Atmos. Chem. Phys. Discuss., 15, C3337–C3341, 2015
www.atmos-chem-phys-discuss.net/15/C3337/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Assessment of crop yield losses in Punjab and Haryana using two years of continuous in-situ ozone measurements" *by* B. Sinha et al.

Anonymous Referee #3

Received and published: 8 June 2015

The article presents calculations of yield losses due to ozone in India – both in terms of biomass and monetary value. The work is quite comprehensive and combines available literature data with new damage functions obtained from open-top chambers for various crops. Based on the new functions, which indicate a relative high sensitivity to ozone, the calculated losses are higher by a factor of more than two than previously estimated.

A deficit of the paper is that it uses various cumulative indices to be related with the damage, which all are calculated from concentrations but not from uptake. This is not state of the art (Danielsson et al., 2013, Yamaguchi et al., 2014), despite AOT40 being

still in use for such exercises (Feng et al., 2015).

The other concern I have about this paper is that it is rather confusing because it mixes a review paper with an analysis based on newly derived functions. Furthermore, it is very difficult to evaluate the methodology because concentrations, indices, and response functions are described at various places and only part of what is given in the descriptions is actually used. In addition, the importance of when the grain is sowed is often stressed but a sensitivity analyses about different sowing dates is not provided.

More specific remarks:

Introduction

P2357 (L20ff): The explanation about possible increased ozone damages under drought stress neglects that drought stress reduces the stomata conductance and thus the ozone uptake and damage. I guess that the somewhat strange argumentation refers to the impact of ozone to stomata regulation (Paoletti & Grulke, 2010). Differences in sensitivity to this effect could indeed cause a different ozone responses but I cannot follow the argumentation that is should occur more often in South Asia than in other regions.

P2358: The overview about ozone damages seems more or less comprehensive but more recent reviews are available as references (Ainsworth et al., 2012, Kangasjärvi & Kangasjärvi, 2014, Leisner & Ainsworth, 2012). Particularly the role of induced defences, which could be the cause of yield declines without visible injuries could be mentioned (Heath, 2008, Iriti & Faoro, 2009).

Materials and Methods

Here, five metrics and a historical overview about ozone damage related indices is presented although only two indices are used for further analysis. Moreover, the flux based calculation may be complemented by more recent formulations (Danielsson et al., 2013). Overall, this seems to be unnecessary comprehensive as is also the de-

scription of cropping seasons and crops where not only the crops used in the investigation but many others are also described. However, a simple percentage of coverage and thus a reason for choosing these particular crops is not given.

The description of the ozone dose exposure relationships is much too short and irritating. It is not clear which calculations are done with new OTC derived functions and which are not. This is partly done in the results sections (e.g. page 2371, parts of chapters 3.2.1 – 3.2.4) where it doesn't belong. It is also not quite clear from which periods the data for the newly derived functions are obtained and of different periods are used which then might need weighting with phenological preconditions. It would be a great help if all this information could be concentrated and re-written.

Results and Discussion

P2377, L1ff: I agree that rainfall can will reduce ozone related precursors but it would obviously be correlated with low radiation also. So the ozone forming potential would be low and the stomata would be less open, reducing uptake and relative yield loss. Can this be confirmed from the data? It is also a bit frustrating to read and think about the possible mechanistic relationships and then learn that no new exposure relationships exist for cotton and maize. In my opinion, the article should focus on wheat and rice (as implied in the title). The other crops may however complement the analysis in order to judge the relative importance of the new findings.

What I feel is missing is an analysis about the relative sensitivity of the results to 1) weather conditions in different years and the determination of ozone concentrations for the region and seasons, and 2) the exposure – damage functions used. To which degree can damage be avoided if sowing dates are adapted? Is it necessary to include a seasonal dynamic sensitivity to judge this and in which way would a cumulative uptake calculation be beneficial to the analysis?

Conclusion

P2383, L10ff: The polical demands seem to be quite unrelated to the research presented here. Despite they might generally be valid I don't think they should be voiced here.

Others

Despite an overall understandable stile, there are some problems with spelling and grammar as well as referring to the correct equation number (p.2366), full description of equation variables and other abbreviations (IGP). The text should also be checked for repetitions (e.g. p2370) and caption descriptions which belong beneath the figures (e.g. p.2371, 2374) that give some room for shortenings.

Figures and Tables

I a bit irritated by seeing cumulative exposure indices per month. I thought that the cumulative index always refers to the period of a plants (leaves) exposure to ozone. If any, the index should be steadily increasing until harvest. Could you thus please explain what the relevance or meaning of the values presented in Table 2?

Ainsworth E.A., Yendrek C.R., Sitch S., Collins W.J. & Emberson L.D. (2012) The effects of tropospheric ozone on net primary productivity and implications for climate change. Annual Review of Plant Biology, 63, 637-661.

Danielsson H., Karlsson P.E. & Pleijel H. (2013) An ozone response relationship for four Phleum pratense genotypes based on modelling of the phytotoxic ozone dose (POD). Environmental and Experimental Botany, 90, 70-77.

Feng Z., Hu E., Wang X., Jiang L. & Liu X. (2015) Ground-level O3 pollution and its impacts on food crops in China: A review. Environmental Pollution, 199, 42-48.

Heath R.L. (2008) Modification of the biochemical pathways of plants induced by ozone: What are the varied routes to change? Environmental Pollution, 155, 453-463.

Iriti M. & Faoro F. (2009) Chemical diversity and defence metabolism: How plants cope

with pathogens and ozone pollution. International Journal of Molecular Sciences, 10, 3371-3399.

Kangasjärvi S. & Kangasjärvi J. (2014) Towards Understanding Extracellular ROS Sensory and Signaling Systems in Plants. Advances in Botany, 2014, 10.

Leisner C.P. & Ainsworth E.A. (2012) Quantifying the effects of ozone on plant reproductive growth and development. Global Change Biology, 18, 606-616.

Paoletti E. & Grulke N.E. (2010) Ozone exposure and stomatal sluggishness in different plant physiognomic classes. Environmental Pollution, 158, 2664-2671.

Yamaguchi M., Hoshino D., Inada H., Akhtar N., Sumioka C., Takeda K. & Izuta T. (2014) Evaluation of the effects of ozone on yield of Japanese rice (Oryza sativa L.) based on stomatal ozone uptake. Environmental Pollution, 184, 472-480.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 2355, 2015.