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

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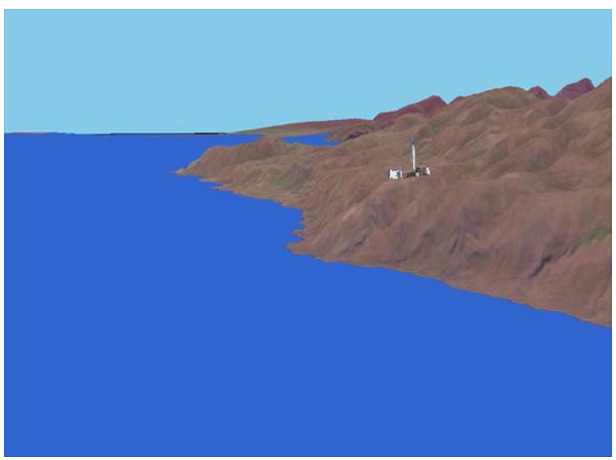
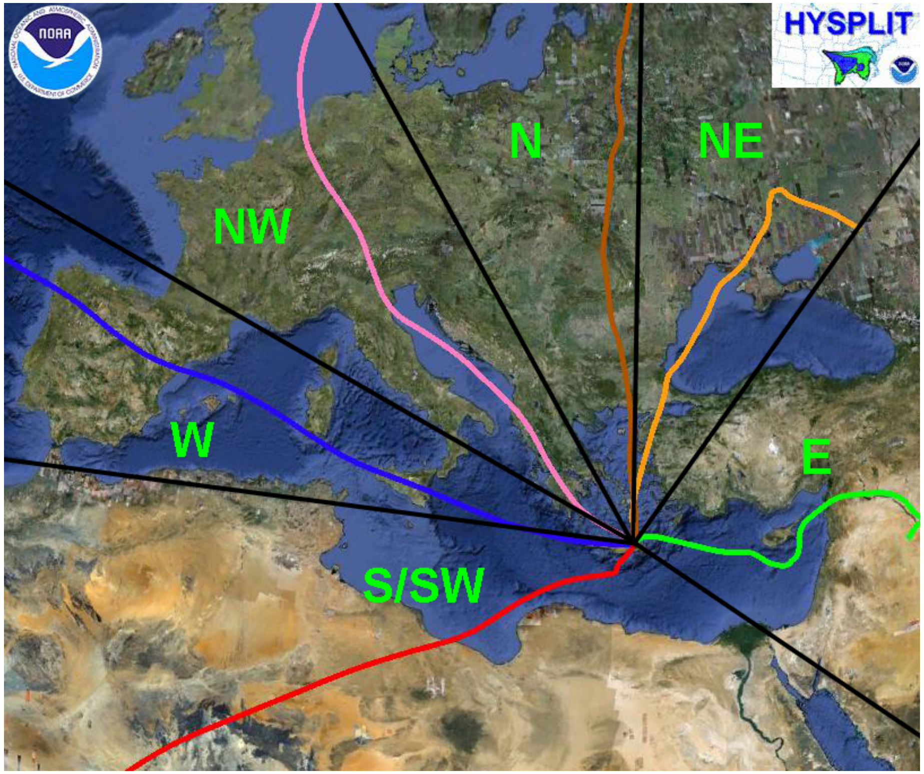
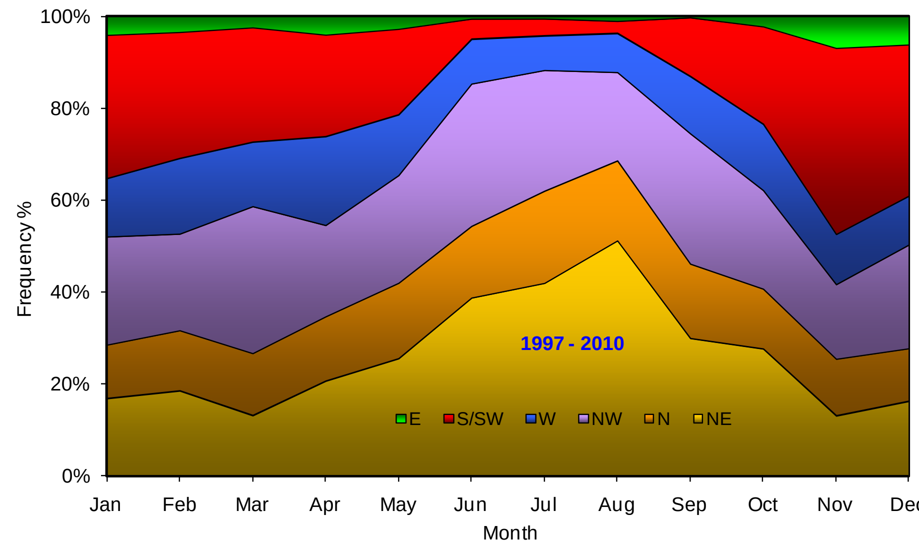
Location of Finokalia



Latitude = 35.34^{0}N - Longitude = 25.67^{0}E - Elevation = 252 a.s.l.

Trajectory clusters @1 km arrival height

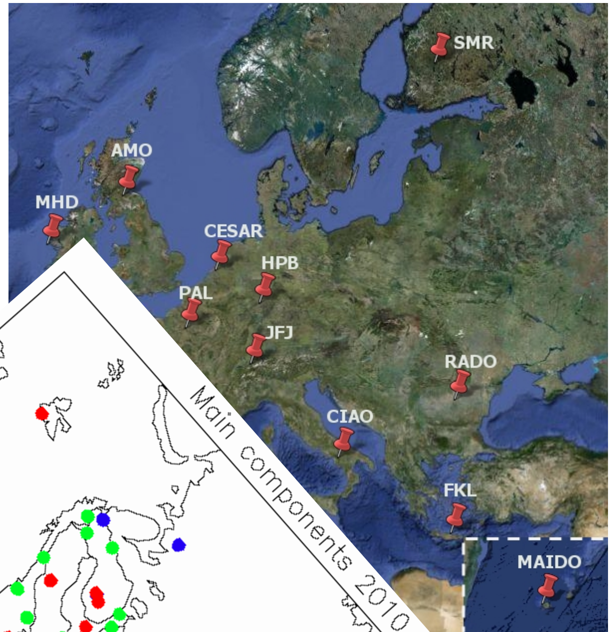




In-situ measurements performed during the last 20 years showed that marine and dust particles are present 95% of the time. Smoke from forest fires can be occasionally detected as well as urban pollution from nearby megacities in the Aegean Sea (Athens, Istanbul)

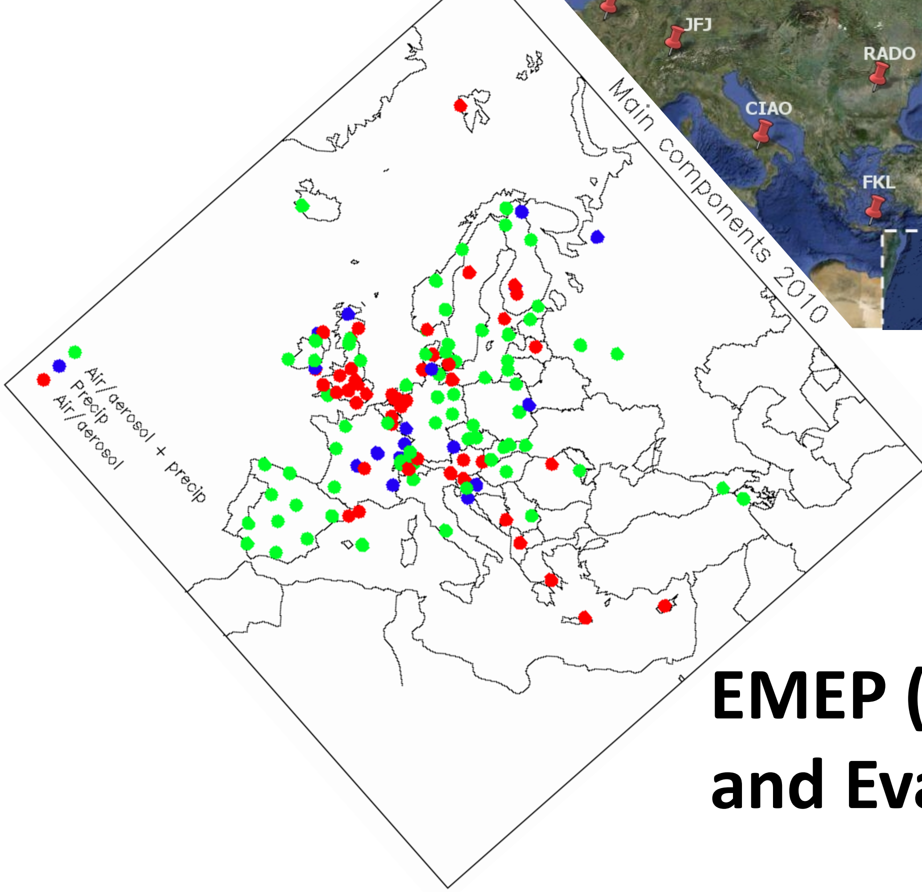

Thermo Environmental Instruments Inc.
PILS
PFEIFFER VACUUM
API
Magee Scientific
Aethalometer™

Networking



ACTRIS

ICOS (Integrated Carbon Observation System)



EMEP (European Monitoring and Evaluation Programme)

Remote Sensing instrumentation During ESA-CHARADMexp campaign

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)

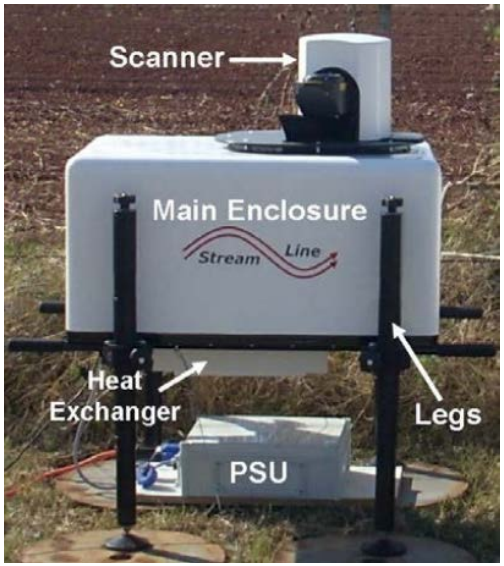
Remote sensors deployed
2. EMORAL lidar

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

EARLINET

Remote sensors deployed
3. HALO wind lidar

ACTRIS IAASARS



- 1 backscatter channel (1.5 μm)
- Doppler lidar capable of providing wind speed and direction and turbulence

esa

Remote sensors deployed
4. MWR

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 (IWV)
3. Temperature and RH profiles within the PBL (for CHARADMexp, the synergy with the lidars will be utilized to derive WV profiles)

Remote sensors deployed
5. Sunphotometers

AERONET-CIMEL

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)

Airborne measurements
CyI UAVs

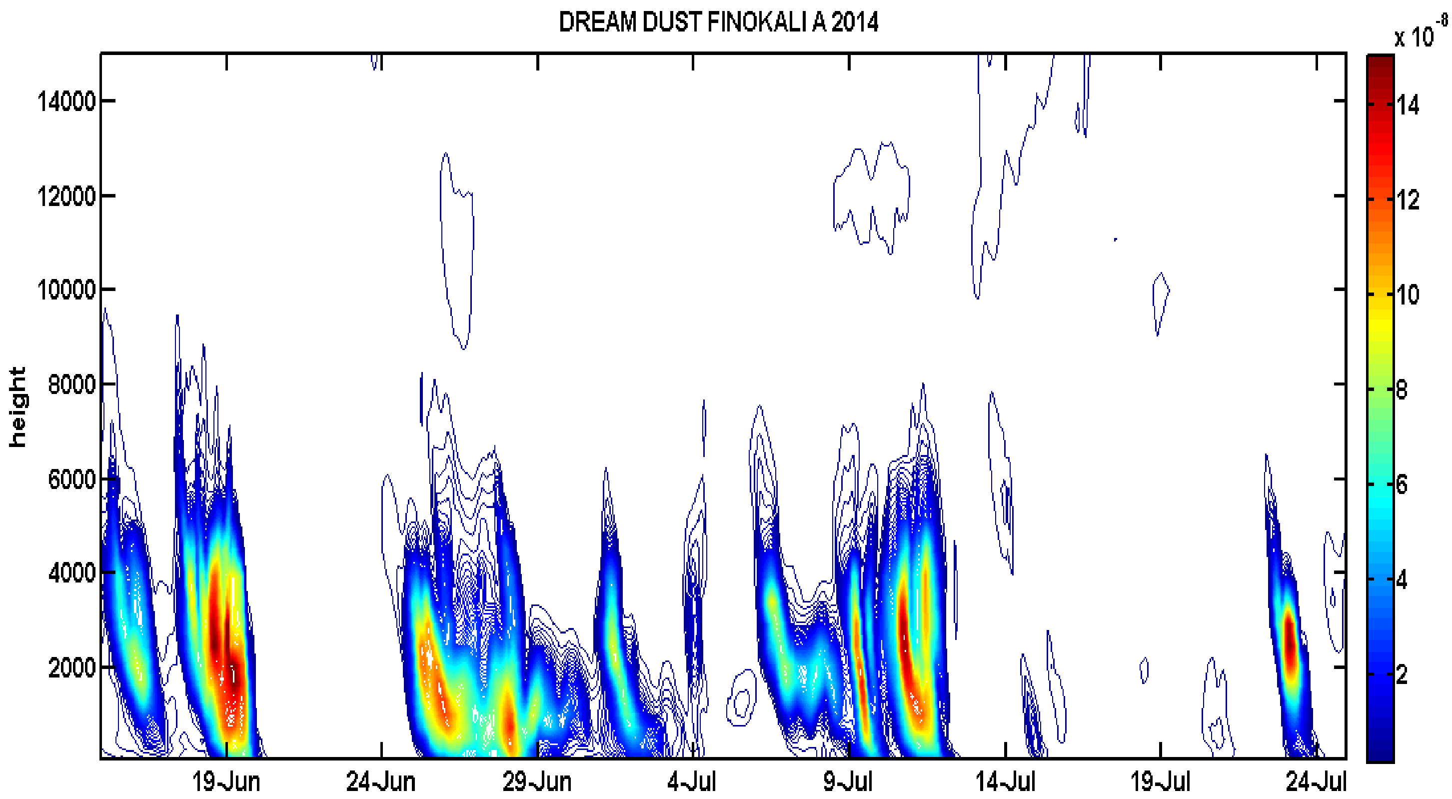
Ground Control Unit

Black carbon (aethalometer)

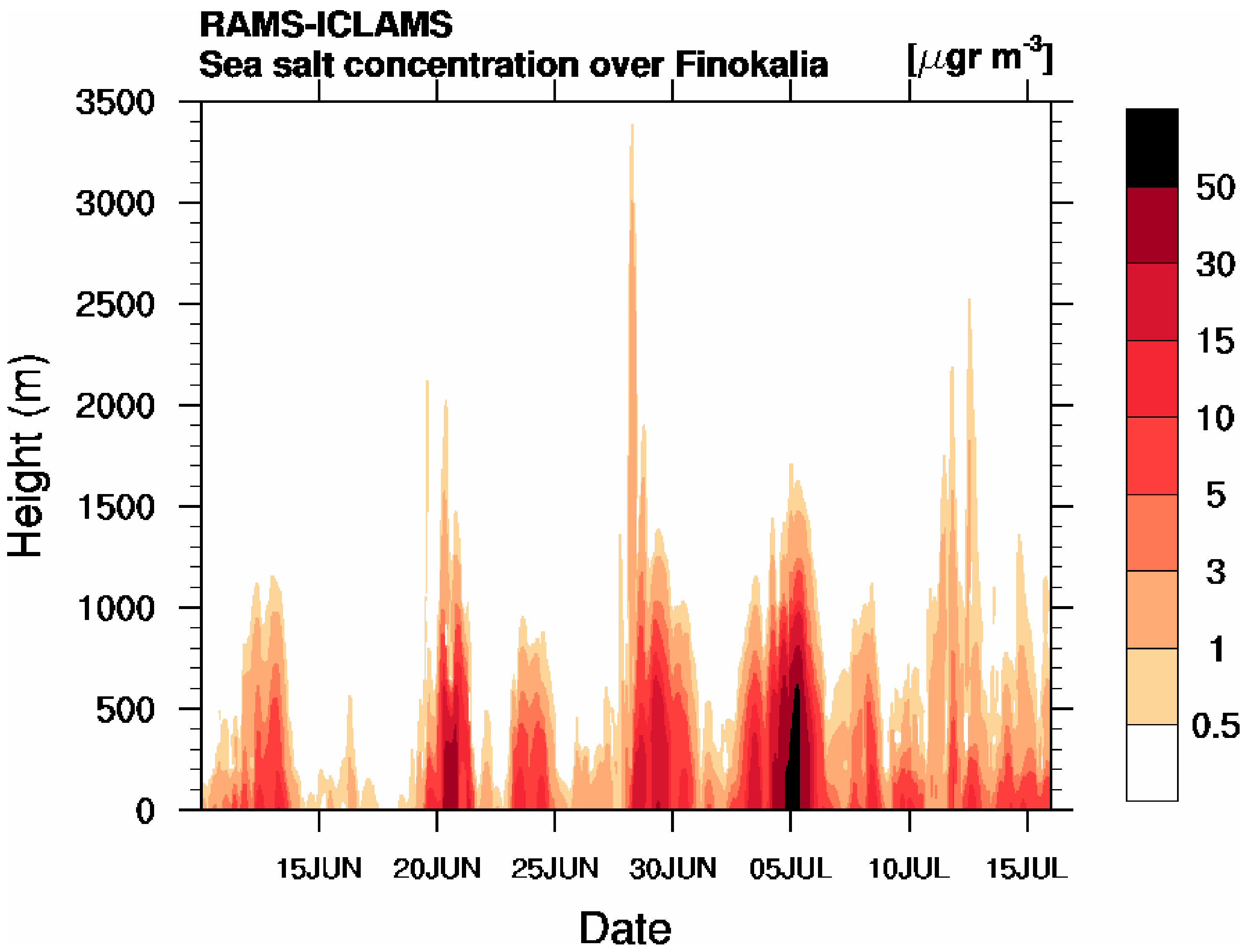
Ozone (UV absorption)

Condensation Particle Counter (CPC)

BSC-DREAM8b dust vertical distributions



Marine vertical distributions

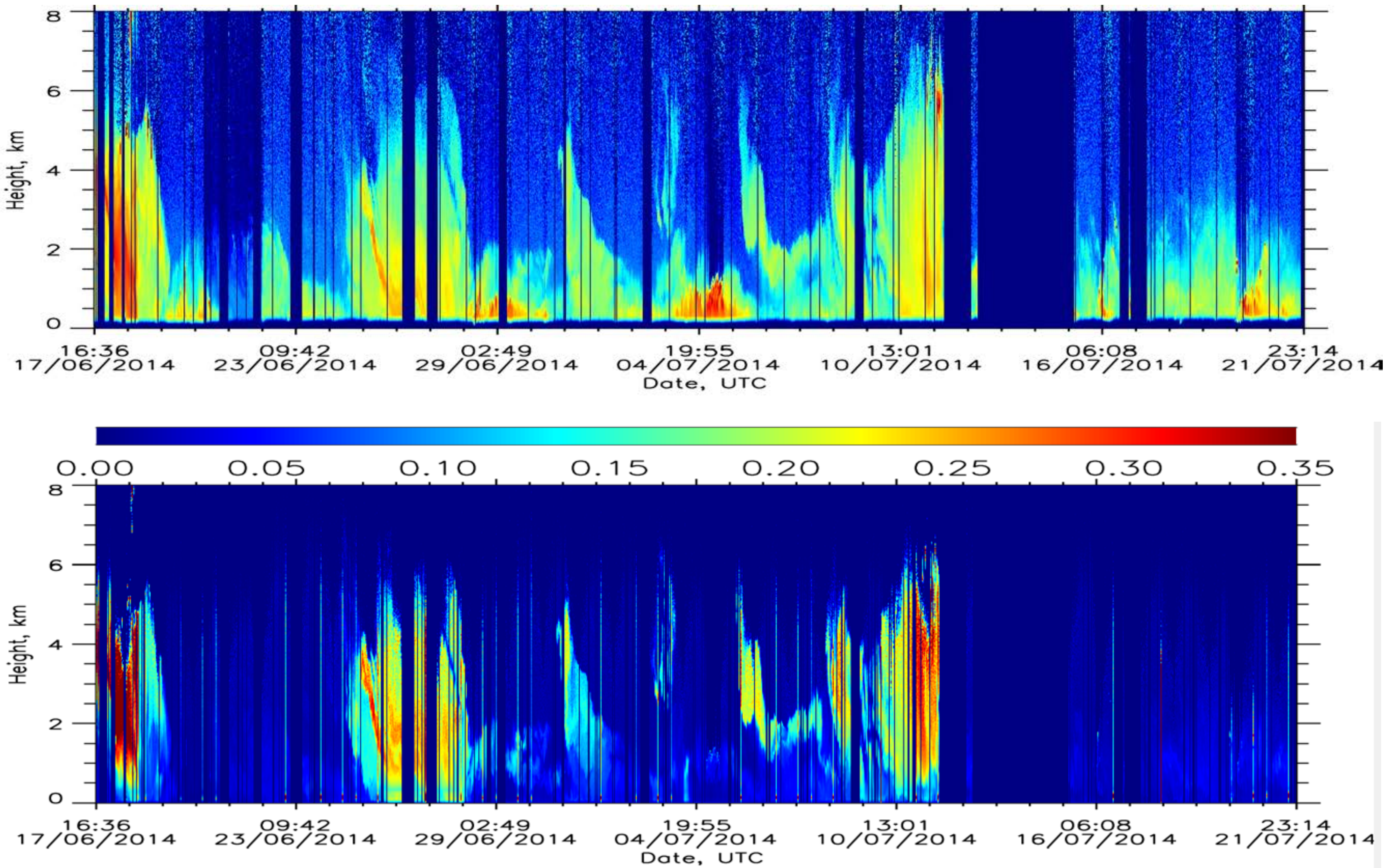


Retrieval examples

EARLINET ACTRIS IAASARS

Range corrected signal at 1064nm

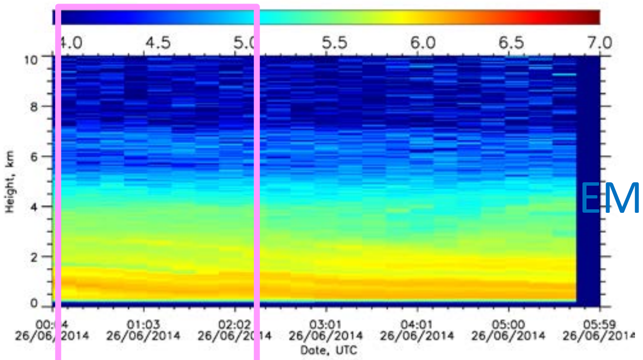
Depolarization: cross/total @532nm



esa

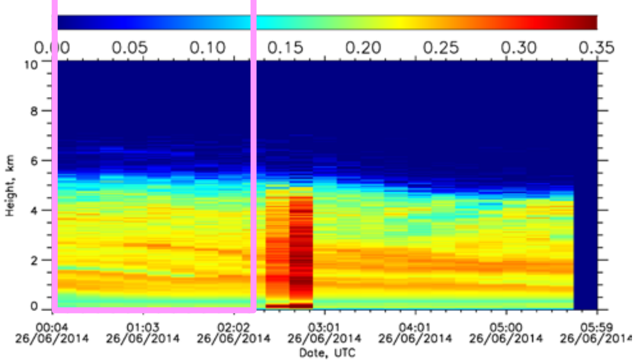
Retrieval examples

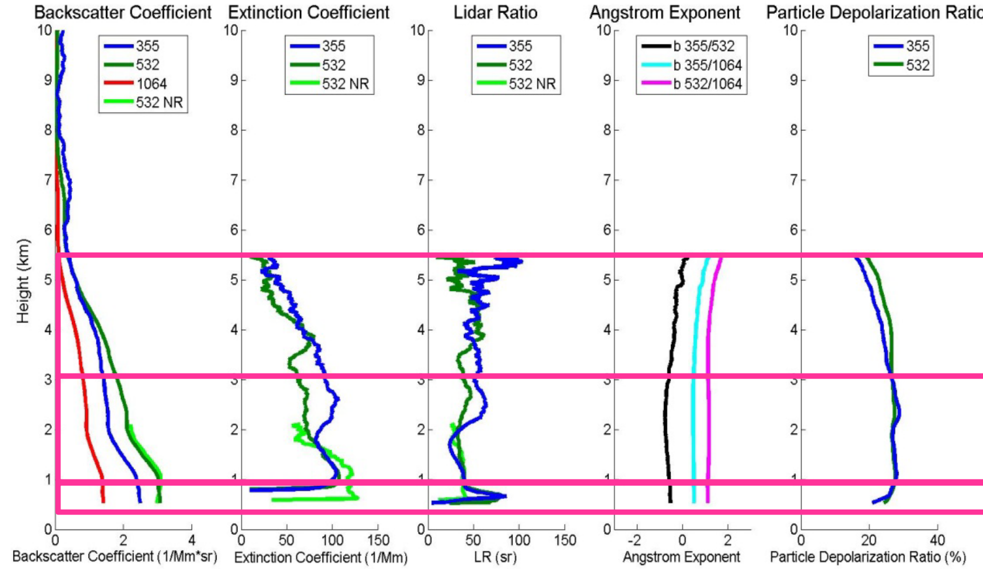
Range corrected signal @1064nm



EMORAL

Depolarization: cross/total @532nm



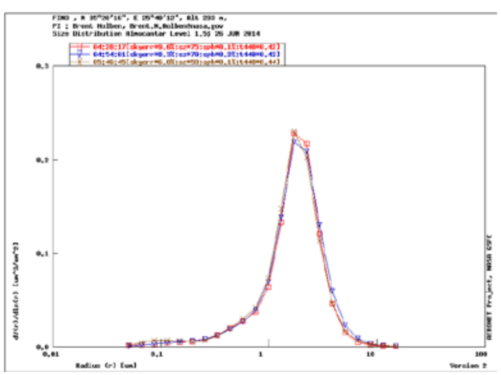


Cimel

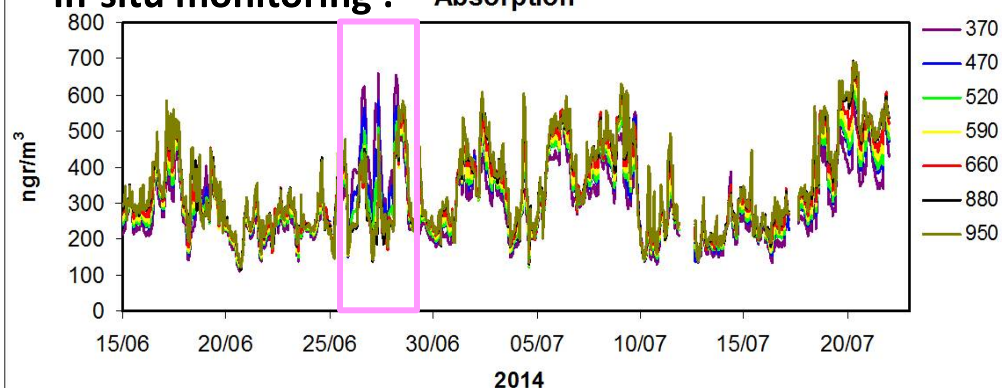
AOD$_{500}$: 0.42

Ang: 0.08

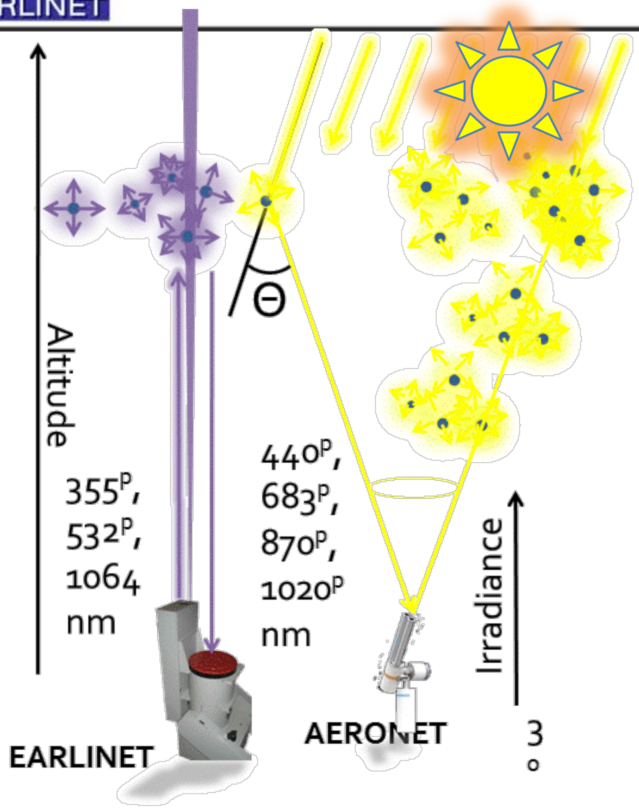
Dominance of coarse mode

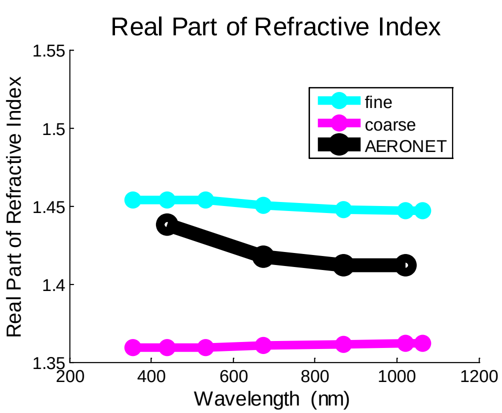


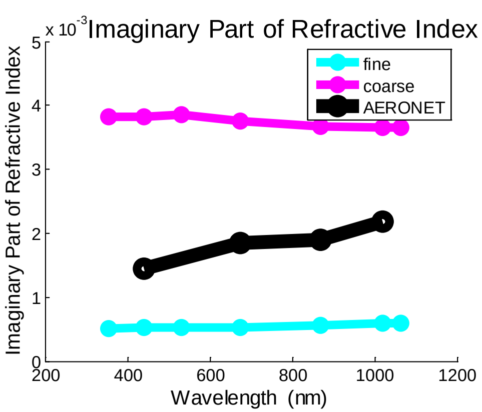
In-situ monitoring : **Absorption**

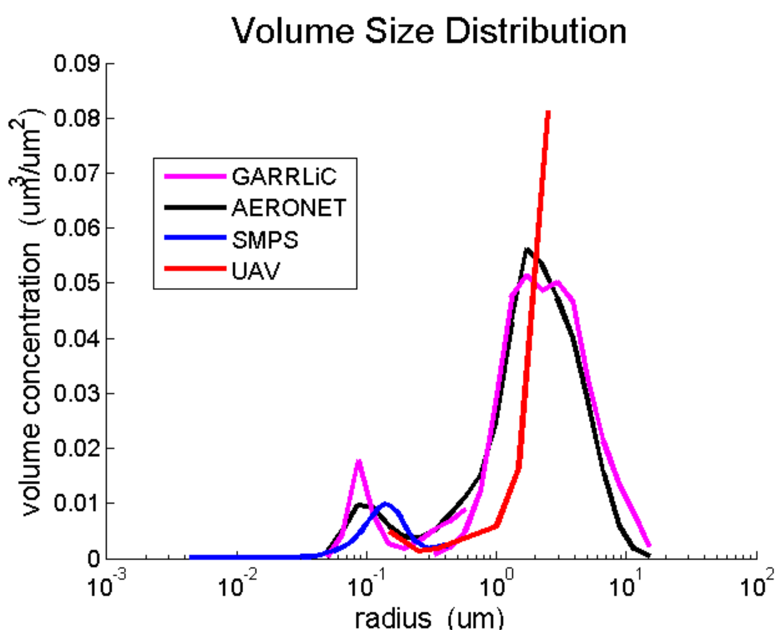


Microphysics - GARRLiC

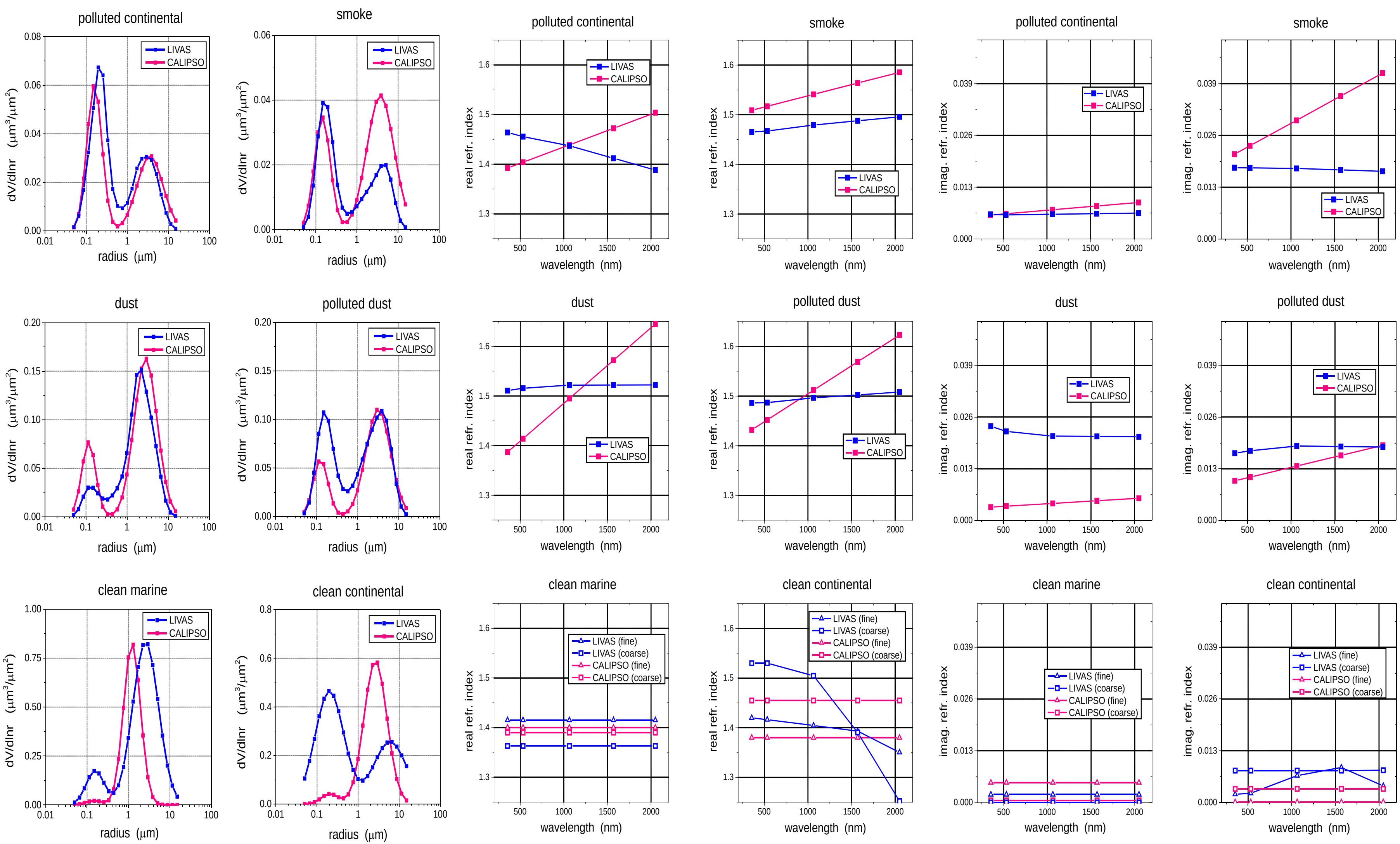




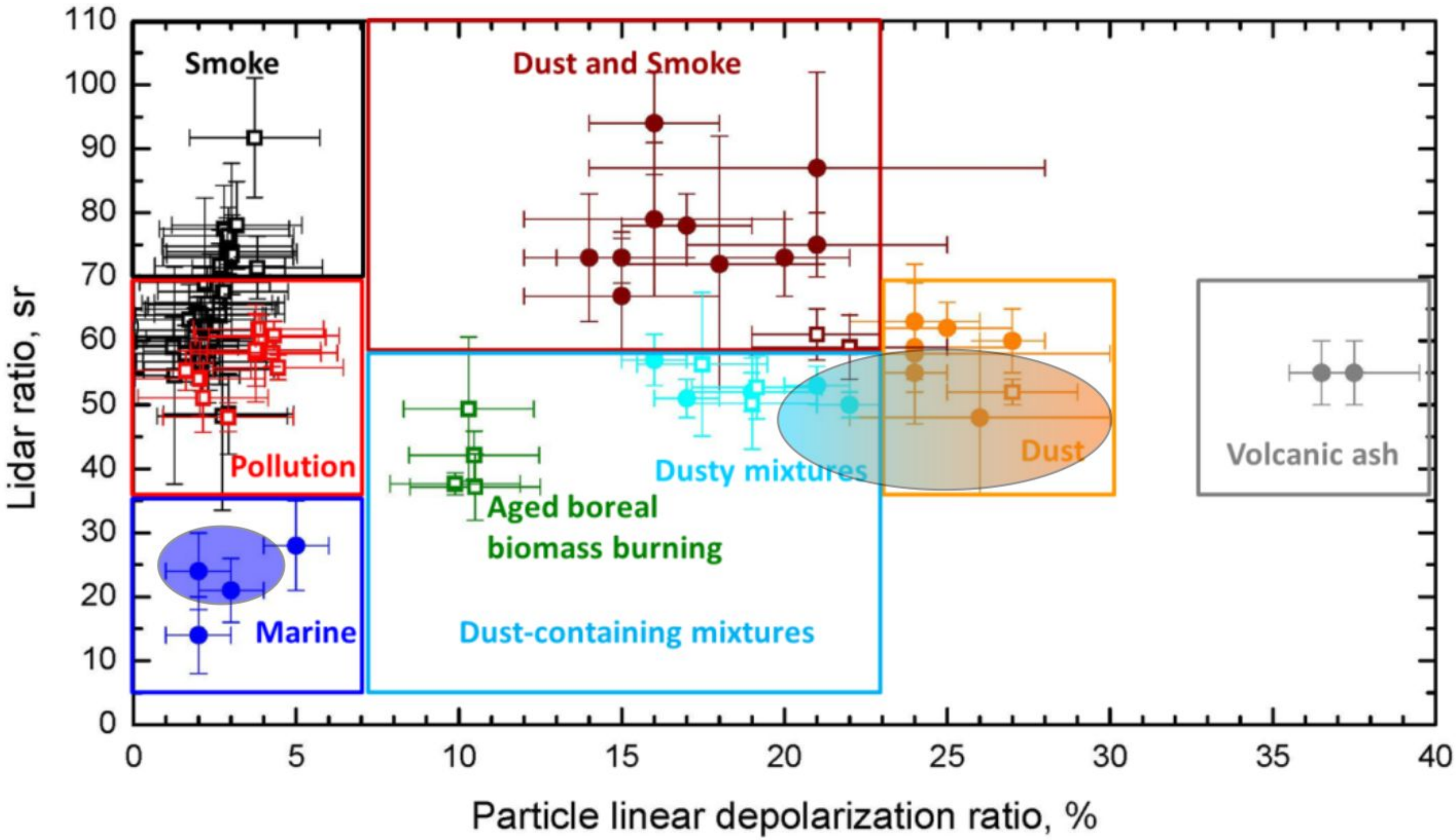




Aerosol model – First results



EarthCARE properties for aerosol classification



Personal communication: Ulla Wandinger (TROPOS)

Past and ongoing ESA studies + Gaps

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.

Future plans

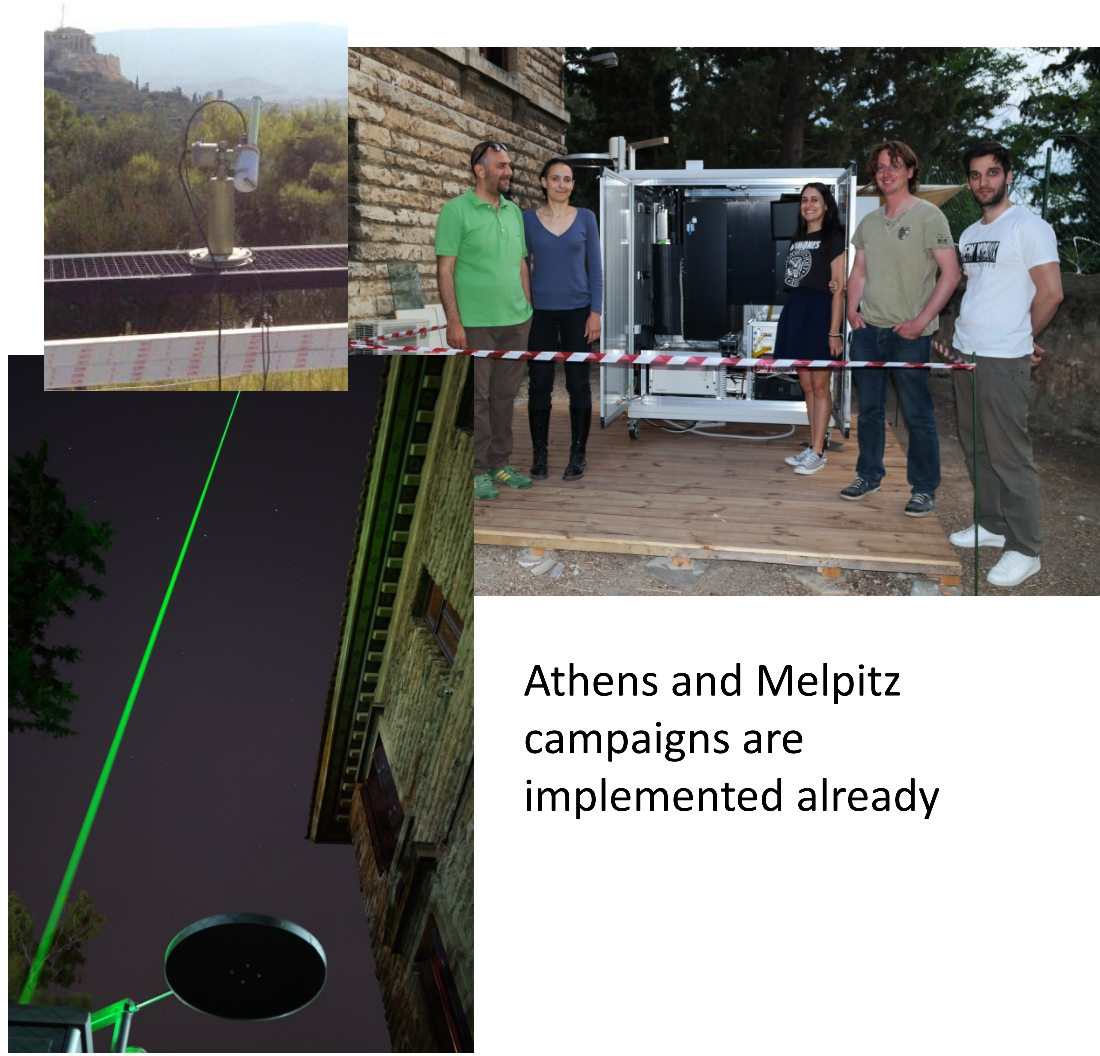
ACTRIS-2 campaigns: NOA will organize 4 experimental campaigns @ Athens, Crete, Granada, Melpitz

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

CIMEL sunphotometer

Polly^{XT} OCEANET lidar

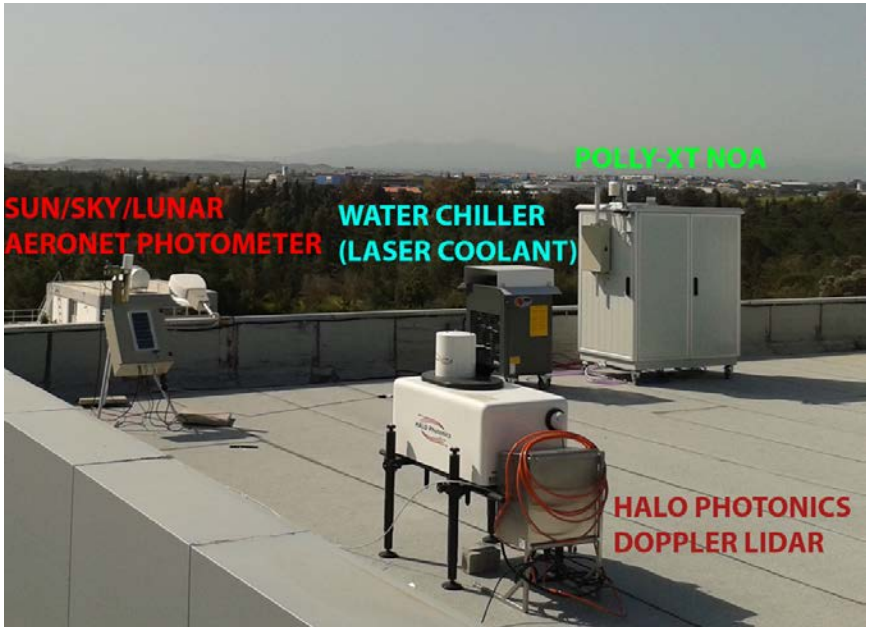
In-situ measurements with Unmanned Aerial Vehicles (UAVs) and/or tethered balloons

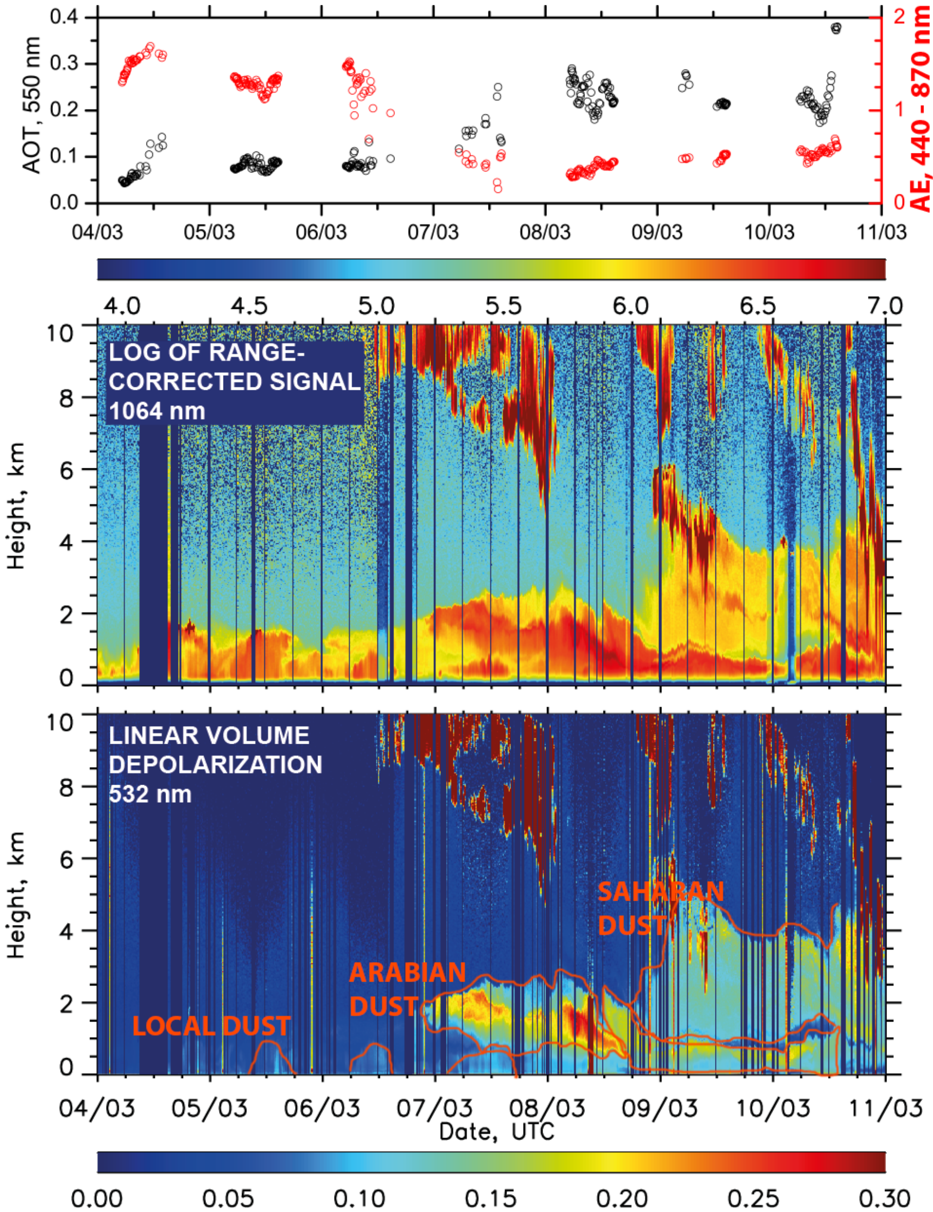


Athens and Melpitz campaigns are implemented already

Future plans

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





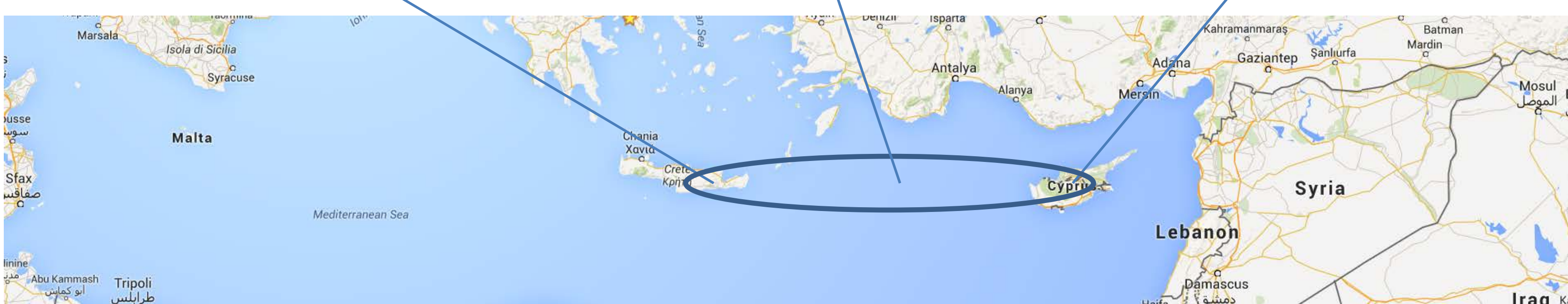
Future plans

Large scale experimental campaign in Eastern Mediterranean – April 2017

NOA:
Replicate LACROS
@ Crete

DLR:
50 flight-hours
over East.Med.
(ERC project A-LIFE)

TROPOS:
LACROS @ Cyprus



EARLINET

Finokalia instrumentation from 2016

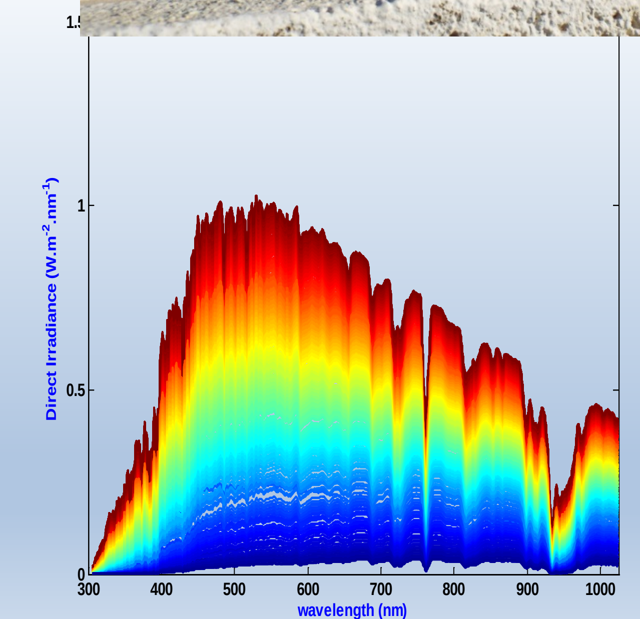
ACTRIS

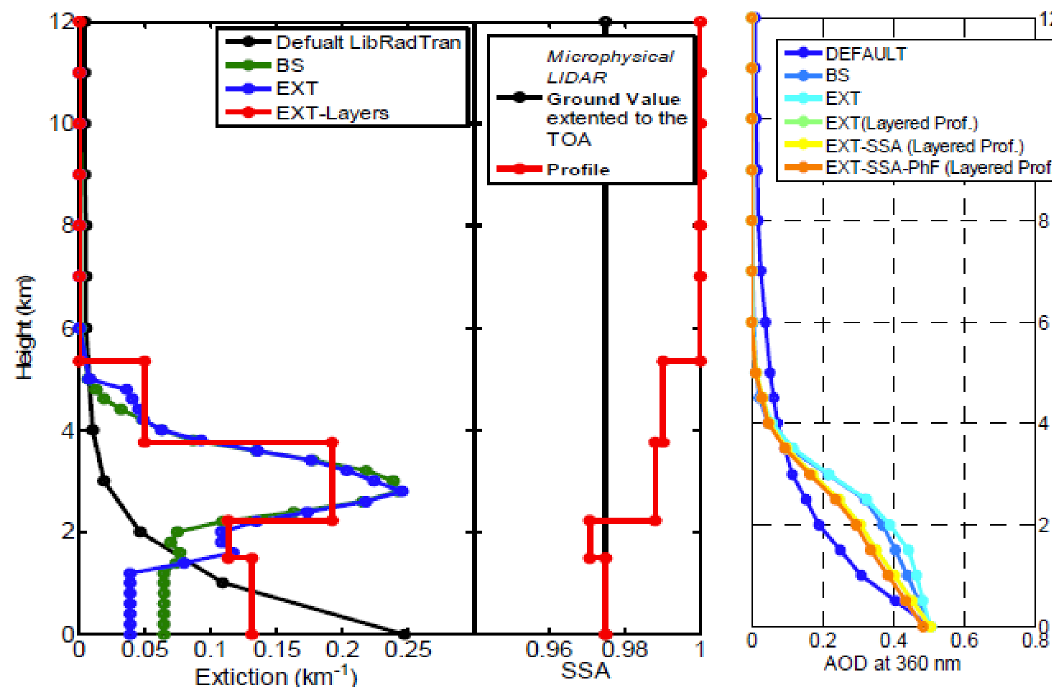
IAASARS

Include radiation measurements

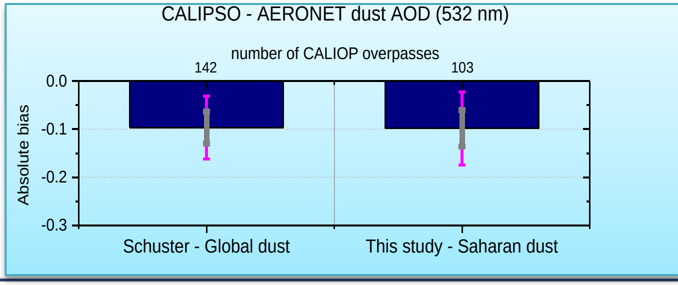
To include high-precision radiation measurements in the campaign of 2017 at Crete and Cyprus, in a similar manner that we did in CHARADMexp, including airborne sensors onboard FALCON

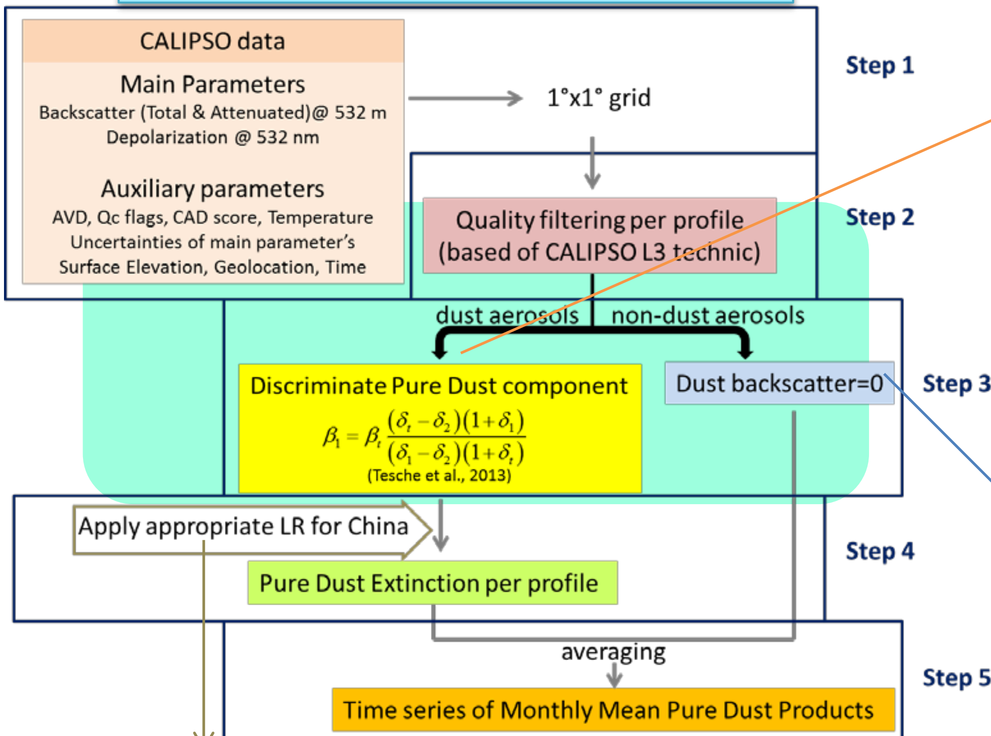
Objective: Run radiative transfer models to simulate surface and upwelling radiation using lidar/photometric input from the campaigns (analogous to EarthCARE TOA)





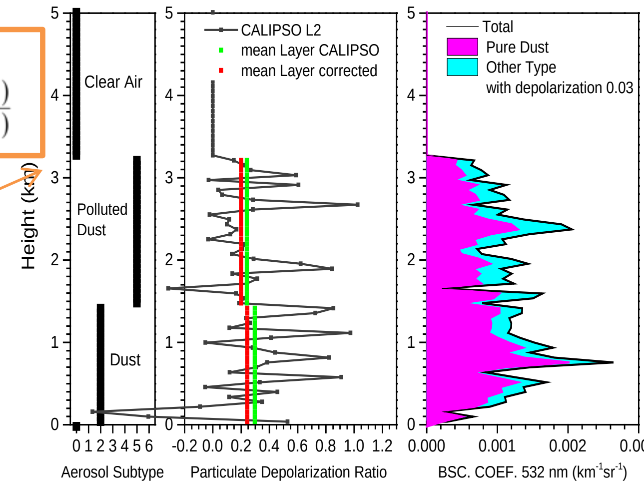
Application1: 8-year 3D dust climatology

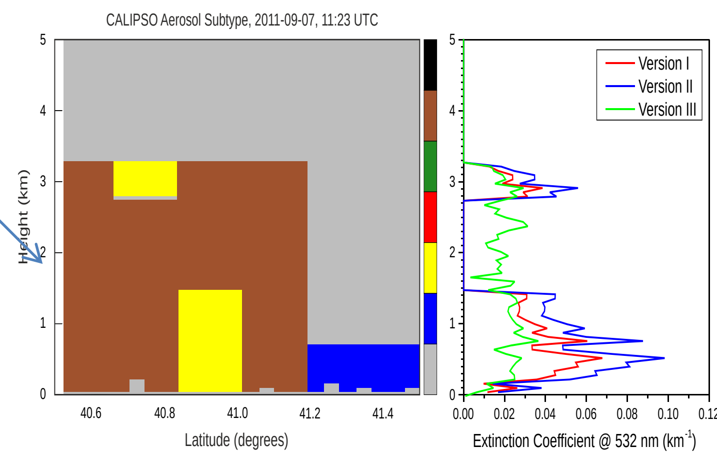




Tesche et al., 2012

$$\beta_1 = \beta_t \frac{(\delta_t - \delta_2)(1+\delta_1)}{(\delta_1 - \delta_2)(1+\delta_t)}$$



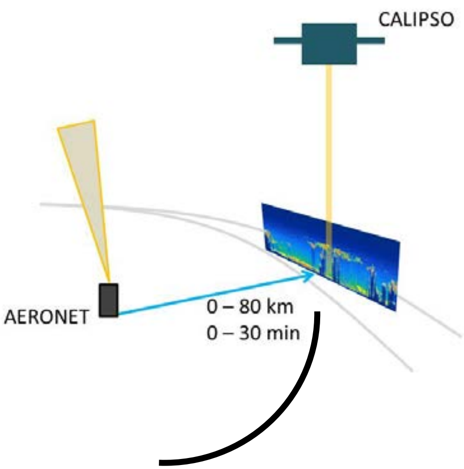


Appropriate LR for China from ground-based lidar measurements

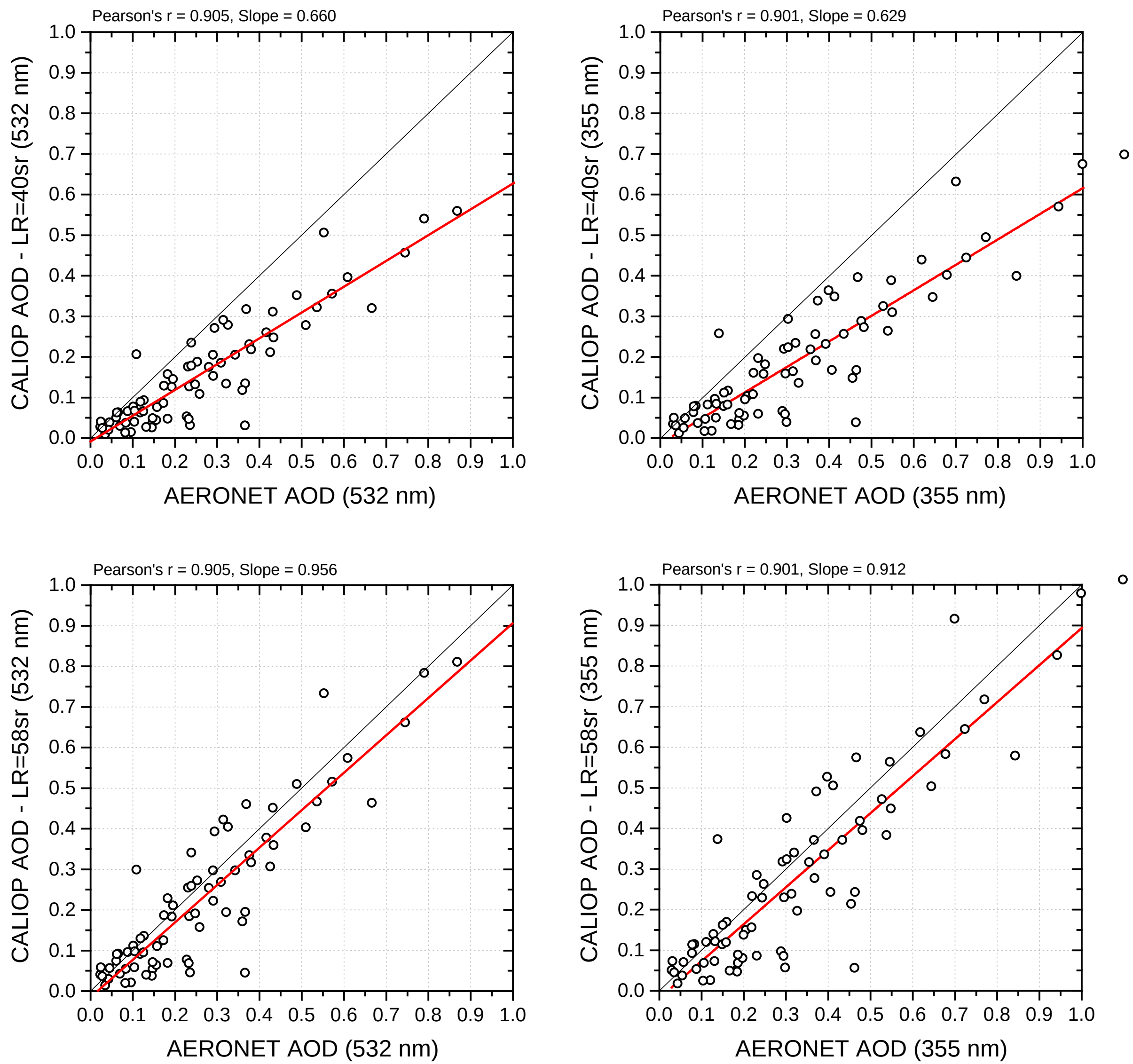
Amiridis et al., 2013
Optimizing CALIPSO Saharan dust retrievals

Application1:
8-year 3D dust climatology

CALIPSO-AERONET Collocation

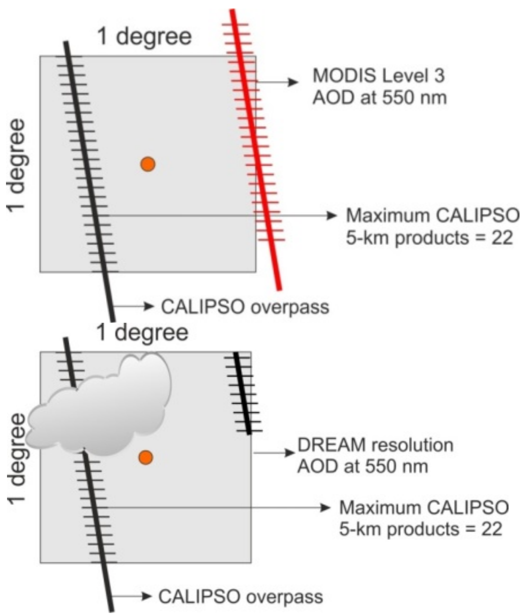


In pure Dust cases from CALIPSO typing

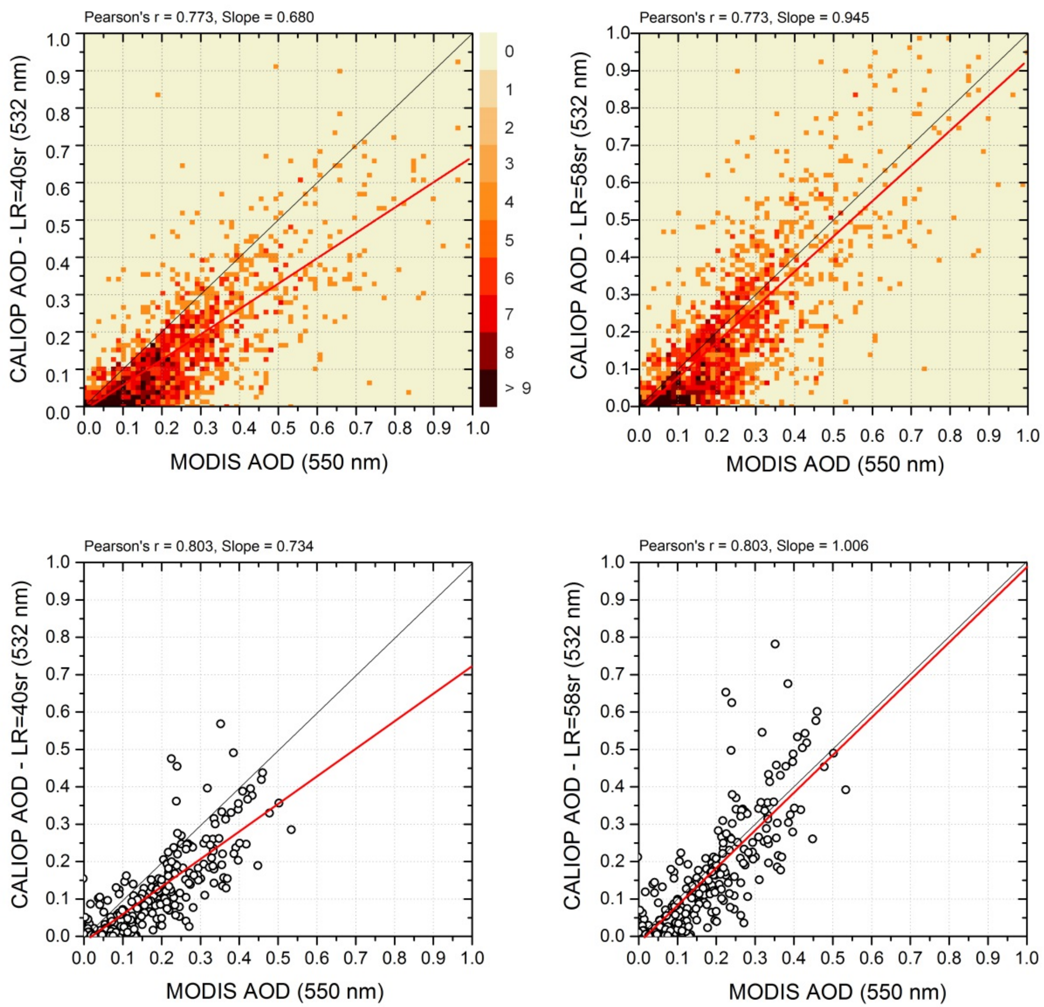


Application1:
8-year 3D dust climatology

CALIPSO-MODIS Collocation



Red overpasses rejected



Application1:
8-year 3D dust climatology

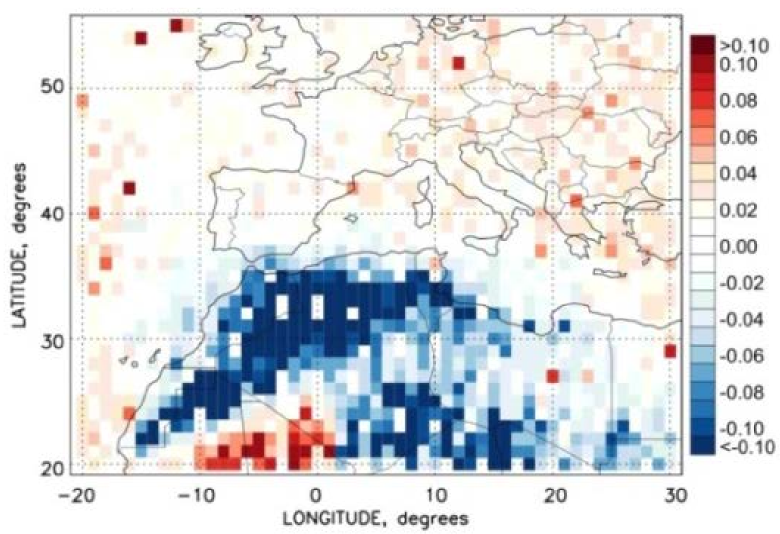
Compare our Pure Dust product for Saharan Dust
In the domain: North Africa / Europe

using years 2007 to 2013

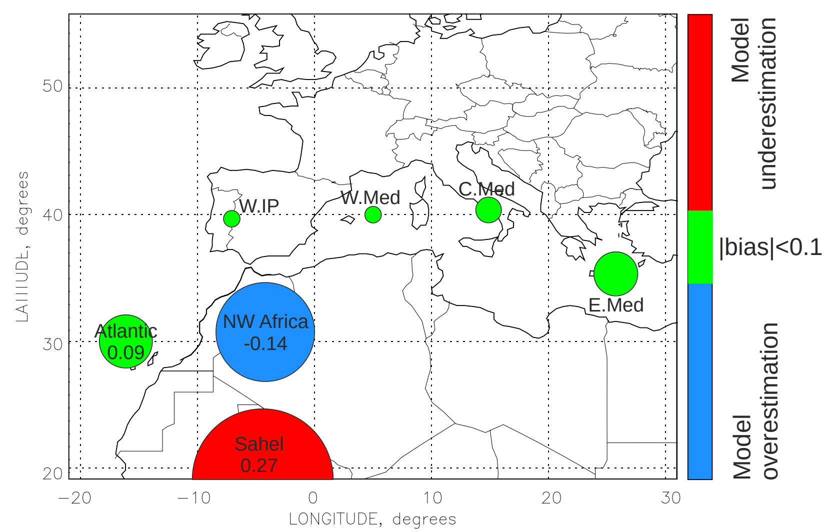
With BSC-DREAM 8b

All Climatology

Absolute Bias with our Pure Dust Product



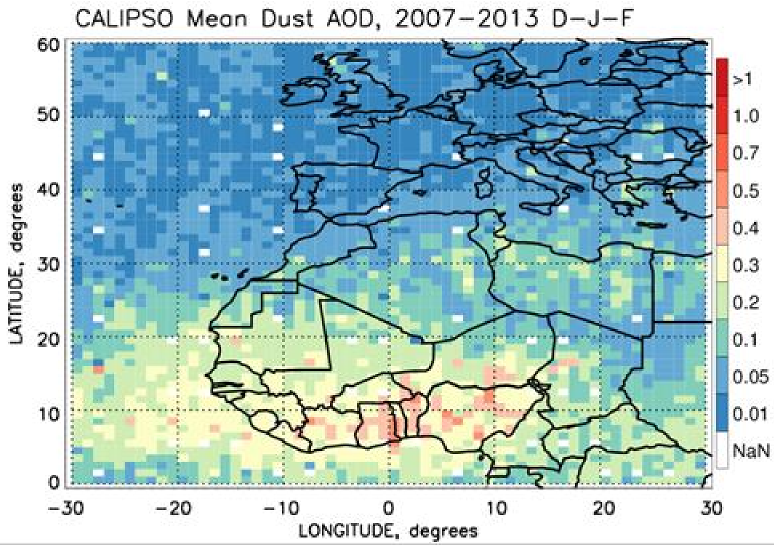
Absolute Bias of DREAM with AERONET

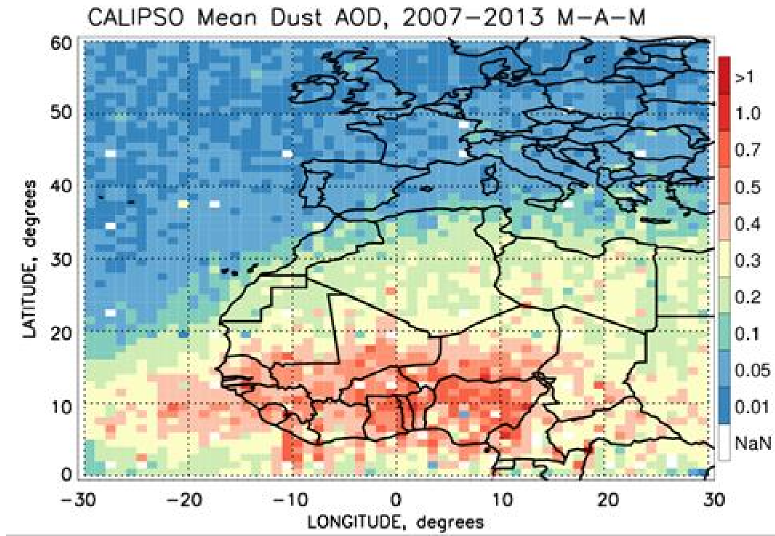


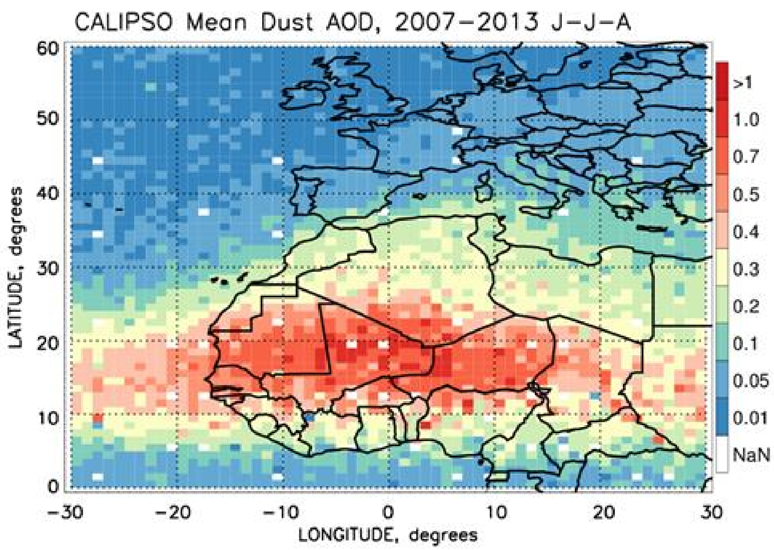
Biases observed follow known model biases

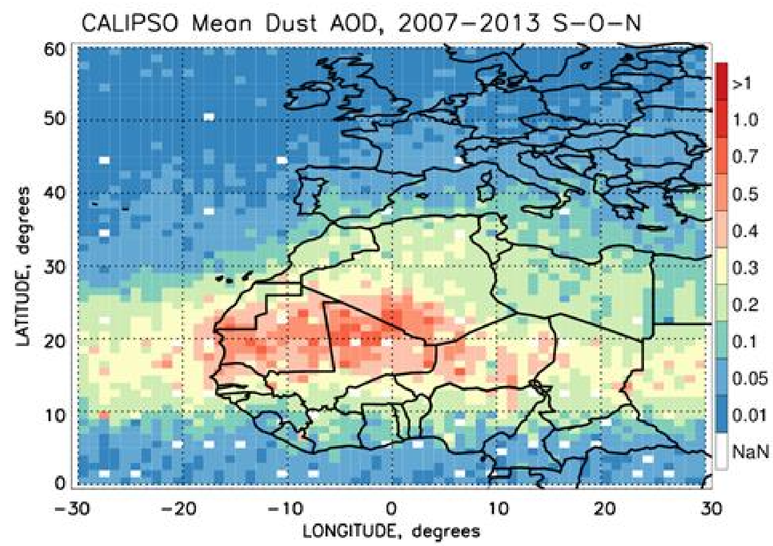
Application1:
8-year 3D dust climatology

Amiridis et al., ACP, 2013

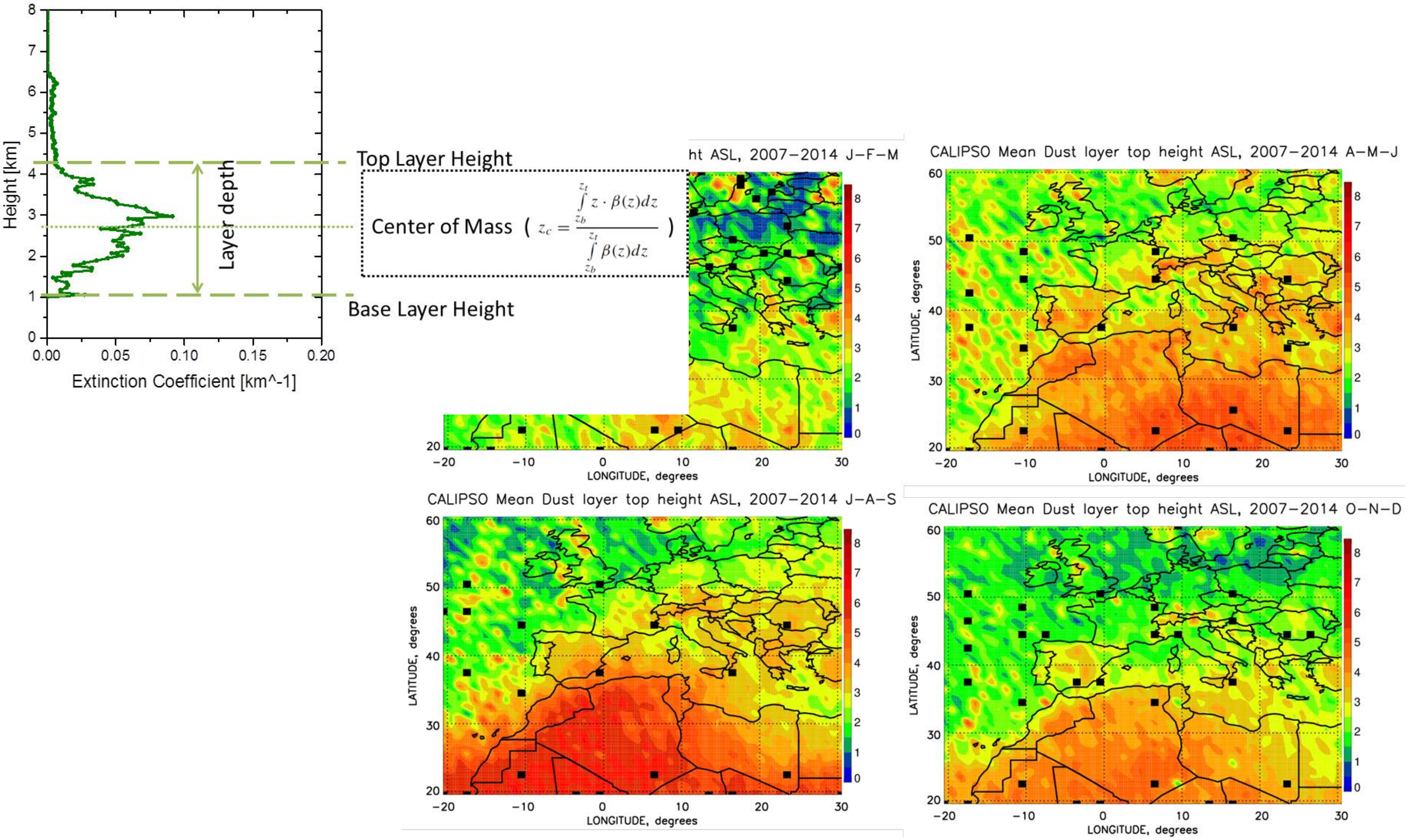




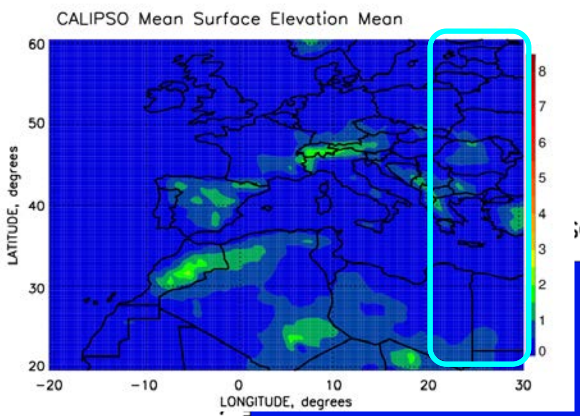


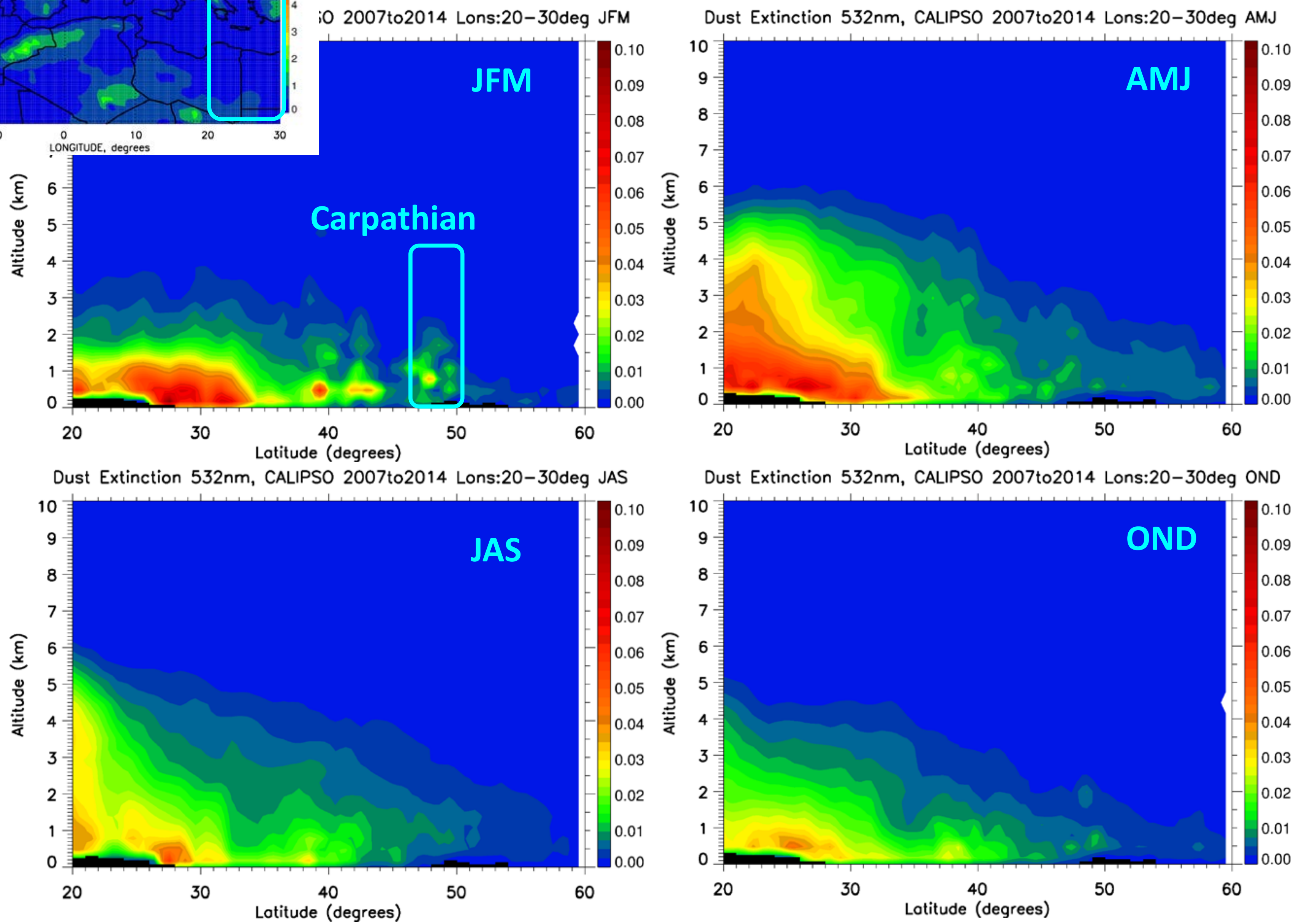


Application1:
8-year 3D dust climatology

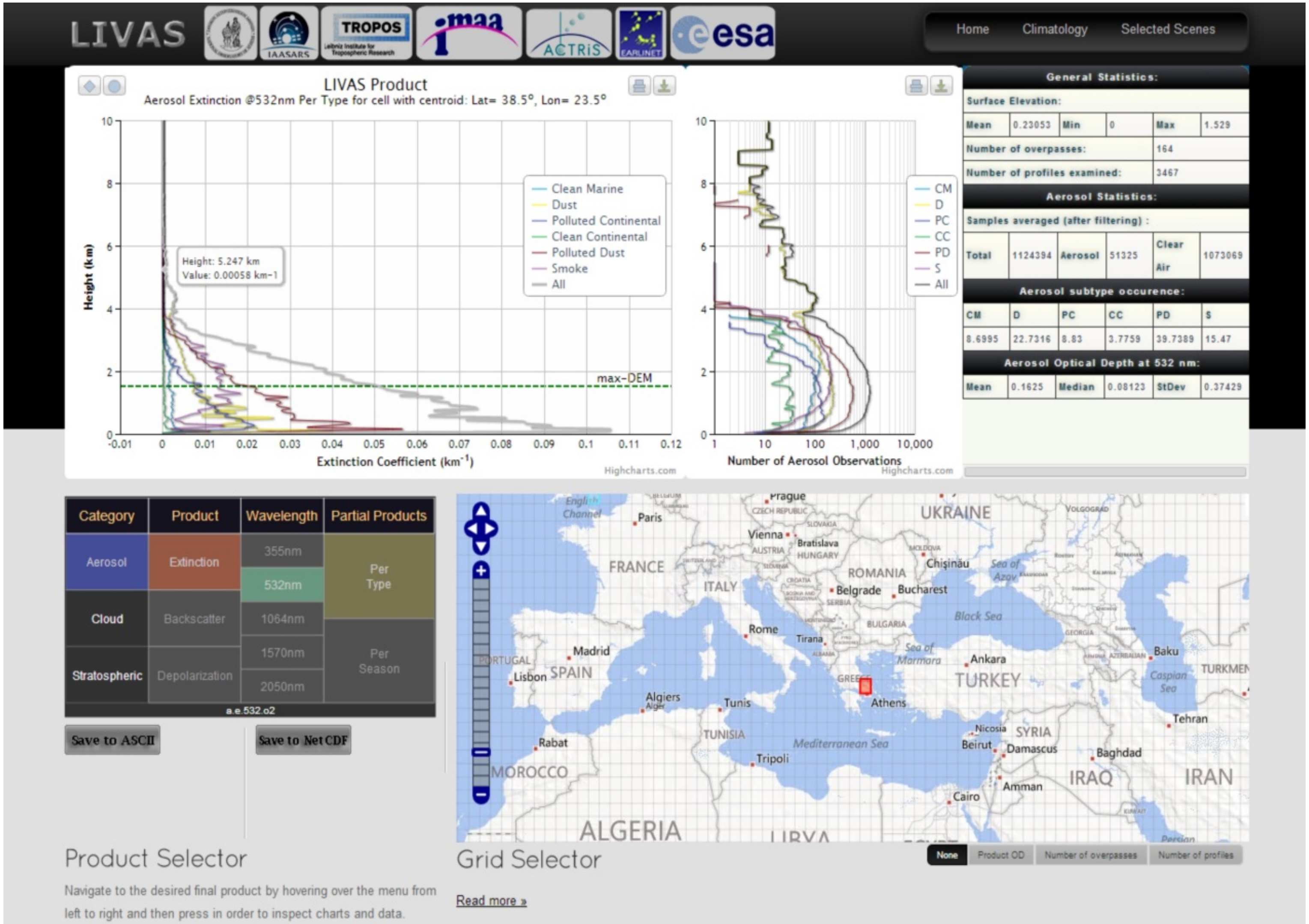


Extinction Coefficient 20-30 deg Longitude



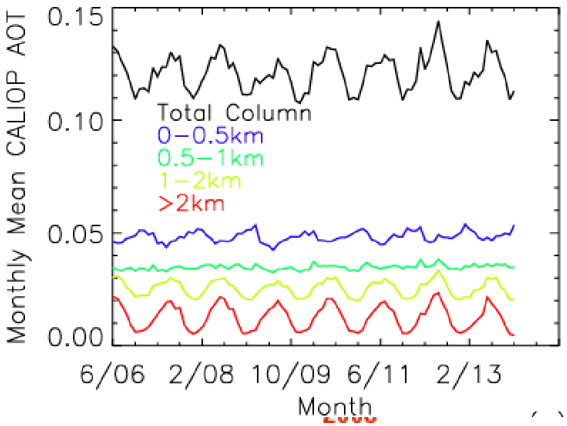


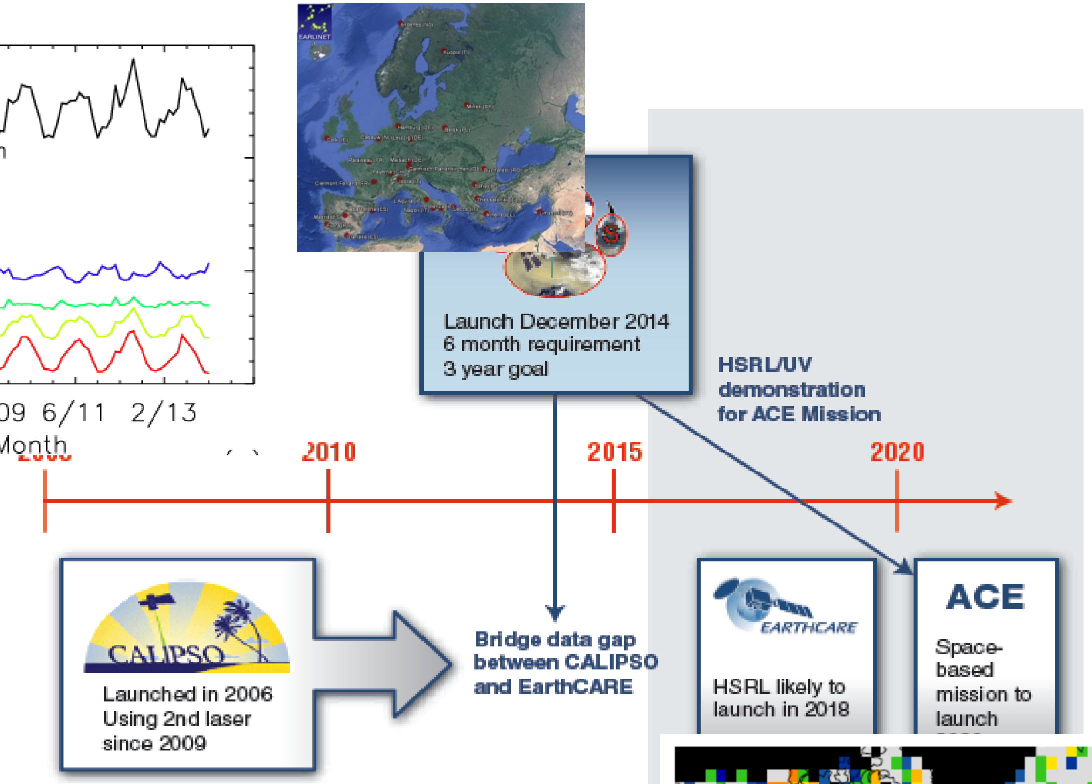
Application2: 3D Climatology

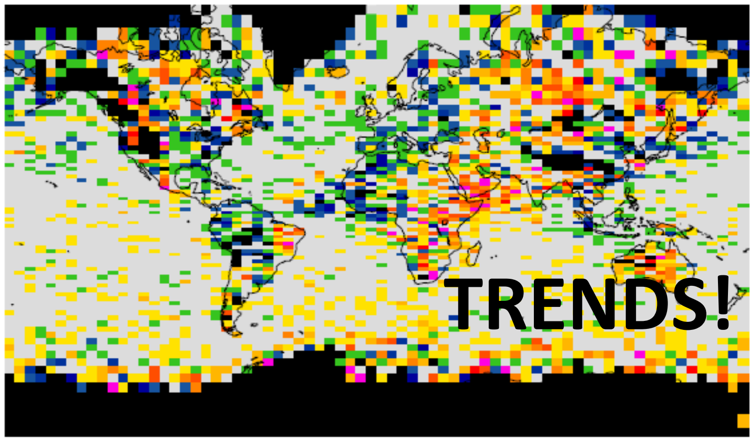


http://lidar.space.noa.gr:8080/livas/

Application2: 3D Climatology

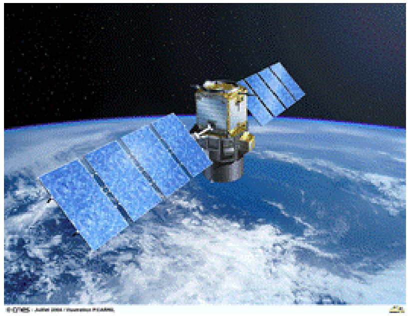


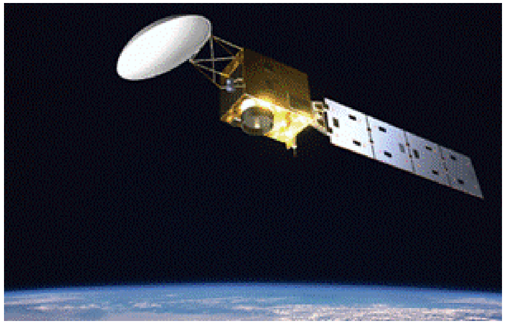




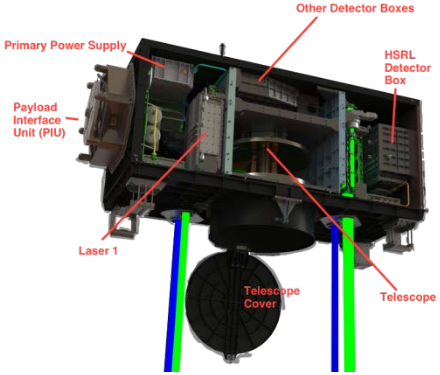
Application2: 3D Climatology

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.