URBANAIR®

An operational modelling system for survey and forecasting of air quality at urban scale

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Outline

- Presentation of the system
- Deployment methodology
- Examples of operational applications
- Current developments
- Applied use in the PACA Region (Atmo PACA)
Presentation

**URBAN AIR®**: high resolution modeling system

- An operational modeling system developed by NUMTECH (2005) with the support of ADEME, in collaboration with Ecole Centrale de Lyon since 2009.

- Based on high resolution dispersion models: ADMS-Urban (Mc Hugh et al., 1997) and SIRANE (Soulhac, 2000).

- The system provides pollutant concentrations ($\text{NO}_2$, $\text{O}_3$, $\text{PM}_{10}$, $\text{C}_6\text{H}_6$, $\text{SO}_2$) at street scale on the whole urban area, generally at hourly time step.
Presentation

Air quality observations

Meteo observations and predictions

Background concentrations

Emission inventory

Surface topography

Land use

Daily pollution map

Text & data summaries

UAS performances

Alerts and informations
Diurnal profiles

Adaptive gridding

Meteo pre processor

Boundary layer

"Street canyon" effect

Topography effects

Building effects

Meteo data

With buildings
Presentation

Operating modes

### Diagnostic mode
- study of pollution episode
- AQ directive / reporting
- Mitigation / source apportionnement

### Operational mode
- “Nowcasting” calculation of concentrations
- 48-hour forecasting
Deployment of the system
Deployment of the system

- Step 1: Modeling phase and first calculations
Deployment of the system

- Step 1: Modeling phase and first calculations
- Step 2: capacity of the system to reproduce the spatial distribution of the concentrations?

\[ y = 0.9734x - 0.3922 \]

\[ R = 0.856 \]
Deployment of the system

- Step 1: Modeling phase and first calculations
- Step 2: capacity of the system to reproduce the spatial distribution of the concentrations?
- Step 3: capacity of the system to reproduce the temporal evolution of the concentrations?
Deployment of the system

- Step 1: Modeling phase and first calculations

- Step 2: capacity of the system to reproduce the spatial distribution of the concentrations?

- Step 3: capacity of the system to reproduce the temporal evolutions of the concentrations?

- Step 4: quality of the results in forecast mode (which depends on meteorological and background pollution prediction)
Deployment of the system

- Step 1: Modeling phase and first calculations
- Step 2: capacity of the system to reproduce the spatial distribution of the concentrations?
- Step 3: capacity of the system to reproduce the temporal evolutions of the concentrations?
- Step 4: quality of the results in forecast mode (which depends on meteorological and background pollution prediction)
- Step 5: Implementation of the operational system
Adjustment of the system

Sensitivity tests and evaluation of the system

step 1

ADMS-Urban

Output data

Short/long term results

Focus on pollution

Episodes

Pollution maps

Statistical validation

Comparison of model results and measurements

Input data

• topography

• meteorological data
  – wind components
  – minimal LMO ...

• background concentrations

• emission data

System modifications

• adjustment of input data that influences the dispersion

• integration of new input data

• system simplification

Take decisions based on the statistical analysis

• $R^2 \rightarrow 1$

• BIAS, RMSE $\rightarrow 0$

Sensitivity tests

Observations

• stations

• tubes passifs

step 2

step 3

step 4

Average annual NO$_2$ concentration
Dubai Municipality

Site: DUBAI
Units: $\mu g/m^2$ (0.000001 g/m$^2$)
Averaging time: Hourly
Meteorological period: 2007

NO$_2$ ($\mu g/m^2$)

- 2 - 4
- 4.1 - 10
- 11 - 18
- 19 - 28
- 29 - 39
- 40 - 51
- 52 - 65
- 66 - 85
- 86 - 160

July 2008 – © NUMTECH
Cette carte représente la spatialisation des sous-indices en dioxyde d’azote rencontrés sur Strasbourg pour la journée du jeudi 03/06/2010.

Le dioxyde d’azote provient des installations de combustion (centrales thermiques, chaudières,…) et de la circulation routière. La circulation routière est actuellement la principale source d’émission en Alsace. Le NO2 intervient dans le processus de formation d’ozone dans la basse atmosphère.
Some results for Strasbourg

Proportion of good prediction (%) of AQ indexes for the year 2009

![Bar chart showing proportions of good prediction for different AQ indexes: AQI, O3, NO2, and PM10 for days D, D+1, and D+2.](chart.png)
Some results for Strasbourg

Proportion of good prediction (%) of AQ indexes +/- 1 for the year 2009

![Bar chart showing the proportion of good prediction for AQ indexes (AQI, O3, NO2, PM10) over three days (D, D+1, D+2).]
Some results for Aix-en-Provence

Comparison between UAS and regional modeling platform (AIRES/PREVAIR)

Proportion of good prediction (index +/-1) for all forecasted indexes
From January to May 2010

- O3
- NO2
- PM
- AQI
Some results for Aix-en-Provence

Comparison between UAS and regional modeling platform (AIRES/PREVAIR)

Proportion of good prediction (index +/-1) in case of observed indexes ≥5
From Januray to May 2010
Current developments

- Optimization of the codes
- Development of a “tool box” for the users
- Assimilation of observation data (partnership with INRIA)
- Current implementation of the system on several cities: Aix-en-Provence, Nice, Orléans, Tours, Clermont-Ferrand…
4 urban platforms dedicated to air quality survey in PACA region

Alexandre Armengaud, Frédéric Pradelle, Gaëlle Luneau, Céline Pesin, Marie Noëlle Rolland, Jonathan Virga, Benjamin Rocher
38 observatories approved by the French Ministry of the Environment and gathered within federation ATMO

ATMO PACA

Atmo PACA
MISSIONS

We have to:

- Know the air quality on the territory and its evolution in time,
- Characterize the levels by report/ratio with health and environmental standards,
- Forecast episodes of pollution,
- Inform population within the best time,
- Sensitize with the air quality,
- To be used as point of support with research,
- To take part in the reflexions on urban development: tools of decision-making aid.
AIRES-MEDITERRANEE.ORG

Inter REGIONAL SYSTEM AIRES
METEO & CHIMISTRY

MM5
WRF

CHIMERE

System Integrated, Modular for Forecast (48h), Survey and Scenarios at different scales, O₃, NO₂, PM ...

AIRES - from occitan « Aire » [aire] : n.m. air - Atmospheric
Integrated REgional System
REGIONAL TO URBAN SCALE
• No background concentrations (cadastre approach) ; 103 observations
• Bias : -3 mg/m³ (annual)
• Correlation : 0.8 (annual)
- 6000 roads
- 95000 calculation pts
- 340 industrials sources
- 21000 vol. sources

AIX EN PROVENCE – PAYS D’AIX

- No background concentrations (cadastre approach) ; 200 observations
- Bias : -1 mg/m³ (summer) +1.3 mg/m³ (winter)
- Correlation : 0.84 (summer) - 0.86 (winter)
• No background concentrations (cadastre approach) ; 102 observations

• Bias : +4.6 mg/m³ (summer) -0.8 mg/m³ (winter)

• Correlation : 0.89 (summer) - 0.92 (winter)
No background concentrations (cadastre approach); 160 observations

- Bias: +3 mg/m$^3$ (summer) - 8 mg/m$^3$ (winter)

- Correlation: 0.7 (summer & winter)
Soil occupation, buildings, population
CONCLUSIONS

Mapping Air Quality & Survey territory

Forecast and Communication

Regulation & actions plans

Urban and Metropolitan Air Quality platforms are necessary

National, European Reporting European Directives and Urban Health impacts

Scenarios Decision making aid
THANK YOU FOR YOUR ATTENTION

More details

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