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The Joint Aeolus Tropical Atlantic Campaign - First Results for Aeolus Calibration/Validation and Science in the Tropics

Gail Skofronick-Jackson, Thorsten Fehr, Dietrich Althausen, Vassilis Amiridis, Holger Baars, Jonas von Bismarck, Maurus Borne, Tânia Casal, Quitterie Cazenave, Shuyi Chen, et al.

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A central graphic for ATMOS 2021. It features a globe with a satellite in orbit. The globe is surrounded by a circular arrangement of 12 smaller circular images, each showing a different atmospheric or satellite data visualization. The text 'ATMOS 2021' is overlaid in large, white, bold letters across the center of the globe.


ATMOS 2021

The Joint Aeolus Tropical Atlantic Campaign First Results for Aeolus Calibration/Validation and Science in the Tropics

Thorsten Fehr on behalf of the JATAC Community

ATMOS2021

25/11/2021



Gail Skofronick-Jackson^{1,16}, Thorsten Fehr², Dietrich Althausen³, Vassilis Amiridis⁴, Holger Baars³, Jonas von Bismarck⁵, Maurus Borne⁶, Tânia Casal², Quitterie Cazenave⁷, Shuyi Chen⁸, Ronny Engelmann³, Cyrille Flamant⁷, Marco Gaetani⁹, Alexander Geiß¹⁰, Sofia Gómez Maqueo Anaya³, Peter Knipperz⁶, Pavlos Kollias⁴, Rob Koopman², Trismono Krisna², Christian Lemmerz¹⁰, Oliver Lux¹⁰, Eleni Marinou⁴, Uwe Marksteiner¹⁰, Griša Močnik¹¹, Anca Nemuc¹², Tommaso Parrinello⁵, Peristera Paschou⁴, Aaron Piña¹, Razvan Pirloaga¹², Stephan Rahm¹⁰, Oliver Reitebuch¹⁰, Andreas Schäfler¹⁰, Nikos Siomos⁴, Annett Skupin³, Anne Grete Straume², Viet Duc Tran¹³, Pouya Vaziri¹⁰, Ulla Wandinger³, Tobias Wehr², Fabian Weiler¹⁰, Denny Wernham², Benjamin Witschas¹⁰, Cordula Zenk^{14,15} and many more

¹Science Mission Directorate, NASA, Washington, USA;

²ESA/ESTEC, The Netherlands;

³Leibniz Institute for Tropospheric Research, Leipzig, Germany;

⁴IAASARS, National Observatory of Athens, Penteli, Greece;

⁵ESA/ESRIN, Italy;

⁶Karlsruhe Institute of Technology, Karlsruhe, Germany;

⁷LATMOS/IPSL, CNRS, Sorbonne Université, Université Paris-Saclay, Paris, France;

⁸Department of Atmospheric Sciences, University of Washington, Seattle, USA;

⁹Scuola Universitaria Superiore IUSS, Pavia, Italy;

¹⁰Institute für Physik der Atmosphäre, DLR, Oberpfaffenhofen, Germany;

¹¹University of Nova Gorica, Ajdovščina, Slovenia;

¹²National Institute of Research&Development for Optoelectronics, INOE, Magurele, Romania;

¹³Directorate of Operations, ESA, Darmstadt, Germany;

¹⁴Ocean Science Centre Mindelo, Mindelo, Cape Verde;

¹⁵GEOMAR Helmholtz Centre for Ocean Research, Kiel, Germany;

¹⁶Deceased 07 September 2021

JATAC Campaign Objectives



Campaign Objectives:

- Aeolus Validation, support to EarthCARE and WIVERN preparation
- Tropical convection, aerosol transport, winds, and atmospheric scale interactions
 - Dry air and Saharan dust associated with African Easterly Waves and the African Easterly Jet
 - Interactions of wind, aerosol, clouds, and precipitation and effects on long range transport and Air Quality
 - Vertical structure and variability of the marine boundary
 - Interactions of convective cloud systems and tropospheric winds

- Instrument performance
- Precision, unknown bias and response slope error
- Influence of homogenous and inhomogeneous atmospheres
- Temperature and pressure correction
- Mie and Rayleigh Response calibration and of the zero-wind calibration
- Accuracy and variability of the products

Validation

JATAC

Science

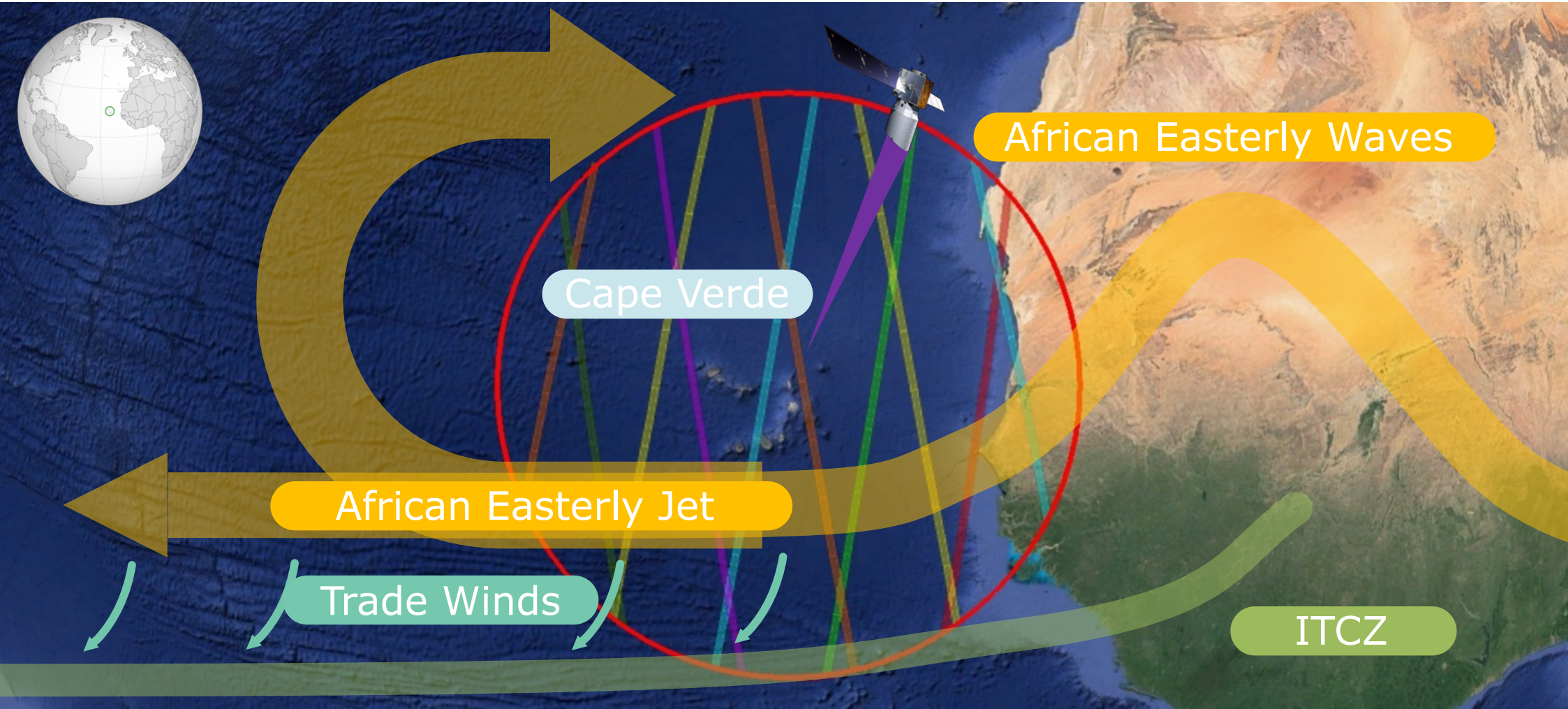
Technology

- Lidar technology developments, e.g., Aeolus-FO
- Supporting future developments
- Testing new reference measurements

- Wind and optical products development
- Preparation and support of the scientific exploitation, e.g., Tropical dynamics, gravity waves, dust transport, ...
- Supporting the operational use of DWL observations









Wind Systems, dust and clouds







Tropical Campaign – Instruments









Askos 

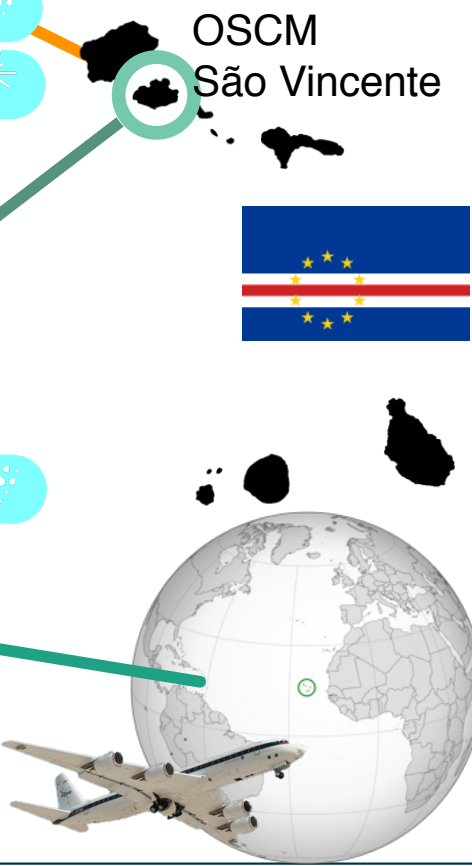
- ESA-EVE 
- ACTRIS Aerosol 
- ACTRIS Cloud Radar 
- Doppler wind lidar 
- ... and more 


Light Aircraft 



- Nephelometers 
- Filter light abs. photom. 
- Optical particle counters 


CPEX-AW 








- DAWN 
- HALO 
- Drosondes 
- APR-3 
- HAMSR 



AVATAR-T 

- A2D 
- 2 μ m-DWL 

CADDIWA 

- LNG 
- RASTA 
- CLIMAT 
- Drosondes 
- GDP/CIP 
- Nevzorov P 
- UHSAS/FSSP 



ATMOS2021 - Joint Aeolus Tropical Atlantic Campaign



Campaign - in a nutshell



Campaign - Calendar



Flight and Measurement Operations Summary

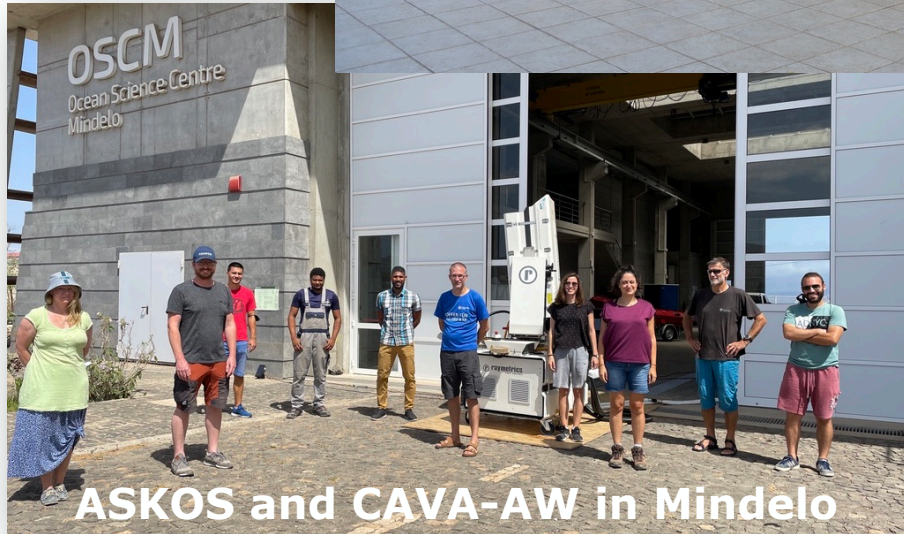
Date	DLR Falcon-20	Safire Falcon 20	Aerovizija Advantec-10	ASKOS	DC-8	Notes
Tue., 17 August 2021						
Wed., 18 August 2021						
Thu., 19 August 2021						
Fri., 20 August 2021						
Sat., 21 August 2021						Flight incl. Aeolus underflight
Sun., 22 August 2021						Flight incl. Aeolus underflight
Mon., 23 August 2021	Aeolus:	Total:				
Tue., 24 August 2021	42.5 fl. hrs.	32 fl. hrs.				Flight incl. Aeolus underflight
Wed., 25 August 2021	11 underfl.s	11 underfl.s				
Thu., 26 August 2021	10600 km	12000 km				Flight incl. Aeolus underflight
Fri., 27 August 2021						
Sat., 28 August 2021						Flight Hurricane IDA
Sun., 29 August 2021						
Mon., 30 August 2021						
Tue., 31 August 2021						
Wed., 1 September 2021						Flight incl. Aeolus underflight
Thu., 2 September 2021						
Fri., 3 September 2021						
Sat., 4 September 2021						Flight Hurricane Larry
Sun., 5 September 2021			Transfer Flight (no obs)	Operational		
Mon., 6 September 2021	Transfer Flight (obs)	Transfer Flight (no obs)		Operational		
Tue., 7 September 2021			Test flight with observatio	Operational		
Wed., 8 September 2021	Aeolus Underpass AM	Aeolus Underpass AM	Aeolus Underpass AM	Operational		D/S/A flight with Mindelo overpass
Thu., 9 September 2021	Aeolus Underpass PM	Down Day	Aeolus Underpass PM	Operational	Transfer	D/A flight
Fri., 10 September 2021	Aeolus Underpass PM	Aeolus Underpass PM	Aeolus Underpass PM	Operational		D/S/A tripple flight with Mindelo overpass
Sat., 11 September 2021		μPhysics AM + PM	Local Flights	Operational		
Sun., 12 September 2021				Operational		
Mon., 13 September 2021	Aeolus Underpass PM	Down Day	Local Flights	Operational		
Tue., 14 September 2021		Aeolus Underpass AM	Local Flights	Operational		
Wed., 15 September 2021				Operational		
Thu., 16 September 2021	Aeolus Underpass PM	Aeolus Underpass PM	Aeolus Underpass PM	Operational		D/S/A tripple flight
Fri., 17 September 2021	Aeolus Underpass PM	Aeolus Underpass PM	Aeolus Underpass PM	Operational		D/S/A tripple flight with Mindelo overpass
Sat., 18 September 2021		μPhysics AM		Operational		Mindelo Overpass
Sun., 19 September 2021		μPhysics AM		Operational		
Mon., 20 September 2021	Aeolus Underpass AM	Down Day	Transfer Flight SID-LPA w	Operational		
Tue., 21 September 2021	Aeolus Underpass AM	grounded	Transfer Flight LPA-XRY	Operational		
Wed., 22 September 2021	Aeolus Underpass AM	grounded	Transfer Flight XRY-MBX	Operational		
Thu., 23 September 2021	Aeolus Underpass PM	Transfer Flight	-	Operational		
Fri., 24 September 2021	Aeolus Underpass PM	-	-	Operational		
Sat., 25 September 2021						
Sun., 26 September 2021	Calibration Flight					
Mon., 27 September 2021						
Tue., 28 September 2021	Transfer Flight					



It all about the teams!



AVATAR-T and CADDIWA on Sal



ASKOS and CAVA-AW in Mindelo



CPEX-AW in St. Croix

ATMOS2021 - Joint Aeolus Tropical Atlantic Campaign



And the person we will miss ...

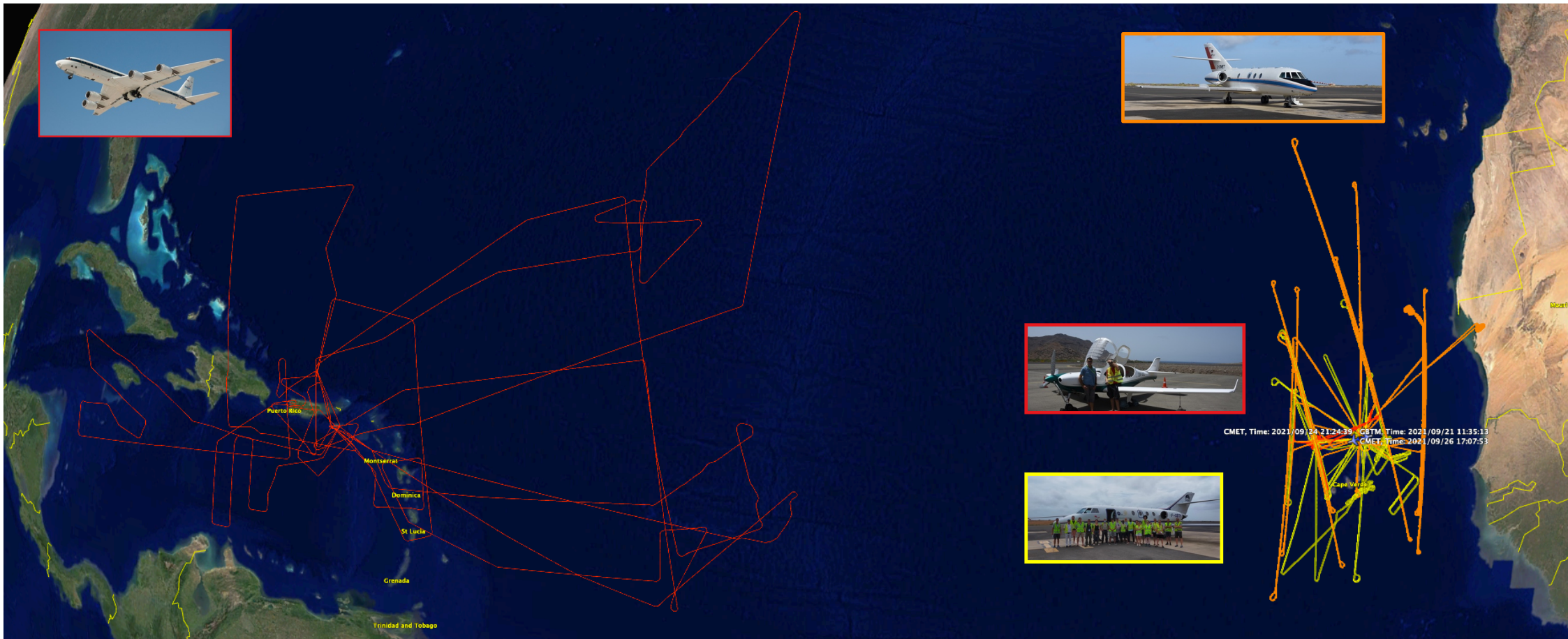


In memory of our colleague and friend Gail.

The Aircraft – Leading the way



Joint Aeolus Tropical Atlantic Campaign – From East to West



On the ground – some examples!



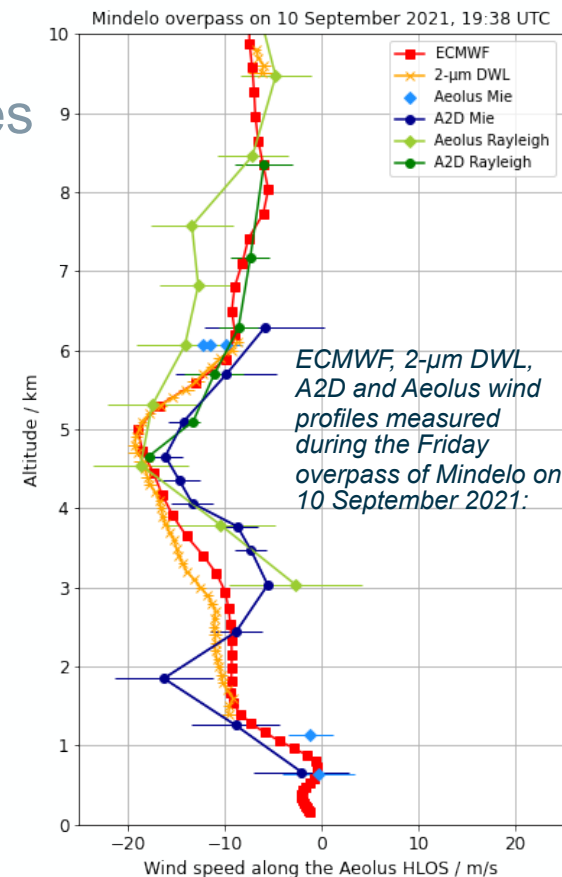
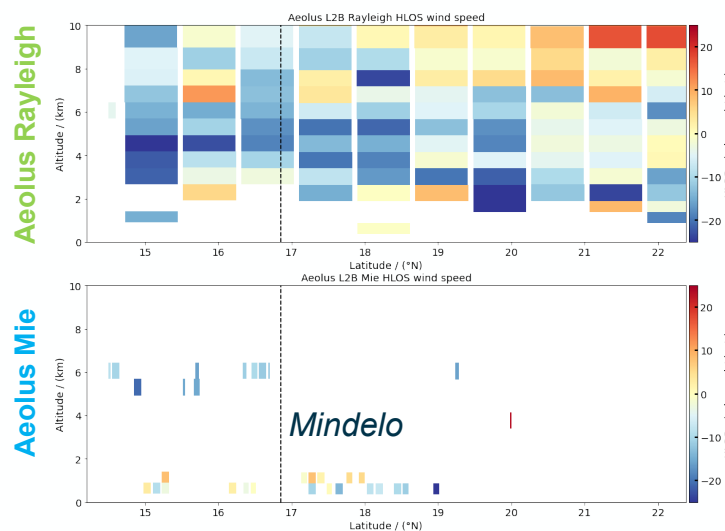
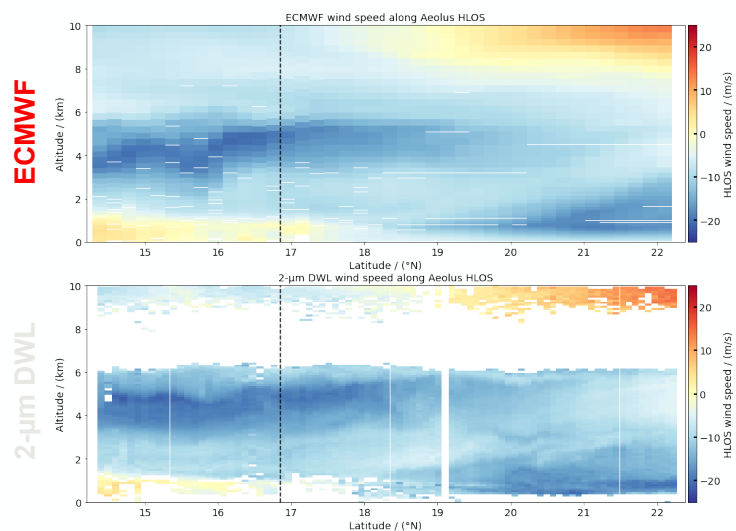
P1.3.6:
 EVE Polarization Lidar on
 the Joint Aeolus Tropical
 Atlantic Campaign 2021 –
 First Results of Aeolus L2A
 Products Validation
 Peristera Paschou, NOA,
 Greece



AVATAR-T Status



- Analysis is ongoing – first preliminary results are available, but analysis was slowed down by Aeolus re-switch on activities



ECMWF, 2-µm DWL and Aeolus wind results measured along the ascending orbit on 10 September 2021



AVATAR-T Status: A2D Winds



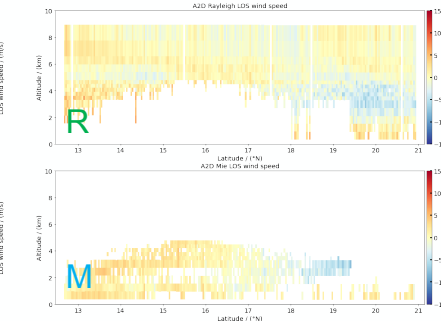
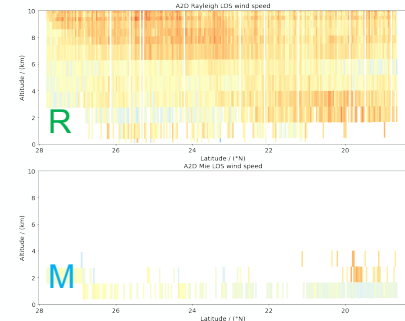
08/09

13/09

20/09

23/09

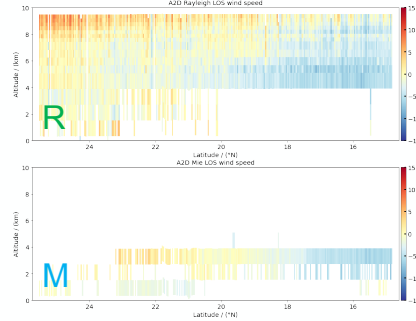
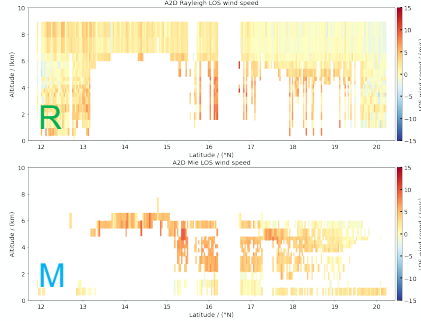
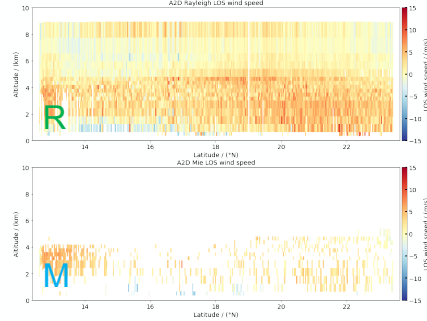
24/09



09/09

16/09

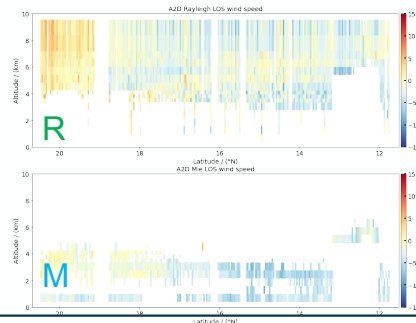
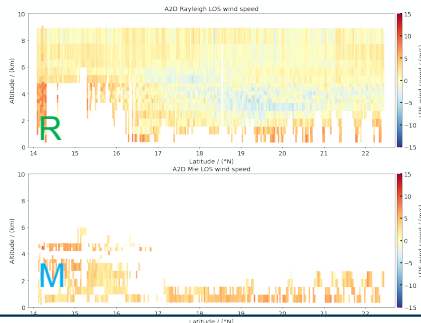
21/09



10/09

17/09

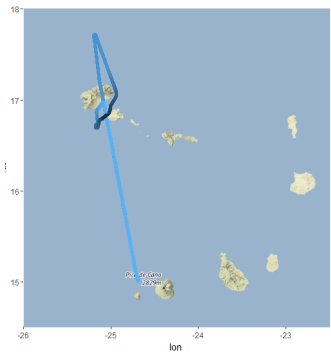
22/09



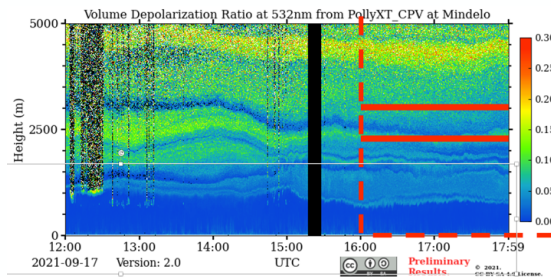
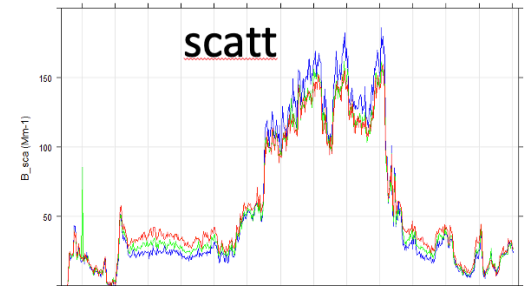
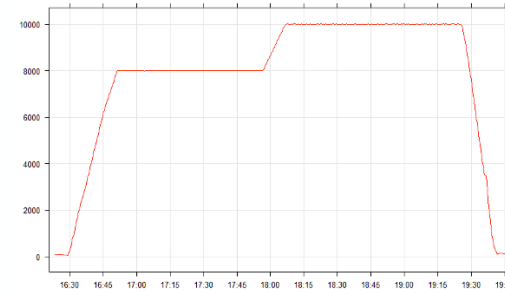
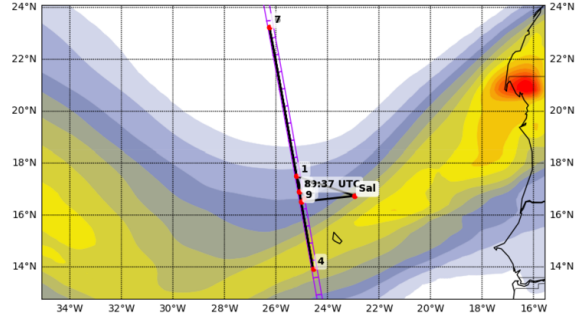
- 11 Aeolus underflights typically covering >1000 km of the Aeolus swath (≈ 60...90 min of measurement time)
- Very good A2D data coverage thanks to complimentary Rayleigh and Mie channel
- Rayleigh winds are obtained from clear sky above clouds and SAL
- Mie winds are collected from cloud and aerosol backscatter
- Wind speeds are rather low (<10 m/s LOS)



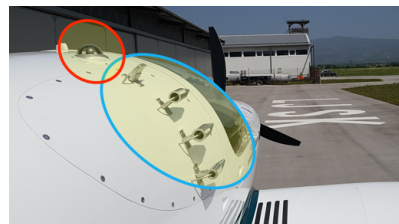
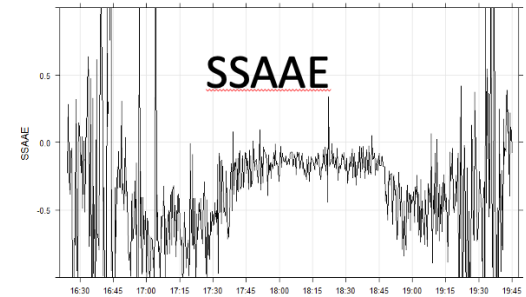
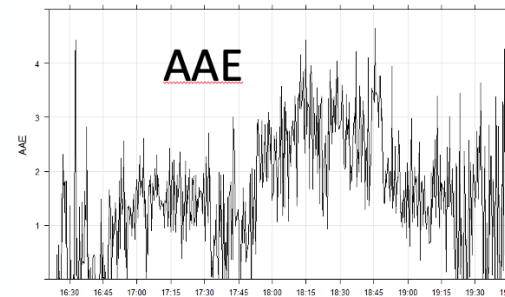
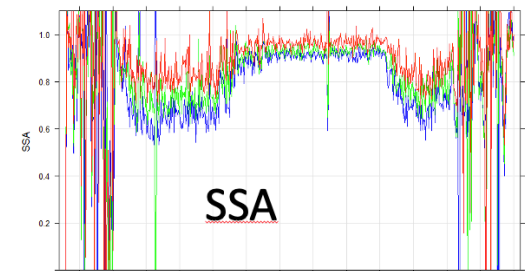
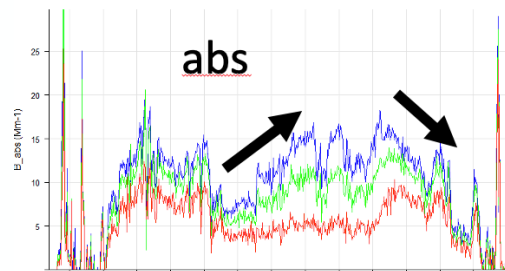
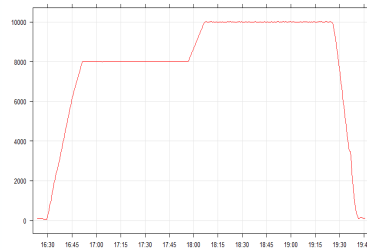
CAVA-AW: 17 September 2021



Dust aerosol optical depth at 550 nm (provided by CAMS, the Copernicus Atmosphere Monitor)
Valid: 2021-09-17T18:00:00Z



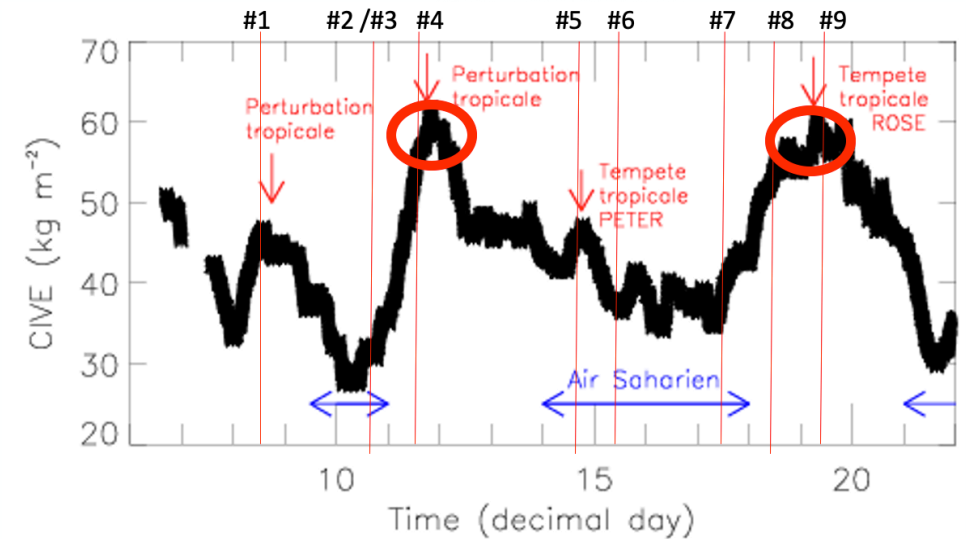
3 km
2.4 km



CADDIWA: Summary



- Nine flights realized in 8 days for:
 - ❖ 32 flight hours
 - ❖ 46 dropsondes dropped
 - ❖ 12000 km covered by the SAFIRE Falcon 20
- 5 flights along Aeolus orbits & documentation of Saharan air transport episodes (*Aeolus & IASI Cal/Val*)
- 4 flights for providing proxy data for EarthCARE E2E development and data for EE11 Wivern radar phase A studies (*EartCARE & Wivern preparation*)
- 4 flights in the environment of disturbances and tropical storms developing on African east waves, including the Tropical Storm ROSE → **11 Sept case Vs 18/19 Sept case**
 - ❖ Contrasted cases of interaction with Saharan Air Layer (Tropical Disturbance on 11 Sept did not develop into a Tropical Storm because of dust?)
- GNSS station now in Praia with University of CV@Praia with Mateus and Nicolau →
 - ❖ Education and research purposes with new teaching program



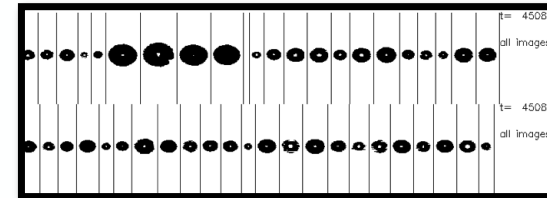
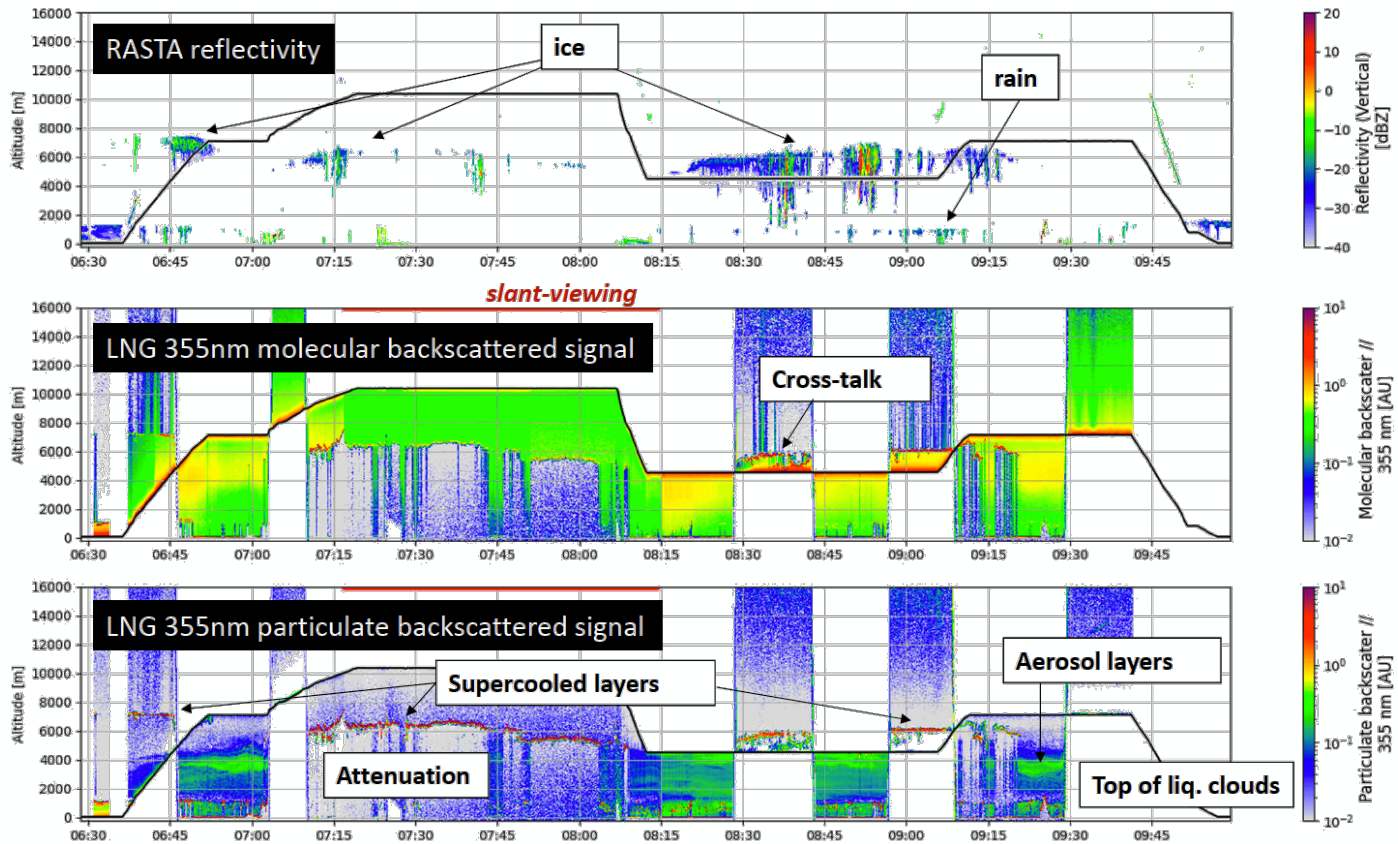
ATMOS

CADDIWA Examples: RALI and μ Physics (2DS)

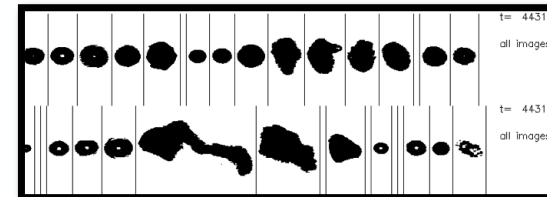


Status:
Beta-version in preparation

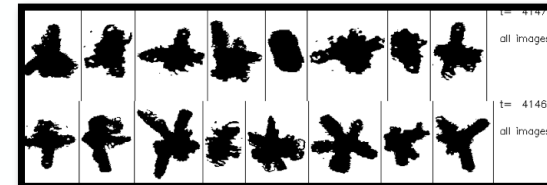
CADDIWA 20210908 F5



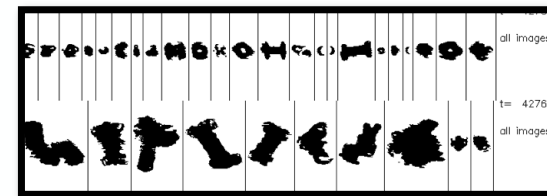
Drizzle



Melting flakes



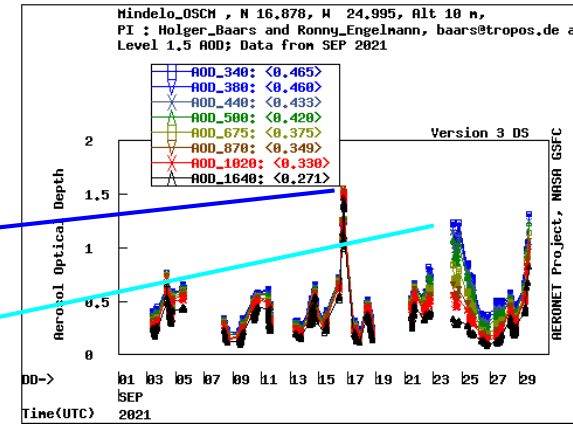
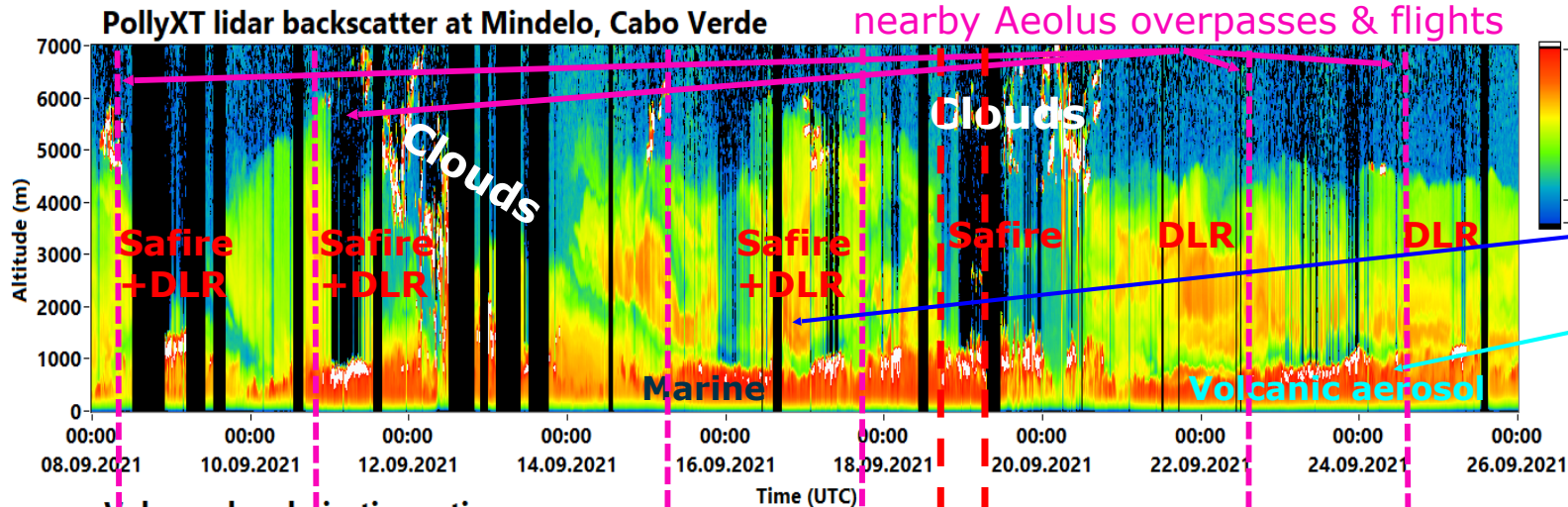
Bullet rosettes



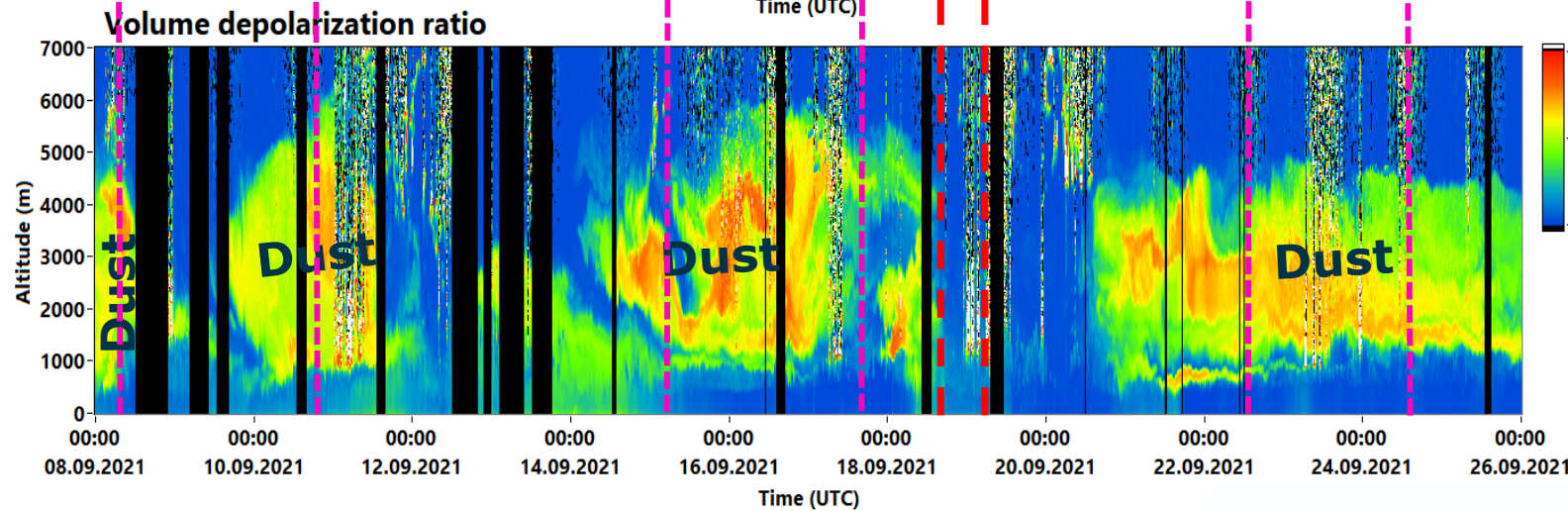
Capped column



ASKOS: Example September 2021 observations



Aeronet AOD



11/9/2021 flight



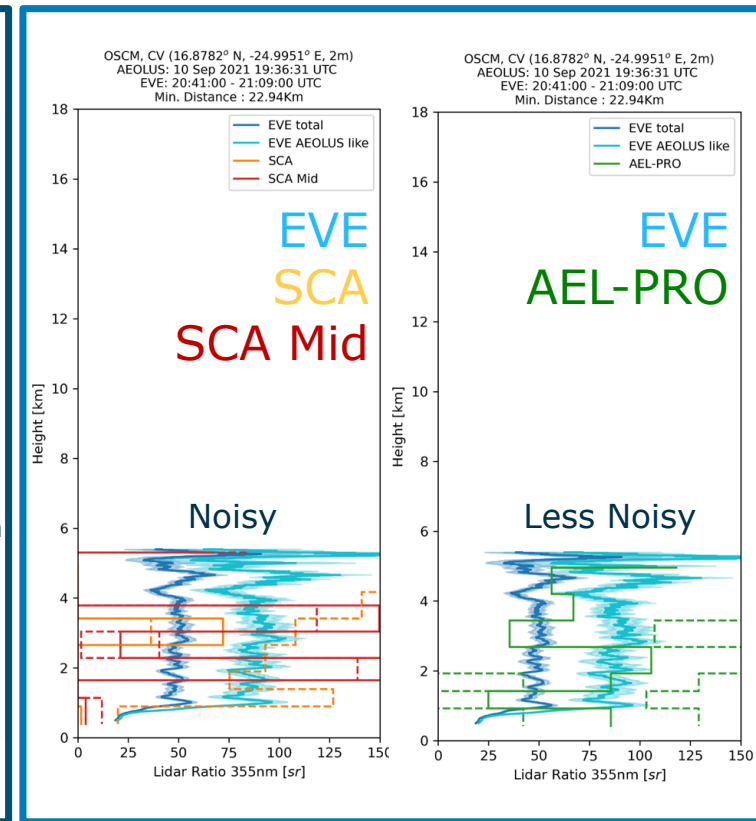
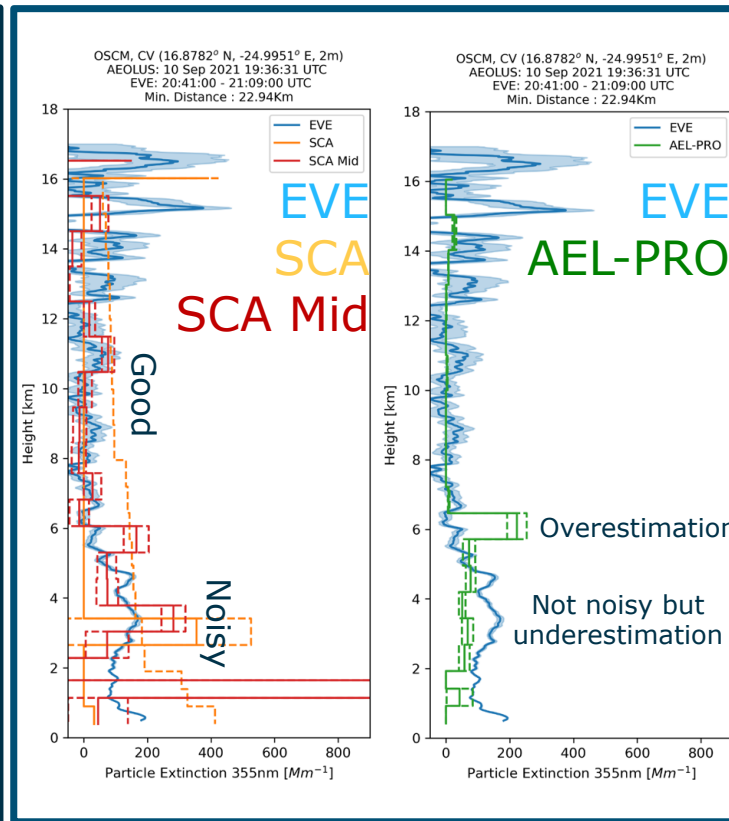
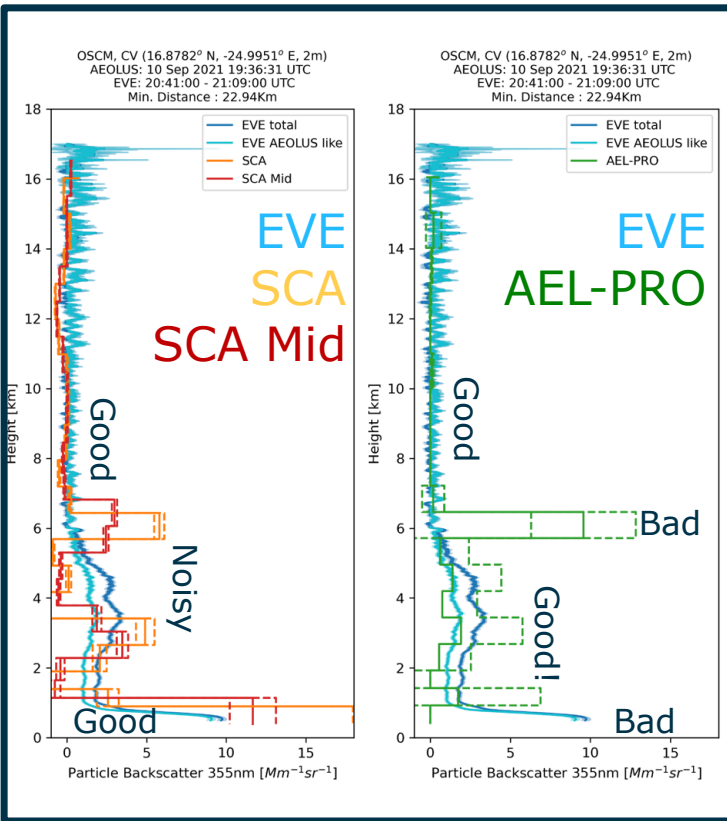
ASKOS: eVe vs Aeolus aerosol products on Friday 10/9



Backscatter coefficient

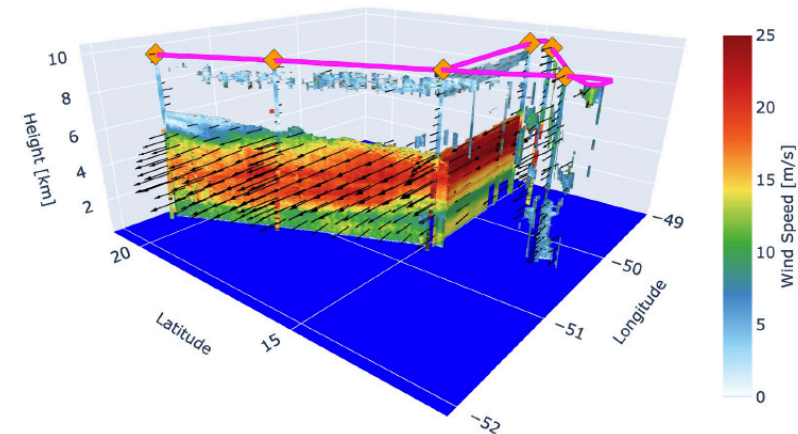
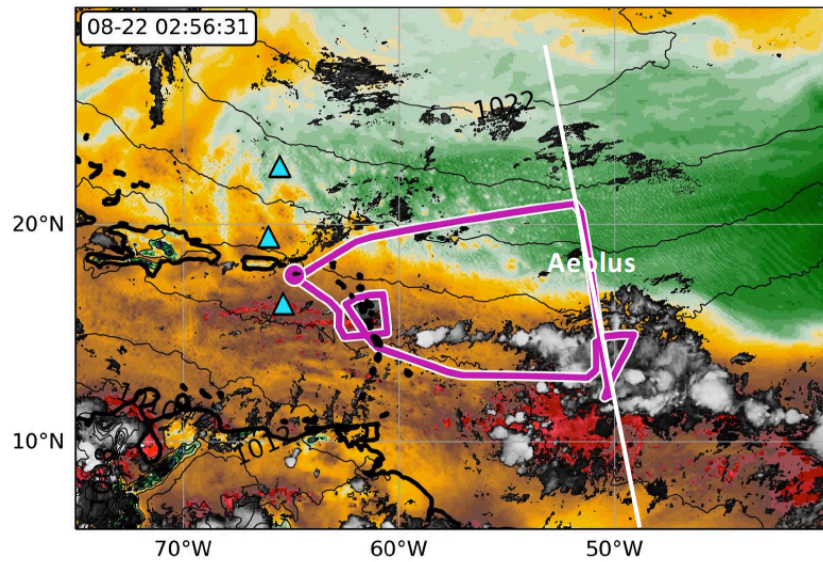
Extinction coefficient

Lidar Ratio



CPEX-AW: DAWN along Aeolus

CPEX-AW RF02: 21 Aug 2021

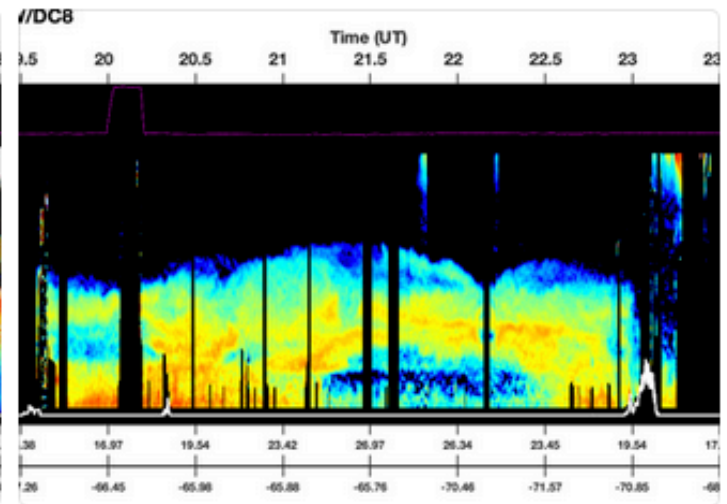
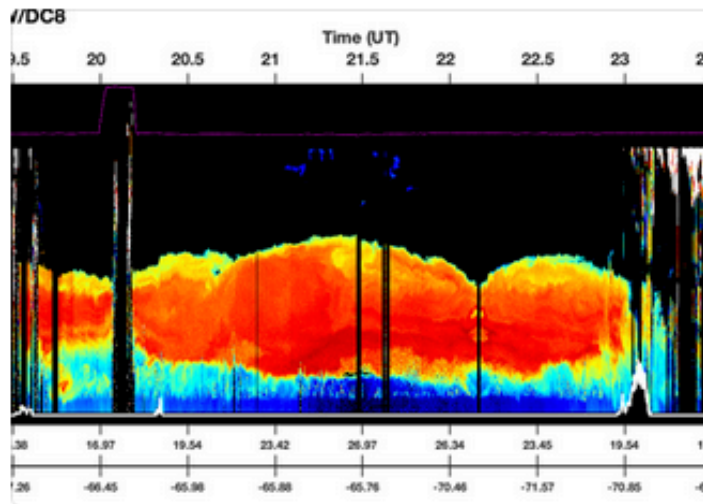
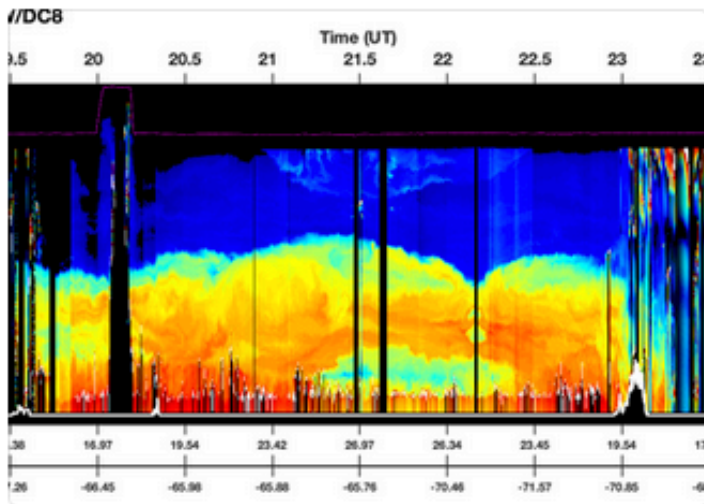
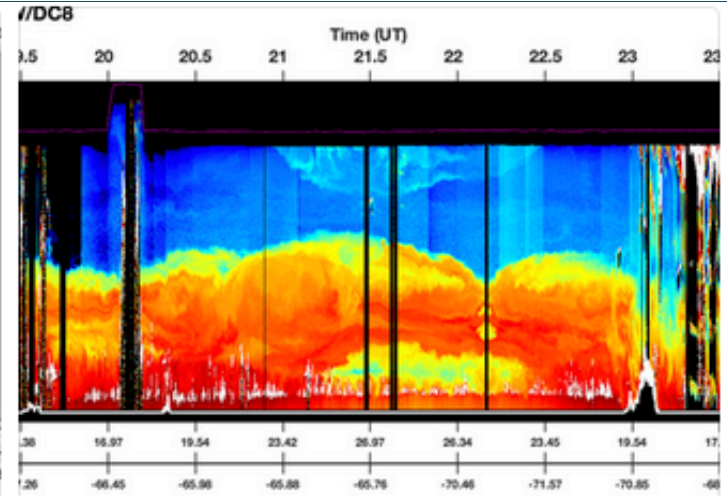
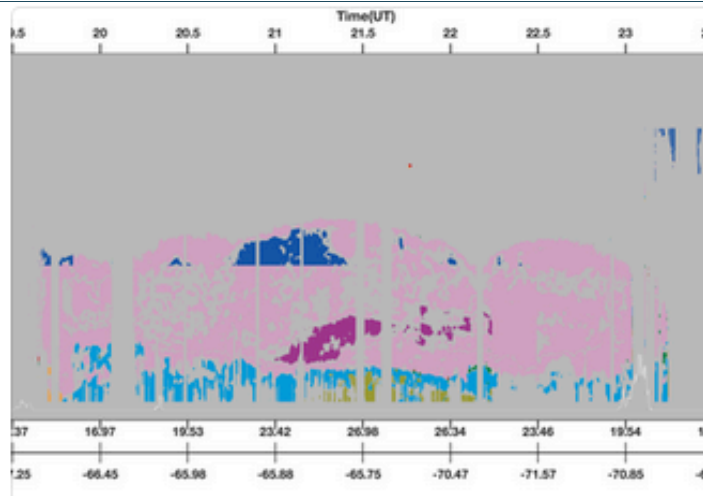
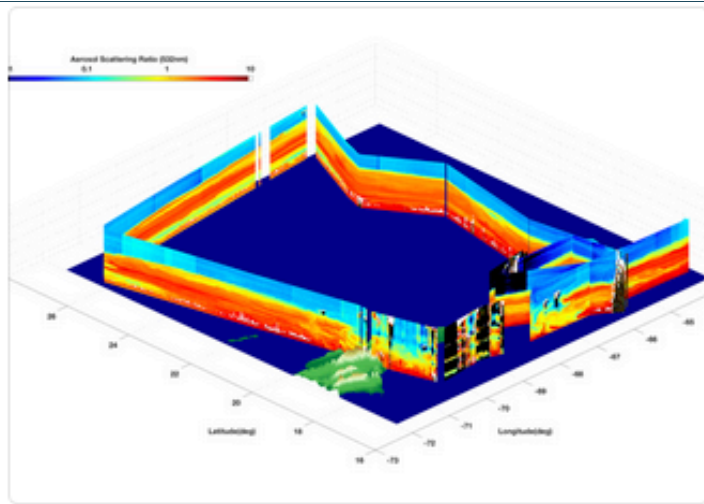


20
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→ THE EUROPEAN SPACE AGENCY

CPEX-AW: HALO on Research Flight #1 (2021-08-20)



→ THE EUROPEAN SPACE AGENCY

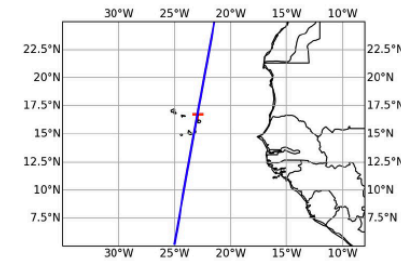
ASKOS/KIT: Radiosondes



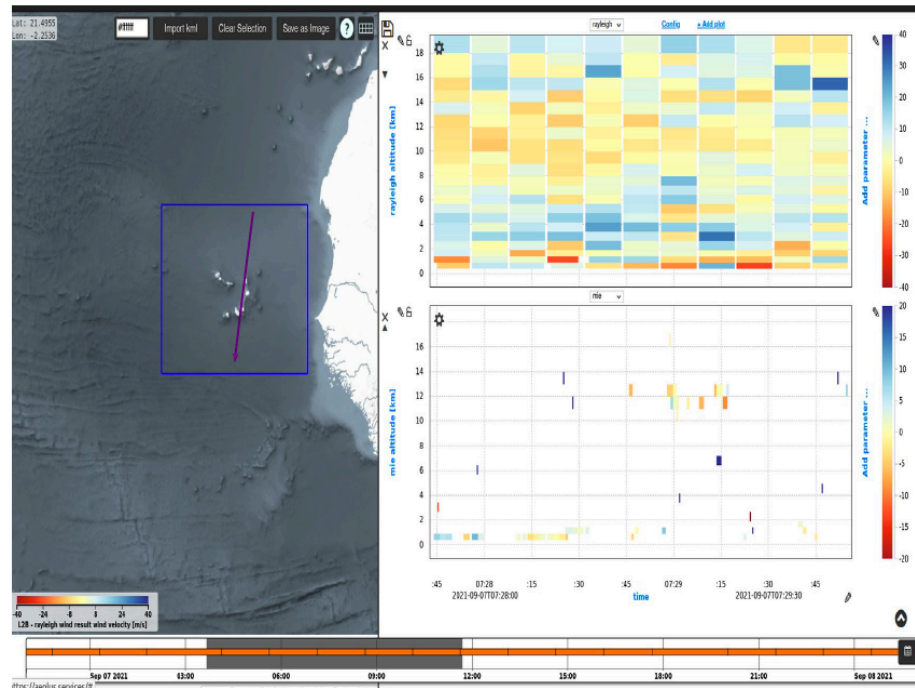
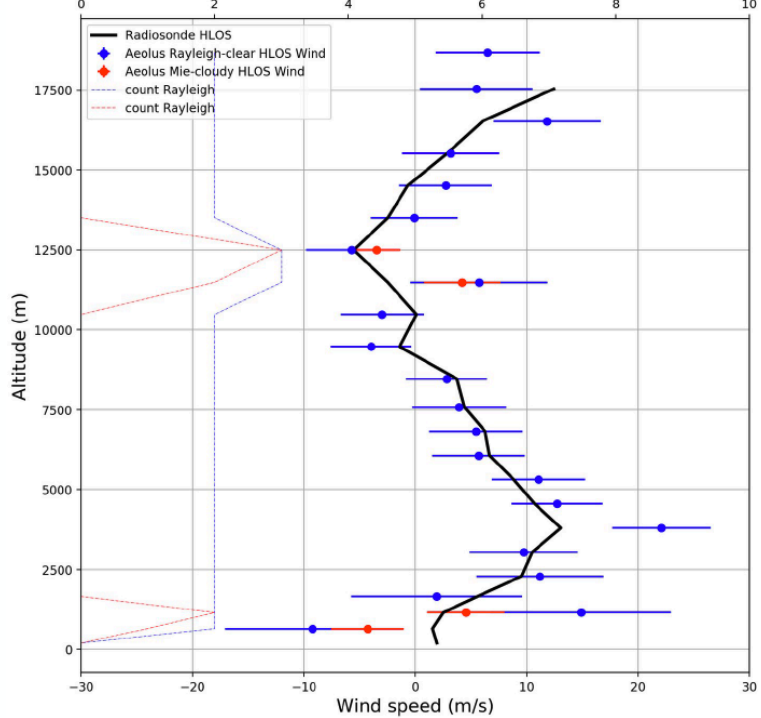
Aeolus Tuesday Descending orbit above Sal

Collocation criteria: 120 km around Sal, average over 24 RB

2021-09-07T07:30



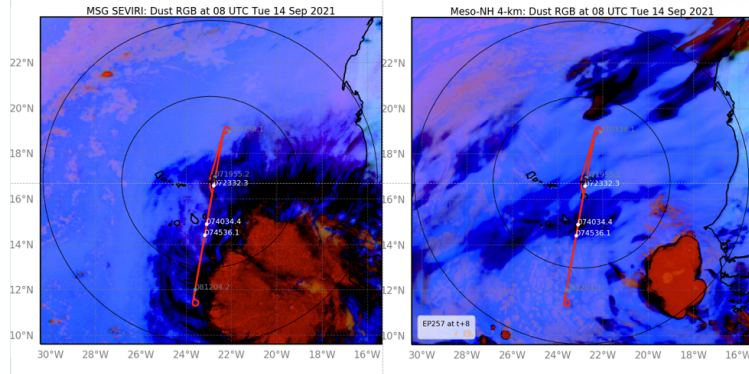
2021-09-07-07:30UTC descending orbit counts



Support from home – Model and Forecast Support



fs210009 - 14 Sep 2021

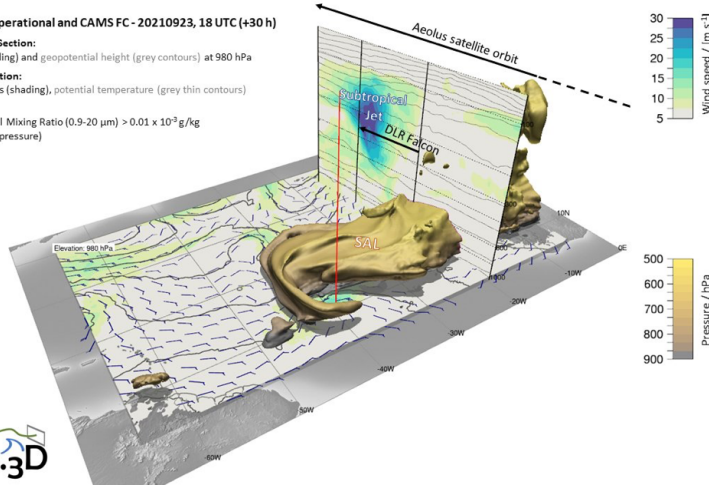


ECMWF operational and CAMS FC - 20210923, 18 UTC (+30 h)

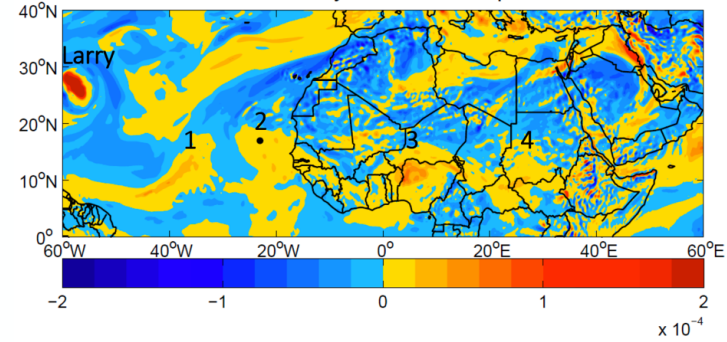
Horizontal Section:
Winds (shading) and geopotential height (grey contours) at 980 hPa

Vertical Section:
Wind speeds (shading), potential temperature (grey thin contours)

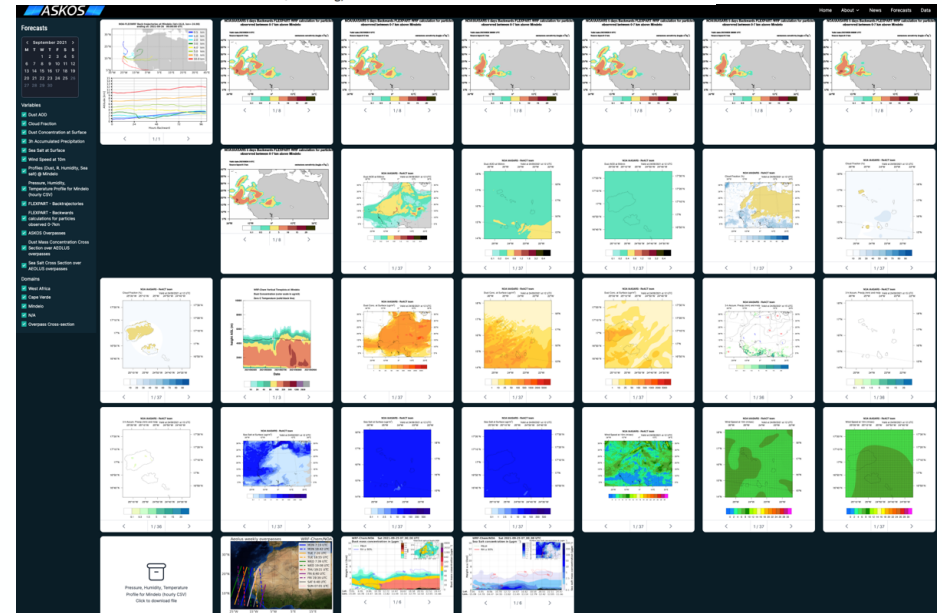
Isosurface:
Dust Aerosol Mixing Ratio (0.9-20 µm) > 0.01 x 10⁹ g/kg (colored by pressure)



ERA5 vorticity 700 hPa: 8 Sep 2021



JATAC QL Meeting, Cabo Verde 2021-09-22



ATMOS2021 - Joint Aeolus Tropical Atlantic Campaign



JATAC on Twitter



esa aeolus mission @esa_aeolus

The LNG high-spectral-resolution aerosol/cloud Doppler #lidar retrieves wind measurements in clear air that will be used for #Aeolus validation & supports another major #CADDIWA campaign goal: the assessment of the effects of dust aerosols on atmospheric dynamics in the region 🌍



11:49 AM · Sep 24, 2021 · Twitter Web App

4 Retweets 11 Likes

OSCM @OSCM_

@OSCM is proud to host the joint #Aeolus Tropical Atlantic Campaign! An international team performs ground and airborne atmospheric measurements from #Cabo Verde. @esa Head of Mission, Thorsten Fehr visits OSCM in support of the Aeolus campaign. @GEOMAR_en @esa_aeolus



11:00 AM · Sep 20, 2021 · TweetDeck

ASKOS Aeolus Cal/Val Campaign @ASKOS_Aeolus

#ASKOS: During the 94GHz Cloud Radar calibration with liquid nitrogen (LN2).

#JATAC #Aeolus @inoe_RemSensing @TROPOS_eu @EAA_NOA @OSCM_



11:08 AM · Sep 15, 2021 · Twitter Web App

DLR - English @DLR_en

Exact flight planning based on the current weather forecast ☀️ is also part of the intensive preparations. The goal is to fly the #Falcon20 over the strongest wind fields & dust layers along the #Aeolus orbit. 🌍



KIT Karlsruhe and 4 others

2:27 PM · Sep 20, 2021 · Twitter Web App

Terre & Univers - CNRS @INSU_CNRS

Lancement de la mission #CADDIWA qui va étudier les interactions #orages /poussière au large de l' #Afrique de l'Ouest 🌍

insu.cnrs.fr/fr/cnrsinfo/la...

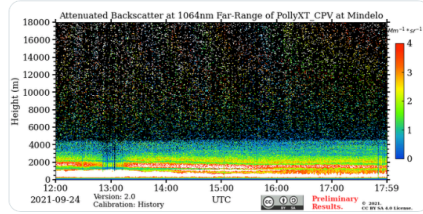
Translate Tweet



5:29 PM · Sep 7, 2021 · Twitter Web App

TROPOS_eu @TROPOS_eu

Thick air over #Mindelo #CaboVerde with low #visibility. Our #lidar shows a shallow but strong layer on ground up to 2km: bit.ly/2XPkAlf Probably #SO2 from #CumbreVieja #volcano + #SaharanDust. #JATAC analysis @esa_aeolus will show it later... #AirPollution @m_parrington



10:01 AM · Sep 25, 2021 · Twitter Web App



Conclusion

- Campaign successfully carried out with more than one year delay due to COVID-19 to allow for save implementation
- All aircraft deployed to Sal and St. Croix, with ASKOS ground based instruments on Mindelo
- Unique datasets for the Aeolus validation/calibration, tropical atmospheric science and technology development
- Data analysis is ongoing with a dedicate Data Workshop foreseen in February 2022
- Dataset will be open to the science community
- Ground based instruments continue operating on Cape Verde, with second ASKOS ground based campaign in summer 2022





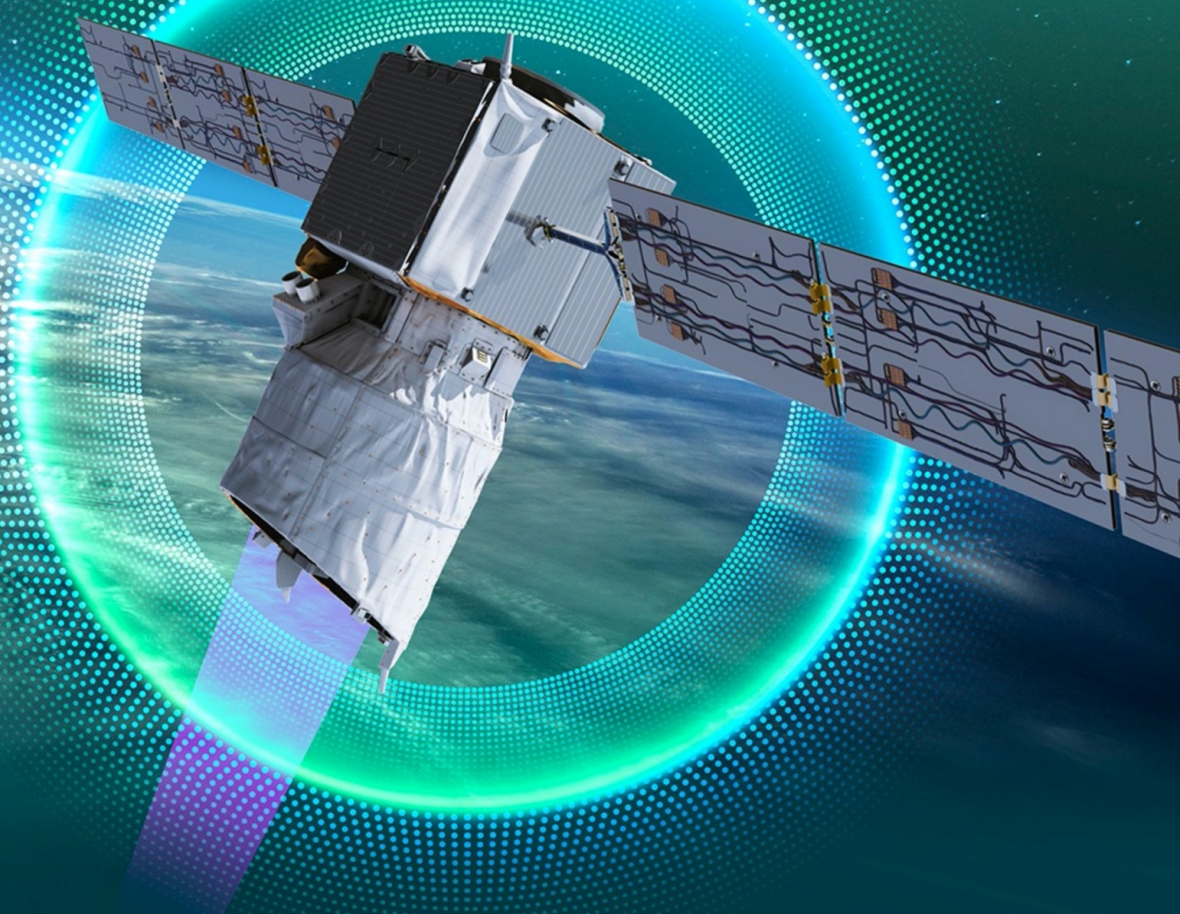
AEOLUS

3rd ANNIVERSARY CONFERENCE

28.03–01.04 2022 | TAORMINA, ITALY

DEADLINES

- | Abstract submission opens: **OCTOBER 25, 2021**
- | Abstract submission closes: **DECEMBER 17, 2021**
- | Registration opens: **JANUARY 10, 2022**
- | Draft programme: **FEBRUARY 21, 2022**
- | Registration closes: **MARCH 11, 2022**
- | Final programme: **MARCH 28, 2022**



But nothing will go without dedication!

