FOREST FIRE AEROSOLS

Optical and microphysical properties from EARLINET observations

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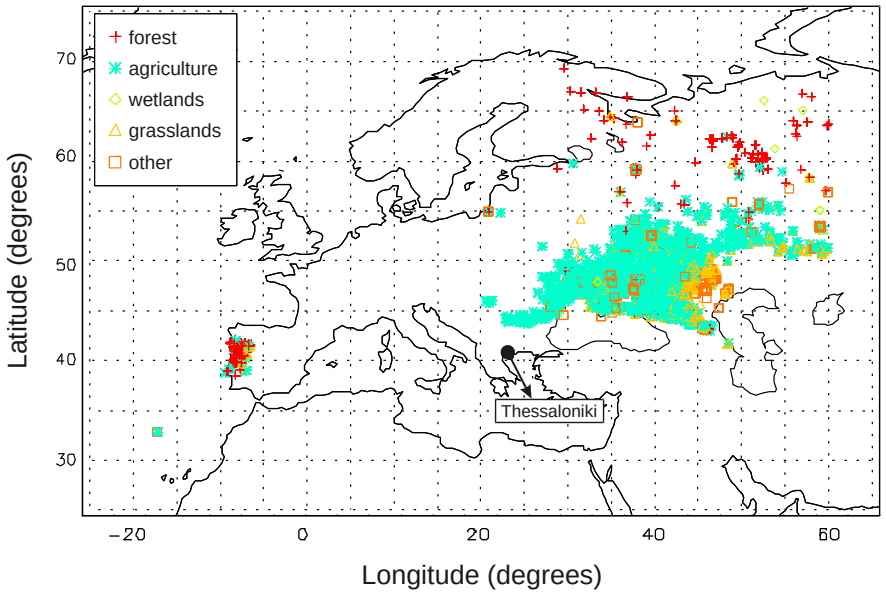
Outline

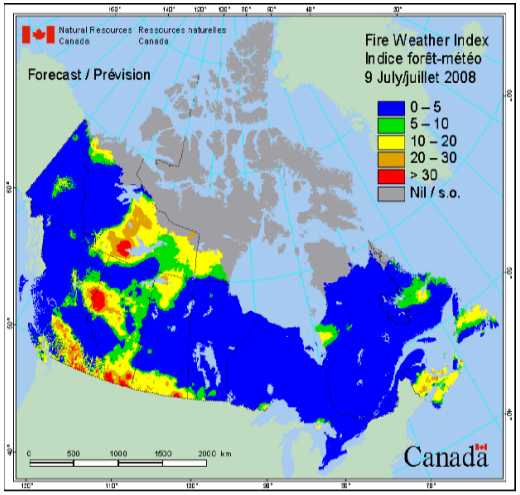
- Fire sources affecting Europe
- Tools for smoke identification
- Optical properties for smoke from EARLINET observations
- Microphysical retrievals for smoke within EARLINET
- Effects of ageing of smoke plume
- Summary

Systematic sources affecting Europe

In Europe

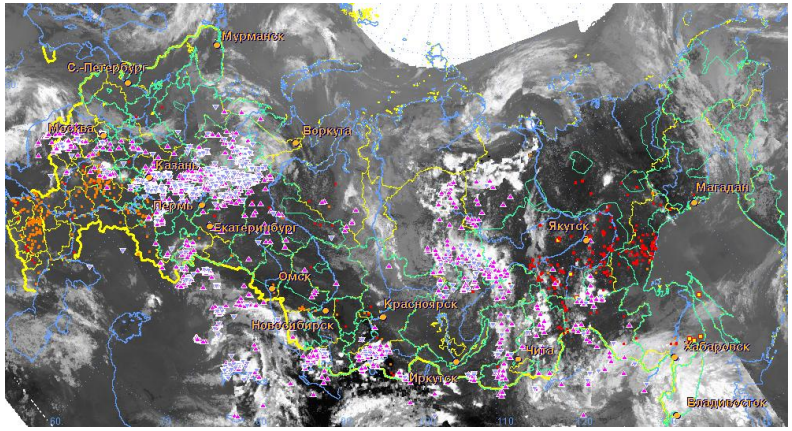


In N. America



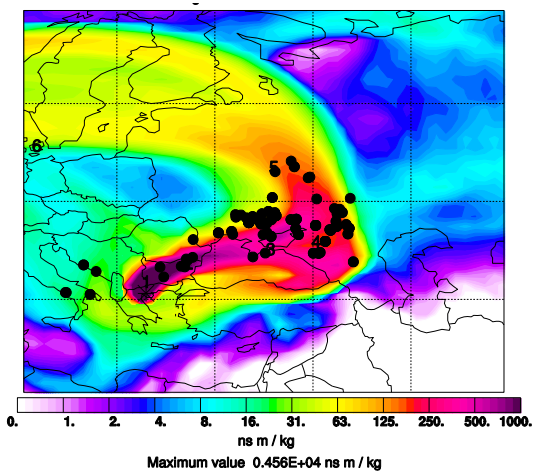
Regional scale example (August 2007)

In Siberia

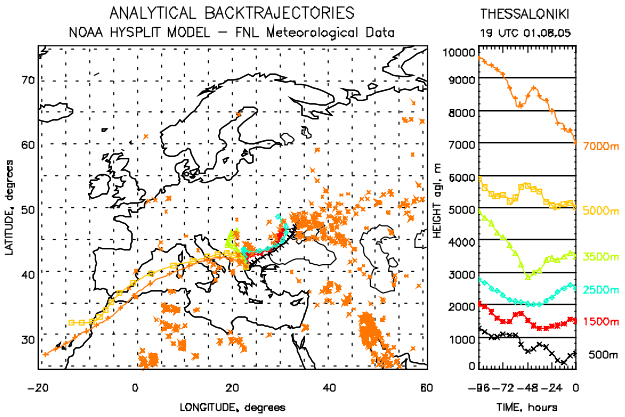


Tools for identification of fire sources and the possibility of advection over a lidar station

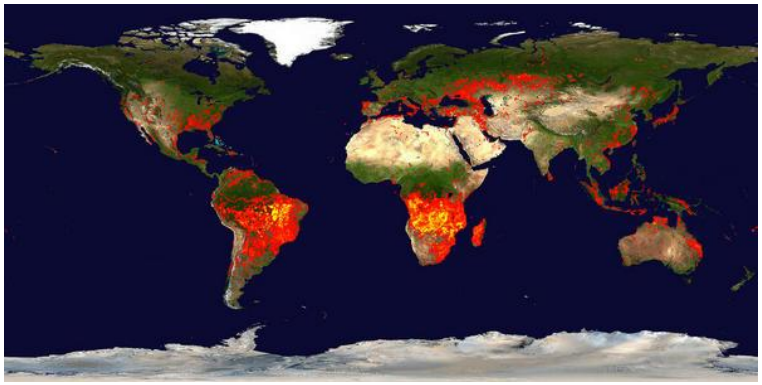
Emission sensitivity obtained from 20-day backward simulations with FLEXPART



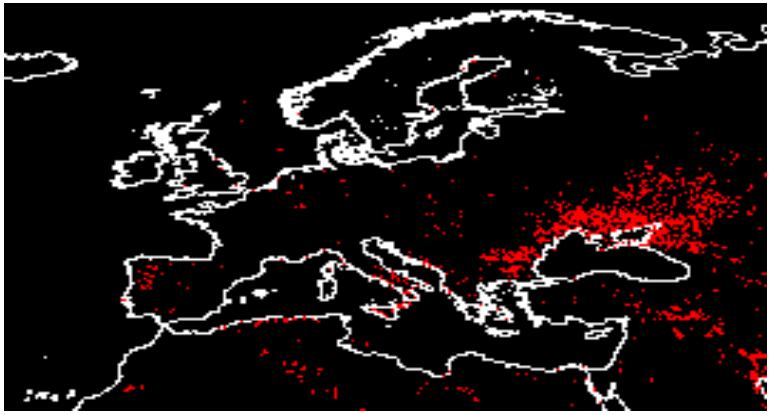
HYSPLIT-backtrajectories



MODIS rapid response system

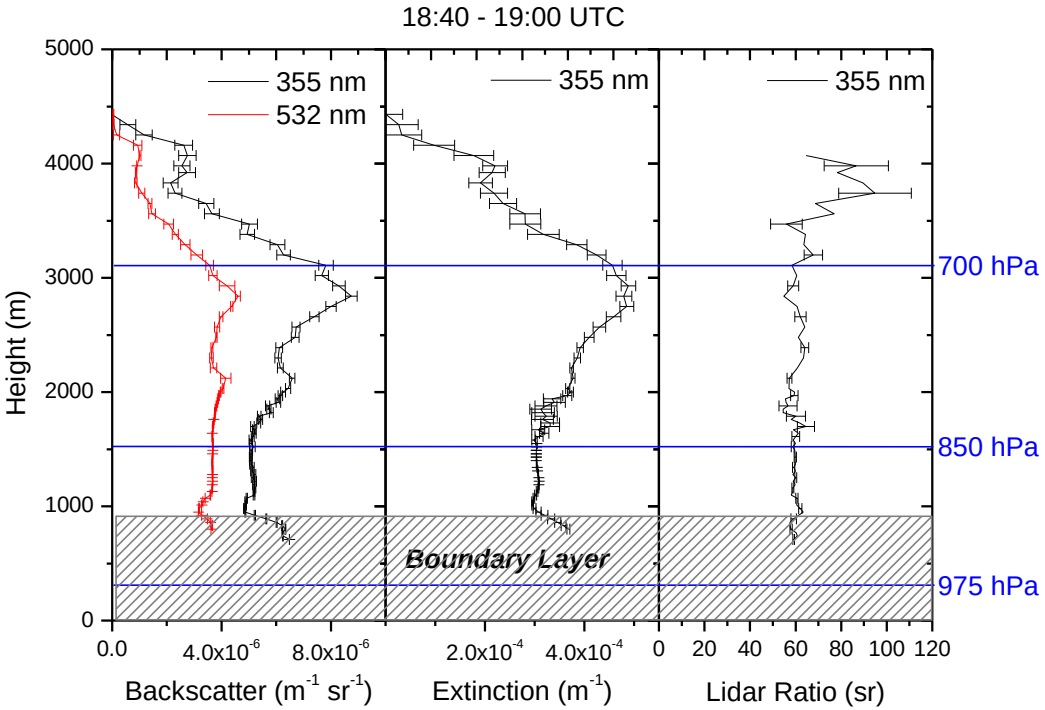


World Fire Atlas (ATSR)

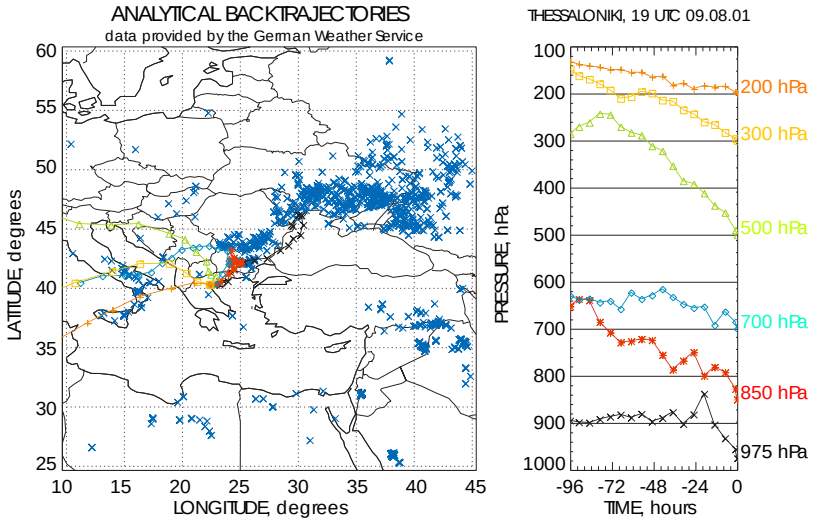


Optical properties for smoke from EARLINET observations

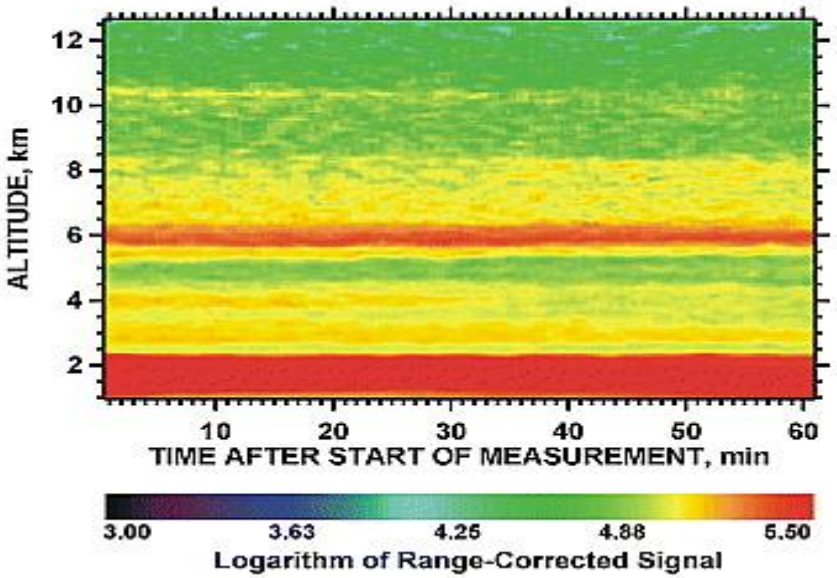
Thessaloniki, 9 August 2001

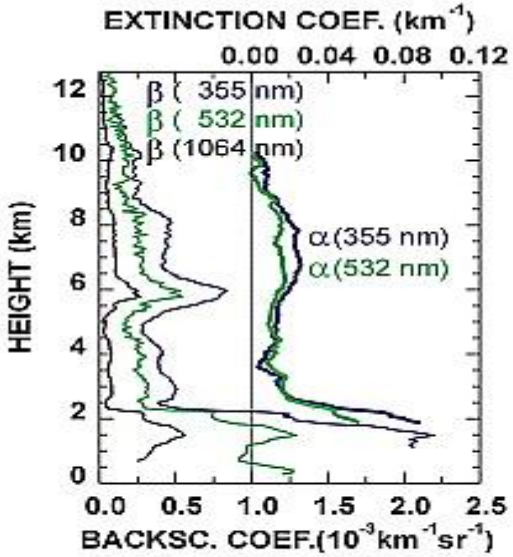


Smoke originating mainly from Russia's Agricultural District and other regional sources

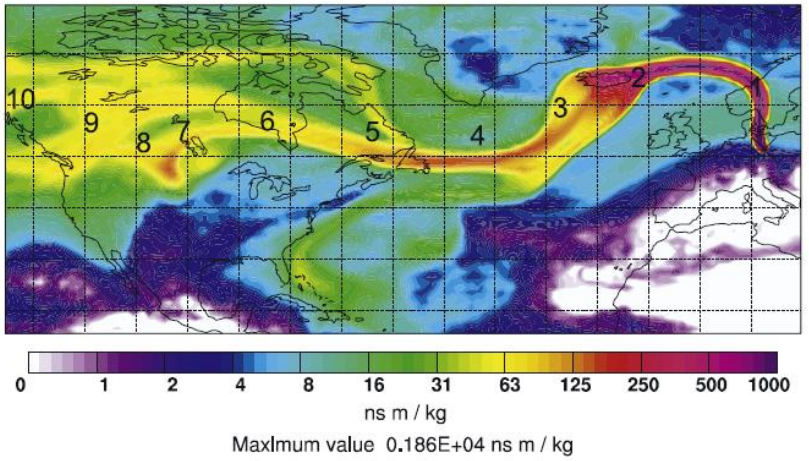


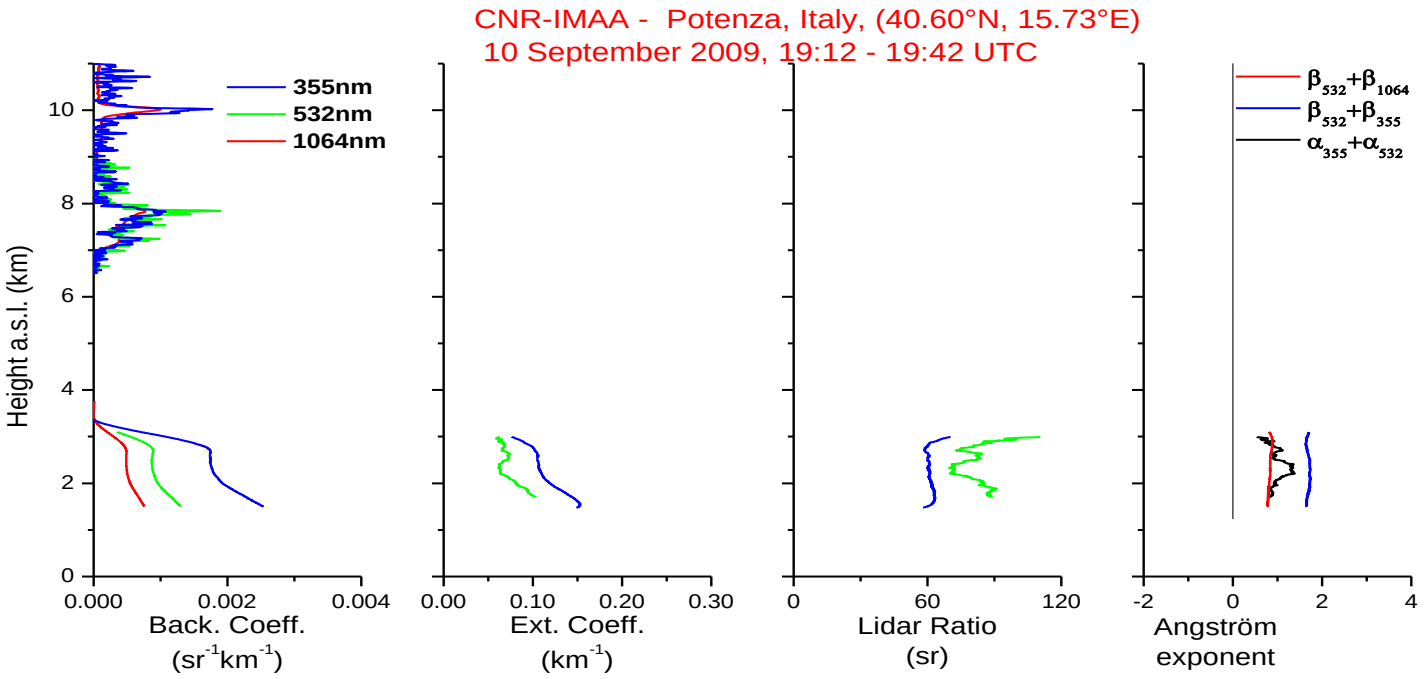
Example of 3+2 lidar retrievals of extinction and backscatter for a smoke case study (Mueller et al., 2004)

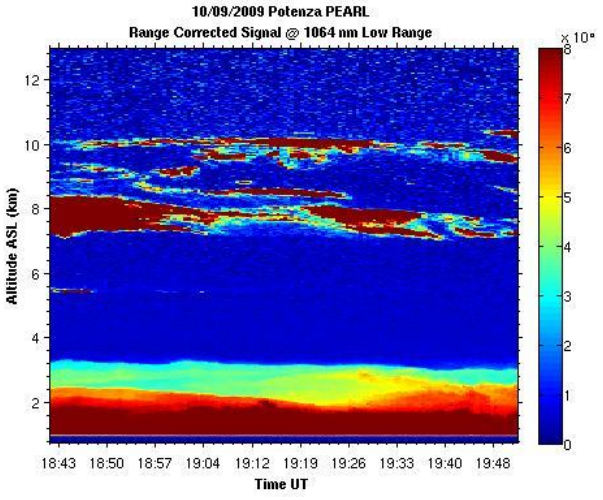


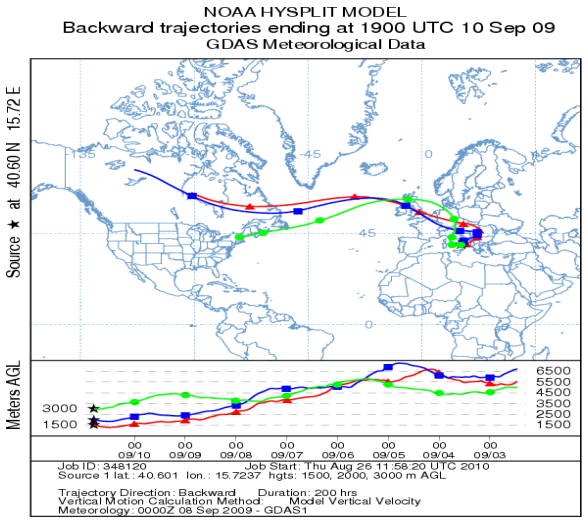


Canadian fires detected over Leipzig June 2003







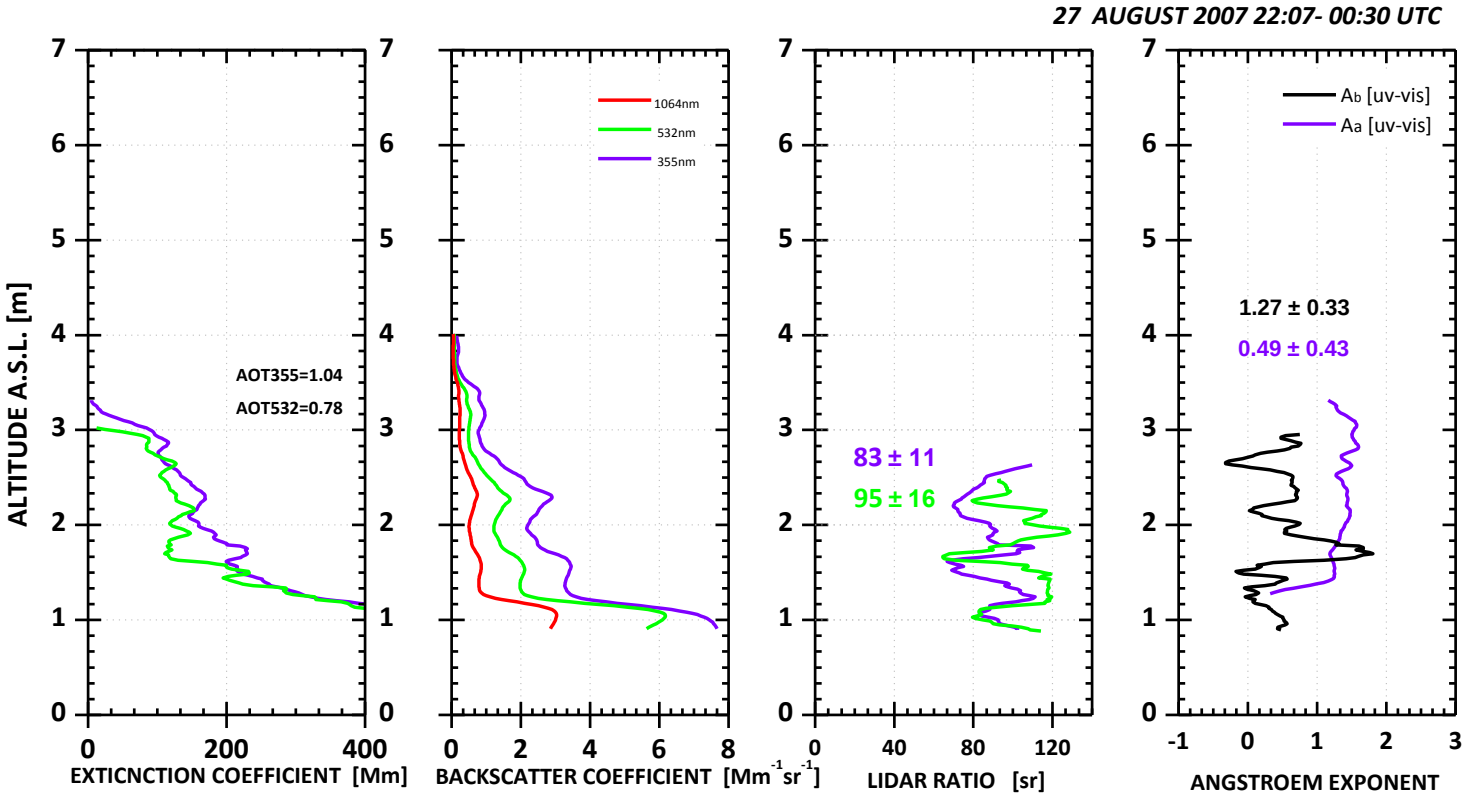


Possible intrusion of forest fires particles coming from East Mediterranean region.

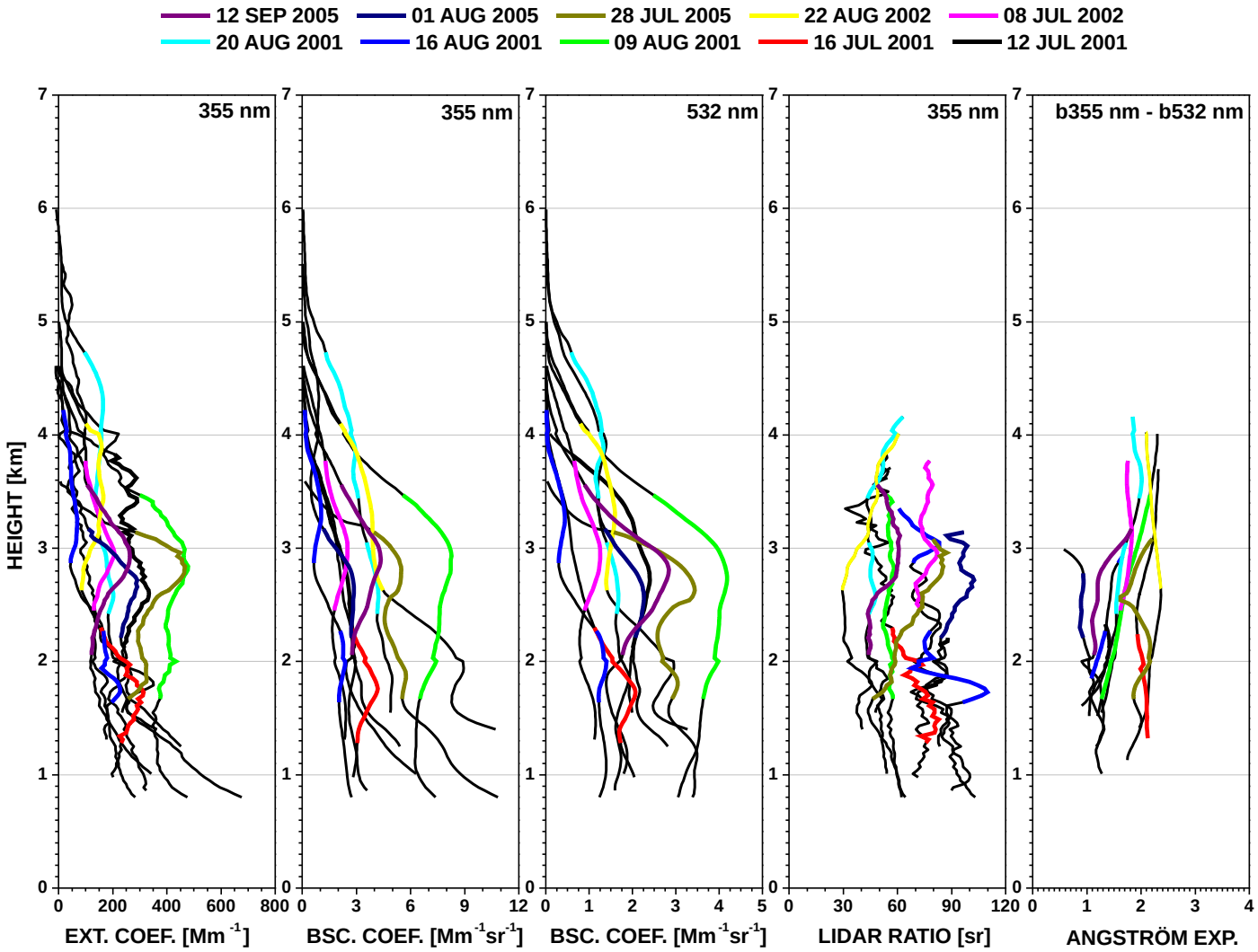
It is also possible a mixture with forest fires particles coming from North US –Canada

Detection very close to the source

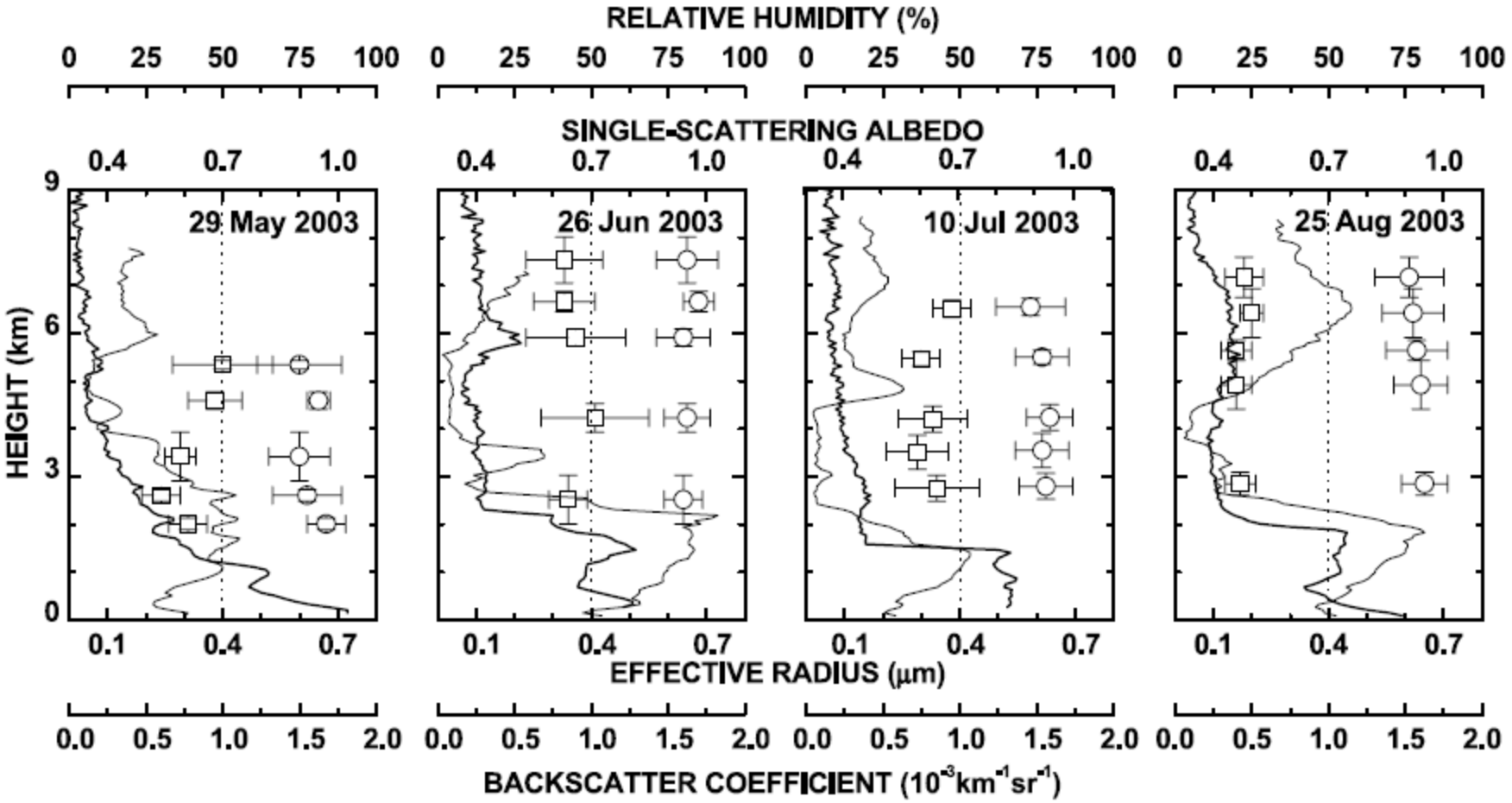
Athens
27-30 August 2007



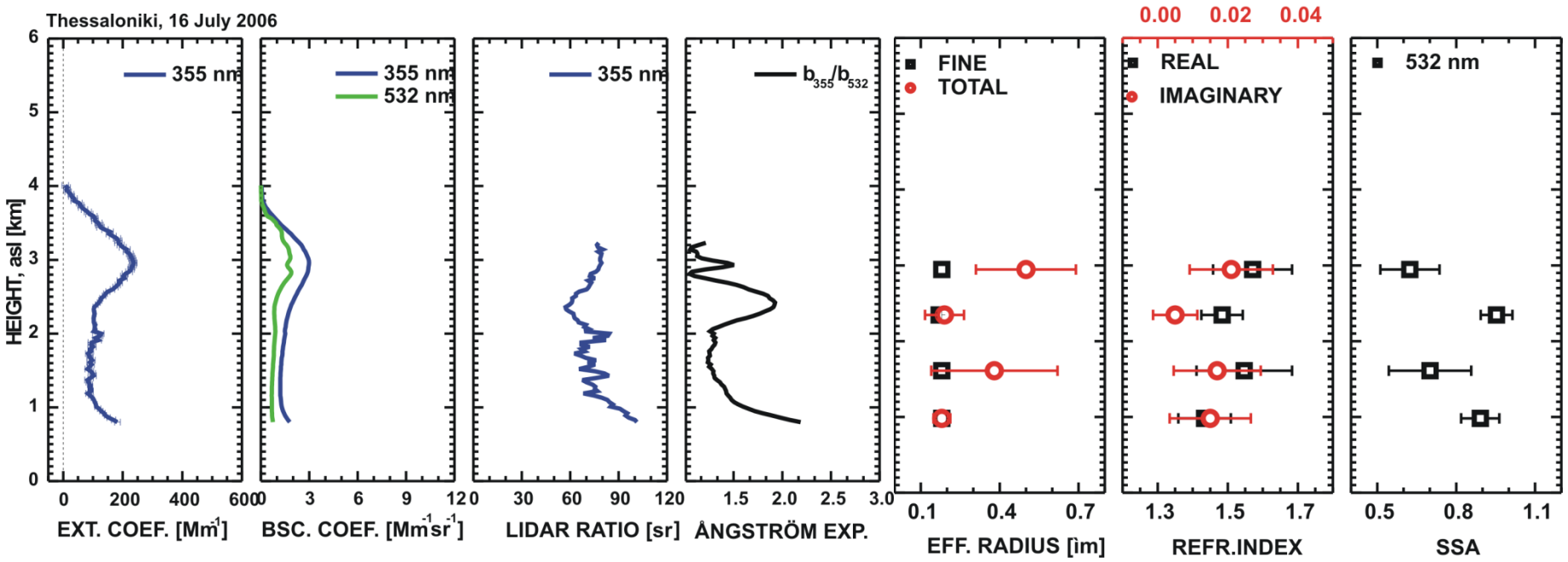
Wide range of optical properties for 10 smoke cases (identified with FLEXPART) over Thessaloniki (Amiridis et al., 2009)

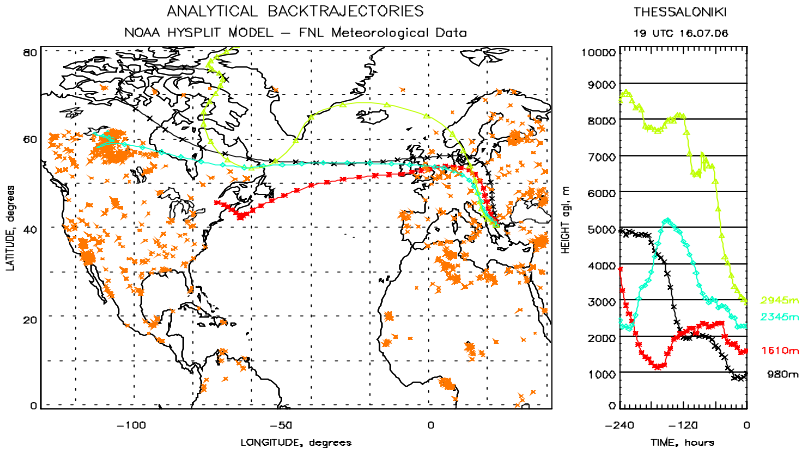


Microphysical retrievals for smoke within EARLINET



Muller et al. JGR, 2005

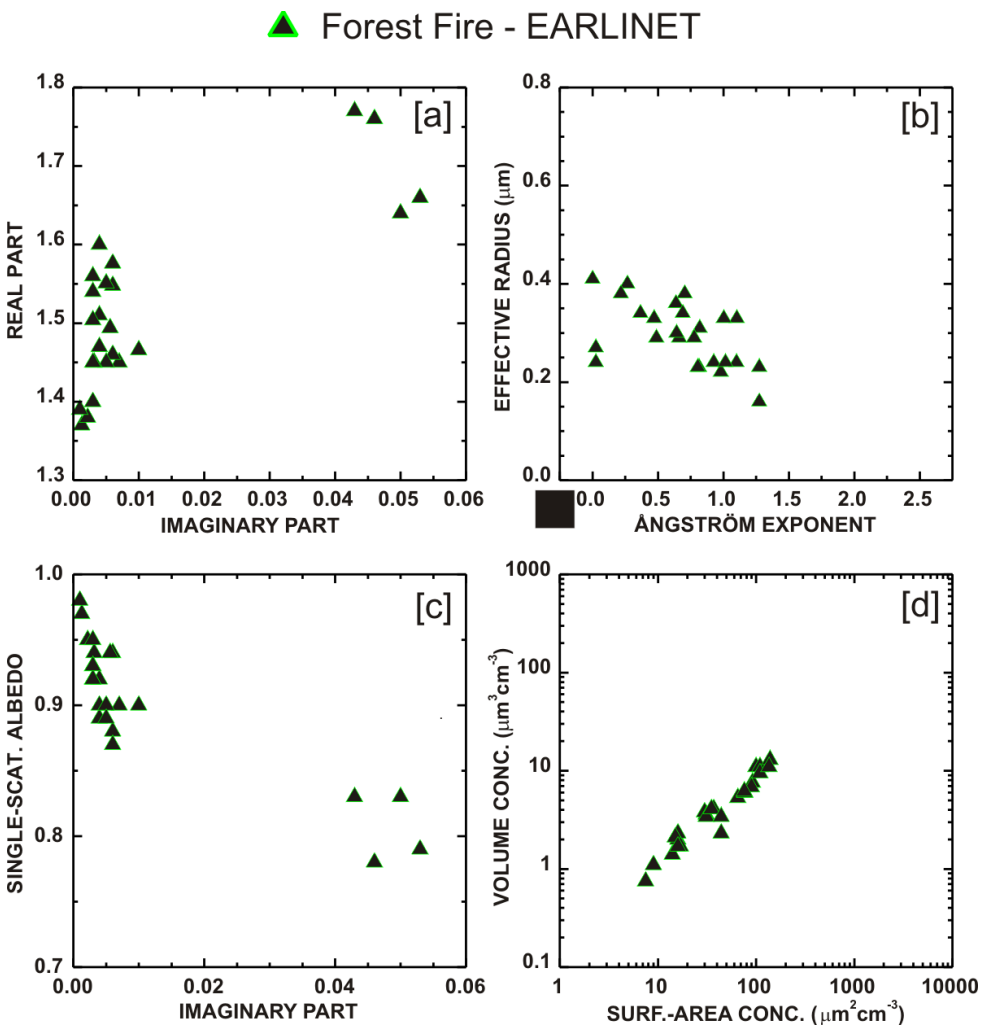




Balis et al., JGR, 2010

Variation of microphysical properties for smoke cases studied within EARLINET

The wide range of the values could be attributed on **the source type** or on **ageing** of the source plumes



Mueller et al. personal communication)

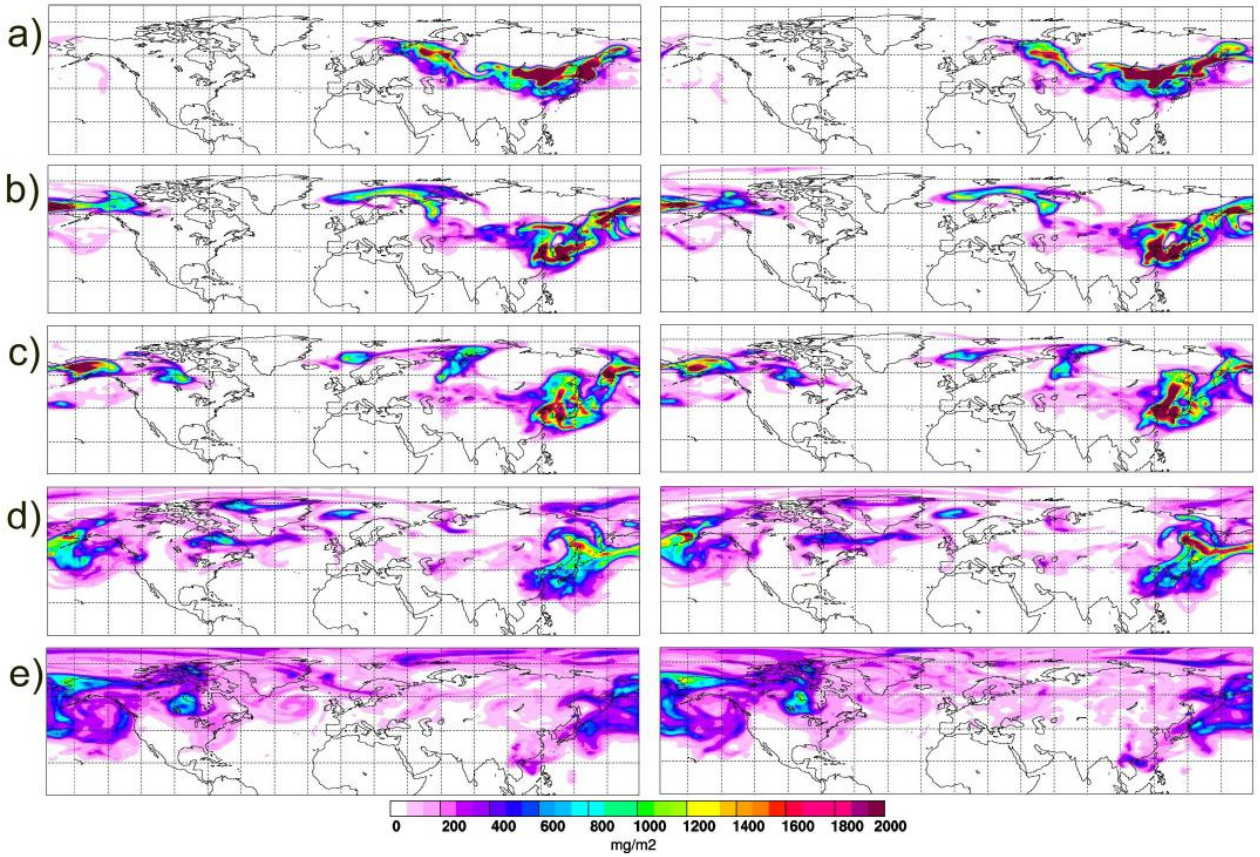
Possible differences in optical and microphysical properties due to the source?

Date	Region	Lidar Ratio	SSA	Aerosol Index	AOD @ 355nm	Ångstrom exponent	Color Index
12 Jul 2001	RAD	95	-	0.27	-	-	0.61
16 Jul 2001	RAD	75	0.96	-0.35	0.85	1.6	1.26
09 Aug 2001	RAD	57	-	0.86	1.52	1.3	1.33
16 Aug 2001	RAD	87	0.95	-0.53	0.62	1.3	1.29
20 Aug 2001	RAD	67	0.95	0.49	0.99	1.43	0.29
08 Jul 2002	RAD	72	0.99	0.29	0.51	1.1	0.26
22 Aug 2002	Portugal	46	-	-0.18	0.52	2.2	2.12
28 Jul 2005	RAD	55	0.98	-0.78	0.93	1.3	1.82
01 Aug 2005	RAD	85	0.95	-0.3	0.85	1.5	1.26
12 Sep 2005	Portugal	58	0.96	-1.51	0.7	1.2	1.57

Region	Lidar Ratio	SSA	AOD	Ångstrom	Color Index
RAD	**74 ± 14**	**0.96 ± 0.01**	**0.89 ± 0.32**	**1.36 ± 0.16**	**1.26 ± 0.36**
Portugal	**52 ± 8**	**0.96**	**0.61 ± 0.12**	**1.7 ± 0.7**	**1.84 ± 0.38**

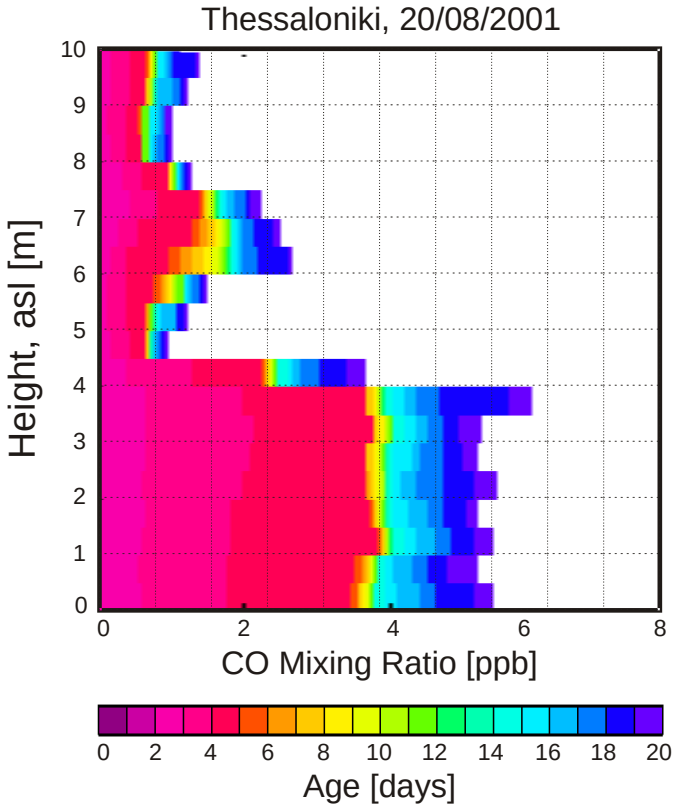
Smoke plumes can travel for many days in the free troposphere
(e.g. Damoah et al. ACP, 2004)

Simulated total CO columns (ECMWF and GFS)

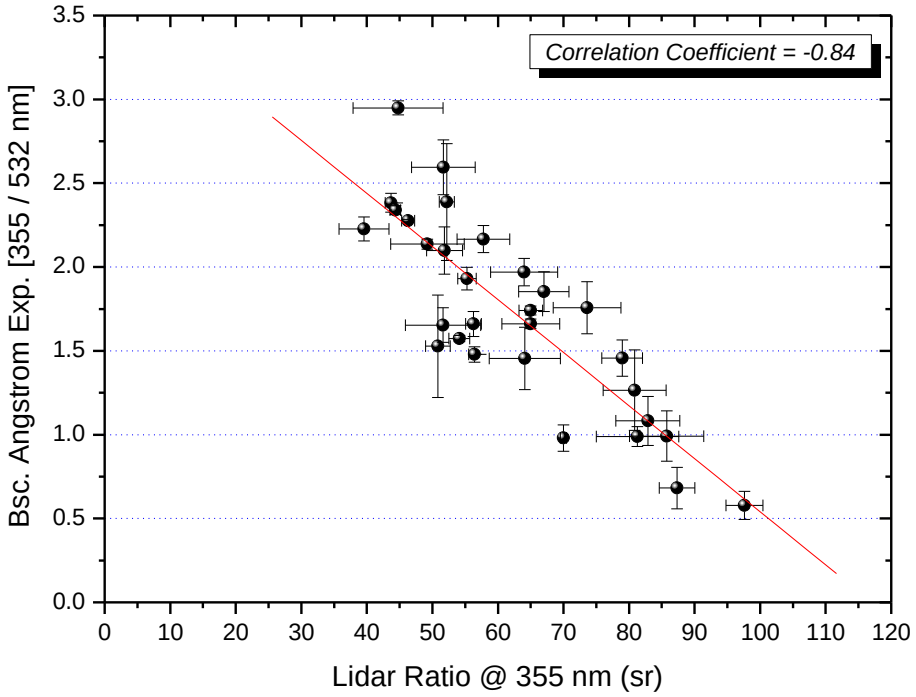


For the same source (e.g. Eastern Europe). The age of the travelling smoke plume should be the reason for the wide range of values.

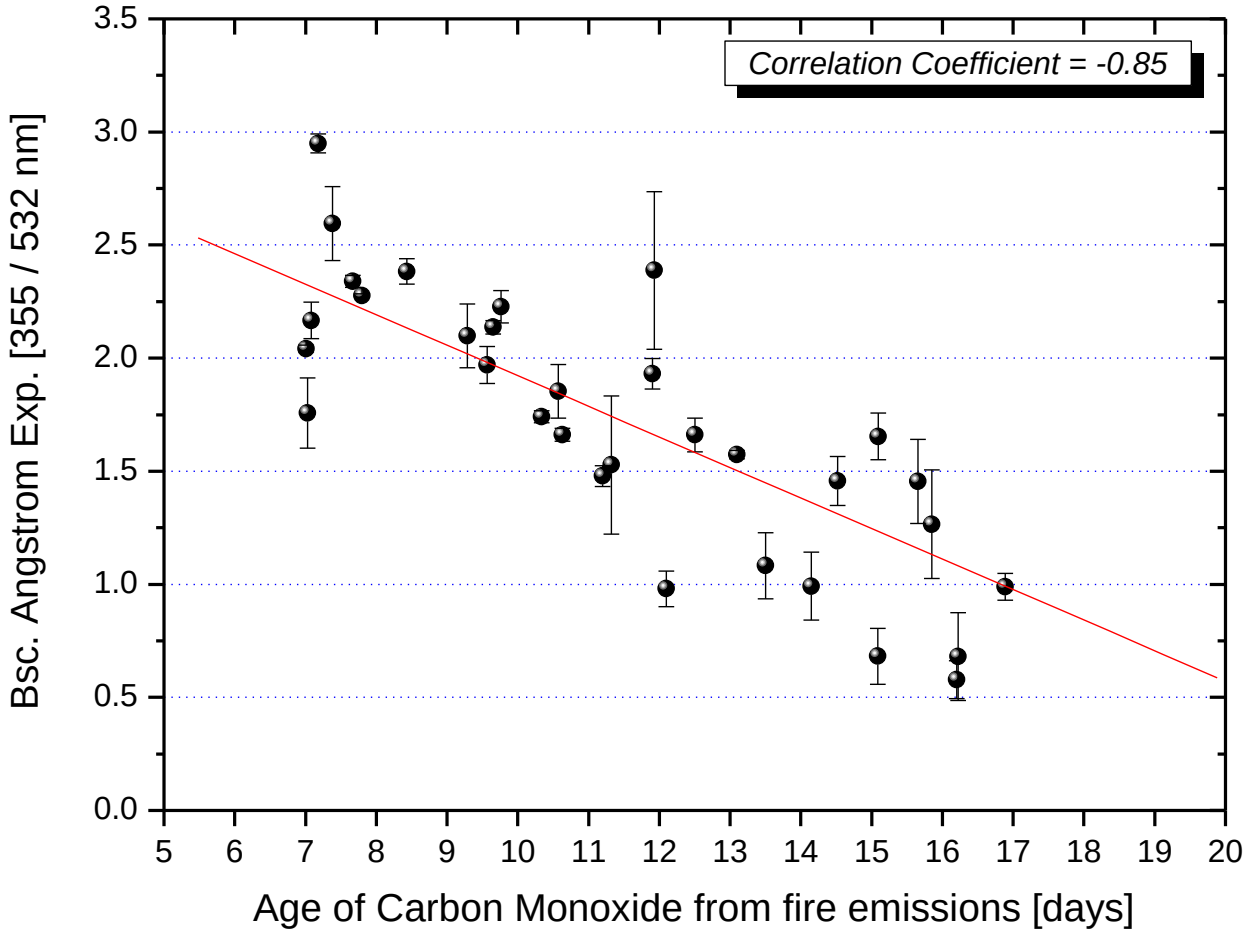
Use of CO age from FLEXPART to estimate the age of the smoke plume.
Model calculations were performed considering CO emissions only from fire hotspots detected by ATSR.

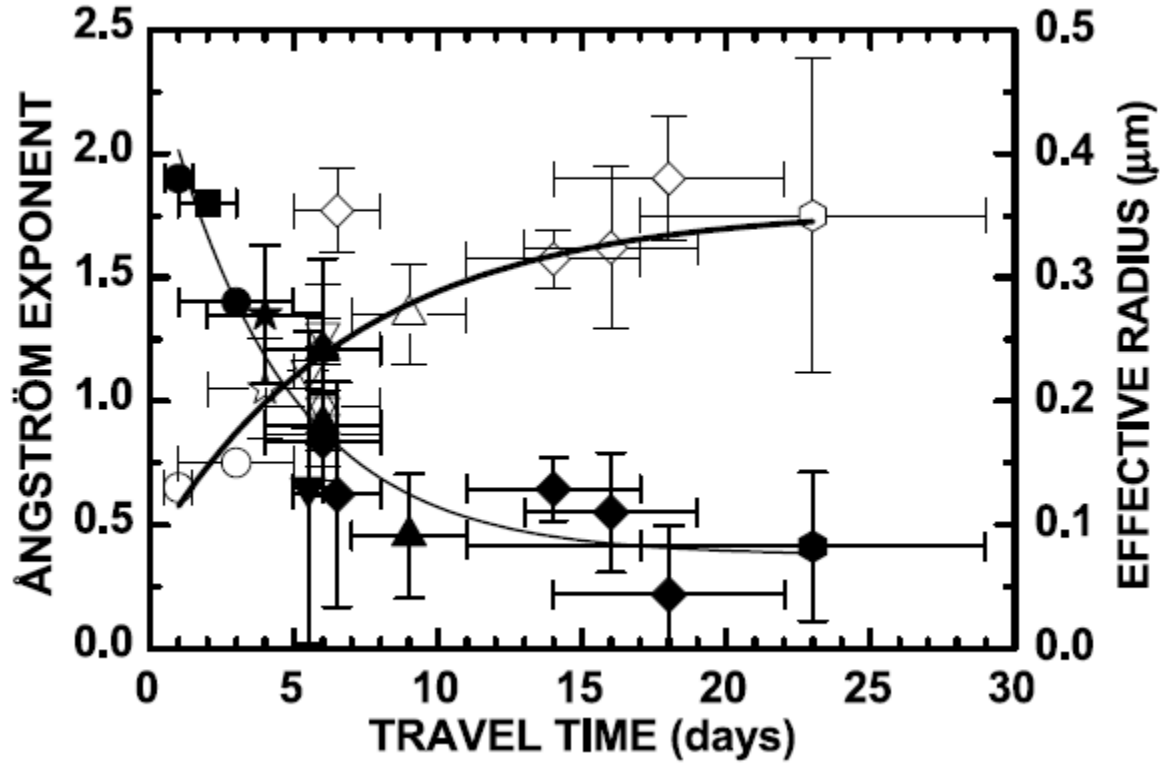


Vertical mean values of the backscatter related Ångström exponent calculated from the backscatter coefficients at 355 and 532 nm versus vertical mean values of the lidar ratio at 355 nm, calculated ***for the same height ranges of smoke presence***



Vertical mean values of the backscatter related Ångström exponent calculated from the backscatter coefficients at 355 and 532 nm versus weighted mean age of the carbon monoxide tracer, calculated for height ranges of smoke presence





Mueller et al., JGR 2007

Summary

- EARLINET stations are systematically affected by forest fires (Russia, Siberia, N. Canada, Portugal, regional ones)
- Smoke plumes can travel for many days in the free troposphere and can result to very high optical depths and extinction coefficients (1.7 and 400 Mm^{-1} respectively)
- Estimated optical and microphysical properties for smoke show a wide range of values (lr355=30-90 sr, lr532=40-100sr, lr355/lr532<1, $Å_{a(355/532)}$=0.5-1.5, r_{eff}=0.2-0.4 μm, ssa: the majority of cases 0.9-0.95)
- The ageing of the smoke plume and/or different source type can explain part of the observed variability

Thank you for your attention!