EMISSION INVENTORIES

| Hugo Denier van der Gon

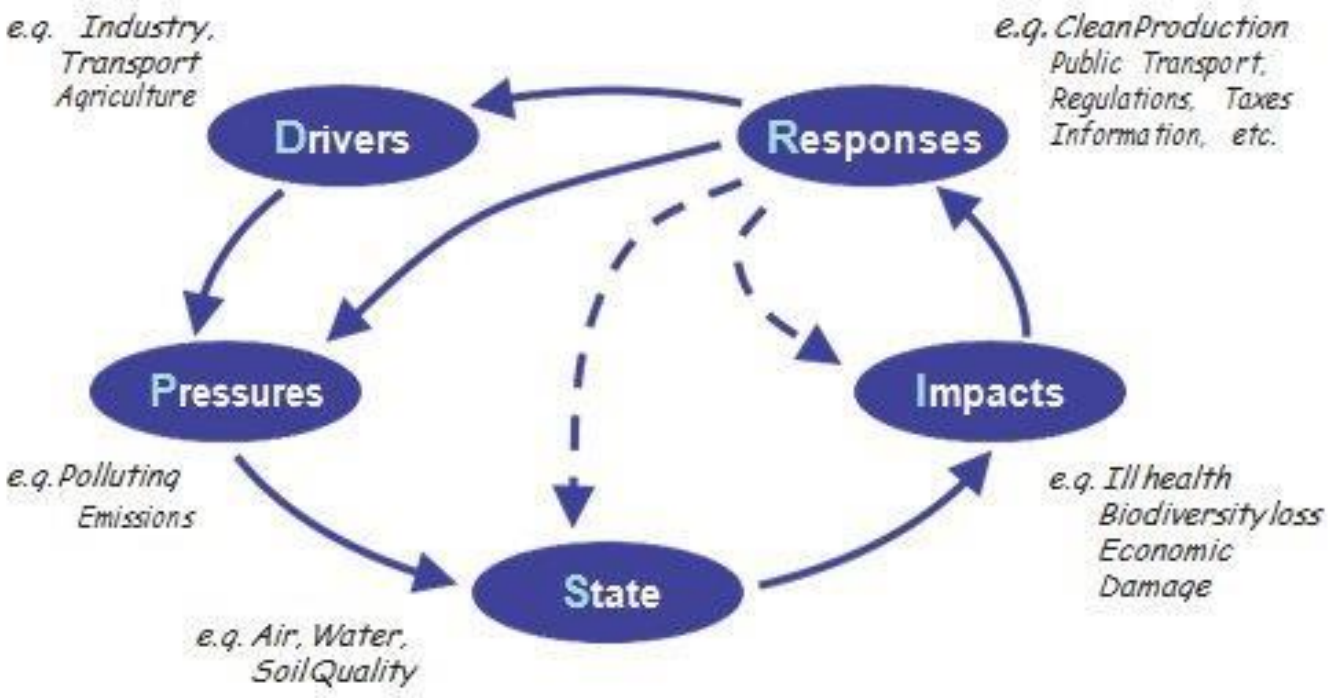
TNO innovation for life

OUTLINE

- Introduction - Why & how make an inventory ?
  - Insight in emission reporting
  - Emission database and trends
  - Comparison between countries (examples)
  - Some definitions
  - Zooming in on the city
  - Air quality – what is it made of?
  - Validate and Verify
- Questions & Discussion

DPSIR FRAMEWORK….

- **Emissions are key!**



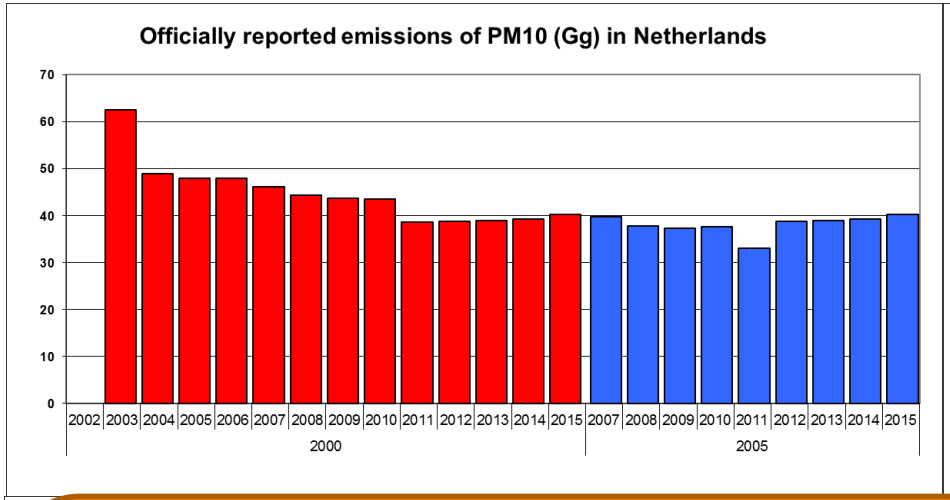
BOTTOM-UP EMISSION INVENTORIES AND HYBRID, COMPILED INVENTORIES

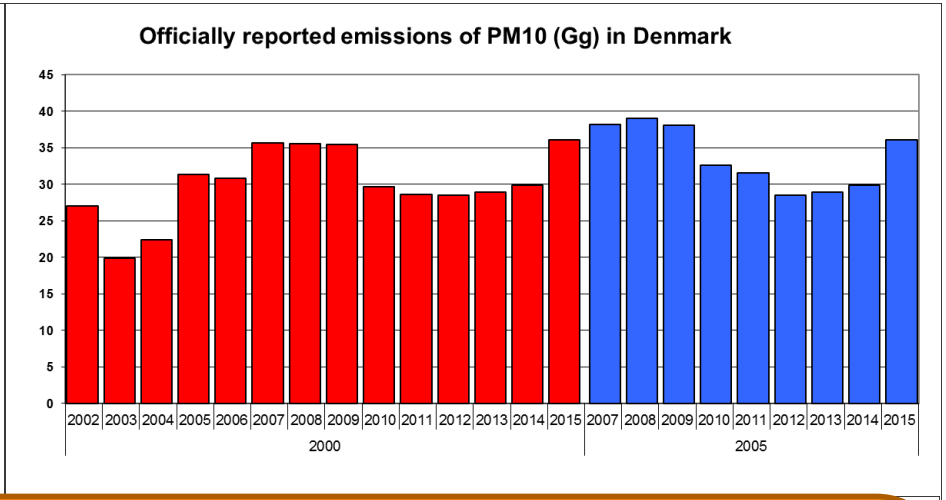
- **Classic Emission inventory**

$$Emission_{pollutant} = \sum_{activities} Activity\ rate_{activity} \times Emission\ factor_{activity,pollutant}$$

- **EMEP/EEA air pollutant emission inventory guidebook:** Technical guidance to prepare national emission inventories http://www.eea.europa.eu/publications/emep-eea-guidebook-2016
  - Examples: Dutch Emission Registration; The Emissions Database for Global Atmospheric Research (EDGAR) http://edgar.jrc.ec.europa.eu/
- **Hybrid, compiled Emission inventory** (collecting various different bottom-up estimates, possibly including expert judgements)
  - Example TNO-MACC (Kuenen et al., ACP, 2014)

OFFICIALLY REPORTED EMISSIONS OF PM10 (KT)



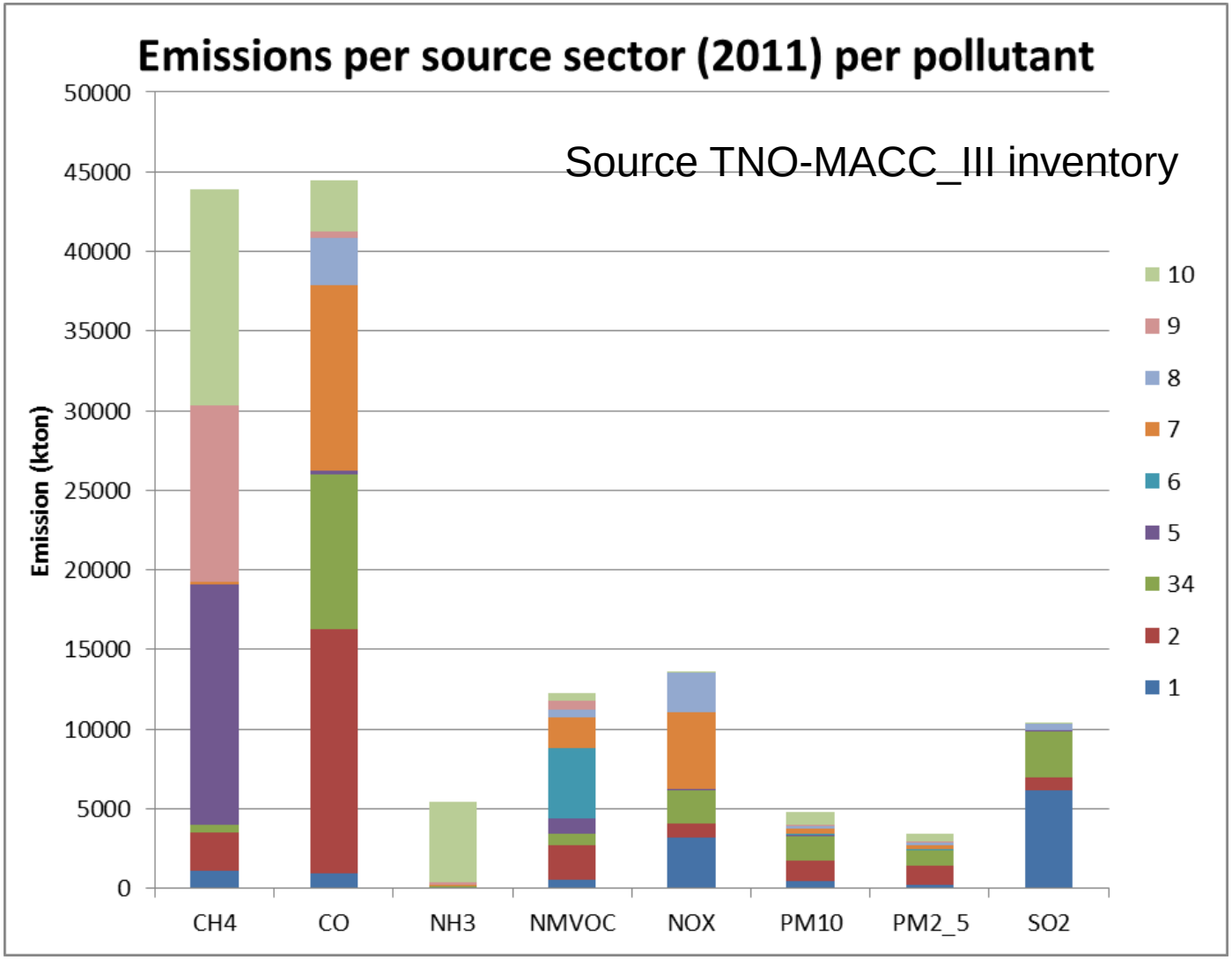


Important consequences:

- Emission inventories are not fixed! New insights generate revised EIs
- As a user you need to be aware of what you use (year, version)
- Rule in EI world: If the time series is extended, all years need to be updated

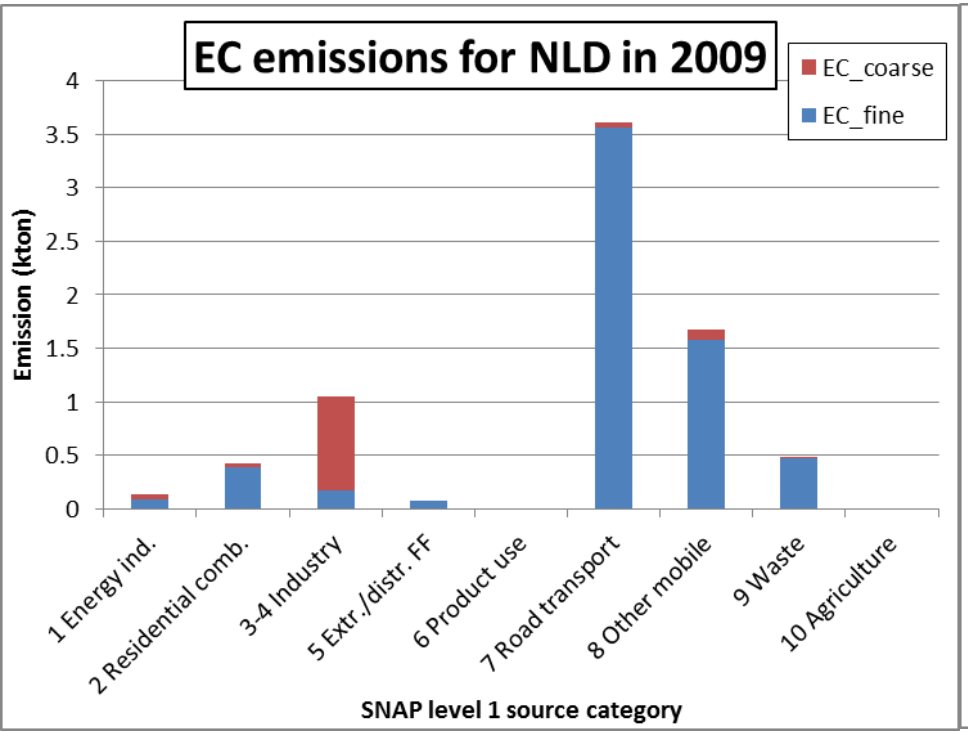
Thanks to EMEP- CEIP for keeping the data and making it available!

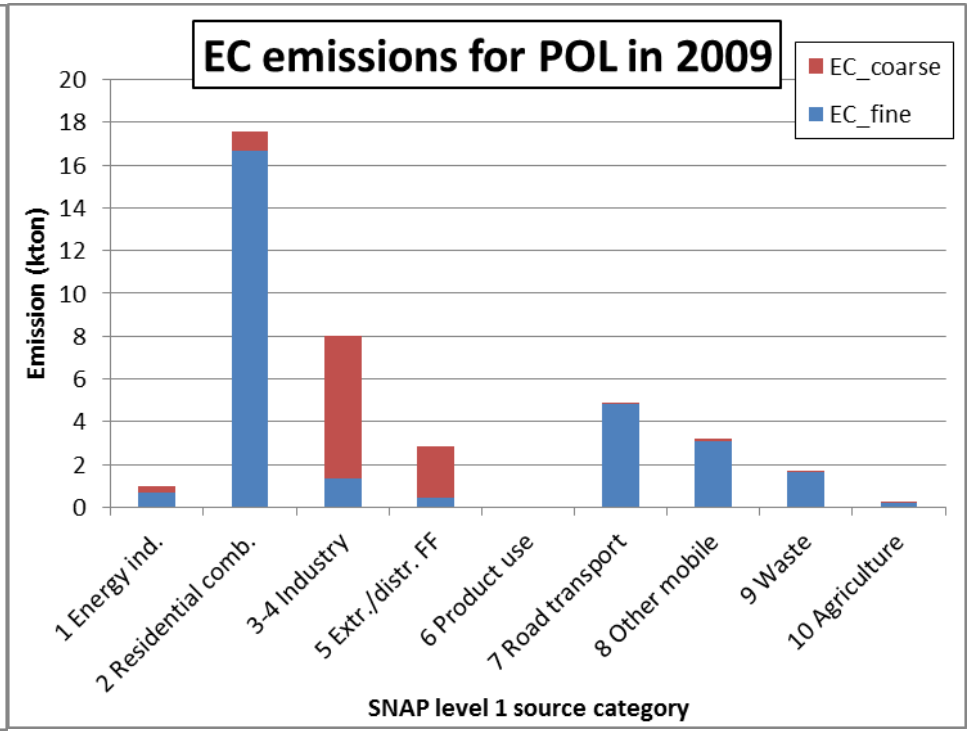
EUROPEAN EMISSION INVENTORY CONTAINS PRIORITY AIR POLLUTANTS FROM 200+ SOURCES (GROUPED IN 10 CATEGORIES)



Example of derived

Elemental carbon emissions by country by sector



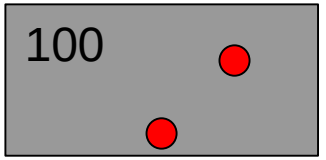


Dominant sources vary by country!
Effective policy in Netherlands addresses road transport,
in Poland focus should be on residential combustion

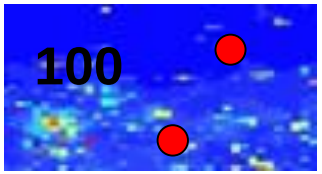
SOME EMISSION INVENTORY (EI) DEFINITIONS…

IF ONLY FOR 20 MINUTES

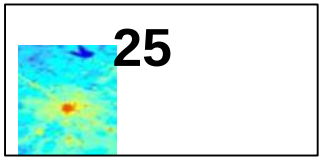
1. **Bottom-up EI at the national scale**



2. **Top-down or downscaled based on 1)**

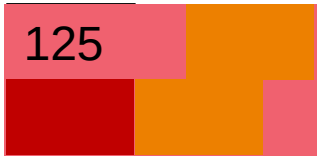


3. **Bottom-up city EI**

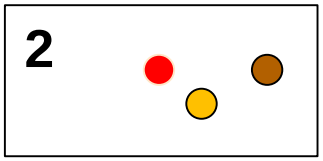


---

4. **Top-down EI using inverse modelling, Earth observations (EO), concentration measurements**



5. **Bottom-up using EO data (the EO give the activities e.g. burnt area)**

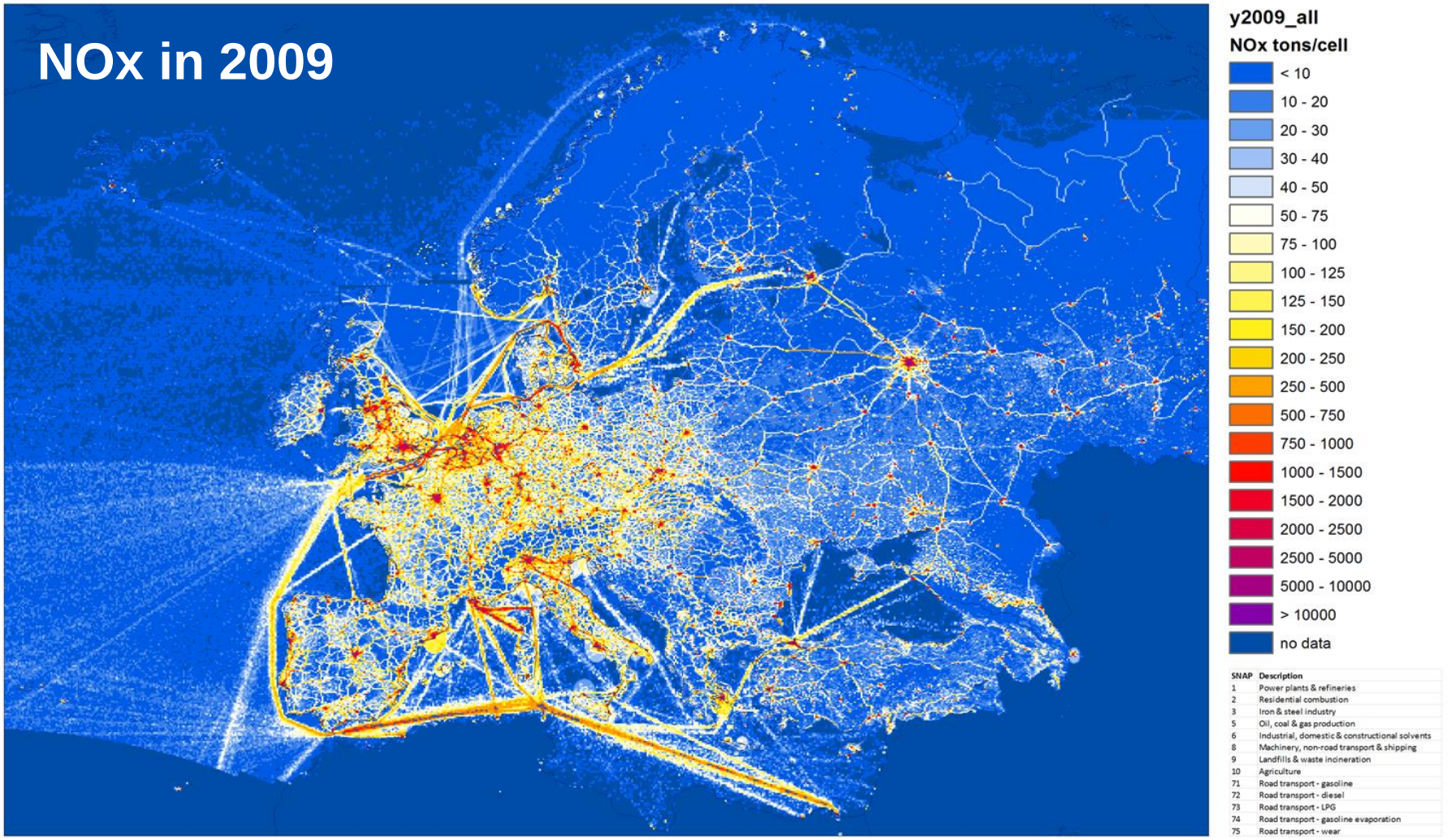


A NATIONAL SCALE BOTTOM-UP EI FOR DIFFUSE SOURCES WOULD HAVE THIS RESOLUTION…

Point sources are independent of resolution if the coordinates are known…
Errors could be in wrong assignment of emissions or address complications (head quarters vs facility)

Monitoring atmospheric composition & climate

RESULTING EMISSION MAPS



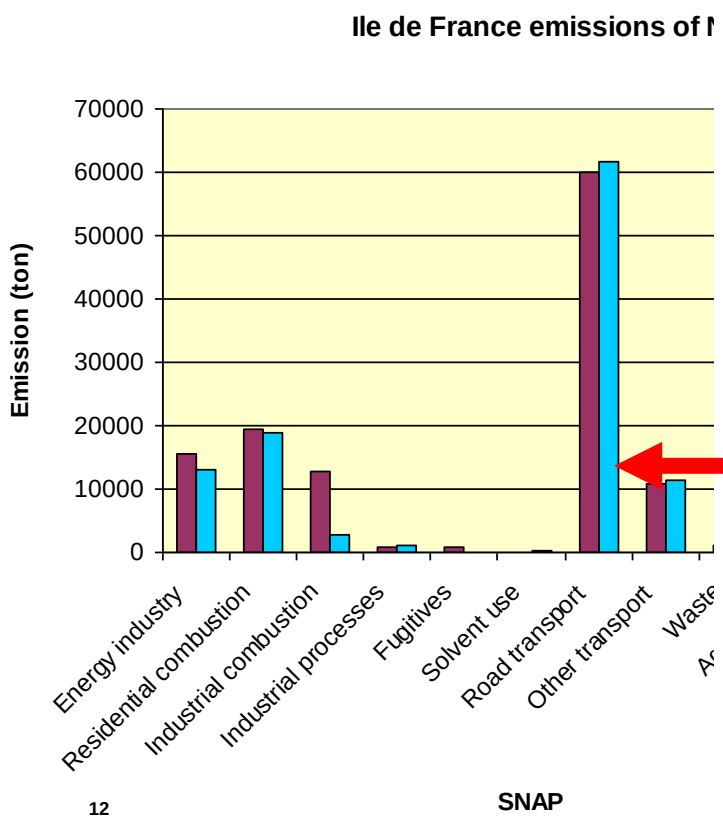
QUANTIFICATION OF THE URBAN AIR POLLUTION INCREMENT AND ITS DEPENDENCY ON THE USE OF DOWN-SCALED AND BOTTOM- UP CITY EMISSION INVENTORIES

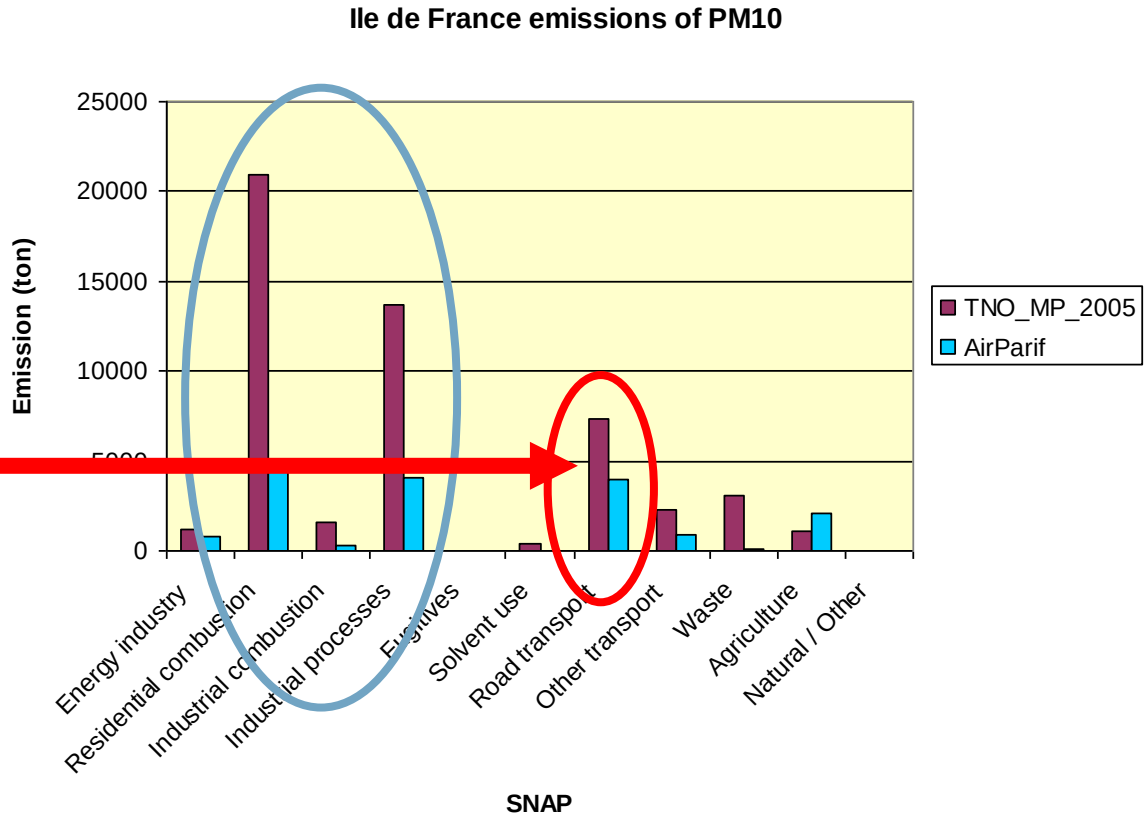
Timmermans, R. H.A.C. Denier van der Gon, J.J.P. Kuenen, A.J. Segers, C. Honoré, O. Perrussel, P.J.H. Builtjes, M. Schaap,

Urban Climate 6 (2013) 44–62, 2013

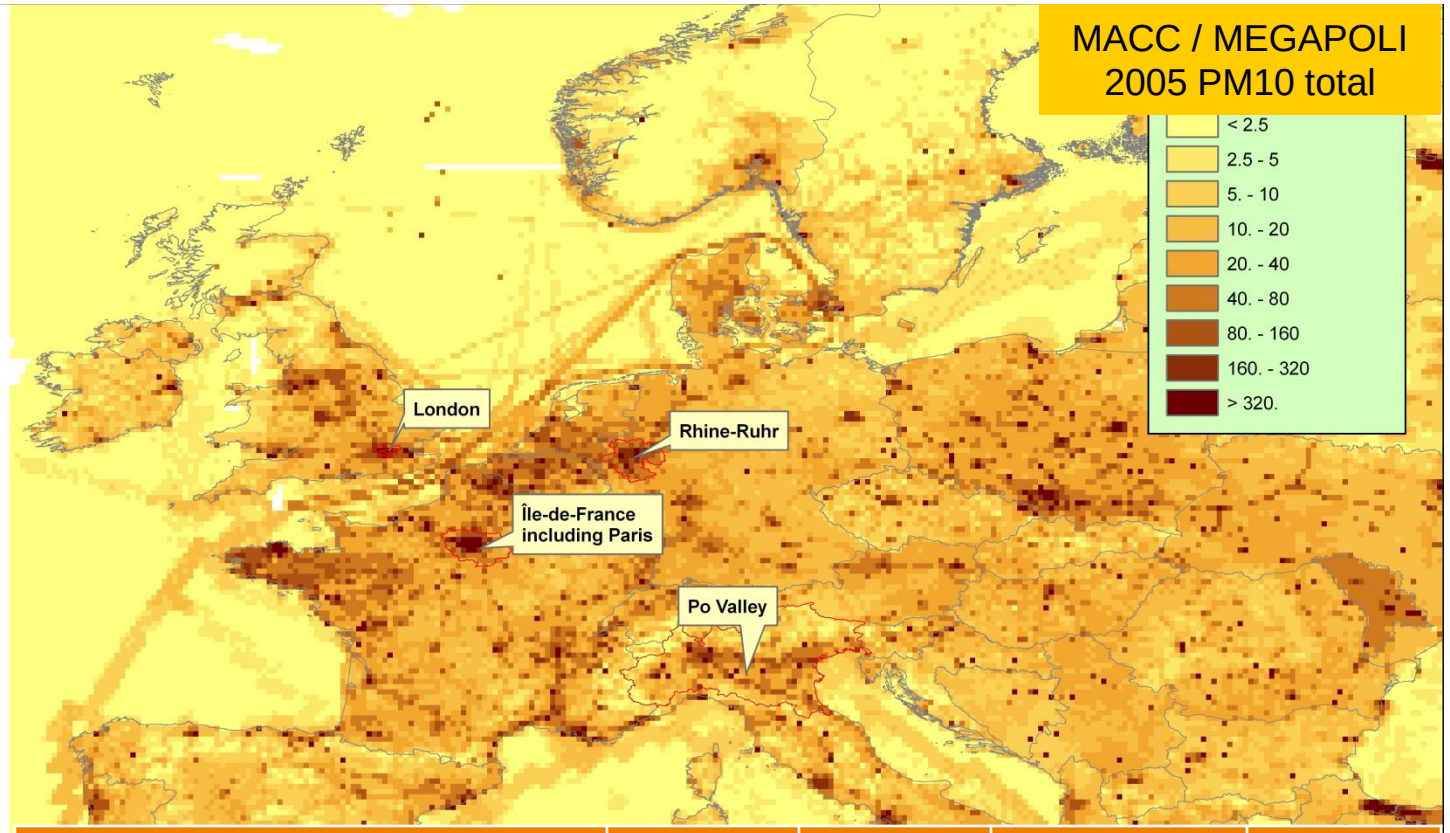
CASE STUDY 1: PARIS

- The emission authority in Paris is AirParif (http://www.airparif.asso.fr/).
- Emission inventory for the Ile-de-France region incl. Paris
- To keep consistency we take over complete Ile-de-France region
- Compare local bottom-up inventory to European down-scaled inventory per sector





RESULT: DOWNSCALED EMISSION DATA SET WITH NESTED BOTTOM-UP EMISSION INVENTORIES



Bottom up devided by TNO-MACC	London	Paris	Rhine-Ruhr	Po Valley
PM10	26%	33%	55%	110%
NOx	62%	95%	108%	107%

AIR POLLUTION
WHAT IS IT MADE OF?

NOx emissions = NO + NO2;

It is what it is….

PM = ….?

TROOPER STUDY (RIEDIKER ET AL)

Study about traffic particles and cardiovascular health

- NC highway patrol troopers
- Troopers work up to 9 hrs inside their cars
- Health effects associated with metals in PM2.5 (brake wear)

Riediker, et al. 2003. Environ Sci Technol. 37:2084-2093.

Riediker, et al. 2004. Am J Respir Crit Care Med. 169:934-940.

Riediker et al. 2004. Part Fib Toxicol. 1:2.

TROOPER STUDY

- **Traffic particles are associated to negative health effects**

- **(This) Occupational study proposes brake wear involvement**

  - Strong response to “Speed change” PM;

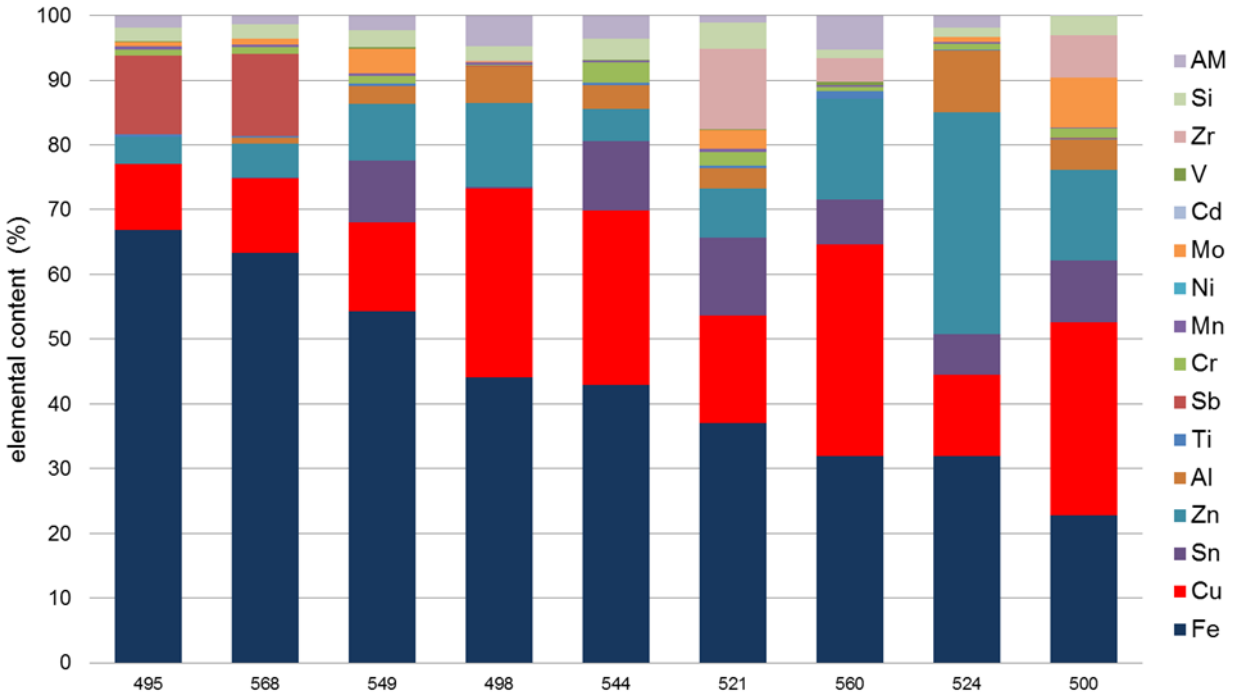
  - Vascular inflammation & coagulation; Changed autonomous control of the heart

  - Cell studies show increased inflammation to brake wear

- **Insufficient data to estimate scale for general population**

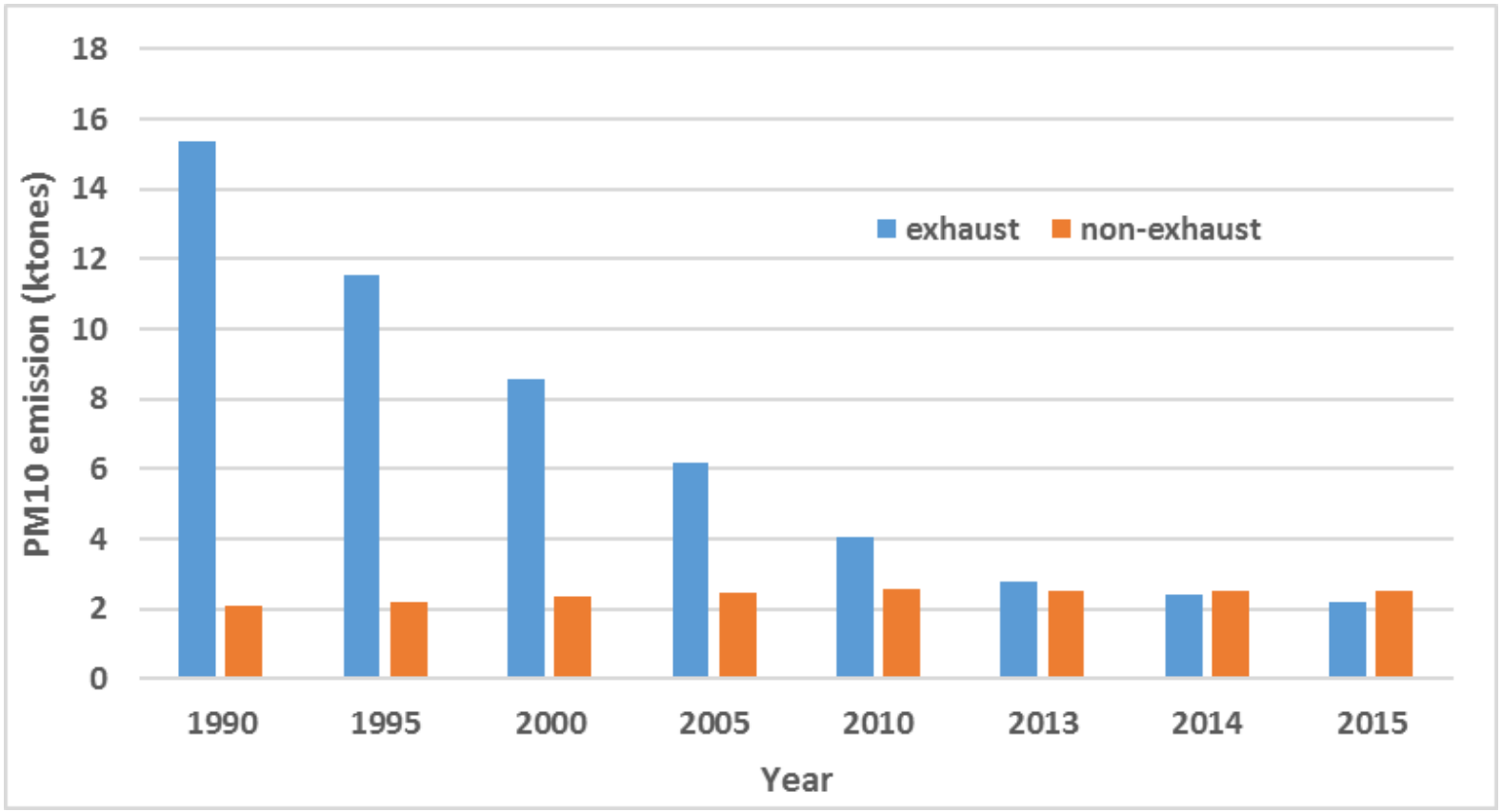
- **In the Netherlands we realized the data and composition profiles in our emission inventory were outdated…..**

METAL CONTENT (% M/M) OF SELECTED BRAKE PAD SAMPLES BY XRF ANALYSIS



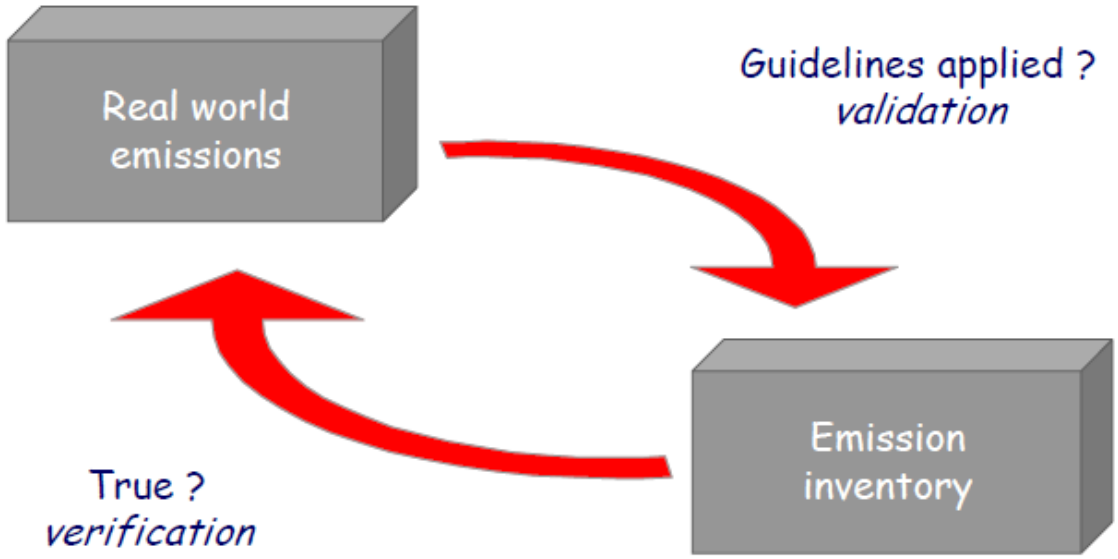
Hulskotte, J.H.J., G.D. Roskam, H.A.C. Denier van der Gon, Elemental composition of current automotive braking materials and derived air emission factors, Atmospheric Environment, 99, 436–445, 2014

TREND IN ROAD TRANSPORT PM EMISSIONS IN THE NETHERLANDS 1990-2015



A major change in composition – from combustion to wear dominated…..

VALIDATION AND VERIFICATION



- ***Validation*** *checks whether or not the guidelines have been applied, whereas* ***Verification*** *checks whether the data are true*.

TO SUMMARIZE….

Good emission data are crucial!

- To understand the state of the environment
- Source sector information (from inventories) is essential for mitigation policies
- Bottom-up at the national scale results in a down-scaled map at grid level
- A national downscaled map is often not accurate at the city scale…corrections can be made but takes time – (see Kuik et al., ACP 2016)
- PM10 / PM2.5 is complex differs from other pollutants like NO_2 or SO_2
- PM composition is a big issue in inventories and in health impact
- Ambient PM composition changes over time due to shifting source contributions
- Independent verification of inventories is necessary

THANK YOU FOR YOUR ATTENTION

TNO innovation for life

Contact: Hugo.deniervandergon@tno.nl

macc Monitoring atmospheric composition & climate

MEGAPOLI