L2A+

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

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

Progress Meeting 04
[PM04]

Virtual
20/11/2023
10:00 - 11:30 UTC

L2A+

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

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- *Agenda.*

Day: Monday, 20th of November, 2023.

Time: 10:00 - 11:30 UTC.

Webex link: https://noa-react.my.webex.com/meet/vamoir

Agenda:

Title:	Introduction – Welcome.	10:00 – 10:10
Presenter:	Christian Retscher (ESA), Vassilis Amiridis (NOA).	

Title:	WP1000 – Management, reporting and promotion.	10:10 – 10:20
Presenter:	Emmanouil Proestakis (NOA).	

Title:	WP2000 – ASKOS ground-based datasets in support of L2A+.	10:20 – 10:35
Presenter:	Holger Baars (TROPOS).	

Title:	WP3000 – Development of the L2A+ aerosol product.	10:35 – 10:50
Presenter:	Konstantinos Rizos (NOA).	

Title:	WP4000 – Assimilation of L2A/L2A+ and application of WRF-L experiments.	10:50 – 11:05
Presenter:	Athanasios Georgiou (NOA).	

Title:	WP5000 – Impact Studies - KO.	11:05 – 11:10
Presenter:	Emmanouil Proestakis (NOA).	

Title:	Summary, discussion and Concluding Remarks.	11:10-end of PM04

- L2A+ Gantt Chart.

PM04

L2A+ Gantt Chart		2022	2023											2024										DELIVERABLES
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug Sep Oct	
WORKPACKAGES																								**DELIVERABLES**
WP1000: Management, Reporting, and Promotion.	*V. Amiridis / E. Proestakis*																							D01 / D07 / D08
WP2000: ASKOS ground-based datasets in support of L2A+.	*H. Baars*																							D02 / D04 / D05
WP3000: Development of the L2A+ aerosol product.	*K. Rizos / E. Proestakis / *A. Gkikas*																							D03 / D04 / D05
WP4000: Assimilation of L2A/L2A+ and application of WRF-L	*A. Georgiou / A. Kampouri*																							D03 / D05
WP5000: Impact Studies	*E. Proestakis / E. Drakaki / *E. Marinou*																							D06
WP6000: Recommendations	*A. Benedetti*																							D04 / D09
DELIVERABLES																								
D01: Requirements Baseline Document (RB).	*NOA*				□			□																
D02: ASKOS Datasets.	*TROPOS*					□											□						□	
D03: Description of the Algorithm Developments (ALGO)	*NOA*								□				□			□						□		
D04: Analysis of the Validation Activities carried out (VAL)	*NOA / TROPOS/ ECMWF*												□			□						□	□	
D05: Output data product (OP)	*NOA / TROPOS*											□							□				□	
D06: Final Datasets.	*NOA*																				□			
D07: Project website.	*NOA*			□													□							
D08: Multimedia material (MM).	*NOA*												□										□	
D09: Final Report.	*ECMWF*																						□	
MILESTONES / MEETINGS / REVIEWS																								
KO Project Kick-Off		■		●																				
MTR Mid-Term Report - Milestone 2													●											
FR / EoA Final Report - Milestone 3																							●	
PM Progress Meeting				■		■			■							■			■			■		

Status of Deliverable Items

Code	Deliverable Item	Type	Delivery Date	Status
MoM	Minutes of Meeting – Kick-Off Meeting	Documentation	KO	Completed.
PR01	Progress Report 1	Documentation	KO+2 Months	Completed.
D01 – V1	Requirement Baseline Document (RB)	Documentation	KO+3 Months	Completed.
D07 – V1	L2A+ project website (WEB)	Webpage	KO+3 Months	Completed.
MoM-PM01	Minutes of Meeting – Progress Meeting 1	Documentation	KO+3 Months	Completed.
PR02	Progress Report 2	Documentation	KO+4 Months	Completed.
D01 – V2	Requirement Baseline Document (RB)	Documentation	KO+6 Months	Completed.
D02	Data Pool (DP)	Dataset	KO+6 Months	Completed.
PR3	Progress Report 3	Documentation	KO+6 Months	Completed.
MoM-PM02	Minutes of Meeting – Progress Meeting 2	Documentation	KO+6 Months	Completed.
PR04	Progress Report 4	Documentation	KO+8 Months	Submitted.
MoM-PM03	Minutes of Meeting – Progress Meeting 3	Documentation	KO+9 Months	Pending.
D03	Description of the Algorithm Developments (ALGO)	Documentation	KO+9 Months	Pending.
PR05	Progress Report 5	Documentation	KO+10 Months	Pending.
D05	Output data product (OP)	Dataset	KO+12 Months	Pending.
PR06	Progress Report 6	Documentation	KO+12 Months	Pending.
MoM-MTR	Minutes of Meeting – Mid Term Review Meeting	Documentation	KO+12 Months	Pending.
PR07	Progress Report 7	Documentation	KO+14 Months	Pending.
D02	Data Pool (DP)	Dataset	KO+15 Months	Pending.
D03	Description of the Algorithm Developments (ALGO)	Documentation	KO+15 Months	Pending.
D04	Analysis of the Validation Activities carried out (VAL)	Documentation	KO+15 Months	Pending.
MoM - PM04	Minutes of Meeting – Progress Meeting 4	Documentation	KO+15 Months	Pending.
PR08	Progress Report 8	Documentation	KO+16 Months	Pending.
D05	Output data product (OP)	Documentation	KO+18 Months	Pending.
D07 – V2	L2A+ project website (WEB)	Webpage	KO+18 Months	Pending.
PR9	Progress Report 9	Documentation	KO+18 Months	Pending.
MoM - PM05	Minutes of Meeting – Progress Meeting 5	Documentation	KO+18 Months	Pending.
PR10	Progress Report 10	Documentation	KO+20 Months	Pending.
D02	Data Pool (DP)	Dataset	KO+21 Months	Pending.
D03	Description of the Algorithm Developments (ALGO)	Documentation	KO+21 Months	Pending.
D04	Analysis of the Validation Activities carried out (VAL)	Documentation	KO+21 Months	Pending.
D06	Scientific Analysis, Impact Assessment and Scientific Roadmap (SIR)	Documentation	KO+21 Months	Pending.
MoM - PM06	Minutes of Meeting – Progress Meeting 6	Documentation	KO+21 Months	Pending.
PR11	Progress Report 11	Documentation	KO+22 Months	Pending.
D04	Analysis of the Validation Activities carried out (VAL)	Documentation	KO+24 Months	Pending.
D05	Output data product (OP)	Documentation	KO+24 Months	Pending.
D06	Scientific Analysis, Impact Assessment and Scientific Roadmap (SIR)	Documentation	KO+24 Months	Pending.
D08	Multi-media material (MM)	Documentation	KO+24 Months	Pending.
D09	Final Report and Executive Summary Report (FR)	Documentation	KO+24 Months	Pending.
MoM -FR	Minutes of Meeting – Final Review Meeting	Documentation	KO+24 Months	Pending.

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- DIs.

V1

Ref: *Ref: ESA AO/1-11041/22/I-NS*
DI05: Output Data Products (OPs)
Page: 1

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-

Output Data Products
(OPs)

Deliverable Item 05
[DI05]
(Version 1)

Submitted to: Christian Retscher (ESA)

	Name	Function	Date
Prepared by:	E. Proestakis	WP1000 – NOA	11/2023
	K. Rizos	WP3000 – NOA	11/2023
	A. Gkikas	WP3000 – NOA	11/2023
	A. A. Floutsi	WP2000 – TROPOS	11/2023
	H. Baars	WP2000 – Co-I – TROPOS	11/2023
Approved by:	V. Amiridis	PI	11/2023

-

National Observatory of Athens (NOA)
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

ESA-L2A+ Deliverable Item 05 [DI05]

WP2000	
Protocol:	SFTP (Port 22)
Username:	l2aplus_wp2000
Password:	eYst5kuxngzn
Host:	react.space.noa.gr

L2A+ OPs	
Protocol:	SFTP (Port 22)
Username:	l2aplus_ops
Password:	thzq6JMfe9zQoL
Host:	react.space.noa.gr

esa

Comments
&
feedback

- DI05 V2: end of April 2024.

- DI05 V3: end of October 2024.

*To be submitted with PM04 MoM.

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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- Height-resolved feature mask over Mindelo (D2): combination of Cloudnet and PollyNET/EARLINET target classification

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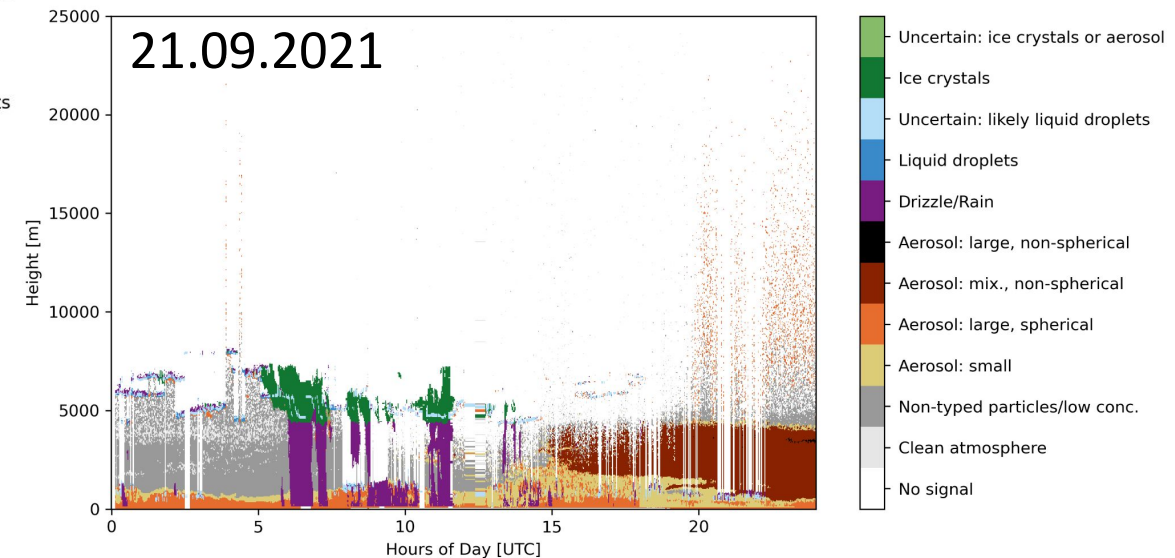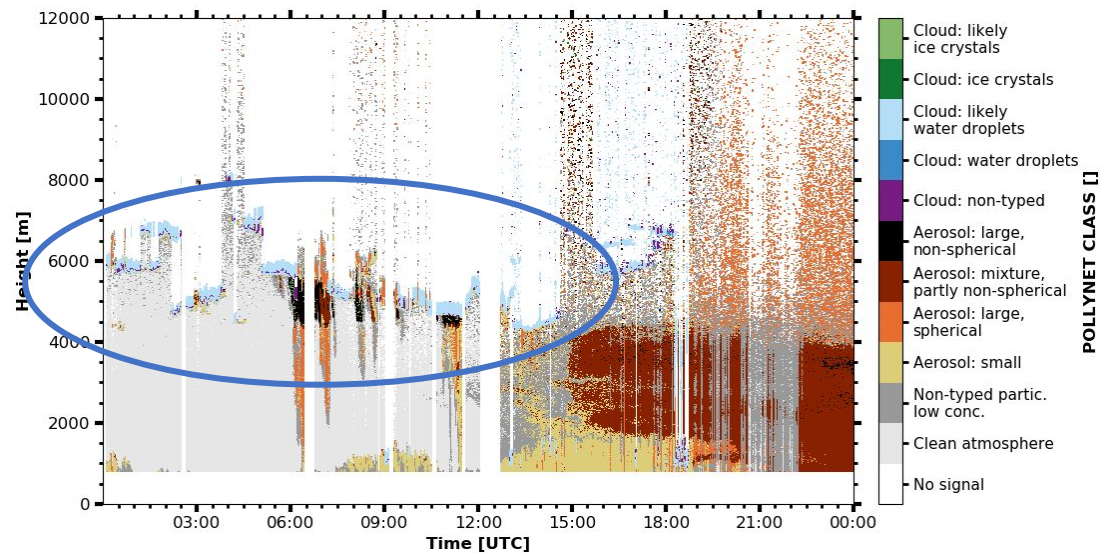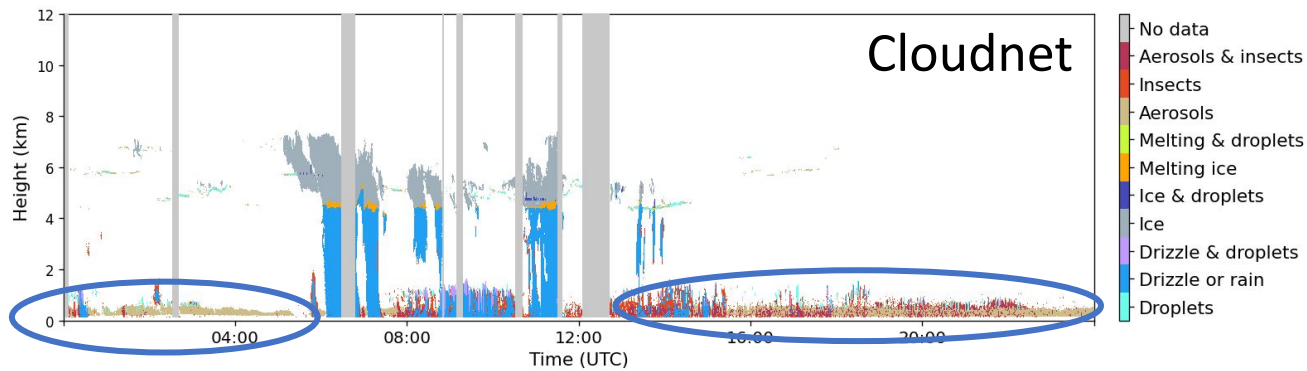
WP2000: *ASKOS ground-based datasets in support of L2A+.*

- Aerosol optical properties for September 2021, June 2022, September 2022 (D2 - new version)
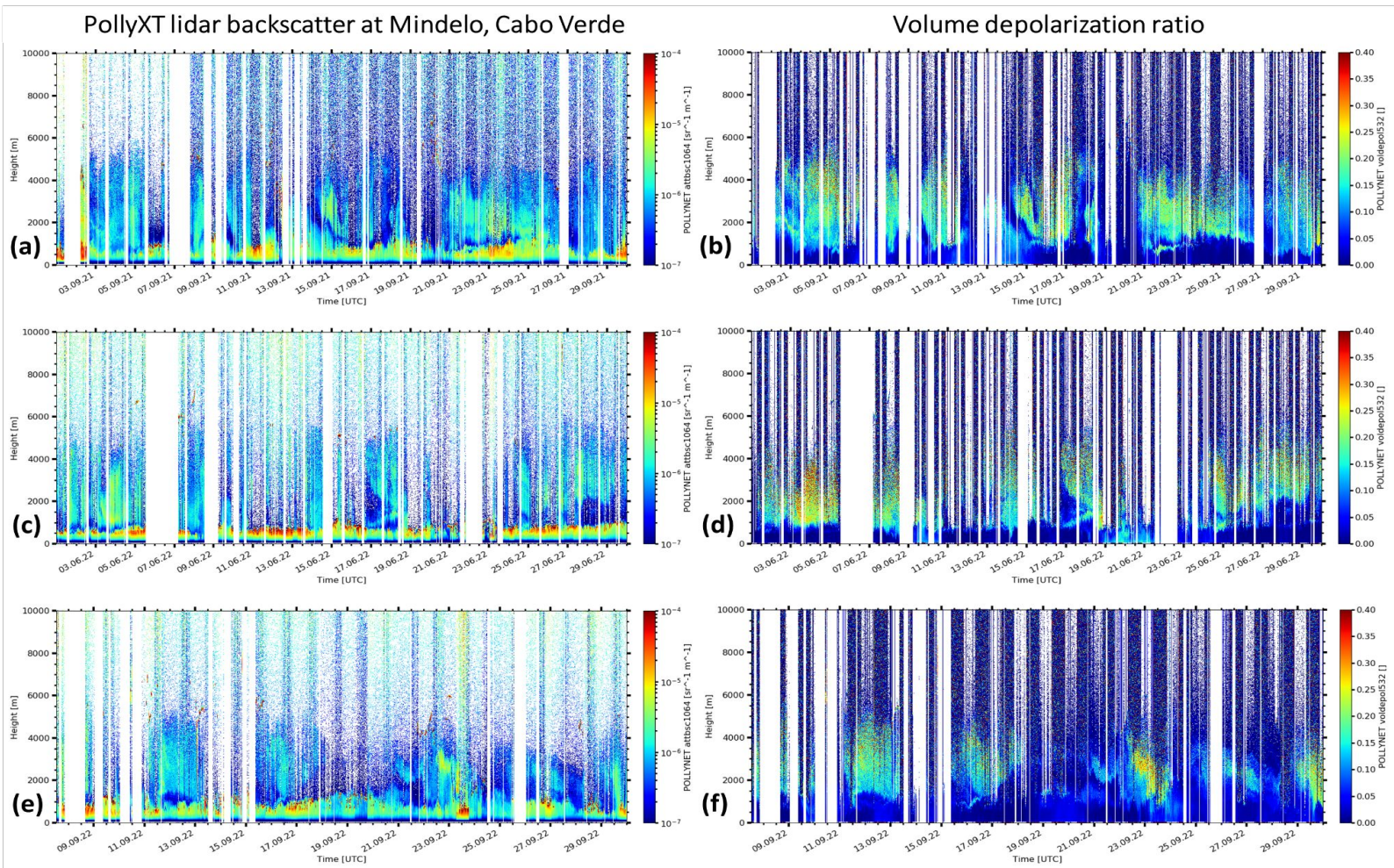
Updated quality-assurance (QA) and cloud screening procedures

- Dust-only profiles for September 2021, June 2022, September 2022 (D5 - based on new version of D2)

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)

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WP3000:	*Development of the L2A+ aerosol product.*
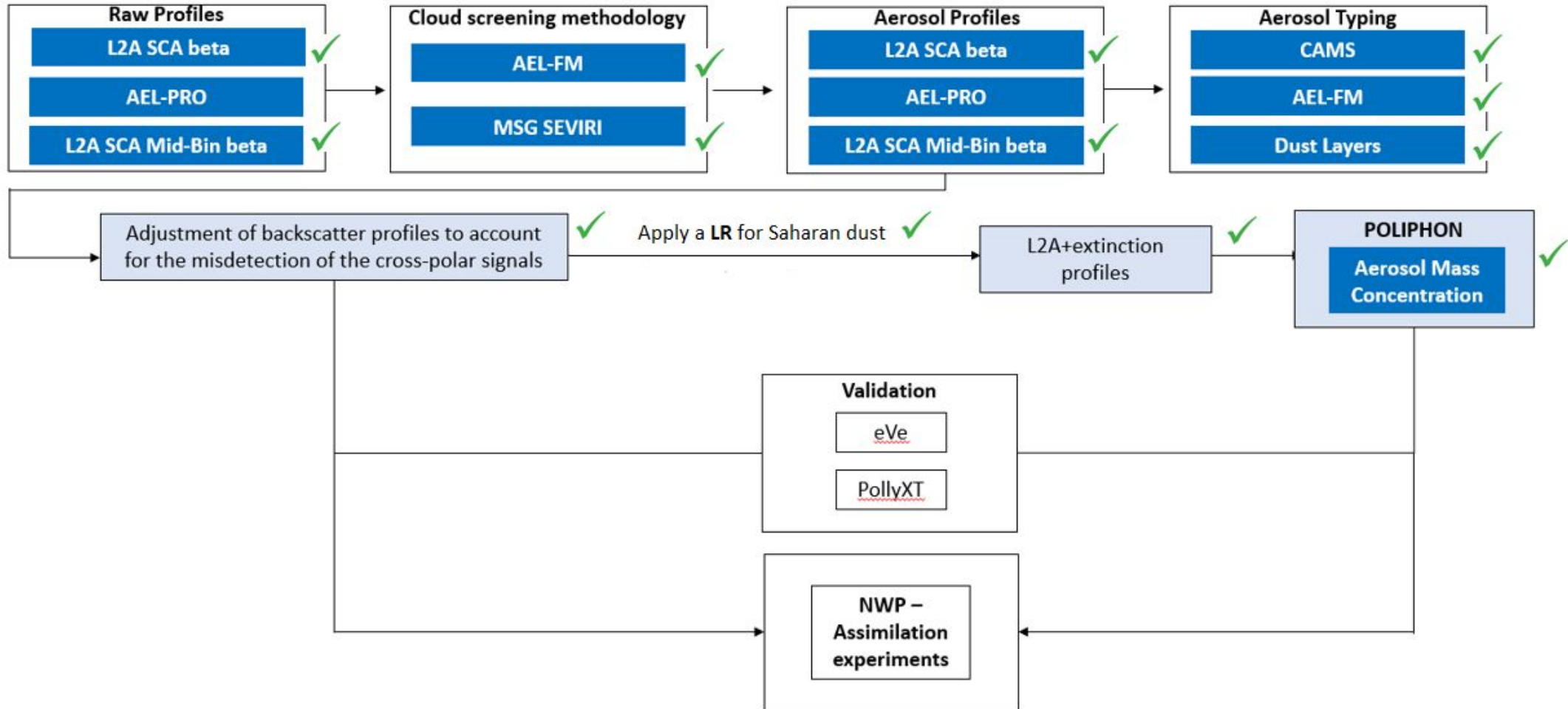
Raw Aeolus L2A retrievals

Aeolus Ascending orbit
Start: 17 Sep 2021 19:32:32UTC
Stop: 17 Sep 2021 19:44:07UTC
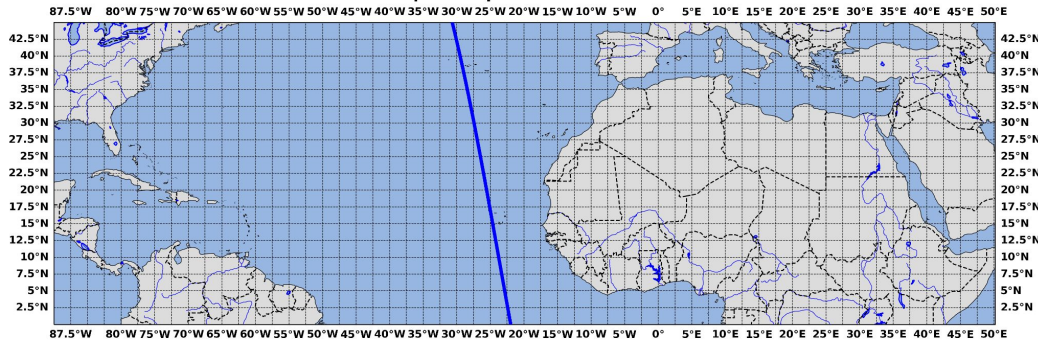
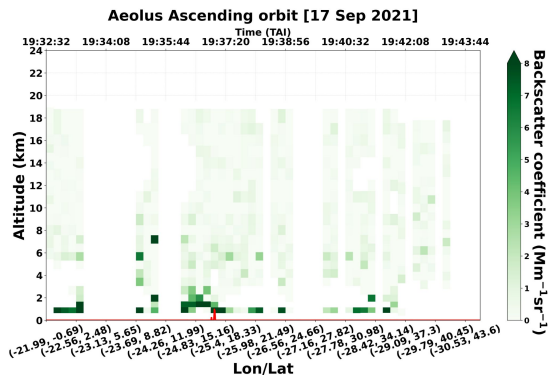- The Raw Extinction and Backscatter Profiles derived from the SCA and SCA Mid-Bin algorithms are presented for an Aeolus overpass on 17 September 2021 (orbit: 017790)

SCA Backscatter

SCA Mid-Bin Backscatter

SCA Extinction

SCA Mid-Bin Extinction

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WP3000: *Development of the L2A+ aerosol product.*
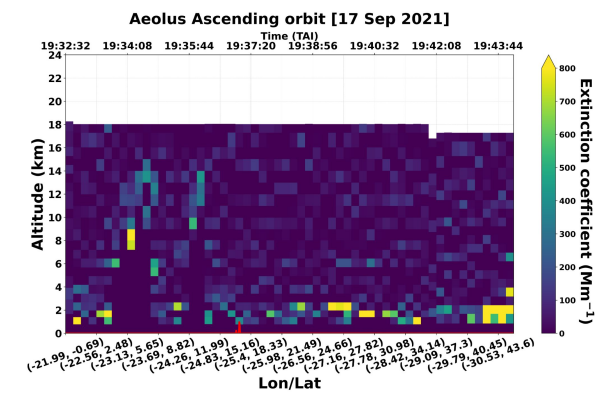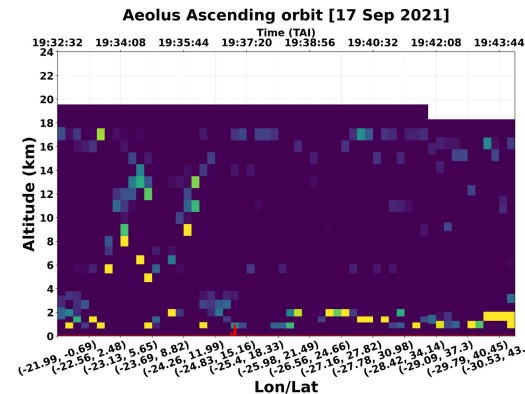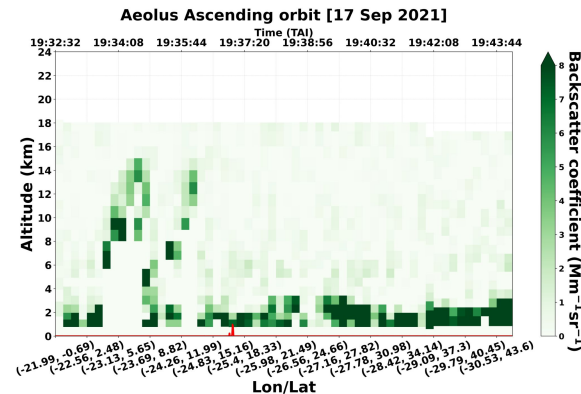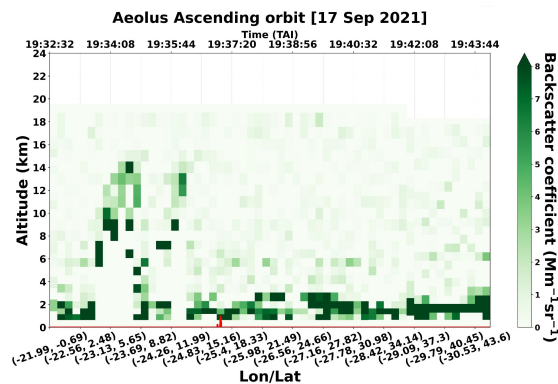
Cloud-filtering based on AEL-FM and MSG CLAAS-3 SEVIRI datasets

AEL-FM

Legend:
- Clouds
- Most likely clouds
- Very likely clouds or aerosols
- More likely clouds or aerosols
- Likely clouds or aerosols
- Expected low altitude aerosol
- Unlikely clouds or aerosol
- Likely only molecules
- Very likely only molecules
- Most likely only molecules
- Clear sky
- Fully Rayleigh attenuated
- No retrievals
- Surface data
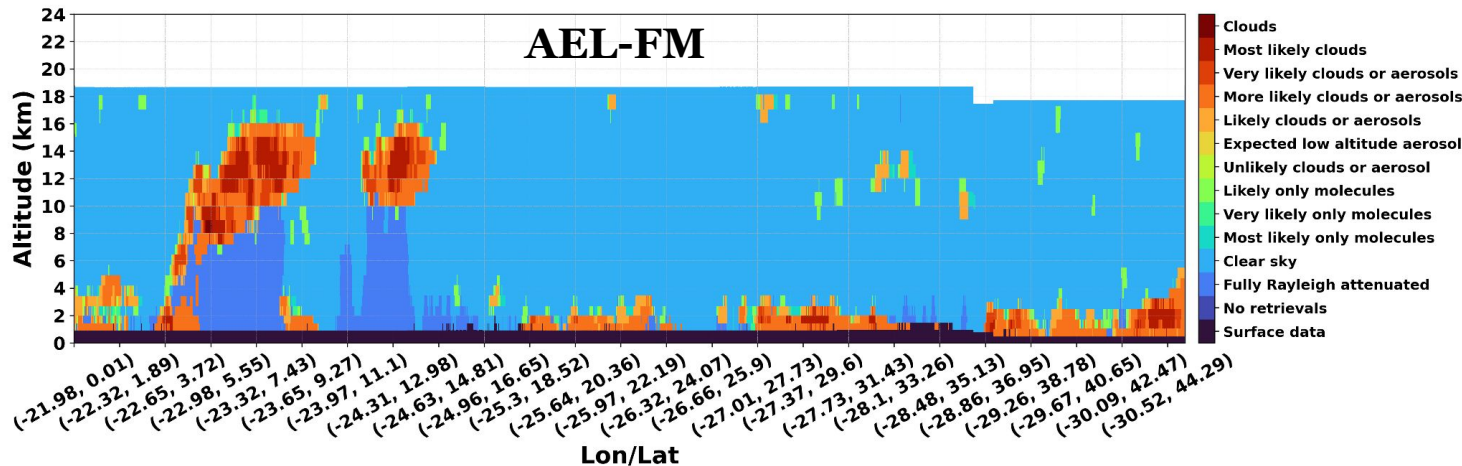
Aeolus Ascending orbit
Start: 17 Sep 2021 19:32:32UTC
Stop: 17 Sep 2021 19:44:07UTC
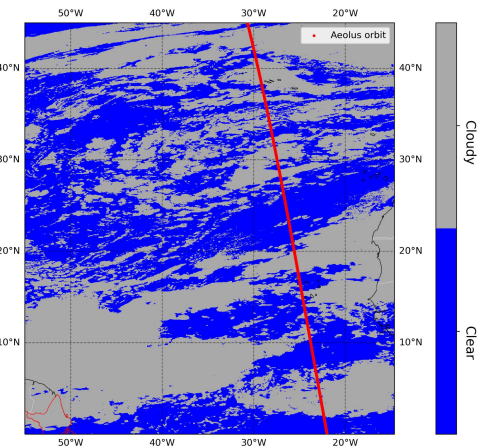
Cloud-free SCA Backscatter

Cloud-free SCA Mid-Bin Backscatter

Cloud-free SCA Extinction

Cloud-freeSCA Mid-Bin Extinction

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WP3000: *Development of the L2A+ aerosol product.*
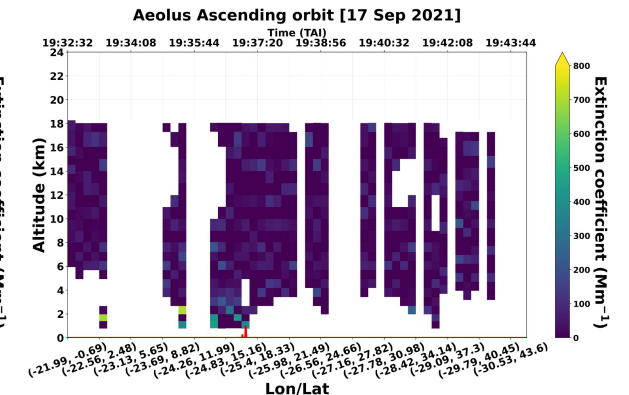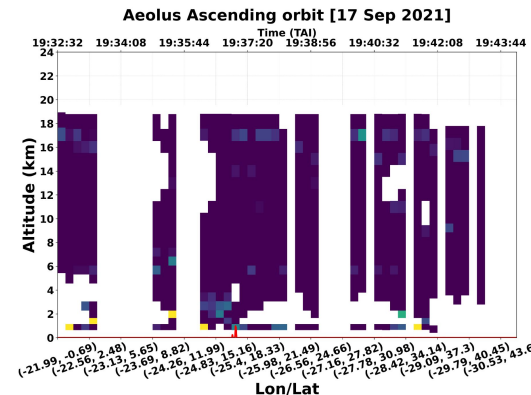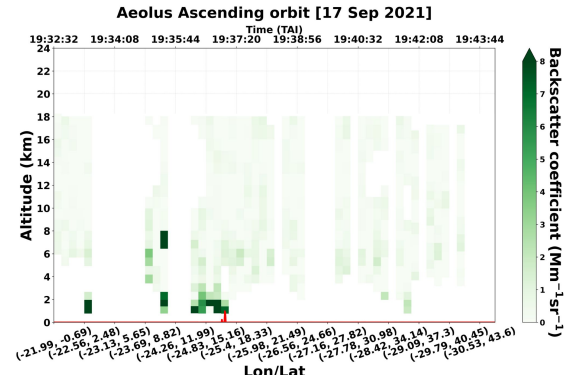
Aerosol typing using CAMS reanalysis dataset

- 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.

Date: 17 Sep 2021 21:00 UTC
Pressure Level: 710 hPa

Dust mass concentration (μg/m³)

Aeolus Ascending orbit [17 Sep 2021]

WP3000:	*Development of the L2A+ aerosol product.*
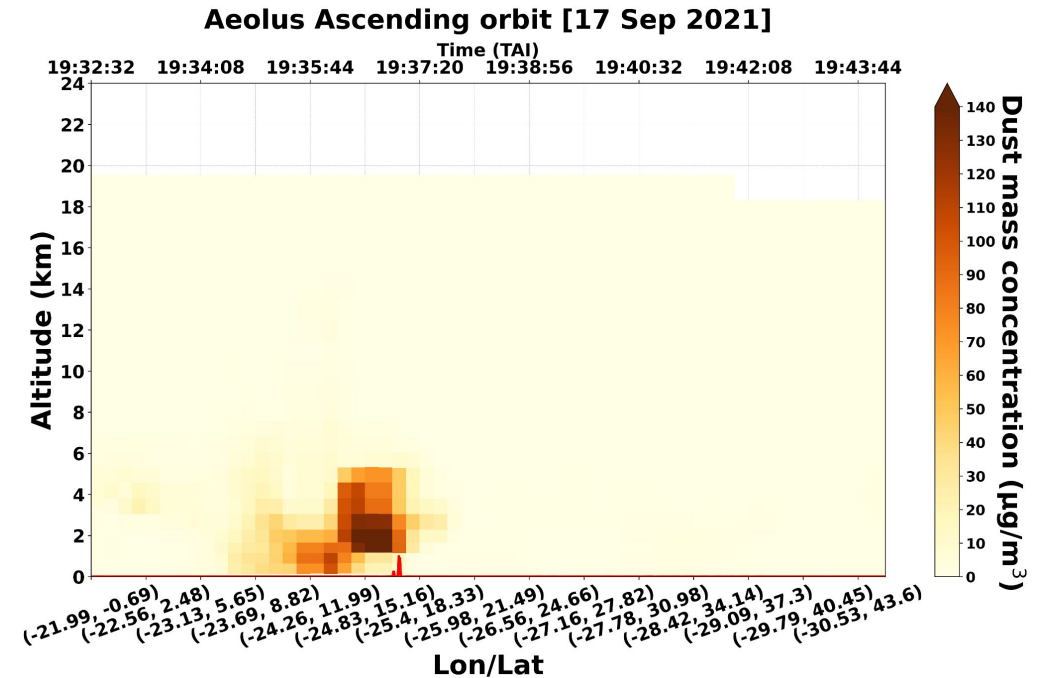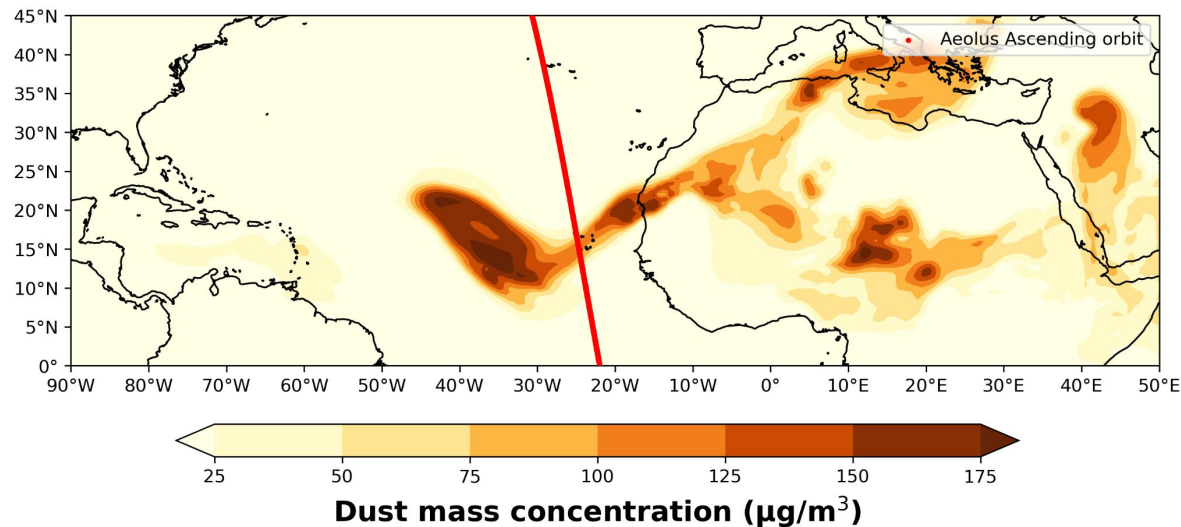
Reconstruction of the Aeolus cloud-free dust extinction profiles

Aeolus cloud-free dust extinction profiles were reconstructed through the following **steps**:

1. Derivation of the missing cross-polar backscatter: **bcross = bco * PCDR**, PCDR the Particle Linear Depol.Ratio (355nm) computed by **PCDR = 2*PLDR/(1 − PLDR)** (The value of PLDR for mineral particles was selected according to the DeLiaN database (Floutsi et al., 2023))
2. Derivation of the total backscatter profiles by summing the co-polar and cross-polar backscatter.
3. Computation of the new extinction profiles using the total backscatter and a lidar ratio for Saharan dust (LR = 53.5 sr).

Co-polar SCA Backscatter
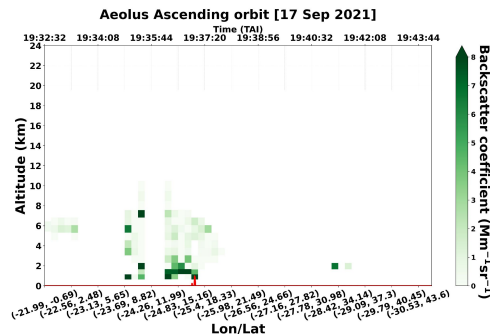
Cross-polar SCA Backscatter
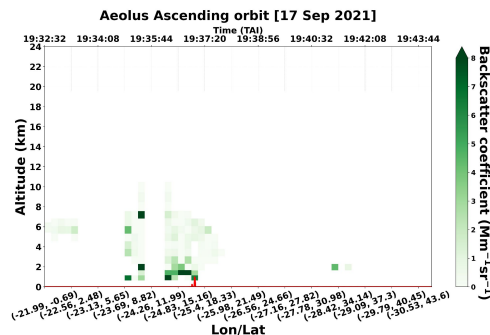
Total SCA Backscatter
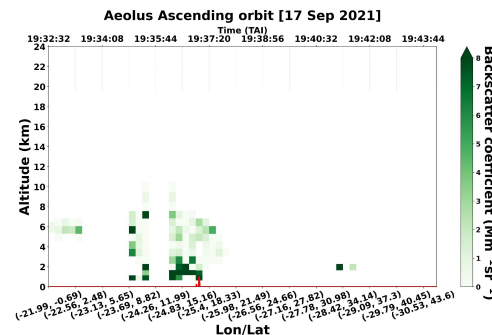
Apply **LR=53.5sr** for Saharan dust

L2A+ Extinction (355nm)

L2A+

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WP3000: *Development of the L2A+ aerosol product.*
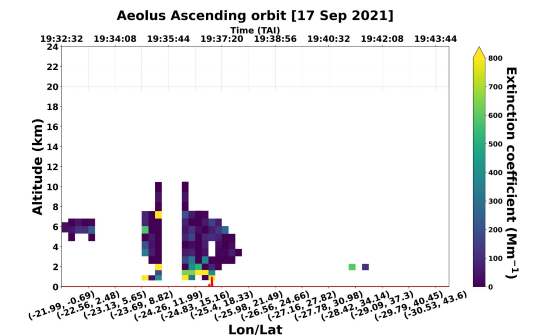
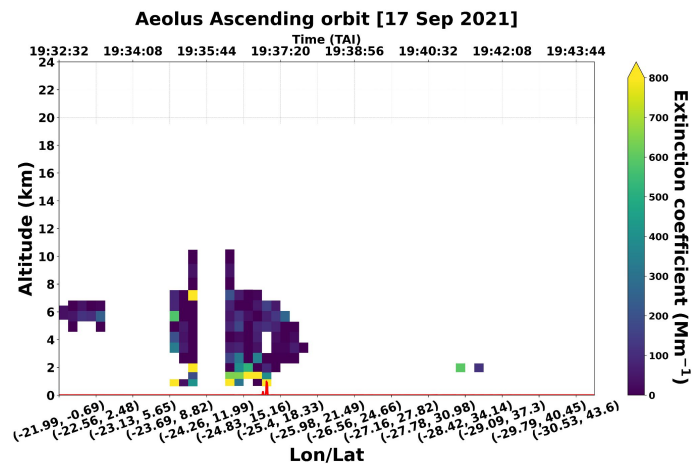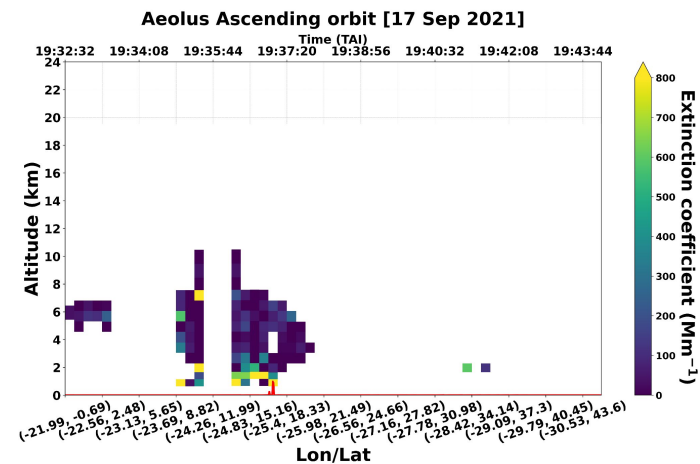### Derivation of dust mass concentration

• 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.
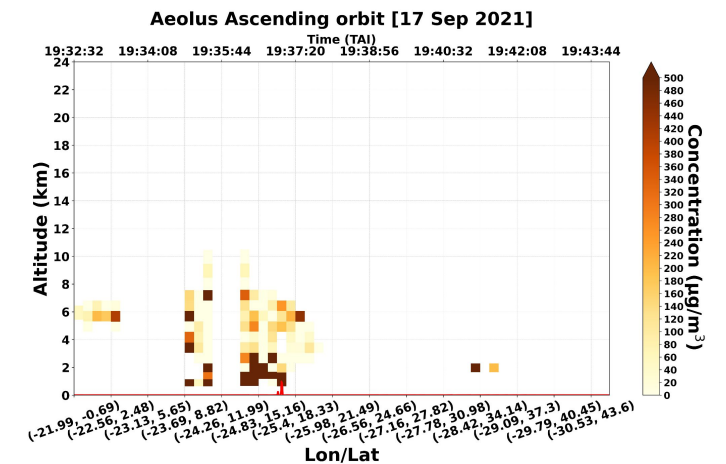
L2A+ Extinction (355nm)　　　　L2A+ Extinction (532nm)　　　　Mass Concentration

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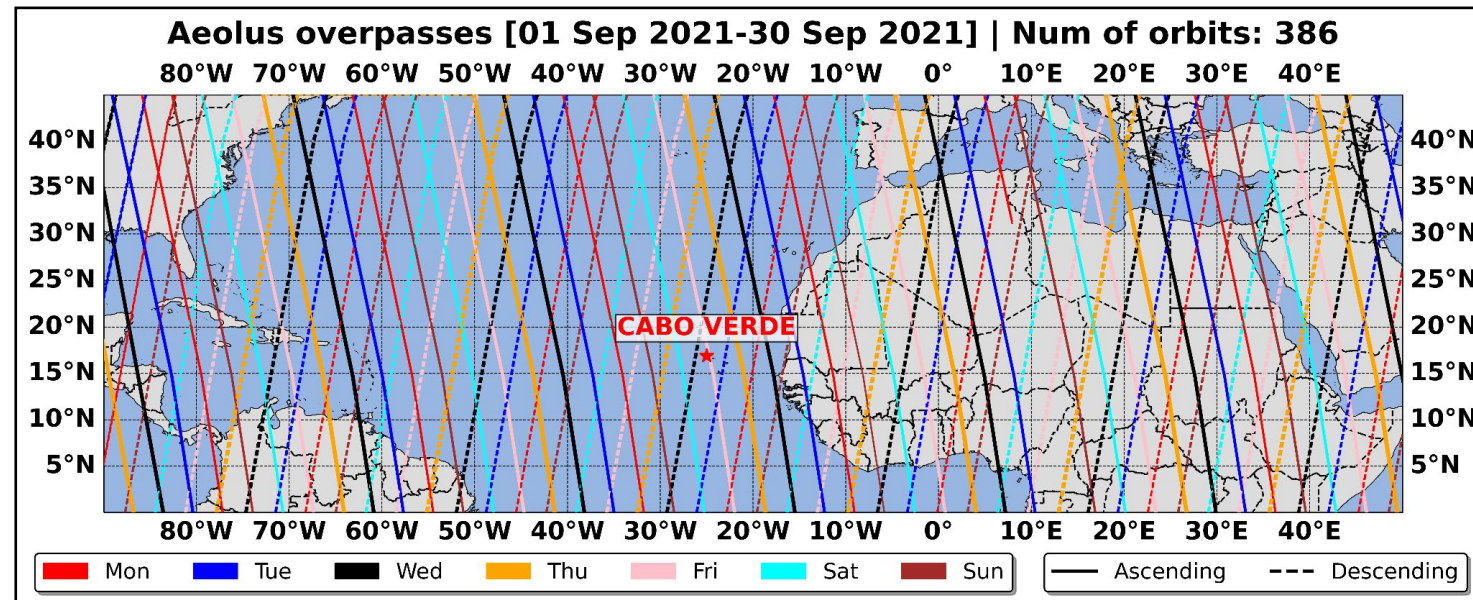| WP3000:	*Development of the L2A+ aerosol product.*

NetCDF output format

- All the Raw and L2A+ Aeolus retrievals have been included to three netcdf file for three indicative Aeolus overpasses on 10th, 17th, and 24th September 2021.
- The files have been uploaded to: "/mnt/nas-2/L2Aplus/OPs/ncfiles"

Name	Long Name	Type
▼ AE_OPER_ALD_U_N_2A_17_Sep_2021_19_32_32_19_44...	AE_OPER_ALD_U_N_2A_17_Sep_2021_19_32_32_19_44_08.nc4	Local File
▼ CLOUD_FILTERED	CLOUD_FILTERED	—
▶ 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	—
▼ SCA	SCA	—
alpha_plus_355	L2A+ extinction coefficient at 355nm	2D
alpha_plus_532	L2A+ extinction coefficient at 532nm	2D
beta_co	Co-component of backscatter coefficient	2D
beta_cross	Cross-component of backscatter coefficient	2D
beta_total	Total backscatter coefficient	2D
dust_concentration	Dust mass concentration	2D
▼ SCA_MID_BIN	SCA_MID_BIN	—
alpha_plus_355	L2A+ extinction coefficient at 355nm	2D
alpha_plus_532	L2A+ extinction coefficient at 532nm	2D
beta_co	Co-component of backscatter coefficient	2D
beta_cross	Cross-component of backscatter coefficient	2D
beta_total	Total backscatter coefficient	2D
dust_concentration	Dust mass concentration	2D
▼ PURE_DUST	PURE_DUST	—
▶ SCA	SCA	—
▶ SCA_MID_BIN	SCA_MID_BIN	—
▼ RAW_DATA	RAW_DATA	—
▶ SCA	SCA	—
▶ SCA_MID_BIN	SCA_MID_BIN	—

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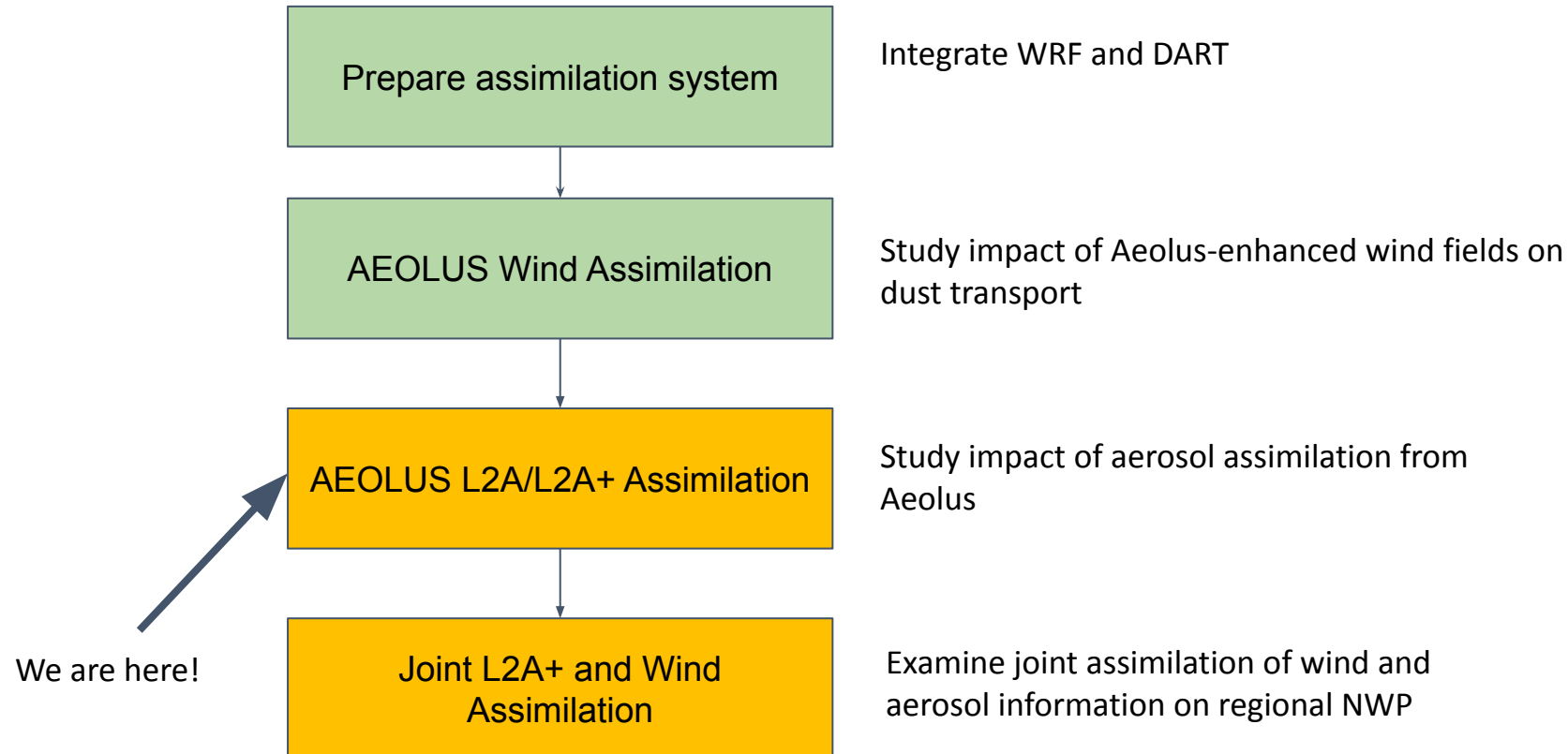
Next steps of WP3000

- **Evaluation of the new L2A+ product versus eVe and Polly^{XT}**

- **Expand the methodology to all the Aeolus overpasses that fall within the RoI for the study period of September 2021** (see figure)

Aeolus overpasses [01 Sep 2021-30 Sep 2021] | Num of orbits: 386

L2A+

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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.

L2A+

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

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

Work package begun in May 2023

Work Plan for WP4000

Box	Description
Prepare assimilation system	Integrate WRF and DART
AEOLUS Wind Assimilation	Study impact of Aeolus-enhanced wind fields on dust transport
AEOLUS L2A/L2A+ Assimilation	Study impact of aerosol assimilation from Aeolus
Joint L2A+ and Wind Assimilation	Examine joint assimilation of wind and aerosol information on regional NWP

We are here!

L2A+

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

aeolus   ECMWF TROPOS

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

✅Added AEOLUS winds support to the Data Assimilation Research Testbed (DART)

- Available online:
  `https://github.com/NOA-ReACT/DART/tree/aeolus`
- **WIP**: Extinction assimilation
- **TODO**: Contribute to upstream project

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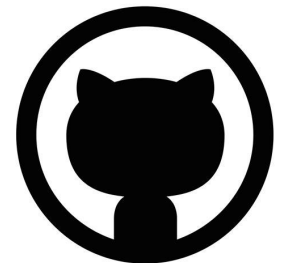
✅WRF-DART integration

DART documentation states:

> *We do not claim that this is a "turnkey" or "black box" system. Be mentally prepared to invest a reasonable amount of time on the learning curve. There are many outstanding research issues which have no easy answers. This is not a one week/grad student/naive user system.*

We tried to fix that. Available online:

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

WIP: Add WRF-CHEM support

TODO: Documentation

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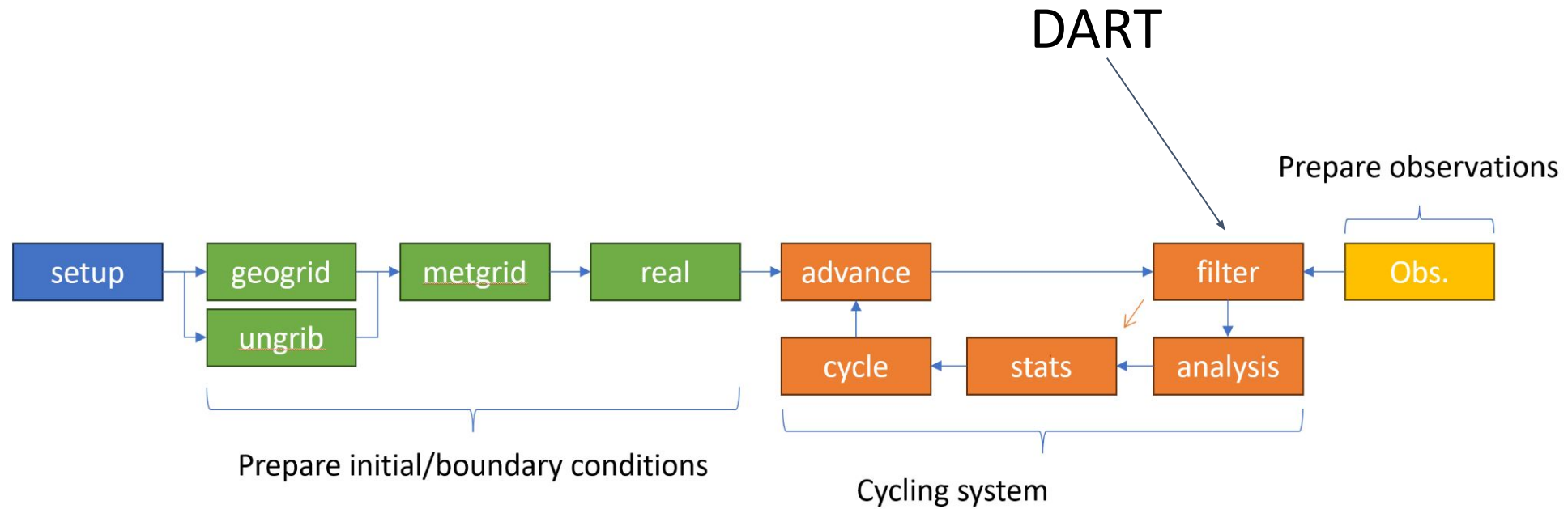
Wind assimilation experiment:
- North Atlantic domain, 30×30 km spatial resolution
- ERA5 Reanalysis initial/boundary conditions
- WRF v4.5.1 (latest)
- AEOLUS L2B Assimilation (Mie only)
- 6h cycles, 7 days
- Figure shows 885 hPa pressure level

WP5000:	*Scientific Analysis and Impact Assessment.*

Objective:	To assess the impact of the L2A+ product.
Inputs:	1) DI02: ASKOS observational dataset and Data Pool. 2) 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.

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WP5200: *Scientific Analysis and Impact Assessment.*

L2A+ products and quantification of dust deposition variability across the N. Atlantic Ocean.

The ESA-DOMOS project: To create a unique 4D-reconstruction of the dust full cycle including deposition based on the synergy of models and observations including vertical profiling through the use of advanced retrieval methods and of 4D-Var and Ensemble Kalman Filter analyses.