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INNOVATIVE WEB VISUALIZATION OF VERY LARGE CALCULATIONS

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Abstract: Modelling as a support decision tool in crisis management requires high-resolution calculations on very large urban domains. Usability of modelling requires also the capability to convert this large amount of data into fast and easy to understand visualizations, especially for non-expert users. First person views of ground concentrations produced by the model and in a realistic environment could greatly help first responder to make use of modelling results. The Street View Service provided by Google makes available large amount of realistic first person views of cities, both outside and inside buildings. By creating overlays of ground concentration images over Street View Service, first person views of concentration fields were derived. This approach was applied on the very large calculations performed during the EMERGENCIES projects and made it possible to produce realistic first person views incorporating modelling results.

Key words: *very large calculations, crisis management, urban modelling, Street View, innovative web visualization.*

INTRODUCTION

Usage of more complex atmospheric dispersion models (ADMs) for decision-making (Leitl et al. 2014) is increasing due to integration of parallel algorithm in models (Oldrini et al. 2017a) and to availability of parallel computing power. Such models are usually deployed for calculation in urban domains that require very fine grid steps. Nonetheless, responsibility areas of emergency units are usually quite large compared to traditional domain size for such models. Hence the model calculations usually lead to very large numerical results that are difficult to explore. This is especially true for emergency teams that require visualizations rapidly and with high usability, especially for a non-expert user.

Web approaches relying on tiled pyramidal images, introduced in Google Map, make possible fast visualizations for large emergency calculations (Oldrini et al. 2017b). This approach was tested on very large calculations performed in EMERGENCIES and EMERGENCIES-Mediterranean (EMED) projects.

In this paper we focus on the introduction of higher level of visualizations for better usability by first responders and emergency team within crisis center. This includes visualization of concentration maps in so-called StreetView (SV) mode introduced in Google Map. With this visualization, we were able to present views of concentration map in a first person view, and for calculation performed either within streets or inside public buildings.

After introducing the EMERGENCIES calculations, we will present the approach used to perform SV visualizations and then the test results obtained using the EMERGENCIES calculation.

APPLICATION CASE

The EMERGENCIES projects are a set of projects performed to demonstrate the capability of modelling as a support tool for crisis management. The modelling exercises consist in the transport and dispersion of fictitious CBRN-E releases on gigantic urban areas.

The first EMERGENCIES project (Oldrini et al. 2016) modelled the Great Paris area. This domain is the responsibility area of Paris Fire Brigade. The size of modelling domain is 40 by 40km with a resolution of 3m. Calculations were performed on CCRT (*Centre de Calcul Recherche et Technologie*), the French Atomic and alternative Energies Commission (CEA) intensive cluster, using from 1,000 to 30,000 computational cores.

Modelling was realized considering three hypothetical CBRN-E releases near, or inside, public buildings in Paris centre area: a museum, a train station and an administrative building. Three nested domains were defined around these buildings, modelling both the inside and the outside at 1m resolution. The 40 by 40km grid has a 3m resolution and is split in 1,088 sub domains, computed in parallel. Meteorology is computed using forecasts on a 24h basis.

The second project EMERGENCIES, EMED – Emergencies MEDiterranean sea (Armand et al. 2017), was performed on a domain encompassing “Provence, Alps & French Riviera” region (a large part of the French Mediterranean coast) at a 1-km resolution with zooms in on the largest cities of this region (Marseille, Toulon and Nice) at 3-m resolution. The size of the inner domains peaked at 58 x 50 km (Marseille domain). Up to three gaseous or particulate tracer were fictitiously released from different locations in the cities for 20 minutes. Plumes transport and dispersion were computed for 5 to 6 hours.

Both projects EMERGENCIES were labelled “Grand Challenge” by the CEA. Figure 1 displays an overview of the Great Paris and Marseille 3D domains, including the buildings.

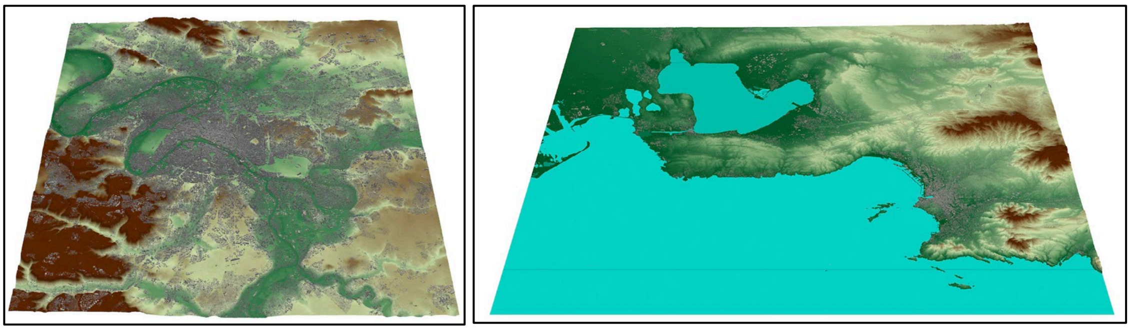

Figure 1, 3D view of topography and buildings for the Great Paris (left hand side) and Marseille (right hand side) domains

APPROACH

SV was introduced by Google and allows the display first person views in streets and within buildings (Google Street View Service). It makes use of the plate carrée projection, known also as the geographic projection, because of it straightforward relation between pixel coordinates and latitude and longitude on the projection sphere around the point of view (PoV). Views are stored in panoramic pictures using plate carrée projection and are available for multiple locations worldwide, both outside but also inside of buildings. An example of such an image is displayed in Figure 2.

Figure 2, Panoramic view of the inside of the Grand Palais building, used in EMERGENCIES. The view relies on plate carrée projection

To overlay concentration results over SV, a dynamical overlay approach was chosen: for each and every pixel of the view, we search for the intersection of the ground picture of the concentration field with the ray coming from the PoV and going through the pixel. The colour of the pixel is given by the colour of the intersection.

In a more detailed way, the algorithm consists in:

- Create an overlay over SV,
- Compute the parameters of the view,
- For each pixel P of the view:
    - Find the location in the 3D space of P,
    - Compute the intersection M of the line (PoV,P) and the concentration image plane,
    - Find the colour of M in the concentration image,
    - Colour P using the colour of M.

RESULTS

The above algorithm has been applied to calculations from EMERGENCIES. The example used the Grand Palais museum building in Paris. The building has been modelled using a nested domain at a 1m resolution, both inside and outside of the building. The Figure 3 displays an overview the building.

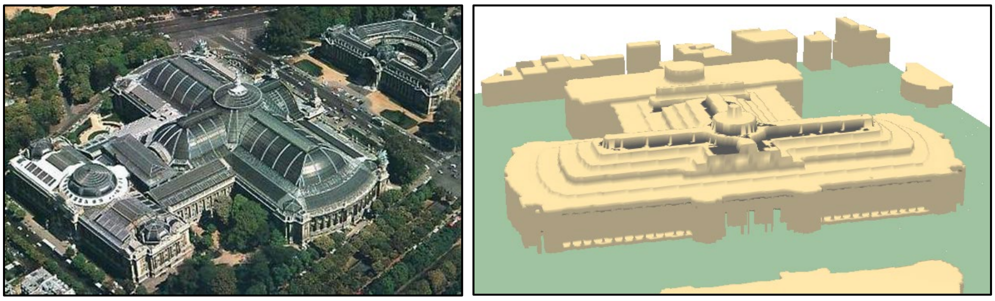

Figure 3, Grand Palais museum building (left hand side, seen from the south west), and its 1m resolution model (right hand side, seen from the east)

The fictitious release performed within the Grand Palais was used to test the SV overlay (SVO). Figure 4 Presents the ground concentration within the Grand Palais building some time after the release. Due to complex flow driven by the main and side entrances, the plume persisted in some vortices located in the largest room.

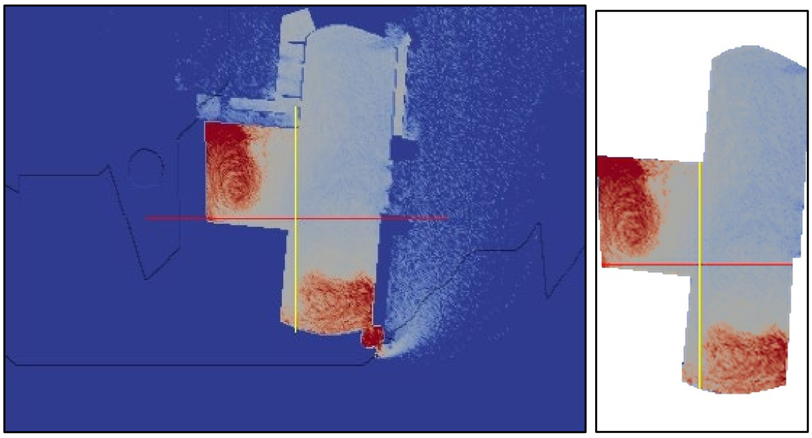

Figure 4, Ground concentration computed in the Grand Palais nested domain (left hand side) and close-up view of the largest room (right hand side). Concentrations are ranging from low values (blue) to large values (red)

The ground concentration image on the right hand side of Figure 4 was use to test SVO. Results are presented below on Figure 5. The SVO is displayed within the red square, the red and yellow line on the ground concentration picture helps to understand the orientation of the view..

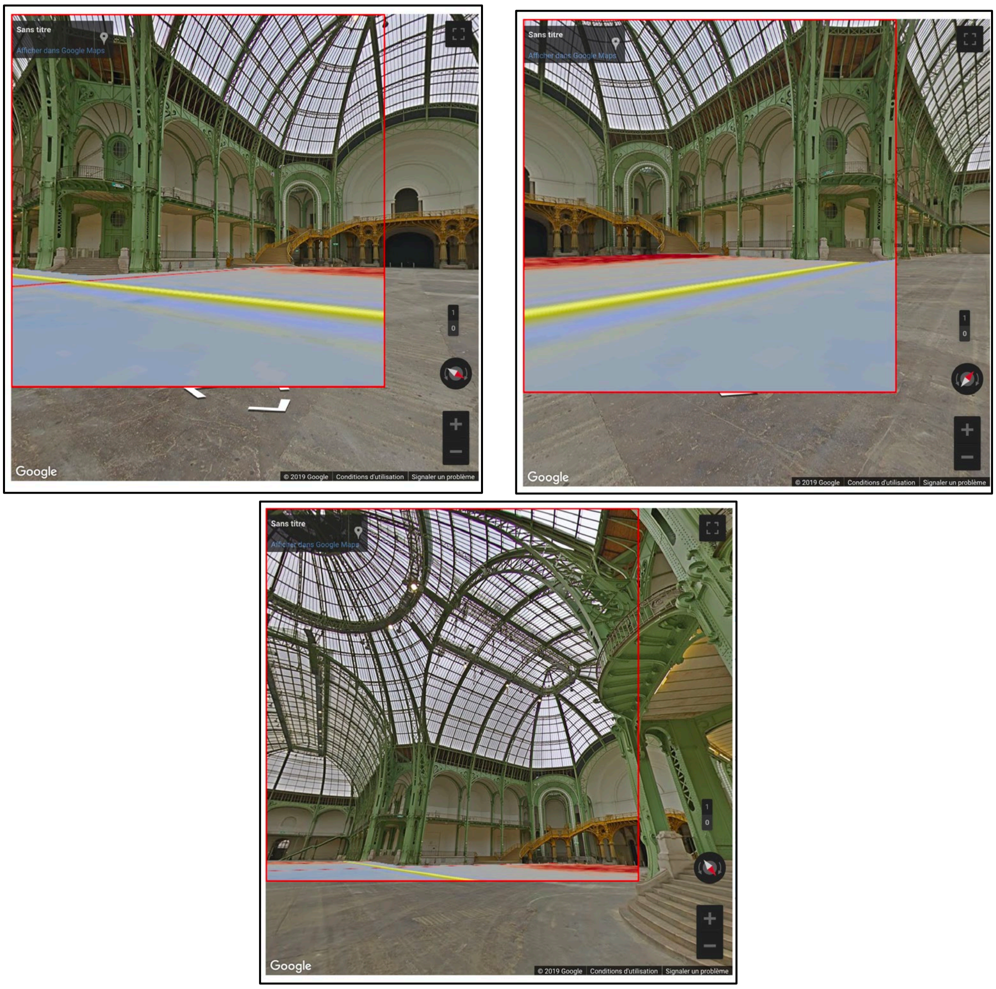

Figure 5, SVO of the ground concentration field due to fictitious release within the Grand Palais building, seen using various PoV

CONCLUSION

Usage of modelling as a support tool for crisis management requires visualization capabilities that enable non-expert users to have fast but meaningful views that help understand rapidly the impact on the field. An innovative web visualization was presented to allow for first person view of ground concentrations due to accidental or malevolent airborne releases. This first person view can be used outside but also inside of buildings. It relies on Google Street View by using an overlay of the view. The approach was applied to EMERGENCIES very large calculations and permitted to display ground concentration near the fictitious release location inside the Grand Palais museum building.

We expect this kind of approach to be a first step towards immersive display of transport and dispersion modelling as a support tool for crisis management.

REFERENCES

Armand, P., C. Duchenne, O. Oldrini and S. Perdriel, 2017: Emergencies Mediterranean – A Prospective High Resolution Modelling and Decision-Support System in Case of Adverse Atmospheric Releases Applied to the French Mediterranean Coast. 18th Int. Conf. on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Harmo'18, October 9-12, 2017, Bologna, Italy.

Google Street View Service: https://developers.google.com/maps/documentation/javascript/streetview

Leitl, B., Castelli, S. T., Baumann-Stanzer, K., Reisin, T. G., Barmpas, P., Balczo, M., ... & Milliez, M., 2014. Evaluation of Air Pollution Models for Their Use in Emergency Response Tools in Built Environments: The 'Michelstadt'Case Study in COST ES1006 ACTION. *Air Pollution Modeling and its Application XXIII* (pp. 395-399). Springer International Publishing.

Oldrini, O., P. Armand, C. Duchenne, C. Olry and G. Tinarelli, 2017a: Description and preliminary validation of the PMSS fast response parallel atmospheric flow and dispersion solver in complex built-up areas. *J. of Environmental Fluid Mechanics*, Vol. 17, No. 3, 1-18.

Oldrini, O., S. Perdriel, P. Armand and C. Duchenne, 2017b: Web visualization of atmospheric dispersion modelling applied to very large calculations. 18th Int. Conf. on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Harmo'18, October 9-12, 2017, Bologne, Italy.

Oldrini, O., S. Perdriel, M. Nibart, P. Armand, C. Duchenne and J. Moussafir, 2016: EMERGENCIES – A modelling and decision-support project for the Great Paris in case of an accidental or malicious CBRN-E dispersion. 17th Int. Conf. on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Harmo'17, May 9-12, 2016, Budapest, Hungary.