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Comment on acp-2021-552

Anonymous Referee #3

Referee comment on "Evaluation of the WRF and CHIMERE models for the simulation of PM_{2.5} in large East African urban conurbations" by Andrea Mazzeo et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-552-RC1>, 2022

General Comments:

Overall, this paper uses a sound scientific approach that supports its main conclusion that the coupled WRF-CHIMERE model is suitable as a tool for air quality management in East Africa. It could be improved with more in depth discussion of some results and clarification/correction of several minor items.

Specific Comments:

I couldn't tell from the text if anthropogenic emissions inputs to the model had any diurnal variations. Only annual total emissions are mentioned, possibly indicating that constant emission rates are used for each pollutant. This could have a major impact on correlation to hourly data.

Not entirely clear how statistical measures are averaged (lines 336-338). Are measures calculated for each site and then those values for each domain are averaged (e.g., the 5 Relative Humidity NRMSE values for the 5 KEN2K weather stations are averaged to produce the KEN2K NRMSE value?) Or are the observed and modelled data for all the sites within a domain used together to calculate the average measure?

It would be helpful to specify how wind direction statistics were calculated. Since wind direction is a circular variable, calculating means, RMSE, etc. is different than for linear variables. Also, I'm not sure that normalized measures, MNB, NRMSE make sense for

wind direction.

In the discussion of statistical evaluation of meteorological parameters it would be helpful to include criteria for what constitutes "good agreement" (line 361), "acceptable agreement" (line 443), etc.

Table 3 needs to include units for each meteorological variable. Shouldn't the MNB for KEN2K wind speed be negative?

There are conflicting statements about model performance for wind speed and direction. Lines 426-427 claim that the Nairobi and Kampala show higher agreement than Addis Ababa, but line 431 says that Kampala is the worst performing of the three cities.

In Table 4, why are the Mean MOD PM2.5 values different for Daily and Hourly? And it seems strange that the hourly NRMSE values are lower than the daily NRMSE.

In Figure 8 the data for Nanyuki show what appears to be a nearly constant baseline PM2.5 concentration of around 2 to 2.5 $\mu\text{g}/\text{m}^3$. Why would this be occurring?

The PM2.5 data from Figure 9 and Figure 8 don't seem to agree. For the period March 3 – March 10, Figure 9 reports a daily concentration of 53-55 $\mu\text{g}/\text{m}^3$ each day. In Figure 8, however, the hourly concentrations for that same time period hover around 2.2 $\mu\text{g}/\text{m}^3$ and never exceed 4 $\mu\text{g}/\text{m}^3$.

Discussion of impacts on human health uses population density by itself (lines 26, 726-728, 743-746). It might be more meaningful to determine the total population exposed to elevated PM2.5.

In presenting data table results, the text is often mainly just stating the values that are already shown in the tables. (e.g., sections 3.1.2, 3.2.1, 3.2.2) These sections could be condensed and/or modified to include additional description and discussion of what the data values mean. For example, why might model performance for wind speed and wind direction vary for airport vs. urban locations, why is there such a strong correlation between model and observation in Nanyuki, what are possible reasons for differences in model performance between the different domains?

Technical corrections:

Throughout the manuscript the authors mention "low air quality index". This could be interpreted as a low numerical value of the air quality index, indicating good air quality, but from the context it seems the authors are instead describing poor, or low, air quality. It would be better to use a different word than "low".

I found the initial paragraphs of section 2, Materials and Methods, to be unnecessary (lines 104-127). They provide a partial summary of emissions, observational data, and model simulations, but since it is not a complete description, the reader is left with many questions. There are separate subsections that do provide all the pertinent details and they are much easier to follow. I would suggest removing lines 104-127 and incorporating that information into the subsections as appropriate.

Clarify in section 2.2 that CHIMERE is run only for the 6x6 and 2x2 km domains. This is somewhat implied in the discussion of boundary conditions (line 174), but not clearly specified. It is not until section 3 (lines 303-304) that it becomes clear.

It might be clearer to mention the rural Nanyuki, Kenya site (lines 285-287) immediately following the description of the urban Nairobi, Kenya site (lines 280-281).

Symbols and text on figures with maps (Fig 1, Fig 3, Fig 7, Fig 11) were too small to read without zooming in to at least 200%. I was left searching for tiny triangles, numbers, and colored dots.

Table 2 – units on Elevation written as "(m a. g. l)" are unclear. I interpret this as meters above ground level. "Above ground level" would imply monitoring sites aloft. I suggest just using "(m)" because elevation of ground sites can be assumed as height above sea level.

Line 392 – does "small mean bias" refer to MB or NMB, and is it only for temperature peaks or all temperature measurements? There is similar ambiguity about the use of "mean bias" of relative humidity in line 406

Line 414 – change "...sampled, a better ..." to "...sampled. A better ..."

Line 436 – not clear what is meant by "both observation sites". The text seems to be describing results at Addis Ababa which only has a single site.

Would be helpful to add a sentence after line 332, stating the frequency of weather station data observations. From Figure 4 it seems to range from every 3 hours to every 6 hours.

Table 4 needs to include units for PM2.5 (presumably micrograms/m³, but not specified).

Line 524 - 526, Eq. (2) and Eq. (3) are missing parenthesis in the denominator around (Co+Cm)

Table 5 is never referred to in the text.

Line 598-599. Figure 7 is mentioned twice, but text seems to be describing Figure 8.

Figure 7 seems to be almost the same as Figure 3c. Not sure why it is needed.

Figure 9 should use a date format consistent with other figures in the paper. (Figure 9 writes dates as YYYY-MM-DD, while other figures use DD/MM/YY)

Lines 674-680. Could also consider the impact of precipitation on particulate levels.

Line 689, change "constituencies where analyzed" to "constituencies were analyzed"

Line 690-691, text mentions relative population density and references Figure 11, but Figure 11 does not include any population density data.

May want to mention that the AQI levels are for hourly measurements, while the WHO limit used is for a daily average.

In Figure 11, the concentration scale for the plot on the right is set at 50 µg/m³, which is lower than the maximum concentrations. It would be better to use a scale that encompasses the entire concentration range.

Line 737-738, Figure caption mentions "top right" and "bottom right" maps, but only one is shown.