

Carbonaceous aerosol source apportionment using $\delta^{13}\text{C}$ -A study in southern Sweden

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INTRODUCTION

The rarer stable isotope of carbon, ^{13}C , has been used in source characterization and apportionment of the total carbonaceous aerosol (TC) since the 1980's (Chesselet et al., 1985). Due to fractionation between the isotopes during chemical and physical transformation the ^{13}C content, expressed as $\delta^{13}\text{C}$, varies between common sources of carbonaceous aerosol such as fossil fuels and biomass.

$\delta^{13}\text{C}$ as a source marker has the benefits that the sample preparation time is short and the cost of analysis is low compared to measurement of ^{14}C . A major drawback of $\delta^{13}\text{C}$ in source apportionment is that several common sources overlap in $\delta^{13}\text{C}$ values which make source apportionment harder.

In this study we evaluate the performance of $\delta^{13}\text{C}$ in source apportionment at a rural measurement site in southern Sweden.

METHODS

Aerosols were collected on a weekly basis on quartz fiber filters at the Vavihill measurement station (172 m. a. s. l.) in southern Sweden during 2008-2009. $\delta^{13}\text{C}$ was measured with Isotope Ratio Mass Spectrometry (IRMS) and generated data was complemented with already published data of levoglucosan, F^{14}C , OC and EC (Genberg et al., 2011).

Source emission profiles of levoglucosan/EC, F^{14}C and $\delta^{13}\text{C}$ were established for the three investigated sources; fossil fuel combustion, biomass burning and biogenic emissions. These profiles were mainly based on literature data. Two Markov Chain Monte Carlo (MCMC) simulation runs were performed for the source apportionment calculations (Andersson et al., 2015). The model run named *MCMC2* only contained data on levoglucosan/EC and F^{14}C , while in *MCMC3* $\delta^{13}\text{C}$ was added to the above mentioned parameters.

CONCLUSIONS

In general, the *MCMC3* model apportioned 4% more of the TC to biomass burning compared to the *MCMC2* (Figure 1). Also the *MCMC3* model apportioned 8% less of the biogenic fraction

compared to *MCMC2*. The observed 3% difference in fossil fuel contribution was mainly caused by the suspected outlier showed in Figure 1. Thus the contribution of $\delta^{13}\text{C}$ to source apportionment of the TC aerosol at the investigated site is of minor impact. There was a considerable overlap in $\delta^{13}\text{C}$ between the biogenic and biomass burning source profiles which probably made the division between the two sources harder.

For the *MCMC3* apportionment, the biogenic emissions dominated during summer (68% of TC). During winter fossil fuel combustion and biomass burning was dominating the contribution to TC with 30 and 41%, respectively. Air mass trajectory analysis revealed that biogenic contribution was significantly higher when the air mass was arriving from western or northern direction.

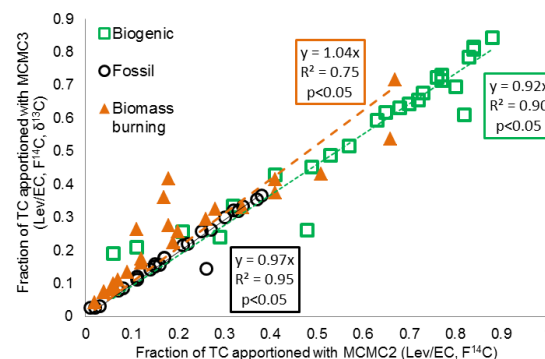


Figure 1. Relationship between the fraction TC apportioned from *MCMC2* (without $\delta^{13}\text{C}$) and *MCMC3* (with $\delta^{13}\text{C}$).

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