EGU21-10144, updated on 03 Dec 2022
https://doi.org/10.5194/egusphere-egu21-10144
EGU General Assembly 2021

A novel bottom-up global ship emission inventory for conventional and alternative fuels in a well-to-wake approach

Diogo Kramel[1], Helene Muri[1], YoungRong Kim[2], Radek Lonka[1], Jørgen Bremnes Nielsen[3], Anna Ljønes Ringvold[1], Evert Alwin Bouman[1], Sverre Steen[2], and Anders Hammer Strømman[1]

[1]Industrial Ecology Programme (IndEcol), Department of Energy and Process Engineering, Norwegian University of Science and Technology (NTNU), Trondheim, Norway

[2]Department of Marine Technology (IMT), Norwegian University of Science and Technology (NTNU), Trondheim, Norway

[3]SINTEF Ocean AS, Trondheim, Norway

The maritime sector is one of the most efficient freight modal options in terms of emissions per tonnage transported per kilometer. However, alongside aviation, it is one of the most challenging transportation sectors to be decarbonized. Among the possible mitigation options are a switch towards less carbon-intensive fuels. However, the adoption of a global strategy towards cleaner fuels is not possible before fully understanding the climate implications throughout their entire life cycle. For such assessment at a global level, reliable and robust emission inventories are necessary. For this purpose, we present a novel bottom-up assessment of emissions of greenhouse gases (GHGs) and aerosols (NOx, SOx, CO, OC, EC and BC) in the maritime sector. Our high-resolution, data-driven emission inventory comprises a baseline of emissions for the year 2017, in which the global fleet has a fuel mix of heavy-fuel oil (HFO) and marine diesel oil (MDO). In addition, we present three scenarios in which the global fleet runs in its entirety with one of the potential fuel substitutes; i) Low-Sulphur diesel, ii) Liquefied-natural gas (LNG), and iii) Ammonia.

These emission inventories are developed through the use of the state-of-the-art MariTEAM model, which combines ship satellite data (AIS), historical weather data, and individual ship information in its emissions calculations. Additionally, the emissions resulting from the fuel production and processing life cycles are included and presented geospatially, resulting in a full 'well-to-wake' emission inventory. The spatiotemporal inventories for the alternative scenarios reveal that technology used in the fuel production, the weather, and heavy traffic regions all have a significant environmental impact on the overall emissions, both globally and regionally, highlighting the importance of measuring and modelling this correctly. Results show that a full transition towards LNG could achieve a reduction in terms of global warming potential (GWP100) of 21% and, in the case of ammonia, around 88%. The emission inventories also allow us to estimate the global annual efficiency ratio for each alternative fuel combining upstream and downstream emissions, indicating the need for more comprehensive metrics for designing appropriate policies aiming at net-zero emissions by 2100.