

Interactive comment on “Measurement report: Fireworks impacts on air quality in Metro Manila, Philippines during the 2019 New Year revelry” by Genevieve Rose Lorenzo et al.

Genevieve Rose Lorenzo et al.

grhlorenzo@email.arizona.edu

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Response: We thank the two reviewers for thoughtful suggestions and constructive criticism that have helped us improve our manuscript. Below we provide responses to reviewer concerns and suggestions in blue font. All changes to the manuscript can be identified in the version submitted using Track Changes.

Anonymous Referee #1 Received and published: 25 November 2020

In this study, most contents are spent on describing the data without enough discussion. There was no new information on the method development and conclusion. The

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suggestions are as follows:

Response: Thank you for your blunt evaluation but we want to also remind the reviewer that according to ACPD, a Measurement Report aims to do the following: “Measurement reports present substantial new results from measurements of atmospheric properties and processes from field and laboratory experiments. Analysis of the measurements may include model results and conclusions of more limited scope than in research articles.” We fit into this category as we report substantial new results from field measurements of aerosols over Metro Manila (satisfying the first sentence in the quotation above). Further, we discuss the results and reach a series of conclusions (satisfying the second sentence in the quotation above). If there is any concern that the conclusions are of limited scope, that is fine and not an issue as that is partly the nature of Measurement Reports based on the quotation above.

1. Fireworks have been widely studied all over the world. Although the studies in the Southeast Asian are not so much, the authors must tell us the difference with other regions and the significance of studying fireworks in this region.

Response: Thank you for this comment. China (East Asia) and India (South Asia) where most of the other firework studies have been done are not part of Southeast Asia (SEA) that includes Cambodia, Laos, Myanmar (Burma), Peninsular Malaysia, Thailand, Vietnam, Brunei, East Malaysia, East Timor, Indonesia, Philippines, Singapore, and a small part of India. East Asia and South Asia have different meteorological conditions and geology as compared to SEA. SEA has a unique hydrometeorological condition (high moisture) and geology (islands and mainland) and as such complicates the study of aerosols in the area. Aerosol studies in SEA are generally limited. An extreme event such as New Year with fireworks adds to the complexity and there are scarce studies on this. More specifically, there are no size-speciated chemical analysis as well as optical properties of firework emissions in Manila. Results of this work can improve understanding of the local impacts on health and the environment, which currently are still lacking. Several sentences and sources were added to the introduction

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about these. Here is the added text:

“Studies on the properties of aerosols in general in South East Asia (Tsay et al., 2013) which is one of the rapidly developing regions in Asia are limited. This compounds the challenge to understand the interactions between aerosols and the complex hydro-meteorological and geological environment in South East Asia (Reid et al., 2013). Increased local and transported emissions (Hopke et al., 2008; Oanh et al., 2006) in South East Asia adds to the complexity and affects air quality in the region. Firework emissions are an example of extreme and regular local emissions in South East Asia. And even while several studies exist in the neighboring regions of East Asia and South Asia, there currently is no in-depth analysis of the chemical, physical, and optical properties of firework emissions in a South East Asian megacity where fireworks are culturally significant. Studies on the impacts on health and the general environment due to firework emissions in South East Asia are as scarce.”

2. There are too many questions that the manuscript wants to address. Please combine some of them, so that the aims of this work can be better understood.

Response: Thank you for this note, we have condensed the questions to two major questions: “We address the following questions in order: (i) what are the conditions of the atmosphere during the study period in relation to aerosols, and how are these affected by firework emissions?; and (ii) what are the concentrations, mass size distributions, and morphological characteristics of different elemental and ionic species specific to fireworks, and how do these affect bulk aerosol hygroscopicity?”

3. Why the carbon fractions were not detected in this work? The manuscript said that “Although fireworks emit extensive amounts of inorganic species, the calculated κ values were still relatively low because the background air is dominated by organics and black carbon, which are relatively hydrophobic species: : :”. Carbon fractions accounted for high percentages of PM, and they are important product of fireworks as reported in many literatures. In addition, the carbon aerosol is critical for studying the

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optical properties and hygroscopicity, which are important parts of this work. Thus, it is a big problem if the carbon fractions were not detected.

Response: We were not able to analyze both for elemental and organic carbon because of the need for separate analysis which was not available at that time. We used related literature on a study done in a nearby site to estimate the ratio of elemental carbon in the samples. An issue was insufficient substrate surface area to do all of the various types of analyses possible. We cut the substrates into portions for the different types of analyses we report in the paper and there was insufficient sample left for more detailed carbon analysis.

4. Many results were reported in this work. However, the explanation and the discussion are lacked. And the relationships among data from different methods must be discussed.

Response: Thanks for this note, hopefully the condensed conclusions and rearranged sentences helped to address the connection between the data, analysis, and implications.

5. The size distribution of chemical compositions can be very useful to study the PM properties, but related discussion is unabundant. And the influence of size distribution of chemical compositions on the optical properties and hygroscopicity must be studied.

Response: We have added text to address the implications of the composition results for optical and hygroscopic properties:

“Higher concentrations of secondary particles, which in this study is in the accumulation mode, from fireworks are related to increased mass extinction efficiency and therefore decreased visibility (Jiang et al., 2014) as was observed. The increased water-soluble fraction, especially in the submicrometer mode, during firework events coincides with elevated particle hygroscopicity which is related to CCN activity (Drewnick et al., 2006) at smaller diameters (Yuan et al., 2020) and which can be part of a future study.”

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6. More evidences (such as fire plots) should be provided and combined to get conclusion.

Response: We are not fully sure what the reviewer is referring to here as the suggestion is vague to us. We feel that we have reported our measurement data effectively and comprehensively already. We have tried to improve our conclusions, as also mentioned in response to the next comment. Extending the analysis is beyond the scope of this work as this is just a Measurement Report where we report special data for a specific region; more extensive analysis and discussion would warrant a regular article submission which is not what our intention is at this point.

7. The conclusion should be rewritten. The conclusion now just listed some results of the data. The logical relationship of results must be analyzed and more deeper conclusion must be summarized.

Response: Thank you for this note. We have rewritten the conclusion to address the two major science questions in the introduction. We reordered the sentences also to give the context of the work and connect the analysis and results better and more fluidly.

8. The results about compositions have been widely reported, and no new information is provided in this work. The size distribution may be an interesting topic, but it was not studied abundantly in the discussion and no conclusion about it is provided.

Response: We believe the novelty of this work is the “combination” of different datasets used to characterize firework emissions in a critically important (and highly populated area) without a detailed firework study in the peer-reviewed literature yet. We respectfully disagree that we did not study the size distribution behavior as that is the foundation of our analysis (i.e., the MOUDI data). We have addressed this comment thought by adding some more discussion and improved conclusions.

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2020-1028, 2020.

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