

(26-240329-A) Continuous Cargo-ship Based Multi-species Observations for Urban Emissions in Japan Bay

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Continuous shipborne observations of trace gases and aerosols are essential for the estimation of emission outflows to the oceans. However, despite their importance such observations are extremely limited in the Asian region which is one of the emissions hotspots. In this context, we report the results from continuous year-round (Jan 2022-Mar 2023) cargo-ship (Nichiyu-maru) observations of trace gases (CO, CO₂, CH₄, NO, NO₂, NO_y, O₃ and SO₂) and aerosols (size segregated PM, BC, EC, OC) measured simultaneously along the Japanese East coast, a hub to the major industrial areas. The results show significant spatial and temporal variations of these species across the Japanese East Coast with a spring maximum and particularly high emissions in the Tokyo Bay region. Using high-resolution emissions inventory, observed characteristic ratios and Flexpart, we constrain their sources focusing on the major urban bays - Tokyo, Nagoya, Kobe and Hiroshima. Additionally, the background levels of CO, CO₂ and CH₄ are delineated from their excess values and it is shown that the CO₂ excess levels were high but remained lower than 35 ppm for all four regions. Further, we estimate monthly CO emissions using a top-down approach and show that they better capture monthly CO variations compared to REAS and CEDS emissions inventories. Qualitative fields of emissions fluxes are also obtained from Flexpart trajectories and GridFED emissions and have been compared against the observed concentrations. Current work thus serves as a baseline to further utilise these systemic observations for validating GOSAT-GW data and developing a high-resolution top-down emissions framework for Japan.

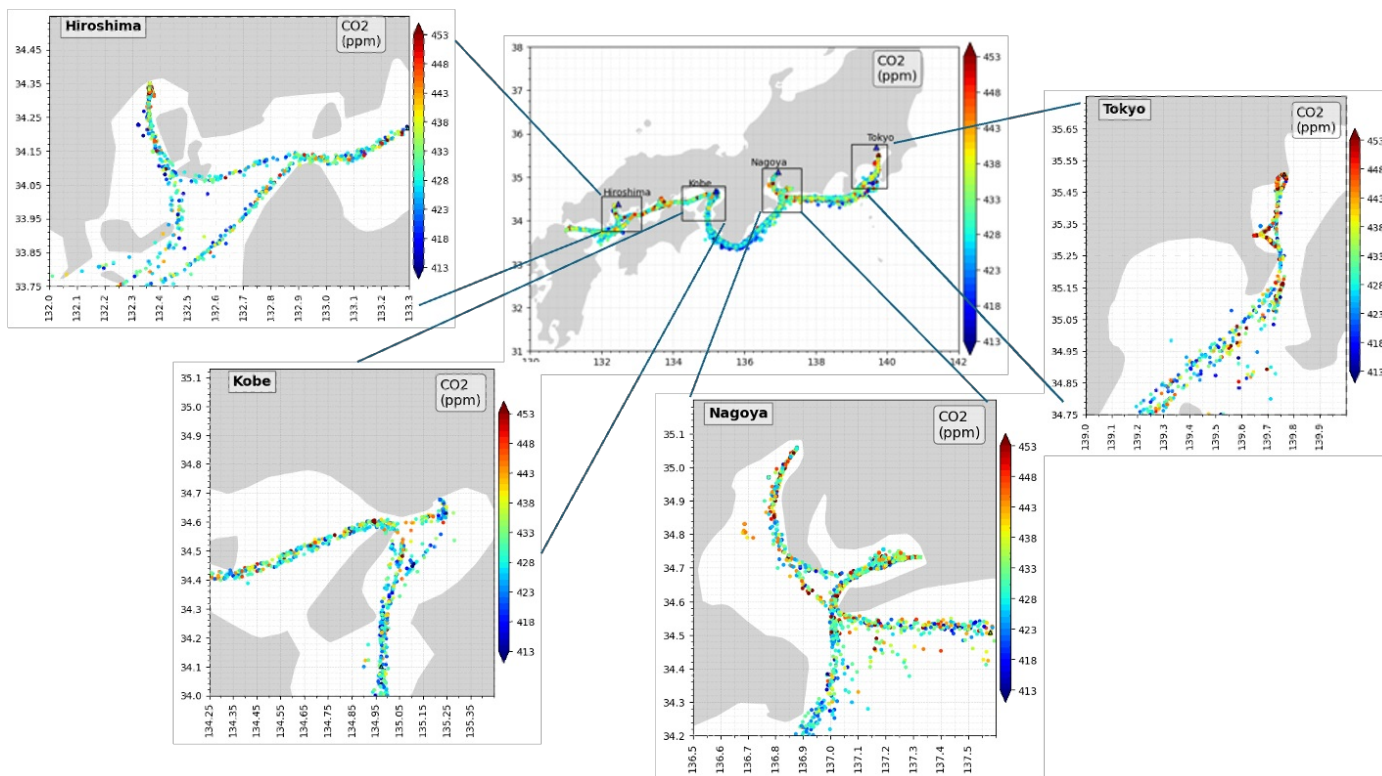


Figure 1. Scatter plot of CO₂ observations from cargo ship (Nichiyumaru) over the Japan bay region from Jan 2022-Mar 2023 in centre with zoomed plots for Hiroshima, Kobe, Nagoya and Tokyo.