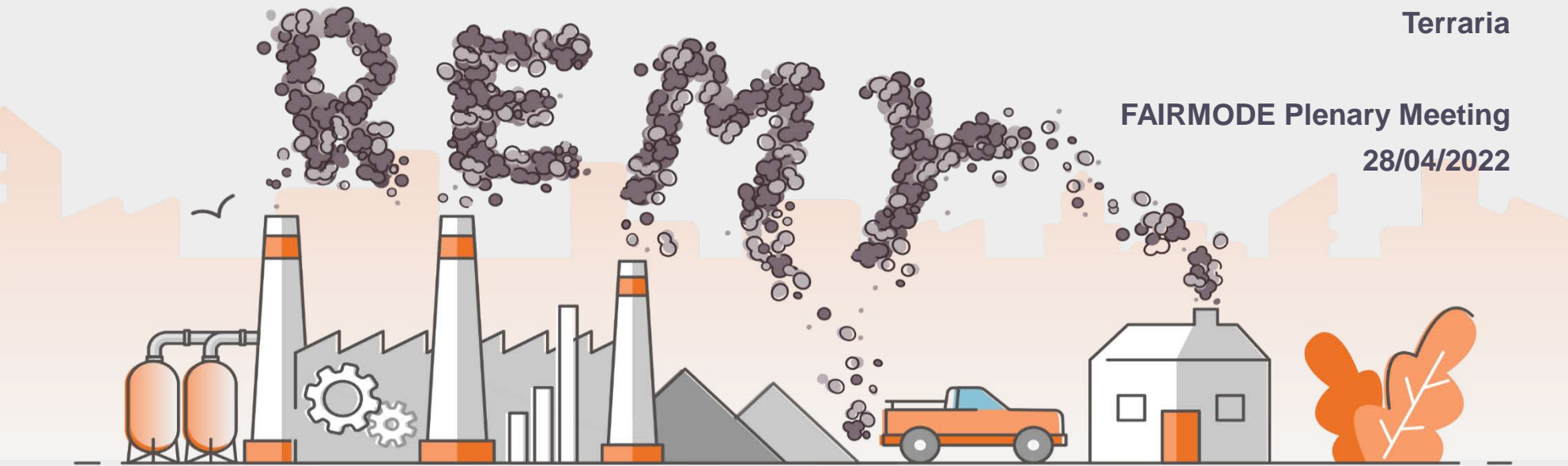


LIFE-REMY (Reducing Emission Modelling uncertainty)

Overview and current status

Guido Pirovano – RSE
AMAT
CSIC- IDAEA
IOS-PIB
Terraria

FAIRMODE Plenary Meeting
28/04/2022



General Project Objectives

1. Contribute to **a better development, implementation and evaluation of numerical modelling for air quality assessment, air quality plans and source apportionment in the framework of the Ambient Air Quality Directives.**
2. Reduction of **(some of the) most relevant model uncertainties related to emission processing**, thus aiming at providing operational guidelines concerning integration and **harmonization of urban/regional emission inventory, emission estimates for most uncertain sources, modelling** of emission and formation processes involving primary and secondary organic particulate generation, multiscale modelling in urban and peri-urban areas including both CTM and local modelling also including spatially varied resuspension.
3. Provide updated, comprehensive and harmonized **recommendations to support modelling groups in reducing modelling uncertainties.**

Methods and Expected Results

- **Quantitative** results on the impact of the **emission uncertainty on air quality estimates in three areas: Po-Valley/Milan, Southern Poland/Krakow, Catalonia/Barcelona** (regions and urban areas + local domains) and **two case studies: BASELINE** (yearly) and the **COVID19**.
- Evaluation of the sensitivity to the uncertainty in emission inventories **before (diagnostic phase)** and **after** the application of **project recommendations (sensitivity phase)**.
- **Operational recommendations to support the emission processing** (for the selected topics).

Key Topics

Project Topics

- **Road dust resuspension** (experimental activity, literature review, receptor modelling).
- **Residential heating systems** (experimental activity, literature review, receptor modelling).
- **Open burning of solid waste** (experimental activity, literature review).
- **Emission inventories integration and spatialization** (modelling activity, sw development).
- **Organic matter** (literature review, minor experimental activity).

“Local” Project Topics

- **Waste burning for residential heating** (literature review).
- **Wood oven** (experimental activity, literature review, receptor modelling).

Optional Topics (to be further discussed)

- **Agriculture** (literature review).
- **Emission temporal modulation** (literature review for Agriculture, Biomass burning, industry).

Regional and urban Study Areas



SPAIN

CTM: CAMx (RSE)
RM: Barcelona (CSIC)
UM: UTAQ Barcelona (TA)

ITALY

CTM: CAMx (RSE)
RM: Milan (CSIC)
UM: UTAQ Milan (TA/AMAT)
IAM: RIAT+ (TA)

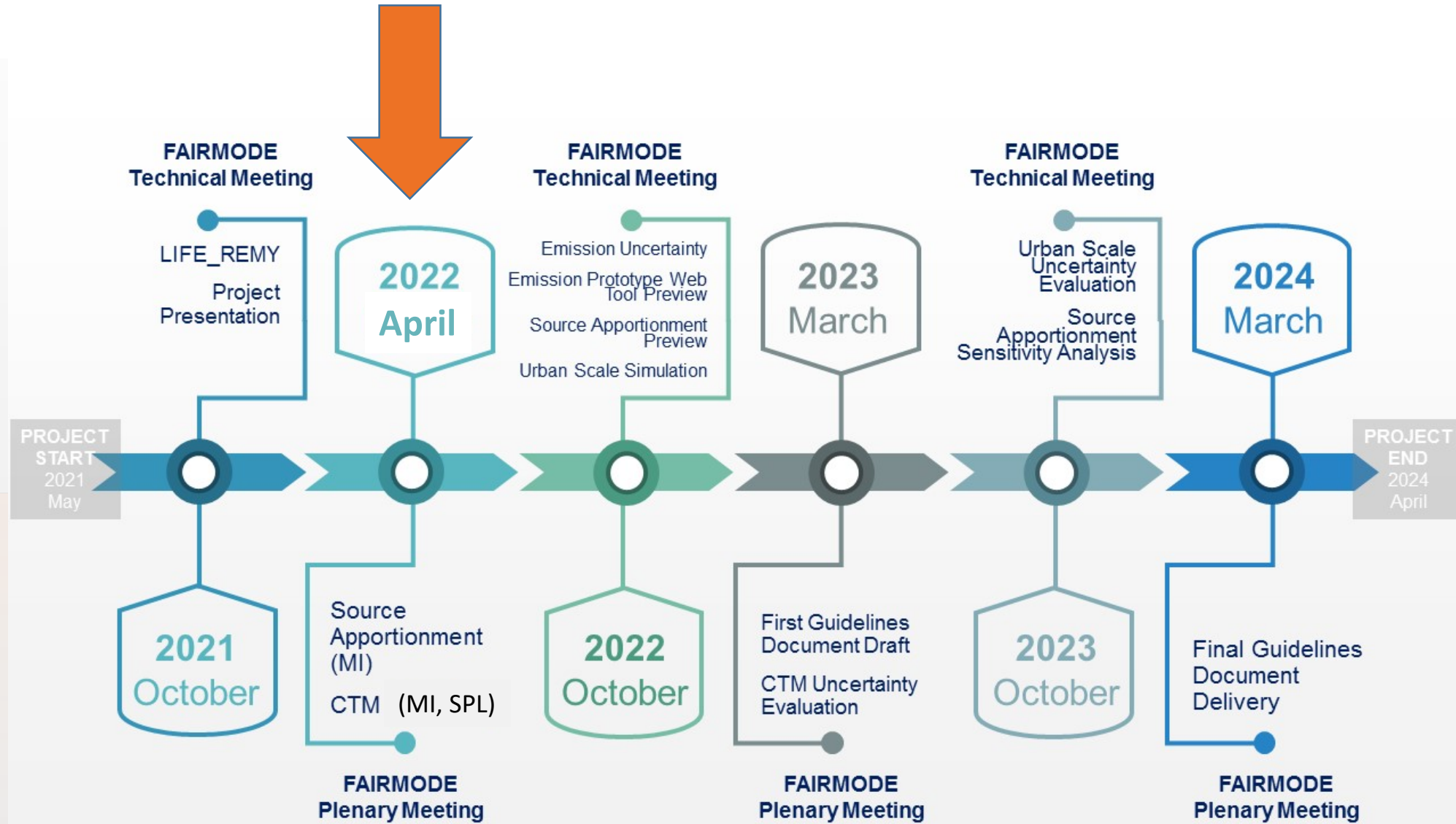
POLAND

CTM: GEM-AQ (IEP-NRI)
RM: Krakow (CSIC/IEP-NRI)
UM: GEM-AQ Krakow (IEP-NRI)

CTM: Chemical Transport Model
RM: Receptor Model
UM: Urban Model
IAM: Integrated Assessment Model

Stakeholders: FAIRMODE

Stakeholders' involvement on the whole REMY project is fundamental and in particular in the sharing of the results on the uncertainty and of the recommendations to be included in the guideline.



A1 - Identification of the uncertainties related to emission factors for selected activities

Completed activities

1) Domestic heating systems: the in-field environmental measurement campaign on the emissions of heating plants in Milan under normal operating conditions was completed. More than 50 heating plants have been investigated with portable analyzers, in some cases in parallel with a UNI Accredited laboratory

2) Thanks to the support of IOS-PIB, the Report "Emission factors used in Poland for the estimations of emissions from small combustion appliances" was produced.



A1 - Identification of the uncertainties related to emission factors for selected activities

Scheduled activities for summer and fall 2022

1) Road dust resuspension: experimental measurements (conclusion of activities: September 2022)

2) Domestic heating systems: elaboration and summary of the obtained results (June 2022)

3) Open waste burning: operational tests with drones (conclusion of activities: November 2022)

4) Wood ovens: laboratory measurements (conclusion of activities: end of June or July 2022)

5) NMVOC emissions and speciation: in support to OM modelling (conclusion of activities: September 2022)



A1 – A4 Organic matter modelling

Ongoing activities

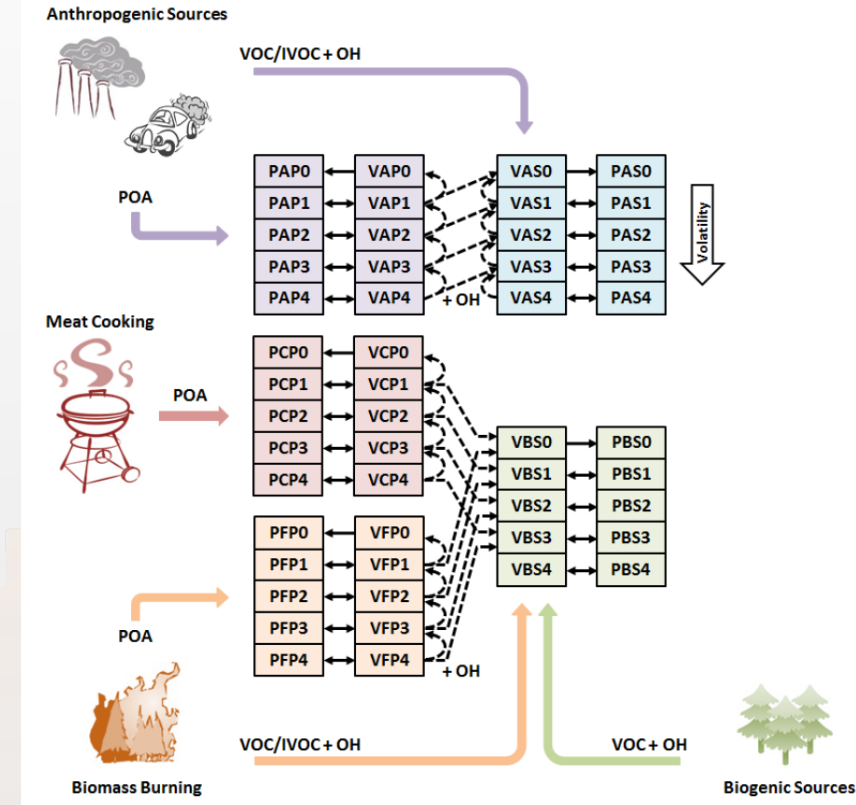
1) Literature review: e.g. CAMS, EMEP, NWR-RWC project, SIMPLE model,... (conclusion of activities: **June 2022**)

2) OM Modelling activities:

2.0 semi-volatile equilibrium scheme with standard POA emissions and no IVOC (**completed**)

2.1 semi-volatile equilibrium scheme with revised POA and IVOC emissions (December 2022)

2.2 VBS scheme with revised SVOC and IVOC emissions (August 2023)



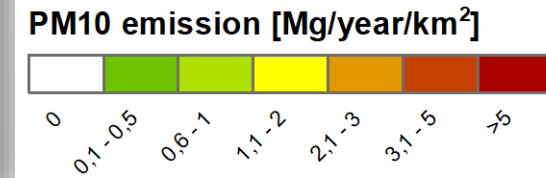
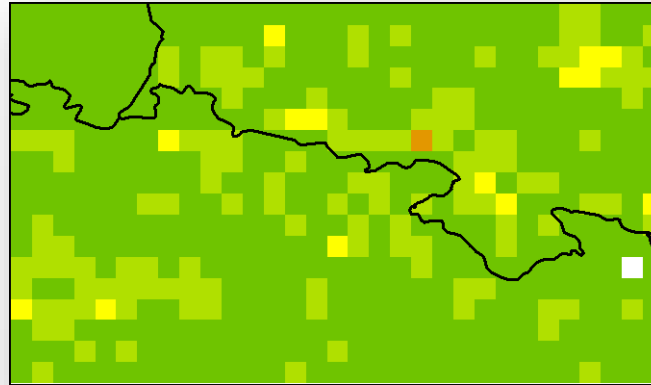
(In cooperation with RAMBOLL)

A2 - Web-tool for emission integration

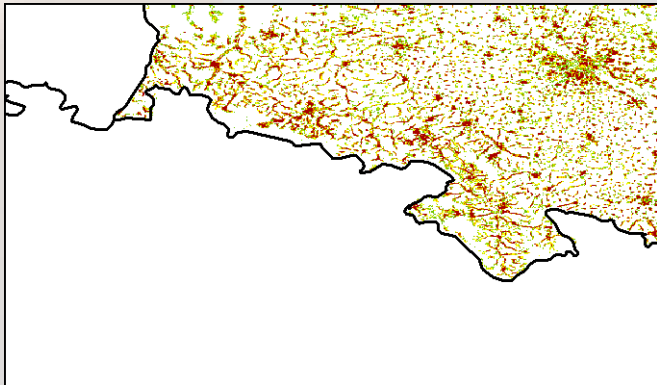
Scheme of Off-line methodology based on PM10 emission – GNFR C

- Emission gridding usually requires some skills: using the web tool might be a good solution for the stakeholders;
- Harmonizing local and regional inventories may improve modelling results

EMEP emissions – 2019 (resolution 0.1x0.1)

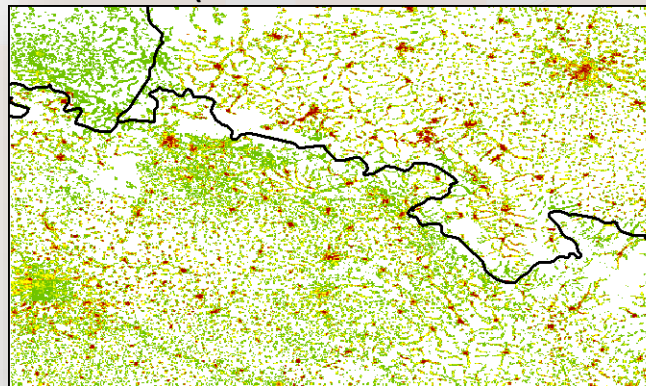


bottom up inventory PL- 2019
(resolution 0.005x0.005)

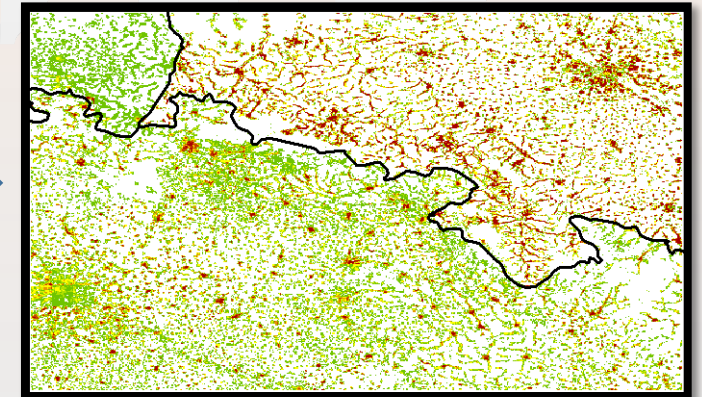


Relocation with proxy of
OpenStreetMap and Corine
LandCover

(resolution 0.005x0.005)

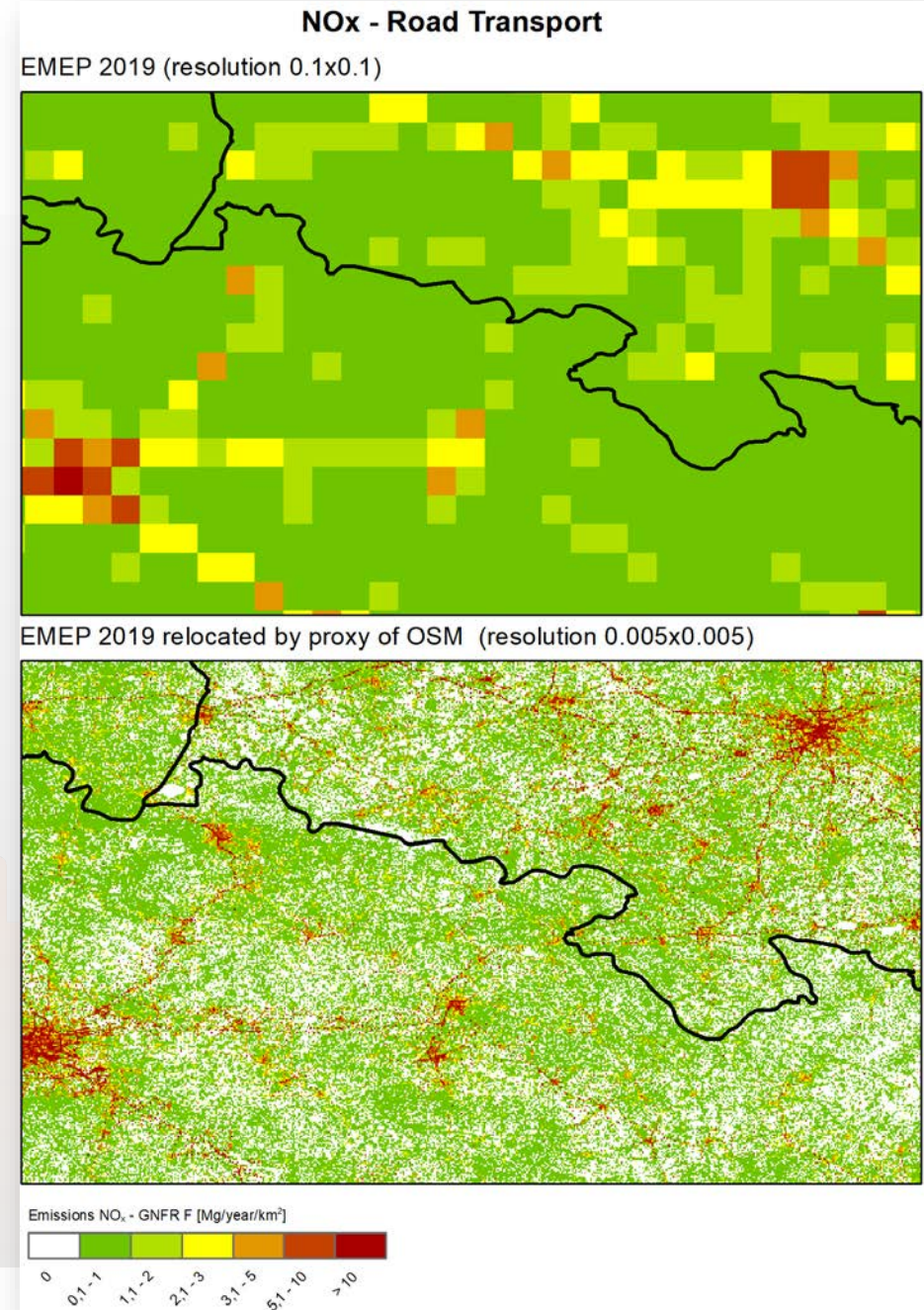


**bottom up inventory PL merged
with relocated EMEP inventory**
(resolution 0.005x0.005)



A2 - Off-line methodology

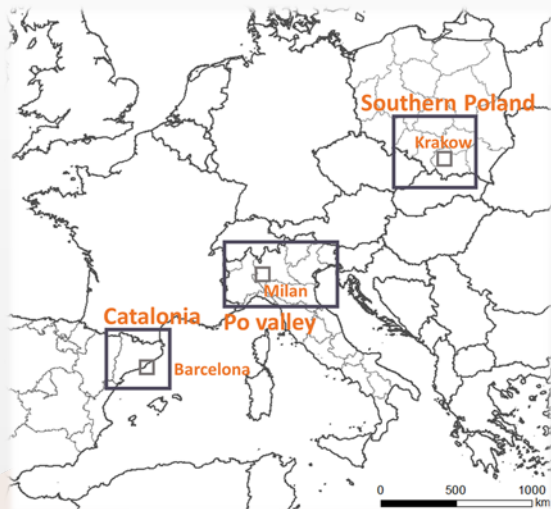
- **Key features:**
 - Relocation is based on data proxy (OSM, Corine LandCover, Urban Atlas, Large Combustion Plants);
 - Total emissions load per original low-resolution grid will be preserved
 - No factors changing emission loads will be applied
- **Ongoing work:**
 - Methodology is developed and tested on other GNFR sectors (e.g. GNFR F on the right side);
 - Methodology will be tested in three european regions: southern Poland, Po valley, Catalonia region;
 - Design of web tool has started



A3 - RECEPTOR MODELLING (RM) AS A SUPPORT FOR UNCERTAINTY ANALYSIS AND REDUCTION

Goal: compare the source apportionment (SA) information obtained by source-oriented dispersion modelling (SMs) and receptor modelling (RMs) and integrate them as much as possible in order to increase the level of knowledge reducing the existing uncertainties of the SMs approach.

LIFE-REMY'S REGIONAL AND URBAN AREAS



LIFE-REMY'S DATASETS 2017 - 2020

STUDY AREA PM ₁₀ – PM _{2.5}	METALS; IONS	OC/EC	Others
SPAIN Barcelona (urban)  Montseny (rural)	24h	1h	
ITALY Pascal (urban)   Schivenoglia(rural)	24h	24h	Levoglucosan: 7days
POLAND Skavina (urban)  Rokitno (rural)	7 days	24h	PAHs: 7days

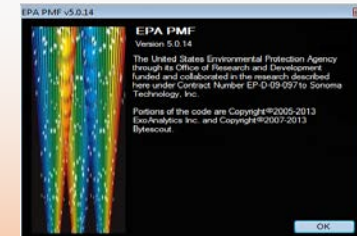
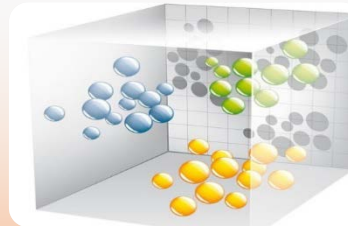
METHODOLOGY: RECEPTOR MODELLING



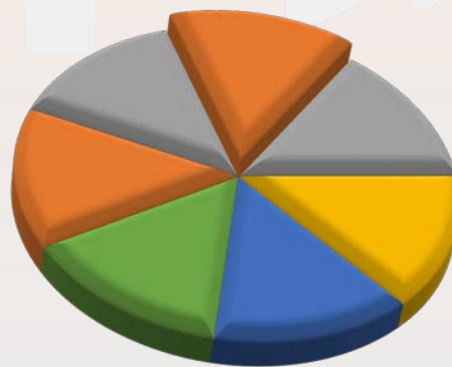
AMBIENT AIR PM SAMPLING



OFF-LINE CHEMICAL CHARACTERIZATION



POSITIVE MATRIX FACTORIZATION SOURCE APPOINTMENT

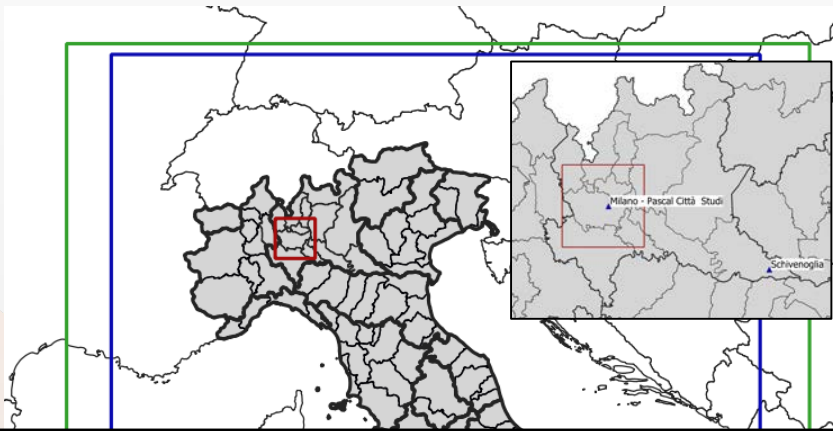


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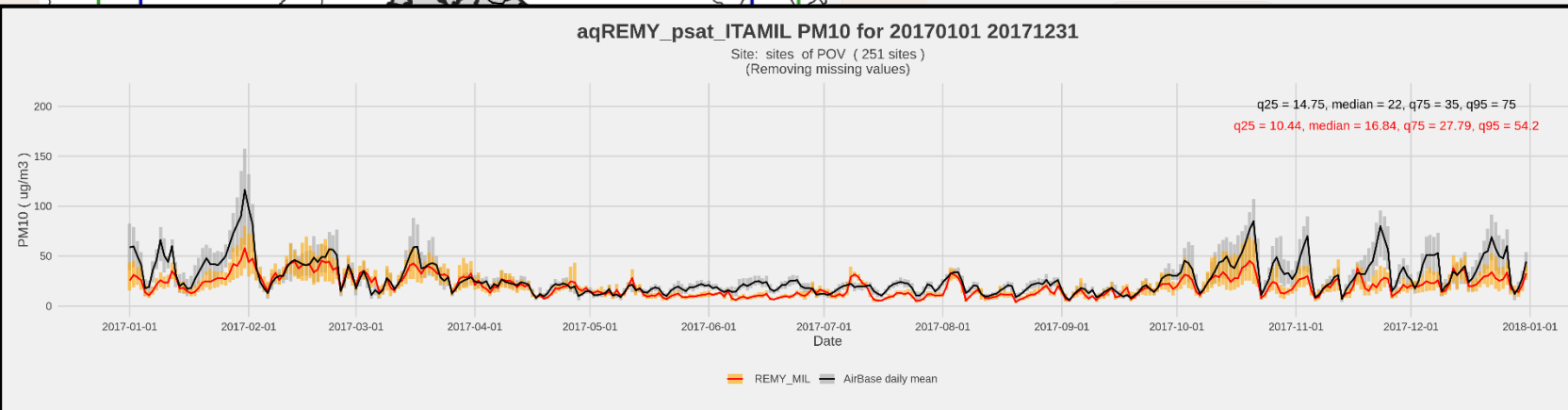
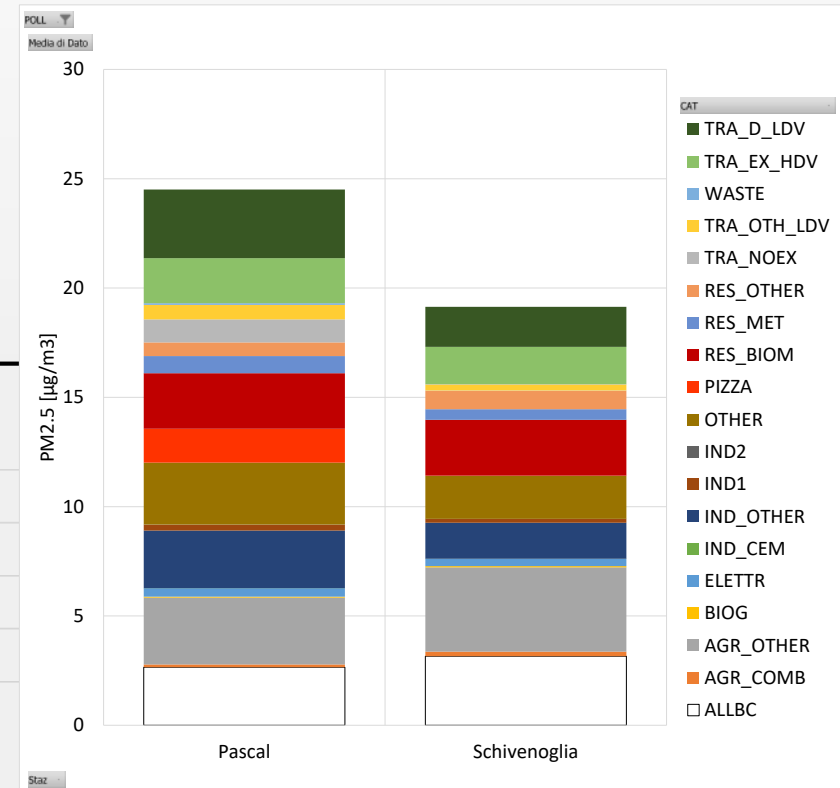
A4 - Sensitivity analysis in regional modelling on both BASELINE and COVID19 scenario

Po Valley Case study - Obtained results:

- Po Valley baseline scenario (2017)
- PM composition validation in two monitoring stations (OA, EC, NH4, NO3, SO4)
- Po Valley source apportionment (CAMX-PSAT): 18 emission categories defined



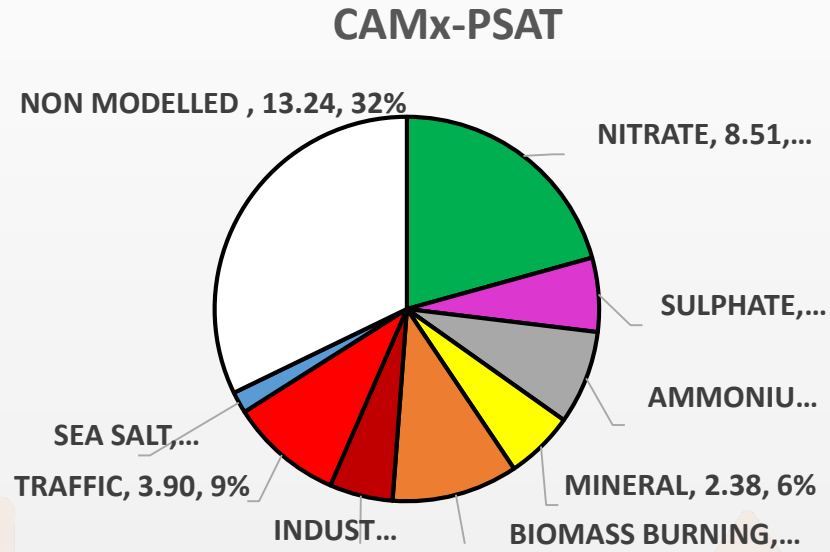
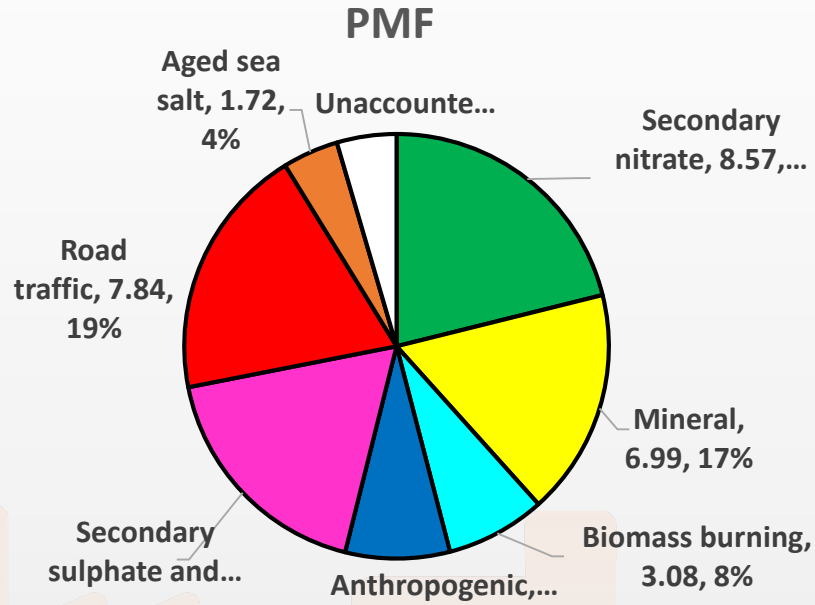
Example of CAMX PM2.5 source apportionment results extracted for two monitoring stations in Lombardy region



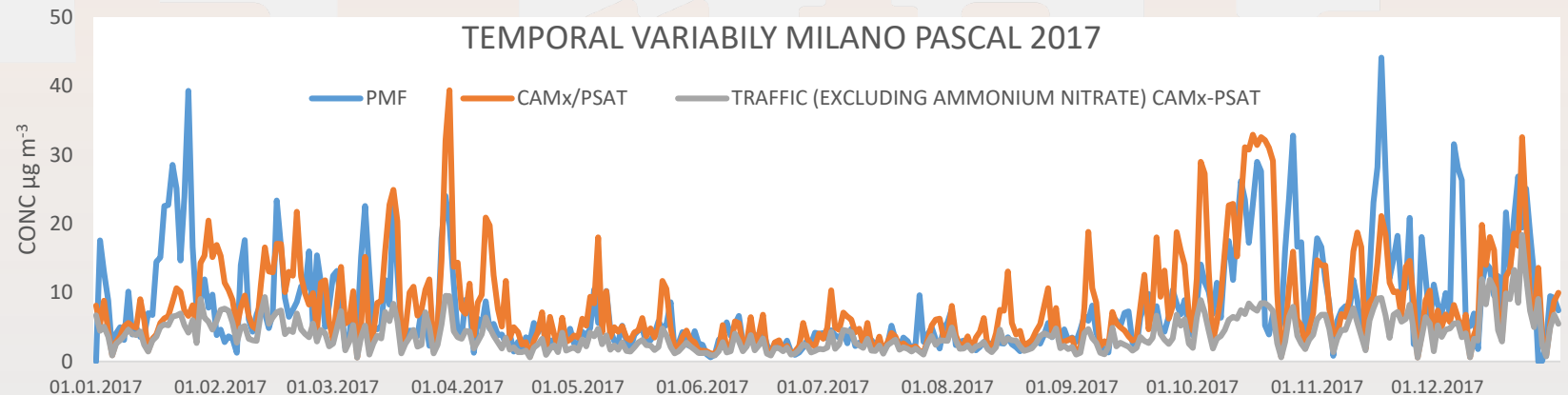
A3-A4 COMPARISON CAMx-PSAT AND PMF (POV 2017)

CAMxPSAT CATEGORIES	PMF SOURCES	
Road Transport		
1TRA_EX_HDV	TRAFFIC	SECONDARY NITRATE
2TRA_D_LDV	TRAFFIC	SECONDARY NITRATE
3TRA_OTH_LDV	TRAFFIC	SECONDARY NITRATE
4TRA_NOEX	TRAFFIC	
Residential/commercial heating		
5RES_BIOM	BIOMASS BURNING	SECONDARY NITRATE
6PIZZA	BIOMASS BURNING	SECONDARY NITRATE
7RES_MET	SECONDARY NITRATE	
8RES_OTHER	SECONDARY NITRATE	SECONDARY SULPHATE AND ORGANICS
Agriculture		
9AGR_COMB	BIOMASS BURNING	SECONDARY NITRATE
10AGR_OTHER	MINERAL	SECONDARY NITRATE SECONDARY SULPHATE AND ORGANICS
Industry		
11IND1	ANTHROPOGENIC	SECONDARY NITRATE SECONDARY SULPHATE AND ORGANICS
12IND2	ANTHROPOGENIC	SECONDARY NITRATE SECONDARY SULPHATE AND ORGANICS
13IND_CEM	MINERAL	
14IND_OTHER	ANTHROPOGENIC	SECONDARY NITRATE SECONDARY SULPHATE AND ORGANICS
Other sectors		
15WASTE	BIOMASS BURNING	SECONDARY NITRATE SECONDARY SULPHATE AND ORGANICS
16ELETTR	SECONDARY NITRATE	
17BIOG	SECONDARY SULPHATE AND ORGANICS	AGED SEA SALT
18OTHER	BIOMASS BURNING	SECONDARY NITRATE

A3-A4 PM10 COMPARISON BETWEEN PMF AND CAMx-PSAT IN URBAN BACKGROUND MILANO PASCAL 2017



EX. TRAFFIC SOURCE COMPARISON
Daily mean concentrations



A3-A4 Next steps... to June 2022

PO VALLEY - MILAN

- **BASELINE 2017**
 - Extend PMF vs PSAT comparison to PM2.5
- **COVID19**
 - Po Valley BAU and LOCK scenario (road transport) for the lockdown period (2020 Feb 24-Apr 30)
 - CAMx validation (also including OA, EC, NH4, NO3, SO4)
 - Po Valley source apportionment (CAMX-PSAT) for road transport, residential heating, natural emission
 - PMF vs PSAT comparison for PM10 and PM2.5

CATALONIA – BARCELONA

- **BASELINE 2017**
 - Catalonia baseline scenario (2017)
 - Catalonia source apportionment (CAMX-PSAT)
 - PMF vs PSAT comparison in Catalonia urban and rural sites for 2017

SOUTHERN POLAND – KRAKOW

- **BASELINE 2019** (last "pre-Covid" year)
 - Base run and two sensitivity scenarios at the regional scale - ongoing (to be completed before Barcelona meeting)
- **COVID19**
 - Emission scenario during first Covid19 lockdown developed
 - Simulations for the period March-May 2020 prepared to launch

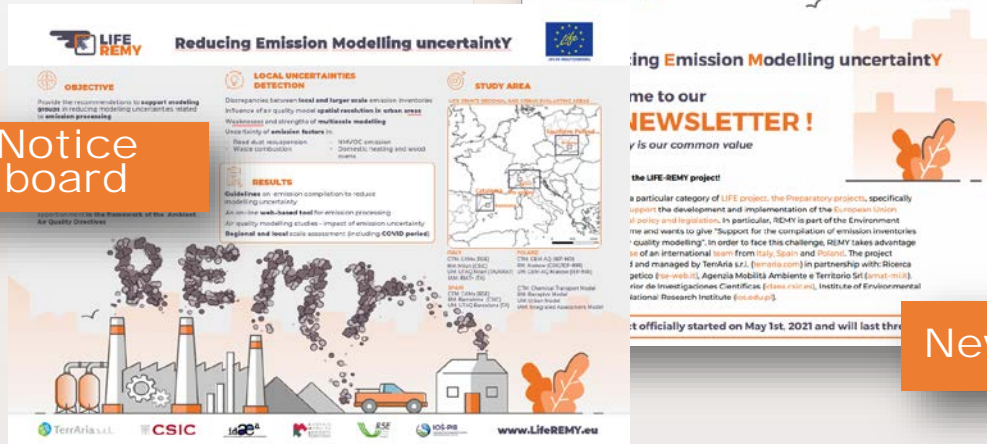
B1 - Communication and dissemination

Activities covered till now

- LIFE-REMY webpage
- Notice boards
- Twitter, Facebook and LinkedIn profiles
- E-mail newsletter
- Project visual identification

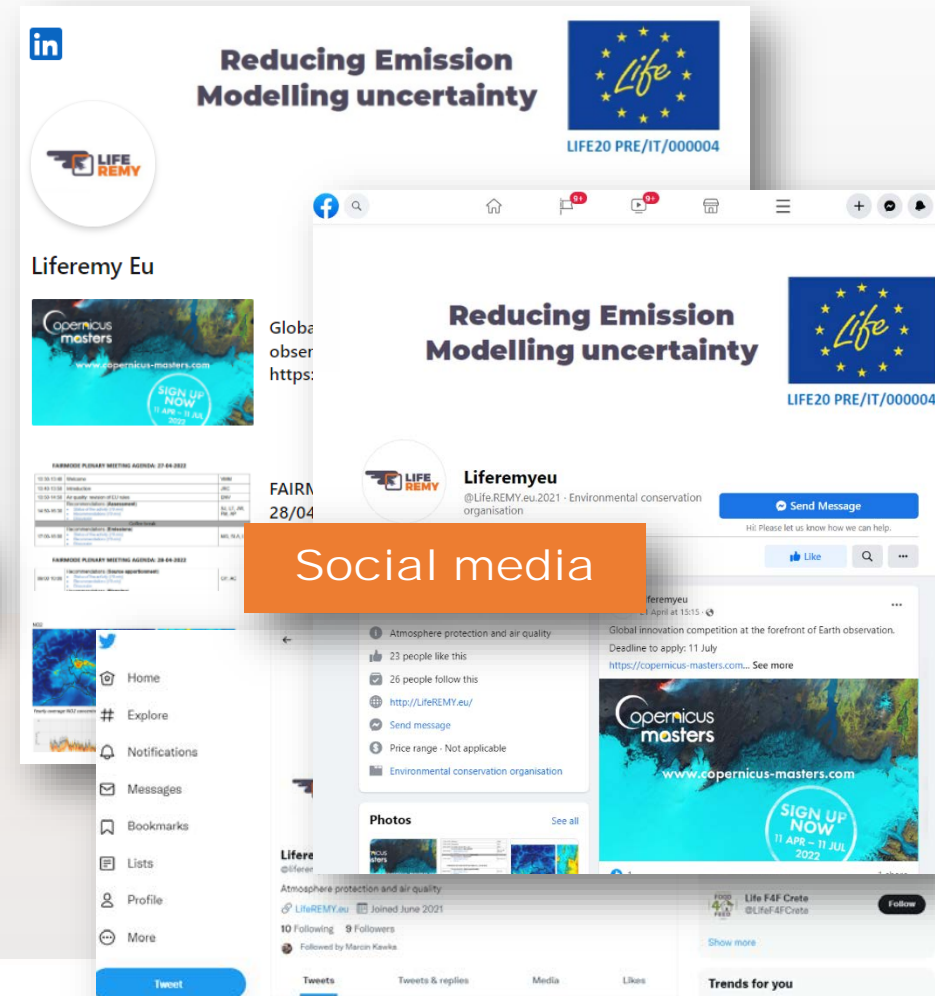


Webpage



Notice board

Newsletter



Social media



www.LifeREMY.eu

LIFE REMY Expert meeting

14th June 2022 (Hybrid event: face-to-face and online)

Institute of Environmental Assessment and Water Research (IDÆA) - Spanish National Research Council (CSIC) C/Jordi Girona 18-26 Barcelona, Spain

Rationale

LIFE REMY assesses how Emission uncertainty impact air quality modelling and offers a set of modelling/observed case studies to support the implementation/assessment of guidelines to reduce air quality modelling uncertainties.

LIFE REMY invites experts and stakeholders that can offer interesting outcomes from their ongoing activities and also suggest new issues that, to a limited extent, could be assessed by REMY.

LIFE REMY Expert meeting

Preliminary agenda

Session A: Preliminary results of LIFE REMY project

9:00 – 10:00

- *LIFE REMY LIFE project: an overarching introduction*
 - *Literature and experimental emission factors uncertainty*
 - *Top-down bottom approach: uncertainty source in emission inventory*
 - *Po Valley and Milan case study*
 - *Catalonia and Barcelona case study*
 - *Southern Poland and Krakow case study*
- 10:00 – 10:15 Questions time

Session B: Learning from other ongoing activities/projects

10:15 – 11:15

- *Residential waste burning emission factors (A. Gelencsér – University of Pannonia / J. Stijn VITO) TBC*
- *One talk on condensables and organic matter modelling (TBC)*
- *Emission temporal disaggregation and effect on modelling (M. Guevara BSC)*
- *RI-URBANS project (X. Querol - CSIC)*

Session C: Stakeholders discussion (Italy, Spain, Poland, FAIRMODE, TFEI)

11:30 – 13:00 (Chair P. Thunis – JRC TBC and G. Maffei)

- *Round table on REMY project topics: some issues to be addressed are put on the table and provided before to Stakeholder. Open debate.*
- *Conclusions (30 min: P. Thunis TBC and G. Maffei)*

Close session

THANK YOU!

Guido Pirovano
guido.pirovano@rse-web.it



Project & Partners

Coordinating Beneficiary



Associated Beneficiaries



Duration: 36 months 1/5/2021 – 30/4/2024

Financial contribution: Total cost: 1'538'414 €
with EU contribution: 923'048 € (60%)

Project type: LIFE preparatory project

*REMY meets the specific need under the Environment sub-programme: “**Support for the compilation of emission inventories to improve air quality modelling**”*

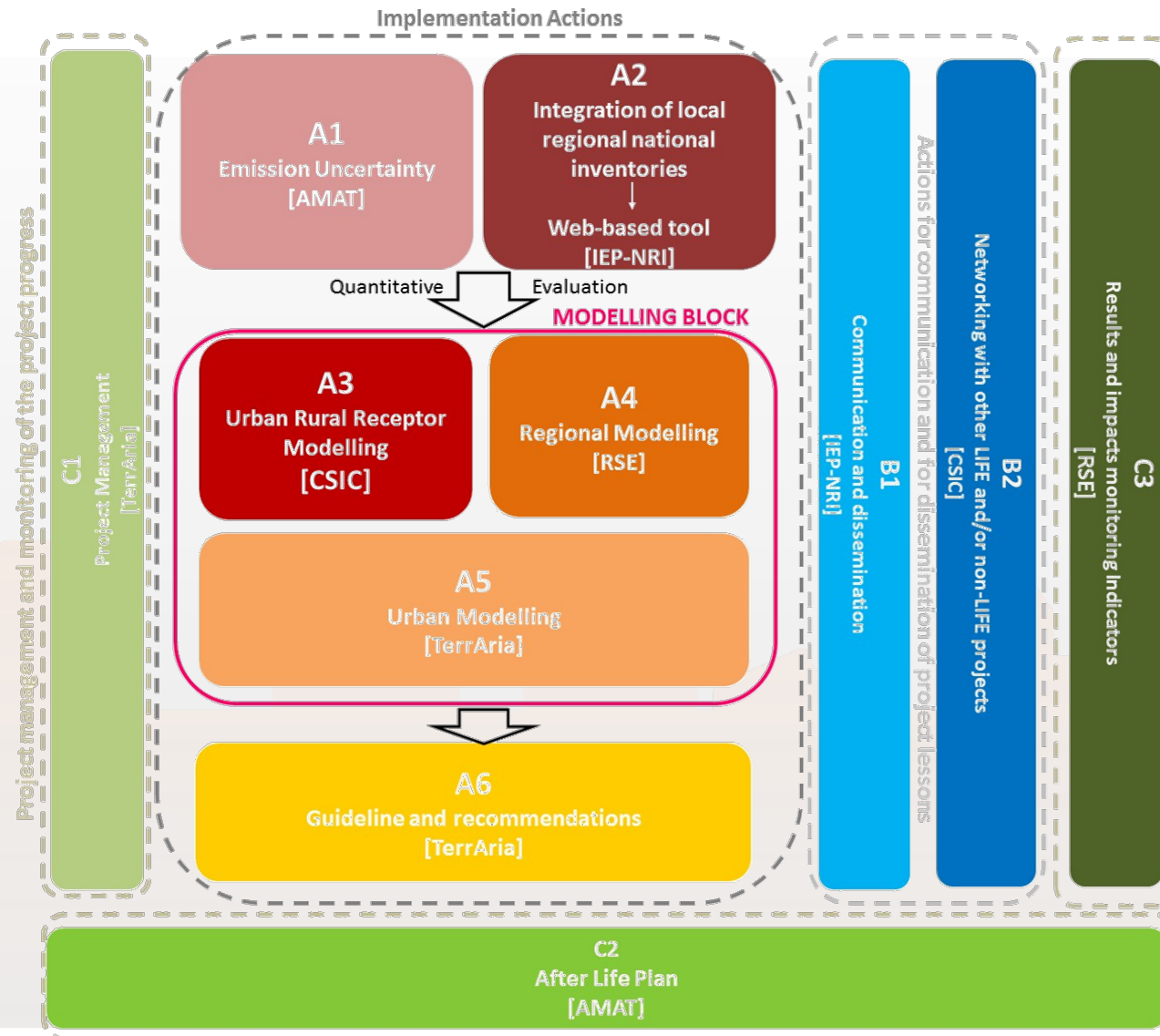
Methods and Expected Results

- **Quantitative** results on the impact of the **emission uncertainty on air quality estimates in three areas: Po-Valley/Milan, Southern Poland/Krakow, Catalonia/Barcelona** (regions and urban areas + local domains) and **two case studies: BASELINE** (yearly) and the **COVID19**.
- Evaluation of the sensitivity to the uncertainty in emission inventories **before (diagnostic phase)** and **after** the application of **project recommendations (sensitivity phase)**.
- **Operational recommendations to support the emission processing** (for the selected topics).

Modelling activities involved:

- **Source apportionment modelling to better constraint key emission sources** (both receptor and source-oriented modelling).
- Integration of modelling results at **different spatial scales** through different tools.
- **Integrated assessment modelling** to see the effect of the emission uncertainty on the air quality plan through the definition of optimal measures through **RIAT+** tool **in Po Valley**.
- Evaluation of the **model performance**, mainly based on **FAIRMODE indicators**.

Project Action's Structure



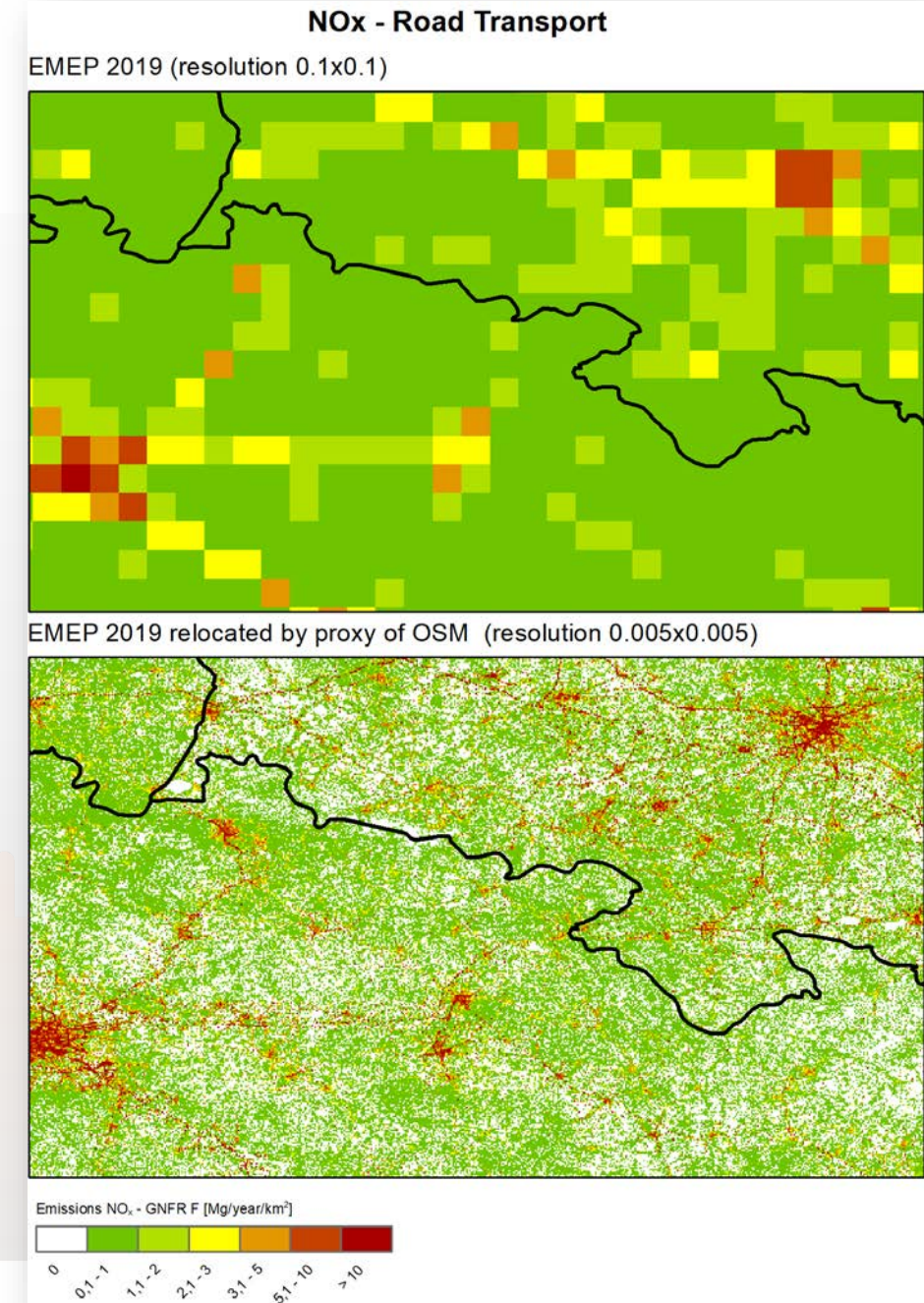
A1 - Identification of the uncertainties related to emission factors for selected activities

Pollutants / indicators investigated

- 1) Road dust resuspension: solid PM
- 2) Domestic heating systems: NO₂/NO_x, solid PM (only gas oil and biomass), TOC (only biomass)
- 3) Open burning of waste: activity indicators
- 4) Wood ovens: Solid and condensable PM, NO_x, TOC, levoglucosan
- 5) NMVOC emissions and speciation: definition in progress

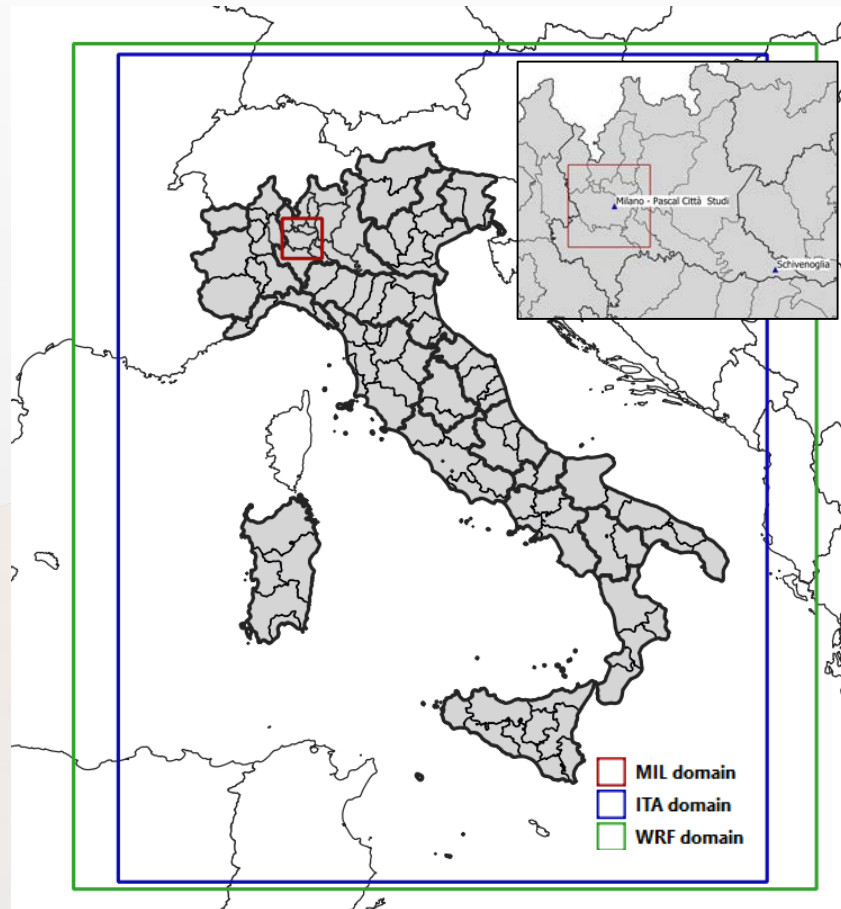
A2 - Off-line methodology

- Additional information
 1. There are other relocation tools but this usually requires some skills while using the web tool might be a good solution for the stakeholders
 2. Regional data are available "everywhere" while detailed only in some specific regions - the tool may help to get better (refined) results for the regions where high resolution bottom up inventory is not available. Also, it may improve (we hope at least) the results for high res simulations in terms of the inflow if local high resolution emission must be coupled with regional (e.g. transboundary studies or urban/regional)
 3. Relocated EMEP will be available for the regions without BU inventories
 4. Proxies are fixed and based mainly on the OSM (openstreetmap) and Corine Land Cover. We haven't assume to let user for any modification.
 5. At the moment all test are made with EMEP inventory. In the future we will test the availability of other inventories, but first we will focus on a prototype
 5. We believe it would be possible to use other TD inventories but for sure not at this stage
 6. The high resolution grid must be a nested grid of the low resolution one. We consider to define a list of resolutions (for example: 0,005; 0,01; 0,025; 0,05) that will be available. However we haven't made the decision about available list of resolutions yet.



A4 - Sensitivity analysis in regional modelling on both BASELINE and COVID19 scenario

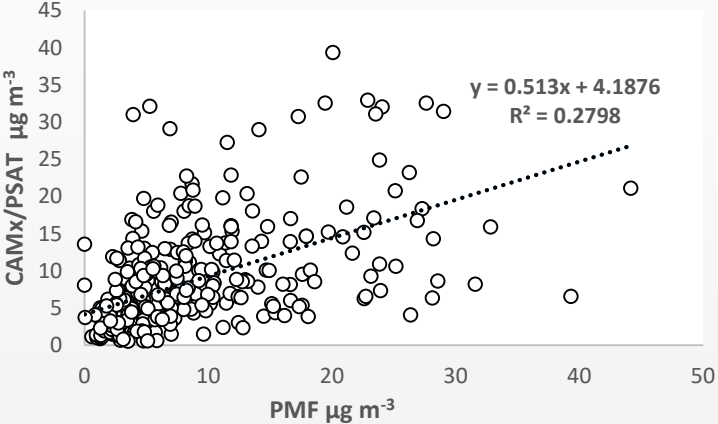
Modelling setup



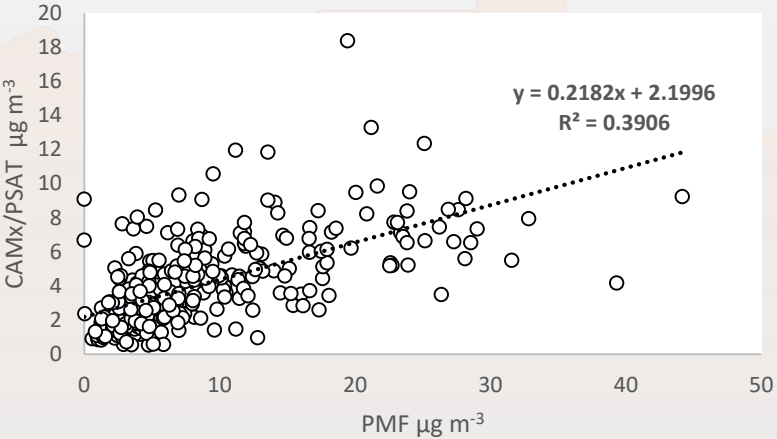
Year	2017
Meteorological input	WRF 2017
BC	CHIMERE
Chemical mech	CB06r5
Inorg Aerosols	ISORROPIA/RADM
OA mech	SOAP2.2
Domains	2 nested domains: ITA 4x4 km MIL 1x1 km
Emission	Regional+National+E MEP
Biogenic	MEGAN

EX. TRAFFIC SOURCE COMPARISON IN MILANO PASCAL URBAN SITE 2017

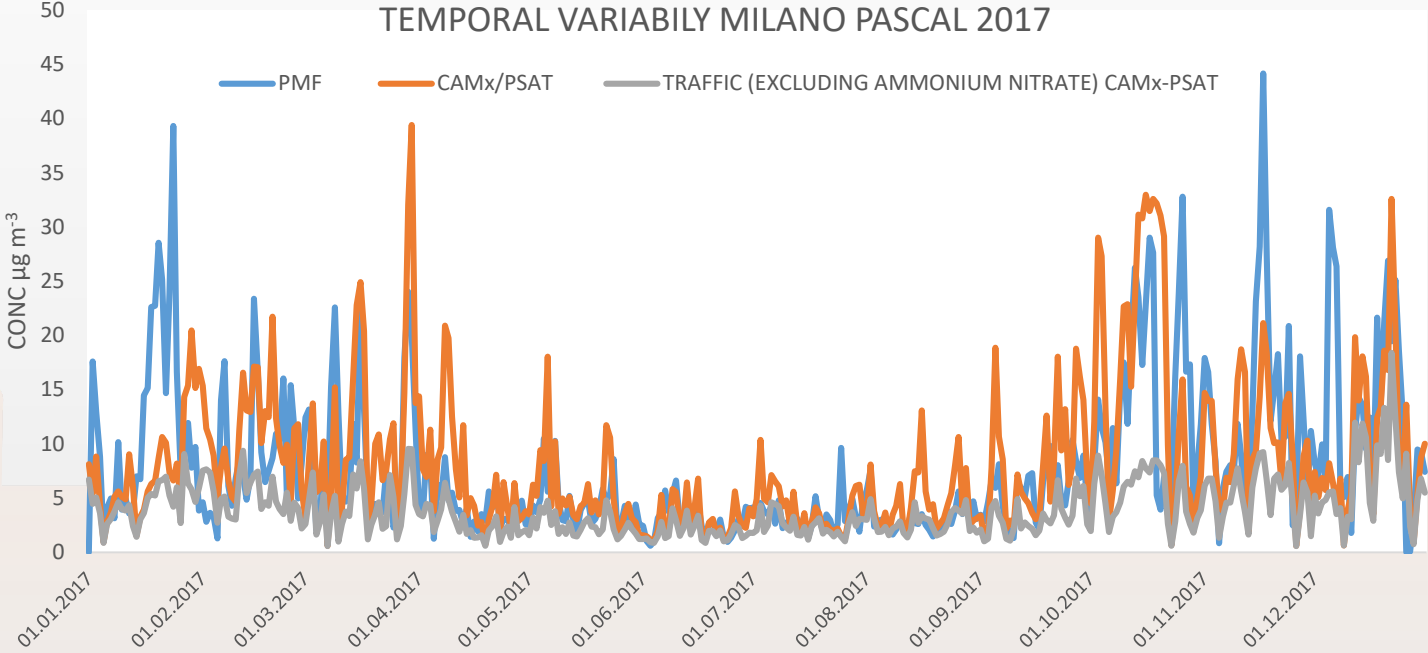
TRAFFIC



TRAFFIC (excluding NO_3NH_4)



TEMPORAL VARIABILITY MILANO PASCAL 2017



Plan of sensitivity analysis 2022/2023 – Po Valley

project phase	case study	deadline	POV + MIL	RWC	non RWC	Pizzeria	Industry	Exhaust	Non-Exhaust	OffRoad	Agri	Solvents
SENSITIVITY - AQ ASSESSMENT	BASELINE	JAN 2023	Resuspension S7	1	1	1	1	1	1*	1*	1	1
SENSITIVITY - AQ ASSESSMENT	BASELINE	JAN 2023	Res Heating S2	1*	1*	1	1	1	1	1	1	1
SENSITIVITY - AQ ASSESSMENT	BASELINE	JAN 2023	A2	1E	1E	1E	1E	1E	1E	1E	1E	1E
SENSITIVITY - AQ ASSESSMENT	BASELINE	JAN 2023	A2	1E*	1E*	1E*	1E*	1E*	1E*	1E*	1E*	1E*
SENSITIVITY - AQ ASSESSMENT	BASELINE	JAN 2023	IVOC (SOAP)	1+IV-S	1	1+IV-S	1	1	1+IV-S	1+IV-S	1	1+IV-S
SENSITIVITY - AQ ASSESSMENT	BASELINE	JAN 2023	IVOC + SVOC (SOAP)	1+IVSV-S	1	1+IVSV-S	1	1	1+IVSV-S	1+IVSV-S	1	1+IVSV-S
SENSITIVITY - AQ ASSESSMENT	BASELINE	JAN 2023	BASE (After mandatory updts)	1*+ IVSV-S	1*	1*+ IVSV-S	1	1	1*+ IVSV-S	1*+ IVSV-S	1	1*+ IVSV-S
SENSITIVITY - AQ ASSESS. + SA	BASELINE	OCT 2023	BASE + PSAT(After all updts)	1*+ IVSV-S	1*	1*+ IVSV-S	1	1*	1*+ IVSV-S	1*+ IVSV-S	1*	1*+ IVSV-S
SENSITIVITY - SA & planning	BASELINE	OCT 2023	BF50% (After all updts)	0.5*	1*	1*+ IVSV-S	1	1*	1*+ IVSV-S	1*+ IVSV-S	1*	1*+ IVSV-S
SENSITIVITY - SA & planning	BASELINE	OCT 2023	BF50% (After all updts)	1*+ IVSV-S	0.5*	1*+ IVSV-S	1	1*	1*+ IVSV-S	1*+ IVSV-S	1*	1*+ IVSV-S
SENSITIVITY - AQ ASSESSMENT	BASELINE	OCT 2023	IVOC (VBS)	1+IV-V	1	1+IV-V	1	1	1+IV-V	1+IV-V	1	1+IV-V
SENSITIVITY - AQ ASSESSMENT	BASELINE	OCT 2023	IVOC + SVOC (VBS)	1+IVSV-V	1	1+IVSV-V	1	1	1+IVSV-V	1+IVSV-V	1	1+IVSV-V
SENSITIVITY - AQ ASSESS. + SA	COVID	OCT 2023	BASE (After all updts)	1*+ IVSV-S	1*	1*+ IVSV-S	1	1*	1*+ IVSV-S	1*+ IVSV-S	1*	1*+ IVSV-S
SENSITIVITY - SA & planning	COVID	OCT 2023	LOCK (After all updts)	1*+ IVSV-S	1*	1*+ IVSV-S	1	LOCK	LOCK	1*+ IVSV-S	1*	1*+ IVSV-S

1* updated emissions (after A1+A3 results)
1E emissions based only on EMEP 2017 "large scale"
1E* emissions based only on EMEP 2017 after A2

1+IV-S additional IVOC emissions for SOAP
1+IVSV-S additional IVOC and SVOC emissions for SOAP
1+IV-VS additional IVOC emissions for VBS
1+IVSV-V additional IVOC and SVOC emissions for VBS