Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP

Progress Meeting 06
[PM06]

Virtual
23/05/2024
12:30 - 14:00 CET

- *Agenda.*

Agenda:

Title:	Introduction – Welcome.	12:30 – 12:35
Presenter:	Edward Malina (ESA), Vassilis Amiridis (NOA).	

Title:	WP1000 – Management, reporting and promotion.	12:35 – 12:45
Presenter:	Emmanouil Proestakis (NOA).	

Title:	WP2000 – ASKOS ground-based datasets in support of L2A+.	12:45 – 13:00
Presenter:	Holger Baars (TROPOS).	

Title:	WP3000 – Development of the L2A+ aerosol product.	13:00 – 13:20
Presenter:	Konstantinos Rizos (NOA).	

Title:	WP4000 – Assimilation of L2A/L2A+ and application of WRF-L experiments.	13:20 – 13:35
Presenter:	Athanasios Georgiou (NOA).	

Title:	WP5000 – Impact Studies - KO.	13:35 – 13:45
Presenter:	Emmanouil Proestakis (NOA).	

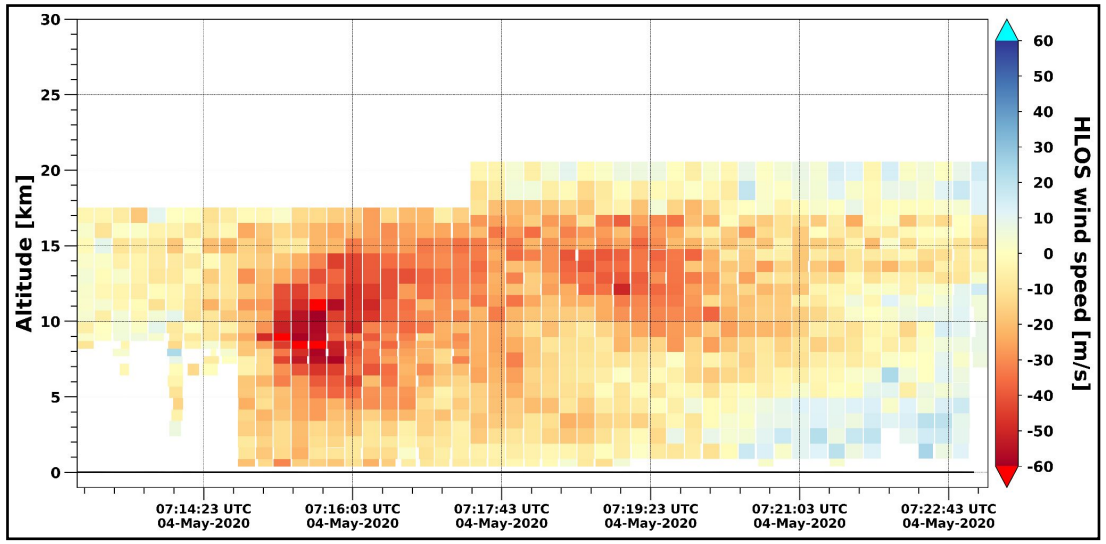
Title:	Summary, discussion and Concluding Remarks.	13:45-end of PM06

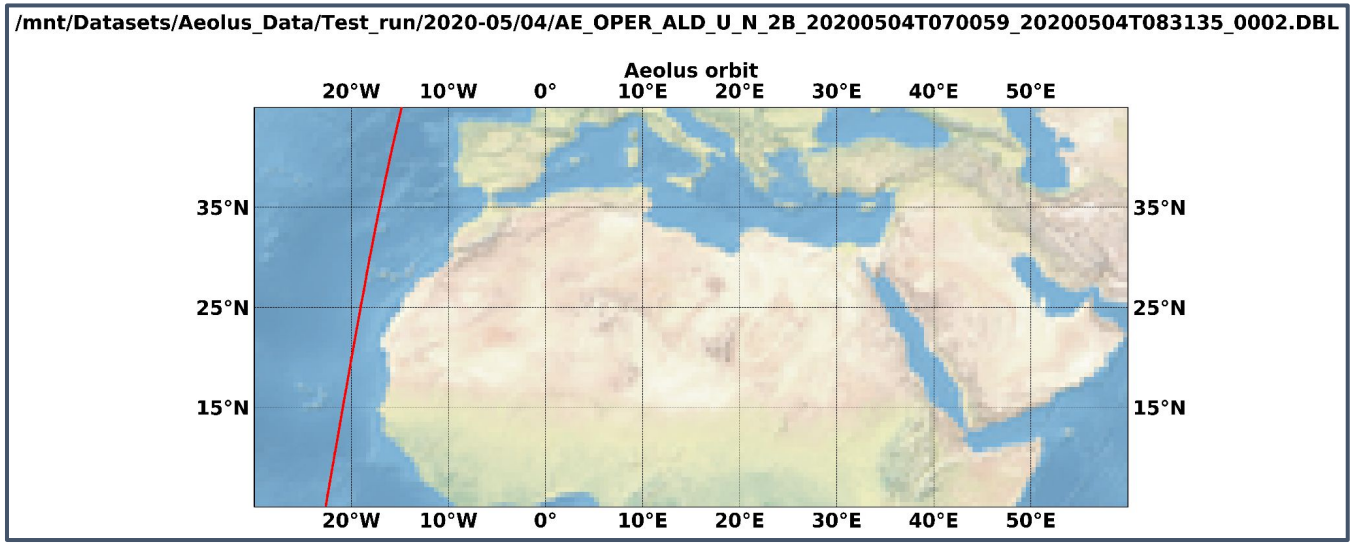
L2A+

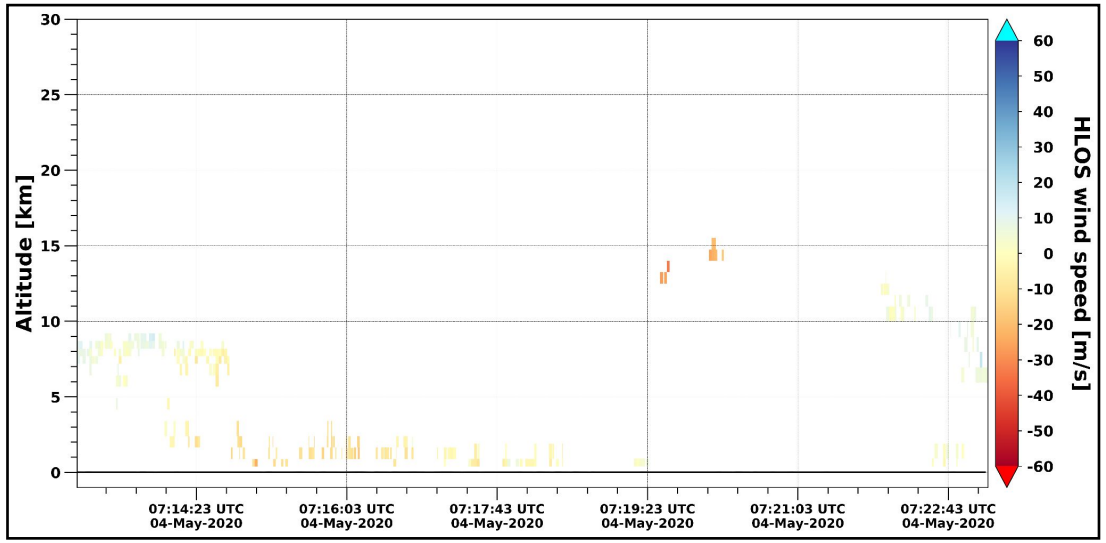
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

- *Background.*

Aeolus, ESA's DWL – ALADIN – space mission provided:
- profiles of the HLOS wind component in the troposphere and the lower stratosphere.
- profiles of optical properties of aerosols and clouds (i.e., extinction/backscatter coefficients, lidar ratio).







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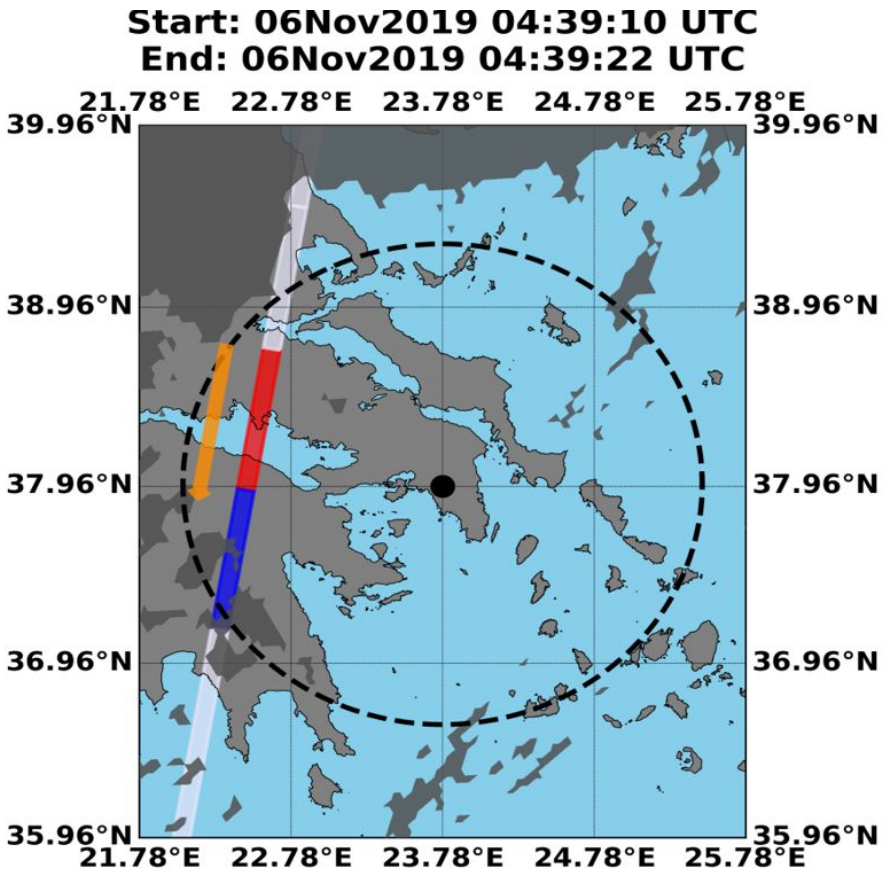
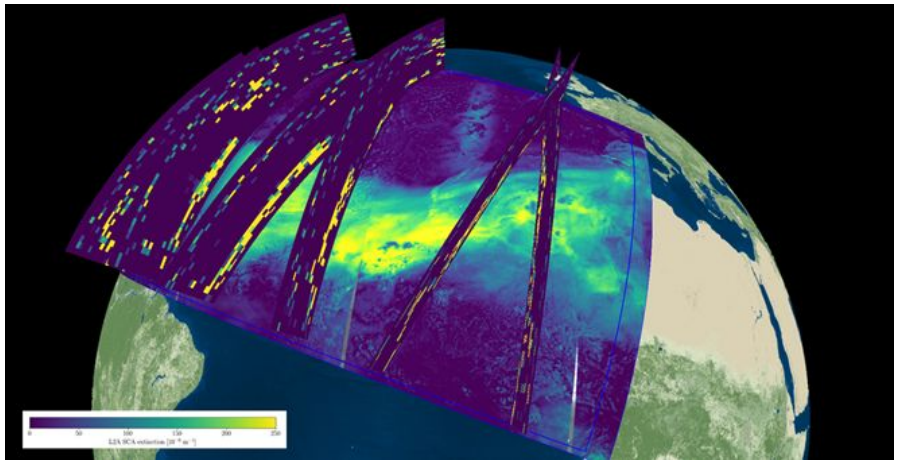
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

- Challenge (1): Cloud Contamination.

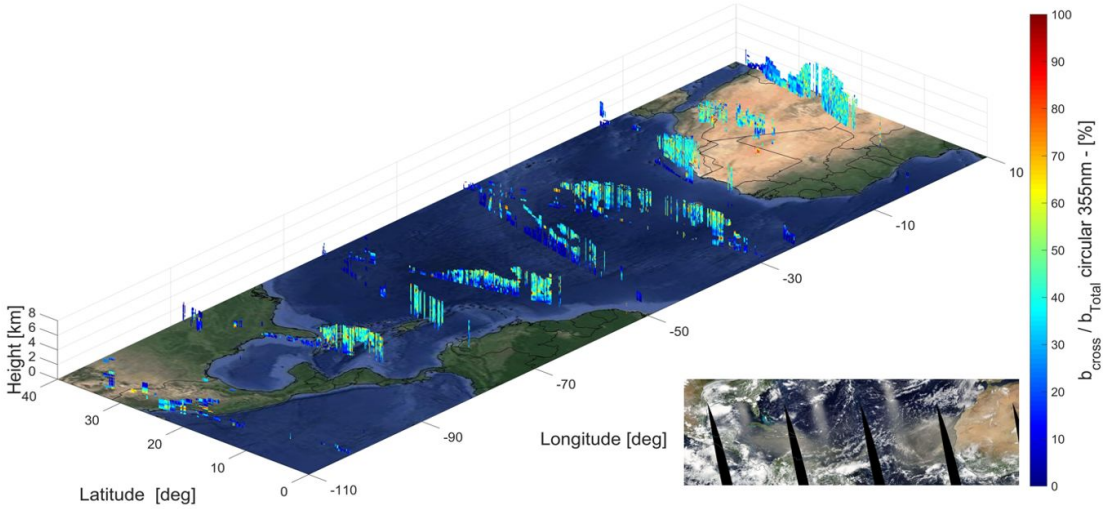


(Gkikas et al., 2022, ACPD)

- Challenge (2): Undetected cross polar backscattered component.



Retrieved from: esa.int



Estimates of Aeolus L2A underestimation due to the missing cross-channel using the Aeolus-like profiles retrieved based on CALIPSO for the transAtlantic Godzilla dust event on the 23rd of June, 2020.

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- Project Objectives.

Objective 1. **Develop a refined Aeolus aerosol optical product** (L2A+) over the **Atlantic,** based on AEL-FM/AEL-PRO algorithms, CAMS, and new AOD retrievals from the Aeolus itself. The product will be thoroughly **compared with L2A** and **validated** against quality-assured measurements from the ASKOS/JATAC experiment in Cape Verde.

Objective 2. Examine the impact of L2A and L2A+ **on aerosol assimilation** and dust transport models.

Objective 3. Assess the **impact of Aeolus on NWP**, utilising L2A+ aerosol assimilation in an online coupled regional model driven by Aeolus wind-assimilated meteorological fields.

Objective 4. Highlight the benefit of the Aeolus joint aerosol and wind assimilation for **simulating dust deposition fields**, and compare with CAMS reanalysis to assess the impact of L2A+ for ocean biogeochemistry studies (working in parallel with the ESA-DOMOS study).

Objective 5. Compare the **monthly averaged L2A+** product with the **CALIPSO L3 product**, to assess the **climatological value of L2A+** for aerosol databases such as the **ESA-LIVAS long-term climate dataset**.

L2A+

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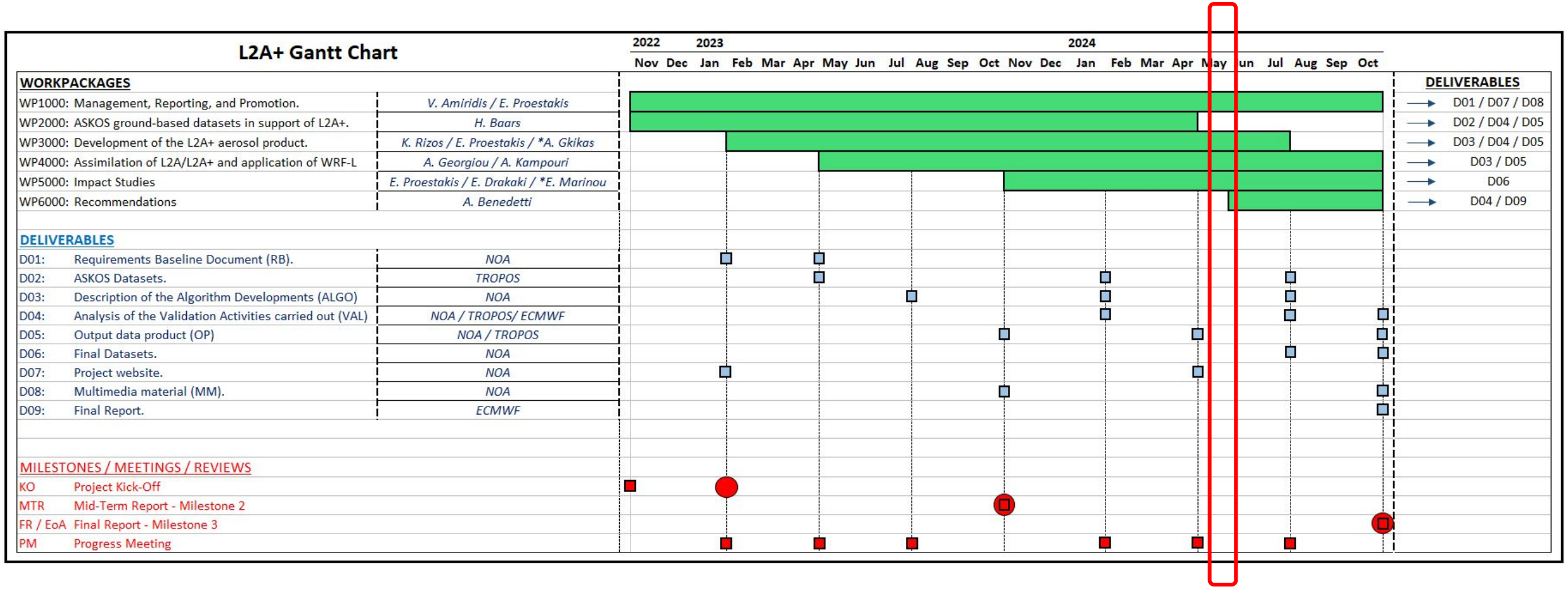
- *L2A+ Gantt Chart.*



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WP1000: *Management, reporting and promotion.*

Objective:	Monitoring of the L2A+ project, ensuring the timely and efficient accomplishment of the planned activities and administrative tasks and promotion of the project to the scientific community. Furthermore, WP1000 aims at consolidating the scientific requirements for L2A+ study.
Inputs:	All documents produced during the project.
Tasks:	Overall management and coordination of the project, in accordance with the terms of the signed contract.
Output:	• Building in and updating the project website. • Presenting the L2A+ results at scientific conferences and other international forums. • Publishing the work undertaken in peer-reviewed journals and conference proceedings. • DI01: Requirements Baseline Document (RB) • DI07: Project website including the compliance to the ESA Open Science catalogue server. • DI08: Multimedia material (MM) (Publications in peer-reviewed journals and conference proceedings, representation of the research at scientific conferences and other international forums through scientific presentations and exhibitions).

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- *Deliverable Items in the PM05/06 period*

L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP

-

"ASKOS ground-based datasets in support of L2A+"
Deliverable Item 02
[DI02]
(Version 4.1)

Submitted to: Edward Malina (ESA)

	Name	Function	Date
Prepared by:	A. A. Floutsi	WP2000 – TROPOS	04/2024
	H. Baars	WP2000 – Co-I – TROPOS	04/2024
	E. Proestakis	WP1000 - NOA	04/2024
Approved by:	V. Amiridis	PI	04/2024

-

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Institute for Astronomy, Astrophysics, Space Applications & Remote Sensing (IAASARS)
Vas. Pavlou & I. Metaxa, 15236 Penteli, Greece
&
Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, Germany
&
European Centre for Medium-Range Weather Forecasts
[ECMWF]
Reading, United Kingdom

L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP

-

Output Data Product
(OP)

Deliverable Item 05
[DI05]
(Version 2.0)

Submitted to: Edward Malina (ESA)

	Name	Function	Date
Prepared by:	E. Proestakis	WP1000 – NOA	04/2024
	K. Rizos	WP3000 – NOA	04/2024
	A. Gkikas	WP3000 – NOA	04/2024
	A. A. Floutsi	WP2000 – TROPOS	04/2024
	H. Baars	WP2000 – TROPOS – CoPI	04/2024
Approved by:	V. Amiridis	PI	04/2024

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Reading, United Kingdom

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP

L2A+

-

Progress Report 09 – PR09
[03/2024-04/2024]
-
(Version 1.0)

Submitted to: Edward Malina (ESA)

	Name	Function	Date
Prepared by:	E. Proestakis	WP1000 – NOA	05/2024
	H. Baars	WP2000 – CoPI – TROPOS	05/2024
	A. Floutsi	WP2000 – TROPOS	05/2024
	A. Gkikas	WP3000 – NOA	05/2024
	K. Rizos	WP3000 – NOA	05/2024
	A. Georgiou	WP4000 – NOA	05/2024
	A. Kampouri	WP4000/5000 – NOA	05/2024
	E. Drakaki	WP4000/5000 – NOA	05/2024
Approved by:	V. Amiridis	PI	05/2024

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Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

- *Deliverable Items in the PM05/06 period*

L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP

"ASKOS ground-based datasets in support of L2A+"
Deliverable Item 02
[DI02]
(Version 4.1)

Submitted to: Edward Malina (ESA)

	Name	Function	Date
Prepared by:	A. A. Floutsi	WP2000 – TROPOS	04/2024
	H. Baars	WP2000 – Co-I – TROPOS	04/2024
	E. Proestakis	WP1000 - NOA	04/2024
Approved by:	V. Amiridis	PI	04/2024

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Reading, United Kingdom

L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP

Output Data Product
(OP)

Deliverable Item 05
[DI05]
(Version 2.0)

Submitted to: Edward Malina (ESA)

	Name	Function	Date
Prepared by:	E. Proestakis	WP1000 – NOA	04/2024
	K. Rizos	WP3000 – NOA	04/2024
	A. Gkikas	WP3000 – NOA	04/2024
	A. A. Floutsi	WP2000 – TROPOS	04/2024
	H. Baars	WP2000 – TROPOS – CoPI	04/2024
Approved by:	V. Amiridis	PI	04/2024

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Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP

L2A+

Progress Report 09 – PR09
[03/2024-04/2024]
(Version 1.0)

Submitted to: Edward Malina (ESA)

	Name	Function	Date
Prepared by:	E. Proestakis	WP1000 – NOA	05/2024
	H. Baars	WP2000 – CoPI – TROPOS	05/2024
	A. Floutsi	WP2000 – TROPOS	05/2024
	A. Gkikas	WP3000 – NOA	05/2024
	K. Rizos	WP3000 – NOA	05/2024
	A. Georgiou	WP4000 – NOA	05/2024
	A. Kampouri	WP4000/5000 – NOA	05/2024
	E. Drakaki	WP4000/5000 – NOA	05/2024
Approved by:	V. Amiridis	PI	05/2024

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DI07: https://l2a.space.noa.gr/

L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

aeolus ECMWF TROPOS

WP2000: *ASKOS ground-based datasets in support of L2A+.*

Objective:	Provide ASKOS ground-based datasets for L2A+ product validation and model evaluation studies
Inputs:	Data acquired during ASKOS as part of the Joint Tropical Atlantic campaign (JATAC). All data has already been collected, but the analysis and exploitation has not yet been intensified or completed.
Tasks:	• Creation of a unique feature mask (Combined Cloudnet + EARLINET lidar target categorisation) • Application of the well-established Poliphon method to estimate the vertical resolved dust fraction • Application of an EarthCARE-like (HETEAC-Flex) typing scheme on the data from ground-based lidar in Mindelo to retrieve the volume concentration of mineral dust • Extraction of Aeolus-like profiles taken by the Aeolus reference instrument eVe •Use of the vertical wind information obtained with Doppler lidar and radar to estimate dust flux
Output:	•D2: Data set of feature mask over Mindelo for September 2021 including aerosol optical properties; Documentation on time series of profiles of wind speed over Mindelo and radiosonde profiles obtained at Sal. • D4: Analysis of Aeolus-like optical properties for Aeolus overpasses for validating/evaluating the new retrievals • D5: Final data set on the height-resolved dust-only profiles above Mindelo, Cabo Verde

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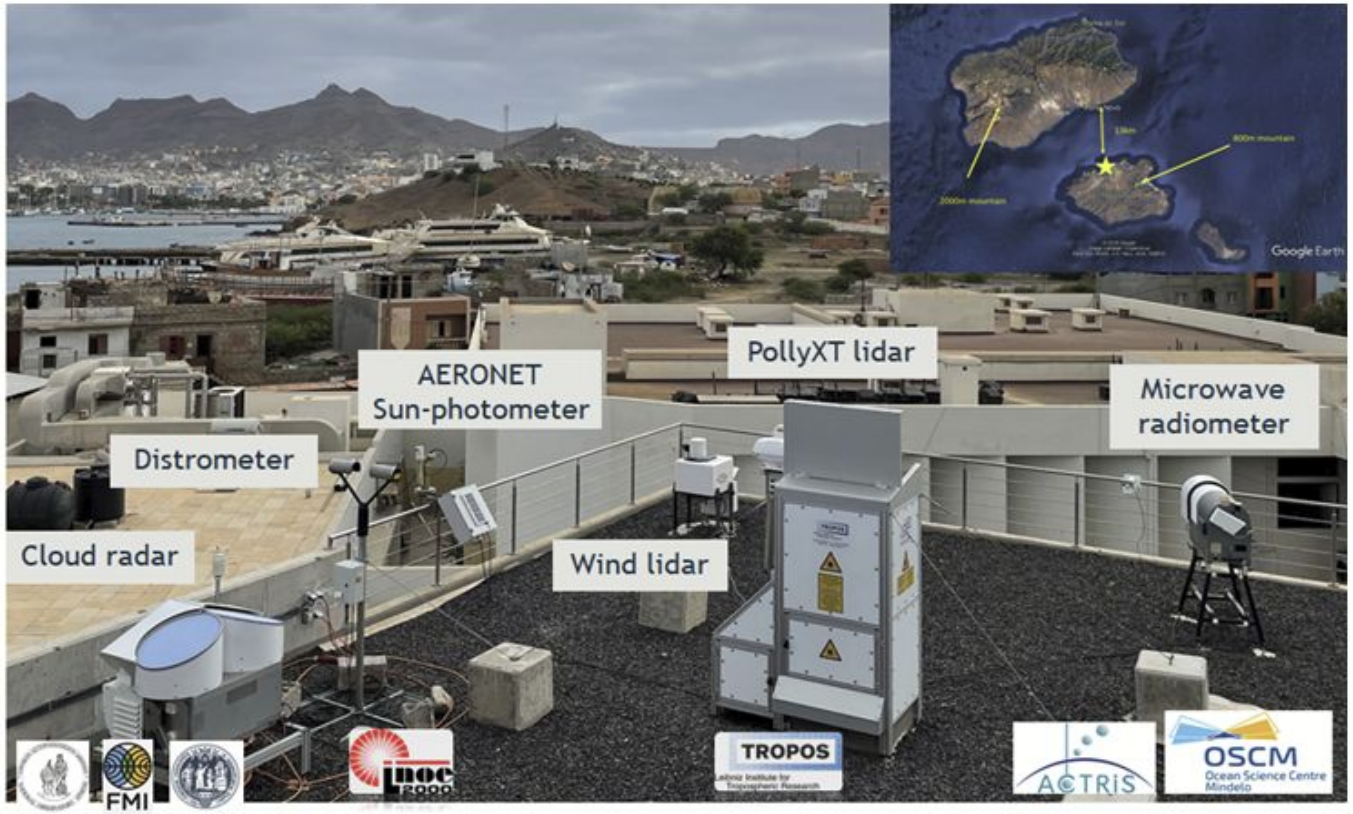
WP2000: *ASKOS ground-based datasets in support of L2A+.*

Instrumentation: Patchwork ACTRIS Aerosol & Cloud remote sensing facility



Ground-based instrumentation in September 2021

TROPOS:
- AERONET station (Cimel sun-photomoter)
- PollyXT lidar
- Wind lidar (Halo)
- Microwave radiometer (RPG)

ESA/INOE:
- 94Ghz Cloud radar (RPG)
- Disdrometer

NOA:
- EVE reference lidar

Quicklooks:
- polly.tropos.de (PollyXT quicklooks and products)
- All other products: askos.space.noa.gr

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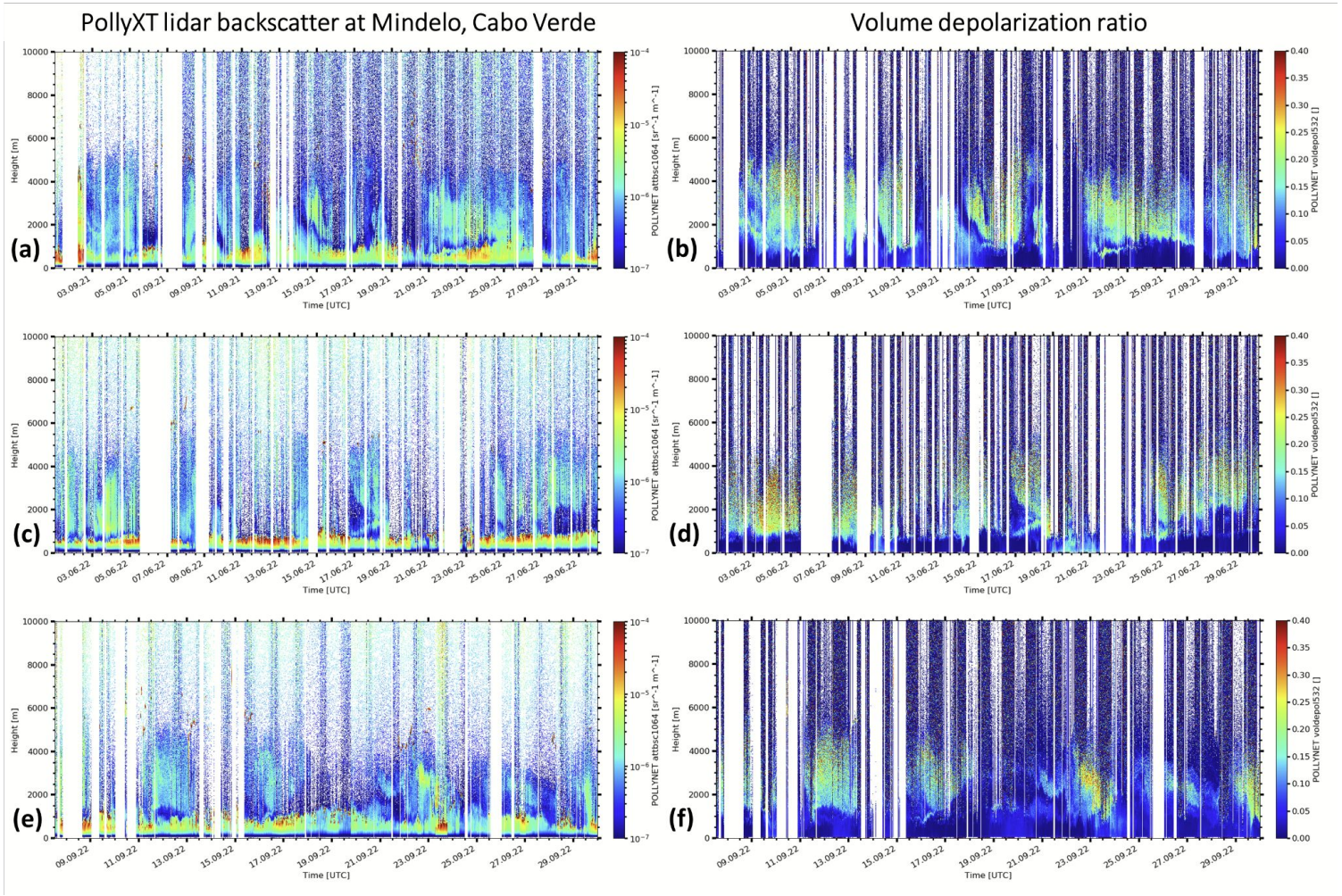
WP2000: *ASKOS ground-based datasets in support of L2A+.*

Aerosol optical properties for September 2021, June 2022 and September 2022

429 profiles

1332 profiles

1010 profiles



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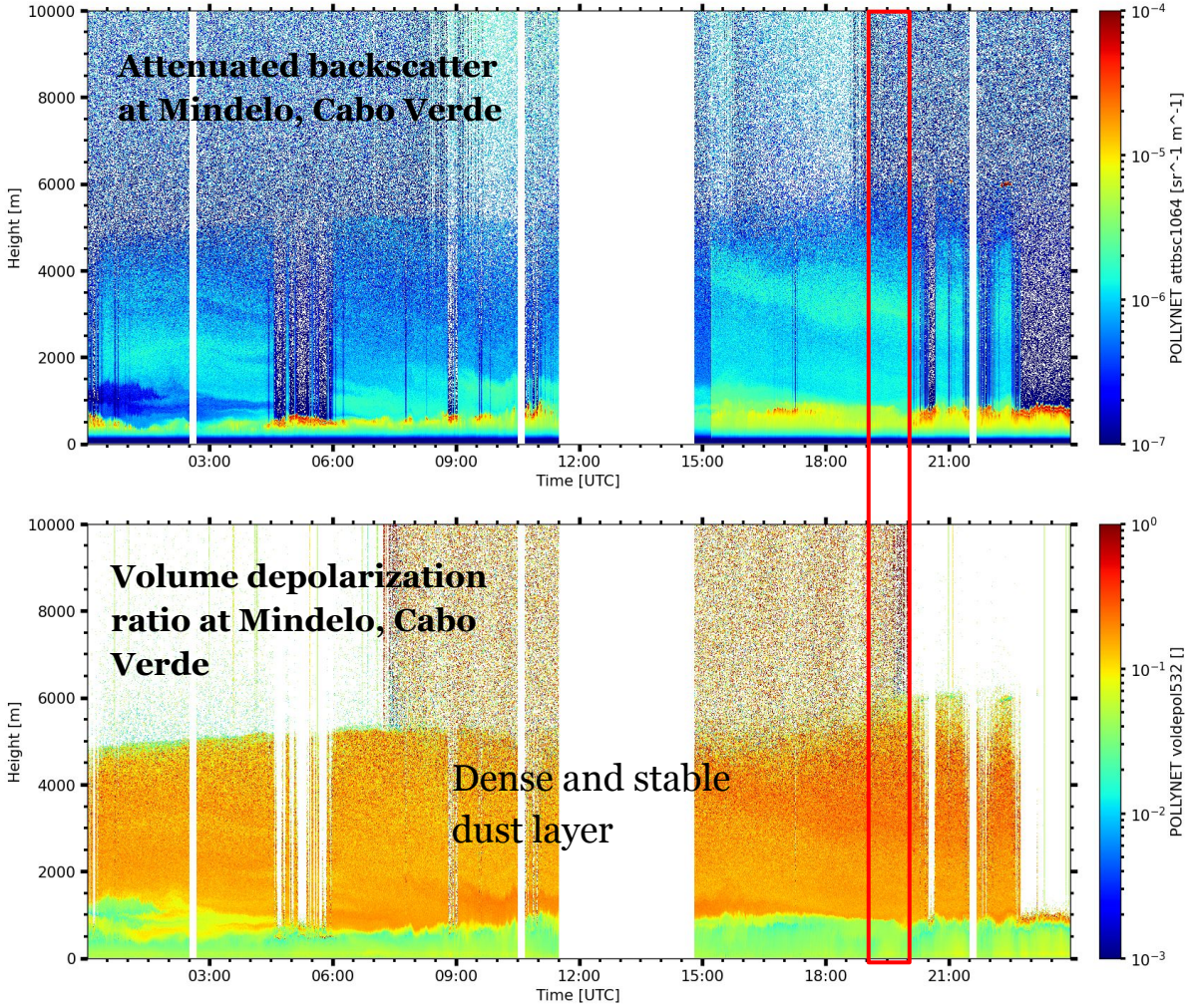
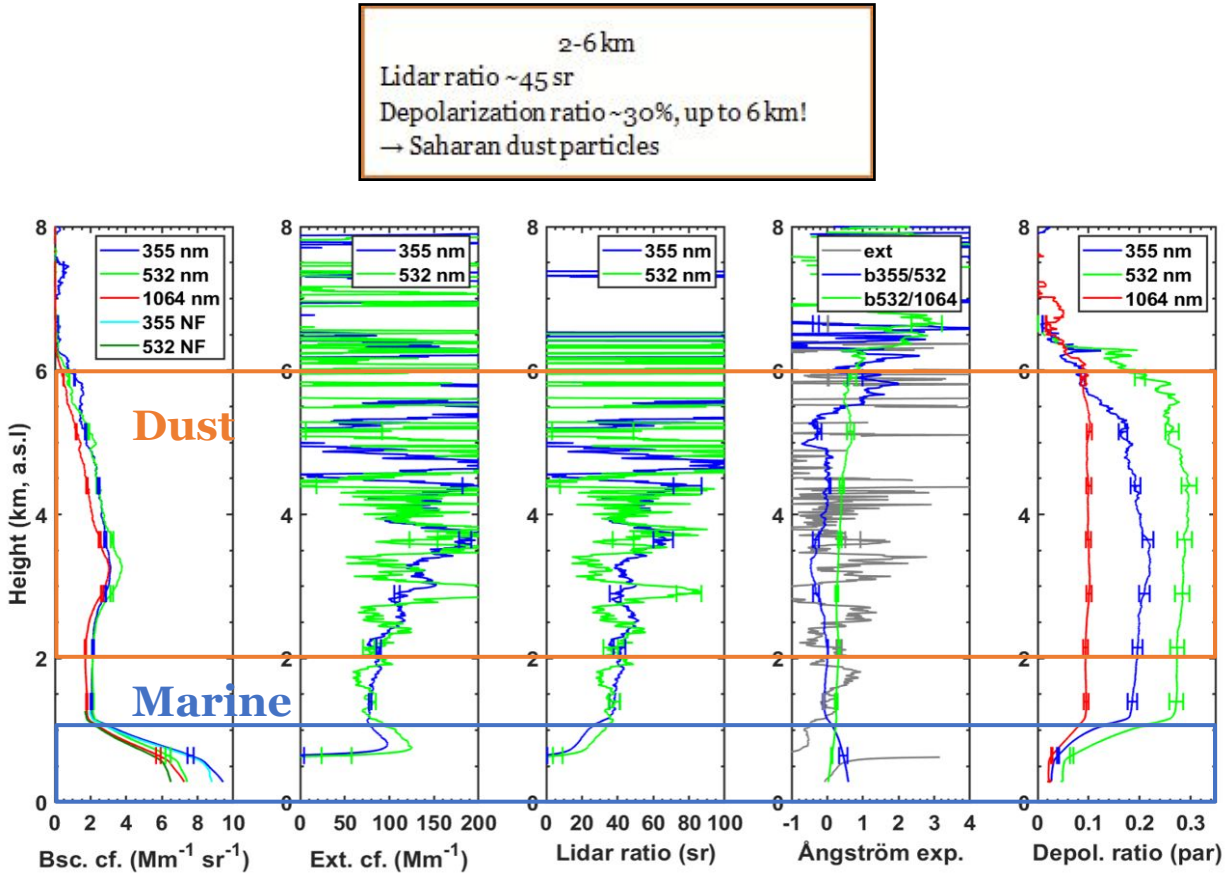
WP2000: *ASKOS ground-based datasets in support of L2A+.*

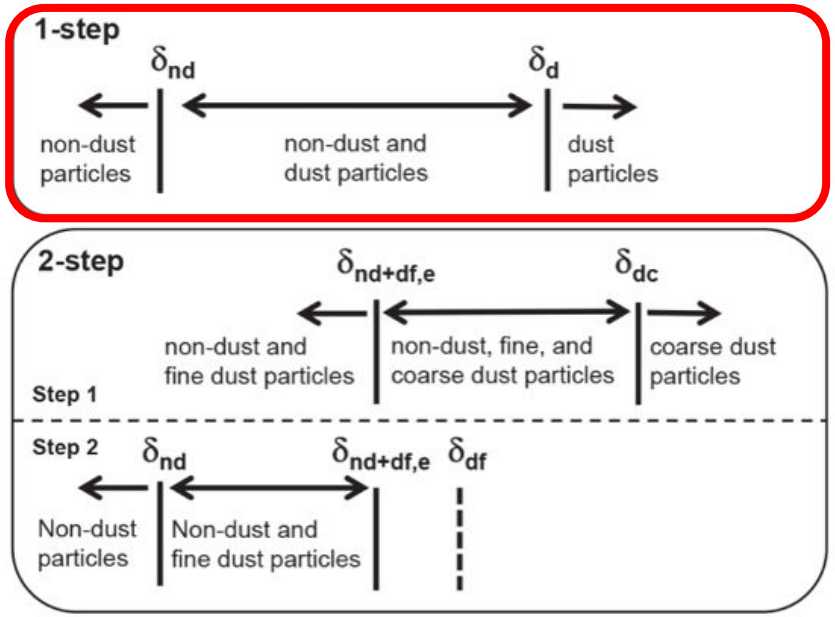
Friday 10 September 2021



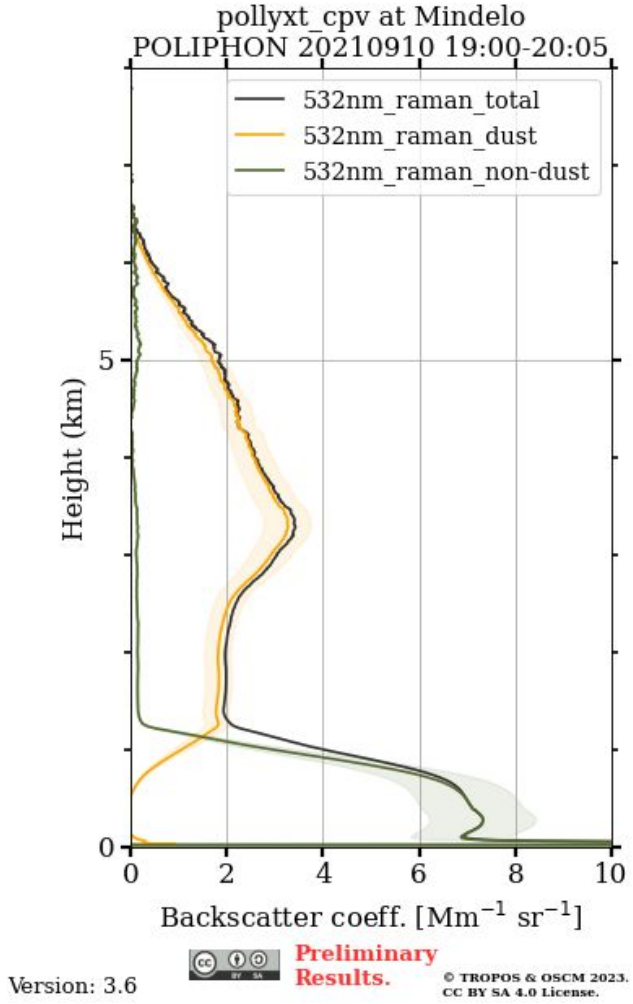


PBL
Medium aerosol load (Extinction < 200 Mm-1)
Lidar ratio ~25 sr, 5% particle depolarization ratio
→ Marine aerosol

POLIPHON: dust-only backscatter coefficient



Mamouri and Ansmann, Atmos. Meas. Tech., 2014



- Coarse dust dominates between 1 and 6 km
- Small contributions from non-dust particles between 1 and 4 km

→ **HETEAC-Flex** can be used to determine the type of non-dust particles

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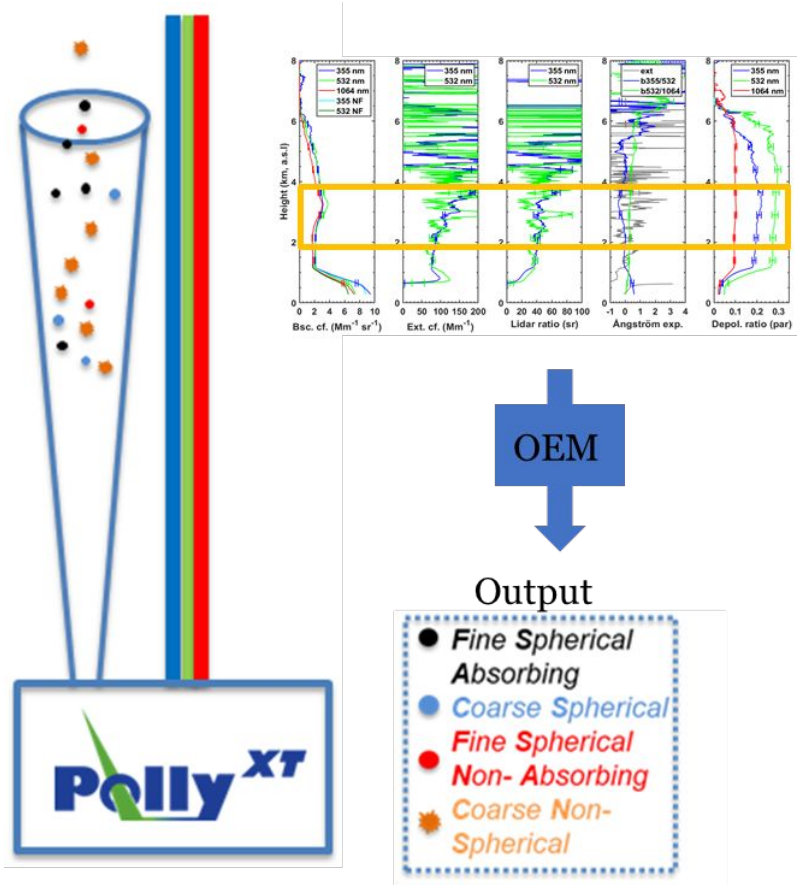
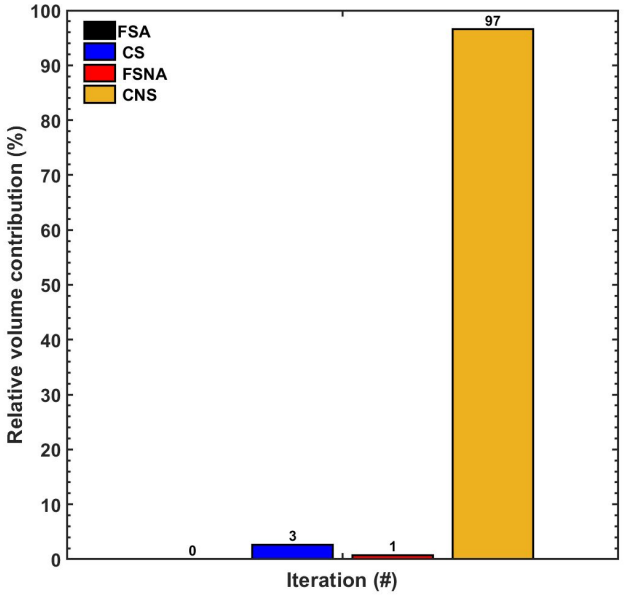
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

WP2000: *ASKOS ground-based datasets in support of L2A+.*

HETEAC-Flex: an EarthCARE-like typing algorithm

Available for Sept. 2021 overpasses





Relative volume

0±14% FSNA
3±16% CS
1±16% FSNA
96±22% CNS

Volume concentration

0±1.9 μm³/cm³ FSNA
3.5±4.1 μm³/cm³ CS
1±2.2 μm³/cm³ FSNA
126±19 μm³/cm³ CNS

$R_{eff} = 1.7 \pm 0.2$ μm

Number concentration

0±390 #/cm³ FSNA
0.3±0.4 #/cm³ CS
194.6±439 #/cm³ FSNA
12.2±1.8 #/cm³ CNS

Floutsi et al., Atmos. Meas. Tech., 2024

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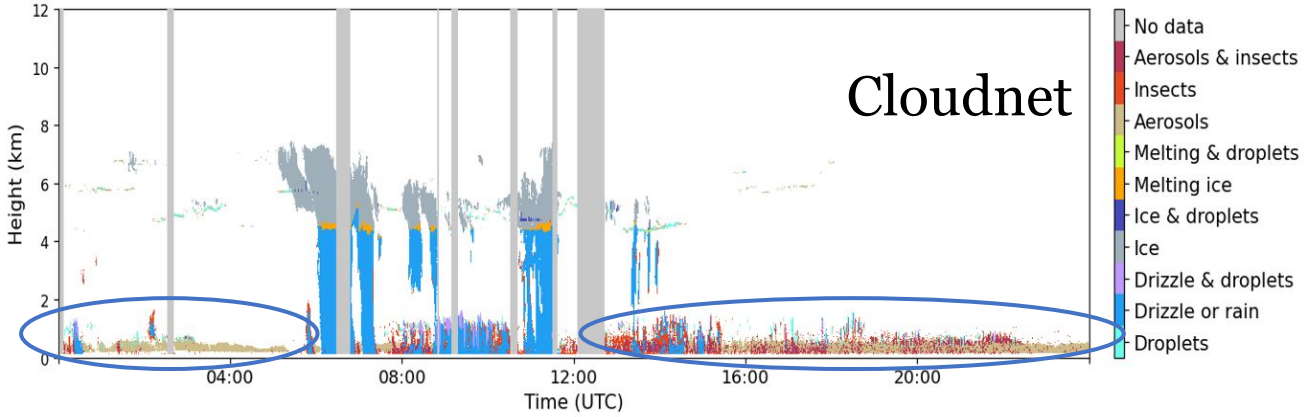
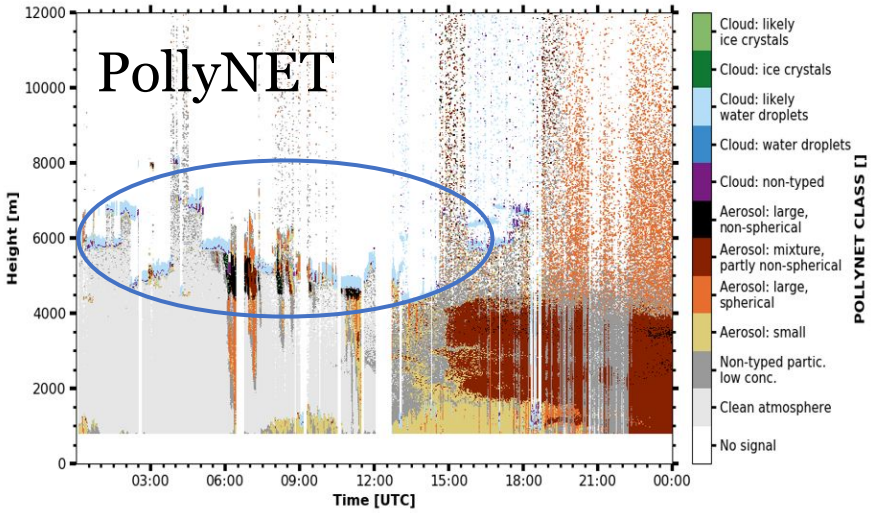
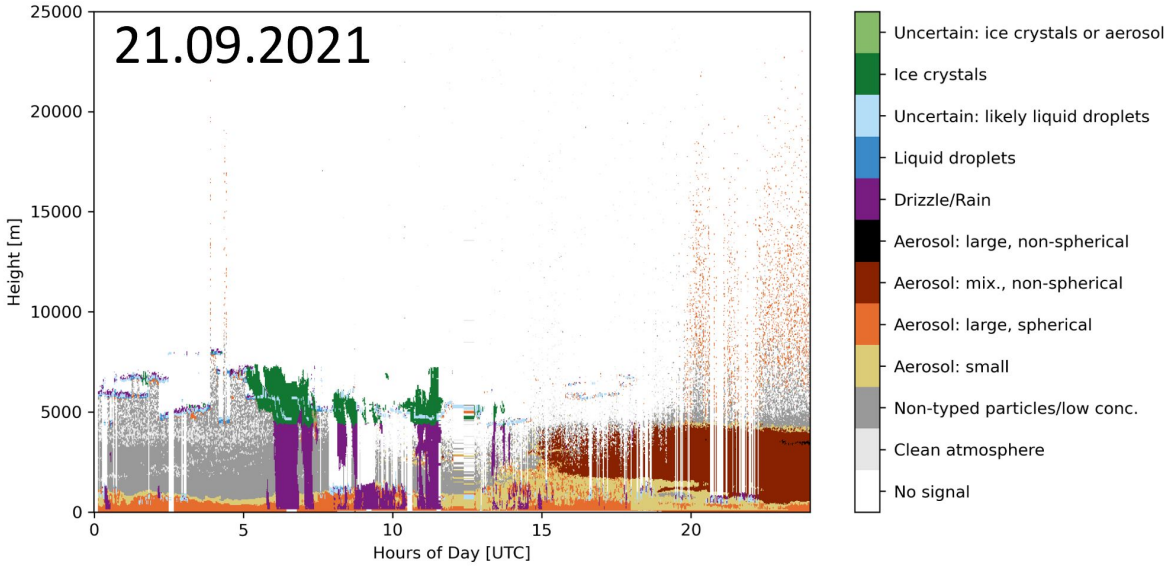
WP2000: *ASKOS ground-based datasets in support of L2A+.*

Height-resolved unique **feature mask** over Mindelo: combination of Cloudnet and PollyNET/EARLINET target classification







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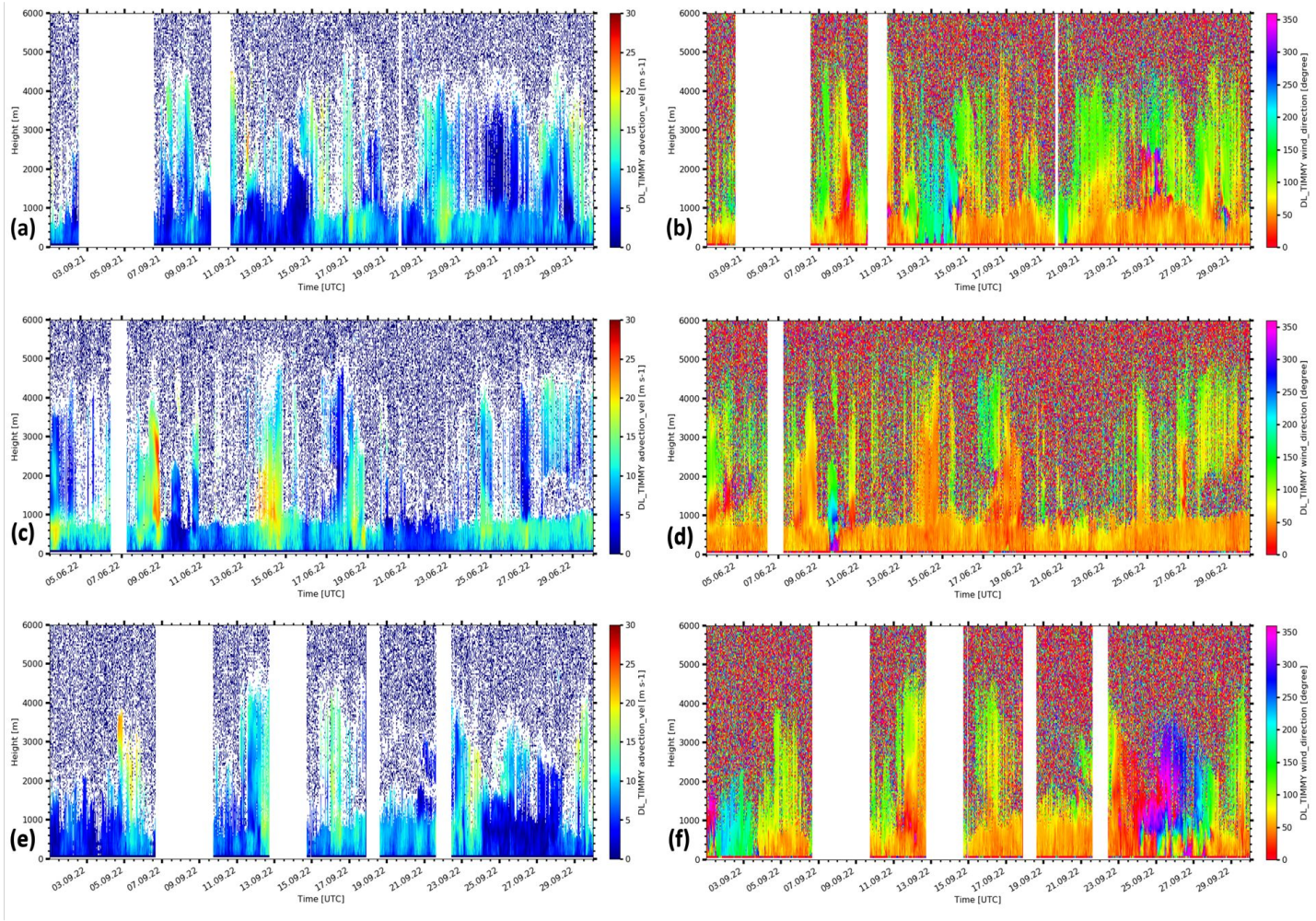
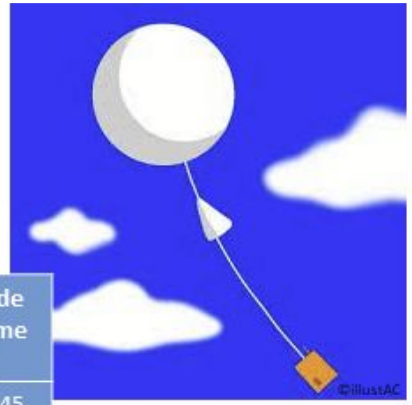
WP2000: *ASKOS ground-based datasets in support of L2A+.*

Wind speed and direction for September 2021, June 2022, September 2022



Radiosondes at SAL



Weekday	Radiosonde release time [UTC]
Monday	06:40, 10:45
Tuesday	06:50, 10:45
Wednesday	07:00, 10:45
Thursday	18:50, 10:45
Friday	19:00, 10:45
Saturday	10:45
Sunday	10:45

Borne et al., 2024

WP2000: *ASKOS ground-based datasets in support of L2A+.*

Summary & Status of WP2000

Status: finalized

- ASKOS Datasets (DI02) delivered:
  - PollyXT-derived aerosol optical properties and target classification (September 2021, June 2022, September 2022)
  - Unique feature mask for Mindelo (September 2021, June 2022, September 2022)
  - Dust-only vertical profiles (1-step POLIPHON) September 2021, June 2022, September 2022)
  - HETEAC-Flex typing results for the four Aeolus overpasses during September 2021 (03, 10, 17, 24), which include the relative volume contributions of four aerosol components, the volume and number concentration (per component) , etc.
  - Radiosonde profiles obtained at Sal
  - eVe lidar Aeolus-like profiles

L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

WP3000: *Development of the L2A+ aerosol product.*

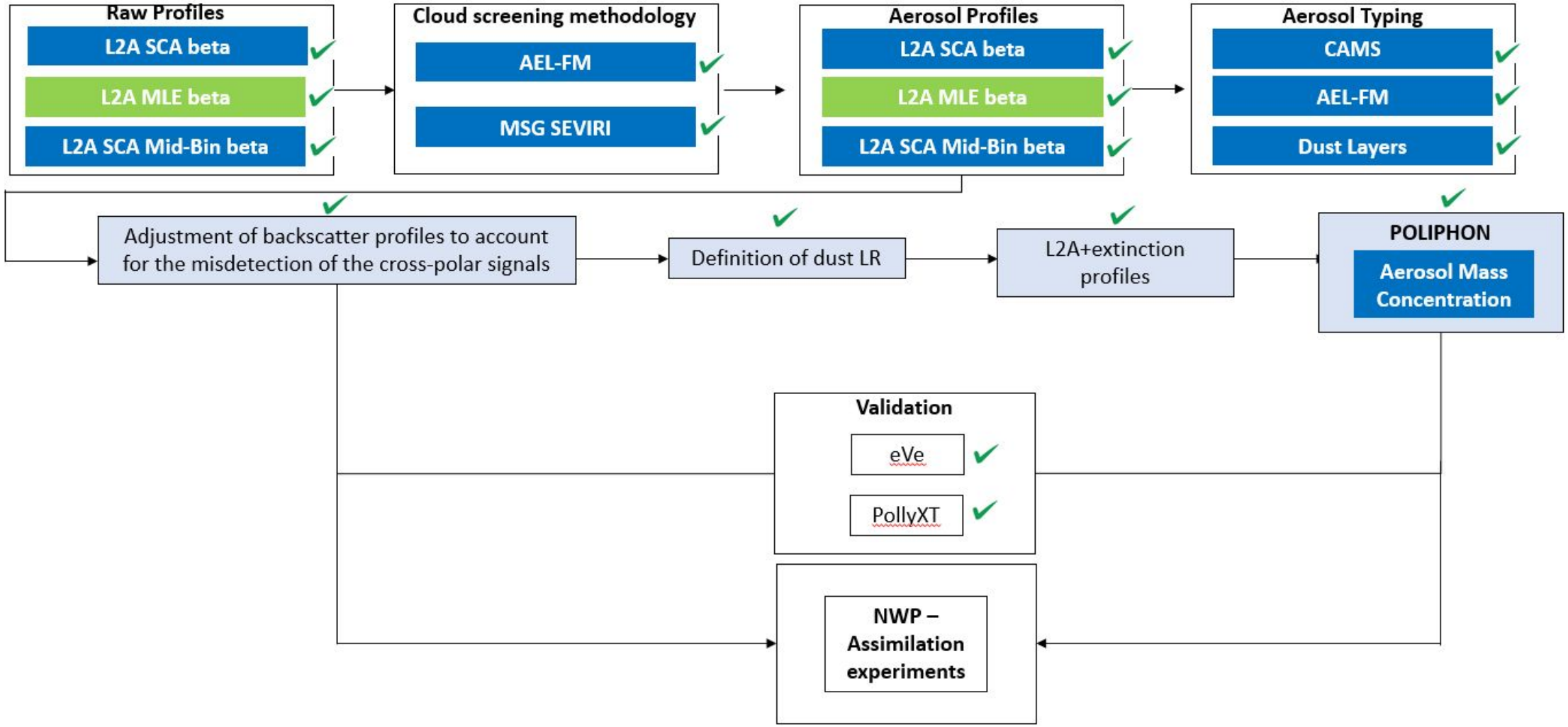
Objective:	**Derivation of the L2A+ extinction and aerosol mass concentration product**
Inputs:	Aeolus L2A profiles, AEL-FM/PRO, SEVIRI CLAAS-3 cloud dataset, CAMS
Tasks:	1. **Implementation of a rigorous screening of cloud contaminated Aeolus profiles** via the synergy of AEL-FM retrievals and MSG geostationary cloud imagery 2. **Exploitation of CAMS vertically resolved aerosol typing** for identifying the vertical extension of dust layers within the RoI 3. **Reconstruction of Aeolus cloud-free dust extinction profiles** by adjusting the absent cross-polar backscatter and defining suitable dust lidar ratio(s) 4. **Assessment analysis of Aeolus L2A+ aerosol profiles**
Output:	• D3: Description of the Algorithm Developments (ALGO) • D4: Analysis of the Validation Activities carried out (VAL) • D5: Output data product (OP)

L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

aeolus ECMWF TROPOS

WP3000: *Development of the L2A+ aerosol product.*



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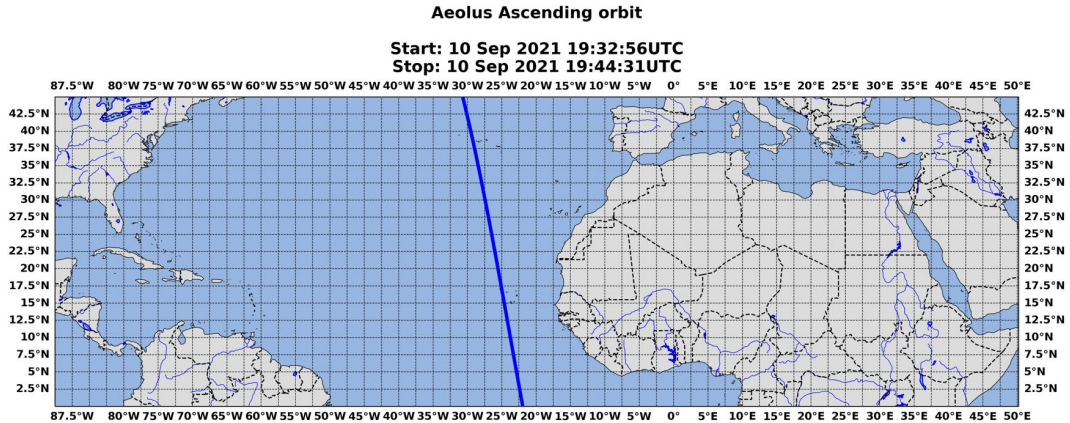
WP3000: *Development of the L2A+ aerosol product.*

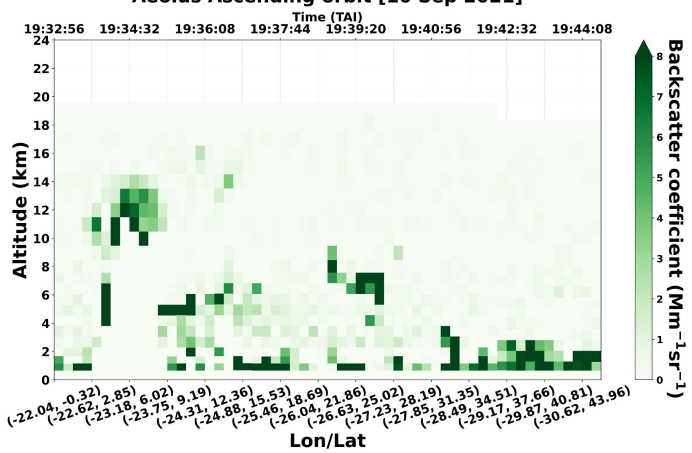
Raw Profiles

- L2A SCA beta ✓
- L2A MLE beta ✓
- L2A SCA Mid-Bin beta ✓

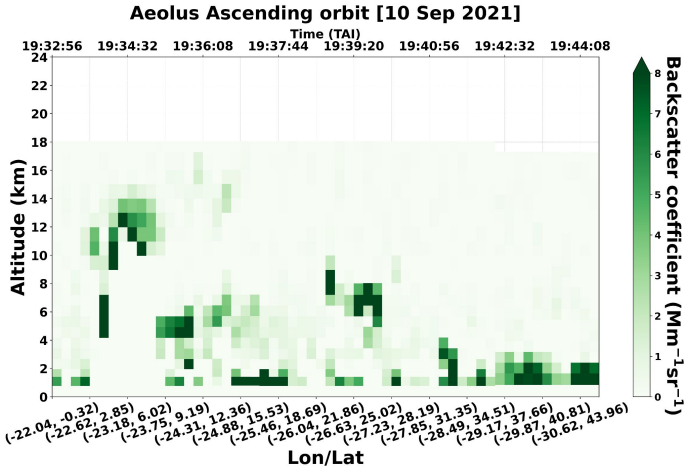
Raw Aeolus L2A retrievals



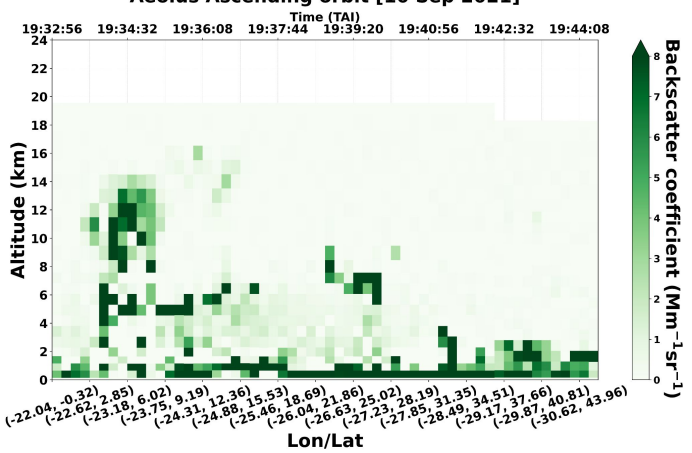
SCA Backscatter - 355nm



SCA mb Backscatter - 355nm



MLE Backscatter - 355nm



L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

WP3000: *Development of the L2A+ aerosol product.*

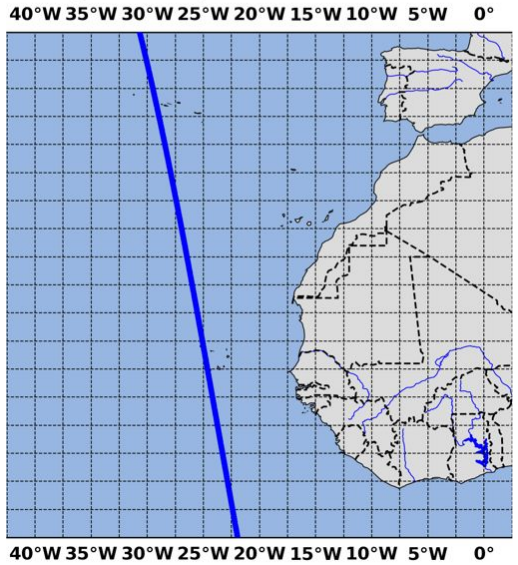
Cloud screening methodology

- AEL-FM ✓
- MSG SEVIRI ✓

Aeolus overpass on 10 Sep 2021
orbit id: 017679

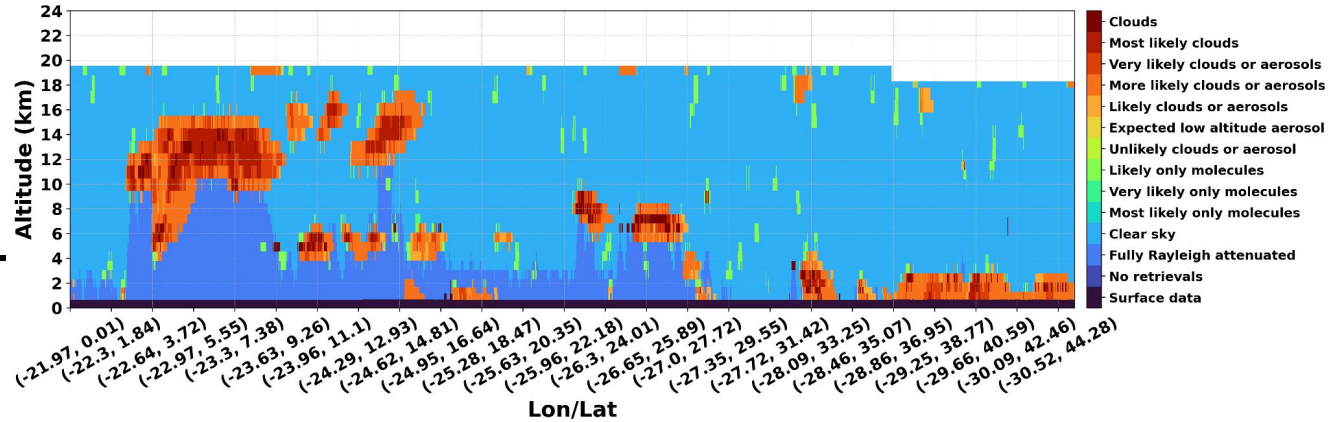
Aeolus Ascending orbit

Start: 10 Sep 2021 19:32:56UTC
Stop: 10 Sep 2021 19:44:31UTC



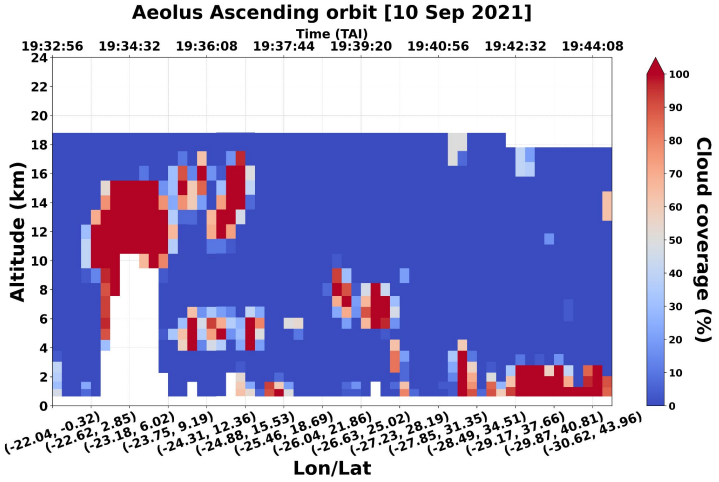
Implementation of cloud-filtering using the AEL-FM feature mask product

Primary AEL-FM dataset (Measurement scale)

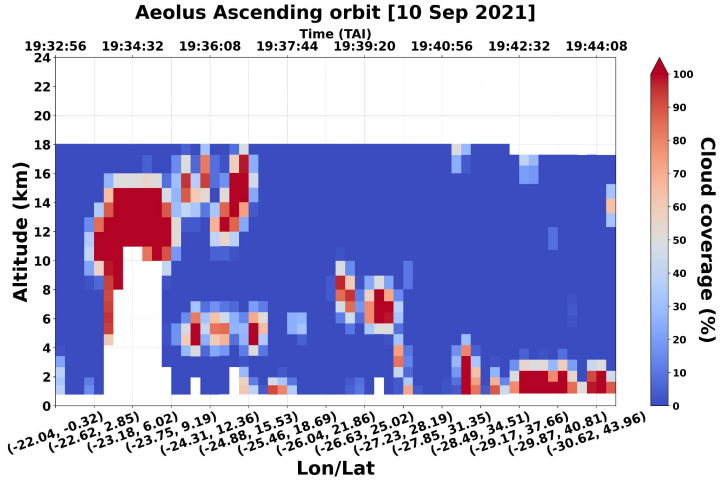


Convert to:

Ray scale (24 vertical bins)



Mid-bin scale (23 vertical bins)



L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

aeolus | ECMWF | TROPOS

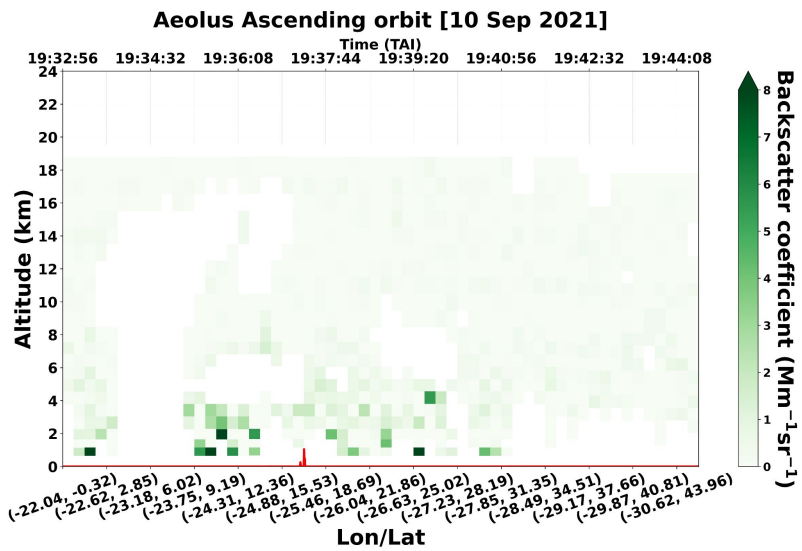
WP3000: *Development of the L2A+ aerosol product.*

Cloud screening methodology

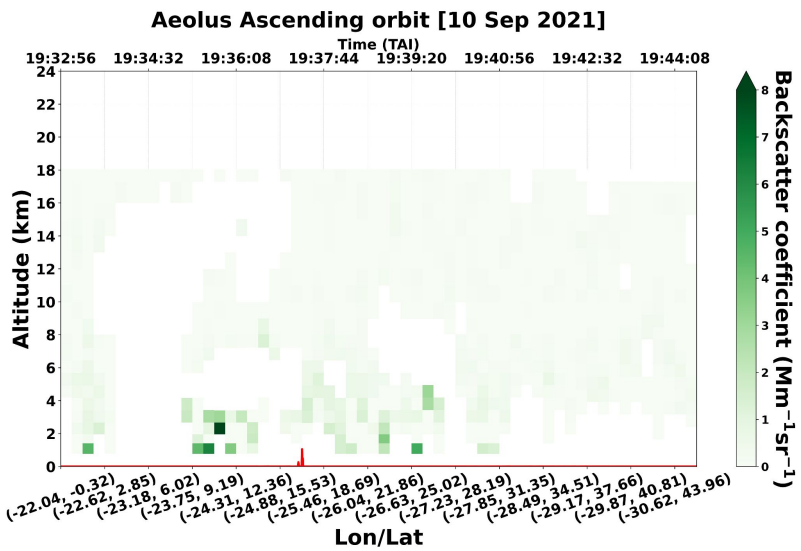
- AEL-FM ✓
- MSG SEVIRI ✓

Implementation of cloud-filtering using the AEL-FM feature mask product

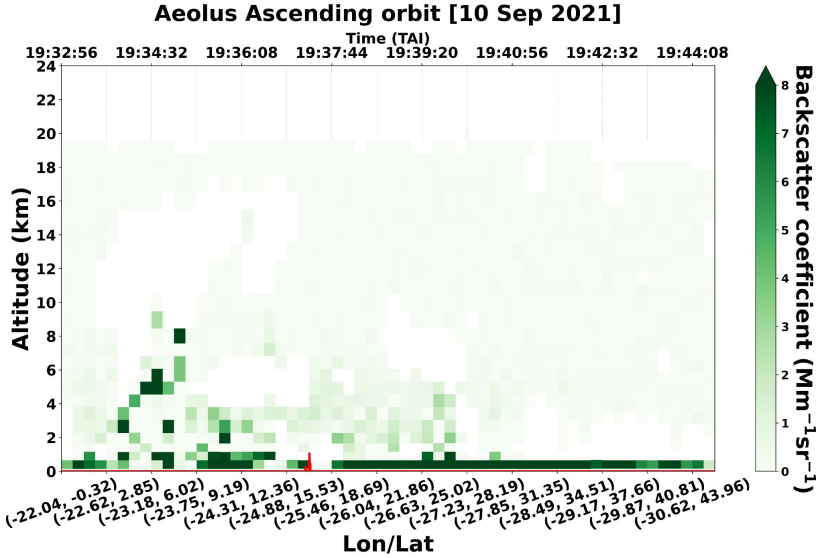
Cloud-free SCA Backscatter - 355nm



Cloud-free SCA mb Backscatter - 355nm



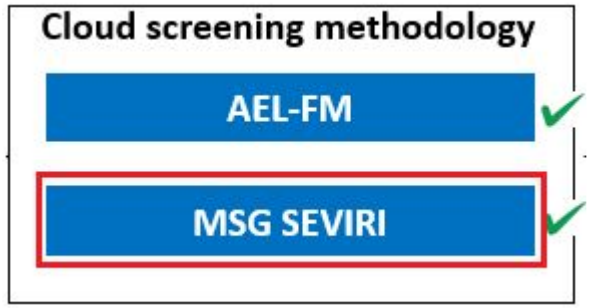
Cloud-free MLE Backscatter - 355nm



L2A+

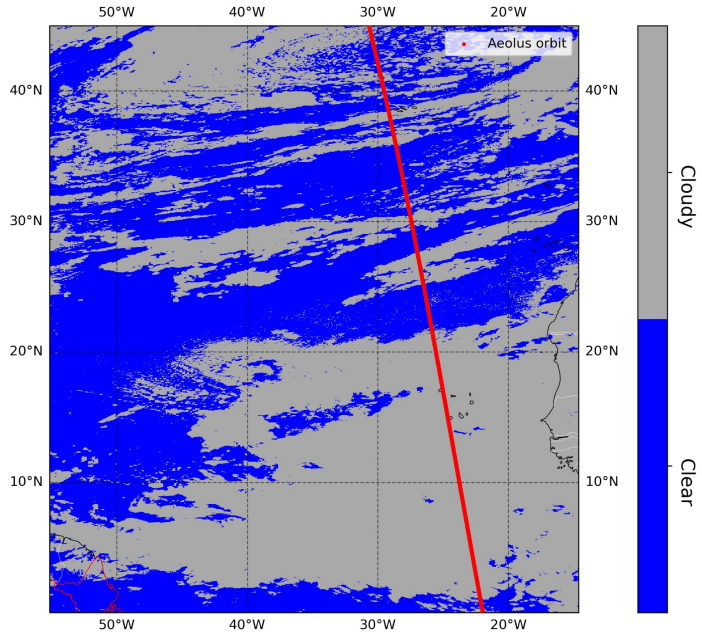
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

WP3000: *Development of the L2A+ aerosol product.*

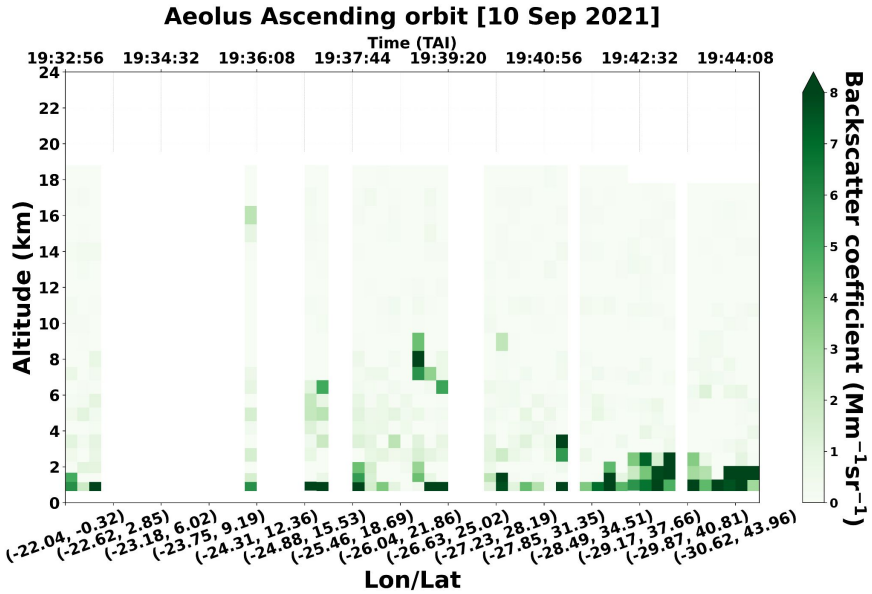


Implementation of cloud-filtering using MSG SEVIRI CLAAS3 dataset

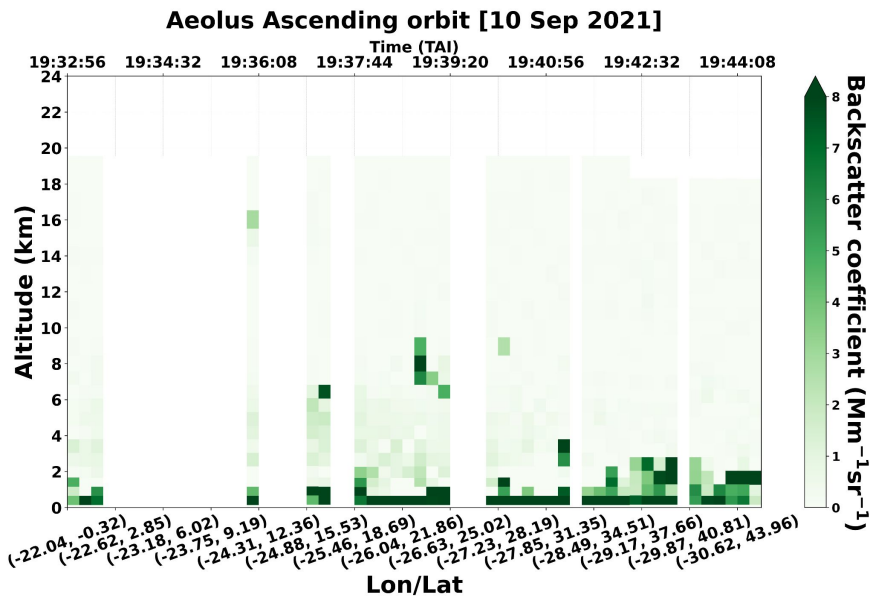
- SEVIRI cloud-mask: A pixel based dataset which contains the cloud mask product in 15 min temporal resolution.
- For an indicative Aeolus overpass on 10 Sep 2021, the spatial distribution of the cloud-contaminated (grey areas) and cloud-free (blue areas) pixels is displayed.
- Cloud-filtering: Eliminate the BRC profiles with cloud-contaminated measurements over a given threshold value (60% in our case).
- The SCA, MLE cloud-filtered profiles of backscatter coefficient are presented below.



Cloud-free SCA Backscatter - 355nm



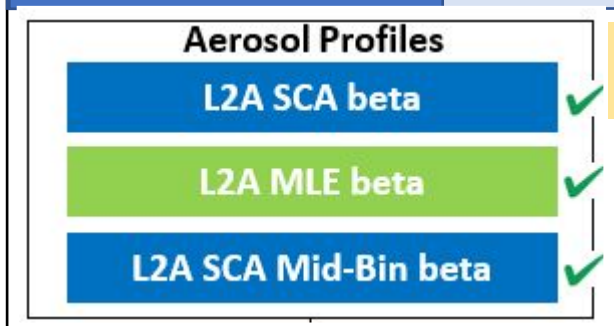
Cloud-free MLE Backscatter - 355nm



L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

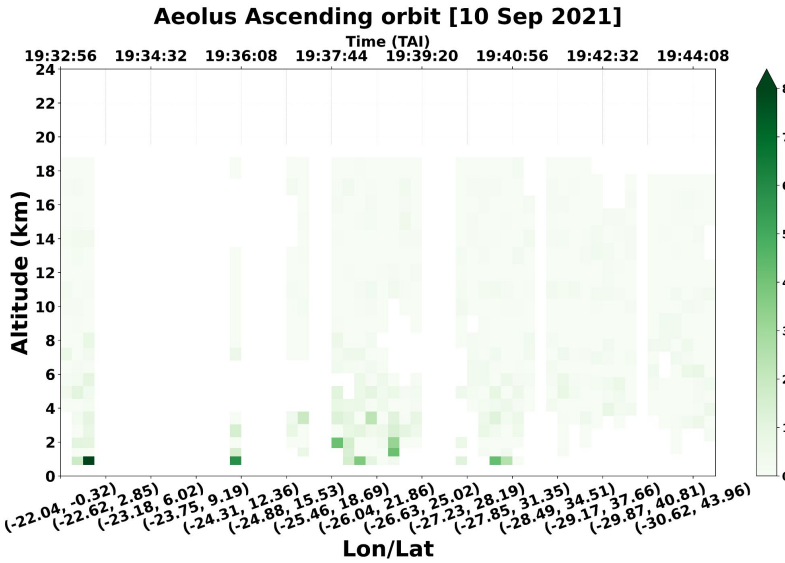
WP3000: *Development of the L2A+ aerosol product.*



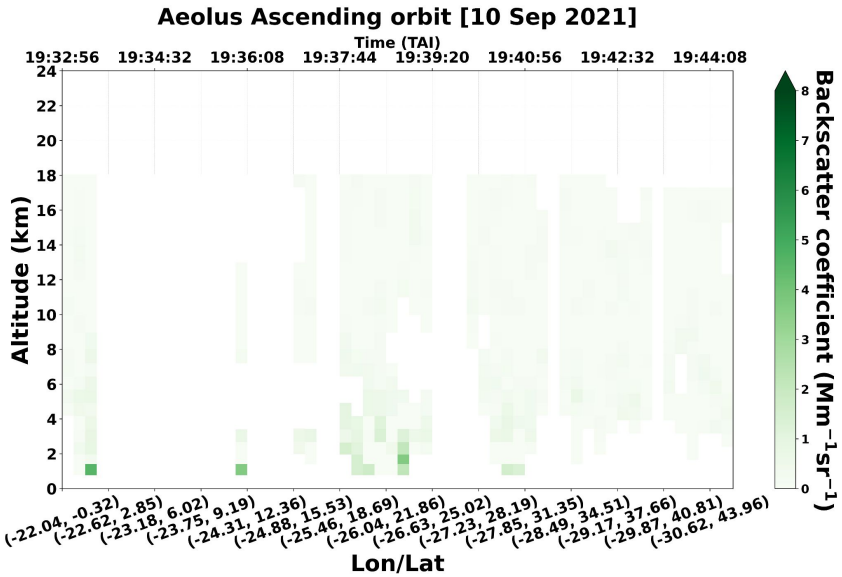
Implementation of cloud-filtering using AEL-FM + MSG SEVIRI

- For a more robust cloud-filtering, both filtering approaches were also combined.
- The pure aerosol SCA, SCA mb, and MLE backscatter profiles along an indicative Aeolus overpass on 10 September 2021, are illustrated below:

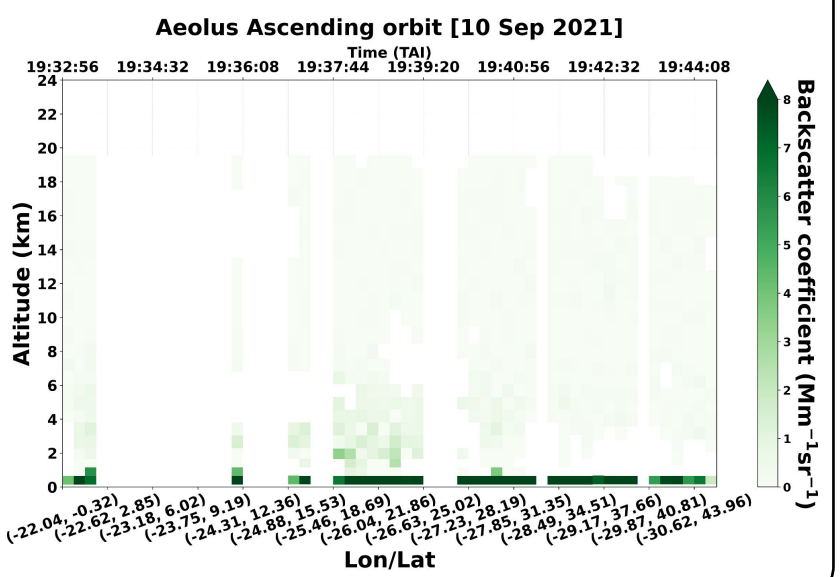
Cloud-free SCA Backscatter - 355nm



Cloud-free SCA Backscatter - 355nm



Cloud-free MLE Backscatter - 355nm



L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

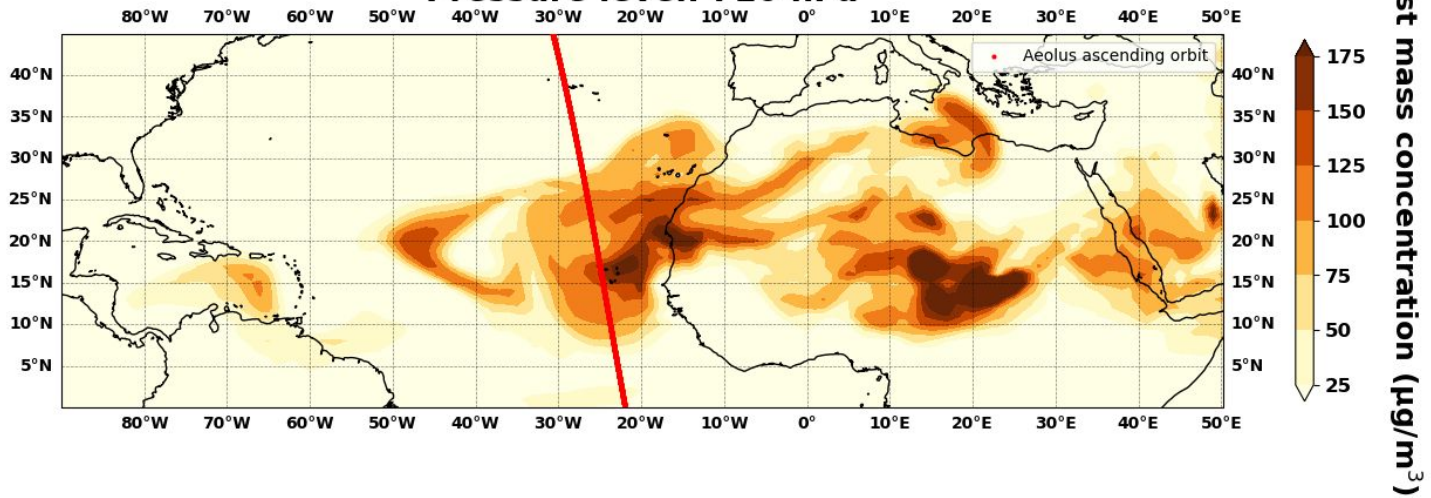
WP3000: *Development of the L2A+ aerosol product.*

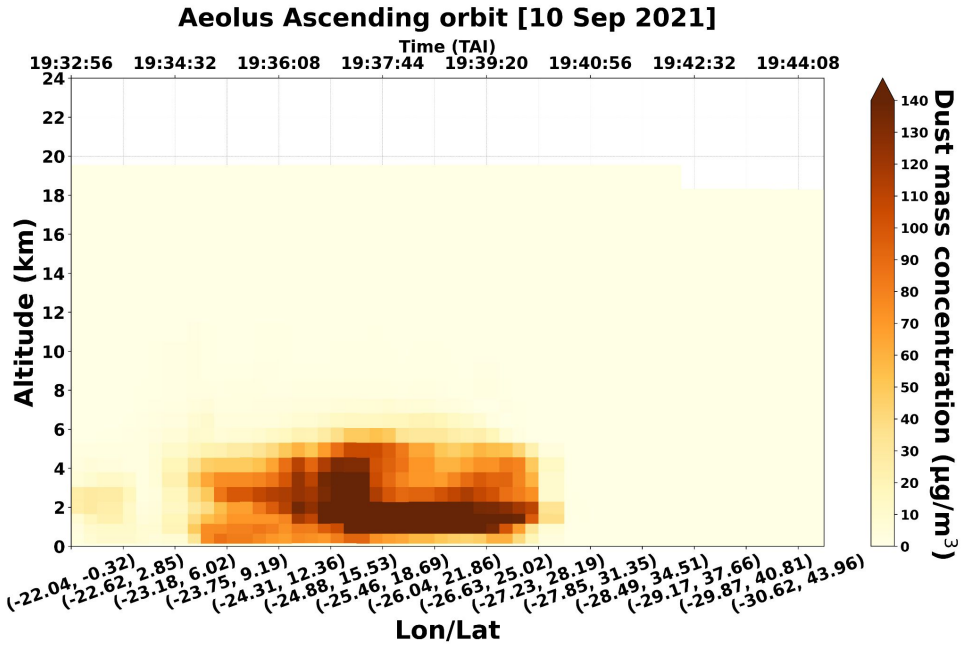
Aerosol Typing

- CAMS ✓
- AEL-FM ✓
- Dust Layers ✓

Aerosol typing using CAMS reanalysis dataset

- Due to the absence of an aerosol classification scheme for the raw Aeolus L2A data, numerical outputs from the Copernicus Atmosphere Monitoring Service (CAMS) reanalysis were implemented for the assignment of aerosol typing.
- BRC bins with a strong presence of dust were selected for the adjustment of backscatter profiles.





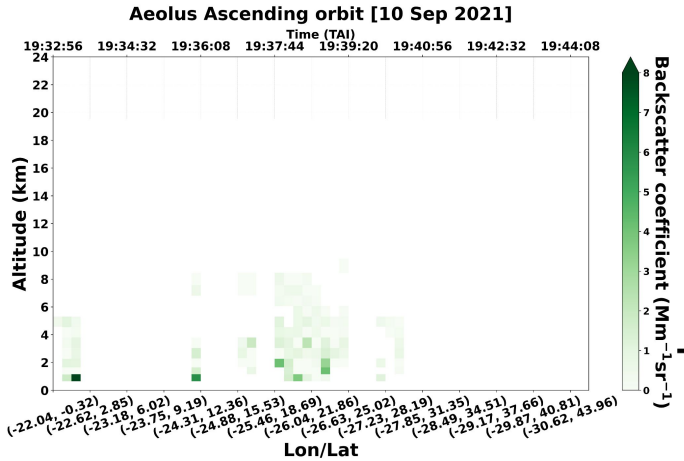
L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

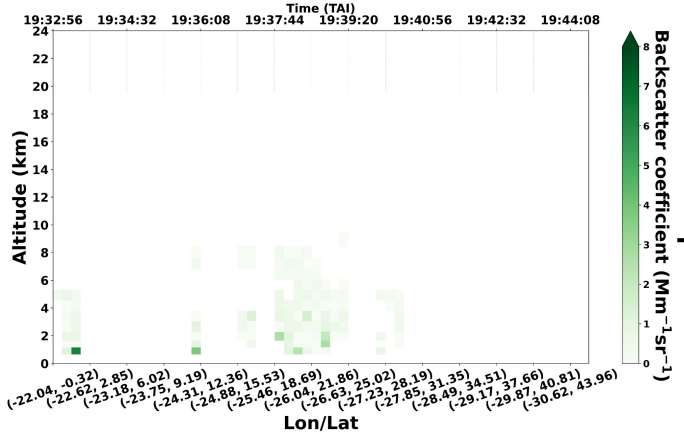
WP3000: *Development of the L2A+ aerosol product.*

Reconstruction of the Aeolus cloud-free dust extinction profiles

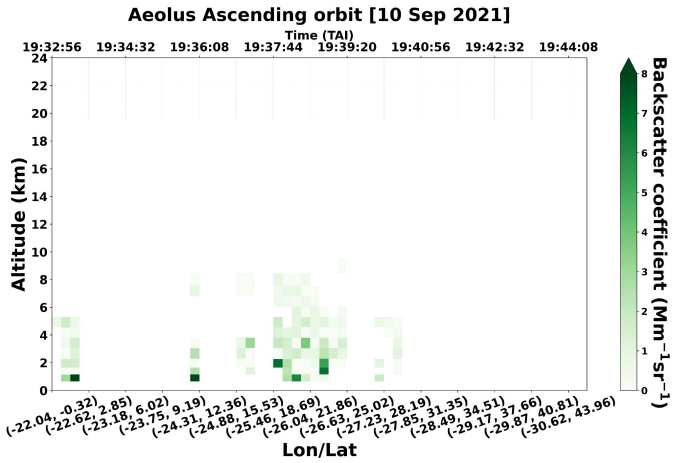
Co-polar SCA Backscatter



Cross-polar SCA Backscatter

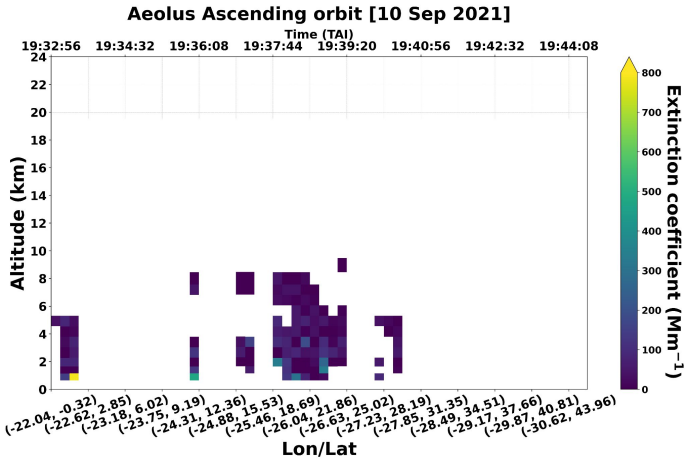


Total SCA Backscatter



LR=53.5sr

L2A+ Extinction (355nm)



L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

WP3000: *Development of the L2A+ aerosol product.*

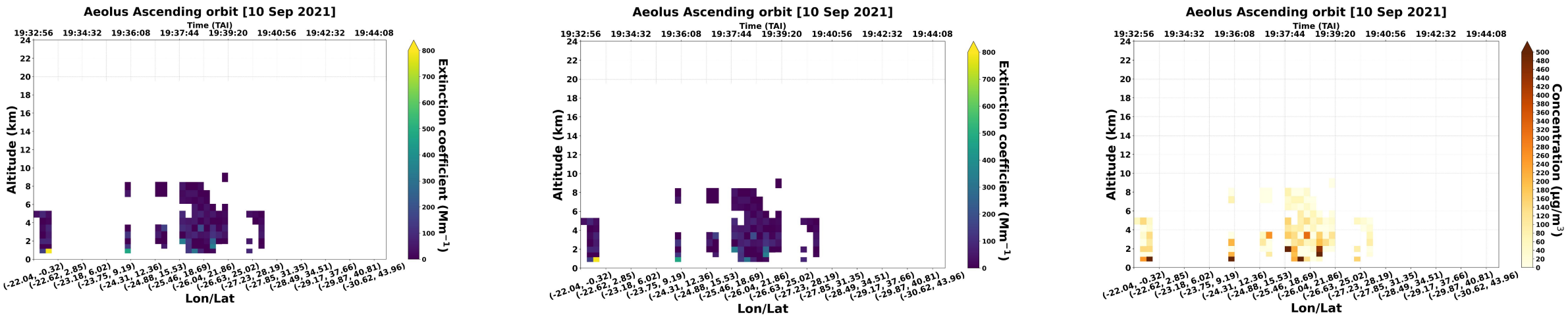
Derivation of dust mass concentration

•In the final step, the reconstructed dust extinction profiles were converted to mass concentration using the **POLIPHON** method (see details in Ansmann et al., 2019).

•For the implementation of the POLIPHON method, the L2A+ Extinction at 355nm needed to be converted at 532nm

•Below we present the SCA L2A+ extinction profiles and the final mass concentration profiles for an indicative case.

L2A+ Extinction (355nm) → **L2A+ Extinction (532nm)** → **Mass Concentration**



L2A+

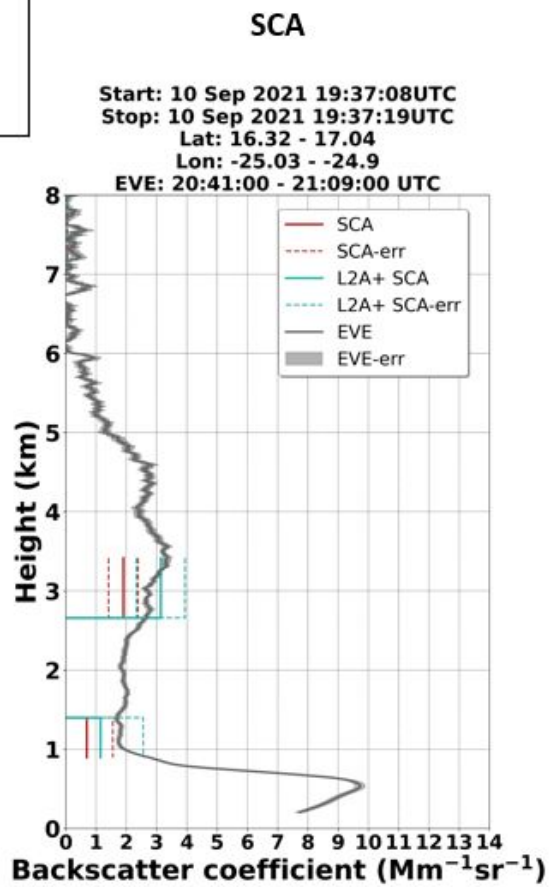
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

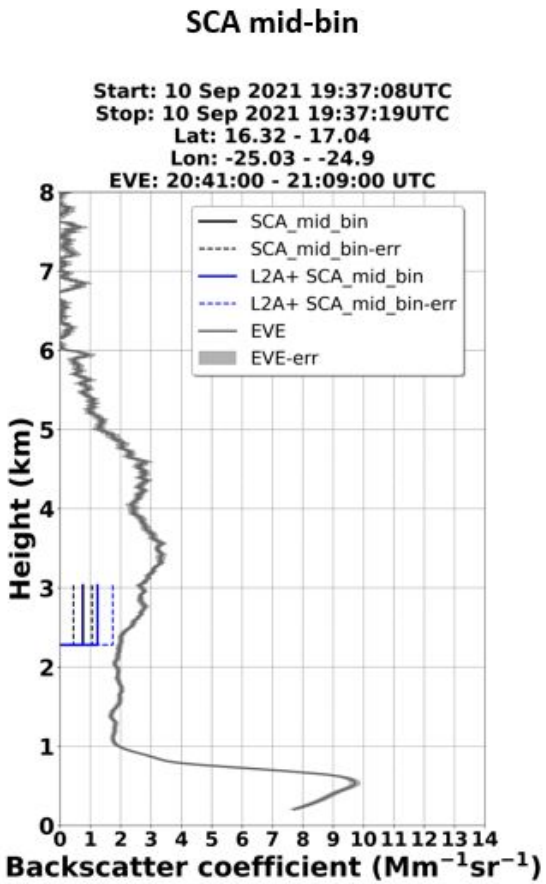
WP3000: *Development of the L2A+ aerosol product.*

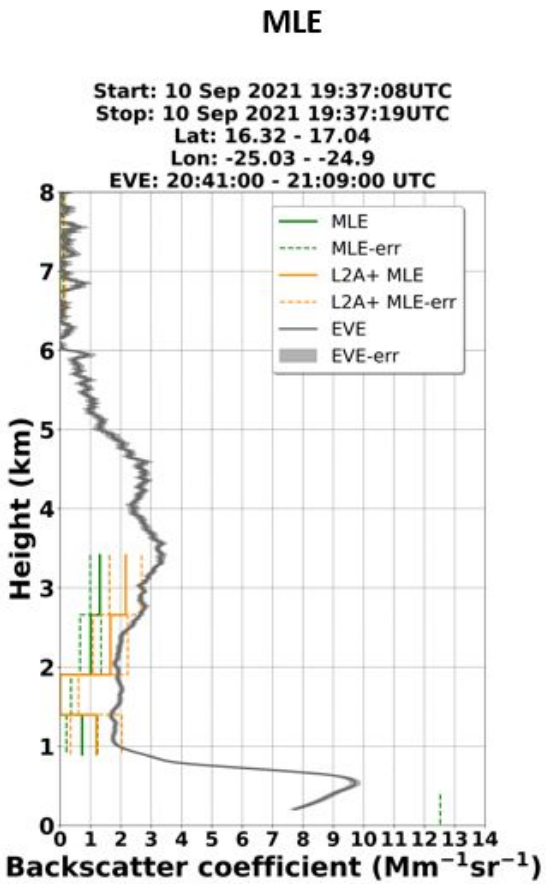
Validation

- eVe ✔
- PollyXT ✔

Assessment of the L2A+ product against eVe lidar (10 Sep. 2021)







L2A+

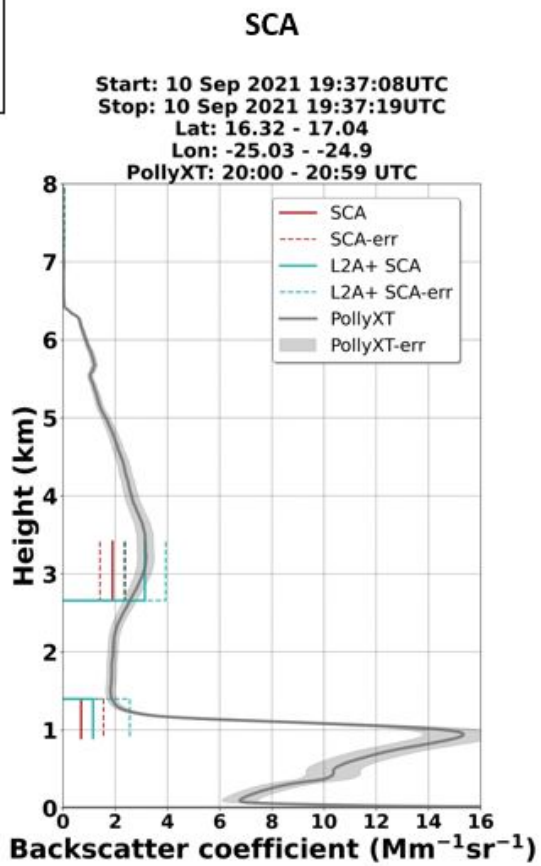
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

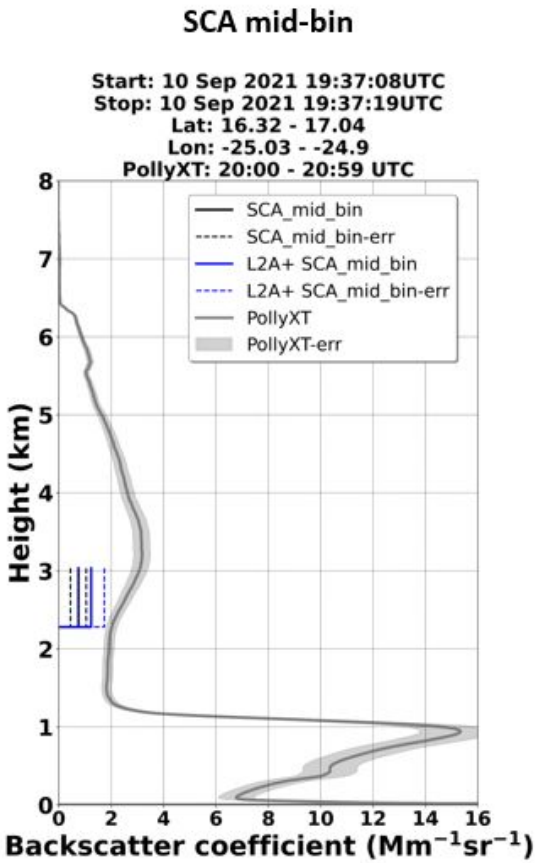
WP3000: *Development of the L2A+ aerosol product.*

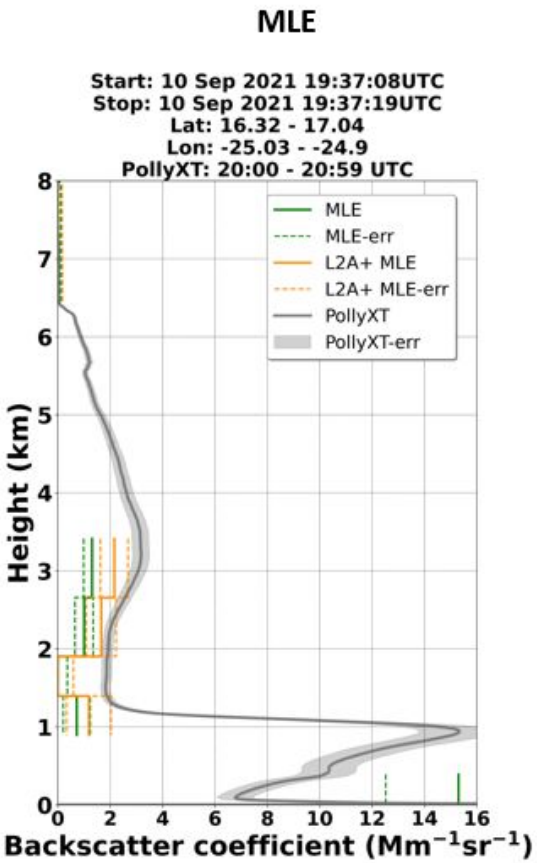
Validation

- eVe ✔
- PollyXT ✔

Assessment of the L2A+ product against PollyXT lidar (10 Sep. 2021)







L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

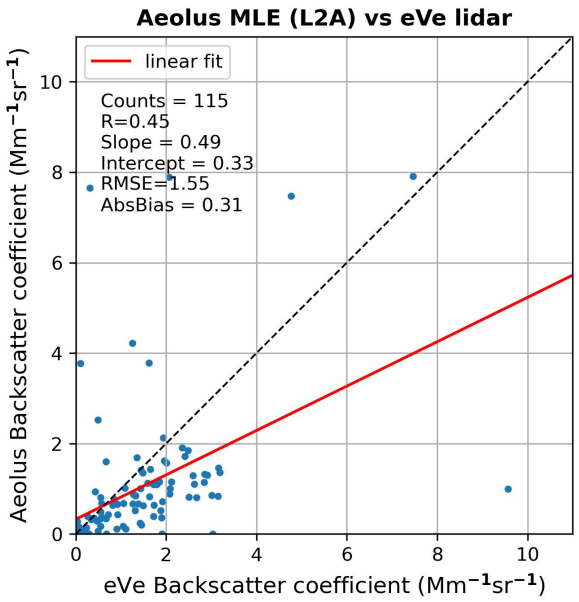
WP3000: *Development of the L2A+ aerosol product.*

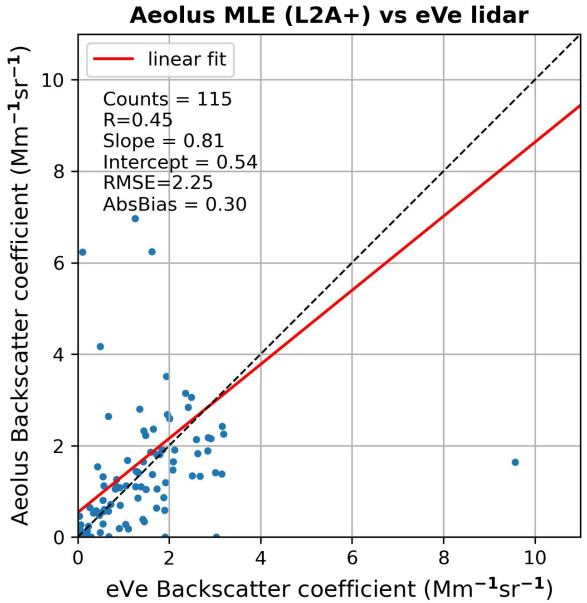
Validation

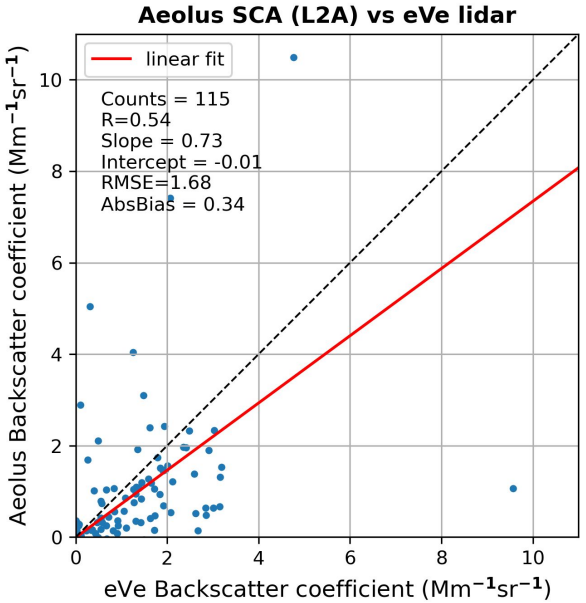
- eVe ✔
- PollyXT ✔

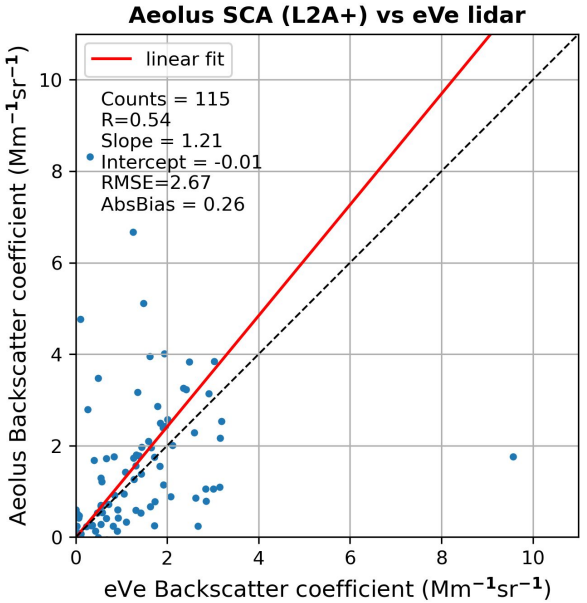
Assessment of the L2A+ product against eVe lidar

- Regression plots between L2A/L2A+ Aeolus (y-axis) and eVe ground-based (x-axis) backscatter coefficient retrieved from the SCA and MLE algorithms are illustrated in the figures below.
- For the comparison process, the study period was expanded to increase the number of collocated and concurrent Aeolus and ground-based cases - The L2A+ product was developed for the months July and September of 2021, and June and September of 2022 and a total number of 14 Aeolus collocated profiles were assessed.









WP3000: *Development of the L2A+ aerosol product.*

Structure of the final output product

AE_OPER_ALD_U_N_2A_20210901T042056037_005423...	AE_OPER_ALD_U_N_2A_20210901T042056037_005423982_017...
CLOUD_FILTERED	CLOUD_FILTERED
MLE	MLE
SCA	SCA
SCA_MID_BIN	SCA_MID_BIN
GEOLOCATION	GEOLOCATION
DEM_INTERSECTION	DEM_INTERSECTION
MIDDLE_BIN_SCALE	MIDDLE_BIN_SCALE
REGULAR_SCALE	REGULAR_SCALE
L2APLUS	L2APLUS
MLE	MLE
SCA	SCA
SCA_MID_BIN	SCA_MID_BIN
PURE_DUST	PURE_DUST
MLE	MLE
SCA	SCA
SCA_MID_BIN	SCA_MID_BIN
RAW_DATA	RAW_DATA
MLE	MLE
SCA	SCA
SCA_MID_BIN	SCA_MID_BIN

- All the output Aeolus orbit files (NetCDF format) are now available for the period of July, September 2021 and June, September of 2022.

The files include among others:

- Geolocation information
- Raw Aeolus L2A retrievals processed with Baseline 16 for SCA, SCA mid-bin, and MLE
- Cloud-free Aeolus L2A retrievals.
- Pure-dust Aeolus products
- L2A+ Aeolus products (total backscatter coefficient 355nm, extinction coefficient 355nm, dust mass concentration)

Data access:

- All the orbit files have been uploaded to NOA server: “/mnt/nas-2/L2Aplus/OPs/ncfiles”

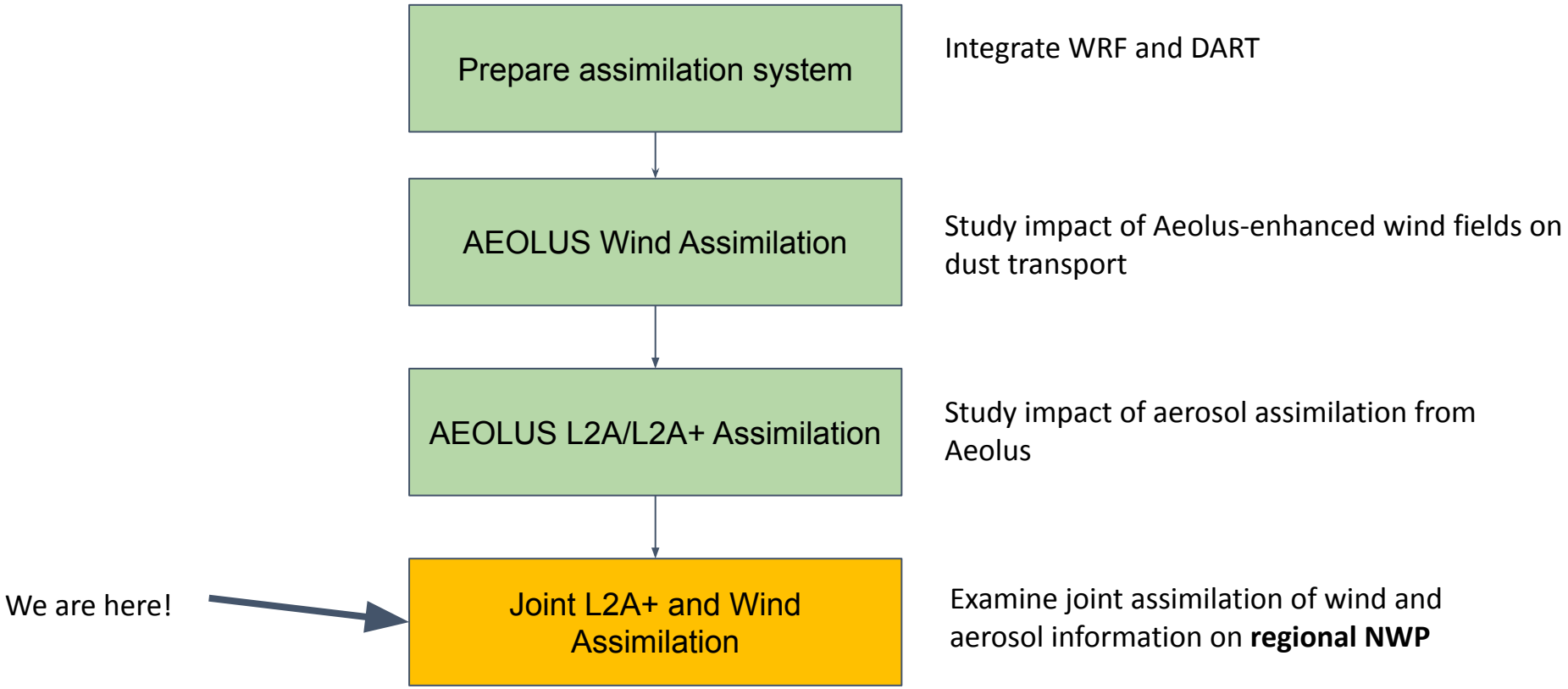
WP4000: *Assimilation of L2A/L2A+ and application of WRF-L experiments.*

Objective:	Assimilation of L2A/L2A+ and application of WRF-L experiments.
Inputs:	1) Aeolus L2A and L2A+ dust profiles from WP3000 2) ECMWF IFS wind fields with /without Aeolus assimilation (available from ECMWF)
Tasks:	1) Development of data assimilation routines (DART) 2) Evaluation of assimilation methodology 3) Performance of short term dust and NWP forecasts with WRF model.
Output:	DI03: Description of the Algorithm Developments (ALGO) for assimilating Aeolus L2A and L2A+. DI05: WRF simulation outputs for all experiments.

WP4000: *Assimilation of L2A/L2A+ and application of WRF-L*

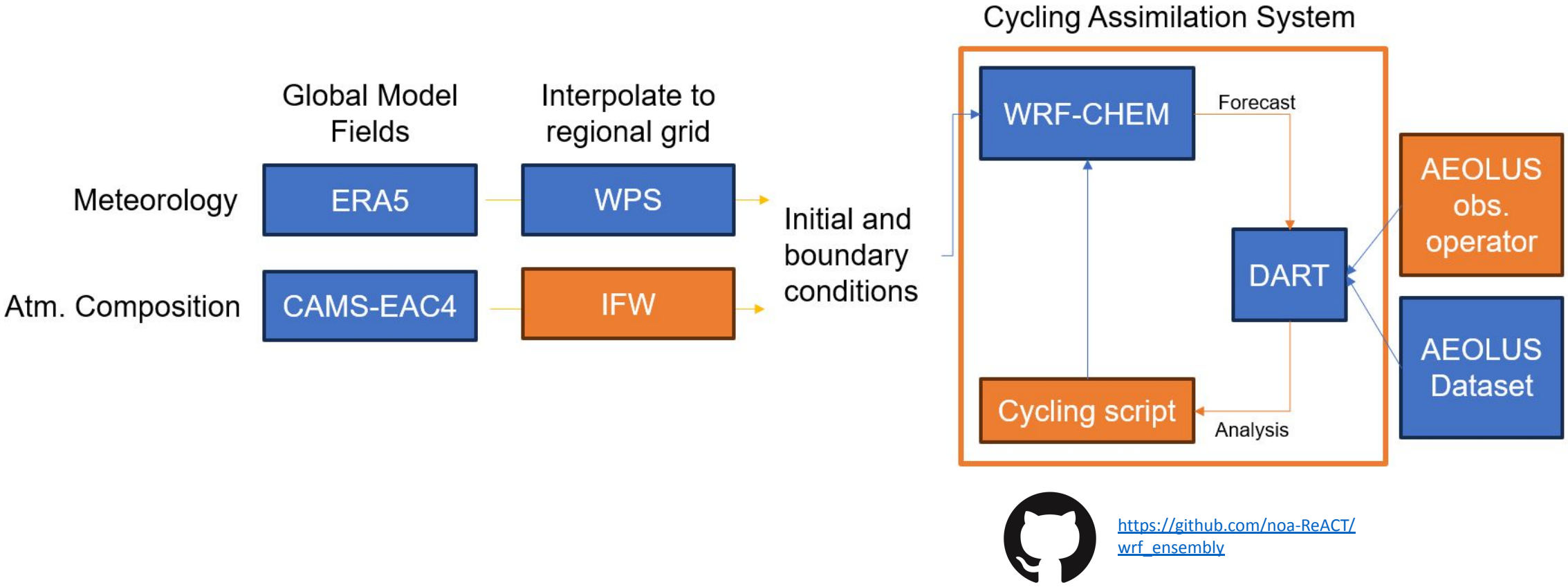
Work package begun in May 2023

Work Plan for WP4000



WP4000: *Assimilation of L2A/L2A+ and application of WRF-L*

Assimilation system overview



https://github.com/noa-ReACT/wrf_ensembly

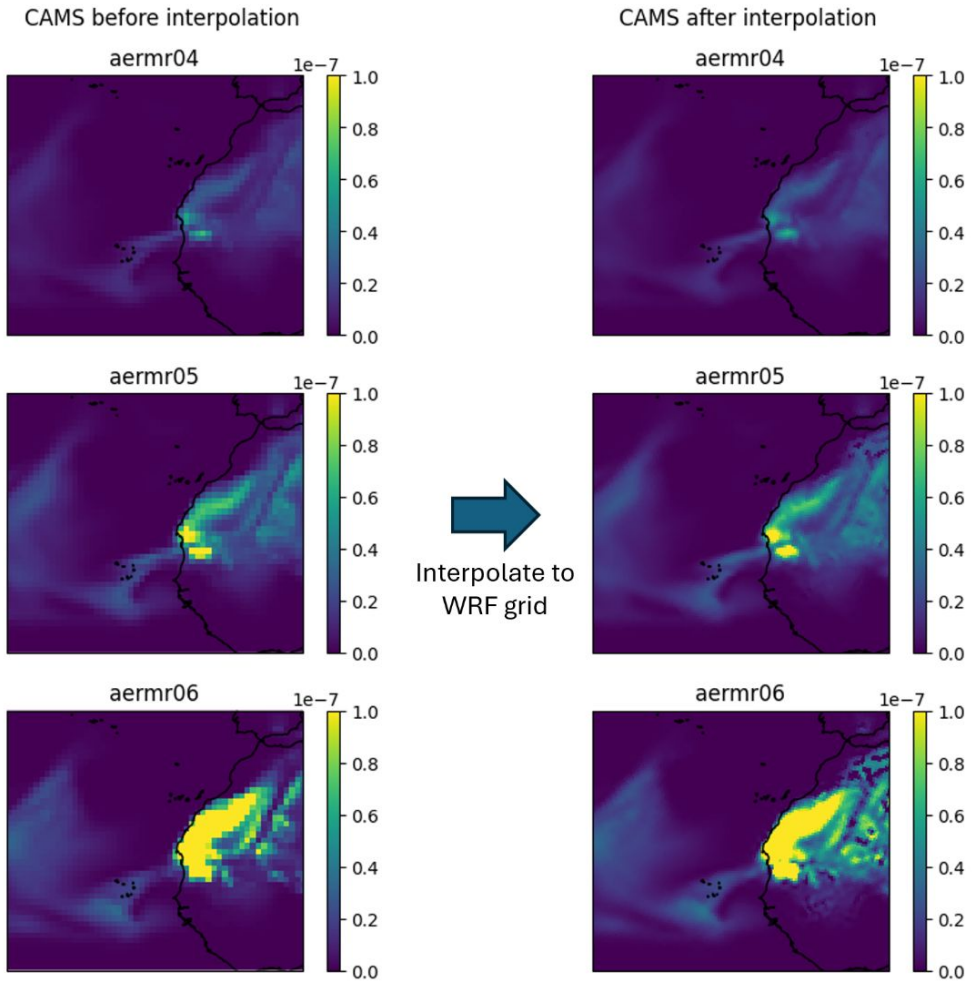
Orange boxes represent developments done during L2A+

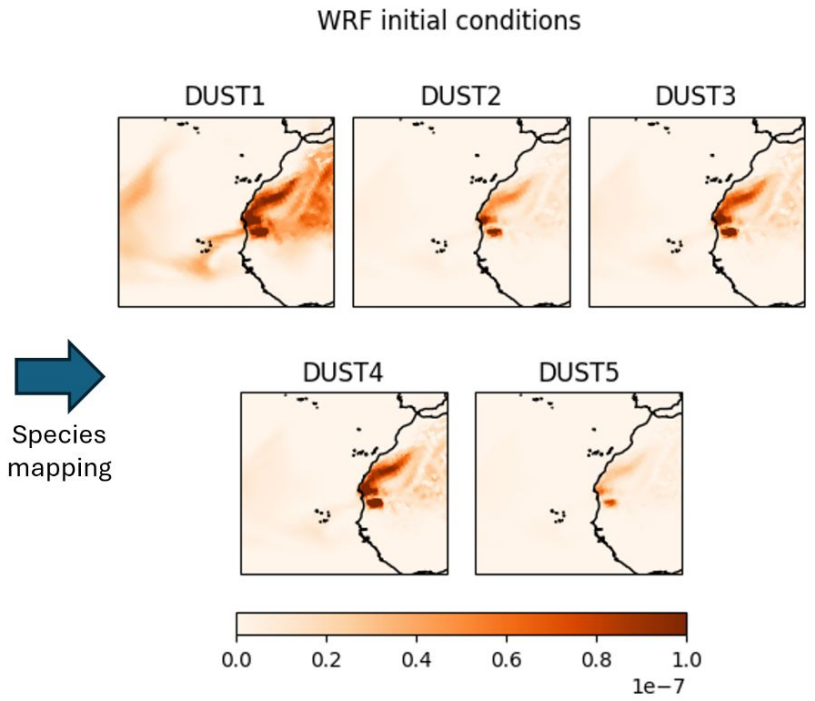
L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

WP4000: *Assimilation of L2A/L2A+ and application of WRF-L*

Chemistry pre-processor





CAMS bin	Size range (μm)
aermr04 CAMSD1	0.06 - 1.1
aermr05 CAMSD2	1.1 - 1.8
aermr06 CAMSD3	1.8 - 40

GOCART bin	Size range (μm)
DUST1	0.2 - 2.0
DUST2	2.0 - 3.6
DUST3	3.6 - 6.0
DUST4	6.0 - 12.0
DUST5	12.0 - 20.0

https://github.com/NOA-ReACT/interpolator_for_wrfchem

Coefficients:

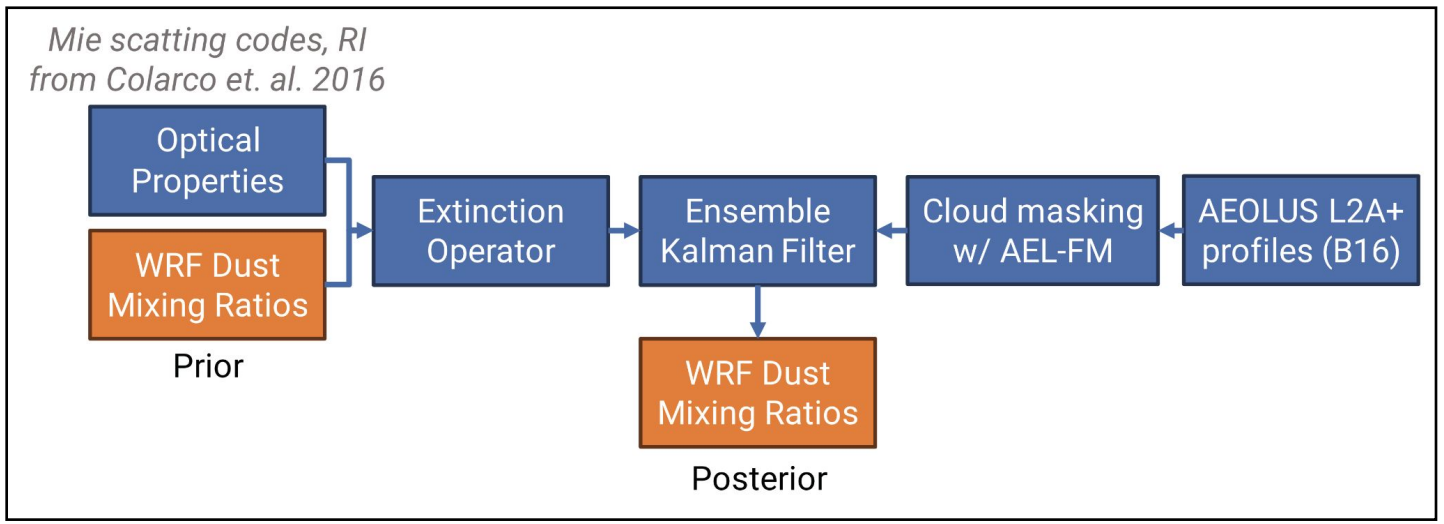
Dust Bin	*CAMSD1*	*CAMSD2*	*CAMSD3*
DUST1	0.96	1.0	0.16
DUST2			0.19
DUST3			0.30
DUST4			0.35
DUST5			0.11

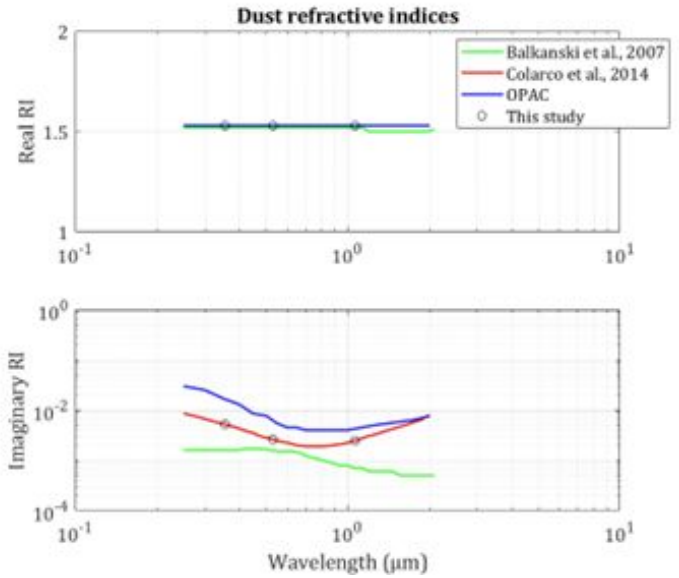
Operators

WIND

Project model winds to line of sight vector: $HLOS = -u \sin\varphi - v \cos\varphi$

DUST





Assimilation experiments

Assimilation experiments performed:

- Control
- Aeolus HLOS
- Aeolus HLOS + Extinction

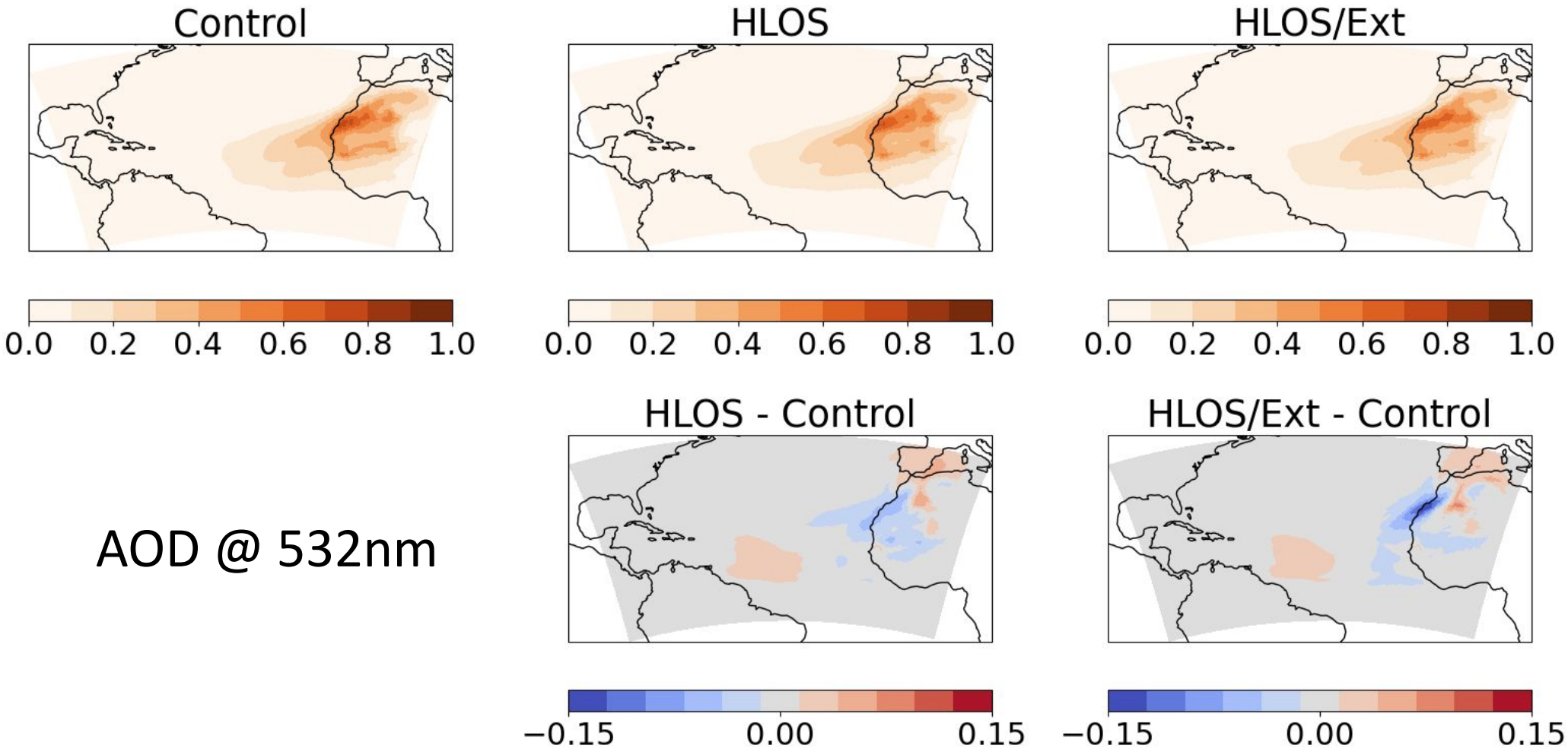
Model details:

- Resolution: 30x30 km, 44 vertical levels
- Domain: North Atlantic, West Africa
- Model Version: WRF-CHEM v4.5.1

WP4000: *Assimilation of L2A/L2A+ and application of WRF-L*

Assimilation experiments

AOD @ 532nm

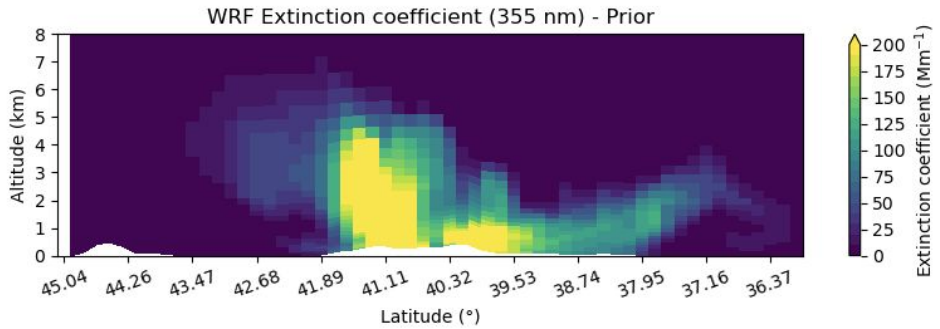


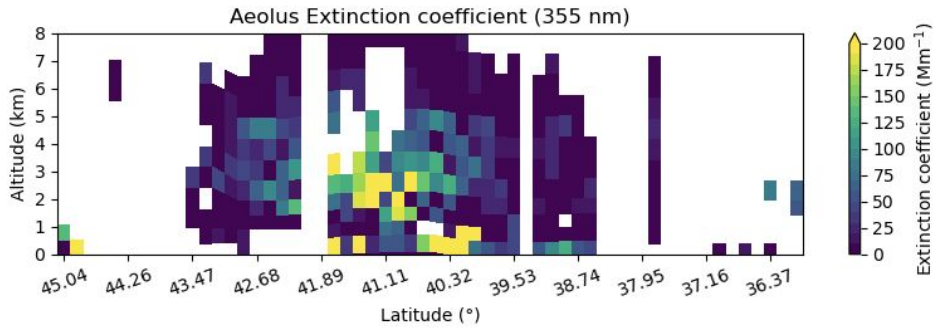
L2A+

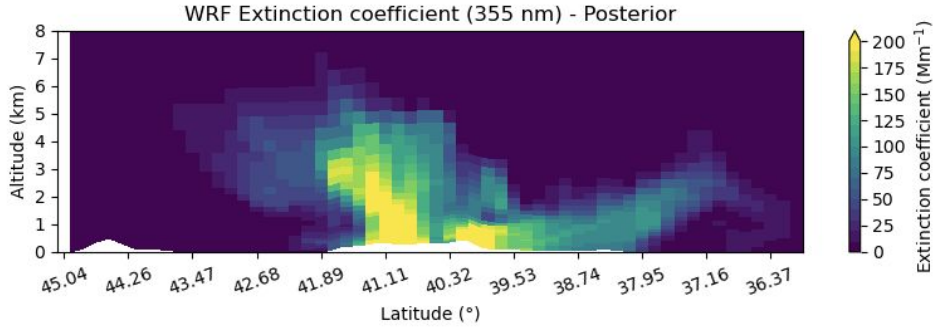
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

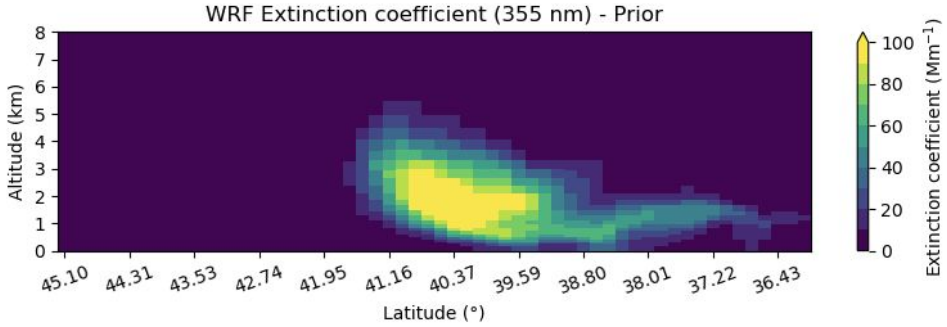
WP4000: *Assimilation of L2A/L2A+ and application of WRF-L*

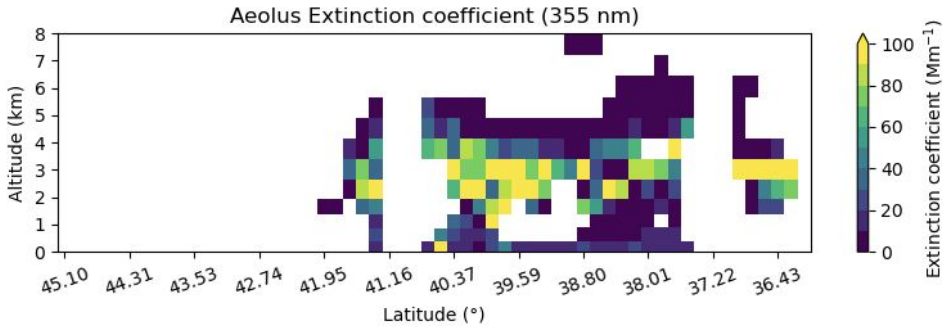
Assimilation experiments

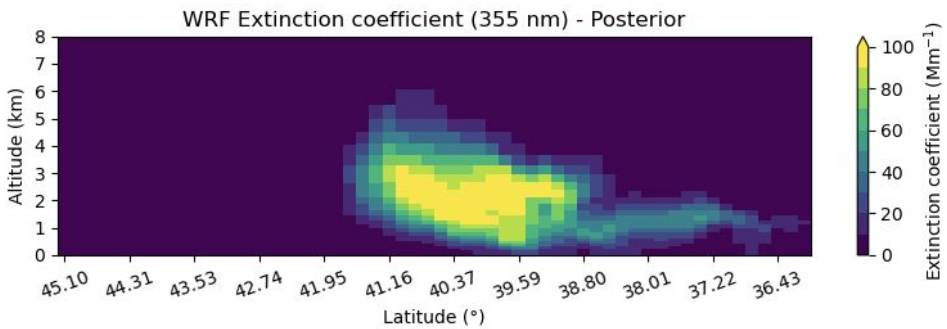












L2A+

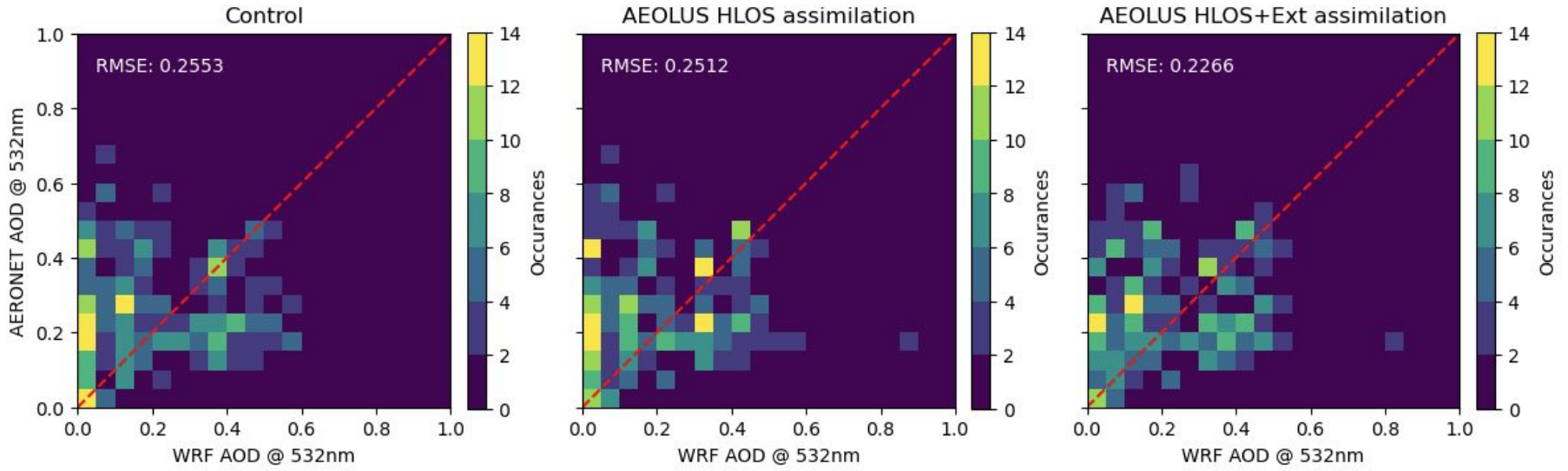
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

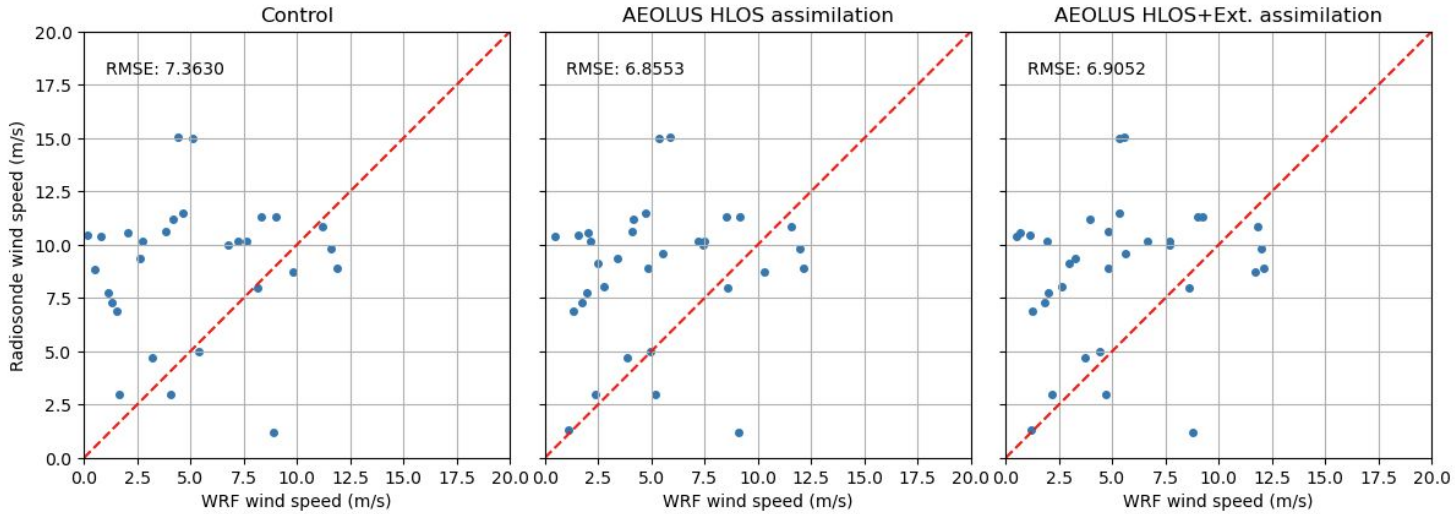
WP4000: *Assimilation of L2A/L2A+ and application of WRF-L*

Preliminary validation

Available Datasets:

- AERONET
- ASKOS Campaign
  - Radiosondes from Sal, Cabo Verde
  - HALO Wind Lidar
  - PollyXT Lidar
  - EVE lidar
- CADDIWA Campaign
  - Dropsondes
  - RASTA Wind Radar
  - LNG-lidar





WP4000: *Assimilation of L2A/L2A+ and application of WRF-L*

Next steps

- Longer experiments to cover whole period of validation data availability, increase resolution
- Assimilate L2A+ product
- Add option to extinction operator to simulate only co-polar, study impact
- **Do experiment with interactive aerosols, check impact on NWP**

L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

WP5000: *Impact Studies*

Objective:	To assess the impact of the L2A+ product.
Inputs:	DI02: ASKOS observational dataset and Data Pool. DI03: L2A+ Database; L2A+ Database Description Document; L2A+ assimilation outputs - Database; L2A+ assimilation outputs - Database Description Document
Tasks:	1) Assessment of L2A+ assimilation impact on NWP. 2) L2A+ products and quantification of dust deposition variability across the N. Atlantic Ocean. 3) Assessment of the contribution of Aeolus L2A and L2A+ optical properties profile products to the ESA-LIVAS atmospheric aerosol database.
Output:	DI06: Scientific Analysis, Impact Assessment and Scientific Roadmap (SIR), providing: Impact assessment report of L2A/L2A+ assimilation on Trans-Atlantic dust transport and NWP. Evaluation Report on L2A/L2A+ dust deposition fields. Integrated database of L2A, L2A+, and ESA-LIVAS optical products. Assessment Report on the integration of L2A/L2A+ optical products to the ESA-LIVAS database.

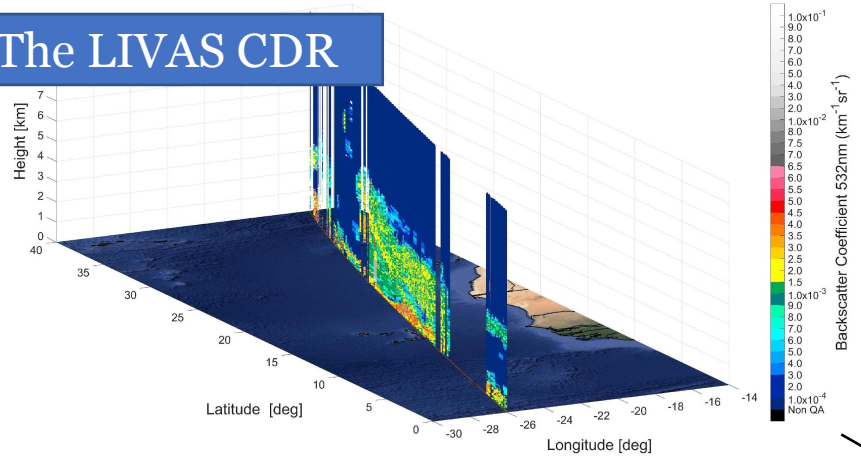
L2A+

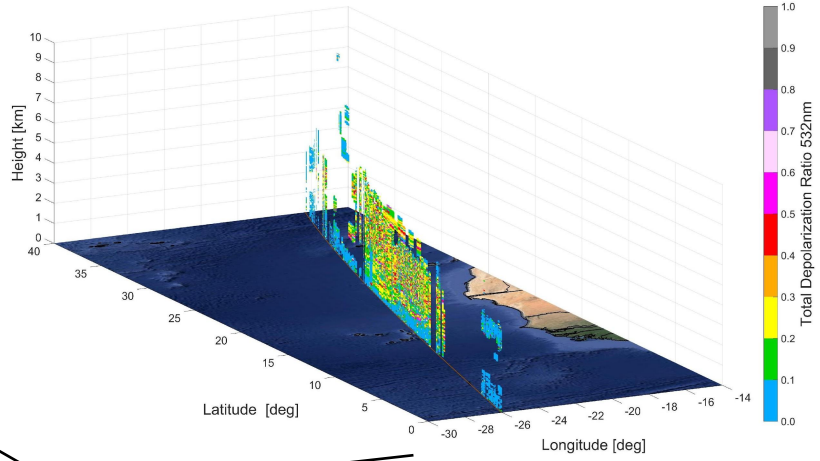
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

WP5000:

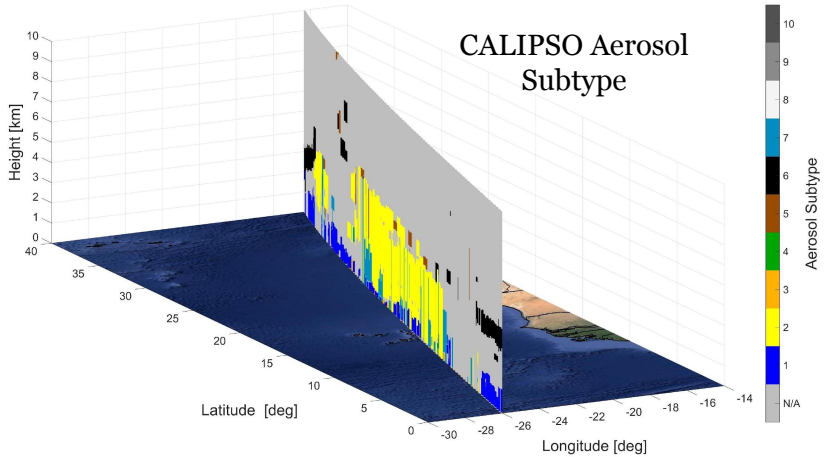
Assessment of the contribution of Aeolus L2A and L2A+ optical properties profile products to the ESA-LIVAS atmospheric aerosol database.

The LIVAS CDR



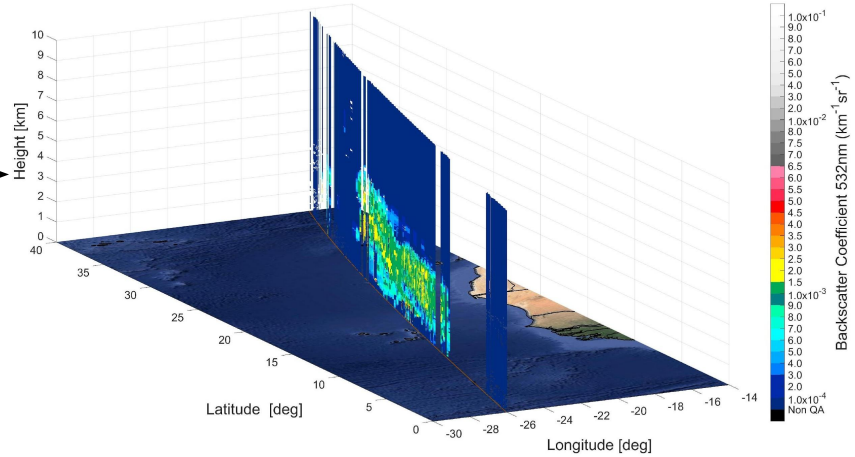


Tropospheric	1	Marine
	2	Dust
	3	Polluted Continental/Smoke
	4	Clean Continental
	5	Polluted Dust
	6	Elevated Smoke
	7	Dusty Marine
Stratospheric	8	PSC aerosol
	9	Volcanic Ash
	10	Sulfate/other

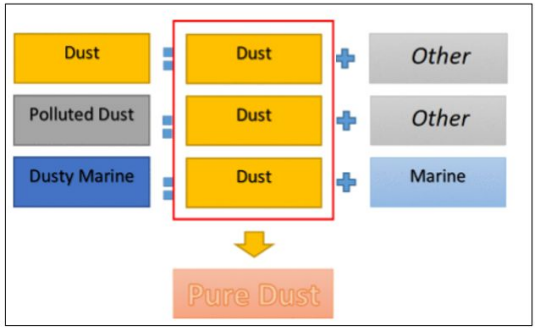


CALIPSO Aerosol Subtype

Tesche et al., 2009
Amiridis et al., 2013



Kim et al., 2018
Kar et al., 2019



L2A+

Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

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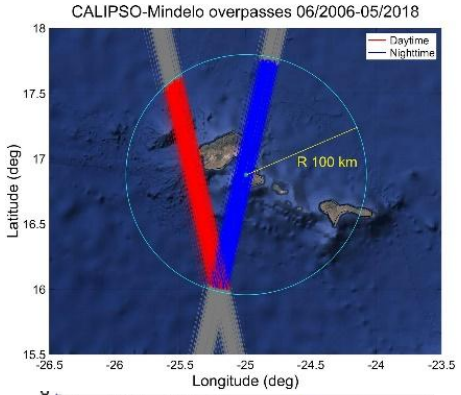
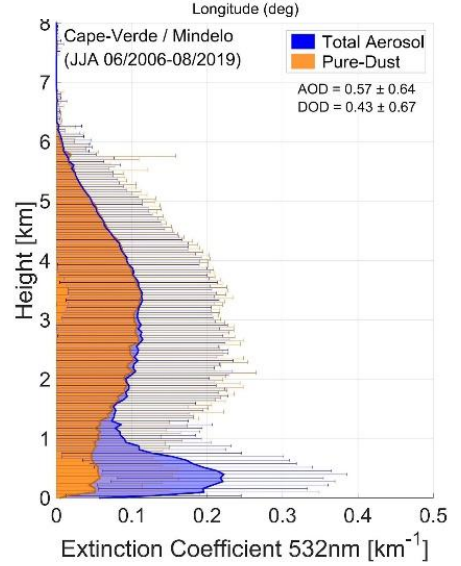
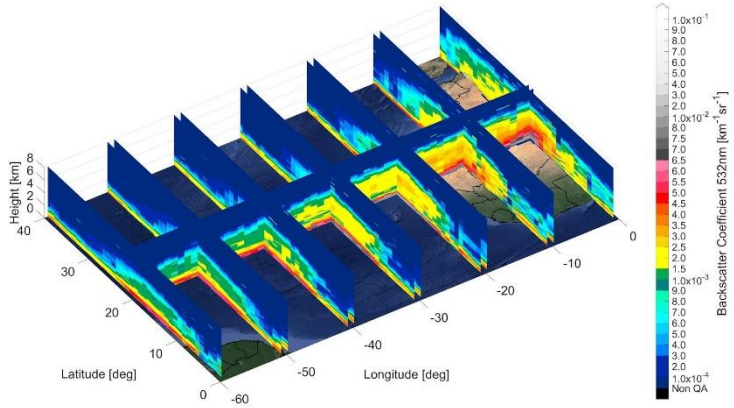
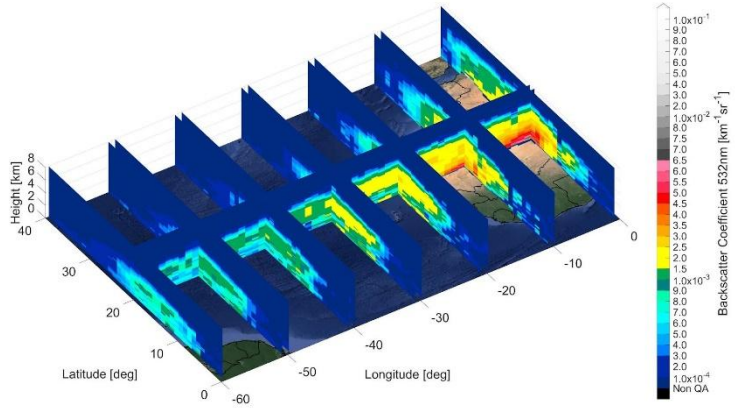




Total b532nm
JJA 2006-2020



LIVAS Pure-Dust b532nm
JJA 2006-2020



L2A+

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WP5000:

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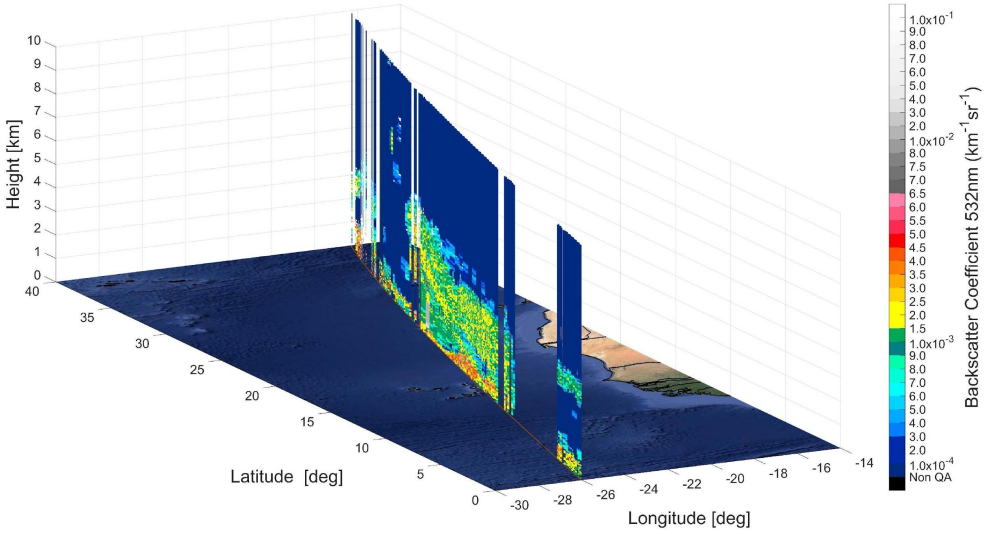
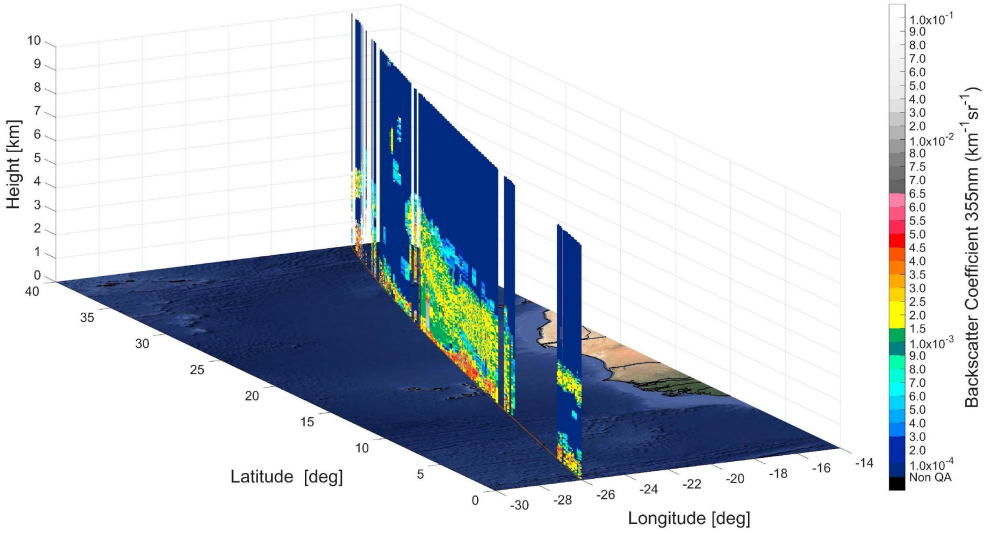
The LIVAS CDR

Total Backscatter Coefficient 532 nm - QA



Total Backscatter Coefficient 355 nm - QA



L2A+

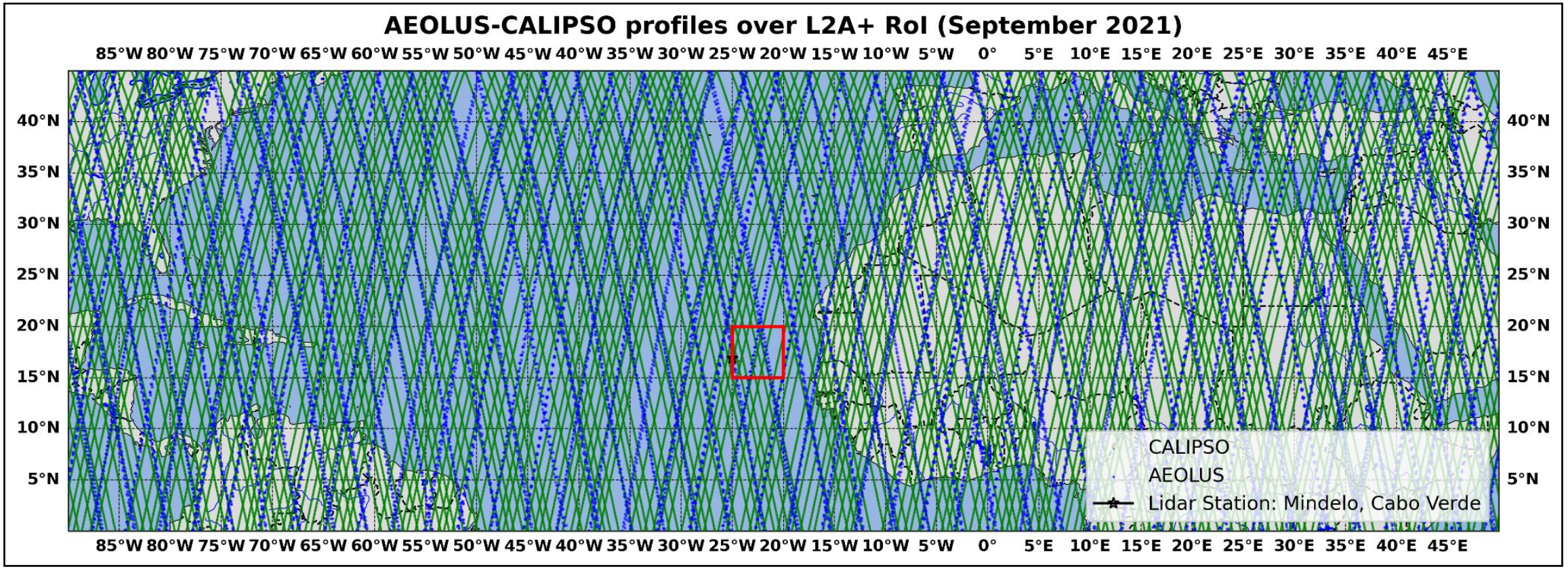
Enhanced Aeolus L2A for depolarizing targets and impact on aerosol research and NWP.

aeolus ECMWF TROPOS

WP5000:

Assessment of the contribution of Aeolus L2A and L2A+ optical properties profile products to the ESA-LIVAS atmospheric aerosol database.

The LIVAS CDR



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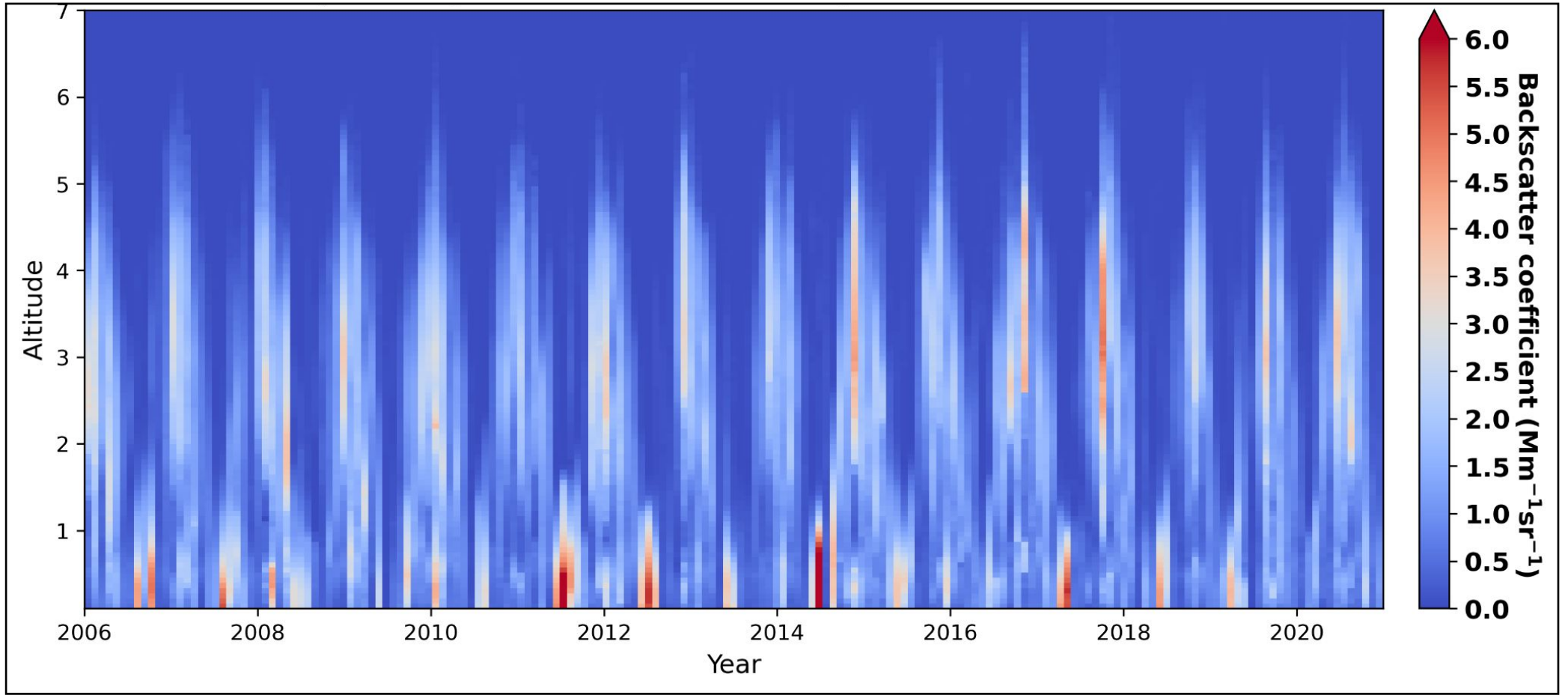
WP5000: Assessment of the contribution of Aeolus L2A and L2A+ optical properties profile products to the ESA-LIVAS atmospheric aerosol database.



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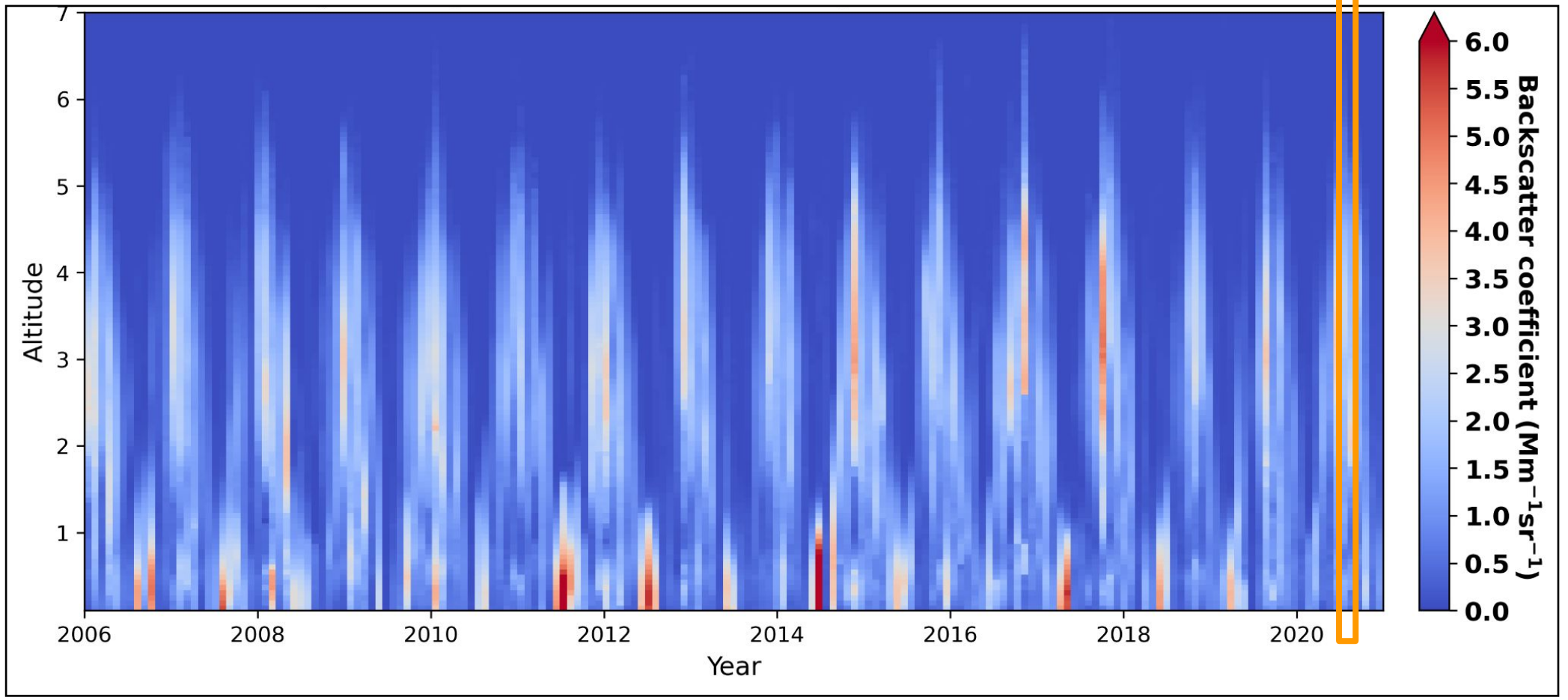
ESA-ASKOS campaign 09/2021



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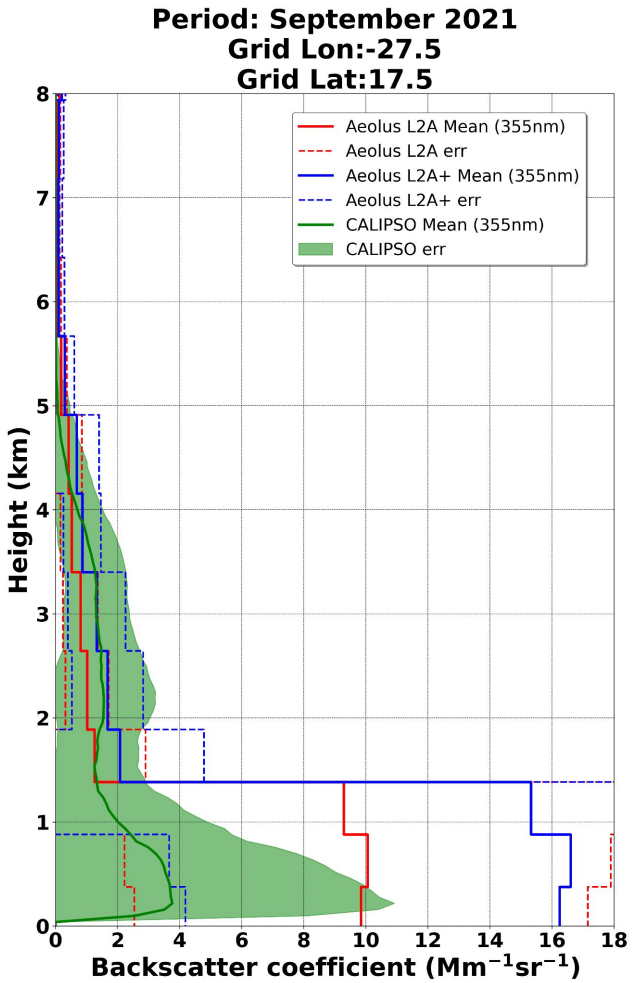

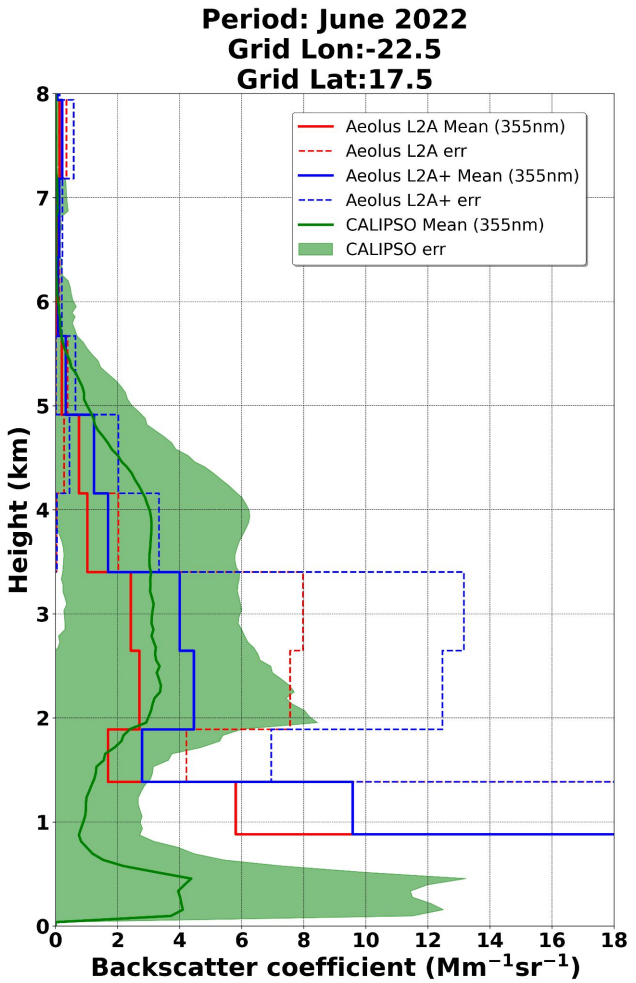

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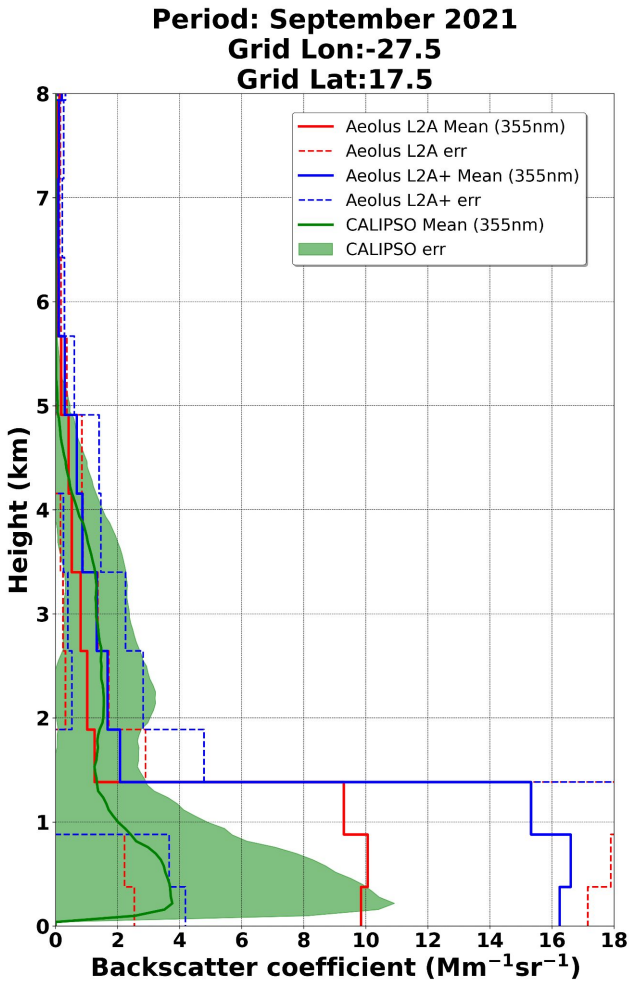

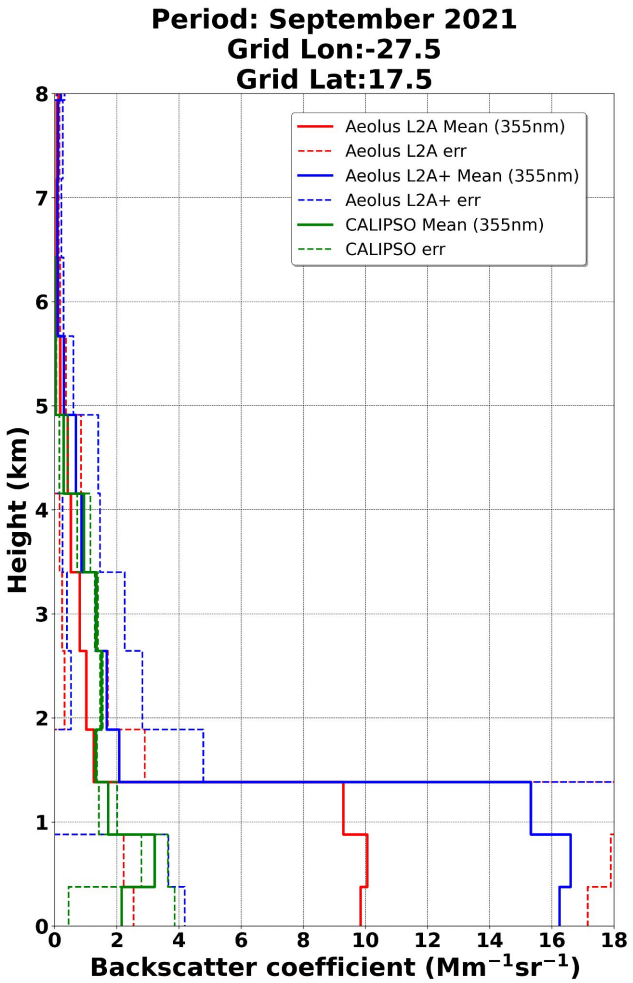

WP6000: *Recommendations*

Objective:	Summary of the main scientific outcomes of the project and recommendations for expanding the performed research activities.
Inputs:	1) All Deliverable Items. 2) Outputs from WP2000, WP3000, WP4000 and WP5000.
Tasks:	1) A synthesis and recommendation report summarising all the results from input WPs. 2) Synthesis of the final Analysis Report of the Validation activities carried out 3) A scientific roadmap for future studies in the relevant research area. 4) Based on the obtained findings, suggestions for improving Aeolus observational capabilities will be provided to the Agency. 5) Promotion of L2A+ data exploitation in atmospheric research.
Output:	• DI04: Analysis of the Validation Activities carried out (VAL). • DI09: Final Report (FR).