We are very grateful to the reviewers for their valuable comments and suggestions, which have helped us greatly in improving our manuscript. We have addressed all the comments and revised the manuscript accordingly. The point-to-point responses are provided below in Italic.

Anonymous Referee #2

This publication represents a robust analysis of contributions to surface and tropospheric ozone. While several prior studies have found similar results, and in this sense the study is maybe not completely new, the comprehensive analysis of contributors to ozone over Asia has clearly added value.

On the downside, I think it is regrettable that the authors have not attempted to align their study better with the HTAP2 source-receptor studies, that included harmonized simulations of emission sensitivities and responses over East Asia and a number of other world regions, updated and harmonized emissions, etc. As a result, it is becoming more difficult to evaluate uncertainties related to the use of one specific model compared to other models.

Nevertheless, I find the overall analysis convincing, the material well presented, and therefore recommend to publish the manuscript in ACP, with some suggestions for minor revision presented below.

Minor suggestions:

l. 17 East Asia defined as : : :.

We added the geographic boundaries to define the domain of East Asia in this study.

l. 48 the ecosystem=>ecosystems.

Thanks. The sentence has been revised.

l. 54 why?

This sentence is revised to explain why.

l. 57 I don't find this in Fiore's paper. Anyway as the ozone response depends on the emission reduction strength, the sensivity will depend on the magnitude of perturbation. In this sense perturbations that are close to the present situation (i.e. a 5, 10 or 20 %) are used for Source-receptor relationships, sometimes with a correction for larger perturbation sizes. These have been used e.g. in HTAP1, and HTAP2, and other studies by individual researchers also for Asia. A nice paper that combines source attribution and tagging paper: https://www.geosci-model-dev.net/11/2825/2018/. It can be used to address some of the uncertainties. I also note that it is not very clear around

Thanks for this point. It is better to call this method as "perturbation (sensitivity) method "as suggested by Butler et al. (2018). Reducing the emissions of ozone precursors in source regions to zero in this study is one of the scenarios of the perturbation method. In the manuscript, the 'emission zero-out' has been revised as 'emission perturbation'.

l. 154 how exactly the tagging was done- and there are several ways to do so.

In this study, ozone molecules were tagged based on the geographical model domains in which the ozone molecules are formed (Wang et al., 1998). Using the daily ozone production and loss data archived from a full chemical simulation conducted beforehand, net ozone production at each model grid was resolved. For a specific source region A, ozone produced in A is labelled as a tracer. The tracer excludes the ozone molecules formed outside A. Therefore, how the tracer distributes spatially directly show the ozone transport from A to the outside. The amount of the tracer in a receptor region can be directly attributed to ozone production in A. Overall, the tagged ozone simulation in this study tracks ozone produced in the troposphere over each of the defined source regions along its transport into a receptor region. The

explanation is added in the last paragraph of section 2.

l. 98. It is confusing to talk about trends when you really talk about interannual variability.

Thanks for the point. The discussion about the trend has been deleted.

l. 127 I notice that this resolution is meanwhile not really state-of-the-art. Mention already here that you also do higher resolution sensitivity simulations

Thanks. We added statements on our run at higher resolutions.

l. 130 Unfortunately the different choice of regions compared to HTAP1 or HTAP2 does not help in comparing to other model simulations.

Definition of the study domains in this study is slightly different to that in HTAP1, but with similarities (Table R1). The comparison has been added.

Table R1. Comparison of the definition of the study domains between this study and HTAP1.

	This study	*HTAP1*
East Asia	*95 °E-150 °E, 20 °N-60 °N*	*95 °E-160 °E, 15 °N-50 °N*
North America	*170 °W-65 °W, 15 °N-70 °N*	*125 °W-60 °W, 15 °N-55 °N*
Europe	*15 °W-50 °E, 35 °N-70 °N*	*10 °W-50 °E, 25 °N-65 °N*
South Asia	*60 °E-95 °E, 5 °N-35 °N*	*50 °E-95 °E, 5 °N-35 °N*

142-145 I guess what the authors are doing here is introducing a correction factor so that the sum of the individual region 100 % perturbations nicely sums up to a global perturbation? How large are these corrections?

Yes. In Equation (1), $\sum_{i=1}^{8}$ (CTRL - EAnth-X_i) is the sum of the ozone response to the 100% perturbation at each of the defined regions, CTRL - EAnth-GLO is the ozone response to the 100% perturbation for the globe. In the East Asian troposphere, ozone

concentration from $\sum_{i=1}^{8}$ (CTRL - EAnth-X_i) is 0-4 ppbv (0-20%) higher than that from CTRL - EAnth-GLO (Figure S1). For each source region, the correction over East Asia is less than 1 ppbv. The magnitude of these corrections are added.

l. 164. Linoz. Does this effectively mean a constant yearly influx of stratospheric ozone by 484 Tg in these variation. Note that it is likely that there is a correlation between large scale circulation (and I guess monsoon as well) and strat-trop exchange.

Thanks. The influx of stratospheric ozone to the troposphere varies interannually and is ~484 Tg in 2005. The explanation has been added.

l. 137 Why were 2006/2007 chosen? And not more recent years (e.g. HTAP's 2010)

Thanks. In this study, GEOS-Chem was driven by GEOS-4 meteorological data, which has strong performance in simulating tropospheric ozone (Choi et al., 2017; Y. Zhu et al., 2017; Han et al., 2018). GEOS-4 covers 1985-2006, which is the study period here.

l. 157 No variation in chemistry. In the next line the authors explain this is achieved by extracting production/loss data for 2005. This is going to lead to inconsistencies (and hopefully identical results for 2005). This needs discussion.

Thanks. Daily ozone production and loss data in 2005 were used for all the years from 1986 to 2006. Therefore, in the simulations, the daily data in 2005 allow a seasonal variation, but no interannual variation in chemistry. Here "No variation in chemistry" means no interannual variation in chemistry. The sentence is revised to clarify the meaning.

l. 170. The results of using different resolutions and meteorological drivers, needs to be somehow included in the discussion of uncertainties.

Thanks. Added in the section of Discussion and Conclusions.

l. 194 here the operational definition of troposphere needs to be given.

Thanks. Added.

l. 202-204 In this case North American ozone is both from natural and anthropogenic emissions as well as stratospheric ozone that entered the North American region?

Thanks. For a specific region, ozone produced in the troposphere over that region is named after that region, such as 'North American ozone'. Ozone produced in the stratosphere and then entered the troposphere is labelled as 'stratospheric ozone', an independent tracer. So, North American ozone excludes stratospheric ozone that entered North America. The original Table 2 (present Table S1) explained this. We further clarified this in this revision.

l. 330 I recommend also to consider the results of Turnock et al, ACP, 2018, which discusses HTAP2 results.

Thanks. Added.

l. 346. This finding warrant a bit more discussion, given the similarity of emissions but longer distance compared to Europe.

Thanks. The expression has been revised. On annual average, North America and Europe contributes 5-13 ppbv (7-12%) and 5-7 ppbv (3-11%) to ozone in the East Asian middle and upper troposphere, respectively. The annual mean of North American ozone is higher than that of European ozone over East Asia at layers above 500 hPa.

To compare the two, we further conducted four sensitivity experiments. In two of simulations, biogenic emissions in North America and Europe were turned off, respectively. In another two simulations, lightning NO_x emissions in North America and Europe were turned off respectively. The difference between the results from the

control experiment and those from these four sensitivity simulations are shown in Figure S4. It is demonstrated that the difference between North America and European ozone over East Asia is from both anthropogenic and natural emissions including biogenic and lightning sources. The analysis has been added in the first paragraph of section 3.2.1.

l. 368 I guess that can well be, also given the fact that many other models have larger stratospheric influxes. Would the conclusions change substantially if the number would be double. It is unclear to me how stratospheric ozone influx is accounted in the various attribution methods (e.g. influx of ozone In Europe, is that European ozone as well?)

Thanks for the points. In this study, stratospheric ozone is ozone produced in the stratosphere and then transported into the troposphere. Stratospheric-to-troposphere ozone flux is the amount of the stratospheric ozone that entered the troposphere. European ozone is the ozone produced in the European troposphere. So, stratospheric-to-troposphere ozone flux over Europe is excluded in European ozone. Stratospheric ozone transported downward to the troposphere is showed in Figures 9 and 10. The values of ozone concentrations from different source regions (Figures 9a-9d) would not changed if the stratospheric ozone is doubled. We assessed the fractional contribution of ozone from different source regions in Figures 9e-9h and Figures 9i-9l, respectively. A change in the influxes of stratospheric ozone would not affect the results in Figures 9e-9h but in Figures 9i-9l. This is explained in section 2 in this revision.

l. 410 It is not so clear why you would need 3x2 monsoon indices. If they are so different, please summarize what aspects they would represent stronger. Please also clarify how monsoon (summer phenomenon) indices also can have significant correlation with winter ozone.

Thanks. We used three monsoon indices for winter and three for summer, respectively. In each season, the three indices describe the features of the EAM from different perspectives. The monsoon indices were correlated with ozone variation in the same season. The monsoon indices in summer were not connected to wintertime ozone. The explanation has been added. We have also added the correlation coefficients for each of the indices in Table S2, and the corresponding analysis is added in section 4.

l. 540 It would have been great to use the HTAP2 compilation for 2008/2010- as did many other models. It would be good to mention at least the differences.

Thanks. In future studies, the HTAP2 emission inventory can improve the estimates of foreign influences on ozone over East Asia and their long-term trends. The difference between the anthropogenic emissions in this study and that for HTAP2 is briefly discussed in the last section. From 2000 to 2010 in EDGAR emission inventories, NO_x, CO, and NMVOCs respectively changed by 9.5%, -1.2%, and 5.2% globally, and the three species decreased across North America and Europe but increased in East Asia (Turnock et al., 2018).