FAIRMODE WG8 workshop on spatial representativeness, webinar 14/12/2023

A workshop was arranged within FAIRMODE WG8 for participants to present results from further testing of the proposed methodology for defining spatial representativeness (SR) that has been developed during the last few years within the working group. A checklist to guide the testing was circulated before the workshop and six country contributions were presented during the workshop. This document provides a short summary of the contributions and the main conclusions from the discussion. The presentations from the workshop have been uploaded to a Teams folder that all WG8 participants will have access to.

Testing SRA definitions on different countries, Bart Degraeuwe

Bart Degraeuwe (VITO) presented results from testing of the methodology for defining SR areas for stations in four different countries (IE, BE, SK and HR). In general, the monitoring stations showed quite good coverage within air quality zones. However, a clear conclusion from this work was that there is an issue with the limitation of SR areas to the AQ zone, specifically for rural background stations. There are issues with coverage of some rural areas and even suburbs of cities. This seems to depend on how MS have defined their zones and problems arise due to the fact that there is not always a rural background station in each zone. In some cities, street canyons with high concentrations were not covered by the SR areas. It was also clear that the definition of the lower cut-off needs to be further refined and clearly explained since the current formulation can be interpreted in different ways. The results also showed that the SR area can change over time, for example in traffic sites, where reductions in concentrations due to decreasing emissions lead to larger coverage.

Testing from different cities in East Sweden, Jenny Lindvall

Jenny Lindvall (SLB-analys, City of Stockholm) presented results from 4 different cities in the East Sweden Air Quality Management Association, together with a short recap of previous results from Stockholm. There was not such a large difference in SR areas using tolerance levels of ±15 % or ±20 % for traffic stations within the cities. Highways outside the city were included in the SR area of street canyon stations, which could be questionable and could indicate the need for further criteria/limitations on SR areas. A lower tolerance level (e.g. ±5 %) could be more appropriate for some background stations, since the SR areas even using ±10 % can be very large. The lower cut-off values can also be problematic in some cases, particularly where rural and urban background concentrations are similar. SR areas for percentiles are very similar to SR areas using annual means, although this could be due to the methodology used where percentiles are calculated using empirical formulas, and not from modelling of hourly/daily mean values.

SR tests from Germany, Stefan Feigenspan

Stefan Feigenspan (UBA, German Environment Agency) presented results from testing using their urban and regional-scale background model (2x2 km^2 resolution) for the different zones in Germany. The best coverage was seen for ozone, where almost the entirety of Germany was covered by the SR areas of measurement stations. Issues were however seen for NO2 and PM10, where the coverage of SR areas was low in some zones. An increase in the tolerance level to ±30 % would improve the coverage, although this issue may also be solved by addressing the AQ zone limitation for regional background stations. Results using both raw model data and data fusion datasets were presented and showed that the use of correction can have a significant impact on the size of the SR areas, in particular for NO2, where raw data gave larger coverage in rural areas but corrected data gave larger coverage in urban areas. The results also indicate that a ±15 % tolerance level for urban background stations would lead to over-representation, i.e. very large SR areas that cover the whole urban area. For example, urban background stations can be representative of highways outside of the cities, which is questionable. Further work is needed to consider if issues with low coverage can be due to issues with the network design or the design of the AQ zones.

Intercomparison of SR, Antwerp case from WG4, Fernando Martin

Fernando Martin (CIEMAT) presented results from an intercomparison exercise that has been carried out within FAIRMODE WG4 (microscale assessment) using results from different models for an urban district of Antwerp. Significant differences in results were seen in the SR areas using different types of models. The size of the SR areas increases significantly with higher tolerance levels, but only up to a critical point. This critical point is much lower for the background station compared with the traffic station. Results also indicate that for traffic stations, there is a relationship between size of the SR area and station concentration, with higher concentrations leading to smaller SR areas. For the urban background station, it is not clear if a similar relationship exists. Some ideas for further testing include, comparing SR areas for monthly vs annual data and to compare SR areas derived from model results to SR areas derived from a sampling campaign.

SR area of NO2 traffic stations in exceedance in 2021 & comparison with surface in exceedance, Frédéric Tognet

Frédéric Tognet (INERIS) presented an analysis for monitoring stations in exceedance for NO2 in 5 assessment zones in France. The results showed clearly that the SR area and the area exceeding the limit value are not equivalent. In cases where concentrations were closer to the limit value, the SR area was larger than the exceedance area. In contrast, in cases where concentrations exceed the limit value by a larger margin, the exceedance area was larger than the SR area. The results also showed that the use of a ±15 % or ±20 % tolerance level for traffic stations gives very similar patterns in the SR areas and that the use of ±20 % simply extends the SR areas along main roads. One issue that was raised was the two stations in the same zone may not have overlapping SR areas, but may be representative of different parts of the same road (e.g. one station's SR area can include the side of the road and another station's SR area can cover the centre of the same road). Is this a problem and how could it be dealt with?

SR analysis for Tuscany Region (IT), Francesca Guarnieri

Francesca Guarnieri (Consorzio Lamma) presented results from testing in the Tuscany Region focusing mainly on urban and rural background stations using results from a model with 2 km resolution and no bias adjustment. The analysis shows quite large SR areas for both PM10 and NO2, with very similar patterns using different tolerance levels and even for different years 2015 – 2022. The changes that can be seen in different years seem to be due to differences in the emission inventory rather than meteorology. A comparison was also made between SR areas using the proposed FAIRMODE methodology and the current method used in Tuscany region, and these methods give similar results. An important issue identified by the analysis is how to handle cases where stations have overlapping areas, but which have different exceedance statuses (i.e. one station exceeds the limit value, while the other station does not). The initial analysis indicates that the use of percentiles gave less overlapping areas with different exceedance statuses. An analysis of two hotspot stations for PM10 confirmed that these stations have a very local representativeness, which was the expected outcome. The analysis indicates that the 2 µg/m^3 lower cut-off is OK for the pollutants tested.

Development of guidance documents

A guidebook on monitoring network design with a compilation of experiences from the joint FAIRMODE-AQUILA activity with the MoNET tool is planned to be developed during the coming months. A Teams library has been created to allow participants to provide contributions from their own experiences. Further development of the guidance on SR is also planned before the FAIRMODE plenary meeting. Documents will also be uploaded to the Teams library to allow participants to contribute to improving the guidance and to provide input on key open issues.

Initial conclusions on key open issues

Some key issues were identified during the workshop where further testing and discussion is needed:

- **AQ zone limitation for SR areas:** It seems that this limitation is particularly problematic for rural background stations, which are not required for every AQ zone. Possible solutions could be to remove this limitation entirely for rural background stations or to replace it with a maximum SR area. The directive may provide some guidance on what relevant maximum SR areas for rural background stations could be, although these areas may vary depending on assessment requirements. For example, requirements for representativeness and station density range between 10 000 km^2, 20 000 km^2, 20 000 km^2, 40 000 km^2, 50 000 km^2 and 100 000 km^2.

- **Tolerance levels:** The results indicate that the use of different tolerance levels for background stations and hotspots remains valid. For traffic stations, the use of ±15 % or ±20 % produce relatively similar results. SR areas of background stations are in general very large, so a tolerance level of at most ±10 % still seems to be relevant.

- **Lower cut-off:** There seems to be different interpretations of the lower cut-off, which means that it is difficult to judge the usefulness of applying a lower cut-off and to agree on which levels the cut-off should be set at. It is a clear priority to better define and describe the lower cut-off so that it can be properly tested.

- **Handling of overlapping SR areas & differences in SR areas vs exceedance areas:** it was clear from the results that there are differences in the SR areas of monitoring stations and the area that may exceed a limit value. This needs to be made clear in the guidance. How to handle potential overlaps in SR areas also needs to be clearly described, particularly when one station is in exceedance and another is not.

- **Bias correction & use of observed or modelled values:** further refinement and discussion is needed regarding the use of bias correction and whether observed or modelled values should be used. It seems reasonable to allow the use of the best available AQ map, but there can be differences with how bias correction is applied. Methods for bias correction needs further discussion within FAIRMODE. Even if you use the best available map with some bias correction, there may still be issues with bias at some specific stations. It should be clear how this is handled and if some provision to use observed values rather than modelled values should be made.

- **Missing analyses:** We are still lacking analyses for some pollutants (SO2, CO, benzene, B(a)P and metals), for some station types (industrial & domestic heating hotspots) and from lower-tier methods.

Next meeting

A follow-up meeting is needed to further discuss the open issues and to give another opportunity for WG8 participants to present results from further testing. This will be planned for January and details will be sent out shortly.