

EMISSION OF BC AND TRACE METALS AT AN URBAN LOCATION IMPACTED BY WOOD BURNING

A. Bougiatioti¹, M.J. Desservettaz², I. Stavroulas^{1,2,3}, D.G. Kaskaoutis^{1,3}, E. Liakakou¹, M. Tsagkaraki³, M. Ramonet⁴, M. Delmotte⁴, N. Hatzianastassiou⁵, N. Mihalopoulos^{1,3}

¹ Institute for Environmental Research and Sustainable Development, National Observatory of Athens, Athens, 118 51, Greece
² Climate and Atmosphere Research Centre, The Cyprus Institute, Nicosia, 2121, Cyprus
³ Environmental Chemical Processes Laboratory, Department of Chemistry, University of Crete, 70013, Greece
⁴ Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, CEA-CNRS-UVSQ, Université Paris-Saclay, 91191, Gif-sur-Yvette, France
⁵ Laboratory of Meteorology, Department of Physics, University of Ioannina, 45110 Ioannina, Greece

INTEREST OF THE STUDY

Recently, greenhouse gases measurements in Athens, Greece, have revealed that both gases exhibit maxima during wintertime, with increased levels during night and early morning hours being attributed to traffic/heating emissions and leakages of residential natural gas for CO₂ and CH₄, respectively (Dimitriou *et al* 2021). In view of the above, we performed a one-month measurement campaign during December 2021-January 2022 in the city of Ioannina is characterized by intense residential wood combustion (RWB) for heating purposes especially during winter night-time that, in combination with its topography, results in magnified accumulation of atmospheric pollutants (Kaskaoutis *et al* 2020), comparable to highly polluted megacities globally. Given that RWB accounts for more than 90% of BC during night and more than 70% on a 24h basis, the area is considered as an ideal location to study emissions of BC and other elements related to BB.

SITE DESCRIPTION-ANALYSES

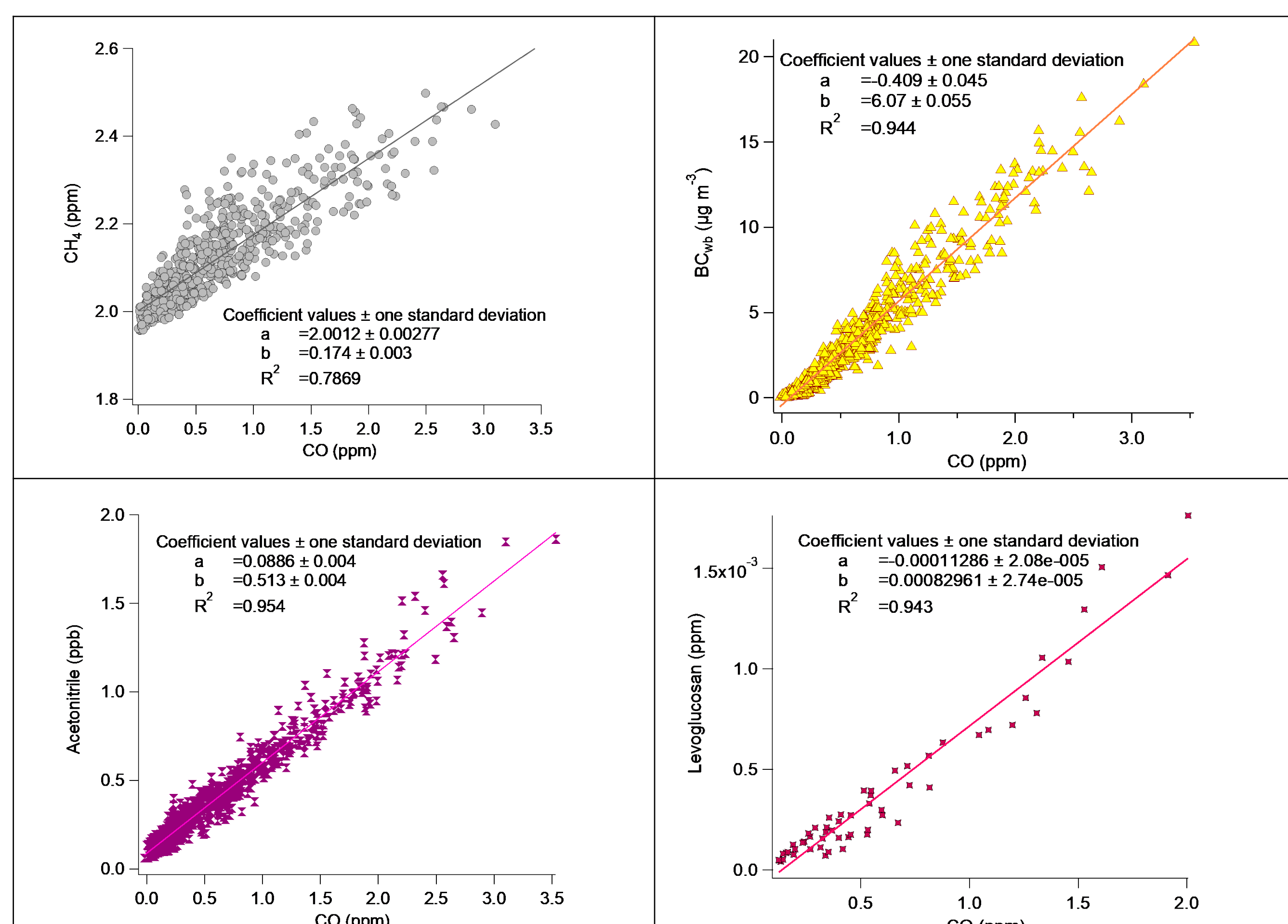


Measurements were conducted at the rural mountainous city of Ioannina in the northwest of Greece during December 2021-January, The city is numbering ~115.000 inhabitants. Measurements of gaseous pollutant and aerosols were performed with the Mobile Air Quality Monitoring Station of NOA.

Measurements at the site include:

- Aerosol Chemical Speciation Monitor (Organics, Sulfate, Ammonium, Nitrate, Chloride)
- Aethalometer Magee AE33 for BC
- GHG gas monitor (Picarro 2301)
- Gas analyzers (O₃, NO_x, CO)
- Meteorological parameters
- Low volume samplers for filter collection and subsequent offline analyses (e.g. ICP-MS, IC, OC/EC, sugars)

CORRELATIONS BETWEEN SPECIES



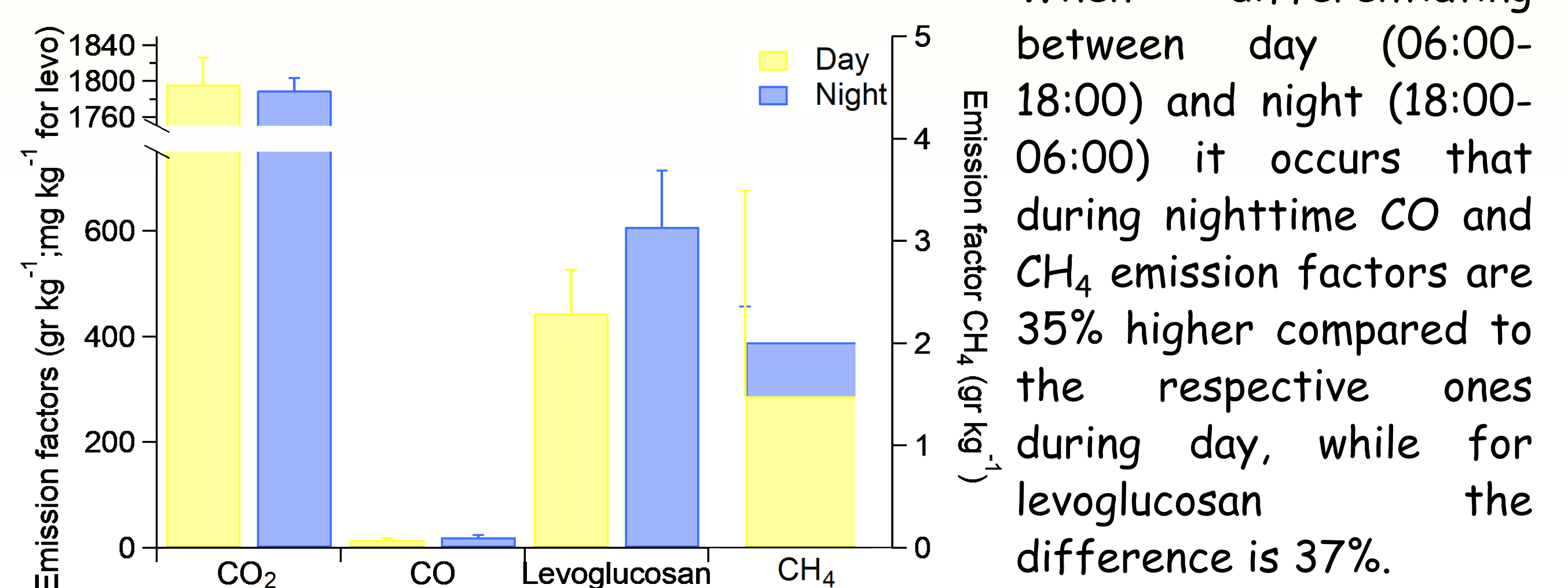
CALCULATED EMISSION FACTORS

Emission factors were calculated using the carbon mass balance approach, in conjunction with the emission factor of CO and the molar emission ratios to CO:

$$E_{m,x} = (Em_{CO}) \frac{C_x (MW)_x}{C_{CO} 28}$$

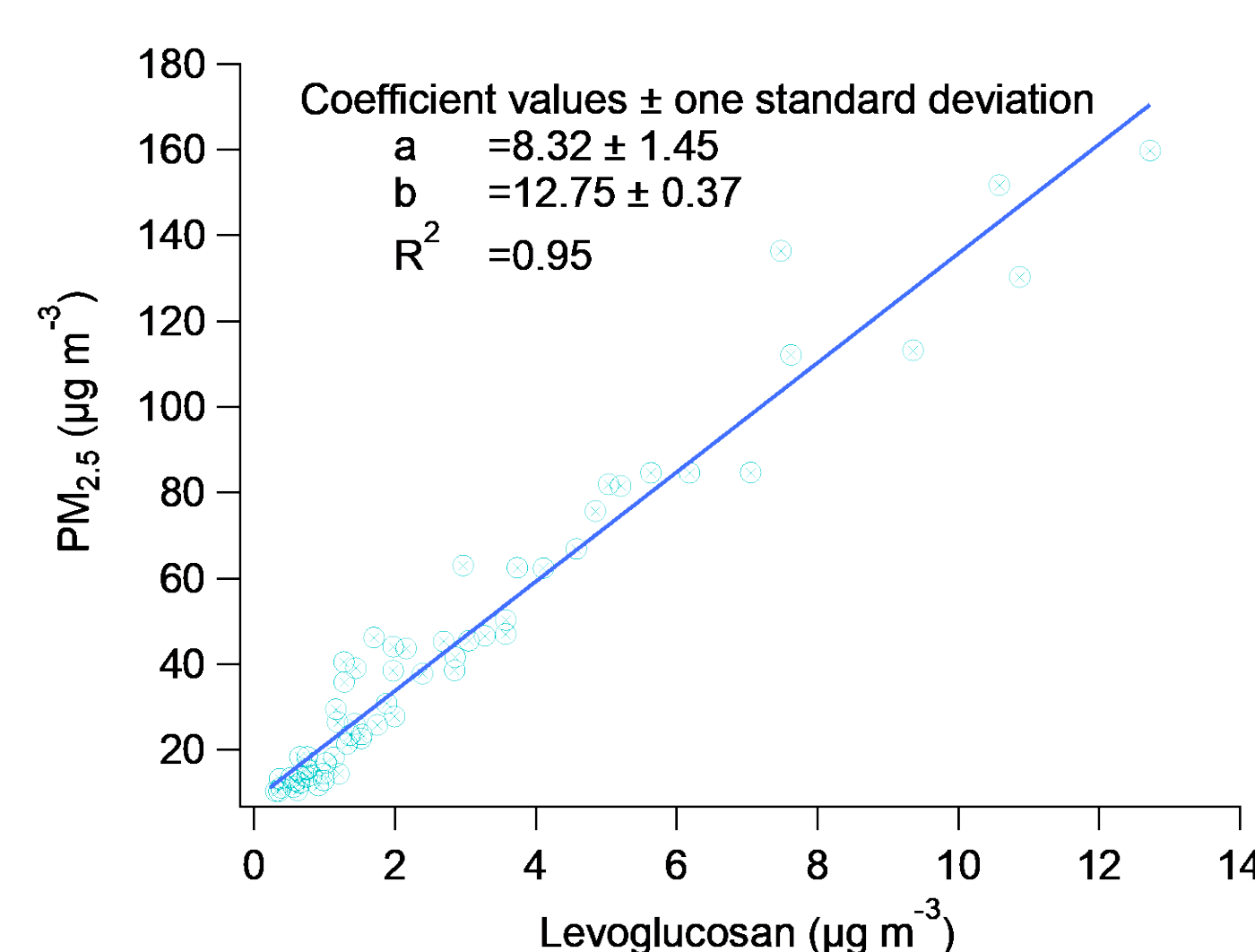
gr per kg burnt	Average	Day	Night
EF CO	17.81 (4.08)	14.9 (2.9)	20.2 (3.5)
EF CO ₂	1793 (23)	1796 (30)	1789 (14)
EF CH ₄	1.74 (0.41)	1.48 (0.28)	2.01 (0.35)
EF BC	0.13 (0.03)	0.14 (0.03)	0.19 (0.03)
EF Levoglucosan*	528.3 (125.8)	443.7 (82.7)	607.4 (106.6)
EC Mannosan*	6.5 (2.6)	4.8 (1.6)	8.0 (2.5)
EC Galactosan*	4.9 (1.9)	3.5 (1.4)	6.0 (1.9)
EC Acetonitrile	0.013 (0.003)	0.011 (0.002)	0.015 (0.003)

* EF for anhydrosugars in mg per kg burnt



- Temperate forest CO₂ emissions from biomass burning 1637±71 (Akagi *et al.*, 2011)
- Temperate forest CH₄ emissions from biomass burning 3.92±2.39 (Akagi *et al.*, 2011)
- The emitted amounts of levoglucosan are typically 40-1200 mg per kg combusted wood.
- Typical emissions of BC are in the order of 0.2±0.1 gC per kg (Noblet *et al.*, 2021)

WOOD BURNING AND POLLUTION



	L/M	L/G	M/G
Ratio	14.6±1.4	19±1.5	1.3±0.1

Typically
 L/M 14-17 indicative of hardwood combustion
 L/M 2.5-3.5 softwood combustion

- Fine particulate matter at Ioannina mostly is related to wood combustion
- The combustion material is most probably hardwood rather than softwood
- Similar ratios have been found during wintertime in Lumbini, Nepal (16.1±13.1)

CONCLUSIONS

- ✓ Modified Combustion Efficiency (MCE) was very high throughout the wintertime campaign (99%)
- ✓ Almost all air quality components exhibit excellent correlation with CO, indicating provenance from combustion
- ✓ Emission factors (EFs) were calculated based on the carbon balance approach for CO₂, CH₄, CO, BC, and wood combustion tracers such as levoglucosan and acetonitrile
- ✓ Emission factors were almost 40% higher during night compared to day
- ✓ PM_{2.5} exhibited excellent correlation with levoglucosan, denoting that pollution is mostly associated with wood combustion
- ✓ The L/G ratio denotes the combustion mainly of hardwood at Ioannina during winter

Acknowledgments

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