PLUREL

Land Use Relationships
In Rural-Urban regions

Module 2

August 2010

PERI-URBAN LAND USE RELATIONSHIPS – STRATEGIES AND SUSTAINABILITY ASSESSMENT TOOLS FOR URBAN-RURAL LINKAGES, INTEGRATED PROJECT, CONTRACT NO. 036921

D2.3.13

Scenario maps on emissions

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SIXTH FRAMEWORK PROGRAMME

Classification of results / outputs:
For the purpose of integrating the results of this deliverable into the PLUREL Explorer dissemination platform as fact sheets and associated documentation please classify the results in relation to spatial scale; DPSIR framework; land use issues; output indicators and knowledge type.

Spatial scale for results: Regional, national, European	European at NUTSx level
DPSIR framework: Driver, Pressure, State, Impact, Response	Pressure
Land use issues covered: Housing, Traffic, Agriculture, Natural area, Water, Tourism/recreation	Housing, Traffic: Air pollution related to allocation of human activities
Scenario sensitivity: Are the products/outputs sensitive to Module 1 scenarios?	yes
Output indicators: Socio-economic & environmental external constraints; Land Use structure; RUR Metabolism; ECO-system integrity; Ecosystem Services; Socio-economic assessment Criteria; Decisions	Statistical relationships between air pollution and land use Response functions to estimate effects of land use change on air pollution patterns and volume addressing the urban, peri-urban and rural compartments of the NUTSx regions
Knowledge type: Narrative storylines; Response functions; GIS-based maps; Tables or charts; Handbooks	maps

How many fact sheets will be derived from this deliverable:	**2**

Overview

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- The **map-book**

  presents the final outcomes of the response function applications to estimate air pollution pattern (for certain air pollutants – see later) and the expected changes for the years 2015 and 2025 expected for different peri-urbanisation trends as assumed from the 4 PLUREL scenarios .
- The future emission pattern is conducted applying (statistical) **response functions** which refer to different input data, Response functions are result of statistical analysis. We concentrated on emission patterns where spatial distribution data are available, and reliable, and which can be explained through local activities. (Emissions released through sources which are – in terms of statistics – "singular events" (e.g. allocation of power generators or large industrial plants) cannot be estimated through those functions and are therefore excluded.
- The response functions refer only to a limited set of variables which are available for the PLUREL scenarios and *consider only those effects of land use (and population distribution) change* and (to some extent) as effect of economic development, which are depicted by the explanatory data and the spatial pattern of these data (in 2000-2004) in relation to the emission patterns.
- **General technological mitigation** trends are reflected indirectly to a limited extent by the GDP development, but explicitly by assuming certain technological efforts . As the response functions refer to a static relation between explanatory variables and emission data, no trends over time can be considered, nevertheless the results have been compared with Europe-wide emission projections which estimate instead of the spatial effects the effects of technology-development and energy price development.
- The response function estimation has been carried out in several ways (for countries, for Rural Urban Region (RUR) sub-regions, for EMEP raster cells) here finally the NUTSx regions application is presented which is based on a (limited) explanatory data set for today and future scenarios, carried out by other PLUREL tasks mentioned above.)

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- **Input data** of the baseline situation and for carrying out the final response function analysis are :
  - The emission pattern for entire Europe (EMEP/CORINEAIR emission inventory (50x50 km EMEP raster),*)
  - Population for NUTS 3 from EUROSTAT, disaggregated by S. Rickenbusch / Univ. Edinburgh to 1x1 km cells, re-aggregated by AIT to NUTSx (and EMEP) applying the region-typologies and the urban/peri-urban/rural sub-region delineation,
  - Artificial surface (as proxy for settlement area (fro m S. Rickenbusch), based on CORINE land cover data,
  - GDP data (EUROSTAT) for NUTS2 regions , disaggregated by AIT based on GDP per capita values and NUTS3 population numbers
- Spatial relation of emission data to the EMEP raster set and the statistical data to NUTSx regions is conducted by AIT. Further intersection of EMEP and NUTSx regions to allow estimation of the emission load per NUTSx region and an estimation of the sub-regional population and artificial surface area and GDP values for each EMEP cell (and NUTSx – region).

- **Explanatory data t**o estimate the effects of peri-urbanisation on future air pollution emission by response functions are finally:
  - Artificial surface area by 1x1km cells (by S. Rickebusch/ Univ. Edinburgh), aggregated by AIT to NUTSx and sub-regions and to EMEP raster cells.
  - GDP data for NUTS2 regions from NEMESIS model (by B. Botier/ ERASME-Team) , disaggregated by AIT
  - Population totals (V. Skirbekk / IIASA), allocated (by AIT) to the urban, peri-urban and rural sub-regions of each NUTSx based on artificial surface growth and artificial surface : population quotas.

*)density data have not been applied as emission volume – related to vary different regions sizes which are populated to different extent , producing very different densities, which do not reflect the pressure situations

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- The **response functions** are a product of statistical analysis, which do not reflect effects of population / human activities on land use, but estimate the spatial distribution of the demographic structure, as assumed to be released through the land use pattern and the expected changes (e.g. assuming that the urban centres or peri-urban landscapes attract certain groups of people or households, observed by exploring the current age - , household - or education distribution in relation to the distribution of artificial surface (as proxy for urban areas and related infrastructure) and in relation to the regional GDP, affecting lifestyle and demands on floor space, social and other infrastructure or releasing constrains regarding affordability of flats or houses.
- **Response function output data** for the PLUREL scenarios' target years 2015 and 2025 are emission totals per NUTSx regions for certain emission sources NOx emission from road traffic, small combustion (heating), CO emissions (small combustion) and HC (Hydrocarbon) emissions from solvent use production and local heating combustion. The maps show following content per NUTSx region (baseline situation and projections 2025 according to the PLUREL scenarios A1, A2, B1,B2).
- The **maps** show the spatial distribution per NUTSx region (baseline situation and the change as expected from the projections 2025 according to the 4 PLUREL scenarios. Only those regions are shown where data are available or could be projected with available input data, no gap-filling has been conducted.
- Some single regions show odd results because of diverse population and artificial area development depending on the input data. A further reason for odd results refers to the region definition: The NUTSx regions are administrative entities, which do not always match the urban influence sphere, covering the entire rural-urban region extent. Some NUTSx regions (e.g.,. around capitals) cover either urban or peri-urban areas which will lead to changes only in one of the sub-regions causing implausible population structure changes in the certain NUTSx region.

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Considered emission sources:

- NOX small combustion emissions
- CO small combustion emissions
- NOX road traffic emissions
- HC emissions from solvent use, production, local heating combustion)

Data: Emission loads 2004*) per 50 x 50 km EMEP raster cell

Source: EMEP /CORINEAIR data base –

Current download site: http://www.ceip.at/emission-data-webdab/emissions-used-in-emep-models/

EEA (2007) EMEP/CORINEAIR Emission Inventory Guidebook 2007

http://www.eea.europa.eu/publications/EMEPCORINAIR

*) 2004 was the latest data available in 2007, when the task started and the spatial relationships between land use and air pollution were explored.

Maps

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Baseline situation:

Emission loads 2004 per EMEP raster cell – as input data (source: CORINEAIR data, EEA)

(explanatory data for the response functions in D.2.3.11 Scenario maps on population - extended)

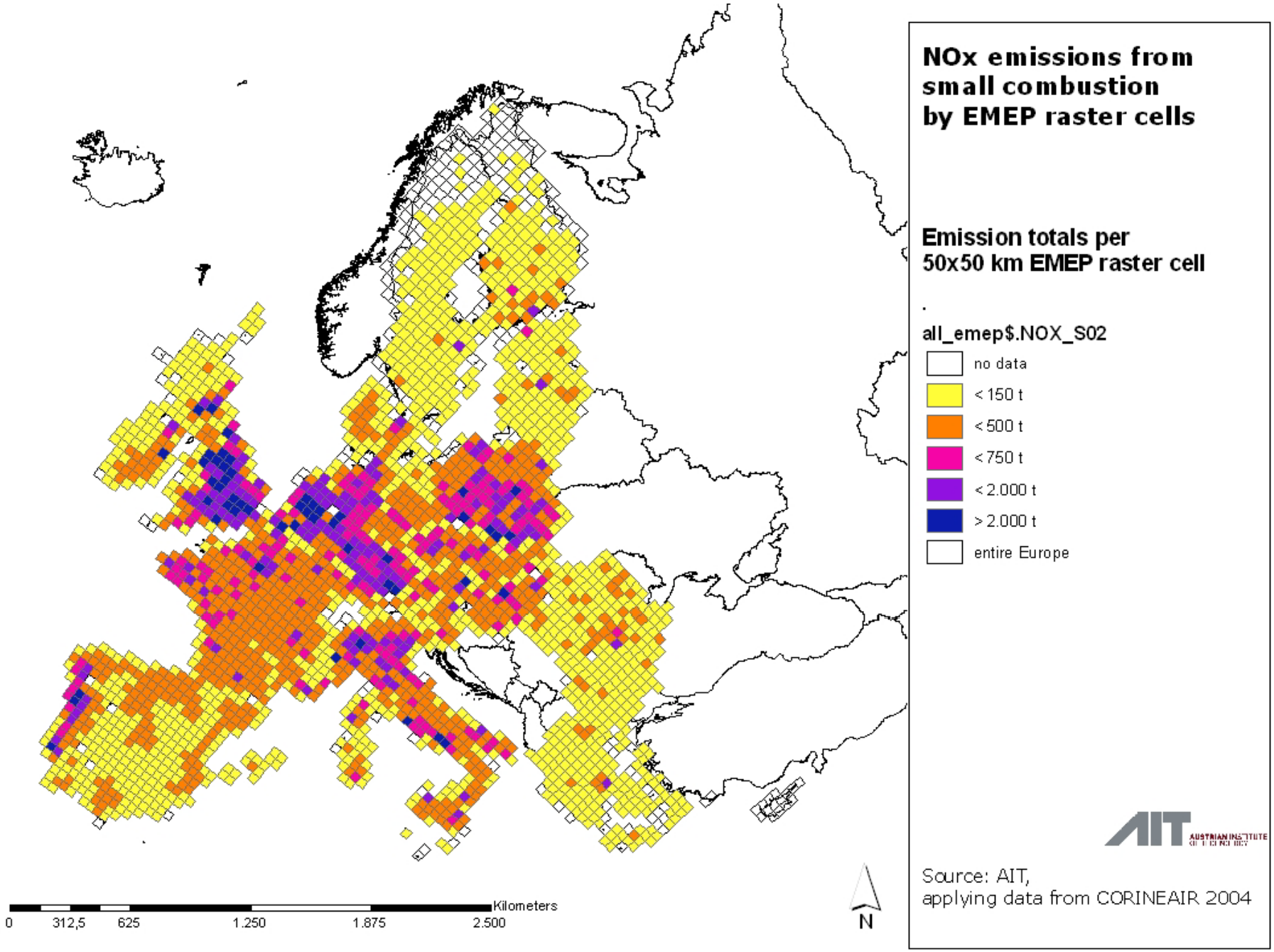
- NOX emissions from small combustion (heating…),
- CO emissions from small combustion,
- NOX emissions from road traffic,
- Residuals of the response function estimations for NOX road traffic emission: deviation as factor of the recored emission values *)
- HC (Hydrocarbon) emissions from solvent use, production, heating

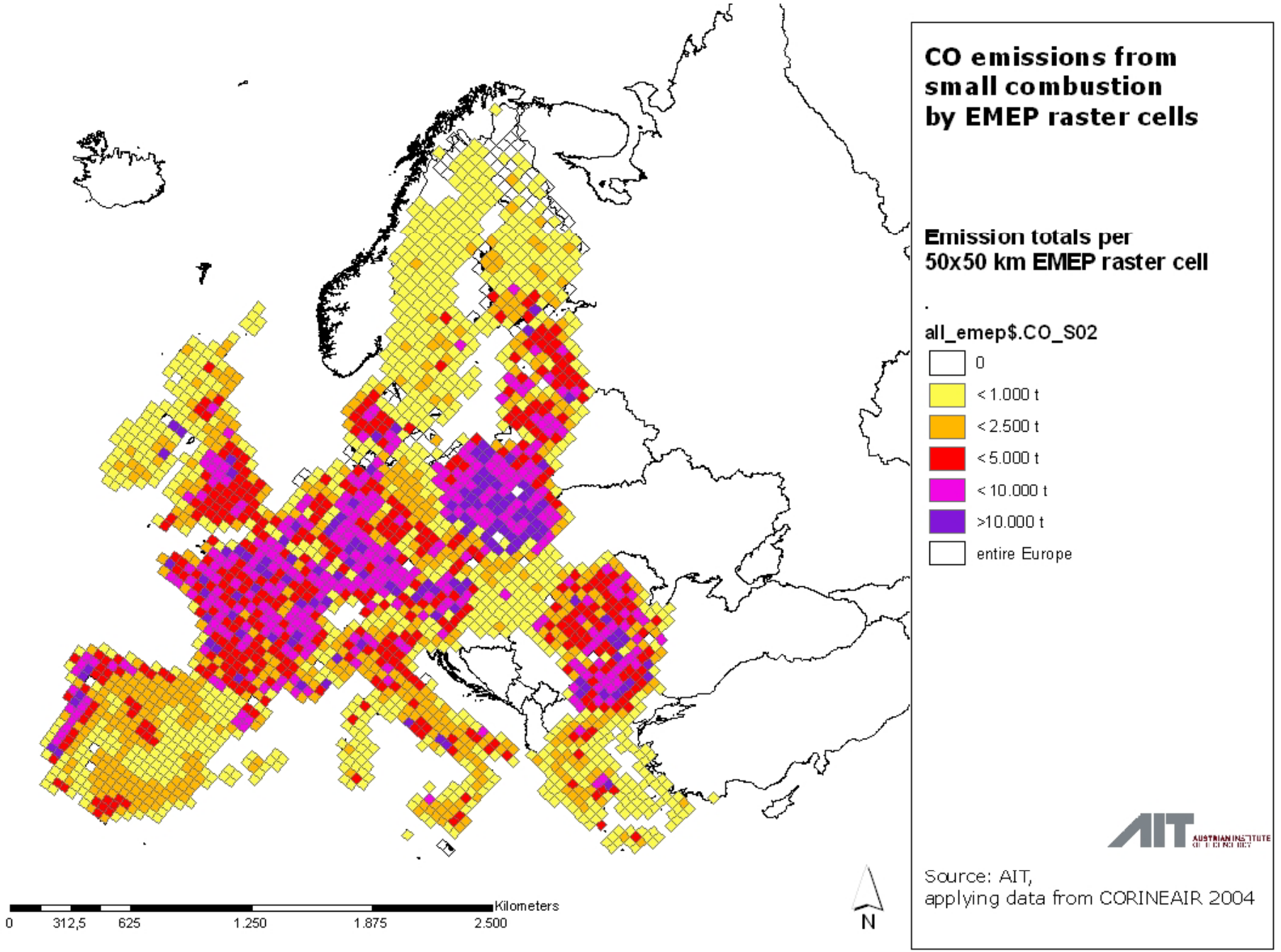
Results:

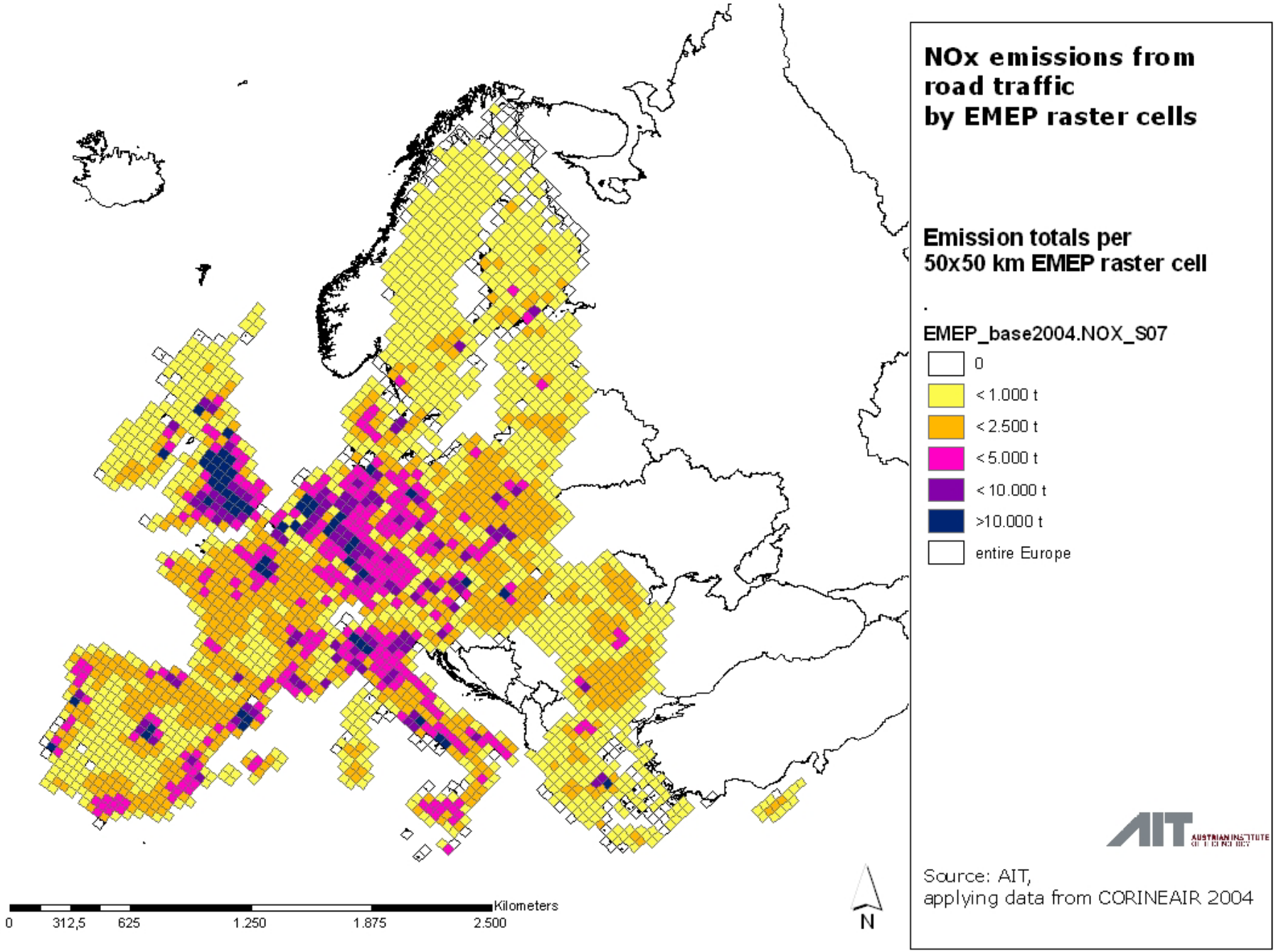
Change of emission volume (and densities) 2005-2025 per NUTSx region for PLUREL scenarios: A1,A2, B1,B2

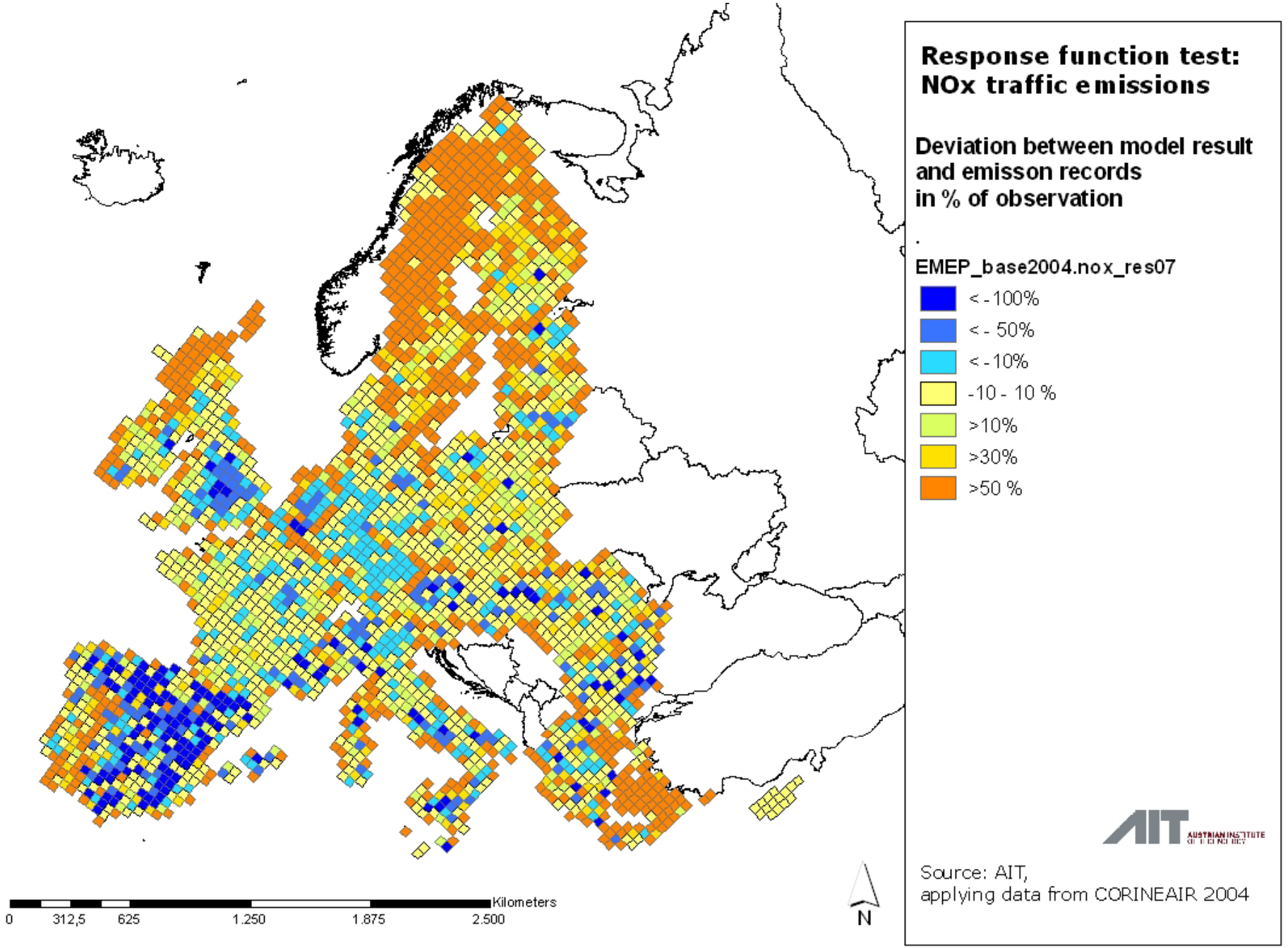
- NOx combustion emission
- CO combustion emission
- NOx road traffic emission
- HC solvents and production emission

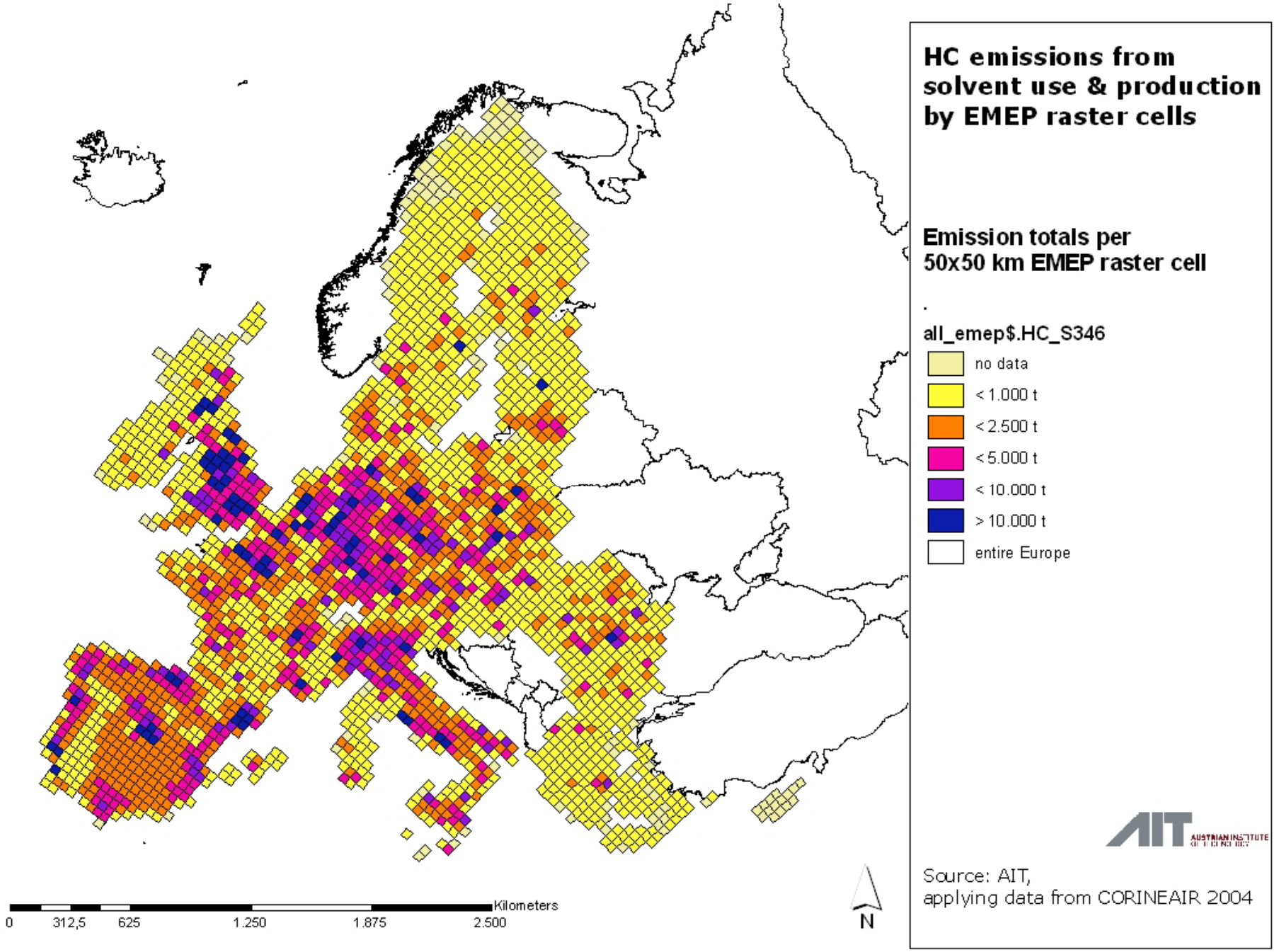
***)** Residuals for NOX road traffic emission response functions are included as example to show the regional deviations from the general relationship between air pollution and land use pattern, reflecting human activities releasing emissions, as estimated through the response functions.


NOx emissions from small combustion by EMEP raster cells
Emission totals per 50x50 km EMEP raster cell
all_emep$.NOX_S02
no data
< 150 t
< 500 t
< 750 t
< 2.000 t
> 2.000 t
entire Europe
Kilometers
0
312,5
625
1.250
1.875
2.500
N
Source: AIT,
applying data from CORINEAIR 2004


CO emissions from small combustion by EMEP raster cells
Emission totals per 50x50 km EMEP raster cell
all_emep$.CO_S02
0
< 1.000 t
< 2.500 t
< 5.000 t
< 10.000 t
>10.000 t
entire Europe
Source: AIT, applying data from CORINEAIR 2004
Kilometers
0
312,5
625
1.250
1.875
2.500
N


NOx emissions from
road traffic
by EMEP raster cells
Emission totals per
50x50 km EMEP raster cell
.
EMEP_base2004.NOX_S07
0
< 1.000 t
< 2.500 t
< 5.000 t
< 10.000 t
>10.000 t
entire Europe
Source: AIT,
applying data from CORINEAIR 2004
Kilometers
0
312,5
625
1.250
1.875
2.500
N


Response function test:
NOx traffic emissions
Deviation between model result
and emisson records
in % of observation
EMEP_base2004.nox_res07
< -100%
< - 50%
< -10%
-10 - 10 %
>10%
>30%
>50 %
AIT
AUSTRIAN INSTITUTE OF TECHNOLOGY
Source: AIT,
applying data from CORINEAIR 2004
N
Kilometers
0
312,5
625
1.250
1.875
2.500


HC emissions from solvent use & production by EMEP raster cells
Emission totals per 50x50 km EMEP raster cell
all_emep$.HC_S346
no data
< 1.000 t
< 2.500 t
< 5.000 t
< 10.000 t
> 10.000 t
entire Europe
Source: AIT, applying data from CORINEAIR 2004
Kilometers
0
312,5
625
1.250
1.875
2.500
N

EU-wide trends

Change of emission totals 2004-2025 in EU (countries where data are available)

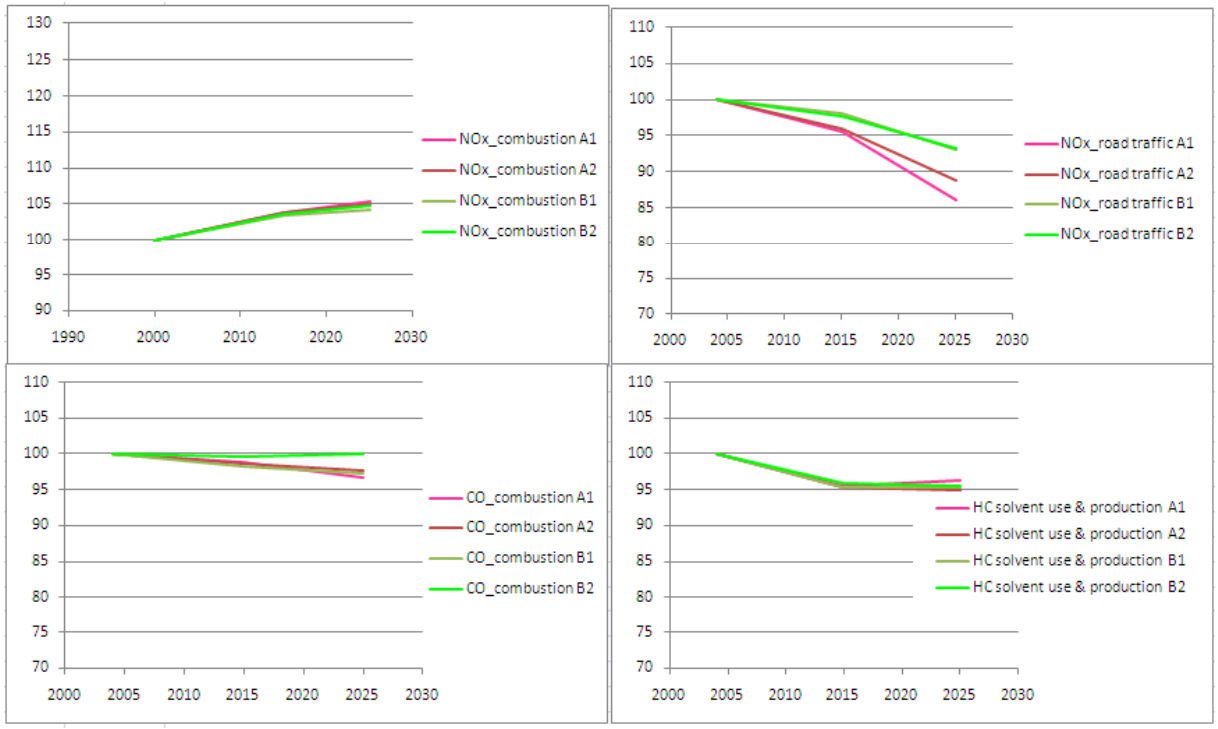


Figure: European emission trends 2004 – 2025 (index 2004 = 100)
for the 4 PLUREL scenarios as effect of different peri-urban development trends

General trends:

- The overall trends in Europe let expect declining emission volume, but different directions and intensities can be observed for different emission sources and different pollutants.
  - Increase of NOx emissions from combustion is an effect of economic wealth, technology and higher energy efficiency resulting in higher combustion temperature, emitting more NOx.
  - Decline of NOx emissions from road transportation is an effect of technology and of policy (due to definition of emission thresholds). Currently the NOx volume from transportation in the western countries is steadily declining due to vehicle fleets with newest engine technologies. Harder emission limits will further force car producers developing better NOx reduction technologies.
  - CO from combustion is expected to decline due to future change of old heating technology and changes in fuel types. This can be observed specially in the eastern europen countries.
  - HC emissions are also expected to decline. Local sources like households and small production sites will use less solvents for coating and degreasing purposes and better technology for heating able to reduce organic emissions through combustion.

- These general trends can be depicted to some extent in these diagrams, but territorial development (and so peri-urban development) appears only as one influence factor among several others. Nevertheless, to some extent these trends can be accelerated or slowed down through alternative peri-urbanisation policies which may trigger changes in human activities releasing certain „peaks“ or „sinks“ in the European“ emission surface“, reflecting the overall trends.

  Further discussion can be found in Deliverable report D2.3.8. Response functions for energy consumption and air pollution (Loibl W., R. Orthofer, M. Köstl, September 2010)

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Change of emission densities 2004-2025 per NUTSx region

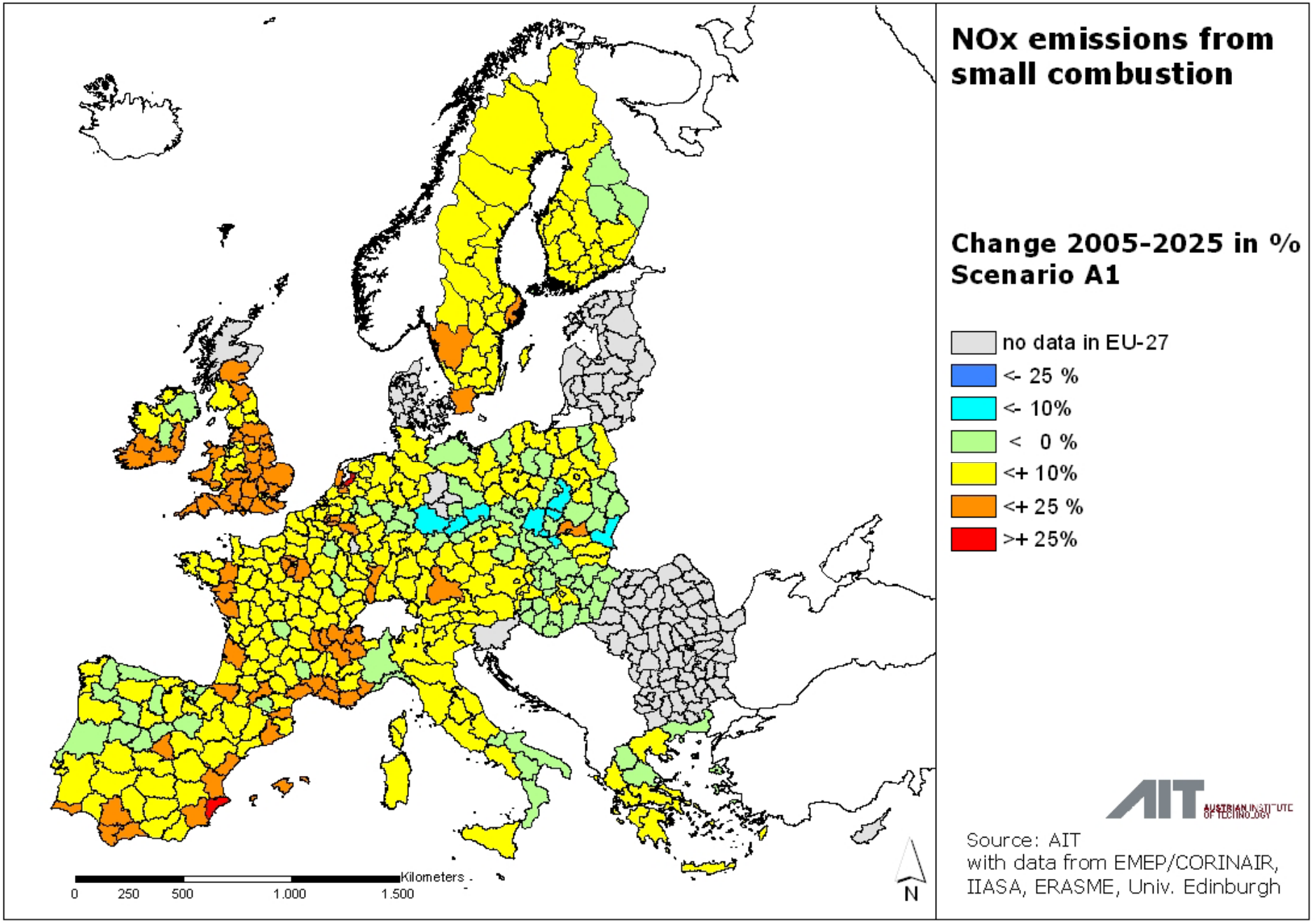
Results for all 4 PLUREL scenarios: A1,A2, B1,B2

Maps for those source groups which show distinct changes are included:

- NOX small combustion emissions
- CO small combustion emissions
- NOX traffic emissions

The explanation quality of these functions (the R^2) is relatively high – nevertheless the equations reflect only one influence factor on air pollution emissions which is the spatial pattern and the relationships of human activities as reflected by land use, triggered by peri-urbanisation.

The previous figure depicts little changes for (local) hydrocarbon emissions from households and local businesses (due to human activity pattern and land use)
The R^2 of 0,16 shows also, that only 16 % of the variance of the emission volume is explained by the response function, which means, changes in peri-urban activity patterns have only little influence on HC emissions (like solvent use).


NOx emissions from small combustion
Change 2005-2025 in %
Scenario A1
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
<+ 25 %
>+ 25%
Kilometers
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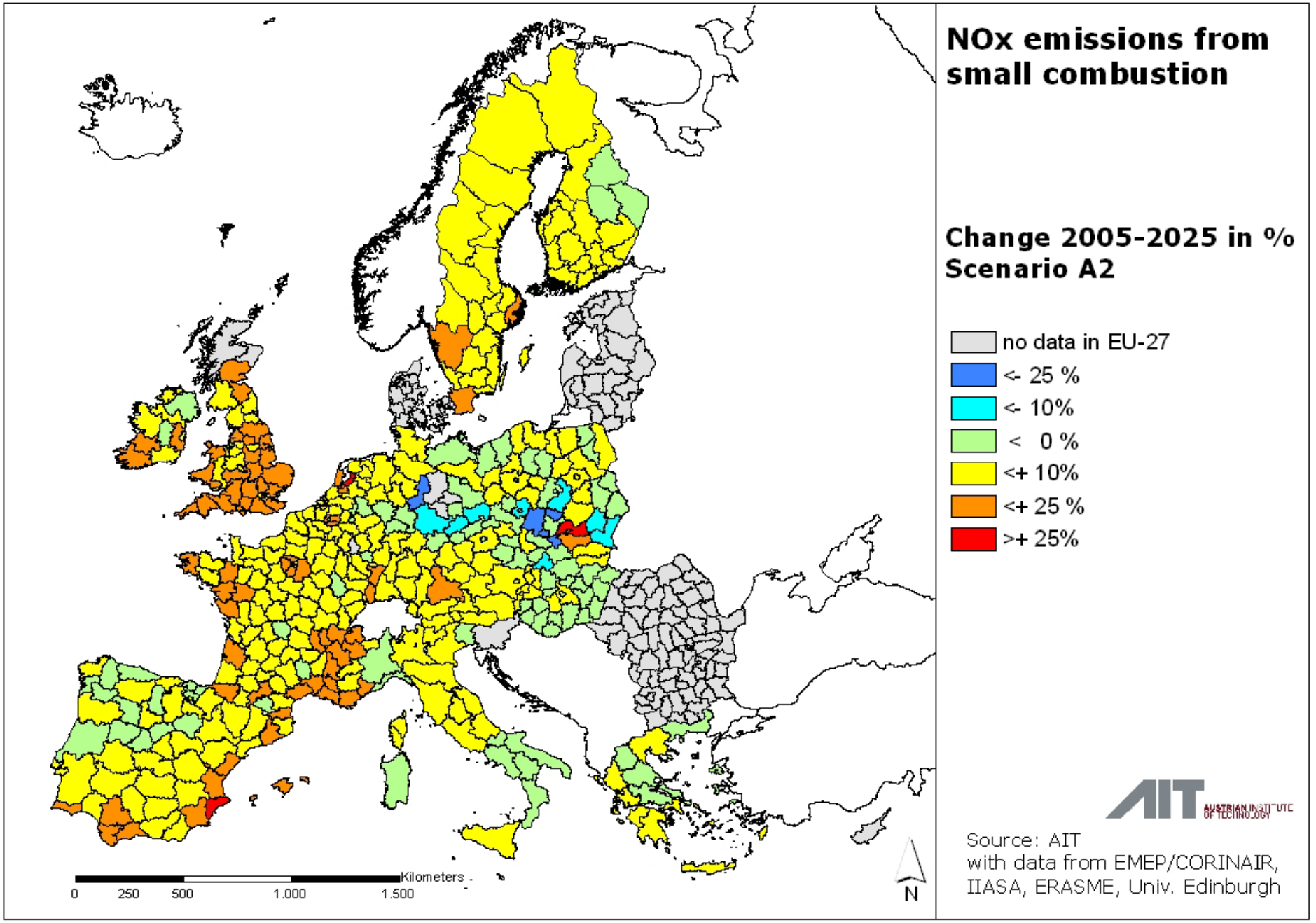
Source: AIT
with data from EMEP/CORINAIR,
IIASA, ERASME, Univ. Edinburgh


NOx emissions from small combustion
Change 2005-2025 in %
Scenario A2
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
<+ 25 %
>+ 25%
Kilometers
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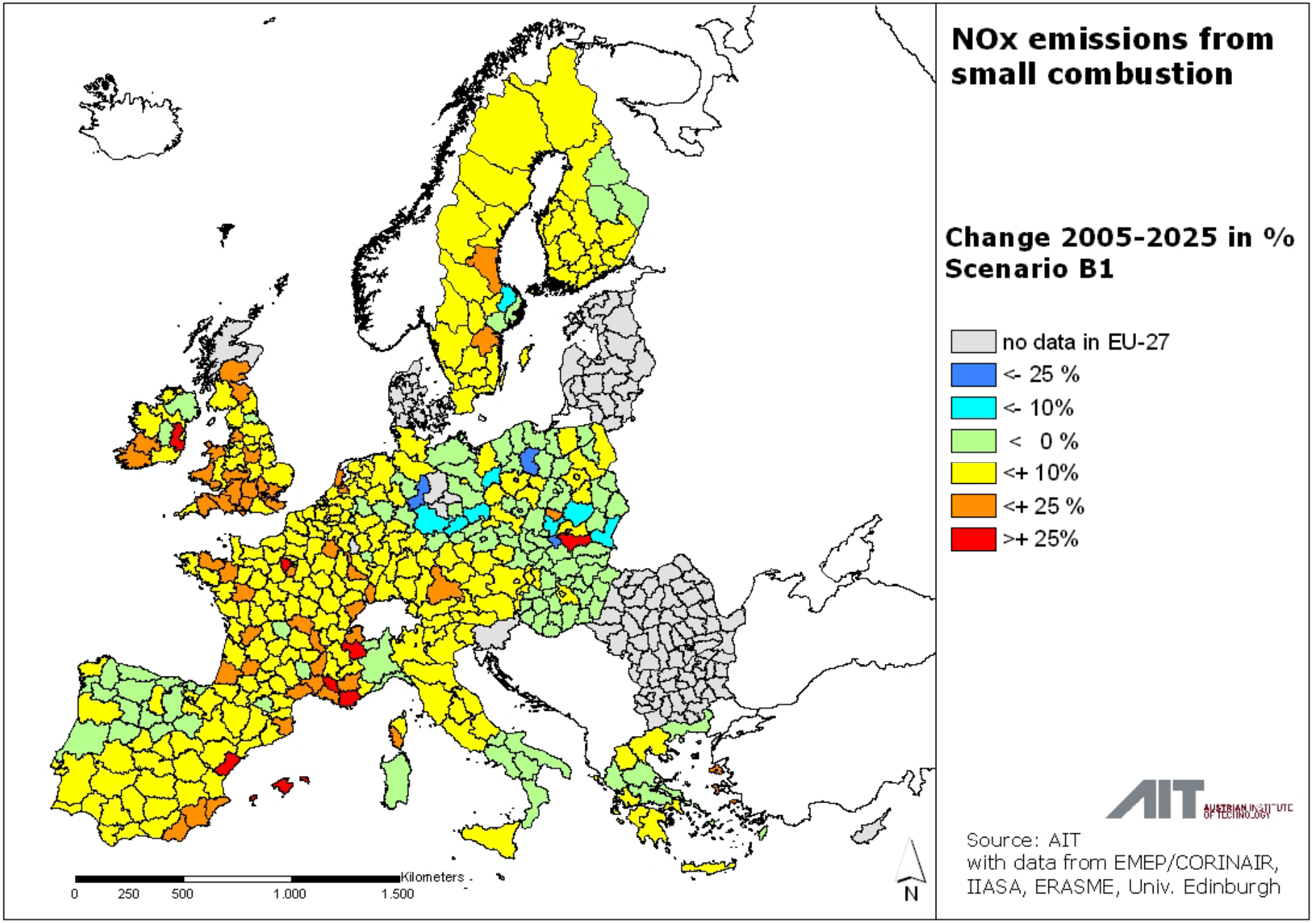
Source: AIT
with data from EMEP/CORINAIR,
IIASA, ERASME, Univ. Edinburgh


NOx emissions from small combustion
Change 2005-2025 in %
Scenario B1
no data in EU-27
<- 25 %
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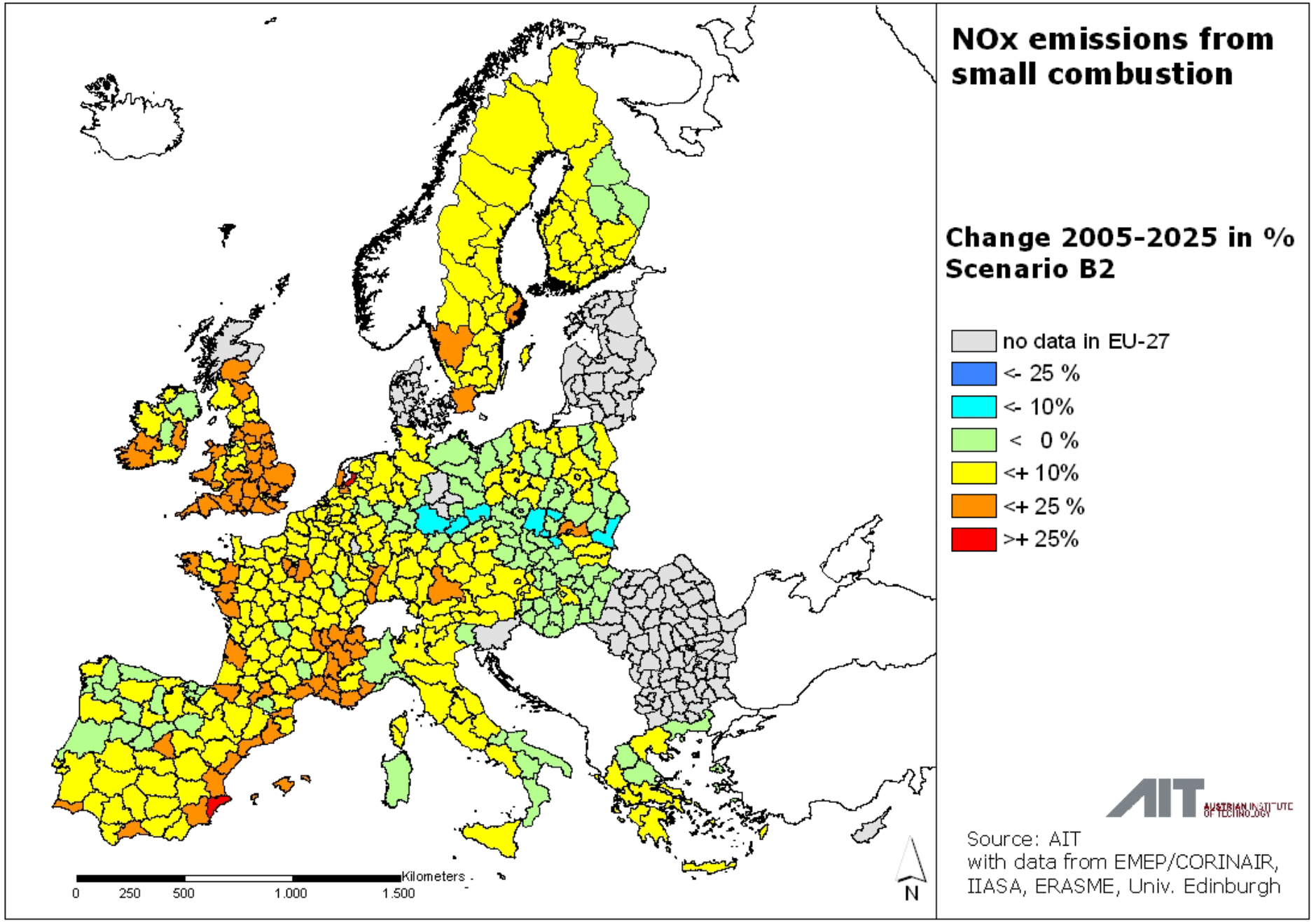
NOx emissions from small combustion
Change 2005-2025 in %
Scenario B2
no data in EU-27
<- 25 %
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Kilometers
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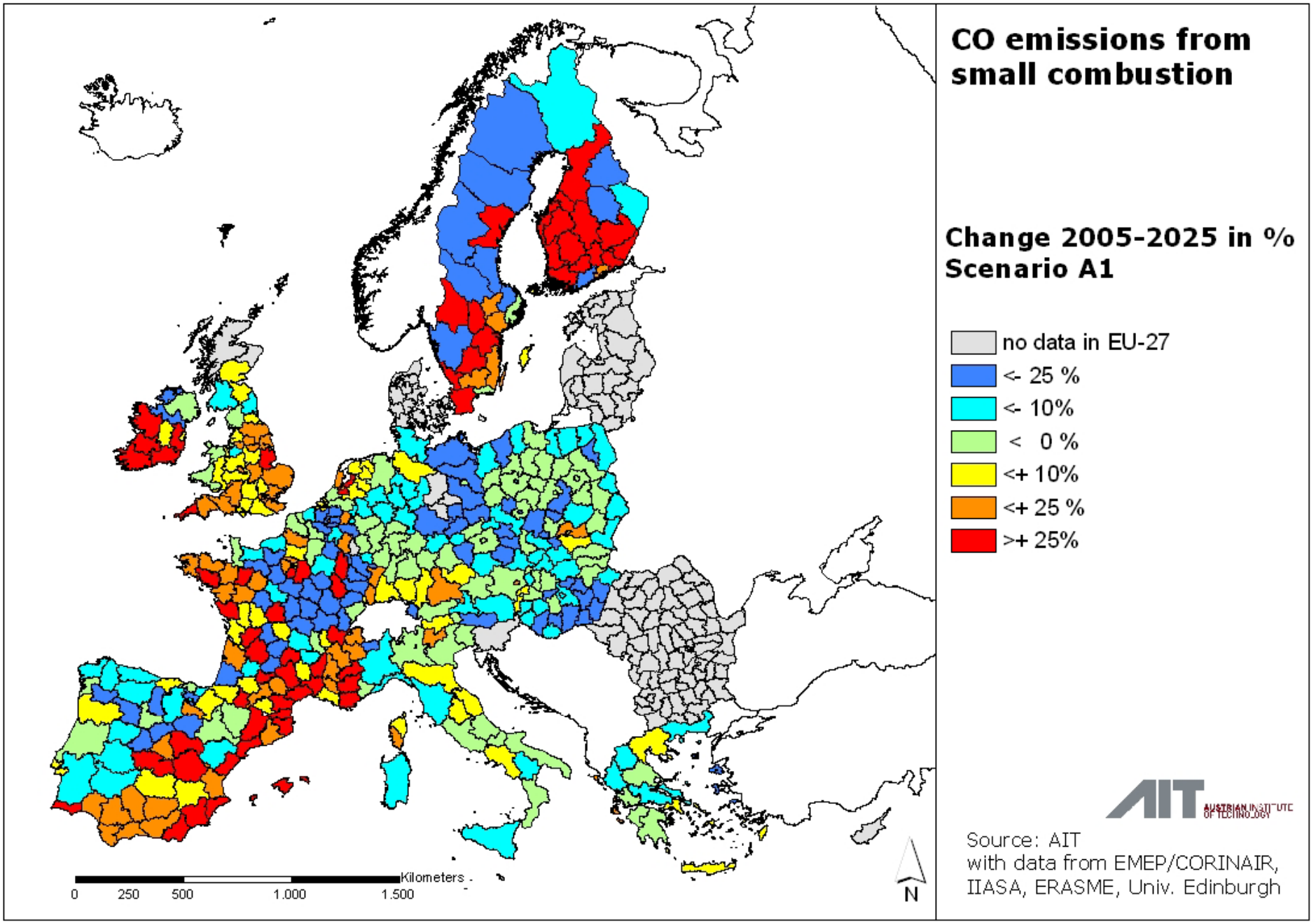
CO emissions from small combustion
Change 2005-2025 in %
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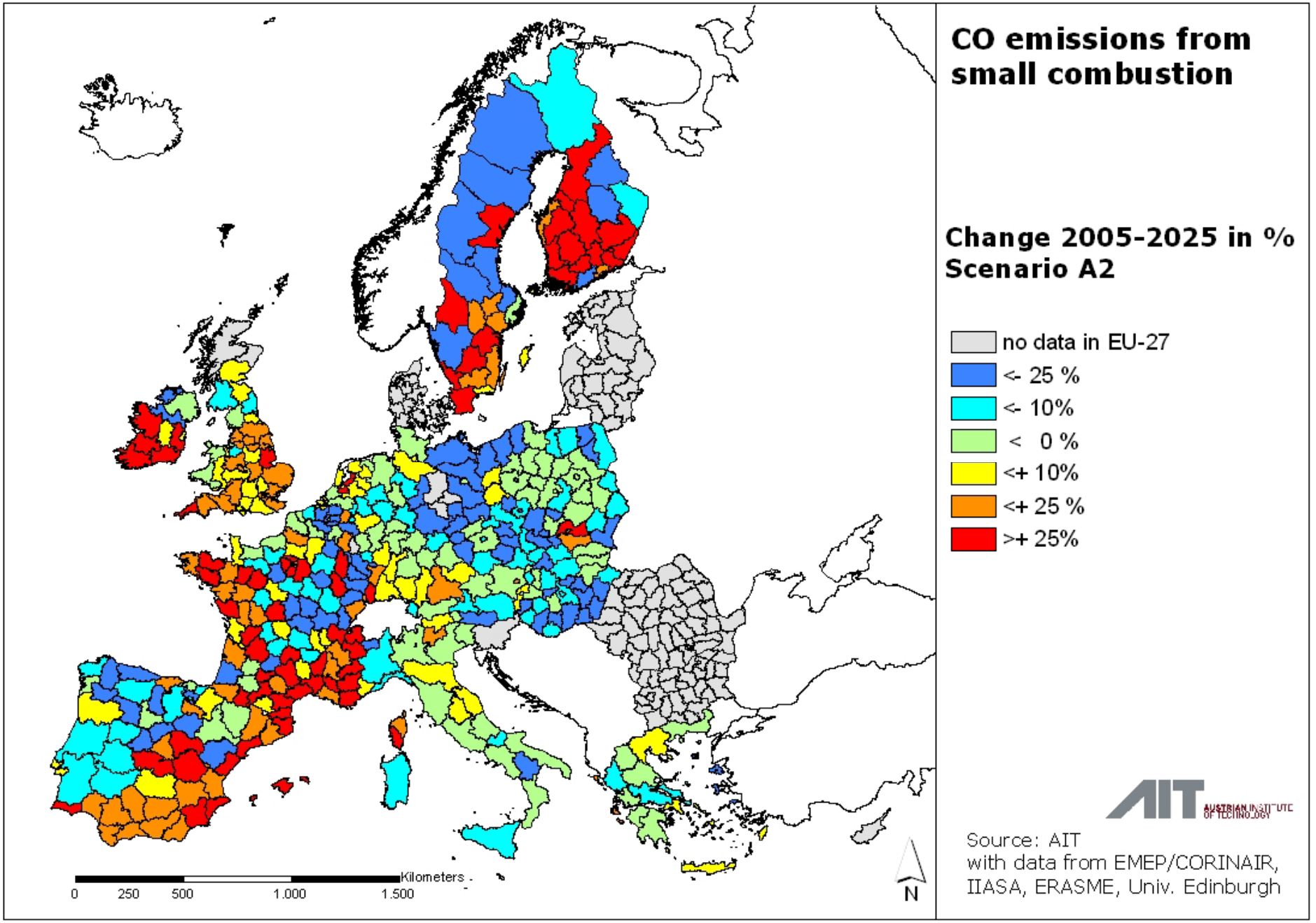
CO emissions from small combustion
Change 2005-2025 in %
Scenario A2
no data in EU-27
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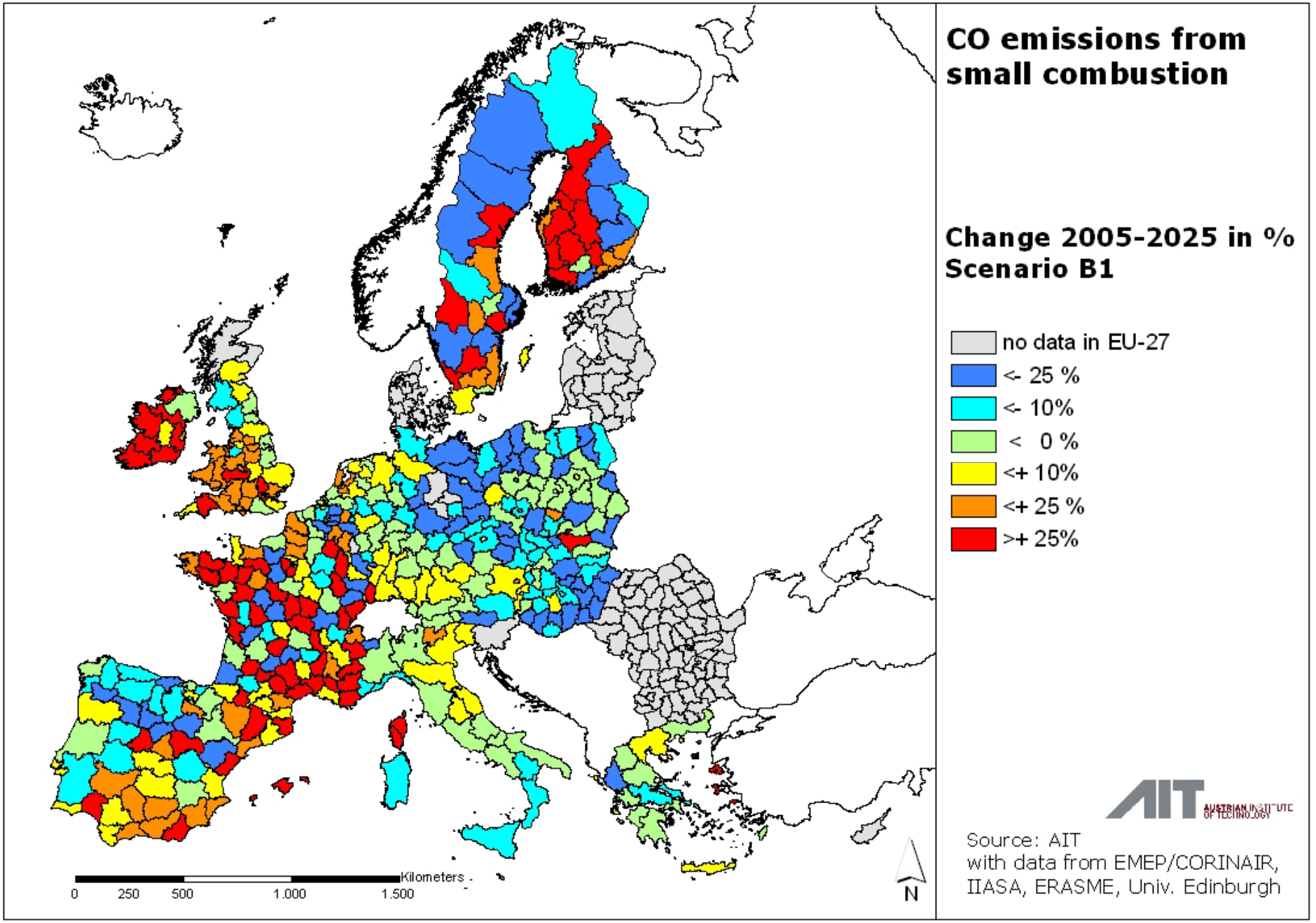
IIASA, ERASME, Univ. Edinburgh


CO emissions from small combustion
Change 2005-2025 in %
Scenario B1
no data in EU-27
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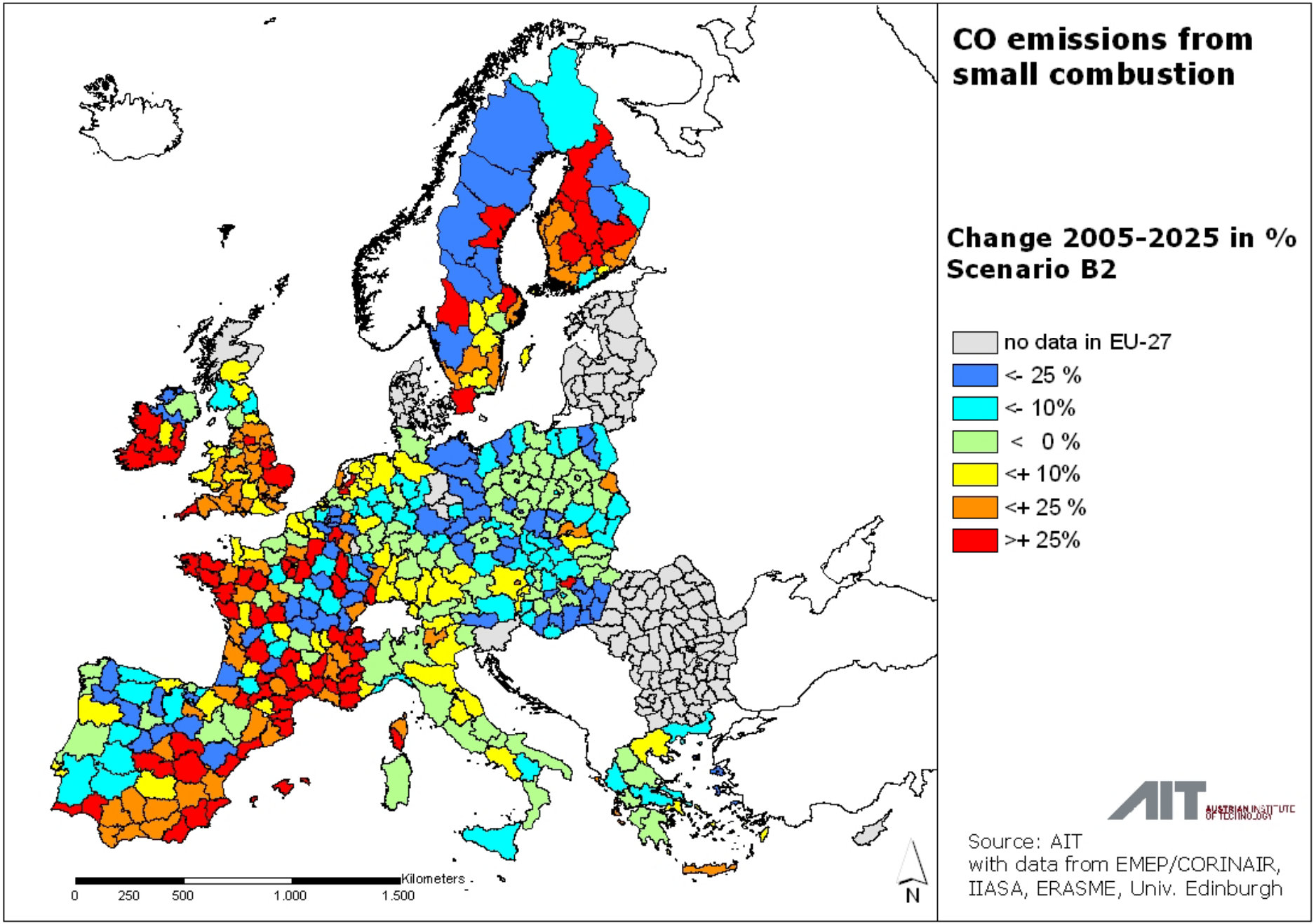
CO emissions from small combustion
Change 2005-2025 in %
Scenario B2
no data in EU-27
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<+ 25 %
>+ 25%
Kilometers
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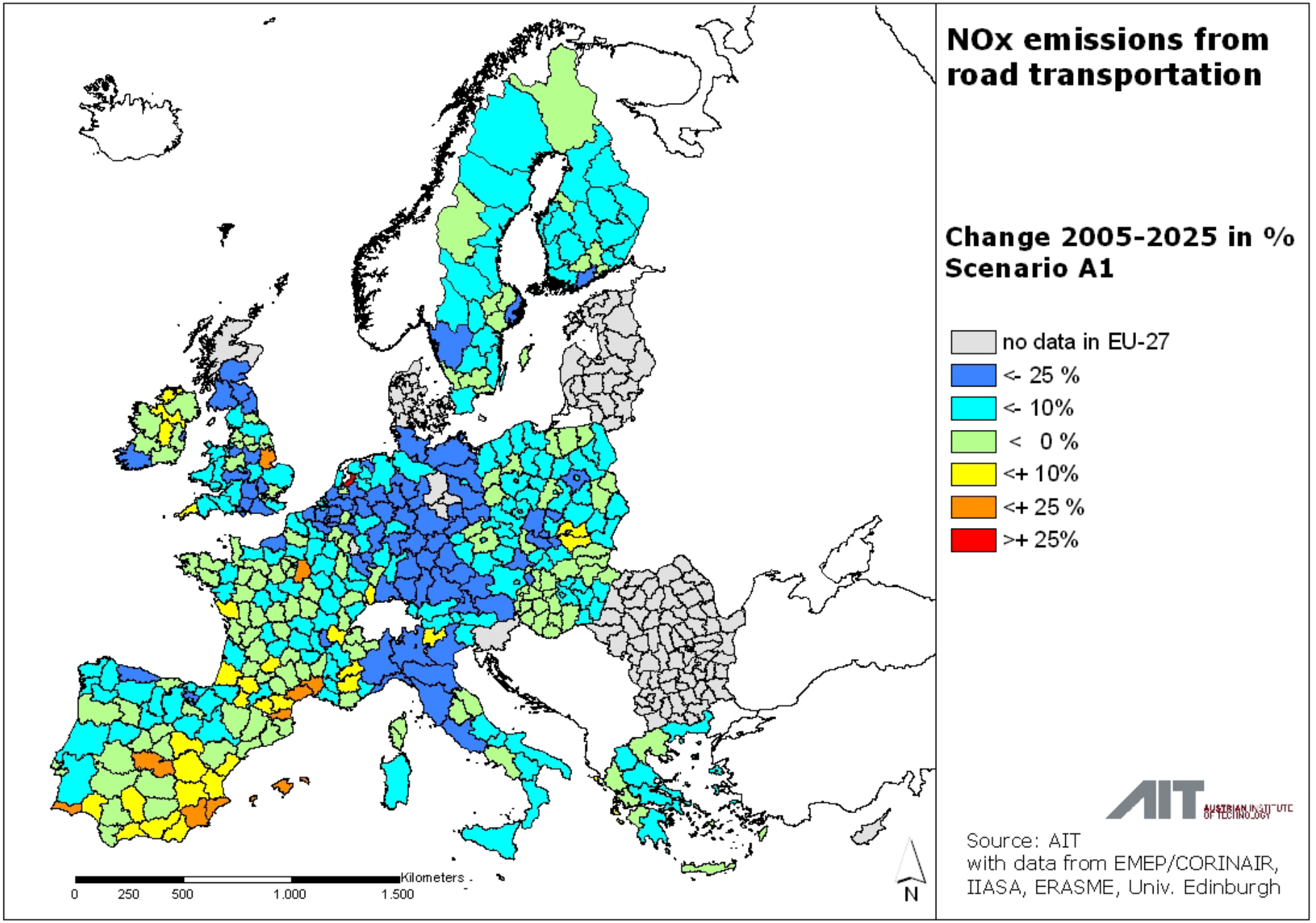
NOx emissions from road transportation
Change 2005-2025 in %
Scenario A1
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
<+ 25 %
>+ 25%
Kilometers
0 250 500 1.000 1.500
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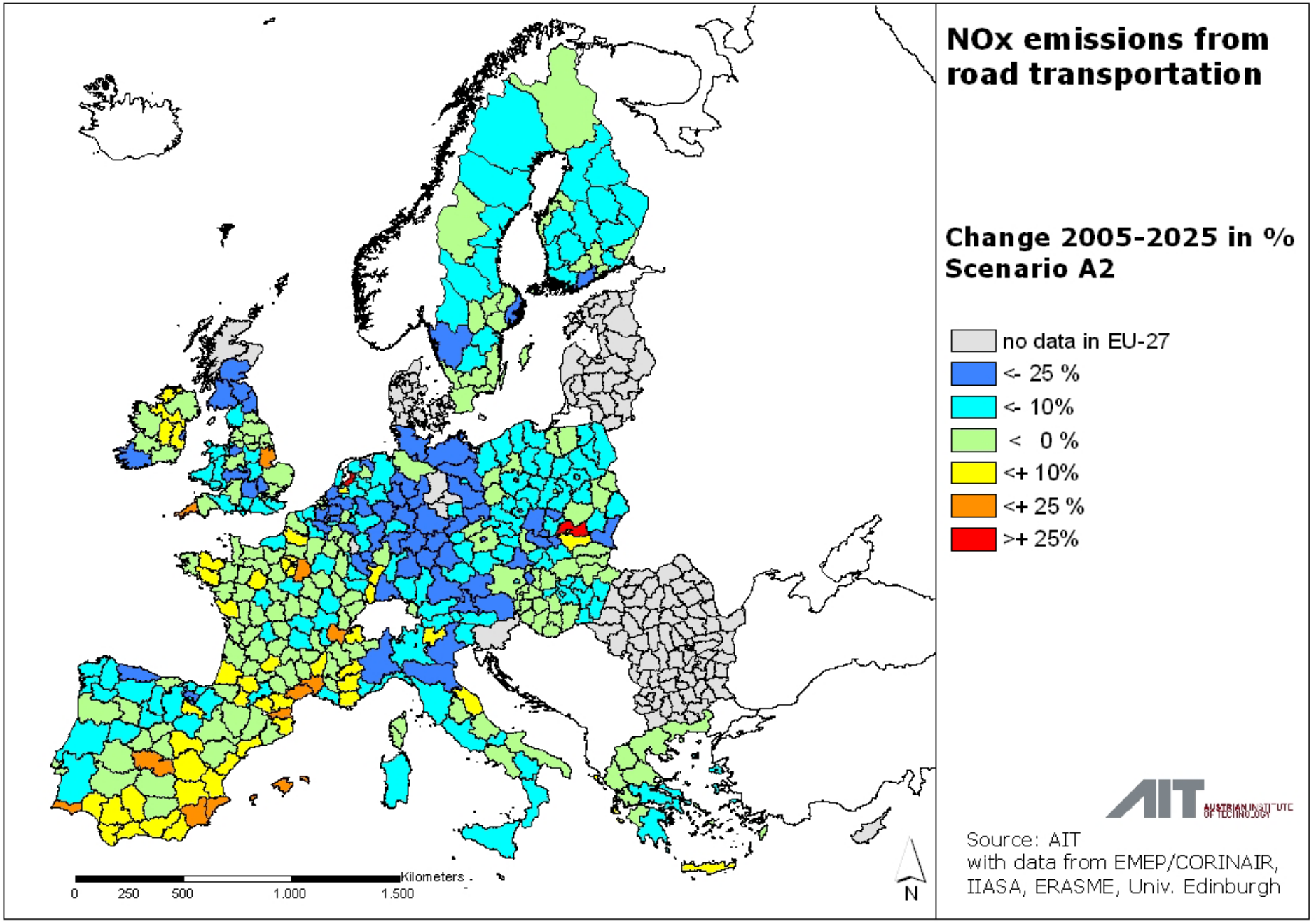
Source: AIT
with data from EMEP/CORINAIR,
IIASA, ERASME, Univ. Edinburgh


NOx emissions from road transportation
Change 2005-2025 in %
Scenario A2
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
<+ 25 %
>+ 25%
Kilometers
0 250 500 1.000 1.500
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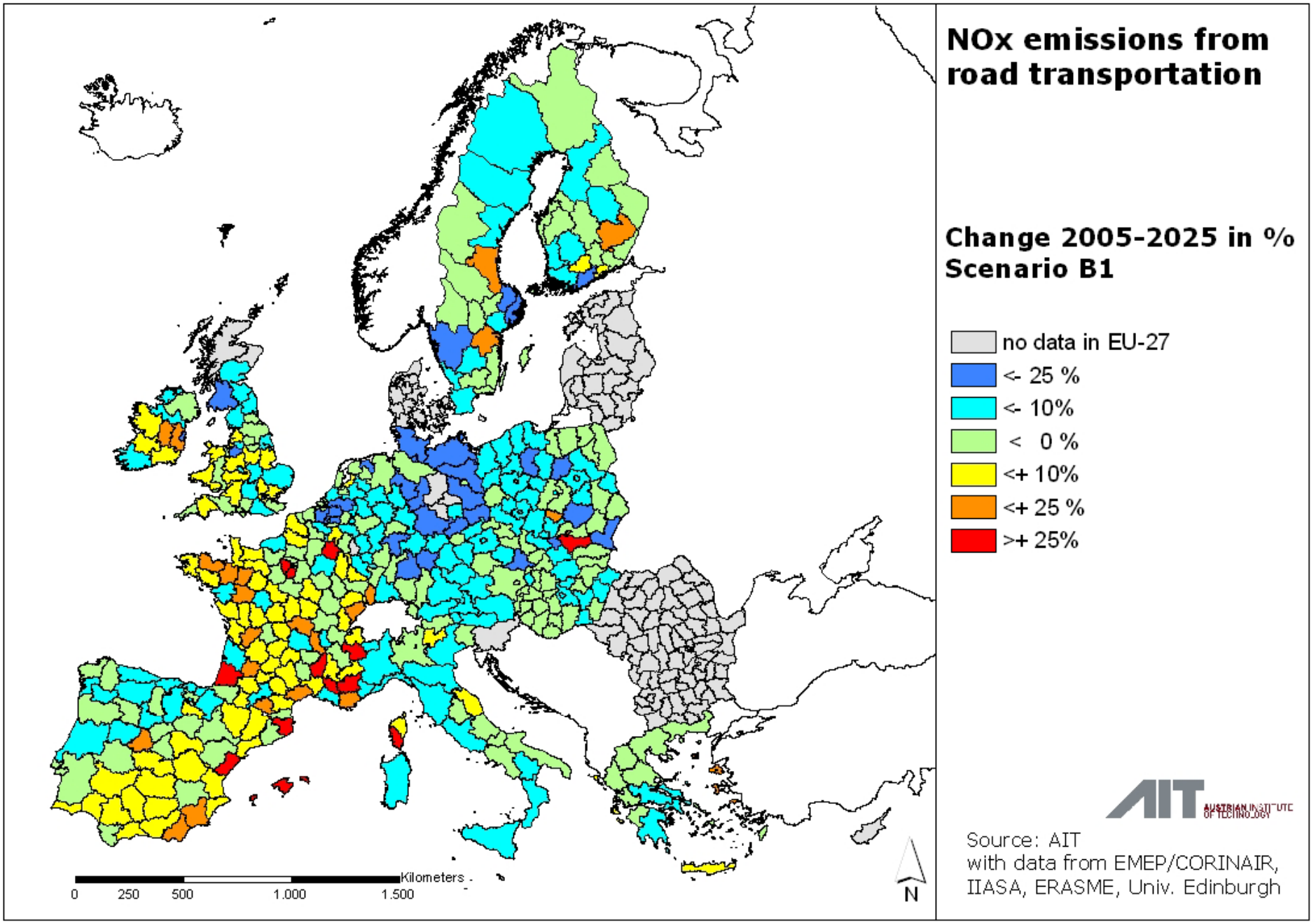
Source: AIT
with data from EMEP/CORINAIR,
IIASA, ERASME, Univ. Edinburgh


NOx emissions from road transportation
Change 2005-2025 in %
Scenario B1
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
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Kilometers
0 250 500 1.000 1.500
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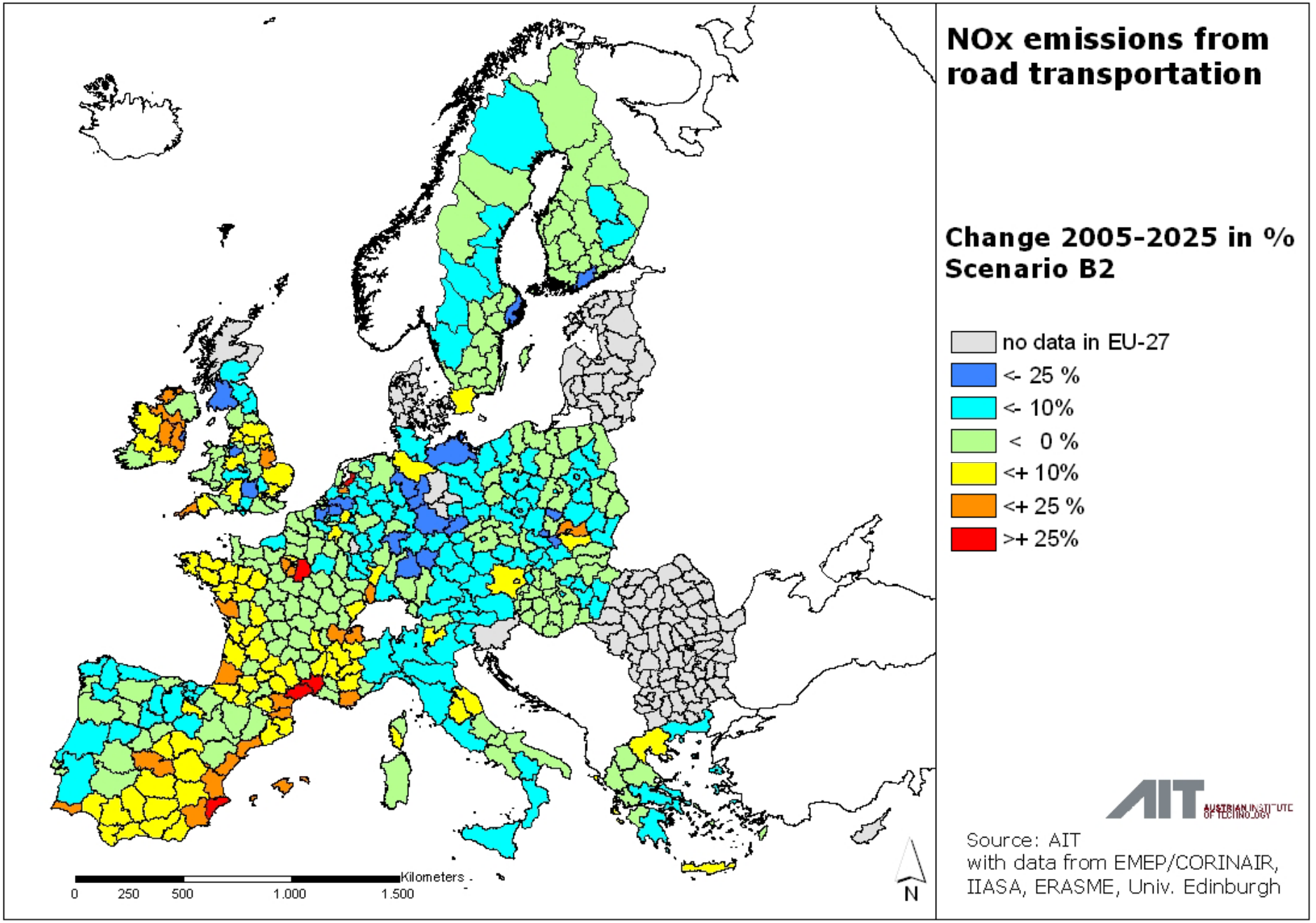
IIASA, ERASME, Univ. Edinburgh


NOx emissions from road transportation
Change 2005-2025 in %
Scenario B2
no data in EU-27
<- 25 %
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<+ 10%
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>+ 25%
Kilometers
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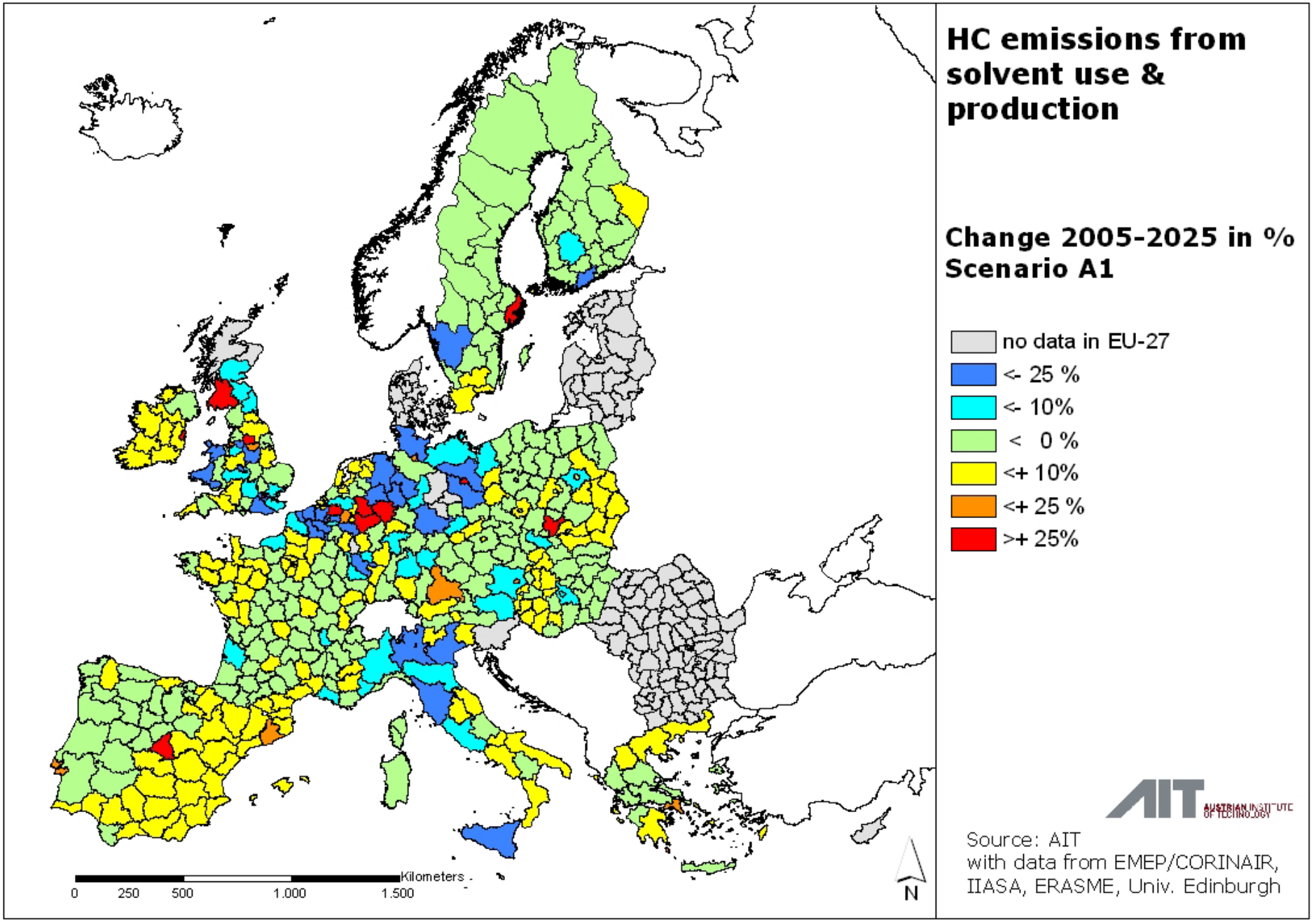
HC emissions from solvent use & production
Change 2005-2025 in %
Scenario A1
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
<+ 25 %
>+ 25%
Kilometers
0 250 500 1.000 1.500
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AIT
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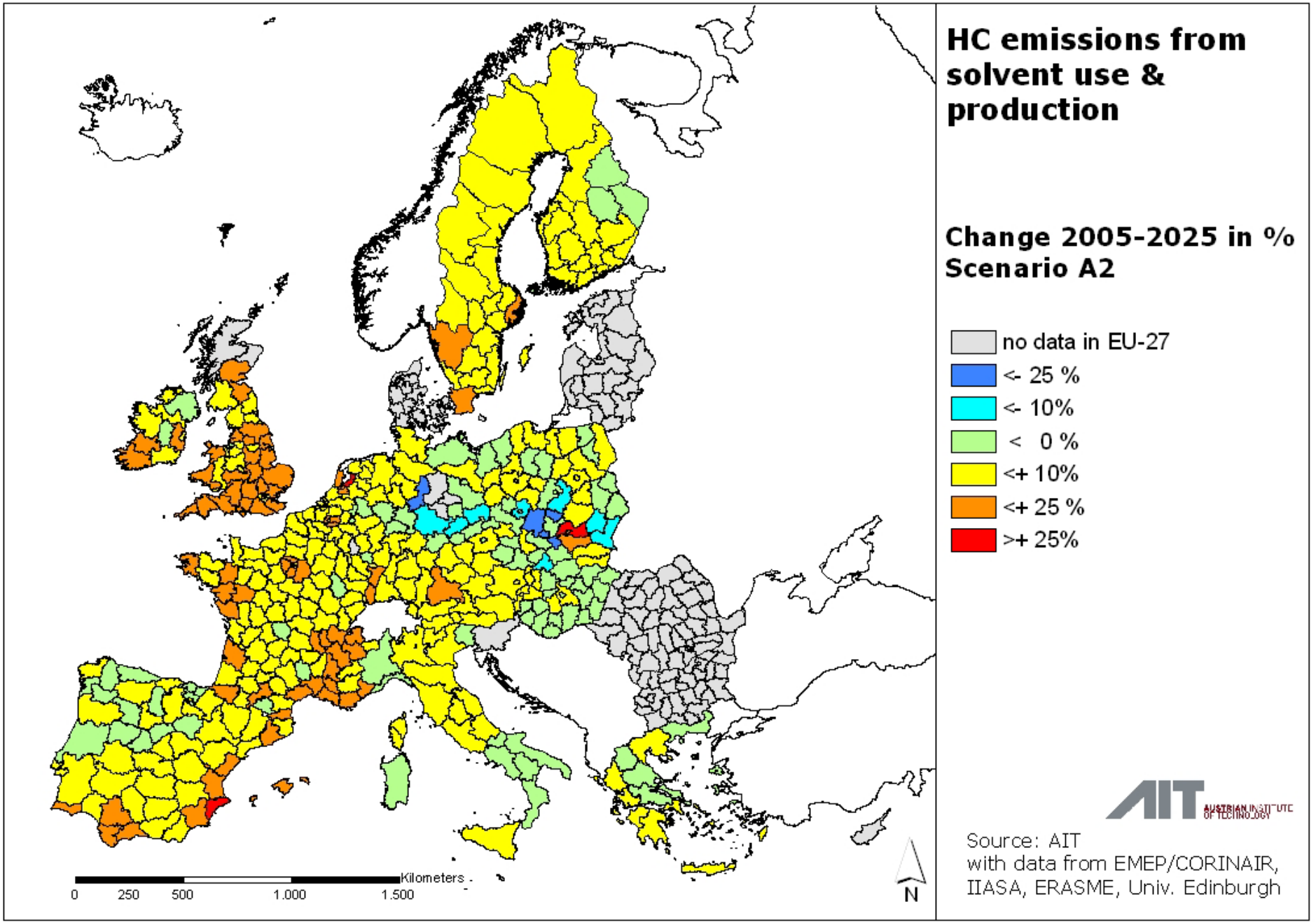
Source: AIT
with data from EMEP/CORINAIR,
IIASA, ERASME, Univ. Edinburgh


HC emissions from solvent use & production
Change 2005-2025 in %
Scenario A2
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
<+ 25 %
>+ 25%
Kilometers
0 250 500 1.000 1.500
N
AIT
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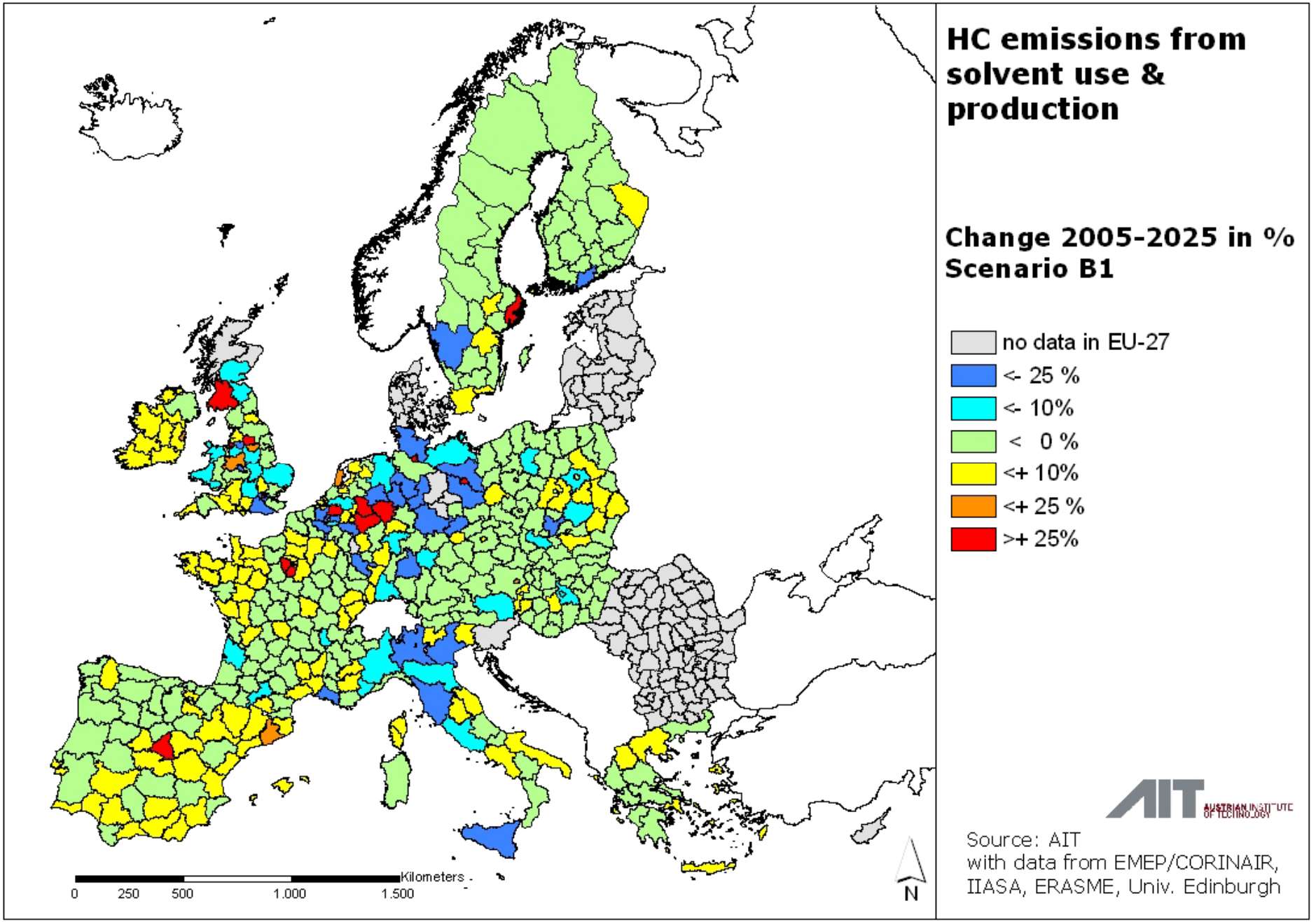
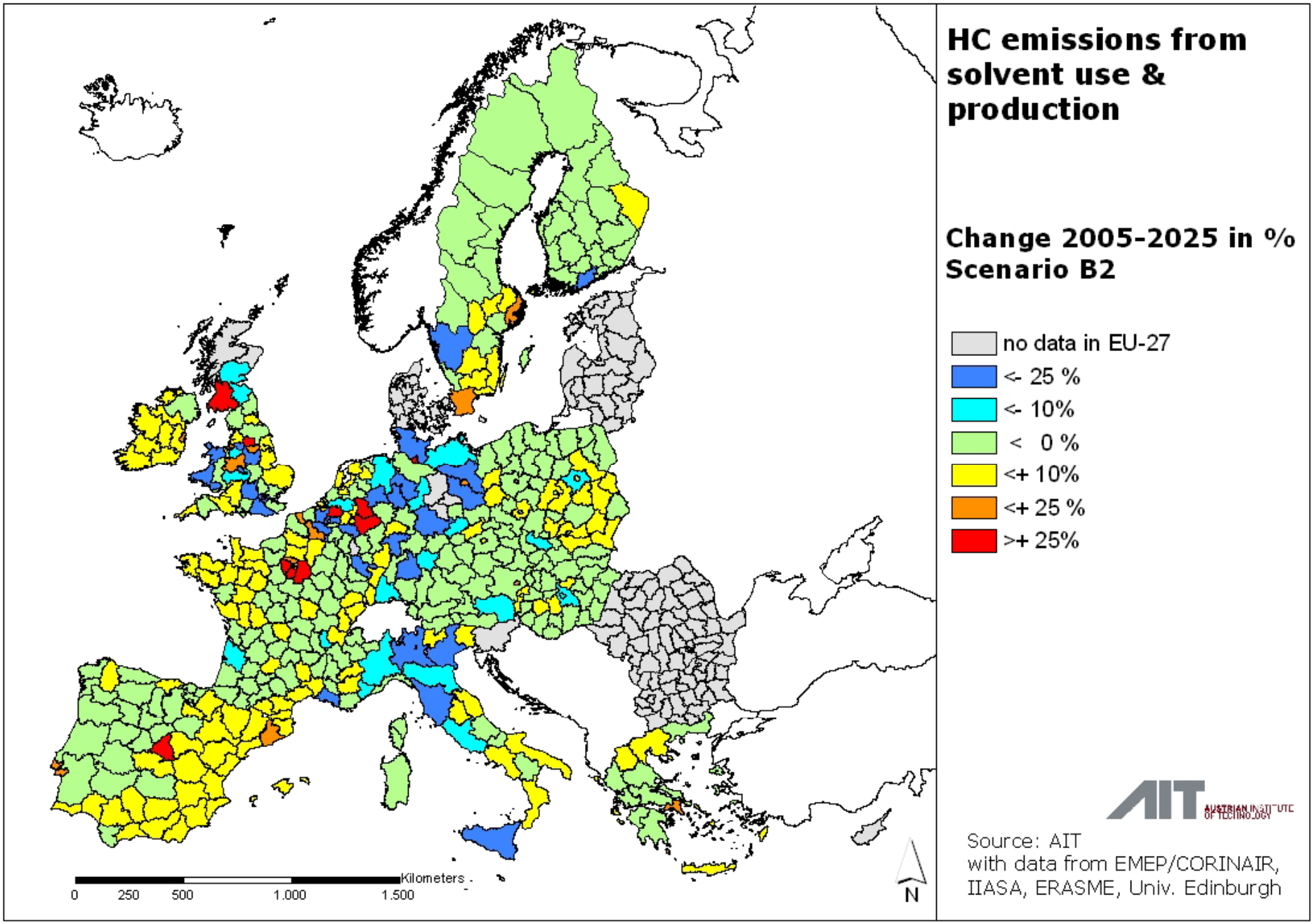
Source: AIT
with data from EMEP/CORINAIR,
IIASA, ERASME, Univ. Edinburgh


HC emissions from solvent use & production
Change 2005-2025 in %
Scenario B1
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
<+ 25 %
>+ 25%
Kilometers
0 250 500 1.000 1.500
N
AIT
AUSTRIAN INSTITUTE OF TECHNOLOGY
Source: AIT
with data from EMEP/CORINAIR,
IIASA, ERASME, Univ. Edinburgh


HC emissions from solvent use & production
Change 2005-2025 in %
Scenario B2
no data in EU-27
<- 25 %
<- 10%
< 0 %
<+ 10%
<+ 25 %
>+ 25%
Kilometers
0 250 500 1.000 1.500
N
AIT
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Source: AIT
with data from EMEP/CORINAIR,
IIASA, ERASME, Univ. Edinburgh