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Geoscientific Model Development Discussions
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Interactive comment on "Historical (1750–2014) anthropogenic emissions of reactive gases and aerosols from the Community Emission Data System (CEDS)" *by* Rachel M. Hoesly et al.

Anonymous Referee #1

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In this paper, the authors document the methodology used to develop a new historical (1750-2014) short-lived species emissions data set for use by global chemistry-climate models for the upcoming Coupled Model Intercomparison Phase 6 (CMIP6). The paper provides detailed information on input data sets (e.g., emissions factors, activity data, population) and steps applied to generate the new emissions trends in Community Emissions Database System. The authors also compare this new dataset with existing emission inventories to place CEDS emissions in the context of existing data sets.

Emissions inventories provide crucial input data for global chemistry-climate models to simulate the spatial and temporal distributions of short-lived pollutants many of which are also climate forcers. Although gridded emissions inventories existed prior to the

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inventory of Lamarque et al (2010), there was a lack of consistency in the use of these products by different global modeling groups participating in multi-model intercomparisons. Development of a global gridded emissions inventory for not just the present conditions but going back in time is a major undertaking. I am sure the global chemistry-climate modeling community would be very appreciative of the service provided by the authors in not only updating the previous extensively used inventory (Lamarque et al., 2010), but also creating a consistent, transparent, and trackable process that can hopefully be sustained going forward. The paper is generally well-written and is appropriate for GMD.

My main comment on the paper is that the authors do not provide any comparisons of the spatial distribution of the gridded emissions against existing gridded products. A panel plot with maps of present day (e.g., 2010) species emissions should be included in the main text. Some discussion of how they compare with the spatial distributions in existing inventories would be helpful.

Below are some specific comments to help improve the paper:

Specific comments:

P2: Suggest arranging the discussion of existing emission inventories chronologically. EDGAR has a long history of developing emissions data set and was available much before the inventory of Lamarque et al (2010) (referred to as L2010 hereafter). In fact, the EDGAR informs the L2010 and the work described in this paper.

L84: What is the time period for the historical data?

L85-L87: The chemical formulas for these species are first used on L55 without defining them. Suggest moving the full names closer to where the formulas are used for the first time in the text.

L102-103: At what point is the seasonality added?

Figure 1, captions: replace “produces” with “products” on P4.

L116: What does “energy balance statistics” mean here?

L117: A quick search on google tells me that there are 196 countries in the world (not considering Taiwan separately would bring the count down to 195). Am I missing something? Could the authors please provide a color coded map of countries considered in the work?

L123: A reference is needed for the IPCC guidelines and Nomenclature for reporting document.

L137: What kind of “additional effort” would be needed? Please elaborate.

L140-141: Please elaborate on the “confidentiality issues.” As I understand, sector level emissions are provided in the gridded files, so I am confused by this statement.

P4L143: What is meant by “emission control degradation?”

L161-162: Does the population data used to disaggregate energy data for CEDS countries change with time? Describe any assumptions made. Also, please provide a reference for the population data set used.

L170: Is the BP data freely available?

L180: Please provide a reference for the MEIC inventory.

L195-196: This statement conveys ambiguity in the use of population data for generating emission trends. Please clarify.

L214: I feel that this equation can be moved up near the beginning of section 2.1 as it describes clearly how activity data and emissions factors are combined to obtain emissions.

P9L310-311: To clarify, is the “value” of the scaling factor limited to greater than 1/100 and less than 100? If so, please rephrase the sentence.

L344: Replace does with do.

L396-399: Specify that the discussion in paragraph is pertinent to soil NH3 and NOx emissions.

L413: Which CEDS sectors are the authors referring to here? The 55 working sectors, the 16 intermediate sector or the 9 aggregated sectors?

L414: Please clarify what sector (of the 9 aggregated) is the flaring emission relevant for.

P15, Figure 2: The figure caption says that aviation emissions are not included but the color bar shows “Air” as an option. Please clarify

P16, Figure 3: The label “International” to describe international aviation and shipping is misleading. Suggest replacing it with Air_ship (or some combination of air and ship) so that it is clear the authors are referring to combined aviation and shipping emissions.

L451: Please clarify “anthropogenic emissions” from which inventory are being referred to here. Are the CEDS anthropogenic emissions 20-30% of the total global emissions for BC, OC, NMVOC, and CO?

L459: replace “in 1950” with “post 1950”

L460: Insert a reference to Figure 3 at the end of the sentence.

L480: Can the authors postulate any specific reasons for the flat residential biomass emissions in latin America despite a growing rural population, and flatter China emissions than rural population after 1990?

L496: replace ‘species of emissions” with “species emissions”

L506: Please refer to a figure to support the statement “Global CO emissions flatten”.

L514-515: Please clarify the sentence: “offset by international shipping emissions grow then decrease. . .”

L516: Is it possible that the decline in North American NOx emissions is driven by

the decreases in US NOx emissions in response to the NOx control regulations implemented in the US (NOx SIP call). This is fairly well documented and literature should be referenced here as this lends confidence to the trends in NOx emissions derived from CEDS.

L521: A reference is needed for “more stringent emission standards for power plants”

L554-L559: Please refer to a specific figure in the Figures and Tables Supplement for this comparison (e.g., Figure S40). I would also suggest doing the same for other species in the paragraphs below as it is cumbersome to sift through the many plots.

Section 3.4: It would be very helpful to have a table with published level of uncertainties in emissions for each species (CO2, SO2, CO, NOx, NMVOC, BC, OC) and specific sectors. Much of the information is contained in this section and can be pulled into a summary table that will come in handy when uncertainties in CEDS emissions are determined.

L622: This sentence can be rephrased to “ Emissions uncertainties for CO, NOx, and NMVOCs typically lie between those of carbonaceous aerosols. . ..”

L626-627: Hassler et al (2016) should also be cited here.

L637-639: Paulot et al can be cited here as an example of detailed modeling of agricultural NH3 emissions.

Section 5. The ultimate test of an emission inventory is comparison of species concentrations simulated by a model driven by an inventory against observations (e.g., Parrish et al., 2014; Hassler et al., 2016). If the model is able to capture the distribution and trends then the said inventory is considered to represent the real conditions well. I think a case could be made for better coordination between modelers and emission inventory developers so that a two-way interaction can help improve both models and emissions inventories.

An outline of long-term plans for the CEDS database is needed in the summary section

to build confidence in its sustainability. Modelers would like to know if they can rely on the CEDS system working even after CMIP6. What are the plans for maintenance of the back-end software, frequency of updates to the input data and for maintaining funding for CEDS?

References:

Paulot, F., D. J. Jacob, R. W. Pinder, J. O. Bash, K. Travis, and D. K. Henze (2014), Ammonia emissions in the United States, European Union, and China derived by high-resolution inversion of ammonium wet deposition data: Interpretation with a new agricultural emissions inventory (MASAGE_NH3), J. Geophys. Res. Atmos., 119, 4343–4364, doi:10.1002/2013JD021130.

Hassler, B., et al. (2016), Analysis of long-term observations of NOx and CO in megacities and application to constraining emissions inventories, Geophys. Res. Lett., 43, 9920–9930, doi:10.1002/2016GL069894.

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