Validation of the local-scale atmospheric dispersion model CEDRAT on ground level 85-Kr measurement campaigns over Cap de La Hague

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HARMO9

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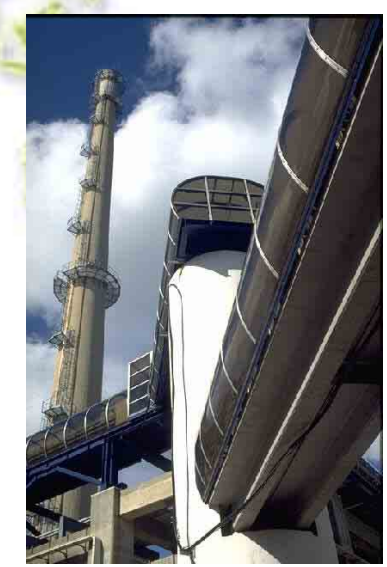
Outline

1. **Background**
2. **Model description: CEDRAT principles & specificities**
3. **Experimental campaigns description**
4. **Model and experiment comparison results**
5. **Conclusion & future prospects**

La Hague reprocessing plant location

- La Hague, Cotentin peninsula, France
  (Reprocessing of nuclear used fuel)



Atmospheric radioactive releases
3 main stacks: height of 100 m

Radiological impact assessment for routine releases

Goals

- **Ensure respect of the regulatory requirements and go further**
  - **Gas and aerosols concentrations at any time or place**
  - **Impact for a predicted and/or carried out release program**
- **Improve the environmental monitoring program**

Recommendations from the North-Cotentin Radioecological Group on the impact of the local nuclear facilities

Lack of accuracy within a short distance and for low speed winds (weak diffusion) of gaussian approximation

Need for an accurate and operational atmospheric dispersion model

1. Background

IRSN and COGEMA collaboration

IRSN skills to answer COGEMA's concerns

➔ annual research contract

- **Research axis : Micrometeorology (better description of local atmospheric stability conditions), dry deposition for aerosols, marine dispersion…**
- **Experimental campaigns**
  - **Altitudes data: tethered balloons [2000 – 2001]**
  - **Ground data [2001- 2002] for Krypton, aerosols (in progress)**
  - **Marine campaigns**
- **Modelling : hydrodynamic model for marine discharges**

Shared interests:

Carry out the best available technologies;

Enlarge knowledge on dispersion modelling

CEDRAT 2.0.0

Needs

1. Accuracy (with respect to gaussian models)
2. Rapid computation
3. Simplicity of use for on site operational conditions

2 working modes

Release scenarios

Computation time: 20 min to 1h30

Statistical scheme over a definite time period for an average concentration assessment

Help: wind field pre-processed data base

No pre-existing model answering these requirements

- How to obtain accuracy ?

  Navier-Stokes equations under Boussinesq approximation solved by Finite Elements Method through a freeware fluid mechanics solver developed by Paris 6 University (FreeFEM+)

- How to gain computation time ?

  - '2.5' D modelling: 2D for the flow computation + lateral dispersion through a finite difference scheme in parallel vertical sections
  - Eddy viscosity depending only on height (O'Brien, Laiktman, Mc Pherson approx)

- How to answer to operational constraints ?

  - **Friendly interface for atmospheric dispersion non-specialists**

  Ex: Automatic correlation between available meteorological data and associated Pasquill class

  - **Linux O.S. on a standard PC (maintenance concern)**

Importance of the validation process

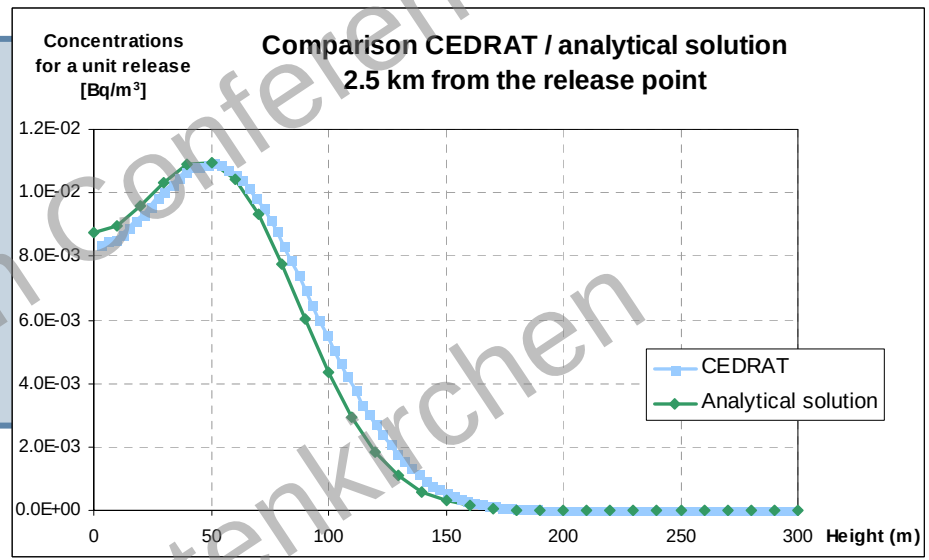
Validation process in two steps

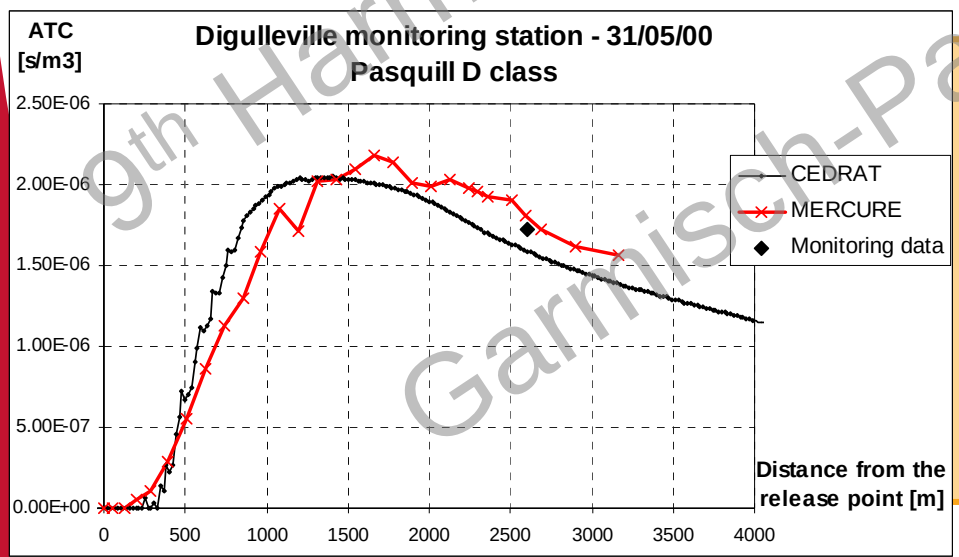
Theoretical step

vs analytical solutions

- **Each module separately**
- **Comparison with 3D accurate model MERCURE**

Validation of the numerical choices





Physical step (SGN)

vs release episodes

- **Five continuous monitoring stations around the site (from 1.1 km to 5 km)**
- **MERCURE evaluation**

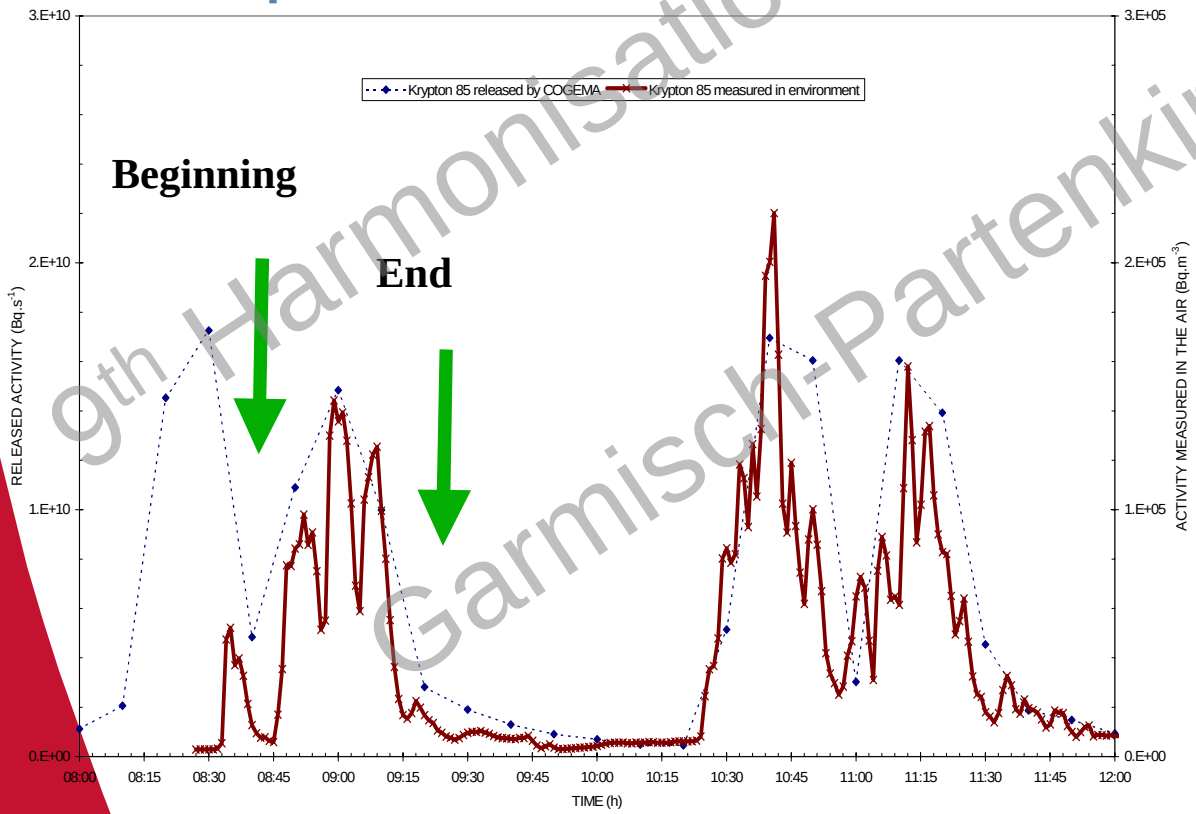
Deviation less than 50% in 80% of the cases

3. Experimental campaigns

Tracer: Krypton-85 noble gas

- Fission product trapped in nuclear fuel, released during the fuel shearing and dissolution steps
- Beta emitter and low branching ratio gamma emitter

Experimental device



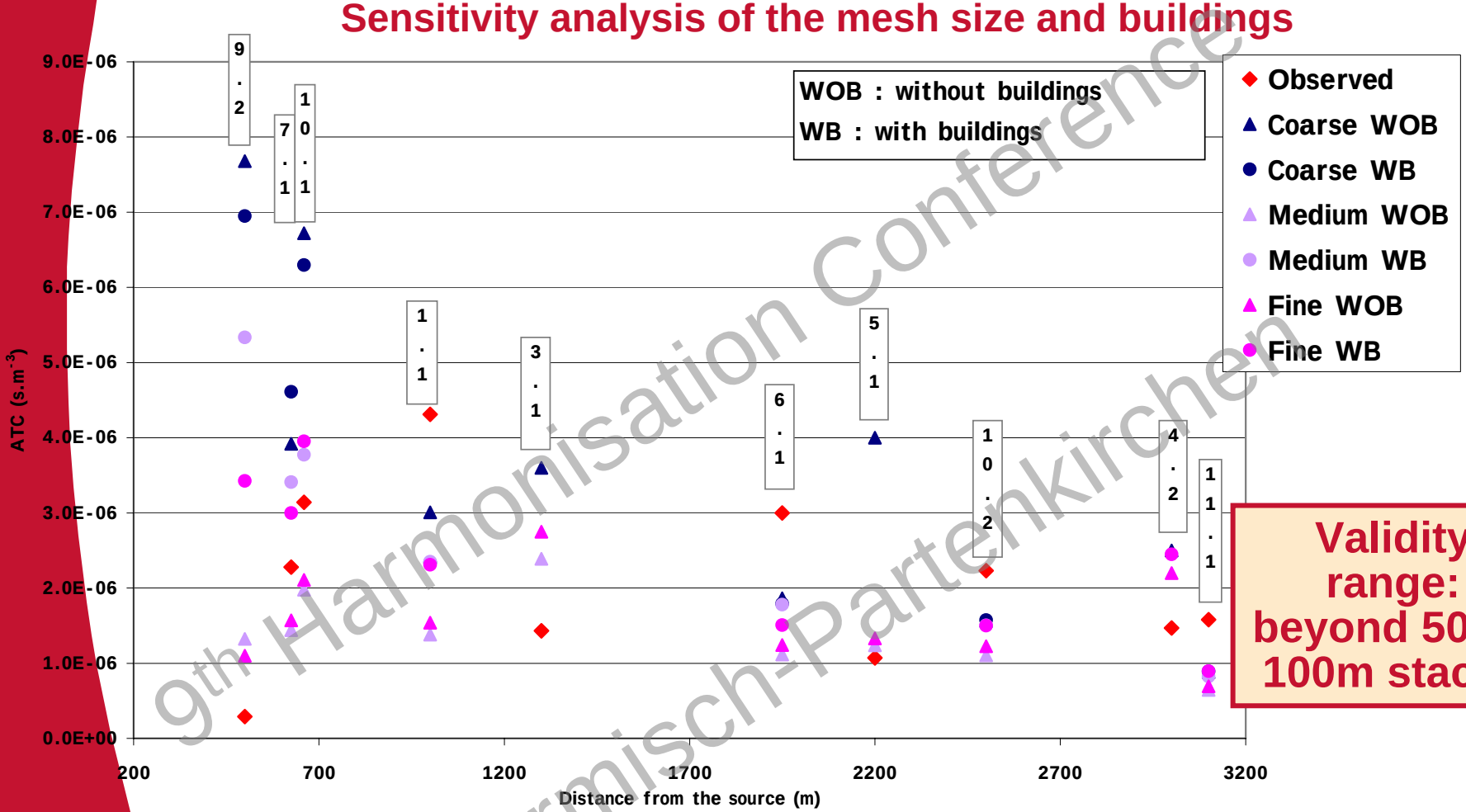
- DIAPEG system (air samplers) split around an arc
- Synchronized data given by COGEMA meteorological station

10 episodes

- 500 m to 3 km from the source
- C and D Pasquill classes

4. Comparison results

Sensitivity analysis of the mesh size and buildings



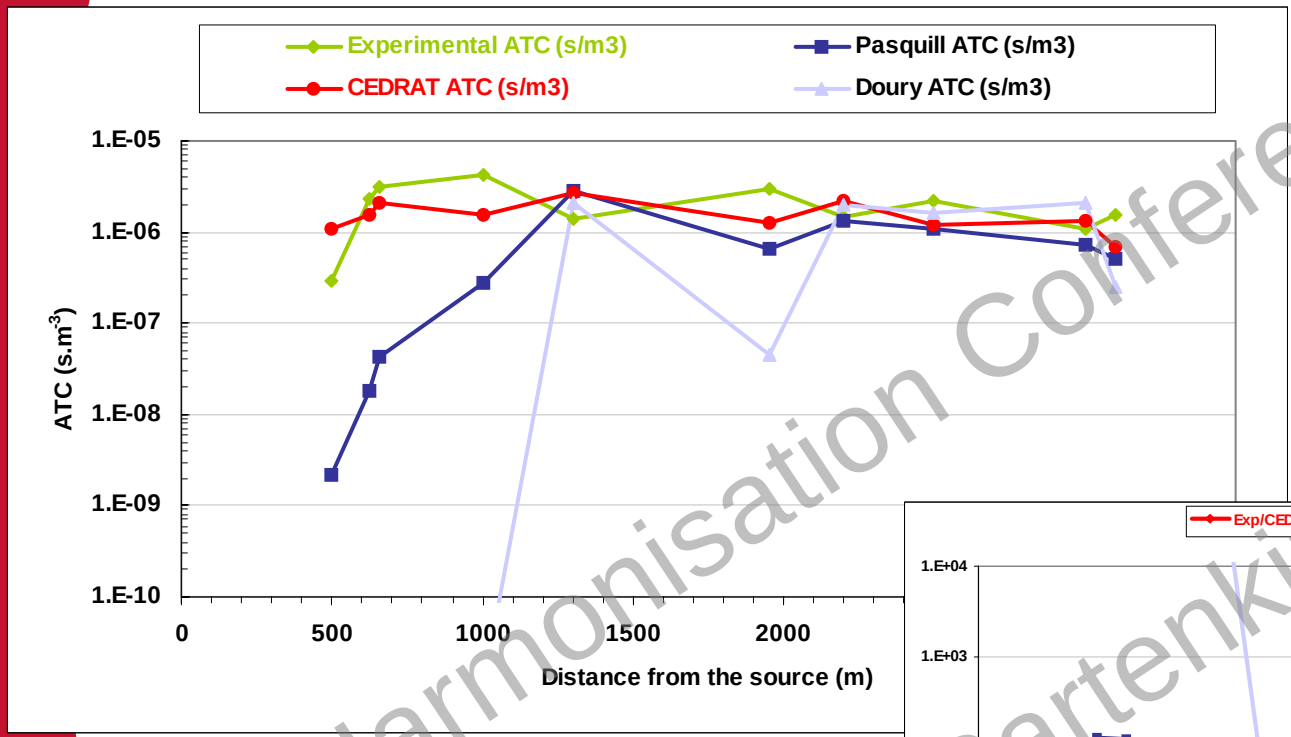
Validity range: beyond 500m 100m stacks

Stronger data spreading at short distances

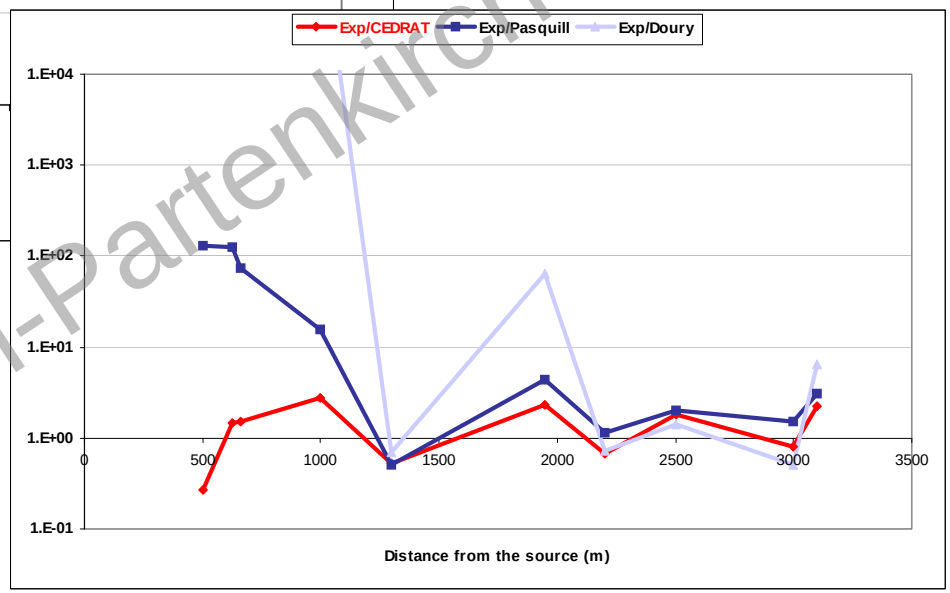
Influence of buildings: highest [Kr] near the source

Mesh size choice: fine without buildings

4. Comparison results



ATC ground values in the wind direction



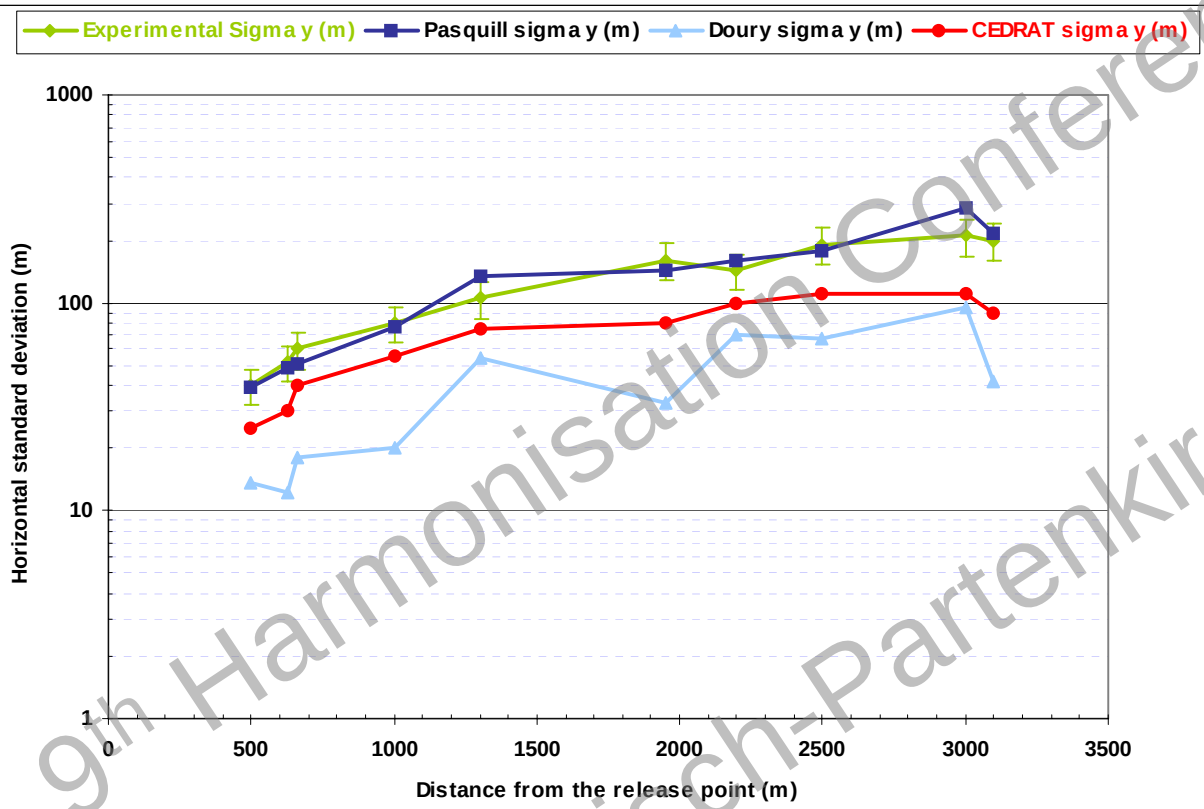
Mean deviation exp/model

- **1.4** for CEDRAT
- **36** for Pasquill
- **several decades** for Doury

Better description than gaussian models

4. Comparison results

In the lateral direction



Horizontal standard deviation

Global mass consistency

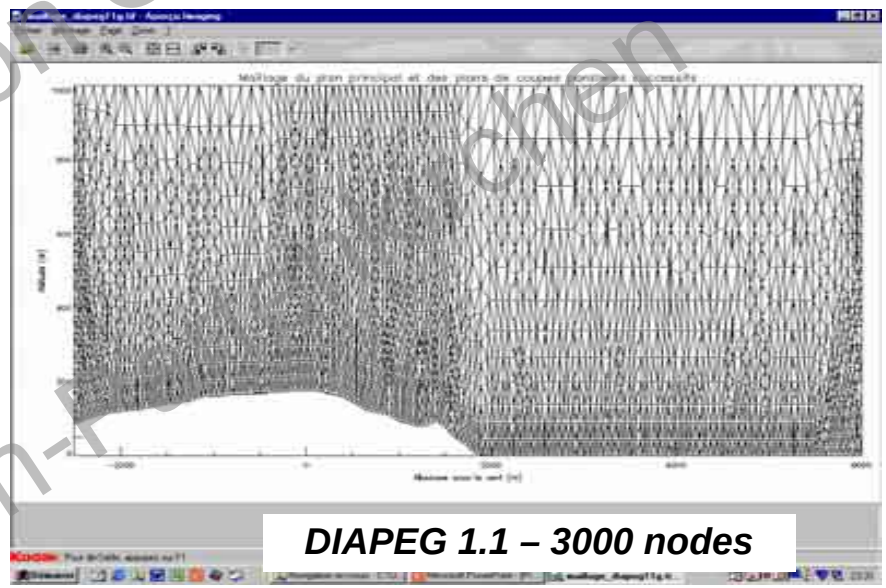
- Slight deviation with experimental data (30%), under predicting
- Plume vertically too developed

0.5 D to improve

5. Conclusion

- **COGEMA is given a more accurate, rapid and user-friendly model**
  - **Coherent description in the main cross sections**
  - **Quite insufficient description for the lateral processing**

Strong assumptions confirmed for this use



DIAPEG 1.1 – 3000 nodes

- **Fruitful collaboration between industrial managers and scientific experts to be continued**

How to improve the tool ?

- Improvement of the lateral dispersion modelling scheme (spreading of the cross sections)
- Adaptations for a coherent behaviour with buildings
- Changes in the wind direction for daily simulation
- Better stability characterization using the standard deviation of the wind direction vertical component
- Adaptable tool for different sites

How will IRSN and COGEMA collaboration proceed ?

- Comparison with experiments at higher altitudes with tethered balloons
- Emphasis on extremely stable conditions (night experiments) ≈ 15% of the cases found