FAIRMODE survey about deriving annual mean concentration maps using microscale modelling

CT4. Micro-local scale AQ modeling

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CIEMAT

FAIRMODE Plenary Meeting,

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History

- Some sessions in former FAIRMODE meetings,
  - **Athens, 2017**, first contact among few interested people on CFD modelling,
  - **Tallin, 2018**, special session on CFD modelling with more than 25 people attending. CFD gained attention for practical application linked to the AQD. FAIRMODE is good for exchange ideas and best practices, provide guidance…
  - **Warsaw, February 2019**, CFD is quite interesting topic but competence building and benchmarking are yet necessary
  - **Madrid, October 2019**: feedback on questionnaire about relevance ➔ need to focus on micro scale (CFD, obstacle resolved modeling). Local scale is out of scope here (much more mature). **New questionnaire to find out how annual mean concentrations are derived from microscale models related to AAQDs.**

Questionnaire

FAIRMODE survey about deriving annual mean concentration maps using microscale modeling in the framework of AAQDs:

1. Do you agree with the new name "Microscale modeling" for this working group?
2. Do you compute annual averaged concentration maps (and potentially other metrics as maxima, percentiles…) with your microscale-CFD model?

   If yes:

   a. What is the purpose of computing annual averaged concentration maps with your microscale-CFD model (air quality assessment, compliance with the directives, reporting, planning, others)?
   b. How do you derive annual averaged concentration maps (and potentially other metrics as maxima, percentiles…) with your microscale model?
   c. Did you validate the methodology to derive annual statistics and do you have confidence in it?

3. Some additional information about microscale-CFD simulation:
   a. What kind of inputs do you use in your microscale-CFD model?
      1. How do you deal with emissions data?
      2. How do you deal with the boundary conditions (meteorology and background concentrations)?
   b. How do you deal with the fast NOx-O3 chemistry?

Results

7 responses:

- *VITO, BELGIUM*
- *IVU Umwelt GmgH, GERMANY*
- *City of Stockholm, SWEDEN*
- *Aarhus University, DENMARK*
- *University of Aveiro, PORTUGAL*
- *ENEA, ITALY*
- *CIEMAT, SPAIN*

1. **Do you agree with the new name "Microscale modeling" for this working group?**
   - YES, ALL GROUPS (7).

Results

2. **Do you compute annual averaged concentration maps (and potentially other metrics as maxima, percentiles…) with your microscale-CFD model?**
   - 4 YES (VITO,IVU,STOCKHOLM,CIEMAT).
   - 3 NO (AARHUS,AVEIRO,ENEA)

If yes:

a. **What is the purpose of computing annual averaged concentration maps with your microscale-CFD model (air quality assessment, compliance with the directives, reporting, planning, others)?**

   - Air quality assessment (IVU, CIEMAT)
   - Compliance with the directives (VITO, IVU, STOCKHOLM, CIEMAT)
   - Reporting
   - Planning (IVU, STOCKHOLM, CIEMAT)
   - Others (CIEMAT: Representativeness of AQMS)

Results

2. **Do you compute annual averaged concentration maps (and potentially other metrics as maxima, percentiles…) with your microscale-CFD model?**
   - 4 YES (VITO,IVU,STOCKHOLM,CIEMAT).
   - 3 NO (AARHUS,AVEIRO,ENEA)

If yes:

b. How do you derive annual averaged concentration maps (and potentially other metrics as maxima, percentiles…) with your microscale model?

- Using meteorological statistics (frequency of wind direction, wind speed,…) and combining simulated scenarios. (ALL GROUPS)
- Some differences in certain aspect of this computation (how to choose scenarios to simulate, how to build annual averaged map from scenarios maps, how to deal with background concentrations,…). TO DELVE INTO THESE POINTS

Results

2. **Do you compute annual averaged concentration maps (and potentially other metrics as maxima, percentiles…) with your microscale-CFD model?**
   - 4 YES (VITO,IVU,STOCKHOLM,CIEMAT).
   - 3 NO (AARHUS,AVEIRO,ENEA)

c. **Did you validate the methodology to derive annual statistics and do you have confidence in it?**

   - Specific validation of methodology with experimental measurements (VITO,CIEMAT)
     - Passive samplers
     - Monitoring stations
     - Wind tunnel
   - Evaluation comparing with traditional models (STOCKHOLM)
   - Confidence on the methodology (IVU,CIEMAT)
   - Need to improve the methodology (VITO,CIEMAT)

Results

3. Some additional information about microscale-CFD simulation:

a. What kind of inputs do you use in your microscale-CFD model?

1. How do you deal with emissions data?

- Mostly top-down or proxies approaches.
- Mainly traffic.
  - Unitary emission rates and scaled later (emission data or traffic counting and measured concentrations) (VITO, CIEMAT)
  - Traffic counting. Open Transport maps information. Checked with national inventory (Aveiro).
  - Traffic emissions in GIS (Stockholm)
  - Point and line (traffic) sources (Microscale-Lagragian model, ENEA)
  - Line-shape files with traffic intensity (ADT) and converted to volumetric source using average emission factors (Aarhus)
  - Several ways. But not explained (IVU)
  - *Using a microscale traffic emission model (CIEMAT) (bottom-up - microscale)*

Results

3. Some additional information about microscale-CFD simulation:

a. What kind of inputs do you use in your microscale-CFD model?

2. How do you deal with the boundary conditions (meteorology and background concentrations)?

- Meteorology:
  - From closest weather station (at certain height) and boundary layer profiles (VITO, IVU, Aarhus, Aveiro, CIEMAT)
  - From mesoscale models (Aveiro, CIEMAT)
  - Meteorological network (Mass-consistent wind fields). (ENEA)
- Background concentration
  - Value added to simulated concentrations in modeled domain (All CFD groups)
  - Values obtained from:
    - Background air quality monitoring stations (Aarhus, ENEA, CIEMAT)
    - Gaussian model (method for not double counting) (Stockholm)
    - Mesoscale models (Aarhus, Aveiro, ENEA, CIEMAT)

Results

3. Some additional information about microscale-CFD simulation:

b. How do you deal with the fast NOx-O_3 chemistry?

- **Not considered chemical scheme (VITO, IVU, Stockholm, Aarhus, AVEIRO, CIEMAT):**
  - Relationship between NOx and background O_3. NO_2/NOx from in-house dispersion model (VITO)
  - Empirical relationship NOx/NO_2 (Stockholm, CIEMAT)
  - NO/NO_2 conversion model - VDI guidance (IVU, Aarhus)
- **Considered an chemical scheme (not for the computations of annual averages) (CIEMAT, ENEA)**
  - NOx-O_3-VOCs simplified chemistry scheme implemented in CFD (CIEMAT).
  - Chemical reactions implemented in Lagragian model (ENEA)

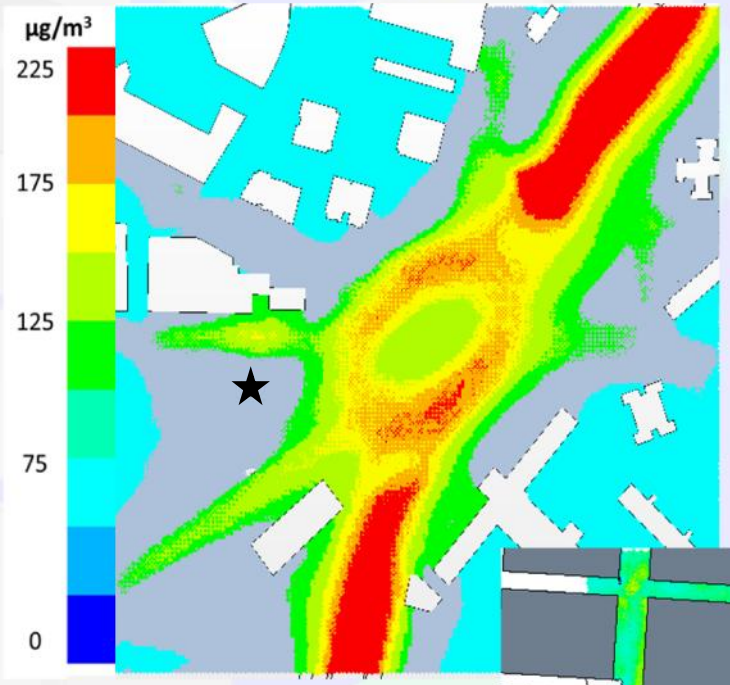
Very important questions

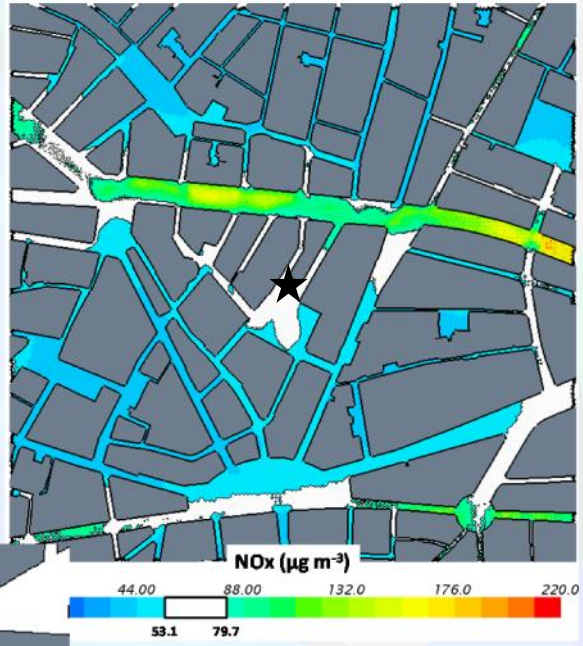
- Can the Crosscutting Task on micro scale modelling be endorsed by FAIRMODE?
- Do you agree with to follow the works to define a work plan for Benchmarking?
- What is most relevant to focus on: calculation of annual averages, inputs and boundary conditions, validation strategies,… ?

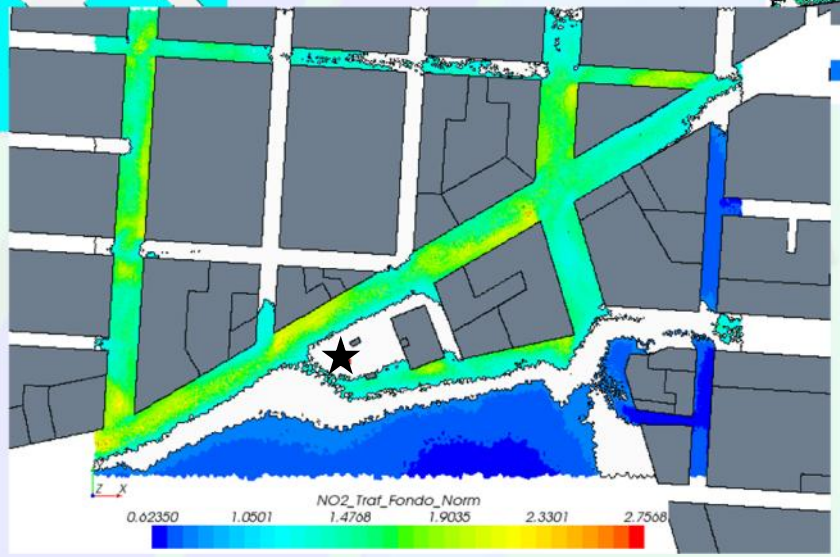
Very important questions

- **Can the Crosscutting Task on micro scale modelling be endorsed by FAIRMODE?**
- Why YES?:
  - Need to know the high-resolution spatial distribution of pollutant concentration in urban hot spots (*AQ station does not use to be located in the maximum concentration area*). Microscale models (CFD) are good tools (combined with measurements)!
  - *Spatial representativeness* in urban AQ stations ➔ *population exposure or network optimatization*. *(CT8 also highlights these needs)*
  - Urban AQ management and planning (*source apportionment, LEZ, use of vegetation for AP mitigation, vegetation barriers, etc*).
  - Increasing use and interest by microscale models (CFD, …)?

AQ station does not use to be located in the maximum concentration area







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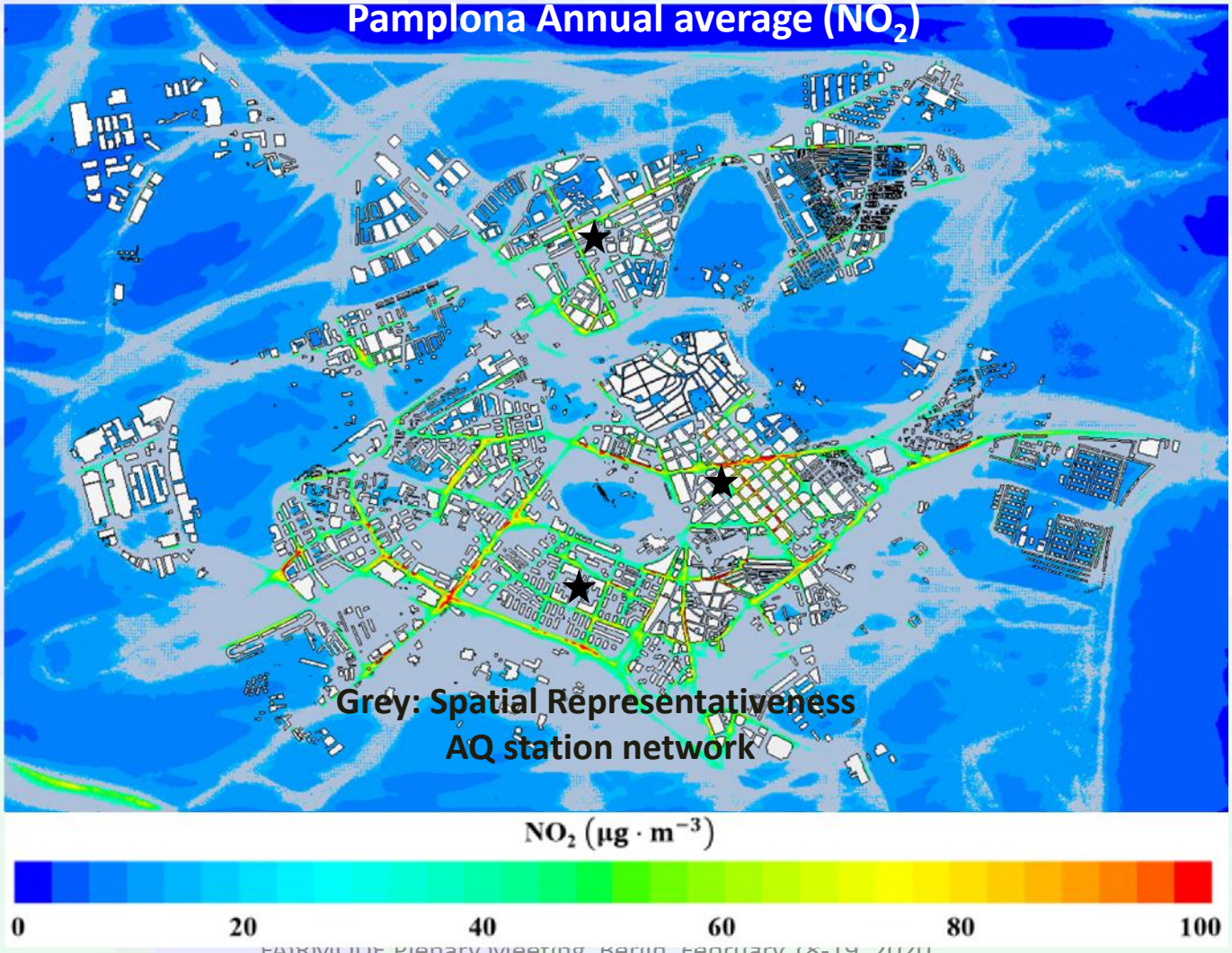
Network optimatization.



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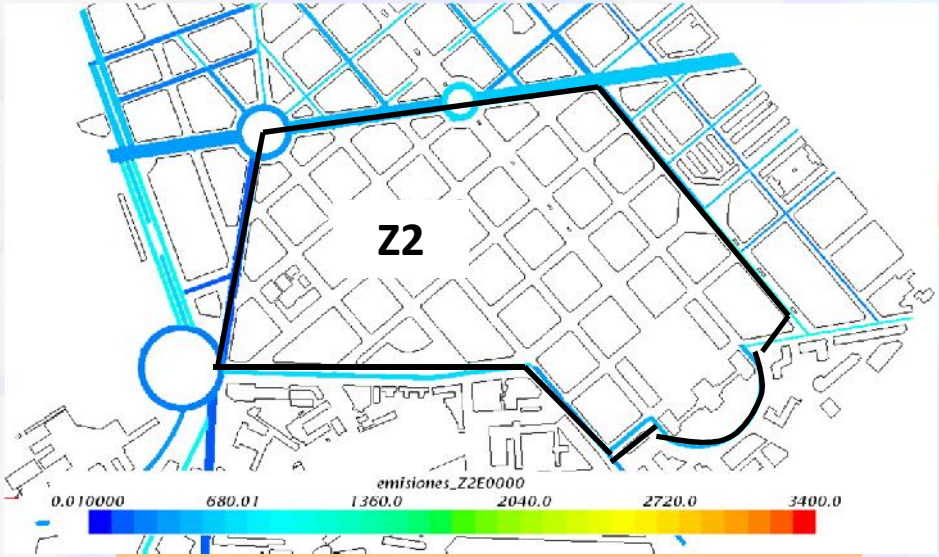
Low emissions zones (LEZ)



A district of Pamplona.

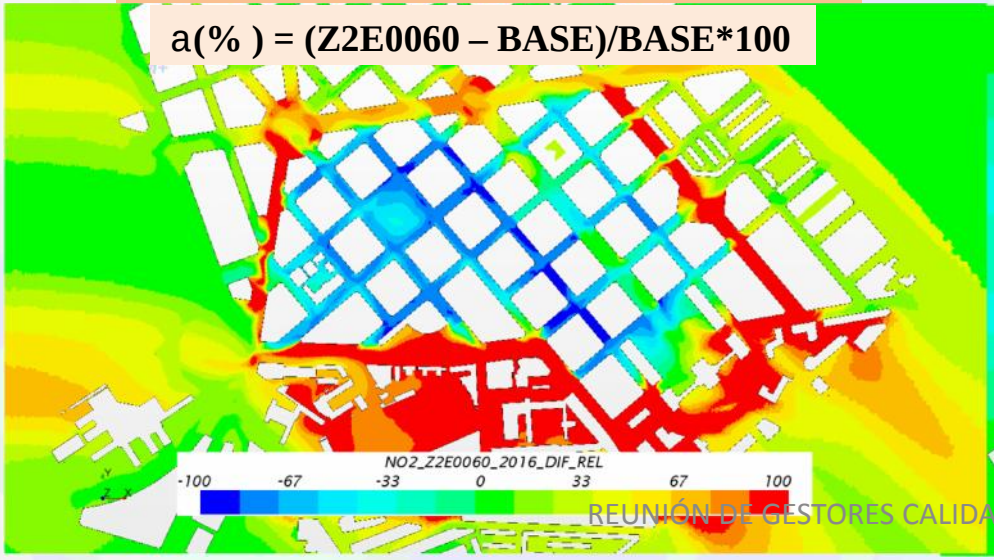
2016 NO_2 annual average concentration

Restriction zone. 6 scenarios, combination of:

- Traffic inside restriction zone reduced to:
  - 0% (no traffic)
  - 20% (few traffic)
- Traffic increases around restriction zone:
  - 0% (no traffic divertion),
  - 30% (some traffic divertion),
  - 60% (important traffic divertion)

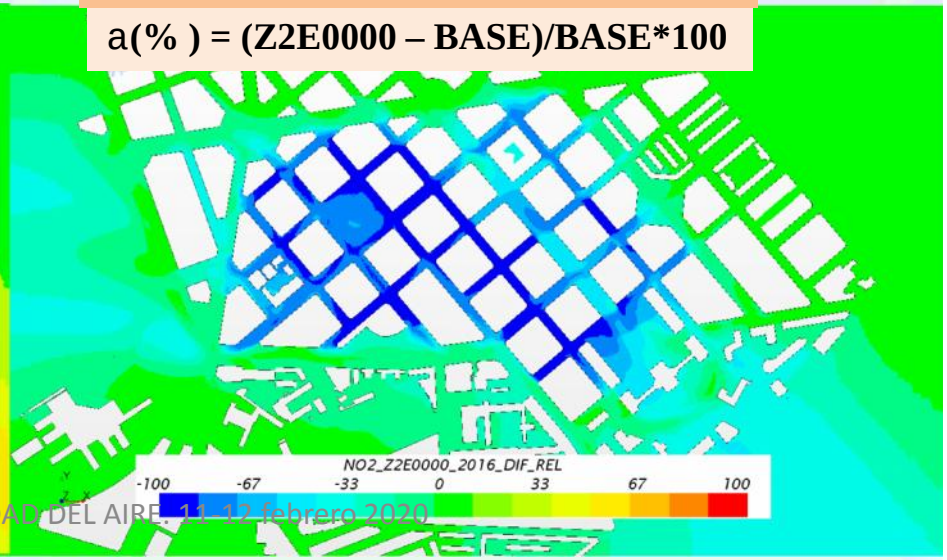
No traffic inside, strong traffic divertion

a(%) = (Z2E0060 – BASE)/BASE*100



No traffic inside, no traffic divertion

a(%) = (Z2E0000 – BASE)/BASE*100



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