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# Multi-year chemical composition of the fine-aerosol fraction in Athens, Greece, with emphasis on the contribution of residential heating in wintertime

**Christina Theodosi et al.**

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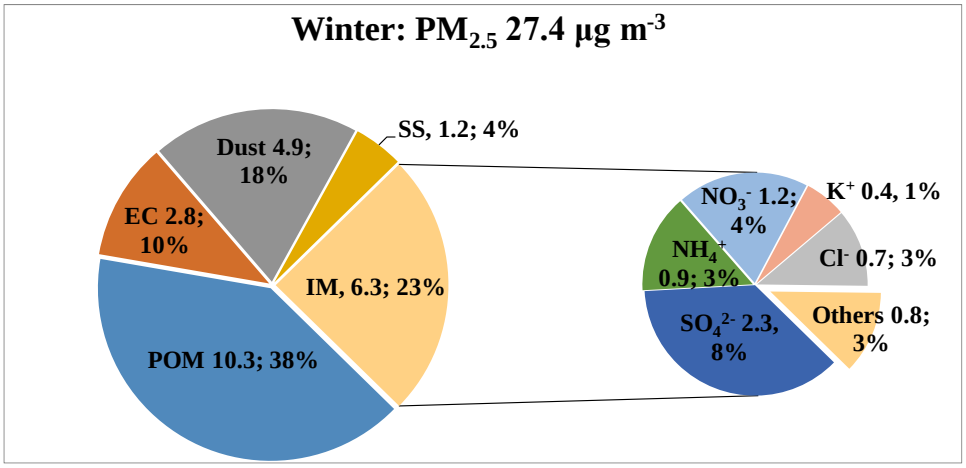
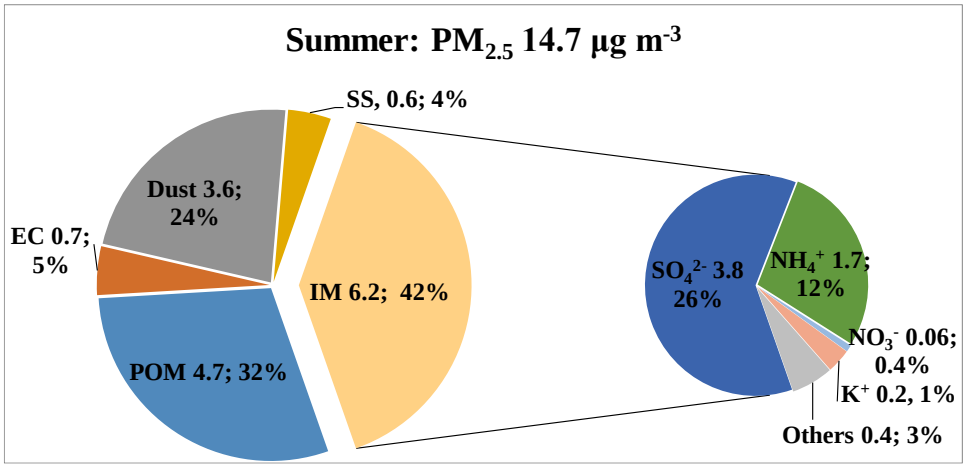
a)




b)




c)

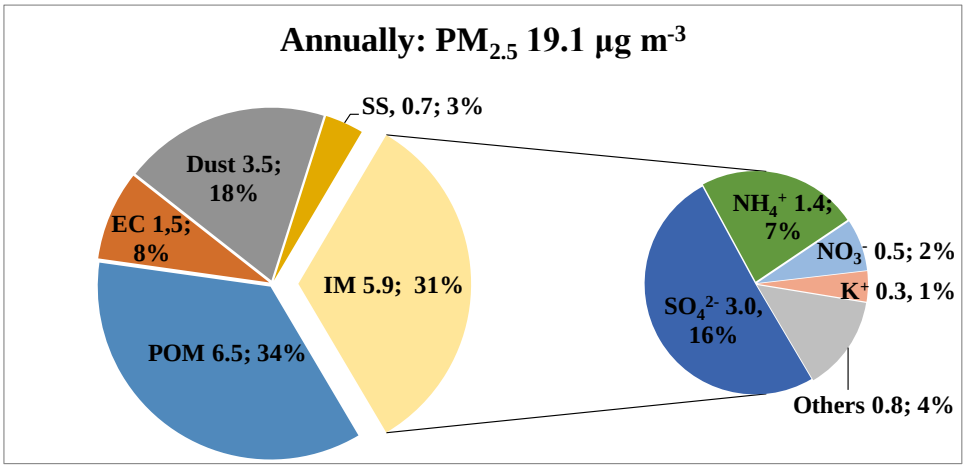



**Figure S1: $PM_{2.5}$ chemical composition and relative contribution of each aerosol species for the studied period (2013–2016) (a) in winter, (b) in summer and (c) annually.**

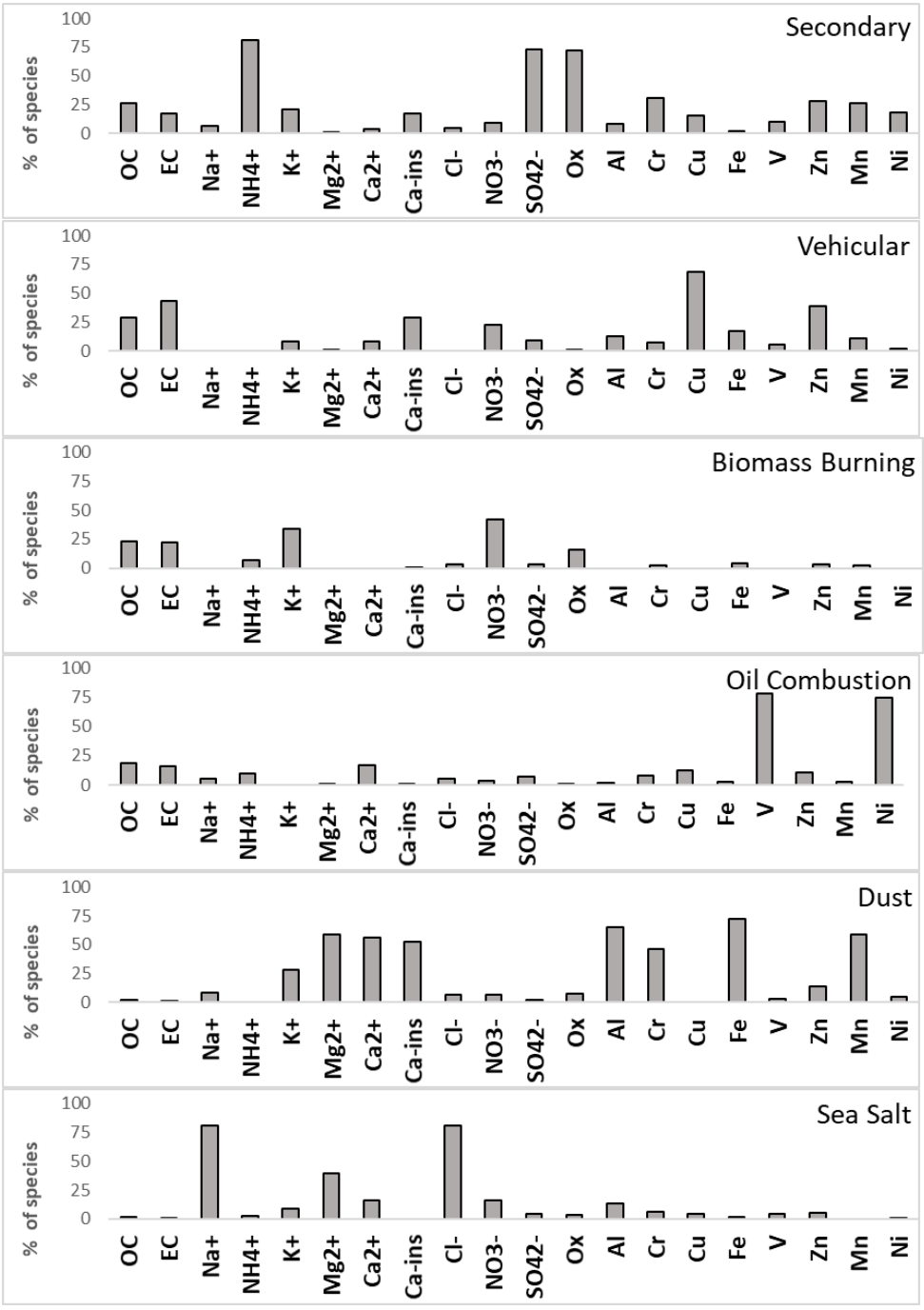



**Figure S2: Percentage of species attributed to each factor, from PMF analysis for daily average concentrations between March 2014-February 2016.**

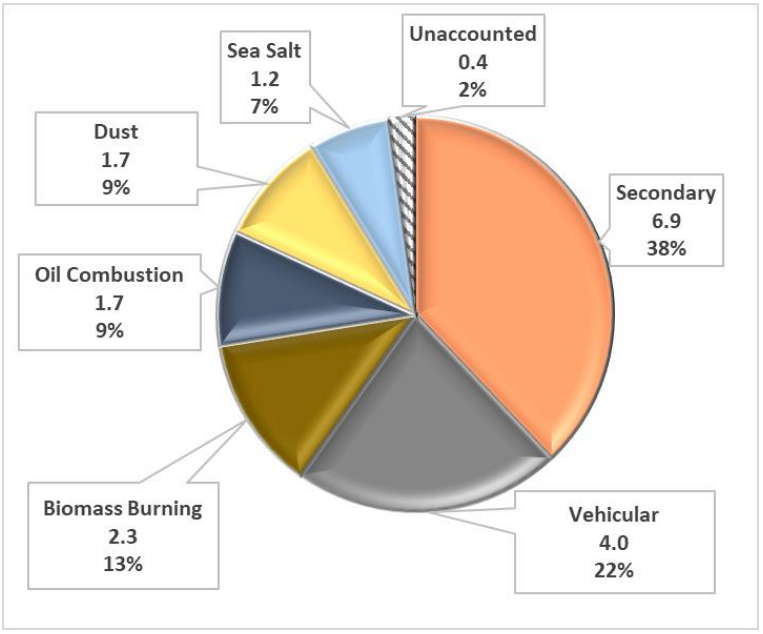



**Figure S3: Mean contribution (µg $m^{-3}$ and %) of $PM_{2.5}$ sources for the two-year period.**

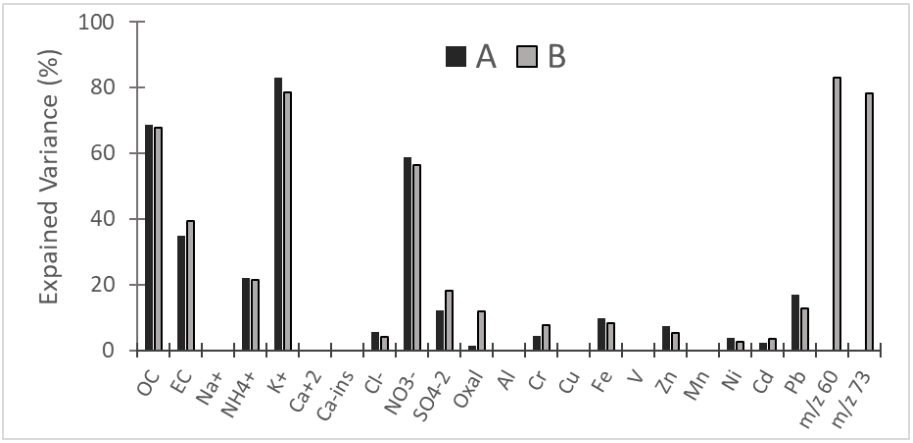



**Figure S4: Explained variances for $PM_{2.5}$ components by the biomass-burning factor in the original solution (A) and in the solution including data on ACSM fragments for the winter of 2015-2016 (B).**

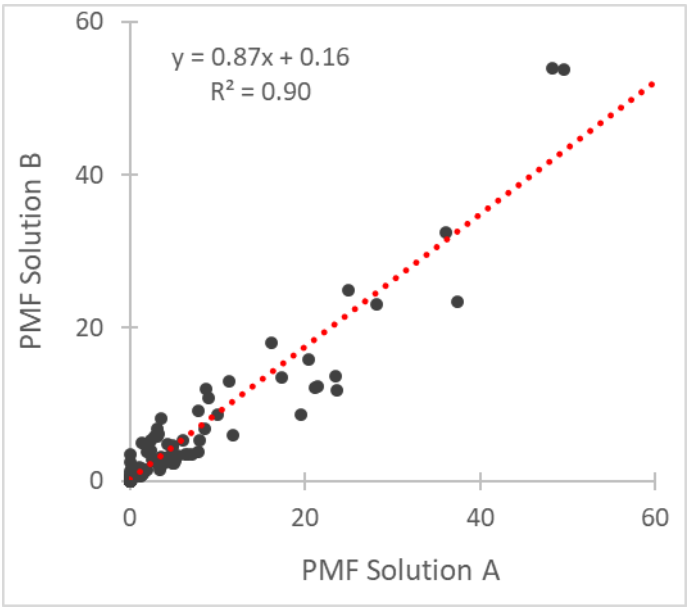



**Figure S5: Comparison of the calculated contributions of the biomass burning factors by the original solution (A) and by the solution including data on ACSM fragments for the winter of 2015-2016 (B).**

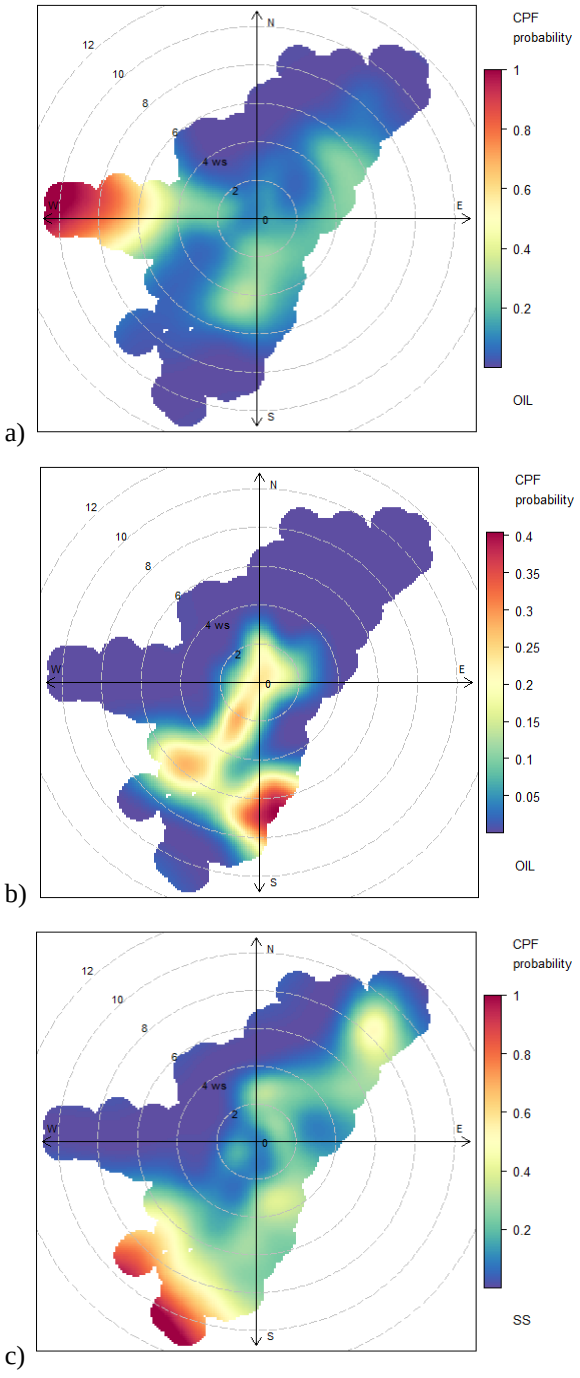



**Figure S6: Bivariate (wind direction and speed in m $s^{-1}$) polar plots of the conditional probability function (CPF) for PMF-estimated contributions: a) in the 50$^{th}$ -75$^{th}$ percentile range for the oil combustion (OIL) factor b) exceeding the 75$^{th}$ percentile for the oil combustion factor c) in the 50-90$^{th}$ percentile for the sea salt (SS) factor. Calm winds (wind speed < 0.5 m $s^{-1}$) were excluded.**

**Table S1: Summary of PMF settings and error estimation (EE) diagnostics**

| PMF parameter | |
|---|---|
| N species included | 21 |
| N samples | 146 |
| Down-weighted species * | Cd, $Ca^{2+}$, Ca-ins |
| Excluded species ** | $Mg^{2+}$, As |
| Added uncertainty | 5% |
| **Base Solution** | |
| N factors | 6 |
| $Q_{ROBUST}$ / $Q_{EXP}$ | 3.15 |
| $Q_{ROBUST}$ / $Q_{EXP}$ (-1 factor) | 3.52 |
| $Q_{ROBUST}$ / $Q_{EXP}$ (+1 factor) | 3.12 |
| $r^2$, Slope | 0.85, 0.94 |
| **BS-DISP results** | |
| Number of bootstrap resamples | 100 |
| % of BS factors assigned *** | 98%(VEH), 99% (SS), 100%(remaining 4) |
| DISP %dQ | -0.44 |
| DISP % of factor swaps | 0 |
| BS-DISP Displaced species | K, Cu, $SO_4^{2-}$, Ni, Fe, $Cl^-$ |
| BS-DISP %dQ | -0.78 |
| BS-DISP % of factor swaps | 2 |
| BS-DISP error interval**** ratios for factor identifying species | K : 0.79<br>Cu : 1.20<br>$SO_4^{2}$: 0.37<br>Ni: 0.82<br>Fe: 0.54<br>$Cl^-$: 0.24 |

* Signal to noise ratio (S/N) between 0.5-2. Uncertainty tripled.

** S/N below 0.5.

***$R^2$>0.6 required.

**** Calculated as the ratio of the $95^{th}$- $5^{th}$ percentile difference to the mean concentration of displaced species