Post Processing of the Air Quality Forecasting system: PREV’AIR

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This platform is proposed by the PREV’AIR consortium - \url{http://www.prevair.org}

Questions about PREV’AIR? Please send an e-mail to frederik.meleux@ineris.fr
Principles of the PREV’AIR system: www.prevair.org (i)

- An operational system that has become a part of the French air quality monitoring strategy.
- A new approach, borne by numerical tools, to reinforce the air quality management network, with new products:
  - Forecasts: since 2003, public information procedures and emergency measures are based not only on measurements but also on forecasts. This is one of the decision of the “Air Plan” adopted by the national authorities after the August heat wave
    - Regulatory pollutants: O3, NO2 and PM
    - Global / European / French scales
    - 3 days ahead ➔ Prevention of exposure
  - Monitoring: not all regions are fully covered by fixed measurement stations
    - Measurements and model results are combined to provide « analyses »: the most relevant
    - Air pollution maps describing air pollution patterns on a hourly or daily basis
Principles of the PREV’AIR system: www.prevair.org (ii)

- Daily broadcast of information through Internet: http://www.prevair.org
- A user-oriented system which to reach different kinds of products
  - Free access, open scope: forecast maps / observations / analyses
  - Restricted access, registered users: numerical model data
- More than 60 users among which local and regional air quality monitoring agencies, research laboratories, private companies

- Daily information about the model performances is also available to build users’ confidence
- Fully operational running conditions in summer with 24h/24h turns to guarantee the data availability on the user accounts each morning at 8:00 a.m.
- In case of persistent (more than 2 days) and large scale (more than 2 administrative regions) ozone episodes, PREV’AIR maps are sent to TV media for informing general public
Modelling platform

1. Processing meteorology
2. Processing data inputs
3. Air quality models:
   - Chimere (CNRS/INERIS)
   - Mocage (METEOFRANCE)
4. Post-processing:
   - combining obs and model

Meteorological fields
wind, temperature...

Chemical transport models
Gaseous chemistry
Aerosol chemistry
Advection, turbulence
Dry and wet deposition

Hourly Concentrations:
gas (O$_3$, NO$_2$, CO, SO$_2$...)
aerosols (PM10, PM2.5, dust...)

Data inputs
- Boundary conditions
- Emission inventory
- Landcover

Post-processing tools
mapping, scores calculations
Analyses – AQ forecast with statistical approach

DCO - 08/09/2004 - titre - 4
The website Prev’Air: www.prevair.org

- Delivered on a daily basis before 8 am
- Daily peak and daily averaged values for: J+0, J+1, J+2
- Pollutants: $O_3$, $NO_2$, Particules ($PM_{10}$, $PM_{2.5}$ and DUST)
PREV’AIR and observations

French databases:
- BASTER (NRT)
- BDQA

European databases:
- Ozoneweb (NRT)
- Airbase
PREV’AIR and observations: forecast evaluations

1. Statistical indicators
   - Bias, RMSE, correlation ...

2. Time series
   - Comparison with in-situ measurements in near real time (BASTER, OzoneWeb): Rural, suburban, urban

3. Contingency tables
   - European standards (180 µg/m³ and 240 µg/m³ for O₃)

4. …
PREV’AIR and observations: AQ forecast upgraded

**Analyses: data assimilation:**
- Goal: have the best possible picture of air quality over France
- Idea: inject information in the system based on current observations

**Maps with statistical correction:**
- Requires a chemical climatological database from past summers:
  - Based upon past error fields, a linear regression is used to assess the ozone error in forecast mode

**Ensemble forecast:**
- A combination of all prev’air models established over a training period (30 days spin-up)
A new challenge for future: downscaling

In the framework of the CITEAIR2 European project, the objectives is to design a processing to compute relevant information over urban area from regional model output.

Baseline: Prev’Air forecast at 50 kmx50km over Europe
Target: Urban air quality forecast over background sites

1. Build a multi linear AQ model: Statistical Adaptation (SA)
   - Formulation of the downscaling process using multilinear regressions

2. Choice of quantitative and qualitative variables as explanatory data
   - Meteorological forecast data
   - European model output
   - Observation data → Model error for the previous day
   - Type of days and hours
Test case: Rotterdam city (Nederland)

Available data for level 1
- 2008 meas. data from DCMR
- 2009 meas. data from airqualitynow.eu
- 2008, 2009 forecast from Prev’Air
- 2008, 2009 meas. from EEA database
Statistical adapted models for ozone

Model formulation: \( C_{AS} = \beta_0 + \beta_1.X_{meas} + \beta_2.X_{forecast} + \beta_3.X_{meteo\ 1} + \ldots + \beta_n.X_{meteo\ n-2} \)

- Measurements at D−1; Forecast at D+0, Error forecast at D−1
- 1 model for each season: winter or summer
- 1 model for each station: four stations for Rotterdam

- Predefine set of predictors
  - \( \text{NO}_2,\ \text{O}_3,\ \text{PM10} \) concentrations
  - Temperature at 2 m (daily min, max and mean)
  - Wind speed (daily min, max and mean)
  - Relative humidity at surface
  - Boundary layer altitude (daily min, max and mean)
  - Qualitative variables (day of the week, week–end or not)

- Define best model with a maximum of explained variability \( R^2 \)
  - Selection of a set of explanatory variables
Statistical adapted models for ozone

**2008 data**
- Ozone Station 1
- O3 forecast
- Wind speed
- Boundary Layer
- R% Humidity
- Previous Error
- Day of the week

**2009 data**
- O3 Forecast
- Wind speed
- Boundary Layer
- R% Humidity
- Previous Error
- Day of the week

**O3] forecasts over urban background sites**

**SA Model**

**SA Model evaluation**

**Ozone observations**

**[O3] forecasts over urban background sites**

**SA Model**

**ROTTERDAM CASE**

**O3 max concentration (MSL station)**

<table>
<thead>
<tr>
<th>Concentrations in ug/m³</th>
<th>0-80</th>
<th>&gt;80</th>
<th>&gt;100</th>
<th>0-80</th>
<th>&gt;80</th>
<th>&gt;100</th>
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<tbody>
<tr>
<td>Number of data</td>
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<td>57</td>
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<tr>
<td>RMSE</td>
<td>12.83</td>
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<td>15.07</td>
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<tr>
<td>E20%</td>
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<td>0.71</td>
<td>0.71</td>
<td>0.79</td>
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