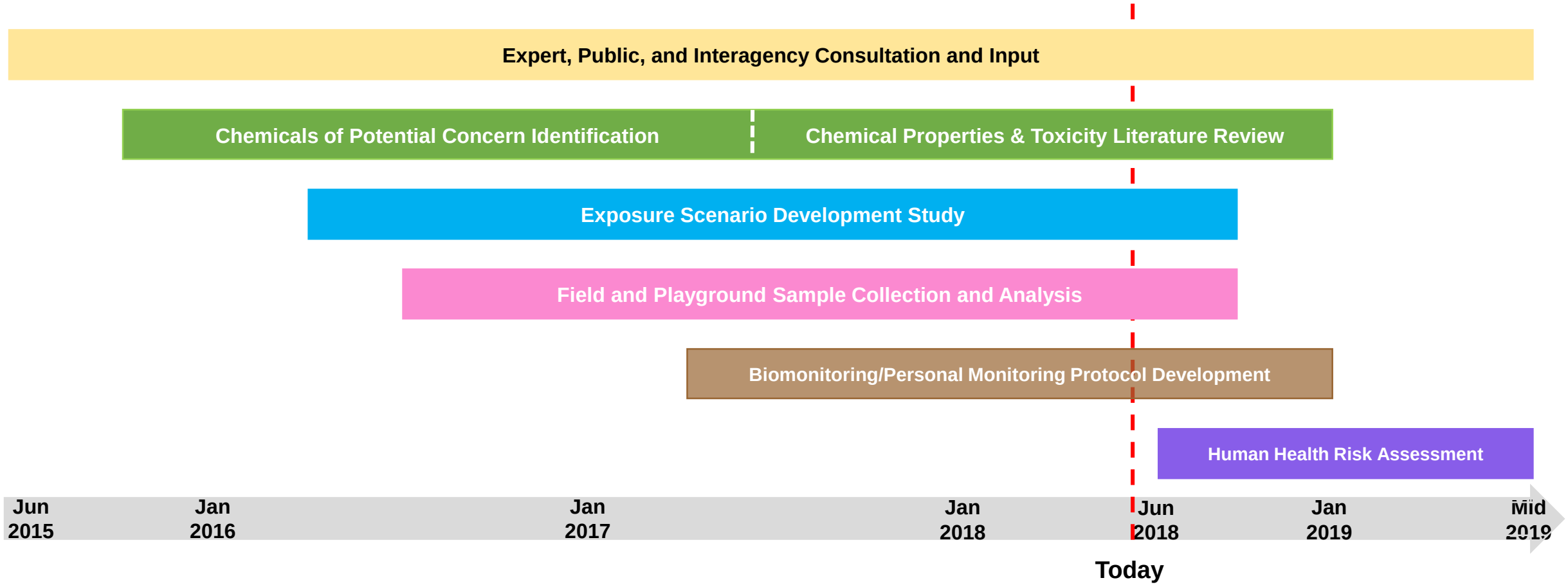
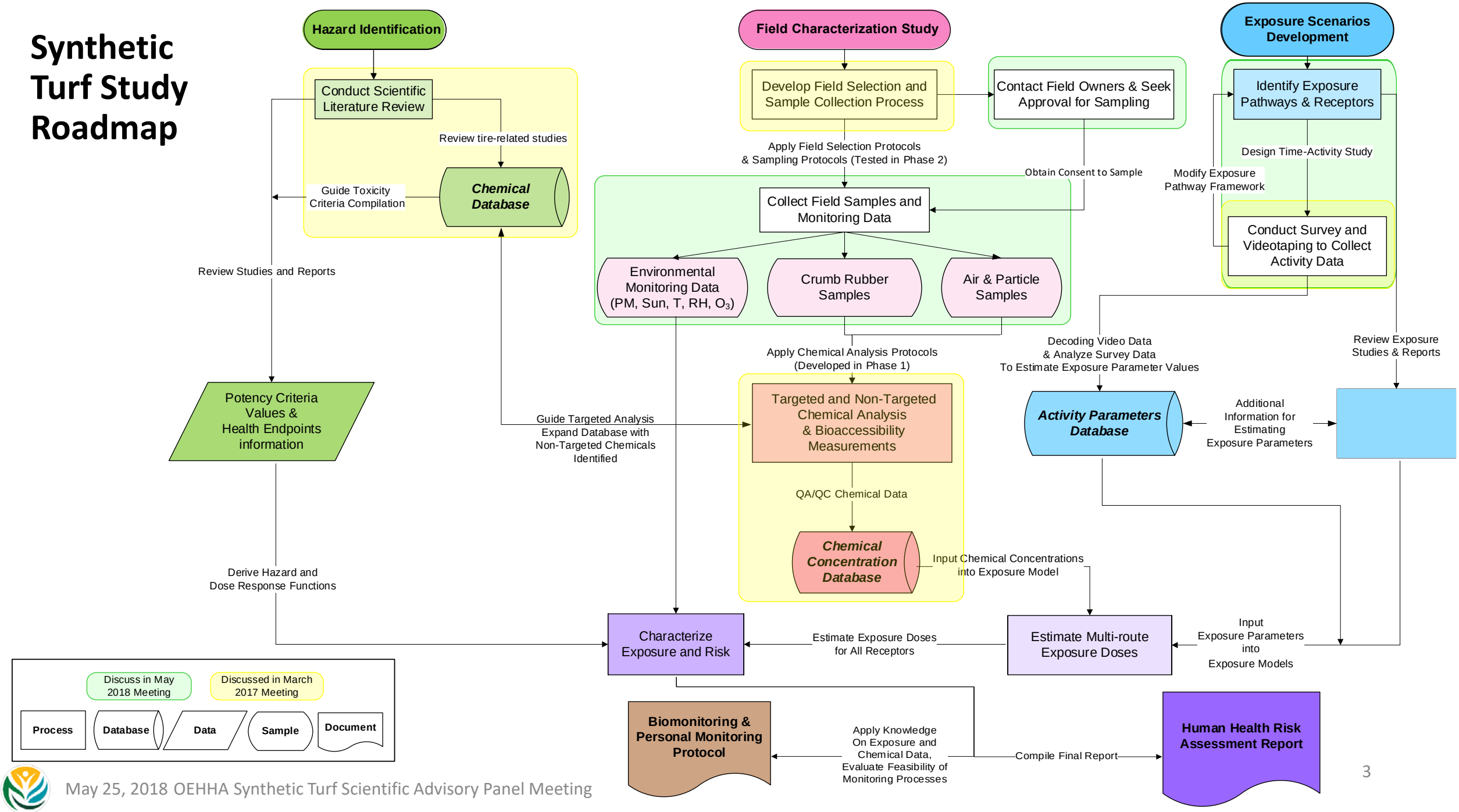
Section 2
Synthetic Turf and Playground Studies Overview

Presenters: Patty Wong, Ph.D., OEHHA

Synthetic Turf Study Overview



Synthetic Turf Study Roadmap



Section 3.1.
Field Characterization Study of Synthetic Turf Fields

Presenters: Rebecca Belloso, MPH

Randy Maddalena, Ph.D., LBNL

Woody Delp, Ph.D., LBNL

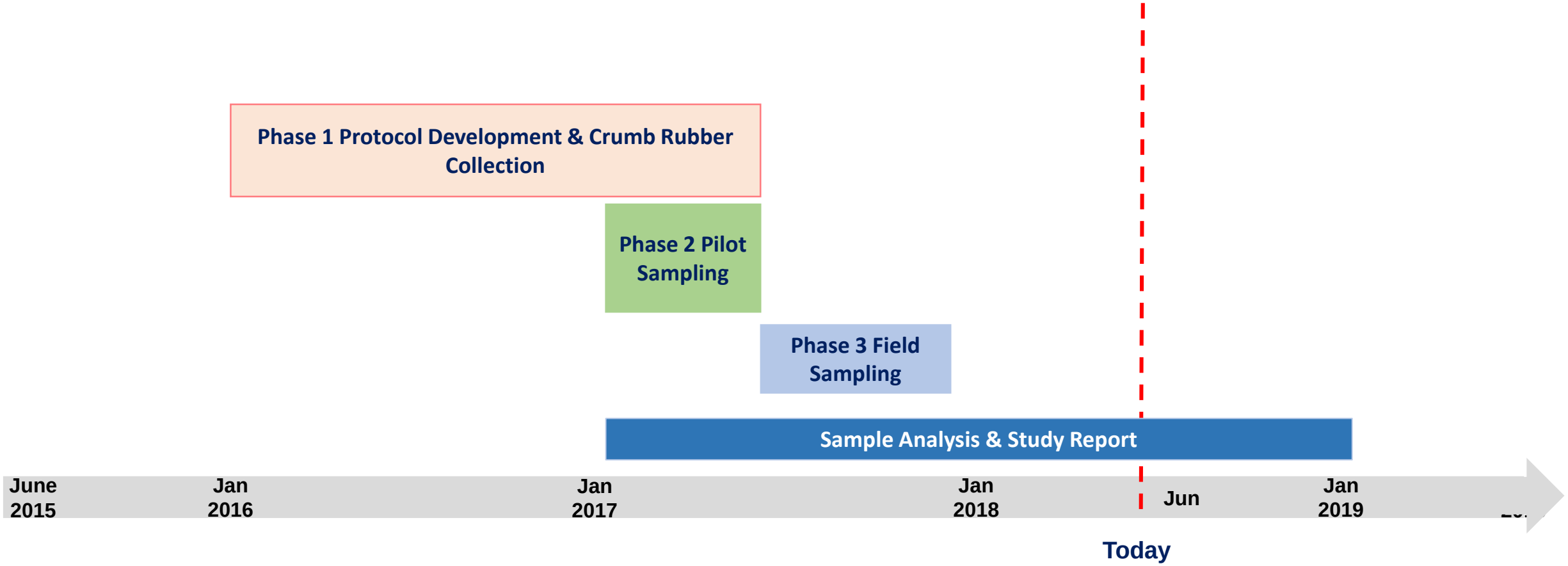
Hugo Destaillats, Ph.D., LBNL

Marion Russell, M.S., LBNL

Section 3.1.1. Field Selection and Sample Collection

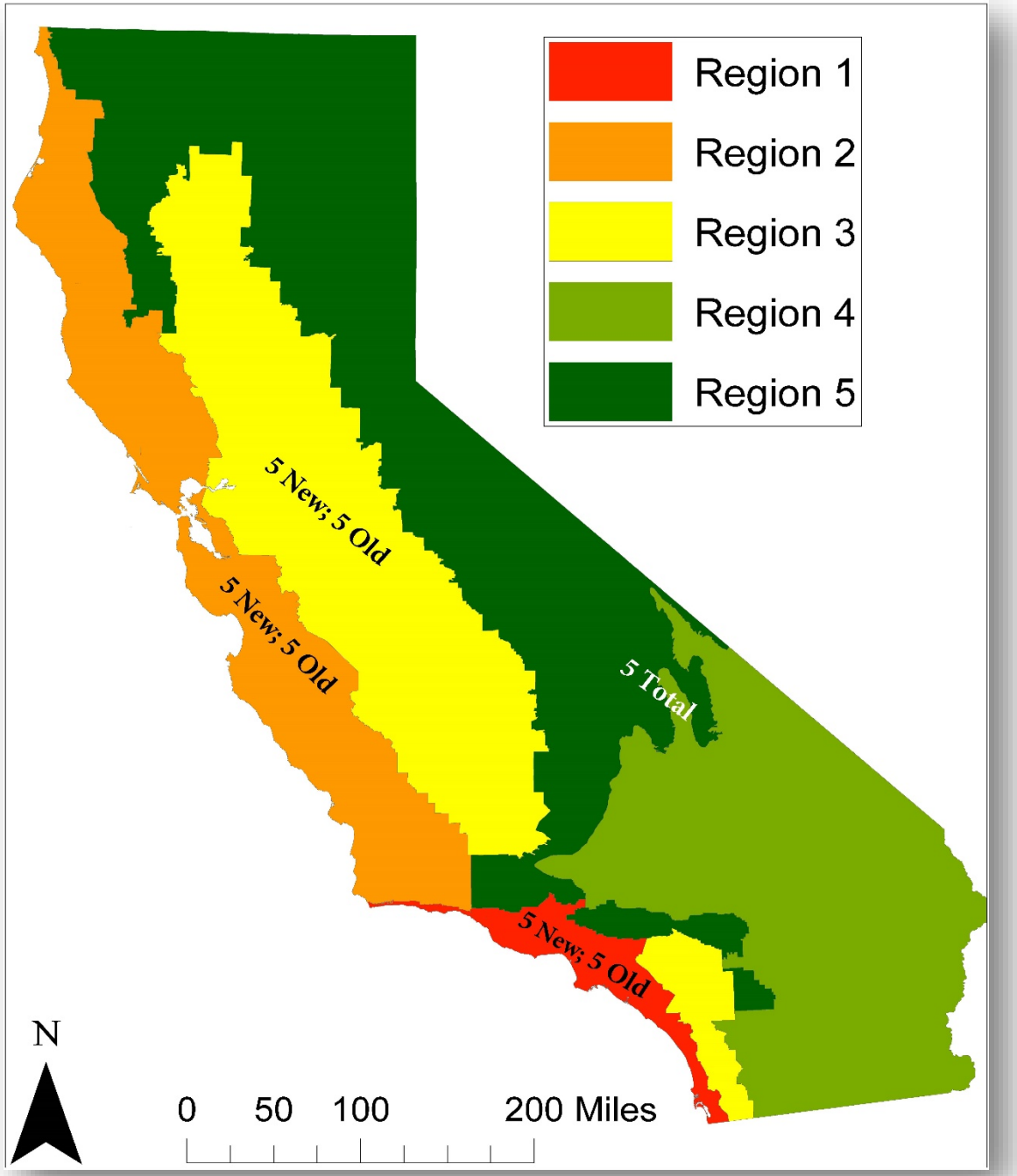
Presenter: Rebecca Belloso, MPH, OEHHA

Field Selection and Sample Collection



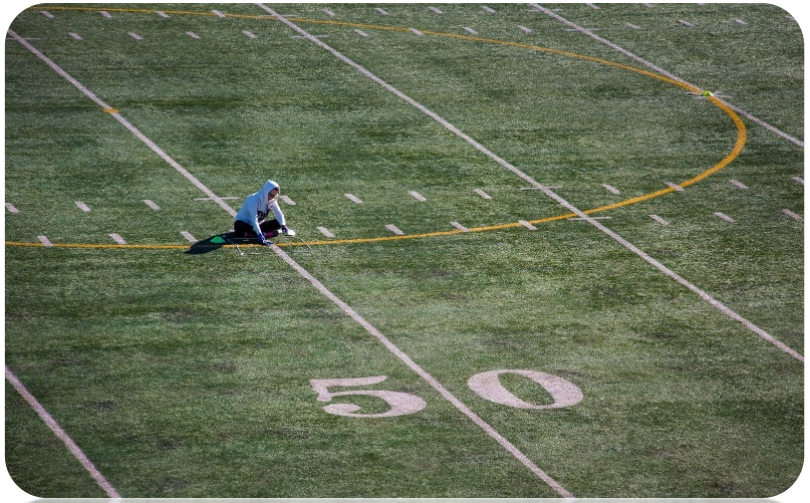
Stratification Factors (Selection Criteria) Phase 3 Field Selection

- Climate Zones and Regions
- Age of Field
- Random Sort



Field Study Goal

Collect samples to characterize and quantify the chemicals that may be released from synthetic turf fields.



Fields Sampled

Climate Region	Field Age (Years)	No. of Fields	No. of Fields Sampled
Region 1 **Southern Coastal Areas**	New (0 to <9)	125	**8**
	Old (≥9)	127	**3**
	Unknown	124	**0**
	Cork/Rubber Mix	Unknown	**2**
	Total	376	**13 (3.5%)**

Fields Sampled

Climate Region	Field Age (Years)	No. of Fields	No. of Fields Sampled
Region 2 **Northern and Central Coastal Areas**	New	99	**4**
	Old	130	**5**
	Unknown	43	**0**
	Total	272	**9 (3.3%)**

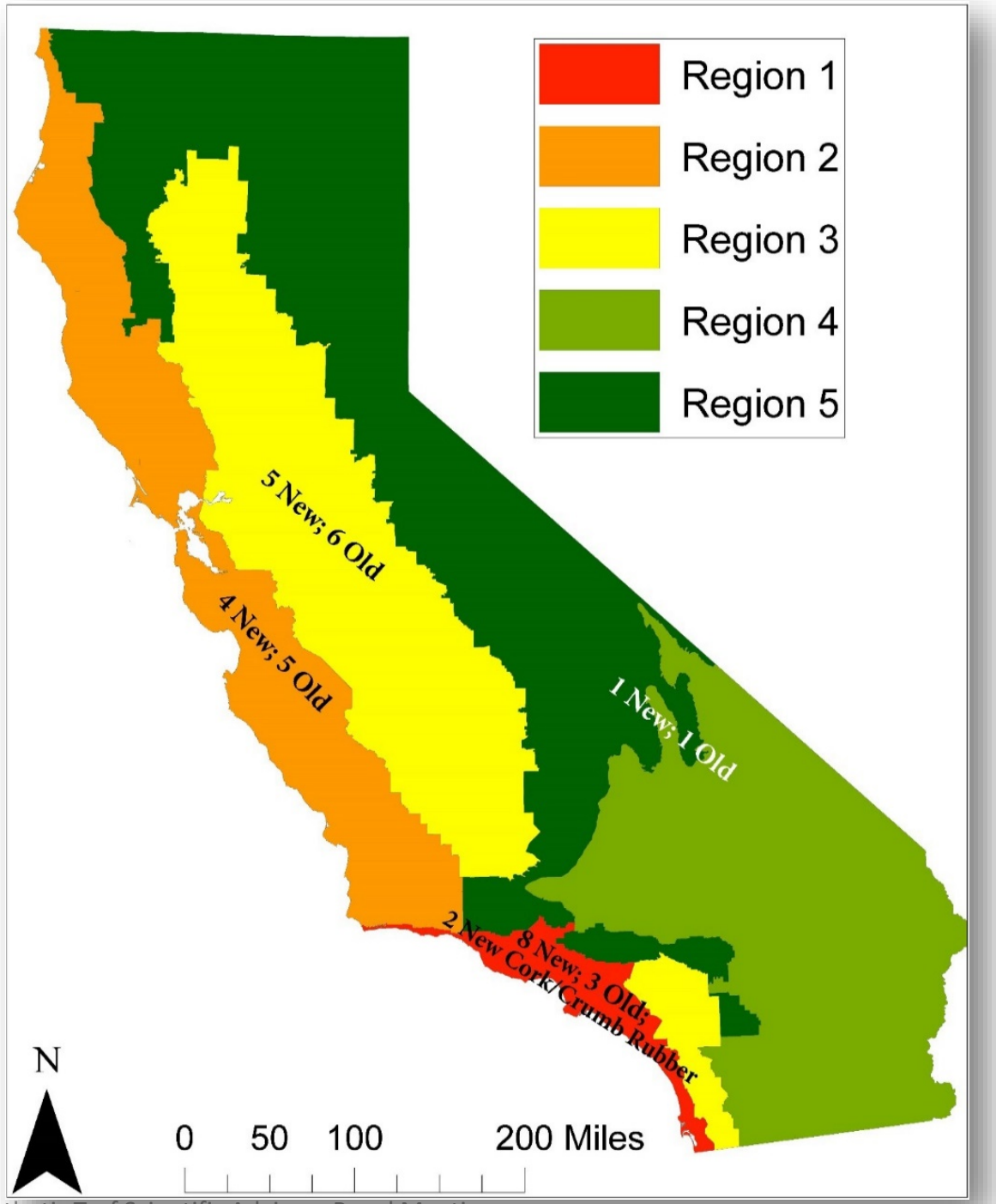
Fields Sampled

Climate Region	Field Age (Years)	No. of Fields	No. of Fields Sampled
Region 3 **Southern Interior Valleys and Northern Central Valley**	New	80	**5**
	Old	108	**6**
	Unknown	45	**0**
	Total	233	**11 (4.7%)**

Fields Sampled

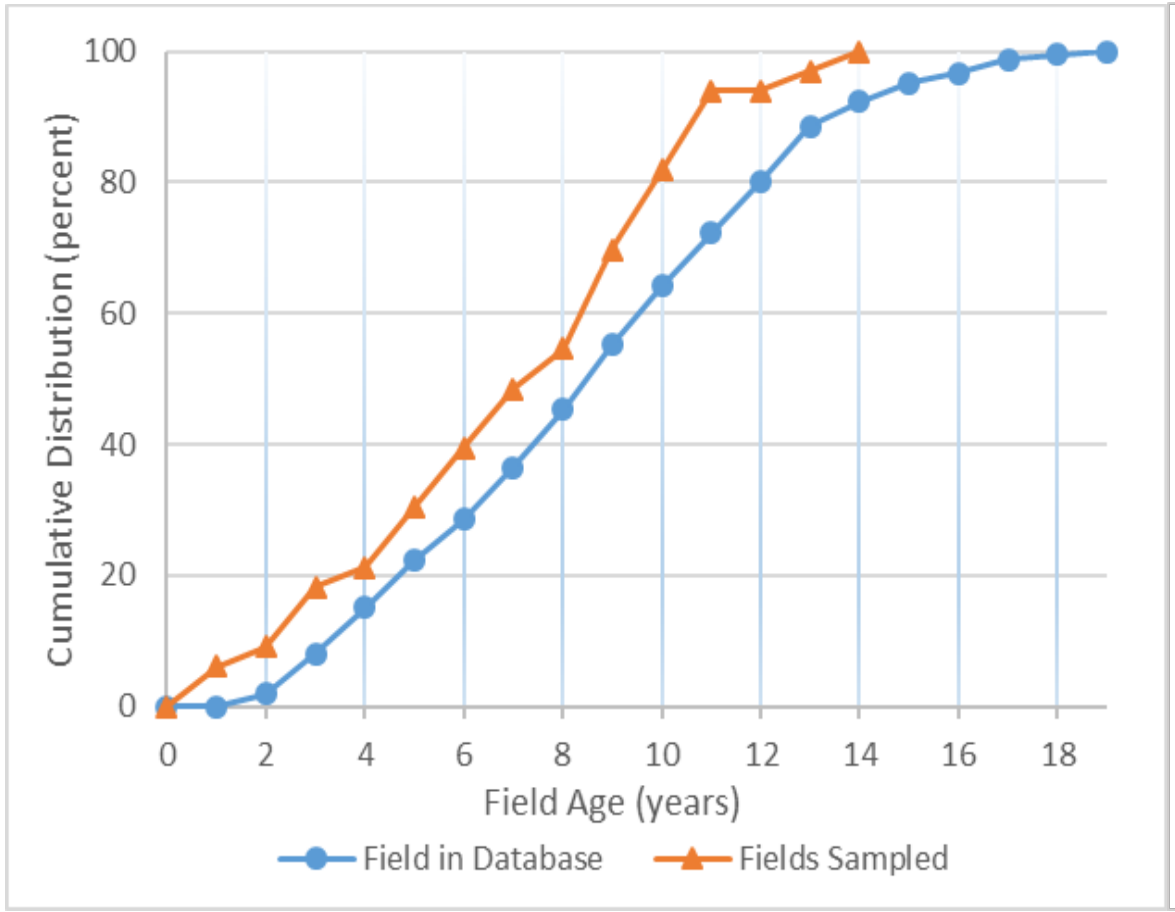
Climate Region	Field Age (Years)	No. of Fields	No. of Fields Sampled
Combined Region 4/5 **Southern High And Low Deserts/ Mountainous Areas**	New	7	**1**
	Old	11	**1**
	Unknown	6	**0**
	Total	24	**2 (8.3%)**

Summary of Field Selection

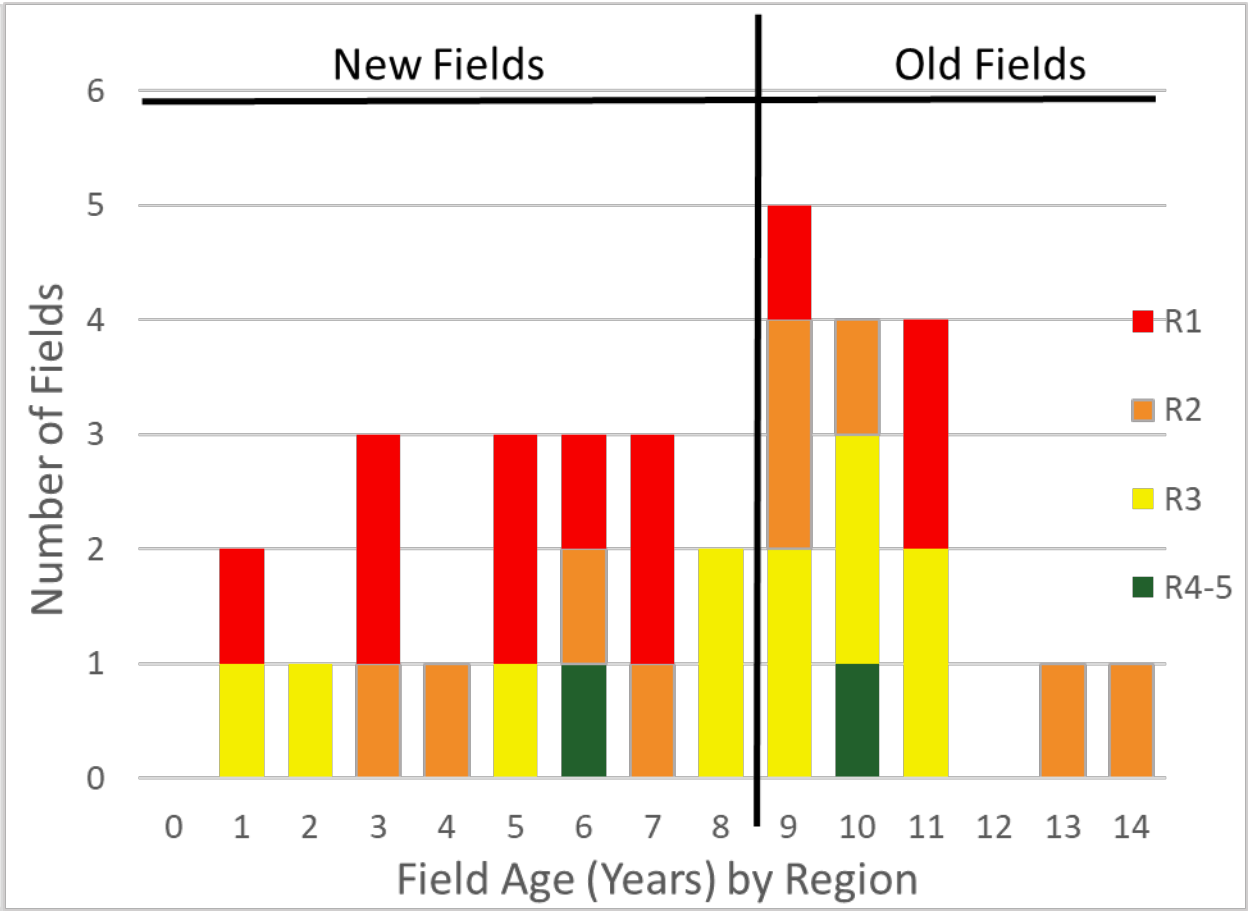


Age Distribution of Sampled Fields

A



B



Section 3.1.3
Overview of Environmental and Physical Conditions at Fields

Presenter: Randy Maddalena, Ph.D., LBNL

Overview of Environmental and Physical Conditions at Fields

Randy Maddalena, Wm. Woody Delp, Marion Russell,
Toshifumi Hotchi and Hugo Destaillats

Lawrence Berkeley National Laboratory

Presentation for Scientific Advisory Meeting

Sacramento, CA, May 25, 2018

Overview

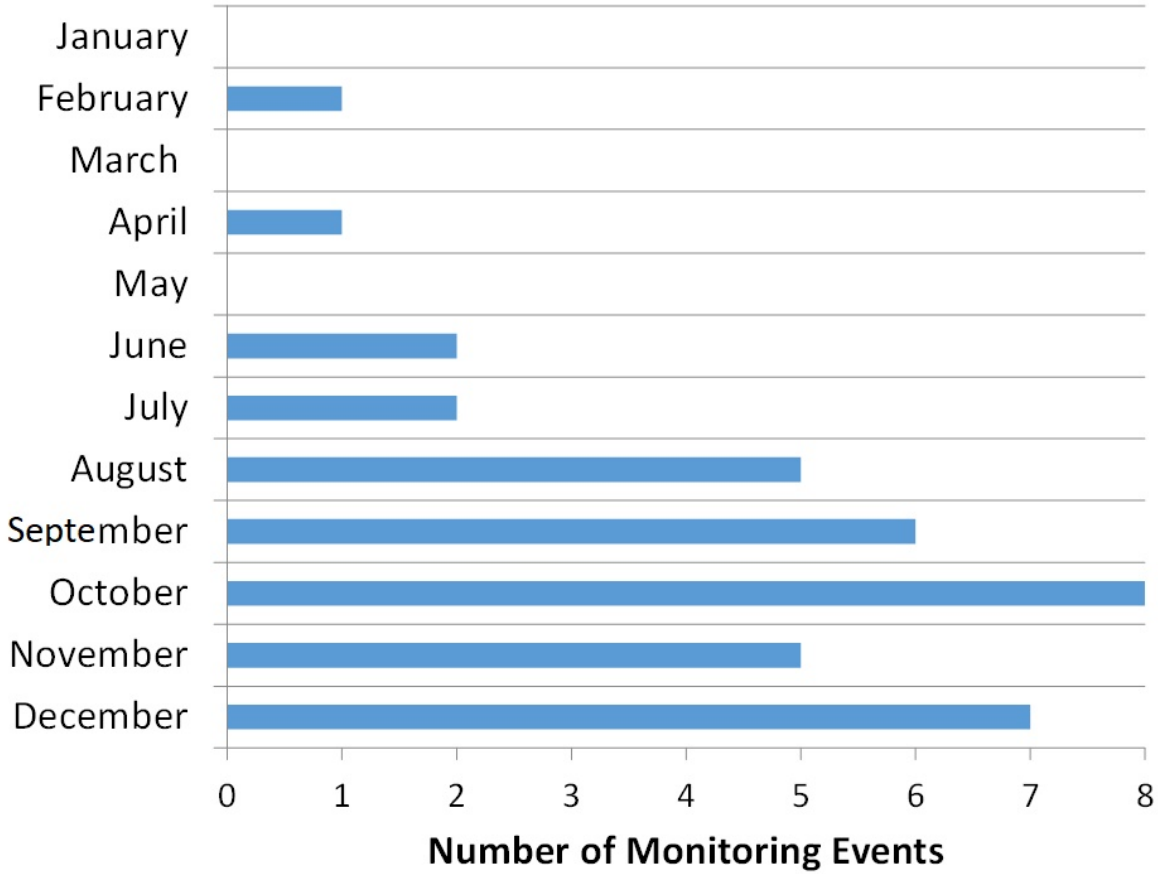
Previous presentation described stratification factors (selection criteria) and how we did with field recruiting.

This presentation will show what we actually got in terms of the range and type of conditions captured by the sample set:

- calendar distribution of monitoring events
- relationship between typical on-field conditions
- distribution of meteorological conditions including i) wind, ii) solar energy, iii) temperature profiles and iv) orientation of monitoring area
- distribution of field/environmental conditions including i) surface type/condition, ii) infill density and consistency and iii) ambient PM and ozone
- human inputs during testing

Distribution of monitoring events

- Fields monitored throughout year
- Scheduled by weather, availability and traveling logistics
- Consecutive monitoring events limited by sample media prep
- Warm fall weather allowed for extended monitoring season



Noon	Daily High	Daily Low
min – max (°F)	min – max (°F)	min – max (°F)
61	65	43
61	70	46
65 - 84	68 - 93	56 - 58
69 - 86	71 - 90	52 - 56
67 - 89	72 – 94	51 - 60
71 - 84	75 - 87	62 - 63
63 - 103	64 - 111	50 - 57
58 - 74	62 - 83	39 - 57
29 - 79	37 - 81	23 - 46

Measuring On-Field Conditions during Testing

Meteorology and VOC stratification tower

Continuous wind speed and direction

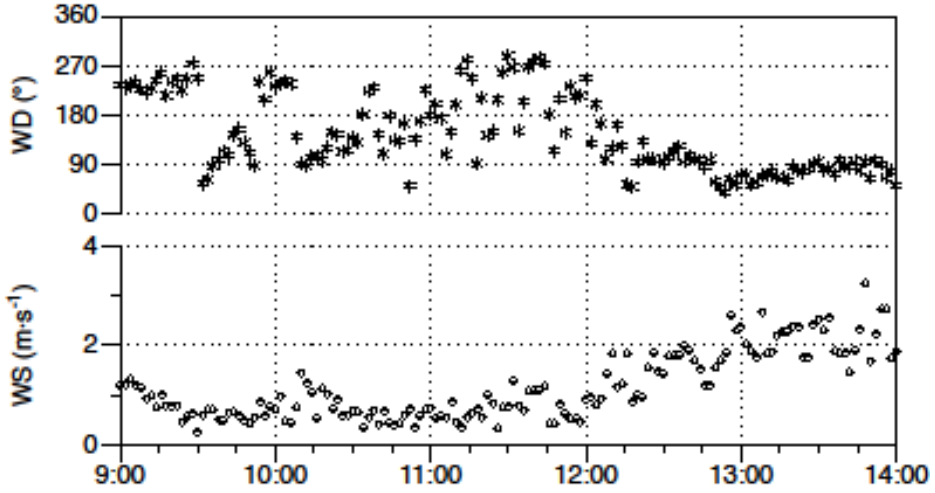
Shielded air temperature (RH at top) with IR Surface temperature

Temperature profile of crumb at two depths

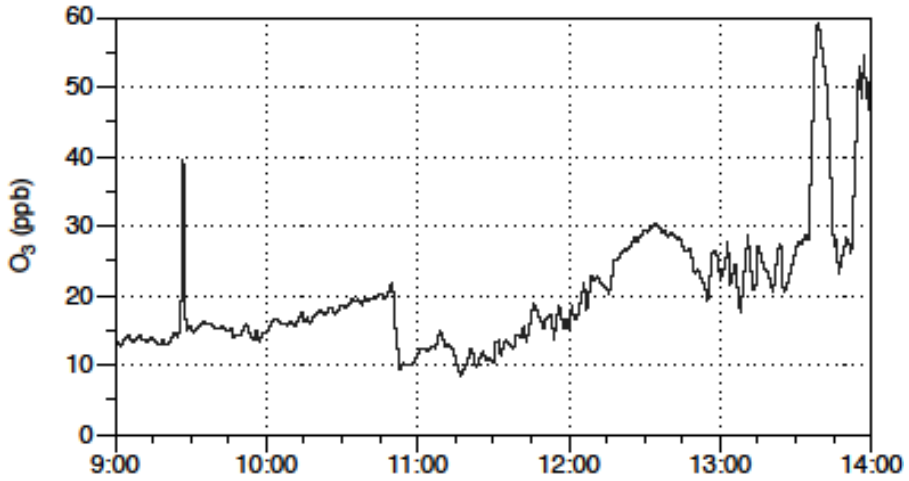
Solar insolation (surface energy & cloud cover)

Typical On-Field Conditions During Testing

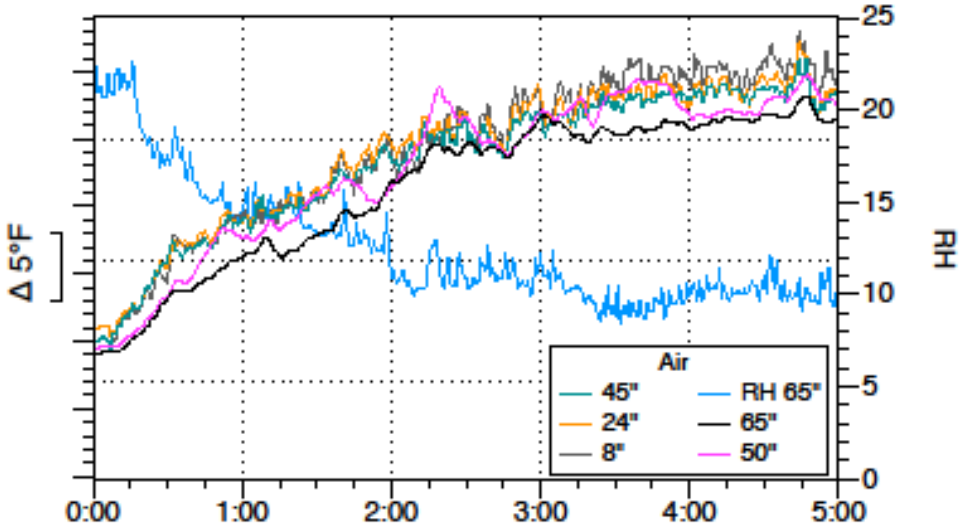
calm & variable in AM with increasing wind later in day



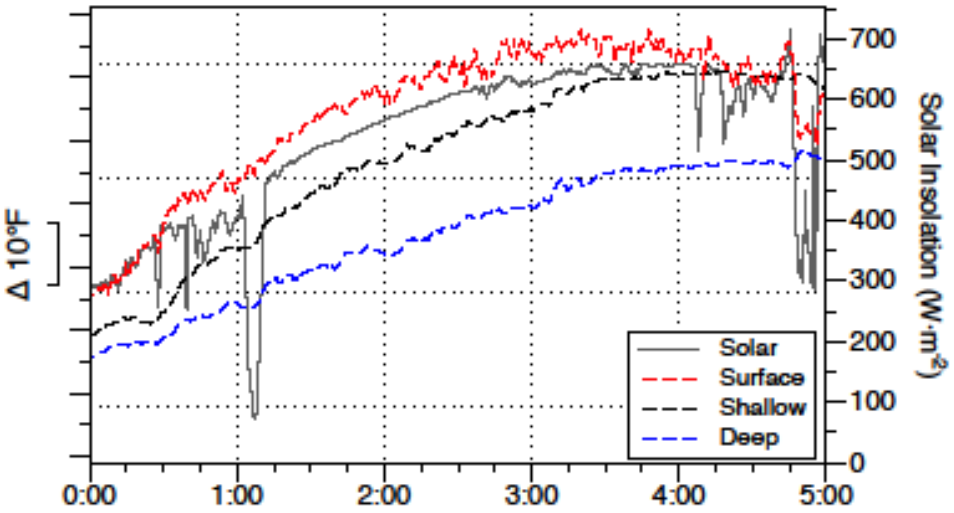
changing air mass as wind develops



increasing stratified air temp over field and decreasing RH



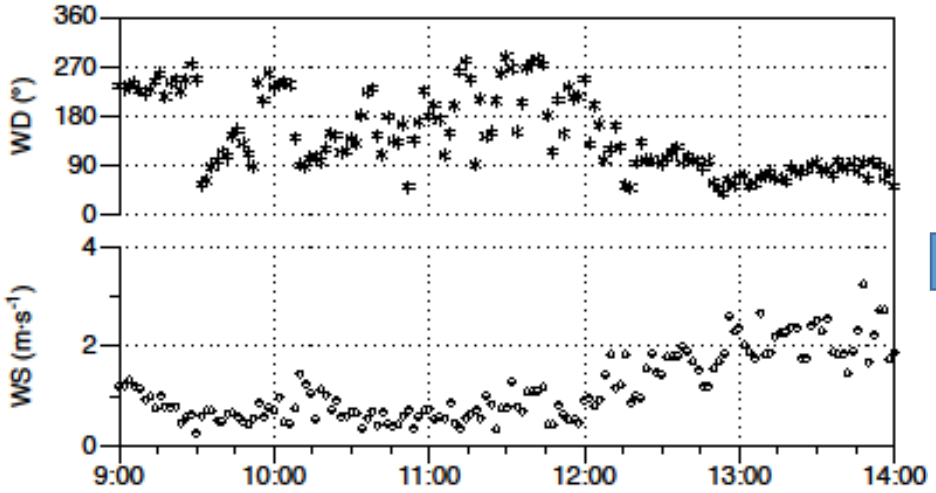
strong relationship between insolation and surface temp



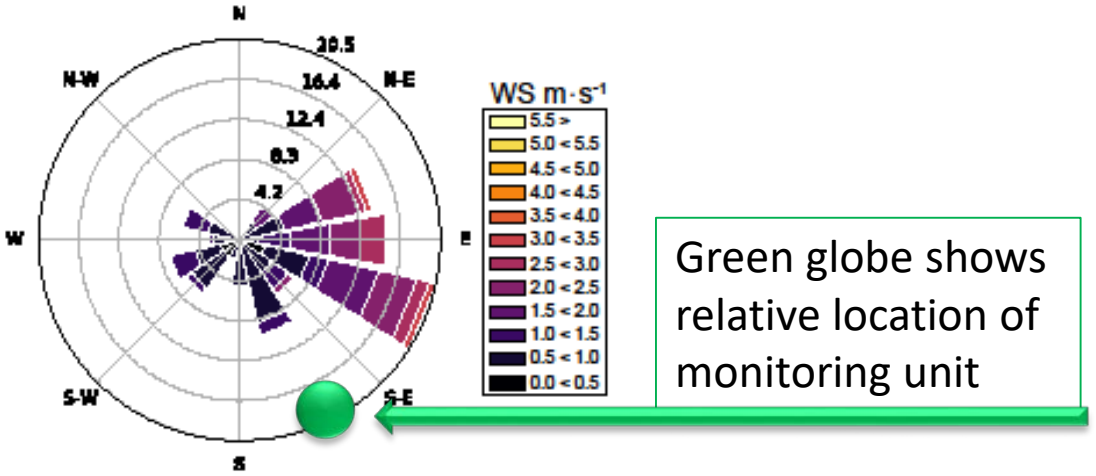
Alternate way to look at wind speed/direction

Wind direction (blowing too)

West
South
East
North



- Rings indicate percent of time wind blowing in speed/direction

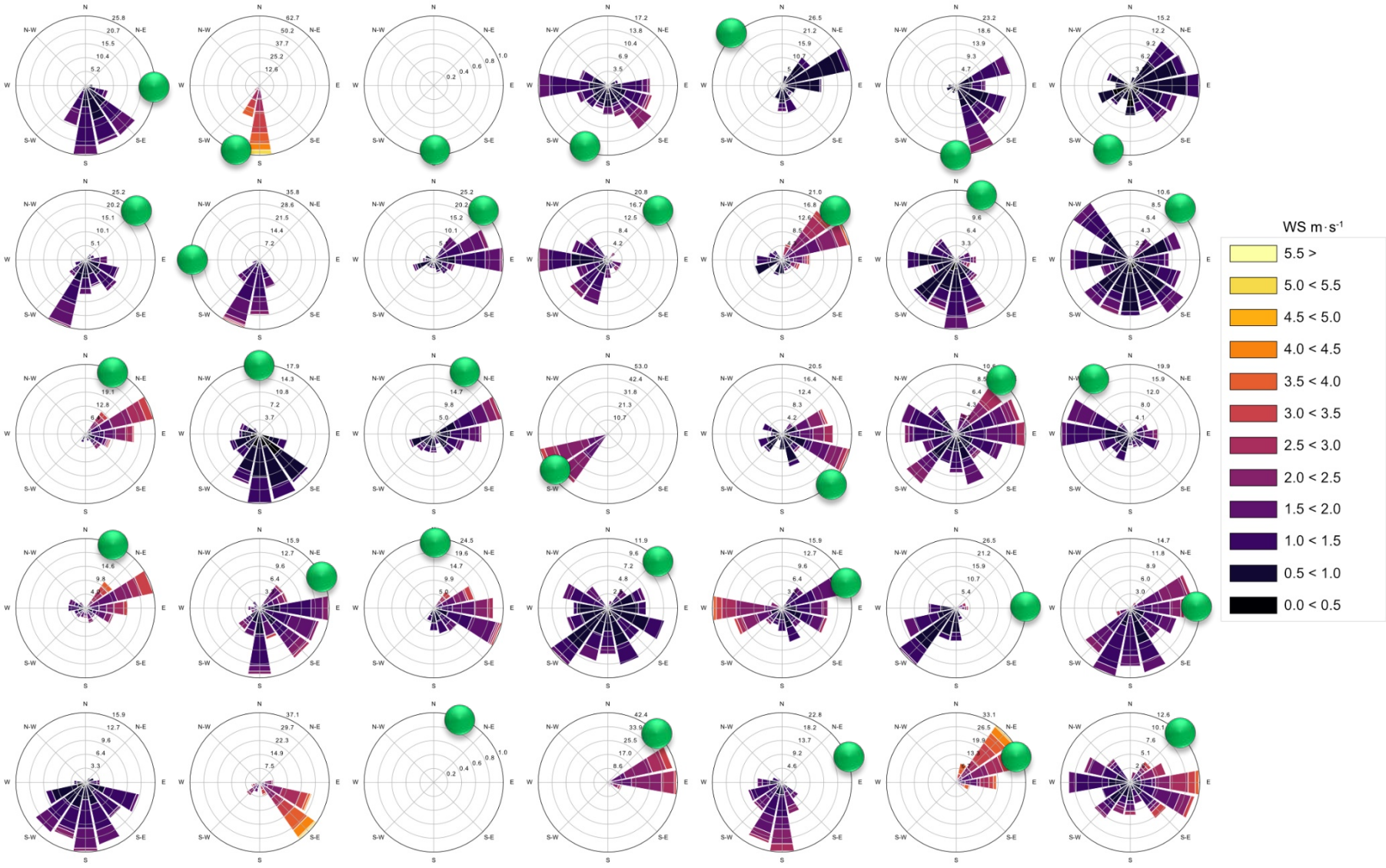


Green globe shows relative location of monitoring unit

- Color of bar indicates wind speed during that percentage of the time.
- Orientation of bars indicate wind direction (blowing too)

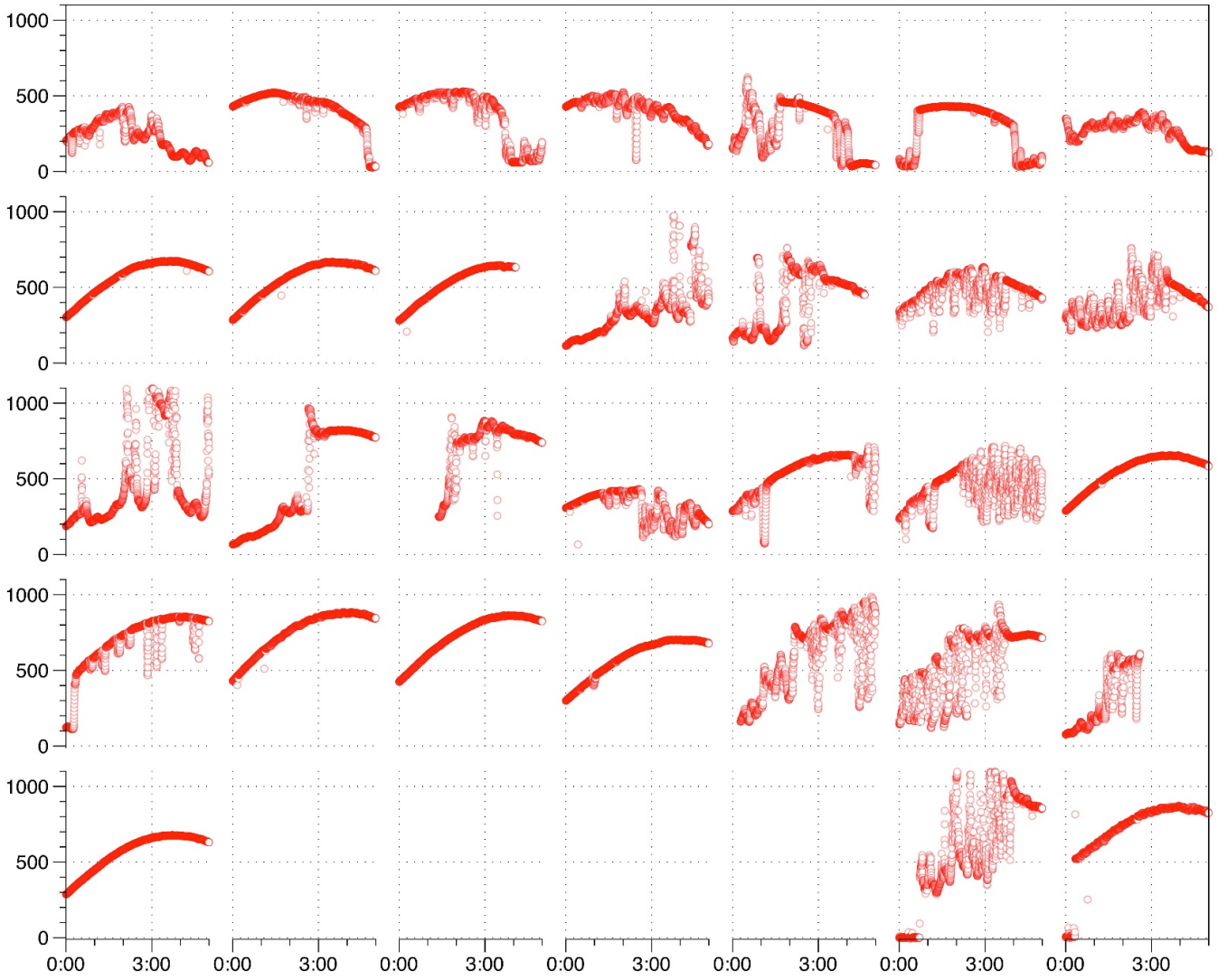
Distribution of Wind Conditions

Average wind pattern during monitoring includes calm days with scattered wind direction and breezy days with consistent wind direction.



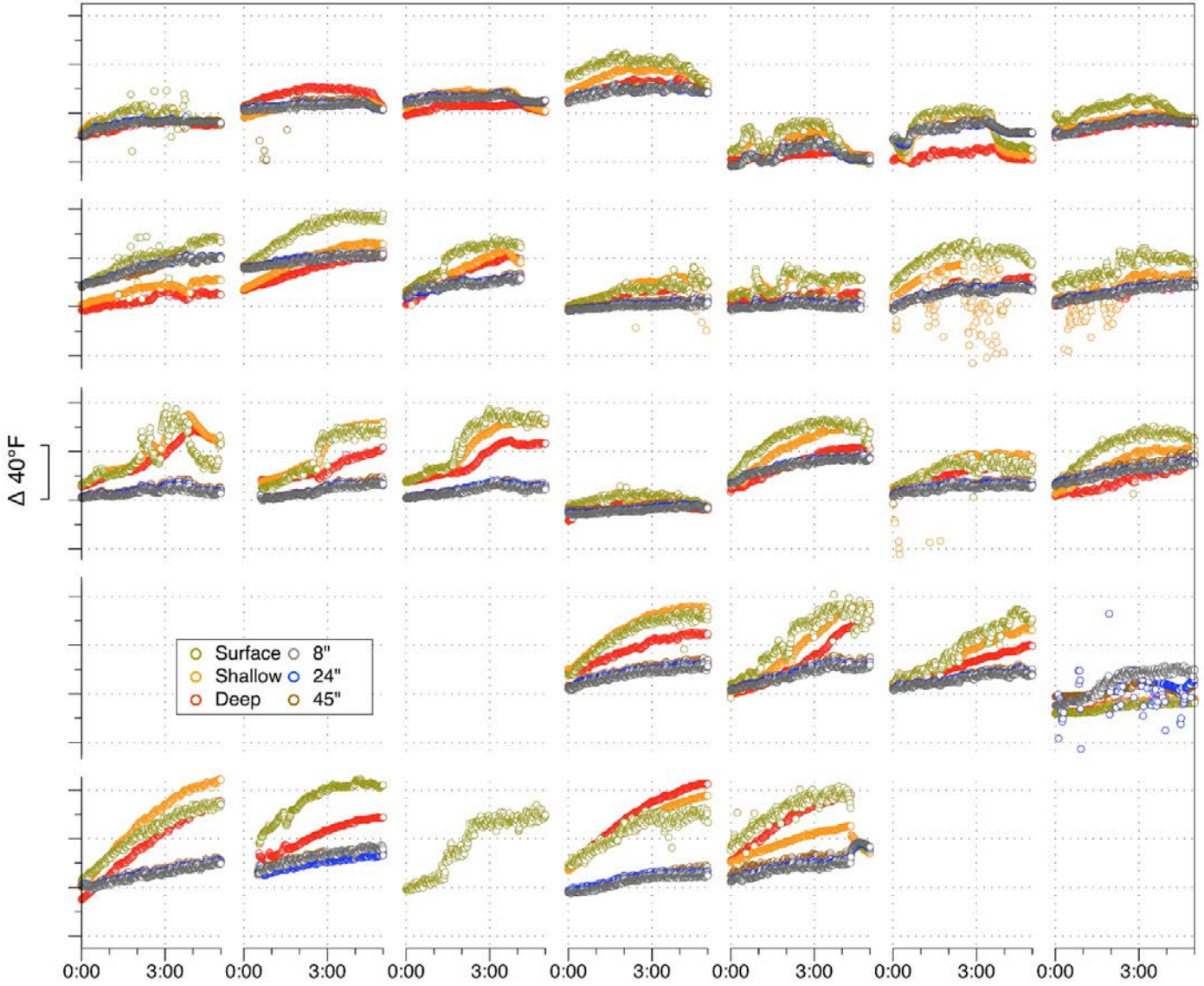
Distribution of solar insolation

Solar energy shows mix of clear and cloudy days.



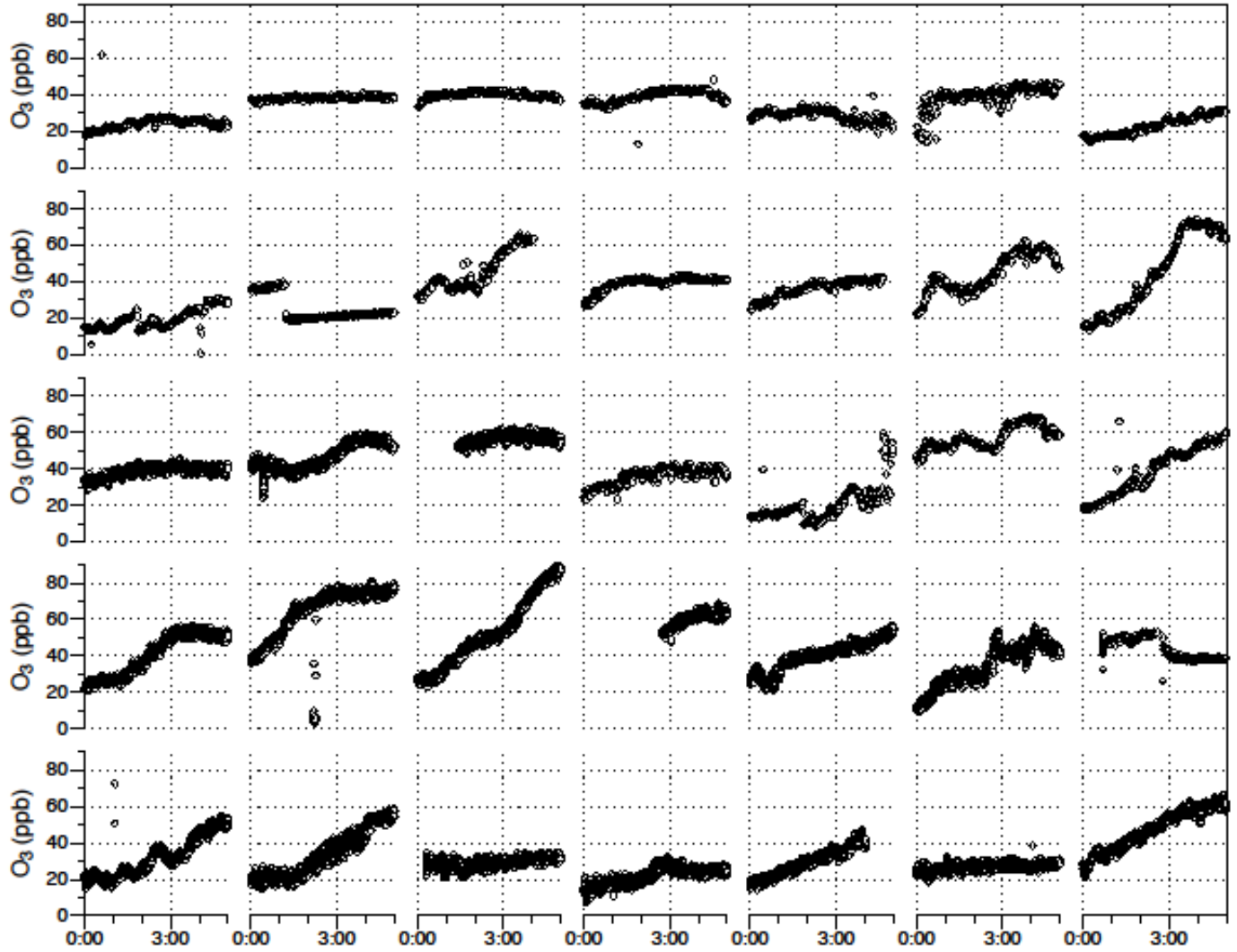
Distribution of temperatures

- Temperature profile across depth and across all fields show both temporal and spatial variation



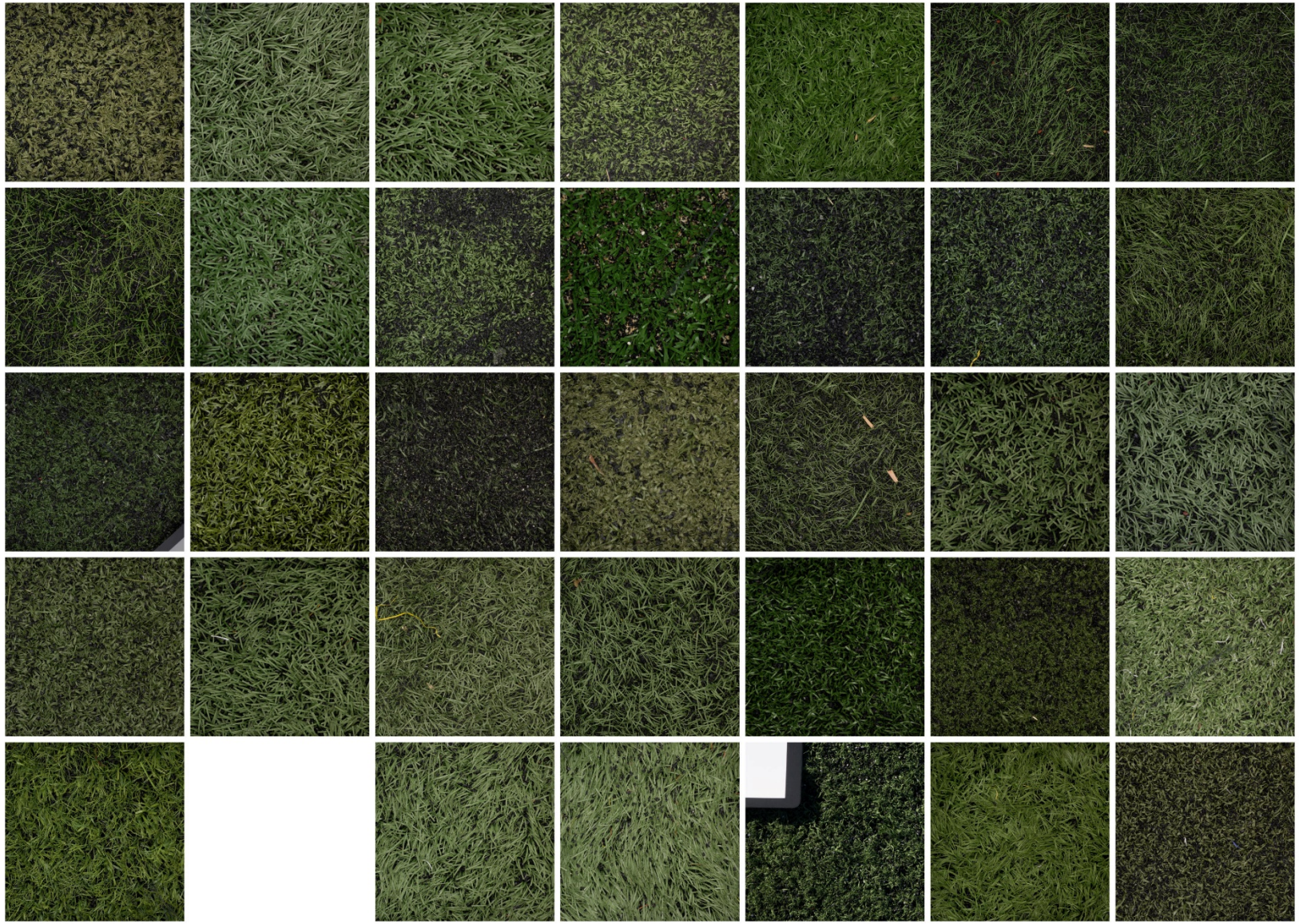
Distribution of ozone concentrations

Ozone profiles show typical regional differences and temporal variation

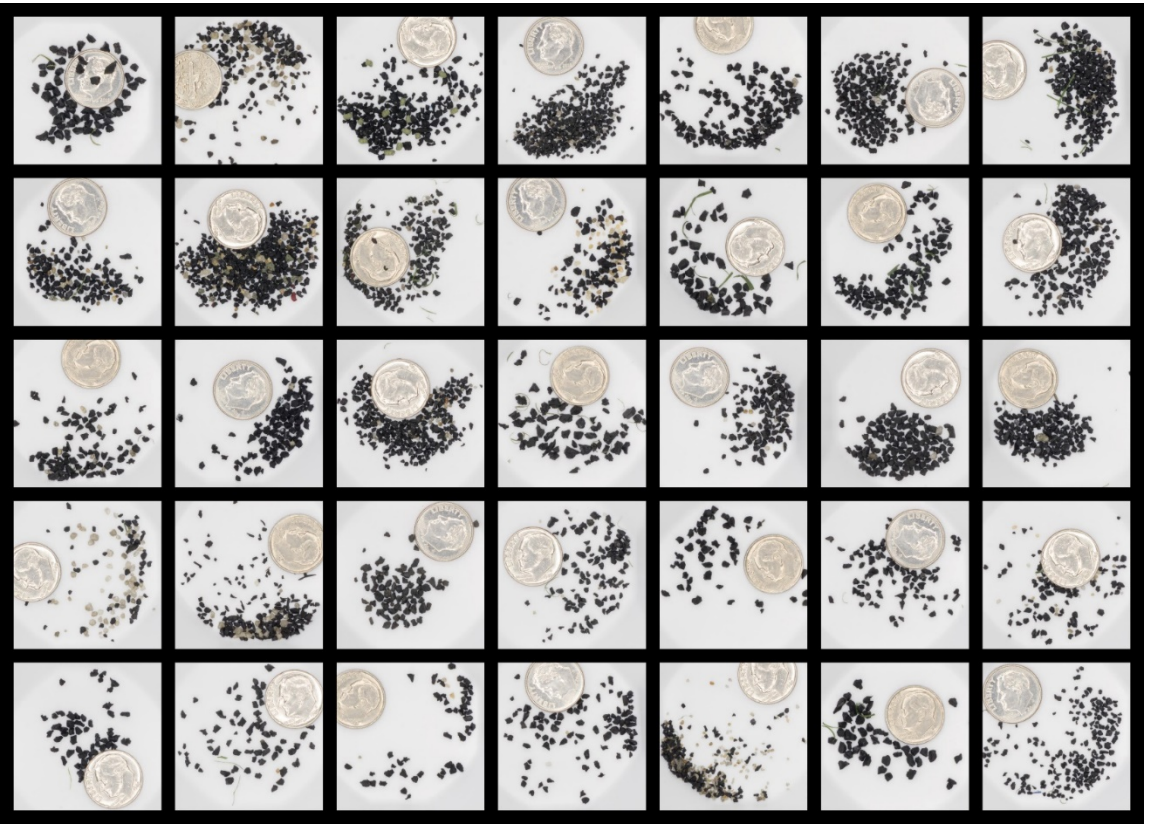


Distribution of Field Surface Types/Conditions

- Images collected using portable LED studio
- All images “color graded” for consistency
- Results show a range of turf type and condition



Distribution of Infill Composition and Density

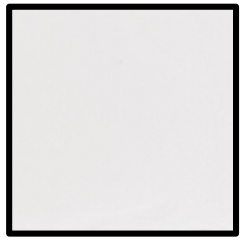


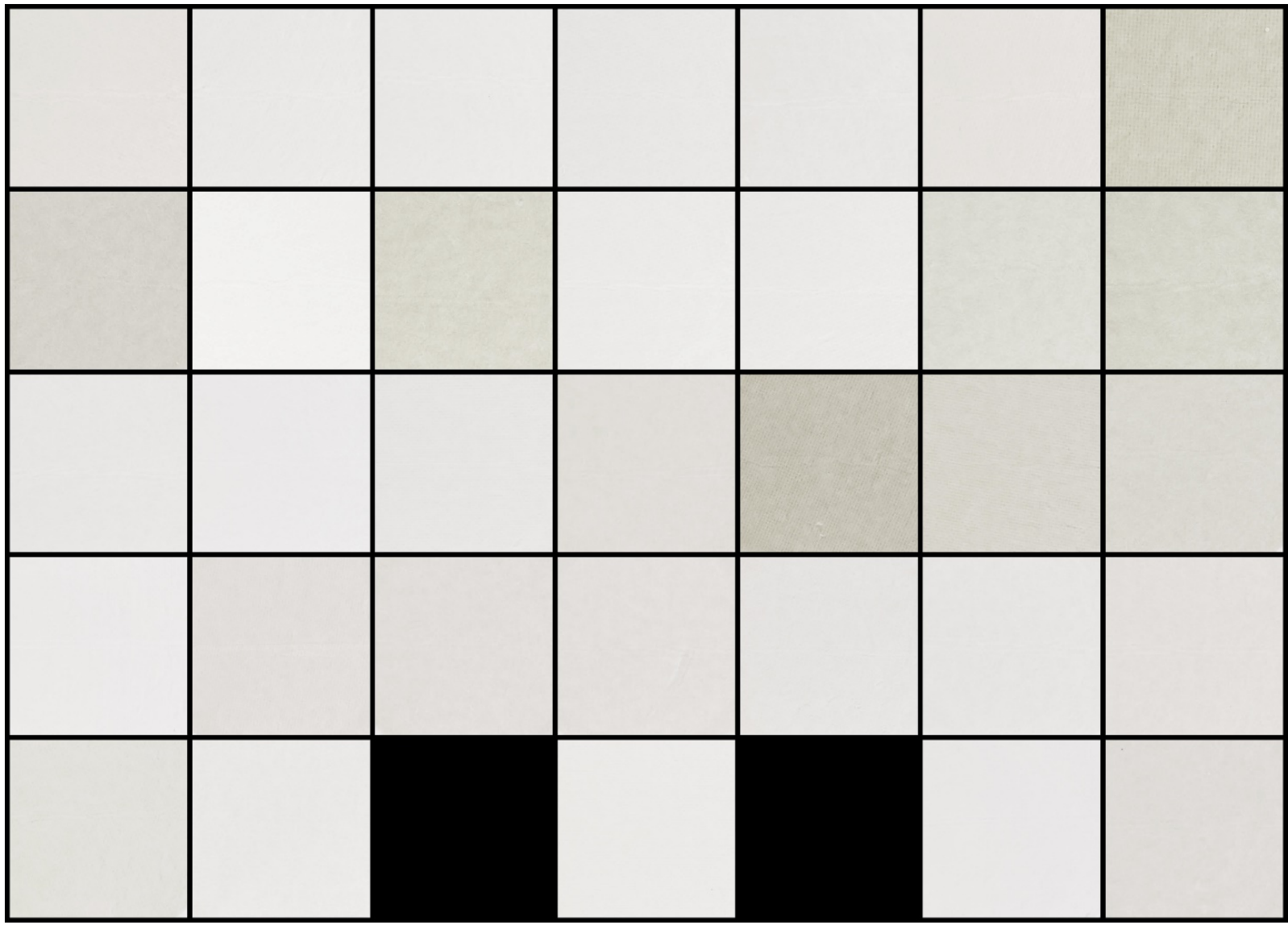
Equal mass (3 g) samples of infill collected from fields

Pre-installed reference crumb rubber material

Distribution of Atmospheric PM Conditions

- Color graded images of PM2.5 collected on glass fiber filters showing off-field condition at each location.
- Filters collected during three hour active period.
- Image below is an unused filter for reference





Distribution of Player Activity

- 74 different players recruited
- Approved human subjects protocol used
- Players participated 122 times (3.5 players per field)
- Experience range from “I used to play” to professional

Section 3.1.2
Particles in Air

Presenter: Woody Delp, Ph.D., LBNL

Preliminary Analysis of Airborne Particles at Synthetic Turf Fields

Woody Delp, Toshifumi Hotchi, Marion Russell, Hugo Destaillats

and Randy Maddalena

Lawrence Berkeley National Laboratory

Presentation for Scientific Advisory Meeting

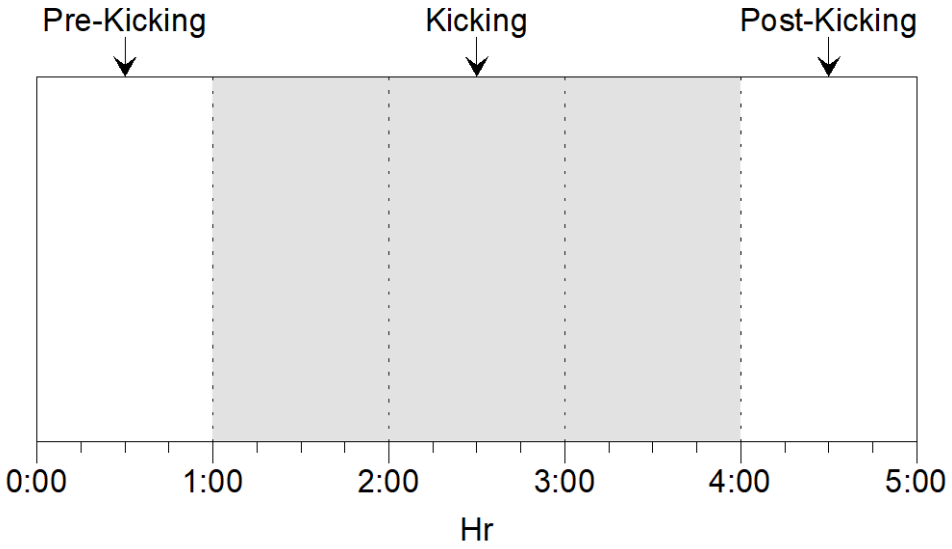
Sacramento, CA, May 25, 2018

Overview

- Define the Sampling Strategy
  - Temporal variability
  - Spatial variability
    - horizontal, vertical and between fields
- Particle Instruments (what did we measure)
- Initial Particle results
- Discussion

Temporal variability in air concentrations

Pre- and Post- are quiet periods with kicking in between



elapsed time during monitoring event

Temporal variability

Spatial variability in air concentrations

- Horizontal
- On vs. Off field
- Vertical

Particle sizing and counting equipment

TSI 3321 APS

- Aerodynamic Particle Sizer
- 52 channels 0.5 – 20 μm
- 1 min resolution
- On-field
- #/cm^3, and mg/m^3 (with assumed density)

MetOne BT637s

- Optical Particle Counter
- 6 channels 0.3 – 10 μm
- 1 min resolution
- On-field vertical profile
- #/L

Particle Mass Equipment

TSI 8530 DustTrak

Side scatter photometer
AZ road dust
2min resolution
On / Off –field
PM2.5, PM10

MetOne ES642, BT645

Forward scatter photometer
0.54 μm PSL
1 , 10 s resolution
On / Off –field
PM2.5

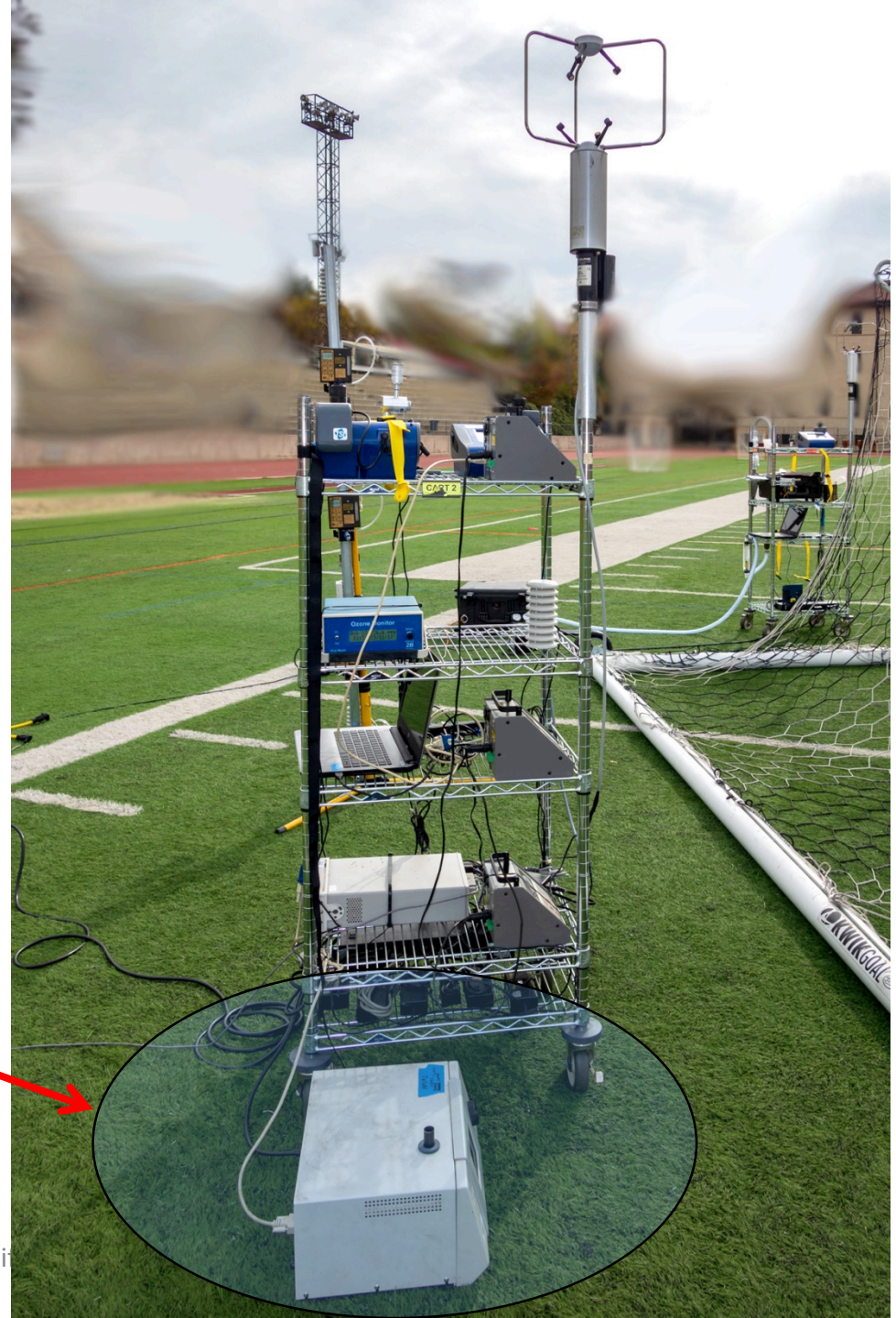
MSP Model 200 PEM

Gravimetric
10 lpm, 37 mm filter
3 hr sample
On / Off –field
PM2.5

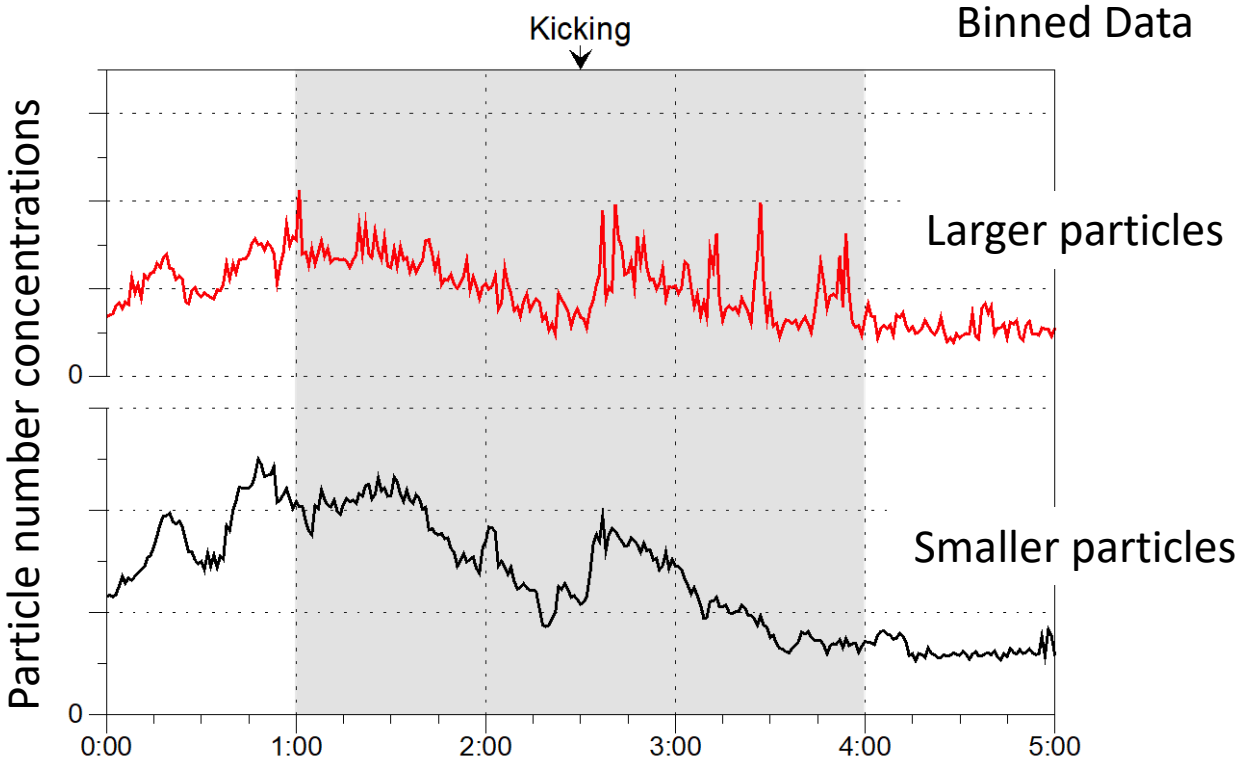
Assessing temporal variation in particle number concentrations and particle size distributions

TSI 3321 APS

Aerodynamic Particle Sizer
Provides very wide and continuous measurement range at single location



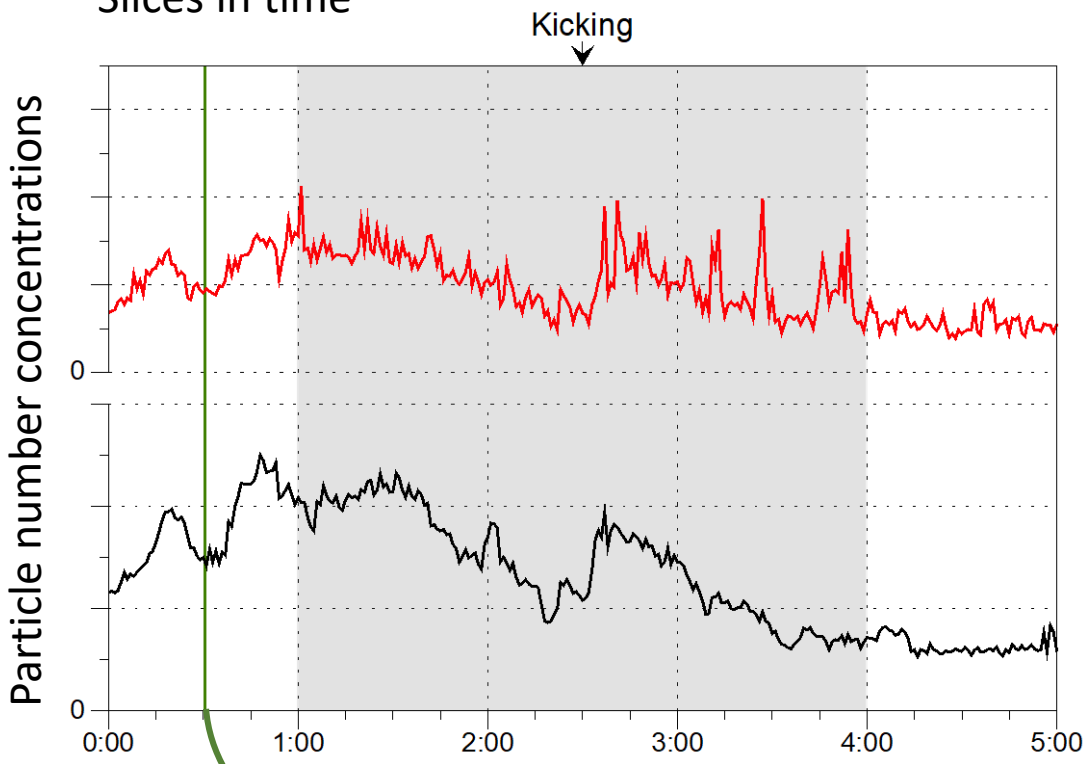
Temporal trend of on-field particle counts



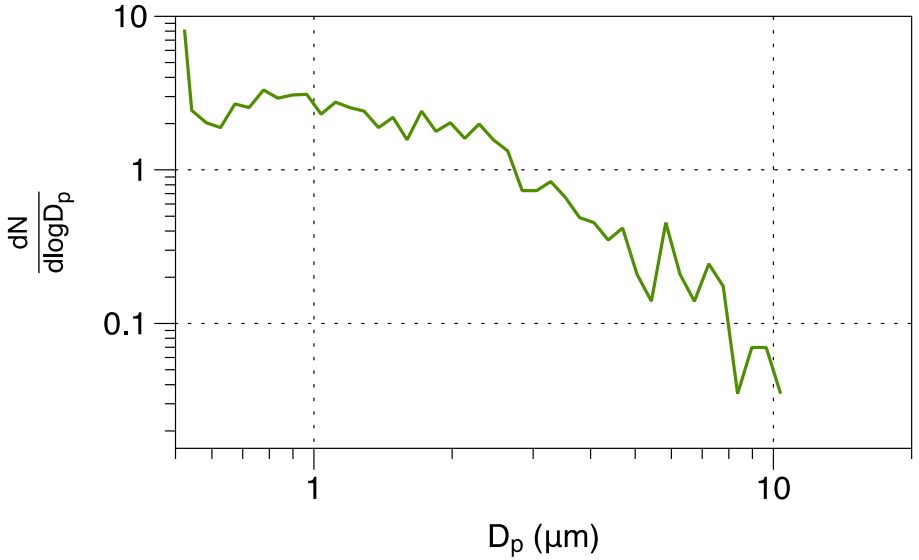
Measured with APS instrument installed at Cart 2 location with inlet at 9 inches above turf surface

APS – normalized particle size distribution

Slices in time

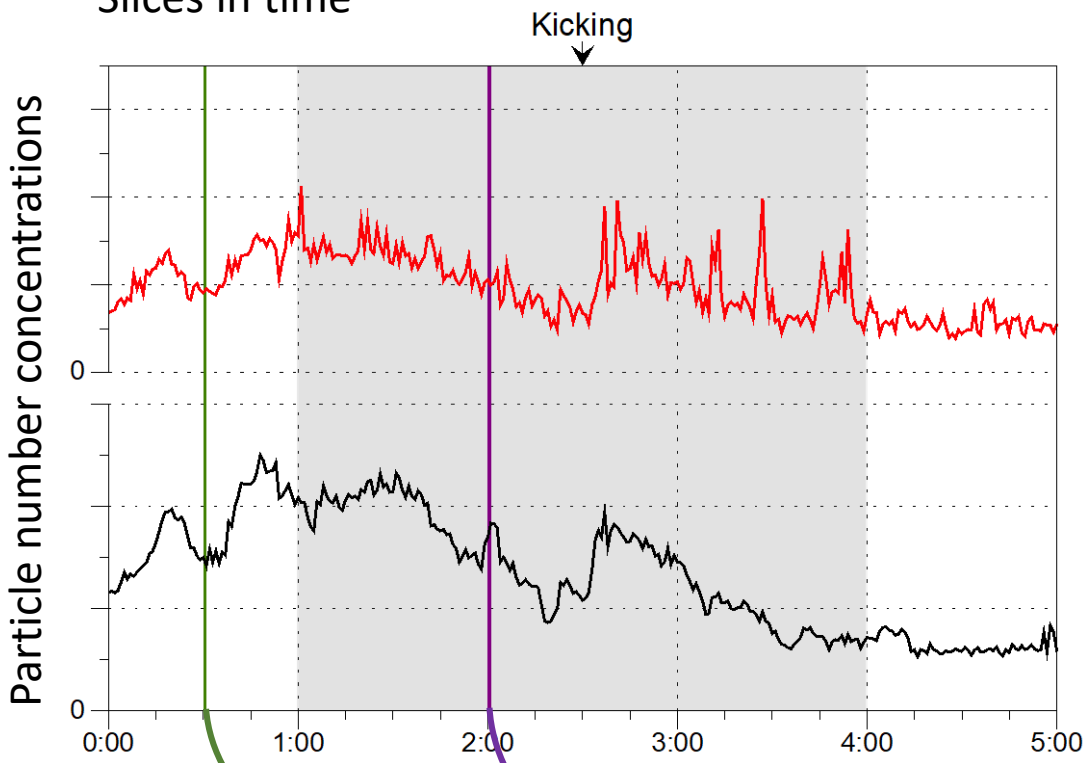


Particle size distribution measured using all 52 channels at time point indicated in figure to left

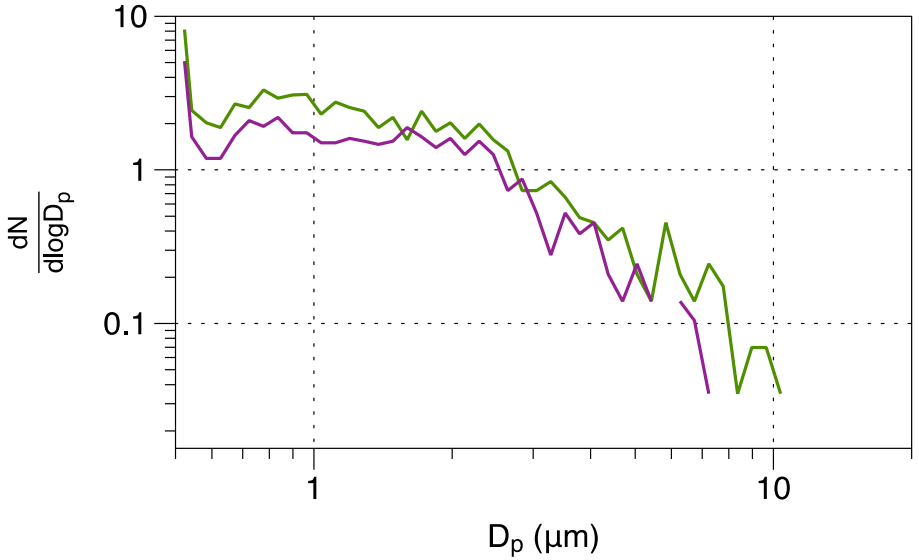


APS – normalized particle size distribution

Slices in time

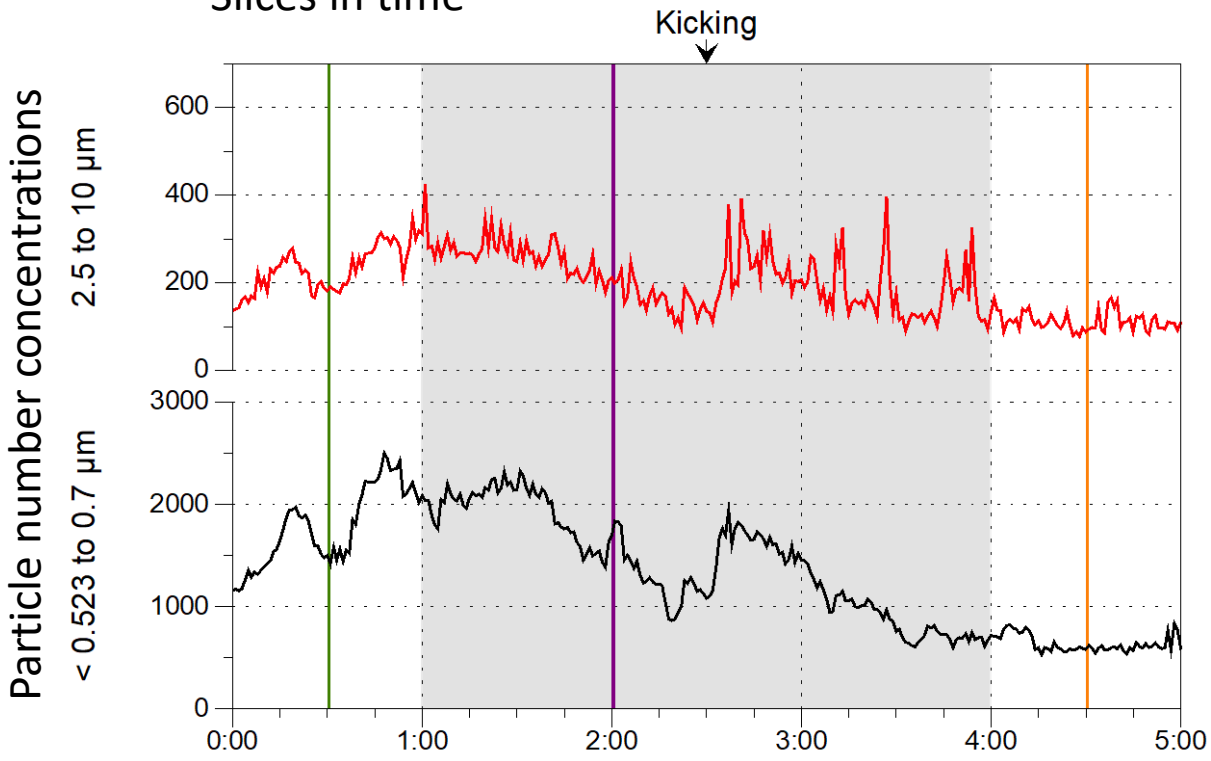


Particle size distribution measured using all 52 channels at time point indicated in figure to left

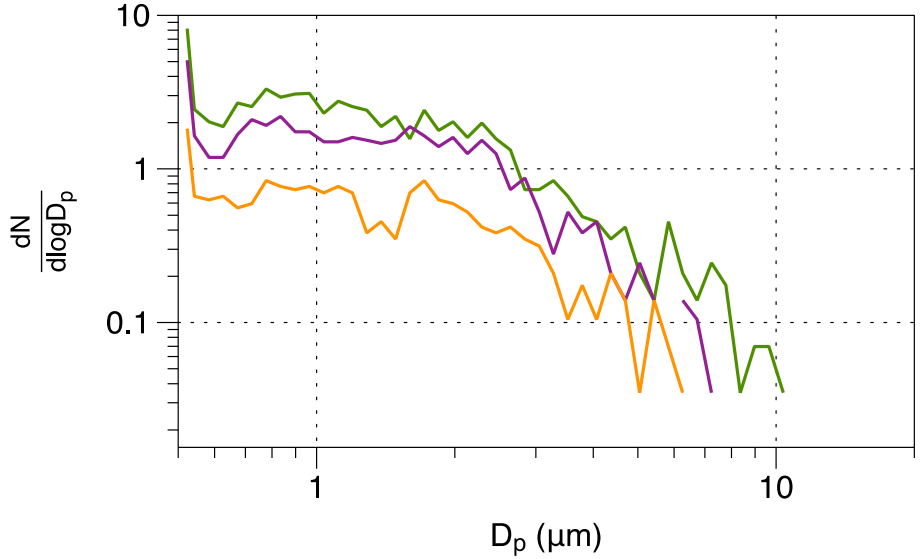


APS – normalized particle size distribution

Slices in time

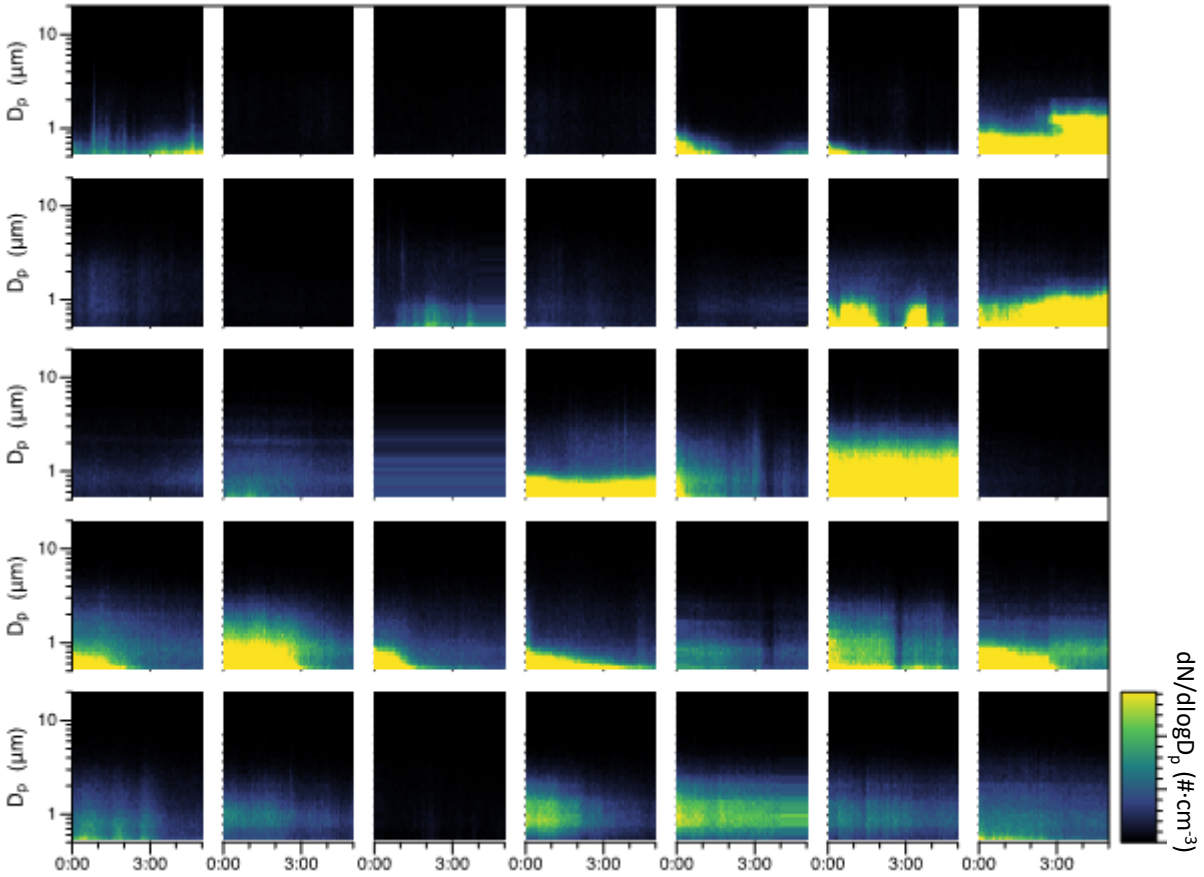


Particle size distribution measured using all 52 channels at time point indicated in figure to left

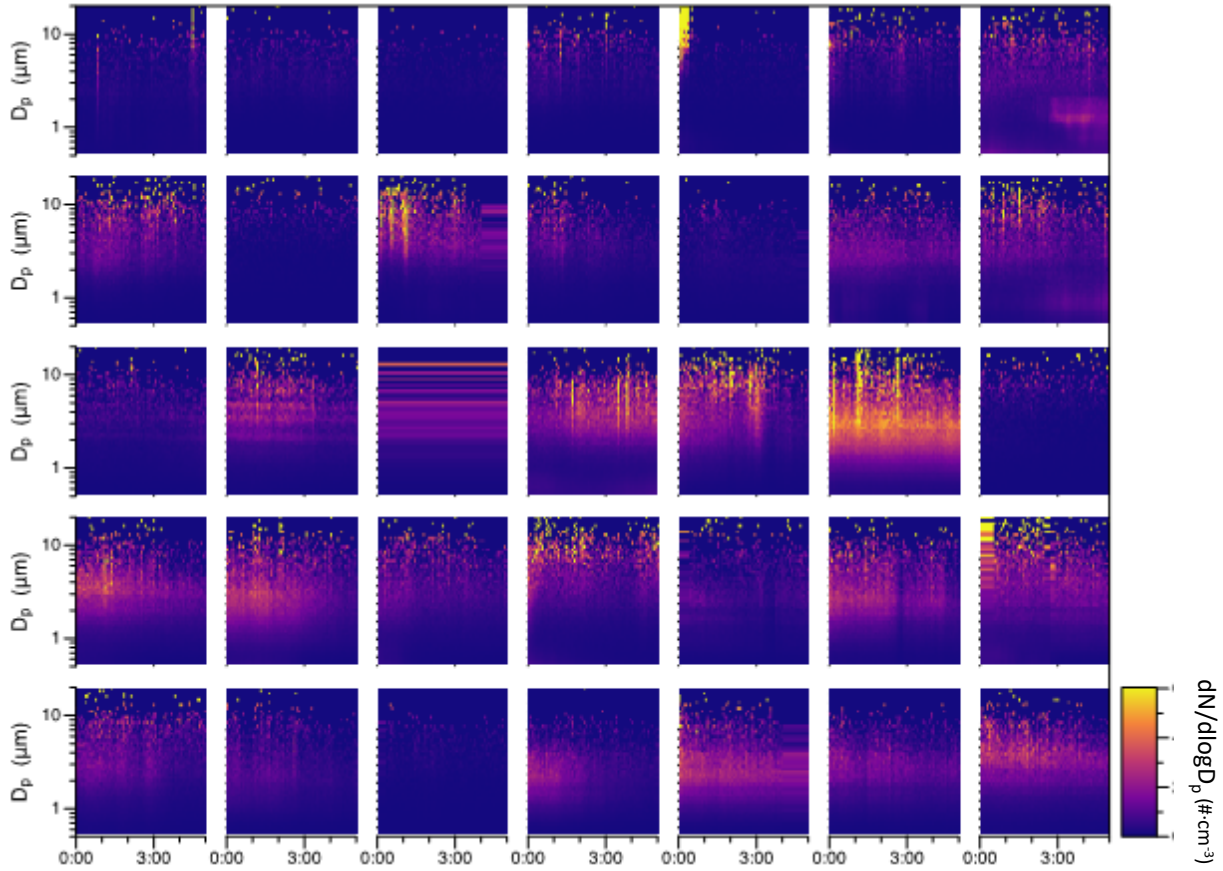


APS – normalized particle distribution

Across all fields



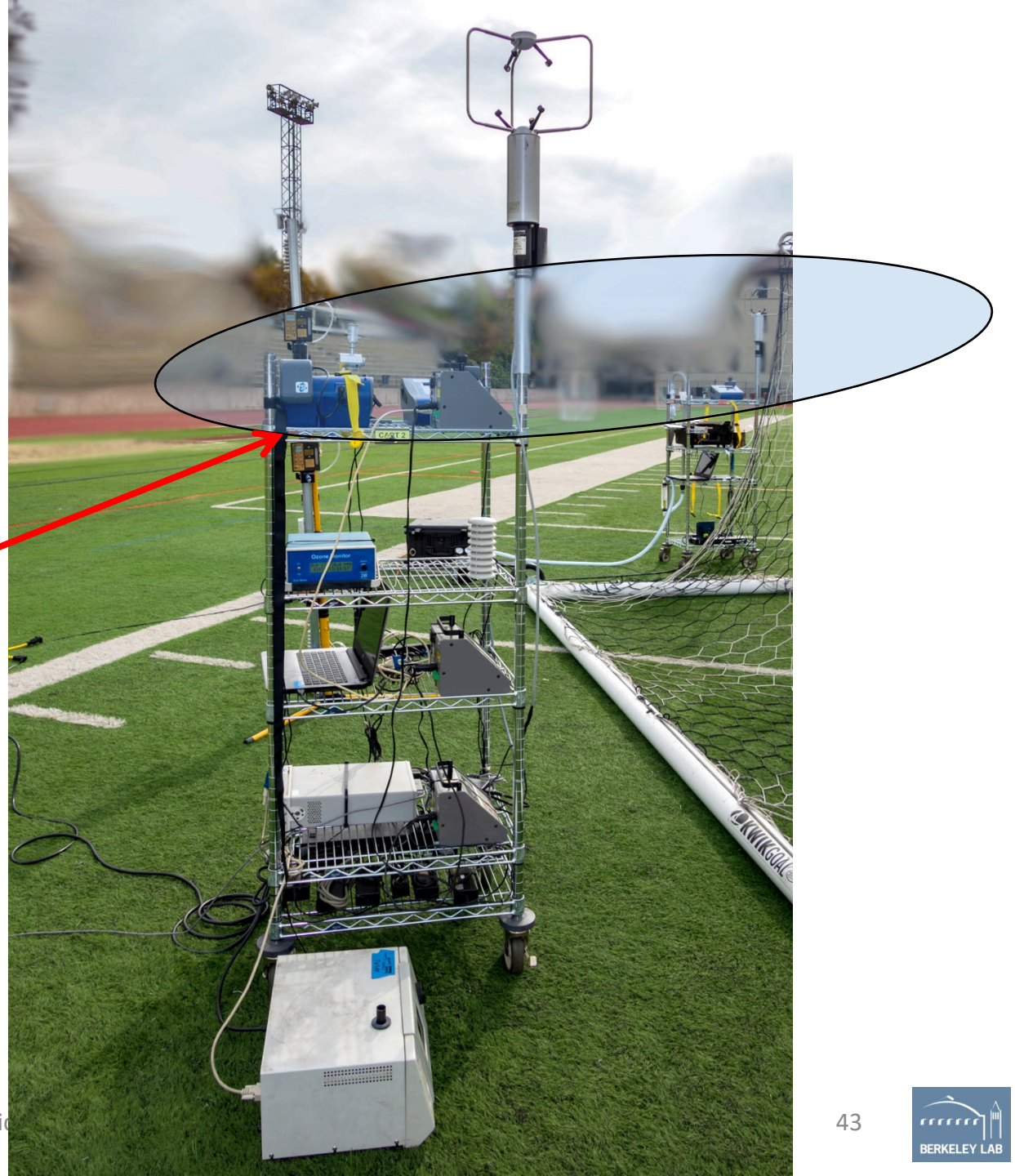
Number

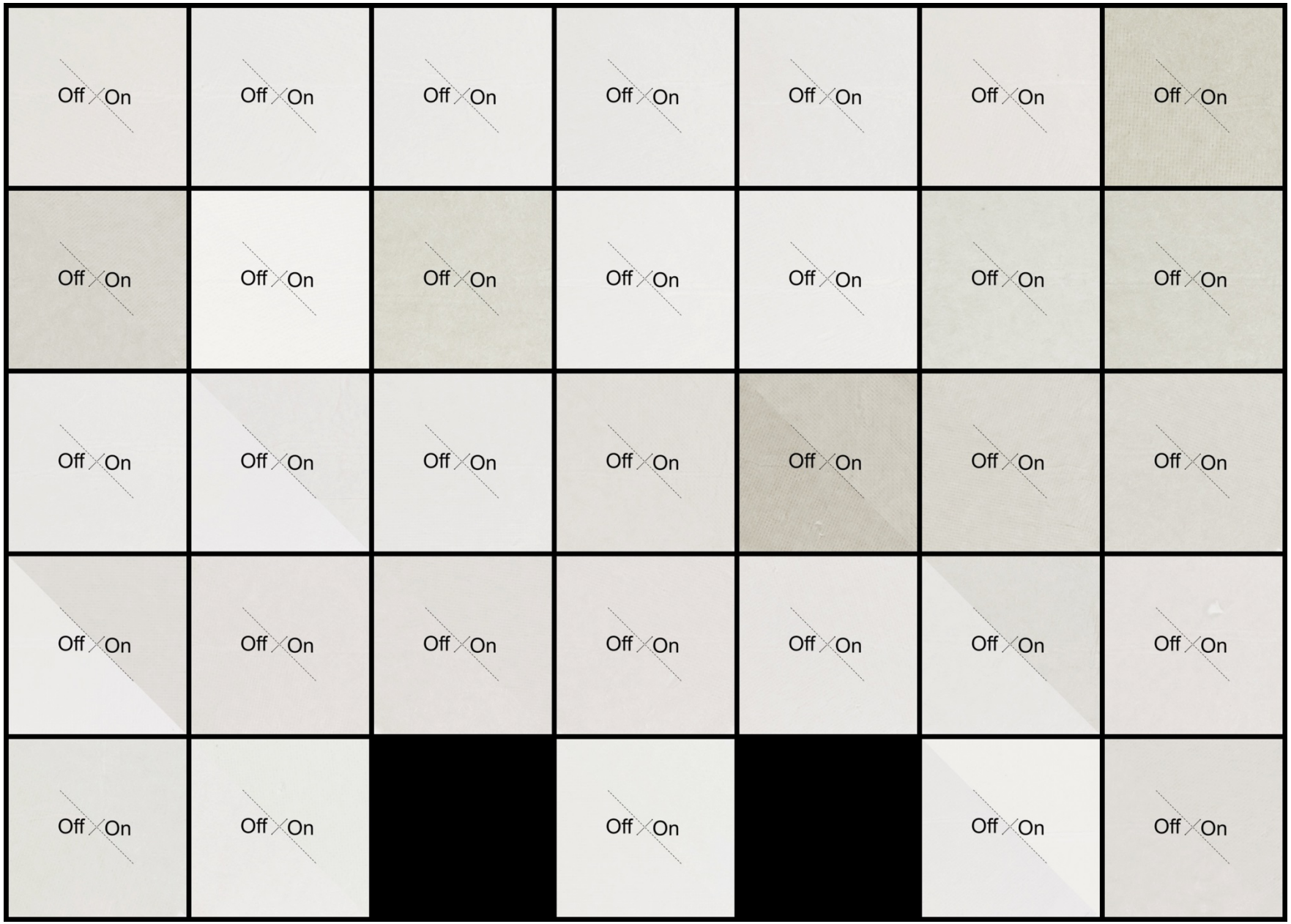


Mass

Spatial variability in particle mass concentration (PM2.5) measured on and off field and across different fields

PM measurements on / off field





PEMs

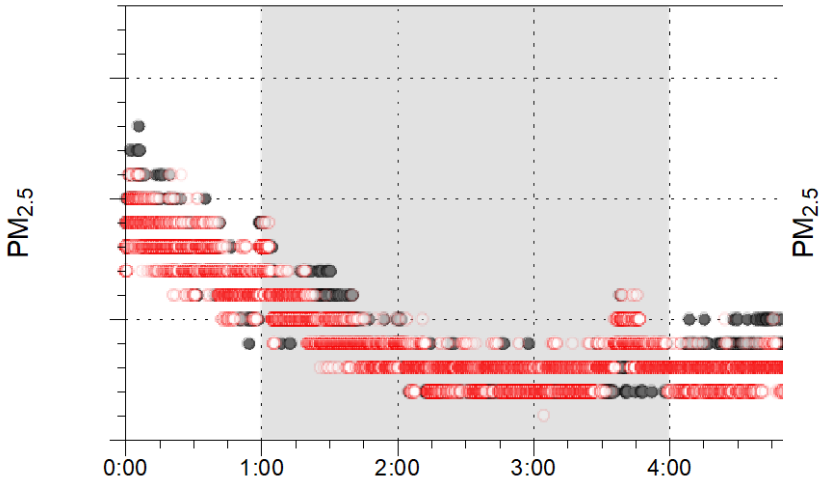
(3hr sample)

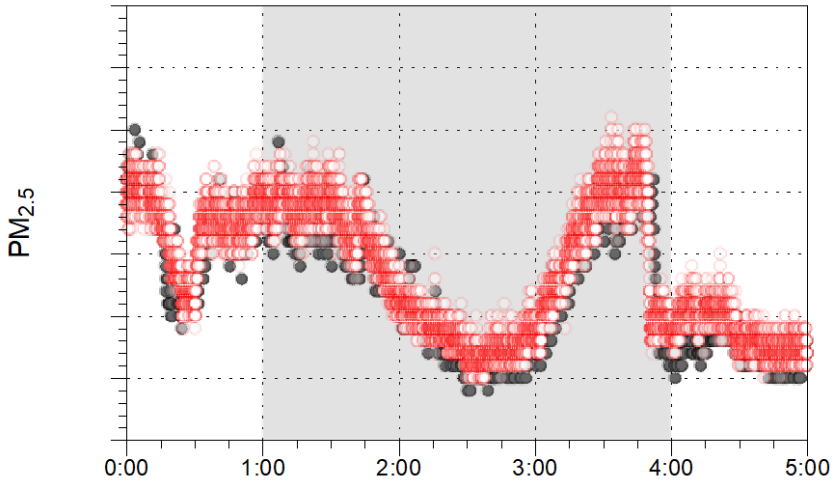
$PM_{2.5}$

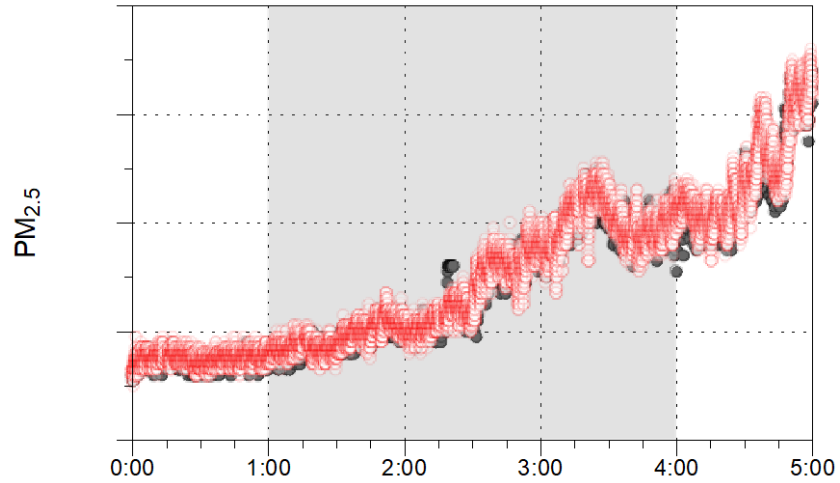
All fields

Three example fields

MetOne Photometers





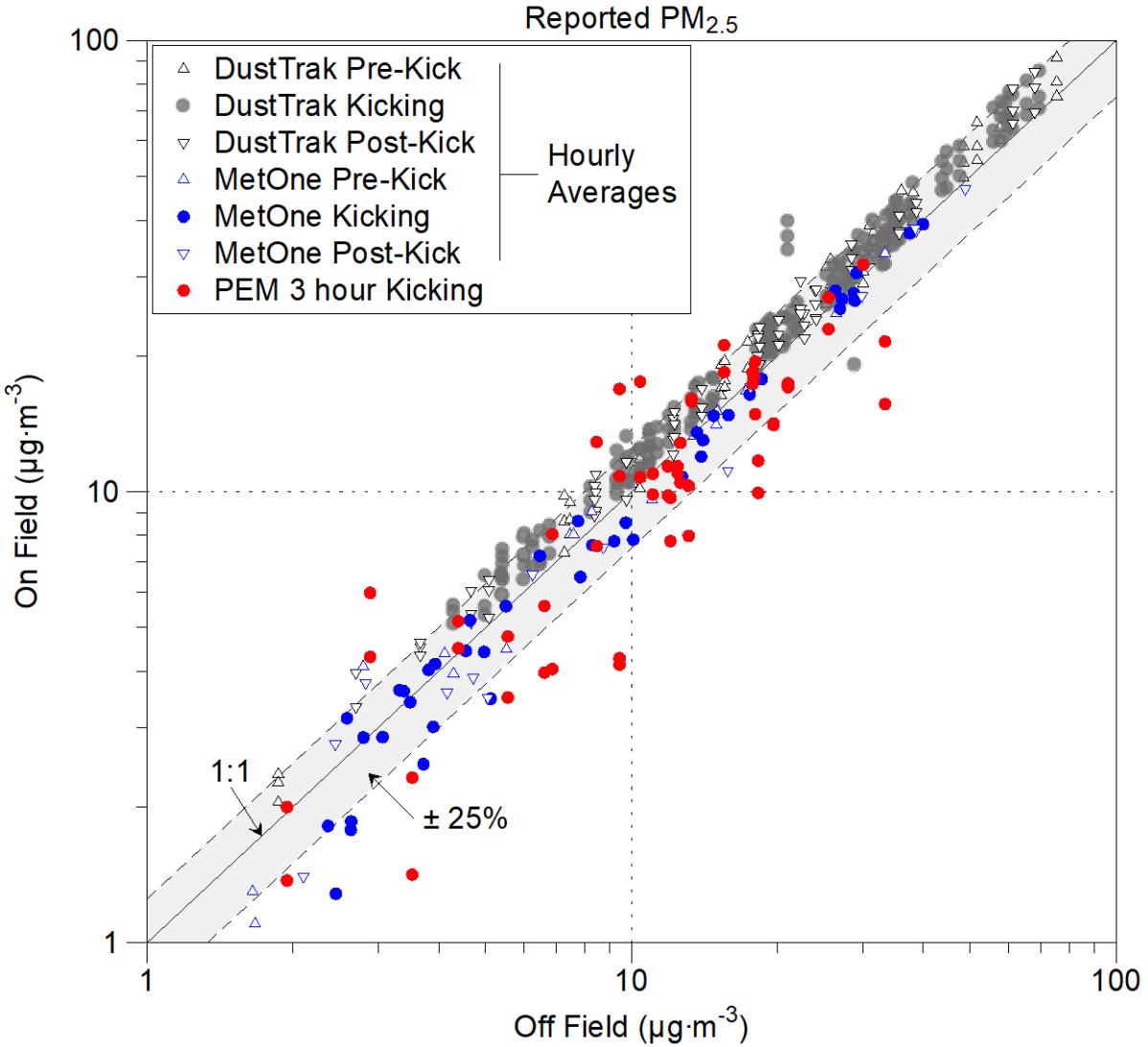


On Field Off Field

Scales are different
Measurement inlets at 60 inches

Off- vs On-field $PM_{2.5}$

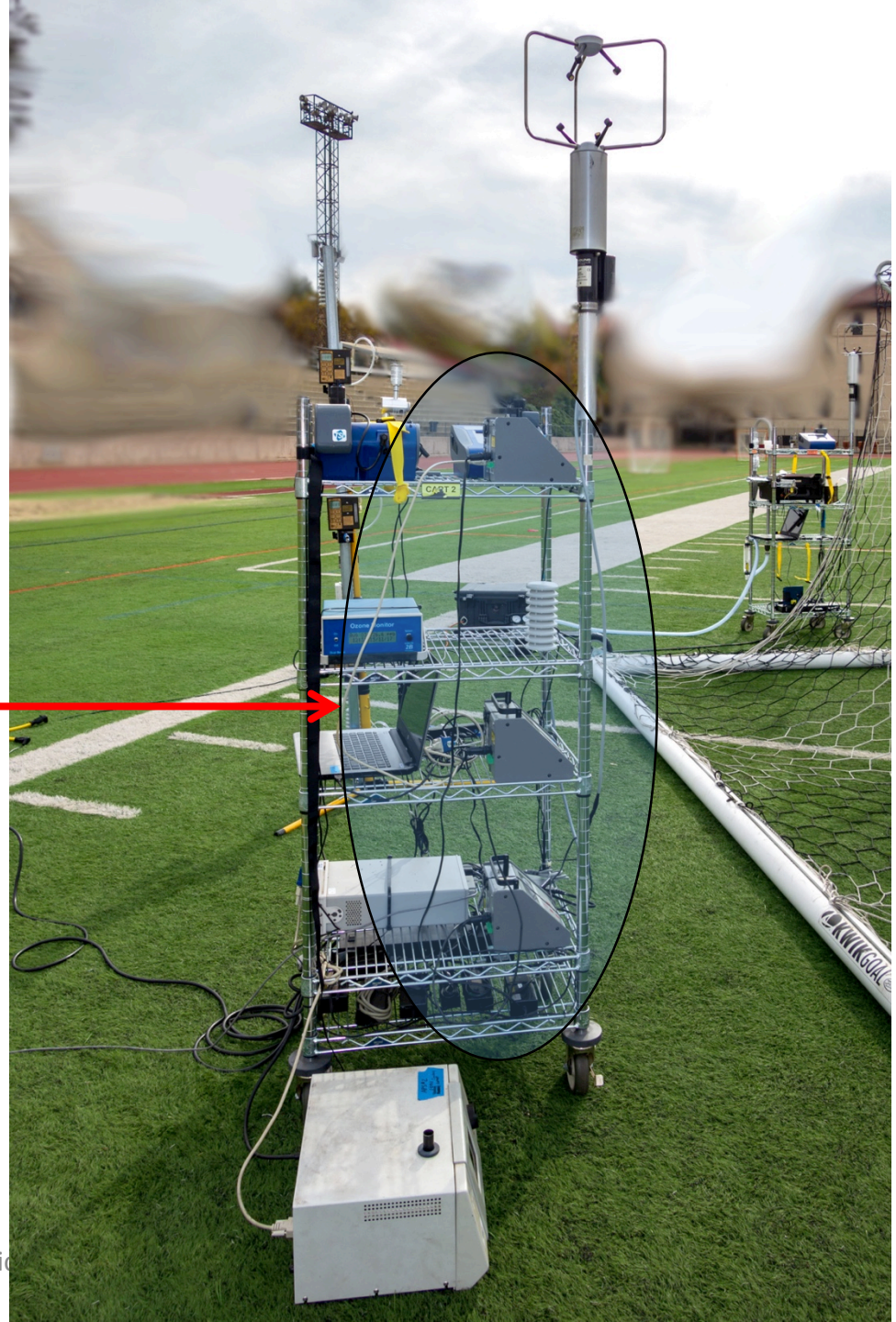
- DustTrak PM2.5 somewhat higher off-field
- Less so with the other measurement devices

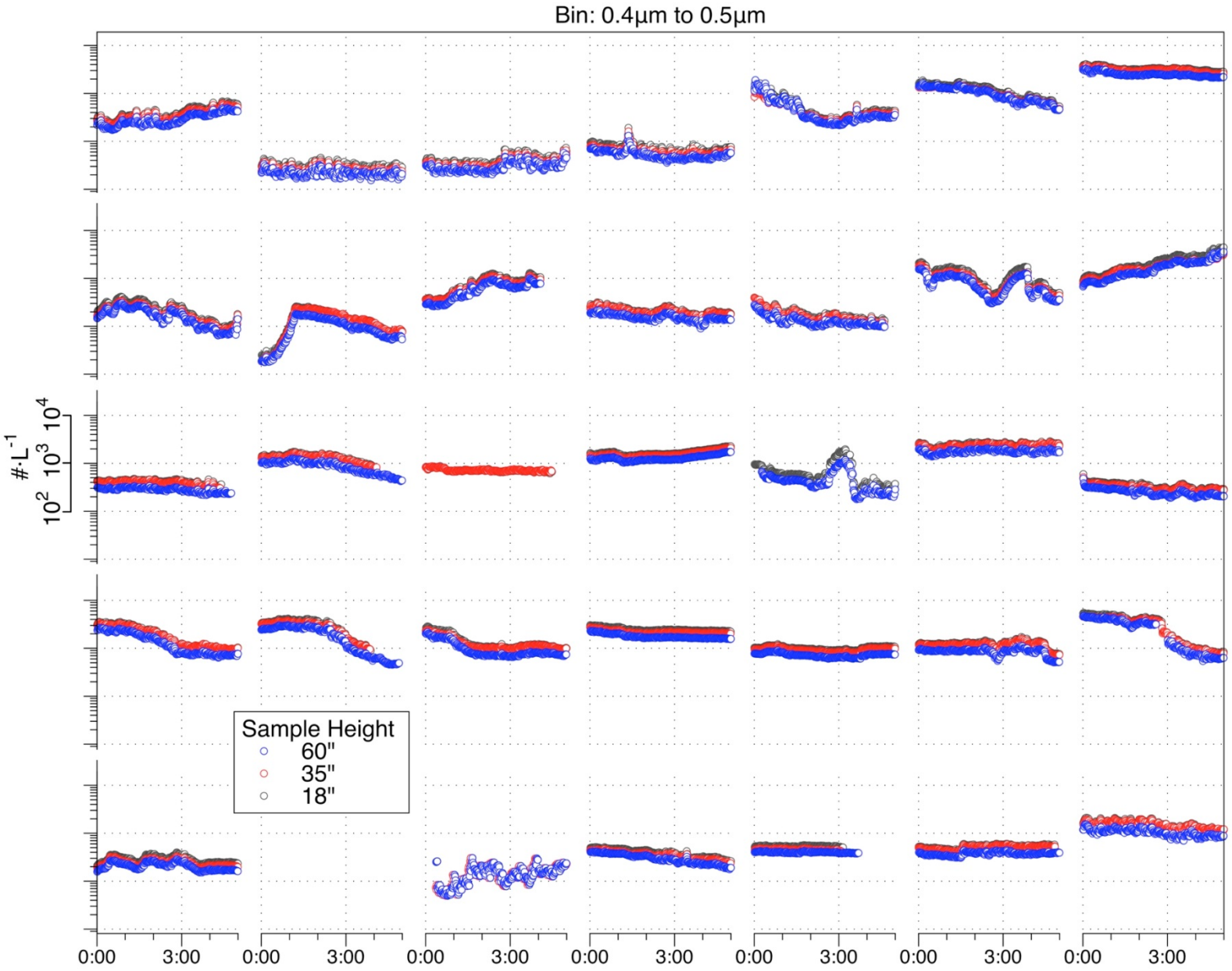


Particle counter and particle sizers instruments

MetOne BT637s

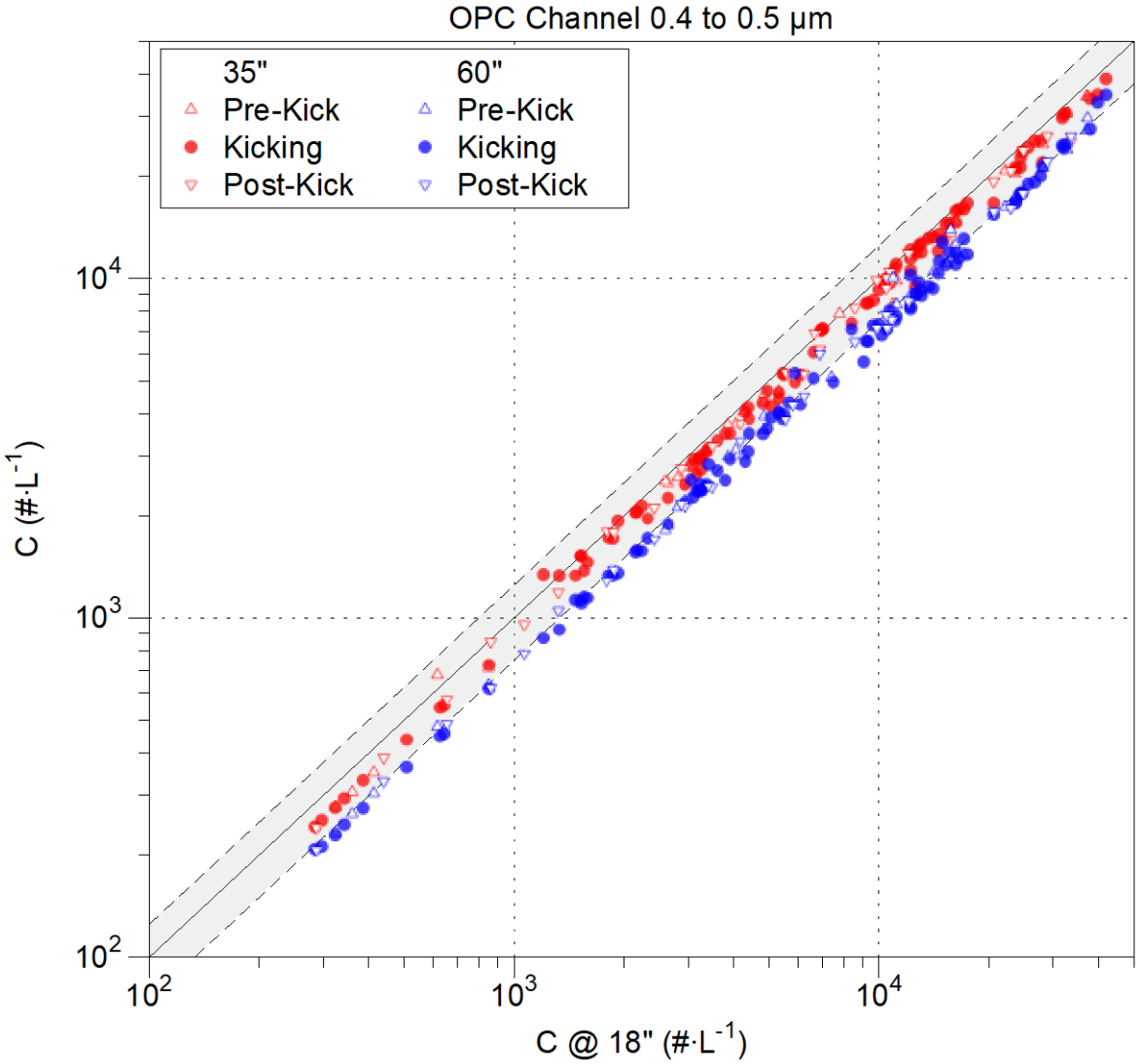
Optical Particle Counters with inlets mounted at
60 inches
35 inches and
18 inches above field surface





Single channel at different heights

All fields

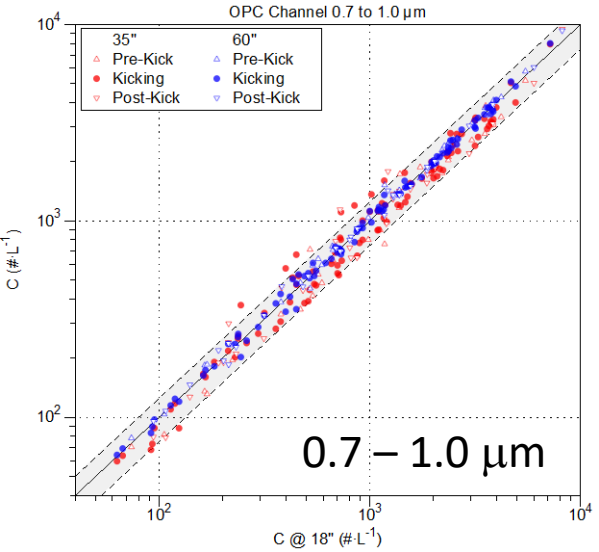


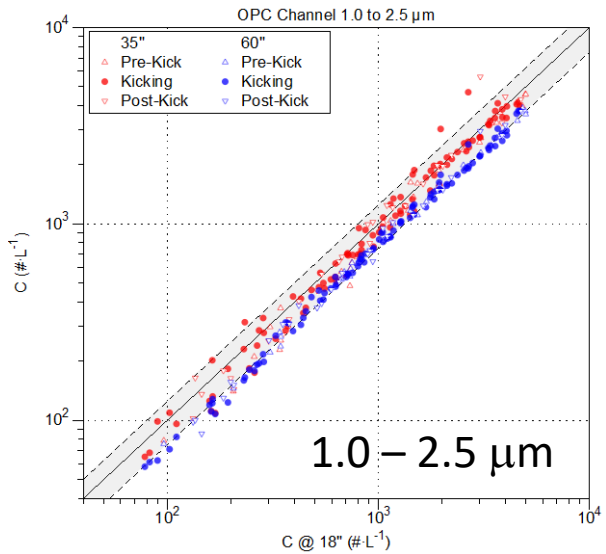
(hourly averaged values)

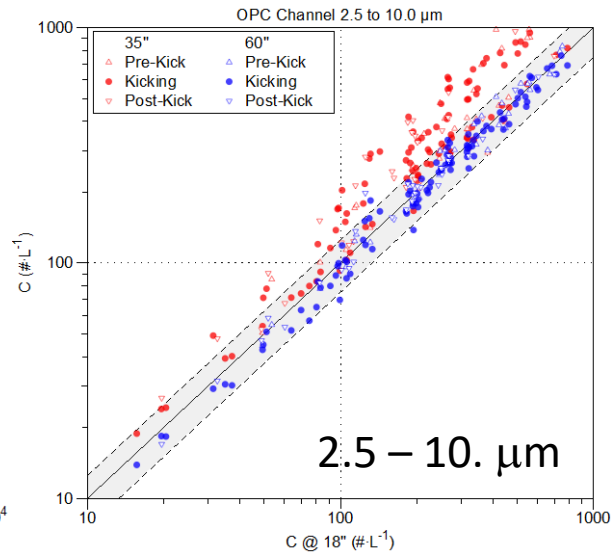
OPC

Single channel at different heights

- Apparent Vertical Gradient

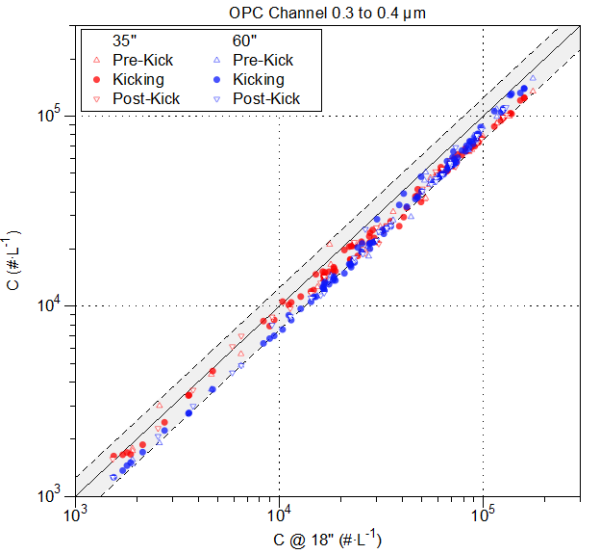


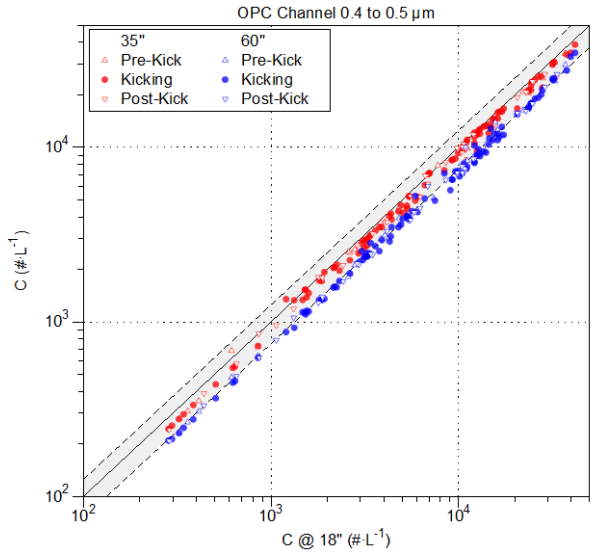


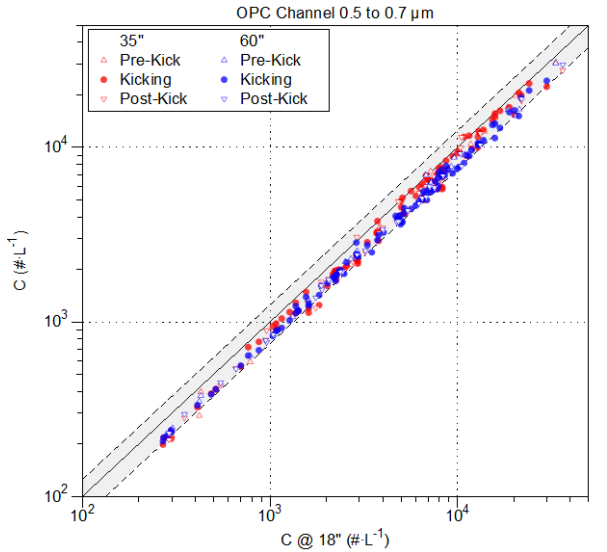


OPC

All channels





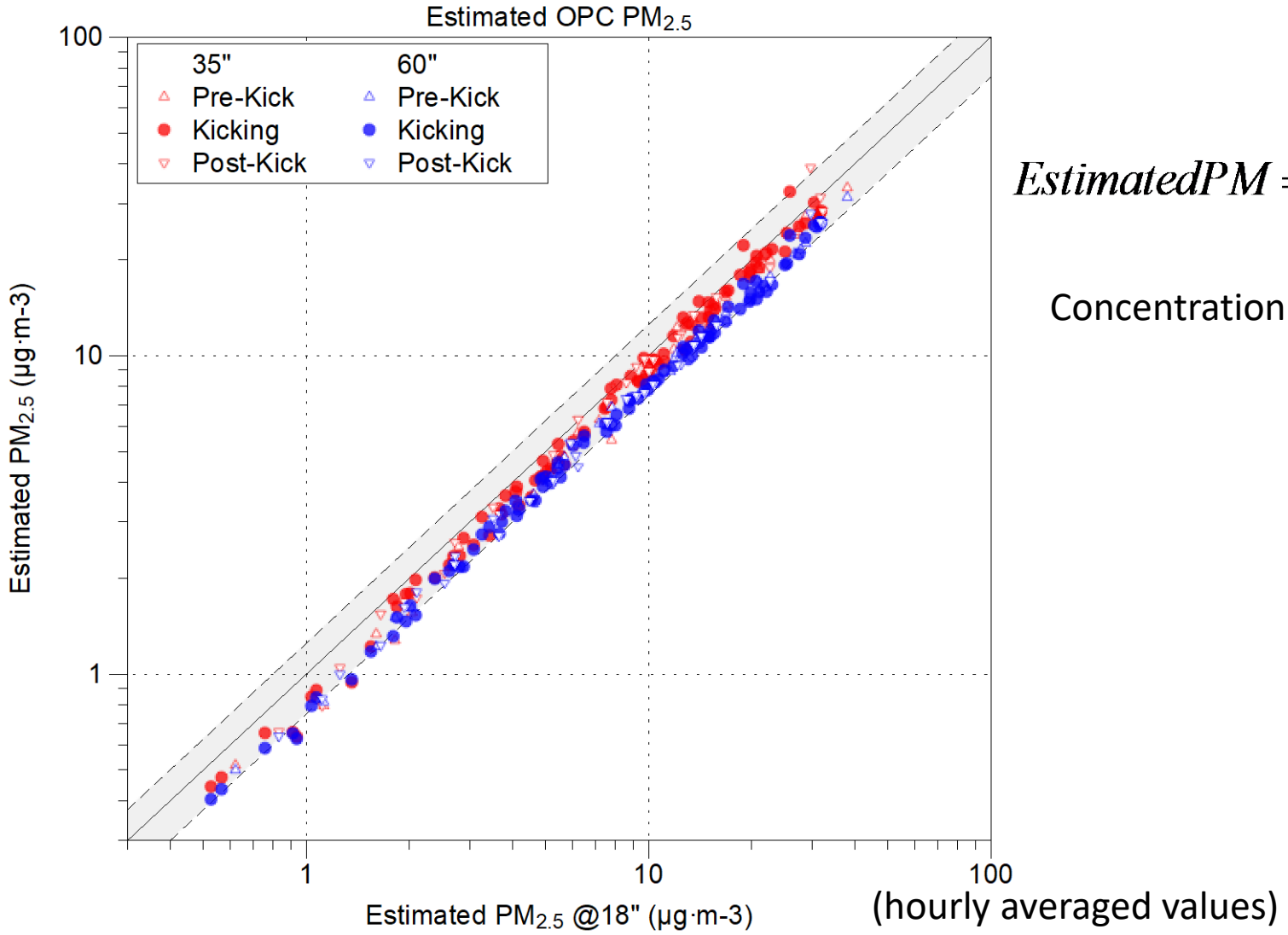


- Apparent Vertical Gradient
  - Smaller channels only?

(hourly averaged values)

x.x – y.y µm Channel (bin) boundaries

Estimated $PM_{2.5}$



(hourly averaged values)

OPC

All channels

$$EstimatedPM = \sum_i \rho C_i V_i$$

Concentration in bin

Volume of single particle in bin

- Apparent Vertical Gradient

We clearly are moving stuff around, but airborne?

Discussion

1. Do you have any comments on the field-sampling portion of the study? Do you have any comments on the descriptions provided in the meeting materials?

2. Given the sample size and the range of environmental/physical factors captured in the study, do you have recommendations for specific ways to aggregate the data set for illustrating field conditions?

3. For the purpose of evaluating exposure to particles on field, does the panel have recommendations for determining particle data as being associated with on-field environment versus background environment?

Section 3.1.4
Preliminary Metal Data of Crumb Rubber

Presenter: Hugo Destaillats, Ph.D., LBNL

Preliminary Elemental Composition of Crumb Rubber

Hugo Destaillats[1], Jocelyn Claude[2], Wenming Dong[1], Marion Russell[1,]
Sharon Chen[1], Jin Pan[1], Rebecca Belloso[2],
Toshifumi Hotchi[1], Woody Delp[1], Patty Wong[2] and Randy Maddalena[1]

1. Lawrence Berkeley National Laboratory
2. OEHHA, CalEPA

Presentation for Scientific Advisory Meeting

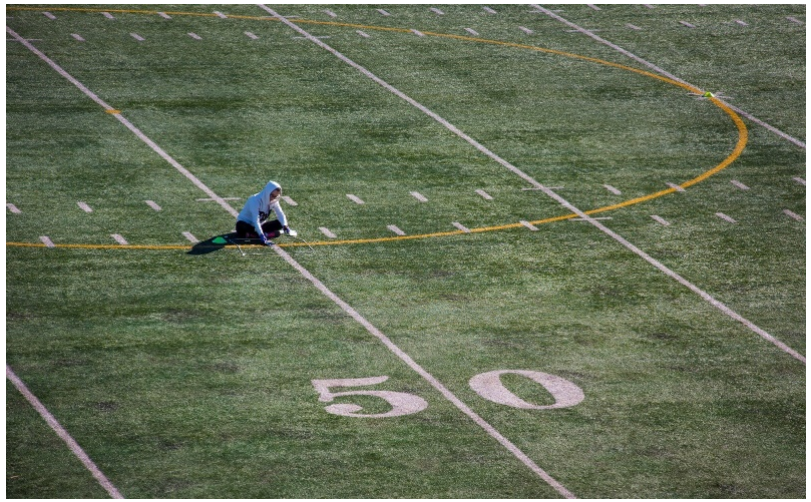
Sacramento, CA, May 25, 2018

Overview

- Sample collection and handling
- Methods used for metal extraction and analysis
  - EPA 3051A: “total” acid digestion
  - ASTM F3188-16: acidic conditions simulating gastric fluids
  - LBNL/OEHHA method using biofluid surrogates (oral pathway, fasting)
- Results corresponding to 19% of samples
- Discussion, perspectives and next steps

Sample collection and handling

- Ten different locations were identified on each field
- A 1-m^2 area marked with indicator
- Infill material collected with pre-cleaned plastic scoops, onto 120 mL polyethylene bottles
- Stored in staging area until end of sampling, then transported to LBNL



Sample processing at LBNL

- Received ten 120-mL samples containing crumb rubber from each field (total: 403 samples), in polyethylene bottles
- Stored in the dark at room T and RH
- Shook bottle to ensure adequate mixing before separating ~3g fractions using clean plastic scoop
- Labeled with blind codes and sent for ICPMS analysis (ELAN®, Perkin Elmer)

Analytical methods for inorganics in crumb rubber

1. Total digestion (EPA 3051A):
   - Characterize "total" inorganic content in crumb rubber
   - Data for calculating oral bioaccessibility of inorganics
2. Gastric digestion (ASTM F3188-16):
   - "*relates to the amount of certain metals that have the potential to be extracted from synthetic turf infill materials if ingested*"
   - Data for calculating oral bioaccessibility of inorganics
3. LBNL/OEHHA biofluid extraction (presented in SAP 2017)
   - Biofluids from literature, which are commonly used in pharmaceutical testing
   - Simulate physiological conditions
   - Data for calculating oral bioaccessibility of inorganics

EPA 3051A Method (total digestion)

- Microwave assisted acid digestion
- 0.2 g of sample dissolved in 9 mL concentrated HNO_3 + 3 mL concentrated HCl
- Heated to 175 ^oC in 5.5 min, digested during 10 min
- Cooled overnight, filtered and diluted to volume
- Dilution factor: 5000 for Zn; 20 for other elements
- Hg was analyzed separately by ICPMS after Au standard solution (in 2% HNO_3) was added, to reach a concentration of 200 ppb Au.

ASTM F3188-16 Method

- Specific for extractable metals in synthetic turf infill materials if ingested
- Extraction time, T and pH simulate digestive process
- 0.2 g of sample added to 10 mL 0.08 M HCl, then 2 M HCl was added to reach pH 1 – 1.5
- Shaken for 1 h at 37 ^{o}C, then stood for 1 h at 37 ^{o}C
- Extracts were filtered and diluted (factor: 10)
- Hg was analyzed separately by ICPMS after Au standard solution (in 2% HNO_3) was added, to reach a concentration of 200 ppb Au.

LBNL/OEHHA Method

- Simulated biofluids from saliva, gastric fluid and intestinal fluids
- 0.5 g of sample added to 5 mL artificial saliva buffer; incubated at 37 ^{o}C for 5 min
- Added 20 mL simulated fasted gastric fluid; incubated 2 h at 37 ^{o}C with shaking
- Added 20 mL simulated fasted intestinal fluid; incubated 18 h at 37 ^{o}C with shaking
- Filtrated extract, analyzed by ICPMS (Hg analyzed separately)

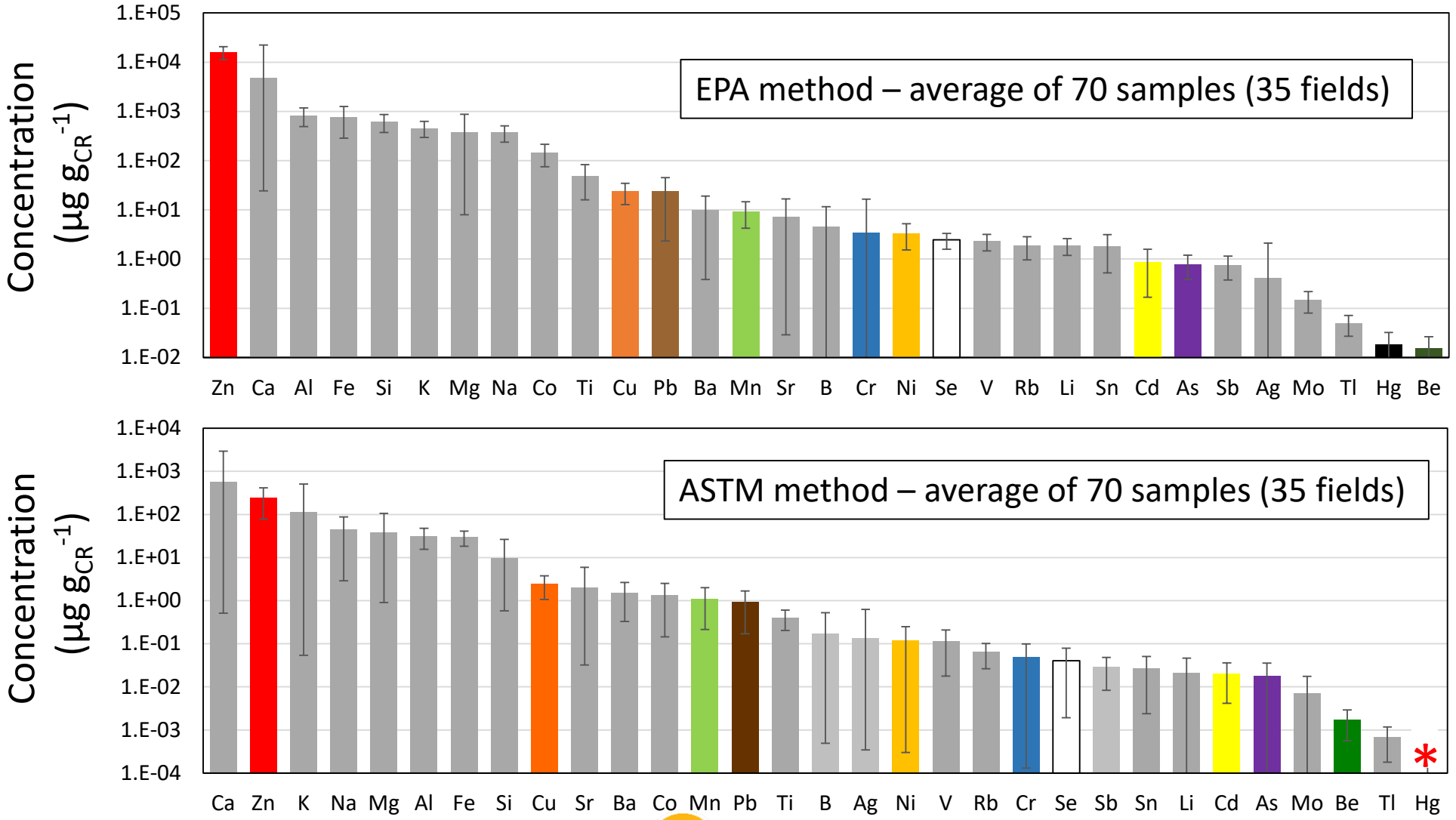
Status of analysis to date

- Total field samples collected for metal analyses: **403 samples**
- Samples of pre-installed crumb rubber from **4 manufacturers**

Number of fields or manufacturers	Number of samples per field or per manufacturer	Number of analyses (EPA & ASTM method)
3	10 out of 10	30
4	3 out of 10	12
3	1 out of 10 (duplicate analysis)	6
25	1 out of 10 (single analysis)	25
4	1 from each manufacturer	4
35 fields + 4 manufacturers	**TOTAL**	**77**

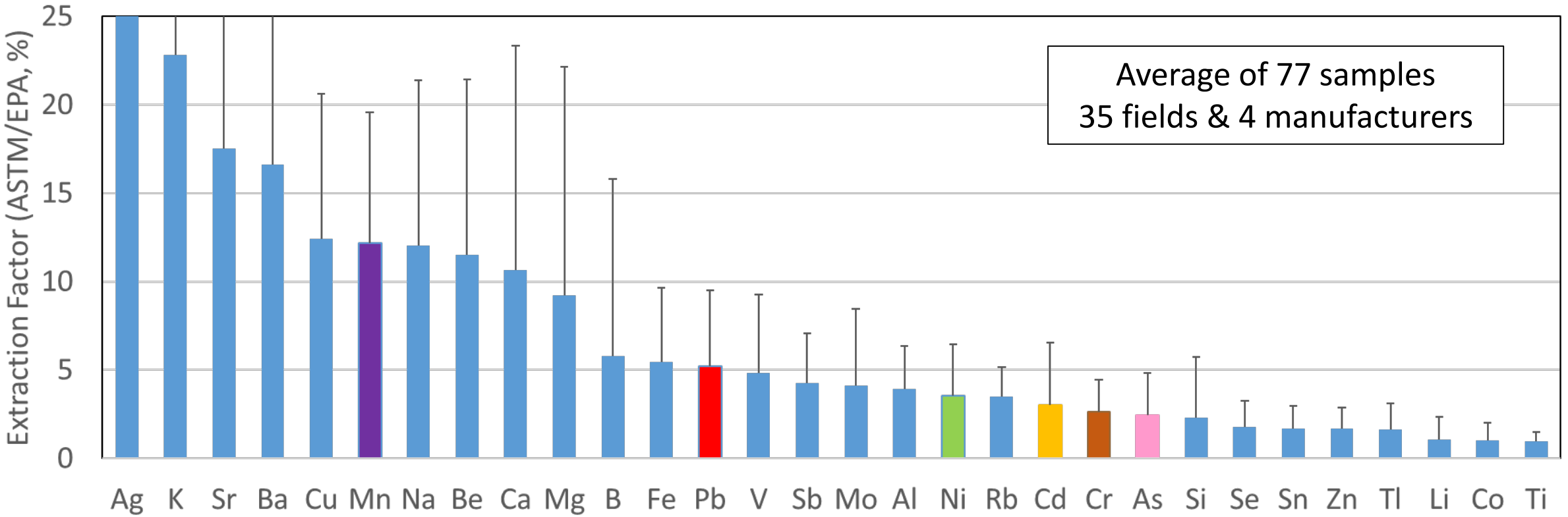
19%

Average concentration in crumb rubber

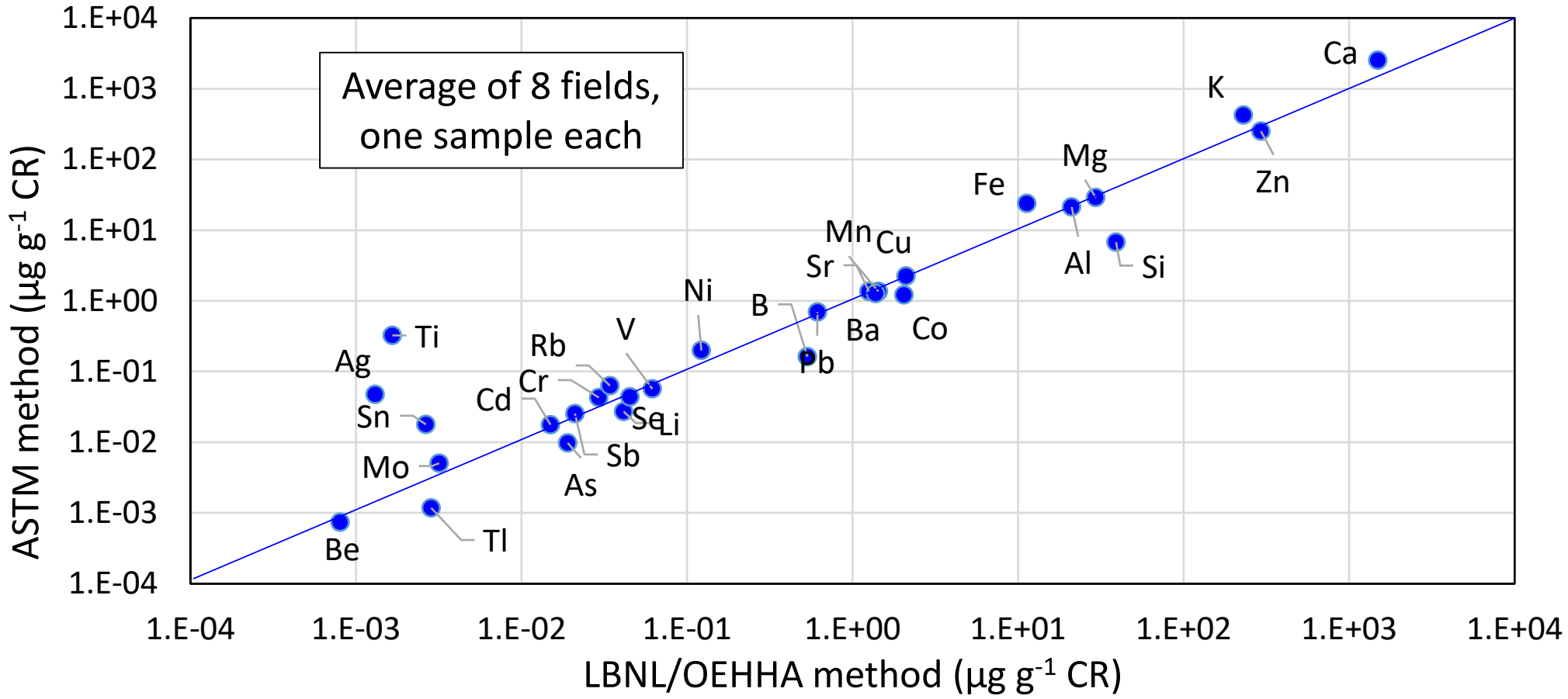


Comparing ASTM and EPA methods

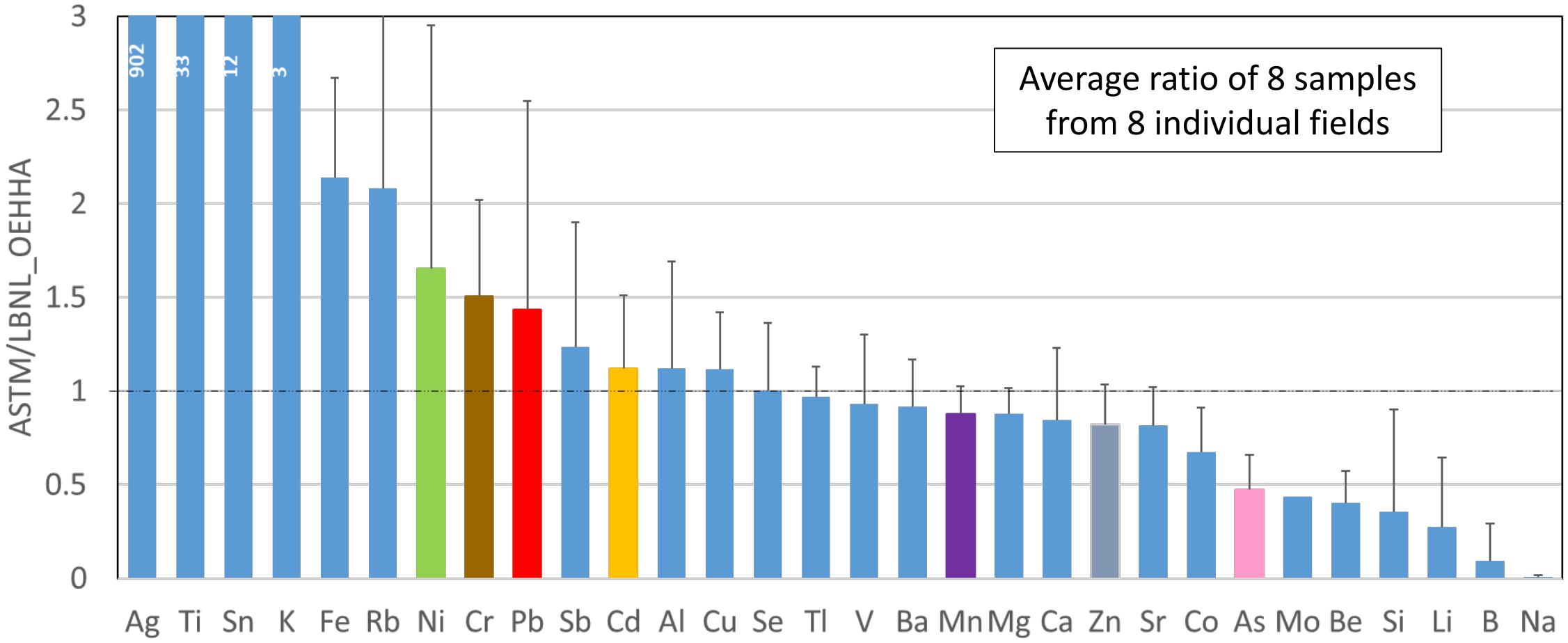
$$\text{Extraction Factor} = \frac{\text{Concentration (ASTM method)}}{\text{Concentration (EPA method)}} \times 100\%$$



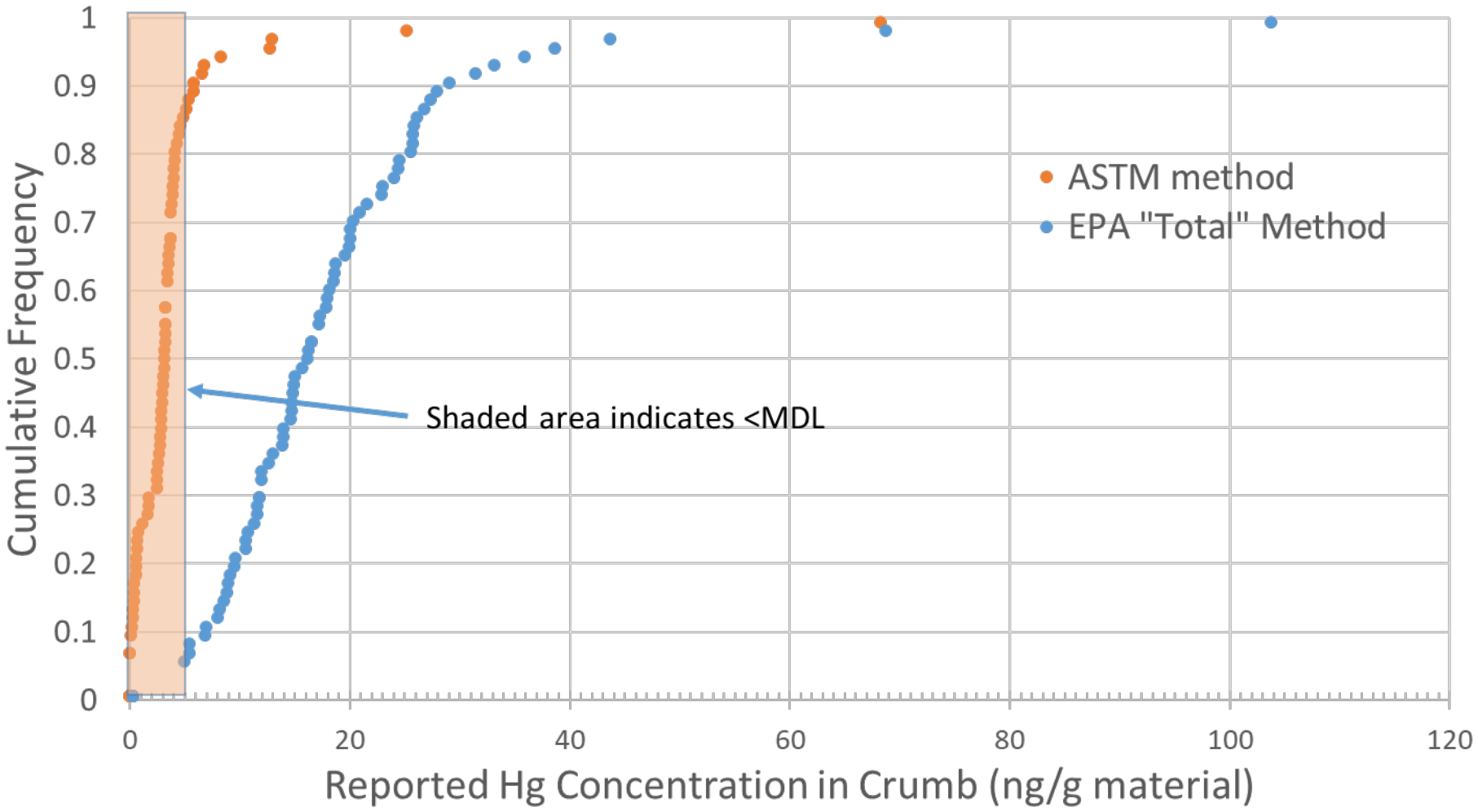
Comparing ASTM and LBNL/OEHHA method (1 of 2)



Comparing ASTM and LBNL/OEHHA method (1 of 2)



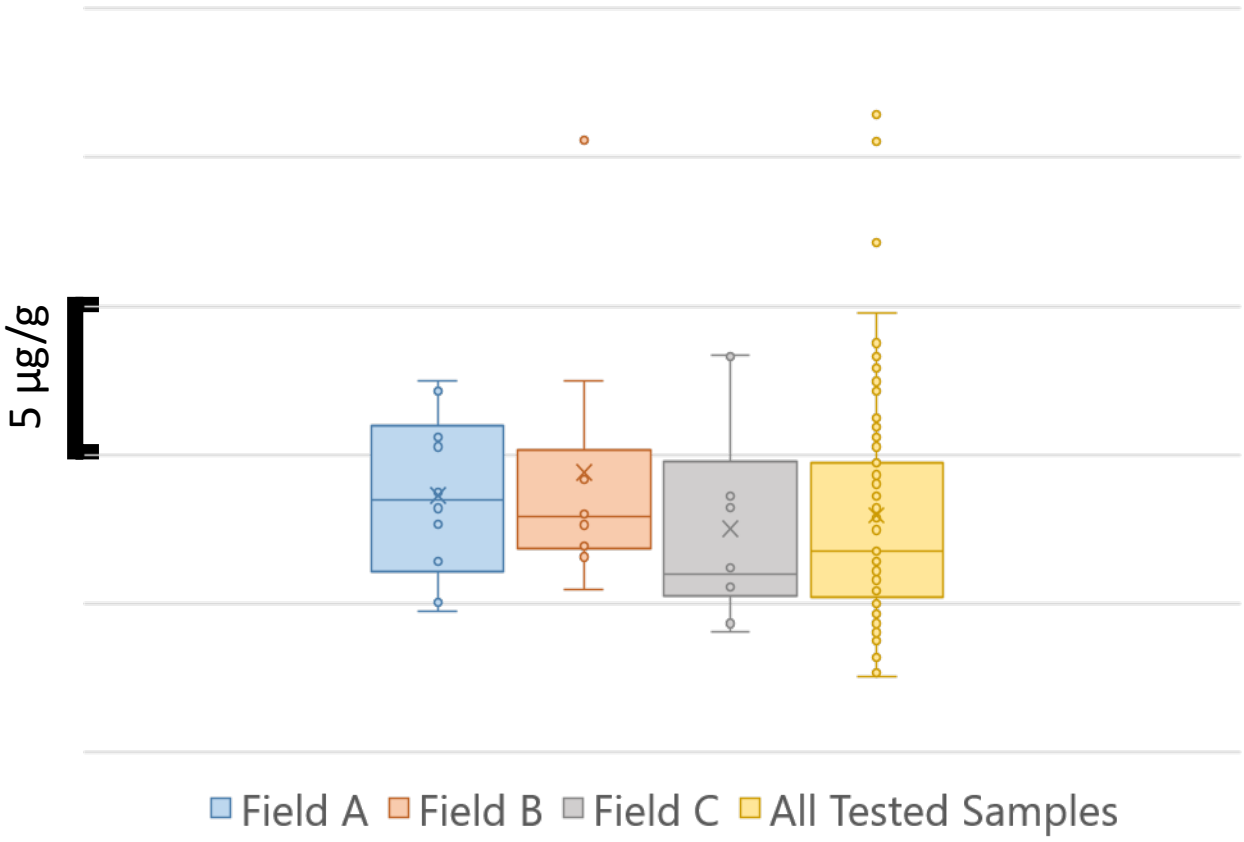
Hg quantification by ASTM and EPA methods



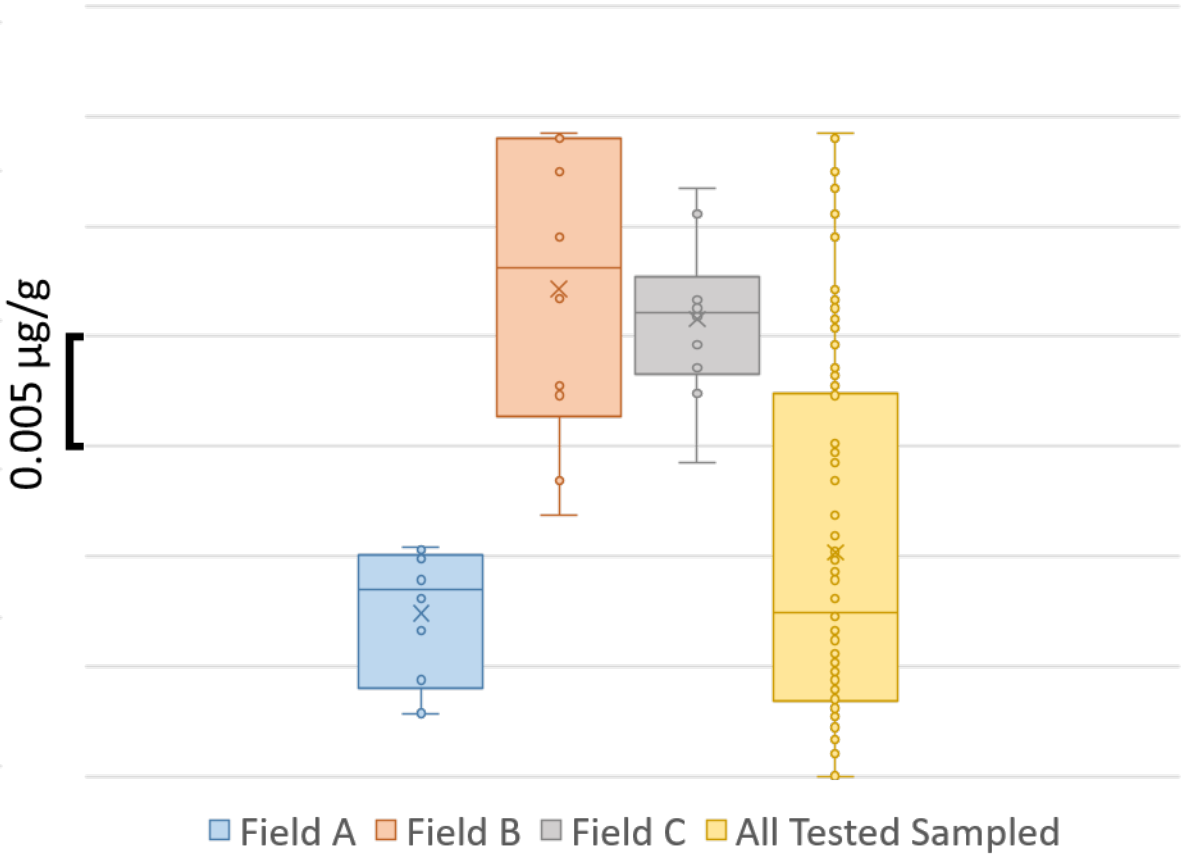
*Results from 3 fully analyzed fields & 77 samples tested to date

Summary of results* for As

EPA Method

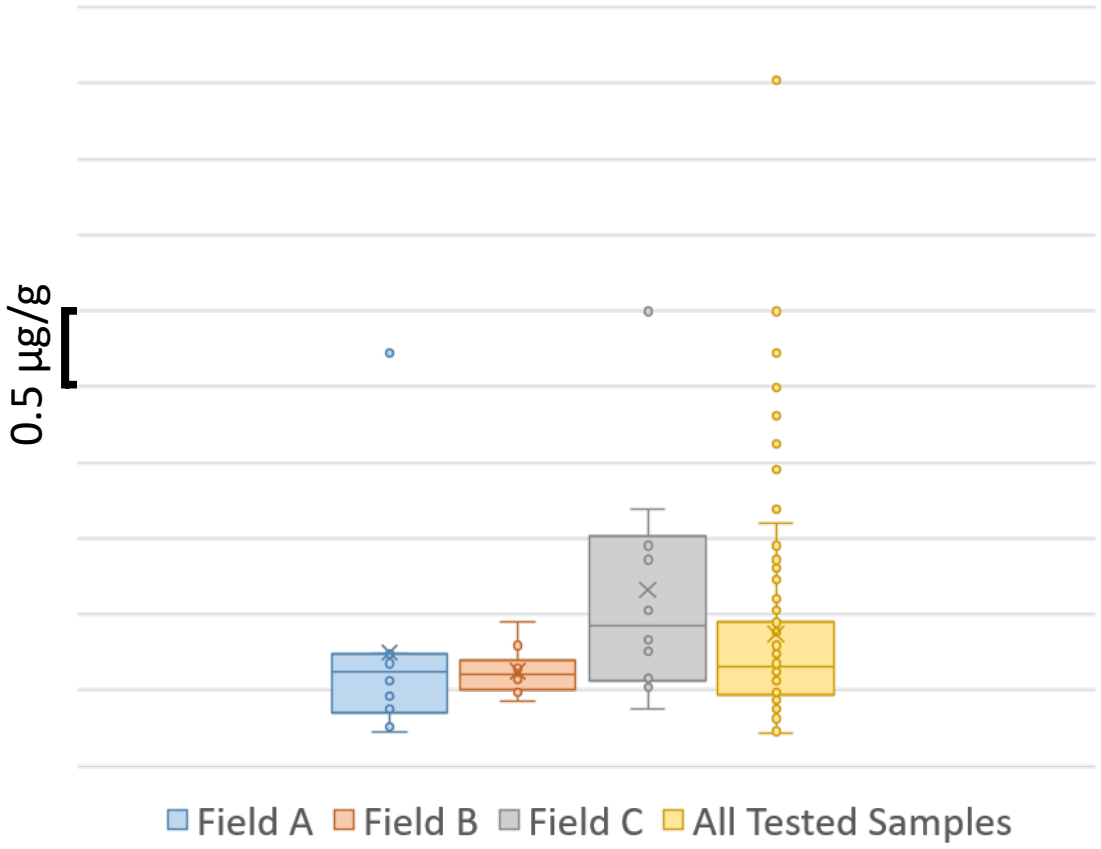


ASTM Method

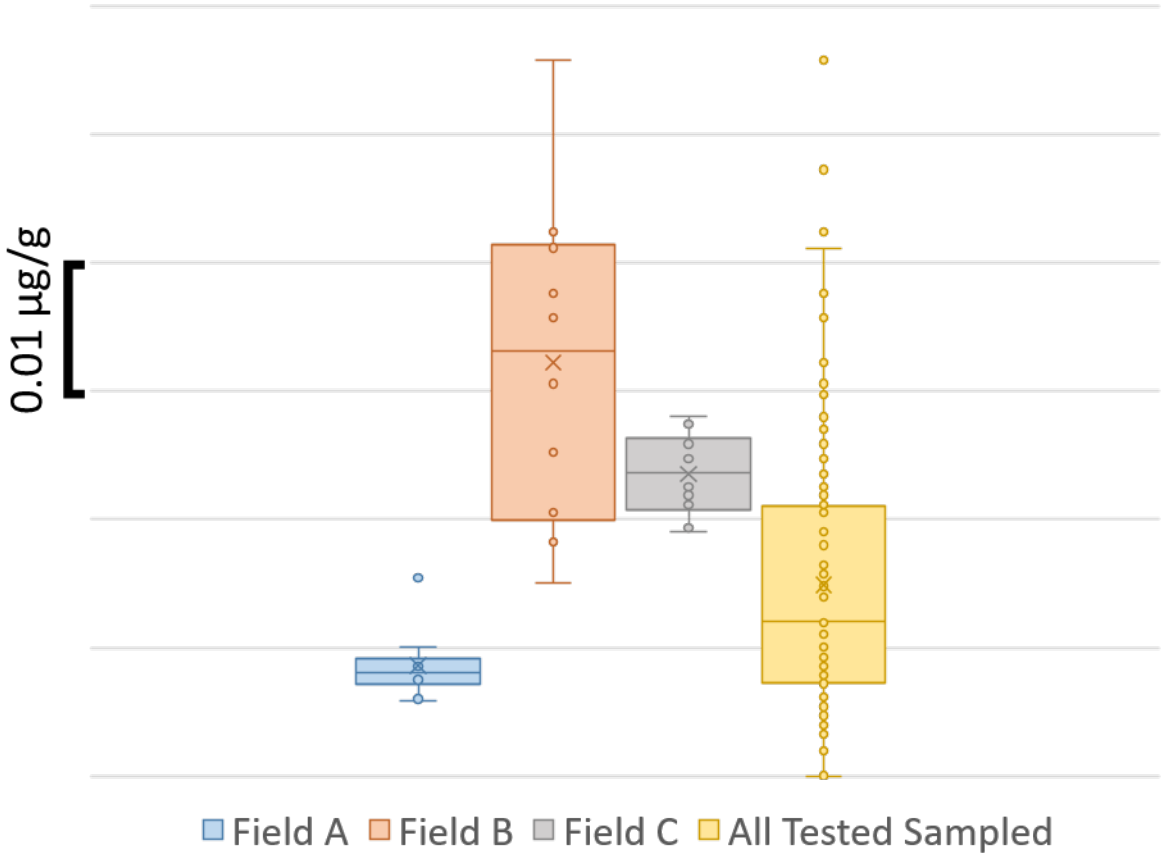


Summary of results for Cd

EPA Method



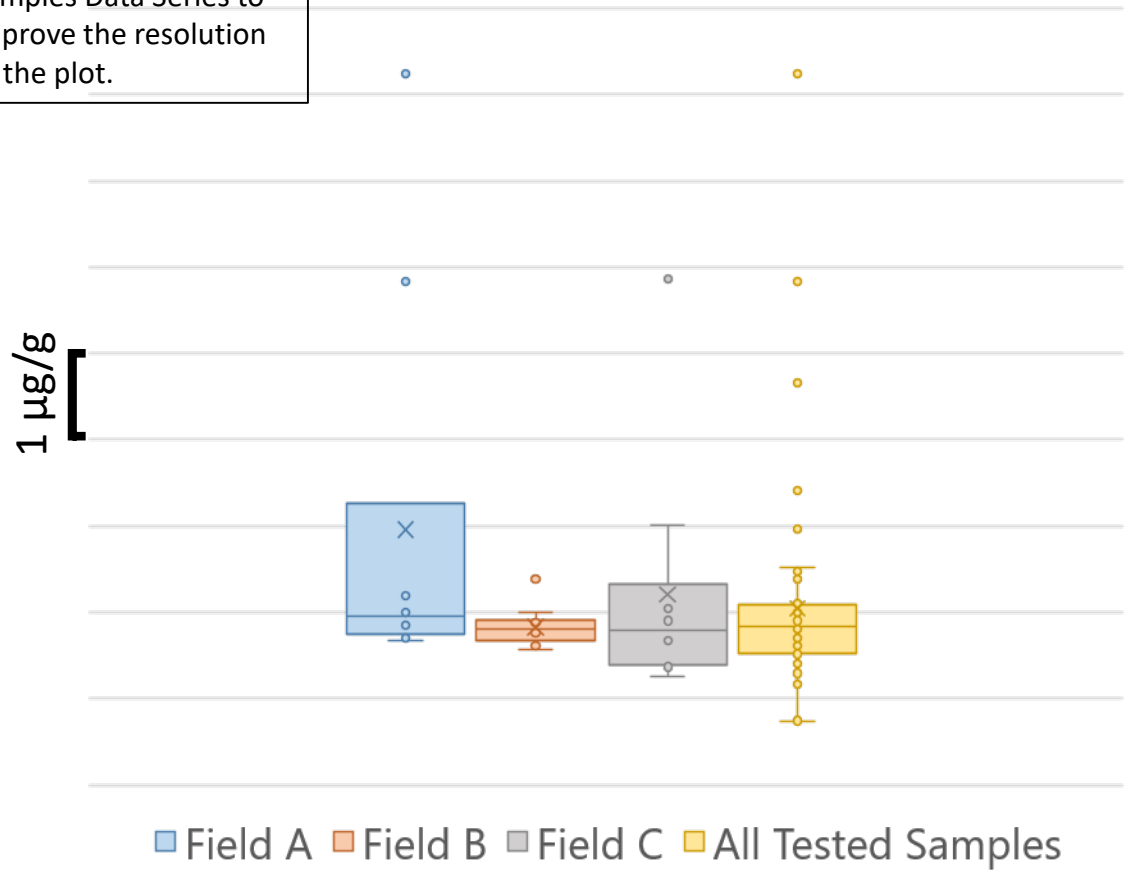
ASTM Method



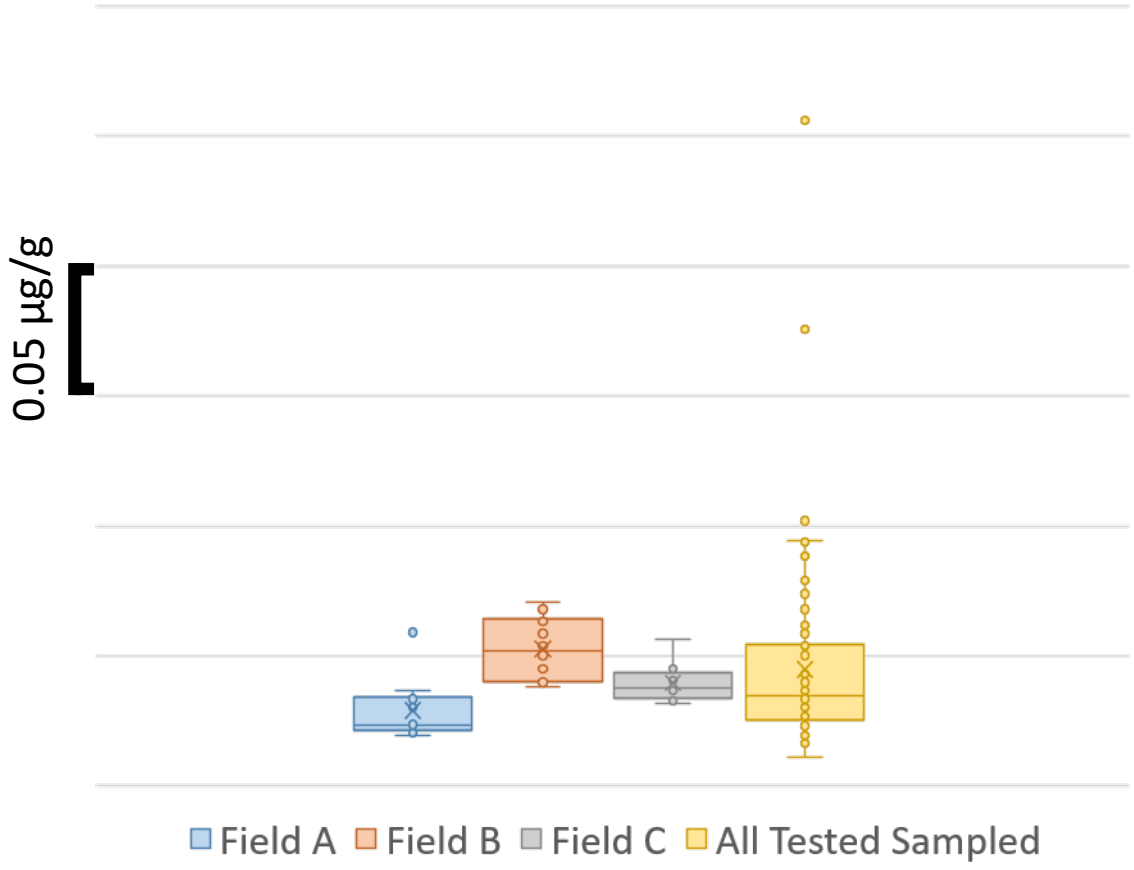
Summary of results for Cr

*An extreme maximum value was removed from the All Tested Samples Data Series to improve the resolution of the plot.

EPA Method*

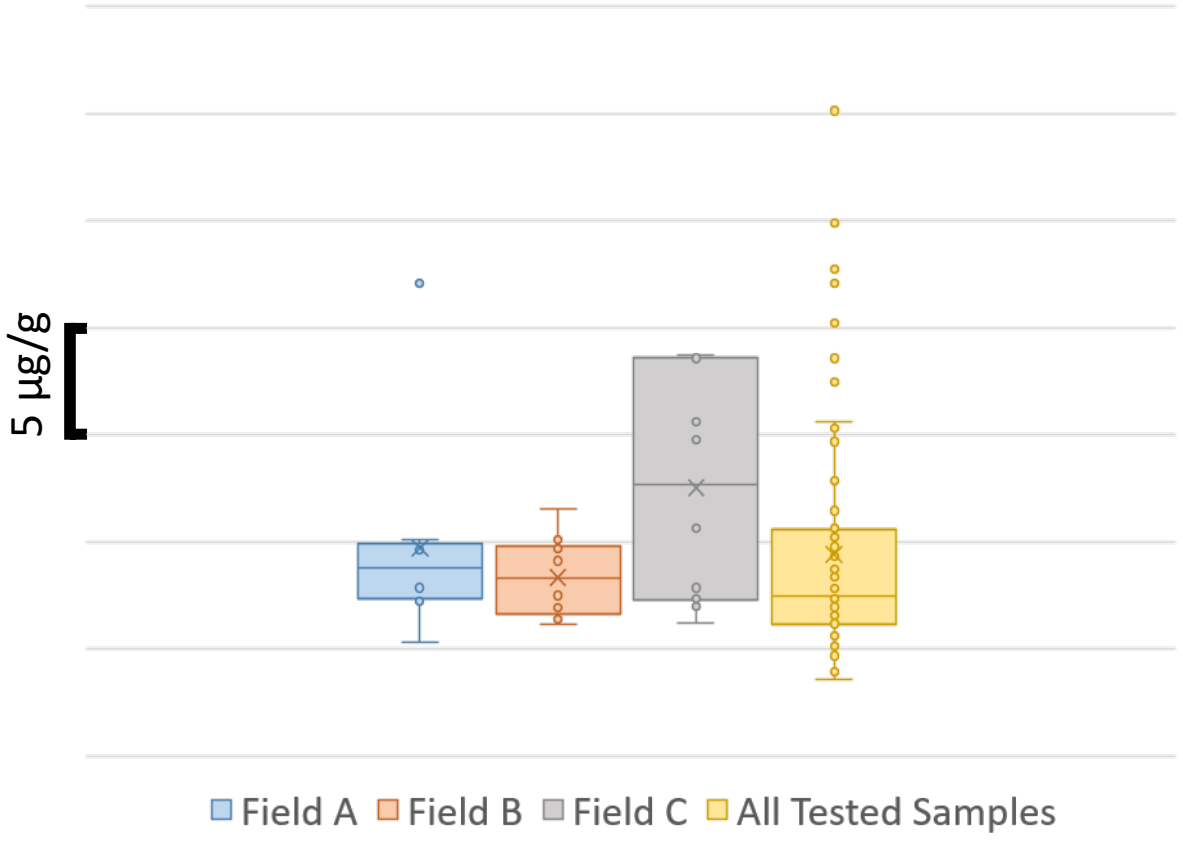


ASTM Method

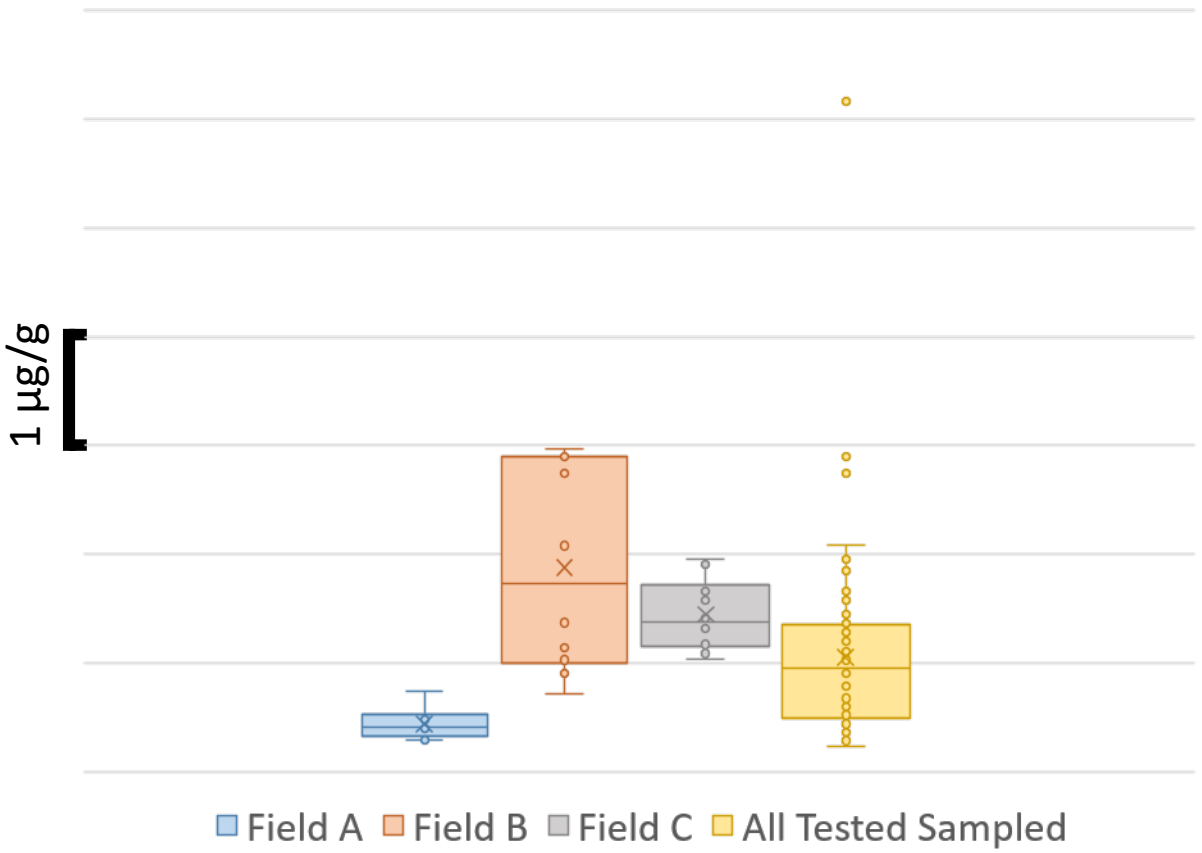


Summary of results for Mn

EPA Method

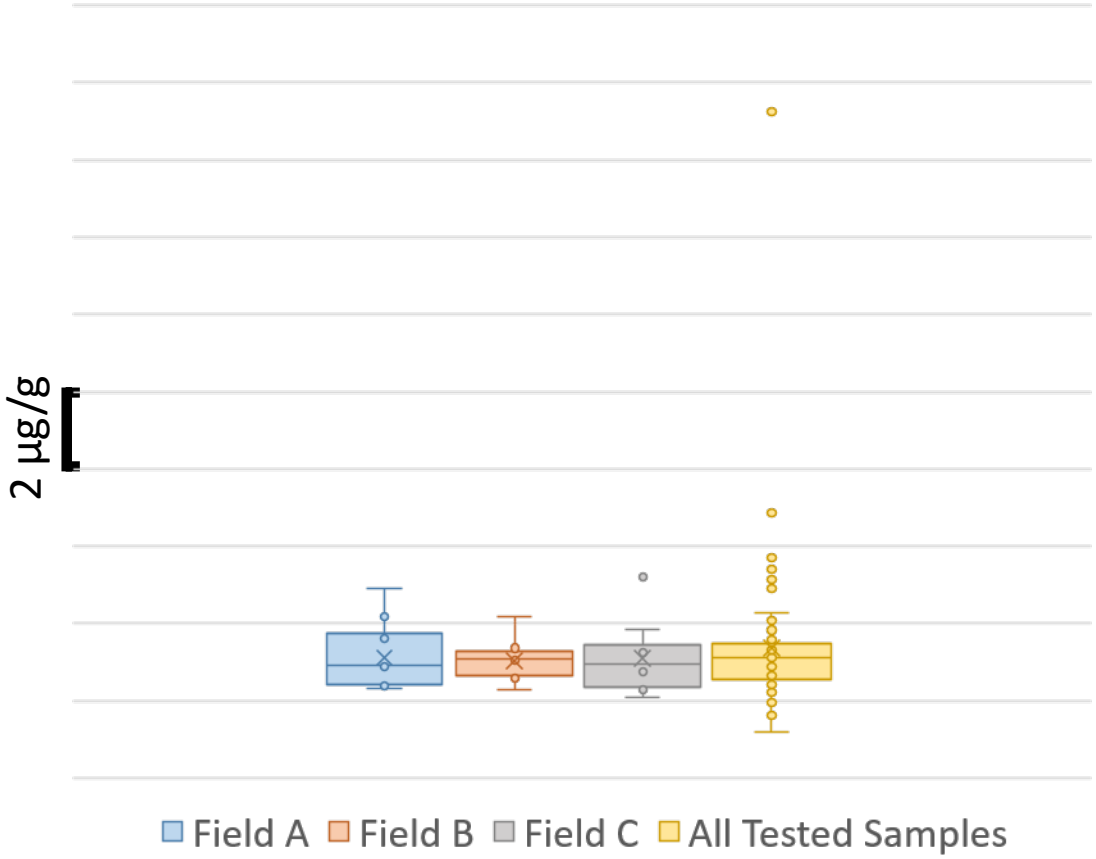


ASTM Method

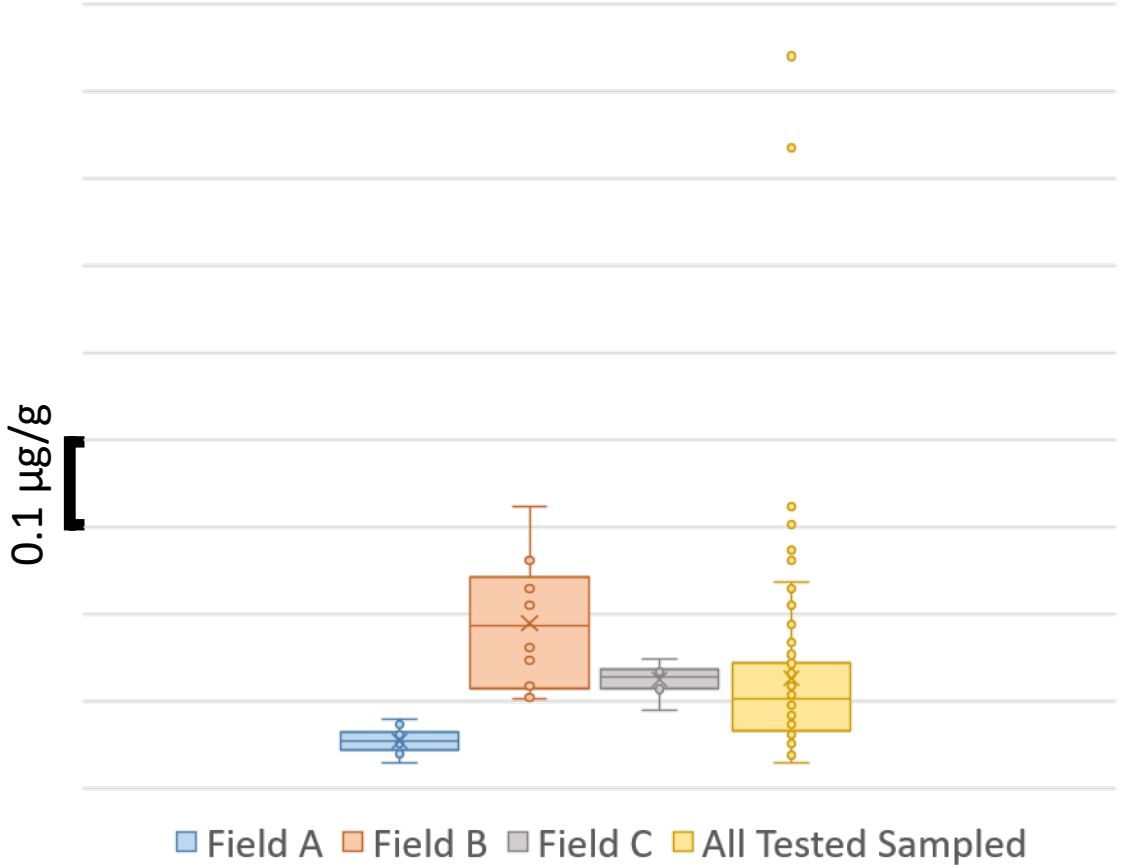


Summary of results for Ni

EPA Method

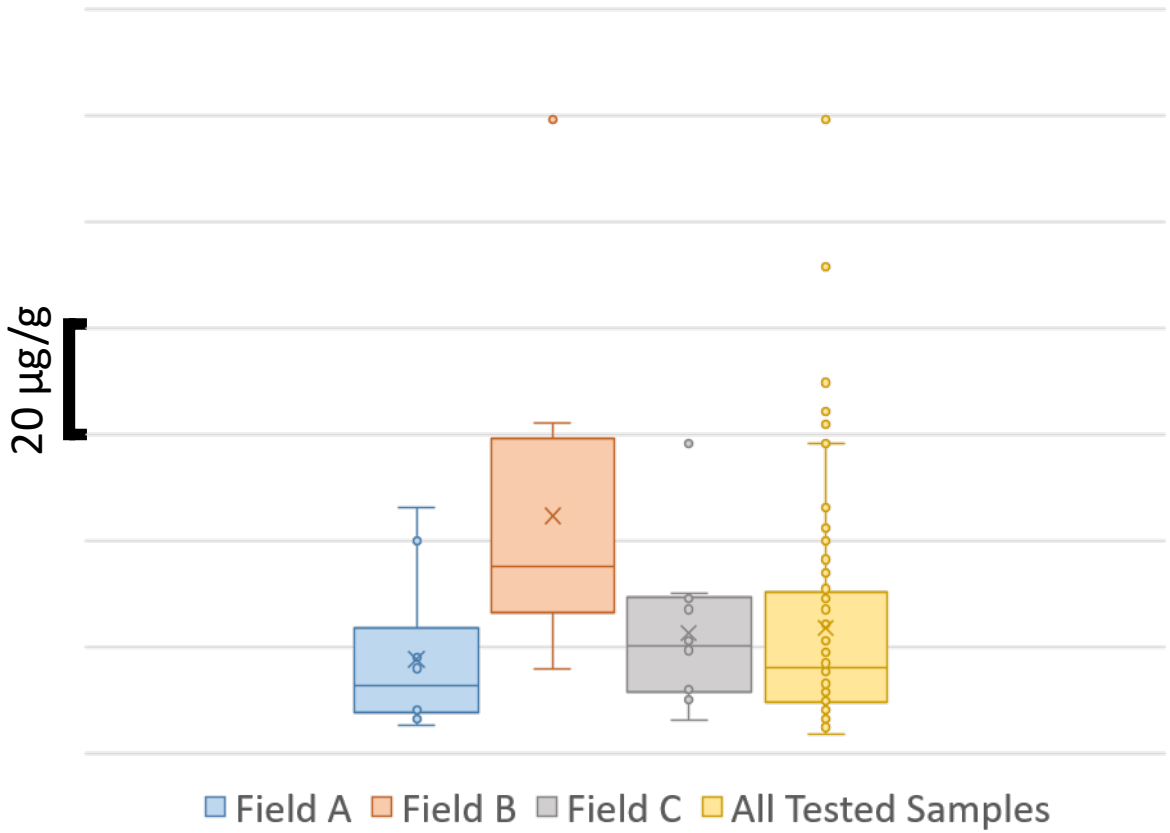


ASTM Method

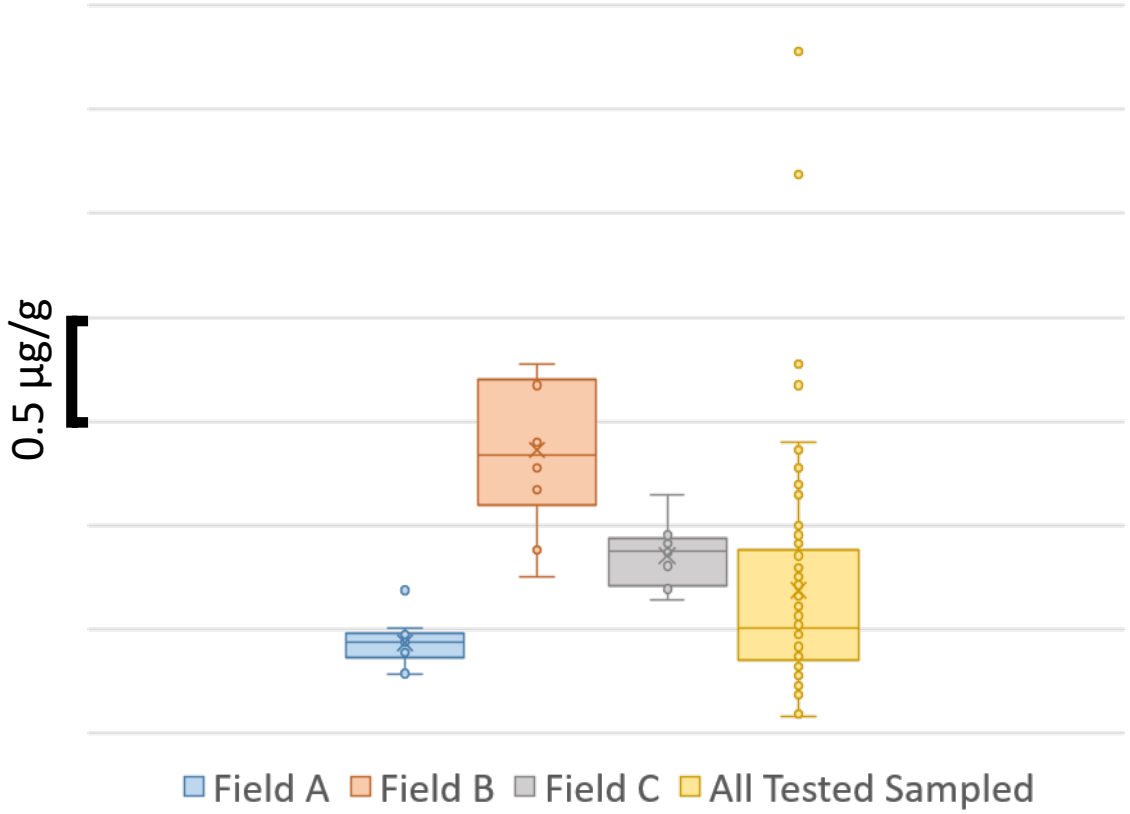


Summary of results for Pb

EPA Method



ASTM Method



Discussion

1. The concentrations of the six selected metals do not vary greatly within each of the 3 fields for which the metals analyses have been finalized. Given that on-field activities occur throughout the field, should we composite within-field samples for metal analyses for the remaining 731 field samples for extraction with biofluids?

2. The total digestion analysis (EPA 3051A) provides the total concentration of each metal analyzed in crumb rubber. 61 metal samples were analyzed, 1 to 10 for each field or manufacturer. We intend to stop processing samples for total metal digestion. Do you have any comments on the data and the use of these total metal concentration data in the study?

3. Do you agree that the ASTM F3188 method works as well as the LBNL/OEHHA previously proposed biofluid extraction method? Do you recommend we use the ASTM F3188 method to measure the oral bioaccessible concentration of metals?

4. The analysis for Hg is carried out with different analytical methods than the other metals. The samples analyzed so far show non-detect or low levels of Hg, for each of the fields. Have we done enough to understand the Hg content in crumb rubber used on synthetic turf fields?

Section 3.1.5
Volatile Organic Compounds in Air

Presenter: Marion Russell, M.S., LBNL

Preliminary Analysis of Airborne Volatile Organic Compounds (VOCs) at Synthetic Turf Fields

Marion Russell, Toshifumi Hotchi, Sarah Nordahl, Jin Pan, Hugo Destaillats

and Randy Maddalena

Lawrence Berkeley National Laboratory

Presentation for Scientific Advisory Meeting

Sacramento, CA, May 25, 2018

Overview

- Define the Sampling Strategy
  - Spatial variability
  - Temporal variability
- Analysis Methods
- Initial VOC Results
- Preliminary Formaldehyde Results
- Discussion

Spatial Variability in Air Concentrations

- Horizontal
- Vertical
- On vs. Off field

Other fields

Cart 4: Off Field

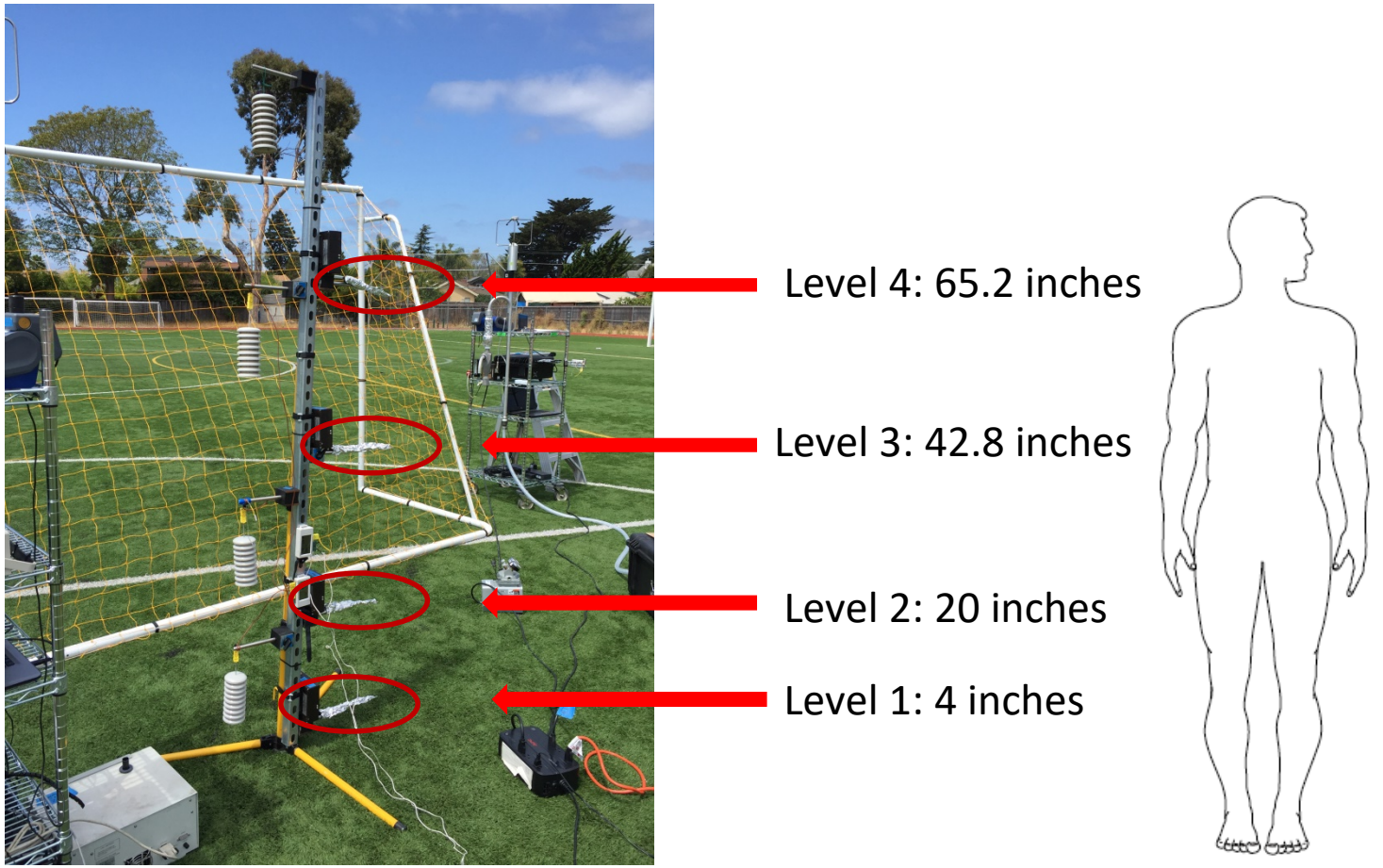
Cart 1: On-field to side of monitoring unit

Cart 3: On-field to side of monitoring unit

Cart 2: On-field to rear of monitoring unit with vertical stratification on tower

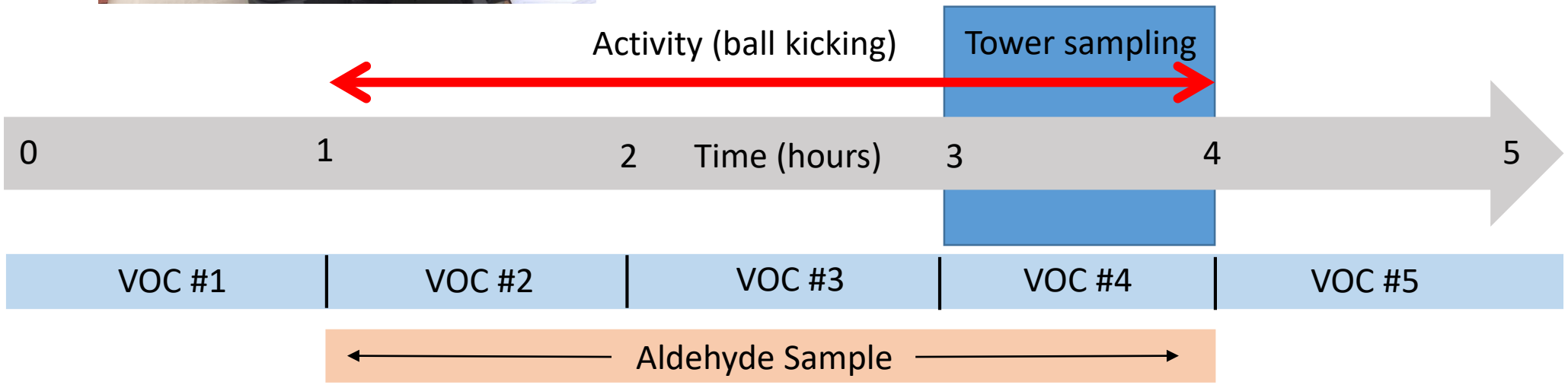
Vertical Variability in Air Concentrations

Sampling Position 2: The sampling Tower was placed directly behind the goal next to Cart 2



Activity Timeline

- Showing temporal resolution of VOC and Aldehyde sampling.
- Vertical (Tower) sampling typically occurs from hour 3 to hour 4



Analysis Methods

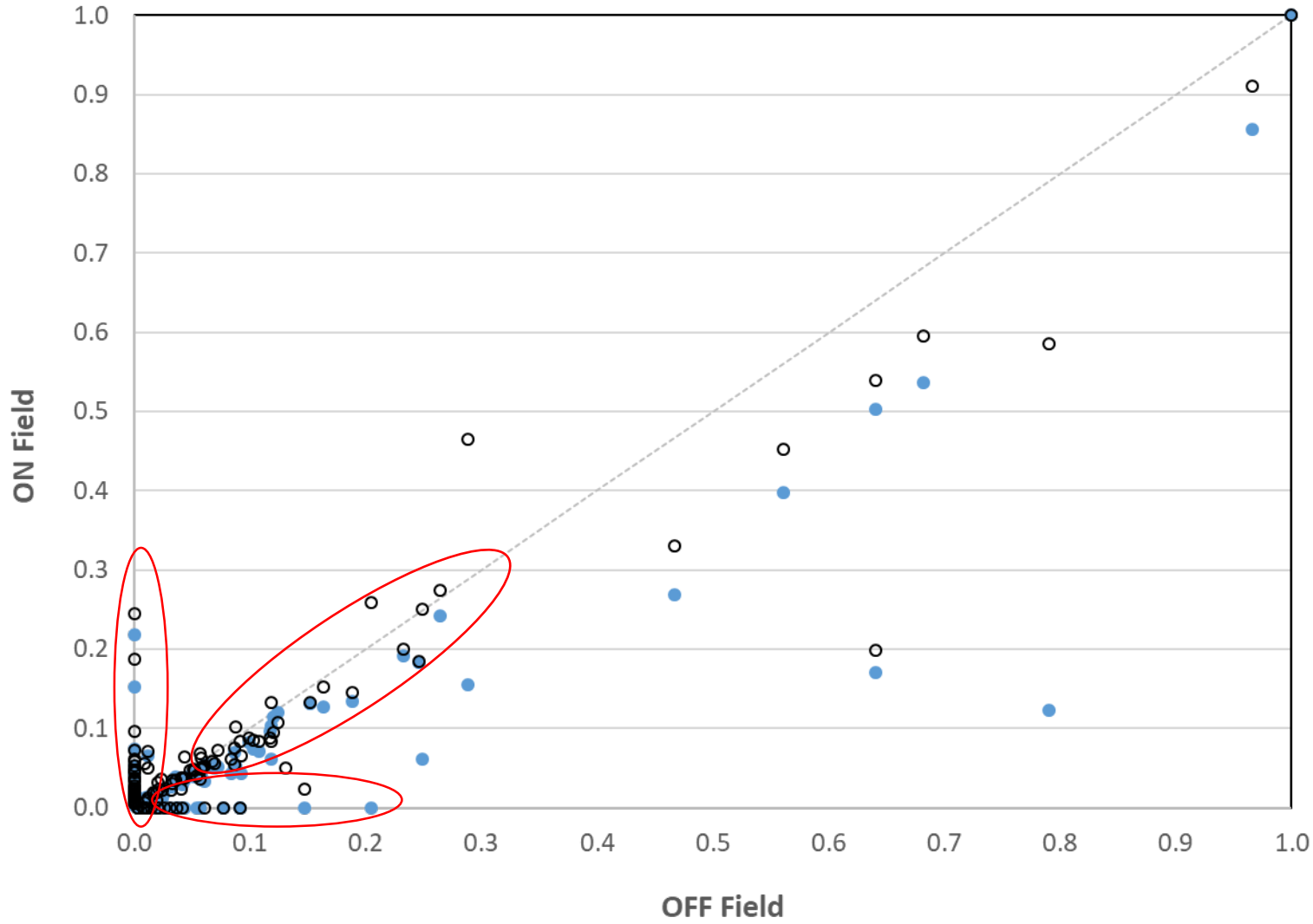
- Volatile Organic Compounds (19 hourly samples collected on carbopak sorbent) analyzed by thermal desorption gas chromatography mass spectrometry (TD-GCMS)
  - o EPA Method TO-17
- Volatile Aldehyde Species (duplicate 3 hour samples collected on cartridge with ozone scrubber)
  - o EPA Method 8315A
- Travel and Field blanks included with each package
- Sample IDs were barcoded and recorded in a tracking sheet database. Chain of custody forms were present in each sampling package.

Preliminary Results Summary

- Comparison of VOCs found both on and off field locations
- Select VOCs identified as detected on field
- Spatial distribution of on-field VOCs
- Temporal distribution of on-field VOCs
- Distribution of formaldehyde concentrations across 30 fields

Preliminary VOC Data for a Typical Field

Volatile Compounds found Both ON and OFF Field



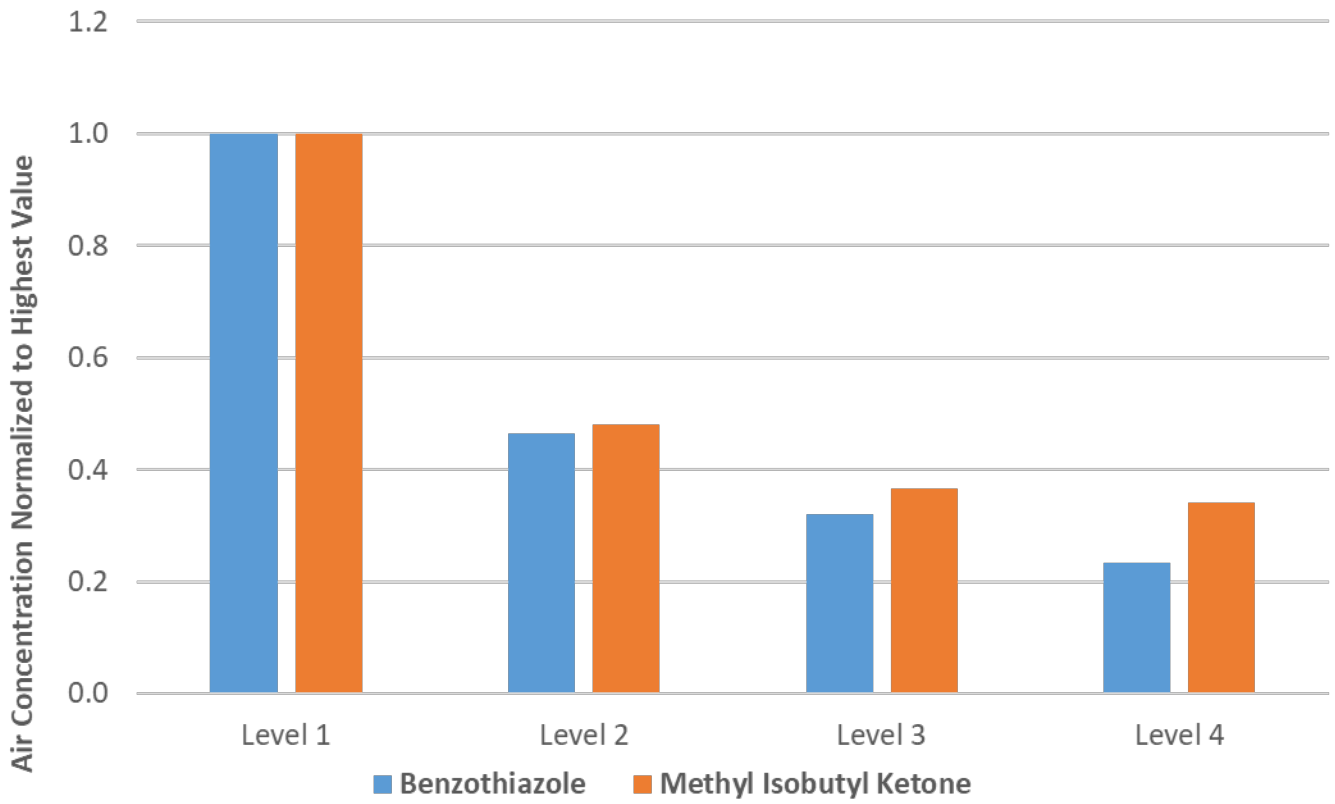
Position 1

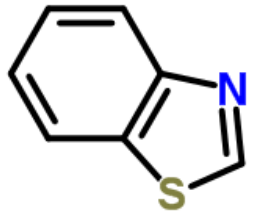
Position 3

- 95 VOCs identified On field
- 99 VOCs identified Off field

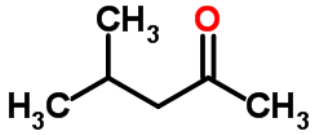
Vertical Distribution of 2 VOCs Found On Field

An Average of 5 Fields reported as Normalized Relative Response





Benzothiazole

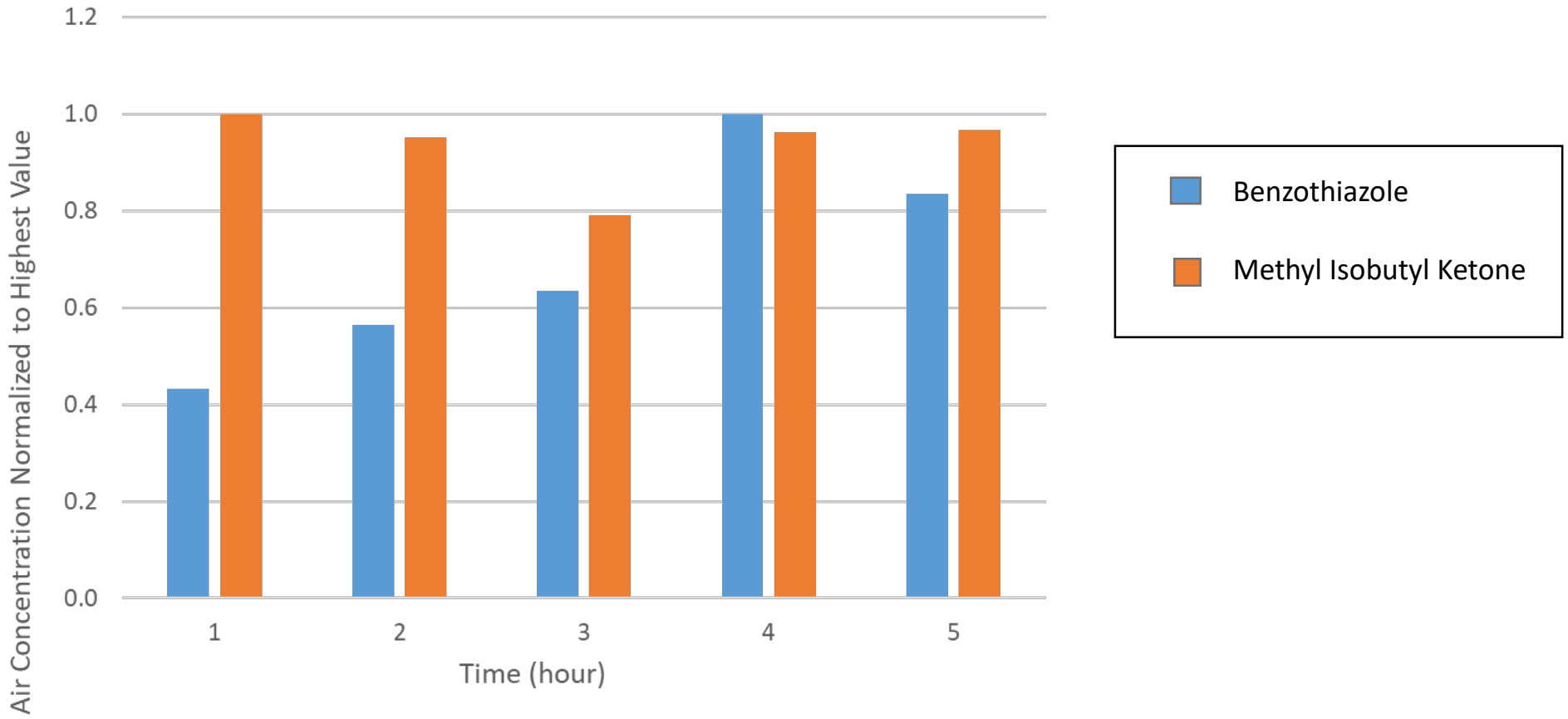


Methyl Isobutyl Ketone

Both compounds are known markers of tires.

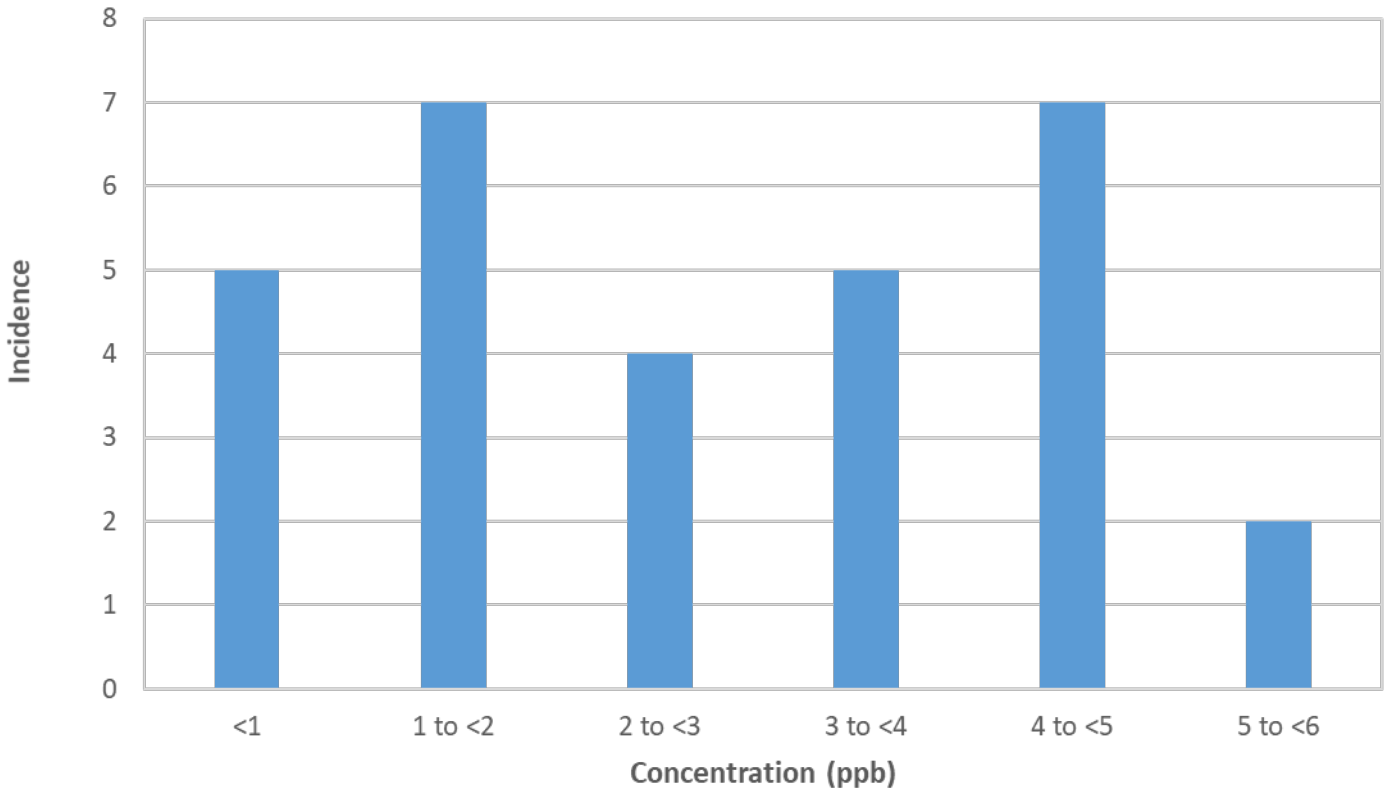
Temporal Distribution of 2 VOCs found On Field

An Average of 5 Fields reported as Normalized Relative Response



On Field Formaldehyde Air Concentrations

For 30 Fields



Discussion

1. For VOCs with very low GC/MS peaks on the chromatograms, there is high uncertainty in the spectral matching with the chemical reference library for identification. What are your recommendations on choosing the appropriate probability cutoff for identifying an un-targeted detected chemical (chemicals not on the current tire-chemical database, but identified using the NIST database)?

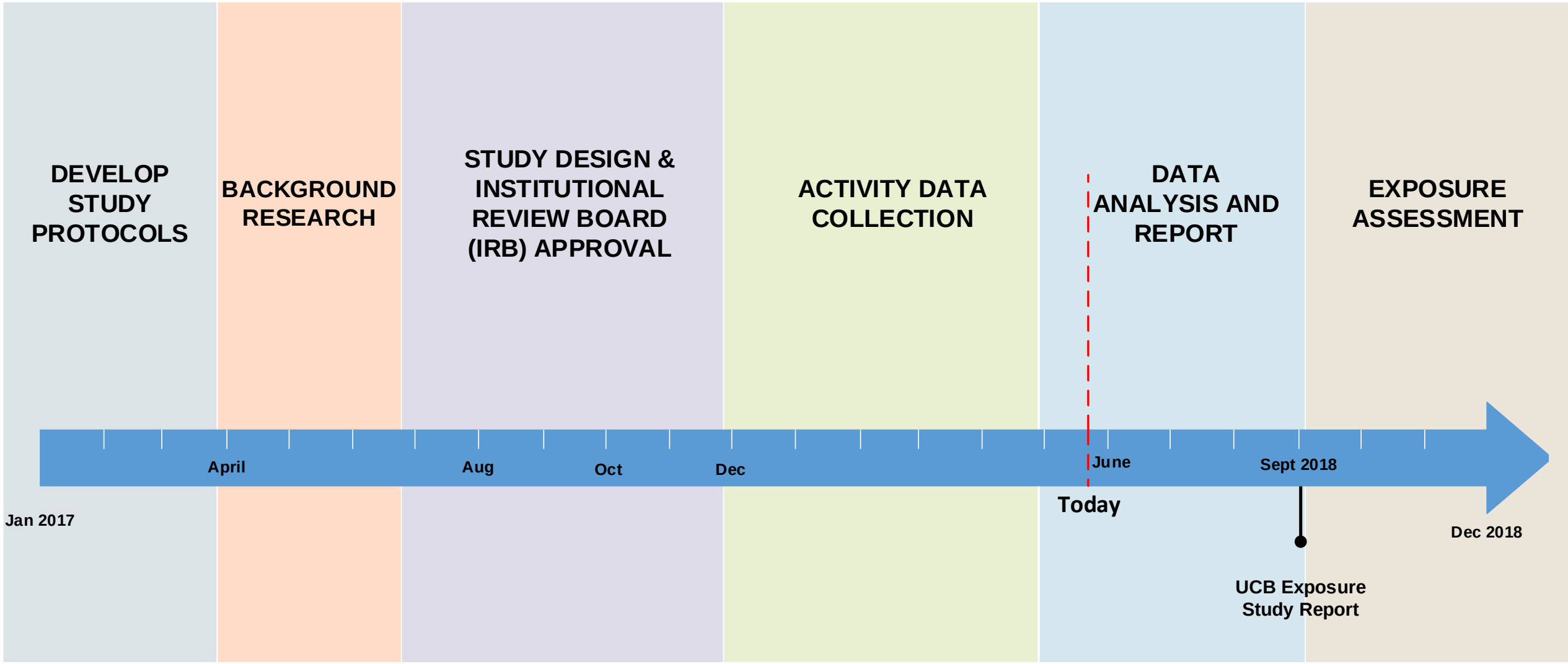
2. Does the panel have recommendations for categorizing VOCs as crumb rubber markers versus common environmental air pollutants?

Section 3.2
Exposure Scenarios of Synthetic Turf Fields

Presenters: Jocelyn Claude, Ph.D., OEHHA

Asa Bradman, Ph.D., MS, UC Berkeley

Task 3 Exposure Scenario Development



Section 3.2.1.
Pathways of Exposures

Presenter: Jocelyn Claude, Ph.D., OEHHA

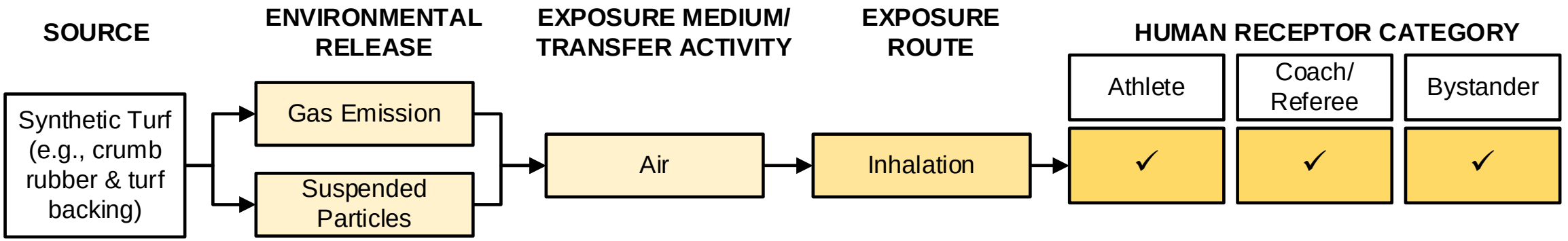
Human Receptor Categories

Athletes

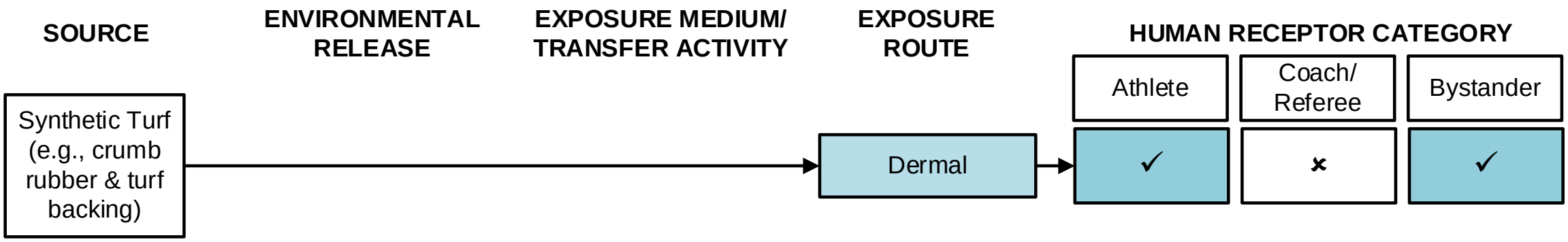
Coaches/Referees

Bystanders

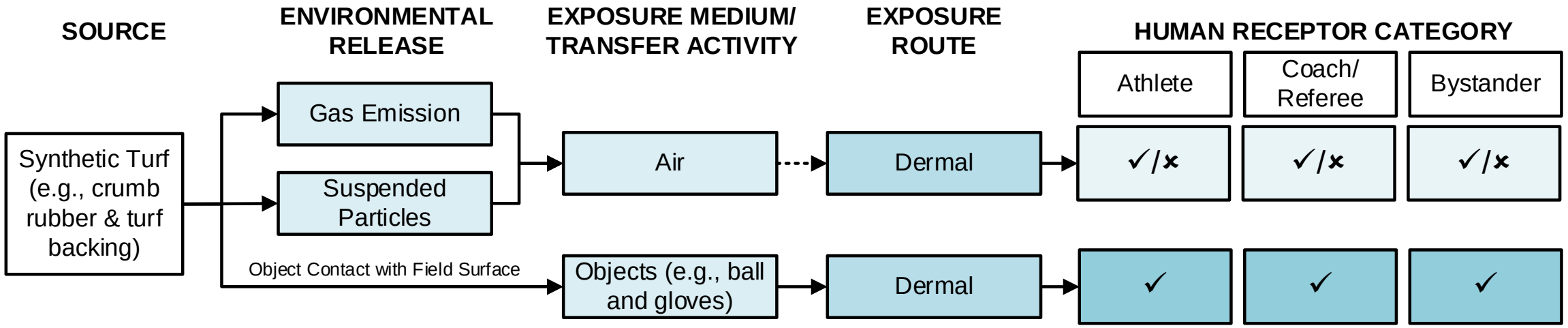
Inhalation Pathway



Direct Dermal Pathway

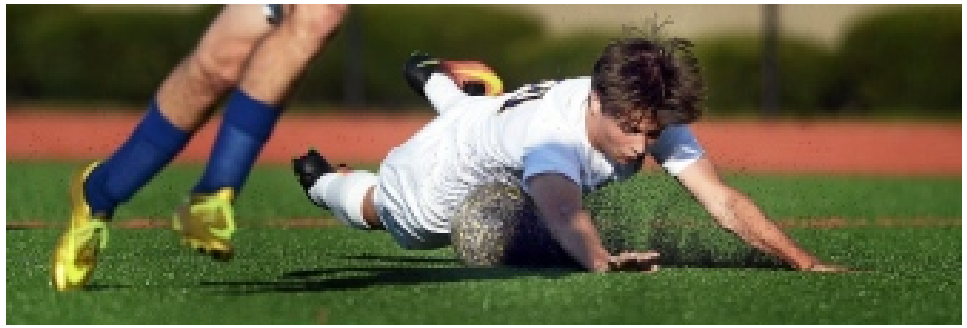


Indirect Dermal Pathways

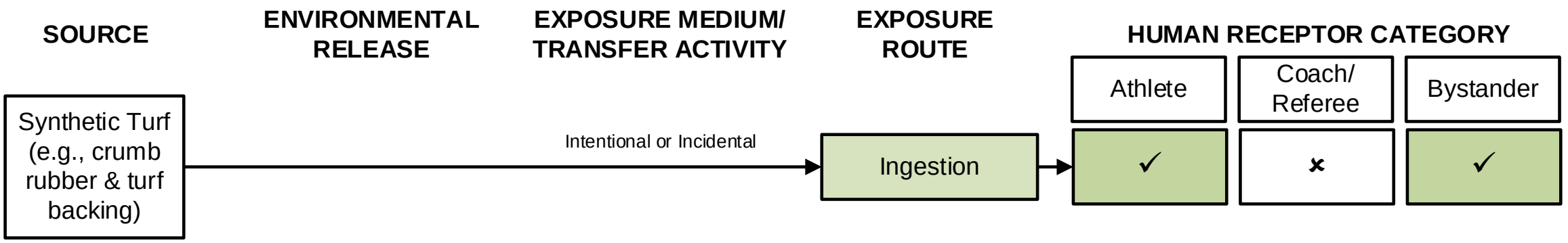


Direct Ingestion Pathways

Incidental Ingestion



Intentional Ingestion



Hand-to-Mouth

Indirect Ingestion Pathway

SOURCE	ENVIRONMENTAL RELEASE	EXPOSURE MEDIUM/ TRANSFER ACTIVITY	EXPOSURE ROUTE	HUMAN RECEPTOR CATEGORY		
				Athlete	Coach/ Referee	Bystander
Synthetic Turf (e.g., crumb rubber & turf backing)	Hand Contact with Field Surface or Object Contact with Field Surface then Hand Contact with Object	Hand-to-Mouth	Ingestion	✓	✓	✓

Hand-to-Object-to-Mouth

Indirect Ingestion Pathway

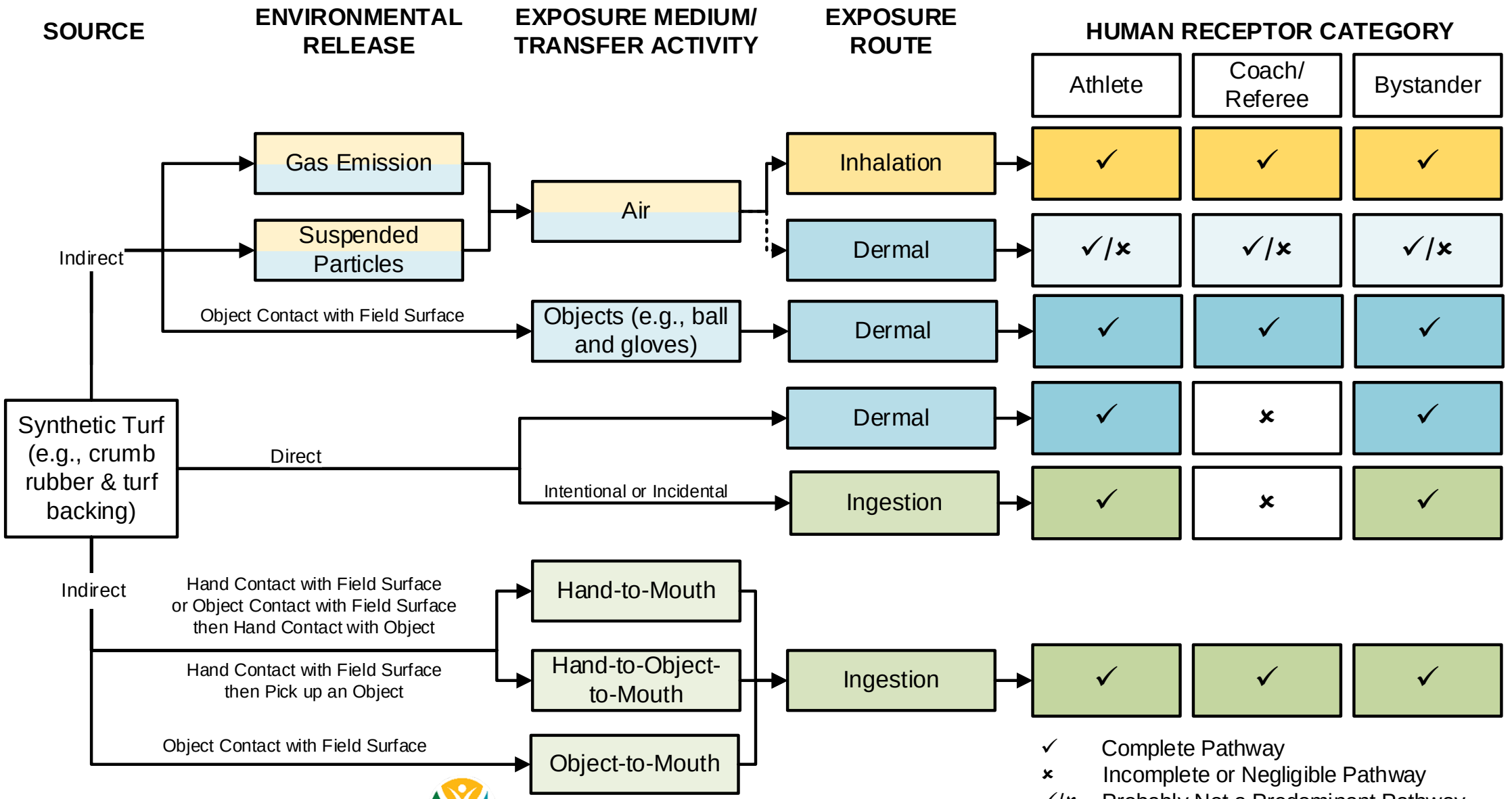
SOURCE	ENVIRONMENTAL RELEASE	EXPOSURE MEDIUM/ TRANSFER ACTIVITY	EXPOSURE ROUTE	HUMAN RECEPTOR CATEGORY		
				Athlete	Coach/ Referee	Bystander
Synthetic Turf (e.g., crumb rubber & turf backing)	Hand Contact with Field Surface then Pick up an Object	Hand-to-Object-to-Mouth	Ingestion	✓	✓	✓

Object-to-Mouth

Indirect Ingestion Pathway

SOURCE	ENVIRONMENTAL RELEASE	EXPOSURE MEDIUM/ TRANSFER ACTIVITY	EXPOSURE ROUTE	HUMAN RECEPTOR CATEGORY		
				Athlete	Coach/ Referee	Bystander
Synthetic Turf (e.g., crumb rubber & turf backing)	Object Contact with Field Surface	Object-to-Mouth	Ingestion	✓	✓	✓

On-Field Pathways Model



Section 3.2.2.
Time-Activity Behavior Study

Presenter: Asa Bradman, Ph.D., MS, UC Berkeley

Synthetic Turf Exposure Assessment Study: Characterizing Exposure-Related Behaviors

Asa Bradman, PhD
Carly Hyland, MS
Rosemary Castorina, PhD

Center for Environmental Research and Children's Health
School of Public Health
University of California, Berkeley

Paloma Beamer, PhD
Nicolas Lopez-Galvez, MPH, MA

University of Arizona, College of Public Health

Objective

- Characterize exposure-related human activity patterns to support OEHHA's efforts to model exposures resulting from use of synthetic turf fields in California

Relevance to California Soccer

- Provide current state-wide information specific to California
- Research from real soccer players
- Nothing in literature with this level of detail
- Wide cross-section of California soccer players
  - Ages
  - Geographic
  - Demographic
  - Player position

California Soccer Overview

Competitive Level	Gender	Age Range	Estimate	Year
Recreational/Competitive Youth	Both	4-18	162,297	2013-2014 seasonal year (Northern CA)
			159,278	2013-2014 seasonal year (Southern CA)
High School	Boys	14-18	52,266	2016
	Girls		46,778	
College (Divisions I-III)	Men	18-22	1,614	2016-2017
	Women		1,681	
College Intramural	Both	18-22	5,000	2017
Adult Recreational	Both	18+	11,000	2017
Professional and Semi-Professional	Men	18+	566	2015-2017
	Women		241	
			Total	**440,721**

Study Components

1. Online Survey
   - Soccer players and their parents throughout California
   - Goal = 1,000 participants

2. In-Person Questionnaire and Videotaping
   - Videotape soccer players at practices and games using turf fields containing crumb rubber
     - Data being analyzed by University of Arizona
   - Administer questionnaire to players or parents
   - San Francisco Bay Area and Sacramento.
   - Goal = 40 participants
     - Videotape 10 events with participants from each of the 4 positions (goalie, defender, midfielder, forward)

Survey Development

- Focused on use of synthetic turf fields with crumb rubber
- Information Collected:
  - Demographic
  - Contact frequency
  - Potential dermal and ingestion exposures
  - Exertion to inform inhalation exposure estimates
  - Hygiene practices
  - Player history

Online Survey Recruitment

- Obtained publically available email addresses for coaches, managers, and soccer club affiliates in California (NorCal Premier, Cal North, Cal South)
- Flyers at in-person events and Facebook page
- Targeted competitive and recreational soccer teams of all ages

Online Survey Data Collection

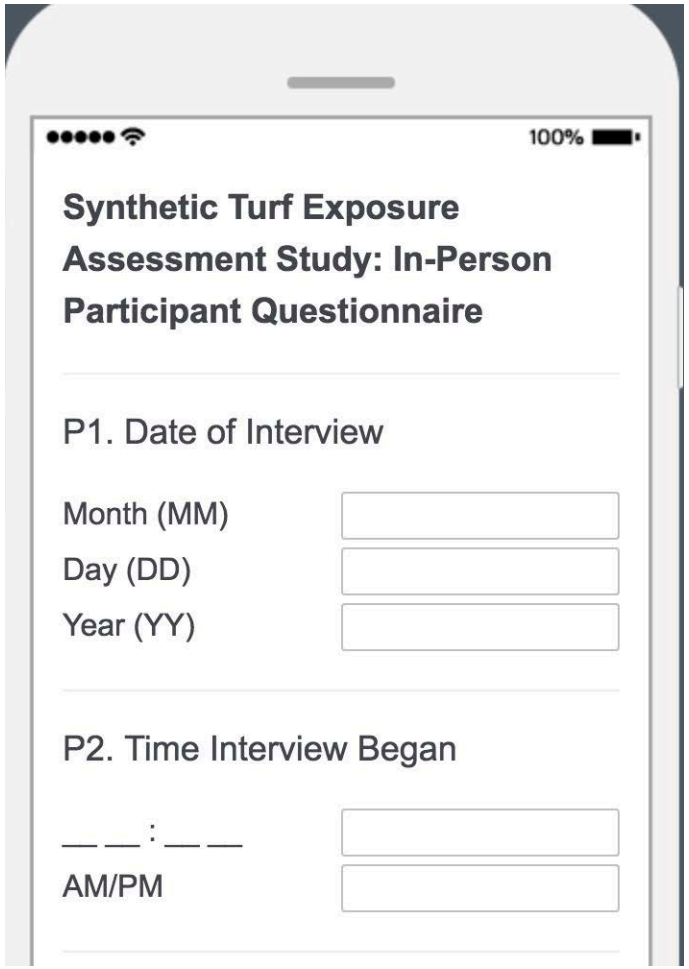
- Recruitment email sent to over 10,000 addresses with survey link in English and Spanish
- Parent/guardian asked to complete survey for child under 18
- Dec 2017 – April 2018

In-Person Questionnaire and Videotaping Recruitment

- Recruited participants through coaches and managers in San Francisco Bay Area and Sacramento area
- Coach usually helped identify players and parents interested in participating
- Obtained permission to attend scheduled practice/game
- Study Coordinator managed consent and compliance with IRB protocols

In-Person Questionnaire and Videotape Data Collection

- Each player videotaped by team of two study staff
- Notes recorded on players' contact with objects
- Administered questionnaire
  - Players under 14: Completed by parent
  - Players 14 or older: Completed by player
- Dec 2017 – April 2018



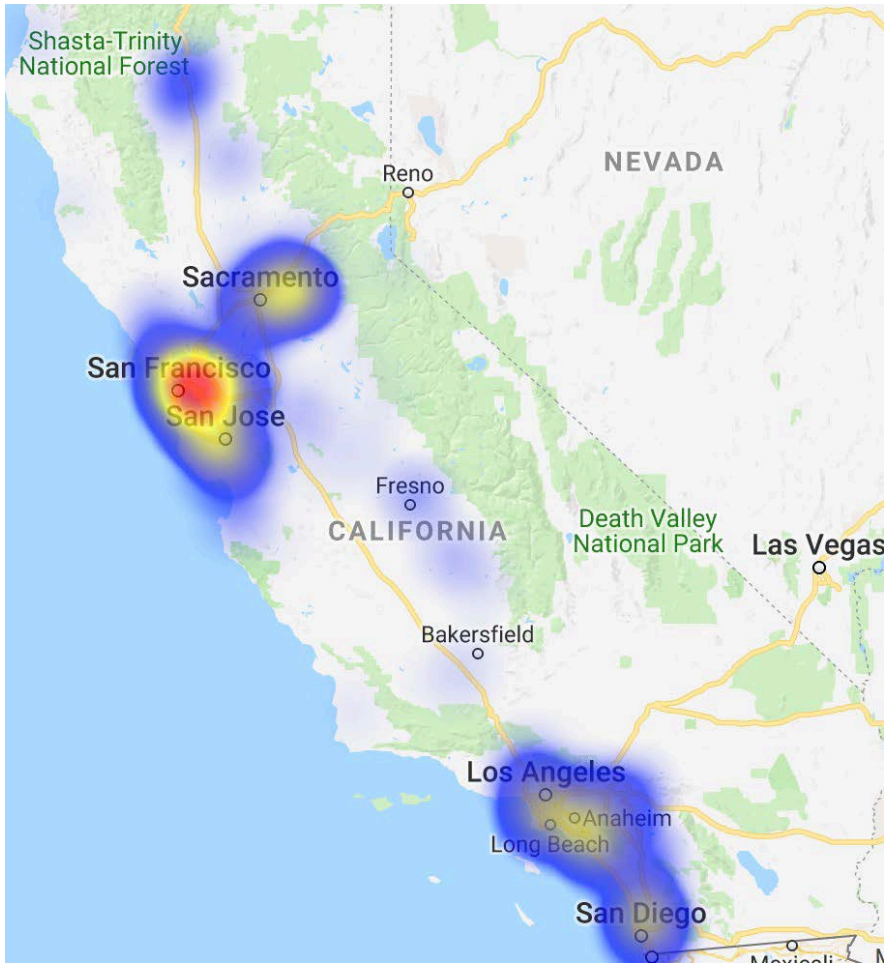
Preliminary Results

- Online and in-person questionnaire
  - N=1,069
- Videotaping
  - N=40
- Today's presentation includes information for all respondents

Videotaping Player and Event Summary

Age (Years)	Gender		Event Type	Players Videotaped (n)
	Male (n)	Female (n)		
8-9	3	4	Game	7
11-12	4	4	Practice	8
14-15	--	4	Practice	9
14-15	5	--	Game	
16-18	4	4	Game	8
19-22	4	4	Practice	8
			TOTAL	**40**

Heat Map of Zip Code from Online Survey Respondents



Demographic Characteristics of Online and In-Person Survey Respondents (n=1,069)

Age of player	N (%)
< 8	18 (1.7)
9-12	231 (22)
13-17	467 (44)
18-25	138 (13)
26-30	38 (2.6)
31-40	64 (6.0)
41-50	82 (7.7)
> 50	30 (2.8)
Prefer not to answer	11 (1.0)
Gender	
Male	539 (50)
Female	522 (49)
Prefer not to answer	8 (0.8)

Demographic Characteristics (cont.)

Ethnicity	**N (%)**
Asian/Pacific Islander	55 (5.1)
Black/African American	19 (1.8)
Caucasian	640 (60)
Hispanic/Latino	158 (15)
Native American	5 (0.5)
Mixed	139 (13)
Other	17 (1.6)
Prefer not to identify	36 (3.4)
Survey Language	
English	1,060 (99)
Spanish	9 (0.8)

Soccer Player Characteristics of Online and In-Person Survey Respondents

Soccer Position	N (%)
Goalie	120 (11)
Forward	117 (11)
Midfielder	258 (24)
Defender	263 (25)
Multiple Positions	300 (28)
DK/No response	11 (1.0)
Recreational/Competitive Soccer Player	
Recreational	115 (11)
Competitive	815 (76)
Both	134 (13)
DK/No response	5 (0.5)
Plays Soccer Year-Round	
No	118 (11)
Yes	946 (89)

Soccer Player Characteristics (cont.)

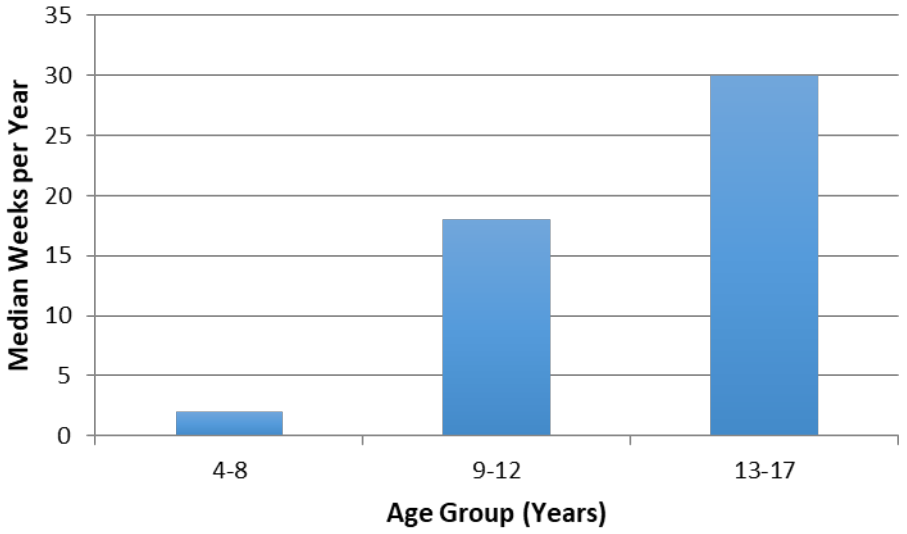
	N (%)
Proportion of practices on synthetic turf with crumb rubber	
0%	132 (12)
> 0 – 25%	175 (16)
> 25 – 50%	155 (15)
> 50 – 75%	157 (15)
>75%	443 (41)
Don't know/No response	7 (0.7)

Proportion of games on synthetic turf with crumb rubber	
0%	19 (1.8)
> 0 – 25%	168 (16)
> 25 – 50%	216 (20)
> 50 – 75%	243 (23)
>75%	418 (39)
Don't know/No response	5 (0.5)

Child Player History:
Average Weeks per Year Played on Synthetic Turf Field

Age Range (Years)	n[1]	Weeks Per Year Played						
		Percentiles				Range	Mean	SD
		25	50	75	95			
4-8	705	0	2	12	40	0-52	9.3	13.4
9-12	692	4	18	36	48	0-52	20.5	16.7
13-17	402	15	30	45	52	0-52	29.5	16.4

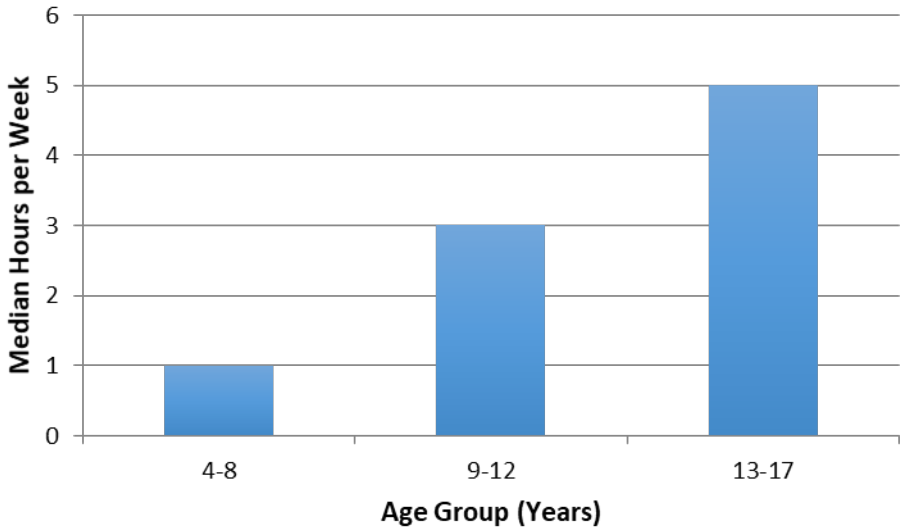
[1]Sum > 1,069 because many children played in multiple age groups



Child Player History:
Average Hours per Week Played on Synthetic Turf Fields

Age Range (Years)	n[1]	Hours Per Week Played						
		Percentiles				Range	Mean	SD
		25	50	75	95			
4-8	705	0	1	2	6	0-104	1.8	4.6
9-12	692	1.5	3	4.5	10	0-52	3.6	4.1
13-17	402	3	5	7	14	0-100	6.1	6.9

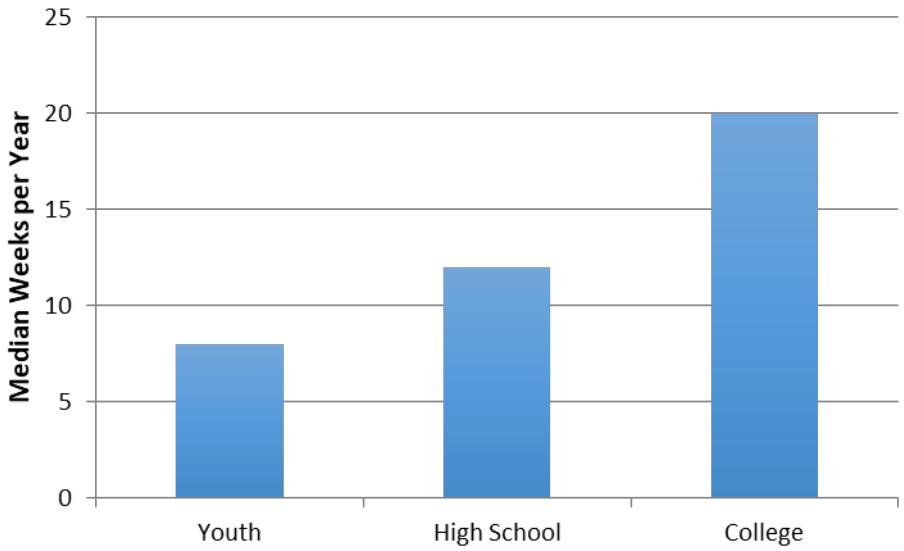
[1]Sum > 1,069 because many children played in multiple age groups



Adult Player Life History:
Average Weeks per Year Played on Synthetic Turf Fields

	n[1]	Weeks Per Year Played[2]						
		Percentiles				Range	Mean	SD
		25	50	75	95			
Youth	223	0	0	8	40	0-48	6.9	13.0
High School	230	0	0	12	40	0-52	7.5	12.5
College	191	0	2	20	42	0-52	10.0	13.8

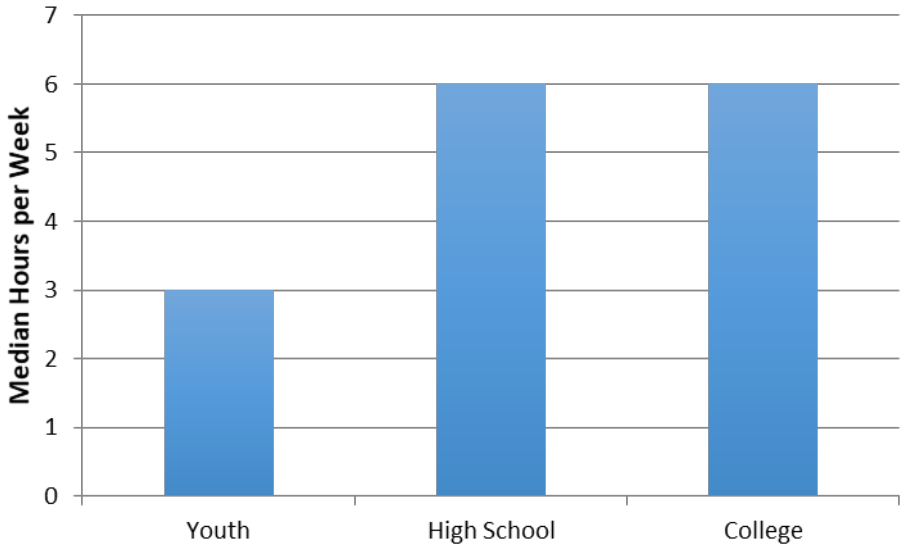
[1]Many adults reported playing soccer in multiple age groups
[2]Adult life history from online survey



Adult Player Life History: Hours per Week Played on Synthetic Turf Fields

	n[1]	Hours Per Week Played[2]						
		Percentiles				Range	Mean	SD
		25	50	75	95			
Youth	226	0	0	3	9	0-25	2.0	4.1
High School	231	0	0	6	15	0-35	3.4	5.6
College	189	0	2	6	18	0-42	4.3	6.4

[1]Many adults reported playing soccer in multiple age groups
[2]Adult life history from online survey



In Past Year, Longest Time Played on Synthetic Turf Field in Single Day

Practices (% of responses)					
Age Range (Years)	**<1 Hour**	**>1-2 Hours**	**>2-4 Hours**	**>4-5 Hours**	**>5 Hours**
4-8	0	44	44	0	11
9-12	2.4	50	37	5.8	5.3
13-17	1.6	37	45	8.8	7.0
18-25	0.8	20	58	12	7.6

Games (% of responses)					
Age Range (Years)	**<1 Hour**	**>1-2 Hours**	**>2-4 Hours**	**>4-5 Hours**	**>5 Hours**
4-8	0	90	0	10	0
9-12	5.9	37	40	12.2	5
13-17	2.4	28	45	17	8.4
18-25	1.5	23	42	19	12

Reported Exertion During Practices and Games

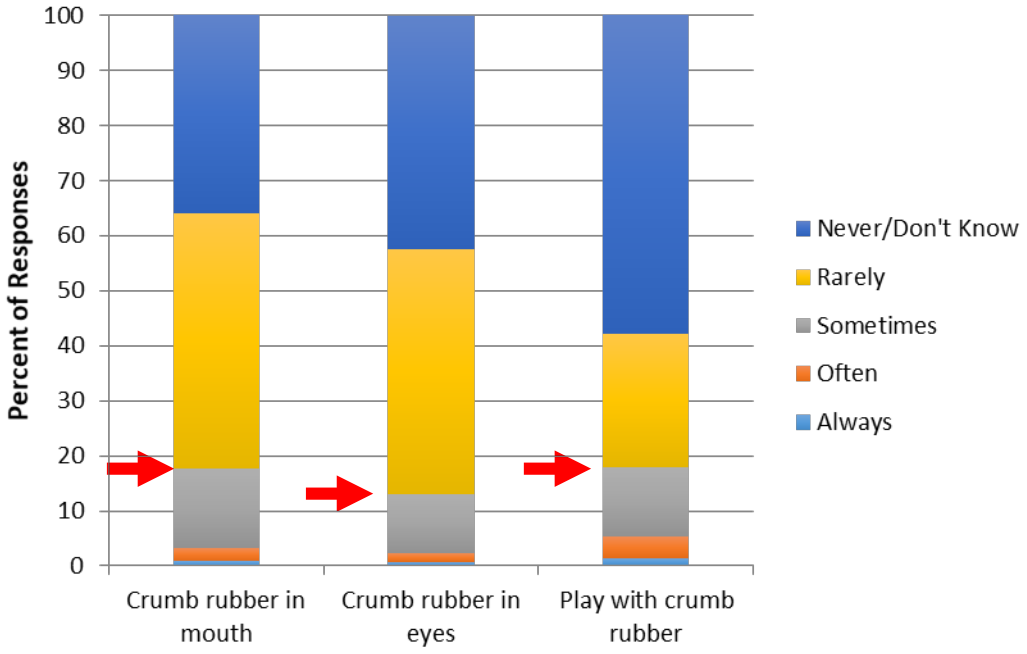
Practices							
Resting (%)		Lightly Active (%)		Moderately Active (%)		Highly Active (%)	
Median	Max	Median	Max	Median	Max	Median	Max
10	55	15	80	30	80	35	100

Games							
Resting (%)		Lightly Active (%)		Moderately Active (%)		Highly Active (%)	
Median	Max	Median	Max	Median	Max	Median	Max
10	90	10	60	30	80	35	100

[1]n=886 with complete responses

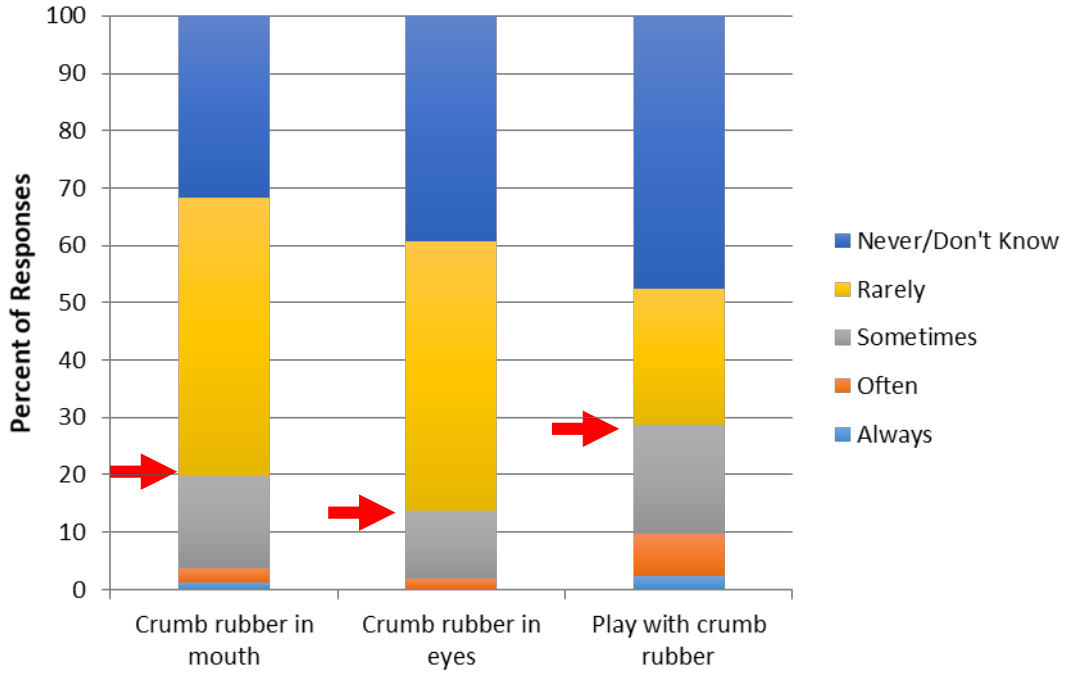
Frequency and Type of Contact with Crumb Rubber During Practices and Games

Practices



- 18% in mouth at least “sometimes”
- 12% in eyes at least “sometimes”
- 18% play with crumb rubber at least “sometimes”

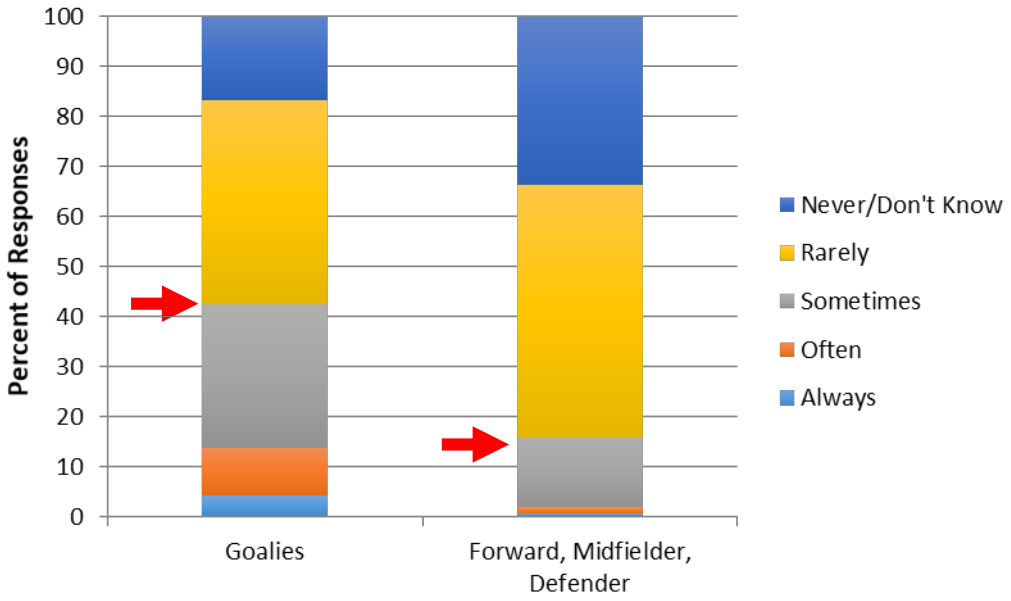
Games



- 20% in mouth at least “sometimes”
- 14% in eyes at least “sometimes”
- 29% play with crumb rubber at least “sometimes”

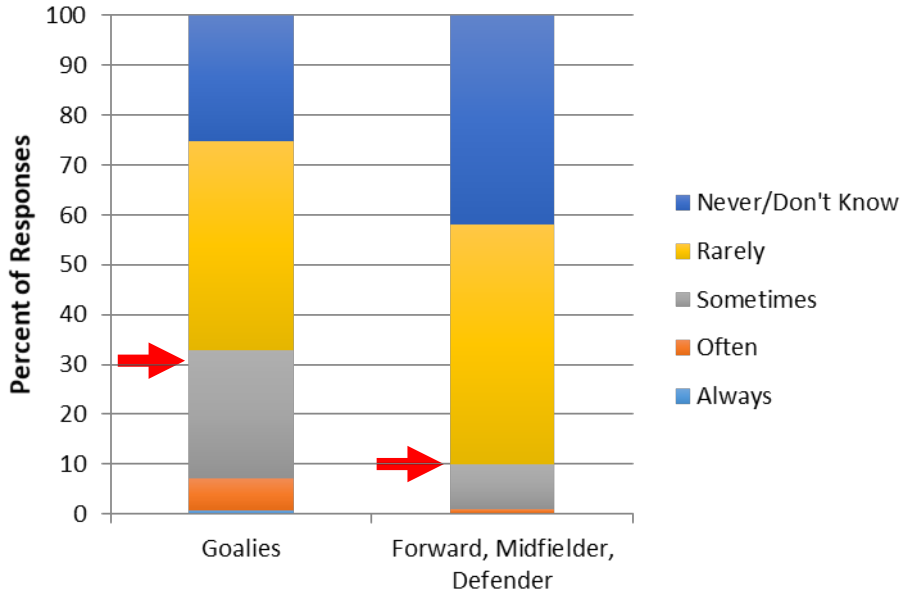
Frequency of Contact with Crumb Rubber During Practice: Goalies vs Other Positions

Crumb Rubber in Mouth



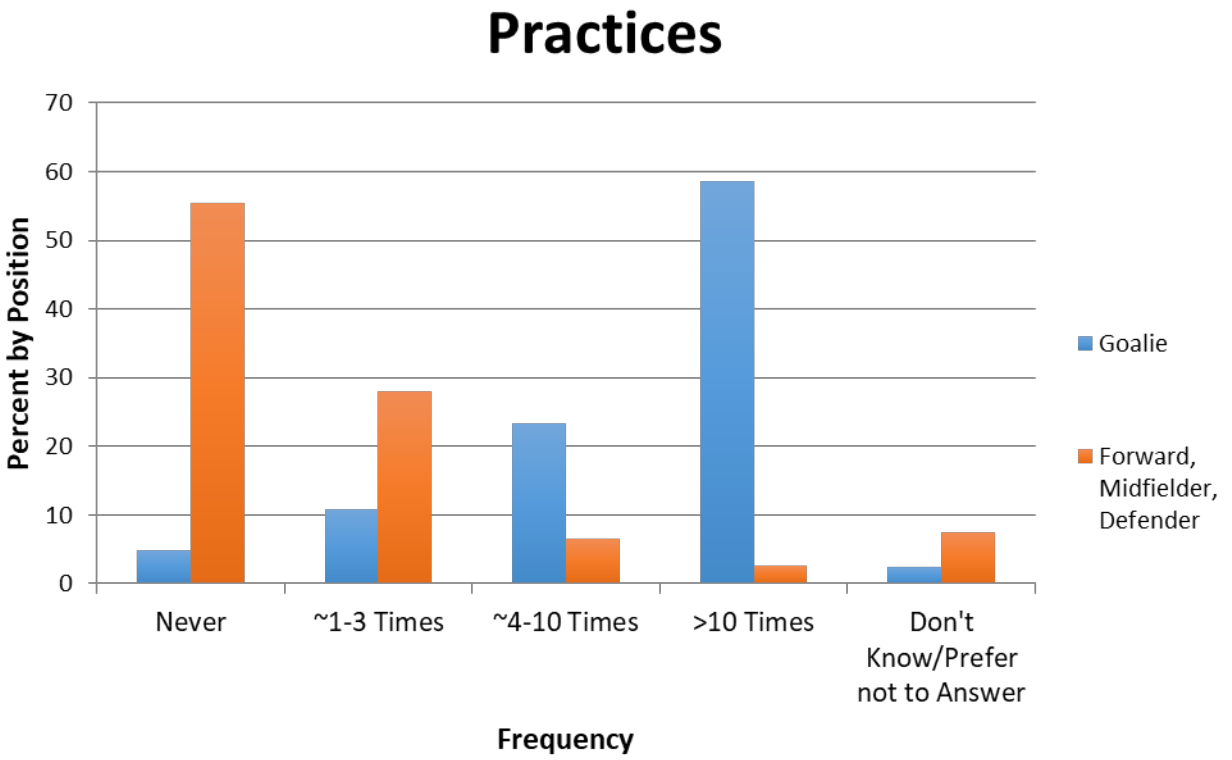
- Goalies: 42% at least “sometimes”
- Others: 16% at least “sometimes”

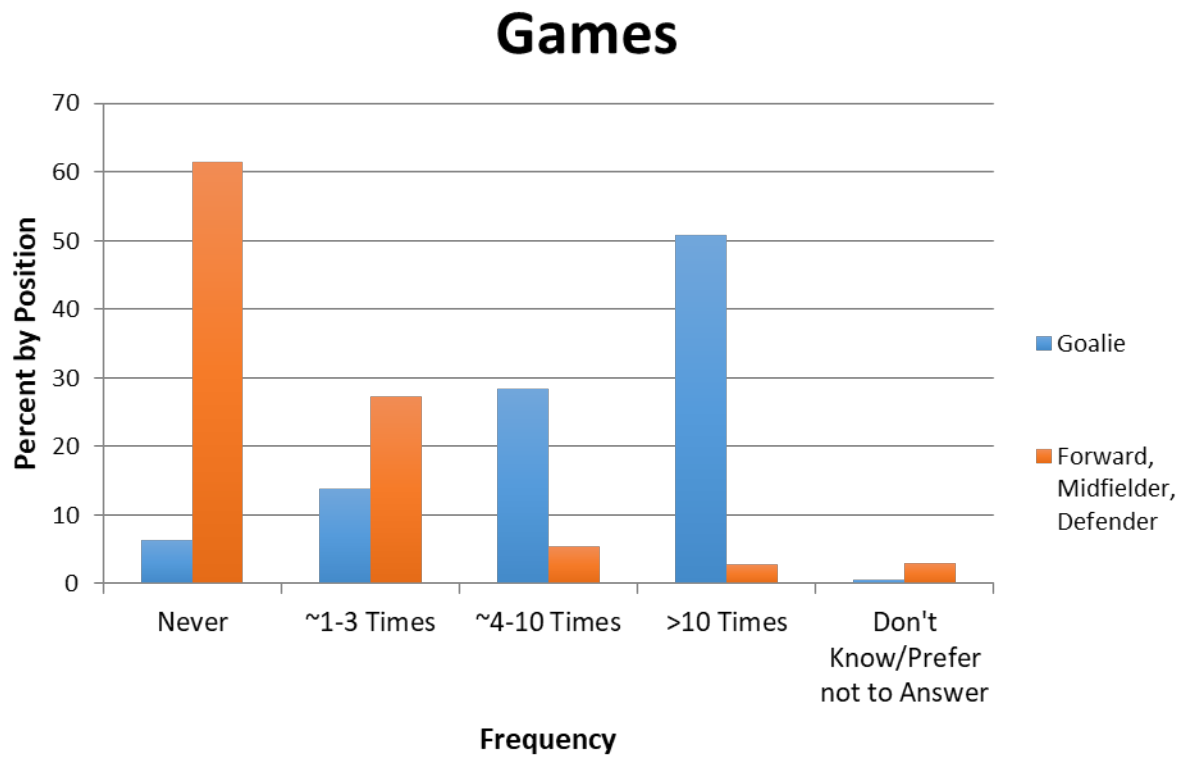
Crumb Rubber in Eyes



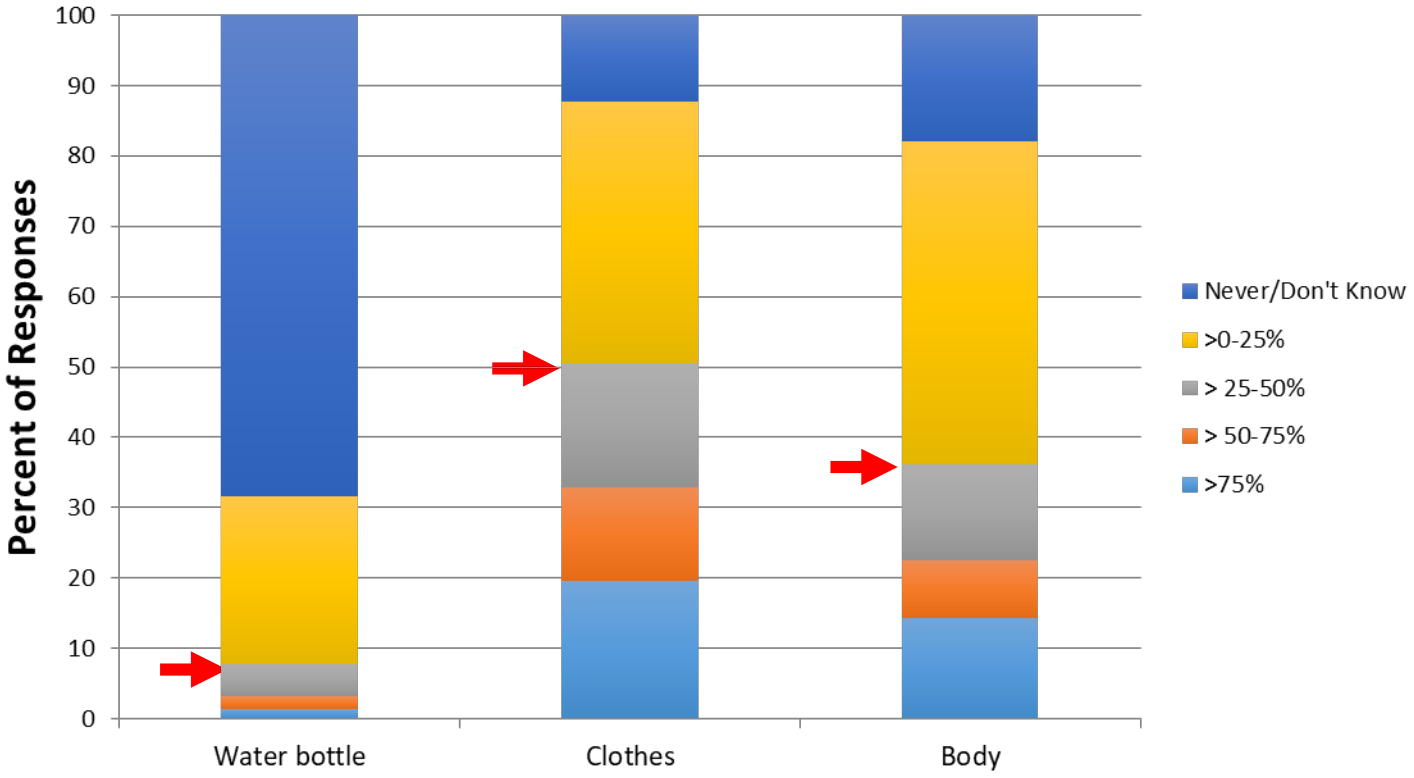
- Goalies: 33% at least “sometimes”
- Others: 10% at least “sometimes”

Dive Frequency: Goalies vs. Other Positions





Frequency Crumb Rubber Observed on Player or Personal Objects After Game or Practice



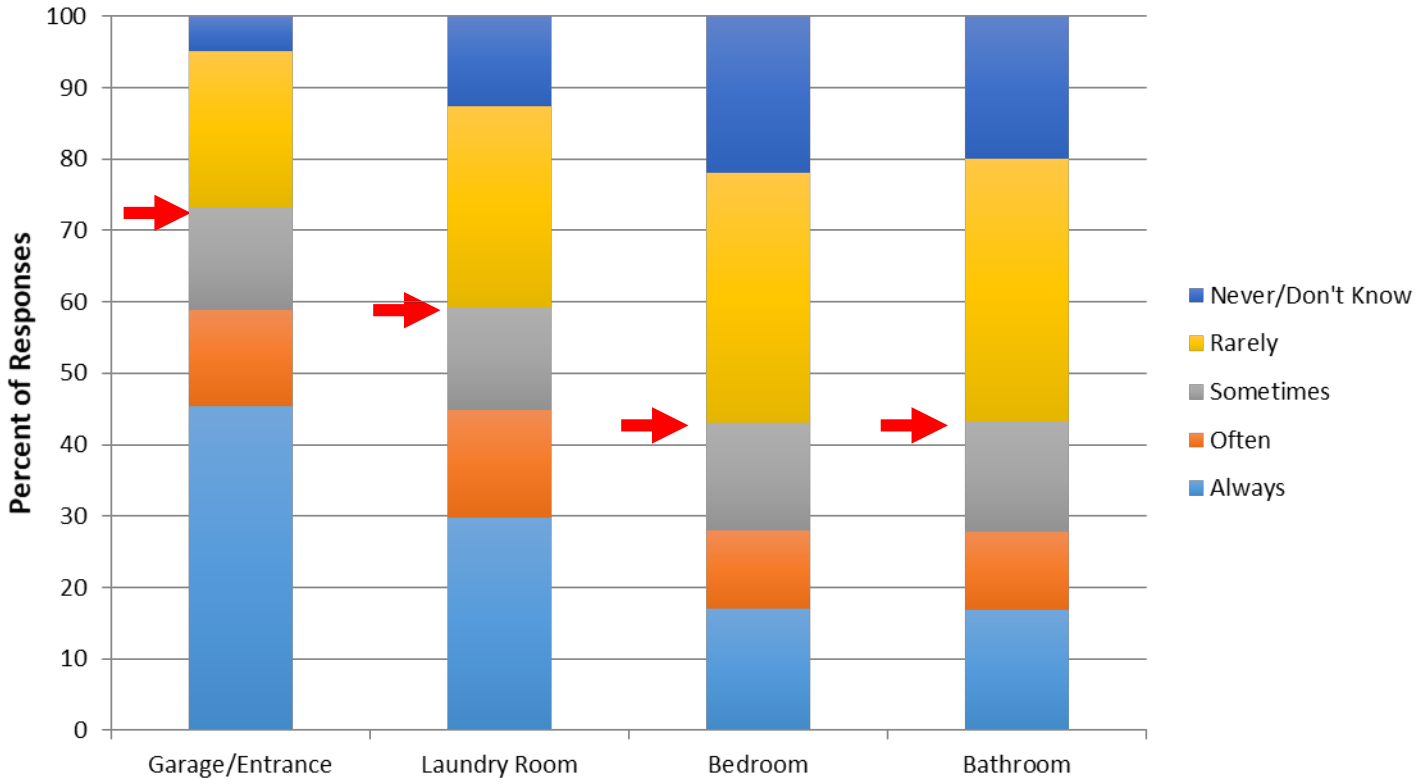
Percent of participants that reported observing crumb rubber at least 25% of the time:

- Water bottle = 8%
- Clothes = 51%
- Body = 36%

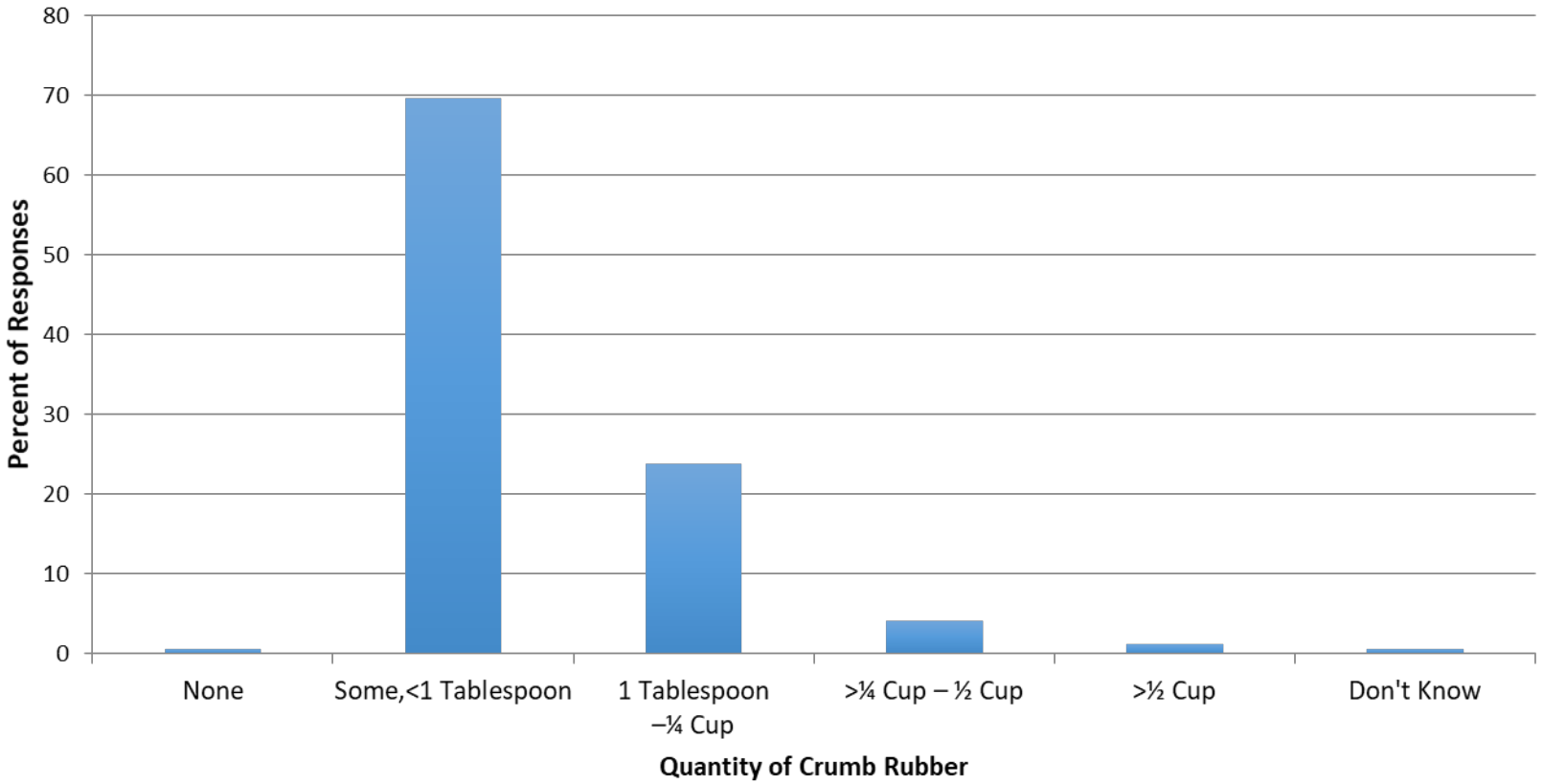
Frequency of Crumb Rubber Observed in Home After Playing Soccer

Percent of participants that reported crumb rubber at least "sometimes":

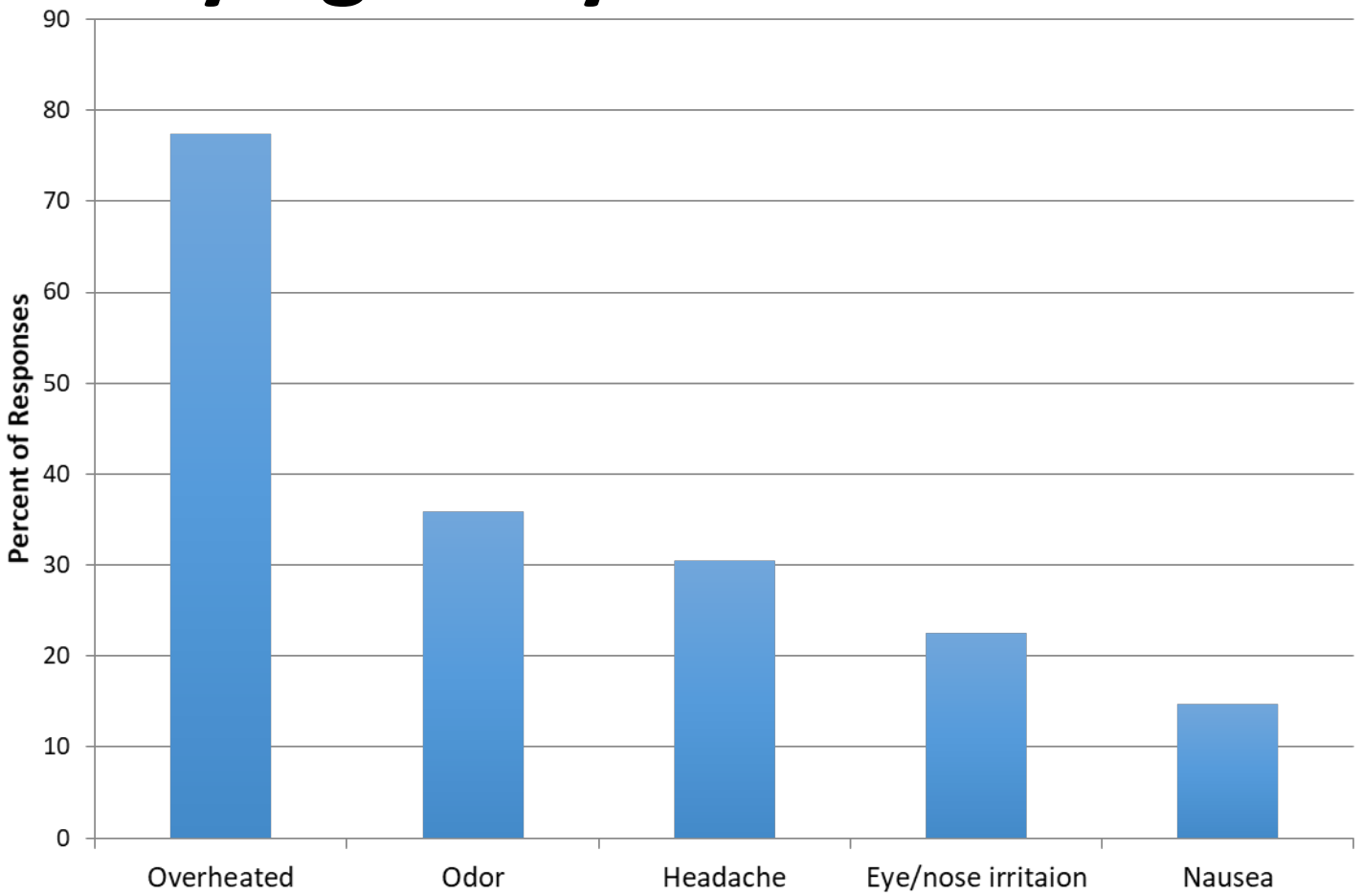
- Garage = 73%
- Laundry room = 59%
- Bedroom = 43%
- Bathroom = 43%



Quantity of Crumb Rubber Observed in Home After Playing Soccer



Reported Player Concerns Related to Playing on Synthetic Turf Fields



Next Steps

- Will analyze time-activity video data summer 2018
- Analyses will include evaluation of:
  - Contact with objects
  - Type of activities and intensity
  - Time spent on field
- Use behavior data to model exposure

Discussion

1. Are the receptor categories and pathways reasonable?
2. Have any receptor categories or pathways been overlooked?
3. Do you agree with the categorization of pathways as negligible or complete?
4. Please comment on the Time-Activity Behavior Study.

Section 3.3
Playground Characterization Study

Section 3.3.1
Draft Playground Sampling Protocol

Presenter: Randy Maddalena, Ph.D, LBNL

Draft Playground Sampling Protocol

Randy Maddalena, Marion Russell, Wm. Woody Delp,

Toshifumi Hotchi and Hugo Destaillats

Lawrence Berkeley National Laboratory

Presentation for Scientific Advisory Meeting

Sacramento, CA, May 25, 2018

Overview

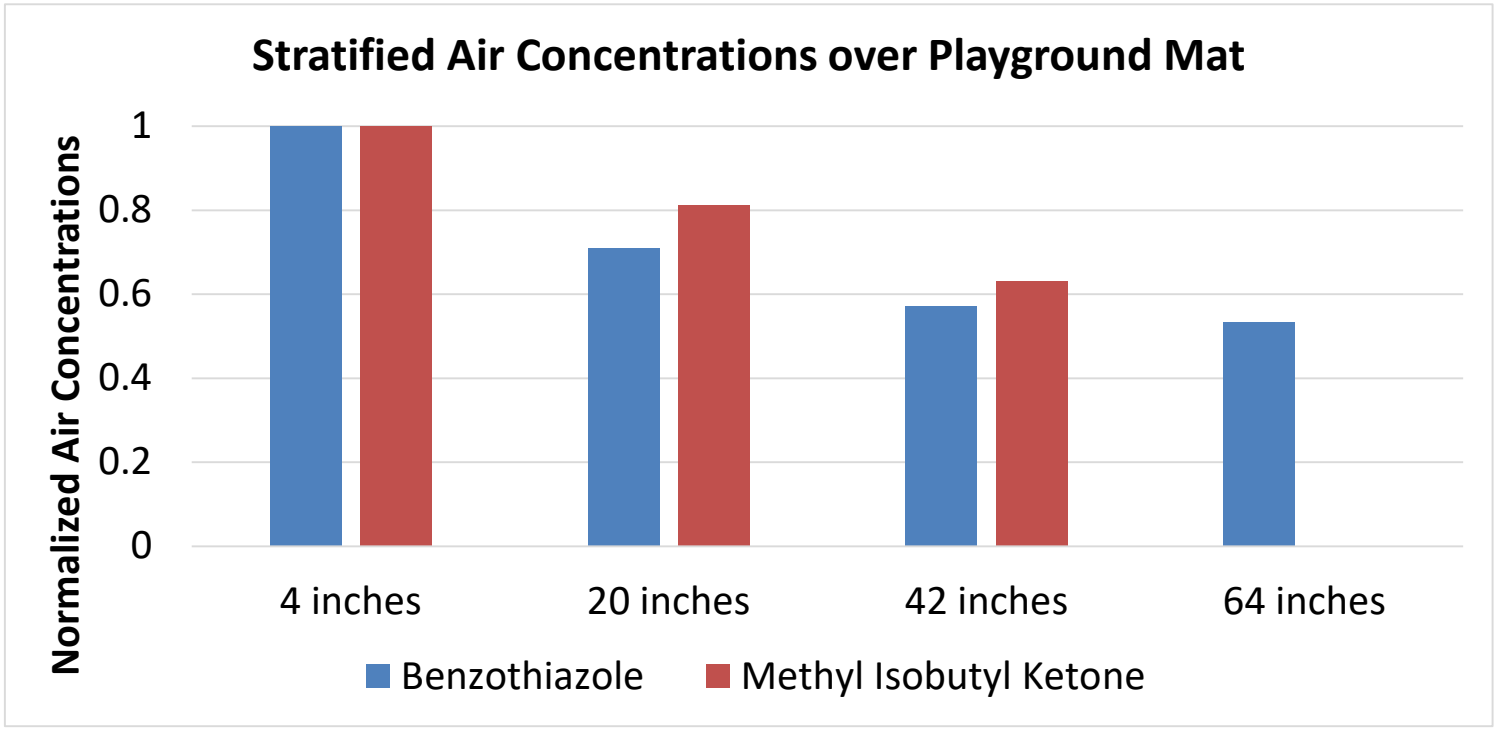
- Description of the typical playground settings
- Protocol for collection of environmental data and air samples
- Protocol for collection of surface samples
- Next steps

Environmental data and air sampling strategy

- Three hour monitoring event near center of play area
- On- and off-playground air and environmental data collected with same packages used for fields
- Playground surface temp collected for sun and shade conditions if feasible and at off-playground location
- No subjects or scripted activity planned but researcher activity will be ongoing

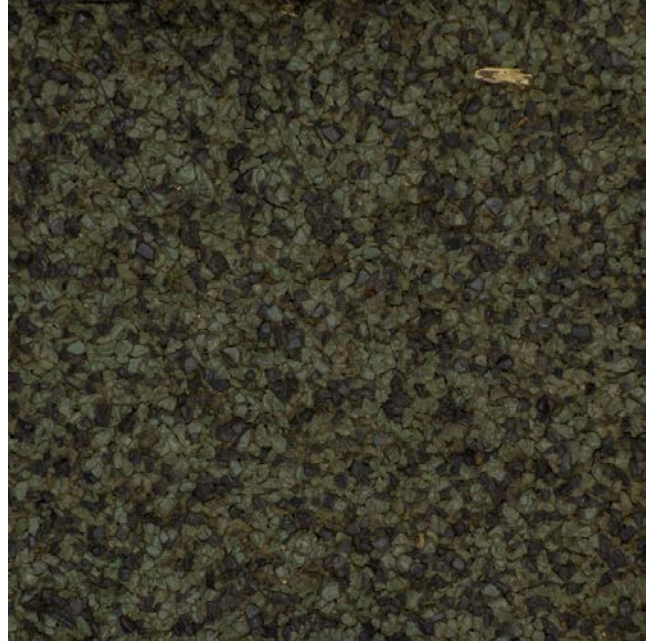
Sampling heights for playground monitoring

- Preliminary data (one playground) shows increasing concentrations for “tire markers” closer to surface
- Suggest setting sample inlet for VOCs/ALD and SVOCs at approximately ½ the breathing zone height for kids or 0.5 meter (~ 20 inches)



- Sampling height for all other measurements taken at 1 meter (40 inches) except for stratified measurements taken from 4 inches up to 64 inches

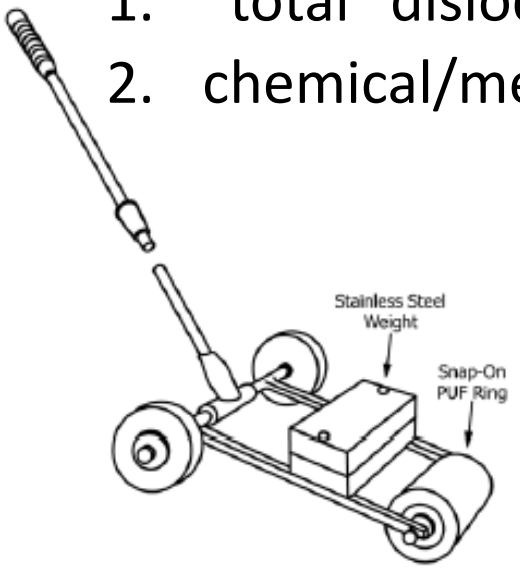
Surface sampling strategy

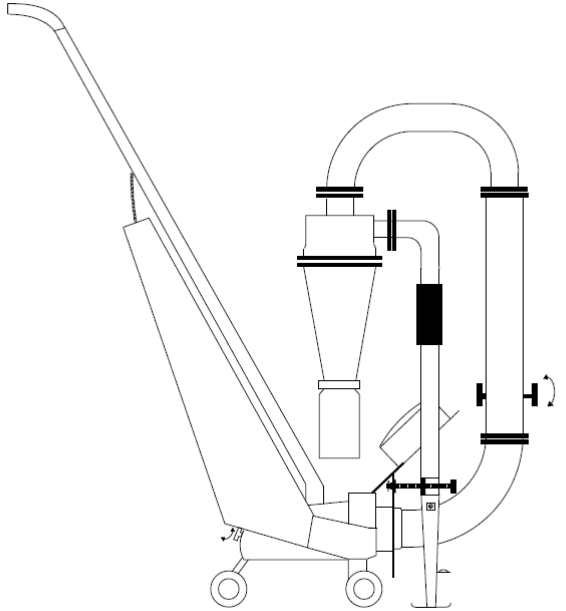


- Playground surfaces are textured like carpet but smooth like vinyl with a more spongy surface than either
- Published methods for collecting “residue samples” from surfaces including
  - blotting with dry or wetted cloth
  - wiping with dry or wetted cloth
  - vacuuming and rolling a sorbent material over surface
  - dragging a weighted sleigh
- Preliminary tests found surface too rough to wipe, too porous to blot, and too crumbly to drag over

Proposed method for playground surfaces

- sample from different locations on mat for elemental (metal) and organic chemical analysis
- use “high volume small surface sampler” HVS3 vacuum to collect surface dust
- use polyurethane foam sorbent material on weighted roller to collect
  1. “total” dislodgeable residue from un-vacuumed surface
  2. chemical/metal residue from previously vacuumed surface





Playground surface sampling schematic

A. Roller sample collected from surface (inside dash line) for metal analysis

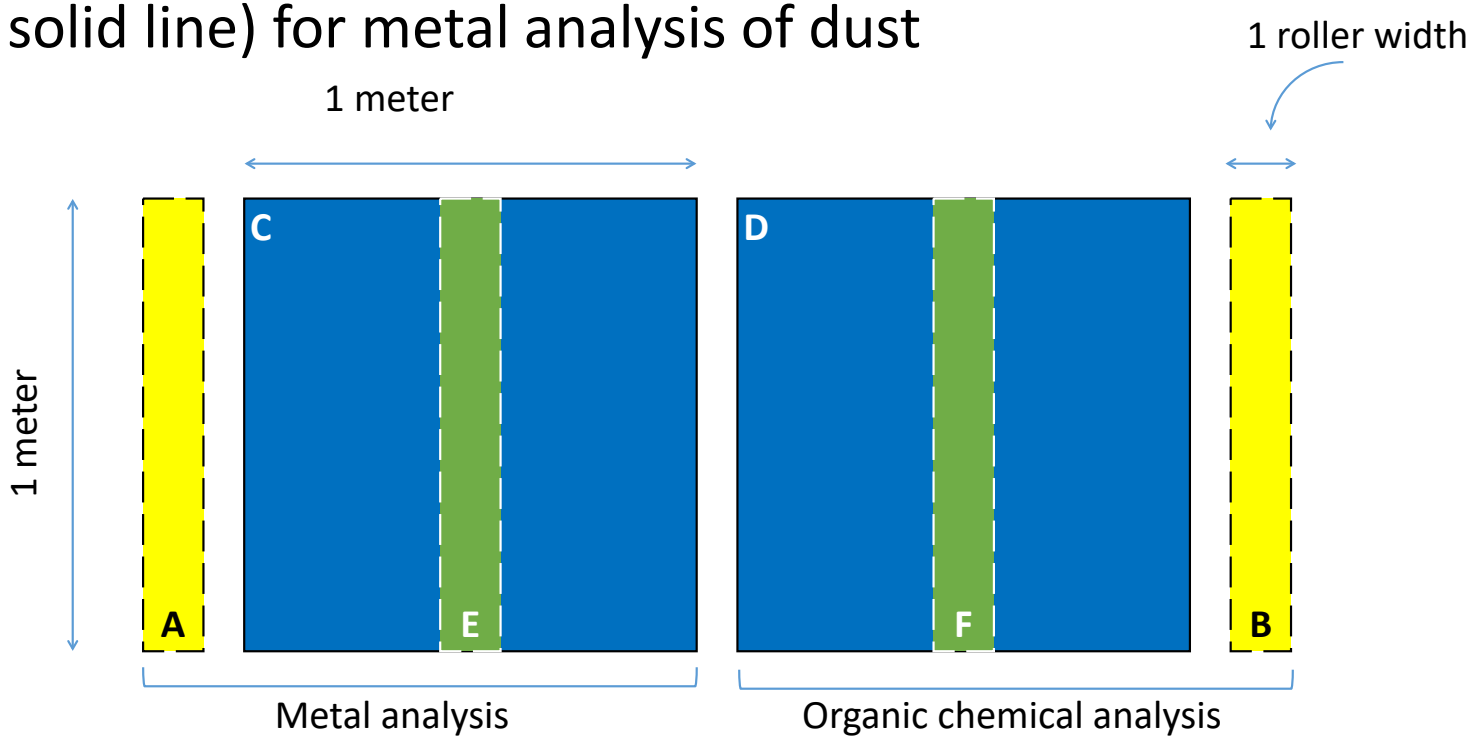
B. Roller sample collected from surface (inside dash line) for organic analysis

C. Vacuum sample collected (inside solid line) for metal analysis of dust

D. Vacuum sample collected (inside solid line) for organic analysis

E. Roller sample collected from vacuumed surface (inside dash line) for metal residue

F. Roller sample collected from vacuumed surface (inside dash line) for organic residue



Discussion

1. Is the draft protocol sufficient for a preliminary study on potential exposure to chemicals released from playground mats made with crumb rubber?
2. Will the activities of collecting the air and particle samples on the mats create enough disturbance to suspend surface dust that may be used to characterize inhalation exposures of young children?
3. Samples proposed to be collected are listed below, along with the *potential uses of the data* in the exposure assessment. Please comment on the proposal that ultimately seeks to collect samples to characterize chemical exposures of young children playing on playground mats. Do you have any additional comments?
    - Air and particle samples collected at or below 0.5 m above surface (*inhalation exposure*)
    - total dislodgeable dust + residue collected with roller from unvacuumed surface (*overall chemical environment, supplement information for estimating dermal adhesion of dust and residue for evaluating the dermal and hand-to-mouth pathways*)
    - surface dust collected with vacuum (*dermal adhesion of particles for evaluating the dermal and hand-to-mouth pathways*)
    - dislodgeable residue collected with roller from vacuumed surface (*dermal adsorption of residue for evaluating the dermal and hand-to-mouth pathways*)

Section 3.3.2. Preliminary Children Hand-to-Mouth Activity Data

Presenter: Asa Bradman, Ph.D., MS, UC Berkeley

Quantification of Micro-level Activities for Children Playing on Playgrounds

Asa Bradman, PhD
Center for Environmental Research and Children's Health
School of Public Health
University of California, Berkeley

Paloma Beamer, PhD
Nicholas Lopez-Galvez, MPH
College of Public Health
University of Arizona

Context

- Challenge to collect time-activity data for young children
- California-specific data available for young children
- Valuable data to inform exposure modeling

Objective

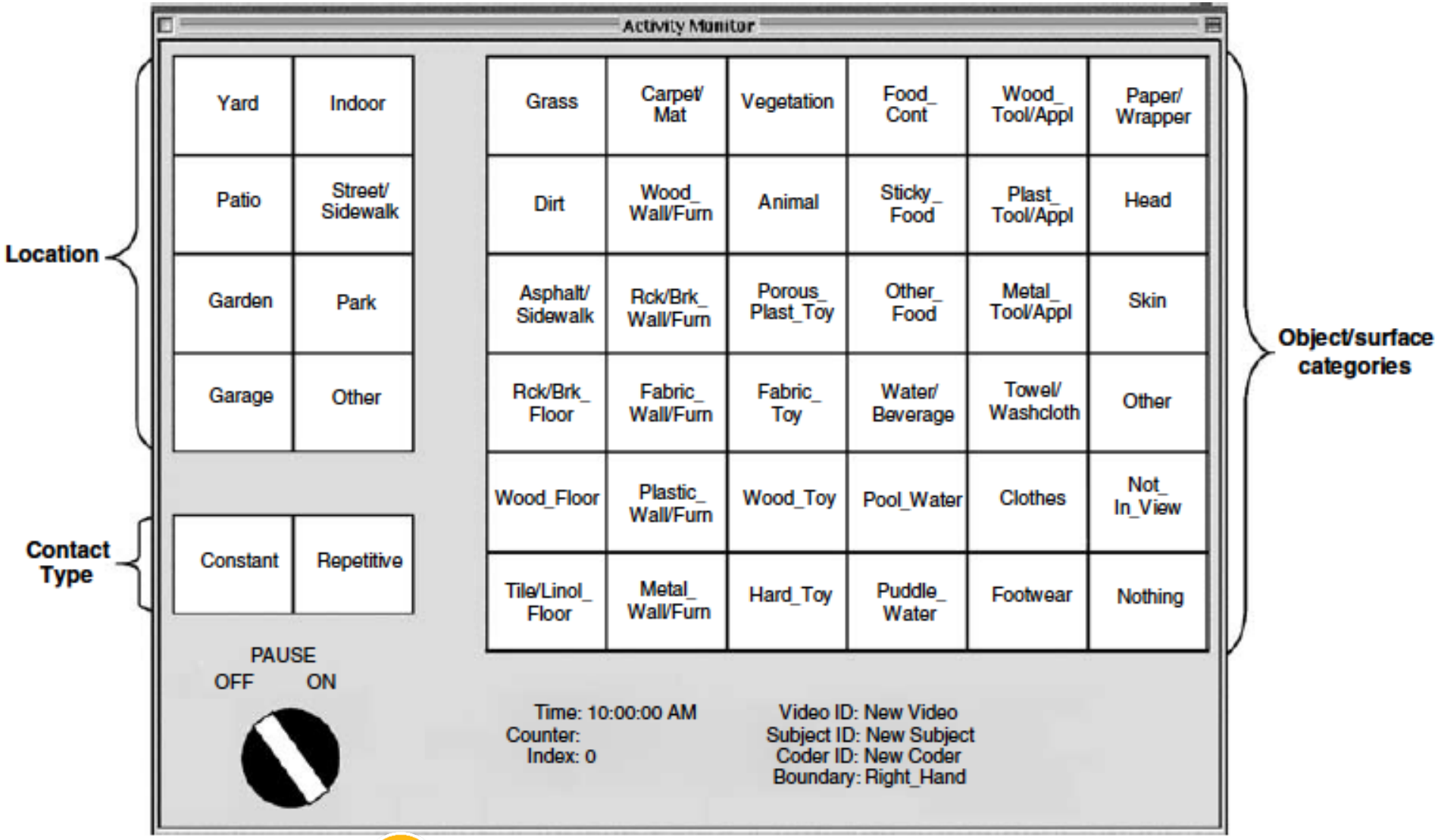
- To quantify dermal and mouthing activity in young children playing in playground environments
- Methods
  - We analyzed existing micro-level activity time series (MLATS) data and video footage of 24 children collected by Stanford's Exposure Research Group in 1998-2000.
  - Videotapes were transcribed to provide a second-by-second time series of everything a child contacted with their hands or mouth, as well as location and activity levels.

See references for study background: AuYeung et al., 2004; AuYeung et al. 2006; Ferguson et al., 2006; Beamer et al. 2008

Characteristics of children (n=24 total)

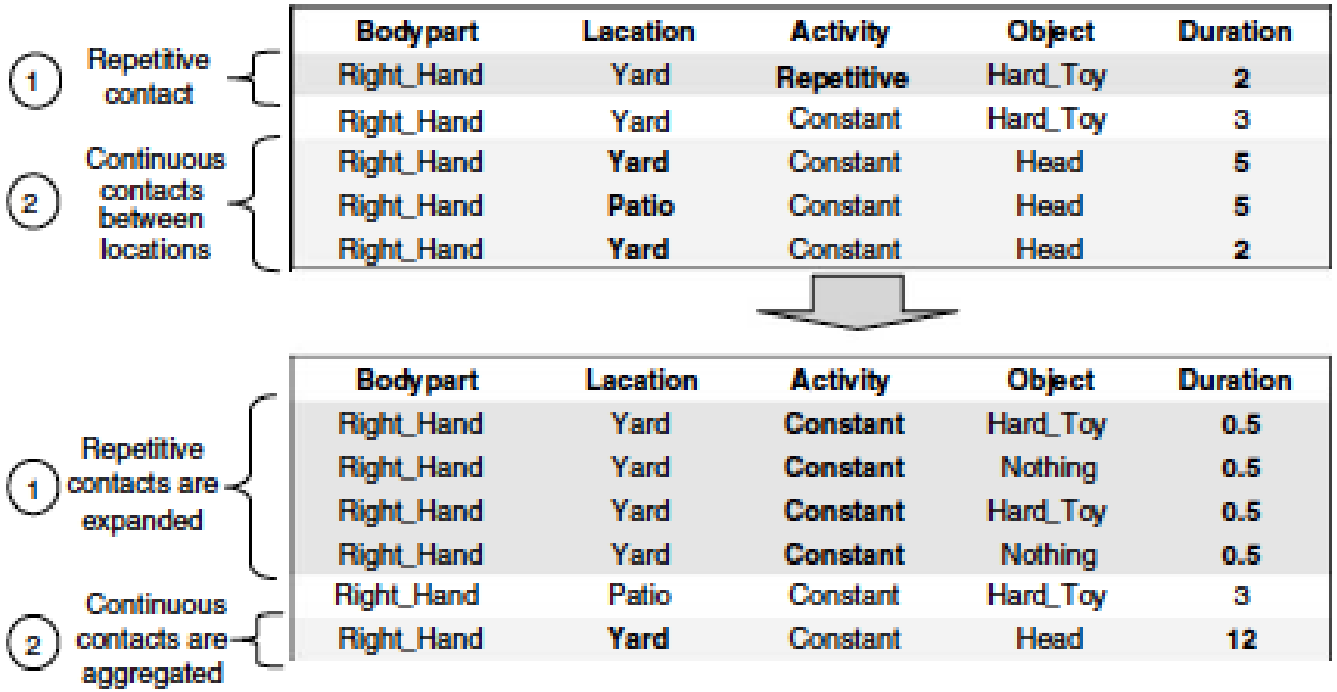
Gender	Age Groups (Years)				
	1 to <2	2 to <3	3 to <6	6 to <11	Total
Male	3	4	4	0	11
Female	2	1	4	6	13
Total	5	5	8	6	24

Example Palette from Software



Data Collection

- For this analysis:
  - Archived videotapes were reviewed to determine the time each child played in playground environments;
  - Activity data was quantified to describe:
    - Contact frequency
    - Hourly duration



Data processing

- We reanalyzed existing videotapes of children playing on playground structures (n=24).

Selected categories for object/surfaces on playgrounds	
Location	
Outdoor	Yard, Park, Garden, Patio, Driveway/Parking
Specific location	Playground
Objects categories	
Floors	Dirt, Asphalt, Rock floor, wood floor, tile, carpet/mat
Dietary objects	Water/beverage, sticky food, other food, food container
Non-Dietary objects	Everything, but dietary categories
Hands*	Hands
All objects/surfaces	Wood wall, wood tools, wood toy, vegetation, hard toys, porous plastic toys, fabric toys, plastic tool, plastic wall, paper, pool water, puddle water, metal wall, metal tool, footwear, deck floor, tile floor, rock floor, sidewalk, dirt
*** Only used for mouthing events**	

Data Analysis

- We quantified activities, including:
  - Right hand, left hand, and mouth contact frequency
    - Total # contact with a specific object/total time child was in view
  - Contact duration
    - Total time that hand or mouth was in contact with object/total time child was in view
- Data were summarized by age and gender

Time spent on Playground

Playground (n=24)	Time in view	Time not in view
Total observed minutes	531.0	38.2
Median time per child (minutes)	21.0	0.3

- There were no significant differences in contact frequency or duration with object/surfaces between **right and left hand**, *so both hands summarized together*

Contact frequency (n=24)

Hands

	Floors	Dietary	Non-Dietary	All Objects
Min	0.0	0.0	30.6	30.6
Median	12.1	0.0	261.4	262.3
p75	36.3	0.6	401.0	401.6
p95	141.2	10.8	634.2	634.2
Max	786.6	15.9	991.7	991.7

Mouth

	Floors	Hands	Dietary	Non-Dietary	All Objects
Min	0	1.4	0.0	0.0	0.0
Median	0	9.8	0.0	10.2	20.4
p75	0	25.4	3.2	30.3	66.0
p95	0	67.5	313.4	82.5	335.0
Max	2.3	67.5	379.0	218.2	379.0

Event/hour

Contact duration (n=24)

Hands

	Floors	Dietary	Non-Dietary	All Objects
Min	0.0	0.0	23.0	23.0
Median	0.4	0.0	33.4	34.1
p75	2.3	0.1	36.5	36.7
p95	9.7	5.0	38.6	39.7
Max	10.1	22.2	39.7	59.6

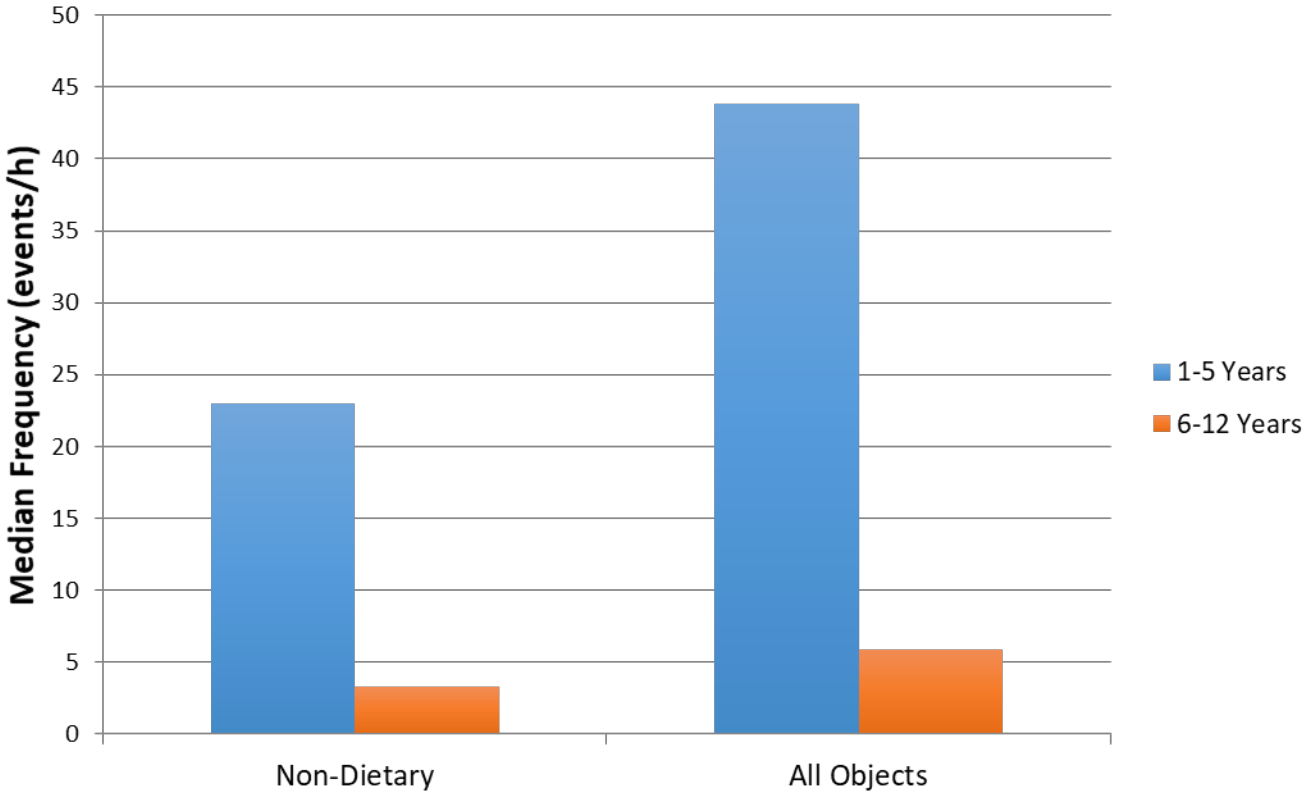
Mouth

	Floors	Hands	Dietary	Non-Dietary	All Objects
Min	0.0	0.02	0.0	0.0	0.0
Median	0.0	0.3	0.0	0.3	0.8
p75	0.0	0.7	0.2	1.3	3.8
p95	0.0	5.0	11.4	5.0	16.6
Max	0.0	5.0	16.5	20.0	20.0

Minutes/hour

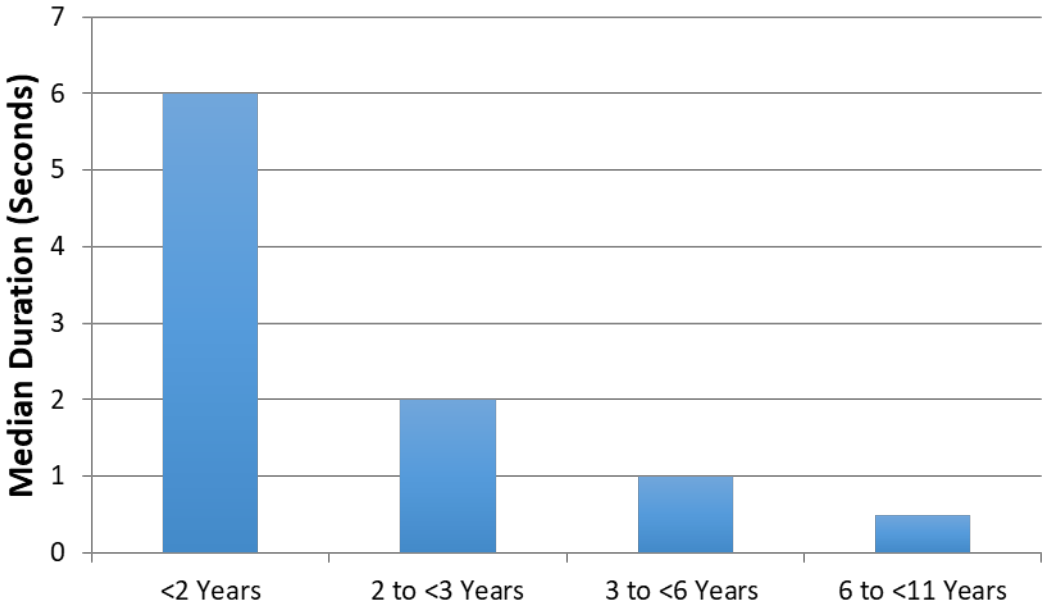
Age differences in mouthing frequency

- Mouthing frequency was significantly higher among younger children (n=24)

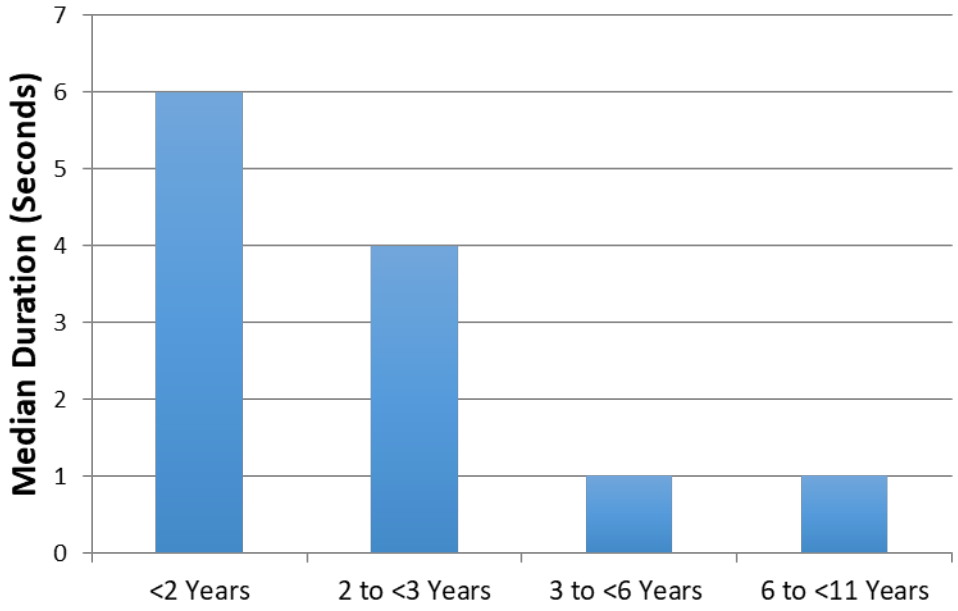


Age differences in mouthing duration

Non-Dietary



All Objects



Median mouthing duration with non-food objects also significantly higher in younger compared to older age groups (n=24)

Summary and Next Steps

- Wide variability in children's interaction with playground environments
- Differences were observed by age
- Study provides important information that will inform exposure modeling
- Next steps: analyze MLATS data for contact and duration for other body parts

References

- AuYeung, W., Canales, R.A., Beamer, P., Ferguson, A.C., and J.O. Leckie. (2004). "Young Children's Mouthing Behavior: An Observational Study via Videotaping in a Primarily Outdoor Residential Setting." *J Children's Health*, 2 (3-4), pg. 271-295
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- Beamer, P., Key, M.E., Ferguson, A.C., Canales, R.A., AuYeung, W., and J.O. Leckie. (2008) "Quantified Activity Pattern Data from 6-to-27-Month-Old Farmworker Children for Use in Exposure Assessment." *Environ Res*, 108: 239-246. PMID: 18723168.
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Discussion

Please comment on the children activity data