

## ***Interactive comment on* “Long-term historical trends in air pollutant emissions in Asia: Regional Emission inventory in ASia (REAS) version 3.1” by Junichi Kurokawa and Toshimasa Ohara**

### **Anonymous Referee #1**

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I've reviewed the paper "Long-term historical trends in air pollutant emissions in Asia: Regional Emission inventory in ASia (REAS) version 3.1" by Kurokawa and Ohara. This is an important contribution to the literature, covering a region where emissions are changing rapidly, as mentioned by the authors. The authors should also be commended for providing summary data on-line.

As detailed below, however, significantly more detail needs to be provided in terms of definitions and methodology. The present paper gives a general overview of the methodology, but the resulting emissions are still too much of a "black box" otherwise. I would like to re-iterate that this is important and useful work, but I believe additional

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documentation is required as discussed below.

Section 2 "Methodology and data" provides a reasonable overview of the methodology, but this needs to be supplemented with much more detail in the supplementary information. There are numerous places throughout this section where a general procedure is described, but then no details are provided. This additional detail is needed is both to satisfy the general scientific publishing principle that work must be, in principle, reproducible, but also so that readers and users of the data can better interpret these results. This information should largely be in the supplementary material.

Some specific points in this regard:

Definitions of the sectors that are included within REAS needs to be provided in much more detail. The EDGAR inventory, for example, provides a fairly comprehensive list of sectors (although even here not all sources are included - REAS includes human waste sources of NH<sub>3</sub>, for example, while EDGAR does not. This is an example of why it is important to have comprehensive documentation of the methodology and definitions). It is important for users of this data to have this information available.

What is needed is a detailed table with sub-sector definitions. For example Table S3 in Janssens-Maenhout et al 2019 and Tables A1 and A2 in Hoesly et al. 2018.

It is not clear the extent to which non-combustion emissions are included in REAS (I presume they are), and which sectors are included and how they are estimated. For example see the list of non-combustion sectors from EDGAR noted above. Are all of these included for all species in REAS, or just some? (Industrial process emission sources are mentioned in the text, but that is not very specific. Some of the specific non-combustion sources that should be discussed (whose level of inclusion varies between inventories) include: emissions from coke production, non-ferrous metal smelters, refineries, agricultural NO<sub>x</sub>, open residential waste burning (and waste burning in dumps), and so on.

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For these sectors, clarify if just combustion-related emissions are considered, or also if process (non-combustion) emissions. This is particularly important for sectors that have both combustion-related and non-combustion emissions such as refining, coke production, etc.

Similar to sectors, the fuel categories used in the calculation need to be discussed as well. While the table "3.2 Fuel types" in the document "Brief description about table data v3.1.pdf" gives an overview, this is not a complete definition of each fuel type. To give just one example, it is not clear what category LPG is in. Since the authors use the IEA energy statistics, what would be most useful is a correspondence between the fuels detailed in IEA and the aggregate fuels reported by the authors.

Given that multiple data sources are used for fuel consumption, comparability of definitions and data time series between multiple sources used for some countries should be addressed.

The authors mention that fuel use by sector is extrapolated back into time before the point where detailed data is used by constant sector shares. This is an important assumption, so the year at which this assumption comes into force should be listed in the supplement. (For example, given the greater data availability for Japan, perhaps fuel use by sector is available over all time periods.)

For some countries and time periods fuel consumption in non power plant transformation sectors, particularly coal coke production, is large. How this and other non-combustion or feedstock use of fuels is dealt with over time should be discussed.

Overall, the data sources for assumptions for both activity data (including associated information such as fuel use by vehicle type) and emission factors are unclear. What would be helpful is a comprehensive table (or, likely set of tables), that list this information by sector and country (and species, where relevant). It appears that there are specific data sources for some countries, while for others more generic assumptions are used (in which cases, those countries could be grouped together).

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For road vehicles, the relationship between the "tentative emission factors" and final emission factors in section 2.3.3 Emission factors is unclear.

One of the significant contributions of this work is the consideration of emission controls. The data sources and assumptions for these calculations by country should be described in greater detail (again, largely in the supplement). This will provide the readers with important context in terms of how reliable this information might be (e.g., presumably more reliable for Japan than for some other countries!)

At minimum, figures for countries other than Japan and China (e.g. Figure 3, and 5) should be provided in the supplement (at least for those countries with non-zero levels of control). Ideally numerical values would be provided as well.

The development of emission control assumptions for industry is not described in the text. This is an important sector for air pollution, so further information should be provided. For example, it is not clear to me what BC or SO<sub>2</sub> controls in China represent going back as far as 1990. (Very recently SO<sub>2</sub> controls were mandated in industrial boilers, but my understanding is that these controls were only for very recent years.)

Also, are emission controls considered for only industrial combustion emissions? Or also for industrial process emissions. Note that technology changes can have a very significant impact on emissions from industrial process technologies (e.g., metal smelters, coke production plants, refineries, etc.). The assumptions here should be discussed. (As noted above, it is not clear the extent to which emissions from these sources/sectors, other than combustion emissions, are included.)

It is unclear what is meant by "In REASv3.1, aviation and ship emissions are not included", except then it is said "emissions from domestic shipping including fishing ships were roughly calculated for comparison with other inventories (see Section 3.3)." Clarify. I assume this means that international shipping emissions are not included at all. Does this mean that domestic shipping and fishing emissions are included? What are the data sources for these? (Presumably largely IEA?) So are these emissions

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included in the REAS3.1 totals? Or are they just included for comparison with other inventories? P

Note the substantial literature on shipping emissions, which notes that shipping fuel use, particularly into the past, is inconsistently and incompletely reported in general.

I note that with these additional details in the supplement, it will likely be possible to streamline the main text somewhat to make the paper more readable.

Section "3.1 Trends of Asian and national emissions" is a bit tedious with the reporting of numerical results. Given that the numerical results are available on-line, the detailed recitation of numerical values in the text is not necessary and detracts from reading the manuscript. A more general overview of the trends and drivers with fewer numerical values would be more useful.

Line 595 "As described in Section 2.5". I believe this is Section 2.6?

In "3.3 Comparison with other inventories" it should be mentioned if the sectoral coverage of the inventories compared are the same? Different sectoral coverage can lead to artificial differences in such comparisons.

Note that for many emissions and countries in Asia the CEDS data was calibrated to REAS2.1 - hence the similarity in results.

This section is long and difficult to read. The extremely long paragraphs should be broken up and, where possible, streamlined.

The uncertainty calculation is a valuable and important portion of the paper. However, the specific uncertainty assumptions used need to be provided (e.g. in supplemental information), It would be useful to provide some equations here.

How do these assumptions vary by sector and fuel? Are these assumptions constant across countries? And across time? How is uncertainty in emission control percentages handled? One important assumption is how uncertainty was combined across

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fuels and sectors is a critical part of the methodology and needs to be described (e.g. are independent uncertainties assumed, or is some correlation assumed?).

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