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Comparison of the Performance of 2016 CMAQ Platforms at 12km and 4km Resolutions

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Introduction

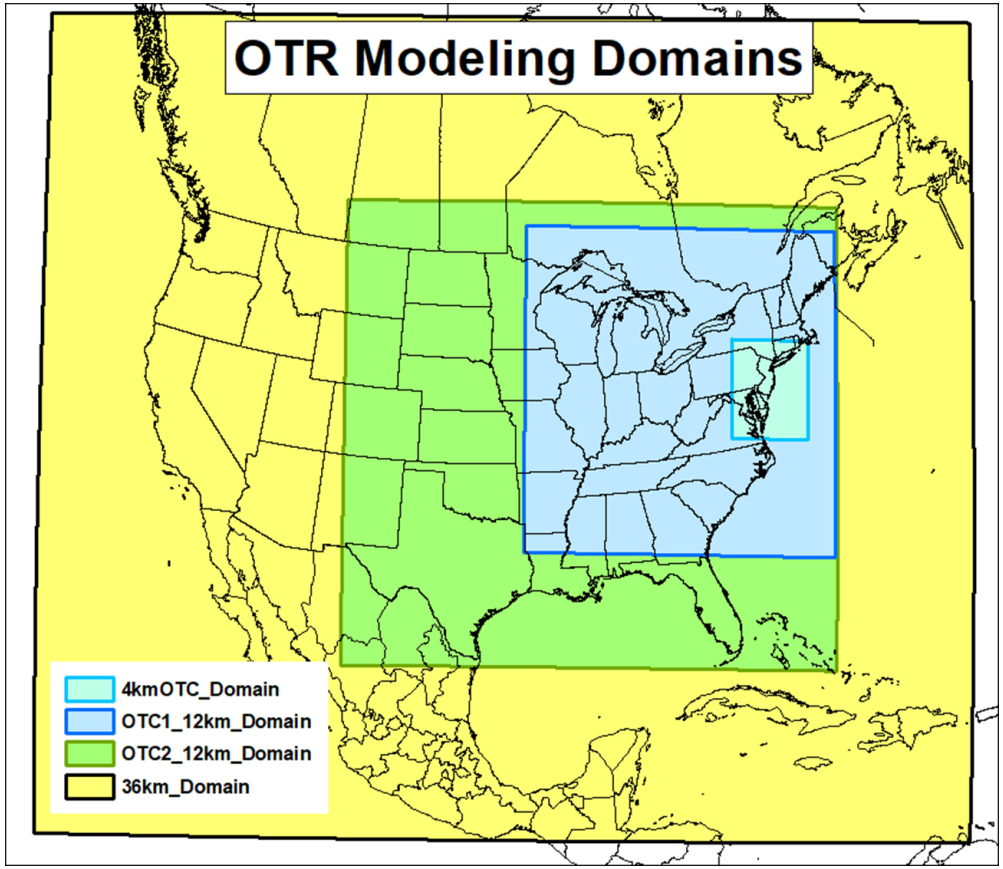
The performance of 2016 CMAQ model run at 12km resolution was poor over coastal water cells due to the difficulty in characterizing the land/water interface in the air quality and meteorological models, and accurate allocating emission over large emission gradient area.

CMAQ simulations at 12 and 4km resolutions were evaluated for 113 monitoring sites over northeastern US

1) Comparison of daily maximum 8-hour average (MDA8) O_3
2) Comparison of diurnal variations of MET and EMIS data
3) Comparison of 2023 DVFs

Modeling Components

	2016 platform at 12km modeling	2016 platform at 4km modeling
Emissions	**2016 V1 (fi) emissions inventory at 12km**	**2016 V1 (fi) emissions inventory at 4km**
EGU point	ERTAC	ERTAC
Meteorology	WRF v3.8 12km (provided by EPA), MCIP v5.0 (processed by NYSDEC)	WRF v3.8 4km (provided by EPA), MCIP v5.0 (processed by NYSDEC)
Boundary/Initial conditions	36US3 run using CMAQv5.3.1 and 2016 V1 emissions (NYSDEC)	12OTC2 run using CMAQv5.3.1 and 2016 V1(fi) emissions (NYSDEC)
Domain	OTC2 12 km domain	OTC 4km domain
Modeling period	April to October	April to October
Model layers	35	35
Model	CMAQ v5.3.1	CMAQ v5.3.1



Thanks to Michael Geigert

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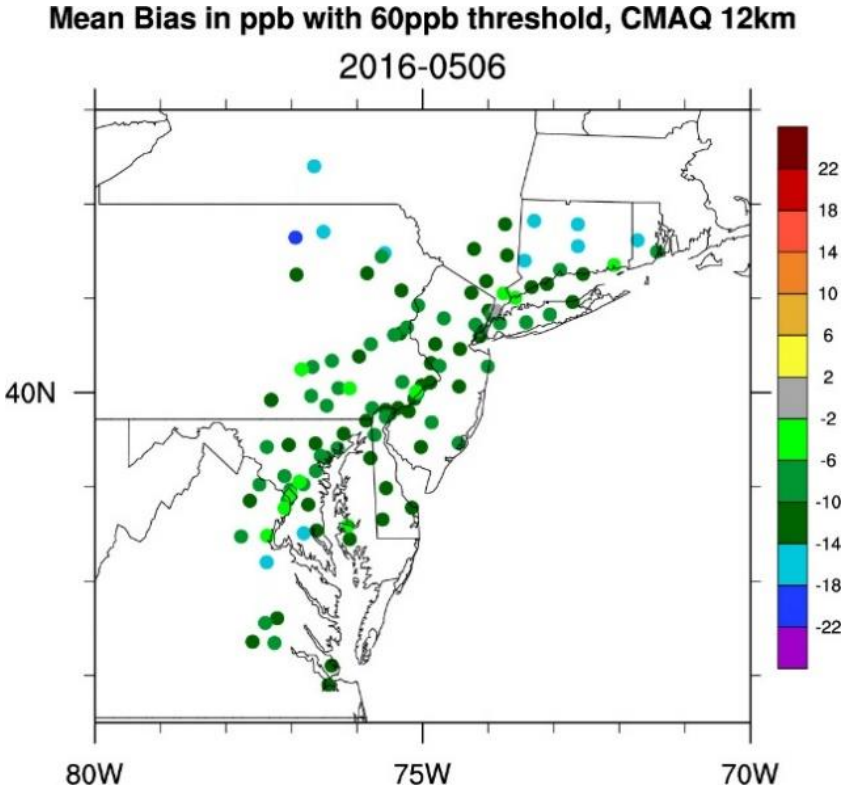
Results

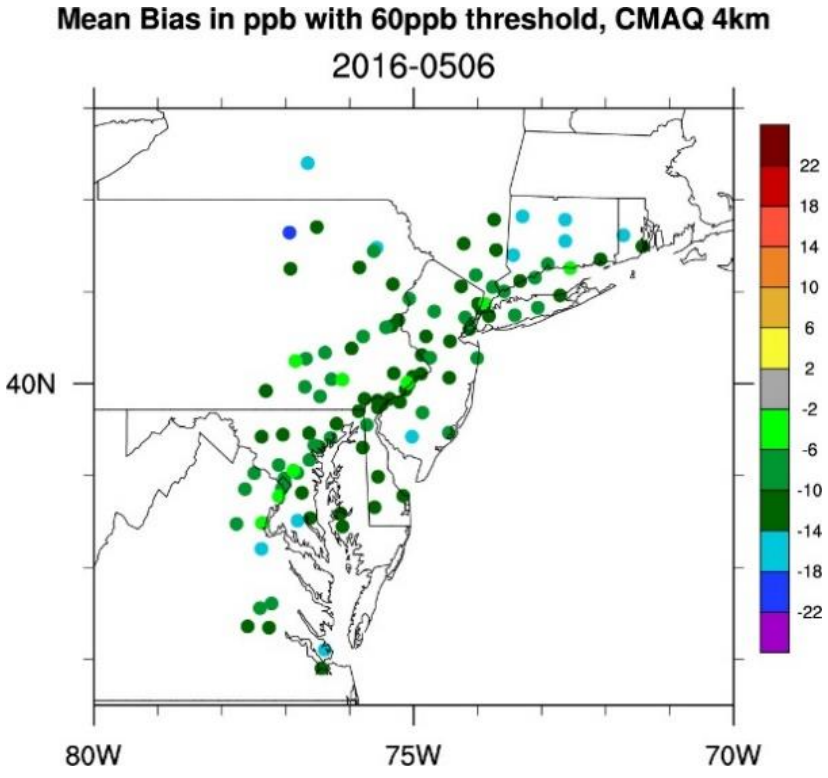
1) Comparison of MDA8 O_3

2) Comparison of diurnal variations of MET and EMIS data

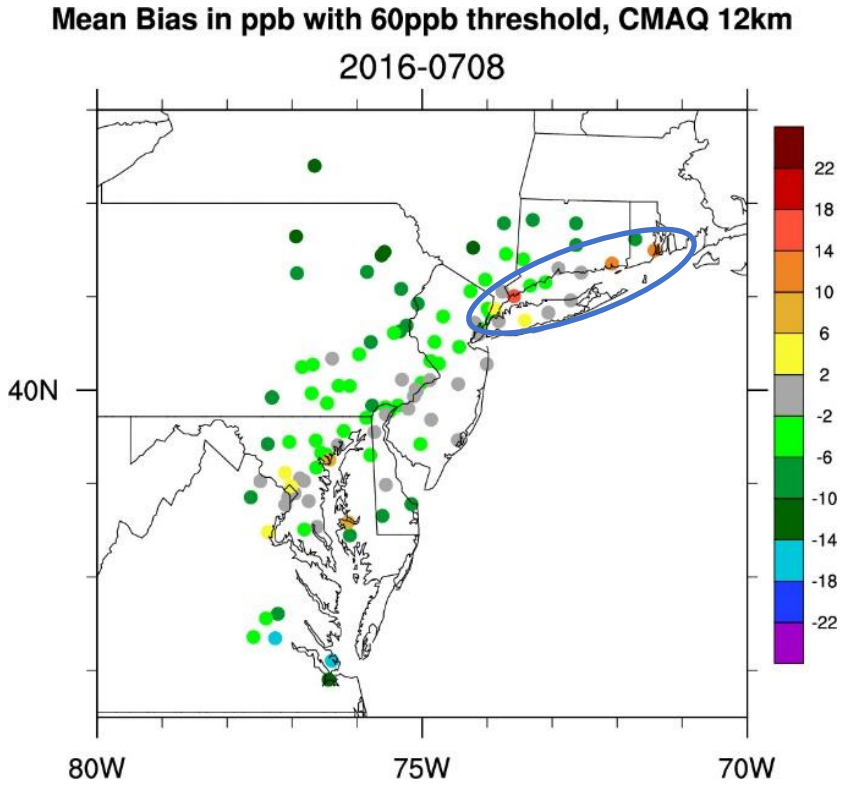
3) Comparison of 2023 DVFs

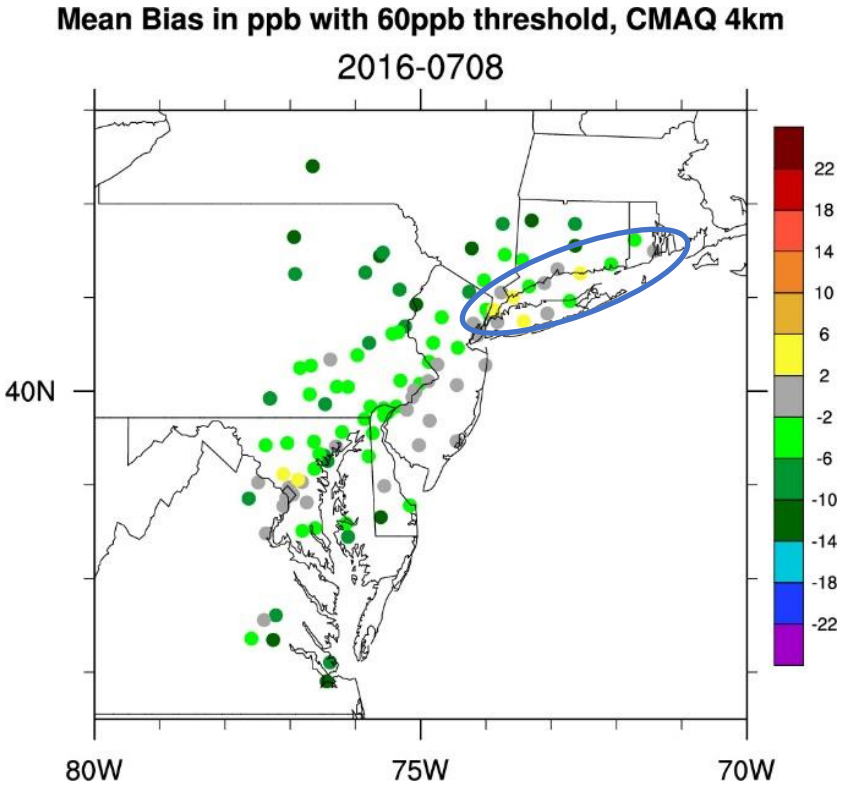
MDA8 O_3 Mean Bias (Modeled – Observed) with Obs. MDA8 O_3 >= 60 ppb (May to June 2016)



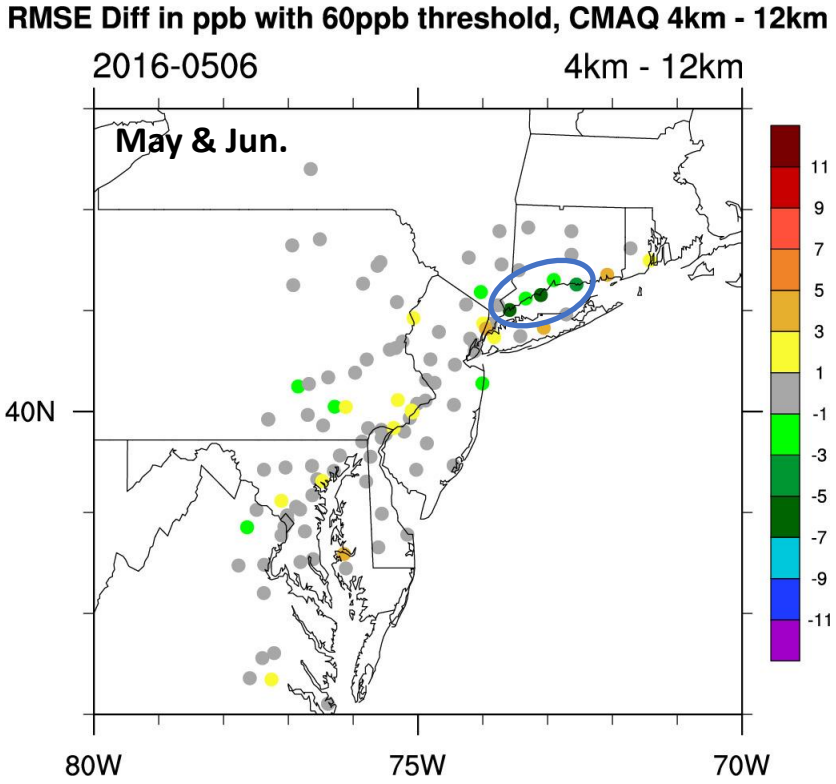


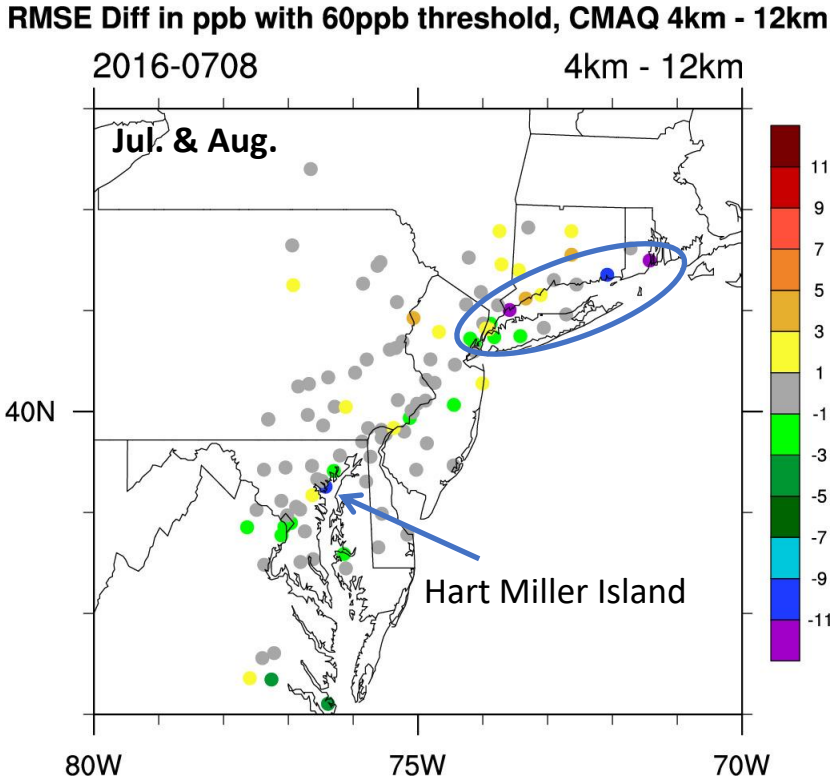
MDA8 O_3 Mean Bias (Modeled – Observed) with Obs. MDA8 O_3 >= 60 ppb (July to August 2016)





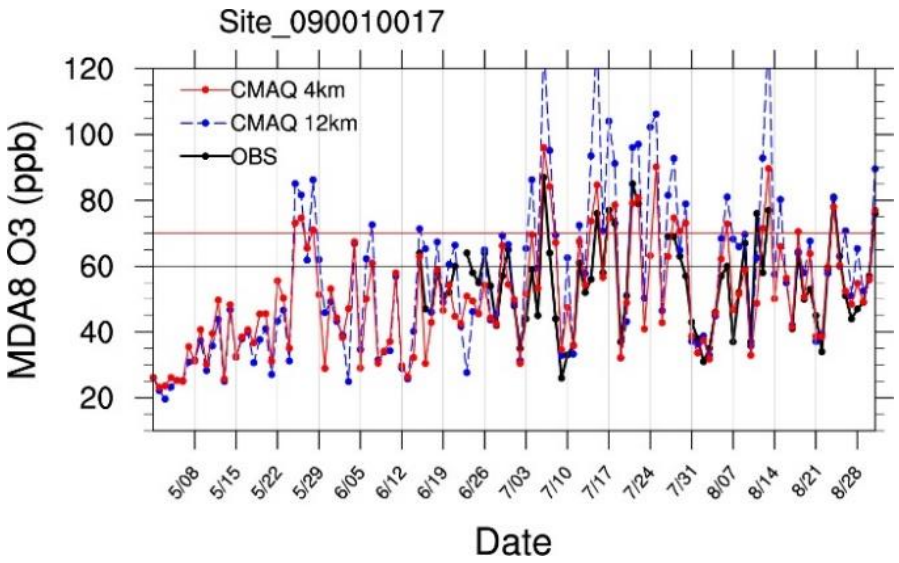
MDA8 O_3 RMSE Difference (4km -12km) with Obs. MDA8 O_3 >= 60 ppb



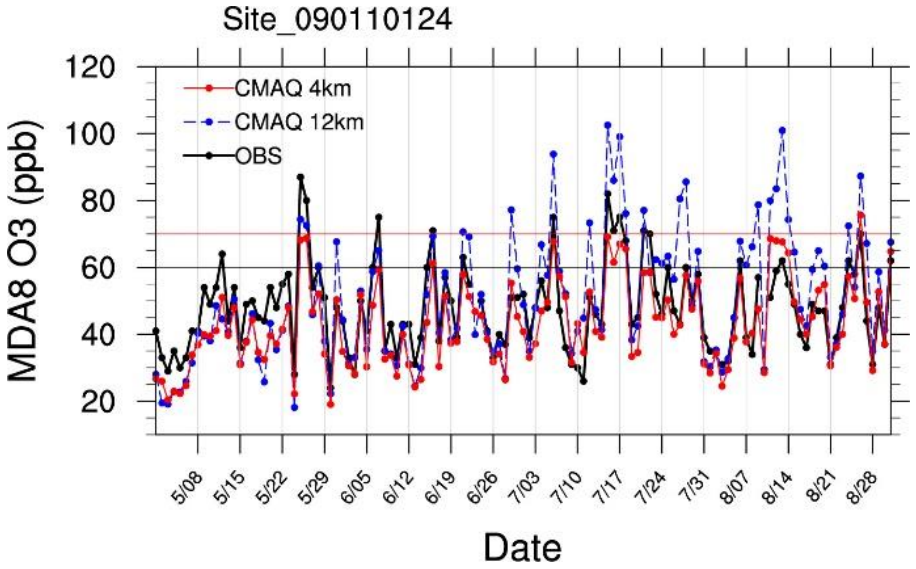


MDA8 O_3 Time Series

Greenwich (12km Water|4km Water)



Groton (12km Water|4km Land)



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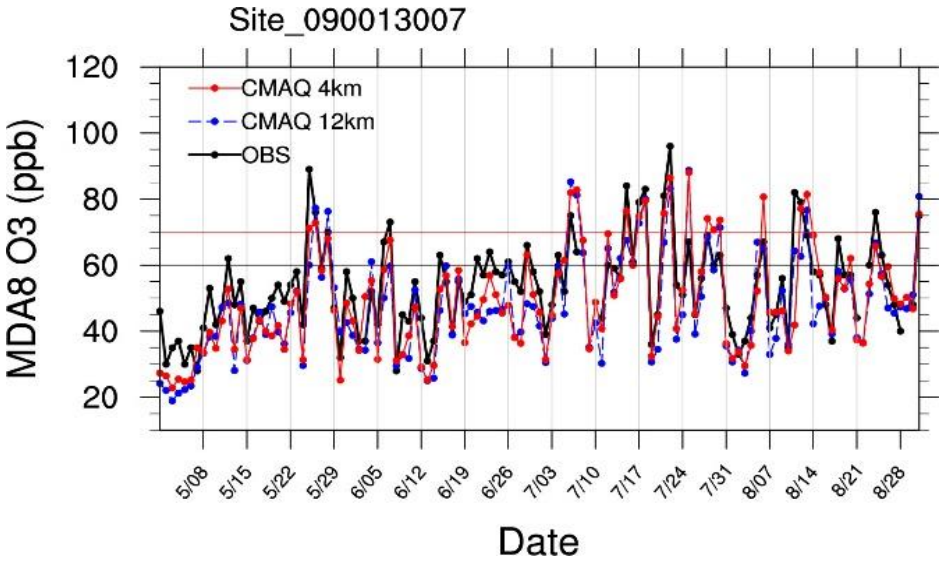
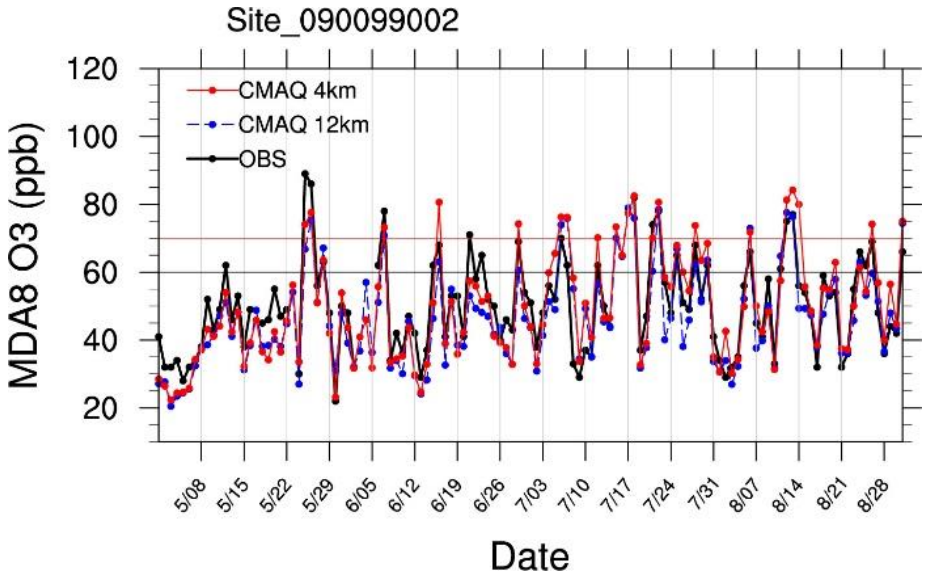
MDA8 O_3 Time Series

Stratford (12km Land|4km Water)



Madison (12km Land|4km Water)



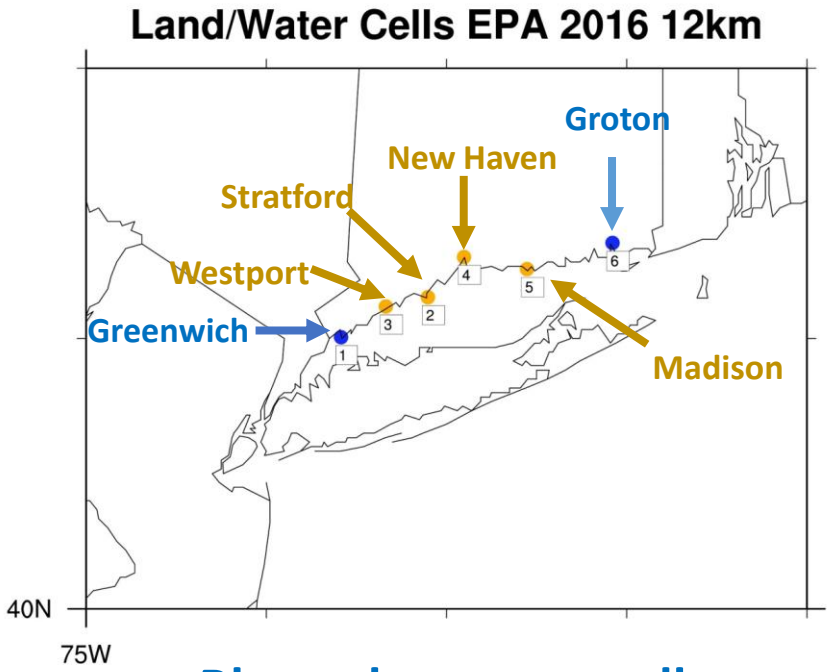
Results

1) Comparison of MDA8 O_3

2) Comparison of diurnal variations of MET and EMIS data

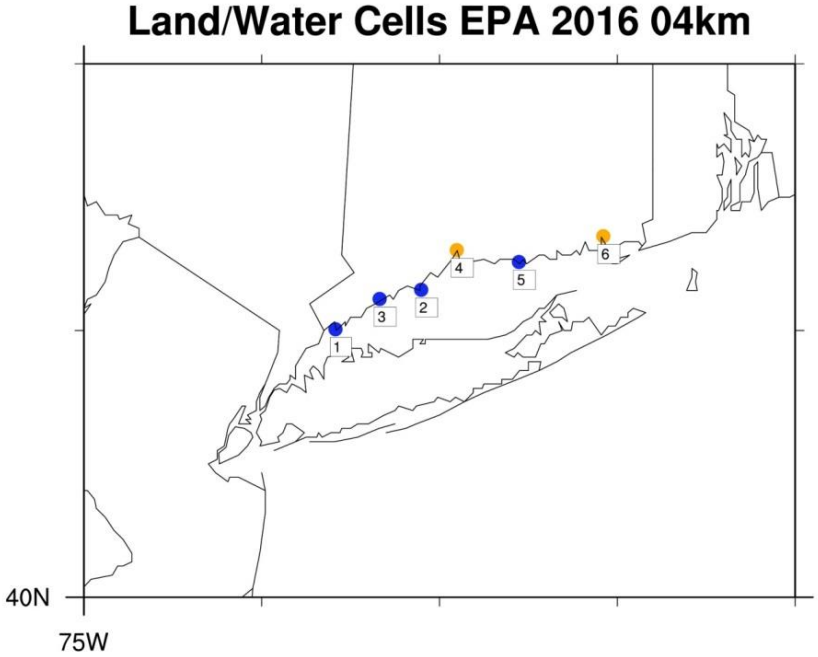
3) Comparison of 2023 DVFs

Locations of 6 Sites over Coastline



Blue color: water cells

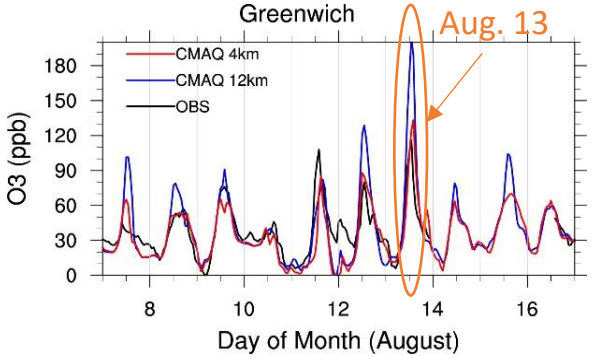
Yellow color: land cells

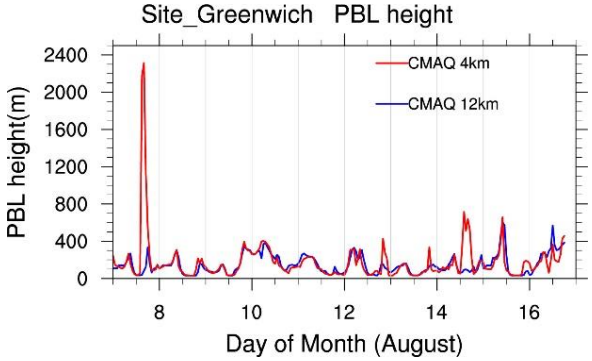


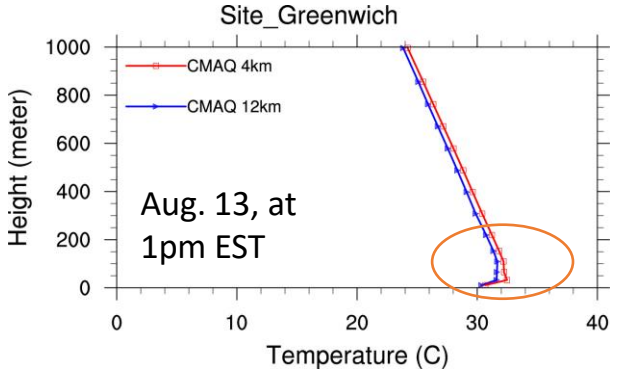
Sites 1, 2, 3, 5 are labeled as water cells at 4 km resolution

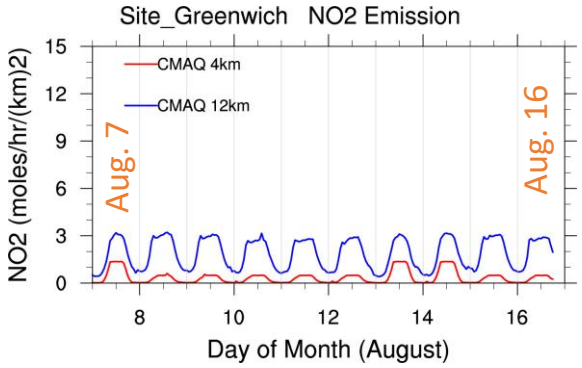
Diurnal Variations of MET and EMIS during 8/7 ~ 8/16

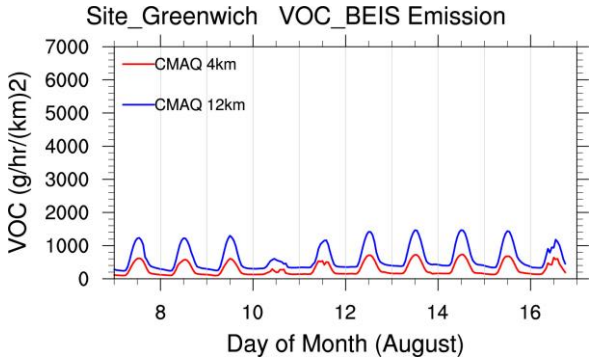
Greenwich (12km Water|4km Water)

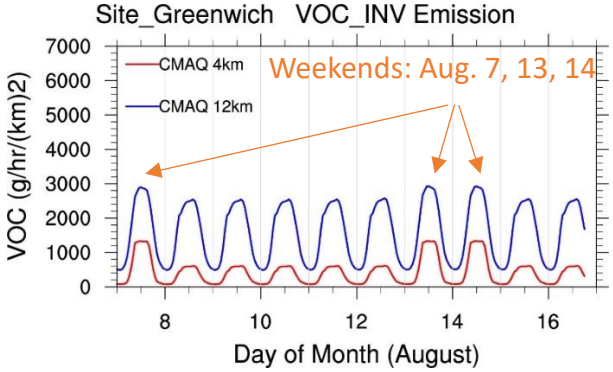






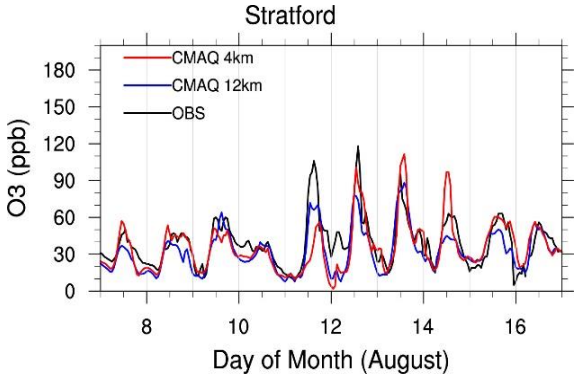


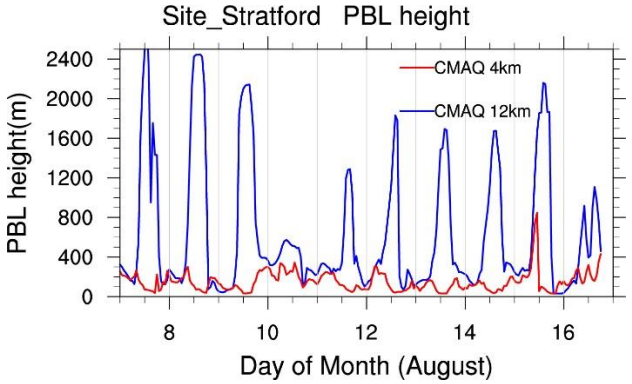


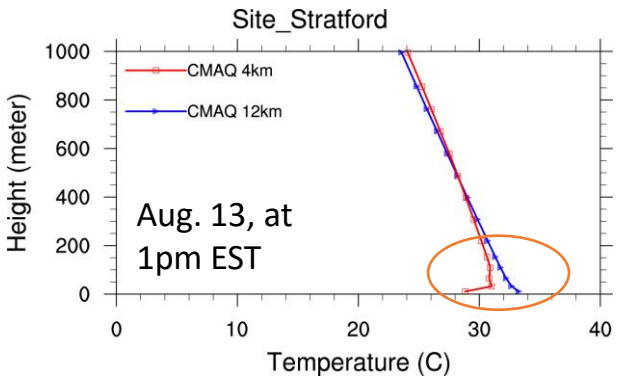


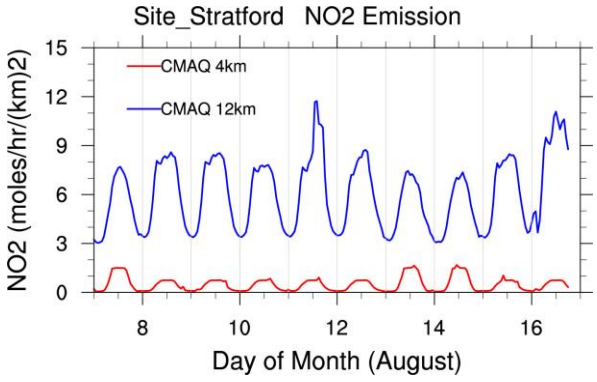
Diurnal Variations of MET and EMIS during 8/7 ~ 8/16

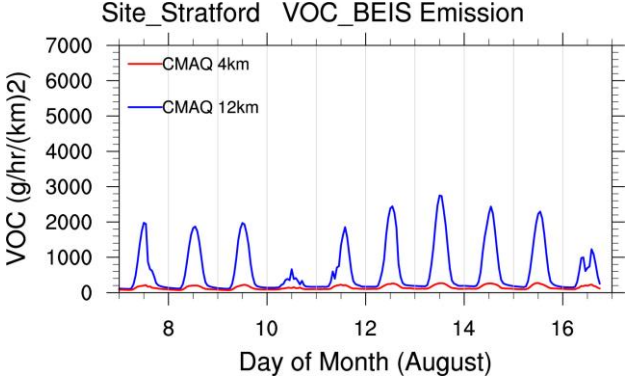
Stratford (12km Land|4km Water)

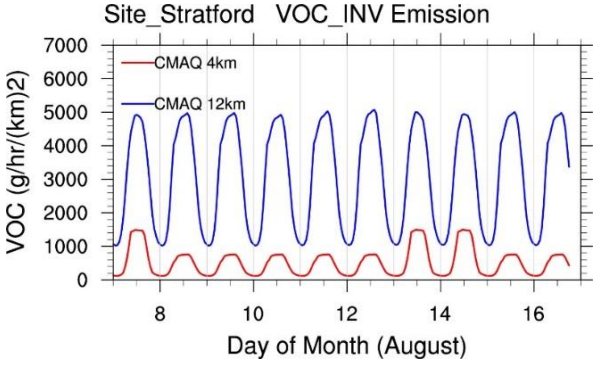






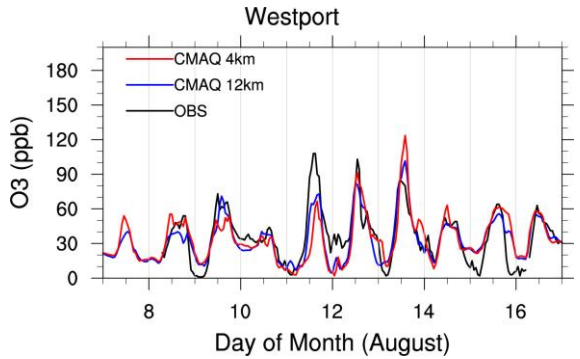


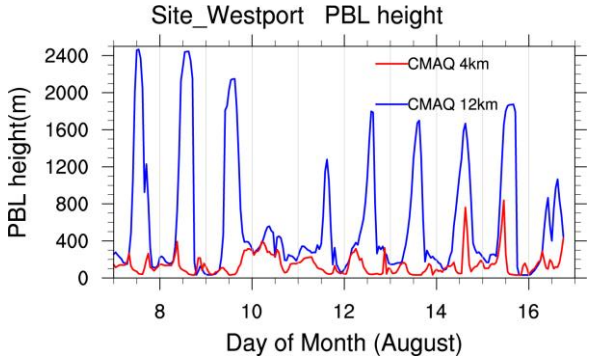


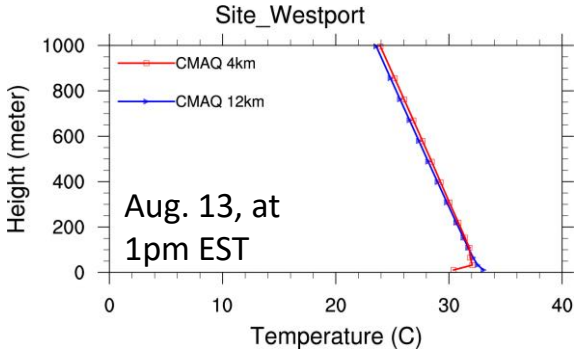


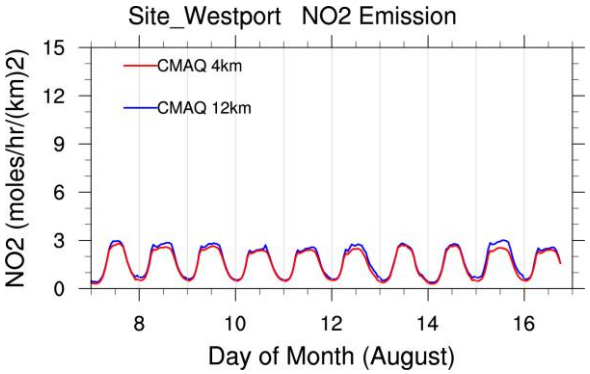
Diurnal Variations of MET and EMIS during 8/7 ~ 8/16

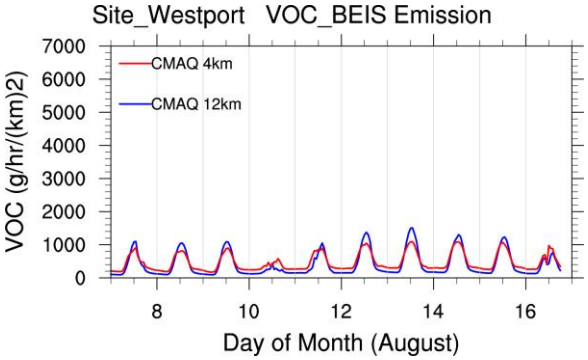
Westport (12km Land|4km Water)

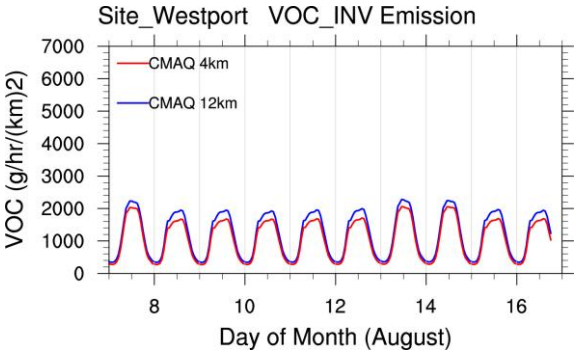






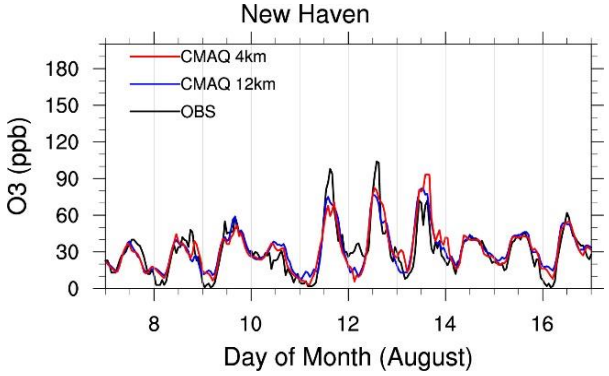


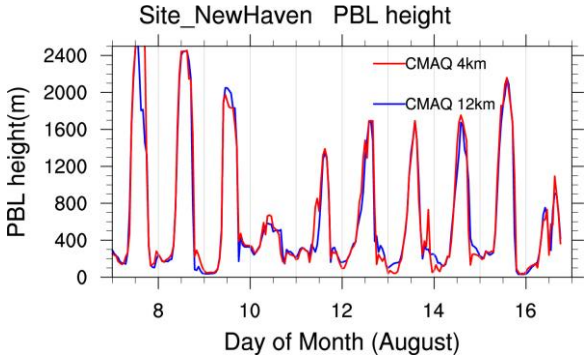


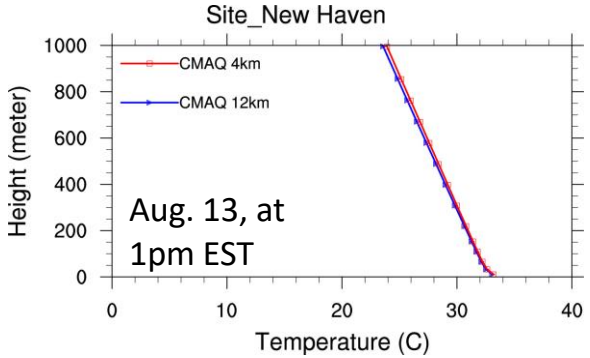


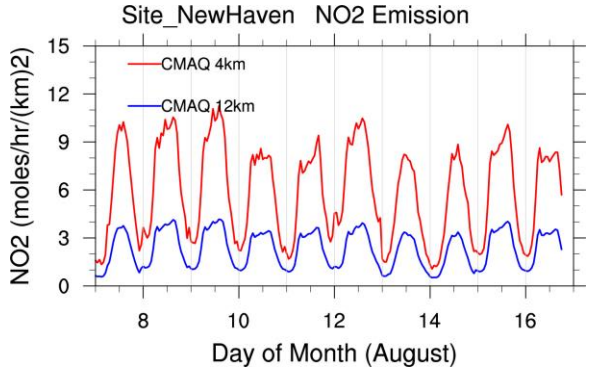
Diurnal Variations of MET and EMIS during 8/7 ~ 8/16

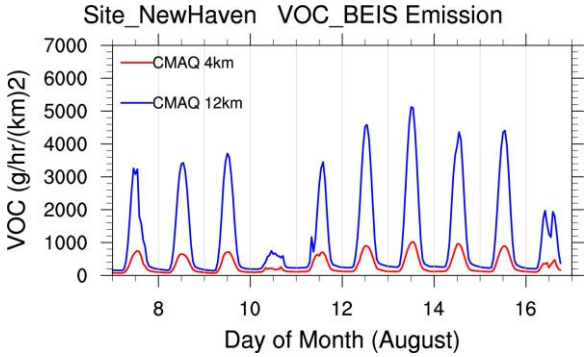
New Haven (12km Land|4km Land)

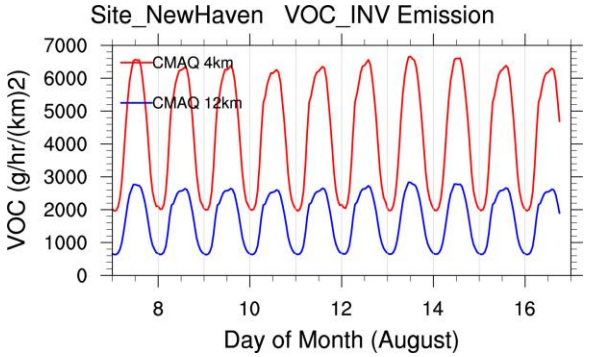






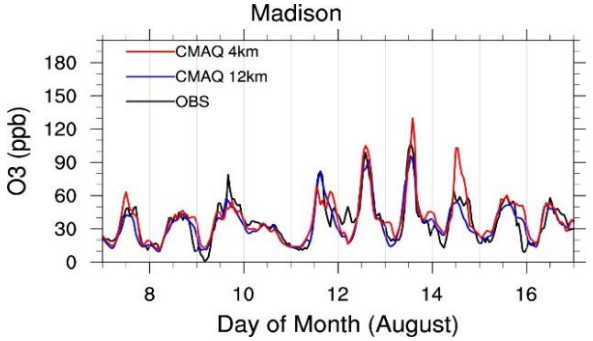


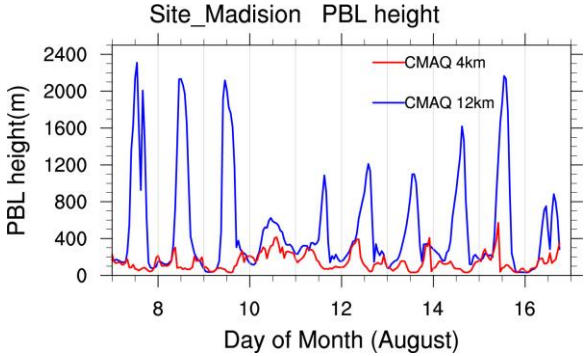


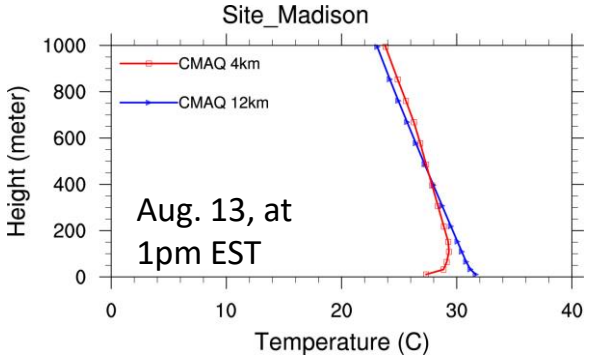


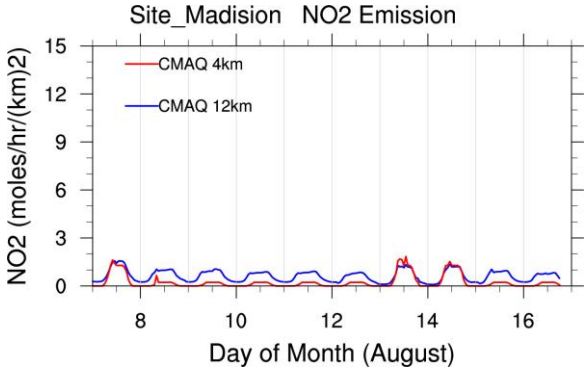
Diurnal Variations of MET and EMIS during 8/7 ~ 8/16

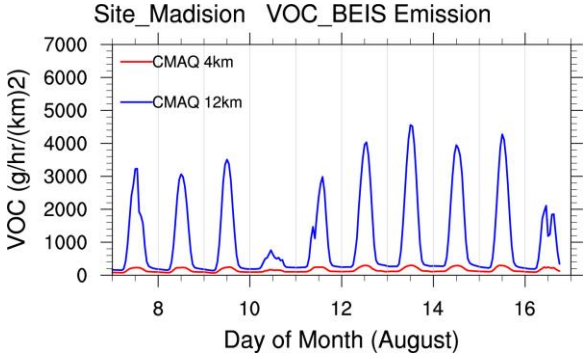
Madison (12km Land|4km Water)

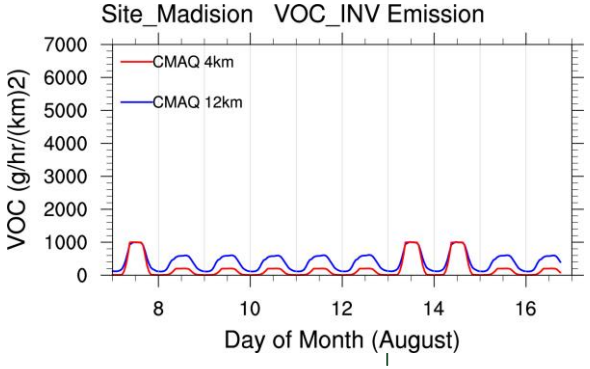






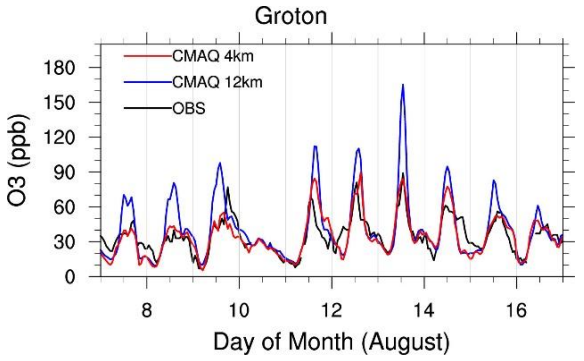


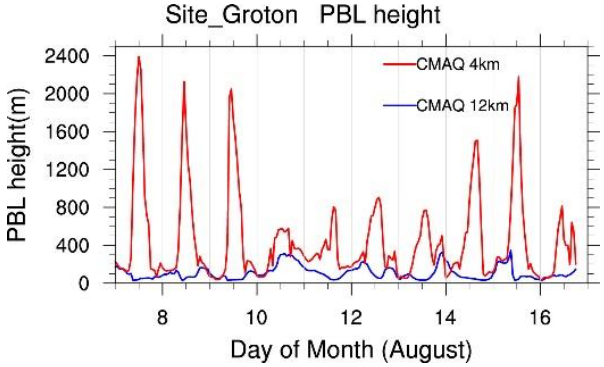


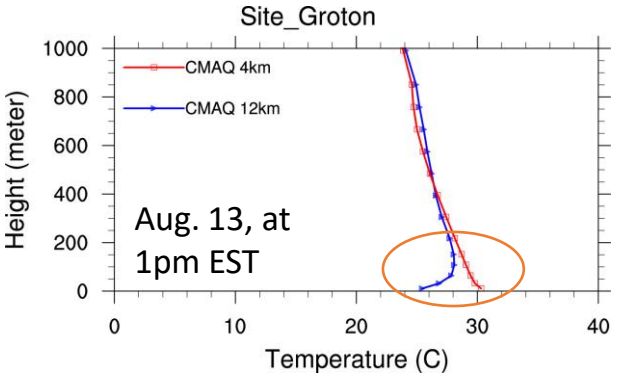


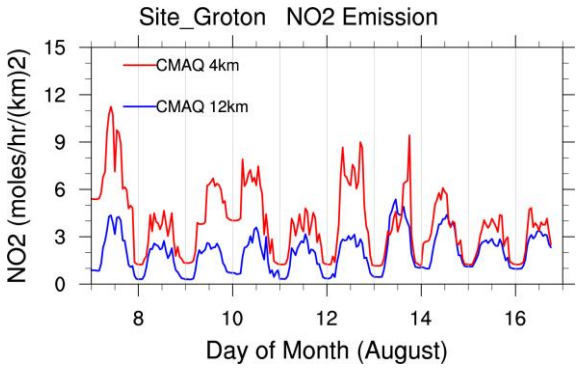
Diurnal Variations of MET and EMIS During 8/7 ~ 8/16

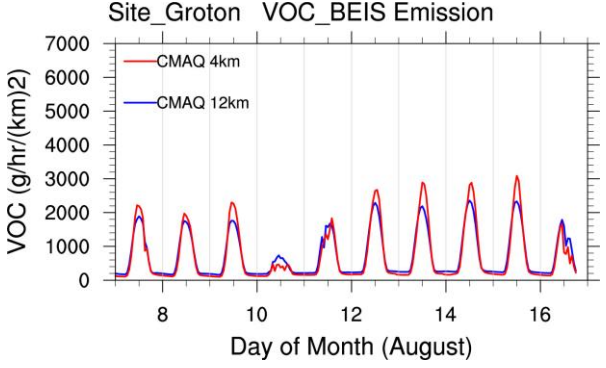
Groton (12km Water|4km Land)

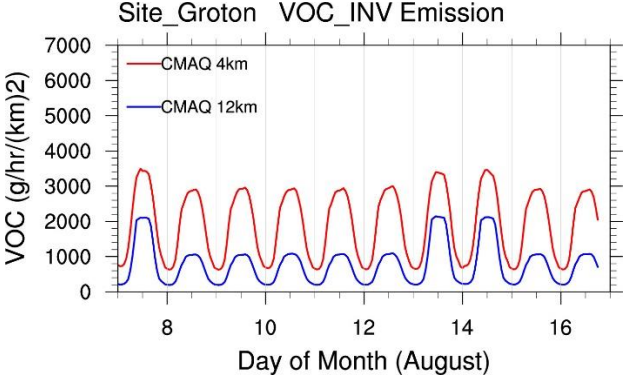












Results

1) Comparison of MDA8 O_3

2) Comparison of diurnal variations of MET and EMIS data

3) Comparison of 2023 DVFs

Four Methods Used in the DVF Calculations

1) 3x3 method:

   Use 3x3 grid cells centered on the grid cell where the monitoring site is located.

2) 3x3 no water 1 method:

   Modified 3x3 method. Eliminate the grid cells that are classified as water cell by WRF and that do not contain the monitoring site.

3) 3x3 no water 2 method:

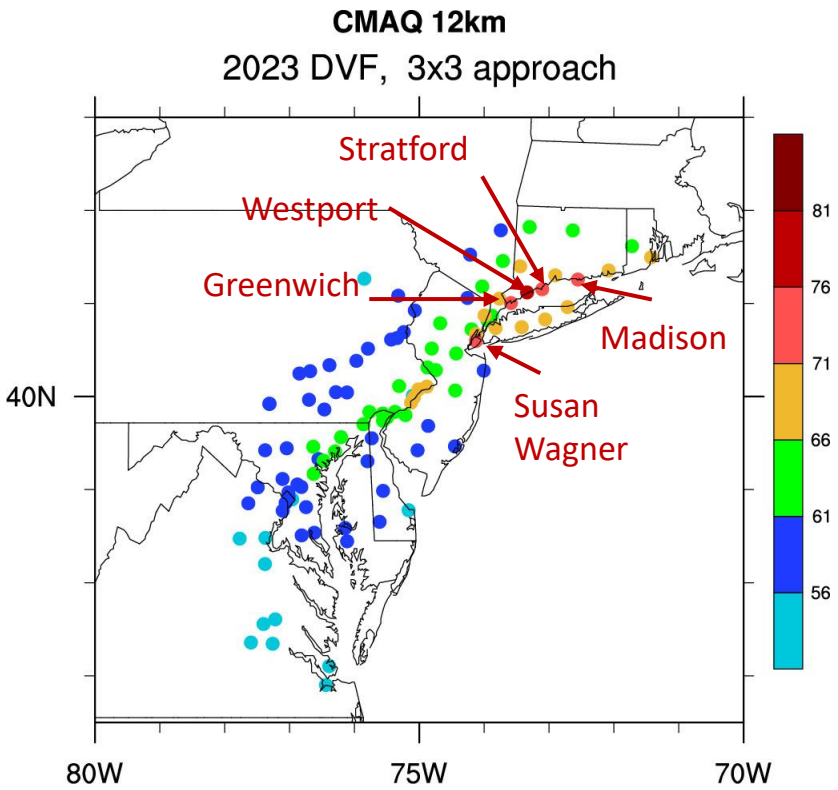
   Further modified 3x3 method. Excludes all water cells including the water cell in which the monitoring site is located.

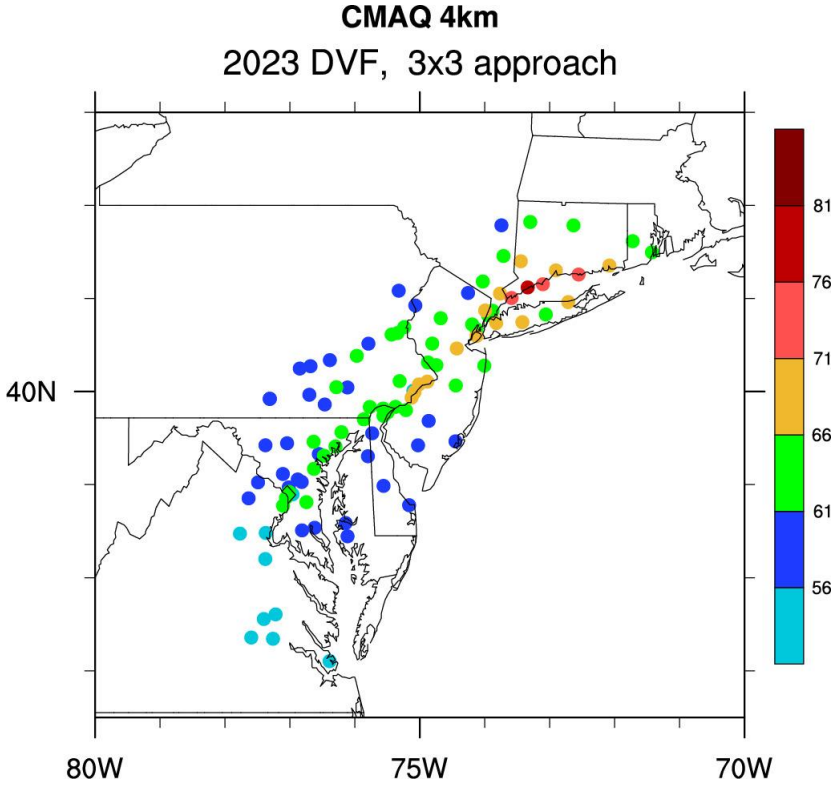
4) 1x1 method:

   Use the grid cell where the monitoring site is located.

2023 DVFs (12km vs. 4km)

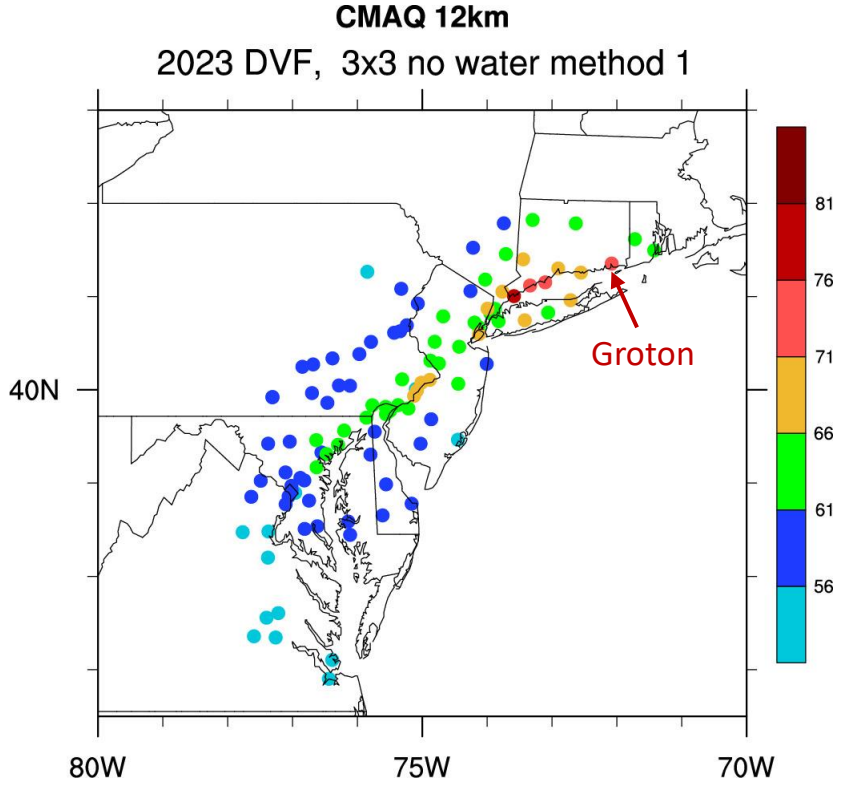
3x3 method: 3x3 grid cells centered on the grid cell where the monitoring site is located.

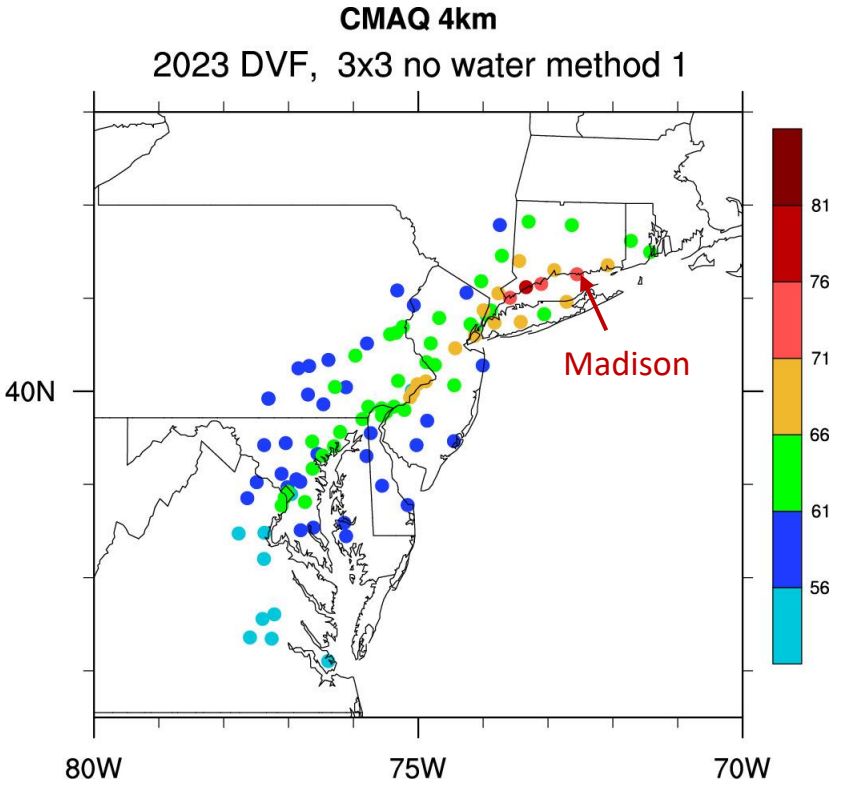




2023 DVFs (12km vs. 4km)

3x3 no water 1 method: Modified 3x3 method. Eliminate the grid cells that are classified as water cell by WRF and that do not contain the monitoring site.





2023 DVFs for Six O_3 Monitoring Sites

		12km CMAQ					4km CMAQ				
Name	Site No.	12km Land Cover Type	12km 3X3	12km 3X3 no water 1	12km 3X3 no water 2	12km 1X1	4km Land Cover Type	4km 3X3	4km 3X3 no water 1	4km 3X3 no water 2	4km 1X1
Greenwich	1	W	71.7	78.8	72.2	78.8	W	75.1	74.9	74.3	75.2
Stratford	2	L	74.6	75.1	75.1	74.5	W	75.4	75.7	75.0	75.7
Westport	3	L	80.6	75.5	75.5	76.4	W	76.3	76.6	76.2	78.5
New Haven	4	L	69.3	68.4	68.4	68.2	L	70.2	69.1	69.1	68.9
Madison	5	L	71.8	70.8	70.8	71	W	73.8	73.3	73.2	73.3
Groton	6	W	67.9	71.3	66.7	71.3	L	68.7	68.3	68.3	68.8

Conclusions

1. On average, the performances of CMAQ at 4km and at 12km are very similar.
2. In July and August, CMAQ at 4km resolution significantly improved the O_3 simulations over two of the CT coastal monitoring sites (i.e., Greenwich and Groton), one of the MD Chesapeake Bay area sites (i.e., Hart Miller Island) and one of RI sites. These four sites were defined as water at 12km resolution.
3. For monitoring sites that were defined as land both at 4km and 12km resolutions, two platforms have similar performance.
4. CMAQ simulations at 4km resolution did not get worse over monitoring sites that were defined as water at 4km resolution (but were defined as land at 12km resolution).

Conclusions

5. Our work suggests that for CMAQ, grid resolution plays a crucial role in modeling O_3 along the land/water interface area where more accurate allocation of emissions at 4km resolution improved the O_3 estimations.

6. For most of land monitoring sites, the 2023 DVFs from 4km platform are very similar to those from 12km platform. For the 6 monitoring sites along CT coastline, 4 of them have similar 2023 DVFs for the 12km and 4km platforms. Monitoring sites Greenwich and Westport showed relatively large DVF difference among 4 calculation methods at 12km platform, but very consistent DVFs among 4 methods at 4km platform.

Thank you very much!

Questions?

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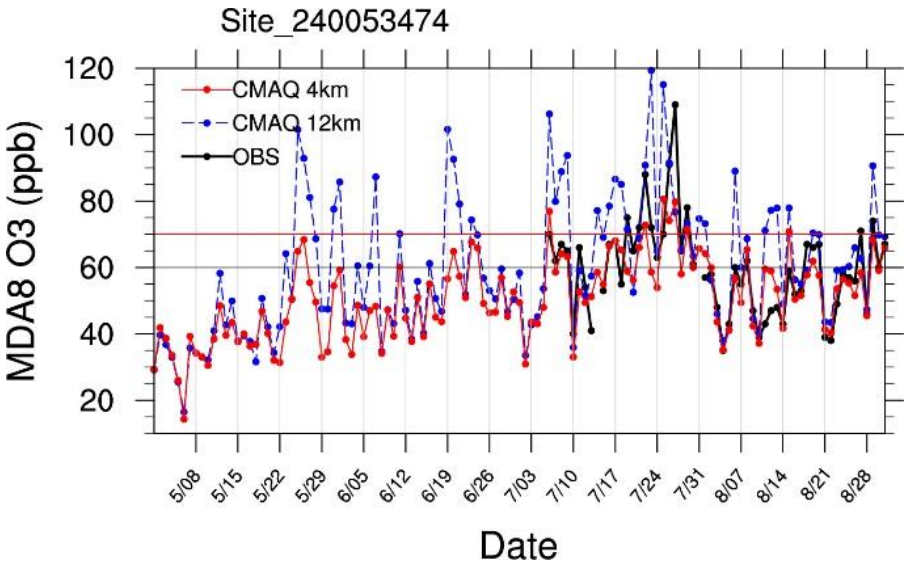
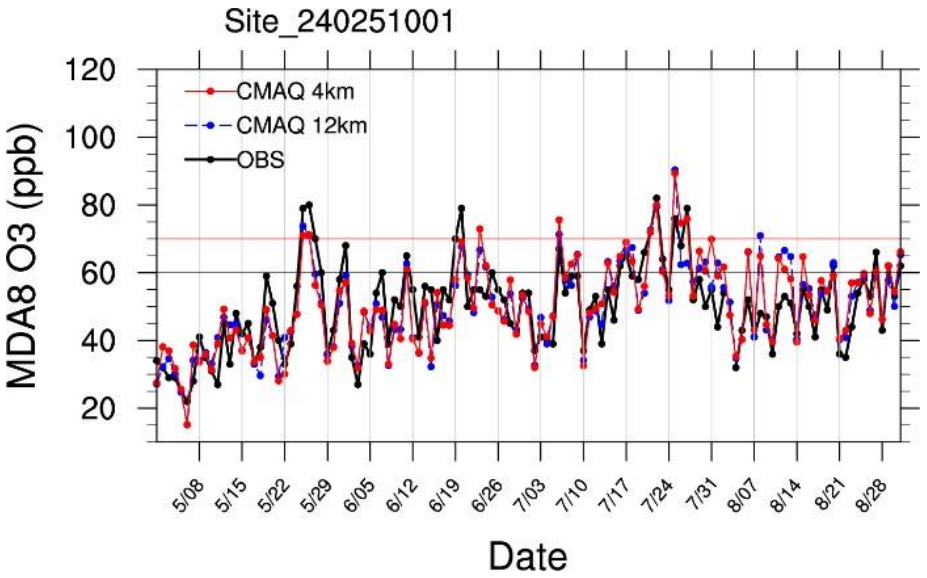
Extra Slides

MDA8 O_3 Time Series

Hart Miller Island (12km Water|4km Land)



Edgewood (12km Land|4km Land)



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