Reviewer 1

General comment:

This paper presents ozone and water-stress impact on wheat productivity under current and future climate scenarios in India to highlight the importance of the irrigation for crop production. The effects of ozone stress on the yield under the different humidity and climate conditions were quantified based on WRF model simulation, and their sensitivities influenced by climate and plant were discussed. Overall, the study addresses a significant gap in the understanding of the agricultural impact of ozone and its coupling with water stress in India, a region experiencing increasing ozone pollution. The conception is interesting and impressive. However, authors only discuss the average result of ozone impact during the study period, the spatial and temporal variations of ozone impact are not included, which need more comprehensive investigations. Additionally, the method introduction should be more specific and detailed.

The following changes should be made to improve the manuscript with respect to clarity, information content and thus value to the reader.

We thank the reviewer for their insightful comments which have greatly improved the quality of the manuscript, we address the specifics of their feedback below.

Specific questions/issues:

Table 1： Temperature（°c）→℃
Corrected

Line 192: How to calculate the RstoH2O? based on Gsto?
Yes, it is the inverse of stomatal conductance to H2O, we add this into the manuscript to provide extra clarity to the reader.

Line 199-200: “Ky is the crop-specific yield response factor assumed to be 1.15 for the whole growing season” Are there any difference for the response factor of different wheat cultivars? as the different stomatal sensitivity and gmax.
The Ky values come from the FAO crop response to irrigation and drainage report, where 1.15 is the standard value reported for spring wheat. While it is highly likely that this value will vary slightly between different cultivars due to multiple cultivar-specific factors including gas exchange and photosynthesis, 1.15 is considered the average for spring wheat, while for winter wheat it is 1.05. In the absence of a specific value for Indian wheat, but knowing spring wheat cultivars are grown in the country, we use the spring wheat value.

Table 2: Canopy height: How about the variability of canopy height? Canopy height depends on wheat growth, and it increases from 0 m after sowing to the maximum height (~ 1 m) at the end of growth stage. Why do you choose the maximum height as canopy height in the simulation? How does the height affect the simulation? (Crop height: https://doi.org/10.1007/s12524-024-02028-4)
The canopy height affects how the O3 concentrations are propagated from the height at which they were measured to the crop canopy level. The accumulation of stomatal O3 flux using the method described in the present study begins at approximately mid-

anthesis (since mid anthesis to maturity is the O3 sensitive period for wheat). At mid-anthesis the crop can be assumed to be at its maximum height hence the choice of maximum height for the simulation.

Section 2: The method of chemistry simulation and evaluation in WRF model should be added, as ozone concentration is critical to ozone uptake and impact.
We have now made clear that the WRF-Chem model description provided in section 2.2 is for both meteorological and O_3 concentration data, the references provided give additional information on the O_3 chemistry used in the WRF-Chem model. A paper by Sharma et al. (2017) describing evaluation of the WRF-Chem model is included in this section:

"*WRF-Chem with the RADM2 chemical mechanism has been found to reproduce diurnal average ozone over India in February-May relatively well, while noontime ozone concentrations show considerable differences between simulations with various emission inventories (Sharma et al., 2017)*."

Section 3.1: Although phenology is crucial for leaf stomatal conductance and ozone uptake, the magnitude of ozone uptake is the most important for the accurate evaluation of ozone impact on yield loss. How do you assess the uncertainty of modelled POD?
We thank the reviewer for spotting that we have not included details of the certainty with which the DO3SE model can estimate PODy. We have now added text in Section 3.1 (which has been renamed to 'Phenology and stomatal ozone uptake') to provide additional details of how well the DO3SE model performs in simulating stomatal ozone flux.

Section 3.2: What is the definition of water-stress condition? Are there any indexes or indicators to measure the humidity? As POD is a cumulative metric for the whole period of wheat growth, how do you simulate the cumulative ozone flux under two humidity conditions? How about the spatial distribution of O3-related yield loss and WSRYL?
Water stress is defined within the text at line 112 as 'yield losses due to water stress [being] based on yield responses to the ratio of actual vs potential evapotranspiration (cf. FAO (2012))'. Soil humidity is defined by plant available water (PAW) which is defined in Table 2 and associated text, we now include units for PAW in the notes to the Table. PAW is also a cumulative variable (increasing and decreasing depending upon the balance between incoming precipitation and outgoing evapotranspiration). Since the estimate of PAW is intrinsically linked to g_{sto} via R_{stoH2O} (see Eq 5) the estimates of different levels of soil water stress are internally consistent with estimates of ozone flux. The spatial distribution of O_3- and water-stress-relative yield loss is not considered in this study as the model has been applied at a site-level.

Line 289-292: "Under rainfed conditions, mean O3RYL was projected to be negligible (0.6%), significantly lower than the mean O3RYL when no water-stress is assumed under irrigation (10.7% with a range of 4.8-15.4%). This demonstrates the importance of irrigation for wheat production in India and highlights the substantial influence on the yield of O3 for irrigated wheat." What are the main pathways through which the irrigation could reduce ozone impact? and their relative contributions?

Irrigation will actually increase ozone impact since irrigated conditions will increase stomatal conductance since there is no need for the stomates to close to conserve water. Irrigation will also increase transpiration which will reduce the leaf to air vapour pressure deficit which will also lead to an increase in stomatal conductance. These mechanisms are included in the introduction (i.e. see line 79) therefore no additional action is taken to address this comment.

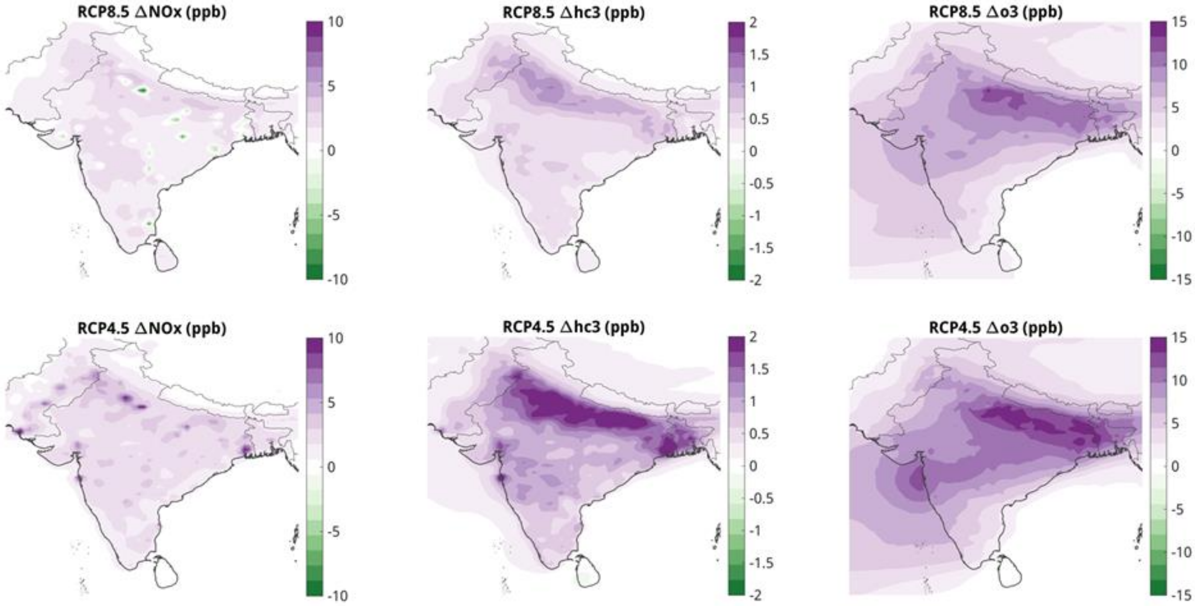
Lines 328-330: “The current climate represents the lowest mean O3, suggesting O3, rather than other environmental conditions that might influence sensitivity to O3, is the most important factor in determining O3-induced yield loss.” Please rephrase this sentence, it’s a bit hard to understand. Whose sensitivity do the environmental conditions influence?

Sentence modified to ‘*The recent past current climate represents the lowest mean* O_3*, suggesting* O_3*, rather than other environmental conditions that might influence sensitivity to* O_3*, (i.e. via alterations to stomatal* O_3 *uptake) is the most important factor in determining* O_3*-induced yield loss*’ to make it easier to understand.

Lines 350-355: “Whilst the RCP4.5 scenario sees a global reduction in [O3] due to pollution regulation, the South Asian region is an exception to this rule, where [O3] continues to increase at a similar rate as occurred in previous decades (Tai and Martin, 2017). RCP8.5 projects a worldwide increase in [O3] due to the lack of regulation of precursor emissions except in parts of the US, East and Southeast Asia (Tai and Martin, 2017). Therefore, mean [O3] during the growing season is lowest in the current climate at 48.6ppb but similar, at least in South Asia, in both the RCP4.5 and RCP8.5 scenarios (60.5ppb and 59.7ppb respectively; Table 1)”

Ozone concentration continues to increase at a similar rate under the RCP4.5 emission scenario, and RCP8.5 also will lead a worldwide increase to ozone due to the lack of emission regulation. So why are ozone concentrations at the similar levels under RCP4.5 and RCP 8.5? and ozone in the RCP4.5 is even slightly higher than that in the RCP8.5.

We agree that the similarity in future ozone concentration change between RCP8.5 and RCP4.5 may sound counterintuitive. We have looked into the WRF-Chem model results for some of the ozone precursors, NOx and hc3 (a lumped NMVOC compound covering several alkanes), and their future changes over India are also similar between the two scenarios, with somewhat larger increases for RCP4.5 than RCP8.5:



10-year averaged WRF-Chem results of 2046-2055 minus 1996-2005 concentration changes for December-April zoomed in over India.

These NOx and hc3 concentration changes are strongly influenced by changes in local NOx and NMVOC emissions, and are likely to explain why O_3 is slightly higher in RCP4.5 than RCP8.5, although several factors contribute. To shed some more light on this issue, we have added the following after the above-mentioned text:

"*Relatively small differences in 2000-to-2050 increases in O3 over South Asia between RCP4.5 and RCP8.5 have also been found before (Tai et al., 2014; their Supplementary Figure 1). Our WRF-Chem model results do show a slightly higher increase in O3 precursors over India in RCP4.5 than RCP8.5 (not shown), likely explaining the slightly higher ozone increase in the RCP4.5 scenario. However, several factors influence the modelled future ozone concentration changes, such as the future change in meteorological variables, the non-linearities of ozone chemistry, and natural interannual variability. Future studies should utilize emission scenarios that are more updated in terms of air pollution policies*."