# Analysis and comparison of two models response to an emissions abatement scenario

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Laboratoire Inter-universitaire des Systèmes Atmosphériques

# The “Air 2030 project”

## A prospective study

A contribution to the assessement of an ambitious **energy scenario** proposed by the French Environment and Energy Management Agency (ADEME) for the time horizon of 2030.

focused on air quality issues...

keep in mind GHG emissions.

## Air quality and environmental impact

The regulated air pollutants targeted in this study:

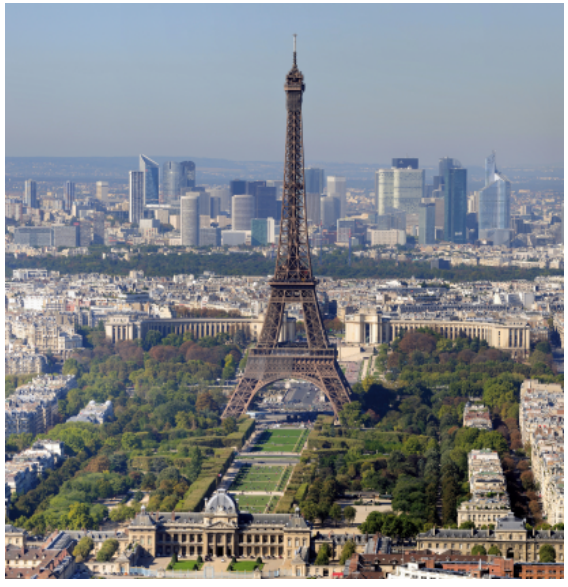
- **fine particles ($\mathbf{PM_{2.5}}$)**
- **nitrogen dioxide ($\mathbf{NO_2}$)**
- ozone ($O_3$)

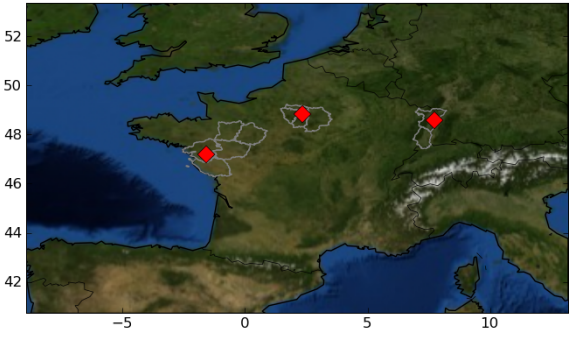
but other species and deposition fluxes could be investigated.

# The “Air 2030 project”

## Nantes

| | |
|---|---|
| *city* | |
| inhabitants | 280 000 |
| density | 4 350 / km$^2$ |
| *urban area* | |
| inhabitants | 580 000 |
| density | 1 100 / km$^2$ |






## Paris

| | |
|---|---|
| *city* | |
| inhabitants | 2 234 000 |
| density | 21 200 / km$^2$ |
| *urban area* | |
| inhabitants | 10 413 000 |
| density | 3 700 / km$^2$ |

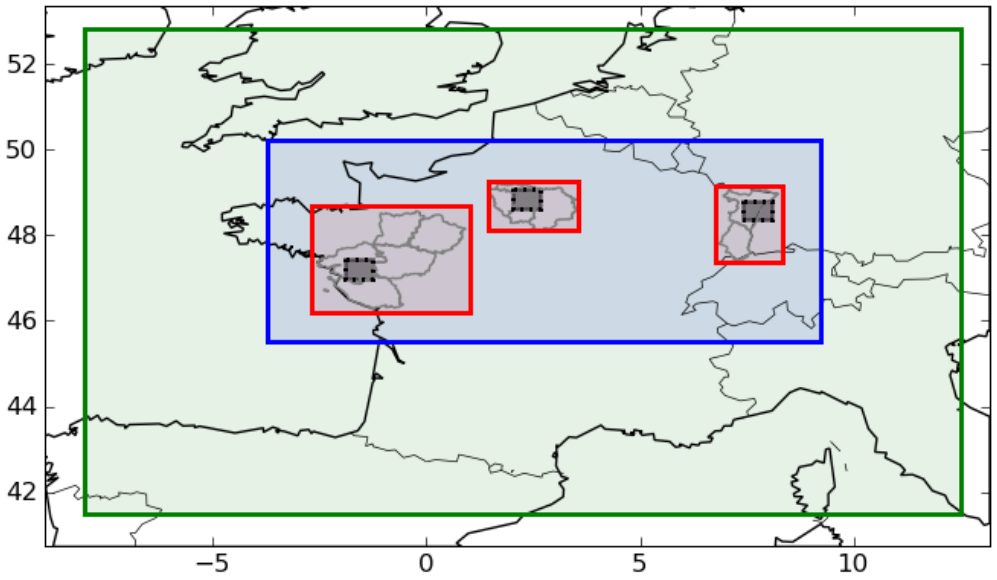
## Strasbourg

| | |
|---|---|
| *city* | |
| inhabitants | 270 000 |
| density | 3 500 / km$^2$ |
| *urban area* | |
| inhabitants | 440 000 |
| density | 2000 / km$^2$ |

# Air quality simulation

## Two “state-of-the-art” Chemistry Transport Model

POLYPHEMUS `http://cerea.enpc.fr/polyphemus/`
Chimere `http://www.lmd.polytechnique.fr/chimere/`




## Spatial resolution

| | |
|---|---|
| “Europe” | $\sim$ 60 km$\times$60 km |
| “France” | $\sim$ 15 km$\times$15 km |
| Pays de Loire | $\sim$ 5 km$\times$5 km |
| Île de France | $\sim$ 3 km$\times$3 km |
| Alsace | $\sim$ 3 km$\times$3 km |
| Nantes | $\sim$ 1 km$\times$1 km |
| Paris | $\sim$ 1 km$\times$1 km |
| Strasbourg | $\sim$ 1 km$\times$1 km |

## Data provided to the CTM

- Meteorology from WRF model simulations (NCEP)
- Boundary conditions from global models LMDzT-INCA or MOZART

# Emission inventories

## Continental and regional inventories

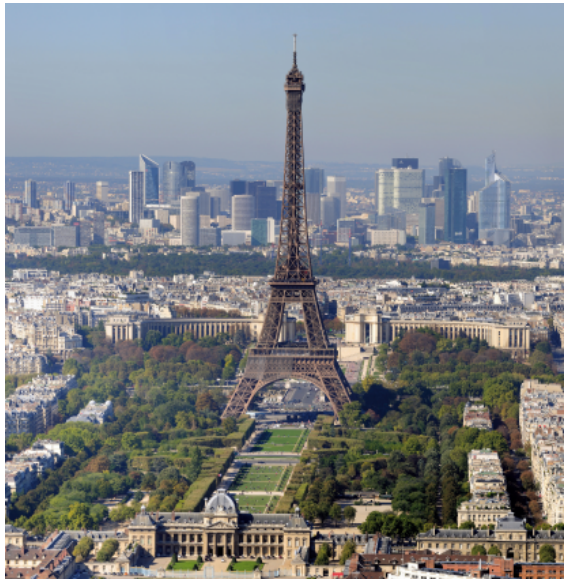
Provided by organisations in charge of air quality monitoring:

- “EMEP” - Europe with a 50 km$\times$50 km horizontal resolution.
- “Air Pays De Loire” - Pays de Loire with a 0.5 km$\times$0.5 km horizontal resolution.
- “Airparif” - Île de France with a 1 km$\times$1 km horizontal resolution.
- “Aspa” - Alsace with a 1 km$\times$1 km horizontal resolution.

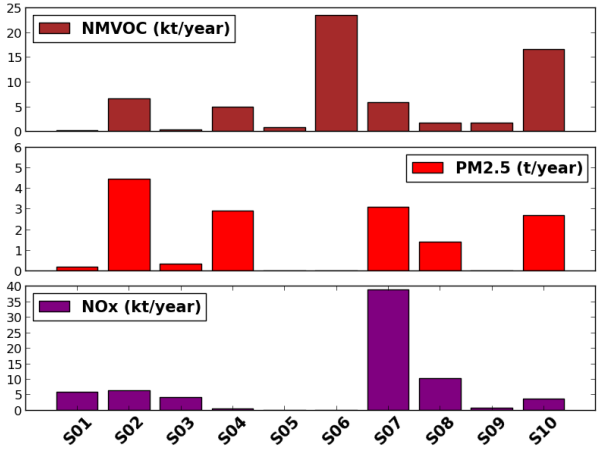
## Emissions projection for France

The emissions changes were assessed at national scale for SNAP sectors and/or sub-sectors by the Interprofessional Technical Centre for Studies on Air Pollution (CITEPA) in collaboration with ADEME.

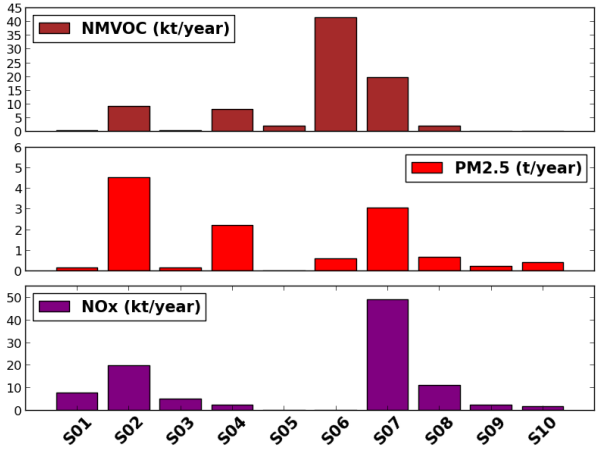
# Emission inventories



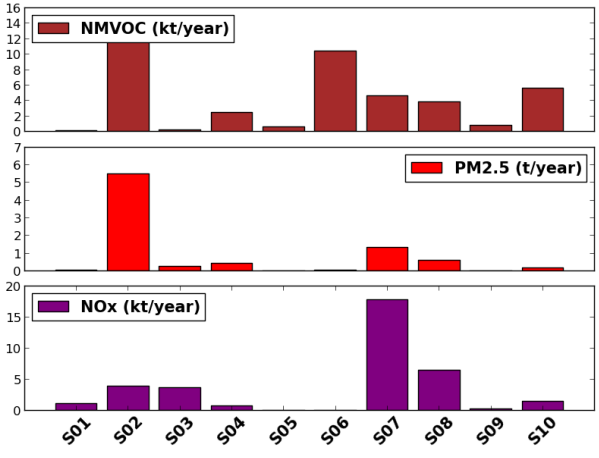
## Nantes - Pays de Loire



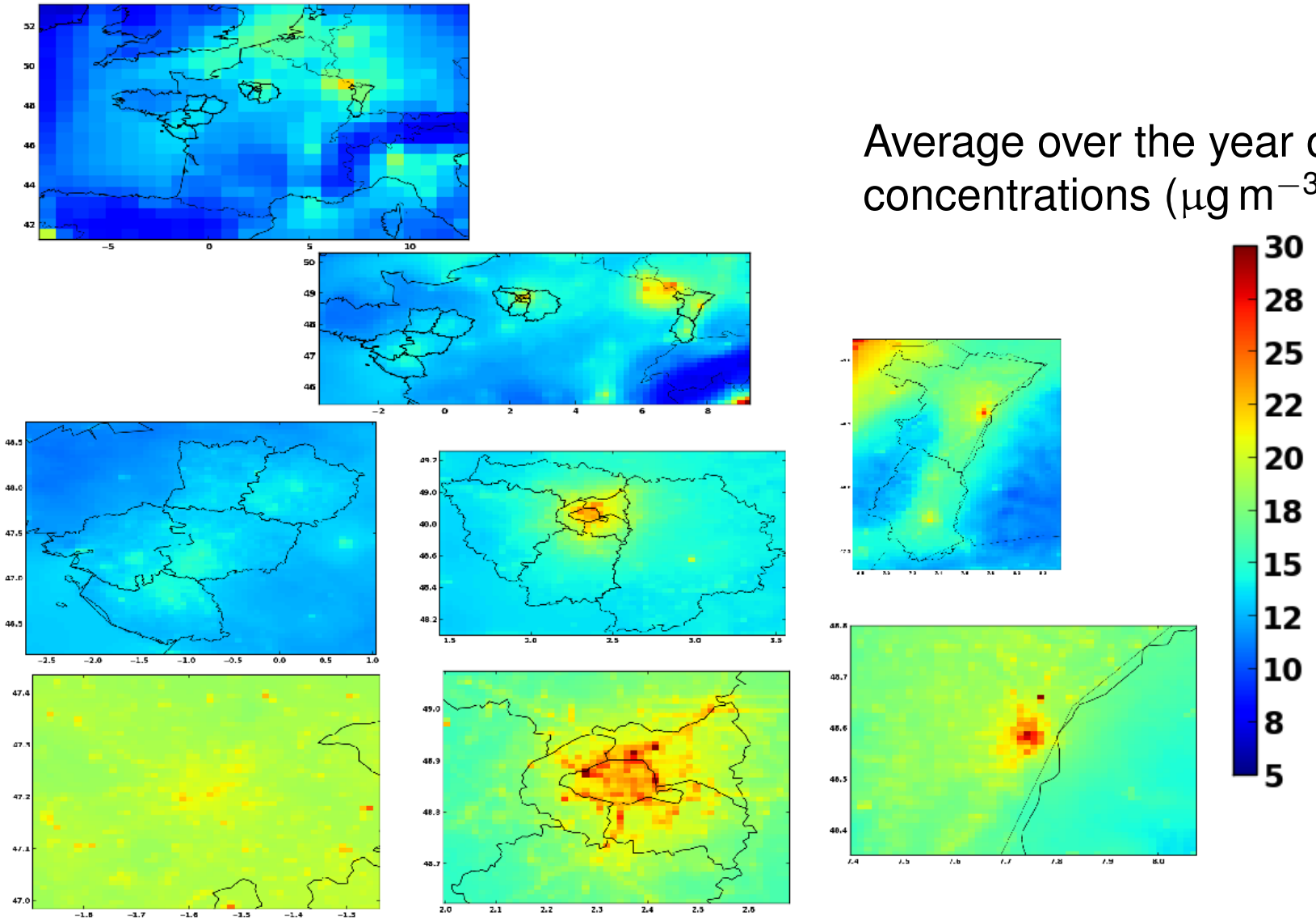

## Paris - Île de France




## Strasbourg - Alsace

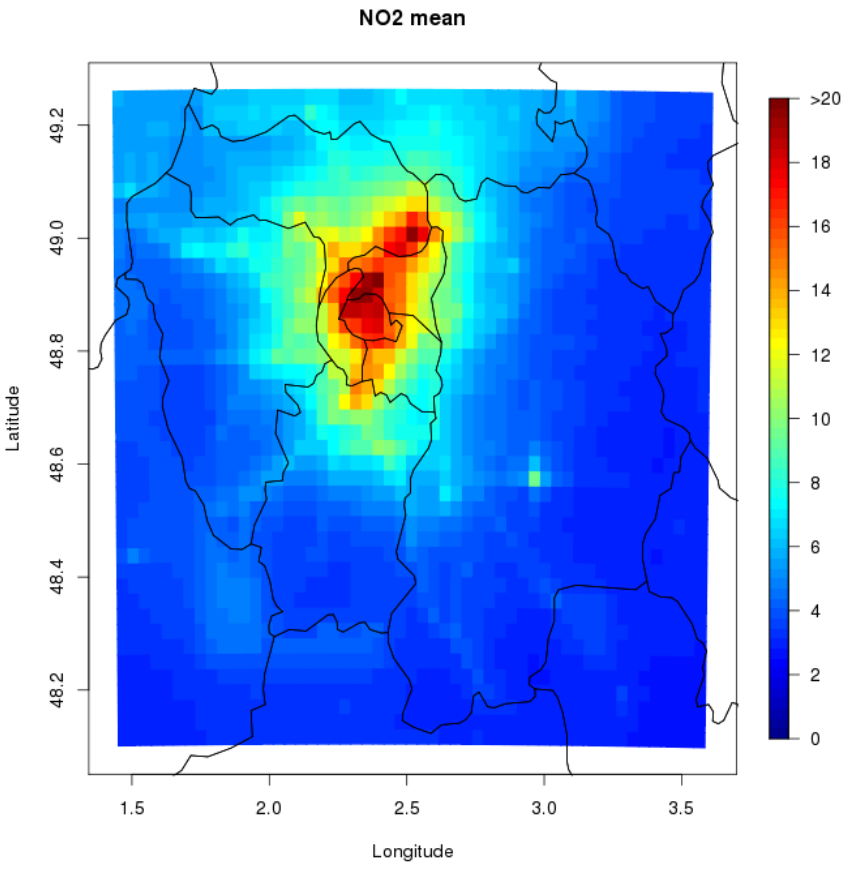


# Example for the $PM_{2.5}$ concentrations

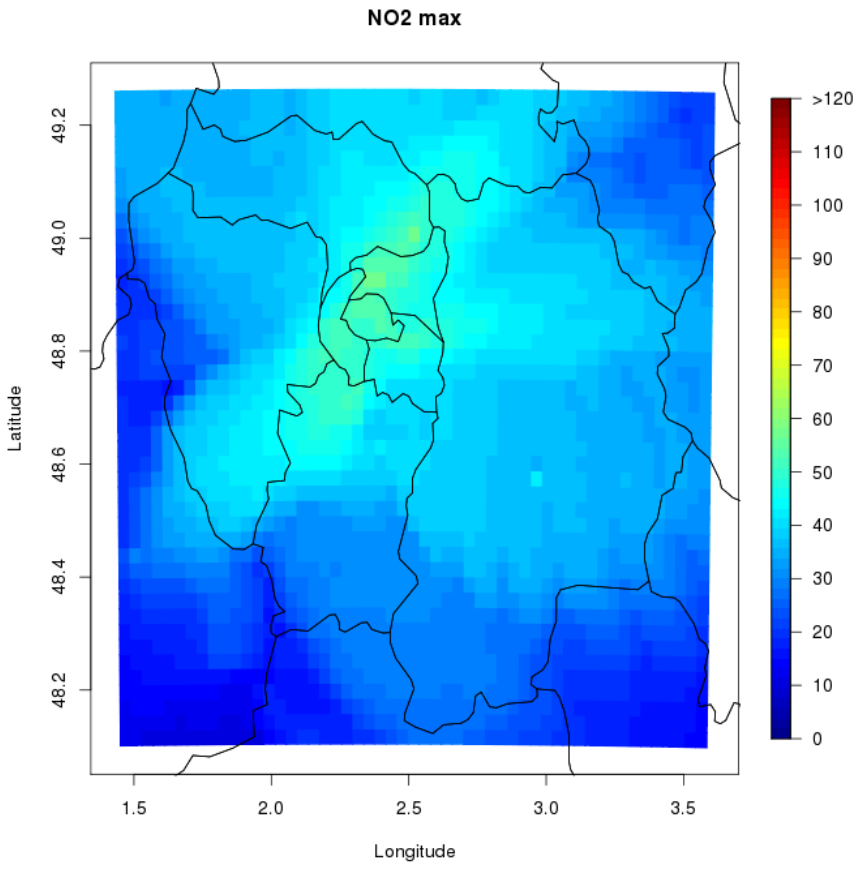



Average over the year of hourly concentrations ($\mu g\, m^{-3}$).

# Example for the $NO_2$ concentrations

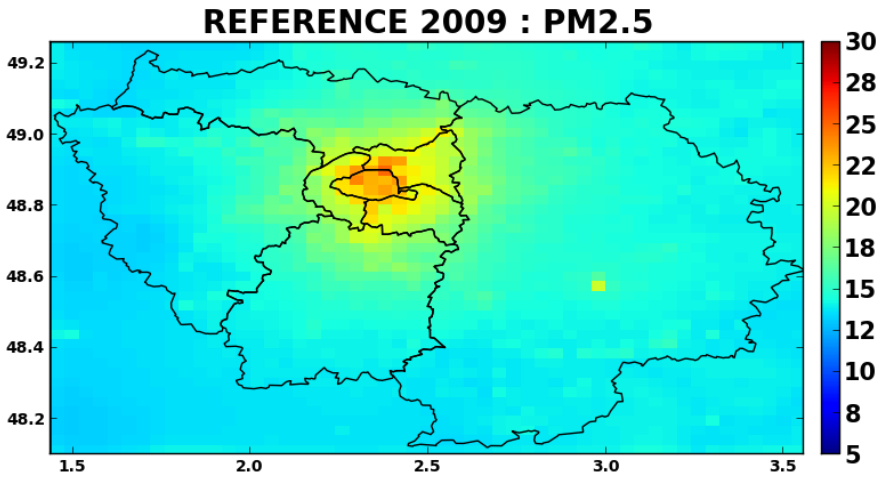



Mean over a winter period of hourly concentrations ($\mu g\, m^{-3}$).




Maximum over a winter period of hourly concentrations ($\mu g\, m^{-3}$).

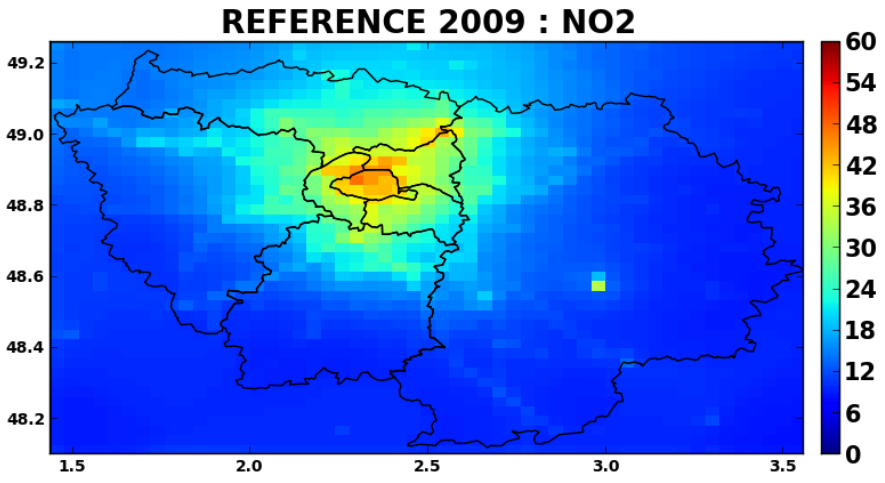
# Example of evaluation against “BDQA” observations




Comparison to daily observations ($\mu g\, m^{-3}$) over 2009.

| | |
|---|---|
| Nº stations | 4 |
| Observation | 19.7 |
| Simulation | 21.8 |
| RMSE | 11.0 |
| Correlation | 60.3% |

Beyond 20 $\mu g\, m^{-3}$ in Paris!



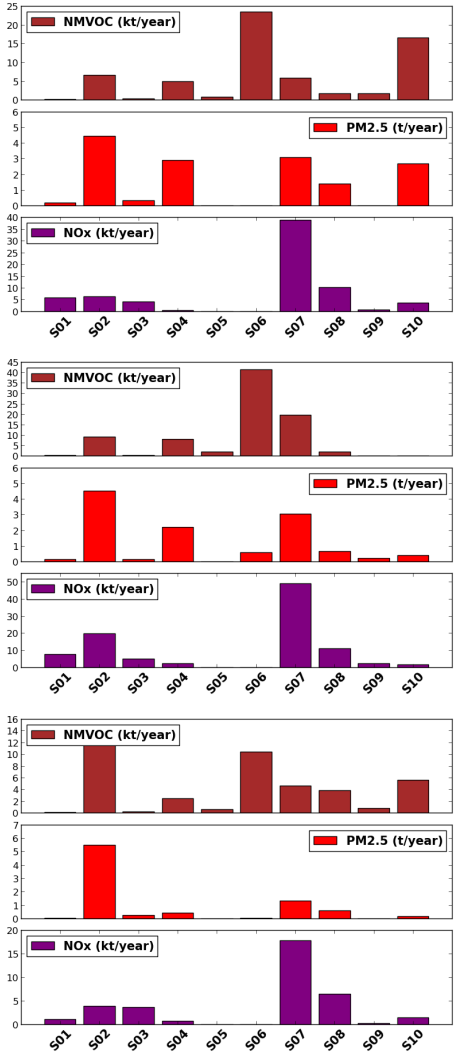

Comparison to hourly observations ($\mu g\, m^{-3}$) over 2009.

| | |
|---|---|
| Nº stations | 36 |
| Observation | 31.4 |
| Simulation | 26.0 |
| RMSE | 17.0 |
| Correlation | 65.2% |

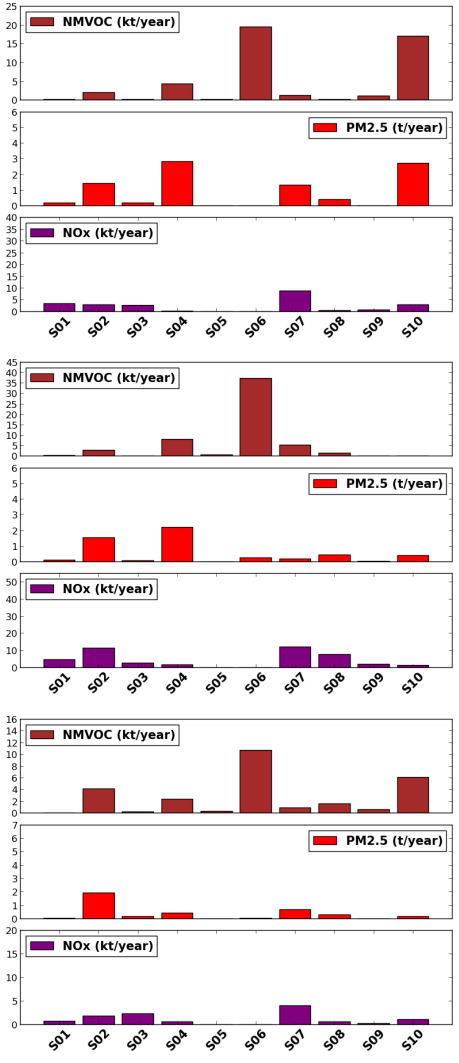
Beyond 40 $\mu g\, m^{-3}$ in Paris!

# Impact of the ADEME energy scenario on the emissions

## Base emissions




## ADEME scenario




### Pays de Loire

| | |
|---|---|
| NMVOC | -26% |
| $PM_{2.5}$ | -39% |
| NOx | **-69%** |

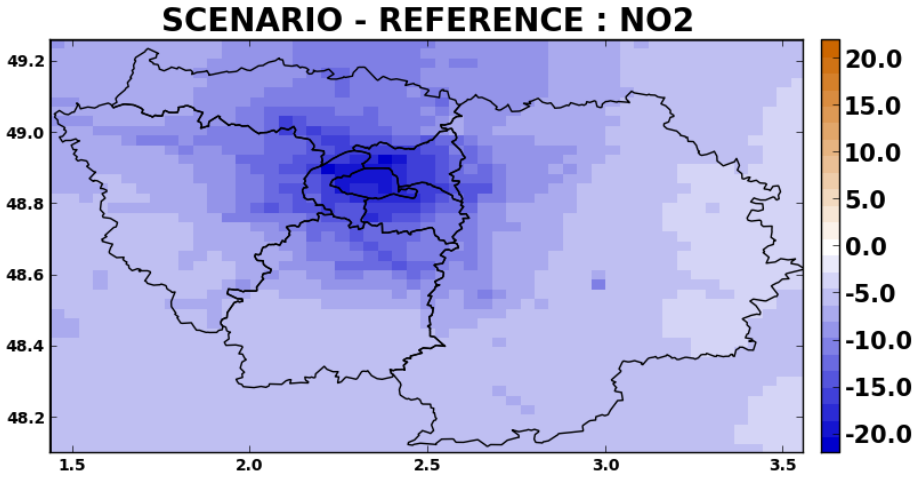
### Île de France

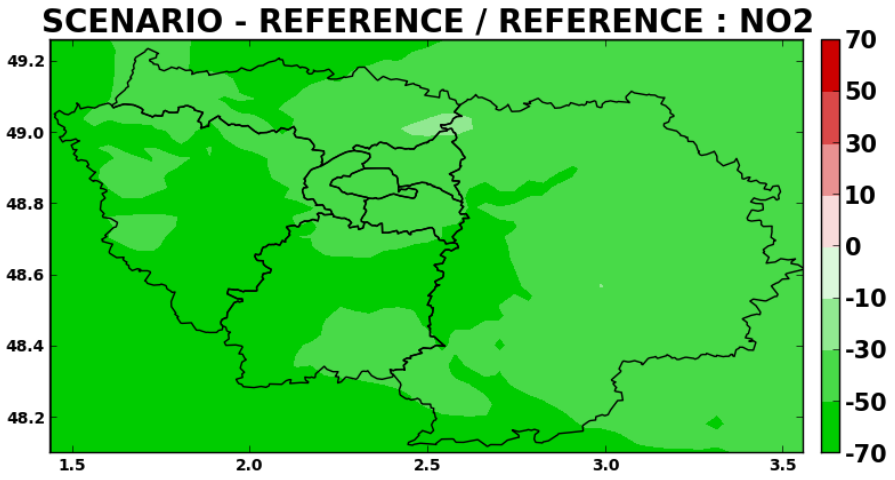
| | |
|---|---|
| NMVOC | -32% |
| $PM_{2.5}$ | **-55%** |
| NOx | **-57%** |

### Alsace

| | |
|---|---|
| NMVOC | -36% |
| $PM_{2.5}$ | **-55%** |
| NOx | **-68%** |

# Impact of the ADEME energy scenario on the air quality : $NO_2$




Simulated evolution of $NO_2$ concentrations ($\mu g\, m^{-3}$) over a winter period (15 january - 15 february).

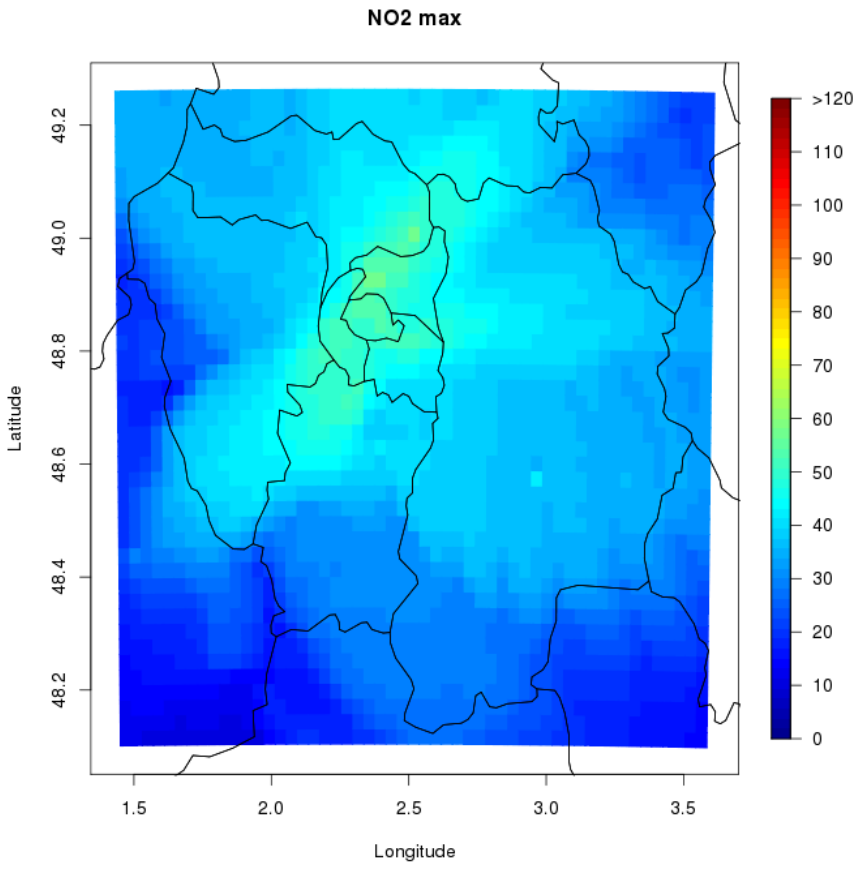
Average $\Delta$ over the domain : -6.9 $\mu g\, m^{-3}$

"Minimum" : -4.0 $\mu g\, m^{-3}$
"Maximum" : -20.8 $\mu g\, m^{-3}$

Average $\%\Delta$ over the domain : -49%

"Minimum" : -19%
"Maximum" : -57%

# Impact of the ADEME energy scenario on the air quality : $NO_2$

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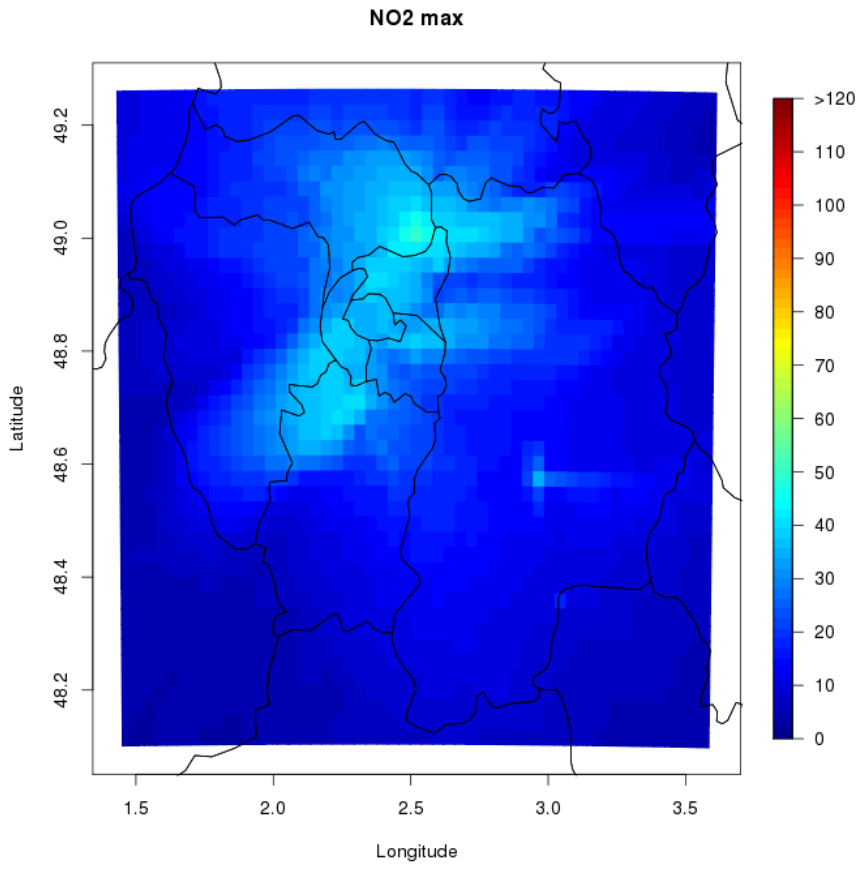
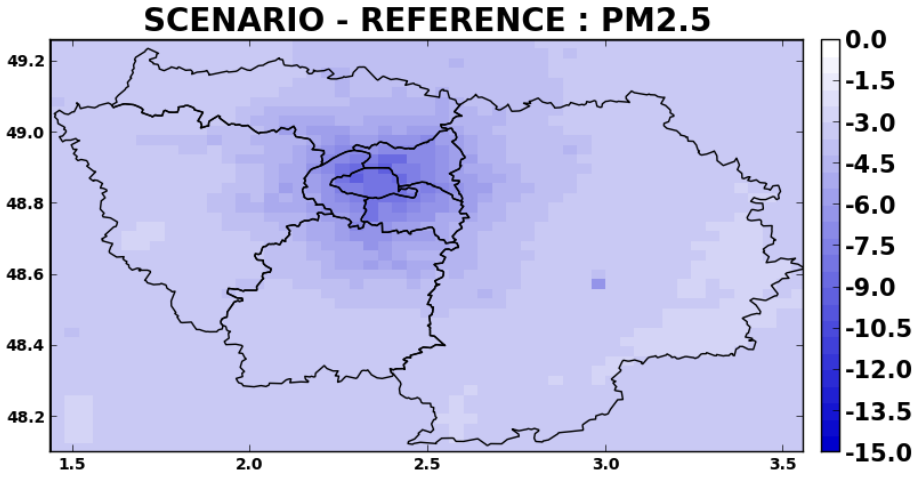
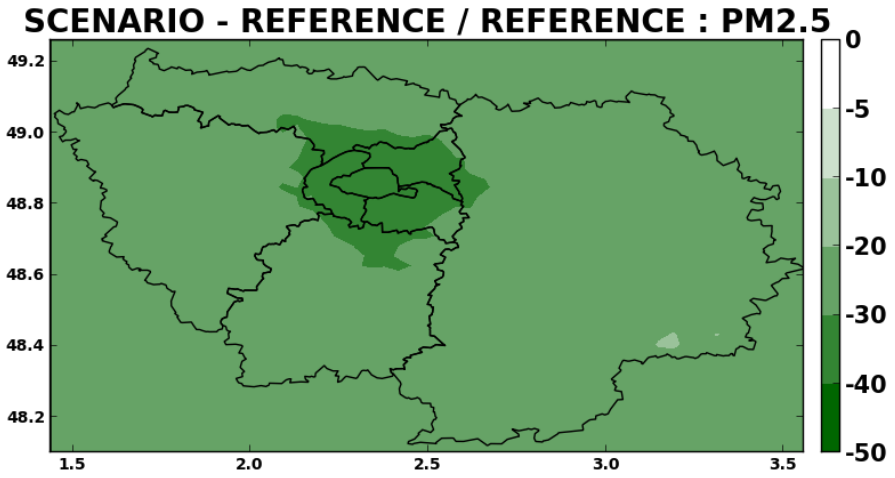



ADEME SCENARIO

Maximum over a winter period of hourly concentrations ($\mu g\, m^{-3}$).

# Impact of the ADEME energy scenario on the air quality : $PM_{2.5}$




Simulated evolution of $PM_{2.5}$ concentrations over the year.

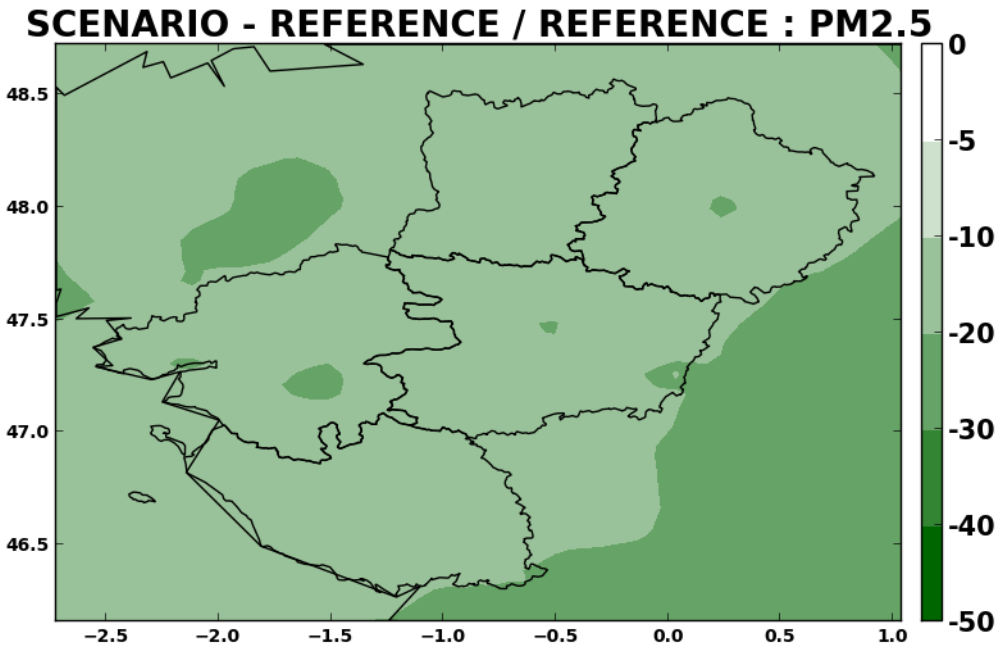
Average Δ over the domain :
-3.6 $\mu g\, m^{-3}$

"Minimum" : -2.9 $\mu g\, m^{-3}$
"Maximum" : -9.3 $\mu g\, m^{-3}$

Average %Δ over the domain :
-24%

"Minimum" : -19%
"Maximum" : -38%

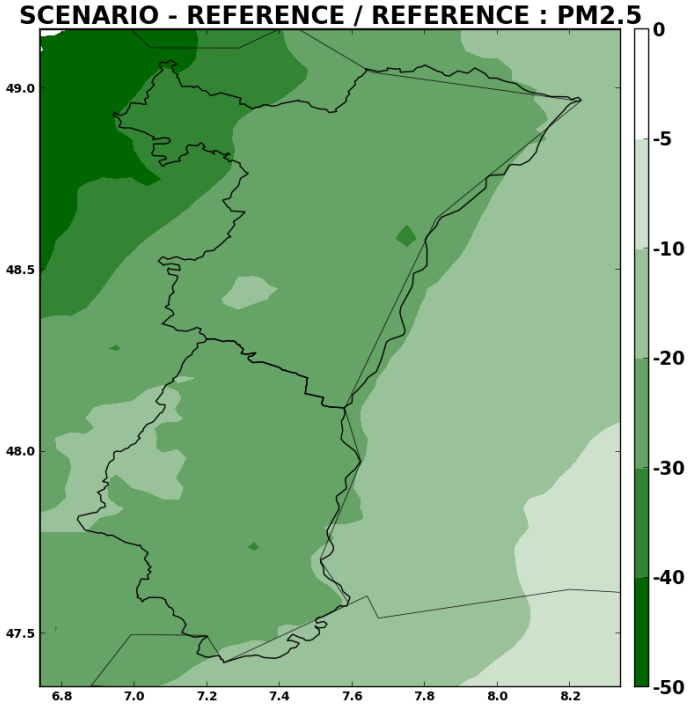
# Comparison to the other regions : $PM_{2.5}$




Pays de Loire

Average Δ over the domain :
-2.4 $\mu g\, m^{-3}$

Contribution of natural source (sea-salt).

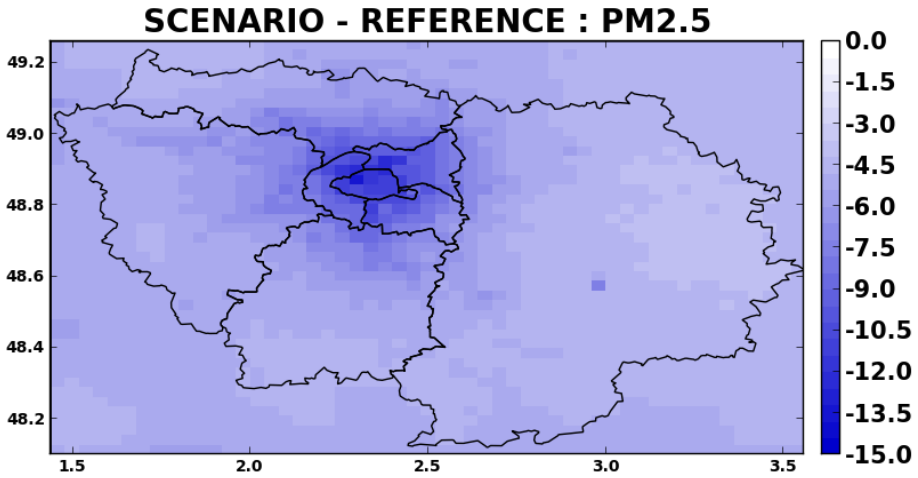


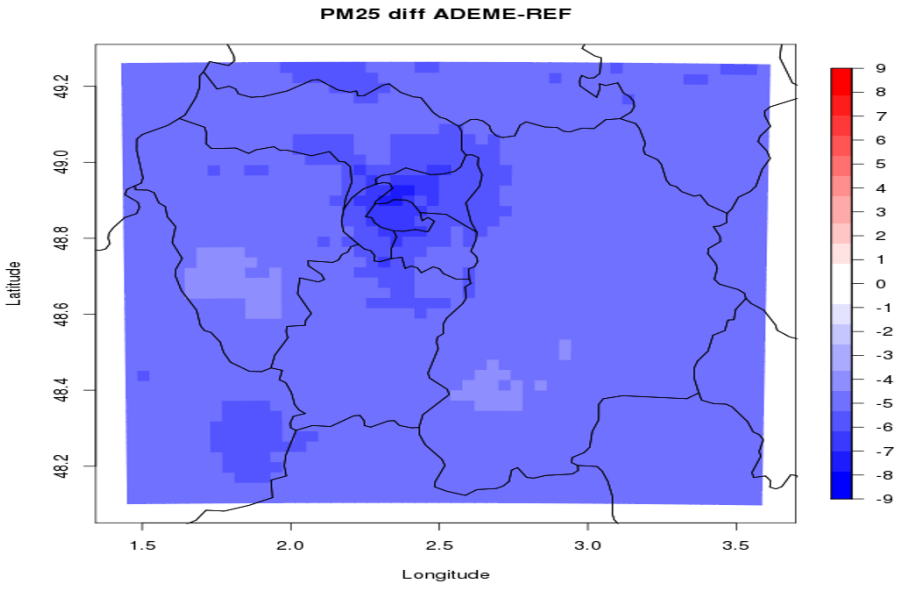

Alsace

Average Δ over the domain :
-3.5 $\mu g\, m^{-3}$

Contribution of other areas in the viscinity.

# Comparison of the models response : $PM_{2.5}$



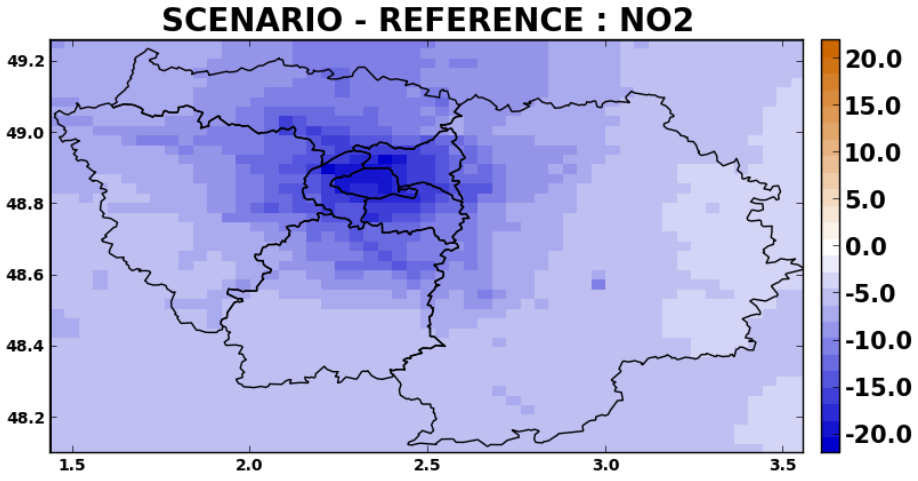



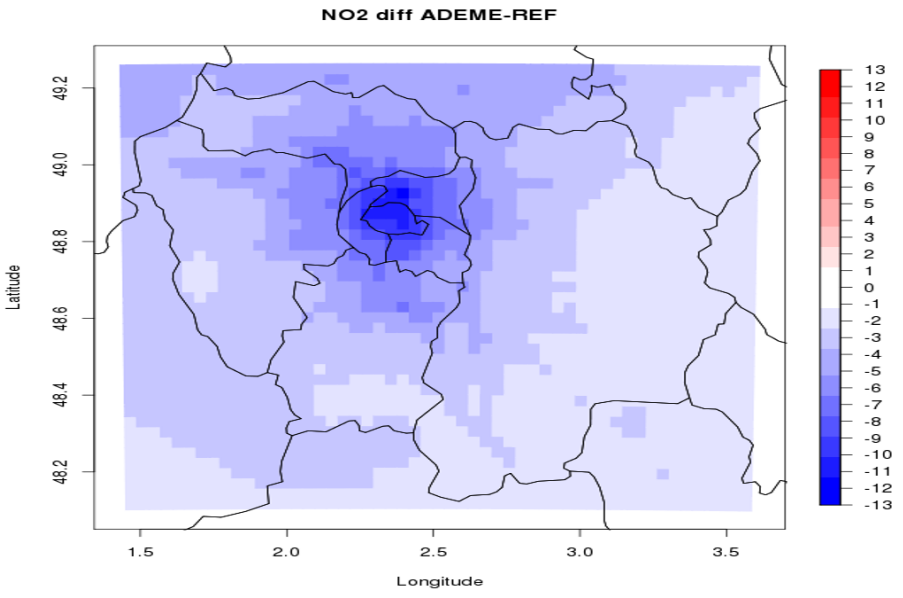

Simulated evolution of $PM_{2.5}$ concentrations ($\mu g\, m^{-3}$) over a winter period (15 january - 15 february).

$\sim 4\ \mu g\, m^{-3} < |\Delta| < \sim 13\ \mu g\, m^{-3}$

$\sim 3\ \mu g\, m^{-3} < |\Delta| < \sim 8\ \mu g\, m^{-3}$

# Comparison of the models response : $NO_2$




Simulated evolution of $NO_2$ concentrations ($\mu g\, m^{-3}$) over a winter period (15 january - 15 february).

$\sim 4\ \mu g\, m^{-3} < |\Delta| < \sim 21\ \mu g\, m^{-3}$

$\sim 2\ \mu g\, m^{-3} < |\Delta| < \sim 13\ \mu g\, m^{-3}$

# Next steps

## Next month

- Extend the analysis to the urban domains.
  - Impact of the spatial resolution on the results?
- Extend the comparison with a “BAU” scenario.
  - “AME” scenario from the CITEPA.

## Next year

- Health impact assessment.
- Environmental impact assessment.

Thanks for your attention.