Long-term aerosol and cloud database from correlative CALIPSO and EARLINET observations

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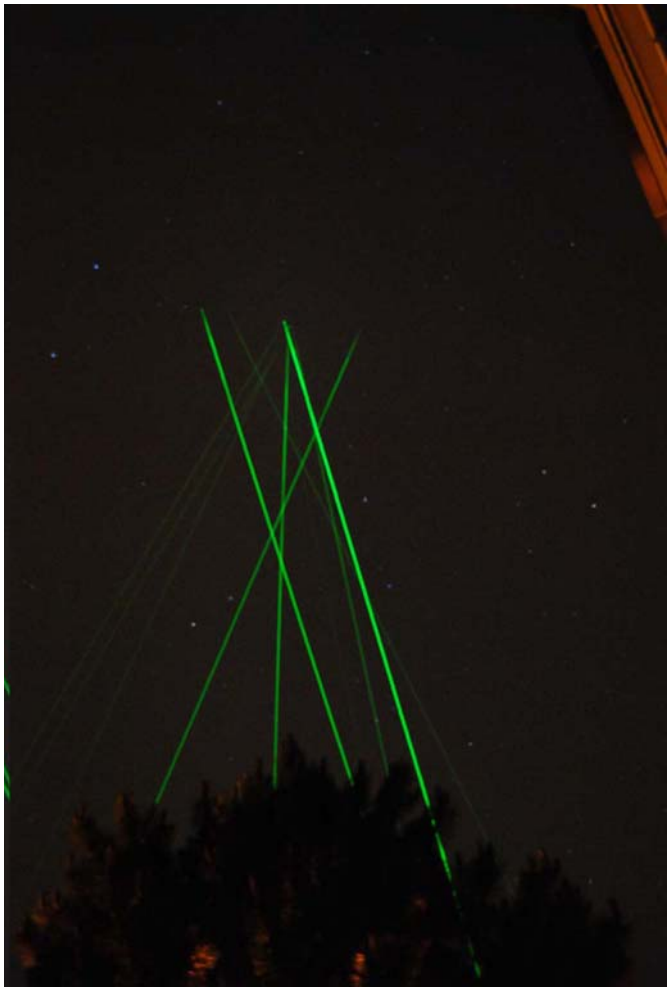
With contributions from 16 EARLINET stations

Outline

- Motivation
- ESA–EARLINET activity during the CALIPSO mission
- Case study: Saharan dust outbreak 27-30 May 2008
- Conclusion and outlook

EARLINET – European Aerosol Research Lidar Network



EARLINET Intercomparison Campaign 2009

- continental-scale lidar network
- long-term, regular observations since 2000
- Raman/multiwavelength lidar instrument
- QA program for instruments and algorithms
- correlative observations during CALIPSO overpasses based on a sophisticated measurement strategy since June 2006

ESA–EARLINET activity

Aerosols and Clouds: Long-term Database from Spaceborne Lidar Measurements
since April 2008, 16 stations

Objectives of the ESA–EARLINET activity

- provide a tool for homogenizing long-term space-borne observations conducted with different lidar instruments, operating at different wavelengths, on various platforms
- study the representativeness of the limited number of satellite lidar cross sections along an orbit against long-term lidar network observations on a continental scale

Specific tasks

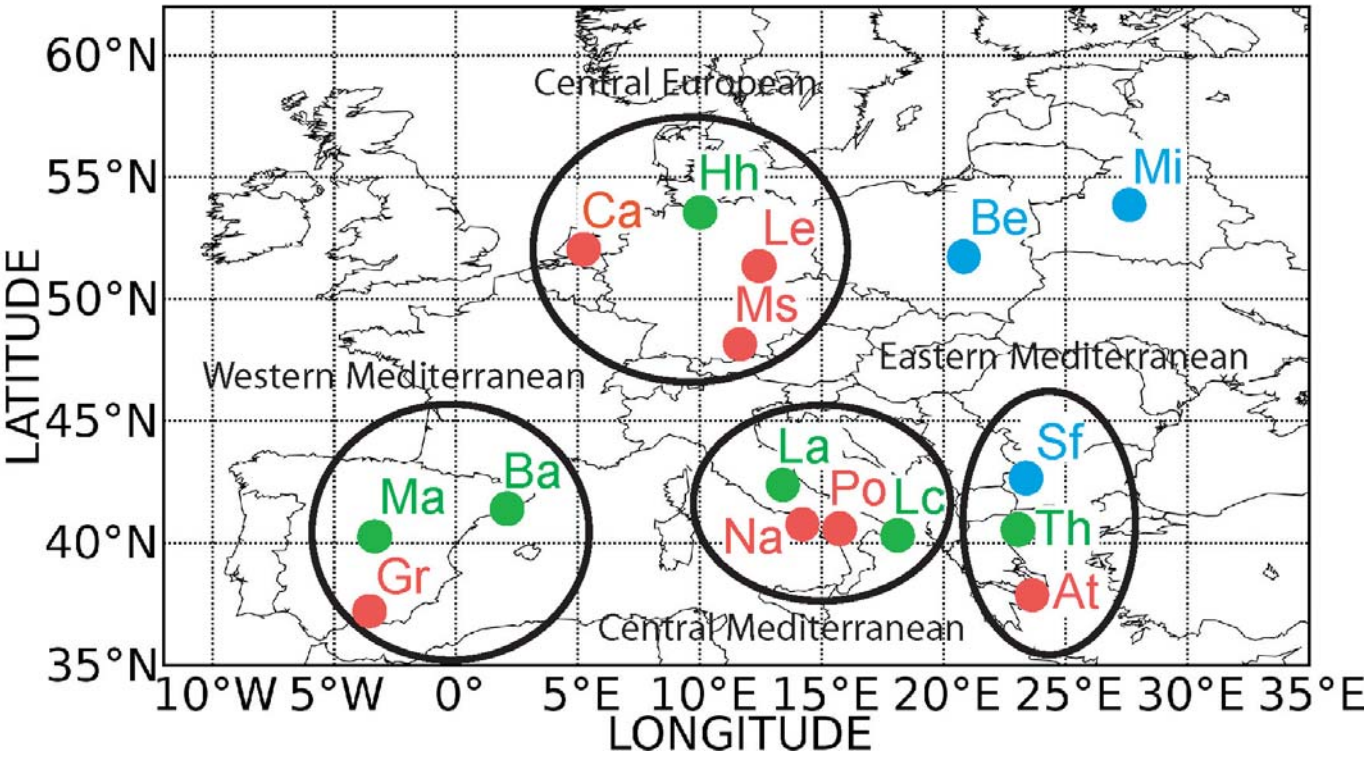
⇨ develop common aerosol classification schemes

⇨ characterize the optical properties (lidar ratio, depolarization ratio, Ångström exponents) of major aerosol types

⇨ derive wavelength conversion schemes to harmonize space-borne observations

⇨ establish statistically significant datasets based on a correlative measurement strategy for verification/validation purposes and representativeness studies

ESA–EARLINET network measurements



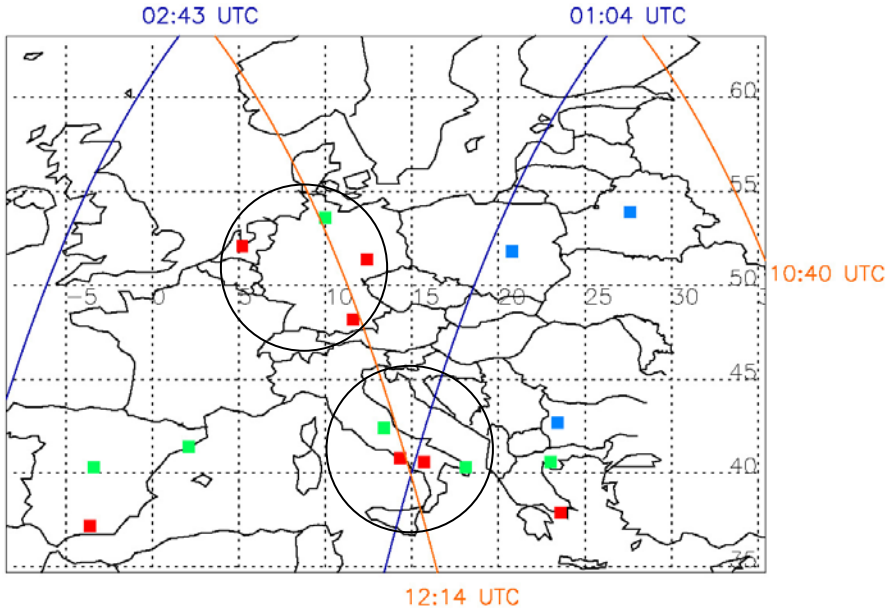
- high-performance stations = extinction and backscatter at 355 + 532 nm (+ backscatter at 1064 nm + depolarization)
- contributing stations = extinction and backscatter at one wavelength

Observational Strategy

CASE A:
Measurements within 100 km of the overpass

CASE B:
Simultaneous measurements of more than one station within the same cluster, when one station has a CASE A overpass

CASE C:
Measurements during special events (e.g., large Saharan dust intrusions, forest-fires smoke plumes, volcanic eruptions)



ESA–EARLINET study approach

→ 18 months of correlative measurements of EARLINET and CALIPSO

→ evaluation of the geometrical and optical properties of aerosols and clouds

→ rely on CALIPSO aerosol and cloud classification schemes

- **Marine aerosol**
- **Mineral dust**
- **Polluted continental aerosol**
- **Clean continental aerosol**
- **Biomass-burning smoke**

+ dependence on source region
+ mixtures of different types
+ processing/aging during transport
+ humidity

- **Ice clouds**
- **Water clouds**
- **Mixed-phase clouds**

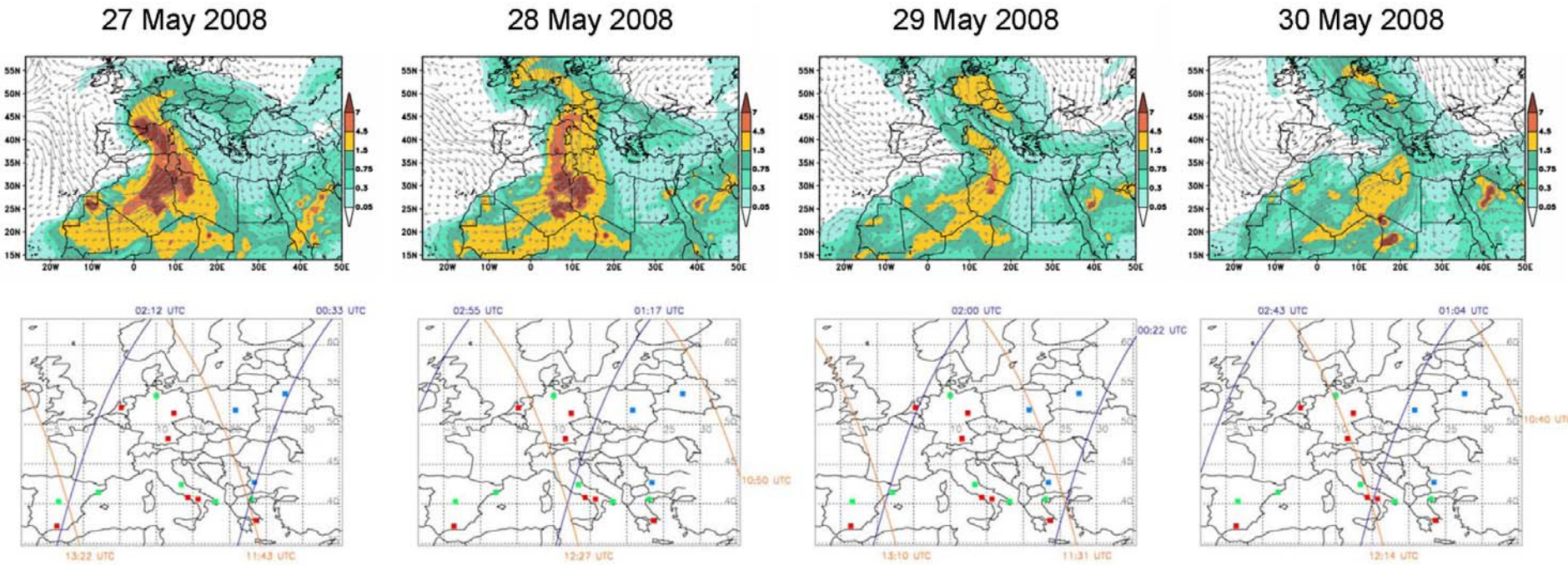
→ representativeness study

→ results stored in a long-term database for further use and extension during

→ can be continued during future missions

Case study: Saharan dust outbreak, 27-30 May 2009

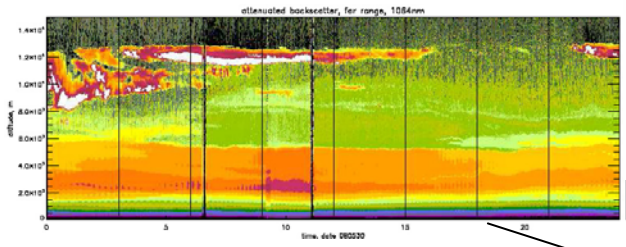
DREAM Forecast

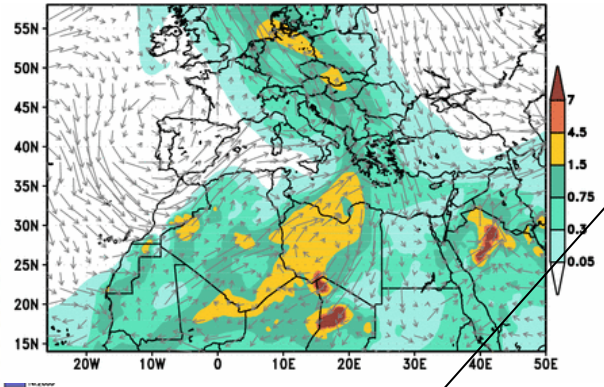


CALIPSO overpasses

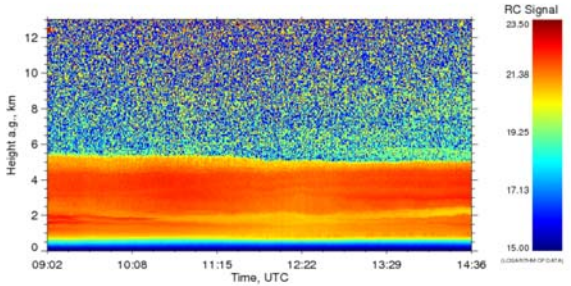
30 May 2008

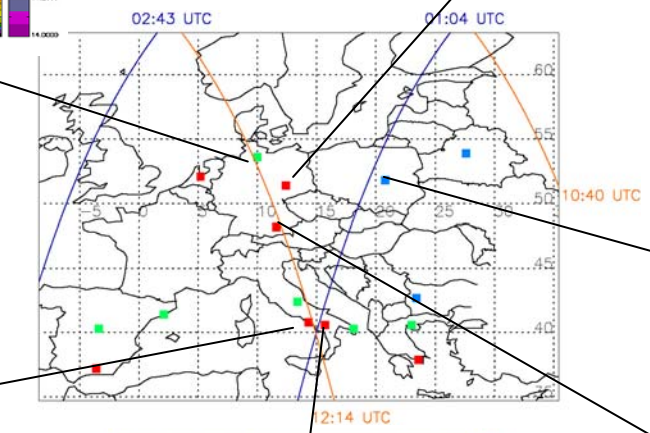
Hamburg



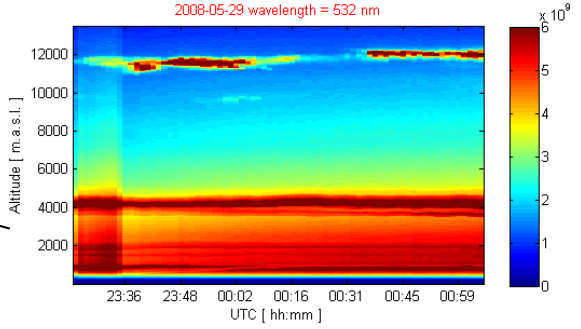


Leipzig

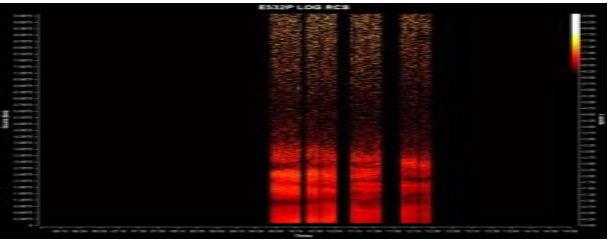




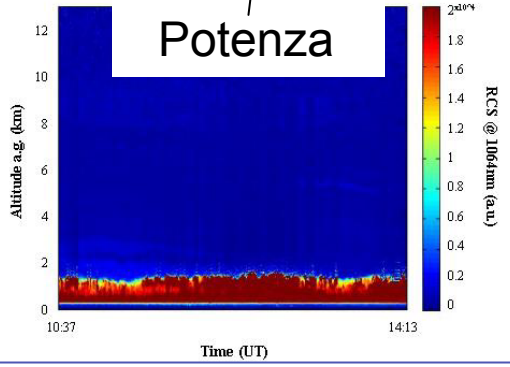
Belsk



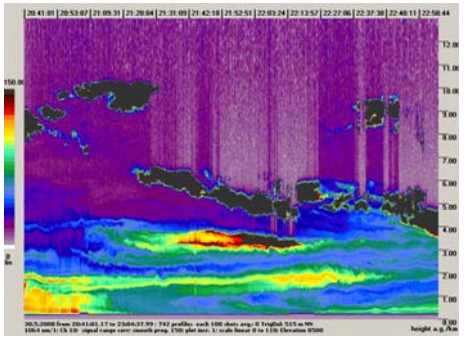
Naples



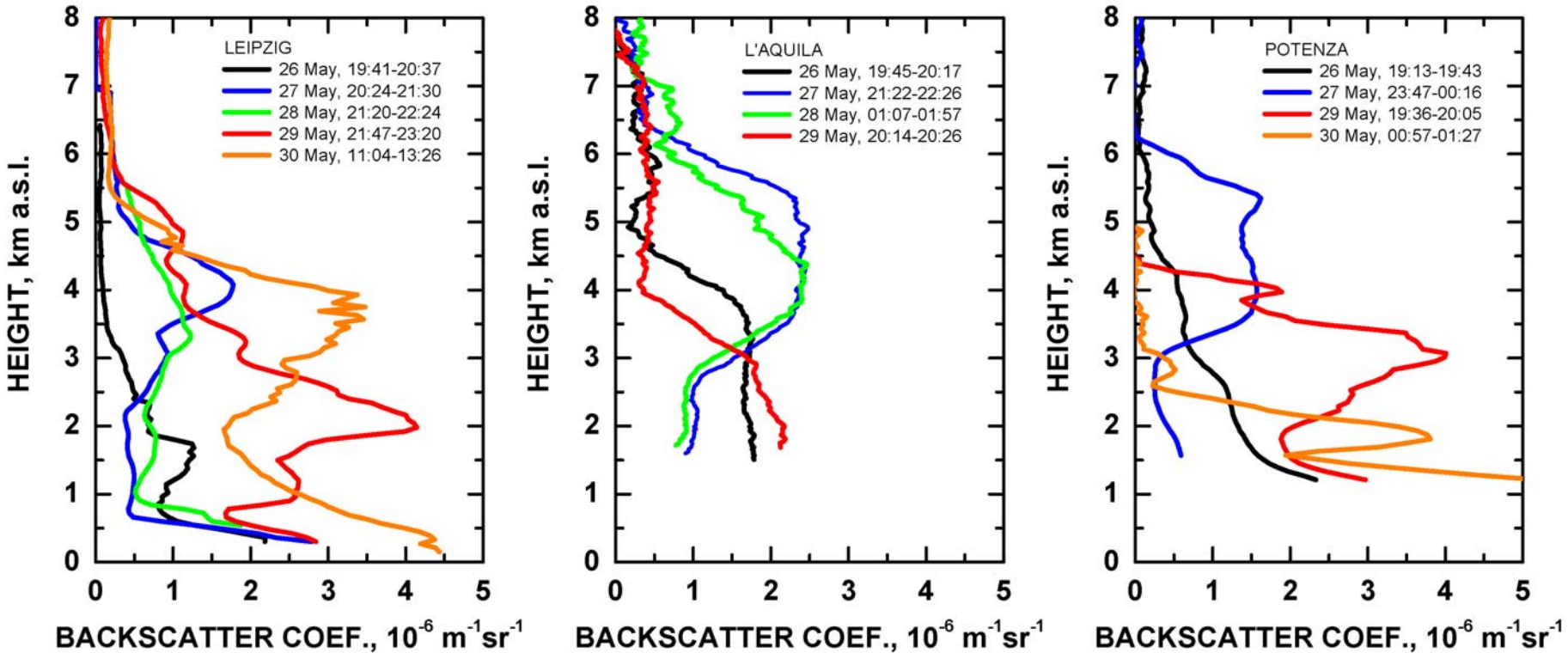
Potenza



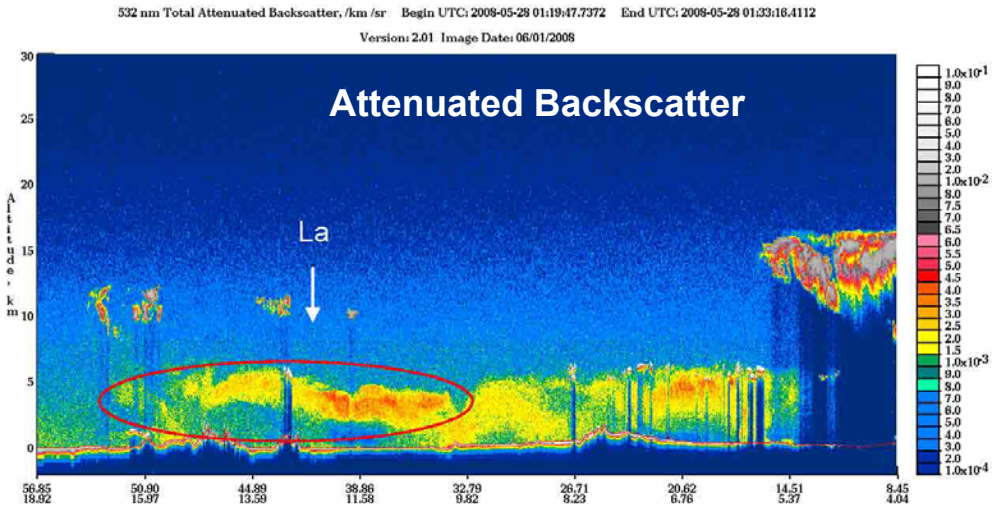
Munich

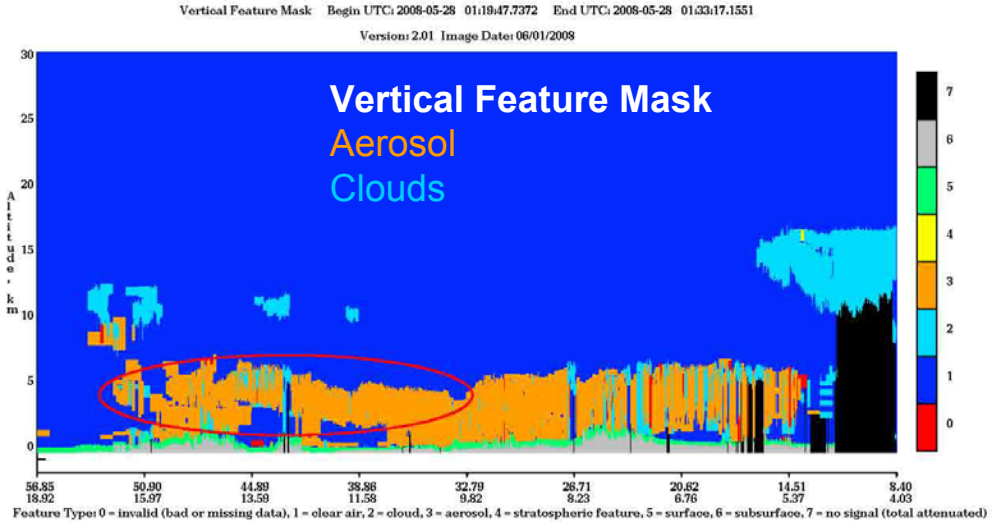


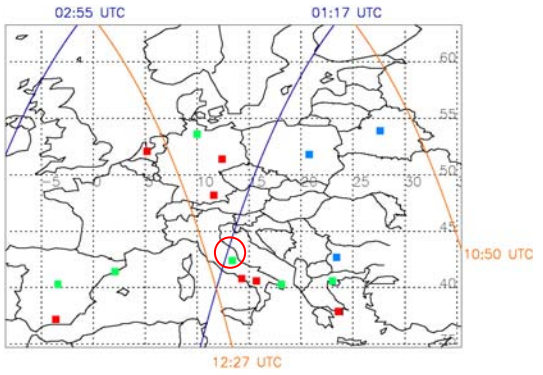
North-south and day-to-day variability of the dust load in terms of backscatter coefficient

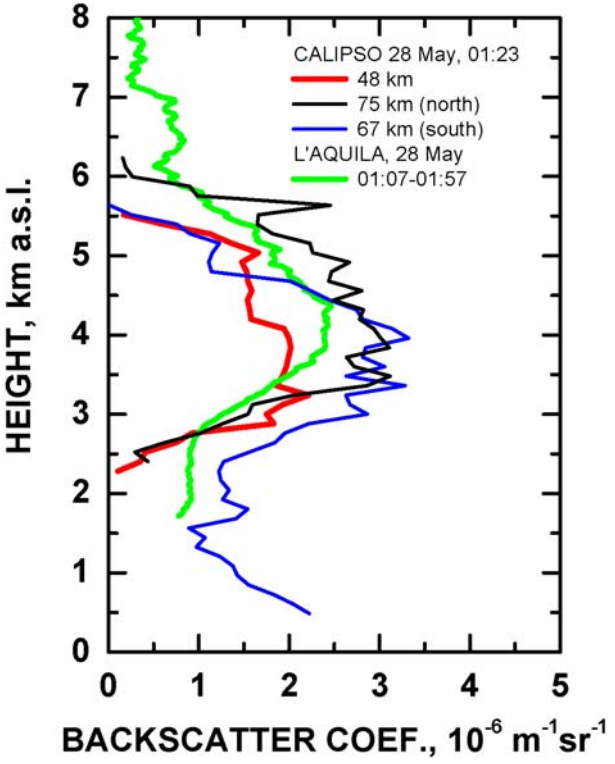


L2 product comparison: 28 May, night

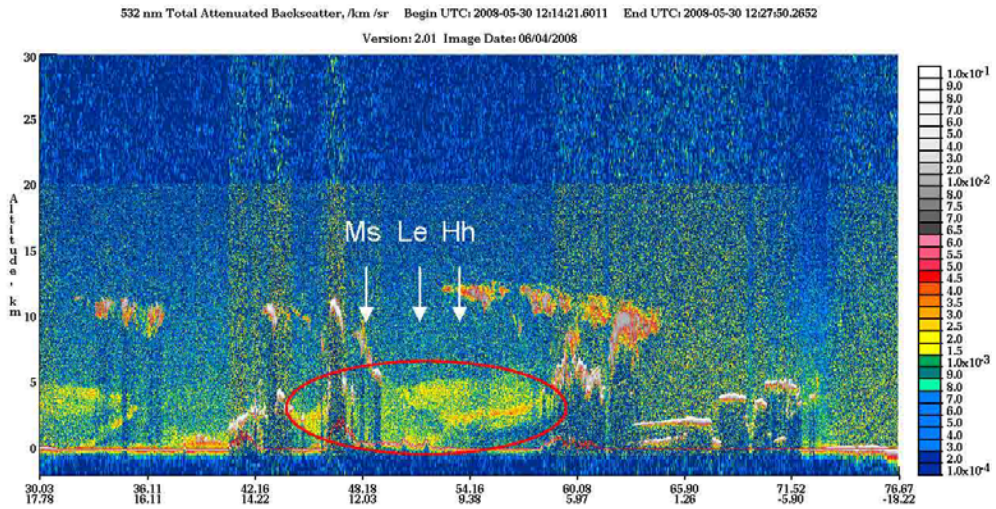


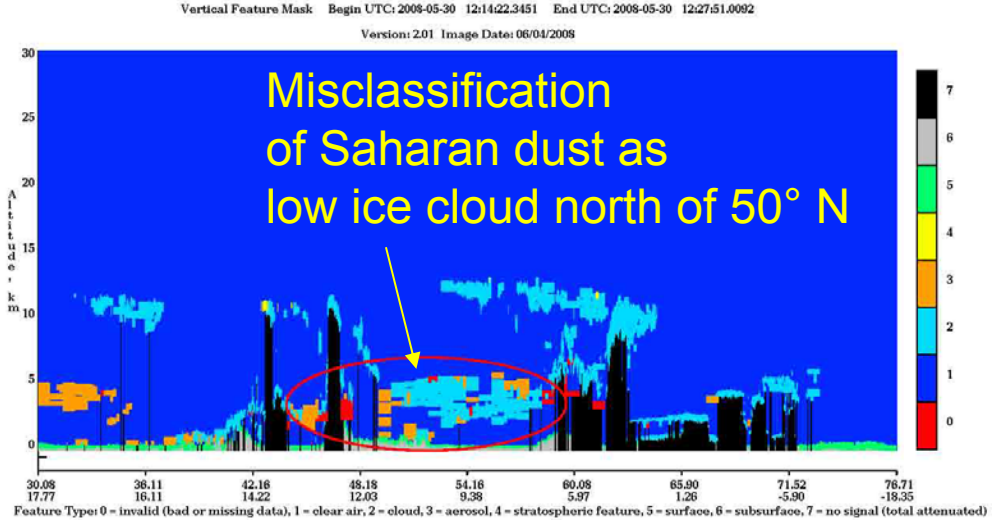


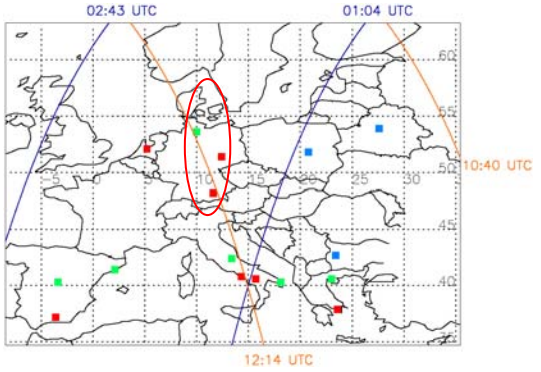


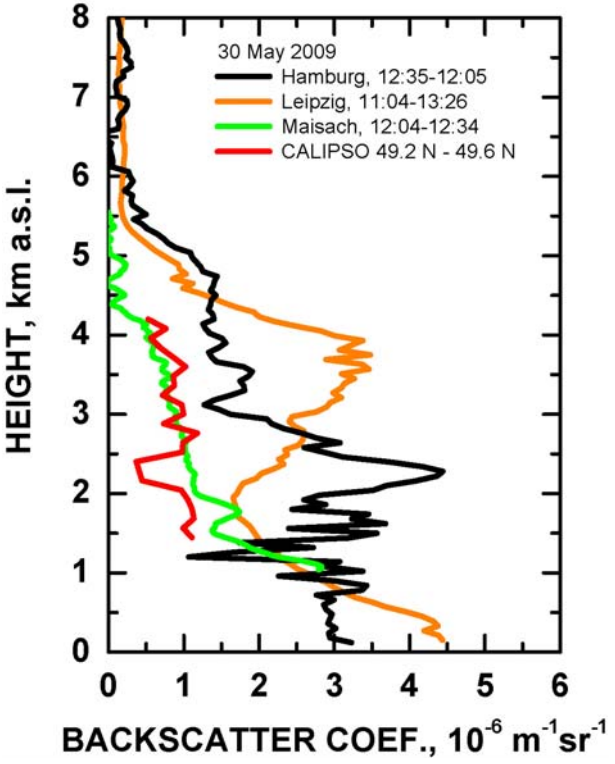


L2 product comparison: 30 May, day

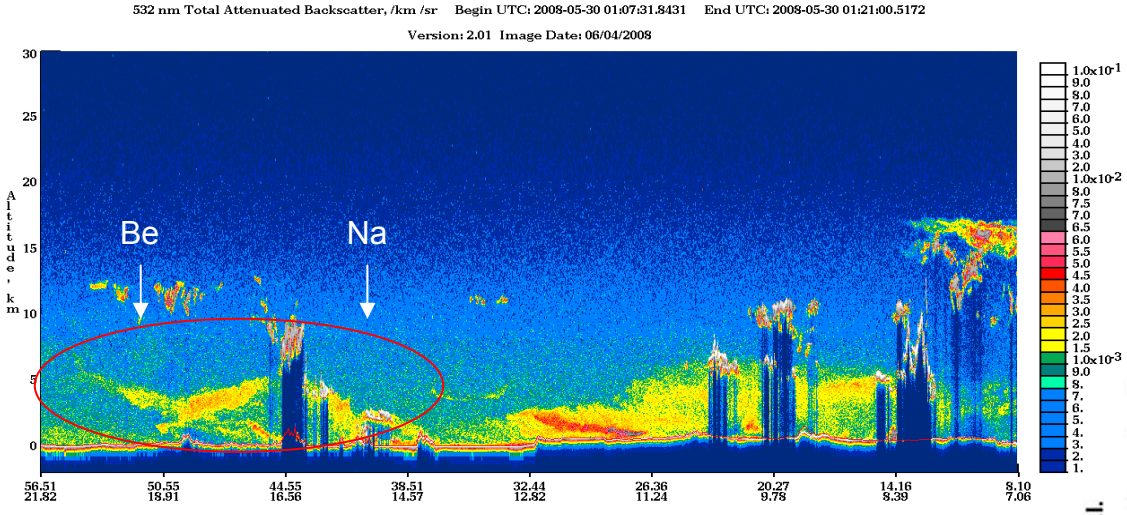


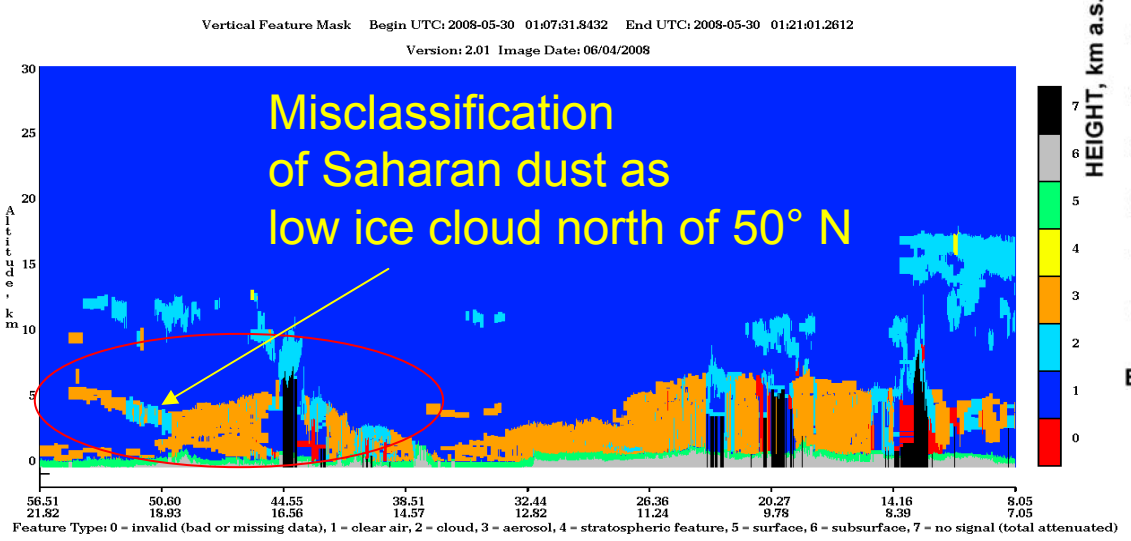


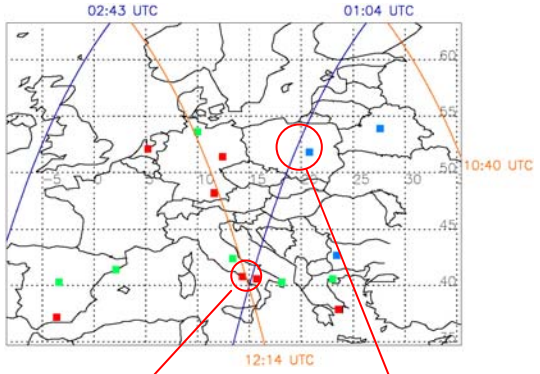


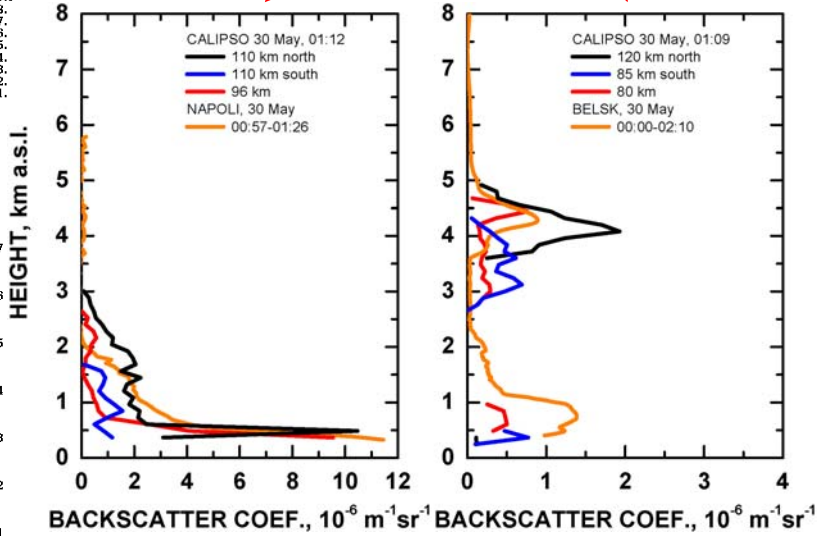


L2 product comparison: 30 May, night

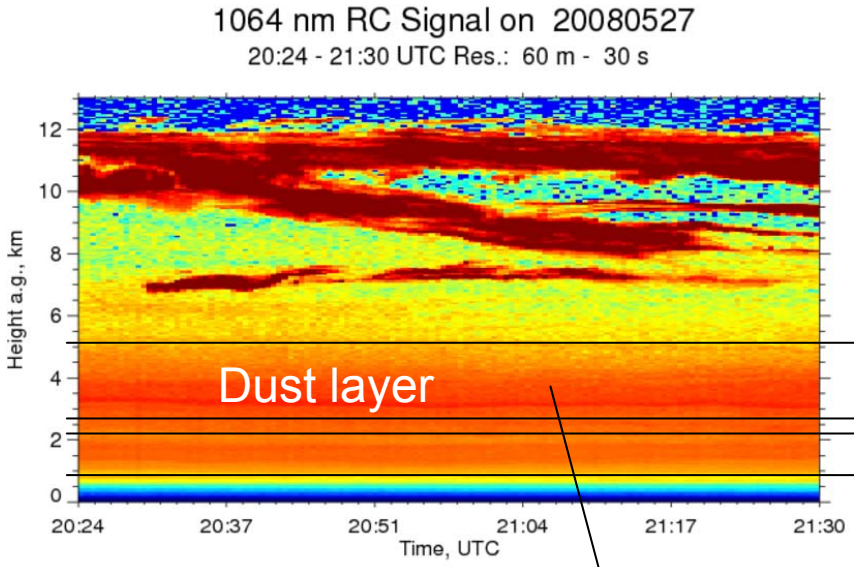


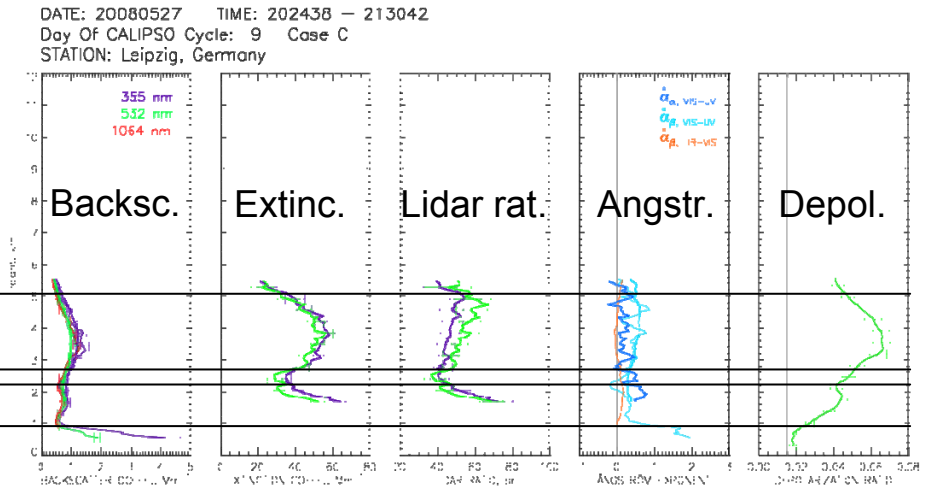






Optical data products: Leipzig, 27 May 2008



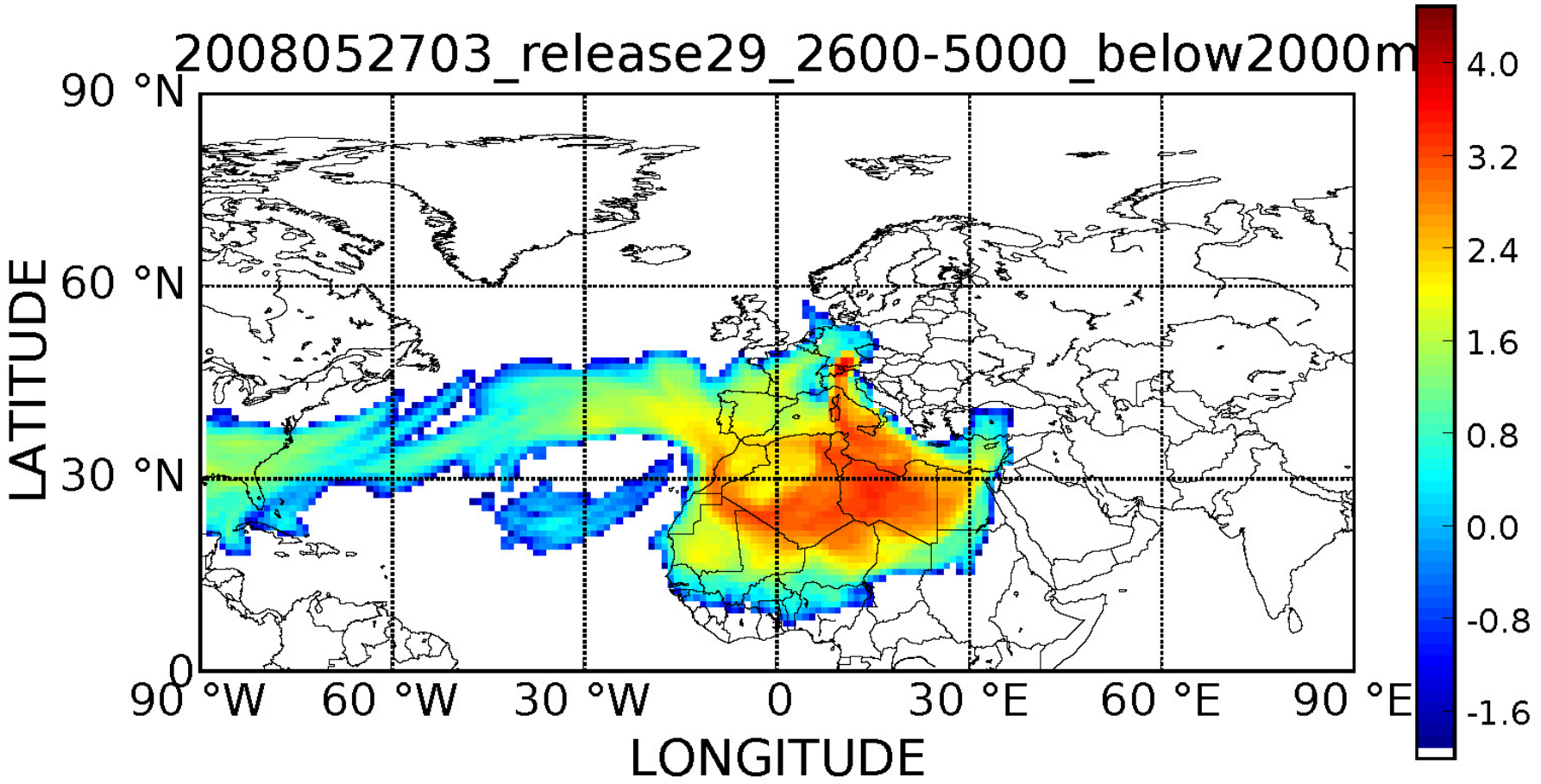


Layer-mean values

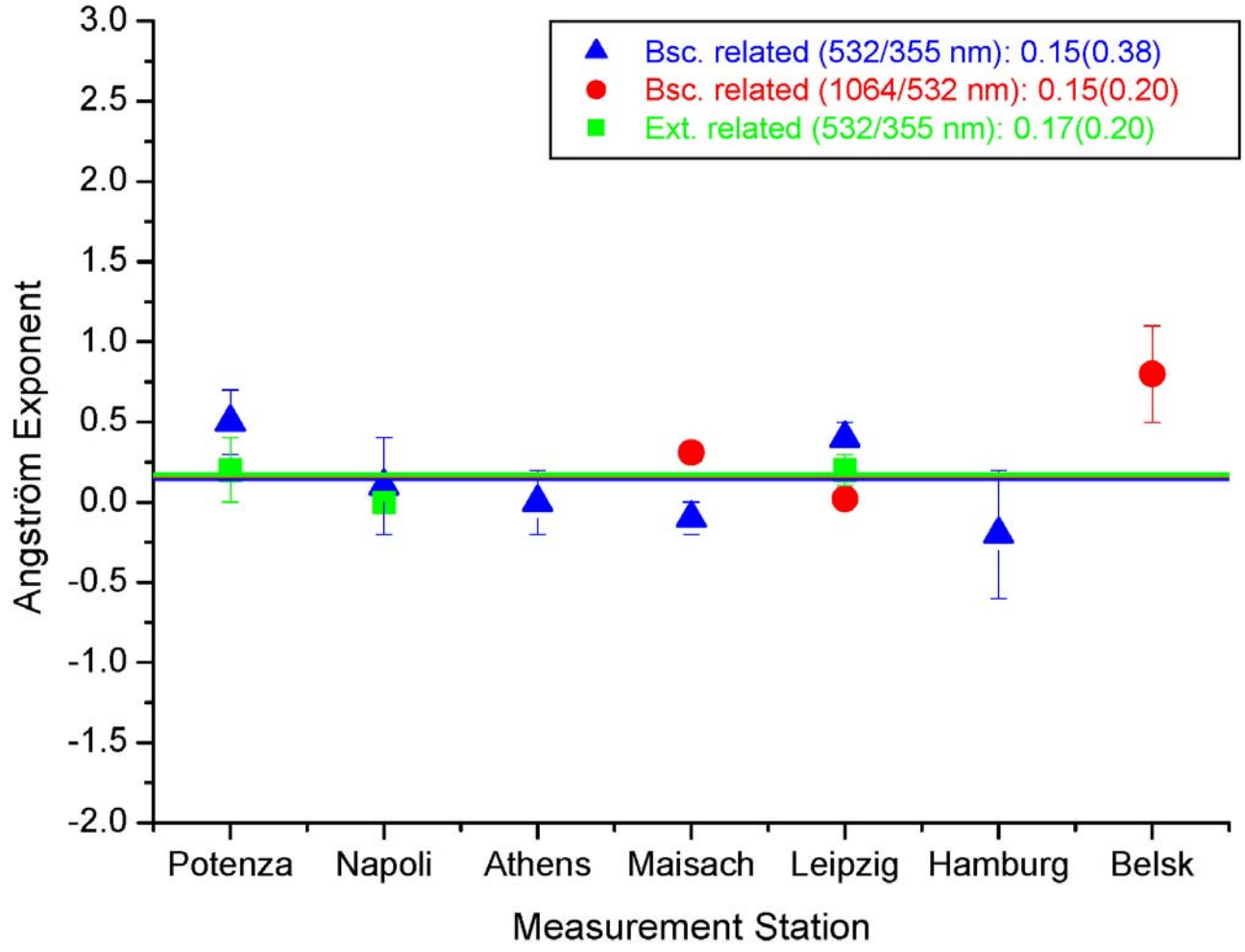
Backsc.	Extinc.	Lidar rat.	Angstr.	Depol.
0.9±0.2	47±5	54±6	0.09±0.01	0.06±0.01
0.9±0.2	50±6	46±3	0.40±0.07	
1.1±0.3			0.30±0.10	

⇨ Statistics from 44 layers at 8 stations

Classification of aerosol with respect to source region: FLEXPART aerosol transport simulation (10 days backward)



Saharan dust – Angström exponents

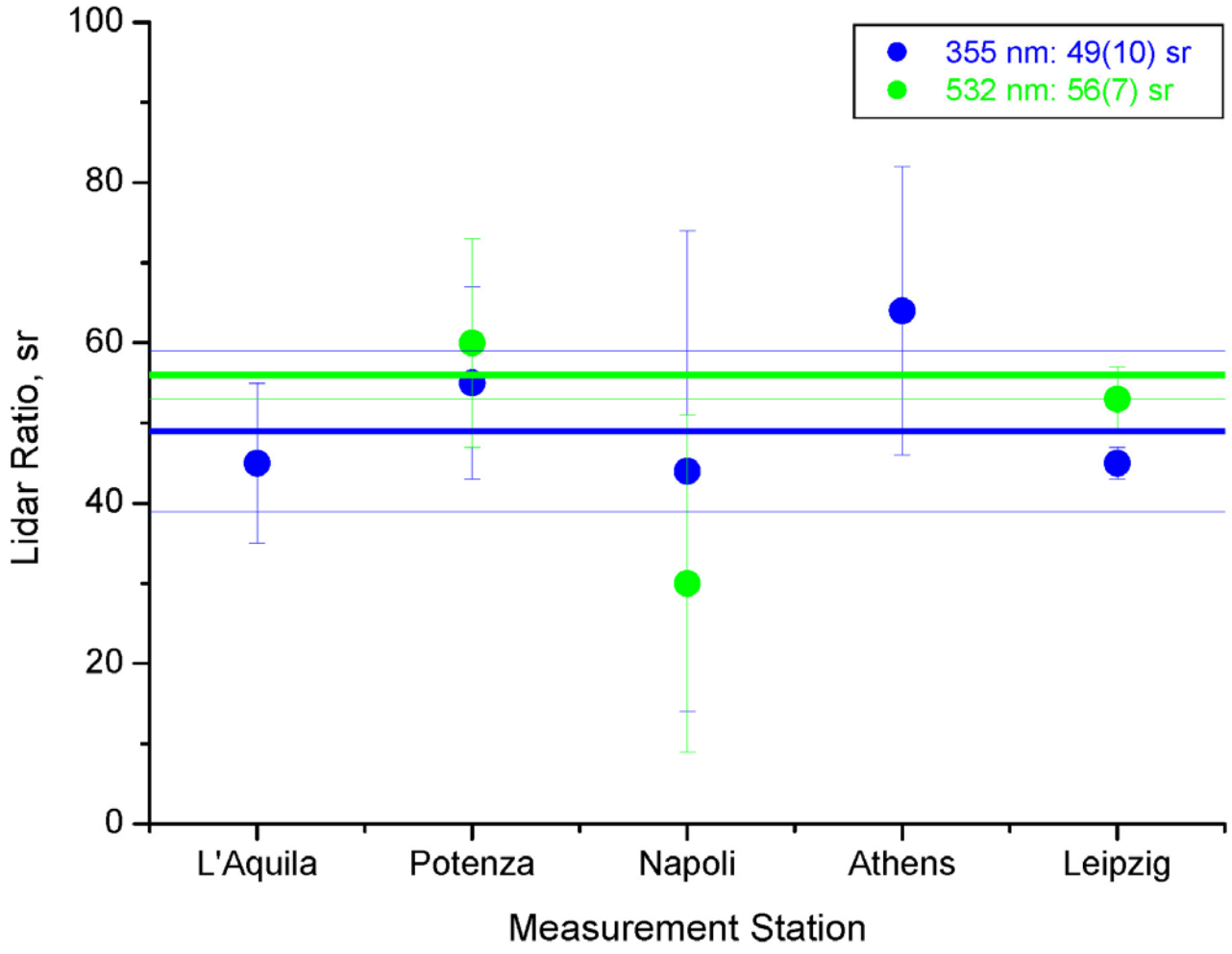


0.17 ± 0.20

0.15 ± 0.38

0.15 ± 0.20

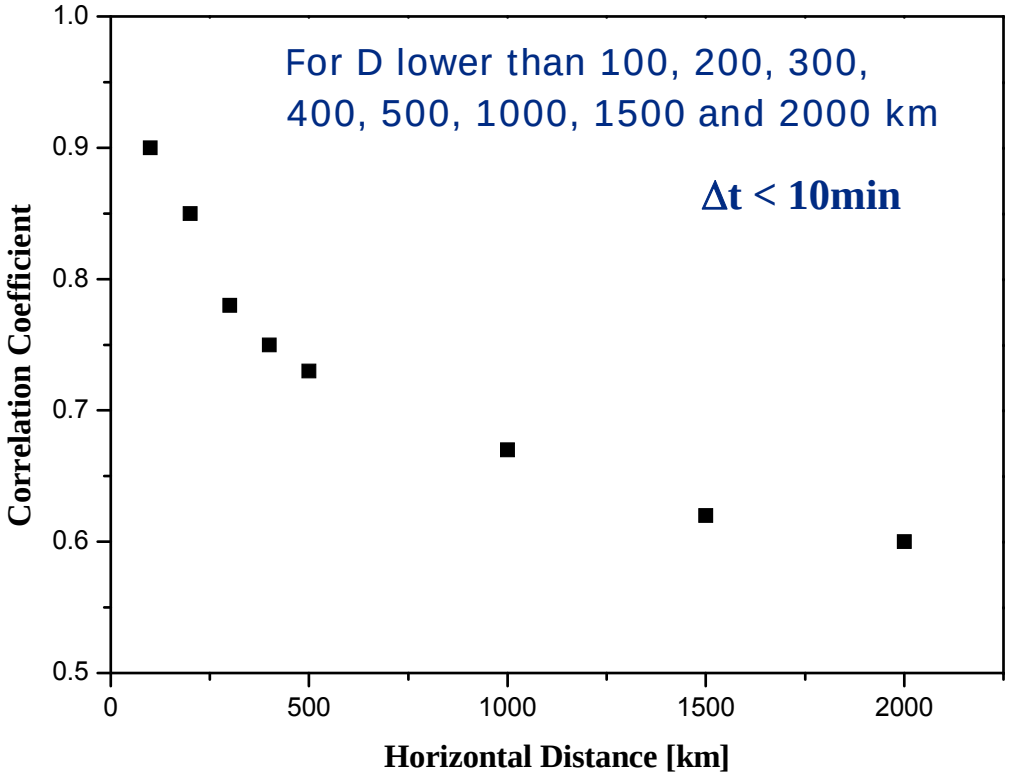
Saharan dust – Lidar ratios



56 ± 7 sr

49 ± 10 sr

Representativeness study



Comparisons within 10 minutes and different horizontal distances

(see poster by Gelsomina Pappalardo et al.)

Relational Database

on remote database server

PostgreSQL + pgAdmin III
(open source, platform independent)

Database tables

Basic definitions	EARLINET measurements	EARLINET-CALIPSO comparisons
• *EARLINET stations* • *Feature types* • *Feature properties* • *Optical data types* • *Source regions*	• *EARLINET measurements* • *EARLINET profiles* • *EARLINET features* • *Conversion factors*	• *CALIPSO data* • *EARLINET-CALIPSO feature comparisons* • *EARLINET-CALIPSO profile comparisons*

Conclusion and outlook

- EARLINET is establishing a long-term database from correlative observations of ground-based instruments with CALIPSO.
- The database provides:
  - profiles of aerosol and cloud parameters at multiple wavelengths
  - layer-integrated optical properties per aerosol and cloud type
  - conversion factors to relate different space-borne missions
  - CALIPSO-EARLINET difference profiles and difference layer properties
- For the moment an 18-months observational period is foreseen, but this can be extended (continued during future missions).
- There is a strong need for such observations in other regions of the globe. GALION can contribute here in the future.

→ Harmonization/validation of space-borne data sets of the next decade(s)