A combined line-point-source model for ship emissions in the port of Hamburg, Germany

2016 CMAS Conference
10/24 - 10/26/2016

Armin Aulinger, Volker Matthias, Johannes Bieser

Helmholtz-Zentrum Geesthacht

21. Oktober 2016

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

Inhalt

Data and set-up

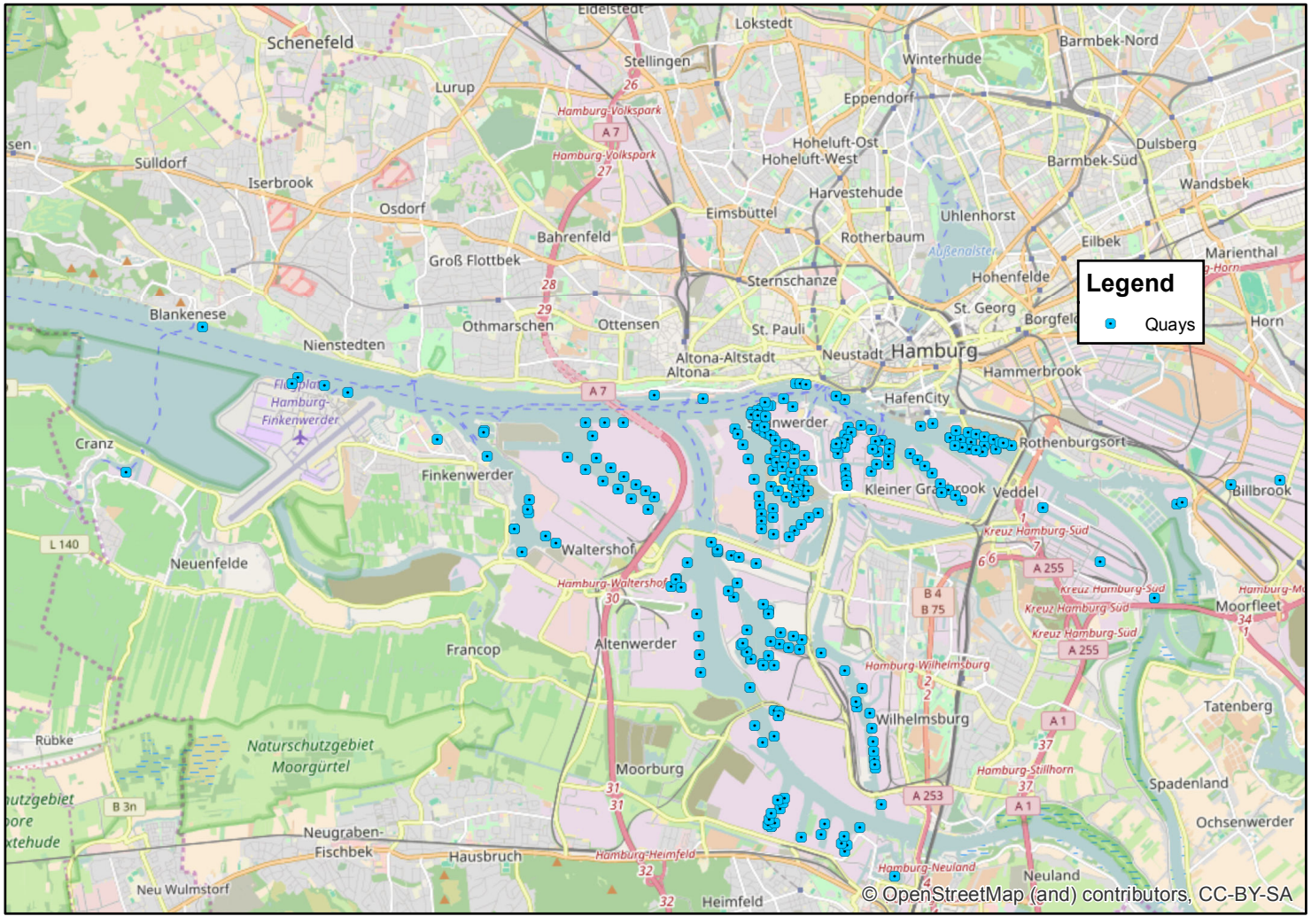
Ship activities

Emission calculation

Results

Outlook

Port of Hamburg

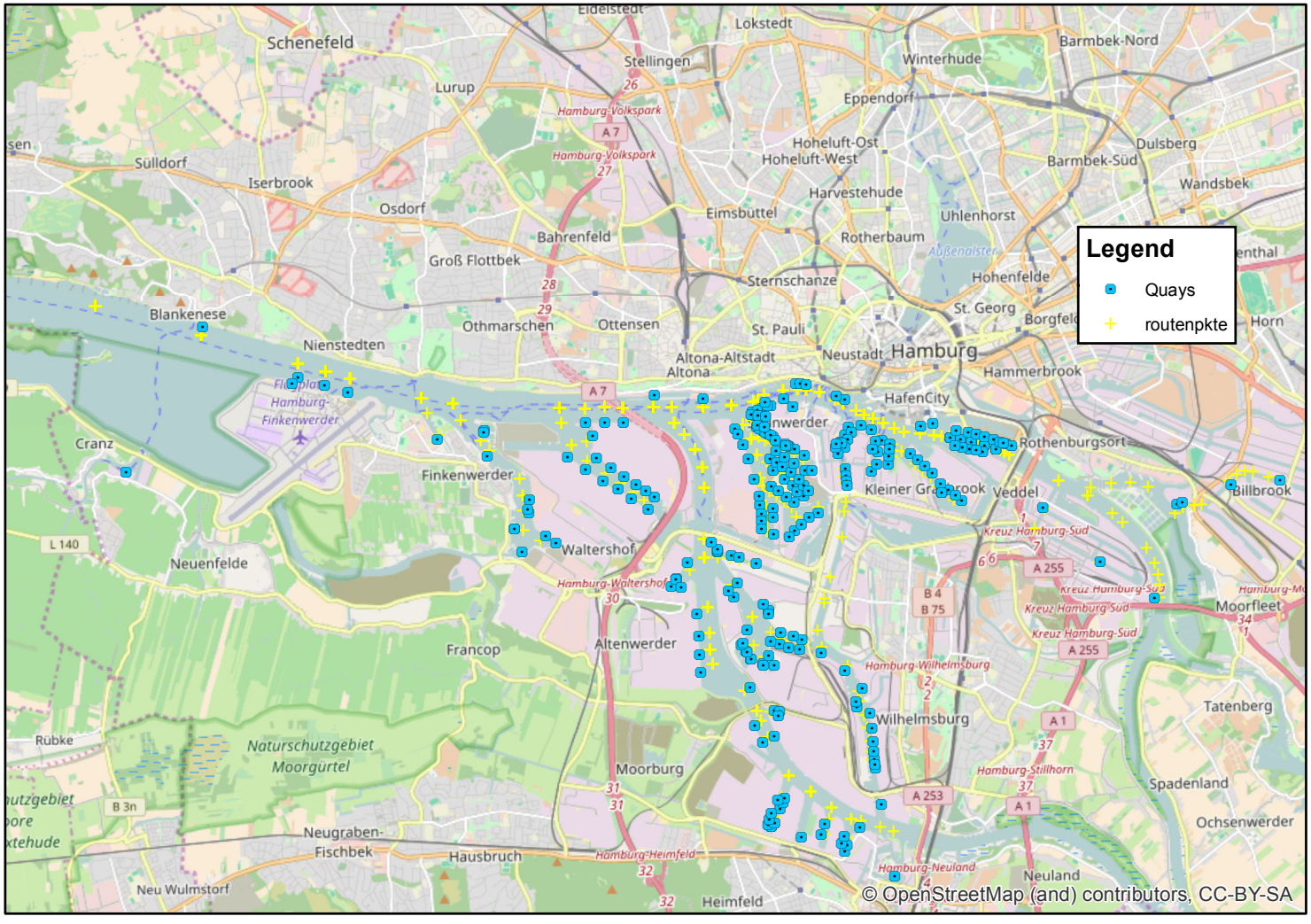


HPA data table

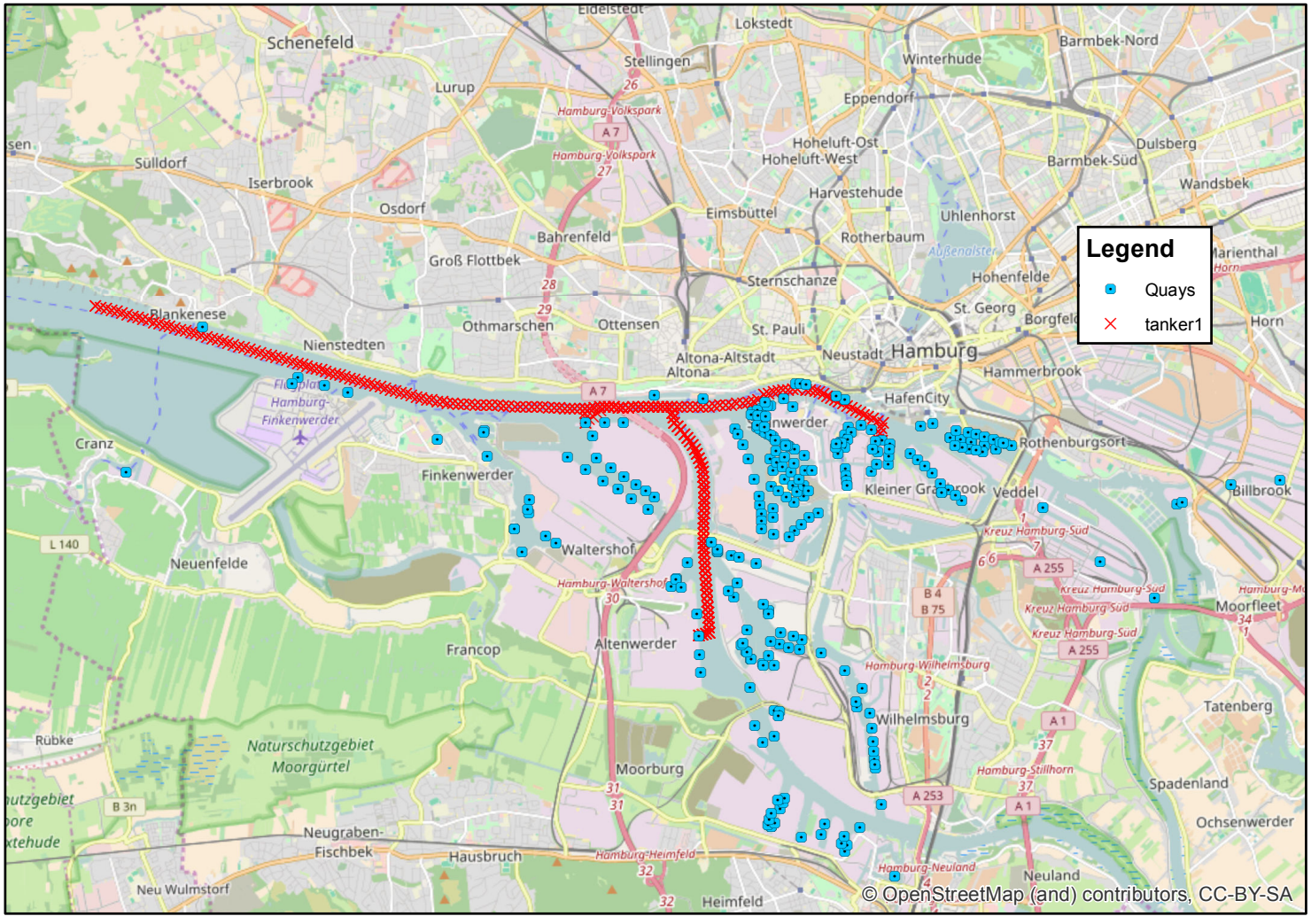
- time of entering the port area
- time of leaving the port area
- time of arriving at the quay
- time of departing from the quay
- quay identifier
- ship info
  - unique IMO number
  - shiptype: container, general cargo, tanker, bulk,...

Additional info about the engines of the vessels are obtained from an IHS Fairplay data base.

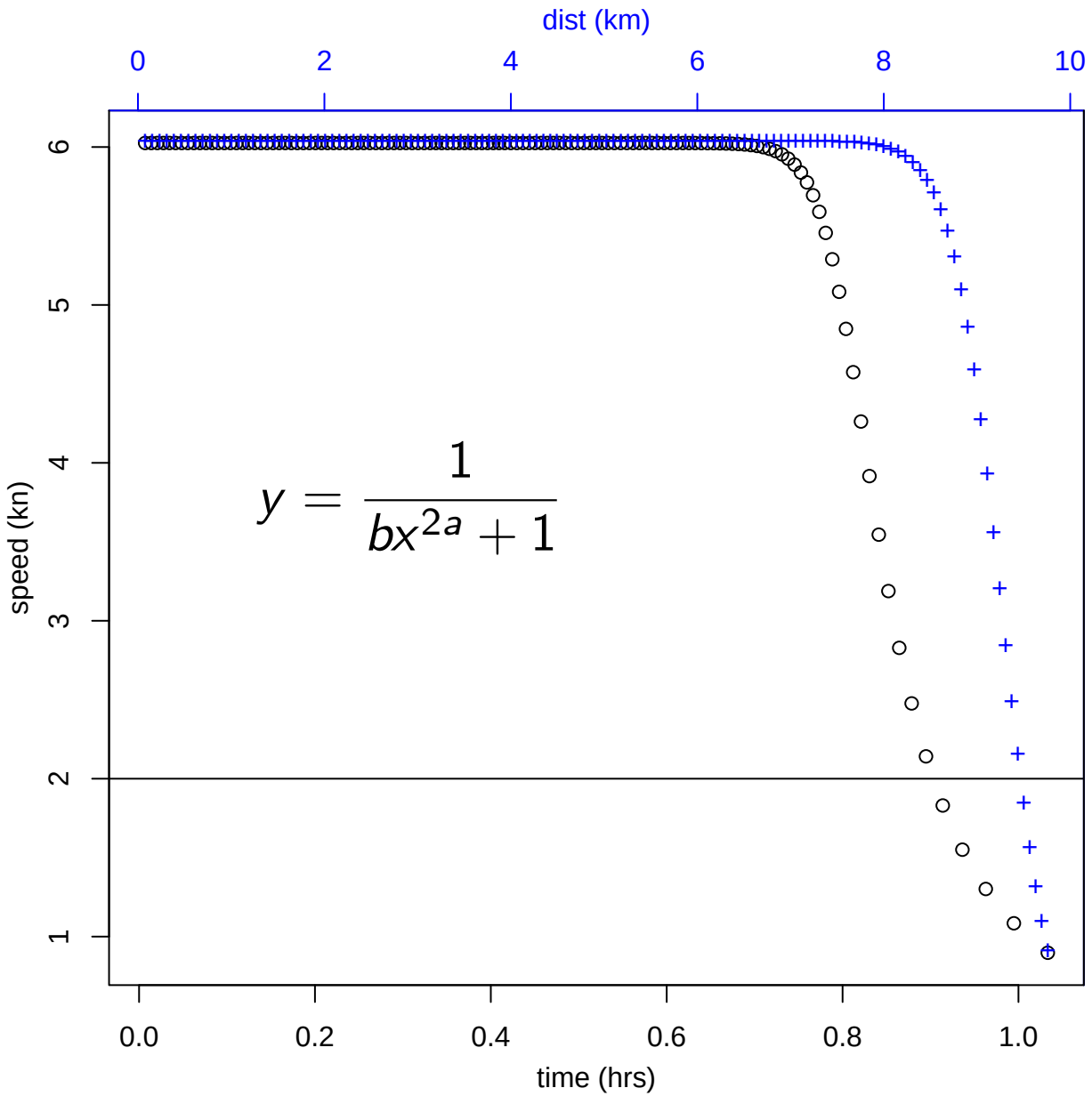
Route points



Interpolated track



Time profile for the tracks



Three types of activities

sailing

- line source emissions
- energy specific emission factors ($\frac{\mathrm{g}}{\mathrm{kWh}}$)
- calculate load from speed over ground
- fixed loads for auxiliary engines

Three types of activities

sailing

- line source emissions
- energy specific emission factors ($\frac{\mathrm{g}}{\mathrm{kWh}}$)
- calculate load from speed over ground
- fixed loads for auxiliary engines

manoeuvring

- point/line source emissions
- energy specific emission factors ($\frac{\mathrm{g}}{\mathrm{kWh}}$)
- fixed loads for main and aux. engines

Three types of activities

sailing

- line source emissions
- energy specific emission factors ($\frac{\mathrm{g}}{\mathrm{kWh}}$)
- calculate load from speed over ground
- fixed loads for auxiliary engines

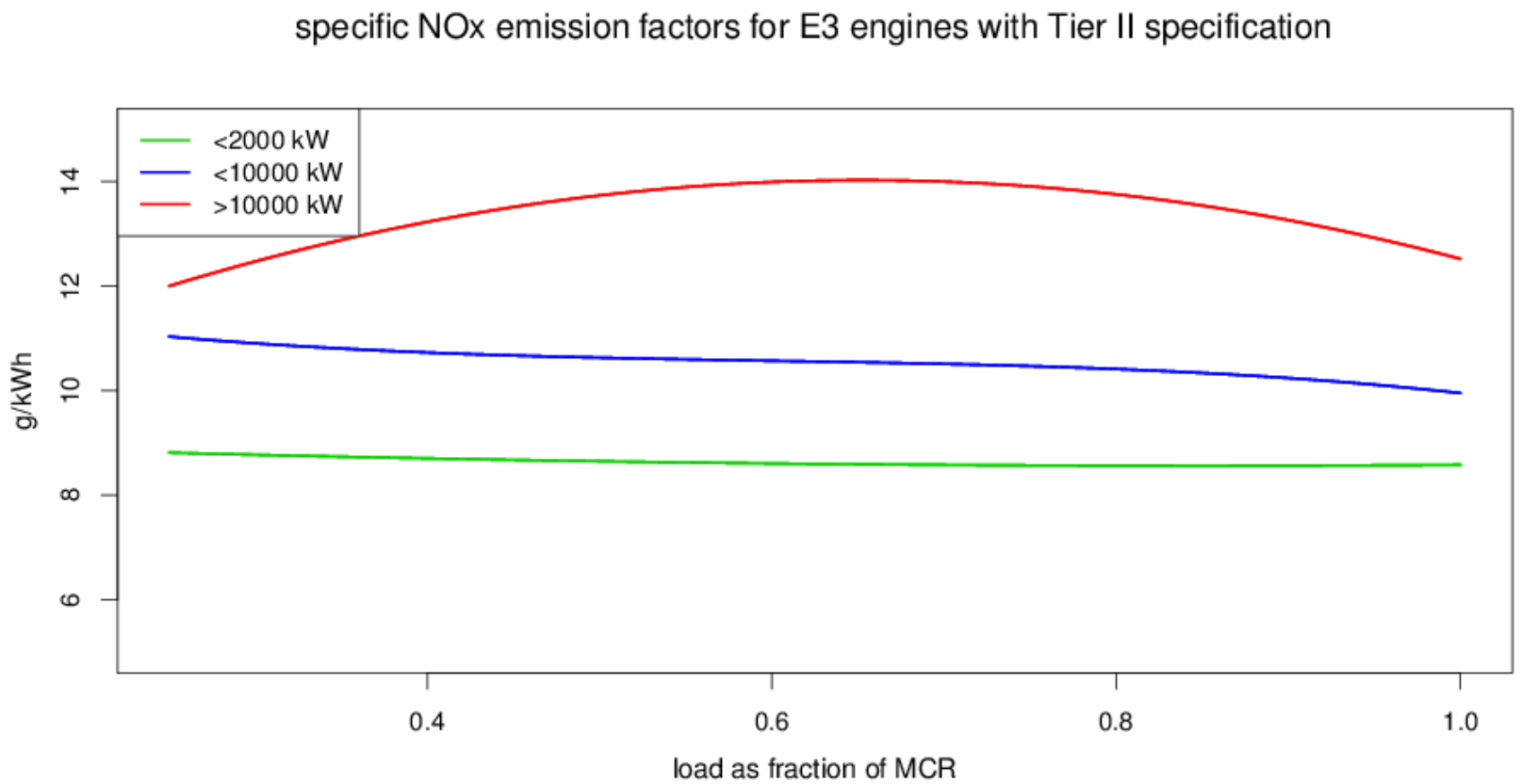
manoeuvring

- point/line source emissions
- energy specific emission factors ($\frac{\mathrm{g}}{\mathrm{kWh}}$)
- fixed loads for main and aux. engines

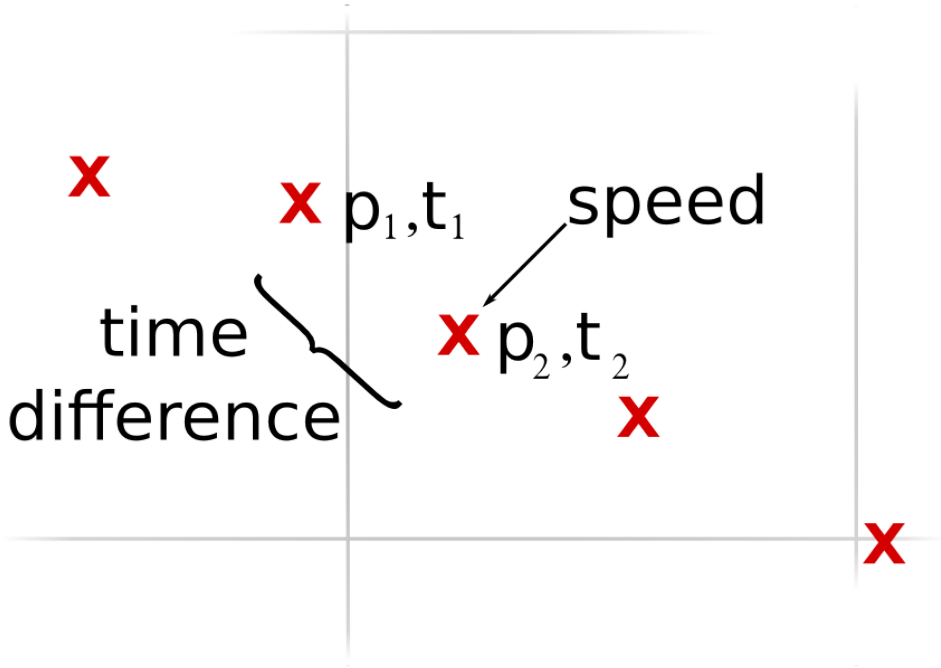
berthing

- point source emissions
- fuel specific emission factors ($\frac{\mathrm{g}}{\mathrm{kg}}$)
- data about fuel consumption from surveys

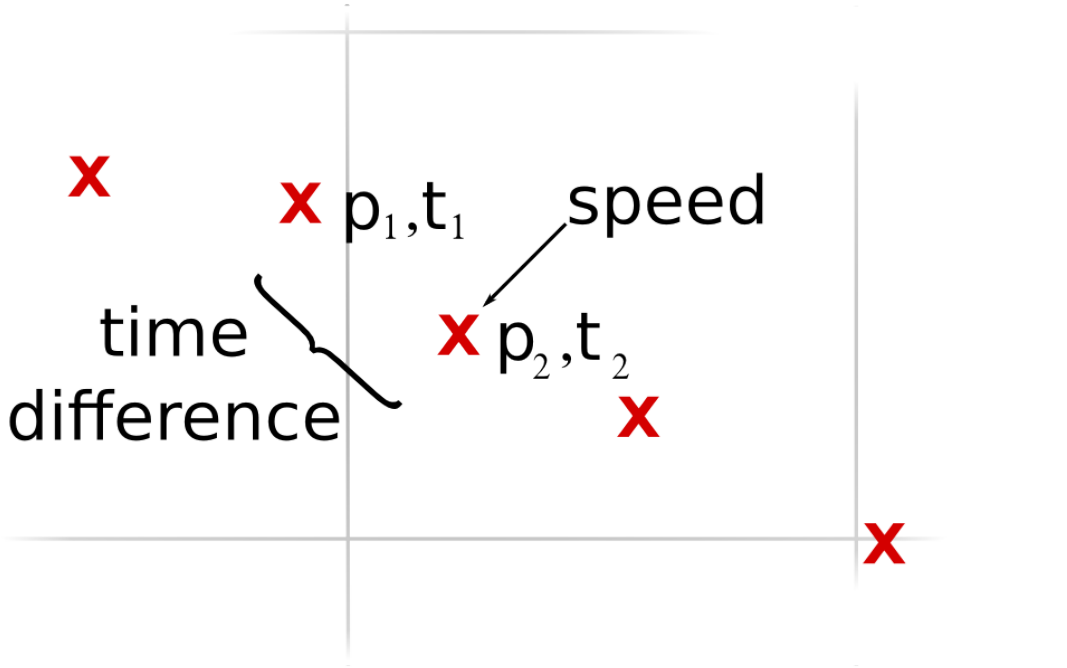
Load based emissions



Load based emissions



Load based emissions



$$E(v, p_2, t_2) = (\frac{speed}{speed_{max}})^3 MCR_{max} \Delta t EF + E_{aux}$$

Aulinger, A., V. Matthias, M. Zeretzke, J. Bieser, M. Quante, Backes, A. 2016: The impact of shipping emissions on air pollution in the greater North Sea region – Part 1: Current emissions and concentrations. Atmos. Chem. Phys., 16, 739-758.

Fuel based emissions at berth

Survey on board 175 seagoing ships

- fuel consumption at berth (fc in $\frac{\mathrm{kg}}{\mathrm{h}}$).
- ratio of boiler usage (r).
- fuel specific emission factors for auxiliary engines and boilers (EF_{aux}, EF_b in $\frac{\mathrm{g}}{\mathrm{kg}}$).

Hulskotte, J. H. J., H. A. C. Denier van der Gon, 2010: Fuel consumption and associated emissions from seagoing ships at berth derived from an on-board survey. Atmos.Environ., 44, 1229-1236.

Fuel based emissions at berth

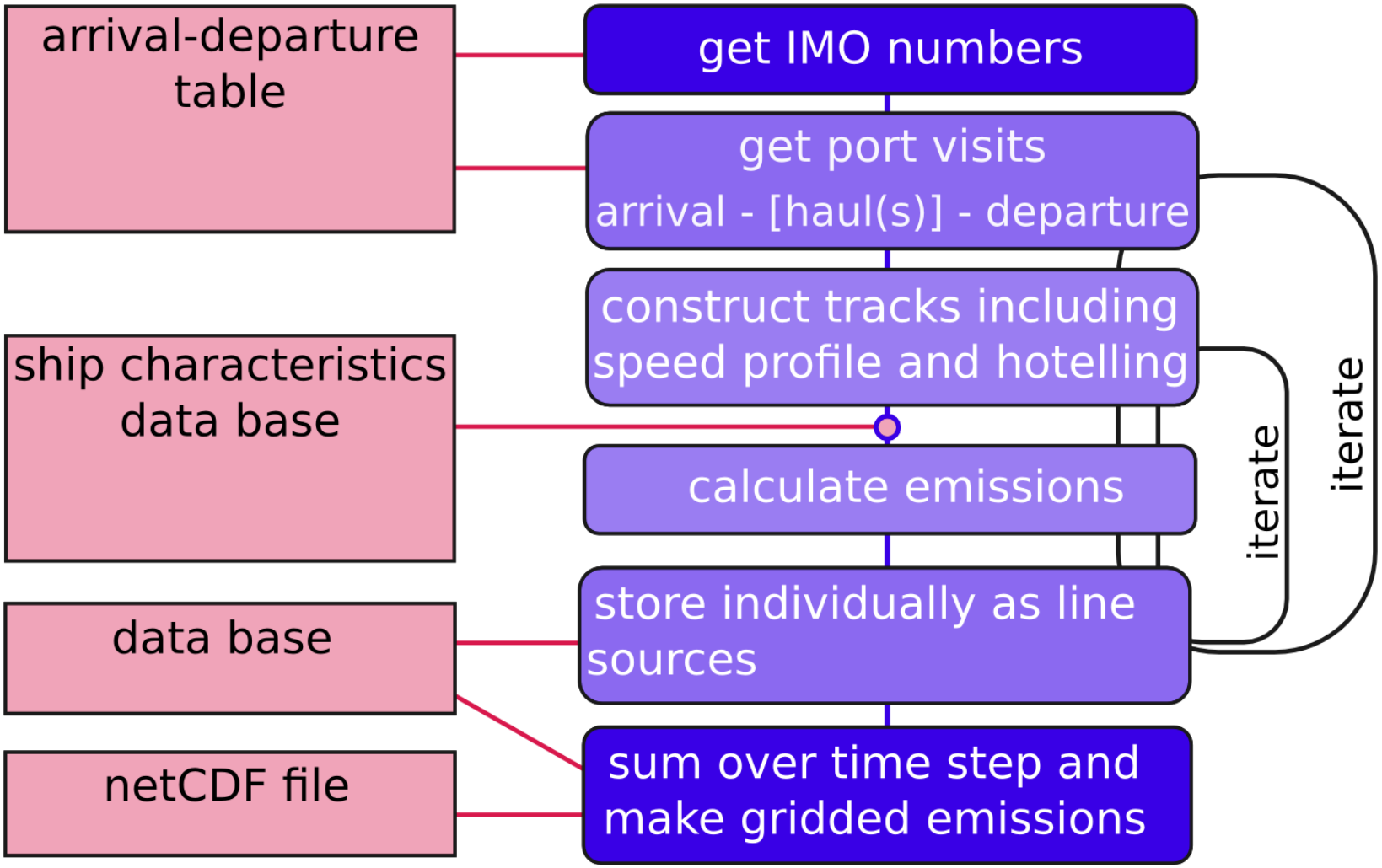
Survey on board 175 seagoing ships

- fuel consumption at berth (fc in $\frac{\mathrm{kg}}{\mathrm{h}}$).
- ratio of boiler usage (r).
- fuel specific emission factors for auxiliary engines and boilers (EF_{aux}, EF_b in $\frac{\mathrm{g}}{\mathrm{kg}}$).

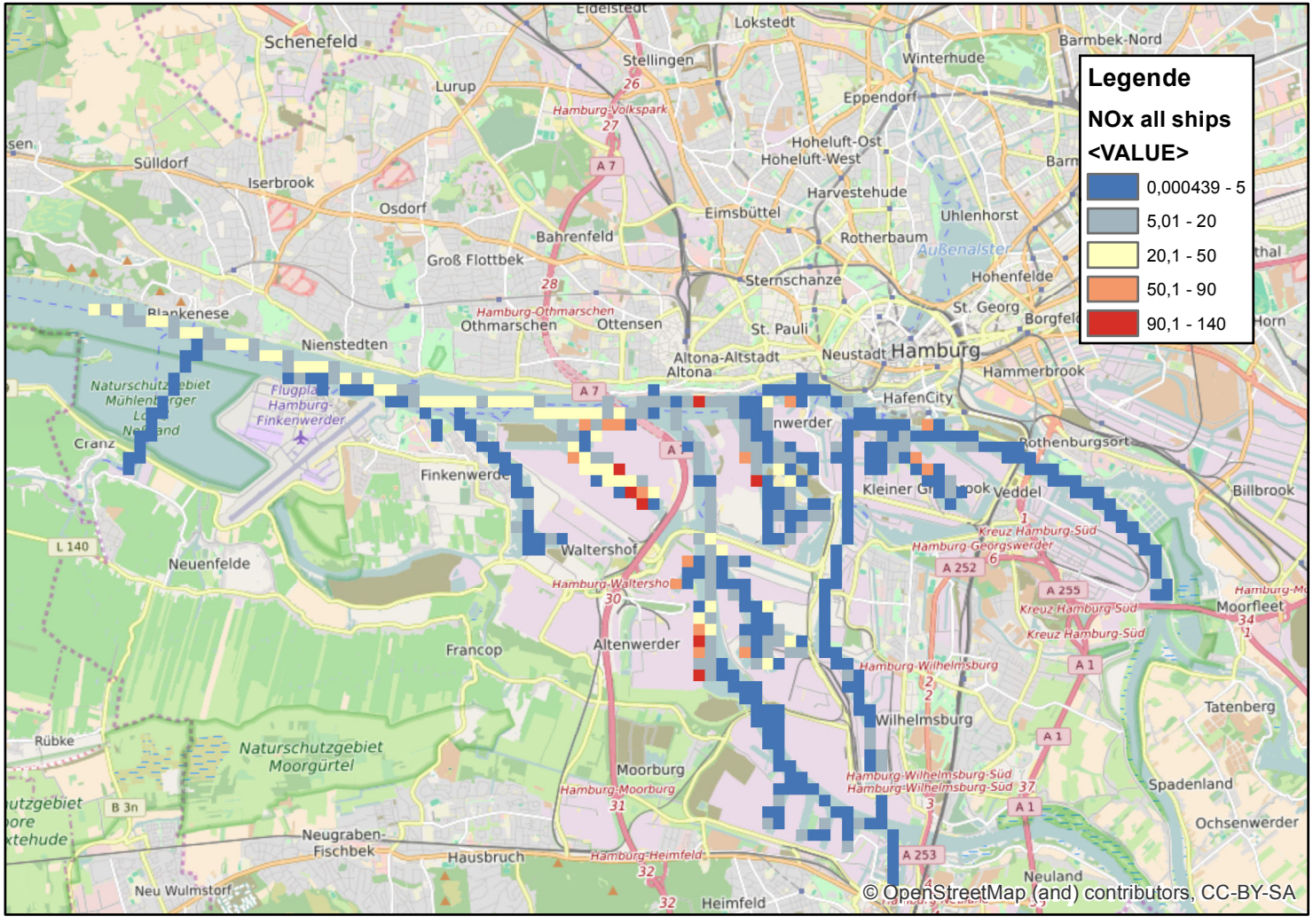
$$E(v, q, t_1, t_2) = (rEF_b + (1 - r)EF_{aux})fc\Delta t$$

Hulskotte, J. H. J., H. A. C. Denier van der Gon, 2010: Fuel consumption and associated emissions from seagoing ships at berth derived from an on-board survey. Atmos.Environ., 44, 1229-1236.

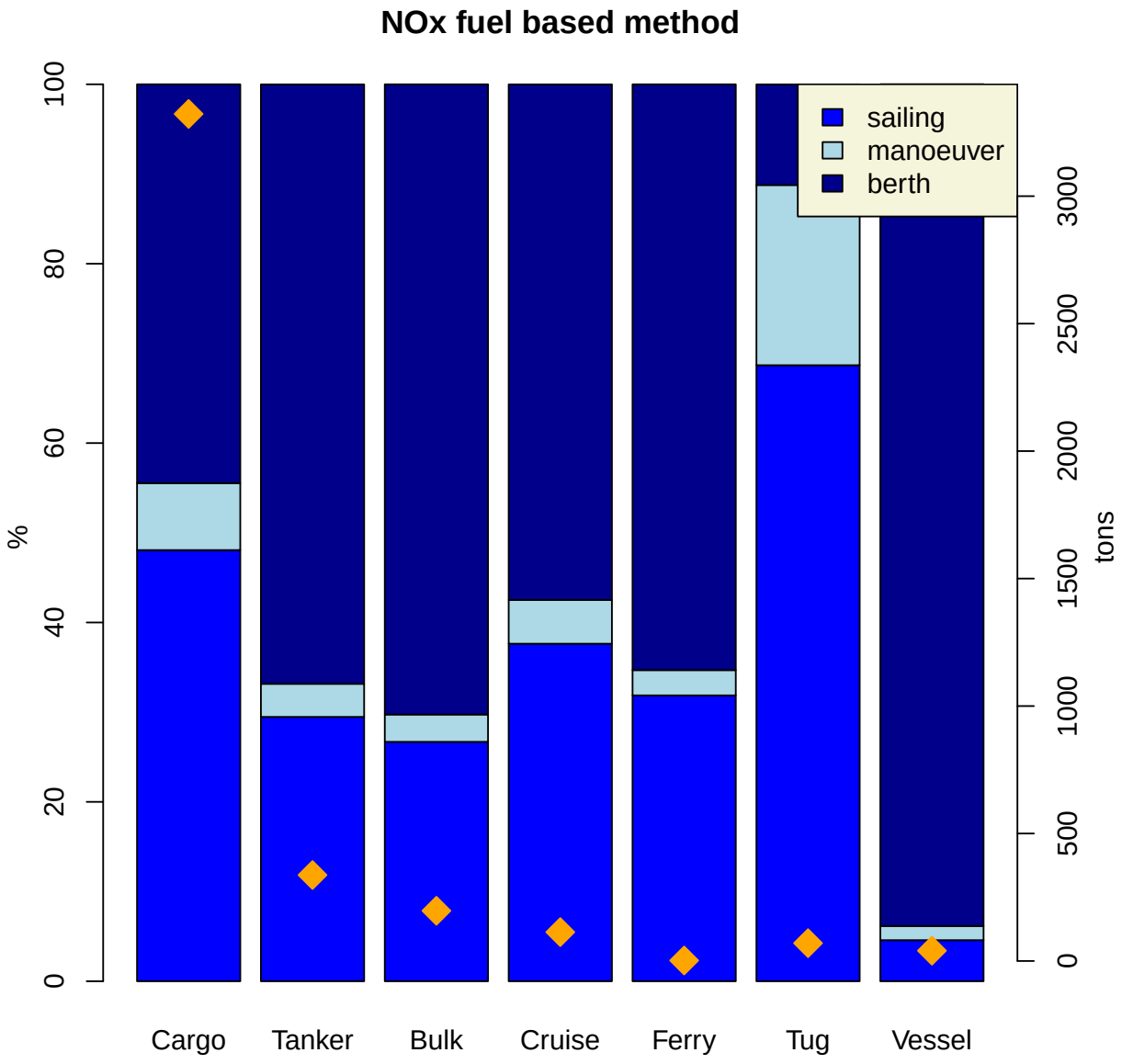
Model scheme



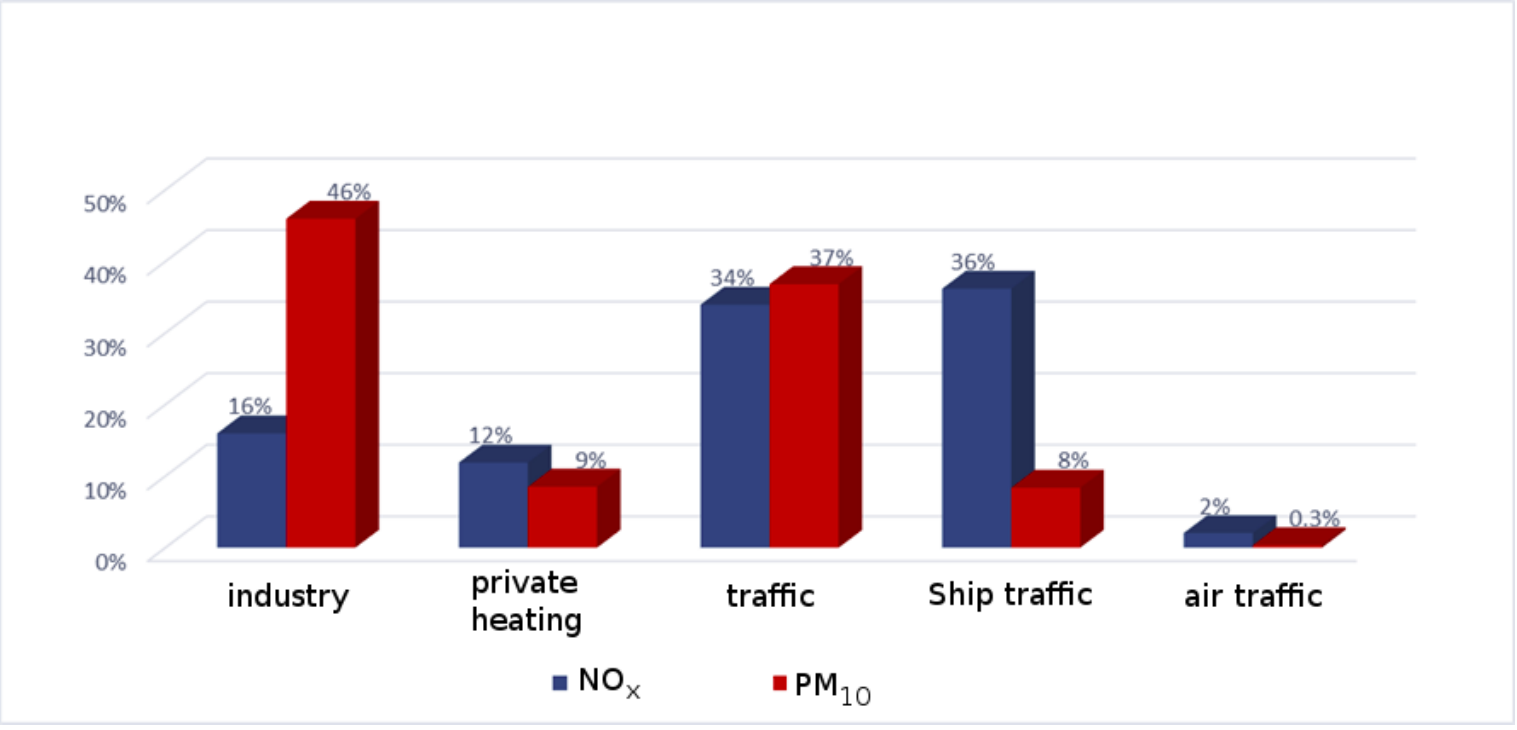
Total NO_x emissions by ships 2013



NO_x emissions per activity and ship type



Ship emissions compared to other emissions



Outlook

- Evaluate further.

Outlook

- Evaluate further.
- Provide tools for scenario creation.

Outlook

- Evaluate further.
- Provide tools for scenario creation.
- Integrate option to create tracks from AIS signals.

Outlook

- Evaluate further.
- Provide tools for scenario creation.
- Integrate option to create tracks from AIS signals.
- Consider emission height (and flue gas temperature).

Outlook

- Evaluate further.
- Provide tools for scenario creation.
- Integrate option to create tracks from AIS signals.
- Consider emission height (and flue gas temperature).
- Make source available (GPL).