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17TH INTERNATIONAL CONFERENCE ON

Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes

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INTEGRATED URBAN AIR POLLUTION DISPERSION MODELLING FRAMEWORK AND APPLICATION IN AIR QUALITY PREDICTION OF THE CITY OF GYŐR

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Contents

1. Goals, objectives and methods of 3DAirQC
2. The 3DAirQC framework
3. The modules of 3DAirQC
4. Conclusions

Goals, objectives and methods of 3DAirQC

The goals of the project

- Develop an accurate, fast, modular, easy-to-deploy software framework for urban AQ prediction and urban traffic control

Main tasks: develop

- interfaces to data providers (meteorology, traffic services, authorities)
- 3D geometry model
- traffic model
- emission model
- CFD for dispersion
- validation
- traffic control framework
- cloud e-infrastructure to support the framework

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Goals, objectives and methods of 3DAirQC

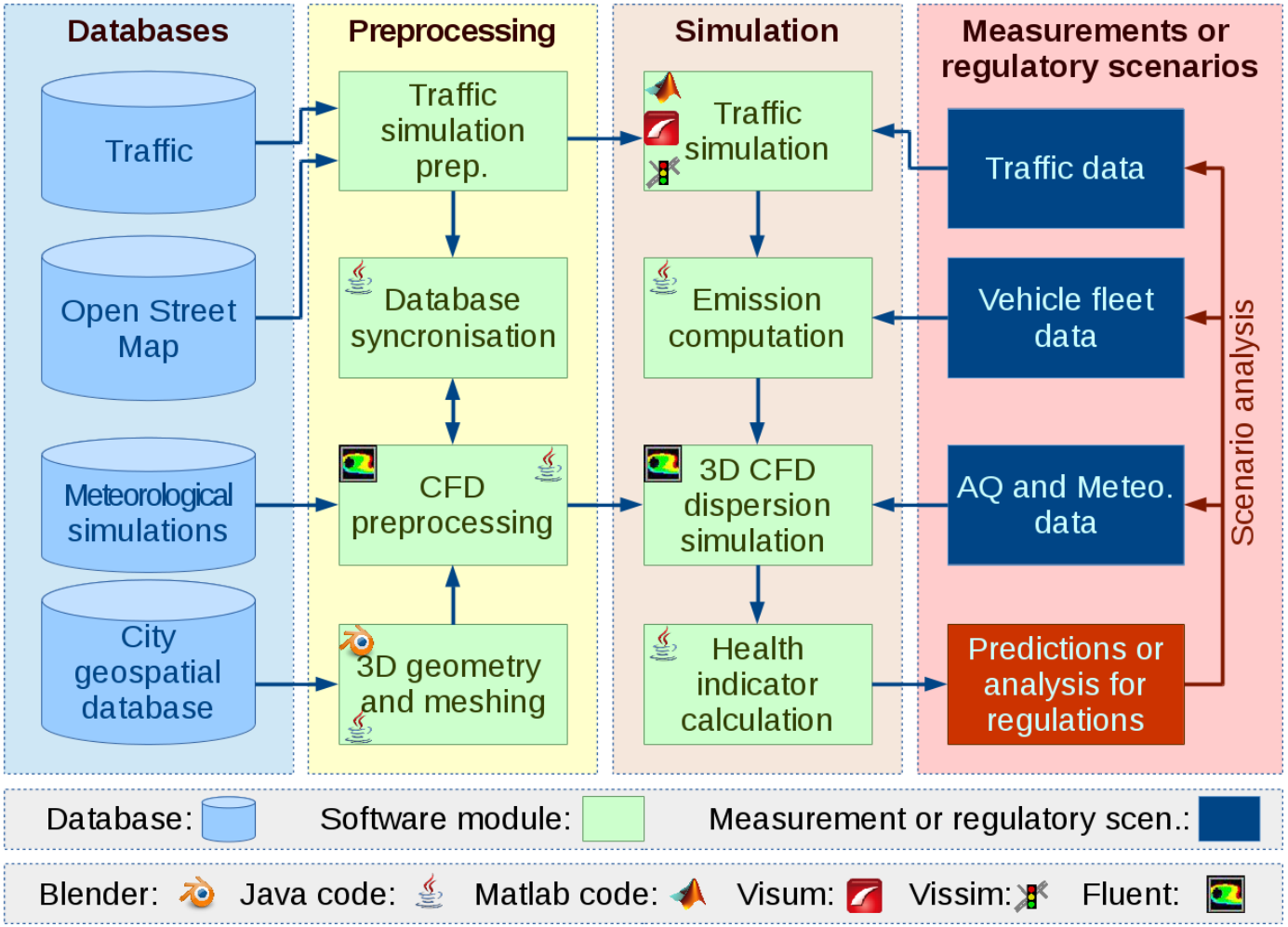
Methods

- Use best practices of the fields of the components
- Use standard forms (follow standardization guidelines)
- Implement all components from open source tools
- Use the most modern and effective maths and ICT methods and tools of the communities (EU-MATHS-IN, ETP4HPC, …)

- At this time: we apply the state-of-the-art engineering tools to establish benchmarking

Support from EU structural funds.

The 3DAirQC framework and its modules



Framework with usual AQ components

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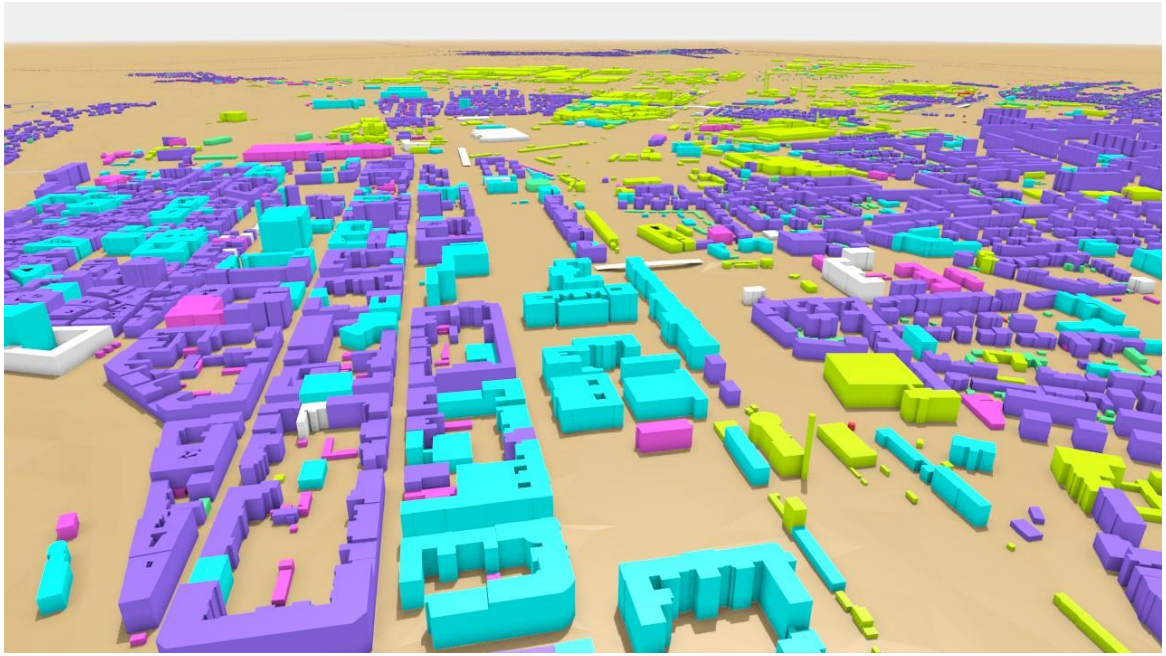
Preprocessing of the geometrical data: 3D geometry construction

3D from GIS database with Blender scripts

Application to Győr, Hungary (of 130.000 inhabitants with strong traffic)



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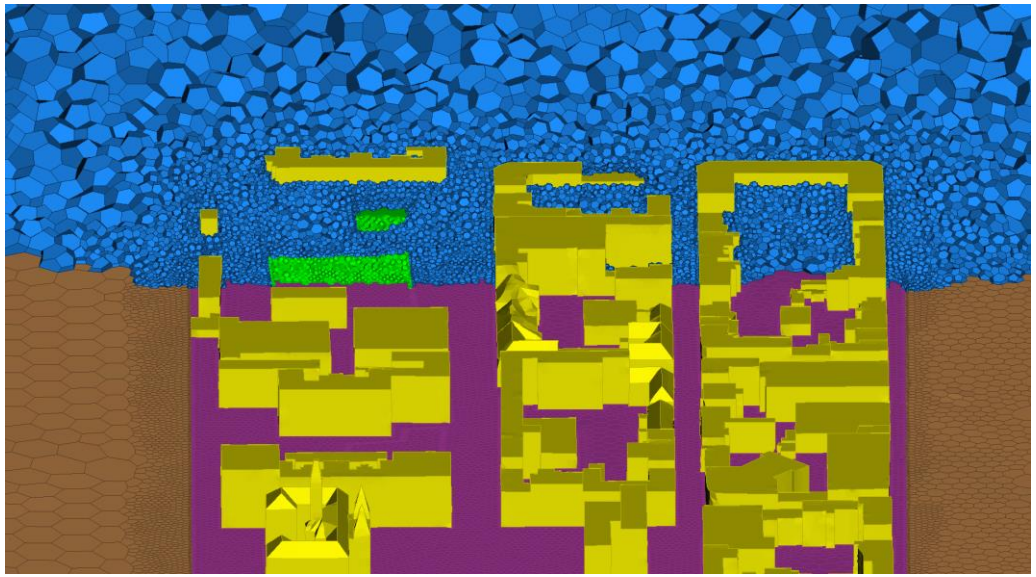
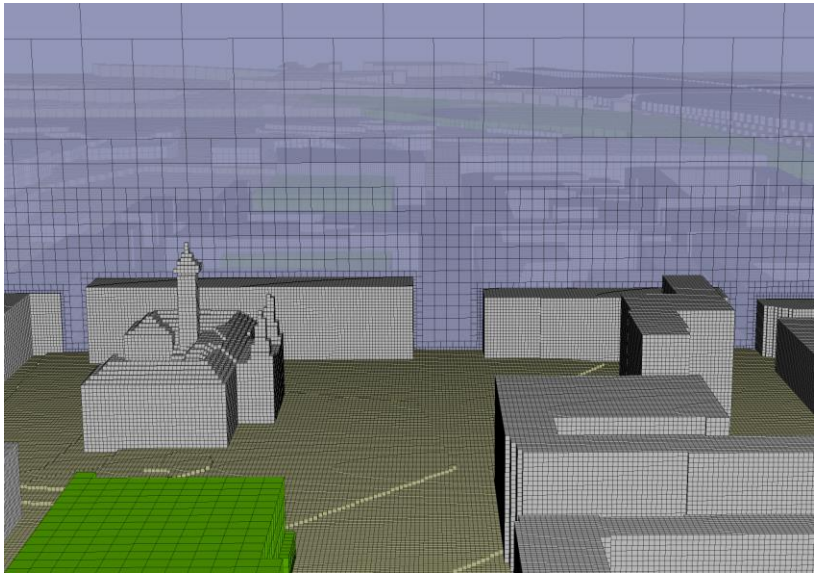
Preprocessing of the geometrical data: meshing

Meshing with ANSA, ANSYS and/or in-house parallel octree mesher

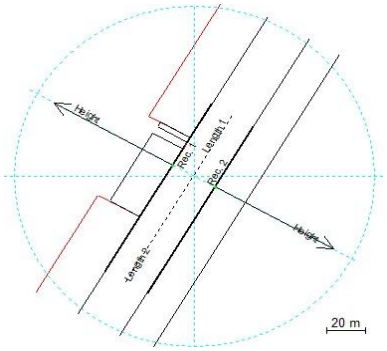


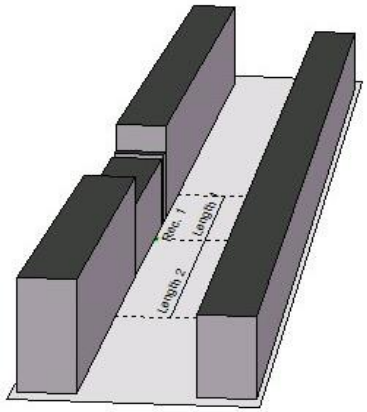


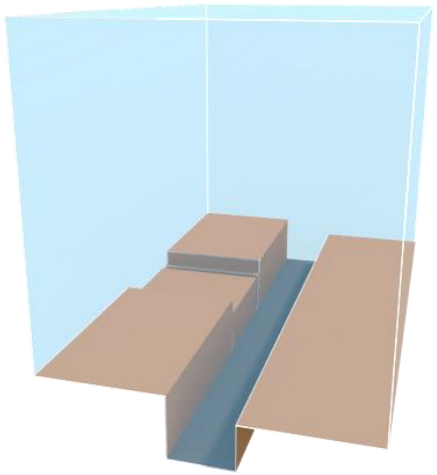
Preprocessing of the geometrical data: parametric 3D geometry and meshing by scripts (example)

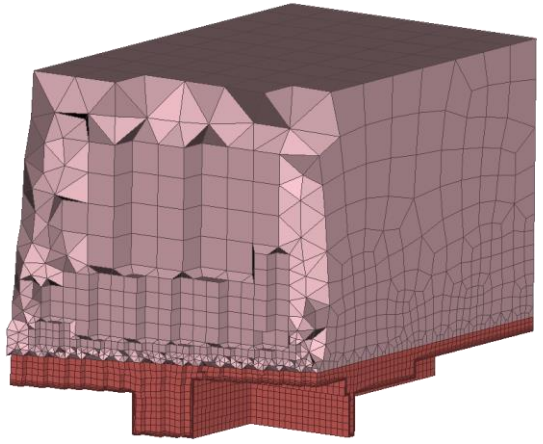
- 3D geometry from OSPM parametric geometry:
  - OSPM street configuration converted to 3D geometry by script using some additional parameters (for the 3D model size)
- CFD compatible mesh generated from 3D geometry

- Example: Jagtvej street example. Element number: 90,000 (tetra+hexa+penta+pyramid)

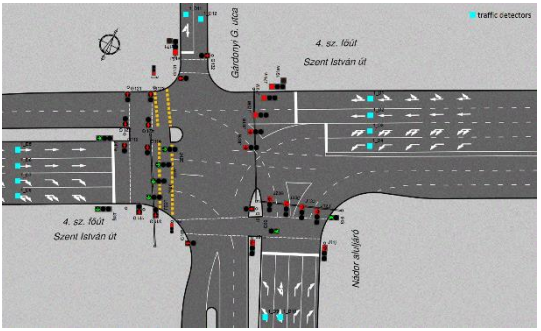






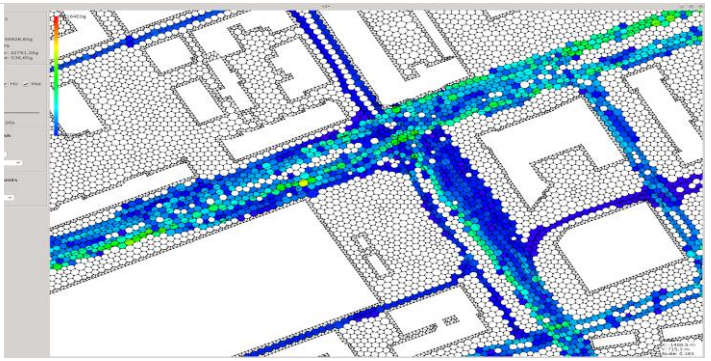


Preprocessing of the geometrical data: fitting the traffic geometry to the CFD mesh



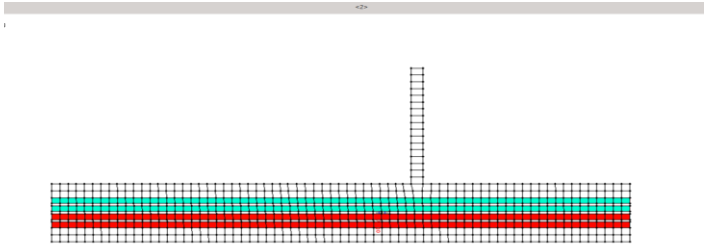
OpenStreetMap and the national road authority's format

Emission source location fit from traffic model to CFD mesh, calculated with in-house Java program

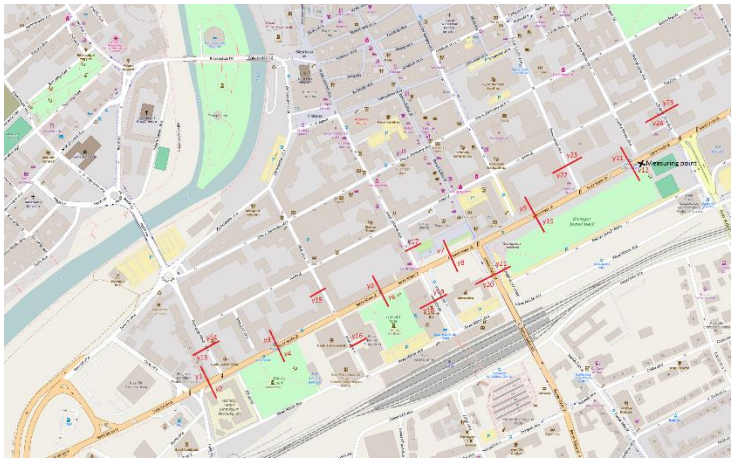


or

parametric
lanes defined by some measures (distances)



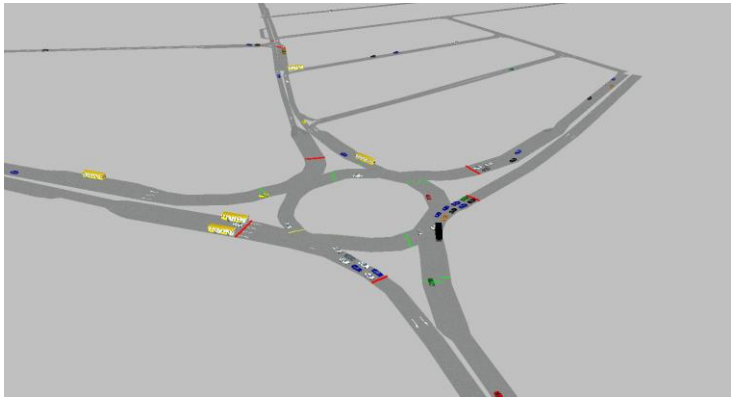
The traffic and emission modules



Traffic is modelled by PTV VISSIM based on calibrated historical data

or

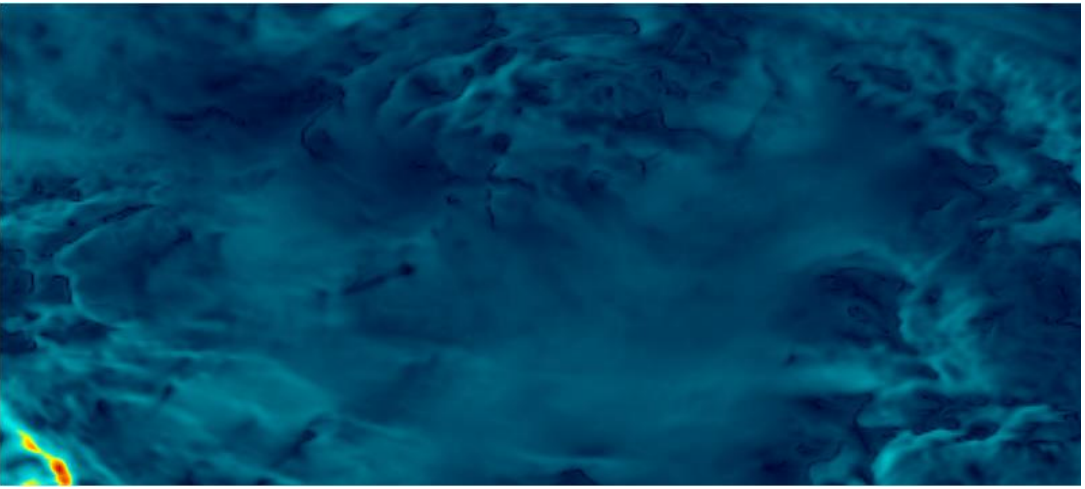
by interpolating measurements from operational road traffic data (at red sections on the figure)

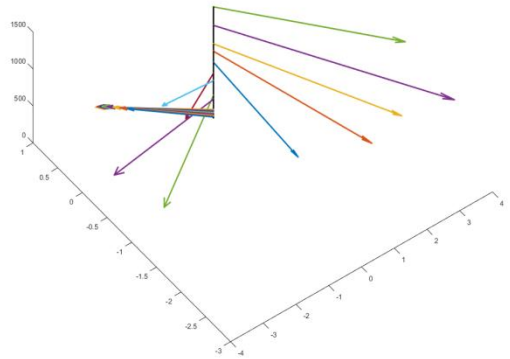


Emission model

Copert 4 implemented in Java based on regional fleet data

The meteorology modules





AROME model running by OMSZ (the Hungarian Meteorological Services) for the whole Carpathian basin

Resulting wind fields at different heights for the demonstration area, selected automatically

Boundary conditions from the AROME model for the demonstration area through netcdf files and scripts

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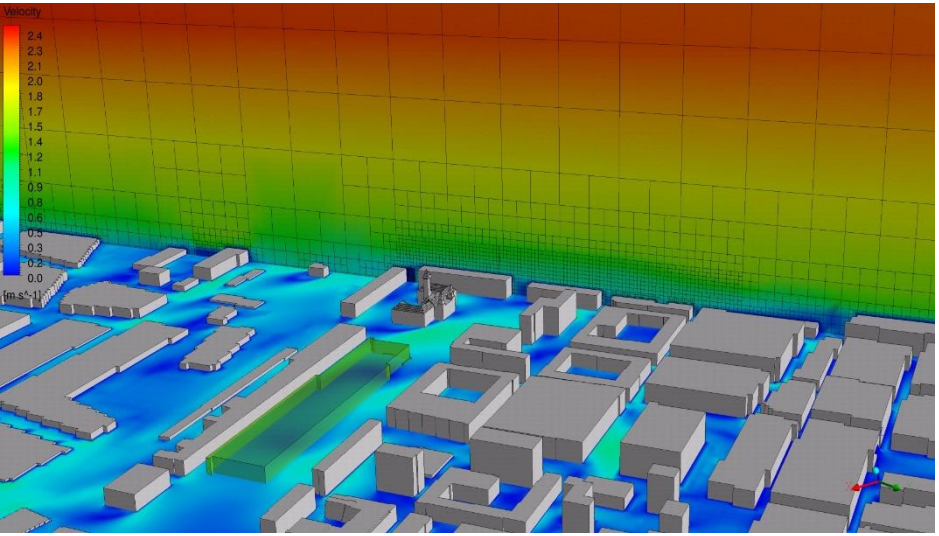
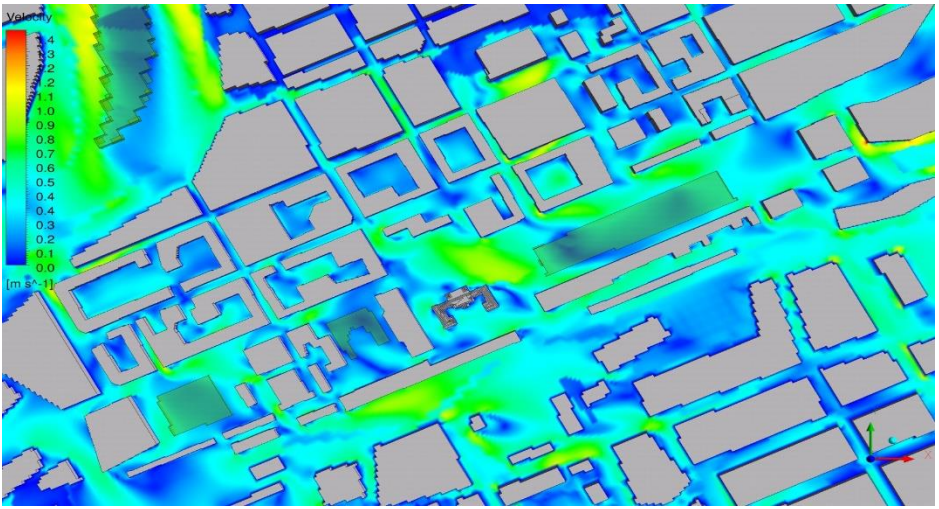
The dispersion simulation

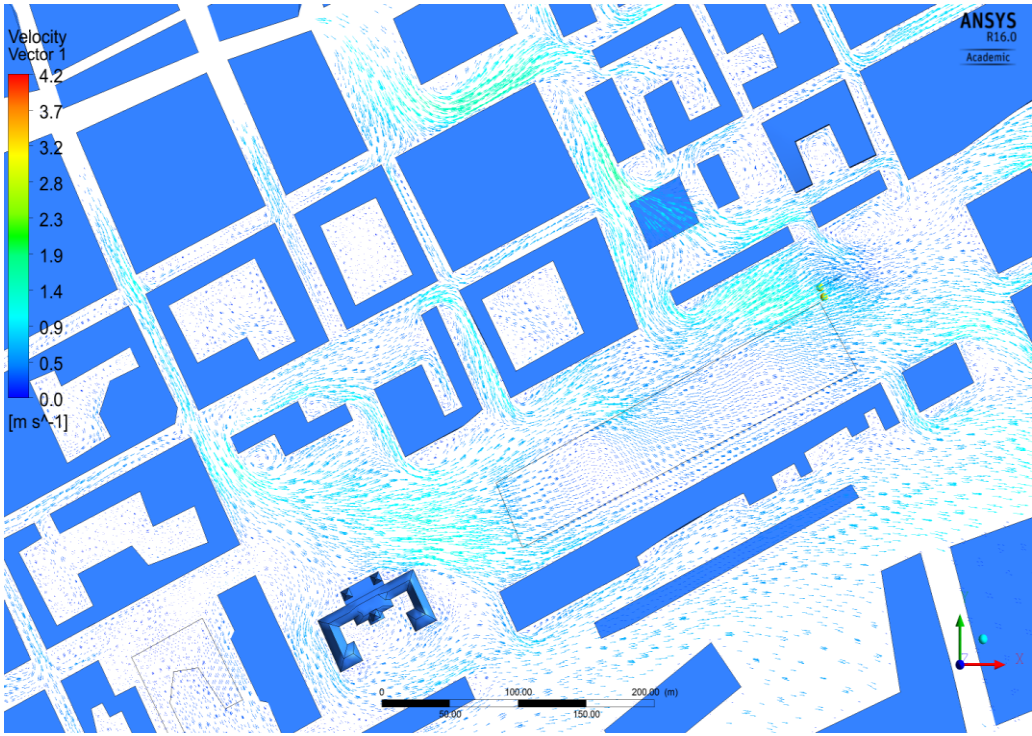
- Used models (until now): ANSYS Fluent, OpenFOAM and Parmod
- CFD model components:
  - 3D RANS k-ε turbulence model with calibrated coefficients
  - Humidity
  - Parks and groves as porous zones
  - Meteorological wind data as inlet boundary condition
  - Initialized with wind profiles
  - Polyhedral and hex core meshes, with/without boundary layer resolutions
  - Full transient and frozen flow field models

- Fluent seems the most robust one among these

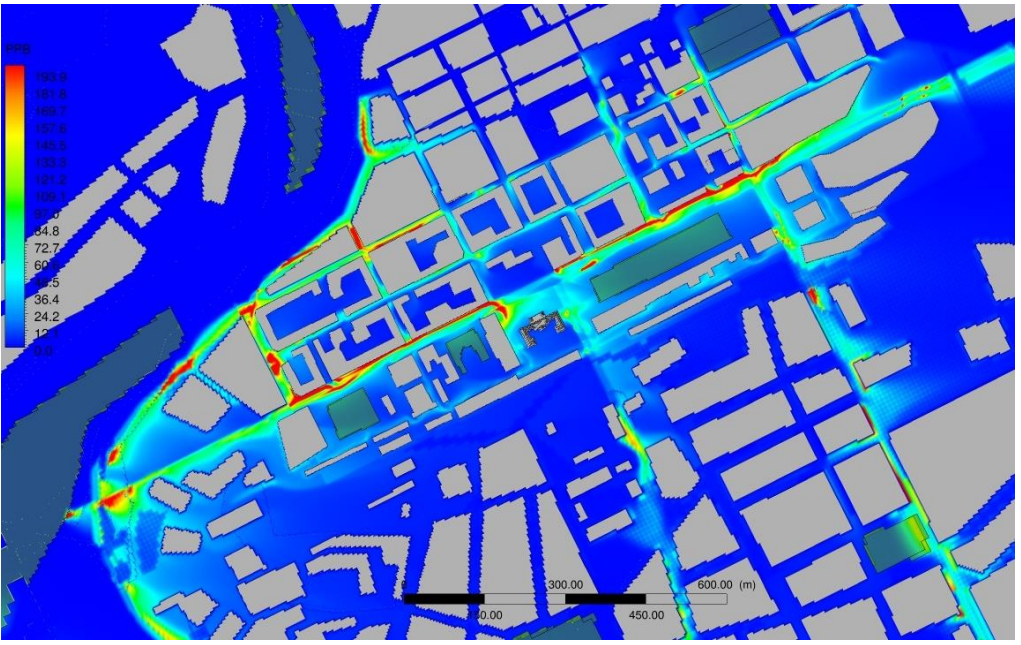
The dispersion module: windfield

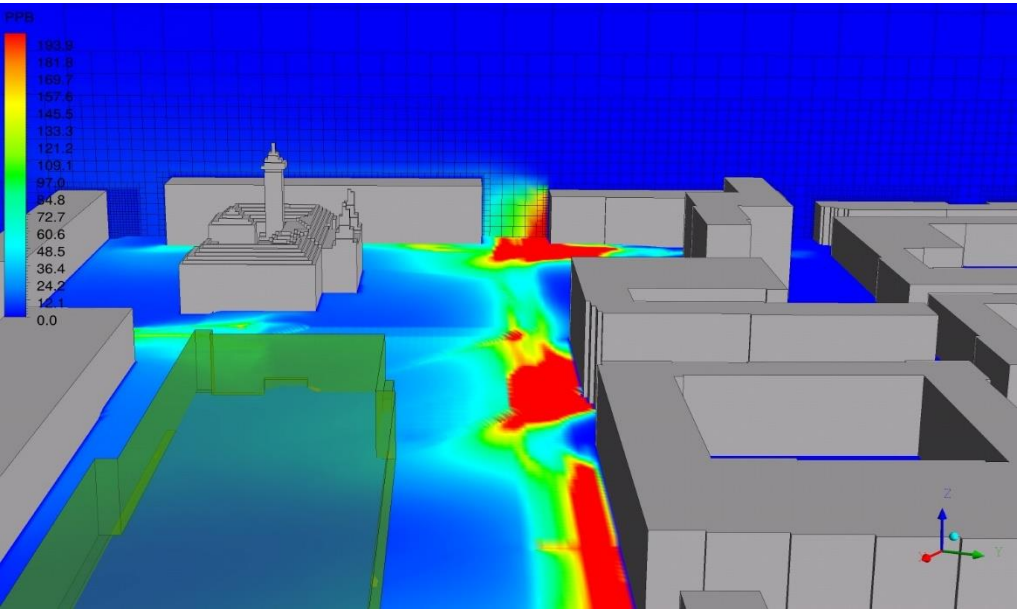


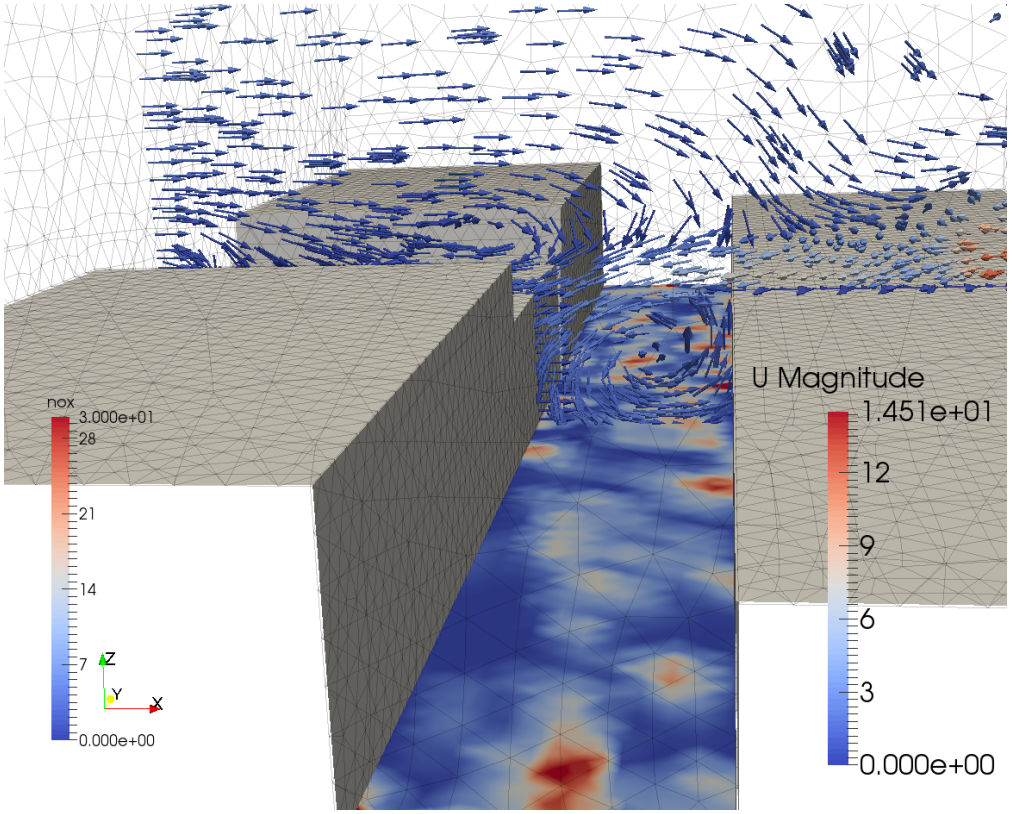




The dispersion module: NOx







Jagtvej example with OpenFOAM

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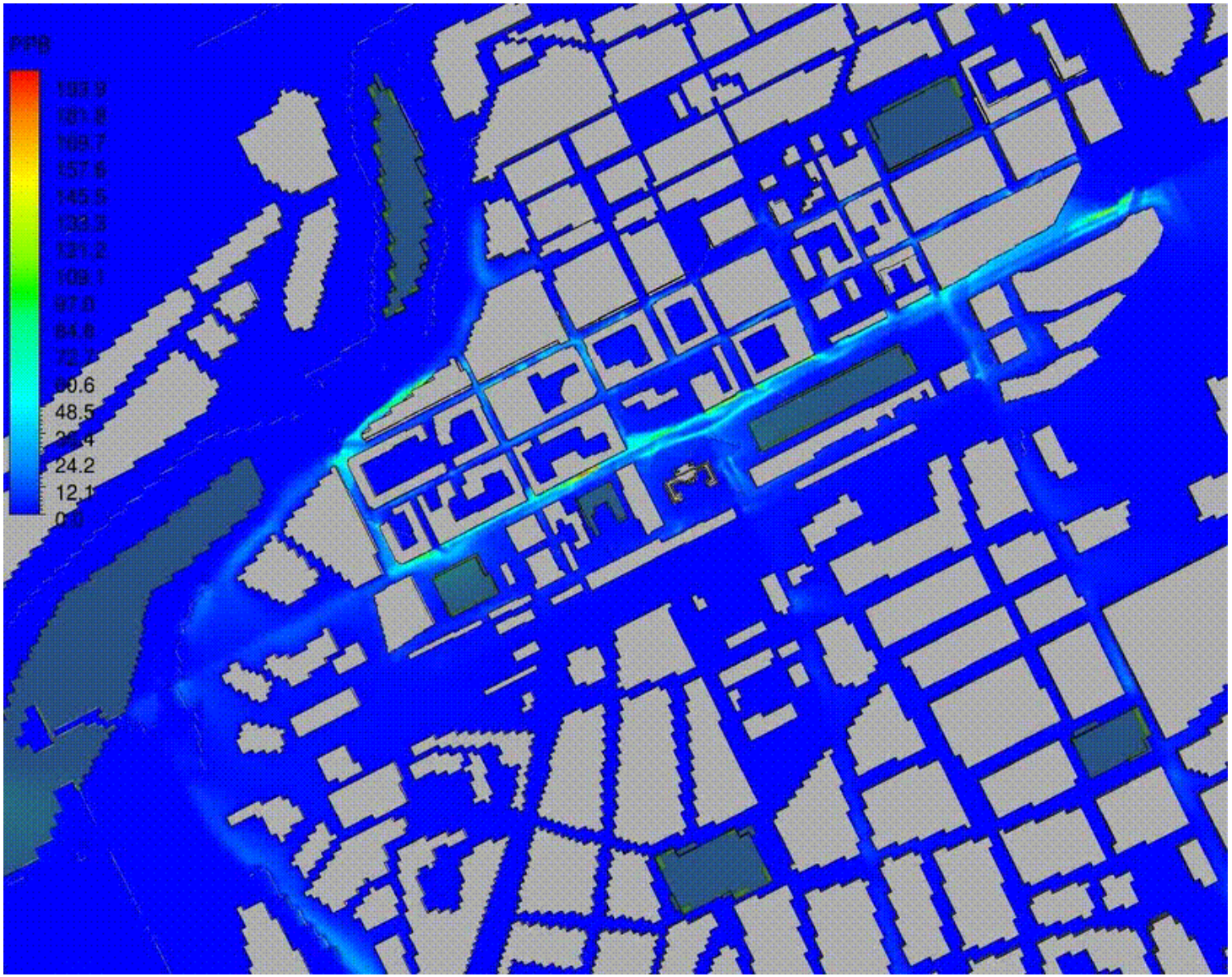
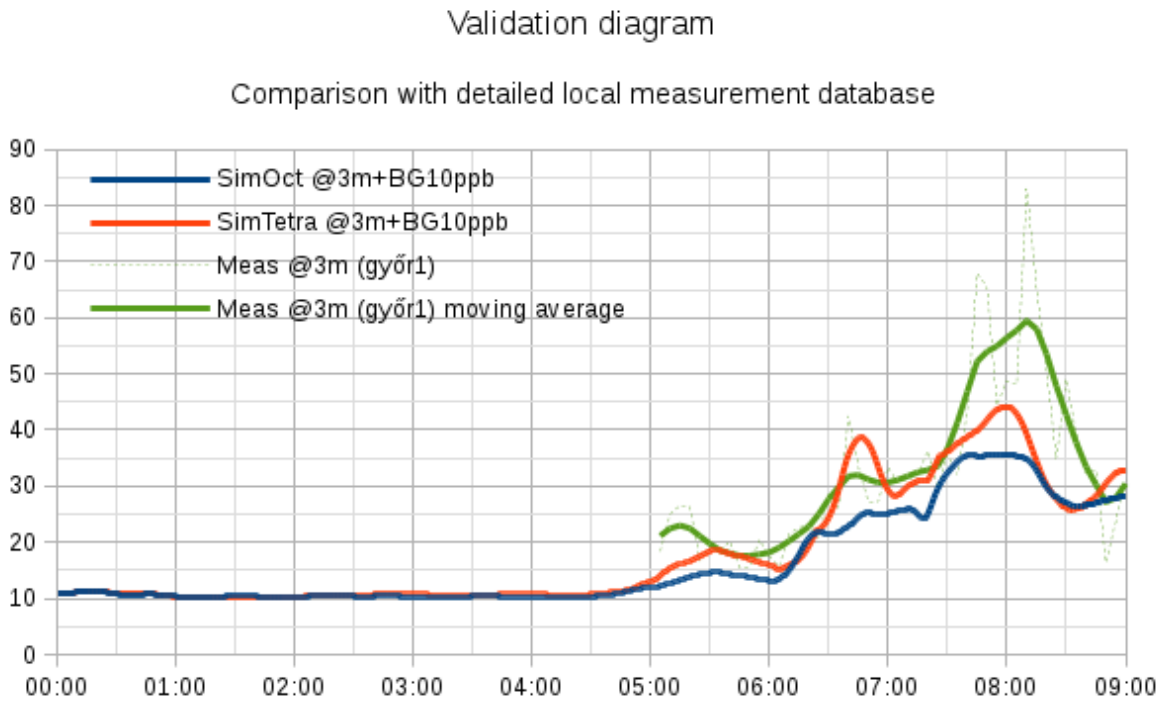
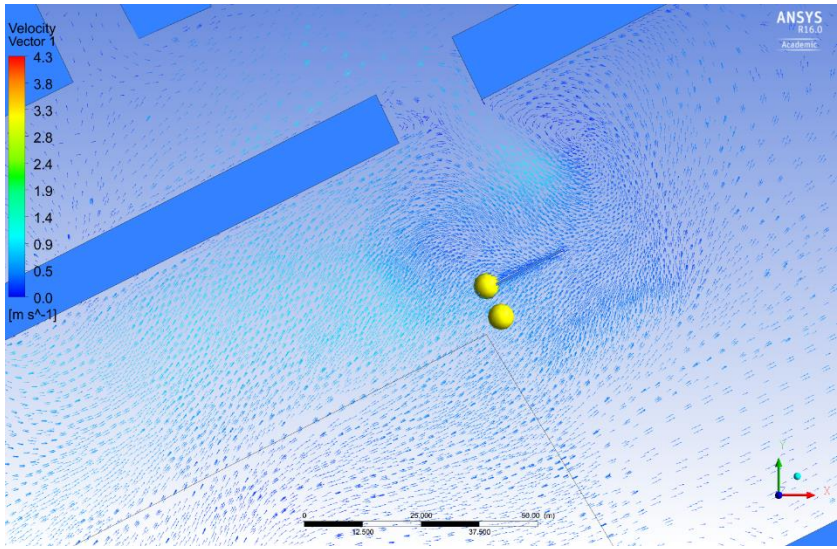
The dispersion module: NOx



Validation

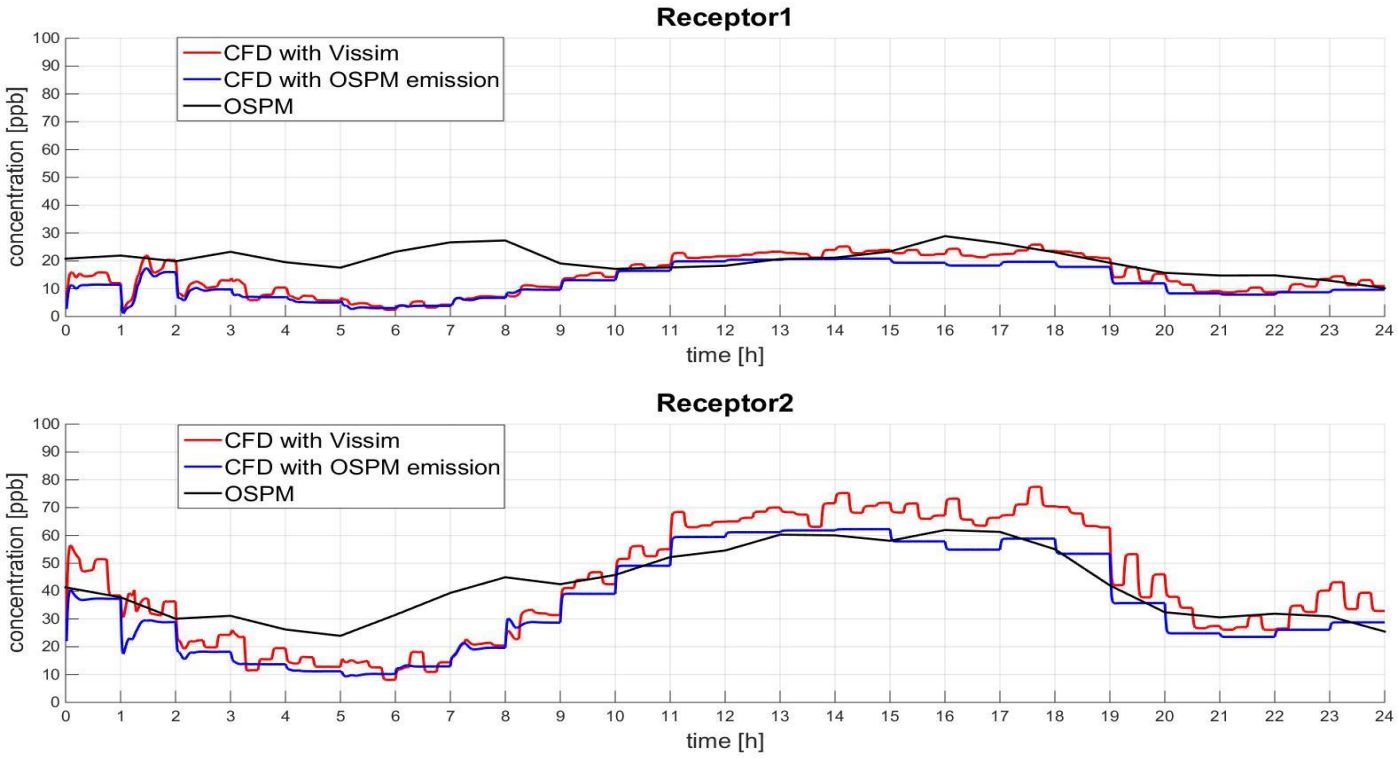
Validation with the official results of the Hungarian AQ Network at Győr1





Validation in a street canyon of Győr

Validation with the official results of the Hungarian AQ Network at Győr1 and comparison with OSPM



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Conclusions

1. 3DAirQC has been developed for 3D air quality modeling and control
2. Standard ingradients
3. Capable to involve state-of-the-art research codes as well

Thank you for your attention!