

Anonymous Referee #1

The most important of this study is to provide more accurate chlorine emission inventory (with significantly reduced uncertainties) than previous studies. The authors also pointed out that some modeling studies have used the anthropogenic chlorine emission as inputs and found that the simulated concentrations of chlorine species (HCl and pCl) were underestimated against the observations, suggesting that there are large uncertainties or missing sources for the current emission estimation. Therefore, the chlorine emission inventory shall be proved to be more reasonable and has been cross-checked. Otherwise, any study is just a big homework to duplicate or compile previous works. Unfortunately, I do see this study is lack of solid basis or significant improvement in terms of more accurate emissions factors, etc. This flaw makes this study less meaningful.

When comparing with other works, the authors frequently attributed the difference to the use of different methods / different emission factors, without further in-depth explanations. The authors emphasize frequently that this updated inventory considered more anthropogenic sources, used more localized emission factors, and adopted more refined estimation methods. However, which one is better? Can the authors prove that the current emission factors / methods are more accurate? Can the authors prove that the uncertainties have been significantly reduced? For example, comparing results with observations?

**Response:** Thank you for your feedback. We have improved the emission inventory in the following aspects: (1) The anthropogenic chlorine emission inventory has been updated from the year 2018 to 2019 in this study. (2) Added emissions from medical waste disposal, an aspect often overlooked in other studies. With increasing public awareness of hygiene, emissions from medical waste disposal have become more important. (3) For biomass burning, adjustments were made to both household burning rates and open burning rates. Specifically, for biomass open burning ratios, this study re-calibrated the ratios from the research by Zhou et al. (2017) based on changes in fire

radiative power over croplands from MODIS satellite fire point data. Additionally, through literature research and based on Liu et al. (2022), we used statistical linear trend analysis to estimate household burning ratios for 2019. (4) Regarding car washing water, as opposed to Li et al. (2020), which assumed uniform water usage for each car wash, this study considered different types of vehicles with varying water usage and washing frequencies to provide a more realistic estimation.

With these improvements, the uncertainty of the emission inventory is significantly reduced compared with previous research. Additionally, we validated the emission inventory by incorporating it into the WRF-CMAQ model for a one-year simulation and comparing the simulated chlorine species with the observations. This cross-validation further demonstrates the relatively faithful estimation of chlorine emission in this study. The validation can be found in section 4.1.

Major comments:

[Comment]: 1. In all the formulars, there are even no units for each parameter. In the calculation method of Cl<sub>2</sub> and HOCl emissions, they do not consider the available chlorine parameters and Molecular weight and other indicators.

Response: Thank you for your comment. The data referenced in the formulas are mostly provided in the SI manuscript, and units are specified for these data. Furthermore, parameters with units in the main text have been appropriately modified and supplemented. In this study, the term "chlorine addition" refers to the effective chlorine content in water after the addition of disinfectants. Therefore, we believe there is no need for additional parameters such as effective chlorine and molecular weight.

[Comment]: 2. For Industrial Production Process, there are chemical industries producing disinfectants, which will also emit HOCl but neglected. For spatial allocation of industrial production, the paper assumed a uniform emission for them and spatially allocated the provincial emissions evenly to each point!

Response: Thank you for your comment. Unfortunately, we currently lack data on disinfectant production, so emissions from the production of disinfectants cannot be considered at the moment. Additionally, we do not have specific production scale data for each factory. If we obtain this information in the future, we will certainly update the inventory more accurately.

[Comment]: 3. Environmental disinfection: The quantity of disinfectant utilized in each hospital is a very important parameter to estimate Cl<sub>2</sub>/HOCl emissions from hospitals. However, the paper just cited a very old data in Taizhou in 2007 and expanded to year 2018 by using the formula  $U_{2018}=U_{2007} \times C_{2018}/C_{2007}$ .

Response: Thank you for your inquiry. With enhanced awareness of hygiene in hospitals, both the usage of disinfectants and overall healthcare costs tend to increase. The overall healthcare costs can to some extent reflect the changes in disinfectant usage. Therefore, in the absence of specific studies on the quantity of disinfectant used in hospitals, this study's estimation of the disinfectant usage for the year 2019 based on changes in overall healthcare costs is considered reasonable.

[Comment]: 4. Biomass burning: The study used the proportion of open biomass burning of Zhou et al., (2017) to estimate emissions of HCl and pCl from biomass burning sources. However, China has made great efforts to ban open straw burning, will this method introduce overestimations?

Response: Thank you for your suggestion. Consequently, regarding the biomass open burning ratio, this study re-adjusted the ratios proposed by Zhou et al. (2017) based on the variation in fire radiative power over croplands from MODIS satellite fire point data (<https://modis.gsfc.nasa.gov>). In addition, through a literature review and drawing on the research by Liu et al. (2022), we estimated the household burning ratio for the year 2019 using a statistical linear trend. Specific numerical values can be found in Table S8.

Liu, Y., Zhao, H., Zhao, G., Zhang, X., Xiu, A.: Carbonaceous gas and aerosol emissions from biomass burning in China from 2012 to 2021, *Journal of Cleaner Production*, 362, 132199, 2022.

[Comment]: 5. Usage of pesticide: Most data are cited from the year 2016.

Response: Thank you for your inquiry. Regarding the use of pesticides, the activity level data in this study is subject to variation. However, the emission factor, as the pesticide application process typically occurs in open settings, remains constant in its release rate. Therefore, we have set the emission factor for pesticides to be constant and not vary with the years.

[Comment]: 6. Chlorine-containing disinfectant: Table S5 gives the emission factors of Cl<sub>2</sub> and HOCl from various disinfectant sources. Are they inconsistent with the calculations of formulas 3 and 12? If they know the emission factor data for each type of source, the emissions can be calculated directly with the activity level data.

Response: Thank you for your inquiry. The emission factors column in the original Table S5 was not obtained through literature research but was calculated and processed by us. In order to avoid any potential confusion for readers, we have removed that column of data. The table has been revised, and you can find the updated information in Table S11.

Anonymous Referee #2

Review comments on the manuscript titled “ACEIC: a comprehensive anthropogenic chlorine emission inventory for China”

The authors have addressed the points raised by reviewers and improved the manuscript.

I only have the minor comments below for technical corrections:

[Comment]: Line 143, the term of "chlorine content" is confusing. Maybe use something like mass ratio of chlorine in chlorine species.

**Response: Thank you for your suggestion. The phrase "chlorine content in chlorine species" has been revised to "mass ratio of chlorine in chlorine species."**

[Comment]: In Section 4.1, please cite the references properly when you showed values from literature.

**Response: Thank you for your suggestion. The citations have been added as suggested.**

[Comment]: Fig 5, I still think a unit of Mg/grid is meaningless. You can easily transfer the unit to Mg/km<sup>2</sup>.

**Response: Thank you for your suggestion. The units for Figure 5 and Figures S3, S4 have been changed to kg km<sup>-2</sup> yr<sup>-1</sup>.**