WASHINGTON STATE UNIVERSITY

High-resolution Air Quality Modeling over Spokane

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Urbanova

Integrating technology into urban areas to create smarter cities to improve:

- Livability
- Workability
- Sustainability

High resolution air quality model

- Accurately portray urban environment

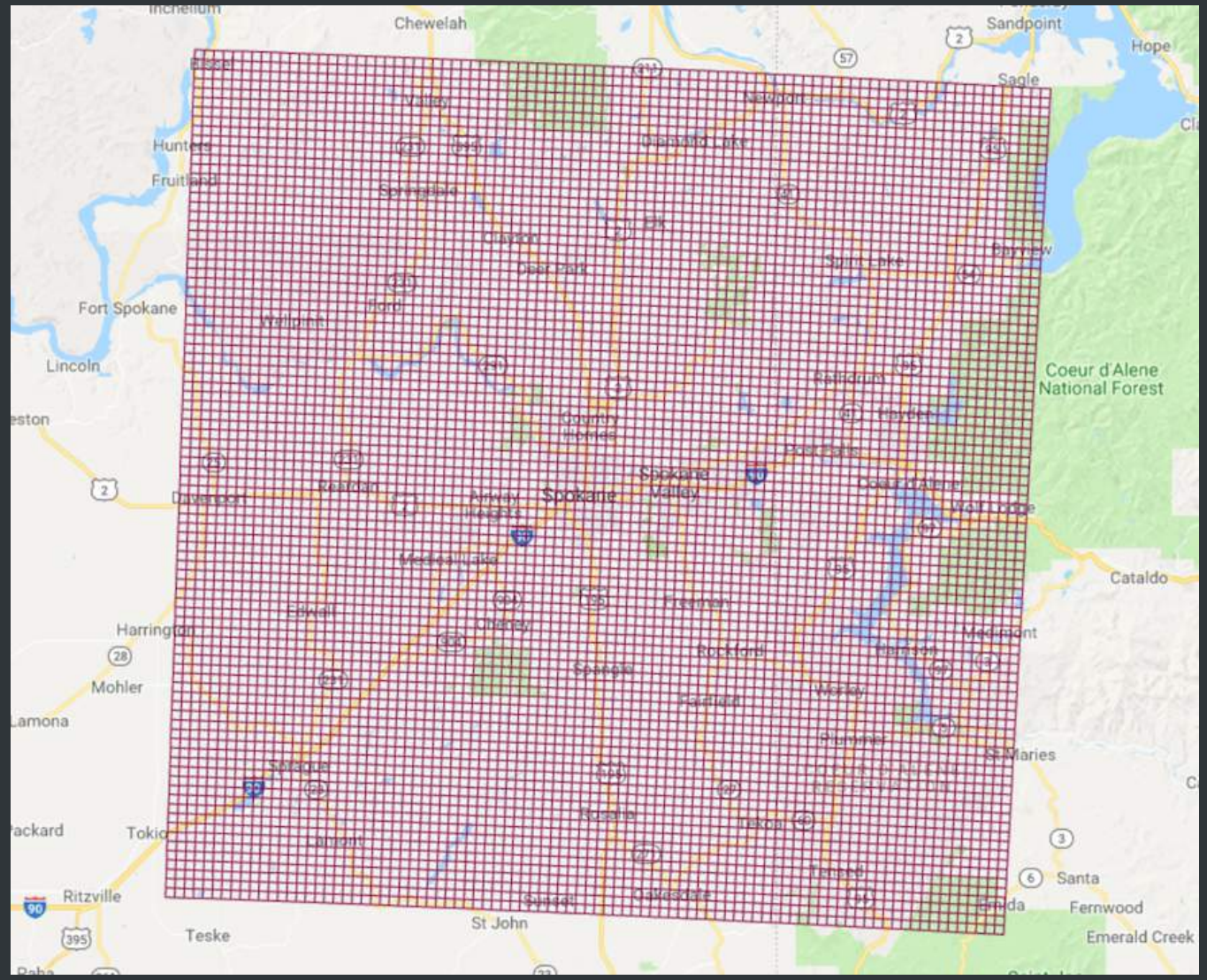
Spokane University District with AIRPACT 1.33 km grids

https://urbanova.org/

AIRPACT with 1.33 km grid over Spokane

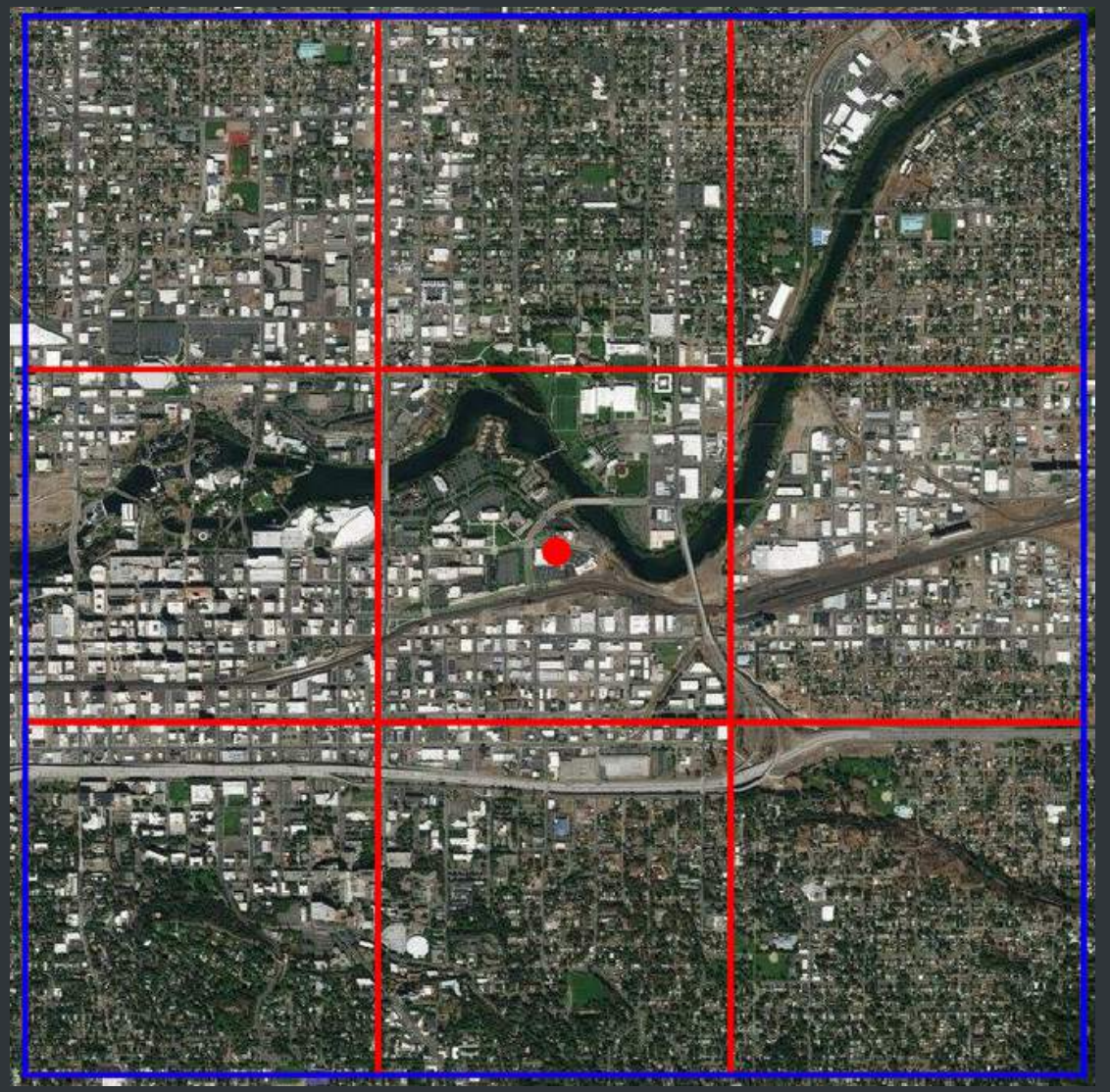
To account for the extreme diversity of urban settings

Does increasing model resolution make a worthwhile difference?



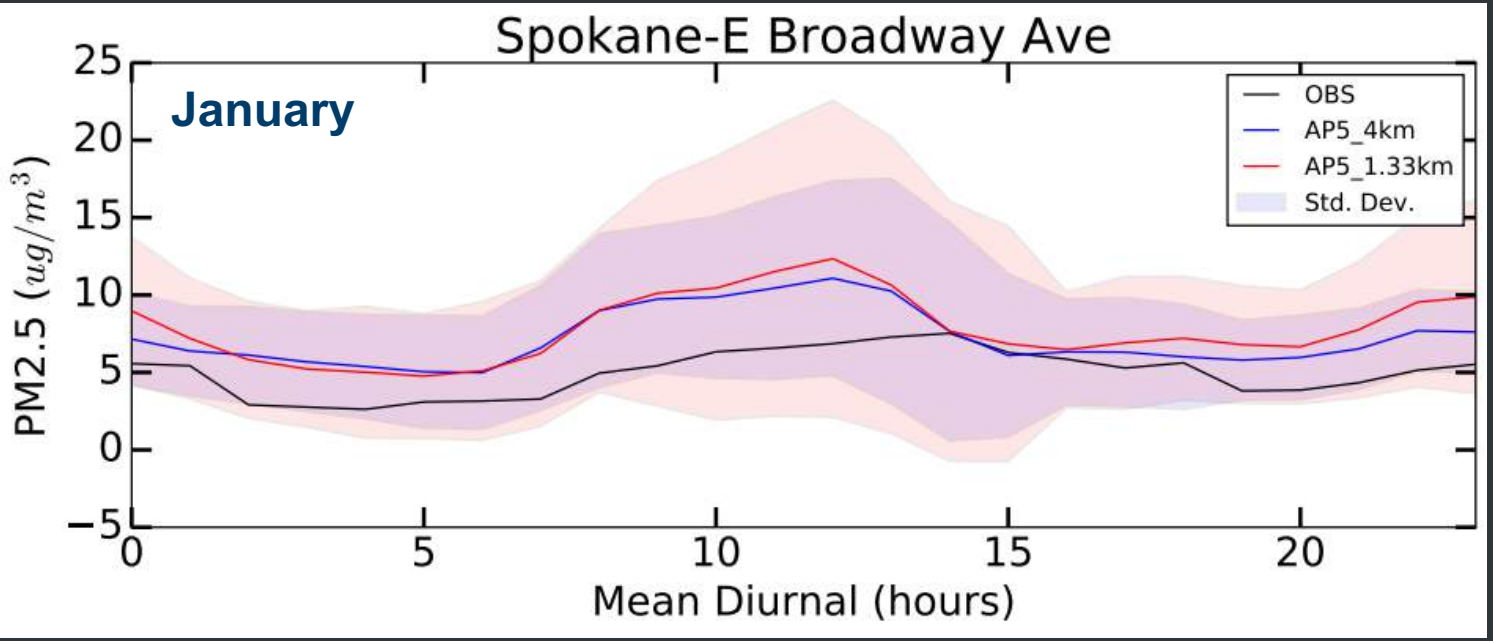
AIRPACT-1.33km setup

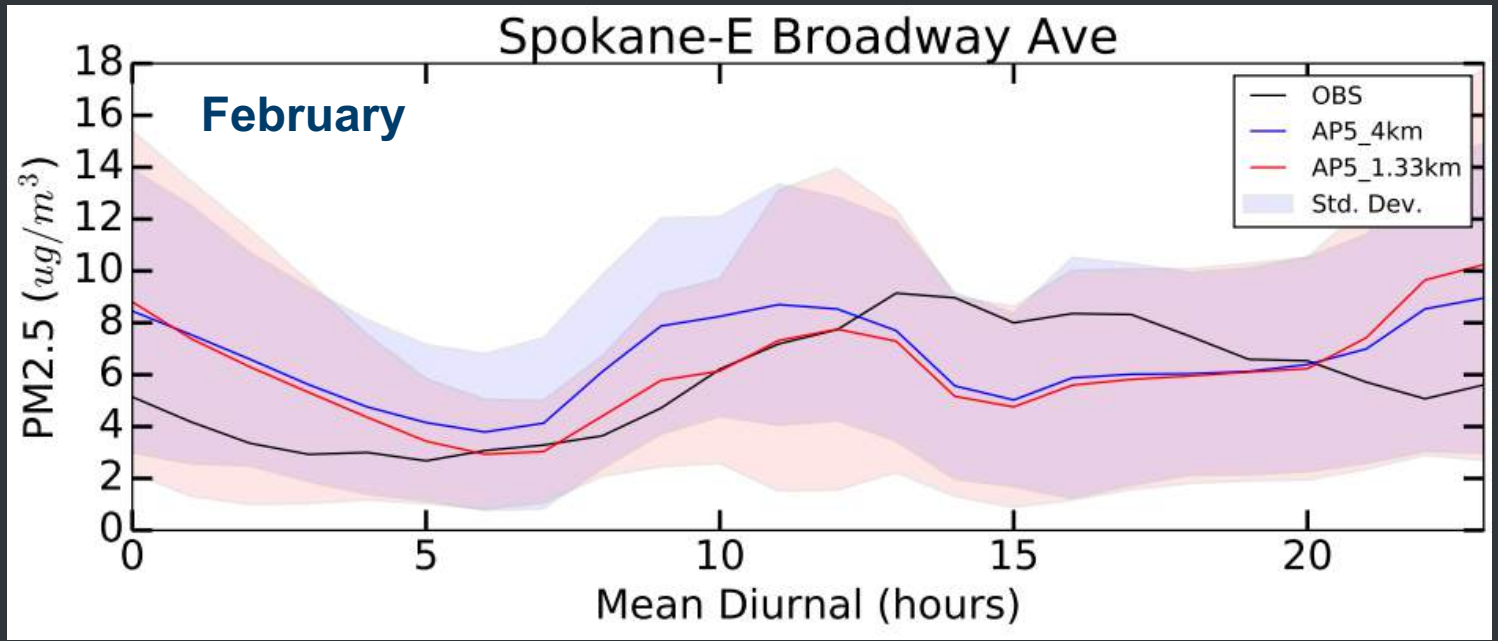
- Meteorology from WRF at 1.33km grids
- Air quality simulations using CMAQ
- Same emissions as AIRPACT-4km
  - No fire emissions
- For a grid in AIRPACT-4km, there are nine 1.33km grids.



Observation Data

- AirNow real-time data
  - $PM_{2.5}$ and O_3
- Urbanova reference site
  - Air quality measurements on WSU/EWU Spokane Campus
    - O_3, NO, NO_2, and SO_2

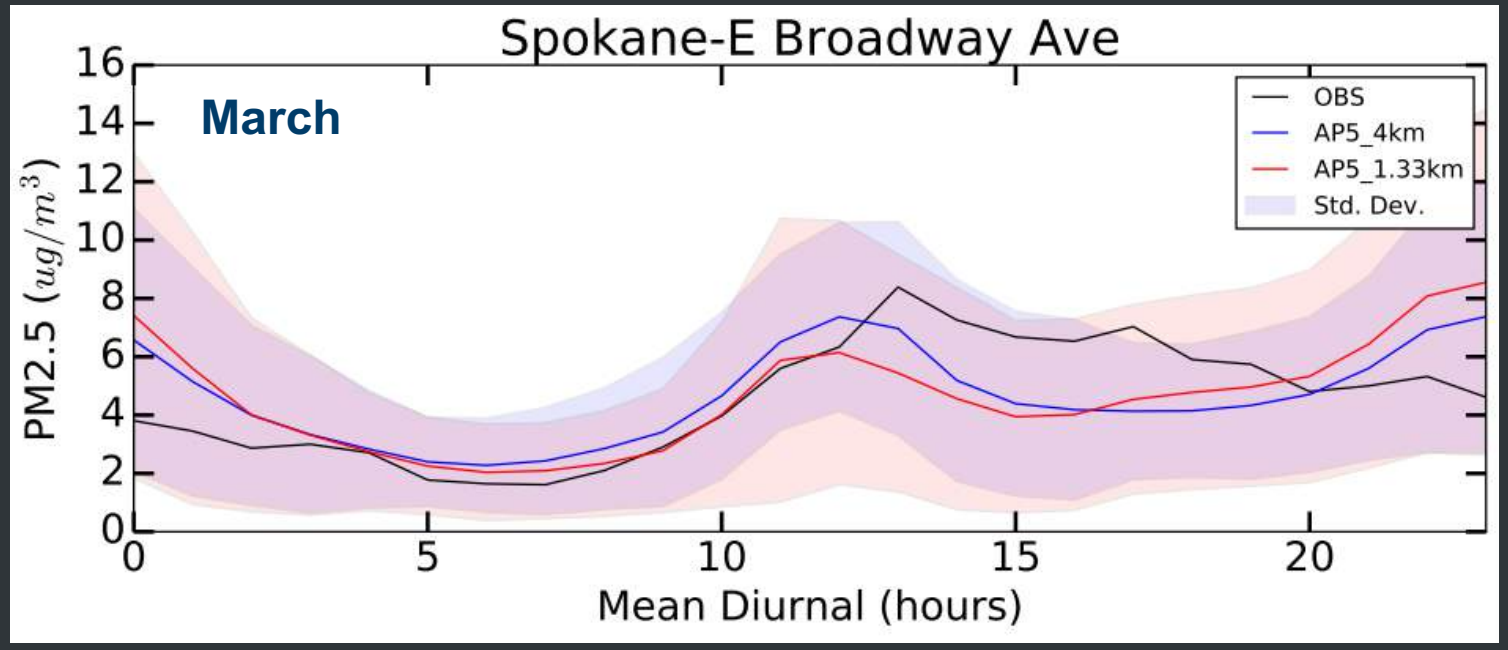


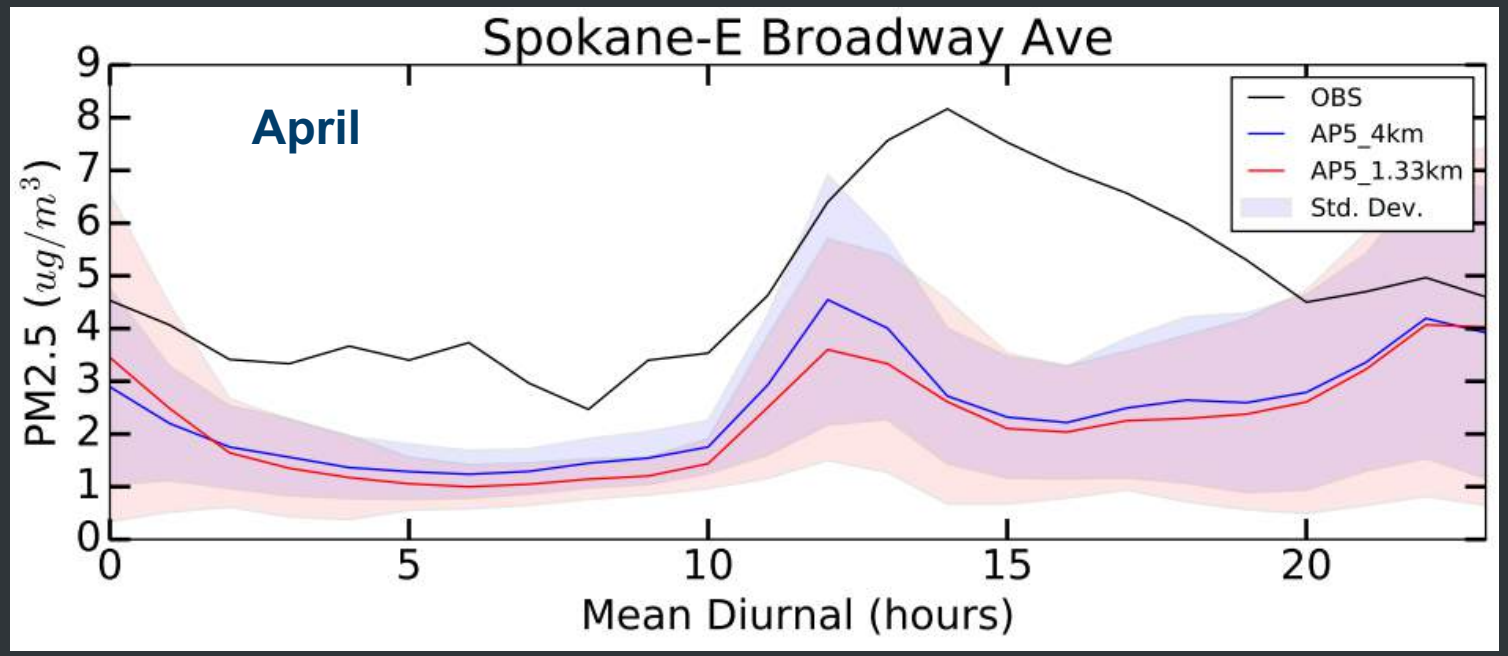


AirNow

Mean Diurnal Cycle of $PM_{2.5}$: Jan and Feb

Month	January		February	
Resolution	1.33km	4km	1.33km	4km
NMB	57.38	45.34	7.92	15.56
NME	90.36	81.46	69.5	69.18
R^2	0.29	0.25	0.18	0.2

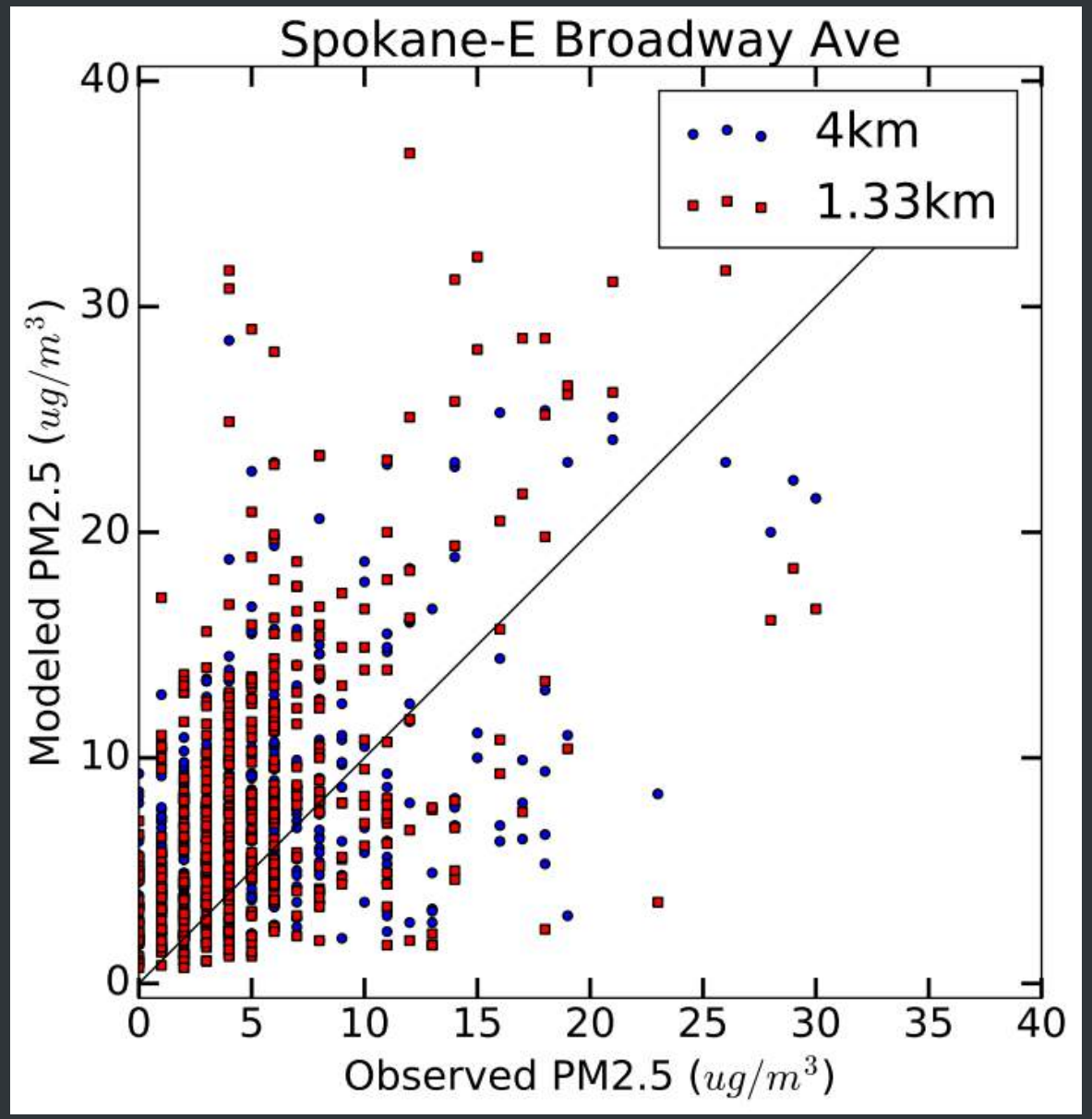




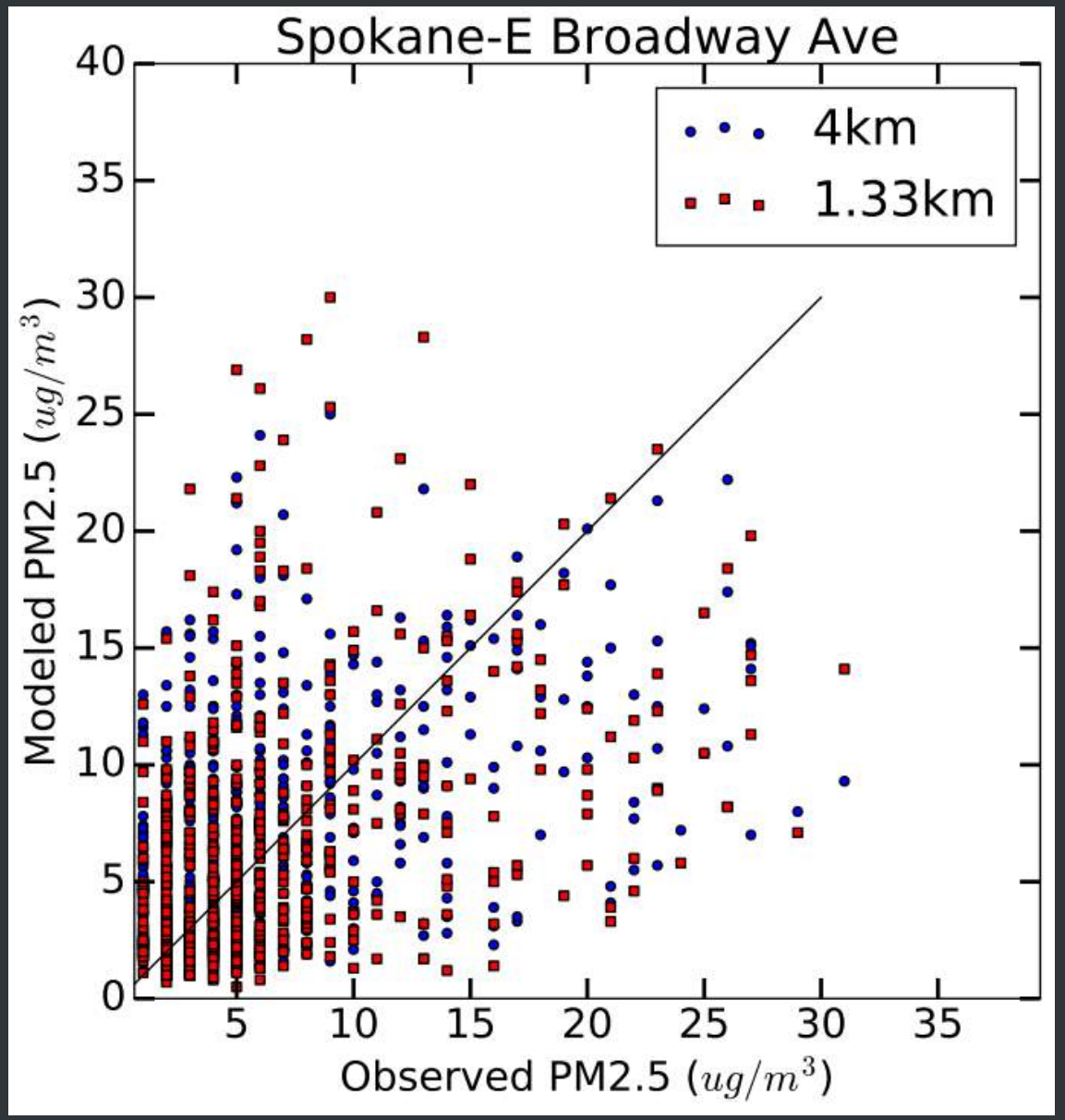
AirNow

Mean Diurnal Cycle of $PM_{2.5}$: March and April

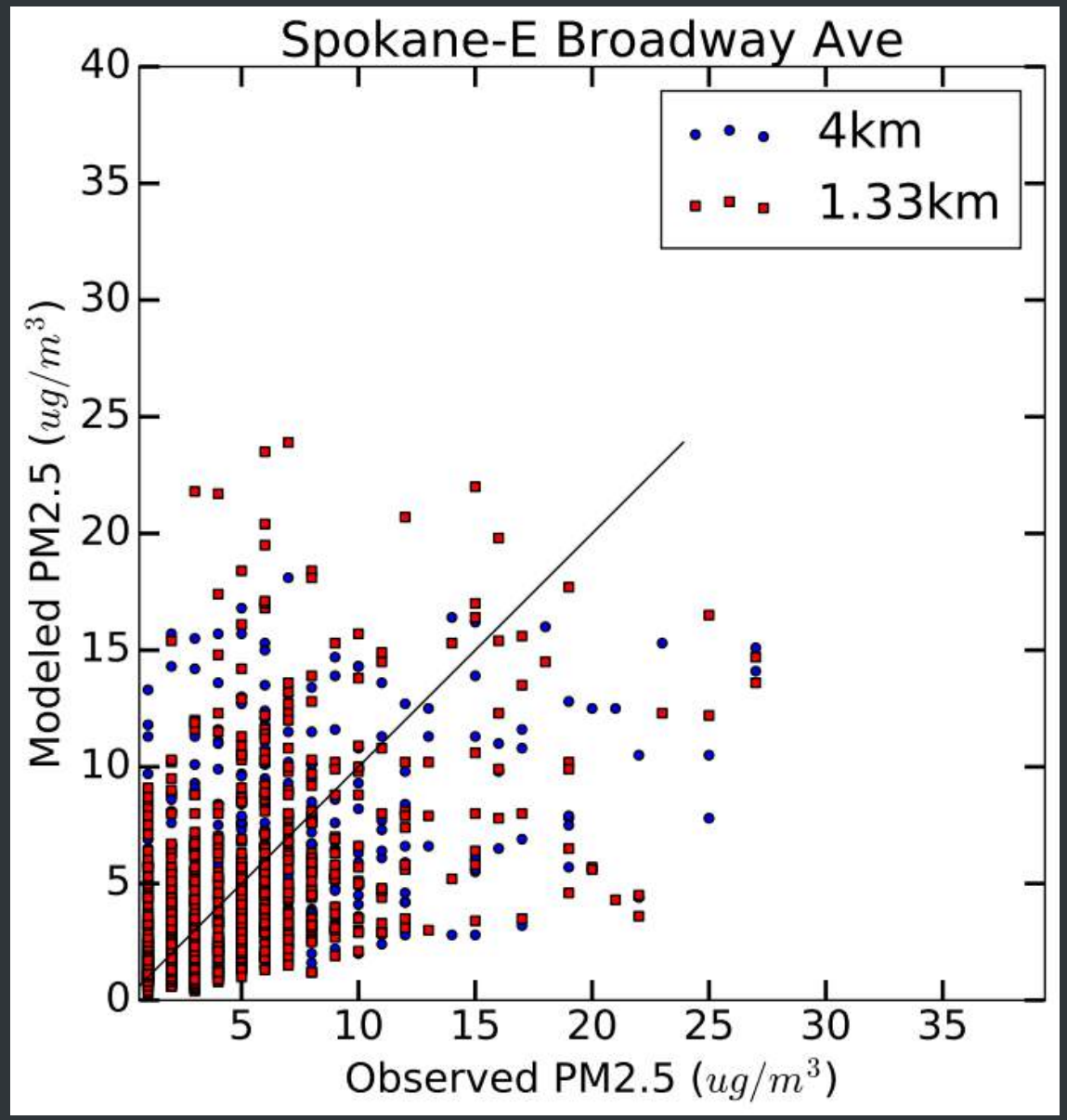
Month	March		April	
Resolution	1.33km	4km	1.33km	4km
NMB	1.92	2.25	-53.6	-49.27
NME	64.85	63.72	65.03	64.25
R^2	0.24	0.23	0.17	0.11



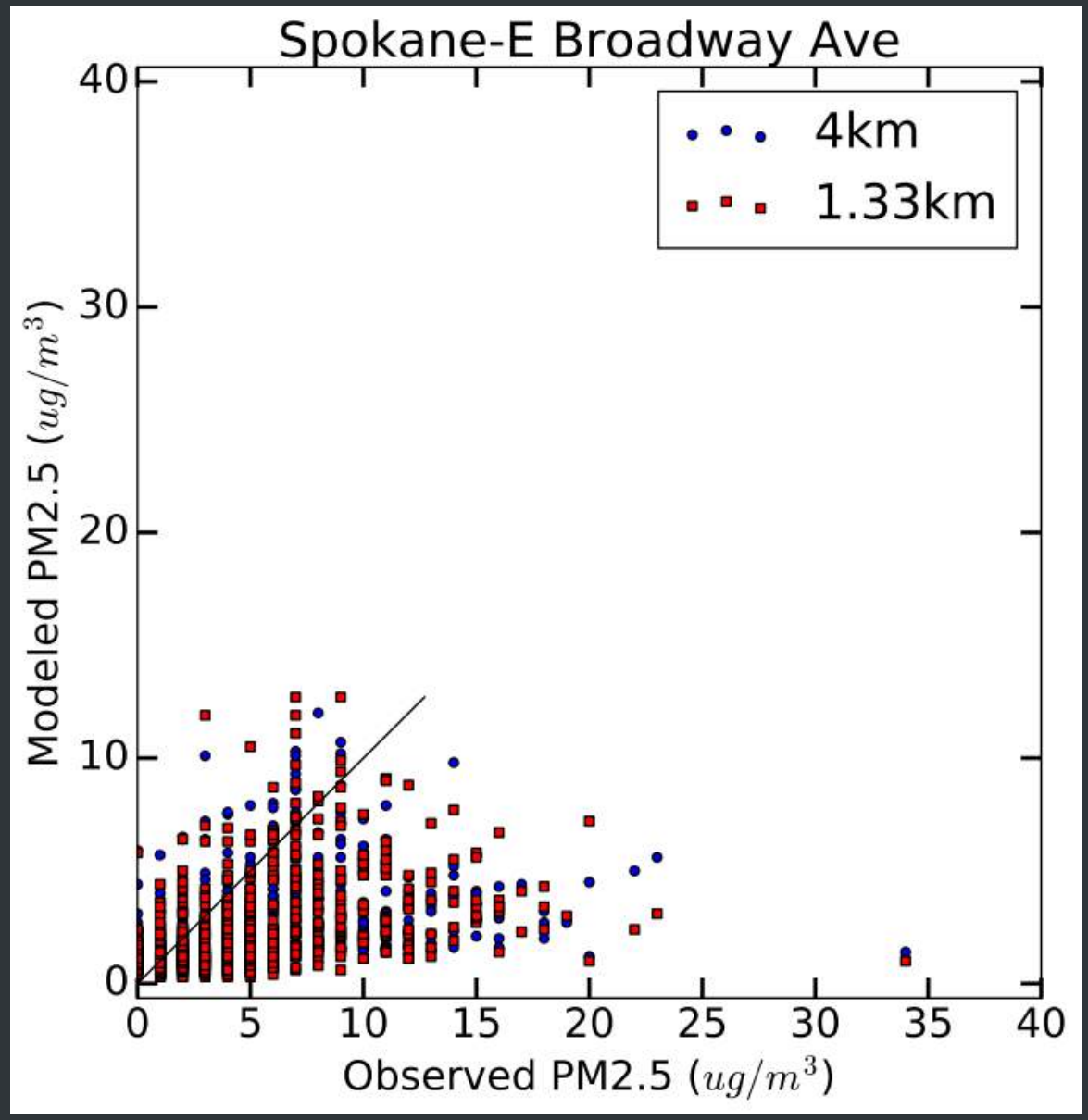
January



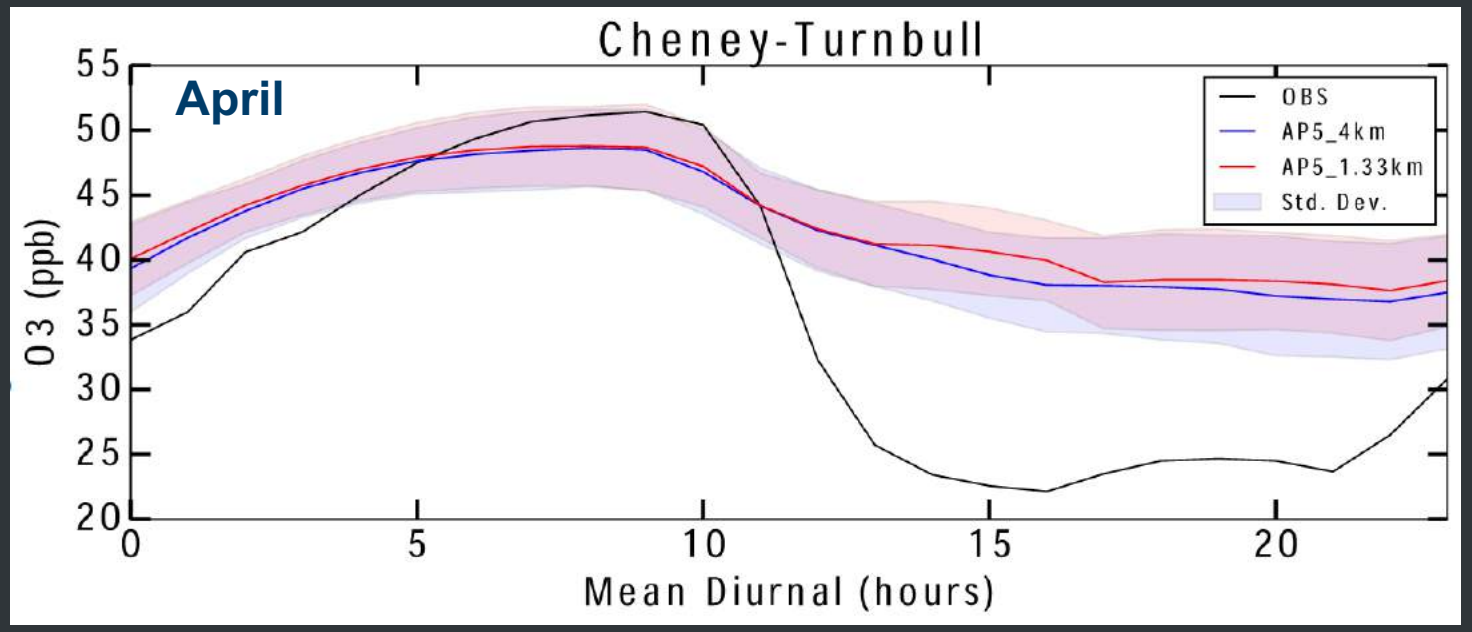
February

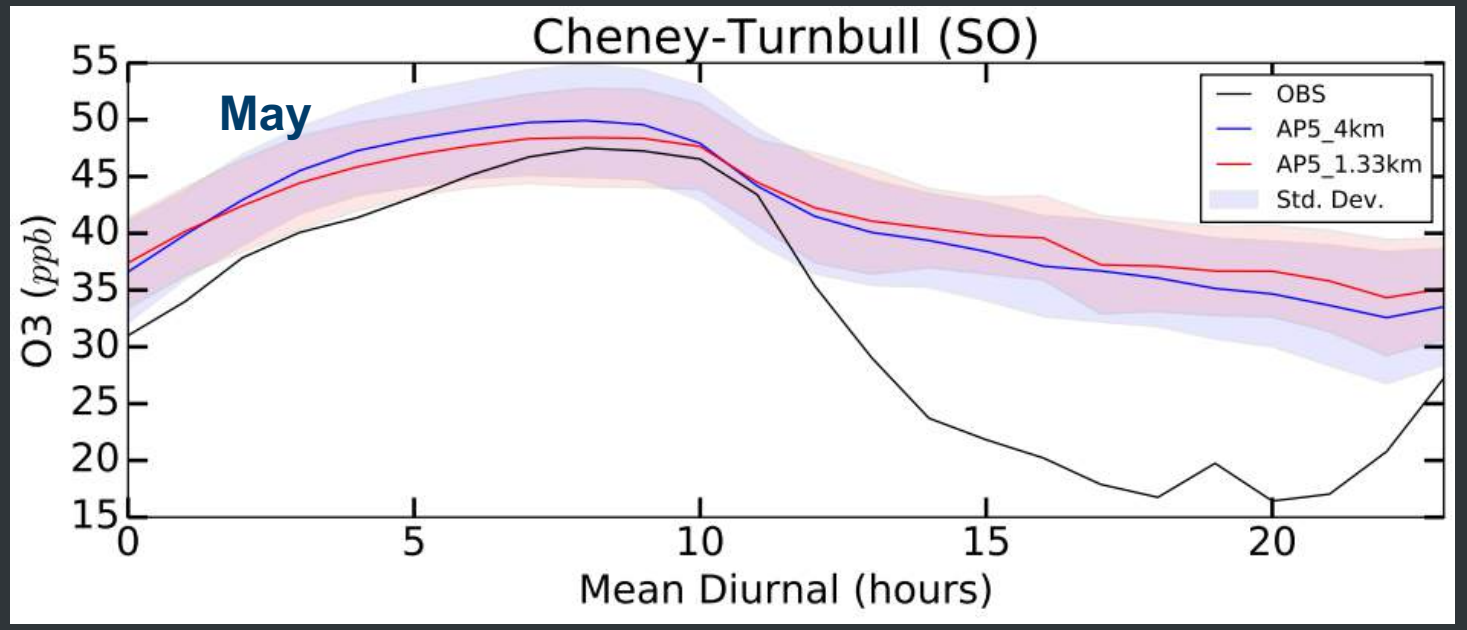

Spokane-E Broadway Ave
4km
1.33km
Modeled PM2.5 (ug/m^3)
Observed PM2.5 (ug/m^3)
0
5
10
15
20
25
30
35
40

March


Spokane-E Broadway Ave
4km
1.33km
Modeled PM2.5 (ug/m^3)
Observed PM2.5 (ug/m^3)
0
5
10
15
20
25
30
35
40

April

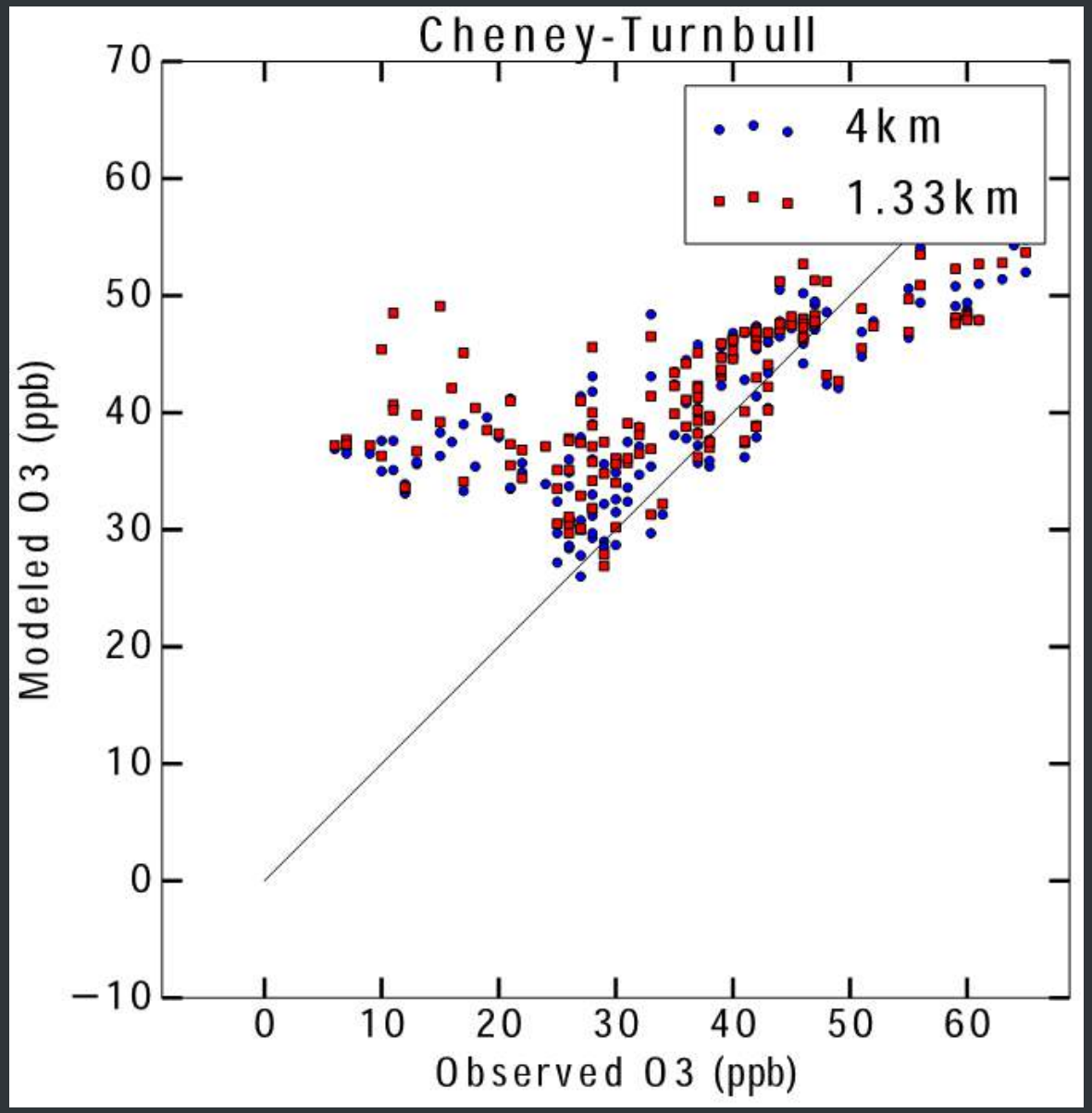




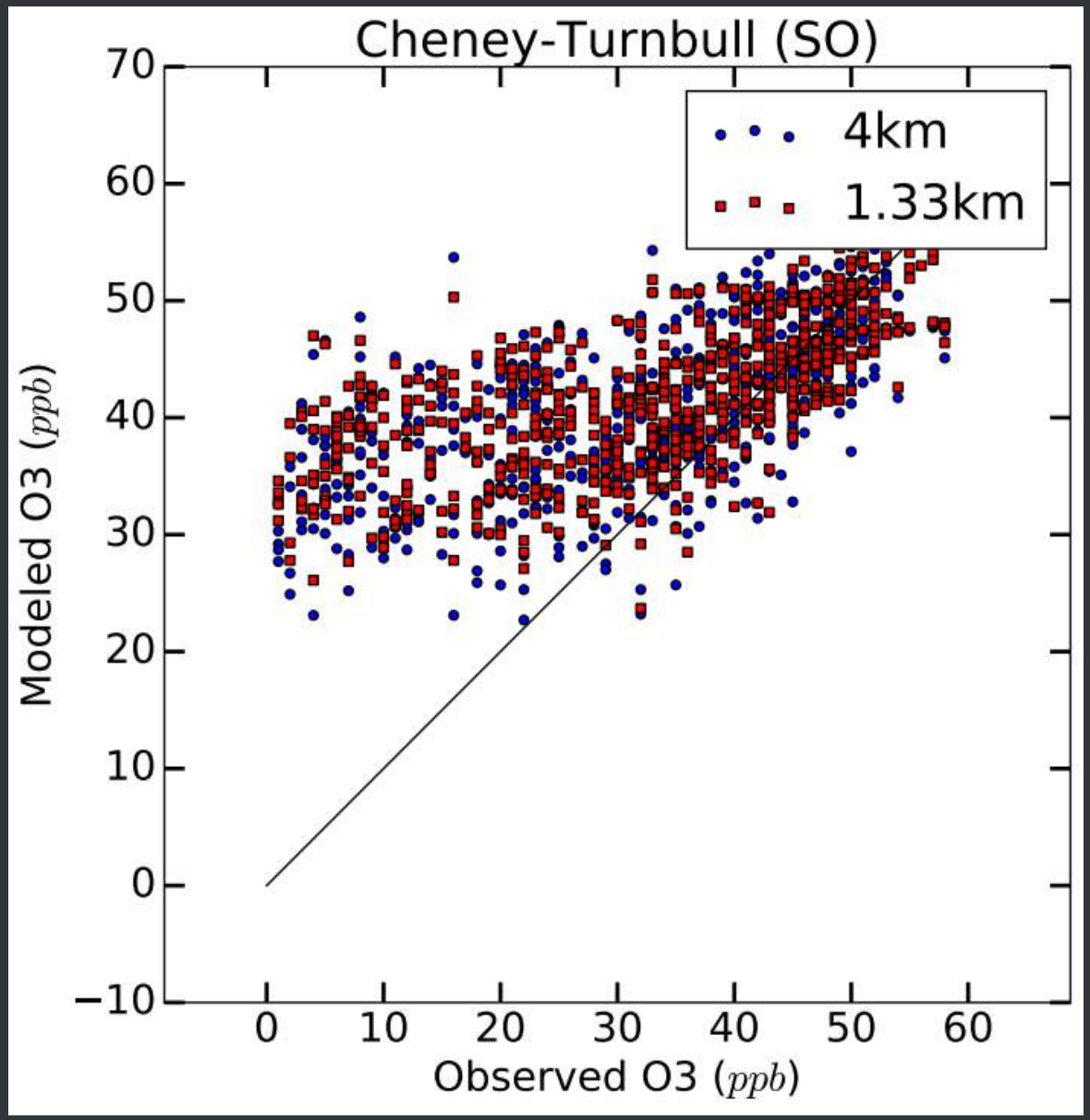
AirNow

Mean Diurnal Cycle of O_3: April and May

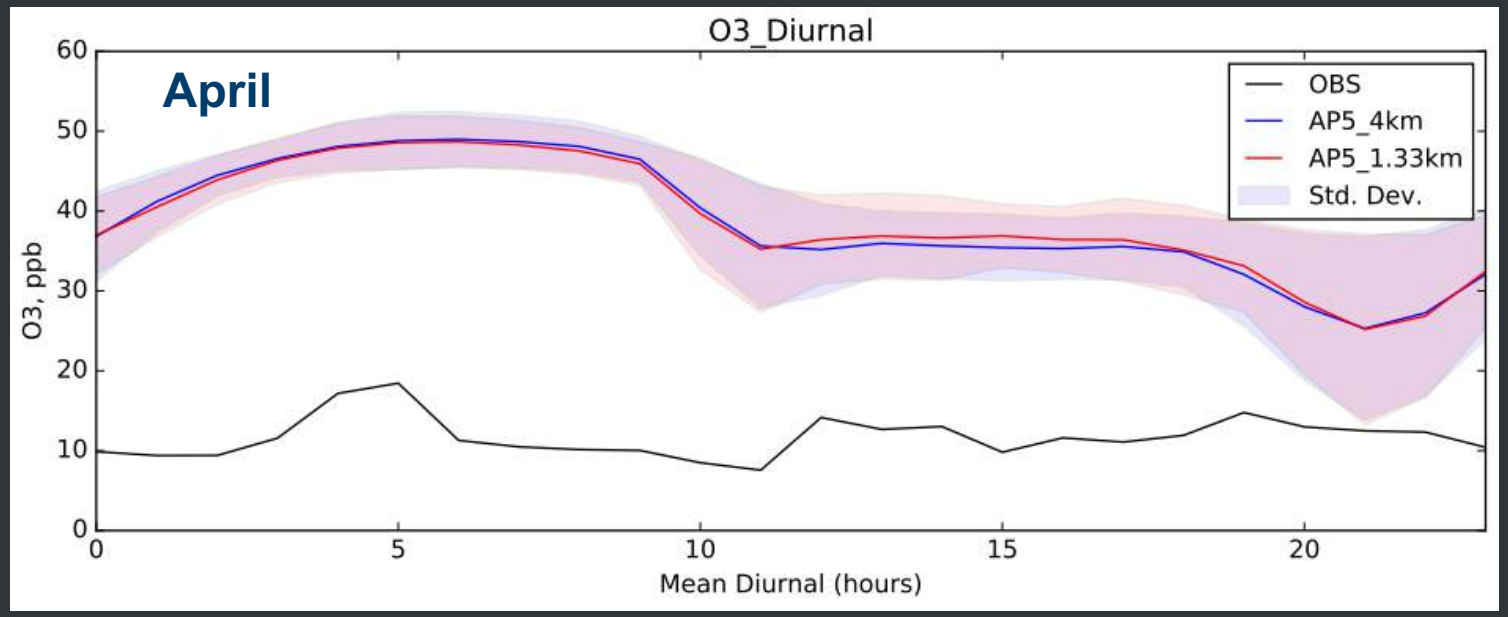
Month	April		May	
Resolution	1.33km	4km	1.33km	4km
NMB	17.54	14.28	28.87	27.87
NME	24.88	22.36	33.88	32.83
R^2	0.15	0.18	0.39	0.43

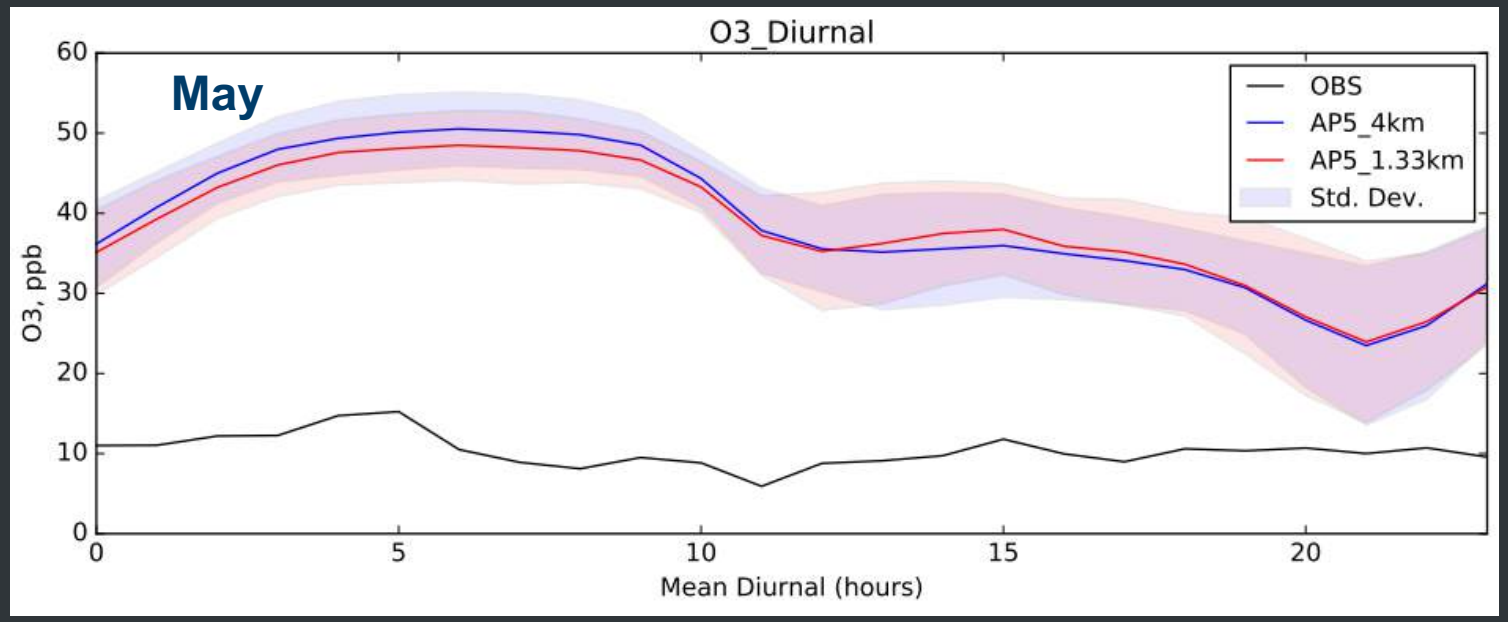

Cheney-Turnbull
4km
1.33km
Modeled O3 (ppb)
Observed O3 (ppb)
70
60
50
40
30
20
10
0
−10
0
10
20
30
40
50
60

April


Cheney-Turnbull (SO)
4km
1.33km
Modeled O3 (ppb)
Observed O3 (ppb)
70
60
50
40
30
20
10
0
−10
0
10
20
30
40
50
60

May

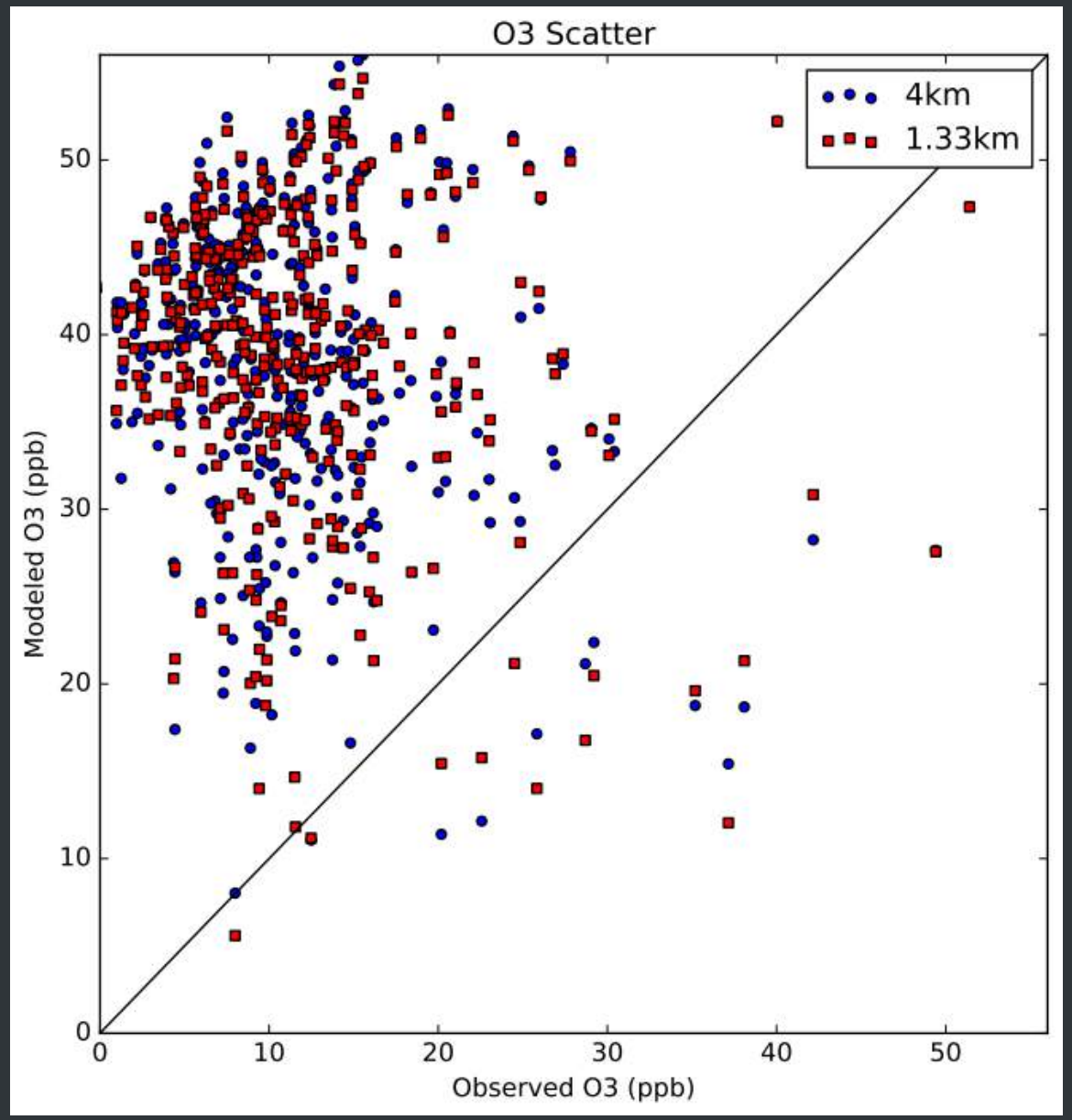




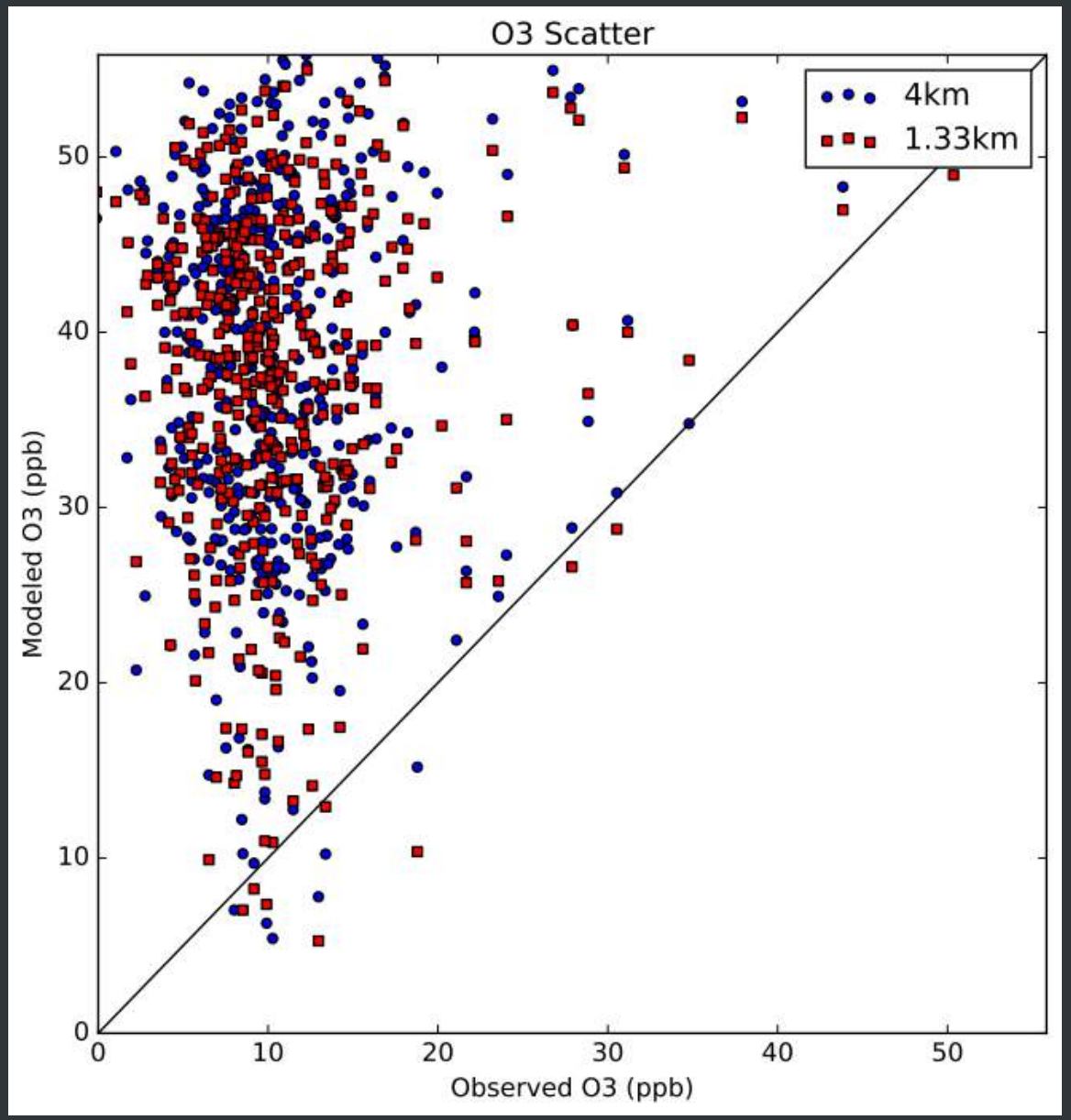
Urbanova reference site

Mean Diurnal Cycle of O_3 : Apr and May

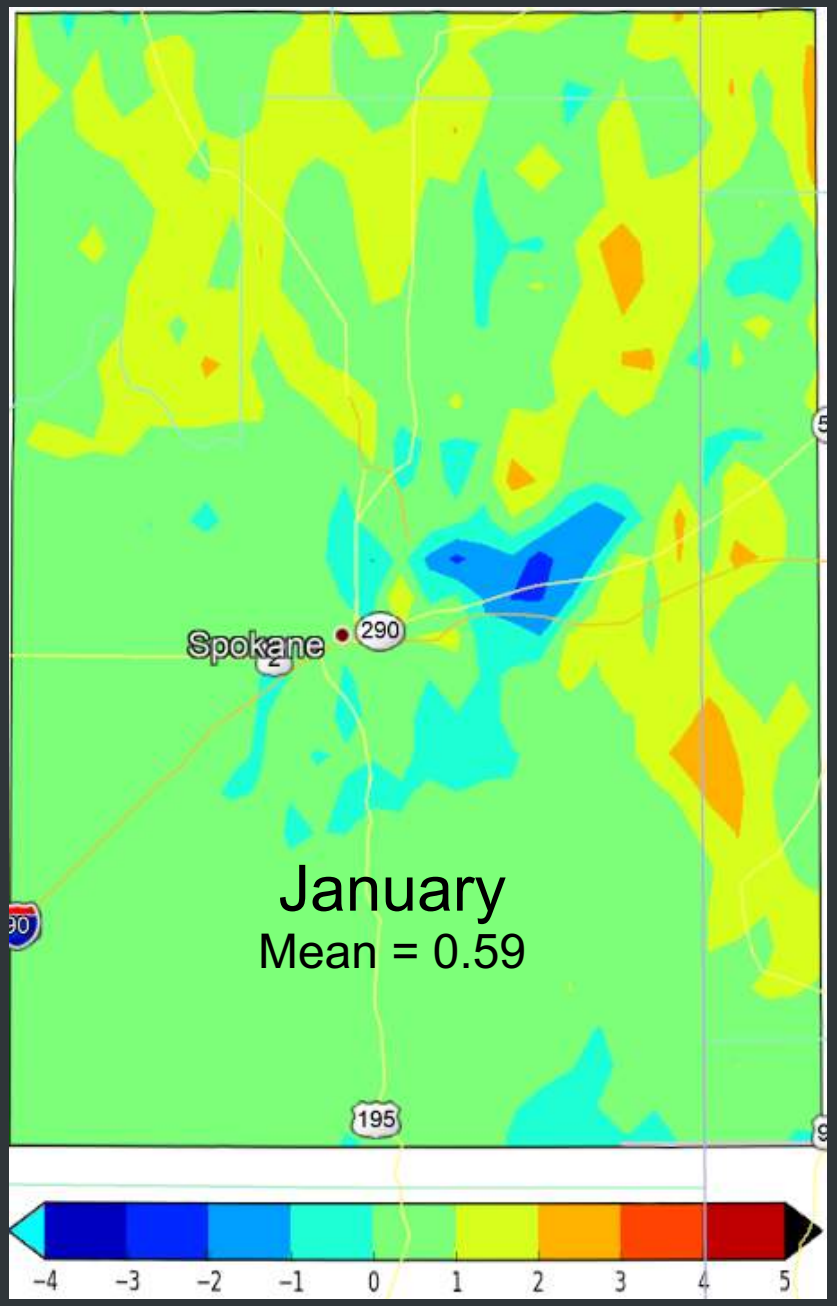
Month	April		May	
Resolution	1.33km	4km	1.33km	4km
NMB	237.8	236.82	265	266
NME	245.49	244.27	266	267
R^2	0.01	0.01	0.01	0.01


O3 Scatter
4km
1.33km
Modeled O3 (ppb)
Observed O3 (ppb)
0
10
20
30
40
50

April

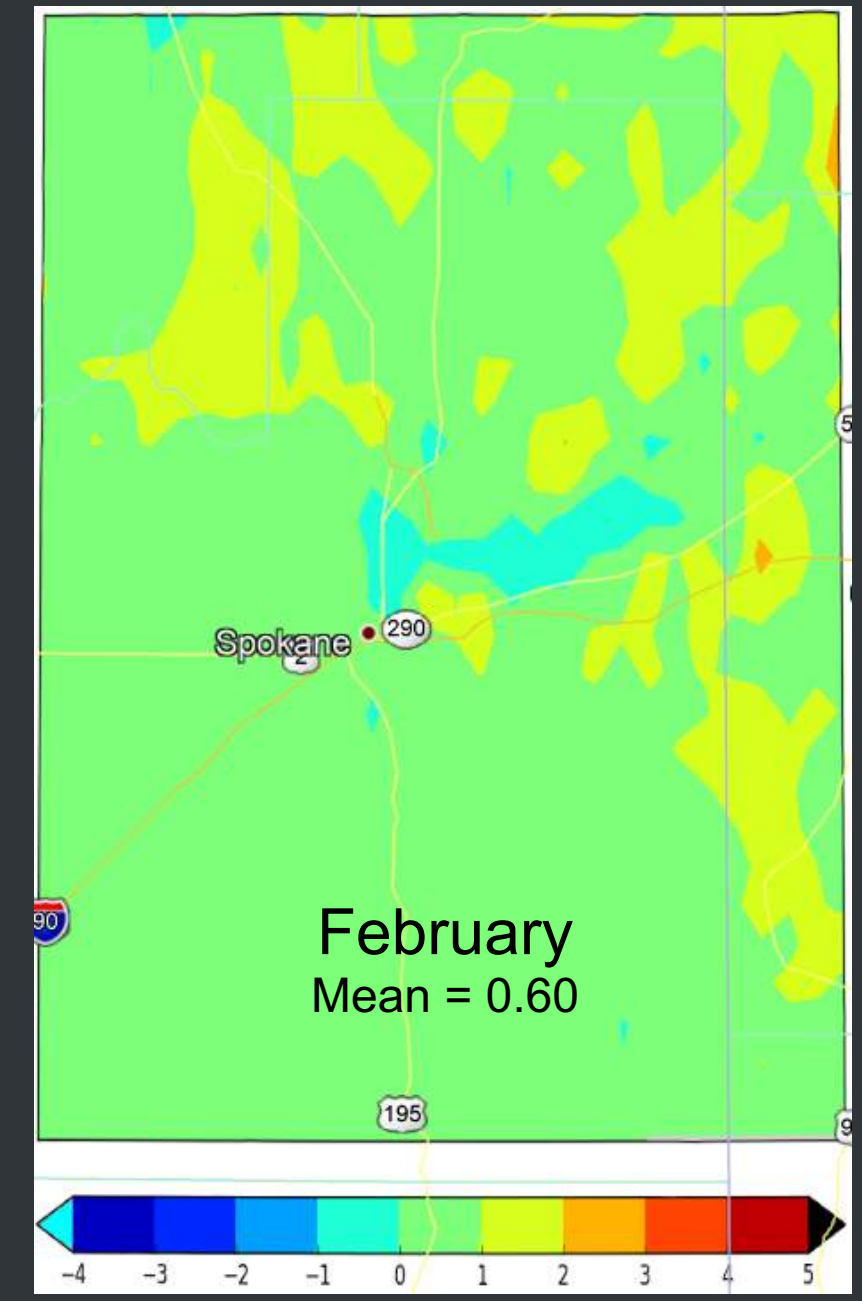

O3 Scatter
4km
1.33km
Modeled O3 (ppb)
Observed O3 (ppb)
0
10
20
30
40
50

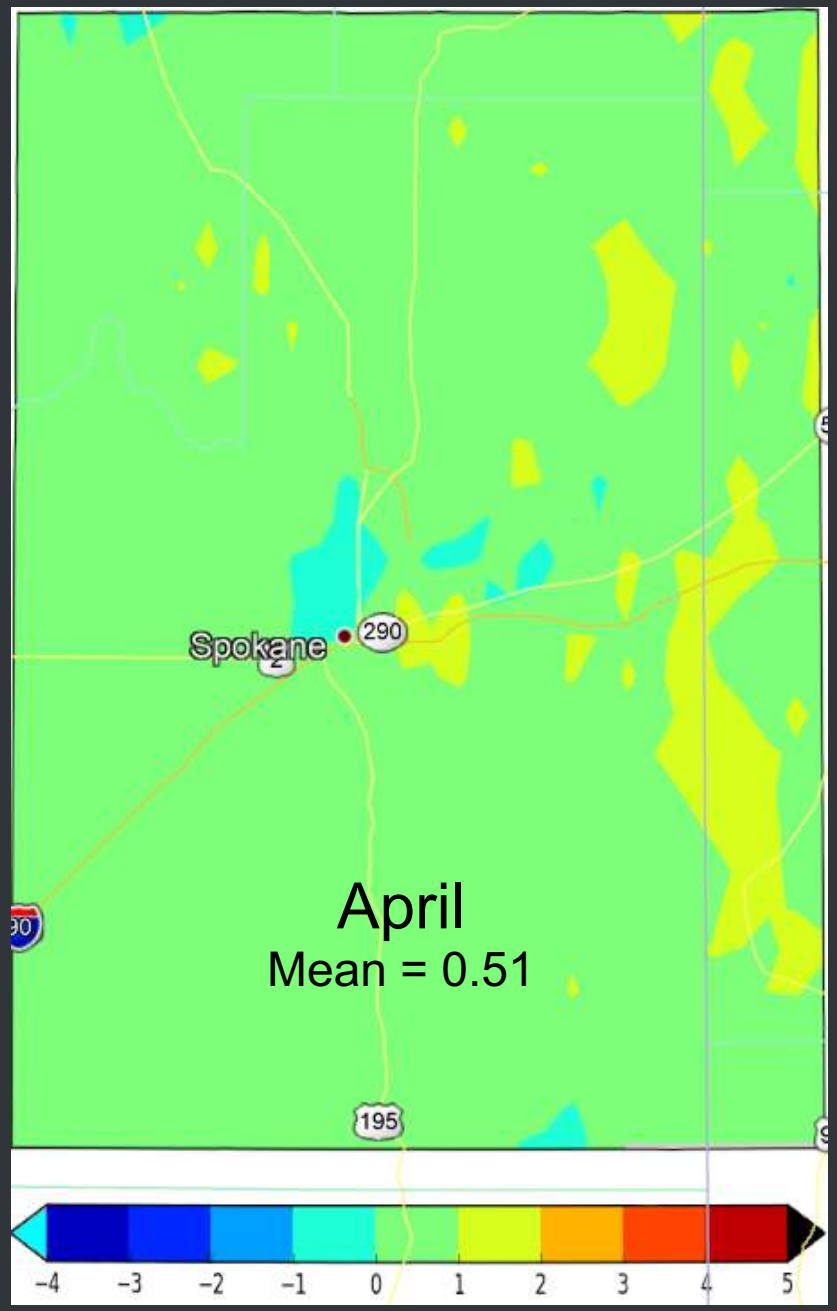
May



O_3 monthly mean difference (1.33km–4km)

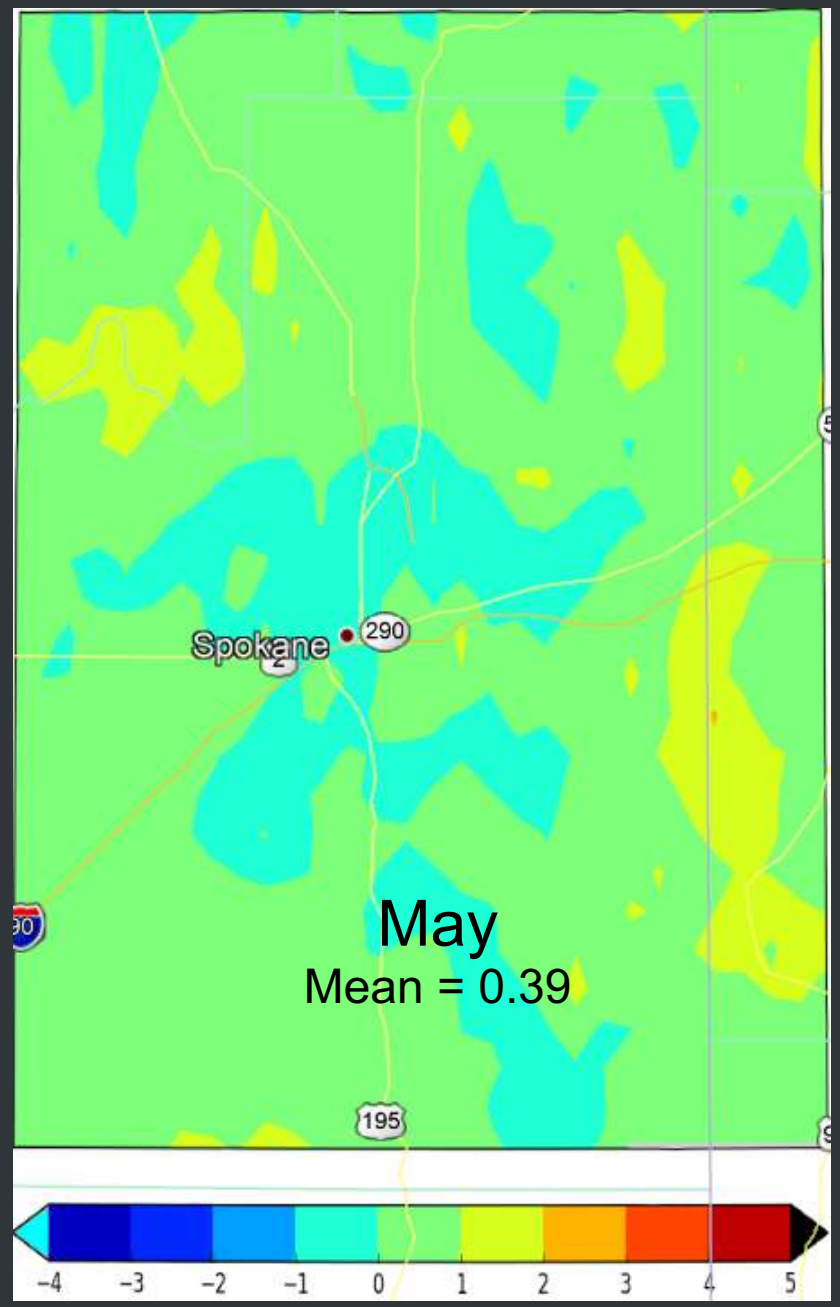
(ppb)

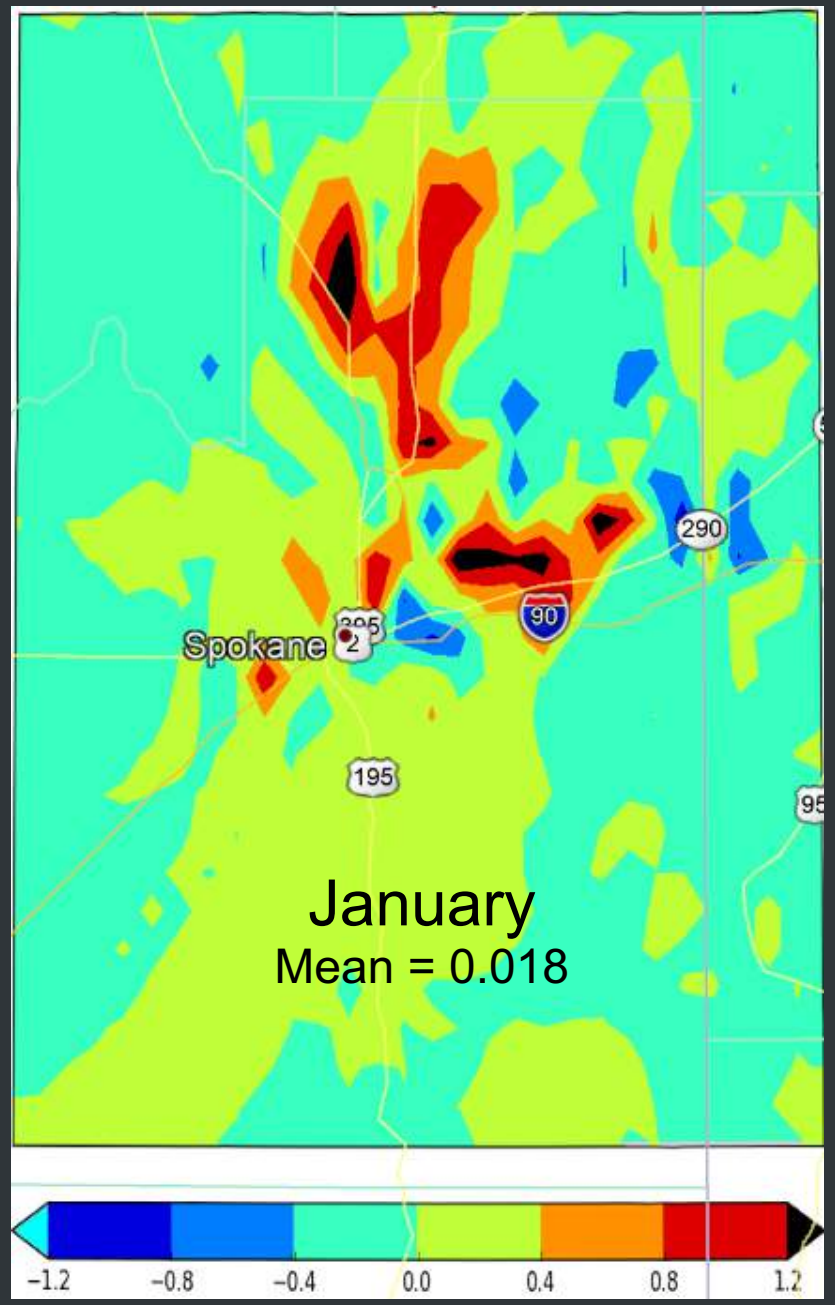




O_3 monthly mean difference (1.33km–4km)

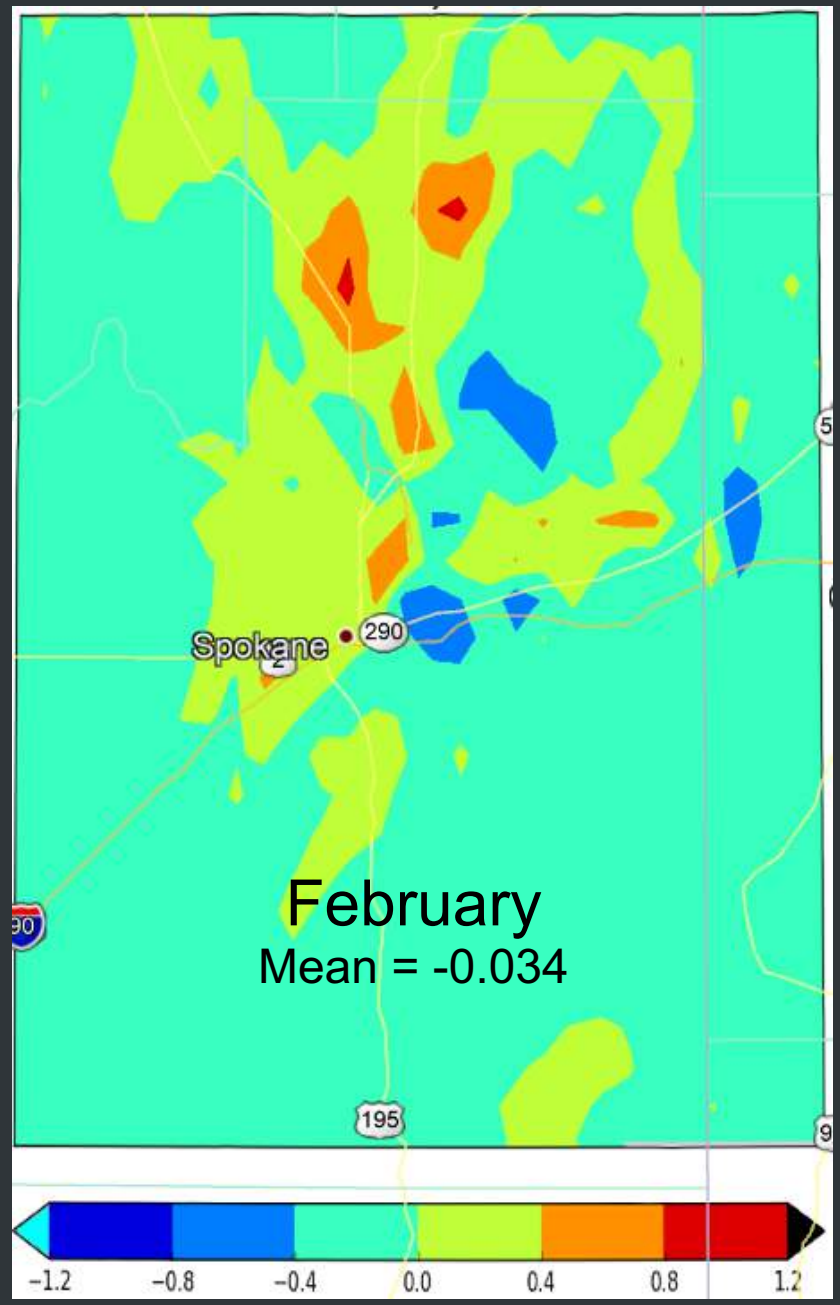
(ppb)

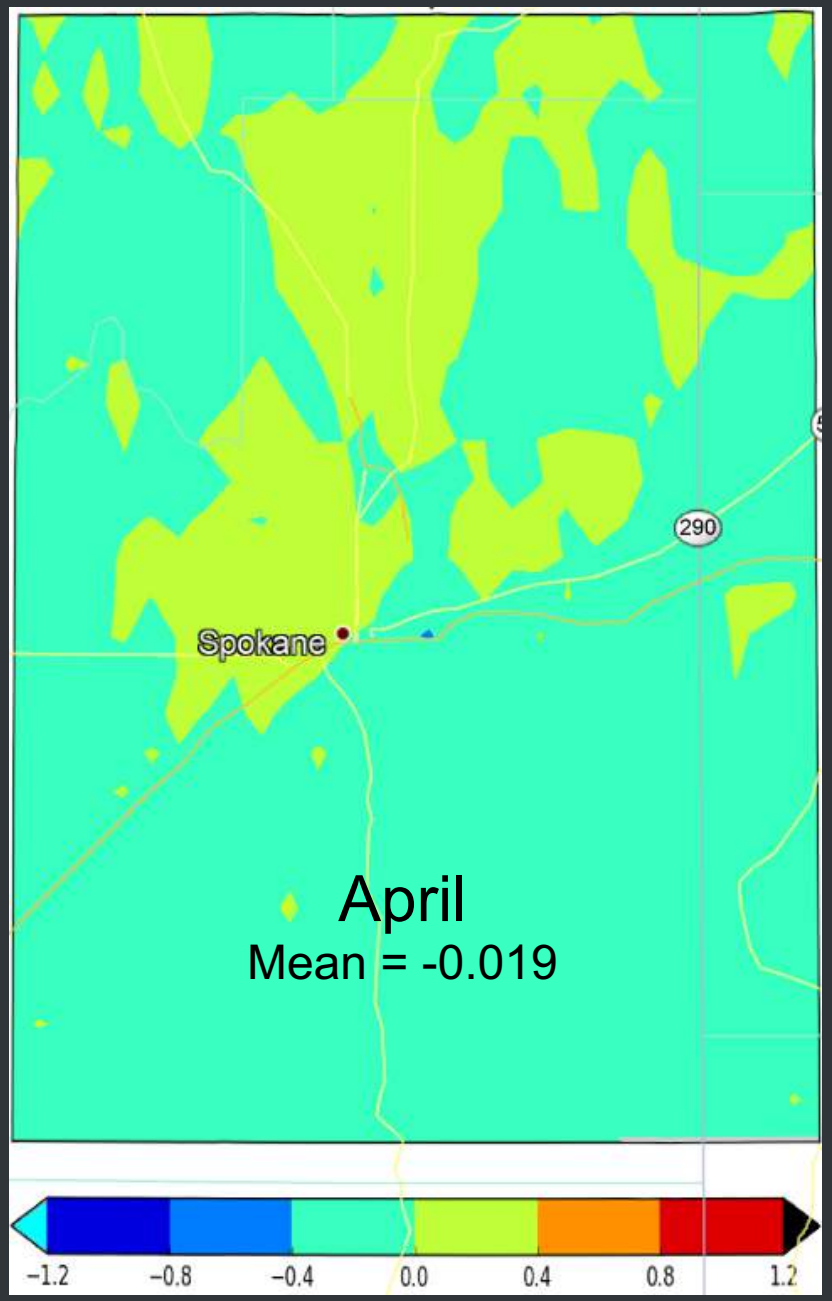




$PM_{2.5}$ monthly mean difference (1.33km–4km)

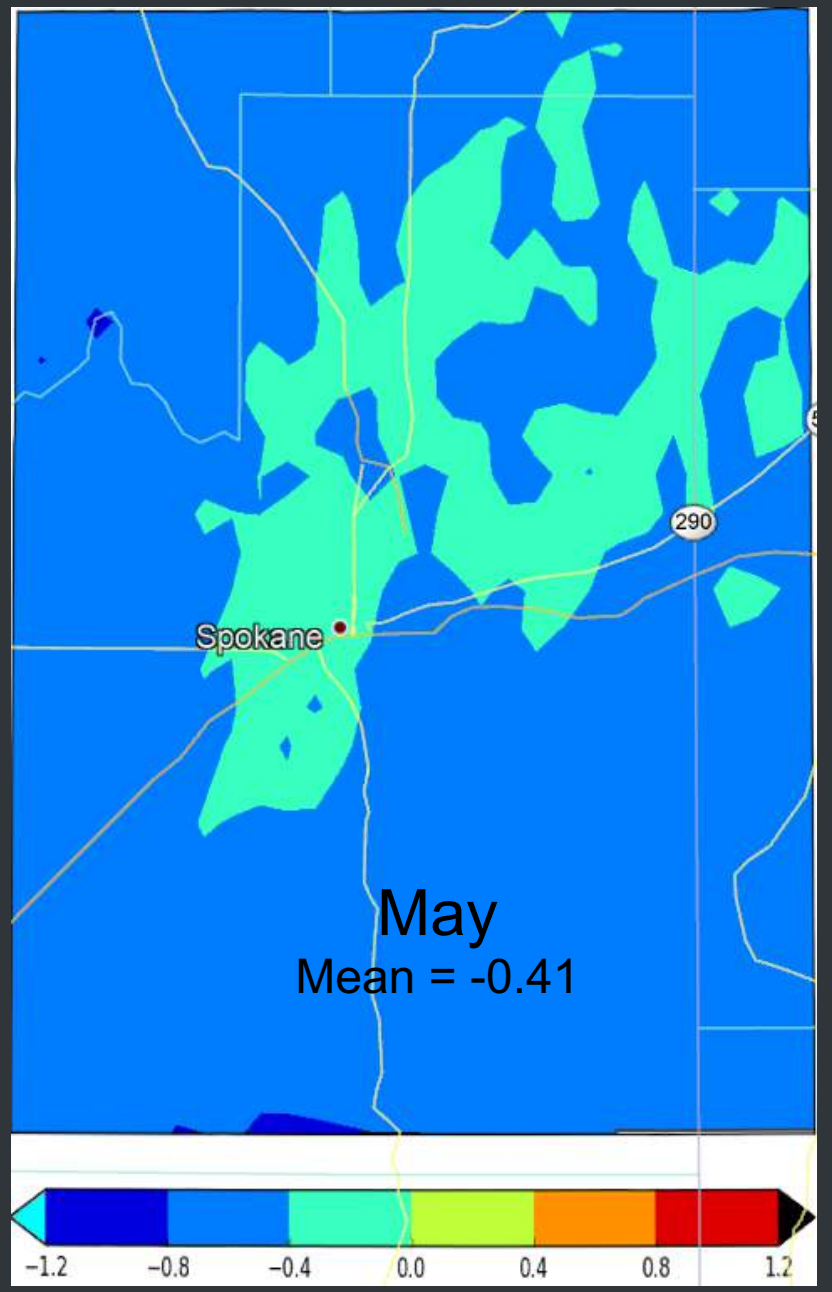
(ug/m^3)



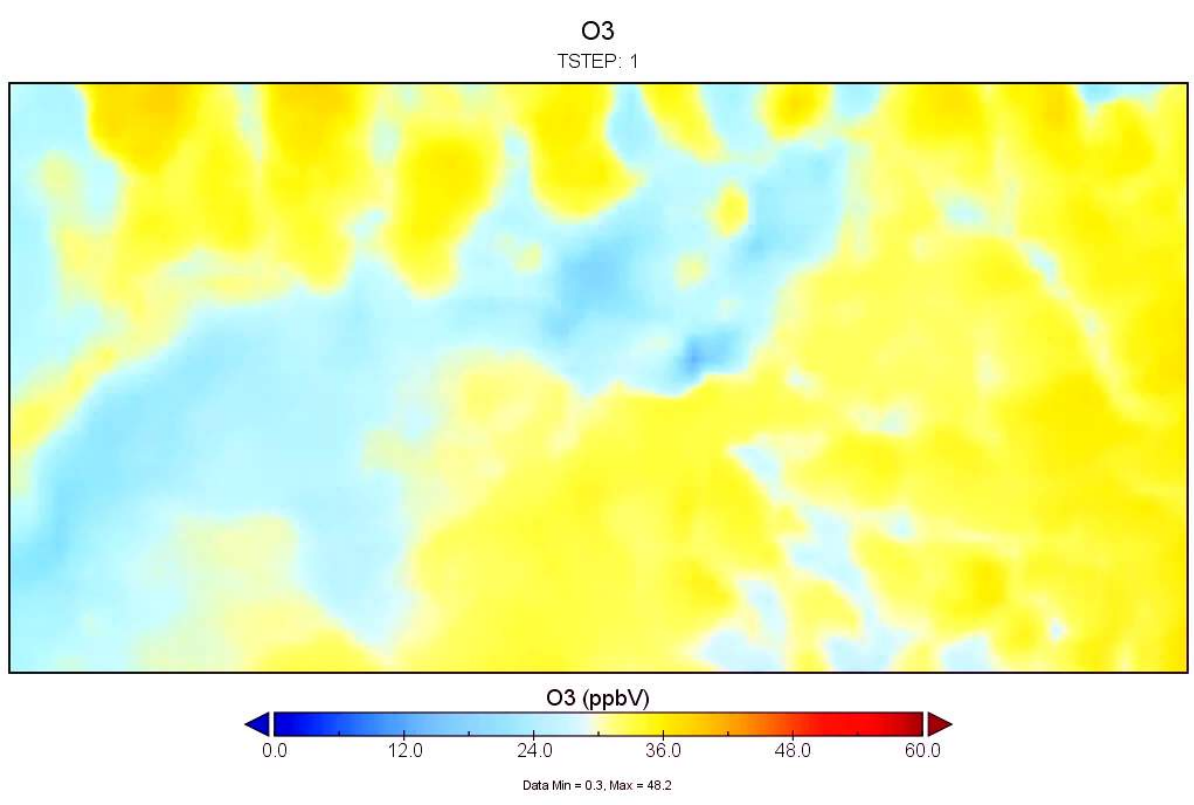


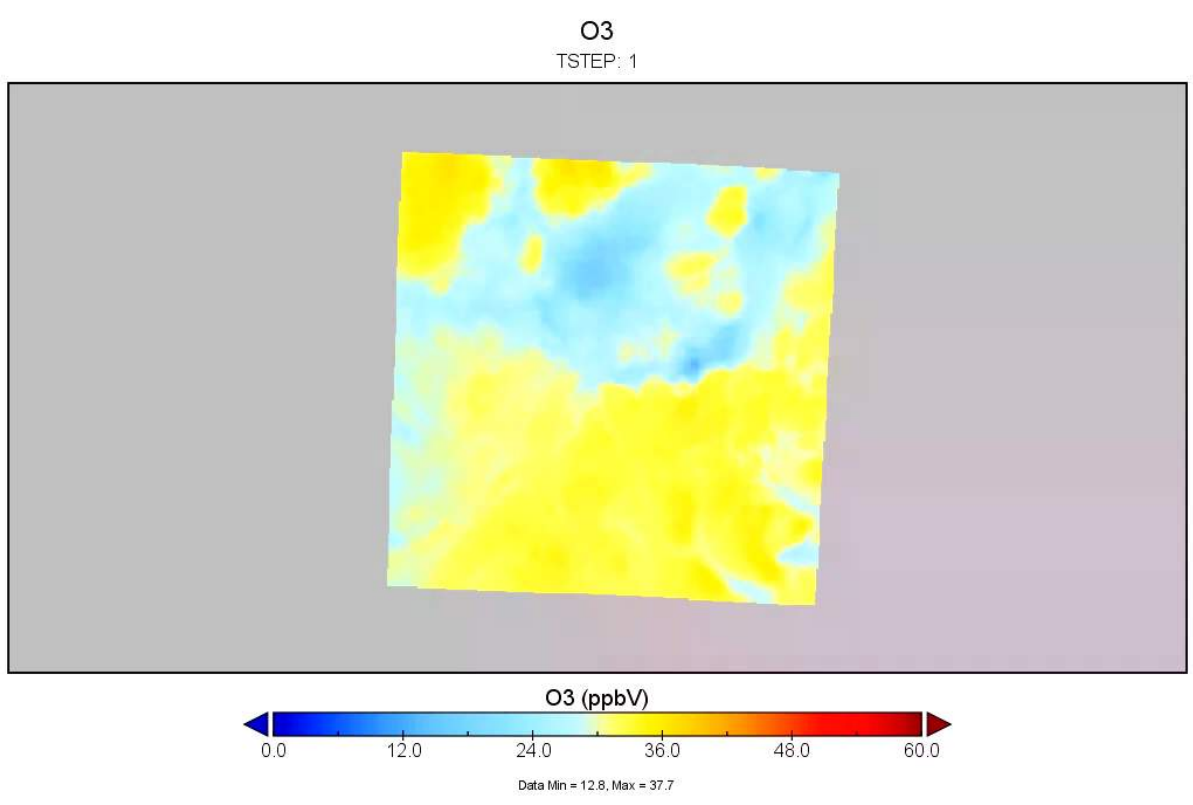
$PM_{2.5}$ monthly mean difference (1.33km–4km)

(ug/m^3)

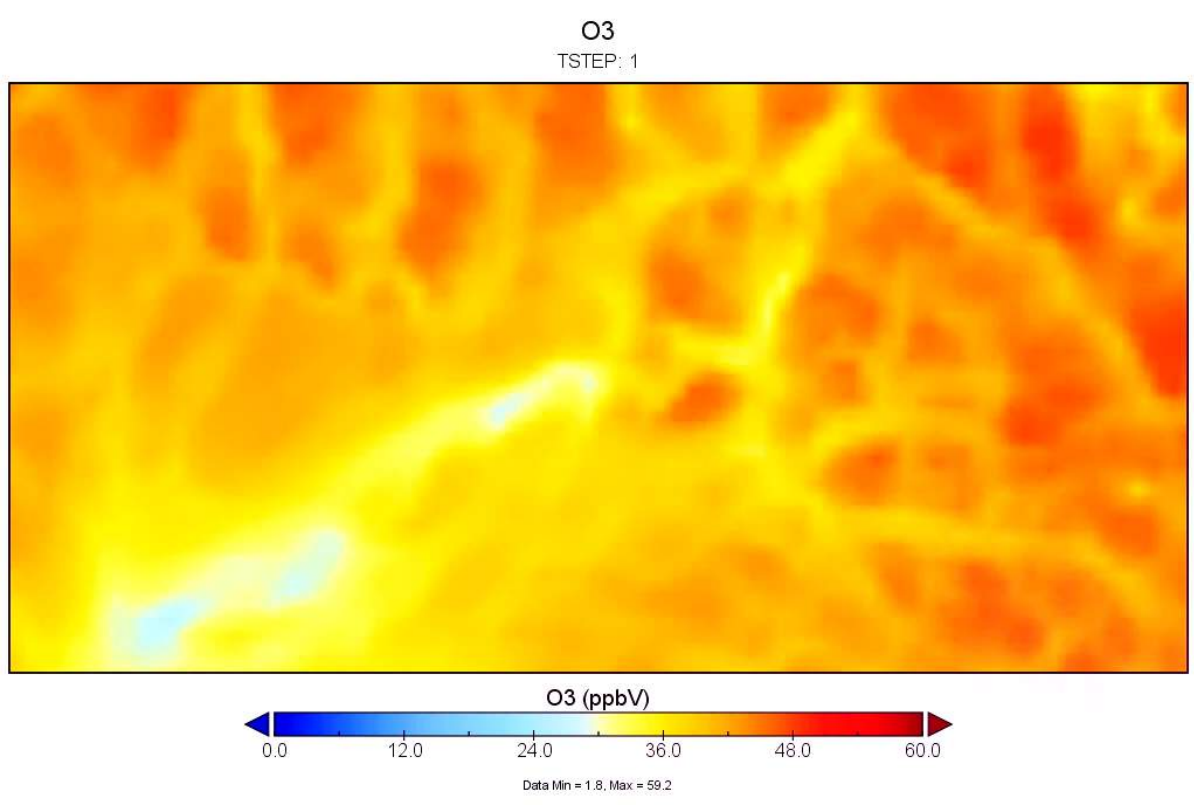


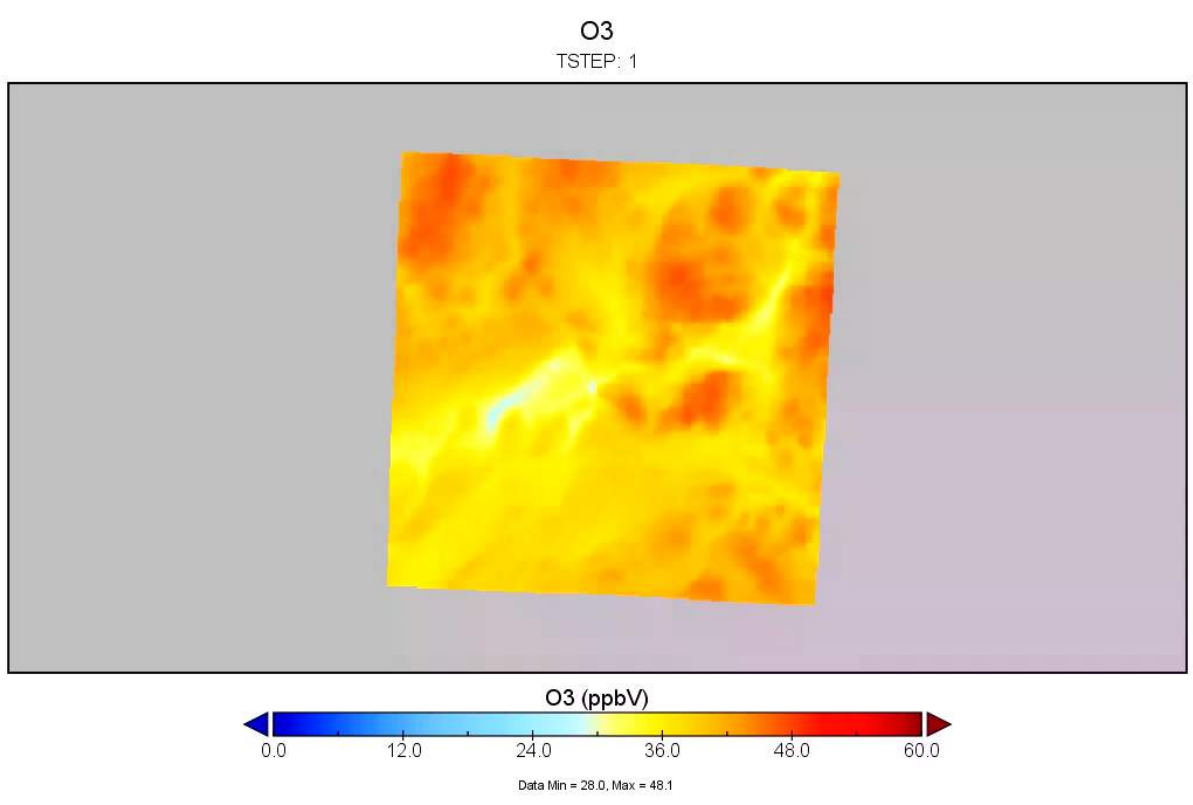
January 11th





March 12th


O3
TSTEP: 1
O3 (ppbV)
0.0
12.0
24.0
36.0
48.0
60.0
Data Min = 1.8, Max = 59.2


O3
TSTEP: 1
O3 (ppbV)
0.0
12.0
24.0
36.0
48.0
60.0
Data Min = 28.0, Max = 48.1

Conclusions

- Using a finer resolution grid results in minimal differences when compared to a coarser resolution grid
  - For $PM_{2.5}$ the monthly mean difference is 0.41 ug/m^3 at the most
  - For O_3 the monthly mean difference is 0.60 ppb at the most
    - 1.33km O_3 generally predicts higher values than 4km
  - Comparing NMB, NME, and R^2, there is no consistent trend showing increased accuracy

Thank you