PARTICULATE MATTER OPTICAL PROPERTIES DETERMINED IN A FEW SITES OF BUCHAREST

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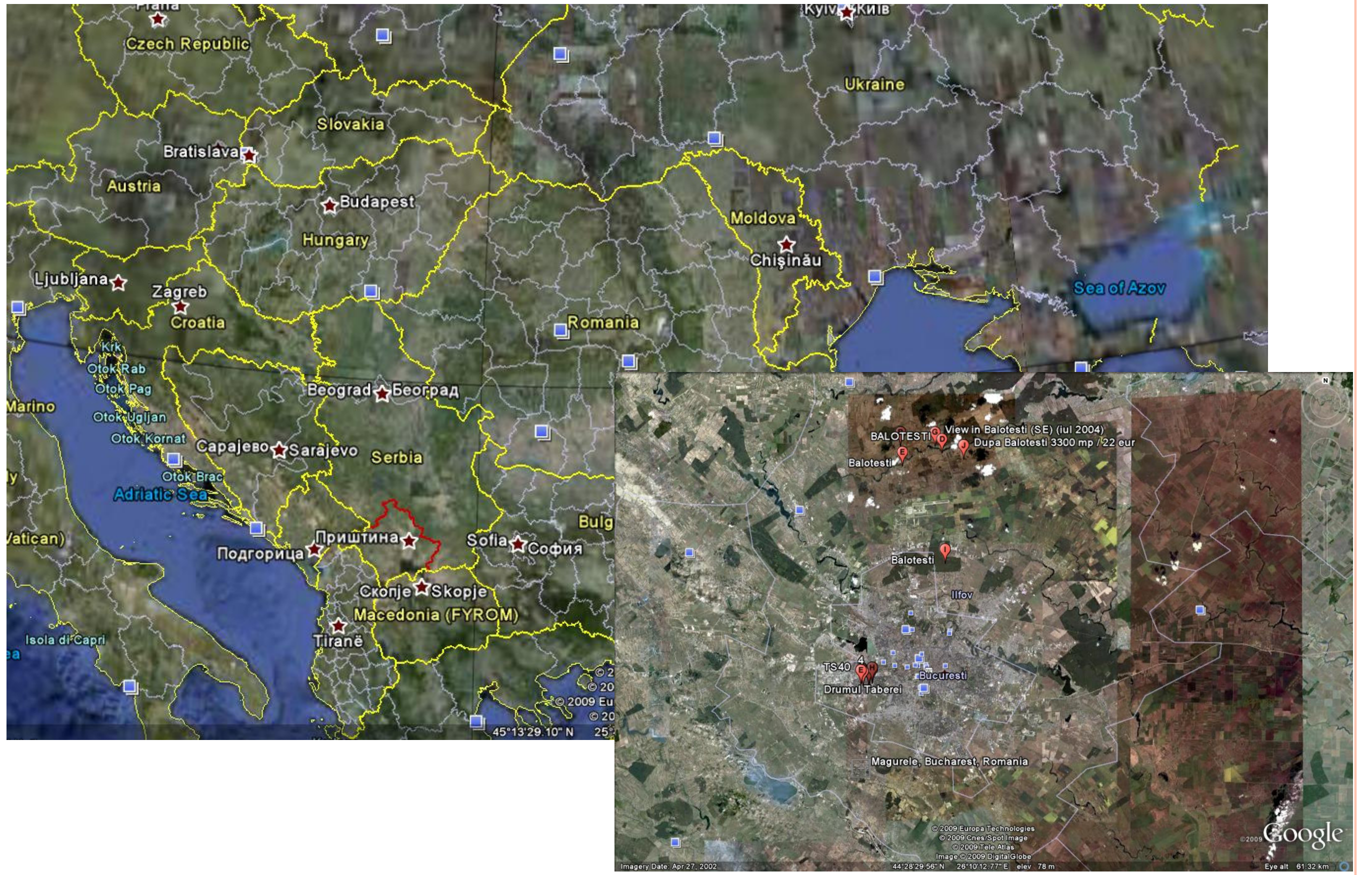
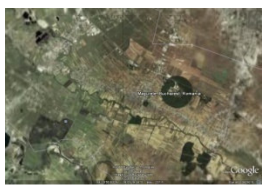


Outline

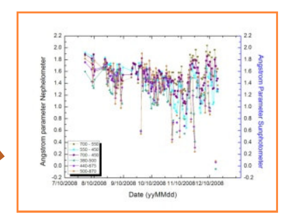
Particulate matter importance



The analyzed sites

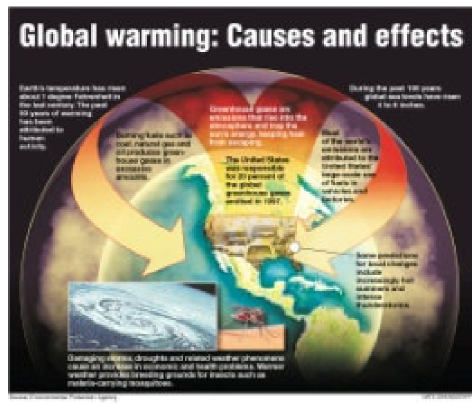
OPAC

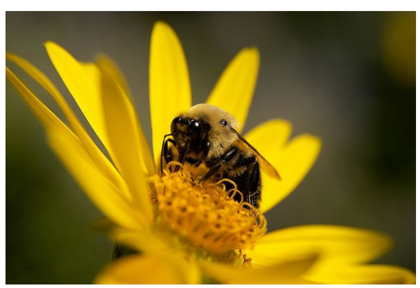
Methods: observational data and simulated data



Results

Particulates matter (aerosols) are one of the largest sources of uncertainty in the Earth radiation budget (IPCC, 2007) due to their different properties. It affect the global climate changes and people health.

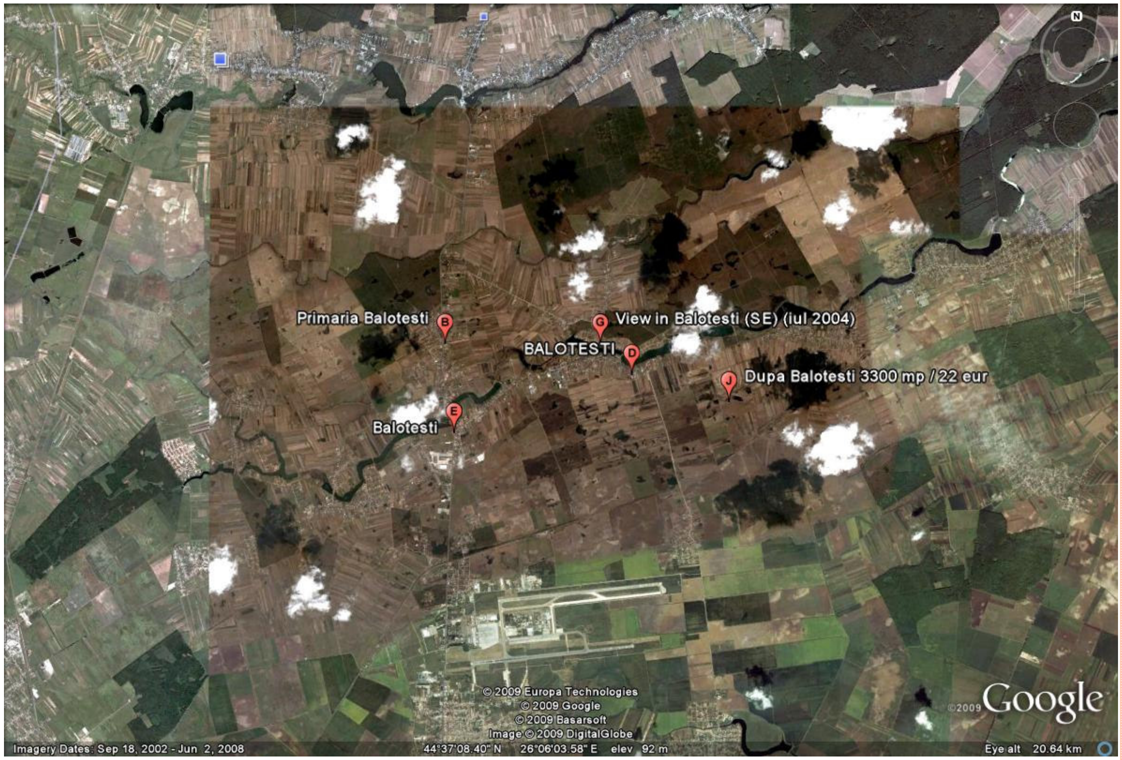




The aim of the present work is to obtain aerosol physical and optical properties that allow evaluation of the direct climate forcing at surface for different sites of Bucharest area: Magurele, Drumul Taberei and Balotesti.

Balotesti (44° 31' 56.07 N and 26° 07' 23.96 E) – continental clean.

- It has very low anthropogenic influences.
- It's an agriculture region → dust



Magurele (44° 21' N and 26° 2' E) – continental average

It has agriculture regions → dust.

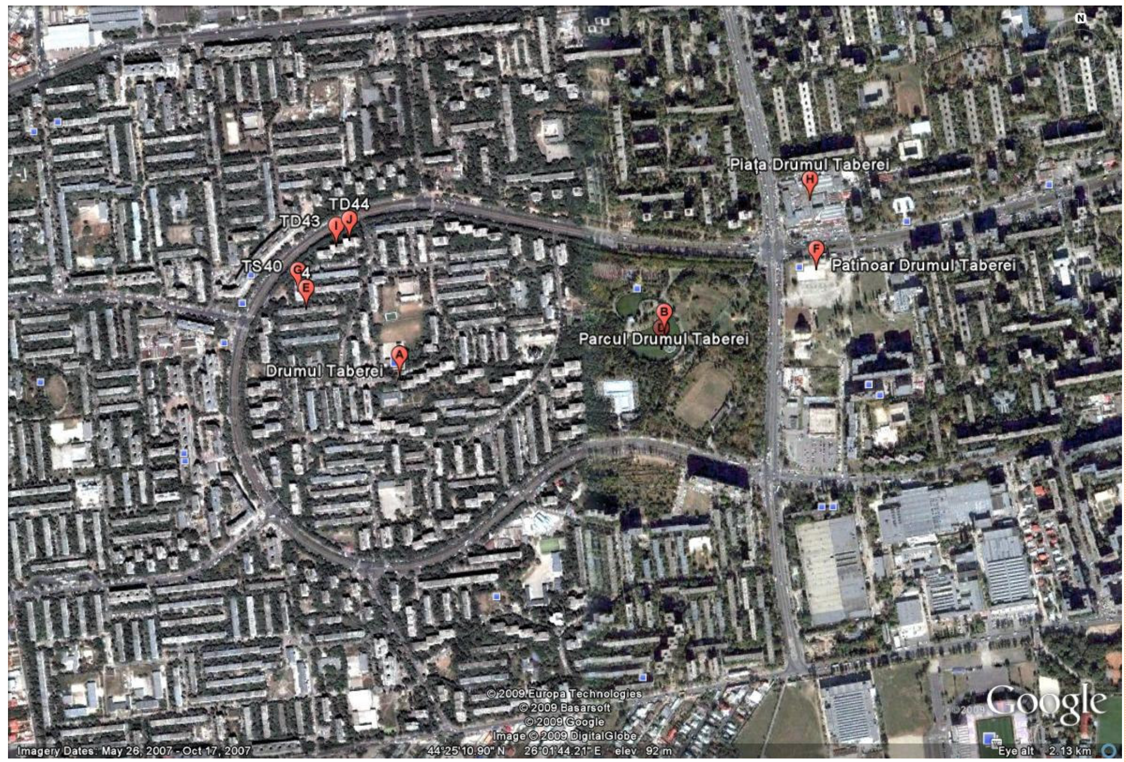
The southern part of Bucharest with power plants → aerosols and trace gases emissions.

The rapid growth of economic activity → fossil / fuel combustion.

Drumul Taberei (44° 25' 17.29” N and 26° 2' E) – continental polluted.

Intense traffic →
fossil / fuel combustion: nitrogen dioxide (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), $PM_{2.5}$ etc.

Electricity generation (power plants), etc.



Methods

OPAC soft
(Hess, 1998)
+
Gravimetric system

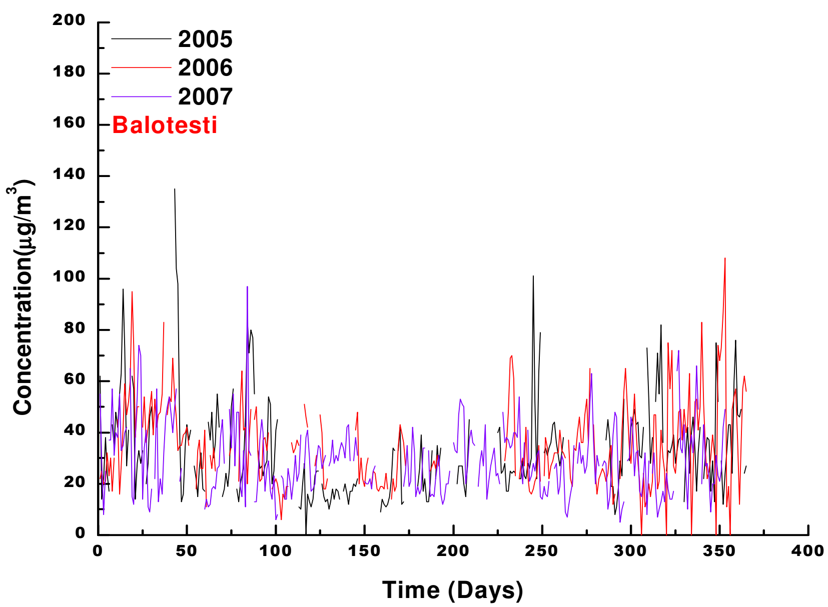
$$\alpha = \ln(\tau_{a1}/\tau_{a2})/\ln(\lambda_2/\lambda_1)$$

$$\tau_a = \beta\lambda^{-\alpha}$$

- Particulate matter concentration (PM10, PM2.5)
- Angstrom Parameter
- Aerosol Optical Depth
- Single scattering albedo
- Radiative forcing
- The backscattering coefficients for 3 wavelengths: 450 nm, 550 nm, 700 nm

Analysis period:
2005, 2006, 2007
July - December 2008

PM Optical Properties
2005, 2006, 2007 PM10 Concentrations for Rural and Urban Sites



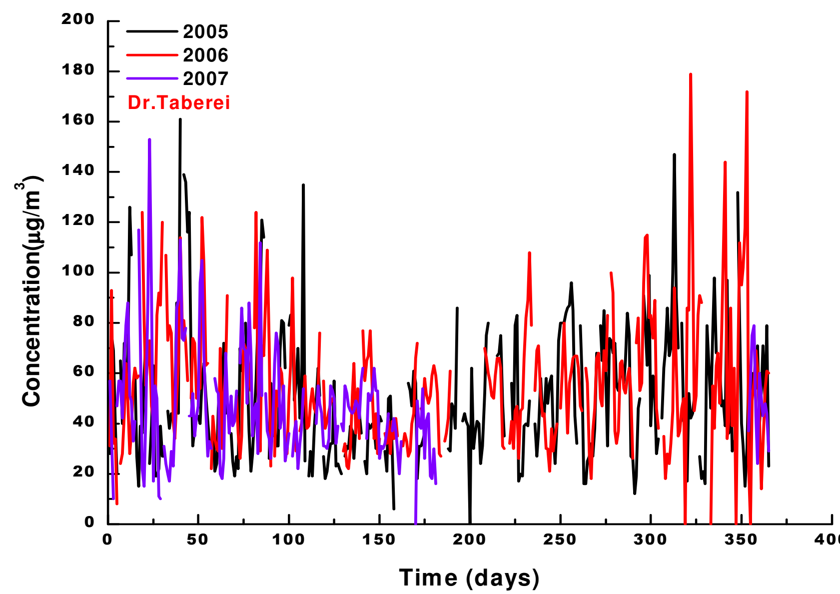
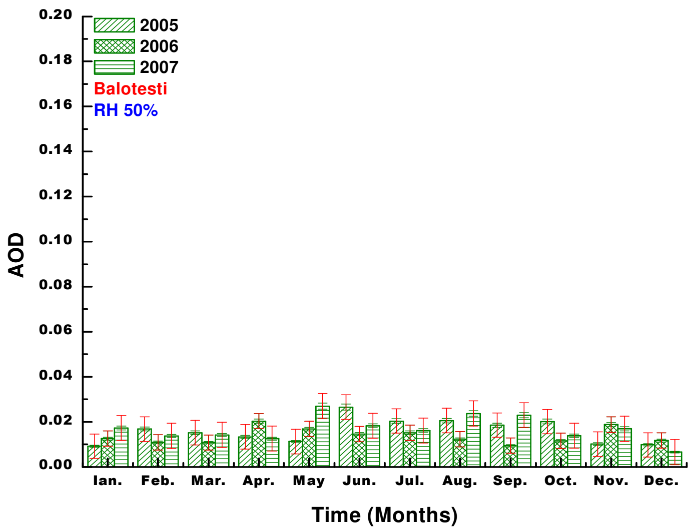
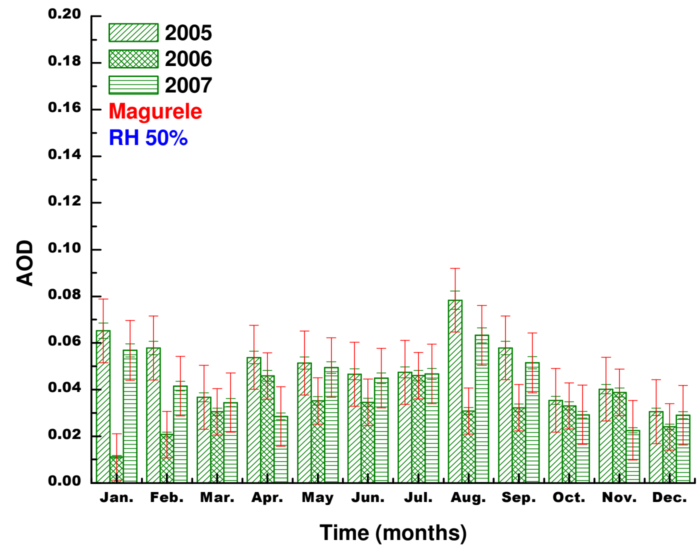


Figure 1. Daily concentrations of PM10 at Balotesti (rural) and Drumul Taberei (industrial) for the three years (2005-2007).

PM Optical Properties
2005, 2006, 2007 AOD for Rural (Balotesti), Urban (Drumul Taberei) and Suburban (Magurele) Sites





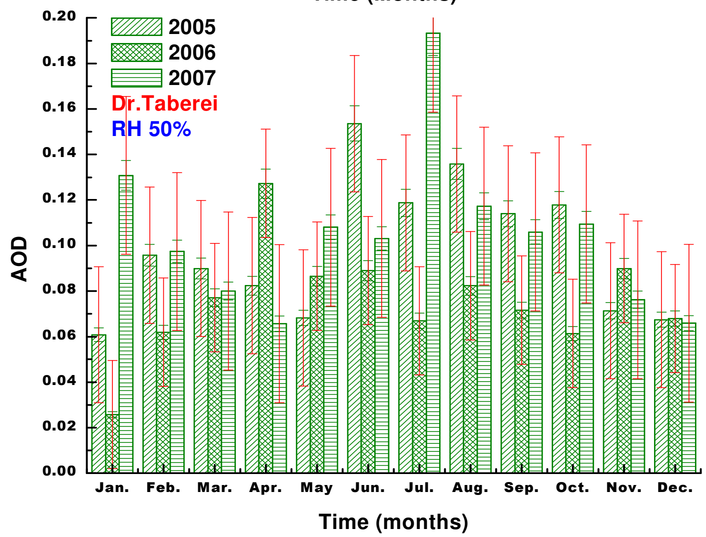
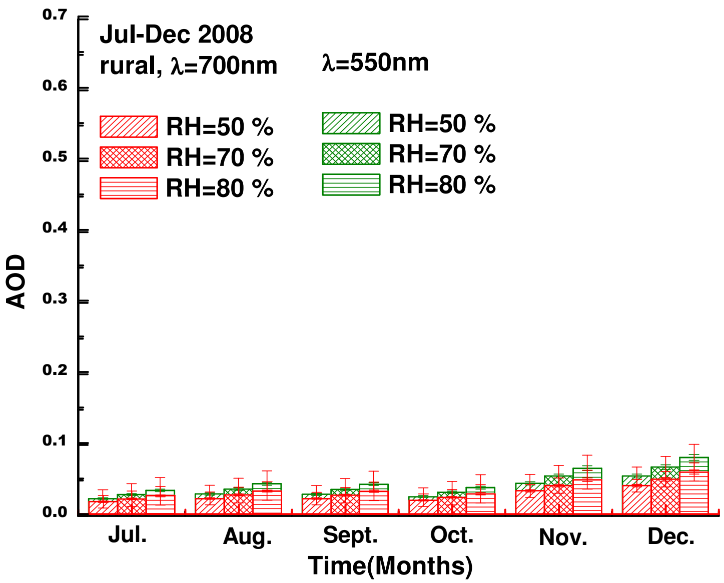
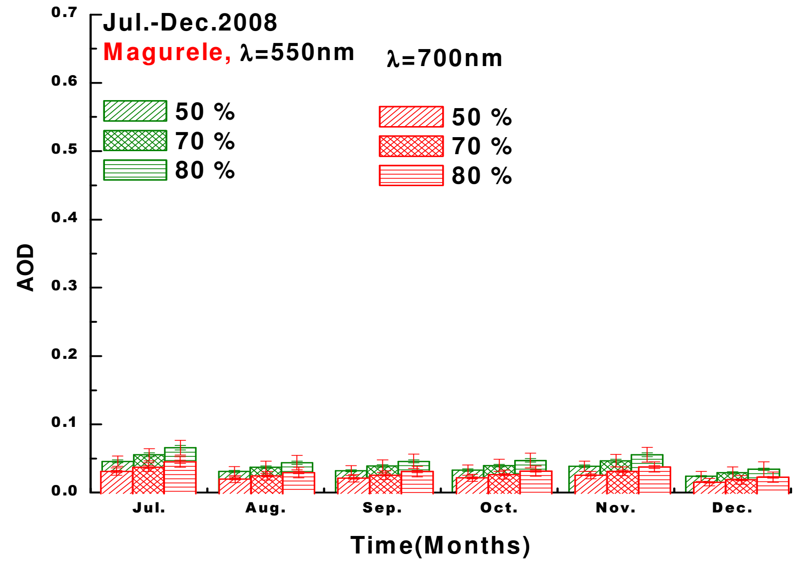


Figure 2 a, b, c. Temporal variation of monthly mean AOD at **550nm** for rural site (a), suburban site (b) and urban site (c) (error bars represent the standard error of the monthly ensembles).

One can observe the AOD highest values in summer 2007 for the urban sites. The AOD values are 10 times smaller at rural site than at urban (urban site).

PM Optical Properties
July – December 2008 AOD for Rural (Balotesti), Urban (Drumul Taberei) and Suburban Sites (Magurele)





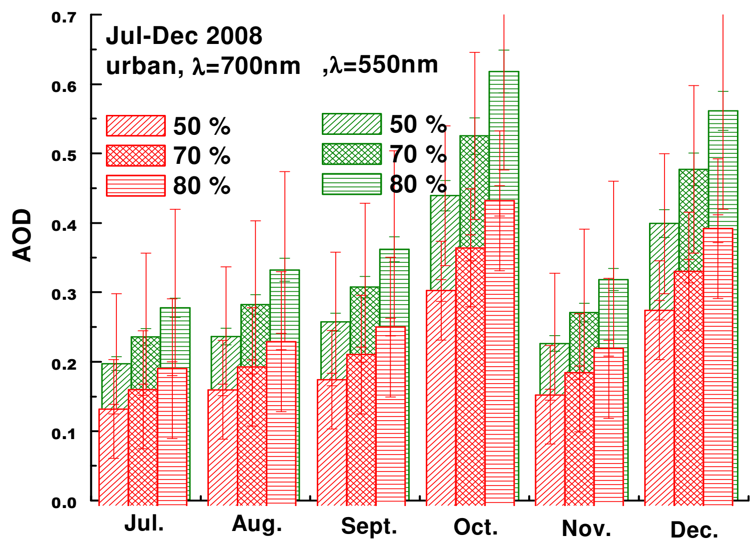
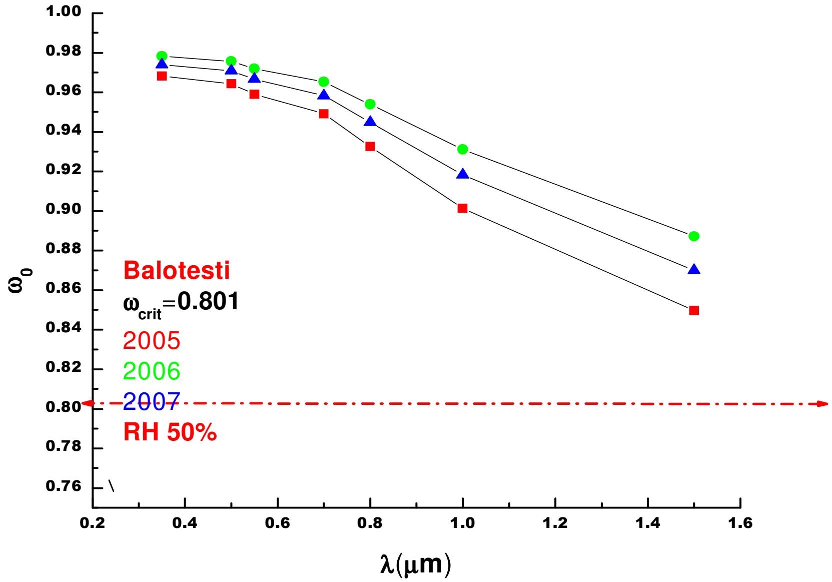
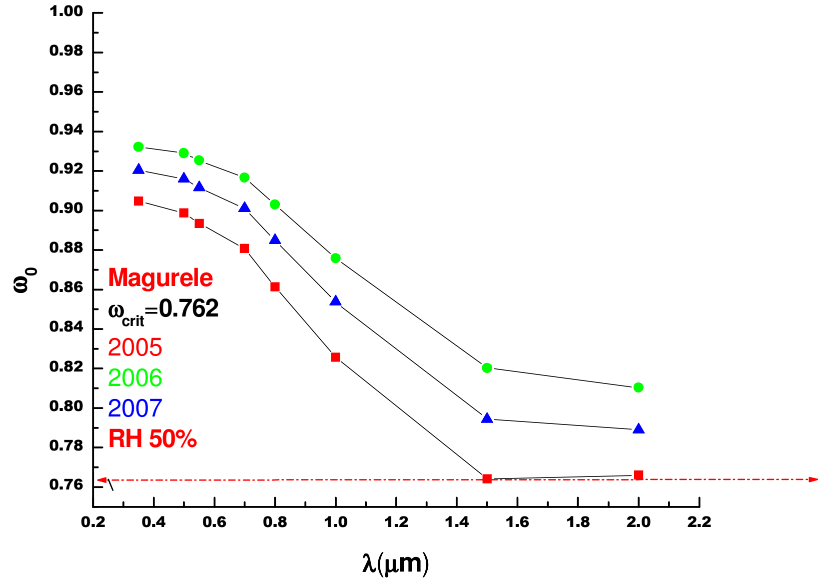


Figure 3 a, b, c. Variation of the AOD with humidity for three different sites: rural (Balotesti - a), suburban (Magurele - b), urban (Drumul Taberei - c).

The AODs is due to aerosol chemical composition, local wind patterns, humidity, and variation of sources, photochemistry and nighttime heterogeneous chemistry.

PM Optical Properties
2005, 2006, 2007 SSA for Rural (Balotesti), Urban (Drumul Taberei) and Suburban (Magurele) Sites





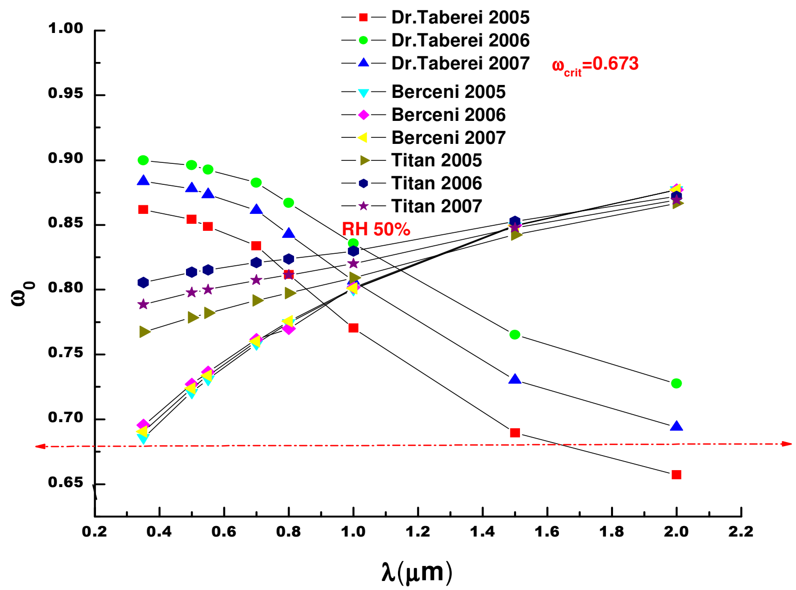


Figure 4 a, b, c. Spectral Single Scattering Albedo (SSA) for rural particulate matter (PM_{10}) (a), suburban (b) and the three industrial sites (c).

The SSA maximum values are in 2006 when the pollution was the higher (Fig. 4 and Fig.1).

$\omega_0 > \omega_{crit}$ → cooling

PM optical properties
July – December 2008 - Magurele - Backscattering coefficients daily averages

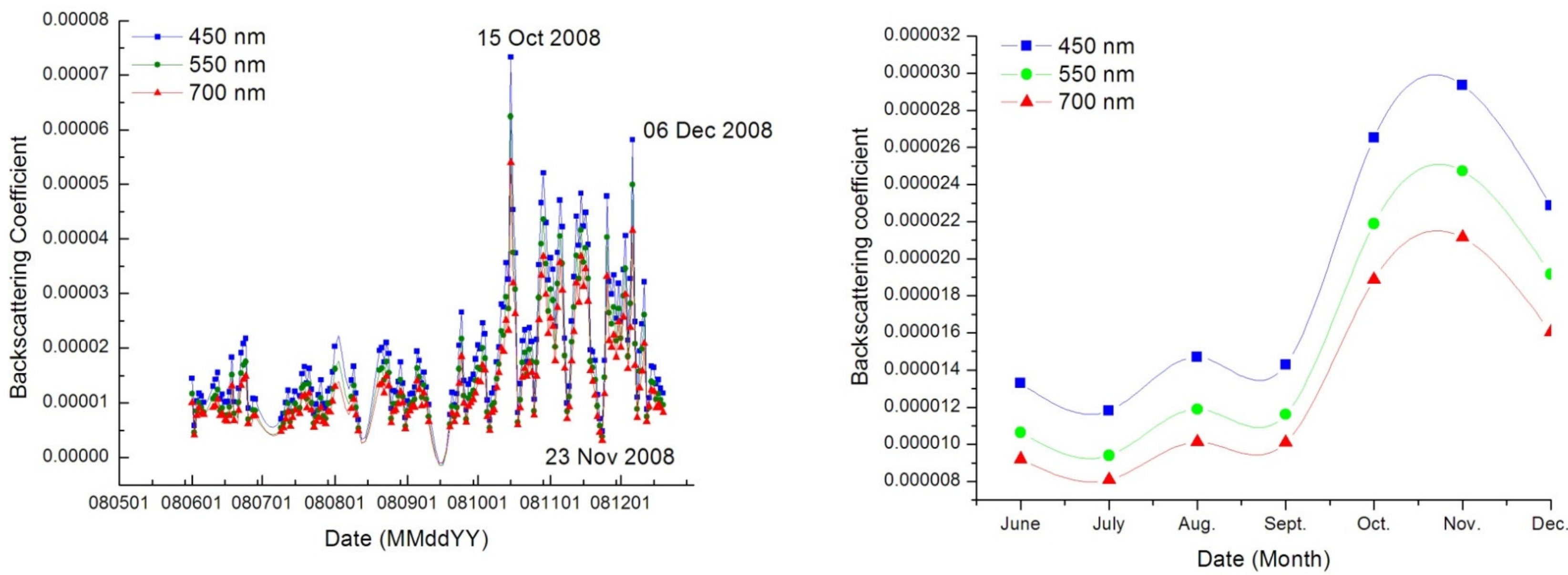


Figure 5. The backscattering coefficients daily (a) and monthly averages, respectively (b).

PM optical properties
July – December 2008 - Magurele - Angstrom parameter -daily and monthly averages

$$\alpha = \ln(\tau_{a1}/\tau_{a2})/\ln(\lambda_2/\lambda_1)$$

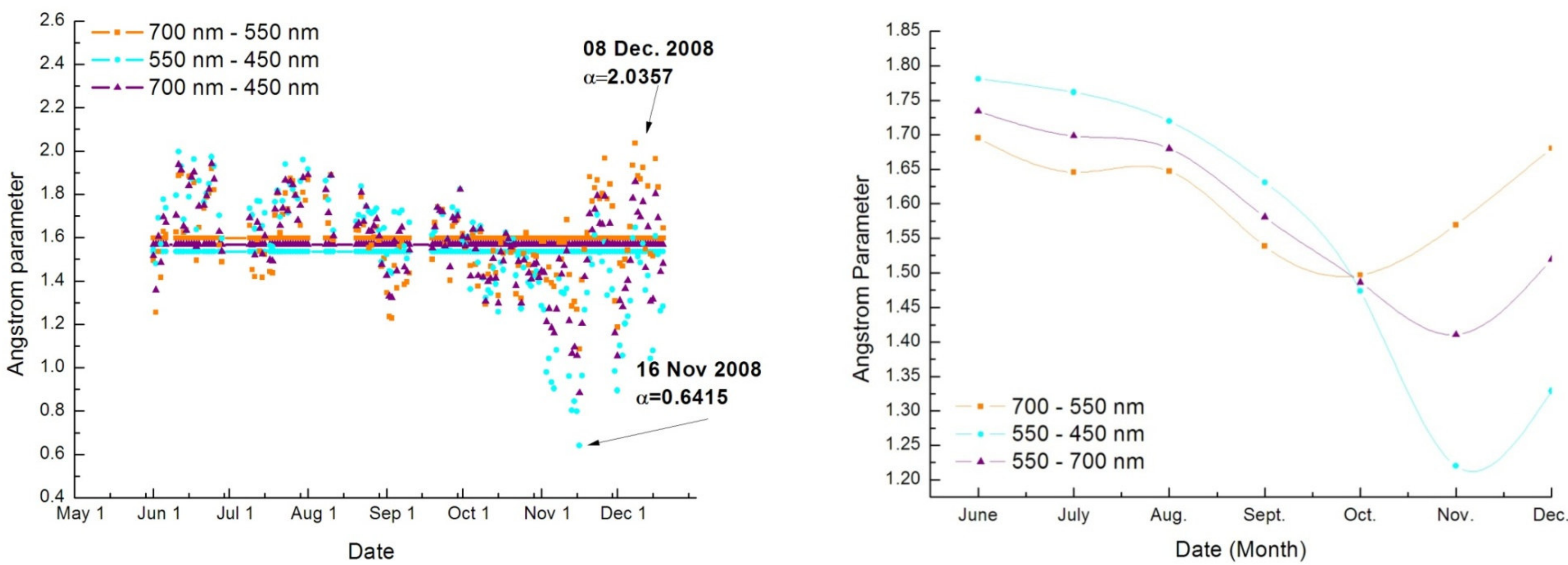


Figure 6. The Angstrom parameter calculated from angstrom turbidity equation for daily averages (left) and monthly averages (right).

PM optical properties
July – December 2008 - Magurele - AOD and RF - monthly averages

- We used the sun-photometer data to obtain the turbidity factor (β).
- We computed the AOD from Nephelometer data using relationship: $\tau_a = \beta \lambda^{-\alpha}$

For the fine particles the smaller values are in October comparing with PM 10 values which has the highest values in this month.

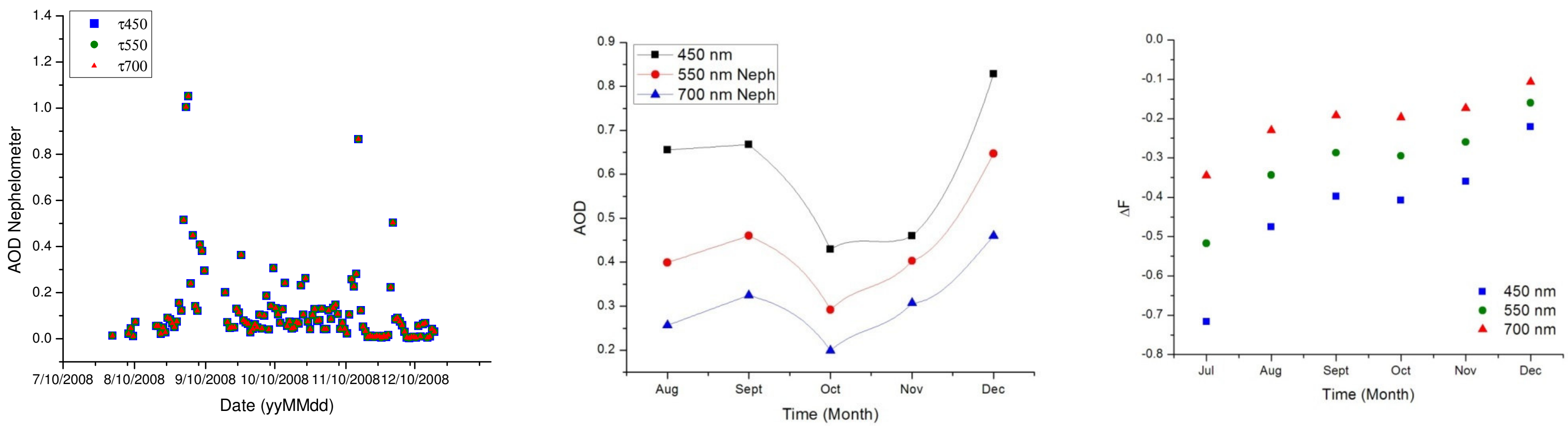


Figure 7. Aerosol Optical Depth, daily (a) and monthly(b) averages and the radiative forcing(c) calculation for Magurele in period July – December 2008 for three different wavelengths.

PM Optical Properties
July – December 2008 - Radiative Forcing for Suburban (Magurele) and Urban (Drumul Taberei) Sites

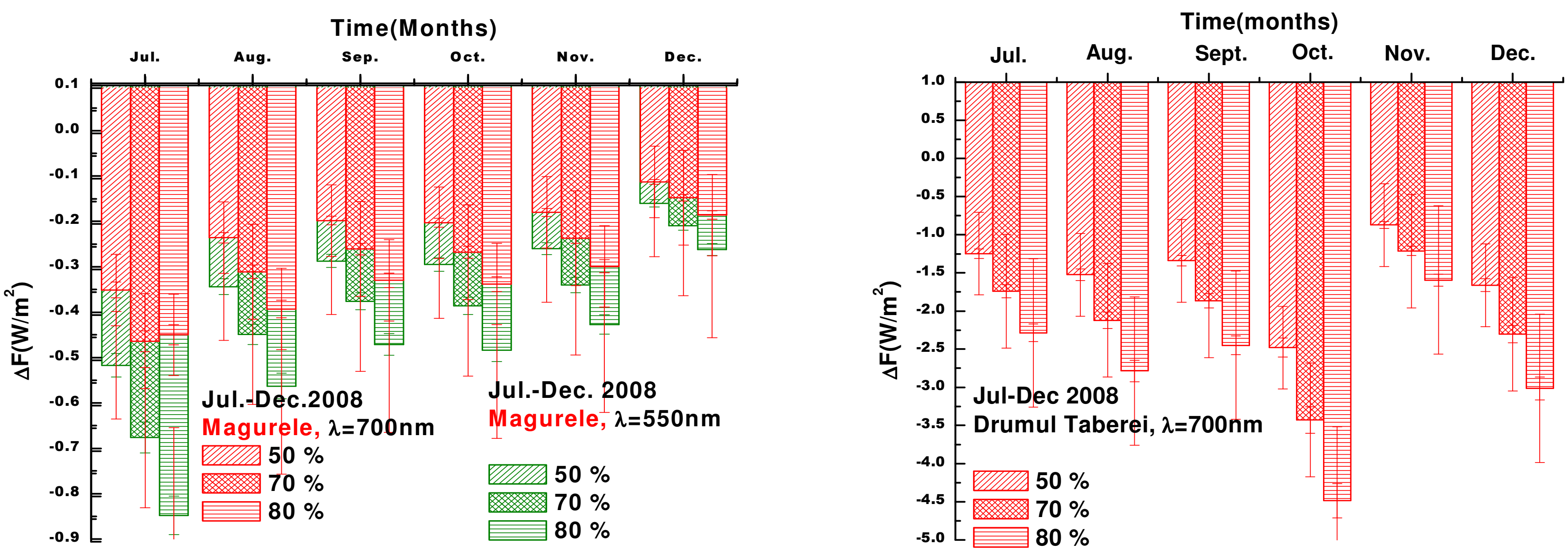


Figure 8. Radiative forcing results for suburban (Magurele - a), urban (Drumul Taberei - b) sites.

RF in (-0.9, -0.1) → direct effect (IPCC, 2007).

PM optical properties
July – December 2008 - Magurele - Radiative Forcing for each month in period

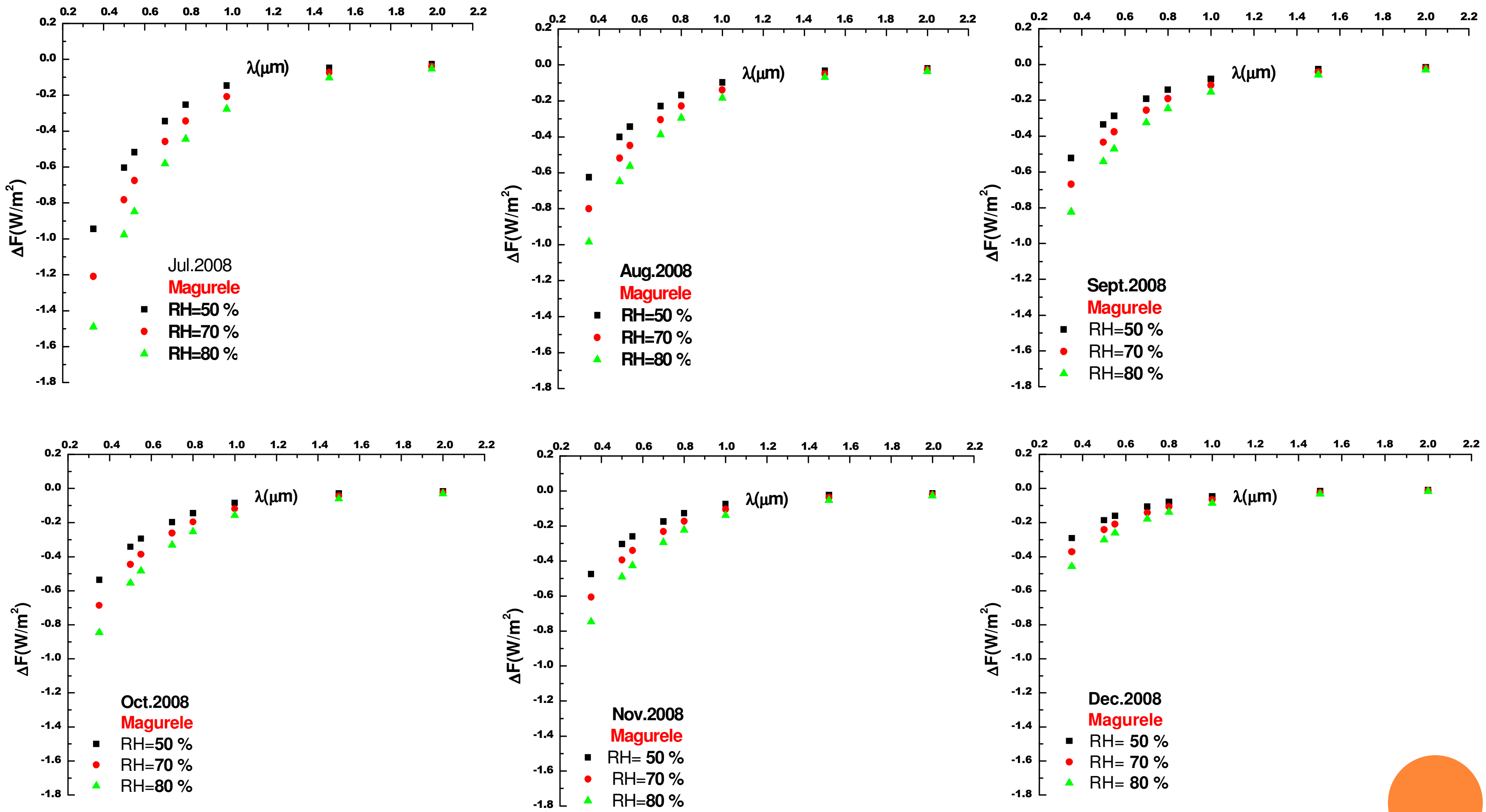
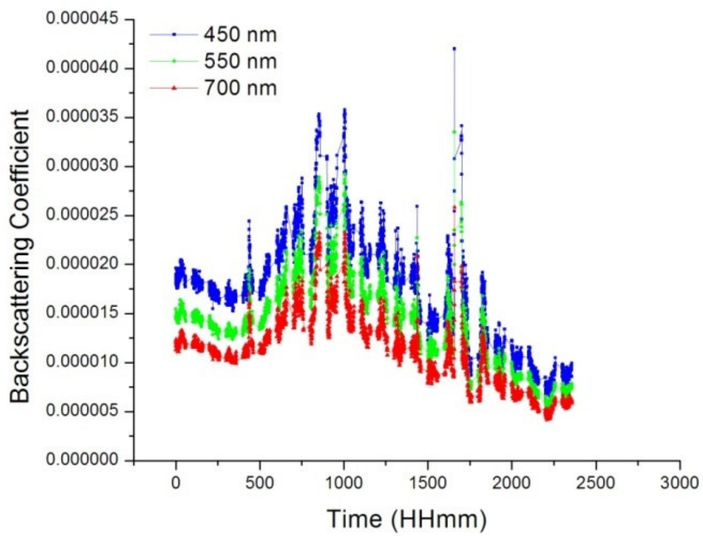


Figure 10. Magurele radiative forcing computed for each month of the interval July – December 2008 for three different wavelengths.

PM optical properties
Magurele - clean day (23 March 2009) backscattering coefficients and Angstrom parameter



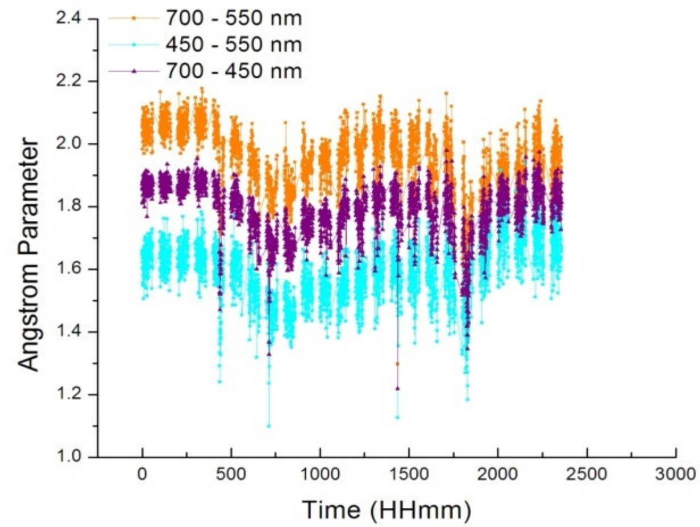
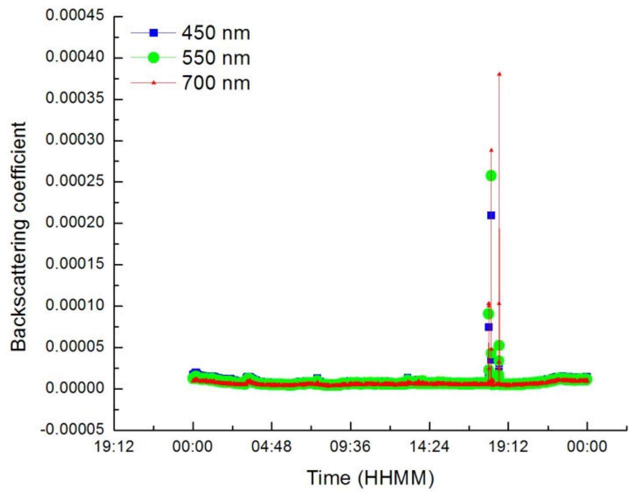
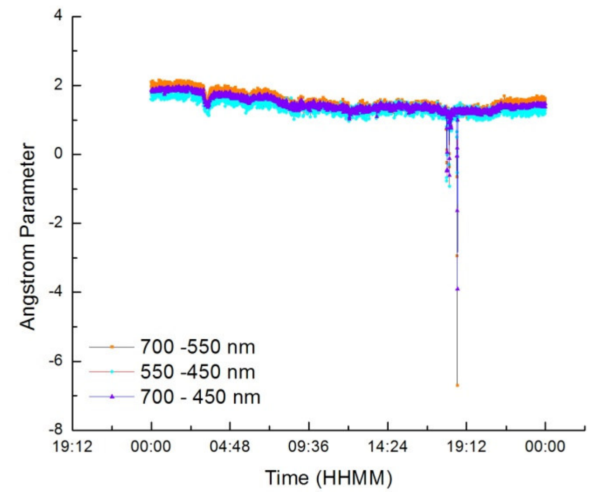


Figure 11. Backscattering coefficients and the Angstrom parameter for the chosen clean day.

PM optical properties
Magurele - turbid day (12 December 2008) backscattering coefficients, Angstrom parameter and radiative forcing





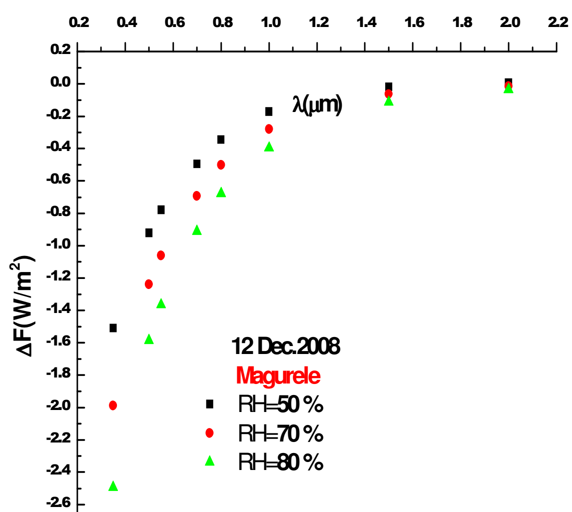


Figure 12. Three wavelength backscattering coefficients (a), Angstrom parameter (b) and radiative forcing (c) for the chosen turbid day.

Conclusions

- The differences between AOD values for rural, suburban and industrial (urban) sites are very large with the largest AOD values during summertime of 2006 year.

- For industrial sites the AOD values are larger than over rural site, indicating a polluted urban zone.

- The low values of SSA (Single Scattering Albedo) observed in autumn and winter months over urban area are attributed to the relative dominance of absorbing aerosols.

- The backscattering coefficients results showed the highest values in winter, so the loading of atmosphere with aerosol is important in cold season of year. The peak daily values in the winter month, confirm the enhanced pollution days.

- The Angstrom parameters data showed day by day and seasonal variations and the loading of atmosphere with fine particles during the 6 months and the presence of both: coarse and fine particles in the winter.

- The optical parameters dependency on the relative humidity and wavelength was showed.

- Radiative forcing is less dependent on the wavelength on the winter then in the summer and decrease with relative humidity.

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