

A multi-approach to study and communicate on the effect of highway infrastructures on the dispersion of traffic-related air pollutants.



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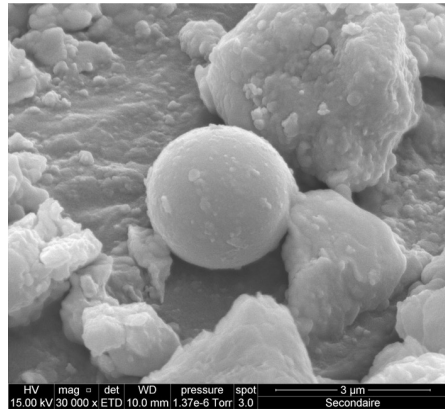
The beginning of the story: a public concern about a potential deterioration of air quality.



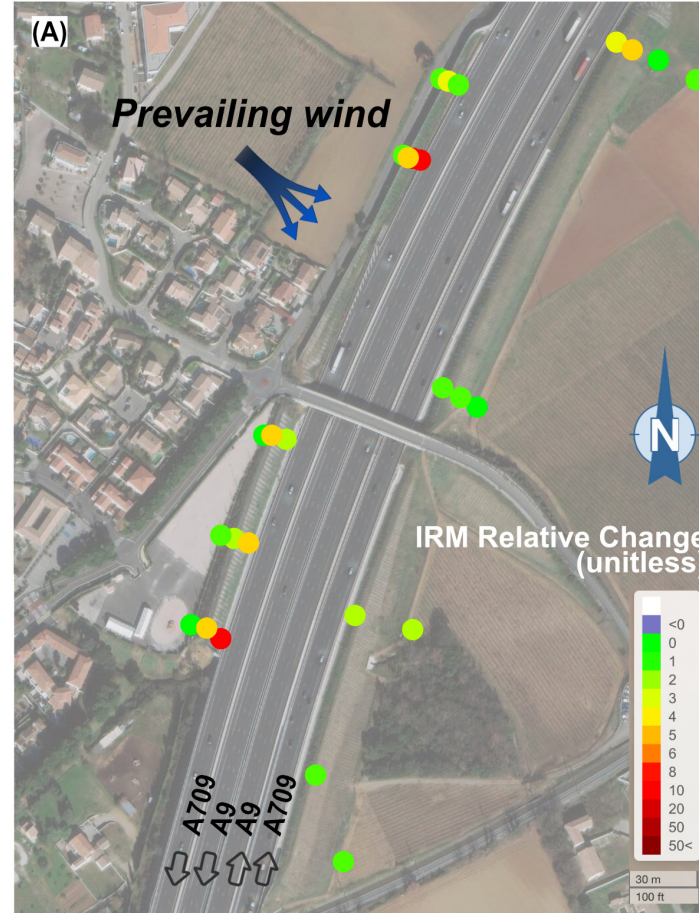
modified from
Google Earth (2022)

The challenge was to work with and for the citizens on a complex problem involving the understanding of turbulence in the ABL.

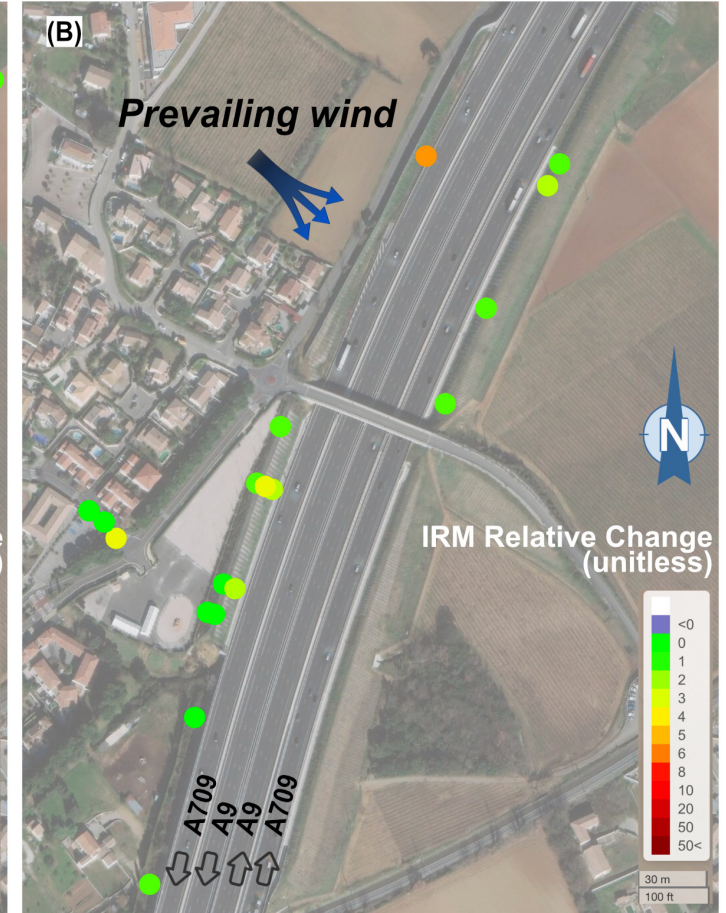
First implemented tool: a citizen mapping of dust deposition on accumulative surfaces.



Artificial filters



Cercis Siliquastrum leaves

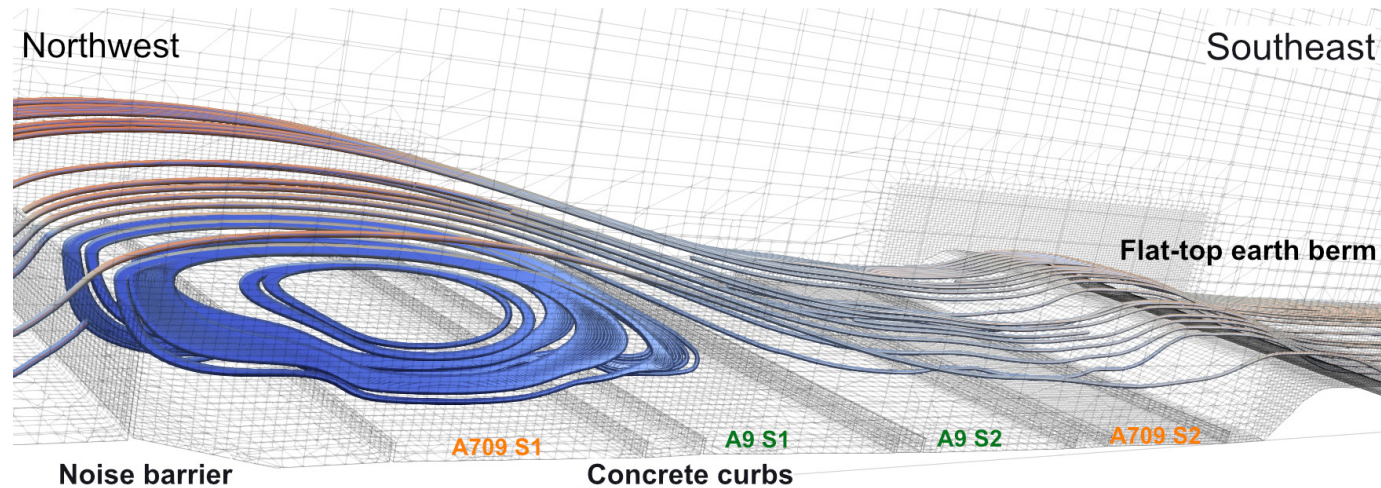


Letaïef et al., *Atmosphere*, 2020.

The result

was counterintuitive for the citizens, as maximum concentrations are downwind of the noise barrier, and minimum concentrations are downwind of the traffic lanes.

A simplistic CFD modelling by means of RANS turbulence simulation with k- ϵ closure supports the results.



OpenFOAM simulation.

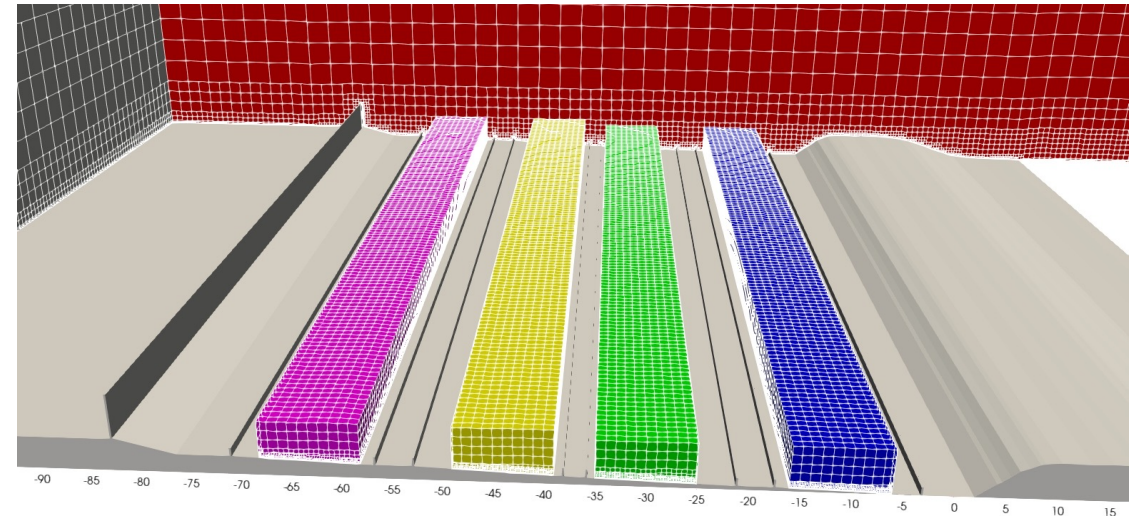
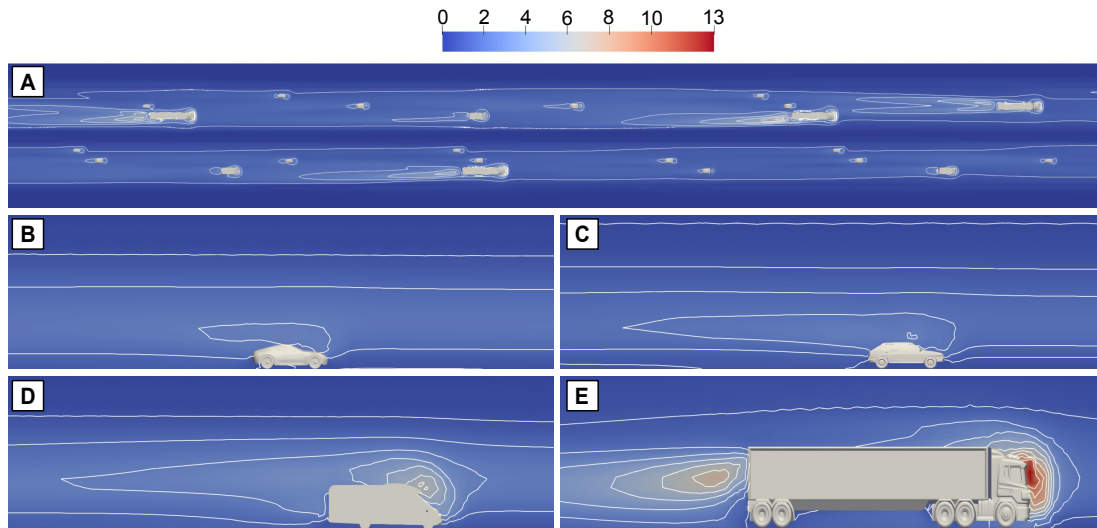
The challenge was then to include in the modelling the traffic ~ 120 000 veh/day.

The key to including the actual traffic flow was to build a precursor model ([Atkins CH2M JV technical report, 2019](#)).

The CFD domain for 2 carriageways (6 lanes) includes :

- * stationary vehicles
- * periodic inlet and outlet boundaries directing air at 90 km/h through the domain.

We extracted the **VIT** and **VIM** volume-averaged values.

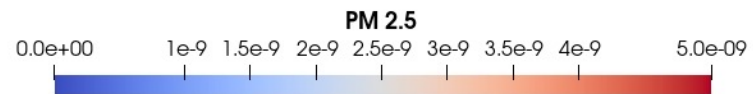
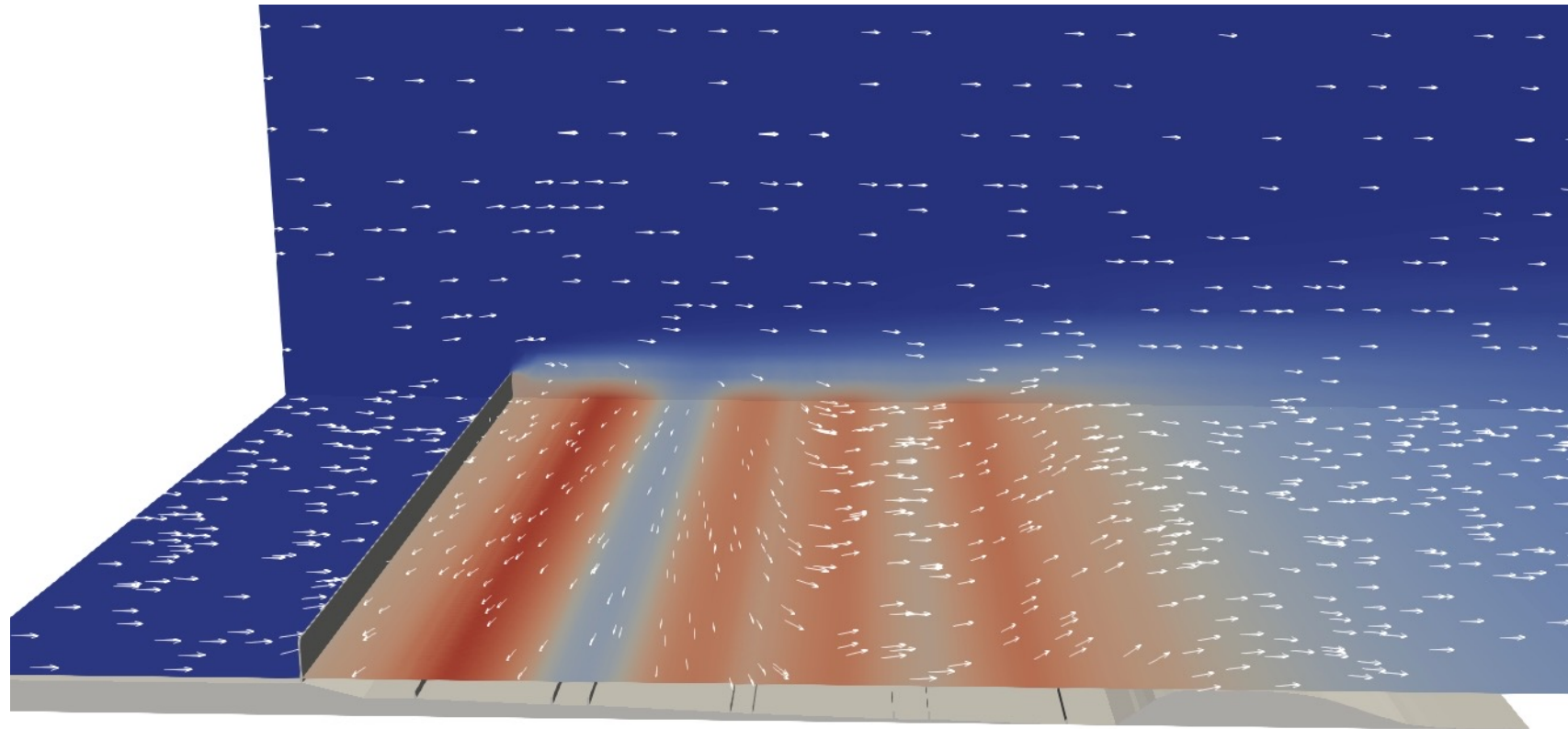


[Letaïef et al., Atmosphere, 2020.](#)
[Source codes @zenodo](#)

VIT and VIM

values were subsequently used as source terms in traffic carriageway volumes for each of the CFD model scenarios for inlet airflow.

Second implemented tool: a CFD modelling of the pollutant dispersion (advection – diffusion) taking into account the actual traffic flow



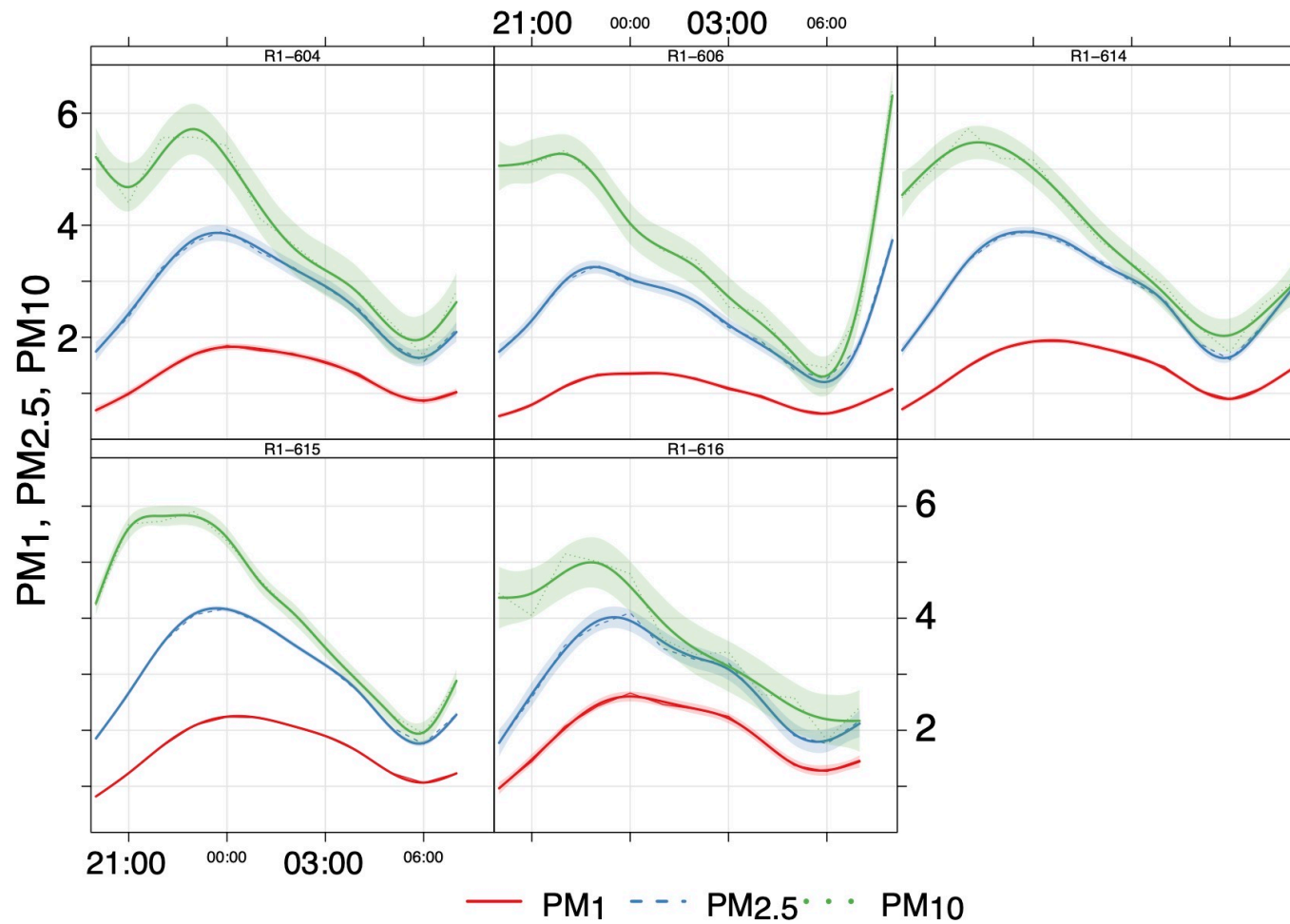
Letaïef et al., Atmosphere, 2020.

Third implemented tool: low-cost PM μ -sensors (Alphasense R1 Optical Particle Counters) campaign.



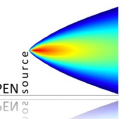
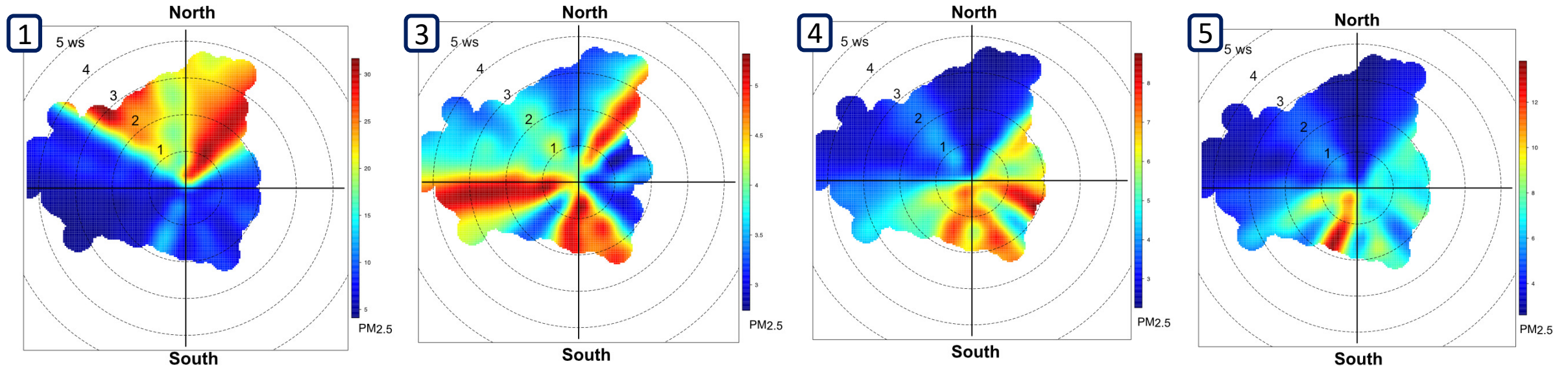
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low-cost PM μ -sensors (Alphasense R1 Optical Particle Counters) campaign.



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1-week Overall patterns of PM_{2.5} with Non-parametric Wind Regression approach (Henry et al. 2009)



Fourth implemented tool:

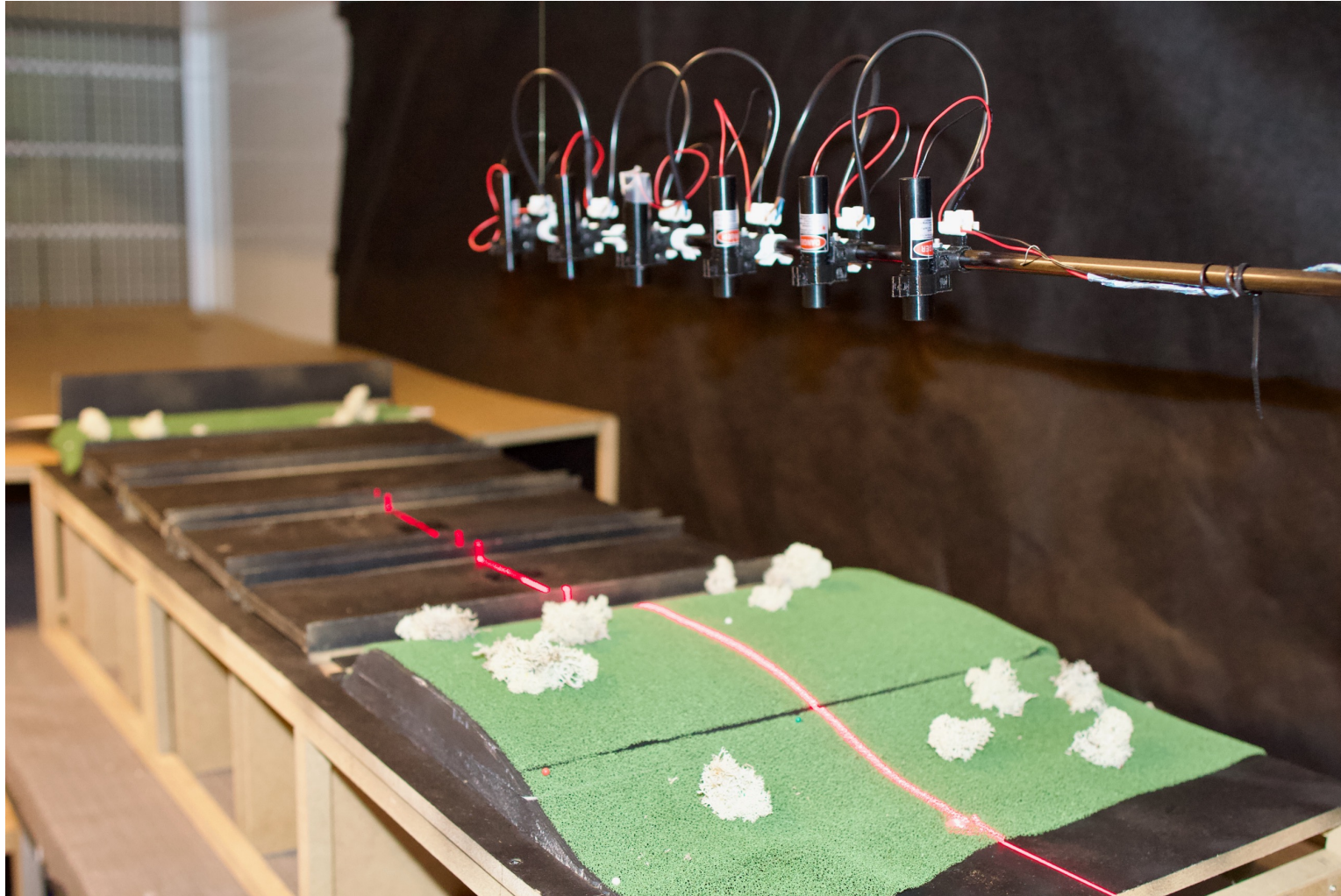
visualizing the microturbulence from a 1/100 scale model of the motorway cross-section in a wind tunnel



The challenge was double: fix the wind velocity profile with the elevation (log-law type) “similar” to the one in CFD model.
& take photos in difficult light conditions.

Fourth implemented tool:

visualizing the microturbulence from a 1/100 scale model of the motorway cross-section in a wind tunnel

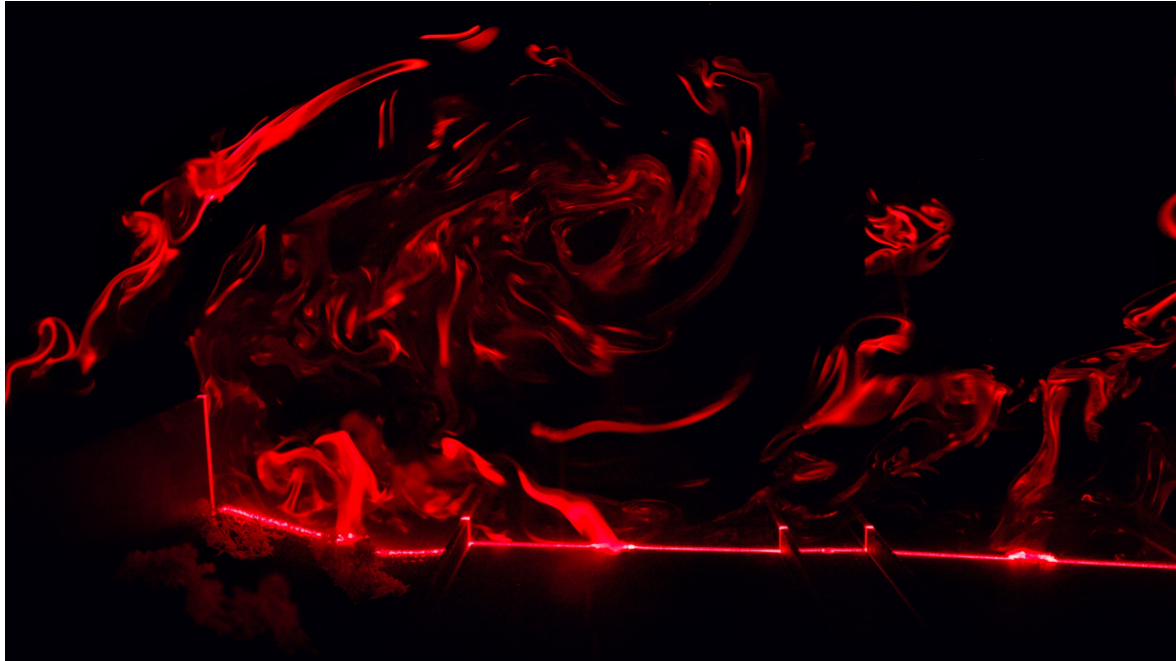


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Fourth implemented tool:

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Wind direction



Wind speed = ~ 0.08 m/s
 28.8 km/h

Wind direction

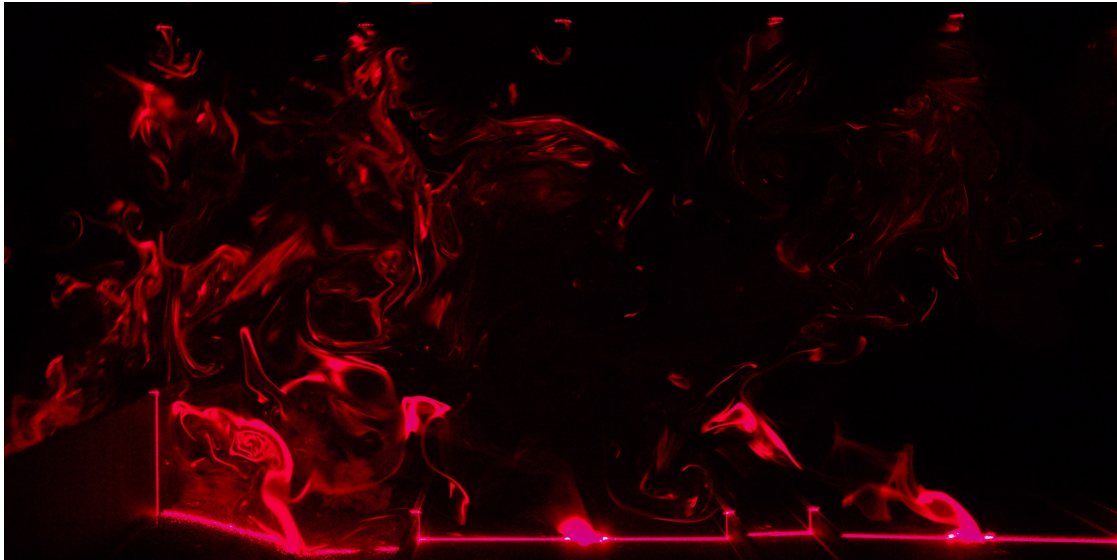


Wind speed = ~ 0.05 m/s
 18.0 km/h

Fourth implemented tool:

visualizing the microturbulence from a 1/100 scale model of the motorway cross-section in a wind tunnel

Wind direction



Wind speed = 0.16 m/s
~ 57.6 km/h

Wind direction



Wind speed = 0.20 m/s
~ 72 km/h

What to take home: Surveys related to turbulence in the ABL are well-suited for Citizen Sciences
... provided that experiments and communication media are well thought before.

