

ANNEX

Scenario Analysis

Project:	IST-1999-11244 HEAVEN
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Prepared by (organisation):	Airparif
Author(s):	Fanny Mietlicki
Editor(s):	Peter Rapp (Carte Blanche Conseil)
Reviewed by:	

1.1 Scenario analysis : 20 % Speed reduction

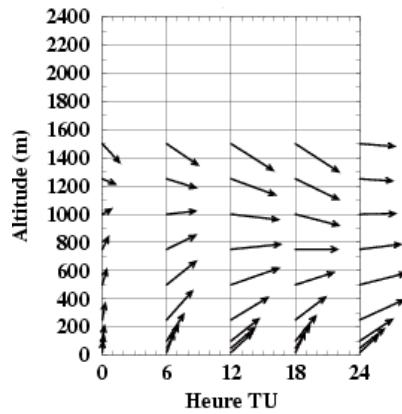
<p><u>Title</u> : Impact of an homogeneous speed reduction of 20% for the whole running fleet on background air quality</p>		
<p><u>Practical description of the scenario implemented</u> :</p> <p>An homogeneous speed reduction of 20% for the whole running fleet (passengers cars, Light Duty Vehicles, Heavy Duty Vehicles, Buses, Mopeds, Motorcycles) is enforced and the impact of this measure on emissions and air quality is evaluated for two different sets of meteorological conditions.</p>		
<p><u>Extension of the geographical domain described</u> :</p> <p>Size of the domain : 180 x 180 km²: the whole Ile-de-France region (for background O₃ concentrations)</p> <p style="padding-left: 150px;">90 x 90 km² : the whole Parisian agglomeration (for background NO₂ concentrations)</p>		
<p><u>Pollutants described</u> :</p> <p>Background : NO₂ (winter) O₃ (summer)</p>		
<p><u>Reference period</u> :</p> <p>Hourly description for the whole day</p>		
<p><u>Meteorological conditions</u> :</p> <p>Two different sets of meteorological conditions have been used to test the scenario. The first set called "WINTER EPISODE" is related to acute conditions, leading to high levels of air pollution (NO₂) in winter and the second one called "SUMMER EPISODE" is related to acute conditions, leading to high levels of air pollution (O₃) in summer. These two sets of meteorological conditions are based on real case conditions. Figures below describe these two sets of meteorological conditions used.</p>		

“WINTER EPISODE” METEOROLOGICAL CONDITIONS

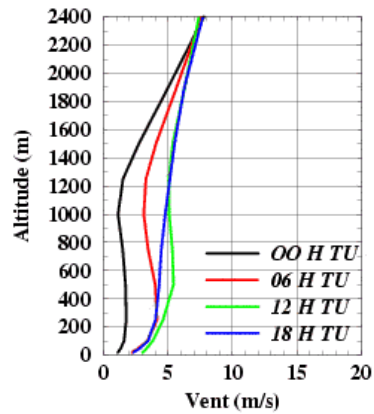
Real case date : 21/02/2000

Tmin : 4°C, Tmax : 7°C
 Wind speed : morning : 2 m/s, afternoon : 3 m/s
 Wind direction : South, South West
 Mixing layer height : 200–700 m
 Precipitations : none
 Nebulosity : very low

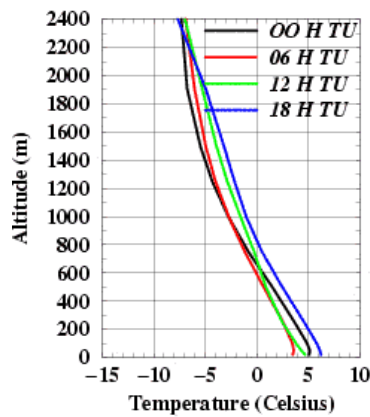
Direction du Vent



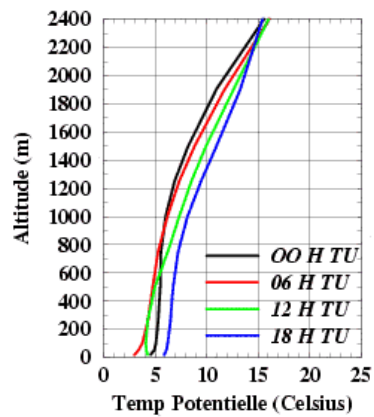
Profil de Vent



Profil de Temperature



Temperature Potentielle



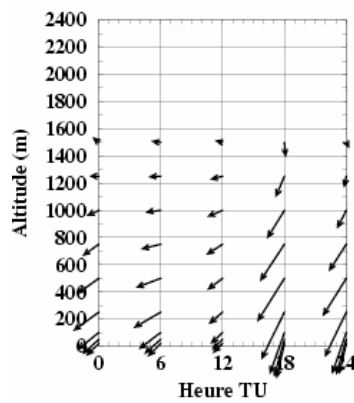
Profils faits le 22-02-2000 pour le 21-02-2000

“SUMMER EPISODE” METEOROLOGICAL CONDITIONS

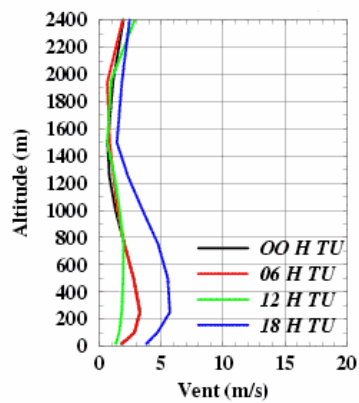
Real case date : 27/07/2001

<p>Tmin : 23 °C, Tmax : 27 °C Wind speed : morning : 2 m/s, afternoon : 3 m/s Wind direction : variable Mixing layer height : 200 –2500 m Precipitations : none in the morning, few in the afternoon Neblosity : low in the morning, average in the afternoon</p>

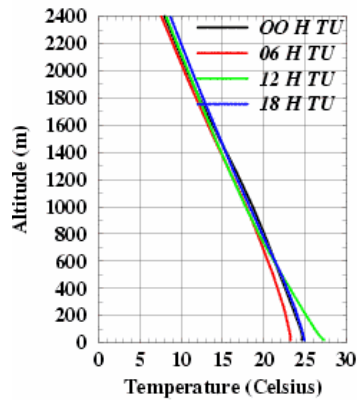
Direction du Vent



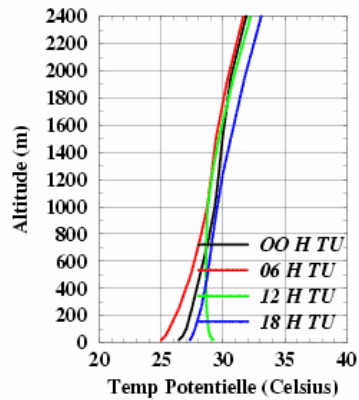
Profil de Vent



Profil de Temperature

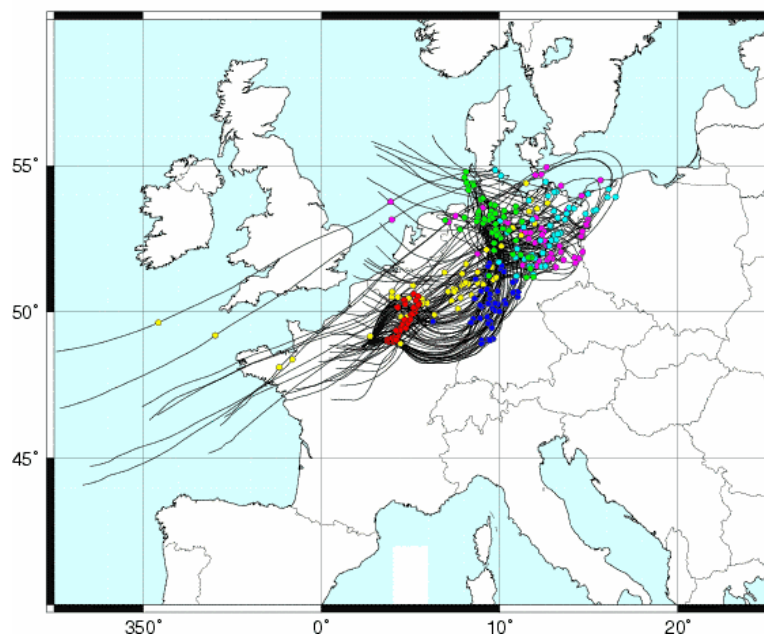


Temperature Potentielle



Profils faits le 28-07-2001 pour le 27-07-2001

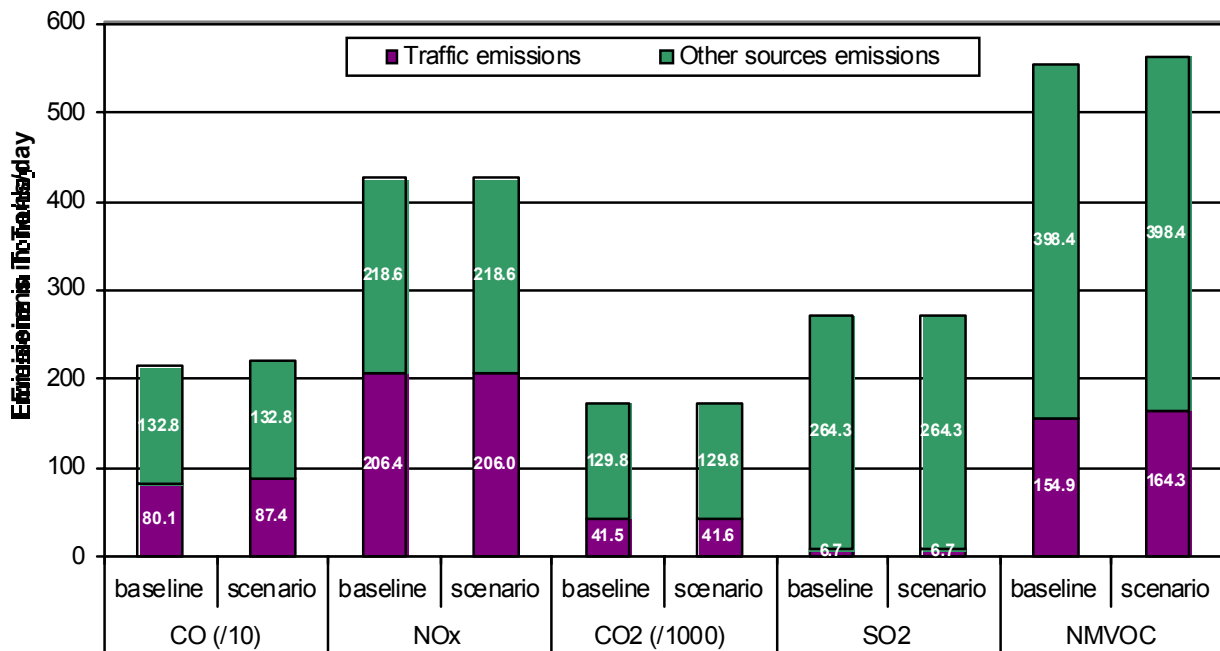
28-07-2001 : Retrotrajectoires pour le 27-07-2001



1.1.1 Description of the impact of the measure (-20 % speed) on the emissions for the winter meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	-3.4	
CO	9.2	3.4
NOx	-0.2	-0.1
CO2	0.3	0.1
SO2	-0.5	0.0
NMVOc	6.1	1.7

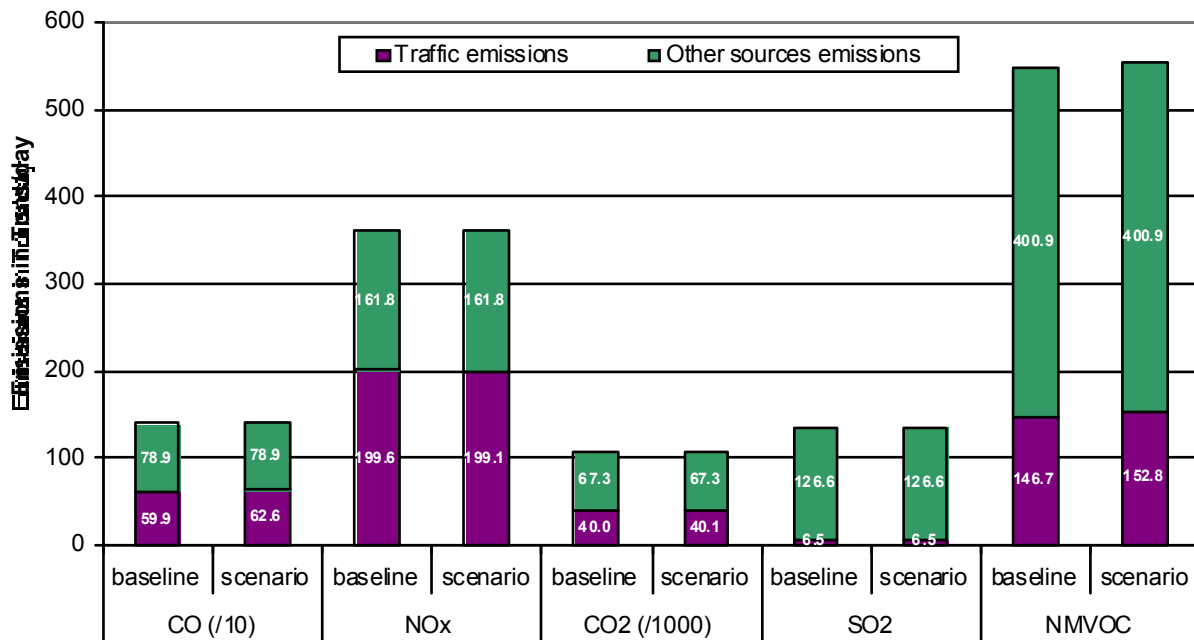
Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (-20 % speed)



1.1.2 Description of the impact of the measure (-20 % speed) on the emissions for the summer meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	-4.3	
CO	4.5	1.9
NOx	-0.2	-0.1
CO2	0.1	0.0
SO2	-0.7	0.0
NMVOc	4.2	1.1

Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (-20 % speed)



1.1.3 Description of the impact of the measure on NO₂ concentrations for a winter episode

baseline

scenario (-20 % speed)

	NO2 maximum concentration
Baseline	307 $\mu\text{g}/\text{m}^3$
Scenario (-20 % speed)	320 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	+4.2 %

This measure has a slight negative impact on the NO₂ concentrations at the regional scale in case of a high winter episode. The slight increase in NO₂ concentrations appears in the urban areas where average speed of vehicles is relatively low (< 40 km/h) and where a decrease in speed increases emissions of NO_x.

1.1.4 Description of the impact of the measure on ozone concentrations for a summer episode

baseline

scenario (-20 % speed)

	O3 maximum concentration
Baseline	250 $\mu\text{g}/\text{m}^3$
Scenario (-20 % speed)	251 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	+ 0.4 %

This measure has no impact on the ozone concentrations at the regional scale in case of a high summer episode

Real case date : 21/02/2000

Tmin : 4°C, Tmax : 7°C

Wind speed : morning : 2 m/s, afternoon : 3 m/s

Wind direction : South, South West

Mixing layer height : 200–700 m

Precipitations : none

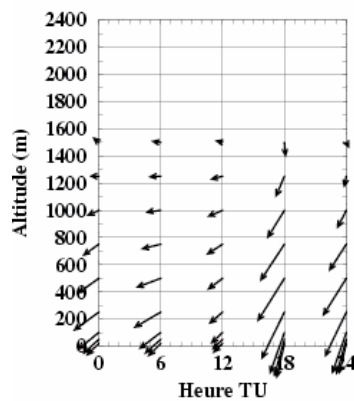
Neblosity : very low

“SUMMER EPISODE” METEOROLOGICAL CONDITIONS

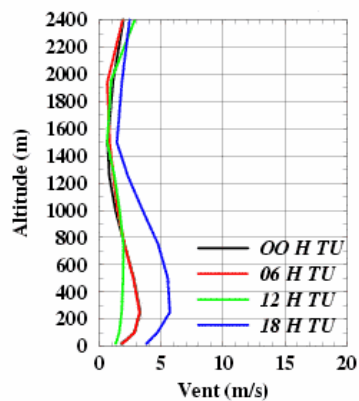
Real case date : 27/07/2001

<p>Tmin : 23 °C, Tmax : 27 °C Wind speed : morning : 2 m/s, afternoon : 3 m/s Wind direction : variable Mixing layer height : 200 –2500 m Precipitations : none in the morning, few in the afternoon Neblosity : low in the morning, average in the afternoon</p>

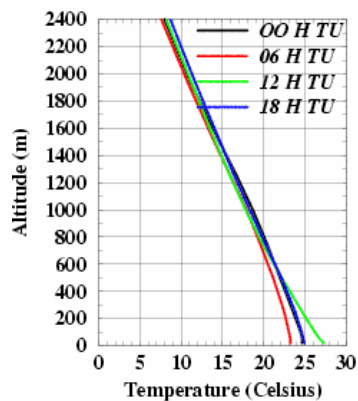
Direction du Vent



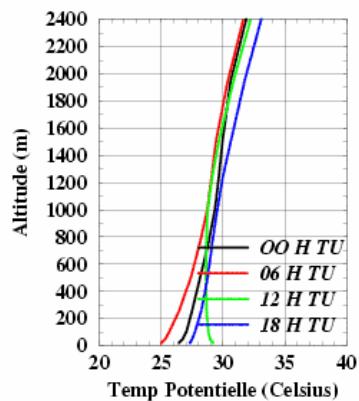
Profil de Vent



Profil de Temperature

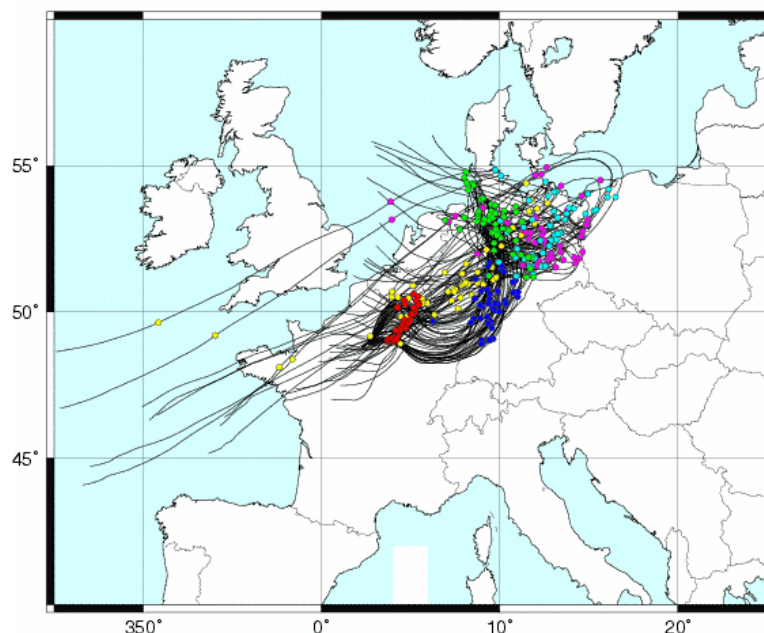


Temperature Potentielle



Profils faits le 28-07-2001 pour le 27-07-2001

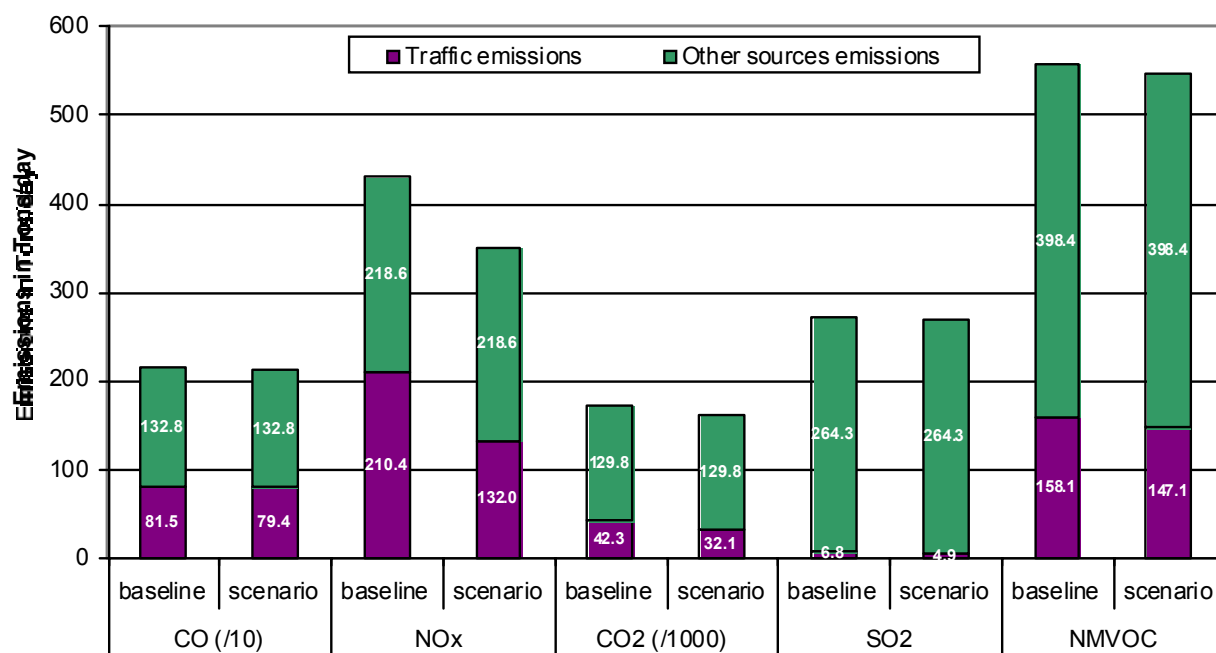
28-07-2001 : Retrotrajectoires pour le 27-07-2001



1.2.1 Description of the impact of the measure (no Heavy Duty Vehicles) on the emissions for the winter meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	-22.0	
CO	-2.5	-1.0
NOx	-37.3	-18.3
CO2	-24.1	-5.9
SO2	-28.8	-0.7
NMVOc	-6.9	-2.0

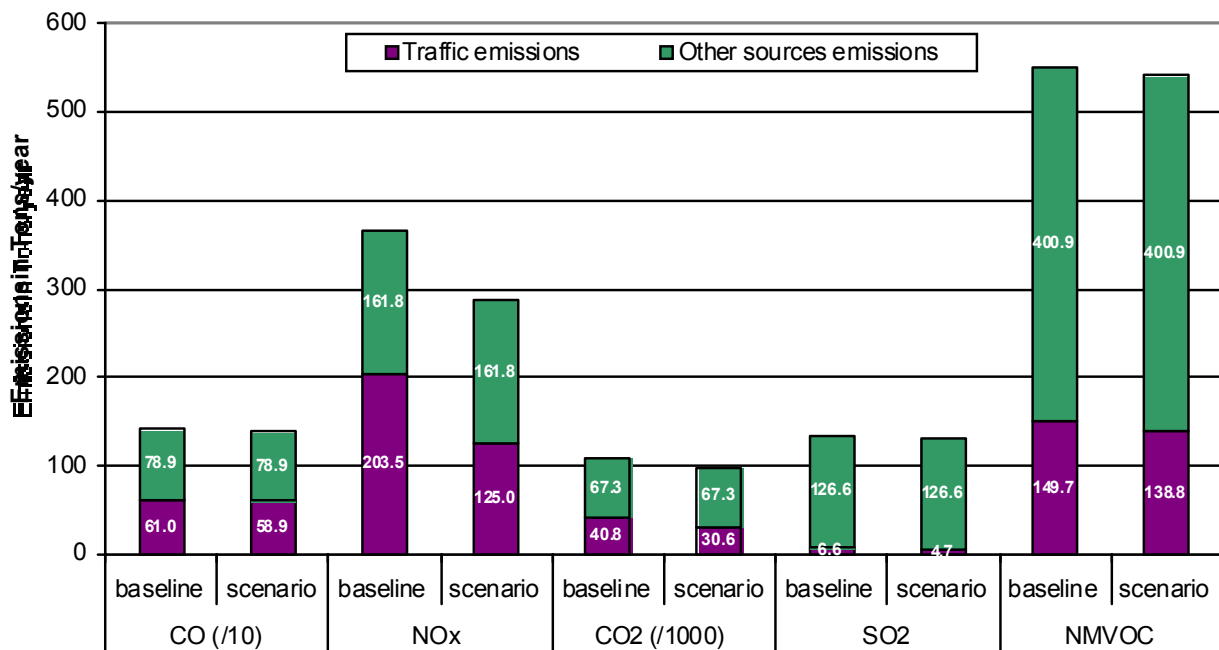
Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (no Heavy Duty Vehicles)



1.2.2 Description of the impact of the measure (no Heavy Duty Vehicles) on the emissions for the summer meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	-29.3	
CO	-3.4	-1.5
NOx	-38.6	-21.5
CO2	-25.0	-9.4
SO2	-29.7	-1.5
NMVOc	-7.3	-2.0

Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (no Heavy Duty Vehicles)



1.2.3 Description of the impact of the measure on NO₂ concentrations for a winter episode

baseline

scenario (no Heavy Duty Vehicles)

	NO2 maximum concentration
Baseline	307 $\mu\text{g}/\text{m}^3$
Scenario (No Heavy Duty Vehicles)	195 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	- 36.5 %

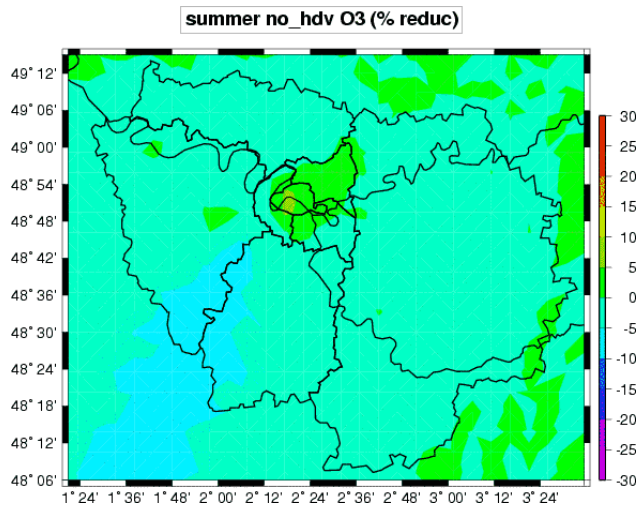
This black and white scenario has an important impact on the NO2 concentrations at the regional scale in case of a high winter episode.

1.2.4 Description of the impact of the measure on ozone concentrations for a summer episode

baseline

scenario (no Heavy Duty Vehicles)

O3 maximum concentration	
Baseline	250 $\mu\text{g}/\text{m}^3$
Scenario (No Heavy Duty Vehicles)	235 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	- 6 %



This measure has a positive impact on the ozone concentrations at the regional scale in case of a high summer episode. Taking into account that a constant amount (146 $\mu\text{g}/\text{m}^3$) of imported ozone has been considered in both scenarios (baseline and no traffic), the local production of ozone due to the emissions of the Ile-de-France region decreases (- 14.5%), going from 104 $\mu\text{g}/\text{m}^3$ to 89 $\mu\text{g}/\text{m}^3$.

1.3 Scenario analysis : No Two-wheelers

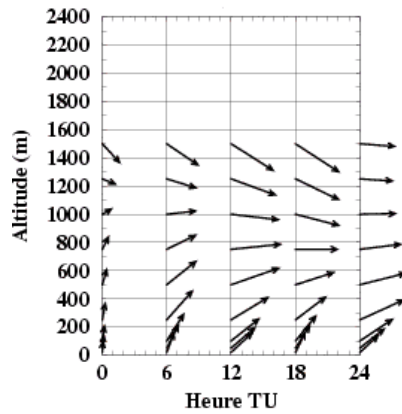
<p><u>Title</u> : “black and white” scenario based on a total removal of two wheelers (mopeds and motorcycles) in the whole Ile-de-France region. Impact of a vehicle fleet without two wheelers on background air quality</p>		
<p><u>Practical description of the scenario implemented</u> :</p> <p>The scenario consists in setting two wheelers related emissions at zero and in evaluating the impact of such a virtual measure on emissions and air quality for two different sets of meteorological conditions.</p>		
<p><u>Extension of the geographical domain described</u> :</p> <p>Size of the domain : 180 x 180 km²: the whole Ile-de-France region (for background O₃ concentrations) 90 x 90 km² : the whole parisian agglomeration (for background NO₂ concentrations)</p>		
<p><u>Pollutants described</u> :</p> <p>Background : NO₂ (winter) O₃ (summer)</p>		
<p><u>Reference period</u> :</p> <p>Hourly description for the whole day</p>		
<p><u>Meteorological conditions</u> :</p> <p>Two different sets of meteorological conditions have been used to test the scenario. The first set called “WINTER EPISODE” is related to acute conditions, leading to high levels of air pollution (NO₂) in winter and the second one called “SUMMER EPISODE” is related to acute conditions, leading to high levels of air pollution (O₃) in summer. These two sets of meteorological conditions are based on real case conditions. Figures below describe these two sets of meteorological conditions used.</p>		

“WINTER EPISODE” METEOROLOGICAL CONDITIONS

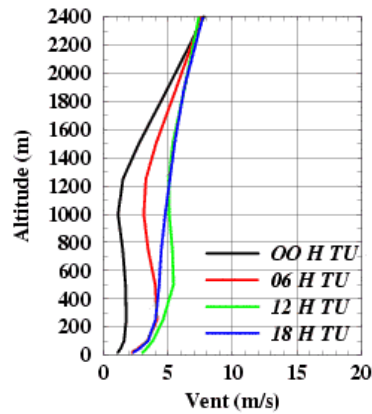
Real case date : 21/02/2000

Tmin : 4°C, Tmax : 7°C
 Wind speed : morning : 2 m/s, afternoon : 3 m/s
 Wind direction : South, South West
 Mixing layer height : 200–700 m
 Precipitations : none
 Nebulosity : very low

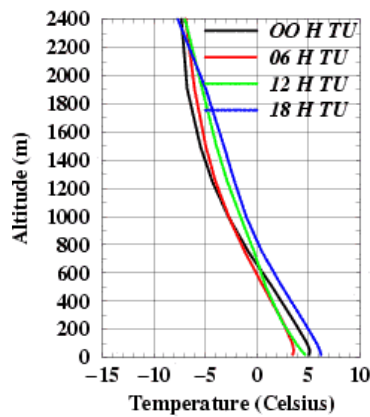
Direction du Vent



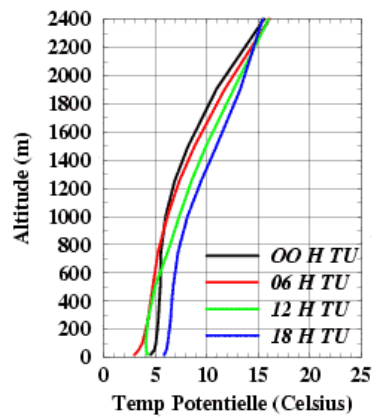
Profil de Vent



Profil de Temperature



Temperature Potentielle



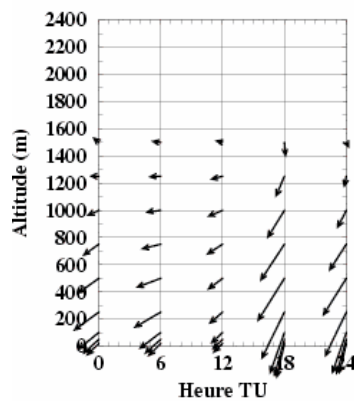
Profils faits le 22-02-2000 pour le 21-02-2000

“SUMMER EPISODE” METEOROLOGICAL CONDITIONS

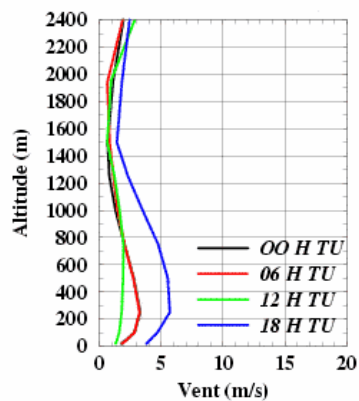
Real case date : 27/07/2001

<p>Tmin : 23 °C, Tmax : 27 °C Wind speed : morning : 2 m/s, afternoon : 3 m/s Wind direction : variable Mixing layer height : 200 –2500 m Precipitations : none in the morning, few in the afternoon Neblosity : low in the morning, average in the afternoon</p>

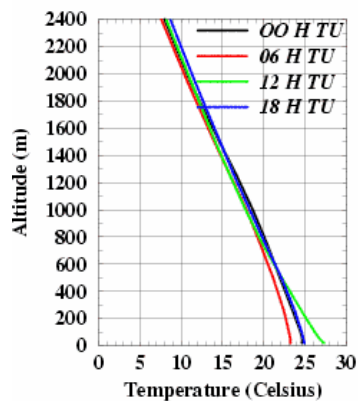
Direction du Vent



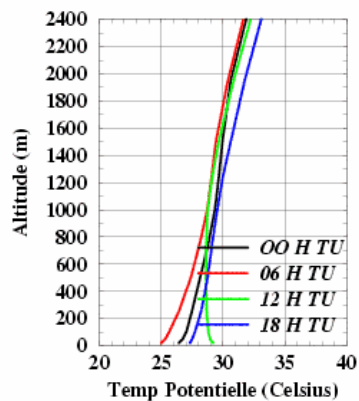
Profil de Vent



Profil de Temperature

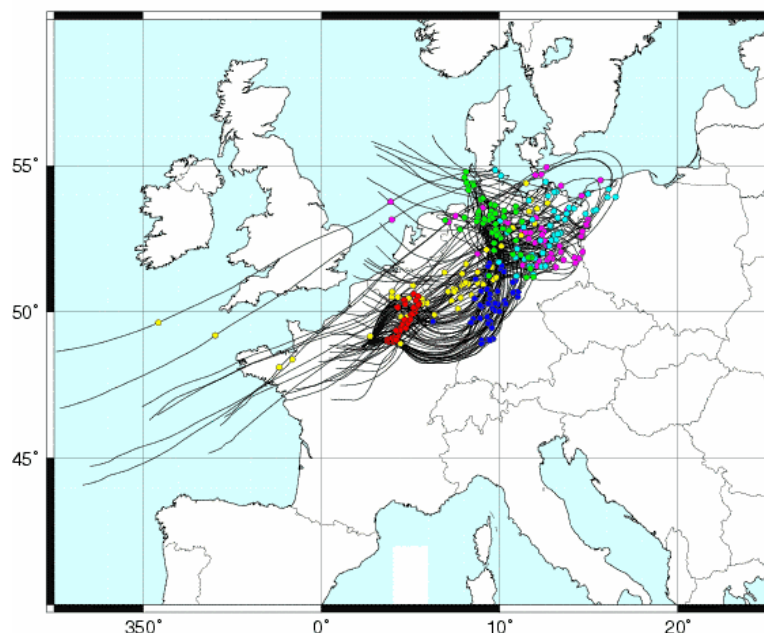


Temperature Potentielle



Profils faits le 28-07-2001 pour le 27-07-2001

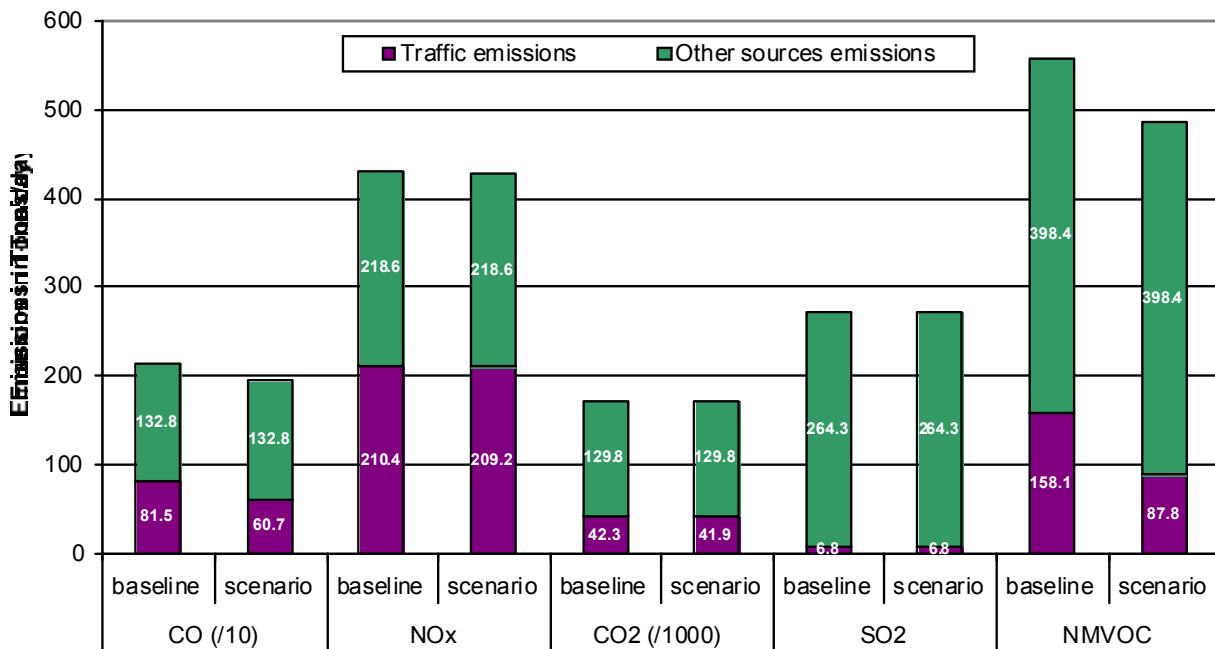
28-07-2001 : Retrotrajectoires pour le 27-07-2001



1.3.1 Description of the impact of the measure (no two wheelers) on the emissions for the winter meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	0.0	
CO	-25.5	-10.7
NOx	-0.6	-0.3
CO2	-1.0	-0.3
SO2	-1.2	0.0
NMVOc	-44.5	-12.6

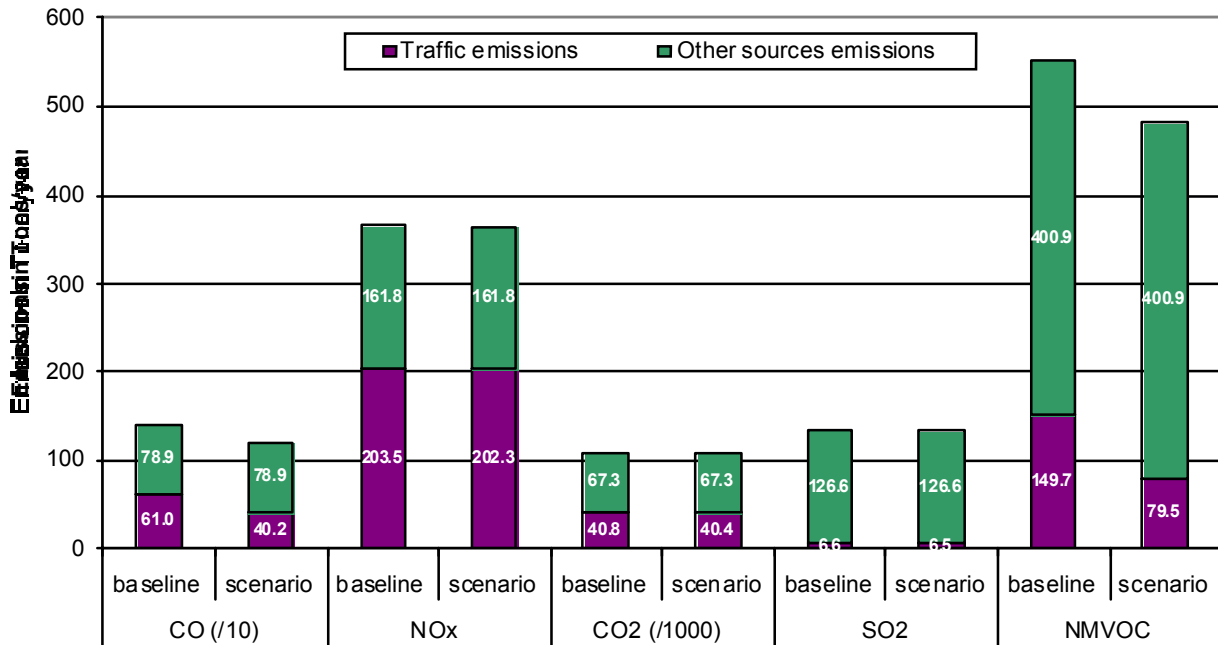
Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (no two wheelers)



1.3.2 Description of the impact of the measure (no two wheelers) on the emissions for the summer meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	0.0	
CO	-34.0	-17.4
NOx	-0.6	-0.3
CO2	-1.1	-0.4
SO2	-1.2	-0.1
NMVOc	-46.9	-12.8

Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (no two wheelers)



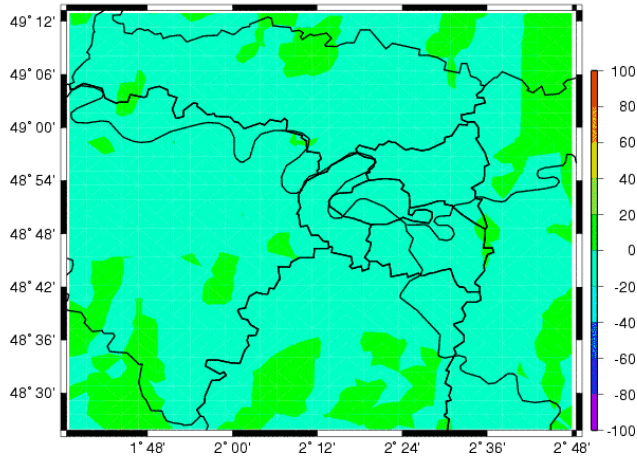
1.3.3 Description of the impact of the measure on NO₂ concentrations for a winter episode

baseline

scenario (no two wheelers)

NO2 maximum concentration	
Baseline	307 $\mu\text{g}/\text{m}^3$
Scenario (No two wheelers)	306.5 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	0 %

winter no_2wh NO2 (% reduc)



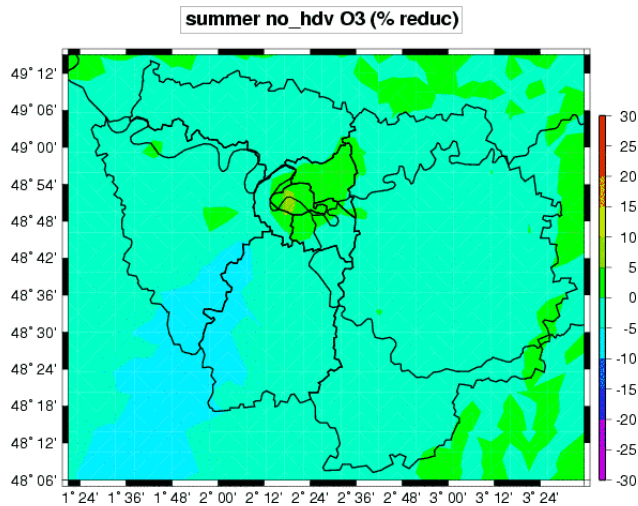
This black and white scenario has no impact on the NO2 concentrations at the regional scale in case of a high winter episode.

1.3.4 Description of the impact of the measure on ozone concentrations for a summer episode

baseline

scenario (no two wheelers)

O3 maximum concentration	
Baseline	250 $\mu\text{g}/\text{m}^3$
Scenario (No two wheelers)	230 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	- 8 %



This measure has a positive impact on the ozone concentrations at the regional scale in case of a high summer episode. This measure seems a little more efficient than the banishment of Heavy Duty Vehicles in decreasing ozone concentrations. Taking into account that a constant amount (146 $\mu\text{g}/\text{m}^3$) of imported ozone has been considered in both scenarios (baseline and no traffic), the local production of ozone due to the emissions of the Ile-de-France region decreases (- 19 %), going from 104 $\mu\text{g}/\text{m}^3$ to 84 $\mu\text{g}/\text{m}^3$.

1.4 Scenario analysis : No Traffic

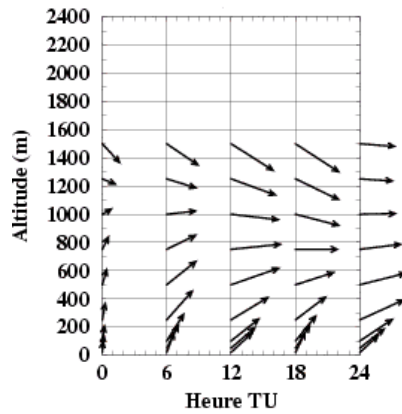
<p><u>Title</u> : “black and white” scenario based on a total removal of vehicles in the whole Ile-de-France region. Impact of traffic related emissions removal on background air quality</p>		
<p><u>Practical description of the scenario implemented</u> :</p> <p>The scenario consists in setting traffic related emissions at zero and in evaluating the impact of such a virtual measure on emissions and air quality for two different sets of meteorological conditions.</p>		
<p><u>Extension of the geographical domain described</u> :</p> <p>Size of the domain : 180 x 180 km²: the whole Ile-de-France region (for background O₃ concentrations) <div style="margin-left: 150px;">90 x 90 km² : the whole parisian agglomeration (for background NO₂ concentrations)</div></p>		
<p><u>Pollutants described</u> :</p> <p>Background : NO₂ (winter) O₃ (summer)</p>		
<p><u>Reference period</u> :</p> <p>Hourly description for the whole day</p>		
<p><u>Meteorological conditions</u> :</p> <p>Two different sets of meteorological conditions have been used to test the scenario. The first set called “WINTER EPISODE” is related to acute conditions, leading to high levels of air pollution (NO₂) in winter and the second one called “SUMMER EPISODE” is related to acute conditions, leading to high levels of air pollution (O₃) in summer. These two sets of meteorological conditions are based on real case conditions. Figures below describe these two sets of meteorological conditions used.</p>		

“WINTER EPISODE” METEOROLOGICAL CONDITIONS

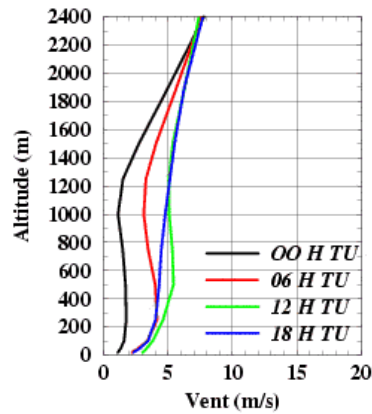
Real case date : 21/02/2000

Tmin : 4°C, Tmax : 7°C
 Wind speed : morning : 2 m/s, afternoon : 3 m/s
 Wind direction : South, South West
 Mixing layer height : 200–700 m
 Precipitations : none
 Nebulosity : very low

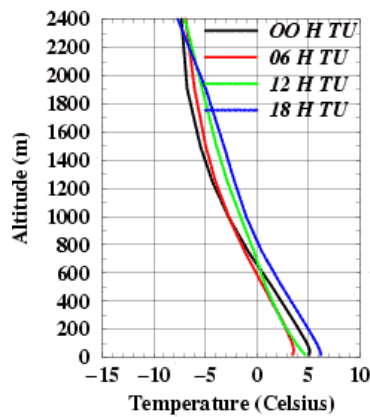
Direction du Vent



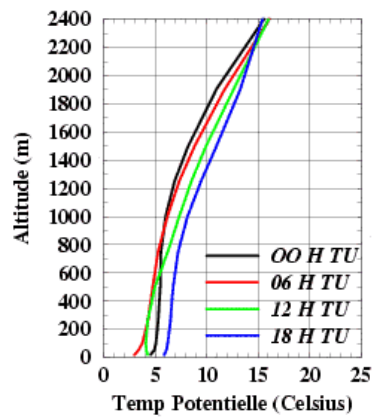
Profil de Vent



Profil de Temperature



Temperature Potentielle



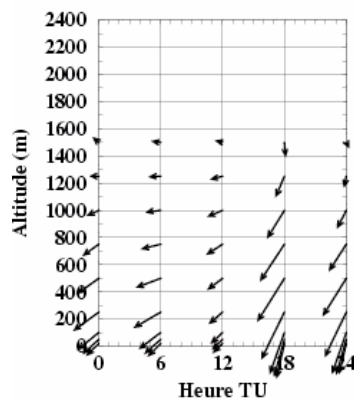
Profils faits le 22-02-2000 pour le 21-02-2000

“SUMMER EPISODE” METEOROLOGICAL CONDITIONS

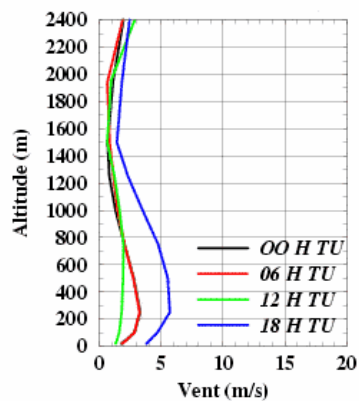
Real case date : 27/07/2001

<p>Tmin : 23 °C, Tmax : 27 °C Wind speed : morning : 2 m/s, afternoon : 3 m/s Wind direction : variable Mixing layer height : 200 –2500 m Precipitations : none in the morning, few in the afternoon Neblosity : low in the morning, average in the afternoon</p>

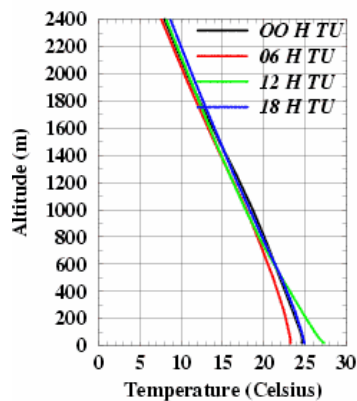
Direction du Vent



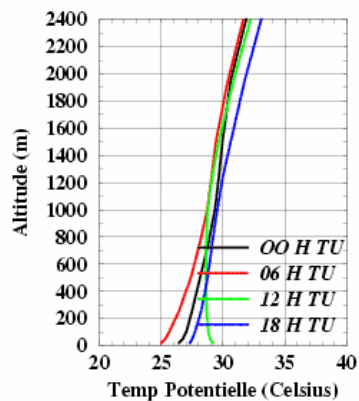
Profil de Vent



Profil de Temperature

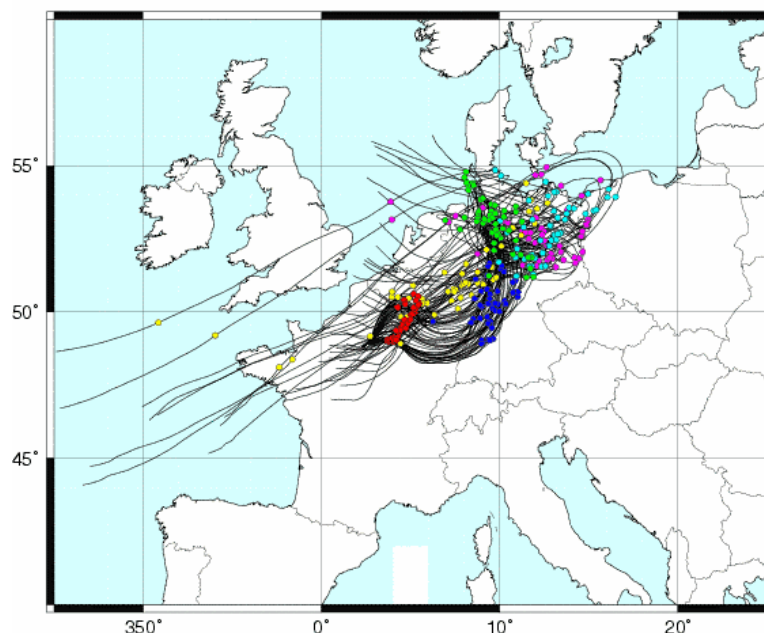


Temperature Potentielle



Profils faits le 28-07-2001 pour le 27-07-2001

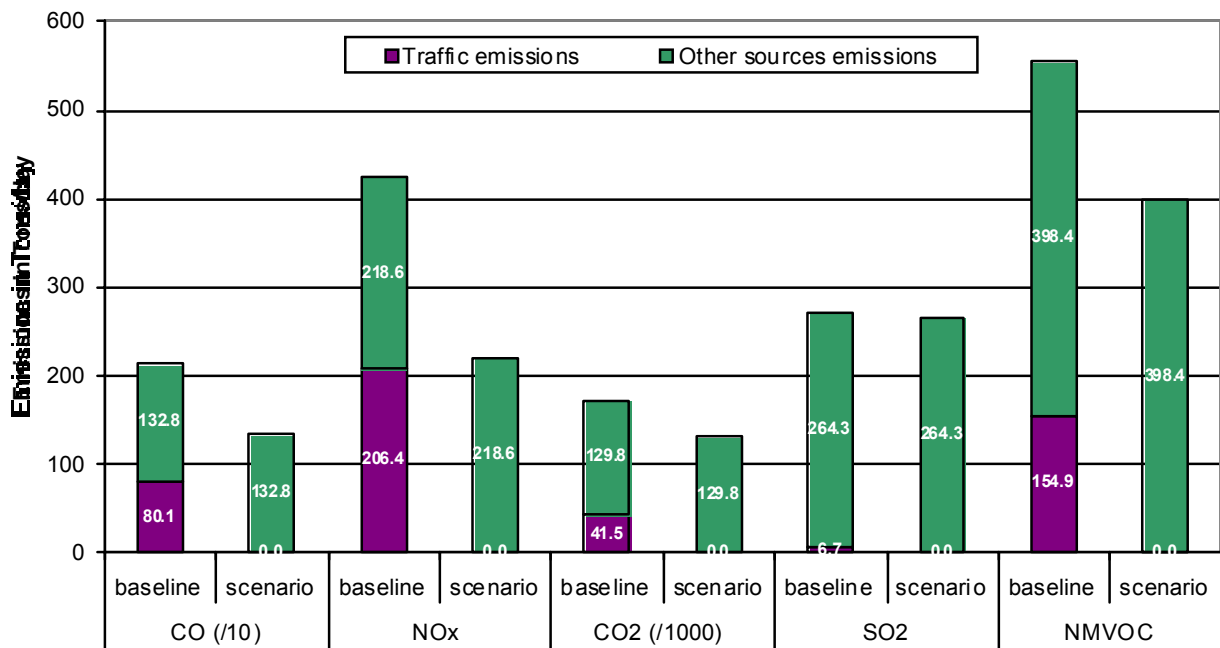
28-07-2001 : Retrotrajectoires pour le 27-07-2001



1.4.1 Description of the impact of the measure (no traffic) on the emissions for the winter meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	-100.0	
CO	-100.0	-37.6
NOx	-100.0	-48.6
CO2	-100.0	-24.2
SO2	-100.0	-2.5
NMVOc	-100.0	-28.0

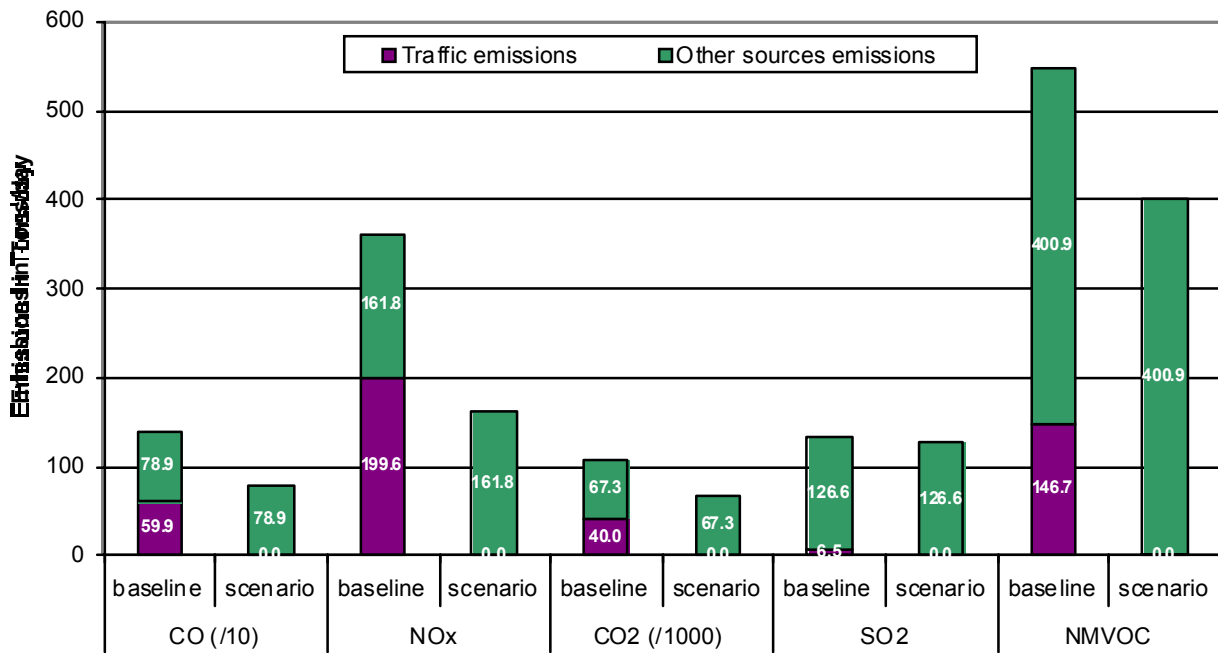
Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (no traffic)



1.4.2 Description of the impact of the measure (no traffic) on the emissions for the summer meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	-100.0	
CO	-100.0	-43.2
NOx	-100.0	-55.2
CO2	-100.0	-37.3
SO2	-100.0	-4.9
NMVOc	-100.0	-26.8

Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (no traffic)

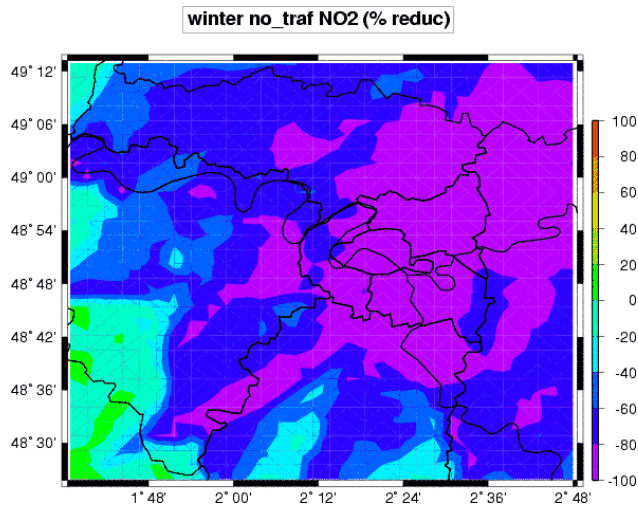


1.4.3 Description of the impact of the measure on NO₂ concentrations for a winter episode

baseline

scenario (no traffic)

NO2 maximum concentration	
Baseline	307 $\mu\text{g}/\text{m}^3$
Scenario (No traffic)	49 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	- 84 %



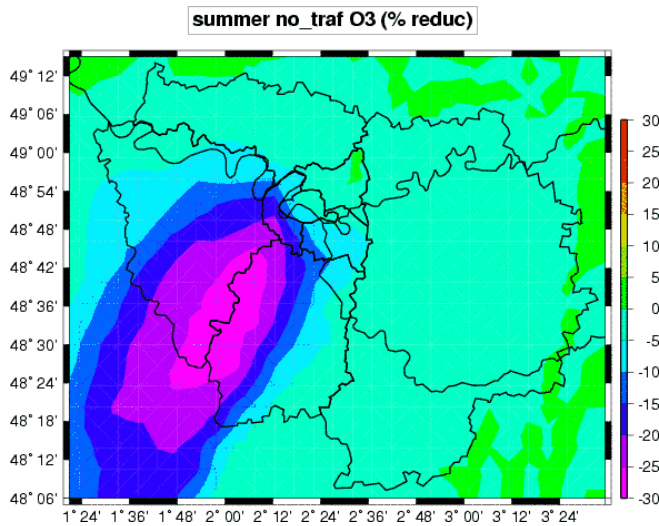
This black and white scenario has a very important impact on the NO2 concentrations at the regional scale in case of a high winter episode.

1.4.4 Description of the impact of the measure on ozone concentrations for a summer episode

baseline

scenario (no traffic)

O3 maximum concentration	
Baseline	250 $\mu\text{g}/\text{m}^3$
Scenario (No traffic)	187 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	- 25 %



This measure has a positive impact on the ozone concentrations at the regional scale in case of a high summer episode. Taking into account that a constant amount (146 $\mu\text{g}/\text{m}^3$) of imported ozone has been considered in both scenarios (baseline and no traffic), the local production of ozone due to the emissions of the Ile-de-France region decreases a lot (- 60.5 %), going from 104 $\mu\text{g}/\text{m}^3$ to 41 $\mu\text{g}/\text{m}^3$.

1.5 Scenario analysis : Euro IV emission standard

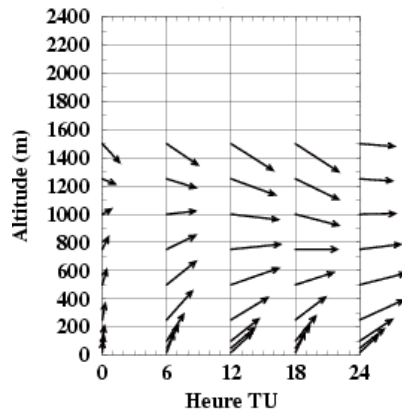
<p><u>Title</u> : Impact of the anticipation of the implementation of the Euro IV legislation related to the vehicle emission factors on background air quality</p>
<p><u>Practical description of the scenario implemented</u> :</p> <p>The scenario consists in anticipating for each type of vehicle fleet (passengers cars, light duty vehicles, heavy duty vehicles, buses, mopeds, motorcycles) the implementation of one of the most advanced legislation (Euro IV) related to the emission factors and in evaluating the impact of such a measure on emissions and air quality for two different sets of meteorological conditions.</p>
<p><u>Extension of the geographical domain described</u> :</p> <p>Size of the domain : 180 x 180 km²: the whole Ile-de-France region (for background O₃ concentrations)</p> <p style="padding-left: 150px;">90 x 90 km² : the whole parisian agglomeration (for background NO₂ concentrations)</p>
<p><u>Pollutants described</u> :</p> <p>Background : NO₂ (winter) O₃ (summer)</p>
<p><u>Reference period</u> :</p> <p>Hourly description for the whole day</p>
<p><u>Meteorological conditions</u> :</p> <p>Two different sets of meteorological conditions have been used to test the scenario. The first set called "WINTER EPISODE" is related to acute conditions, leading to high levels of air pollution (NO₂) in winter and the second one called "SUMMER EPISODE" is related to acute conditions, leading to high levels of air pollution (O₃) in summer. These two sets of meteorological conditions are based on real case conditions. Figures below describe these two sets of meteorological conditions used.</p>

“WINTER EPISODE” METEOROLOGICAL CONDITIONS

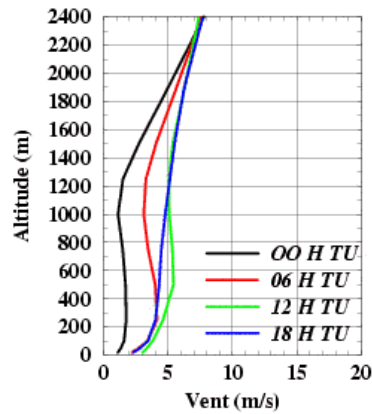
Real case date : 21/02/2000

Tmin : 4°C, Tmax : 7°C
 Wind speed : morning : 2 m/s, afternoon : 3 m/s
 Wind direction : South, South West
 Mixing layer height : 200–700 m
 Precipitations : none
 Nebulosity : very low

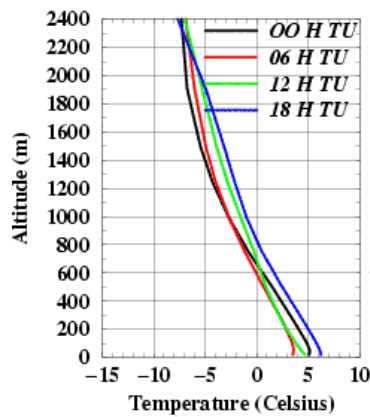
Direction du Vent



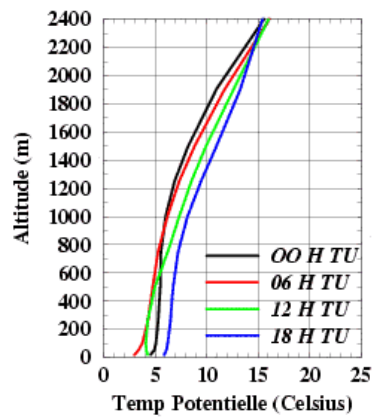
Profil de Vent



Profil de Temperature



Temperature Potentielle



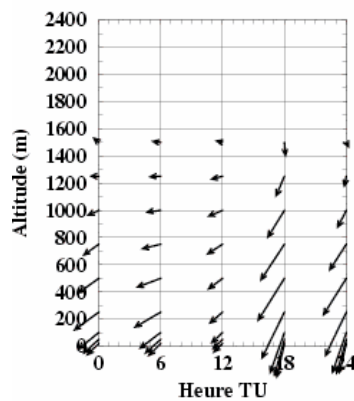
Profils faits le 22-02-2000 pour le 21-02-2000

“SUMMER EPISODE” METEOROLOGICAL CONDITIONS

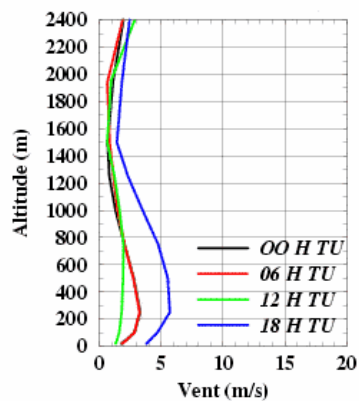
Real case date : 27/07/2001

<p>Tmin : 23 °C, Tmax : 27 °C Wind speed : morning : 2 m/s, afternoon : 3 m/s Wind direction : variable Mixing layer height : 200 –2500 m Precipitations : none in the morning, few in the afternoon Neblosity : low in the morning, average in the afternoon</p>

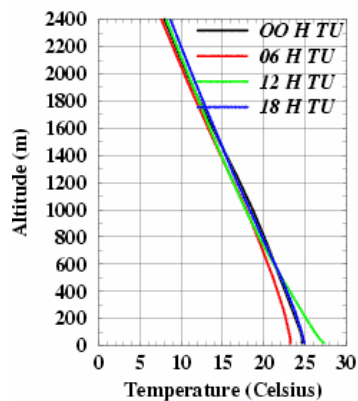
Direction du Vent



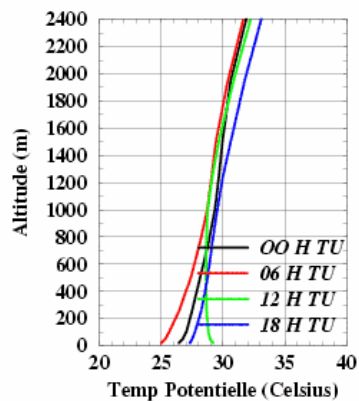
Profil de Vent



Profil de Temperature

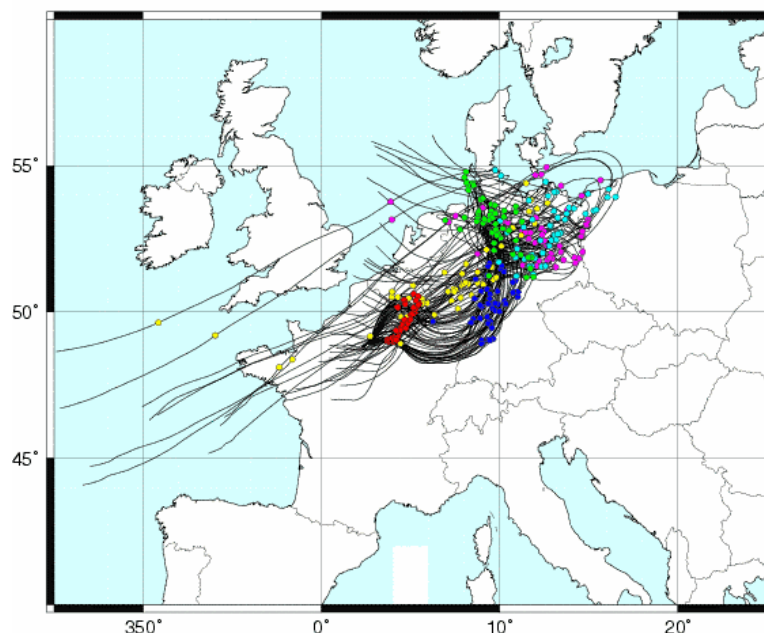


Temperature Potentielle



Profils faits le 28-07-2001 pour le 27-07-2001

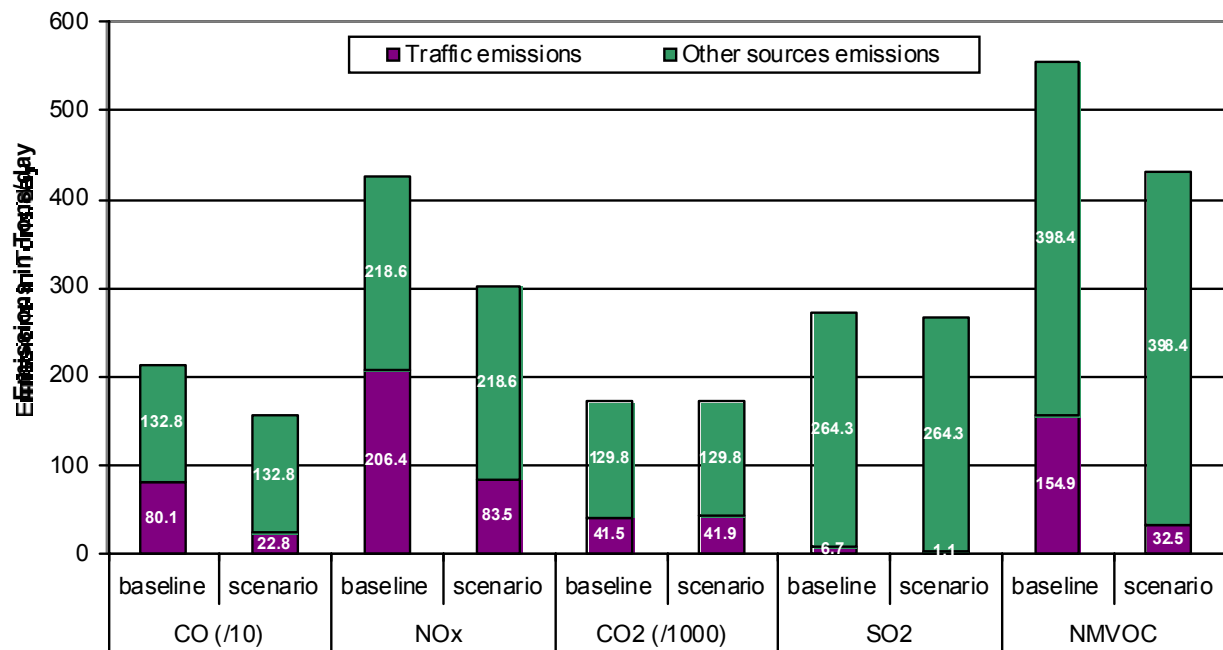
28-07-2001 : Retrotrajectoires pour le 27-07-2001



1.5.1 Description of the impact of the measure (Euro IV) on the emissions for the winter meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	-72.4	
CO	-71.5	-26.9
NOx	-59.5	-28.9
CO2	1.1	0.3
SO2	-84.0	-2.1
NMVOc	-79.0	-22.1

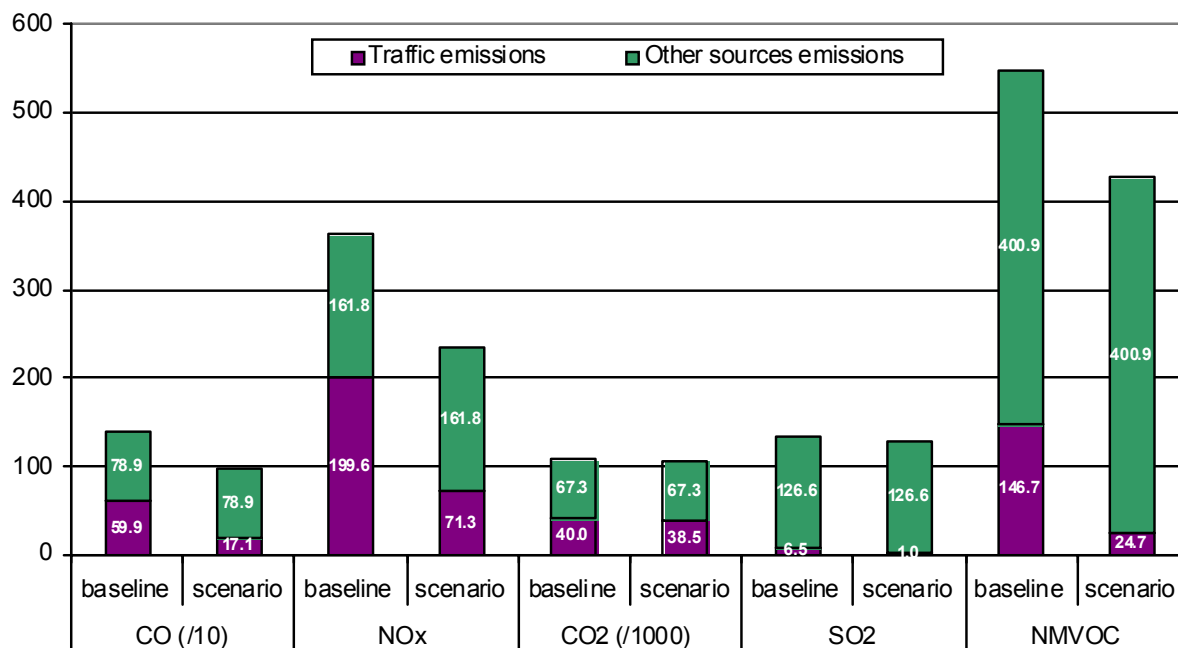
Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (Euro IV)



1.5.2 Description of the impact of the measure (Euro IV) on the emissions for the summer meteorological conditions

	Relative differences in traffic emissions (%) (scenario vs baseline)	Relative differences in total emissions (%) (scenario vs baseline)
PM	-74.2	
CO	-71.4	-30.8
NOx	-64.3	-35.5
CO2	-3.8	-1.4
SO2	-84.8	-4.1
NMVOc	-83.2	-22.3

Comparison of traffic and total emissions for the whole Ile-de-France region between reference case (baseline) and scenario (Euro IV)



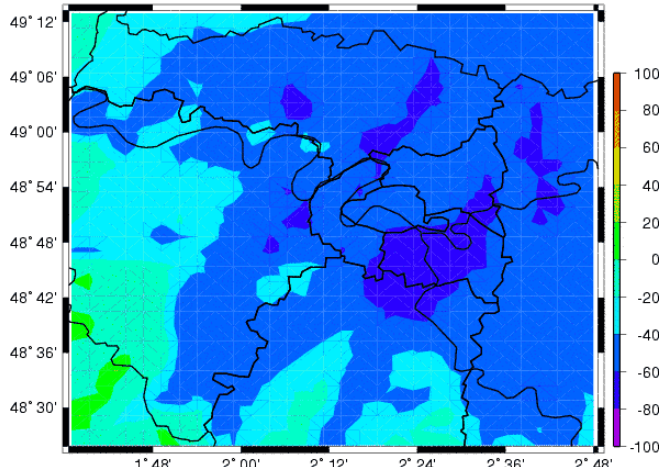
1.5.3 Description of the impact of the measure on NO₂ concentrations for a winter episode

baseline

scenario (Euro IV)

NO2 maximum concentration	
Baseline	307 $\mu\text{g}/\text{m}^3$
Scenario (Euro IV)	155 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	- 49.5 %

winter euroiv NO2 (% reduc)



This measure has a large positive impact on the NO2 concentrations at the regional scale in case of a high winter episode.

1.5.4 Description of the impact of the measure on ozone concentrations for a summer episode

baseline

scenario (Euro IV)

	O3 maximum concentration
Baseline	250 $\mu\text{g}/\text{m}^3$
Scenario (Euro IV)	211 $\mu\text{g}/\text{m}^3$
Relative difference (%) in maximum concentration (scenario vs baseline)	- 15.6 %

This measure has an important positive impact on the ozone concentrations at the regional scale in case of a high summer episode. Taking into account that a constant amount (146 $\mu\text{g}/\text{m}^3$) of imported ozone has been considered in both scenarios (baseline and euro IV), the local production of ozone due to the emissions of the Ile-de-France region decreases a lot (- 37.5 %), going from 104 $\mu\text{g}/\text{m}^3$ to 65 $\mu\text{g}/\text{m}^3$. Nevertheless, the impact of the measure is less in a summer case episode than in a winter case.