

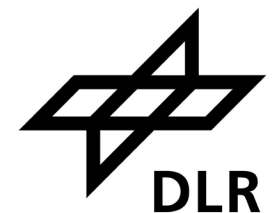


AIRBORNE LIDAR MEASUREMENTS: PERCUSION'S CONTRIBUTION TO VALIDATE EARTHCARE ATLID L2 OPTICAL PROPERTIES

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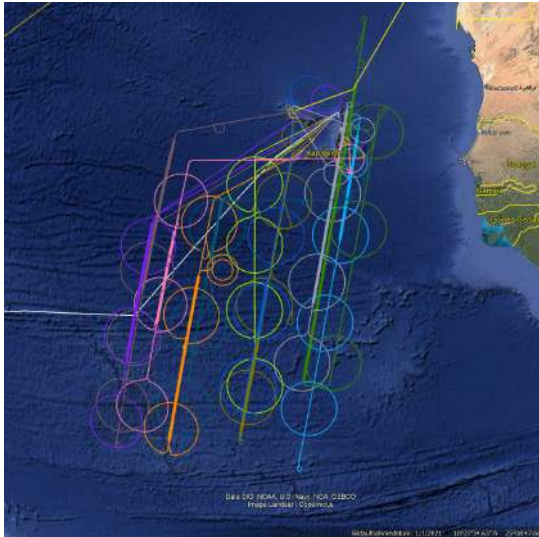




EarthCARE Validation



Sal, Cape Verde



8 August – 6 September 2024

- 10 EC underflights
- 4 overpasses over Mindelo ground station
- 3 coordinated flights (curtain) with ATR (2 direct EC overpass)
- 3 coordinated flights (curtain) with King Air (1 direct EC overpass)
- Coordination with METEOR

Barbados



6 – 29 September 2024

- 11 EC underflights
- 3 (+1) flights coordinated with PACE
- Overpasses/measurements near BCO ground station
- various METEOR overpasses

Oberpfaffenhofen



5 – 19 November 2024

- 12 EC underflights
- 2 overpasses (each) Lindenberg, Leipzig, Jülich, Munich, Antikythera
- 1 coordinated flight (profile) with BAe (FAAM)

**3 Location
30 Flight
33 Underpasses
290 Flight hours**





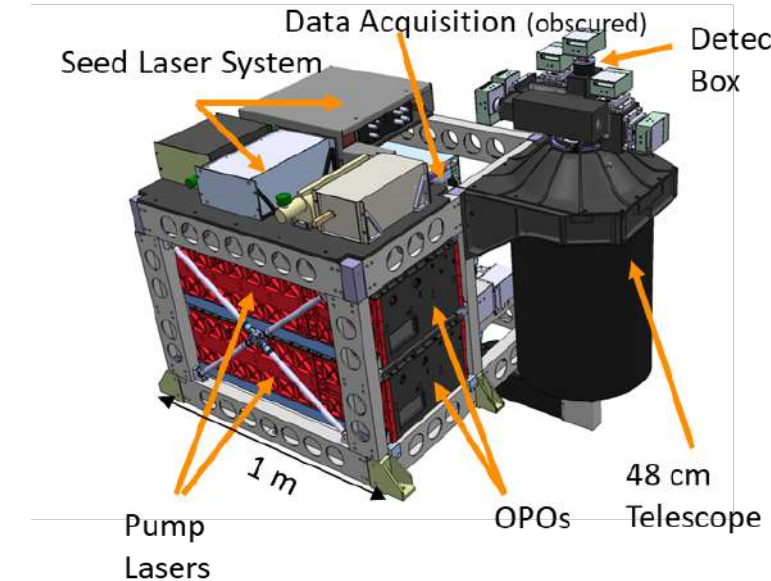
WALES Lidar system

Airborne water vapor DIAL and HSRL, developed and build at DLR-IPA



Aerosol

- Backscatter coefficient (532 nm, 1064 nm)
- Color ratio (532 nm/1064 nm)
- Aerosol **depolarization** 532 nm
- Aerosol **extinction 532 nm – I₂-cell-HSRL**
- Resolution (raw data): range 7.5 m, time = 0.2 s
(standard products): range 15.0 m, time 1.0 s



→ Possibility of aerosol classification

Water Vapor

- H₂O mixing ratio (4 wavelengths ~935 nm)
- Resolution: range 250 m, time = 24 s
- Relative humidity (with external temperature data)

→ In-cloud and outside cloud distribution of relative humidity and water vapor

Parameter	WALES lidar
Number of Wavelength @ 935 nm	4
Laser pulse energy 532nm, 935nm, 1064 nm	50 mJ / 40 mJ / 150 mJ
Pulse repetition frequency	2 x 100 Hz
Mie Crosstalk HSRL channel	< 10 ⁻³
Laser Frequency stability 935 nm	< 60 MHz
Laser Frequency stability 532 nm	< 2 MHz
Laser spectral purity	> 99.9%
Telescope diameter	0.48 m
Telescope field of view	1 mrad
Receiver bandpass filter-width (fwhm)	1 nm
Detector type 935 nm / 1064 nm	APD
Detector type 532 nm	PM
Acquisition Method	analog



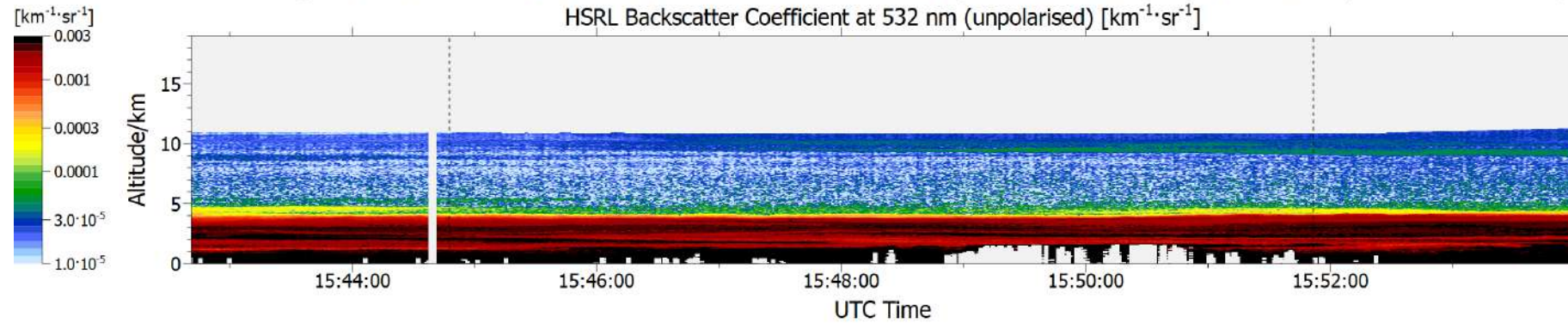
EarthCARE L1 Comparison – 13 Aug. 2024 (Sal; dust/mixture)



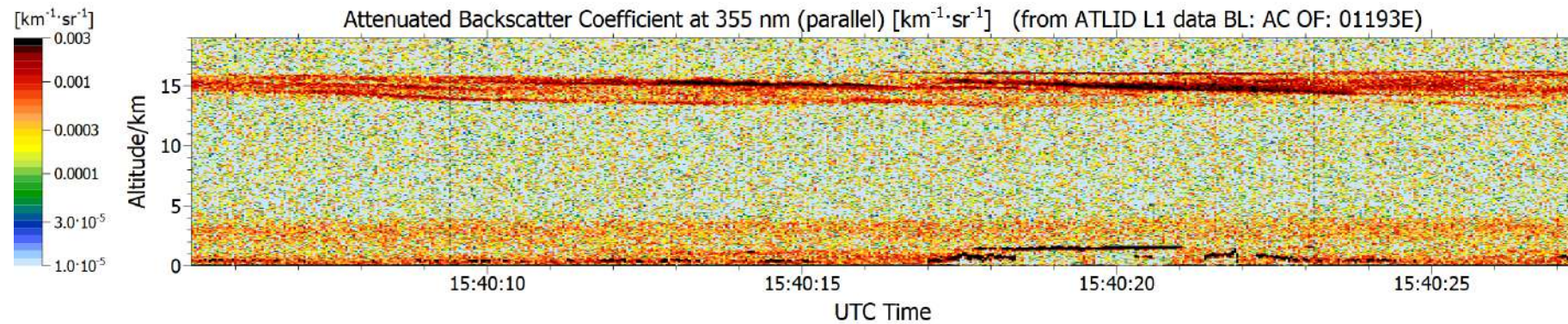
ATLID / WALES Comparison PERCUSSION 2024-08-13

Data average: WALES at: 15:48:20.362 ATLID at: 15:40:16.28 over ± 50.00 km (mean track distance: 1.10 km, mean temporal distance: 484.1 s)

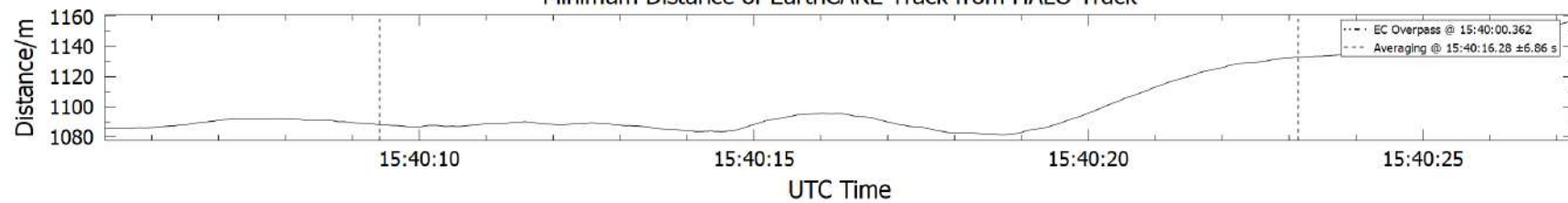
HSRL Backscatter Coefficient at 532 nm (unpolarised) [$\text{km}^{-1} \cdot \text{sr}^{-1}$]



Attenuated Backscatter Coefficient at 355 nm (parallel) [$\text{km}^{-1} \cdot \text{sr}^{-1}$] (from ATLID L1 data BL: AC OF: 01193E)



Minimum Distance of EarthCARE Track from HALO Track





EarthCARE L2 Comparison – 13 Aug. 2024 (Sal; dust/mixture)

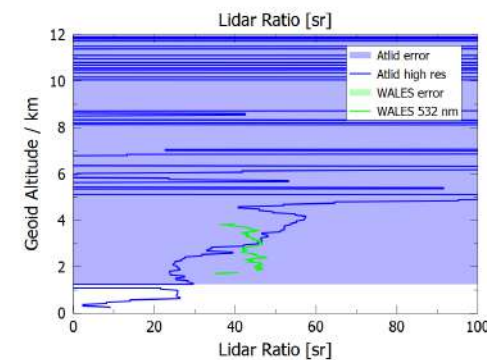
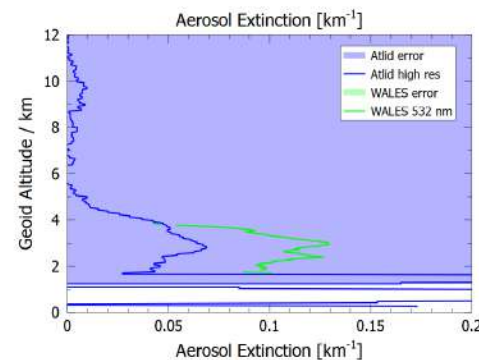
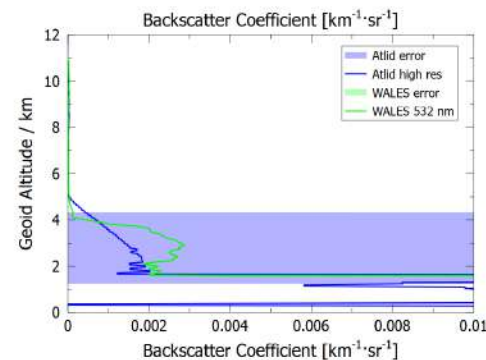
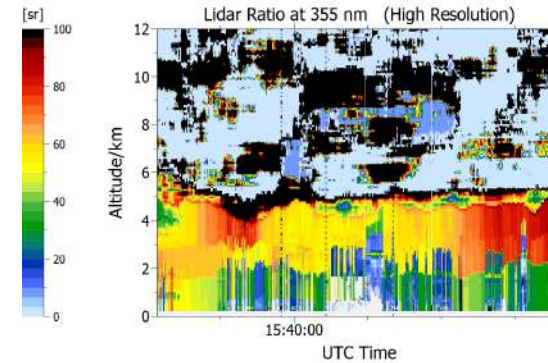
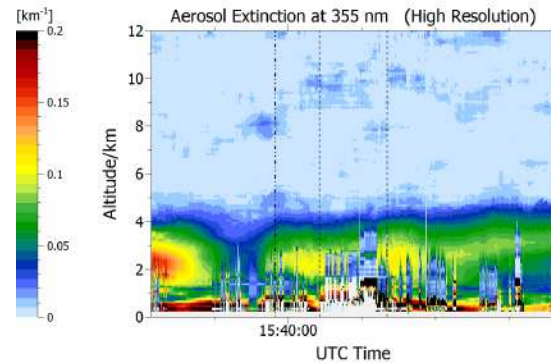
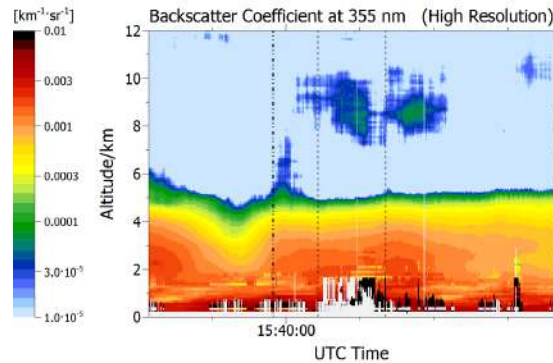
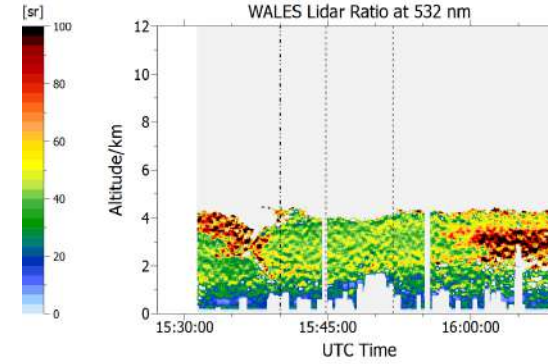
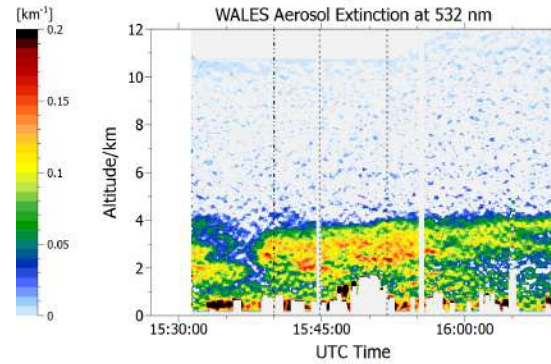
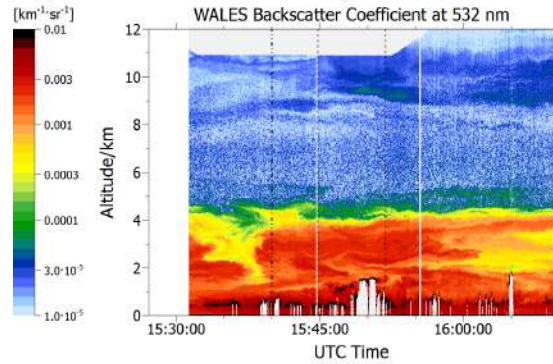


ATLID L2 AER data BL: AD OF: 01193E

BSC

EXC

LR



- BSC cannot capture profile / sharp upper boundary
- EXC too low (artefact above clouds?)
- Lidar ratio too high in upper part of the aerosol layer



EarthCARE L2 Comparison – 13 Aug. 2024 (Sal; dust/mixture)



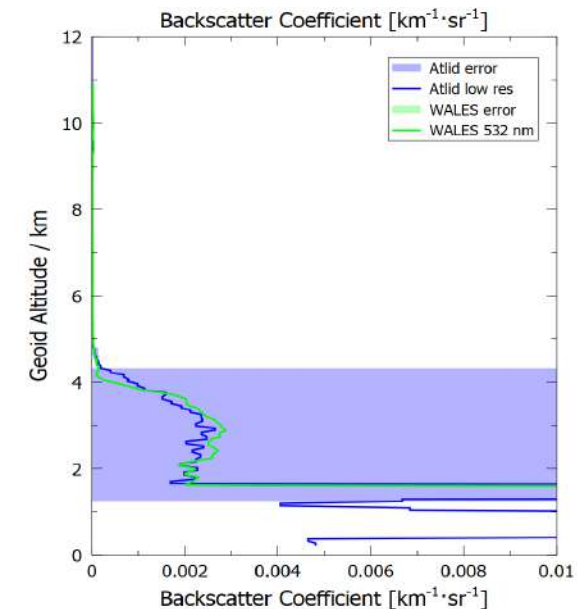
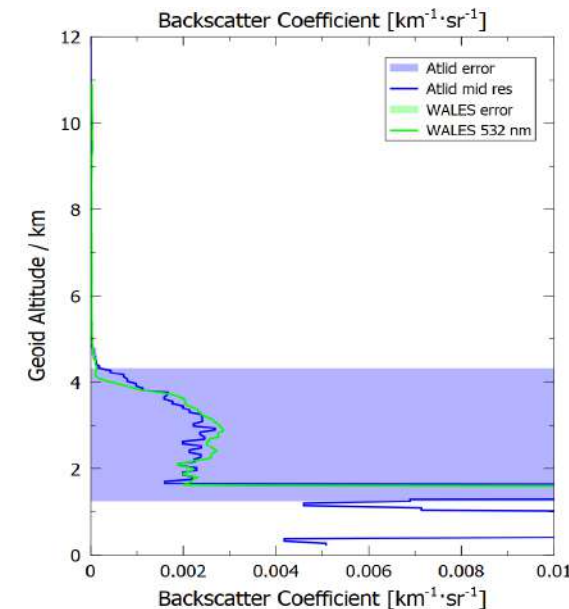
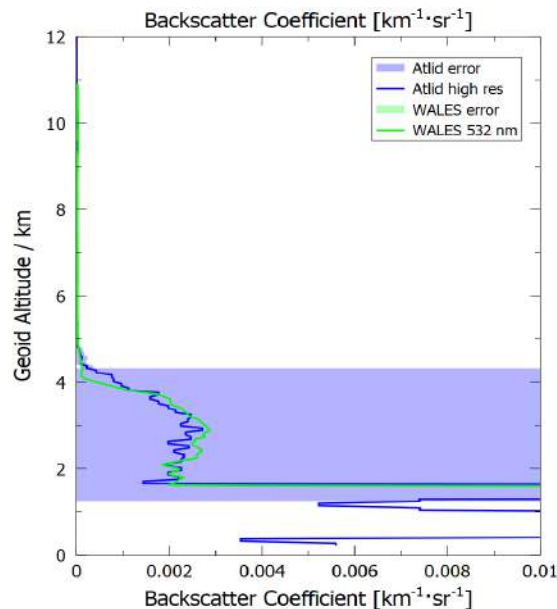
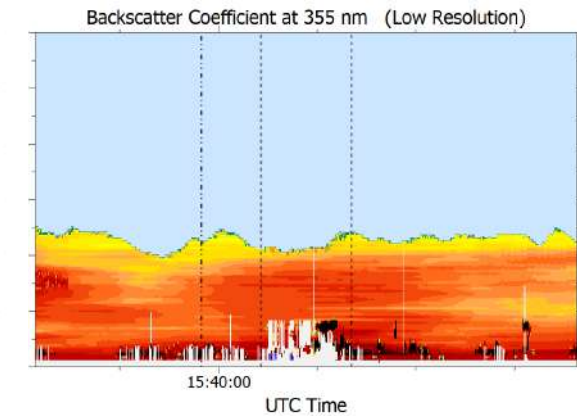
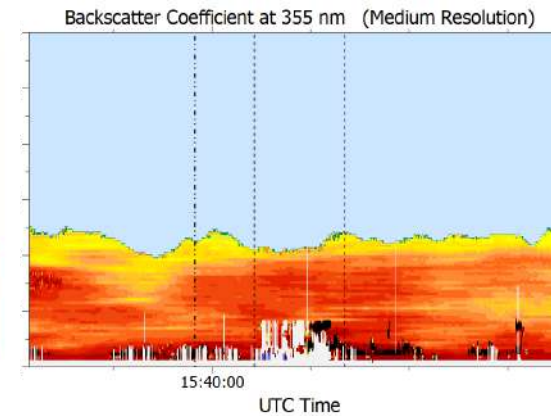
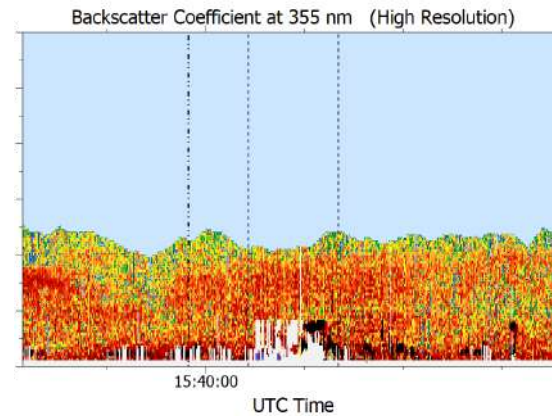
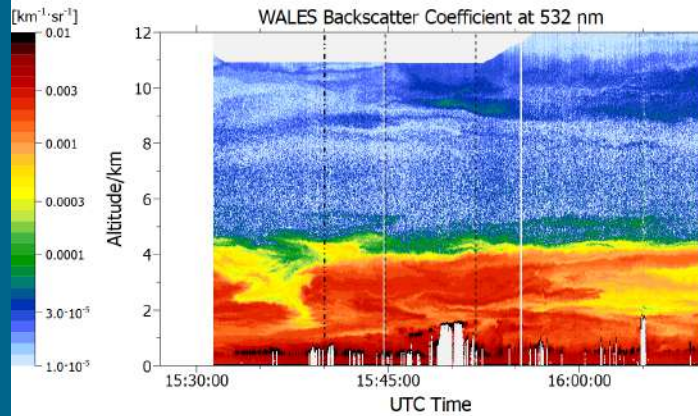
ATLID L2 EBD data BL: AD OF: 01193E – Backscatter coefficient

WALES

High Resolution

Medium Resolution

Low Resolution



- Good agreement of mean particle backscatter profile
- Upper boundary with artificially looking modulations

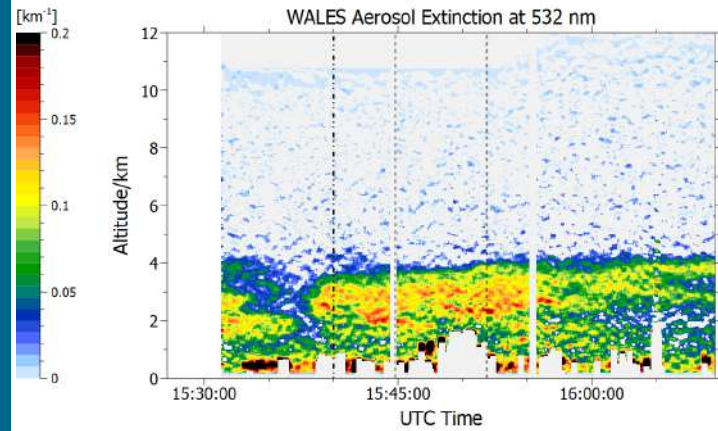


EarthCARE L2 Comparison – 13 Aug. 2024 (Sal; dust/mixture)

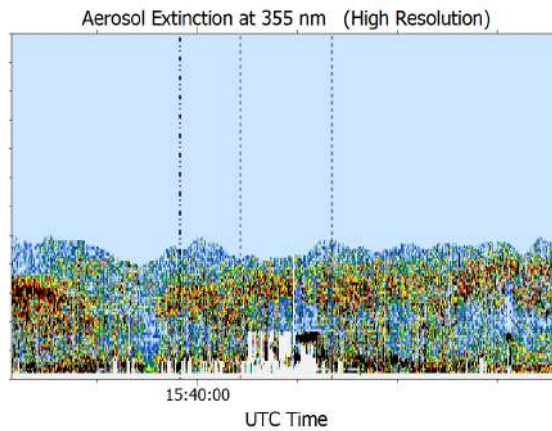


ATLID L2 EBD data BL: AD OF: 01193E – Extinction coefficient

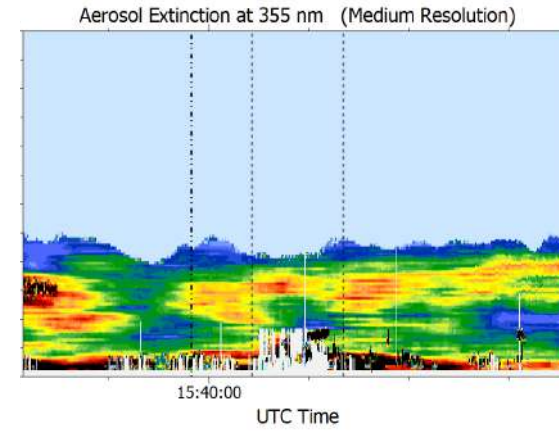
WALES



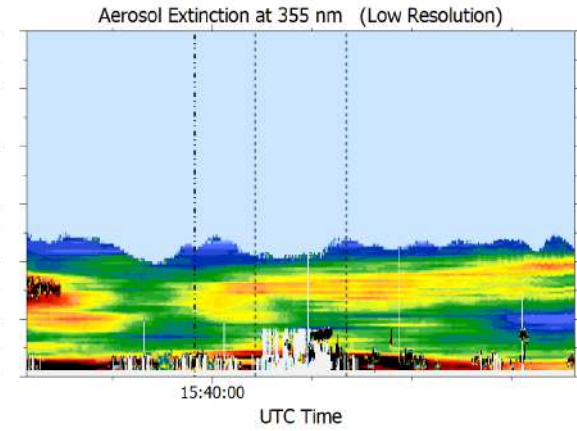
High Resolution



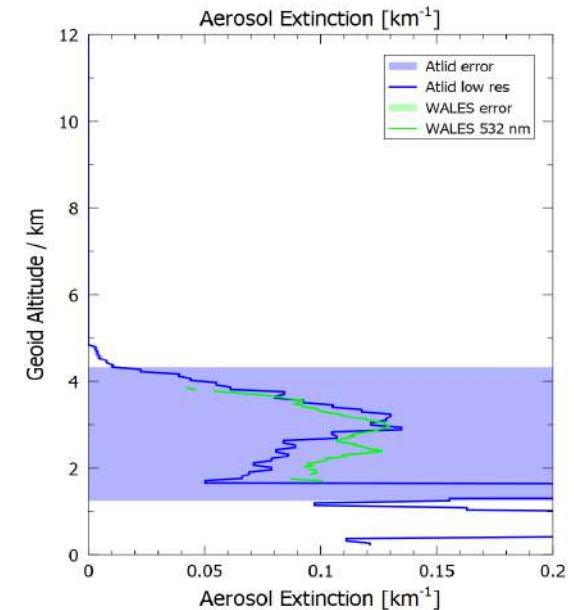
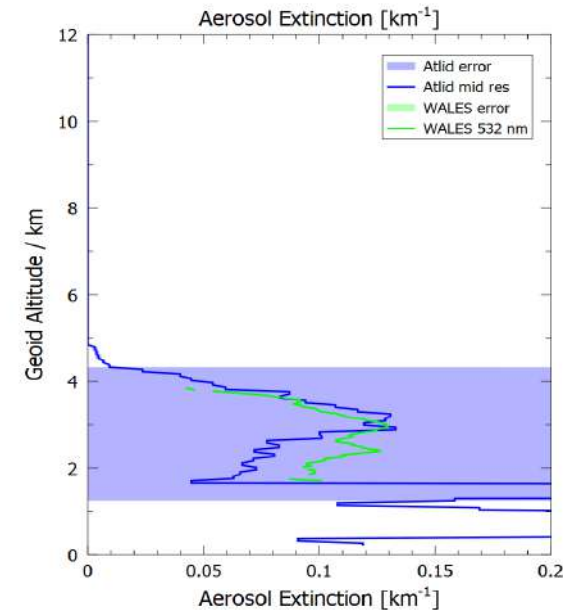
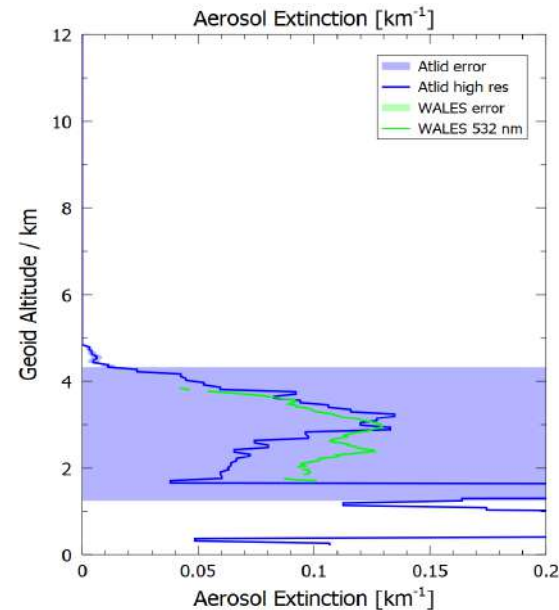
Medium Resolution



Low Resolution



- Higher value (ATLID) of extinction in the upper part
 - Significantly lower in lower part of dust layer
- Not visible in L1 Rayleigh profiles



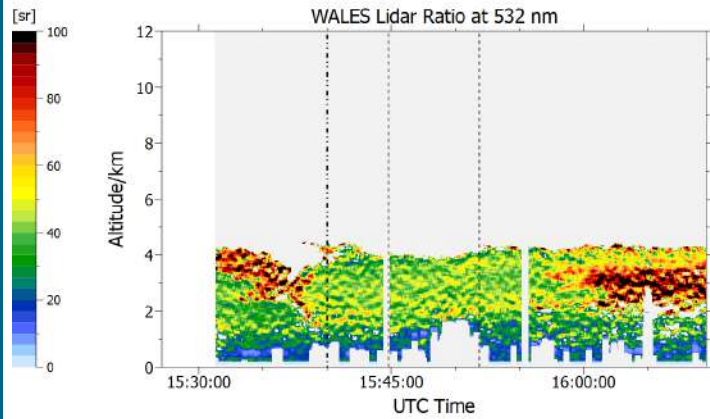


EarthCARE L2 Comparison – 13 Aug. 2024 (Sal; dust/mixture)

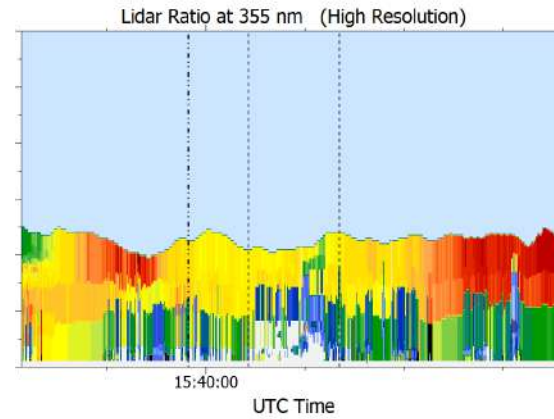


ATLID L2 EBD data BL: AD OF: 01193E – Lidar ratio

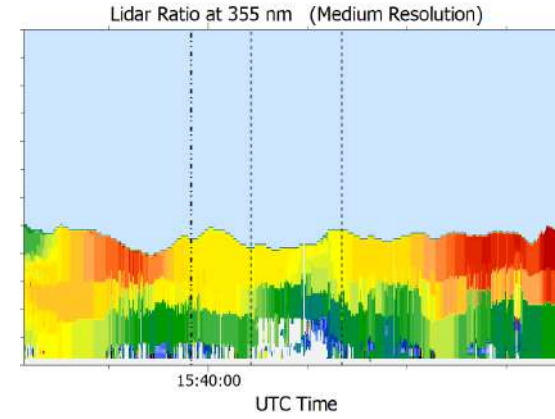
WALES



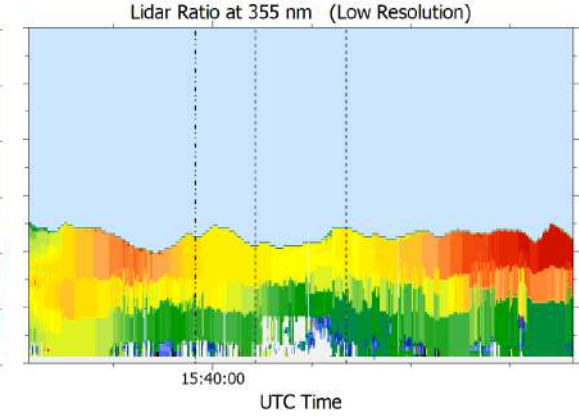
High Resolution



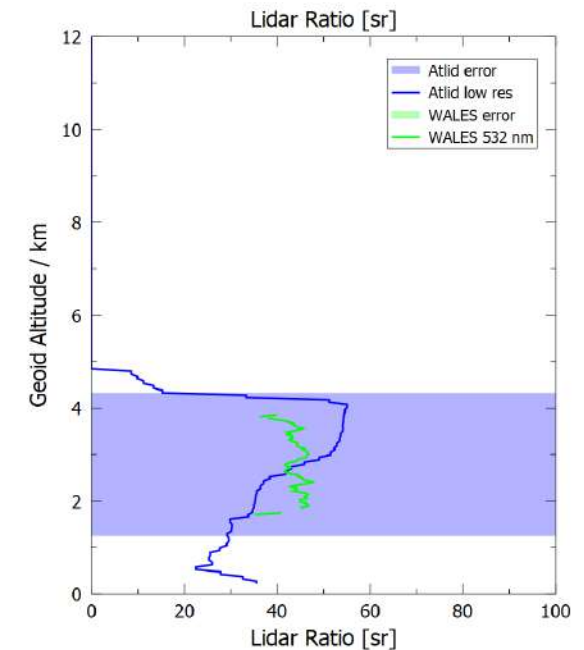
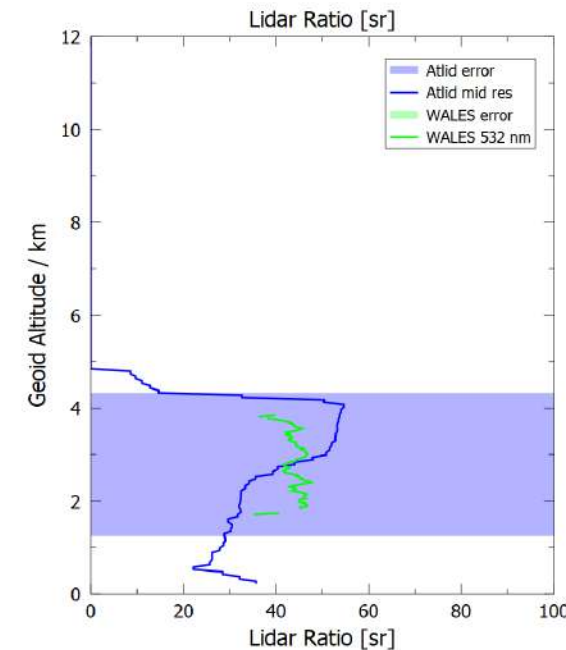
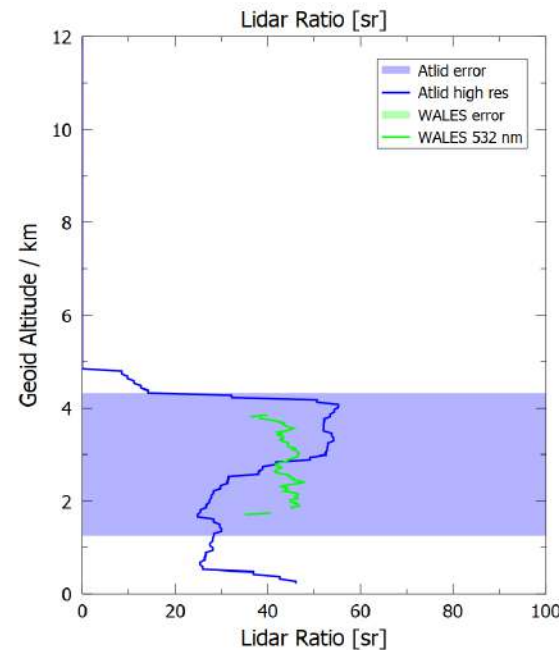
Medium Resolution



Low Resolution



- Lidar ratio fits well in the mean but not in profile
- Layering structure (like for depolarization)





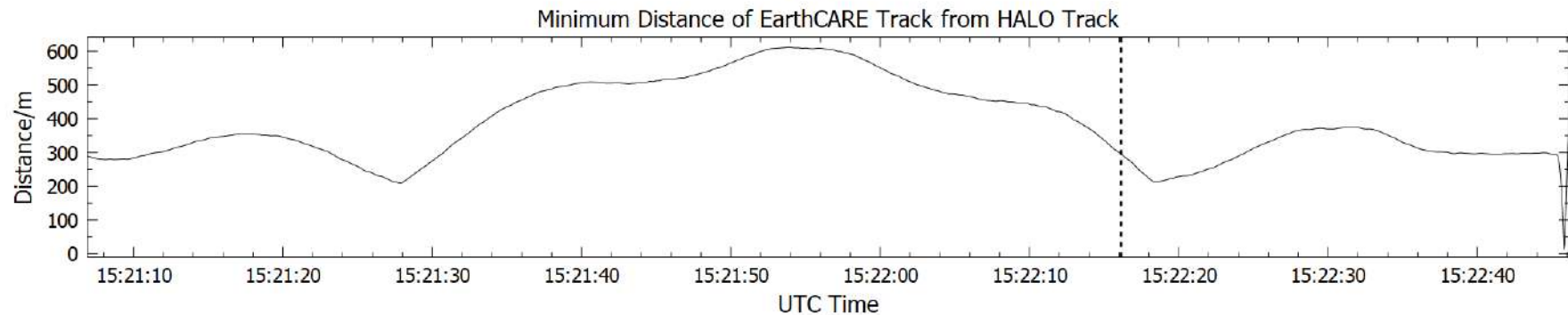
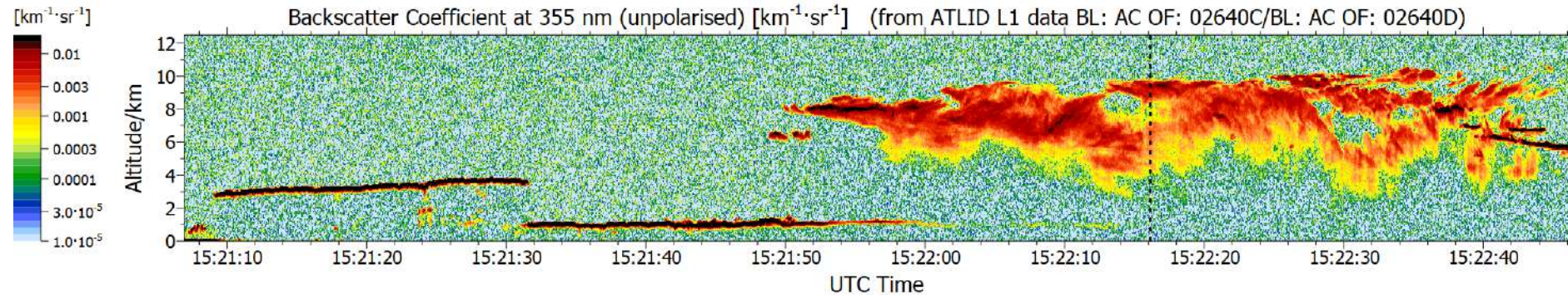
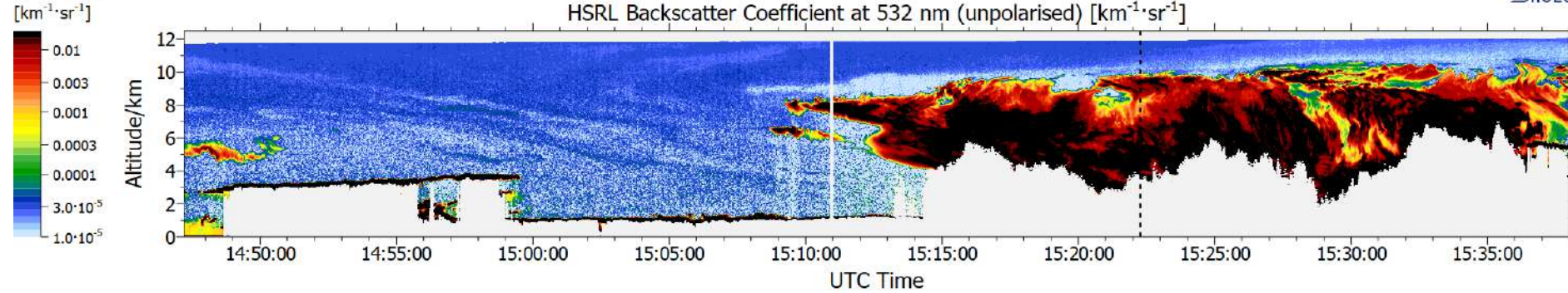
EarthCARE L1 comparison – 14 Nov. 2024 (OP; ice cloud)



PERCUSION 14-11-24

HALO RF30 (EarthCARE Track 76.17°N → 70.37°N)

HSRL Backscatter Coefficient at 532 nm (unpolarised) [$\text{km}^{-1}\cdot\text{sr}^{-1}$]

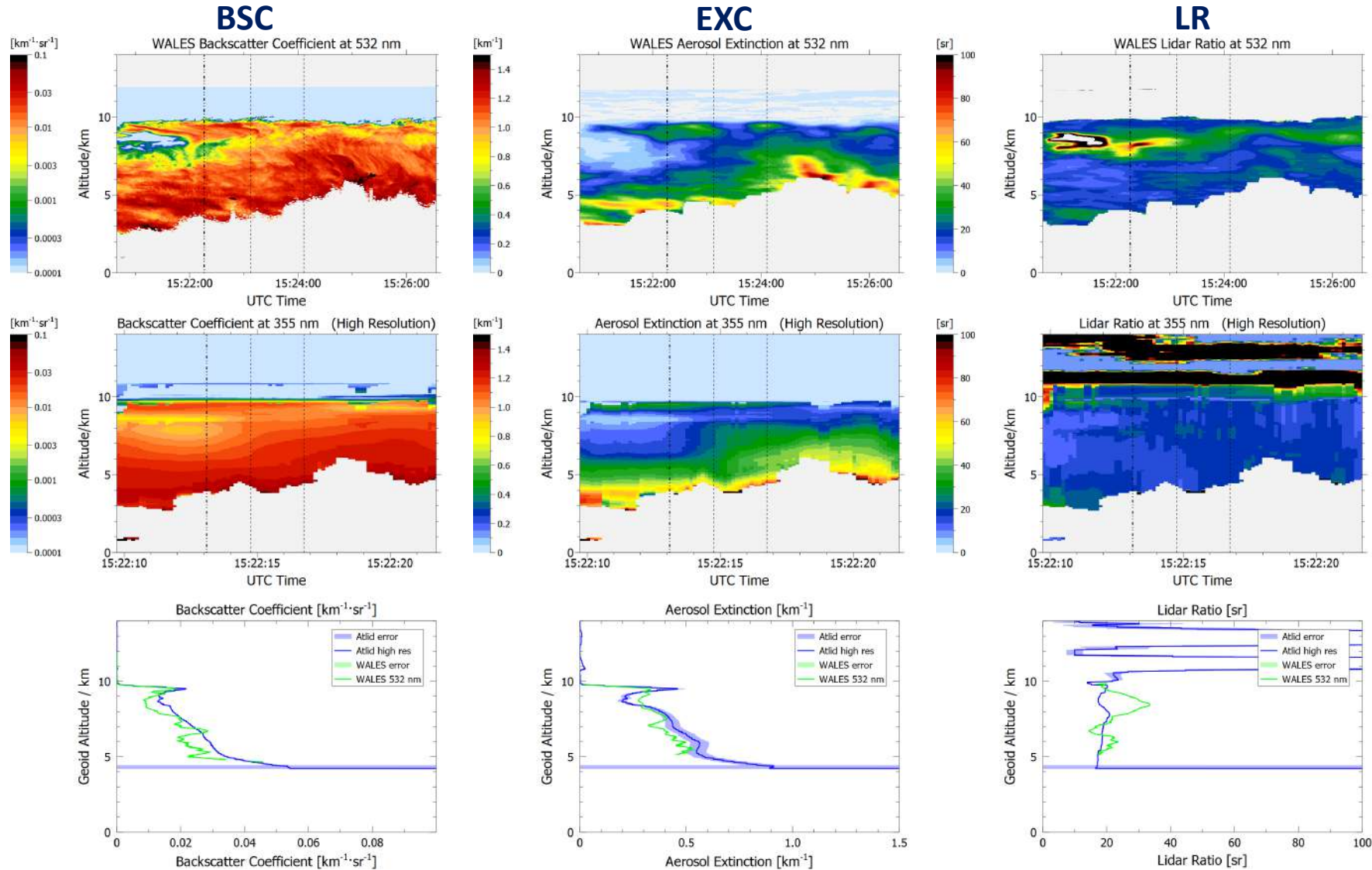




EarthCARE L2 comparison – 14 Nov. 2024 (OP; ice cloud)



ATLID L2 AER data BL: AD OF: 02640D



- Good agreement of BSC and EXC (ATLID higher)
- Good agreement for lidar ratio



EarthCARE L2 comparison – 14 Nov. 2024 (OP; ice cloud)

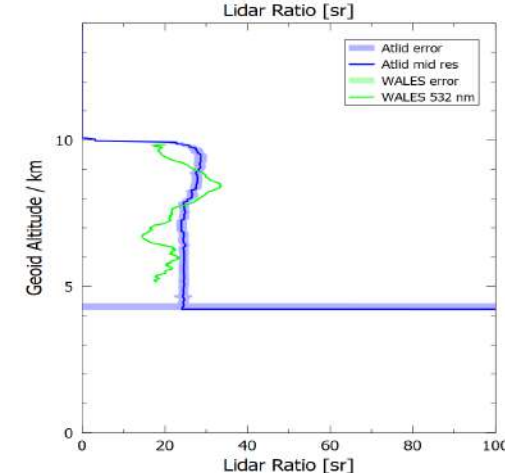
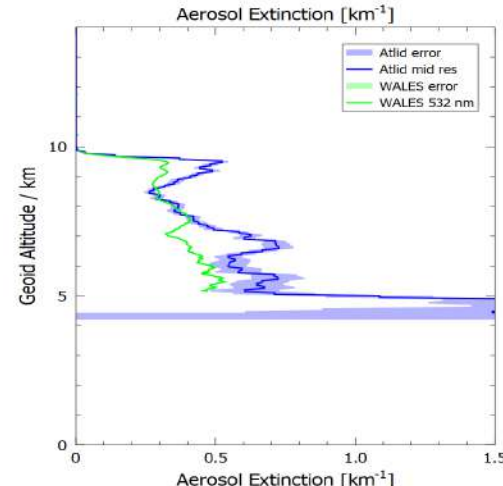
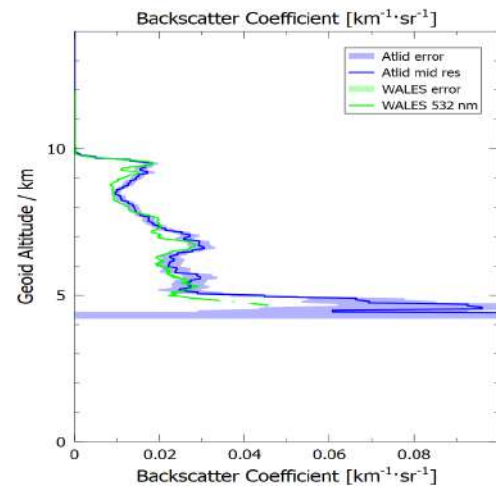
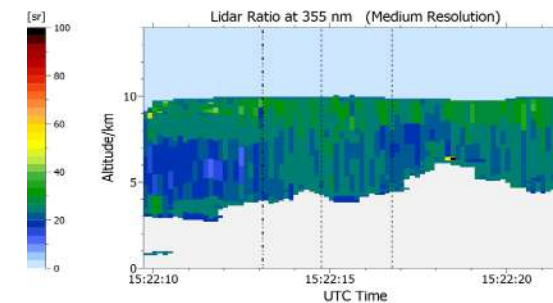
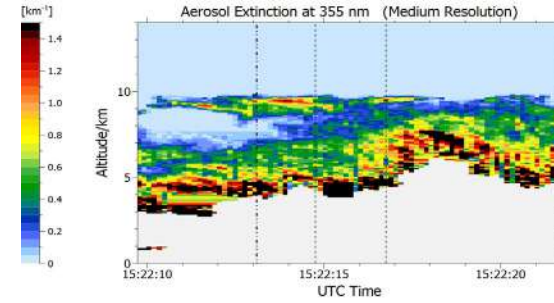
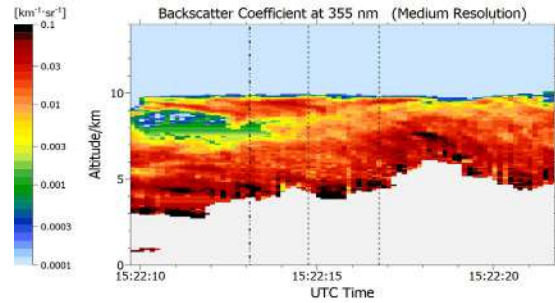
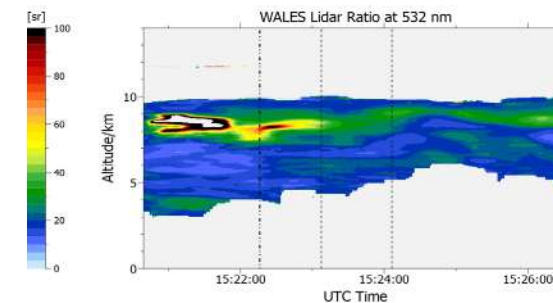
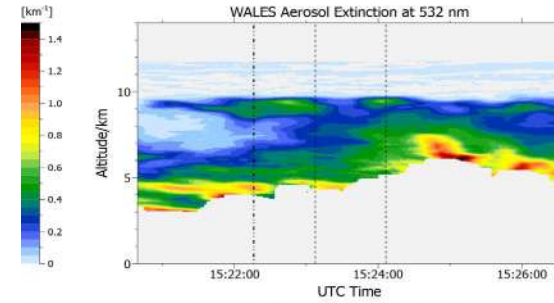
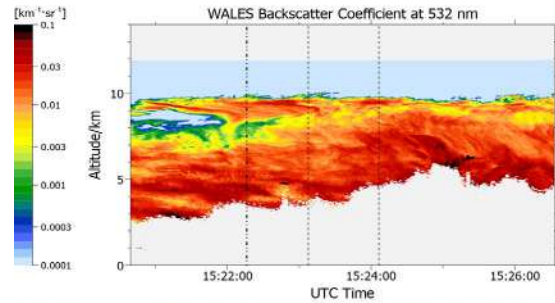


ATLID L2 EBD data BL: AD OF: 02640D

BSC

EXC

LR



- Very good agreement of mean particle backscatter profile
- ATLID extinction higher than WALES (contradiction to L1 data)
- Lidar ratio slightly higher than in AER product



Summary



- Comparison of ATLID-L2 EBD and AER product
- AER:
 - Strong smoothing → Backscatter could not pick up vertical structure and strong boundary in aerosol case
 - Lower extinction (ATLID) in aerosol case (not visible in the L1 Rayleigh profiles) → effect from low clouds?
→ Impact on lidar ratio?
 - Good agreement for cirrus cloud case
- EBD:
 - Good agreement of the backscatter ratio
 - ATLID extinction profiles not following airborne profile → effect from a priori LR?
 - Lidar ratio does not agree in profile for aerosol case
 - Good agreement for cirrus cloud case
- Careful selection which product to use for scientific application.