Intercomparison of spatial representativeness Antwerp Case

WG4 MICROSCALE ASSESSMENT

Vera Rodrigues (UA), Fernando Martin (CIEMAT)

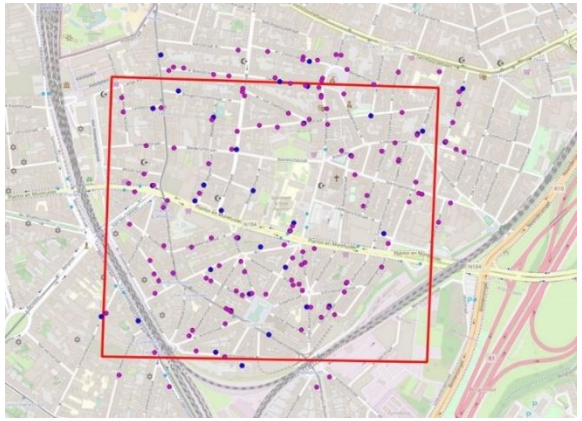
FAIRMODE WG8 Webinar on SR.

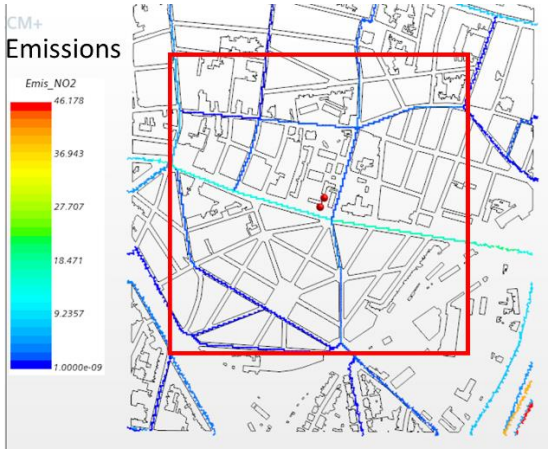
December 14th, 2023

WG4 Intercomparison exercise

Domain and data

- Urban district (800x800 m) of Antwerp (Belgium). NO_2.
- Measurements from two AQ stations and 72 samplers.
- Emission data for traffic.

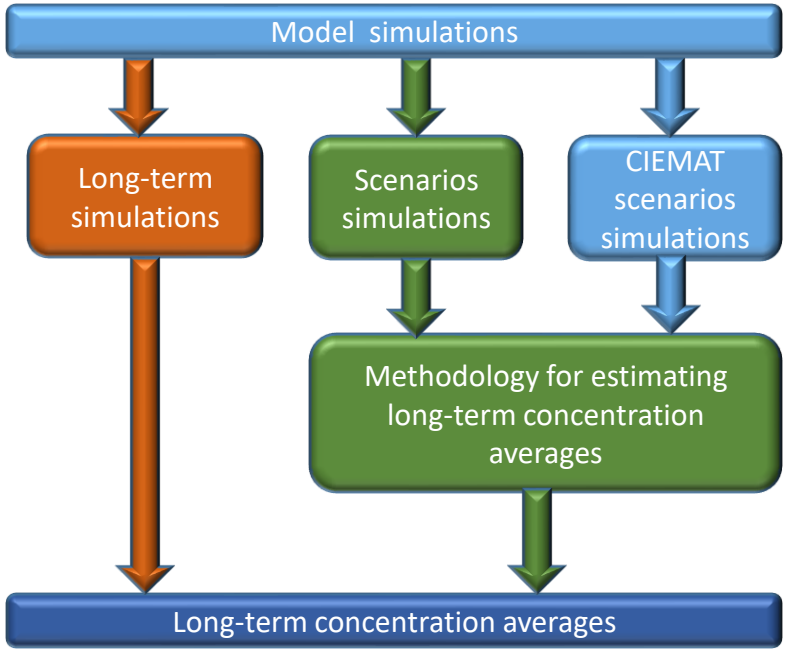




Models and methodologies

- **CFD models (RANS mostly), Gaussian, Lagrangian, AI.**
- Different methods for computing annual indicators of pollutant concentrations.
  - **Methods based on simulating a set of selected scenarios** (wind scenarios and/or emission scenarios) **and then a postprocessing** (PDF of scenarios, rebuilding a entire year, etc) of model results for retrieving annual indicators.
  - **Simulating the full-year**, (mostly for No CFD models but one of them run CFD models a complete year).

Ways of participating in the exercise:



WG4 Intercomparison exercise

Type of evaluations and comparisons

1. ***Hourly time series for <u>one day</u> with high pollution.***
   - ***May 6th, 2016 selected to simulate.***
   - ***The model results compared with <u>two AQ stations data</u>***

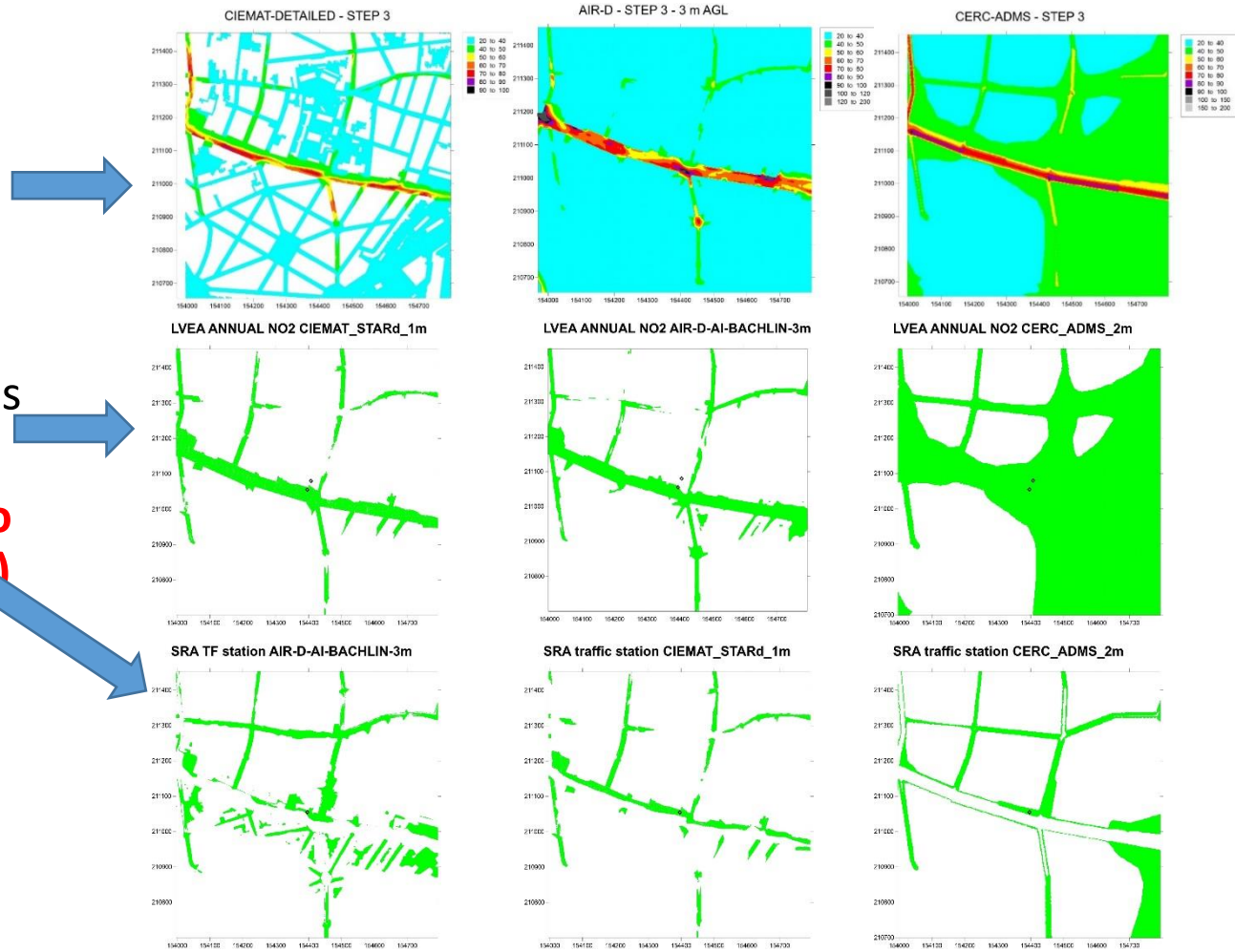
2. ***Monthly averaged concentration map for the <u>campaign period</u> (April 30 – May 28).***
   - ***Comparison with <u>passive samplers' data</u>***
   - ***Intercomparison among models results (2D maps).***

3. ***Annual concentration map for <u>2016 year</u> .***
   - ***Intercomparison of results from every methodology (2D maps).***

4. ***To compute LV exceedance and spatial representativeness areas of AQ stations.***
   - ***Intercomparison of results from every methodology (2D maps).***

Intercomparison of spatial representativeness/exceedances areas

- Using the results of annual average of NO_2 computed by the different models/methodologies for Antwerp domain.
- Intercomparison of:
  - NO_2 anual limit value (40 µg/m^3) exceedance areas (LVEA) in the Antwerp district domain.
  - **Spatial representativeness areas (SRA) of the two air quality stations (background and traffic types)**
- Two key questions:
  - How different are the LV exceedance areas?
  - **How different are the spatial representativeness areas?**
- Discussion about areas computed leaving out the area covered by buildings



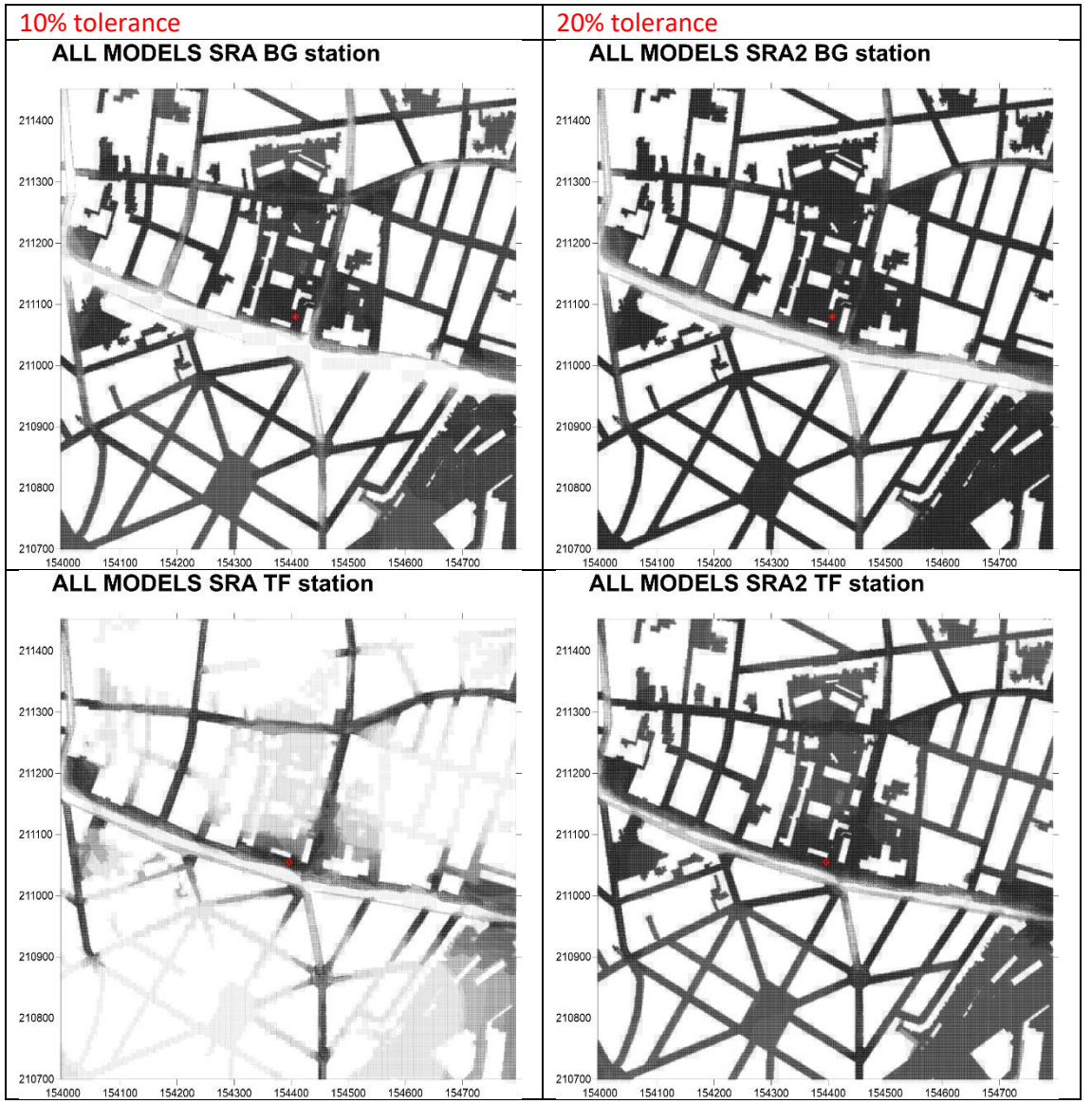
Comparison of SRA for urban stations

Comparison size and shape. How different are SRA?

SRA are larger for the background station than for the traffic one.

20% tolerance provides much larger SRA (SRA2) than when using 10% tolerance (SRA).

The highest growths for the traffic station.



100% models

75% models

50% models

25% models

0% models

20 models

5 Gaussian

12 CFD

1 Lagrangian

2 AI

Two tolerances:

10% SRA

20% SRA2

Comparison of SRA for urban stations

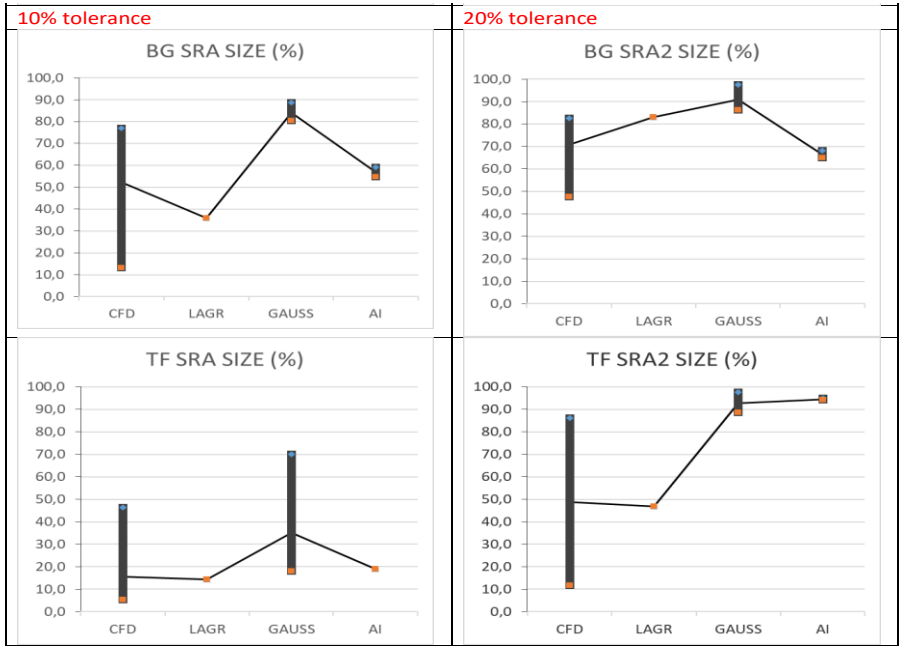
Comparison size and shape. How different are SRA depending on model type?

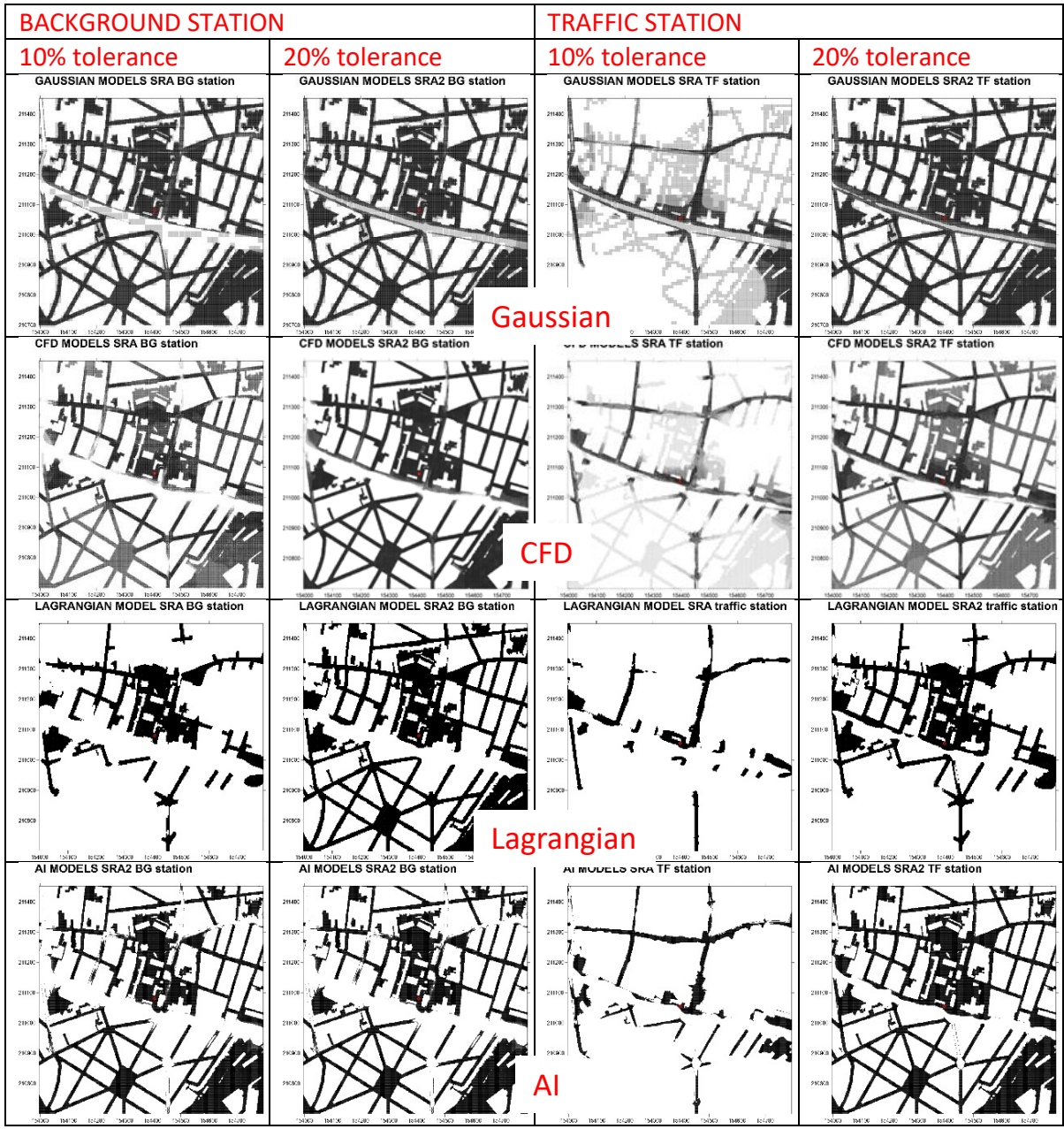
Larger SRA (10% tolerance) and SRA2 (20% tolerance) for most of Gaussian models, but strong variability among models (highest SRA for EPISODE).

High variability of SRA computed with Gaussian models for the traffic station, not for background station or 20% tolerance.

Strong variability of SRA and SRA2 computed with CFD models specially for the traffic station.

Except for one (EPISODE) of the Gaussian models, SRAs of both stations do not include most part of the main street (inside the LVEA).





Comparison of SRA for urban stations

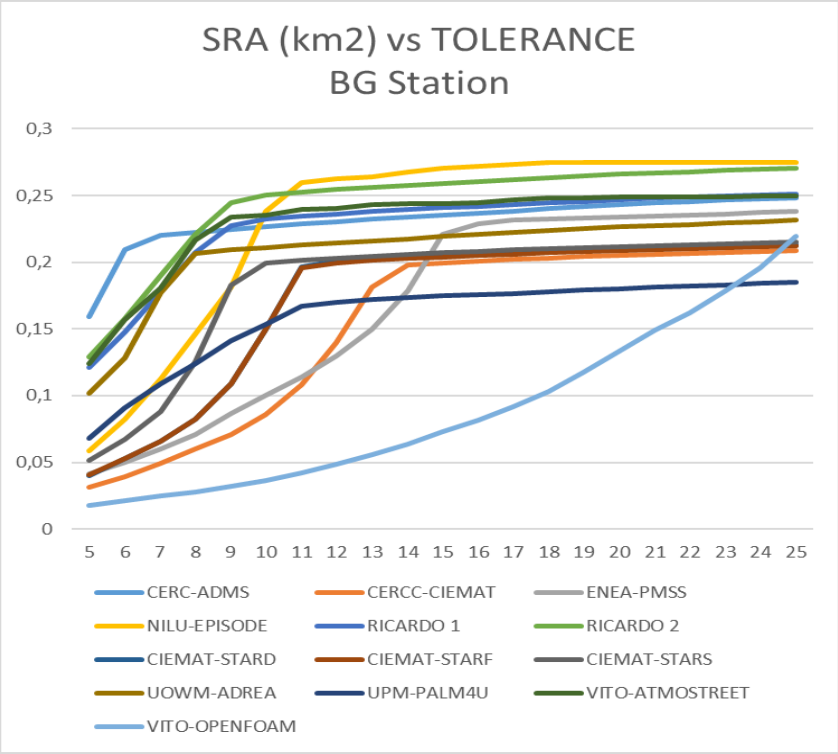
How different are SRA depending percentage of tolerance?

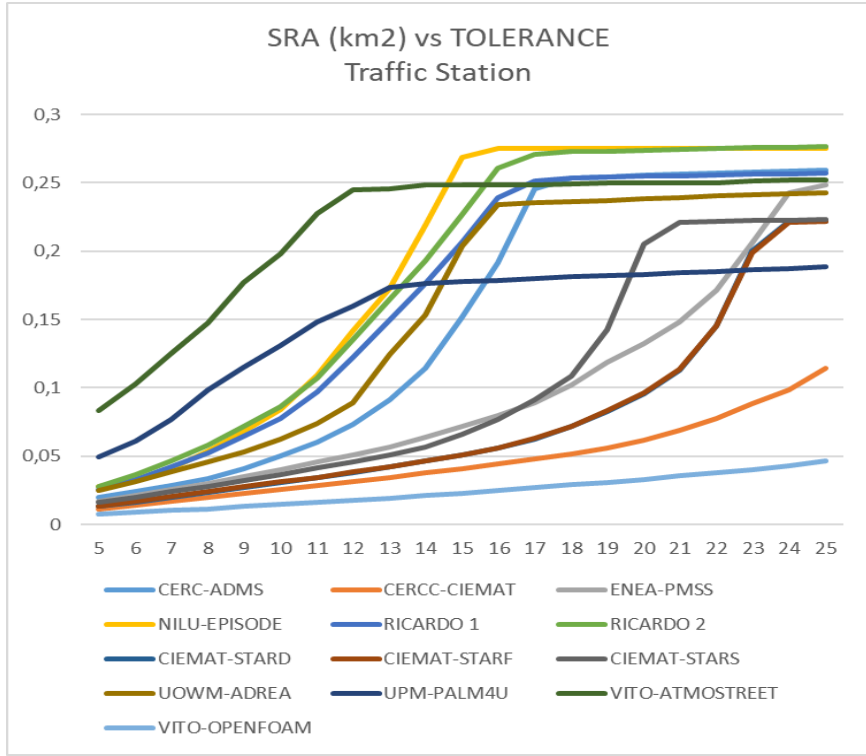
SRA sizes increase strongly as tolerance increase but up to some critical tolerance and then, the increasing is very low.

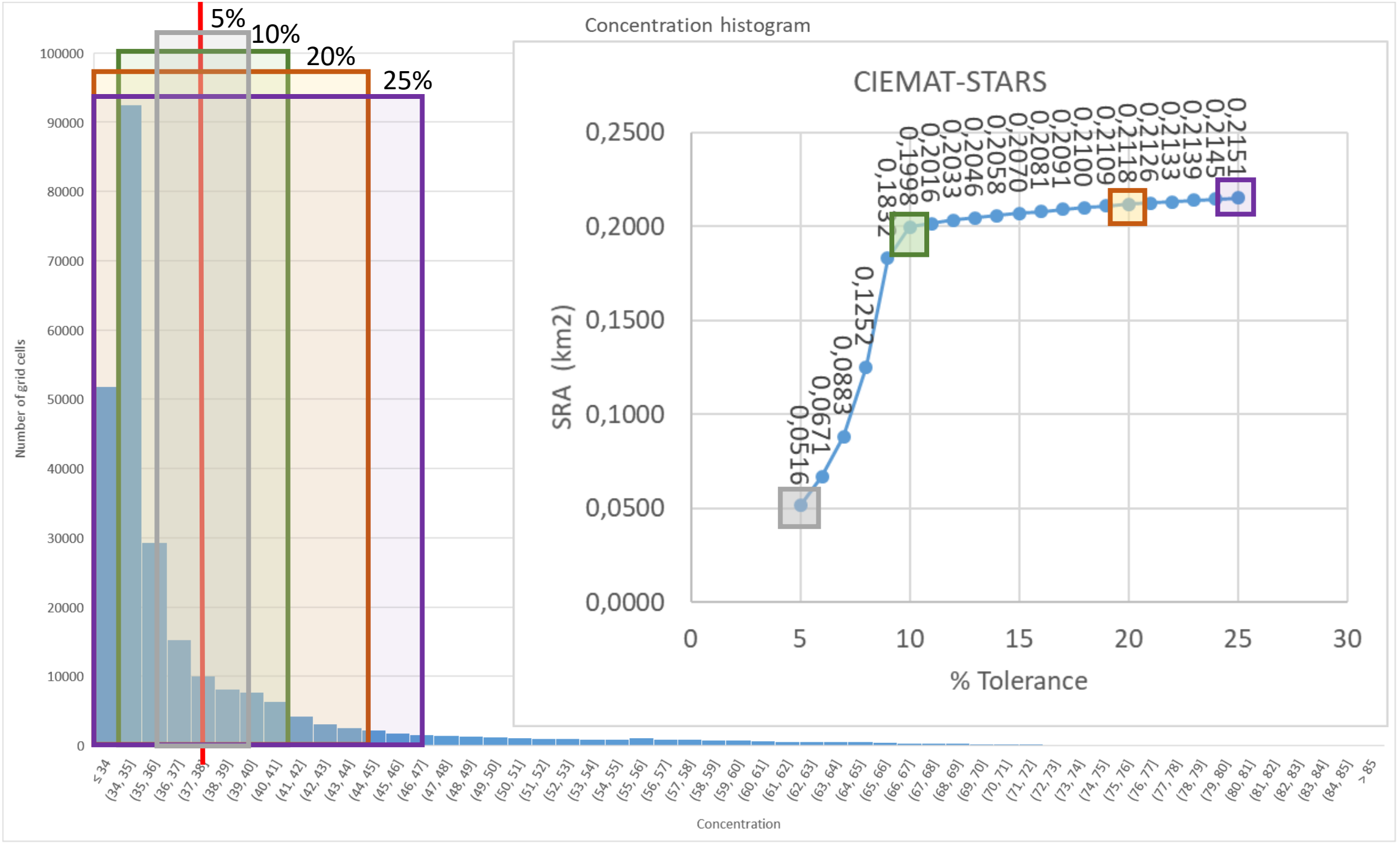
Critical tolerance is different for each station (higher for the traffic station).

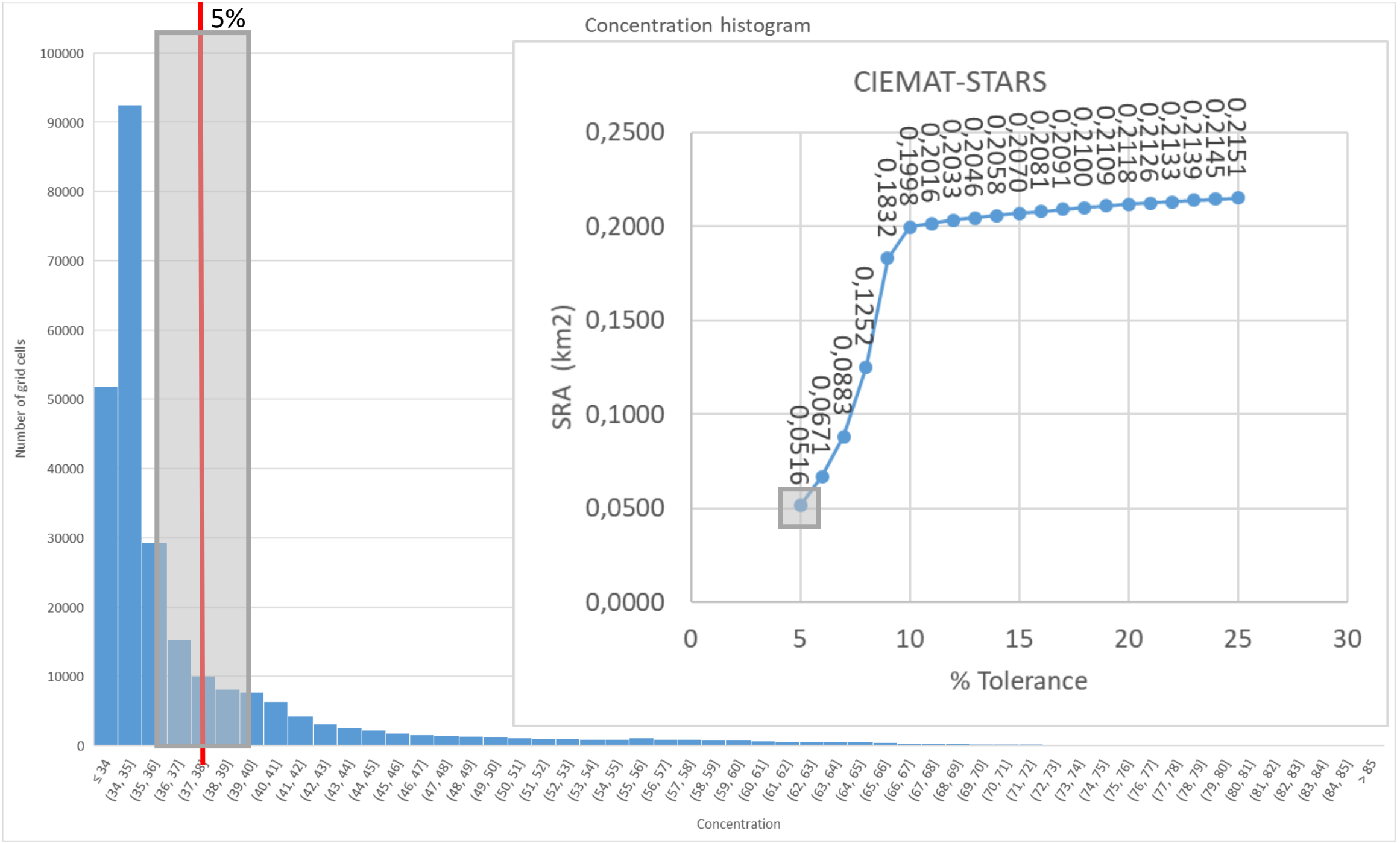
Critical tolerance is different for each model.

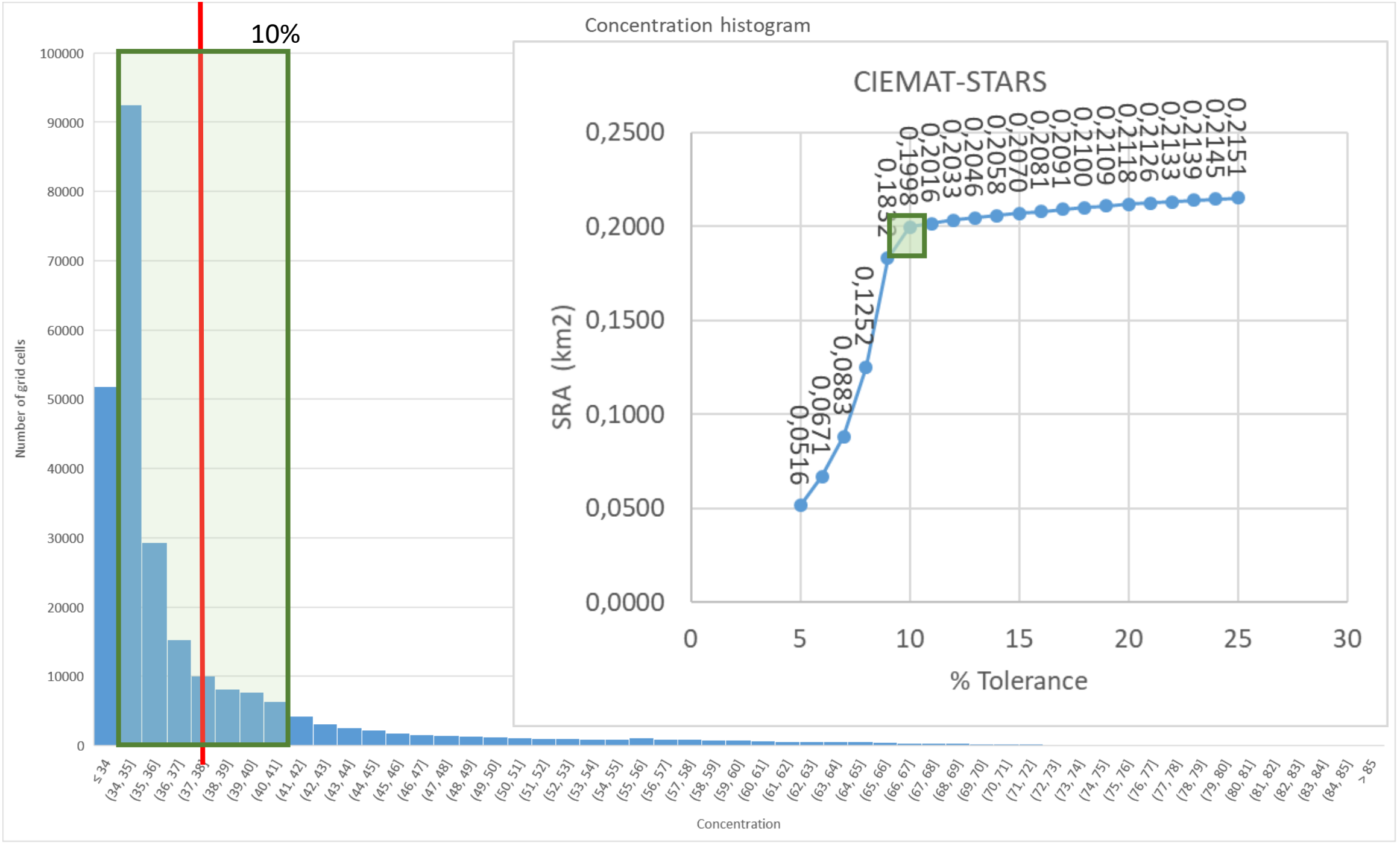
Is it a limit for tolerance? Is it worth to investigate this?

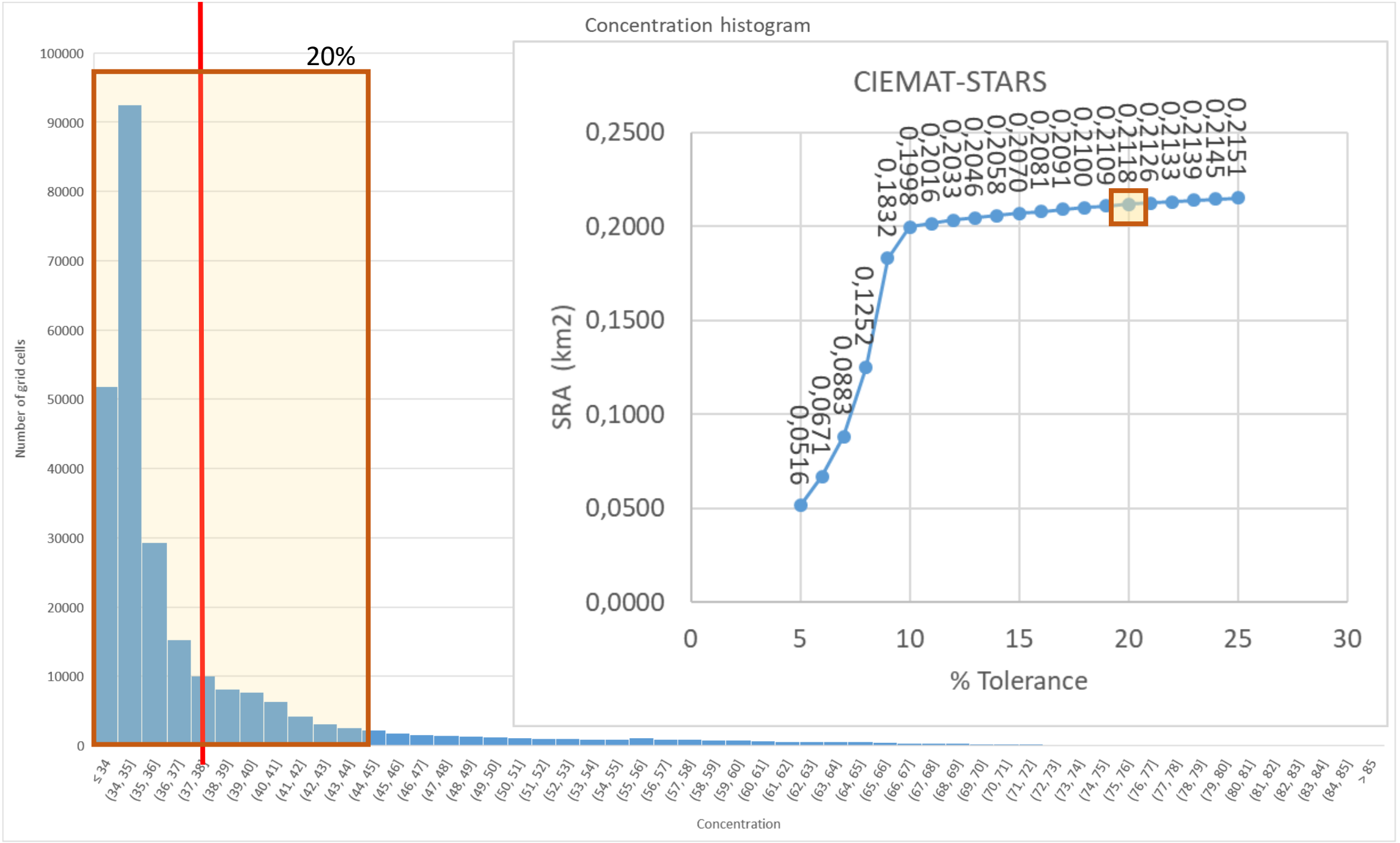


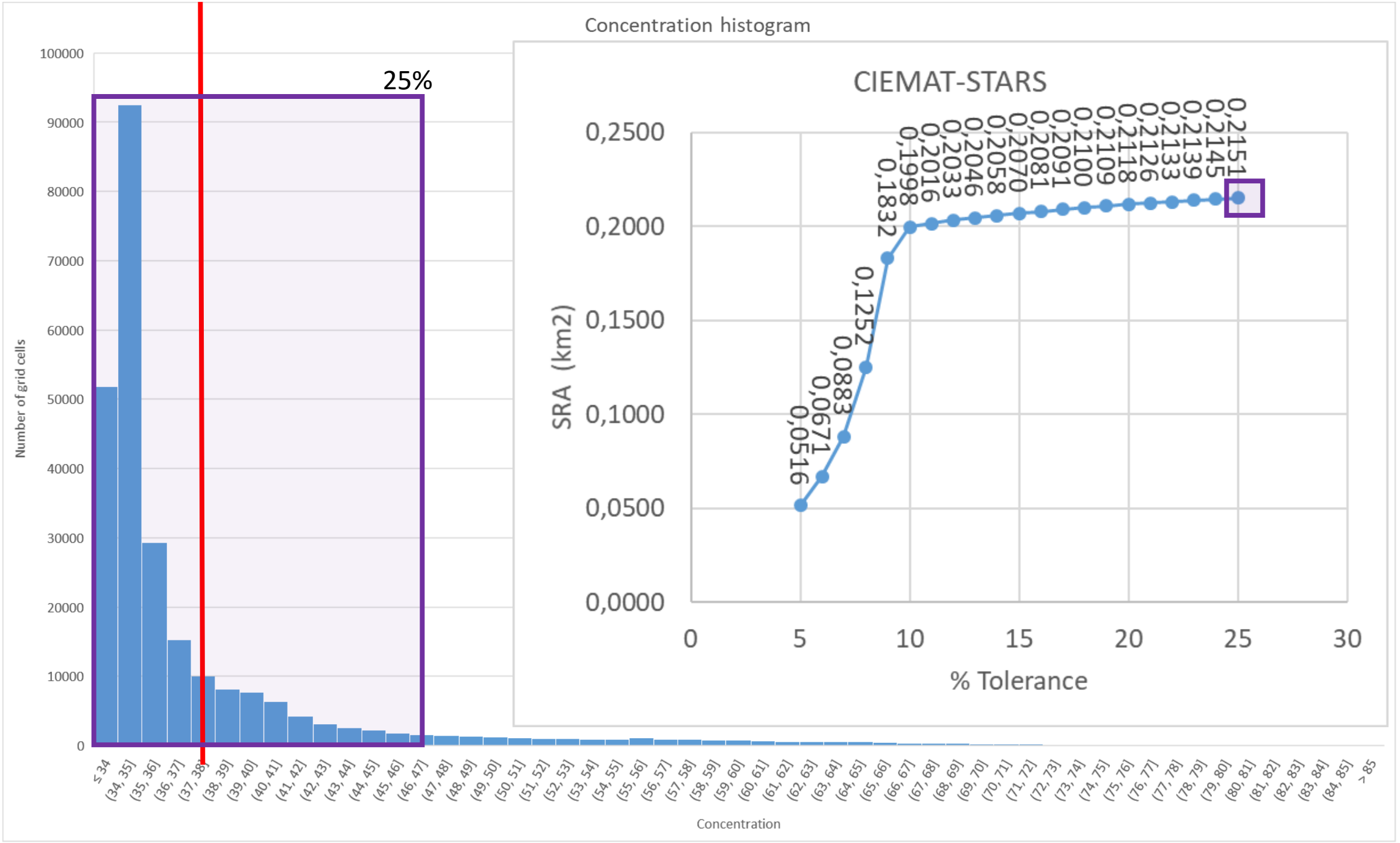



5%
10%
20%
25%
Concentration histogram
CIEMAT-STARS
SRA (km2)
% Tolerance
Number of grid cells
Concentration
0,0516
0,0671
0,0883
0,1252
0,1832
0,1998
0,2016
0,2033
0,2046
0,2058
0,2070
0,2081
0,2091
0,2100
0,2109
0,2118
0,2126
0,2133
0,2139
0,2145
0,2151


5%
Concentration histogram
CIEMAT-STARS
SRA (km2)
% Tolerance
Number of grid cells
Concentration
0,0516
0,0671
0,0883
0,1252
0,1832
0,1998
0,2016
0,2033
0,2046
0,2058
0,2070
0,2081
0,2091
0,2100
0,2109
0,2118
0,2126
0,2133
0,2139
0,2145
0,2151


10%
Concentration histogram
Number of grid cells
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
≤ 34
(34, 35]
(35, 36]
(36, 37]
(37, 38]
(38, 39]
(39, 40]
(40, 41]
(41, 42]
(42, 43]
(43, 44]
(44, 45]
(45, 46]
(46, 47]
(47, 48]
(48, 49]
(49, 50]
(50, 51]
(51, 52]
(52, 53]
(53, 54]
(54, 55]
(55, 56]
(56, 57]
(57, 58]
(58, 59]
(59, 60]
(60, 61]
(61, 62]
(62, 63]
(63, 64]
(64, 65]
(65, 66]
(66, 67]
(67, 68]
(68, 69]
(69, 70]
(70, 71]
(71, 72]
(72, 73]
(73, 74]
(74, 75]
(75, 76]
(76, 77]
(77, 78]
(78, 79]
(79, 80]
(80, 81]
(81, 82]
(82, 83]
(83, 84]
(84, 85]
> 85
Concentration
CIEMAT-STARS
SRA (km2)
0,2500
0,2000
0,1500
0,1000
0,0500
0,0000
0,0516
0,0671
0,0883
0,1252
0,1832
0,1998
0,2016
0,2033
0,2046
0,2058
0,2070
0,2081
0,2091
0,2100
0,2109
0,2118
0,2126
0,2133
0,2139
0,2145
0,2151
0
5
10
15
20
25
30
% Tolerance

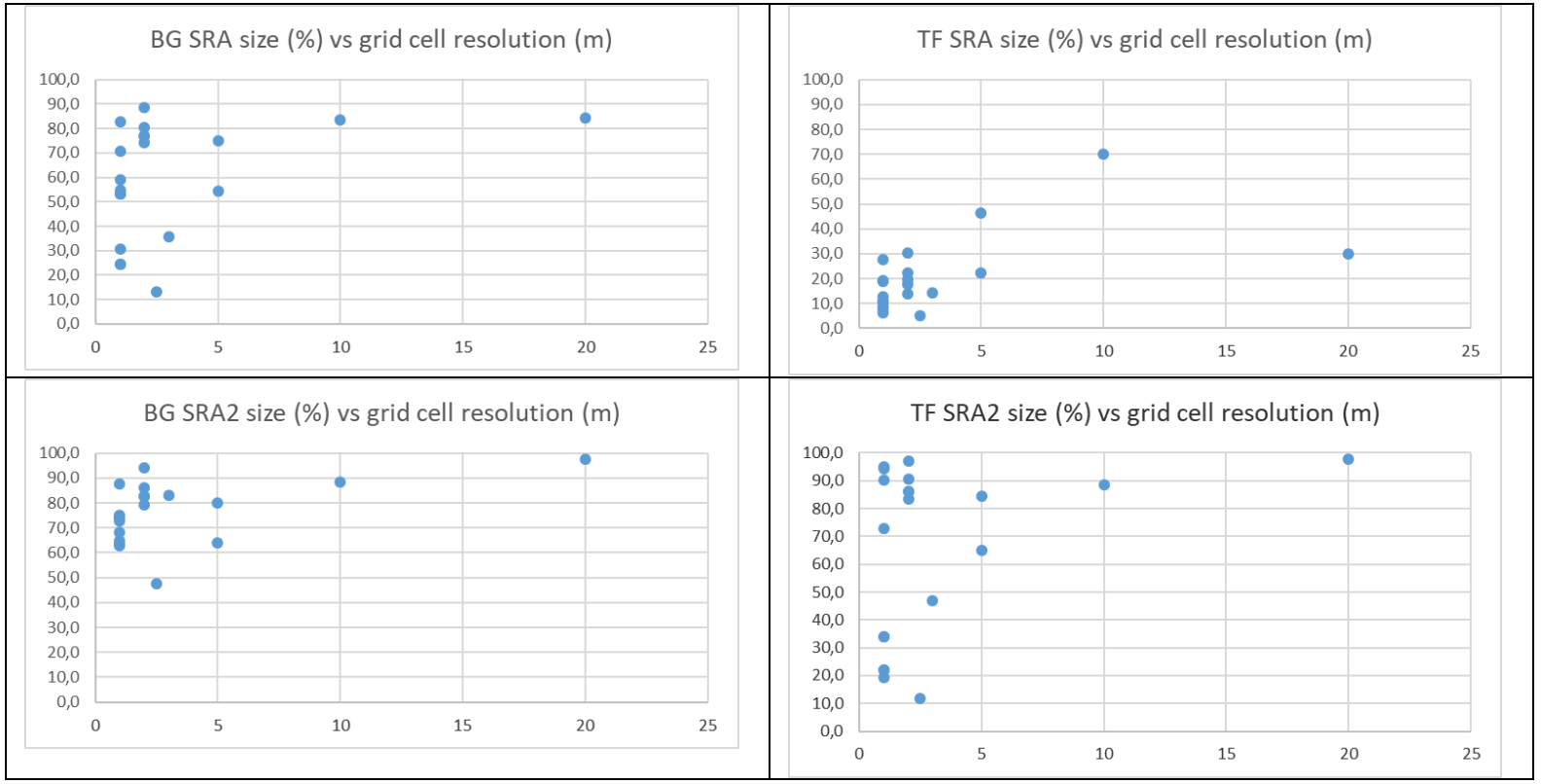

Concentration histogram
20%
Number of grid cells
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
≤ 34
(34, 35]
(35, 36]
(36, 37]
(37, 38]
(38, 39]
(39, 40]
(40, 41]
(41, 42]
(42, 43]
(43, 44]
(44, 45]
(45, 46]
(46, 47]
(47, 48]
(48, 49]
(49, 50]
(50, 51]
(51, 52]
(52, 53]
(53, 54]
(54, 55]
(55, 56]
(56, 57]
(57, 58]
(58, 59]
(59, 60]
(60, 61]
(61, 62]
(62, 63]
(63, 64]
(64, 65]
(65, 66]
(66, 67]
(67, 68]
(68, 69]
(69, 70]
(70, 71]
(71, 72]
(72, 73]
(73, 74]
(74, 75]
(75, 76]
(76, 77]
(77, 78]
(78, 79]
(79, 80]
(80, 81]
(81, 82]
(82, 83]
(83, 84]
(84, 85]
> 85
Concentration
CIEMAT-STARS
SRA (km2)
0,2500
0,2000
0,1500
0,1000
0,0500
0,0000
0
5
10
15
20
25
30
% Tolerance
0,0516
0,0671
0,0883
0,1252
0,1832
0,1998
0,2016
0,2033
0,2046
0,2058
0,2070
0,2081
0,2091
0,2100
0,2109
0,2118
0,2126
0,2133
0,2139
0,2145
0,2151


Concentration histogram
25%
Number of grid cells
Concentration
CIEMAT-STARS
SRA (km2)
% Tolerance
0,0516
0,0671
0,0883
0,1252
0,1832
0,1998
0,2016
0,2033
0,2046
0,2058
0,2070
0,2081
0,2091
0,2100
0,2109
0,2118
0,2126
0,2133
0,2139
0,2145
0,2151

Comparison of SRA for urban stations

How the SRA sizes changes with grid resolution?

It seems low grid resolution used to provide larger SRA, but high grid resolution can give large and small SRA.

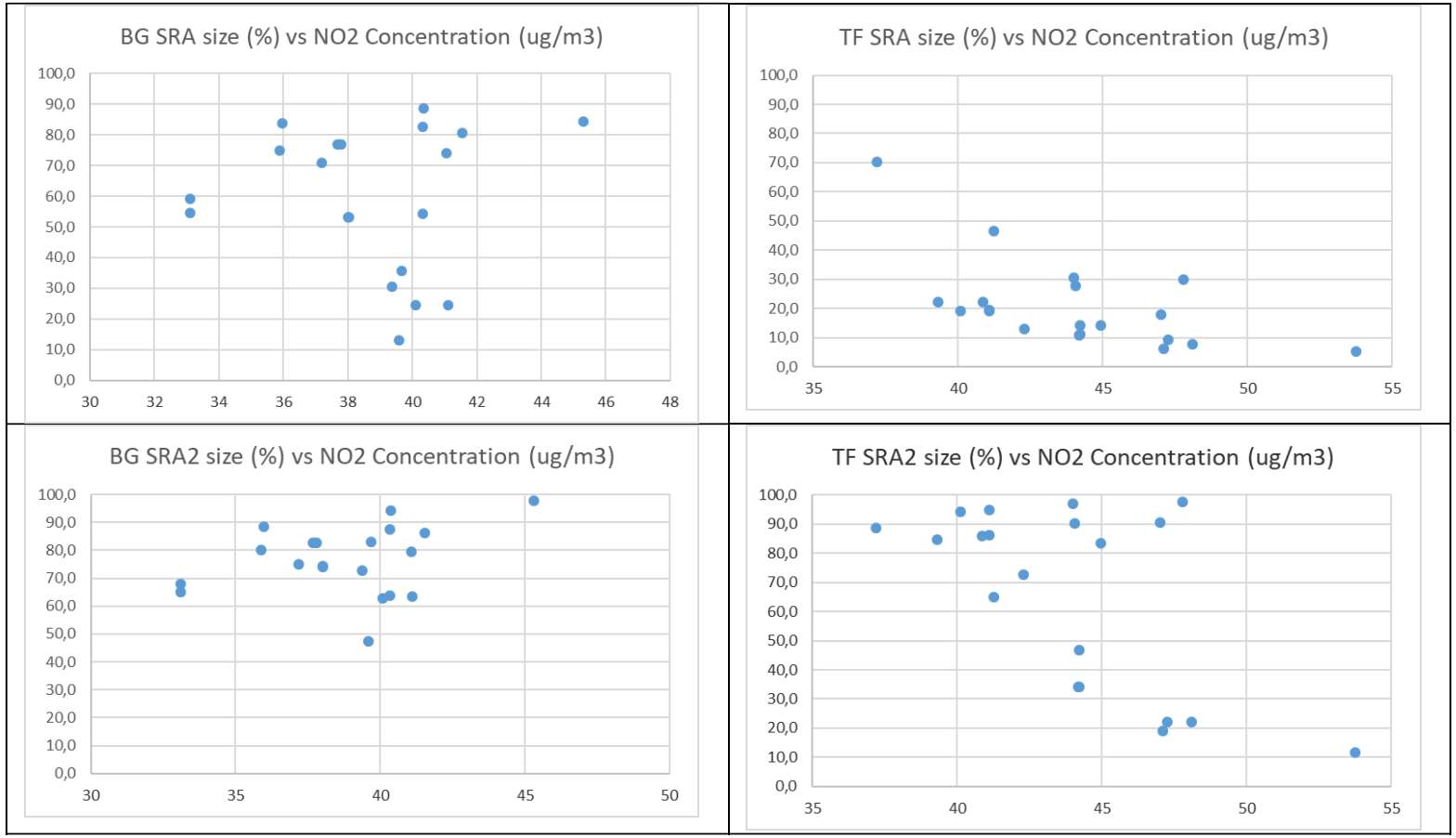


Comparison of SRA for urban stations

How the SRA sizes changes with model concentration at the stations cells?

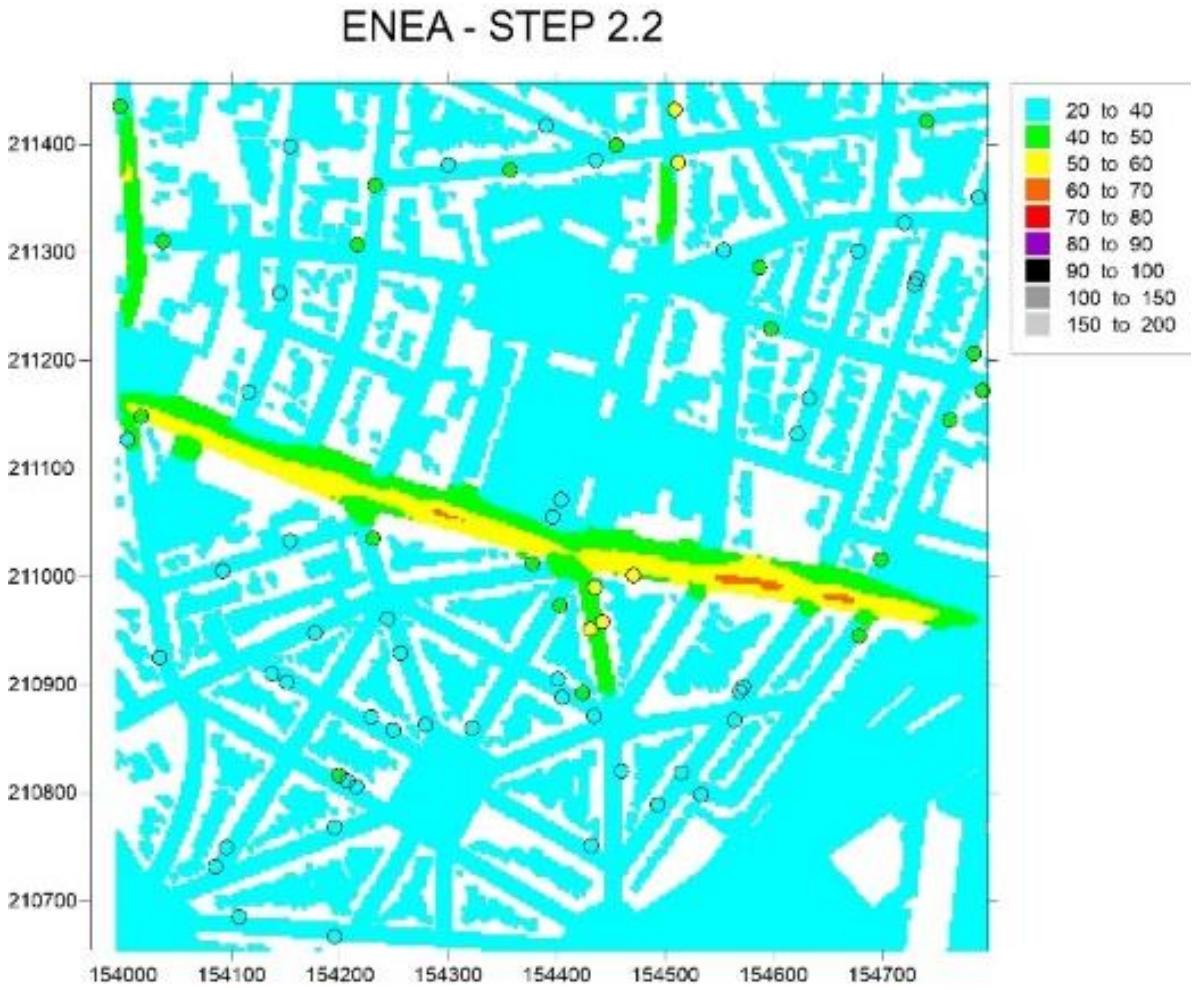
There seems to be some relation with station concentration for the traffic station.

Not clear for background station.



Comparison of SRA for urban stations. Next steps

- Try 15%? Others? Some work done…
- Compute an average of model results and then, compute the SRA?
  - all models or
  - by groups (CFD, Gaussian, AI)
- Analysis for SRA depending on methodologies and the number of scenarios.
  - Comparing CFD scenario simulations with OPEN FOAM unsteady full-year simulation from SZE. Now we have more results with different number of scenarios for different methodologies (CIEMAT, VITO, UOWM and SZE)!!
- To compute SRA with monthly model data and compare with *observed* SRA (using the campaign sampler data)?
- Compare monthly and annual SRA?

Compute SRA with monthly model data and compare with observed SRA

- NO_2 concentration from 72 samplers campaign (May 2016).
- Compute what samplers are inside the tolerance interval (10%, 20%) respect the concentration at 2 AQ stations ("observed" SRA).
- Compare with the estimated SRA by the models for the same tolerances.