Air quality modelling: A support for short term and long term policies

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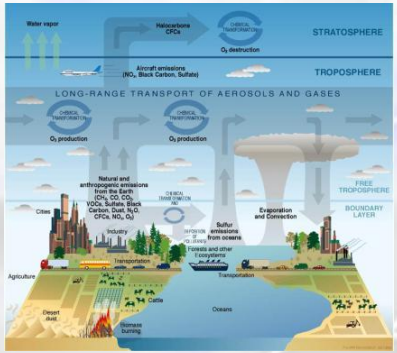
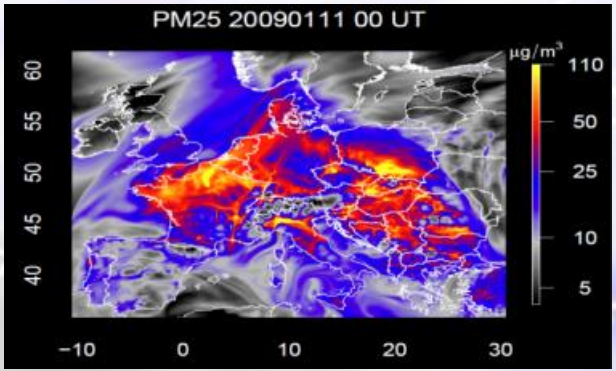
Institut National de L'Environnement Industriel et des Risques

- how AQ models are involved in short term policies to deal with current situation
- how AQ models are used to assess long-term policies in a climate change context.





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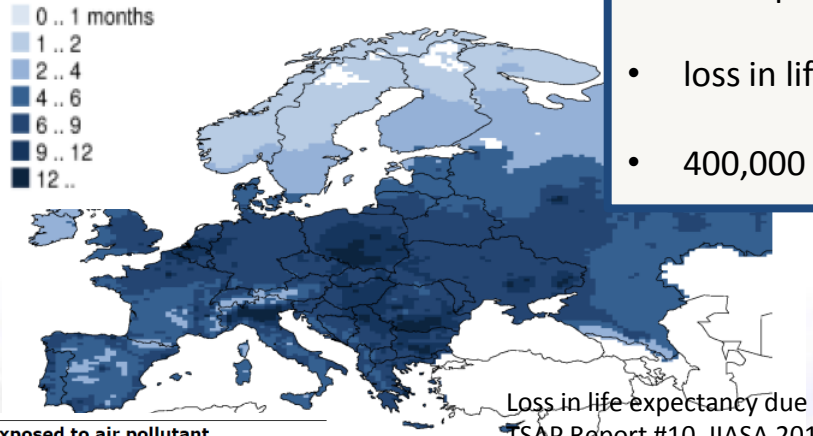
Air quality impacts on health in Europe

Health impacts:

Premature death in people with heart or lung disease
nonfatal heart attacks
irregular heartbeat
aggravated asthma
decreased lung function
respiratory symptoms (coughing or breathing difficulty).



Loss in life expectancy due to PM2.5
TSAP Report #10, IIASA 2013

Health impacts in Europe:

- loss in life expectancy ~8.5months
- 400,000 anticipated deaths each year

Table ES.1 **Percentage of the urban population in the EU exposed to air pollutant concentrations above the EU and WHO reference levels (2009–2011)**

Pollutant	EU reference value	Exposure estimate (%)	WHO AQG	Exposure estimate (%)
$PM_{2.5}$	Year (20)	**20–31**	Year (10)	**91–96**
PM_{10}	Day (50)	**22–33**	Year (20)	**85–88**
O_3	8-hour (120)	**14–18**	8-hour (100)	**97–98**
NO_2	Year (40)	**5–13**	Year (40)	**5–13**
BaP	Year (1)	**22–31**	Year (0.12)	**76–94**
SO_2	Day (125)	**< 1**	Day (20)	**46–54**
CO	8-hour (10)	**< 2**	8-hour (10)	**< 2**
Pb	Year (0.5)	**< 1**	Year (0.5)	**< 1**
Benzene	Year (5)	**< 1**	Year (1.7)	**12–13**

Colour coding:	< 5 %	5–50 %	50–75 %	> 75 %

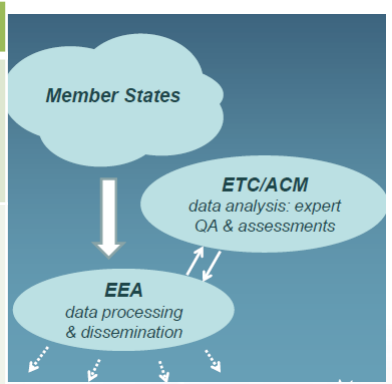
AQ targets largely exceeded in urban areas

European legislation for ambient air quality: Air quality package

- Council Directive **96/62/EC** of 27 September 1996 on ambient air quality assessment and management
- Directive **2004/107/EC** of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air
- Directive **2008/50/EC** of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe: Ozone, PM10, PM2.5, NO2, SO2, CO, C6H6, Pb
  - Monitoring standards : certified instruments, network set-up rules (number of sites, typology, location), quality objectives
  - Limit and target values for ambient concentrations
  - Implementation provisions for regulatory reporting
  - Actions in plans in terms of non attainment of air quality objectives
  - Public information

Current situation : Limit values

Pollutants	AQ Directive 2008/50/EC	Guideline values (WHO)
PM10	50 µg/m^3 daily average not exceeded more than 35 times/year 40 µg/m^3 yearly average	50 µg/m^3 daily average 20 µg/m^3 yearly average
PM2.5	Exposure index based on the daily average 25 µg/m^3 yearly average (20µg/m^3 in 2020)	25 µg/m^3 daily average 10 µg/m^3 yearly average
O3	120 µg/m^3 8-hours average not exceeded more than 25 days/year	100 µg/m^3 8-hours average
NO2	40 µg/m^3 yearly average 200 µg/m^3 hourly average not exceeded more than 18 times/year	40 µg/m^3 yearly average 200 µg/m^3 hourly average
SO2	350 µg/m^3, hourly average not exceeded more than 18 times/year 125 µg/m^3 daily average not exceeded more than 5 times/year	20 µg/m^3 daily average 500 µg/m^3 10min average



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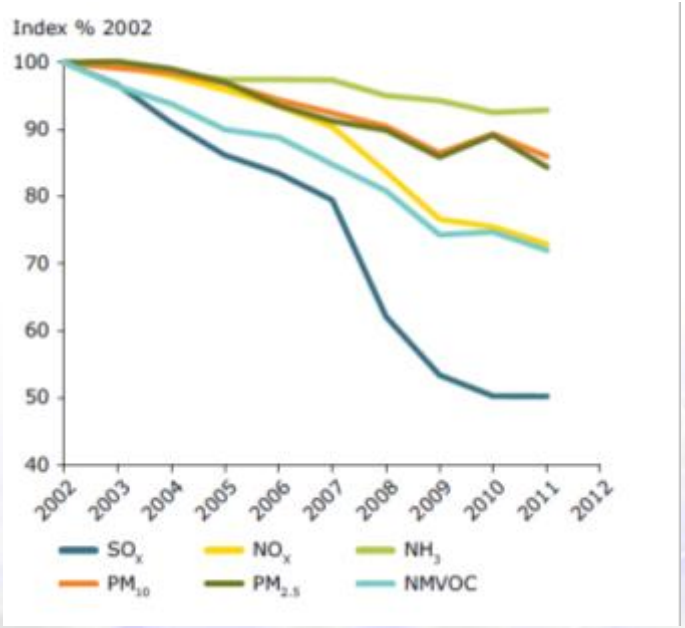
  - Public information
- Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 **on national emission ceilings for atmospheric pollutants**
  - **NOx, VOCs, SO2, NH3 -> should be revised in 2013 to include fine PM**

Emissions have decreased… but exposure remains high



Emissions reduction relative to 2002 for the main pollutants and precursors

Fraction of the urban population exposed to air pollution exceeding WHO air quality guidelines EEA, 2013

Air quality in Europe, 2013 report

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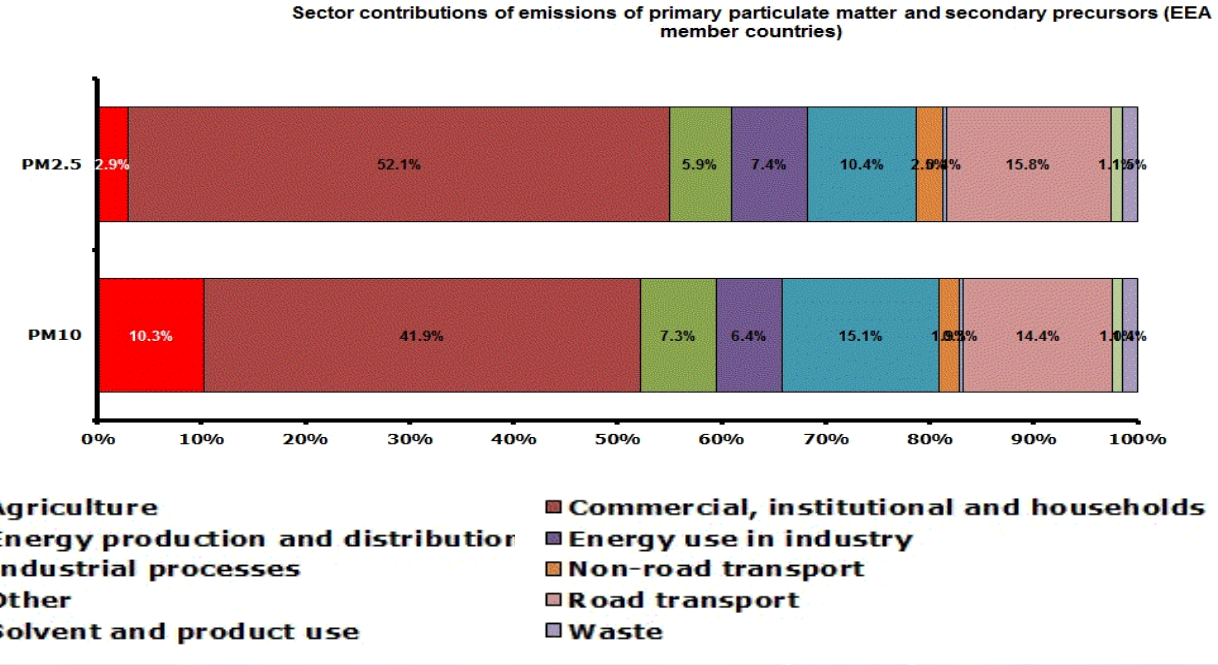
Main challenges for PM pollution today in the EU

- Residential (wood burning)
- Agricultural emissions : (ammonia is a precursor of fine particles)
- Traffic
  - Low emission zones (road)
  - Reducing speed limits (road)
  - Cleaner engines and fuels (whatever the mode)
  - Control of road resuspension
- Industrial emissions
- Quantify the contribution of natural sources (fires, mineral dusts)



Source: EEA

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The French response to improve air quality

- French order of March 26th, 2014

JORF n°0075 du 29 mars 2014 page 6139
texte n° 30

ARRETE

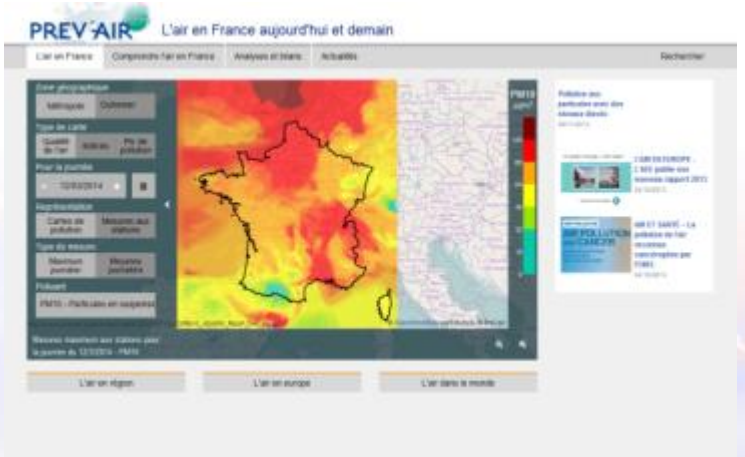
Arrêté du 26 mars 2014 relatif au déclenchement des procédures préfectorales en cas d'épisodes de pollution de l'air ambiant

Objectives:

- Anticipation of pollution episodes to implement mitigation measures in a more efficient way
- Definition of exposure criteria based on air quality forecasts

The prevair.org system

- An operational system building on numerical tools to reinforce the air quality management network:
  - Daily forecasts delivered by 8 am
  - Daily peak and daily averaged values for: J+0, J+1, J+2
  - Pollutants: O3, NO2, Aerosols (PM10, PM2.5 and DUST)



PREV'AIR

cnrs
dépasser les frontières

Institut Pierre Simon Laplace

METEO FRANCE

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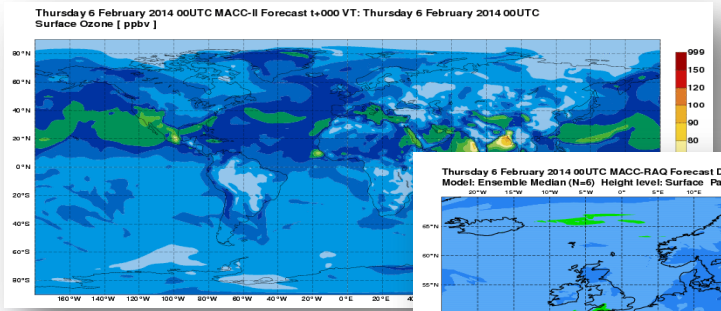
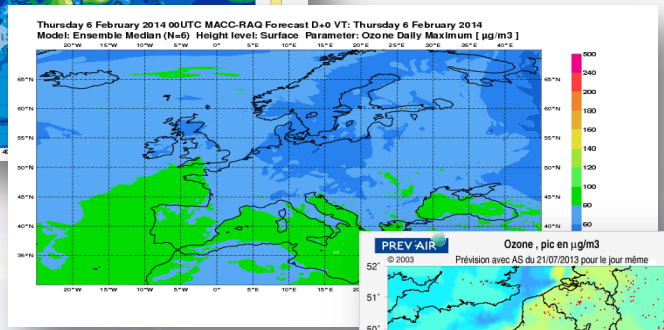
Cascade of air quality forecasts at various scale

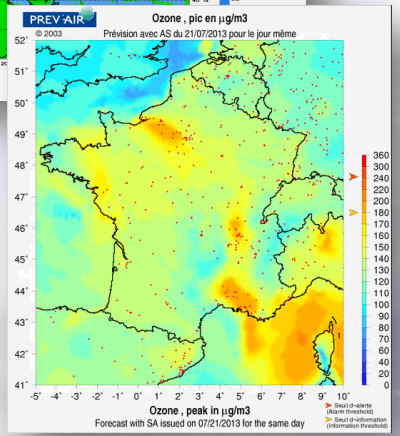
Global



Europe



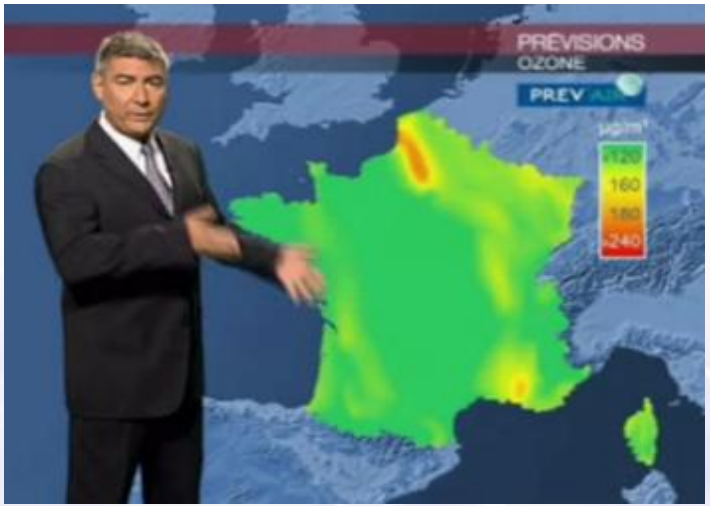
National



-bridging the scale in forecast mode:
contribution of long-range transport as well as local emissions

PREv'AIR objectives: public information

- In case of pollution events, there is an agreement between ministry of ecology and National TV for broadcasting air quality forecasts



Definition of an air quality episode (according to the order)

A **reported or forecast** exceedance is characterized as a pollution episode **if one of the following conditions is fulfilled:**

Condition based on	Scale	Criterion
Surface	French adminsitrative region	At least 100 km^2 inside a region are affected by an exceedance
Population	French department	At least 10% of the population within a department of more than 500000 inhabitants are exposed to an exceedance. or At least 50000 inhabitants within a department of less than 500000 inhabitants are exposed to an exceedance.
Local particularities	Local area	Specific conditions (geographical and dispersion conditions, local emissions…) likely to cause exceedances

Threshold ($\mu g.m^{-3}$)	O_3	PM_{10}	NO_2
Info & recommendations	180	50	200
Alert	240	80	400

⇨ **Requirement:** evaluation of criteria with AQ forecasts

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Communication to local authorities

All the results (exceedance area, exposed population, comparison with the criteria) are gathered in synthetic files (one per region, per pollutant and per threshold) which are made available to the AASQAs on the PREV'AIR website (+ email sending) around 8.30 am.

```
S0 Produit                                : Adaptation statistique
S0 Resultat pour la region                : NORD-PAS-DE-CALAIS

S0 Code de la region                      : 31
S0 Polluant                               : PM10
S0 Seuil de depassement            :  50
S0 Date D+0                        :  20140917
S0 Nombre de mailles               : 1352
S0 Nb habitants dans la region     :  4042818
S0 Nb habitants concernes          :  398812
S0 Nb habitants concernes en %     :  9.9
S0 Surface en m2 couverte par la region :  12633638559
S0 Surface en m2 concernee                :  1279423652
S0 Surface concernee en %          :  10.1
S0 Maximum sur la region           :  55.6
S0 Moyenne sur la region           :  36.4
S0 Critère sur popu                :  non_vérifié
S0 Critère sur surf                :  vérifié
S0 ------------------------------------
S-1
S00 Resultat pour le departement          : NORD
L01 Date D+0                              :  20140917
L02 Produit                               : Adaptation statistique
L03 Polluant                              : PM10
L04 Seuil de depassement                  :  50
S05 Code departement                      : d59
L06 D+0 : Nombre de mailles en depassement  :  937
L07 D+0 : Nb habitants dans le depart.    :  2577092
L08 D+0 : Nb habitants concernes          :  265084
L09 D+0 : Nb habitants concernes en %     :  10.3
L10 D+0 : Surface du departement en m2  :  5751079907
L11 D+0 : Surface concernee en m2       :  871471556
L12 D+0 : Surface concernee en %          :  15.2
L13 D+0 : Maximum sur le departement      :  55.6
L14 D+0 : Moyenne sur le departement      :  34.9
S06 D+0 : Critère sur popu                :  vérifié
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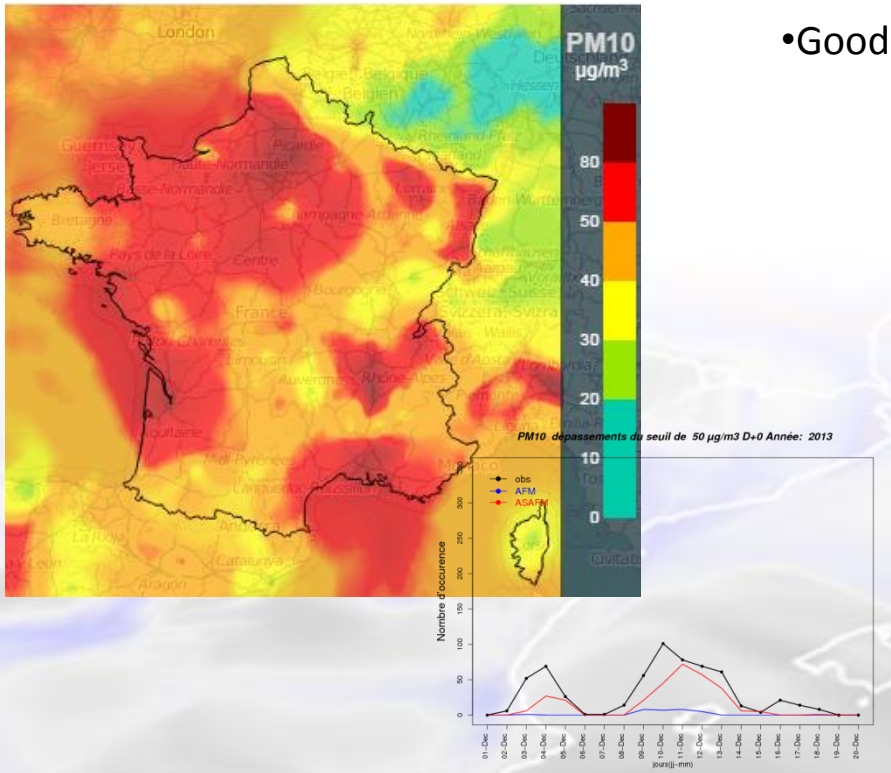
Example of possible use of PREV'AIR products by the AASQAs

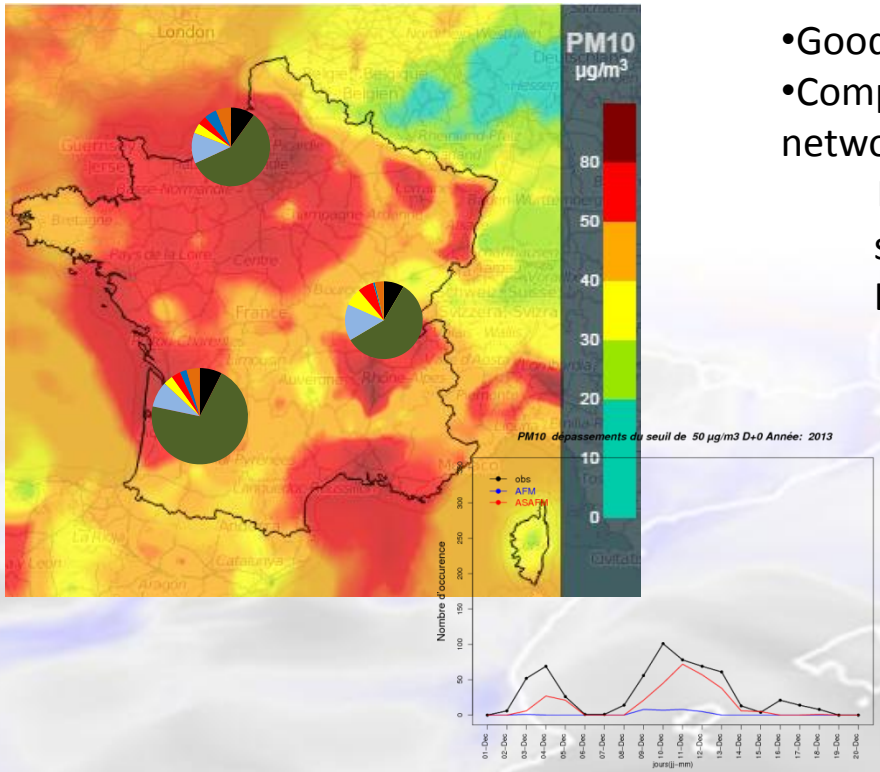
http://www.atmo-ca.asso.fr

PM10 episode : decembre 2013



- Good temporal detection of exeedances

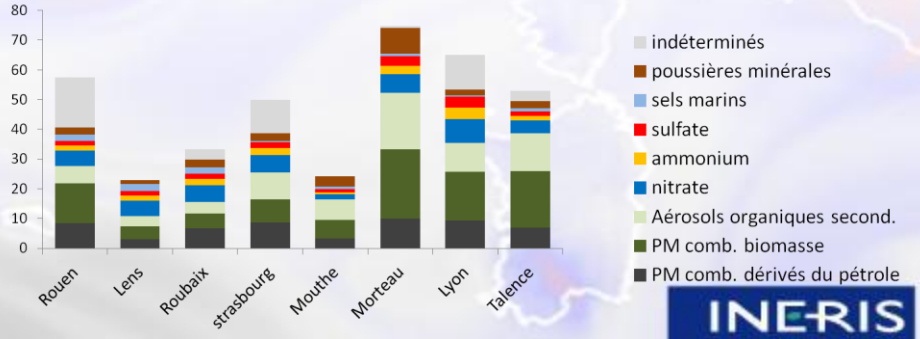
PM10 episode : decembre 2013



- Good temporal detection of exeedances
- Complementary to the chemical data from the CARA network

During episodes, chemical analyses of the major species and source tracers are performed by the LCSQA in collaboration with university laboratories.

Evolution toward automatic measurement.



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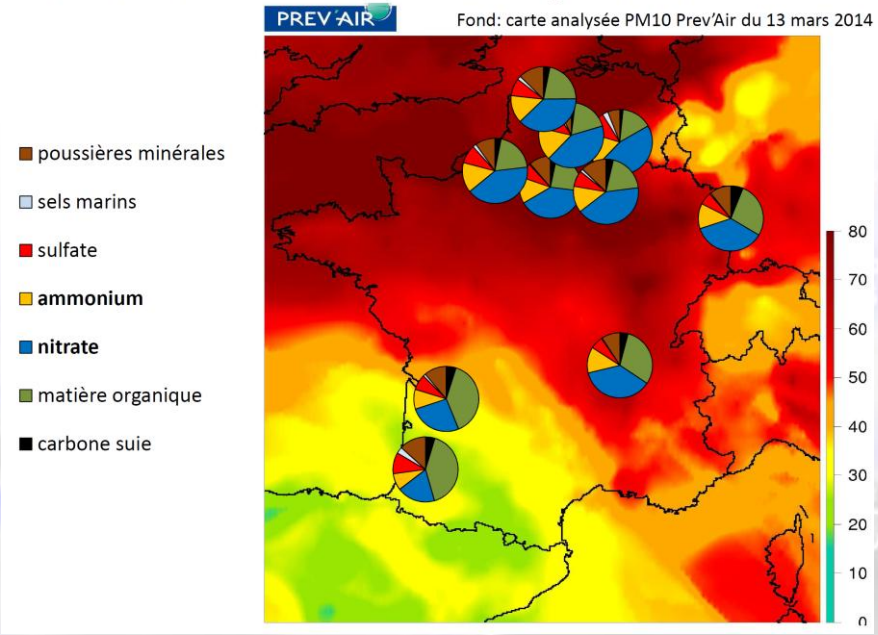
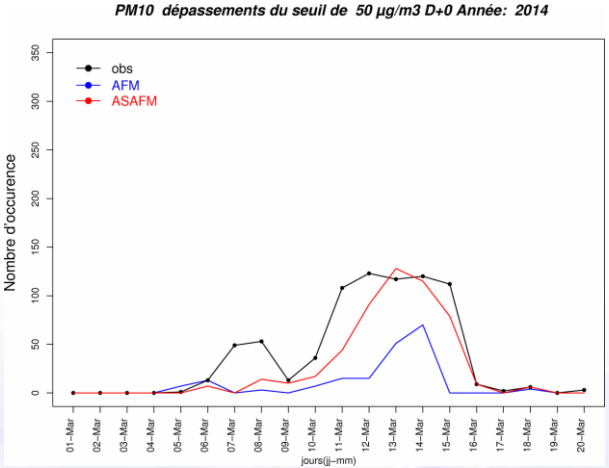
PM10 episode : March 2014

Répartition des espèces chimiques majeures au sein des PM_{10} , moyenne du 11 au 15 mars 2014





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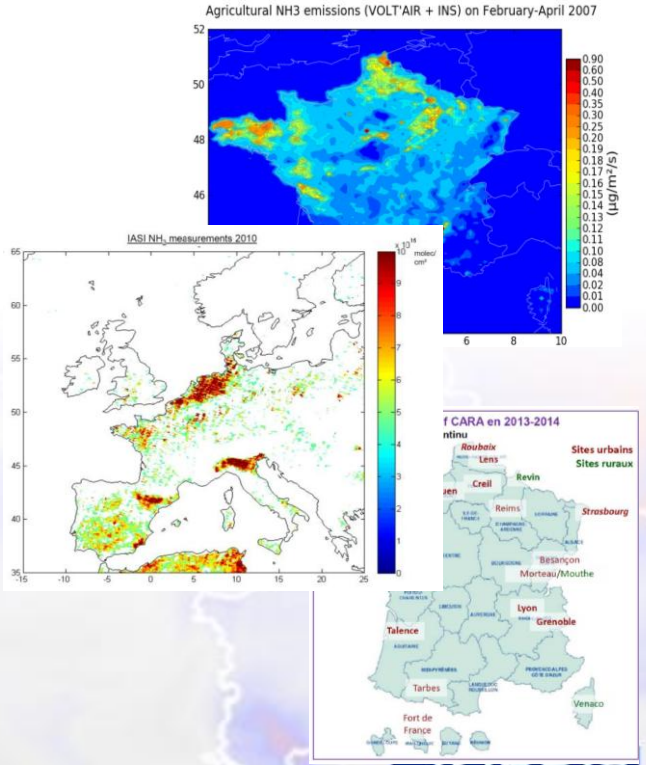
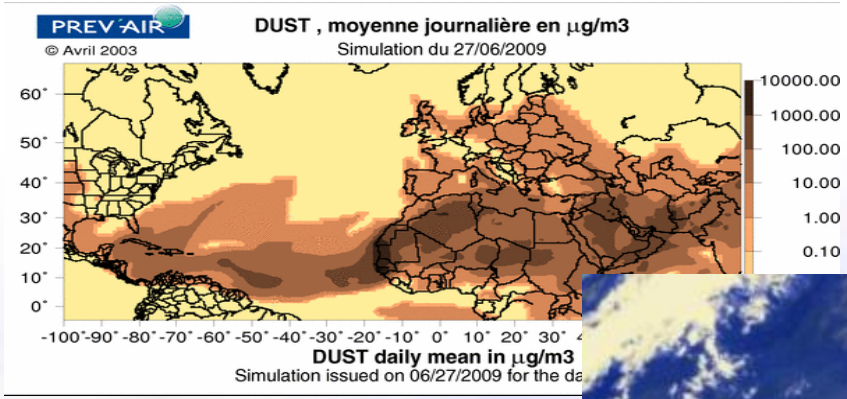
Interactive emissions

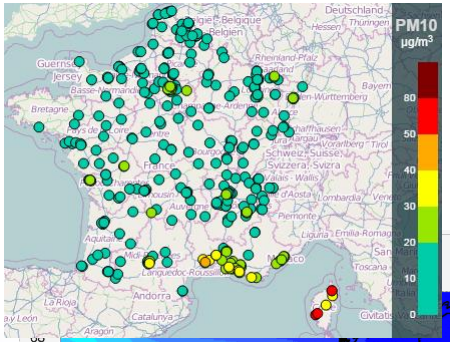
- The emissions are based on annual total emission on which are applied fixed temporal profile to provide hourly emissions
- Dynamic emissions mean to forecast the impact of meteorological conditions (forecasts) on emission intensity and variability (temporal)
  - Effort has been done successfully to modulate the emission of the domestic sector (SNAP2)
    - Significant improvement of the PM10 forecasts during wintertime
- For others emission sectors, it would need to extent such approach:
    - SNAP6: solvant emissions dependant of the temperature
    - SNAP10: Agricultural emissions (NH3)
    - SNAP7: Traffic emissions

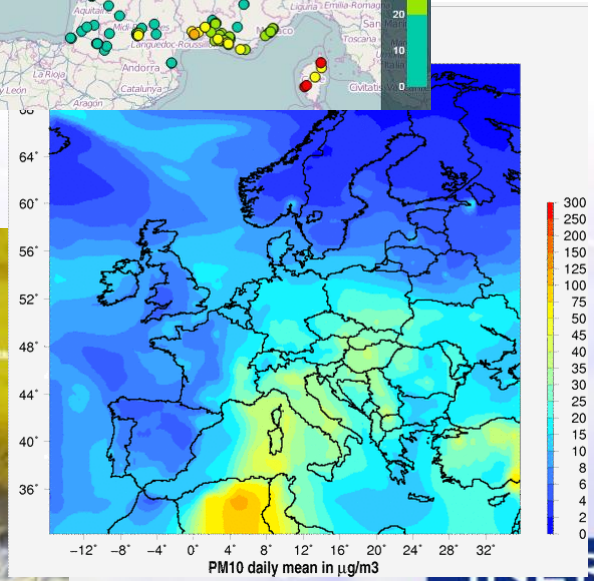


Evaluation of the natural contributions: desert dust

- Saharan dusts events can make the PM10 concentrations exceed information thresholds







13/10/2014

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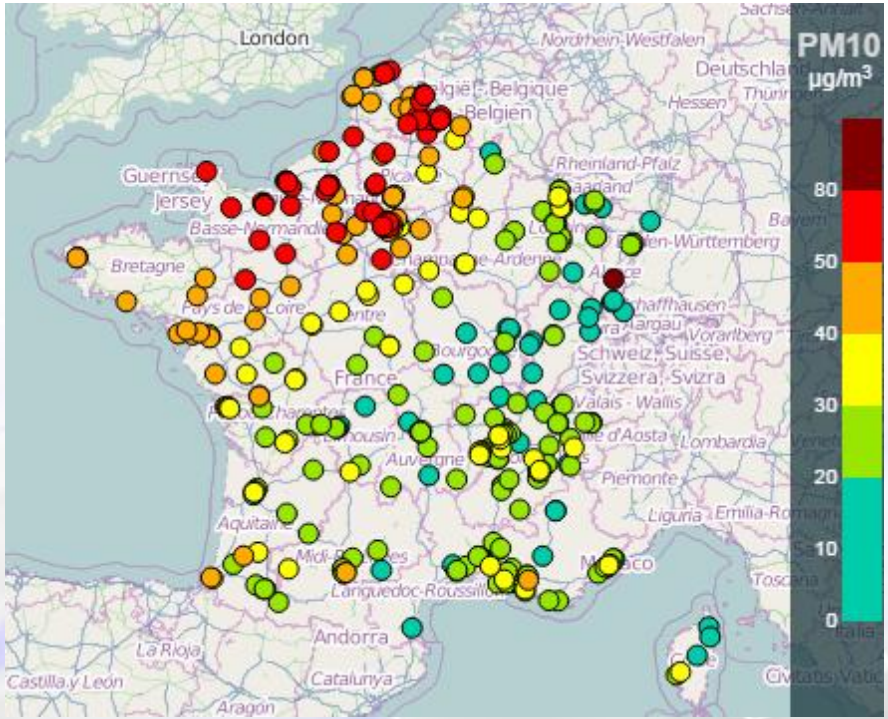
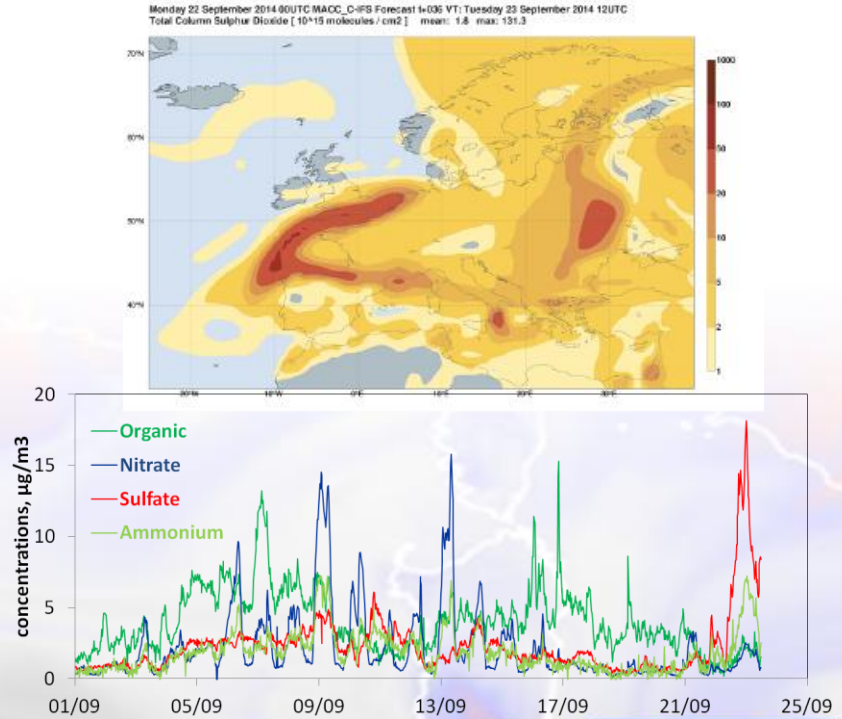
Volcanic eruption in Iceland – Bardarbunga (Sep. 2014)





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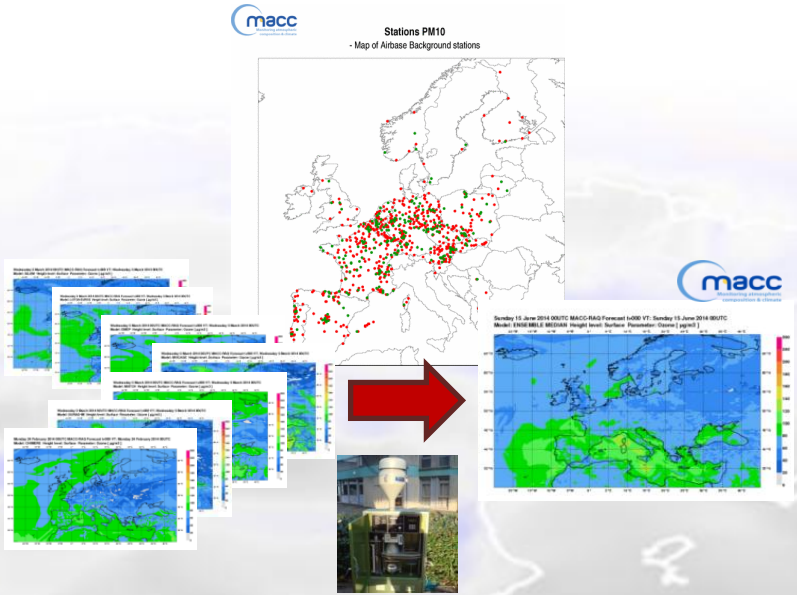
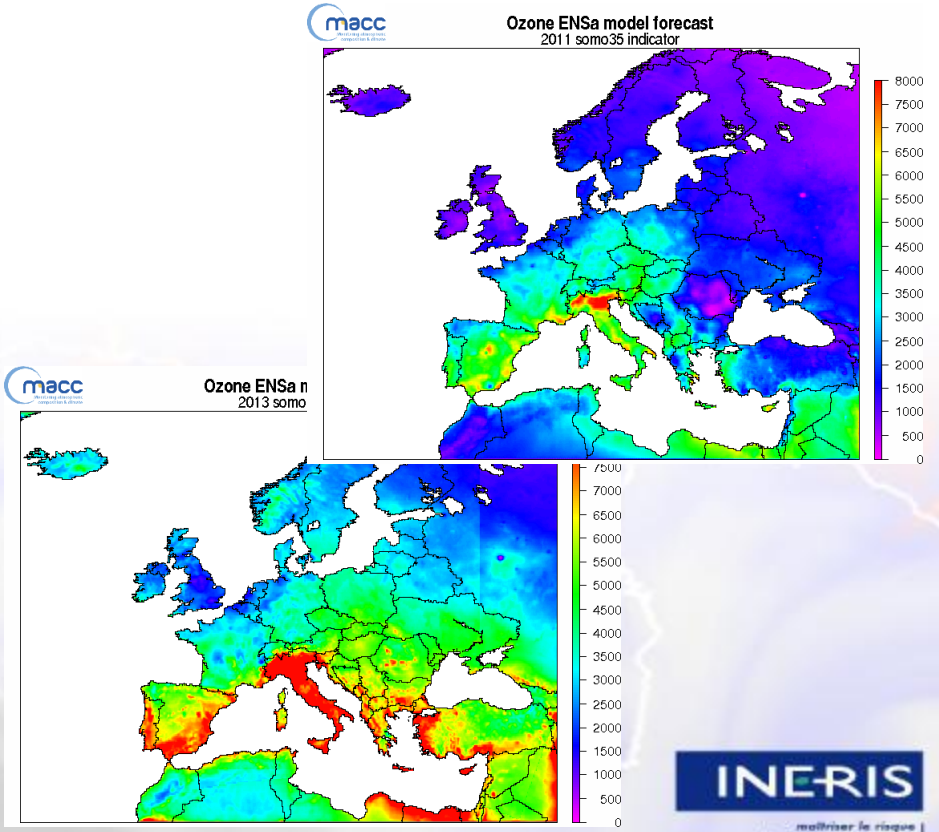
Why assessing natural contribution is important ?

- Specific treatment to remove the natural contributions from PM10 measurements
  - Sea salt, biomass burning, dust & volcano contributions
  - Implies a reduction of number of non regulatory report of PM10 values
    - Savings

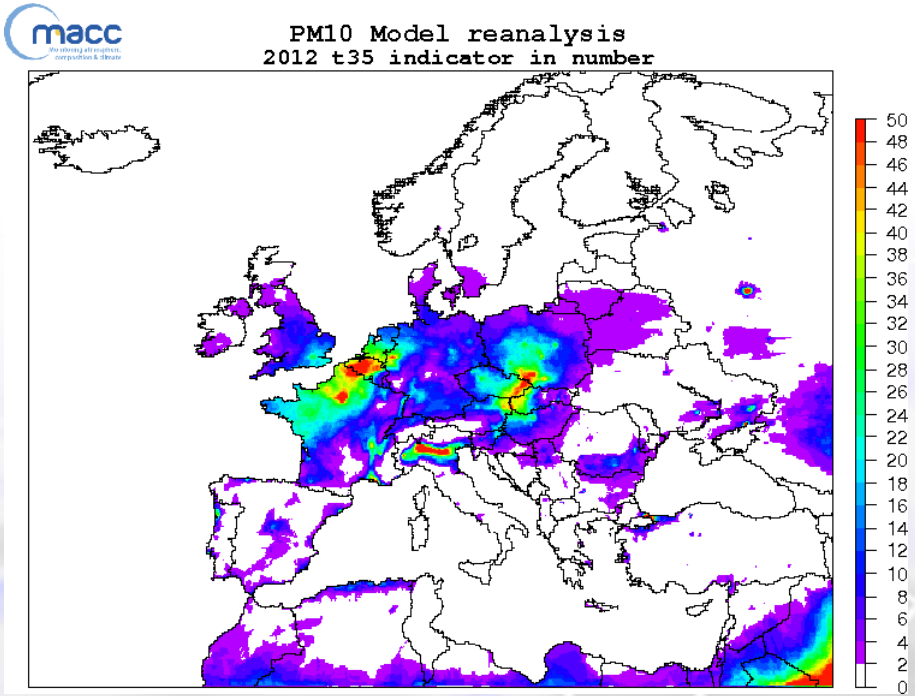
MACC-reanalyses : EEA support

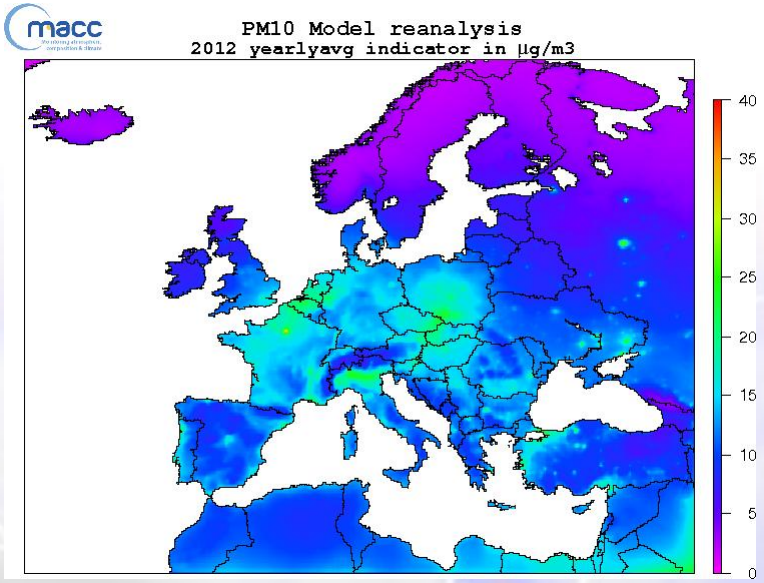
Every year, MACC produces AQ report for previous year describing AQ indicators





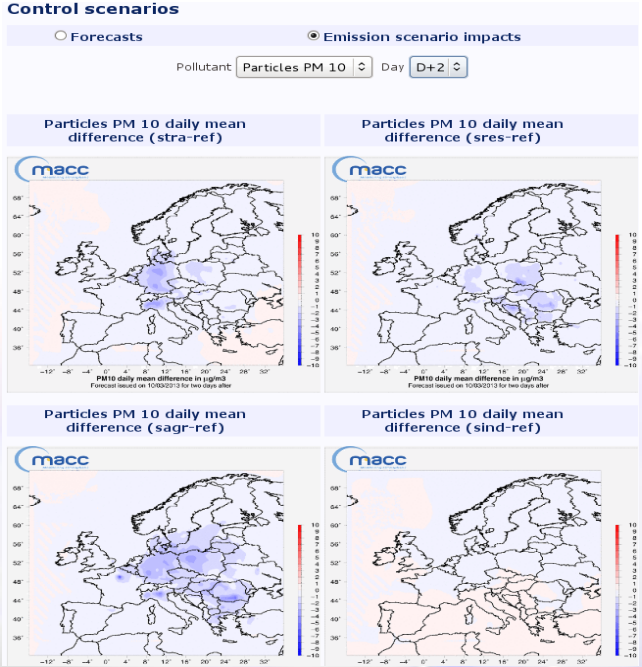
MACC-reanalyses : EEA support





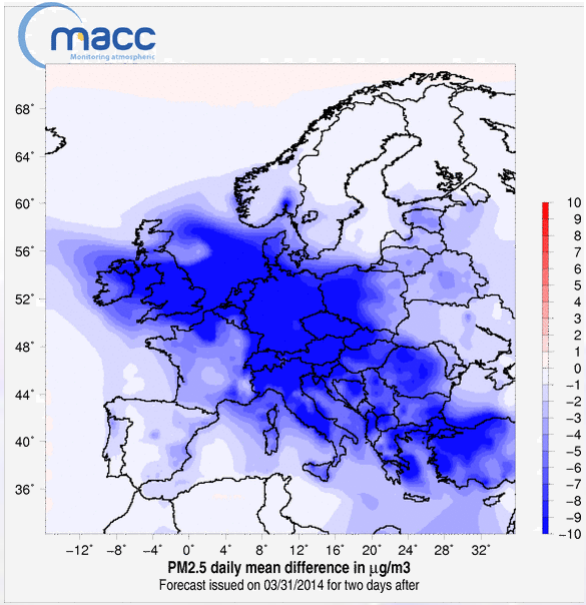
Additional products: Copernicus scenarios

- To help policy users to select the most efficient measure, a toolbox has been developed for visualizing the impact of control emission scenarios on pollutant concentrations (O3, NO2,PM10,PM2.5)

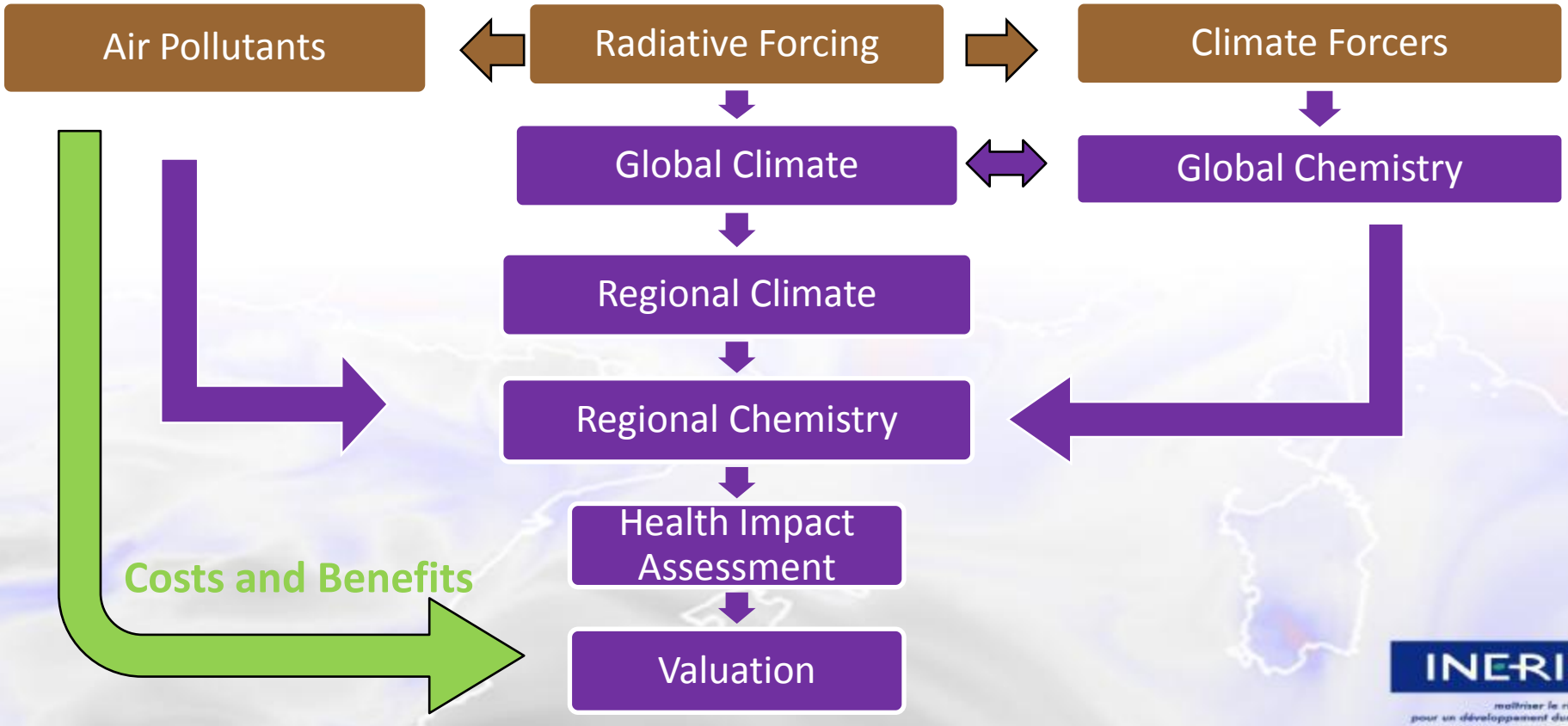


Evolution of the PREV'AIR role in the French air quality management

- To help policy users to select the most efficient measure, a toolbox has been developed for visualizing the impact of Gothenburg scenarios on pollutant concentrations (O3, NO2,PM10,PM2.5)



Future Air Quality Projections, Health Impacts, Valuation



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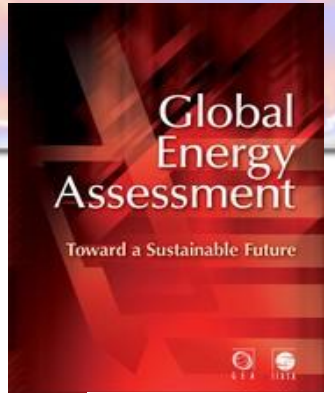
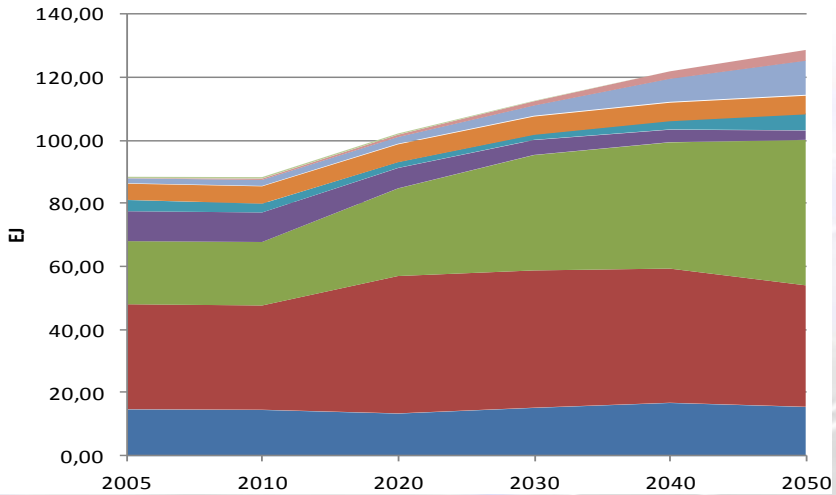
Emission projections

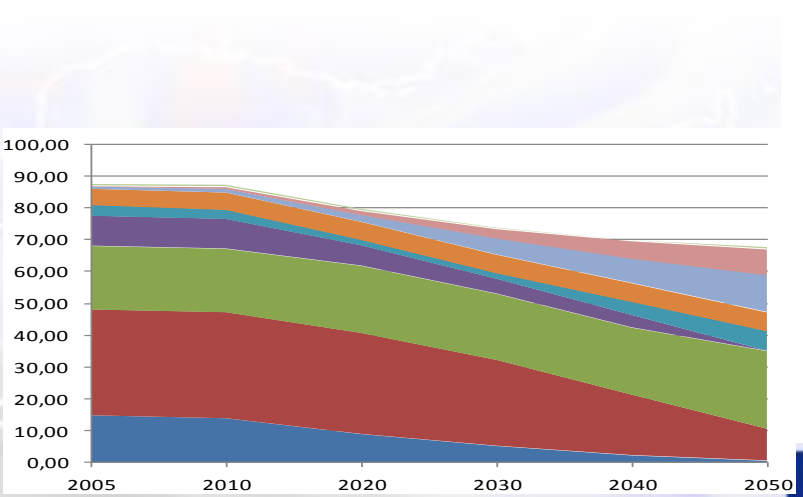


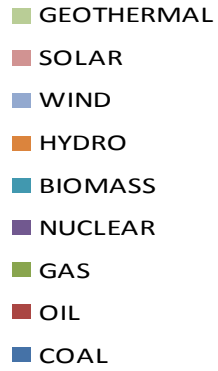
- The Global Energy Assessment (2012)
- Primary energy consumption in Europe:
  - Same AQ Legislation
  - Different Climate policies

Business as usual



Mitigation





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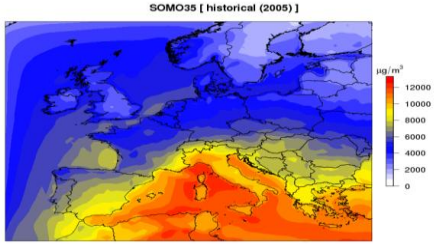
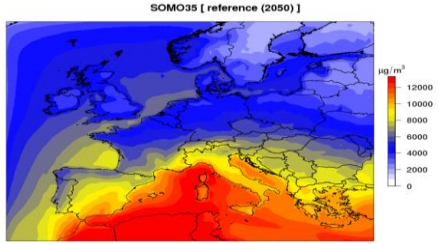
Future Air Quality: SOMO35 (sum of O3max > 35ppb)

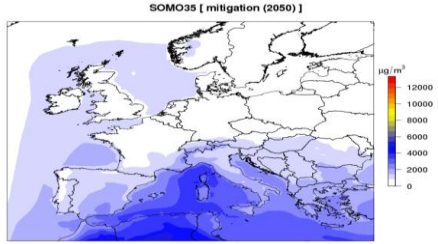
Historical



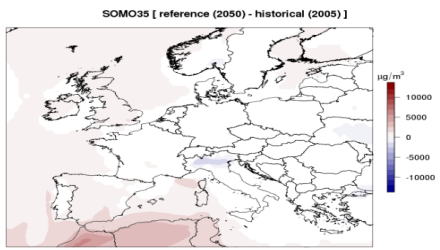
2050 Reference

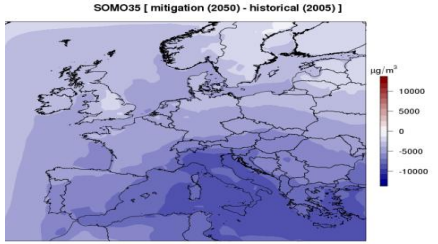


2050 Mitigation



Difference
%
historical





- Projections: status-quo for the Reference, large decrease for the Mitigation

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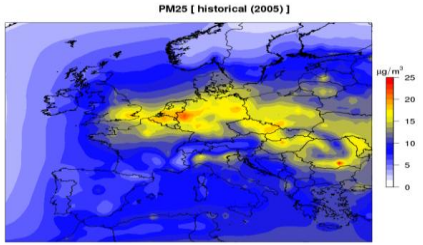
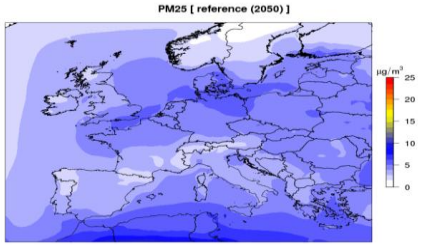
Air Quality: PM2.5 (annual mean)

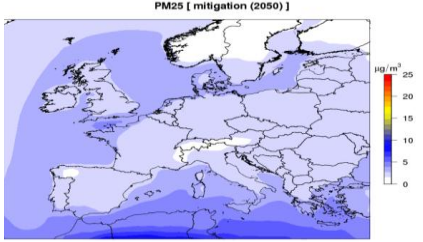
Historical



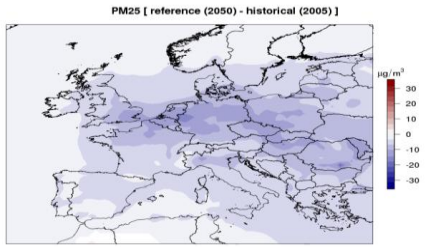
2050 Reference

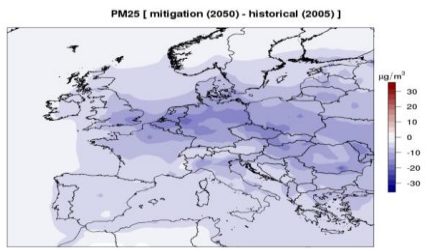


2050 Mitigation



Difference % historical





- Projections: significant decrease under both scenarios

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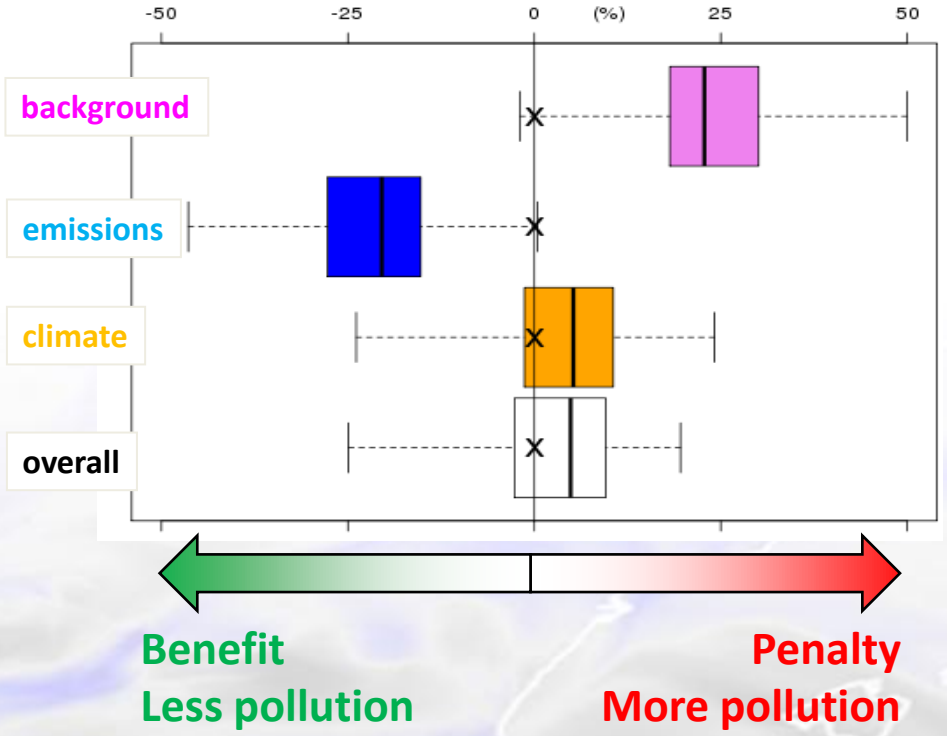
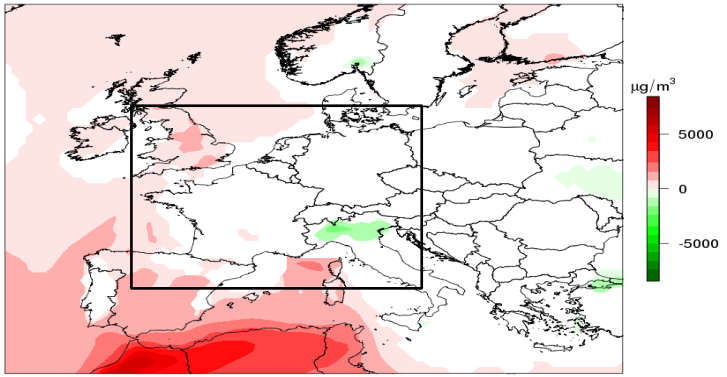
decomposition of the external factors: ozone





- Climate penalty confirmed
- Major influence of global chemistry
- AQ legislation efficient

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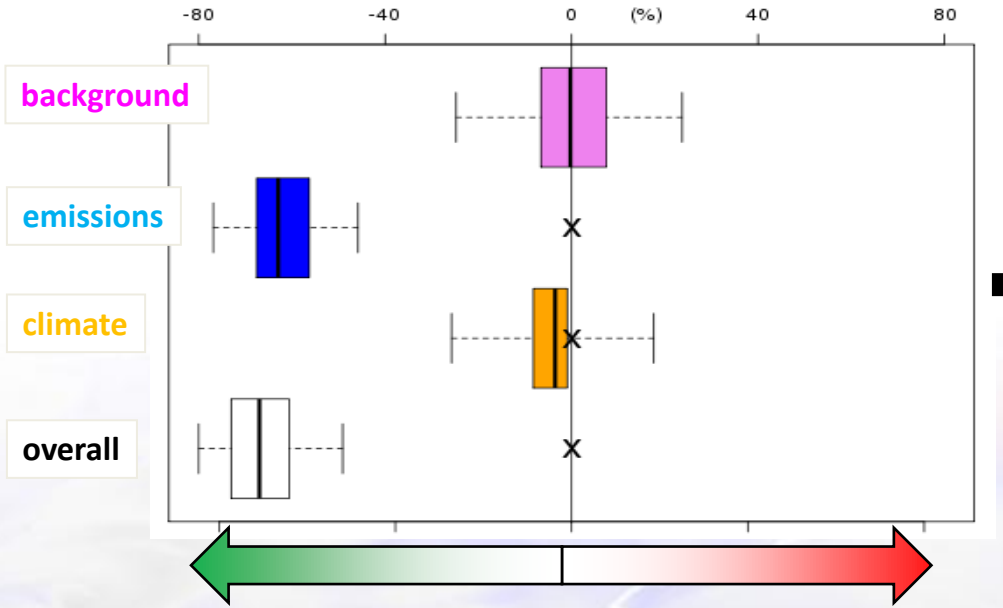
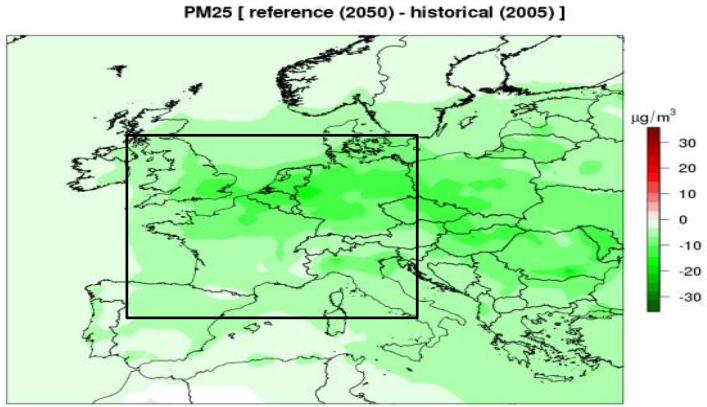
decomposition of the external factors: PM





- Climate benefit (but model dependant)
- AQ legislation dominates

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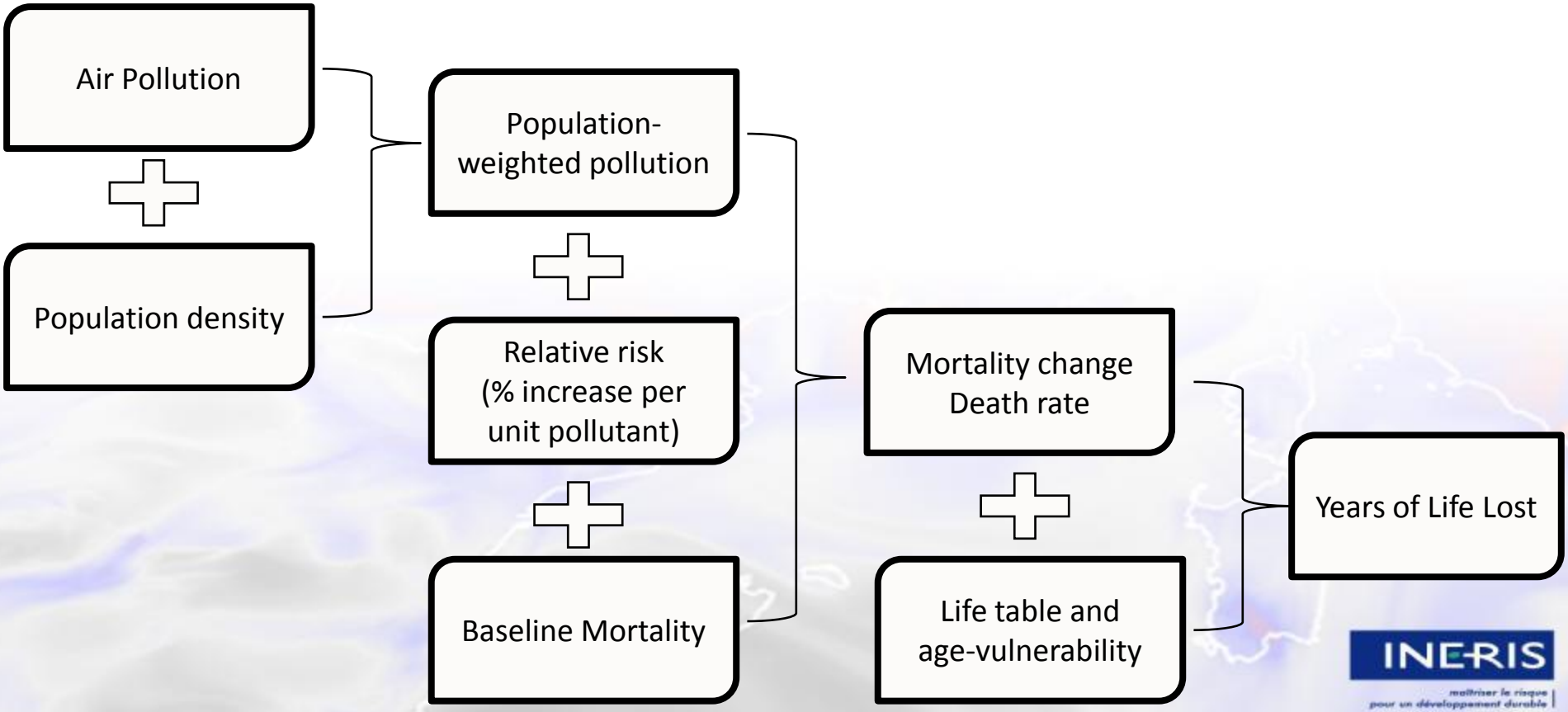
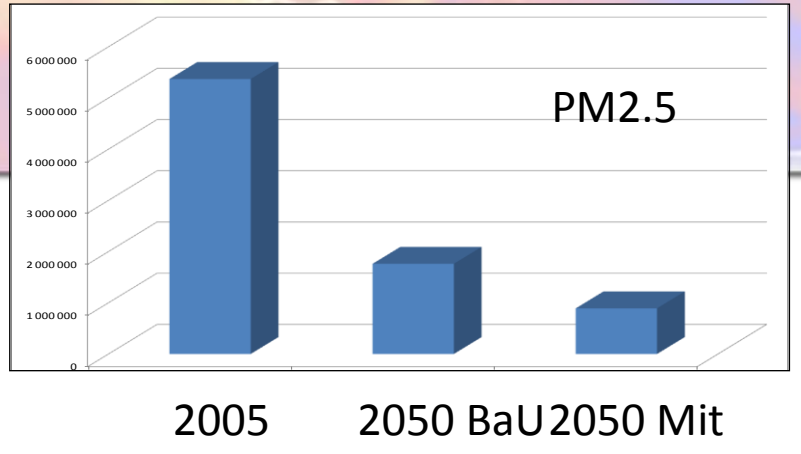
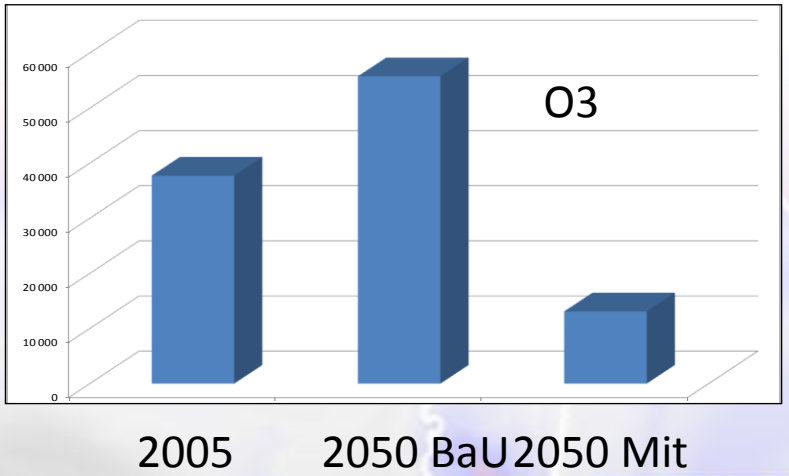
Health impact assessment



Health impacts PM & O3

- PM2.5:
  - 5 300 000 life-years are lost in 2005
  - ~ 450 000 premature deaths
  - Decrease in both scenarios
- Ozone
  - 60 000 premature deaths
  - Increase in 2050 under Business as Usual scenario
  - Decrease with climate mitigation





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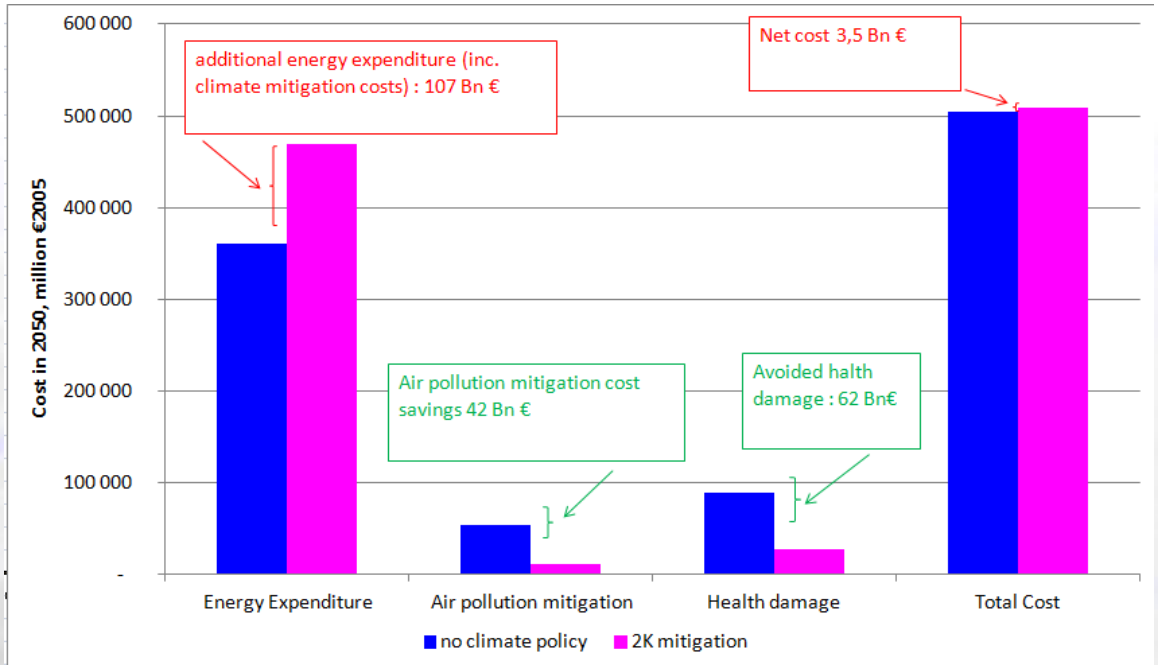
Cost Benefit analysis Synthesis

- The cost of climate mitigation is compensated by
  - Savings in air quality mitigation (less end-of-pipe measures required in low-carbon economy)
  - Reduced health damage



Conclusions

- France has developped a new approach to overcome pollution episodes based on forecast and near real time observations
- Europe has already a solid legislation on air quality even if standards are lower than WHO, and targets are not reached yet
- Monetised cost benefit analyses are a relevant instrument to support mitigation measures