Investigating the Impact of Port Congestion on Air Pollutant and Greenhouse Gas Emissions from Operations of the Ports of Los Angeles and Long Beach: Insights from the COVID-19 Era and the Influence of Policies

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CALIFORNIA AIR RESOURCES BOARD

1. Background

- Port-related activities, encompassing the operation of vessels, trucks, locomotives, and cargo handling equipment, are a significant source of air pollutants:
  - Nitrogen oxides (NOx) and particulate matter (PM) emissions that lead to adverse health impacts, especially for disadvantaged communities near ports or freeways
  - Carbon dioxide (CO_2) emissions that are greenhouse gases contributing to global climate change

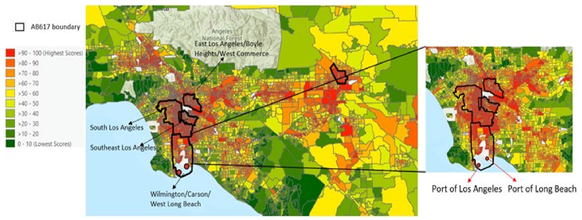

Figure 1. The Ports of LA/LB, and AB 617 designated disadvantaged communities near the goods movement corridors in Southern California, overlaid with the CalEnviroScreen 4.0 Cumulative Impact score.

- The Ports of Los Angeles (LA) and Long Beach (LB) serve as vital gateways for freight movement in the United States, handling 40% of cargo entering the nation.
- The Ports of LA/LB experienced unprecedented high cargo throughput and vessel congestion from late 2020 to 2021, which significantly increased emissions from Port operations.

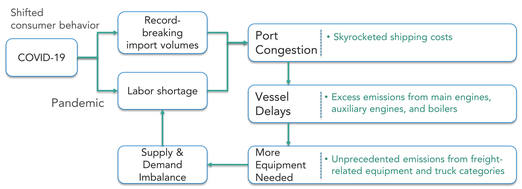

Figure 2. Factors leading to the unprecedented port congestion and increased emissions at the Ports of LA/LB

2. Objectives

- Provide the first comprehensive monthly assessment of PM, NOx, and CO_2 emissions during the Port Congestion Period (July 2020-June 2022), covering not only vessels but also trucks, locomotives, and cargo handling equipment
- Estimate excess emissions in the South Coast Air Basin due to increased cargo throughput and port congestion by comparing two scenarios:
  (1) Business as usual (BAU) scenario for the 2020-2022 period, which serves as a counterfactual scenario assuming the port congestion had not occurred
  (2) ACTUAL scenario, based on observed activity data that reflects the port congestion
- Investigate the impact of strategies to mitigate emissions associated with increased port activities

3. Method for developing emissions inventory

Emissions of pollutant i for each source category are calculated as $E_i=\sum_j EF_{i,j} \times Activity_j$, where $EF_{i,j}$ is the emission factor of pollutant i (i.e., NOx, PM, or CO_2) when the source category is operating in j mode/process, and $Activity_j$ is measure of the source category in j mode/process.

Source Category	Data Source for Activity	Data Source for Emission Factors
Vessels (within 24 nautical miles of the coast)	Automatic Identification System (AIS) from National Oceanic and Atmospheric Administration (NOAA)	U.S. Environmental Protection Agency's 2020 Updates to OGV Emission Factors
Cargo Handling Equipment	Twenty-foot Equivalent Unit (TEU) of containers data from Ports of LA/LB	Air emissions inventories from Ports of LA/LB
Locomotives	TEU data from Ports of LA/LB	Air emissions inventories from Ports of LA/LB
Trucks	Truck trips data from Ports of LA/LB	CARB's EMFAC model

Table 1. Data sources for activity and emission factors of different source categories.

4. Increased cargo throughput and activity of vessels at anchorage

- The freight movement of containerized goods through the Ports of LA/LB decreased in early 2020 relative to pre-pandemic levels. However, the trend reversed in summer 2020, and freight movement continued to increase in 2021.

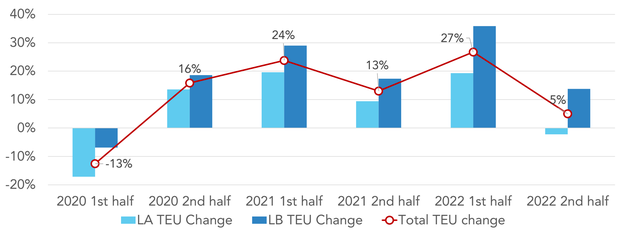

Figure 3. Percentage increase in TEU of the Port of LA, Port of LB, and the combined Ports during 2020-2022, compared to the corresponding periods in 2019.

- In November 2021, the Pacific Maritime Management Services (PacMMS) implemented a queuing system to encourage vessels to wait for a berthing assignment outside of the "Safety and Air Quality Area," which is up to 150 nautical miles off the shore of California.
- Containership congestion dissipated and the numbers of vessels at anchorage returned to pre-pandemic levels, despite high volume of TEUs.

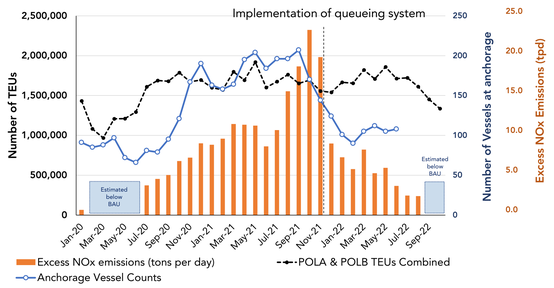

Figure 4. Number of TEUs being moved through the Ports of LA/LB, number of vessels at anchorage, and excess NOx emissions from all source categories from 2020 to 2022.

5. Excess emissions from vessels due to port congestion

- Unprecedented high numbers of vessels at anchorage led to significantly increased emissions in July 2020 through June 2022 (Figure 4), as the continuous operation of engines and generators in vessels while loitering near the shore generated excess emissions.
- Since the implementation of the new queuing system, the number of anchored or loitering containerships and their emissions significantly decreased and fluctuated around the BAU level.
- Anchorage and loitering activities for cruise and tanker vessels were not significantly influenced by trends in freight movement or port congestion-related activities.

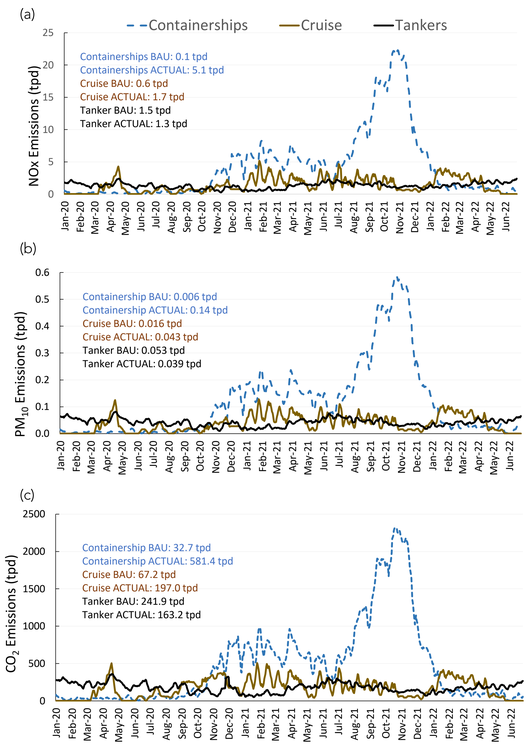

Figure 5. ACTUAL emissions (tons per day) of (a) NO_x, (b) PM_{10}, and (c) CO_2 from at-berth, anchored, and loitering containerships, cruise vessels, and tankers at Ports of LA/LB. Average BAU and ACTUAL emissions for each vessel category during the port congestion period (July 2020-June 2022) are shown in text.

7. Conclusions

- The surge in freight movement and port congestion that began during the pandemic led to an unprecedented high number of vessels waiting for berths at Ports of LA/LB, along with increased activities of trucks, locomotives, and cargo handling equipment, resulting in excess emissions.
- The implementation of the queueing system for vessels by PacMMS effectively reduced excess emissions from ships operation near the Ports of LA/LB.

6. Excess emissions from ground transportation due to increased freight movement

- The increase in freight movement above BAU levels required additional activity by port trucks and locomotives that operate to support port operations, as well as cargo handling equipment used at the Ports of LA/LB.
- Freight-related ground transportation emission sources (i.e., trucks, locomotives, and cargo handling equipment) had higher activity and greater emissions than BAU from Summer 2020 to Summer 2022.

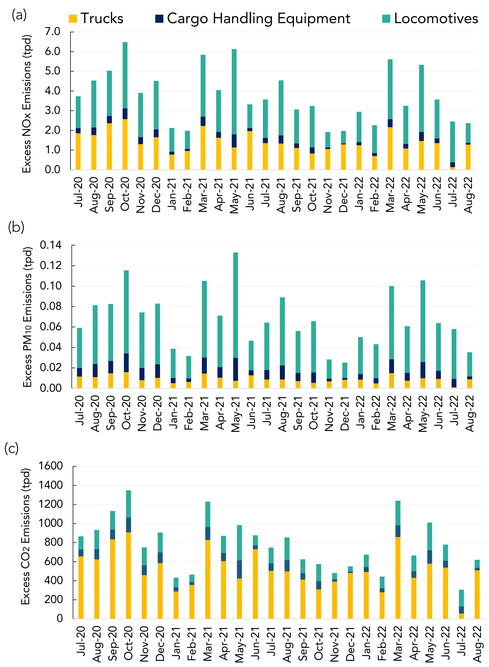

Figure 6. Excess emissions (tons per day) of (a) NOx, (b) PM_{10}, and (c) CO_2 from freight movement by trucks, locomotives, and cargo handling equipment at the Ports of LA/LB

8. Future work

- Continue partnerships between port operators, shipping lines, and government to optimize freight transport using advanced, low-emission, and clean technologies to meet air quality goals, both in the near-term and long-term
- Evaluate emissions impacts of various future scenarios involving increased freight movement and/or port congestion, as well as cleaner vessels and other components of the freight system