Prediction of Air Quality Improvement brought by Progress in Automobile and Fuel technologies with Air Quality Simulation Model

Feb. 22, 2002
Air Quality Modeling WG
Content

- Purpose

- Evaluation of Air Quality Improvement Effects due to Introduction of New Short-term and Long-term Regulations
  - Reduction effects on emission inventory from vehicles
  - Air quality improvement effects in urban area
  - Air quality improvement effects in roadside

- Conclusion
Objectives of JCAP Air Quality Model Study

- Analyze the emission reduction effect on the air quality by Air Quality Model Simulation, based on the estimated total emission inventory from automobiles and other sources.

- Assist in establishing various policies for air quality improvement.
Evaluation of Air Quality Improvement Effects due to Introduction of New Short-term and Long-term Regulations

Emission Inventory Reduction Effects

- Estimation was conducted with JCAP emission inventory estimation model taking into account of emission factors excluded from consideration such as emissions at engine start, evaporative emissions, etc.

Air Quality Improvement Effects in Urban Area

- Concentration of SPM including inorganic and organic secondary particles, Ozone and NO2 was predicted with 3D Air Quality Simulation Model.

Air Quality Improvement Effects in Roadside

- Roadside Air Concentration was predicted with traffic flow simulation, emission inventory estimation by transient emission model, and 3D dispersion model.
### Measures for automobiles targeted to the evaluation

<table>
<thead>
<tr>
<th>Year</th>
<th>Case</th>
<th>Gasoline-powered vehicle</th>
<th>Diesel-powered vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>New Short-term</td>
<td>New Long-term</td>
</tr>
<tr>
<td>2000</td>
<td>No regulation is intensified since ‘99</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Introduction of New Short-term regulations for G/D vehicles</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Introduction of New Short- &amp; Long-term regulations for G/D vehicles</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>5</td>
<td>All vehicles meet New Long-term regulations</td>
<td>-</td>
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</tbody>
</table>
Target Area

Urban Airshed Model: Automobile NOx Law area 
( in plan)

Roadside Model: Location of Kamiuma Roadside Monitoring Station 
( in plan)

(Area for calculation: 215km x 261km x 1-2km, 
Grid cell dimension = 5.66km x 5.55km x variable)

(Area for calculation: 1000m x 1000m x 100m, 
Minimum grid cell dimension: 2m x 2m x 1m)
Emission Inventory Reduction Effects
Summer

Winter

Evapo. HSL
Evapo. DBL
Evapo. RL
Starting motorcycles
Starting D vehicles
Starting G vehicles
Running motorcycles
Running G vehicles
Running G vehicles

New Short-term
To be introduced up to New Short-term and Long-term

No regulation is intensified since 99.

New Long-term
To be introduced up to New Short-term and Long-term

New Short-term and Long-term

Year 2000
Year 2015
**Japan Clean Air Program**

**NOx Emission Inventory from vehicles**

*Automobile NOx Law area*

**Summer**

- **Year 2000**: No regulation intensified since '99.
- **Year 2015**: New Short-term regulation for all vehicles.

**Winter**

- **Year 2000**: No regulation intensified since '99.
- **Year 2015**: New Short-term regulation for all vehicles.

**Legend**

- **Starting motorcycles**
- **Starting D vehicles**
- **Starting G vehicles**
- **Running motorcycles**
- **Running D vehicles**
- **Running G vehicles**

*To be introduced up to New Short-term and Long-term regulated G/D vehicles*
Air Quality Modeling WG

Japan Clean Air Program

PM Emission Inventory from Vehicles
Automobile NOx Law area

**Summer**

- New Short- & Long-term PM emission inventory (t/day)

- Year 2000
- No regulation is intensified since ‘99
- To be introduced up to New Short-term and Long-term regulated G/D vehicles

- Year 2015
- No regulation is intensified since ‘99
- To be introduced up to New Short-term and Long-term regulated G/D vehicles

**Winter**

- New Short- & Long-term PM emission inventory (t/day)

- Year 2000
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- To be introduced up to New Short-term and Long-term regulated G/D vehicles

- Year 2015
- No regulation is intensified since ‘99
- To be introduced up to New Short-term and Long-term regulated G/D vehicles

Legend:
- Starting D vehicles
- Running D vehicles
- Road Dust
- Tire Wear
Japan Clean Air Program

THC Emission Inventory from various sources

Automobile NOx Law area

Summer

Winter

- Vehicle Exhaust
- Refinery, Gas Station
- Paint Solvent
- Print Solvent
- Print Solvent
- Point Source
- Biogenics

New Long-term regulation for all vehicles
To be introduced up to New Short-term regulated G/D Vehicles
New Long-term regulation for all vehicles
To be introduced up to New Short-term and Long-term regulated G/D Vehicles

New Long-term regulation for all vehicles
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Year 2000
No regulation is intensified since '99.

Year 2015
No regulation is intensified since '99.

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Vehicle Exhaust

0 500 1000 1500
NOx emission inventory (t/day)

0 500 1000 1500
NOx emission inventory (t/day)

THC Emission Inventory from various sources

Automobile NOx Law area

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THC Emission Inventory from various sources

Automobile NOx Law area

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No regulation is intensified since '99.

No regulation is intensified since '99.
Air Quality Modeling WG

Japan Clean Air Program

NOx Emission Inventory from Various Sources

Automobile NOx Law area

Summer

Year

2000

2015

NOx emission inventory (t/day)

0

100

200

300

400

500

600

700

Vehicle Exhaust
Airplane, Ship
Residence, Office
Point Source

Winter

Year

2000

2015

NOx emission inventory (t/day)

0

100

200

300

400

500

600

700

No regulation is intensified since '99.
To be introduced up to New Short-term and Long-term regulated G/D vehicles.
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New Long-term regulation for all vehicles.
PM Emission Inventory from Various Sources

Summer

- Vehicle Exhaust
- Road Dust
- Tire Wear
- Residence, Office
- Airplane, Ship
- Point Source

Winter

1. No regulation is intensified since '99.
2. No regulation is intensified since '99.
3. New Long-term regulation for all vehicles
4. To be introduced up to New Short-term and Long-term regulated G/D vehicles
5. To be introduced up to New Short-term and Long-term regulated G/D vehicles
6. New Long-term regulation for all vehicles
Air Quality Improvement Effects
**Japan Clean Air Program**

**Contribution of vehicle emission control measures to NO\textsubscript{2} concentration reduction**

**Summer**

- NO\textsubscript{2} Average concentration variation rate in 24 hours

**Winter**

- NO\textsubscript{2} Average concentration variation rate in 24 hours

Calculation under meteorological conditions on August 3, 2000

Calculation under meteorological conditions on December 10, 1999

**Average in Automobile NOx Law area**

**Year 2000**

- No regulation is intensified since '99.

**Year 2015**

- New Long-term regulation for all vehicles
- To be introduced up to New Short-term and Long-term regulated G/D vehicles
- No vehicles exhausts

**To be introduced up to New**

- New Long-term regulation for all vehicles
- New Short-term and Long-term regulated G/D vehicles
- No vehicles exhausts

**Average in Automobile NOx Law area**

**Year 2000**

- No regulation is intensified since '99.

**Year 2015**

- New Long-term regulation for all vehicles
- New Short-term and Long-term regulated G/D vehicles
- No vehicles exhausts
## Contribution of vehicle emission control measures to SPM concentration reduction

### Average in Automobile NOx Law area

#### Summer

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#### Winter

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* Calculation under meteorological conditions on August 3, 2000

* Calculation under meteorological conditions on December 10, 1999

*: Tire wear and road dust remained without change
Japan Clean Air Program

Contribution of New Long-term Regulations to Roadside Concentration

Hourly value at Time Zone with High Concentration (Contribution by Vehicles only)

**NOx**
- Year 2000: No regulation is intensified since '99.

**SPM**
- Year 2000: No regulation is intensified since '99.

Vehicle exhaust
- Tire wear, Road dust
Japan Clean Air Program

Contribution of New Long-term Regulation to Roadside Concentration

- Averaged value per day -

- Measured values, direct (emission)
- Measured values, BG
- Direct (Vehicle exhaust emission)
- BG (Stationeries, automobiles, etc.)

Year 2000
No regulation is intensified since '99.

Year 2015
To be introduced up to New Short-term and Long-term regulated G/D vehicles

New Long-term regulation for all vehicles
To be introduced up to New Short-term and Long-term regulated G/D vehicles

Measured values, direct (emission)
Measured values, BG
Direct (Vehicle exhaust emission)
BG (Stationeries, automobiles, etc.)
Effect of Vehicle Emission Reduction and SPM Concentration (Year 2000→2015)

Year 2000

Year 2015

(Average per day in 2015: Example of introduction of New Short-term and Long-term regulations)

The reduction effect in Metropolitan area is large and approx. 30% Max.
Attainment Rate Expectation of NO\textsubscript{2}, SPM Concentration at General Continuous Monitoring Stations
(1998, 2000→2015, All stations in Tokyo Metropolis, evaluated with 98% value)

NO\textsubscript{2} Attainment rate is expected vastly improved.

90% of GMS, some% of RMS
Expected Attainment rate

100% of GMS, 90% of RMS
Expected Attainment rate

GMS: General Monitoring Station
RMS: Roadside Monitoring Station
Conclusion (1)

Analyzed Air Quality improvement effects in urban and roadside areas targeted 2015 based on Emission Inventory and Air Quality Simulation, and the results are;

1. Due to the introduction of New Short-term and New Long-term regulations, vehicle emission inventory of HC, NOx, PM* reduces approx. 1/3 to 1/5 of that of 2000.

2. According to the results, vehicle emission inventory rate of HC, NOx, PM* in their total emission inventory in urban area is approx. 5%, 30%, 10% respectively.

3. Air Quality improvement effects in urban area (Automobile NOx Law area) of NO$_2$, Oxidant, SPM is predicted approx. 25%, 20%, 15% respectively.

*: Excl. Tire wear, Road Dust
4 Although standard limits of NO$_2$, SPM are affected by meteorological conditions, 
   • NO$_2$ attainment rate is expected to be vastly improved 
   • SPM attainment rate is expected to be 90-100% for General Monitoring Stations, in the range of several% to 90% for Roadside Monitoring Stations 
5 Roadside Air Quality is expected to be improved; NOx and SPM is expected to be approx. 45%, 30% respectively. 
6 As for roadside, atmosphere in urban area has a large influence as background concentration. 
7 Considering secondary particles and oxidant formed by photochemical reaction, following items are estimated to be effective for realizing further Air Quality improvement: 
   1) PM: Reduction of primary emission inventory from factories  
   2) HC: Reduction of emission inventory from solvents  
   3) NOx: Reduction of emission inventory from factories, offices, diesel-powered vehicles, and so on.