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Interactive comment on "River Breezes for Pollutant Dispersion in GoAmazon2014/5" *by* Adan S. S. Medeiros et al.

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Response to Review #1 1 - Comment from Referee: This study analyzed the effect of the river breezes on the dispersion or canalization of the Manaus pollution using observational data and numerical simulations with high spatial resolution. Results show that the river breeze cell is, on average, confined below 150 m suggesting that the river breeze effect on pollution dispersion above this level is negligible. Observed data of CO NOx and O3 concentration confirmed that the river breeze does not affect the pollution dissipation at 500 m. On the other hand, the river breezes remarkably affect the pollutant dispersion near the surface, mainly over "R1" and "R2" locations. This study demonstrated that the river breezes play an important role in the Manaus pollution dispersion in the low atmospheric levels. Moreover, this paper also highlights locations

where the river breeze influence on pollution dispersion is more effective. These finds are very important to the Amazon local-climate understanding and complement the previous discoveries. The used methods are appropriate for the study purpose and the paper, in general, is well written. However, some "major" points should be reviewed. The points are below listed.

1 - Author's response: The authors thank the reviewer for the careful reading of the manuscript and the valuable input that was provided.

2 - Comment from Referee: In the paragraph that starts in line #38, I recommend citing the dos Santos, M. J., M. A. F. Silva Dias, and E. D. Freitas (2014),doi:10.1002/2014JD021969, since this paper shows evidence of river breeze for the Manaus area using long-term observation.

2 - Author's response: The citation is added to the revised manuscript.

3 - Comment from Referee: The citation of dos Santos, M. J., M. A. F. Silva Dias and E. D. Freitas (2014) is also recommended in the paragraph that starts in the line #52;

3 - Author's response: The citation is added in the suggested paragraph, followed by the sentence:

3 – Author's changes in Manuscript: Line 54: "Oliveira and Fitzjarrald (1993, 1994) studied the river breezes in the Manaus region during the Amazon Boundary Layer Experiments (ABLE) (Garstang et al., 1990;Harriss et al., 1990). Based on observations of the meridional component of wind speed, the river breezes were reported as more intense during the dry season than in the wet season, as explained by greater contrast between river and land temperatures given the greater average insolation of the dry season. Simulations further suggested that the river breeze induced by the Rio Negro significantly affected the surrounding daytime surface winds to a distance of 20 km from the rivers (Oliveira and Fitzjarrald, 1994). The modeled distance was further than initially expected based on earlier modeling studies, and the key difference appeared

to be an improved representation of the planetary boundary layer (PBL) in the model. More recently, dos Santos et al. (2014) studied the river breeze near Manaus, concluding that this local circulation affects wind patterns and, consequently, spatial/temporal distribution of the precipitation on the region."

4 - Comment from Referee: This part of the text should be improved. "On at least one day, a reversal in wind direction caused by the afternoon influence of the river breeze was associated with a shift in concentrations representative of background and polluted conditions". It is not clear.

4 - Author's response: The revised text is clarified as follows:

4 - Author's changes in Manuscript: Line 72: "On at least one day, a reversal in wind direction caused by the afternoon influence of the river breeze was associated with an increase in pollutant concentrations."

5 - Comment from Referee: There is no information about the soil initialization. In other words, the soil initial conditions (i.e., soil temperature and moisture) used in these simulations have to be described in this section.

5 - Author's response: We thank the reviewer for this important comment. The soil initial conditions were obtained from Climate Forecast System Reanalysis (CFSv2) product of the National Center for EnvironmentÂăPrediction (NCEP). The following clarification is added to the manuscript:

5 - Author's changes in Manuscript: Line 109 "The meteorology of the outside boundary of the outer domain was forced by the Climate Forecast System Reanalysis (CFSv2) product of the National Center for Environment Prediction (NCEP) at a temporal resolution of 6 h and a spatial resolution of 0.5° (Saha et al., 2011). The inputs of surface temperature, and soil conditions were also considered based on CFSv2 product."

6 - Comment from Referee: The following sentence is not clear at all. "After the spin-up period, simulations in lots of 72 h were performed for March 2014 as a balance between

conserving computing resources and avoiding excessive numerical drift (Medeiros et al., 2017)."

6 - Author's response: We thank the reviewer for this observation. The intention of the sentence was to explain that the simulations were performed in groups of 72 h. This approach provided a balance between computational time and numerical diffusion. The revised text is clarified as follows:

6 - Author's changes in Manuscript: Line 136: "Simulations of the wR and woR cases were carried out for all days in March 2014. Other characteristics between the two simulations remained the same. This approach aimed to isolate the river breeze effects on the transport of pollutants downwind of Manaus. For time zero, the inner and outer domains were both initialized to CFSv2 and MOZART-4. The simulations were performed in groups of 96 h, with 24 h of spin-up followed by 72 h of valid run, as described in Medeiros et al. (2017)"

7 - Comment from Referee: In line 166 It is written: "Figure 4 shows that the flight paths intercepted the Manaus pollution plume in the planetary boundary layer on March 14 from 10:20 to 11:20 (local time; UTC - 4 h)". Figure 4 show does not show It since there is no time information there.

7 - Author's response: We thank the reviewer for the observation. The points A and H were considered as begin and end of the paths for March 14 (i.e. left panels) and March 21 (i.e. right panels), and the time that the measurements were performed corresponds to 10:20 for point A and 11:20 for point H. The caption of Figure 4 is revised, as follows:

7 - Author's changes in Manuscript: "Caption of Figure 4: Concentrations of O3, NOx, and CO, for (left) March 14 and (right) March 21 from 10:20 and 11:20 (local time, UTC – 4 h), measured by instrumentation on board an aircraft during GoAmazon2014/5 at an altitude of approximately 500 m (Martin et al., 2017). Concentrations are plotted in false color, and the legends on the right-hand side of each row show the scaling. Below each main panel, a line plot shows the concentrations marked by points A (10:20)

through H (11:20) along the flight paths. Red shading demarcates periods when the aircraft was flying over a river."

8 - Comment from Referee: In lines 186 and 187, I suggest you present the maximum absolute concentration differences instead of maximum concentration differences. If you present the maximum absolute concentration, the NOx difference value will be larger than 5 ppb.

8 - Author's response: We thank the reviewer for this suggestion. In order to prevent any misinterpretation from general readers, the mentioned sentence is removed from the manuscript.

9 - Comment from Referee: In lines 170-171 It is written: "The results show that there was no obvious influence of river breezes on the dispersion of the Manaus pollutant plume at 500 m". This affirmation can be corroborated by plotting vertical cross-sections of the simulated pollutants across Manaus pollutant plume. Thus, I suggest to include these cross-sections on the paper discussion.

9 - Author's response: We thank the reviewer for this suggestion. The Figure "S3" is inserted in the supplement, and the manuscript is revised, as follows:

9 - Author's changes in Manuscript: Line 183: "The results show that there was no obviousÂăinfluence of river breezes on the dispersion of the Manaus pollutant plume at 500 m, which is corroborated by cross sections of O3, NOx, and CO concentrations shown in Figure S3."

10 - Comment from Referee: In lines 187-190 I agree with the following sentence: "The overall implication is that the effects of the trade winds on transport largely dominated over the influence of river breezes in this region when considering the larger part of Manaus pollutant outflow". But, I do not agree with this part: "in agreement with the modeling and observational results of section 4.1." In section 4.1, It showed the concentration of pollutants at 500 m altitude, where the river breeze effect is negligible.

In section 4.2, It was analyzed the pollutant concentration near the surface where the local circulations are remarkable. In other words, the conditions are different.

10 - Author's response: We thank the reviewer for this perspective. The mentioned agreement is related to the following line of thinking. The aircraft data do not appear to support a river breeze effect on Manaus pollution plume at 500 m. This observation can be explained by the conclusions in section 4.1 that changes in horizontal winds are confined to near the surface in the first 150 m of altitude. The presence of the rivers does not interfere on pollutant dispersion at 500 m. This result is corroborated by Figure "S3", which shows the cross-section of the considered pollutants.

11 - Comment from Referee: The small perturbations (concentration difference less than 6%, line 186) caused by the presence of the rivers is, probably, related to the river breeze activity. The river breeze occurrence is more frequent in the dry season, please check, dos Santos M. J., M. A. F. Silva Dias, and E. D. Freitas (2014).

11 - Author's response: The authors agree with the reviewer. In order to enrich the discussion, the following sentence is inserted in the revised manuscript:

11 - Author's changes in Manuscript: Line 243: "Differences in surface river concentrations exceeded 10 ppb for at least two pollutants at a frequency of 5% for March 2014. In caveat, this value represents the wet season and might differ for the dry season (dos Santos et al., 2014)."

12 - Comment from Referee: In lines 209-210 the following sentence is unclear. "which can be called strong canalization, for at least two pollutants at 5% frequency for March 2014."

12 - Author's response: For clarification, the following sentence is inserted in the manuscript:

12 - Author's changes in Manuscript: Line 221: "The difference between the wR and woR cases exceeded 10 ppb at R2 for at least two pollutant at 5% frequency for March

2014. These conditions were considered as a strong channeling cases."

13 - Comment from Referee: In Figure 2 and 8, I suggest that you replot the right column figures using a Diverging Color Schemes for a better visualization of the results. The following link shows many options. https://www.mathworks.com/matlabcentral/fileexchange/34087-cbrewerâĂŤcolorbrewer-schemes-for-matlab

13 - Author's response: We thank the reviewer for this valuable input. In this regard, please see improved Figures 2 and 8.

14 - Comment from Referee: In the captions of Figure 5,6 and 7, you should mention the atmospheric level of the presented pollutant concentrations.

14 - Author's response: Information concerning height of the pollutant concentrations is added to the captions of Figures 5, 6, and 7, as follows:

14 - Author's changes in Manuscript: Caption of Figure 5: "Time series of O3 near-surface concentrations at the T3, R1, and R2 locations. The left column plots the cases of wR ("with rivers"; blue) and woR ("without rivers"; red). The right column shows the difference in concentrations as (wR - woR)." Caption of Figure 6: "Time series of NOx near-surface concentrations at the T3, R1, and R2 locations. The left column plots the cases of wR ("with rivers"; blue) and woR ("without rivers"; red). The right column shows the difference in concentrations as (wR - woR)." Caption of Figure 7: "Time series of CO near-surface concentrations at the T3, R1, and R2 locations. The left column plots the cases of wR ("with rivers"; blue) and woR ("without rivers"; red). The right column shows the difference in concentrations as (wR - woR)."

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