Assessment of the spectral absorptions by black and brown carbon for different sources: application in Athens

D.G. KASKAOUTIS, G. GRIVAS, I. STAVROULAS, A. BOUGIATIOTI, E. LIAKAKOU, E. GERASOPOULOS, N. MIHALOPOULOS

Scope-Objectives

- **We describe a new approach using a combination of common assumptions for the differentiation of spectral absorption from aethalometer measurements into five components related to black and brown carbon (BC, BrC) and for sources of fossil-fuel combustion, biomass burning and secondary organic aerosol formation.**

Science of the Total Environment 801 (2021) 149739

Contents lists available at ScienceDirect

Science of the Total Environment

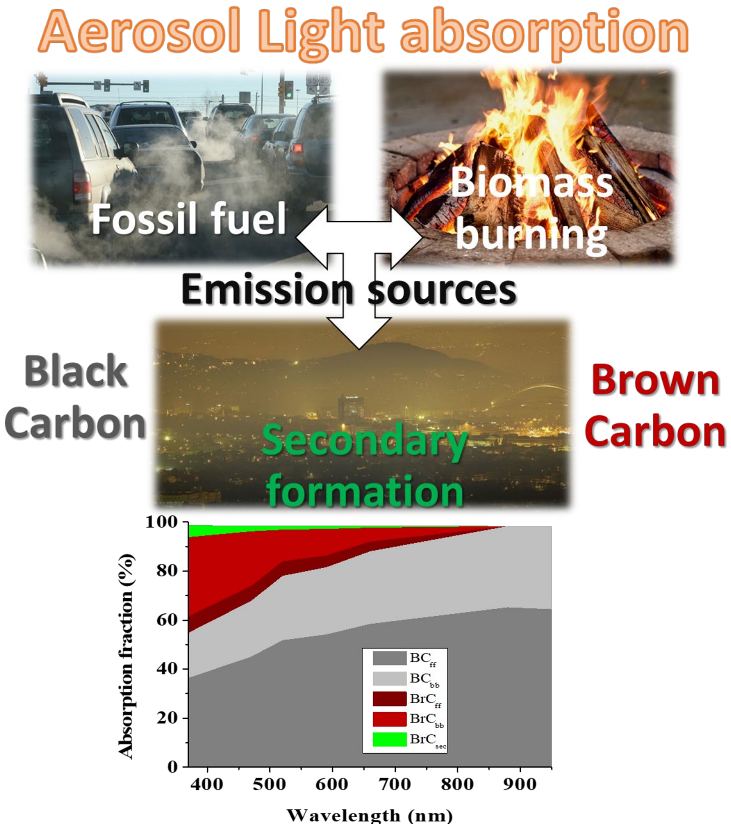
journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

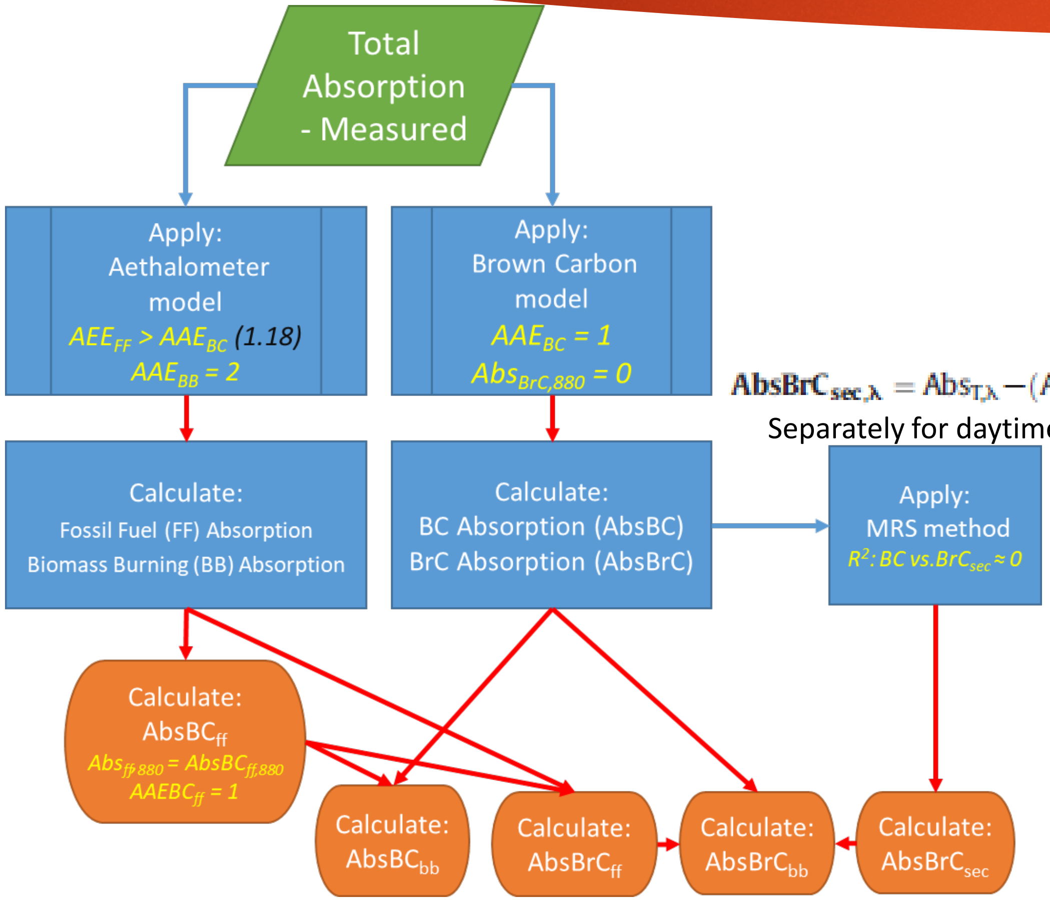
Apportionment of black and brown carbon spectral absorption sources in the urban environment of Athens, Greece, during winter

D.G. Kaskaoutis [a,b,*], G. Grivas [a,**], I. Stavroulas [a], A. Bougiatioti [a], E. Liakakou [a], U.C. Dumka [c], E. Gerasopoulos [a], N. Mihalopoulos [a,b]

[a] Institute for Environmental Research and Sustainable Development, National Observatory of Athens, Palaia Penteli, 15236 Athens, Greece
[b] Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital 263 001, India
[c] Environmental Chemical Processes Laboratory, Department of Chemistry, University of Crete, 71003 Crete, Greece



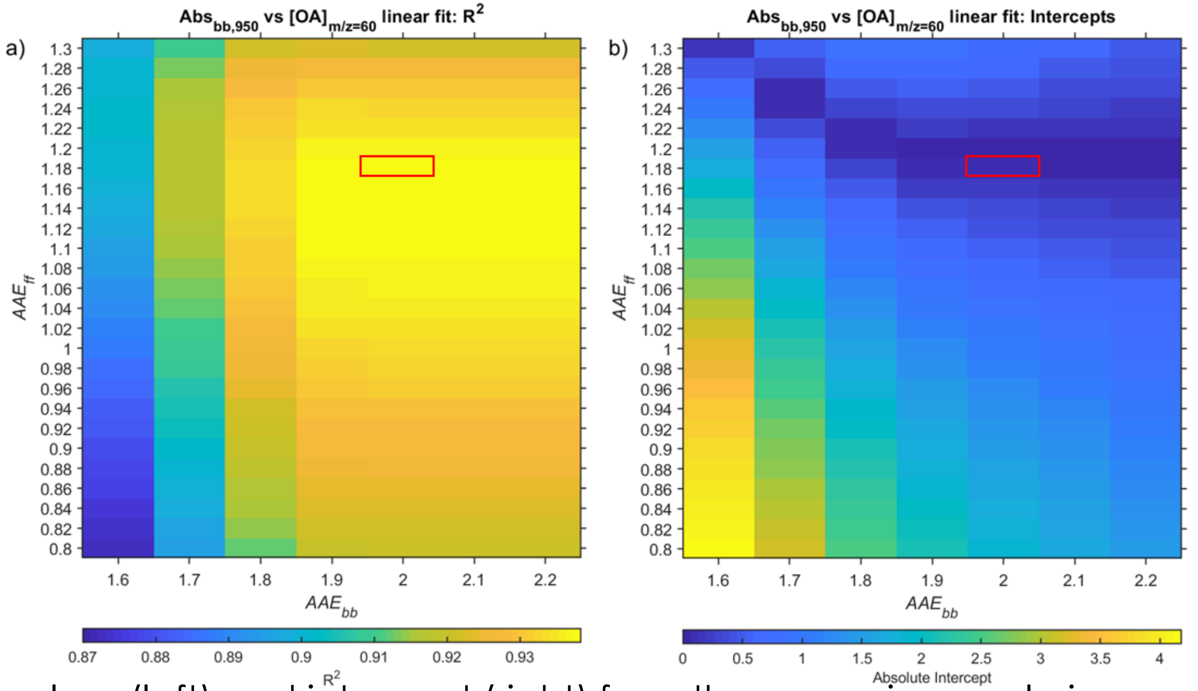
Methodology



$$AbsBrC_{sec,\lambda} = Abs_{T,\lambda} - (Abs_{T\lambda}/BC_{880})_{pri} * [BC_{880}]$$

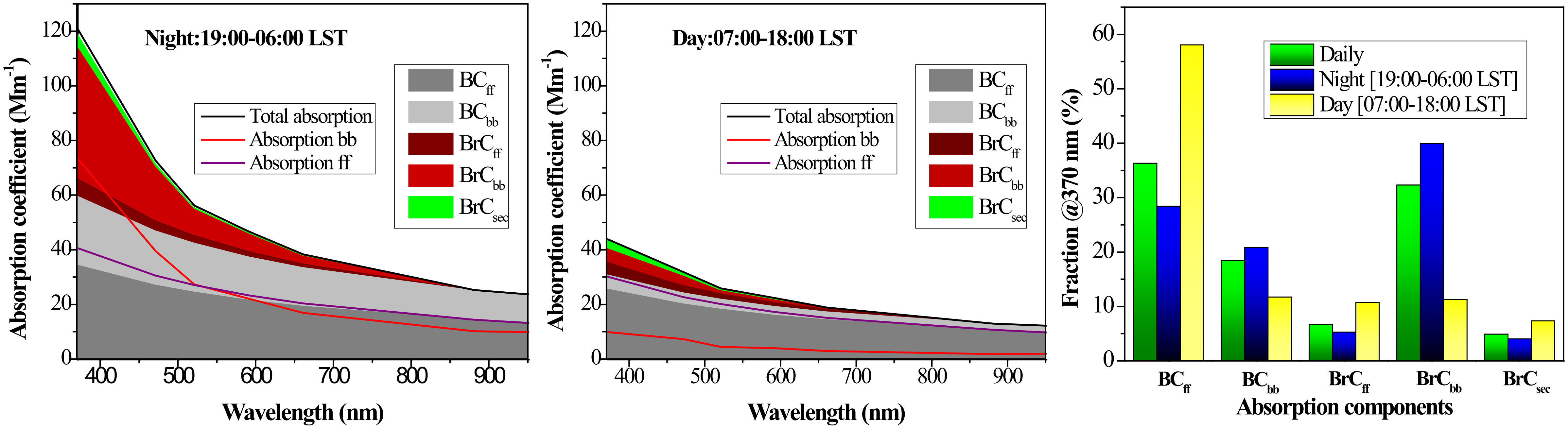
Separately for daytime & nighttime

Schematic flowchart of the methodology for the spectral calculation of the 5 absorption components. Values in yellow signify the assumptions made.



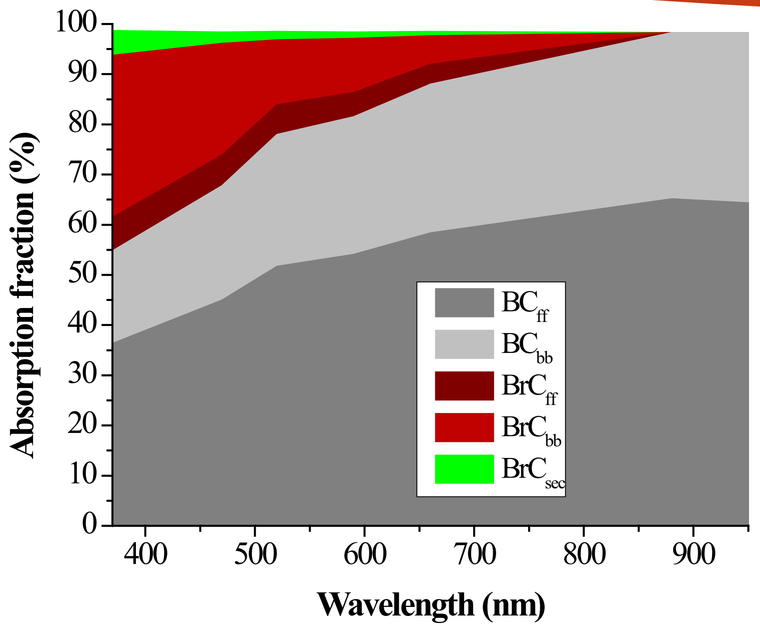
R^2 values (left) and intercept (right) from the regression analysis between the BB absorption coefficient at 950 nm ($Abs_{bb,950}$) calculated with the aethalometer model (y-variable) and the m/z 60 ACSM fragment (x-variable), for different pairs of AAE_{ff} and AAE_{bb}. The selected pair (AAE_{ff}=1.18 and AAE_{bb}=2.0) is shown by the red box.

Results: Application in Athens: Dec.2016-Feb.2017

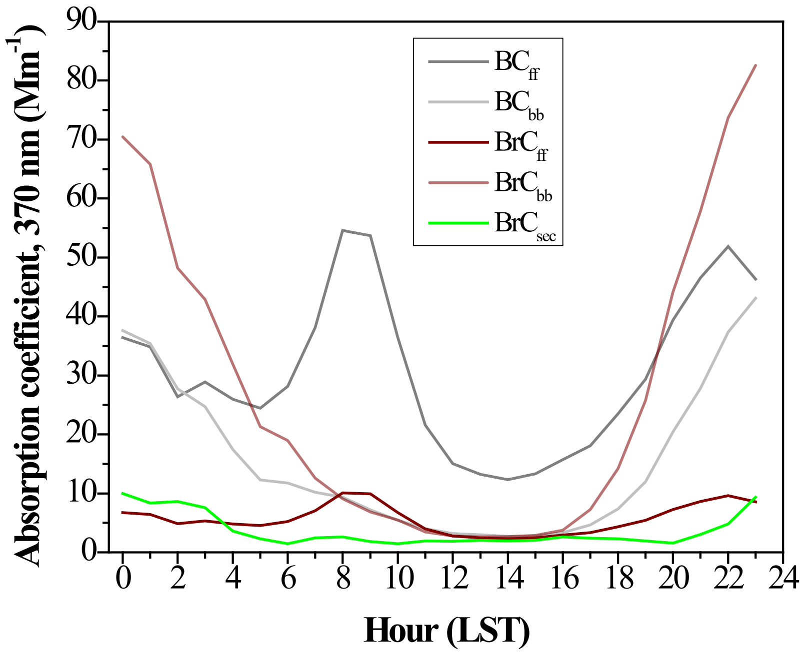


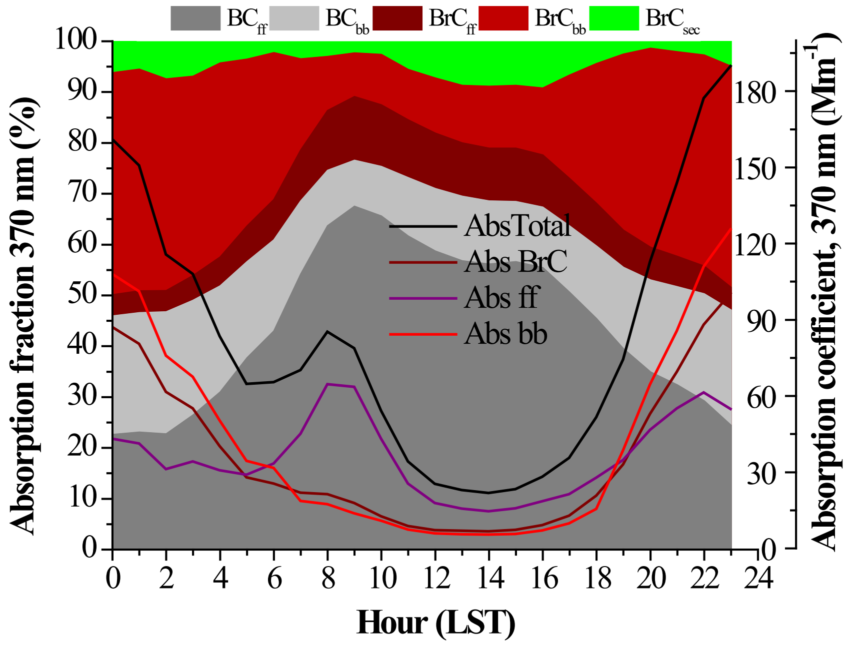
Cumulative spectral dependence of aerosol absorption components for night-time and daytime in Athens during December 2016–February 2017. Fractional contribution for each absorption component at 370 nm for daily, night-time and daytime measurements

Results: Application in Athens: Dec.2016-Feb.2017



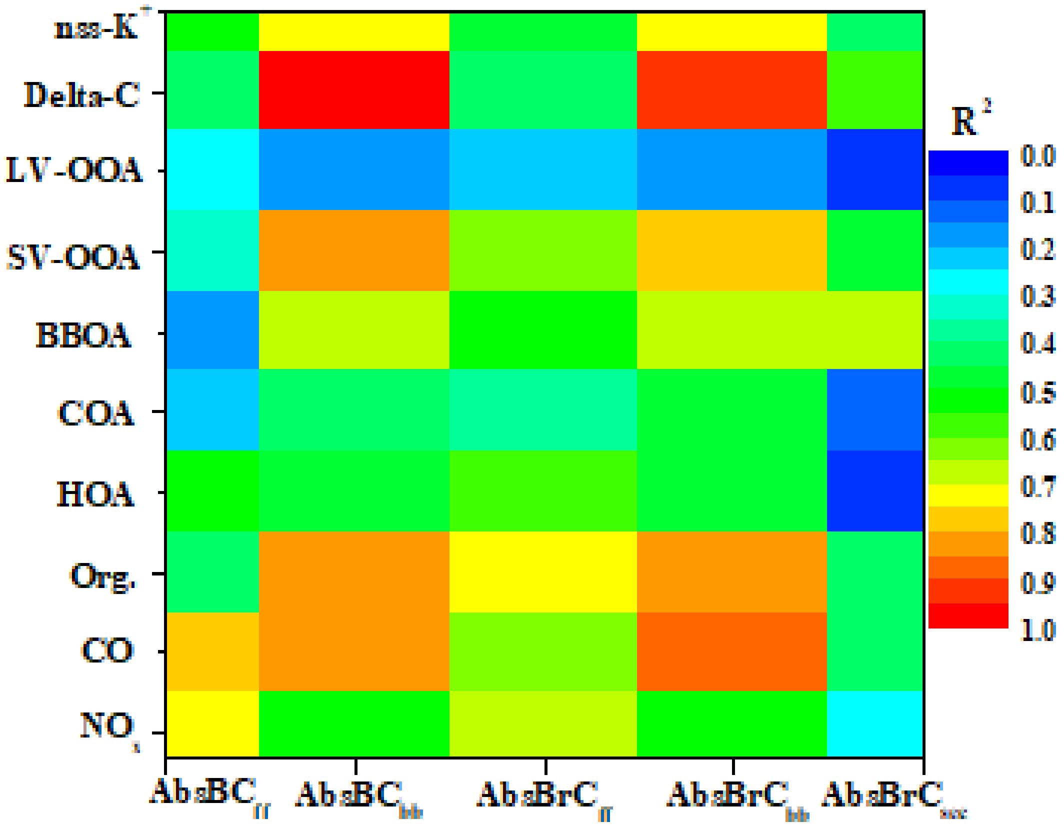
Spectral contribution of the five absorption components to total aerosol absorption, for AE-33 measurements in Athens during wintertime.





Mean diurnal variation of the absorption coefficient at 370 nm for the five absorption components and their contribution to total absorption, along the mean diurnal patterns of total, BrC, fossil-fuel and wood-burning absorption

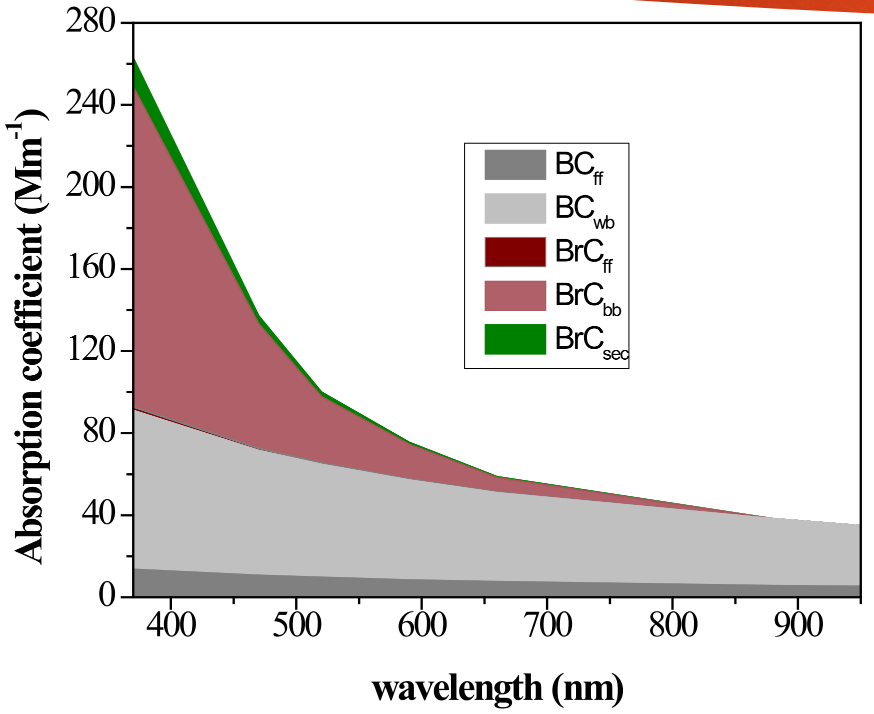
Results: Application in Athens: Dec.2016-Feb.2017



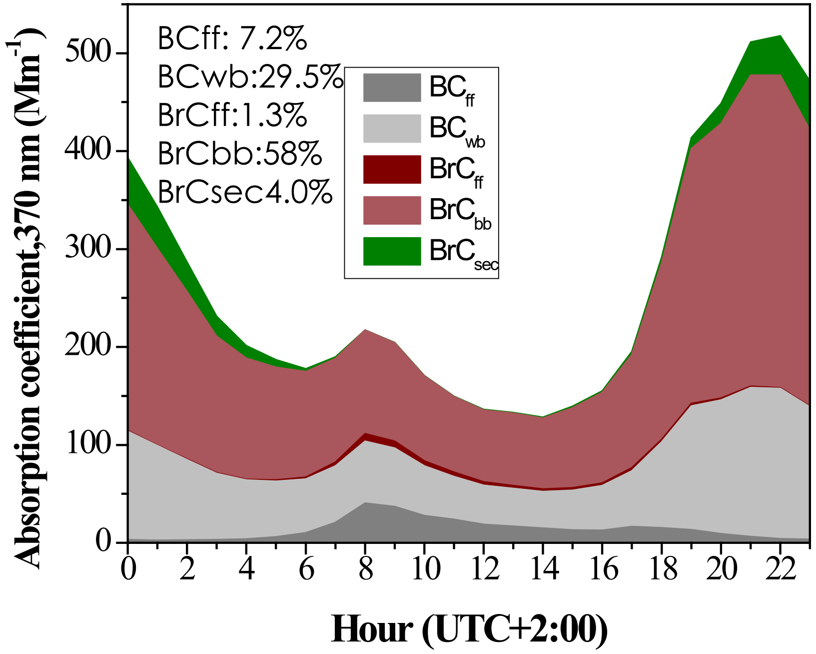
Squared Pearson correlation coefficients (R^2) between the absorption components and other optical and chemical composition variables.

- **High correlations between the BB absorption components with CO, Organics, BBOA, SV-OOA, Delta-C, nss-K^+**
- **High correlations between the FF absorption components with NOx, HOA and much lower with the BB tracers.**
- **Secondary OC absorption seems to be mostly related with BB emission sources.**

Results: Application in Ioannina (Dec.2019 – Feb.2020)



Cumulative spectral dependence of aerosol absorption components in Ioannina during winter 2019/20.



Mean diurnal variation of the absorption coefficient at 370 nm for the five absorption components and their contribution to total absorption in Ioannina.

Extremely high BB emissions and absorption components from BrC_{bb} and BC_{bb}.

Conclusions

1. We developed a new approach for the deconvolution of 5 absorption components related to the absorption of BC and BrC, separately for fossil-fuel combustion and biomass burning and due to absorption from secondary organic aerosol absorption.
2. We used the Aethalometer model for determining the AAEff and AAEbb values and assuming that BrC absorption is negligible at 880 nm and beyond, and AAE for pure BC is 1.0.
3. We applied this technique in Athens and Ioannina, Greece during winter, and the same can be applied to any environment.
4. Results were very promising. We also performed sensitivity analysis and analytic description of uncertainties.

Science of the Total Environment 801 (2021) 149739

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

Apportionment of black and brown carbon spectral absorption sources in the urban environment of Athens, Greece, during winter

D.G. Kaskaoutis[a,b,*], G. Grivas[a,**], I. Stavroulas[a], A. Bougiatioti[a], E. Liakakou[a], U.C. Dumka[c], E. Gerasopoulos[a], N. Mihalopoulos[a,b]

Contact at: Dimitris Kaskaoutis dkask@noa.gr

THANK YOU