EARLINET, the ACTRIS aerosol vertical profiling component

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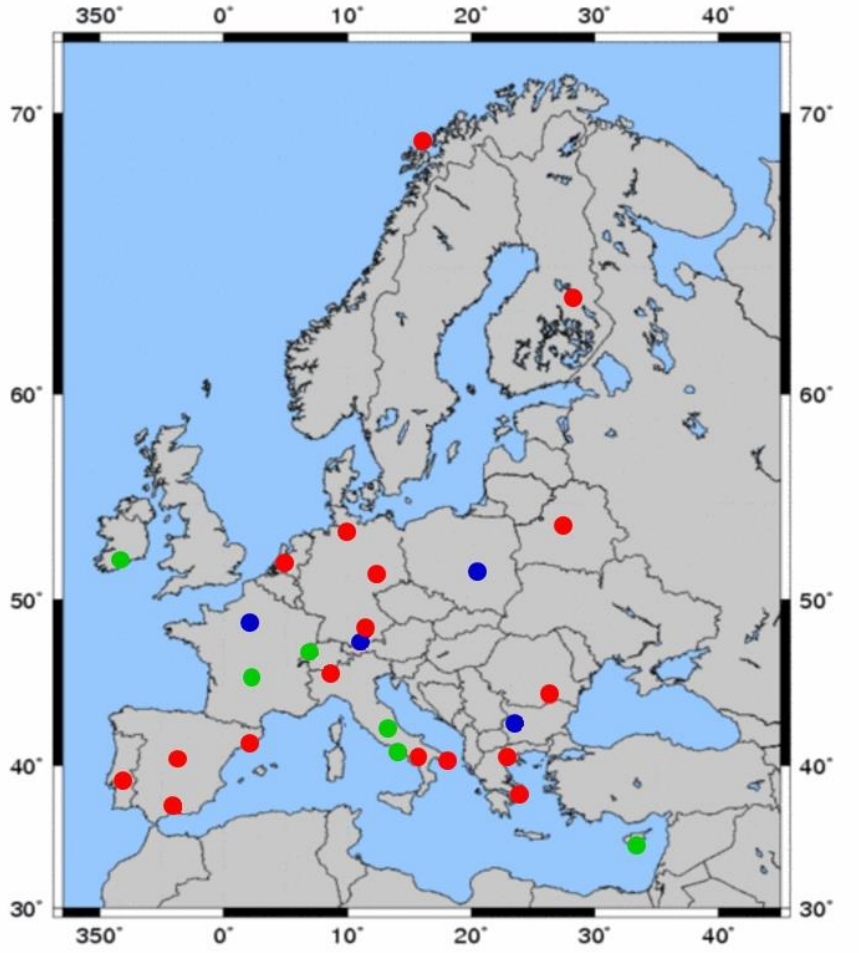
ITALY

OUTLINE

- ✓ What is EARLINET
- ✓ Which measurements performs
- ✓ Which products are now available
- ✓ Examples of integrated studies with models
  - ➢ Extinction Dust profiles evaluation
  - ➢ Concentration Dust profiles evaluation
  - ➢ Attenuated Backscatter NRT assimilation
- ✓ Future perspectives

EARLINET (European Aerosol Research LIdar NETwork)



www.earlinet.org

- since 2000
- 27 lidar stations

-17 multiwavelength Raman lidar stations

-6 Raman lidar stations

- 4 single backscatter lidar stations

- comprehensive, quantitative, and statistically significant data base
- Continental and long-term scale

FP5

EARLINET-ASOS Sixth Framework Programme

2000 2006 2011 2015 2019

EARLINET

EARLINET started in 2000 under FP5 based on research aerosol lidar stations already available around Europe.

Different lidar set-ups and software analysis around the network.

Main strength of the network: sharing the single station know-how for a continuous improvement of the network as a whole and acting as a single body.

EARLINET pillars:

- ✓ **Quality assurance**
- ✓ **Optimization of the instruments**
- ✓ **Optimization of the data processing**
- ✓ **Centralized measurements scheduling**

EARLINET

Quality assurance of the instruments

- ✓ Routine quality checks of the system
- ✓ Side-by-side intercomparison with reference instruments

Quality assurance of the algorithms

- ✓ Comparison of algorithms available within the network
- ✓ Best-practices
- ✓ Implementation into a common automated processing algorithm: SCC Single Calculus Chain

Common database

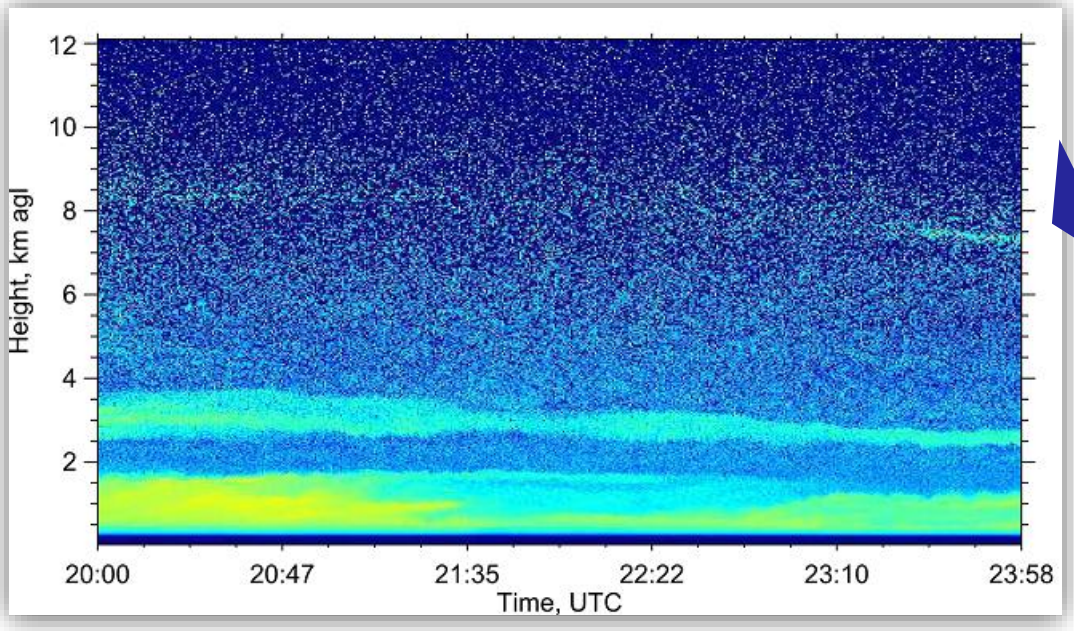
- ✓ Netcdf format
- ✓ Post processing quality check of the products (manual)
- ✓ First volumes of data published on CERA database –CF compliant

EARLINET measurements

Climatological schedule

Measurements are performed almost simultaneously at all EARLINET stations on a fixed time schedule:

- **Monday, 14:00 LST ± 1 hour (daytime measurement)**
- **Monday & Thursday at sunset -2h +3h (night-time meas.)**



Example of quick-look Evora- 30 june 2012 RCS signal at 1064nm

Quicklooks are typically reachable for each EARLINET station in NRT at http://www.earlinet.org/quicklook

EARLINET measurements

Saharan dust

Longer run of measurements are triggered by alerts based on operational outputs of the DREAM (Dust REgional Atmospheric Model), and the Skiron models distributed to all EARLINET stations by the NTUA (National Technical University of Athens) group.

Volcanic eruptions

Measurements based on alerting system.

Monitored eruptions:

North Pacific ring (2008-2010), Etna 2001 /Etna 2002, Eyjafjallajökull 2010, Grimsvotn 2011, Nabro 2011

Relational database about identified volcanic layers is freely available at:

www.earlinet.org *Pappalardo et al., ACP 2013*

EARLINET measurements

Correlative measurements

CALIPSO Measurements performed following a devoted measurement strategy realized and optimised by the CNR-IMAA group

Measurement campaigns

ICARTT

SAMUM-2

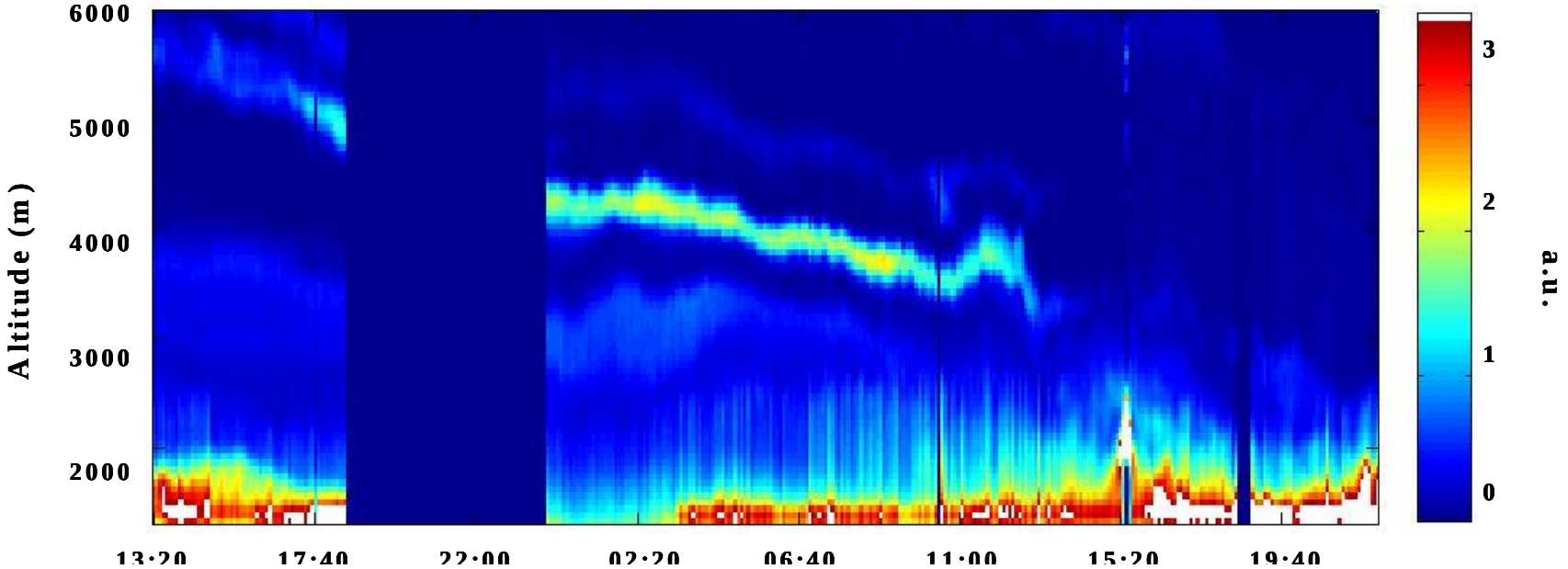
ACTRIS summer 2012

EARLINET products

Lidar Range Corrected Signal:

almost raw signal unless background subtraction and multipled by range^2

provides rapid snapshot of temporal - vertical evolution of aerosol layers



Etna 2002 Volcanic eruption – Potenza, Southern Italy

Pappalardo et al., GRL, 2004, Villani et al., JGR 2006,
Wang et al., Atm. Env. 2008

EARLINET products

EARLINET standard products :

-Aerosol backscatter coefficient
(355, 532 and 1064 nm)
-Aerosol extinction coefficient
(355 and 532nm)
-Linear particle depolarization ratio
(355 and 532 nm)
-Lidar Ratio
(355 and 532 nm)

These quantities are reported in the EARLINET database in the netcdf standardized format.

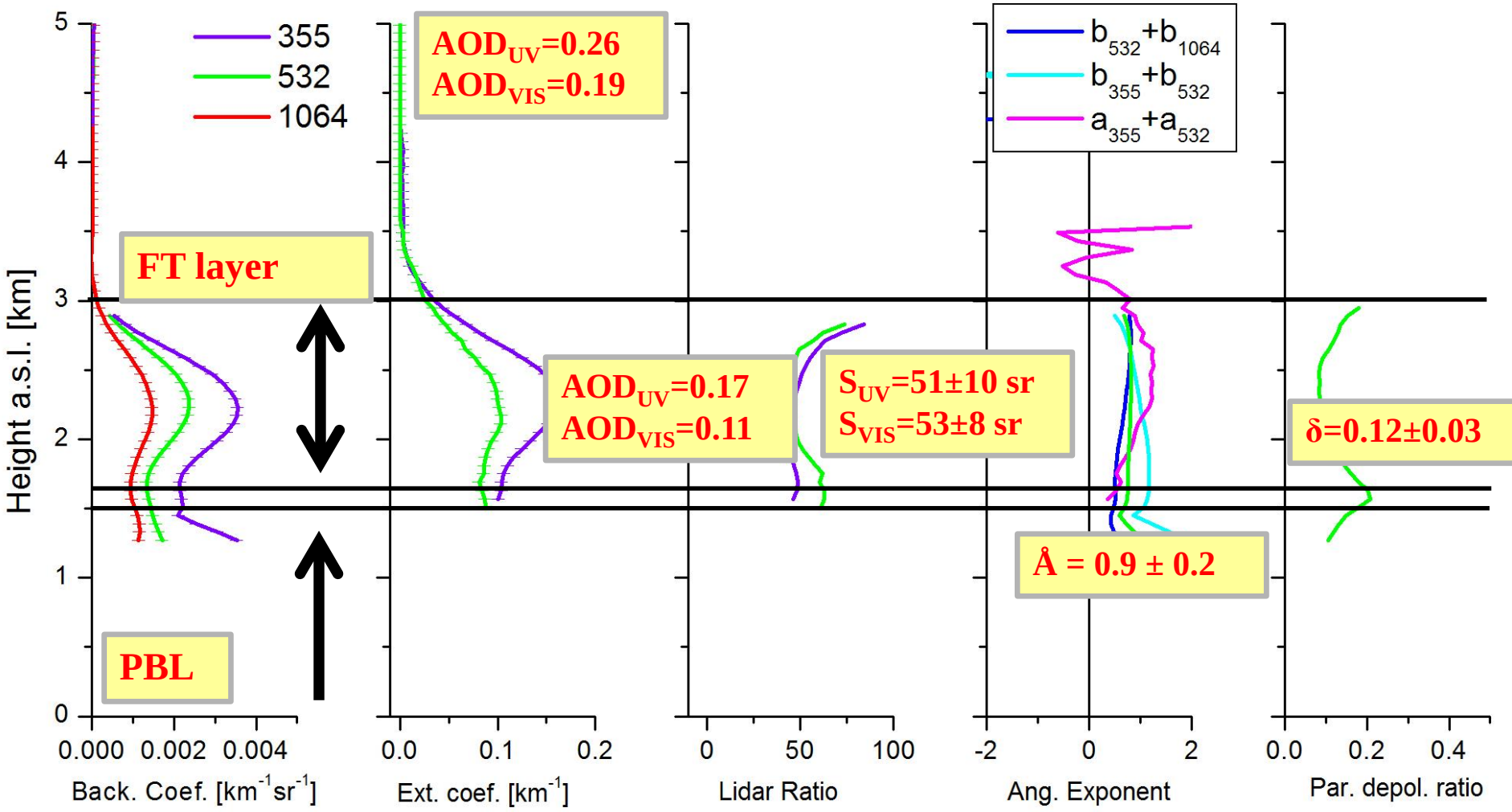
-Angstrom exponent
(355 and 532nm)
-Backscatter related Angstrom exponent
(355 -532 nm , 532-1064 nm)

These are important for the aerosol typing because do not depend on aerosol quantity.

Quantities are reported together with their errors.

EARLINET products

Potenza, Italy, (40.60°N, 15.73°E), 05 July 2012, 19:43- 21:31 UTC



EARLINET vs BSCDREAM-8b

12-year one site Extinction systematic comparison

Geographical coverage: Potenza (Italy)
(the largest database of dust profiles)

Temporal coverage: May 2000 – June 2012

Compared parameters: dust layer geometrical properties
&
dust extinction coefficient

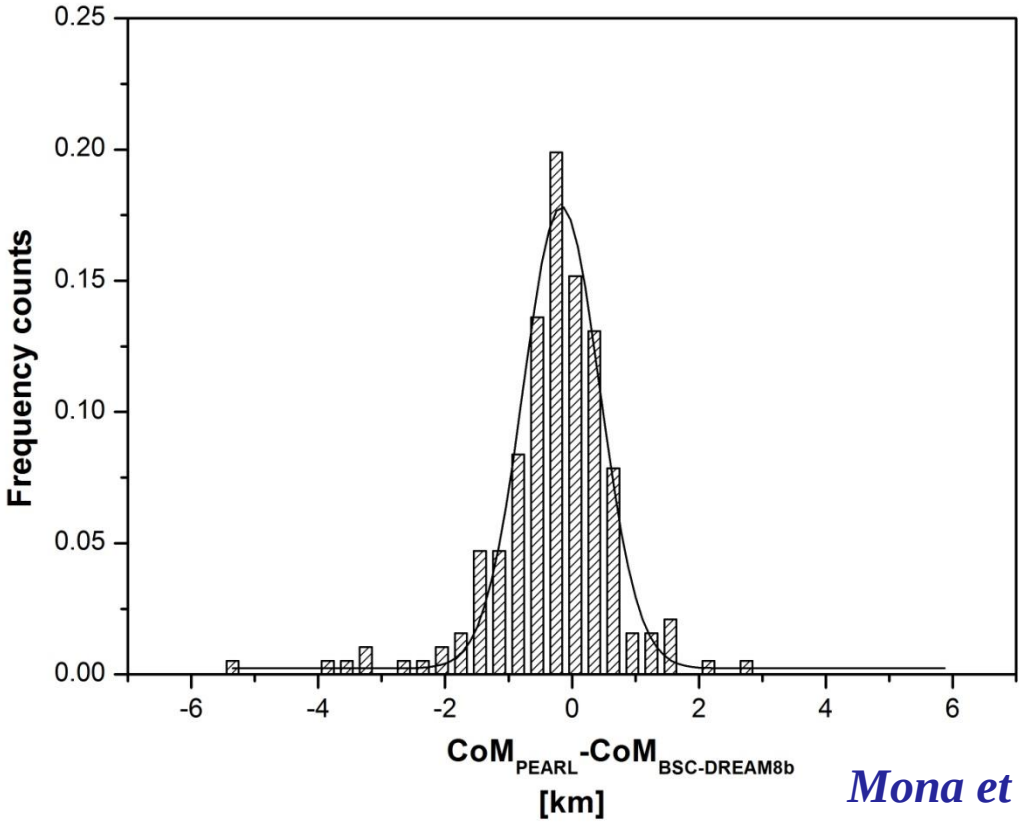
Issue: Saharan dust layers have to be identified in the lidar profiles

Mona et al. ACP 2014

EARLINET vs BSCDREAM-8b

12-year one site Extinction systematic comparison

Geometrical features of dust layer are well described by the model in terms of center of mass.



Mona et al. ACP 2014

Good correlation between optical properties and concentration profiles apart from cases with low dust load (AOD <0.1)

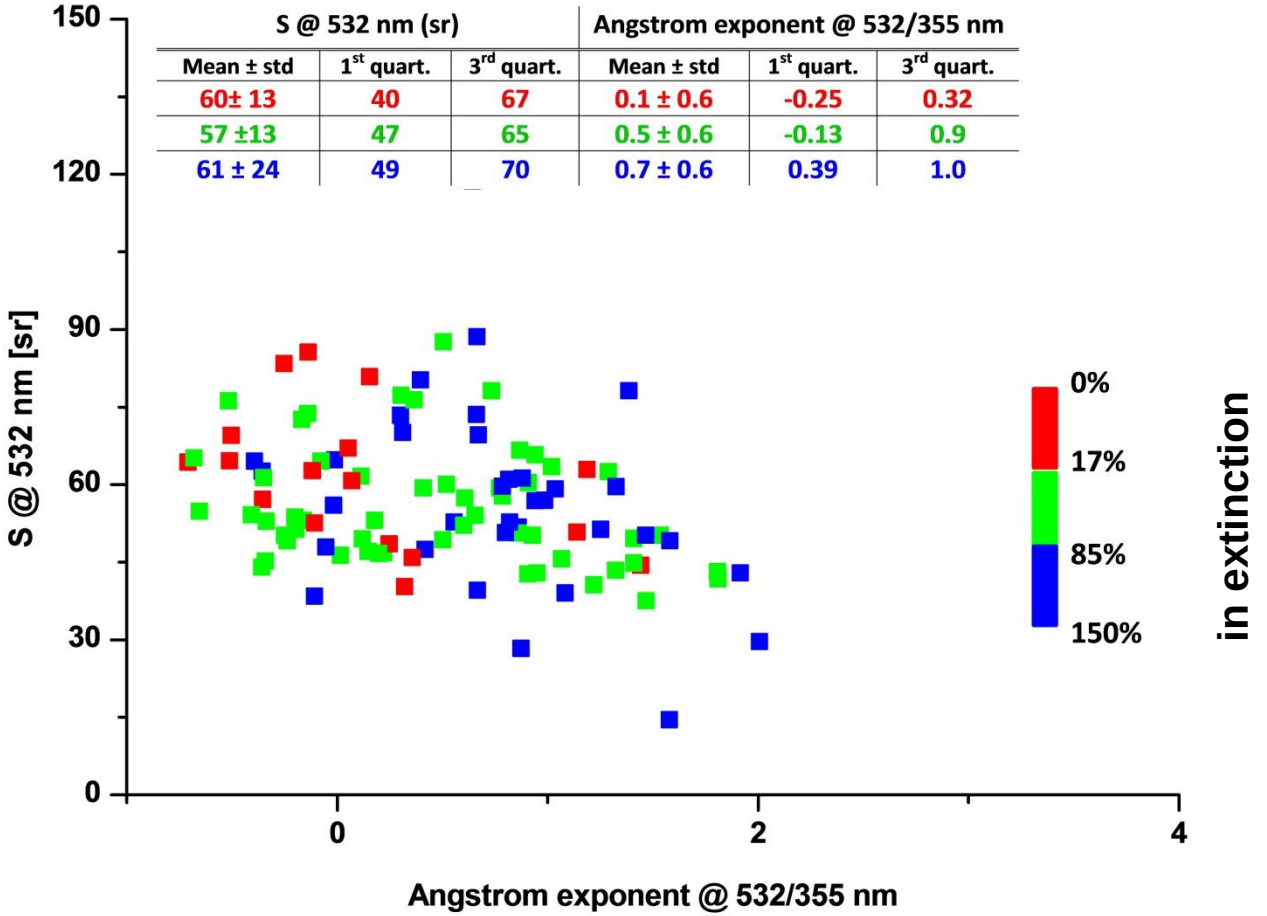
EARLINET vs BSCDREAM-8b

12-year one site Extinction systematic comparison

Differences below 17%:
S: 60 ± 13 sr
Angstrom 0.1 ± 0.6

Differences higher than 85%:
Angstrom 0.5 ± 0.6

S @ 532 nm (sr)			Angstrom exponent @ 532/355 nm		
Mean ± std	1st quart.	3rd quart.	Mean ± std	1st quart.	3rd quart.
60± 13	40	67	0.1 ± 0.6	-0.25	0.32
57 ±13	47	65	0.5 ± 0.6	-0.13	0.9
61 ± 24	49	70	0.7 ± 0.6	0.39	1.0



Mona et al. ACP 2014

All these aspects indicate that the level of agreement decreases with increasing of mixing/modification processes.

EARLINET vs models

Concentration comparison

Geographical coverage: 10 stations
(4 Iberia, 2 Italy, 2 Greece, 1 Germany, 1 Poland)

Temporal coverage: 50 cases

Models: BSC-DREAM8bv2, NMMB/BSC-DUST, DREAMABOL, DREAM8-NMME-MACC

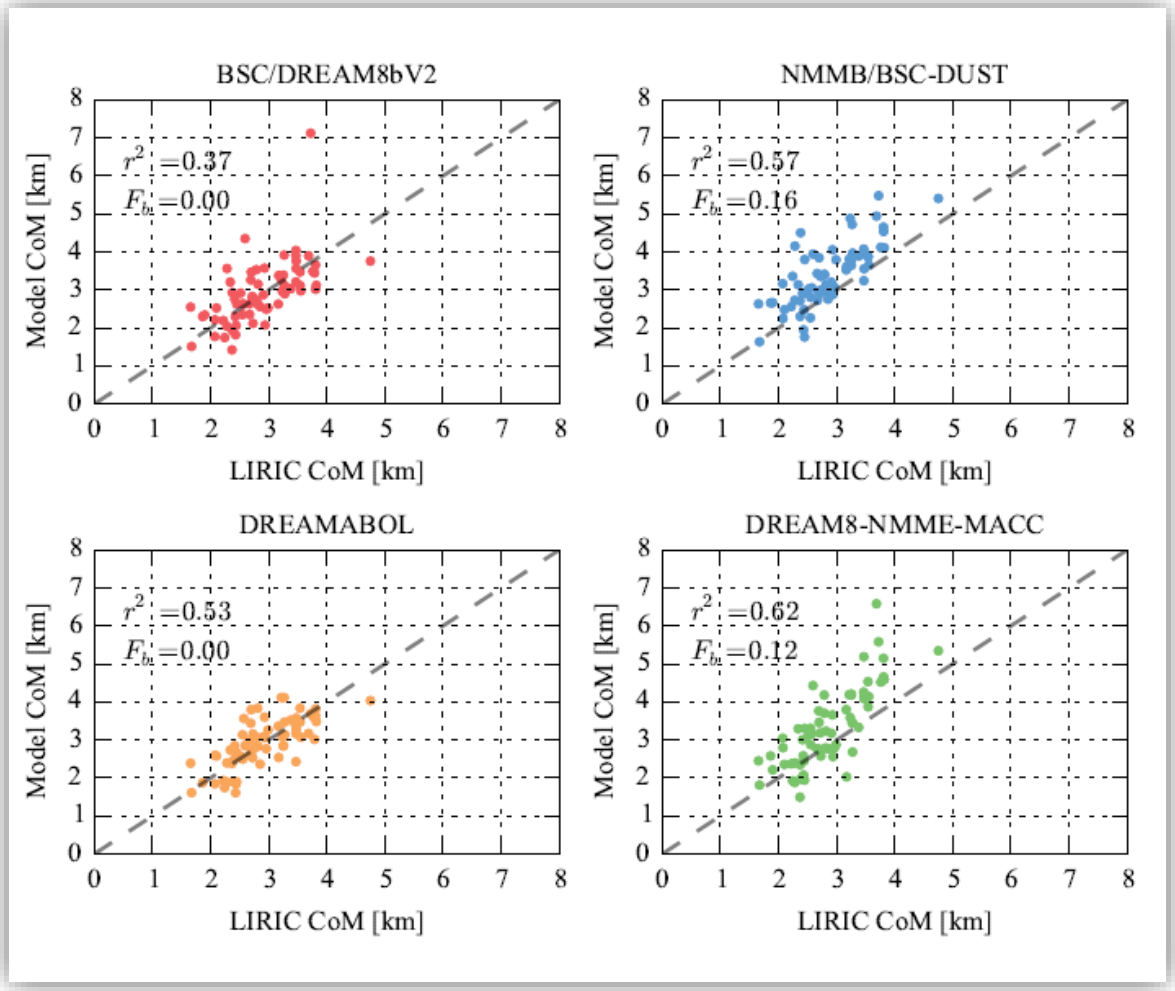
Compared parameters: dust layer geometrical properties
&
dust concentration

Issue: Concentration from LIRIC algorithm (lidar +sunphotometer) under assumption fine (sphere) coarse (spheroid randomly oriented)

Binietoglou et al. AMT 2015 - on review

EARLINET vs models

Concentration comparison

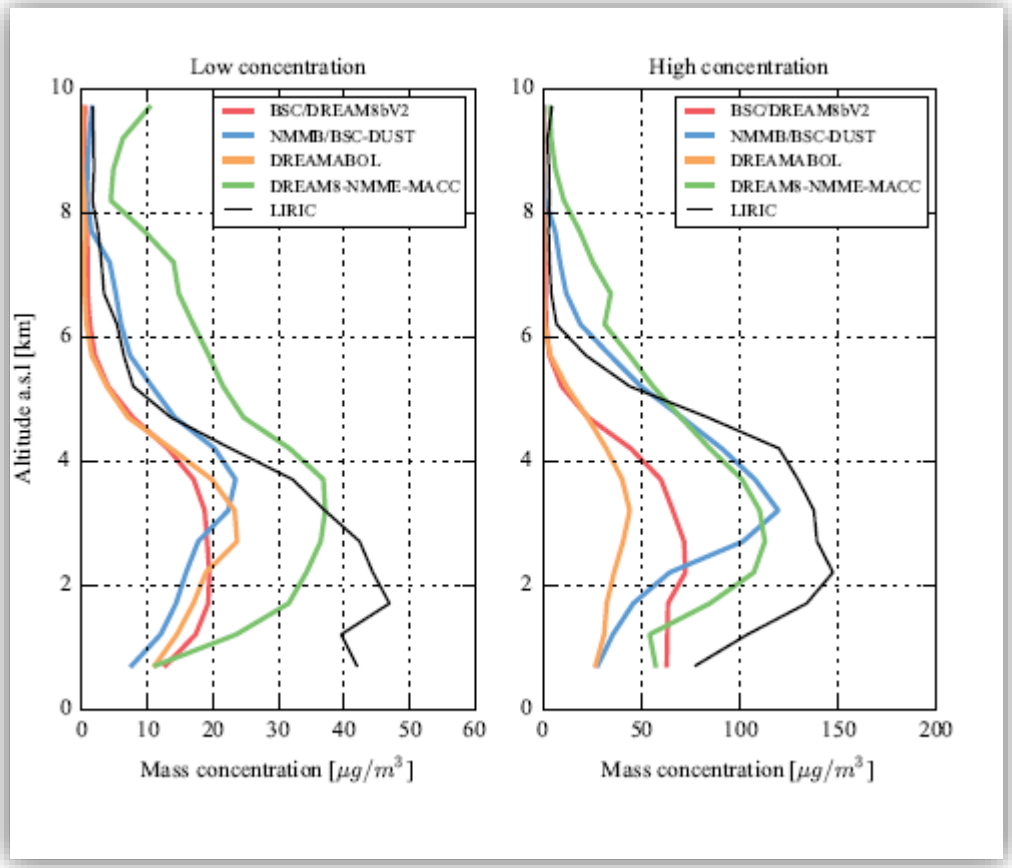


Good correlation on average between the obs and mod CoM apart from cases of very high modelled CoM

Binietoglou et al. AMT 2015 - on review

EARLINET vs models

Concentration comparison



Typically an underestimation of modeled concentration is observed.

Shape of profile on average well reconstructed.

Different models have different behaviors for small /high concentration.

Binietoglou et al. AMT 2015 - on review

NRT data provision exercise

Geographical coverage: **11stations**
(4 Iberia, 1 France, 1 Swit., 2 Italy, 1 Greece, 1 Cyprus, 1 Romania)

Temporal coverage: **72h – 9-12 July 2012**

Provided data: **P*z^2**

Issue: **for the first time SCC was used by many stations for preprocessing data in real time.**

Sicard et al., AMTD 2015 in press

NRT data provision exercise

Duration per recorded file: 60 min.

Raw temporal resolution: a number that 30 min. should be a multiple of in order to guarantee a minimum integration time of 30 min. for all systems.

Range resolution: the system raw resolution.

No cloud screening is performed by the stations. Instead, each station is responsible for providing information about the maximum height (m asl) up to which the profile is cloud free.

Creation of one single netcdf file of the raw signals (power) per measurement.

Upload to the SCC central server.

Sicard et al., AMTD 2015 in press

NRT data provision exercise

Product:

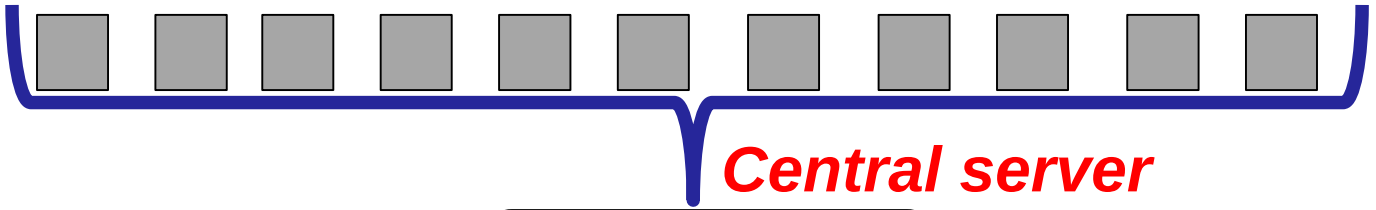
pre-processed range-square corrected signal (RCS) in netcdf format

These products were generated in a full automatic way and in real time.

At the same time the outputs were stored, an email was automatically sent to the contact point of the originating station.

This email gave a real time feedback from the SCC about the pre-processing status and revealed to be extremely useful for real time fine-tuning the SCC configuration of each individual system and of its associated products.

Sicard et al., AMTD 2015 in press



Stations

Central server

662 raw files

98% of success

648 RCS files

14 files did not pass pre-processing quality check

86% of success

555 opt prod files

14% of the cases problems with calibration/SNR

Extinction profiles:
189 @ 351/355nm
172 @ 532nm

Backscatter profiles:
497 @ 351/355nm
452 @ 532nm
452 @ 1064nm

Sicard et al., AMTD 2015 in press

NRT data provision exercise

Range corrected signals were assimilated in the Eulerian chemistry transport model POLAIR3D (Sartelet et al., 2007) of the air quality platform POLYPHEMUS (Mallet et al., 2007).

Their findings :

- **a horizontal correlation length of 100 km**
- **an assimilation altitude range of 1 – 3.5 km and an assimilation period length of 12 hours give the best scores for PM10 and PM2.5.**
- **the temporal impact of assimilating lidar signals is longer than 36 hours after the assimilation period.**

Wang et al., ACP 2014

The way forward

✓**EARLINET technically ready for provision of RCS in NRT**

✓**Some datasets available for assimilation/evaluation from the past**

✓**new EARLINET data products will be developed and included into the database**

✓**Adding depolarization to SCC is in progress.**

✓**Advanced products suitable for models evaluations will be implemented during ACTRIS2**

✓**Combined studies with aerosol models are planned within ACTRIS2**

Thank you!

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www.earlinet.org