Point-to-point response to the referees

- **Bolded text is the referees' comments.**
- Black regular text is the authors' response.
- *Black italics are the corresponding revisions in the main text.*

Response to Referee #1

The study of Cui et al. provided a detailed national and subnational energy-related CO2 emission dataset for 40 emerging economies whose emissions are much understudied than other large emitters. One key feature of this dataset is that it includes emissions from biomass combustion which might be a significant emission source for those economies. The data collection, data analysis, and interpretation are done in a good manner. I only have some minor comments.

Reply:

We appreciate your valuable advice. Here are our point-to-point replies and *revisions* based on **your comments.**

Intro section: authors should list some examples of energy-related emission sources.

Reply:

Thank you for your advice. We have added the description of energy-related emissions as follows:

Line 58-61: Among them, energy-related CO_2 emissions account for the largest proportion of total CO_2 emissions, amounting to 33.6 Gt globally in 2019, which represents over 90% of the total CO_2 emissions (International Energy Agency, 2022), including emissions from energy combustion via industrial production, residential heating and cooking, transportation, et al.

References:

International Energy Agency: World CO_2 Emissions from Fuel Combustion, 2022.

Line 37: "the single" or "any single"?

Reply:

Thank you for your correction. We have revised the sentence as follows:

Line 37-39: Although any single emerging economy (excluding China and India) contributed less than 2% of annual global emissions during this period, their collective emissions (i.e. of 99 country's economies) grew faster than the global average of 2.3% per year.

Line 72: first time showing 'CEAD', add what it stands for.

Reply:

Thank you for your advice. We have revised the sentence as follows:

Line 97-99: Here, to fill this gap, we present the Carbon Emission Accounts and Datasets for emerging economies (CEADs, https://ceads.net), which aims to provide transparent, verifiable, open-access data on the CO_2 emissions of 40 emerging economies (accounting for 17.5% of the emissions and 12.9% of GDP of the world) for the period 2010-2019.

Line 103: change '6.2-8.8' to '6.2 to 8.8'

Reply:

Thank you for your correction. We have revised the sentence as follows:

Line 106: From 2010-2019, the collective emissions raised from 6.2 to 8.8 Gt, and we noted a continuous surge in emissions growth of 4.0% on average annually.

Section 2.1.3: there are 47 sectors and 17 merged sectors in Supplemental Information. Authors should clarify which was used for analysis. Also, what if a sector from a national statistics overlaps with multiple sectors that are used in this study, how was that treated? For example, if a national report only has mining as a category, how is that broken down into coal mining and mineral mining?

Reply:

Thank you for your advice. We have revised the related sections as follows:

Line 279-282: Myanmar's CO_2 emissions from sectoral and energy sources provides an insightful example for identifying solutions and strategies to mitigate emissions in emerging economies (for the sake of convenience, the emissions of 17 merged sectors analysed here); emissions data from other institutes, including IEA, EDGAR and GCB, are included for purposes of comparison (for other emerging economies, see Table S10 and Figure S2 in Supplemental Information).

Line 153-169: Since the energy consumption statistics from each of the 40 emerging economies vary in terms of sectors represented, we standardized the sectors into 47, based on the sector definitions of the countries. Using sector-mapping indicators, we then distributed emissions among the 47 sectors (see Table S4 in Supplemental Information). The indicators included sectoral data on energy consumption, production, outputs and employment, among other categories, and they are comparable among similar sectors. When it comes to metal production, both ferrous and nonferrous metals are classified under the same raw sector. Therefore, it is imperative to use a consistent mapping indicator to differentiate between the two sectors. One potential solution is to use the product of each metal production and its corresponding average energy intensity as the sector-mapping indicator to distinguish the ferrous and nonferrous metal sectors. In case energy intensity data is not available, economic indicators such as value added can be utilized to aid the process.

However, for sectors that are not associated with a single raw sector, the sector-mapping indicators can differ. For instance, employment data could serve as the sector-mapping indicator for service sectors. On the other hand, when allocating emissions from the residential sector into urban and rural sectors, the sector-mapping indicator can be based on the urban and rural population rather than production or economic indicators as is the case with manufacturing sectors.

The priority order for sector-mapping indicators data is as follows: energy consumption data, energy intensity data, value added data, output data, employment data, and population data. The indicators are collected from national statistical institutes, national economic reports, industrial reports and continental and regional statistics. (Detailed data sources are listed by country in Table S1 in Supplemental Information.)

Line 173: 'CE_{IJ}' should be 'CE_{iJ}'

Reply:

Thank you for your advice. We have revised the sentence as follows:

Line 184: where $\boldsymbol{CE_{iJ}}$ is the CO_2 emissions from the activity type i (such as the energy type for energy-related emissions accounting, industrial process type for process-related emissions accounting, etc.) from sector J.

Table S6: to better visualize the difference between inventories, authors can consider making a map similar to Figure 2 showing the difference in emission estimates between inventories.

Reply:

Thank you for your advice. We have added a supplemental figure (Figure S2 in Supplemental Information) to show the different results of each dataset.

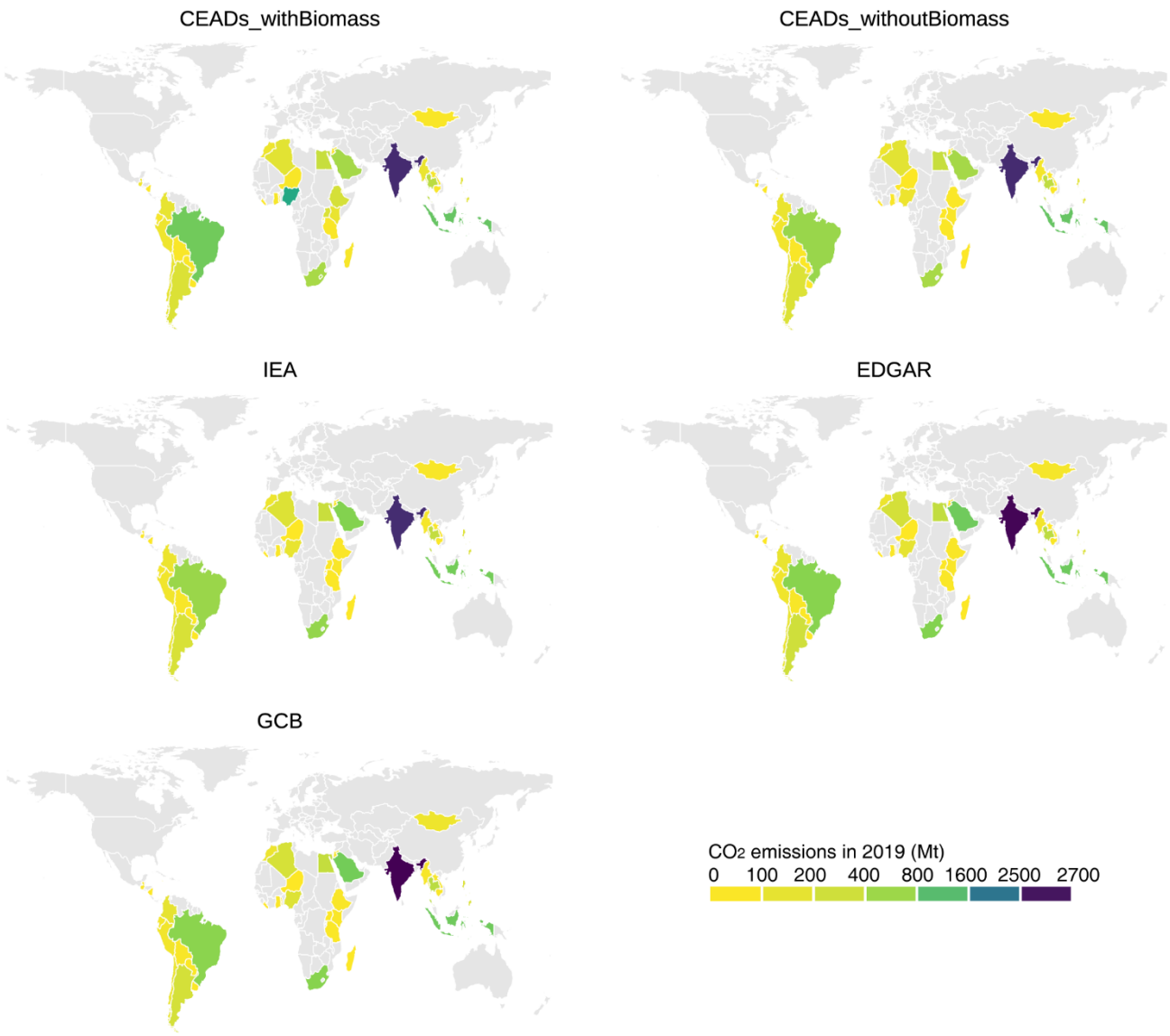

Figure S 2 Comparison of this dataset (CEADs with and without biomass) and IEA, EDGAR, and GCB.

Line 322: need more details on how Monte Carlo simulation was done, in method section.

Reply:

Thank you for your advice. We have added the process of Monte Carlo simulation in the Method section, and provided more details in the Table S7-S9 and Figure S1 Supplemental Information. Below are the revisions in the main text:

Line 225-244: 2.2.4 Uncertainty analysis

Incomplete or inaccurate data collection can lead to uncertainty in both activity volume data and emission factor data, which in turn affects the accuracy of emissions accounting. To address this issue, Monte Carlo simulation is utilized in this study to evaluate the uncertainty of emissions accounting. The simulation process includes three steps:

1) Determine the probability distributions of activity volume and emission factor data in developing countries. As statistical data and energy types vary among different countries in developing countries, this study determines the activity volume data distribution by 17 sectors and 5 energy types on a national level. The probability distribution of activity level data is set based on the quality of certain data sources and corresponding uncertainty ranges recommended in the IPCC National Greenhouse Gas Inventory Guidelines (Intergovernmental Panel on Climate Change (IPCC), 2006). The probability distribution of emission factor data is obtained by simulating the distribution of emission factors for corresponding energy types and categories from each country. Detailed uncertainty information of activity volume and emissions factor data are described in Table S7-S9 and Figure S1 in Supplemental Information.

2) Randomly sample from the activity level and emission factor distributions obtained in step 1 and calculate the corresponding CO_2 emissions for each category based on the formula.

3) Repeat step 2 for 20,000 simulations to obtain the distribution of CO_2 emissions for different categories and the total emissions, as well as the corresponding uncertainty statistics.

Below are revisions in Supplemental Information:

The distribution of activity level data and emission factor data by sector and energy type for each country and year is determined based on specific data sources, degree of missing data, and the IPCC National Greenho use Gas Inventory Guidelines(Intergovernmental Panel on Climate Change (IPCC), 2006). Generally, countries with more complete statistical data have lower uncertainty in their activity level data, and energy-intensive sectors such as electricity and heavy industries have lower uncertainty in their activity levels. The uncertainties in activity levels for each country and sector are based on information shown in Table S 7, S 8 and S 9. As for emission factors, fossil fuel emission factors with higher commercialization have lower uncertainty (such as natural gas), while emission factors for energy sources with large differences in production regions and fuel types have higher uncertainty (such as coal and biomass energy). The uncertainty distributions of each emission factor are shown in Figure S 1.

Table S 7 Country groups (CGs) by activity volume data sources.

Country Group	***Countries***
CG1	*Algeria; Argentina; Cambodia; Djibouti; Jamaica; Jordan; Kenya; Laos; Liberia; Madagascar; Micronesia; Myanmar; Nicaragua; Niger; Rwanda; Thailand; Uganda; Uruguay*
CG2	*Bolivia; Brazil; Chile; Colombia; Ecuador; Egypt; Ethiopia; Ghana; Guatemala; India; Indonesia; Mauritius; Mongolia; Morocco; Nigeria; Panama; Paraguay; Peru; Philippines; South Africa; Tanzania; Togo*
CG3	*Algeria; Argentina; Cambodia; Djibouti; Jamaica; Jordan; Kenya; Laos; Liberia; Madagascar; Myanmar; Nicaragua; Niger; Rwanda; Thailand; Uganda; Uruguay*
CG4	*Bolivia; Brazil; Chile; Colombia; Ecuador; Ethiopia; Ghana; Guatemala; Indonesia; Mauritius; Morocco; Nigeria; Panama; Paraguay; Peru; Philippines; Tanzania; Togo*

Table S 8 Sector groups (SGs) by uncertainty level of activity volume data.

Sector Group	*Sectors*
SG1	*Agriculture, forestry, hunting, fishing and husbandry; Construction; Logging, Timber, Food, Beverage and Tobacco; Ordinary, Special, Transportation, Electric, Electronic and Instrument Machinery; Other Manufacturing and Waste; Papermaking, Printing and Cultural; Textile, Garments and Leather*
SG2	*Coal Mining, Petroleum and Natural Gas Extraction; Metal Smelting, Pressing and Products; Minerals Mining and Dressing; Nonmetal Mineral Products; Petroleum Processing, Raw Chemical, and Medical*
SG3	*Other Services; Residential; Transportation, Storage, Post and Telecommunication Services; Wholesale, Retail Trade and Catering Services*
SG4	*Production of Electricity, Heat, Gas and Tap Water*
SG5	*Agriculture, forestry, hunting, fishing and husbandry; Construction; Logging, Timber, Food, Beverage and Tobacco; Ordinary, Special, Transportation, Electric, Electronic and Instrument Machinery; Other Manufacturing and Waste; Other Services; Papermaking, Printing and Cultural; Residential; Textile, Garments and Leather; Transportation, Storage, Post and Telecommunication Services; Wholesale, Retail Trade and Catering Services*
SG6	*Residential*

Table S 9 Uncertainty level of activity volume data by country groups (CGs) and sector groups (SGs).

CG	*SG*	*Uncertainty (statistics)*	*Uncertainty (estimated)*
CG1	***SG1***	*12.5%*	*17.5%*
	SG2	*2.5%*	*7.5%*
	SG3	*12.5%*	*20.0%*
	SG4	*1.5%*	*7.5%*
CG2	***SG5***	*4.0%*	*7.5%*
	SG2	*2.5%*	*4.0%*
	SG4	*1.0%*	*4.0%*
CG3	***SG6***	*45.0%*	*80.0%*
CG4	***SG6***	*20.0%*	*30.0%*

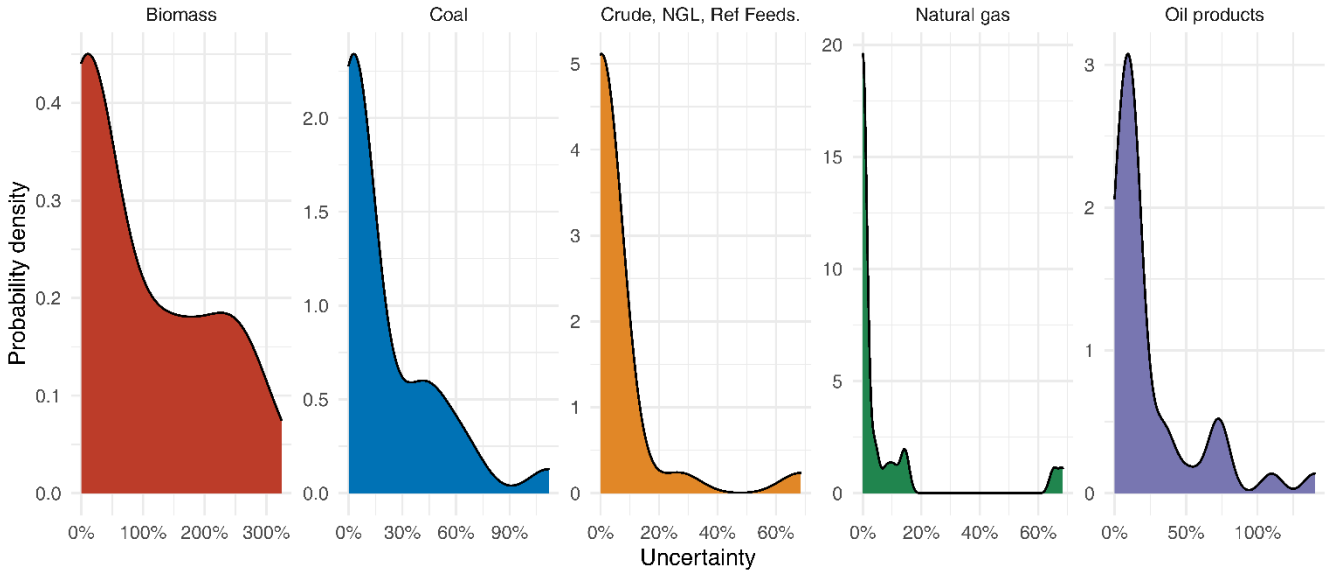

Figure S 1 Probability distribution of emission factor uncertainty by energy types.

Reference:

Intergovernmental Panel on Climate Change (IPCC): IPCC Guidelines for national greenhouse gas inventories, Institute for Global Environmental Strategies (IGES), Hayama, Japan, 2006.

Response to Referee #2

This study provides a detailed energy-related CO_2 emission dataset for 40 emerging economies whose emissions are largely ignored in the previous studies. This is a relatively standard data set and manuscript. I have some minor comments.

Reply:

We appreciate your valuable advice. Here are our point-to-point replies and *revisions* based on **your comments.**

I suggest that the reference should not be included in the abstract.

Reply:

Thank you for your comment. We noticed that the journal ESSD requires the citation of the dataset (https://www.earth-system-science-data.net/submission.html), so we kept the citation in the abstract.

Abstract: the abstract should be intelligible to the general reader without reference to the text. After a brief introduction of the topic, the summary recapitulates the key points of the article and mentions possible directions for prospective research. Reference citations should not be included in this section (except for data sets) and abbreviations should not be included without explanations. At least for the final accepted publication, a functional data set DOI and its in-text citation must be given in the abstract. If multiple data set DOIs are necessary, please instead refer to the data availability section.

Some data are presented as national and others are subnational, which need to be further distinguished and explained.

Reply:

Thank you for your advice. We have added the description of our dataset in the main text and Supplemental Information:

Line 103-105: The emissions dataset covers 47 economic sectors and 8 major energy categories in the 40 emergent economies, and in 28 of these we provided a subnational inventory. The 40 countries are selected based on economic development stages, geographic locations, and data availability (for details, see Table S3 in Supplemental Information).

Currently, this dataset covers 40 countries of year 2010-2019 (see Table S 3), in which 28 countries have subnational inventory.

Table S 3 Countries covered in this Dataset.

Country	***Location***	***Development stage***	***Number of regions***	***Time span***
Asia				

Cambodia	*Southeast Asia*	*Least Developed Countries*	*-*	*2010-2019*
Laos	*Southeast Asia*	*Least Developed Countries, Landlocked Developing Countries*	*-*	*2010-2019*
Myanmar	*Southeast Asia*	*Least Developed Countries*	*-*	*2010-2019*
India	*South Asia*	*Developing Economies*	*33*	*2 007-2019*
Philippines	*Southeast Asia*	*Developing Economies*	*17*	*2 010-2019*
Indonesia	*Southeast Asia*	*Developing Economies*	*34*	*2010-2019*
Mongolia	*East Asia*	*Landlocked Developing Countries*	*22*	*2010-2019*
Jordan	*West Asia*	*Developing Economies*	*-*	*2010-2019*
Thailand	*Southeast Asia*	*Emerging Market Economies, Developing Economies*	*-*	*2010-2019*
Saudi Arabia	*West Asia*	*Developing Economies*	*13*	*2010-2019*
Africa				
Madagascar	*East Africa*	*Least Developed Countries*	*22*	*2010-2019*
Liberia	*West Africa*	*Least Developed Countries*	*-*	*2010-2019*
Niger	*West Africa*	*Least Developed Countries, Landlocked Developing Countries*	*8*	*2010-2019*
Rwanda	*East Africa*	*Least Developed Countries, Landlocked Developing Countries*	*-*	*2010-2019*
Ethiopia	*East Africa*	*Least Developed Countries, Landlocked Developing Countries*	*11*	*2010-2019*
Uganda	*East Africa*	*Least Developed Countries, Landlocked Developing Countries*	*135*	*2010-2019*
Togo	*West Africa*	*Least Developed Countries*	*5*	*2010-2019*
Tanzania	*East Africa*	*Least Developed Countries*	*23*	*2010-2019*
Djibouti	*East Africa*	*Least Developed Countries*	*-*	*2010-2019*
Kenya	*East Africa*	*Developing Economies*	*47*	*2010-2019*
Nigeria	*West Africa*	*Developing Economies*	*37*	*2010-2019*
Ghana	*East Africa*	*Developing Economies*	*16*	*2010-2019*
Morocco	*North Africa*	*Developing Economies*	*13*	*2010-2019*
Algeria	*North Africa*	*Developing Economies*	*48*	*2010-2019*
Egypt	*North Africa*	*Developing Economies*	*27*	*2010-2019*
Mauritius	*East Africa*	*Small Island Developing States*	*3*	*2010-2019*
South Africa	*South Africa*	*Developing Economies*	*9*	*2010-2019*
Latin America				
Nicaragua	*North America*	*Developing Economies*	*-*	*2010-2019*
Bolivia	*South America*	*Landlocked Developing Countries*	*9*	*2010-2019*

Guatemala	*North America*	*Developing Economies*	*22*	*2010-2019*
Jamaica	*North America*	*Small Island Developing States*	*-*	*2 010-2019*
Paraguay	*South America*	*Landlocked Developing Countries*	*-*	*2010-2019*
Colombia	*South America*	*Emerging Market Economies, Developing Economies*	*32*	*2010-2019*
Ecuador	*South America*	*Developing Economies*	*24*	*2010-2019*
Peru	*South America*	*Emerging Market Economies, Developing Economies*	*25*	*2010-2019*
Brazil	*South America*	*Emerging Market Economies, Developing Economies*	*26*	*2010-2019*
Argentina	*South America*	*Emerging Market Economies, Developing Economies*	*23*	*2010-2019*
Chile	*South America*	*Emerging Market Economies, Developing Economies*	*16*	*2010-2019*
Uruguay	*South America*	*Developing Economies*	*-*	*2010-2019*
Oceania				
Micronesia		*Small Island Developing States*	*4*	*2010-2019*

There are some format problems in many references. The author should check the full text carefully.

Reply:

Thank you for your advice. We have checked and corrected the references.

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Why choose Myanmar as the case study area. Data and regional representativeness need to be emphasized.

Reply:

Thank you for your advice. We have added the representativeness of Myanmar as the case study area as follows:

Line 273-282: Myanmar, located in Southeast Asia, has experienced remarkable economic growth in recent years. However, this growth has led to a significant increase in greenhouse gas emissions, making it one of the fastest-growing emitters of CO_2 in the world. Unsustainable biomass fuels, accounting for over 50% of the country's energy needs, contribute to high emissions and deforestation.

Myanmar's expanding industrial sector, including energy-intensive manufacturing, also adds to emissions. Balancing economic growth with environmental sustainability remains a challenge for emerging economies. Myanmar's CO_2 emissions provide an insightful example for identifying solutions to emission reduction in emerging economies. Therefore, analysing Myanmar's CO_2 emissions from sectoral and energy sources provides an insightful example for identifying solutions and strategies to mitigate emissions in emerging economies (for the sake of convenience, the emissions of 17 merged sectors analysed here); emissions data from other institutes, including IEA, EDGAR and GCB, are included for purposes of comparison (for other emerging economies, see Table S10 and Figure S2 in Supplemental Information).

There should be more details on how Monte Carlo works in manuscript.

Reply:

Thank you for your advice. We have added the process of Monte Carlo simulation in the Method section, and provided more details in the Table S7-S9 and Figure S1 Supplemental Information. Below are the revisions in the main text:

Line 225-244: 2.2.4 Uncertainty analysis

Incomplete or inaccurate data collection can lead to uncertainty in both activity volume data and emission factor data, which in turn affects the accuracy of emissions accounting. To address this issue, Monte Carlo simulation is utilized in this study to evaluate the uncertainty of emissions accounting. The simulation process includes three steps:

1) Determine the probability distributions of activity volume and emission factor data in developing countries. As statistical data and energy types vary among different countries in developing countries, this study determines the activity volume data distribution by 17 sectors and 5 energy types on a national level. The probability distribution of activity level data is set based on the quality of certain data sources and corresponding uncertainty ranges recommended in the IPCC National Greenhouse Gas Inventory Guidelines (Intergovernmental Panel on Climate Change (IPCC), 2006). The probability distribution of emission factor data is obtained by simulating the distribution of emission factors for corresponding energy types and categories from each country. Detailed uncertainty information of activity volume and emissions factor data are described in Table S7-S9 and Figure S1 in Supplemental Information.

2) Randomly sample from the activity level and emission factor distributions obtained in step 1 and calculate the corresponding CO2 emissions for each category based on the formula.

3) Repeat step 2 for 20,000 simulations to obtain the distribution of CO2 emissions for different categories and the total emissions, as well as the corresponding uncertainty statistics.

Below are revisions in Supplemental Information:

The distribution of activity level data and emission factor data by sector and energy type for each country and year is determined based on specific data sources, degree of missing data, and the IPCC

National Greenho use Gas Inventory Guidelines(Intergovernmental Panel on Climate Change (IPCC), 2006). Generally, countries with more complete statistical data have lower uncertainty in their activity level data, and energy-intensive sectors such as electricity and heavy industries have lower uncertainty in their activity levels. The uncertainties in activity levels for each country and sector are based on information shown in Table S 7, S 8 and S 9. As for emission factors, fossil fuel emission factors with higher commercialization have lower uncertainty (such as natural gas), while emission factors for energy sources with large differences in production regions and fuel types have higher uncertainty (such as coal and biomass energy). The uncertainty distributions of each emission factor are shown in Figure S 1.

Table S 7 Country groups (CGs) by activity volume data sources.

Country Group	***Countries***
CG1	*Algeria; Argentina; Cambodia; Djibouti; Jamaica; Jordan; Kenya; Laos; Liberia; Madagascar; Micronesia; Myanmar; Nicaragua; Niger; Rwanda; Thailand; Uganda; Uruguay*
CG2	*Bolivia; Brazil; Chile; Colombia; Ecuador; Egypt; Ethiopia; Ghana; Guatemala; India; Indonesia; Mauritius; Mongolia; Morocco; Nigeria; Panama; Paraguay; Peru; Philippines; South Africa; Tanzania; Togo*
CG3	*Algeria; Argentina; Cambodia; Djibouti; Jamaica; Jordan; Kenya; Laos; Liberia; Madagascar; Myanmar; Nicaragua; Niger; Rwanda; Thailand; Uganda; Uruguay*
CG4	*Bolivia; Brazil; Chile; Colombia; Ecuador; Ethiopia; Ghana; Guatemala; Indonesia; Mauritius; Morocco; Nigeria; Panama; Paraguay; Peru; Philippines; Tanzania; Togo*

Table S 8 Sector groups (SGs) by uncertainty level of activity volume data.

Sector Group	***Sectors***
SG1	*Agriculture, forestry, hunting, fishing and husbandry; Construction; Logging, Timber, Food, Beverage and Tobacco; Ordinary, Special, Transportation, Electric, Electronic and Instrument Machinery; Other Manufacturing and Waste; Papermaking, Printing and Cultural; Textile, Garments and Leather*
SG2	*Coal Mining, Petroleum and Natural Gas Extraction; Metal Smelting, Pressing and Products; Minerals Mining and Dressing; Nonmetal Mineral Products; Petroleum Processing, Raw Chemical, and Medical*
SG3	*Other Services; Residential; Transportation, Storage, Post and Telecommunication Services; Wholesale, Retail Trade and Catering Services*
SG4	*Production of Electricity, Heat, Gas and Tap Water*
SG5	*Agriculture, forestry, hunting, fishing and husbandry; Construction; Logging, Timber, Food, Beverage and Tobacco; Ordinary, Special, Transportation, Electric, Electronic and Instrument Machinery; Other Manufacturing and Waste; Other Services; Papermaking, Printing and Cultural; Residential; Textile, Garments and Leather; Transportation, Storage, Post and Telecommunication Services; Wholesale, Retail Trade and Catering Services*
SG6	*Residential*

Table S 9 Uncertainty level of activity volume data by country groups (CGs) and sector groups (SGs).

CG	*SG*	*Uncertainty (statistics)*	*Uncertainty (estimated)*
CG1	***SG1***	*12.5%*	*17.5%*
	SG2	*2.5%*	*7.5%*
	SG3	*12.5%*	*20.0%*
	SG4	*1.5%*	*7.5%*
CG2	***SG5***	*4.0%*	*7.5%*
	SG2	*2.5%*	*4.0%*
	SG4	*1.0%*	*4.0%*
CG3	***SG6***	*45.0%*	*80.0%*
CG4	***SG6***	*20.0%*	*30.0%*

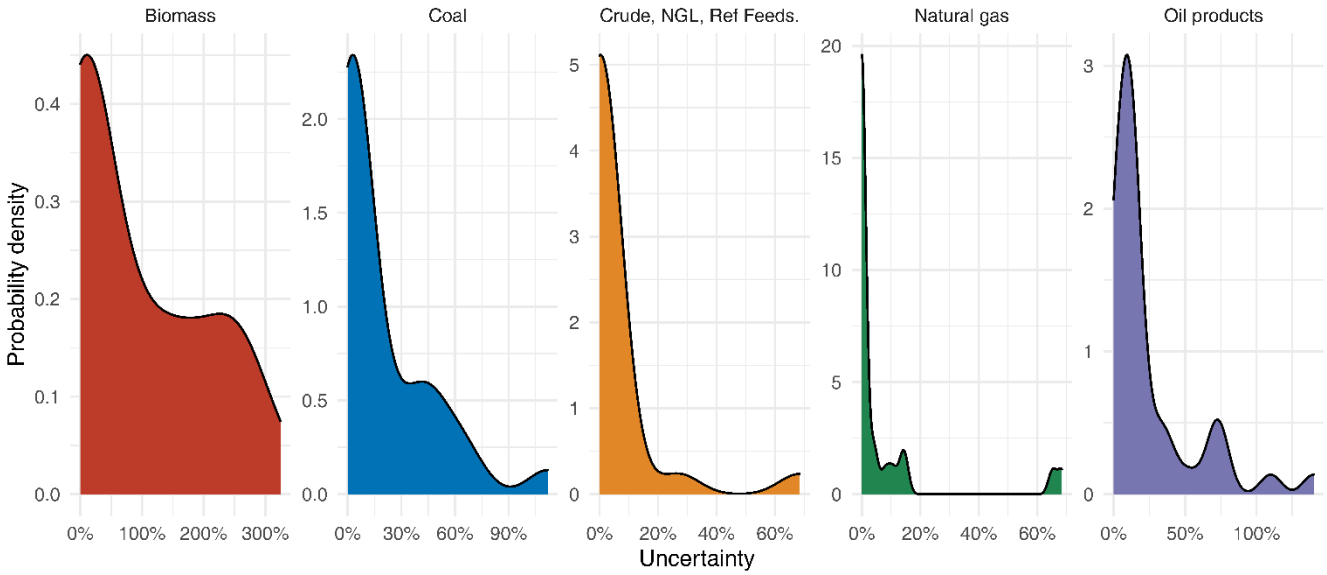

Figure S 1 Probability distribution of emission factor uncertainty by energy types.

Reference:

Intergovernmental Panel on Climate Change (IPCC): IPCC Guidelines for national greenhouse gas inventories, Institute for Global Environmental Strategies (IGES), Hayama, Japan, 2006.

There should be more explanations and descriptions on how the emissions are allocated to economic sectors.

Reply:

Thank you for your advice. We have revised the related sections as follows:

Line 157-169: 2.1.3 Sector-mapping indicators

Since the energy consumption statistics from each of the 40 emerging economies vary in terms of sectors represented, we standardized the sectors into 47, based on the sector definitions of the

countries. Using sector-mapping indicators, we then distributed emissions among the 47 sectors (see Table S4 in Supplemental Information). The indicators included sectoral data on energy consumption, production, outputs and employment, among other categories, and they are comparable among similar sectors. When it comes to metal production, both ferrous and nonferrous metals are classified under the same raw sector. Therefore, it is imperative to use a consistent mapping indicator to differentiate between the two sectors. One potential solution is to use the product of each metal production and its corresponding average energy intensity as the sector-mapping indicator to distinguish the ferrous and nonferrous metal sectors. In case energy intensity data is not available, economic indicators such as value added can be utilized to aid the process.

However, for sectors that are not associated with a single raw sector, the sector-mapping indicators can differ. For instance, employment data could serve as the sector-mapping indicator for service sectors. On the other hand, when allocating emissions from the residential sector into urban and rural sectors, the sector-mapping indicator can be based on the urban and rural population rather than production or economic indicators as is the case with manufacturing sectors.

The priority order for sector-mapping indicators data is as follows: energy consumption data, energy intensity data, value added data, output data, employment data, and population data. The indicators are collected from national statistical institutes, national economic reports, industrial reports and continental and regional statistics. (Detailed data sources are listed by country in Table S1 in Supplemental Information.)