Response to Reviewers #1's Comments

General Comment:

I really enjoy reading this well-written and highly interesting manuscript presented by Yi et al. The authors use a Shipping Emission Inventory Model to carefully analyze and generate a powerful set of global emission inventory. The analytical process was thoroughly stepped through in the manuscript, and the data was well-presented. These figures and data would be useful to policy-makers and technology-developers, in addition to scientists in atmospheric and ocean sciences. I'd recommend publication with minor revision.

Response:

Thank you very much for your recognition. We improved our manuscript according to your suggestions and tried our best to address all the concerns in this revision.

Comment #1:

One small suggestion I have for the authors is that, the definitions of some terms could be better clarified so that the general audience who are not so familiar with the field can understand more easily. For example, I am not 100% sure what AIS signal means – does this mean how many ships there are in this dataset? If so, the authors can simply say this in the captions of Table 1 and Figure 2, and also define this term in the text.

Response:

AIS signals are generated by the Automatic Identification System (AIS) installed on ships. The system consists of onboard equipment, shore-based and satellite-based receivers. During navigation, the onboard equipment transmits AIS signals every 2 seconds to several minutes, which are received by terrestrial or satellite-based AIS receivers and then transmitted in-time to servers for storage. AIS messages record the ship's unique identifier and high-frequency dynamic information that changes continuously as the vessel progresses. The fields within an AIS message include the vessel's MMSI code, IMO number, signal transmission time, ship's position (longitude and latitude), over-ground speed, operational status, draft, and destination, among others. As such, the volume of AIS signals reaches billions, far exceeding the number of ships in the dataset. To better clarify the meaning of AIS signals, we have included an explanation of "AIS signals" in the manuscript.

Revisions in manuscript:

Line 70-76: AIS consists of onboard equipment, shore-based and satellite-based receivers. During navigation, the onboard equipment transmits AIS signals every 2 seconds to several minutes, which are received by terrestrial or satellite-based AIS receivers and then transmitted in-time to servers for storage. AIS messages record the ship's unique identifier and high-frequency dynamic information that changes continuously as the vessel progresses, including the vessel's MMSI code, IMO number, signal transmission time, ship's position (longitude and latitude), over-ground speed, operational status, draft, and destination, among others.

Comment #2:

Also, please define HC, BC, and other abbreviations that appear in the manuscript.

Response:

Regarding abbreviations, we conducted a review and reintroduced explanations for the following abbreviations: HC (Hydrocarbon), BC (Black Carbon), MMSI (Maritime Mobile Service Identity), EDGAR (Emissions Database for Global Atmospheric Research), and GHGs (Greenhouse Gases).

Revisions in manuscript:

Line 21-26: Concerning the major air pollutants and greenhouse gases, global ships emitted 847.2 million tons of CO_2, 2.3 million tons of SO_2, 16.1 million tons of NO_x, 791.2 kilo tons of CO, 737.3 kilo tons of HC (Hydrocarbon), 415.5 kilo tons of primary $PM_{2.5}$, 61.6 kilo tons of BC (black carbon), 210.3 kilo tons of CH_4, 45.1 kilo tons of N_2O in 2021, accounting for 3.2% of SO_2, 14.2% of NO_x, and 2.3% of CO_2 emissions from all global anthropogenic sources, based on the Community Emissions Data System (CEDS).

Line 116-118: IMO numbers are employed as the primary identifier to match AIS data and Ship Technical Specifications Database (STSD), and for those that cannot be matched, MMSI (Maritime Mobile Service Identity) codes are used as the secondary identifier.

Line 144-145: Then, the model will calculate GHGs (Greenhouse gases) and air pollutant emissions for every ship by every two subsequent AIS signals.

Line 335-340: Figure 3 summarizes this study and open-source dataset of major atmospheric pollutants and greenhouse substances emitted by global shipping over the past decade. The ship emission calculation method employed in this research, which is AIS-based, aligns with those utilized in the EDGAR (Emissions Database for Global Atmospheric Research) inventory and the Fourth IMO GHG Study released in 2020, while the CEDS inventory is established

based on a top-down fuel-based approach (Mcduffie et al., 2020).

Comment #3:

In addition, figures could have higher resolutions. Right now, it is hard to read the legends. Figure 3i, 'N2O' does not have the subscript.

Response:

The figures in the manuscript have all been updated, now with a resolution of 300 dpi, according to the requirement of ESSD.

Particularly, Fig. 3 has been updated, with the previously non-subscripted "N_2O" in the title corrected and legends enlarged. The updated Fig. 3 has been provided in the ***Revisions in Manuscript*** below (Figure Q1). Other figures, which were only updated with enhanced resolution, without any content changes, has not been provided below.

Revisions in manuscript:

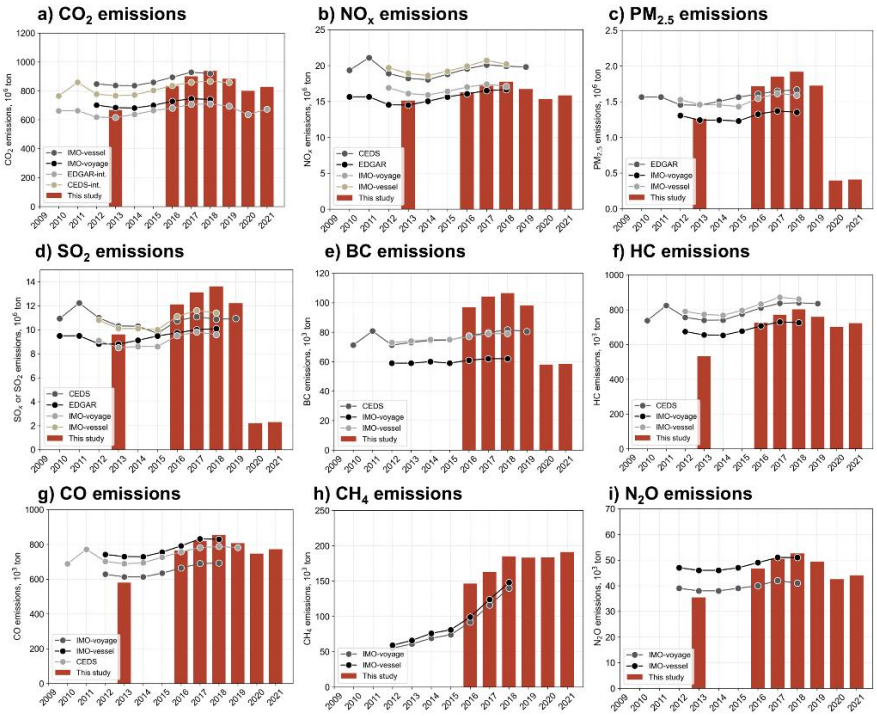

Figure Q1: Global trends in shipping emissions from 2010 to 2021. Data source: IMO (Jasper Faber, 2020), where IMO-Voyage results were calculated based on a voyage-based method and IMO-Vessel on a vessel-based algorithm. Community Emissions Data System (Mcduffie et al., 2020); Emissions Database for Global Atmospheric Research (Crippa, 2021).