

Interactive comment on “Analysis of CO₂ spatiotemporal variations in China using tower data and a weather-biosphere-online-coupled model, WRF-VPRM” by Xinyi Dong et al.

Anonymous Referee #1

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In this manuscript, “Analysis of CO₂ spatiotemporal variation in China using tower data and a weather-biosphere-online-coupled model, WRF-VPRM”, authors analyzed the spatiotemporal variations of CO₂ concentrations and fluxes measured at a flux tower (Lin'an), column-concentrations of satellite and flask measurements, and compared with WRF-VPRM simulation results for three years from 2016 to 2018. The study finds that anthropogenic emissions determined the spatial distribution of CO₂ and that the observations and simulations showed an increasing trend in XCO₂. It also displayed the WRF-VPRM model successfully reproduced both ground and satellite-column CO₂ concentrations but was relatively largely overestimated by the flux measurements. The authors have conducted tremendous work on both analyses of various measurement

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data and simulations for this study. However, this paper is not proper for publication on Atmospheric Chemistry and Physics, considering the arrangement and completeness of the logical development, and a bit unreasonable application of WRF-VPRM. The detailed comments can be described below.

General comments Authors never reported model configurations, specifically for meteorology, although one of the key works for this study is a numerical simulation. For the publication of modeling work, the basic model configuration for both CO₂ and meteorology is essential for the scientific community's numerical experiments' reproducibility. The model configuration is also significant for understanding the analysis of CO₂ concentrations near the ground, interacting with the PBL and stable boundary layer (Section 3.3). Without prior knowledge about the model set-up, readers cannot be sure of the quality assurance of simulation results. For the analysis of CO₂ concentration near the ground, especially in nighttime, the PBL scheme's choice is significant. As the “first” WRF-VPRM simulation over the study domain, authors must conduct the PBL scheme sensitivity tests and find the best physics scheme combinations before progressing this manuscript. The fine resolution (20-km) is too coarse to capture Lin'an's footprint area, which would be roughly < 4 km at the height level under stable conditions. Therefore, it is hard and a bit unreasonable to directly compare with local-scale measured fluxes. This manuscript's key sites or regions are Lin'an and Hangzhou, but their locations and site descriptions are missing. No mark on maps or description sub-section. This is very important for readers' understanding. In Line 295, for example, the authors tried to describe the transport of CO₂ plume from Hangzhou. However, readers do not know their spatial location, so they cannot catch up the further discussion. How far are the two locations? How much is Hangzhou close to efficiently affect to Lin'an? The authors explained in Line 240 that the Lin'an site could be affected by regional anthropogenic emissions. However, readers would not understand which regions or directions could be the main culprit. Therefore, wind direction analysis should be needed in Figure 6, where only wind speeds are displayed. Besides the location of Lin'an, its LULC features should be described in a sub-section. A native English speaker should edit this

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paper, especially for tense. Usually, past tense is supposed to be used in the method and the results and discussion sections, especially for the action and experiment have done already.

Specific comments

1) The main title is not proper for summarizing the whole content. Specifically, the first part of the sentence (before 'and') indicated only tower data, although the authors used integrated various measurement data. In the later part, after 'and', the sentence sounds like the WRF-VPRM model analysis, which is odd because we do not usually analyze the model itself. 2) Figures are a bit chaotically mixed, so readers cannot smoothly follow the writing flow. Please explain figure by figure in the body for the consistency of the flow of paragraphs. In Figure 1, for example, the spatial distribution (upper panel) and the photo of the Lin'an site (bottom panel) should be drawn on two different figures. In Figure 6, some sub-figures should also be separated.

Line 92: Add the version of WRF. Line 283: What is ΔH ? Line 300: Footprints at each level of the flux site should be quantified

Technical corrections Figure 1: Figure 1(f) is missing, although Line 131 referred to it. Figure 4: The graphic resolution is poor for (e). Readers cannot identify or separate the difference between the shaded area and others. Figure 6. The scale of the y-axis must be matched for a clear comparison. Line 162: The full name of NMB is mentioned later, Line 166.

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