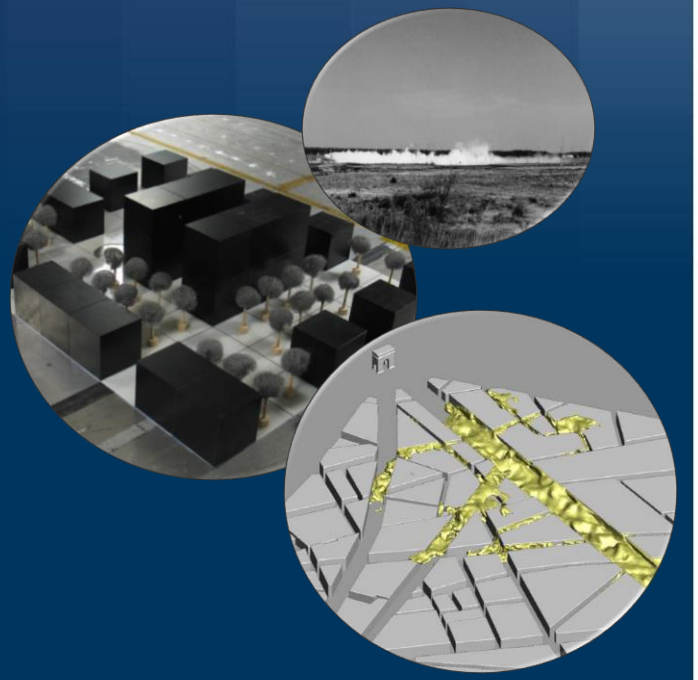
MODITIC

Modelling the dispersion of toxic industrial chemicals in urban environments

Comparison of various operational models against new experimental dispersion data



Harmo'17
12.05.2016

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FFI Forsvarets forskningsinstitutt
Norwegian Defence Research Establishment

FOI

DGA

INERIS

UNIVERSITY OF SURREY

OPERATIONAL MODELS

QUIC PUMA

PMSS ARGOS

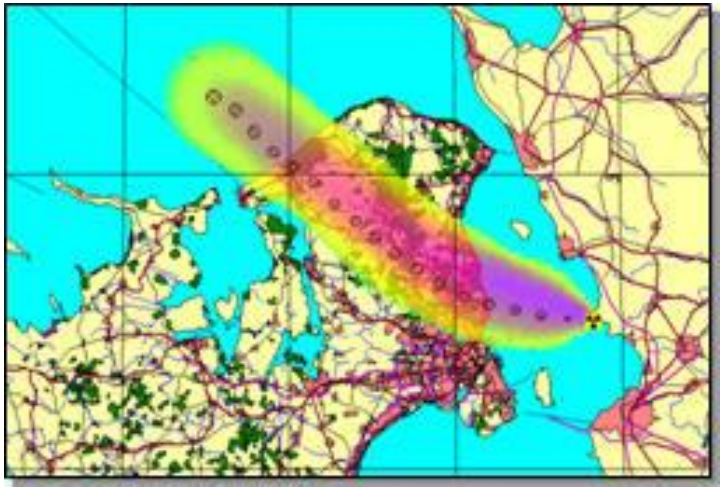
FOI

Goal

- To test the available operational models at hand for the contributing members of the project against new experimental data
- Not a comprising or systematic model evaluation

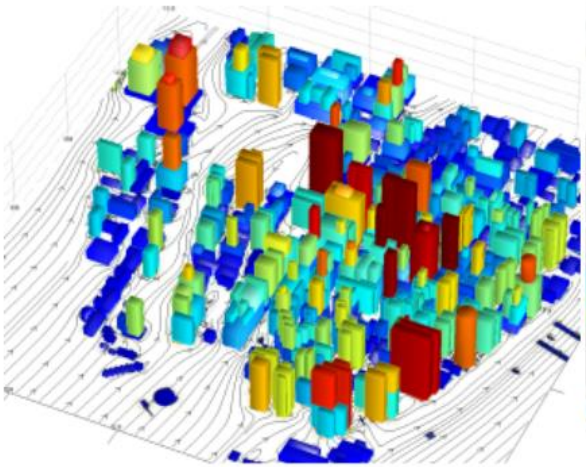
ARGOS

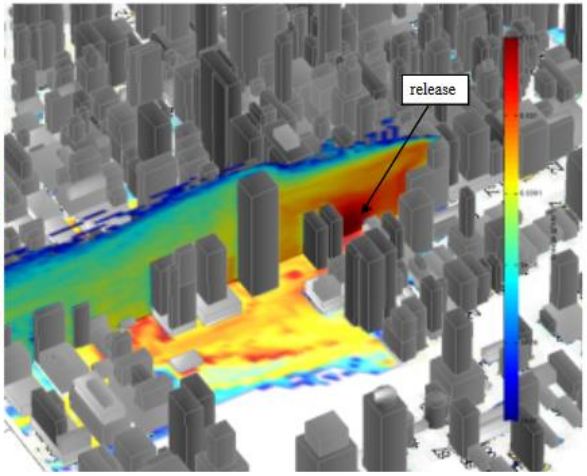
- Commercial program by PDC-ARGOS, Denmark
  - Gaussian puff model - Rimpuff
  - Source estimation
  - Box model for dense gases
  - Urban wind field generator, URD, that allows for obstacles (not compatible with dense gases)



QUIC

- Los Alamos National Laboratory, US
  - Quick Urban & Industrial Complex
  - Focused on urban environments
  - QUIC-URB, mass preserving flow field model
  - QUIC-PLUME, Lagrangian particle model
  - Includes a dense gas model
  - Supports multiphase releases





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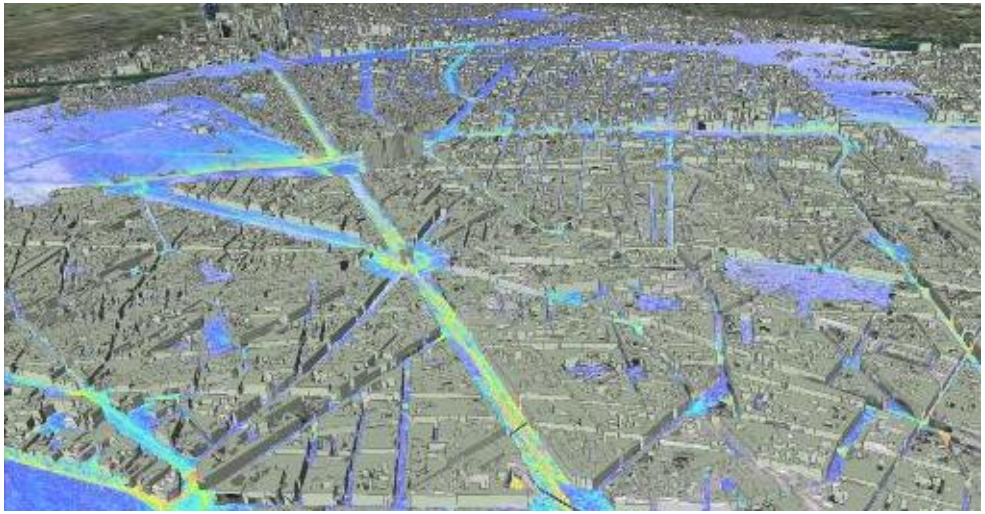
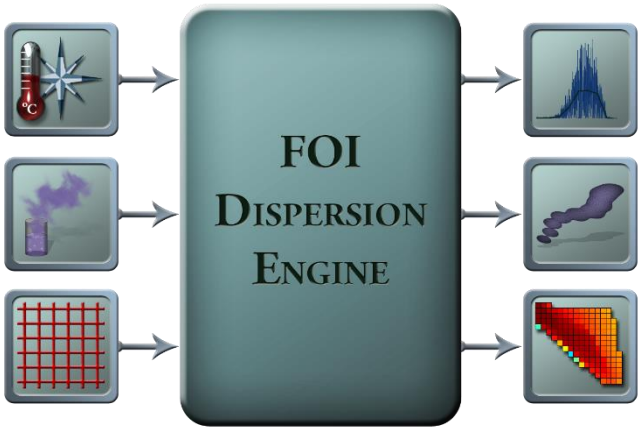
PMSS

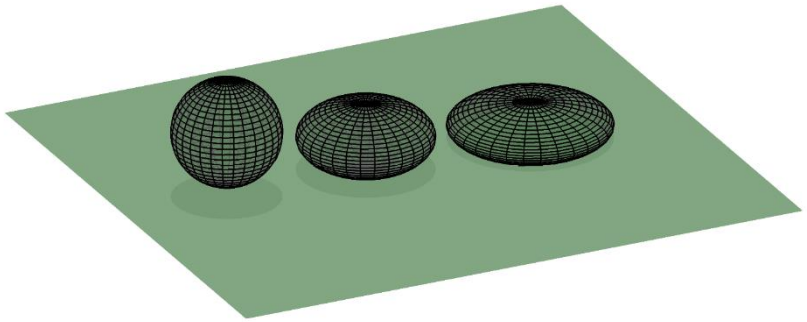
- Commercial program by ARIA Technologie, France
  - Parallel Micro-SWIFT-SPRAY
  - Micro Swift, diagnostic 3D wind fields
  - Lagrangian particle dispersion model
  - Allows for obstacles
  - Air quality monitoring
  - Dense gas module exist but was **not** available here

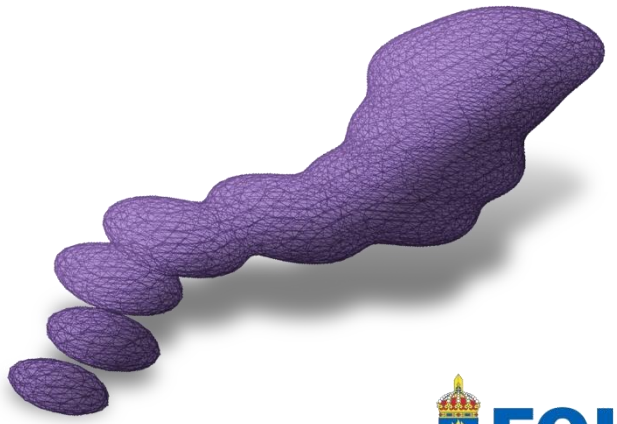


PUMA

- PUMA is one of several models in FOIs custom made software package *Dispersion Engine*
- Puff Model of Atmospheric Dispersion
  - Real-time dispersion model
  - Designed for third-party implementations
  - Dense gas effects implemented in MODITIC







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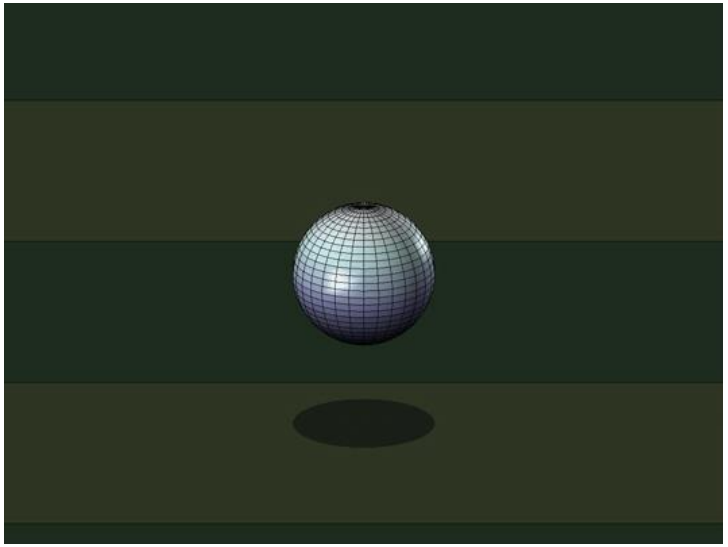
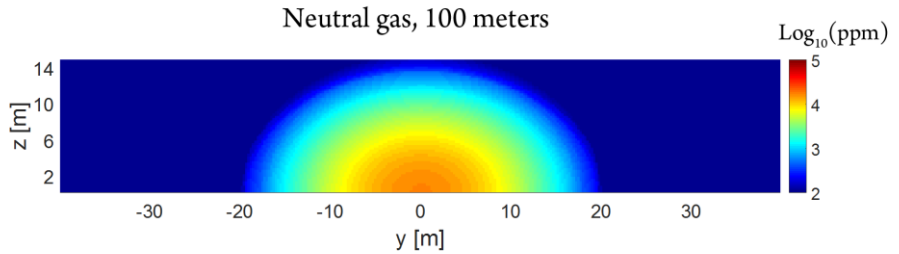
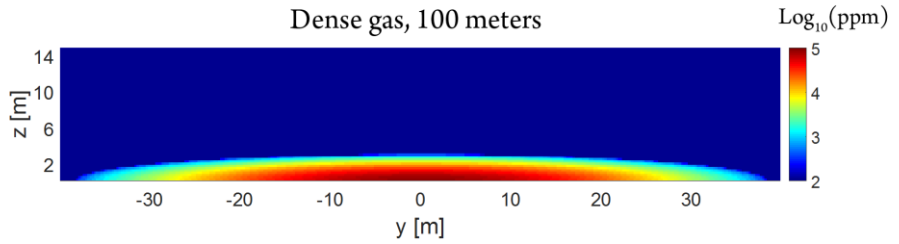
PUMA

- Going from neutral gas to dense gas
  - Linear → nonlinear system
  - Geometric effects
  - Thermodynamical effects







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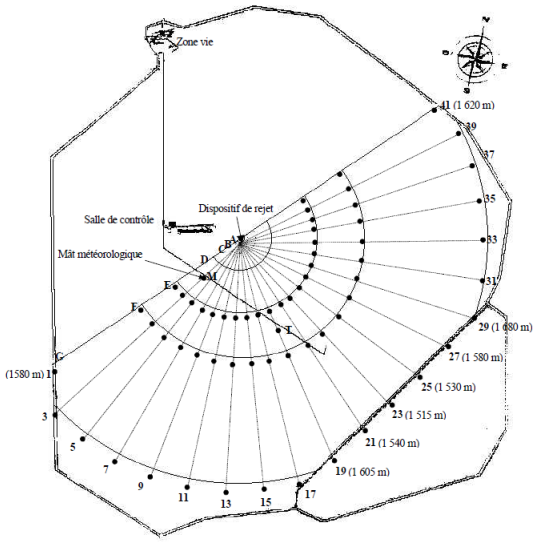
CASE 1 – OPEN FIELD EXPERIMENTS

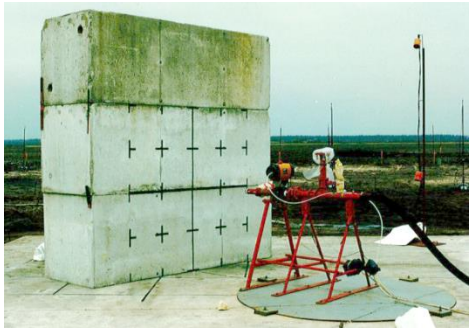
ARGOS
QUIC
PUMA

FOI

INERIS test site (CEA-CESTA)

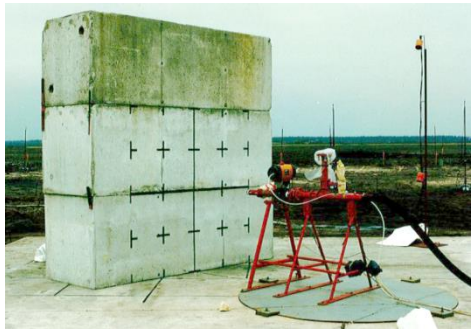
- Experimental setup:
  - Ammonia, 4.2 kg/s
  - Open field, 800 meters
  - With and without a wall

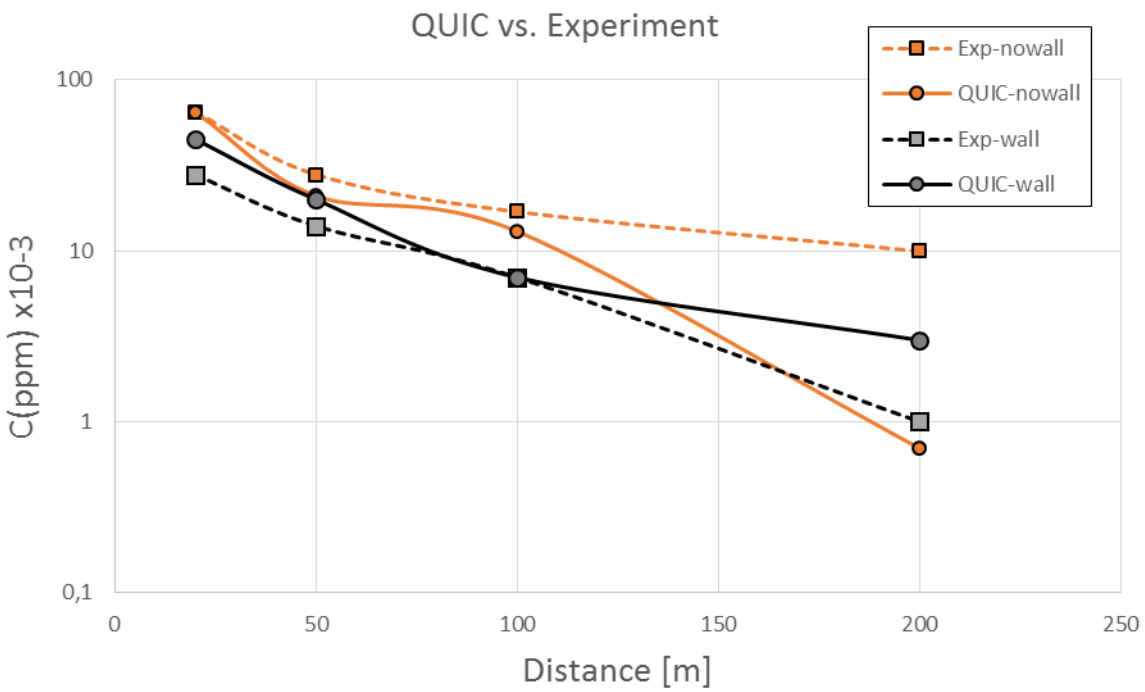


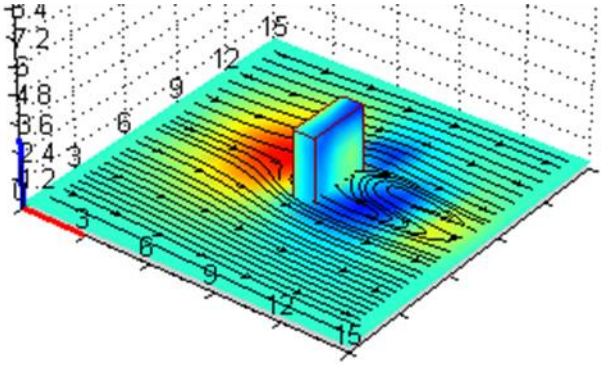


QUIC

- With and without a wall







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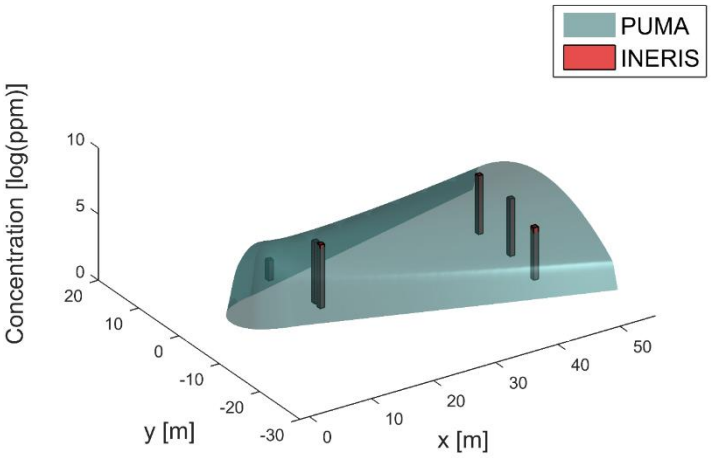
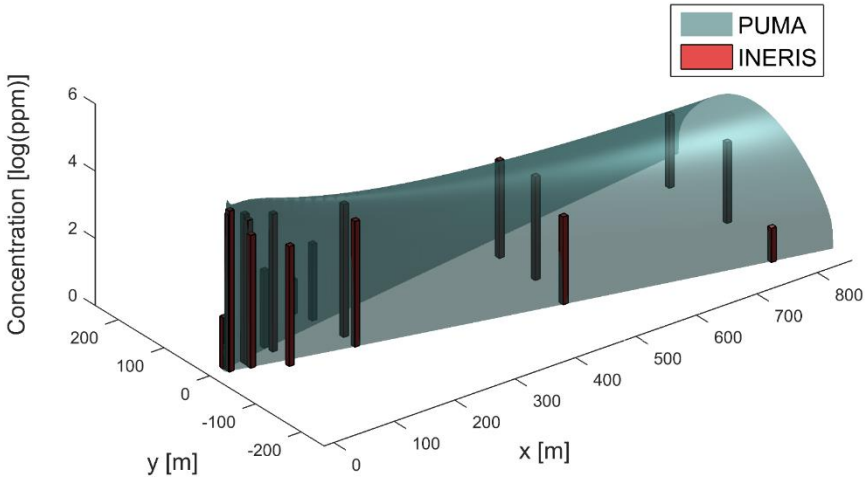
PUMA

- 3D fields vs. point measurements



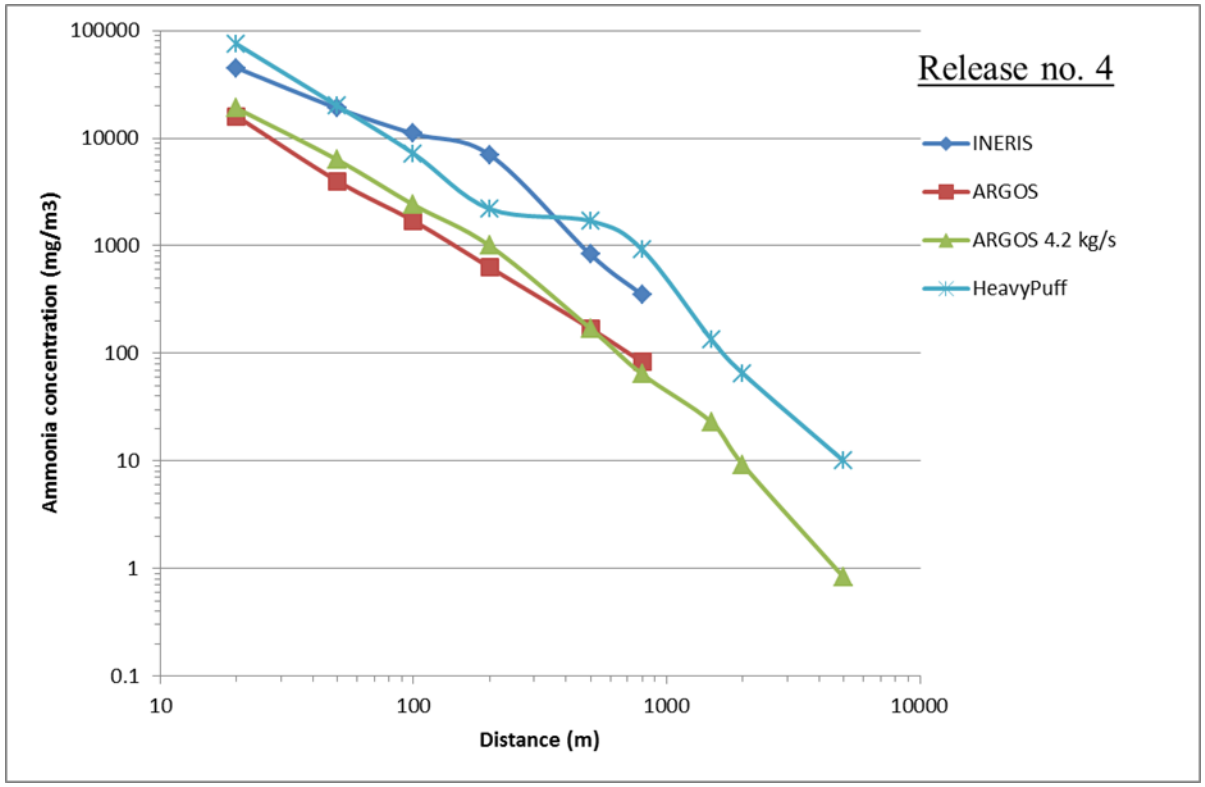
Near source



Entire field

ARGOS

- Comparison of both neutral and dense gas models vs. measurements – without a wall
- Also tested with an up-scaled wall



INERIS = experiment
ARGOS = neutral gas
HeavyPuff = dense gas

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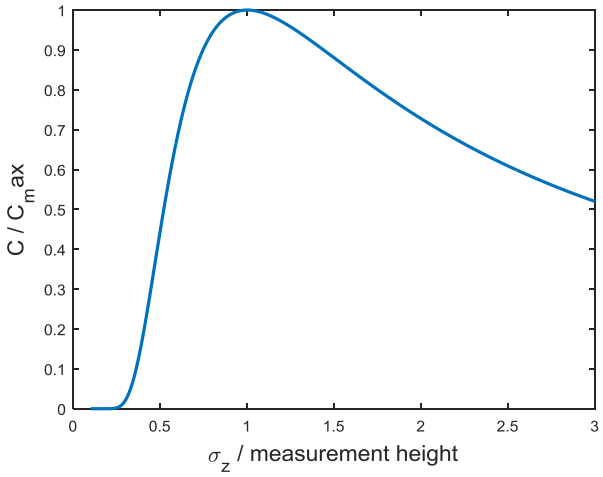
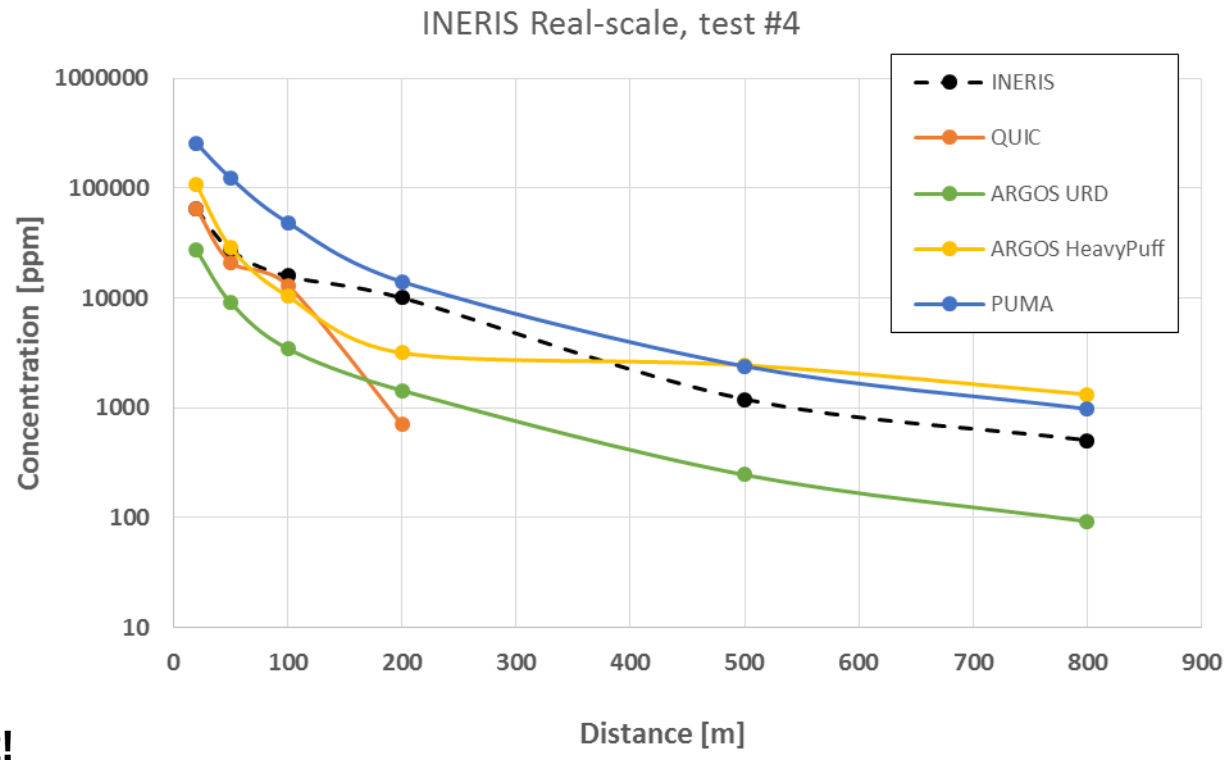
All models

- Plume centreline concentration at z = 1.0 meters





Note : Sensitive to the height!
E.g., with gaussian distribution:
An increase in σ_z/z from 0.5 to 0.6 implies 53% higher C

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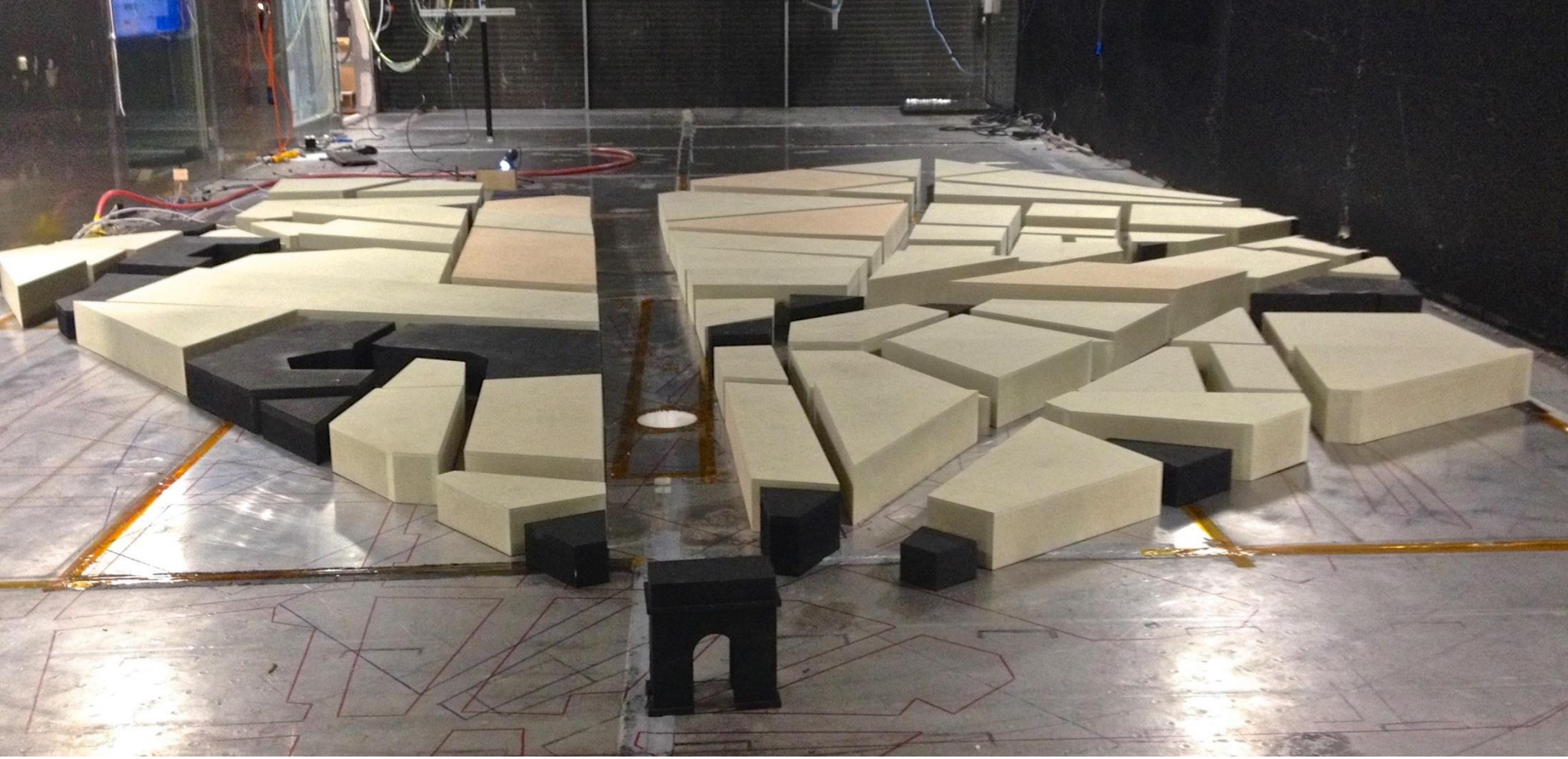


CASE 2 – PARIS WIND TUNNEL EXPERIMENTS

ARGOS
PMSS

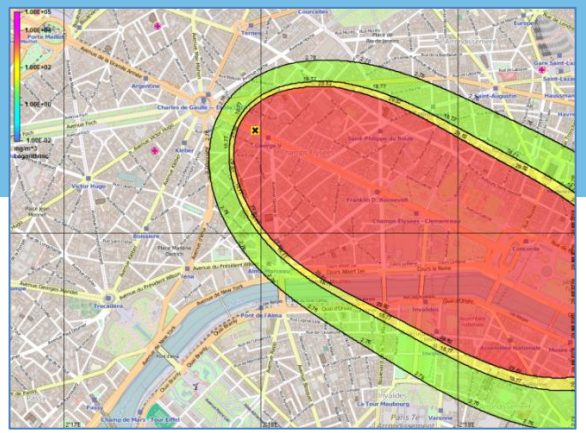
FOI

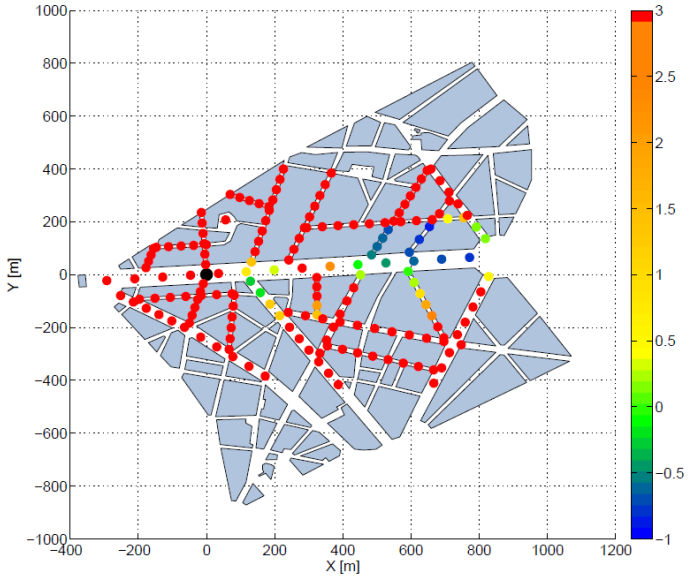
ARGOS

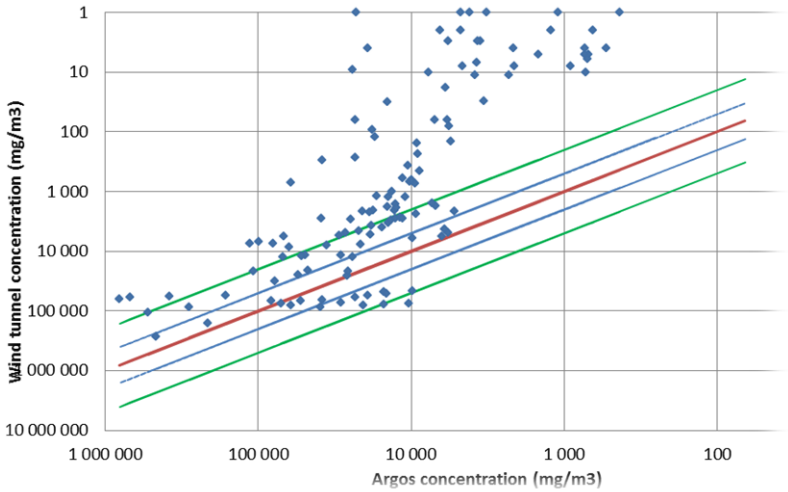
- Neutral gas only, Rimpuff & URD
- Scaled up the wind tunnel to full size, factor of 350
- Runtime a few minutes for URD

ARGOS

- Release point #1



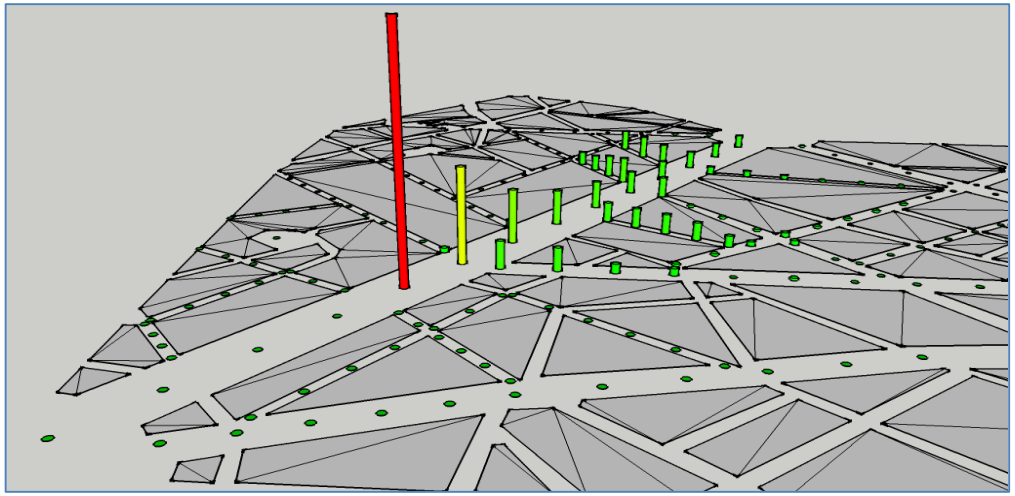




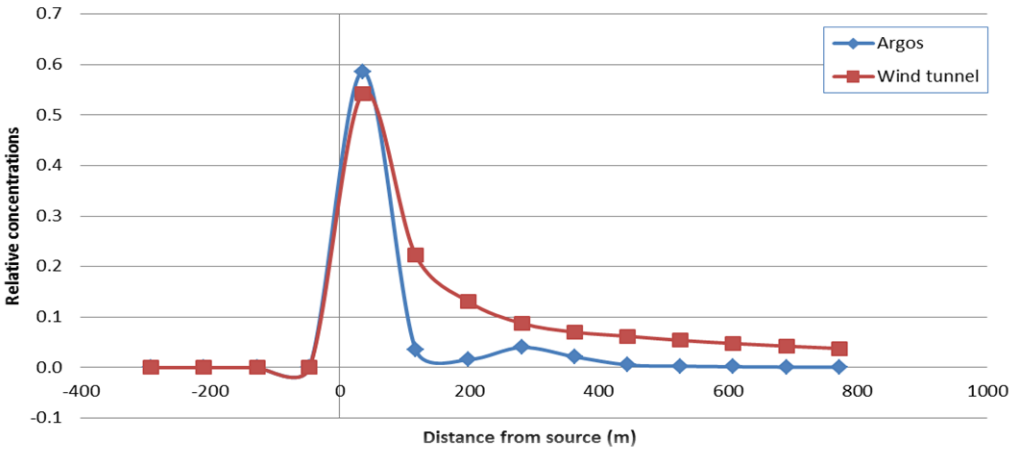
Conclusion : ARGOS underestimates the tunnelling effect of Champs Elysees and therefore overestimates the concentration outside Champs Elysees

ARGOS

- Release point #1



Wind tunnel data



Relative concentrations along Champs Elysees

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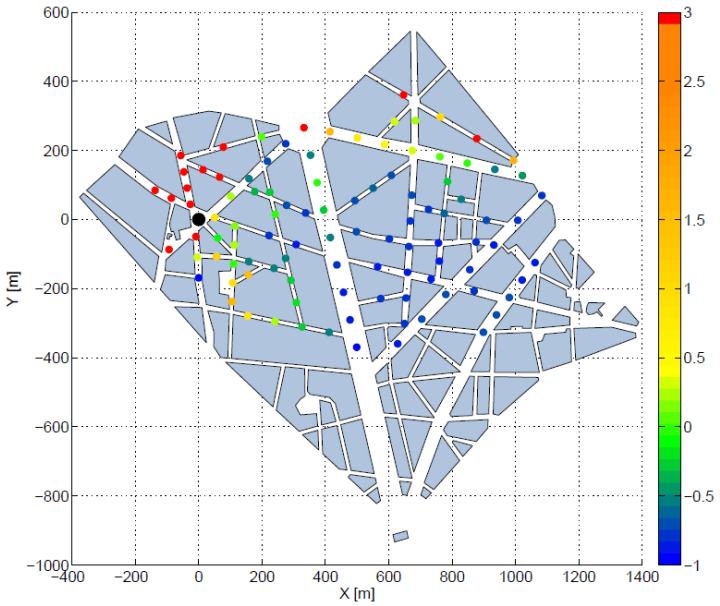
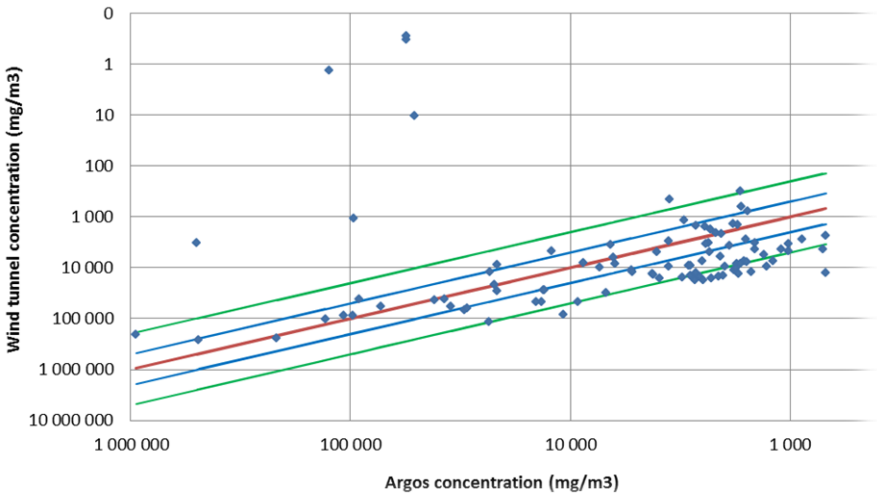
ARGOS

- Release point #3





Source position	Fraction within FAC2	Fraction within FAC5
1	0.08	0.26
2	0.18	0.47
3	0.30	0.69

Conclusion : Better results without any ’tunneling’, but overestimation close to the source

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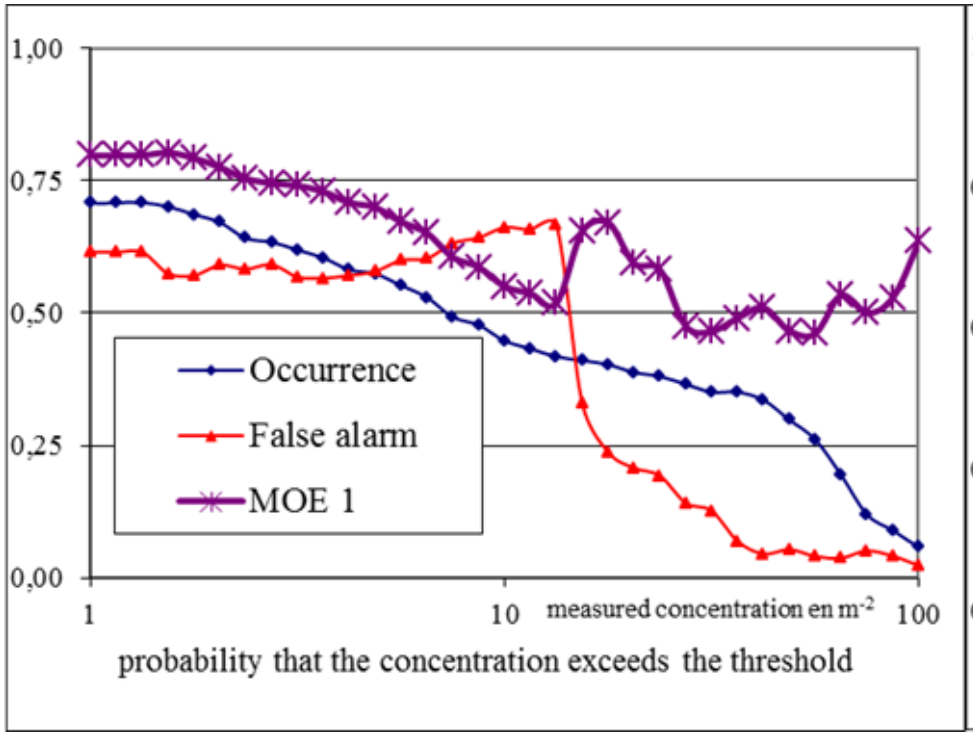
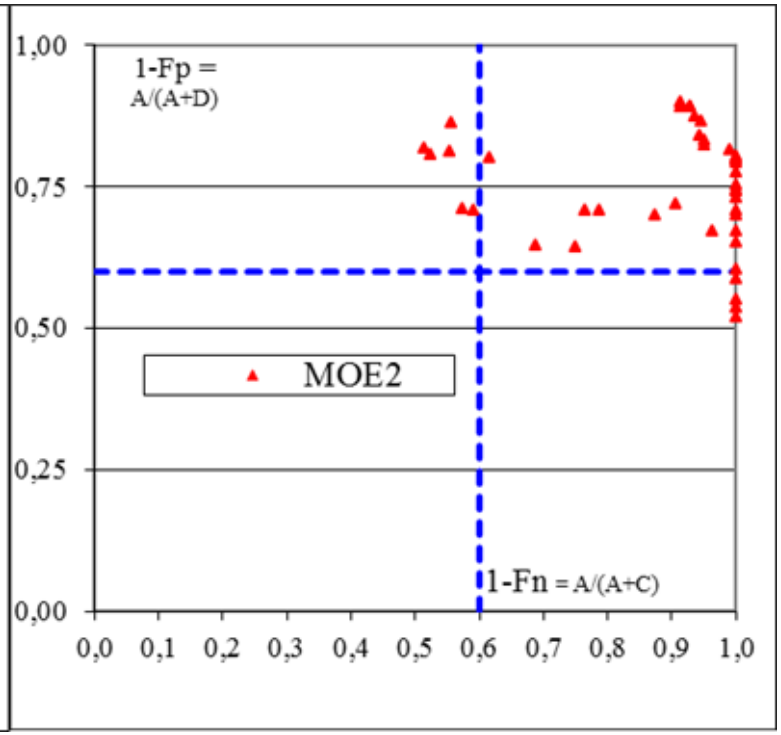
PMSS

Occurrence	= how many points that exceed the threshold for measurement
False alarm	= fraction false positive
MOE 1	= how large fraction of the total area that overlap
MOE 2	= false positive vs. false negative for each threshold





Conclusions

- We have tested 4 models
- Two different main geometries – open field & urban
- Dense gas and neutral gas
- … but not all combinations!
- Only QUIC could be tested in all cases

Conclusions

- Setting up sources and meteorology might be time-consuming
- Execution time is short, seconds - minutes
- Results:
  - Open field : No strong general trend in the results
    - HeavyPuff in ARGOS gives results closer to experimental data than Rimpuff
  - Urban : Hard to catch the strong effect of Champs Elysees. Overestimation close to the source.

Full report:

Burkhart, S., Gousseff, A., Tørnes, J., & Björnham, O. 2016. MODITIC - Simulation Report on Operational Urban Dispersion Modelling

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