Validation of EarthCARE's ATLID L2 aerosol profiling products

with ground-based lidar stations – case studies

ACTRIS
Exploring the Atmosphere

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Member of the Leibniz Association

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TROPOS
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Validation of EarthCARE/ATLID aerosol profiling products with ground-based PollyNET lidars – case studies

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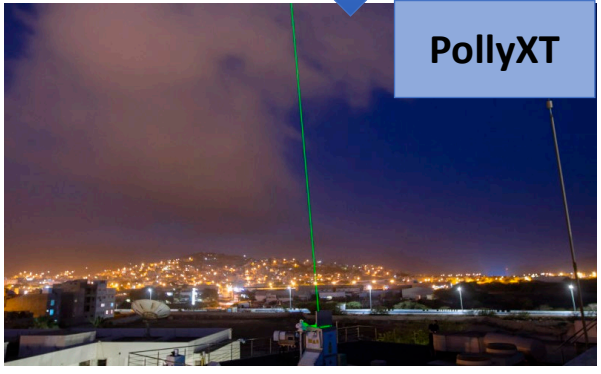
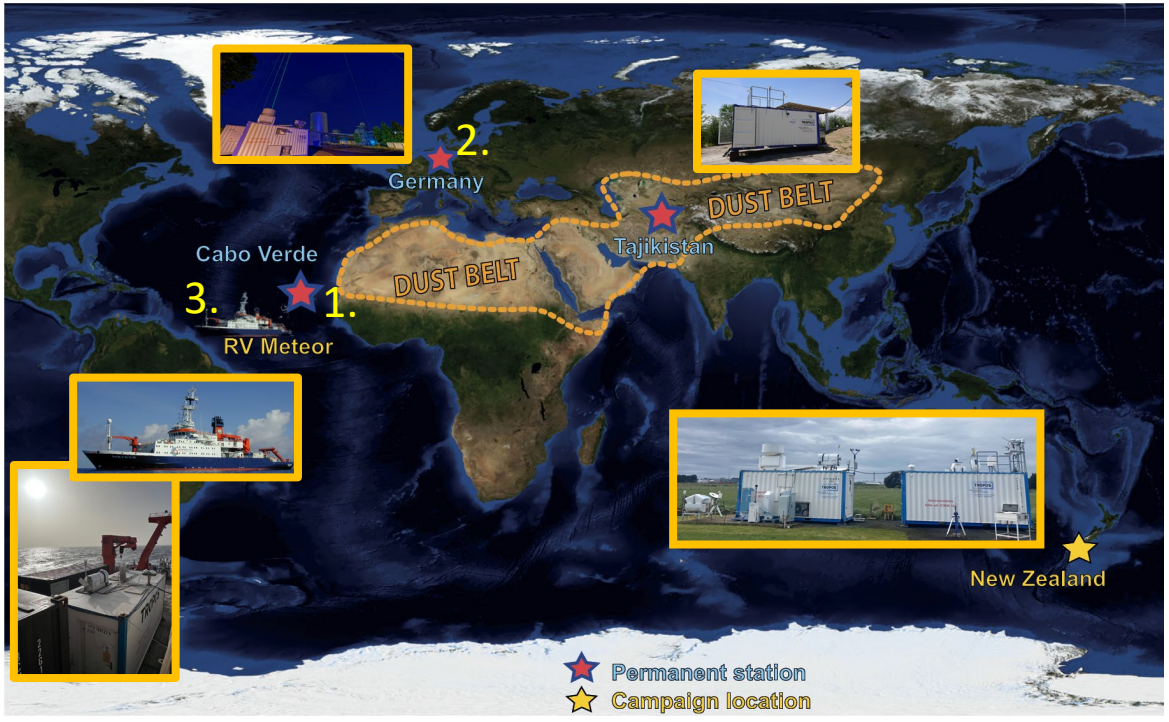
7 intensively discussed case studies for Baselines BA/BB (A-EBD and A-AER)

Update including Japanese ATLID Products (A-CLA) and Prototype CA data

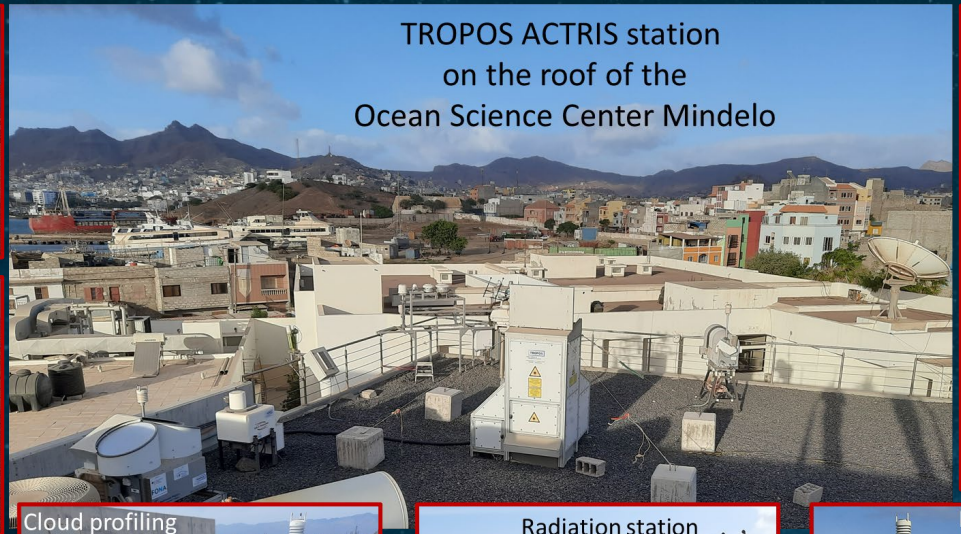
TROPOS ACTRIS Cal/Val activities

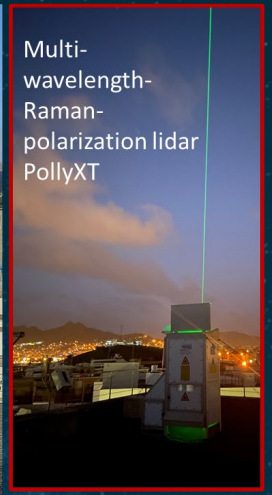


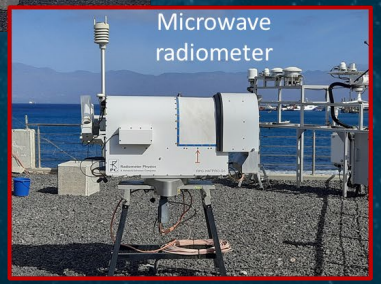


Networks measurements + mobile platforms give the chance for **dedicated "golden" case studies**
→ close overpasses with appropriate conditions

Mindelo, Cabo Verde, 1 June 2025 – the golden case







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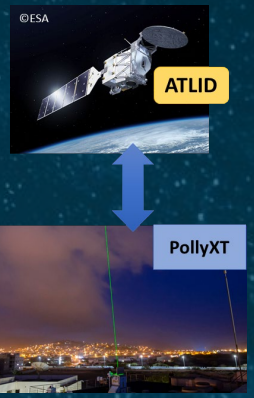
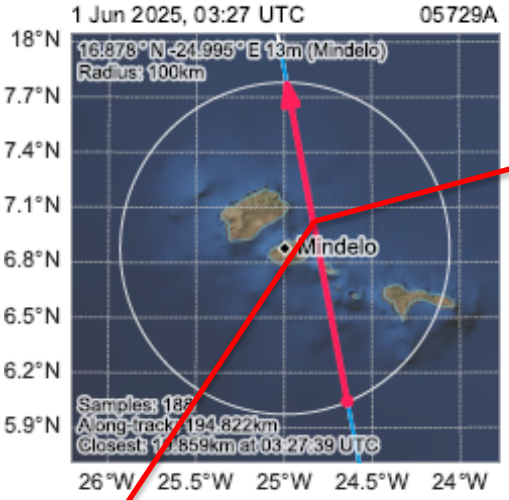
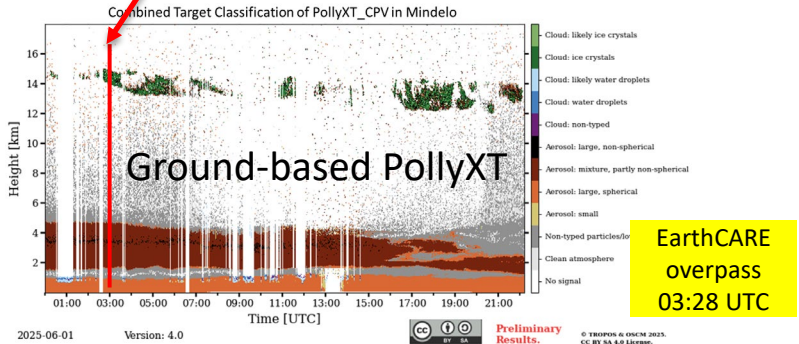
Aerosol and Cloud Remote Sensing



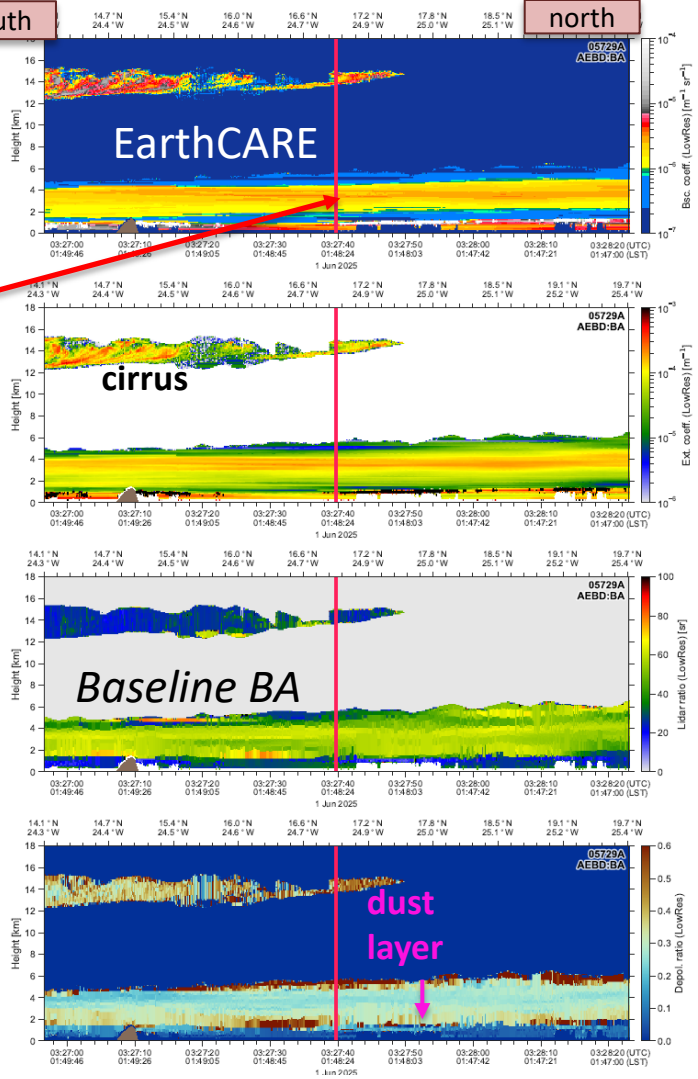
Mindelo, Cabo Verde, 1 June 2025:



20 km distance



EarthCARE overpass 03:28 UTC



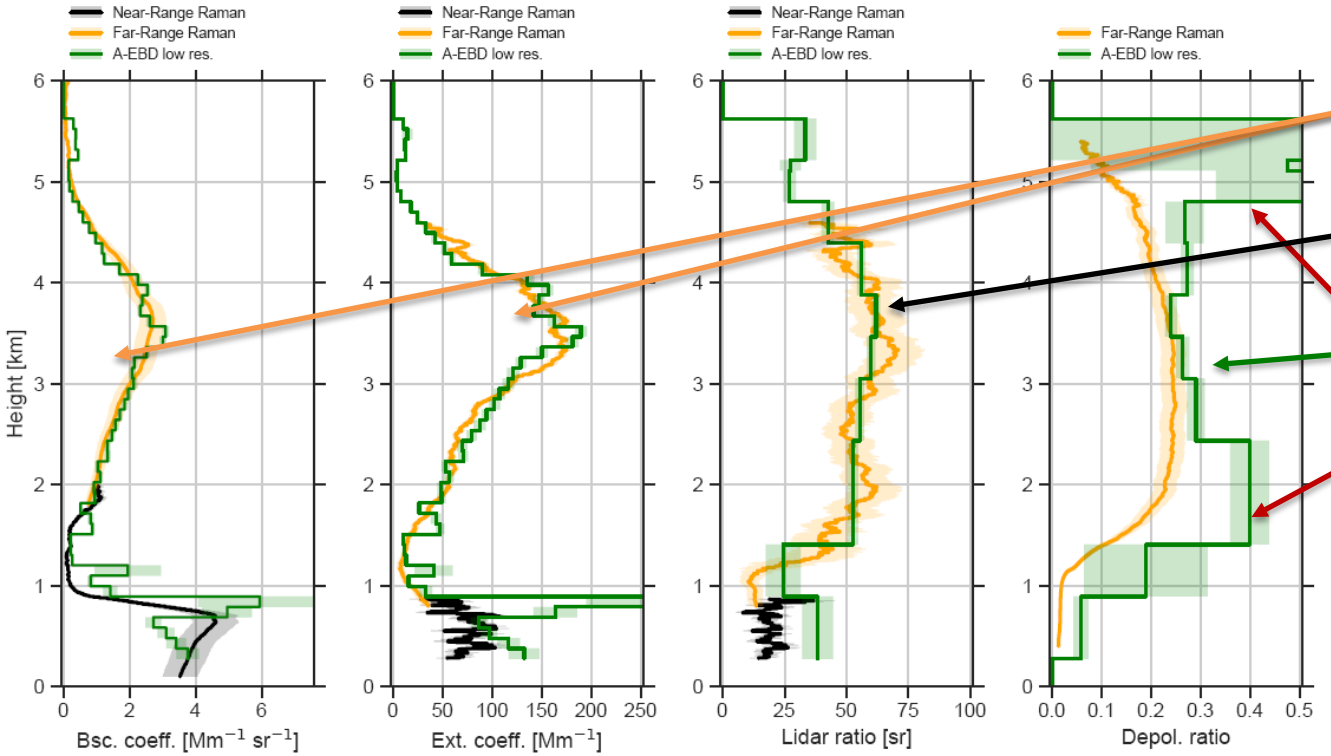
backscatter coefficient (bsc)

extinction coefficient (ext)

lidar ratio (LR)

depolarization ratio (depol)

Mindelo, Cabo Verde, 1 June 2025: ATLID vs. PollyXT



- Excellent agreement for backscatter + extinction
- Lidar ratio: Good agreement
- Depol:
  - partly agree
  - partly different

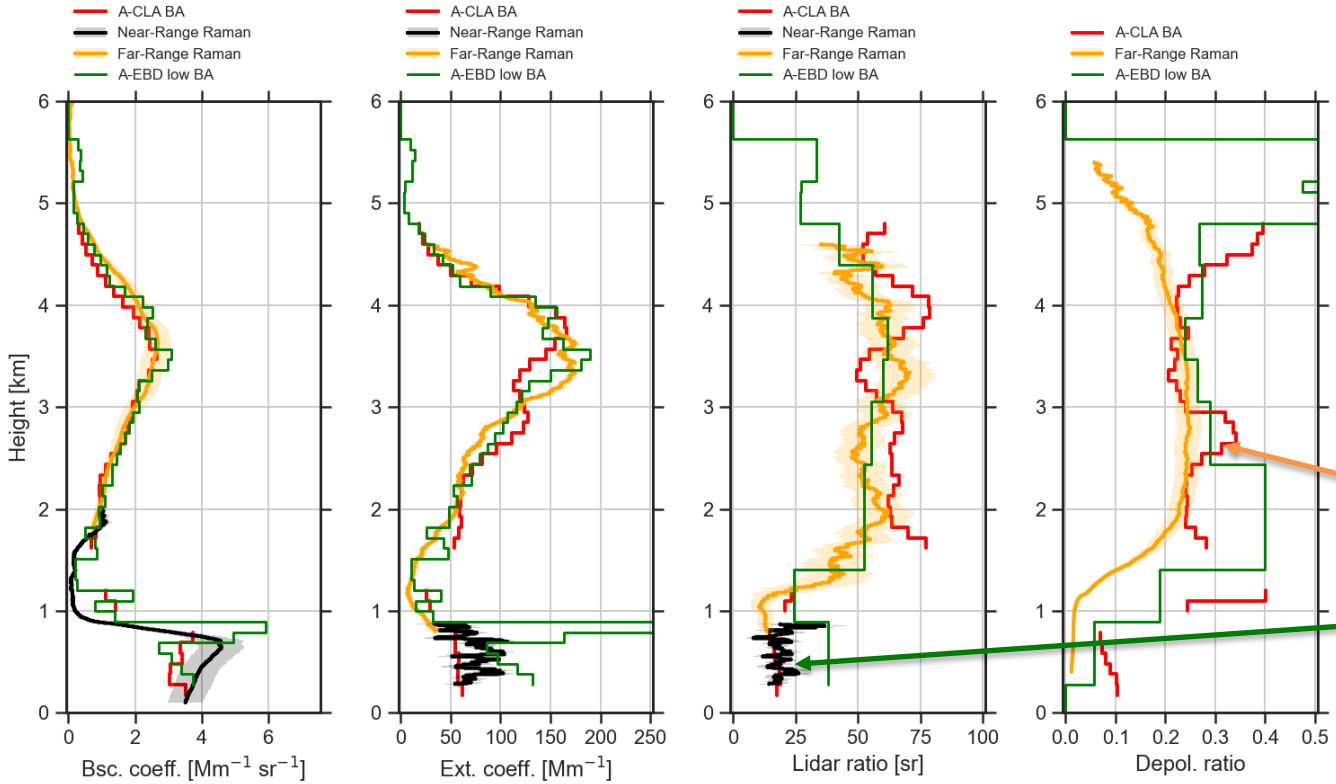
Great results for low-resolution products
Depol products partly problematic

Baseline BA:
A-EBD low resolution

Note: Depol and Lidar ratio is provided layer wise in A-EBD

How does the JAXA product perform?

Mindelo, Cabo Verde, 1 June 2025: ATLID vs. PollyXT



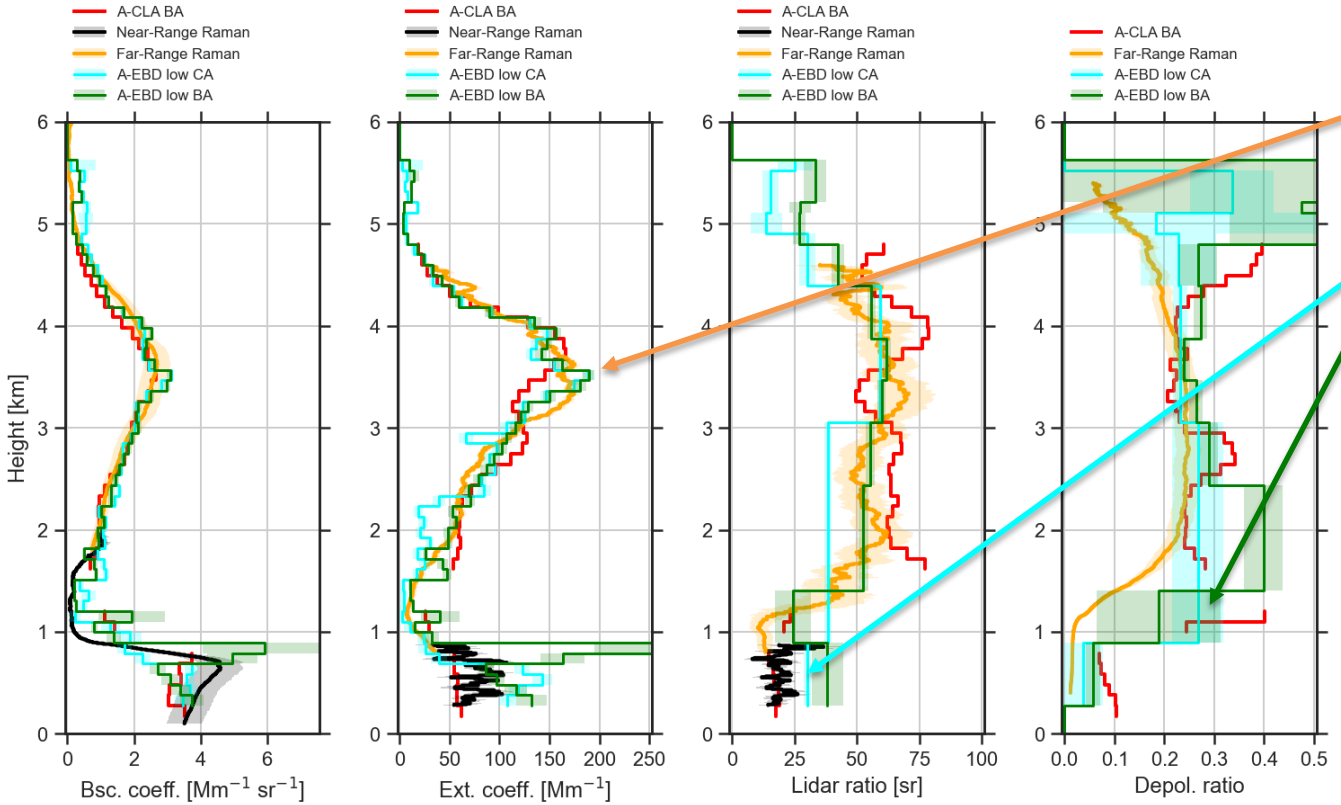
- Excellent agreement for backscatter + extinction
- Lidar ratio: Good agreement
- Depol:
  - partly agree
  - partly different
- JAXA (BA):
  - Similar to A-EBD in dust layer
  - Better performance in marine BL

Baseline BA:

A-EBD low resolution + A-CLA (JAXA Product)

Preview: Prototype CA ESA products

Mindelo, Cabo Verde, 1 June 2025: ATLID vs. PollyXT



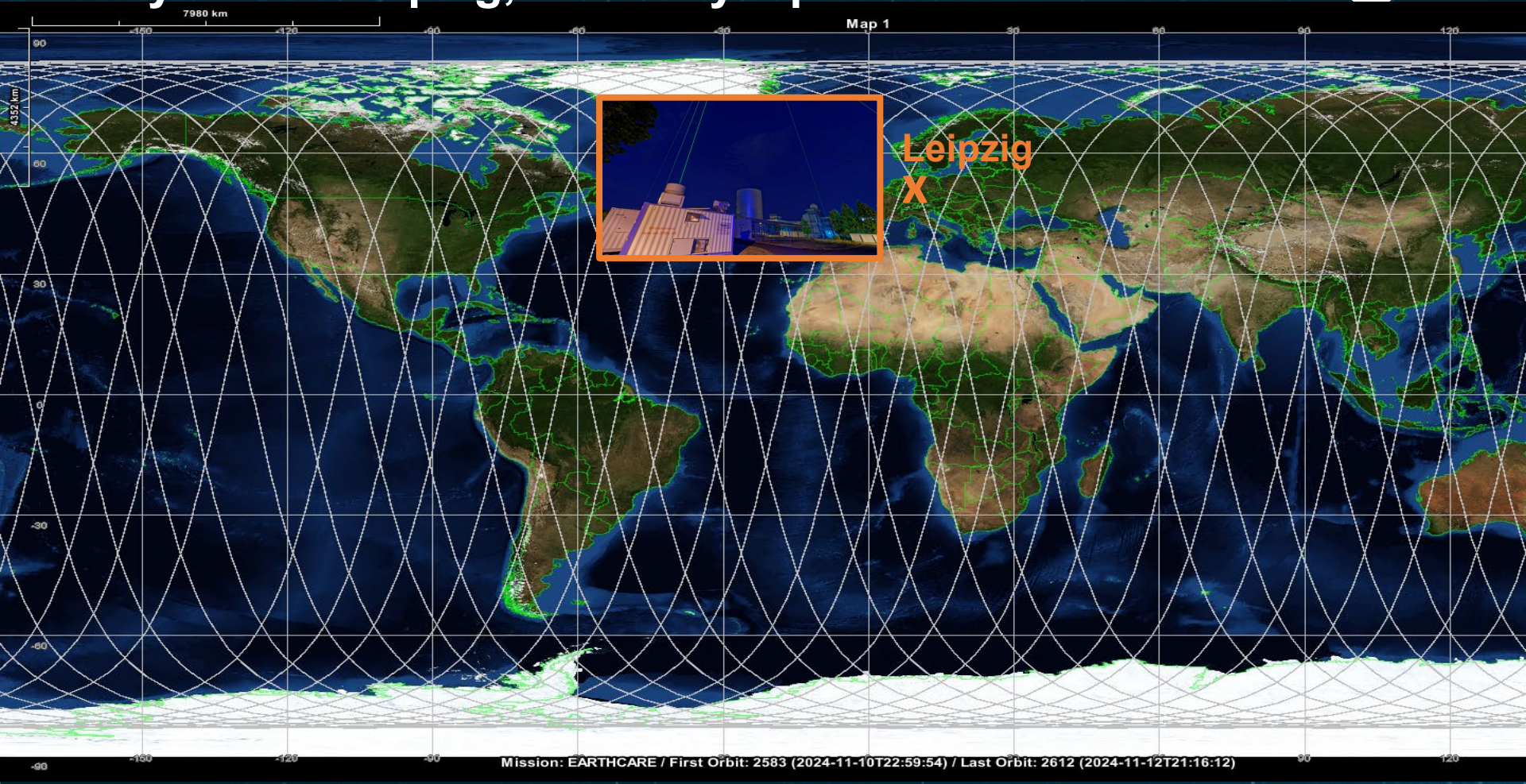
- Excellent agreement for backscatter + extinction stays
- Lidar ratio:
  Improved in Marine BL
- Depol:
  - Significantly improved

Significant improvement for Baselines CA expected wrt depol

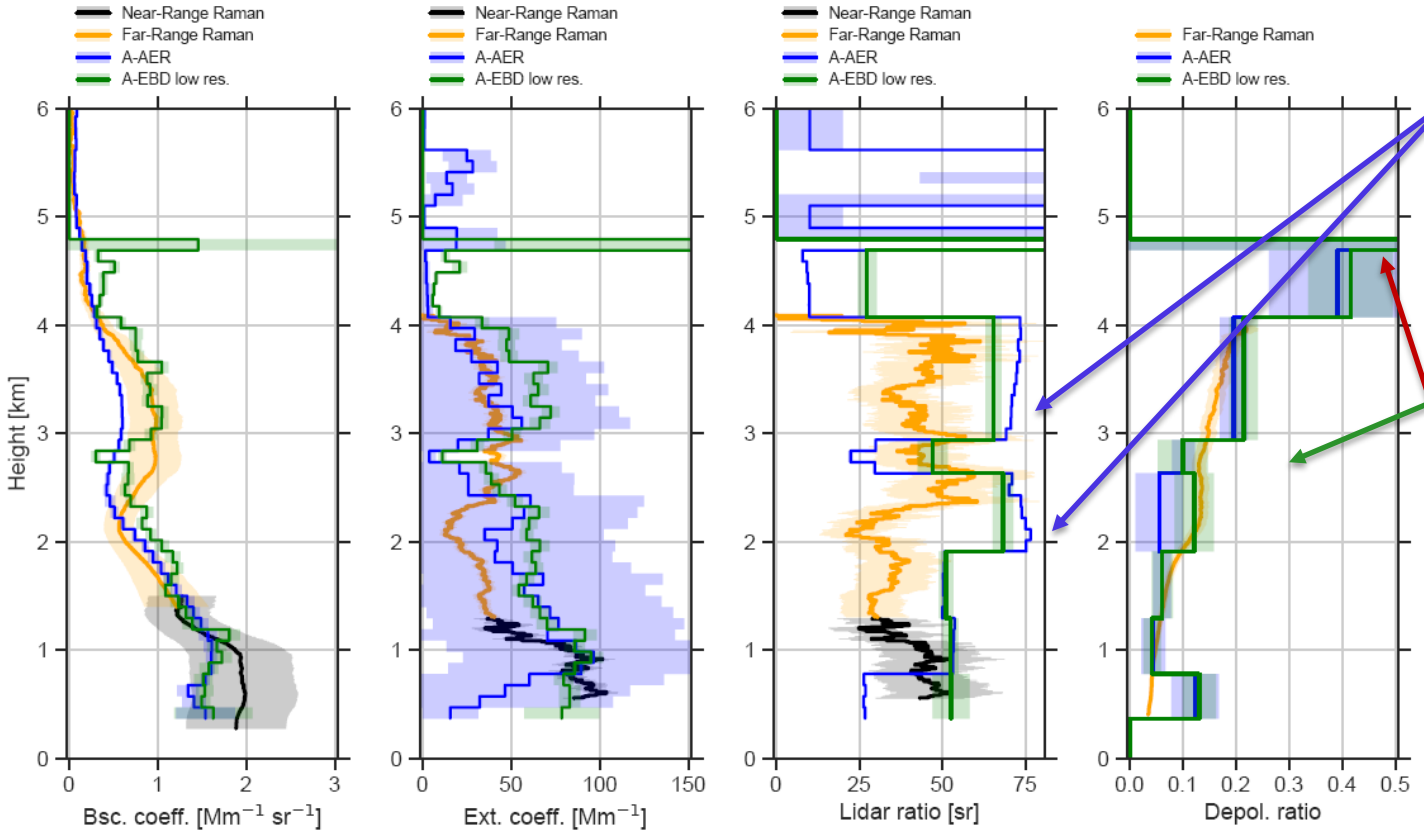
Baseline BA:
A-EBD low resolution + A-CLA +

Baseline CA:
A-EBD low resolution

Dusty mix at Leipzig, Germany – problematic case



Leipzig, 26 June 2025: Problematic case



Significant overestimation of lidar ratio in A-AER (input for A-EBD) + Very low uncertainties

Depol profile well represented,

but edge effects become visible

How does the JAXA product perform?

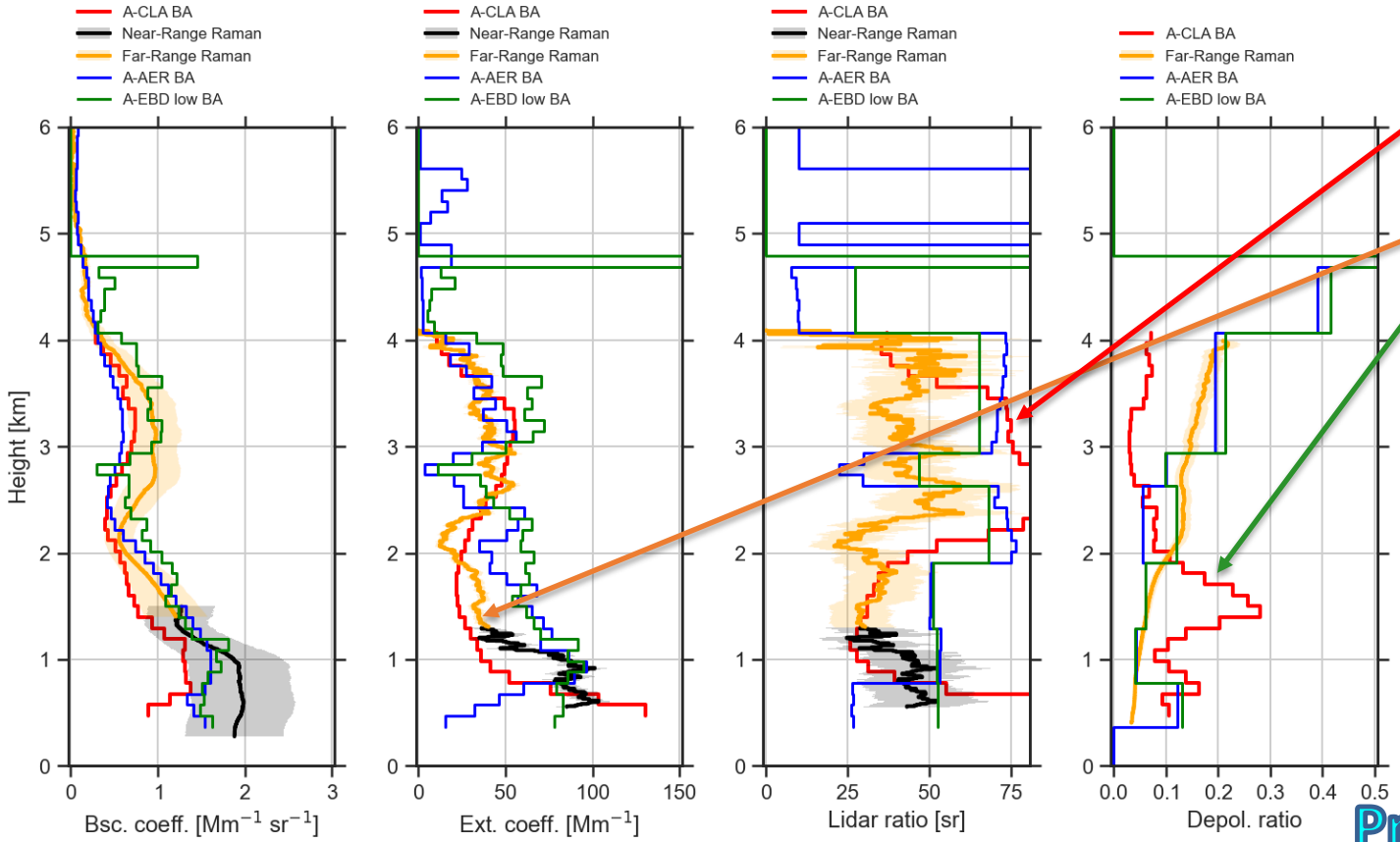
Baseline BA:

A-EBD low resolution + A-AER

Root cause of deviations: one erroneous profile in L1 data

→ you still need to be careful using ATLID data

Leipzig, 26 June 2025: Problematic case



- Similar problems with lidar ratio
- Ext. closer to truth
- Depol profile well off,
- **Hor. Resolution:** 10 km vs 100 km (EBD)

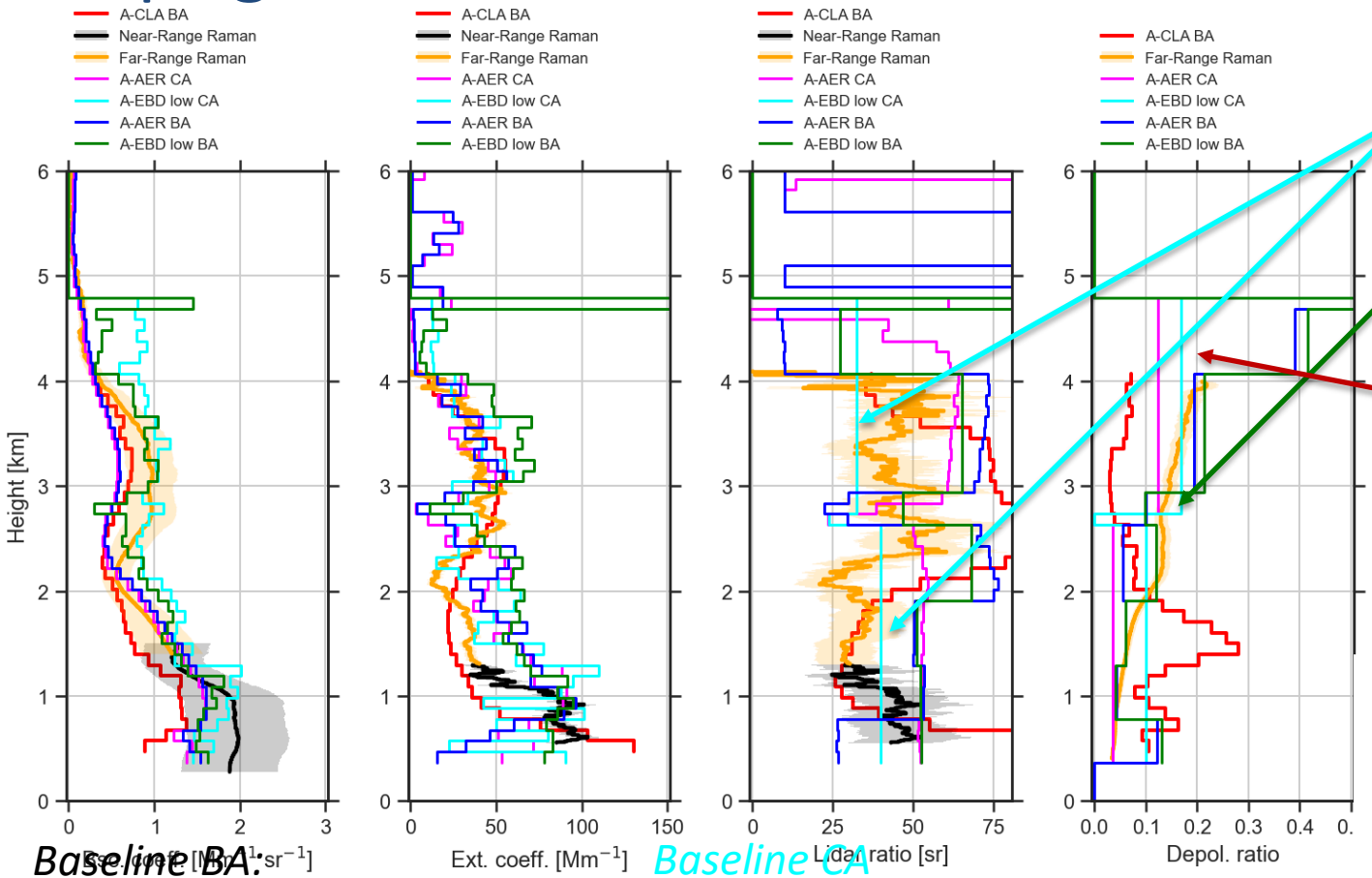
Root cause of deviations confirmed as L1 data

Baseline BA:

A-EBD + A-AER + A-CLA (JAXA Product)

Preview: Prototype CA ESA products

Leipzig, 26 June 2025: Problematic case



Significant improvement for EBD lidar ratio

Depol profile stays well represented,

no edge effects anymore

CA L1 and ESA L2 products seem to be significant improved

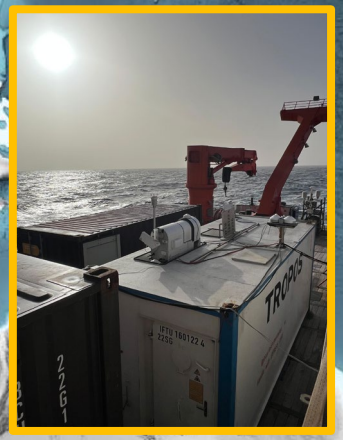
Baseline BA:

A-EBD + A-AER + A-CLA

Baseline CA

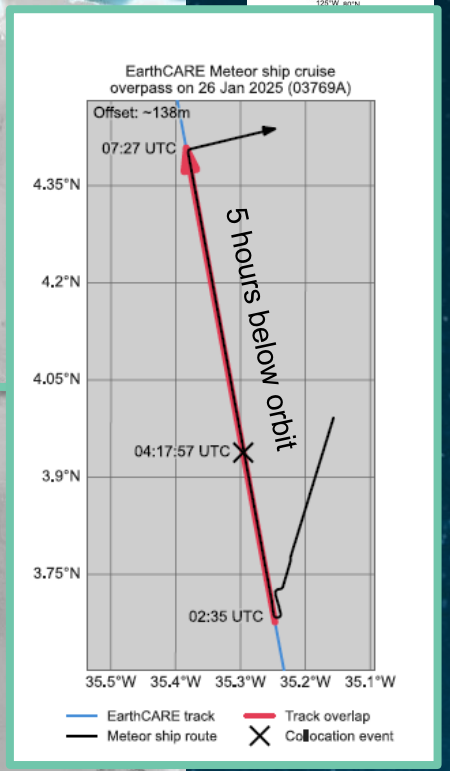
A-EBD low resolution + A-AER

RV Meteor, 26 January - below orbit deployement

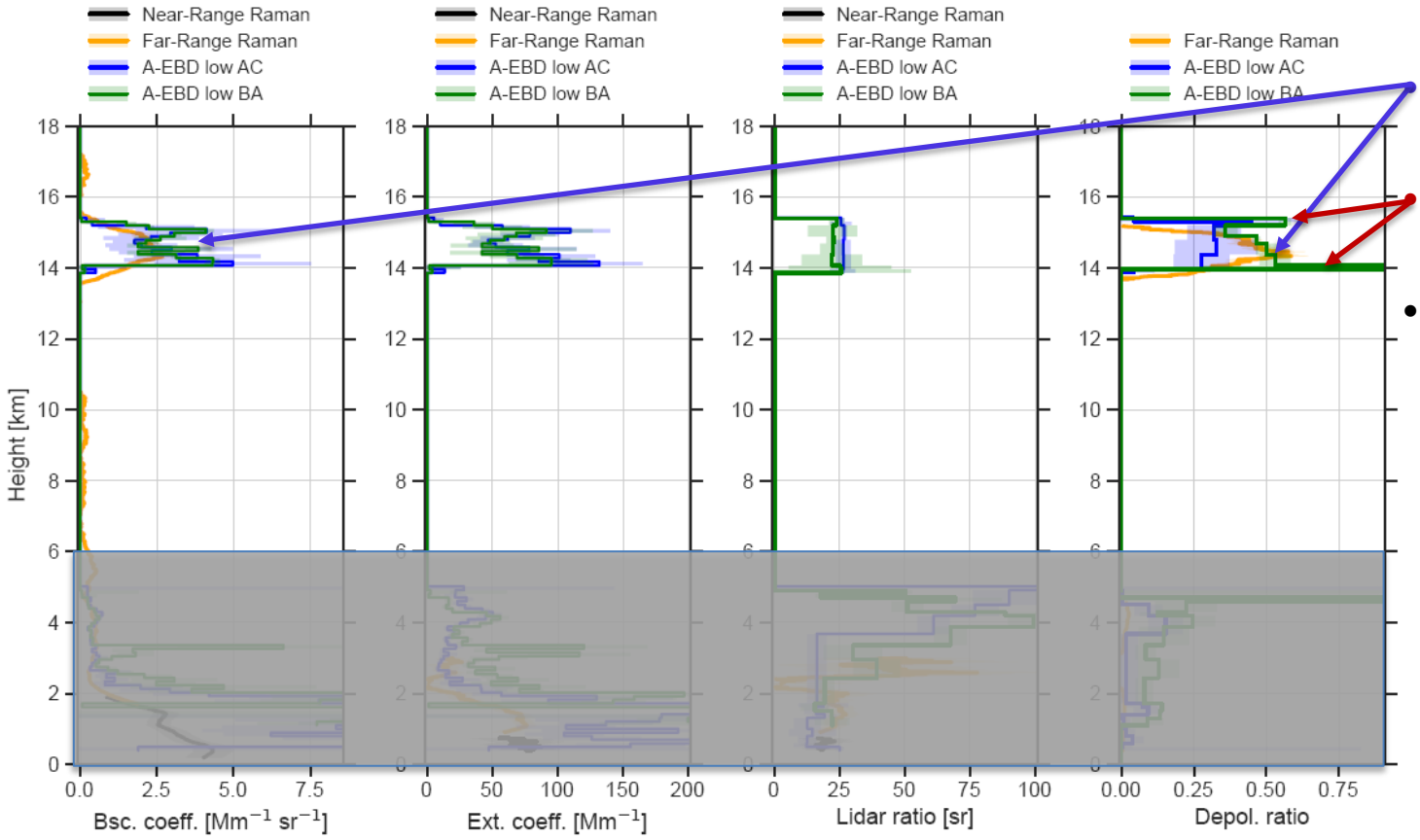


OCEANET
ACTRIS mobile
platform

RV Meteor



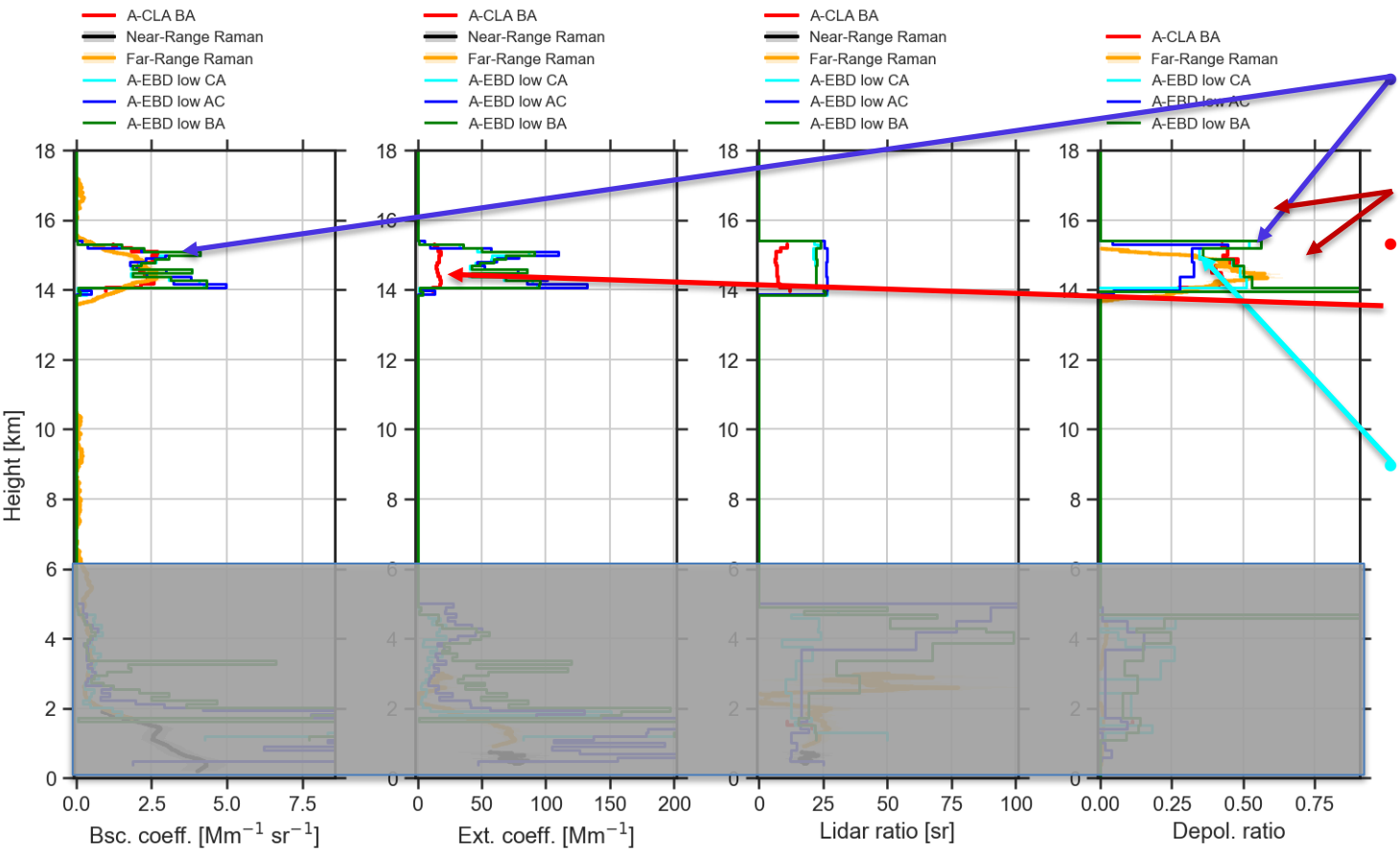
Meteor, 26 Jan 2025 – Cirrus: Polly vs. Atlid



Good agreement in Cirrus region,
but significant edge effect visible

- Significant improvement from Baseline AC to BA

Meteor, 26 Jan 2025 – Cirrus: A-CLA + the future



- Good agreement in Cirrus region wrt backscatter
- Extinction underestimated in A-CLA (multiple scattering?)
- Edge Effects significantly reduced

Promising results for prototype products of Baseline CA

Conclusion

- Strong **validation efforts** using ground-based ACTRIS lidars
- 2 independent processing chains (ESA: EBD + AER, JAXA: CLA)
- EarthCARE is powerful and **ATLID performs very well**
- **Low resolution** aerosol products gives **mostly good backscatter and extinction** products in **Baseline *BA***
- **Partly, lidar ratio is erroneous** retrieved (remember Leipzig case)
- **Depolarization ratio** values **still problematic for *BA***
  - Higher than the reference (nighttime) in aerosol regime
  - Suffering from noise at daytime
  - Valid for both chains (ESA and JAXA)

→root causes identified, **improvements with Baseline *CA***

- **Edge effects occur in Baseline** BA → **solved with CA?**
- **First science can be done with BA** when knowing the drawbacks

→ Please **read the disclaimer and use data with care!**

3 cases shown→ if you want to read more:
https://amt.copernicus.org/articles/19/3831/2026/