SLO COUNTY apcd | Air Pollution Control District San Luis Obispo County

APCD Review of "Scripps/UCSD Interim Report 2021"

October 28, 2021

Executive Summary

The most recent Scripps report discusses the results of PM_{10} and $PM_{2.5}$ sampling from earlier this year at CDF. Like last year, the District has serious concerns about the sampling methodology employed by the researchers. Previously we criticized the researchers for not collecting PM_{10} samples and for using an SCC size separator to collect $PM_{2.5}$ samples. This year, Scripps collected both PM_{10} and $PM_{2.5}$ samples, and they used a VSCC size separator for $PM_{2.5}$. We view these changes as improvements. However, the Scripps samplers also incorporated flow splitters between their size separators and filter holders. The District believes these flow splitters likely resulted in biased sample collection at the filter, since they do not appear to have been engineered to ensure laminar, isokinetic flow. The report provides no data and cites no references to demonstrate that these novel devices perform as assumed. In contrast to the Scripps devices, EPA-approved particulate samplers—including those used by the District—either direct their entire flow to the filter/detector or use flow splitters that are engineered to ensure isokinetic flow.

Introduction

The San Luis Obispo County Air Pollution Control District ("APCD" or "District") offers this review of "Scripps/UCSD Interim Report 2021: Preliminary Results from the May 2021 Aerosol Measurements," by Scripps/UCSD Professor Lynn Russell. These comments are specifically on the version dated September 30, 2021, provided to the District on about October 1, 2021. The District appreciates the opportunity to provide these comments.

Background

This is the fourth in a series of reports by Scripps/UCSD on State Parks-funded research at the Oceano Dunes.

The first report in the series, "Marine Contributions to Aerosol Particulates in a Coastal Environment," dated March 6, 2018, described the results of DNA analysis of E-BAM filter tapes.[1] The report was touted in some circles as evidence that vehicle activity at the

[1] B. Palentik, M. Nagarkar (2018). "Report: Marine Contributions to Aerosol Particulates in a Coastal Environment," March 3, 2018.

ODSVRA is not the cause of the PM_{10} issue, but the District did not find the study to be relevant to the issue, as we described in a June 2019 FAQ[2] and a comment letter to State Parks.[3] We also offered suggestions for how future investigations could be improved.

The next report was released in early 2020. "First Year (2019) Summary Report: Investigation of Aerosol Particulates in a Coastal Setting, South San Luis Obispo County, California" described the analysis of air samples collected by Scripps at the District's CDF monitoring site.[4] Reviews of the report by the District and members of the Scientific Advisory Group (SAG) noted several methodological and other issues with the study and its findings.[5] The District also provided suggestions for improving future sampling campaigns.

The third report, "UCSD Supplemental Report 2020: Preliminary Results from May 2020 Aerosol Measurements," was released in September 2020.[6] As with the previous reports, the District and SAG were critical of it, noting problems with the study design, sampling methodology, and data presentation, and again offering suggestion for improving future work.[7,8]

The current report describes work conducted earlier this year. The field work incorporates some of the suggestions made by the SAG and the District in our previous reviews, including adding PM_{10} sampling to the study and collecting $PM_{2.5}$ samples using a VSCC size separator. Nonetheless, the District has identified deficiencies in the study and has serious concerns about the report's conclusions.

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[2] SLOCAPCD (2019). "Response to Comments on the May 1st Workshop Version of the Draft Particulate Matter Reduction Plan Required by Stipulated Order of Abatement 17-01," June 12, 2019. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/Response%20to%20Comments_FINAL_PostedJune122019.pdf.

[3] Gary E Willey to Dan Canfield (2019). "California Department of Parks and Recreation's February 1, 2017, Oceano Dunes SVRA Concept Draft Particulate Matter Reduction Plan in Response to Stipulated Order of Abatement Number 17-01," February 25, 2019. Available online at: https://storage.googleapis.com/slocleanairorg/images/cms/upload/files/Feb%2025%202019%20APCD%20Response%20to%20SPFeb%201%202019%20PMRP%20%28Signed%29%20%281%29.pdf.

[4] L. Russell, M. Kahru, B. Palenik (2020). "First Year (2019) Summary Report: Investigation of Aerosol Particulates in a Coastal Setting, South San Luis Obispo County, California," February 21, 2020.

[5] See Attachment 7 in State of California, Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division (2020). "Oceano Dunes State Vehicular Recreation Area Dust Control Program 2020 Annual Report and Work Plan (Draft)," August 2020. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2020%20Draft%20ARWP%208-1-2020%20w%20exhibits.pdf (main document) and https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2020%20ARWP%20Attachments%208-1-2020%20%28002%29.pdf (attachments).

[6] L. Russell (2020). "UCSD Supplemental Report 2020: Preliminary Results from May 2020 Aerosol Measurements," September 20, 2020. Available online at https://ohv.parks.ca.gov/pages/1140/files/03-Scripps%20Report.pdf.

[7] SLOCAPCD (2020). "Review of September 2020 Scripps Report," October 30, 2020. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/APCD%20Review%20of%20September%202020%20Scripps%20Report.pdf.

[8] See Attachment 12 in State of California, Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division (2021). "Oceano Dunes State Vehicular Recreation Area Dust Control Program 2021 Annual Report and Work Plan. Conditional Approval Draft." October 1, 2021. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2021ARWP_CondAppDraft_withAttach_20211001.pdf.

A Note on Sampling Methodology

Much of the discussion that follows deals with technical aspects of particulate sampling methodology. For clarity, key terms and concepts are described here.

The Clean Air Act requires that all ambient air monitoring data used for regulatory purposes be collected using instruments and methods designated by the EPA as "reference methods" or "equivalent methods" in accordance with Title 40, Part 53 of the Code of Federal Regulations (40 CFR Part 53).[9] For particulates, Federal Reference Methods (FRMs) are EPA-approved methods that involve gravimetry, i.e., collecting a sample on a filter and then weighing it in a lab. Federal Equivalent Methods (FEMs) are EPA-approved instruments that measure particulates in (near) real-time and analyze sample mass indirectly.

The District collects particulate data for regulatory purposes and is thus required to employ FRM or FEM methods for this purpose. The specific, EPA-approved instrument employed by the District is Met One Instrument's BAM 1020,[10] which is an FEM.[11]

PM_{10} and $PM_{2.5}$ samplers use size selectors to remove particles that do not meet the regulatory definition of PM_{10} or $PM_{2.5}$. For FEMs and FRMs, the size selector is part of the EPA-approved method. The Very Sharp Cut Cyclone (VSCC), manufactured by BGI, is a $PM_{2.5}$ size selector employed in many FRMs and FEMs, including the BAM 1020.[11] For it to work properly, the sample flow through the device must be 16.7 L/min. BGI also manufactures various other cyclones, including the SCC, which under certain flow rates can achieve particle size selections approximating a true $PM_{2.5}$ cut; however, none of these other cyclones are part of any EPA-designated $PM_{2.5}$ FEM or FRM.

General Comments

Scripps Reports Significantly Lower Particulate Matter Concentrations than the District

Like the previous Scripps report,[6] the current one discusses samples collected at the District's CDF monitoring station during the spring windy season. The previous report found the mass concentrations of their $PM_{2.5}$ samples to be an average of 26% lower than the masses recorded by the District's $PM_{2.5}$ BAM instrument. On high PM_{10} days—defined as days when hourly PM_{10} exceeds 140 ug/m^3 in the afternoon—the difference was even larger, with the Scripps samples 38% lower than the District's measurements.

The results of Scripps's 2021 sampling are also lower than the District's BAM measurements. For $PM_{2.5}$, Scripps collected two sets of samples: one using a VSCC operated at 16.7 L/min (on loan from the District), and a second using an SCC operated at 7.5 L/min, the same method used in their 2020 sampling. The VSCC samples are reported to be 13% lower than the District's BAM measurements on average, and 18% lower on high wind days. The SCC samples were 32% lower on average and

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[9] EPA (2021). "LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS," June 15, 2021. Available online at https://www.epa.gov/sites/production/files/2019-08/documents/designated_reference_and-equivalent_methods.pdf.

[10] SLOCAPCD (2021). "2021 Ambient Air Monitoring Network Plan," June 2021. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2021-network-plan-for-publication.pdf.

[11] EPA Method Numbers EQPM-0798-122 (PM_{10}) and EQPM-0308-170 ($PM_{2.5}$). See Reference 9.

39% lower on high PM_{10} days. For PM_{10}, the Scripps masses are 29% lower than the District's BAM measurements on average, and 35% lower on high PM_{10} days.

The District has also collected PM_{10} and $PM_{2.5}$ filters samples for gravimetric analysis at CDF.[12] As shown in Table 1, below, the mass concentrations for these samples compare well to the measurements from the District's collocated BAMs, with all R^2 values greater than 0.9 and most greater than 0.95. However, for PM_{10}, the Scripps masses are only about 65% of the District's, as indicated by the slope of 0.65 for the regression of gravimetric mass versus BAM concentration, with the linear fit forced through the origin. For the District's sampling campaigns, the slopes are much closer to 1—0.896 to 1.040. The same is true of the $PM_{2.5}$ data.

Table 1: Comparisons of BAM and Gravimetric PM Concentrations Made at CDF

Sampling Campaign	**Gravimetric Lab** [a]	**Regression results using all above detection limit samples**				
		gravimetric = slope × BAM + intercept			**gravimetric = slope × BAM**	
		Slope	**Intercept**	R^2	**Slope**	R^2
PM_{10} Samples						
Scripps 2021[c]	CLN	n.r. [b]	n.r.	n.r.	0.65	0.77
APCD 2021 [d]	SCAQMD	1.007	1.4	0.991	1.040	0.996
APCD 2020 [d]	DRI	0.883	0.8	0.995	0.896	0.995
APCD 2019 [e]	BAAQMD	0.954	4.8	0.990	1.044	0.990
APCD 2019 [f]	FAL	0.876	6.9	0.901	0.979	0.966
$PM_{2.5}$ Samples						
Scripps 2021, VSCC [c]	CLN	n.r.	n.r.	n.r.	0.82	0.84
Scripps 2021, SCC [c]	CLN	n.r.	n.r.	n.r.	0.64	0.84
Scripps 2020, SCC [g]	CLN	0.509	4.26	0.688	n.r.	n.r.
APCD 2019 [e]	BAAQMD	0.999	1.13	0.955	1.079	0.976

[a] Gravimetric Labs: CLN, Chester LabNet; SCAQMD, South Coast Air Quality Management District; DRI, Desert Research Institute; BAAQMD, Bay Area Air Quality Management District; FAL, Forensic Analytical Laboratories. [b] n.r. = not reported. [c] "Scripps/UCSD Interim Report 2021: Preliminary Results from the May 2021 Aerosol Measurements," i.e., the subject of this review. [d] Preliminary data. A full report describing this sampling and the results is expected in the spring 2022. [e] Unpublished District data. [f] Appendix B in SLOCAPCD (2019), "Annual Air Quality Report for 2018. Available online at https://www.slocleanair.org/library/air-quality-reports.php. "
[g] Reference 6.

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[12] Samples were collected using FRMs, specifically the Thermo Scientific Partisol-FRM Model 2025i (EPA Methods: RFPS-1298-127, RFPS-0498-118) and Rupprecht & Patashnick Model 2000-H (EPA Method ID: RFPS-1298-126 / RFPS-0694-098) samplers. For $PM_{2.5}$ samples, a VSCC size separator was used. Gravimetry was performed by the labs noted in Table 1 following the FRM method or a NIOSH method.

Evaporative Loss Still Does Not Explain the Discrepancy in Mass

Scripps's 2020 report argued that "[i]t is likely that the 38% difference in mass on high PM_{10} days is due to water evaporating, although other semi-volatile components (ammonium nitrate and organic mass) could also be included in the BAM method and not in the gravimetric method."[6] Their current report argues similarly that "it [is] likely that the difference in mass on high-PM_{10} days is due to adsorbed water and other semi-volatile components (ammonium nitrate and organic mass) evaporating less in the BAM method and more in the gravimetric method."

The District finds this explanation unlikely. We note, as we have previously, that while gravimetric methods are known to be subject to losses of water and semi-volatiles, the design of the BAM 1020 instrument includes a sample heater to mimic this effect and thus produce comparable results. If significantly more water and semi-volatiles were lost from the gravimetric method than from the BAM, then this ought to also affect the gravimetric samples collected by the District, but as seen in Table 1, the this is not the case.

The report further speculates that "[a]nother possibility is that the BAM calibration does not apply well to the composition and concentration conditions that are relevant to this site." Prior to receiving FEM designations for PM_{10} and $PM_{2.5}$ from the EPA, the BAM 1020's manufacturer had to conduct trials in diverse locations under diverse conditions to demonstrate equivalence to gravimetric, FRM methods. Given the BAM's extensive track record since receiving EPA approval, it is unlikely that it would fail to generate comparable data in this location. Furthermore, as shown in Table 1, gravimetric samples collected by the District do indeed compare well to BAM measurements at this site.

The Scripps reports also speculates that sample duration might play a role in explaining the discrepancy. Their samples were mid-day samples collected over 7 hours, while the District comparisons noted in Table 1 are for 24-hour samples. The report states that "errors often vary with time of day, with water adsorption in the BAM affecting afternoon readings and desorption affecting readings after midnight, so that hourly BAM concentrations may have biases of ~20 µg m-3 even when 24 hour averages include cancelling errors. [Kiss et al., 2017]" Again, the District finds this explanation unlikely. As shown in Figure A3 of the Scripps report, the Scripps samples were collected during the lowest humidity part of the day, when any positive bias in the BAM due to water adsorption would be at its minimum. Furthermore, Kiss et al., 2017, concludes that "Positive and negative apparent readings [of the BAM] are observed with increasing and decreasing relative humidities, respectively."[13] As shown in Figure A3, generally humidity was decreasing during the beginning of Scripps's 7-hour sampling period and increasing at the end. While there was typically a net increase in relative humidity across the 7-hour period, the change was generally small (<10%), making it unlikely that humidity effects could account for the large discrepancy between Scripps's and the District's measurements.

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[13] Kiss, G., Imre, K., Molnar, A., and Gelencser, A. (2017), "Bias caused by water adsorption in hourly PM measurements." *Atmos. Meas. Tech.*, 10(7), 2477–2484.
https://doi.org/10.5194/amt-10-2477-2017

The Discrepancy in Particulate Matter Concentrations is Likely Due to Scripps's Sampling Methodology

The District's BAM sampling was and is conducted in full accord with the BAM FEM designation and all federal quality control and assurance requirements of 40 CFR 58. For the gravimetric sampling summarized in Table 1, the District used Partisol FRM samplers to collect the filters,[12] and gravimetry was performed according to either FRM methods (SCAQMD, BAAQMD, and DRI labs) or NIOSH Method 500/600 (FAL). For $PM_{2.5}$, a VSCC was used as the size separator. These are standard methods, used around the world for collecting regulatory data. The PM_{10} BAM method carries a weight of evidence of more than 20 years of legally defensible data collection.

Based on the description provided in the Scripps report, the gravimetric analysis of their samples seems to have followed the FRM method or a procedure very close to it. The key difference between the methods employed by Scripps and the District is Scripps's use of non-standard sample collection devices.

In 2020, Scripps used an SCC size separator operated at 7.5 L/min to collect their $PM_{2.5}$ samples. The District and SAG were critical of this setup, with the District noting that the SCC was not part of any EPA-approved FRM or FEM $PM_{2.5}$ method. We are not aware of studies in the academic literature using it for $PM_{2.5}$ sampling. In our critique of Scripps's 2019 sampling, we wrote: "The District suspects that Scripps's method is under sampling particulates from the ambient air, particularly when winds are high, and that this effect is much more important than evaporative loss in explaining why the gravimetric masses are consistently lower than the BAM masses." We suggested that Scripps use a VSCC size separator in future $PM_{2.5}$ sampling.

This year, Scripps employed a louvered PM_{10} sampling head for PM_{10} sampling and a VSCC separator (preceded by a PM_{10} head) for $PM_{2.5}$ sampling. These are the same inlet configurations used by the District with our BAMs and gravimetric samplers. However, as shown in Figure 1, below, Scripps's $PM_{2.5}$ setup also incorporates what appears to be a Swagelok T to split the flow after the VSCC. While the flow through the VSCC was 16.7 L/min and a regulatory $PM_{2.5}$ sample was likely exiting the bottom of it, an unspecified portion of the sample flow was then diverted, and less than 16.7 L/min of flow was directed to the filter. The District believes the use of a non-engineered—and likely non-laminar and non-isokinetic—flow splitter likely caused a non-representative sample to be collected by the filter.

Scripps employed a similar setup for their PM_{10} sampling (Figure 2). Here, 16.7 L/min enters the inlet and flows through the PM_{10} size separator and is then split using a T, with an unspecified portion of the flow continuing to the PM_{10} sample filter. The remainder of the flow is diverted to another T which further splits the flow into bypass and $PM_{2.5}$ SCC sample streams. This setup thus collected both a PM_{10} sample and an SCC $PM_{2.5}$ sample from the same 16.7 L/min sample inlet stream.

Had the Scripps's devices simply directed the entire 16.7 L/min flow through the size separators and directly to the sample filters, then their setup would have been analogous to the sampling streams of the District's BAMs and FRM samplers. Unfortunately, splitting the sample flow as done by Scripps likely renders the samples invalid. In the absence of laminar, isokinetic flow splitting, the sample stream impacting the filters cannot be assumed to be representative. It is well known that sub-

Figure 1: Scripps's $PM_{2.5}$ sampling setup for 2021. Note the T fitting and bypass flow between the VSCC and the sample holder.

Figure 2: Scripps's PM_{10} sampling setup for 2021. Note the T fitting between the PM_{10} head and the sample holder. The split-off flow is further split by a second T before a portion is run through an SCC.

isokinetic sampling of particulates will result in under-sampling of sample mass, and that is likely what is occurring here. Turbulence introduced by the T fitting may also cause particles to be deposited on the sides of the downtube, rather than traveling down to the filter. The report provides no data and cites no references to demonstrate that these novel devices perform as they assume.

In most EPA-approved particulate samplers—including the BAM 1020 and the Partisol samplers used by the District—the sample flows straight down from the size separator to the filter, and no flow is diverted. There are some EPA-approved FEM samplers that do split the sample flow. In these instruments, 16.7 L/min flows through the inlet and size separators before a portion of that flow is drawn off and bypasses the detector. For these instruments—and in contrast to Scripps's devices—the flow splitter is an engineered component of the sample path, designed to maintain isokinetic, laminar flow. For example, and as shown in Figure 3, below, the TEOM 1405 (EPA Method EQPM-1090-079) incorporates an isokinetic tube-within-a-tube flow splitter to reduce sample flow to its detector to 3 L/min.[14] The T640x (EPA Method EQPM-0516-239) incorporates a similar tube-within-a-

[14] ThermoFisherScientific (2007), "Operating Guide, TEOM 1405." Available online at https://tools.thermofisher.com/content/sfs/manuals/EPM-TEOM1405-Manual.pdf.

tube flow splitter to reduce the flow from 16.7 L/min to 5 L/min for the optical chamber of the instrument.[15]

In summary, the District believes that Scripps's use of non-engineered, non-isokinetic flow splitters has resulted in the collection of non-representative PM_{10} and $PM_{2.5}$ samples, which are likely biased low. This likely also explains the poor correlation, apparent in Figure 2 of the report, between Scripps's VSCC and SCC $PM_{2.5}$ samples.

Scripps's Speciation Data Should Be Interpreted Cautiously

Given the problems with sample collection noted above, the District is hesitant to interpret Scripps's speciation results. Without representative sampling of the ambient air, it cannot be assumed that the speciation results are representative of particulates impacting the sampling site.

Regarding the speciation results, the District notes the following unusual findings:

- The fraction of mineral dust reported in the $PM_{2.5}$ samples is higher than the fraction in the PM_{10} samples. Typically, crustal materials are more enriched in PM_{10} versus $PM_{2.5}$.
- For $PM_{2.5}$, mineral dust is enriched on high PM_{10} days, as expected for wind-blown dust, but for PM_{10}, the fraction mineral dust is the same on high versus low PM_{10} days.

It is the opinion of the District that these results are artifacts resulting from non-representative sampling caused by the flow splitters.

[15] EPA (2019), "Standard Operating Procedure Teledyne Model 640x Real-Time Continuous PM Monitor." Available online at https://www.epa.gov/sites/default/files/2021-03/documents/teledyne_api_t640x_sop_-_041219.pdf.

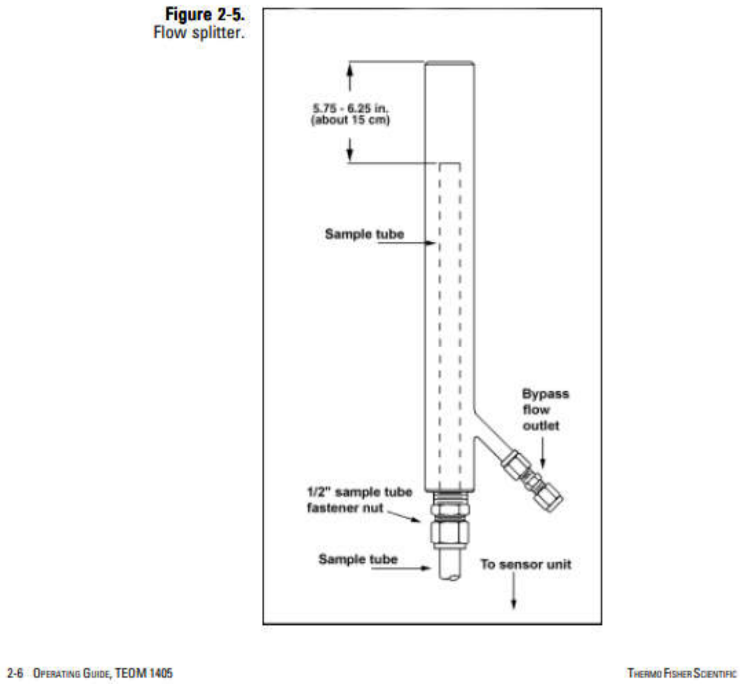

Figure 3: Diagram of the isokinetic flow splitter in the TEOM 1405. From Reference 14.

Finally, high PM_{10} at CDF is correlated with strong winds from the direction of the ODSVRA.[16] It is well known that dust is generated by saltation when strong winds blow across sand dunes, and this has been documented in numerous studies conducted at the Oceano Dunes. It is therefore reasonable to expect that mineral dust from this ODSVRA makes up a large fraction of the PM_{10} impacting CDF on wind event days, and this consistent with the results of the Phase 1 and other studies. In contrast, here Scripps concludes that mineral dust and sea salt constitute only 14% and 4%, respectively, of the PM_{10} measured on high PM_{10} days, with the balance composed of water, organic materials, inorganic aerosols, and other semi-volatiles. The report offers no hypothesis as to why these other species would be correlated with high onshore winds at this site.

With regard specifically to water, the District notes that at CDF humidity and BAM PM_{10} are negatively correlated (r = -0.52), as shown in Figure 4, below.

Similarly, the spatial pattern of PM_{10} concentration on wind event days is consistent with the disturbed area of the ODSVRA being the source of particulates, with concentrations at CDF being the highest, followed by Mesa2, and with much lower levels at the Oso Flaco monitoring site. If the source of particulates on high wind days was sea spray or an offshore source, much more homogenous impacts on these sites would be expected.

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[16] See especially Appendix B in SLOCAPCD (2013), "Annual Air Quality Report for 2012," and Appendix B in SLOCAPCD (2014), "Annual Air Quality Report for 2013." Both available online at https://www.slocleanair.org/library/air-quality-reports.php.

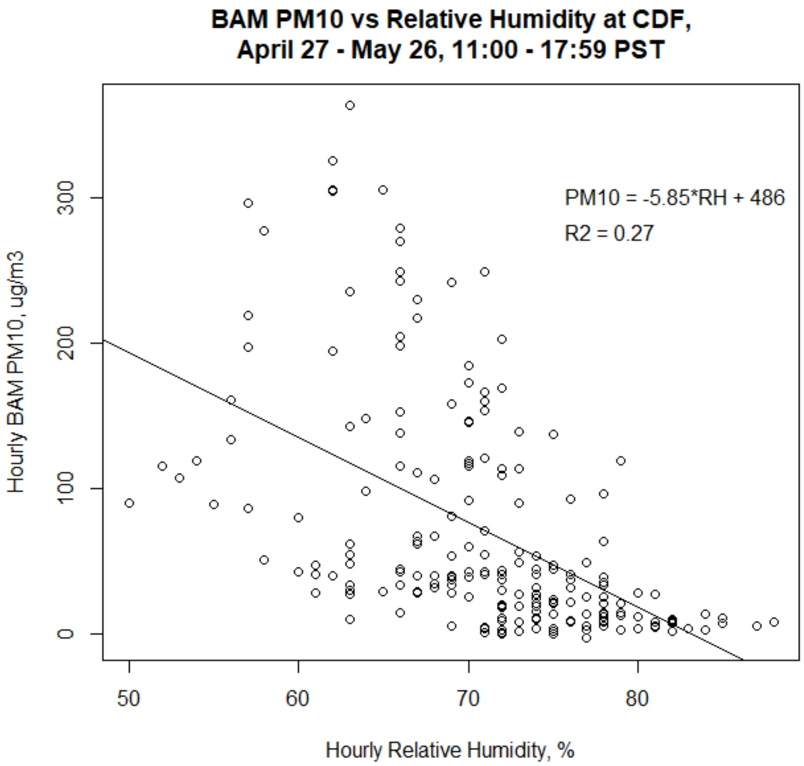

Figure 4: Correlation between Humidity and PM_{10} BAM concentrations. For consistency with the Scripps report, only data from the period of Scripps's 2021 sampling is shown.

Specific Comments

Page 2: "*However, the lack of difference between weekday and weekend coarse particle emissions supports natural rather than anthropogenic sources [Li et al., 2013]*" This statement fails to consider how vehicular activity causes elevated PM_{10} levels downwind of the ODSVRA. If tailpipe emissions or "rooster tails" kicked up by active off-roading caused the degraded air quality, then a day-of-week effect would be expected. But these are not major contributors to the issue. As the District has noted elsewhere, "it is the secondary effects to vegetation and dune shapes that lead to greater wind erosion and more dust when the wind blows."[7,17] The SAG has noted that "decades of OHV activity have fundamentally altered the natural beach-dune landscape, making the dunes significantly more susceptible to PM emissions than they would be in a natural state."[18] Most recently, a DRI study commissioned by State Parks found that the emissivity of bare sand within

[17] SLOCAPCD (2020). "Frequently Asked Questions: Air Quality and the Temporary Closure of Oceano Dunes," June 30, 2020. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/June2020FAQ-42.pdf.

[18] Scientific Advisory Group, "Memo: SAG comments on the temporary closure of Oceano Dunes State Vehicular Recreation Area (ODSVRA) and impacts on particulate matter (PM) emissions," April 6, 2020. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/SAG%20Letter.pdf.

ODSVRA steadily decreased while the ODSVRA was closed to riding due in 2020 to the COVID-19 pandemic.[19]

Page 3: "*the California 24-hr PM10 standard of 50 μg m-3 is exceeded 25% of the time [Motallebi et al., 2003]*." This sentence could imply that the situation downwind of the ODSVRA is typical, which it is not. The cited source is almost 20 years old and reviews data from more than 20 years ago.

Page 3: "*Since the association of PM2.5 with toxics is likely responsible for the association of PM2.5 with health effects, the use of PM2.5 as a health indicator assumes it co-occurs with toxics*." In the context of this report, this statement may imply that $PM_{2.5}$ is driving the District's regulation of the ODSVRA, which is not the case.

Page 3: "*These standards were developed based on measurements completed by federal reference methods (FRM) … Since then, BAM has been approved as a federal equivalent method (FEM) … Those test locations typically include concentrations below 100 μg m-3 and frequently below 30 μg m-3 [Chung et al., 2001; Gobeli et al., 2008; Hafkenscheid and Vonk, 2014; Hart, 2009], as these conditions were more typical of areas of concern for PM2.5.*" In the context of this paragraph, "these standards" seems to include the federal and California PM_{10} standards, but all the studies cited to support this statement are of $PM_{2.5}$. Some readers may understand this paragraph to mean that the BAM was given its PM_{10} FEM designation without being tested at the high concentrations observed here at the CDF monitoring station. This impression would be incorrect. The instrument was designated a PM_{10} FEM in 1998,[20] and at the time the EPA testing requirements of 40 CFR 53 were that at least 3 of the 10 trial days had concentrations above 80 μg/m^3.[21]

Page 5: "…*seven one-hr measurements reported for PST* ***start times*** *of 1100 through* ***1800*** *to provide comparison points…*" (Emphasis added.) This is likely a typo, and "1800" should be replaced by "1700". Scripps collected 7-hour samples, so if the sampling period began at 11:00 and ended at 18:00, then the start time of the final hourly BAM measurement would be 17:00.

Page 5: "*At high relative humidity (>70%, such as those at CDF in May 2021, see Appendix, Figure A3), hourly measurements will report higher mass concentrations than multi-hour* ***filter*** *measurements [Schweizer et al., 2016]. Comparisons at other sites between gravimetric and BAM PM2.5 mass concentrations have shown correlation coefficients (R2) that varied between 0.65 and 0.99 and slopes that differed by as much as 30% depending on season and chemical composition [Hauck et al. 2004]*" (Emphasis added.) These statements are not supported by the cited references. The Schweizer study compared BAM and EBAM measurements, not BAM and filter samples, as stated in the report. Furthermore, it is well known that the EBAM over-reports due to insufficient sample drying; the EBAM is not an EPA-approved FEM, and it was not used to collect any of the data discussed in the

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[19] J.A. Gillies, E. Furtak-Cole, G. Nikolich, and V. Etyemezian (2021), "Examining Dust Emissions and OHV Activity at the ODSVRA." Attachment 10 in State of California, Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division (2021). "Oceano Dunes State Vehicular Recreation Area Dust Control Program 2021 Annual Report and Work Plan. Conditional Approval Draft." October 1, 2021. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2021ARWP_CondAppDraft_withAttach_20211001.pdf.

[20] 63 FR 41253

[21] Personal Communication, David Gobeli, Met One Instruments, October 18, 2021.

Scripps report or this review. The Hauck study was of an older, non-FEM BAM, so it is a stretch to assume that its results apply to the modern, FEM-designated BAM used by the District.

Page 6: "*XRF analysis provided trace metal concentrations for elements heavier than Na. Atmospheric ambient sea-salt concentrations were calculated using measured Cl- and 1.47*Na+ concentrations…*" There seem be to two typos in this statement. The first sentence states that elements heavier than Na were measured (but not Na itself), but the next sentence mentions measurements of Na. The second sentence should likely say "Cl" and "Na" instead of referencing ions, since the ions were not measured directly (according to the Methods section).

Page 7: "*The offline gravimetric method is lower on average than the online BAM instrument for most samples at CDF for both VSCC and SCC cyclones (Figure 1).*" This appears to be a typo, as this sentence is in the PM_{10} section, and there is no VSCC or SCC data in Figure 1.

Page 10: "*Corrections for BAM to gravimetric have been developed for some regions in order to use BAM to determine if air quality standards are exceeded [Le et al., 2020].*" This statement could imply that the District could or should apply a correction to our BAM data; however, even if we believed a correction was warranted, we are not allowed to apply one under CARB and EPA regulations. If this statement is retained, it should be note that the "regions" where this may be happening are outside of the U.S.

Page 11: "*Another possibility is that the BAM calibration does not apply well to the composition and concentration conditions that are relevant to this site. EPA approval of BAM relied on testing conditions that were typically limited to concentrations lower than 100 µg m-3 and that were 24-hr average measurements [Chung et al., 2001; Gobeli et al., 2008; Hafkenscheid and Vonk, 2014; Hart, 2009]. At PM10 concentrations exceeding 30 µg m-3, BAM and gravimetric methods were not found to be equivalent using consistency criteria [Gebicki and Szymanska, 2012].*" As already noted for the similar statement on page 3, the Chung, Gobeli, Hajkensheid, and Hart papers are specifically about $PM_{2.5}$, not PM_{10}. The Gebicki and Szymanska paper is about a non-FEM BAM, not the BAM 1020, so does not apply.

Page 13: "*While prior results did not report the mineral dust fraction of BAM or gravimetric PM10 [SLOAPCD, 2007], the reported mineral dust (crustal) fraction of gravimetric PM2.5 reported by the San Luis Obispo Air Pollution Control District for its Nipomo Mesa Particulate Study (Phase 1) for the Mesa2 annual 24-hr average was 20% [SLOAPCD, 2007]. This value is similar to the 7-hr afternoon average in May 2021 for above detection samples reported here (23% of gravimetric) …*" While factually accurate, this statement is misleading because it compares an annual average to a short-term average covering a portion of the windy season. The contribution of mineral dust to ambient $PM_{2.5}$ is expected to be highest on wind event days, and those occur most frequently in April and May, i.e., the time of year when Scripps collected their samples. In the late fall and winter, mineral dust is not expected to contribute much to $PM_{2.5}$ mass, and this is indeed what the Phase 1 Study found. So, while the Phase 1 Study found that mineral dust contributed only 20% to annual $PM_{2.5}$ average at Mesa2, it is likely that it was a much greater fraction of the $PM_{2.5}$ mass during April and May. Furthermore, of the 7 $PM_{2.5}$ samples from Mesa2 that were fully speciated in the Phase 1 Study (Figure 17), only one sample, May 9, 2014, is from a day when PM_{10} exceeded 50 $\mu g/m^3$ (as determined by cross-referencing the sample dates in Figure 17 with the PM_{10} data in Figure 7). For that sample, mineral dust comprised more than 60% of the $PM_{2.5}$ mass.

The conclusions of the Phase 1 Study note that "The study results clearly identify wind blown crustal particles as the single largest cause of the high particulate concentrations measured on the Mesa … Elemental analysis of the PM2.5 samples further confirm that on these high particulate days, the largest fraction of particles are composed of the crustal elements of silicon, iron, aluminum, and calcium."[22]

Page 14, "*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.*" Like the statement on page 2 noted above, this statement fails to consider how vehicular activity causes elevated PM_{10} levels downwind of the ODSVRA. While high winds are natural forces, the surface of the dunes has been unnaturally disturbed by the long history of vehicular activity. Thus, more dust is generated when high winds blow across the ODSVRA then would be from undisturbed dunes.

Page 14: "*There is no evidence of mineral dust contributing all or even the majority of BAM PM10, as has apparently been assumed in past reporting [SLOAPCD, 2007]*." This implies that the District once assumed that all PM_{10} was mineral dust, which is not the case.

Page 24, "*The SCC method has **demonstrated** size cut sharpness of 1.25 [Cauda et al., 2014]. The VSCC method has a **reported** sharpness of 1.16 under clean conditions [Kenny and Thorpe, 2000]…"* (Emphasis added.) "Demonstrated" versus "reported" implies that the sharpness parameter of SCC is more proven or accepted than that of the VSCC.

Page 25, "*The low bias of SCC relative to VSCC could only be explained by the larger sharpness value of 1.25 compared to 1.16 if there are higher mass concentrations just below 2.5 µm than above the 2.5 µm …*" Another explanation is the novel sampling apparatuses noted above, namely the use of non-engineered, non-isokinetic sample flow splitters resulting in non-representative sample deposition on the filters. In addition to that issue, we note that for Scripps's SCC sampling, particles must travel in a zig-zag to reach the filter (Figure 2), while for the VSCC sampling the sample path is straight down (Figure 1). Because of the straighter path and the effect of gravity, more sample likely reaches the VSCC filter than the SCC.

Page 26, Figure A3. The Scripps samples were collected for 7 hours, but the green box spans 8 hours of data.

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[22] SLOCAPCD (2007). "Nipomo Mesa Particulate Study." Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/Phase1PMStudyReport2.pdf.