

The Finokalia ground-based station in Crete and its potential for ESA activities

Vassilis Amiridis¹, Nikos Mihalopoulos^{1, 2}, Stelios Kazadzis¹, Rodanthi Mamouri³, Ulla Wandinger⁴, Albert Ansmann⁴

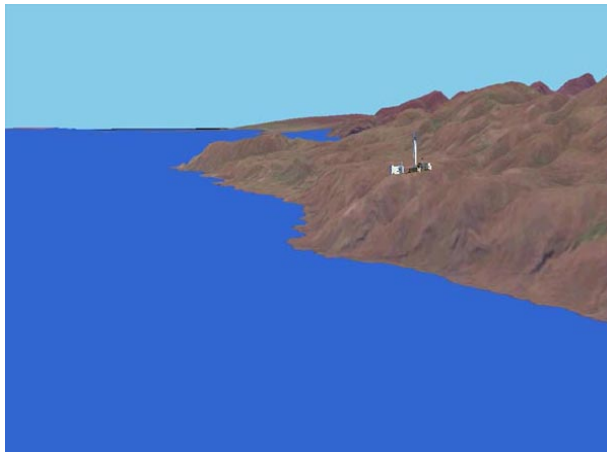
¹ *National Observatory of Athens (NOA), Greece*

² *University of Crete (UoC), Greece*

³ *Cyprus University of Technology (CUT), Cyprus*

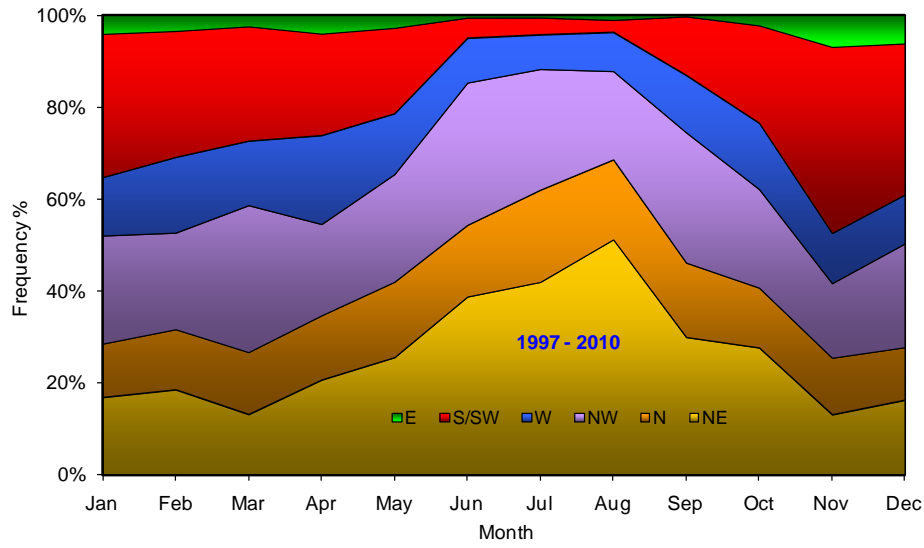
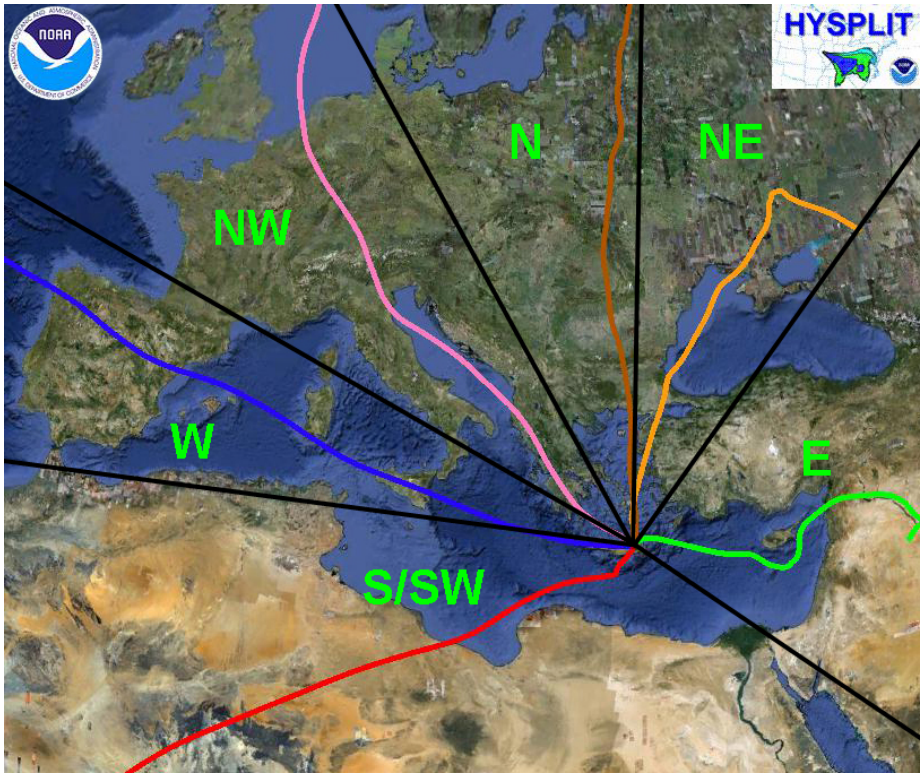
⁴ *Leibniz Institute for Tropospheric Research (TROPOS), Germany*

Location of Finokalia



Latitude = 35.34°N - Longitude = 25.67°E - Elevation = 252 a.s.l.





In-situ measurements performed during the last 20 years showed that marine and dust particles are present 95% of the time. Smoke from forest fires can be occasionally detected as well as urban pollution from nearby megacities in the Aegean Sea (Athens, Istanbul)



Thermo Environmental Instruments Inc.
Model 502 Analyser

Thermo Environmental Instruments Inc.
Model 502 Analyser

Thermo Environmental Instruments Inc.
Model 502 Analyser

Thermo Environmental Instruments Inc.
Model 502 Analyser

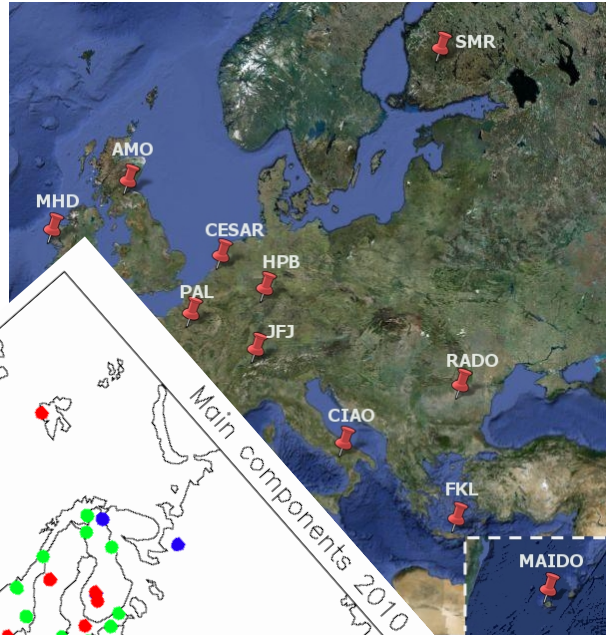
PILS

Thermo
PM2.5

Magor Scientific
Aethalometer™

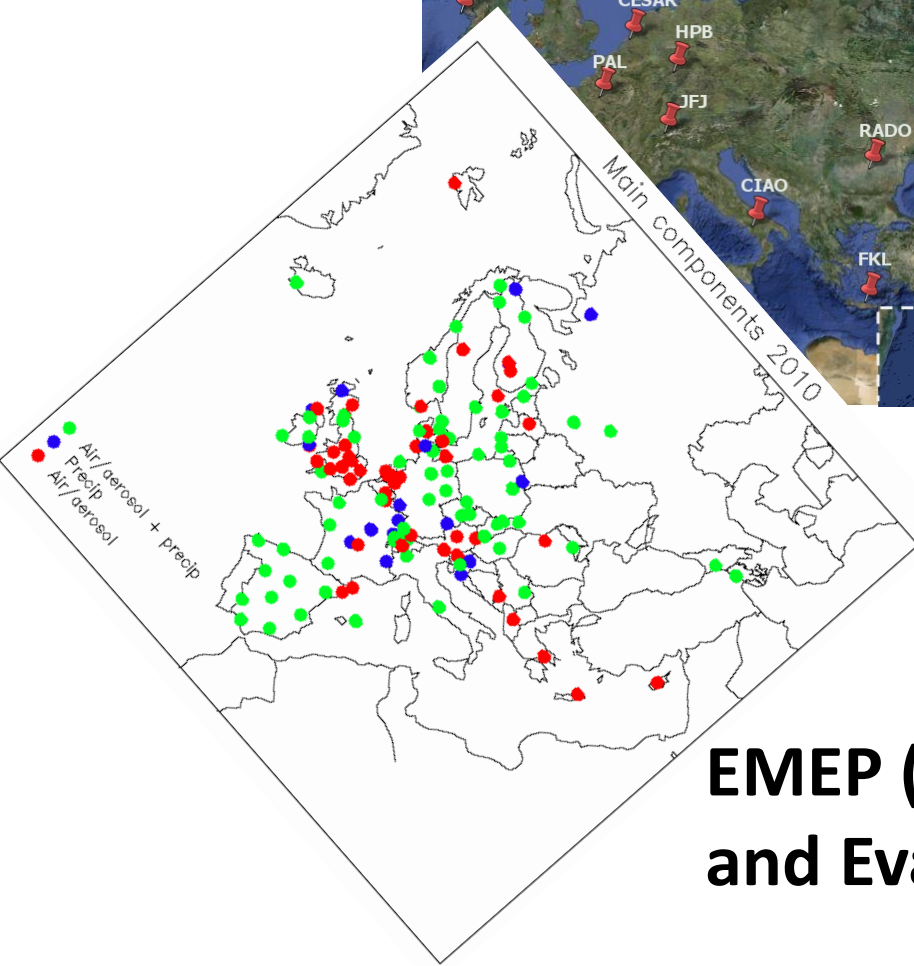
Main Menu
Settings
Data Average
Report Pref

Vassilis Amiridis, 4th ACTRIS WP2, WP20 Workshop, Lille, Oct



ACTRIS

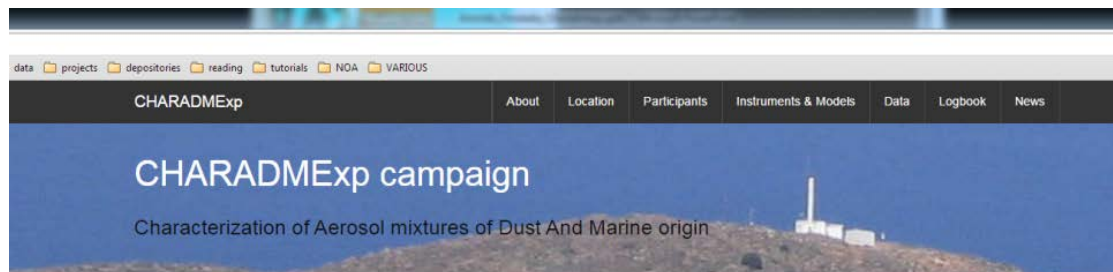
ICOS (Integrated Carbon Observation System)



EMEP (European Monitoring and Evaluation Programme)



Remote Sensing instrumentation During ESA-CHARADMexp campaign



The campaign

The CHARADMexp campaign aims to derive optical, microphysical and chemical properties of marine component and its mixture with dust, employing sophisticated instrumentation installed on an appropriate site. Specifically, aerosol characterization will be established by ground-based active/passive remote sensing techniques, surface in-situ measurements and airborne UAV observations.

The campaign will take place from **20th of June until 10th of July** at the Finokalia site, Creta, Greece.

The site

The site for the campaign is the monitoring station of [Finokalia](#), Greece where only marine and dust particles are present 95% of the time (smoke can be advected as well during the August-September forest fire period). Finokalia station is located at a remote coastal site in the northeast of the island Crete, Greece, in the Eastern Mediterranean (35.338°N, 25.670°E, 252 asl). The station is located at the top of a hilly elevation (150m above sea level), facing the sea within a sector of 270° to 90°. No touristic or other human activities can be found at a distance shorter than 20 km within the aforementioned sector. In-situ measurements are performed in Finokalia continuously for the last 20 years.

Recent activity

News

- [ITaRS participation in CHARADMexp](#) (Jul 10th)
- [UAV measurements \(video\)](#) (Jul 1st)
- [Cyprus Institute UAVs are heading to Sitia's airport](#) (Jun 29th)
- [Saharan dust is approaching](#) (Jun 24th)
- [Getting prepared for UAV flights over Crete](#) (Jun 23rd)

Uploaded data

- [HALO realtime](#) (Sep 9th)
- [FLEXPART](#) (Jul 31st)
- [WRF WIND](#) (Jul 31st)
- [WRF WIND](#) (Jul 31st)
- [WRF WIND](#) (Jul 31st)

<http://charadmexp.gr/>



Remote sensors deployed

1. PollyXT lidar



- 3 backscatter channels (355, 532, 1064 nm)
- 2 extinction Raman channels (387, 607 nm)
- 2 depolarization channels (355, 532 nm)
- 1 water vapor channel (407 nm)
- 1 near-range channel (532, 607 nm)

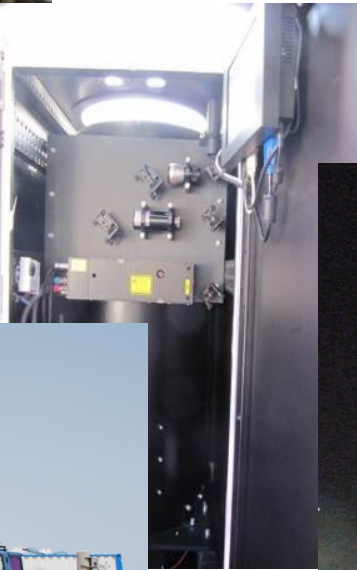


Remote sensors deployed

2. EMORAL lidar

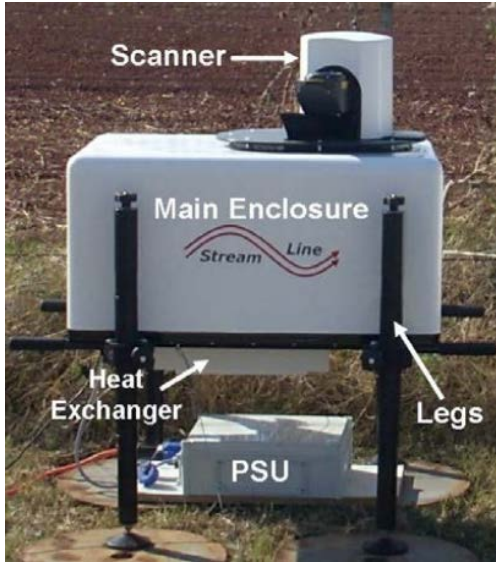


- 2 backscatter channels (355, 532 nm)
- 1 extinction Raman channel (387 nm)
- 2 depolarization channels (355, 532 nm)



Remote sensors deployed

3. HALO wind lidar



- 1 backscatter channel ($1.5 \mu\text{m}$)
- Doppler lidar capable of providing wind speed and direction and turbulence





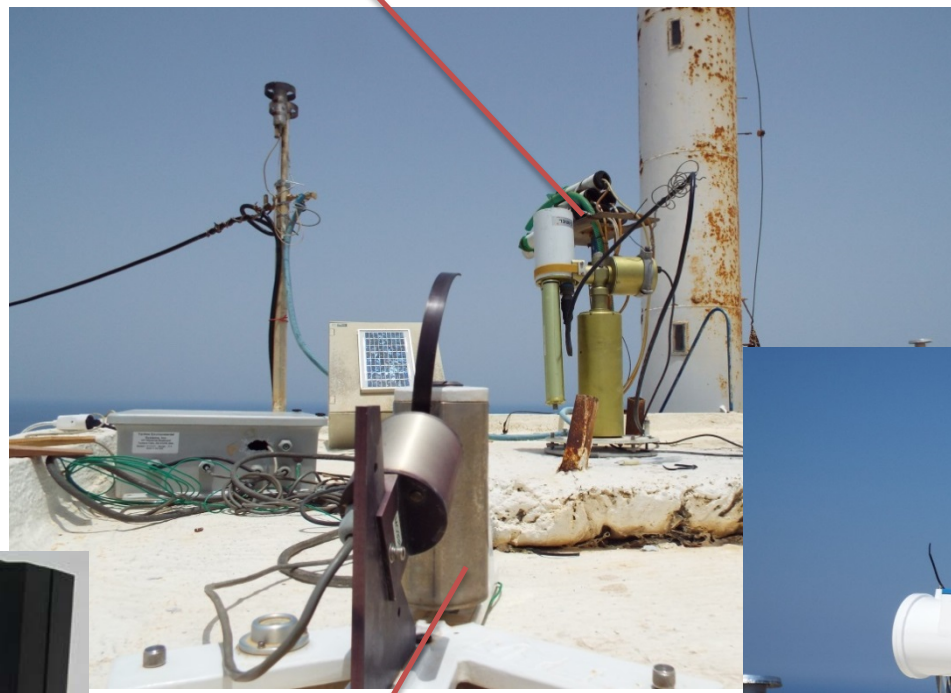
MicroWave Radiometer HATPRO

Measures the brightness temperatures in the range between 2.7K (cosmic background) and ambient temperature

Capable of providing:

1. Liquid Water Path (LWP)
2. Integrated Water Vapor (I WV)
3. Temperature and RH profiles within the PBL (for CHARADMexp, the synergy with the lidars will be utilized to derive WV profiles)





PSR



Microtops II



UV-MFR

Existing Instrumentation (in-situ)

Measurements to be used in CHARADMexp:

Instrument	Measurement
FH62 I-R Thermo Scientific	PM10 concentration
Aethalometer MAGEE SCI Model AE31 7-Wavelength	Aerosol Absorption
Nephelometer Model Aurora 1000	Aerosol Scattering
Thermo Scientific Model 49i	Ozone
SMPS – CPC3772 TSI	Aerosol size distribution (in dry conditions -10 – 880 nm)





Black carbon (aethalometer)

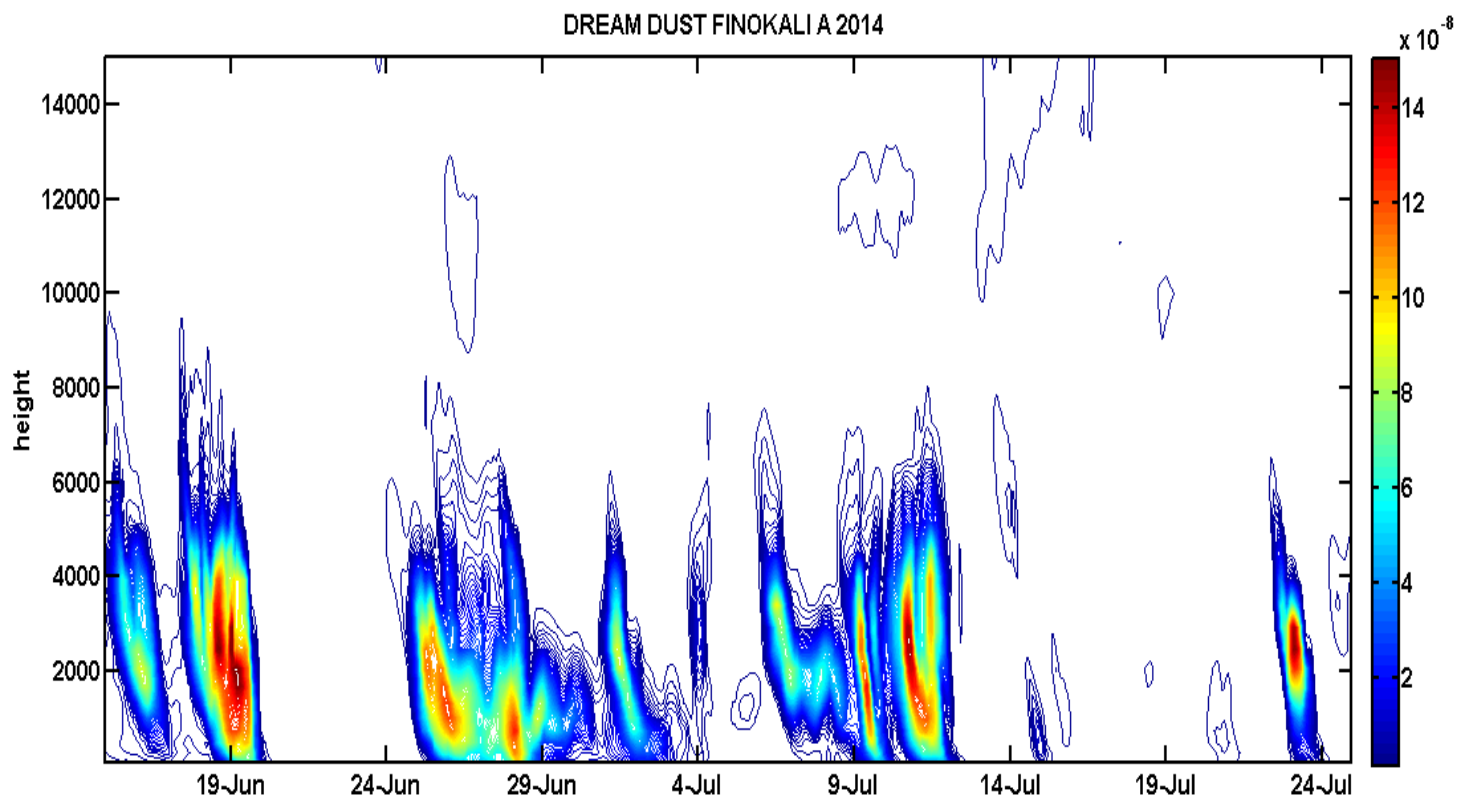
Ground Control Unit

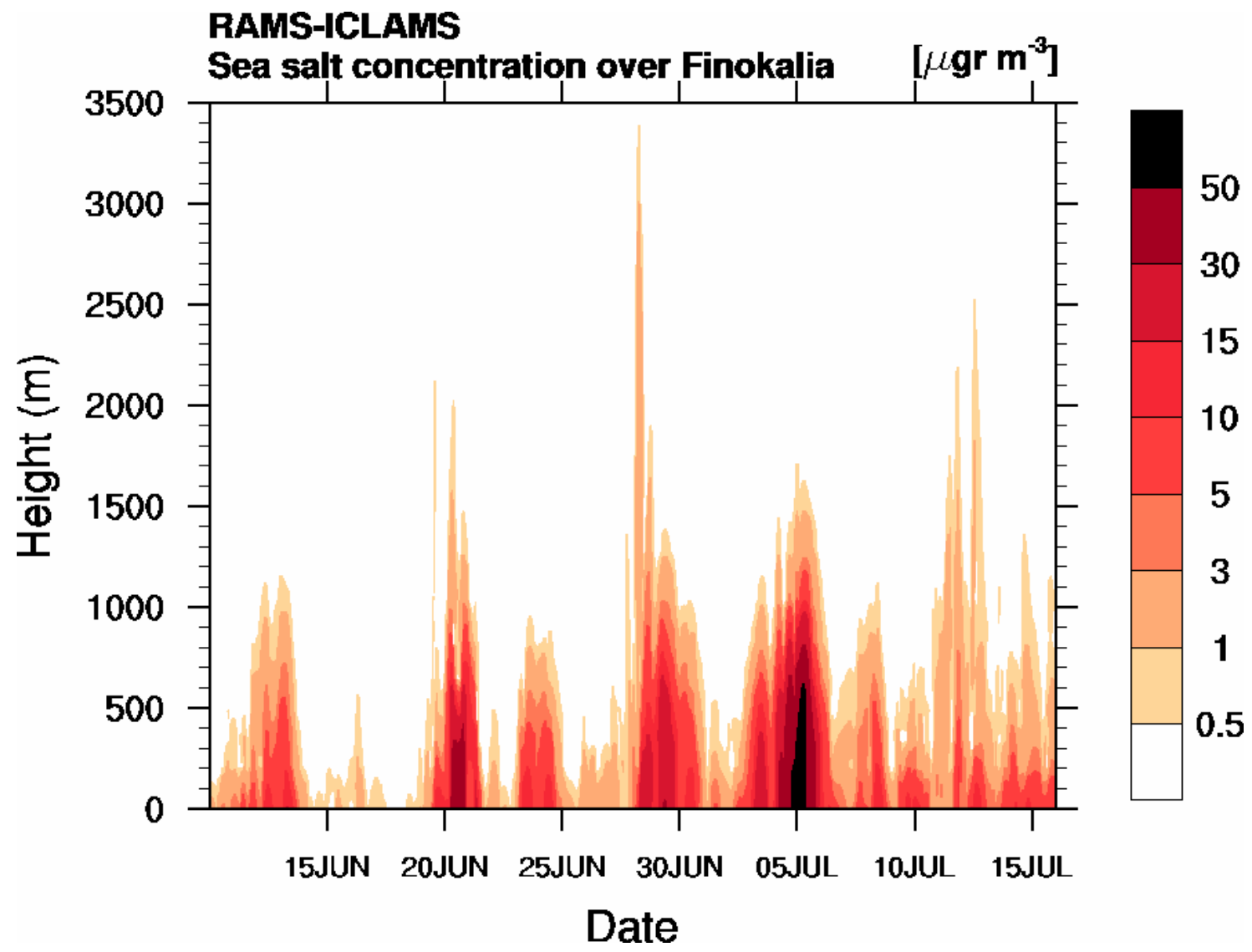


Ozone (UV absorption)



Condensation Particle Counter (CPC)



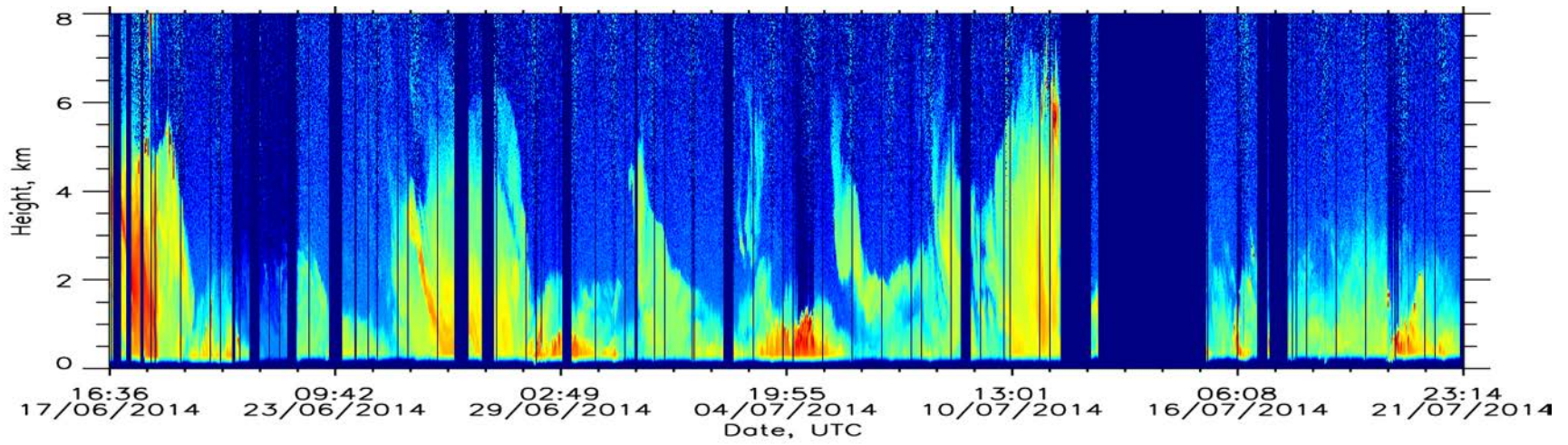




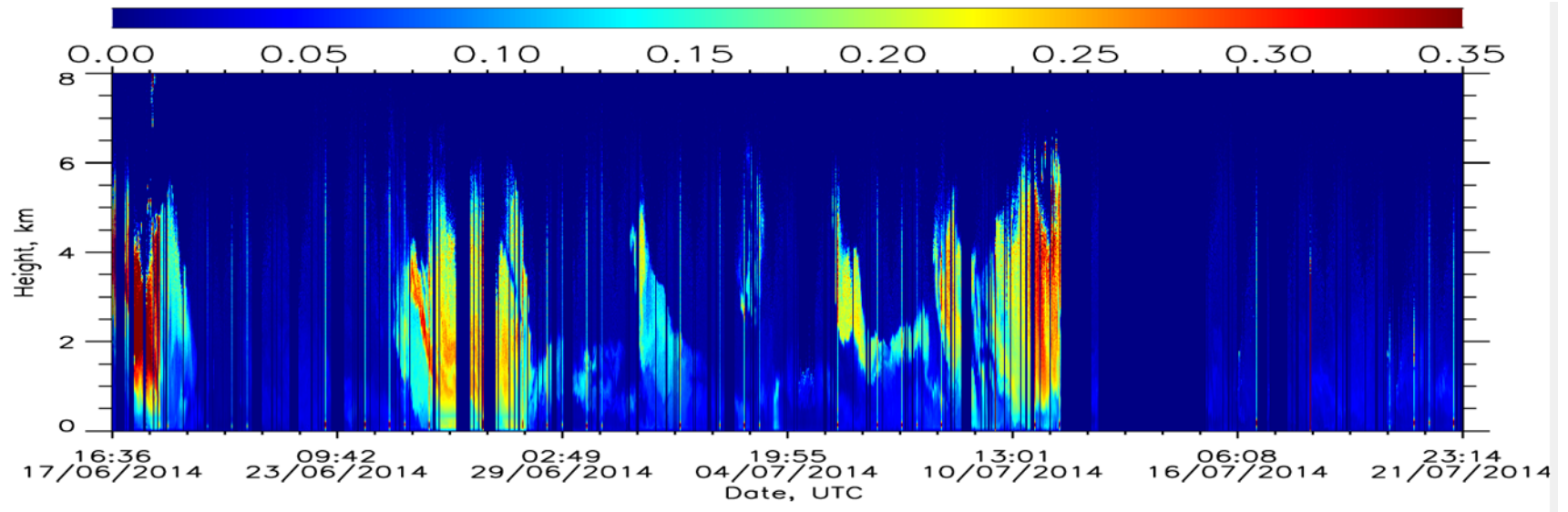
Retrieval examples

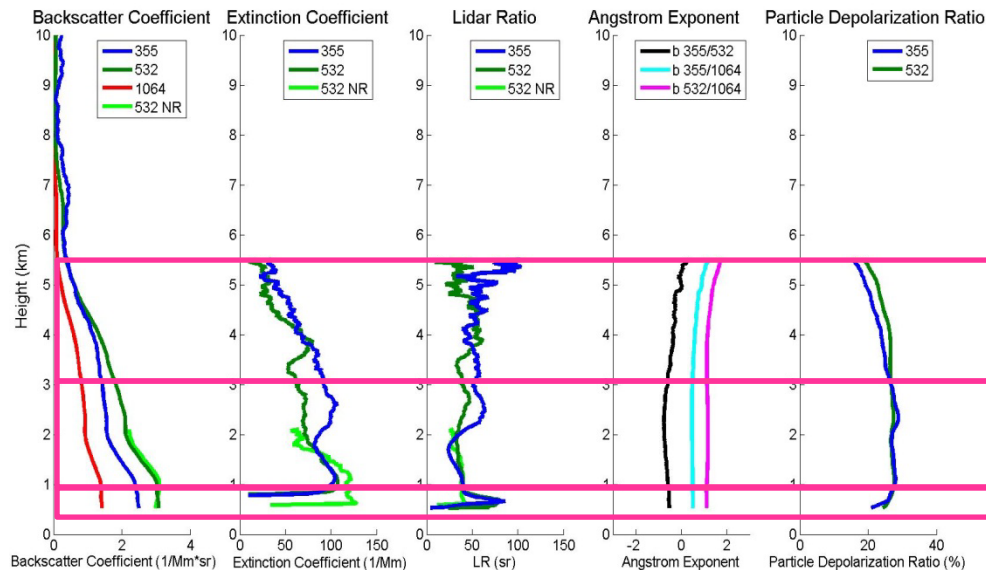
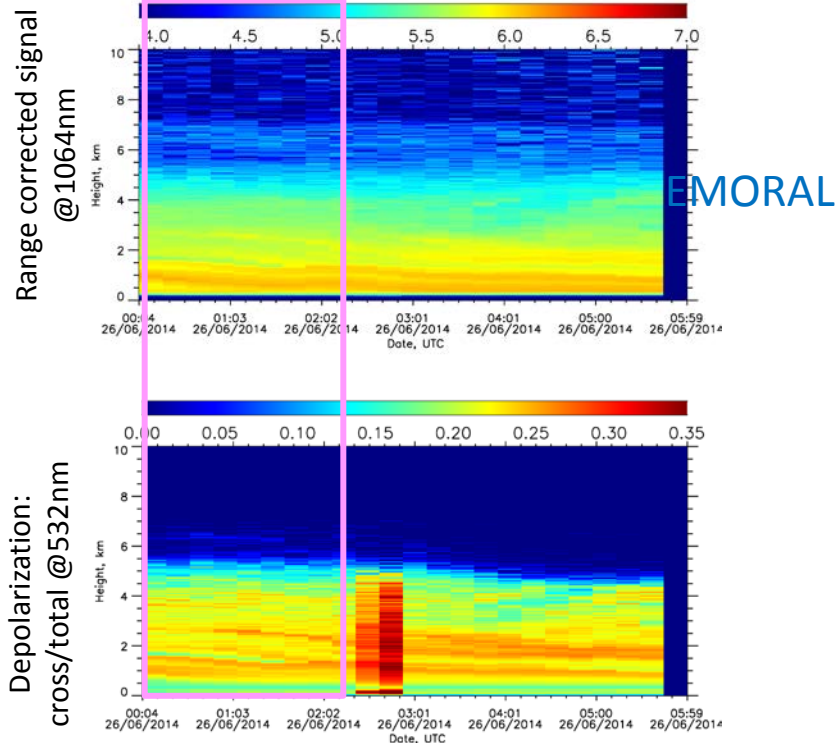


Range corrected signal
at 1064nm



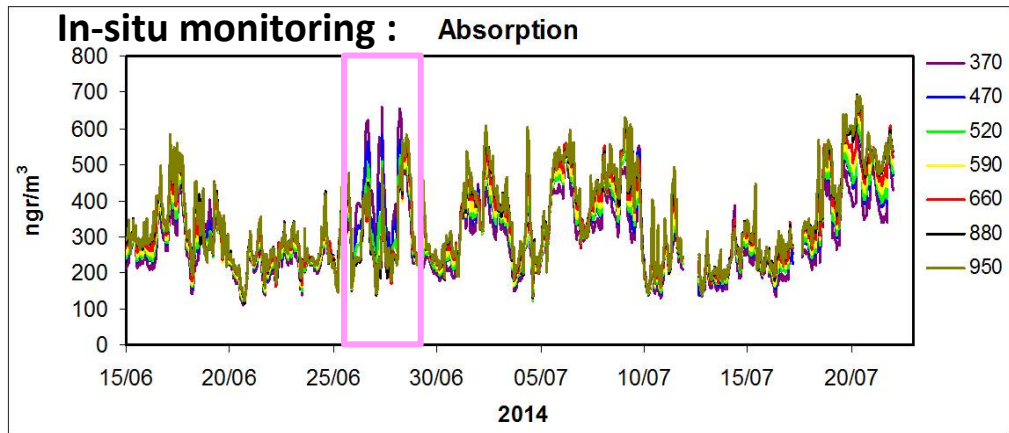
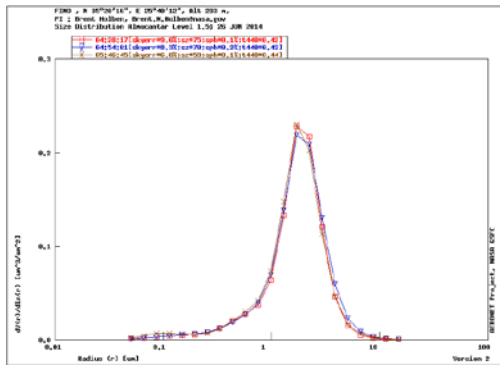
Depolarization:
cross/total @532nm





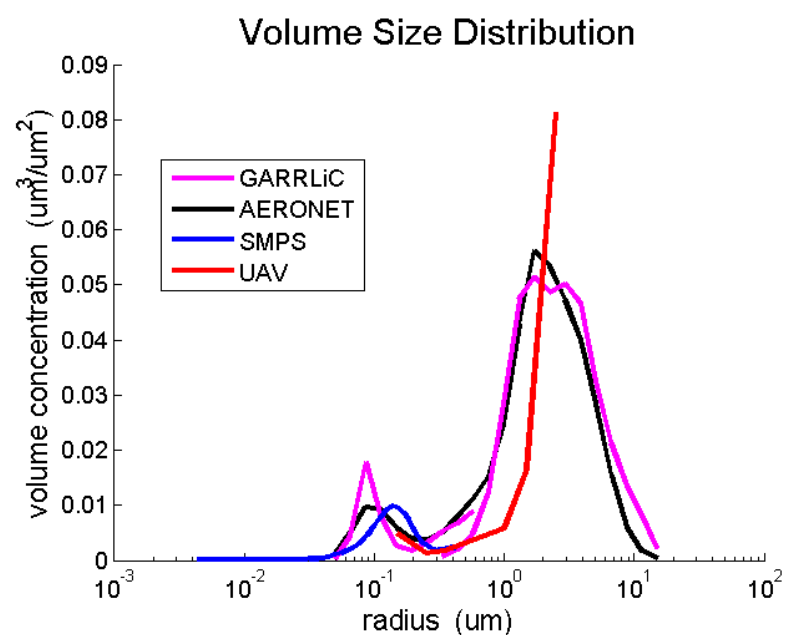
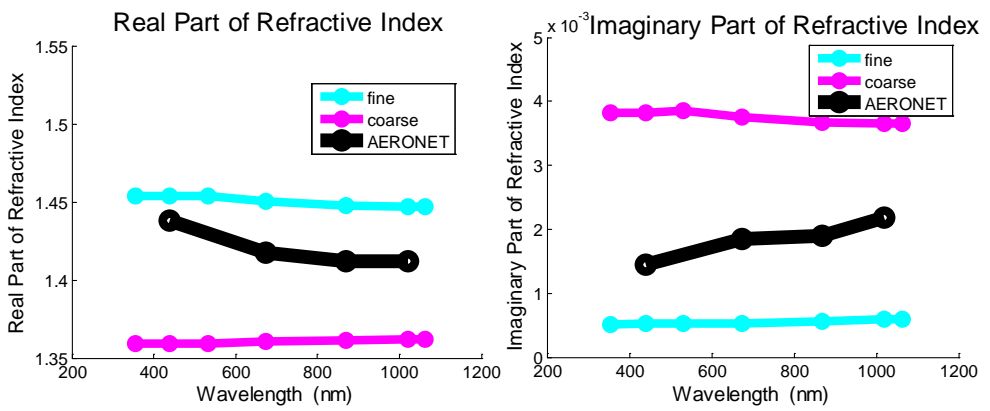
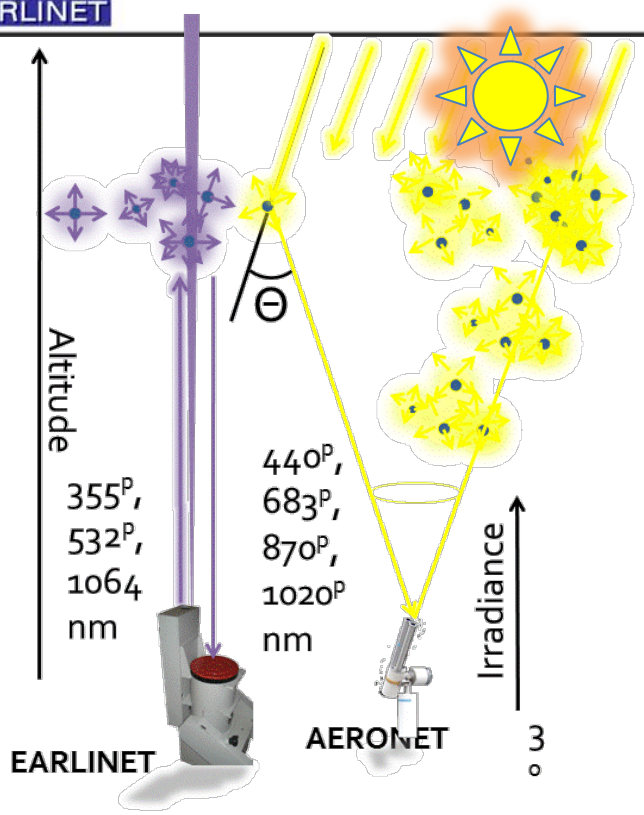
Cimel
 AOD₅₀₀: 0.42
 Ang: 0.08

Dominance of coarse mode



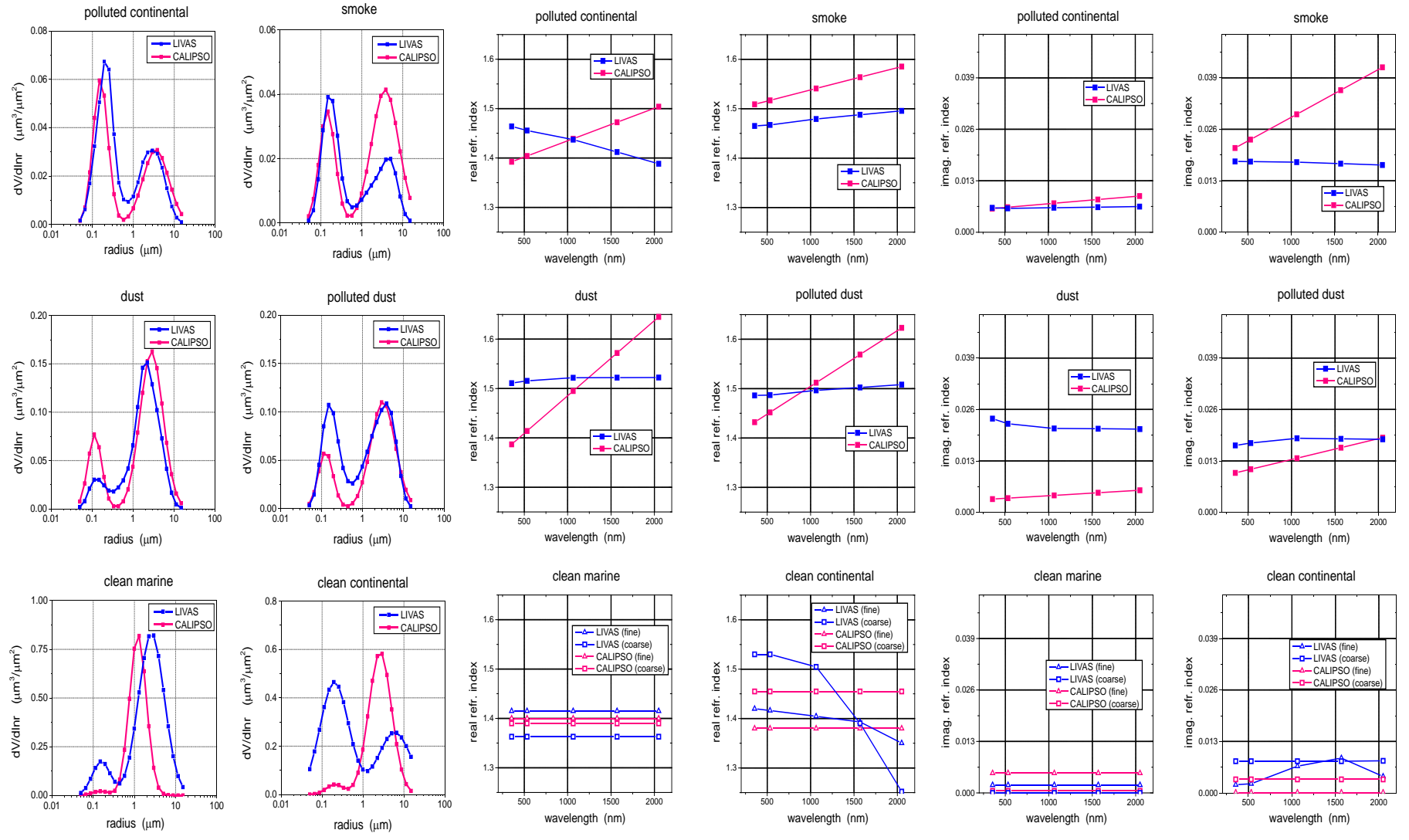


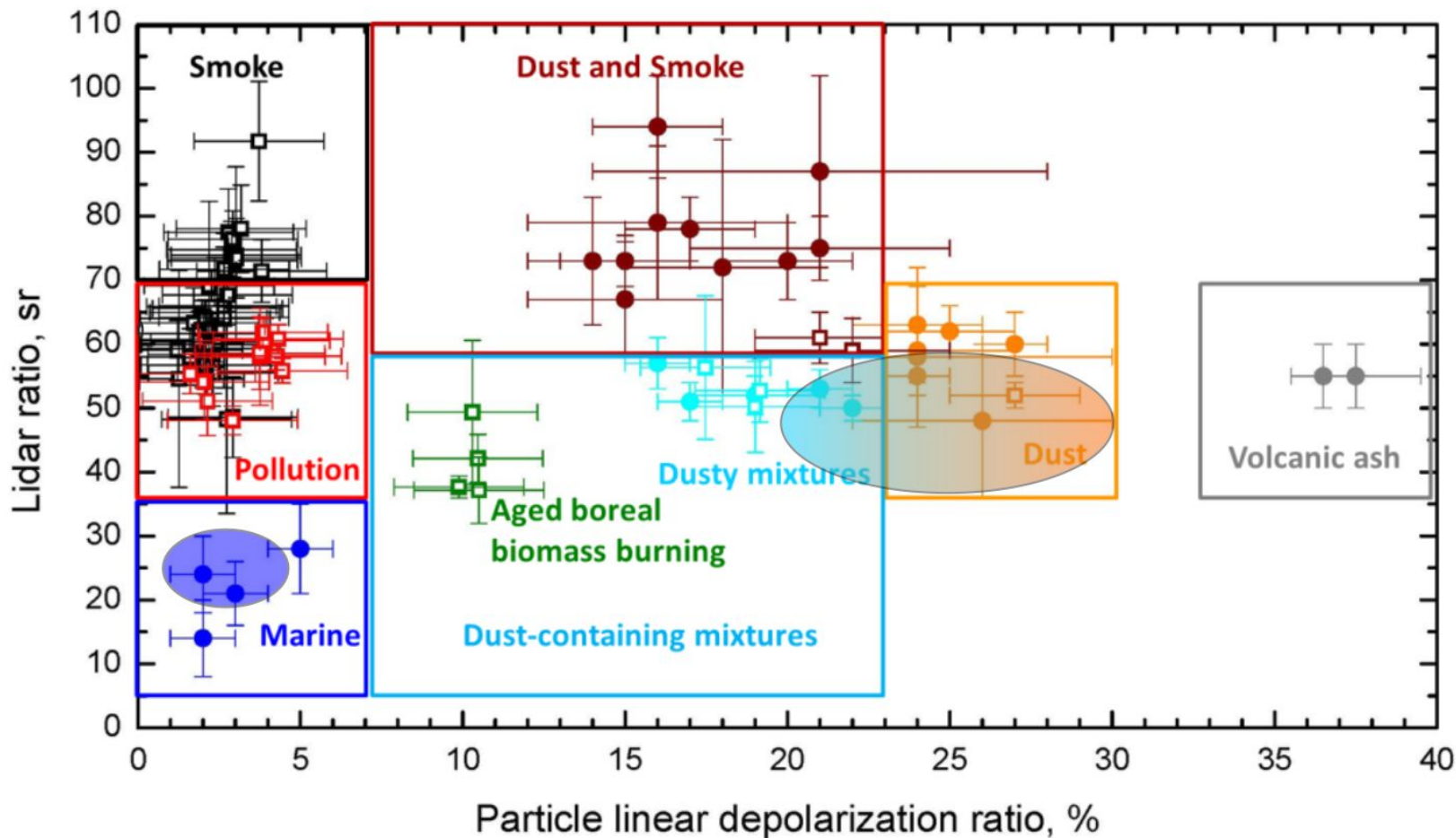
Microphysics - GARRLiC





Aerosol model – First results





Personal communication: Ulla Wandinger (TROPOS)



EARLINET ESA studies for the development of an aerosol model for space-borne lidar applications in order to facilitate aerosol characterization :

- ESA-CALIPSO** (EARLINET study led by TROPOS)
- LIVAS** (NOA and TROPOS)
- CHARADMexp** (NOA)
- DEDICAtE** (NOA)
- HETEAC** (KNMI and TROPOS)

GAPS - NEEDS

- Limited measurements for specific aerosol types
 - mixtures of dust and other types (e.g. marine, smoke)
 - pure marine aerosols (due to the overlap limitation)
- No measurements for linear particle depolarization at 355nm and conversion factors from 532 to 355 nm, no system for circular particle depolarization at 355, 532 nm
- The aerosol model at its current stage provides only specific lidar-related optical properties. Microphysics and radiative properties are missing. Inversion of lidar data can add to that direction in conjunction with theoretical scattering studies.

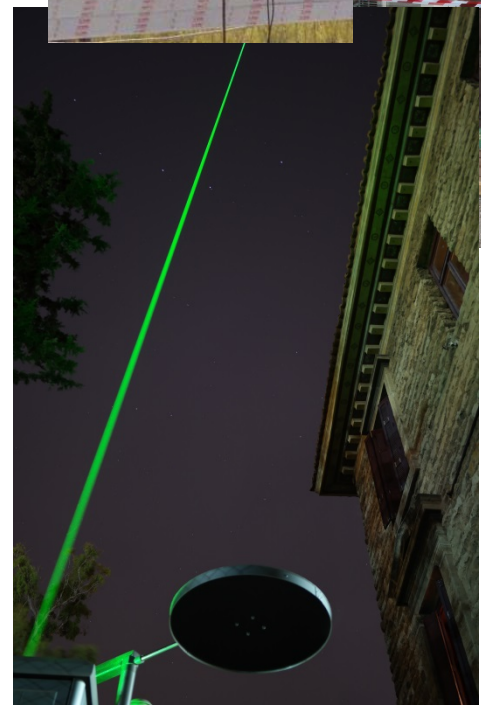
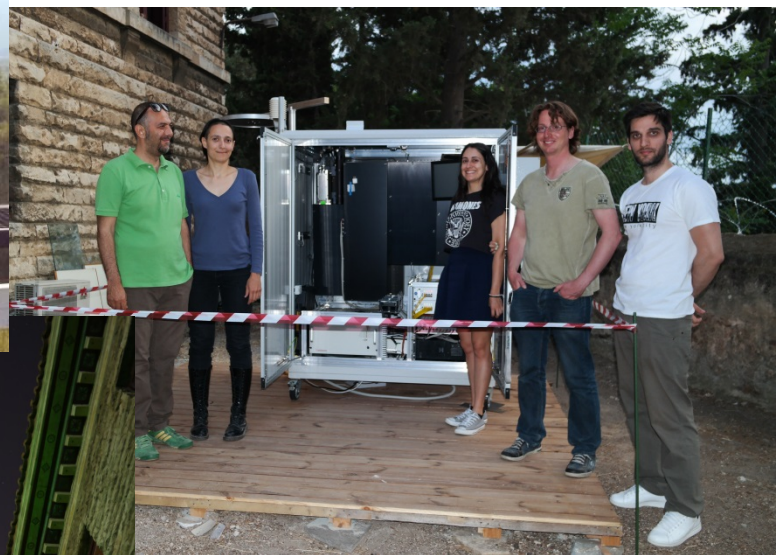
ACTRIS-2 campaigns: NOA will organize 4 experimental campaigns @ Athens, Crete, Granada, Melpitz

Night-time retrievals with sun/lunar/star photometer and Raman lidar



CIMEL sunphotometer PollyXT OCEANET lidar

In-situ measurements with Unmanned Aerial Vehicles (UAVs) and/or tethered balloons



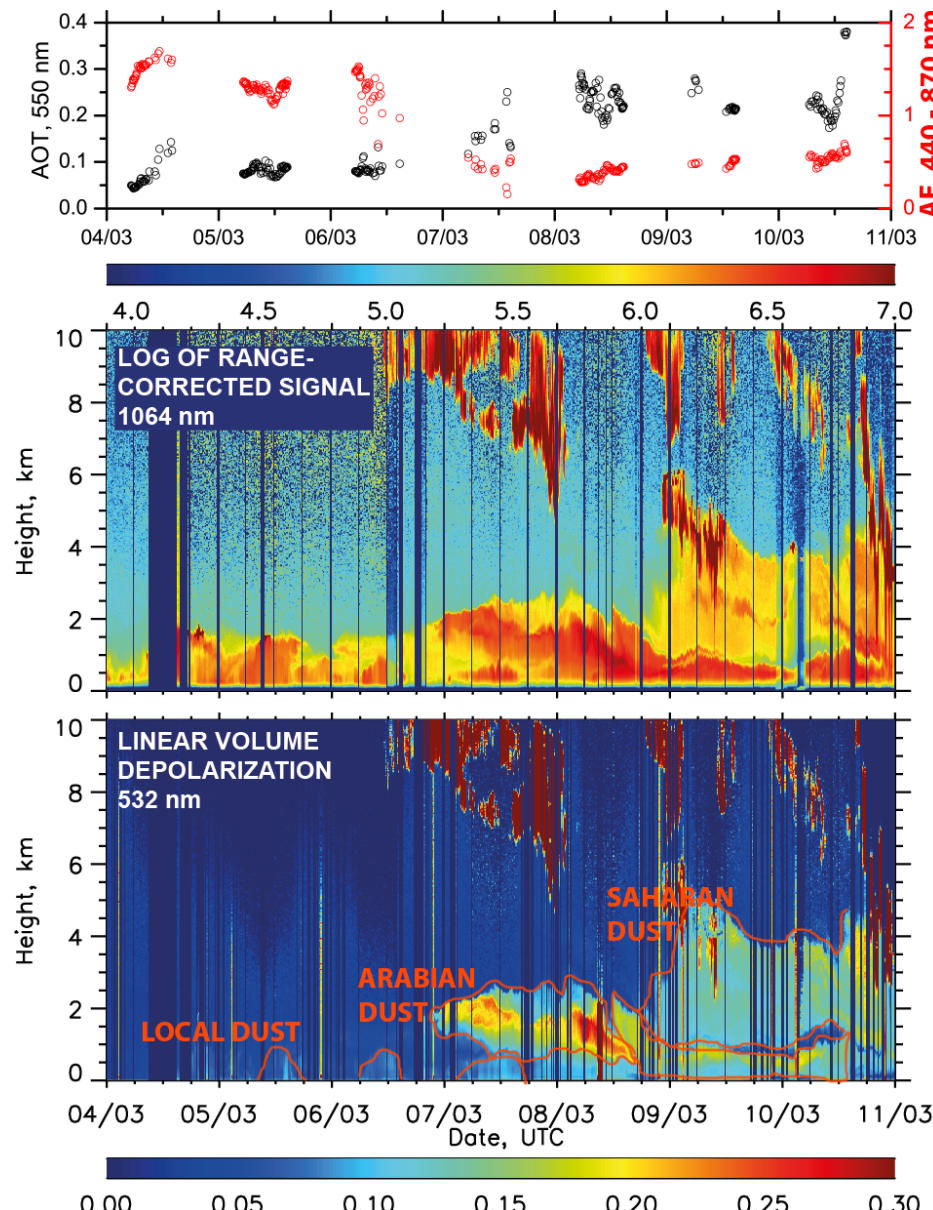
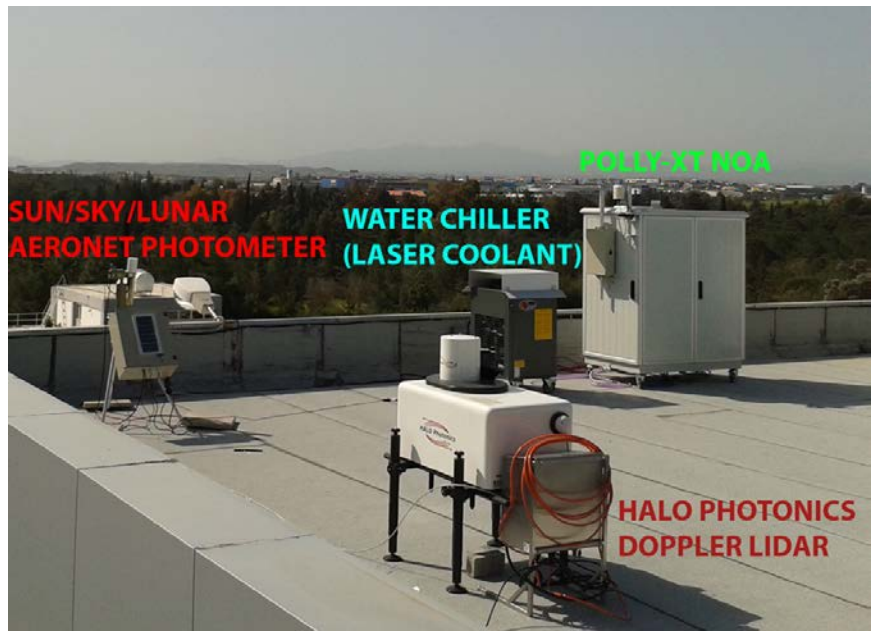
Athens and Melpitz campaigns are implemented already



Future plans



Utilize data from the campaign performed in Cyprus by TROPOS, NOA and Cyl for adding information on Arabian dust properties.

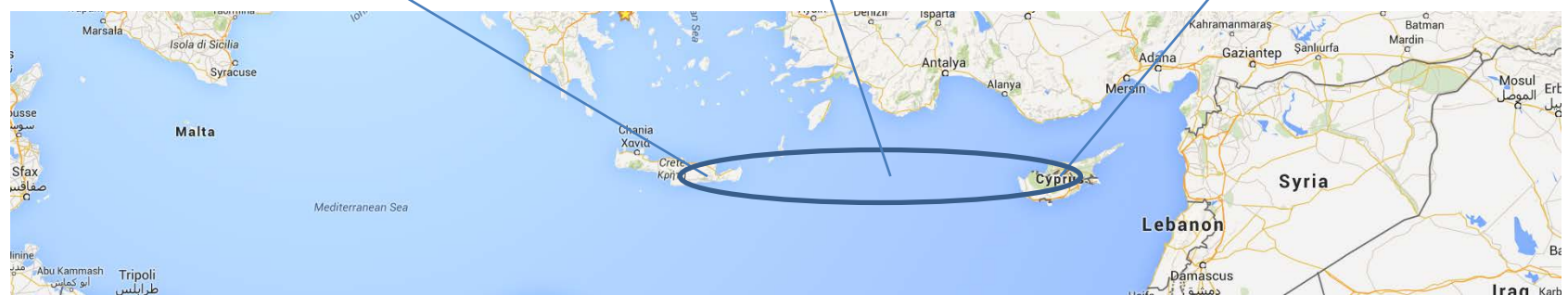


Large scale experimental campaign in Eastern Mediterranean – April 2017

NOA:
Replicate LACROS
@ Crete



TROPOS:
LACROS @ Cyprus





Finokalia instrumentation from 2016

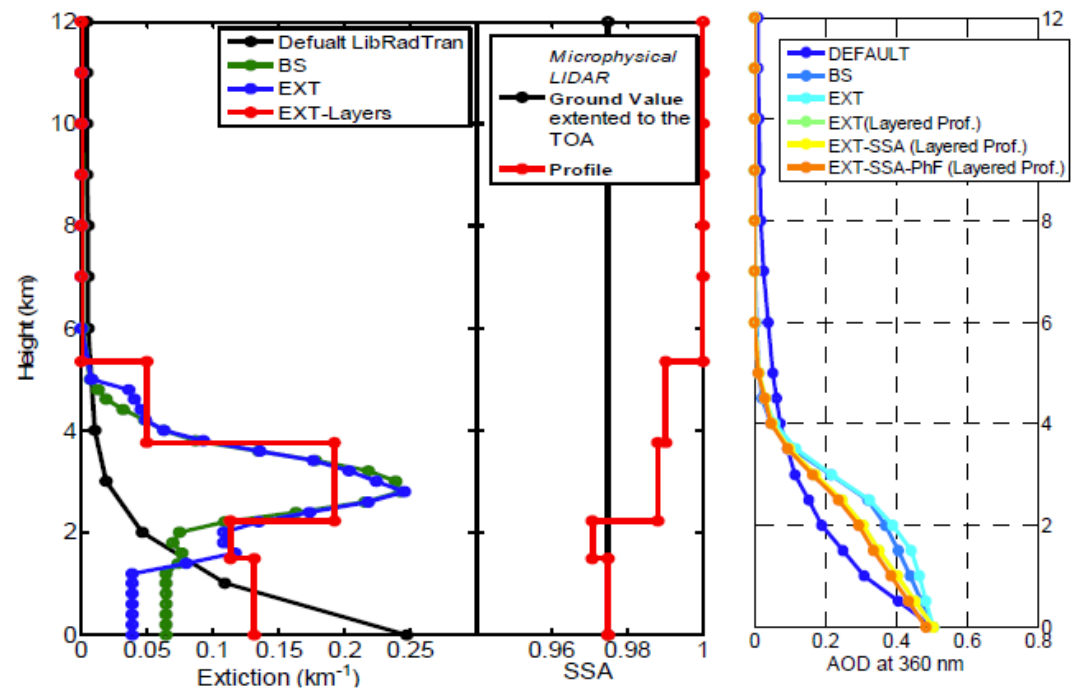
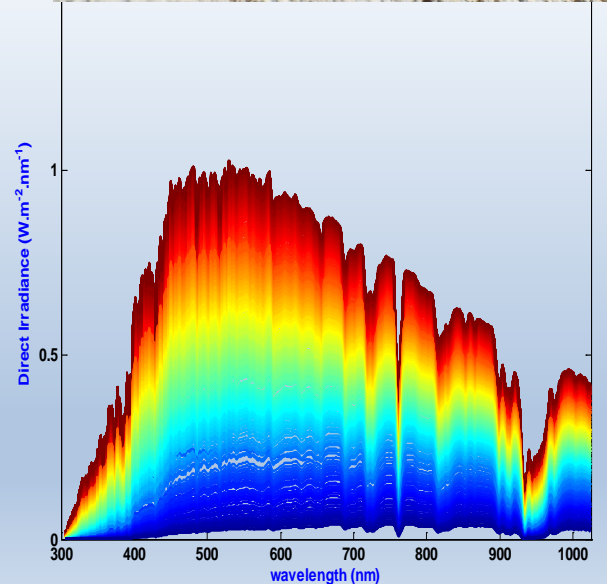


Include radiation measurements

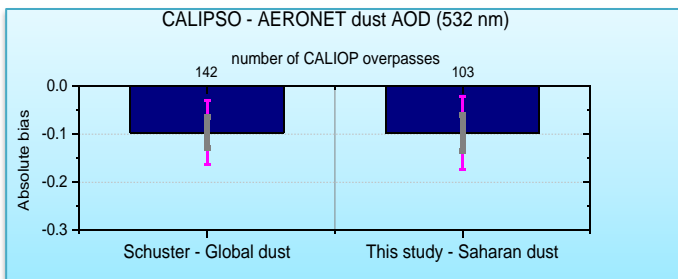
To include high-precision radiation measurements in the campaign of 2017 at Crete and Cyprus, in a similar manner that we did in CHARADMexp, including airborne sensors onboard FALCON



Objective: Run radiative transfer models to simulate surface and upwelling radiation using lidar/photometric input from the campaigns (analogous to EarthCARE TOA)

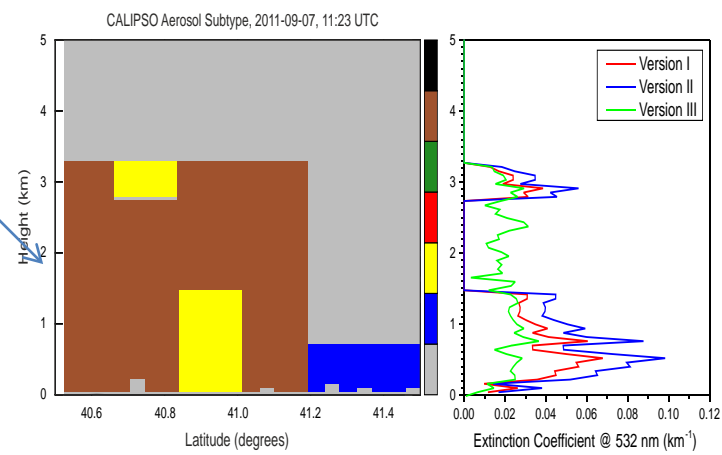
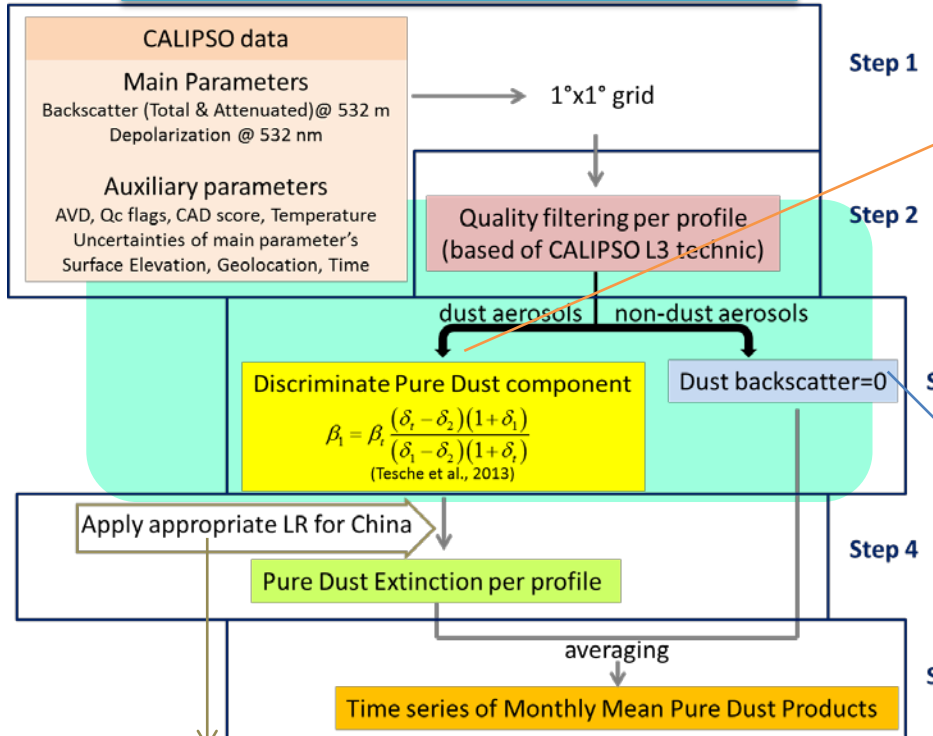
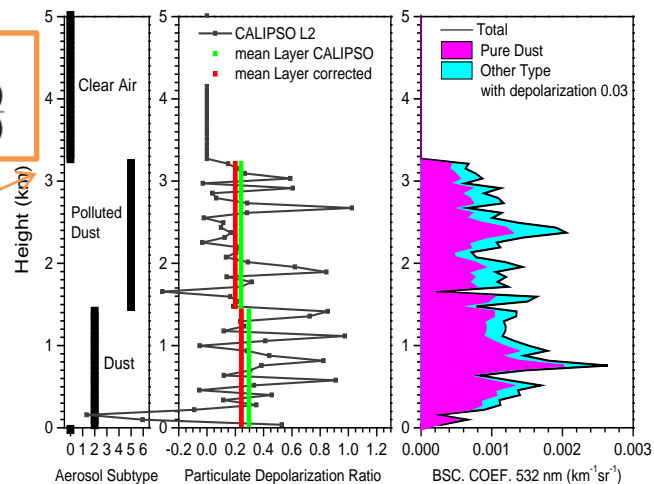


Application1: 8-year 3D dust climatology



Tesche et al., 2012

$$\beta_1 = \beta_i \frac{(\delta_i - \delta_2)(1 + \delta_1)}{(\delta_1 - \delta_2)(1 + \delta_i)}$$



Appropriate LR for China from ground-based lidar measurements

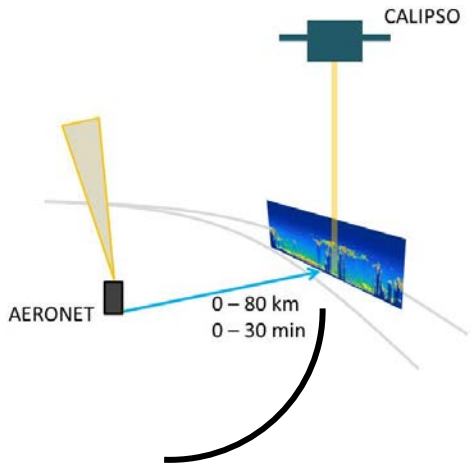
Amiridis et al., 2013
Optimizing CALIPSO Saharan dust retrievals



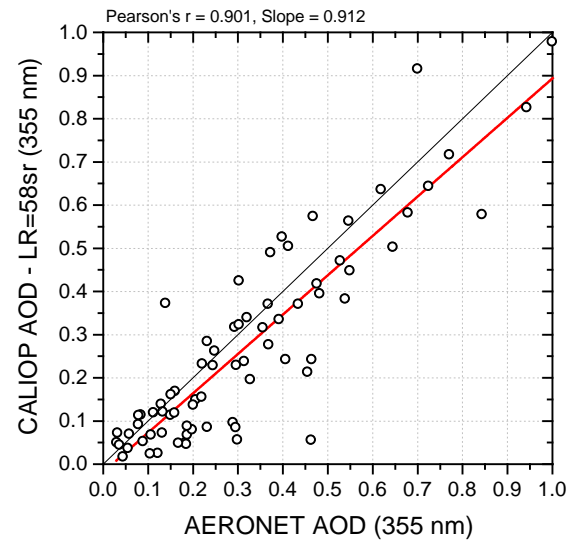
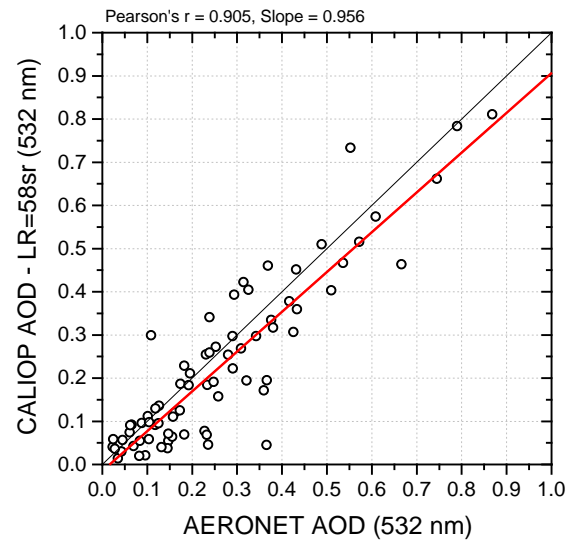
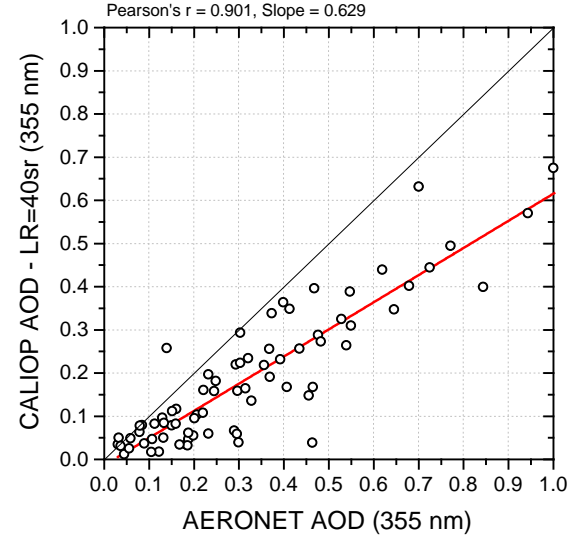
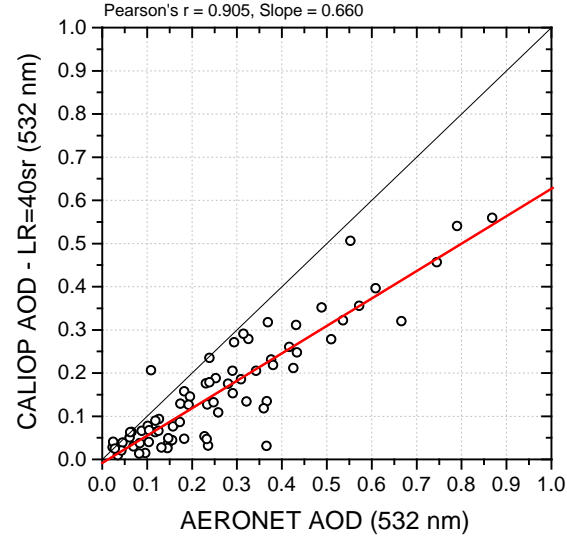
Application1: 8-year 3D dust climatology



CALIPSO-AERONET Collocation



In pure Dust cases
from CALIPSO typing

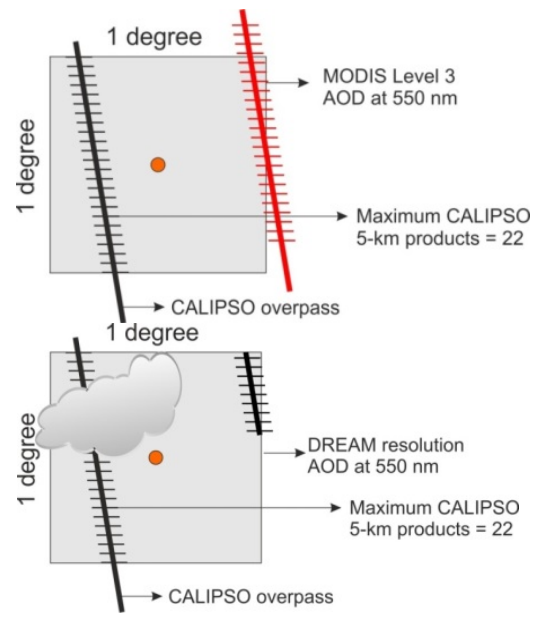




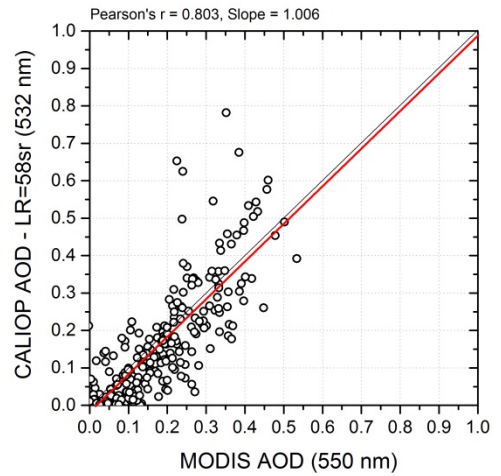
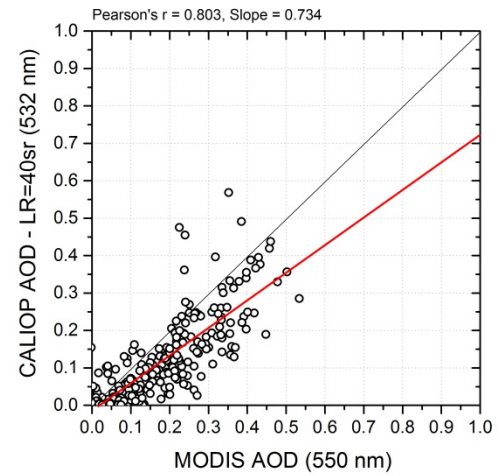
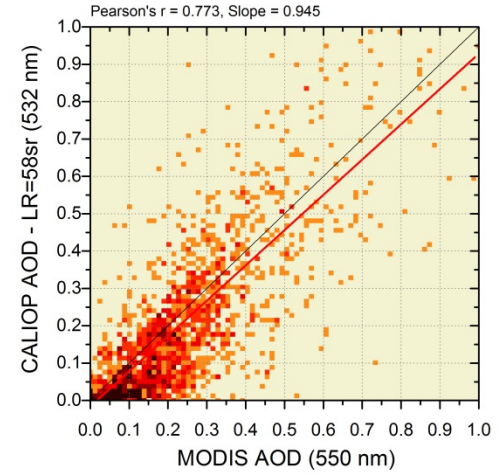
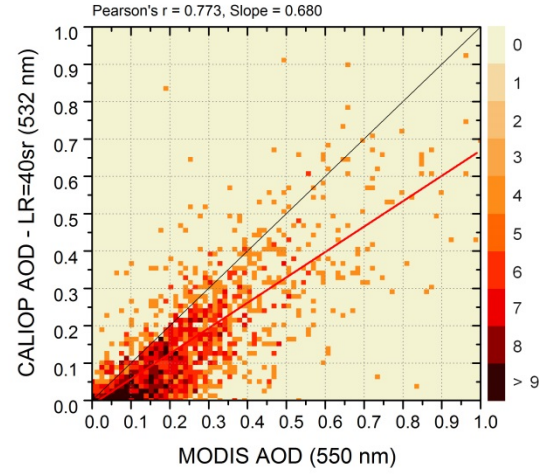
Application1: 8-year 3D dust climatology



CALIPSO-MODIS Collocation



Red overpasses rejected





Application1: 8-year 3D dust climatology



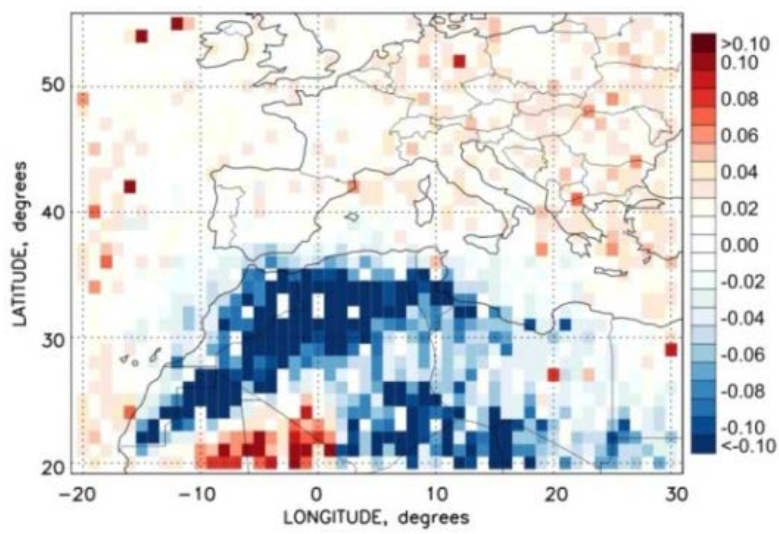
Compare our **Pure Dust product** for **Saharan Dust**
In the domain: North Africa / Europe

using years 2007 to 2013

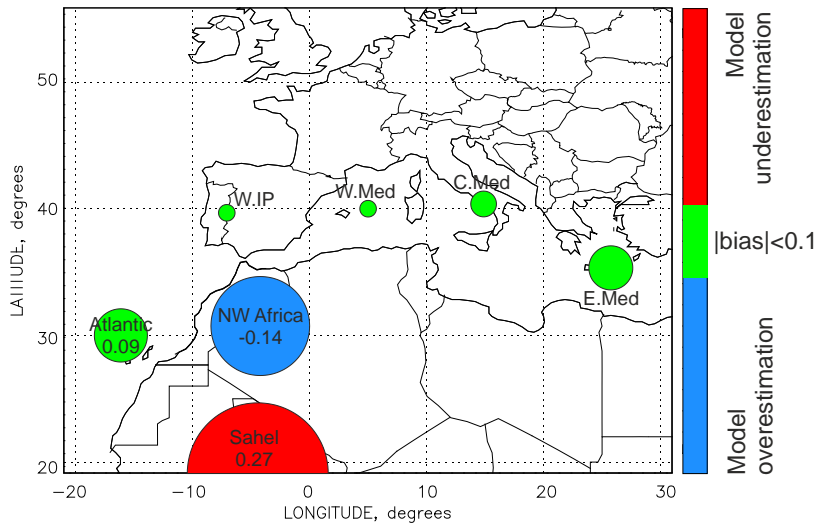
With BSC-DREAM 8b

All Climatology

Absolute Bias with our Pure Dust Product



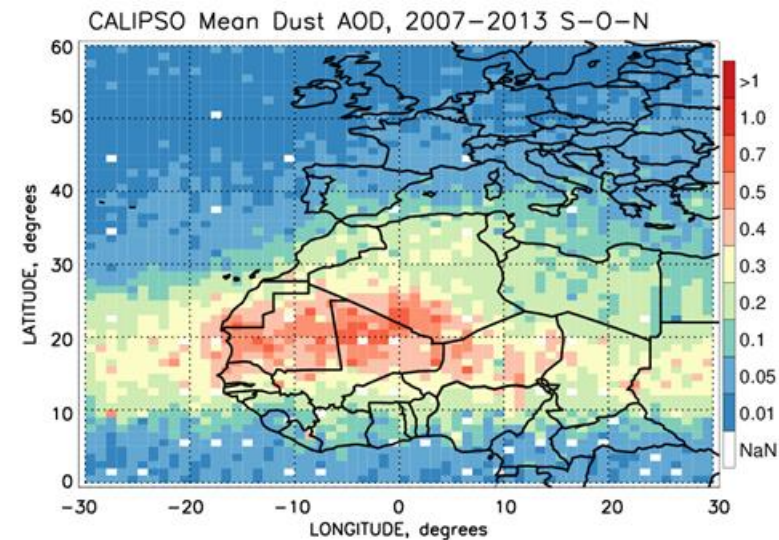
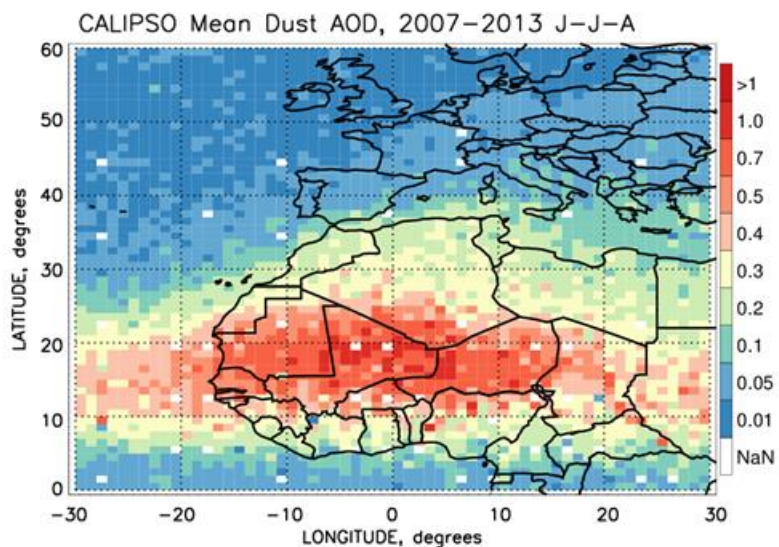
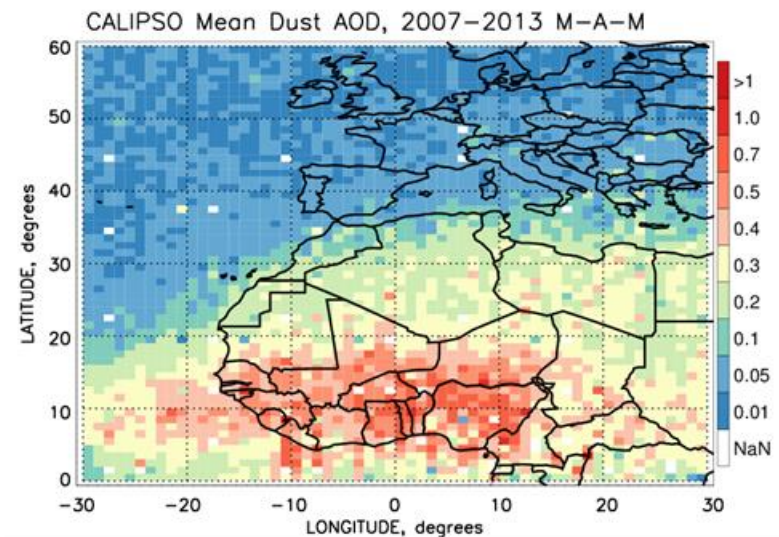
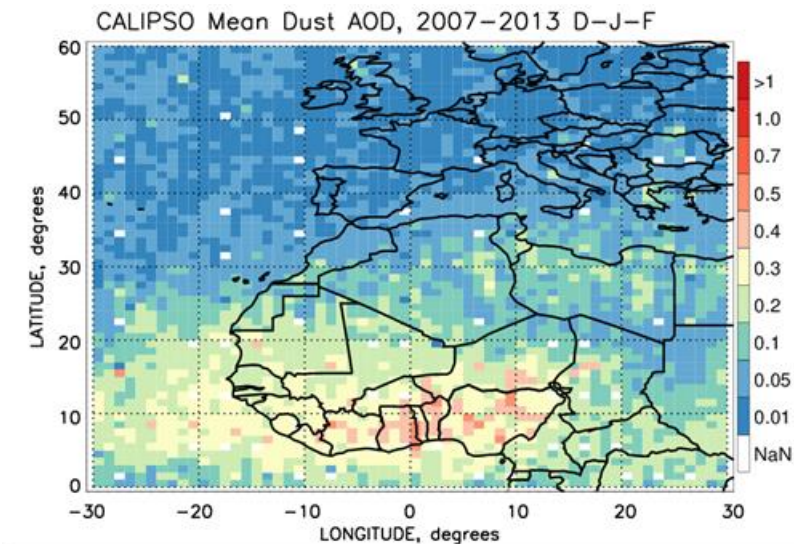
Absolute Bias of DREAM with AERONET



**Biases observed
follow known model biases**

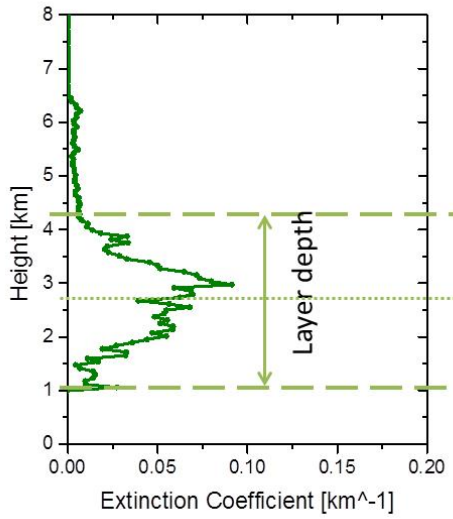
Application1: 8-year 3D dust climatology

Amiridis et al., ACP, 2013





Application 1: 8-year 3D dust climatology

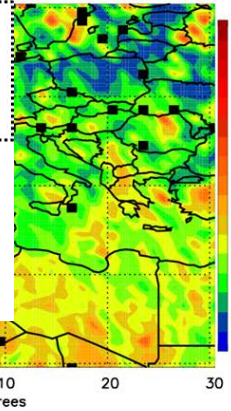


Top Layer Height

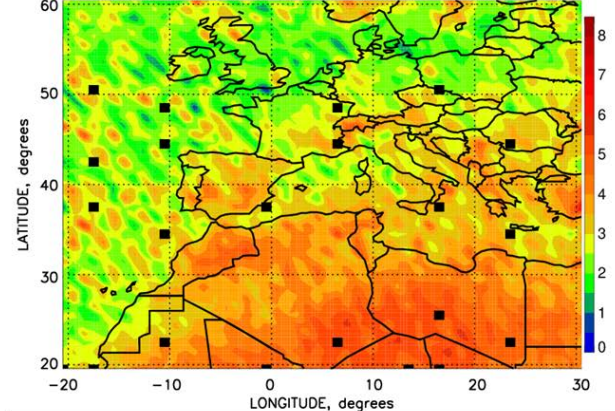
Center of Mass ($z_c = \frac{\int_{z_b}^{z_t} z \cdot \beta(z) dz}{\int_{z_b}^{z_t} \beta(z) dz}$)

Base Layer Height

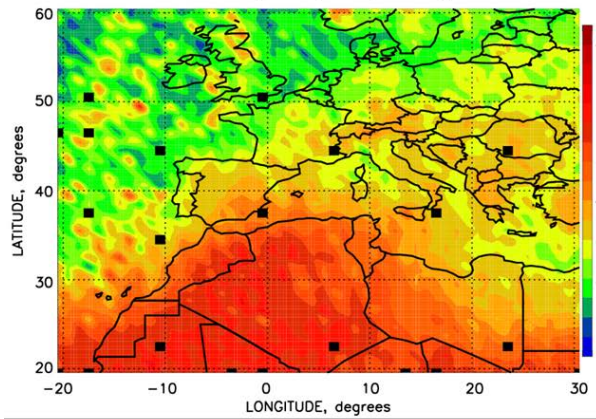
ht ASL, 2007–2014 J–F–M



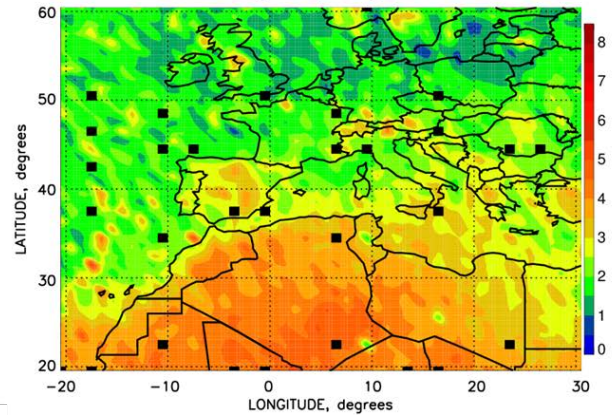
CALIPSO Mean Dust layer top height ASL, 2007–2014 A–M–J

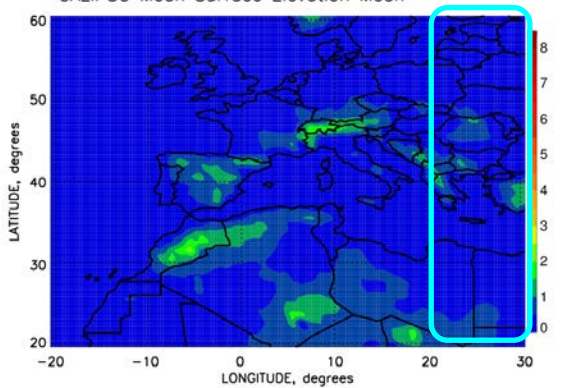


CALIPSO Mean Dust layer top height ASL, 2007–2014 J–A–S



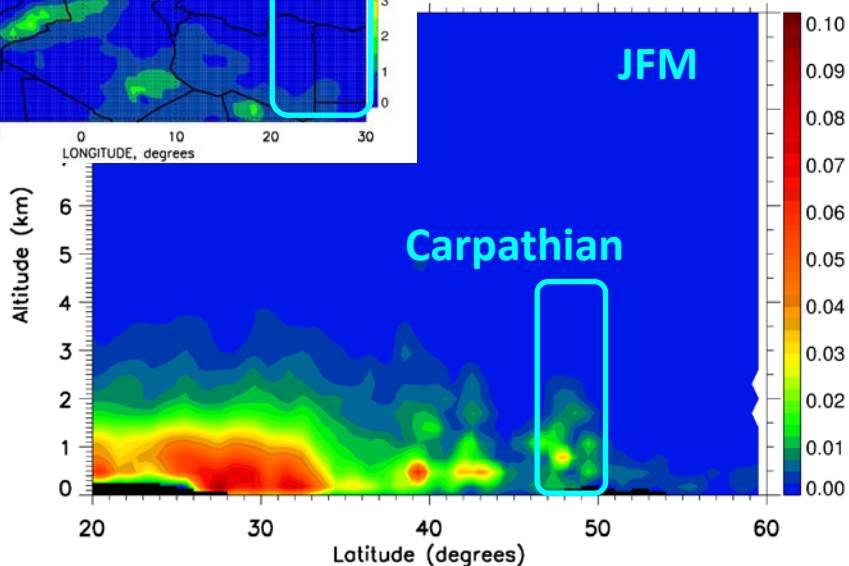
CALIPSO Mean Dust layer top height ASL, 2007–2014 O–N–D



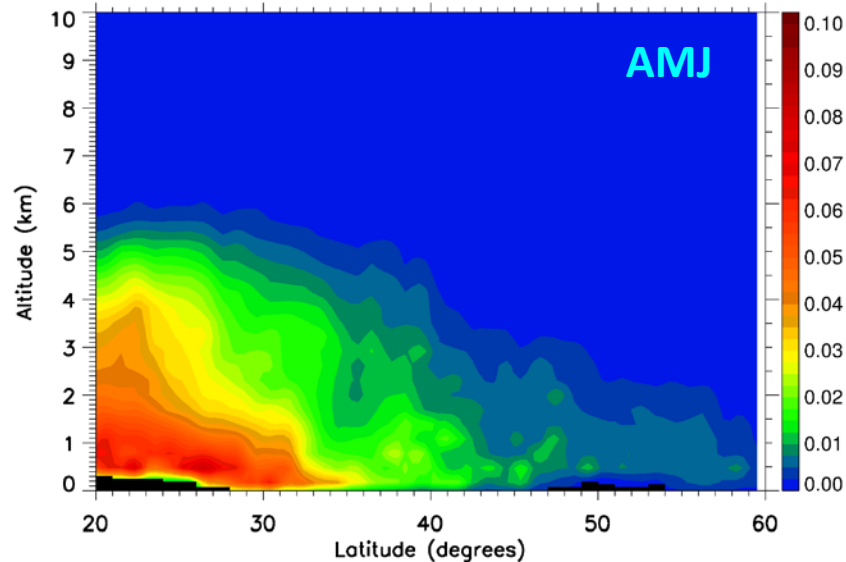


Extinction Coefficient 20-30 deg Longitude

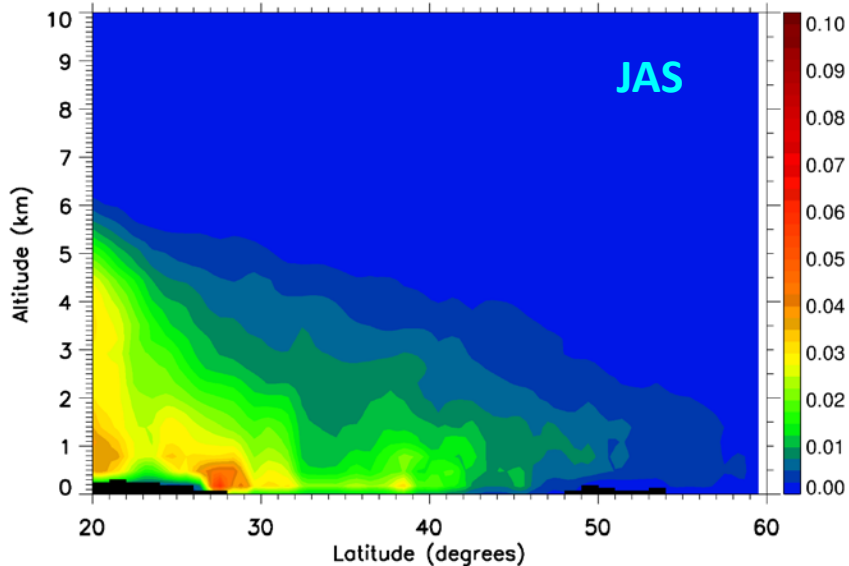
Dust Extinction 532nm, CALIPSO 2007to2014 Lons:20-30deg JFM



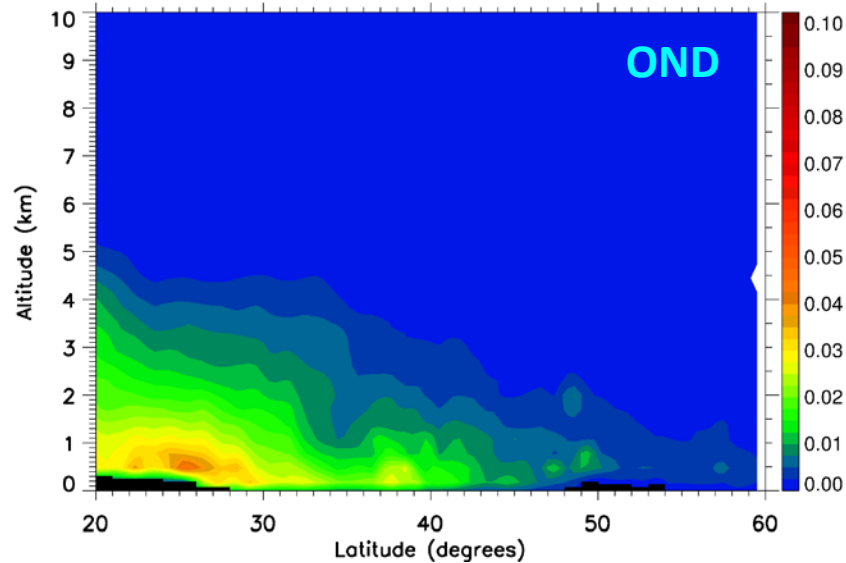
Dust Extinction 532nm, CALIPSO 2007to2014 Lons:20-30deg AMJ



Dust Extinction 532nm, CALIPSO 2007to2014 Lons:20-30deg JAS



Dust Extinction 532nm, CALIPSO 2007to2014 Lons:20-30deg OND



[Home](#) [Climatology](#) [Selected Scenes](#)

LIVAS Product
 Aerosol Extinction @532nm Per Type for cell with centroid: Lat= 38.5°, Lon= 23.5°

General Statistics:

Surface Elevation:			
Mean	0.23053	Min	0
Max	1.529		
Number of overpasses:			
164			
Number of profiles examined:			
3467			
Aerosol Statistics:			
Samples averaged (after filtering) :			
Total	1124394	Aerosol	51325
Clear Air	1073069		
Aerosol subtype occurrence:			
CM	D	PC	CC
8.6995	22.7316	8.83	3.7759
PD	S		
39.7389	15.47		
Aerosol Optical Depth at 532 nm:			
Mean	0.1625	Median	0.05123
StDev	0.37429		

Category	Product	Wavelength	Partial Products
Aerosol	Extinction	355nm	Per Type
		532nm	
Cloud	Backscatter	1064nm	Per Season
		1570nm	
		2050nm	

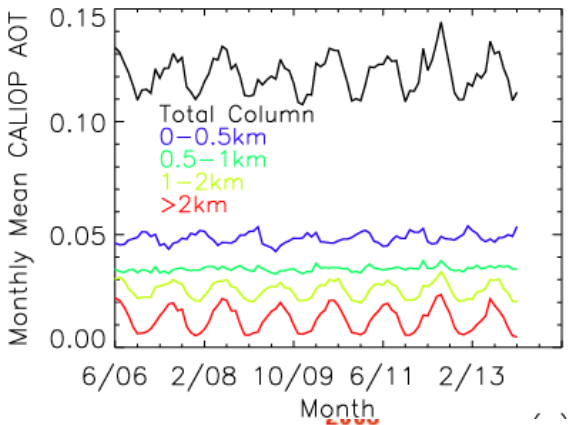
Save to ASCII Save to NetCDF

Grid Selector

Product Selector

Navigate to the desired final product by hovering over the menu from left to right and then press in order to inspect charts and data. [Read more >](#)

Application2: 3D Climatology



Launch December 2014
 6 month requirement
 3 year goal

HSRL/UV
 demonstration
 for ACE Mission

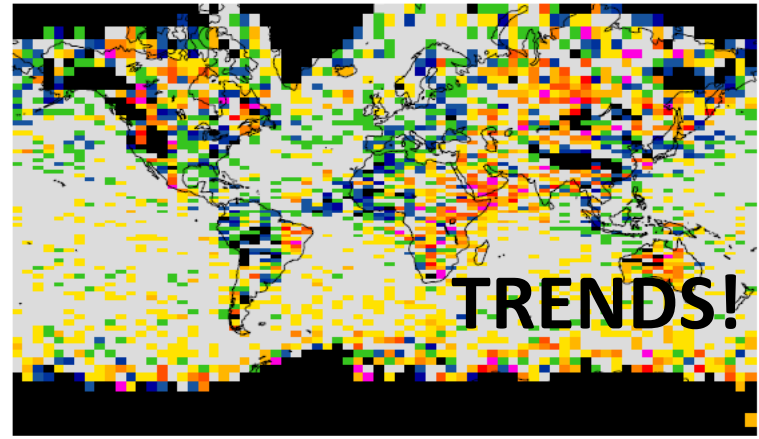


Launched in 2006
 Using 2nd laser
 since 2009

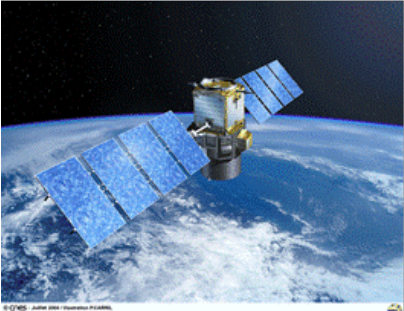
Bridge data gap
 between CALIPSO
 and EarthCARE

HSRL likely to
 launch in 2018

ACE
 Space-
 based
 mission to
 launch



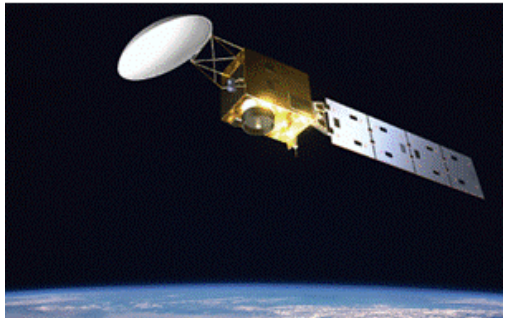
CALIPSO (532nm)



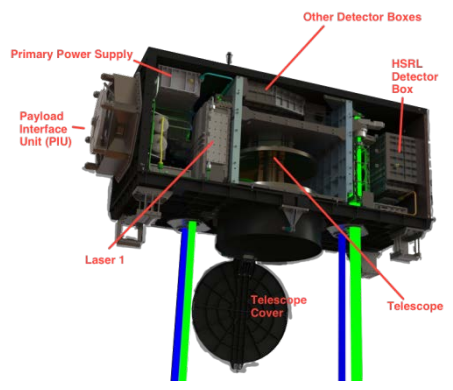
ADM-Aeolus (355nm)



EarthCARE (355nm)



Multi-wavelength lidars are needed for homogenization



**U.S. solution:
CATS mission
(355, 532, 1064 nm)**

**European solution:
EARLINET
(355, 532, 1064 nm)**





Concluding remarks



1. Finokalia is expected to add unique aerosol data to the EARLINET model and fill the gaps on dust, marine, smoke, and their mixtures. The dataset continuously expands and new data will be added from ACTRIS and future EU and ESA campaigns in Eastern Mediterranean.
2. The aerosol model has been applied to provide a trustworthy pure-dust climatology from CALIPSO. This can be expanded for other aerosol types to achieve the discrimination of natural and anthropogenic aerosols from space.
3. CALIPSO, ADM, EarthCARE and CATS/ACE missions can be homogenized through the lidar-based aerosol model in order to provide a unique long-term 3D climate record.
4. Passive sensor retrievals can benefit from active remote sensing for (a) validation of layering retrievals such as stratospheric or dust layer heights, (b) validation of retrievals over high reflectance areas like deserts, (c) cloud screening and above-cloud aerosol studies, (d) near-surface air quality estimations.