FAIRMODE CT7

WG7 – Compilation of high-resolution emissions

Emission benchmarking exercise - Update

S. López-Aparicio[1], M. Guevara[2]

[1] NILU – The Climate and Environmental Research Institute

[2] Barcelona Supercomputing Center

European Commission

Detailed Agenda _ Dublin 2024

Tuesday 8th October _ 9:00 – 10:30

- Welcome (Susana Lopez-Aparicio)
- General Update of the emission benchmarking exercises (Susana Lopez-Aparicio)
- Modifications of the benchmarking tool based on participants' feedback (Philippe Thunis)
- Open discussion in relation to the Technical guidance document on AQ modelling (Marc Guevara)

Tuesday 8th October _ 14:00 – 16:00

- Participants contributions to the benchmarking exercise (Susana Lopez-Aparicio)
- **EDGAR, Slovenia, Poland, Belgium and Germany**
- Open discussion about next steps (Marc Guevara)

WG7 – Road map 2023-2025

- Best – practise through QA/QC

Identifying best practices through QA/QC approaches and drafting recommendations for the compilation of sectorial high resolution emission inventories that are relevant at the urban scale.

- Metadata recommendation

Elaborating recommendations for a common system to document the use of ancillary data and define the relevant meta-data that support each emission inventory at the urban scale.

- Benchmarking and Emission dashboard

Benchmarking and creating an emission dashboard (EU, bottom-up national and local inventories) to monitor progress and identify inconsistencies among inventories. Regular inter-comparisons will be carried out to support this objective.

- Use of Composite mapping platform

i) as spatial information support to evaluate specific sectors/ topics identified as inconsistency by the dashboard;
ii) to carry out emission evaluation in relation with activities of the composite mapping for assessment purposes

- Provide relevant feedback

To European inventories used for regulatory purposes (EMEP, CAMS-REG) and research project (e.g., REMI, RI-URBANS, NordicWelfAir, “Others”).

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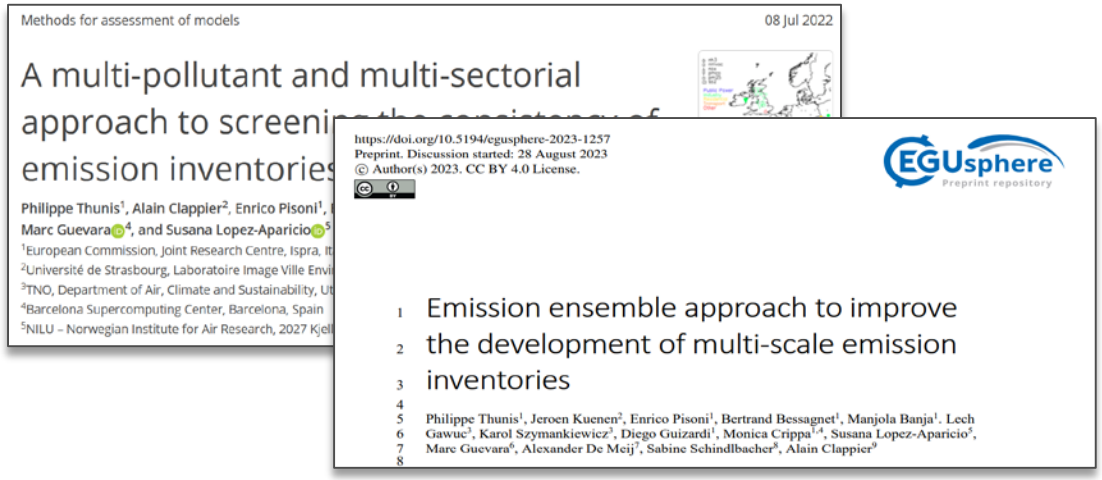
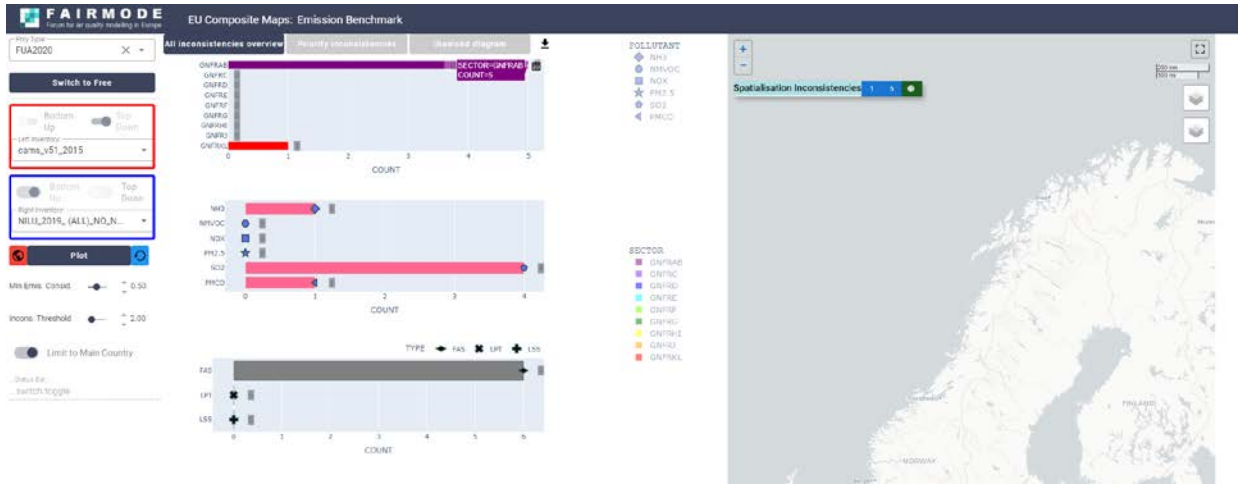
Recap on the benchmarking exercise

- QA/QC of emission inventories is challenging because of the multiplicity of information to check: sectors * pollutants * space * time
- The FAIRMODE screening approach aims at detecting inconsistencies that should then be further discussed and explained, and potentially resolved
- Main principle: If two emission estimates differ largely, then one of the inventory value or both need to be checked (and maybe corrected)

The method

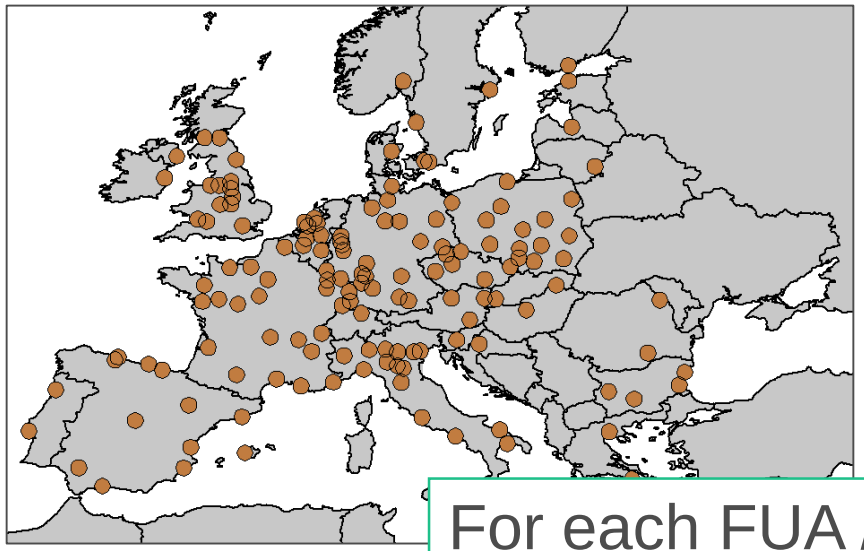


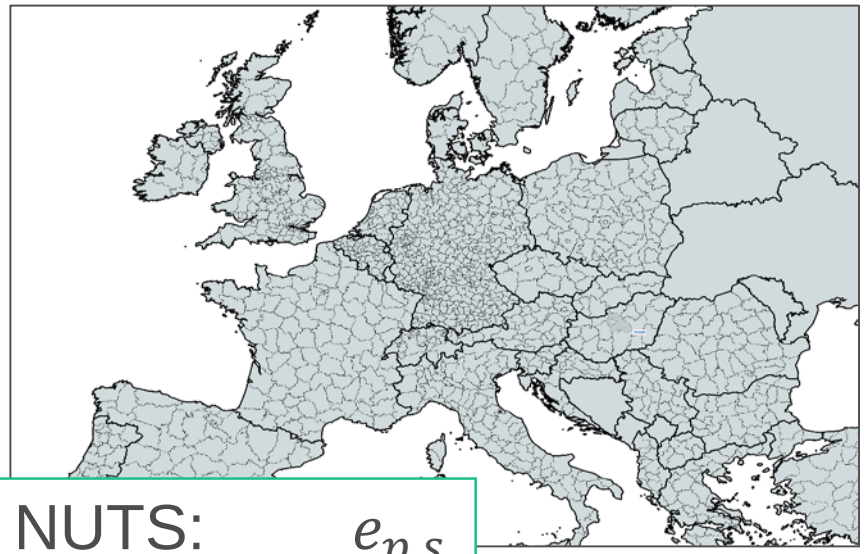
The tool



The methodology and simplifications

FOCUS: Emissions aggregated per NUTs or FUA!



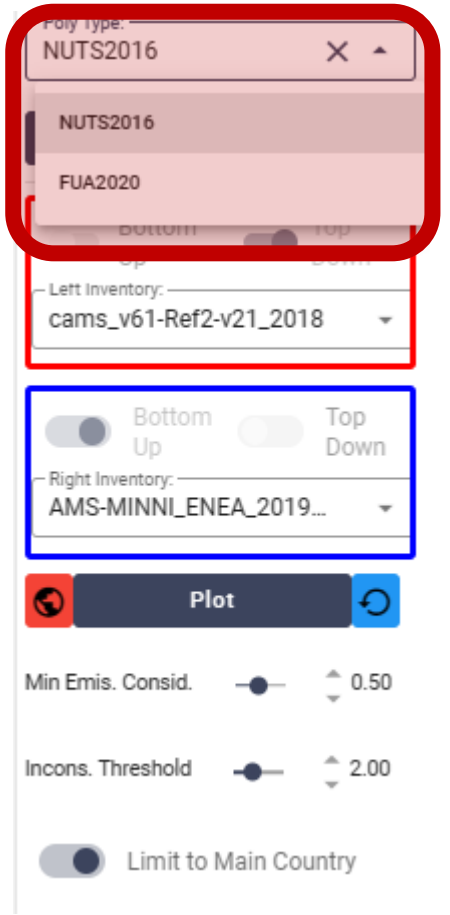


For each FUA / NUTS: $e_{p,s}$

For each country/region: $E_{p,s}$

pollutant

sector



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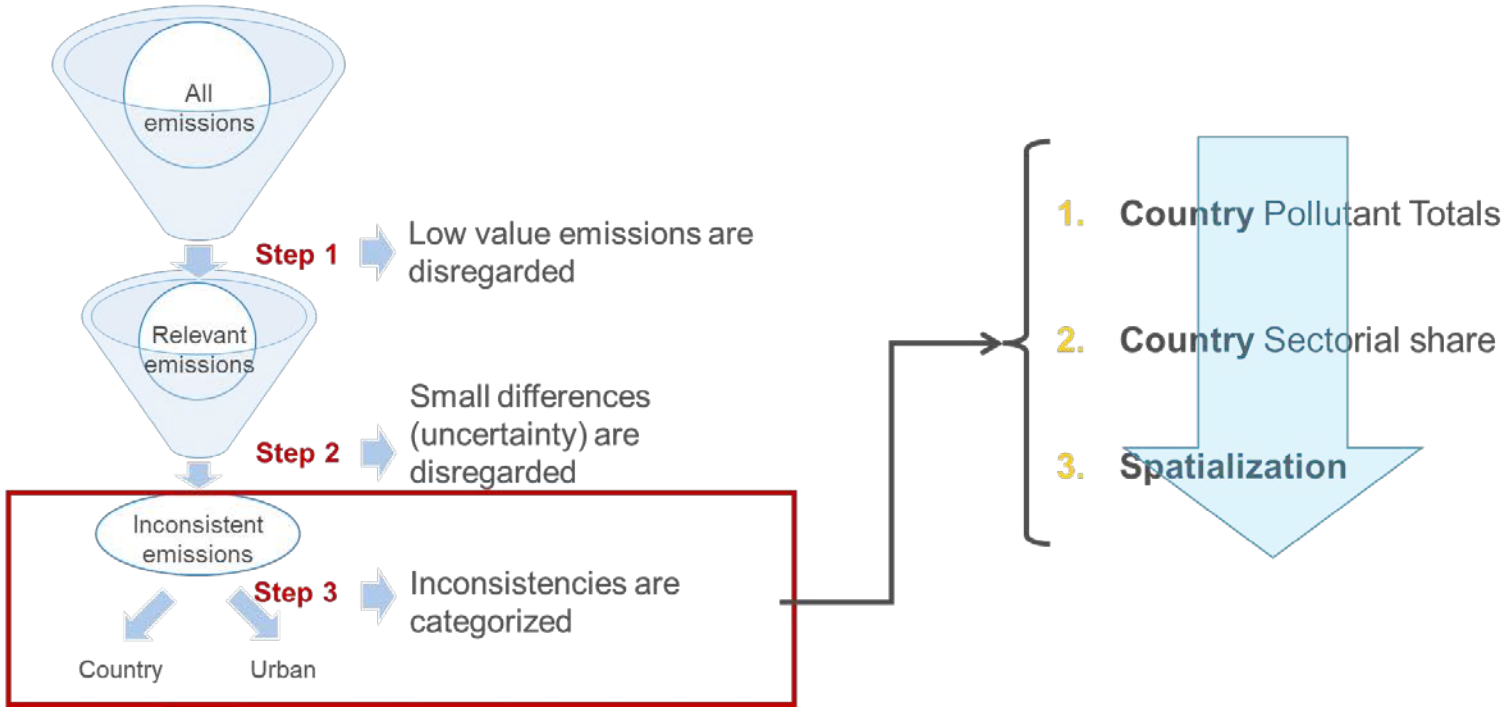
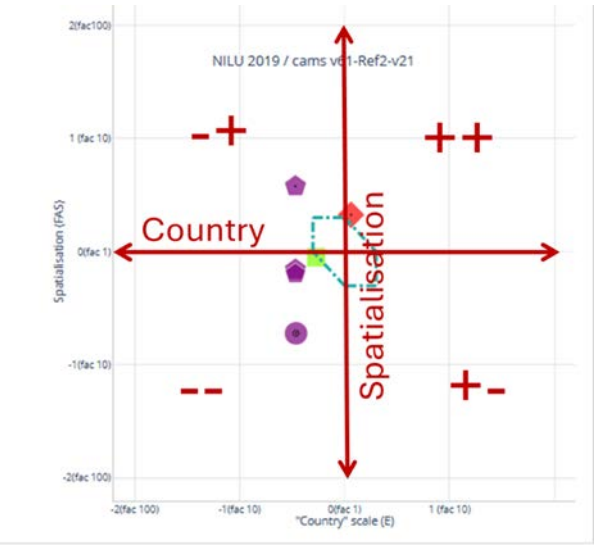
The methodology and simplifications

FOCUS: Relevant and inconsistent emissions only!



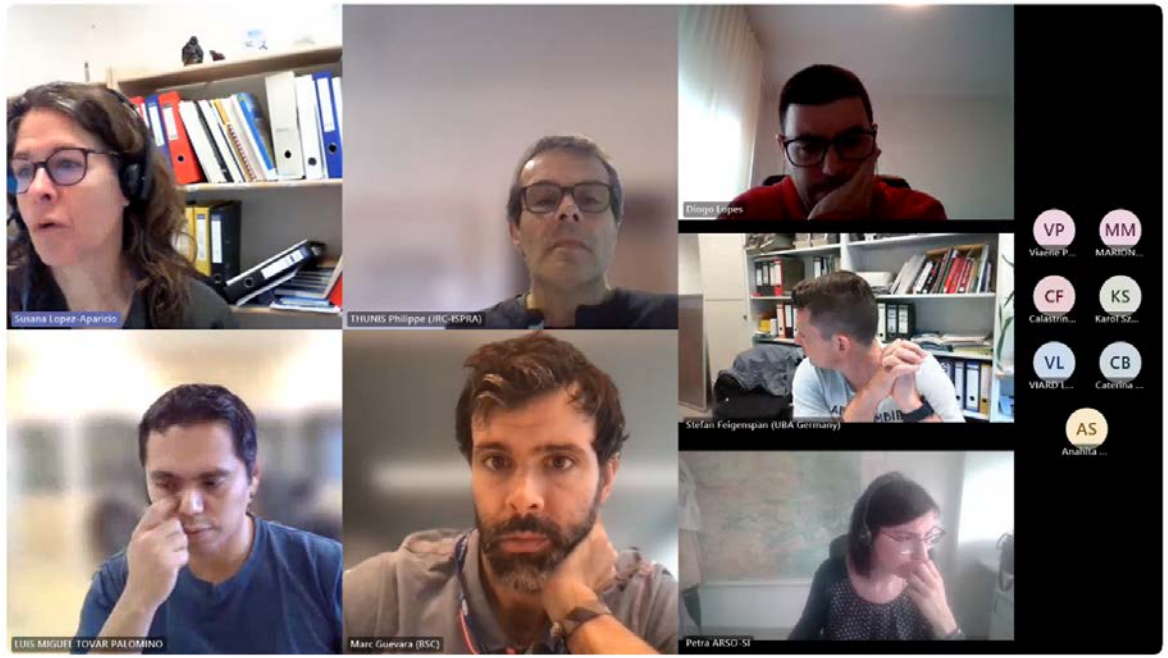
Different visualizations

Step 8



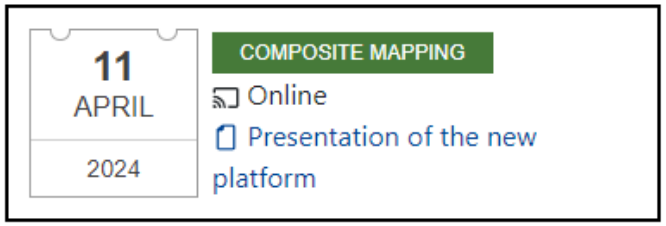
Benchmarking methodologies to improve emission inventories – 1st Webinar

- **April 2024**
- **# Participants: 20**



Agenda

	Topic	Responsible
9:00-9:10	Welcome and Introduction ▪ Intro ▪ Participants introduction ▪ Purpose of the webinar	Susana Lopez-Aparicio
9:10-9:25	Methodology behind the EU Composite Map for Emission	Philippe Thunis
9:25-10:10	Catalonia and Norway as practical examples	Marc Guevara Susana Lopez-Aparicio
10:10-10:30	Open Questions and Discussion	All
10:30-10:40	Summary of the Protocol	Marc Guevara
10:40-10:50	Final Remarks ▪ Homework, ▪ The 2nd Webinar	Susana Lopez-Aparicio and Marc Guevara



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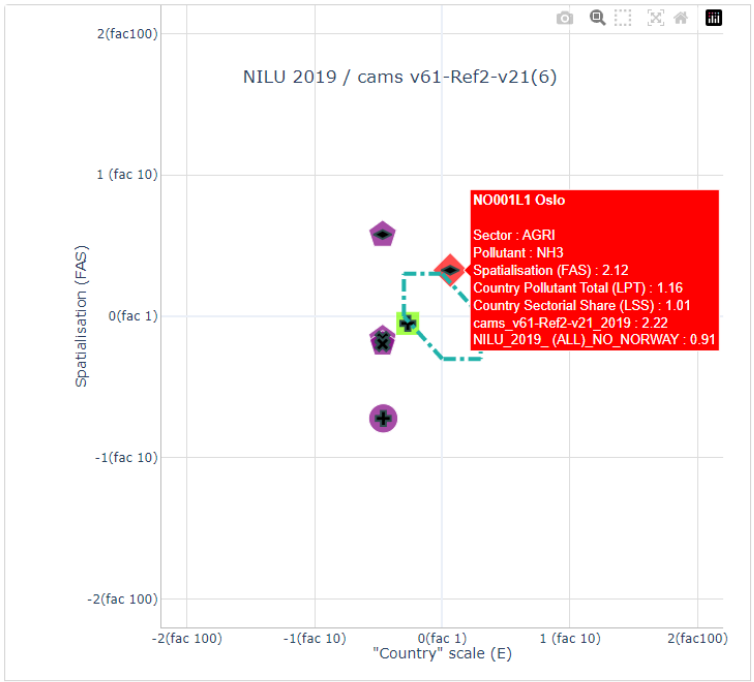
1st Webinar – Example Norway based on FUA

Agriculture – KL; NH3 – Agriculture K (Livestock)

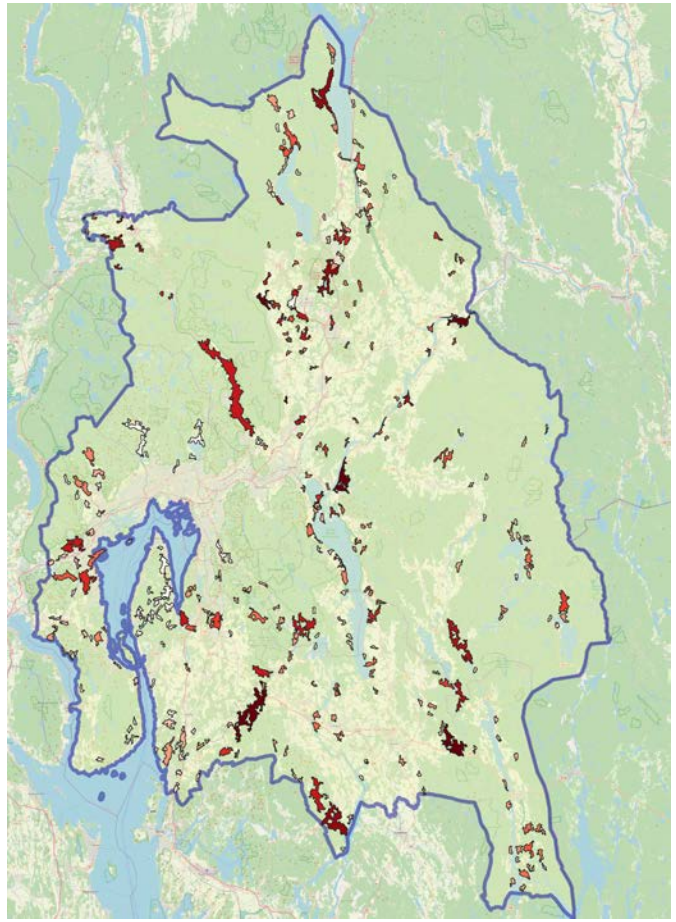


Data sources:

CAMS: Gridded livestock of the world (FAO, 2010), available from the UN Food and Agricultural Organisation (FAO), has been obtained per animal type and converted to a 0.05∘ × 0.1∘ resolution.

Local (NILU): Livestock number and type per municipality from Statistics Norway for the year 2019 + CORINE agriculture land use (subclass level)

Example of #cattle – agriculture areas



fua_name	Oslo

Sum of Sheep	Sum of Swine	Sum of Goats	Sum of Horses	Sum of Hens	Sum of Broilers	Sum of Other	Sum of Cattle	Sum of Diary
15 968	4 334	-	-	350 747	-	-	26 659	5 706

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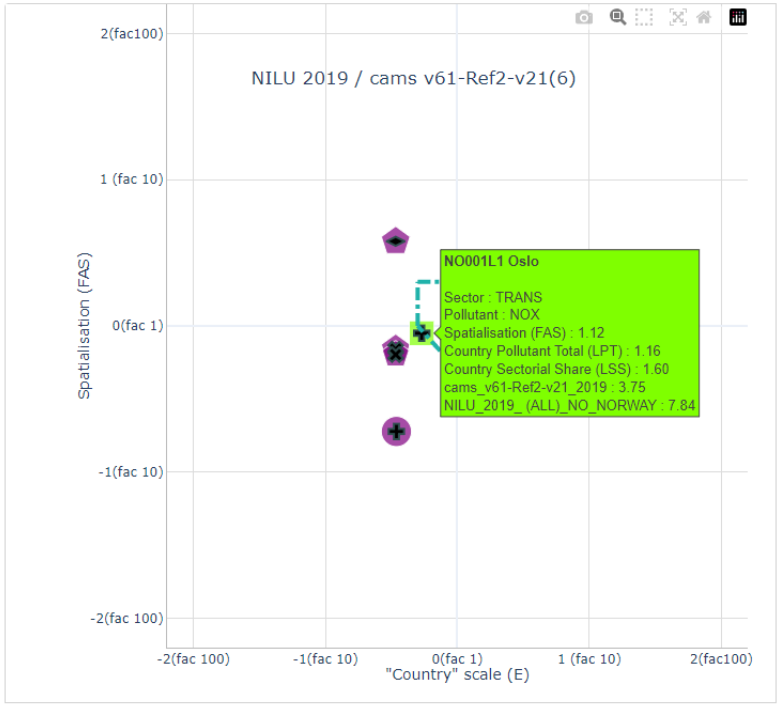
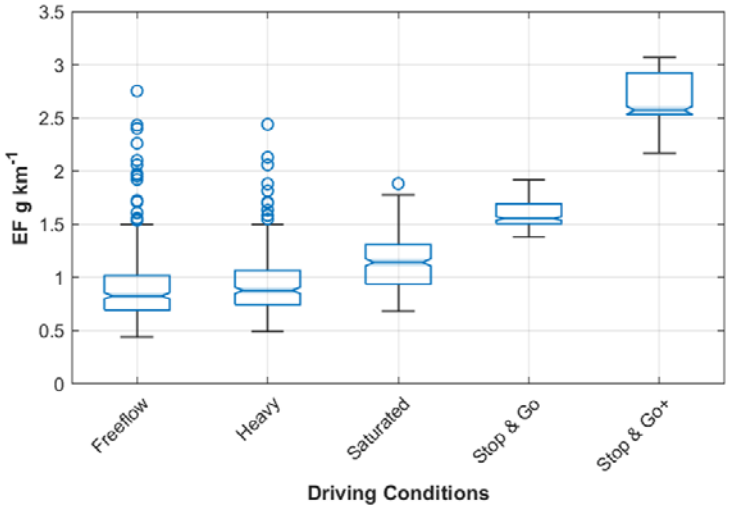
1st Webinar – Example Norway based on FUA





Road Traffic – F

Data sources:

CAMS: merging OSM (road network) and OTM for the traffic volumes in main roads. Intensity is used as proxy for the emissions, not considering more detailed parameters like vehicle speed, traffic jams, etc. For smaller roads, where traffic volume was not available, CAMS uses population density.

Local (NILU): a bottom-up model is used as distribution key, which considers the distribution of the technology class, vehicle speed, congestion, slope….

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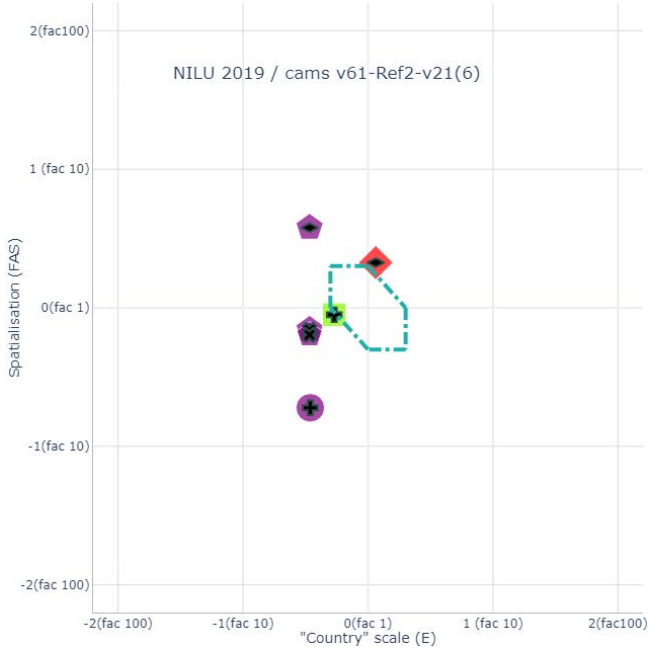
1st Webinar – Example Norway based on FUA

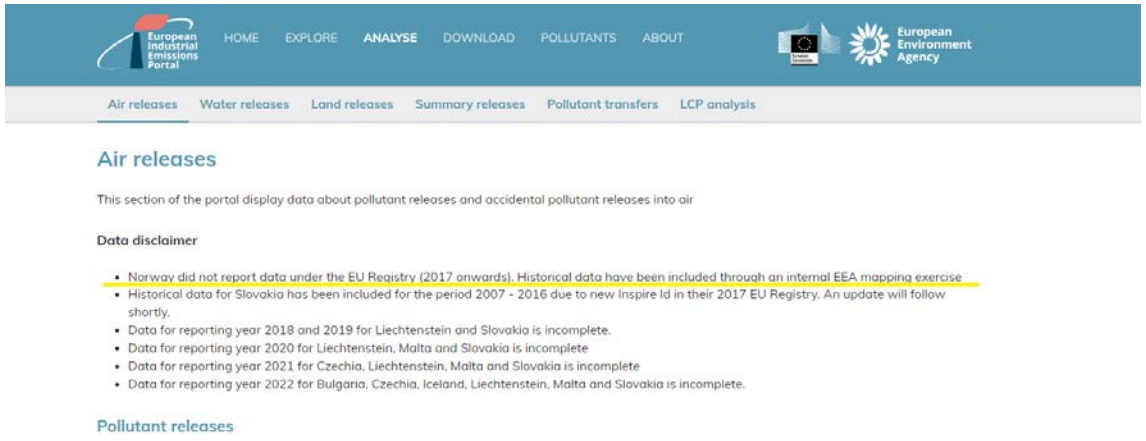


Industry – AB – SOx

Data sources:

CAMS: E-PRTR + own point source database + CORINE land cover 2012 industrial area

Local (NILU): Norwegian – PRTR + own point source database for land and off-shore point sources + CORINE land cover industrial area



Hypothesis - two problems: i) national level + ii) local level (it is mainly observed for SO2)

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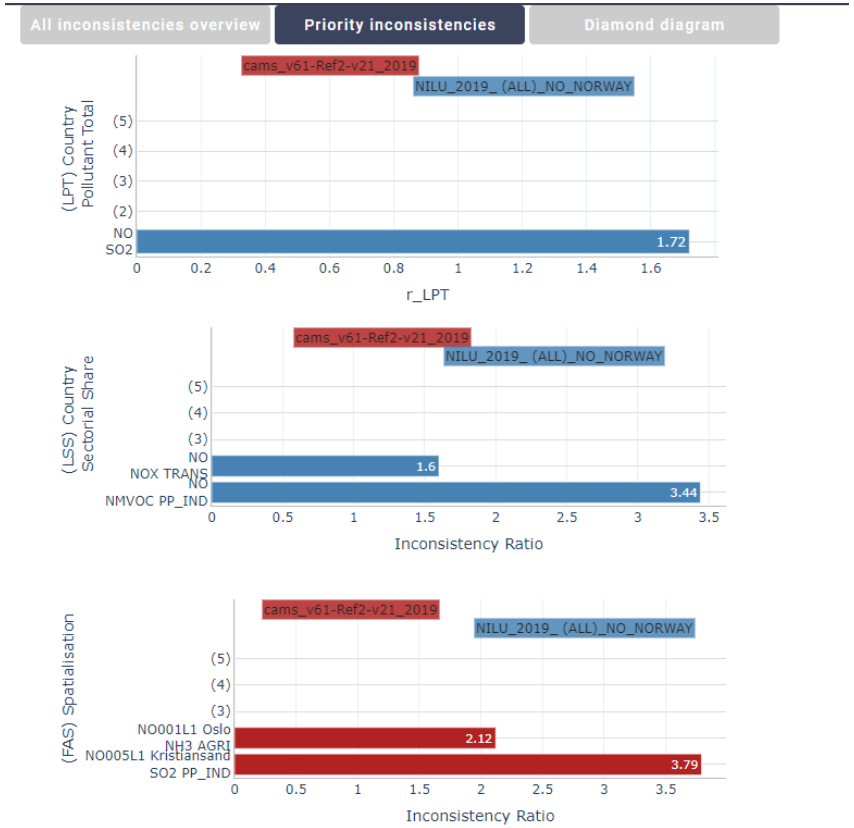
1st Webinar – Example Norway based on FUA



Industry – AB – SOx

Data sources:

CAMS: E-PRTR + own point source database + CORINE land cover 2012 industrial area

Local (NILU): Norwegian – PRTR + own point source database for land and off-shore point sources + CORINE land cover industrial area

Inconsistency at LPT – Country Pollutant Totals

SO2 – check nationals

AB _ CLRTAP (Annex 1): 13.48 kt

≠ from offshore

Local (NILU):

NUTS: 13 kt

FUA: 4.74 kt

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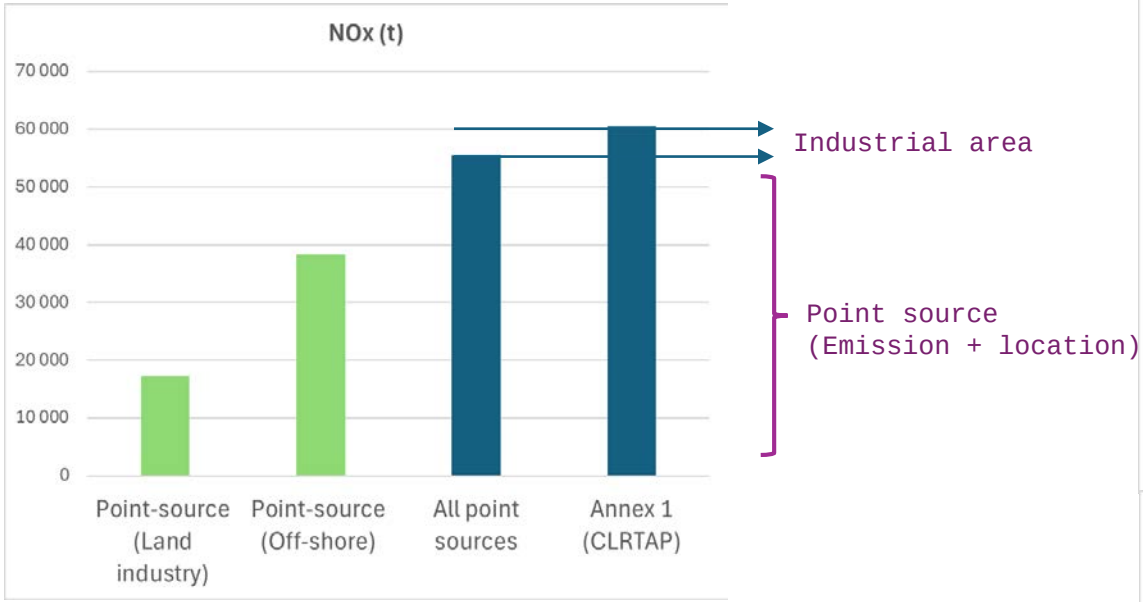
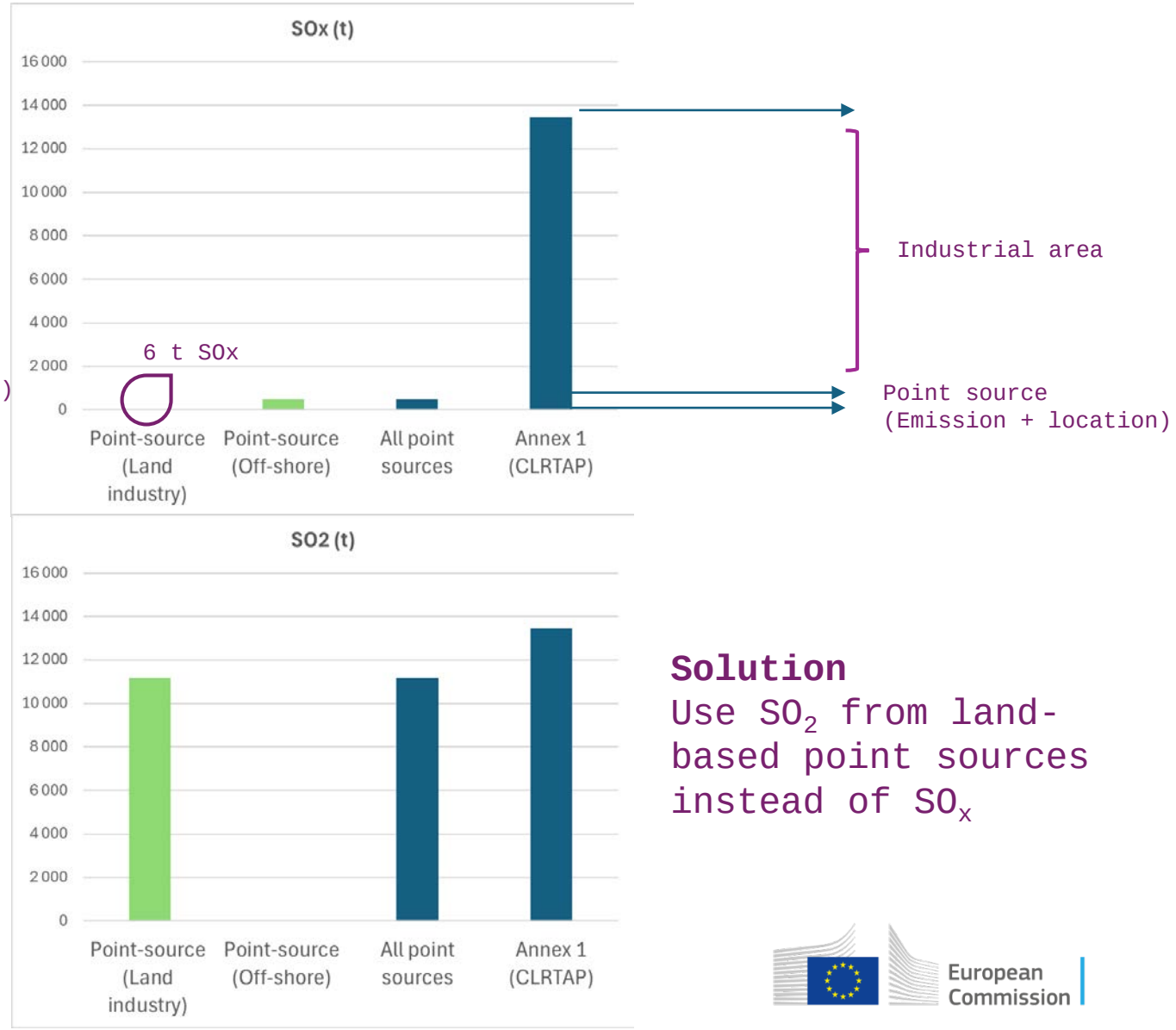
1st Webinar – Example Norway based on FUA

Norwegian – PRTR





Inconsistency in the Norwegian PRTR in reporting as SO_x and SO_2

Solution
Use SO_2 from land-based point sources instead of SO_x

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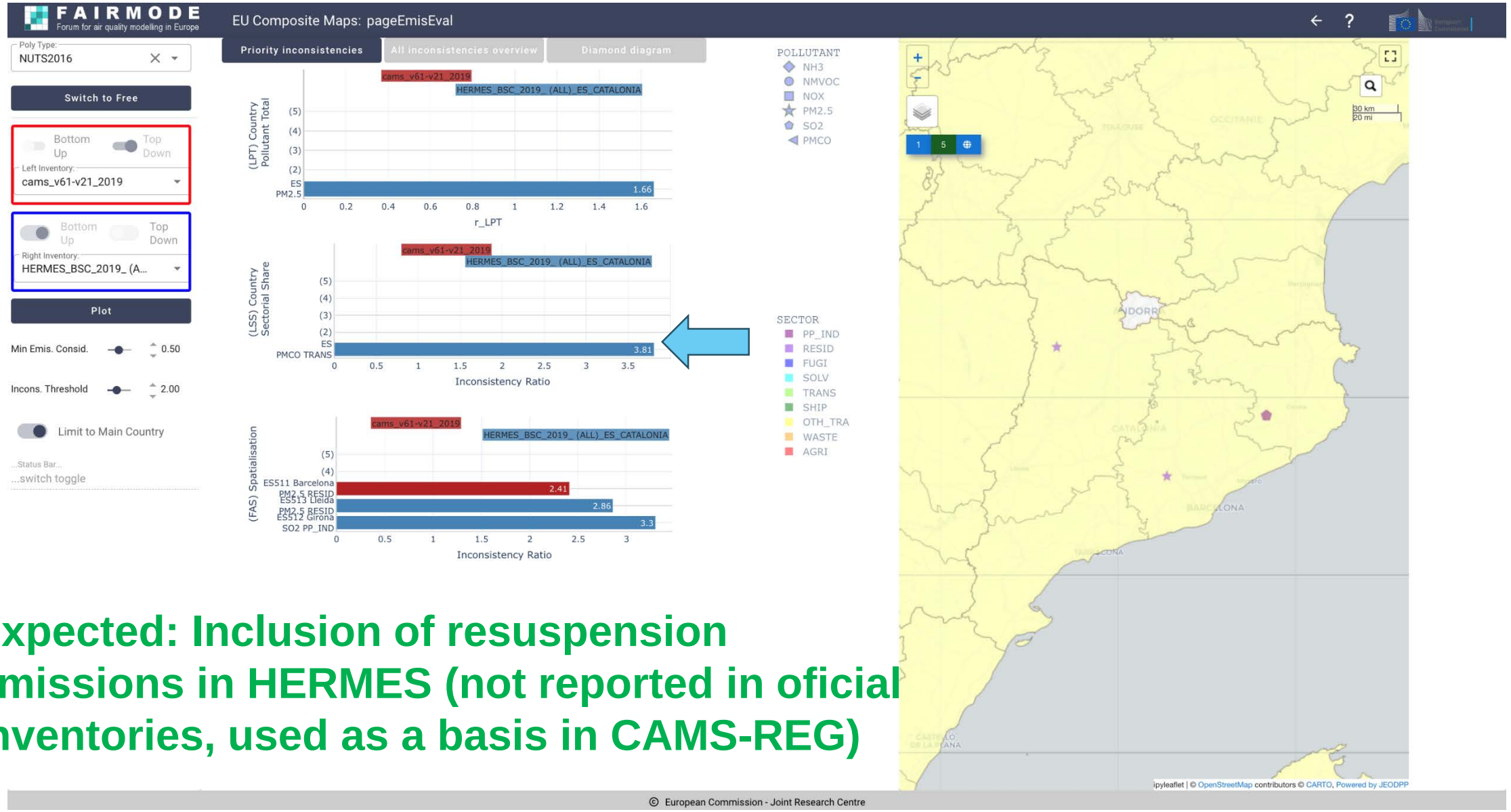
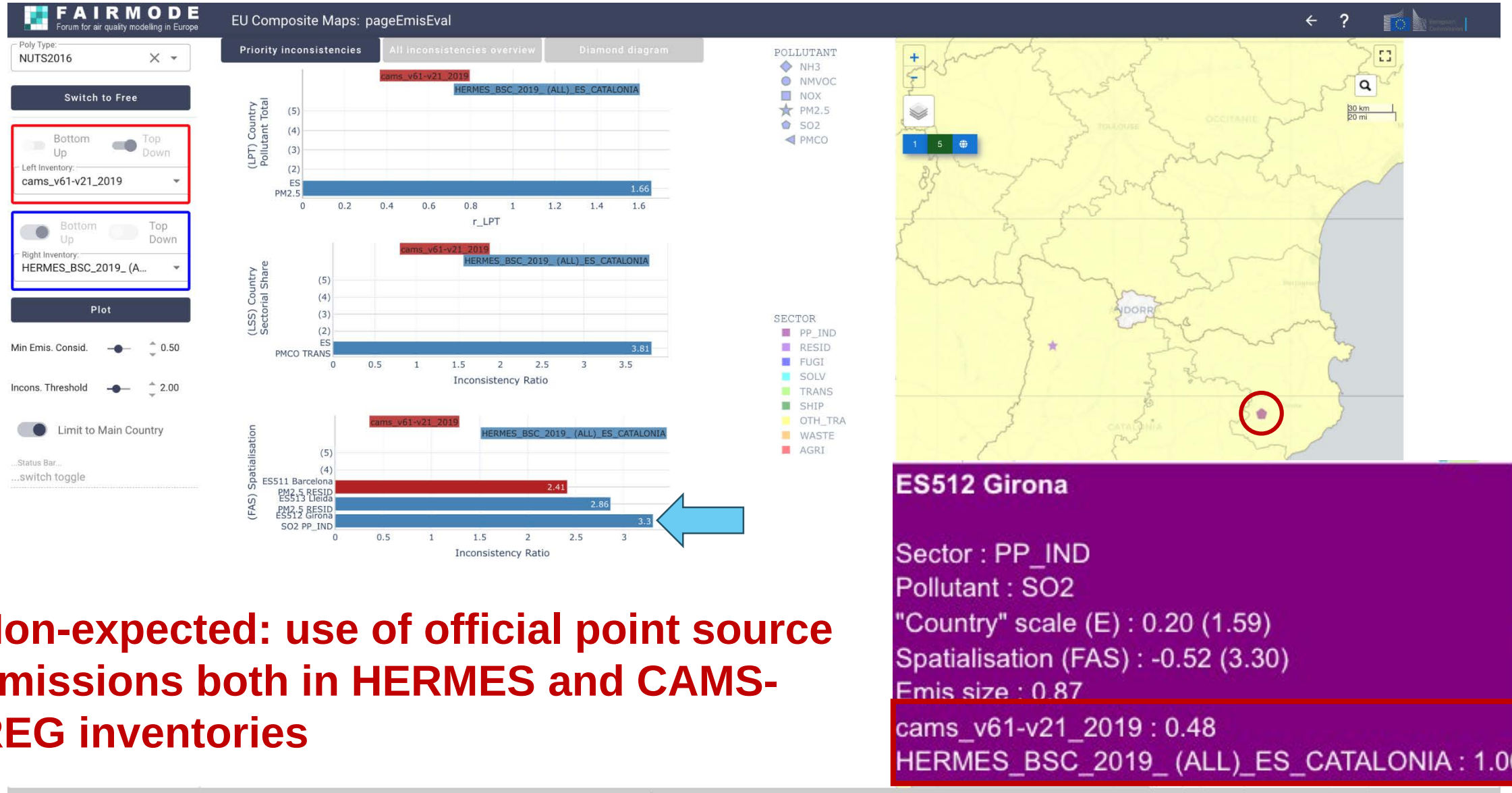
1st Webinar – Example Catalonia based on NUTs



Expected: Inclusion of resuspension emissions in HERMES (not reported in oficial inventories, used as a basis in CAMS-REG)

1st Webinar – Example Catalonia based on NUTs



Non-expected: use of official point source emissions both in HERMES and CAMS-REG inventories

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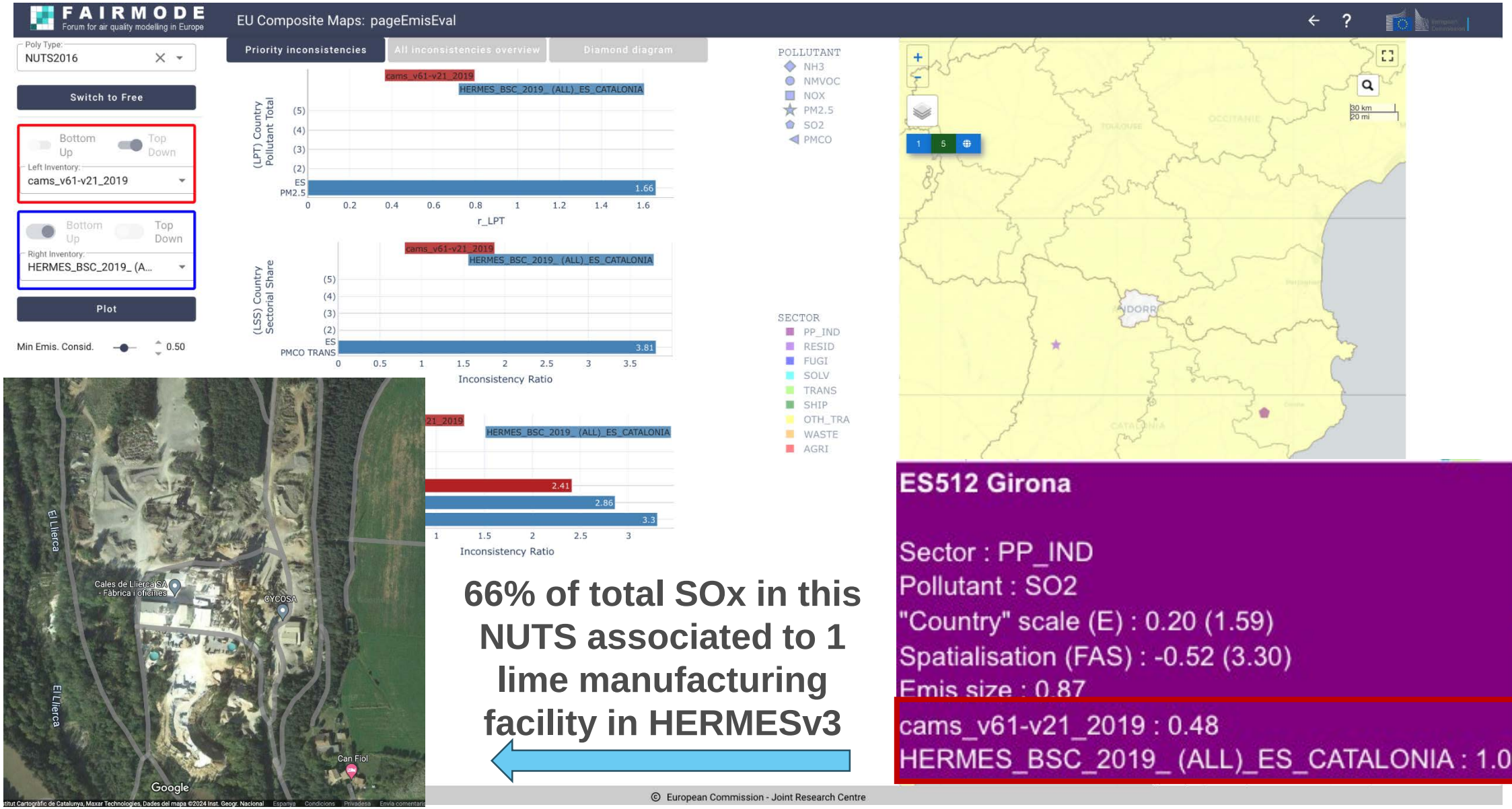
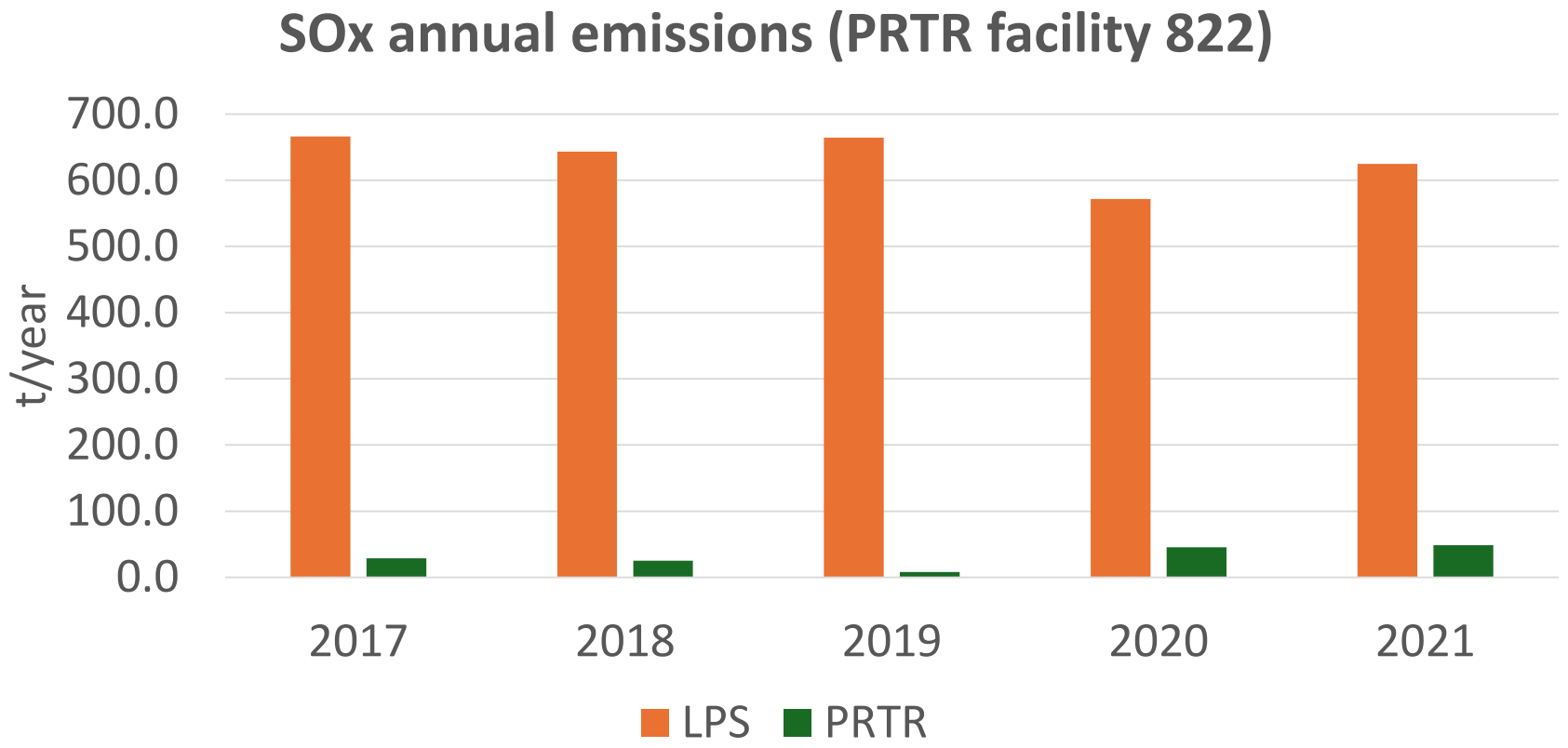
1st Webinar – Example Catalonia based on NUTs



1st Webinar – Example Catalonia based on NUTs

- HERMESv3 → LPS + PRTR
- CAMS-REG → distribution of national emissions according to PRTR + CORINE land use for “leftovers”



If we replace LPS by PRTR in HERMESv3: 0.99 kt/year → 0.35 kt/year (closer to 0.48 kt/year reported by CAMS-REG)

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Protocol - Distributed as homework for the 2nd Webinar

10 steps to follow

Protocol for the FAIRMODE Emission Composite Map

1. Select polygon type (NUTS or FUA; Figure 1).
2. Select the EU wide inventory to consider for the comparison exercise (i.e., CAMS-REG, EDGAR, EMEP; Figure 1). For each inventory, different reference years are available.
3. Select the bottom-up inventory to consider for the comparison exercise (Figure 1).
4. Keep the "Min Emission Consideration" and "Inconsistency Threshold" default values (0.5 and 2.0; Figure 1)
5. Click "Plot" (Figure 1)
6. Click the "Diamond diagram" (Figure 1) to evaluate inconsistencies in term country level (LPT + LSS; x-axis) and due to spatial distribution of emissions (FAS; y-axis). Inconsistencies aligned along the x-axis indicate issues in term of country level (LPT or LSS), whereas inconsistencies aligned along the y-axis indicate issues related to the spatial distribution of emissions. Assess how many inconsistencies there are, which type, sector, pollutant, over- vs underestimation (Figure 2).

When you position the mouse on top of the symbol, you get detailed information:

a. **Sector**: sector name
b. **Pollutant**: pollutant name
c. **Spatialisation (FAS):** Ratio of the two inventory estimates for spatialisation for the selected sector and pollutant. It assesses how country emissions are distributed to a given NUTS/FUA.
d. **Country Pollutant Total (LPT):** Ratio of the two inventory country total estimates for the selected sector and pollutant.
e. **Country Sectorial Share (LSS):** Ratio of the two inventory estimates for the country sectoral share for

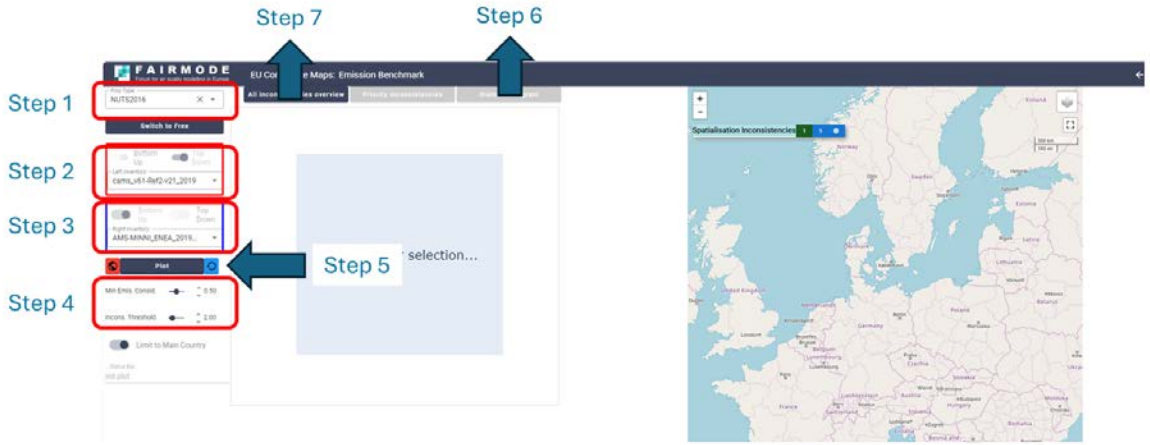

Figure 1: Home page of the Emission Composite Map, and steps 1 to 7 from the protocol.

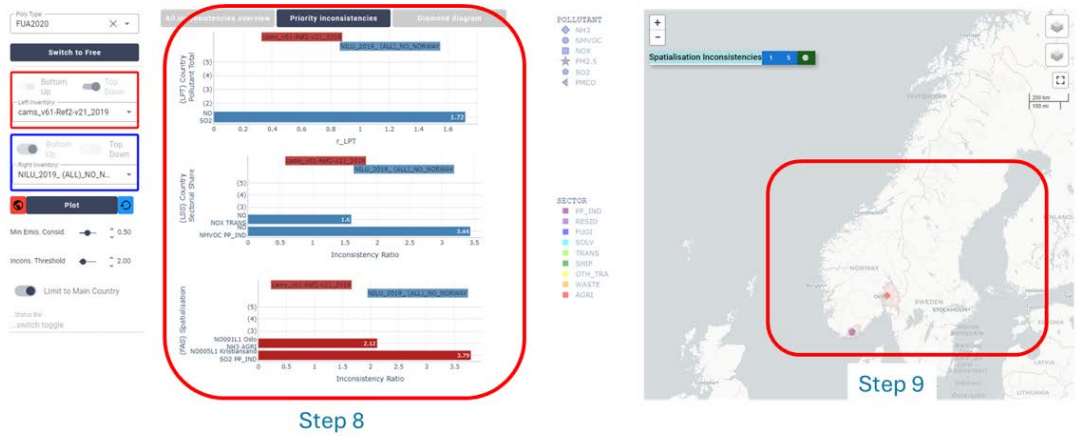

Figure 4: Main inconsistencies tab and map (Steps 7 and 8)

2nd Webinar - template

- **June 2024**
- **# Teams sharing their experience: 6**

What are the main lessons learned?

1

2

- What are the main inconsistencies found?
- Are these inconsistencies expected?
- Are them the same in NUTS and FUA?
- Are the inconsistencies the same when comparing to CAMS-REG and EMEP?

3

- What are the main inconsistencies found?
- Are these inconsistencies expected?
- Are them the same in NUTS and FUA?
- Are the inconsistencies the same when comparing to CAMS-REG and EMEP?

4

- Can we explain them?
- Is it possible to solve these inconsistencies?
- Are you stuck at a certain point?
- Do you need additional information?

5

- Any suggestions to improve the tool?

Next talk: Modifications of the benchmarking tool (Philippe Thunis)

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2nd Webinar

- **June 2024**
- **# Teams sharing their experience: 6**

1. **Welcome and Introduction (Marc/Susana)** *(5 min)*
2. **EU Composite Map for Emission - Exchange of experiences**
    1. **Madrid** (ca 8 min + 2 questions)
    2. **Germany** (ca 8 min + 2 questions)
    3. **Slovenia** (ca 8 min + 2 questions)
    4. **Belgium** (ca 8 min + 2 questions)
    5. **Poland** (ca 8 min + 2 questions)
    6. **Portugal** (ca 8 min + 2 questions)
    7. **Way forward and next steps (All)** Potential points to support the discussion.
        1. Did you find the exercise relevant/useful?
        2. Is the exercise useful to identify opportunities for improvement (EU wide inventory – Local inventory)?
        3. What's the best way to resolve the questions/doubts that arise from the intercomparison exercises?
        4. Should we organize a 3rd workshop e.g., "thematic" (sector-based?)
        5. How can we put together / translate the findings into a best practice publication?

WG7 Session at 14:00

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Thanks!

S. López-Aparicio[1], M. Guevara[2]

1 NILU – The Climate and Environmental Research Institute

2 Barcelona Supercomputing Center

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Open discussion about next steps

- Is the exercise useful to identify opportunities for improvement (EU wide inventory – Local inventory)?
- What's the best way to resolve the questions/doubts that arise from the intercomparison exercises?
- Should we organize a 3rd workshop e.g., "thematic" (sector-based?)
- How can we put together / translate the findings into a best practice publication?

Translate the findings (example)

emep

European Environment Agency

Category	Title
General guidance	Spatial mapping of emissions
Version	Guidebook 2023

Lead authors
Jeroen Kuenen

Contributing authors (including to earlier versions of this chapter)
John Van Aardenne, Justin Goodwin, Katarina Mareckova, Martin Adams, Paul Ruyssenaars, Robert Wankmüller, Stephen Pye, Katie King, Nele Veldeman, Wim van der Maas, Susana Lopez-Aparicio, Marlene Schmidt Plejdrup, Ilaria d'Elia, Stefan Feigenspan, Marc Guevara Vilardell

EMEP/EEA air pollutant emission inventory guidebook 2023

- General Tiered guidance for spatial disaggregation of emissions by sector
- Collect feedback from FAIRMODE community and provide it to TFEIP

A.7 Spatial mapping of emissions 2023 Annex

Published 02 Oct 2023 —

Publications > EMEP/EEA air pollutant emission ... > Part A: general guidance chapters > A.7 Spatial mapping of ...

A.7 Spatial mapping of emissions 2023 Annex.xlsx — Microsoft Excel (Office 2010), 36 KB (37610 bytes)

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Open discussion about next steps

- Is the exercise useful to identify opportunities for improvement (EU wide inventory – Local inventory)?
- What's the best way to resolve the questions/doubts that arise from the intercomparison exercises?
- Should we organize a 3rd workshop e.g., "thematic" (sector-based?)
- How can we put together / translate the findings into a best practice publication?

FAIRMODE WG7

WG7 – Compilation of high-resolution emissions

Feedback to the draft technical guidance document on emissions

M. Guevara[1] , S. López-Aparicio[2]

[1] Barcelona Supercomputing Center

[2] NILU – The Climate and Environmental Research Institute

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Main references to emissions in the document

Section 1.2 (Target audience)

"Although very crucial input for any air quality modelling system, ***this guidance document has not a focus on emission or meteorology modelling****. However, (⋯)* ***specific attention will be paid to the specific requirements air quality modelling systems pose to these input data sets****"*

Section 1.4 (General features of models in support of the AAQD)

"Both ***the temporal and spatial resolution of the emission*** *data sets should (⋯)* ***serve the requirements of the modelling system****."*

"In the context of ***air quality planning*** *(⋯)* ***Emission data derived in a top-down approach****, for example via downscaling techniques,* ***cannot be used to evaluate the impact of individual or a set of measures"***

"Detailed guidance *on how to compile a* ***suitable emission inventory*** *can be found in the* ***EMEP/EEA air pollutant emission inventory guidebook*** *(EMEP/EEA, 2023)"*

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Main references to emissions in the document

Section 1.4 (General features of models in support of the AAQD)

Table 1-1 - Appropriate spatial modelling resolution per pollutant and context. Context refers to traffic (T), industrial (I), intensive domestic heating (D), urban (U) and rural (R) environments. The motivation column further details the spatial gradients that should be captured.

Pollutant	Context	Appropriate spatial resolution	Motivation
PM_{10} / $PM_{2.5}$	T / I / D	< 100 m	Capture street canyons and domestic and industrial hotspots
	U	100 m - 1 km	Capture urban patterns in absence of major hotspots
	R	1 km - 5 km	Capture regional patterns in absence of major hotspots
NO_2	T / I / D	< 100 m	Capture street canyons and domestic and industrial hotspots
	U	100 m – 1km	Capture urban patterns in absence of major hotspots
	R	1 km - 5 km	Capture regional patterns in absence of major hotspots

"The appropriate spatial resolution refers to the model grid size and spatial detail of the underlying emission inventory"

Main references to emissions in the document

Section 5.2.4 (Emission inventories and scenarios)

*"(…) it is essential that the **emissions of the relevant sectors are derived in a so-called bottom-up way**. This means that they are **derived from underlying activity data and appropriate emission factors**."*

Section 5.3.4 (Natural sources and winter-sanding/-salting of roads)

***"**If reduced **winter-sanding and winter salting emissions** is part of the air quality plan then these emissions **should be quantified. (…)** The reader is referred to (…) **previous guidance documents concerning methodologies for calculating** (…) **winter road sanding and salting** (SEC2011)."*

Section 6.4.1 (Challenges in operational AQ forecast)

***"Emission data** are a **key source** contributing to the **uncertainties** (…) in particular for **air quality forecasting**. The **uncertainties** (…) arise from various factors, including **incomplete or outdated inventories, inaccuracies in emission estimation methodologies, and the dynamic nature of emission sources**. The recent LIFE REMY project provides some recommendations for reducing emission uncertainty"*

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Main feedback received on emissions

12 comments received:

- **4 comments** related to “the exclusion of top-down inventories in the context of air quality planning“
  - Gridded inventories based on bottom-up activity data for all activity sectors are hardly available
  - Some “bottom-up” inventories are built based on administrative areas and then spatial proxies are applied, which is also a kind of downscaling
  - For some sectors, there is no real alternative to top-down and they do give meaningful results
  - Quantification of the impact of measures is typically done outside of the gridded inventory

Main feedback received on emissions

12 comments received:

- **5 comments** related to "the use of the EMEP/EEA guidebook for the compilation of emissions"
  - the focus of the EMEP/EEA guidebook lies on annual national emission reporting, not on providing emission data for modelling
  - the EMEP/EEA guidebook provides a chapter with (limited) information on how to spatially distribute emissions, and little is said regarding vertical and temporal distribution and speciation
  - Several times the use of a "detailed/robust/complete/bottom-up" emission inventory is mentioned, without suggestions on what to do except using EMEP/EEA guidebook
  - "Please add a chapter on emissions. There should be at least some information about fit-for-purpose of emissions to be used in specific modelling applications"
  - Some of the pollutants of emerging concern included in the revised AAQD are not or only partially covered by the EMEP/EEA guidebook

Main feedback received on emissions

12 comments received:

- **Other comments:**
  - “Emission data often do not meet the required spatial and temporal resolution and quality for model applications as demanded in the guideline (e.g. hourly emission data for domestic heating at a 25 m resolution)“
  - “Some information on quality checks for emission data is needed“
  - “Reference to port sources from shipping in Table 1.1“

Proposal to overcome points raised by reviewers

Related to “the use of the EMEP/EEA guidebook for the compilation of emissions“ → **agreed by the drafting team**

- Add an extra section in each application chapter (i.e., assessment, source apportionment, planning, forecasting) related to specific requirements for emission

  → Balance between not developing a guidance on emission modelling but at the same time respecting the request from the FAIRMODE community

Related to “the exclusion of top-down inventories in the context of air quality planning“ → **still to be discussed. Some suggestions from reviewers...**

- Distinguish between urban and regional/national air quality planning applications: For the first one fine-scale modelling e.g., the traffic emissions of each street should indeed be conducted, but for the former downscaling emission inventories can be accepted.
- Use another terminology instead of “top-down inventories» to avoid confussion

Discussion

What are the most relevant emission requirements/recommendations that the technical guidance document should emphasize for each application?

- Assessment
- Source apportionment
- Planning
- Forecasting

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Example for forecasting

The Copernicus Atmosphere Monitoring Service (CAMS) regional air quality production system has the mandate to use official reported emissions as input

→ 2 year time lag + approx. 1 year to process and prepare CTM ready-to-use emission files (i.e., the TNO CAMS-REG emission inventory; Kuenen et al., 2022)

Two recent updates to reduce this limitation:

- Use of t-1 year emissions (extrapolation of official reported emissions to more recent year) → **reduce the gap between emission inventory year and running year**

- Use of dynamic emissions in the residential/commercial combustion sector (taking into account effect of outdoor temperature) → **improve the representation of daily fluctuation in emissions**

Example for planning

Scientific basis to support the design of the Spanish O_3 abatement plan

Emission projections official reporting template

		NOx emissions (kt) Reporting Years		NMVOC emissions (kt) Reporting Years	
NFR Code	Longname	2019	2030	2019	2030
1A1a	Energy industries (Combustion in power plants)	39.58	25.13	8.38	11.46
			-37%		**+36%**

Additional information considered for the modelling

Fuel	Projected change
Coal	-100%
Natural gas	+10%
Biomass	**+77% (*)**
Oil	-50%
Waste	-64%

Emission changes should be implemented at the finest source level possible to account for the heterogeneity of their impact across space

(*) Location of future biomass power plants unknown

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Discussion

What are the most relevant emission needs/recommendations that the technical guidance document should emphasize for each application?

- Assessment
- Source apportionment
- Planning
- Forecasting

Geneal feedback, e.g.:

“the exclusion of top-down inventories in the context of air quality planning“, rethink definition of top-down?

Spatial representative for Domestic heating at a resolution of 25m, main obstacle are emissions , is it feasible?

European Commission

Thanks!

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