Analysis of the trends in ambient methane in the Baltimore-Washington region and comparison to model output

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Contents of this file

Introduction

- The supporting information contains figures of the geographic location of the towers, modeling domain used in our study, methane flux of WetCHARTs members, distribution of methane flux within EDGAR 6.0, diurnal cycle in summer at ARL and NEB.

- The supporting information contains tables on geographic location and inlet heights of the three towers in our study. In addition, it contains the tables on the bias comparison between observations and model outputs a. with 2nd, 5th, 10th, 15th percentiles as

background b. for all hours in summer and winter c. after adding emissions from various WetCHARTs options.
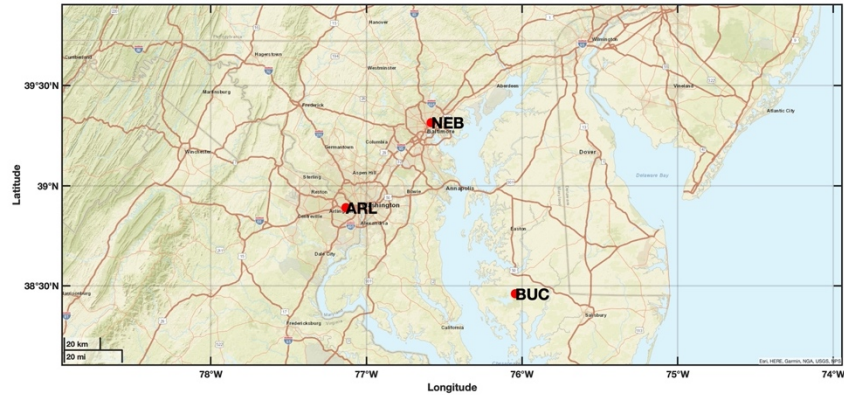
Figure S1: Geographic location of three towers in our study, represented by red dots. Two urban towers NEB (Baltimore, MD), ARL (Arlington, VA) and one rural tower, BUC (Bucktown, MD).
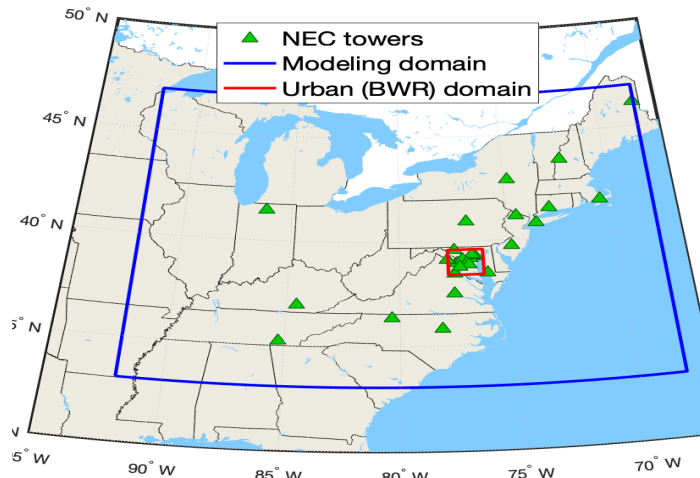
Figure S2: Modeling domains in our study. The larger blue box represents the d01 domain, and the smaller red box represents the BWR.
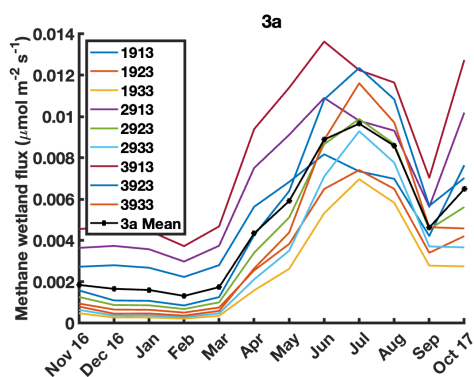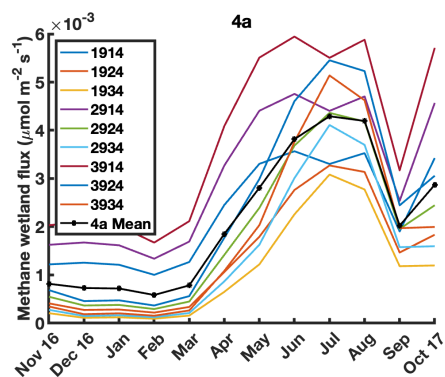
Figure S3a　　　　　　　　　　　　**Figure S3b**

Figure S3. WetCHARTs members for methane flux for d01 domain. The combination 'wet3a' is shown in Figure S3a and 'wet4a' in Figure S3b. The black line is the mean of all members in each plot, which is used in our study.

Figure S4

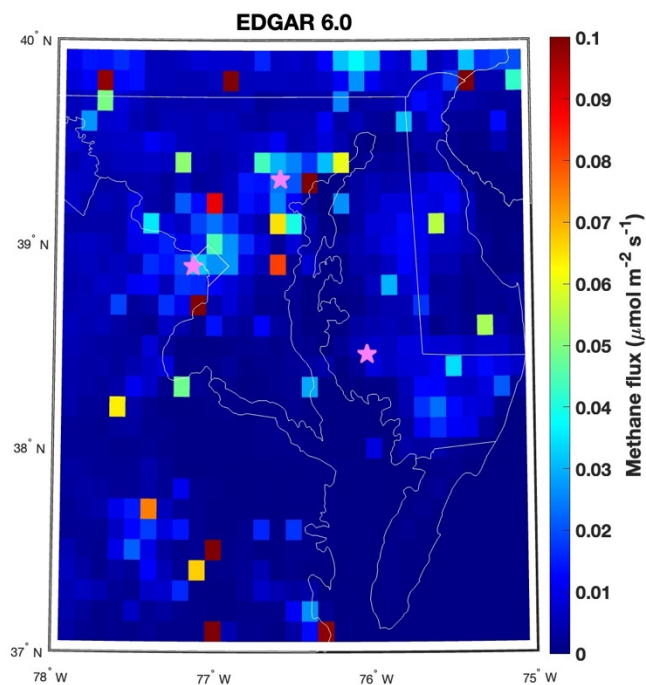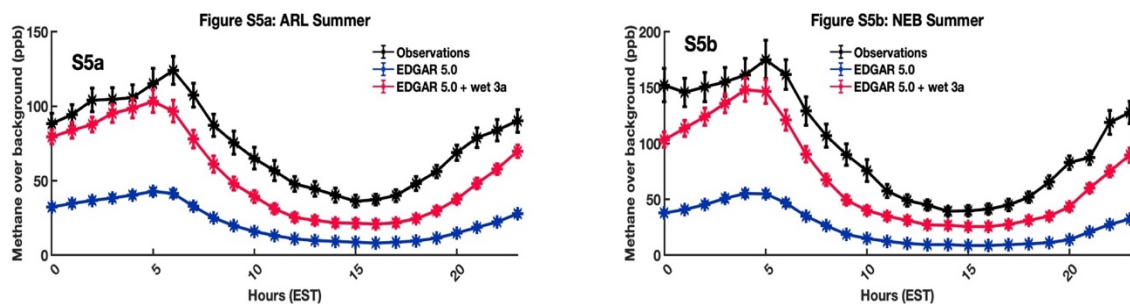**Figure S4**: Distribution of CH_4 emission fluxes (in units of μmol/m^2/s) in EDGAR 6.0 around the towers in the BWR. The pink stars represent the towers in our study. Color axis has been truncated for clarity.

Figure S5. Diurnal cycle of methane at ARL (a) and NEB (b) during summer. The black line represents the hourly averaged methane observed enhancements. The red and blue lines represent the model predicted diurnal cycle using EDGAR 5.0 inventory, with and without wetland emissions respectively.

Tower	Latitude (º)	Longitude (º)	Inlet heights (meters above ground level) (upper/lower)
BUC	38.459699	-76.042970	75/46
NEB	39.315417	-76.583000	67/50
ARL	38.891667	-77.131667	92/50

Table S1: Latitude and longitude of the three towers in our study, along with the inlet heights in the tower.

Tower	Inventory	Season	Percentile	Mean bias (ppb)	NMB
BUC				-22.26	-0.44
NEB	EDGAR 4.2	winter	5th	-42.50	-0.52
ARL				-26.97	-0.40
BUC				-35.59	-0.51

Tower	Inventory	Season	Percentile	Mean bias (ppb)	NMB
NEB	EDGAR 4.2	winter	2nd	-42.22	-0.49
ARL				-38.07	-0.47
BUC	EDGAR 4.2	winter	10th	-17.89	-0.43
NEB				-35.48	-0.50
ARL				-23.54	-0.40
BUC	EDGAR 4.2	winter	15th	-14.99	-0.40
NEB				-35.34	-0.53
ARL				-22.49	-0.41
BUC				-37.50	-0.74
NEB	EDGAR 5.0	winter	5th	-65.93	-0.80
ARL				-51.78	-0.77
BUC				-52.96	-0.76
NEB	EDGAR 5.0	winter	2nd	-69.39	-0.80
ARL				-65.58	-0.80
BUC	EDGAR 5.0	winter	10th	-30.91	-0.74
NEB				-56.74	-0.80
ARL				-45.30	-0.76
BUC	EDGAR 5.0	winter	15th	-27.61	-0.74
NEB				-55.79	-0.83
ARL				-42.40	-0.78

Table S2: Mean bias and normalized mean bias (NMB) after subtracting the 2nd, 5th, 10th, 15th percentiles from tower methane observations and model results for winter afternoon hours.

Tower	Inventory	Season	Percentile	Mean bias (ppb)	NMB
BUC				-35.10	-0.60
NEB	EDGAR 4.2	summer	5th	-26.98	-0.49
ARL				-18.78	-0.39
BUC				-45.99	-0.62
NEB	EDGAR 4.2	summer	2nd	-28.04	-0.45
ARL				-34.98	-0.52
BUC	EDGAR 4.2		10th	-20.06	-0.50
NEB		summer		-24.33	-0.51
ARL				-17.47	-0.42
BUC	EDGAR 4.2		15th	-15.93	-0.48
NEB		summer		-21.90	-0.52
ARL				-14.59	-0.40
BUC				-46.38	-0.80
NEB	EDGAR 5.0	summer	5th	-43.39	-0.79

Tower	Inventory	Season		Mean bias	r²
ARL				-36.40	-0.75
BUC				-59.26	-0.80
NEB	EDGAR 5.0	summer	2nd	-48.84	-0.78
ARL				-53.92	-0.80
BUC	EDGAR 5.0	summer	10th	-30.79	-0.76
NEB				-38.18	-0.80
ARL				-31.78	-0.76
BUC	EDGAR 5.0	summer	15th	-25.71	-0.77
NEB				-34.02	-0.81
ARL				-28.20	-0.78

Table S3: Same as Table S2 for summer afternoon hours.

Tower	Inventory	Season	Mean bias (ppb)	NMB	r^2
BUC		winter	-22.99	-0.42	0.37
NEB	EDGAR 4.2	winter	-49.80	-0.39	0.37
ARL		winter	-21.46	-0.25	0.29
BUC		winter	-39.12	-0.71	0.37
NEB	EDGAR 5.0	winter	-101.10	-0.79	0.34
ARL		winter	-63.57	-0.74	0.30
BUC		summer	-35.10	-0.60	0.30
NEB	EDGAR 4.2	summer	-26.98	-0.49	0.18
ARL		summer	-18.78	-0.39	0.28
BUC		summer	-46.38	-0.80	0.36
NEB	EDGAR 5.0	summer	-43.39	-0.79	0.22
ARL		summer	-36.40	-0.75	0.36

Table S4: Mean bias (ppb), normalized mean bias, and r^2 between model (WRF-STILT + EDGAR 4.2 and 5.0) and observations for all hours in summer and winter.

Tower	Inventory	Mean bias (ppb)	NMB	r^2
BUC	EDGAR 5.0	-37.50	-0.74	0.29
	EDGAR 5.0 + 3a	-34.33	-0.68	0.30
	EDGAR 5.0 + 3b	-33.81	-0.67	0.29
	EDGAR 5.0 + 4a	-36.21	-0.72	0.30
	EDGAR 5.0 + 4b	-36.20	-0.72	0.30
	EDGAR 5.0 + ma	-35.30	-0.70	0.30
	EDGAR 5.0 + mb	-34.99	-0.69	0.30
NEB	EDGAR 5.0	-65.93	-0.80	0.39
	EDGAR 5.0 + 3a	-63.06	-0.77	0.42
	EDGAR 5.0 + 3b	-63.15	-0.77	0.42
	EDGAR 5.0 + 4a	-64.55	-0.79	0.41
	EDGAR 5.0 + 4b	-64.57	-0.79	0.42
	EDGAR 5.0 + ma	-63.80	-0.78	0.42
	EDGAR 5.0 + mb	-63.90	-0.78	0.42
ARL	EDGAR 5.0	-51.78	-0.77	0.36
	EDGAR 5.0 + 3a	-49.05	-0.73	0.37
	EDGAR 5.0 + 3b	-48.99	-0.73	0.37
	EDGAR 5.0 + 4a	-50.25	-0.75	0.38
	EDGAR 5.0 + 4b	-50.40	-0.75	0.38
	EDGAR 5.0 + ma	-49.65	-0.74	0.38
	EDGAR 5.0 + mb	-49.79	-0.74	0.37

Table S5: Model mean bias, NMB, and r^2 after adding emissions from different WetCHARTs options (3a, 3b, 4a, 4b, ma, mb as described in the text) for winter afternoon hours.

Tower	Inventory	Mean bias (ppb)	NMB	r^2
	EDGAR 5.0	-39.12	-0.71	0.37
	EDGAR 5.0 + 3a	-35.08	-0.63	0.37
	EDGAR 5.0 + 3b	-34.09	-0.62	0.36
	EDGAR 5.0 + 4a	-37.60	-0.68	0.37

	EDGAR 5.0 + 4b	-37.52	-0.68	0.37
	EDGAR 5.0 + ma	-36.29	-0.66	0.37
	EDGAR 5.0 + mb	-35.71	-0.64	0.37
BUC				
	EDGAR 5.0	-101.10	-0.7931	0.35
	EDGAR 5.0 + 3a	-96.84	-0.76	0.36
	EDGAR 5.0 + 3b	-96.92	-0.76	0.36
	EDGAR 5.0 + 4a	-99.06	-0.78	0.36
	EDGAR 5.0 + 4b	-98.95	-0.78	0.36
	EDGAR 5.0 + ma	-97.95	-0.77	0.36
NEB	EDGAR 5.0 + mb	-98.04	-0.77	0.36
	EDGAR 5.0	-63.57	-0.74	0.30
	EDGAR 5.0 + 3a	-59.67	-0.70	0.32
	EDGAR 5.0 + 3b	-59.86	-0.70	0.31
	EDGAR 5.0 + 4a	-61.35	-0.72	0.32
	EDGAR 5.0 + 4b	-61.62	-0.72	0.31
	EDGAR 5.0 + ma	-60.53	-0.71	0.32
ARL	EDGAR 5.0 + mb	-60.73	-0.71	0.31

Table S6: Same as Table S5 for all hours in winter.

Tower	Inventory	Mean bias (ppb)	Normalized mean bias	r^2
	EDGAR 5.0	-46.38	-0.80	0.36
	EDGAR 5.0 + 3a	-20.78	-0.36	0.081
	EDGAR 5.0 + 3b	-18.77	-0.32	0.073
	EDGAR 5.0 + 4a	-36.35	-0.63	0.16
	EDGAR 5.0 + 4b	-35.83	-0.62	0.16
	EDGAR 5.0 + ma	-28.86	-0.50	0.11
BUC	EDGAR 5.0 + mb	-27.91	-0.48	0.11
	EDGAR 5.0	-43.39	-0.79	0.22
	EDGAR 5.0 + 3a	-22.82	-0.41	0.17
	EDGAR 5.0 + 3b	-23.72	-0.43	0.18
	EDGAR 5.0 + 4a	-34.75	-0.63	0.20
	EDGAR 5.0 + 4b	-35.09	-0.64	0.20

Tower	Inventory	Mean bias (ppb)	Normalized mean bias	r²
	EDGAR 5.0 + ma	-29.31	-0.53	0.19
	EDGAR 5.0 + mb	-30.10	-0.55	0.19
NEB				
	EDGAR 5.0	-36.40	-0.75	0.36
	EDGAR 5.0 + 3a	-19.01	-0.39	0.28
	EDGAR 5.0 + 3b	-19.92	-0.41	0.27
	EDGAR 5.0 + 4a	-27.92	-0.58	0.34
	EDGAR 5.0 + 4b	-28.44	-0.59	0.34
	EDGAR 5.0 + ma	-23.39	-0.48	0.31
ARL	EDGAR 5.0 + mb	-24.20	-0.50	0.30

Table S7: Same as Table S5 for summer afternoon hours.

Tower	Inventory	Mean bias (ppb)	Normalized mean bias	r²
	EDGAR 5.0	-62.90	-0.80	0.26
	EDGAR 5.0 + 3a	-22.83	-0.29	0.17
	EDGAR 5.0 + 3b	-12.13	-0.15	0.17
	EDGAR 5.0 + 4a	-46.73	-0.59	0.21
	EDGAR 5.0 + 4b	-46.06	-0.58	0.20
	EDGAR 5.0 + ma	-35.59	-0.45	0.20
	EDGAR 5.0 + mb	-29.88	-0.38	0.20
BUC				
	EDGAR 5.0	-72.63	-0.74	0.32
	EDGAR 5.0 + 3a	-28.40	-0.29	0.22
	EDGAR 5.0 + 3b	-37.57	-0.38	0.24
	EDGAR 5.0 + 4a	-56.73	-0.58	0.28
	EDGAR 5.0 + 4b	-58.92	-0.60	0.29
	EDGAR 5.0 + ma	-42.93	-0.44	0.25
NEB	EDGAR 5.0 + mb	-48.38	-0.49	0.27
	EDGAR 5.0	-52.63	-0.70	0.28
	EDGAR 5.0 + 3a	-20.65	-0.28	0.23
	EDGAR 5.0 + 3b	-23.83	-0.32	0.19
	EDGAR 5.0 + 4a	-36.52	-0.49	0.29
	EDGAR 5.0 + 4b	-39.77	-0.53	0.26

	EDGAR 5.0 + ma	-28.94	-0.39	0.26
ARL	EDGAR 5.0 + mb	-32.30	-0.43	0.23

Table S8: Same as Table S5 for all hours in summer.