Emissions from Ships and Offshore Platforms

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ALL DATA AND FINDINGS SHOWN ARE

PRELIMINARY ONLY

AND SUBJECT TO CHANGE

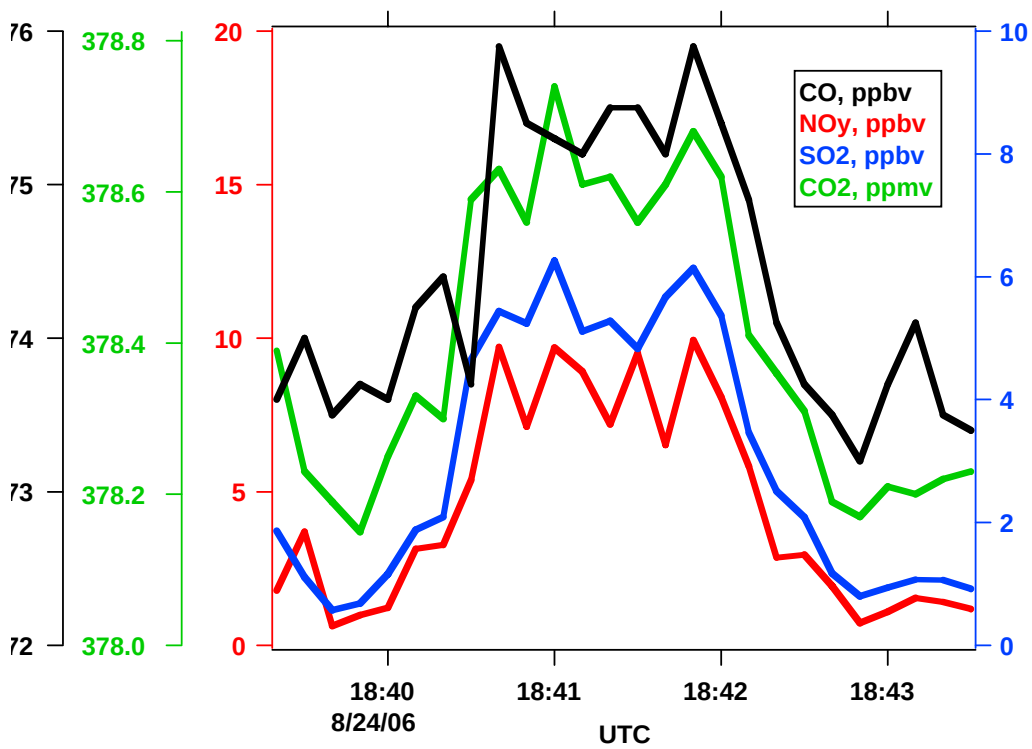
Mass-Based Emission Factor Calculations

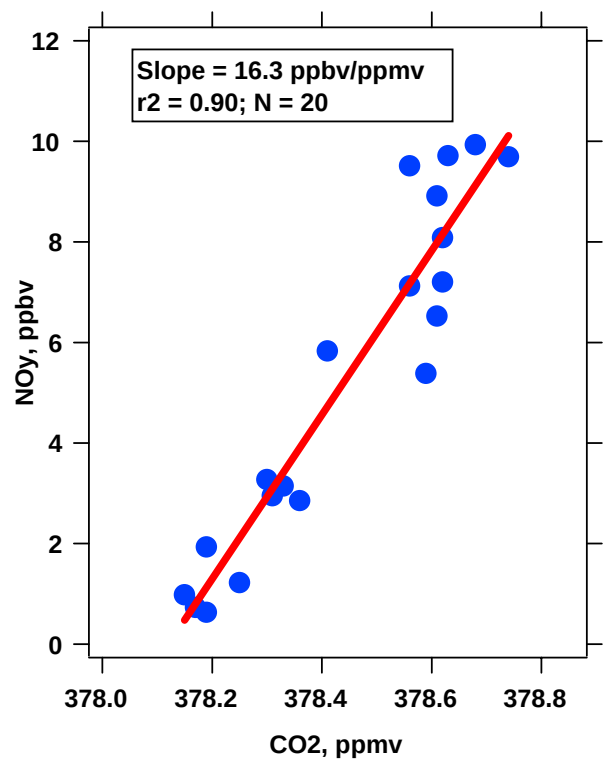
(Assume fuel C content is 86±0.5% C)

$$E.F.\ (NO_x) = \frac{\text{ppmv } NO_y * 46 \text{ g } NO_x/\text{mole } NO_y}{\text{ppmv } CO_2 * 13.9\text{e-}3 \text{ kg fuel/mole } CO_2} = \text{Slope} * 3.31(\pm 0.02) \text{ g/kg fuel}$$

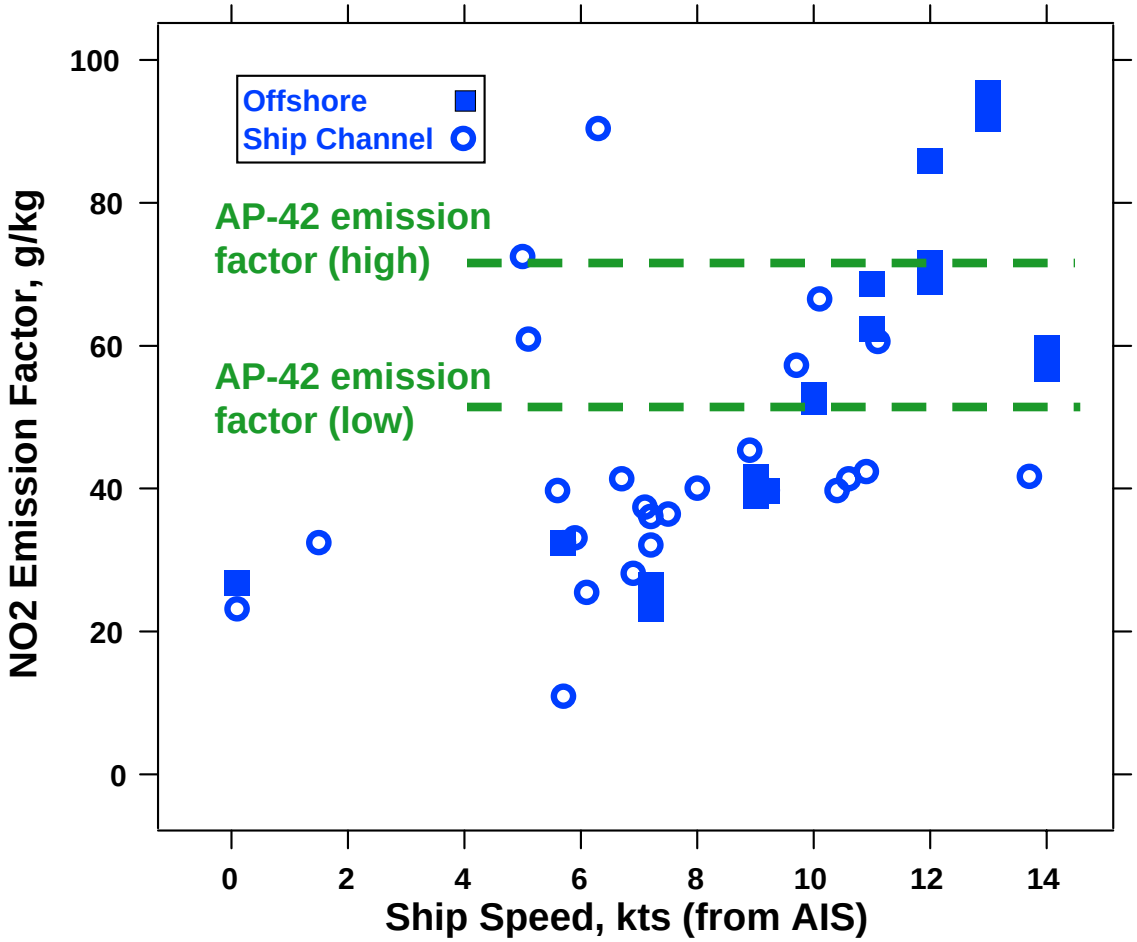
$$E.F.\ (SO_2) = \text{Slope} * 4.60(\pm 0.03)$$ (can also do for CO; VOCs; PM)

SOUTHGATE: bulk freighter outbound from Galveston at 10 knots





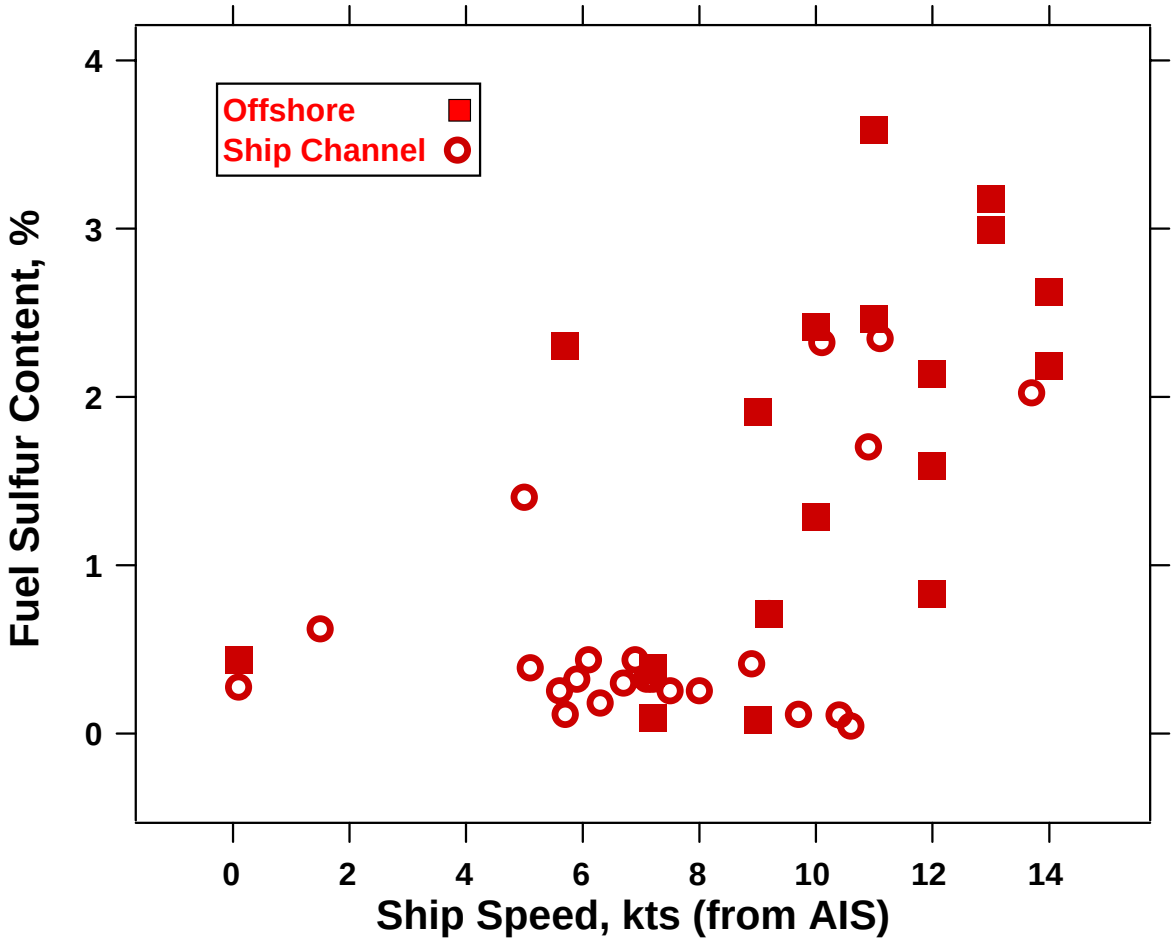
NO_x Emission Factor vs Vessel Speed



- NO_x emission increases with vessel speed (~power law)
- NO_x emission also occur when docked (auxiliary engines)
- Many inventories use constant emission factors (e.g, AP-42)

  This is clearly inaccurate!

Fuel Sulfur Content vs Vessel Speed



- SO_2 emission factor depends directly on fuel S content

  Fuel S content = E.F. / ~20
- High S fuels tend to be used offshore, but not always!!
- SO_2 emissions occur dockside independent of engine speed

Marine Vessel: "Typical" Emission Data

1. Assume vessel at 10 knots using ~500 gal/hr* fuel (0.5 kg fuel/sec)

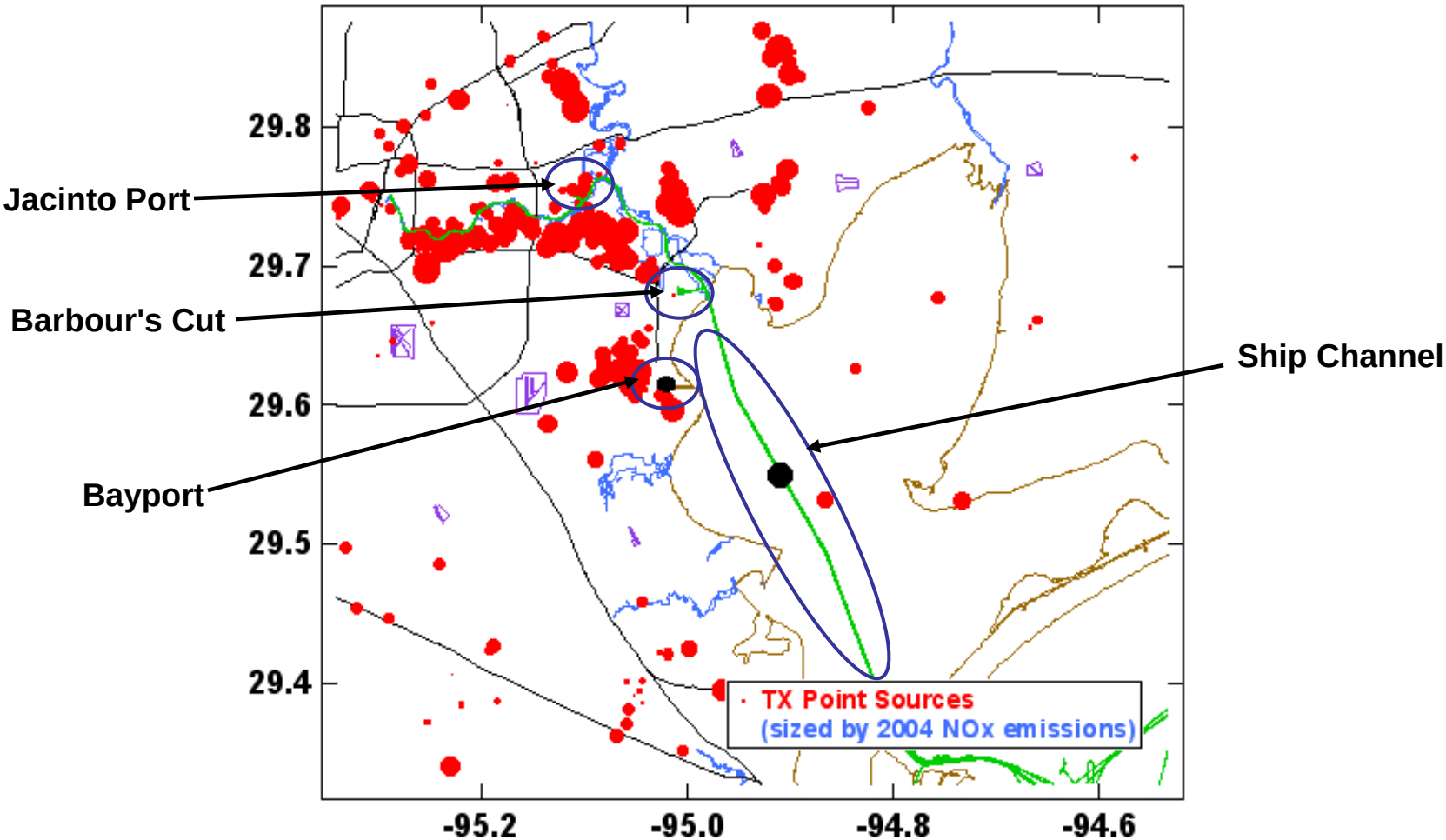
Species	E. F. (g/kg)	Emission Rate (molec/sec)	Emission Rate (tons/day)
NO_x	50	3.3e23	2.4
SO_2 (2% S)	40	1.9e23	1.9
CO	6	0.7e23	0.3

(*Range of fuel use is ~200 gal/hr to ~2000 gal/hr while underway)

2. Assume vessel is docked using ~100 gal/hr fuel (0.1 kg fuel/sec)

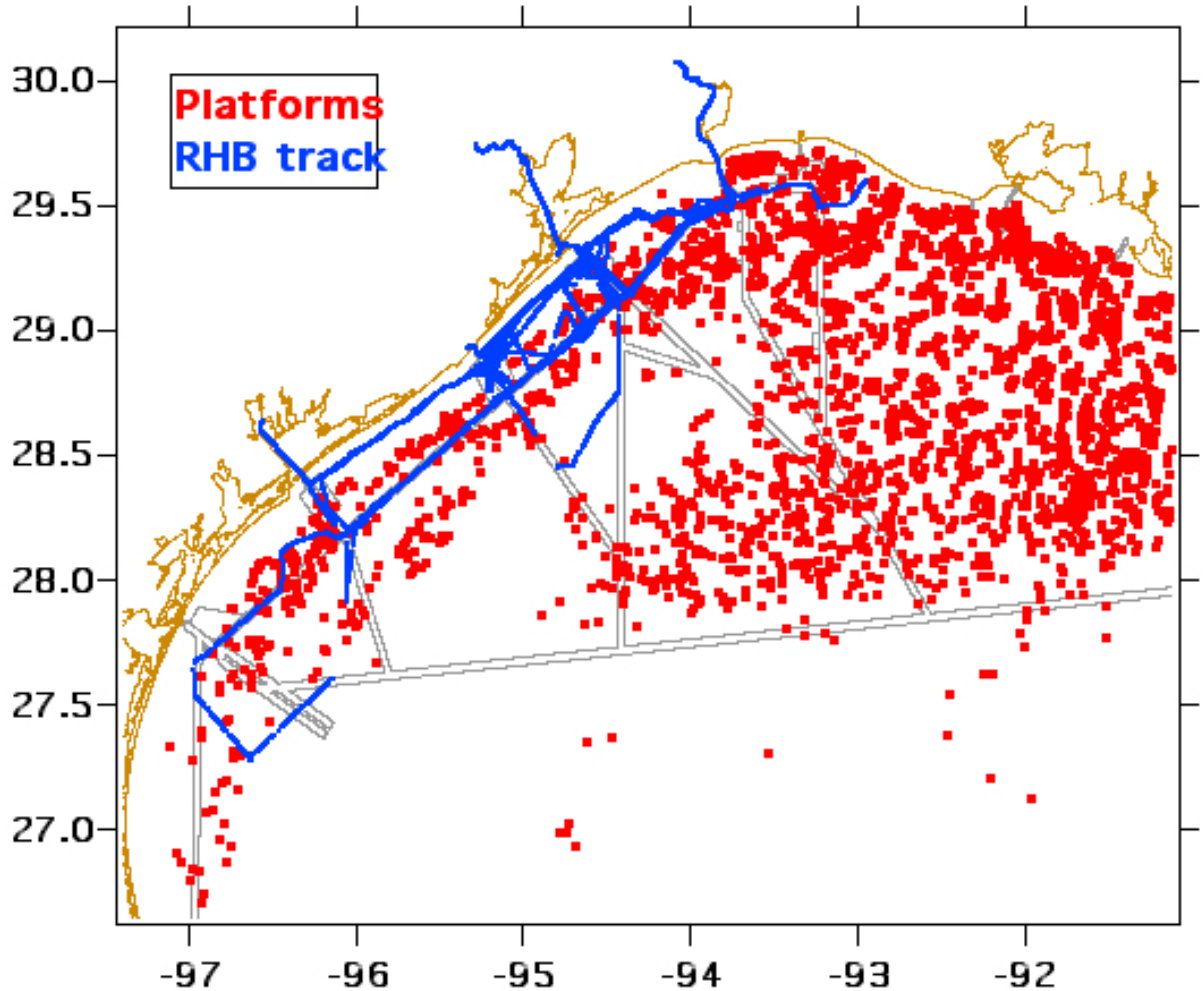
Species	E. F. (g/kg)	Emission Rate (molec/sec)	Emission Rate (tons/day)
NO_x	20	2.6e22	0.2
SO_2 (0.5% S)	10	0.9e22	0.1
CO	6	1.3e22	0.06

Marine Vessels: NO_x Emission Comparison



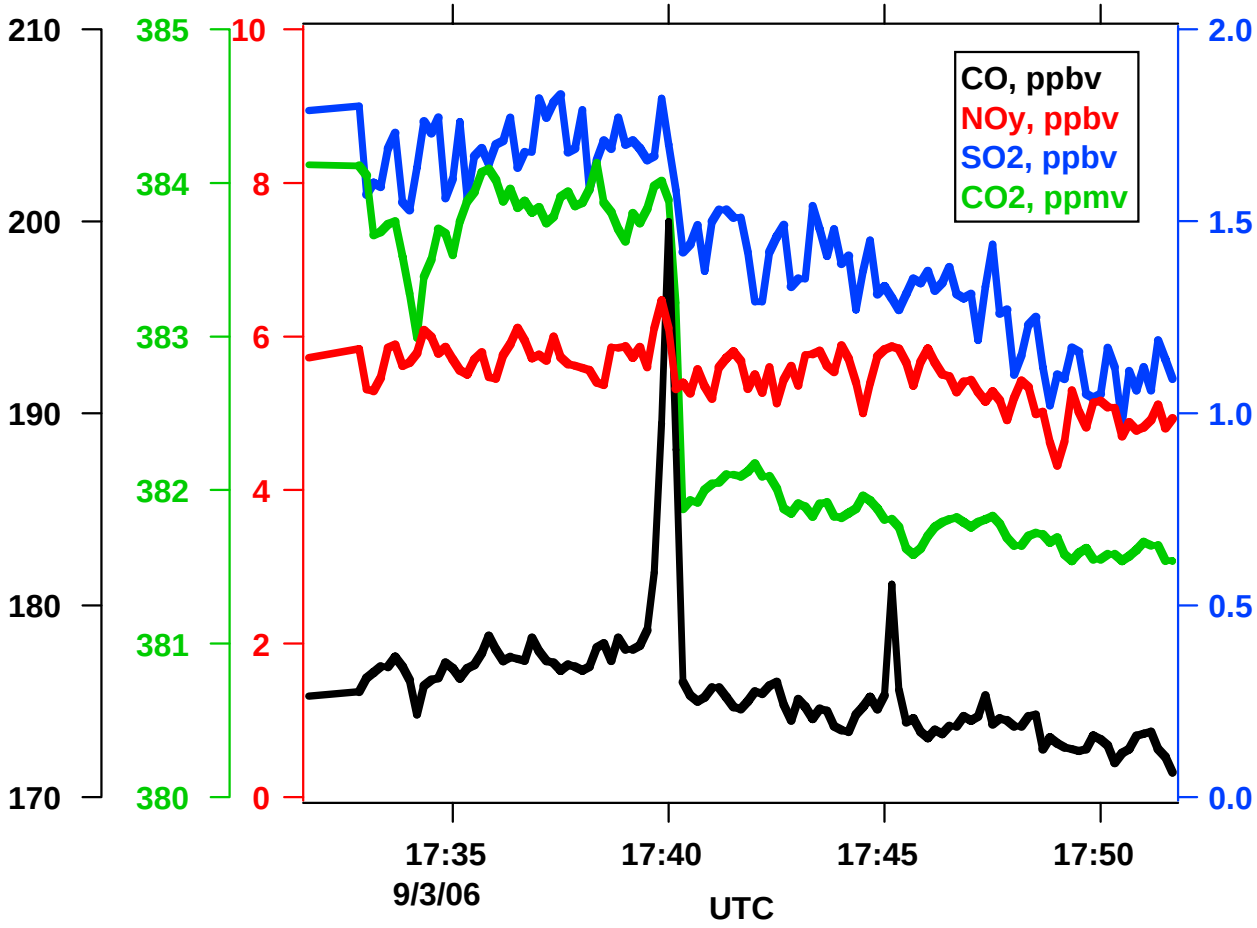
Black dots show NO_x emission from underway ship and docked ship
"Hotspots" of ship activity shown as circled: number of ships varies
Transit speeds along N-S corridor of HSC are 8 - 12 knots!
Similar picture for SO_2

Emissions from Offshore Platforms



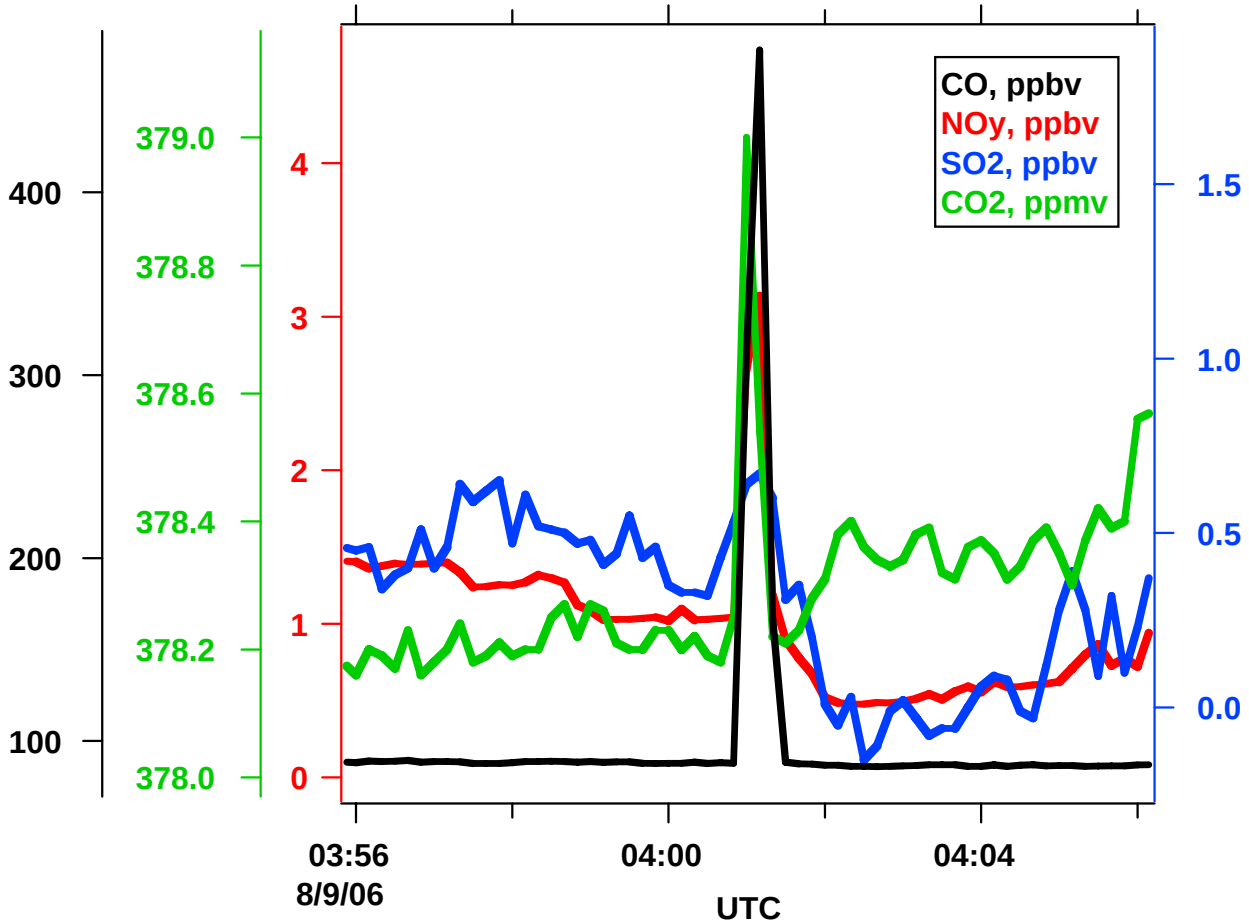
- Emission factors tend to be lower than those of ships, but similar species emitted (diesel generators used)
- In many cases, emissions from platforms are difficult to observe

Emissions from Offshore Platforms



Possible platform emissions near Freeport (28.84 N / 94.96 W)
Plumes at 1740 and 1745 UTC (1245 LT) show increase only in CO
No ships operating upwind (according to AIS)

Emissions from Offshore Platforms



Unusual case south of entrance to Sabine Pass (Port Arthur)

Emission factor for NOy = 7.5 g/kg, but for <u>CO = 860 g/kg !!</u>

Observed similar plume at same location on 10 Aug at 1953 UTC

Observations and Findings

- Emissions of NO_x, SO_2, and CO from commercial marine vessels cannot be neglected in inventories for port regions and possibly for offshore areas (depends on meteorology)

- Vessel traffic, especially in the HSC, usually was significant even on weekends and holidays

- Emission factor measurements are consistent with literature data, but for NO_x there is a strong dependence on vessel speed

- Emissions of NO_x, SO_2, and CO from offshore platforms may not be significant, but thorough analysis is required