APCG
NATIONAL OBSERVATORY OF ATHENS
ATMOSPHERIC PHYSICS AND CHEMISTRY GROUP

SMURBS
ERA-PLANET

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An innovative method to arrive at high resolution emissions for city scale air quality modeling

Kakouri, A. [1,3], Ramacher, M. [2], Athanasopoulou, E. [1], Grivas, G. [1], Speyer, O. [1], Karl, M. [2], Kontos, T. [3] & Gerasopoulos, E. [1]

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Introduction

Cities:

- High amounts of **emissions** and **wastes**
- Numerous **environmental pressures**

Air pollution:

- One of the world's largest environmental **health threat**
- Stands in between **emissions** and **population exposure**
- Impacts on health:
  - Reduces **life span**
  - Exacerbates numerous **illnesses**
  - Causes **premature deaths** and **diseases**

EEA, 2019

Motivation

The problem:

AQ standards being exceeded in urban areas

The need:

Air quality issues & Concentration gradients in

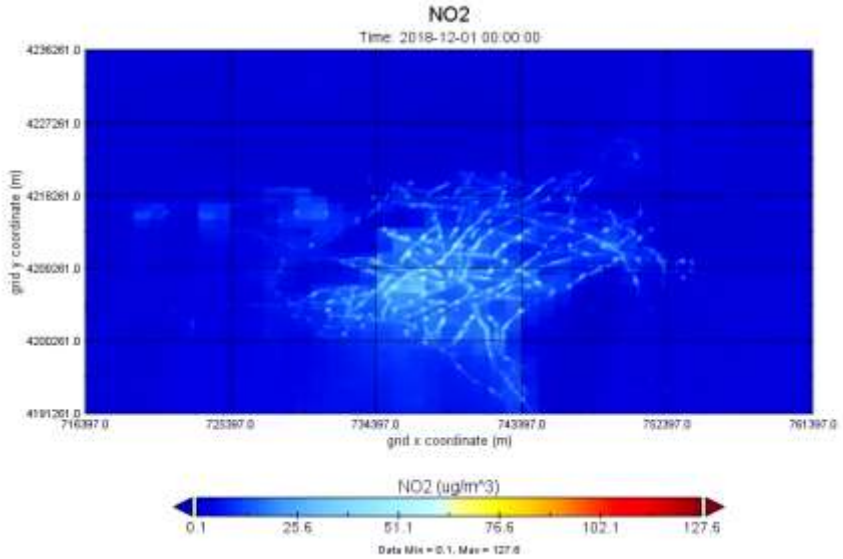
- Proximity to emitters and large agglomerations
  - finer scales and more advanced modeling

Sokhi et al., 2021, ACPD

Essential components:

- Emission inventories Gulia et al, 2015
  - substantial input for 3D CTM systems

Matthias et al, 2018



Bottom-up:

- Accurate & Resource intensive
- Area- & Year-specific

Top-down:

Coarse resolution

Proxy-dependent

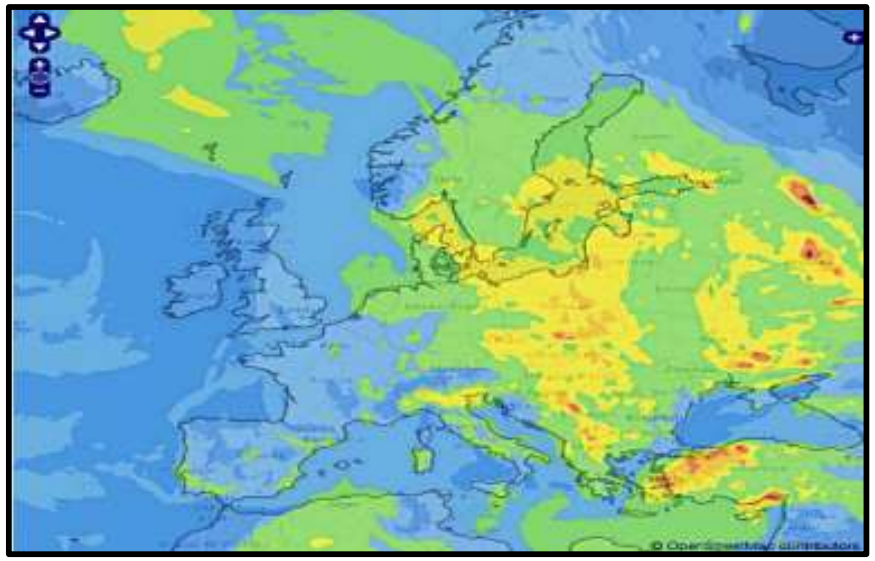
UrbEm:

- High spatial resolution
- Hybrid and modular approach
- Homogeneity between different cities

The UrbEm approach for emissions downscaling

Copernicus Atmosphere Monitoring Service (CAMS):

- consistent
- quality-controlled information



CAMS-REG-AP regional emission inventory (TNO, Copernicus):

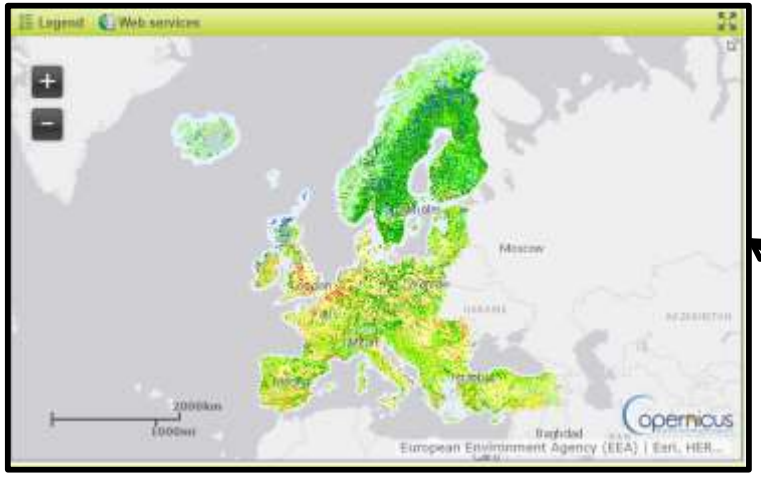
- Spatial resolution: 0.1 x 0.05 deg
- Emissions: CH4, CO, NH3, NMVOC, NOX, PM10, PM2.5 & SO2
- Anthropogenic activity

Ramacher, M, Kakouri, A., Speyer, O., Feldner, J., Karl, M., Timmermans, R., Denier van der Gon, H., Kuenen, J., Gerasopoulos, E. & Athanasopoulou. A.,

The UrbEm hybrid method to derive high-resolution emissions for city scale air quality modeling.

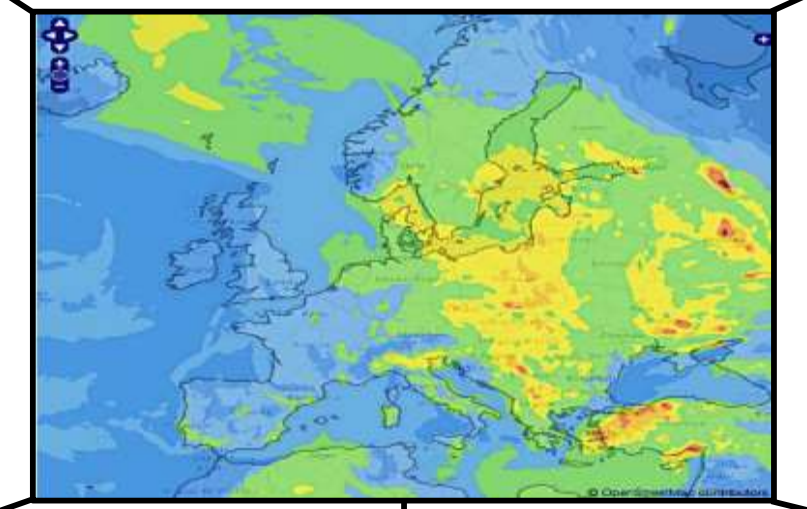
Atmosphere, 2021 (under review)

The utilized spatial datasets



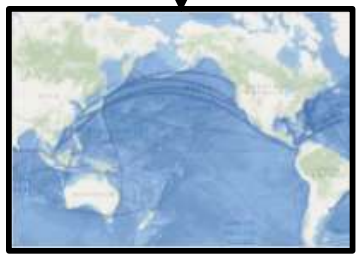
CORINE Land Cover (CLC 2018)

CAMS-REG-AP v3.1 (2016)



E-PRTR facilities (2017)

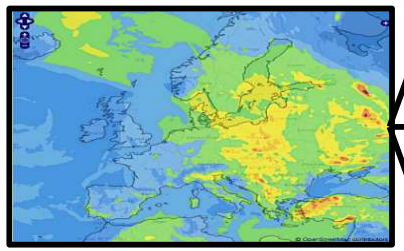
Global Human Settlement Layer (GHSL 2015)



Global Shipping Routes (2013)

Open Street Map

The downscaling method: Overview



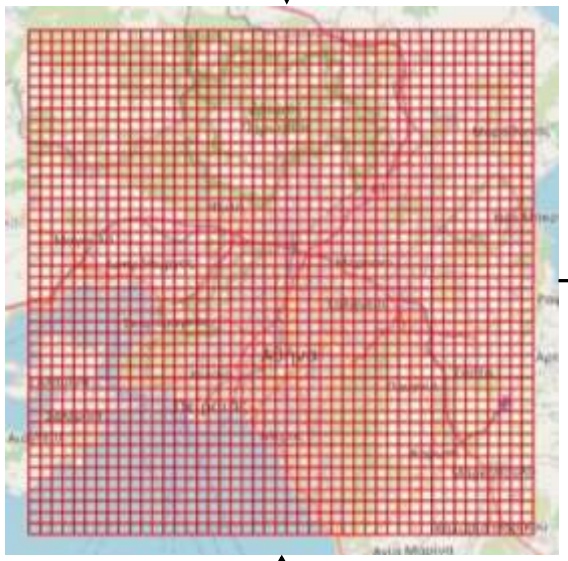
Points

Lines

Areas

CAMS Emissions

High Resolution Area Emissions (UrbEm)



Line Emissions (UrbEm)

Proxies

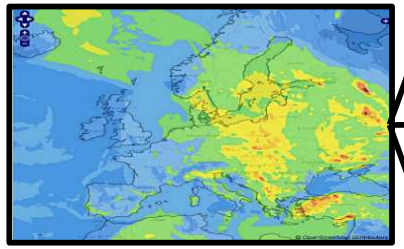
Areas Down-scaling Process

UrbEm cell val to lines

Weighting factor based on:
- Road type
- Total road length

Ramacher et al. 2021 (Atmosphere, under review)

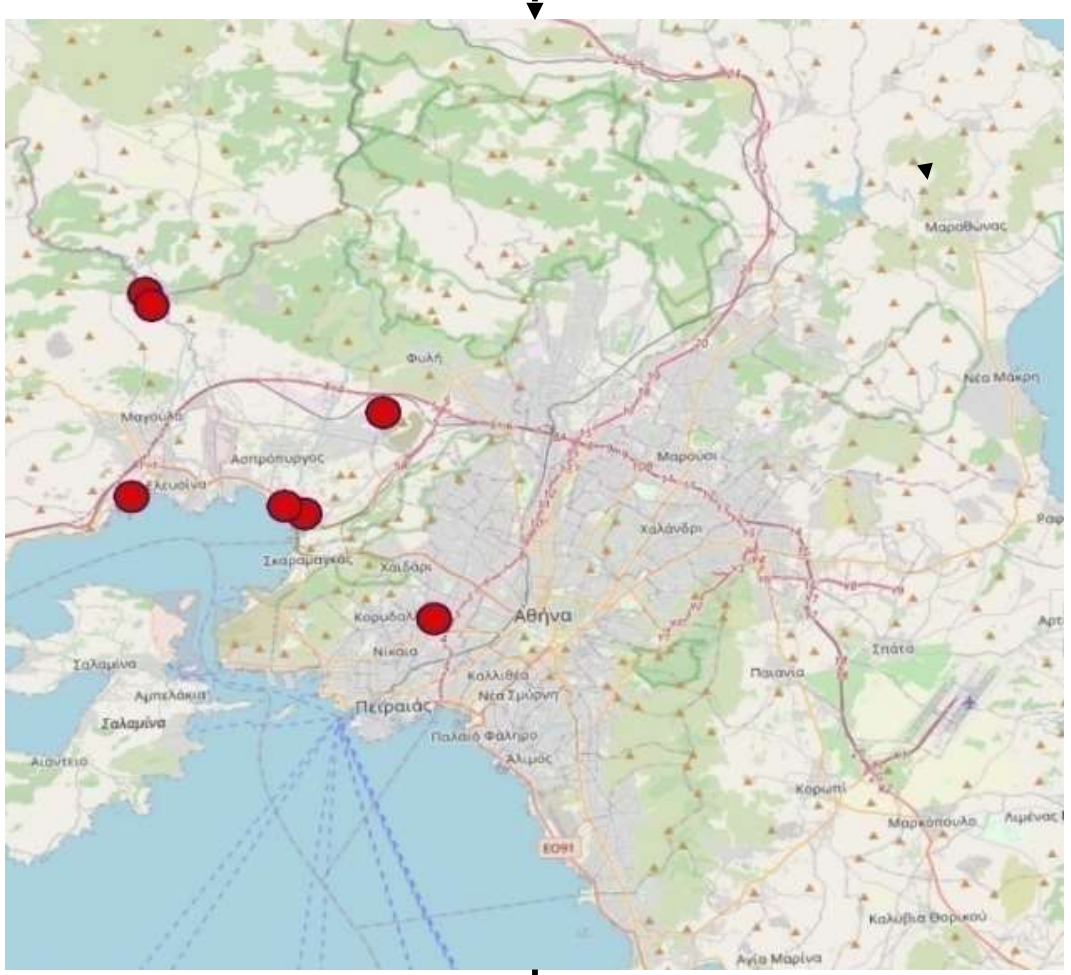
The downscaling method: Industry



Points

Lines

Areas



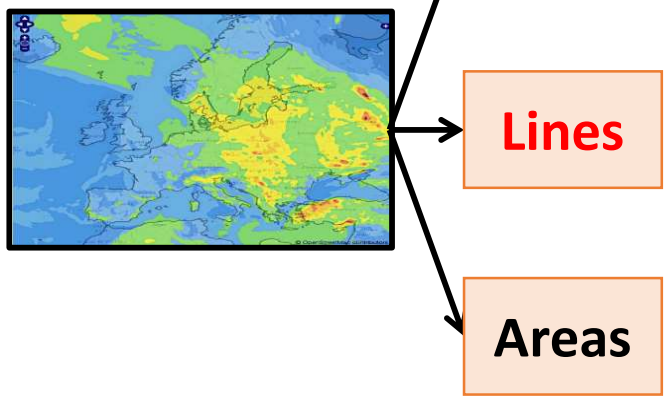
- **Industrial units**:
  - **total emission** values
  - **spatial location** &
  - **sectoral information**.

E-PRTR industrial units

Point Emissions (UrbEm)

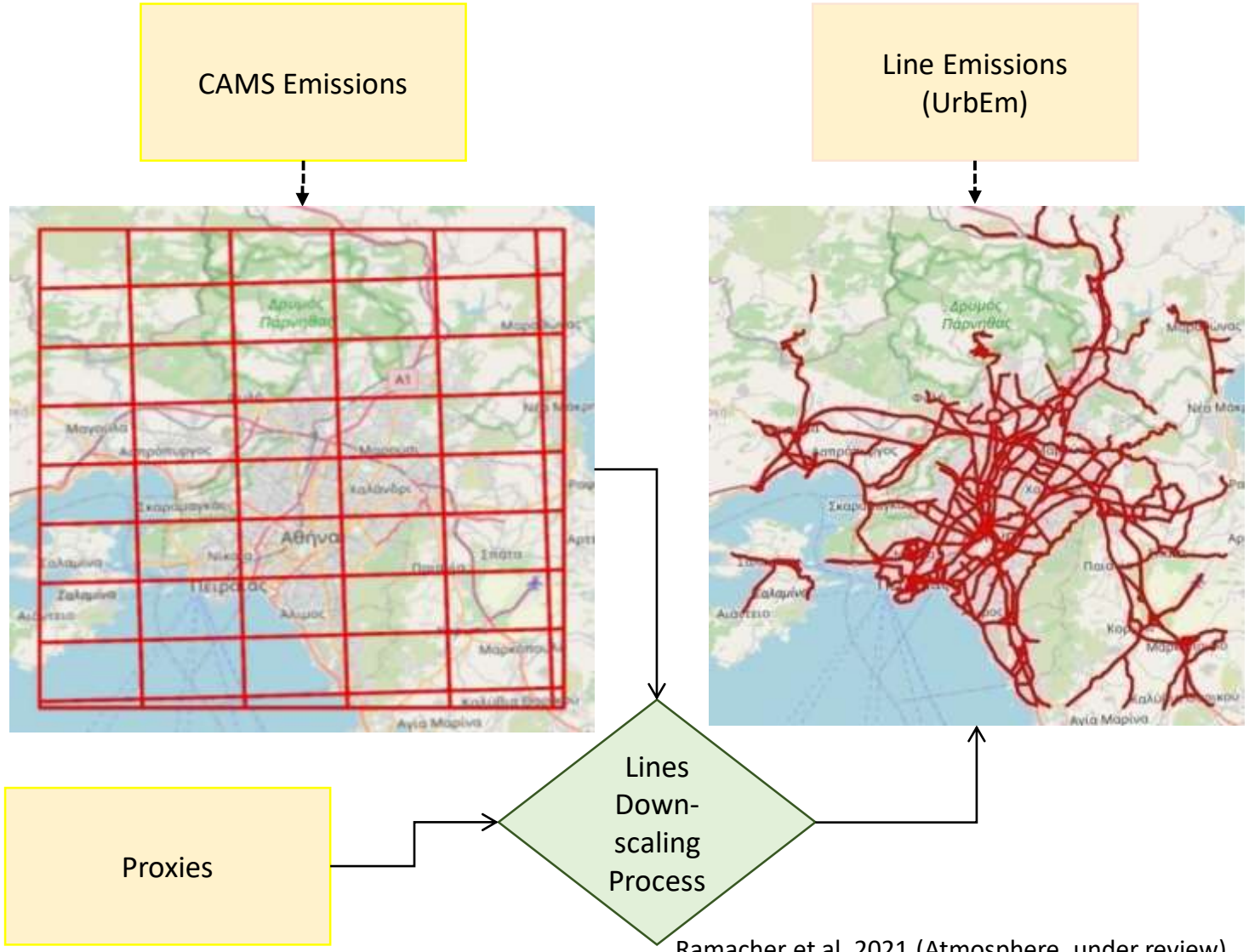
Ramacher et al. 2021 (Atmosphere, under review)

The downscaling method: Vehicles



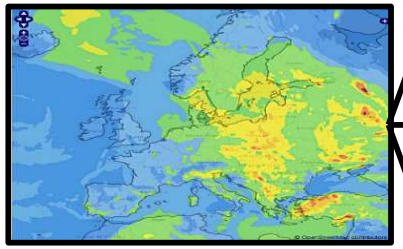
CAMS **road transport** emissions are:

- **downscaled** to **area** sources
- **distributed** to the **roads** derived from OSM.



Ramacher et al. 2021 (Atmosphere, under review)

The downscaling method: Other



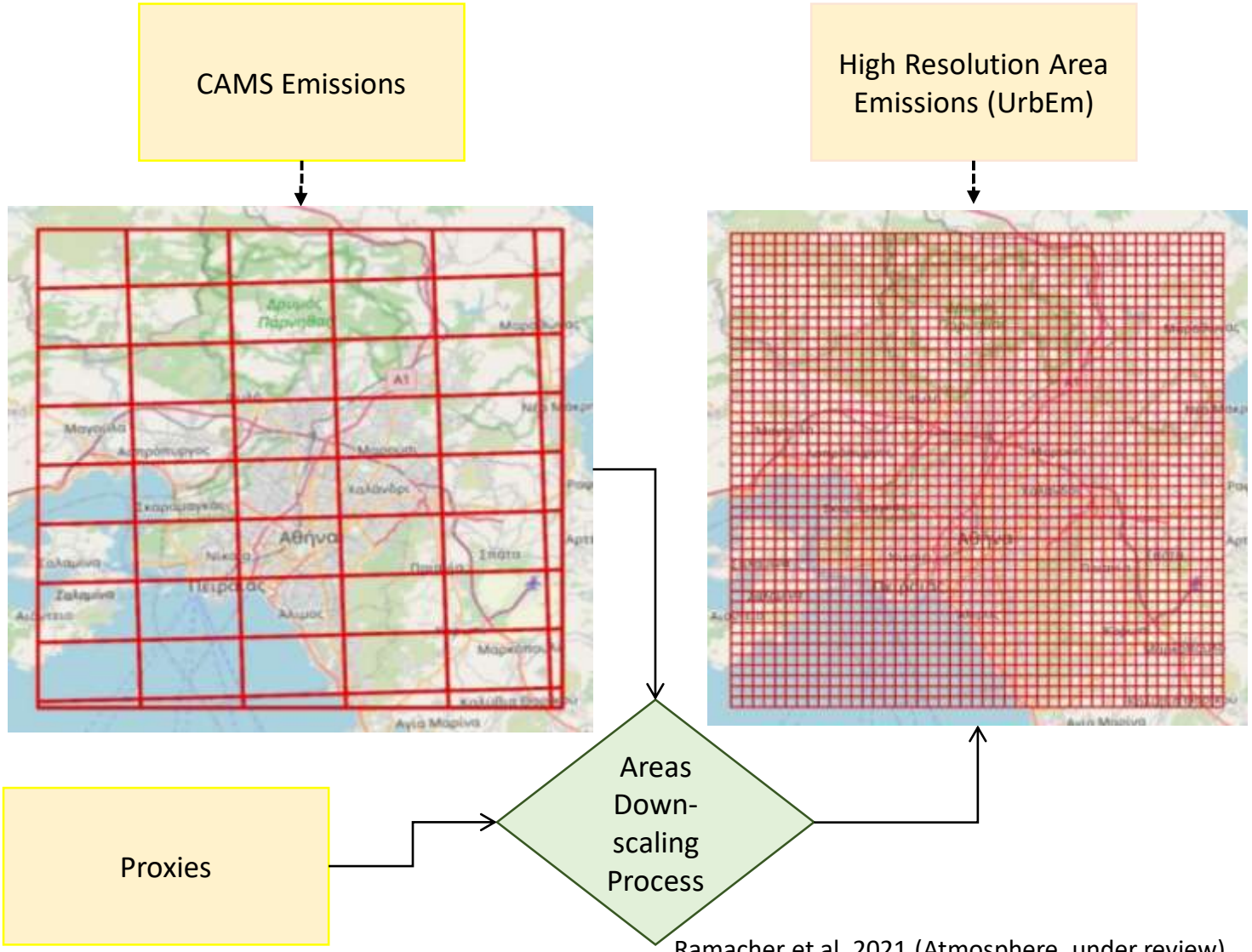
Points

Lines

Areas

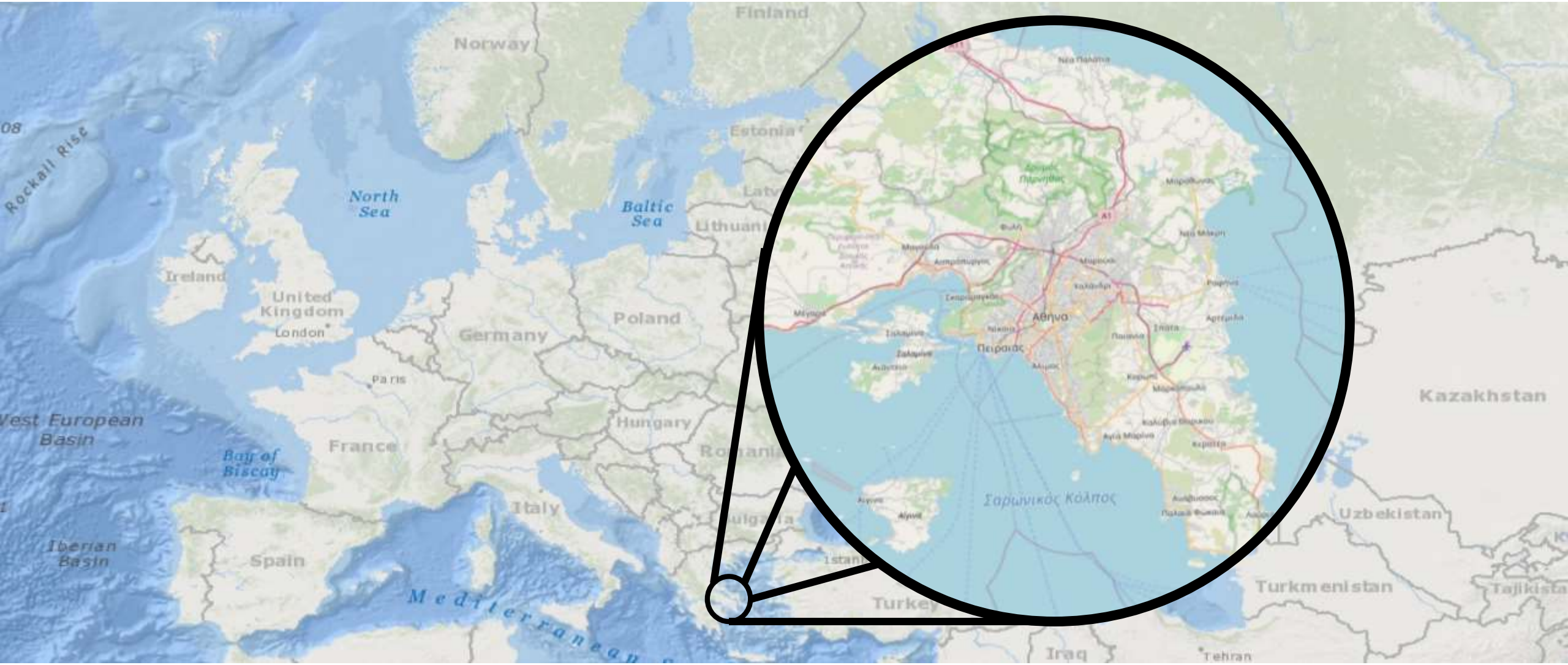
Coarse **CAMS** cell **per anthropogenic activity**

- **spatially disaggregated**, **according** to **high-resolution** spatial **proxy**.



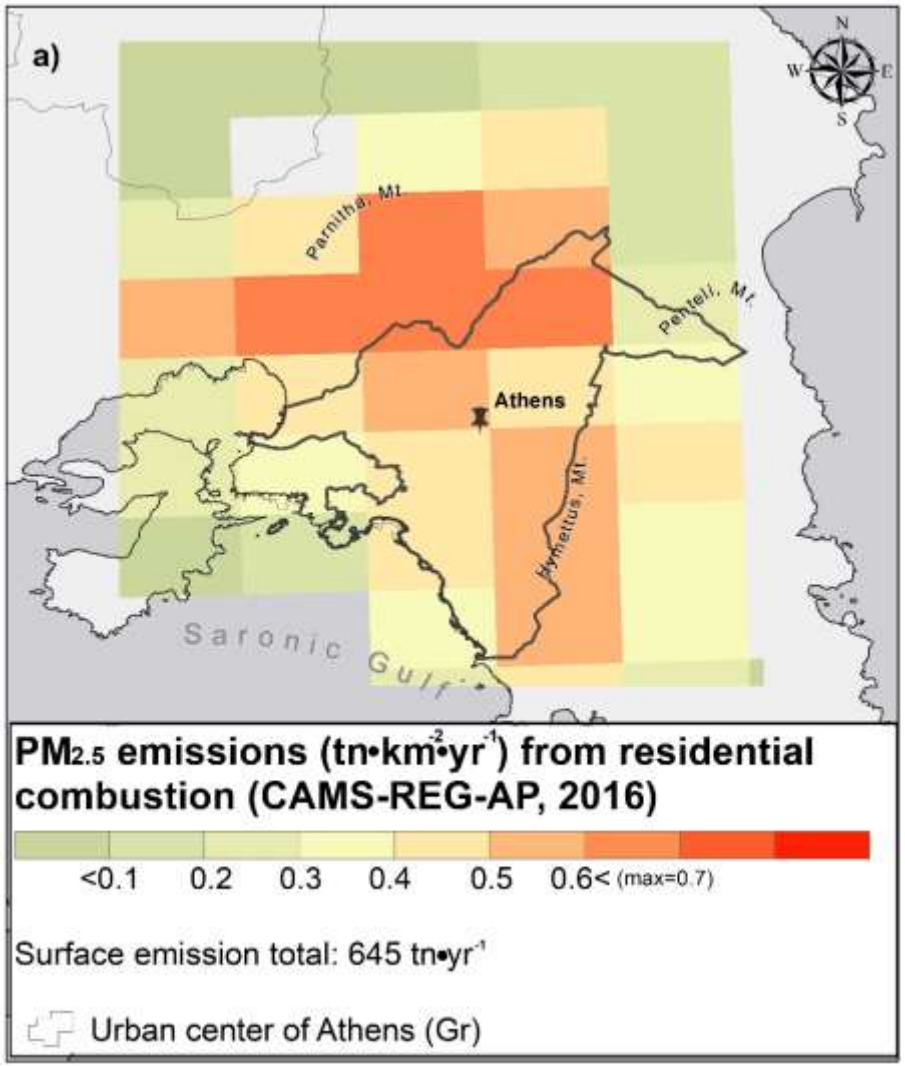
Ramacher et al. 2021 (Atmosphere, under review)

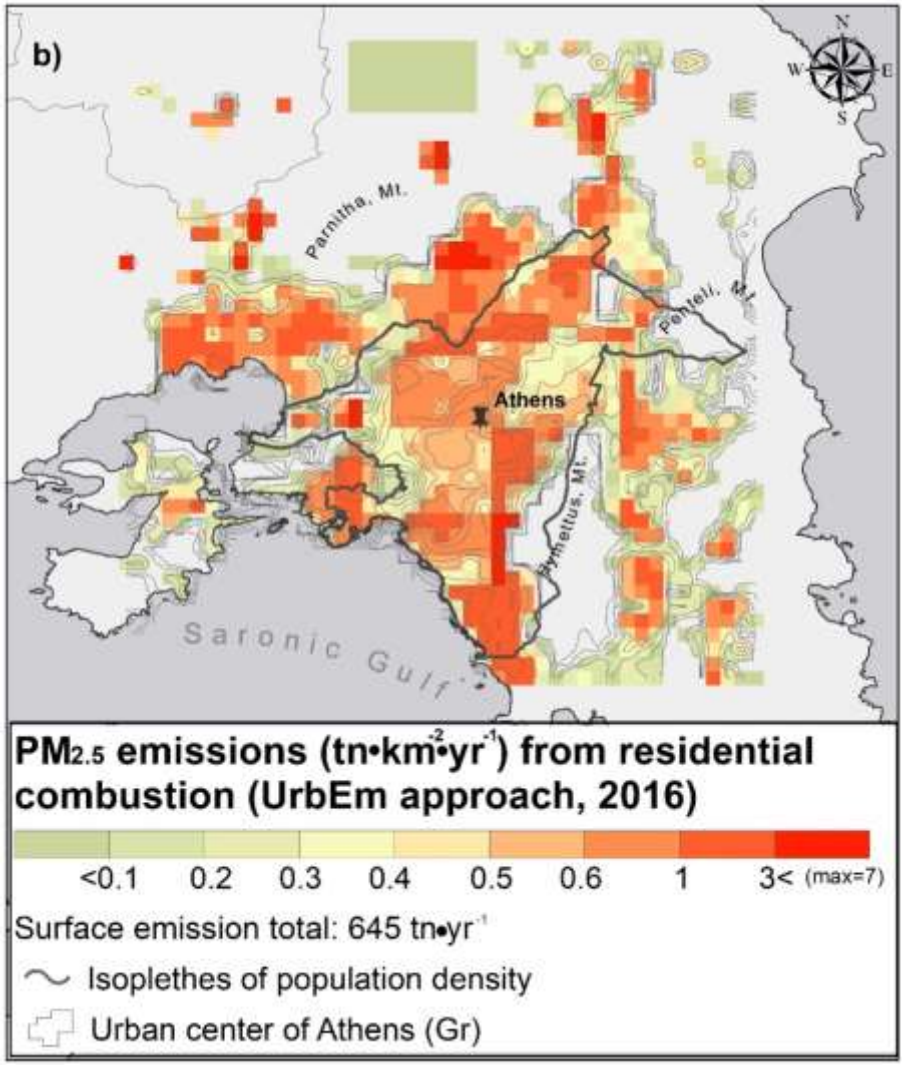
The Athens demonstrator



Ramacher et al. 2021 (Atmosphere, under review)

The Athens demonstrator: Residences





Emissions are allocated at the

Inhabited areas

Foothills

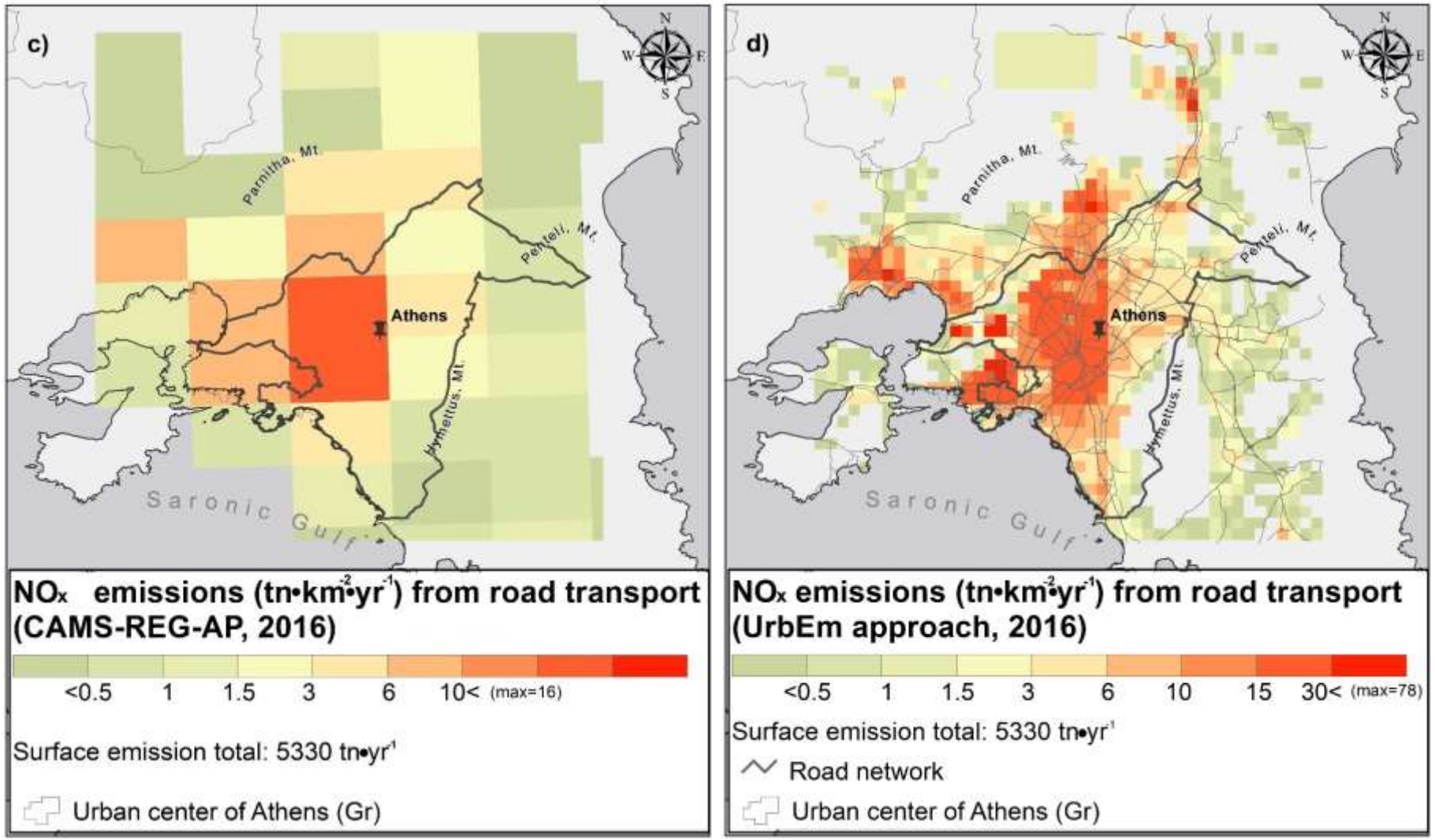
- **northern suburbs** and
- **mountainous residential** areas.

Improvements **overseas** and near the **coastline**

Mass is attributed at the source (max. are larger)

Ramacher et al. 2021 (Atmosphere, under review)

The Athens demonstrator: Road network



Emissions are allocated at the

Road network

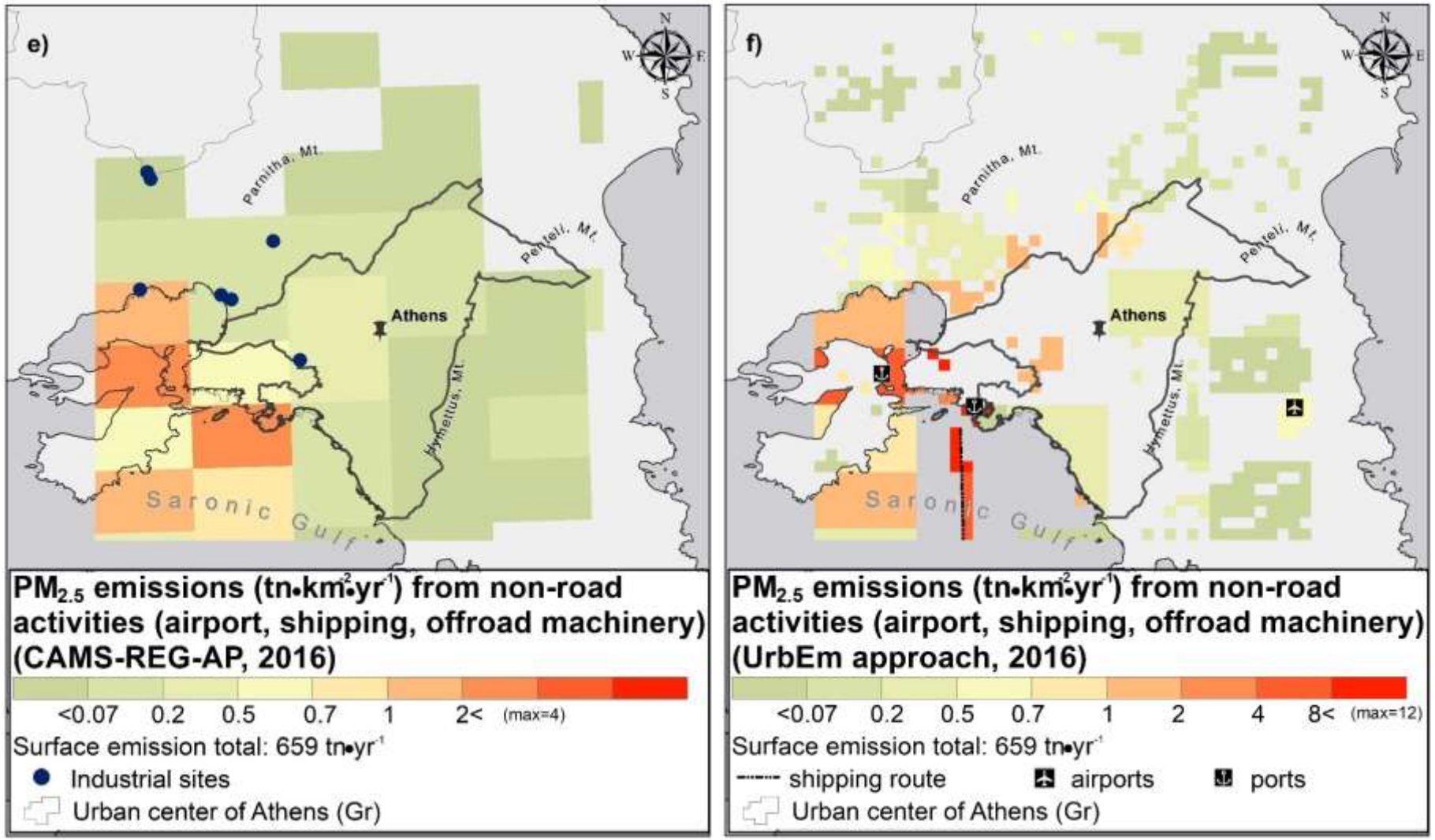
- **National roads** and
- **Urban transport**

Improvements for hybrid CTM (incl. urban canyon processes)

Mass is attributed at the road network (max. are larger)

Ramacher et al. 2021 (Atmosphere, under review)

The Athens demonstrator: Airport, ports etc.



Emissions are allocated at the

Sea surface

Shipping routes

Airport

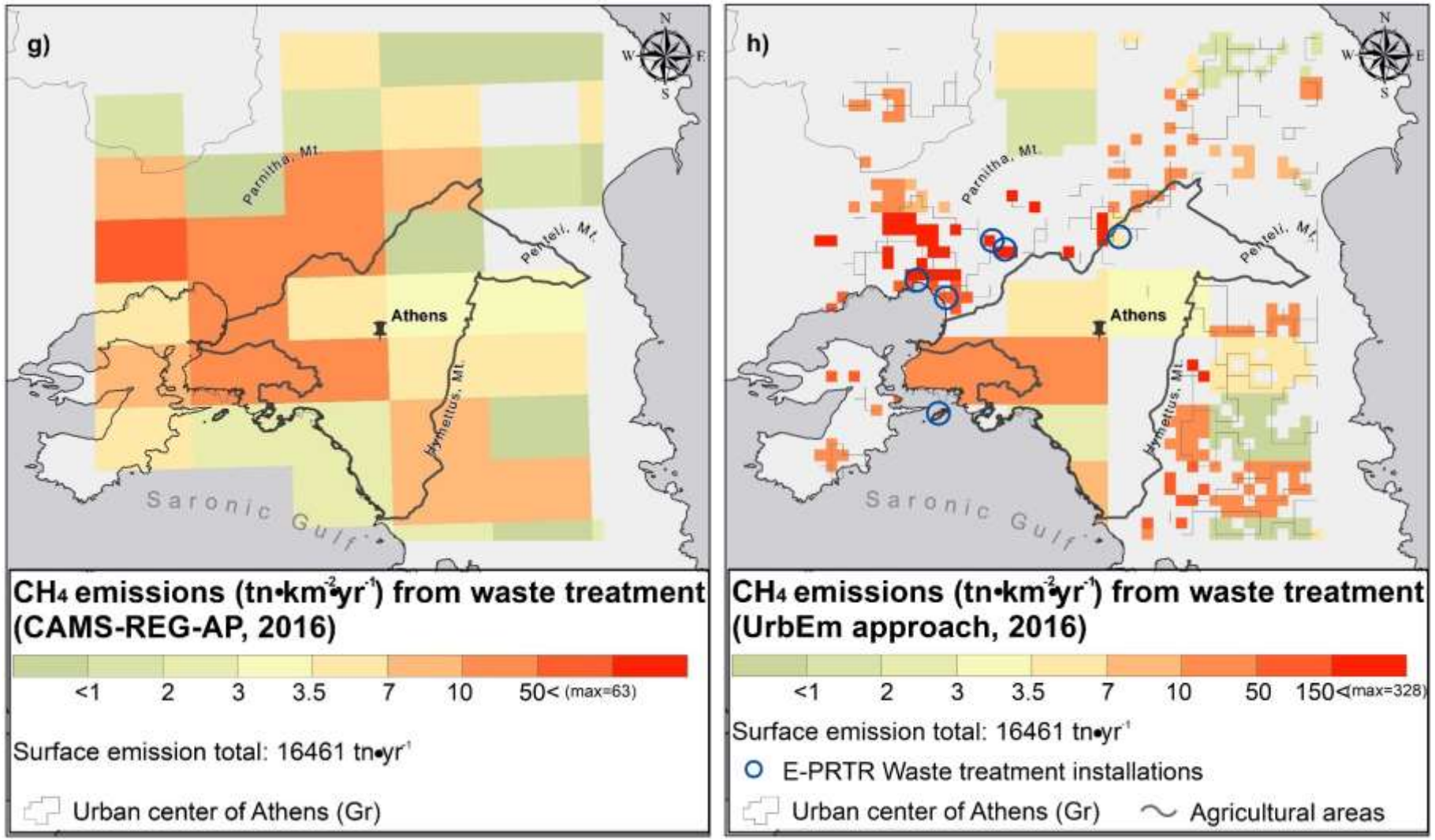
Agricultural, **Industrial** and **Construction** activity areas

Improvements **overseas** and **overland**

Mass is attributed at the source (max. are larger)

Ramacher et al. 2021 (Atmosphere, under review)

The Athens demonstrator: Waste



Emissions are allocated at the

Waste management installations areas

Agricultural areas

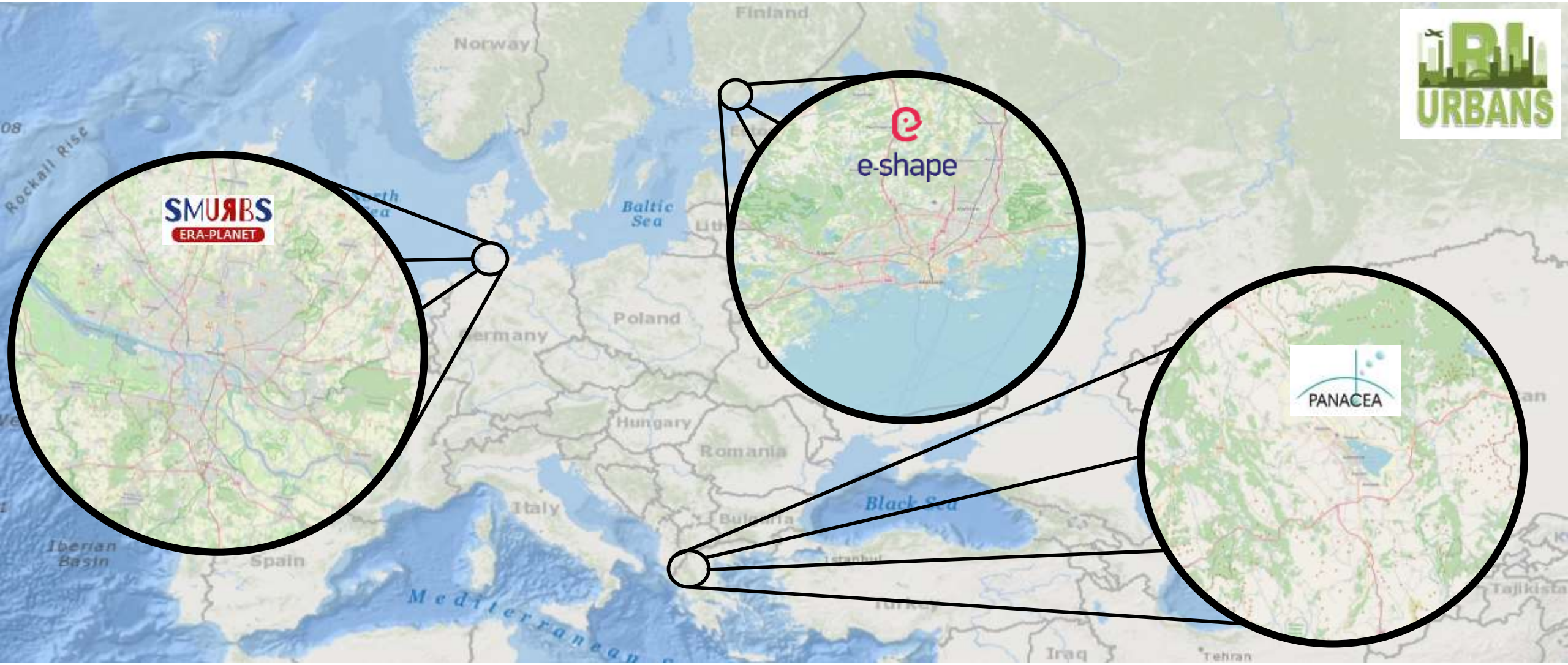
- **Open fires - waste incineration** (where CAMS initially appointed coarse emissions from open burning of waste).

Improvements **overland** and near installations

Mass is attributed at the source (max. are larger)

Ramacher et al. 2021 (Atmosphere, under review)

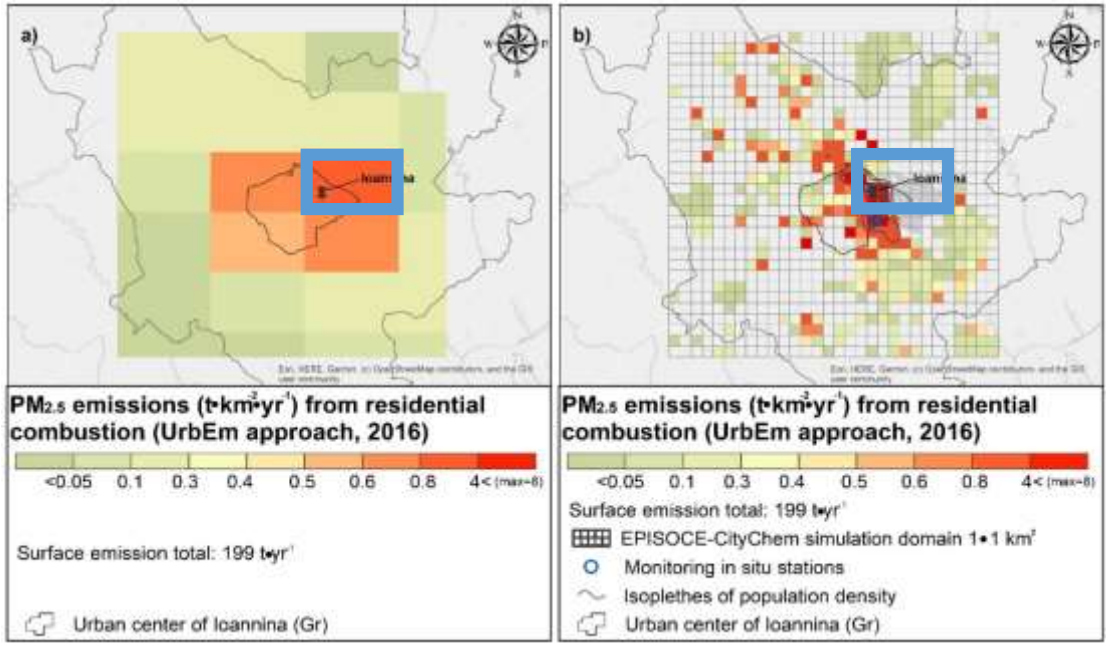
Other case studies



Ramacher et al. 2021 (Atmosphere, under review)

Highlights

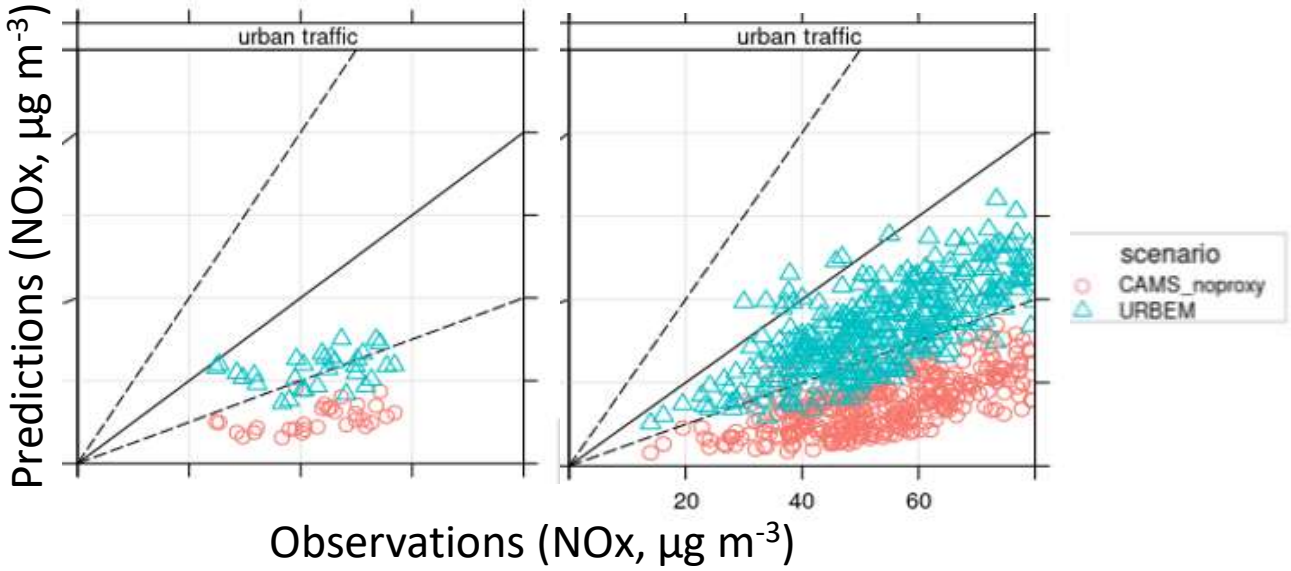
Ioannina



Solomos et al., COMECAP21: Pollutants dispersion from domestic wood burning for heating at Ioannina, Monday, September 27th 2021, 17:10 – 17:25, Poster Session for PANACEA part 1, PANACEA, PANACEA

Athens

Hamburg



Athanasopoulou et al., COMECAP21: Synergy between different earth observation platforms towards the estimation of the intra-urban population exposure to wintertime air pollution of Athens, Wednesday, September 29th 2021,10:30-11:30, Poster Session for Climate Dynamics, Climate Change, Air quality.

Thank you for your attention!