The role of NH_3 on particulate matter pollution over Portugal

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AGÊNCIA PORTUGUESA DO AMBIENTE

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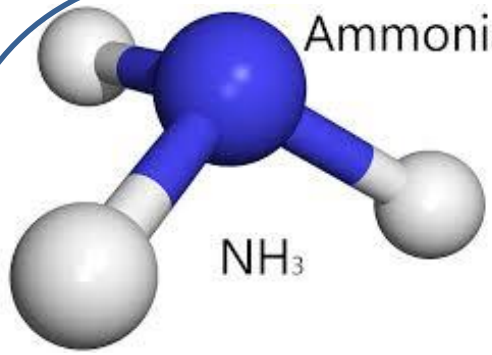
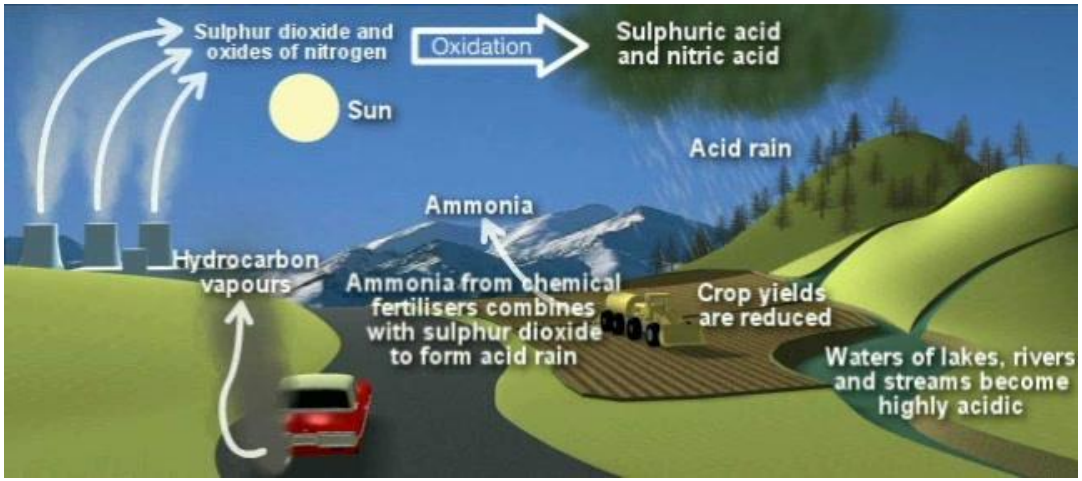
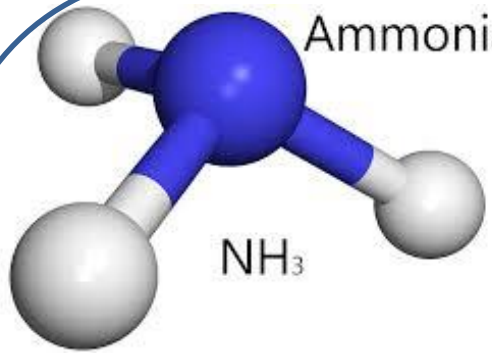


- Plays a vital role in atmospheric chemistry

- Reacts with sulphuric and nitric acids to form **ammonium sulphate** and **ammonium nitrate aerosols**.
- When deposited to ecosystems, causes over-enrichment of nitrogen, decrease in biological diversity, damage to sensitive vegetation, and acidification of soils.





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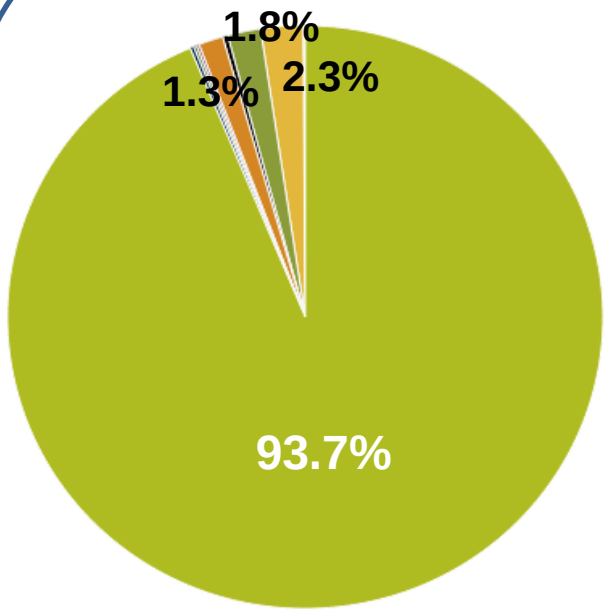
- Under favorable meteorological conditions, ammonium nitrate can contribute to **PM2.5 concentration peaks**

- PM2.5 have been linked to a range of **adverse health** effects such as increased rates of respiratory and cardiovascular illness

Ammonia emissions



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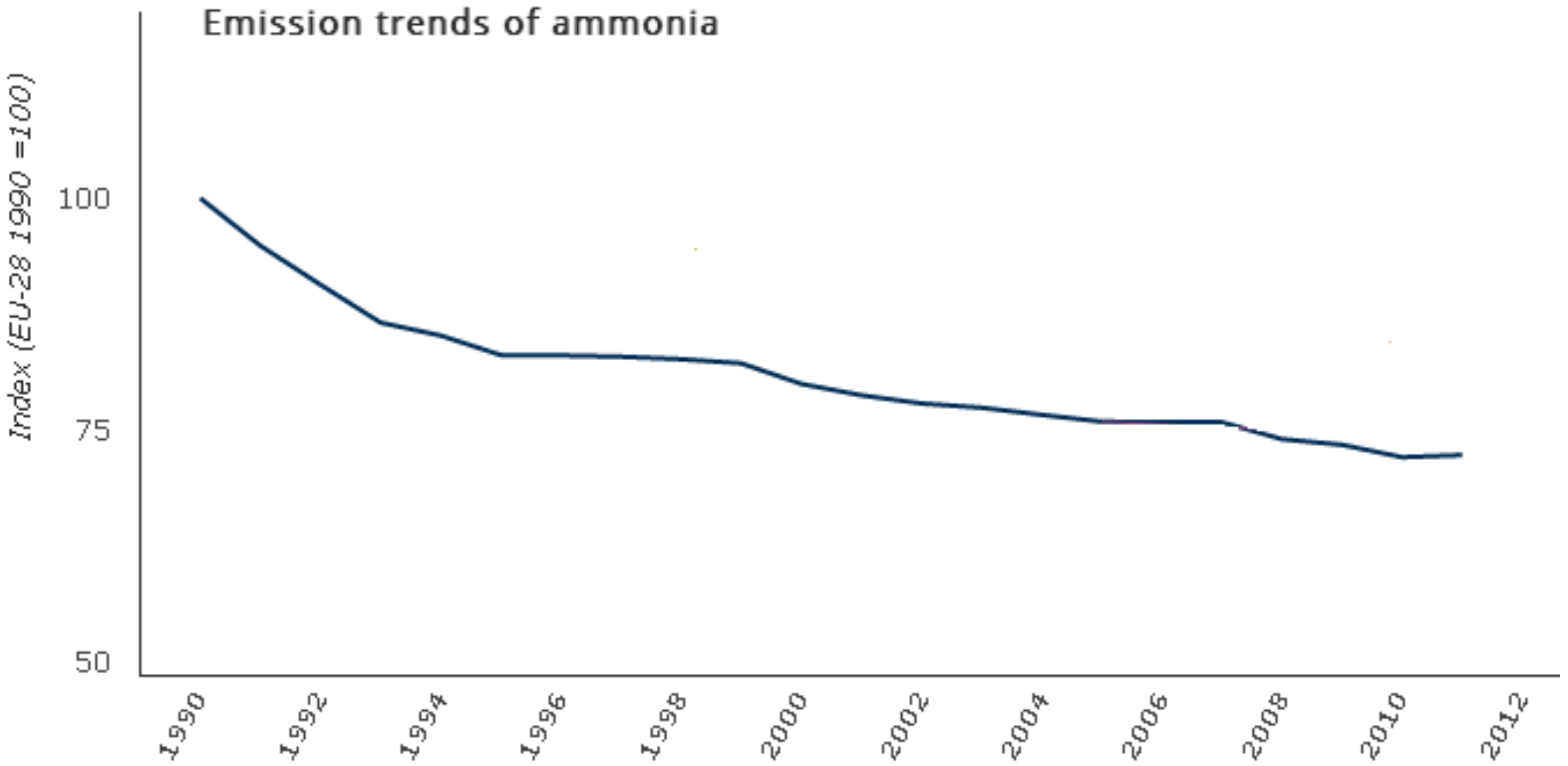
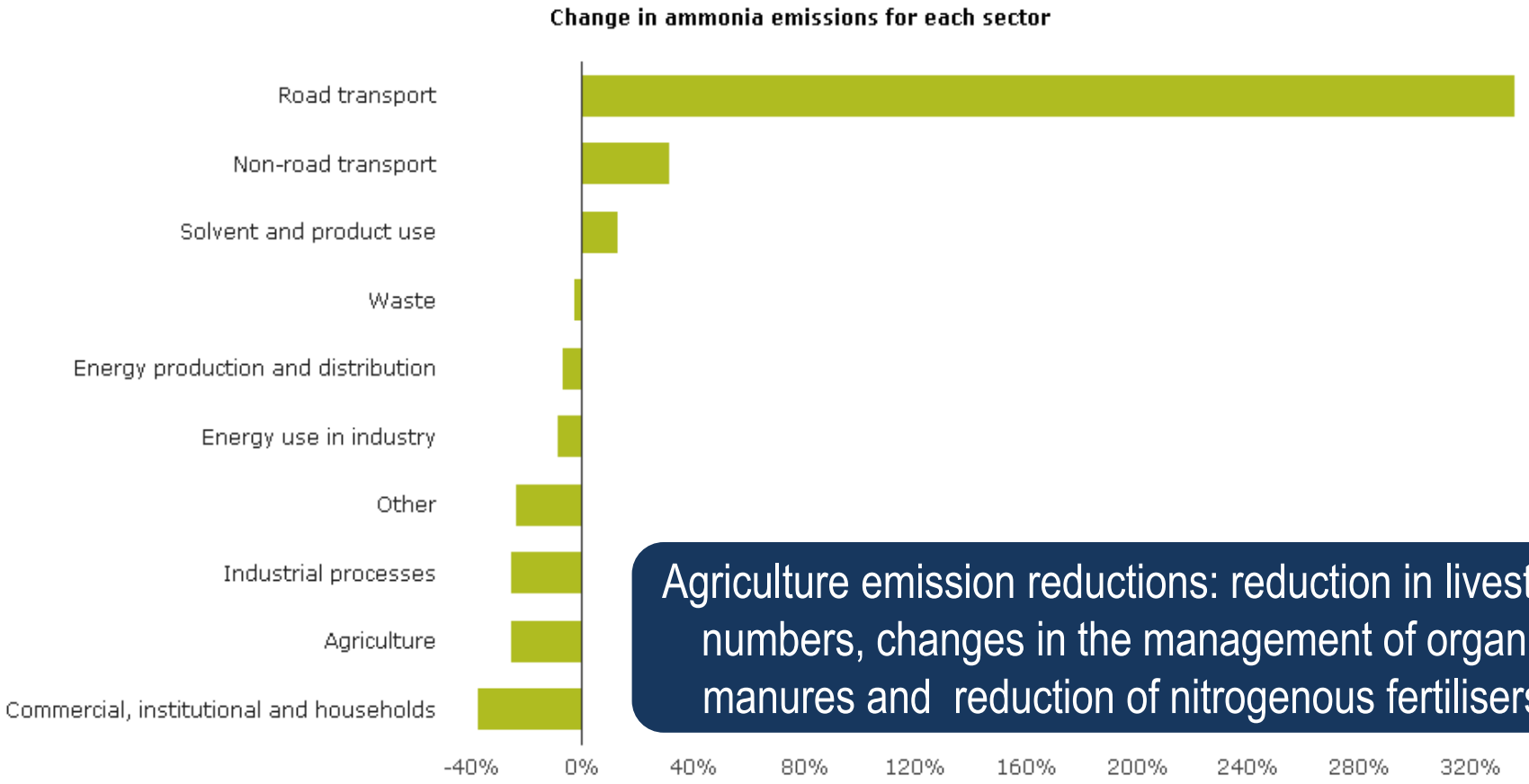


European ammonia emissions have declined by 25% between the years 1990 and 2011

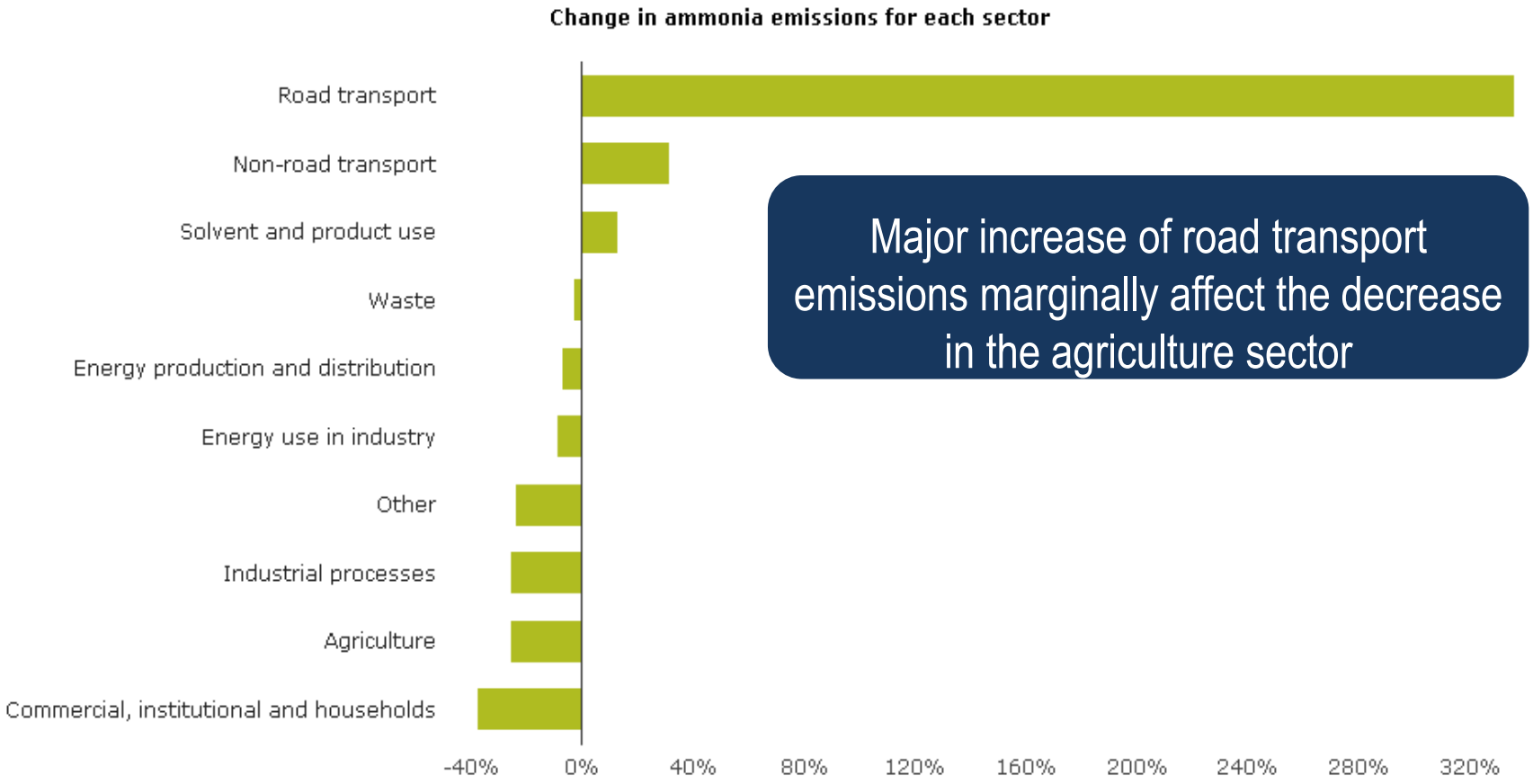
Source: EEA

Ammonia emissions



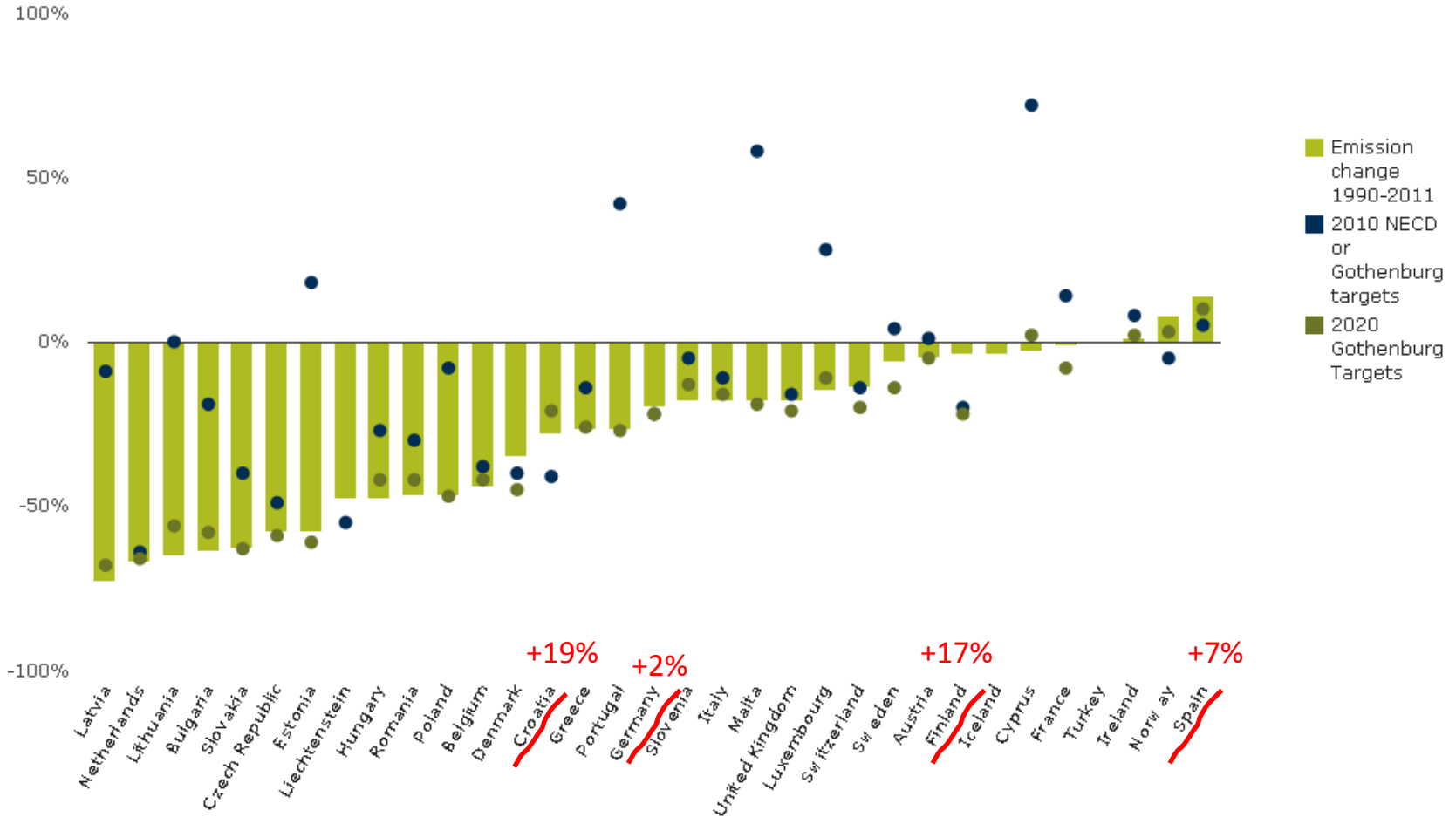
Agriculture emission reductions: reduction in livestock numbers, changes in the management of organic manures and reduction of nitrogenous fertilisers.

Ammonia emissions



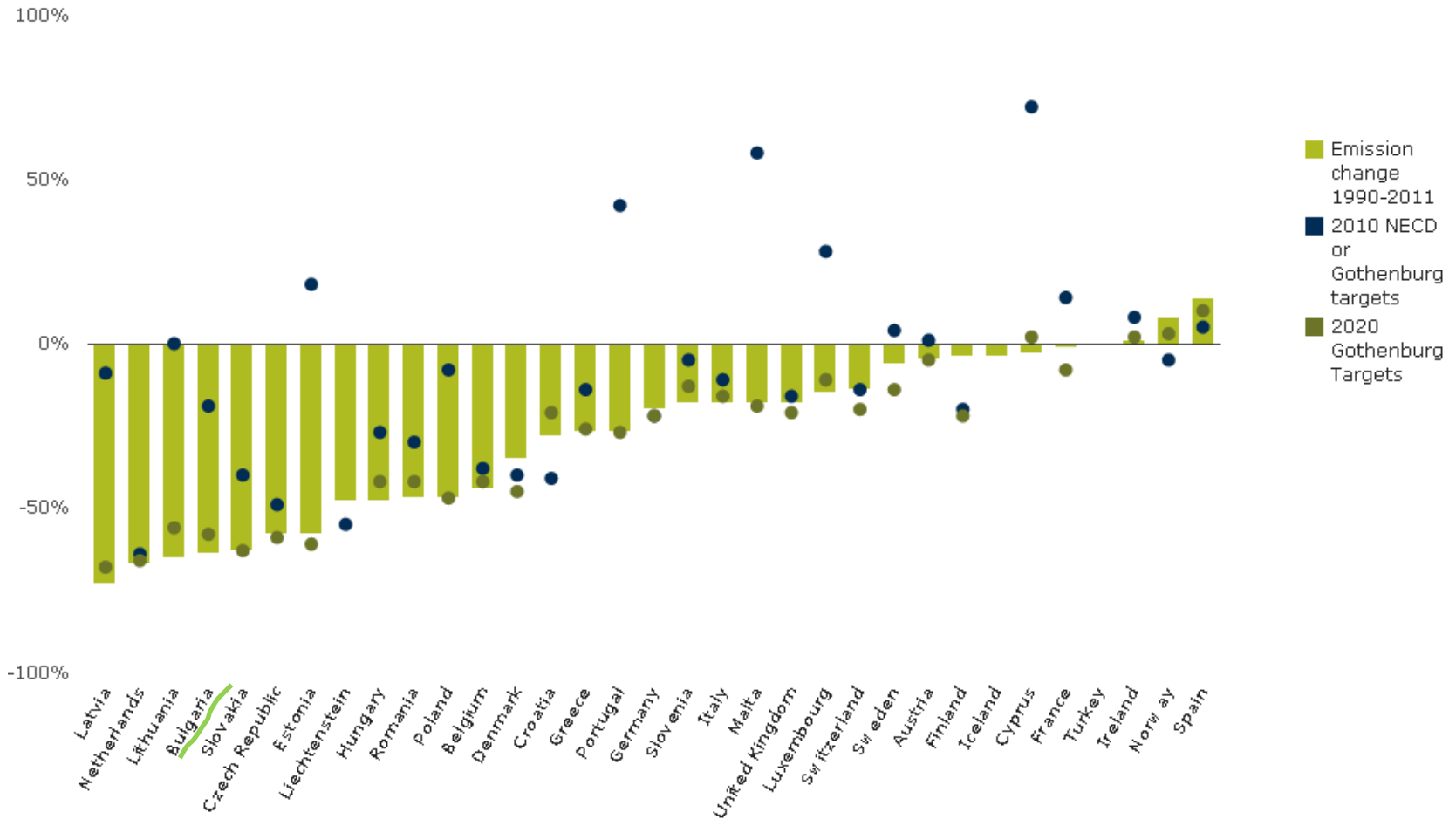
Major increase of road transport emissions marginally affect the decrease in the agriculture sector

Change in ammonia emissions compared with the 2010 NECD and the Gothenburg protocol targets



Of the 28 EU Member States, all but 4 countries reported 2011 ammonia emissions below the level of 2010 emission ceilings

Change in ammonia emissions compared with the 2010 NECD and the Gothenburg protocol targets



15 of the 28 EU Member States, have already met the 2020 targets proposed under the Gothenburg protocol.

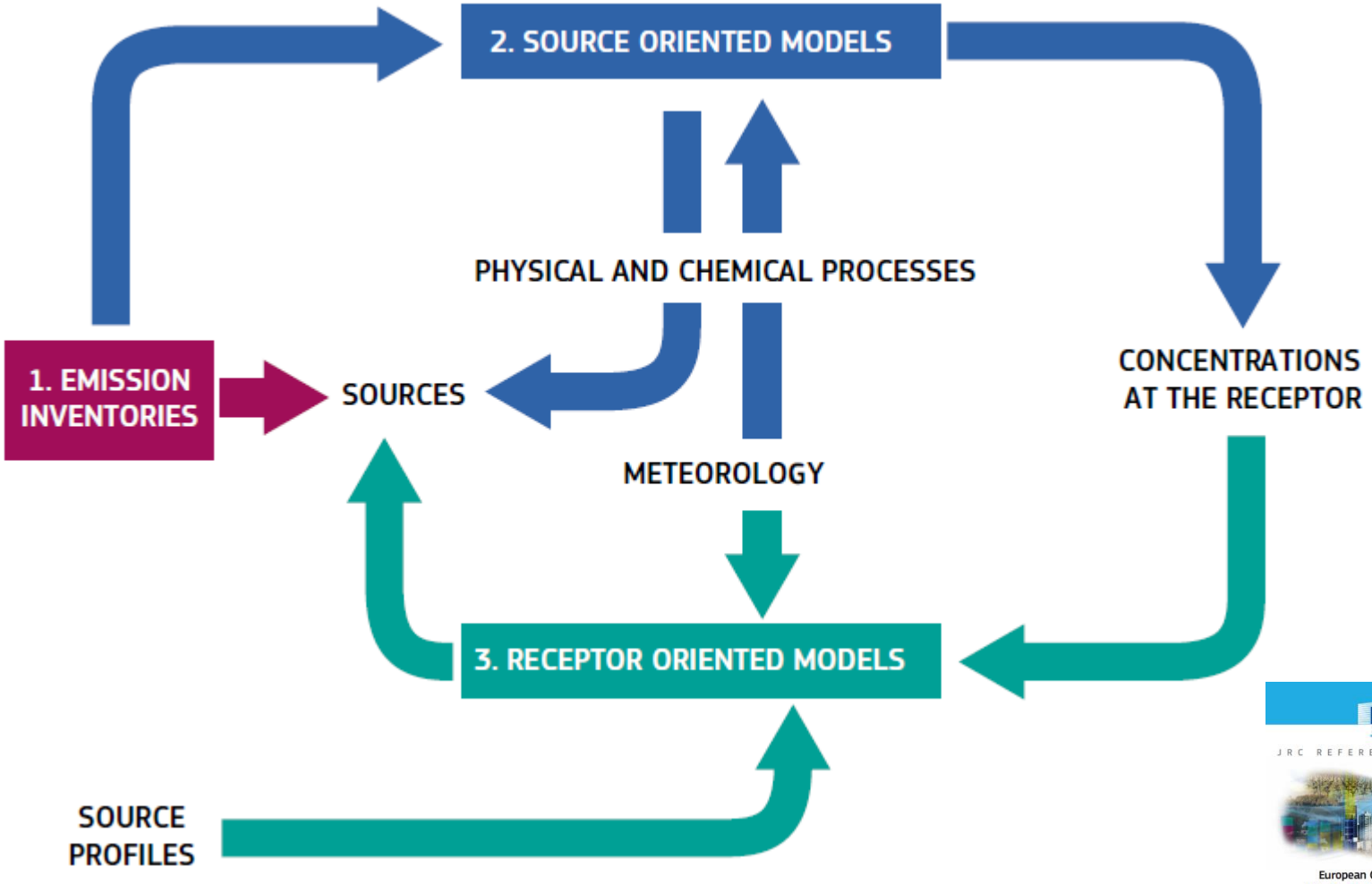
Source apportionment

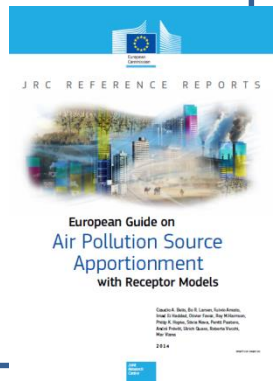
- Abatement of pollution **at its source** is one of the overarching principles of the Thematic Strategy on Air Pollution

- **Source Apportionment** (SA) is the practice of deriving information about pollution sources and the amount they contribute to ambient air pollution levels.

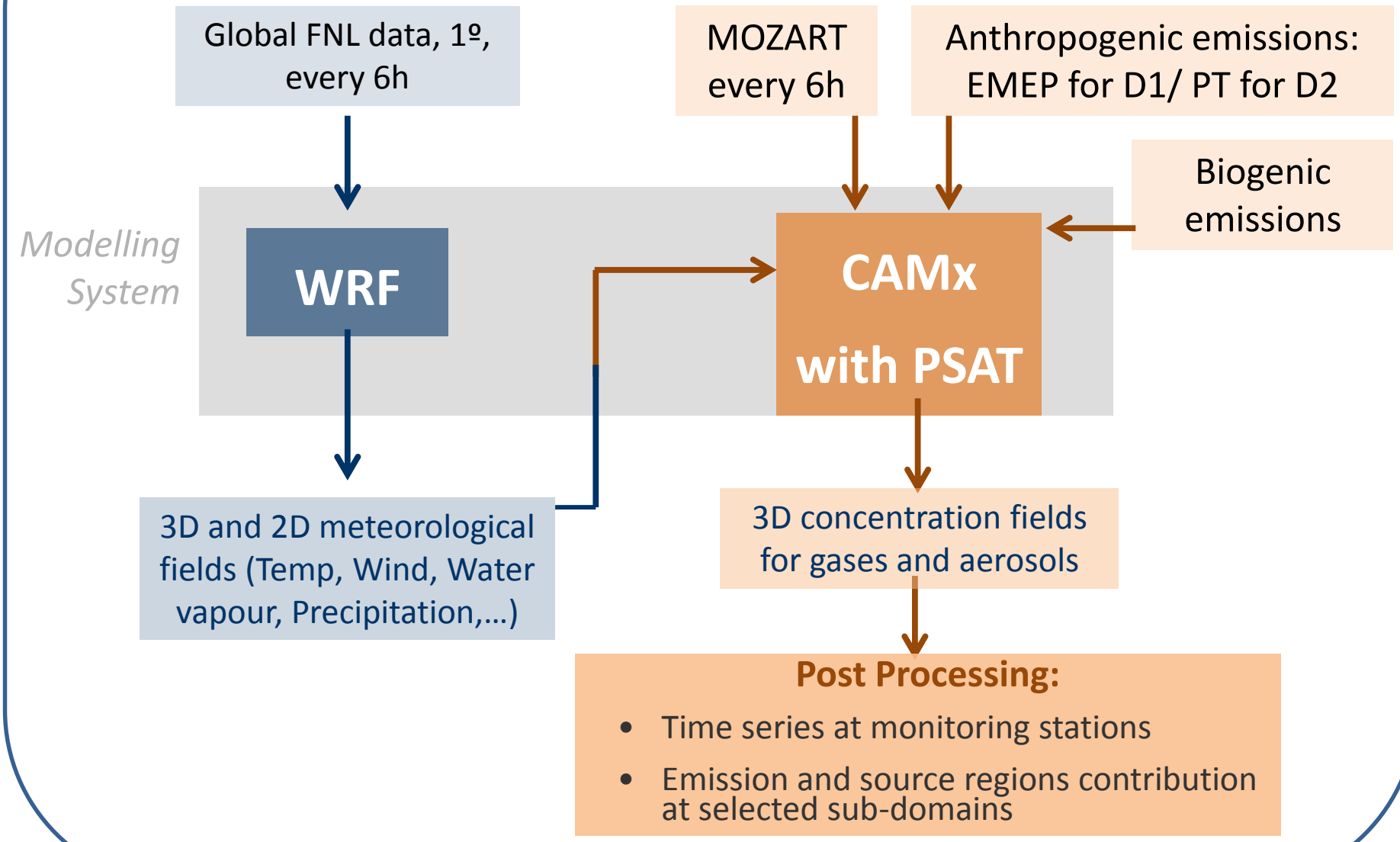
- Information on pollution sources is essential to the design of air quality policies and, therefore, SA is required explicitly or implicitly for the implementation of the **Air Quality Directives**

Different methods for source identification





Methodology – Air quality simulation



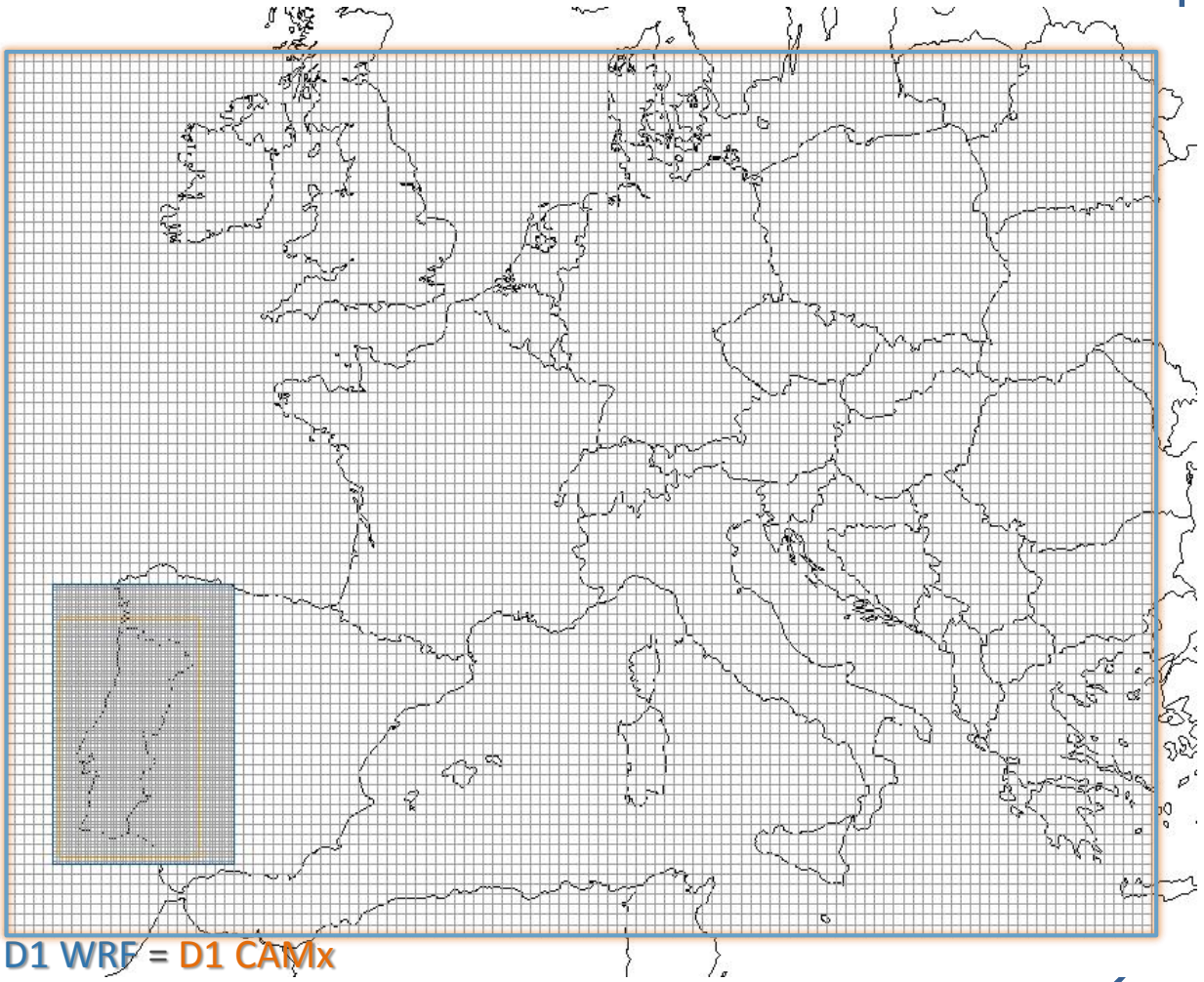
Methodology – Air quality simulation

WRF setup

- 2 simulation periods
  - 10-19 Oct 2011
  - 17-23 Nov 2011
- 28 eta levels
- **D1-EU** 27 km resol

CAMx setup

- CB5 chemical mechanism
- 15 vertical levels
- D1-EU 27 km resol



D1 WRF = D1 CAMx

Methodology – Air quality simulation

WRF setup

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- **D1-EU** 27 km resol
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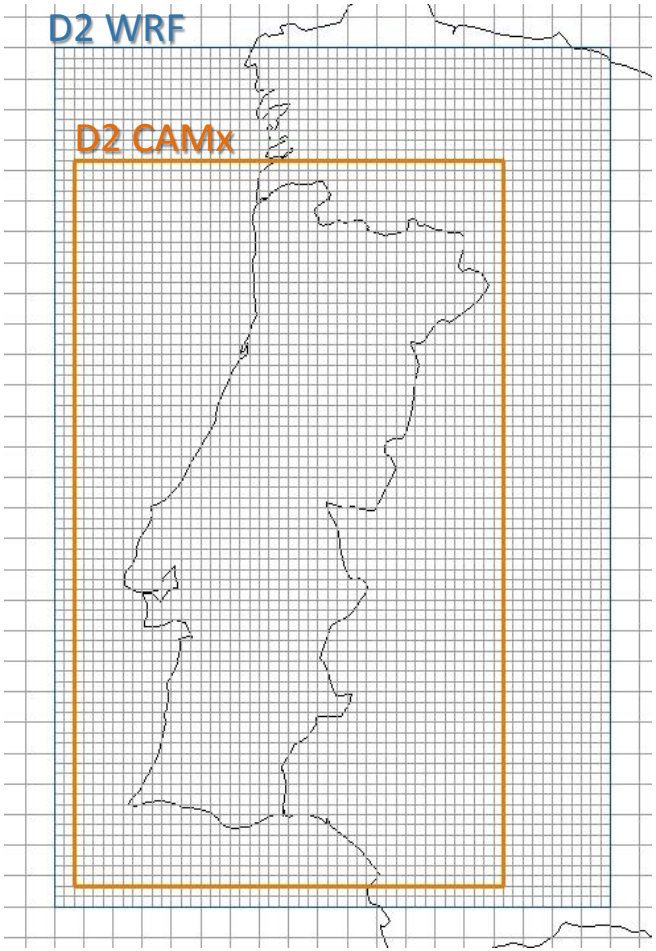
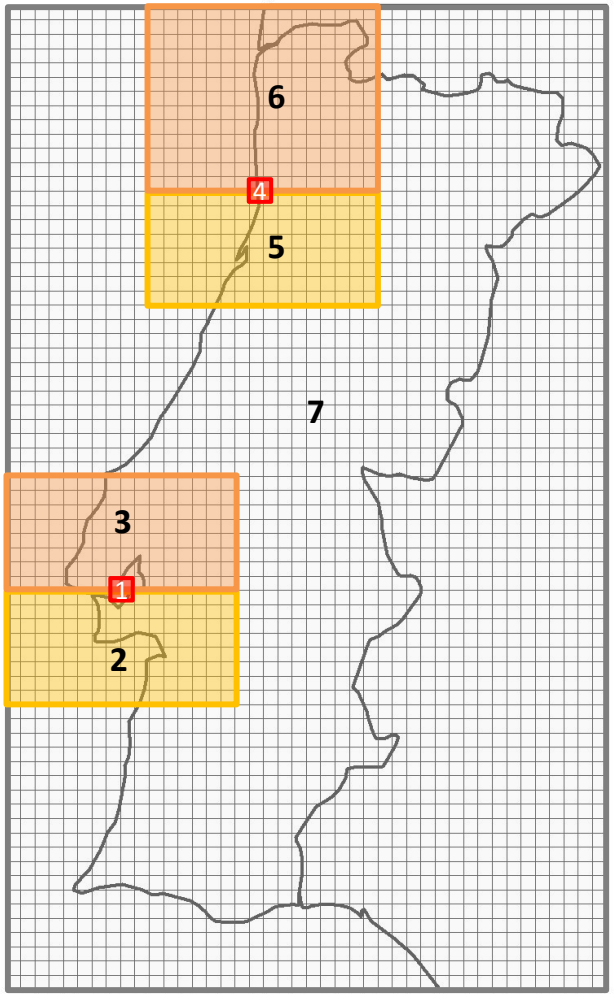


Methodology – PSAT

PSAT source apportionments are calculated using reactive tracers that operate in parallel to the main CAMx calculations.

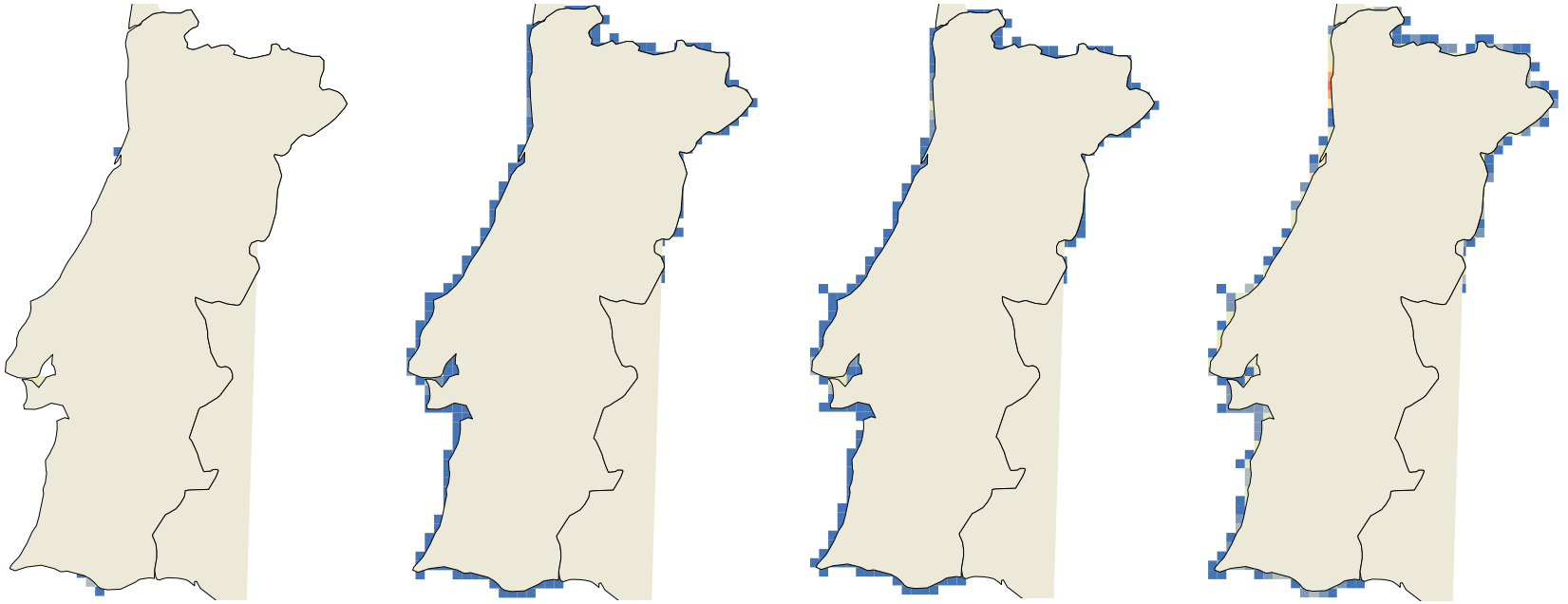
PSAT can apportion PM concentrations from user defined **geographic regions** and **emission categories** plus **IC** and **BC**.

- 2 receptor regions, Lisbon and Porto urban centers
- 7 source regions
- 7 emission categories:
  - Biogenic
  - non-industrial combustion
  - Industrial combustion and processes
  - distribution of fossil fuels and solvent use
  - transport
  - waste treatment and disposal
  - agriculture



Ammonia emissions in Portugal

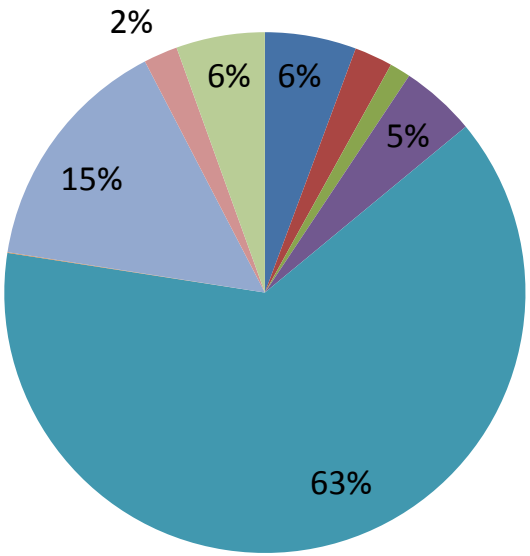
Industry | Traffic | Waste | Agriculture

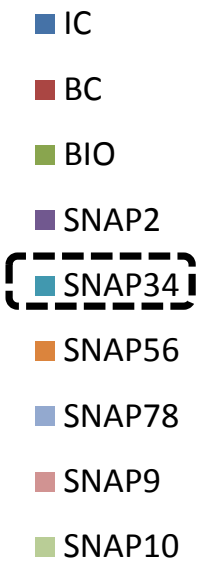


- Industry emissions at important chemical industry complexes
- Traffic and waste treatment and disposal emissions at Porto and Lisbon
- Agriculture emissions highest north of Porto

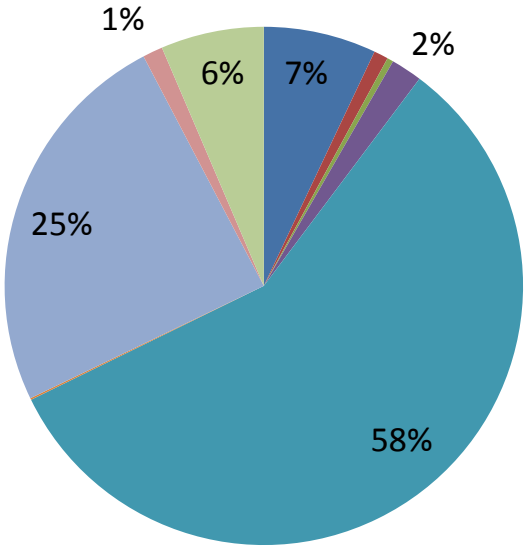
Results
PM2.5 – source emission categories contribution

LISBON



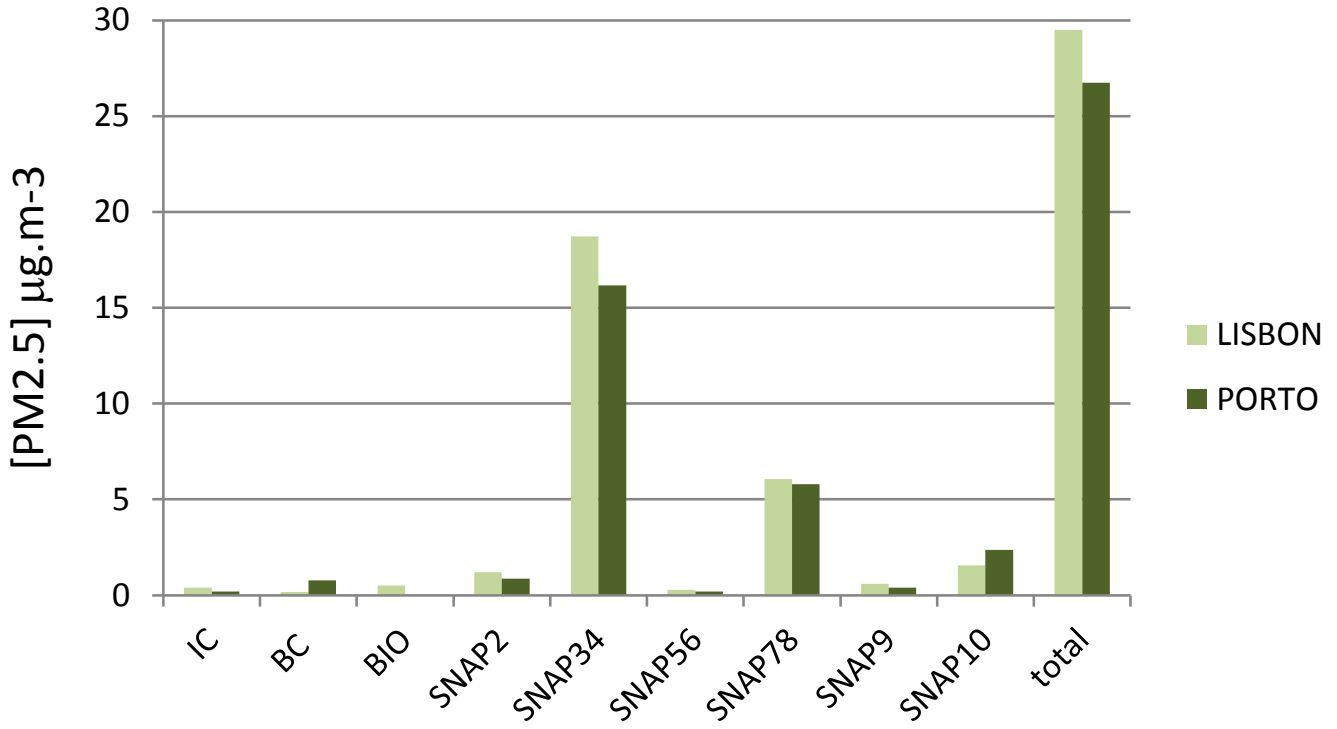


PORTO



- industrial activity is the main contributor to PM2.5 concentrations
- both urban areas show similar contributions

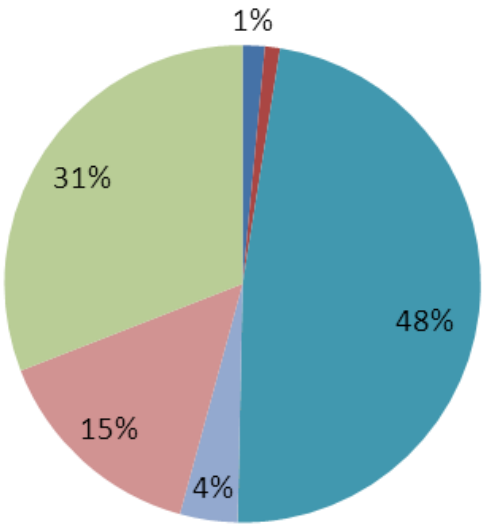
Results
PM2.5 – source emission categories contribution

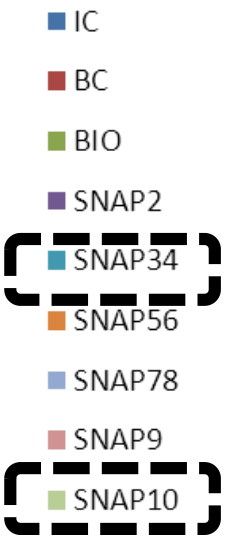


- industrial activity is the main contributor to PM2.5 concentrations
- both urban areas show similar contributions

Results
NH_4^+ – source emission categories contribution

LISBON





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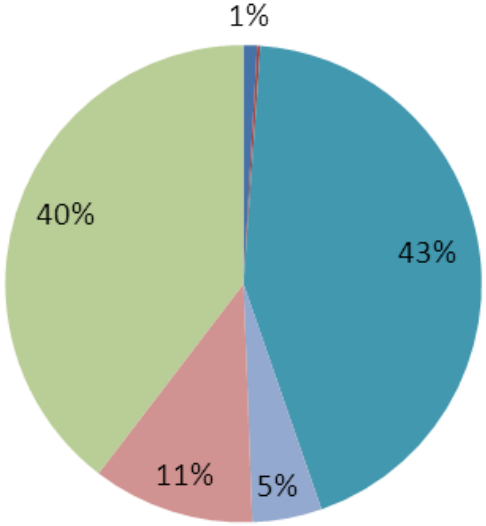
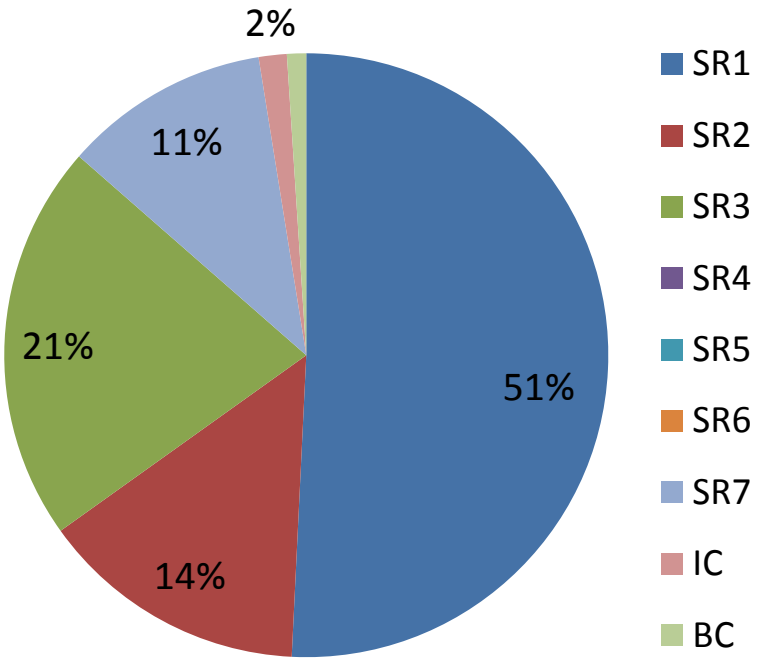


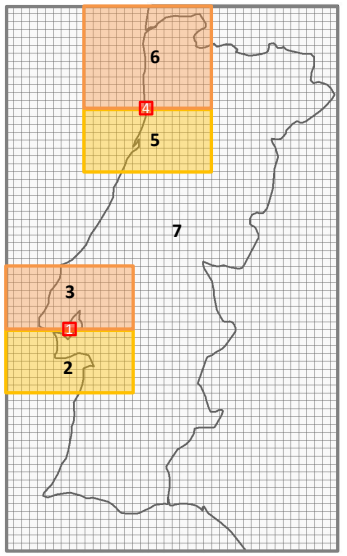
Although industrial activities are a relatively small source of NH_3 emissions compared to agriculture, their influence in these two urban areas is notorious with 48% and 43% of contribution to NH_4^+.

Agriculture is the second biggest contributor to ammonium concentrations (31% in Lisbon and 40% in Porto).

Results

NH_4^+ – source region contribution - Lisbon





- SR1 is the main contributor to ammonium concentrations
- SR3 emissions highly influence Lisbon city, reflecting the dominant wind flow in in coastal Portugal (N/NW)

Results
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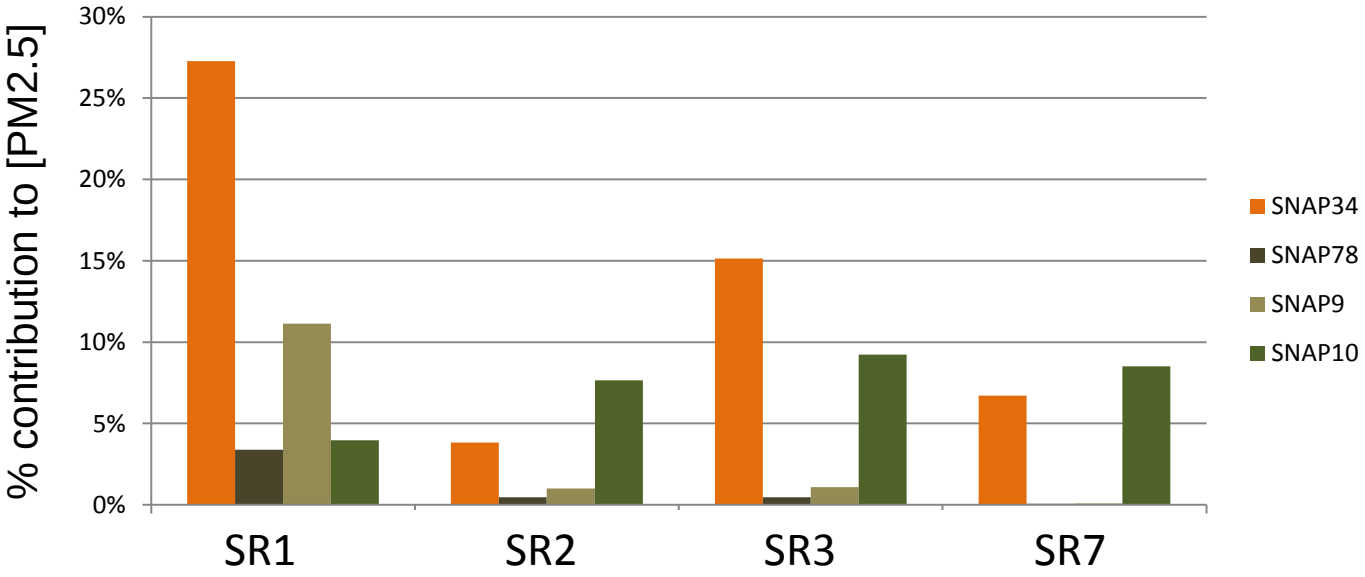
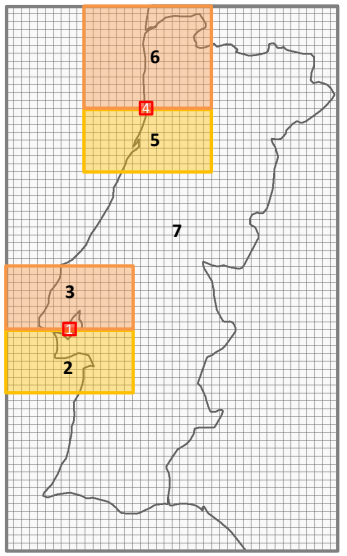
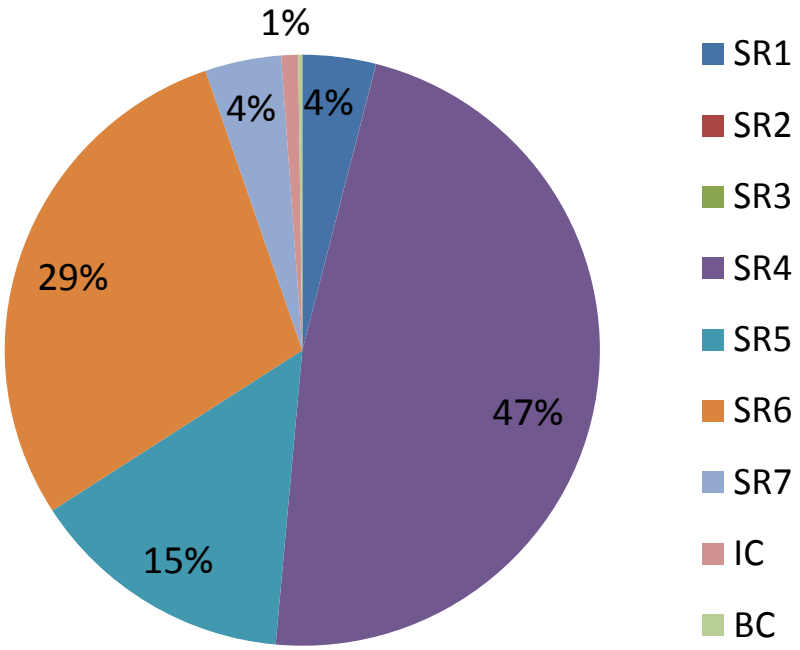


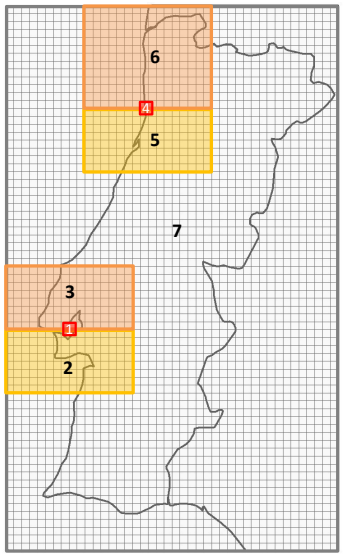


- SR1 is the main contributor to ammonium concentrations
- SR3 emissions highly influence Lisbon city, reflecting the dominant wind flow in in coastal Portugal (N/NW)
- Industrial emissions are the main contributor in SR1 and SR3
- Agriculture dominates remaining SRs

Results

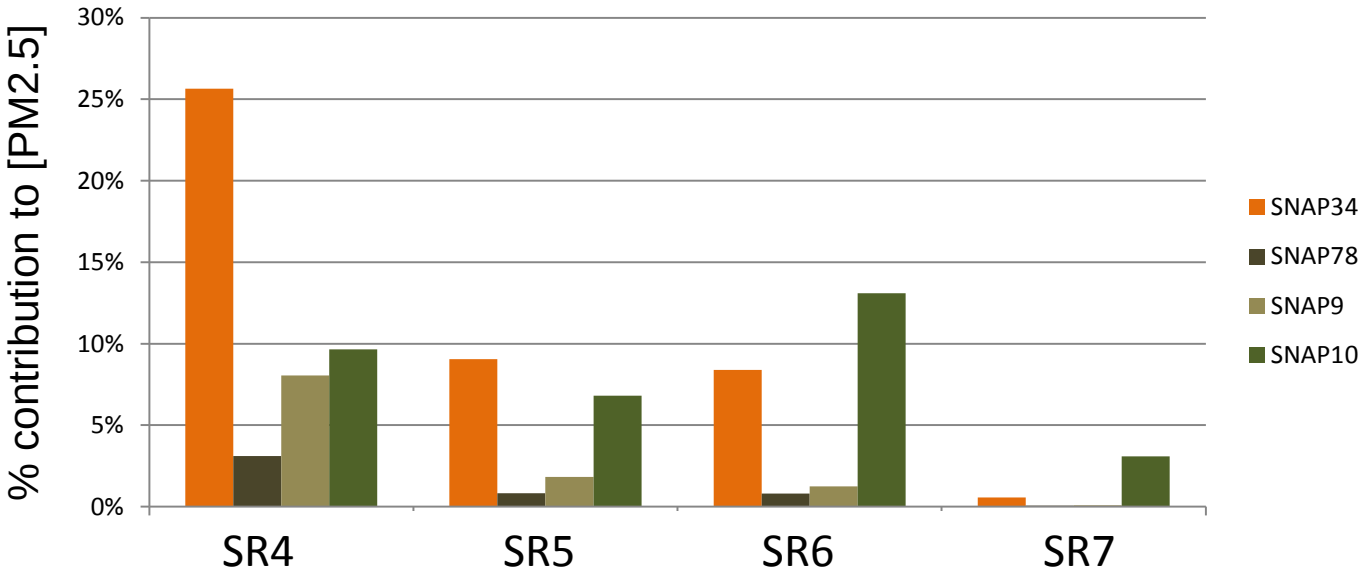
NH_4^+ – source region contribution - Porto

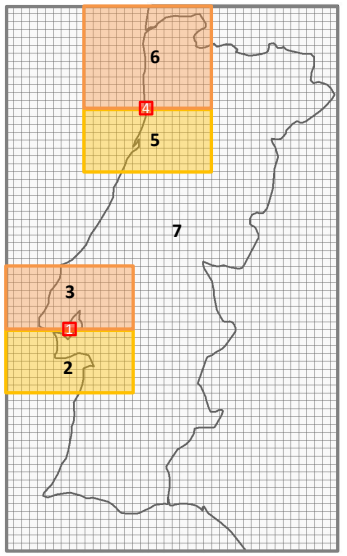




- SR4 is the main contributor to ammonium concentrations
- SR6 emissions highly influence Porto city, reflecting the dominant wind flow in in coastal Portugal (N/NW)

Results
NH_4^+ – source region contribution - Porto





- SR4 is the main contributor to ammonium concentrations
- SR6 emissions highly influence Porto city, reflecting the dominant wind flow in in coastal Portugal (N/NW)
- Industrial emissions are the main contributor in SR4
- Agriculture dominates remaining SRs, particularly SR6

Final remarks

- PSAT proves to be a **valuable** air quality management tool
- Although **industry** is a relatively small source of NH_3 emissions compared to **agriculture**, its influence in urban areas, where it can have a major contribution to local ammonium nitrate, is higher.
- Ammonia will likely play an **increased role in** PM2.5 formation as the emissions of sulfur oxides and nitrogen oxides are reduced
- Next steps:
  - Complement the assessment with the application of **Source Sensitivity** and **Process Analysis** tools also available in CAMx
  - Apply PSAT to emission reduction **scenarios**

Thank you!

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