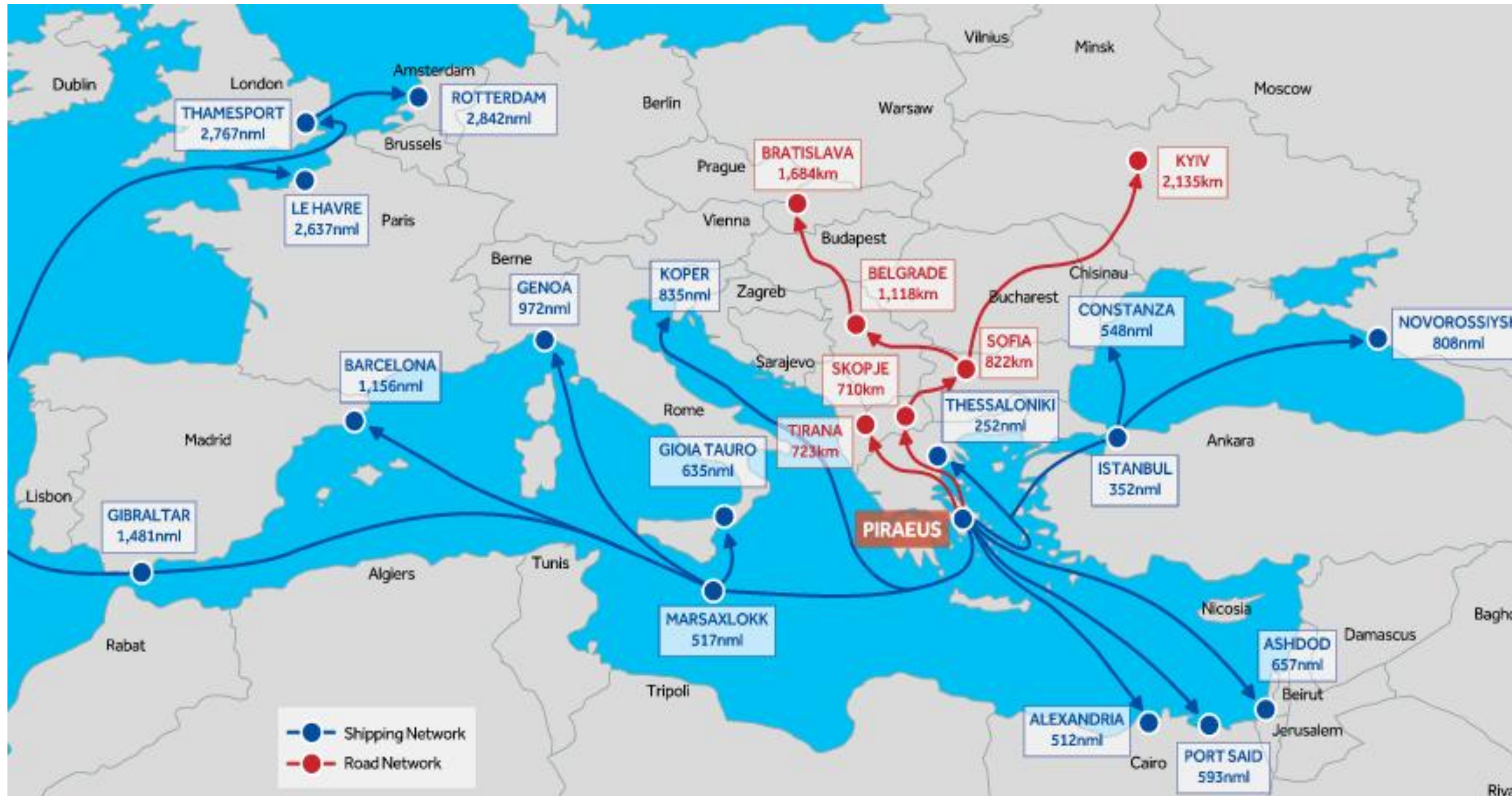




“Air Quality Monitoring and evaluation”

Chrysanthi Kontogiorgi
Chemical Engineer, MSc, NTUA
Head of Environmental Sector
Port Security & Environmental Protection Dpt, PPA SA



Piraeus Port operations



- PPA serves nearly 18 million passengers per annum
- More than 2.0 million cruise passengers,
- Approximately 0.5 million cars with more than 70% transshipment for other Mediterranean countries,
- In the top 10 largest container ports in Europe (in terms of throughput ~ 5 million containers (TEU) per annum)

Piraeus Port environmental management



- EcoPort status port
- Port Environmental Review System Certification (PERS)
- Certified according to ISO 9001:2015 and ISO 14001:2015 standards





- Environmental quality monitoring programs
- Pollution preparedness and prevention planning-sea and land
- Improvement Actions

Implementation of the Air Quality Monitoring Program:

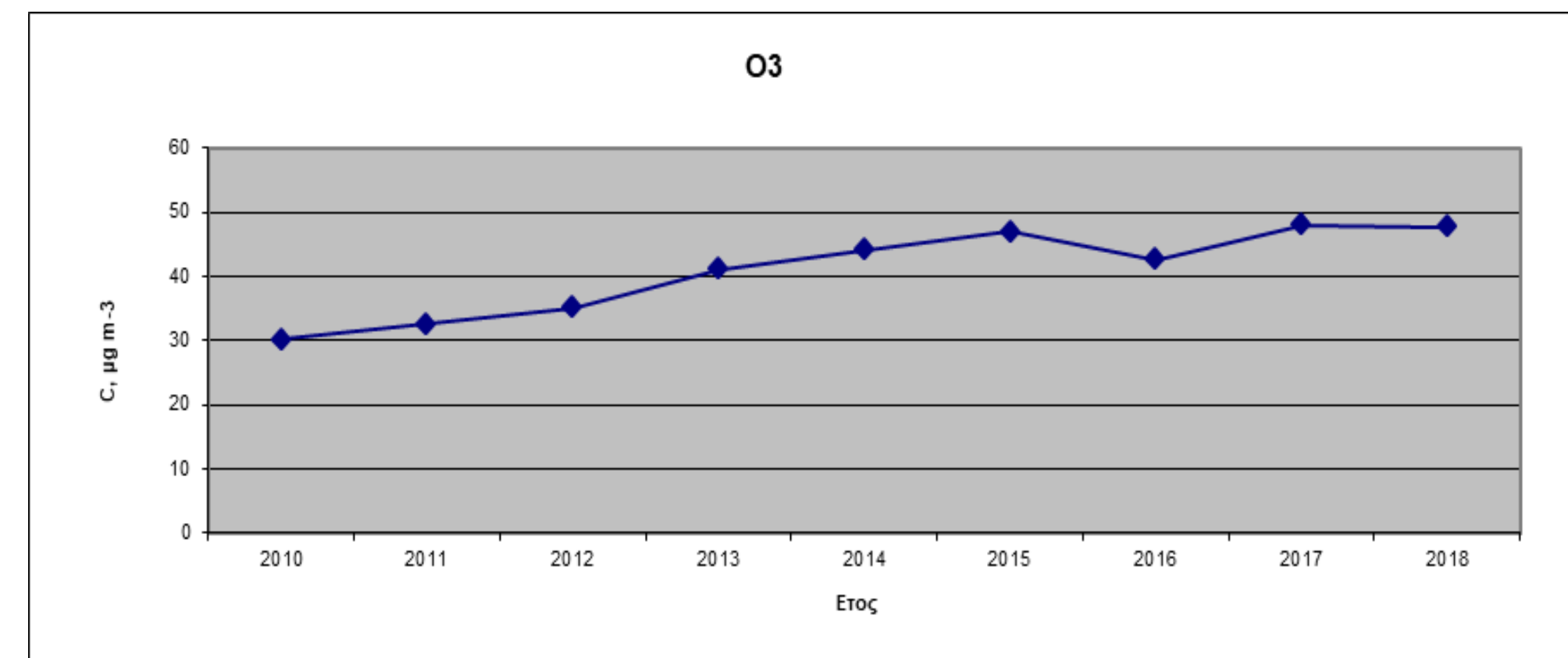
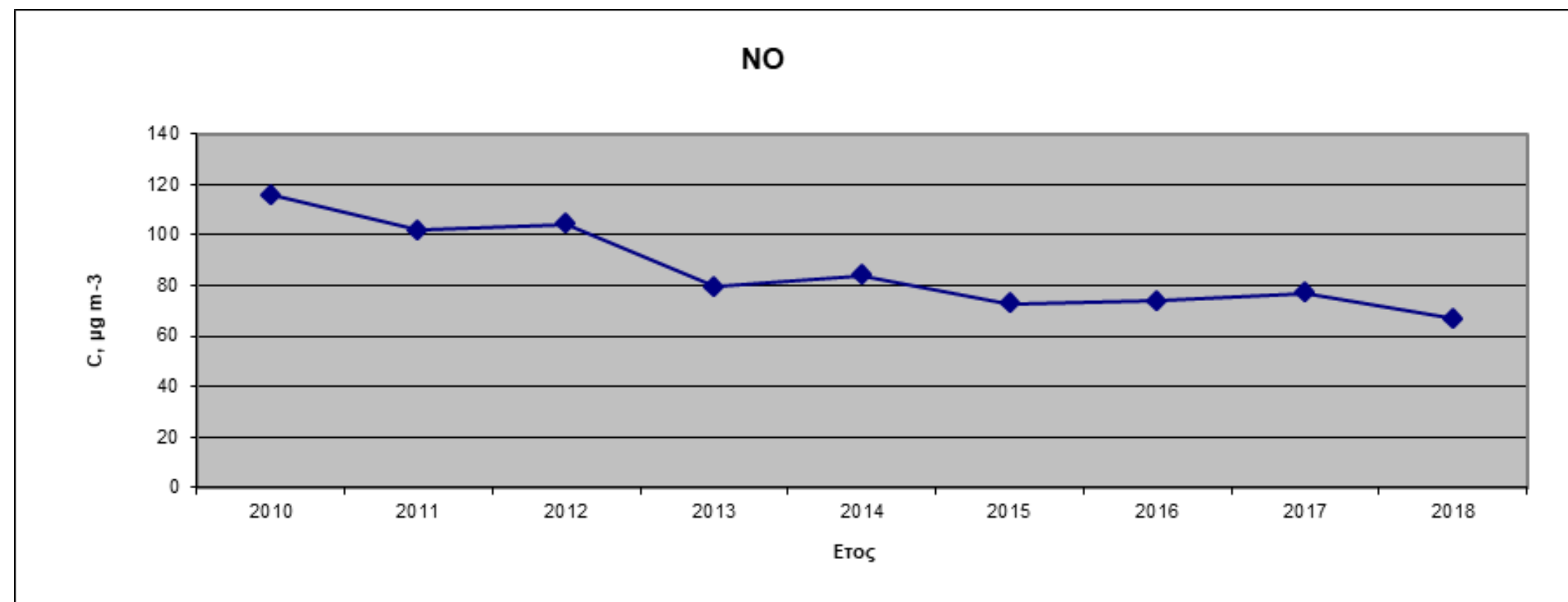
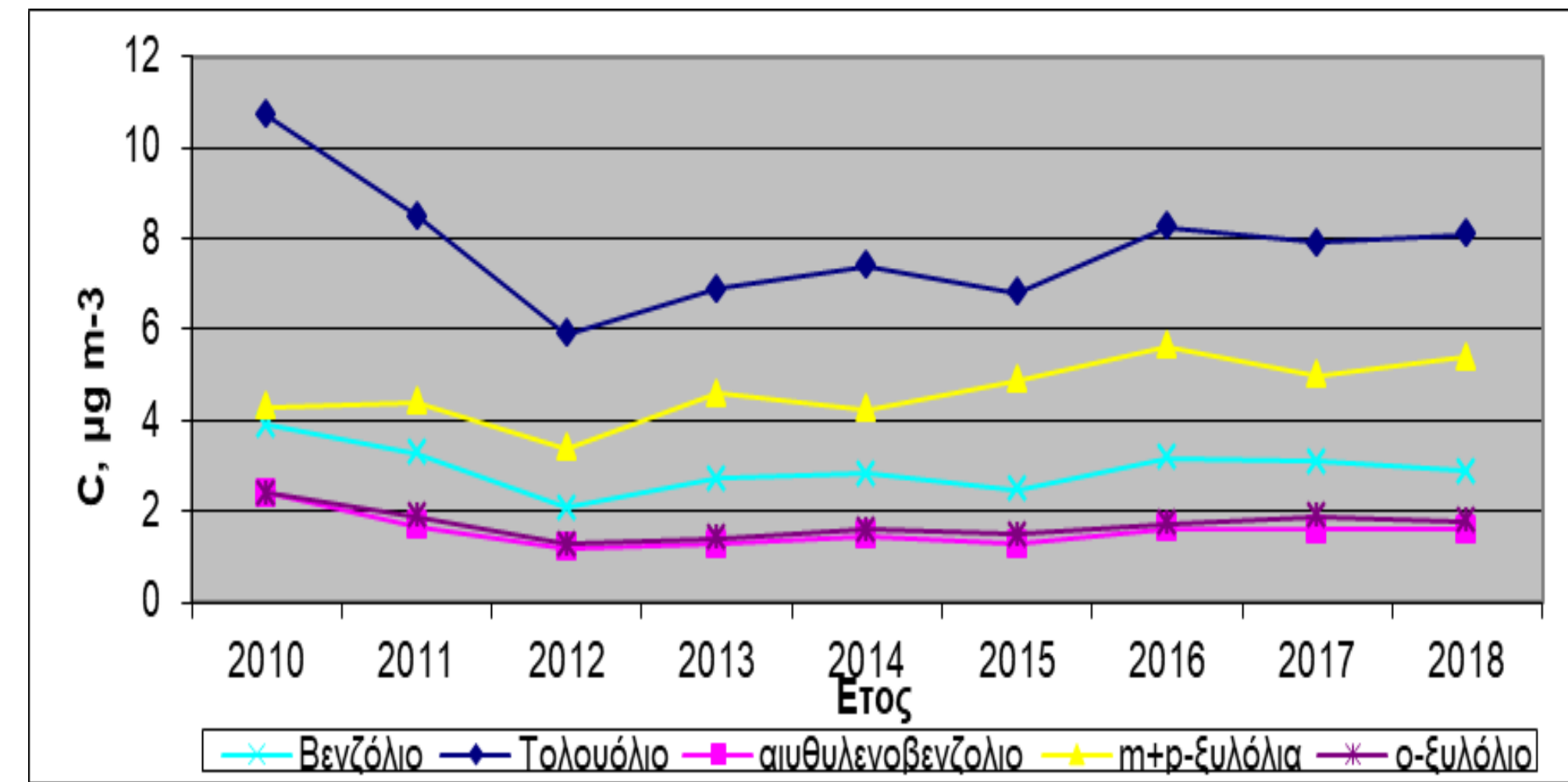
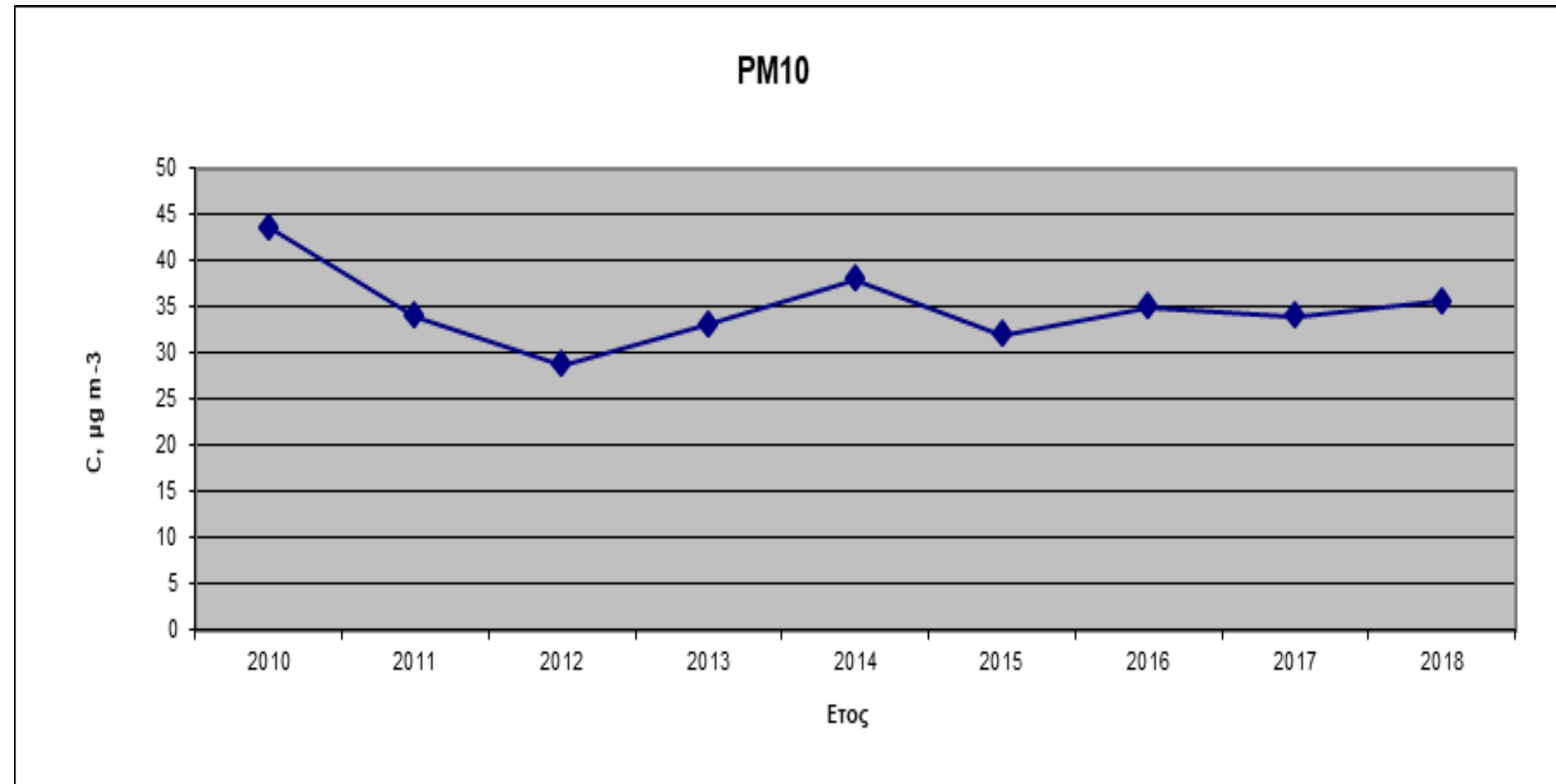
- Since 2009, PPA SA has been implementing, in cooperation with the NTUA/Chemical Engineer School, an integrated program for the monitoring of air pollution
- A permanent monitoring air quality station in the W-NW part of Central Passenger Port (Gates E2-E3)
- Monitoring parameters: BTEX, SO₂, CO, NO_x, PM₁₀, O₃
- 24/7 measurements
- Meteorological data: wind, temperature
- Evaluation of the results /annual reports
- **Records**



ΣΤΑΘΜΟΣ
ΠΑΡΑΚΟΛΟΥΘΗΣΗΣ
ΑΤΜΟΣΦΑΙΡΙΚΗΣ
ΡΥΠΑΝΣΗΣ

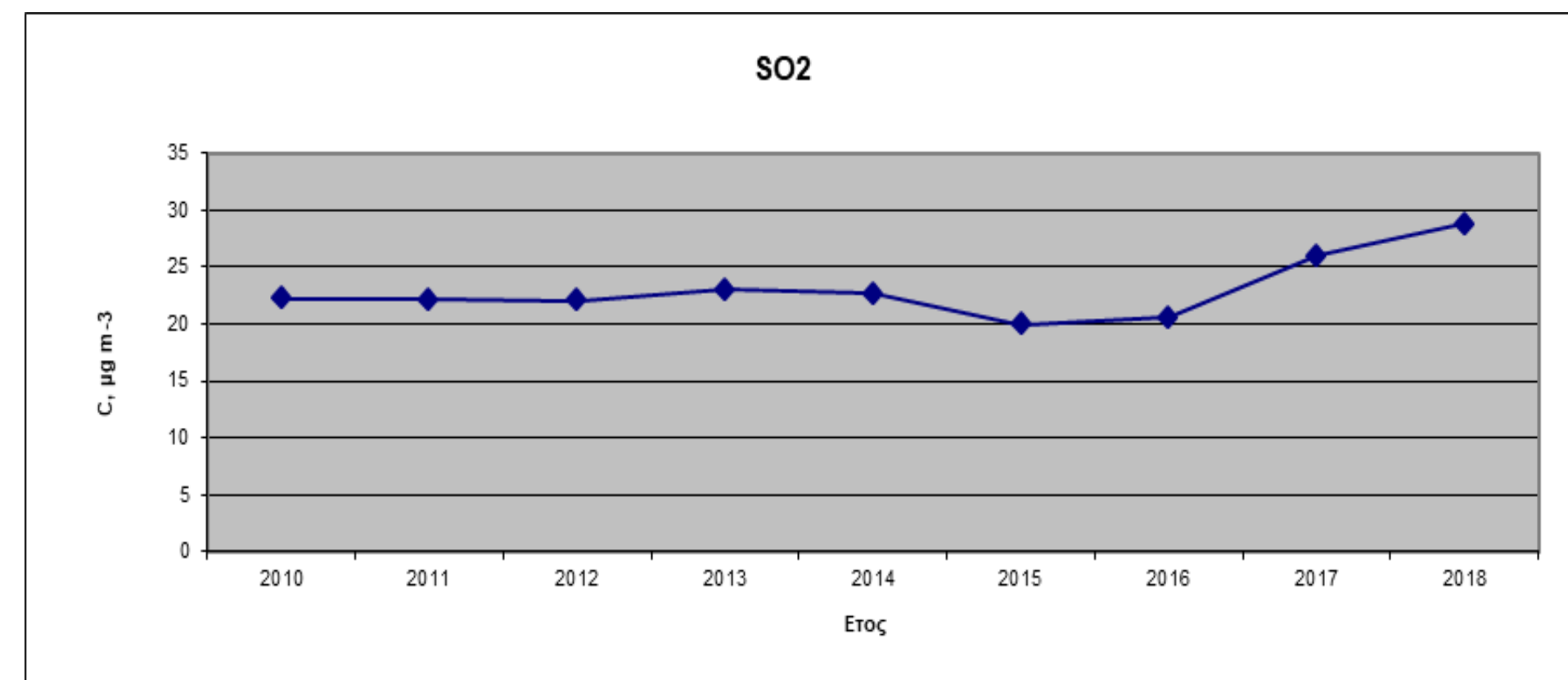
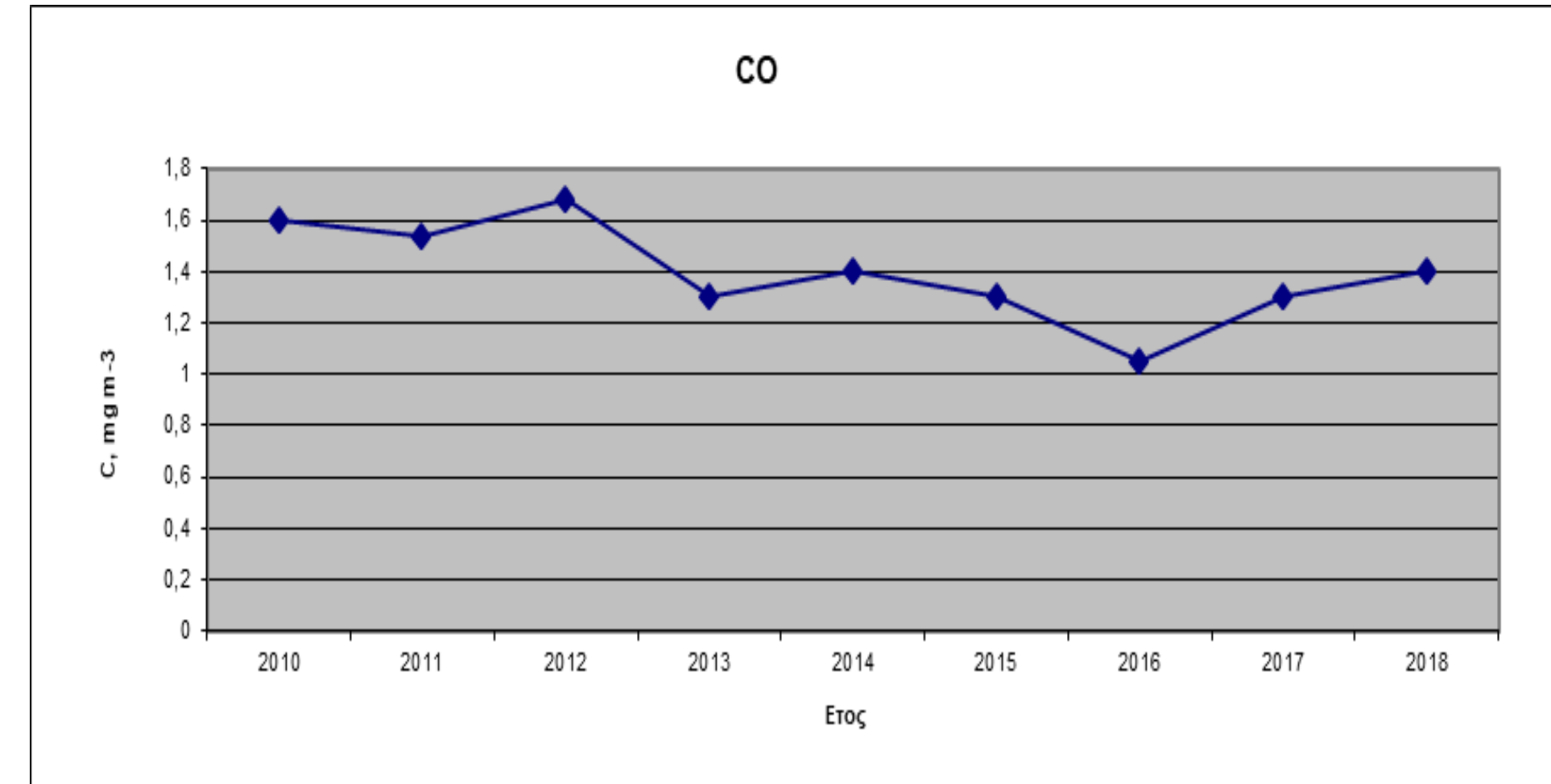
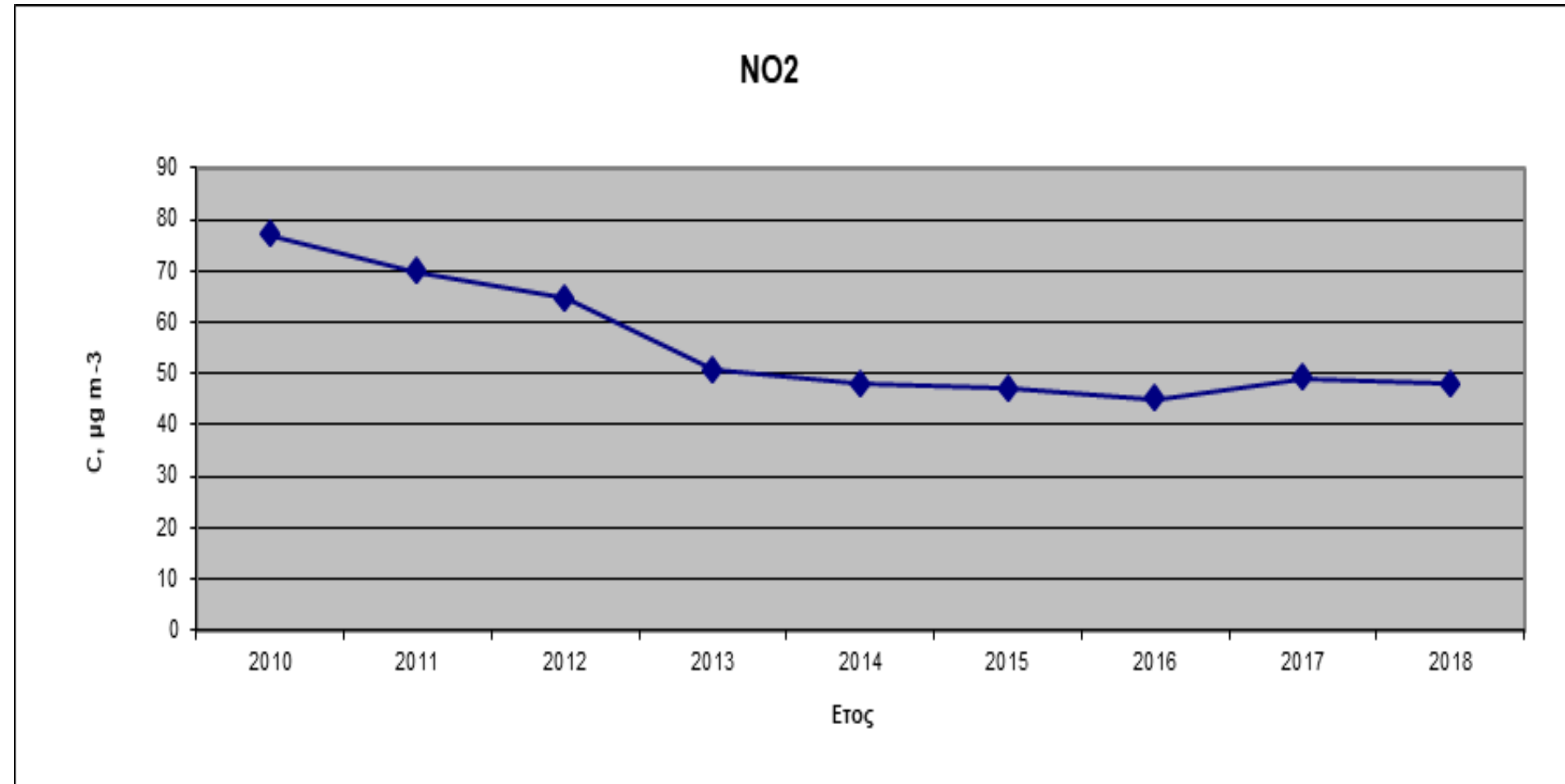


Results –Evaluation:



- Annual averages

Results –Evaluation:



- Annual averages

Results –Evaluation (year 2018):



Pollutant	No of Exceedances	No of Exceedances
NO	-	-
NO2	0 (200 $\mu\text{g m}^{-3}$) ¹	- (40 $\mu\text{g m}^{-3}$) ⁴
SO2	0 (350 $\mu\text{g m}^{-3}$) ¹	0 (125 $\mu\text{g m}^{-3}$) ³
CO	0 (10 mg m^{-3}) ²	-
O3	0 (180 $\mu\text{g m}^{-3}$) ^{1*}	5 (120 $\mu\text{g m}^{-3}$) ²
PM10	48 (50 $\mu\text{g m}^{-3}$) ³	- (40 $\mu\text{g m}^{-3}$) ⁴
Benzene	-	- (5 $\mu\text{g m}^{-3}$) ⁴

- ¹ limit of average hourly value
- ² daily eight hour value
- ³ limit of average daily value
- ⁴ limit of average annual value
- * Information limit

- BTEX : remain at low levels without limits exceedances during the years
- PM 10 : 48 exceedances observed mainly during the winter and summer period. Associated mainly with the smog and sand transfer accordingly
- No particular fluctuations for NO, NO₂, SO₂, CO
- O₃ : remaining in the average daily limit with exceedances of the eight-hour average in five cases

Applied models:

- Weather Research and Forecast – CHEM (WRF-CHEM)
- AERMOD including Meteorological model AERMET and model mapping AERMAP

Elaboration by the National Technical University of Athens/School of Chemical Engineers



Air Quality Dispersion Model Study (2018):

Evaluated pollutants:

- 1) SO_x
- 2) NO_x
- 3) PM₁₀
- 4) CO

Methodology:

- Tier 3 for sea transport taking into account time of arrivals and departures per ship type
- Ship types: container ships, car carriers), passenger ships and cruise ships
- Land transport contribution including: traffic load in the port and in peripheral roads, straddle carriers, trucks
- Data source of port traffic study and port records for vehicles embarkation/disembarkation, transit, ships arrivals and departures



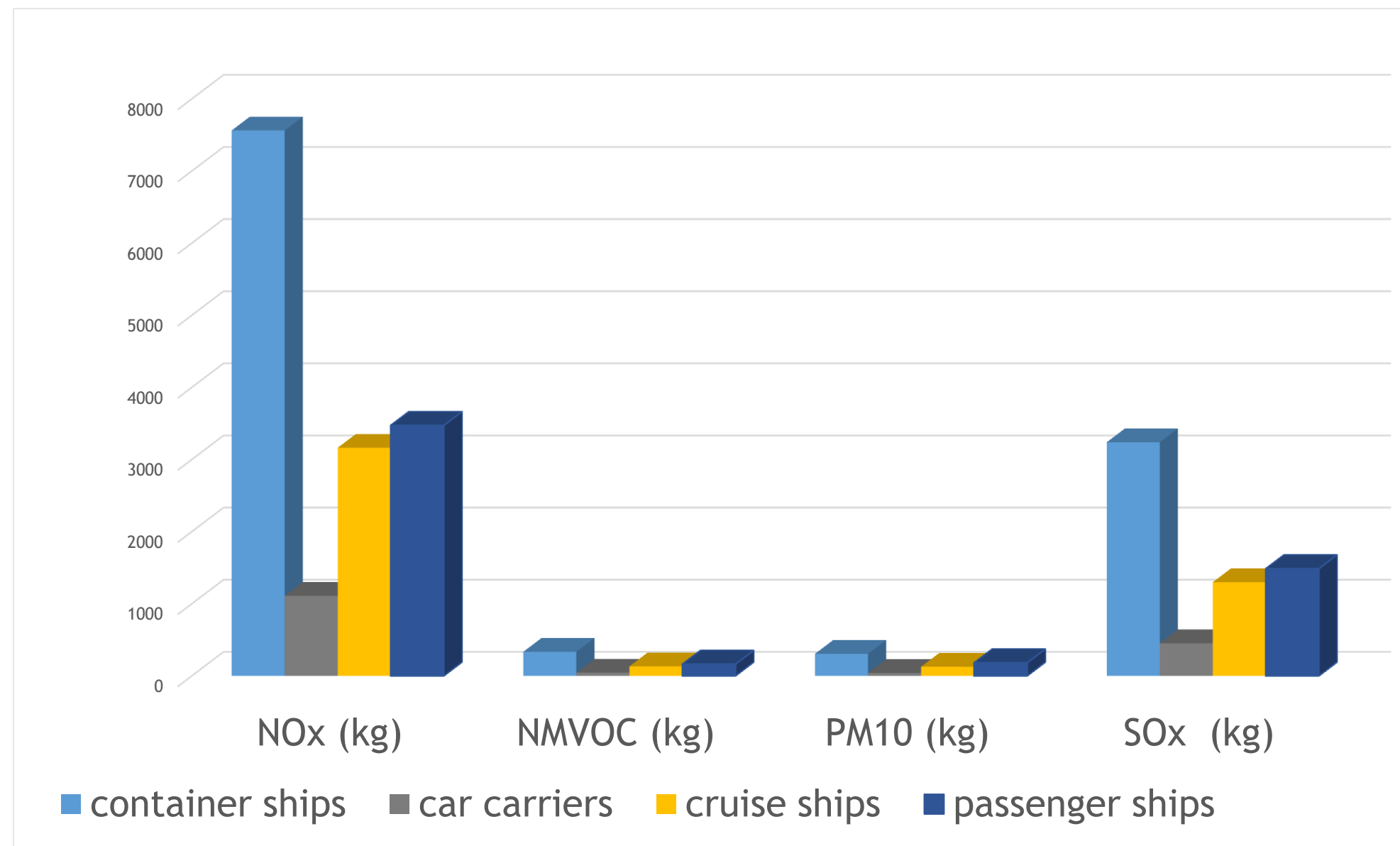
Air Quality Dispersion Model _AERMOD (2018):

Period applied: October 2017 till November 2018

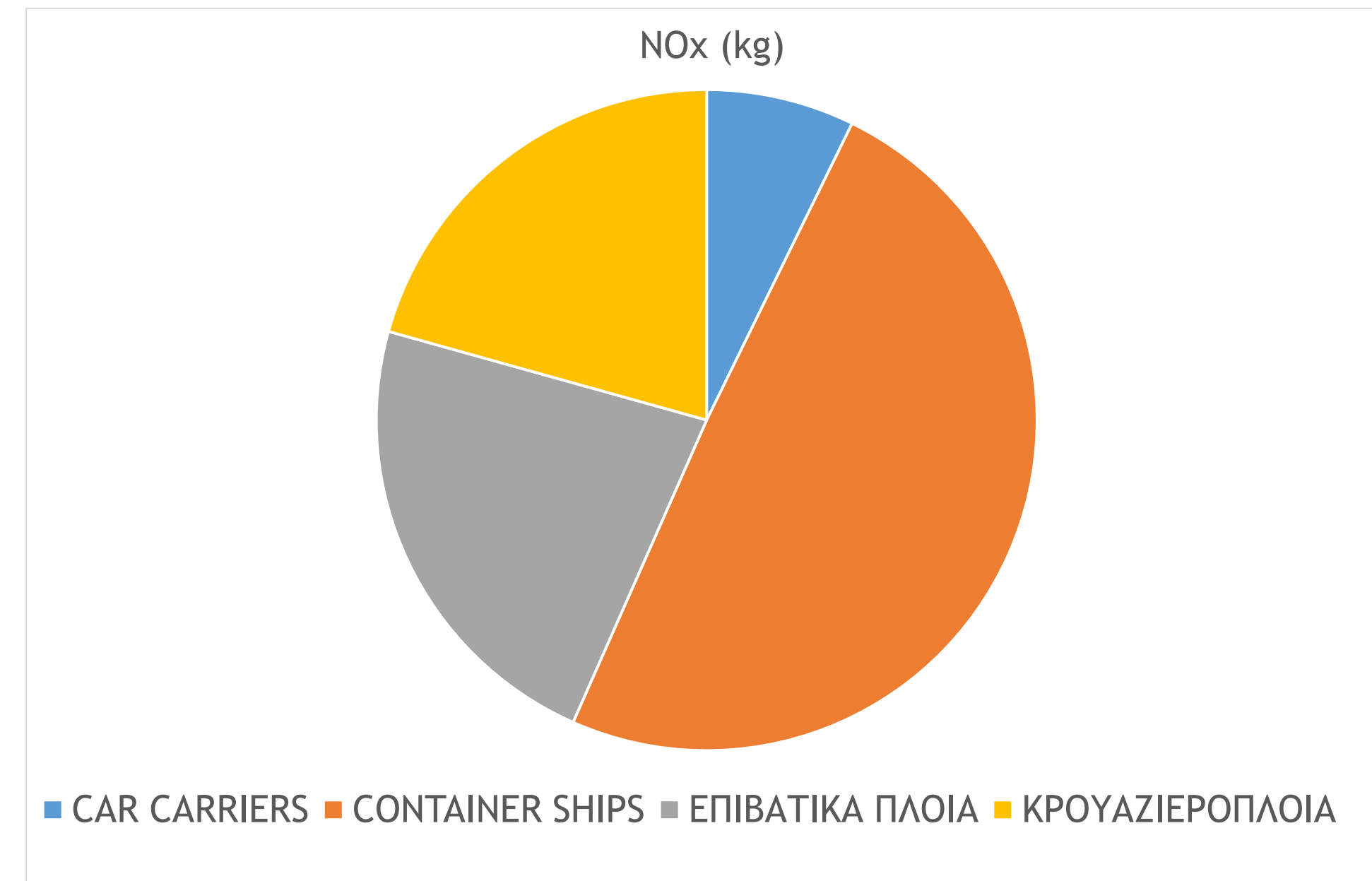
- Representative days in the study scope:
 - 13 August 2018: Significant contribution of all port activities (commercial, passenger and cruise)
 - 19th January 2018: Significant contribution of commercial activity (19 arrivals) no cruise ship arrival
 - 26th April 2018: Ordinary day for commercial and passenger-cruise port
 - 15th September 2018: Significant contribution of cruise ships (6 arrivals)
 -

Air Quality Dispersion Model _AERMOD (2018):

- **15/09/2018**
- **Ships emissions:**



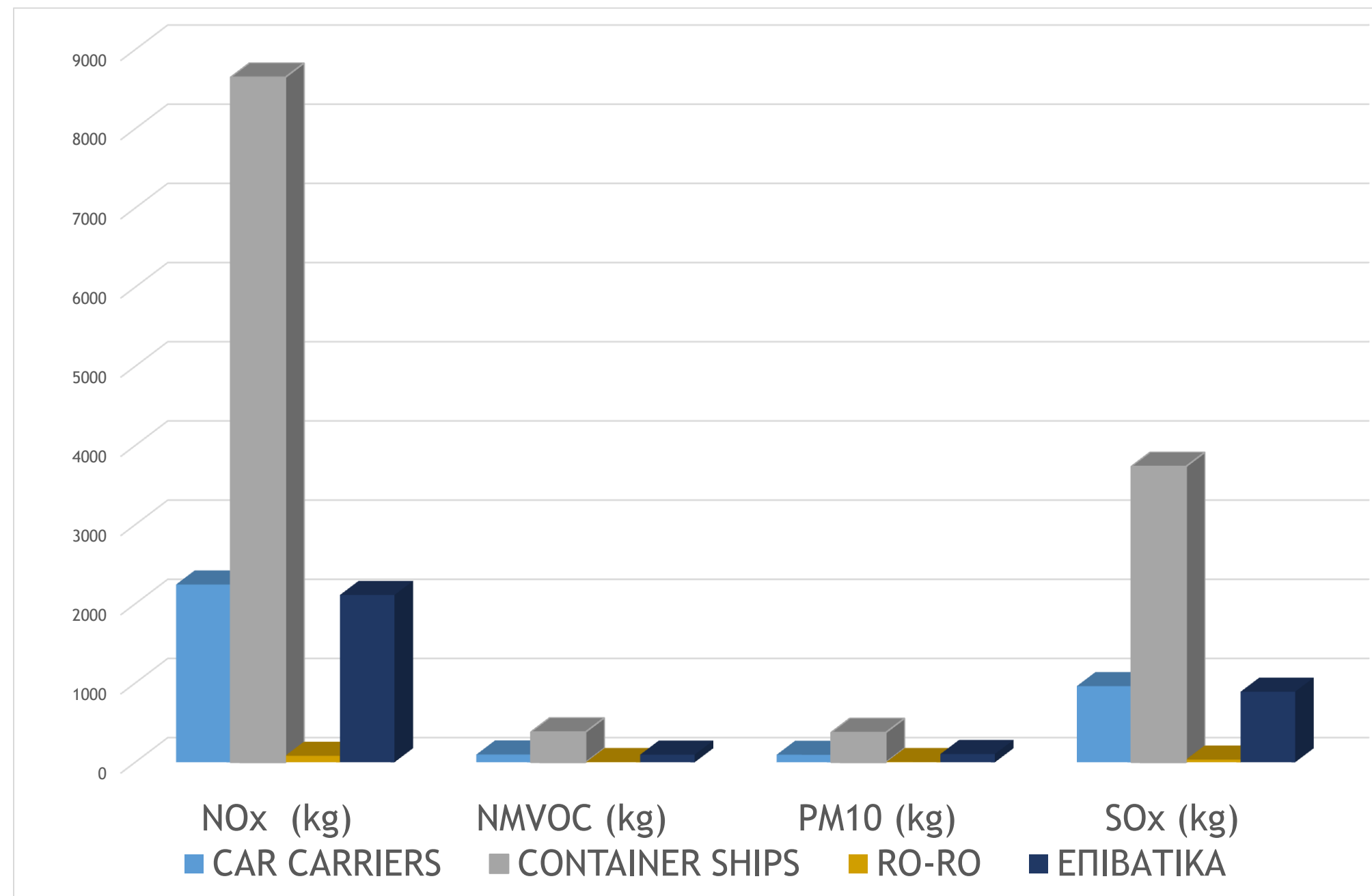
Total daily emissions per ship type



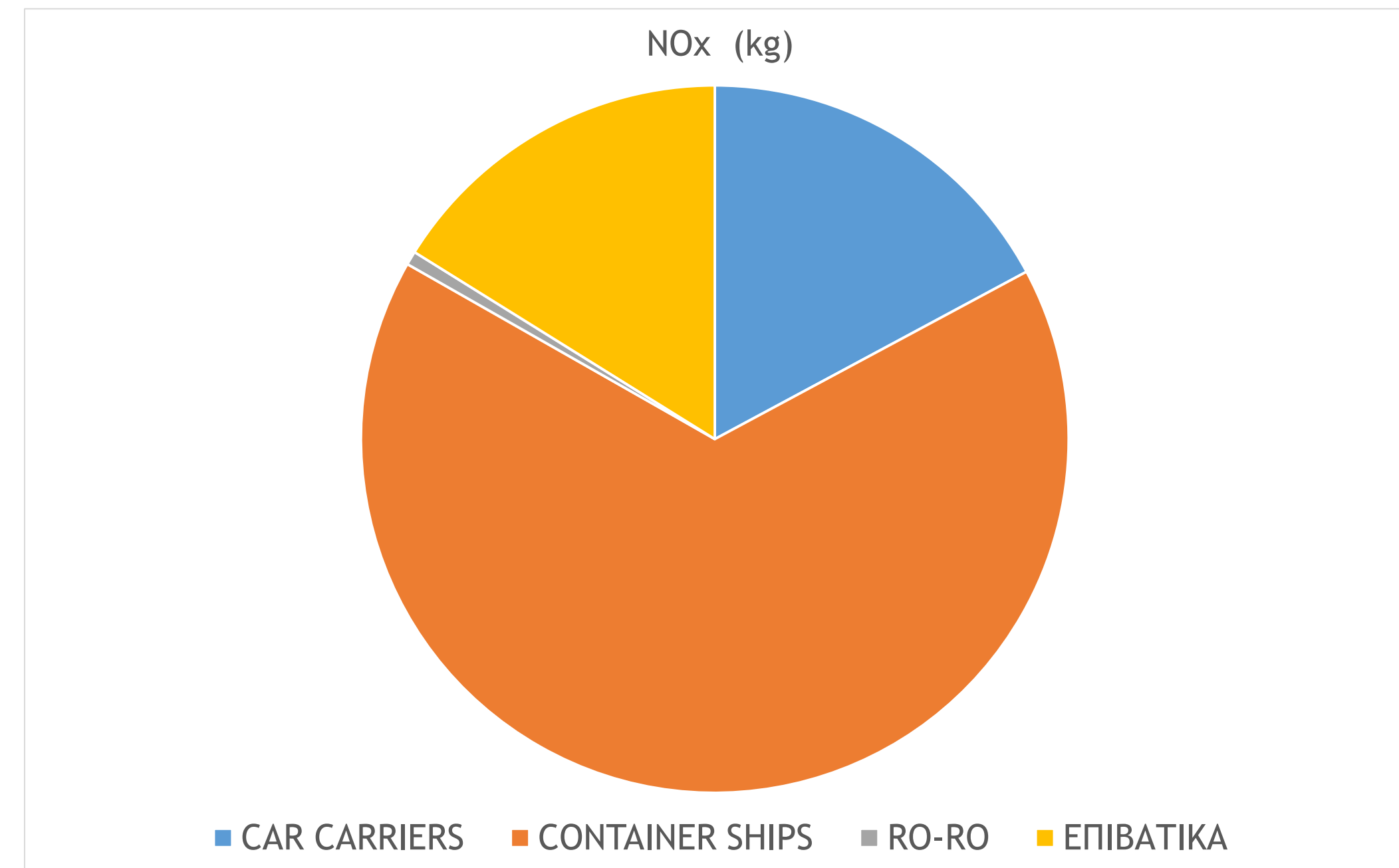
NOx contribution per ship type

Air Quality Dispersion Model _AERMOD (2018):

- **19/01/2018**
- **Ships emissions:**



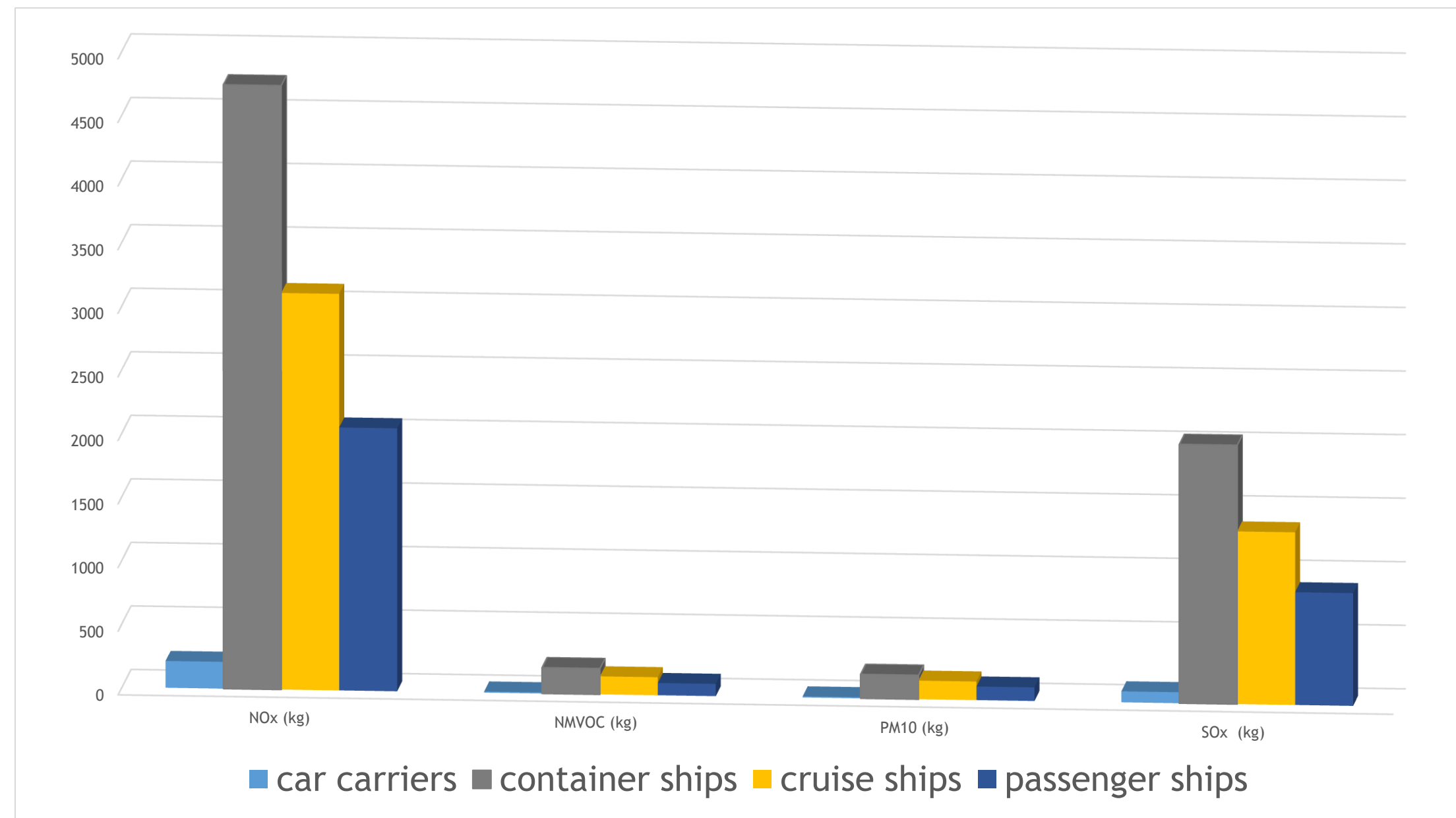
Total daily emissions per ship type



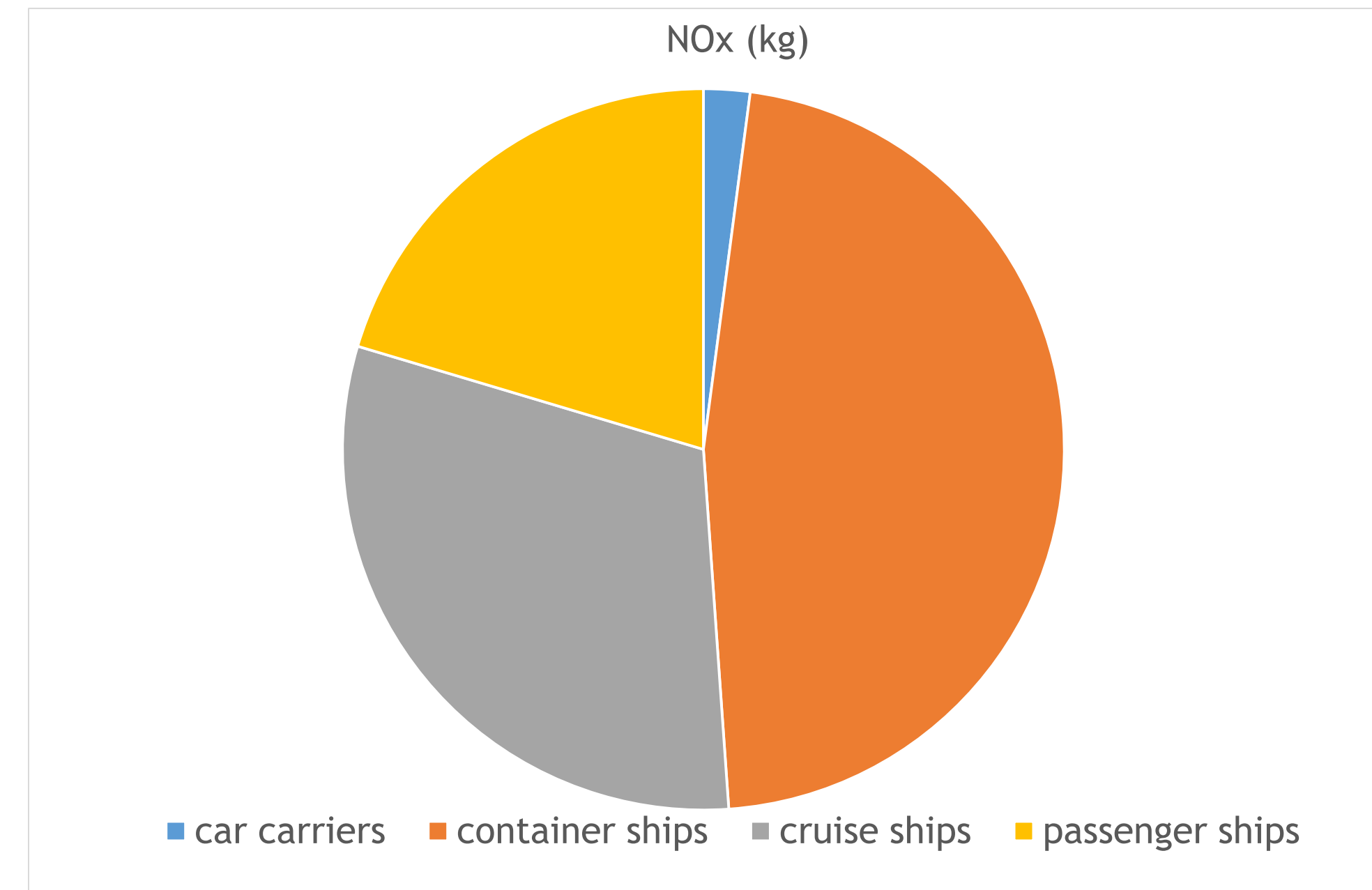
NOx contribution per ship type

Air Quality Dispersion Model _AERMOD (2018):

- 26/04/2018
- Ships emissions:



Total daily emissions per ship type



NOx contribution per ship type

Air Quality Dispersion Model _AERMOD (2018):

Results:

○ 13/08/2018

NO₂



+ Σταθμός παρακολούθησης αέριας ρύπανσης

Concentration of NO₂ on 08.00 [µg/m³]



Concentration of NO₂ on 20.00 [µg/m³]

Air Quality Dispersion Model _AERMOD (2018):

Results:

○ **13/08/2018**

SO₂



Concentration of SO₂ on 08.00 [µg/m³]



Concentration of SO₂ on 20.00 [µg/m³]

Air Quality Dispersion Model _AERMOD (2018):

Results:

○ 13/08/2018

PM₁₀



Air Quality Dispersion Model _AERMOD (2018):

Results:

○ 13/08/2018

CO



Concentration of CO on 8.00 [$\mu\text{g}/\text{m}^3$]



Concentration of CO on 20.00 [$\mu\text{g}/\text{m}^3$]

Air Quality Dispersion Model _AERMOD (2018):

Results:

○ 13/08/2018

CO



Concentration of CO on 14.00 [$\mu\text{g}/\text{m}^3$]



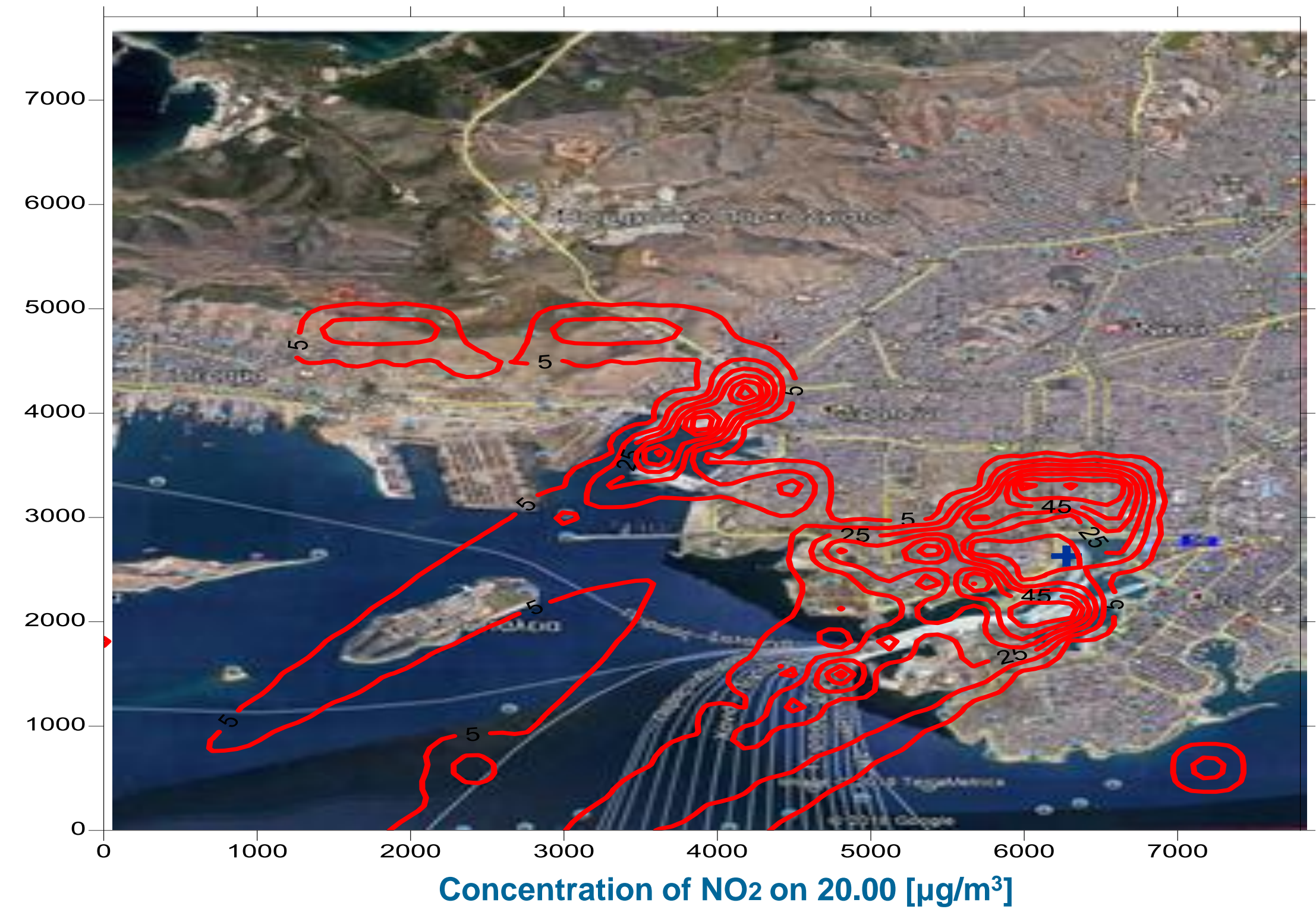
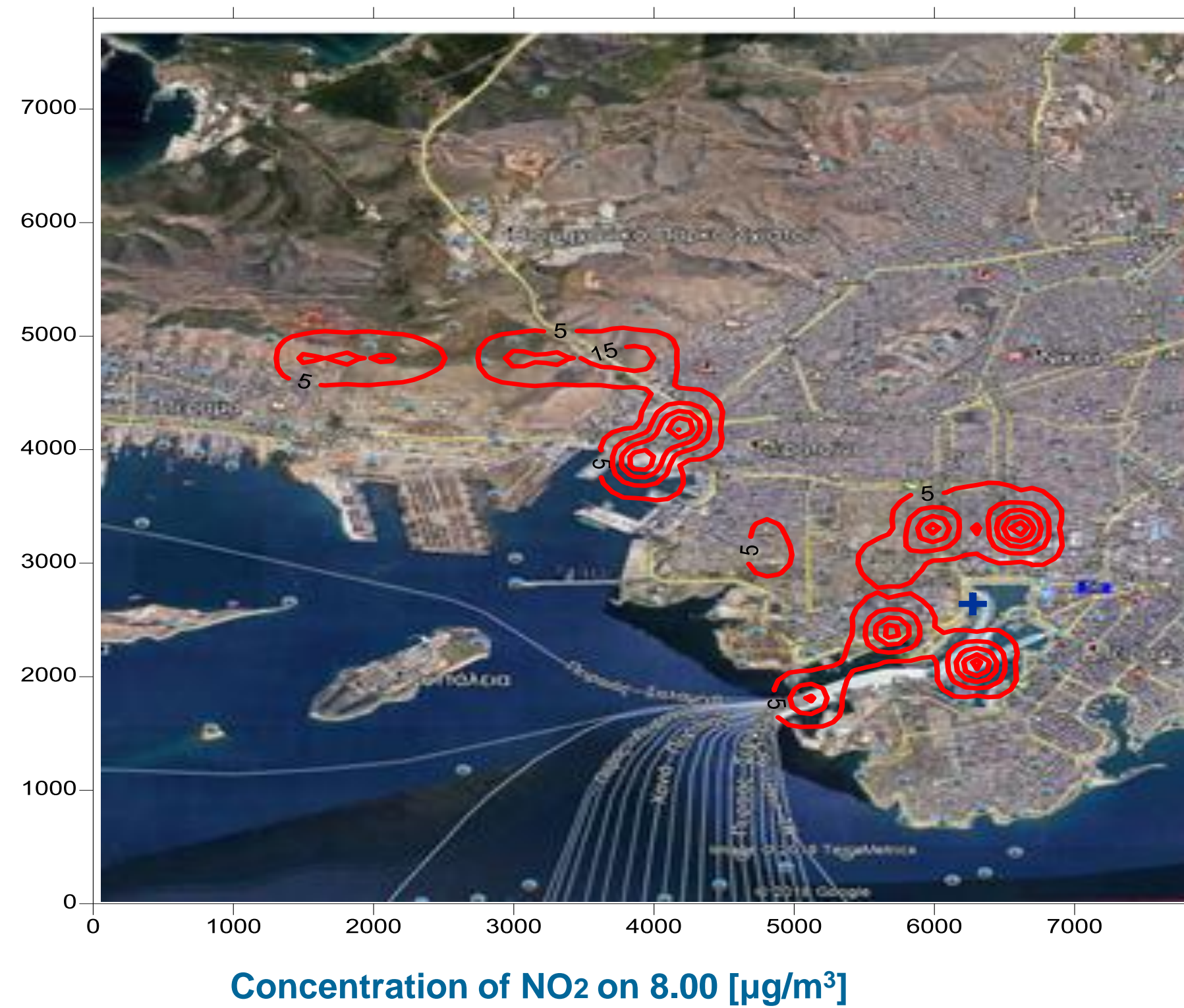
Concentration of CO on 20.00 [$\mu\text{g}/\text{m}^3$]

Air Quality Dispersion Model _AERMOD (2018):

Results:

○ 15/09/2018

NO₂



Air Quality Dispersion Model _AERMOD (2018):

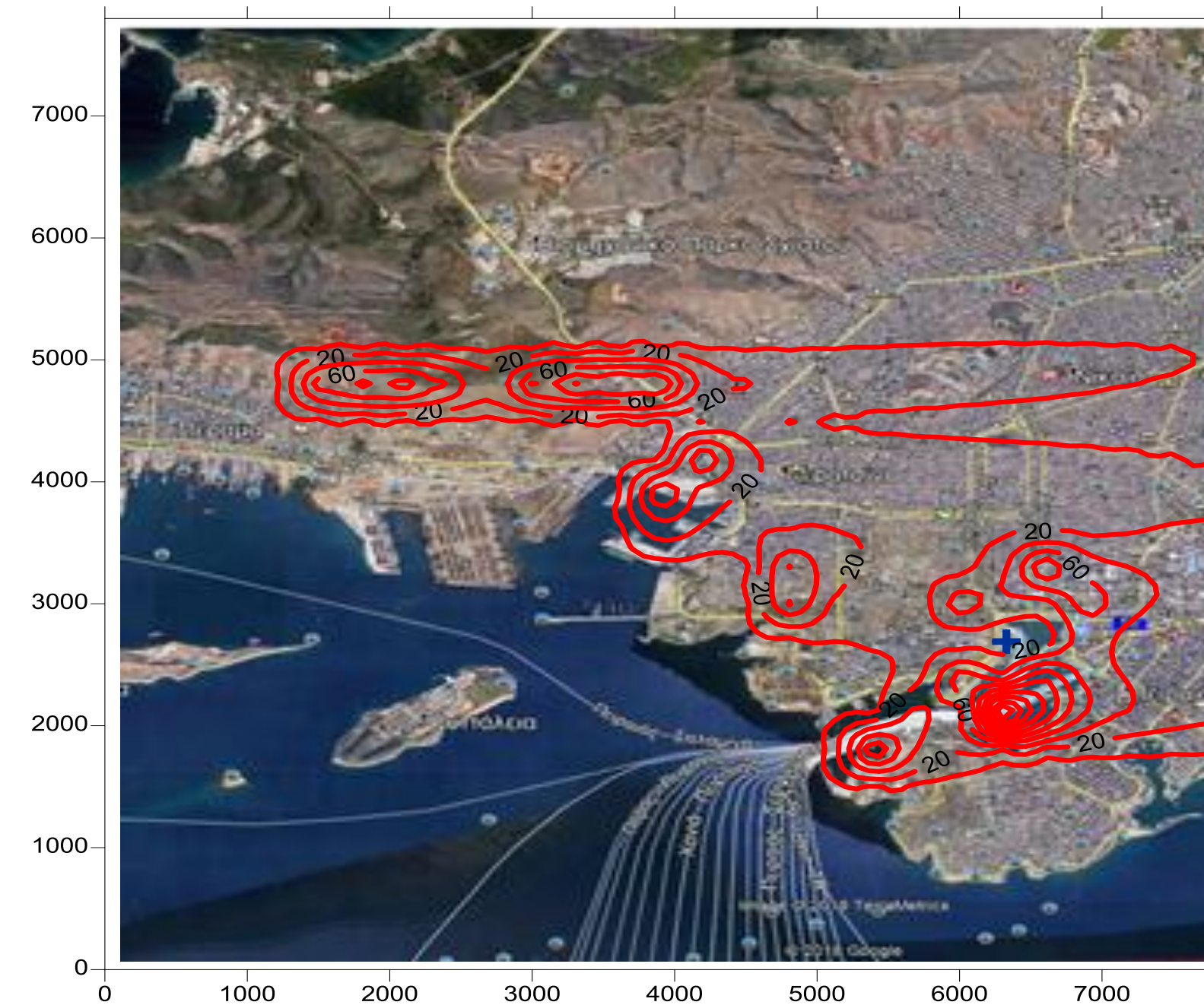
Results:

○ 15/09/2018

SO₂



Concentration of SO₂ on 08.00 [$\mu\text{g}/\text{m}^3$]



Concentration of SO₂ on 20.00 [$\mu\text{g}/\text{m}^3$]

Air Quality Dispersion Model _AERMOD (2018):

Results:

○ 15/09/2018

PM₁₀



Concentration of PM10 on 8.00 [$\mu\text{g}/\text{m}^3$]



Concentration of PM10 on 20.00 [$\mu\text{g}/\text{m}^3$]

Air Quality Dispersion Model _AERMOD (2018):

Results:

○ 15/09/2018

CO



Concentration of CO on 8.00 [$\mu\text{g}/\text{m}^3$]



Concentration of CO on 20.00 [$\mu\text{g}/\text{m}^3$]



Air Quality Dispersion Model _AERMOD (2018):

General results:

Regarding NO₂ :

- The max. levels of hourly concentrations for the scenario of significant contribution of commercial and passenger port (August, September) are met on the morning and night due to the condition of dispersion and the port
- The higher levels are met in the central port area but during the early morning (2.00) are met at commercial port
- A 80% correlation factor with the results of measurements recording was defined

Air Quality Dispersion Model _AERMOD (2018):

General results:

Regarding SO₂ :

- Low concentration levels with upper fluctuations during the night due mainly to the conditions of limited dispersion
- The max. hourly concentrations are met on 20.00, on level of 180µg/m³, in the scenario of significant cruise contribution (15/09/2018) with influence in a strict limit surrounding area.
- The higher levels are met in the central port area but during the early morning are met at commercial port



Air Quality Dispersion Model _AERMOD (2018):

General results:

Regarding PM10

- Limited level concentrations that are not exceed $20 \mu\text{g} / \text{m}^3$, a finding consistent with the limited emissions during to the ship movements and their stay in port
- PM10 emissions are related to road transport and especially heavy vehicle traffic but also to the operation of mobile machines in the port area and road traffic in vicinity with the port area (peripheral road)



Thank you for the attention!!