Campus-Community Partnership for Reducing Air Pollution in the Bathurst Quay Neighborhood

Air quality progress update

Public meeting

Jan 27, 2022 7-8:30pm

Map of Bathurst Quay Neighborhood

Bathurst Quay Air Quality Study

During spring/summer 2019, representatives from BQNA met with the research team, Ports Toronto, the City of Toronto and identified the following project objectives:

Understand population exposure and the contribution of different sources to air pollution in the neighbourhood

Disseminate knowledge that can help inform planning/policy regarding land-use, transportation, and airport operations

Exposure assessment and source contribution

- To better understand exposure and identify the contribution of the airport and road traffic to air pollution, the research team has put together a plan for air quality data collection that involves:
  - Installing fixed monitors at rooftop and ground level at different locations in the neighborhood
  - Conduct mobile sampling to better map near-road air pollution
  - Conduct indoor/outdoor monitoring using low cost sensors

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  - Conduct indoor/outdoor monitoring using low cost sensors

Since fixed monitors are crucial for the analysis of source contribution, these measurements will resume once the level of commercial flights is closer to normal

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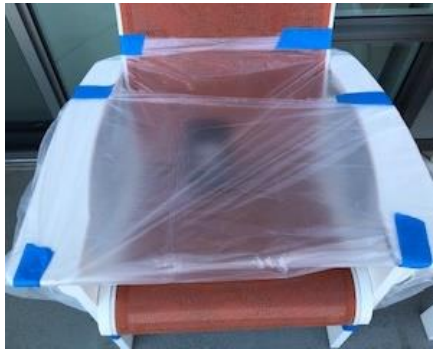
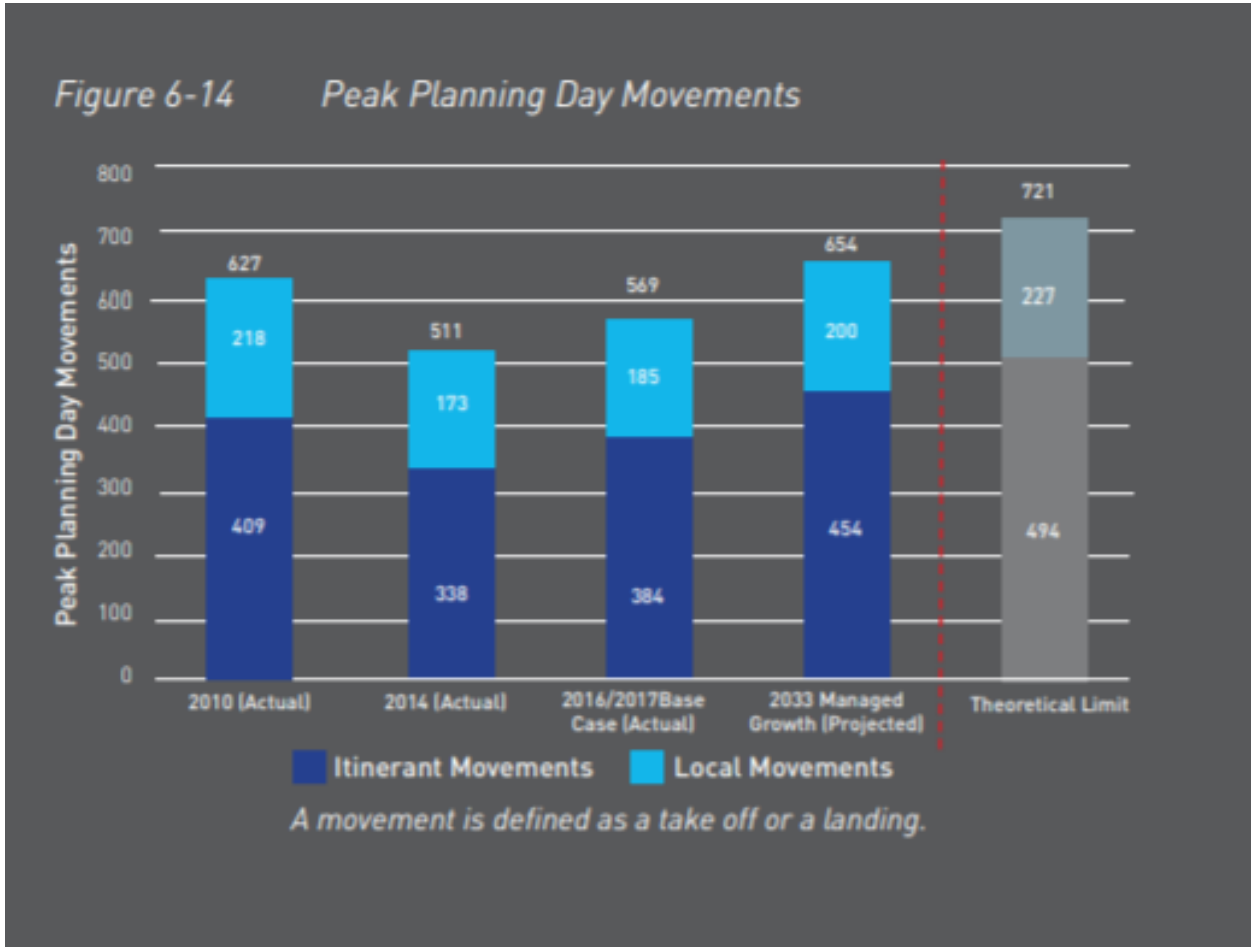
  - Conduct indoor/outdoor monitoring using low cost sensors



This effort continued during the pandemic, despite lower airport operations

Benchmarking and planning remains crucial because of proposed increased airport activity in the future. How can we grow more sustainably?



Source: 2018 Airport Master Plan (Billy Bishop Toronto City Airport, 2018)

The value of indoor/outdoor monitoring using low cost sensors

Helps us understand trends in indoor and outdoor air pollution, using one indicator, the number of fine particles in the air

Helps understand the effect of outdoor particle counts on indoor levels

Helps create a benchmark of air pollution data before airport operations resume to full-capacity

Could be used to visualize the impact of traffic and the airport

Campaign Year	Week	Dates	Indoor	Outdoor	Flight Data
2020	1	Feb 25 - Mar 5	X		
	2	Mar 11 - Mar 18*	X		
	3	Jun 18 - 25	X		
	4	Jun 30 - Jul 7	X		
	5	Jul 10 - 20	X		
	6	Jul 23 - 30	X	X	
	7	Aug 6 - 14	X	X	
	8	Aug 20 - 29	X	X	
2021	9	Feb 4 - 11	X		
	10	Feb 18 - 25	X		
	11	Mar 4 - 11	X		
	12	Mar 18 -25	X		
	13	Apr 1 - 8	X	X	
	14	Apr 15 - 22	X	X	X
	15	Apr 29 - May 6	X	X	X
	16	May 13 - 20	X	X	X
	17	May 27 - Jun 3	X	X	X
	18	Jun 10 - 17	X	X	
	19	Jun 21 - 28	X	X	

Campaign Year	Week	Dates	Indoor	Outdoor	Flight Data
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	4	Jun 30 - Jul 7	X		
	5	Jul 10 - 20	X		
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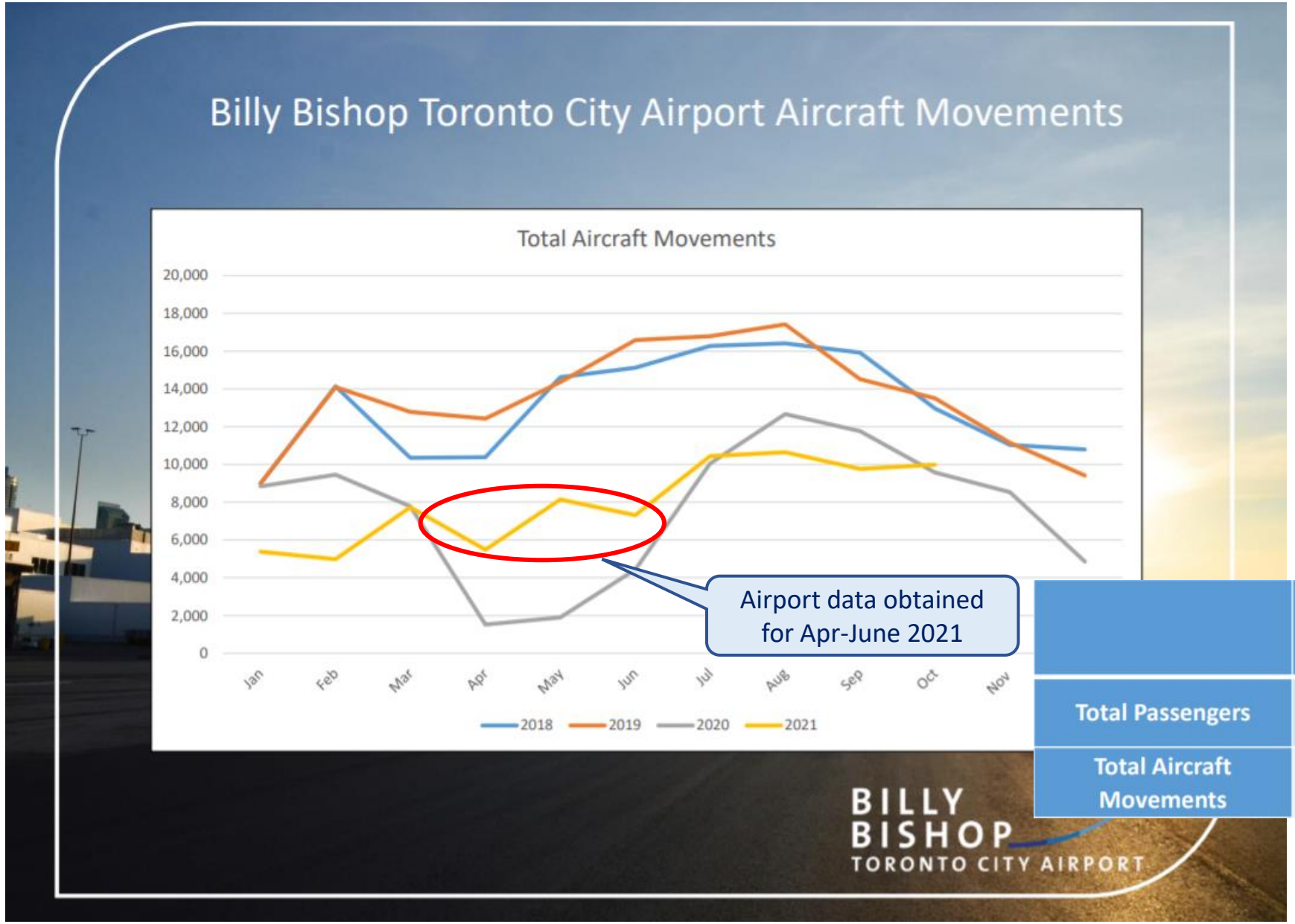
	7	Aug 6 - 14	X	X	
	8	Aug 20 - 29	X	X	
2021	9	Feb 4 - 11	X		
	10	Feb 18 - 25	X		
	11	Mar 4 - 11	X		
	12	Mar 18 -25	X		
	13	Apr 1 - 8	X	X	
	14	Apr 15 - 22	X	X	X
	15	Apr 29 - May 6	X	X	X
	16	May 13 - 20	X	X	X
	17	May 27 - Jun 3	X	X	X
	18	Jun 10 - 17	X	X	
	19	Jun 21 - 28	X	X	

Explore whether the effect of the airport could be visualized despite lower activity

	October vs 2019	Year to Oct vs 2019
Total Passengers	32%	5%
Total Aircraft Movements	74%	56%

Source: Restart and Recovery of Air Service: Overview (Billy Bishop Toronto City Airport, 2021)



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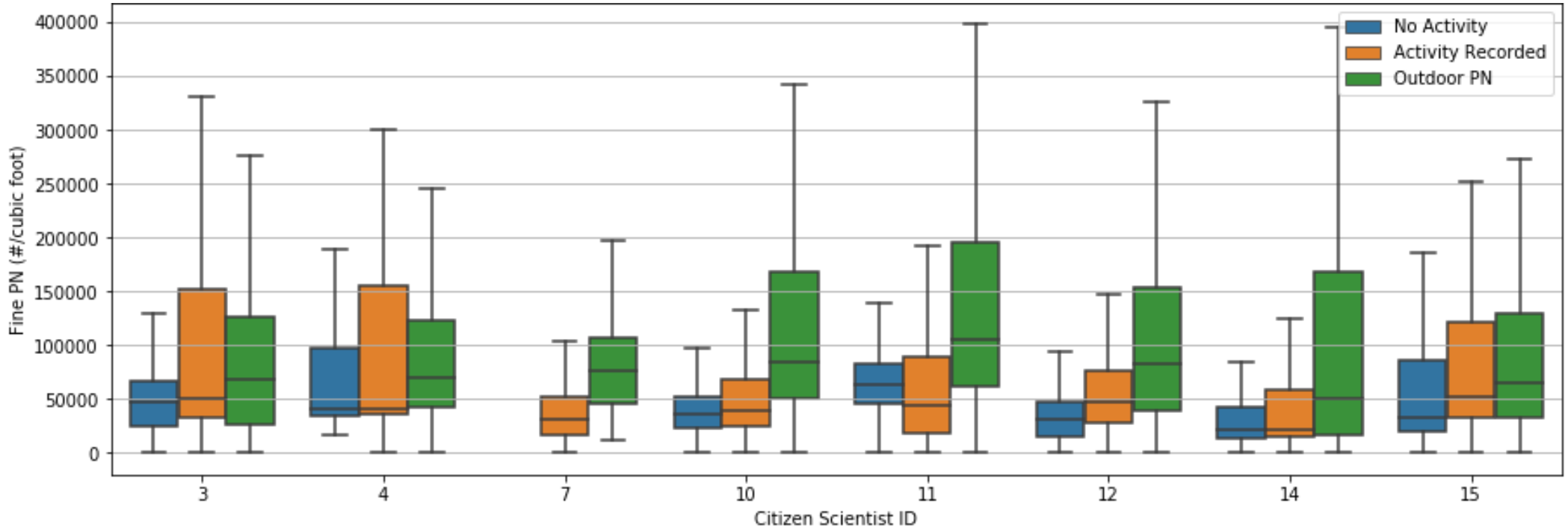
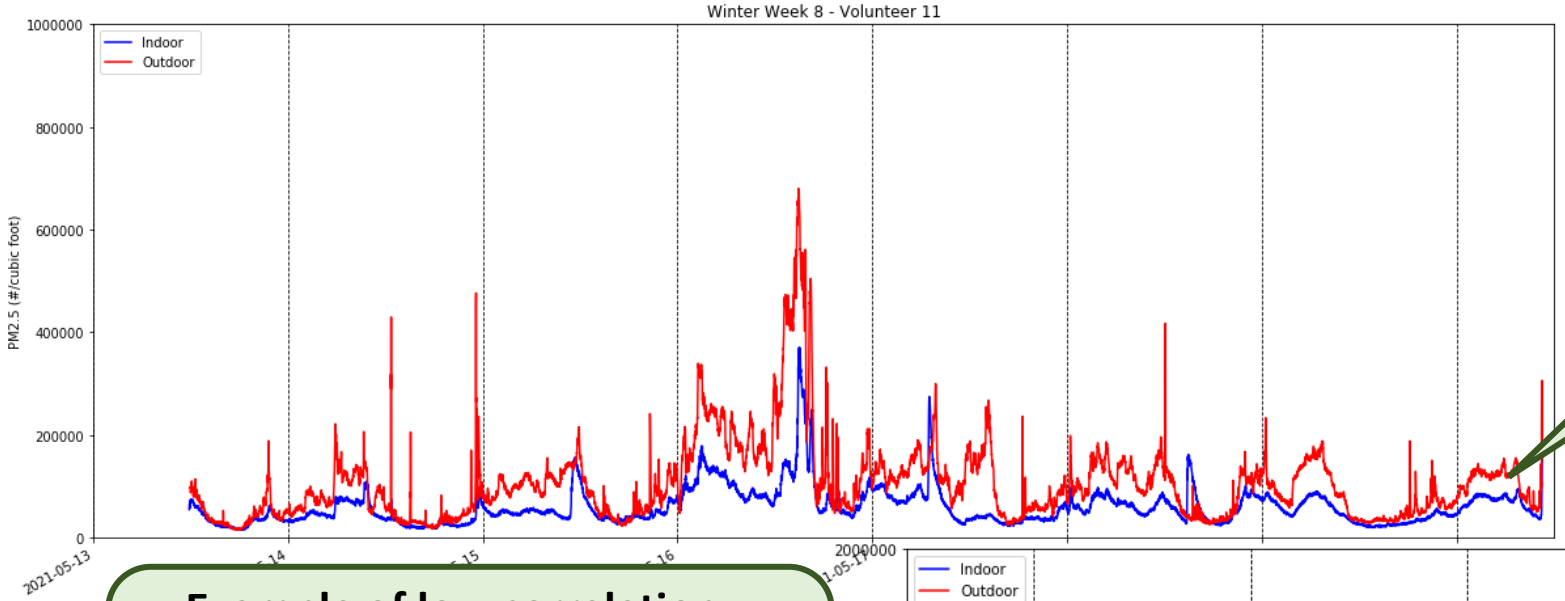
Trends between indoor and outdoor levels

- Fine PN counts are generally higher outdoors
- Indoor levels increase during cooking, cleaning, exercise, opening windows
- There is a variability in indoor and outdoor levels across homes

Fine PN Count 1) Indoors without Activity, 2) Indoors with Activity, and 3) Outdoors by Citizen Scientist (2021 Campaign)

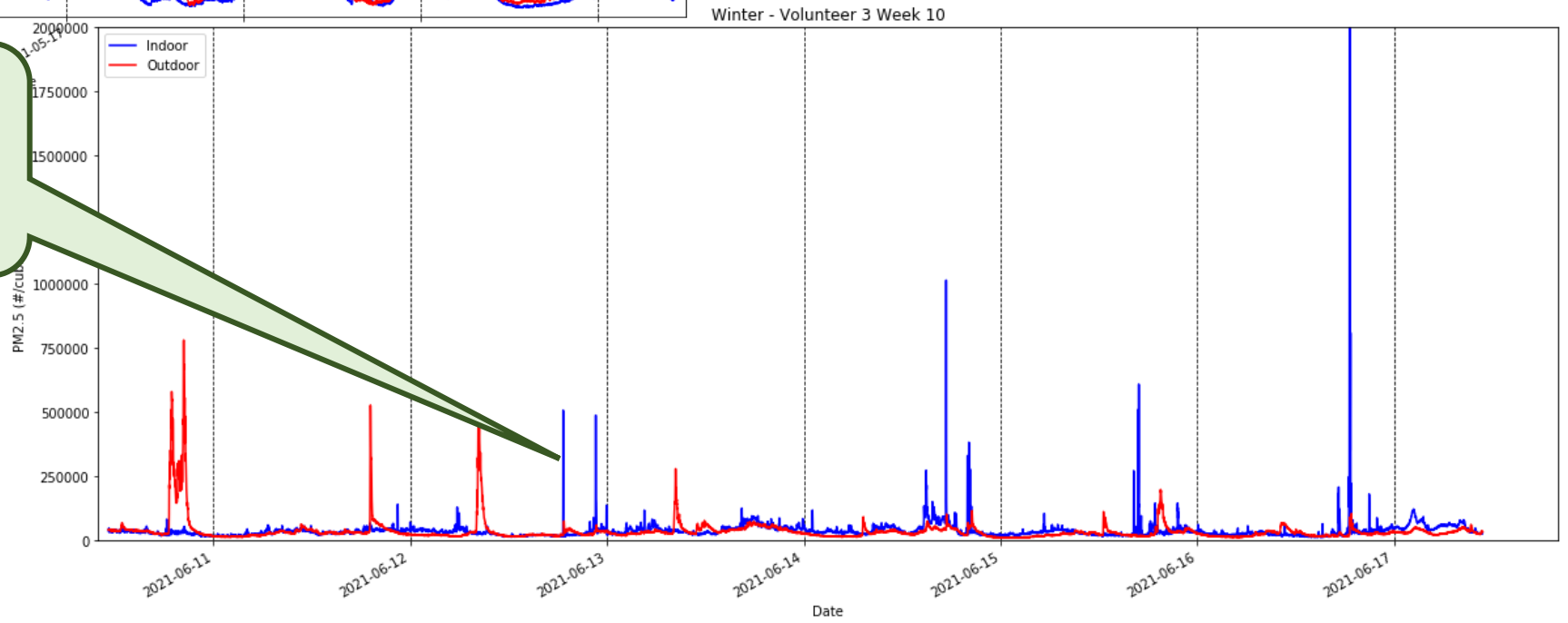


Using indoor AQ data, it is hard to quantify the influence of traffic and the airport because indoor AQ can be driven by indoor activities



Example of high correlation – indoor follows outdoor signal
ρ = 0.66

Example of low correlation – indoor trends driven by indoor activities
ρ = -0.19



Correlation measures how strongly related the indoor and outdoor levels are (move up and down together)

In the next set of analyses, we will focus on outdoor data only

Campaign Year	Week	Dates	Indoor	Outdoor	Flight Data
2020	1	Feb 25 - Mar 5	X		
	2	Mar 11 - Mar 18*	X		
	3	Jun 18 - 25	X		
	4	Jun 30 - Jul 7	X		
	5	Jul 10 - 20	X		
	6	Jul 23 - 30	X	X	
	7	Aug 6 - 14	X	X	
	8	Aug 20 - 29	X	X	
2021	9	Feb 4 - 11	X		
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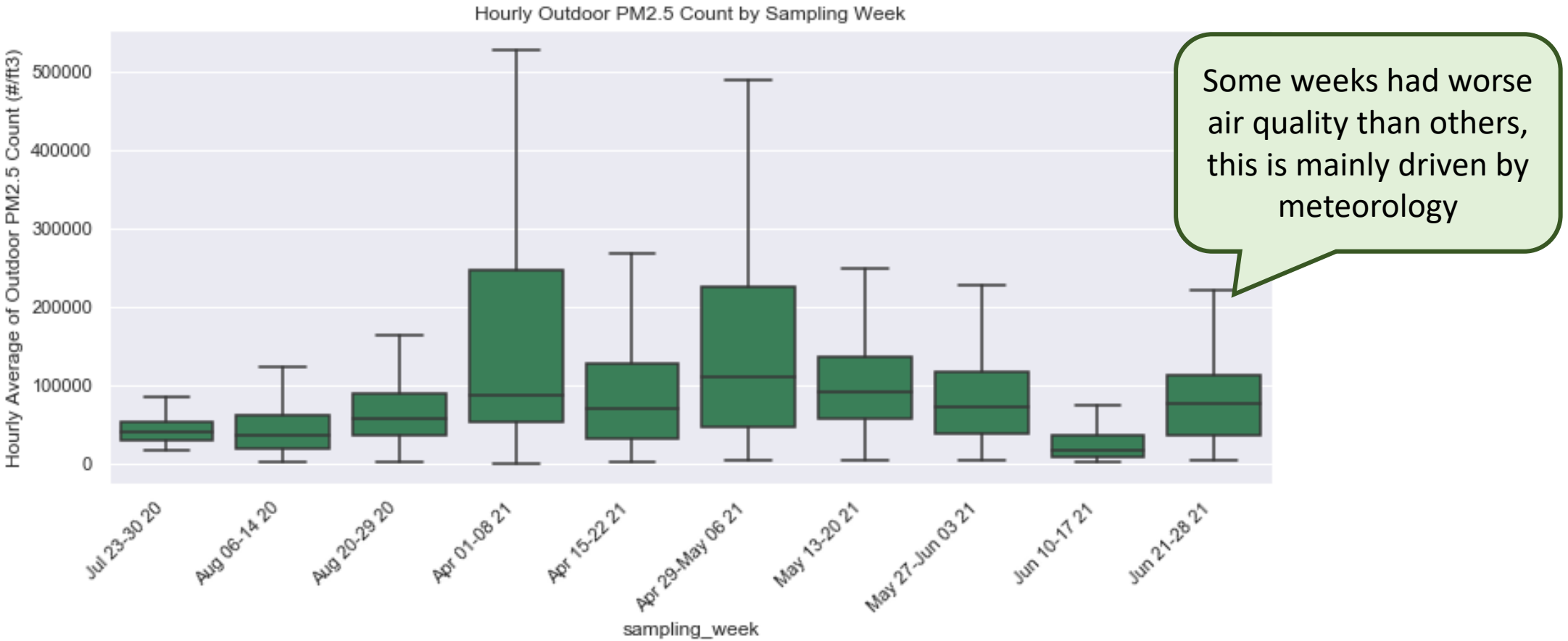
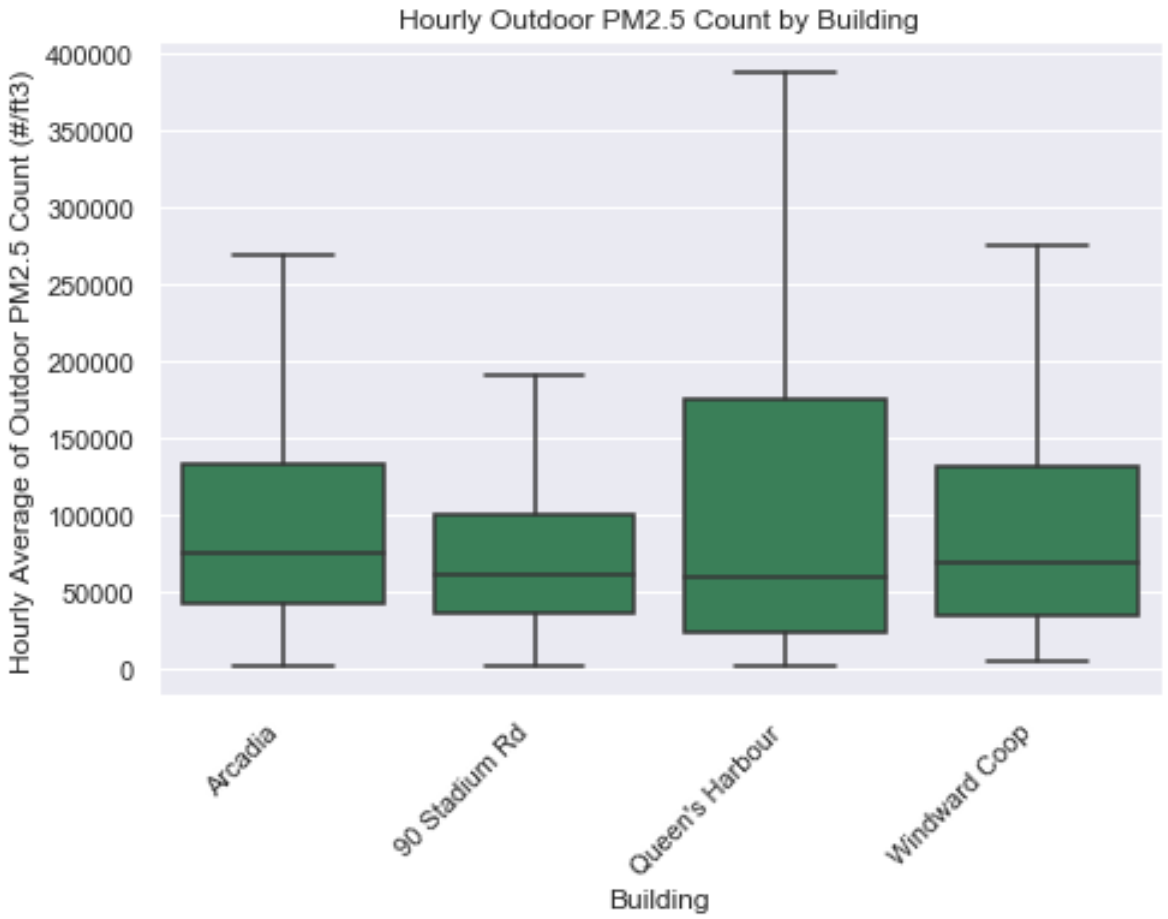
	15	Apr 29 - May 6	X	X	X
	16	May 13 - 20	X	X	X
	17	May 27 - Jun 3	X	X	X
	18	Jun 10 - 17	X	X	
	19	Jun 21 - 28	X	X	



Sampling Week	# Unique Monitors	Total Hours	Sampling Week	# Unique Monitors	Total Hours
Jul 23-30, 2020	2	173	**Apr 29-May 06, 2021**	6	303
Aug 06-14, 2020	5	224	**May 13-20, 2021**	5*	395
Aug 20-29, 2020	5	365	**May 27-Jun 03, 2021**	6	542
Apr 01-08, 2021	4	360	**Jun 10-17, 2021**	2**	66
Apr 15-22, 2021	6	272	**Jun 21-28, 2021**	3	183

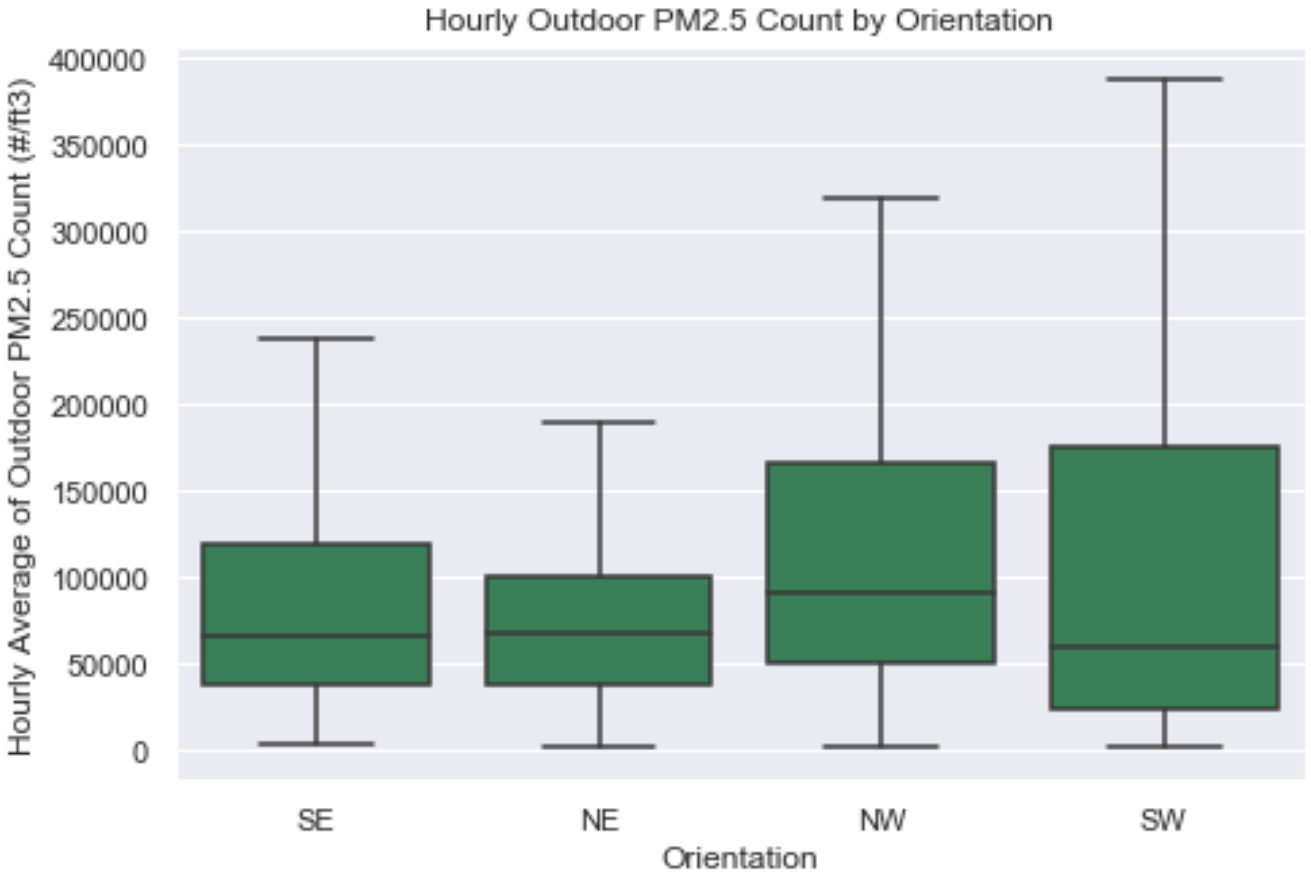
*CS 14 lost due to no hours with 50% or more readings; **2 citizen scientists removed due to possible malfunctioning Dylos



Generally similar concentrations across buildings

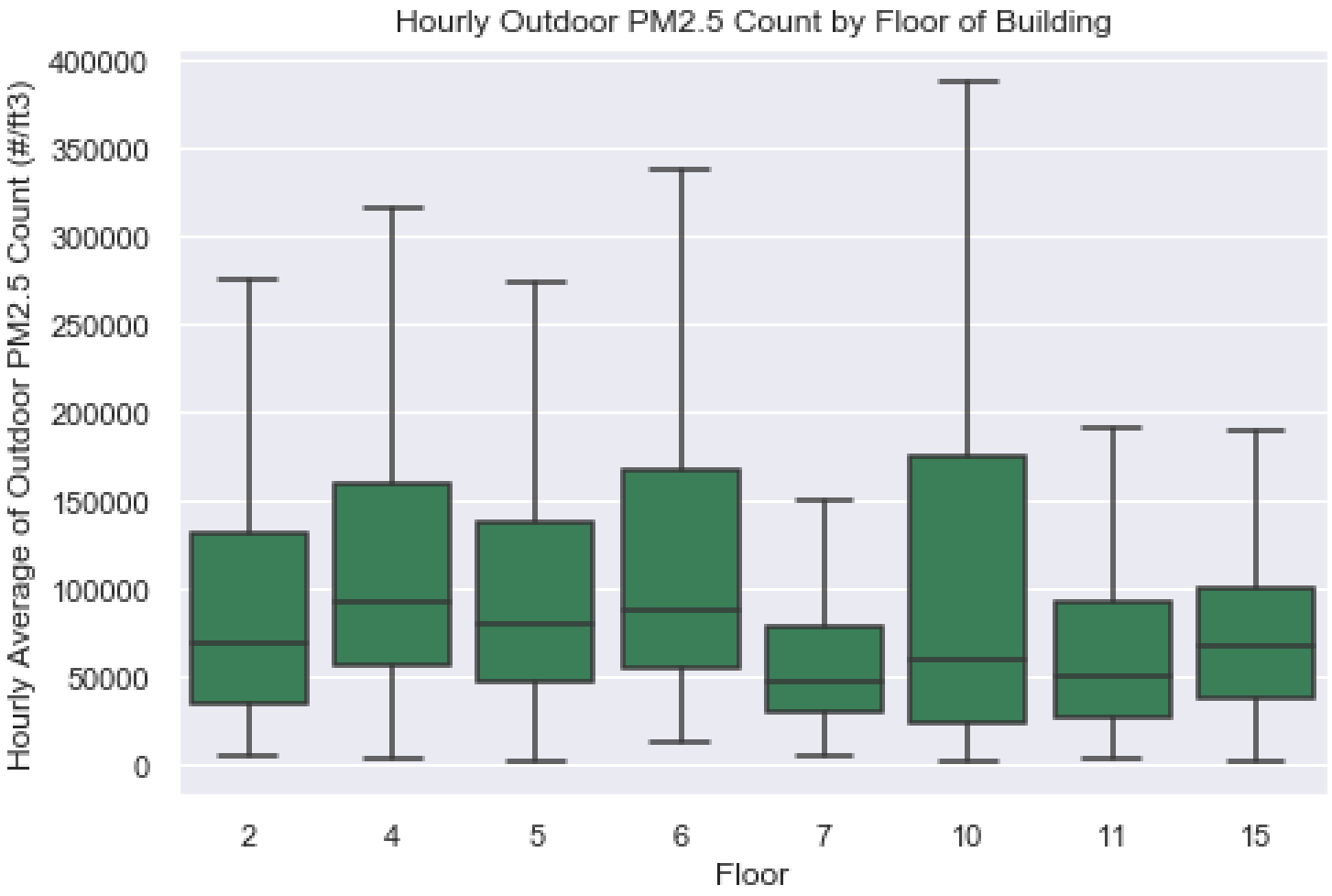
Building	# Weeks	# Hours	# Unique Monitors
Arcadia	10	1612	10
90 Stadium Rd	5	712	7
Queen's Harbour	4	177	2
Windward Coop	4	382	3

Higher concentration distributions at westerly-facing balconies



Balcony Orientation	Buildings	# Weeks	# Hours	# Distinct Monitors
SE	Arcadia, 90 Stadium Rd, Windward Coop	10	1716	11
NE	90 Stadium Road	4	512	4
NW	Arcadia	5	478	4
SW	Queen's Harbour	4	177	2

Mild decrease in outdoor concentration as floor level increases



Floor	Building	# Homes	# Hours
2	Windward Coop	1	382
4	Arcadia	2	518
5	Arcadia	2	349
6	Arcadia	1	268
7	Arcadia	1	477
10	Queen's Harbour	1	177
11	90 Stadium Rd	1	200
15	90 Stadium Rd	1	512

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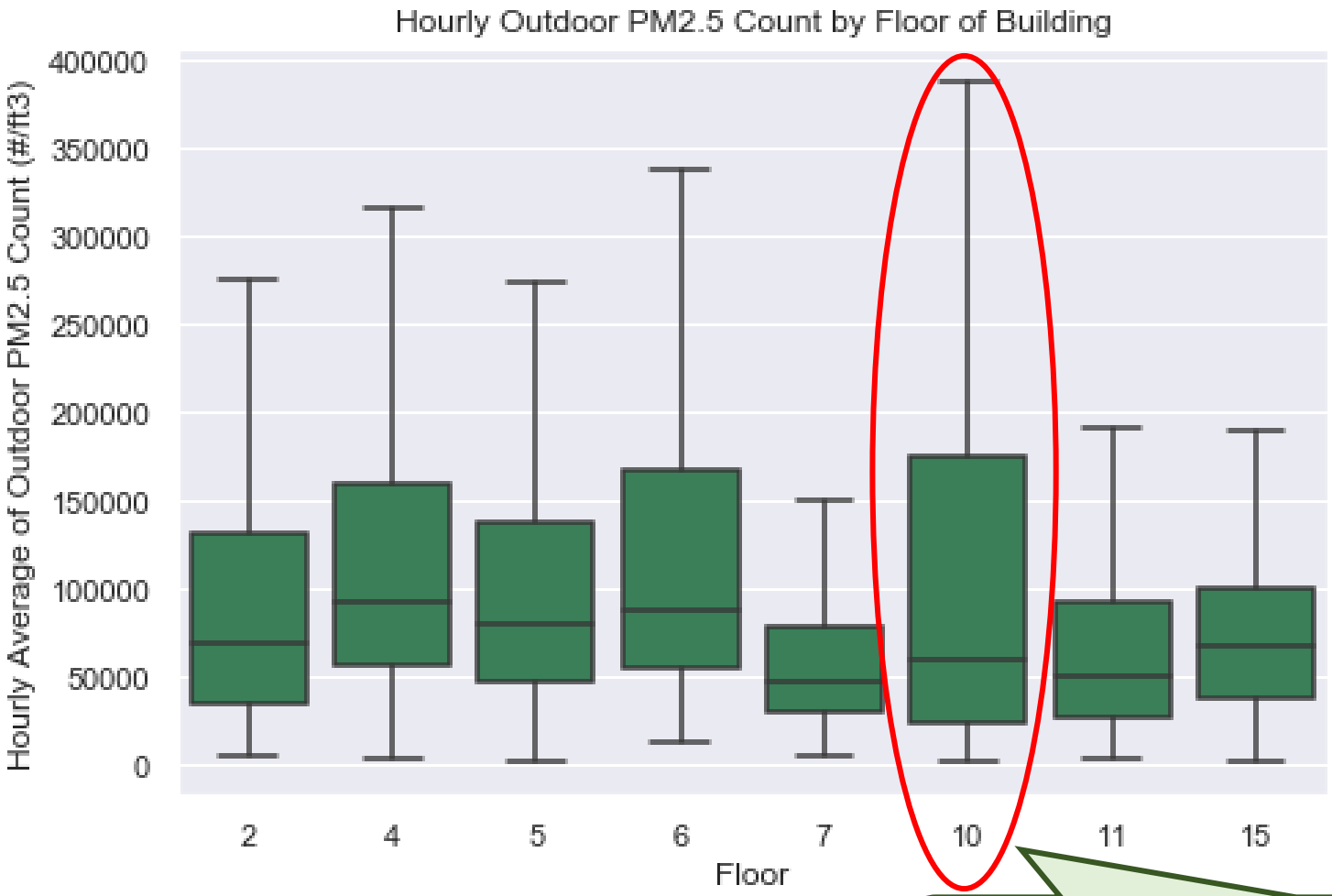

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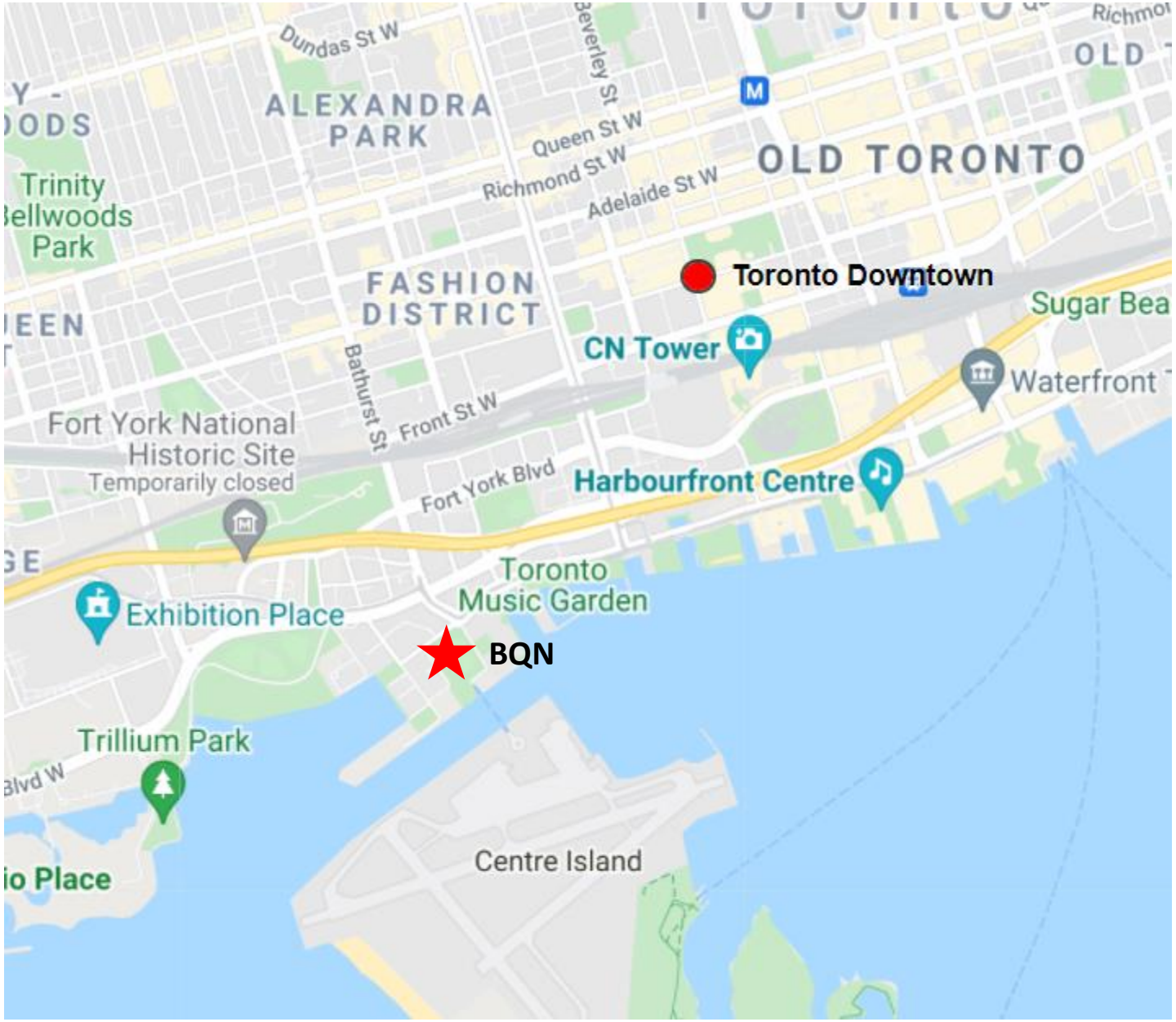
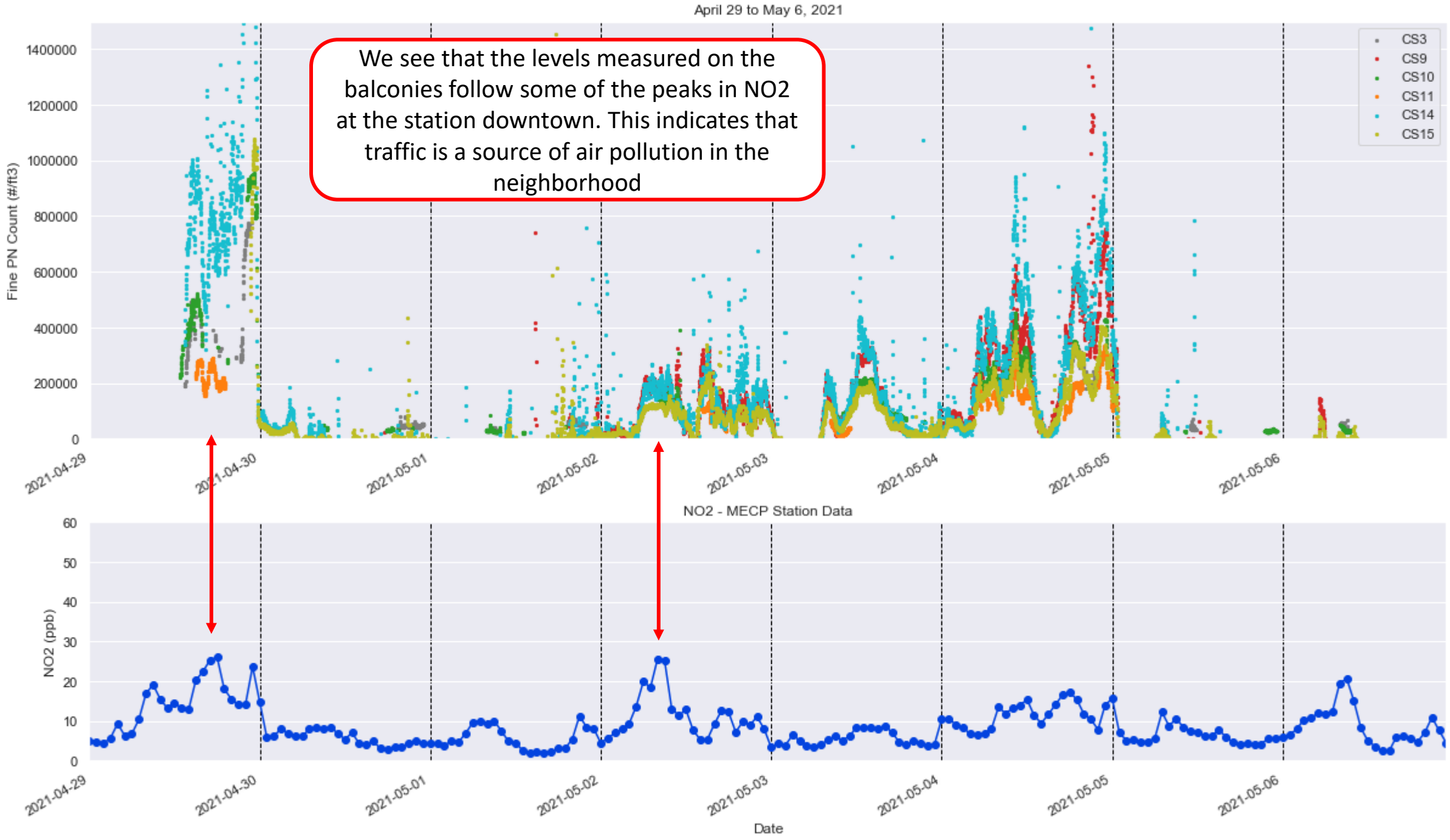
Queen's Harbour has highest outdoor concentration, so this increase is most likely not a height effect

Observations

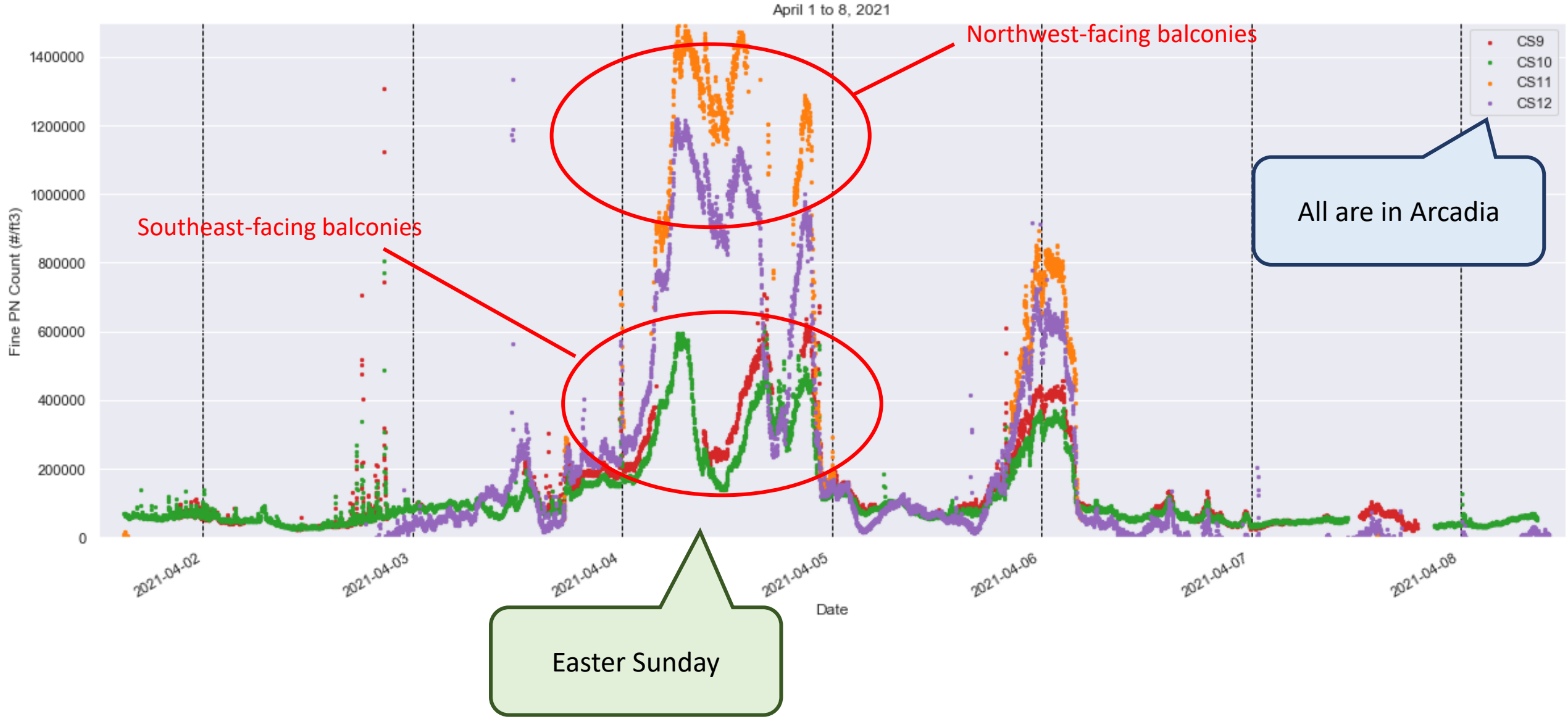
- Fine PN counts are generally higher outdoors
- Indoor levels increase during cooking, cleaning, exercise, opening windows
- Using indoor AQ data, it is hard to quantify the influence of traffic and the airport because indoor AQ can be driven by indoor activities
- Some indication that west-facing balconies have higher outdoor concentrations

Variation in air quality throughout the day and comparison with Ministry of Environment, Conservation, and Parks (MECP) station downtown


Dundas St W
ALEXANDRA PARK
Queen St W
Richmond St W
Adelaide St W
OLD TORONTO
Trinity Bellwoods Park
FASHION DISTRICT
Toronto Downtown
CN Tower
Sugar Bea
Waterfront
Bathurst St
Front St W
Fort York National Historic Site
Temporarily closed
Fort York Blvd
Harbourfront Centre
Toronto Music Garden
Exhibition Place
BQN
Trillium Park
Centre Island


April 29 to May 6, 2021
We see that the levels measured on the balconies follow some of the peaks in NO2 at the station downtown. This indicates that traffic is a source of air pollution in the neighborhood
Fine PN Count (#/ft3)
CS3
CS9
CS10
CS11
CS14
CS15
NO2 - MECP Station Data
NO2 (ppb)
Date

Example of variability between balconies in one week



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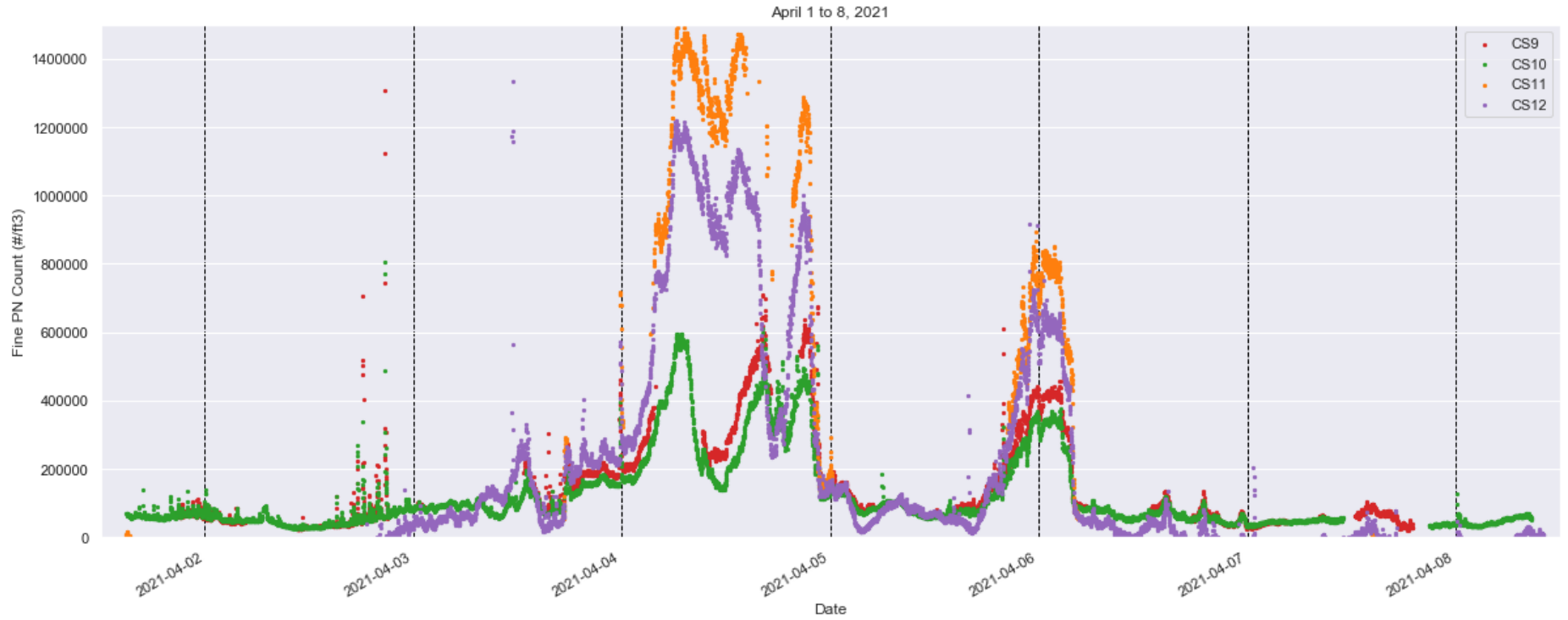
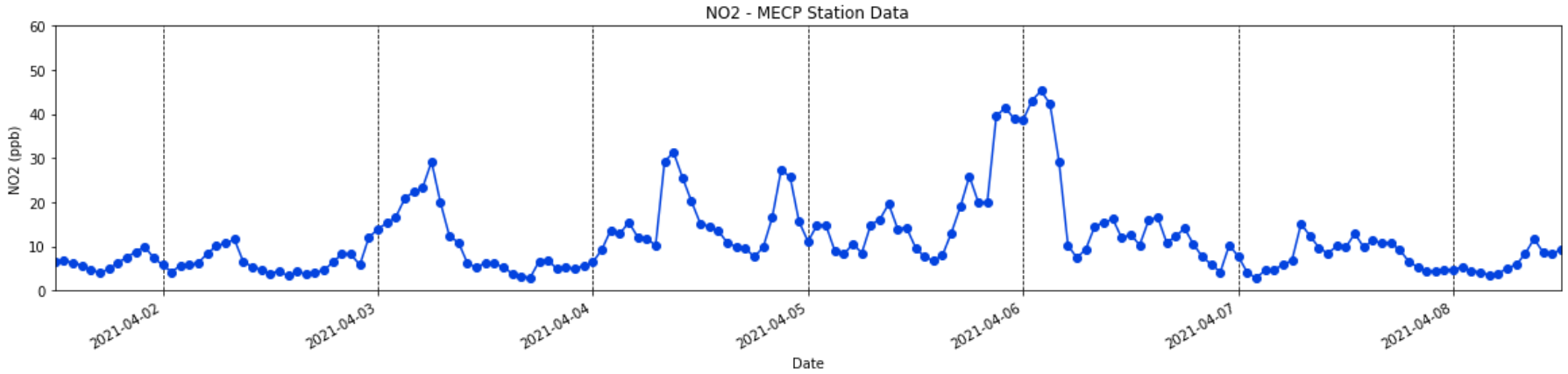
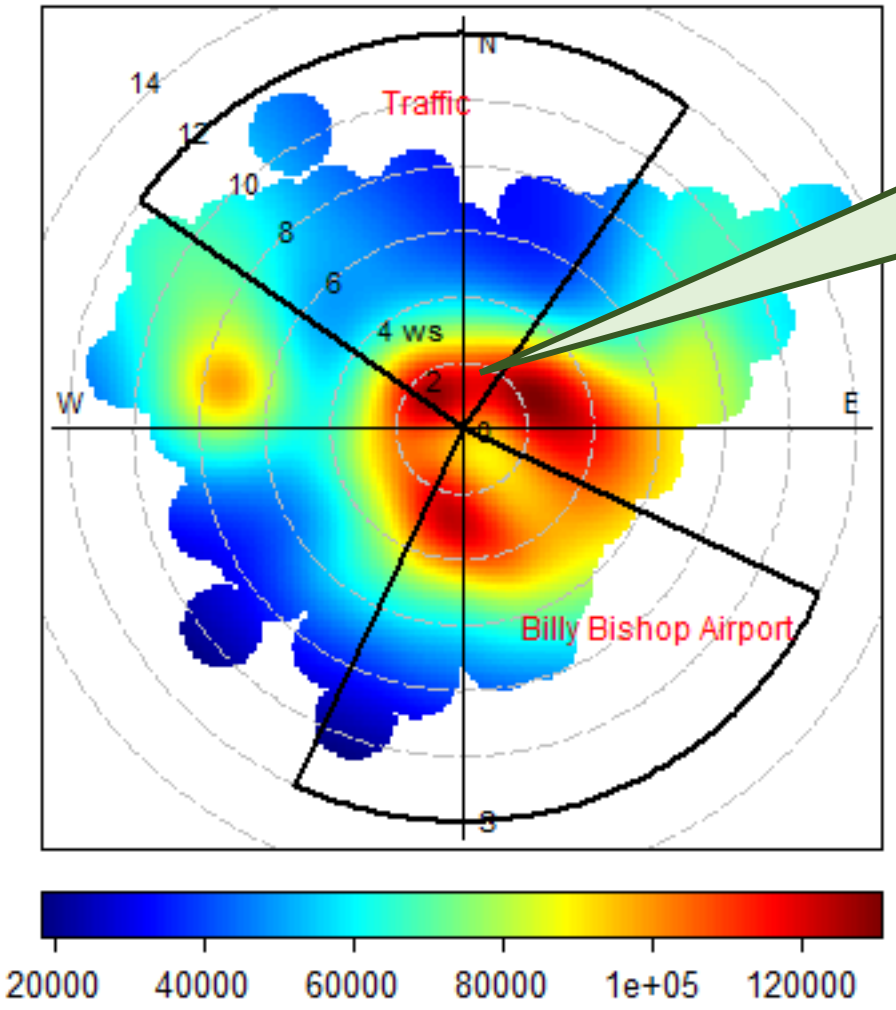




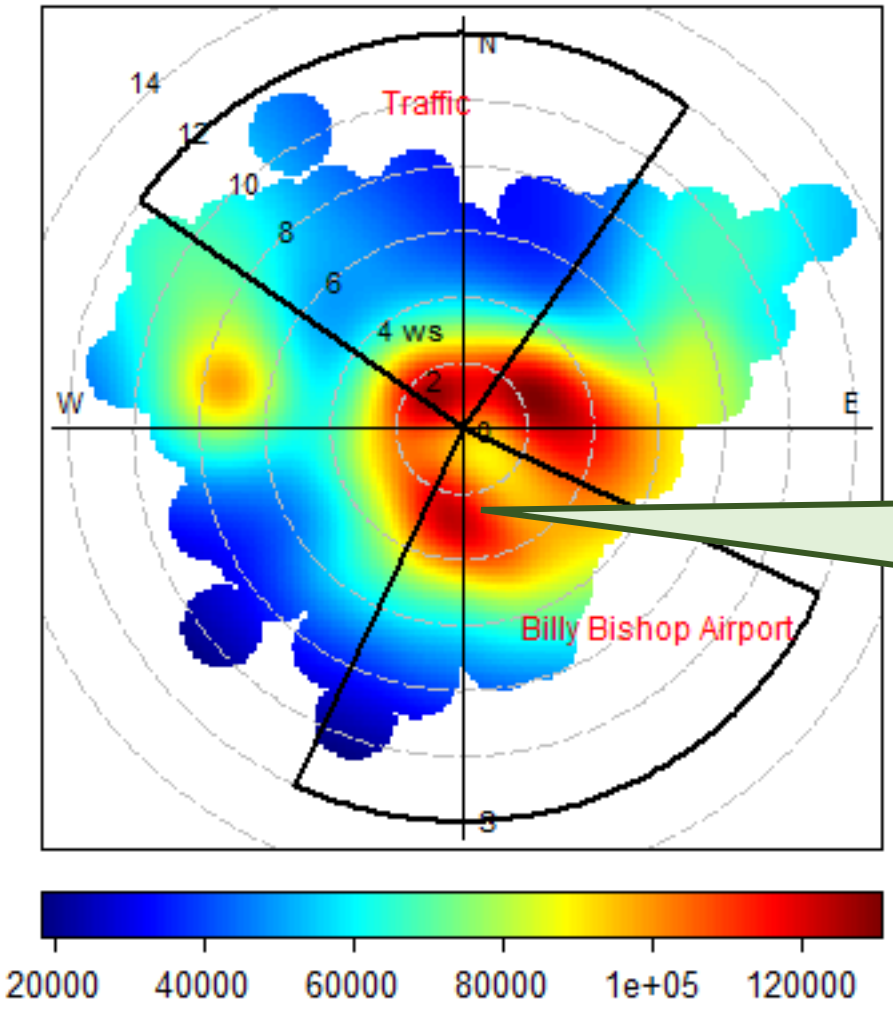
Using all data to visualize traffic and airport contribution

Polar Plot of Outdoor Fine PN count (general trends using data from all buildings)



The highest concentrations are associated with wind at low speed blowing from both the highway….

Polar Plot of Outdoor Fine PN count (general trends using data from all buildings)



… and the airport

Polar plot points to a general effect of airport on AQ when data from all buildings are pooled together.

Can we detect an influence using minute-level data?

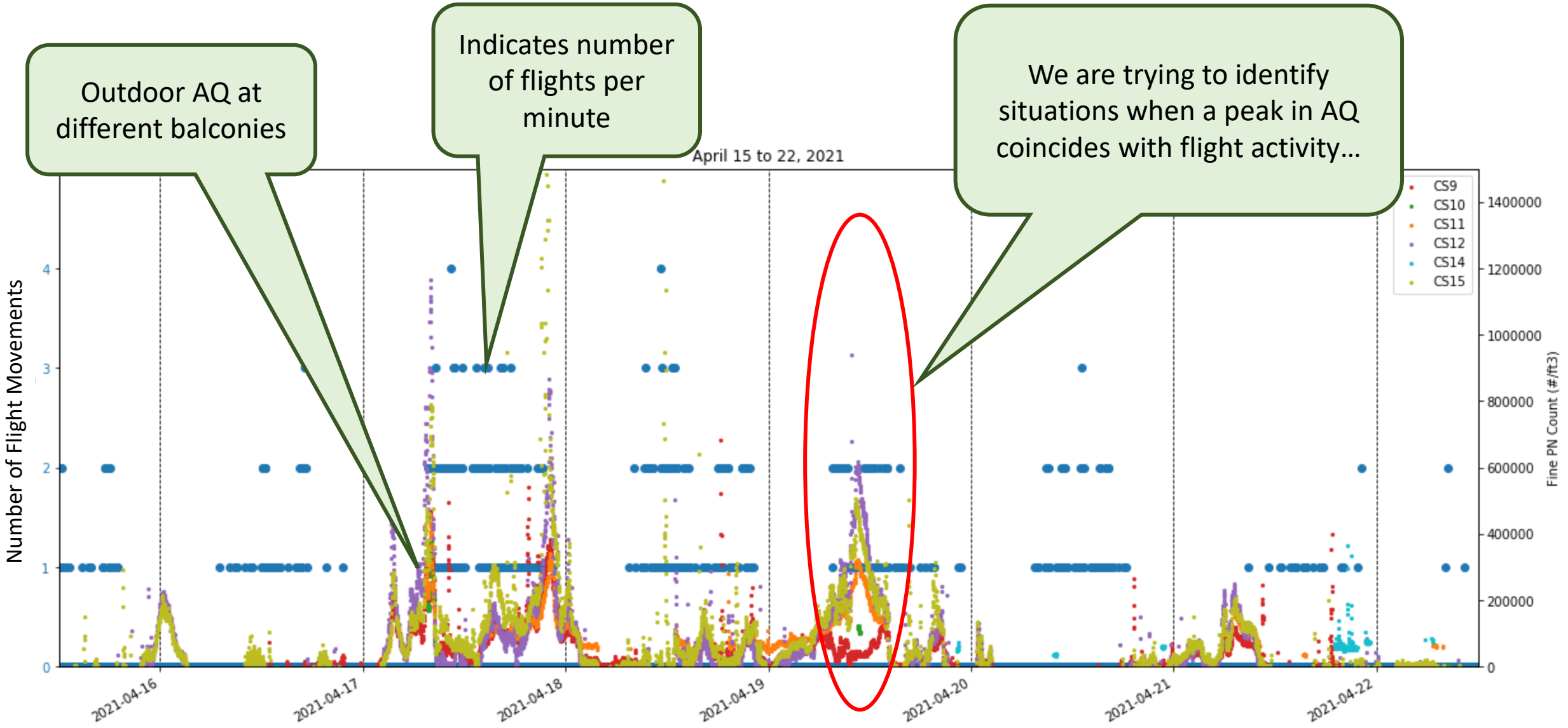
In the next analysis, we will focus on paired outdoor AQ and flight data

Campaign Year	Week	Dates	Indoor	Outdoor	Flight Data
2020	1	Feb 25 - Mar 5	X		
	2	Mar 11 - Mar 18*	X		
	3	Jun 18 - 25	X		
	4	Jun 30 - Jul 7	X		
	5	Jul 10 - 20	X		
	6	Jul 23 - 30	X	X	
	7	Aug 6 - 14	X	X	
	8	Aug 20 - 29	X	X	
2021	9	Feb 4 - 11	X		
	10	Feb 18 - 25	X		
	11	Mar 4 - 11	X		
	12	Mar 18 -25	X		
	13	Apr 1 - 8	X	X	
	14	Apr 15 - 22	X	X	X
	15	Apr 29 - May 6	X	X	X
	16	May 13 - 20	X	X	X
	17	May 27 - Jun 3	X	X	X
	18	Jun 10 - 17	X	X	
	19	Jun 21 - 28	X	X	

Deeper dive into AQ and flight data

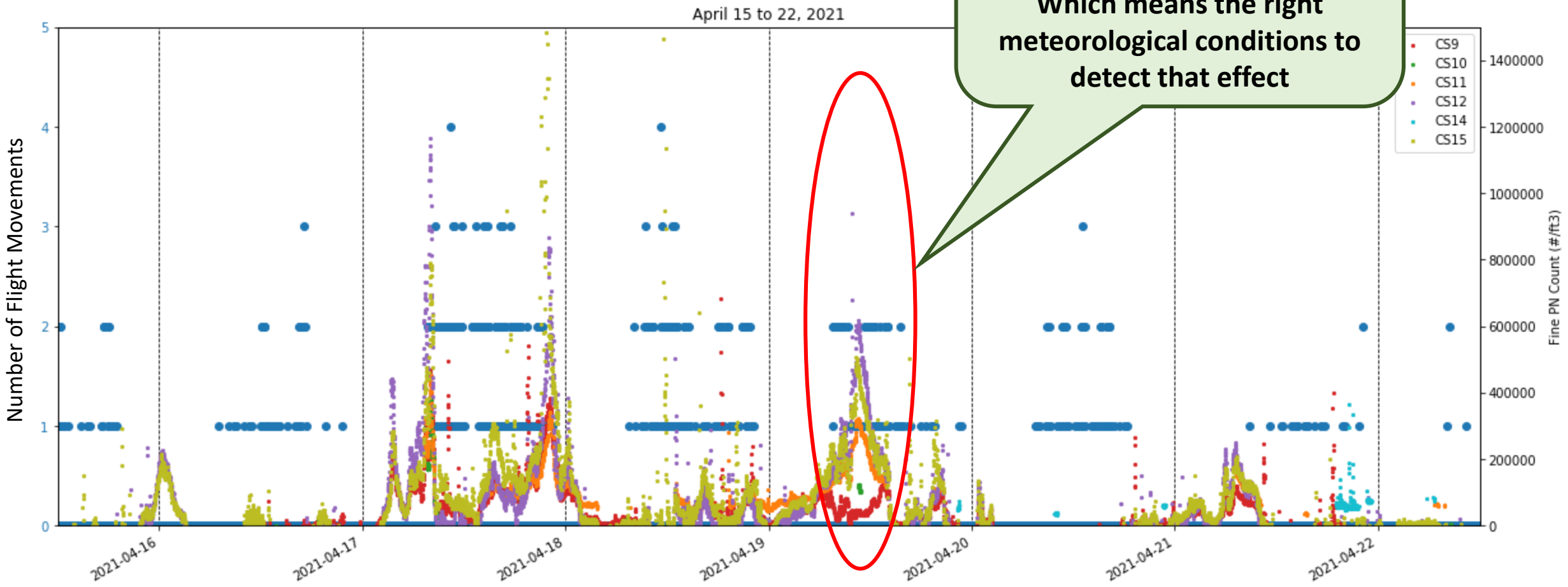
- Flight data includes two types of flight activity:
  - **Itinerant** : Initial takeoff or final landing of a flight
  - **Local**: touch-and-go, stop-and-go, simulated approach without landing, low approach, pullup, while on final approach, missed approach

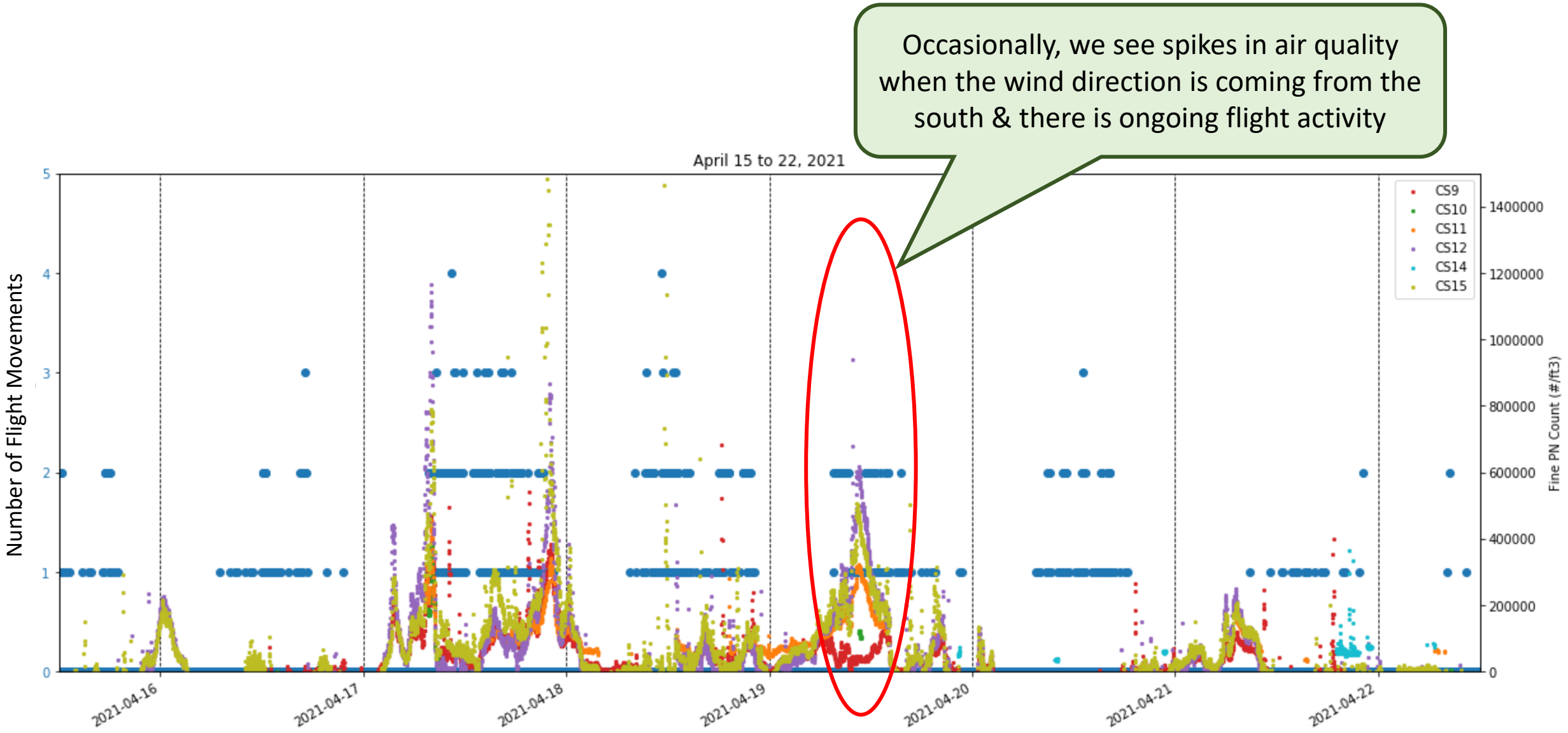
- Minute-by-minute data


Outdoor AQ at different balconies
Indicates number of flights per minute
We are trying to identify situations when a peak in AQ coincides with flight activity…
April 15 to 22, 2021
Number of Flight Movements
Fine PN Count (#/ft3)
CS9
CS10
CS11
CS12
CS14
CS15
0
1
2
3
4
0
200000
400000
600000
800000
1000000
1200000
1400000
2021-04-16
2021-04-17
2021-04-18
2021-04-19
2021-04-20
2021-04-21
2021-04-22

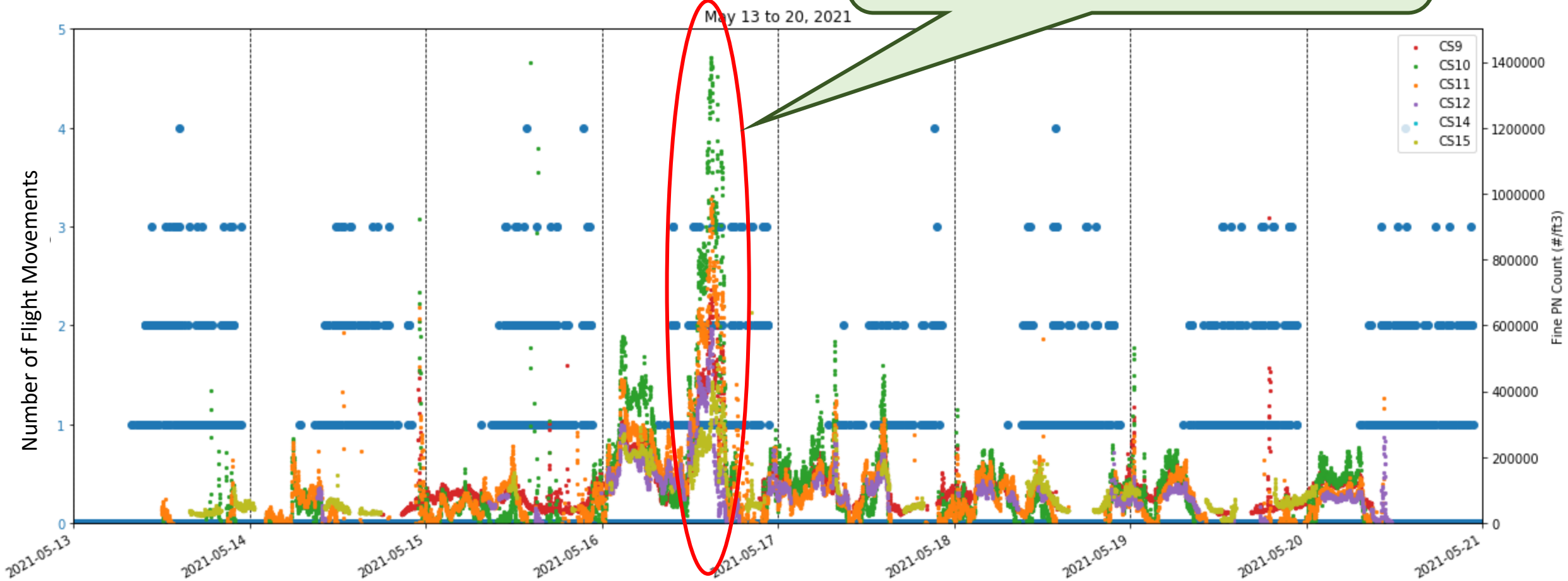
…AND if these situations lead to higher AQ due to the airport

Which means the right meteorological conditions to detect that effect




Occasionally, we see spikes in air quality when the wind direction is coming from the south & there is ongoing flight activity
April 15 to 22, 2021
Number of Flight Movements
Fine PN Count (#/ft3)
CS9
CS10
CS11
CS12
CS14
CS15
0
1
2
3
4
5
0
200000
400000
600000
800000
1000000
1200000
1400000
2021-04-16
2021-04-17
2021-04-18
2021-04-19
2021-04-20
2021-04-21
2021-04-22

Other times, we see peaks with wind coming from other directions, such as the northeast/east



Using the minute-level data, it is difficult to isolate the impact of the airport

Difficult to pick up on the airport's impact on the neighborhood using balcony monitoring with low-cost sensors

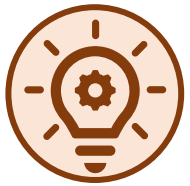
We are seeing a hotspot coming from the airport direction in the polar plot indicating a general trend, but more detailed monitoring is required:

- Data on taxiing, idling
- Measure a wider range of species associated with airport emissions, such as ultrafine particles
- Need a fixed ground-level and rooftop monitoring network

Three actions are planned for future data collection

Project Objectives

Understand population exposure and the contribution of different sources to air pollution in the neighbourhood



Disseminate knowledge that can help inform planning/policy regarding land-use, transportation, and airport operations

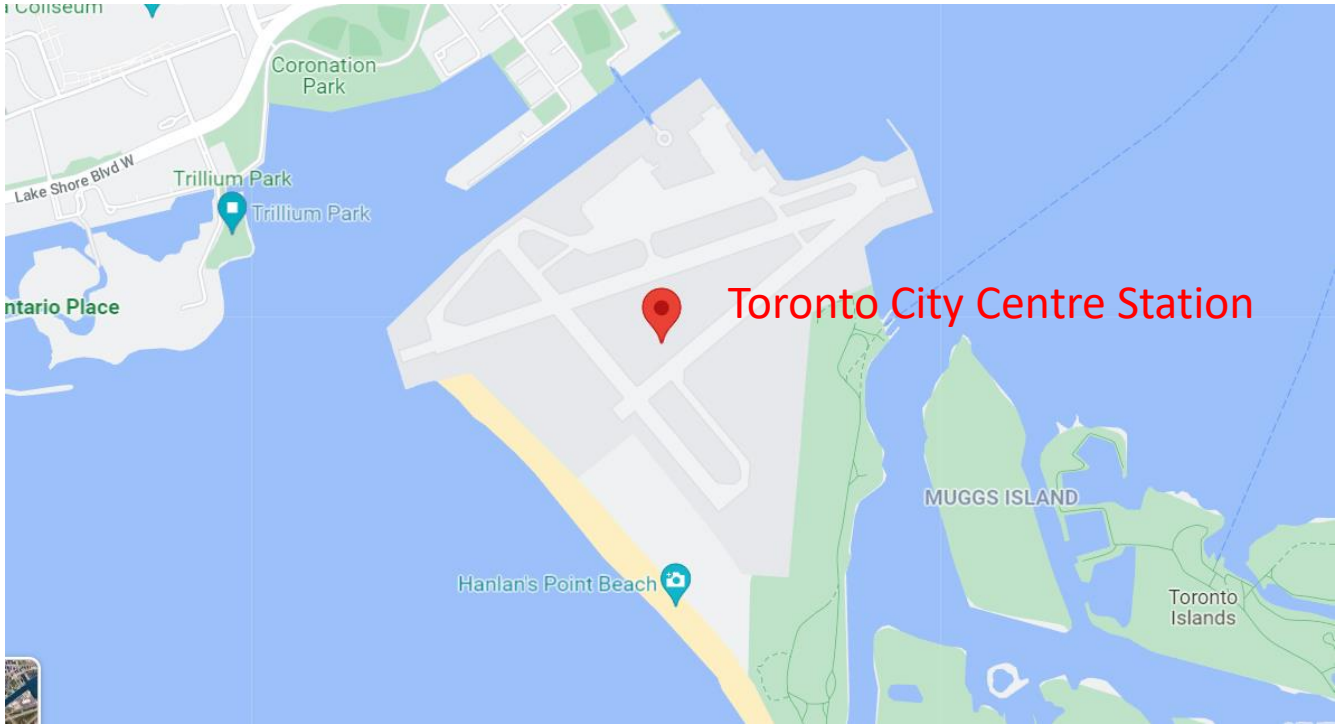
How do we envision a more livable and sustainable neighborhood?

Appendix A

Data Sources

Historical Weather Data Source

- Hourly weather data was obtained from the Toronto City Centre station operated by NAVCAN



Air Quality Data Source

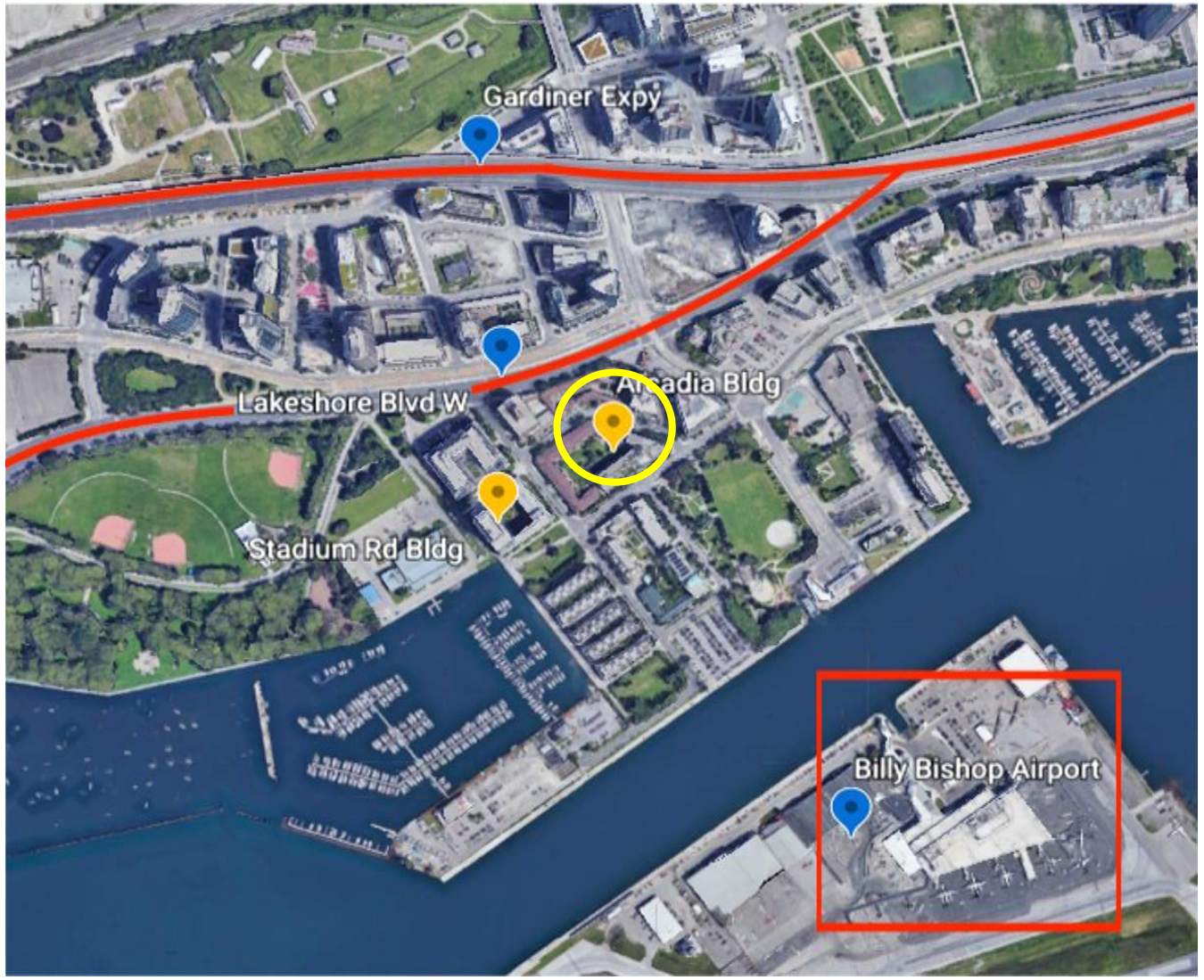
- Obtained from MECP
- Toronto Downtown Station at 55 John St
- Measures O3, PM2.5, and NO2
- PM2.5 measured in µg/m3
- NO2 in ppb

Appendix B

Citizen Scientist Building, Orientation, and Floor Level

Citizen Scientist 3

- Sampled:
  - Summer Week 6, 7, and 8
  - Winter Weeks 7, 9, 10, and 11
- Arcadia
- Balcony faces SE
  - 140 degrees
- 7th floor

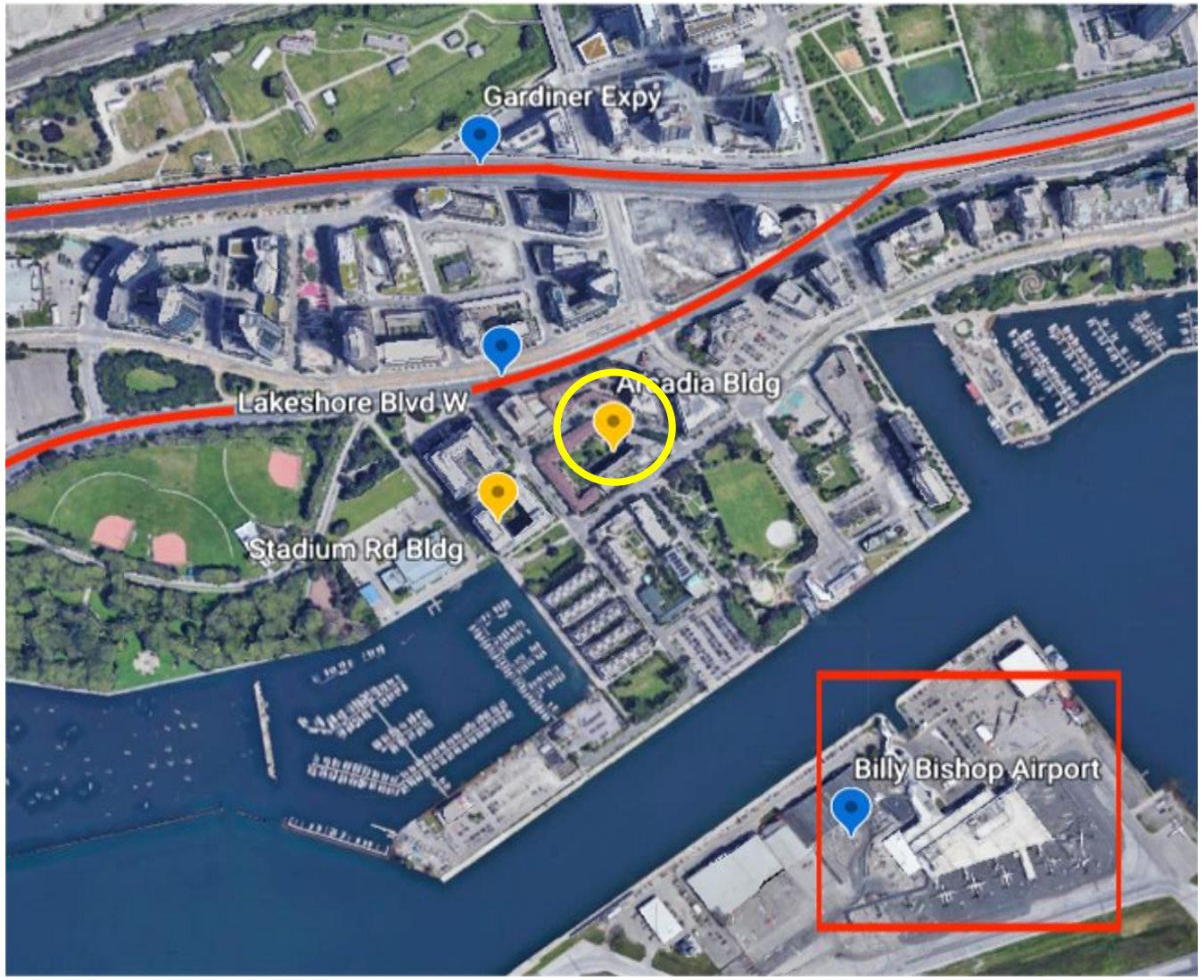


Citizen Scientist 4

- Sampled:
  - Summer Week 6, 7, and 8
  - Winter Weeks 9 and 11
- 90 Stadium Rd
- Balcony faces SE
  - 140 degrees
- 11th floor

Citizen Scientist 5

- Sampled:
  - Summer Weeks 7 and 8
- Arcadia
- Balcony faces SE
  - 140 degrees
- 5th floor
- Not enough data to make CBPF plots

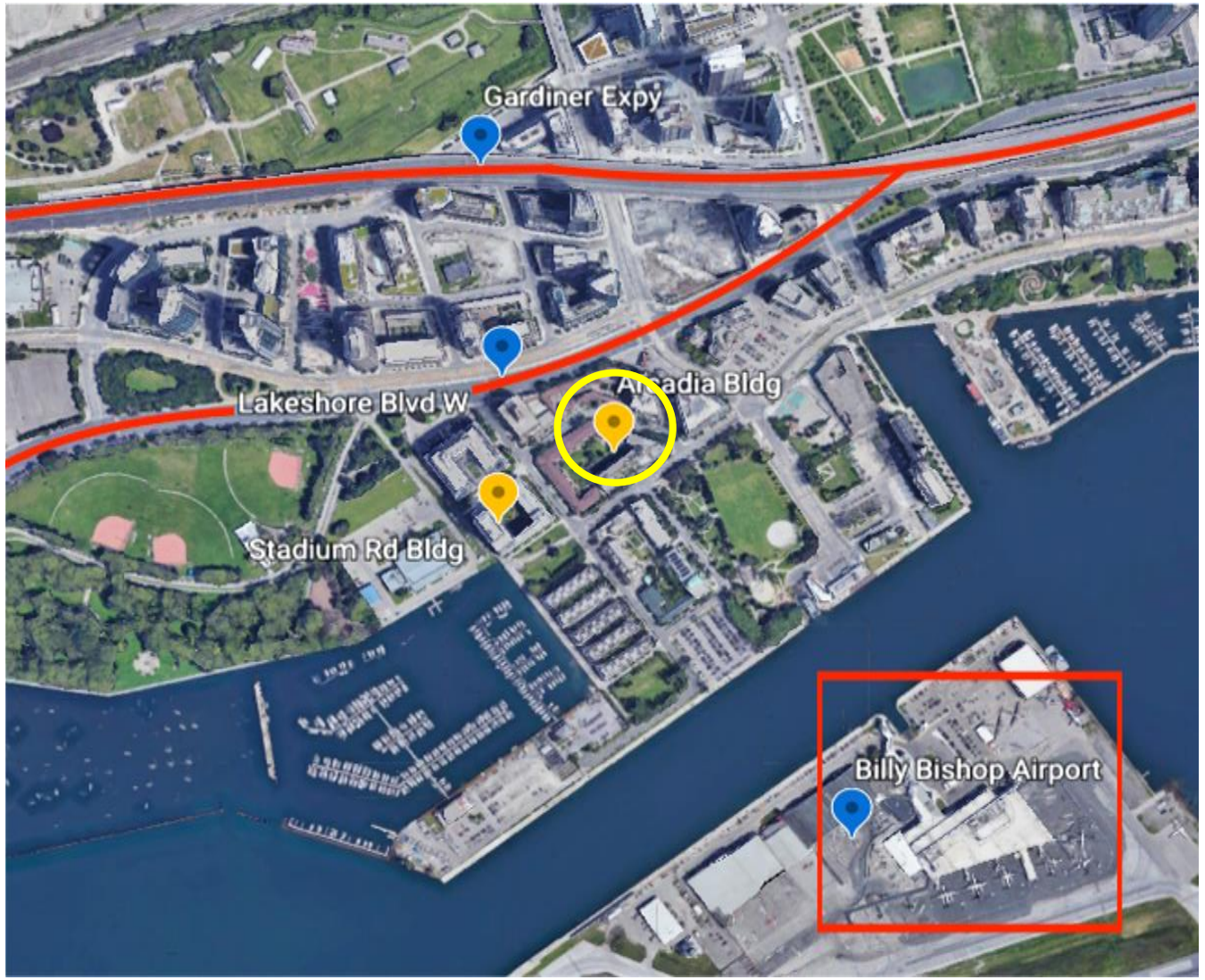


Citizen Scientist 7

- Sampled:
  - Summer Week 7 and 8
  - Winter Weeks 9 and 11
- 90 Stadium Rd
- Balcony faces NE
  - 50 degrees
- 15th floor

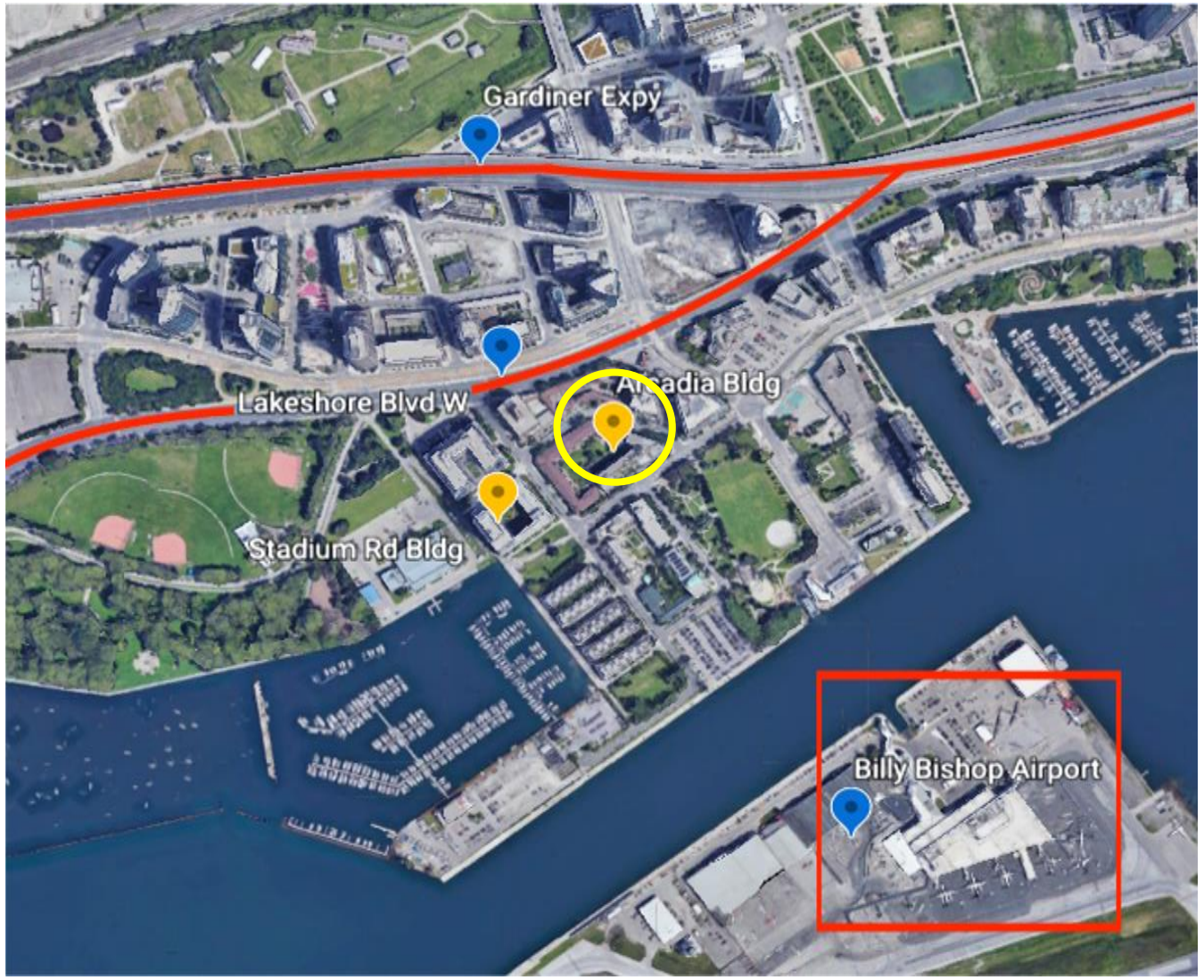
Citizen Scientist 9

- Sampled:
  - Winter 5, 6, 7, and 8
- Arcadia
- Balcony faces SE
  - 140 degrees
- 4th floor



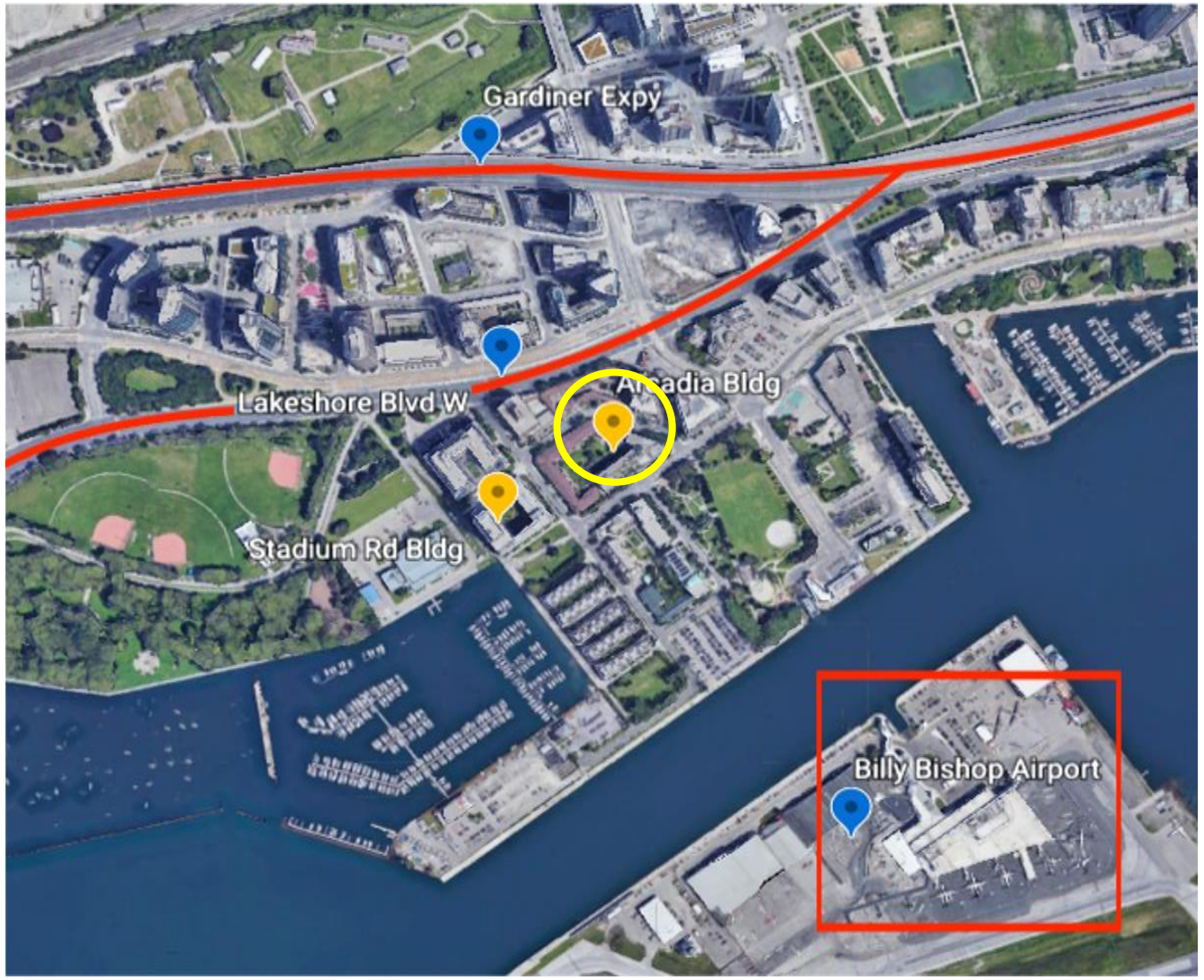
Citizen Scientist 10

- Sampled:
  - Winter 5, 6, 7, and 8
- Arcadia
- Balcony faces SE
  - 140 degrees
- 6th floor



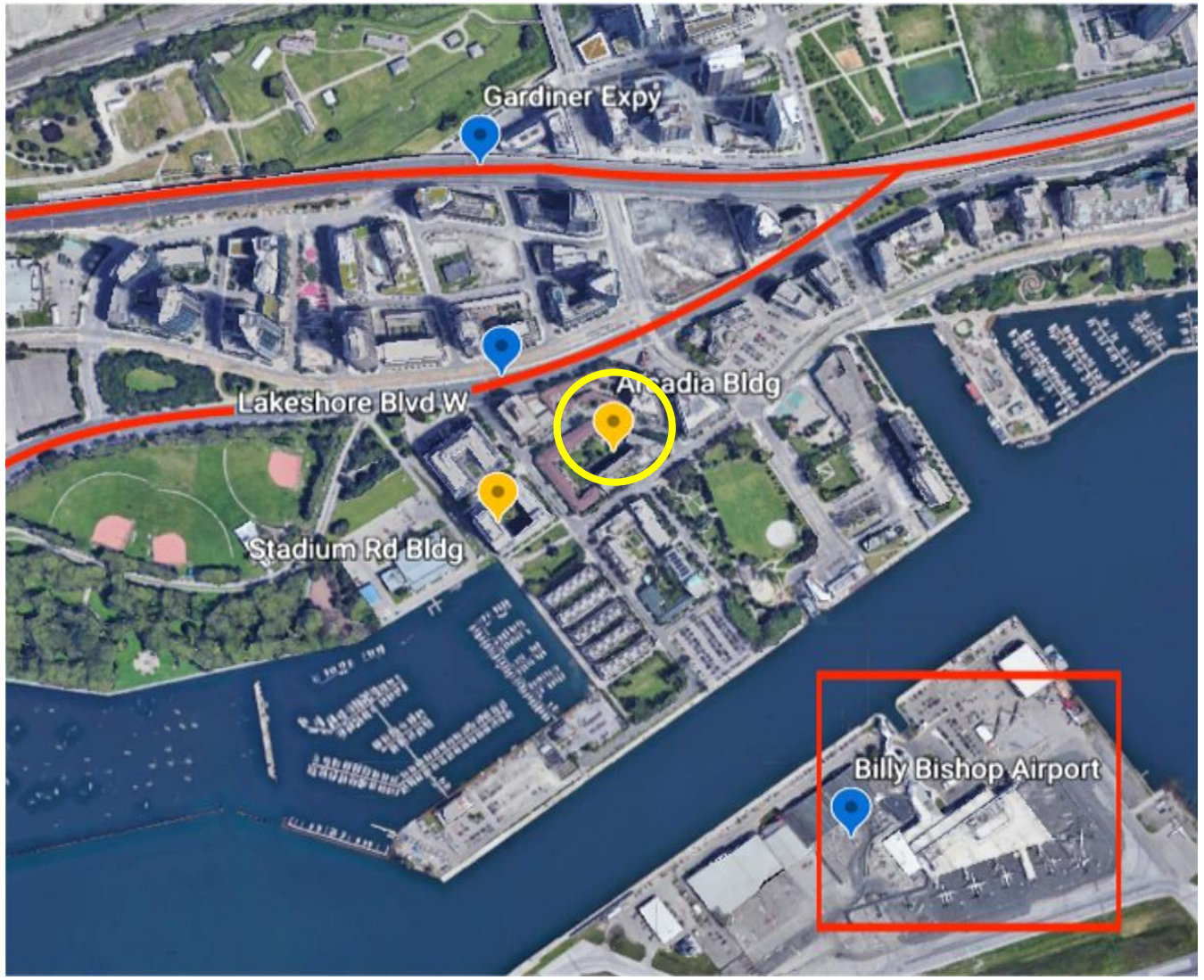
Citizen Scientist 11

- Sampled:
  - Winter 5, 6, 7, and 8
- Arcadia
- Balcony faces NW
  - 320 degrees
- 4th floor



Citizen Scientist 12

- Sampled:
  - Winter 5, 6, 8, and 9
- Arcadia
- Balcony faces NW
  - 320 degrees
- 5th floor



Citizen Scientist 14

- Sampled:
  - Winter 6, 7, 9, and 10
- Queen's Harbour
- Balcony faces SW
  - 210 degrees
- 10th floor

Citizen Scientist 15

- Sampled:
  - Winter 6, 7, 8, and 9
- Windward Coop
- Balcony faces SE
  - 140 degrees
- 2nd floor