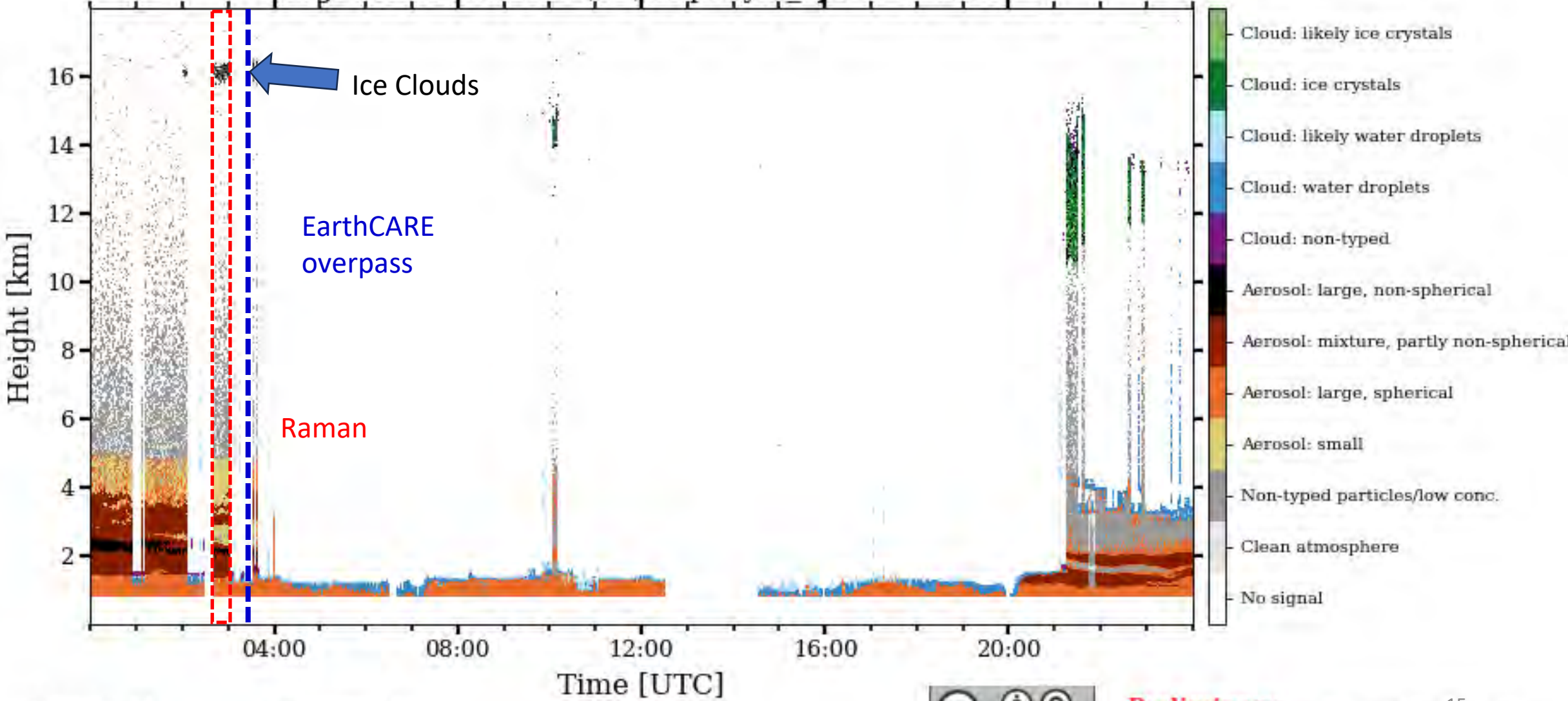Baseline AC

Volcanic plume from Ruang eruption

Mie

Ray

20 km issue

Cross
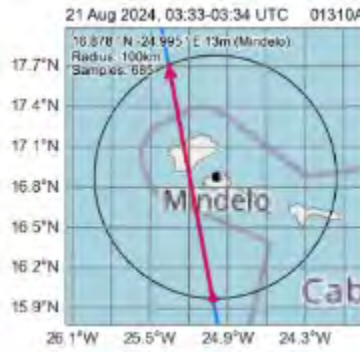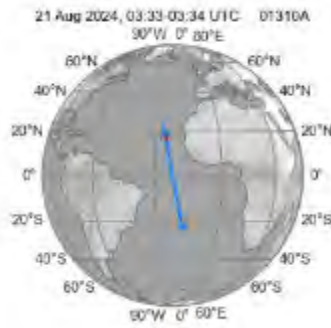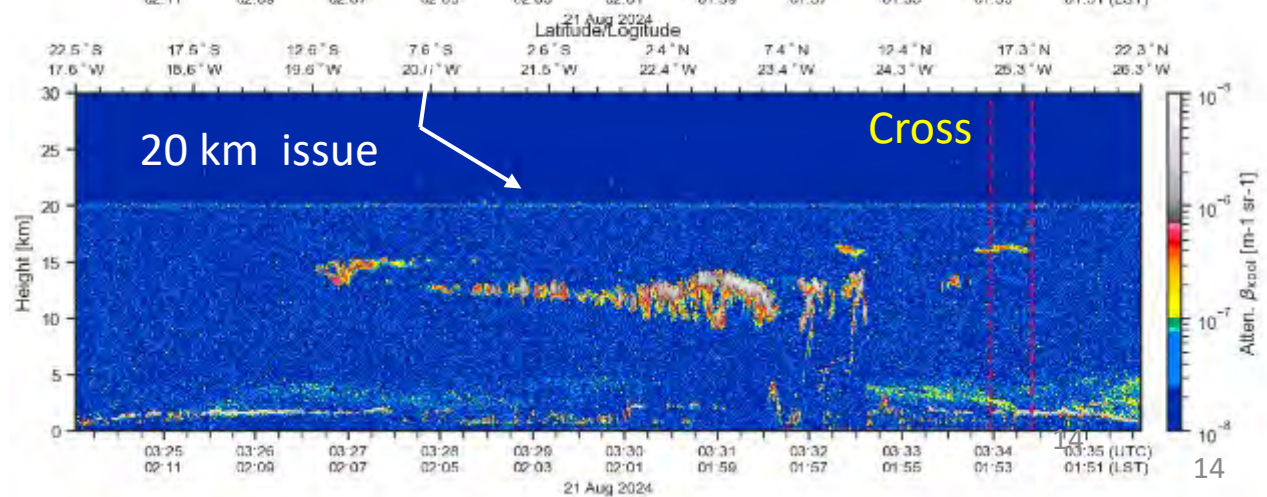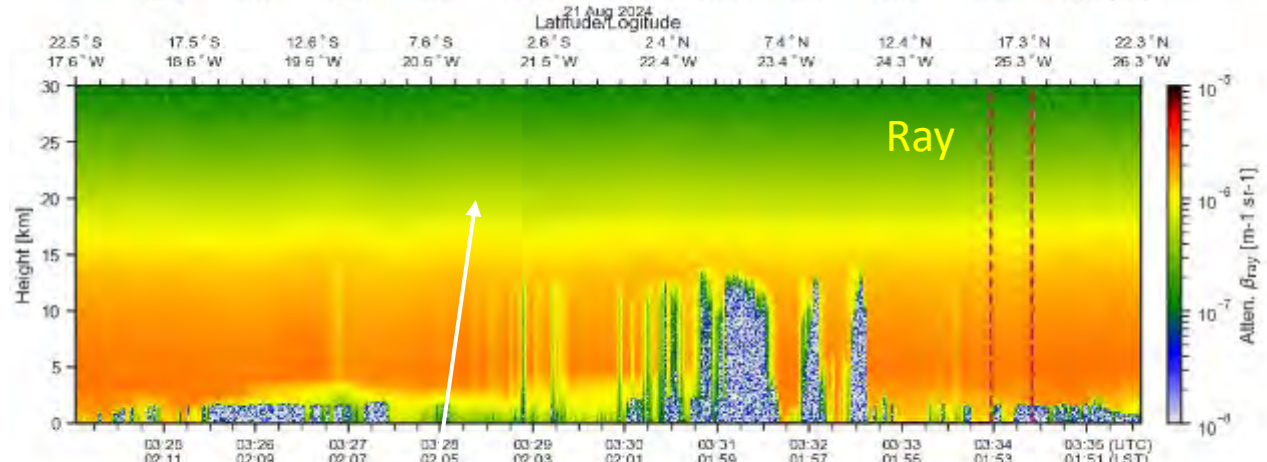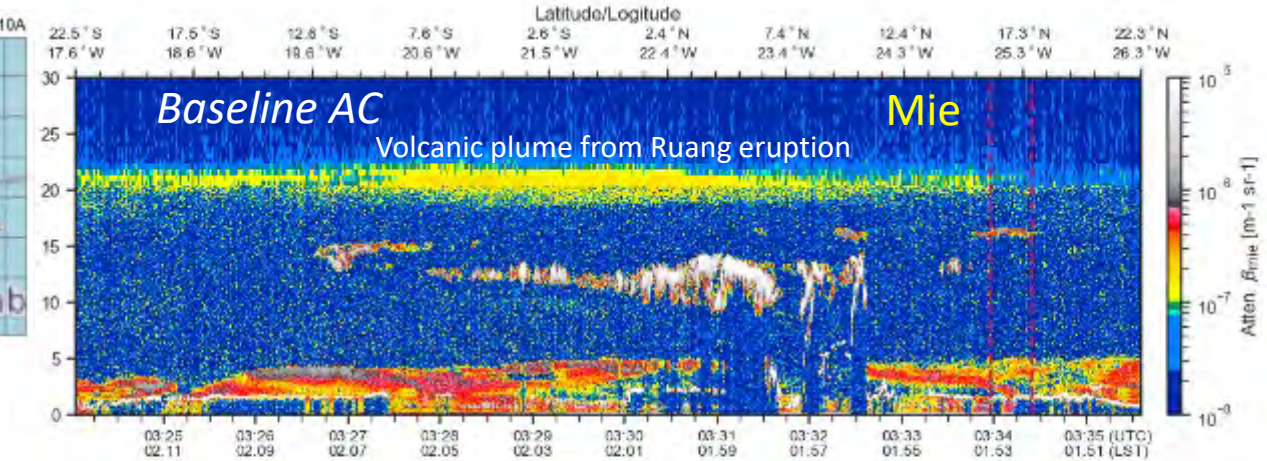
21 Aug 24 ACTRIS lidar observations

Target classifications (V1) of pollyxt_cpv at Mindelo

2024-08-21   Version: 4.0
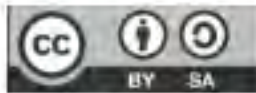
21 Aug 2024 – input for ATLID simulator

a)

02:41-3:05 UTC

extinction calculated from height-dependant constant LR *(layer mean LR PBL and lofted layer, NaN in between, 30sr for the Ci, molecular LR in clear air)*
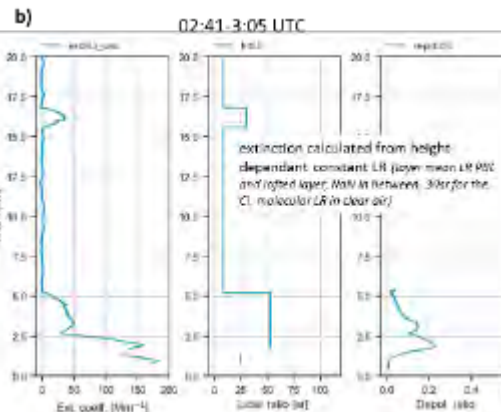
b)

02:41-3:05 UTC
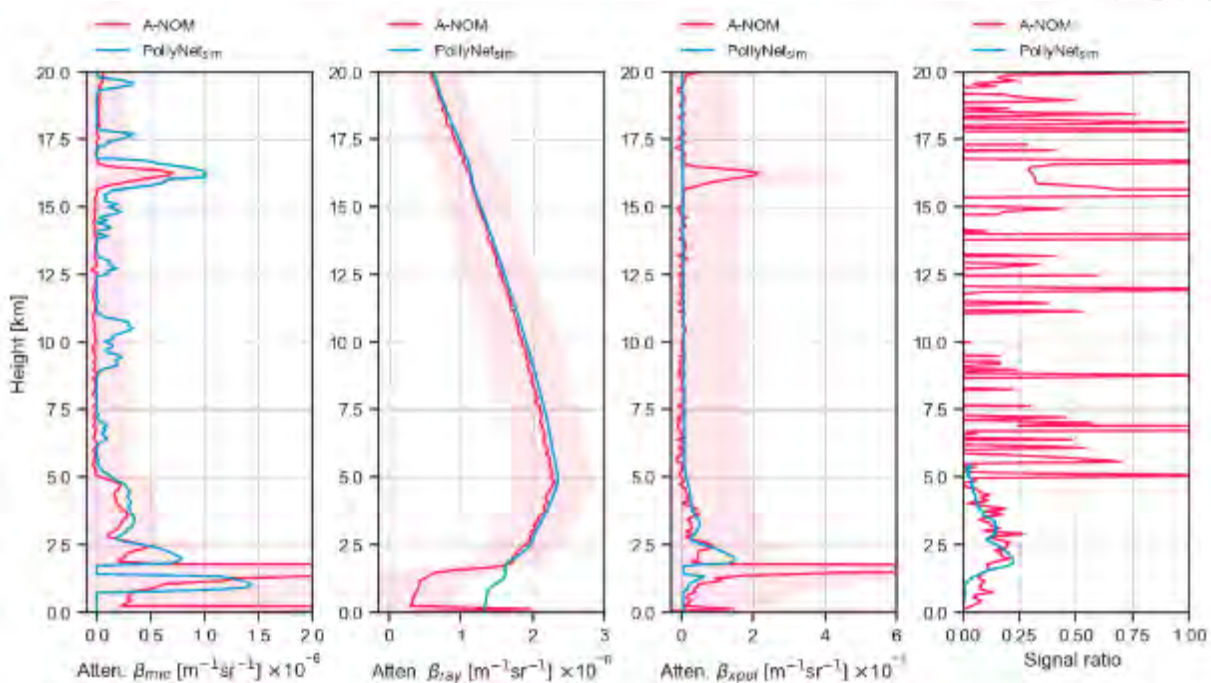

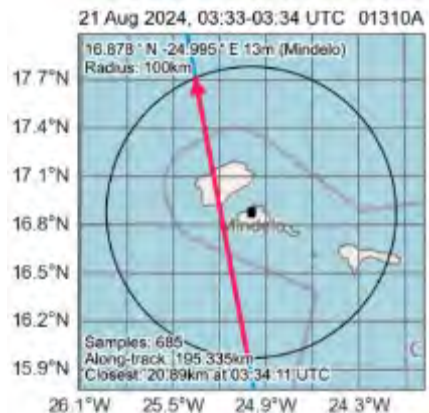extinction + LR up to 4.4 km
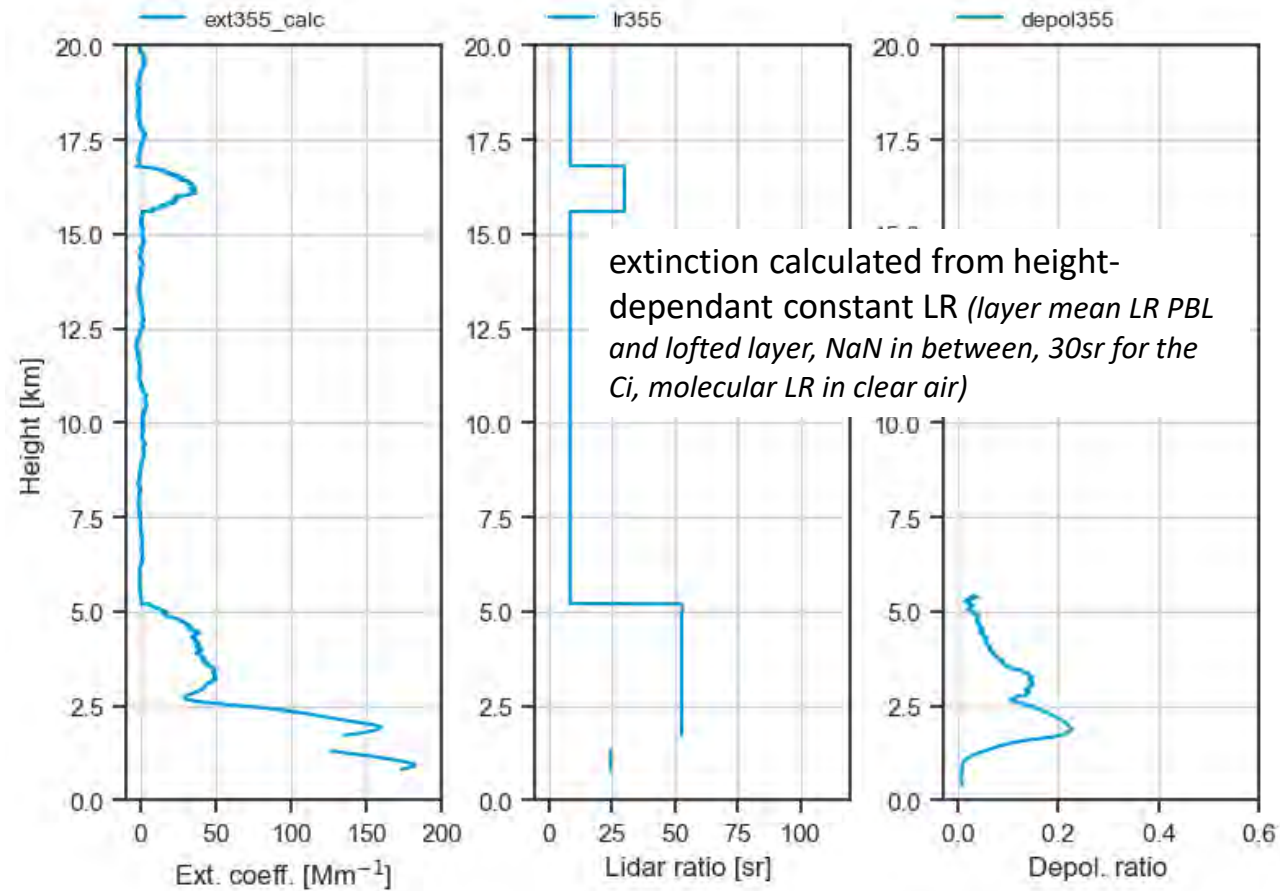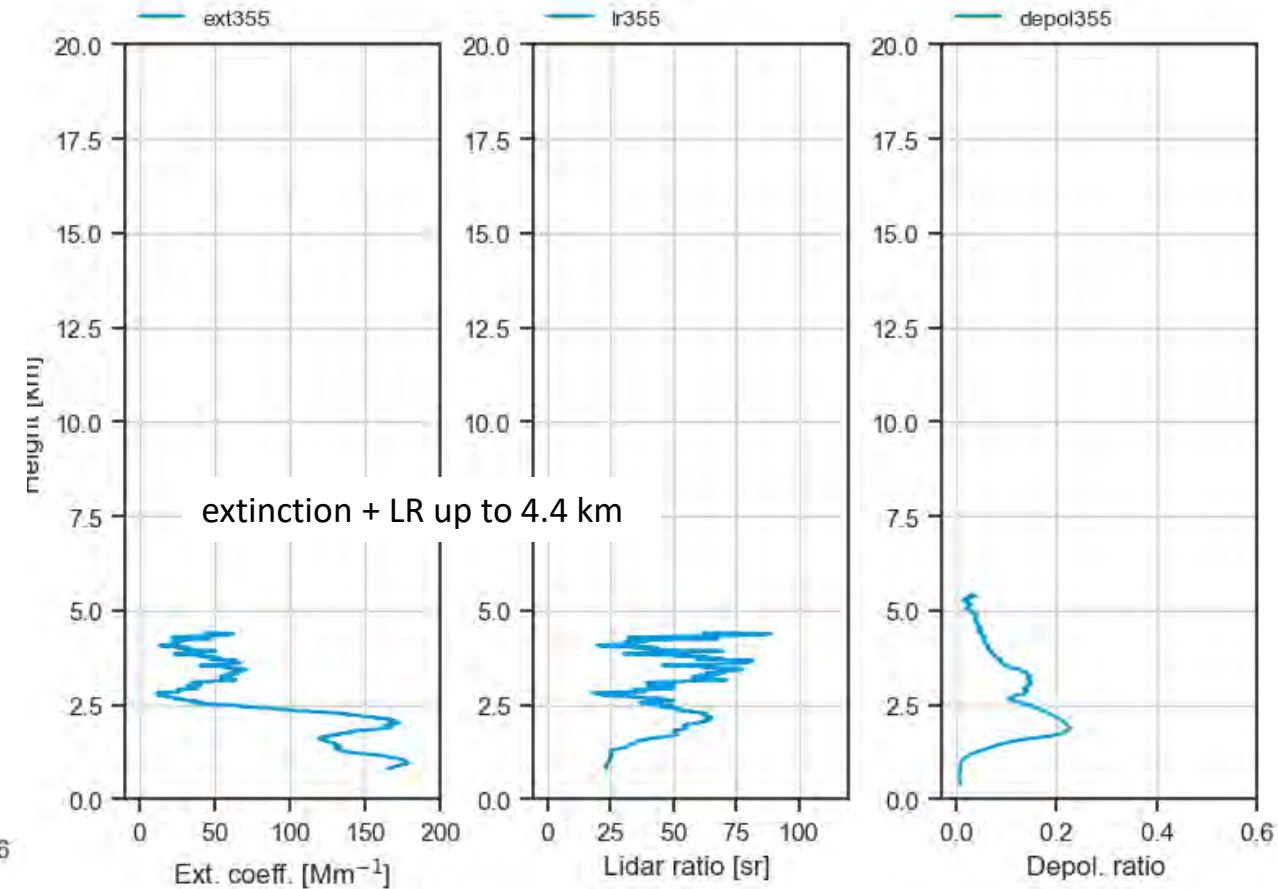
21 Aug 2024
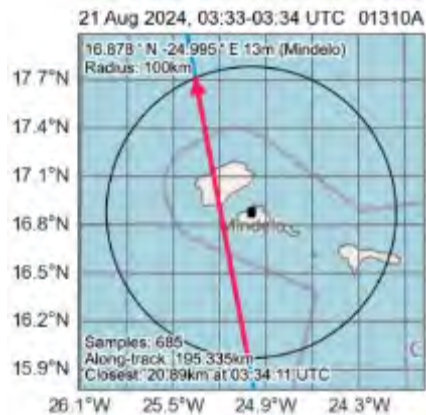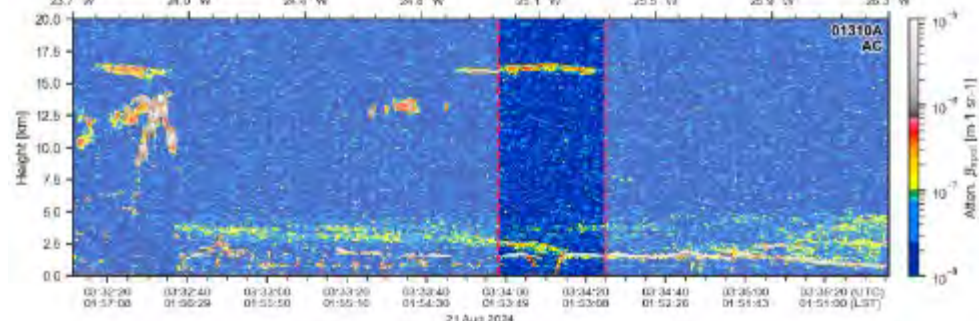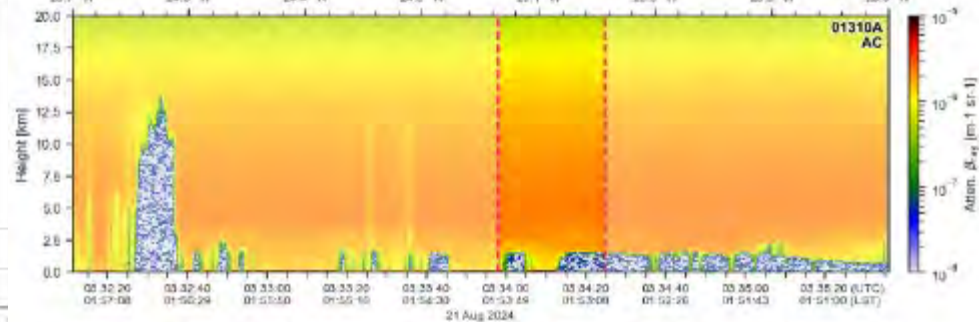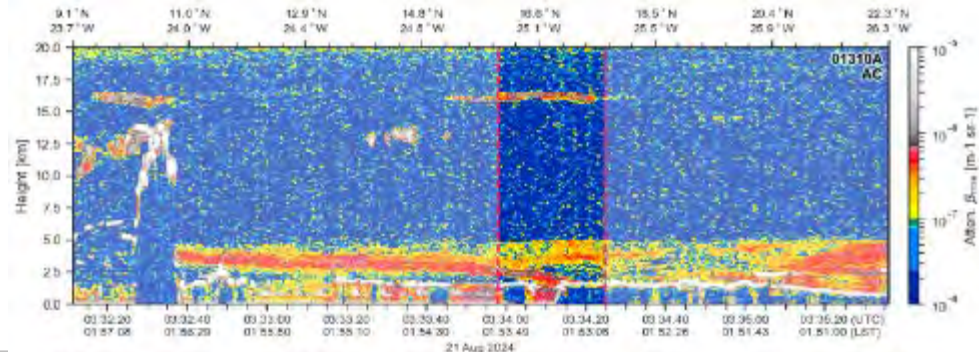
nighttime

Comparison **with cirrus included**:
- Nighttime case showing great signal to noise ratio
- **Good agreement** when considering the ice cloud above 15 km even though temporally more far away and introducing more noise in sim. signal

100 km
Radius

21 km
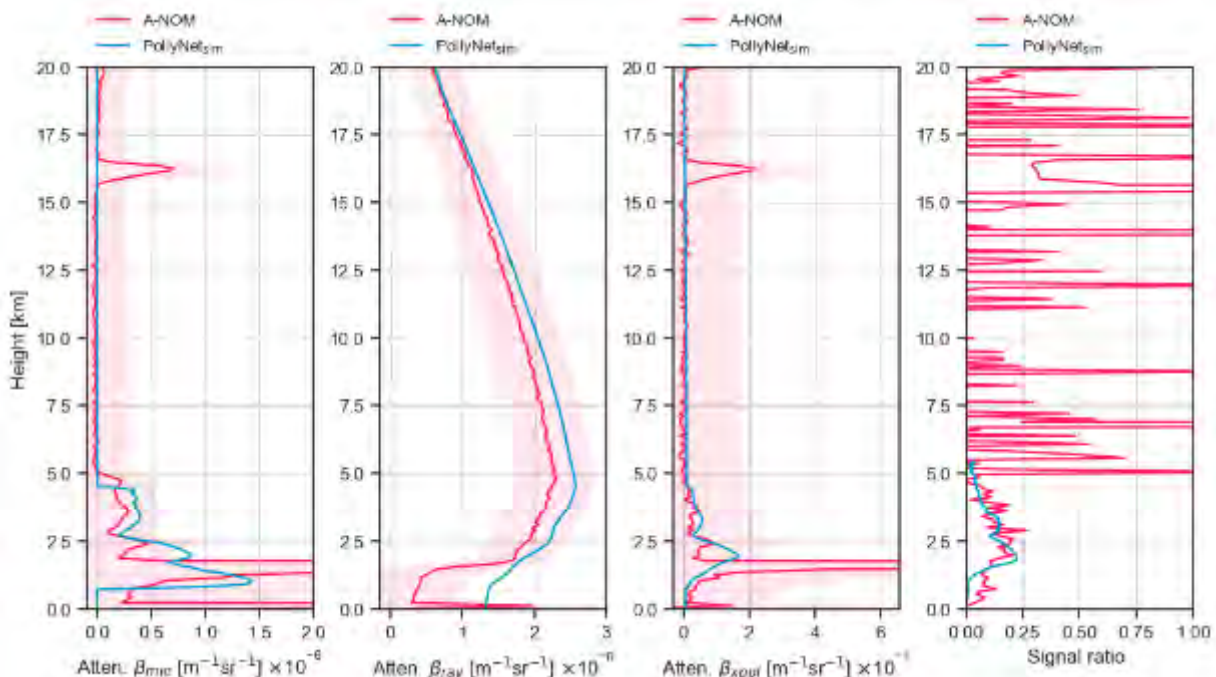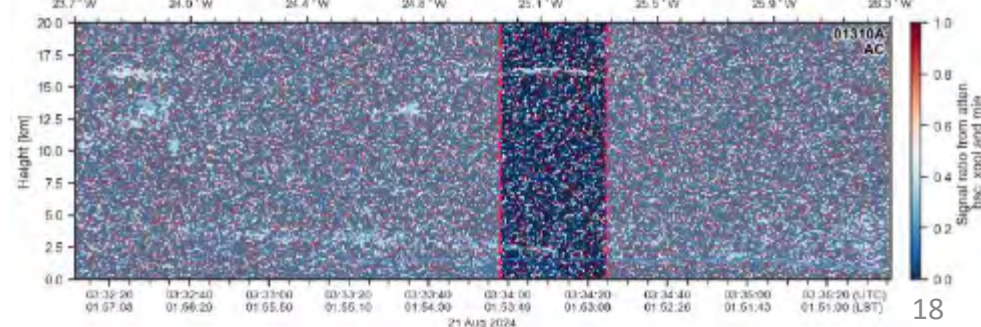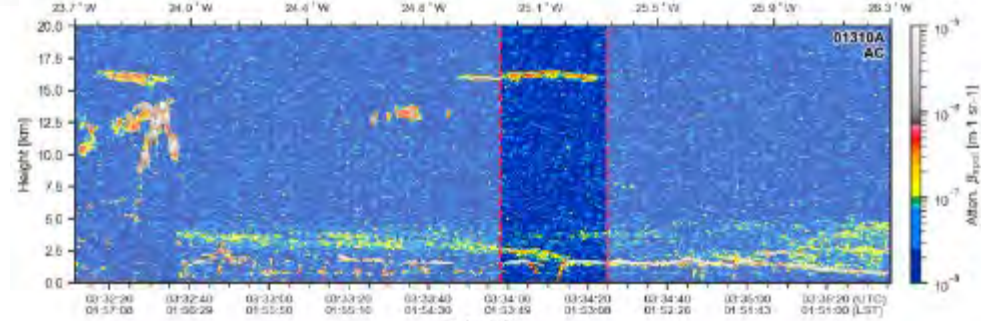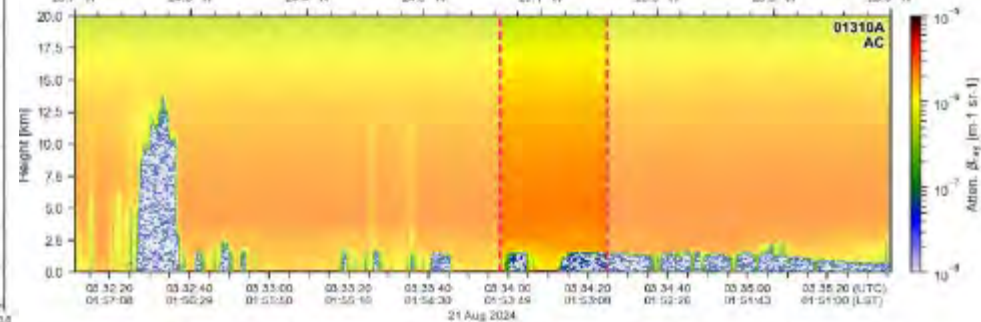
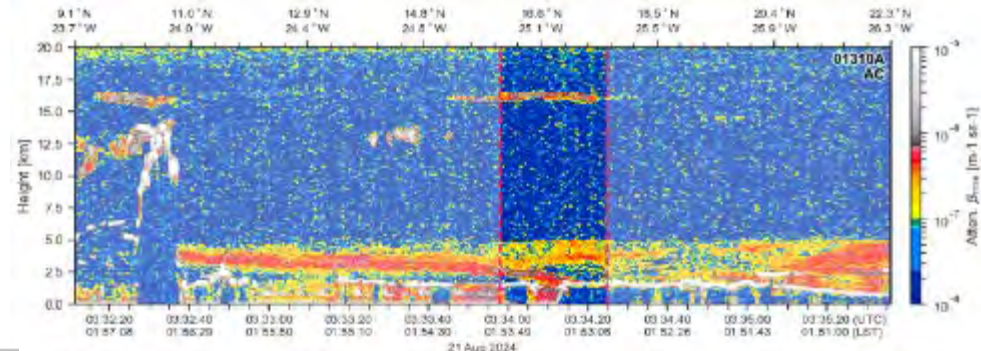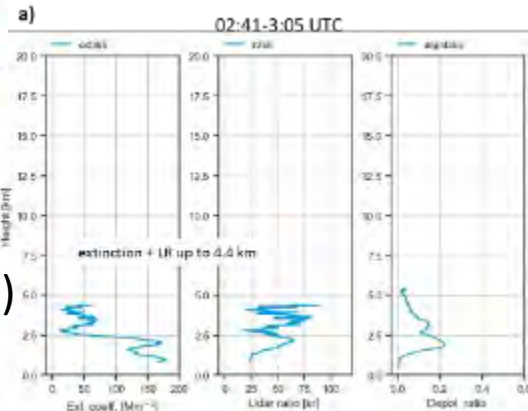# 21 Aug 2024

nighttime

100 km Radius

21 km

Comparison with **cloud-free** profile:
- No match → **different atmospheric scene**
- Comparison only partly useful
  (but can still be used for, e.g., for layer heights)

18

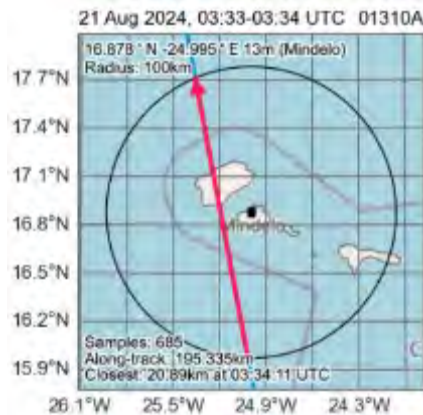# 21 Aug 2024

nighttime

100 km Radius

21 km

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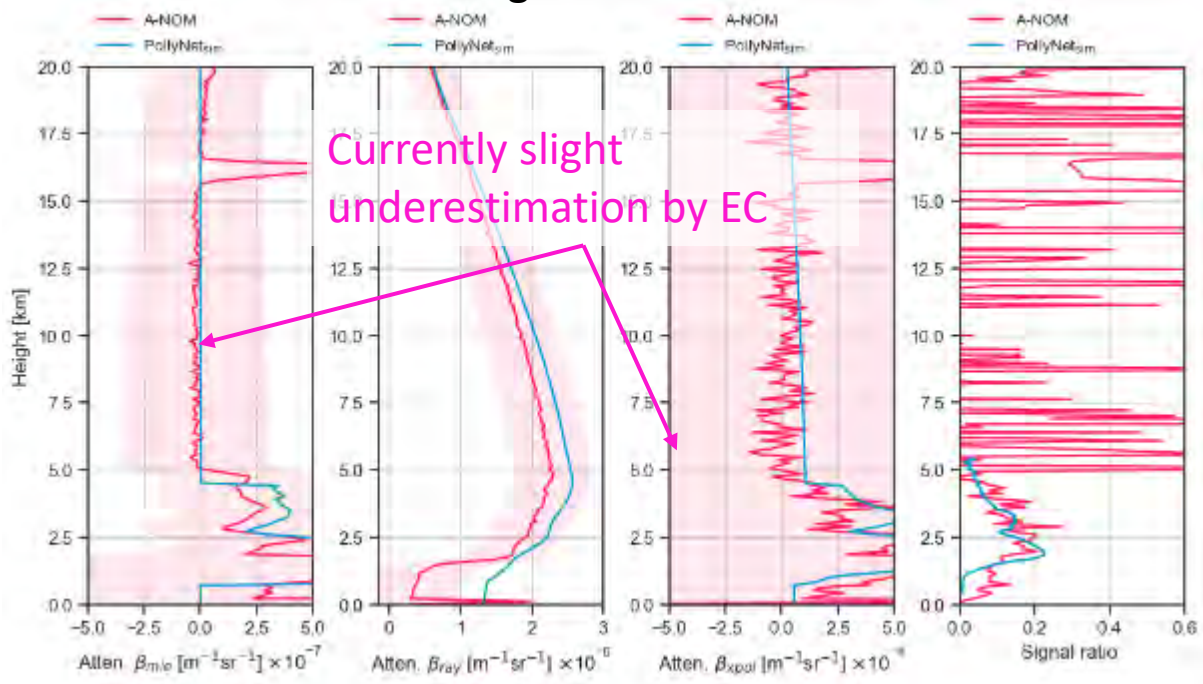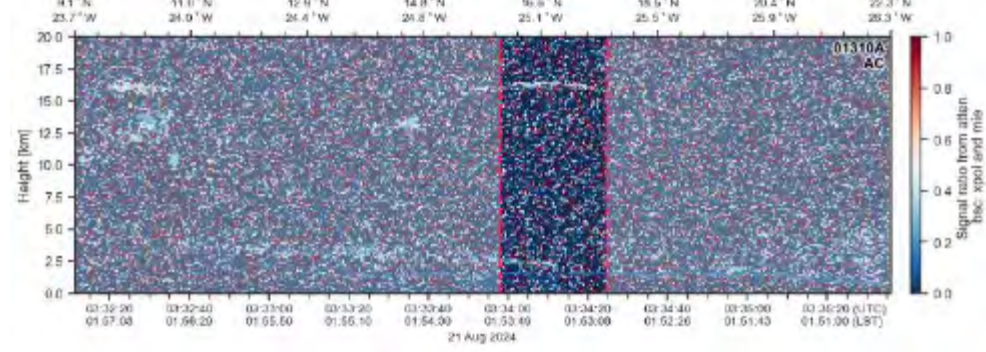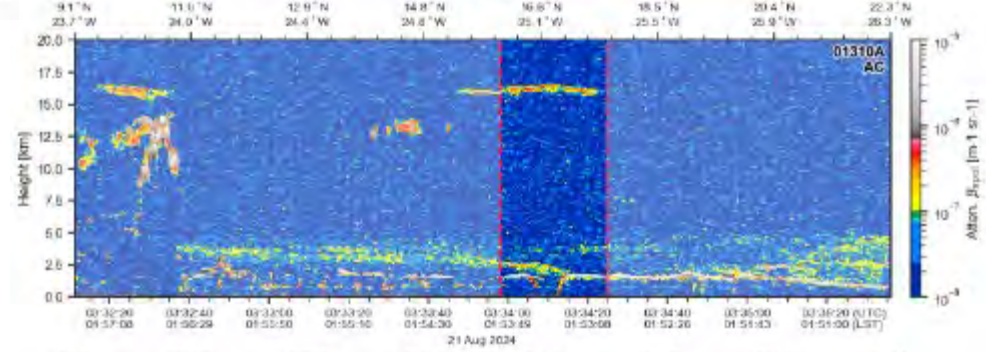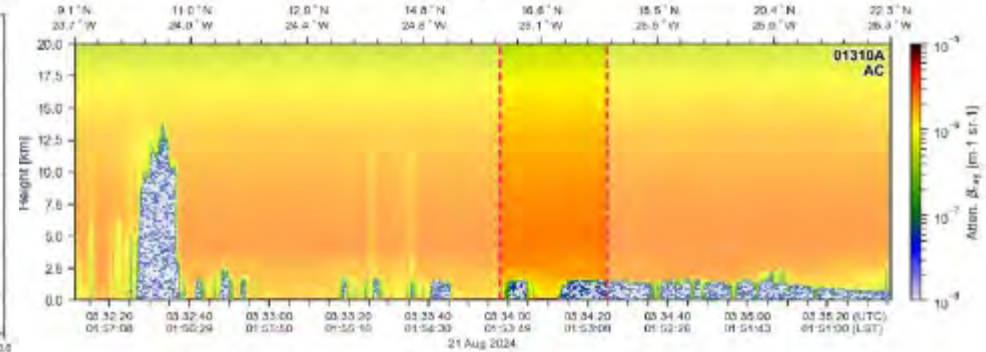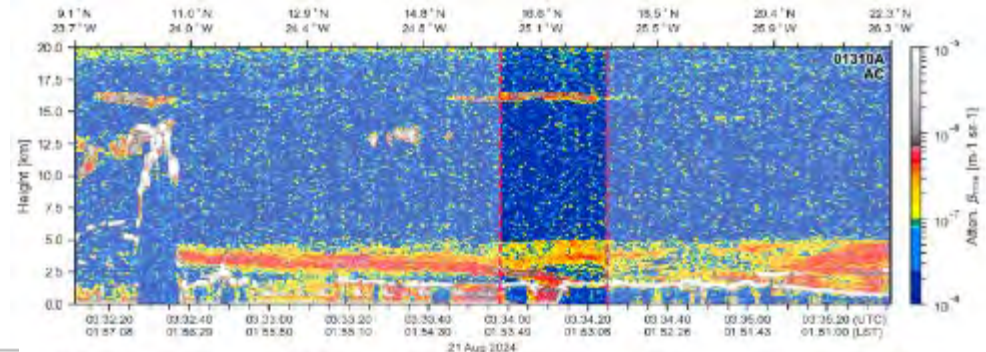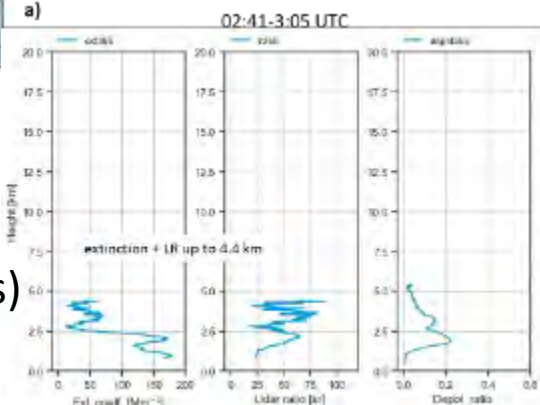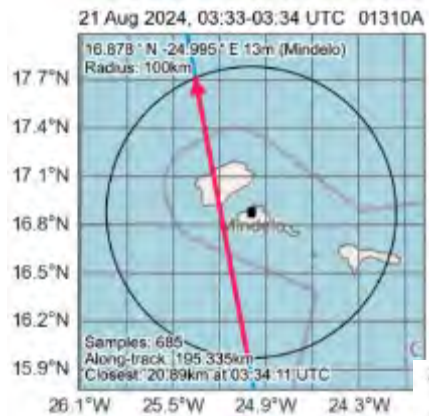 (but can still be used for, e.g., for layer heights)
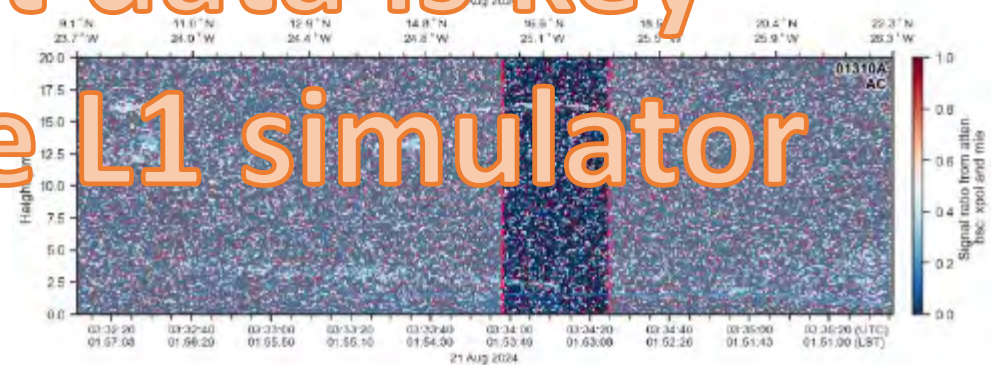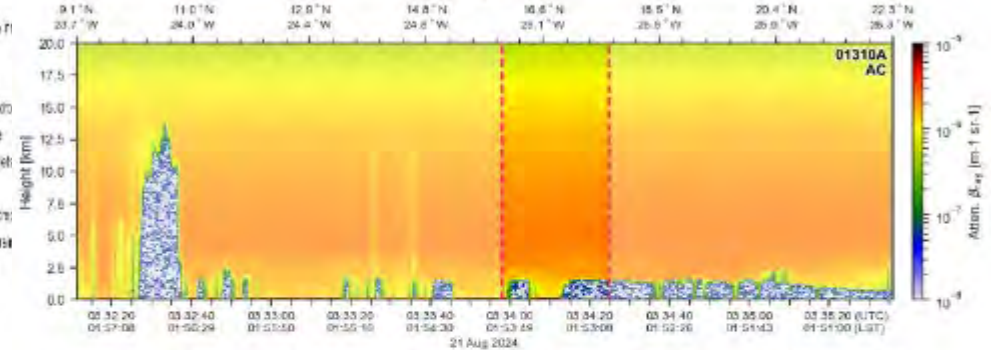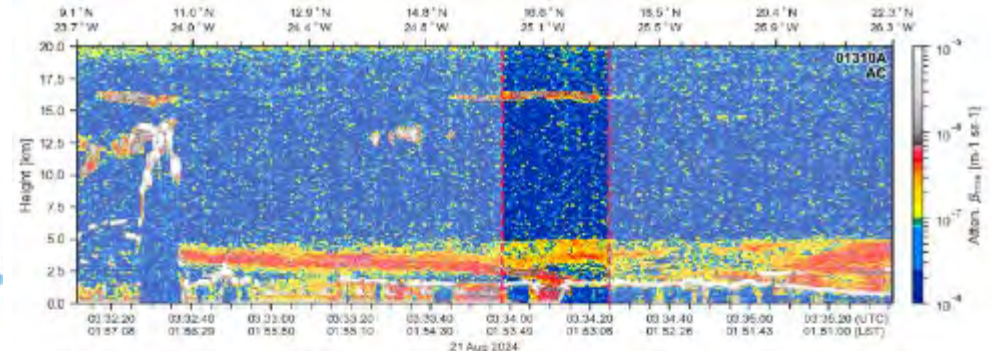- ATLID low bias in clean atmosphere visible
  → cross talk? Background?

Currently slight underestimation by EC

21 Aug 2024

nighttime

21 Aug 2024, 03:33-03:34 UTC 01310A

16.878° N -24.995° E 13m (Mindelo)
Radius: 100km

Samples: 685
Along-track: 195.335km
Closest: 20.89km at 03:34:11 UTC

b)

100 km
Radius

21 km

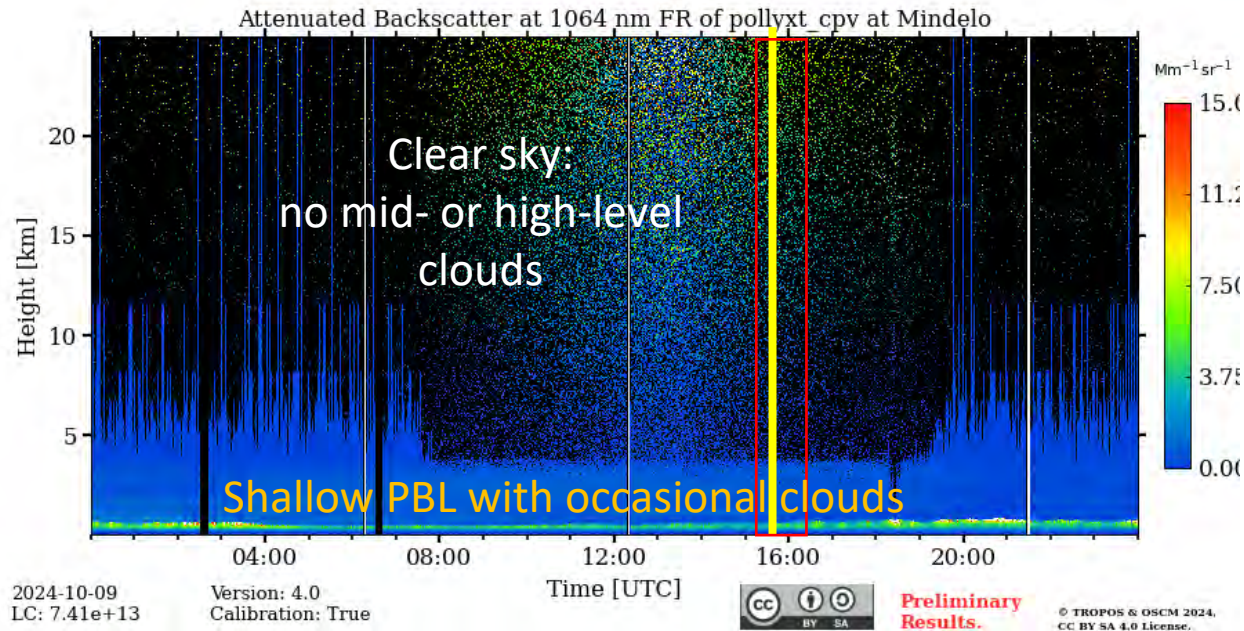Using Cloudnet with focus on low-level cloud:
- Perfect **agreement** in terms of **cloud boundaries**
- But L1 signal generally not simulatable
  due to missing information
→ Possibility to combine Aerosol and Cloud information for simulator?
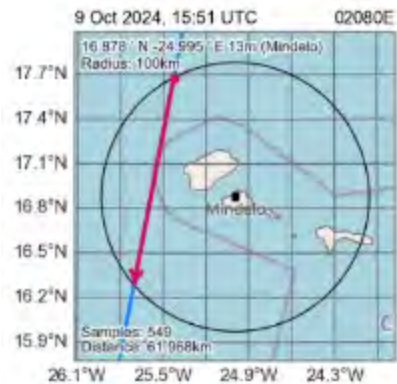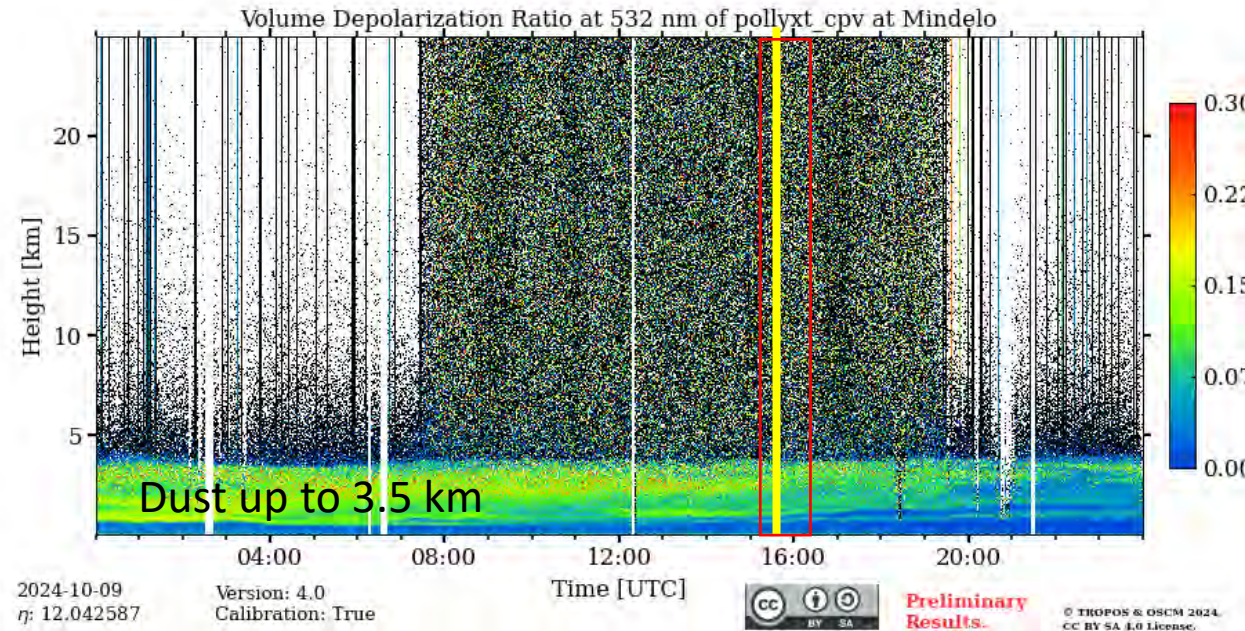

Careful choice of input data is key for the L1 simulator
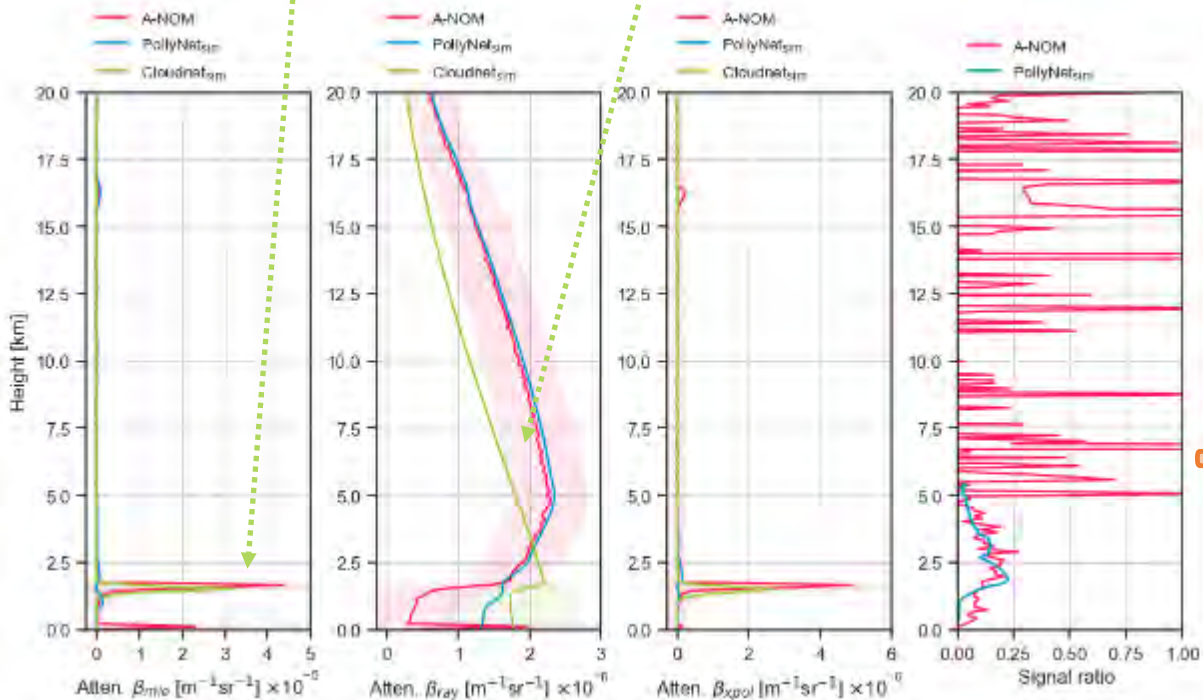
9 Oct 2024 – daytime overpass

Attenuated backscatter 1064 nm

Attenuated Backscatter at 1064 nm FR of pollyxt_cpv at Mindelo

Clear sky:
no mid- or high-level
clouds

Shallow PBL with occasional clouds

2024-10-09
LC: 7.41e+13

Version: 4.0
Calibration: True

Preliminary Results.

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Volume depolarization 532 nm

Volume Depolarization Ratio at 532 nm of pollyxt_cpv at Mindelo

Dust up to 3.5 km

2024-10-09
η: 12.042587

Version: 4.0
Calibration: True

Preliminary Results.

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9 Oct 2024, 15:51 UTC   02080E

EarthCARE overpass 15:52 UTC

Klett Picasso 15:20-16:32 UTC

9 Oct 2024 – daytime overpass

a)

case_study_Klett_Picasso_20241009_1520-1632_cut

9 Oct 2024

9 Oct 2024, 15:51 UTC   02080E

Mindelo

100km radius

62km

Daytime case

9 Oct 2024, 15:51 UTC   02080E

16.878 °N -24.995 °E 13m (Mindelo)
Radius: 100km

Mindelo

Samples: 549
Along-track: 156.621km
Closest: 61.968km at 15:51:35 UTC
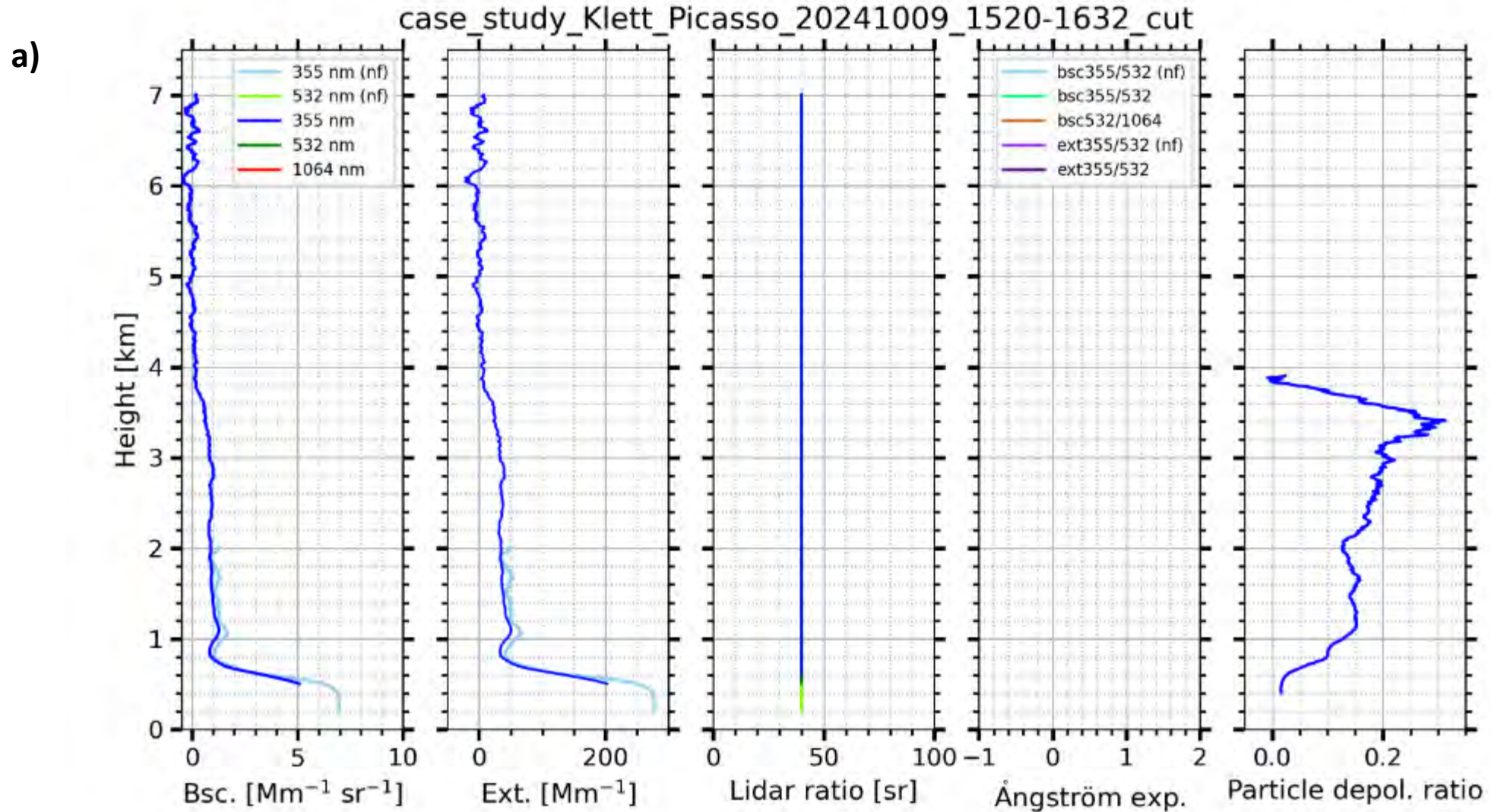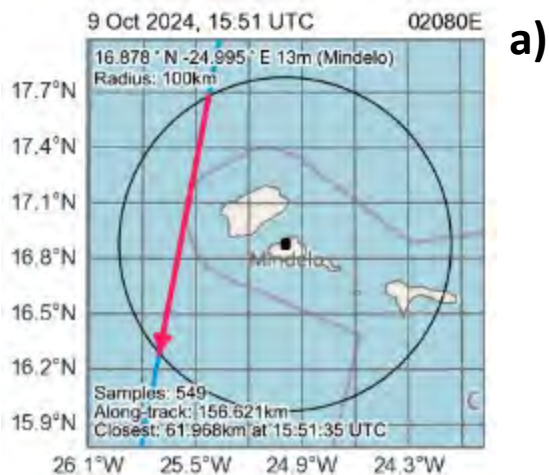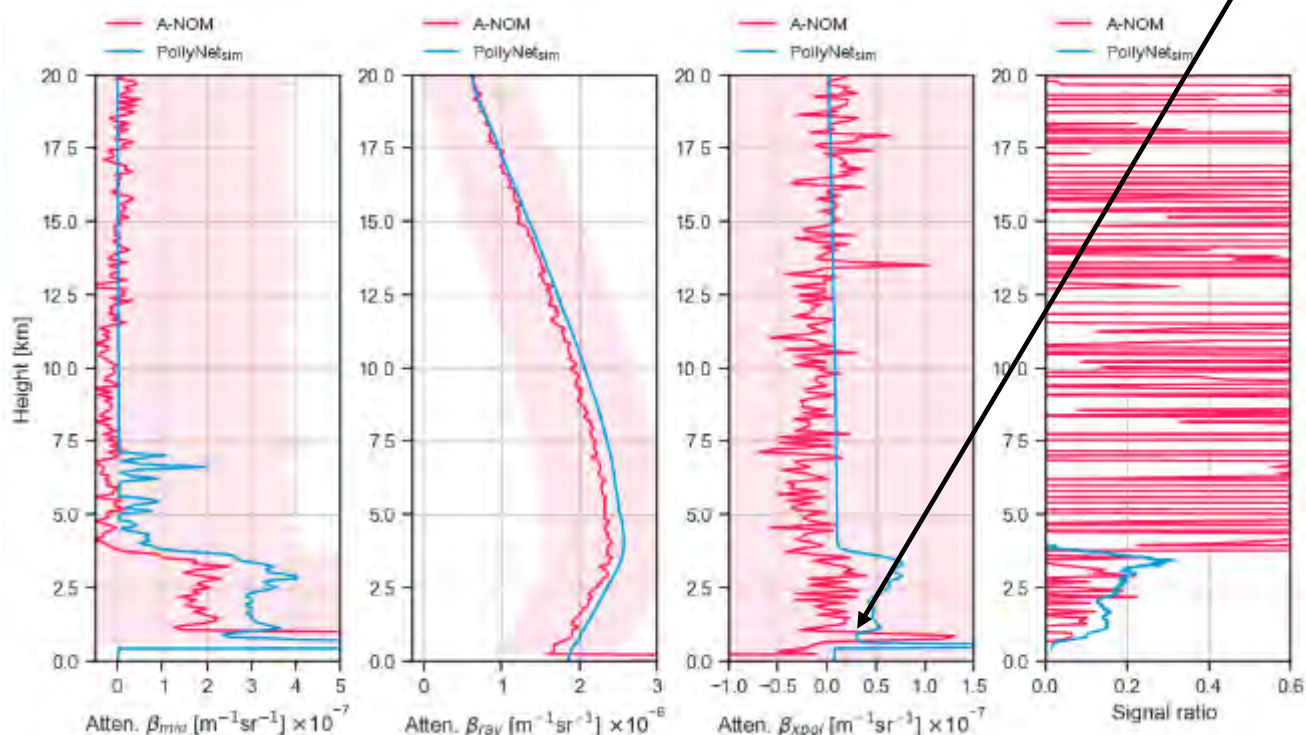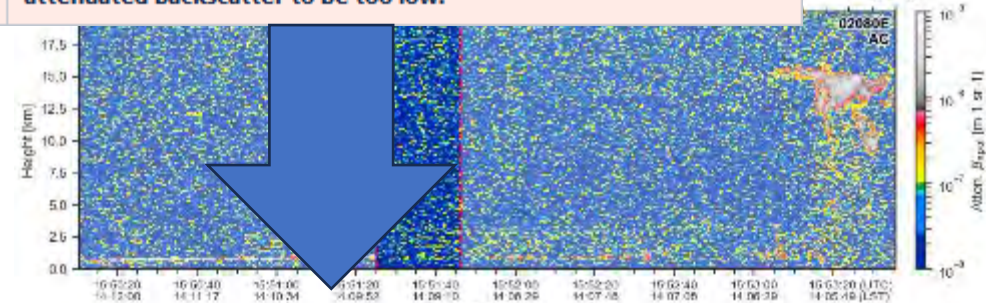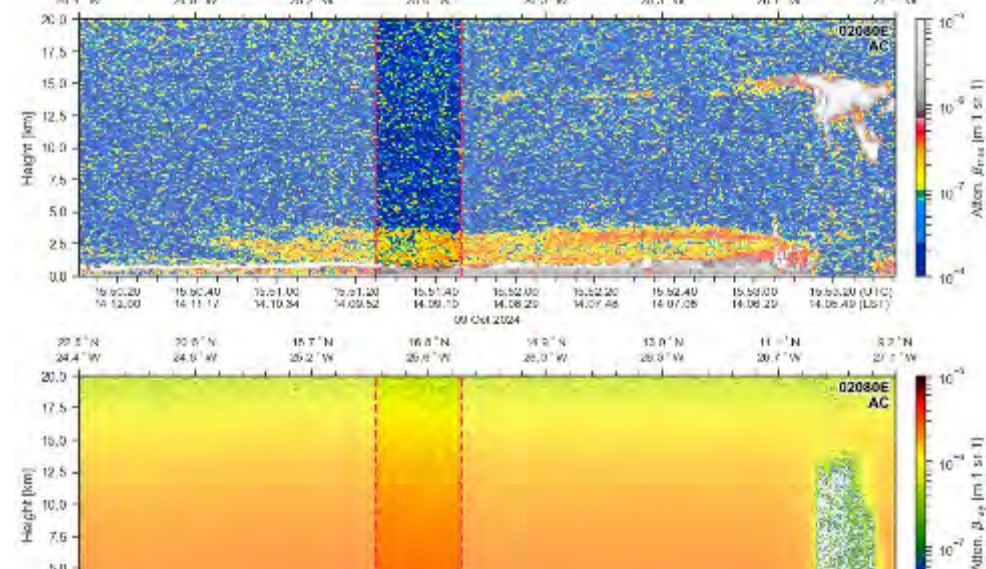
a)

Baseline AC

Negative BIAS due to wrong offset correction

Baseline AC	Incorrect background correction, The largest impact on the final product is that the incorrect offset values affect the calibration of the cross-polar channel in the L1 processor causing the cross-polar attenuated backscatter to be too low.

Updated offset correction
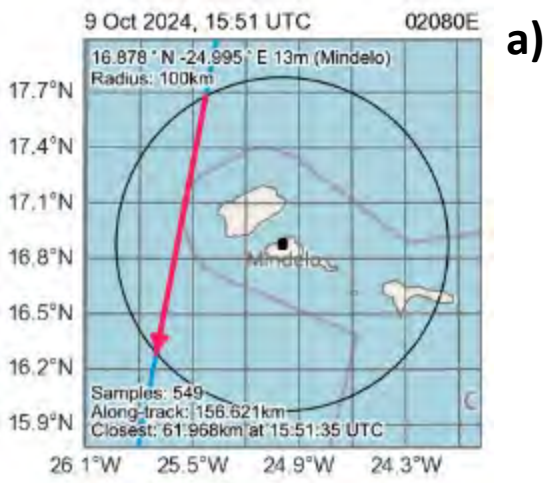→ prototype L1 data (courtesty DISC)

23

9 Oct 2024

9 Oct 2024, 15:51 UTC   02080E

Mindelo

100km radius

62km

Daytime case

Prototype L1 data with improved offset correction
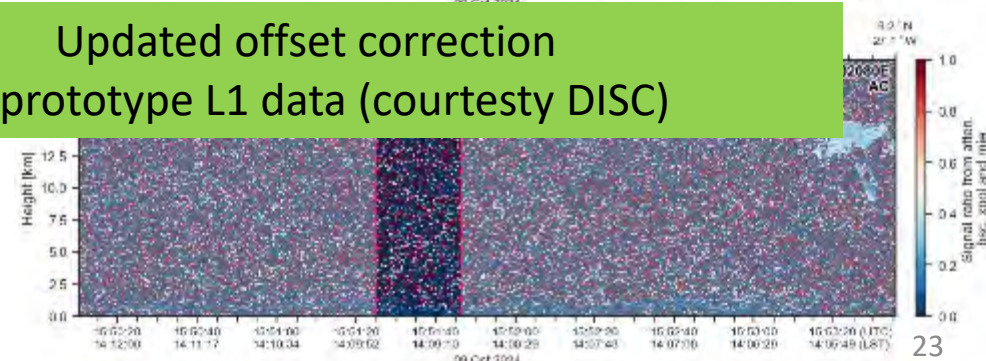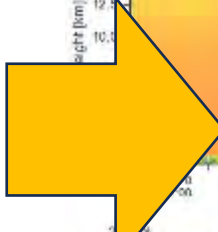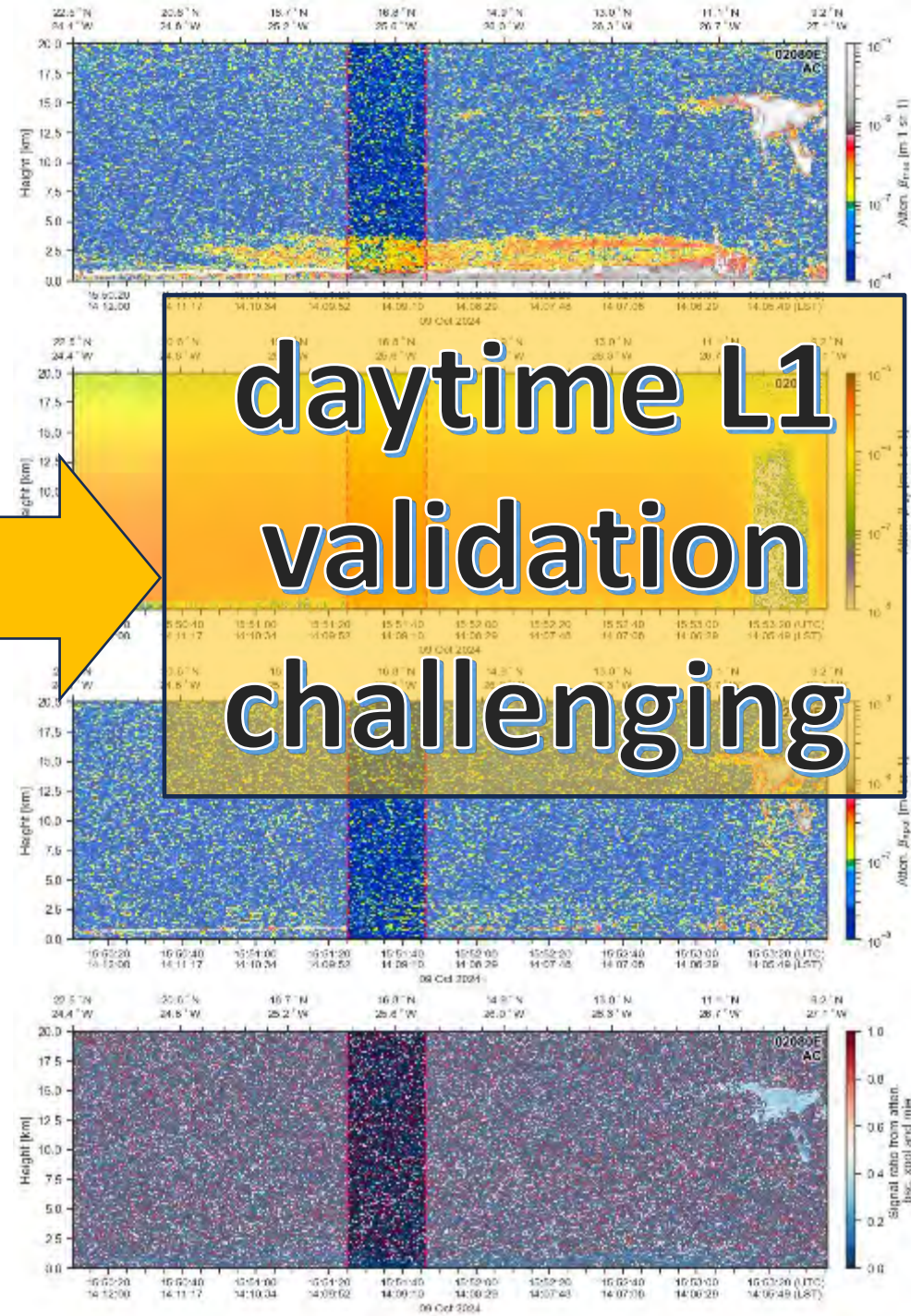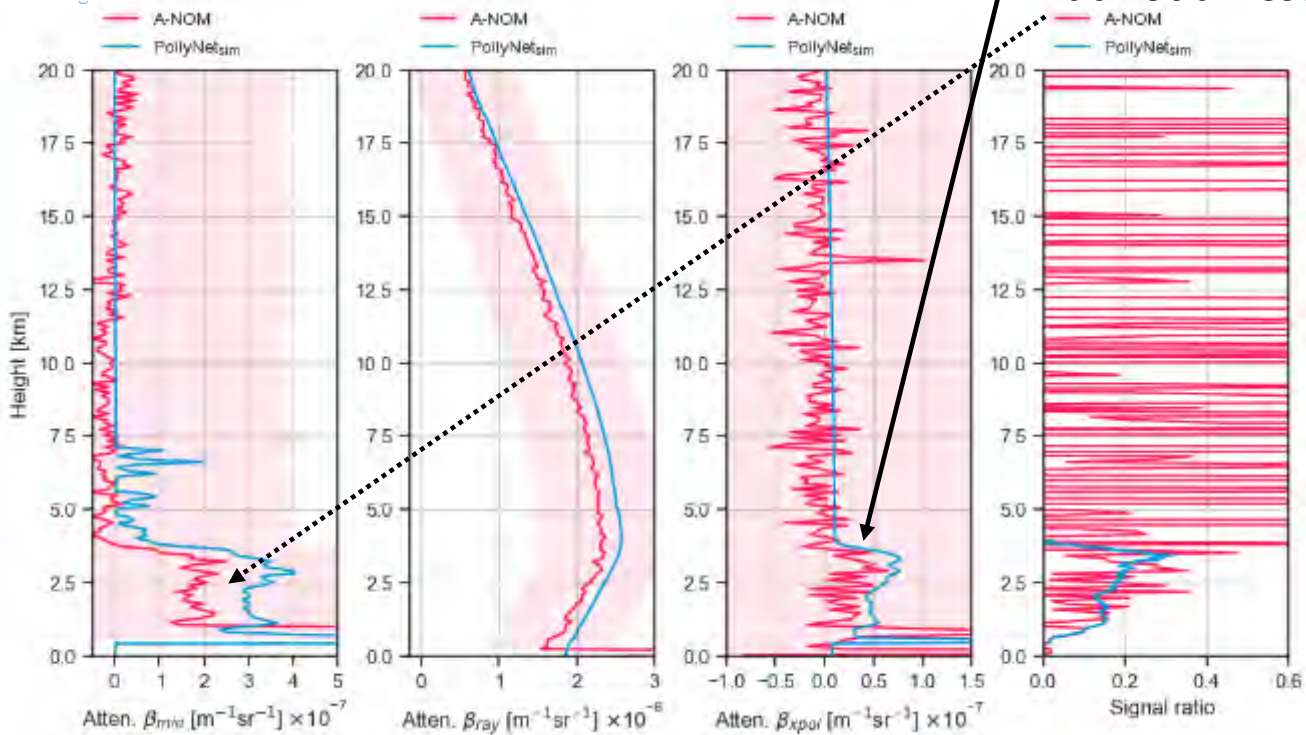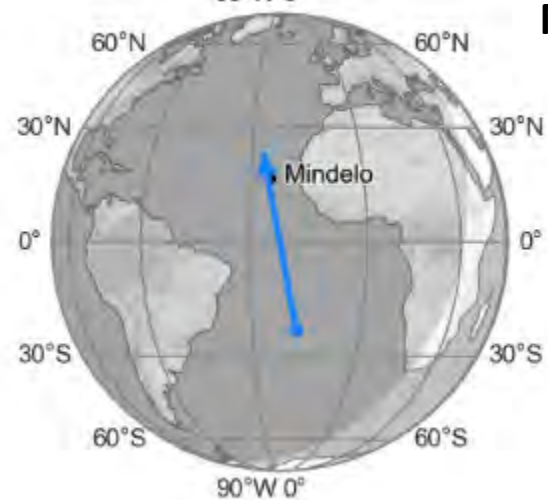
Baseline XY

- Strong improvements in L1 cross
- But not all issues solved

daytime L1 validation challenging

4 Nov 2024
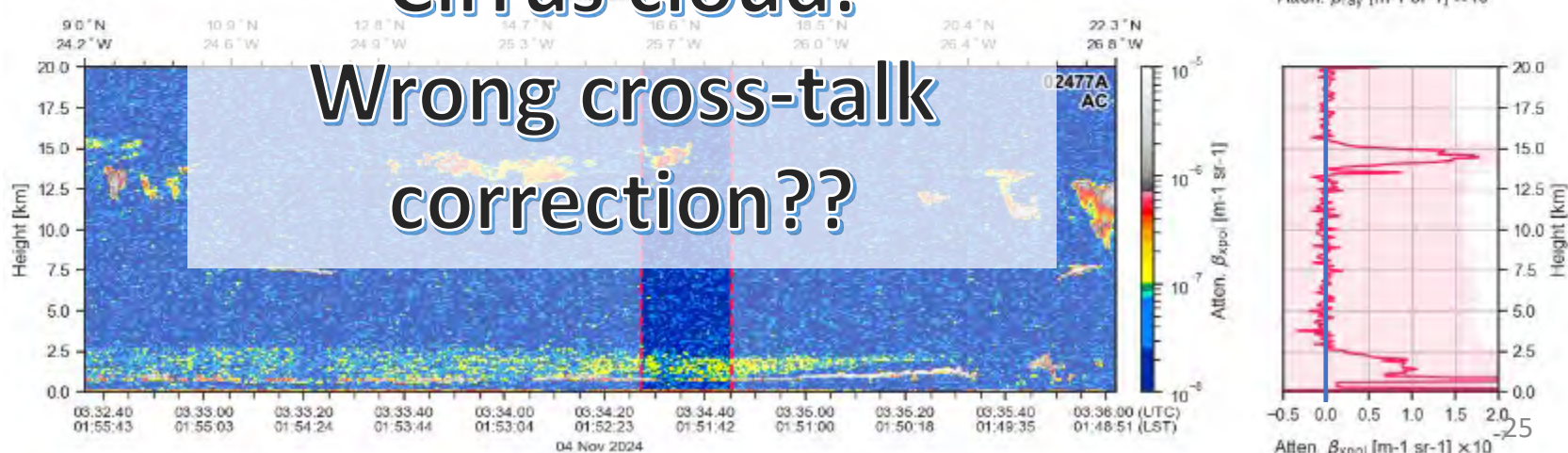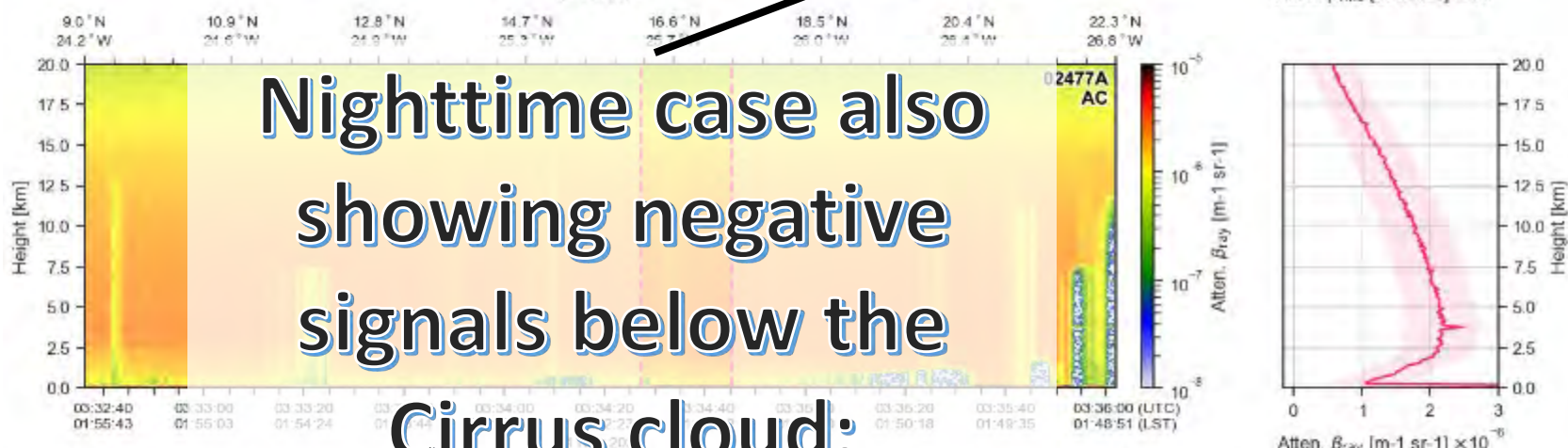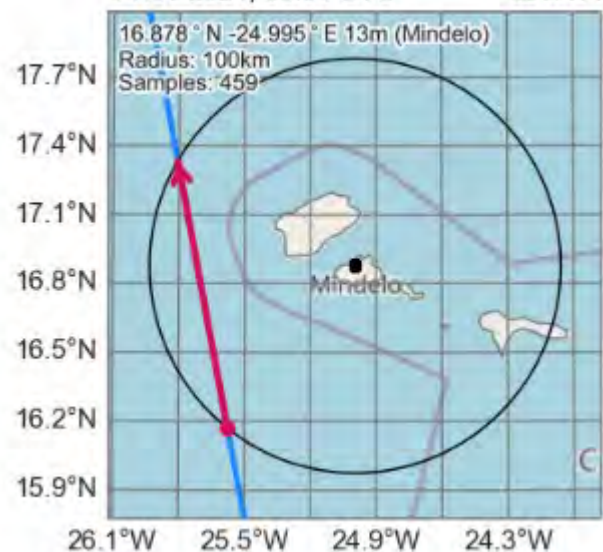
Nighttime case

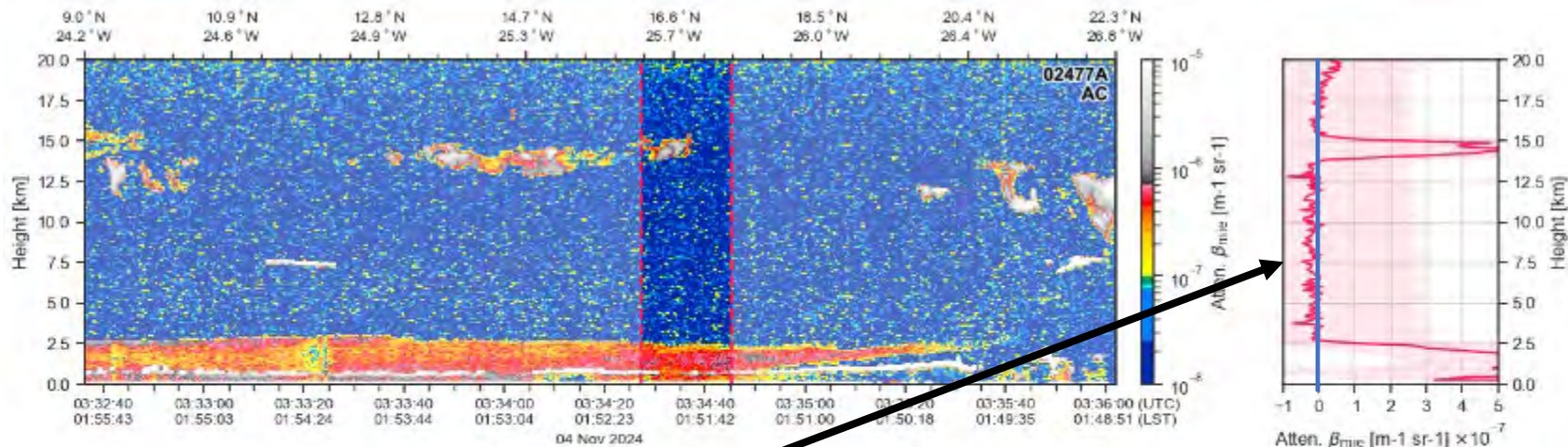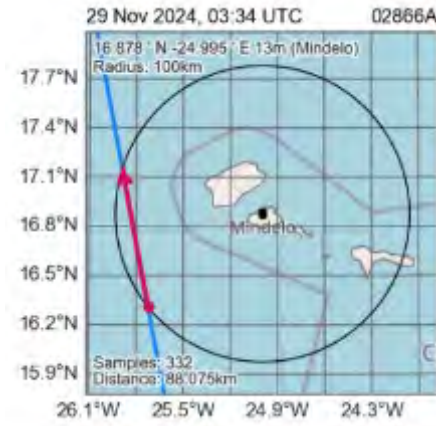Nighttime case also showing negative signals below the Cirrus cloud: Wrong cross-talk correction??
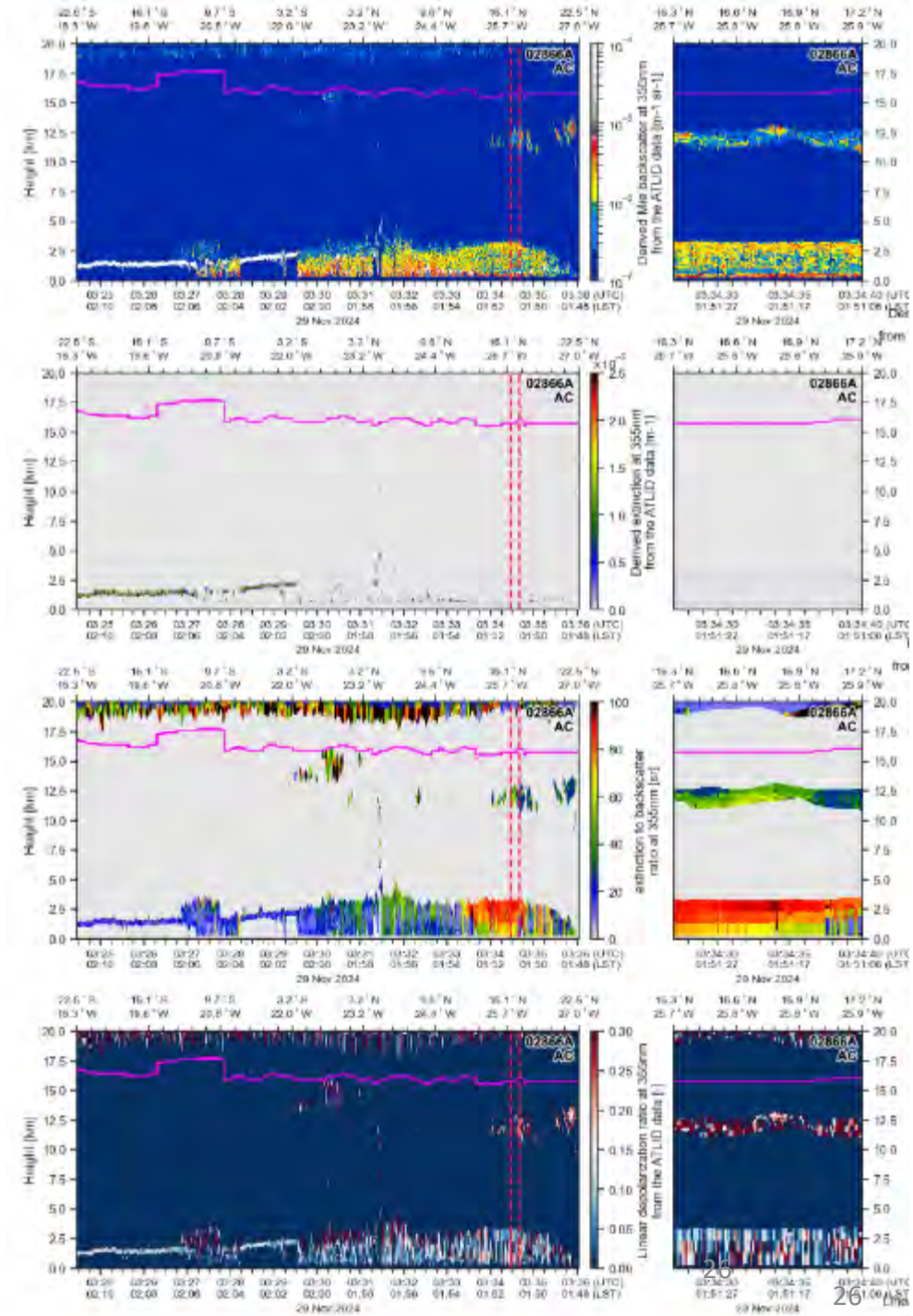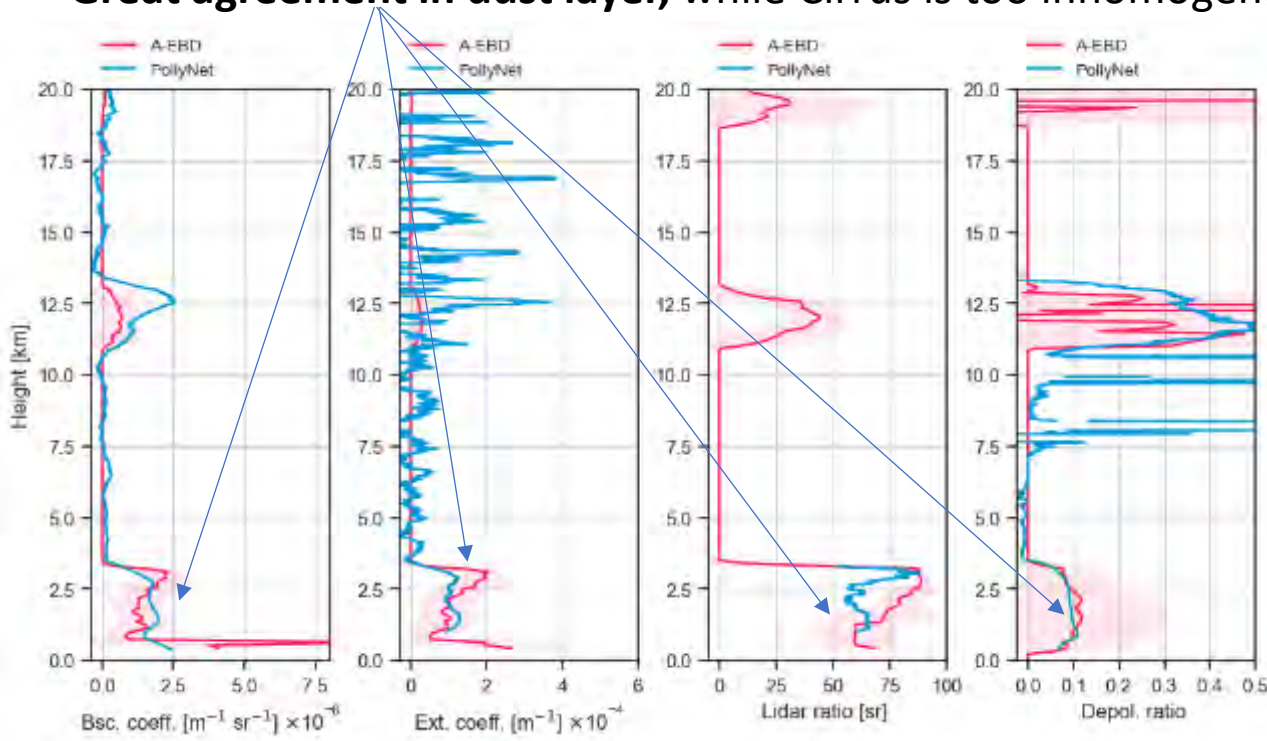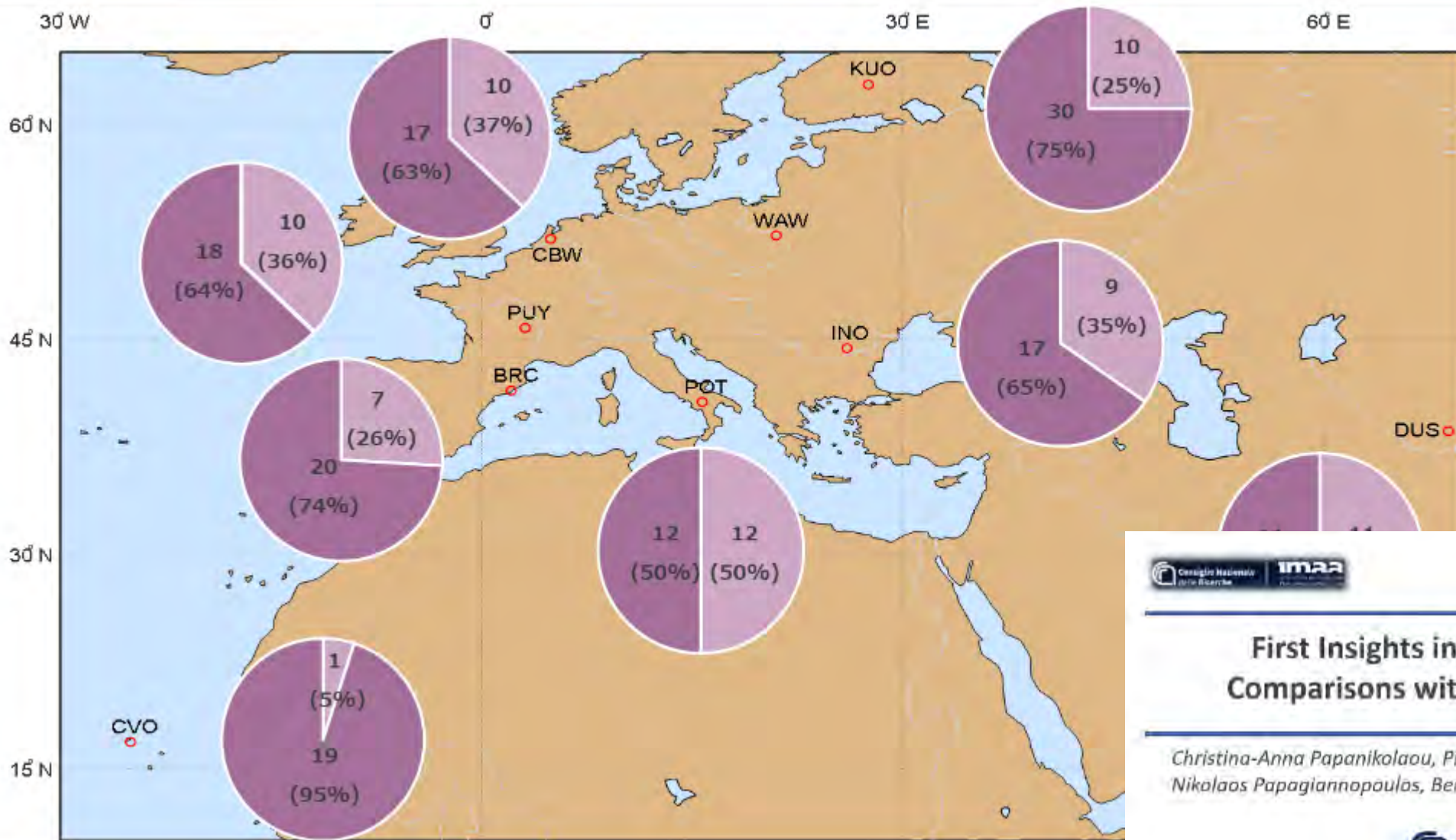
29 Nov 2024

100km radius

88km

Nighttime case

EARLY Level 2 data!!!!

- one does not need to observe the same whole atmospheric column → focus on dedicated targets sufficient, e.g. dust layers, thin ice clouds
  →**Statistical evaluation possible**

- **Great agreement in dust layer,** while Cirrus is too inhomogeneous

355 optical products available

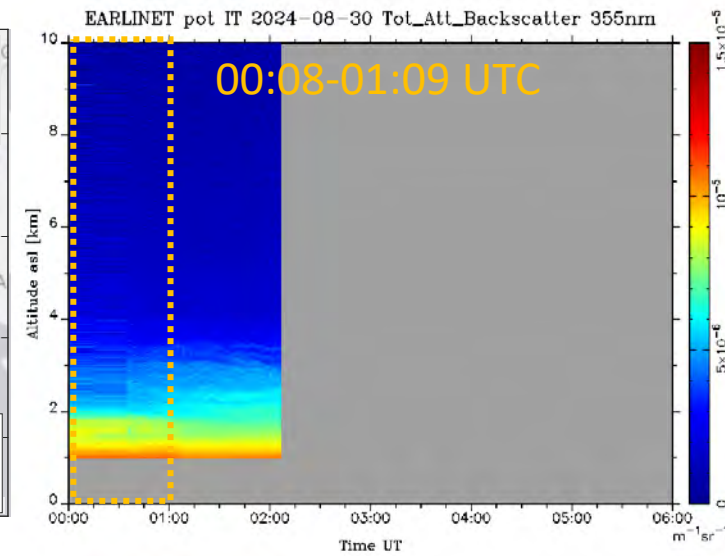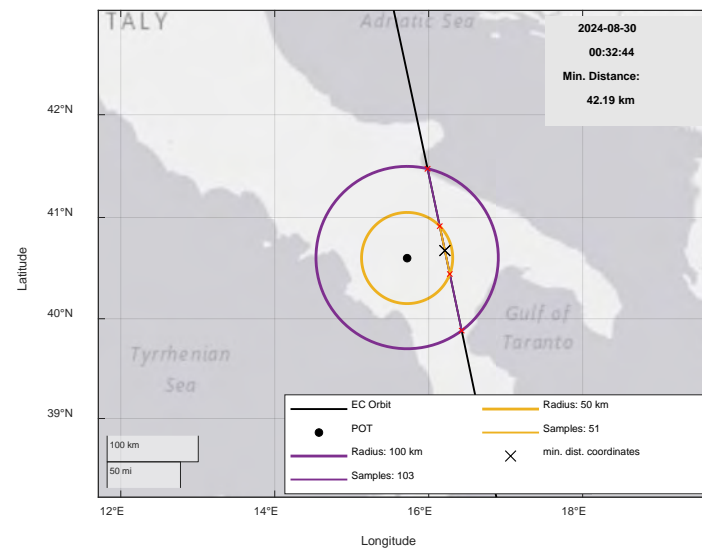Overpass optical product present in the SCC [11 Aug – 02 Dec]

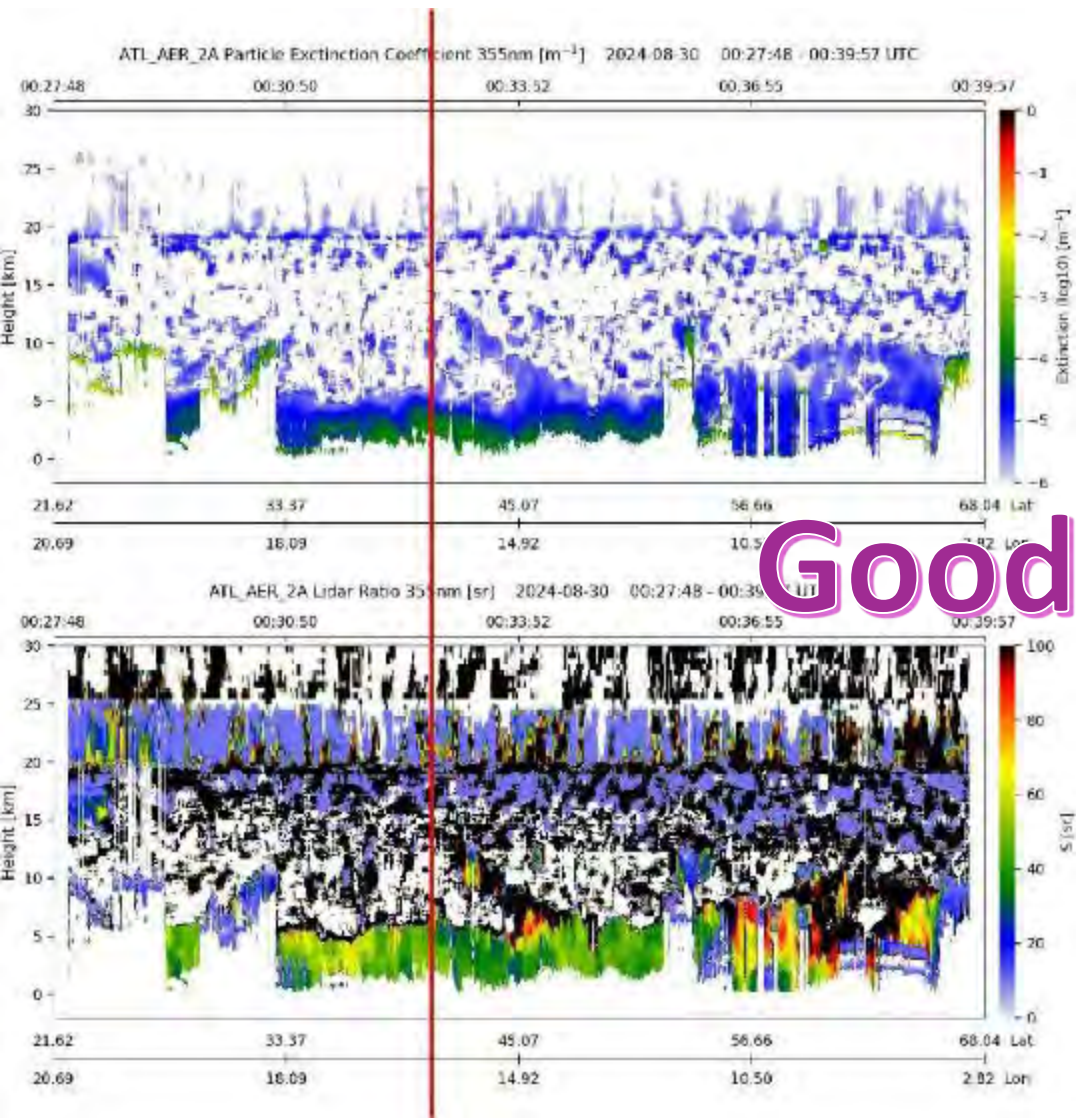First Insights into ATLID Level 2A Data: Comparisons with EARLINET observations
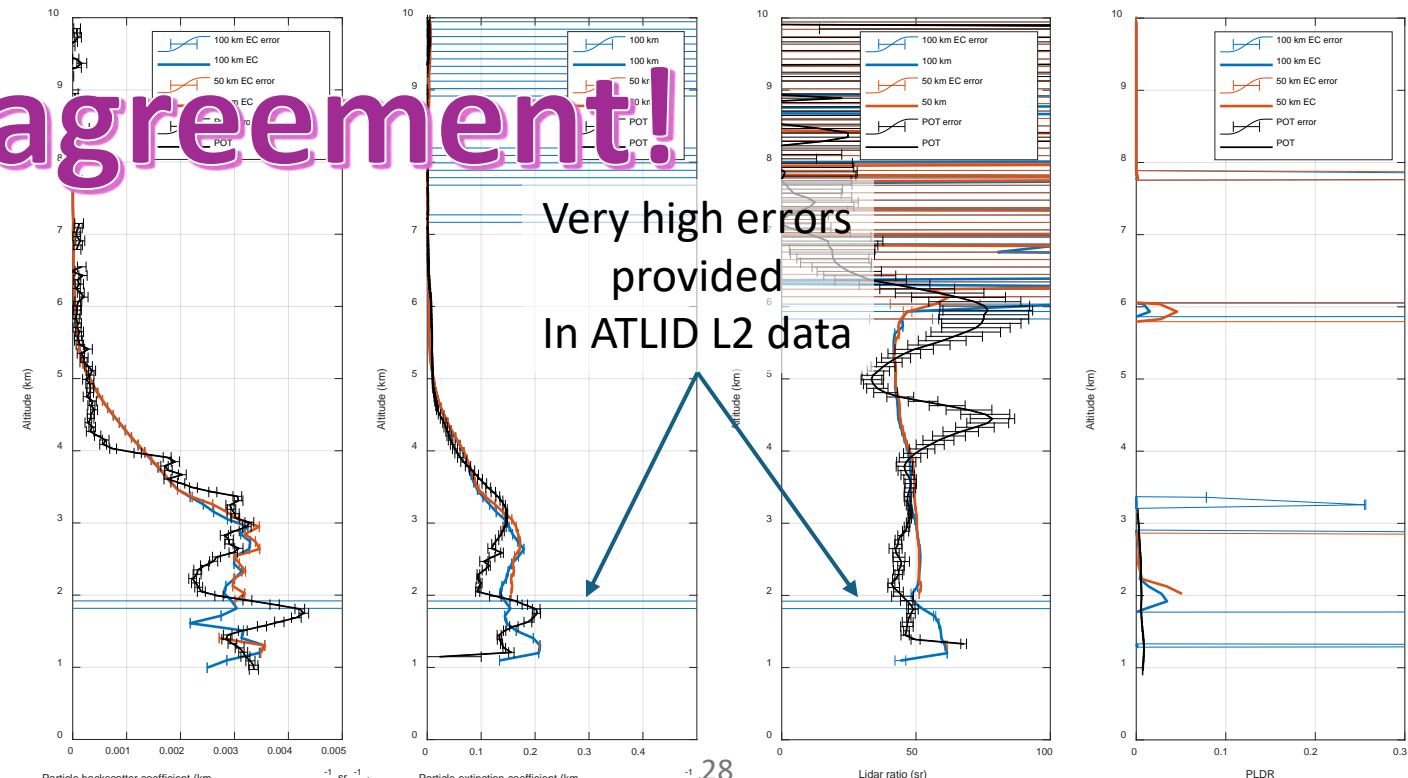
Christina-Anna Papanikolaou, Pilar Gumá' Claramunt, Michail Mytilinaios, Nikolaos Papagiannopoulos, Benedetto De Rosa, Aldo Amodeo, Lucia Mona

Potenza, Italy-2024/08/30-01448B

Good agreement!

00:08-01:09 UTC

Very high errors provided
In ATLID L2 data

No flagging applied on ATLID data

Credits to C. Papanikolaou

Potenza, Italy-2024/09/06-01557B
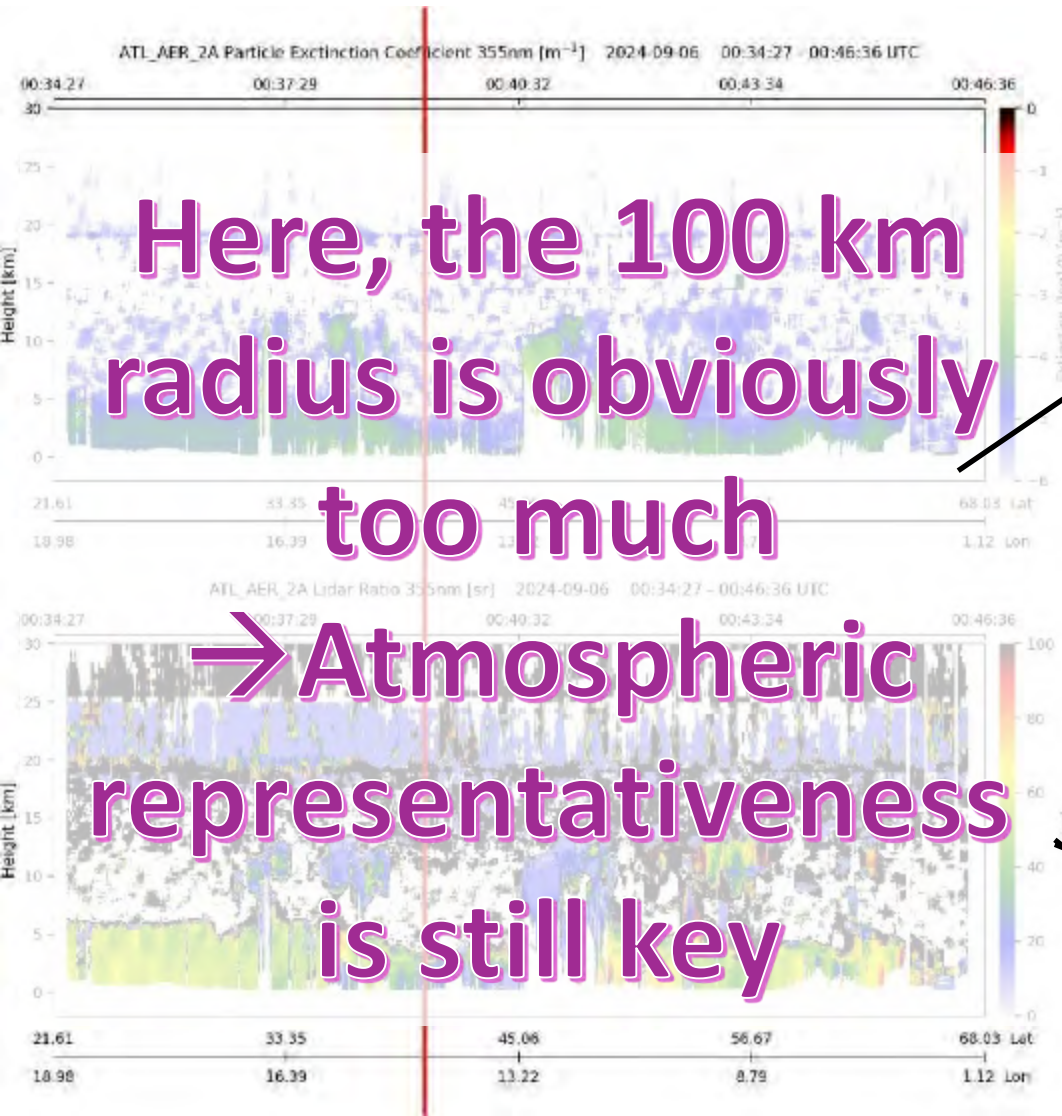
Here, the 100 km radius is obviously too much →Atmospheric representativeness is still key
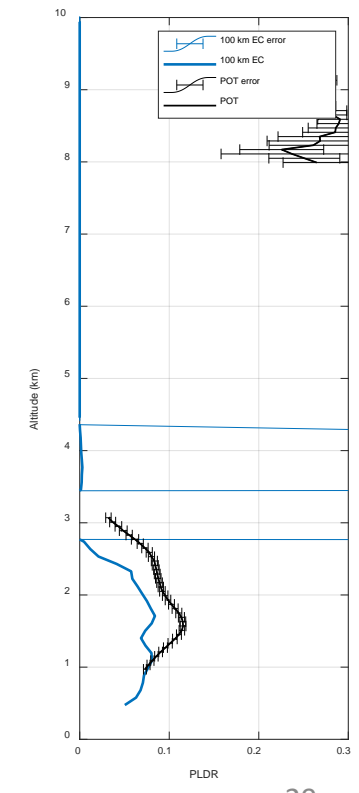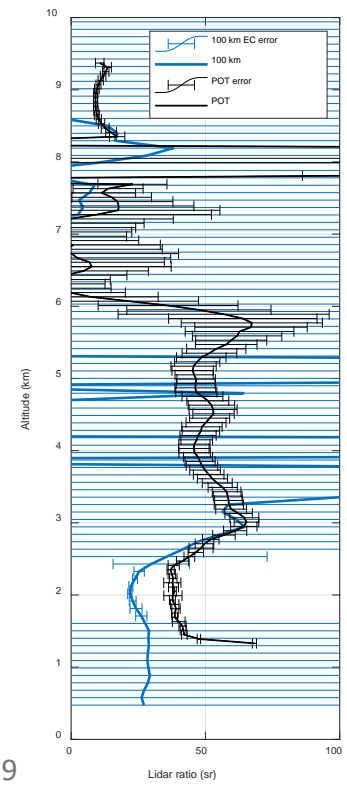
No flagging applied on ATLID data

Credits to C. Papanikolaou

Cabauw, The Netherlands-2024/09/02-01495B

Cirrus Cloud involved

Good agreement! Also partly for ice clouds! More results in Frascati by Christianna!
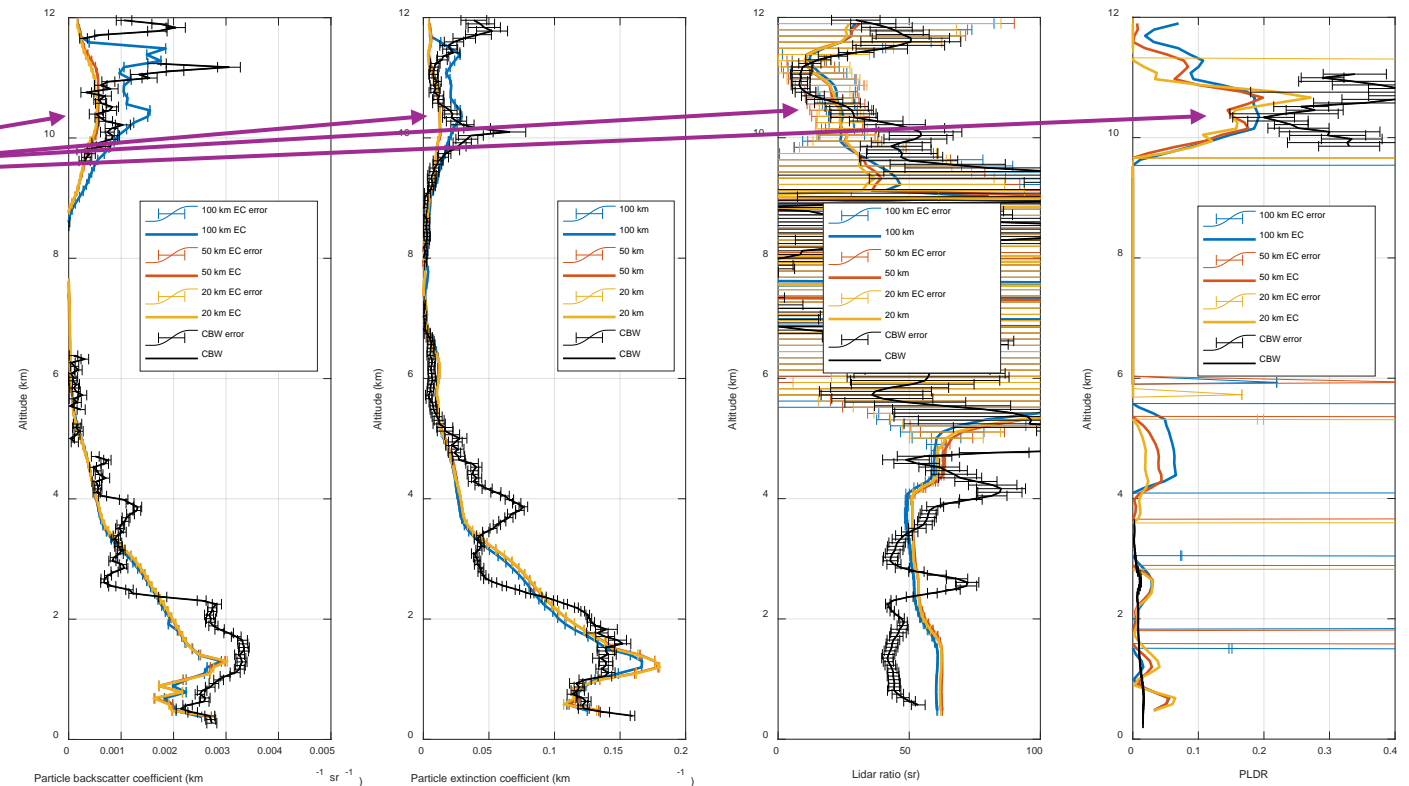
Credits to C. Papanikolaou

Summary I

- AECARE is mainly about data delivery to EVDC
- Several ACTRIS ground-based remote sensing facilities
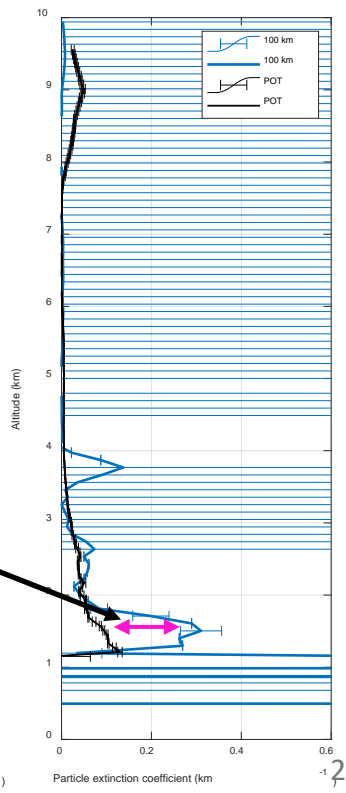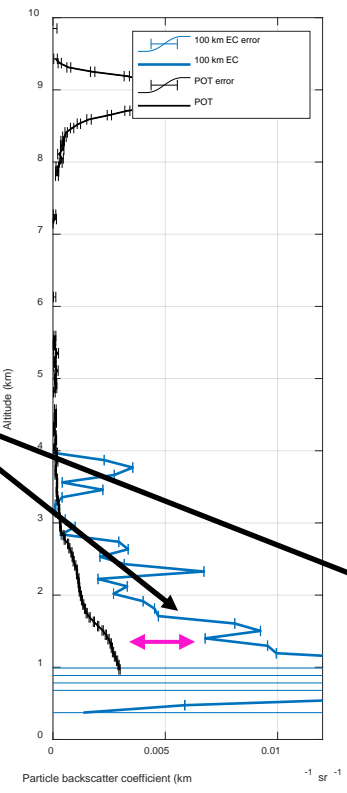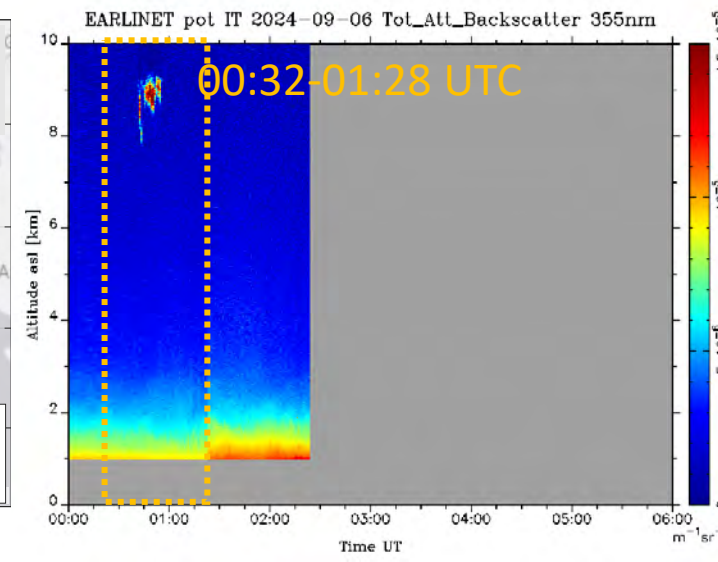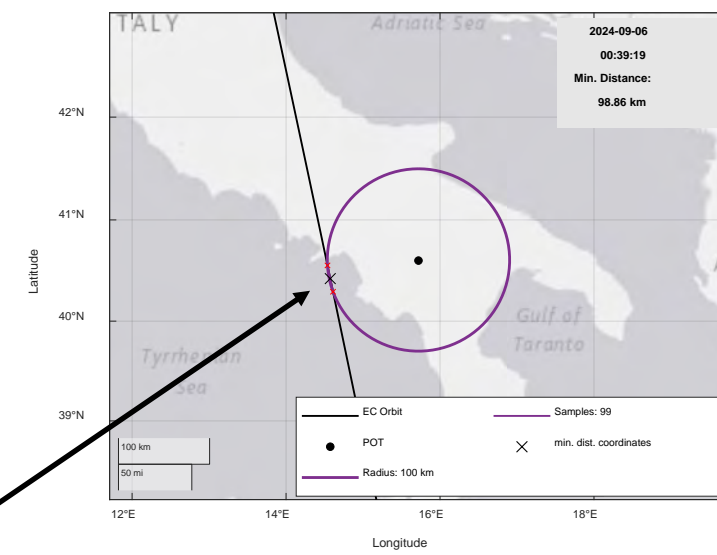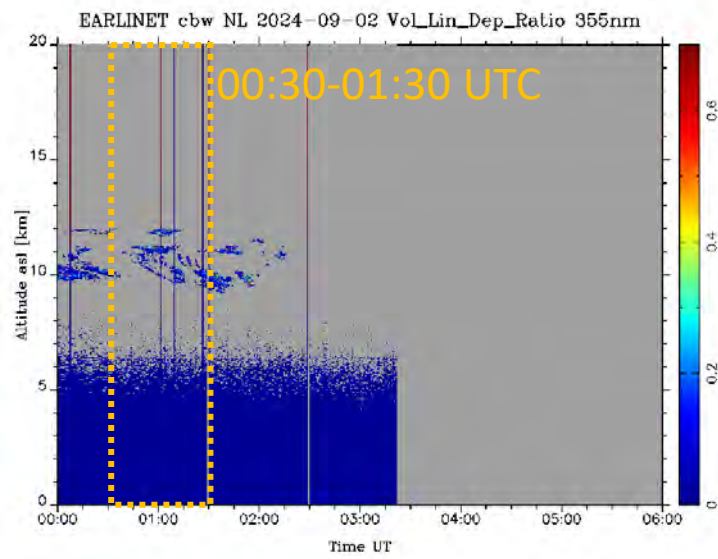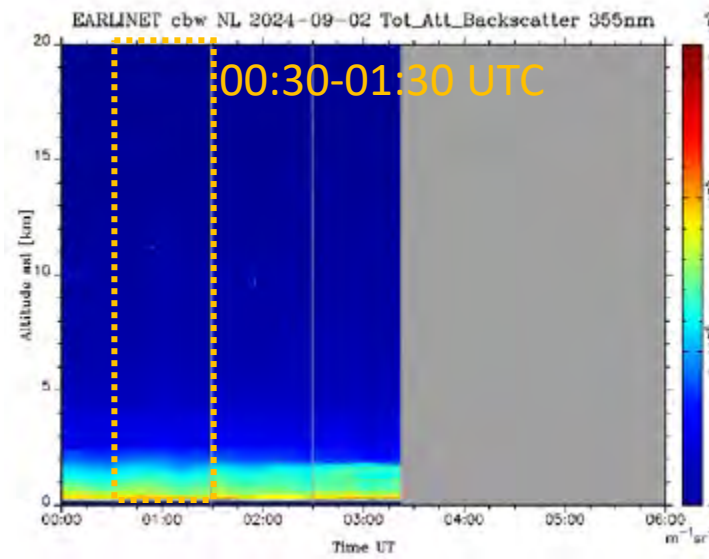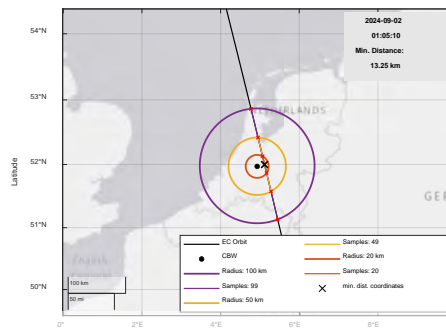- Combined with an ATMO ACCESS pilot

The challenge of L1 validation from ground:

- One needs to observe completely the same atmospheric scene as the satellite→ Difficult for ground stations
- Scenes with clouds are almost impossible to validate
- → Automatic, statistical validation is very difficult
- → Focus on golden cases

Level 2 validation is much appropriate:

- One does not need to observe the same whole atmospheric column
- Focus on dedicated targets, e.g., dust layers, thin ice clouds and special events, like widespread smoke plumes
- Statistical evaluation possible
- → the strengths of the network can come into play
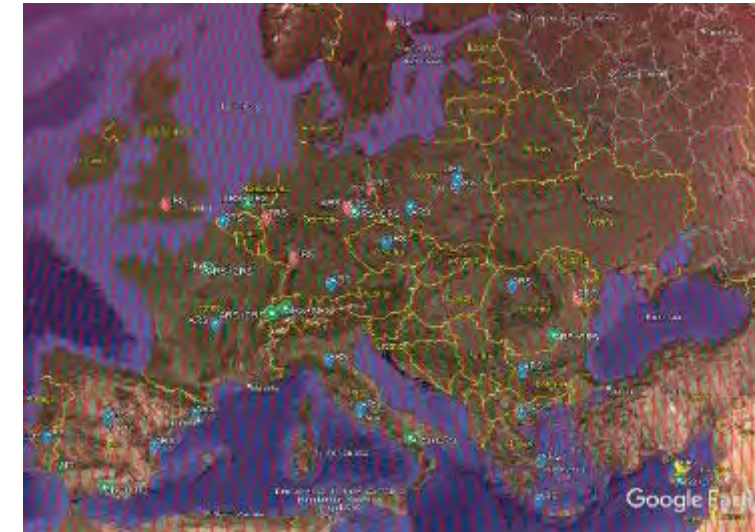
Summary II

- EarthCARE's ATLID in general:
  - **Great signal quality** of ATLID with impressive results.
  - E.g., stratospheric layers in the tropics observed by ATLID since summer have been confirmed by ground-based lidar → **Ruang volcano** plume
  - Layer boundaries do agree well
- Quantitative comparisons reveal still some caveats as expected for an explorer mission:
  - **Hot and cold pixel** are observed
  - **Night time depolarization** based on L1 signal ratios **agrees** reasonably with ground-based obs.
  - Daytime data hard to use for quantitative comparison due to **background/offset correction issue**
  - Nighttime data shows also issues, but maybe related to **cross talk**
  - Preliminary improvement of **offset correction shows promising results** does not solve everything

Summary III

Recommendations:
- Work on:
  - Negative signals in free troposphere
    - Background/offset issue
    - Cross/Talk?
  - Too low depolarization ratio:
    - Background/offset issue, transmission values, configuration parameters
    - Cross/Talk,
  - Hot/cold pixels
    - Need be characterized / corrected
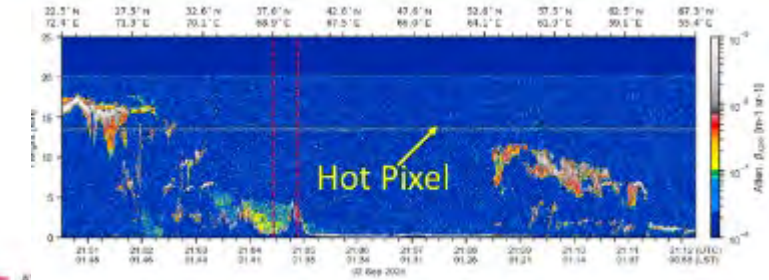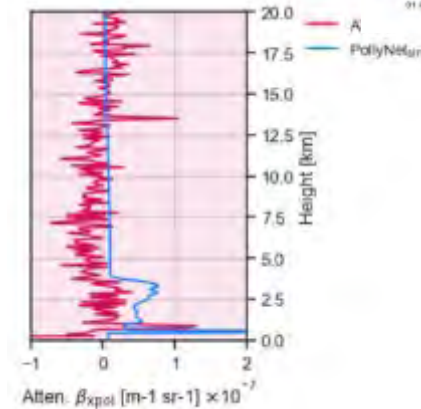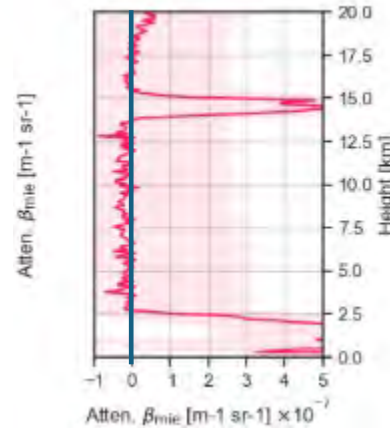   - Flagging periods with hot/col pixel posteriori?
- Re-do validation after processor updates
  - Define critical orbits/cases and re-process
  - Golden validation cases to reuse
- Communicate on what caveats is already worked on
  - keep EVDC up to date
  - Promote and populate page:
    (https://ecvt.csde.esa.int/confluence/pages/viewpage.action?pageId=105545866)