

General Comments

Anthropogenic emissions of gases and particulate matter are thought to adversely affect pollutant levels within the city of Manaus and the surrounding pristine rainforest. However, Manaus emissions inventories have been a major source of uncertainty in modeling studies examining processes affecting atmospheric composition in the Amazon Basin. Rafee et al. aim to improve understanding in three areas: (1) the relative contribution of stationary and vehicular sources to pollution levels in Manaus and the surrounding forest; (2) the location and area of forest affected by pollution in the Manaus plume; and (3) the potential impact of future increases in Manaus emissions on pollution levels in the city and surrounding forest. They accomplish this by conducting high-resolution WRF-Chem model simulations of a region surrounding Manaus for scenarios with current emissions (base case); only biogenic, stationary, or vehicular sources; and a future scenario doubling emissions and urban land use area. They evaluate the simulations against ground-based meteorological and air quality observations, determine the typical direction and extent of the Manaus plume, and compare simulated peak and average pollutant levels for the different scenarios. They conclude that stationary sources are the largest contributors to observed gas and particulate amounts, except for CO, for which vehicles are the most important source. The Manaus plume can extend hundreds of kilometers in the west and southwest direction. The future scenario increases average pollutant concentrations by up to 62% and peak values up to 109% relative to present emissions and land use.

The study is of great interest to those wishing to conduct modeling studies of Manaus and the Amazon Basin, as it provides an improved anthropogenic emissions inventory for Manaus and evaluates it against chemical observations. However, the authors themselves state the caveat that the present study only simulated two case study days during the rainy season due to lack of observations. It provides a methodological advance in emissions estimation for Manaus and new knowledge about the dominance of stationary sources in Manaus. It provides a foundation for future studies utilizing year-round ground-based chemical observations.

Nevertheless, the article could have broader interest and impact by expanding the discussion to the relative contributions of anthropogenic and biogenic sources and their interactions to levels of different pollutants. These anthropogenic-biogenic interactions are described as a motivation for the present study. Simulations were conducted with only biogenic emissions, providing information on the relative contributions of biogenic and anthropogenic sources that needs to be elaborated in the text. See my specific comments below.

Finally, I recommend to the editor that before publication the manuscript be thoroughly proofread for correct English usage and grammar. The manuscript is generally understandable, but there are numerous grammatical errors, only a few of which I have listed in the technical comments below.

Specific Comments

Title - For better alignment with the objectives of the study, I recommend altering the title to "Contributions of mobile, stationary, and biogenic sources to air pollution in the Amazon rainforest: a numerical study with the WRF-Chem model."

Abstract - I recommend including results on the relative impacts of anthropogenic and biogenic emissions on pollutants.

14 Please clarify the purpose of the future scenarios, e.g. “as well as a future scenario to assess the potential air quality impact of doubled anthropogenic emissions.”

28 300 Million tons of coal equivalent relative to what amount previously?

32-34 Understanding the predominant sources of each pollutant is key to designing successful regulatory policy. Since this is a key objective in the study, mention this in the first paragraph.

52 Impact of anthropogenic emissions of air pollutants on what?

58 I recommend stating again here why we want to know the “participation of each type of emission source on air pollution” (e.g. regulatory purposes) to underline the present study’s importance.

84 State here what the four measurement sites observed (e.g. meteorological parameters, air pollutant levels)

104 Why were these WRF-Chem physics options chosen? Some justification should be included here. Were simulations with different options conducted and evaluated against observations to find the best representation? Were they based on previous published studies?

134 It seems to me that initializing the model chemical fields with observed chemical profiles where available would provide a better result than using mid-latitude Northern Hemisphere profiles. How do observed profiles (e.g. from aircraft campaigns) compare with the WRF-Chem default profiles?

151 Please define “gasohol” in the text

153 How reasonable an assumption are emission factors measured in São Paulo? Do they depend on meteorological conditions?

177 Please include some examples of “transport and communication areas”

192-196 Please explain why you used EPA rather than CETESB TPP emission factors.

225 How do the emissions estimated in the present study compare with previous studies (previously existing inventories for Manaus, global inventories)?

255-269 Include numerical values indicating “good representation of the temporal evolution..”, “diurnal peak and minimum night temperatures were weakly represented.”, “relative humidity profiles show a good level of agreement..”, and “IFAM and T3 sites have the greatest discrepancies among the results.”, and “According to the mean bias..”

276-277 Provide values for MNBE

280 What “fire outbreaks”? Do you mean that there was fire influence during this period and fire emissions were not included in the simulations? On lines 93-95 you state “Another important factor when choosing the period of study was the low incidence of biomass burning wildfires in the rainy season.”

288-289 Would you expect a similar linear result if you varied mobile and stationary sources independently?

290-294 Is the range of 84-207 ppb calculated at the same altitude the aircraft sampled at, or in the first model level, where higher CO values would be expected?

319 Do peak values have disproportionately higher impacts on public health? That is, are there threshold values of PM_{2.5}, NO_x, O₃ for health and ecosystem adverse impacts?

323-324 Unclear. Do you mean “In this sense, their impacts on peak average values should be evaluated.”

345 Why was the contour of $PM_{2.5} \geq 5 \mu g m^{-3}$ chosen? Is it associated with some threshold of human health impact?

376-377 I recommend mentioning again that mobile/stationary emissions partitioning is important for designing regulations

379 How would you expect the results to change in the presence of biomass burning emissions?

422 Mention numbers again, e.g. “In all cases, an increase in air pollution concentrations (X%-X%) could be observed..”

Technical Comments

11 Insert “on air pollution” after “impact of the emissions from mobile and stationary sources.”

14 Remove “Results show that”

16 Remove “ones”; I recommend replacing all instances of “futuristic scenario” with “future scenario.”

17-18 Replace two instances of “has shown” with “showed”

19 Insert “transported” after “predominantly.”

31 Alter “oxide nitrogen” to “nitrogen oxides”

33-34 Alter “technologies, which guarantee” to “technologies that guarantee”

37 Alter “the complex combination of the latter” to “their complex combination”

38 Alter “the transportation and the combination of atmospheric pollutants” to “the transport and interactions of atmospheric pollutants”

41-42 Alter “aspects of the pollution impact. For instance, pollution episodes..” to “aspects of the pollution impact, such as pollution episodes..”

43 Alter “transportation” to “transport”

44 Alter “effects on” to “effects of”

46 Alter “Such studies are not capable of investigating the impact of isolated urban plumes.” to “Such studies did not investigate the impact of isolated urban plumes.”

47 Alter “in the last decades” to “in recent decades”

58 Alter “Bela et al., 2014” to “Bela et al., 2015.”; Alter “Therefore, such studies” to “These studies”.

62 Insert “pollutant concentrations above” before “the preserved forest region”

69 Alter “Participation of mobile and stationary sources in..” to “Participation of mobile and stationary anthropogenic sources and biogenic sources in..”

76 Alter “scope” to “region”

77 and 215 Remove “ $\lambda =$ ” and “ $\Phi =$ ”

81 Alter “represents” to “is part of”

101-102 Move “simultaneously” to before “predicts”

113 Delete “side”

118 Insert “reactions” after “photolysis”

121 Insert “masl” after “height”

150 Alter “grid study” to “study grid”

200 Alter “Northern region” to “North region”

202-203 Alter two instances of “admitted” to “assumed”

207 Alter “greater” to “greatest”
214 Alter “northern region” to “North region”
273 Remove “In relation to air pollutants”
276-277 Alter “with CO and NO_x, the tendency is the opposite. They underestimated..”
to “with CO and NO_x, the simulations underestimated..”
288-289 Move “Temporal evolution of PM₁₀ and NO_x concentrations is shown in Figure
S1.” before “Overall, it was observed that the model responds linearly to variations
performed.”
300-303 Insert “downwind of Manaus” after “O₃ mixing ratios.”
313 Insert “significant” before “effects”
314 Alter “in this work” to “in the present study”
323 Alter “its impact” to “their impact”
328-329 Alter “in each extremity. The values recommended by Skamarock et al. (2008)
were used in order to reduce the effect of lateral boundary conditions.” to “in each
extremity, which were the values recommended by Skamarock et al. (2008) to reduce
the effect of lateral boundary conditions.”
332 Insert “spatial” before “average”
335 Alter “parameters applied” to “parameters considered”
345 Alter “In order to analyze the plume of Manaus city, the spatial distributions of
pollutants evaluated have been performed.” to “In order to analyze the spatial extent
and location of impact of the plume of Manaus city, the spatial distributions of pollutants
have been evaluated.”
347-348 Alter “The impact is both on the average values and the peak values.” to “The
impact is both on the spatial average and spatial peak values.”
375 Insert “not present in global inventories” after “daily cycle of emissions”
427 “Network for Climate”

Table 1 - Caption - Alter “Physical parameterization used for this study.” to “WRF-Chem
physics parameterizations used for this study.”; Alter “Soil-Land Parameterization” to
“Soil-Land”

Table 3 - Caption – Alter “per” to “by”

Table 4 - Alter four instances of “natural” to “biogenic”

Table 9 - Insert units in parentheses after “Area”

Figure 2 - Could you combine Fig. 2 with Fig. 1 to save space?

Figure 5 - Caption – format subscripts for PM_{2.5} and NO_x