Oceano Dunes SVRA Dust Control Program

2020 Annual Report and Work Plan

Fourth Draft

ATTACHMENTS

Attachment 1: Evaluation Metrics 2019-2020 –Annual Record with Final Values

Attachment 2: Evaluation Metrics 2020-2021 –Preliminary Target Values

Attachment 3: Oceano Dunes Emission, Dispersion, and Attribution Model results and Treatment Assessment (DRI, 2020)

Attachment 4: SLO APCD SOA FAQ - June 2020

Attachment 5: ASU Scope of Work Survey/Digital Elevation Model

Attachment 6: Defining the 10 baseline days (Updated March 1, 2020)

Attachment 7: SAG Review of Scripps Study

Attachment 8: SAG Letter on COVID-19 Closure

Attachment 9: SAG Review of WeatherSolve Structures Wind Fence Proposal

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Oceano Dunes SVRA Dust Control Program

2020 Annual Report and Work Plan

ATTACHMENT 1

Evaluation Metrics 2019-2020 –Annual Record with Final Values

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Attachment 1

		PMRP EVALUATION METRICS - ANNUAL RECORD 2019-20 (Final Report)								
New ID	General description	Performance Metric	Unit	Target	Reporting Period		Duration	Value	Notes / Plan	DRI Comments March 2020
	Emission reduction:				START	END				
P 1	PM10 emissions	Percentage reduction in 2013 top-ten-days mean 24-hour PM10 emissions relative to pre-mitigation baseline	%	50% of baseline	8/1/2019	7/31/2020	12 months	3.6	Cite: 2020 DRI Dispersion Model Report	2020 PI-SWERL monitoring to be completed in May 2020 to update the erodibility and emissivity grid. In addition, bulk sand samples will be collected for particle size analysis at each PI-SWERL test position. Approximately 100 PI-SWERL test locations parkwide, but precise number and locations tbd.
	Air Quality Regulatory Monitoring									
P 2	California PM10 exceedances	Number of exceedances per year of California PM10 standard at CDF	#	0	8/1/2019	7/31/2020	12 months	30	Though this metric does not directly reflect the performance of ODSVRA dust mitigation, it is still important to monitor this information. Cite: APCD FAQ	
P 3	Federal PM10 exceedances	Number of exceedances per year of Federal PM10 standard at CDF	#	0	8/1/2019	7/31/2020	12 months	0	Though this metric does not directly reflect the performance of ODSVRA dust mitigation, it is still important to monitor this information.	
	Foredune Restoration:									
P 4	Foredune plant fractional cover	Fractional area covered by live plants within each treatment zone	%	TBD	8/1/2019	7/31/2020	12 months	26.6	Cite: May 2020 Foredune Project Update. All Areas percent plot with seedlings value of 38%, less 30% plant loss	
P 5	Foredune sand volume	Net change in foredune sand volume for each treatment zone per unit area.	$m^3\ m^{-2}$	TBD	8/1/2019	7/31/2020	12 months	0.02	Cite: May 2020 Foredune Project Update. 2cm mean center point height. DEM Work by ASU to refine this process	
P 6	Foredune threshold wind shear velocity	Threshold wind shear velocity at which significant saltation is observed in treatment area	$m\ s^{-1}$	TBD	8/1/2019	7/31/2020	12 months	0.38		
P 7	Foredune emissivity	Percentage reduction in emissivity over each foredune restoration zone, relative to pre-mitigation baseline	%	90%	TBD	TBD	TBD	Revisit with the SAG	DRI will conduct 60 PI-SWERL measurements in the foredune area during the May 2020 effort. DRI will work on appropriate reporting outputs. A first report on the value for the metric will be provided in the 2020 ARWP.	Approximately 60 PI-SWERL test locations within the foredune exclosures (6 per treatment area).
P 8	Foredune hummocks	Spatial density of hummocks within each foredune restoration zone	$\#\ m^{-2}$	TBD	TBD	TBD	TBD	Revisit with the SAG	Working with Dr. Walker on UAS/Drone work to assess this metric value. A first report on the value for the metric will be provided in the 2020 ARWP.	
P 9	Foredune rugosity	Rugosity (topographical variability) within each foredune restoration zone	$m\ m^{-1}$	TBD	TBD	TBD	TBD	Revisit with the SAG	Working with Dr. Walker on UAS/Drone work to assess this metric value. A first report on the value for the metric will be provided in the 2020 ARWP.	
P 10	Foredune sand flux	Mean fractional reduction in sand flux within each treatment area relative to pre-mitigation baseline	%	TBD	TBD	TBD	TBD	Revisit with the SAG	State Parks installed 30 BSNE sand traps in the foredune area and will monitor over the 2020 wind season. DRI will analyze results and develop appropriate reporting outputs. A first report on the value for the metric will be provided in the 2020 ARWP.	Five BSNEs to be deployed in foredune restoration area to monitor sand flux.
P 11	Foredune silhouette profile area	Total silhouette profile area within each foredune restoration zone	m^2	TBD	TBD	TBD	TBD	Revisit with the SAG	Need assistance from SAG on this metric.	
	Backdune Stabilization:									
P 12	Backdune plant fractional cover	Fractional area covered by live plants within each treatment zone	%	TBD	8/1/2019	7/31/2020	12 months	Revisit with the SAG	This metric will be analyzed through aerial photo analysis by ASU. Some ground based plots may be established to assess plant survival as well. A first report on the value for the metric will be provided in the 2020 ARWP.	
P 13	Backdune plant burial	Percentage of planted area buried by drifting sand within each treatment zone	%	TBD	8/1/2019	7/31/2020	12 months	Revisit with the SAG	This metric will be analyzed through aerial photo analysis by ASU. Some ground based plots may be established to assess plant survival as well. A first report on the value for the metric will be provided in the 2020 ARWP.	

Attachment 1

New ID	General description	Performance Metric	Unit	Target	Reporting Period		Duration	Value	Notes / Plan	DRI Comments March 2020
		PMRP EVALUATION METRICS - ANNUAL RECORD 2019-20 (Final Report)								
P 14	Backdune sand flux	Mean fractional reduction in sand flux within each treatment area (including areas experiencing sand encroachment) relative to pre-mitigation baseline	%	90%	8/1/2019	7/31/2020	12 months	Revisit with the SAG	State Parks will work with DRI to develop monitoring on dune scrub restoration plots to assess sand flux with BSNE's, threshold wind shear velocity through the 15 meteorological monitoring stations, and emissivity using the Met One Particle Profilers at the 15 monitoring stations. DRI will develop appropriate reporting values.	DRI to advise on the placement of BSNEs in all dust control areas established or to be established in 2020. Twenty-four (24) BSNEs total will be deployed within the two 20-acre seasonal wind fence areas erected in early 2020 (n=12 in each area). Specific locations for each BSNE are noted by DRI. BSNEs will also be deployed at areas vegetated in 2018 through 2020. Locations and numbers of instruments TBD.
P 15	Backdune threshold wind shear velocity	Threshold wind shear velocity at which significant saltation is observed in treatment area	$m\ s^{-1}$	TBD	TBD	TBD	TBD	Revisit with the SAG	State Parks will work with DRI to develop monitoring on dune scrub restoration plots to assess sand flux with BSNE's, threshold wind shear velocity through the 15 meteorological monitoring stations, and emissivity using the Met One Particle Profilers at the 15 monitoring stations. DRI will develop appropriate reporting values.	
P 16	Backdune emissivity	Percentage reduction in emissivity over each backdune restoration zone, relative to pre-mitigation baseline	%	TBD	TBD	TBD	TBD	Revisit with the SAG	State Parks will work with DRI to develop monitoring on dune scrub restoration plots to assess sand flux with BSNE's, threshold wind shear velocity through the 15 meteorological monitoring stations, and emissivity using the Met One Particle Profilers at the 15 monitoring stations. DRI will develop appropriate reporting values. A first report on the value for the metric will be provided in the 2020 ARWP.	2020 PI-SWERL monitoring to be completed in May 2020 to update the erodibility and emissivity grid. In addition, bulk sand samples will be collected for particle size analysis at each PI-SWERL test position. Approximately 100 PI-SWERL test locations parkwide, but precise number and locations tbd.
	General description	**Work Metric**	**Unit**	**Target**	**Reporting Period**		**Duration**	**Value**	**Notes / Plan**	
	Foredune Restoration:									
W 1	Foredune restoration area	Area planted to foster natural foredune restoration	Acres	48	8/1/2019	7/31/2020	12 months	38	See Exhibit 2 and 3 of the 2020 Interim ARWP	
W 2	Foredune plant inspection	Frequency of plant inspection and viability monitoring	#/year	12	8/1/2019	7/31/2020	12 months	need from District	A first report on the value for the metric will be provided in the 2020 ARWP.	
	Backdune Stabilization:	**Backdune Stabilization:**								
W 3	Backdune planting area	Number of acres planted annually to stabilize backdunes	Acres	20	8/1/2019	7/31/2020	12 months	20		
W 4	Backdune planting per acre	Average number of plants per acre replanted	#/Acre	3400	8/1/2019	7/31/2020	12 months	3400	Data from 2019 ARWP Attachment 3	
W 5	Backdune roughness stabilization area	Area stabilized by installation of roughness elements (straw bales or wind fencing)	Acres	44.2	8/1/2019	7/31/2020	12 months	40		
W 6	Backdune straw bales per acre	Average number of straw bales per acre installed	#/Acre	140	8/1/2019	7/31/2020	12 months	147		
W 7	Backdune wind fencing	Length of wind fencing installed per average day	Km/day	1	8/1/2019	7/31/2020	12 months	1.3	Estimate based purely on installation of wind fence on dune surface that has no prior fencing	
	Plant Cultivation:	**Plant Cultivation:**								
W 8	Native seed harvest	Quantities of native seed harvested annually	Kg	400	8/1/2019	7/31/2020	12 months	417.2	This value is for the full seed harvest. Quantities for each species are to be reported in ARWPs.	
W 9	Plant species cultivation	Numbers of plants cultivated annually for initial and replacement planting	#	100,000	8/1/2019	7/31/2020	12 months	96600	This value is for the full planting. Quantities for each species are to be reported in ARWPs.	
	Meteorological Monitoring	**Meteorological Monitoring**								
W 10	Meteorological monitoring stations	Number of meteorological monitoring stations operated in riding, downwind, and adjacent areas	#	18	8/1/2019	7/31/2020	12 months	21	State Parks is installing 15 meteorological monitoring stations throughout the dune system and another 6 stations within the foredune area during the 2020 wind season. DRI will work with the SAG on reporting metrics for these stations.	be deployed parkwide at 15 stations in 2020 (same as 2019). Sensit saltation sensors to be colocated at these 15 station locations. Precipitation will be measured at 3 locations. Meteorological monitoring of the foredune area will also be completed with ClimaVue 500 and Sensit instrumentation, with numbers and locations TBD. Precipitation will be tracked at 3 locations within the
W 11	Met station inspection	Frequency of station inspection	#/week	1 (weekly)	8/1/2019	7/31/2020	12 months	1/week	This information is being provided by TNB systems, who will be overseeing the day-to-day functioning of the meteorology and PM monitoring systems.	

Attachment 1

		PMRP EVALUATION METRICS - ANNUAL RECORD 2019-20 (Final Report)								
New ID	General description	Performance Metric	Unit	Target	Reporting Period		Duration	Value	Notes / Plan	DRI Comments March 2020
W 12	Met station calibration	Frequency of station calibration	#/year	2/year	8/1/2019	7/31/2020	12 months	2/year	To determine the reliability of dust concentration measurements, it is important to perform calibrations on station sensors both before and after the dust season. In addition to providing an overall metric for frequency of station calibration in this spreadsheet, the ARWPs should document additional details on station calibrations, including: 1) calibration by colocation in Las Vegas dust chamber, and 2) calibration by collocation with BAM (in the field). TNB systems is overseeing the day-to-day functionality of the system and will be providing a performance record for the met/PM system. A first report on the value for the metric will be provided in the March 2020 IRWP.	Same as specified.
	Remote sensing	**Remote sensing**								
W 13	Foredune topographic surveys	Frequency of foredune topographic surveys	#/year	2/year	8/1/2019	7/31/2020	12 months	2/year	State Parks is working on a contract amendment with ASU to complete UAS/Drone surveys twice per year covering much of the land within ODSVRA. ASU will be responsible for reporting appropriate metrics on these surveys.	
W 14	Foredune morphologic surveys	Sampling frequency for UAS survey of the foredune area	#/year	2/year	8/1/2019	7/31/2020	12 months	2/year	State Parks is working on a contract amendment with ASU to complete UAS/Drone surveys twice per year covering much of the land within ODSVRA. ASU will be responsible for reporting appropriate metrics on these surveys.	
W 15	ODSVRA topographic surveys	Lidar survey for DEM of ODSVRA (for model input)	#/year	2/year	8/1/2019	7/31/2020	12 months	2/year	State Parks is working on a contract amendment with ASU to complete UAS/Drone surveys twice per year covering much of the land within ODSVRA. ASU will be responsible for reporting appropriate metrics on these surveys.	
	PI-SWERL Emissivity Monitoring	**PI-SWERL Emissivity Monitoring**								
W 16	PI-SWERL frequency	Frequency of PI-SWERL traverses	#/year	1 (annual)	8/1/2019	7/31/2020	12 months	1		2020 PI-SWERL monitoring to be completed in May 2020 to update the erodibility and emissivity grid. In addition, bulk sand samples will be collected for particle size analysis at each PI-SWERL test position. Approximately 100 PI-SWERL test locations parkwide, but precise number and locations tbd.

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Oceano Dunes SVRA Dust Control Program

2020 Annual Report and Work Plan

ATTACHMENT 2

Evaluation Metrics 2020-2021 –Initial Report

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Attachment 2

		PMRP EVALUATION METRICS - ANNUAL RECORD 2020-21 (Preliminary Report)							
New ID	General description	Performance Metric	Unit	Target	Reporting Period		Duration	Value	Notes / Plan
	Emission reduction:				START	END			
P 1	PM10 emissions	Percentage reduction in 2013 top-ten-days mean 24-hour PM10 emissions relative to pre-mitigation baseline	%	50% of baseline	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
	Air Quality Regulatory Monitoring								
P 2	California PM10 exceedances	Number of exceedances per year of California PM10 standard at CDF	#	0	8/1/2020	7/31/2021	12 months	Revisit with the SAG	Though this metric does not directly reflect the performance of ODSVRA dust mitigation, it is still important to monitor this information. Cite: APCD FAQ
P 3	Federal PM10 exceedances	Number of exceedances per year of Federal PM10 standard at CDF	#	0	8/1/2020	7/31/2021	12 months	Revisit with the SAG	Though this metric does not directly reflect the performance of ODSVRA dust mitigation, it is still important to monitor this information.
	Foredune Restoration:								
P 4	Foredune plant fractional cover	Fractional area covered by live plants within each treatment zone	%	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
P 5	Foredune sand volume	Net change in foredune sand volume for each treatment zone per unit area.	$m^3\ m^{-2}$	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
P 6	Foredune threshold wind shear velocity	Threshold wind shear velocity at which significant saltation is observed in treatment area	$m\ s^{-1}$	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	Evaluation is underway and will be provided in October 2020.
P 7	Foredune emissivity	Percentage reduction in emissivity over each foredune restoration zone, relative to pre-mitigation baseline	%	TBD	TBD	TBD	TBD	Revisit with the SAG	Expected measurements in May 2020 were not made due to: 1) precipitation events in May; 2) restricted access due to plover courtship, breeding, nesting, and chick-raising through the end of September.
P 8	Foredune hummocks	Spatial density of hummocks within each foredune restoration zone	$\#\ m^{-2}$	TBD	2/14/2020	7/31/2020	24 weeks	Revisit with the SAG	Cannot assess without fall 2020 UAS survey. A topic for consideration/discussion is that the reference "state" for this metric is dynamic and changes with the evolutionary state of the landscape. There might be more small hummocks in early stages that eventually coalesce into fewer, larger hummocks over time. As such, the target value starts at zero, increases, then decreases. There is no fixed, single value. Related, we don't have reference states for all stages of evolution
P 9	Foredune rugosity	Rugosity (topographical variability) within each foredune restoration zone	$m\ m^{-1}$	TBD	2/14/2020	7/31/2020	24 weeks	Revisit with the SAG	Cannot assess without fall 2020 UAS survey. A topic for consideration/discussion is that the reference "state" for this metric is dynamic and changes with the evolutionary state of the landscape. There might be more small hummocks in early stages that eventually coalesce into fewer, larger hummocks over time. As such, the target value starts at zero, increases, then decreases. There is no fixed, single value. Related, we don't have reference states for all stages of evolution
P 10	Foredune sand flux	Mean fractional reduction in sand flux within each treatment area relative to pre-mitigation baseline	%	TBD	TBD	TBD	TBD	Revisit with the SAG	BSNE data received for analysis on 9/11/2020. Analysis of sand flux data in each treatment area will be available in October 2020.

Attachment 2

		PMRP EVALUATION METRICS - ANNUAL RECORD 2020-21 (Preliminary Report)							
New ID	General description	Performance Metric	Unit	Target	Reporting Period		Duration	Value	Notes / Plan
P 11	Foredune silhouette profile area	Total silhouette profile area within each foredune restoration zone	m^2	TBD	TBD	TBD	TBD	Revisit with the SAG	Requires ASU UAS flight to construct digital elevation model and discussion with SAG to determin if this metric refers to 2d (verical) area along an onshore plane or 2d vertical area alongshore.
	Backdune Stabilization:								
P 12	Backdune plant fractional cover	Fractional area covered by live plants within each treatment zone	%	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	This value can not be provided because the February 2020 UAS imagery did not capture all treatments.
P 13	Backdune plant burial	Percentage of planted area buried by drifting sand within each treatment zone	%	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	This metric will be analyzed through aerial photo analysis by ASU. Some ground based plots may be established to assess plant survival as well.
P 14	Backdune sand flux	Mean fractional reduction in sand flux within each treatment area (including areas experiencing sand encroachment) relative to pre-mitigation baseline	%	90%	8/1/2020	7/31/2021	12 months	Revisit with the SAG	BSNE data received for analysis on 9/11/2020. Analysis of sand flux data in temporary dust control (i.e., sand fence arrays) area will be available in October 2020.
P 15	Backdune threshold wind shear velocity	Threshold wind shear velocity at which significant saltation is observed in treatment area	$m\ s^{-1}$	TBD	5/31/2020	11/31/20	TBD	Revisit with the SAG	Sensit counts and wind speed data will be used to estimate threshold wind speed for sand movement at monitoring stations in the ODSVRA located in open sand areas.
P 16	Backdune emissivity	Percentage reduction in emissivity over each backdune restoration zone, relative to pre-mitigation baseline	%	TBD	TBD	TBD	TBD	Revisit with the SAG	Data collection has been ended in September 2020. Data will be QA/QCed through October 2020. Analyses will be carried out in Nov. 2020.
	Foredune Restoration:								
W 1	Foredune restoration area	Area planted to foster natural foredune restoration	Acres	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
W 2	Foredune plant inspection	Frequency of plant inspection and viability monitoring	#/year	12	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
	Backdune Stabilization:	**Backdune Stabilization:**							
W 3	Backdune planting area	Number of acres planted annually to stabilize backdunes	Acres	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
W 4	Backdune planting per acre	Average number of plants per acre replanted	#/Acre	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
W 5	Backdune roughness stabilization area	Area stabilized by installation of roughness elements (straw bales or wind fencing)	Acres	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
W 6	Backdune straw bales per acre	Average number of straw bales per acre installed	#/Acre	TBD	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
W 7	Backdune wind fencing	Length of wind fencing installed per average day	Km/day	1	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
	Plant Cultivation:	**Plant Cultivation:**							
W 8	Native seed harvest	Quantities of native seed harvested annually	Kg	400	8/1/2020	7/31/2021	12 months	Revisit with the SAG	
W 9	Plant species cultivation	Numbers of plants cultivated annually for initial and replacement planting	#	100,000	8/1/2020	7/31/2021	12 months	Revisit with the SAG	

Attachment 2

New ID	General description	Performance Metric	Unit	Target	Reporting Period		Duration	Value	Notes / Plan
		PMRP EVALUATION METRICS - ANNUAL RECORD 2020-21 (Preliminary Report)							
	Meteorological Monitoring	**Meteorological Monitoring**							
W 10	Meteorological monitoring stations	Number of meteorological monitoring stations operated in riding, downwind, and adjacent areas	#	15	8/1/2020	7/31/2021	12 months	Revisit with the SAG	State Parks is installing 15 meteorological monitoring stations throughout the dune system and another 6 stations within the foredune area during the 2020 wind season. DRI will work with the SAG on reporting metrics for these stations.
W 11	Met station inspection	Frequency of station inspection	#/week	1 (weekly)	8/1/2020	7/31/2021	12 months	Revisit with the SAG	This information is being provided by TNB systems, who will be overseeing the day-to-day functioning of the meteorology and PM monitoring systems.
W 12	Met station calibration	Frequency of station calibration	#/year	2/year	8/1/2019	7/31/2021	12 months	Revisit with the SAG	To determine the reliability of dust concentration measurements, it is important to perform calibrations on station sensors both before and after the dust season. In addition to providing an overall metric for frequency of station calibration in this spreadsheet, the ARWPs should document additional details on station calibrations, including: 1) calibration by colocation in Las Vegas dust chamber, and 2) calibration by collocation with BAM (in the field). TNB systems is overseeing the day-to-day functionality of the system and will be providing a performance record for the met/PM system.
	Remote sensing	**Remote sensing**							
W 13	Foredune topographic surveys	Frequency of foredune topographic surveys	#/year	2/year	8/1/2019	7/31/2021	12 months	Revisit with the SAG	State Parks is working on a contract amendment with ASU to complete UAS/Drone surveys twice per year covering much of the land within ODSVRA. ASU will be responsible for reporting appropriate metrics on these surveys.
W 14	Foredune morphologic surveys	Sampling frequency for UAS survey of the foredune area	#/year	2/year	8/1/2019	7/31/2021	12 months	Revisit with the SAG	State Parks is working on a contract amendment with ASU to complete UAS/Drone surveys twice per year covering much of the land within ODSVRA. ASU will be responsible for reporting appropriate metrics on these surveys.
W 15	ODSVRA topographic surveys	Lidar survey for DEM of ODSVRA (for model input)	#/year	2/year	8/1/2019	7/31/2021	12 months	Revisit with the SAG	State Parks is working on a contract amendment with ASU to complete UAS/Drone surveys twice per year covering much of the land within ODSVRA. ASU will be responsible for reporting appropriate metrics on these surveys.
	PI-SWERL Emissivity Monitoring	**PI-SWERL Emissivity Monitoring**							
W 16	PI-SWERL frequency	Frequency of PI-SWERL traverses	#/year	1 (annual)	8/1/2019	7/31/2021	12 months	1	

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Oceano Dunes SVRA Dust Control Program

2020 Annual Report and Work Plan

ATTACHMENT 3

Oceano Dunes Emission, Dispersion, and Attribution Model Results and Treatment Assessment (DRI, 2020)

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Oceano Dunes
Emission, Dispersion, and Attribution Model Results and Treatment Assessment

J. Gillies, J. Mejia, E. Furtak-Cole, V. Etyemezian,

Desert Research Institute

May 21, 2020

DRI
Desert Research Institute

Approach follows Mejia et al. (2019)

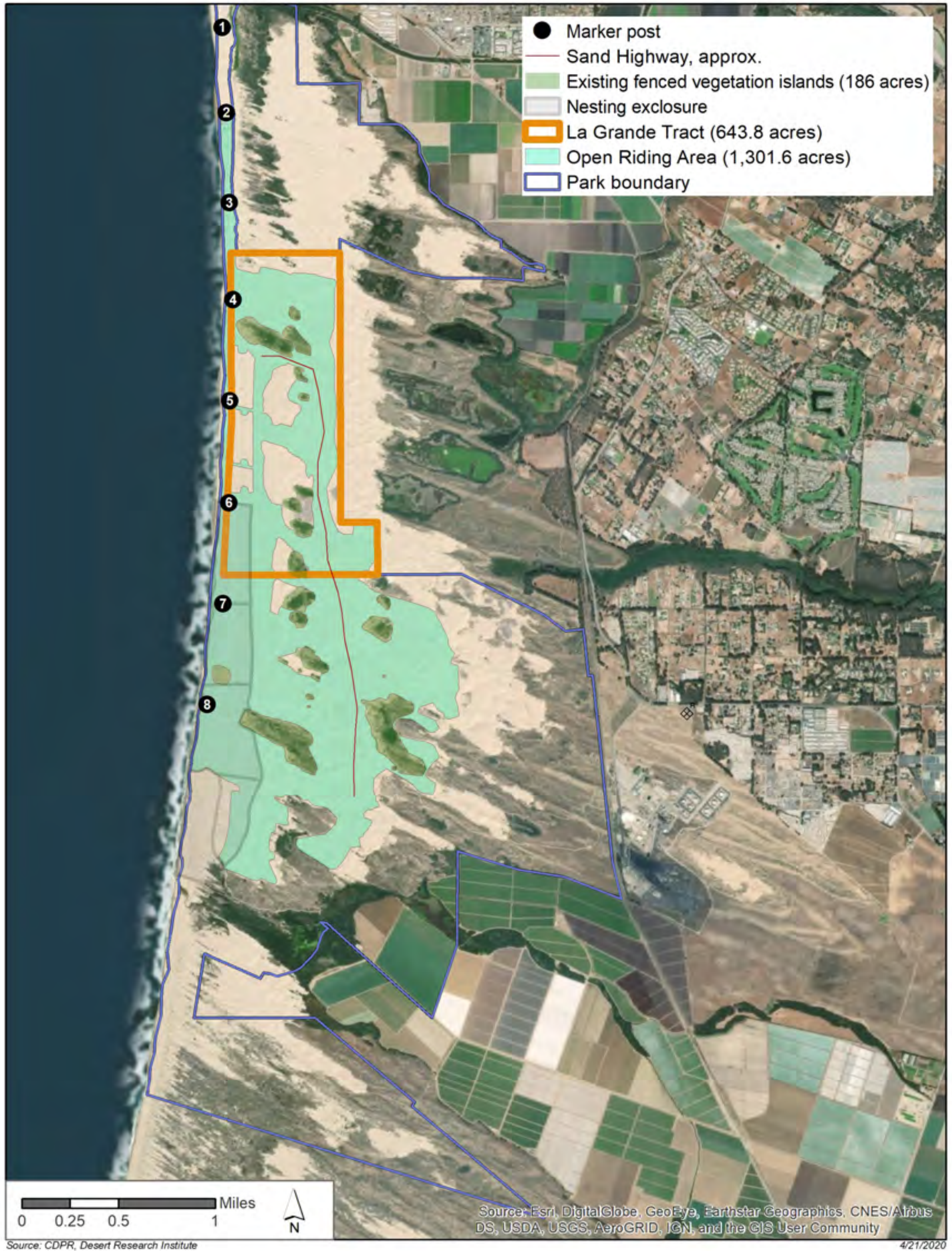
PM_{10} mass emissions (mg m^{-2} s^{-1}, per grid cell [20 m^2]) are a function of emissivity and winds

- PM_{10} emissivity is measured in the ODSVRA using the PI-SWERL
- Wind speed and direction estimates (hourly) are generated by the model CALMET, which also uses measurements within and exterior to the ODSVRA to constrain the estimates

PM_{10} concentrations at downwind receptors are determined using DRI Lagrangian Particle Dispersion Model

PI-SWERL testing ODSVRA 2019

ODSVRA Areas:



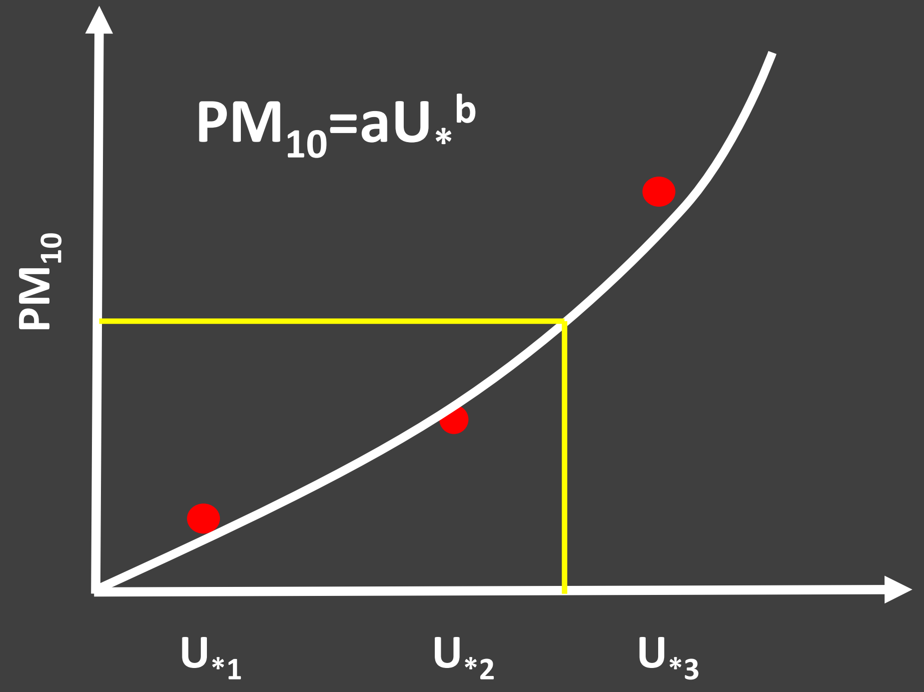
PI-SWERL Measurements

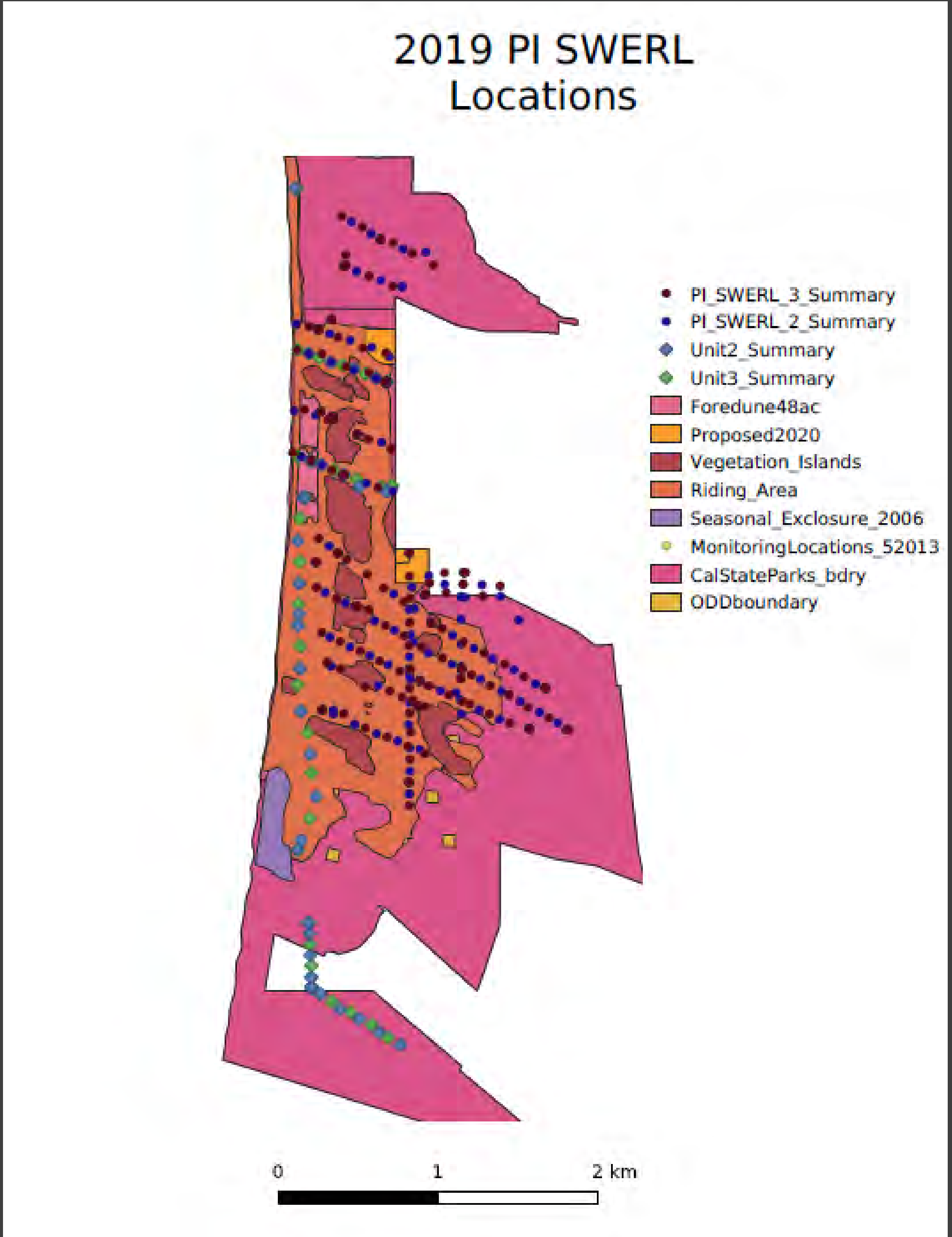
340 locations

Test:

Identify threshold wind speed for emissions

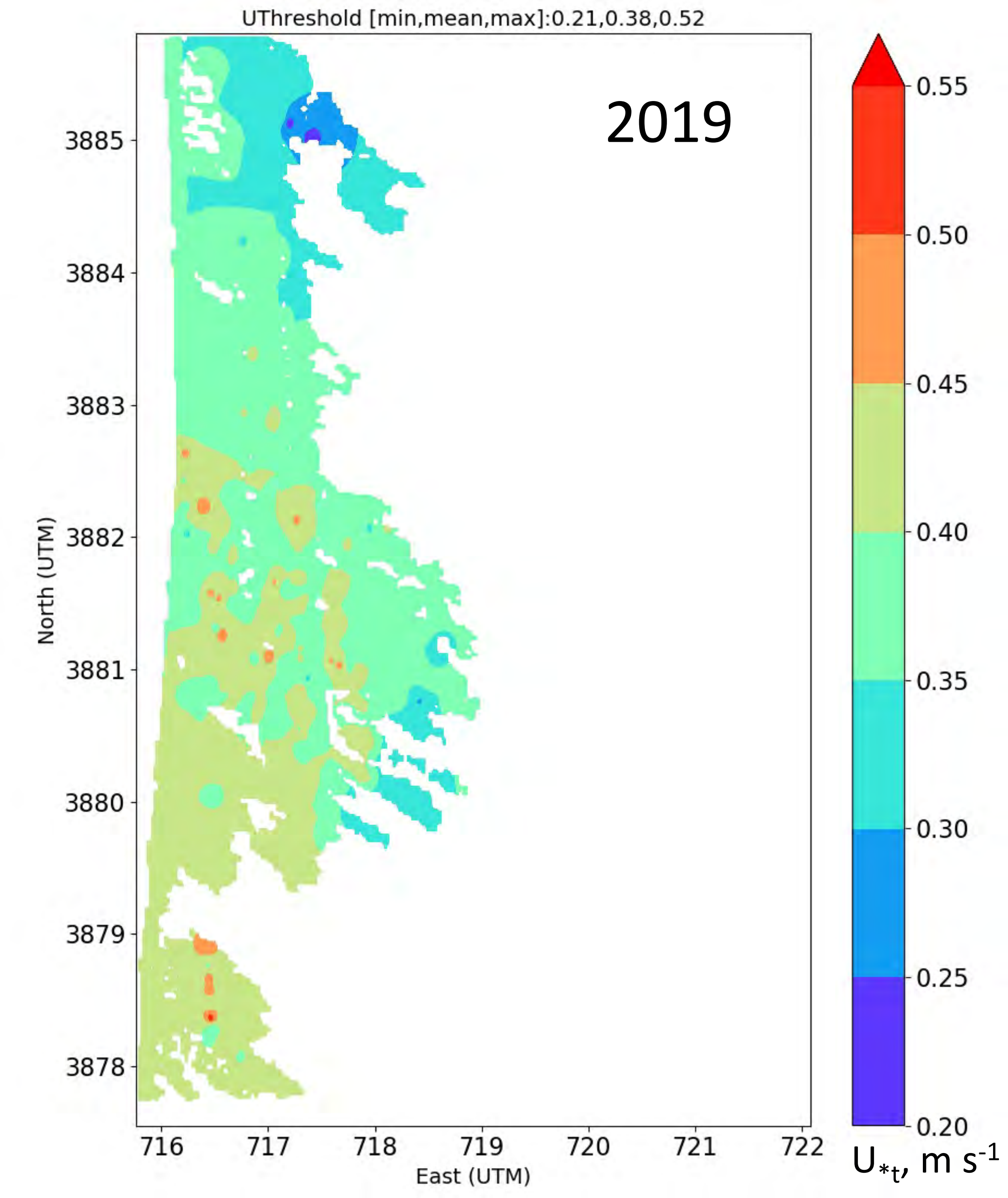
Measure emissivity at 3 wind speeds (same 3 speeds for all tests)





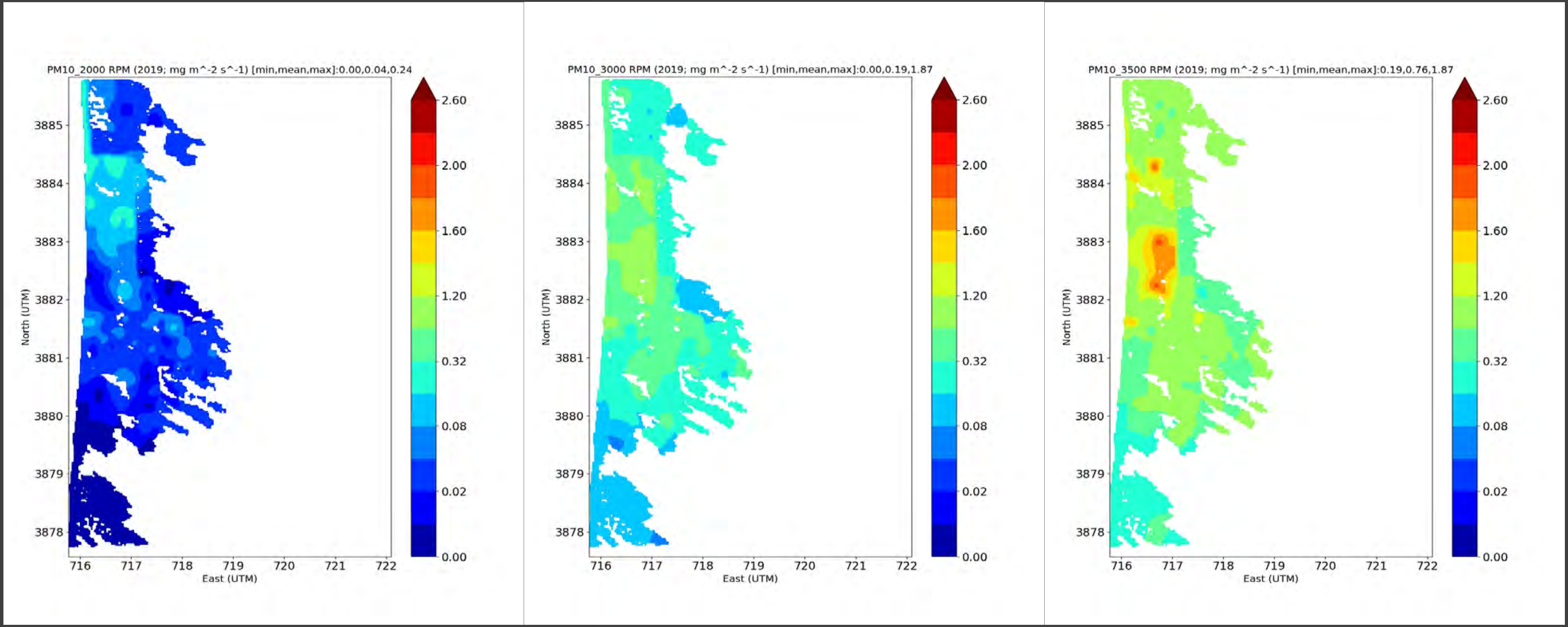
Emission Threshold (U_{*t})

The RPM (wind speed) that corresponds to the threshold of sand particle movement and dust emissions identifies the emission threshold

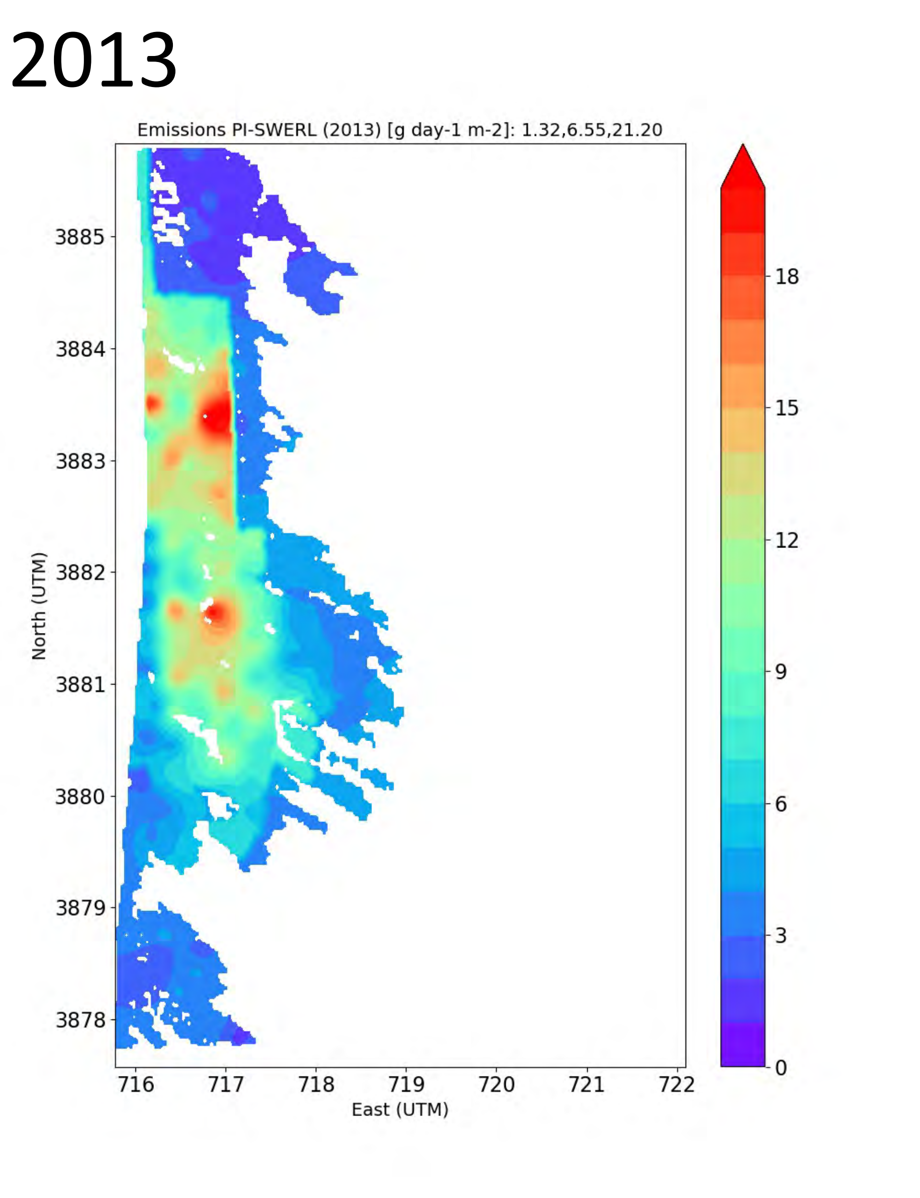


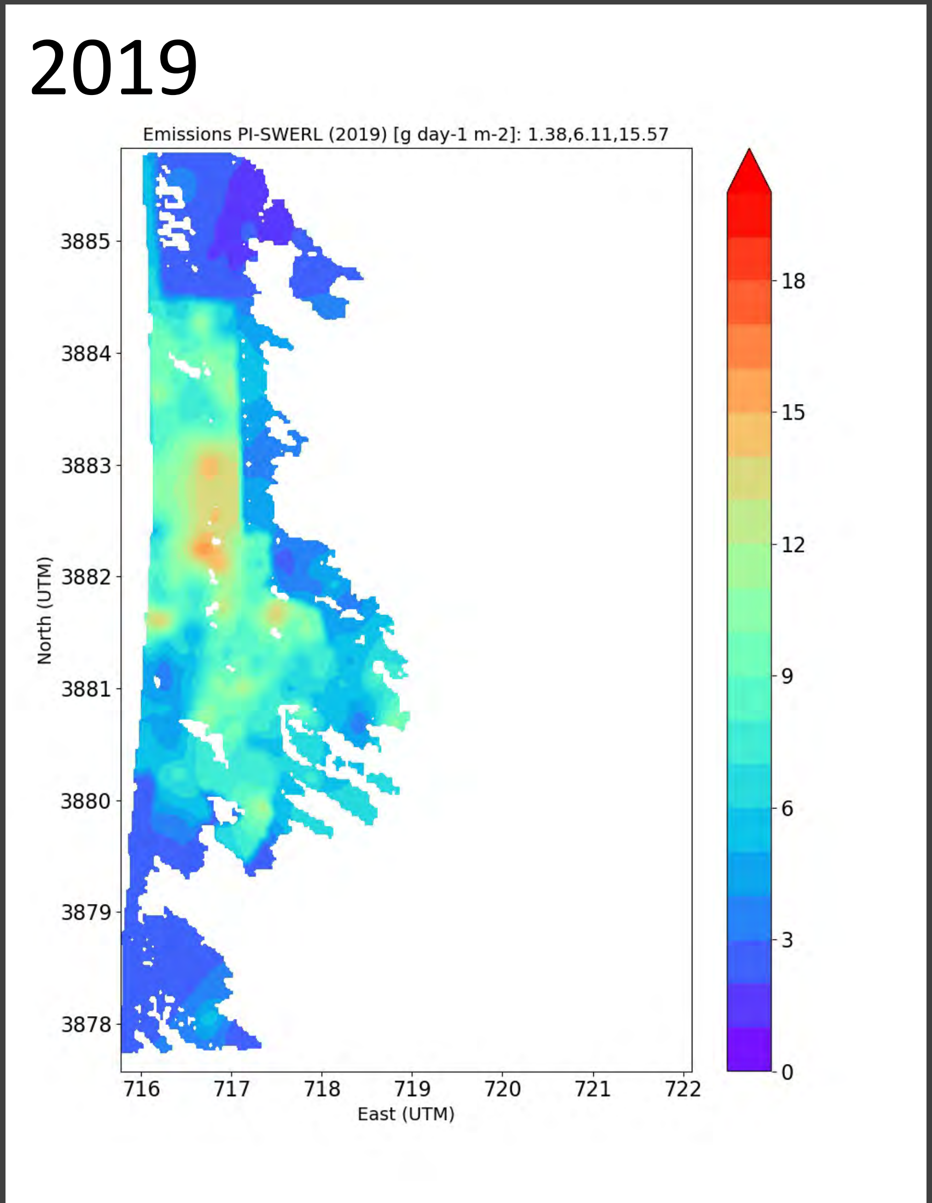
- **Interpolation/Extrapolation used to develop emissivity versus wind speed relationship for each 20 m^2 grid cell (30,000 for ODSVRA, 15,000 for riding area only)**
- **Uses 20 nearest points [inverse distance weighted method]**
- **Followed by a 9 by 9 smoothing filter**

Emissions for 3 PI-SWERL Test "Wind Speeds (u_*)" 2019



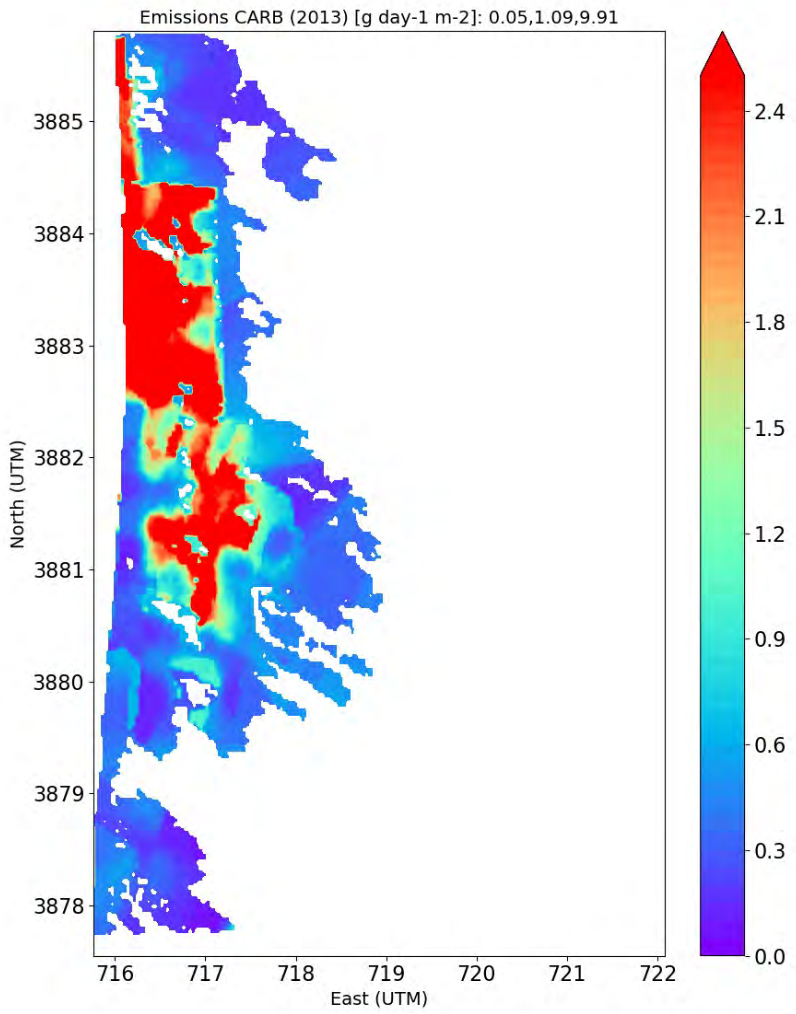
Emission Grid 2013 vs 2019 PI-SWERL data



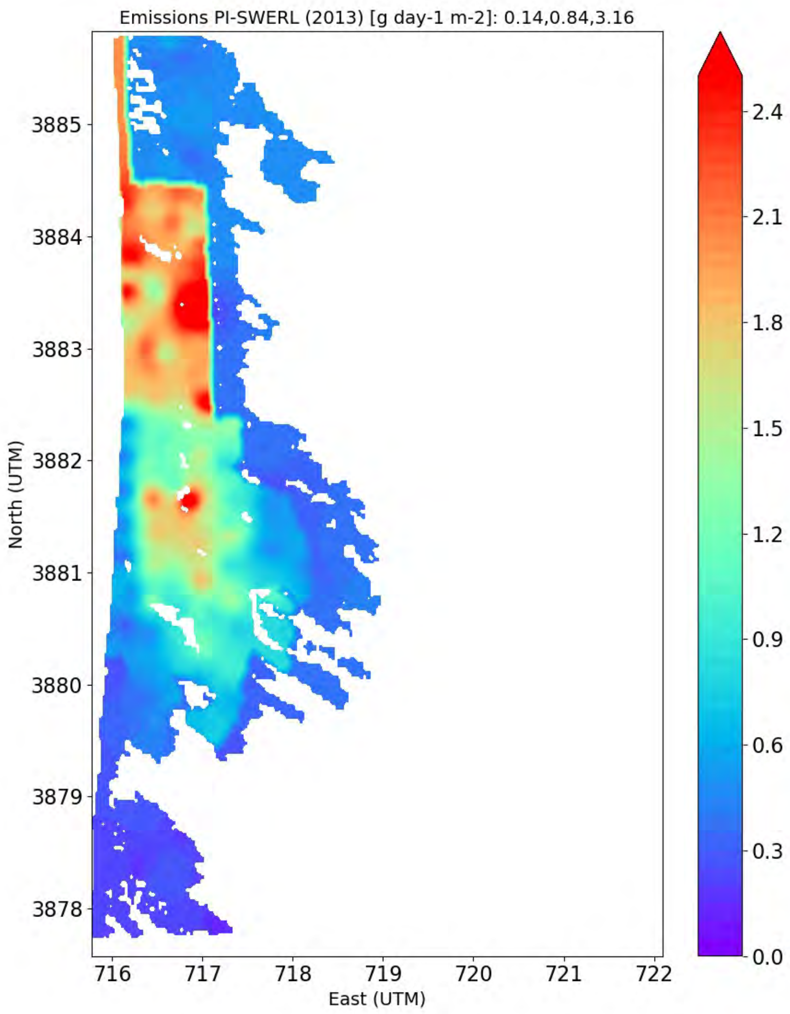


CARB 2018 and DRI 2019 Modeling of 2013 Emissions

CARB Method



DRI Method



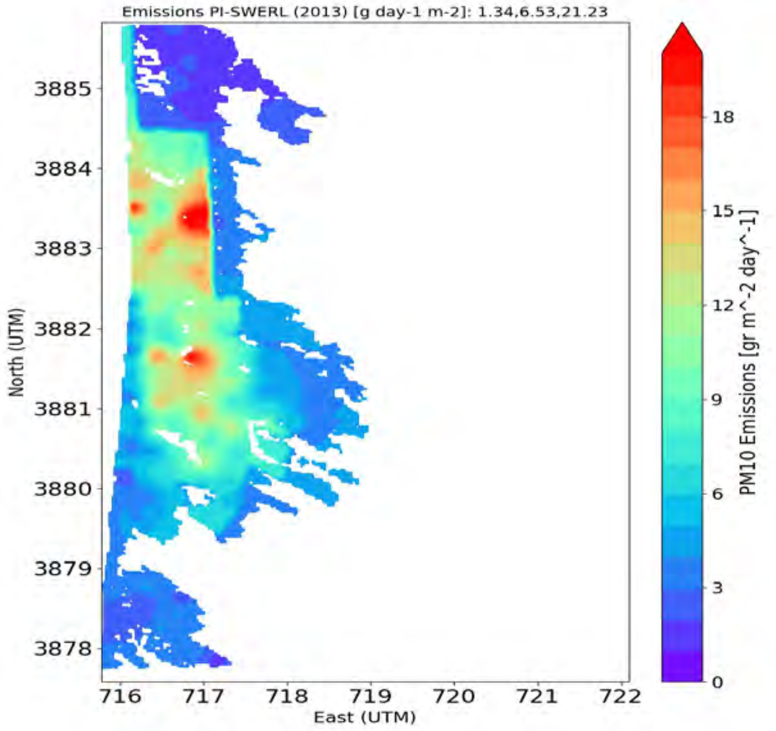
The 10 days with highest emissions

DRI PM10	2013		2019	
Date	Riding Area Only [Metric Tons/day]	Riding and Non-Riding Areas [Metric Tons/day]	Riding Area Only [Metric Tons/day]	Riding and Non-Riding Areas [Metric Tons/day]
5/19/13	115.7	152.8	98.1	140.5
5/22/13	300.0	414.8	270.6	393.8
5/23/13	282.6	386.8	250.9	365.0
5/26/13	228.0	310.6	201.1	294.2
5/27/13	181.8	251.8	158.6	235.6
5/29/13	228.4	312.4	202.6	296.0
5/30/13	212.6	294.0	188.9	278.0
6/17/13	169.7	230.1	149.4	216.3
6/18/13	238.1	324.0	211.9	306.6
6/20/13	173.9	237.9	154.4	225.0
Mean	**213.1**	**291.5**	**188.6**	**275.1**

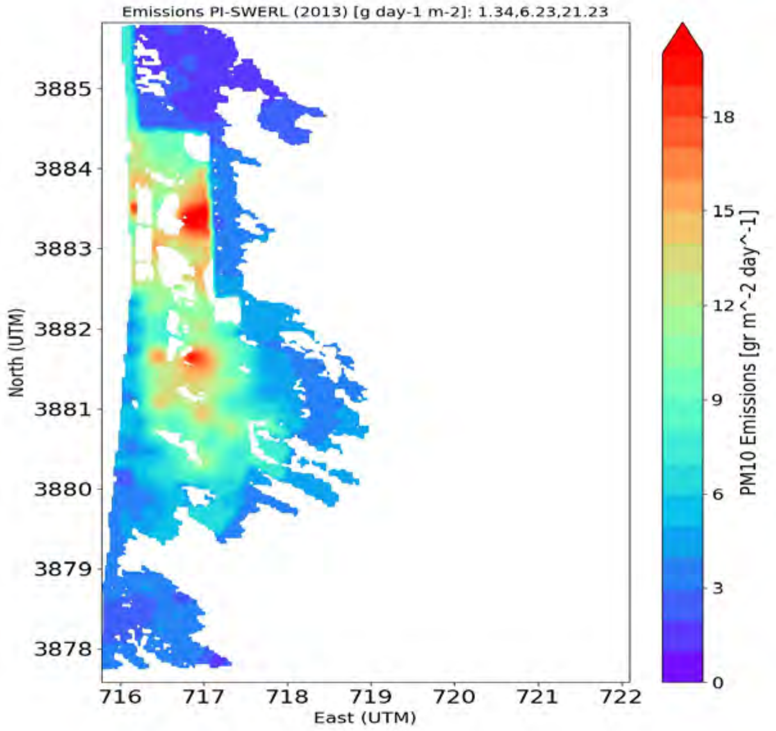
Riding area 2013 > 2019 by 11.5% and only 5.6% when considering the whole park

Emission Grid as Modified by Controls

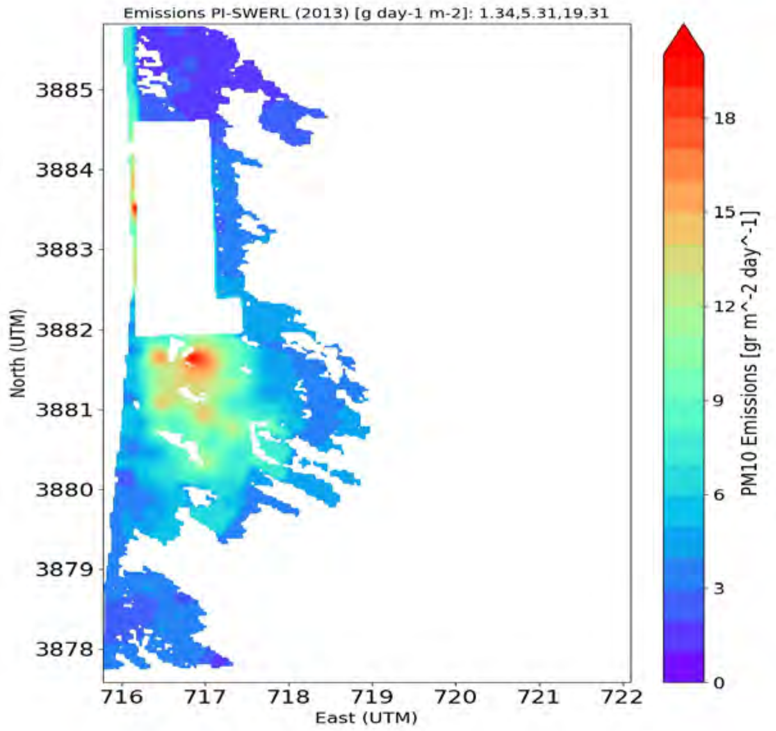
Baseline 2013



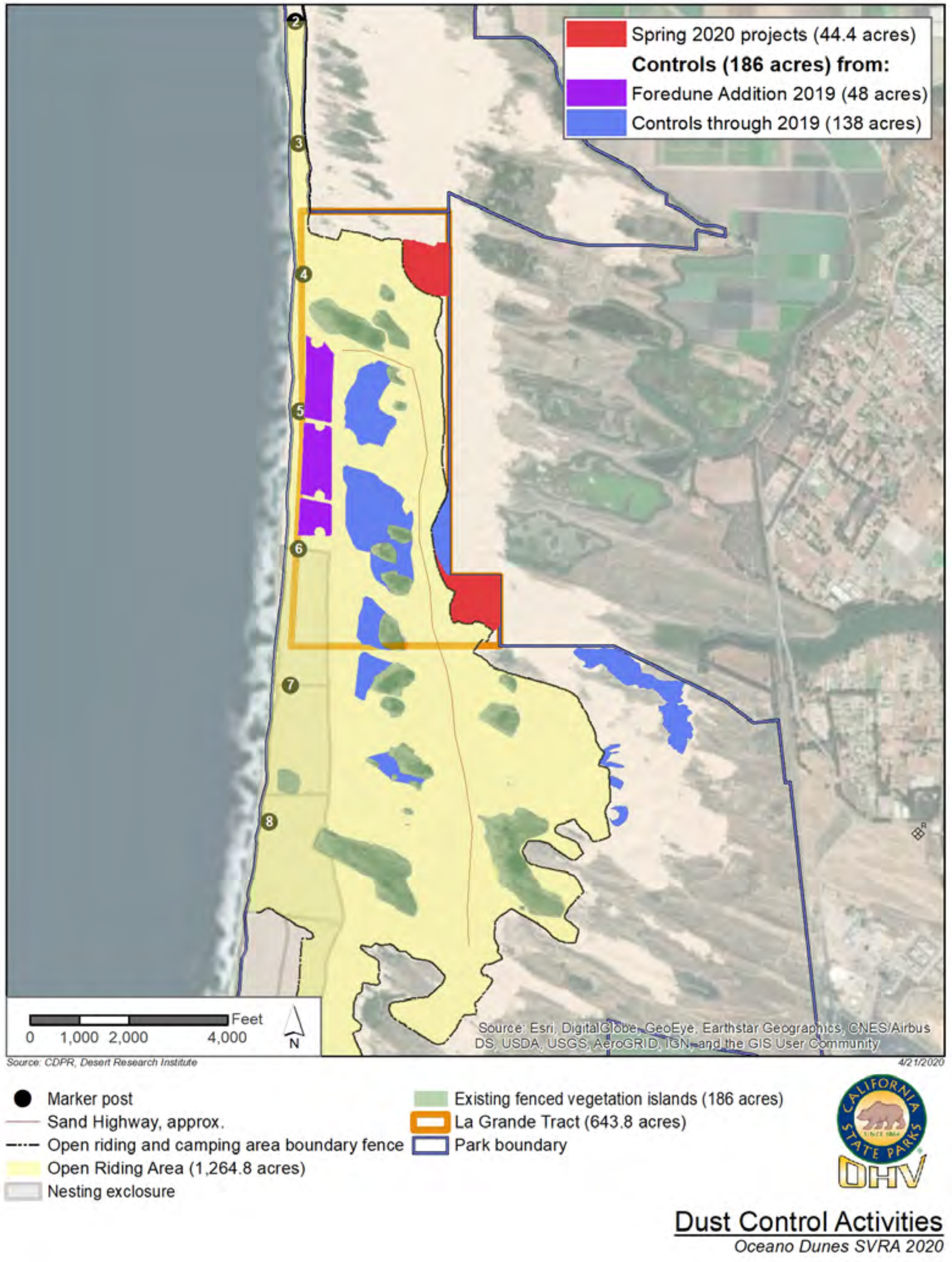
Controls to 2020



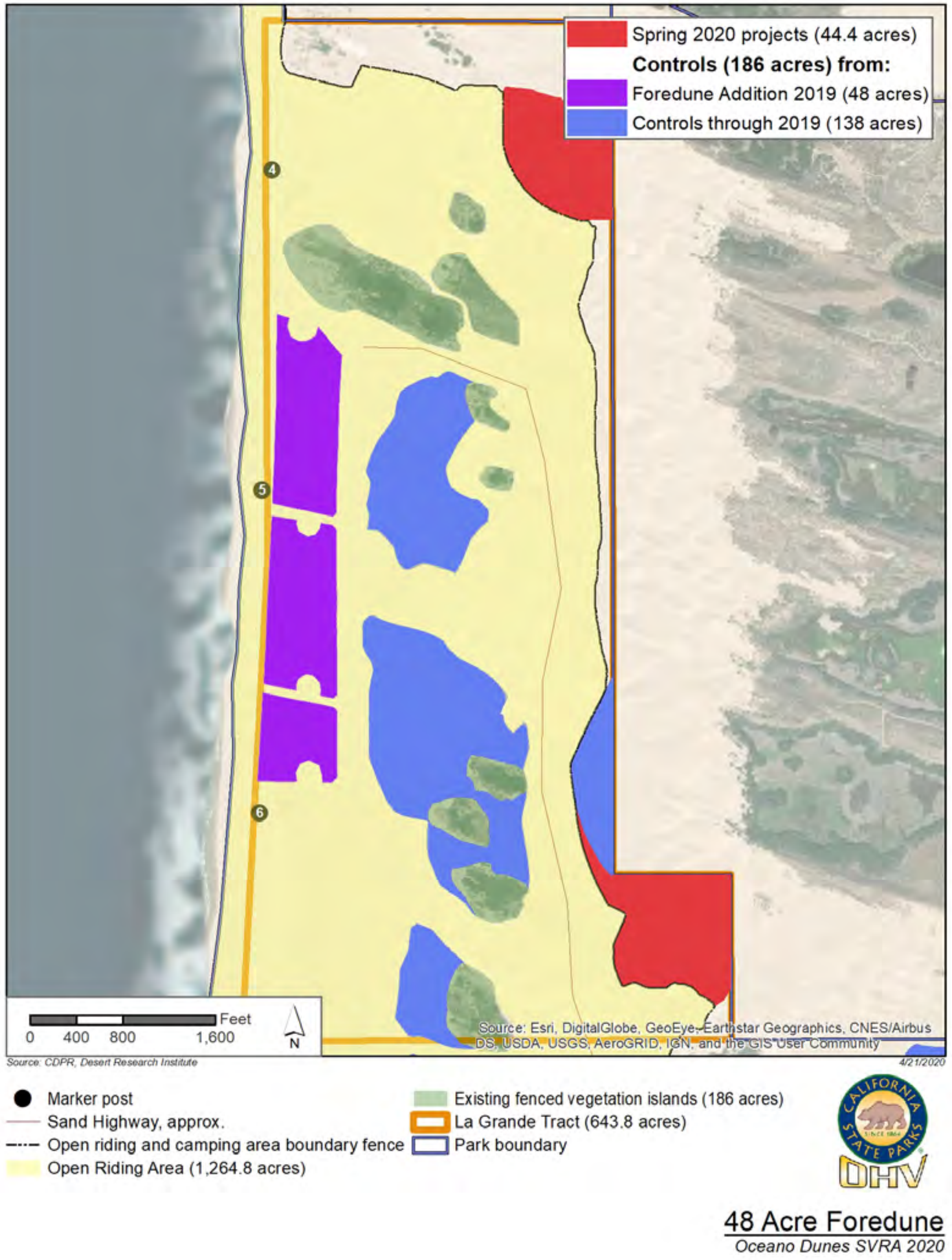
Complete Control of LaGrande Tract



Treatment areas in ODSVRA



Treatment areas in LaGrande Tract



2019 Effectiveness 100%

Areas Under Dust Control Through Time, 100% Effective (Zero emissions)			
Riding and Non Riding Areas		**10 Highest Emission Days**	
Scenarios	**Cumulative Area Treated (acres)**	**[Metric tons/day]**	**Reduction [%]**
Baseline, 2013, no controls	0	275.1	
Controls through 2019	137	253.1	8.0
Foredune Addition	185.6	249.2	9.4
Spring 2020	230.9	244.3	11.2
Riding Area Only		**10 Highest Emission Days**	
Scenarios	**Cumulative Area Treated (acres)**	**[Metric tons/day]**	**Reduction [%]**
Baseline, 2013, no controls	0	188.6	
Controls through 2019	137	169.6	10.1
Foredune Addition	185.6	165.6	12.2
Spring 2020	230.9	160.9	14.7

2019 Effectiveness 100%

		10 Highest Emission Days	
100% Treatment of the LaGrande T	**Cumulative Area Treated (acres)**	**[Metric tons/day]**	**Reduction [%]**
Baseline, 2013, no controls	0 of 1616	206	
All controlled	644 of 1616 (40%)	118	43
		10 Highest Emission Days	
LaGrande Tract	**Cumulative Area Treated (acres)**	**[Metric tons/day]**	**Reduction [%]**
Baseline, 2013, no controls	0 of 644	93	
Spring 2020	196 of 644 (30%)	65	30

Summary

- DRI developed the emission grid based on more available measurements in 2019, and a different interpolation scheme than the original 2018-CARB method.
- DRI uses more measurements and more input parameters for running CALMET at a higher spatial resolution based on our experience with geophysical processes versus air quality modeling experience.
- These choices lead to different outcomes in evaluating the control effectiveness impact on mass emissions, an SOA metric.

Summary

- DRI's emission modeling suggests that reduction in emissions is a linear relation between area under control and emission reductions, i.e., a 1% reduction in emissive area under control lowers mass emission by 1%.
- The expected benefit of targeting "hot spots" as identified initially in the CARB modeling has not resulted in "extra" emission reduction, because that "map" over-emphasized the presence of high emission areas.

Summary

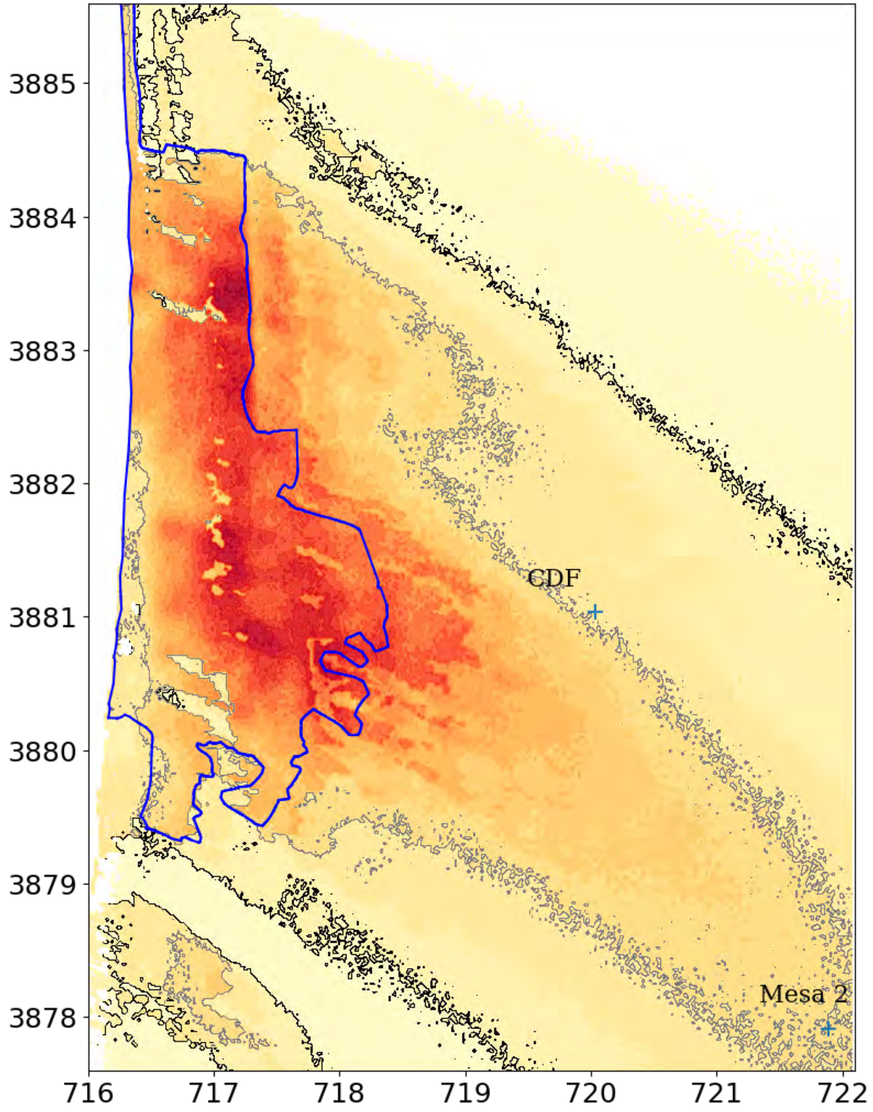
- Either modeling method indicates that the scale of control required to meet the 50% mass emission reduction of the SOA is considerable, and a challenge both from an engineering and Park operations perspective, as well as an ecological/dune dynamics perspective.
- This emissions "accounting" method does not take into account any secondary effects that the control measures (e.g., foredune) may have on erosion, emissions, and transport.

The 10 days with highest emissions

		2013 Emission Grid & 2013 Winds (no controls)	2013 Emission Grid & 2013 Winds, 2020 Controls, 100% Effective	2019 Emission Grid & 2013 Winds (no controls)	2019 Emission Grid & 2013 Winds, 2020 Controls, 100% Effective
Date	**Measured PM_{10} Concentrations at CDF ($\mu g\ m^{-3}$)**	**Modeled PM_{10} Concentrations at CDF ($\mu g\ m^{-3}$)**	**Modeled PM_{10} Concentrations at CDF ($\mu g\ m^{-3}$)**	**Modeled PM_{10} Concentrations at CDF ($\mu g\ m^{-3}$)**	**Modeled PM_{10} Concentrations at CDF ($\mu g\ m^{-3}$)**
5/19/2013	124	79	41	77	47
5/22/2013	169	164	70	135	47
5/23/2013	141	168	66	150	45
5/26/2013	112	143	48	142	48
5/27/2013	129	128	71	115	66
5/29/2013	107	129	72	127	69
5/30/2013	130	132	56	129	65
6/17/2013	107	79	49	77	54
6/18/2013	129	104	45	96	41
6/20/2013	133	108	53	82	33
Mean	**128**	**123**	**57**	**113**	**52**

CDF PM_{10} USING DRI 2013 EMISSIONS

10 Highest Emisison Days (2013 winds/2013 emissions)	PM_{10} ($\mu g\ m^{-3}$)	% Change
Observed	128	
Modeled Baseline	123	
Modeled 2020 Controls 100% Effective	57	46



Baseline, no controls

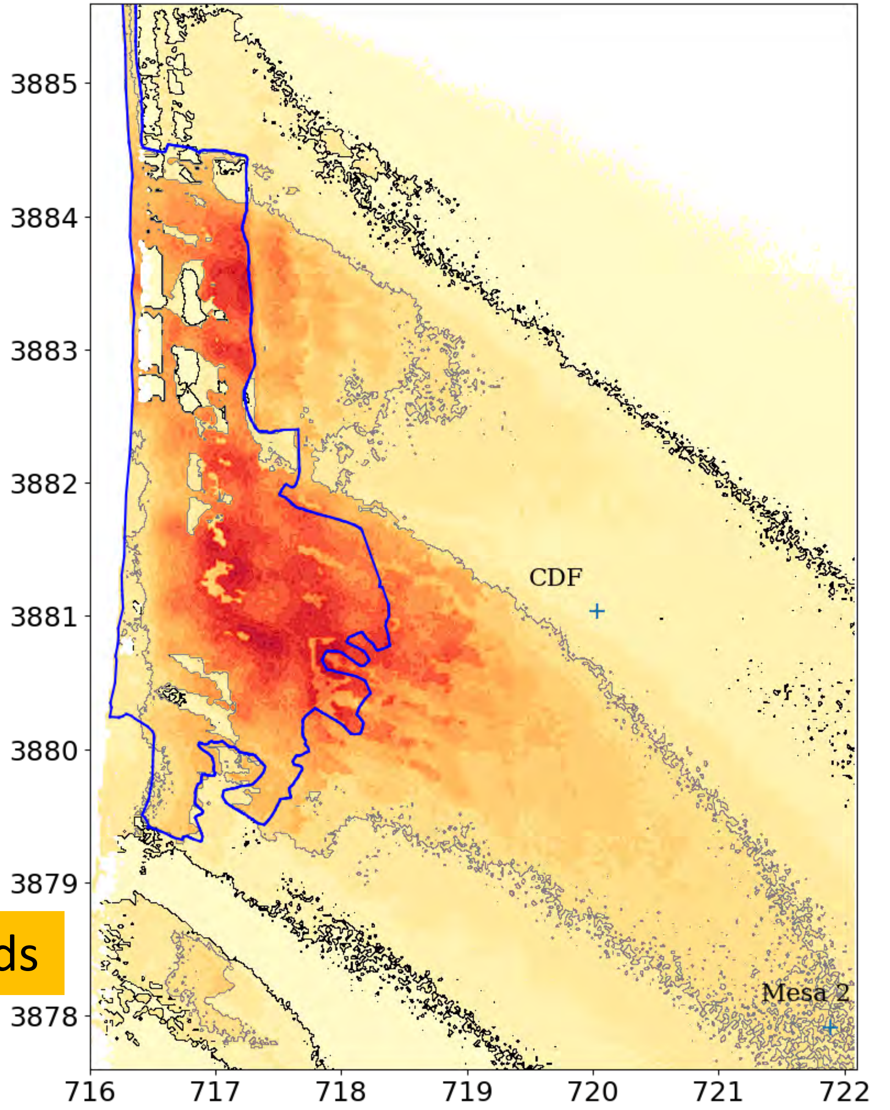
CDF 123 µg m^{-3}

50 microg/m^3

150 microg/m^3

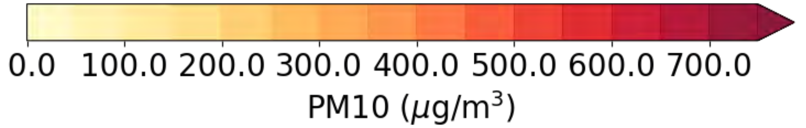
Riding area

2013 Emissions, 2013 winds



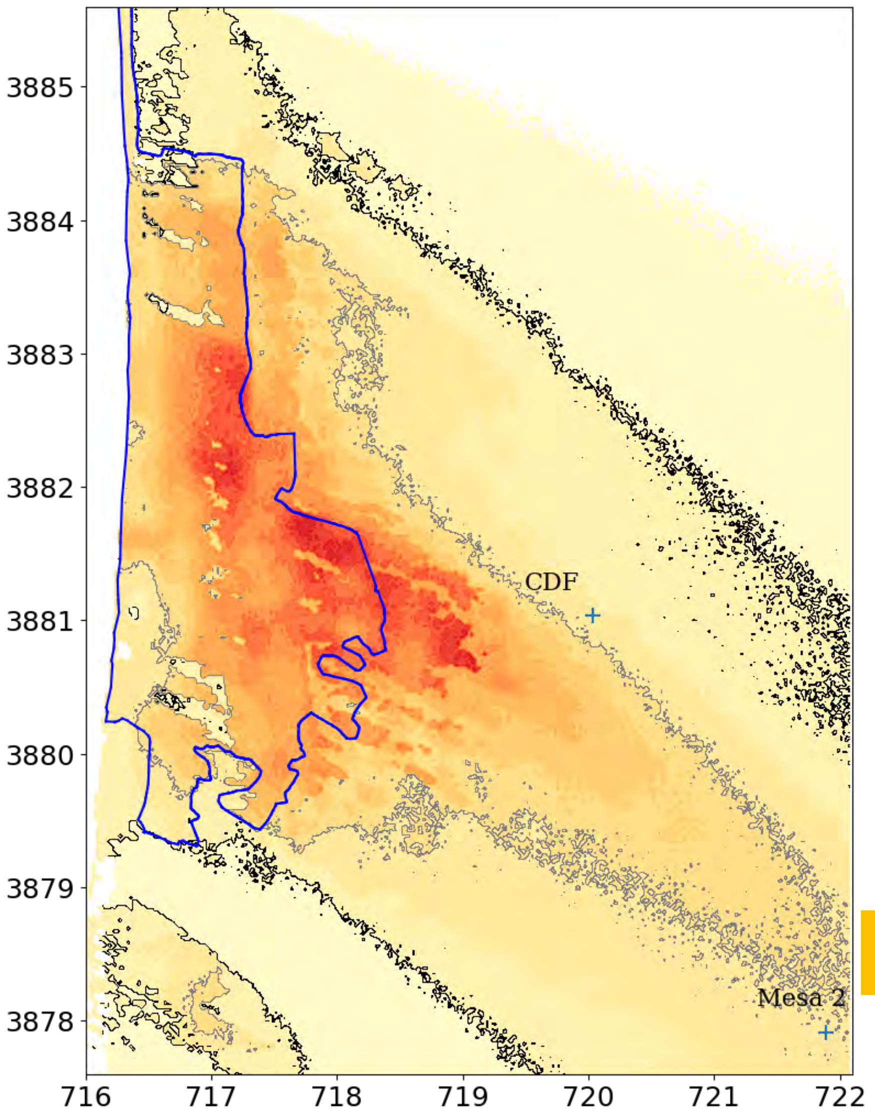
Treatments 2020, 100% Effective

CDF 57 µg m^{-3}



CDF PM_{10} USING DRI 2019 EMISSIONS

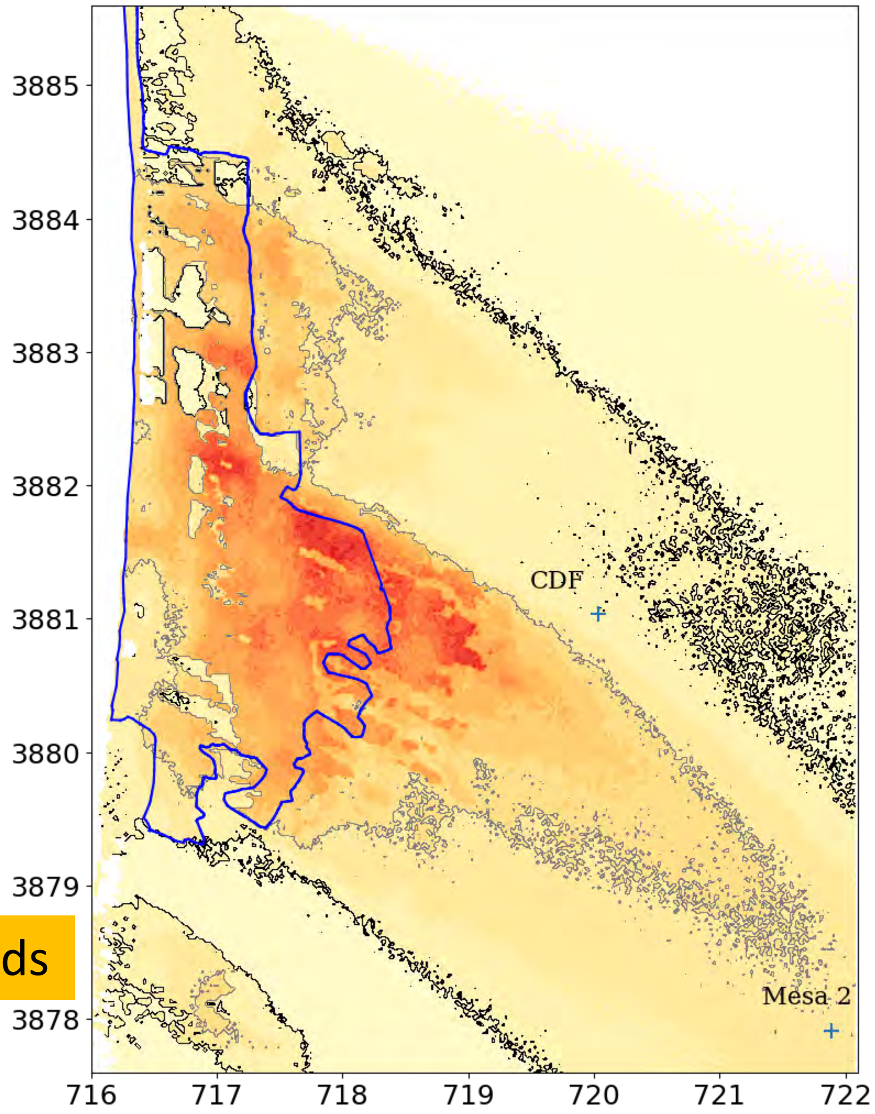
10 Highest Emisison Days (2013 winds/2019 emissions)	PM_{10} ($\mu g\ m^{-3}$)	% Change
Observed	128	
Modeled Baseline	113	
Modeled 2020 Controls 100% Effective	52	46



Baseline, no controls
CDF 113 μg m^{-3}

50 microg/m^3
150 microg/m^3
Riding area

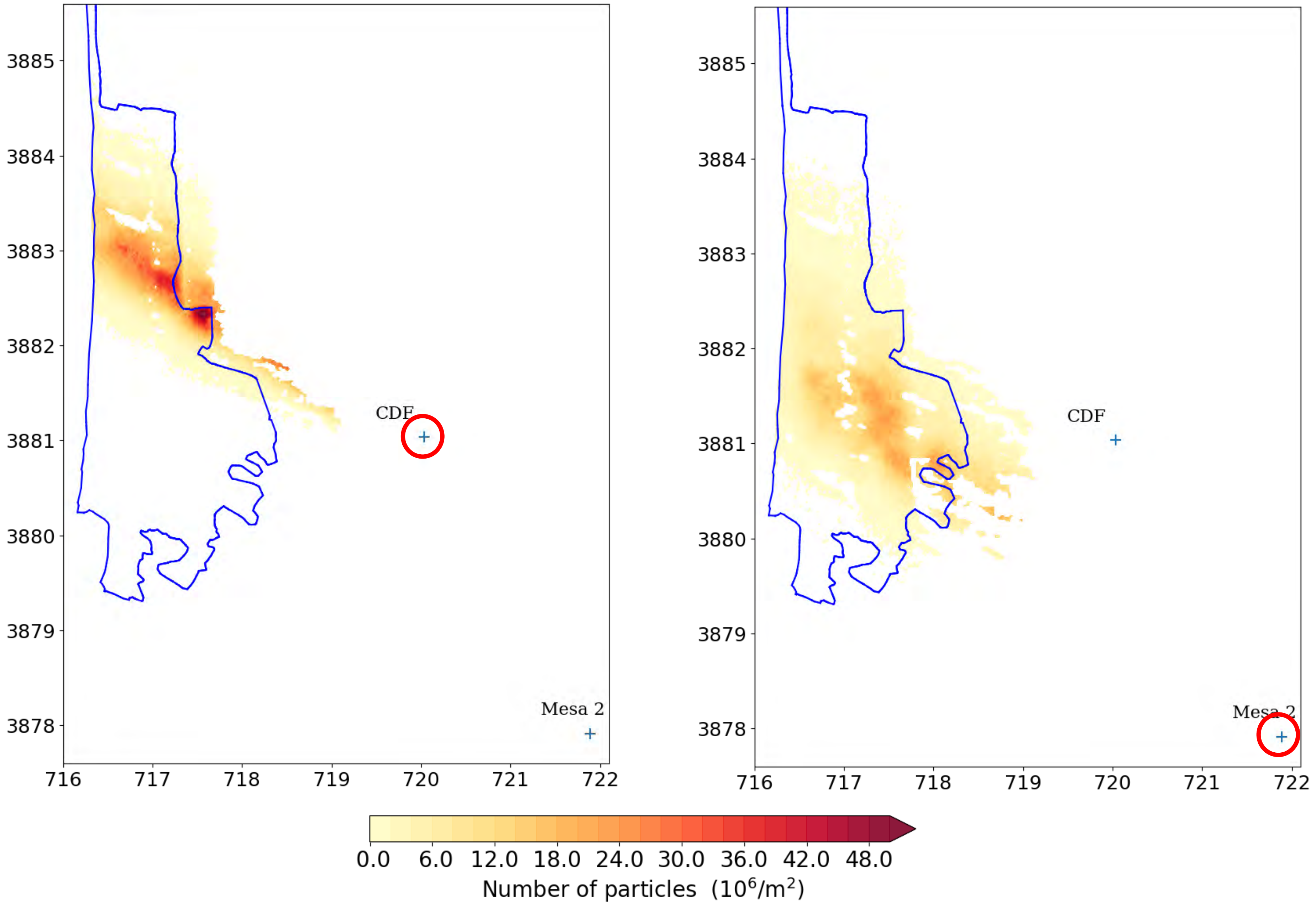
2019 Emissions, 2013 winds



Treatments 2020, 100% Effective
CDF 52 μg m^{-3}

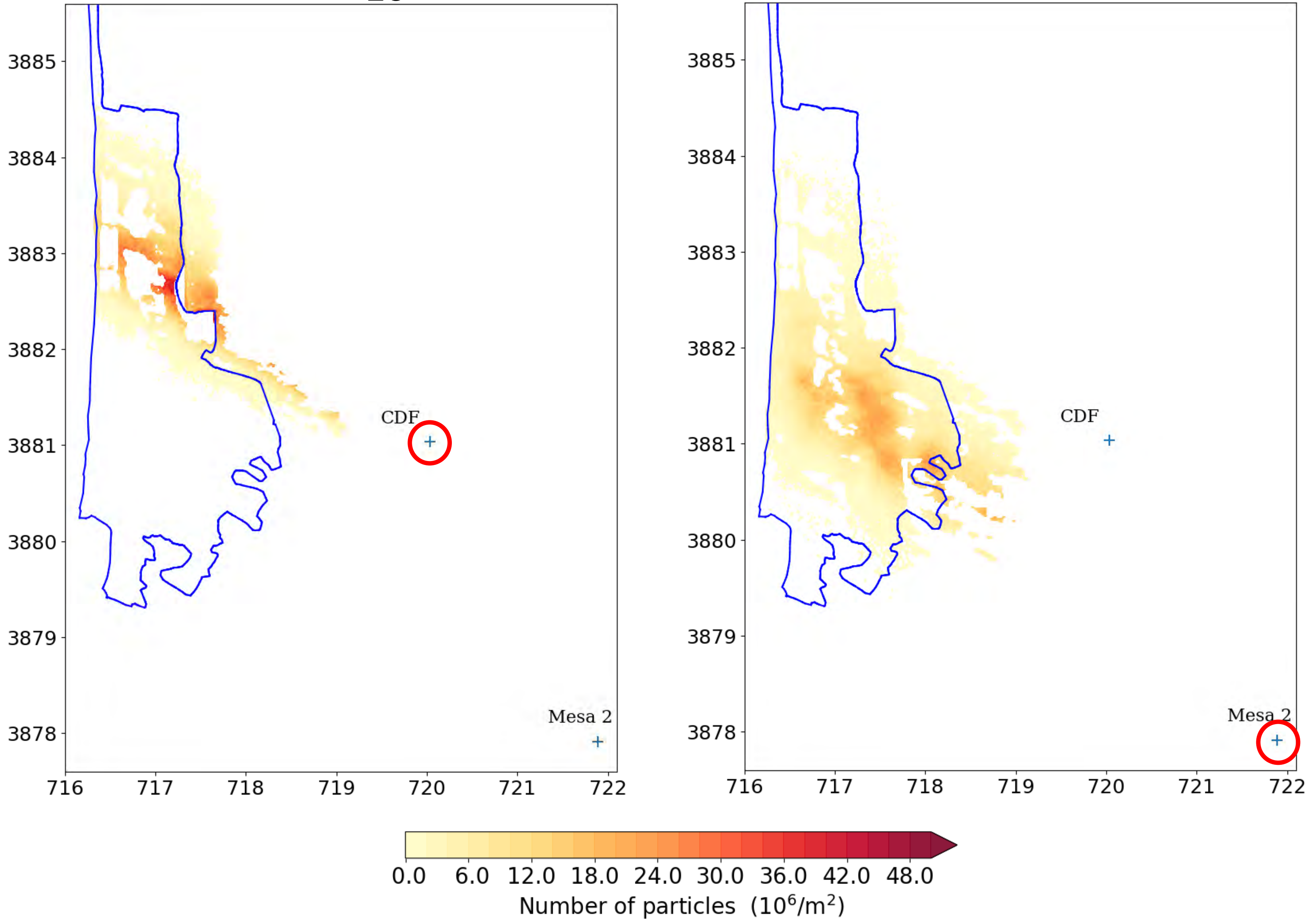
Source Attribution to PM_{10} at CDF and Mesa2 (2013 Emissions)

2013
No Controls

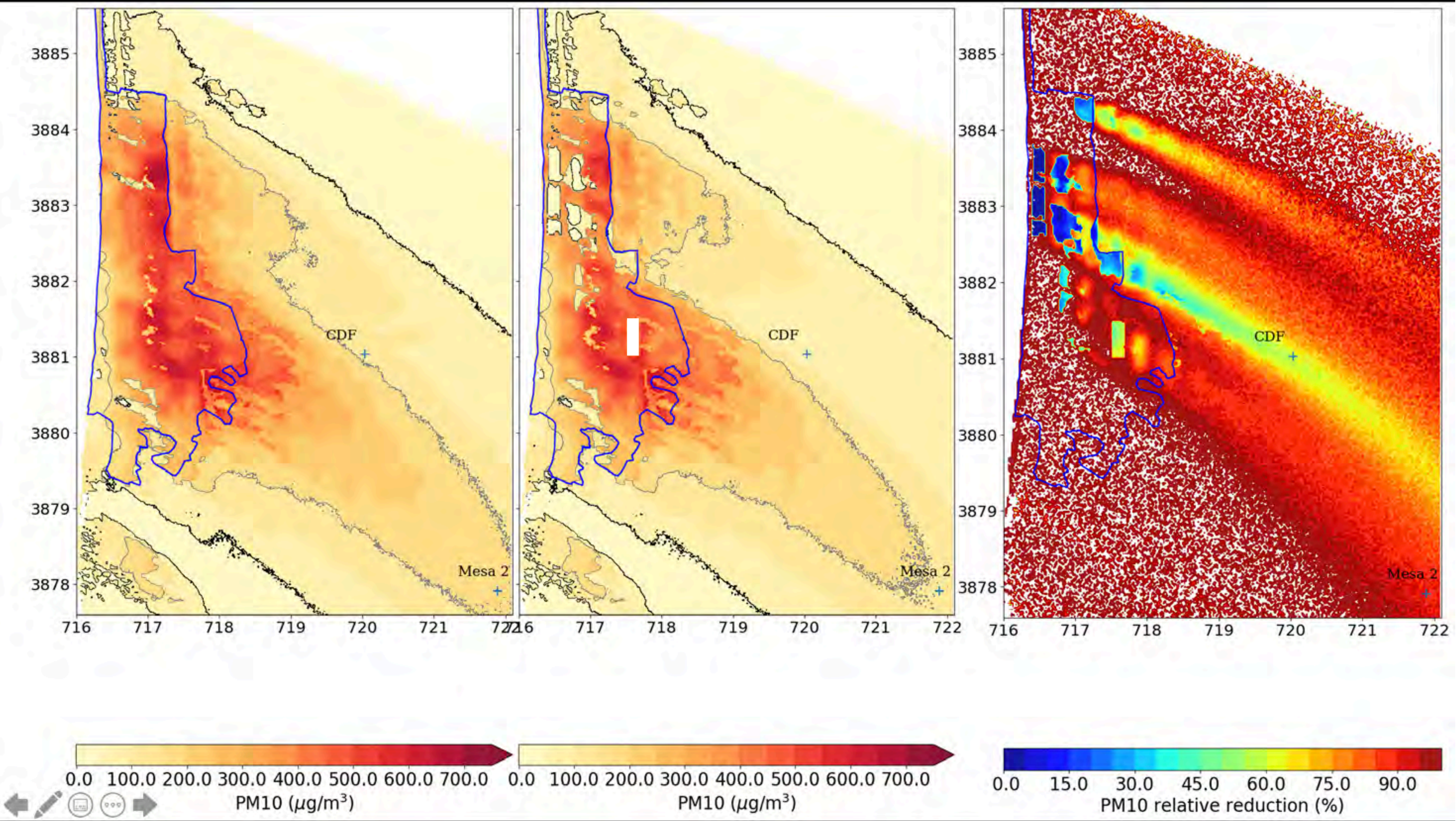


Source Attribution to PM_{10} at CDF and Mesa2 (2013 Emissions)

2013 winds
Controls to
2020 in place



40 Acre Dust Control Area, Effect on Mesa2



Mesa2 PM_{10} USING DRI 2013 EMISSIONS

10 Highest Emission Days	PM_{10} [$\mu g\ m^{-3}$]	% left after Removing
Observations	95	
Modeled Baseline	157	100
Modeled Removing 2011-2020	149	95
Modeled Removing 2011-2020 + 40 acres box	141	90
10% reduction of Observation	86	

Moymell
BBQ
LaGrande
Foredune
windfence
Acacia
Cottonwood
Haybale
Callender
P_66
Scout
Tabletop
CDF
Pipleline
SODAR
MESA2
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Oceano Dunes SVRA Dust Control Program

2020 Annual Report and Work Plan

ATTACHMENT 4

SLO APCD SOA FAQ - June 2020

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Frequently Asked Questions

Air Quality and the Temporary Closure of Oceano Dunes

Created by SLO County APCD, June 30, 2020

Q1: How does the temporary closure of the Oceano Dunes affect air quality?

A1: Neither the District nor the Scientific Advisory Group (SAG)[1] expect the temporary cessation of OHV activity to have any immediate or significant impact on dust levels downwind of the ODSVRA. In a letter dated April 6 and posted to the District website on April 13,[2] the SAG explained 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. The SAG does not expect a few weeks or months of temporary OHV restrictions to substantially alter the balance of human versus natural contributions to PM emissions at ODSVRA."*

Many people have assumed that the current absence of OHVs will result in improved air quality, or that the temporary cessation provides an opportunity to test the impact of OHV activity on air quality. This, however, is based on a common misunderstanding about the connection between OHV activity and dust. As discussed in more detail in an FAQ posted to the District website a year ago,[3] it is not the dust kicked up by OHV activity (i.e. "rooster tails") that causes poor air quality downwind, nor is it their tailpipe emissions. Rather, it is the secondary effects to vegetation and dune shapes that lead to greater wind erosion and more dust when the wind blows. It is true that without wind, there would be no significant dust, but changes to key vegetation areas and dune structures caused by OHVs results in more sand movement and more dust emissions when the wind blows.

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[1] The SAG is the group of experts selected jointly by District and California Department of Parks and Recreation to advise on ODSVRA dust issues.

[2] 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

[3] SLO County APCD, "Responses to Comments Received on the May 1, 2019 Workshop Version of the DPMRP," June 11, 2019. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/Response%20to%20Comments_FINAL_PostedJune122019.pdf

Left alone, it will take years or decades for the dunes to return to their natural, undisturbed state, even in the complete absence of human activity.[4] It takes years for plants to grow and decades for dunes to re-equilibrate. Therefore, it is naïve to assume that a few weeks or months without OHV activity will result in significant improvements in downwind air quality.

Finally, the recent grading by State Parks in front of the foredunes[5,6,7] may be contributing to some of the emissions this year, but it is doubtful the amount can be determined from the existing monitoring system since the grading was not a disclosed activity when the monitoring system was designed.

Q2: Why have there been more exceedances in 2020 than by this point last year?

A2: In simple terms, it was a very windy spring. 2020 is by far the windiest of the last 6 years, while 2019 was the least windy.

The ODSVRA only generates dust when conditions are windy, and this occurs more frequently in some years than others. In other words, just as some years are wetter or hotter than others, some years (or portions of years) are windier than others. All else being equal, more exceedances are expected in a windier year than in a less windy year.

As shown in the Table 1 and Figure 1 below, 2020 has been exceptionally windy, with more wind events to date than over the same period in any of the previous 5 years. A wind event is a day when winds are strong enough and out of the right direction such that the PM_{10} standard is likely to be exceeded.[8] As shown in the table and figure, **2020 is the windiest of the last 6 years, while 2019 was the least windy.**

---

[4] This is why revegetation is the key mitigation measure being used on the ODSVRA. It would certainly require less resources for State Parks to simply fence off large areas from OHV use and let nature reclaim them; however, it would likely take many years before this strategy would result in significant air quality improvements. By "jump starting" areas with seed, seedlings, and in some cases ground cover, air quality benefits can be realized much more quickly.

[5] Vaughn, M., "Coastal Commission investigates bulldozers on the beach at Oceano Dunes," *The Tribune* [San Luis Obispo], May 5, 2020. Available online at https://www.sanluisobispo.com/news/local/environment/article242516126.html.

[6] California Coastal Commission, "Th11a: Staff Report: CDP Amendment Application No. 3-12-050-A1 (California Department of Parks and Recreation ODSVRA Dust Control, Grover Beach/Oceano, San Luis Obispo Co.)," June 19, 2020. Available online at https://documents.coastal.ca.gov/reports/2020/7/Th11a/th11a-7-2020-report.pdf.

[7] Letter from Lisa Haage, California Coastal Commission, to Lisa Mangat and Liz McGuirk, California Department of Parks and Recreation, "Re: Violation File No. V-3-20-0048 - Oceano Dunes State Vehicular Recreation Area (ODSVRA)," June 16, 2020.

[8] In general, strong afternoon winds out the WNW to NW predict a PM_{10} exceedance at CDF. The formal definition used here is any day when the 3 p.m. PST hourly wind speed at CDF exceeds 8 mph and the 1 p.m. PST hourly wind direction is between 290 and 360°; however, small changes to these threshold values don't affect the overall analysis much. For further details, see Appendix A of SLO County APCD, "2017 Annual Air Quality Report," November 2018, available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2017aqrt-FINAL2.pdf.

Table 1: Wind Events and Number of Days Exceeding the PM_{10} Std		
Year	Year-to-Date (Jan 1 – June 28)	
	# of High Wind Event Days	CDF Central Site # of Violations
2020	**55**	**30**
2019	30	16
2018	47	34
2017	47	44
2016	45	44
2015	36	35

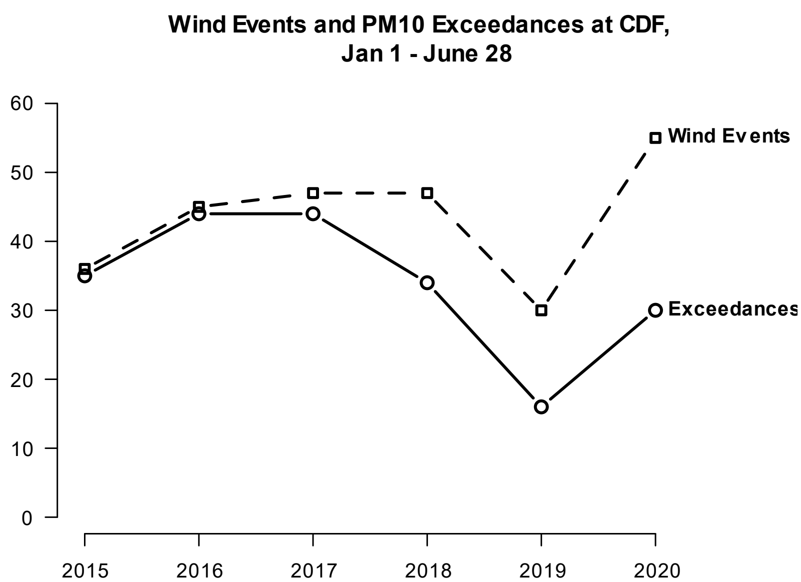

Figure 1: Wind Events and PM10 Exceedances at CDF

The table and figure also show that for 2020 year-to-date, there have been 30 violations of the California PM_{10} air quality standard at the CDF site. Comparing to 2019 only, which had a historically low 16 violations at CDF, it would appear that the 2020 mitigations and COVID-19 closure have not improved the air. However, this ignores the significant year-to-year differences in the winds. For example, other years had fewer wind events yet more exceedances than 2020. Finally, focusing on the number of exceedances ignores the dramatic reductions in the magnitude of the exceedances which is explained in question 3 below.

Q3: What effect have the dust mitigations had on downwind air quality?

A3: The short answer is that we have seen real, significant improvements in air quality, especially at CDF, and especially after taking meteorology (wind) into account. This improvement is not due to the temporary cessation of OHV-activity (as explained in answer A1, above), but rather to the large mitigation projects installed prior to the ODSVRA's closure to vehicles.

Several lines of evidence support this conclusion:

- As noted in answer A2, 2020 so far has been windiest year of the last 6 years, yet it has had the second fewest number of PM_{10} exceedances. The only year with fewer exceedances by this point was 2019, which was the least windy of the last 6 years.

- While there have been 30 exceedances at CDF so far this year as shown in Table 1, the PM_{10} levels there have not been as extreme as in previous years. For example, this year to date there have been only 3 hours at CDF with PM_{10} concentration greater than 300 µg/m^3; by this time last year there were 22 hours above 300ug/m3, and up to 83 hours above 300 ug/m3 in 2017. See Table 2 and Figure 2, below.

Table 2: Number of hours PM_{10} > threshold, Jan 1 through June 28

Year	Hours > 300 µg/m^3		Hours > 400 µg/m^3		Hours > 500 µg/m^3	
	CDF	Mesa2	CDF	Mesa2	CDF	Mesa2
2020	***3***	***16***	**0**	**4**	**0**	**2**
2019	22	10	5	2	0	0
2018	31	9	0	0	0	0
2017	83	18	31	2	8	1
2016	56	20	16	3	2	0
2015	51	23	27	6	10	2

Similarly, there have been no days so far this year when the 24-hour average PM_{10} level exceeded 100 µg/m^3 (twice the daily health standard). By this time last year, which was a low year for pollution, there had already been 2 days with daily averages above 100 µg/m^3. Compare that to 2017 when we had 12 days that were above 100 µg/m^3 by this time of the year. For more information on highest daily hours, see the tables of Top 10 Daily Averages and Daily Maxima, in the Appendix.

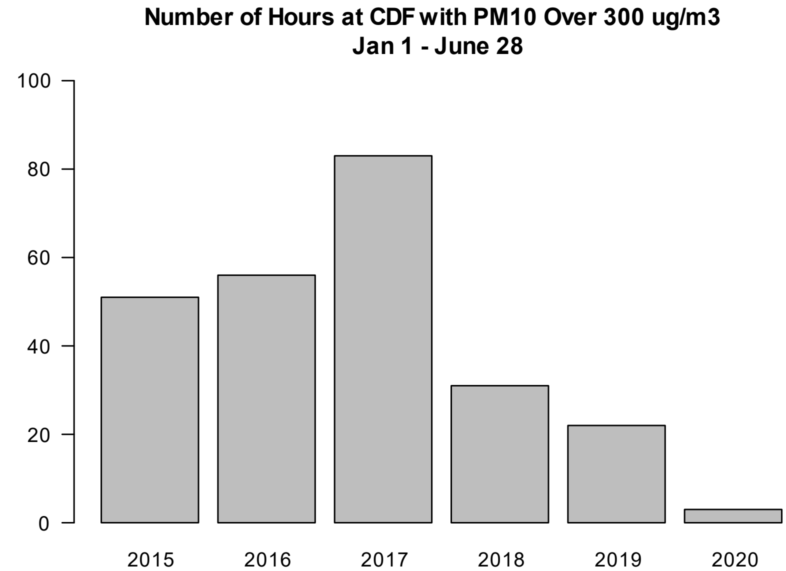

Figure 2: Hours greater than 300 ug/m3 at CDF

- In 2018, State Parks deployed over 100 acres of new dust controls to the ODSVRA, and in late 2019 they began installing another 92.2 acres of dust controls.[9] These were installed mostly upwind of CDF, and were not expected to have significant impacts on air quality at the Mesa2 monitoring station. Consistent with this, **dust levels at CDF have decreased relative to the levels at Mesa2, and now CDF typically has better air quality than Mesa2**. In prior years, during windblown dust events, PM_{10} at CDF was almost always greater than Mesa2, but this year Mesa2 is usually higher. On the 31 days when either or both sites exceeded the standard, the 24-hour average at Mesa2 was higher than CDF 24 times. The CDF average was greater than Mesa2 on only 6 days, and one day was tied.

- Additionally, the air quality improvements at CDF noted in the first two bullet points are not observed at Mesa2:
    - 2020 is the windiest year since 2015 (as shown in Table 1), and in contrast to CDF, Mesa2 has the second highest number of exceedances this year.
    - The number of hours exceeding 300 μg/m^3 at Mesa2 in 2020 is consistent with previous years; this year has most hours exceeding 400 and 500 μg/m^3.
    - As shown in the Appendix tables, the decrease in peak levels seen at CDF in 2020 is not seen for Mesa2.

- Finally, the decrease in PM_{10} levels at CDF relative to Mesa2 can be quantified and doing so implicitly accounts for year-to-year differences in windiness. Applying methodology

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[9] These 92.2 acres are pursuant to the November 2019 Amendment to Stipulated Order for Abatement #17-01 (available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/AMENDED%20Order%20of%20Abatement%2011-18-19_FILED_12.pdf), and include 48 acres of foredune restoration, 4.2 acres of back dune restoration, and 2 20-acres blocks of temporary wind fencing.

previously developed by the District to the recent data,[10] we find that wind event PM_{10} levels at CDF have been steadily decreasing for the January 1 – June 28 period. Relative to 2017, 2018 levels were 13% lower, 2019 levels were 25% lower, and 2020 levels are 33% lower. These decreases are attributed to the mitigation measures on the dunes and are not simply an artifact of meteorology. In other words**, after accounting for changing winds, dust levels at CDF this year are 33% lower during wind events than they would have been without the mitigations.**

Q4: What role does silica play in the dust issue?

A4: Respirable crystalline silica is an occupational health hazard regulated by OSHA. District studies have shown that downwind of the ODSVRA the amount of respirable crystalline silica in the air is below the OSHA standard and that chronic risk is likely to be negligible. Prior to completing these studies, the District had concerns that there may have been a crystalline silica issue; however, none of our regulatory actions were based on concerns over respirable crystalline silica, and none required any findings related to silica. The District has acknowledged the study results in several public forums, including at the hearing to adopt the Stipulated Order of Abatement, which is the agreement prescribing the mitigation requirements currently underway. Instead, all District actions have been based on the long and very well-documented history of PM_{10} exceedances observed downwind of the ODSVRA. $PM_{10,}$ regardless of what it is made of, is a health hazard because of its small size.

To address the silica issue, the District collected 8 samples for respirable crystalline silica analysis in 2017 and 2018, and 26 additional non-respirable silica samples in 2019. The results of the studies were included in the 2017 and 2018 Annual Air Quality Reports,[10] presented to the District Board in November 2018 and November 2019, and discussed at the May 2019 public workshop on the ODSVRA Particulate Matter Reduction Plan.

Respirable crystalline silica was detected in 6 of the 8 samples from 2017-2018, and crystalline silica was detected in all but 5 of the 26 samples from 2019. None of the samples exceeded the OSHA standard and an estimate of the annual average silica level did not exceed the California's risk level for chronic exposure.

The District is aware of claims that the initial sampling results were hidden from the public or not disclosed in a timely manner, but this is not true. It takes time to collect samples, understand and analyze data, and then finally write reports which put the findings in the appropriate context; this is the usual process for any special study. In 2017, the District was still in the data collection phase of the process, when, in good faith, we shared early results with a partner agency. That agency later passed those initial results onto other parties and published them online without the District's knowledge or consent.

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[10] SLO County APCD, "2018 Annual Air Quality Report," November 2019, available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2018aqrt-FINAL.pdf

Appendix: Top 10 Tables

CDF 10 Top 10

Table A1: 10 Highest 24-hr PM_{10} Averages at CDF (ug/m^3) (through June 28)					
2020	2019	2018	2017	2016	2015
91	100	115	145	143	149
81	100	108	138	125	141
77	97	105	130	122	130
73	96	95	130	116	129
73	88	93	122	111	119
72	86	93	111	107	104
71	83	90	111	105	101
71	79	90	108	95	99
68	76	88	108	95	94
67	71	86	106	91	94

Table A2: 10 Highest PM_{10} Daily Maxima at CDF (ug/m^3) (through June 28)					
2020	2019	2018	2017	2016	2015
394	477	387	713	554	642
380	465	371	542	511	588
326	443	362	527	486	578
296	386	362	510	486	556
272	382	353	481	481	535
269	378	352	478	455	517
265	372	339	478	453	504
255	368	338	447	441	482
252	355	336	445	411	469
248	333	333	432	386	426

Mesa2

Table A3: 10 Highest 24-hr PM_{10} Averages at Mesa2 (ug/m^3) (through June 28)					
2020	2019	2018	2017	2016	2015
111	104	124	95	104	122
100	93	103	92	100	121
100	89	95	91	99	118
97	89	86	85	94	94
85	82	82	85	89	92
82	78	74	85	86	86
81	75	73	82	85	84
77	73	73	81	84	83
75	68	71	75	82	79
75	62	68	72	78	78

Table A4: 10 Highest PM_{10} daily hourly maxima at Mesa2 (ug/m^3) (through June 28)					
2020	2019	2018	2017	2016	2015
560	455	390	610	469	509
388	407	363	478	424	503
371	378	361	386	412	459
362	370	335	369	387	452
340	311	329	368	367	399
334	311	283	365	330	389
331	301	258	353	325	377
323	291	257	333	311	368
307	282	250	317	309	340
301	281	250	314	306	311

Oceano Dunes SVRA Dust Control Program

2020 Annual Report and Work Plan

ATTACHMENT 5

ASU Scope of Work Survey/Digital Elevation Model

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10 March 2020

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

RE: Contract amendment (C18V0016/PC#38076)

Dear Jon,

This letter provides rationale, scope of work, and other details for an amendment to my existing contract C18V0016/PC#38076 for work on the Scientific Advisory Group (SAG) on the Oceano Dunes State Vehicular Recreation Area dust mitigation project, per the Stipulated Order of Abatement 17-01.

RATIONALE:

At the December 2019 SAG meeting in Pismo Beach, it was recommended by SAG, APCD, and CalParks staff that the UAS mapping domain in ODSVRA be expanded beyond the foredune restoration zone and reference sites near Oso Flaco Lake, which is the scope of my existing contract. The expanded domain is ~160% larger (~1500 acres) and will include key reference sites of high OHV activity, protected non-riding areas, high saltation activity, and other emissive areas. This is critical for assessing the role of OHV activity on sand transport, morphological change, and dust emissions, as well as for quantifying the effectiveness of other areas of implemented restoration treatments.

Aerial LIDAR and UAS platforms have both been used recently within ODSVRA (LIDAR contracted by DRI in 2018, UAS flown by our ASU team in Oct 2019). Generally, LIDAR is more expensive than UAS, yet the data products are comparable for mapping open dune terrain. Given this cost savings, and existing UAS mapping by ASU, the consensus of SAG and CalParks was that UAS surveys should be expanded.

On 11 Feb 2020, I met with Alex Stehl, Parks Planning Chief, and Don Selleder, Parks GIS Specialist, at the ODSVRA to discuss the proposed amendment scope and rationale and the requirement of CalParks to explore internal or other local providers for such services. Both Don and ODSVRA staff have DJI Phantom UAS platforms, which are limited in flight time, camera resolution, and georeferencing capabilities compared to the ASU Wingtra One fixed-wing VTOL platform. For instance, with favorable weather, the Wingtra can map the new domain in two days with no additional ground surveying (it has an onboard, survey-grade GNSS receiver). The Phantom platform, however, is much more labor intensive, has a smaller mapping range, and requires manual survey of ground control targets for georeferencing. We use the Phantom regularly for small campaigns and estimate it would take >10 days just for acquisition and ground control surveys. Variable site conditions (lighting, weather, sand movement) during a long campaign would seriously challenge post-processing time and accuracy of resulting elevation models.

Another caution is that combining datasets from different UAS platforms, georeferencing methods, and time periods is highly problematic. Based on much experience, combined mapping efforts with different platforms and providers does not yield a timely, quality, integrated dataset. Resulting delays and accuracy issues would challenge our ability to meet the deliverables and reporting timelines established in the SOA.

Alex, Don, and I collectively determined that the CalParks UAS platform would not be capable of mapping the expanded new domain feasibly and that combining datasets between platforms could compromise the integrity and timeliness of data products required by the SOA and related annual reporting and workplans. It was also recognized that aerial or UAS-based LiDAR would be much more expensive for the required frequency of surveys.

Overall, there are 6 points of rationale for the expanded domain and contract amendment, as follows:

1) Key reference sites downwind of the new foredune restoration zone are not included in the current scope of work. The expanded domain will include areas of high OHV activity (e.g., sand highway), low disturbance (e.g., dune preserve areas), high saltation (sand transport) activity, and surfaces spanning the range of dust emissivity within ODSVRA. This is critical for assessing the role of OHV activity on sand transport, morphological change, and dust emissions, as well as for quantifying the effectiveness of implemented restoration treatments, most notably the foredune restoration zone.

2) Linkages between dust emissivity and saltation from the beach through the dunes are unknown. The expanded domain will enable detailed mapping of sand transport vectors (ripple maps) and erosion-deposition maps from aerial imagery and DEMs. This will identify and link key transport corridors to emissive sites. Repeat surveys will enable efficacy assessments of implemented restoration efforts for reducing sand transport activity and dust emissivity over time.

3) Baseline data on volumes and erosion-deposition patterns of sand movement from the ocean and through the dunes does not exist. Repeat UAS surveys will enable high accuracy sand volume estimates and patterns of geomorphic change, including dune migration rates. As above, these changes can be used to assess the efficacy of implemented restoration efforts.

4) Vegetation establishment and health is not being assessed with the existing mapping protocol. Currently, only standard visual (R,G,B) imagery is captured and used to develop aerial orthophoto mosaics and DEMs. Vegetation characterization is not part of the existing scope of work. The ASU Wingtra has an additional multi-spectral payload (Micasense Rededge-MX) that can be used to map vegetation cover, health, and stress. This requires a second flight for vegetation areas using the multi-spectral sensor. These data will enable high-resolution assessment of plant establishment, vigour, and evolution of the foredune restoration treatments.

5) Logistically, UAS provide comparable data products at a significant cost savings vs aerial LIDAR. The ASU team is equipped and experienced for the expanded scope of work. The cost increase is incremental atop existing contracted surveys of the foredune zone and at an educational/research (vs. commercial) cost structure.

6) The ASU team can provide added value deliverables that other contractors cannot provide. This includes: expertise in aeolian geomorphology and geomorphic change detection methods, assessment of dune restoration effectiveness, development of educational and outreach materials, training of CalParks staff in monitoring protocol design and implementation. We are highly experienced and have worked with many parks and land management agencies on these aspects.

SCOPE OF WORK:

Dr. Walker is an appointed member of the Oceano Dunes Scientific Advisory Group (SAG) by mutual agreement between the State of California Department of Parks and Recreation (DPR) and the San Luis Obispo County Air Pollution Control District (APCD) in response to a Stipulated Order of Abatement, Case No. 17-01, pursuant to California Health and Safety Code section 42451. As a member of the SAG, Dr. Walker's work involves attendance at SAG meetings, contributions to SAG reports, review of scientific and technical issues related to the SOA, assist in designing and implementing research components and preparing technical specifications, and analyses of proposed mitigation measures for reducing windblown PM10 emissions at the ODSVRA as outlined in existing contract C18V0016/PC#38076.

This amendment is recommended by the SAG following revisions to the 2019 Annual Report and Work Plan (ARWP) and expands the scope of UAS monitoring at ODSVRA to cover roughly 1.6 times (160%) more area (from ~588 acres to 1500 acres). For reference, the new foredune restoration zone is ~ 48 acres. UAS surveys would occur twice per year vs. annually per the initial contract. The existing and proposed areas are shown in Fig. 1 as well as the CDF monitoring station and new foredune restoration treatment polygons. The actual extent will vary depending on site logistics and weather conditions during campaigns.

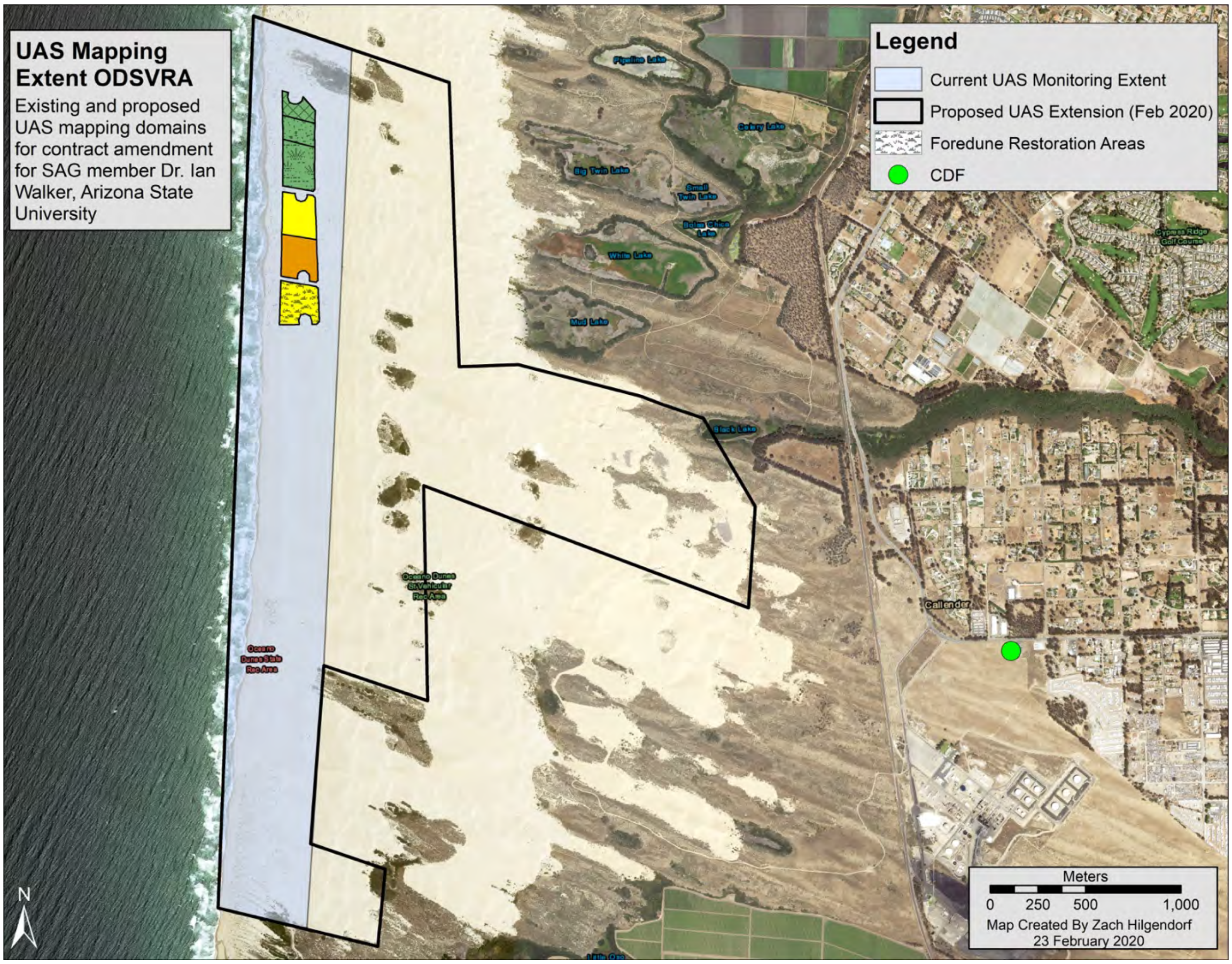
Surveys will be conducted at twice per year to provide seasonal assessments. All UAS surveys will be flown by a licensed pilot in accordance with FAA guidelines and the pilot and field crew will be ASU employees covered by ASU liability insurance. It is expected that CalParks will provide additional staff as available for crowd control, wildlife monitoring, and field logistics support.

This amendment will provide the following primary and secondary data products:

- high-resolution digital aerial photographs (~1-3 cm resolution) in JPEG format
- digital orthophoto mosaics of the entire site in GEOTIFF format georeferenced to NAD83 2011 UTM Zone 10M coordinate system and NAVD88 vertical datum
- digital elevation models (DEMs) of the entire site georeferenced as above
- multi-spectral (5-Band) imagery (R,G,B, Rededge, NIR) of plant cover within restoration sites as GEOTIFF files
- a sand transport vector map showing sand transport patterns within the dune field as GIS shapefiles
- geomorphic change detection (GCD) maps illustrating erosion-deposition patterns over time as GEOTIFF files
- annual sediment budgets (volumetric balance) linking source (beach) to landward sinks (foredune, larger transgressive dunes) derived from GCD analyses as MSExcel spreadheet (.XLSX)
- general geomorphic interpretation of dune dynamics and impacts of the foredune restoration treatments as text that will be integrated into the annual ARWP documents
- general interpretations of plant establishment and community changes within the foredune restoration zone as text that will be integrated into the annual ARWP documents
- training workshops for CalParks field staff on UAS acquisition planning and execution; data collection, QA/QC and post-processing; software requirements/options for acquisition and post-processing (e.g., Pix4d capture, Agisoft Metashape); hardware and equipment needs/considerations; staff onboarding/training needs; and related GNSS/georeferencing and land survey procedures and requirements.

The aforementioned data and data products will be provided to CalParks ODSVRA staff as available or on request in a timely manner. Intellectual property considerations will remain as defined in the original contract Exhibit D, item 7.

Figure 1: Existing and proposed extent of UAS mapping for ODSVRA dust mitigation project. Foredune restoration polygon and CDF monitoring station shown for reference.



BUDGET ITEMS AND JUSTIFICATION:

The timeline for the budget is 3 years beginning May 2020 through the end of the existing contract in April 2023. The total amount for the 3-year contract amendment is $112,457, inclusive of annual salary, benefits (ERE), tuition remission (required for Graduate Research Assistants), and Overhead (F&A) rate of 25% per sponsor requirements. This amount represents an increase of 15.22% of the original contract amount. Amounts subject to ASU review and final contract approval. Amounts/timeline are provided below in Table 1.

Salaries: (total = $46,634)

1. Post-Doctoral Associate ($26,733 or approximately 5 months in 2021)
    - *Duties: assistance with UAS surveys, post-processing, outreach materials, report writing, training workshop delivery, other deliverables and SAG duties in collaboration with PI Walker.*
    - *Note: no additional PI time is requested for this amendment. Rather, the post-doc will assist the PI with deliverables and report writing associated with the additional UAS surveys and other related tasks. No tuition remission is required for post-doctoral RAs.*

2. Graduate Research Assistant ($19,901 or ~2.25 Academic months in AY2021 and AY2022)
    - *Duties: additional field and support for extended UAS surveys, data QA/QC, data archiving, post-processing, assist with training workshops.*
    - *Tuition remission is required for graduate student RAs and is included below as an other direct cost.*

Fieldwork/travel: ($12,132)

3. Additional airfares, accommodations, per diems, and rental vehicles and/or fuel required for additional field survey time

Other Direct Costs: ($31,200)

4. Peripherals and parts for UAS for extended service and flights ($2,500 total- $833 YR2021, $840 YR2022, $827 YR2023)
5. Software, licensing/updates ($1200/yr)
6. Survey control equipment ($1,500 total- $1,500 YR2021)
7. Survey control equipment maintenance ($1,500 total- $750 YR2022, $750 YR2023)
8. Vehicle maintenance for ASU field truck ($900/yr)
9. Tuition remission for ASU graduate student RA ($19,400 for periods 1 and 2)

Direct Costs Total: $89,966

Indirect Costs Total: $22,491

Total Direct & Indirect Costs: $112,457

Table 1: Cost categories for project amendment.

Cost Categories	Period 1 5/4/2020 5/3/2021	Period 2 5/4/2021 5/3/2022	Period 3 5/4/2022 4/3/2023	Cumulative
Other Personnel:	**$36,673**	**$9,961**	**$0**	**$46,634**
Post Doctoral Associate TBD02	$21,667	$0	$0	$21,667
ERE:	$5,066	$0	$0	$5,066
Effort (FTE Months; AY/SUM/CAL):	3/2/5	0/0/0	0/0/0	
Graduate Student TBD01	$9,263	$9,263	$0	$18,526
ERE:	$677	$698	$0	$1,375
Effort (FTE Months; AY/SUM/CAL):	2.25/0/2.25	2.25/0/2.25	0/0/0	
Total Number Other Personnel	2	1	0	3
Total Salary, Wages and ERE:	**$36,673**	**$9,961**	**$0**	**$46,634**
Travel:	**$4,044**	**$4,044**	**$4,044**	**$12,132**
Domestic	$4,044	$4,044	$4,044	$12,132
Other Direct Costs:	**$13,760**	**$13,763**	**$3,677**	**$31,200**
Materials and Supplies: Peripherals & parts for UAS for extended service & fights Computer Software: Software, licensing/updates	$2,033	$2,040	$2,027	$6,100
Tuition Remission	$9,327	$10,073	$0	$19,400
Survey control equipment ($1500)	$1,500	$0	$0	$1,500
Survey control equipment maintenance Vehicle maintenance for ASU field truck	$900	$1,650	$1,650	$4,200
Direct Costs:	**$54,477**	**$27,768**	**$7,721**	**$89,966**
Indirect Costs:	**$13,619**	**$6,942**	**$1,930**	**$22,491**
Total Direct and Indirect Costs:	**$68,096**	**$34,710**	**$9,651**	**$112,457**

Oceano Dunes SVRA Dust Control Program

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ATTACHMENT 6

Defining the SOA 10 Baseline Days

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Baseline update (PMRP Sec. 2.1.3) – updated March 1, 2020

The following baseline process will be followed for assessing progress toward the 50% emissions reduction required by the SOA:

1. **Dust emissions model.** The DRI dust emissions model is to be used to estimate progress toward the SOA goal of 50% emissions reduction. Details for this model are described in Chapter 3 of the draft PMRP.
2. **Baseline area for emissions modeling.** The geographic area for determining the emissions reduction will be the 2013 maximum extent of the Oceano Dunes SVRA public riding area (including exclosed interior "islands") in 2013. See, for example, Fig. 4-1 in the draft PMRP. This baseline area for emissions modeling excludes park areas permanently exclosed from OHV use (i.e., the Dunes Reserve and permanently fenced-off areas east of the riding area).
3. **Baseline days for emissions modeling.** Identify the top 10 most emissive days during the reference period (May 1 – August 31, 2013), in terms of the total mass of PM10 dust emissions determined by the DRI dust emissions model. Determination of the top 10 days by the modeled mass emissions most directly reflects the SOA goal to reduce the "maximum 24-hour PM10 baseline emissions by (50%)," and it also mostly matches the top 10 days as determined by directly examining the top 10 days with the highest measured PM10 concentrations at the CDF monitoring station. (See "Defining the 10 Baseline Days of 2013" at the end of this document for justification.) The top 10 days for modeling are thus:
    a. 5/19/2013
    b. 5/22/2013
    c. 5/23/2013
    d. 5/26/2013
    e. 5/27/2013
    f. 5/29/2013
    g. 5/30/2013
    h. 6/17/2013
    i. 6/18/2013
    j. 6/20/2013
4. **2013 baseline emissions mass.** Apply the DRI model to the 2013 baseline emissivity map (obtained from the 2013 PI-SWERL campaign) over the baseline modeling area to determine the total daily mass of PM10 emissions for each of the 2013 baseline days. Calculate the mean total emissions over these 10 days. This is the 2013 baseline emissions mass.
5. **Emissions modeling for baseline scenarios.** Through ongoing monitoring studies of dust mitigation treatments (i.e., foredune restoration, backdune planting, wind fences), estimate expected reductions in emissivity for these treatments. Then, modify the 2013 baseline emissivity map to account for the spatial extent of dust mitigation treatments. Re-run the DRI dust emissions model for the same top-10 baseline days but over this modified emissivity map. Determine the new total daily mass of PM10 emissions for each of the 2013 baseline days. Calculate the mean total emissions over the 10 days.

This is the 2013 treatment emissions mass. Compare to the 2013 baseline emissions mass to determine the percentage emissions reduction for the treatment.

6. **Model validation.** Perform periodic model assessments to ensure that the DRI model is valid for estimating dust emissions. For 2019, identify a set of emissive wind days (e.g., the top 10 days in 2019) for emissions model validation runs. Using these 2019 daily wind scenarios, the updated 2019 PI-SWERL emissivity map, and improved meteorological monitoring (including SODAR), calculate expected dust concentrations at the CDF monitoring station. Compare to actual measured dust concentrations at CDF to evaluate model performance.

Defining the 10 Baseline Days of 2013

At the last SAG meeting a comparison of three sets of days that could define the 10 Baseline days of 2013 was left as an action item. Set one represents the 10 days that are associated with the 10 highest observed 24-hour mean PM_{10} concentration measured at the CDF site. Set two represent the 10 days that are associated with the highest-model predicted emission days (a product based only on the CALMET generated hourly wind fields and the PI-SWERL [interpolated] emission grid). Set three represents the days identified in Table 4-3 of the PMRP. The period of time from which sets one and two were drawn (May 15-August 31, 2013) was constrained arbitrarily by the availability of the highest quality meteorological data during that period. We make the assumption that the more complete the available meteorological data (i.e., spatial coverage and all other external parameters [e.g., upper air data]), the closer the model-generated wind fields will be to the actual conditions. The three sets of days are shown in Table 1, with paired days shown by the same color cells. Eight of the same days are shared by sets 1 and 2, and 2 and 3. Seven of same days are shared between sets one and three. Based on the selection method, the mean and standard deviation of the 10 days are 129 μg m^{-3} (±18 μg m^{-3} [model-predicted]), 134 μg m^{-3} (±15 μg m^{-3} [measured]), 136 μg m^{-3} (±19 μg m^{-3} [PMRP Table 4-3]). Results from an ANOVA test (Table 2) indicate that the difference in the means among the three sets is not significant (i.e., F (0.52) < F Critical (3.35), therefore null hypothesis not rejected, means are equal).

Based on this analysis, the choice of which 10 days to choose will have no measurable effect on the quantification of the baseline conditions. As the SOA identifies the highest emission days be used, it suggests that the decision should favor the days identified in the first column in Table 1, and because these data are within the time frame of the best-quality meteorological data. This needs to be codified by the SAG, Parks, and APCD so that DRI can move forward with the modeling to quantify dust control area effects on mass emissions, PM_{10} as measured at CDF and Mesa2, and identify the relative importance of non-dust controlled areas that affect PM_{10} concentrations at CDF.

Table 1. The 24-hour mean PM_{10} concentrations measured at the CDF based on selecting the 10 days that are associated with the highest-model predicted emission days and the 10 days that are associated with the 10 highest observed 24-hour mean PM_{10} concentration measured at the CDF site during the period May 15 to August 31, 2013, and for a wider time window of April 4[th] to August 31, 2013 as identified in PMRP Table 4-3..

Date*	PM_{10} Concentrations at CDF [μg m^{-3}]	Date**	PM_{10} Concentrations at CDF [μg m^{-3}]	Date***	PM_{10} Concentrations at CDF [μg m^{-3}]
				4/8/2013	165
				4/15/2013	136
		5/18/2013	136	5/18/2013	136
5/19/2013	112				
5/22/2013	169	5/22/2013	169	5/22/2013	169
5/23/2013	140	5/23/2013	140	5/23/2013	140
5/26/2013	108			5/26/2013	108
5/27/2013	122	5/27/2013	122	5/27/2013	122
5/29/2013	120	5/29/2013	120	5/29/2013	120
5/30/2013	133	5/30/2013	133	5/30/2013	133
6/17/2013	116	6/17/2013	116		
6/18/2013	134	6/18/2013	134	6/18/2013	134
		6/19/2013	138		
6/20/2013	134	6/20/2013	134		
Mean PM_{10} Concentration	**129**		**134**		**136**
Std. Dev of the mean	**18**		**15**		**19**
*Identified from model-predicted mass emission estimates					
**Identified from measurements at CDF					
***PMRP Table 4-3					

Table 2. Results of the Analysis of Variance (ANOVA) comparing the three sets of 10 days of PM_{10} 24-hour mean PM_{10} concentrations shown in Table 1.

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
PMRP	10	1363	136	355		
Model-Derived	10	1287	129	312		
CDF Measured	10	1342	134	216		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	304.3778	2	152.19	0.52	0.60	3.35
Within Groups	7948.524	27	294.39			
Total	8252.902	29				

Oceano Dunes SVRA Dust Control Program

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ATTACHMENT 7

SAG Review of Scripps Study

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Reviewer #1

SAG Comments on SCRIPPS First Year (2019) Summary Report, Aerosolized Particulates 02-21-20020

The SOA is based on the emissions and airborne concentration of PM_{10} not $PM_{2.5}$, so it is unclear why SCRIPPS has focused on $PM_{2.5}$ to frame their discussion around particulate matter effects on regional air quality and potential health effects on the local population.

The discrepancy in $PM_{2.5}$ mass between SCRIPPS and APCD measurements is most likely attributable to the SCRIPPs measurements being made with a non-reference method $PM_{2.5}$ sampler and that they used a sum of species method to estimate mass. This method of estimation relies on the chemical species that were measured, and all species not accounted for will result in higher error in the estimated mass. In addition, the measurements made by the APCD are under far more rigorous Quality Assurance/ Quality Control measures than those of SCRIPPS, so to challenge the precision and accuracy of the APCD measurements would require that SCRIPPS demonstrate their QA/QC matches or exceeds APCDs and the uncertainties also need to be quantified.

Pg.2

What is the basis for the statement: "with relatively minimal OHV recreation occurring between S1 (i.e., the S1 tower) and the shoreline"?

Pg. 3

The statement that airborne mineral dust (from sand dunes) has not been associated with chronic respiratory effects is unsupported and contra to much published literature. See for example:

Miousse, I.R. et al. (2015). *In vitro* toxicity and epigenotoxicity of different types of ambient particulate matter. Toxicological Science, 148 (2), 473-487, doi: 10.1093/toxsci/kfv200.

Rodopoulo, S., et al. (2014). Air pollution and hospital emergency room and admissions for cardiovascular and respiratory diseases in Doña Ana County, New Mexico. Environmental Research, 129, 39-46, doi: 10.1016/j.envres.2013.

In addition, Federal and State air quality standards are mass-based, and invoking particle chemistry as means to defer meeting standards is not supported by current law or understanding of health risk associated with airborne PM.

Pg. 7

The connection made between DNA from marine organisms being found on filters collected by sampling air downwind of the ocean and their potential role in air quality degradation as a major contributor to $PM_{2.5}$ or PM_{10} is not supported by any data or analysis.

What is the role of photosynthetic activity in phytoplankton with respect to air quality degradation that you are hypothesizing?

Reviewer #2

Review and Comments on the SCRIPPS First Year (2019) Summary Report

The Scripps report in general is good in many respects but seems to stray from the initial objectives and by p. 3 starts to read like a lobby for why we should not be concerned about PM at all... To quote, "two major sources of PM in this area (mineral dust from dune processes and sea spray) are larger than 0.1 micron and are from non-toxic natural sources so association of PM2.5 with detrimental health effects may be without foundation." This was stated well before the results and interpretations. A few other specific observations/comments:

- the statement in the cover letter, "Our results suggest the high dust concentrations measured on high wind days in and downwind of Oceano Dunes are likely dominated by natural saltation processes associated with the indigenous geomorphological dune structure" is somewhat misleading or, at least, could be misinterpreted. I think we're all in agreement, based on the Pi Swerl results, that there is more than just 'natural saltation processes' at work to create the high dust emissions in the region. It is clear that surface emissivity within the riding areas of ODSVRA is much higher than non-riding or protected areas. Ergo, the high dust concentrations are not just from 'natural' or 'indigenous' geomorphic processes or deposits. They are most likely exacerbated by vehicle action. As we've discussed, we really need some targeted research on this.

- I'm not sure about that the statement on p. 3, re: "Neither sea spray nor blown mineral dust from sand dunes has been associated with evidence of chronic respiratory effects since (1) most supermicron inhaled components are removed by impaction in the nasal passages and upper airways and (2) sea spray and inert mineral dust are not composed of toxic compounds." If by 'supermicron' they mean >1um, then certainly any particles in the 1-2.5um range can still be inhaled deep into the lungs (hence the use of PM 2.5!?) and even 10um can cause irritation. Am I completely misinterpreting this?

- re: discrepancy in PM2.5 mass, I'll defer to Jack and Karl re: technicalities, but I would be concerned more about the accuracy of their measurements and use of S1 data as a reference point, given that the Scripps data may not have to follow the same QA/QC protocols as CDF. I cannot comment on their other methods (e.g., nss vs. wet dust?), but I find it hard to believe that water could comprise 50% of the 'dust' signal

Reviewer #3

First Year (2019) Summary Report: Investigation of Aerosol Particulates in a Coastal Setting,

South San Luis Obispo County, California

The Scripps report provides useful but not definitive attribution of the various sources of particulate dust observed at Oceano Dunes State Vehicular Recreation Area (ODSVRA). Elemental and organic analyses of PM2.5 (<2.5 micron particulate matter) collected by filter samplers at a site within ODSVRA (“S1”) and at a site downwind of ODSVRA (“CDF”) show small but significant contributions of sea salt, organics (from combustion and biological processes), and sulfates (primarily from marine aerosols) to measured PM2.5. In contrast, inert mineral dust appears to contribute the vast majority of PM2.5 collected in filter samples during prevailing high wind days (Figs. 5 and 6 in report). The report appears to obscure the dominant contribution of mineral dust, presenting it as only “corresponding to 26%-46% of BAM PM2.5” (p. 6, point 1c). In fact, this seemingly low number reflects the systematically low total PM2.5 concentrations measured by the filter samplers, which are only about half of the SLOAPCD BAM PM2.5 measured concentrations. If the constituent concentrations were instead reported as fractions of filter-collected PM2.5, then I expect mineral dust would appear to contribute roughly 50-90% of the total mass of the filter sample, and toward the higher end of this range on high wind days (Figure 5).

The report authors correctly identify this major discrepancy between chemical mass of PM2.5 collected in filters versus PM2.5 measured by the SLOAPCD BAM at CDF. The authors speculate that this discrepancy could be accounted for by high water content in humidity-laden “wet dust” measured at the SLOAPCD BAM versus dry or “nss” dust measured by the filter samplers (Fig. 4). Though I am not familiar with the analytical techniques for measuring PM2.5 concentrations and constituent sources, it appears to me that the report authors are justified in proposing further study to determine the discrepancy between measured SLOAPCD BAM and filter concentrations of PM2.5.

One additional point not mentioned in this report is the attribution of PM10 (<10 micron particulate matter), which serves as the basis for the targets for particulate matter reduction set in the Stipulated Order of Abatement (SOA). Given that SOA targets are based on PM10 rather than PM2.5, further filter sampling should also be conducted to attribute relative particulate matter contributors in the 2.5-10-micron range.

I also noticed one misleading point in the Scripps report, arguing that “the association of high PM10 and PM2.5 with high wind conditions, rather than with weekends and holidays when OHV activity within the Oceano Dunes state park is high, indicates that dune dust is more likely generated by natural processes rather than vehicle activity” (p. 8). This point assumes that vehicles contribute to mineral dust emissions only at the time of vehicular activity, and it neglects the very substantial possibility that intense vehicular activity fundamentally modifies the characteristics of the sand surface, making intensely-trafficked areas of the dunes more vulnerable to saltation and dust emissions in the long-term. Though the specific attribution of dust emissions to vehicular activity remains to be resolved, it cannot so easily be dismissed as the authors attempt to do here.

Finally, I noticed that the authors reported on DNA analyses indicating negligible contribution of phytoplankton to organic PM2.5 (p. 7, point 4), despite the presence of observed high photosynthetic activity immediately offshore (p. 7, point 5). This result seems to indicate that the question of whether marine phytoplankton contributes to observed airborne particulate matter can safely be put to rest – it does not.

Reviewer #4

Comments on Scripps' 2019 Summary Report

Recommendations the Scripps Study in 2020

The Scripps Report dated 2/21/2020 disclosed results from their 2019 sampling campaign at/near the ODSVRA. The study was paid for OHMVR and conducted by Scripps. While the data generated by the campaign may serve the research needs of OHMVR and/or Scripps, unfortunately the study is of limited relevance to the APCD, and in its present form it cannot inform the SOA process. Fortunately, with some changes to the methodology, it could provide useful input into our understanding the dust generating processes impacting the Nipomo Mesa.

A primary limitation of the 2019 sampling campaign is that it sampled only $PM_{2.5}$ and PM_1, but PM_{10} is the pollutant that is driving the both SOA process and the controversy in general. Since sampling began at CDF almost 10 years, there have been anywhere from 47 to 97 exceedances of the state PM_{10} standard per year, almost all of which are associated with windblown dust events. In contrast, the $PM_{2.5}$ standard has only ever been exceeded a few times per year, often in association with wildfires rather than windblown dust. Furthermore, the SOA specifically requires reductions in PM_{10} emissions, not $PM_{2.5}$. **Therefore, we recommend that in future campaigns, sampling be done for PM_{10} instead of or in addition to $PM_{2.5}$ and PM_1.**

Another limitation of the 2019 study is the lack of gravimetric analysis of the $PM_{2.5}$ samples. The report tries to compare their $PM_{2.5}$ masses against the APCD's $PM_{2.5}$ masses, but the filters do not appear to have ever been analyzed for total mass, i.e. the filters were never weighed. Instead, the filters were speciated for certain elements and organic functional groups, and then these contributions were summed. This is not a good surrogate for total mass. **We recommend that in future sampling campaigns, all filters be analyzed for total mass by gravimetry prior to further analysis.** Good alignment between the measured masses and the APCD regulatory data would be a strong indication that the sampling methodology was working well and would increase confidence in the data.

An additional limitation to the 2019 sampling is the use of non-standard methodology. The methods employed may or may not have been adequate for Scripps' research ends, but for the purpose of making comparisons to regulatory standards and regulatory data (such the APCD's BAM data), the methodology employed was inappropriate. The $PM_{2.5}$ samples were not collected with a regulatory sampler, nor do they appear to have been processed according to regulatory requirements. Specifically, the $PM_{2.5}$ samples were collected using an SCC 2.229 cyclone operated at 7.5 lpm—this not an approved method for collecting regulatory $PM_{2.5}$ samples. While the cut point of the method is nominally 2.5 micron, the slope of efficiency/diameter relation is not necessarily the same as that of the regulatory sampler (VSCC operated at 16.7 lpm). Also note that particulate sampling can be biased in windy conditions, but the EPA-approved methods have been shown to be unbiased in high wind conditions like those seen at CDF. EPA and CARB also have strict requirements for filter conditioning (both pre- and post-sampling), time to analysis, sample temperature during storage and transport, and other aspects of the analysis. These do not appear to have been followed in the Scripps study. While it is probably not necessary for a research study such as this to abide by all of the requirements of regulatory sampling, **we recommend that future sampling be conducted with methods**

closer to approved regulatory methods. For $PM_{2.5}$, at a minimum this means using a VSCC cyclone operated at 16.7 lpm for sample collection and adhering to the filter conditioning, transport, and time to analysis requirements of 40 CFR 50 App L.

Finally, the initial Scripps report, dated March 6, 2018, raised the issue of the "[n]earby coastal seawater … contributing biological material to PM10 aerosols". This was qualitative—based on the detection of DNA in E-BAM PM_{10} samples—and the mass fraction of such material in the samples was never quantified. **It would be informative if future campaigns could <u>quantify</u> the contribution of marine biological material to PM_{10} mass at CDF during windblown dust events.** Admittedly, this outside of the APCD's expertise, and we cannot offer any suggestions as to how this might be accomplished.

Request for Confirmation

The report states "The PM2.5 from SLOAPCD BAM measurements is 42% to 63% greater than the sum of dust, salt, organic, and sulfate components," and goes on to question the accuracy of the APCD BAM measurements. The Scripps $PM_{2.5}$ samples were collected with a flow rate of 7.5 lpm. We note that *if* the $PM_{2.5}$ mass concentrations were inadvertently calculated using the more typical flow rate of 16.7 lpm (which is also the same flow rate used for the PM_1 samples), then the calculated masses would be ~45% of what the should be. Thus, the discrepancy between Scripps and APCD $PM_{2.5}$ values *could* be due a calculation error. **We request that calculation of $PM_{2.5}$ mass be checked and confirm the use of the correct flow rate.**

Critique of Scripps Report

Pages 3-4 – Discussion of health effects of PM

In general, the APCD has refrained from opining on the possible health effects of air pollutants, as we are not medical professionals, toxicologists, epidemiologists, etc. Instead, we have always referenced authoritative bodies such as the EPA, OEHHA, etc. In this spirit, we question the whether it is appropriate for the Scripps authors to opine on these topics. Indeed, many of their statements on these pages, appear to be incorrect or misleading:

- *"(1) most super micron inhaled components are removed by impaction in the nasal passages and upper airways."* It may technically be true that *most*—but not all—such particles are removed, but it implies that particulates greater than PM_1 are do not pose a health risk, which is false. EPA's selection of 2.5 and 10 micron as the size cuts for their health-based standards is supported by huge body of scientific literature. The same can be said for OSHA/ACGIH selection of PM_4 for defining the "respirable" size fraction.
- *"(2) sea spray and inert mineral dust are not composed of toxic compounds."* As a general statement, this is not entirely incorrect. As counter examples, both silica and asbestos can occur in mineral dust, and both known to cause cancer and other non-cancer health effects.
- *"Since the association of PM2.5 with toxics and nanoparticles is likely responsible for the association of PM2.5 with health effects, the use of PM2.5 as a health indicator may fail when PM2.5 is not co-emitted with those toxics and nanoparticles."* Note the lack of a citation for this statement.
- *"It is worth noting that there is no evidence that toxic compounds are associated with elevated PM concentrations detected downwind of the south SLO County sand dunes during windy conditions."* This is statement is both incorrect and irrelevant. It is incorrect

because APCD sampling has shown that respirable crystalline silica is a component of the PM concentrations detected downwind of the south SLO County sand dunes during windy conditions, albeit in concentrations that are below regulatory standards. (see https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2018aqrt-FINAL.pdf, Appendix B). It is irrelevant because the ambient air quality standards, which the APCD has the authority and obligation to enforce, are not defined in terms toxic species but rather are defined solely in terms of aerodynamic diameter. From a regulatory standpoint, the composition of the particulate matter does not matter.

- *"For this reason, assessing whether health effects are associated with PM2.5 requires identifying what fraction of PM2.5 is from natural (non-toxic) sources and what fraction is from combustion emissions."* It naïve to assume that health effects are only associated with $PM_{2.5}$, and it is also naïve to assume that only combustion emissions are toxic, and it is further naïve to assume that natural sources are always non-toxic.

Page 5 and Figures 1 – Results of OFG analysis

Figure 1 displays the results of the Organic Function Group (OFG) analysis of both the $PM_{2.5}$ and PM_1 samples from May at CDF. PM_1 is a subset of $PM_{2.5}$, so it is odd that for many of the PM_1 samples, the total OFG mass exceeds that of $PM_{2.5}$ samples. For example, the leftmost bar on the PM_1 chart (corresponding to May 14) extends to about 2.3 ug/m^3, but the corresponding bar for $PM_{2.5}$ is absent, implying that the sample was below the detection limit. Another example is the skinny bar on May 19: on the PM_1 chart it extends to about 1.7 ug/m^3, but on the corresponding bar on the $PM_{2.5}$ chart extends to only about 1.4 ug/m^3.

Pages 5-6, Bullet 1.b

I have read this section multiple times and can't understand it.

Page 6, Bullet 2

"For the nine samples that overlapped in timing, the PM1 organic mass concentration average was…" This is confusing—which nine samples are they talking about? My understanding is that they sampled PM_1 and $PM_{2.5}$ simultaneously, for 20 days, each day with one12-hour overnight sample and two 6-hour daytime samples, so there should be 60 samples of each. Some samples will be inevitably be lost or invalidated, but they should have more than 9 overlapping samples. Looking at Figure 1—which I think plots these data, but I may be confused—there are significantly more than 9 samples where there is data for both $PM_{2.5}$ and PM_1. Even if this passage refers to the data in Figure 10, it's is still incorrect as there are 10 not 9 samples in that figure.

Page 7, Bullet 3

This section reports the results of the sea salt mass and "nss dust" analyses for samples collected at S1. Results for organics and "nssSulfate" are not disclosed. It would useful to have these in order to compare to the CDF samples.

Page 8 – Conclusions

The report makes a big deal about the discrepancy between their $PM_{2.5}$ mass estimates and the APCD's BAM measurements, but this is really an apples-to-oranges comparison. As discussed above in the Recommendations section, the $PM_{2.5}$ samples were not collected or analyzed following EPA requirements, and therefore cannot be compared to regulatory standards or regulatory samples. $PM_{2.5}$ is not a trivial measurement, and it is not by accident that only a handful of methods have received EPA's blessing.

These differences in methodology are not mere technicalities. While many cyclones can achieve a 2.5 micron cut point, only the VSCC operated at 16.7 lpm has been approved for regulatory sampling since other parameters in addition to the cut point are important. Similarly, the Scripps masses are only estimates—they do not appear to have actually weighed their filters, which would have been a more direct (and accurate) measure of mass. By their own admission, their estimates likely omit contributes from adsorbed water, volatiles, and other species which would be included in the APCD's BAM measurements.

It is certainly true that a variety of factors affect the toxicity of PM, including particle size and chemical composition; however, the EPA standards are based solely on particle size, and the EPA sampling methods are designed to separate particles by size, not composition. These are the standards enforced by the APCD, and therefore these are sampling methods employed by the APCD. Researchers such as Scripps are of course free to sample however they wish, but care then needs to be exercised when comparing the results to regulatory measurements. In such cases, as with the present Scripps study, a failure of the study results to match the regulatory results does not call into the question the quality of the regulatory data. Their statement that "*offline chemical and gravimetric analyses would be needed in order to determine whether the SLOAPCD CDF BAM data are representative of actual PM2.5 concentrations at the CDF location*" get this precisely backward.

Regarding the quality of the regulatory data collected by the APCD, note that PM is measured using Met One BAM 1020 monitors, which are EPA-approved Federal Equivalent Methods for PM_{10} and $PM_{2.5}$. The APCD network meets all federal network design, siting, and QA/QC requirements specified in 40 CFR 58 and Volume II of the EPA QA Handbook. All APCD PM monitors undergo QC checks at least every 2 weeks, and all are subject to QA audits by conducted by CARB twice a year. In addition, the EPA conducts PM audits on the APCD every few years. The APCD has never failed a PM audit.

Finally, on page 8 they conclude that: "*dune dust is more likely generated by natural processes rather than vehicle activity."* This is a curious statement. On the one hand, the APCD and SAG have always maintained that vehicle activity—tailpipe emissions and "rooster tails"—does not directly cause the high PM observed downwind of the ODSVRA. Our position has always been that saltation is the source of the high PM. On the other hand, whether this a "natural process" turns on semantics. Saltation itself is certainly natural, but vehicle activity has destroyed vegetation and thus the extent of open sand available for saltation is unnatural. Furthermore, the available data—particularly the PI-SWERL studies—demonstrate that vehicle activity at the ODSVRA increases the amount of dust generated during saltation. This hardly seems "natural."

Oceano Dunes SVRA Dust Control Program

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ATTACHMENT 8

SAG Letter on COVID-19 Closure

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April 6, 2020

Memo: SAG comments on the temporary closure of Oceano Dunes State Vehicular Recreation Area (ODSVRA) and impacts on particulate matter (PM) emissions

From: The Scientific Advisory Group (SAG)

To: Jon O'Brien, California Department of Parks and Recreation
Liz McGuirk, California Department of Parks and Recreation
Gary Willey, APCO, San Luis Obispo County Air Pollution Control District
Jeff Tupen, ECORP Consulting

Cc: California Air Resources Board (CARB)

Background

In response to the escalating COVID-19 pandemic, the Governor of California ordered the temporary closure of all camping at California State Parks effective March 17, 2020. Soon thereafter, the Governor ordered the full closure of California State Parks to all recreational vehicular traffic effective March 29, 2020. As a part of the California State Parks system, the Oceano Dunes State Vehicular Recreation Area (ODSVRA) temporarily closed to camping and all recreational vehicular uses on the dates listed above. Currently, recreational access to ODSVRA is limited to non-campground and non-vehicular uses of outdoor areas of the ODSVRA, including beaches and trails, with appropriate social distancing among visitors. The sole motivation for these temporary changes is the need to reduce crowding and disease transmission to address the ongoing COVID-19 public health emergency.

The abrupt temporary closure of ODSVRA camping and recreational uses occurred in the midst of a multi-year effort to reduce the emissions of particulate matter (PM) from the ODSVRA. On May 4, 2018, the Hearing Board of the San Luis Obispo Air Pollution Control District issued a Stipulated Order of Abatement (SOA) directing the ODSVRA to adopt a Particulate Matter Reduction Plan to reduce PM emissions by at least 50% within four years. The SOA also established a Scientific Advisory Group (SAG), composed of experts on wind erosion, dust emission, and dune restoration, to advise Parks on planning and monitoring of PM reduction activities. Among the most noticeable PM reduction measures has been the temporary and permanent exclosure of sections of the ODSVRA that were previously accessible for use by off-highway vehicles (OHVs). To reduce the emissions of PM from these exclosed surfaces, Parks has installed, at various times, wind fences, straw bales, vegetation plantings, and other restoration measures to stabilize sections of the dunes against wind erosion. However, it is important to note that such restoration measures will never achieve complete elimination of natural PM emissions at ODSVRA; instead the goal is to achieve significant and sustained PM emissions reductions toward attainment of state and federal air quality standards.

Impact of ODSVRA closure on PM emissions

An ongoing question of public concern is the relative impact of OHV activity versus natural processes on PM emissions at ODSVRA. The abrupt closure of ODSVRA has led some to ask whether, due to the temporary cessation of recreational OHV and camping activity, PM emissions will be eliminated or substantially reduced to “natural” levels during this closure period. Here, the SAG seeks to address this question.

Regardless of OHV activity, PM emissions will continue at ODSVRA whenever natural wind-blown sand processes are active. As can be seen at analogue dune locations that have experienced minimal OHV impacts, such as the Oso Flaco section of the park, emission of PM dust is a feature of natural dune landscapes subjected to strong winds. But the current state of the landscape within the riding areas of the ODSVRA has been altered by decades of disturbance. As such, the extent of exposed dust-emitting sand surfaces and perhaps the availability of dust sized grains for emissions is greater today than decades ago. Multiple measurement campaigns have revealed that the dune areas subjected to the most intensive OHV activity also tend to produce the highest PM dust emissions. In contrast, undisturbed locations like Oso Flaco tend to emit less PM dust. In short, enhanced PM emissions will continue in OHV-disturbed sections of the ODVSRA even in the absence of OHV activity.

The time required for the dust emissions from the dune sand to reach levels similar to those prior to large-scale OHV activity remains unknown. The dunes, sediments, and vegetation will each require time to reestablish to a new (lower) regime of disturbance. This could be on the order of years to decades, left to nature's devices. Relative to these natural timescales of adjustment, a few weeks or months of temporary OHV restrictions may not be sufficient to result in substantial declines in PM emissions. The dune and beach system is disturbed and will take time to recover. This is precisely why the SAG has been engaging with Parks to pursue environmental restoration activities to accelerate the transition of certain sections of the ODSVRA to conditions that have lower dust emission potential. Even so, this environmental restoration process takes years for implementation and for vegetation plantings to grow to maturity.

Conclusion
It is the opinion of the SAG that the accumulated impact of OHV activity remains a significant contributor to observed PM emissions at ODSVRA, even during this period in which the ODSVRA is temporarily closed to recreational uses. The SAG acknowledges that the Oceano Dunes are a naturally dusty surface that would experience PM emissions even in the absence of human activity, especially during this spring windy season. But the SAG is also clearly aware 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. The SAG does not expect a few weeks or months of temporary OHV restrictions to substantially alter the balance of human versus natural contributions to PM emissions at ODSVRA. Only through sustained restoration projects does the SAG expect to see a significant reduction in PM emissions. The SAG remains committed to supporting Parks in an adaptive management process for ODSVRA dune restoration to maximize these PM emissions reductions while minimizing impacts on OHV recreational opportunities.

Yours Sincerely,
The Scientific Advisory Group

Dr. William Nickling, Chair of SAG
Dr. Raleigh Martin; Dr. Ian Walker; Dr. Jack Gillies; Ms. Carla Scheidlinger; Mr. Earl Withycombe; Mr. Mike Bush

Oceano Dunes SVRA Dust Control Program

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ATTACHMENT 9

SAG Review of WeatherSolve Structures Wind Fence Proposal

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"Wind Fence Proposal No. WSS1089" (15 November 2019) by WeatherSolve Structures

Review by members of the Oceano Dunes Scientific Advisory Group (SAG).
Prepared 8 March 2020, Revised 20 July 2020.

WeatherSolve Structures (WSS) proposes to build a wind fence to mitigate particulate airborne dust at Oceano Dunes State Vehicular Recreation Area (ODSVRA). As shown in a series of examples presented on p. 23-36 of the proposal, wind fences can be effective at mitigating dust emissions when they are placed immediately upwind of a potentially emissive surface. The wind fence works by creating a shelter zone immediately downwind of the porous barrier within which turbulence and shearing stresses responsible for dust emissions are reduced. This zone is thought to extend downwind 10-12 times the height of the fence (p. 3 of proposal) and follows the extensive wind barrier literature that has developed over the past 75 plus years. For the proposed 30-foot fence height (p. 6 of proposal), a substantial reduction in wind speed, sand transport and dust emissions under ideal performance conditions could be expected only within a distance of approximately 360 feet (about 100 meters) downwind of the proposed fence line. As a result of the relatively short downwind area of protection, multiple parallel fences or tree lines, spaced at approximately 10 times the barrier height, are often used to extend the downwind control length. Multiple barriers of this type and the resultant wind flow patterns and the resultant downwind surface shear stress have been studied a great deal through empirical field testing and detailed wind tunnel studies throughout the world

The SAG discussed this proposal at a team meeting in February 2020 and the following comments focus solely on assessing the potential of the proposed wind fence to mitigate particulate airborne dust at ODSVRA. Any review of the considerable and various logistical considerations for installing such a fence in a dynamic beach-dune environment is beyond the scope of SAG review.

The opinion of the SAG is that the proposed wind fence would be completely ineffective at reducing airborne particulate dust generated within ODSVRA. As shown on p. 37 and p. 39 of the WSS proposal, the wind fence would be installed on the downwind edge of the ODSVRA. Thus, the vast majority of emissive surfaces within ODSVRA would experience no change in surface wind speed or shearing stress and, thus, no change in particulate dust emissions. Fundamentally, solving a dust emissions problem with a wind fence or other sheltering barrier (e.g., hedgerows, tree lines) requires that the barrier be placed upwind of the emissive surface. Wind fences are typically not designed to 'catch' emitted particulates from the incoming wind. Because emitted particulate dust is quickly lofted airborne far above the ground, only a negligible fraction of upwind airborne dust would be caught and settled out by the proposed downwind porous wind fence, particularly given the size of the holes in the mesh (74 times greater than a PM_{10} particle), its limited height of only 30 feet, and the complexity of the dune terrain. Though it is possible that some dust emission would be inhibited immediately downwind of the proposed wind fence, the affected area downwind of the fence (pg. 37) has lower dust emissions relative to the majority of the ODSVRA land surface upwind of the proposed fence. Theoretically, the wind fence could be situated close to the shoreline to shelter more emissive regions but, logistical considerations aside, such an installation would shelter only a narrow swath of the overall ODSVRA from potential dust emissions. Distances to the end of the sand sheet from near the shoreline can exceed 2.8 km, which would leave most of the sand sheet area unprotected by the downwind shelter offered by a single length of the WeatherSolve fence. Similar to the sand fence arrays deployed to reduce coarser sand transport (saltation), multiple lines of wind fencing would need to be emplaced across vast expanses of the dune surfaces for this technology to become effective. The costs to install and maintain such an array of wind fencing would be immense and probably prohibitive, given the costs presented in the proposal. An additional and very important limitation of this type of fence, as described in the proposal, is that it is designed to release the mesh during high wind events (pg. 4), which is when dust emissions on the dunes are typically of greatest concern, further reducing any effectiveness in modulating sand transport and dust emissions.

Therefore, it is the recommendation of the SAG that Parks reject the wind fence proposal submitted by WeatherSolve Structures. This recommendation is not an outright dismissal of the effectiveness of wind fences that, if properly deployed, can be effective at mitigating emissions from concentrated dust sources. Instead, our recommendation is based on the recognition that the use of such a wind fence, as proposed, will be ineffective for addressing the nature and geography of diffuse particulate dust emissions experienced within the ODSVRA.

Oceano Dunes SVRA Dust Control Program

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ATTACHMENT 10

DRI Investigation of the Discrepancy Between DRI and CARB Modeling Results for 2013 Emissivity Conditions

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Investigating the Discrepancy Between the DRI and CARB Model Results for 2013 Emissivity Conditions

J.A. Gillies[1], E. Furtak-Cole[1], J. Mejia[1], V. Etyemezian[2]
Desert Research Institute, Reno and Las Vegas, NV

In 2016 CARB and DRI undertook modeling exercises to characterize the emissions of PM_{10} from the ODSVRA. In both cases the emission grids were based on the underlying PI-SWERL data from the 2013 measurement campaign. The resultant modeling efforts by DRI are documented in Mejia et al. (2019). CARB, as far as we know, did not produce a written document that details their modeling process from receiving the emission grid from DRI to producing their emissivity maps, total mass emission estimates, and the dispersion of the emitted PM_{10} to the receptor sites CDF and Mesa2. DRI received some communications from CARB (S. Du) providing some information, but not a detailed step-by-step accounting of their process. The two approaches produced emissivity maps that had significant differences in the magnitude and areal distribution of the emissivity, and this has been the cause of debate as to why they are different as they both start from the same underlying PI-SWERL measurements.

This brief report attempts to provide explanation for the difference, but an unambiguous explanation was not reached.

The source of the debate and discussions on the representational differences between the DRI and CARB modeling approaches is captured in Fig. 1. This Figure shows a different pattern of emissivity across the ODSVRA between the two modeling approaches for a specific PI-SWERL generated RPM (or shear velocity, u_*). The CARB model results show areas of higher emissions than the DRI model results. Regardless of the difference these maps suggested, at that time, that dust control placement decisions (i.e., where to place controls) could be guided by selecting areas of higher emissions for treatment, which became termed the "hot spot" approach. However, a definition for what a "hot spot" is has not been made and remains only a qualitative description of emissivity for an area.

In 2020, DRI modeled the 2013 and 2019 emissivity using the basic approach described in Mejia et al. (2019) so that a direct comparison between the years could be made for the 10 baseline days as defined by the Stipulated Order of Abatement (SOA) and agreed upon by the Science Advisory Group (SAG). In addition, the use of the DRI model was formally approved by SAG, San Luis Obispo County Air Pollution Control District, and California Department of Parks and recreation at the October 2018 SAG meeting.

To allow the direct comparison between the two years DRI first carried out two interpolation/extrapolation procedures for the PI-SWERL data. The first was the same procedure as previously done by DRI and CARB, i.e., data were extrapolated using a $1/r^2$ weighted distance of the 5 nearest measurements to develop an emissivity relationship for a grid cell that did not have a measurement within it (see Appendix, pg. 10). The size of a grid cell is 21 m x 21 m (441 m^2) in the DRI model. DRI also carried out a second interpolation/extrapolation procedure, with again a $1/r^2$ weighted distance but using 20 nearest neighbor measurements, and with an additional 9 × 9 grid cell smoothing to remove some of the blotchiness to the emissivity pattern. It turned out that the choice of interpolation/extrapolation had little effect on the total emissions for both years of PI-SWERL data, differing by <1% between the two approaches.

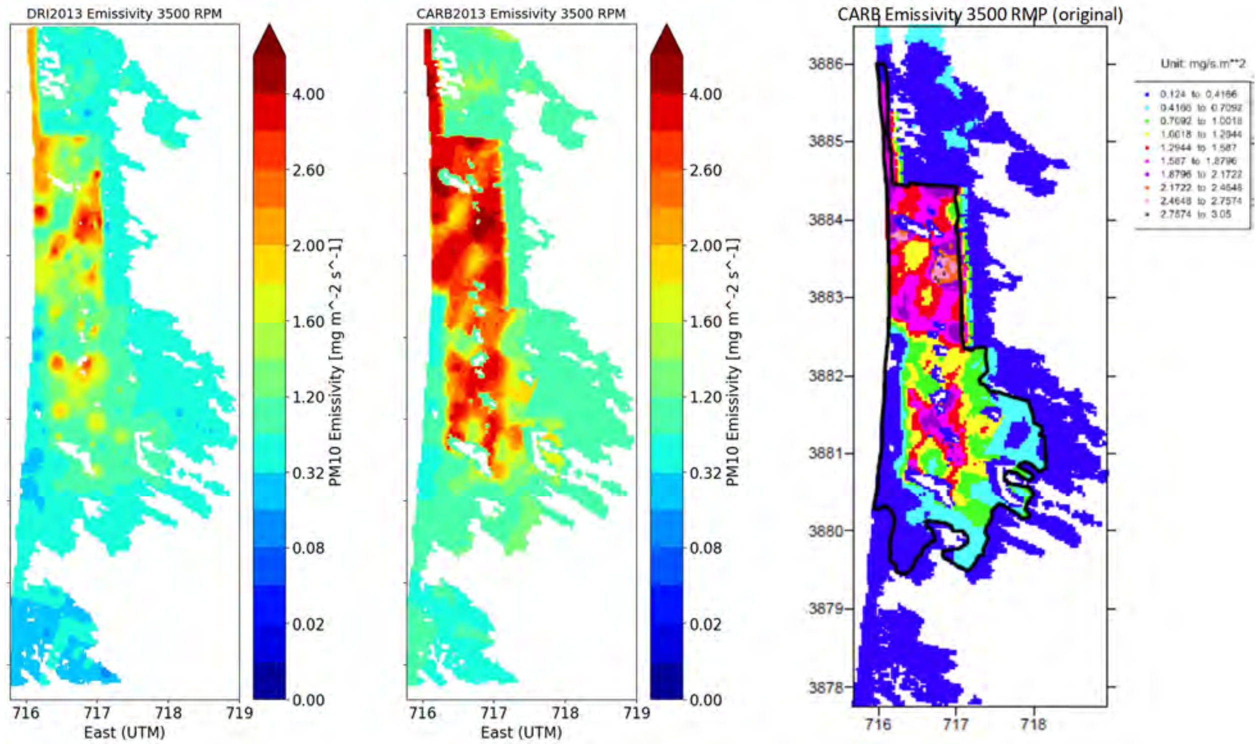


Figure 1. The maps of emissivity based on the 2013 PI-SWERL data for a specific RPM of PI-SWERL as produced from the DRI and DRI-CARB grid reclassification procedure and the original CARB map.

In 2016 CARB received the PI-SWERL emissivity data from DRI, which consisted of lat/long positions of the PI-SWERL tests and the emissions (expressed as mg/m^2 s) at the three PI-SWERL test RPMs (which are expressed in terms of u_*, based on Etyemezian et al., 2014). A key difference between the CARB and DRI approaches is the size of the grid cells, which are 33.9 m × 24.9 m (844.1 m^2) for CARB and 21 m x 21 m (441 m^2) for DRI. CARB interpolated/extrapolated the PI-SWERL data onto their grid where the emissivity is linked to the centroid of each rectangular-shaped cell. An explanatory document from CARB describing their interpolation/extrapolation is provided in the Appendix (pg. 10) of this report. To allow DRI to replicate the CARB emissivity map, DRI mapped the CARB data to the DRI grid using code that looks through the coordinates of the DRI grid and for each cell finds the nearest CARB emissivity coordinate (by eastings/northings). The value at the nearest CARB coordinate is inserted into a copy of the DRI grid. This is done for every point in the grid and represents a nearest neighbor approach for mapping of points. DRI did not interpolate the CARB dataset, rather reclassified it to the DRI grid, making groups of grid cells with the same emissivity approximating the same dimensions as the CARB grid for their defined cell centroid positions. This allowed DRI to test for similarities and differences between emissivity patterns and magnitudes between the methodological approaches and insured that the emission and color bar scales were exactly the same. The CARB map shown in Fig. 1 (middle panel) represents the emissions from reclassifying the grid. For comparison, the original CARB map (right panel) is also included as received from CARB (see Appendix pg. 12). This comparison suggests that the difference in grid size alone alters the emissivity pattern substantially.

In that the modeling done in 2016 by DRI and CARB, forms the basis of evaluating the dust emissions at the ODSVRA and the effects of the placement of dust controls on the emissions is linked to the mean emissions based on the selection of 10 baseline days, which represent the 10 highest mass emission days in 2013 as estimated by the DRI emissions model. Using the meteorology for these 10 baseline days and the underlying emission grids for DRI and CARB, the mean daily emissions were calculated and are shown in Fig. 2. As Fig. 2 shows, the pattern of emissions is similar but the magnitude as a function of location is not. Potential reasons for this are described below.

The pattern of emissions for the CARB data when estimated for the 10 baseline days also shows the location of higher emissions is towards the eastern park boundary, which was not captured in the earlier analysis that used only the PI-SWERL generated u_* to map the emissivity across the ODSVRA. The total ODSVRA (riding and non-riding areas) mass emissions for the DRI map (Fig. 1) is 84 tonnes/day and for the CARB map 152 tonnes/day (Fig. 1), which is greater by a factor of 1.8. The question to resolve is "why the discrepancy in the increased emissivity of the CARB model"? We put forth 2 possible reasons for this.

The first reason may be due to a communications issue. In May 2016, DRI notified CARB in a document (see Appendix, pg. 8) that states: "As discussed previously, these data were found to contain an error that results in an incorrect value by about a factor of 2.1, but this factor varies slightly from one test location to the next." We do not know if this was taken into account by CARB, but the discrepancy in total mass emissions (i.e., the factor of 1.8) is close to the value of 2.1. The effect of increasing the DRI emissions by a factor of 2.1 compared with the CARB emissions is shown in Fig. 3. This comparison demonstrates again that the underlying emissivity distribution pattern is similar.

Our second line of reasoning is that the difference is due to the interpretation of the PI-SWERL data by CARB and the units their method may have used. For example, if they somehow reduced the PI-SWERL emissivity data to g/s, we can see that scaling the mass flux from their coarser grid to the finer grid of DRI results in a similar spatial pattern, but actually lowers the emissivity for CARB compared to DRI (as converting g/s to $\mu g/m^2$ s, creates an emission difference by approximately a factor of two). This is demonstrated in Fig. 4. We cannot substantiate this line of reasoning without explicit documentation of all the steps CARB took to arrive at their emission map.

We are unable to resolve definitively the differences in the DRI and CARB modeling approaches that result in the different emissivity maps. However, when the two methods are compared using the meteorology of the 10 baseline days, the patterns of emissions are much closer in agreement, even though the magnitude is different. The original management decisions made to locate dust controls were based on the patterns of emissivity from the PI-SWERL-generated u_* values, which did not take into account the effects of meteorology as is considered using the 10 baseline days. Using the 10 baseline days to make management decisions on placement of dust controls, in hindsight and in both modeling approaches (Fig. 2), suggests that placement of controls further east may have provided some additional benefit to improving air quality. However, managing via the "hot-spot" approach is perhaps questionable. Without a definition of what a "hot-spot" is, using the concept to make decisions is ambiguous. Based on the emission map for either approach, the range of emissions is from 0 to >36 g/m^2 day (Fig. 2). The hot-spot approach to selecting areas for treatment is less effective the smaller the range of emissions. If there were areas with orders of magnitude increase in emissivity (e.g., 100 to 1000 g/m^2 day), then putting those areas under dust control could have a much greater effect on air

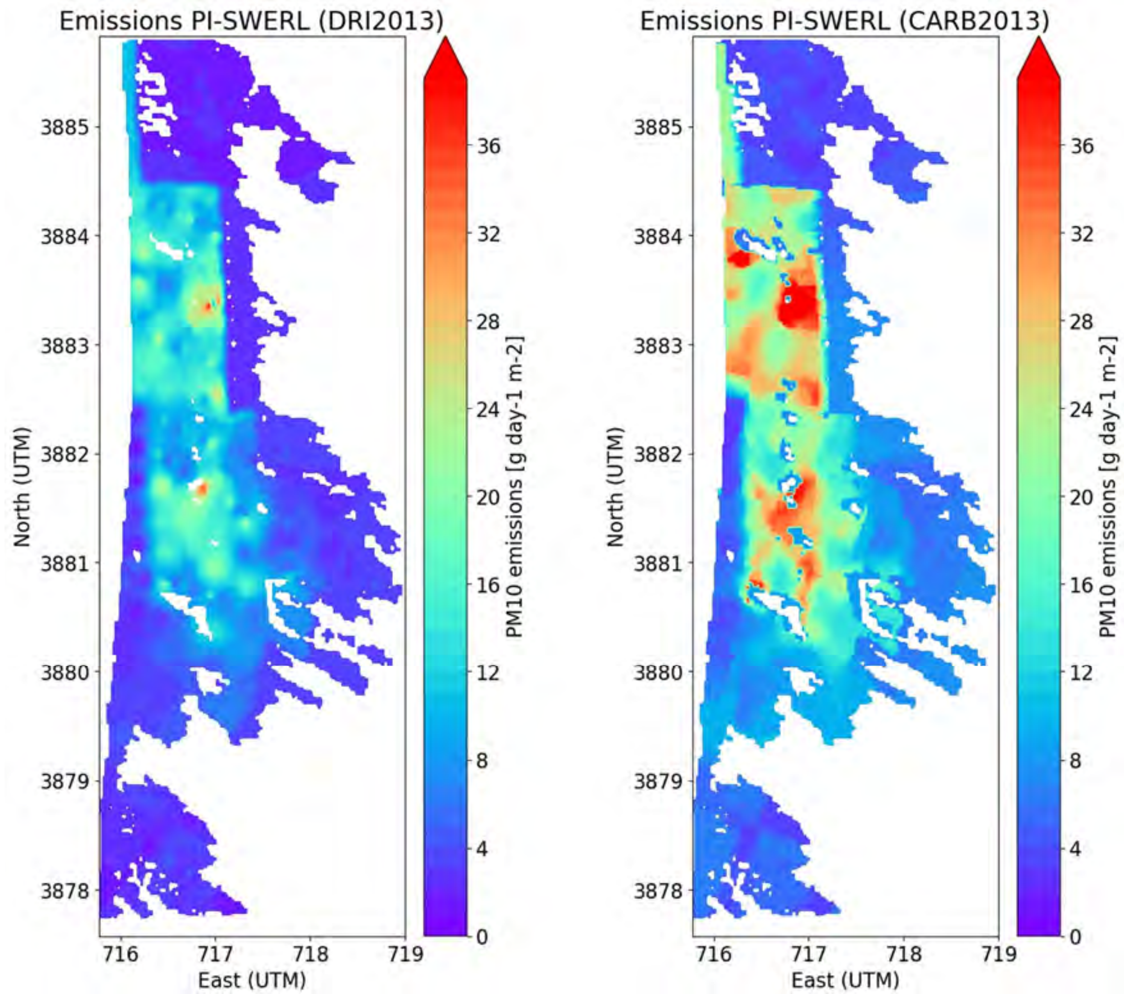


Figure 2. The mean emissions for the ODSVRA for the 10 baseline days for the DRI and CARB emission grids ($1/r^2$, 5 nearest neighbor points interpolation/extrapolation method).

quality, provided they were of sufficient size. The rather restricted range of emissivity at the ODSVRA makes this approach less effective to try and meet SOA-mandated reduction in mass emissions. It should also be noted that areas of high emissivity identified in a given-year's PI-SWERL survey are not guaranteed to be there in subsequent years due to the dynamic natures of the dune system and OHV activity. Based on the pattern of emissivity shown in Fig. 2, the placement of the dust controls through 2020 has generally been in areas that are well-placed to improve air quality, as measured at CDF. This is supported by the dispersion and source attribution modeling (Fig. 5).

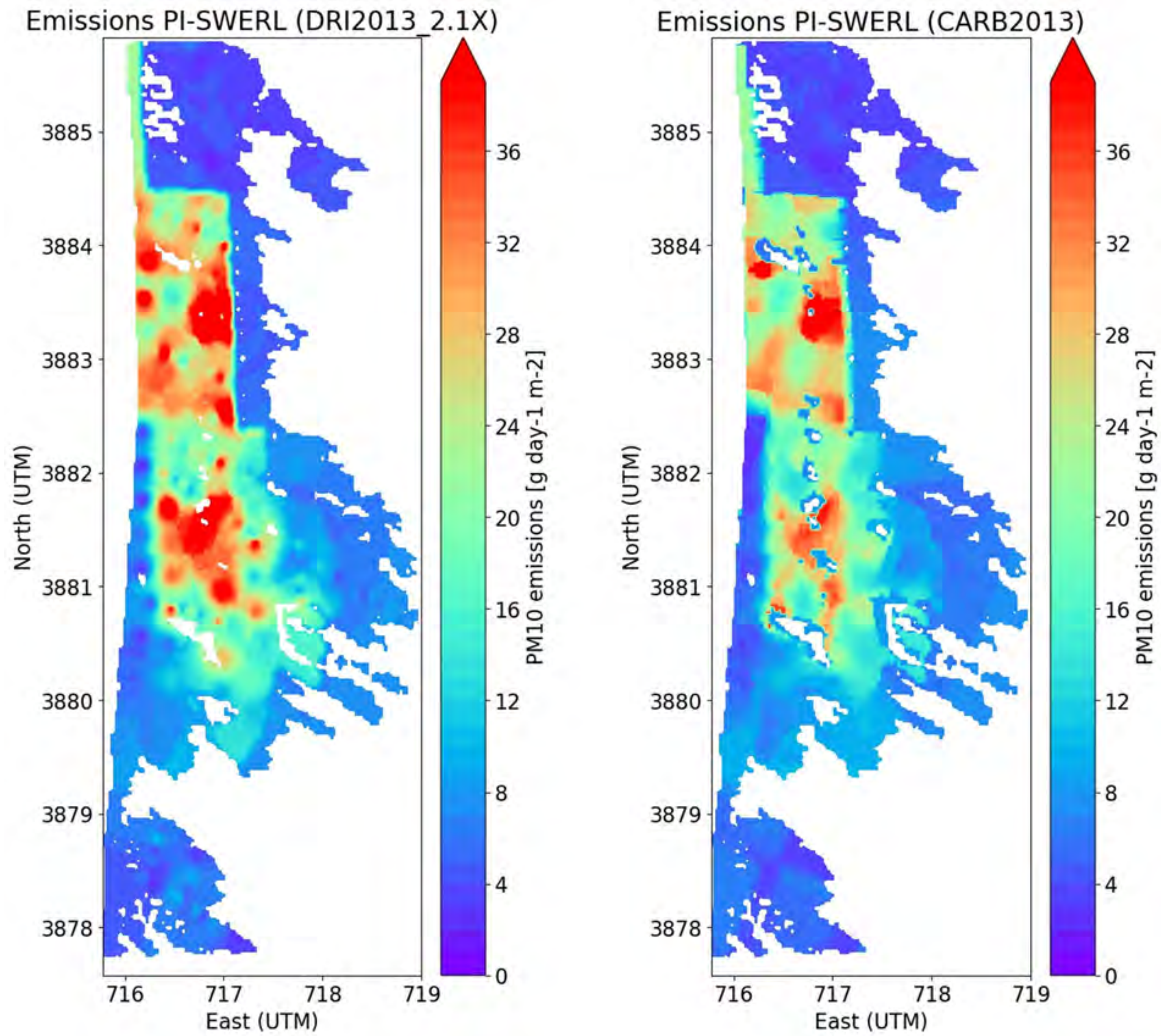


Figure 3. The emissivity map made by increasing the DRI emissions by a factor of 2.1 compared with the CARB for the 10 baseline days.

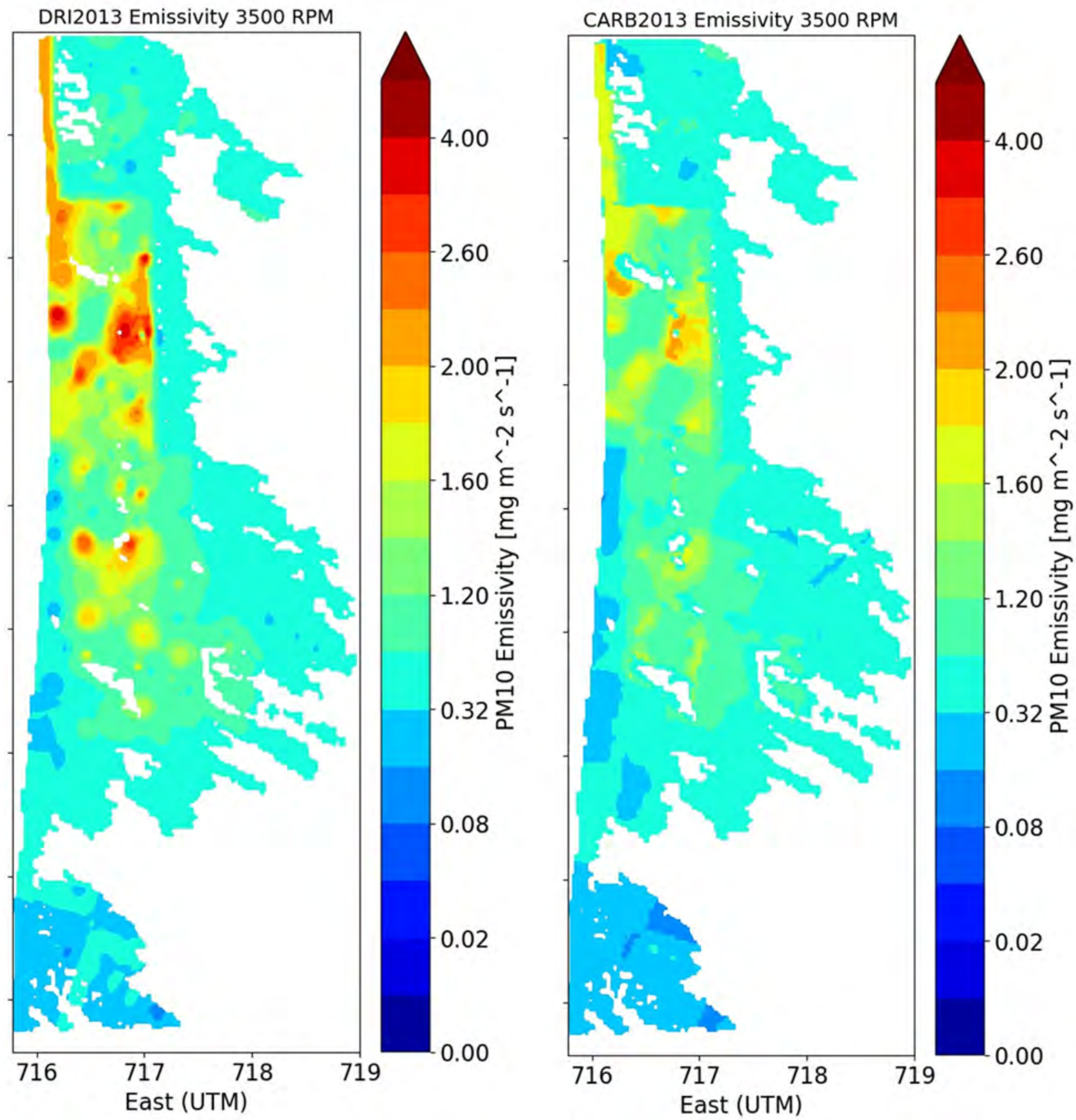


Figure 4. The effect of re-scaling from coarse to fine grid and if the CARB units were g/s converted to μg/m^2 s.

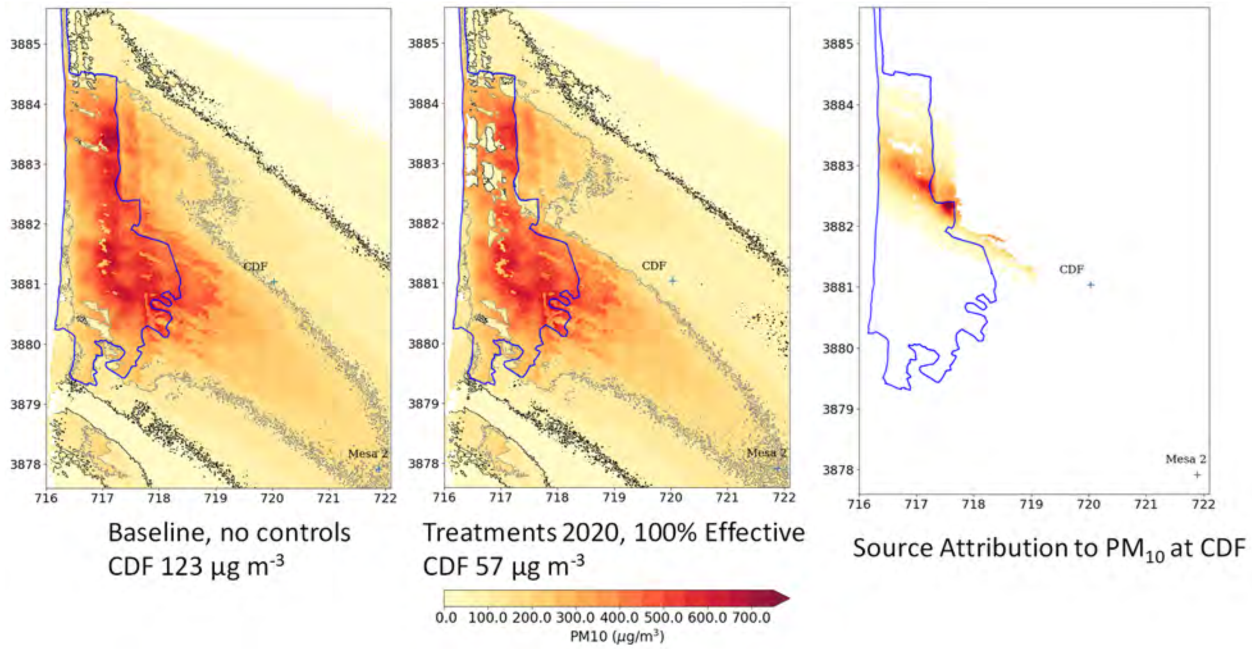


Figure 5. The PM_{10} concentration maps for the baseline period (left panel), with dust controls in place in 2020 (middle panel), and the source attribution areas for PM_{10} impacting CDF for the 10 baseline days (right panel).

References

Etyemezian, V., J.A. Gillies, M. Shinoda, G. Nikolich, J. King, A.R. Bardis (2014). Accounting for surface roughness on measurements conducted with PI-SWERL: Evaluation of a subjective visual approach and a photogrammetric technique. *Aeolian Research* **13**: 35-50, doi: 10.1016/j.aeolia.2014.003.002.

Mejia, J.F., J.A. Gillies, V. Etyemezian, R. Glick (2019). A very-high resolution (20 m) measurement-based dust emissions and dispersion modeling approach for the Oceano Dunes, California. *Atmospheric Environment*, 218, 116977, doi: 10.1016/j.atmosenv.2019.116977.

Appendix

Description of data files provided for 2013 PI-SWERL gridded emissions used in simple plume modeling.

May 7, 2016

Contact: Vic Etyemezian, DRI (702) 862-5569

DRAFT: NOT FOR PUBLIC DISSEMINATION.

This document is intended for internal information sharing within the Oceano Dunes Air Quality Technical Group. It and the data it describes have not undergone quality assurance analyses or peer review. As such, this should be considered a draft document.

The data provided in the MS Excel file "emissionsdata_2013.xlsx" represent the inputs used for estimating emissions from the Oceano Dunes domain during early modeling efforts by DRI. First a brief description of the data is provided. This is followed by a narrative of how these data were used to estimate emissions under a given set of conditions.

Description of Data file content

The worksheet entitled "PI-SWERL_data" contains the distilled emissions measurements from the 2013 PI-SWERL tests. All valid PI-SWERL® data from that effort have been included here. The first column contains the test Identifier. Wherever collocated (replicate) measurements were completed, the test identifier has been replaced with a colocation identifier. These are relatively small numbers (1-26). The emissions measurements displayed correspond to the average of all colocations (regardless of PI-SWERL® unit) at those coordinates. Otherwise, the Test ID (10-digit integer) field represents a unique PI-SWERL® generated number and represents a single measurement. **As discussed previously, these data were found to contain an error that results in an incorrect value by about a factor of 2.1, but this factor varies slightly from one test location to the next.**

The distilled PI-SWERL® measurements were used to obtain gridded emissions over the Oceano Dunes Domain using simple "nearest neighbor" interpolation. This and other gridded information can be found in the "Gridded_data" worksheet. The table below explains the fields in that worksheet.

Column header	Description
Lat_Dec_Deg	Latitude of midpoint of grid cell
Lon_Dec_Deg	Longitude of midpoint of grid cell
Emit_2000_RPM	Emissions of PM10 (mg/m2s) at 2000 RPM
Emit_3000_RPM	Emissions of PM10 (mg/m2s) at 3000 RPM
Emit_3500_RPM	Emissions of PM10 (mg/m2s) at 3500 RPM
Sandy_flag	0 if grid cell is not on a sandy portion, 1 if sandy. Determined visually in ArcMap

WS_multiplier	Quantity to multiply CDF wind speed by to get 3 meter wind speed at grid cell. Based on linear regression analysis by Jack Gillies

Calculating emissions at any given time

The data in the worksheet provide all that is needed to calculate emissions given a specific wind speed at CDF (WS_CDF). Below is an outline of the steps

1. Given WS_CDF, calculate grid wind speed (WS_gridpoint) at 3 meters (using multiplier) and 10 meters, using log relationship
2. Check to see if WS_gridpoint is greater than the assumed threshold for wind erosion. This was conservatively chosen as 4.5 meters per second (at 10 meters) for all sandy areas. If below threshold, emissions from gridpoint are zero. End of calculation. Otherwise, continue to 3.
3. If WS_gridpoint is above threshold, calculate local u_star using log relation and roughness length z_0 = 0.00026 meters. This value of z_0 was estimated from wind speed profile at S1 and applied to the whole domain.
4. Using this value of u_star, estimate emissions by piecewise linear interpolation of grid cell PI-SWERL® data.
    a. For this, 2000 RPM, 3000 RPM, and 3500 RPM translate respectively into u_star= 0.381, 0.534, and 0.607 m/s.
    b. When u_star is between 0 and 0.381 m/s assume emissions at u_star = 0 m/s are 10^{-5} mg/m2s and use this in the interpolation
    c. Assume emissions above u_star = 0.607 m/s increase in proportion to what they are at u_star = 0.607 m/s. E.g., if emissions are *a* at u_star = 0.607 m/s, they are assumed to be 2*a* at u_star = 0.134 m/s. In reality u_star values rarely (if ever) exceeded 0.607 m/s.
5. Once emissions are calculated for the grid cell, multiply by the corresponding value of “sandy_flag”. This will make emission zero if they are not on an actual sandy surface since we know there are no emissions.

CARB Document: Comparison of DRI (addendum1), SLO (fine grid, coarse grid) and ARB 1/r^2 and transition emission calculations.

Comparison of DRI (addendum 1), SLO (fine grid, coarse grid), and ARB 1/r^2 & transition emissions calculation methods

(Updated on 3/1/2017)

A brief summary of ARB's 1/r^2 & transition method:

- Interpolation is based on 2013 PI-SWERL data, data in upper part of private land are not used (per DRI's suggestion);
- Interpolation is done with five nearest data points and the weighting factor of each data point is set to be 1/r^2 where r is the distance between the location where emissivity is to be calculated and the location where PI-SWERL datum is collected;
- Emissivity in riding area is calculated with riding area PI-SWERL data, emissivity in non-riding area is calculated with non-riding area PI-SWERL data, and in particular, emissivity in private land is calculated with PI-SWERL data in private land as well in 'dune preserve' area;
- Emissivity in 'other closed area' within the boundary of riding area is calculated with non-riding PI-SWERL data;
- Emissivity in 'dogleg' area is calculated with riding area PI-SWERL data;
- In transition zone from riding area to private land, emissivity is transitioned from riding area levels to private land levels: for the emission cell in private land that is immediately adjacent to riding area, emissivity is taken as same as in the nearest cell in the riding area; for the respective three cells further to the right, 75%, 50% and 25% of emissivity is from the emissivity in the riding area cell and the remaining contribution is from that calculated in the previous step.

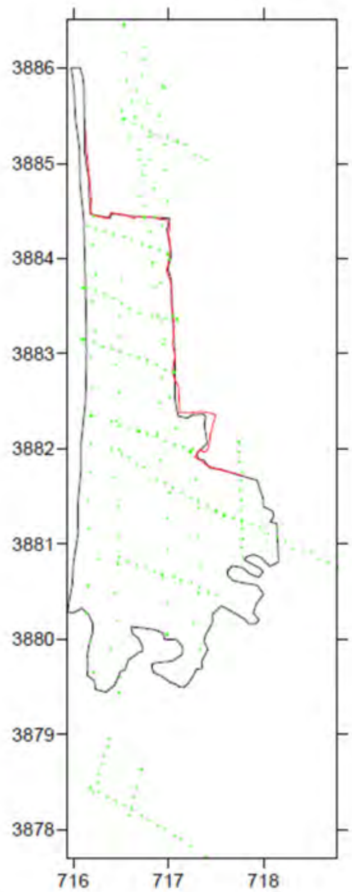
Table 1. Emission totals for June 2013 (in metric tons)

RPM	< 2000	2000 ~ 3000	3000 ~ 3500	All
u* (m/s)	0 ~ 0.44	0.44 ~ 0.64	0.64 ~ 0.73	
DRI Addendum 1	129.5	202.3	1.1	332.9
SLO fine grid	71.3	154.9	0.8	227.0
SLO coarse grid	75.1	156.2	0.9	232.1
ARB 1/r^2 & transition	75.1	142.9	0.8	218.9

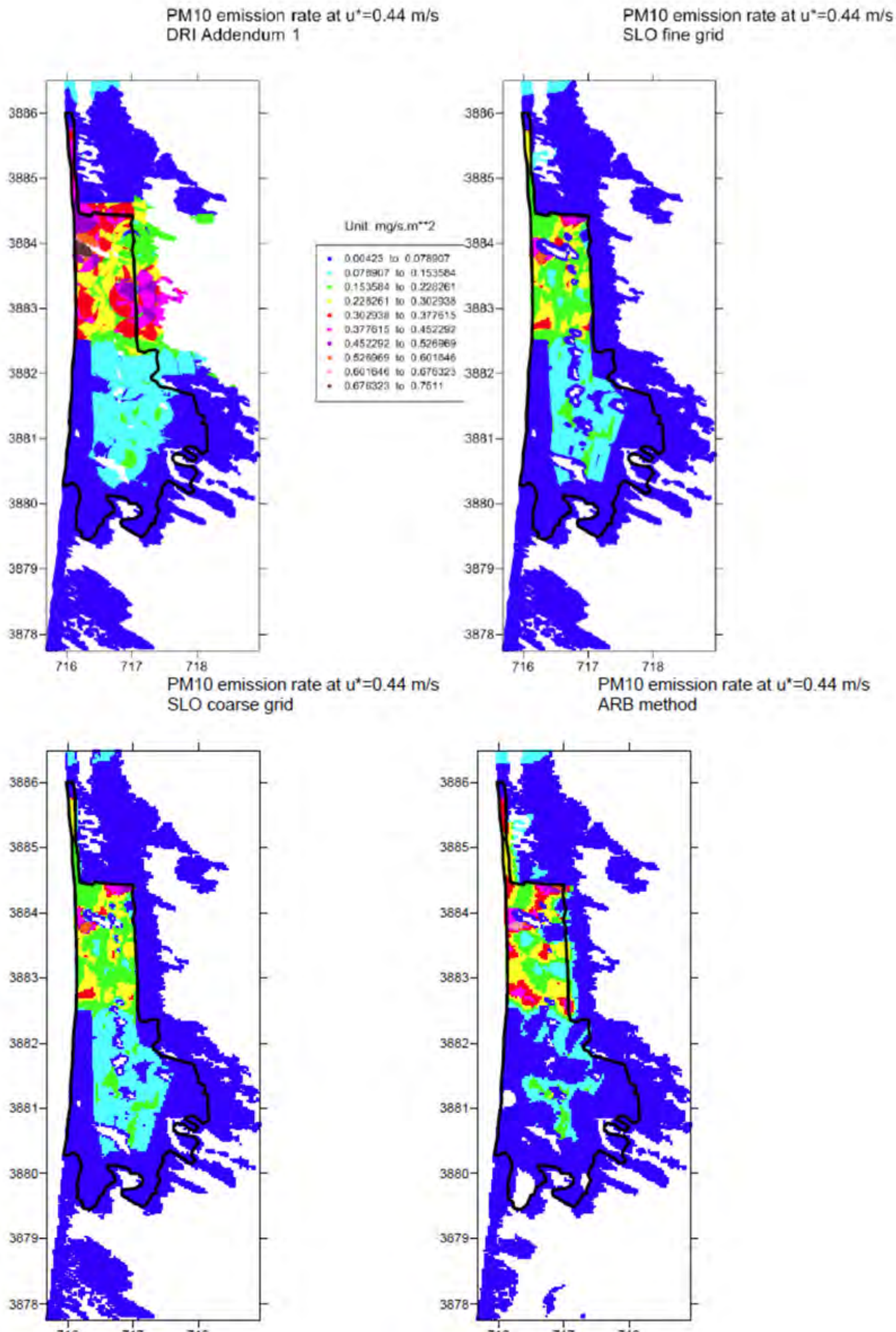
Table 2. Percentages of emissions in each RPM bins for June 2013

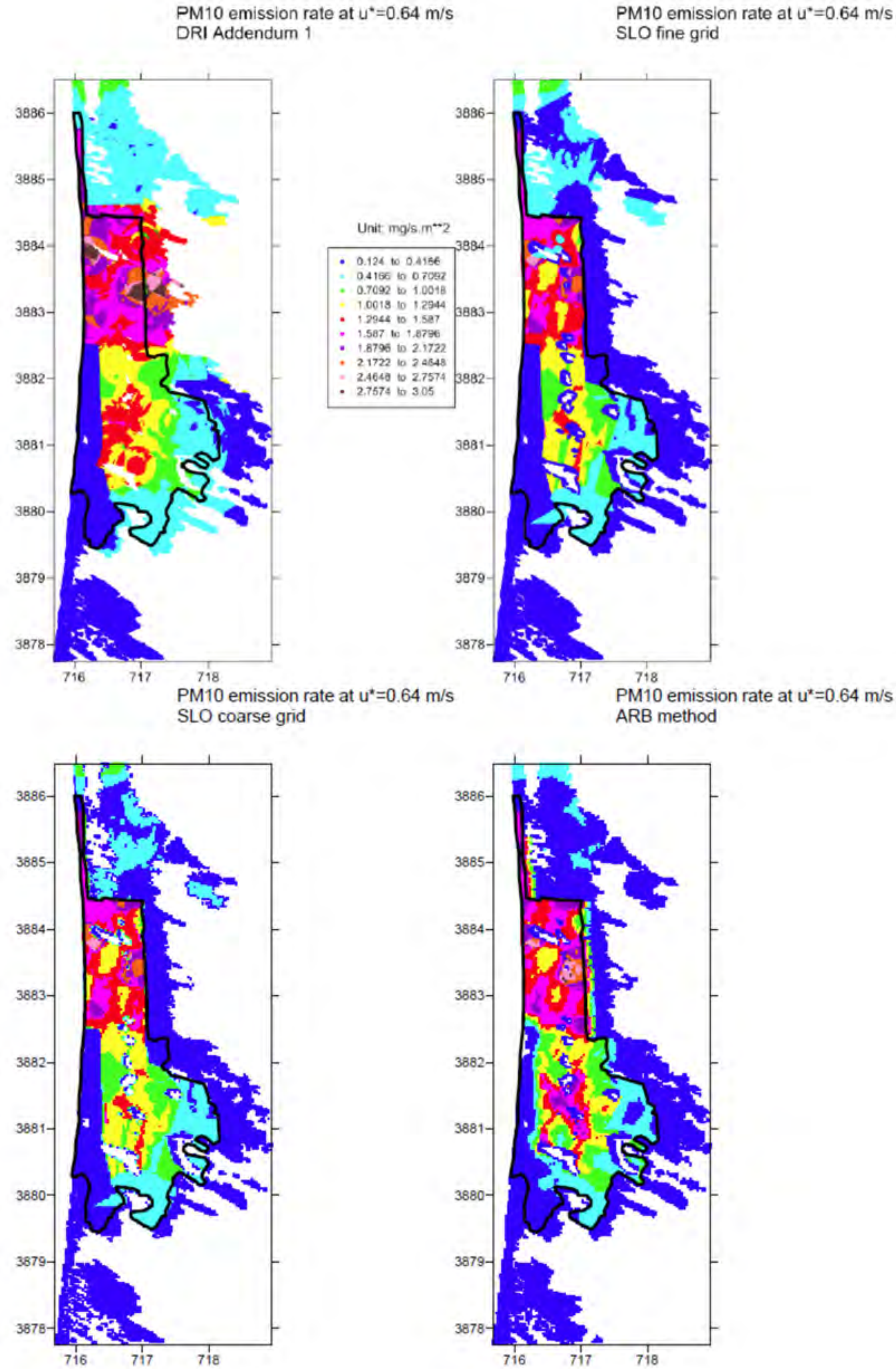
RPM	< 2000	2000 ~ 3000	3000 ~ 3500
u* (m/s)	0 ~ 0.44	0.44 ~ 0.64	0.64 ~ 0.73
DRI Addendum 1	38.9	60.8	0.3
SLO fine grid	31.4	68.2	0.4
SLO coarse grid	32.4	67.3	0.4
ARB 1/r^2 & transition	34.3	65.3	0.4

PI-SWERL Measurement Locations



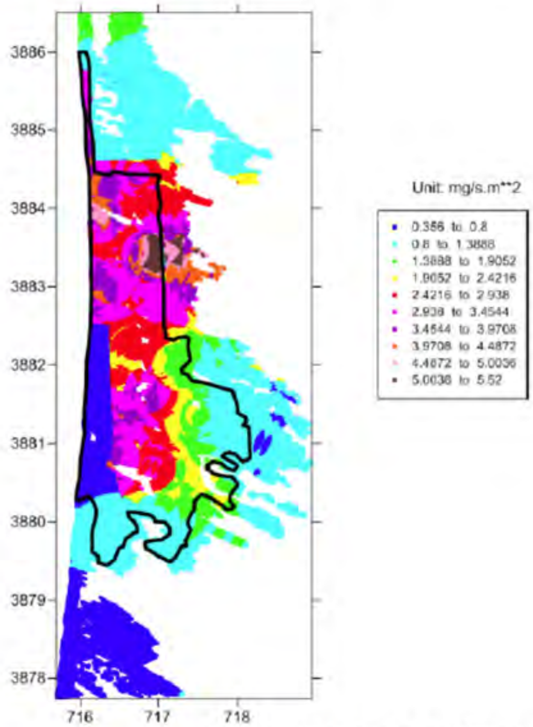
Black line: boundary of riding area
Red line: line separating riding area and private land


PM10 emission rate at u*=0.44 m/s
DRI Addendum 1
PM10 emission rate at u*=0.44 m/s
SLO fine grid
Unit: mg/s.m**2
0.00423 to 0.078907
0.078907 to 0.153584
0.153584 to 0.228261
0.228261 to 0.302938
0.302938 to 0.377615
0.377615 to 0.452292
0.452292 to 0.526969
0.526969 to 0.601646
0.601646 to 0.676323
0.676323 to 0.7511
PM10 emission rate at u*=0.44 m/s
SLO coarse grid
PM10 emission rate at u*=0.44 m/s
ARB method
3886
3885
3884
3883
3882
3881
3880
3879
3878
716
717
718

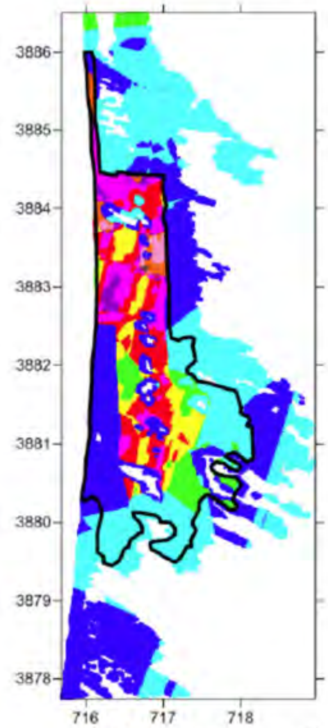

PM10 emission rate at u*=0.64 m/s
DRI Addendum 1
PM10 emission rate at u*=0.64 m/s
SLO fine grid
PM10 emission rate at u*=0.64 m/s
SLO coarse grid
PM10 emission rate at u*=0.64 m/s
ARB method
Unit: mg/s.m**2
0.124 to 0.4166
0.4166 to 0.7092
0.7092 to 1.0018
1.0018 to 1.2944
1.2944 to 1.587
1.587 to 1.8796
1.8796 to 2.1722
2.1722 to 2.4648
2.4648 to 2.7574
2.7574 to 3.05
3886
3885
3884
3883
3882
3881
3880
3879
3878
716
717
718

4

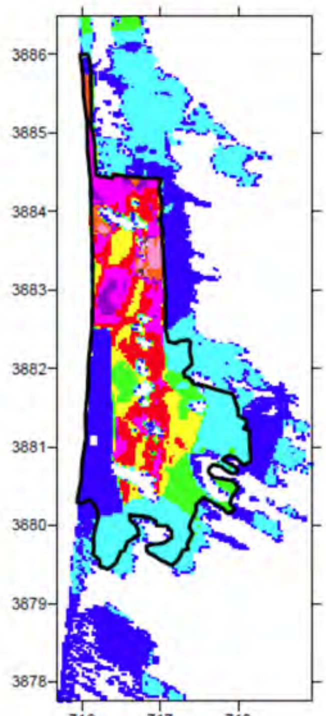
PM10 emission rate at u*=0.73 m/s
DRI Addendum 1



PM10 emission rate at u*=0.73 m/s
SLO fine grid



PM10 emission rate at u*=0.73 m/s
SLO coarse grid



PM10 emission rate at u*=0.73 m/s
ARB method