FIRST RESULTS OF AEROSOL MICROPHYSICAL PROPERTIES BY 3+2 RAMAN LIDAR AT EARLINET GRANADA STATION

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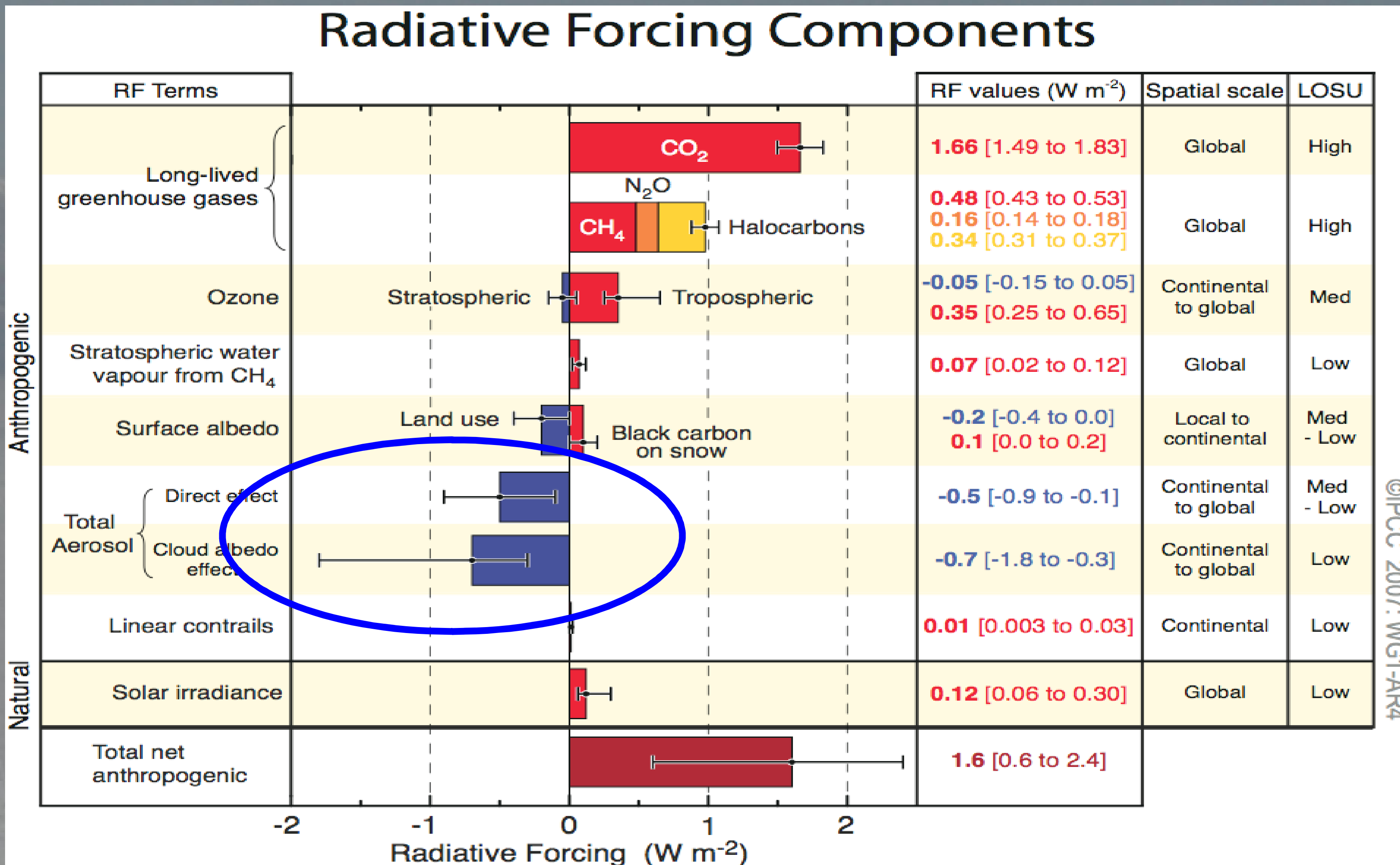
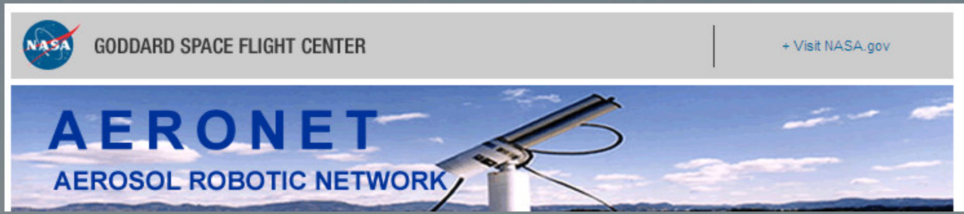
OTEM 2009 workshop
Bucharest, 1st October 2009

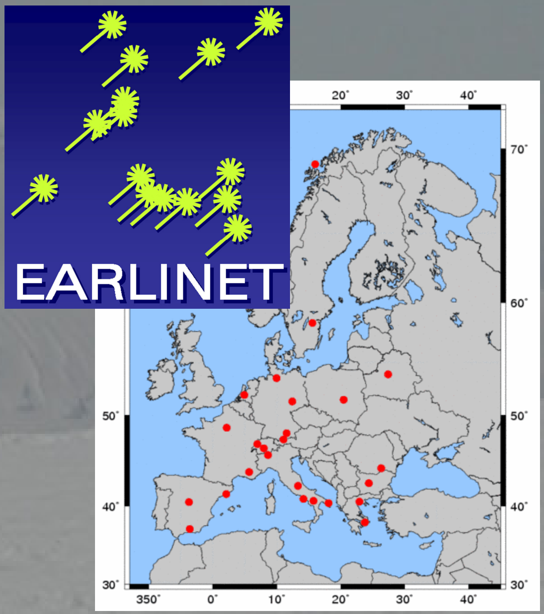
RADIATIVE FORCING GLOBAL AVERAGES IPCC2007



Aerosol radiative forcing remains as one of the largest source of uncertainty in the radiative forcing of Earth's climate



Start date: August 2004



Start date: April 2005

PASSIVE REMOTE SENSING INSTRUMENTATION

CIMEL CE 318 RADIOMETER

INSTRUMENTS IN AERONET and RIMA

Filters 340, 380, 440, 670, 870, 936, 1020 nm

IFOV 1.2°

Robotic System:

- Sun Photometer
- Sky Radiance:
  - Almucantar
  - Principal Plane

SUN PHOTOMETER RETRIEVAL PROCEDURE

δ_{A440}, δ_{A670}, δ_{A870}, δ_{A1020}

$R_{440}(\Theta)$, $R_{670}(\Theta)$, $R_{870}(\Theta)$, $R_{1020}(\Theta)$

SKYRAD.pack code Nakajima et al. (1996)

+

spheroids consideration following Olmo et al. (2006)

$v_c(r)$ from r_m= 0.05 μm to r_M = 10 μm

r_{eff}

m=n + ik
- **from n_m=1.33 to n_M=1.55**
- **from k_m=0 to k_M=0.01**

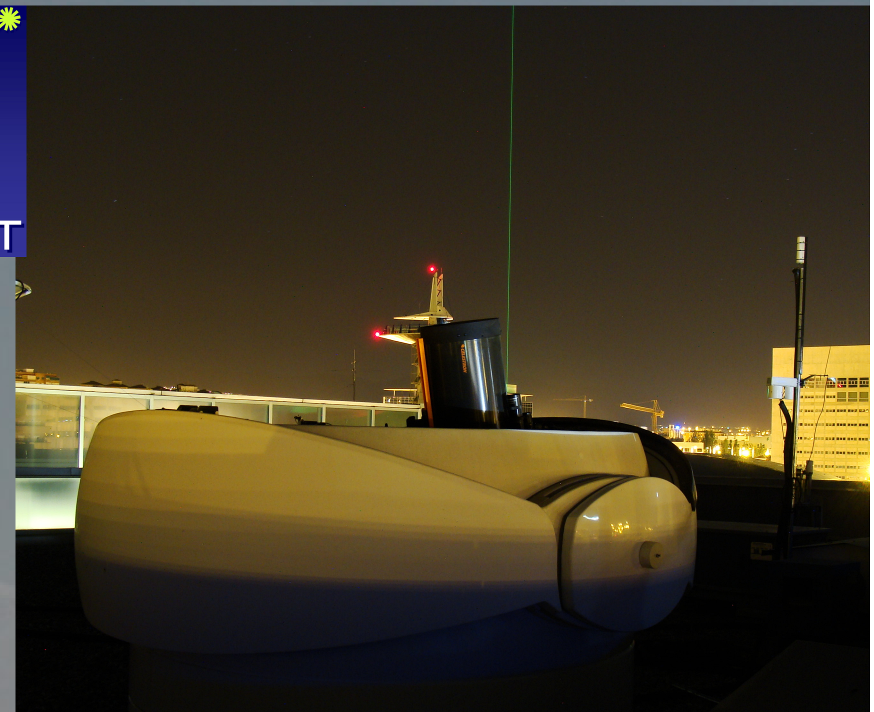
single scattering albedo, Phase function

T. Nakajima et al., Appl. Opt., 2672-2686, 1996

F. J. Olmo, et al., J. Q. S. R. T., 305-314, 2006

RAMAN LIDAR LR331D400

- Laser source: Nd:YAG
- Wavelenghts: 1064, 532 and 355 nm
- Energy/pulse: 110, 65, 60 mJ
- Receiving telescope: Cassegrain design



Detection channels:

elastic @ 1064 nm
elastic @ 532p nm (parallel polarization)
elastic @ 532s nm (cross polarization)
elastic @ 355 nm
Raman @ 408 nm (by water vapor)
Raman @ 387 nm (by atmospheric N_2)
Raman @ 607 nm (by atmospheric N_2)

LIDAR RETRIEVAL PROCEDURE

α_{355}, α_{532}

β_{355}, β_{532}, β_{1064}

Müller et al. (1999a, 1999b, 2001)
+
Veselovskii et al. (2002)

$v_c(r)$ from r_m= 0.04 μm to r_M = 5 μm

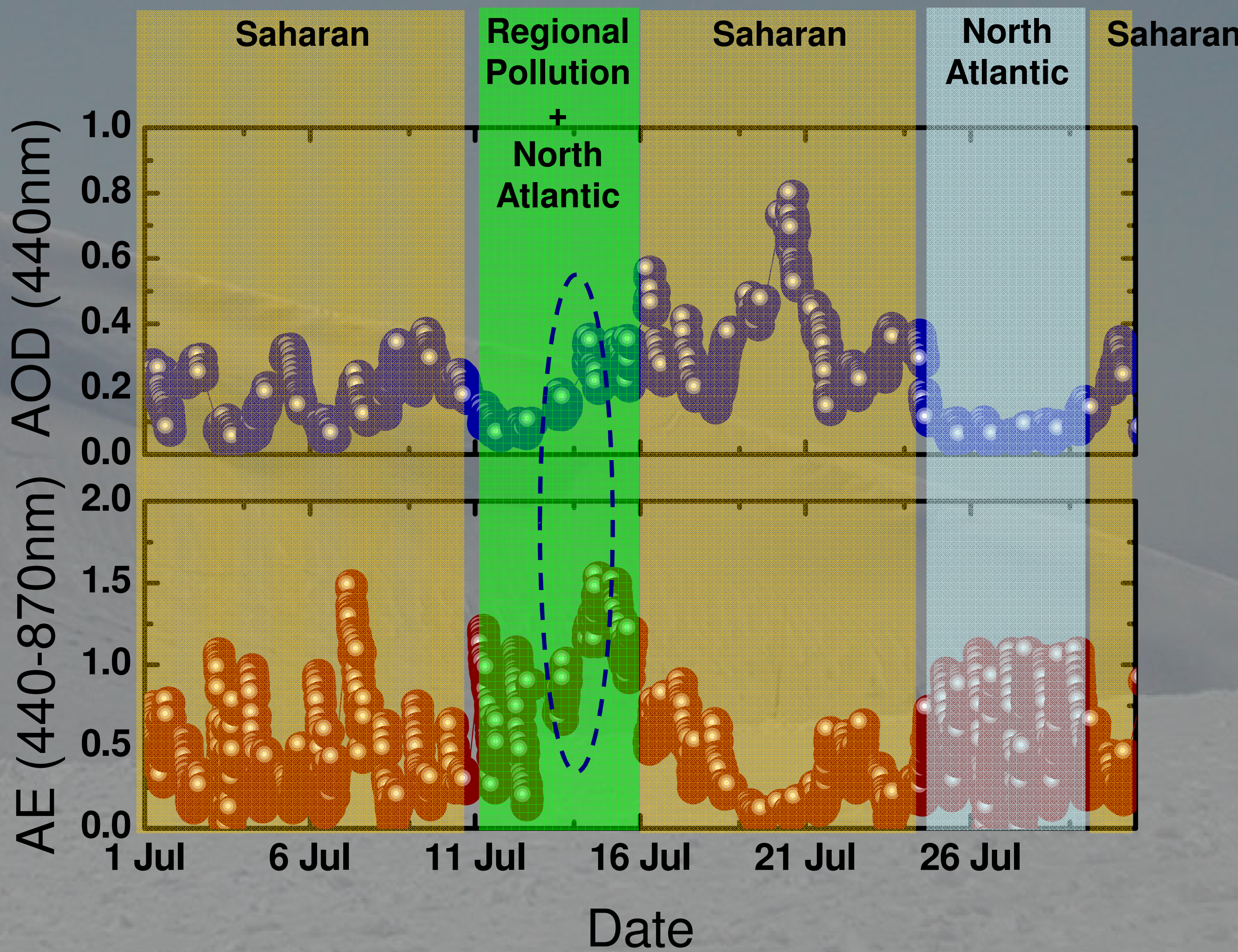
r_{eff}

m=n + ik
- **from n_m=1.325 to n_M=1.8**
- **from k_m=0 to k_M=0.05**

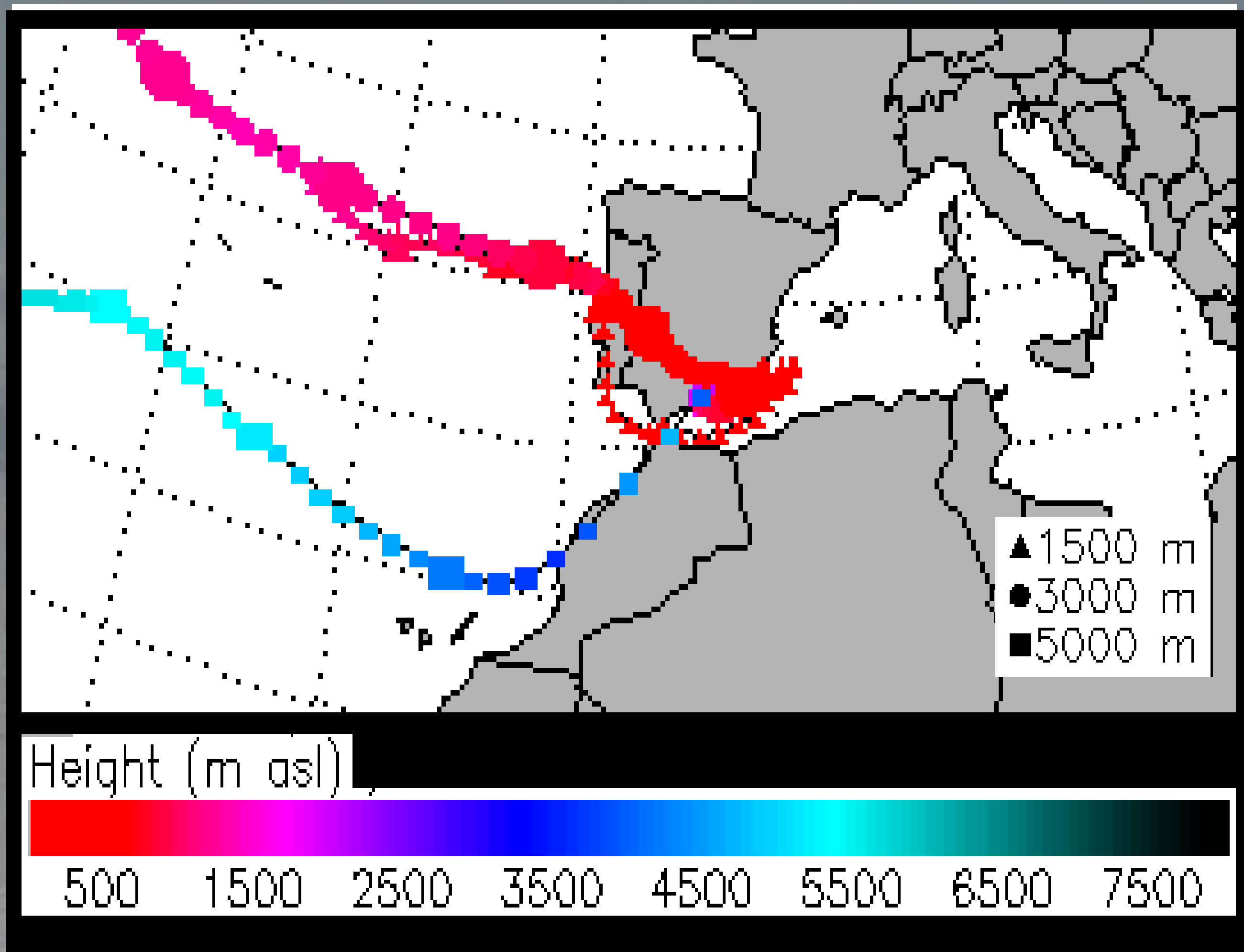
single scattering albedo

D. Müller et al., Appl. Opt., 38, 2346-2357, 1999
D. Müller et al., Appl. Opt., 38, 2358-2368, 1999
D. Müller et al., Appl. Opt., 40, 4863-4869, 2001
I. Veselovskii I., Appl. Opt., 41, 3685-3699, 2002

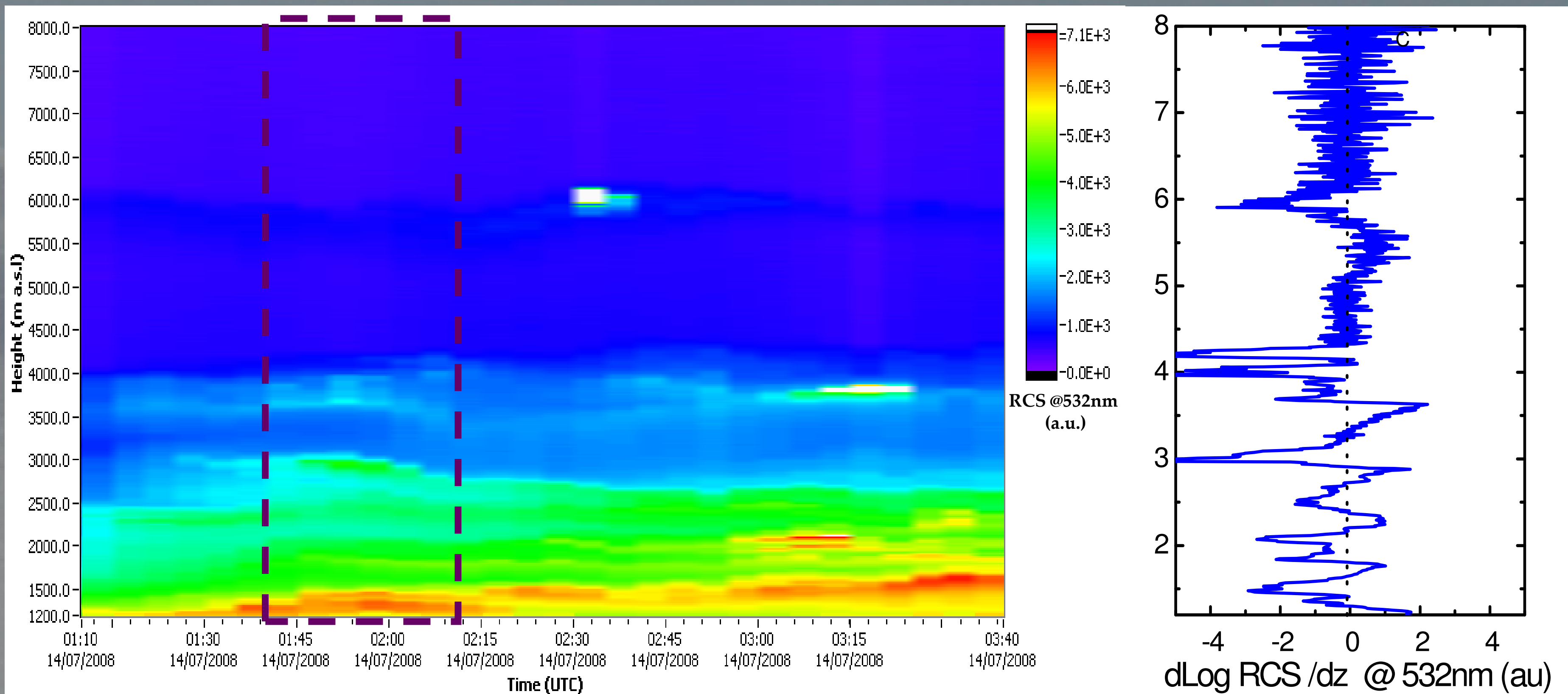
OPTICAL DATA SERIES IN JULY 2008 BY CIMEL SUN-PHOTOMETER



AIR MASS ORIGIN



OPTICAL PROPERTIES BY 3+2 RAMAN LIDAR



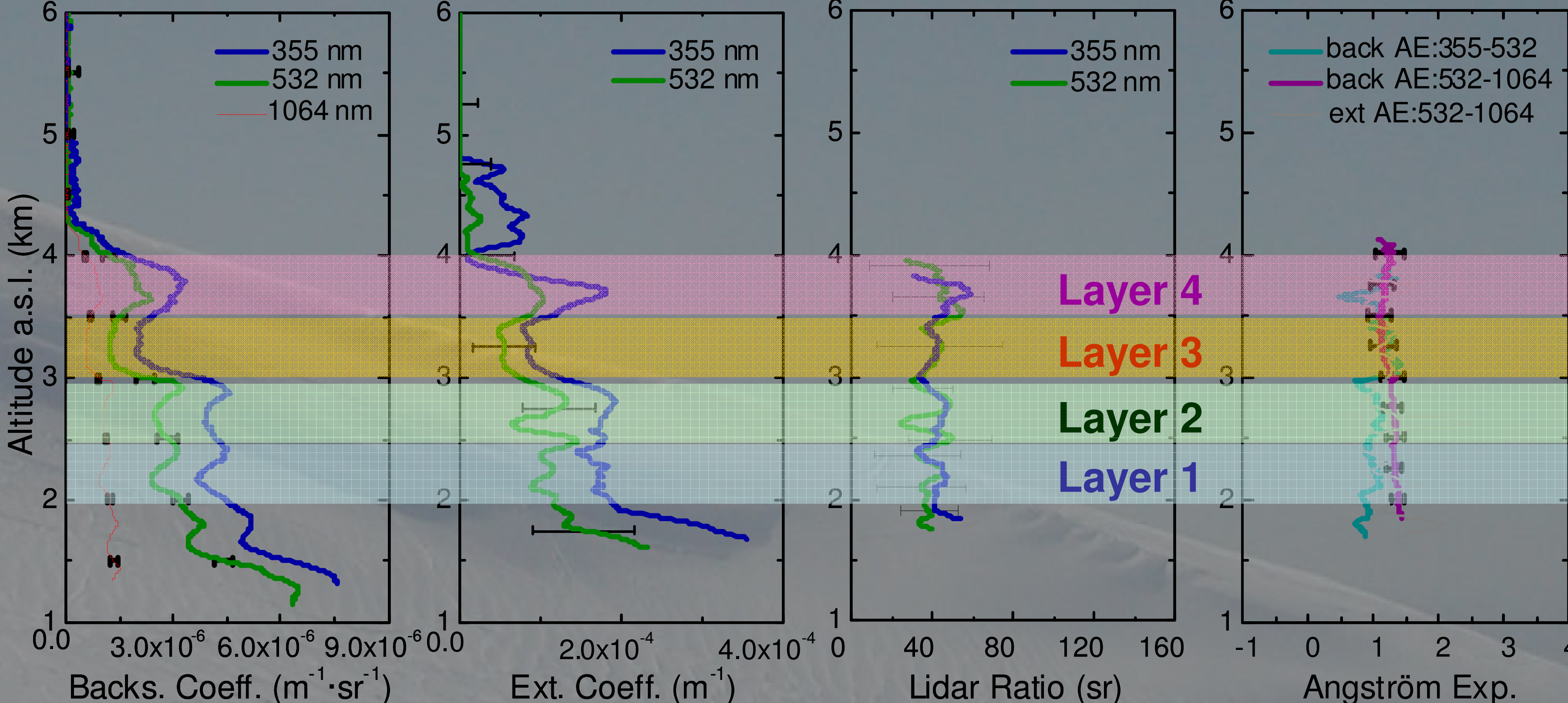
Selected period:

-atmospheric stability

-cloud free

OPTICAL PROPERTIES BY 3+2 RAMAN LIDAR

01:40-02:10 14/07/2008



Lidar computations					
Layer km (a.s.l.)	**AE back 355-532**	**AE back 532-1064**	**AE ext 355-532**	**Lr 355 nm (sr)**	**Lr 532 nm (sr)**
2.0-2.5	0.97 ± 0.09	1.34 ± 0.03	1.08 ± 0.31	40 ± 5	41 ± 4
2.5-3.0	1.00 ± 0.12	1.31 ± 0.03	1.31 ± 0.52	38 ± 8	43 ± 4
3.0-3.5	1.22 ± 0.12	1.16 ± 0.06	1.15 ± 0.18	41 ± 4	40 ± 3
3.5-4.0	0.98 ± 0.22	1.17 ± 0.05	--	43 ± 9	36 ± 19

AE_{Cimel} (380-500nm):

1.15-1.40

MICROPHYSICAL PROPERTIES: COMPARISON WITH SUN-PHOTOMETER RETRIEVALS

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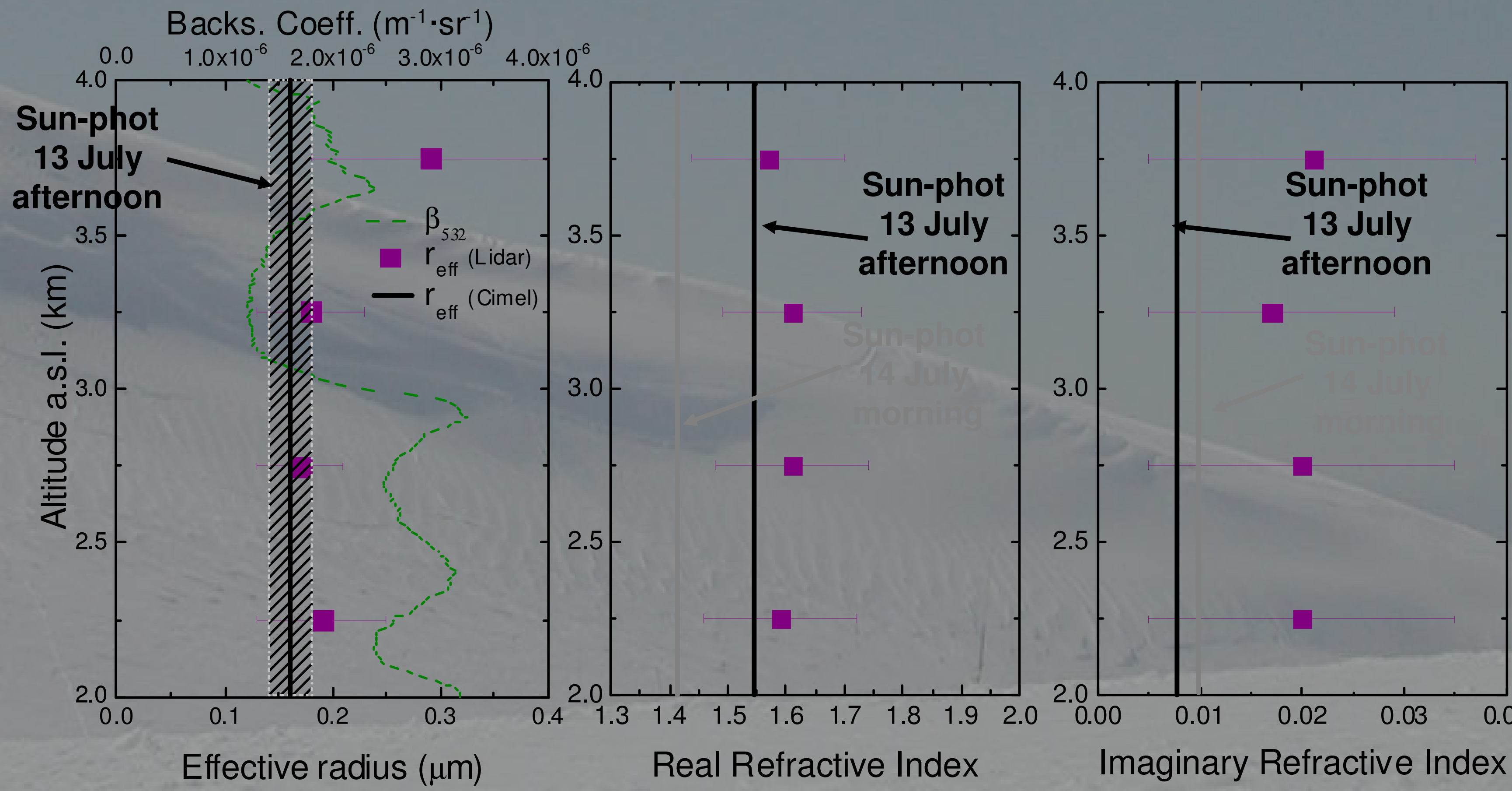
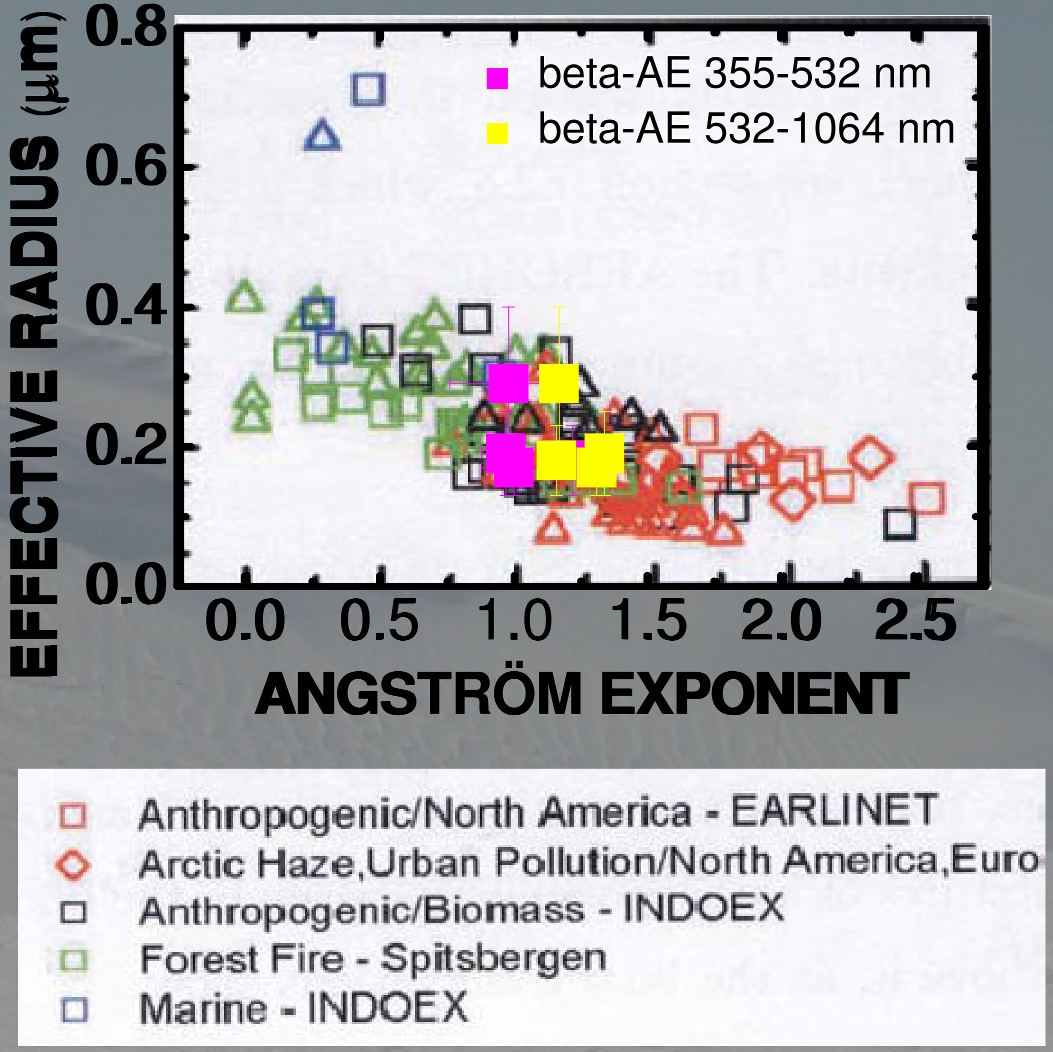
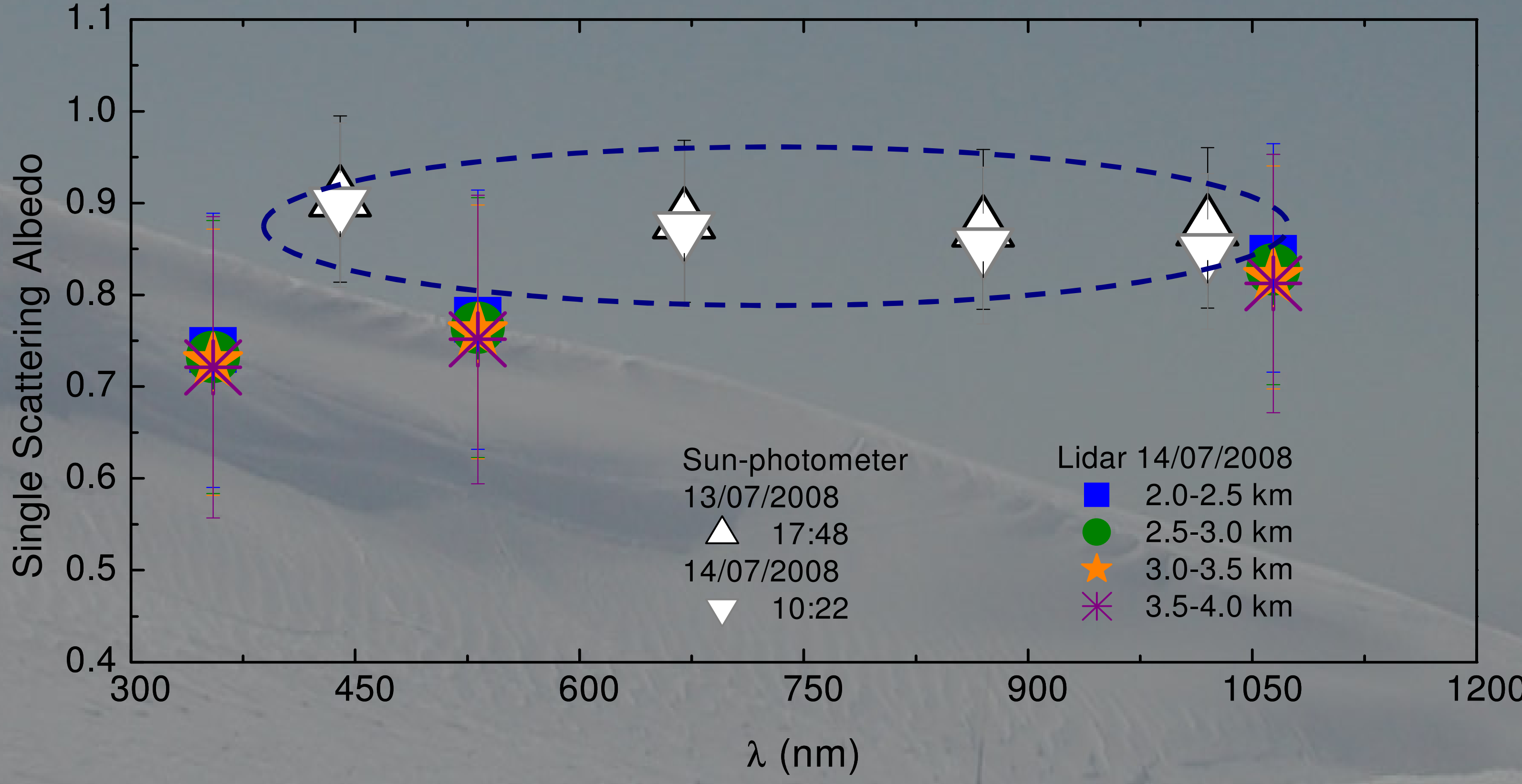


EFFECTIVE RADIUS VERSUS ANGSTRÖM EXPONENT



Habilitation, Detlef Müller, 2007

SSA: COMPARISON WITH SUN-PHOTOMETER RETRIEVALS



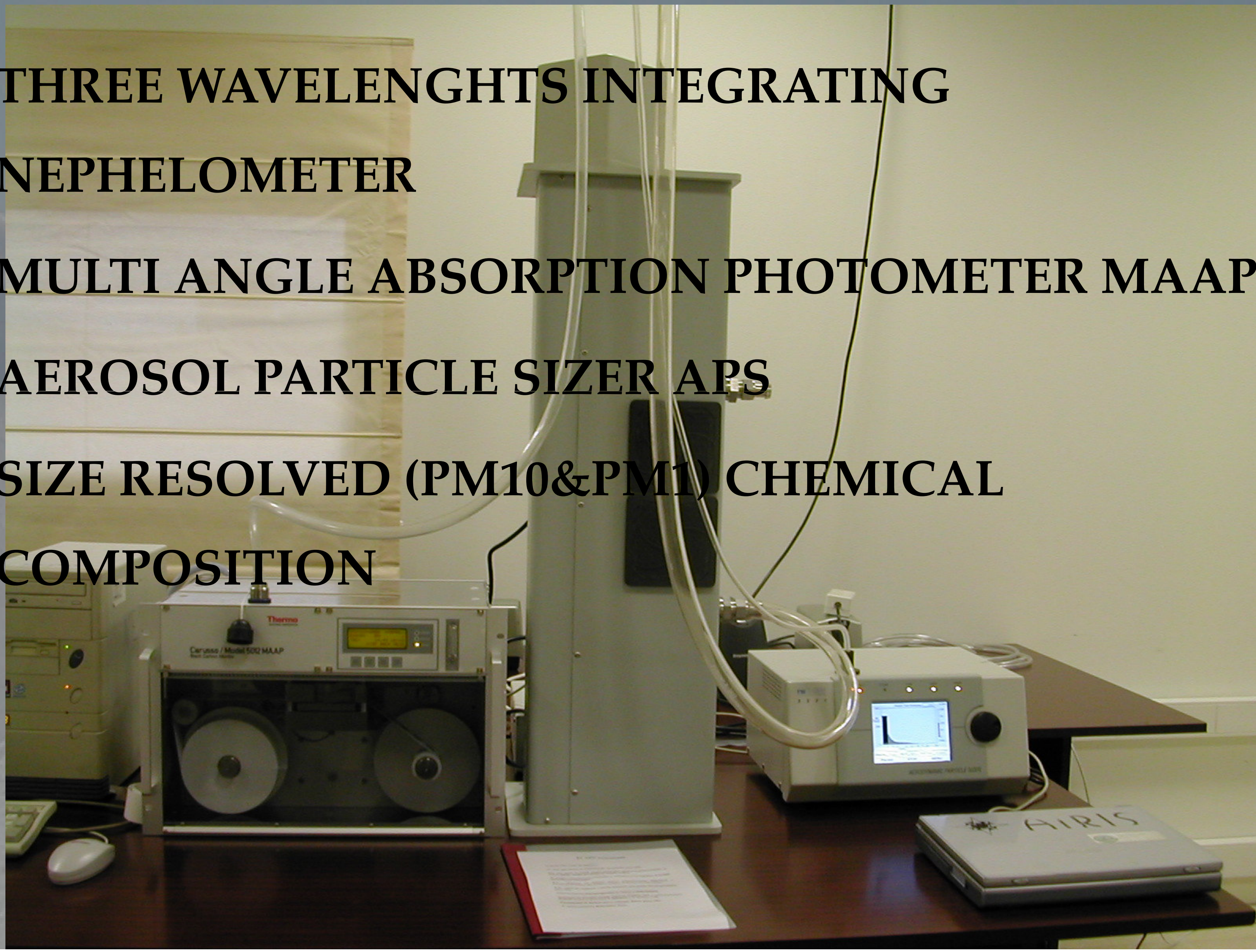
Similar values for layers (2.0-4.0 km)

Columnar values slightly larger than those in layers

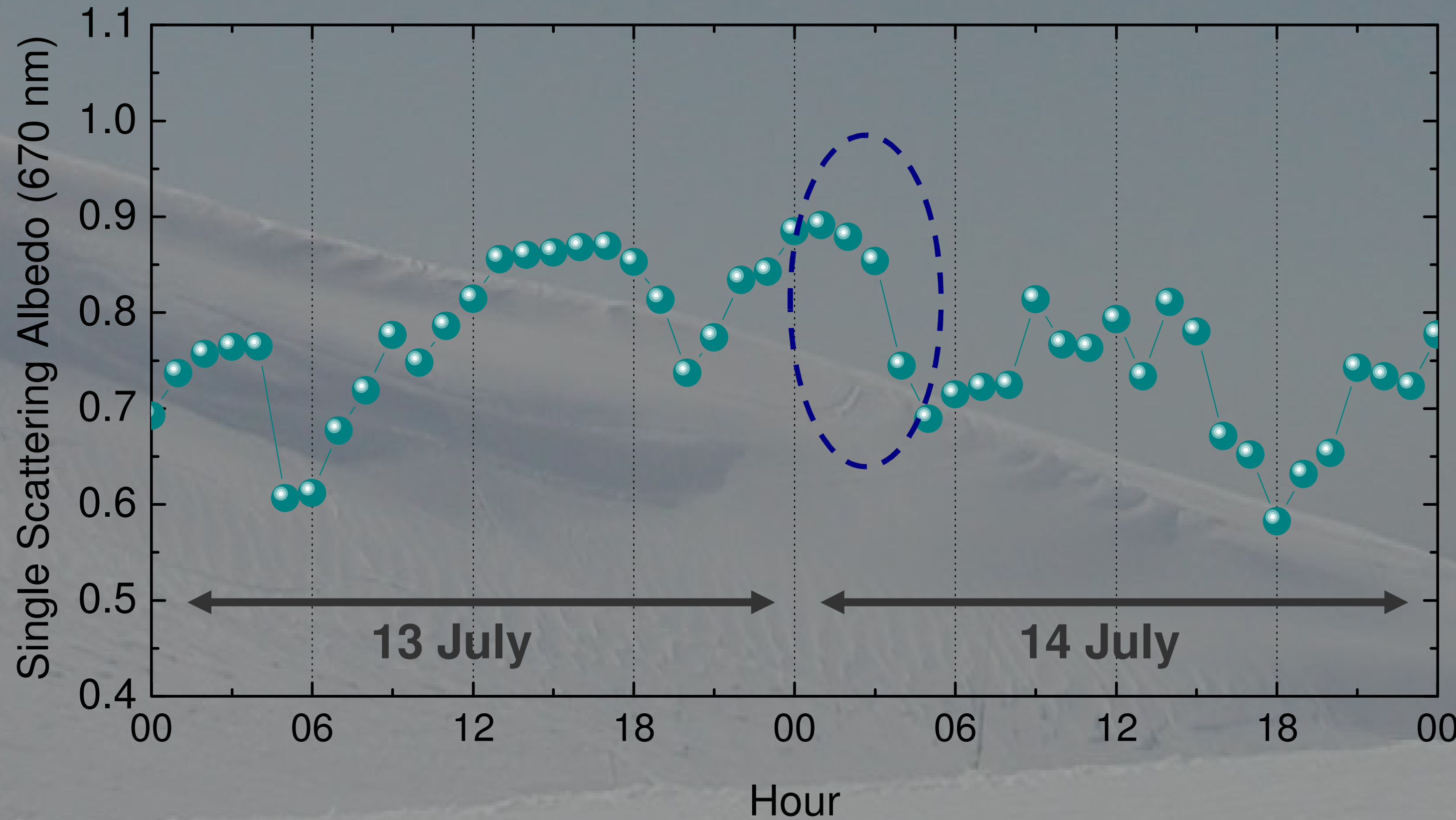
Differences between lidar and sun-photometer are due to the different time: connection to surface boundary layer

IN SITU MEASUREMENTS AT THE SURFACE BOUDARY LAYER

- THREE WAVELENGHTS INTEGRATING NEPHELOMETER
- MULTI ANGLE ABSORPTION PHOTOMETER MAAP
- AEROSOL PARTICLE SIZER APS
- SIZE RESOLVED (PM10&PM1) CHEMICAL COMPOSITION



TEMPORAL EVOLUTION OF SSA: IN SITU MEASUREMENTS



Single scattering albedo determined by TSI nephelometer and Multi Angle Absorption Photometer (MAAP)

CONCLUSIONS

- The approach presented in this study has shown the great potential that the combination of Raman lidar and sun-photometer measurements provides to investigate the relevant properties of atmospheric pollution

- For this study case, we found lidar ratios around 40 sr at 355 and 532 nm with low spectral dependence, mean Angström exponents between 1.04-1.25 for the different spectral ranges

- We also successfully retrieved the climate-relevant microphysical parameters as effective radius and single scattering albedo for this study case. Mean values of the effective radius ranged between 0.17-0.19 μm in most sections of the profile, the mean single scattering albedo varied between 0.72-0.84 at the lidar wavelengths

- Such advanced Raman lidar is an essential tool for characterization of the complex vertical distribution of aerosol particles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… thank you for your attention