



# ***Interactive comment on “Trends, composition, and sources of carbonaceous aerosol in the last 18 years at the Birkenes Observatory, Northern Europe” by Karl Espen Yttri et al.***

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Reply to referee #2: The present study investigates the carbonaceous composition of PM<sub>2.5</sub> and PM<sub>10</sub> obtained at the Birkenes Observatory (GAW - EMEP) from 2001 to 2018. The data series is unique in Europe and has invaluable scientific interest. The treatment and interpretation of the data is adequate, and the results and conclusions obtained are very relevant. The results demonstrated a long-term change in the chemical composition of the aerosol at the background site of Birkenes and therefore also in the sources contribution to PM. Authors applied PMF receptor model to the 2016-2018 chemical dataset identifying 6 carbonaceous aerosol sources. They

demonstrated a decrease of traffic and industry OC/EC emissions, while the abatement of OC/EC from biomass burning has been slightly less successful. Moreover, results emphasize the importance of biogenic sources (BSOA and PBAP) at Birkenes site. The results demonstrated a decrease in OC/EC emissions from traffic and industry affecting the Birkenes site. This decrease is not as obvious for OC / EC from biomass burning, indicating a less successful abatement strategy. The results also emphasize the importance of biogenic sources (BSOA and PBAP) at the Birkenes site. Authors concluded the need of investigating trends in levoglucosan and biomass burning in Europe, given the further importance residential wood burning as a major source of air pollution in Europe. The need of measuring monoterpene and sesquiterpene oxidation products for improving the SOA apportionment is also highlighted. These data can be essential to improve the model outputs.

Reply to minor correction by referee #2:

We would like to thank referee 2 (R2) for his/her work valuable comments and corrections to our manuscript.

The data regarding the decreasing EC fractions in PM<sub>2.5</sub> (-4.0% yr<sup>-1</sup>) and PM<sub>10</sub> (-4.7% yr<sup>-1</sup>) in the abstract differs from the data in the main text (Line380: whereas it decreased for the EC fraction (-3.9 – -4.5% yr<sup>-1</sup>).

a) We have changed the values for the EC fraction of PM<sub>10</sub> and PM<sub>2.5</sub> in the abstract to “PM<sub>2.5</sub> (-3.9% yr<sup>-1</sup>)” and PM<sub>10</sub> (-4.5% yr<sup>-1</sup>) in line with the notification made by R2.

Line 58. I think OC and EC are not regularly measured in Air Quality Monitoring networks, with the exception of EMEP/GAW and aerosol in-situ ACTRIS sites.

b) We have changed the sentence to the following “. . . . . is measured regularly in major air monitoring networks such as e.g., EMEP and IMPROVE (e.g., Malm et al., 1994; Tørseth and Hov, 2003; Tørseth et al., 2012).” The Malm et al. 1994 reference has been added to the reference list.

Method section 2.2.1. What is the difference between the old and the new Birkenes Observatory? When was the new observatory installed? Please add some comments on 2.1.2,2,2 –

c) We have added the following text to include that there was a shift from the old Birkenes station to the new Birkenes Observatory in 2009:

“The Birkenes Observatory (58°23'N, 8°15'E, 219 m above sea level, asl) is an EMEP/GAW (Global Atmospheric Watch) supersite in southern Norway (Figure 1) situated 100 m south-east of the old Birkenes site, initiating measurements in 2009.”

Lines 187 188- It should be noted here that the “novel” positive matrix factorization for BC data is based on the methodology devised by Platt et al, in preparation. Is there any other reference to this method available (e.g., conference proceedings....)?

d) There is not yet any (other) reference available for Platt et al. (in prep.). Platt et al. (in prep.) has been added to the text.

2.4. It should be noted here that the PMF was applied to the 2016-2018 dataset.

e) We have modified the first sentence of Chapter 2.4 to account for the comment made by R2.

“We performed PMF ME2 (Canonaco et al., 2013) (See Sect. S3 for a description of the analysis principal and S4 for its application to filter data) for samples collected in 2016-2018 (151 samples),...”

Line210: was OC in PM2.5-10 calculated by difference (OC<sub>PM10</sub> – OC<sub>PM2.5</sub>)? Was EC in PM25 equal (or similar) to EC in PM10?

f) Yes, OC in PM10-2.5 was calculated by the difference between OC in PM10 and OC in PM2.5.

Concerning, whether EC in PM2.5 was equal (or similar) to EC in PM10: In Line 321-322 we write that: “EC, being from combustion that generates fine PM, was almost

exclusively associated with PM<sub>2.5</sub>, ...”. In line 565-566 we write: “In the present study, low levels of coarse fraction EC occasionally appear in summer and fall (Table S5), following the seasonality of PBAP”. In line 566-559, we argue that coarse EC most likely is an analytical artifact, resulting from charring of some types of PBAP during thermal-optical analysis.

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