LIVAS: a 3D multi-wavelength aerosol climatology

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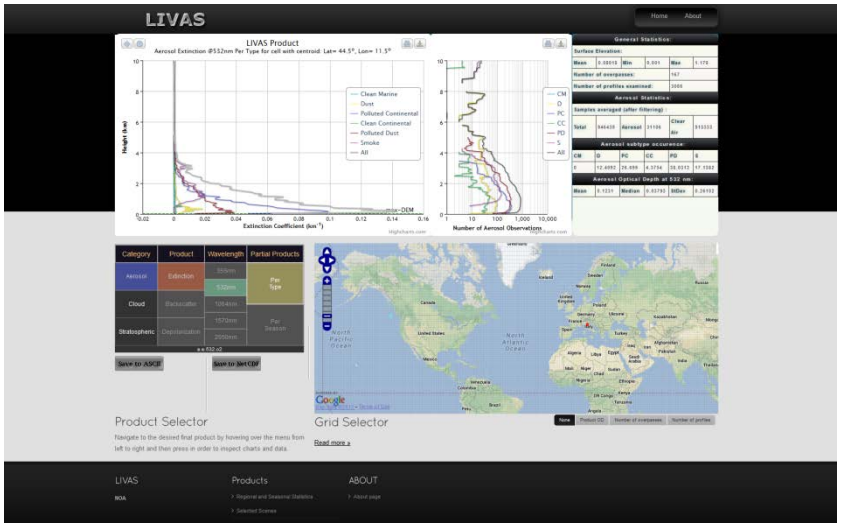
LIVAS climatology

LIVAS ESA effort focus on the conversion of CALIPSO from 532 to 355 nm utilizing spectral conversion factors from EARLINET.

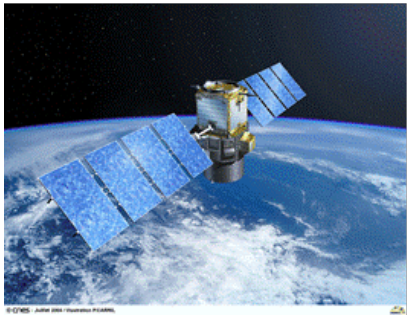
EARLINET already covers 14 years of homogenized multi-wavelength aerosol lidar measurements and continues upgrading its instruments and methods for the provision of high-quality lidar products.

The final LIVAS UV product is envisioned to serve as the link between CALIPSO and EarthCARE, in order to bridge the missions for the provision of a multi-decadal harmonized climatic record.

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



From CALIPSO



EARLINET

To EarthCARE

LIVAS data processing chain

CALIPSO
Main Parameters:
Backscatter @ 532 & 1064 nm
Extinction @ 532 & 1064 nm
Depolarization @ 532 nm

Auxiliary Parameters:
AVD, QC flags, CAD score, Uncertainties, Surface Elevation, Geolocation, Time

$1^0 x 1^0$ grid

Quality screening following CALIPSO Level 3 suggestions

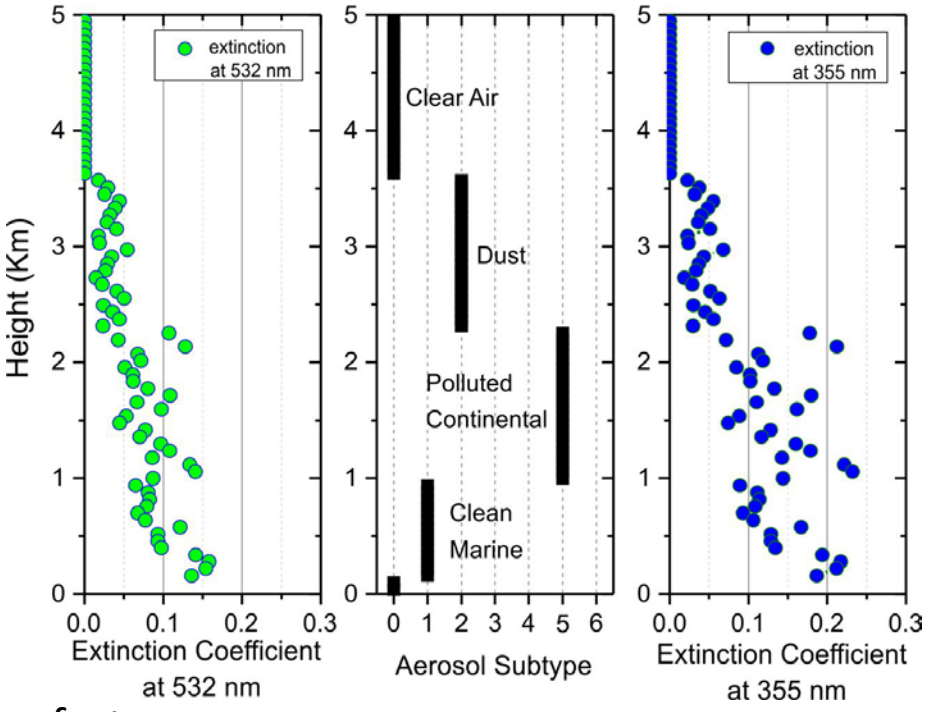
Spectral conversion based on:
1. CALIPSO aerosol classification
2. EARLINET aerosol-type-dependent spectral conversion factors

Averaging of converted profiles following CALIPSO Level 3

Spectral conversion example

Spectral Conversion based on:

1. CALIPSO aerosol classification



2. EARLINET / ESA-CALIPSO conversion factors

LIVAS aerosol type	Backscatter-related conversion factors 532/355	Extinction-related conversion factors 532/355
Dust	0.40	0.55
Polluted continental	1.42	1.24
Polluted dust	0.92	0.71
Smoke	1.46	1.41
Clean marine	0.50	0.78
Clean continental	1.20	1.31

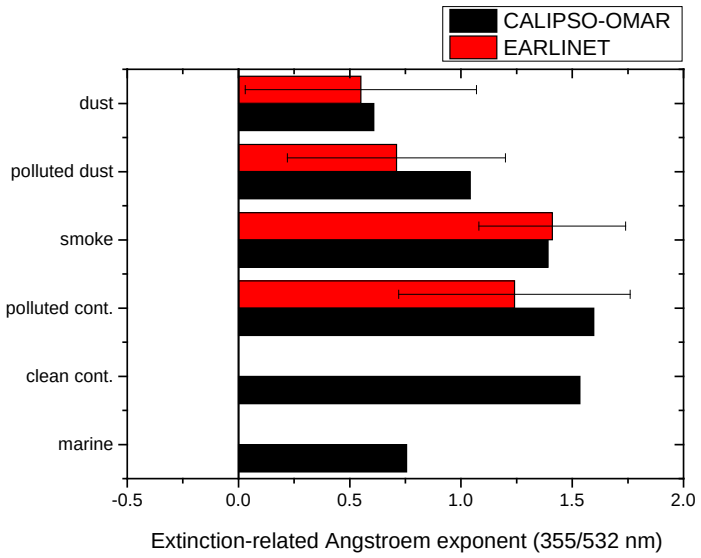
Methodological drawbacks

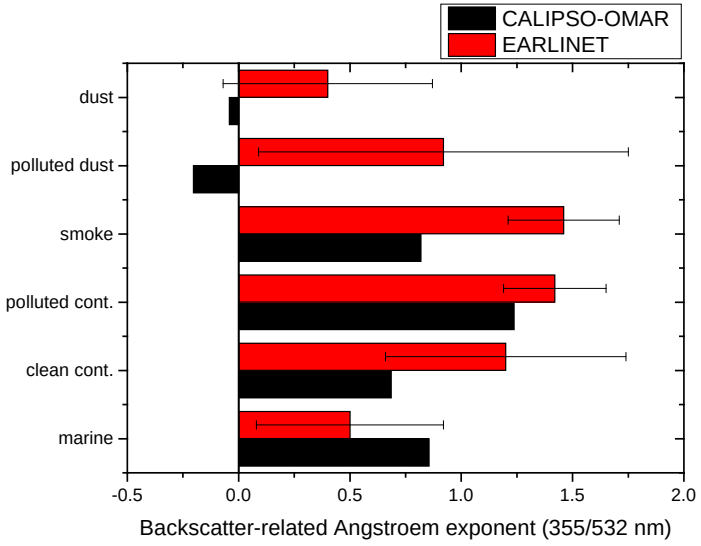
	CALIPSO	EARLINET
Aerosol Classification	Based on CALIPSO L1 product → attenuated backscatter → particulate depolarization ratio → layer height → geographical location → surface type	Based on aerosol layer characterization → dispersion modeling (FLEXPART) → dust modeling (BSC-DREAM8b) → aerosol forecasts (NAAPS) → World Fire Atlas (WAF) → Global Volcanism Program
Aerosol model (typical aerosol properties per aerosol type)	Averaged properties per aerosol type deduced from cluster analysis of AERONET data (Omar et al., 2005; 2009)	Averaged properties per aerosol type, directly inferred by multi-wavelength EARLINET measurements

DRAWBACKS:

→ Different aerosol classification schemes by CALIPSO and EARLINET
→ Different aerosol models coming from AERONET and EARLINET respectively

Comparison of conversion factors





CALIPSO AERONET vs EARLINET aerosol model

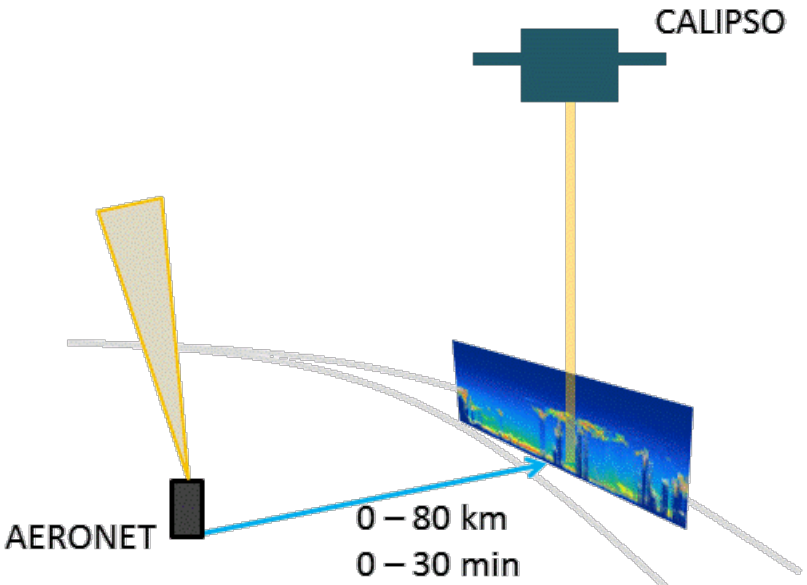
The differences are most likely attributed to:

- ✓ The use of different aerosol classification schemes
- ✓ Columnar AERONET measurements may not be representative of one aerosol type only
- ✓ EARLINET is representative of European aerosol types only
- ✓ AERONET CIMELs are not capable of performing a direct backscatter measurement, thus the modeled backscatter coefficients may deviate much, especially for non-spherical types like dust and polluted dust (for differences observed in backscatter-related Angstroems)

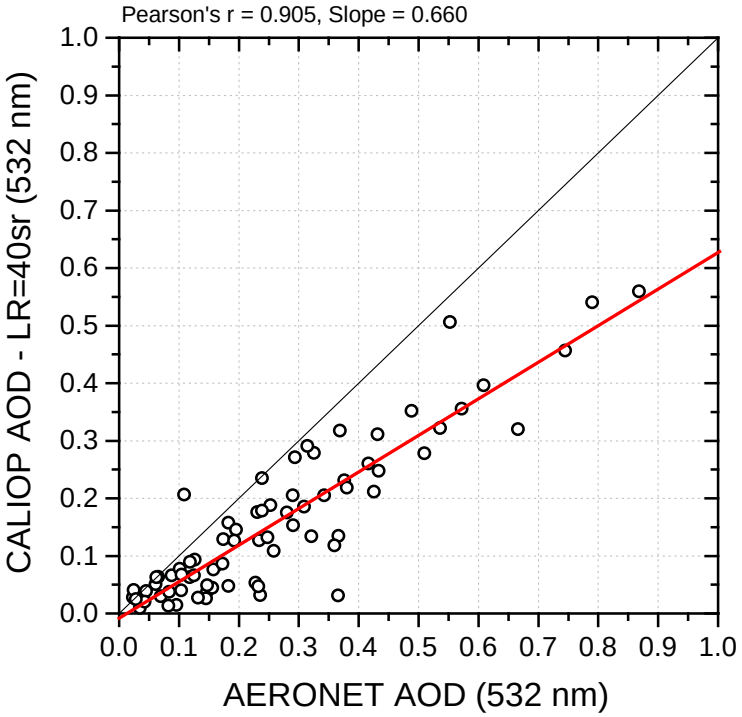
The dust case

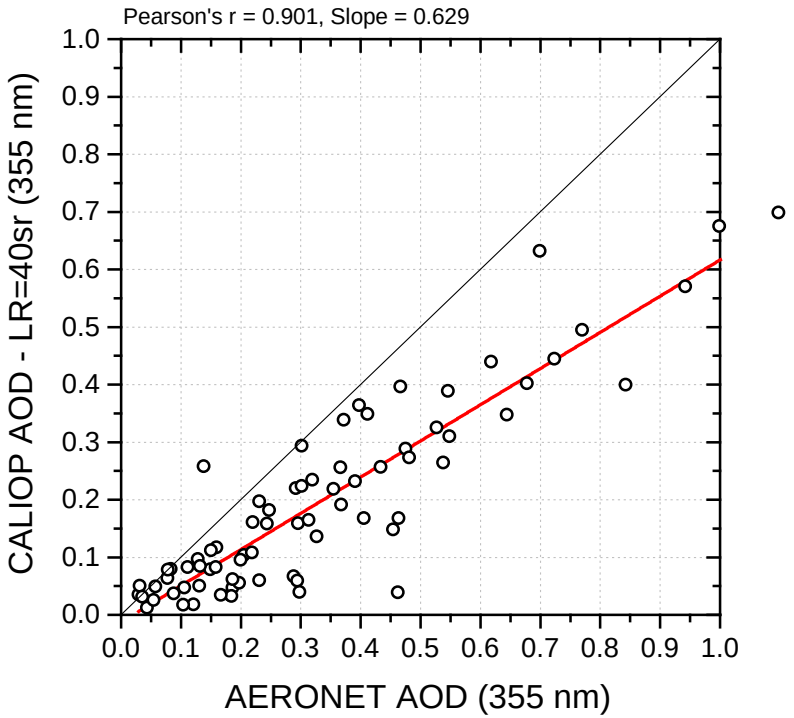
The differences can be eliminated for the case of dust:

- ✓ Differences in aerosol classification schemes are not a major issue for dust which is well detected by both CALIPSO and EARLINET
- ✓ European EARLINET data can be used for Saharan dust
- ✓ Columnar AERONET measurements may be representative of dust type if we cluster AERONET data by collocating with pure dust CALIPSO profiles



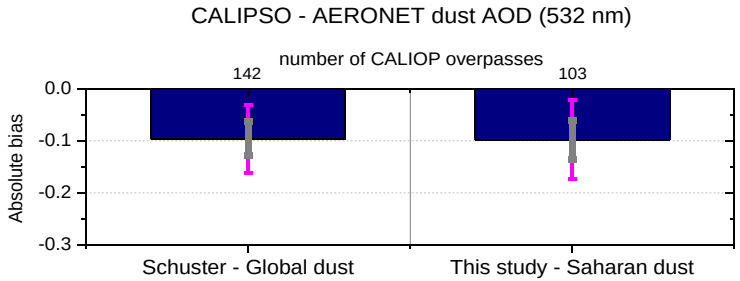
The dust case





Amiridis et al., ACP, 2013

The dust case



Schuster et al., ACP, 2012

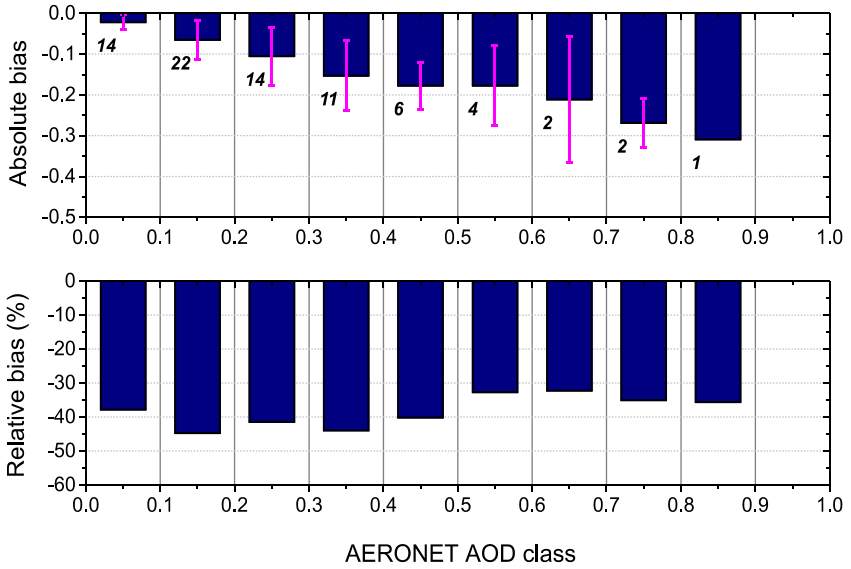
Possible sources of discrepancies:

Failure to detect aerosol base

Aerosol misclassification

Lidar ratio

Amiridis et al., ACP, 2013



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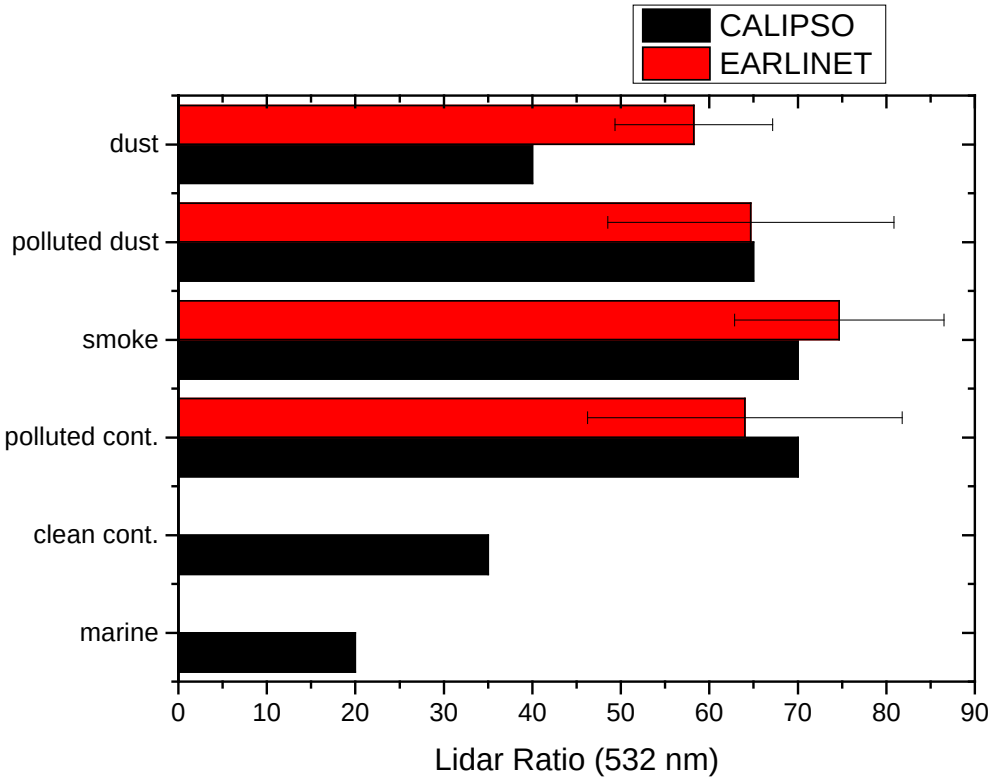

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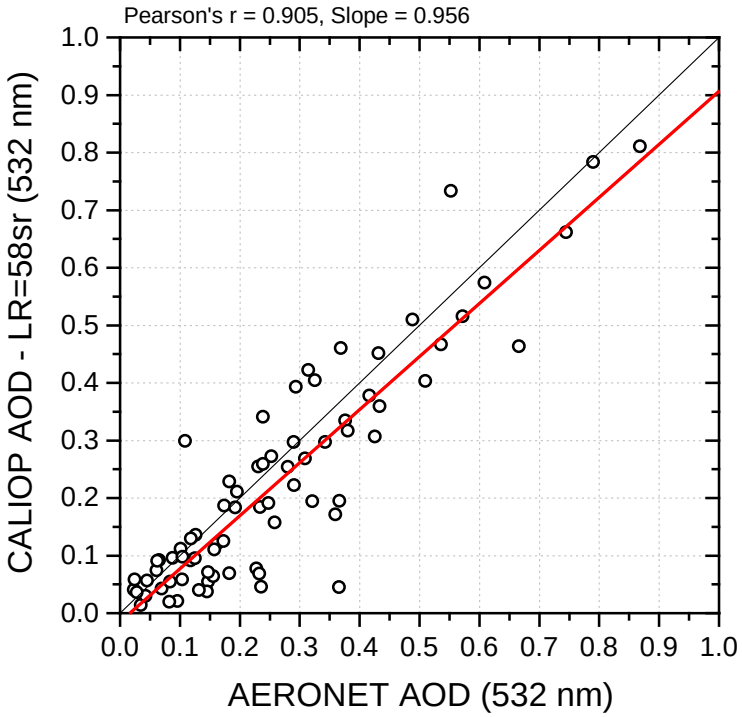

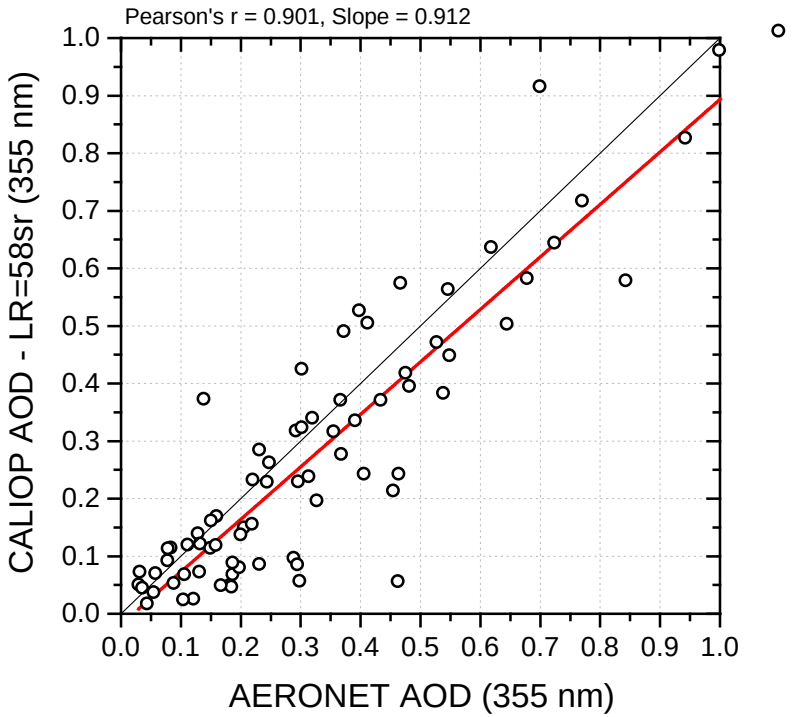

Amiridis et al., ACP, 2013

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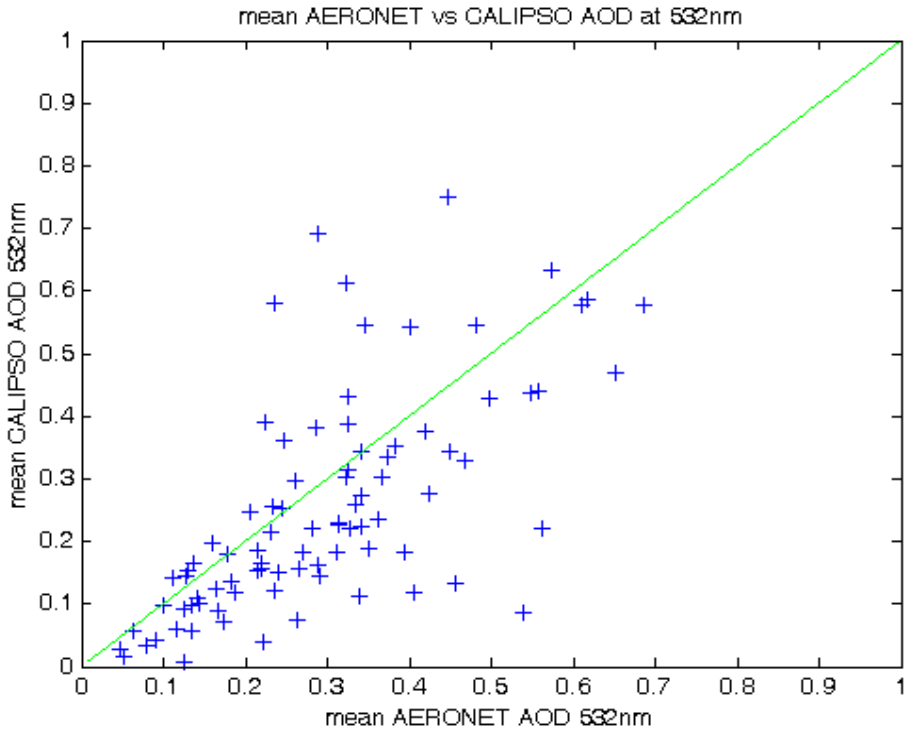
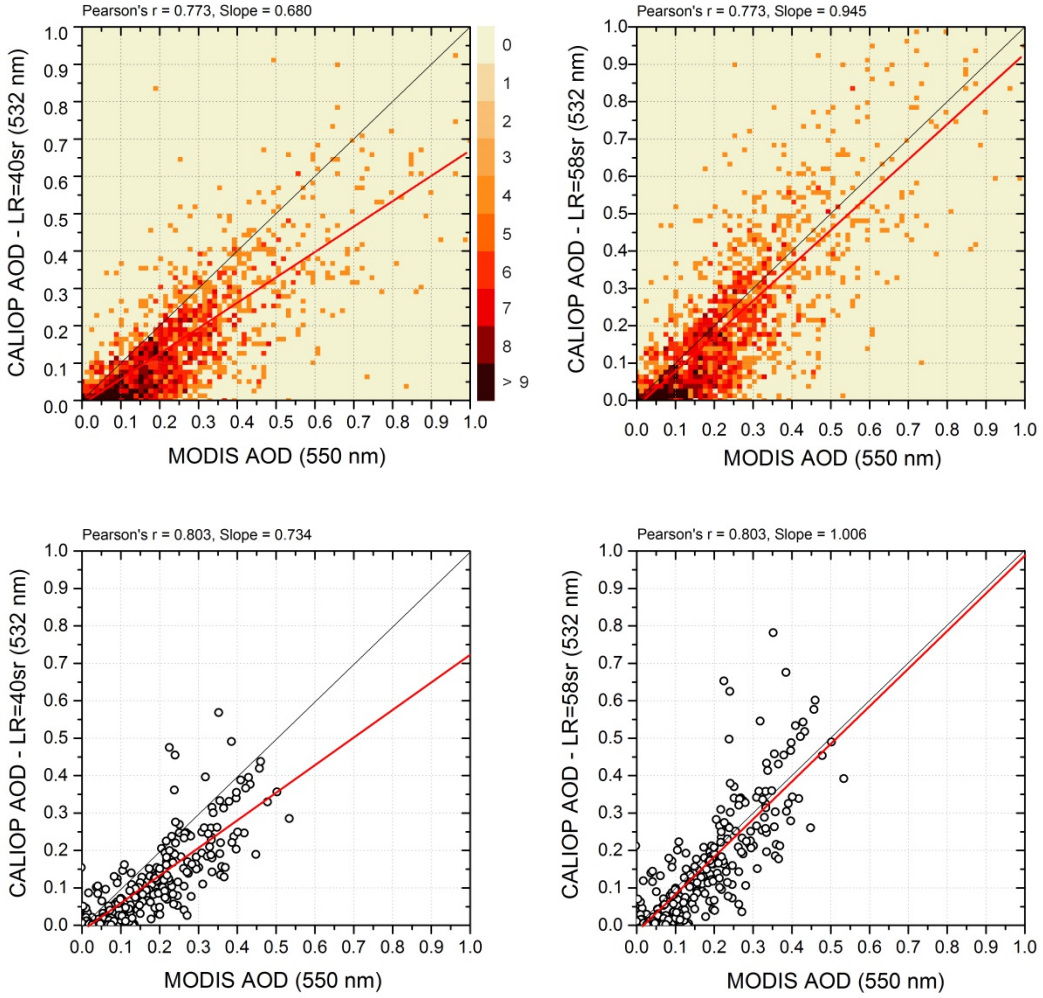


Middle East dust (Lidar ratio = 40 sr, ***Mamouri et al., 2013***)

The dust case



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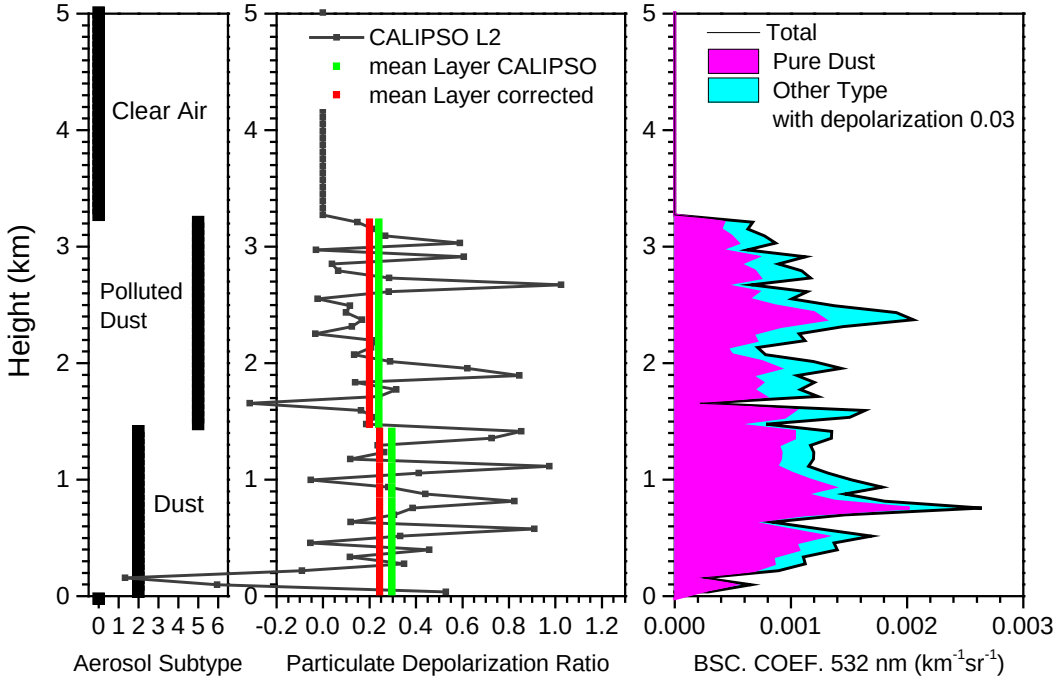
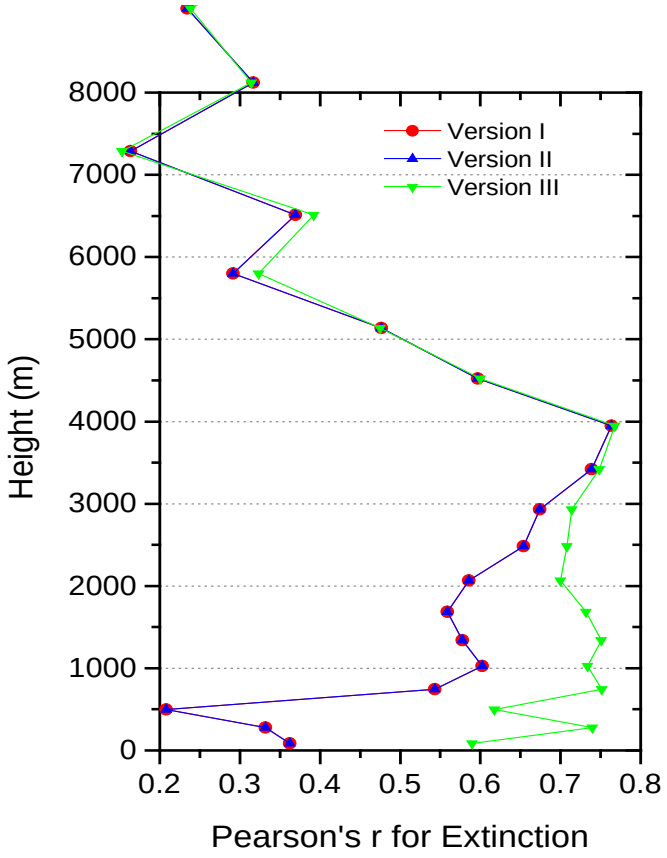


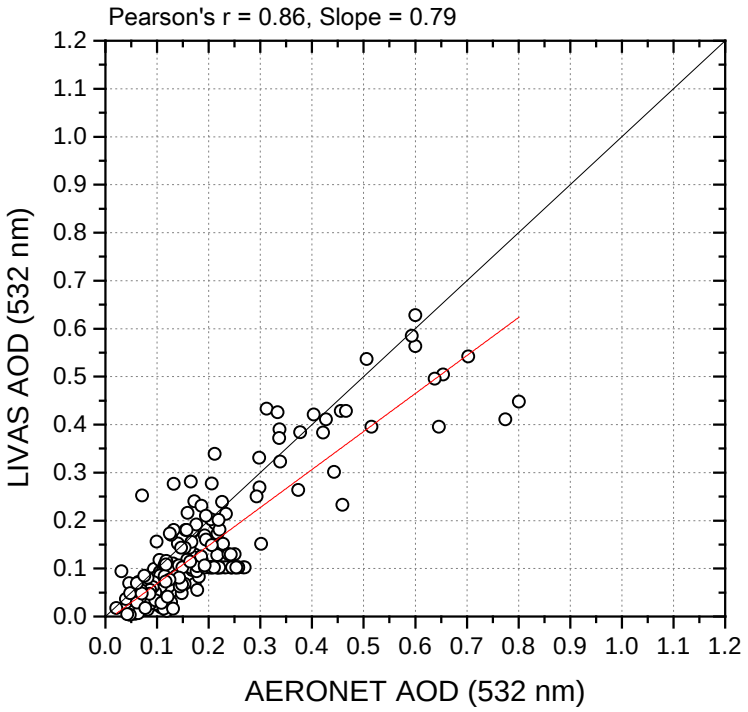
$$\beta_1 = \beta_t \frac{(\delta_p - \delta_2)(1+\delta_1)}{(\delta_1 - \delta_2)(1+\delta_p)}$$

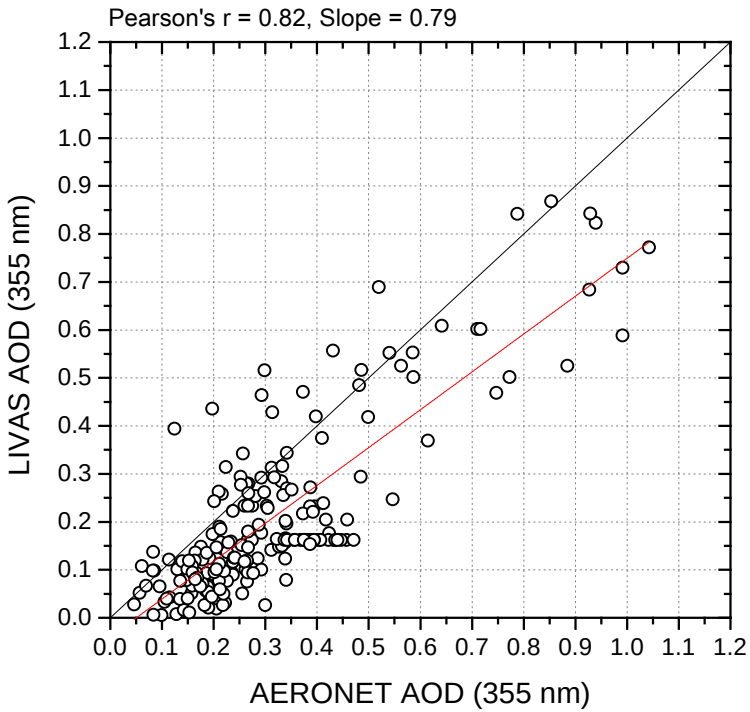
Tesche et al., JGR, 2009



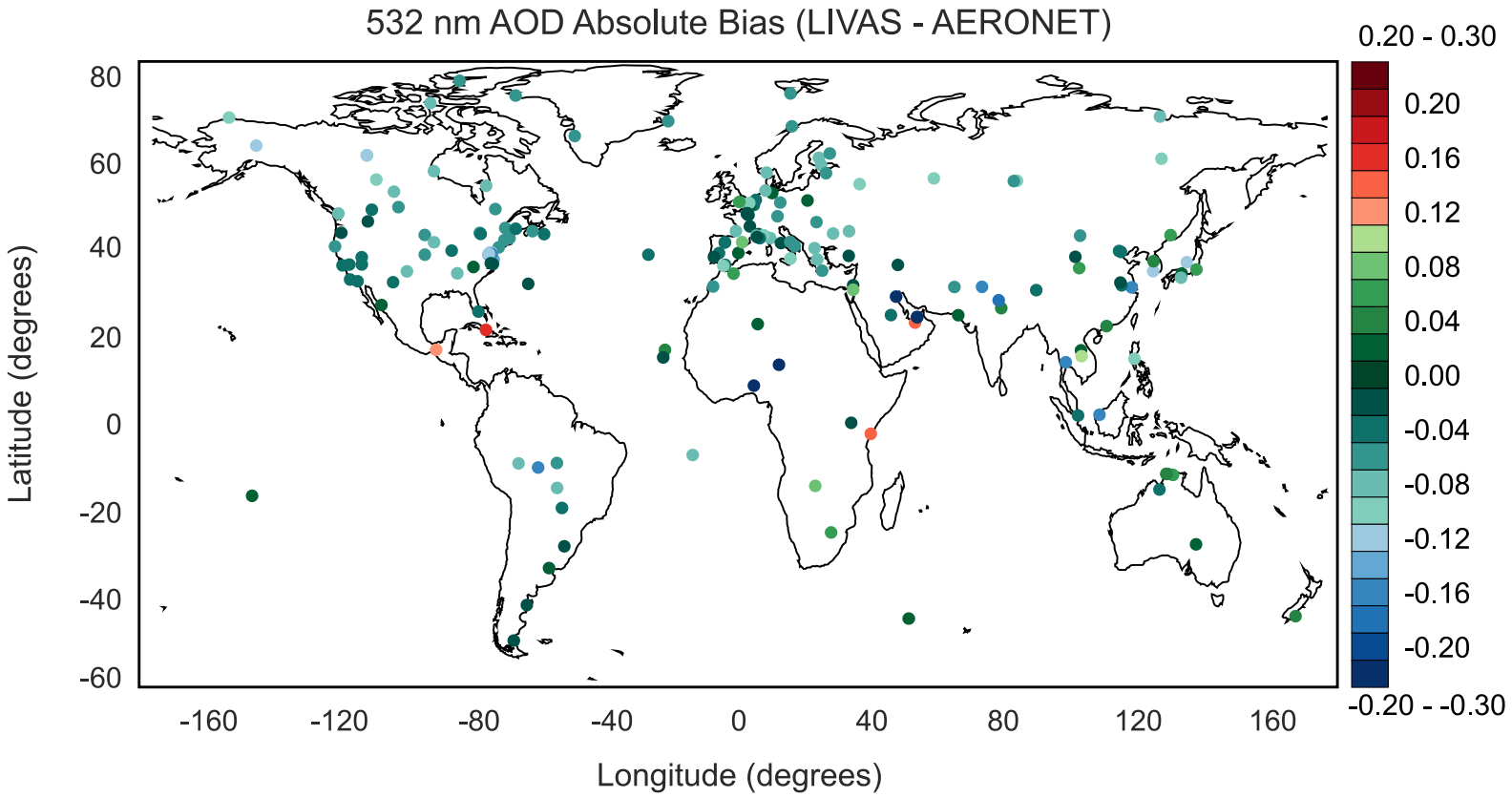
Amiridis et al., ACP, 2013

LIVAS for all aerosol types





LIVAS for all aerosol types



Kanitz et al., AMT 2014

Summary

1. The homogenization of CALIPSO with EarthCARE needs a common classification scheme and an accurate aerosol model for both extinction and backscatter that can be developed and tested using EARLINET as reference.
2. Lidar ratios from EARLINET can be used to optimize CALIPSO.
3. The ESA-CALIPSO EARLINET database is continuously updated and refined with new measurements, including also campaigns outside Europe to support the development of a comprehensive lidar-related aerosol model for space applications.
4. EARLINET will soon provide dual-depolarization measurements (355/532 nm) for converting CALIPSO linear particle depolarization from 532 to 355 nm (EarthCARE).
5. We aim to continue updating LIVAS based on ESA-CALIPSO aerosol model updates and EARLINET optimization procedures for providing CALIPSO extinction monthly means at 355 nm that will be consistent with passive sensors in terms of AODs.