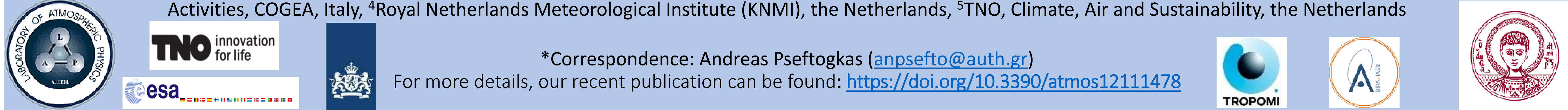# Different Maritime Activities Observed By S5P/TROPOMI Tropospheric NO$_2$ Columns Over The Mediterranean And Black Sea Regions

Andreas Pseftogkas *[1], Maria-Elissavet Koukouli [1], Ioanna Skoulidou [1], Dimitrios Balis[1], Charikleia Meleti [1], Trissevgeni Stavrakou [2], Luigi Falco[3], Jos van Geffen[4], Henk Eskes[4], Arjo Segers[5], Astrid Manders[5]

[1]Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki, Thessaloniki, Greece,[2]Royal Belgian Institute for Space Aeronomy (BIRA-IASB), Belgium, [3]EMODnet Human Activities, COGEA, Italy,[4]Royal Netherlands Meteorological Institute (KNMI), the Netherlands, [5]TNO, Climate, Air and Sustainability, the Netherlands
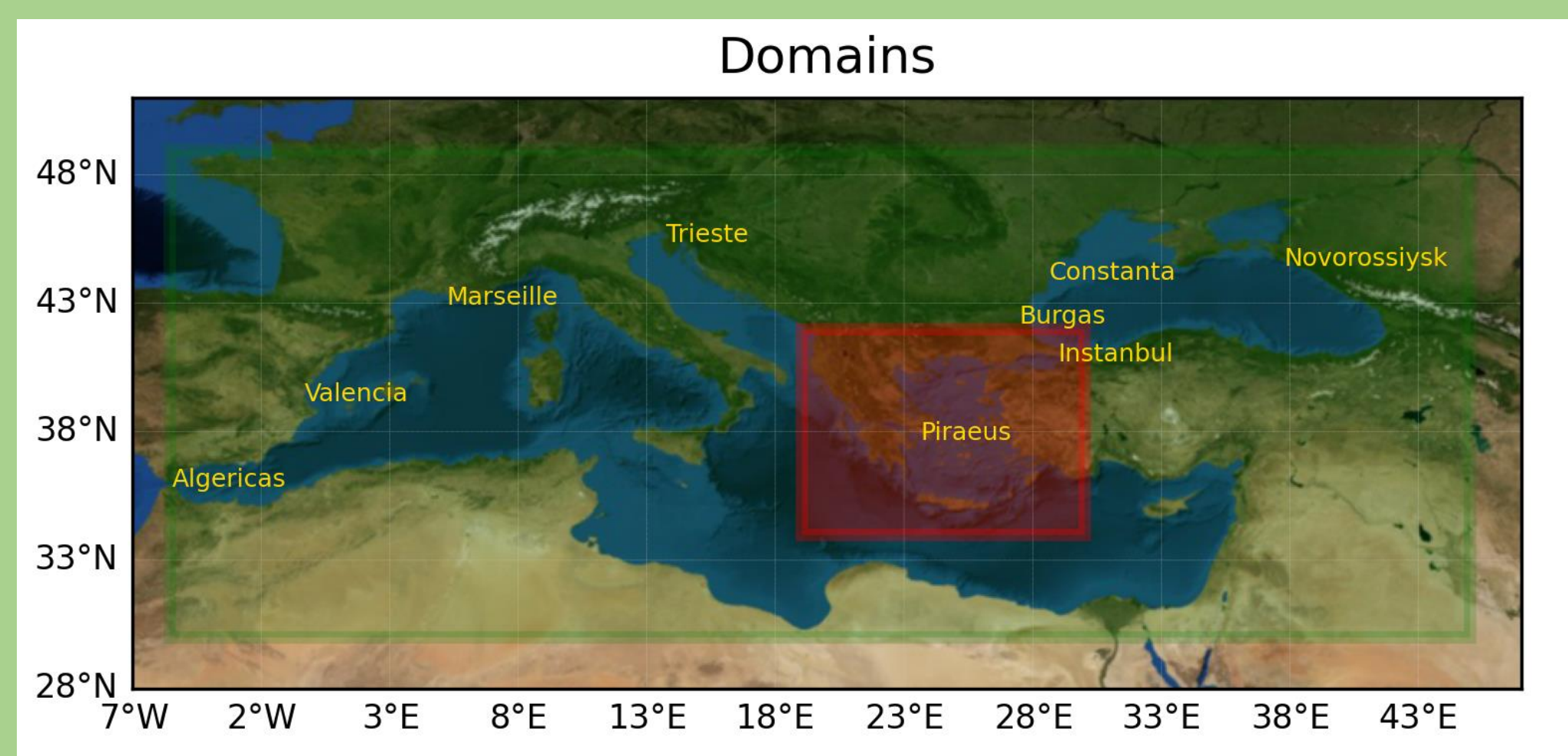
*Correspondence: Andreas Pseftogkas (anpsefto@auth.gr)
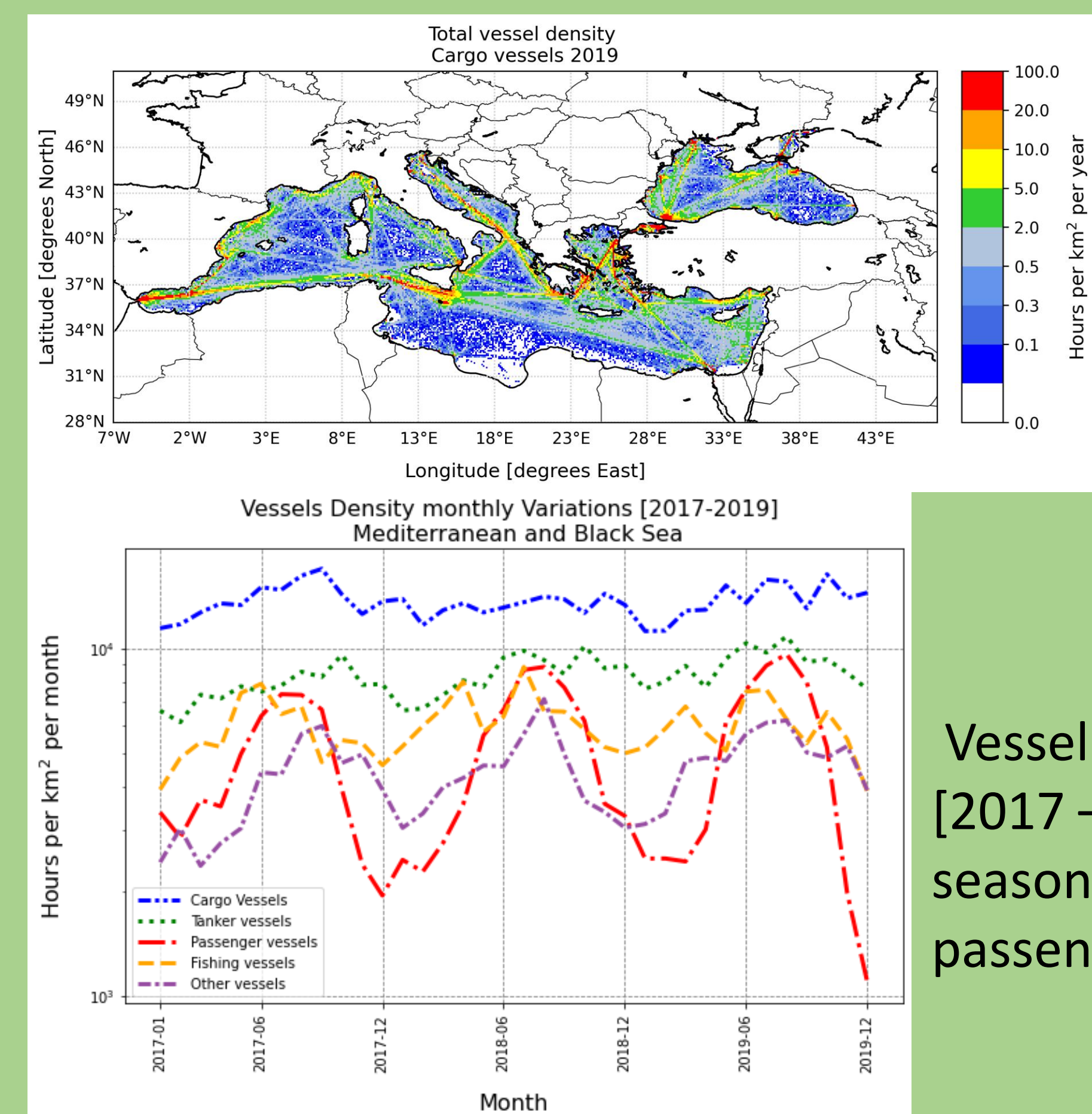For more details, our recent publication can be found: https://doi.org/10.3390/atmos12111478

DEFINING THE VESSEL DENSITY VIA THE EMODNET DATABASE – STEP I

EMODnet

- Provides monthly vessel density (in hours per km^2) according to AIS vessel activity.
- Separation into 5 vessel categories (cargo, tanker, fishing, passenger, other).
- Monthly data from 2017-2019 gridded into 0.1° x 0.1 °.
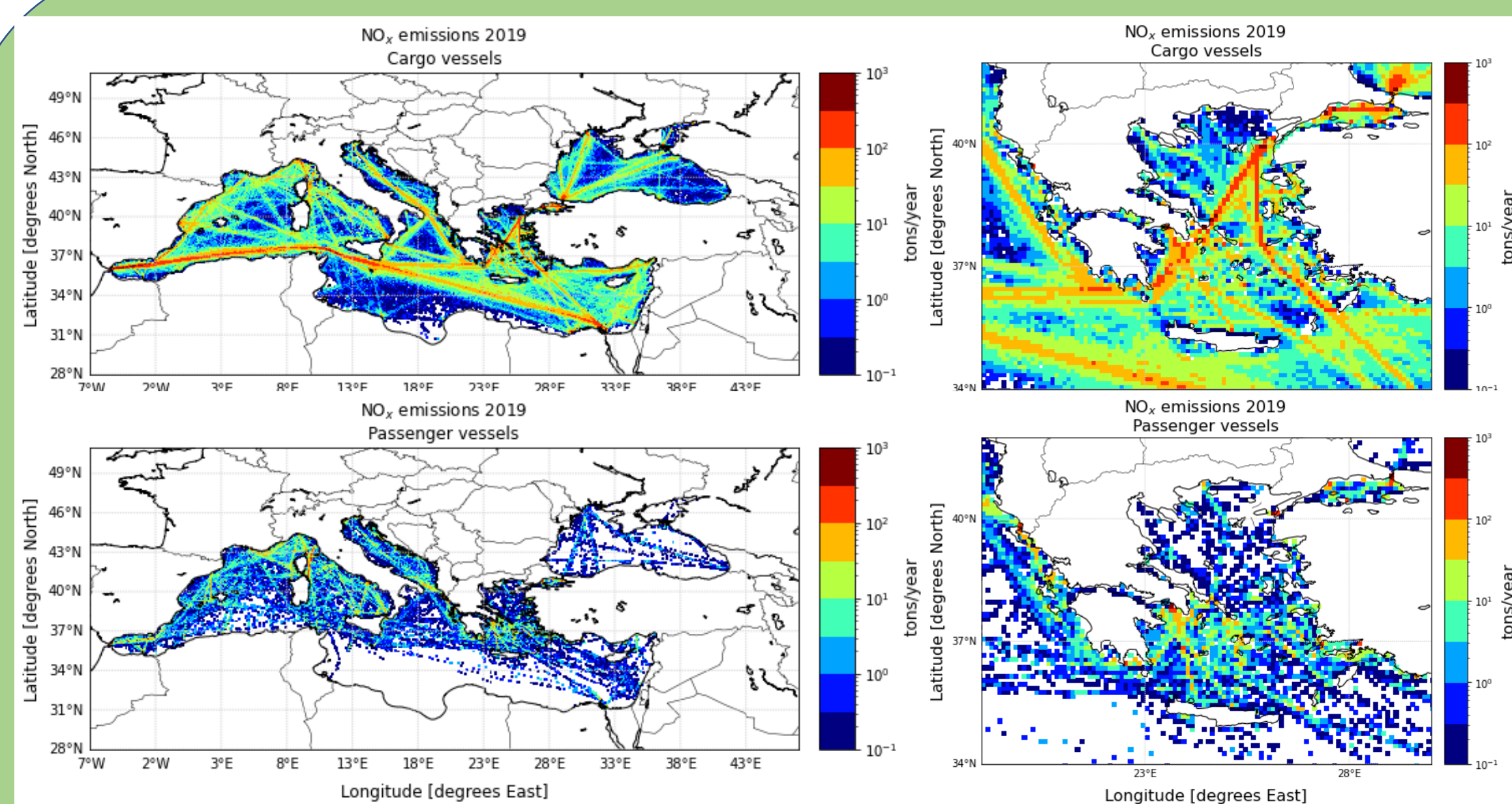

Study domains.

Cargo vessel density for 2019. Main lanes from Gibraltar to the Suez Canal and the Bosporus Straight and in the Adriatic Sea.

Vessel density time series [2017 – 2019]. Obvious seasonal variability for the passenger vessels.

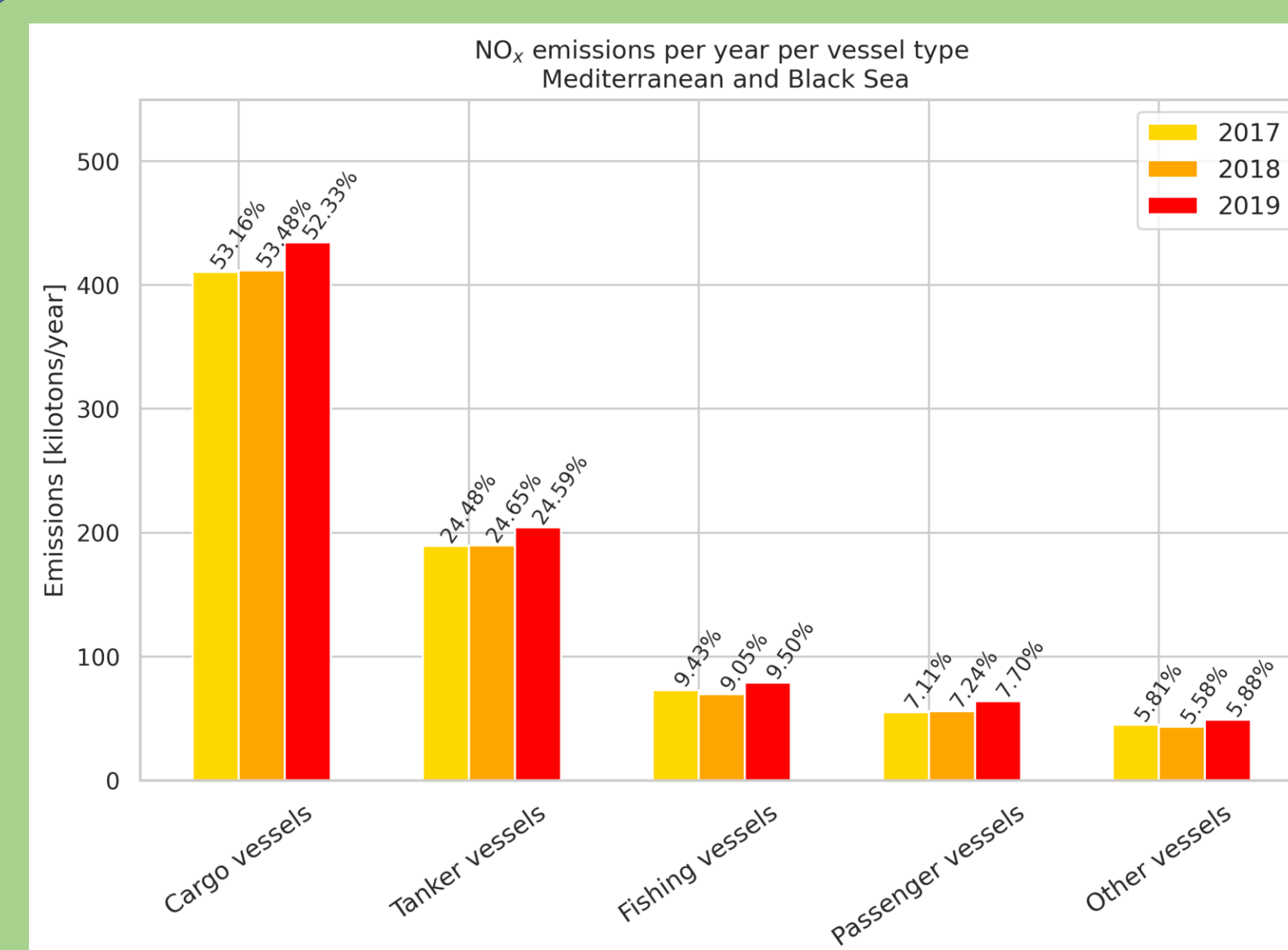## GENERATING EMISSIONS PER VESSEL TYPE WITH THE CAMS-GLOB-SHIP V2.1 EMISSION INVENTORY– STEP II

$$Emissions_{i,j,k} = vessel\ density_{i,j,k}/total\ vessel\ density_{j,k} * CGB\_emissions_{j,k}$$

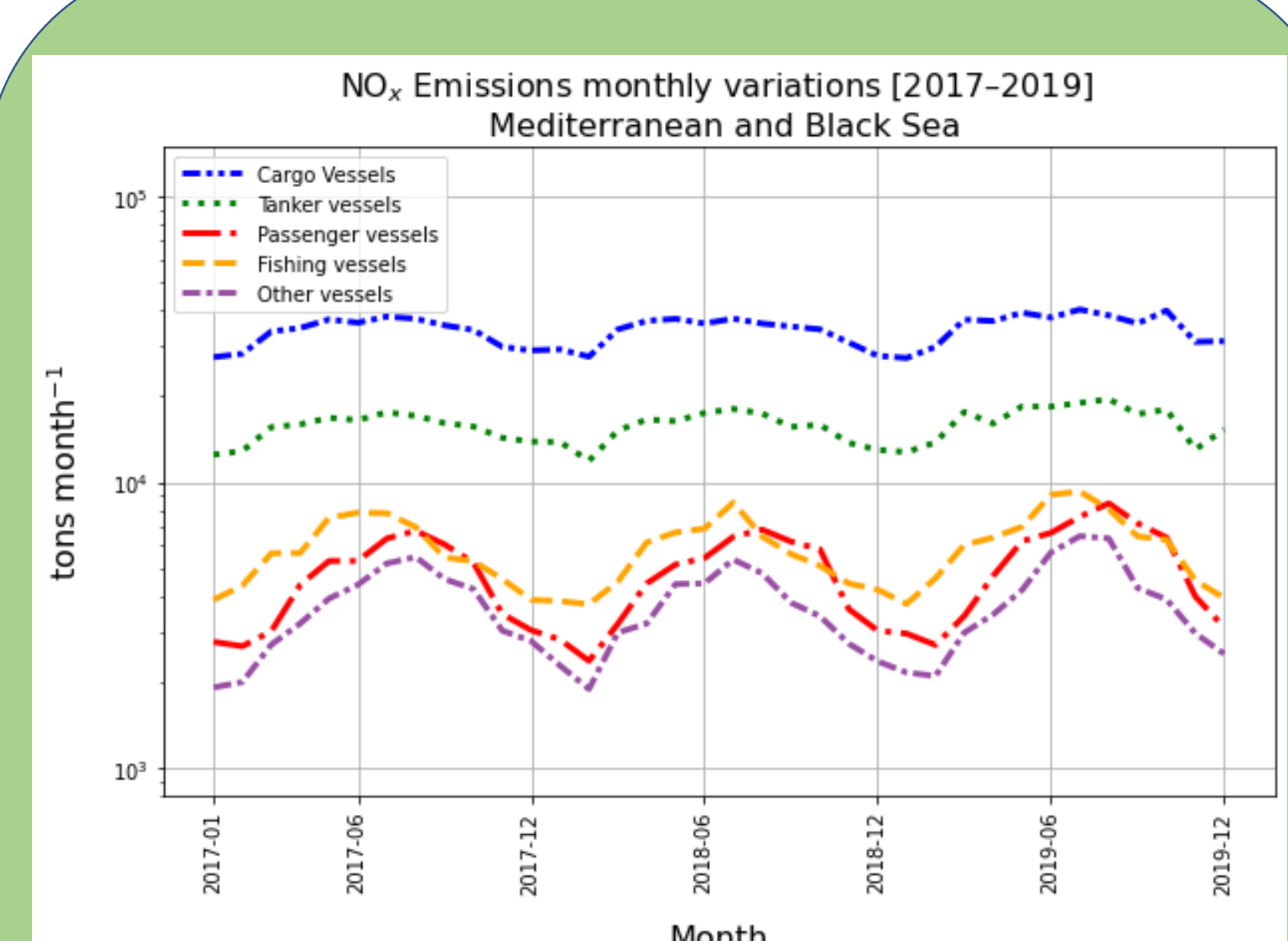i: vessel type, j: pixel, k: time period

Upper: Cargo vessel emissions for Mediterranean (**left**) and Greece for 2019 (**right**).
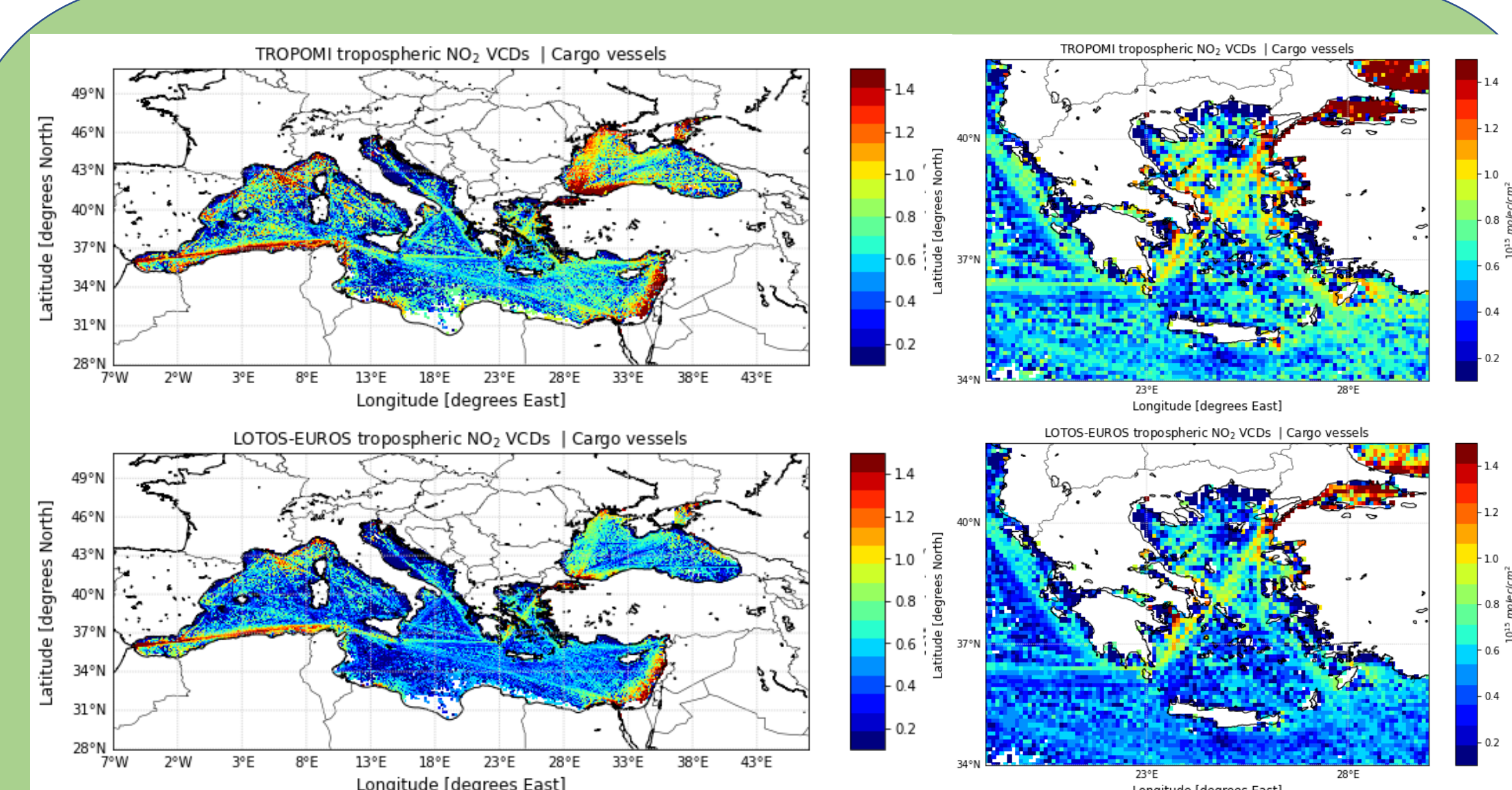**Lower:** Passenger vessels emissions for 2019.

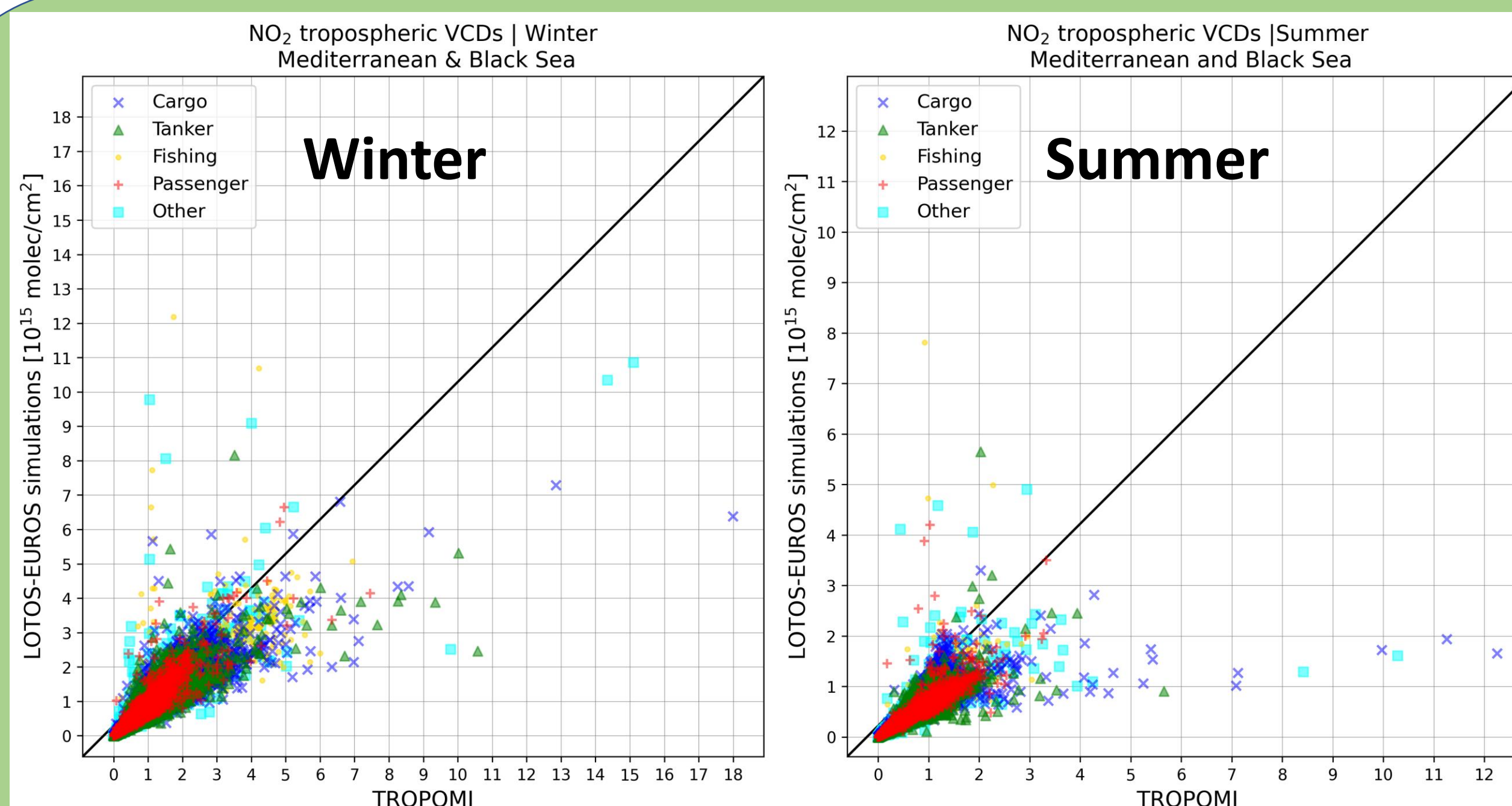Annual emissions distribution per vessel type. Cargo and tanker emissions dominate all years.

Vessel emissions time series [2017 – 2019].

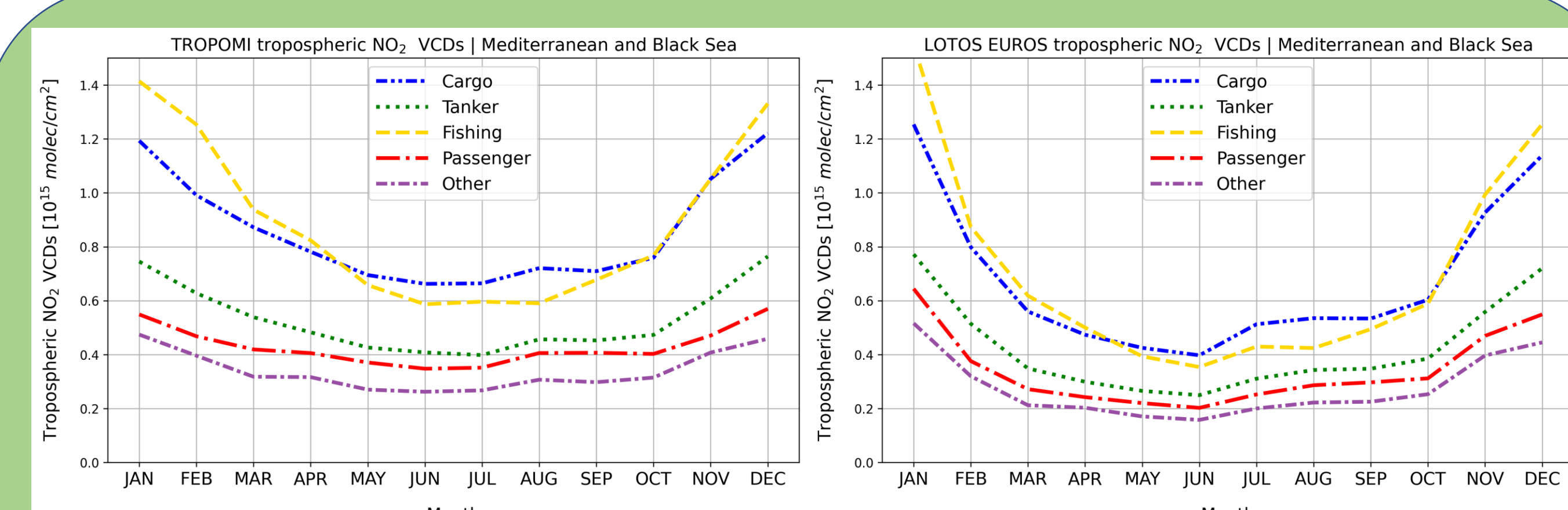## IMPLEMENT THE SAME METHODOLOGY FOR THE TROPOMI AND LOTOS EUROS NO$_2$ TROPOSPHERIC VCDs– STEP III

Upper: TROPOMI cargo NO$_2$ VCDs for 2019, Mediterranean (**left**) and Greece (**right**)
Lower: LOTOS-EUROS cargo NO$_2$ VCDs for 2019.

Seasonal comparison between the NO$_2$ loads of TROPOMI and LOTOS-EUROS per vessel type, winter (**left**) and summer (**right**).

Significant correlations are observed between the NO$_2$ loads of TROPOMI and LOTOS-EUROS, ranging from 0.88 to 0.95 for the winter period and from 0.85 to 0.94 for the summer period. Passenger vessels record the highest correlations for both datasets.

Seasonal variability of tropospheric NO$_2$ VCDs per vessel type according to the 2019 vessel density for the Mediterranean and Black Sea regions for TROPOMI (**left**) and LOTO-EUROS (**right**).

Key remarks

- **Cargo and tanker vessel emissions dominate in the Mediterranean and Black Sea regions.**
- **Clear seasonal variability for the passenger, fishing and other vessel emissions.**
- **The methodology works well for the TROPOMI and LOTOS-EUROS VCDs**
- **High correlations between TROPOMI and LOTOS-EUROS vessel specific. NO$_2$ loads, approximately R=0.9 for the whole reported fleet.**