Operational on-line modelling tool: Evaluation of the three most common techniques (Gaussian puff, Eulerian and Lagrangian).
Application on Fos-Berre data.

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Summary

- **Context**
  - Regulatory constraints
  - Need of a supervision tool

- **General architecture**
  - Input data
  - Dispersion model

- **Application on « Fos-Berre » data**
  - Methodology
  - Results

- **Conclusion**
Regulatory constraints

- **Collective air pollution control in an industrial basin**
  - Share the responsibility and the investments on air concentration bases and not only on total year emission
  - Ambient air monitoring networks are generally not enough to dense to cover the basin

- **Individual air control for some industries**
  - Example of a domestic waste incinerator: Monitoring the impact in the vicinity of the installation (Art 30 et 31 of the law 20 September 2002 concerning burning installation of hazardous and non-hazardous waste):
    - Initial diagnostic: before the installation opening
    - Between 3 and 6 months: after the installation running
    - Routine update: at least annually
  
  - Reference: INERIS (approved by the French MOE) « Méthode de surveillance des retombées des dioxines et furanes autour d'une UIOM » 2001
Need of an on-line Supervision tool

A global tool to:

- Optimize the atmospheric environment supervision
- Improve internal and external communication (HQ and quick adaptability): neighborhood, Local authorities, routine reporting, non governmental association...
- Analyze, understand and explain the impact of their own releases

How?

- On-line concentration and deposition of main pollutants (NO₂, dioxines, heavy metals...) considering real emissions and actual meteorological data
  - Comprehensive Maps
  - Help to design measurement campaign
  - Ready to run in case of accidental / exceptional releases

⇒ A detailed knowledge of the impact of the installation(s)
Need of an on-line Supervision tool

Real-time supervision of atmospheric impact using on-line emission and meteorological data:

- On-line emission data collecting (sensor may be provided)
- On-line meteorological data (specific sensors or Met office data)
- Running a dispersion and impact evaluation software on a routine mode after site configuration and validation.
Need of an on-line Supervision tool

- Editing results every 3 hours:
  - concentration and deposition maps
  - summary table of values

- Continuous update of computational values on key points:
  - daily,
  - Monthly
  - Annually (main statistics as centils)

- Time series of meteorological data and emission
  - daily
  - Monthly and annual wind roses

- Data base backup for all data and results (Yearly base)

- Detailed run on request (peak, accidental or exceptional release)

- Optimization (measurement, day-to-day reporting,…) of the supervision
General flowchart

**Meteo data**
Wind, temperature, rain

Site

**Emission monitoring**
Specific analyses as heavy metals and dioxins...
Sampling program

Self control continuous measurements: HCl, CO, CO2, SO2, NOx, COT, NH3, H2O, O2, N2O, Débit et Température des fumées

**Database consolidation**
Automatic impact model run

**Results**

- Air Concentration data
  - Maximum: Localization and values
  - Editing values on a list of key points
- Monthly and annual synthesis
- Maps of concentrations et deposition (dry and with rain)
- Detailed peak episode on request
- Automatic and exhaustive data backup and archives
Where are the difficulties?

- **Numerical geographical data → OK**
  - Topography and land use largely available worldwide now and especially in Europe
  - GIS are widely used

- **Meteorological data**
  - Better and denser network
  - Numerical forecast and analyses better quality
  - Progress on Meso-scale modeling

- **Emission**
  - Better understanding using universal classification like SNAP and emission factor
  - Self-monitoring emission by main industries

- **Computational and numerical network**
  - Power increased on low cost computer
  - Internet / intranet / ADSL communication

- **Numerical techniques become central**
Application on FOS-BERRE AREA

Main Industrial area

- Raffineries, Petrochemistry, Steelwork, Power Plant
- Many SO\(_2\) episode where regulatory threshold are exceeded
- AI RFOBEP: AQ Monitoring network association
Application on FOS-BERRE AREA

- 3D meteorological building: MINERVE
  - Interpolation
  - Mass consistency
  - Topography and land use respect

- Output compatible with
  - Gaussian puff model
  - Eulerian model
  - Lagrangian model
Application on FOS-BERRE AREA

- Gaussian Puff
  - Model: TRAMES
  - 3D trajectories
  - Sigma based on MINERVE Kz
  - Mixing height reflexion
  - Briggs plume rise
  - Dry and wet deposition
Application on FOS-BERRE AREA

- Eulerian Model
  HERMES
  - Centered scheme
  - Kz given by MI NERVE
  - Briggs plume rise
  - Dry and wet deposition
Application on FOS-BERRE AREA

- Lagrangian Model
  - SPRAY
    - Thomson, 1987
    - Adaptative time step
    - Own turbulence scheme based on data
    - Anfossi plume rise
    - Dry and wet deposition
Application on FOS-BERRE AREA

Lagrangian
(SPRAY)

05/26/1993
00:00:00.00
Application on FOS-BERRE AREA
Application on FOS-BERRE AREA
Application on FOS-BERRE AREA

Date:
- 26/5/93 0:00
- 26/5/93 3:00
- 26/5/93 6:00
- 26/5/93 9:00
- 26/5/93 12:00
- 26/5/93 15:00
- 26/5/93 18:00
- 26/5/93 21:00
- 27/5/93 0:00

Graph:
- Microg/m3
- Date

Legend:
- CRAU - Measures
- Bouffees - Calculs
- Particles - Calculs
- Euler - Calculs
Application on FOS-BERRE AREA

Ecart Mesures / Calculs Concentrations horaires

Lagrangian
SPRAY

Gaussian Puff
TRAMES

Hourly data
Eulerian
HERMES

% d'occurrences

<-50%  [-50%;-25%]  [-25%;-5%]  [-5%;+5%]  [5%;25%]  [25%;50%]  >50%

Bouffées
Particules
Eulérien

9th Harmonisation Conference Garmisch-Partenkirchen
Application on FOS-BERRE AREA

Ecart Mesures / Calculs moyenne journalière

% d'occurrences

Lagrangian
SFRAY

Gaussian Puff
TRAMES

Eulerian
HERMES

Daily data

Bouffées
Particules
Eulérien

<50% [-50%;-25%] [-25%;-5%] [-5%;+5%] [5%;25%] [25%;50%] >50%

Bouffées
Particules
Eulérien

9th Harmonisation Conference Garmisch-Partenkirchen
Conclusion

■ Lagrangian model (SPRAY) gives the best scores:
  ✓ Independence from grid size
  ✓ CPU time acceptable

■ Eulerian model (HERMES) shows that grid is too large for industrial plume
  ✓ CPU time important but not sensitive to the number and geometry of sources
  ✓ Easier to introduce chemical reaction

■ Gaussian Puff Model
  ✓ Not so bad!
### Application on FOS-BERRE AREA

<table>
<thead>
<tr>
<th></th>
<th>MINERVE</th>
<th>HERMES</th>
<th>TRAMES</th>
<th>SPRAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nombre de mailles en X, Y, Z et pas de mailles en X et Y</td>
<td>NX = 44  NY = 31  NZ = 21</td>
<td>NX = 44  NY = 31  NZ = 21</td>
<td>NX = 44  NY = 31  NZ = 21</td>
<td>NX = 44  NY = 31  NZ = 21</td>
</tr>
<tr>
<td></td>
<td>? X = ? Y = 1km</td>
<td>? X = ? Y = 1km</td>
<td>? X = ? Y = 1km</td>
<td>? X = ? Y = 1km</td>
</tr>
<tr>
<td>Hauteur du 1er niveau vertical</td>
<td>15 mètres</td>
<td>15 mètres (DT = 4s)</td>
<td>15 mètres</td>
<td>10 mètres</td>
</tr>
<tr>
<td>Nombre d'espèces</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Nombre de sources</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Nombre de particules</td>
<td></td>
<td></td>
<td></td>
<td>15 / 10 sec.</td>
</tr>
<tr>
<td>Temps de calcul pour 24 h (stockage toutes les heures)</td>
<td>5 minutes</td>
<td>1 heure</td>
<td>3 minutes</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Taille du fichier résultat</td>
<td>30 Mo</td>
<td>12 Mo</td>
<td>6 Mo / espèces</td>
<td>9 Mo (concentrations) 174 Mo (particules)</td>
</tr>
<tr>
<td>Taille du fichier visualisation</td>
<td>30 Mo</td>
<td>12 Mo</td>
<td>6 Mo / espèces</td>
<td>9 Mo</td>
</tr>
</tbody>
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