

Atmos. Chem. Phys. Discuss., referee comment RC2
<https://doi.org/10.5194/acp-2021-496-RC2>, 2021
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Comment on acp-2021-496

Anonymous Referee #2

Referee comment on "What caused a record high PM₁₀ episode in northern Europe in October 2020?" by Christine D. Groot Zwaaftink et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-496-RC2>, 2021

This is an interesting case study on the origin of an episode of high PM in Norway (and Northern countries in general). The authors do a good job in describing the introduction, methods, and analysis. In my minor comments, I have some requests for clarifications, which should be easy to solve. As a major comment, I would question however, what have we really learned on LRT of dust and BC, that we didn't know before? For instance, it would be good to know whether this unique event (at least on a 4-10 year timescale), was and will remain exceptional, are there signs of intensification of emissions, change in transport patterns that could seriously jeopardize air quality in Norway (and other surrounding countries). While I realize that such analysis is beyond scope of the current paper, I do think that the paper could be strengthened, by outlining what further analysis should be done, to answer such questions. The paper also identified rather big differences between CAMS regional model efforts, and FLEXPART. What have we learned from these differences, and what would be steps to improve models?

I therefore complement the authors for the work in this publication, but also invite them to discuss above, to improve the relevance for a wider audience.

Detailed comments

l. 9 awkward sentence. Suggest: recorded weekly values exceeded historical weekly maxima for at least 4 up to 10 years. Why is a comparison made on weekly timescales and not on daily?

l. 11 what does the on-line /off-line refer to? Models? Please clarify

l. 17 expand the 'can not exclude other contributing sources'. Why can not excluded, and what could the 'other sources be.

L 103. I did not find additional information on this assumption in Appendix 1. Can a proper analysis on solubility be given in the appendix, and also why the specific associated ion rates choice.

I. 105 Sure it is an approximation, but is it a good approximation? Indeed reactions do take place, and it would be good if in further analysis later in this paper the validity of these assumptions will be tested- beyond the equation 2 and 3.

I. 115 Clarify if consequently the equations imply an upper and lower limit for biomass burning aerosol, as per mass balance. I think this is done in equation 8.

I. 130 as emission ratios vary widely, did the authors consider making an sensitivity analysis?

133 what is meant with atmospheric depletion? Oxidation?

I. 139 what is the meaning of (TC/levoglucosan)_{bb} I guess this is the emission ratio, but please specify.

I. 140 same for (OC/TC)_{bb}

I. 149/150 if this an important assumption, sensitivity analysis is needed.

I. 164 I expect that EC_{ff} is the difference of two big numbers, and therefore highly uncertain- at least in certain periods. Can the authors analyse the associated uncertainty?

I. 187 something seems missing "10BJ"

I. 215 Give some further information on what aspects can be retrieved by running Flexpart in forward and backward mode, and why a different use is made for BC and mineral dust.

229 why was 1x1 degree resolution used, which is later refined in 0.5 degree output. Simulations should be available on even finer resolution.

249-259 To what extent would these regional models be able to pick up dust emissions from central Asia, as the domain only partly covers the Central Asian desert region, and I guess the link to boundary conditions from the global model is not so straightforward.

163 Define RGB (definition come too late).

270 clarify this is top of the atmosphere radiance as observed by OLCI

273-280 clarify where the values used for the simulations were coming from.

293 days means exceedance days? The statement is somewhat confusing to give a number of exceedance days multiplied by # of stations.

295 to make sure I get this right: the number of 2 exceedance in November, makes up almost 20 % of what is usually (208;2019) observed?

306 already? What is meant?

310 explicitly mention whether a closure between 73 and 93 % is satisfactory or not, and in line/or not with other published results.

324 the long-term mean 2016-2019 refers to the annual average of daily/weekly over these years?

346 contribution of what?

365 simulations refers to the emission module?

391 it would be useful to include at some lines some labels for flexpart in the plots- it is quite tedious to go back and forward to the legenda. Also I am wondering to what extent the coincidence of patterns is really a sign of agreement, the text could be more expanded to explain if also radiative closure is obtained.

410 if there is a clear error identified the result should probably not be used (MOCAGE). It remains unclear why other CAMS models are so much lower than Flexpart. In general wet deposition is an important cause for discrepancies. If I understand well the resolution of CAMS models and Flexpart is the same/similar around 1x1 degree?

425 looking at the Birkeness data, it seems that also flexpart is grossly underestimating dust (assuming that in the period 2-4 October, dust is the dominant PM10 component). Interestingly there is a peak in the models that is not visible in the observations- end of September, although levels seem to be comparable. Not clear how dust concentrations in Birkeness lower panel (around 7 ug/m3 are related to the much higher PM10 levels). Looks inconsistent?

483 how much underestimated?

521 please elucidate a bit better what is displayed in Figure 10a (with unit per second).