**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "CO$_2$ dispersion modelling over Paris region within the CO$_2$-MEGAPARIS project" *by* C. Lac et al.

Anonymous Referee #2

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The paper of Lac et al presents the results of the mesoscale forward model Meso-NH and validates the model using meteorological and CO2 measurements in Paris and its surroundings within the CO2-MEGAPARIS project. The model exercise is validated using 6 days in March 2011. Different modelling approaches are used in order to investigate the role of the Urban Heat Island on the diurnal evolution of weather variables and the boundary layer height in urban/suburban/rural sites, and the role of urban emissions on the diurnal evolution of atmospheric CO2 mixing ratio in urban and background sites. The paper presents a valuable modelling approach in order to understand the temporal and spatial variability of weather variables and CO2 mixing ratios in urban areas and provide new insights in the urban carbon cycle. However, there are few things in the paper that need to be addressed before its publication. General comments:

1. The validation of the model approach with observations is done in a very qualitative way making very difficult for the reader to assess of agreement between the model and observations. Moreover, there is a lack of assessment of global performance of the model and observations. I think that reporting coefficients of determination (R2) or 1:1 plots that compare model vs observations would help to better see the model's performance. The description of the temporal evolution of the model performance is described too qualitatively and sometimes the text is difficult to follow. Furthermore, since one of the goals of the paper is to report urban-suburban-rural transects, I think that it would be good to compare such transitions as seen by observations and by the model.

2. The wording of the text will need a revision. There are some sentences difficult to understand and the text is not properly proof-read.

Specific comments:

Lines 13-19, page 28159. The sentence will need rewording. Not really clear the points why urban areas are challenging in inversion studies. Objectives of the study end page 28159 – beginning 28160. What about the ability of the model in representing the temperature, the relative humidity and the wind fields in the area of the study? I don't fully understand what objective (2) means.

Lines 19-21, page 28161. Which is the temporal resolution of the emissions inventory? Which is the spatial and temporal resolution of the CO2 fluxes?

Last paragraph of page 28161: Not clear what it means "the boundary conditions CO2 profiles during each day's simulations were also taken from homogenous vertical profiles". Are those vertical profiles observed vertical profiles? Or from the model? Why are they homogenous if they are from the previous day's model results? Furthermore the sampling network hasn't been introduced before. Might it be clearer introducing the CO2-MEGAPARIS sampling network first and then the modelling framework?

Line 16 page 28162. Substitute "served" by "used"

Line 20, page 28162. Might it be appropriate to say "the French operational meteorological surface network"? First paragraph page 28163. Which is the precision and accuracy of the CO2 observations? Which is the temporal resolution of observations? Are CO2 mixing ratios referred to the International Scale?

Line 8, page 28163: Substitute "leads" by "leaded"

Line 20-21, page 28163: Propose the following wording for a better understanding "235 stations reporting hourly data for T2M and HU2m and 114 stations reporting daily wind speed and wind direction".

Line 1-2, page 28164. What does it mean that the evaluation of meteorological simulations are performed in operational weather prediction centres?

Lines 13-15, page 28164. Substitute "for the set of stations" by "for all stations", "wet during the day BUT very good agreement AT night".. "...23 March between 04:00 and 11:00 UT".

Lines 23-25, page 28164. There is no evidence that "the excessive cooling and moistening during the day is mainly attributed to the ISBA scheme".

Lines 3-15, page 28165. The description of the temporal evolution of observed temperature for the campaign must be done using past tenses.

Line 17, page 28165. Suggestion of wording: "Also, the dry conditions during previous days reduced the soil..."

Lines 25-26, page 28165. Don't understand what it means "the occasional measurements at SIRTA and TRN sites, not taken into account in the operational analysis".

Lines 3-4, page 28166. A comparison of R2 between REF and RUR simulations will help the reader to see that REF captures well the urban-rural contrasts. Figure 4c is not described in the text and any word regarding the RUR modelling scheme is made. From

the graph is observed that the RUR scheme doesn't capture the urban-rural transect. Why not quantify this transect as seen by "obs", "REF" and "RUR"?

Line 16, page 28166. Substitute "pointed out" by "pointing out"

Line 23. Page 28166. Substitute "not useful" by "not working"

Line 25, page 28166. Substitute "was not able to result" by "was not operational"

Line 4, page 28167. "... mixing LAYER for JUSS, FOLLOWED BY SIRTA and THEN TRN". How different is the boundary layer height for these three sites? The description of the observation should be done in past tenses.

Lines 17-25, page 28168. REF simulations don't capture the BLH at JUSS for the first 3 days of the campaigns. A sentence about this is needed in the text. Maybe calculating R2 for the entire period would help seeing an increase of the accuracy of the REF simulations in comparison with RUR in terms of reproducing the BLH at urban sites? From the graphs looks like that REF simulations captures better the BLH at SIRTA. A word in regard this point will be worthy.

Line 8, page 28169. Will be better to use the term "photosynthesis" instead of "assimilation"?

Line 15, page 28169. "at EIF" repeated twice in the same sentence.

Line 25, page 28169. Adding the value of R2 would help seeing the agreement between the model and observations.

Line 15, page 28170. "MAGNITIUDE of the measurement". I'd say that Paris is a city rather than a town.

Section 5.2. What does it mean "nocturnal amplitude"? Do you mean that there is an increase of 100 ppm during night? Or do you refer as "daily amplitude" It is confusing talking about "nocturnal peaks" and "rush hour". In most cities, rush hours take place between 7-10 am in the morning and 4-6 pm. From the graph it is difficult to

assess the timing of the CO2 peaks. Does the temporal resolution of emissions inventory reproduce the rush hour peaks? If that is the case, why not trying to reduce the emissions intensity in the model and see if it reproduce better the morning rush hour peaks? About the impact of CDG on GON. It is not the airport closed at night? Most of airports close between 00 and 05 local time. Therefore the impact of the airport on GON measurements should be really small at night. If that it isn't the case, further evidence of the impact of the airport emissions to the data should be provided. For example, polar roses showing an increase of the CO2 concentration when the wind is blowing from that direction would be useful.

Line 22, page 281871. I would say "EMISSIONS at rush hours are probably responsible".

Line 23, page 28174. I don't agree that they are small discrepancies. They are reported to be between 30 and 100 ppmv, that is quite a lot. Similarly, line 3-5 page 28175 states that "the good representation of CO2 concentration on urban and sub-urban sites during nighttime" when the better agreements are found during daytime.

Line 27, page 28174. It is pointed that the resolution of anthropogenic inventories is too coarse. Does it mean spatially or temporally?

Fig. 3 and 7. Y-axis text for "Wind direction (degrees)"

Fig.4 Substitute "semi-urban" in the legend by "suburban". The line colour for "suburban" is not consistent in Figs.4 b and c compared to a. In the Figure caption "predicted BY"