

CT4 MICROSCALE MODELING

*Status of the inter-comparison exercise
and next steps*

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CT4 activities: Context and aims

1. Microscale modelling is restricted here to applications in the context of the air quality directives (AAQD)
2. In this context, results of these models are only useful if they can be aggregated to the temporal and spatial scales of interest for the AAQD
3. The CT4 work and in particular the inter-comparison exercise of methodologies for deriving annual statistics (using microscale modelling) aims at comparing and identifying best practices

2020 - 2021 activities

- CT4 Microscale Modeling was endorsed in FAIRMODE Plenary Meeting, Berlin, Feb 2020.
- During 2020 summer, groups interested in microscale modeling were consulted to collect more detailed information about:
 - how the microscale modelers are dealing with the derivation of annual statistics from microscale simulations.
 - the interest of intercomparison exercise among the different methodologies.
- An CT4 session during the FAIRMODE Technical Meeting (October 2nd, 2020)
- Hackathon for preparation of an Intercomparison Exercise (December, 11, 2020)

Scope of CT4 session in FTM

- To discuss the computation of annual averages of concentrations (or other indicators) using microscale modeling
- To give the opportunity to the different groups to show their methodologies in more detail.
- To discuss the interest to carry out an intercomparison exercise (IE).
- In case of yes, how to design the IE

Presentations of the participants CT4-FTM

- 7 presentations from: *Aveiro University, University of West Macedonia (UOWM), Széchenyi István University (SZE), ENEA, RICARDO, VITO and CIEMAT.*
- Many are using CFD models (RANS mostly) but there are also other type of models (parametric, lagrangian, etc).
- Different methods for computing annual indicators of pollutant concentrations.
 - Methods based on simulating a set of selected scenarios (wind scenarios and/or emission scenarios) and then a postprocessing (PDF of scenarios, rebuilding a entire year, etc) of model results for retrieving annual indicators.
 - Methods based on simulating the complete year, which is mostly for the case of no CFD models but SZE university runs CFD models for one year.
- Mostly no chemistry (non-reactive pollutants) or simplified chemistry. Post-process correction is performed NO₂/NO_x in some cases.

Questions for discussion. CT4-FTM

1. Do you use microscale modeling to estimate AQD indicators?



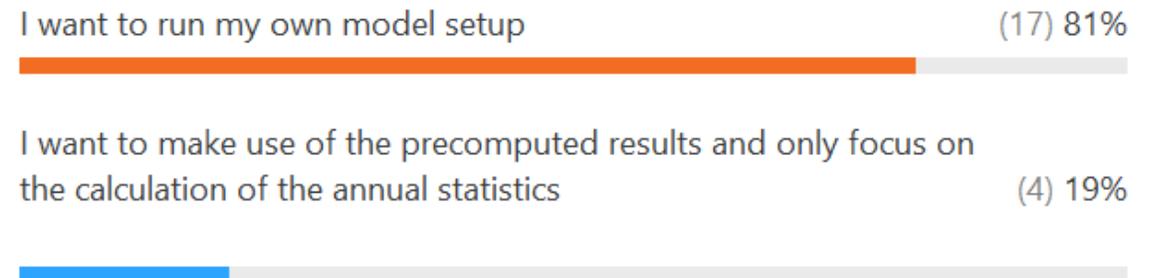
2. If yes, which AQD indicators do you estimate?



3. Are you interested in participating in an intercomparison exercise?



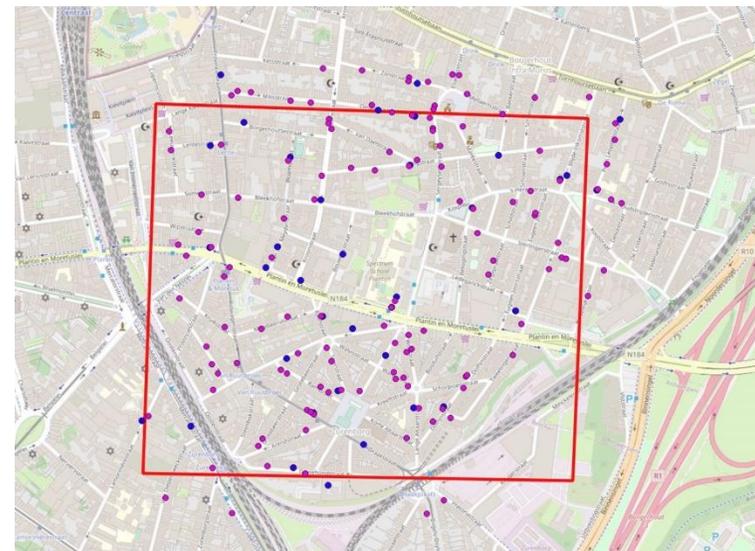
4. How do you prefer to participate?:



Case/domain/city?

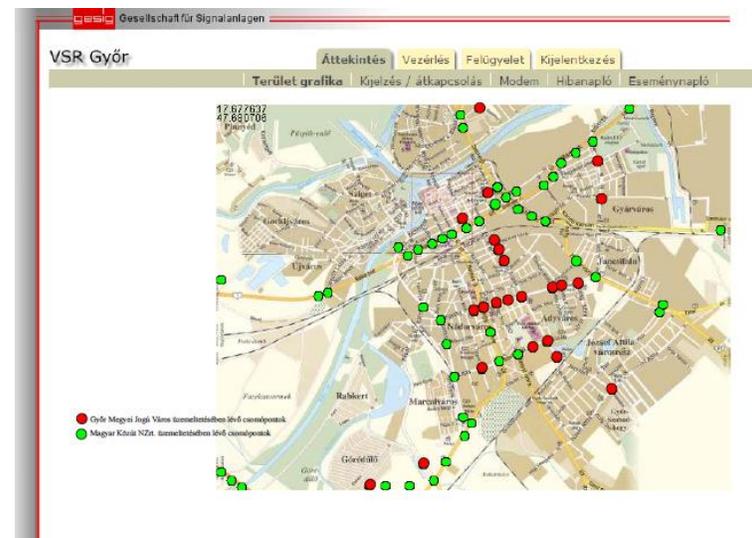
1. Antwerp (Belgium). Area around a traffic station.

- Used in a FAIRMODE spatial representativeness intercomparison exercise in 2016.
- Urban morphology,
- Emission data,
- Meteorological data and air quality data including data from passive NO2 samplers from two citizen science campaigns (VITO),
- NO2 and PM10 CFD simulations for 16 scenarios corresponding to 16 wind sectors (CIEMAT).



2. Győr (Hungary)

- Proposed by Zoltán Horváth (SZE).
- Data from meteorological stations, AQ microsensors and AQ stations
- Real-time emission data for traffic.
- CFD model simulations for the entire year (but need several months of computing)



Questions for discussion. CT4-FTM

- What would be needed for each group for simulations and to retrieve the annual statistic/indicator?
- How can we validate the approaches? How to separate uncertainties: modelling and time averaging method contributions?

After a discussion in the FTM

it was decided that further details will be discussed in a hackathon

Scope of the CT4 Hackathon

- Selection of the city for simulations: Antwerp or Gyor.
 - Presentations of city candidates:
 - Stijn Janssen for Antwerp,
 - Zoltan Horvath for Gyor
- What data are needed by each participant group?
- Proposal of simulations and computations to discuss.
- Preliminary discussion on how to evaluate and carry out the statistical intercomparison of the model and methodological results.
 - Presentation of Kees Cuvelier about a visualization tool developed for other FAIRMODE CT.
 - Presentation of Philippe Thunis about Model Evaluation in CT4 activities.

Selection of pilot city. CT4 Hackathon

- The Intercomparison exercise would be **firstly focus on the Antwerp case**. We would leave for later (2022) to repeat the work for Gyor.
- It is planned to work on **the 2016 campaign**, which is most focused on Antwerp (denser sampling data), while the 2018 campaign extended to all of Flanders
- A **similar domain would be used for all the groups**, but each group could decide the model domain and resolution of their simulations and computations. To be discussed if a final common grid for everyone is required.
- **The work would be done for NO₂**, but it would be possible to extend it to PM₁₀ or PM_{2.5} in possible future extensions of the exercise.

Proposal of simulations. CT4 Hackathon

1. **To simulate a very few selected hours in the year 2016.** Good for comparing only modelling results before applying the annual indicators methodologies. The selected hours will be specific peak hours, off-peak hours, day and night, etc...
 - The model results can be compared with AQ stations data.
 - Models results can be intercompared.

Proposal of simulations. CT4 Hackathon

- 2. To compute averages and percentiles (concentration maps) for May 2016 applying the averaging methodologies of each group.** This is to validate and intercompare results from every methodology.
 - Comparison with passive samplers data
 - Intercomparison among models results

- 3. To compute averages and percentiles (concentration maps) for the complete year 2016 applying the methodologies of each group.** This is to intercompare results from every methodology.
 - Intercomparison among models results

Ways of participating in the exercise

Two ways:

- Running your own model and then applying your own methodology for computing long term concentration indicators (preferred option for most of the participants)
- Using the precomputed simulations of CIEMAT as starting point for the analysis

Data for the intercomparison exercise. CT4 Hackathon

Data for CFD simulations:

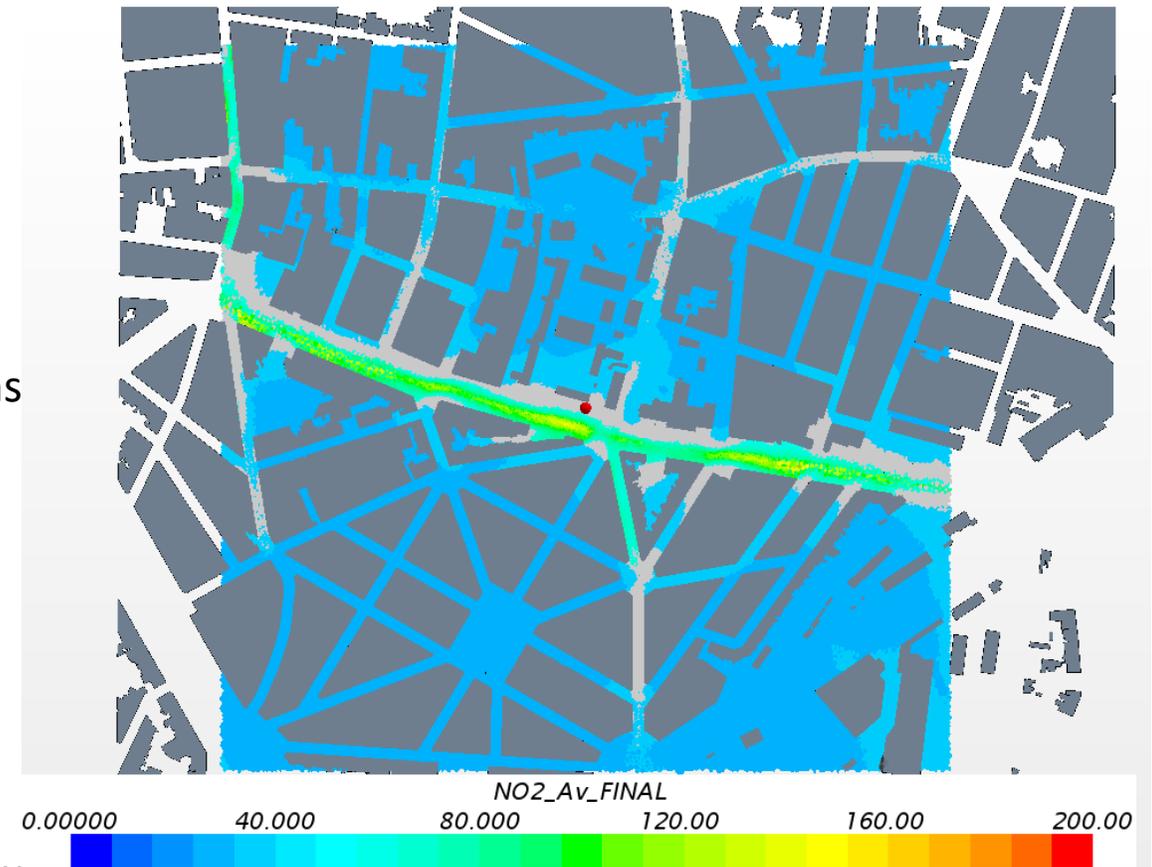
Data of city of Antwerp for 2016 campaign:

- Building information:
- Traffic Emissions: NO_x, NO₂, PM_{2.5} and PM₁₀, type vehicles/y, time profiles, etc
- Meteorological data: wind, temperature, humidity
- Hourly average observed concentration in two AQ stations O₃, NO₂, PM₁₀, PM₂₅, NO
- Large number of passive samplers (1 month). NO_x
- Background concentrations

Other data need for computing long-term concentrations indicators:

Precomputed CIEMAT CFD simulations:

- Simulations will be done in the next weeks.
- 16 concentrations maps (one per direction sector) for NO_x



Statistical intercomparison of the model and methodologies results. CT4 Hackathon

- Delta Benchmarking tool (developed by Kees Cuvelier for CT9) could be very useful for graphical comparison of the concentrations fields provided by the Intercomparison exercise
- Details about the statistical intercomparison of the results of each group will be discussed and defined in the coming months.

Timing

- Input data collection → February 2021
- Modeling simulations and methodology computations → March – June 2021
- Sending results → June 2021
- Statistical intercomparison → September 2021
- Discussion (hackathon?) → Technical Meeting October 2021?

Some flexibility in case of model simulations take longer time

- **INPUT DATA FOR ANTWERP 2016 ARE READY TO SEND**
- **PRECOMPUTED CFD SIMULATIONS FOR 2016 WILL BE DONE IN THE NEXT WEEKS AND SENT AS SOON AS POSSIBLE**

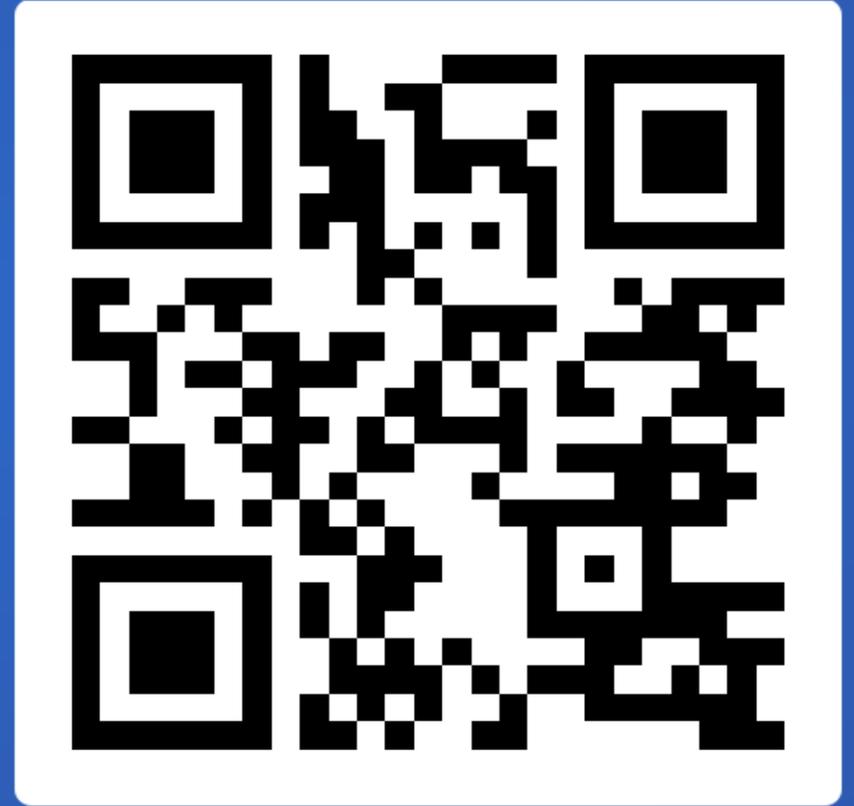
Support to the revision of EU rules on air quality and discussion

Are micro-scale models mature enough to:

- Assess the spatial representativeness of urban/traffic monitoring stations?
- Assess the exceedance situation indicators (area, population, road length in exceedance of the limit value)?
- Assess of the effectiveness of local mitigation measures to reduce exposure (solid barriers, vegetation, urban planning & design...)?

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Support to the revision of EU rules on air quality and discussion

Are micro-scale models mature enough to assess the spatial representativeness of urban/traffic monitoring stations?

- Yes
- No
- Yes but more guidance is needed

Support to the revision of EU rules on air quality and discussion

Are micro-scale models mature enough to assess exceedance indicators (area, population, road length in exceedance of the limit value)?

- Yes
- No
- Yes but more guidance is needed

Support to the revision of EU rules on air quality and discussion

Are micro-scale models mature enough to assess the effectiveness of local mitigation measures to reduce exposure (solid barriers, vegetation, urban planning & design...)?

- Yes
- No
- Yes but more guidance is needed