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15th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes

6-9 May 2013, Madrid, Spain

ESSEM COST ACTION ES1006

Evaluation, improvement and guidance for the use of local-scale emergency prediction and response tools for airborne hazards in built environments.

presented by Silvia Trini Castelli for COST ES1006
CNR – ISAC, Torino, Italy

The motivation

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The motivation

Accidental or deliberate releases of hazardous materials in populated areas induce a growing concern in the society.

Instantaneous accidental releases from ....

Industrial sites

Energy facilities

Transportation of hazardous materials

Terrorist attacks

Accidental or deliberate releases of hazardous materials in populated areas induce a growing concern in the society

Instantaneous accidental releases from….

- industrial sites,
- energy facilities,
- transportation of hazardous materials
- or even a CBRN (Chemical-Biological-Radiological-Nuclear) terrorist attack

…. can lead to catastrophic consequences in terms of population casualties and damage to ecosystems and infrastructures.

Dealing with such releases is complicated by the need for a fast and at the same time sufficiently accurate emergency response tool.

The Emergency Response Tools…

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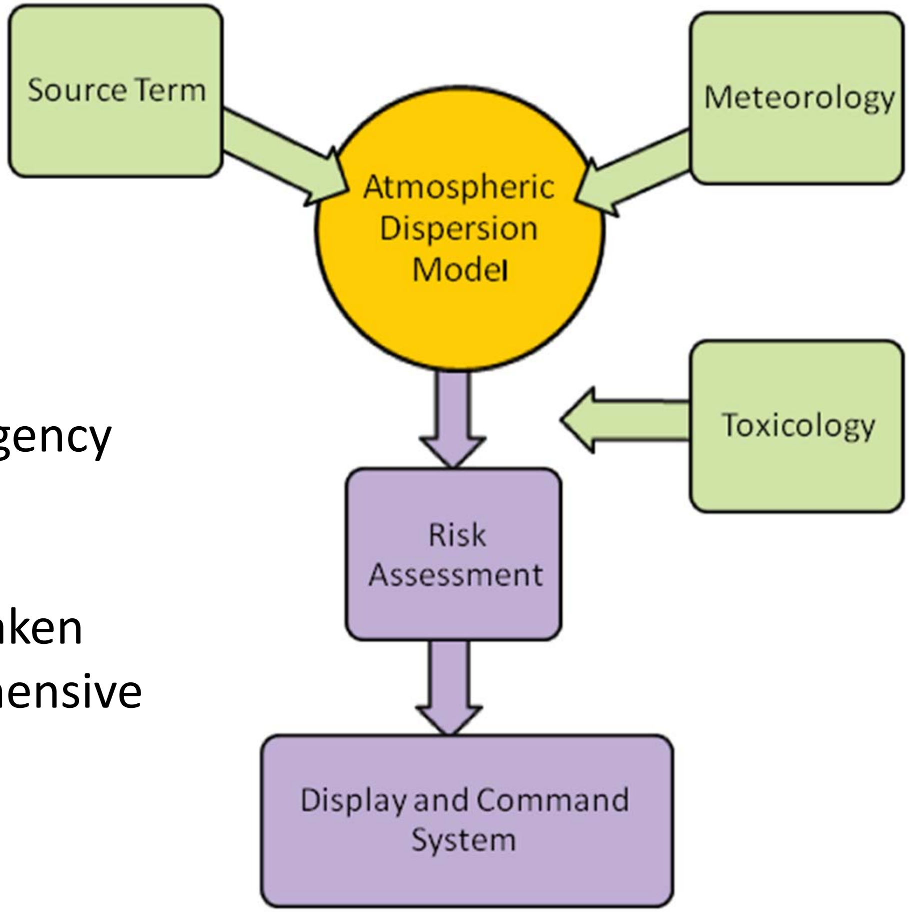
Emergency response tools take the form of fully integrated management systems, or modular concepts that have interfaces between the individual components.

They all have to provide the means to:

- Characterise potential hazards;
- Manage the logistical aspects of emergency incident response;
- Account for different types of release;
- Document the decisions and actions taken during an incident, to facilitate comprehensive post-incident analysis.



… and the dispersion models

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A crucial part of a state-of-the-art emergency response management tool is represented by the **airborne hazards dispersion models**

> *these, combined with sensors that detect and measure hazardous material concentrations are the backbone for any comprehensive emergency management system*.

One of the biggest scientific challenges in local-scale emergency response remains the prediction of airborne hazards dispersion from accidental or deliberate releases at the very local scale, especially within complex environments.

If dispersion of agents and resulting threats are unknown, all subsequent steps of modern emergency response and management quickly become questionable, inefficient and maybe even threatening for first responders.

The keywords: accidental, local scale, built environments

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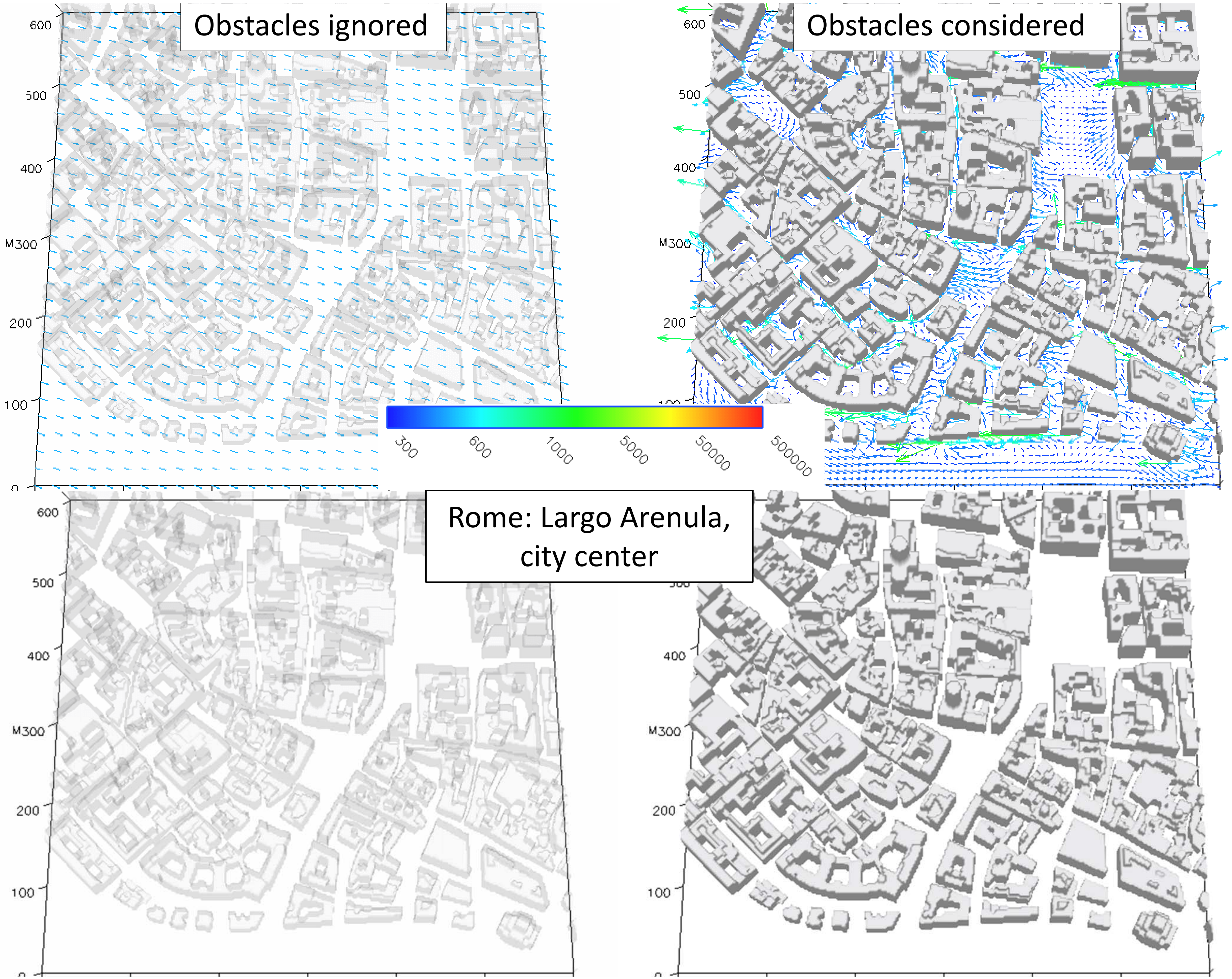
Due to its unexpected nature, an **accidental release** is a complex phenomenon and a challenging situation to handle.

.... A highly **problematic** scenario unfolding in an **uncertain** frame.

At the **local scale**, the situation is typically complicated by the following factors:

- the duration of the release is often very short
- the emission characteristics of the source are only partially known
- the local meteorological conditions are not readily available at the desired level of accuracy, and are subject to constant change
- the response time in which to mitigate the effects of a release is short
- the release occurs in a complex industrial or urban environment



Obstacles ignored
Obstacles considered
Rome: Largo Arenula, city center
300
600
1000
5000
50000
500000
600
500
400
M300
200
100
0

The focus and aims in practice

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The **main focus** of COST Action ES1006 is to improve the quality and robustness of local-scale predictions of airborne hazard dispersion from accidental or deliberate releases in complex urban and industrial environments.

The Action **aims** at establishing a scientific and methodological reference for local-scale airborne hazard modelling through:

✓Improving the scientific basis behind local-scale dispersion modelling;

✓Developing an inventory of models and modelling systems;

✓Developing comprehensive practical guidance for using models to track and predict the dispersion of airborne hazards.

The tasks

The **major tasks** of the COST Action ES1006 are to :

- Review the current tools and models used in characterising hazard dispersion and examine how these are applied operationally in emergency response efforts
- Identify the deficiencies in tools and models that limit their effectiveness and operational use in emergency situations
- Identify the critical input data that must be available to use the tools and models effectively
- Identify ways to improve the accuracy of tools and models
- Measure the quality of model results and identify ways to improve them, a task-specific validation procedure will be adopted

The results achieved today - I

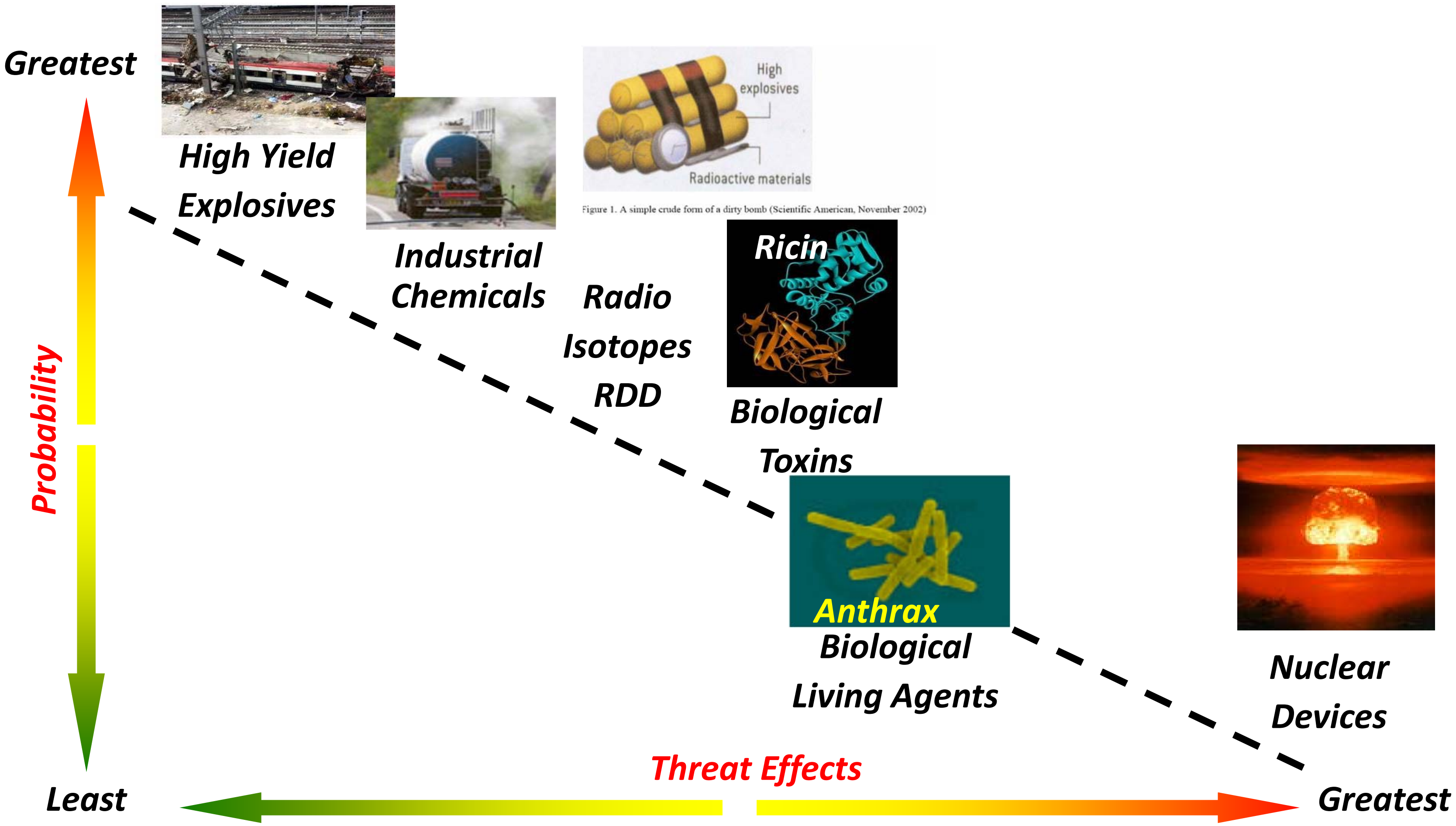
The **Background document** is.....

- Identifying and illustrating the present and future threats and of the challenges related to their handling
- Introducing and reviewing the different modelling approaches and tools currently in use or under development
- Exporting the analysis to specific problems related to the dispersion modelling for emergency planning and response
- Addressing the uncertainties related to the application of modelling systems in emergency response framework
- Outlining the practical constraints, regulations and legal issues and the framework for their implementation

The results achieved today - I

The Background document is.....

- Identifying and illustrating the present and future threats and of the challenges related to their handling



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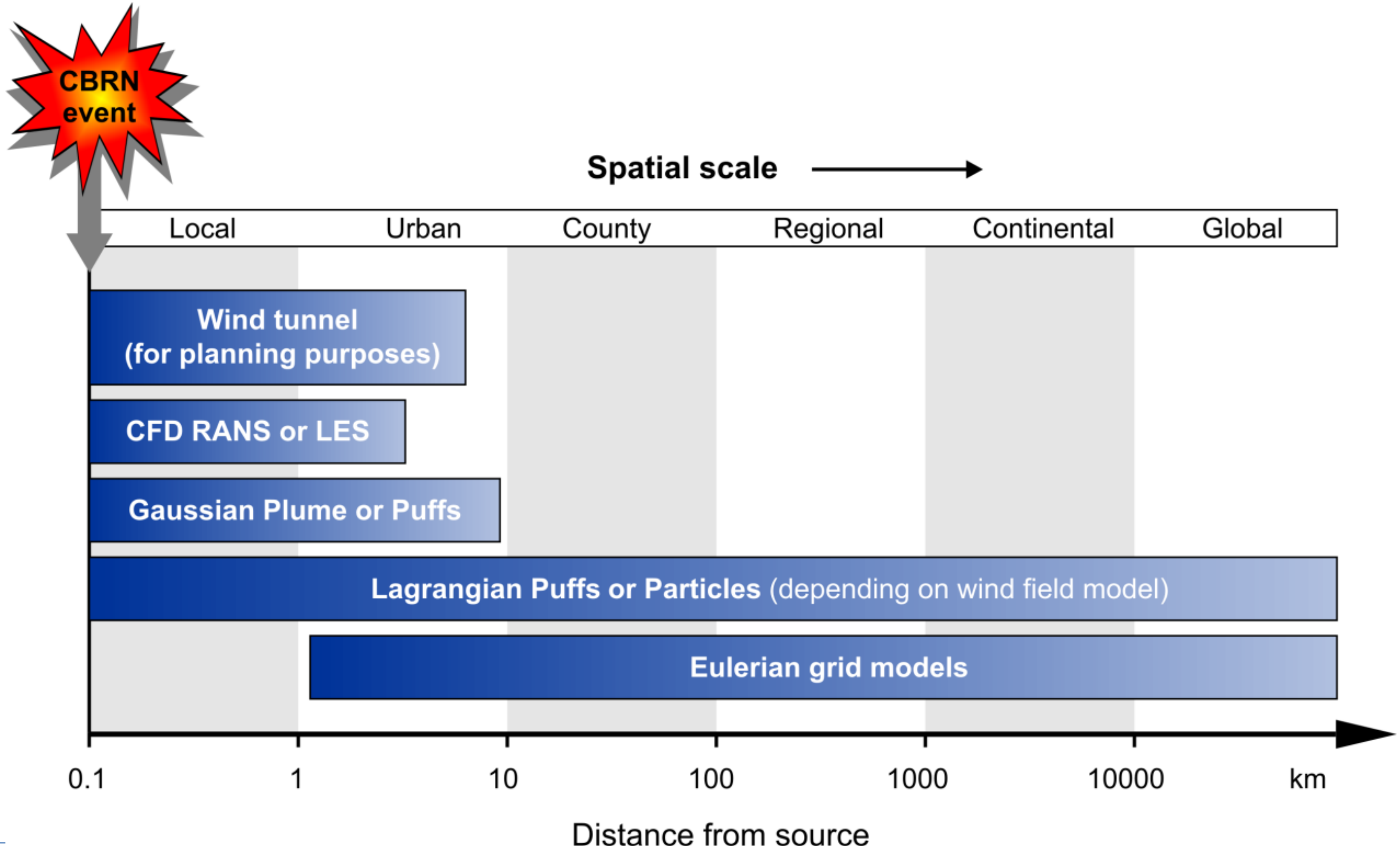

The results achieved today - I

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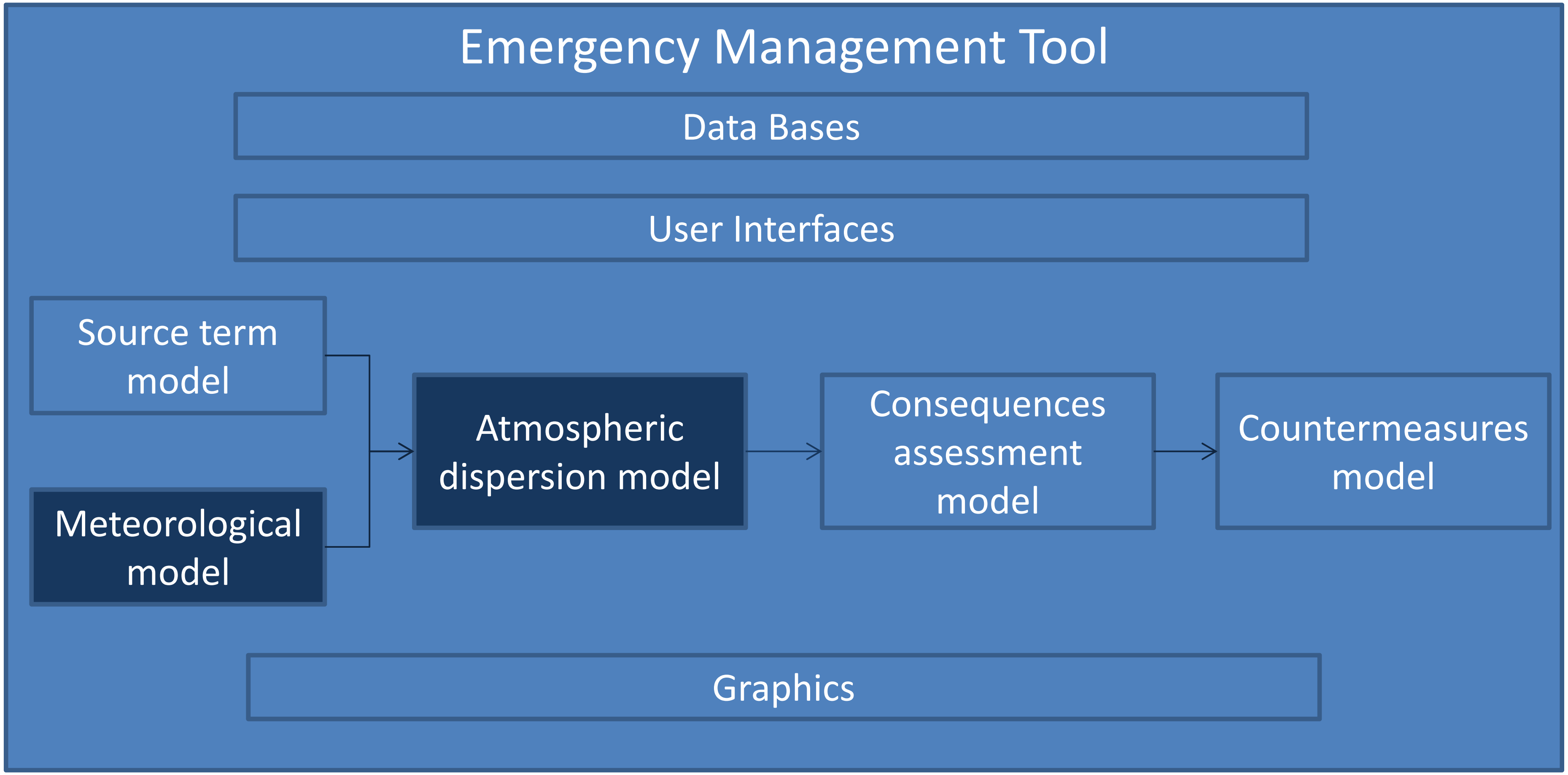

The results achieved today - I

The Background document is.....

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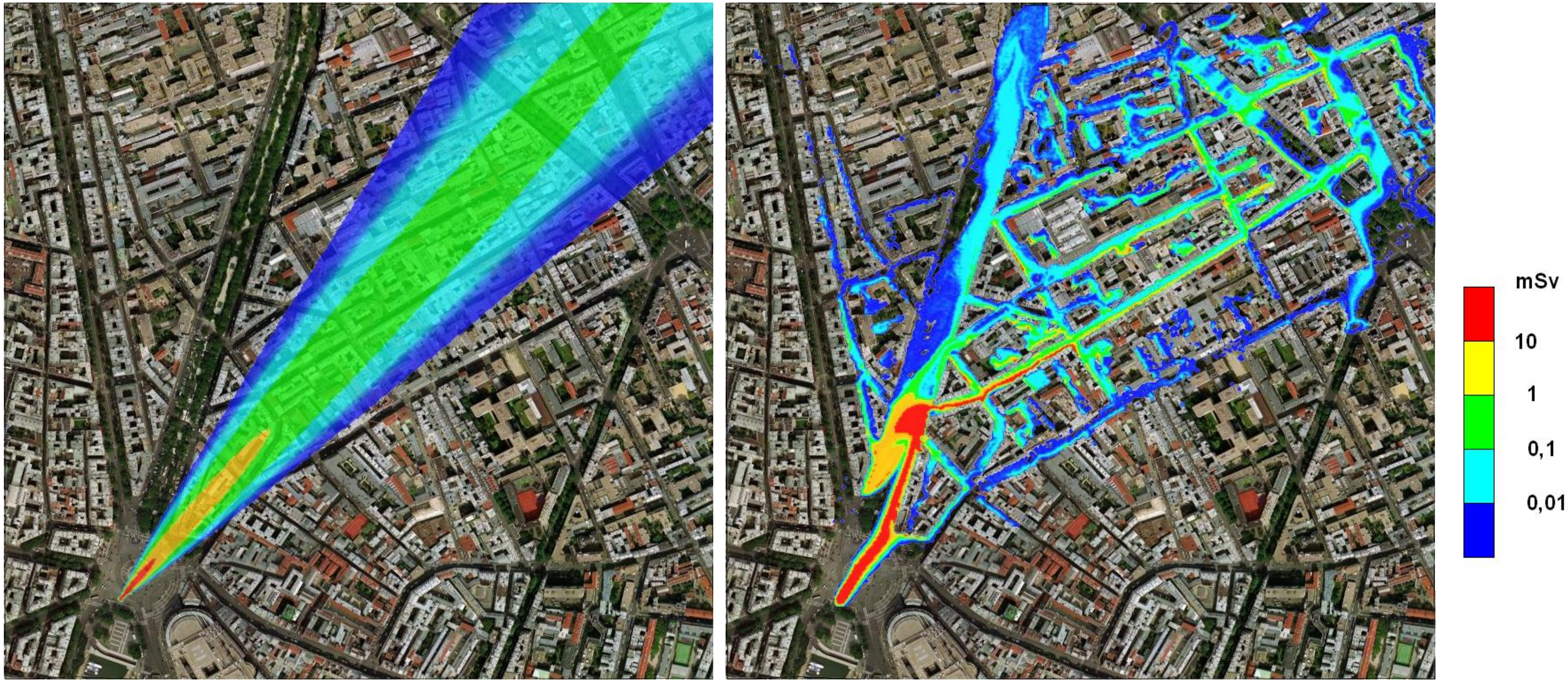
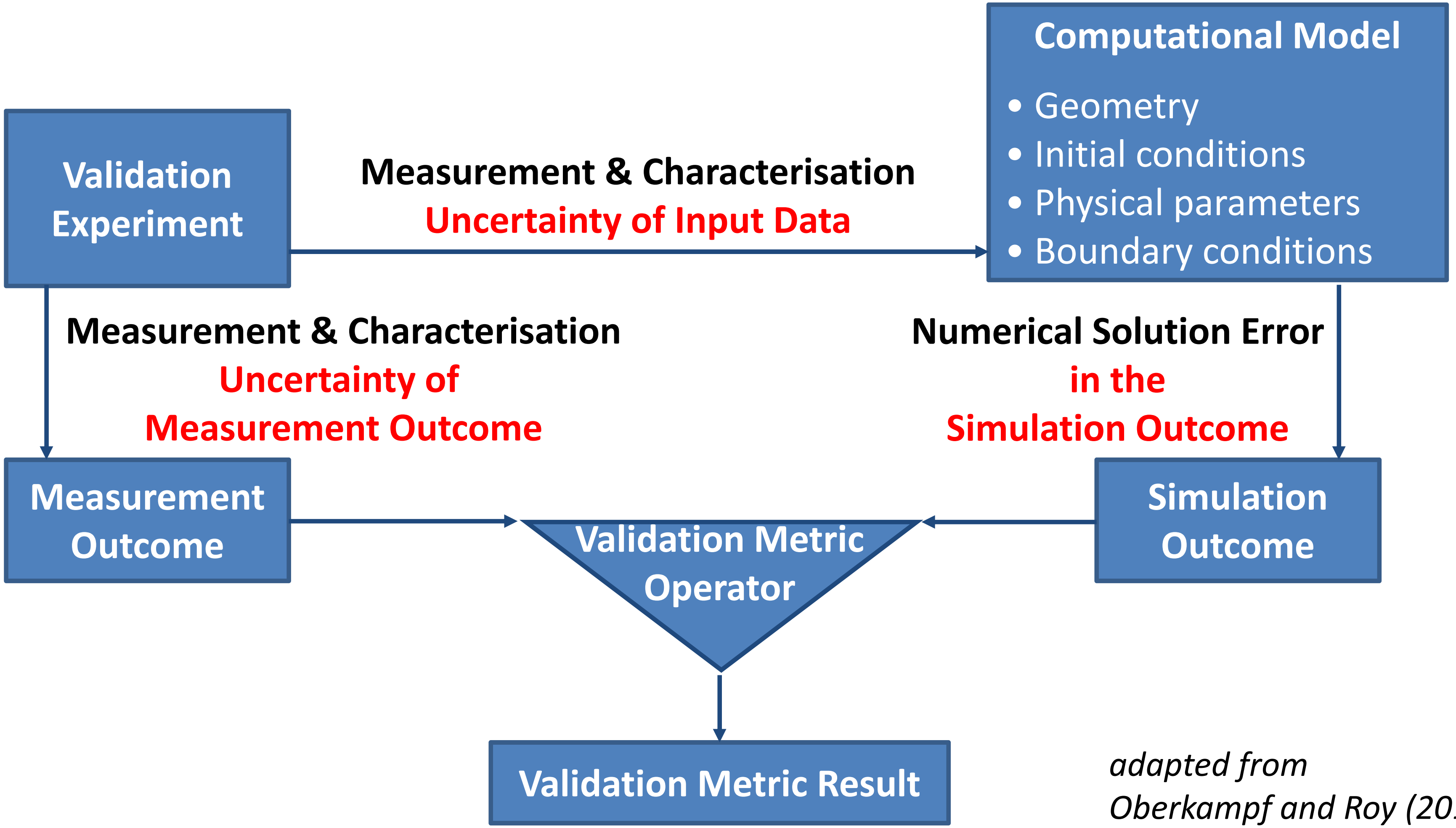


Total Effective Dose Equivalent (in mSv) resulting from the atmospheric dispersion of a radiological threat agent (3 TBq of ^{137}Cs) as seen by a simple Gaussian model and by a Lagrangian Particle Dispersion Model taking the buildings into account

The results achieved today - I

The Background document is.....

• Addressing the uncertainties related to the application of modelling systems in emergency response framework



adapted from Oberkampf and Roy (2010)

The results achieved today - I

The Background document is.....

• Addressing the uncertainties related to the application of modelling systems in emergency response framework

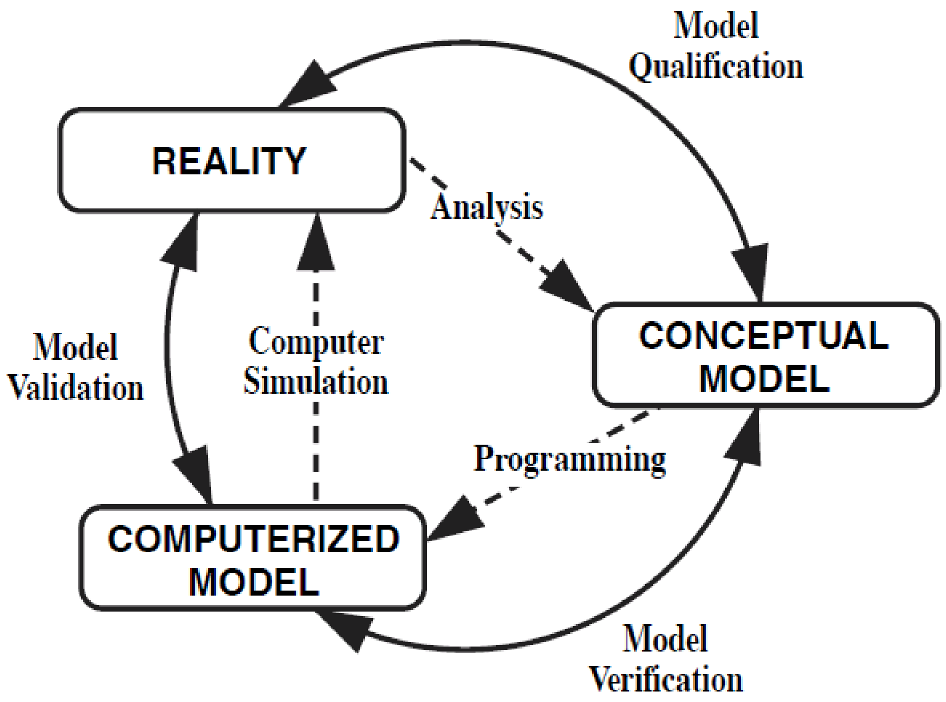
✓ Scientific review

✓ Assurance of correct coding (code verification)

✓ Comparison of model results with experimental data (validation)

✓ Uncertainty quantification for validation and prediction

✓ Operational evaluation



(Schlesinger, 1979)

The results achieved today - II

- **Database of measurements** available from experimental campaigns – *inventory elaborated*, *ongoing identification of useful ones for emergency response*
- **Inventory of emergency response tools and dispersion models** – *inventory elaborated*, *ongoing analysis on their appropriateness*
- **Package with validation metrics** – *development of an ad-hoc tool, ongoing application for the evaluation of air pollution models in emergency response tools*
- **End-users and stakeholders questionnaires** – *elaborated*, *ongoing analysis*
- **Model evaluation procedures** *for emergency response applications – under development*

Reports available on www.elizas.eu

The results achieved today - III

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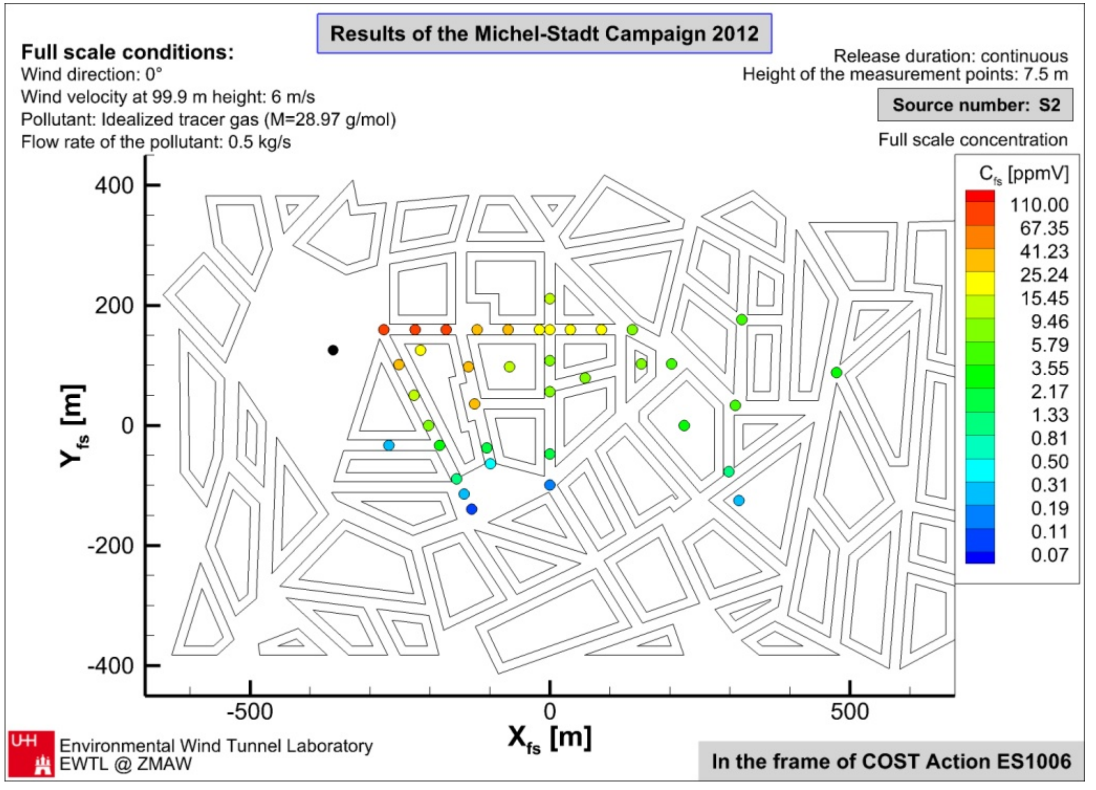
The Michelstadt exercise - Model intercomparison and validation



✓Data gathered during a wind-tunnel flow and dispersion experiment (Hamburg University) – several continuous/puff releases in different locations; **open** and **blind** tests

✓A typical European urban site is reproduced, designed to include potential inhomogeneities, characterising the neighbourhood-scale urban areas across Europe

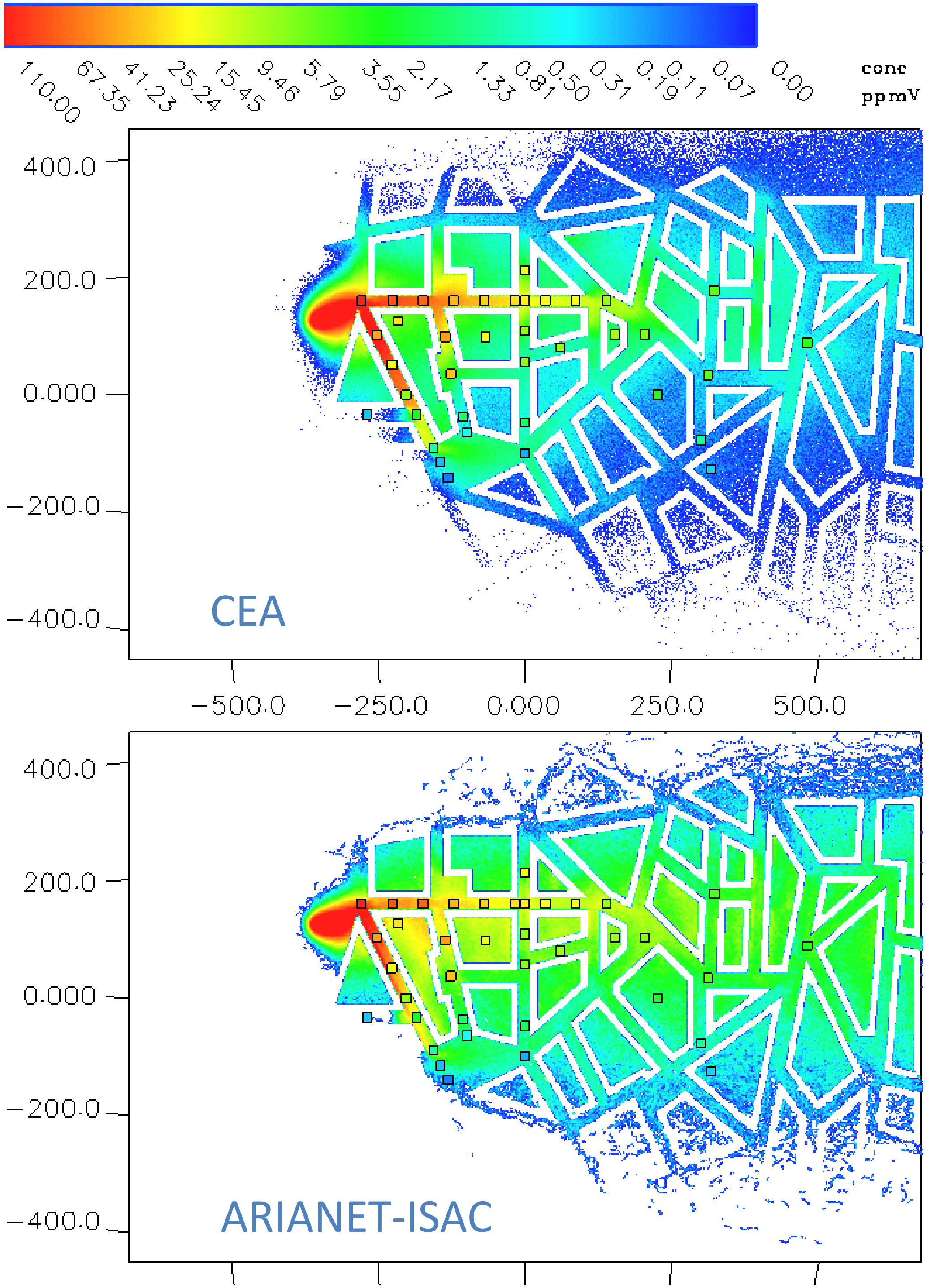
COST is supported by the EU RTD Framework Programme

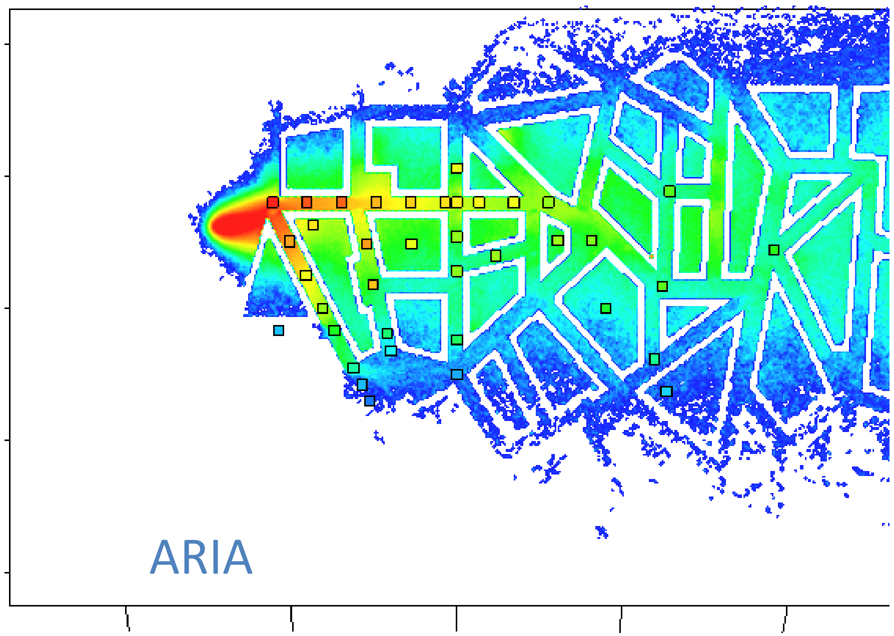
European Science Foundation
ESF provides the COST Office through an EC contract

Three configurations of two versions of the same model

Case S2 – PRELIMINARY TESTS

Concentrations maps at 7.5 m





Today's issues

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- **Quality assessment** of dispersion models used in emergency response systems at local scale requires **suitable**

✓ experimental data for validation,

✓ validation metrics,

✓ methods for the transfer of validation results to predictions.

- **Quality assurance protocol** of dispersion models used in emergency response systems at local scale should

✓ be general to be used for all 3 phases of emergency response:

(1) preparedness (2) response (3) analysis and recovery phase

✓ reflect the uncertainty in dispersion predictions,

✓ be widely accepted by creators and users of simulation results.

Tomorrow's outputs

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- **Results from open and blind Michelstadt case studies**

model intercomparison and evaluation with the application of the data-comparison and statistical tool

- **The catalogue of Threats and Challenges**

a catalogue characterizing and documenting typical and relevant local-scale threats from releases of toxics in populated areas

- **The Best Practice Guideline**

a document providing guidance in how to apply emergency response dispersion models in order to lower the unavoidable uncertainty in simulation results

- **Selection of a real field case study and model evaluation**

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And now... Action!