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25 October 2021

Jon M. O'Brien, Environmental Program Manager
Off-Highway Motor Vehicle Recreation Division
California Department of Parks and Recreation
1725 23rd Street, Suite 200
Sacramento, CA 95816

Dear Mr. O'Brien,

Please find attached my specific responses to the comments provided by the SAG on 22 October 2021, as well as a supplemental report on the SLOAPCD 2020 measurements that Karl Tupper provided to me last week.

Their major points 1 and 2 are based on their neglect of my peer-reviewed literature references, many of which also appeared in my prior reports. They provided no contradictory peer-reviewed literature that could provide a basis for modifying this text. Major point 3 is the only one relevant to the analyses presented here and is somewhat contradictory. While first asserting the data's lack of value, it then concludes that it should be compared to data not yet available.

The failure of the SAG comments to note evidence in support of their major points 1 and 2 is worrisome and does not meet academic standards, with this lack of supporting detail providing the appearance of inattention or obfuscation. Despite this, I provide here attached constructive responses to each individual comment. Moreover, I suggest a path forward that lies at the intersection of our results, providing Parks with the information needed to move ahead considering the limited role of mineral dust from the ODSVRA (or any other source) in contributing to PM. For this intersection of results, I present the subset of the May 2021 results for which BAM and gravimetric methods agree similarly to that of the SLOAPCD 2020 measurements, showing that still only 15% of BAM PM10 is mineral dust (26% on high-PM10 days). While this does leave unanswered the scientific question of whether semivolatile components are sufficient to explain all of the difference between BAM and gravimetric methods on the remaining days, it provides a clear and consistent attribution of the dust from two independent groups.

The openness of the SAG to measurements to identify the ODSVRA contribution is welcome (SAG "welcomes monitoring campaigns and scientific studies…"), but it does beg the question of why such research was not conducted in the several preceding years of the SOA prior to the Scripps/UCSD contract. The methods I have introduced are standard and by no means unique to my laboratory, and yet the SAG did not call out the need for such measurements prior to my

work. It is concerning that they either lacked the expertise or the intent to provide Parks with such findings until my work pointed out this need in 2020. Their failure to note the implications of their own findings as well as mine provides further reason for concern.

Please do not hesitate to contact me if you have any questions; my cell is 858 405 8203.

Best regards,

Lynn M. Russell
Distinguished Professor of Atmospheric Chemistry
Scripps Institution of Oceanography
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Supplemental Discussion of SLOAPCD 2020 Measurements

25 October 2021

The 2020 SLOAPCD confidential results were provided by Karl Tupper by email on 10/20/21 and 10/22/21. They collected 13 samples between April and September of 2020, with XRF, IC, and gravimetric measurements. Their results show that gravimetric measurements are consistently lower than BAM, with gravimetric averaging 88% of BAM for all 13 samples (Figure S1). Moreover, the mineral dust (or “geological”) part of BAM is 30%, which is well under half of the overall PM10 concentration, with a standard deviation of 14% and a minimum value of 5%. (Note that their results were reported per email on 10/22/21 as fractions of gravimetric, but here they are converted to fractions of BAM.) This result is consistent with the measurements of mineral dust reported for May 2021 by Scripps/UCSD for 11 high-PM10 days, which had an average of 14% with a standard deviation of 14% (and a maximum value of 32%). This means that the upper range (mean to maximum) of the Scripps/UCSD results (14%-32%) overlap the lower range of the SLOAPCD measurements (5%-30%). Given the small sample size of each (13 and 11), this overlap shows very similar results.

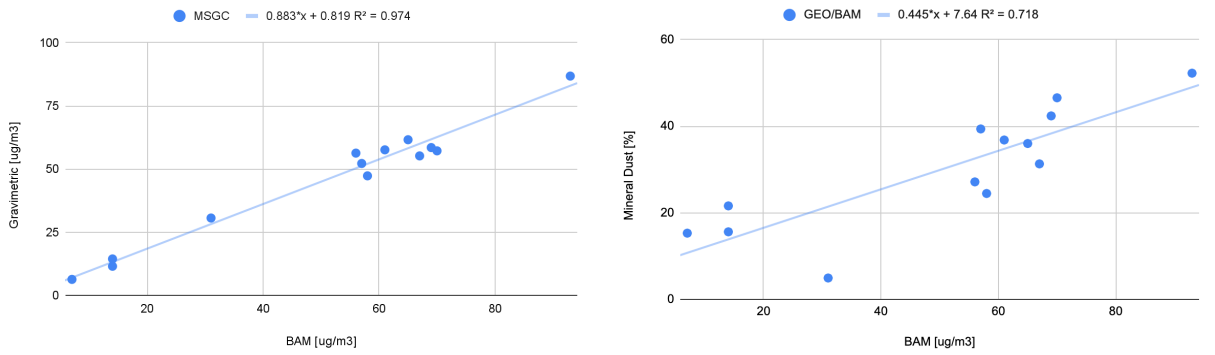

Figure S1. SLOAPCD 24-hr measurements between April and September of 2020, provided by Karl Tupper (10/20/21). Left panel shows the comparison of gravimetric and BAM concentrations, with a slope of 0.88 showing lower values of gravimetric relative to BAM concentration. Right panel shows the mineral dust percentage as a function of BAM concentration, with an average of 30% and standard deviation of 14%.

For a more specific comparison to the SLOAPCD results (Tupper, email 10/22/21), the Scripps May 2021 results can also be screened to match the criteria of their results (Figure S2). Specifically, if we include only the results for which the gravimetric method accounts for 82% or more of the BAM PM10 mass concentration, which includes 3 of the high-PM10 days and 5 of the other May 2021 days, then the agreement of the BAM and gravimetric is comparable to the

SLOAPCD as shown below. In addition, there is a correlation between the mineral dust fraction and the BAM concentration.

It is of course worth noting that this agreement is despite differences in the collection and analysis protocols, including the different collection times (24 vs. 7 hr) and the mineral dust approximation (Malm vs. Usher). Also, while the SLOAPCD measurements targeted windy days, it would be important to compare days of similar windiness.

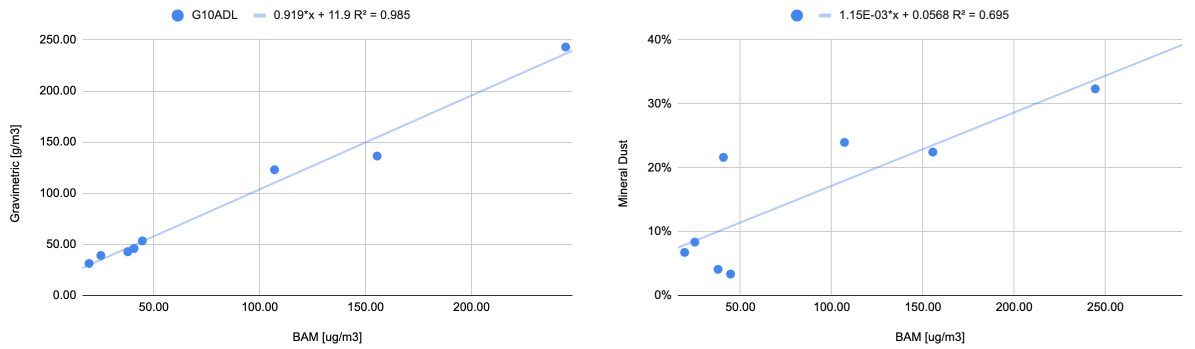

Figure S2. Scripps/UCSD 7-hr afternoon measurements in May of 2021 for the eight days that had agreement between gravimetric and BAM methods similar to that of the SLOAPCD study (namely gravimetric accounted for >82% of BAM concentration). Left panel shows the comparison of gravimetric and BAM concentrations for these 8 days, with a slope of 0.92 showing lower values of gravimetric relative to BAM concentration. Right panel shows the mineral dust percentage as a function of BAM concentration, with an average of 15% and standard deviation of 11% for these 8 days. If only the three high-PM10 days with matching gravimetric and BAM methods are included, the average is 26% and standard deviation of 5%.

Interestingly, when the Scripps/UCSD and SLOAPCD measurements are compared with similar screening, both the BAM and gravimetric comparisons are similar in terms of slope (0.88 and 0.92) and correlation (R^2 of 0.79 and 0.72) and mineral dust fraction (30±14% and 26±5%). This substantial agreement shows that the fraction of PM10 attributable to the ODSVRA consistently accounts for somewhat less than half of the PM10 concentration.

SAG Comments with Scripps Responses on Scripps/UCSD Interim Report 2021			
Reviewer	**SAG Description of Issue**	**SAG Comment**	**Scripps Response**
R1	(p. 2, Background, 1st paragraph, 5th sentence) The fact that there is a lack of difference between weekday and weekend coarse particle emissions does not support the hypothesis that "natural" sources predominate over "anthropogenic" sources. Instead, it suggests that windblown sources predominate over mechanically-generated sources of dust emissions. Windblown sources include those that are entirely natural, such as undisturbed sand dunes outside the riding area at ODSVRA, and those that are anthropogenic, such as sand dunes disturbed by riding activities.	DRI emissivity testing demonstrates that riding-disturbed dunes produce twice as much windblown dust as undisturbed dunes.	No citation is provided and the information discussed is not publicly available. The conclusion on weekend/weekday differences is a direct citation from a peer-reviewed publication that is not contradicted by the information provided. The DRI reports I have seen have not shown PM10 impacts at CDF and they provide informationon emissive potential not ambient PM10.
R1	(p. 2, Background, 1st paragraph, 6th sentence) Supermicron particulate matter between 2.5 and 10 microns in size has been identified by U.S. EPA in assessments of health effects studies to contribute to increases in thoracic flow resistance and heart rate variability, among other impacts, regardless of elemental or chemical composition. It is on the basis of such studies that U.S. EPA maintains the PM10 ambient air quality standard to protect public health. Statements to the affect that windblown sand particles in the coarse particulate size range do not contribute to chronic respiratory effects are erroneous.	Statements to the affect that windblown sand particles in the coarse particulate size range do not contribute to chronic respiratory effects are erroneous.	No citation is provided and the information discussed is not publicly available. The conclusion on the role of coarse dust for health effects is from a peer-reviewed publication that is not contradicted by the unreferenced information provided.
R1	(p. 3, last paragraph, 1st sentence) U.S. EPA has designated PM2.5 to be an air pollutant harmful to public health, regardless of elemental or chemical composition..	To suggest that that the association of PM2.5 with detrimental health effects may be without foundation is erroneous	The interpretation given is not consistent with the text. No contradictory peer-reviewed evidence is cited.
R1	(p. 4, first partial paragraph, last sentence) Assessing the portions of PM2.5 deriving from windblown dust or combustion emissions is irrelevant as to whether PM2.5 is responsible for adverse health effects.	U.S. EPA's several assessments of health effects resulting from PM2.5 exposure – regardless of elemental or chemical composition – are comprehensive and consistent.	No citation is provided and the information discussed is not publicly available. The conclusion on the role of compositiont for health effects is from a peer-reviewed publication that is not contradicted by the unreferenced information provided.
R1	(p. 8, first paragraph) The mineral dust component of filter samples collected on high-PM10 days is reported to range from 2% to 32%, and average 14% with a standard deviation of 14%. In 2020, the SLOAPCD collected eight filter PM10 samples at the CDF monitoring site on windy days between April 23 and September 24, which were analyzed by XRF by the Desert Research Institute. Using the IMPROVE protocol for isolating the geological component of mass (2.2xAl + 2.49*Si +1.63xCa + 2.42*Fe + 1.94xTi), the average geological component was found to be 43.5% with a standard deviation of 10.2%. Because of these significantly different results, it would be useful for Scripps and SLOAPCD to exchange raw data in an attempt to resolve these differences in analytical results.	Because of these significantly different results, it would be useful for Scripps and SLOAPCD to exchange raw data in an attempt to resolve these differences in analytical results.	I have now analyzed the APCD results for 24-hr measurements of dust fraction. While the information provided is not sufficient to review the accuracy of the results, and the results apply to different days, I have now applied a screening similar (but over different period for different sampling duration), and have obtained similar results, when compared on a consistent basis (i.e. BAM). When the APCD 2020 data are evaluated relative to BAM (rather than gravimetric) the average is 30% with standard deviation of 14% for 13 samples. Using a similar screening, the Scripps results give 26% on three high-PM10 days in May. These results are statistically indistinguishable.
R1	(p. 9, first paragraph) The mineral dust component of PM2.5 filters collected on high-PM10 days is reported to average 27% by VSCC inlet and 19% by SCC inlet. Typically, the geologic component is predominately higher in PM10 samples than in PM2.5 samples as the mean particle size of windblown dust is about 4 microns. These results suggesting that the geologic component is higher in the PM2.5 fraction than in the PM10 fraction at the CDF monitoring station are unusual and warrant an explanation.	These results suggesting that the geologic component is higher in the PM2.5 fraction than in the PM10 fraction at the CDF monitoring station are unusual and warrant an explanation.	The reviewer is partially correct that the results imply a mode peaking above the PM2.5 cutoff, but not that this implies a higher fraction of mass in PM10 than PM2.5. The explanation is provided that the size distribution is somewhat different than the canonical expectation, but entirely consistent with previous APCD findings about the size distribution of dust, as cited in the report (SLOAPCD memo).
R1	(p. 13, Figure 3) The labeling of the difference between BAM and PM10 filter measurements as "Semivolatile" is speculative in the absence of further testing.	The positive identification of only 18% of PM10 mass results in very limited information with respect to the composition of PM10 measured at the CDF monitoring	As noted above, while the Scripps study was not funded for complete speciation, the dust results are consistent with those reported by SLOAPCD (Tupper, email 10/22/21).
R1	(p. 13, Conclusions, first paragraph, last sentence) The statement that results of this study were consistent with the chemical composition reported by the SLOCAPCD in its Nipomo Mesa Particulate Study (Phase 1) is misleading in that the Phase 1 study analyzed only total mass, sulfate, nitrate, and chloride values in PM10 samples collected at the CDF monitoring site.	As the Scripps study did not analyze sulfate, nitrate, and chloride contributions at CDF, there is almost no overlap in the constituents measured in the two studies with respect to samples collected at CDF.	The report statement is still correct, in that the overlap of analyzed results for both PM10 and PM2.5 are consistent.
R1	(p. 14, first paragraph, first sentence) The statement that dune-derived mineral dust is more likely to be primarily caused by natural forces (i.e., wind) rather than human activities ignores the results of dune emissivity testing conducted almost annually since 2013 by the Desert Research Institute which shows riding-disturbed dunes are twice emissive as non-disturbed dunes at ODSVRA.	These results demonstrate that human activity on the dunes is responsible for roughly 50% of windblown emissions of PM10 from the riding area.	The interpretation given is not consistent with the text. No contradictory peer-reviewed evidence is cited.
R1	(p. 14, second sentence, second paragraph) The statement that a substantial fraction of PM2.5 was not associated with fossil-fuel combustion emissions ignores the failure in the paper to identify the composition and sources of 63.6% of total mass on PM2.5 samples collected on high PM10 days.		As discussed in the report in context, this statement about fossil fuel emissions is based on the amount of organic mass measured, and it will be supported by the organic composition presented in the final report. These details about minor components of PM do not affect the attribution of PM to mineral dust, which was the focus of the interim report due to its relevance to our study objectives.
R2	(p. 2, Background, first paragraph, 6th sentence, "as well as by source areas") Not clear what this means.	How the source area increase emission?	Emissions of dust increase with the size (area) of dunes, as discussed by references cited in the report. As an illustrative example, the amount of emissions from Oceano dunes is smaller than that of the Gobi desert because the area of the dust source at Oceano is smaller than the area of the Gobi desert.
R2	(p. 2, Background, first paragraph, 7th sentence) But they have been associated with negative impacts on human health. See literature cited by SAG in review of last report.	See literature cited by SAG in review of last report.	Comments in prior review did not cite peer-reviewed literature relevant to this issue, so it is not clear what is intended here.
R2	(p. 3, first partial paragraph, first full sentence)	Where is this in reference to?	The first paragraph on p.3 is a full paragraph, so it is unclear what this question is asking about.
R2	(p. 3, last partial paragraph, first sentence) What about research that links mineral particle inhalation with an asthmatic response?	What about research that links mineral particle inhalation with an asthmatic response?	The cited research does not link mineral dust particle inhalation with an asthmatic response, which is the point of the discussion.
R2	(p. 4, first partial paragraph, last sentence) The opinion stated (still) does not mean that under current laws, that standards are not to be met.	In addition, the focus on PM2.5 does not allow for the setting aside of the SOA's intent to control PM10.	The reviewer is partially correct in that the importance of PM2.5, and moreso of PM1 (and ultrafine particles), for health effects does not set aside the regulatory restrictions on PM10. However, it does imply that the value to society of regulating PM10 is less than believed at the time the regulations were set in force.
R2	(p. 7, bullet 1a)	What does SIO stand for?	Scripps/UCSD.
R2	(p. 13, Figure 3 caption) No analytical measurements were carried out other than XRF.	So doesn't that make the apportionment rather "cursory"?	The Reviewer is correct that the apportionment would be more complete with additional analyses that we had proposed. However, the dust source is effectively entirely mineral, so the dune-related fraction can be apportioned in the absence of characterizing the other remaining (and variable) sources. To summarize, the apportionment to all sources is certainly incomplete, but the apportionment to dust sources is very comprehensive (and not cursory).

	(p. 14, second full paragraph) There has been no recent debate on the source of the PM10 being generated by saltation processes driven by the wind. The recent analysis and reporting of DRI we suggest (the SAG) provide compelling data that demonstrates the OHV activity augments the emissivity of the dunes (PI-SWERL data).	DRI and APCD data show that cessation of OHV activity in 2020 resulted in lower PM10 for the same wind conditions, suggesting that the dunes are becoming less emissive following the removal of OHV activity.	The Scripps report is not an assessment of DRI results, although there appear to have been several confounding factors that may change the interpretation presented here by SAG of those results. However, as noted above, the SLOAPCD 2020 measurements show similar mineral dust contributions to those found in 2021.
	(p. 14, third full paragraph)	This final paragraph again sets aside that the fact that the SOA is in place to lower PM10 and does not address the toxicity of the particles, regardless of the	The reviewer is correct that in this paragraph the topic returns to the impact on the community (or lack thereof) rather than the PM10 regulation that is routinely violated statewide (Motallebi et al., 2003).
R3	I am not qualified to review the methods and some of the conclusions, but one of the conclusions stood out to me. Namely this: "The association of high PM10 and PM2.5 with high wind conditions, even when recreational vehicles were limited at Oceano Dunes compared to prior years, indicates that dune-derived mineral dust is more likely to be primarily caused by natural forces (i.e. wind) rather than human activities." It seems to me that the results of the DRI study conducted on riding vs. non-riding areas would cast a lot of doubt on this conclusion. The DRI work demonstrated that the riding activity itself MODIFIED the sand surfaces in such a way as to make them more emissive, even when vehicles were not present. I don't think we dispute that it is wind that mobilizes dust. But it seems clear from the DRI work that the vehicles make surfaces more emissive of dust when those surfaces have been worked by vehicle activity.	Whatever other conclusions the paper promotes, this one should be flagged as not supported by the data.	We thank the reviewer for noting his/her lack of expertise for the substantive content of the report. The DRI results presented to date, do not show a link between the emissivity differences and the CDF PM10 BAM concentrations, which is the quantity of interest for the SOA. While the DRI emissivity differences could result in differences at CDF (although their value relative to natural emissivity is not clear), they may not. For example, if the DRI emissivity differences are associated with higher emissivity of larger particles, the shorter lifetimes of those larger particles may preclude differences in ambient concentrations at CDF.