Aerosol climatology over Europe from 15 years of EARLINET measurements

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EARLINET since 2000
28 lidar stations
18 multiwavelength Raman lidar stations
19 with depolarization capability

Comprehensive, quantitative, and statistically significant data base
Continental and long-term scale
Different set-up and procedures

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

Harmonized network and standardized measurements
**EARLINET climatological schedule**

**EARLINET main aim:**
*Providing a long term aerosol optical properties profile database at continental scale*

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**Climatological schedule**

- 3 measurements per week at each station at scheduled time/day

- **Monday** - noon and around sunset  &  **Thursday** - around sunset

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Additional measurements are performed for different purposes

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**Not automatic and unmanned systems**
Used data

- Data acquired following *Climatological schedule*:
  - randomly sampling special events like dust intrusion

- Only QC EARLINET data
  - QC procedure for format consistency and statistical error provision

Reduced dataset, but improved results reliability
QC climatological dataset

- Selected files, occurrence of special cases

![Bar chart showing the number of files for different types of special cases.](chart.png)

- Dust: 0.11%
- Volcanic: 0.12%
- Fires: 0.16%
- Stratospheric: 0.18%
- None: 0.82%

# = 12061
Data & methods

Reported in the files:

Further quantities can be obtained by the combination of these parameters

e.g. Lidar Ratio = ext/back

Not depending on aerosol concentration but only on dimension, chemical composition, shape
Data & methods

- AOD$_{UV}$ = 0.26
- AOD$_{VIS}$ = 0.19
- AOD$_{UV}$ = 0.17
- AOD$_{VIS}$ = 0.11
- S$_{UV}$ = 51$\pm$10 sr
- S$_{VIS}$ = 53$\pm$8 sr
- $\delta$ = 0.12$\pm$0.03
- $\bar{\alpha}$ = 0.9 $\pm$ 0.2
Data & methods

- Columnar quantities (AOD – IB)
- Integrated in PBL + FT
- H63: altitude below which stays the 63% of the total column aerosol load
- Intensive properties
  - Lidar ratio
  - Angstrom ext
  - Angstrom back
  
  Evaluated only when ext/back (relative errors) are higher (lower) than a threshold
Is the 2 times per week sampling sufficient for climatological studies?

Is this database representative for climatological investigations?

Comparison and integration with external automatic data is fundamental for addressing these points.
One to one comparison

- AERONET Co-located stations
- Daily averages scaled with daily Angstrom

Limitations in the comparison:
Daytime vs nighttime

Overlap for the lidar

Higher AOD expected in daytime
Lidar underestimation?
Is the regular schedule sufficient for climatological purposes?

Potential differences on aggregated values are due to the low sampling.

For being in 2 sigma:
- 25% → 8dd
- 12% → 11 dd

In 1.5 sigma:
- 5% → 18 dd

Longer the sample more the agreement is related to how data are distributed during it.
Statistics at network level

**H63 typical value around 2km**

Guassian
\[ x_c = (1960 \pm 20) \text{ m} \]
\[ \sigma = (726 \pm 21) \text{ m} \]
\[ r^2 = 0.97 \]

Log-Normal
\[ x_c = (2067 \pm 13) \text{ m} \]
\[ r^2 = 0.99 \]

Seasonal profiles at sites
Clusters

Maritime

Eastern

Central Europe

Central Med

Columnar Integrated Backscatter

@ 532 nm [sr⁻¹]

ca ev an

at be bu sf

le kb mi ms pl

na po is

Clusters

Maritime

Eastern

Central Europe

Central Med

FREE TROPOSPHERE

PBL REGION

Lidar Ratio @355nm [sr]

ab

at

th

hh

le

kb

ia

lc

na

po

Lidar Ratio @355nm [sr]

ab

at

th

hh

le

kb

ia

lc

na

po
Indication of a decrease over Europe
Aerosol Optical Depth 355nm

In agreement with AERONET measurements

Maritime stations

Eastern -SE Europe

Central Europe

Central Mediterranean

Integrated Backscatter 532nm

IB decreasing as well in CE, not in CM and E-SE Europe
Profiling + S uv

E-SE Europe cleaner PBL

Higher H63 Probably cleaner PBL
Lower AOD in CM could be due to lower lidar ratio values.

Less absorbing or larger particles in the PBL in CM.

Stable the FT.

FREE TROPOSHERE

Maritime stations

Eastern -SE Europe

Central Europe

Central Mediterranean
Summary & Conclusion

- Climatological sampling sufficient for climatological study
- H63 typically around 2km asl
- Different clusters with different conditions
- Decreasing in AOD at clusterized samples
- PBL is the main region where aerosol content is changing
- Different changes in different regions
- Indication of less particles, less absorbing and with larger dimension

Next

- Improve statistics
  - satellite overpasses cases include AOD and IB for measurements without errors
- New EARLINET products & processing chain will foster more harmizedoned data collection
- Lunar photometer for really simultaneous AOD
Thank you for your attention

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