Response to reviewer comment on "The contribution of air temperature and ozone to mortality rates during hot weather episodes in eight German cities during the years 2000 and 2017" by Alexander Krug et al.

Anonymous Referee #2

Received and published: 2 June 2020

We sincerely thank you for the overall general feedback of our work as well as the constructive comments on the manuscript. This is highly appreciated. We reply to the reviewer comments below. Reviewer comments are in black and italic, authors' responses in blue.

Specific comments:

RC1: "A major concern is related to the choice of Multiple Linear Regression (MLR) and the fact that all conclusions are based on the MLR test statistics assuming a normal distribution of the data. Crude mortality rates usually do not follow a normal distribution. If they do, please show results of normality testing. Mortality rates are count data and a Poisson distribution can be used as underlying distributional assumption in the scope of generalized linear models."

Answer: The majority of epidemiological studies use generalized linear models to investigate the effect of air temperature or air quality on death counts. Crude death counts typically follow Poisson distributions which excludes the use of common linear regression analyzes. In contrast to this common approach, the underlying method of this study differs in two major points. Firstly, the method does not use crude death counts as effect variable. The mortality rate is used instead, which describes the number of deaths per population unit (mortality) as rate per time unit (day). Secondly, we do not investigate the overall relationship of daily air temperature values, ozone concentrations and death counts. Only episodes of variable duration of at least three days are investigated. For these episodes we assume a normal distribution for values of mortality rates of the investigated cites. Therefore, the method allows the use of simple or multiple regressions. A distribution histogram for the investigated cities is attached below. We do not claim our method to be better than other approaches nor the best in terms to investigate air temperature or air quality effects on death counts or mortality rates, yet it allows a more precise identification of episodes of potential hazardous atmospheric conditions for the public.

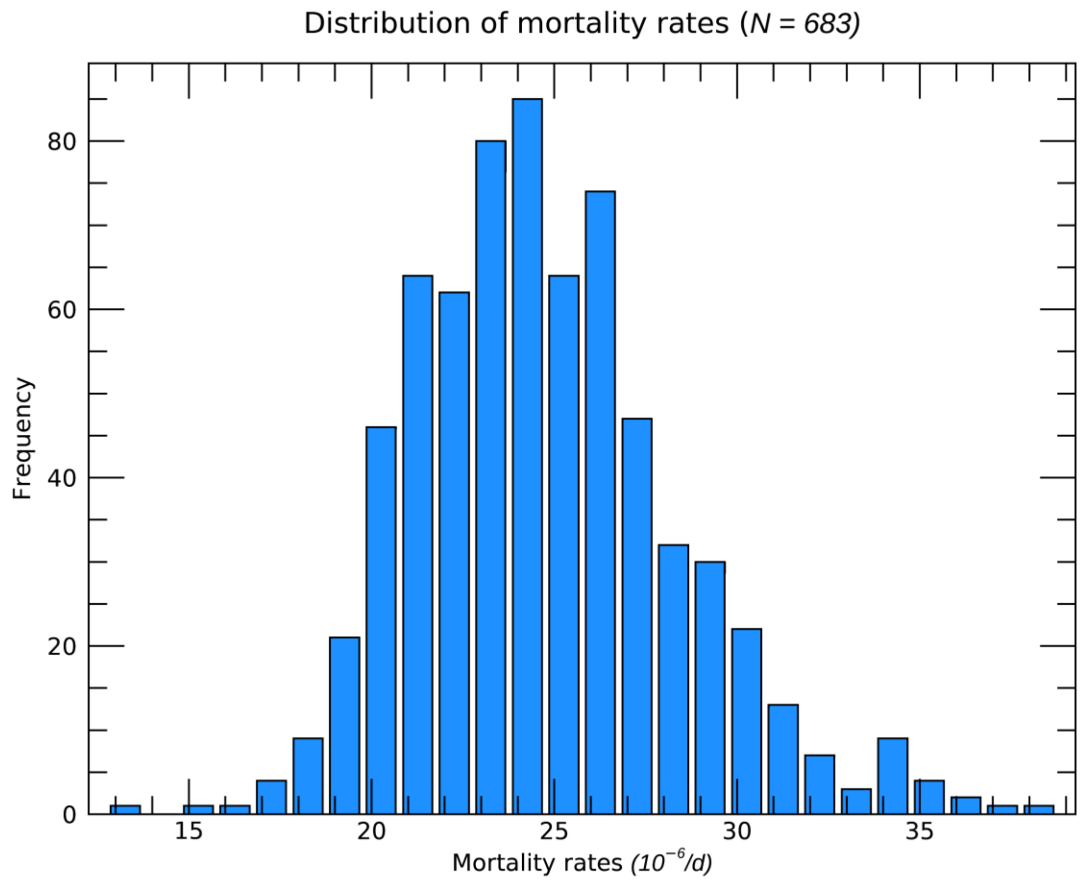

Figure 1: Exemplary distribution histogram of mean mortality rates during episodes exceeding 20 °C (T_{mean}) for at least three consecutive days. The sample contains episode-specific mean mortality rates of all cities.

RC2: "Furthermore, some of the conclusions have to be reconsidered. At page 11, lines 2018-2019 it is stated that the effect of air temperature on mortality is stronger in comparison to the effect of ozone. I disagree with this conclusion, because only events with high temperature have been selected and MLR is tuned towards this variable. These events do not necessarily go along with the ozone concentrations relevant for mortality."

According to numerous investigations, ozone concentrations are highly relevant for public health and mortality. It is not the aim or conclusion of this study to weaken the importance of ozone concentrations. Our results underline quite the opposite; the found interaction underlines that during HWE not only elevated air temperature affects mortality rates. The interaction between air temperature and ozone concentrations as a statistically non-separable portion of the explained variance of mortality rates plays an important role during HWE. The statement you mentioned in your comment refers to the comparison of single proportions of each variable (air temperature magnitude, TA_{Mag} and $MDA8_M$) to mortality rates. In particular, episodes detected via high TA_{Thres}, TA_{Mag} explain more of the variance of the mortality rate that $MDA8_M$ (see Fig. 3 in the manuscript). We also investigated lower TA_{Thres} down to the 70th percentile, in which $MDA8_M$ reaches higher values for the explained variance compared to TA_{Mag}. Nevertheless, we will reconsider the statements in this section according to your concerns.

RC3: "At lines 228ff. you notice that a lower TA_{Thres} captures more HWE in which air temperature is relatively low, but ozone concentrations can reach high values. This suggests that the typical non-linear relationship between temperature and ozone has an impact within your analysis. This should also be further investigated."

Our results show that the relative contribution of TA_{Mag}, $MDA8_M$ and their interaction depends on the distinct TA_{Thres} which identifies HWE (Fig. 3). In our opinion, different r^2 for TA_{Mag} and $MDA8_M$ among different TA_{Thres} indicate a potential non-linearity between air temperature and MDA8. Otherwise, as shown in Fig. 4 in the manuscript, the relationship between HWE and MDA8 shows a linearity for each TA_{Thres}, based on the position of the median, the 25th and the 75th percentile. Therefore, the interpretation of the role of air temperature and ozone concentrations strongly relates to the distinct TA_{Thres} and thus the identification of potential hazardous episodes. Your comment is a truly interesting point for further investigations. However, in terms of our research questions and aims we see no need to extent our study to this point. Yet, your point will be taken into account in further work.

Technical corrections:

All your technical comments will be considered in the revised manuscript.