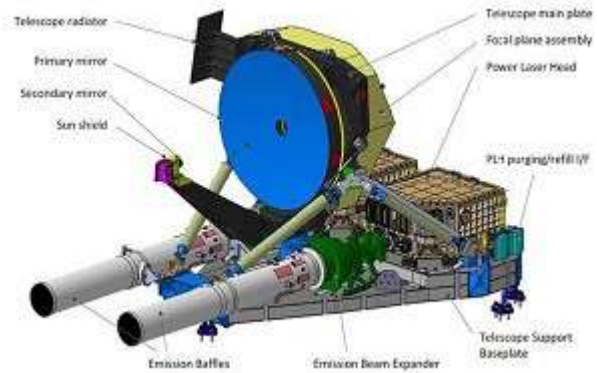
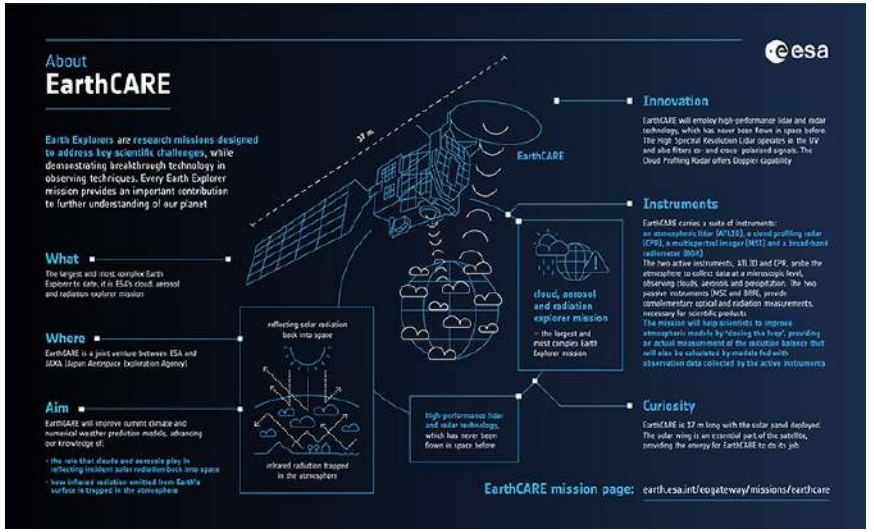
ATLID Level 1 product verification and validation needs



D.P. Donovan, G-J van Zadelhoff

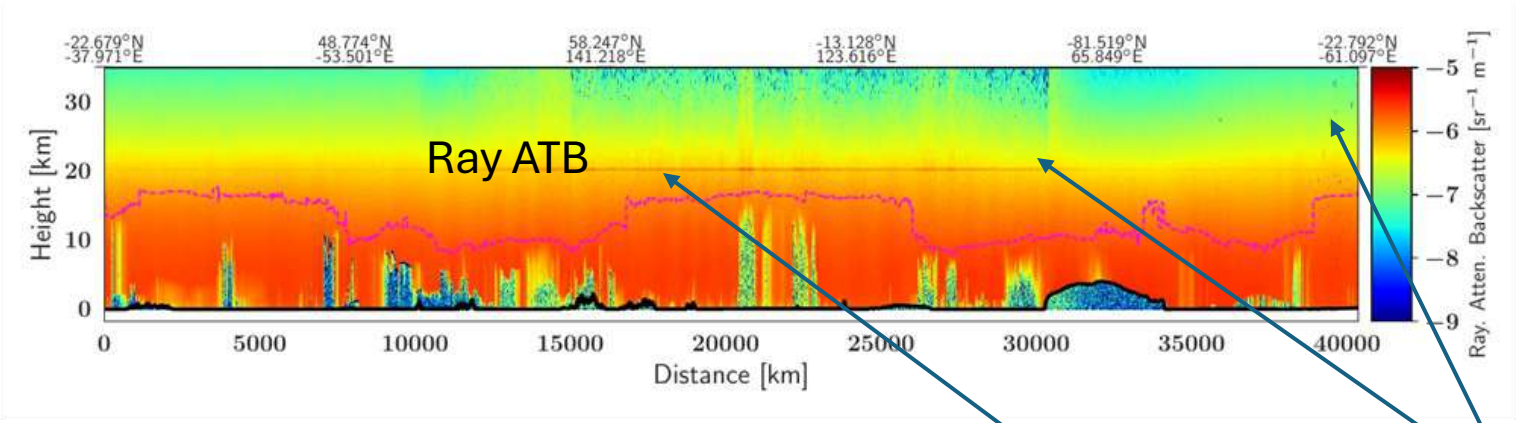
M. Haarig (Tropos)

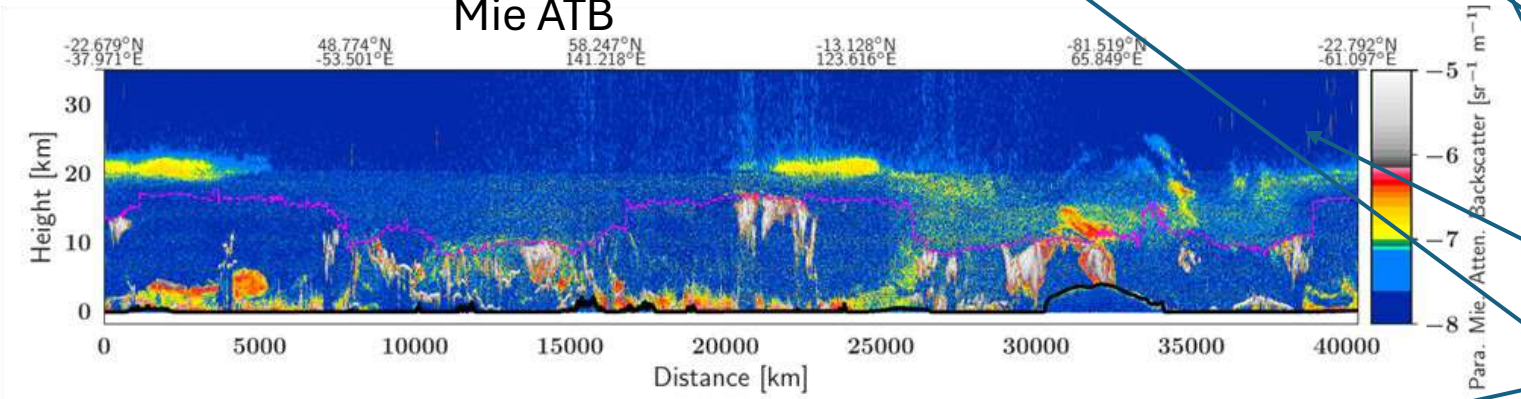
E. Marnas, A. Chantry (ESTEC)

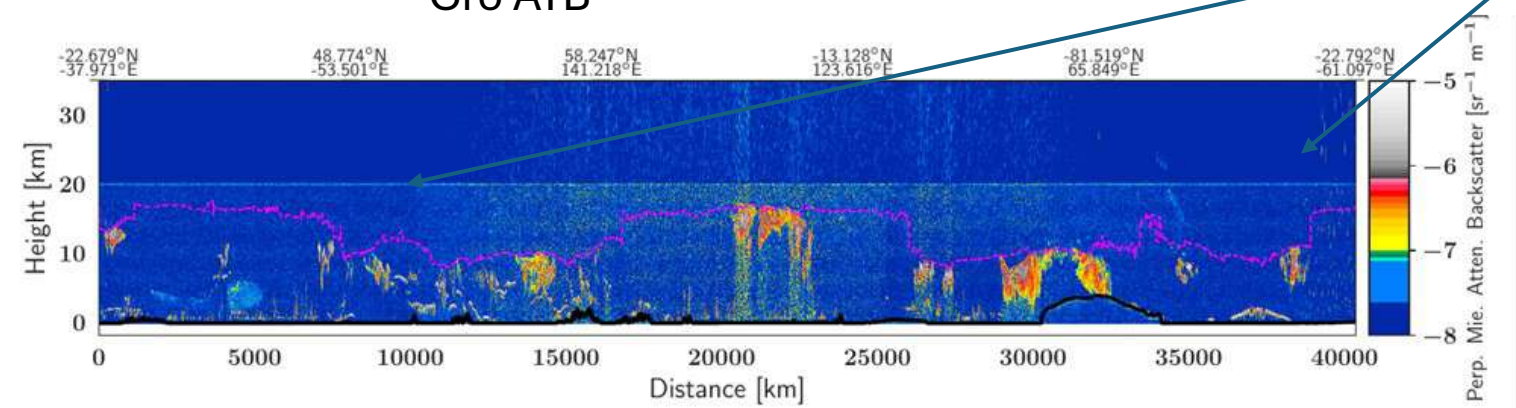


Outline

- Overview of ATLID L1 data
- Main noted Issues and solutions
  - Background and Offset removal issues.
  - Radiation noise
  - Hot Pixels
  - 20km (Charge Transfer Efficiency related) features.
  - Depolarization channel issues
- Summary







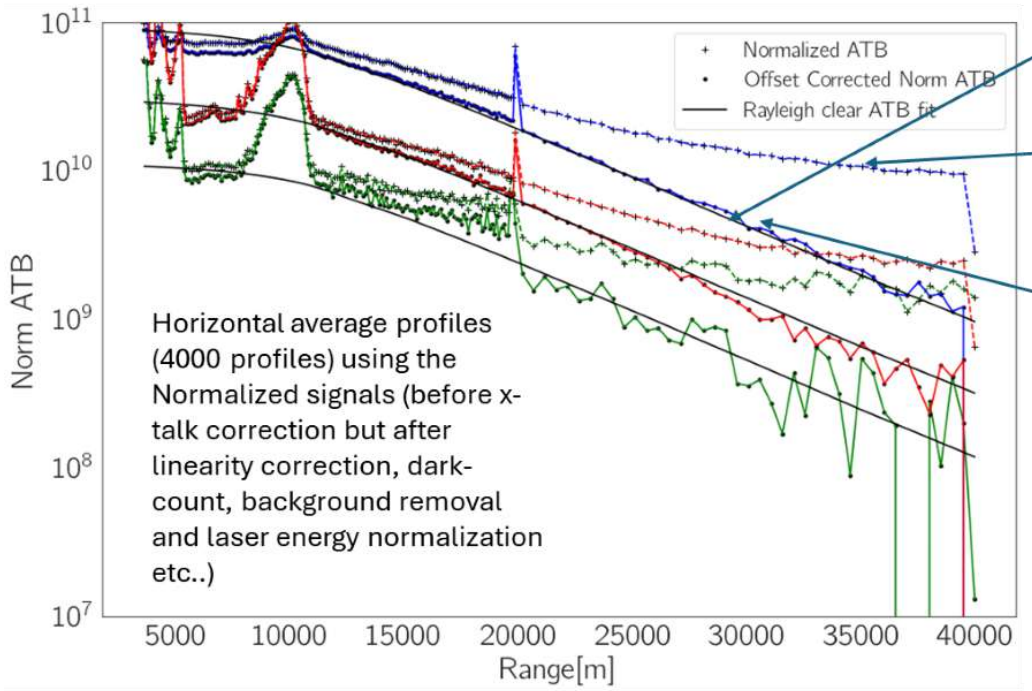
Sample output from the operational processor for one orbit.

Aug 14 Example.

1. **Discontinuities due to bad calibrations, especially in daylight.**
2. **Radiation speckle noise**
3. **Hot Pixels**
4. **20km feature in the Ray and Mie**
5. **Cold Pixel**
6. **Jumps between HR and LR**
7. **Offset Bug**
8. **Depolarization issues**

Background Removal was not working well enough: Relationship between signal acquired in the background sections of the detection CCD and the signal sections of the CCD were not accurate enough !

High background case: 01055D



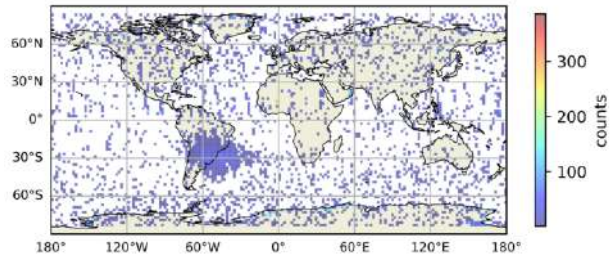
Solid Lines are fits to the expected Rayleigh Clear Signal.

Using Normalized signals without an offset adjustment fits very badly !

Allowing for an offset (i.e. allowing for a small error in the background removal) results in very much better fits !

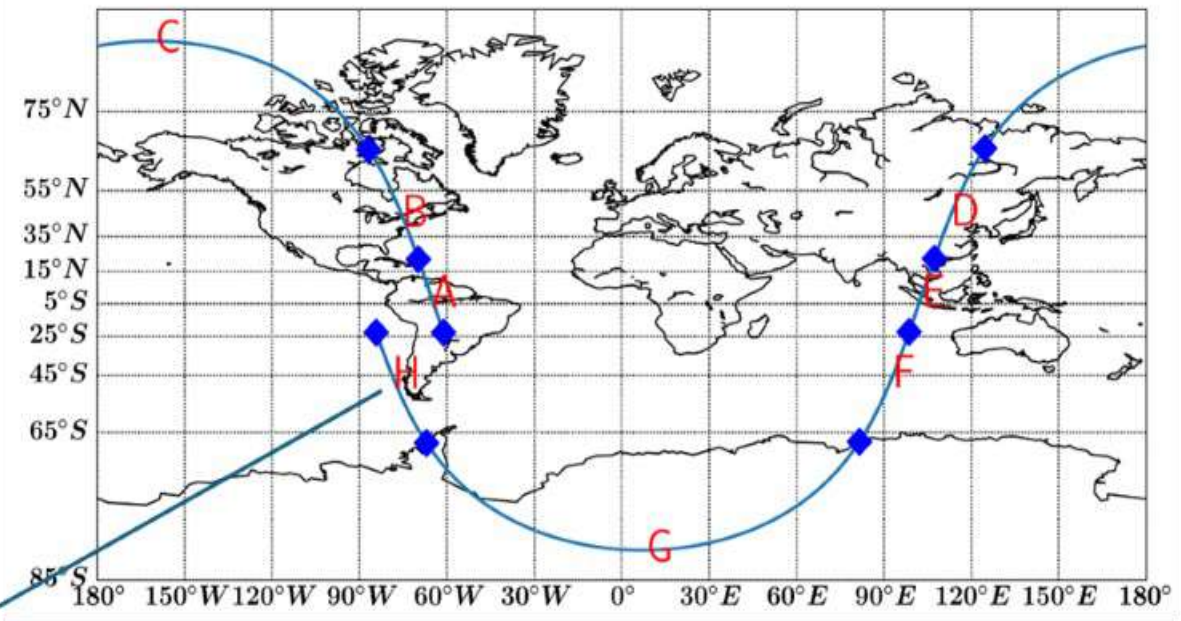
This explains why the calibration is off in daylight and other effects (but does not explain the 20km spike features).

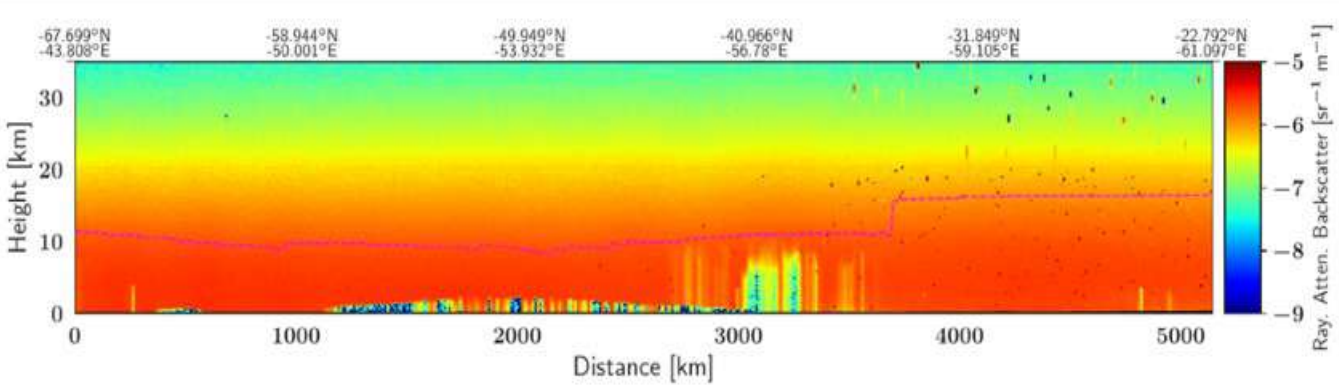
Shape of signal is all wrong. Extinction and backscatter derived using such signals will be way off !



Radiation Noise

Rate is about 20- 30 per 1e+5 profiles per day.





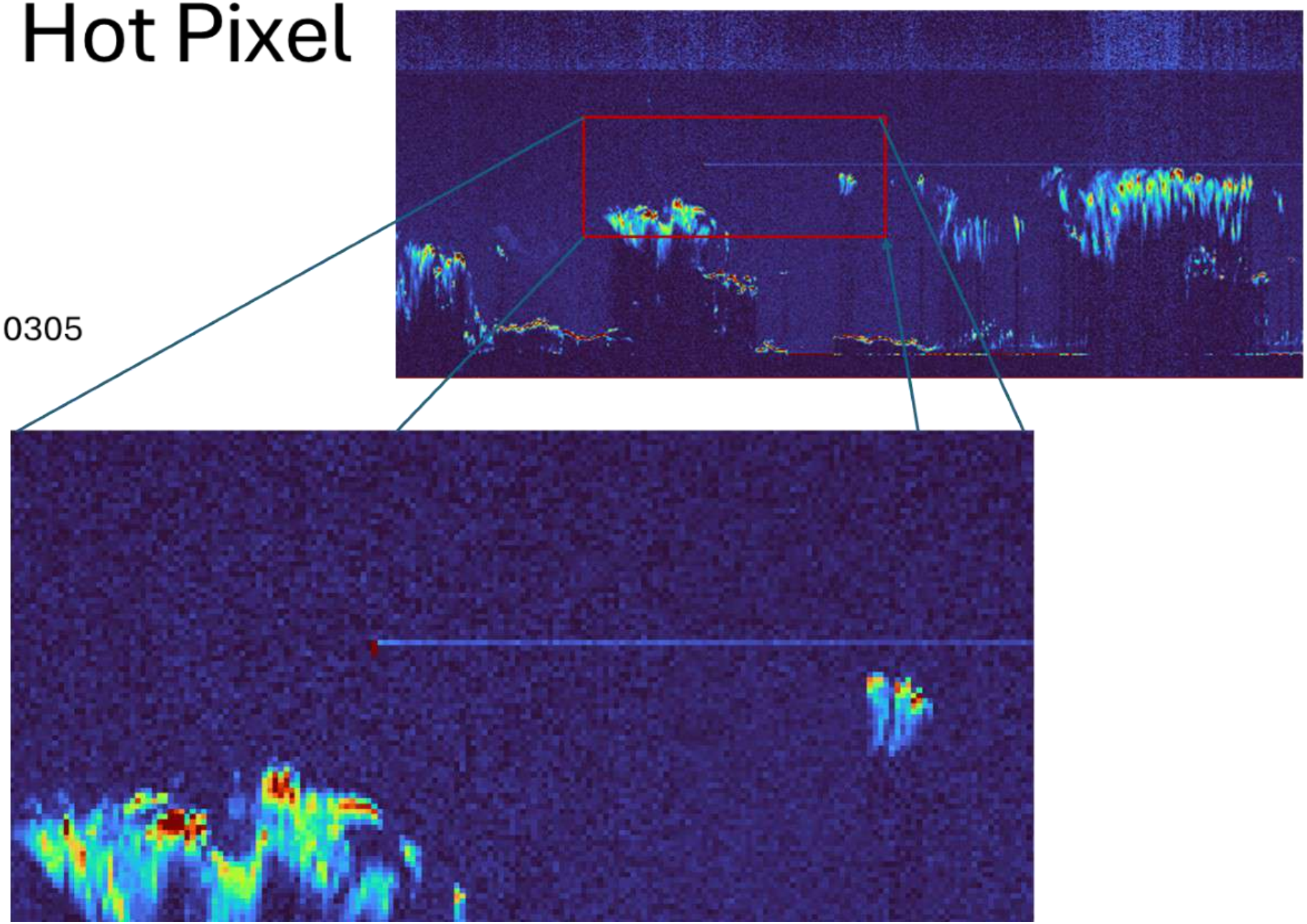
Can be detected by

1) Finding the e.g. 99 percentile level
2) Flagging pixels e.g. 10x higher than this level
3) Checking for false positives by comparing to other channels

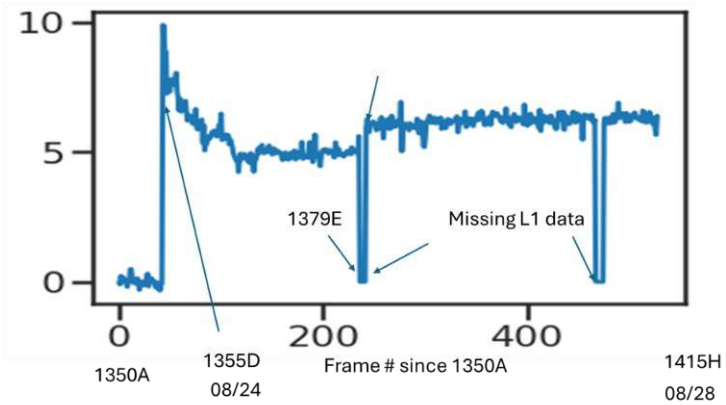
Birth of a Hot Pixel

Cross-Polar Channel

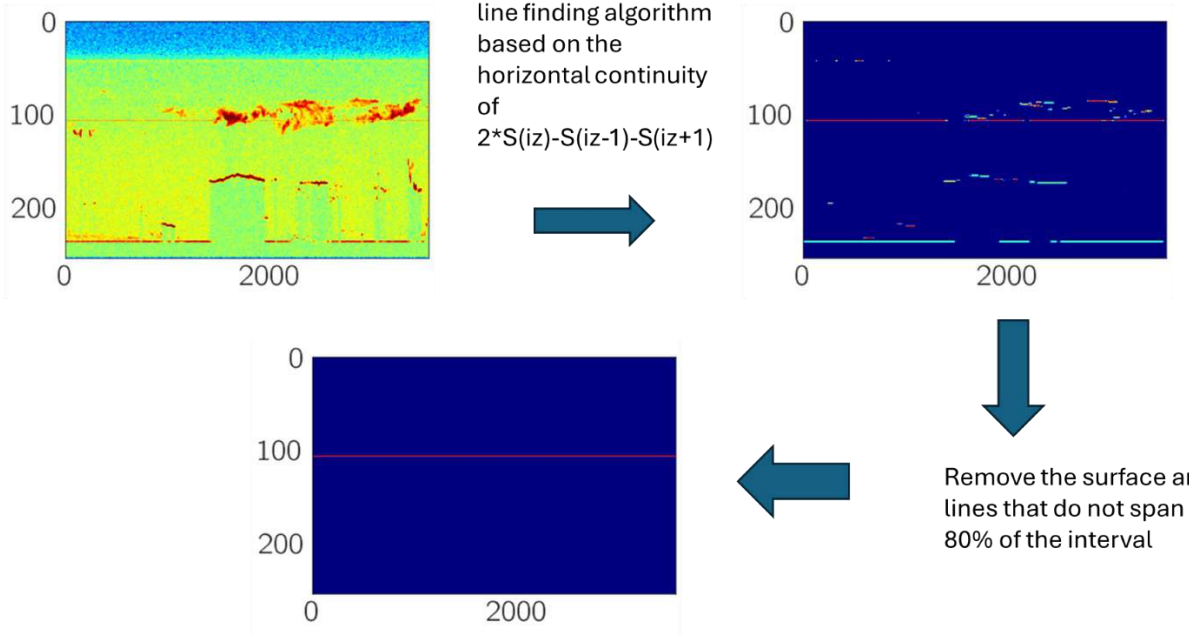
Frame 1355D 08/24 : 0305



Estimated offset in Background in Cro Normalized Signals



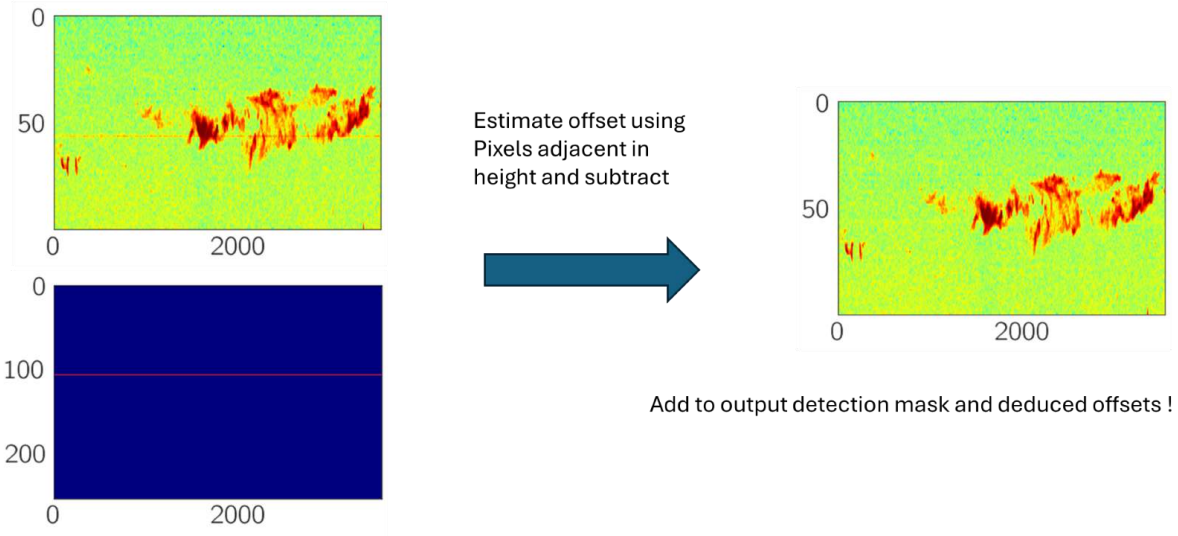
HP detection



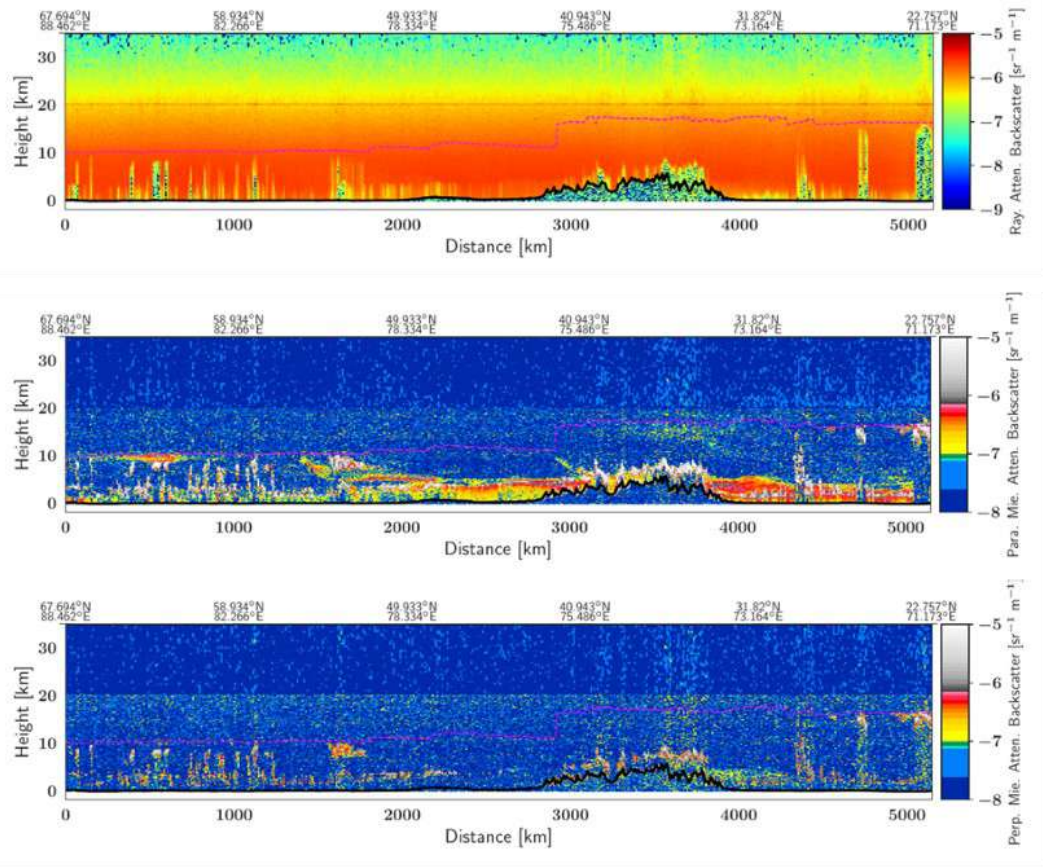
A prototype Software detection and correction algorithm has been developed and being tested.

Weekly Dark-Current maps have been implemented !

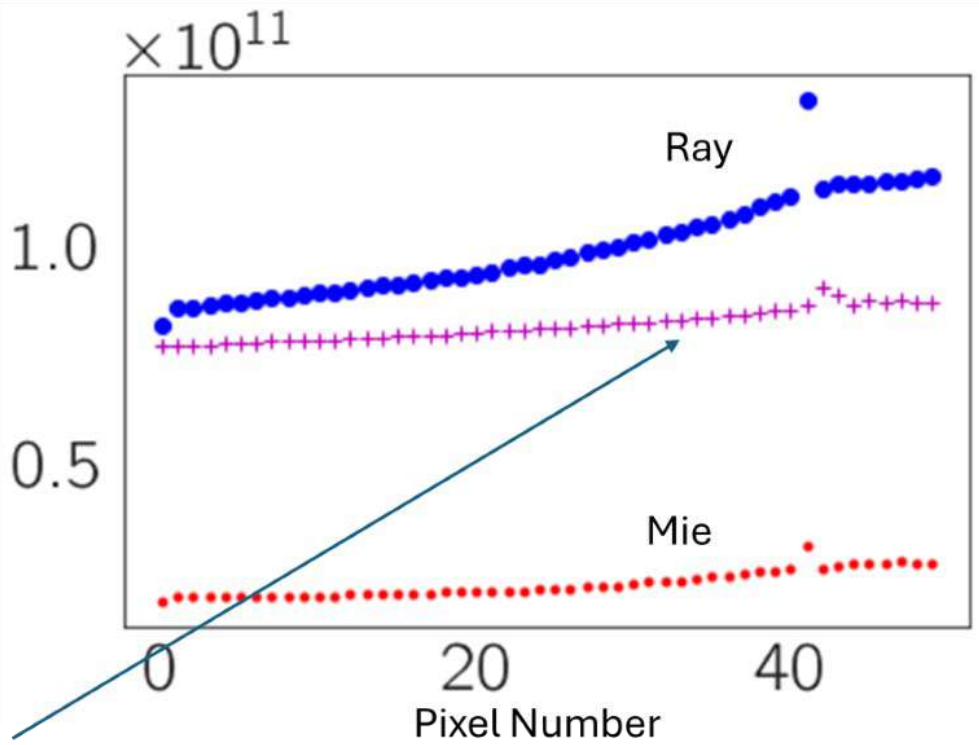
HP replacement



20 Km features in the Ray and Mie Channels



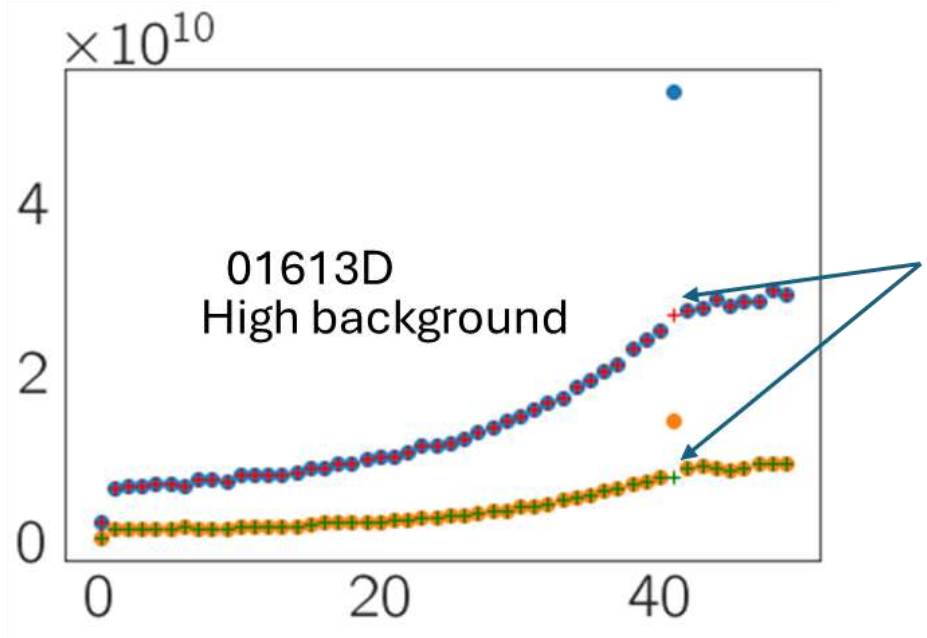
The result of averaging the Raw signals (minus the offset and corrected for the range bin width) for the first 4000km for fn01329D as a function of pixel number.



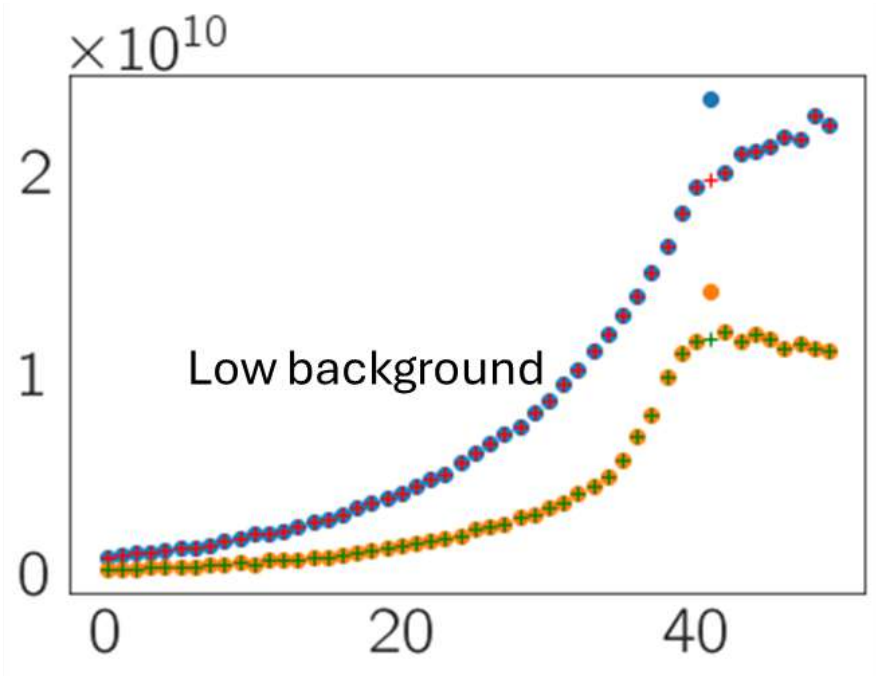
Crosspolar channel is different...?

Recent DCM ➔ Two adjacent Hot Pixels !

Shown are the raw_signals divided by the bin_width and multiplied by the range^2

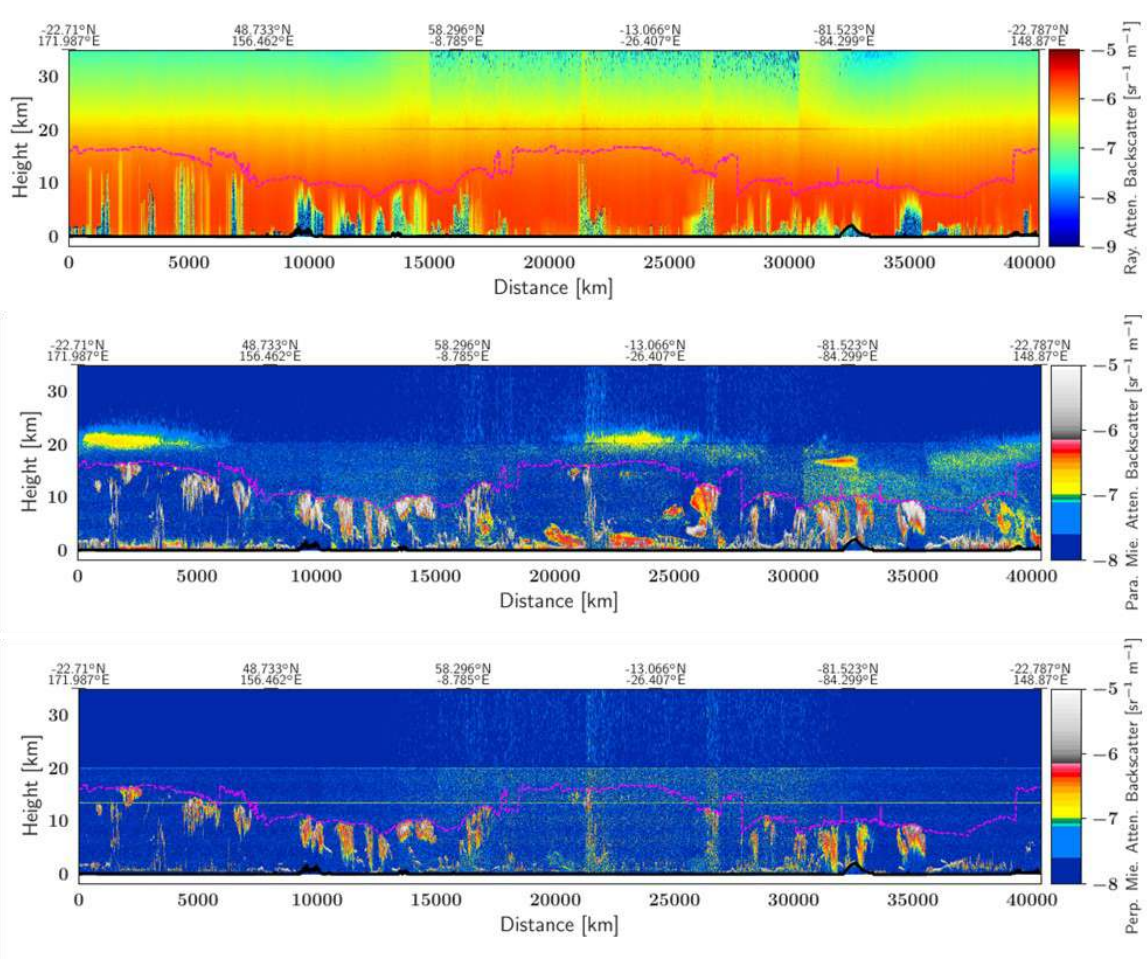


Raw_corrected[41]=Raw[41]-0.04*Raw[40]



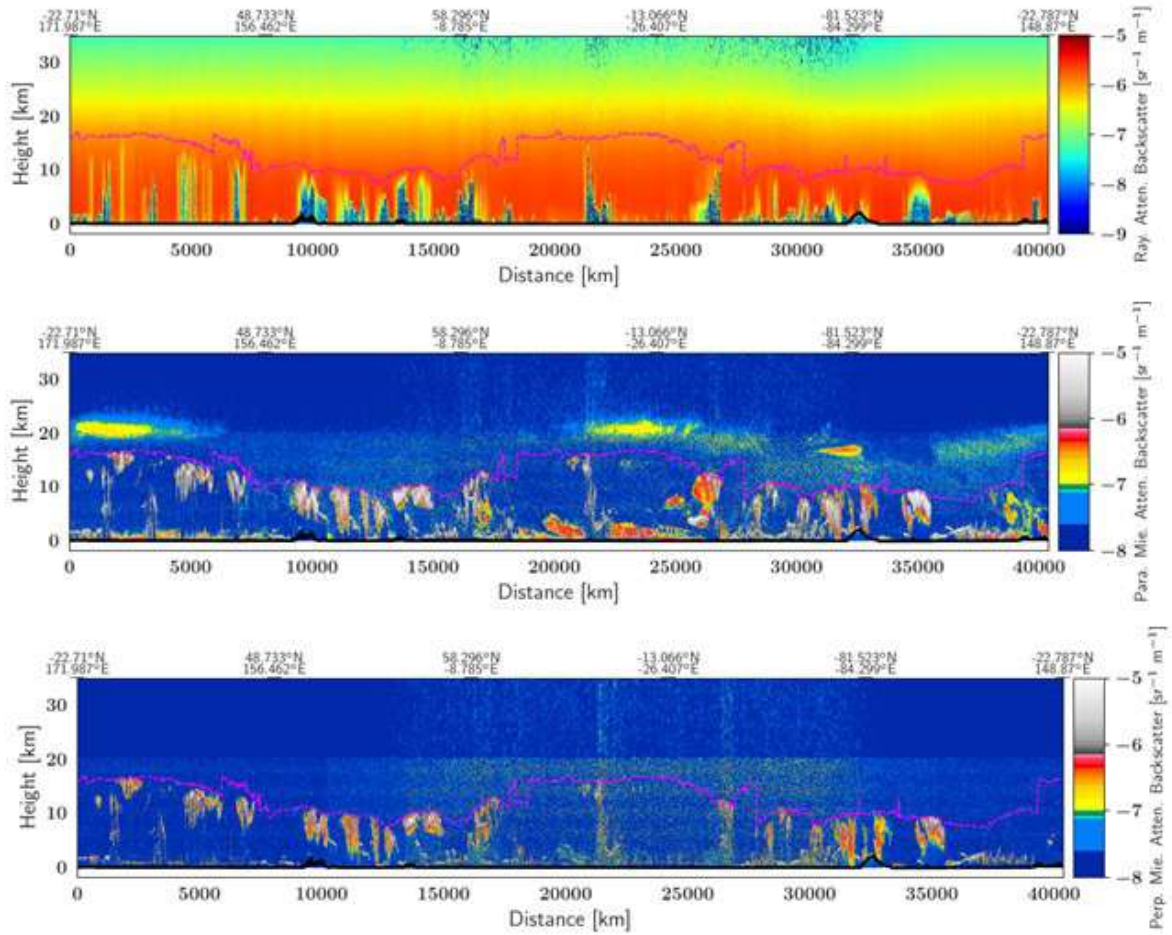
Orbit 01613: Sept 09 2024

Operational Processor

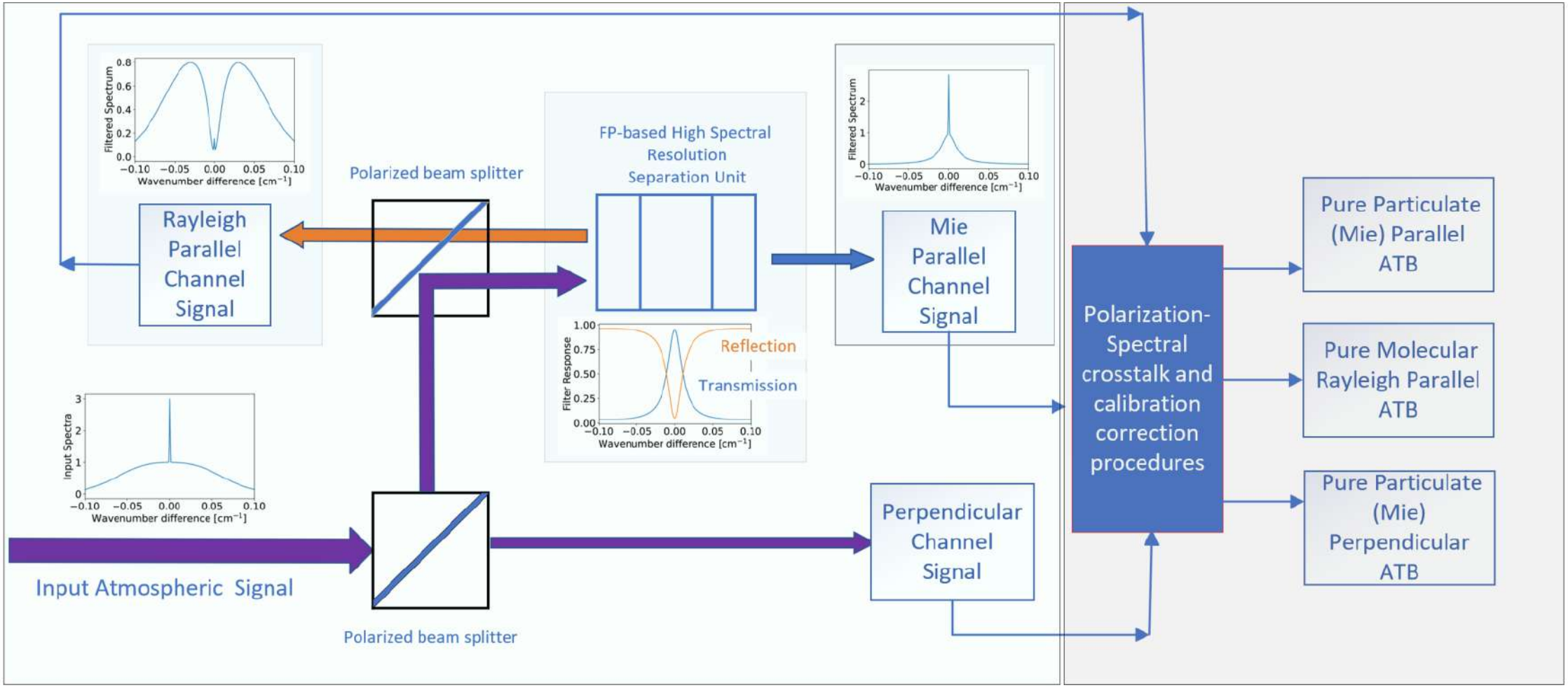


Orbit 01613: Sept 09 2024

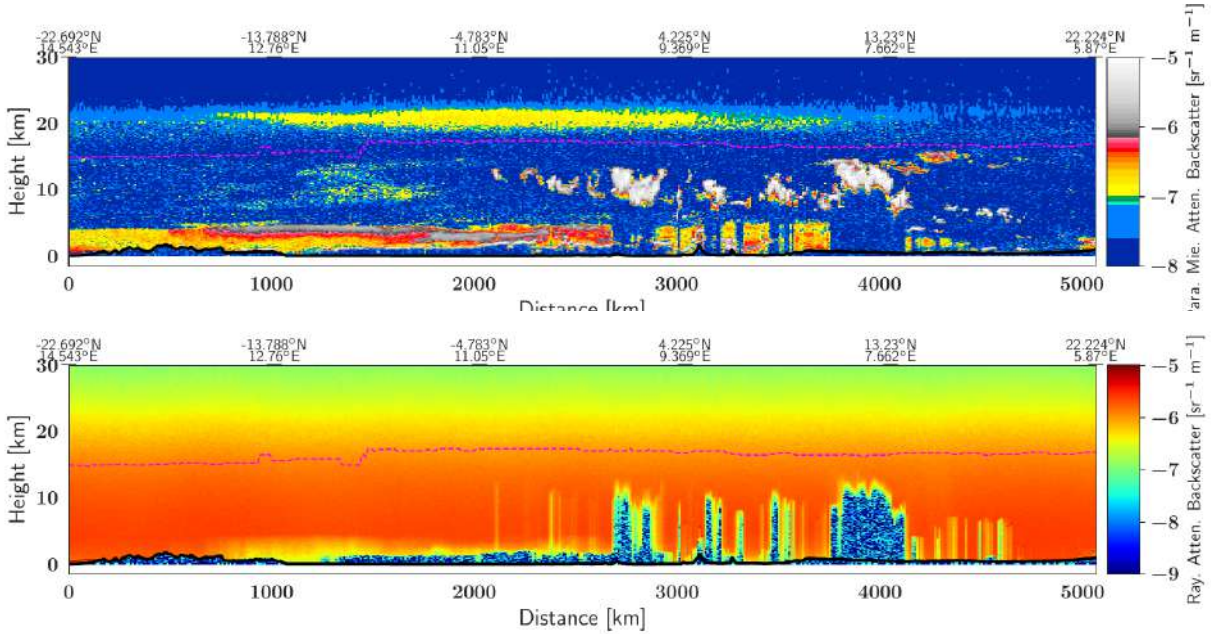
KNMI Post-Processor Prototype

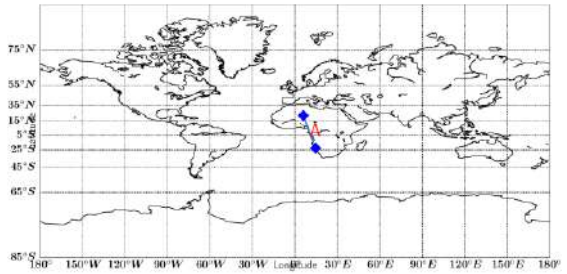


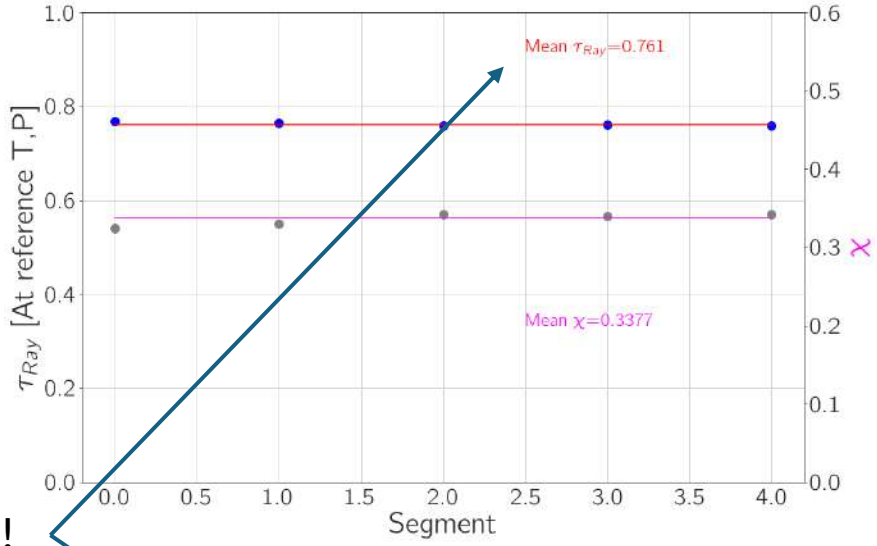
Spectral Cross Talk determinations



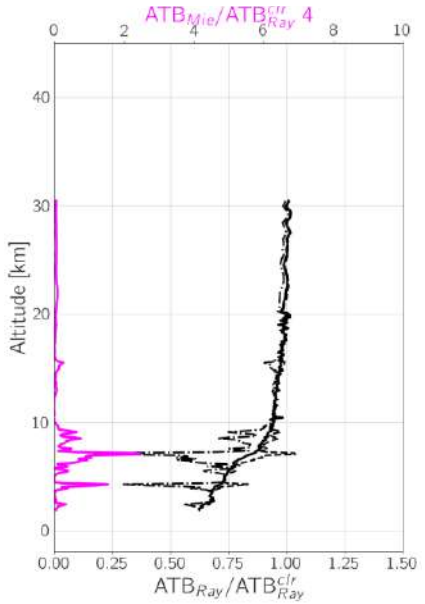
Cross-talk update 01542A: Sept 09

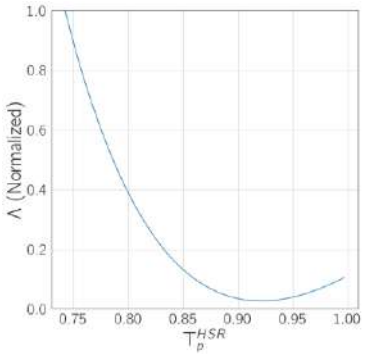


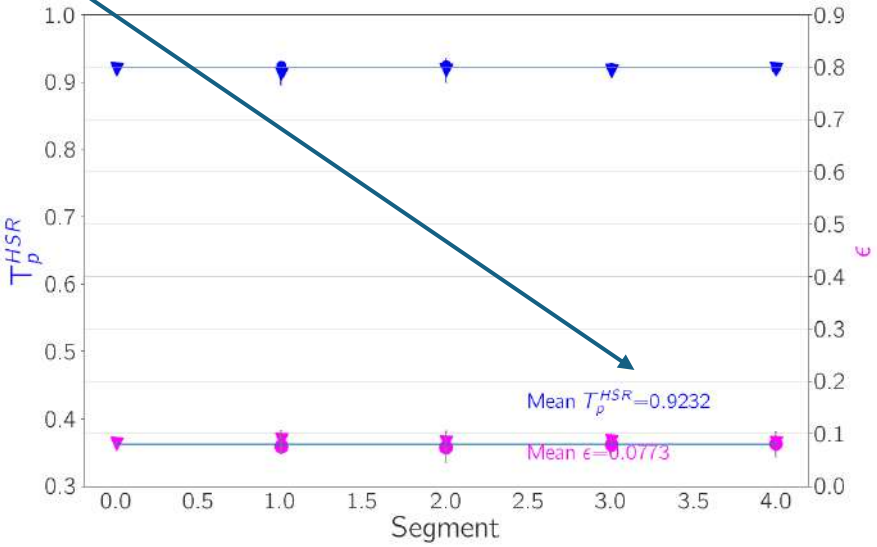




Very close to expected values !



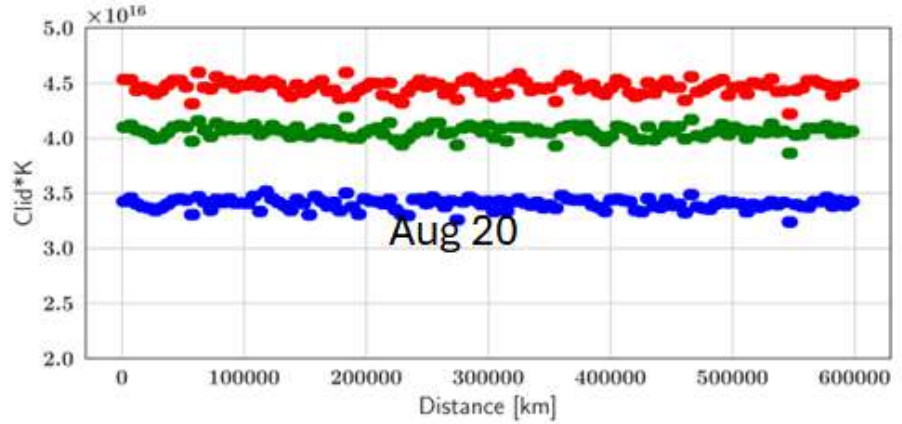




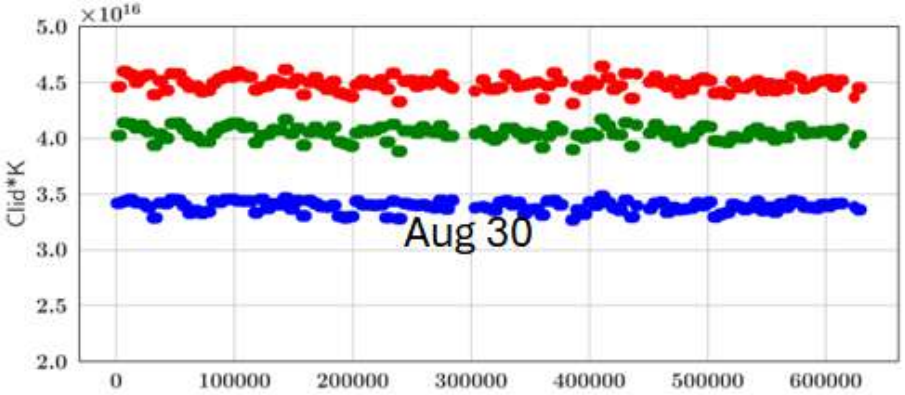
Monitoring

Per-channel effective calibration coefficients.

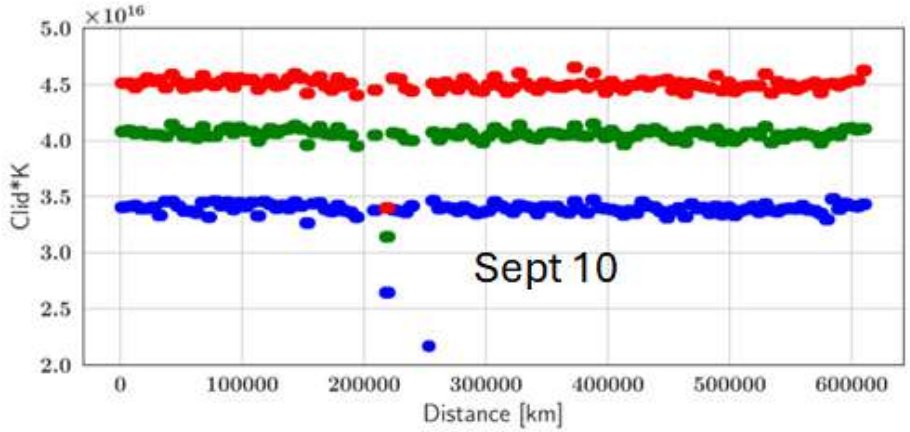
Ray



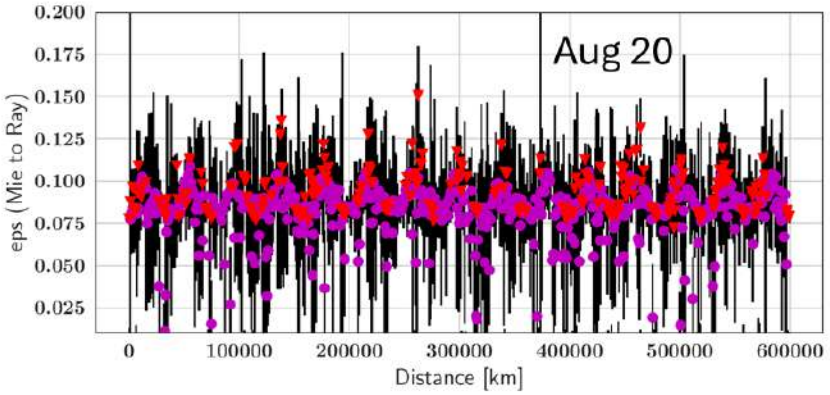
Mie

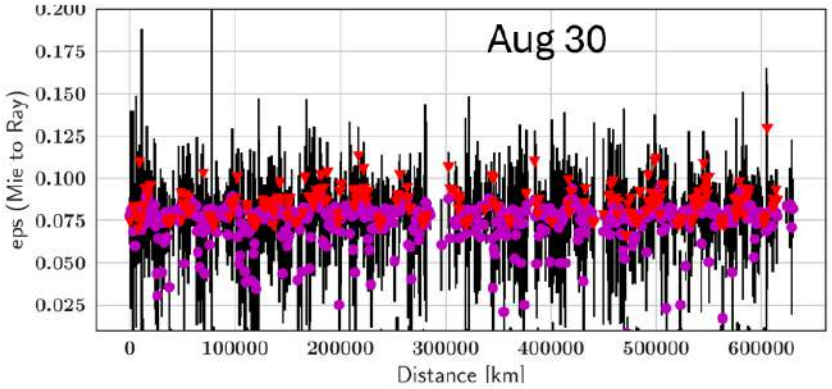


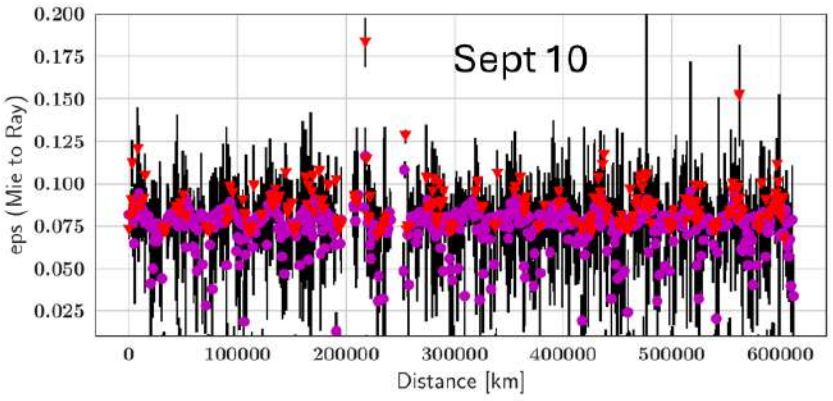
Cro

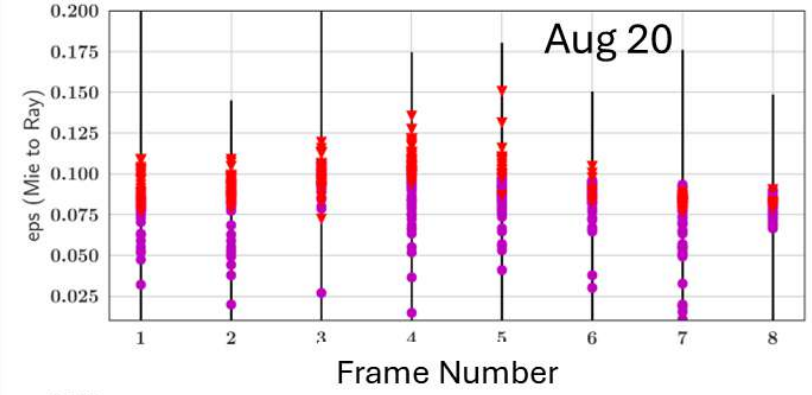


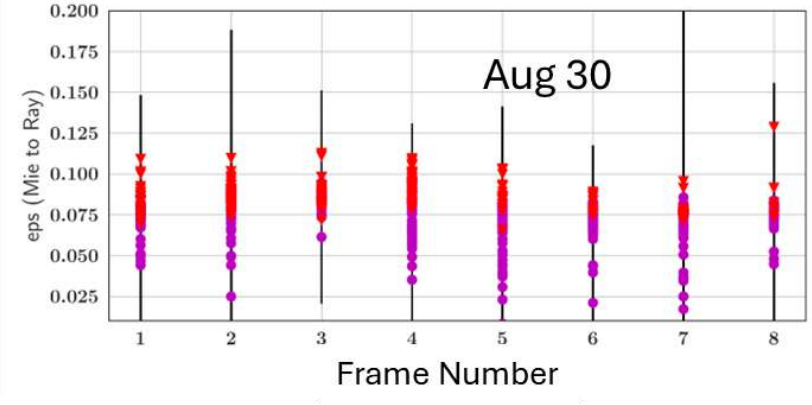
Eps: Mie ➔ Ray

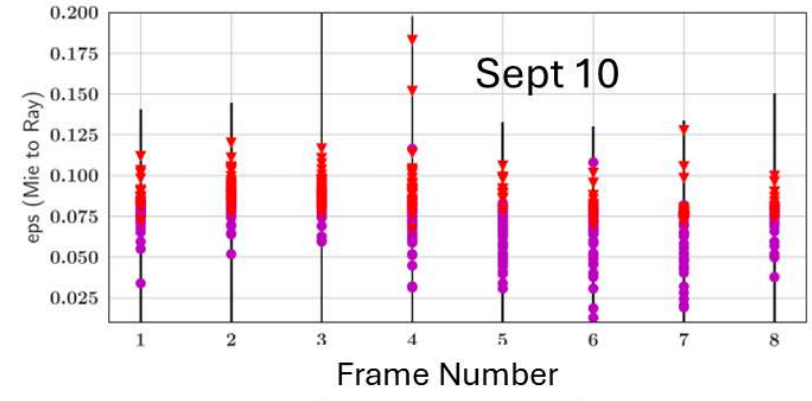

Aug 20
eps (Mie to Ray)
Distance [km]


Aug 30
eps (Mie to Ray)
Distance [km]


Sept 10
eps (Mie to Ray)
Distance [km]


Aug 20
eps (Mie to Ray)
Frame Number


Aug 30
eps (Mie to Ray)
Frame Number

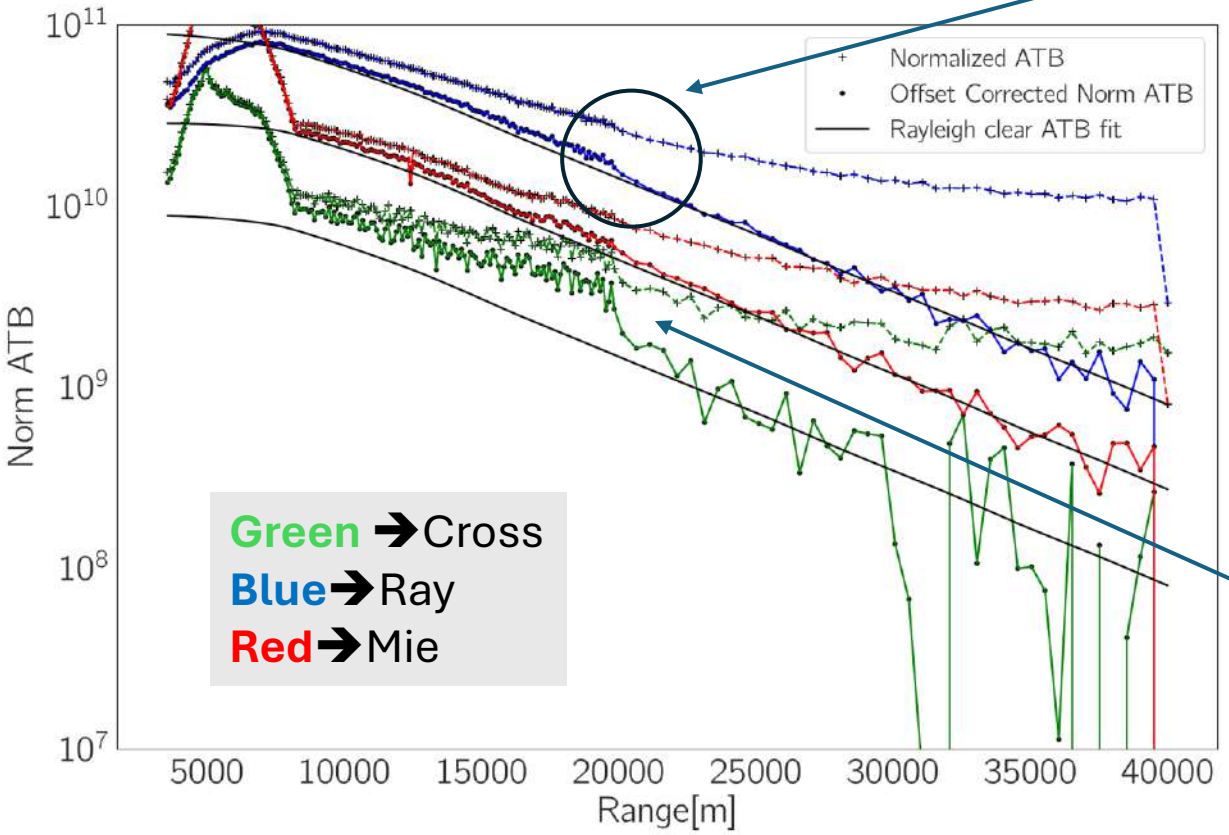

Sept 10
eps (Mie to Ray)
Frame Number

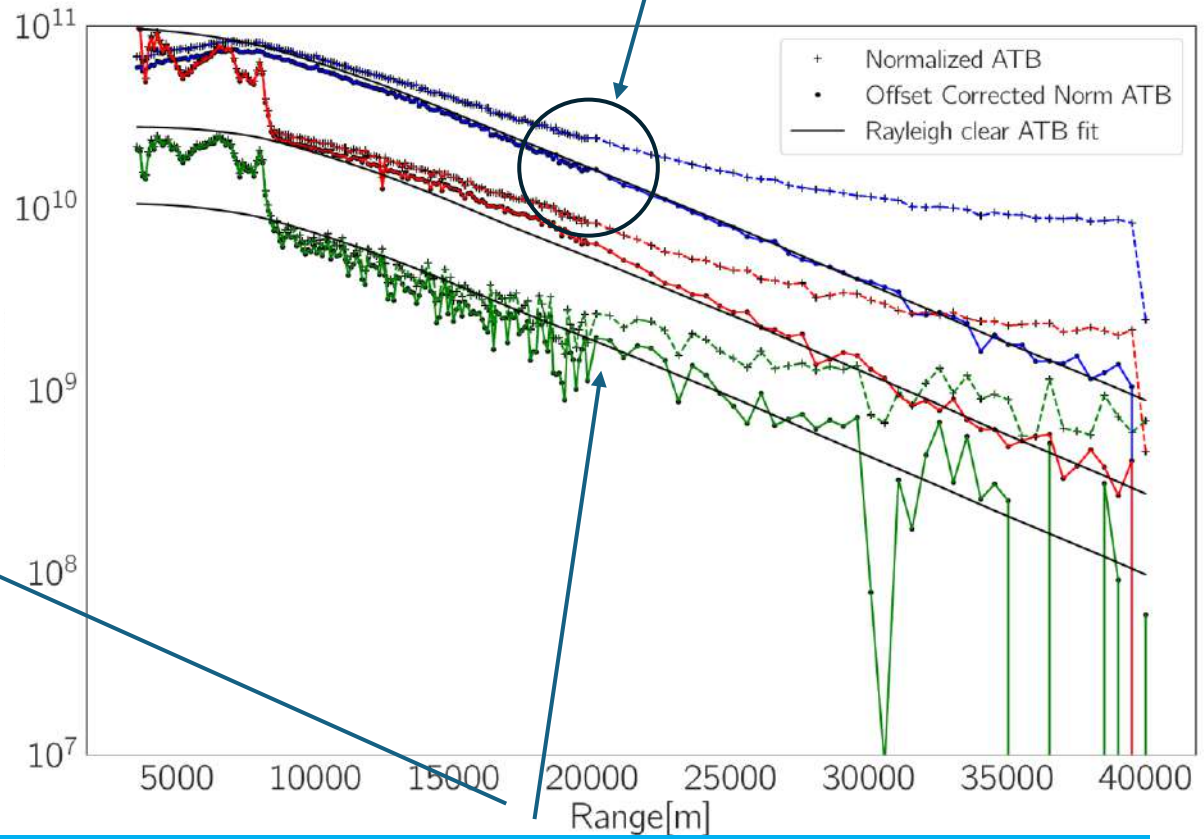
Detection Chain-offset fix really improved things !

Looks like now HR-vs-LR Bkgrn facs are less than 1 !

Before Offset Fix:
No CONT correction
No HR-vs-LR Bkgrn fac

After Offset Fix:
No CONT correction
No HR-vs-LR Bkgrn fac

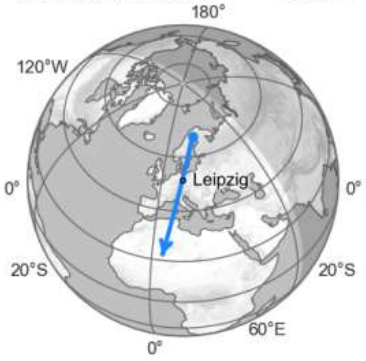




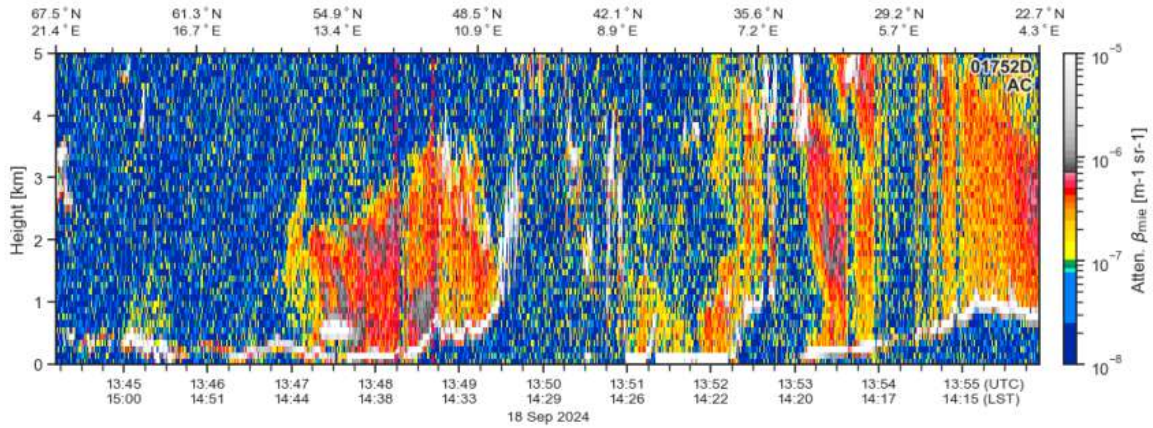
Depol channel continuity above and below 20km looks much better !

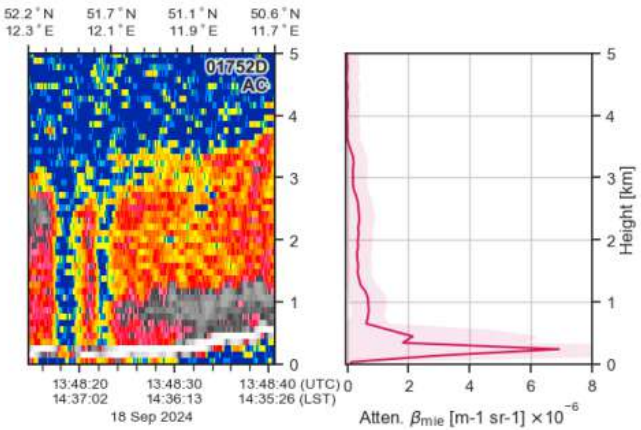
Depolarization

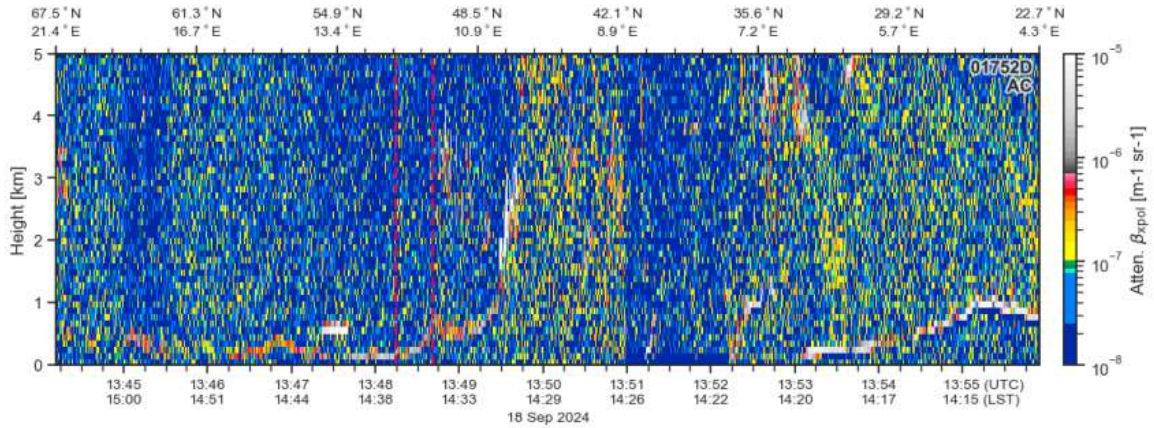
- Could only be really investigated in depth after the background and offset issues were sorted out.
  - Recently a lot of progress has been made though.
    - Most recently inconsistencies between the calibration database definitions of a few relevant factors and the definitions used in the processor were identified.

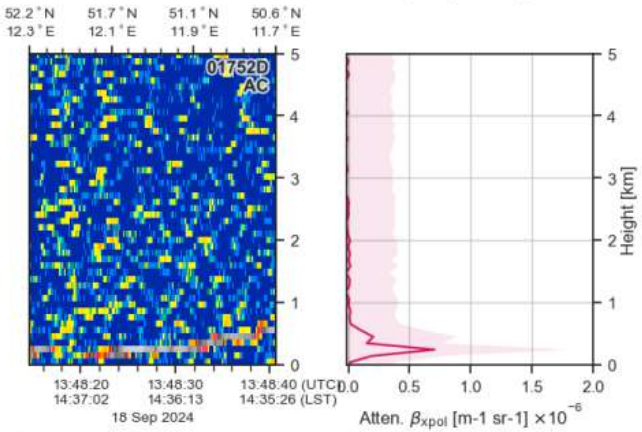

18 Sep 2024, 13:48 UTC
01752D
180°
120°W
0°
0°
20°S
20°S
60°E
0°
Leipzig

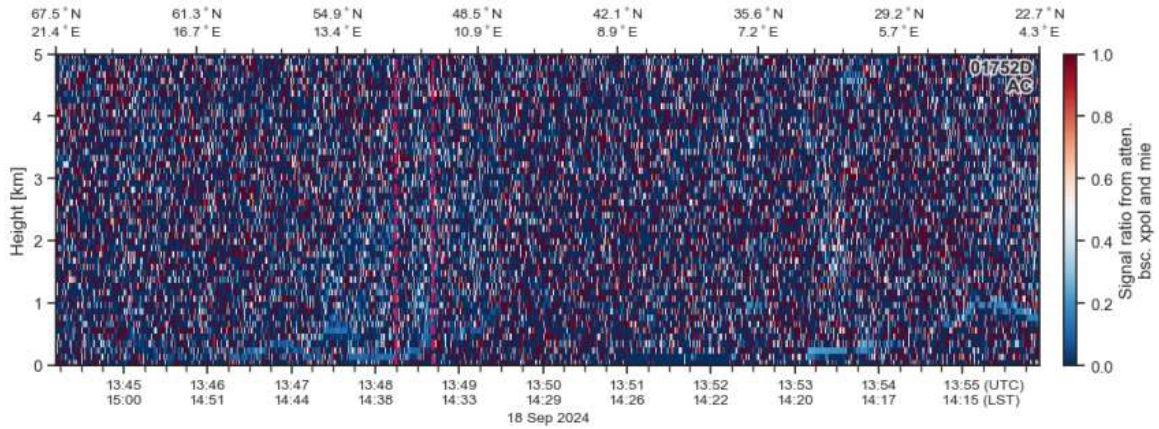

18 Sep 2024, 13:48 UTC
01752D
51.353° N 12.434° E 125m (Leipzig)
Radius: 100km
Samples: 664
Distance: 31.797km
52.2°N
51.9°N
51.6°N
51.3°N
51°N
50.7°N
50.4°N
11°E 11.5°E 12°E
13°E
14°E

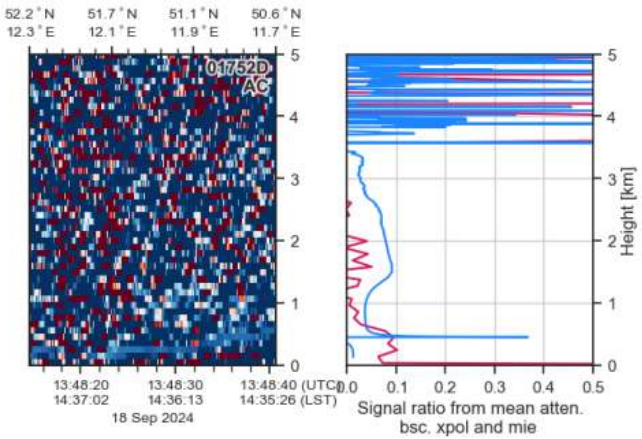

01752D
AC
Height [km]
Atten. β_{mie} [m-1 sr-1]
18 Sep 2024


01752D
AC
Height [km]
Atten. β_{mie} [m-1 sr-1] $\times 10^{-6}$
18 Sep 2024

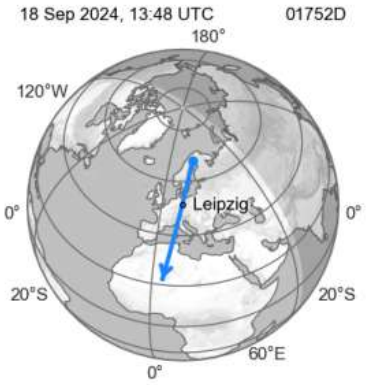

01752D
AC
Height [km]
Atten. β_{xpol} [m-1 sr-1]
18 Sep 2024


01752D
AC
Height [km]
Atten. β_{xpol} [m-1 sr-1] $\times 10^{-6}$
18 Sep 2024

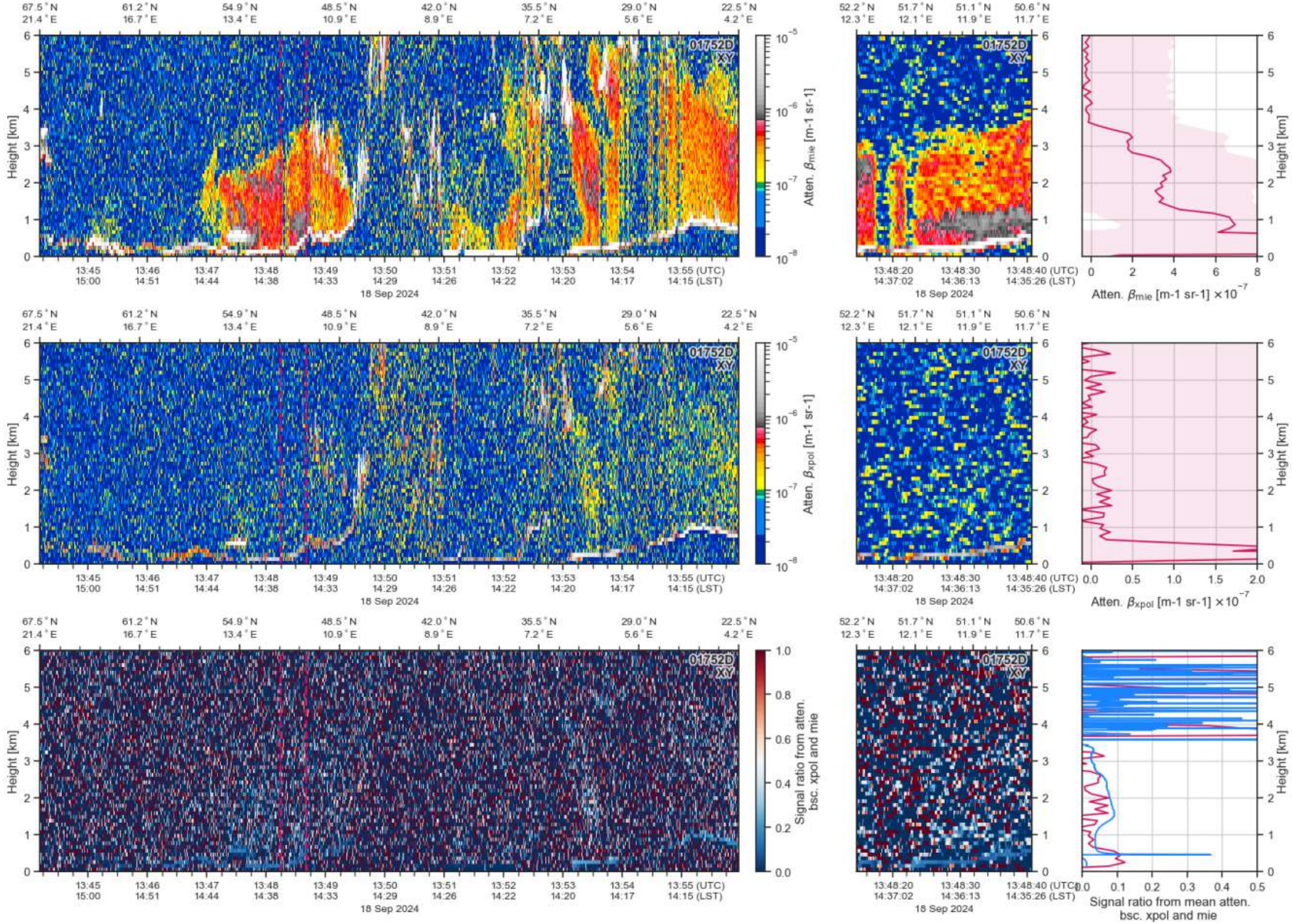

01752D
AC
Height [km]
Signal ratio from atten. bsc. xpol and mie
18 Sep 2024

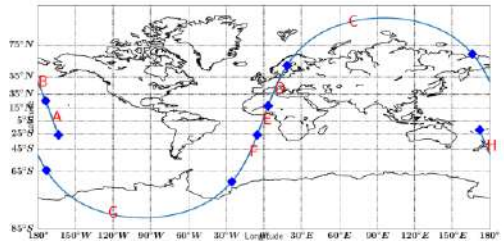

01752D
AC
Height [km]
Signal ratio from mean atten. bsc. xpol and mie
18 Sep 2024


ATLID
parDepol_klett_355

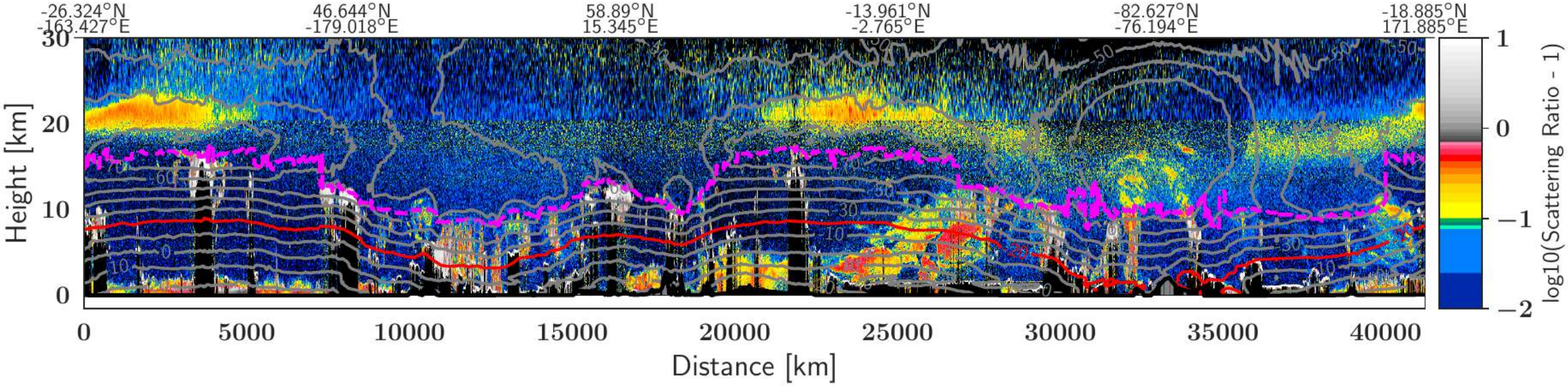

18 Sep 2024, 13:48 UTC
01752D
180°
120°W
0°
0°
20°S
20°S
Leipzig
60°E
0°


18 Sep 2024, 13:48 UTC
01752D
51.353° N 12.434° E 125m (Leipzig)
Radius: 100km
Samples: 664
Distance: 31.797km
52.2°N
51.9°N
51.6°N
51.3°N
51°N
50.7°N
50.4°N
11°E 11.5°E 12°E
13°E
14°E


67.5°N 61.2°N 54.9°N 48.5°N 42.0°N 35.5°N 29.0°N 22.5°N
21.4°E 16.7°E 13.4°E 10.9°E 8.9°E 7.2°E 5.6°E 4.2°E
52.2°N 51.7°N 51.1°N 50.6°N
12.3°E 12.1°E 11.9°E 11.7°E
01752D
XY
Height [km]
Atten. β_{mie} [m-1 sr-1]
Atten. β_{xpol} [m-1 sr-1]
Signal ratio from atten. bsc. xpol and mie
13:45 15:00
13:46 14:51
13:47 14:44
13:48 14:38
13:49 14:33
13:50 14:29
13:51 14:26
13:52 14:22
13:53 14:20
13:54 14:17
13:55 (UTC) 14:15 (LST)
13:48:20 14:37:02
13:48:30 14:36:13
13:48:40 (UTC) 14:35:26 (LST)
18 Sep 2024
Atten. β_{mie} [m-1 sr-1] ×10^{-7}
Atten. β_{xpol} [m-1 sr-1] ×10^{-7}
Signal ratio from mean atten. bsc. xpol and mie
ATLID
parDepol_klett_355

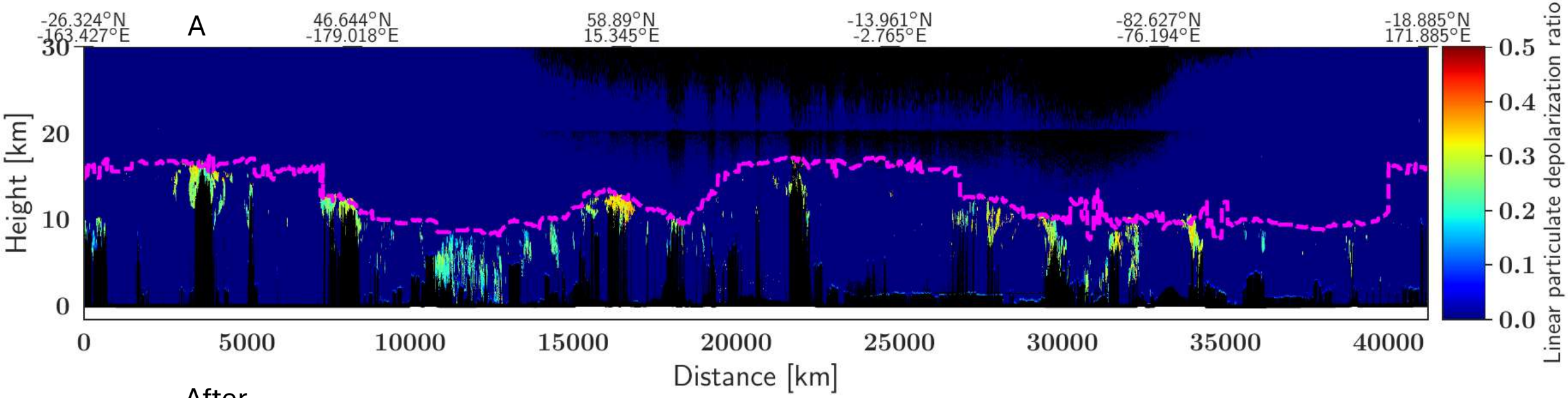


Example Orbit (01752) with Offset fix



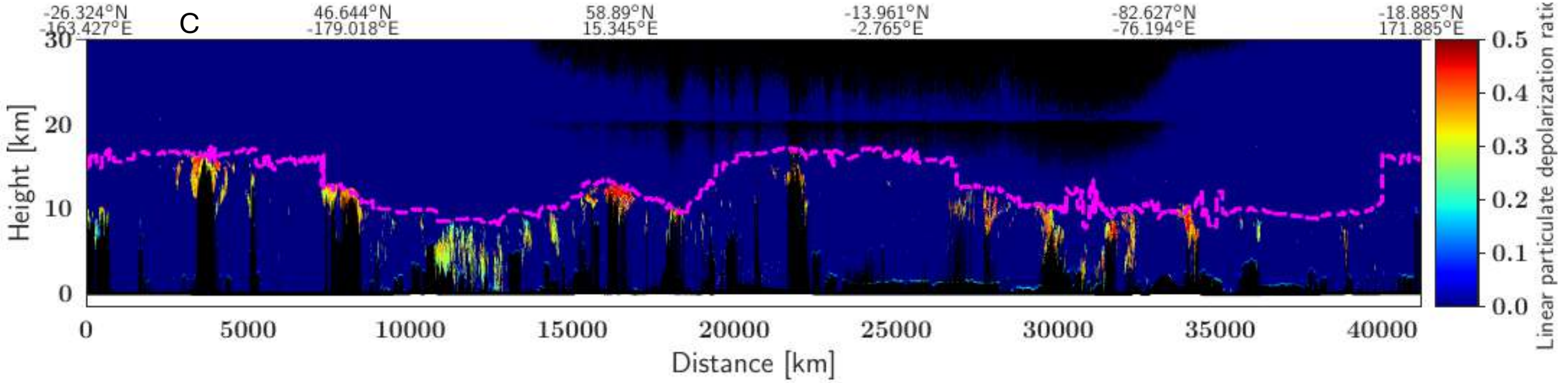
Before

A



After

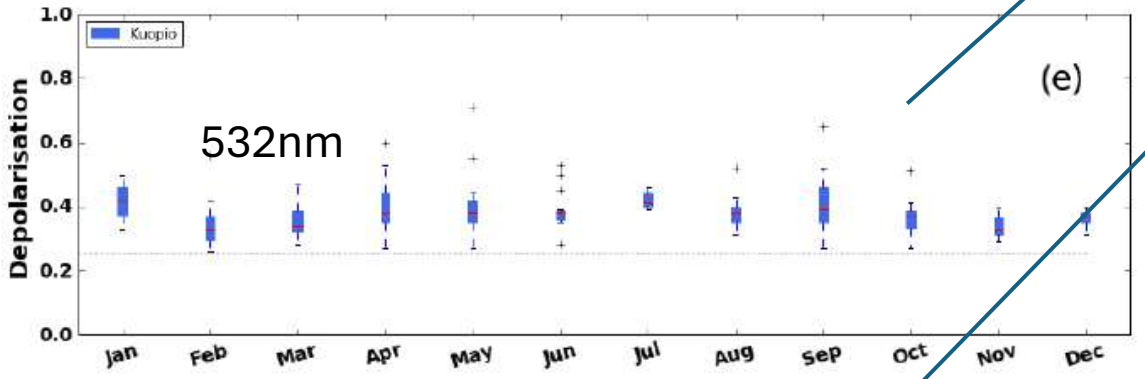
C

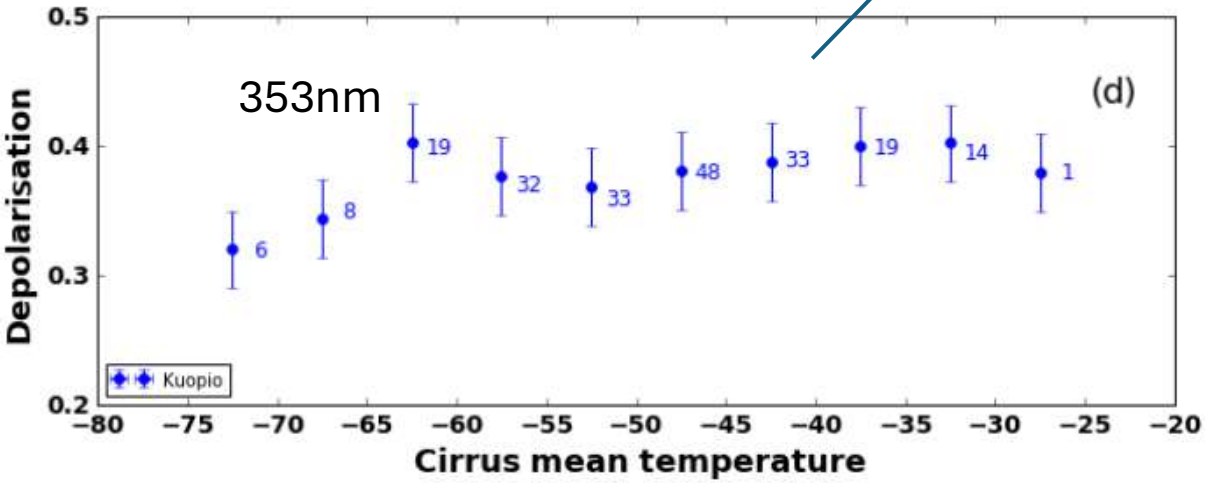


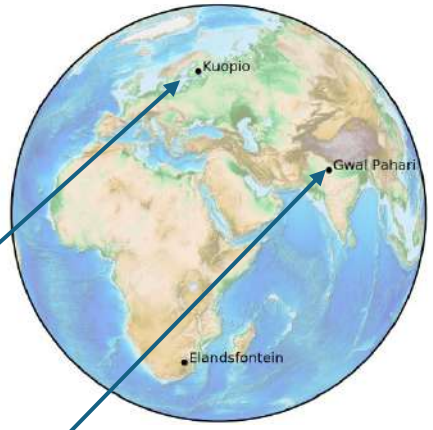
Comparison with results in

Variability in cirrus cloud properties using a Polly^{XT} Raman lidar over high and tropical latitudes

Kalliopi Artemis Voudouri[1], Elina Giannakaki[2,3], Mika Komppula[3], and Dimitris Balis[1]

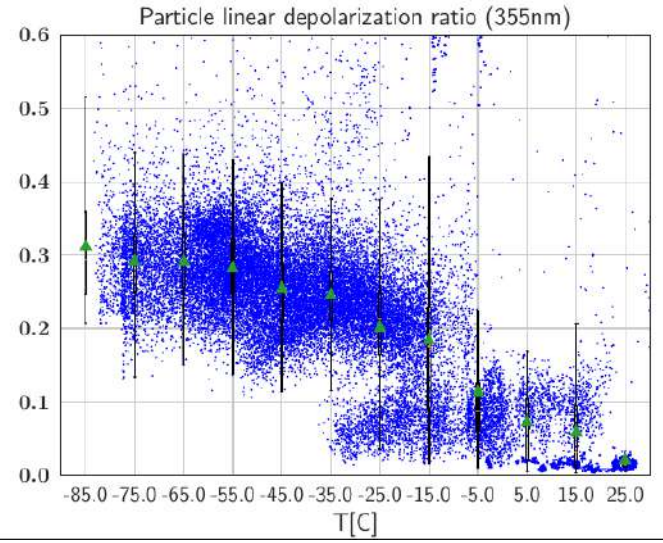




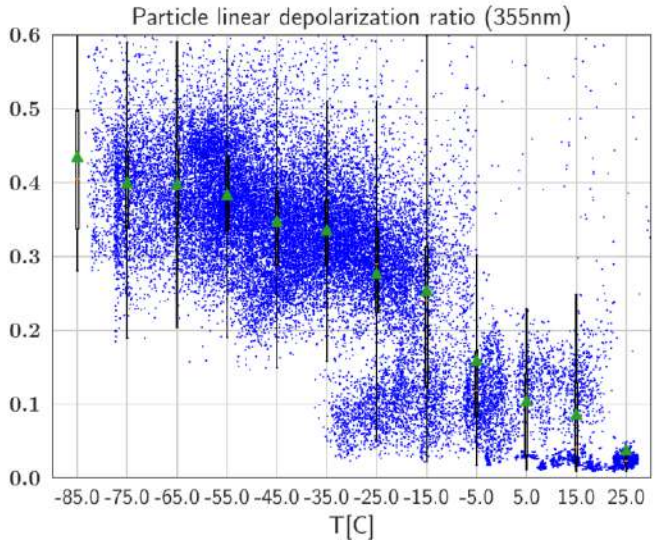


Cirrus properties	Gwal Pahari
N	11 (7 d, 4 n)
% subvisible	0
% thin	20
% opaque	80
LR 355	27 ± 12 23 ± 8 d 31 ± 15 n
LR 532	28 ± 22 23 ± 3 d 33 ± 11 n
COD 355	0.60 ± 0.25 0.40 ± 0.30 d 0.80 ± 0.20 n
COD 532	0.45 ± 0.30 0.30 ± 0.40 d 0.60 ± 0.20 n
CR (355/532)	1.50 ± 0.80

Operational Processor A



Prototype Processor C



Summary (I)

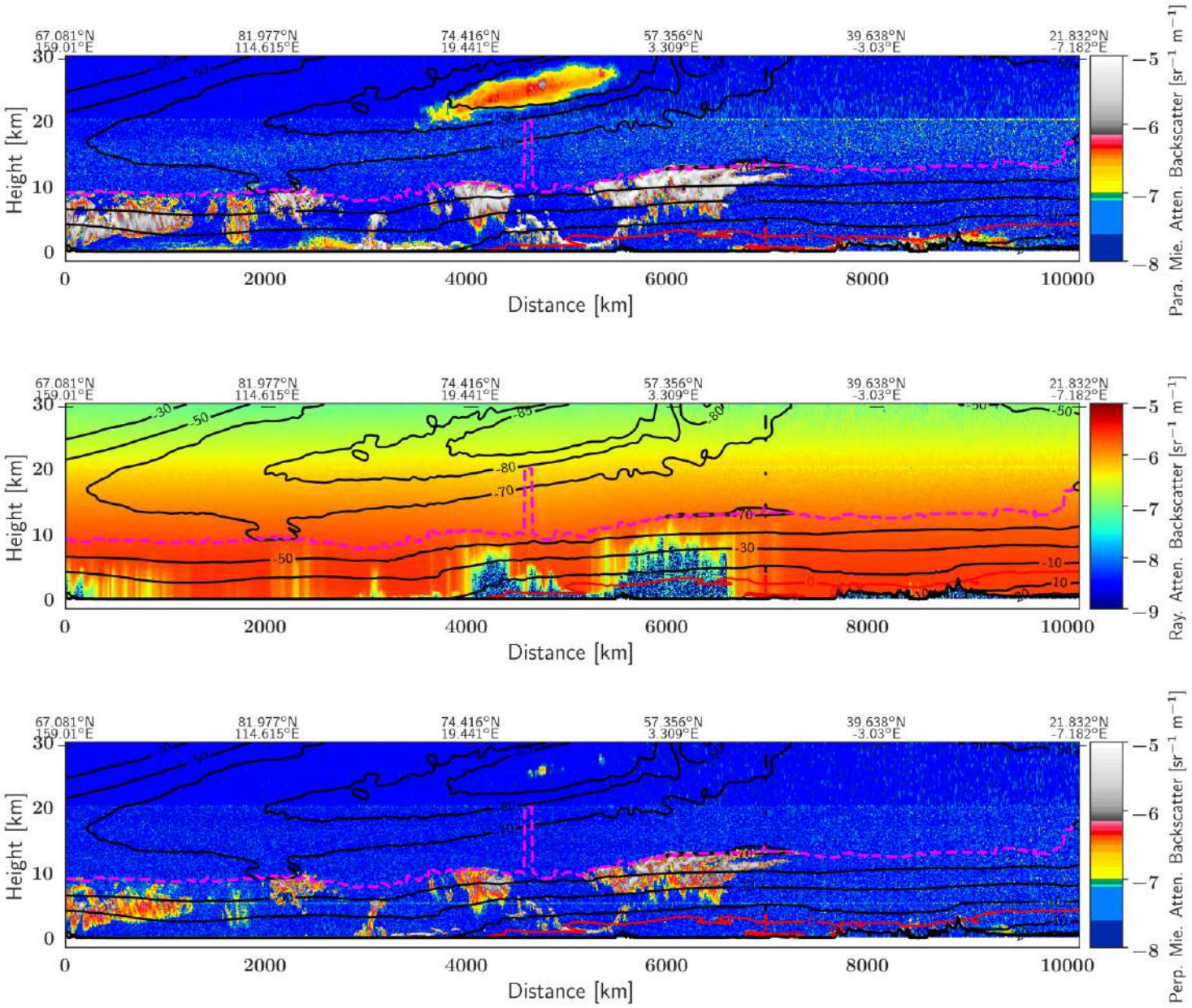
- L1 data is of good quality ! In the first public release
  - Offset fix has been implemented
  - Background fix has been implemented
  - Spurious (protonic) noise spikes filtering
  - Update of the transmission factors➔ “better but not yet good enough Depol !”
    - Further work and checks required.

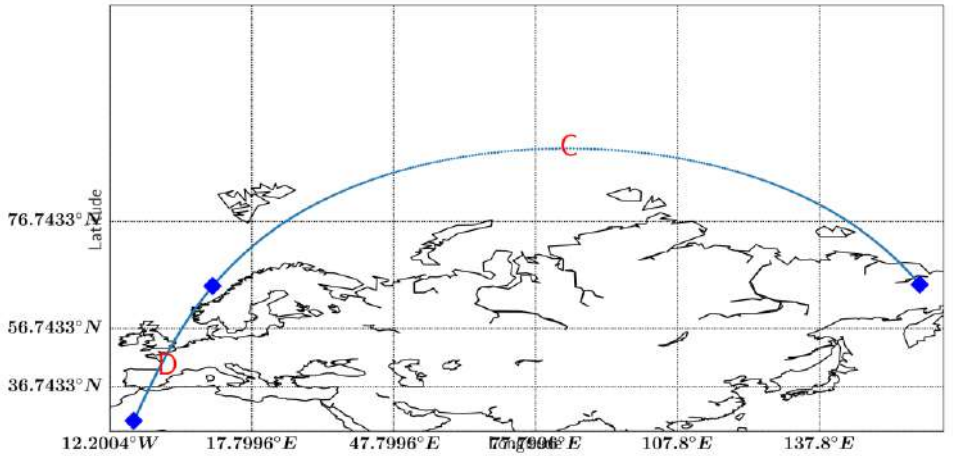
- Still to do :
  - 20km (Charge Transfer Efficiency) spikes correction
  - Missed Hot / Cold Pixel correction / filtering
  - Update of the detector sensitivity values (i.e reading them directly from CCDB)➔ even better Depol

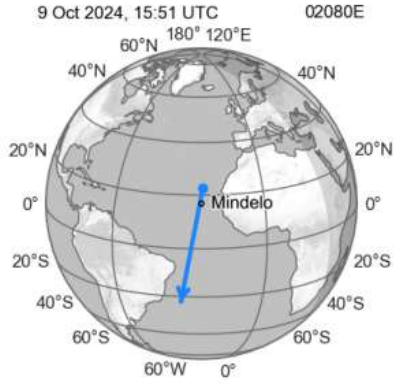
Summary (II)

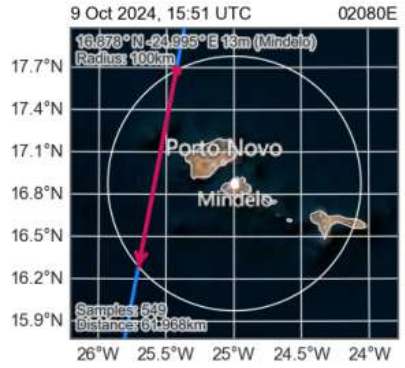
- Range of good Cal/Val cases covering a range of conditions (Day/Night) still useful esp. w.r.t Depol measurements

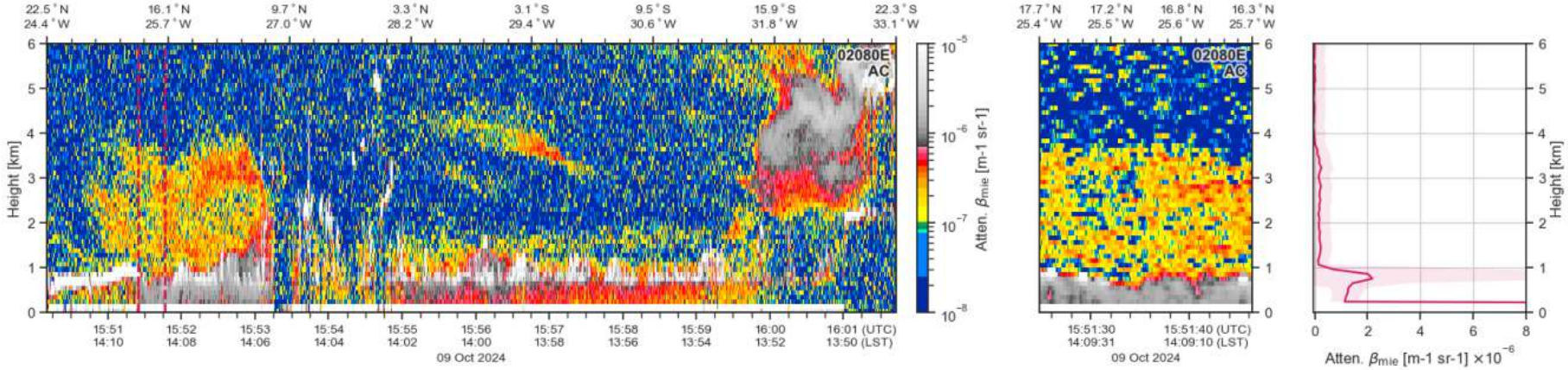
And to finish..... a nice PSC over Europe CASE !

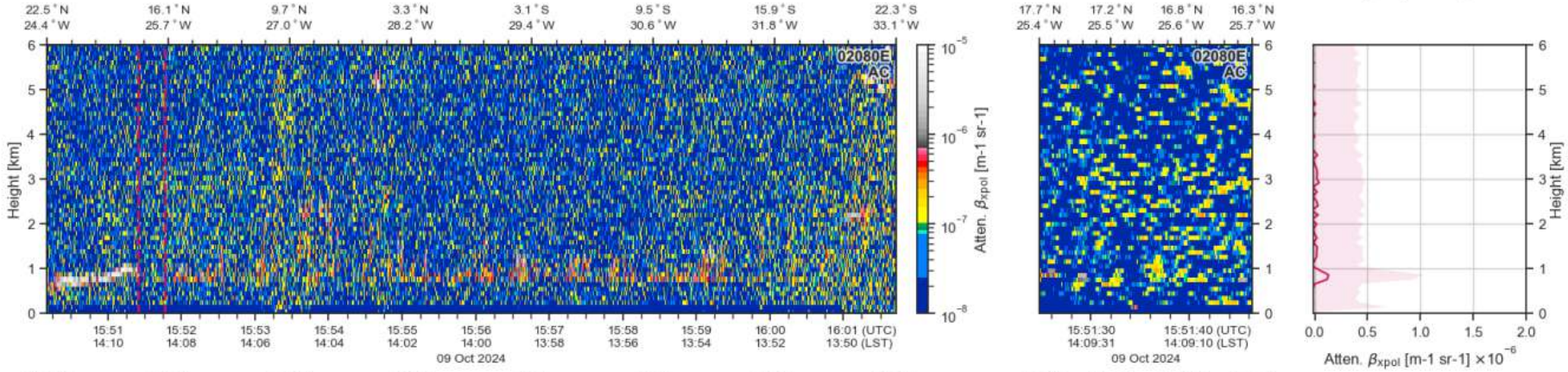


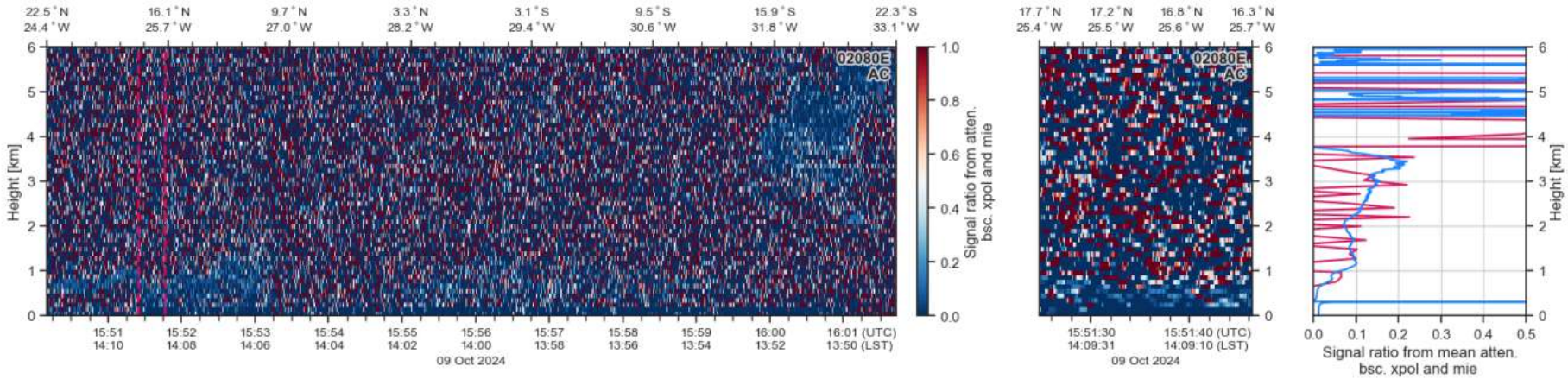


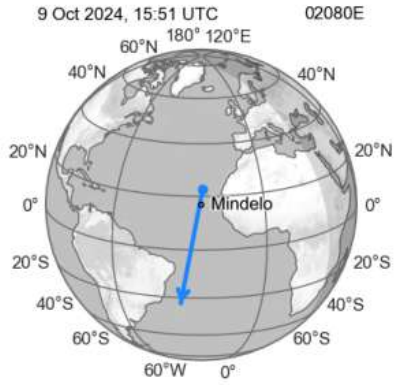

9 Oct 2024, 15:51 UTC
02080E
180° 120°E
60°N
40°N
20°N
0°
20°S
40°S
60°S
60°W
0°
Mindelo

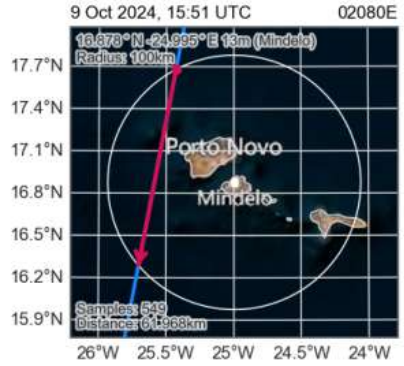

9 Oct 2024, 15:51 UTC
02080E
16.878°N -24.995°E 13m (Mindelo)
Radius: 100km
Porto Novo
Mindelo
Samples: 549
Distance: 61.968km
17.7°N
17.4°N
17.1°N
16.8°N
16.5°N
16.2°N
15.9°N
26°W
25.5°W
25°W
24.5°W
24°W

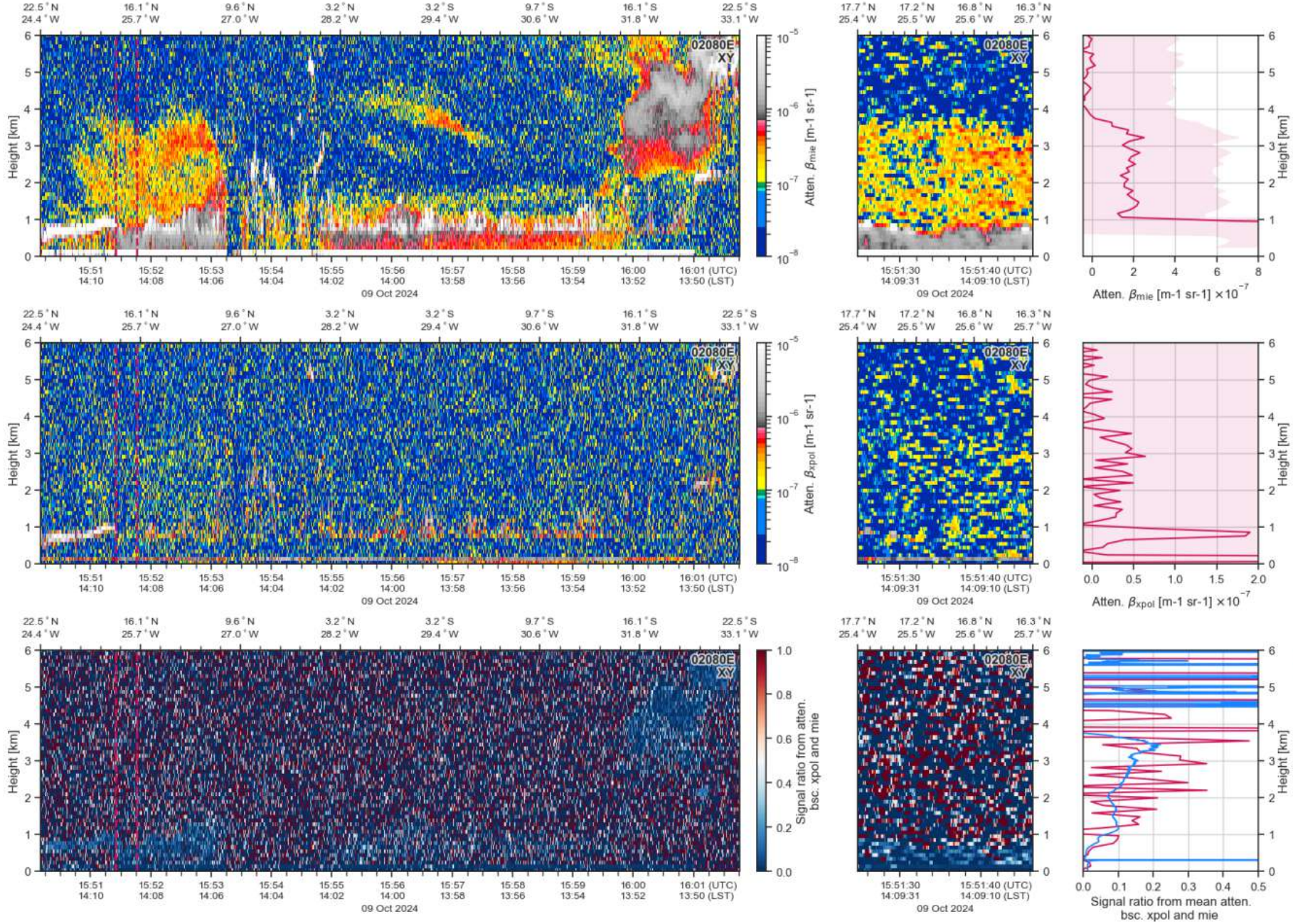

02080E
AC
Height [km]
Atten. β_{mie} [m-1 sr-1]
09 Oct 2024
Atten. β_{mie} [m-1 sr-1] ×10^{-6}


02080E
AC
Height [km]
Atten. β_{xpol} [m-1 sr-1]
09 Oct 2024
Atten. β_{xpol} [m-1 sr-1] ×10^{-6}


02080E
AC
Height [km]
Signal ratio from atten. bsc. xpol and mie
09 Oct 2024
Signal ratio from mean atten. bsc. xpol and mie
ATLID
parDepol_klett_355


9 Oct 2024, 15:51 UTC
02080E
Mindelo


9 Oct 2024, 15:51 UTC
02080E
16.878°N -24.995°E 13m (Mindelo)
Radius: 100km
Porto Novo
Mindelo
Samples: 549
Distance: 61.968km


02080E
XY
Height [km]
Atten. β_{mie} [m-1 sr-1]
Atten. β_{xpol} [m-1 sr-1]
Signal ratio from atten. bsc. xpol and mie
09 Oct 2024
Atten. β_{mie} [m-1 sr-1] $\times 10^{-7}$
Atten. β_{xpol} [m-1 sr-1] $\times 10^{-7}$
Signal ratio from mean atten. bsc. xpol and mie
ATLID
parDepol_klett_355

Cold Pixel

4.2.5 Cold Pixel

The Yop-Panel of Figure 13 shows the cold-pixel (102) present in the Mie channel. In contrast to the hot pixels it appears as a line of lowered intensity. A prototype algorithm for the detection and correction of cold-pixels is described in the companion L1 processor document [RD6].

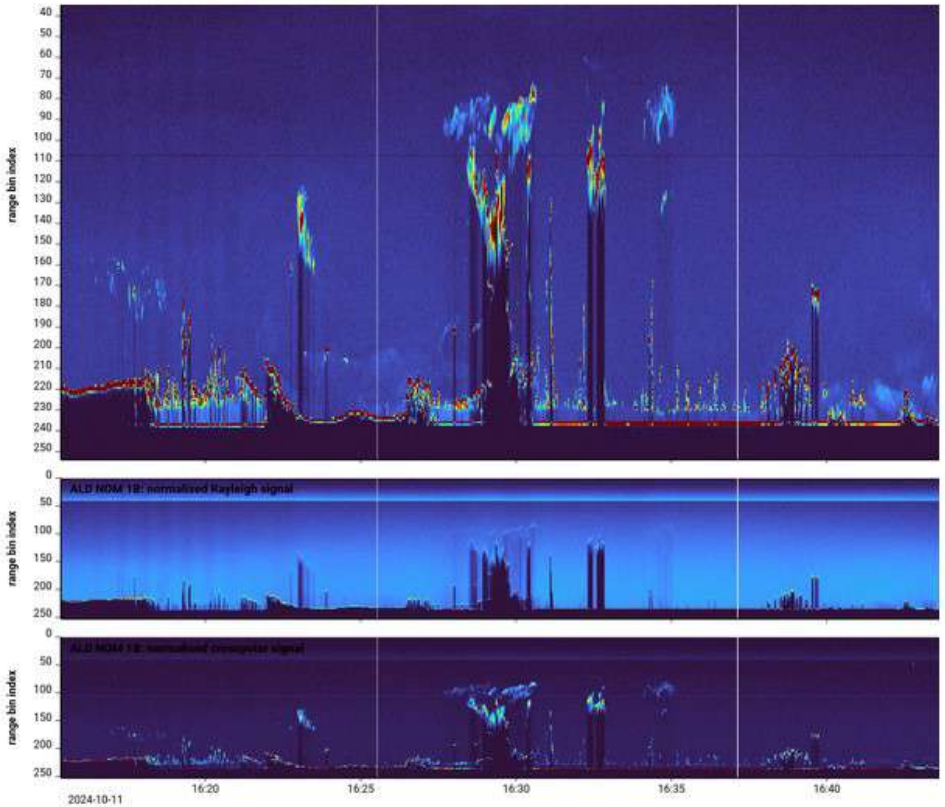


Figure 13. Normalized signals from the Mie, Rayleigh and cross-polar channels. The y-axis is stretched for the Mie channel in order to make the cold-pixel (pixel 102) visible.

4.2.5 Cold Pixel(s)

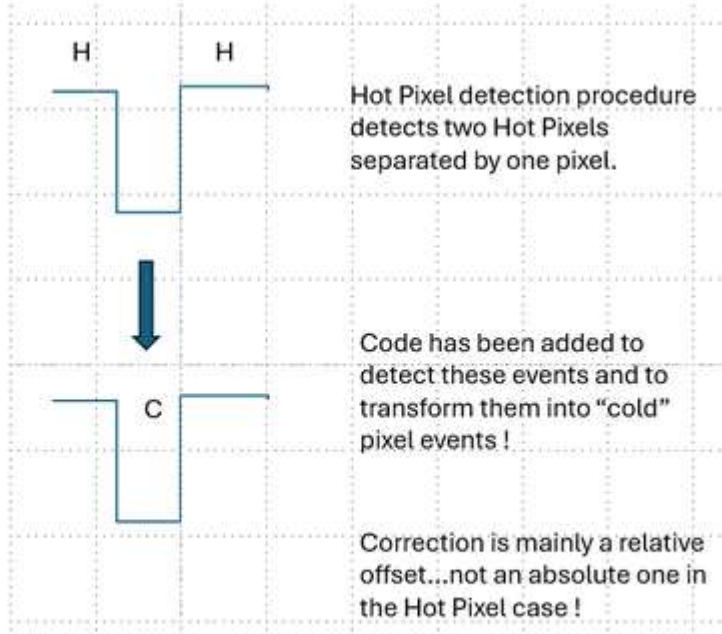


Figure 7: Extension of the HP detection routine to detect CPs.

HR-LR ‘Jumps’

Sometimes…there is a “Jump” in the ratios between the signals below and under 20 km ?

Only present when background is significant ➔not a sensitivity issue.

Seems linked to transition from to Spacecraft Eclipse.

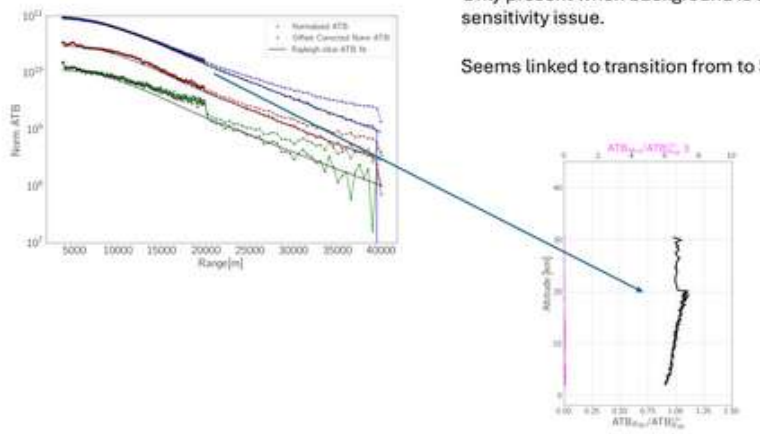
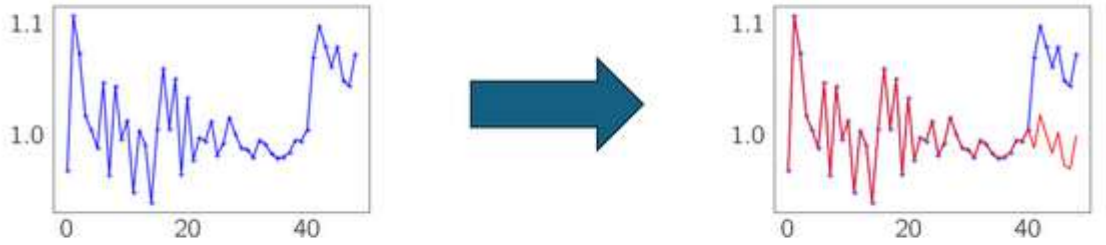
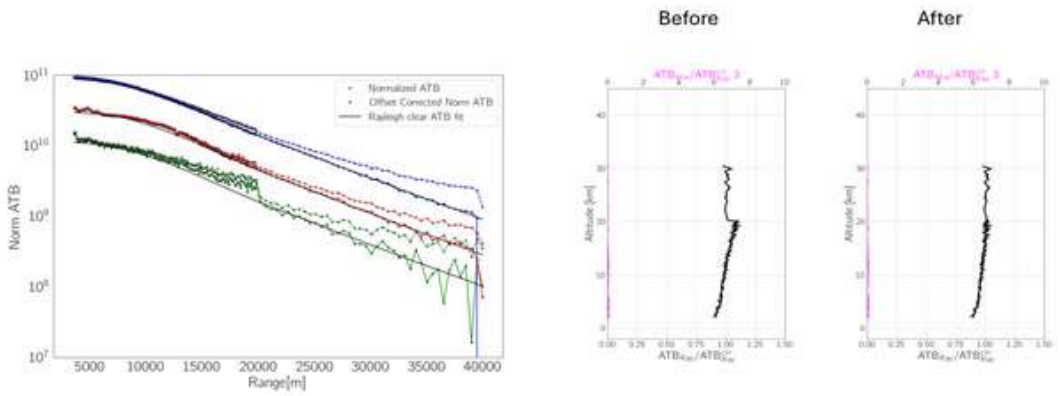


Figure 14. Illustration of the “jumps” sometimes present between the high and low-resolution sections of the signal profiles.

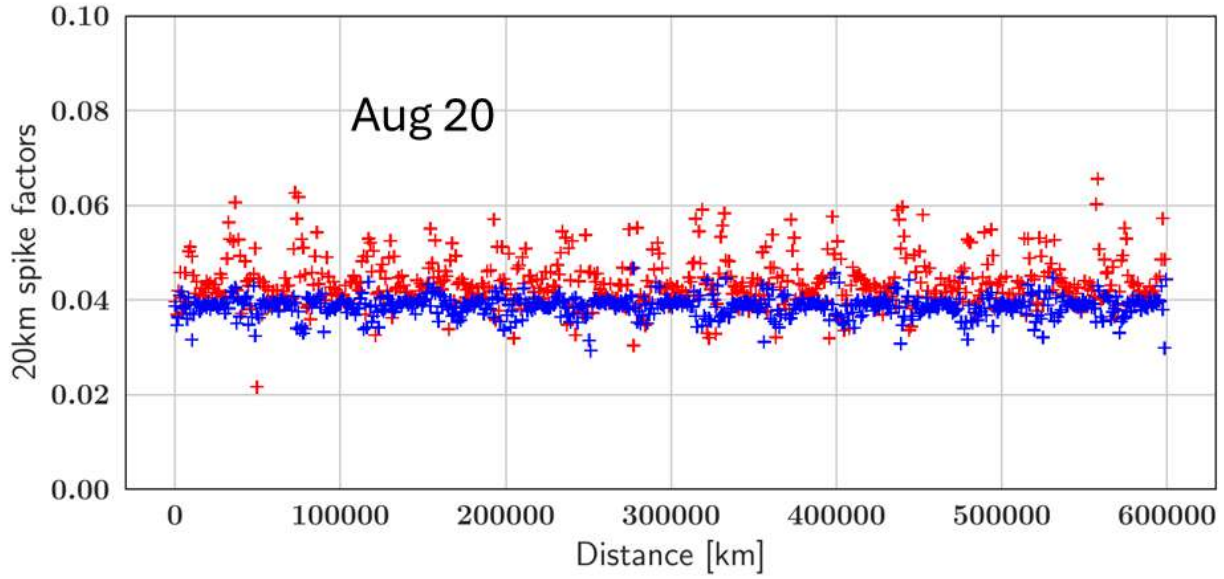
Continuity test and correction has been implemented.

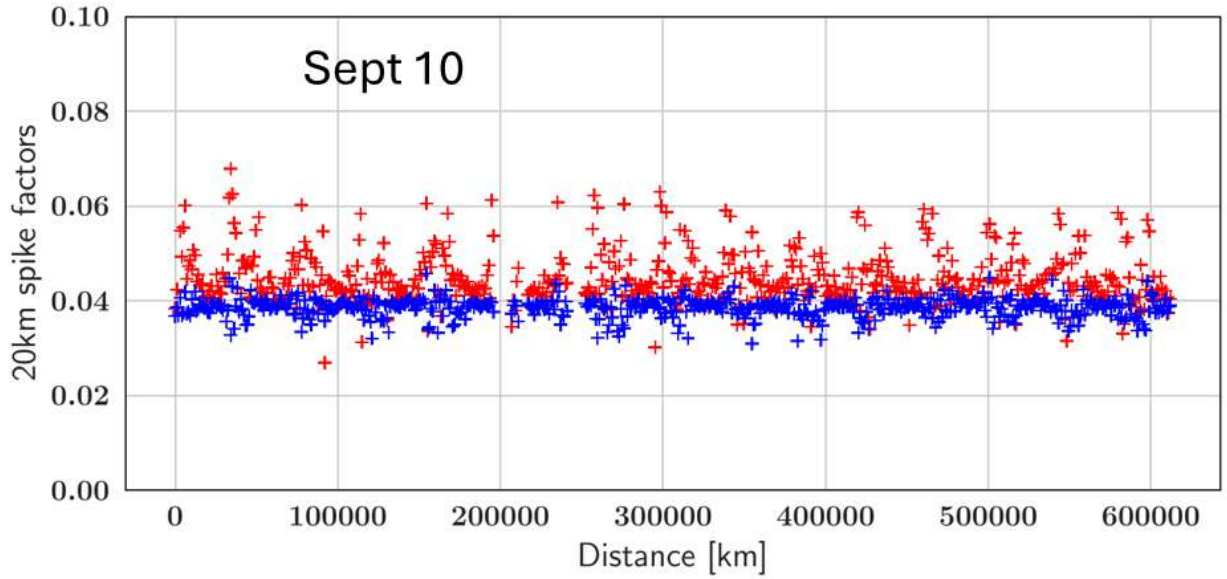


Use the Ray signals to determine what the relative additional background needs to be subtracted from the HR samples ! Use this factor to scale the Cro and Mie default values.



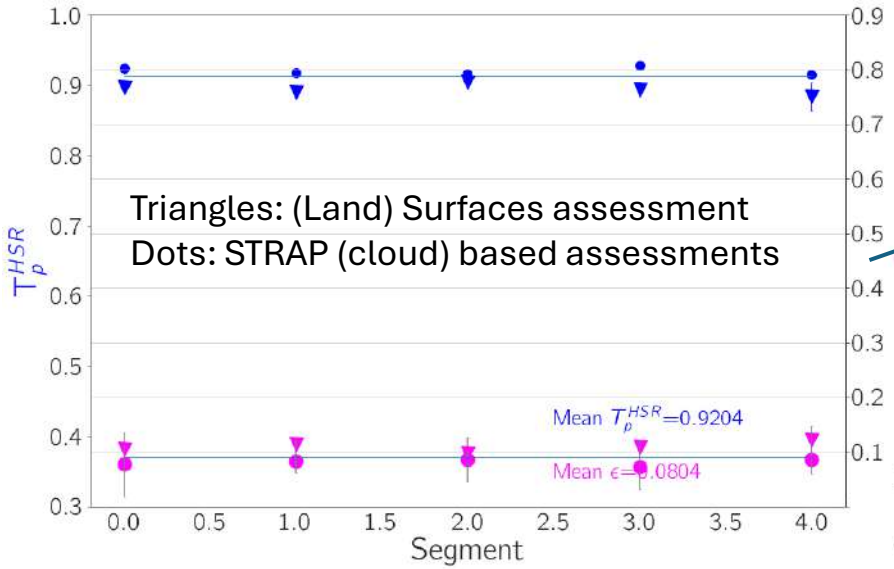
Work by Annabel at ESA revealed a problem with the Offset correction ! This is (very) likely the root cause of the “jumps” and fixing it improves the situation !



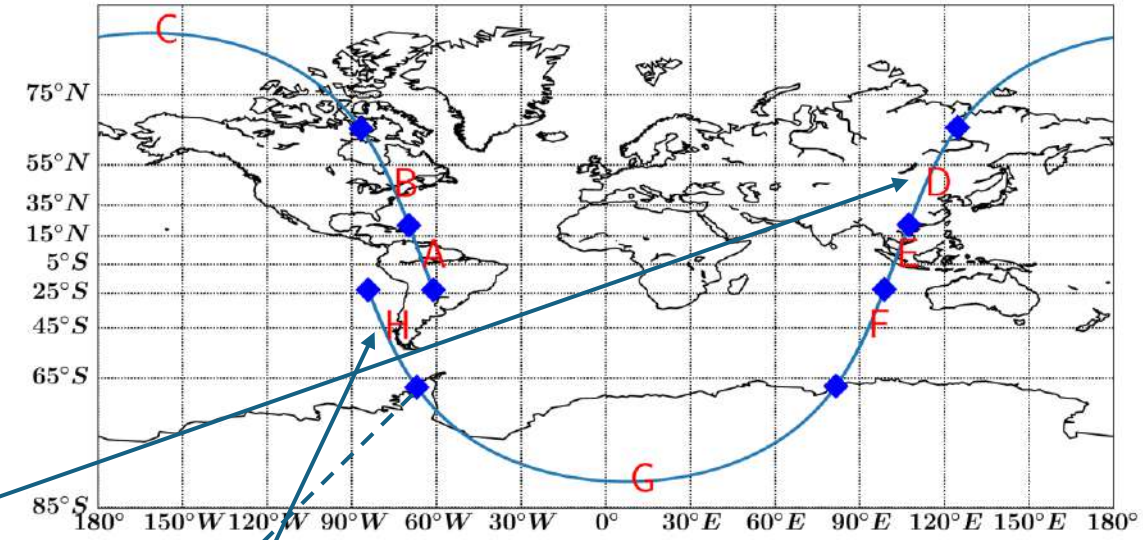


Estimated 20 km spike correction factors for two complete days (Aug 20 and Sept 10). Red corresponds to the Mie channel and Blue corresponds to the Rayleigh channel

Use of Ocean Surface Returns for eps assessment ?

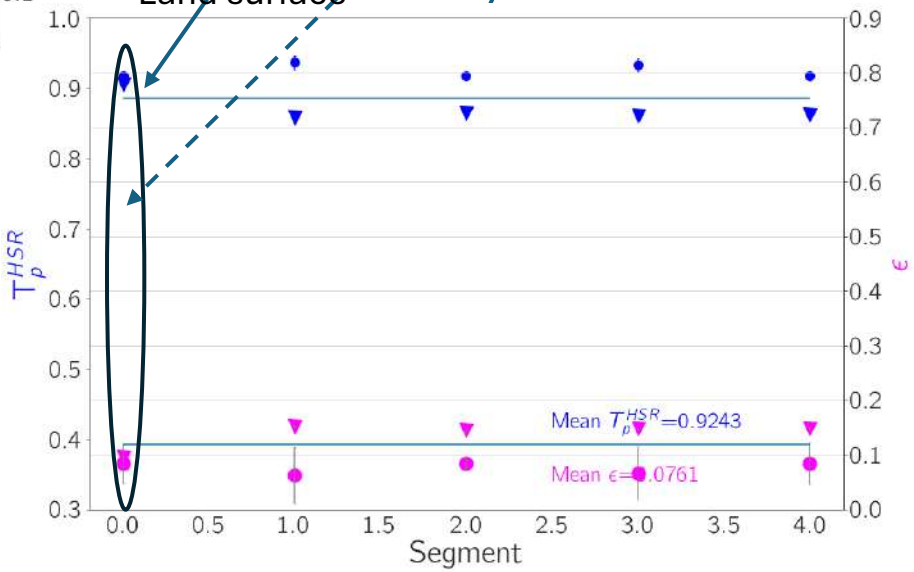


Using land returns the STRAP and surface-based eps assessments usually agree well !



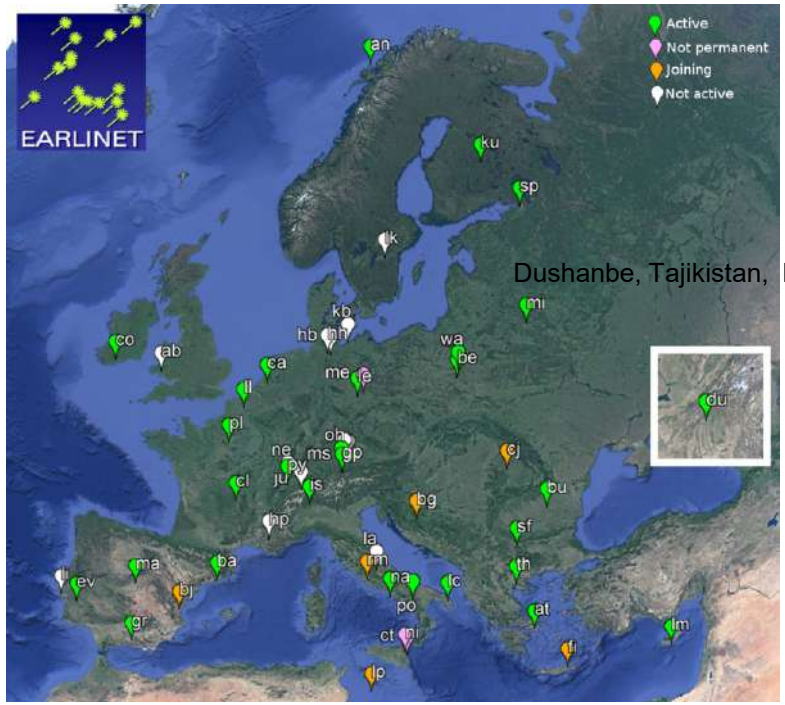
Land surface

Land surface

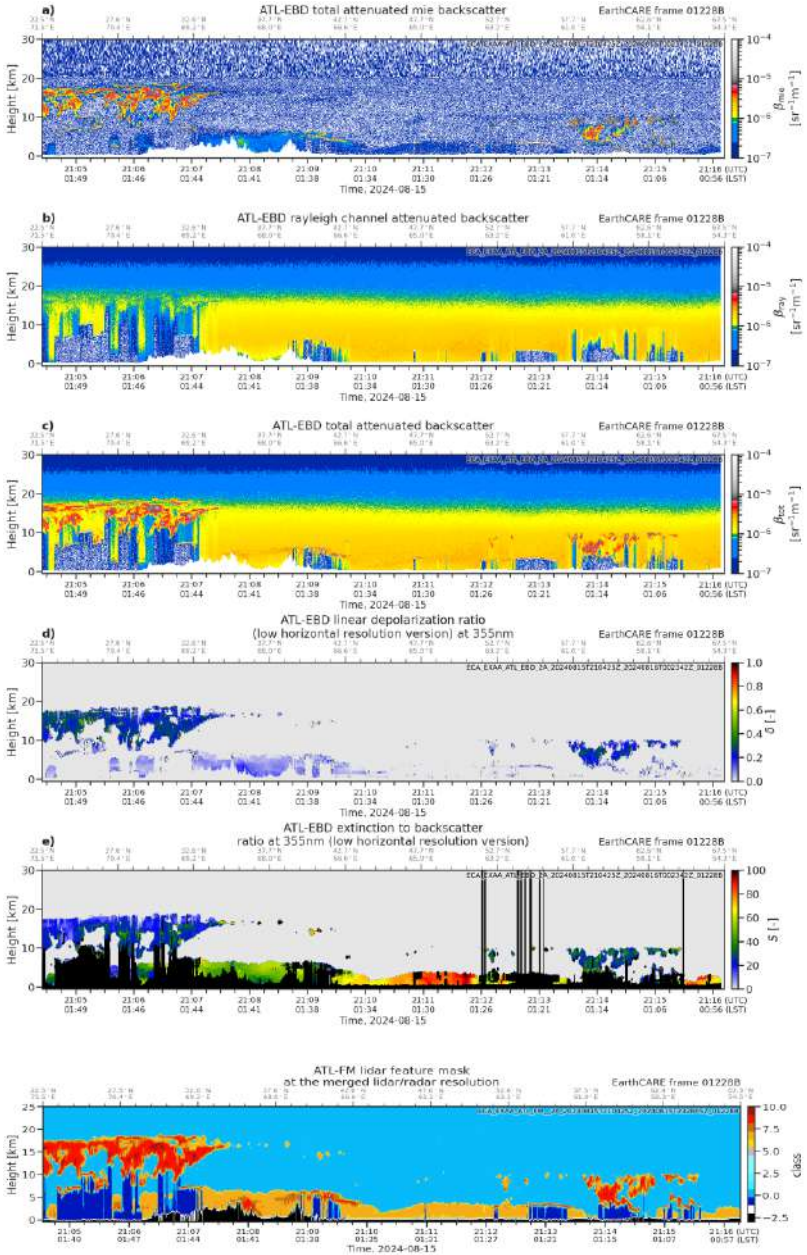


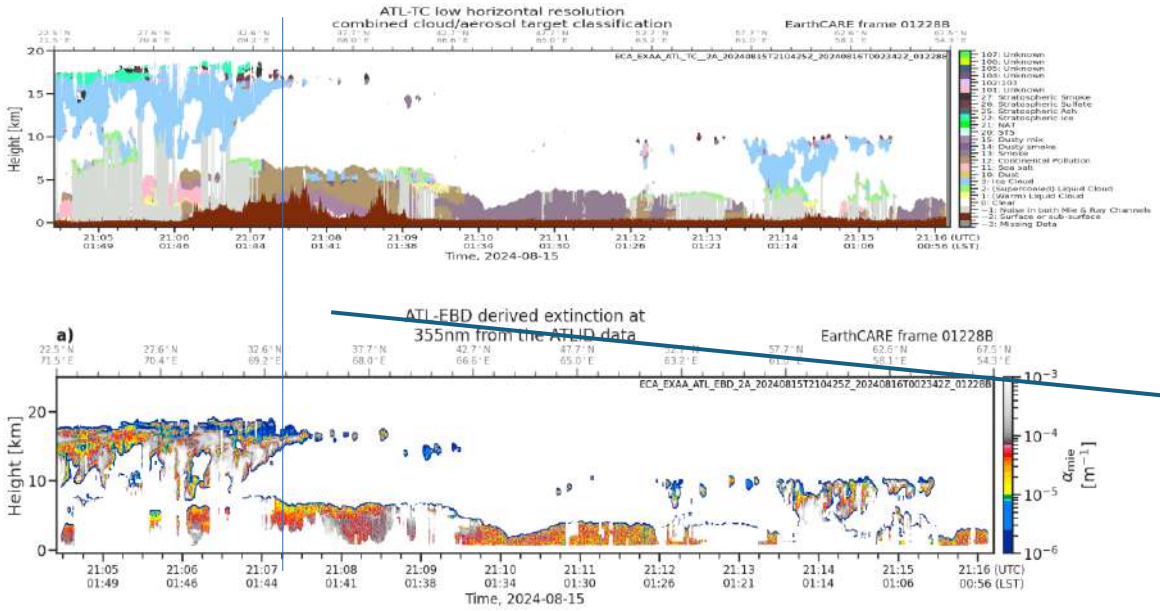
Using water returns the STRAP and surface-based assessments tend to be significantly different !

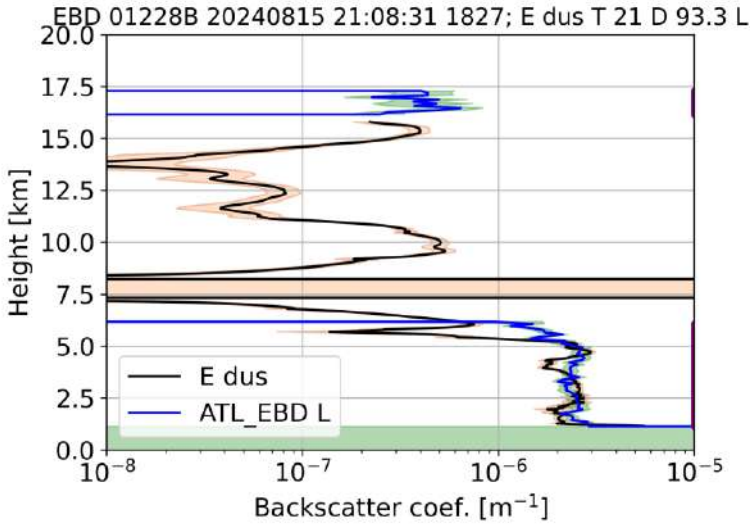
A-FM and A-PRO preliminary comparison with EARLINET data :An example

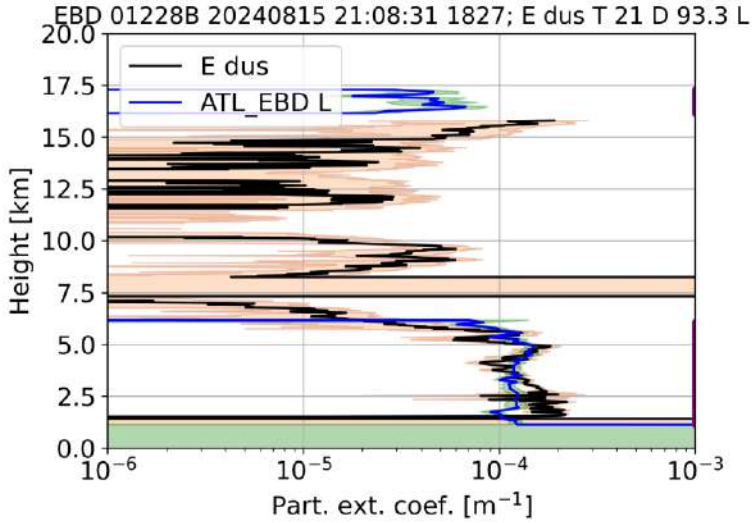


Dushanbe, Tajikistan, DUS or du







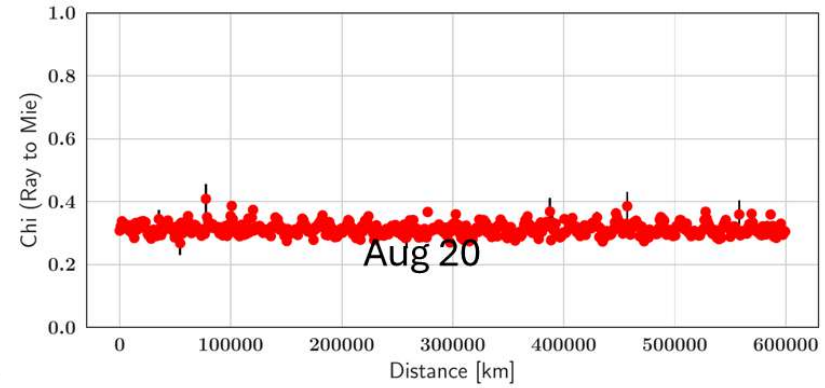


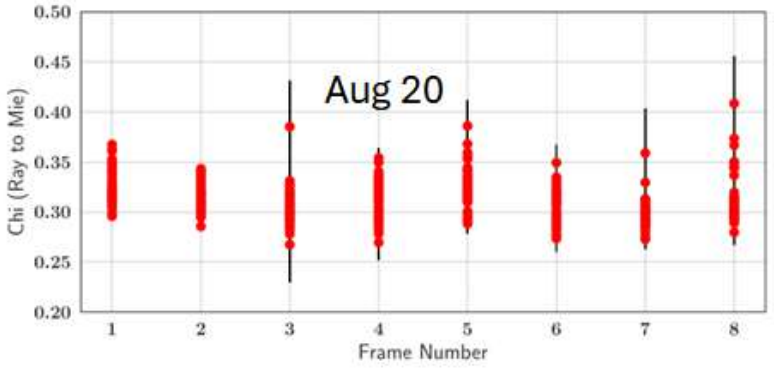
Comparisons for nighttime conditions are reasonable.
Daylight retrievals are bad ! (BB Bug)

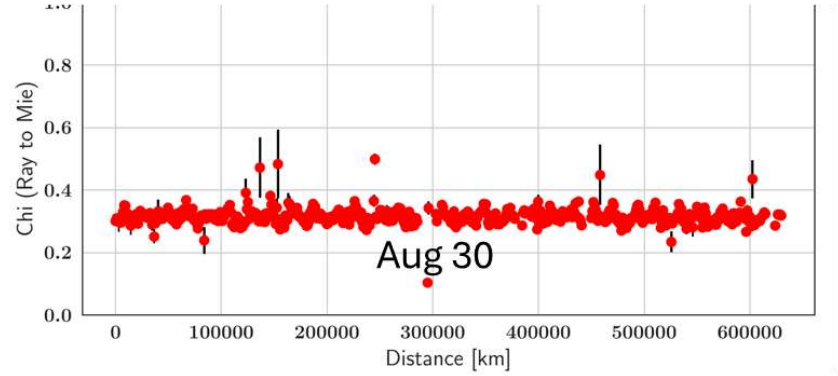
Other known issues: Thick aerosol is misidentified as (water)cloud !

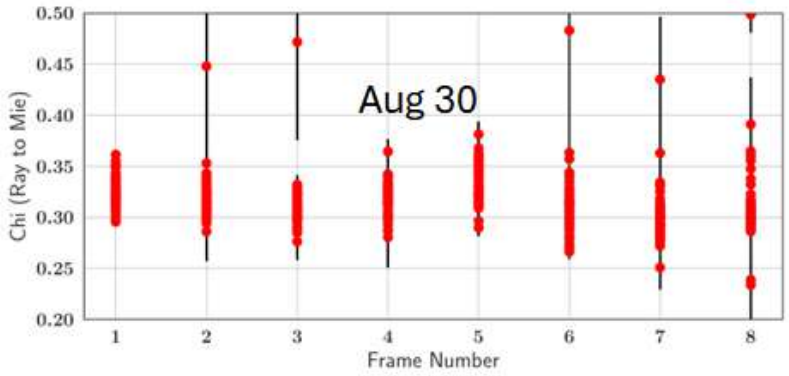
Working on a fix now.

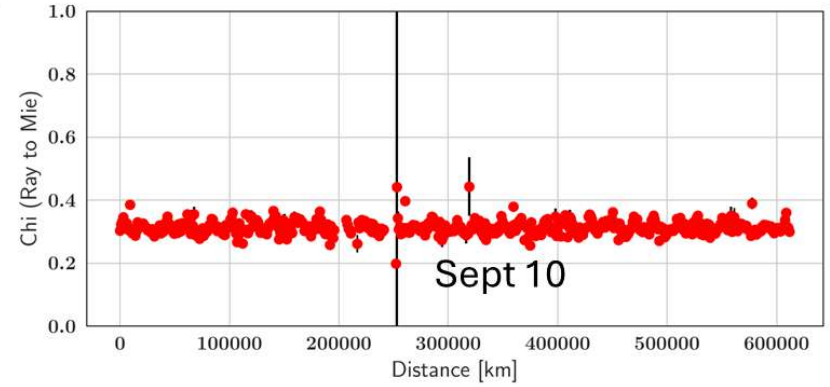
Chi: Ray ➔ Mie

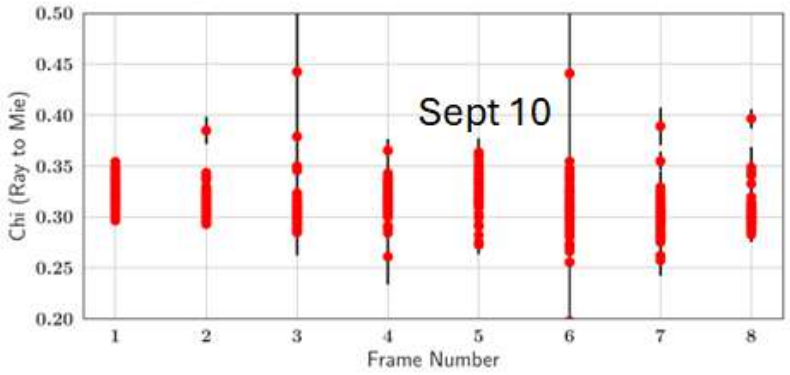

Chi (Ray to Mie)
Distance [km]
Aug 20


Chi (Ray to Mie)
Frame Number
Aug 20


Chi (Ray to Mie)
Distance [km]
Aug 30

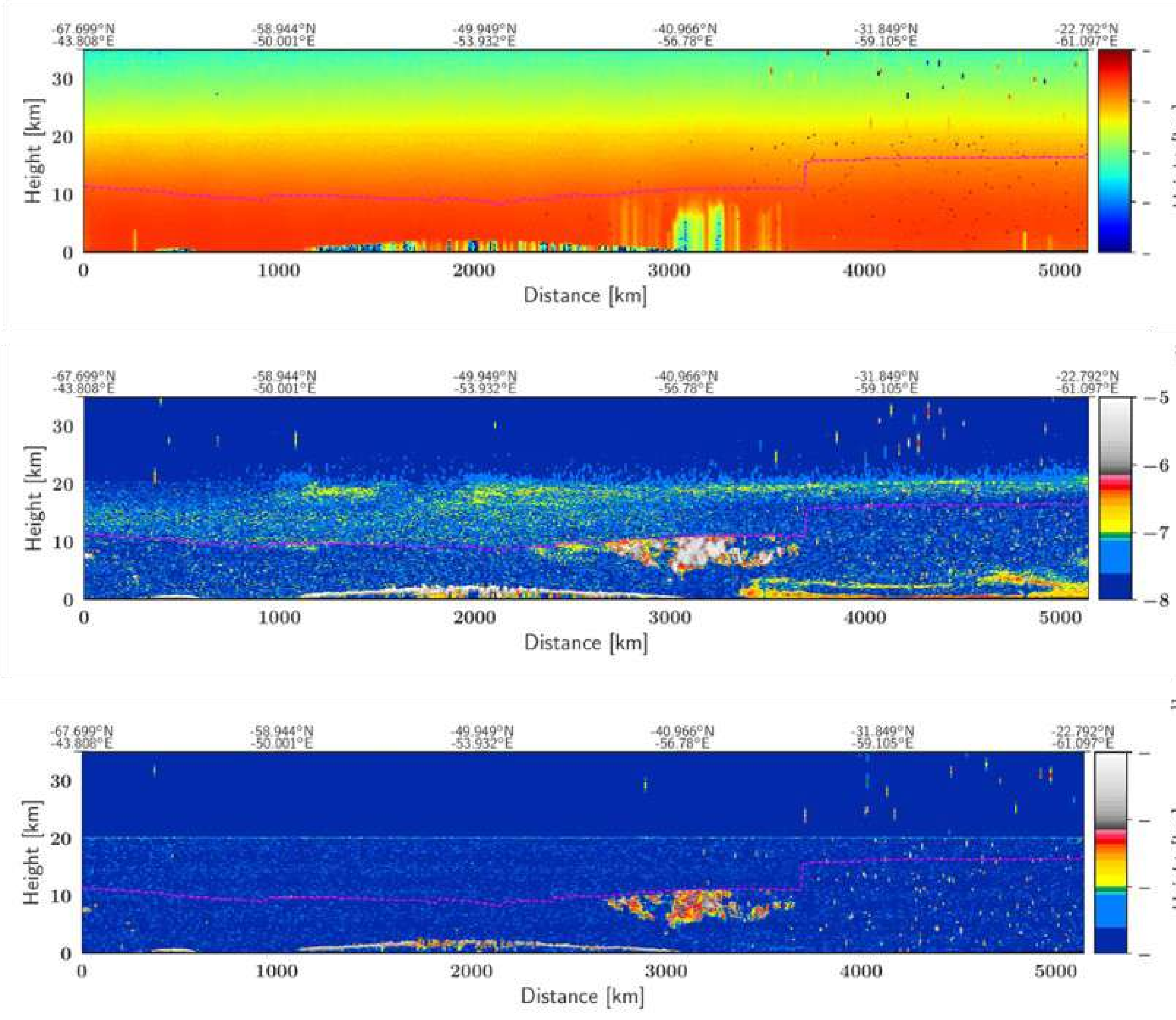

Chi (Ray to Mie)
Frame Number
Aug 30


Chi (Ray to Mie)
Distance [km]
Sept 10

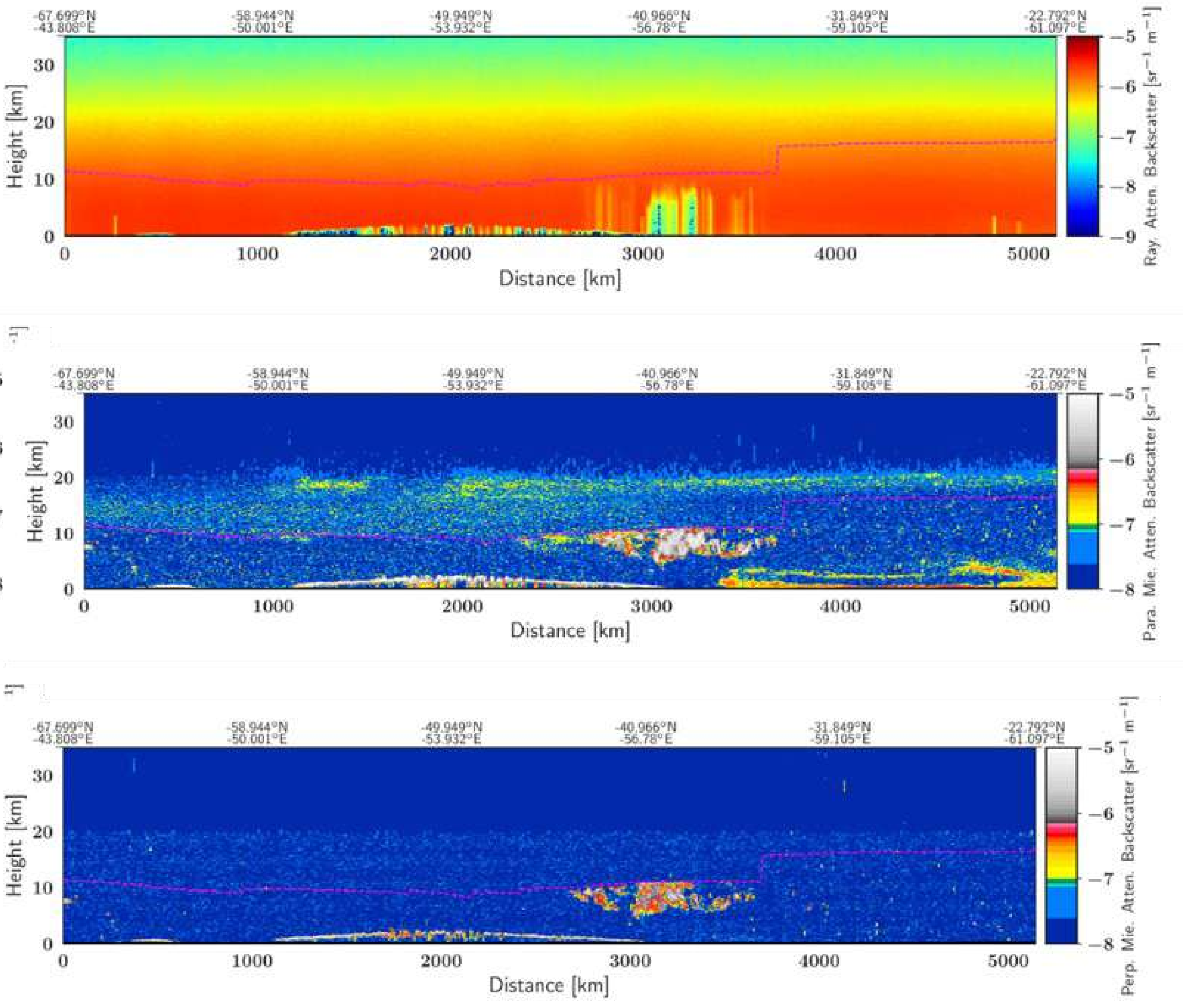

Chi (Ray to Mie)
Frame Number
Sept 10

Orbit 01202 Frame H

Operational Processor Aug 14 2024

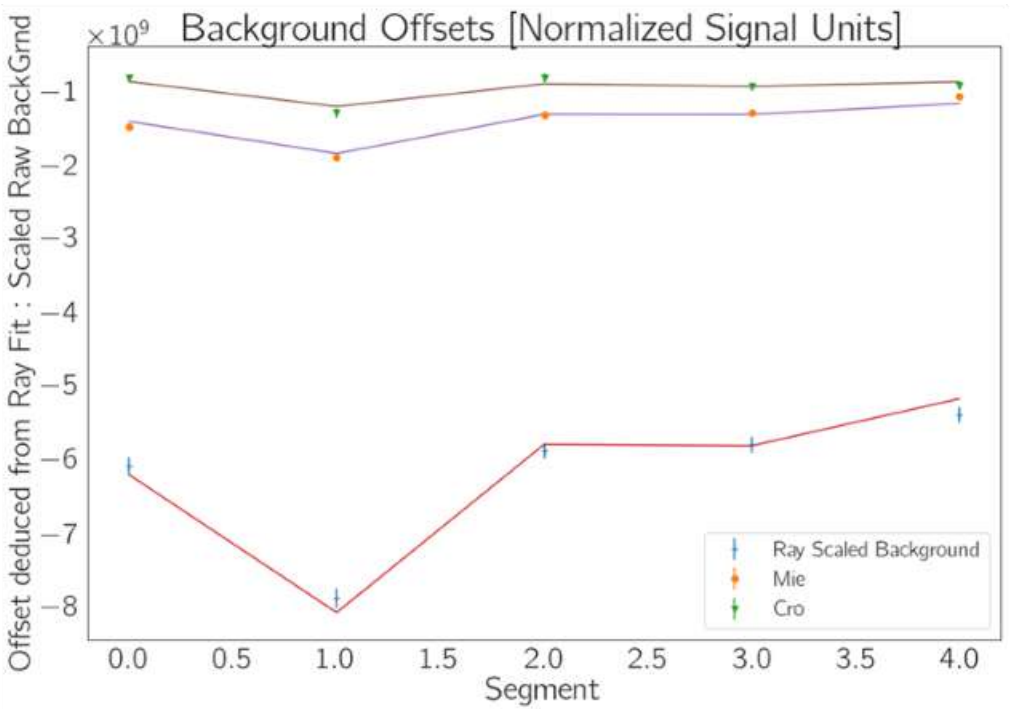


KNMI Post-Processor Aug 26 2024



What does the code do when the background-bug flag is set ?

1) Allows for an offset in the Rayleigh Clear fits
2) Correlates the determined offsets with the Signal Background (available each shot).
3) Subtracts the scaled Signal Background from the Normalized signals for each shot.



The correlation is quite good !

Using the raw signals, it looks like the background subtraction is off by a constant factor for all three channels.

B Offset_factor_ray= 0.0494145831843166 6
B Offset_factor_mie= 0.0453718443354412 9
B Offset_factor_cro= 0.0075480135274717 45

About 5% more signal needs to be subtracted in the Mie and Ray channels and 0.75% in the Cro.