Suggestions for changes from Ane

Title: Pameterisation of the responses of subarctic European vegetation to key environmental variables for ozone risk assessment.

General comment about the Introduction: It may be too long. But we can see what the reviewers think. I also miss some explanation about why we are interested in studying the effects of ozone on these far northern areas. There is justification given in our original project description and in many documents from the EMERALD group.

~~Line 20: “Ozone causes reduced photosynthesis…” instead of “Ozone is a cause…”~~

~~Line 21: Author name is wrong, should be Kangasjärvi. See the reference list, as well.~~

~~Line 35: include an indication of the present levels of ozone, for instance: The current ozone levels in Europe are around 40 ppb, in areas and periods without enhanced ozone formation.~~

~~Line 50: I don’t understand what the term “both pathways” refers to.~~

~~Line 56-58: “A cause for …” This sentence can perhaps be taken out? It doesn’t give me any useful information unless I look up all the referred papers.~~

Line 58: We could add a sentence about what Fennoscandia is, and that our area of interest is within that area? This could also be the place to explain why we care about this area in this study.

~~Line 61: “Meteorology plays …” This sentence seems anecdotal, and can perhaps be taken out?~~

~~Line 97: (see Eq. B6 in Appendix B)~~

~~Line 104: perhaps add a comma? “To achieve this, the concept ..”~~

~~Line 113: “For our study, we conducted a similar bio-monitoring study at Svanhovd, a site with agrometeorological and air pollution monitoring, to assess whether….” (I think we should not give the full name of the institution (NIBIO) every time we mention this place. The institution should be thanked in the Acknowledgement, but they are not a part of our project. They have not contributed to the study.)~~

~~Line 122: “.. saw only about 60 % of normal precipitation, one of the causes of the high rate of forest fires in that area.”~~ We could link the information about the drought and the air pollution in some way. This is only a suggestion. I also wonder if the report from the Norwegian Meteorological Institute had some considerations about the temperatures in Northern Norway that we could cite?

~~Line 126: Mistake with one “)” too many.~~

~~Line 133: We could add a sentence about the year 2019 resembling normal summers before we tell about the summer 2018 being an example of a year representing a probable future climate. So what I mean is to use two sentences instead of one, to avoid the confusion of “2018/19” and then the listing in the wrong sequence of “present and probable future conditions”.~~

~~Line 136: plural: “physiological responses”~~

~~Line 145: “Hence, we determine which parameters require special attention for more accurate pollution impact assessment…”~~

~~Line 146: Biogeochemical, not biochemical.~~

~~Line 149: “The observation site, Svanhovd, and available observational…”~~

~~Line 158-163: Replace the text with: We performed ozone concentration measurements in the subarctic, during the growing seasons of 2018 and 2019. Our chosen location was Svanhovd (69.45 °N, 60.03 °E, 30 m a.s.l.) for several reasons. There were ozone measurements there in the past, there is an agrometeorological station measuring many of the climate variables we needed, e.g. 2 m temperature, precipitation, global irradiance and soil temperature at different depths. We collected atmospheric monitoring and ozone monitoring data taken at Svanhovd over the past 35 years. There is also ongoing national surveillance of air pollution (NO~~~~x~~~~, SO~~~~x~~~~, PM, radiological species). Most of these measurements are performed by the Norwegian Institute for Air Research (NILU) and they also performed our ozone measurements. ­~~

~~Line 165: “All measured essential climate variables for the 2018/2019 growing season were obtained through luftkvalitet.no operated by NILU (a) (last accessed May 2020). Our ozone monitoring data have been added to luftkvalitet.no and the EBAS database…”~~

~~Line 168-170: Is it necessary to mention that Solberg 2003 is sceptical to the data if our conclusion is that they can still be used by us? It confuses me. If we mention this problem, we should explain why it is not a problem for us.~~

Line 174: “…a conventional ozone monitor … was installed during the 2018/19 growing season. We report [O3] in ppb for easy comparison with …” (I don’t see the point of inserting a term (VMR) that we will not need. I saw that you had it in the abstract as well. Maybe we can take it out?)

~~Line 178: “Cultivated species were e.g. clovers (~~*~~Trifolium repens, Trifolium pratense~~*~~), tobacco (~~*~~Nicotiana tabacum~~*~~, cultivars Bel-W3, Bel-B and Bel-C) and potato (~~*~~Solanum tuberosum~~*~~).”~~

~~Line 181: “… observed on the sensitive tobacco cultivar (Bel-W3).”~~

~~Line 209: Replace the first sentence with: Svanhovd is located within the subarctic climate zone. (I moved the coordinates to Chapter 2. I also think that this sentence gives what is common knowledge among scientists, but that it is fine that we confirm it with the following paragraph.)~~

~~Line 220: New sentence after “… < 20 mm).” March precipitation is primarily snow and will influence the start of the growing season.~~

~~Line 225: This sentence about averaged daily maximum and averaged daily mean: is this the average over 35 years of the day with the highest values and the mean value of all days in the growing season in 35 years? I assume that the latter has to be without night-time values? Sorry, that sounds silly. I think I would like to know more about what you are averaging.~~

~~Line 227: as above: Is this for the growing season? Daytime?~~

~~Line 232: “… coincides with the average beginning …”~~

~~Line 233: “In July-September (doy 182-273), ozone is …”~~

~~Line 271: “… enhanced during the growing seasn (GS) 2018/19, …”~~

~~Line 304: “… temperature probability density function (PDF)…”~~

~~Line 317: “… We, therefore, adjust the light sensitivity of stomata such that the PPFD value needed to reach 50 % opening is varied ± 20 %. For this we derive the inverse function…”~~

Line 324: look at the parentheses again.

~~Line 335: “For coniferous trees, we use a MODIS…”~~

~~Line 349: “ … personal communication, June 2020).”~~

~~Line 356: “… personal communication, June 2020). We used 13.5 m height for both deciduous and coniferous trees.~~

~~Line 371-372: “… ozone uptake for the bespoke temperature parameterisation is always …”~~

~~Line 385: “spruce parameterisation was already well acclimated to the prevailing temperatures and therefore differs the least from …” (add p and 2\*the)~~

~~Line 404: “From an agro-economical point of view in our focus area, where grass is cut only once a year, a loss…”~~

~~Line 410: “This means that…” I don’t see the logic here. This seems like a point that should be part of the discussion, but I don’t understand how our found interannual variation in biomass reduction shows that temperature acclimation can revoke or amplify the risk of ozone damage. Maybe you could explain a bit more, and move this part to the discussion?~~

Line 424-428: Large parts of this is a repetition of what has been said before.

~~Line 438: “That might explain why we observed damage in the ozone garden to a larger extent …”~~

Line 441: I am a bit confused about the use of the term intra-species variability in combination with the papers by Subramanian et al. and Girgždiene˙ et al., since they studied inter-species variability. The Bassin paper is about intra-species variability, as I recall it.

~~Line 448: “… cold temperatures leading to higher stomatal conductances at cool temperatures …” I think we should not talk about photosynthesis here, since that is more indirect.~~

~~Line 449-450: “… from observed temperature at Svanhovd …”~~

~~Line 468-469: I don’t understand what you mean with this statement, especially “... and its predictions …”. Can you explain more?~~

~~Line 475: “… established based on studies from less extreme climates.”~~

~~Line 476: “… and coniferous trees were breached in all years and for all …”~~

~~Acknowledgement: We thank NILU for performing the ozone measurements at Svanhovd for us, Bjørg Rognerud (Department of Geosciences, UiO) for processing SeNorge.no data with respect to beginning of growing season, Tore Flatlandsmo Berglen (NILU) for hourly pressure data from Svanhovd, NIBIO Environment Center Svanhovd for establishing and running the ozone garden both years, and Volkmar Timmermann (NIBIO) for sharing ICP Forest data from Svanhovd. This work was supported by the Research Council of Norway (Grant No. 268073).~~