"Un seul métier, L'environnement Atmosphérique"

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 runing***
    - ***Routine update : at least annually***
      - *Reference : INERIS (approved by the French MOE) « Methode de surveillance des retombées des dioxines et furanes autour d'une UIOM » 2001*

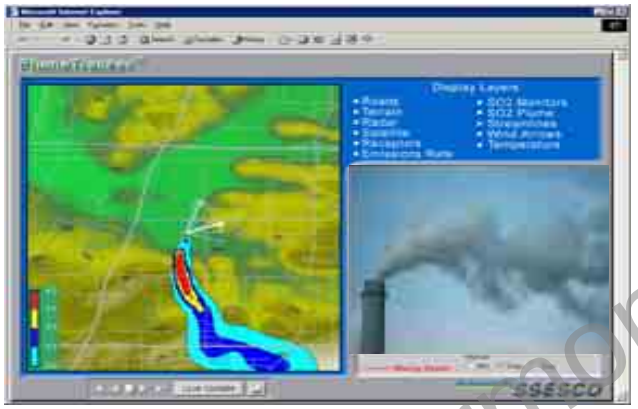
Need of an on-line Supervision tool

- 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 (NO_2,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

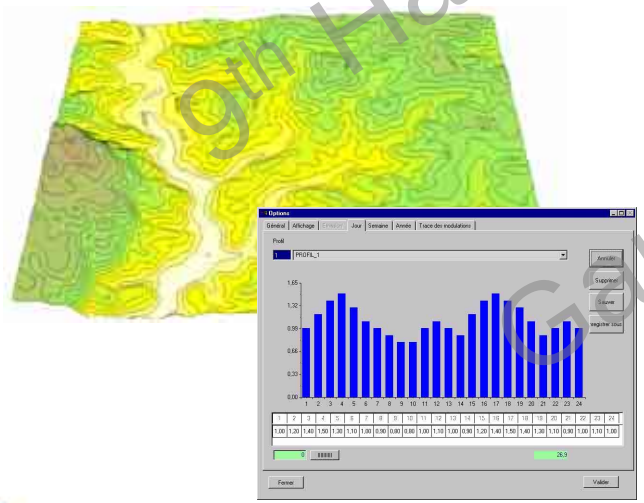
➔ **A detailed knowledge of the impact of the installation(s)**

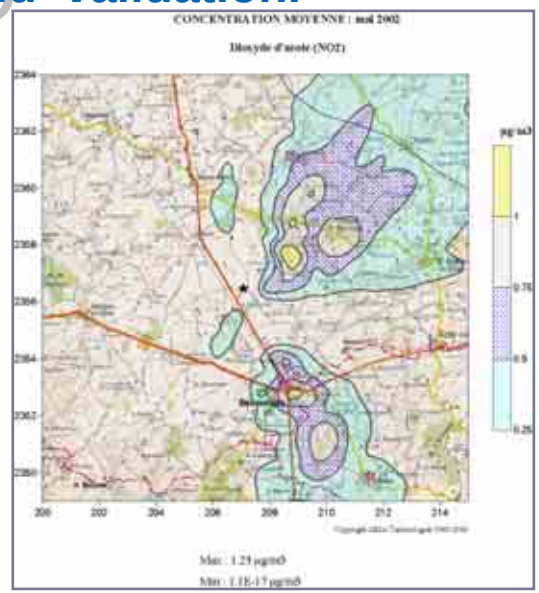
Need of an on-line Supervision tool

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



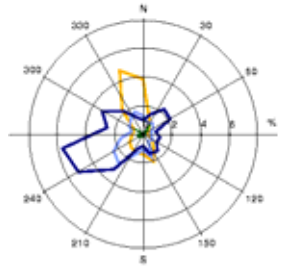
- On-line emission data collecting (sensor may be provided)
- On-line meteorological data (specific sensors or Met office data)
- Running a dispersion and impact evaluation software on a routine mode after site configuration and validation.





Need of an on-line Supervision tool

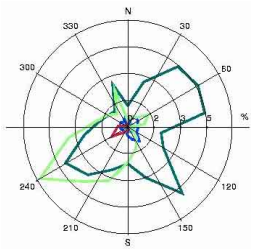
- Editing results every 3 hours :
  - concentration and deposition maps
  - summary table of values
- Continuous update of computational values on key points:
  - daily,
  - Monthly
  - Annually (main statistics as centils)
- Time series of meteorological data and emission
  - daily
  - Monthly and annual 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

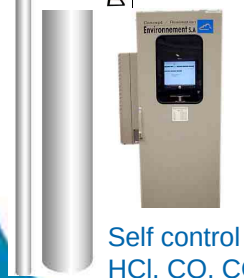


Site

Emission monitoring

Specific analyses as heavy metals and dioxins…)

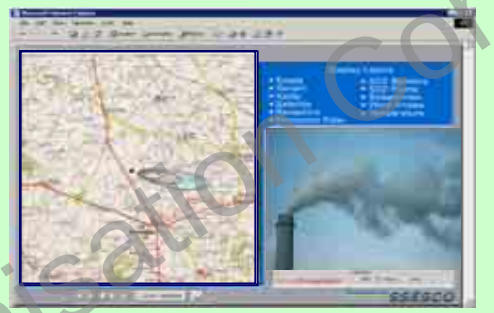
Sampling program



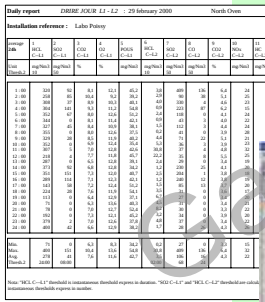
Self control continuous measurements: HCl, CO, CO2, SO2, NOx, COT, NH3, H2O, O2, N2O, Débit et Température des fumées

Database consolidation

Automatic impact model run



Data acquisition system and Automatic report editing



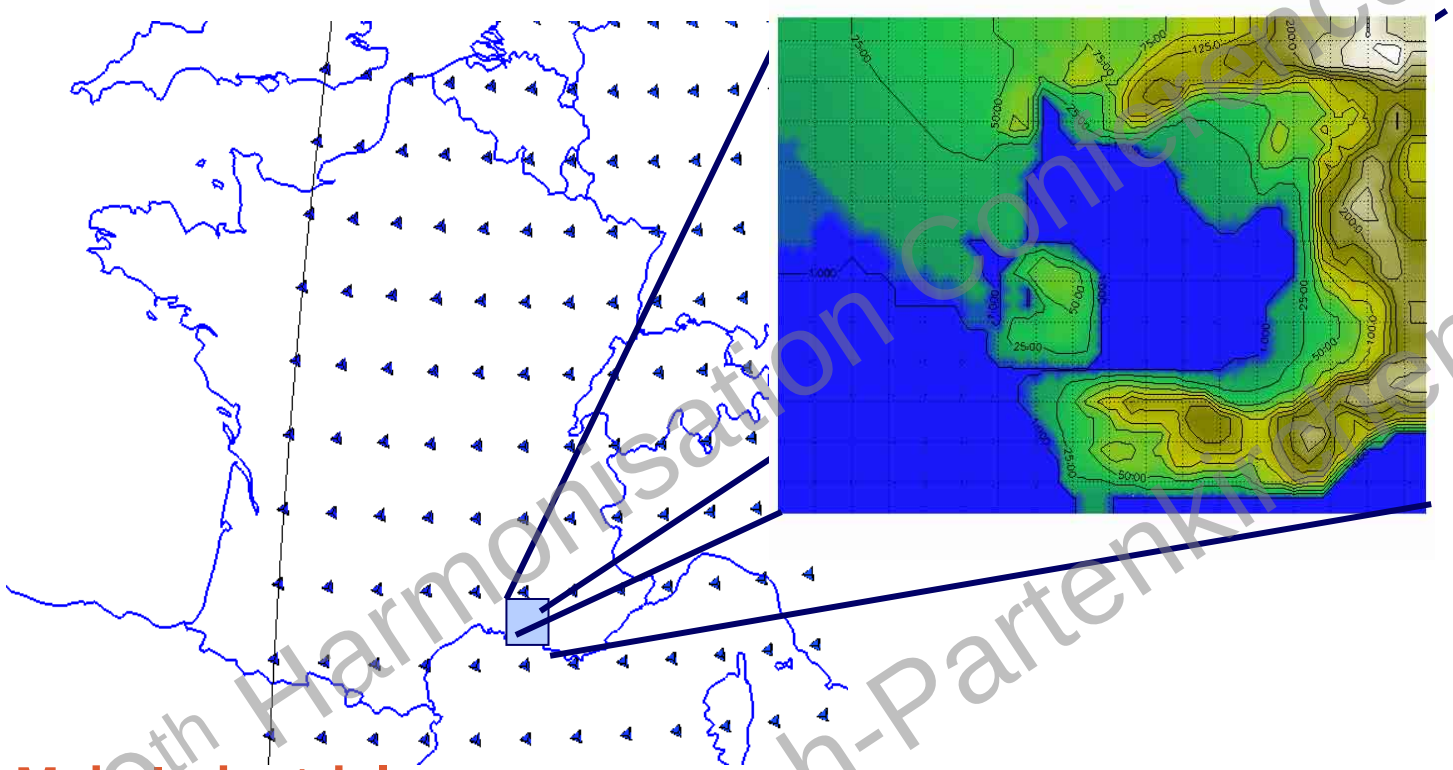
Results

- **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 world wide 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**

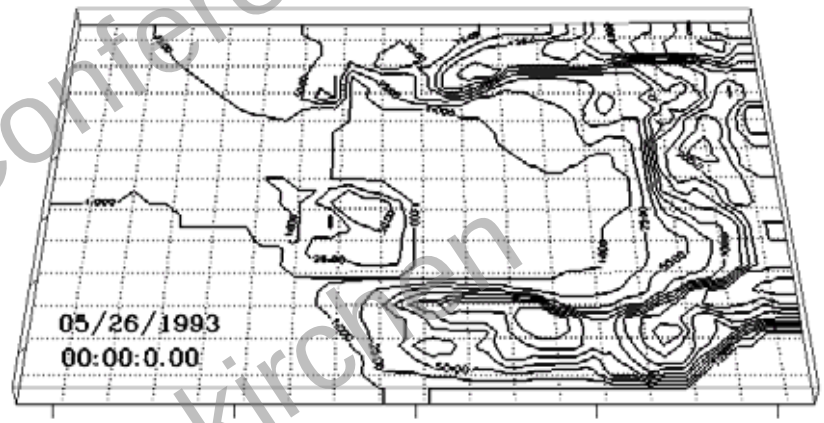
Application on FOS-BERRE AREA

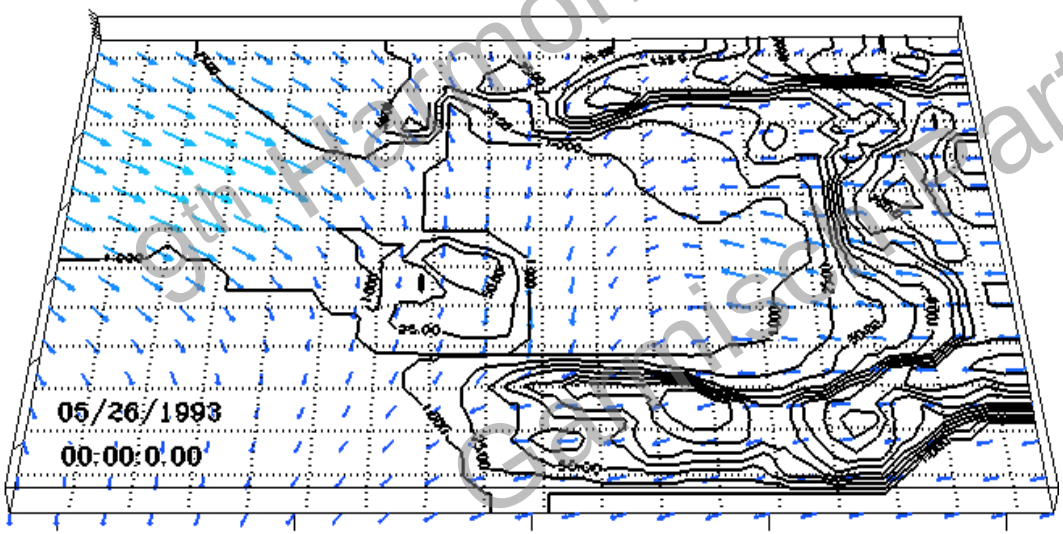


- **Main Industrial area**
  - **Raffineries, Pretrochemistry, Steelwork, Power Plant**
  - **Many SO_2 episode where regulatory threshold are exceeded**
  - **AIRFOBEP : AQ Monitoring network association**

Application on FOS-BERRE AREA

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

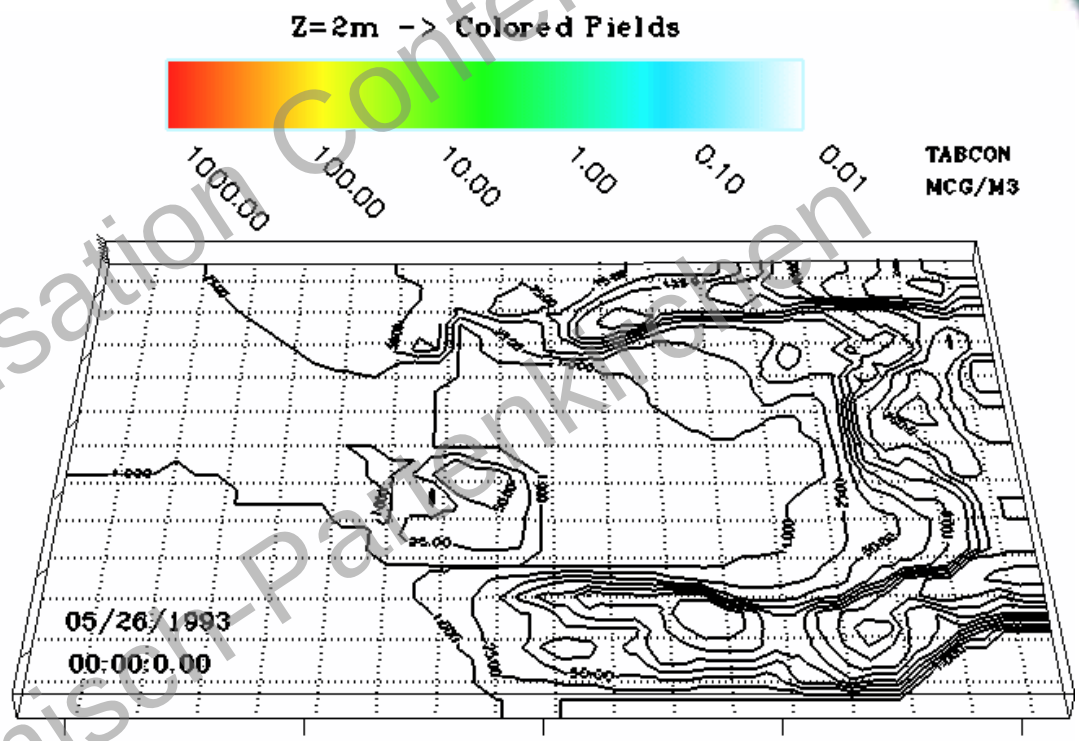




- **Output compatible with**
  - **Gaussian puff model**
  - **Eulerian model**
  - **Lagrangian model**

Application on FOS-BERRE AREA

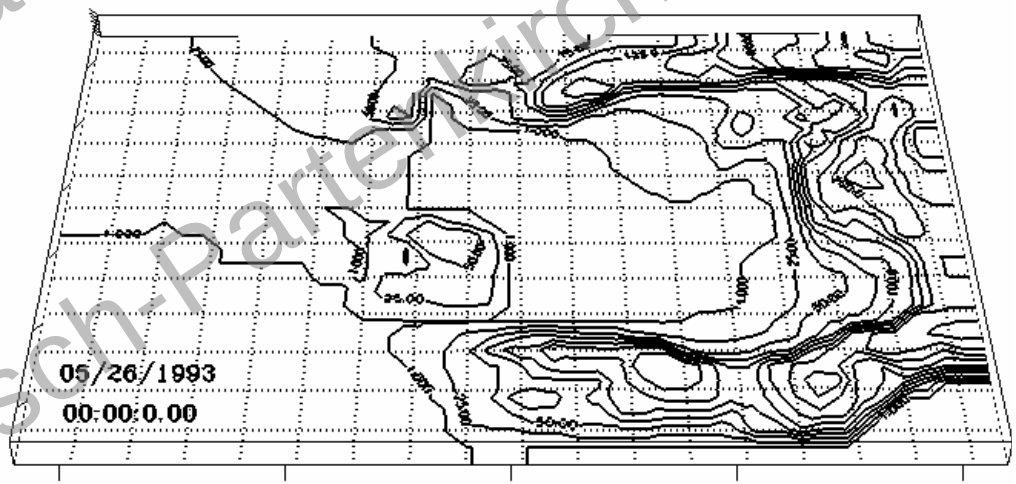
- **Gaussian Puff Model: TRAMES**
  - **3D trajectories**
  - **Sigma based on MINERVE Kz**
  - **Mixing height reflexion**
  - **Briggs plume rise**
  - **Dry and wet deposition**



Application on FOS-BERRE AREA

- **Eulerian Model HERMES**
  - **Centered scheme**
  - **Kz given by MINERVE**
  - **Briggs plume rise**
  - **Dry and wet deposition**

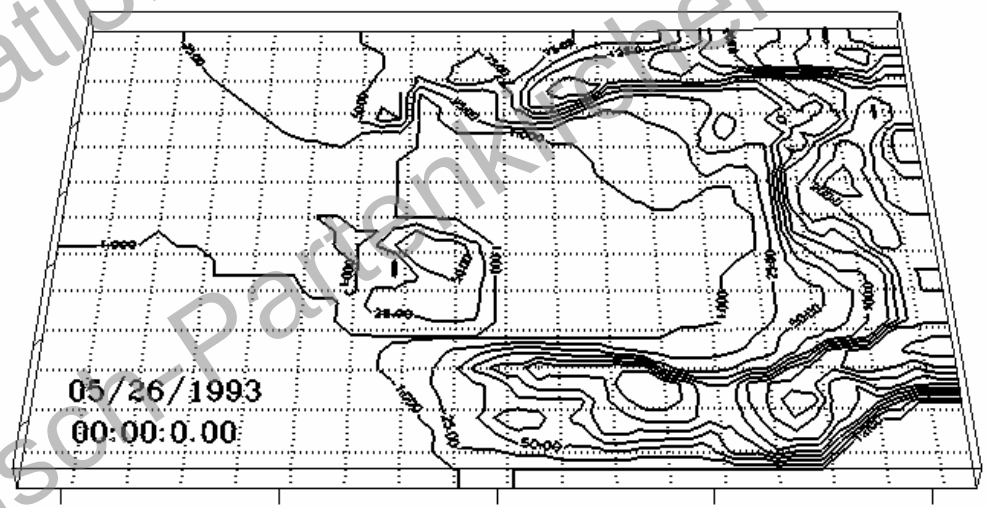
Eulerian



Application on FOS-BERRE AREA

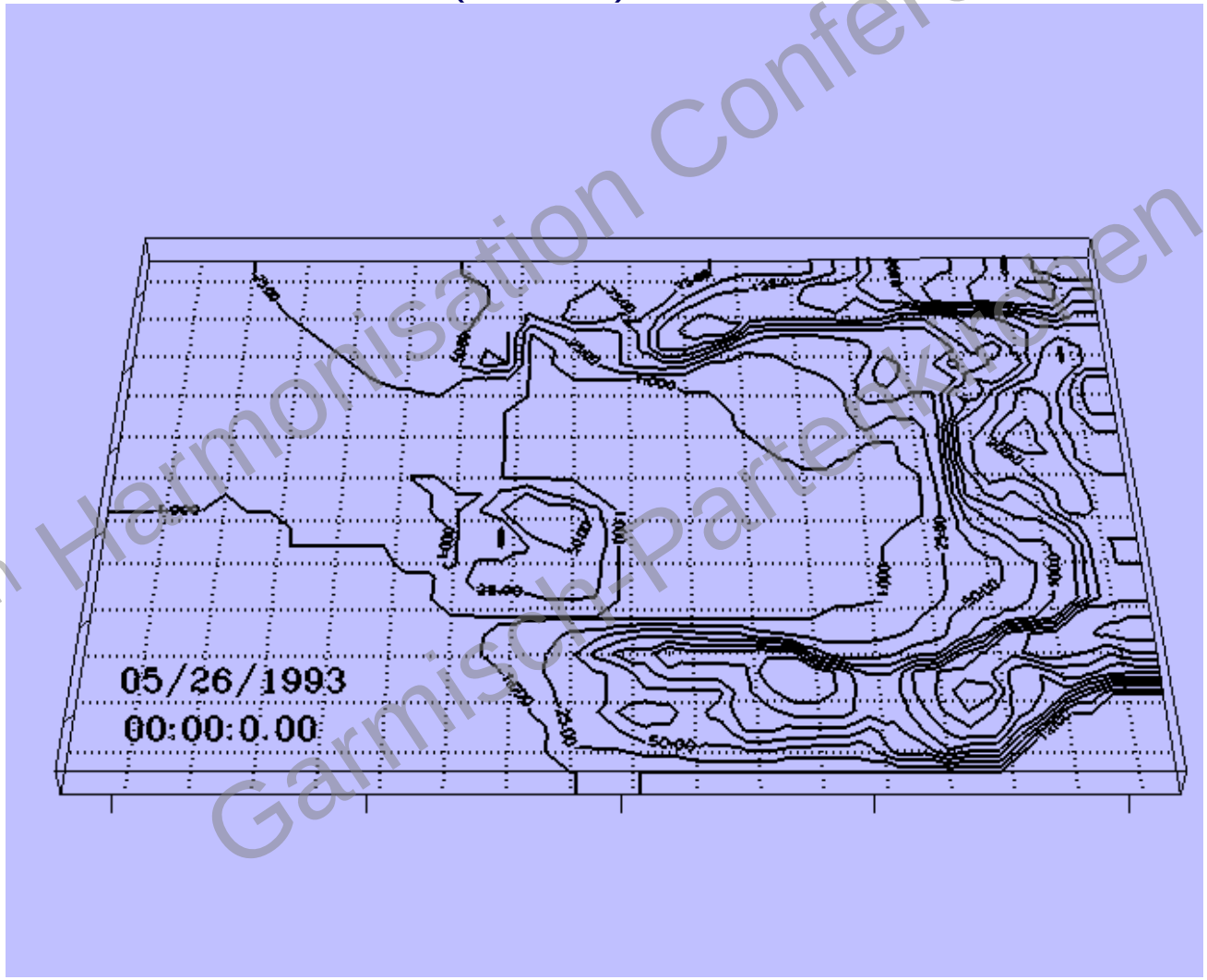
- **Lagrangian Model SPRAY**
  - *Thomson*, 1987
  - **Adaptative time step**
  - **Own turbulence scheme based on data**
  - **Anfossi plume rise**
  - **Dry and wet deposition**

Lagrangian



Application on FOS-BERRE AREA

Lagrangian
(SPRAY)



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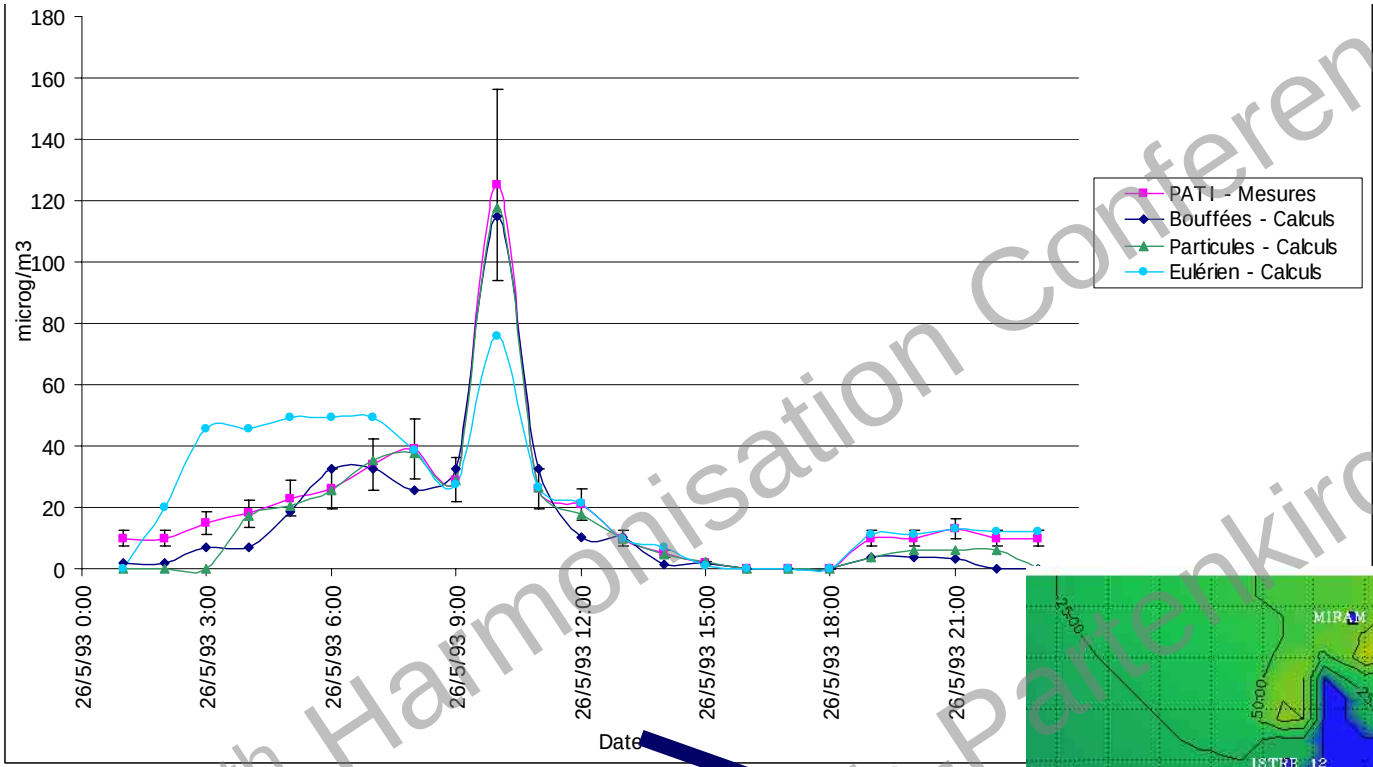

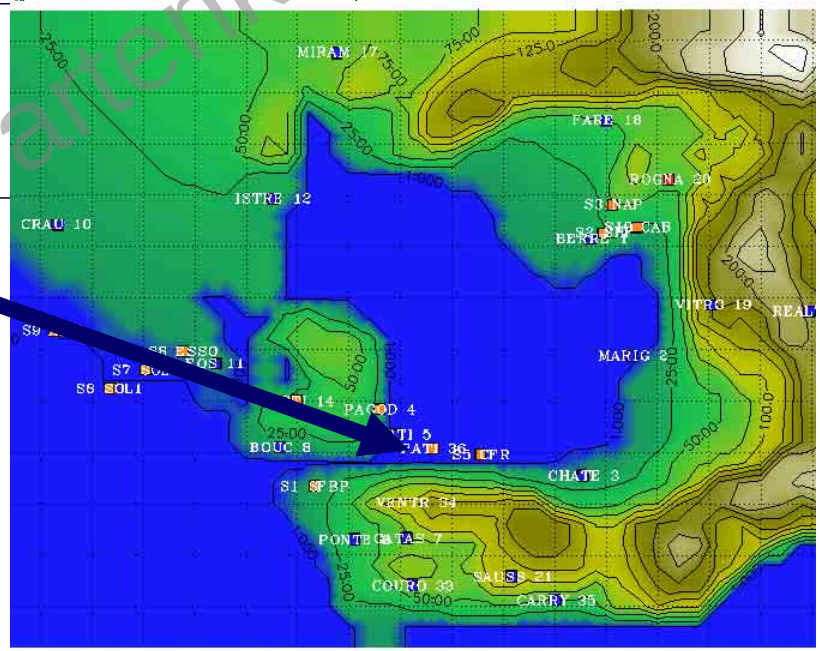

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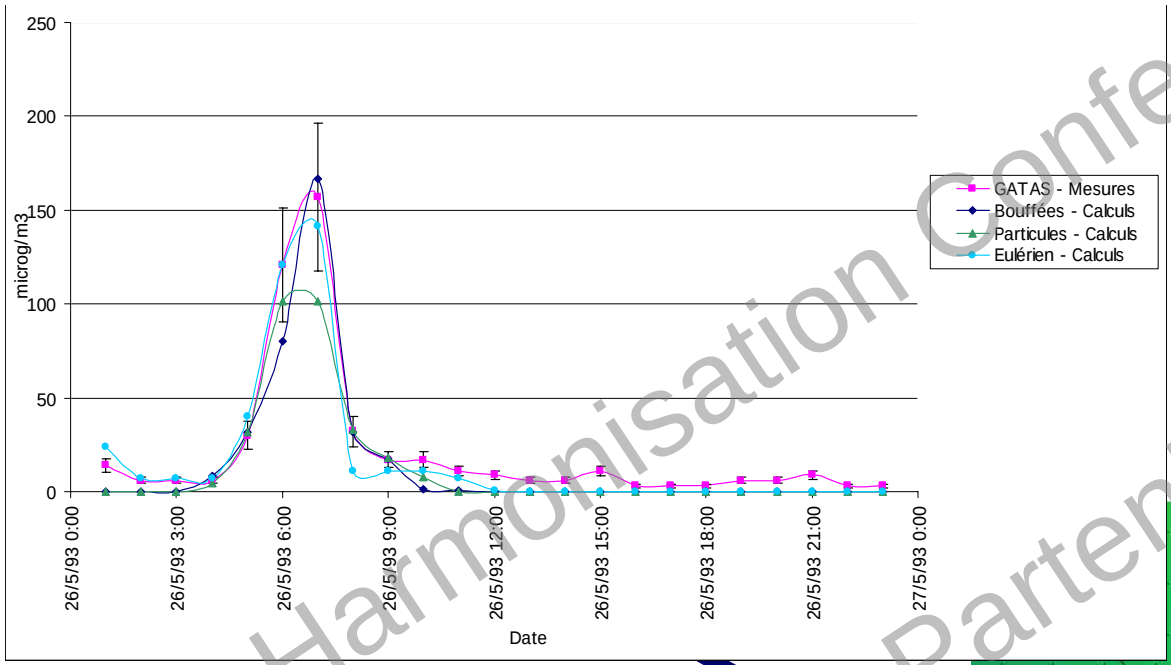

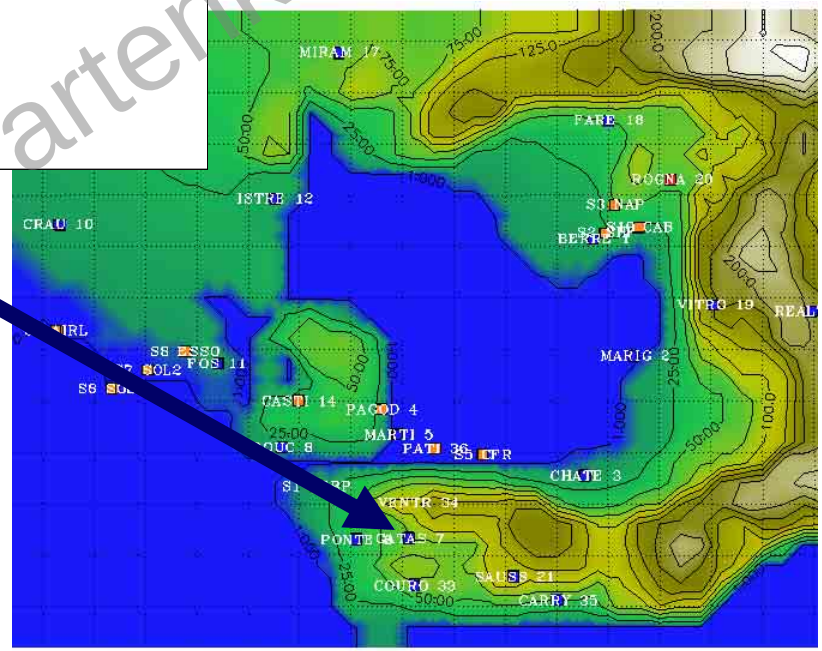

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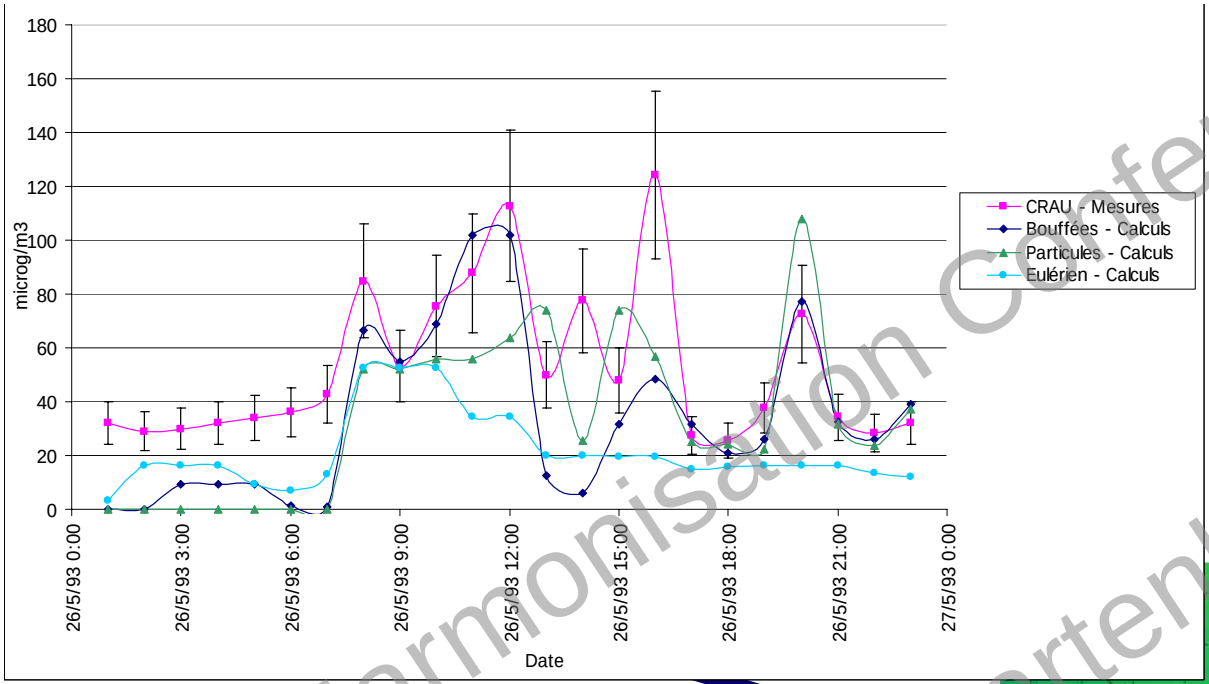

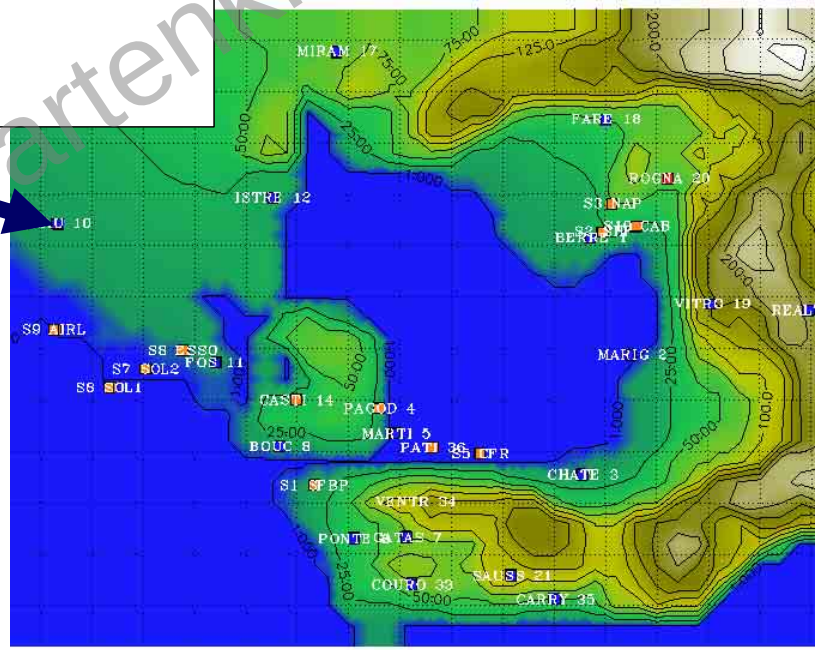

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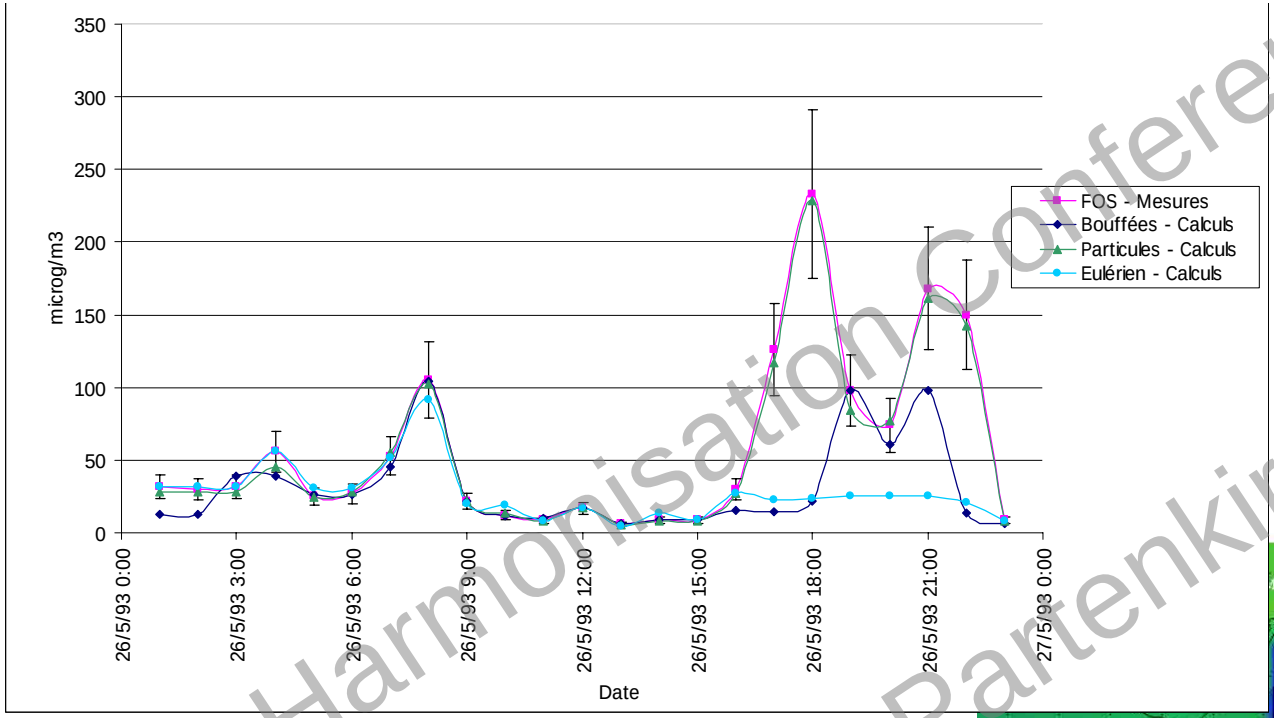

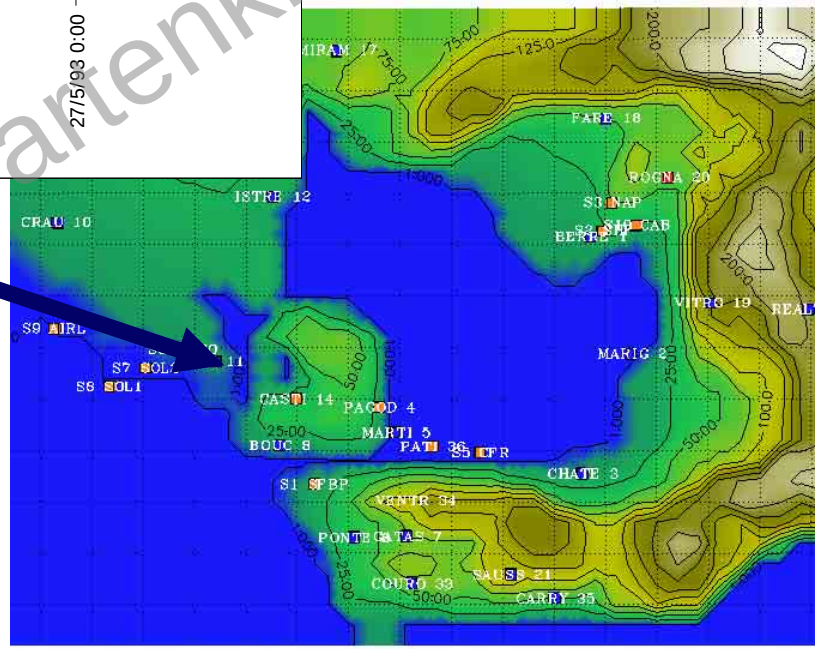

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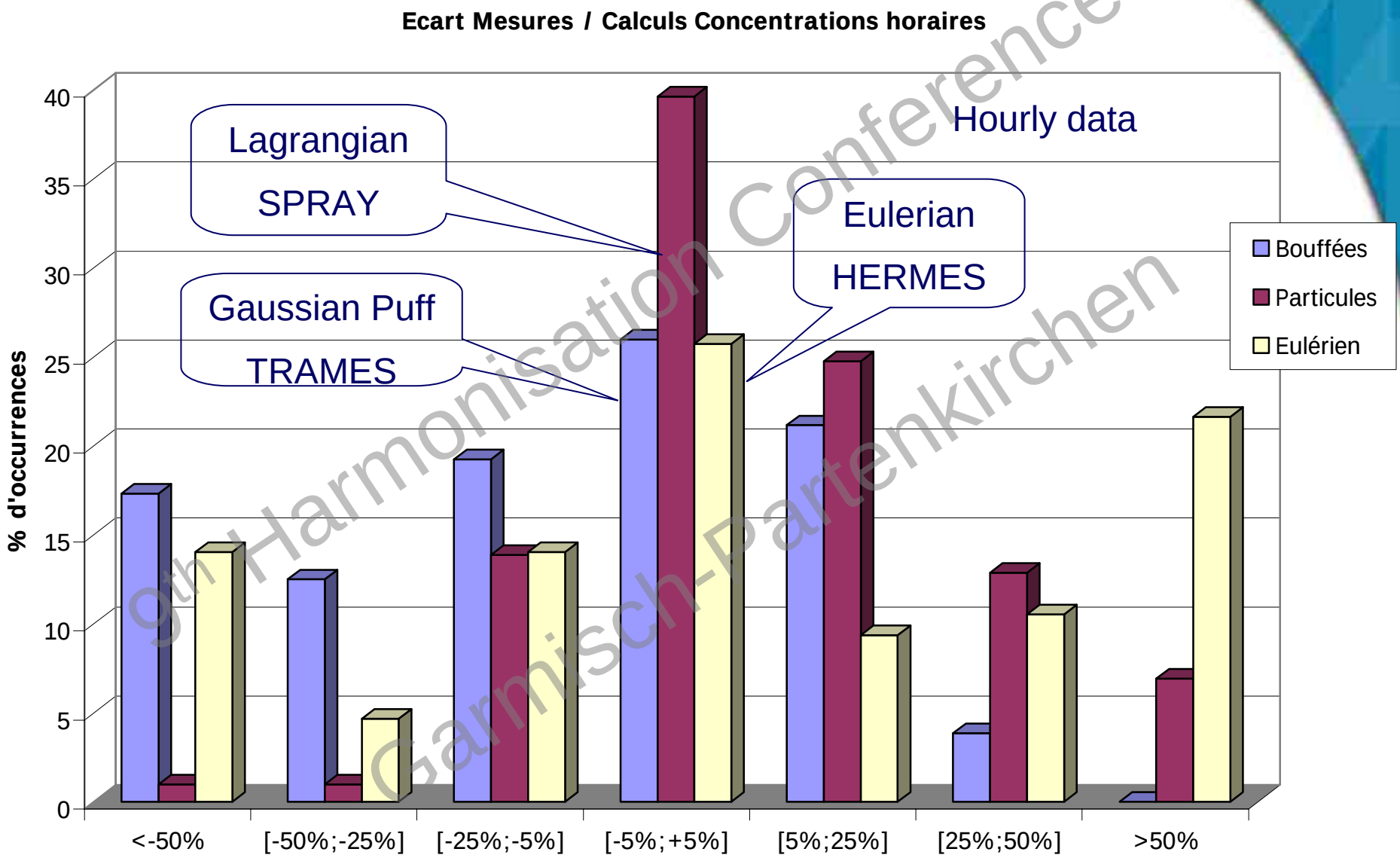

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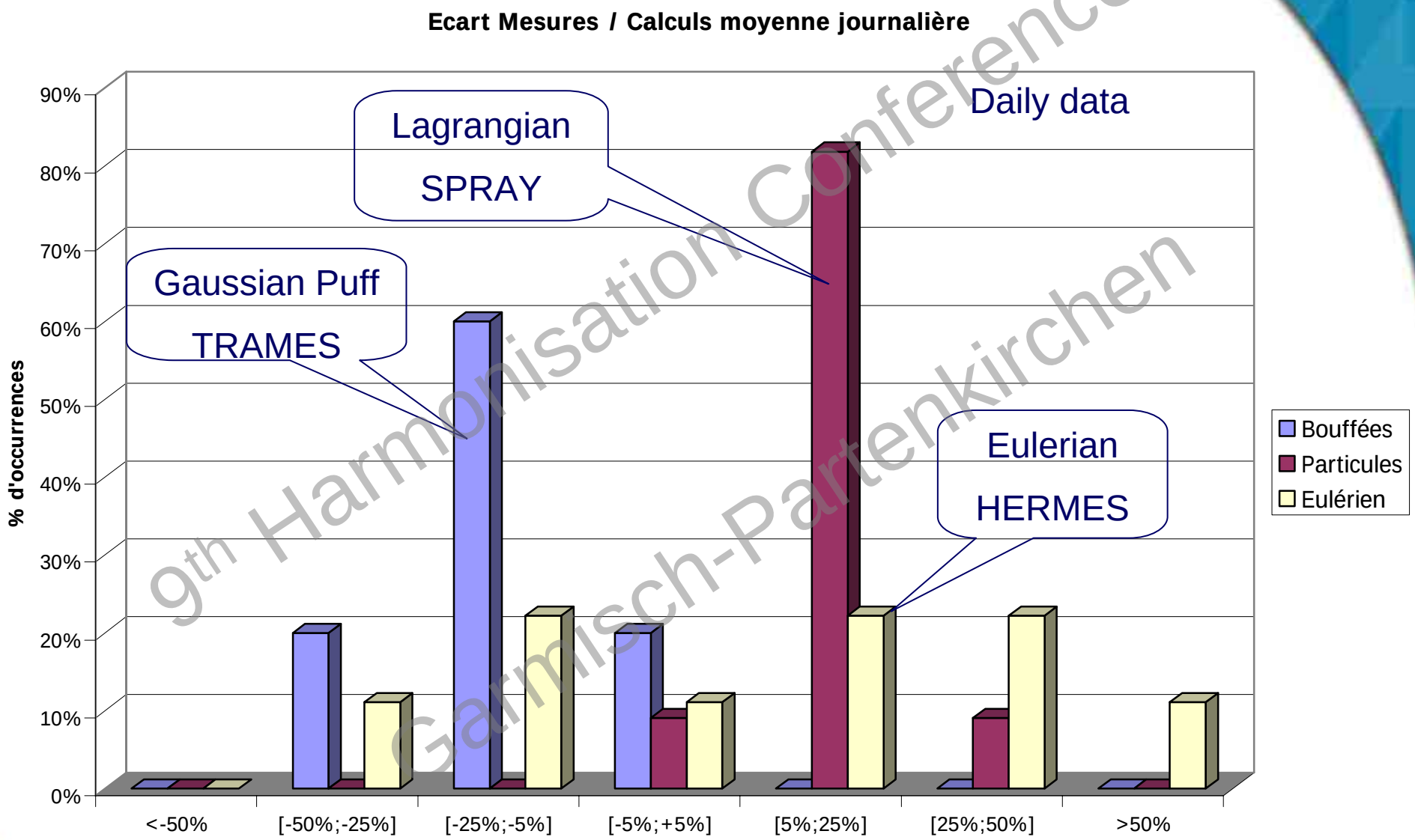

Conclusion

- Lagrangian model (SPRAY) gives the best scores :
  - Independency 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

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