

DB₄IoT

Estimating Greenhouse Gas Emissions
from Connected Vehicle Data

ITS-WA

Annual Conference
December 11, 2018

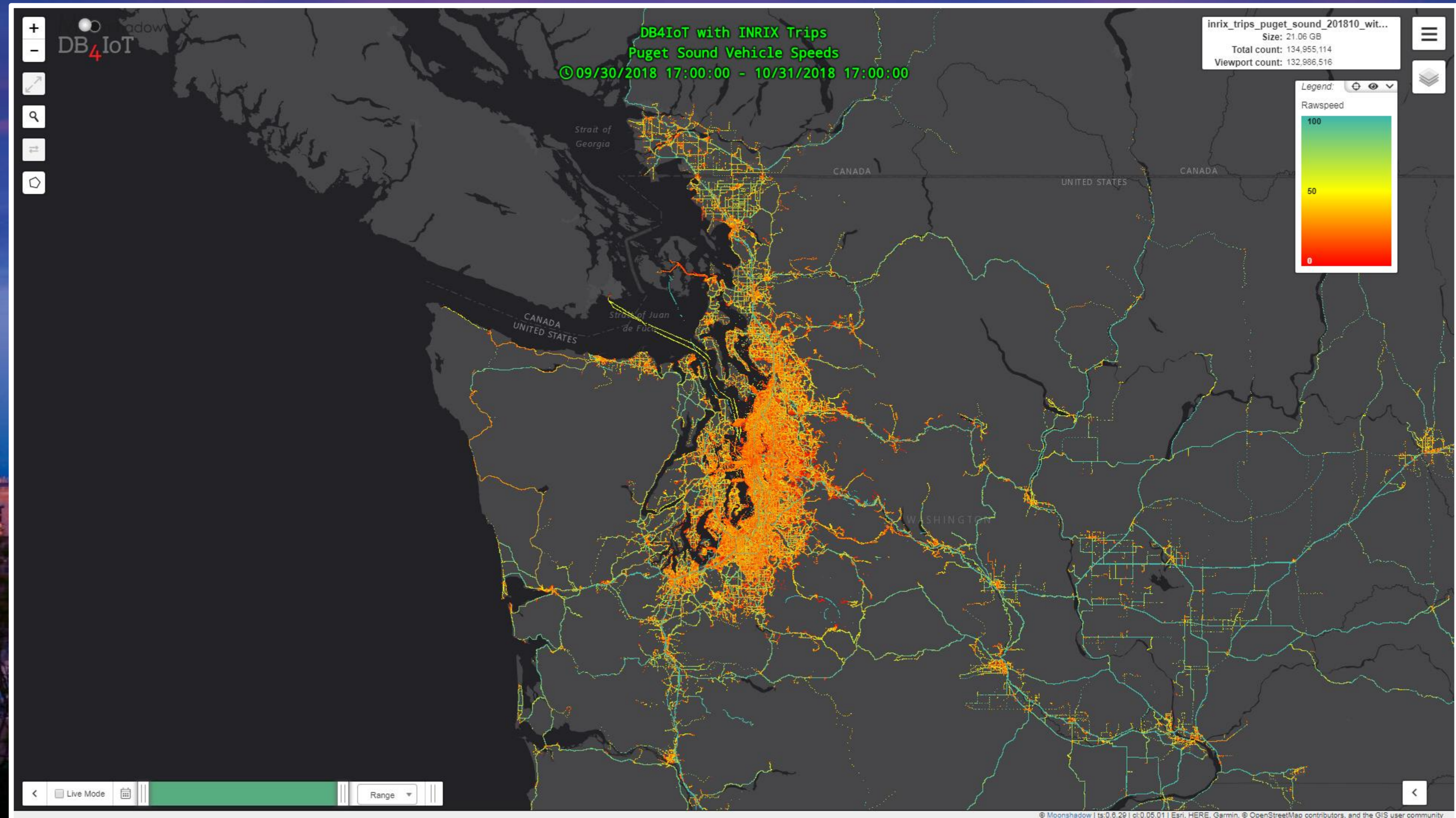
Eimar Boesjes
CEO, Moonshadow Mobile, Inc.

DKS

Moonshadow

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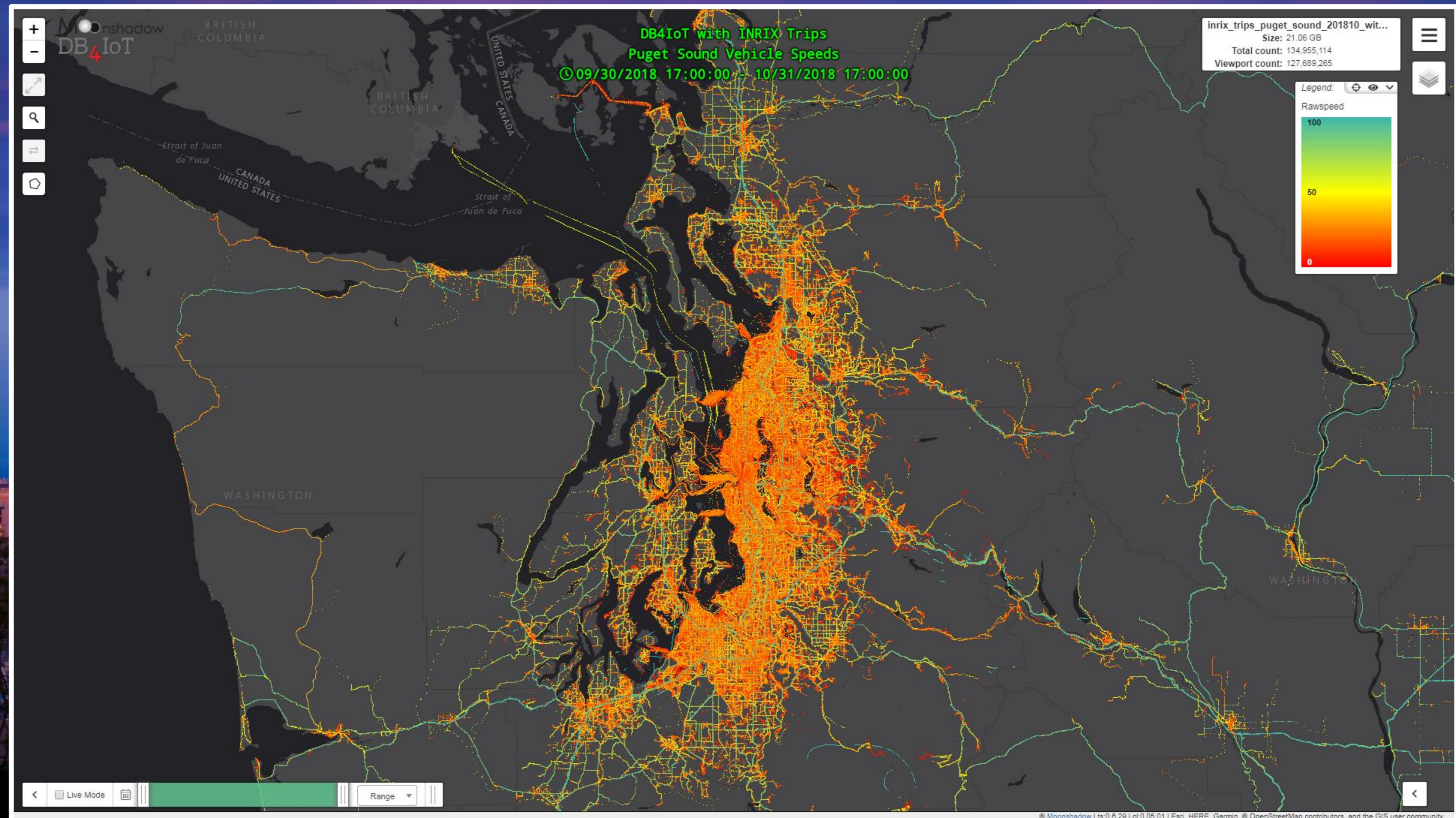
We started with connected vehicle data



Proof of Concept:
Emissions values
not validated

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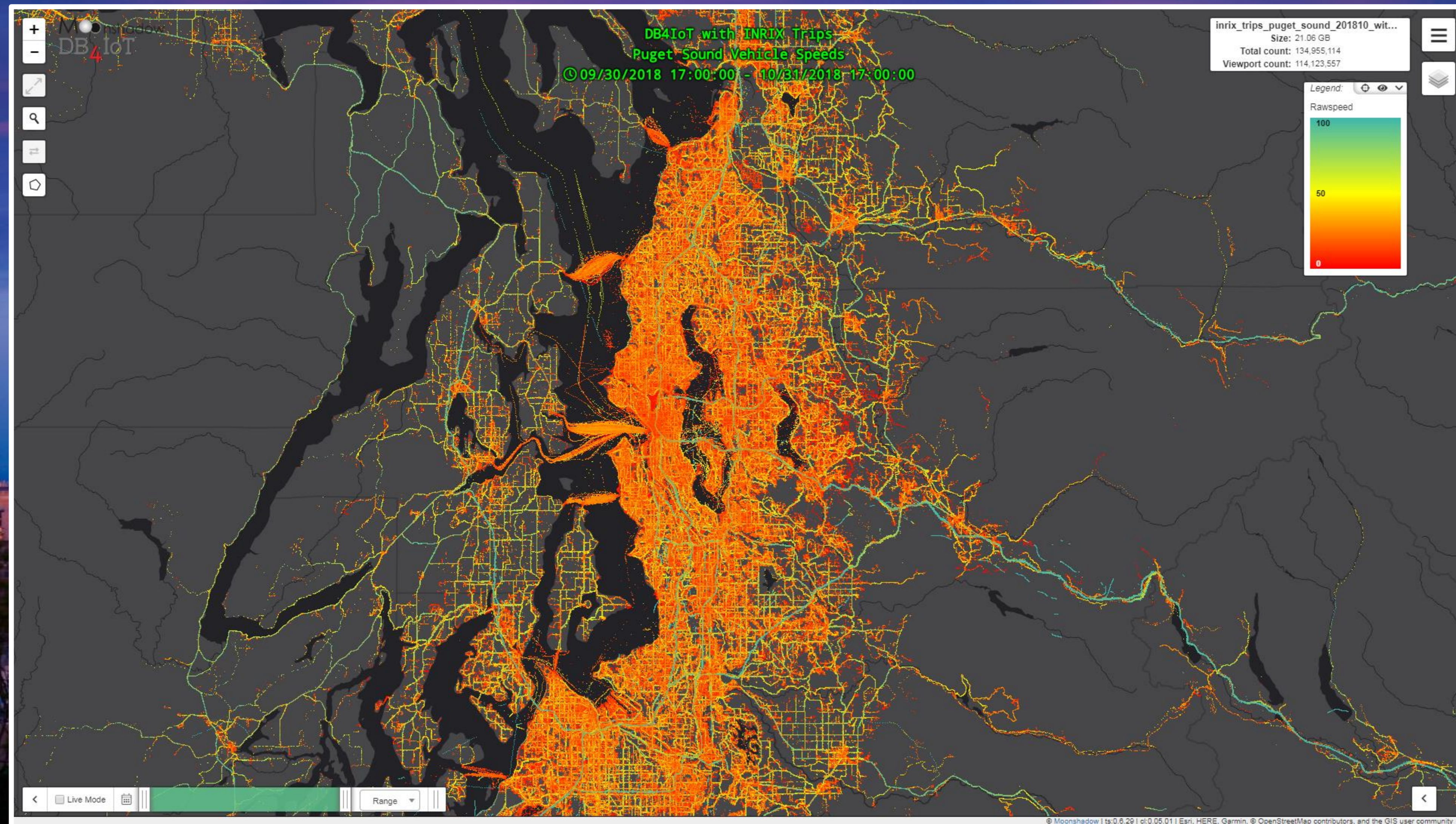
What does connected vehicle data look like?



Proof of Concept:
Emissions values
not validated

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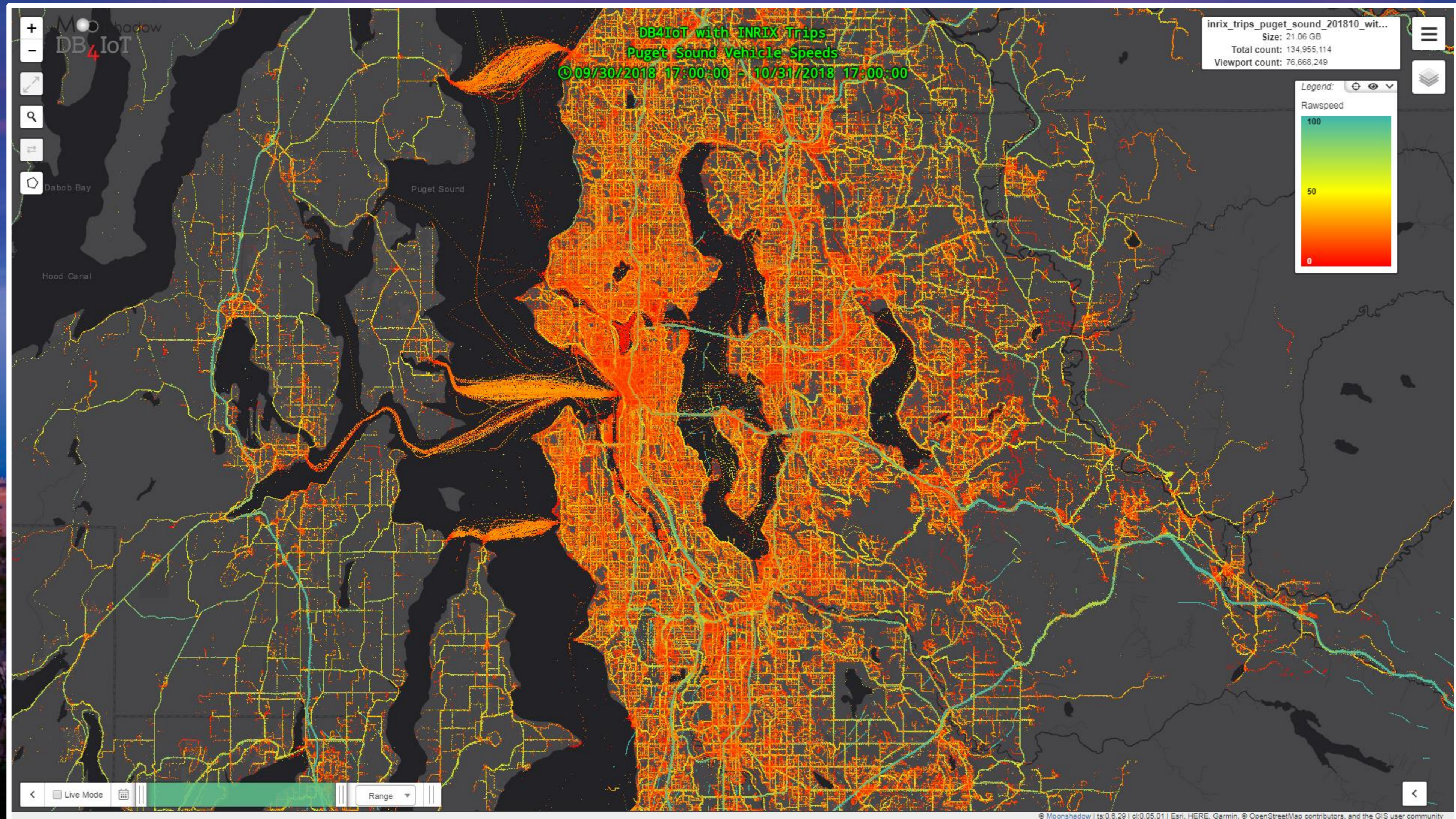
Connected vehicle data from INRIX Trips



Proof of Concept:
Emissions values
not validated

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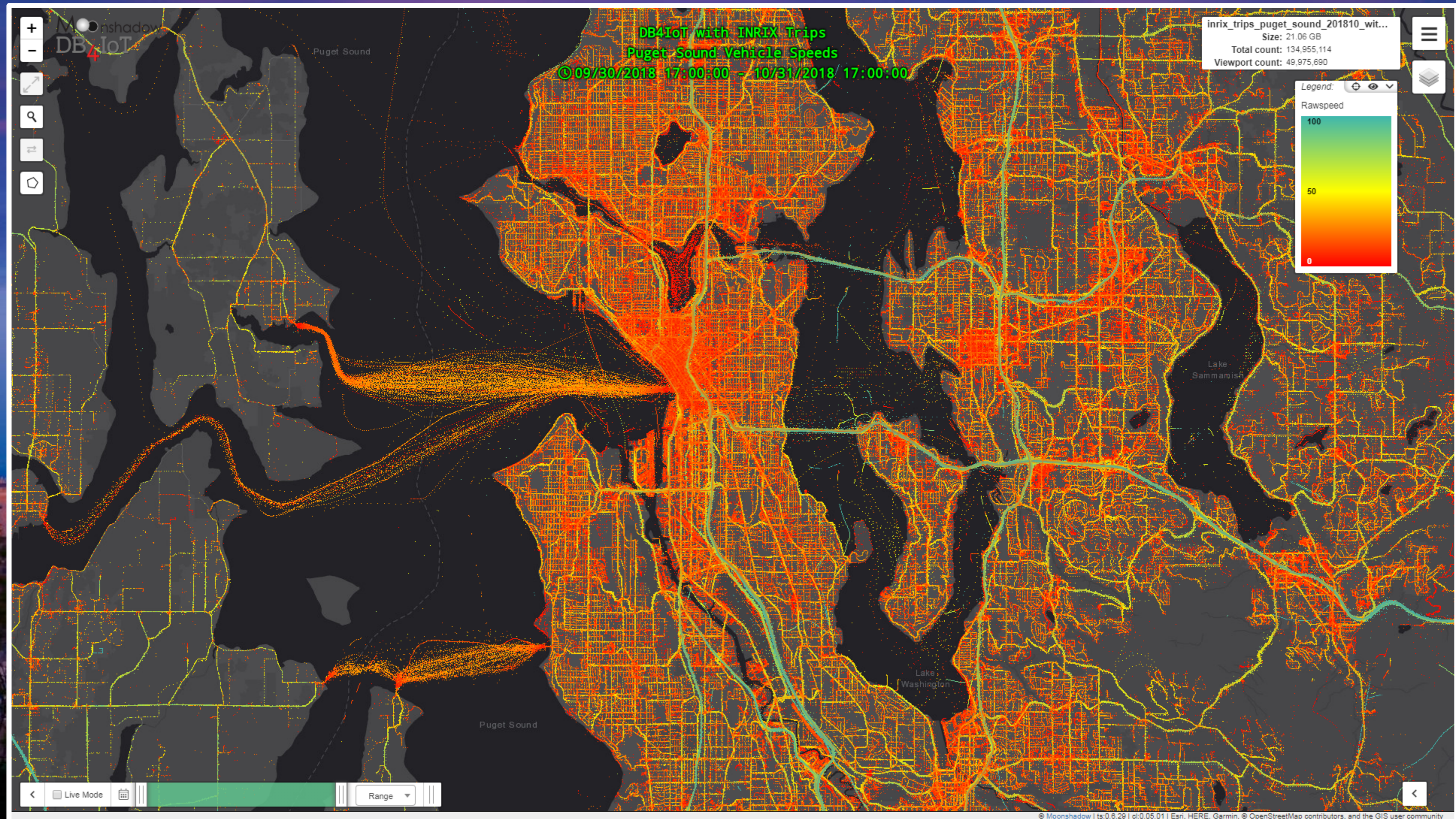
One month of trip data = 135 million records



Proof of Concept:
Emissions values
not validated

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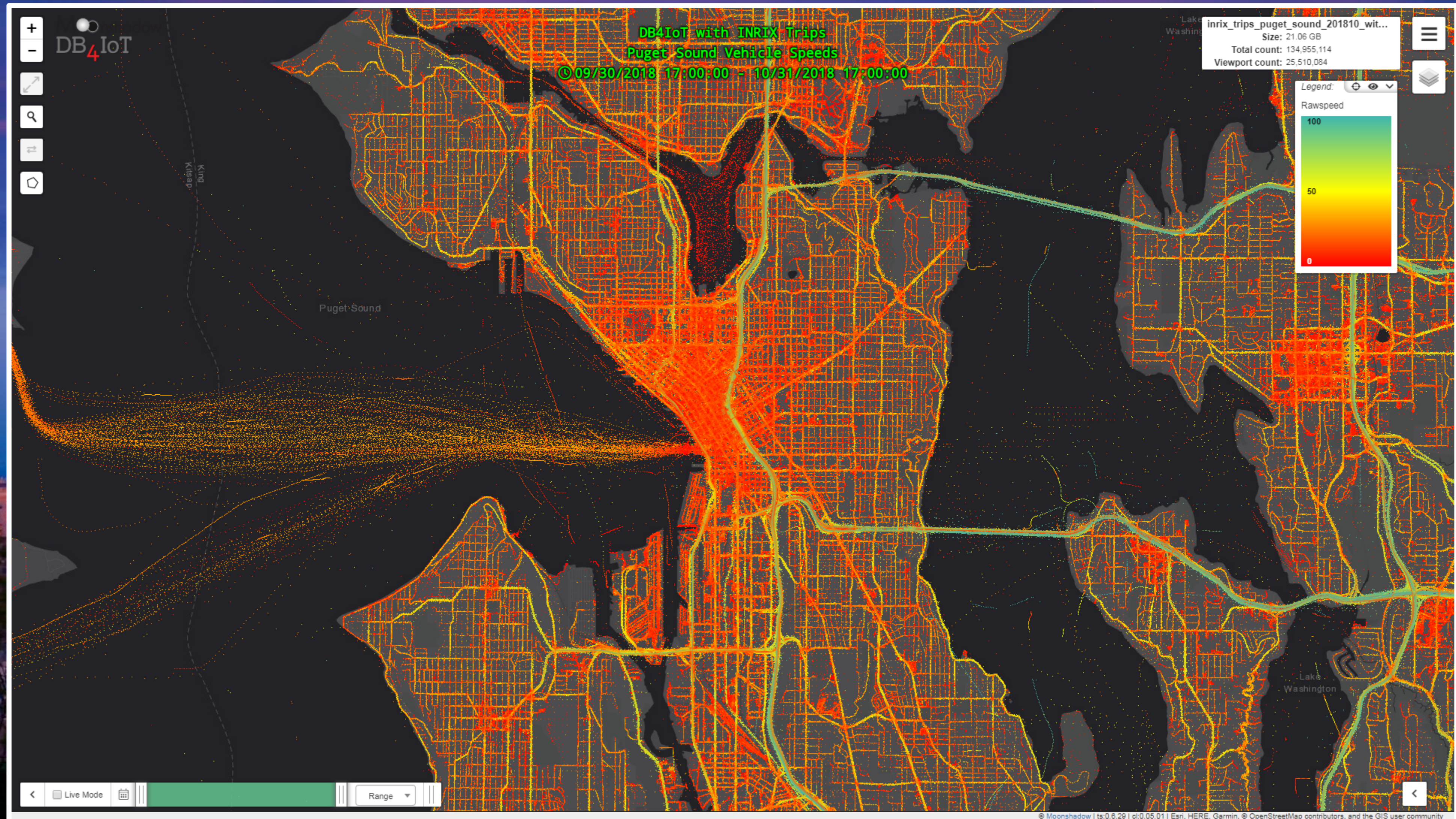
Trip waypoints are colored by speed



Proof of Concept:
Emissions values
not validated

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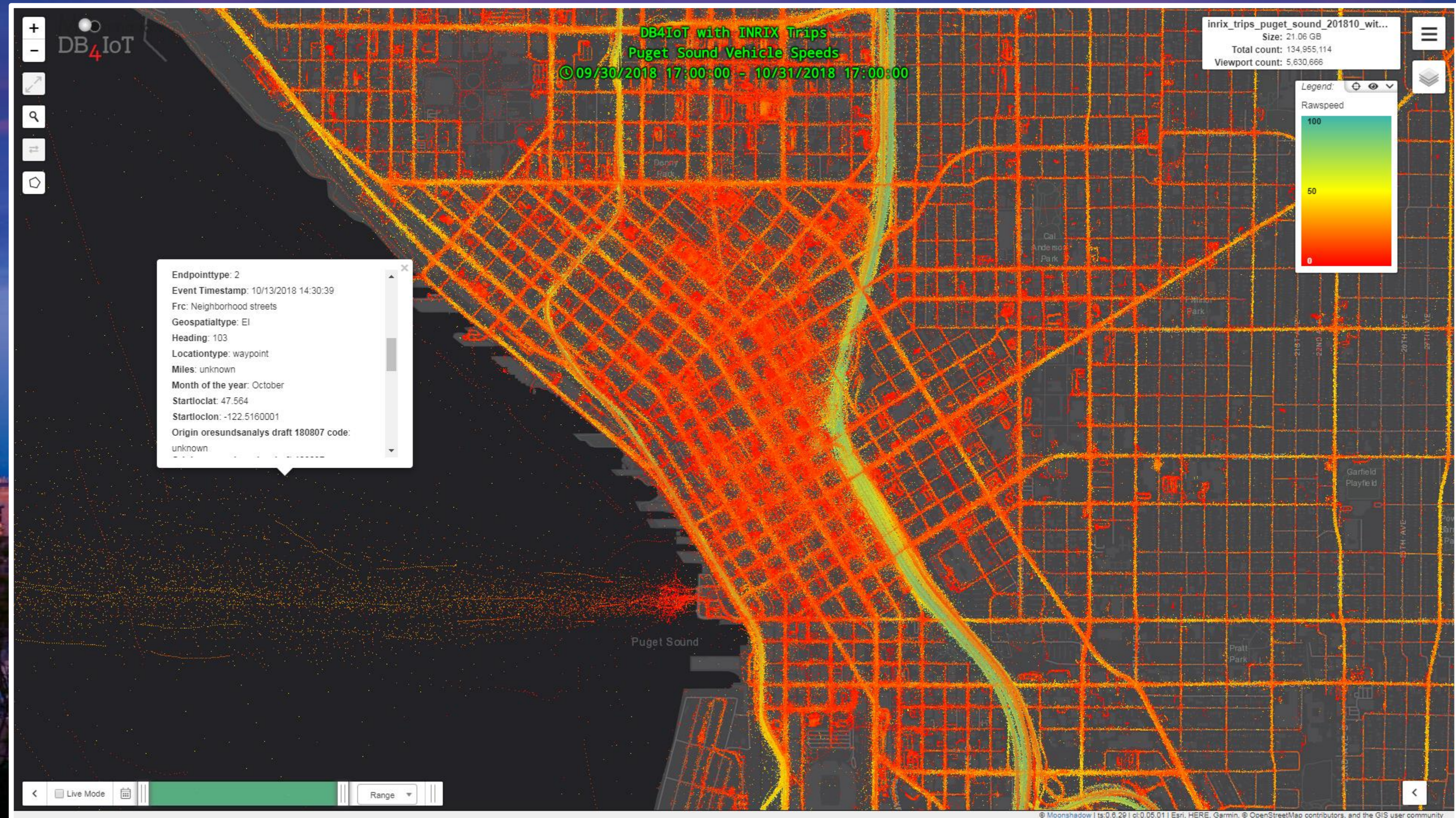
The vehicles in the Puget Sound are on ferries



Proof of Concept:
Emissions values
not validated

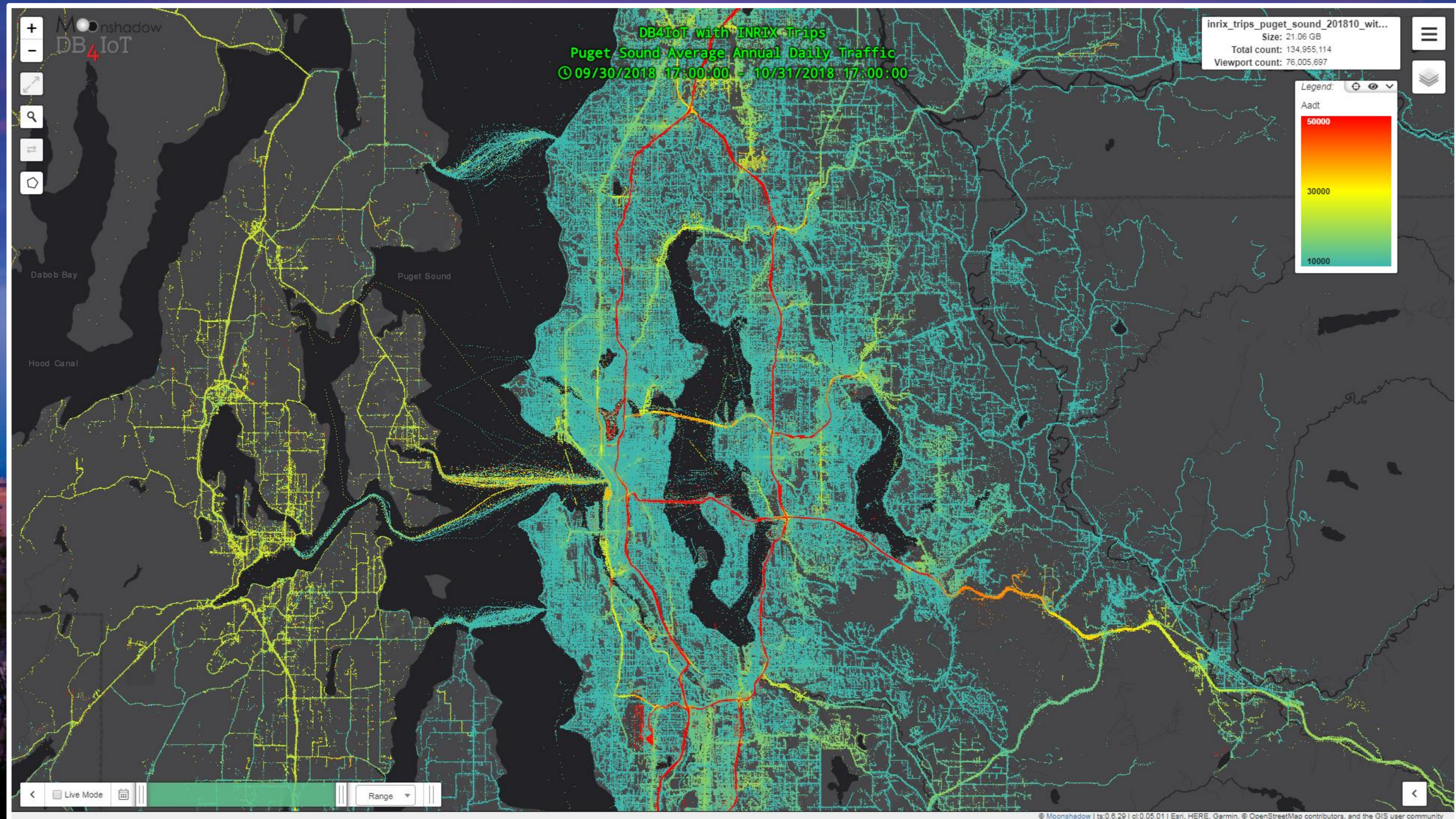
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Every dot is a vehicle reporting its position at a point in time



Proof of Concept:
Emissions values
not validated

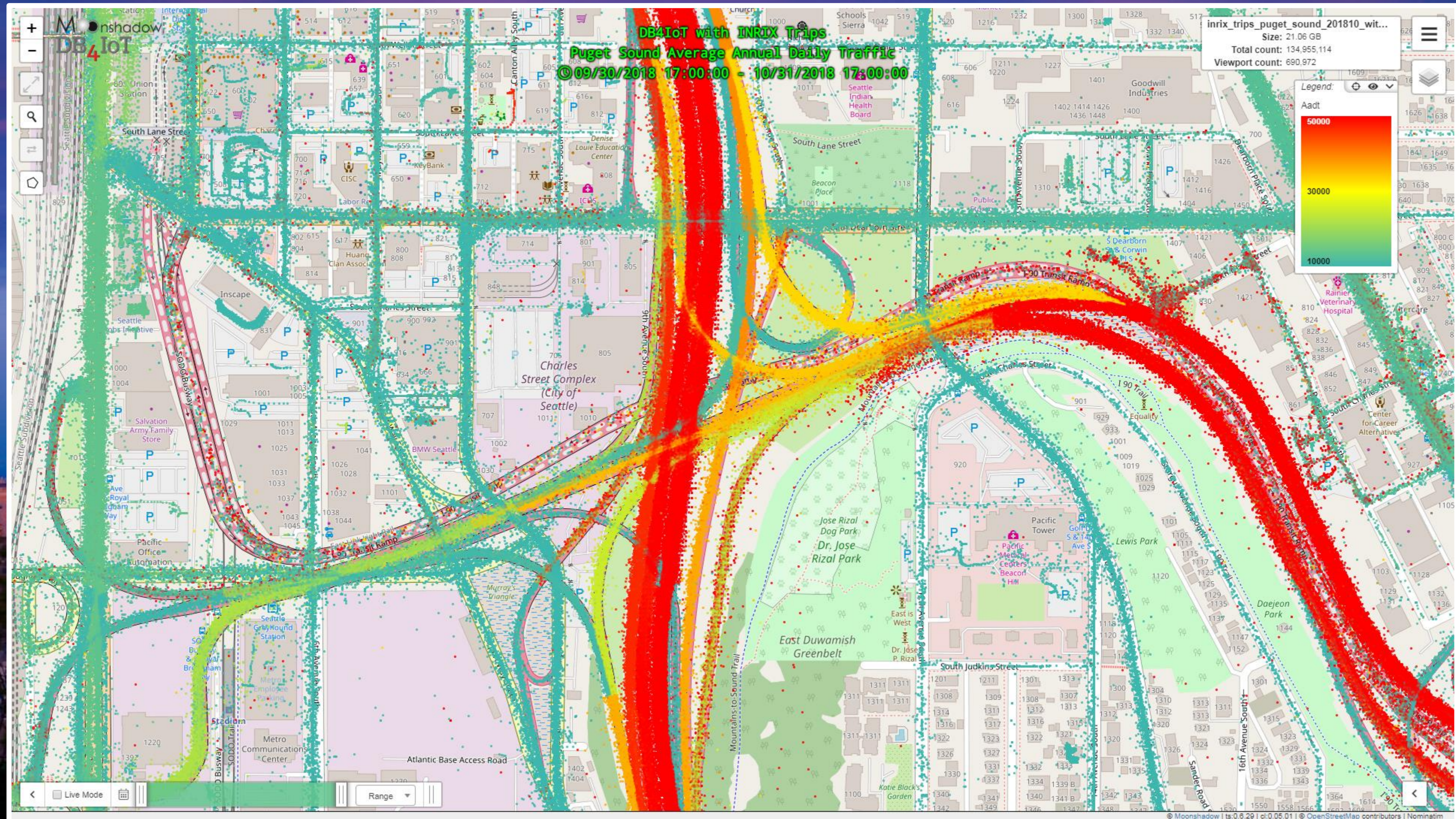
Add average annual daily traffic (AADT) per road segment from INRIX



Proof of Concept:
Emissions values
not validated

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Each point now represents a number of vehicles at a point in time

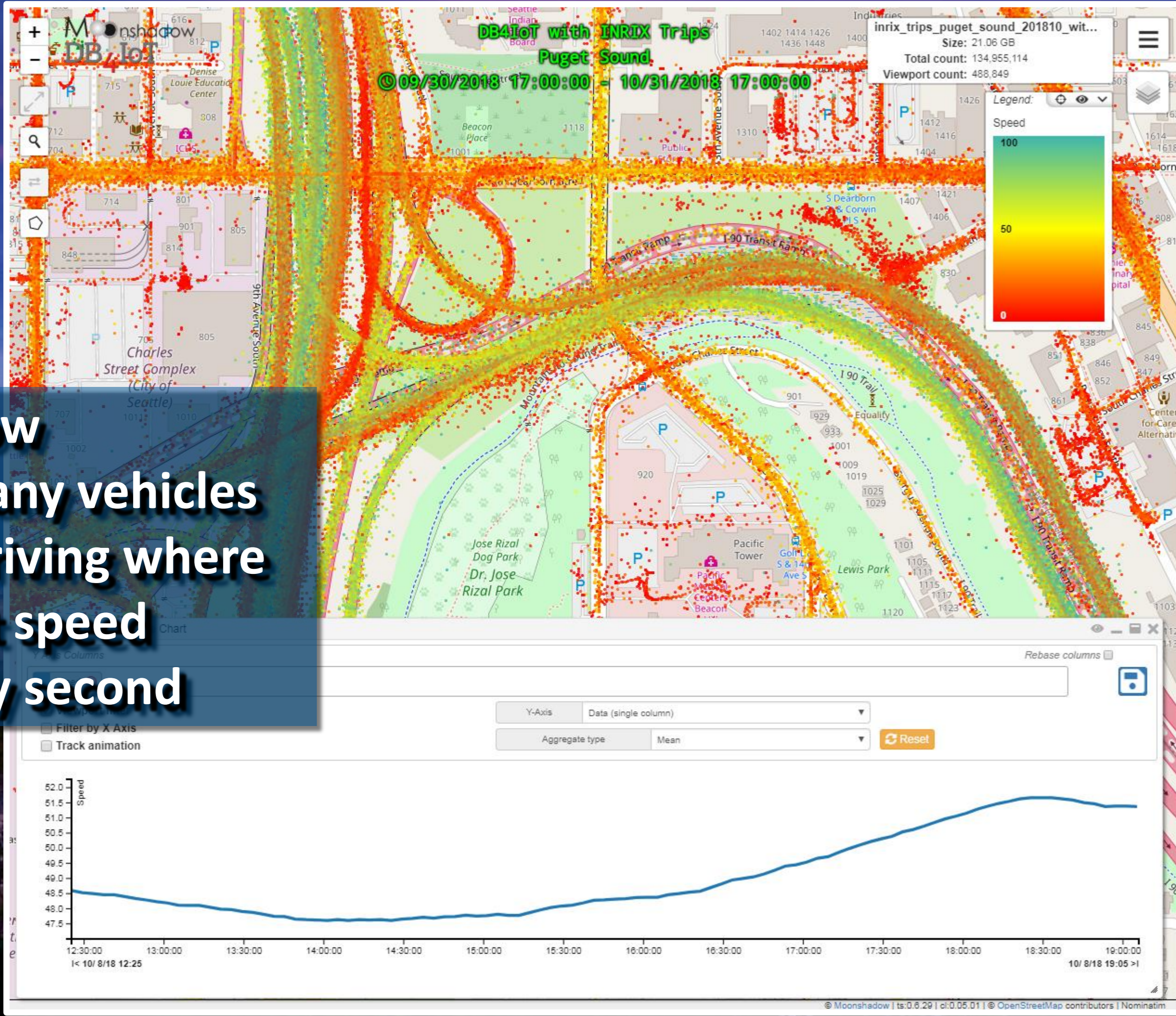


Proof of Concept:
Emissions values
not validated

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Speed data is time-weighted per second

We know how many vehicles were driving where at what speed at every second



Stefan Test Customer eimar.boesjes

inrix_trips_puget_sound_201...
Size: 21.06 GB
Total count: 134,955,114
Viewport count: 488,849

Legend: Speed
100
50
0

Filterable Columns

- Aadt
- Active
- Day of the month
- Day of the week
 - Include unknown
 - Include undefined

	Record Counts	Measurements	Time Weighted			
Monday	11,315,227	8.38%	11,315,223	4.19%	326,800,121,...	5.69%
Tuesday	21,708,350	16.09%	21,708,348	8.04%	369,092,600,...	6.43%
Wednesday	22,854,906	16.94%	22,854,903	8.47%	361,284,887,...	6.29%
Thursday	22,962,318	17.01%	22,962,311	8.51%	442,671,234,...	7.71%
Friday	21,071,860	15.61%	21,071,857	7.81%	495,006,102,...	8.62%
Saturday	21,197,332	15.71%	21,197,327	7.85%	485,356,419,...	8.45%
Sunday	13,845,121	10.26%	13,845,121	5.13%	391,206,492,...	6.81%
Unknown	0	0.00%	0	0.00%	0	0.00%

Emissions co
Emissions co2
Emissions nox
Emissions pm
Rawspeed
Speed

Time of the day

- Include unknown
- Include undefined

	Record Counts	Measurements	Time Weighted			
12:00 AM - 12:15 AM	345,360	0.26%	345,360	0.13%	4,628,422,443	0.08%
12:15 AM - 12:30 AM	323,446	0.24%	323,446	0.12%	3,920,859,449	0.07%
12:30 AM - 12:45 AM	318,273	0.24%	318,273	0.12%	3,339,251,417	0.06%
12:45 AM - 01:00 AM	324,562	0.24%	324,562	0.12%	3,019,863,111	0.05%
01:00 AM - 01:15 AM	321,751	0.24%	321,751	0.12%	2,605,959,848	0.05%
01:15 AM - 01:30 AM	305,379	0.23%	305,379	0.11%	2,180,484,833	0.04%
01:30 AM - 01:45 AM	304,255	0.23%	304,255	0.11%	1,924,379,014	0.03%
01:45 AM - 02:00 AM	298,106	0.22%	298,106	0.11%	1,766,472,513	0.03%
02:00 AM - 02:15 AM	306,943	0.23%	306,943	0.11%	1,644,270,672	0.03%
02:15 AM - 02:30 AM	304,831	0.23%	304,831	0.11%	1,616,737,194	0.03%
02:30 AM - 02:45 AM	304,757	0.23%	304,757	0.11%	1,228,102,436	0.02%
02:45 AM - 03:00 AM	307,292	0.23%	307,292	0.11%	1,338,165,846	0.02%
03:00 AM - 03:15 AM	317,604	0.24%	317,604	0.12%	1,408,232,801	0.02%
03:15 AM - 03:30 AM	326,787	0.24%	326,787	0.12%	1,213,836,119	0.02%
03:30 AM - 03:45 AM	339,969	0.25%	339,969	0.13%	1,435,036,443	0.02%
03:45 AM - 04:00 AM	363,981	0.27%	363,981	0.13%	1,557,124,049	0.03%
04:00 AM - 04:15 AM	383,255	0.28%	383,255	0.14%	1,741,048,486	0.03%
04:15 AM - 04:30 AM	442,751	0.33%	442,751	0.16%	2,076,513,840	0.04%
04:30 AM - 04:45 AM	523,197	0.39%	523,197	0.19%	2,707,207,287	0.05%
04:45 AM - 05:00 AM	585,005	0.43%	585,005	0.22%	3,595,430,306	0.05%

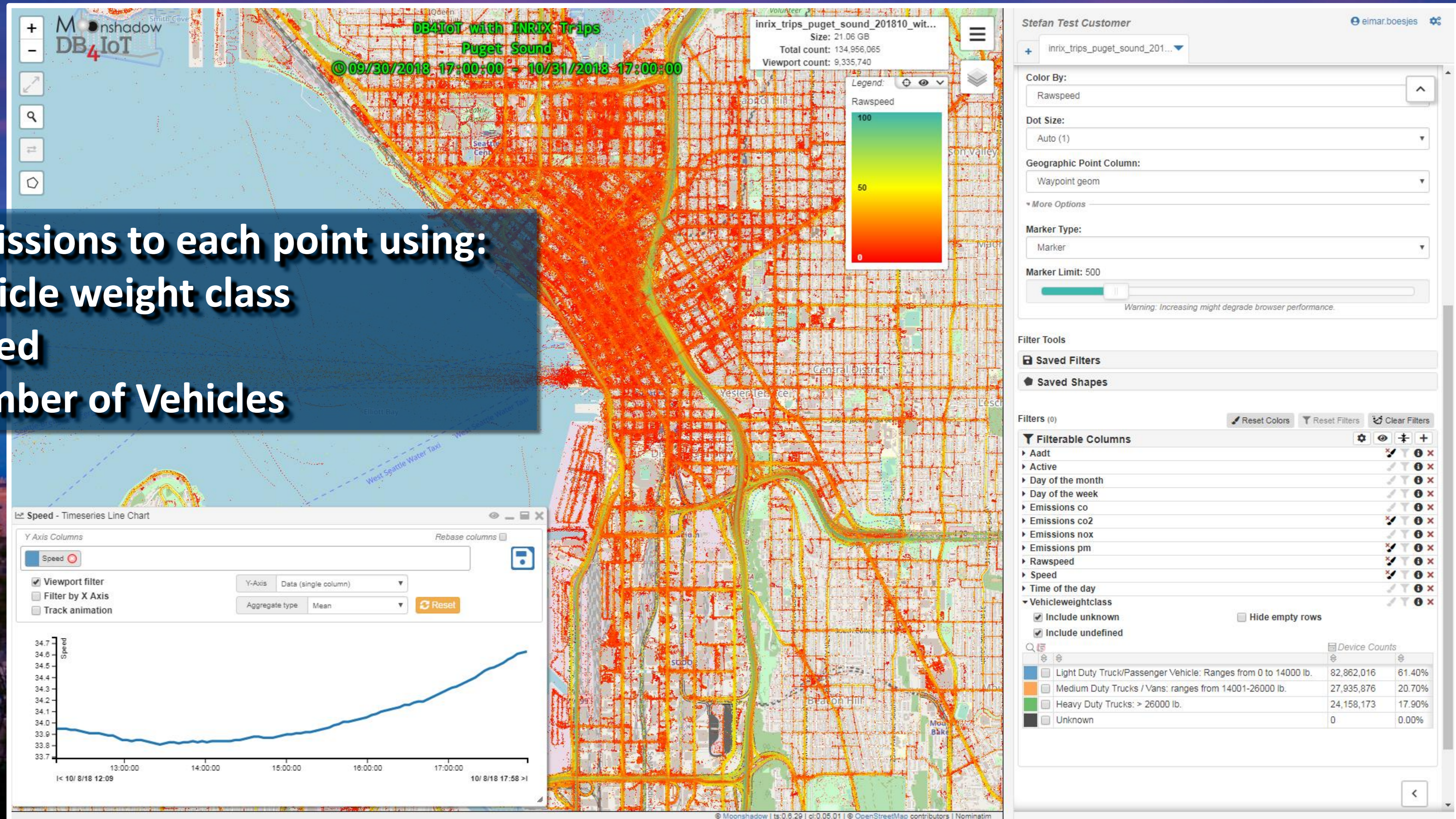
Proof of Concept:
Emissions values
not validated

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Emissions per second are assigned to each waypoint

Assign emissions to each point using:

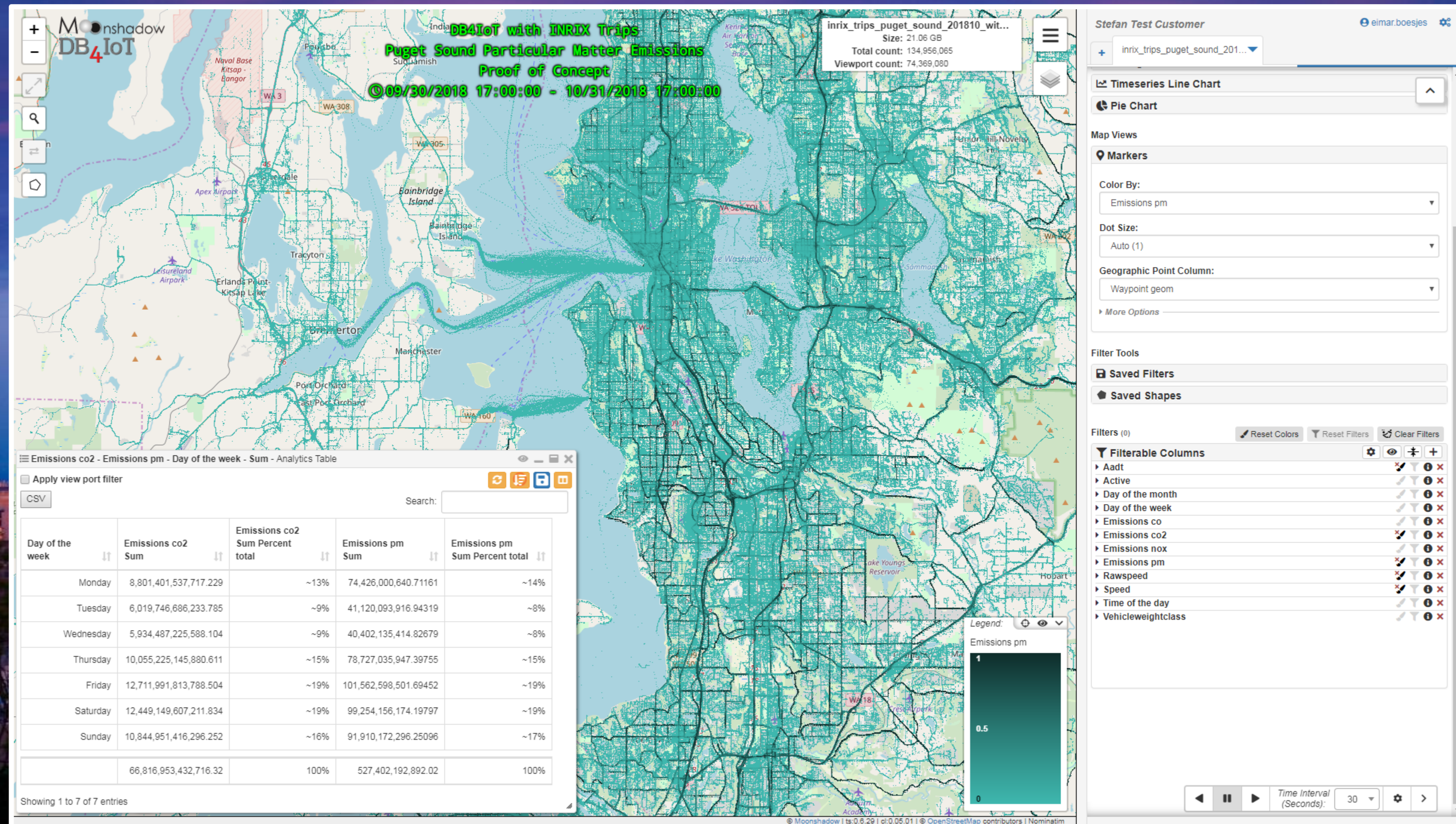
- Vehicle weight class
- Speed
- Number of Vehicles



Proof of Concept:
Emissions values
not validated

DB₄IoT

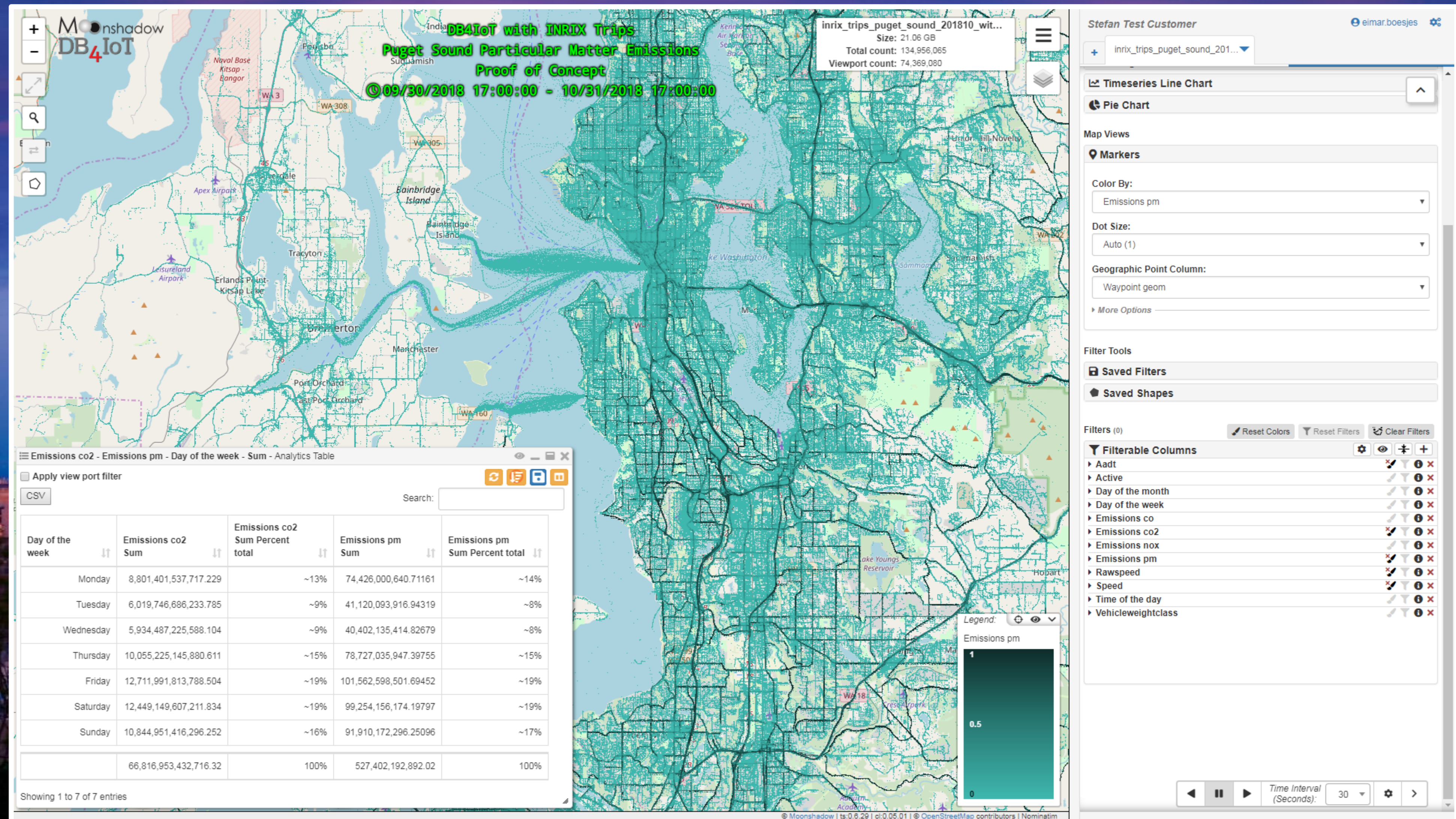
We can now visualize and quantify emissions



Proof of Concept:
Emissions values
not validated

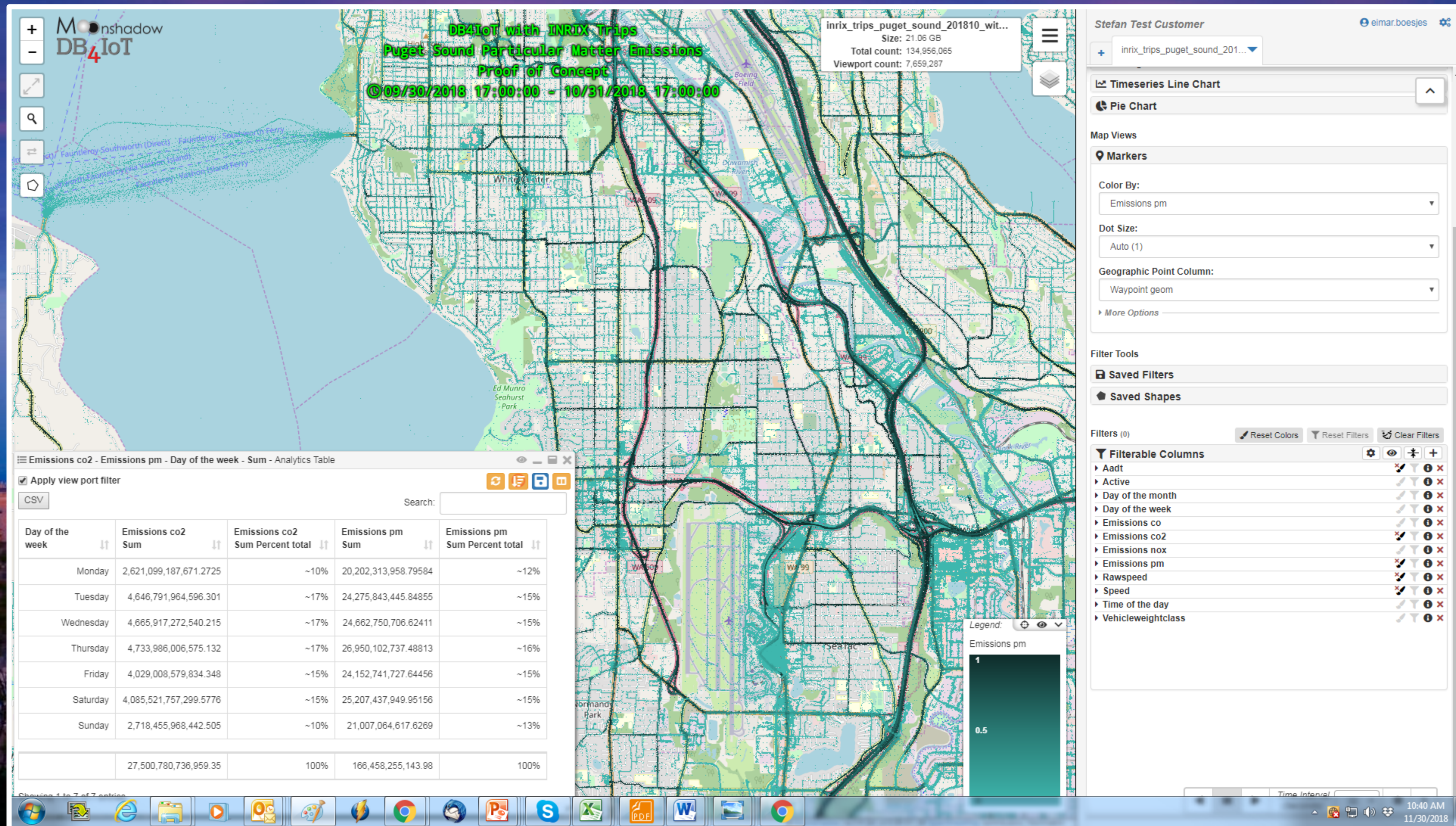
DB₄IoT

We can now visualize and quantify emissions



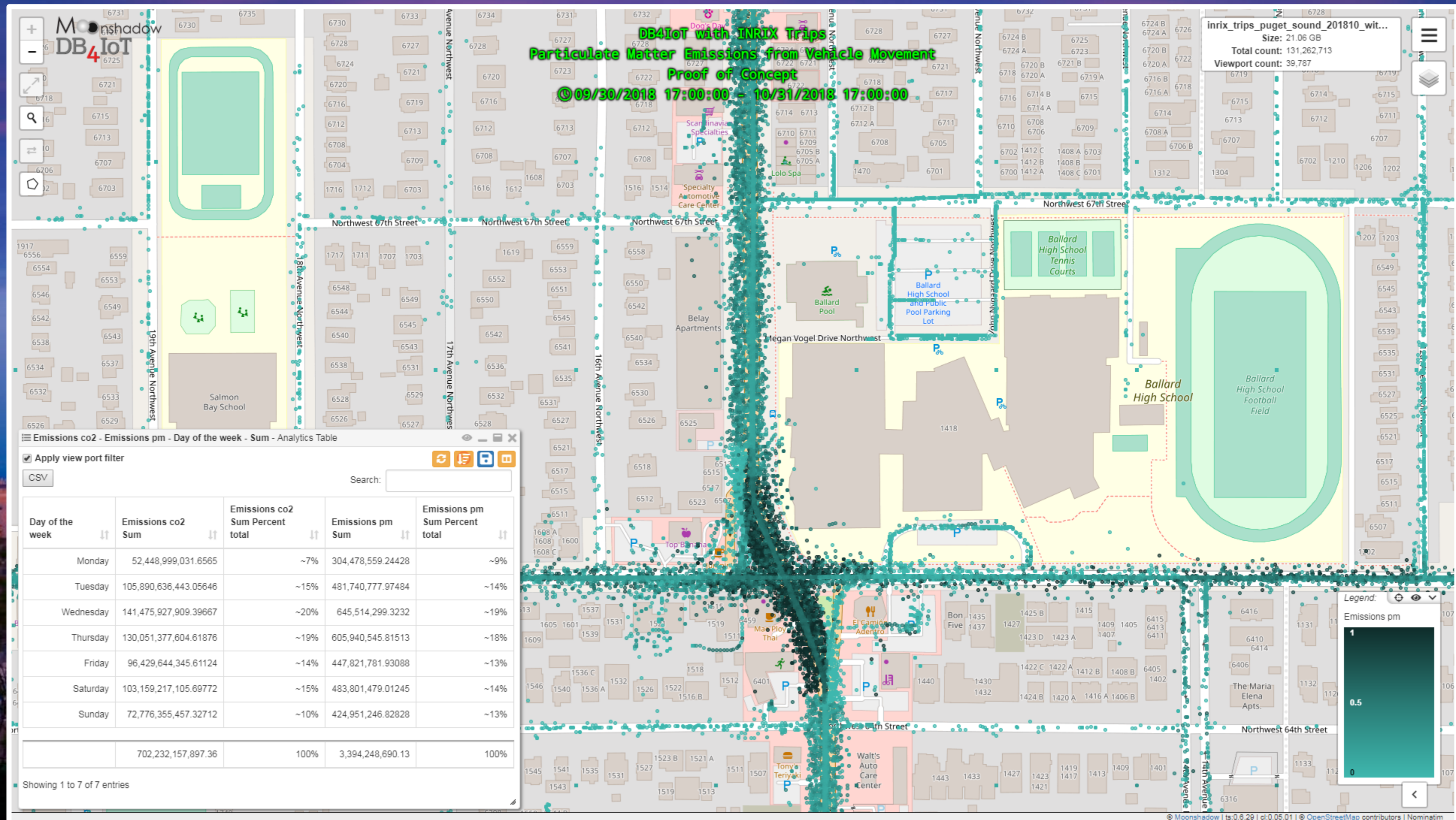
Proof of Concept:
Emissions values
not validated

Particulate matter emissions by weekday within the viewport



Proof of Concept:
 Emissions values
 not validated

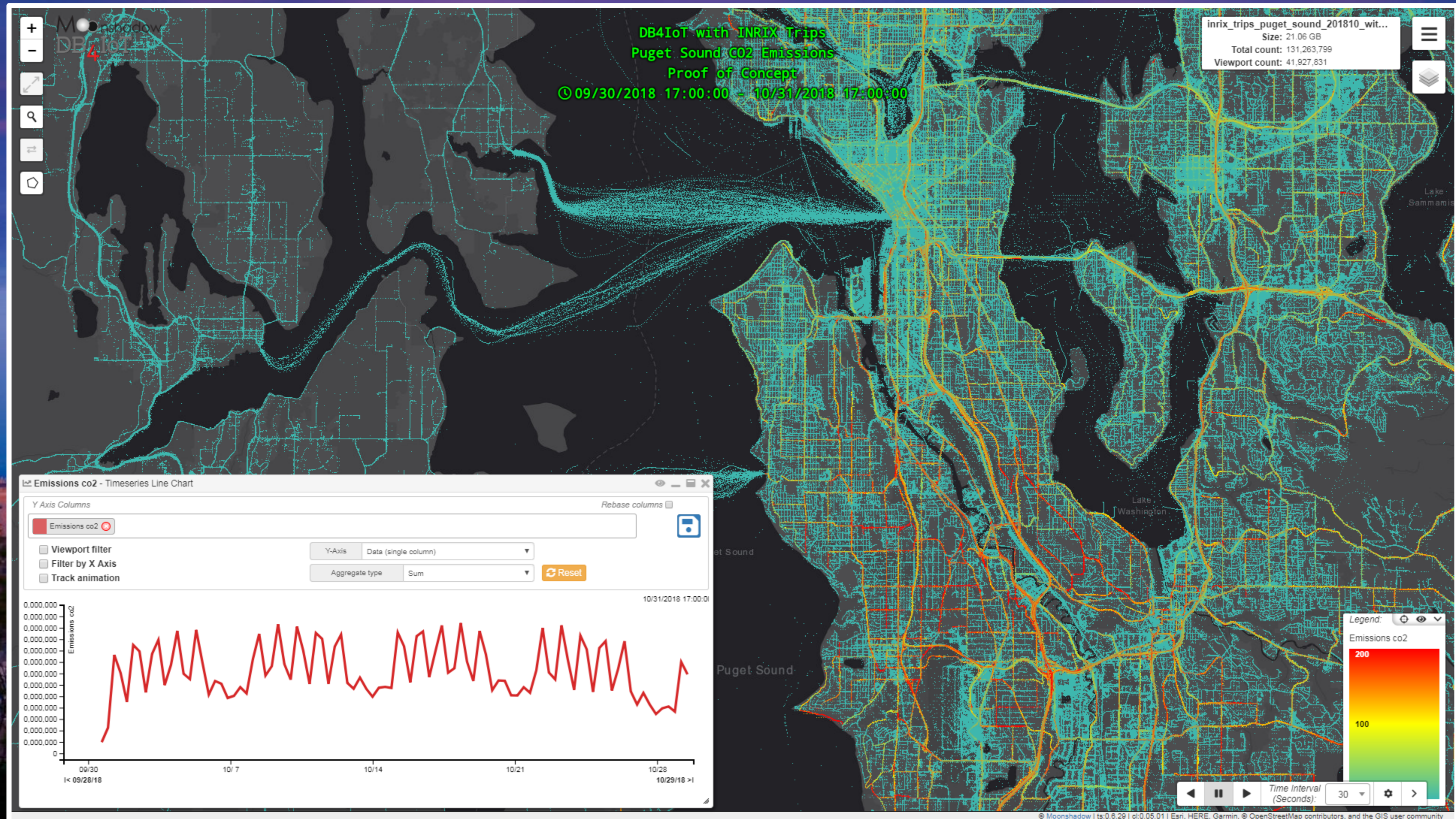
Particulate matter emissions around Ballard High School



Proof of Concept:
 Emissions values
 not validated

DB4IoT

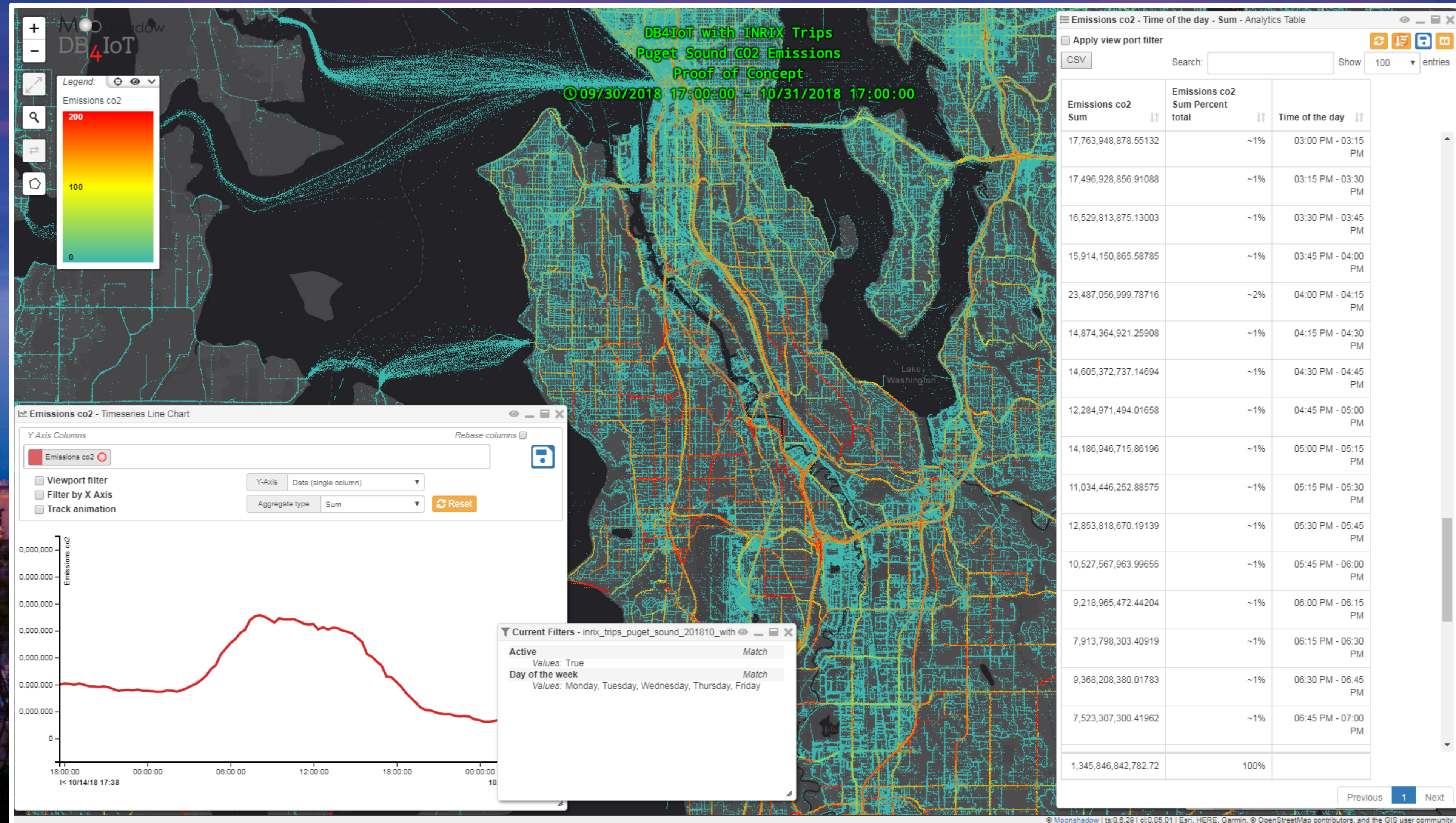
CO2 emissions over time and space



Proof of Concept:
Emissions values
not validated

DB4IoT

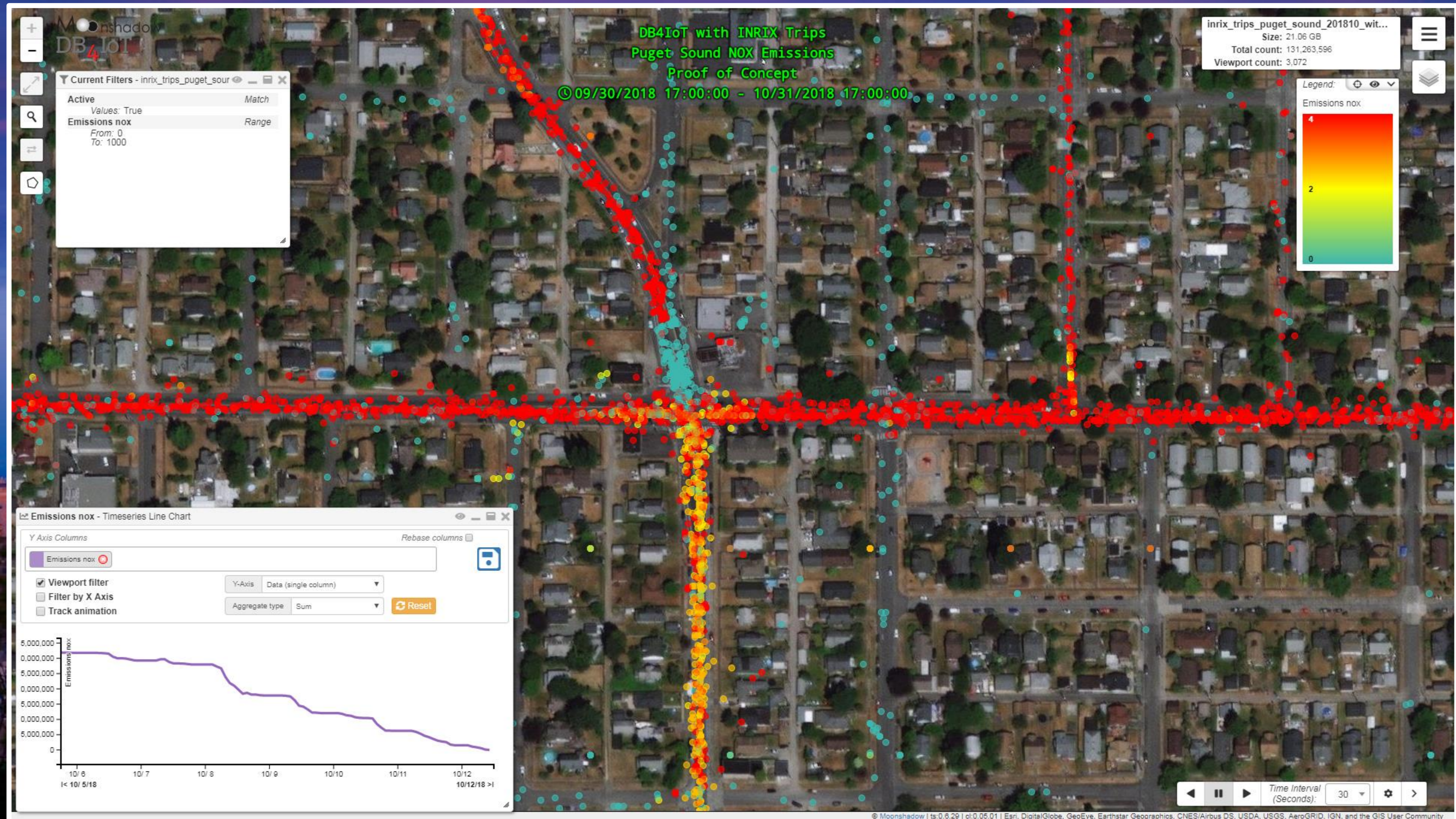
CO2 emissions by time of day on weekdays



Proof of Concept:
Emissions values
not validated

DB₄IoT

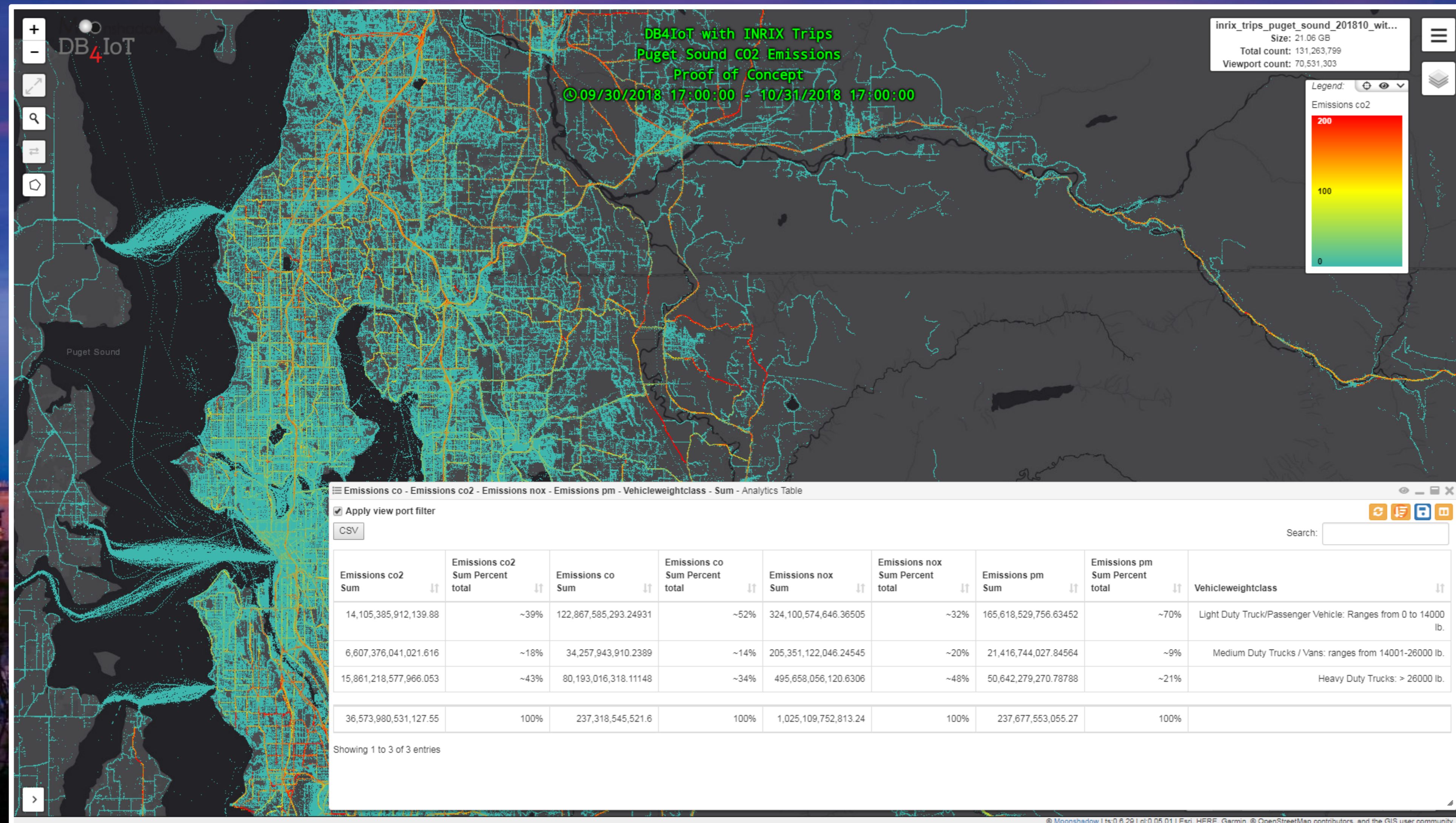
NOX emissions on S Yakima Ave. & S 48th St.



Proof of Concept:
Emissions values
not validated

DB4IoT

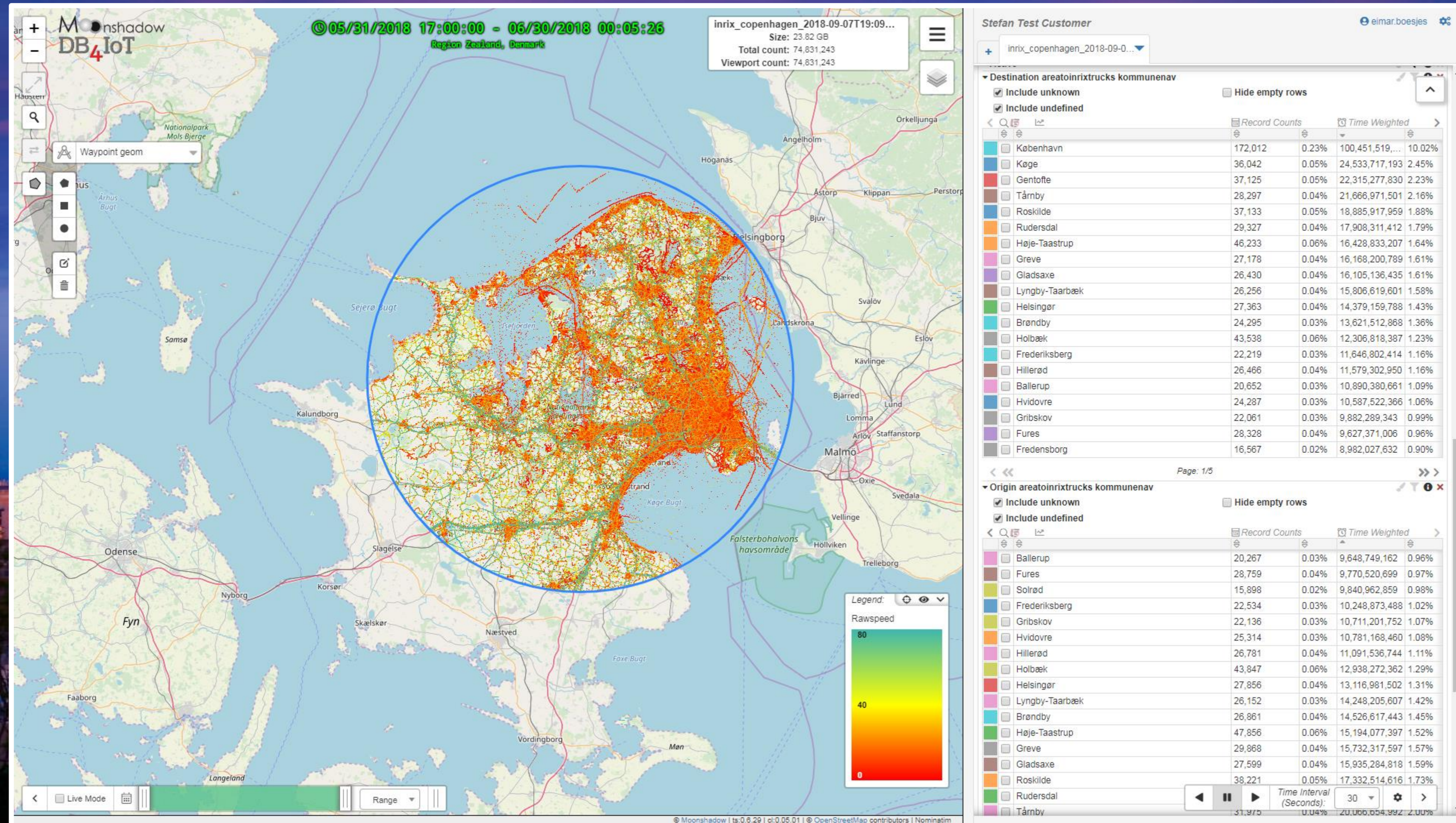
Emissions per vehicle weight class



Proof of Concept:
Emissions values
not validated

DB4IoT

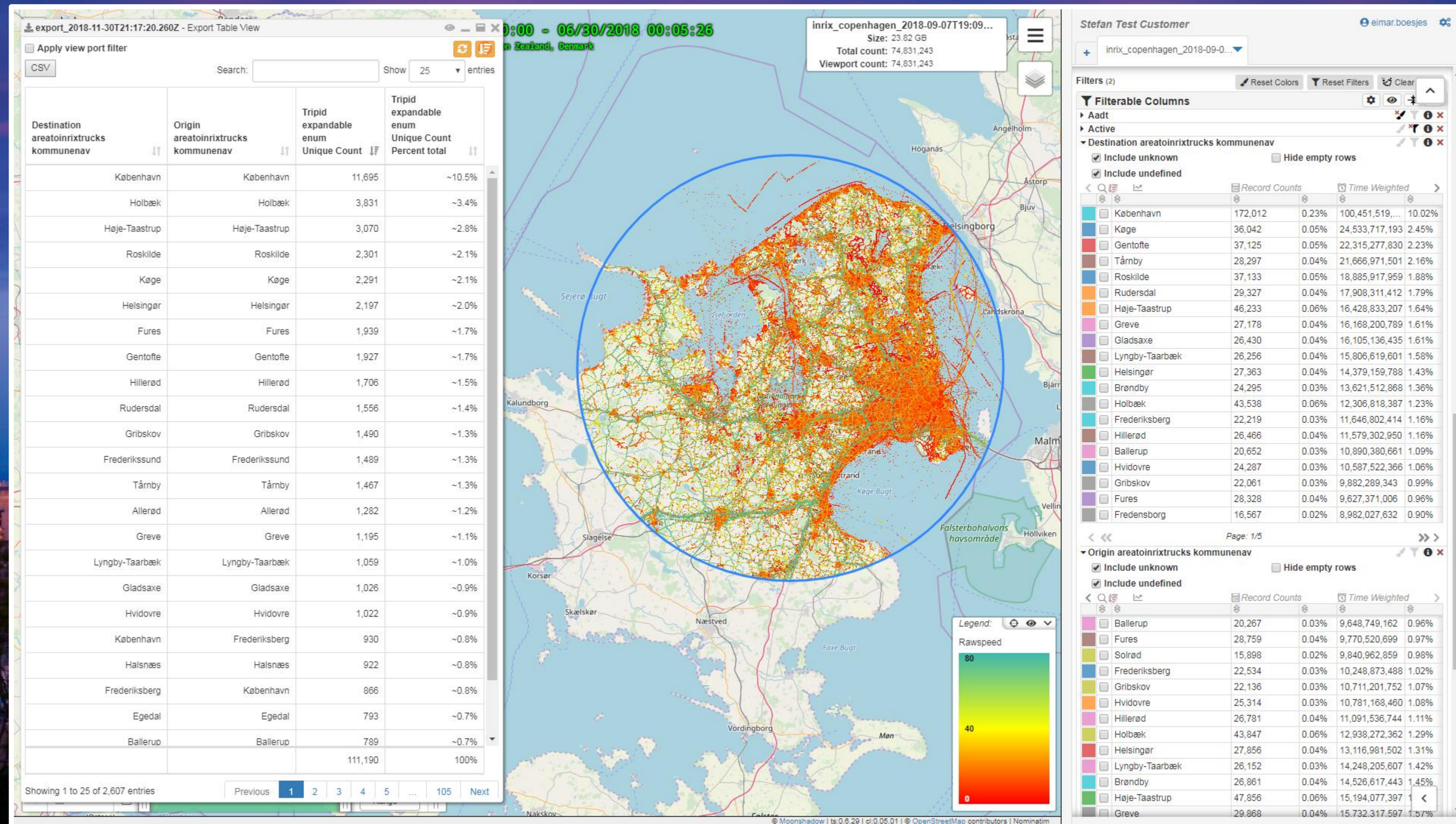
All waypoints within 50 KM of Copenhagen



Proof of Concept:
Emissions values
not validated

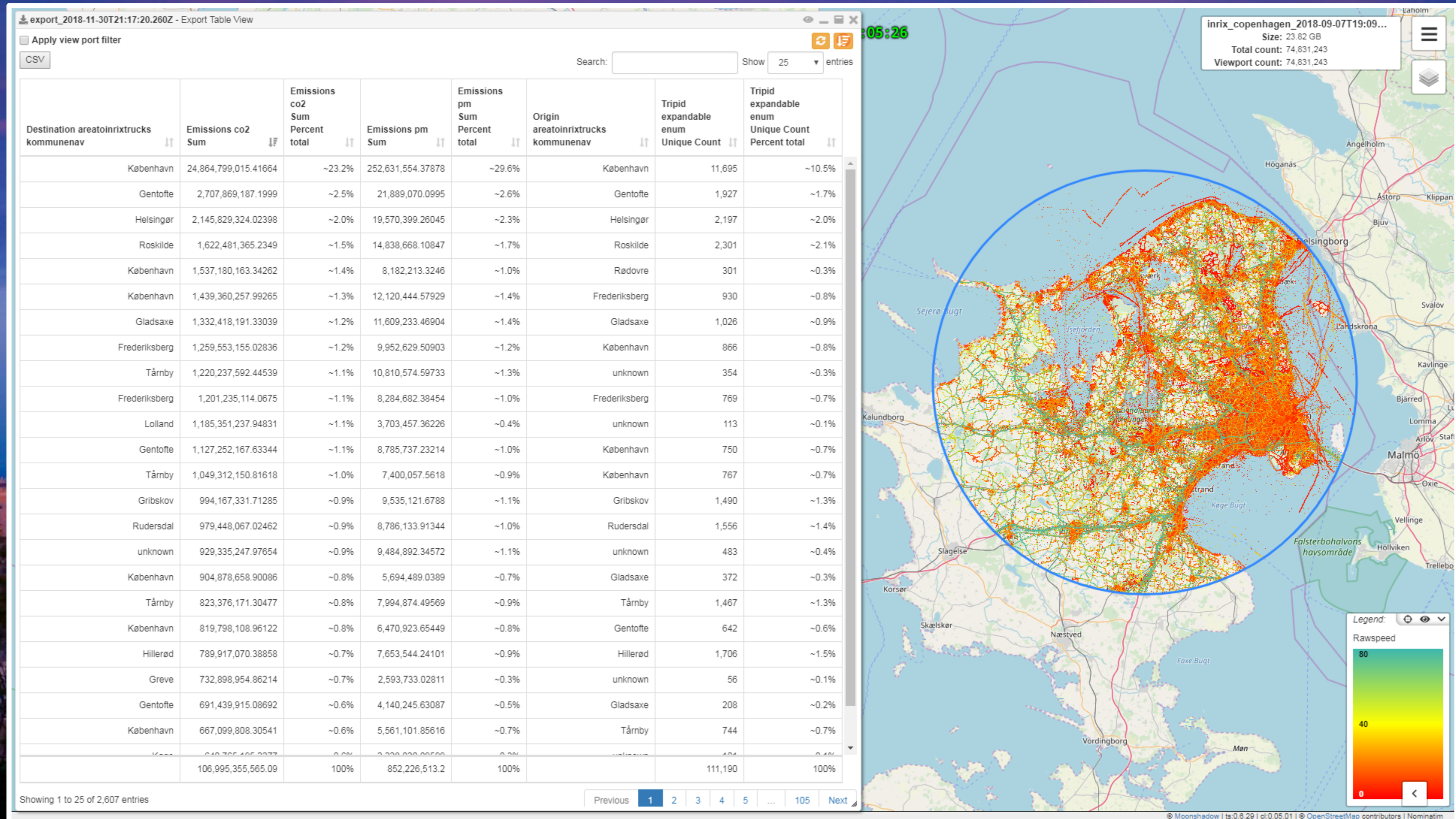
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Origin-Destination matrix for Copenhagen



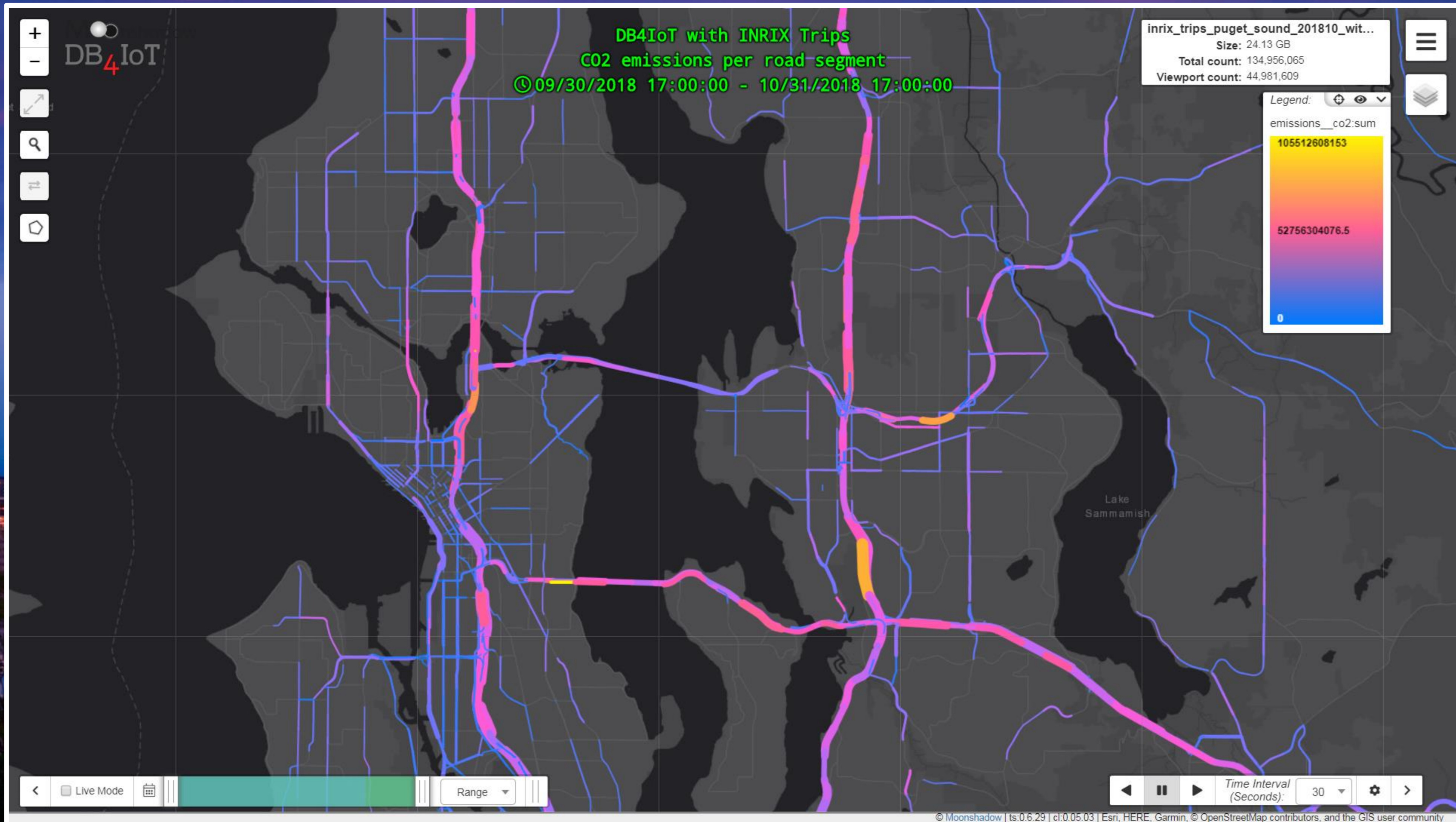
Proof of Concept:
Emissions values
not validated

Origin-Destination emissions matrix for Copenhagen



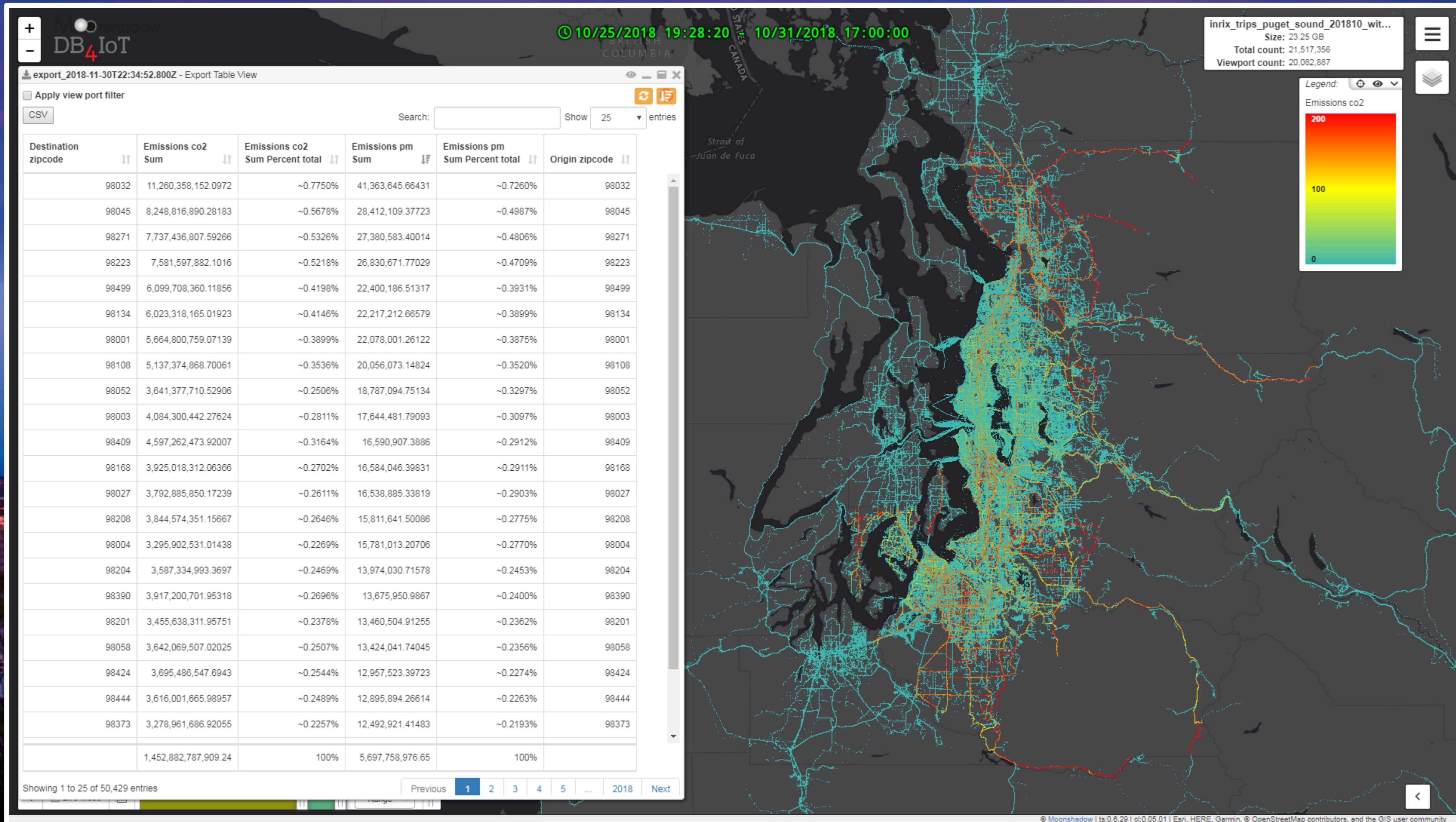
Proof of Concept:
Emissions values
not validated

CO2 Emissions per Road Segment



Proof of Concept:
Emissions values
not validated

ZIP to ZIP Origin-Destination emissions matrix



Proof of Concept:
Emissions values
not validated

ZIP to ZIP Origin-Destination emissions matrix

© 10/25/2018 19:28:20 10/31/2018 17:00:00

export_2018-11-30T22:34:52.800Z - Export Table View

Apply view port filter

CSV Search: Show 25 entries

Destination zipcode	Emissions co2 Sum	Emissions co2 Sum Percent total	Emissions pm Sum	Emissions pm Sum Percent total	Origin zipcode
98032	11,260,358,152.0972	~0.7750%	41,363,645.66431	~0.7260%	98032
98045	8,248,816,890.28183	~0.5678%	28,412,109.37723	~0.4987%	98045
98271	7,737,436,807.59266	~0.5326%	27,380,583.40014	~0.4806%	98271
98223	7,581,597,882.1016	~0.5218%	26,830,671.77029	~0.4709%	98223
98499	6,099,708,360.11856	~0.4198%	22,400,186.51317	~0.3931%	98499
98134	6,023,318,165.01923	~0.4146%	22,217,212.66579	~0.3899%	98134
98001	5,664,800,759.07139	~0.3899%	22,078,001.26122	~0.3875%	98001
98108	5,137,374,868.70061	~0.3536%	20,056,073.14824	~0.3520%	98108
98052	3,641,377,710.52906	~0.2506%	18,787,094.75134	~0.3297%	98052
98003	4,084,300,442.27624	~0.2811%	17,644,481.79093	~0.3097%	98003
98409	4,597,262,473.92007	~0.3164%	16,590,907.3886	~0.2912%	98409
98168	3,925,018,312.06366	~0.2702%	16,584,046.39831	~0.2911%	98168

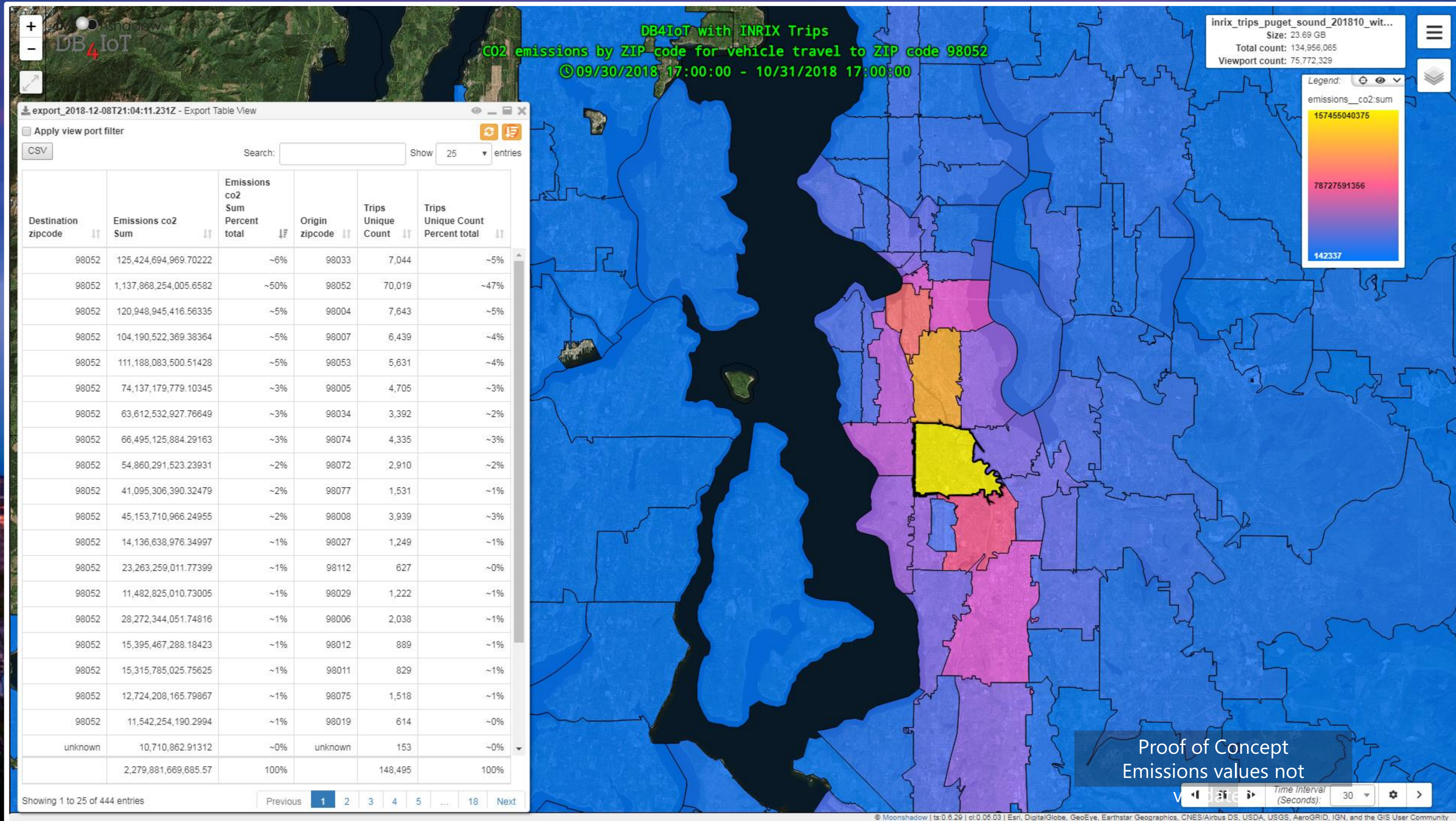
inrix_trips_puget_sound_201810_wit...
Size: 23.25 GB
Total count: 21,517,356
Viewport count: 20,082,887

Legend: Emissions co2
200
100
0

© Moonshadow | ts:0.6.29 | dt:0.05.01 | Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Proof of Concept:
Emissions values
not validated

CO2 Emissions by ZIP code for travel to ZIP 98052



Proof of Concept:
Emissions values
not validated

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The formula for this approach is simple

N = Number of Vehicles

E = Average Emission per Vehicle per Second

T = Time Length in seconds

Total Emissions = N * E * T

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Accuracy will increase as the input variables become more precise

Number of Vehicles:

- **More connected vehicles**
- **More accurate counts from infrastructure**

Average Emission per Vehicle per Second:

- **Better information on composition of vehicle fleet**
 - **Better data on emissions at different speeds**
- **Increased frequency of vehicle movement data**

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Contact Info

Moonshadow

Moonshadow Mobile, Inc.

Eimar Boesjes – CEO

eimar@moonshadowmobile.com

541-343-4281

moonshadowmobile.com

db4iot.com

DKS

Moonshadow