Supplement of Atmos. Chem. Phys., 26, 16029–16045, 2026
https://doi.org/10.5194/acp-26-16029-2026-supplement
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Supplement of

Evaluating the representativeness of aircraft sampling strategies for cloud water content in LASSO simulations over the ARM Southern Great Plains (SGP) Site

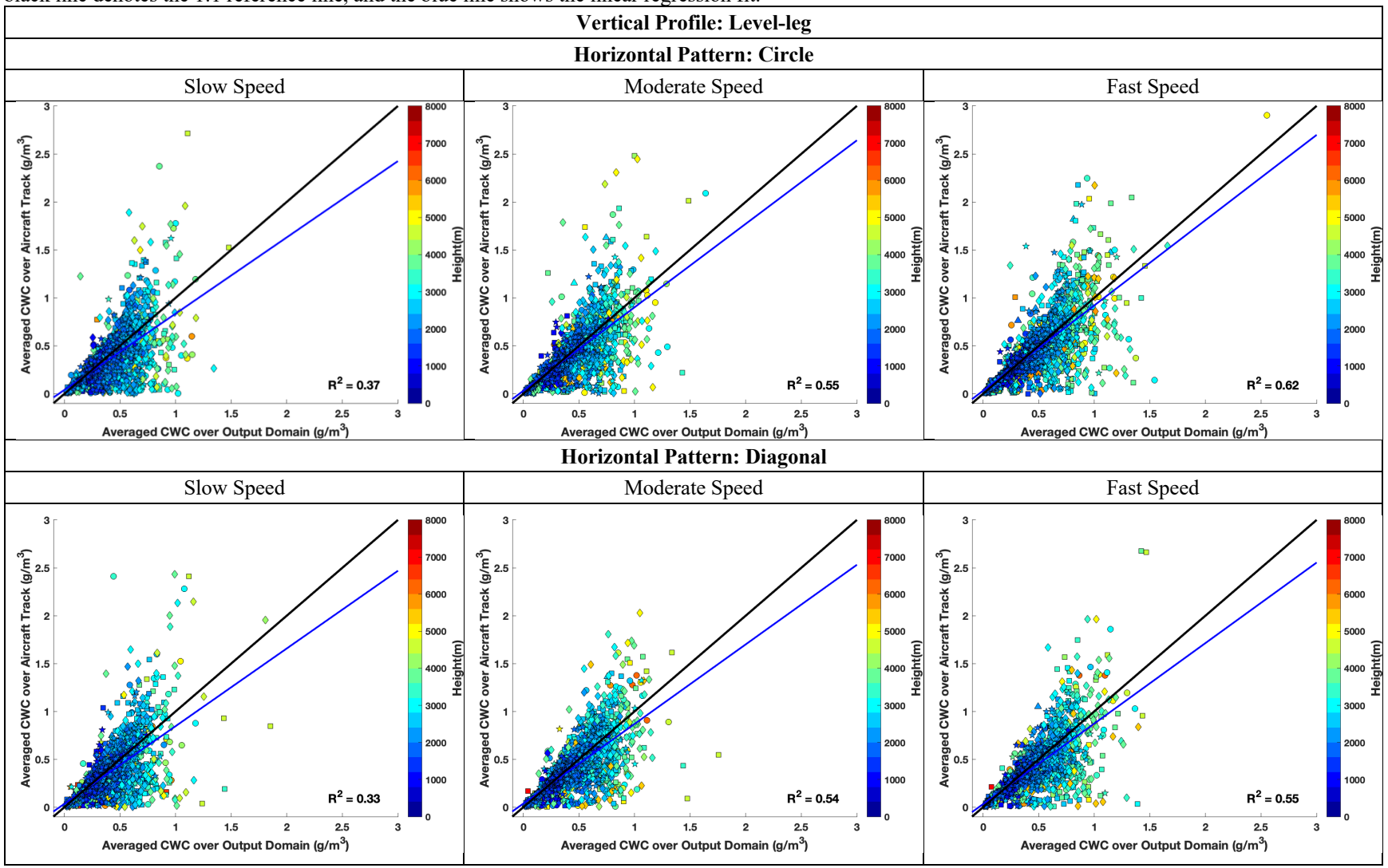
Jiakun Liang et al.

Correspondence to: Jennifer D. Small Griswold (smalljen@hawaii.edu)

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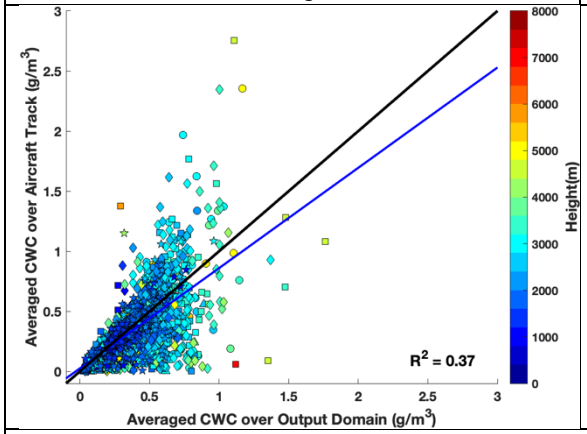
Supplemental Materials

Figure S1. Scatter plots comparing aircraft-sampled and domain-averaged cloud water content (CWC) for all horizontal patterns, vertical profiles, and flight speed categories. The x-axis shows domain-mean CWC over sampled layers, and the y-axis shows trajectory-averaged CWC. Colors indicate sampling height (m). The black line denotes the 1:1 reference line, and the blue line shows the linear regression fit.

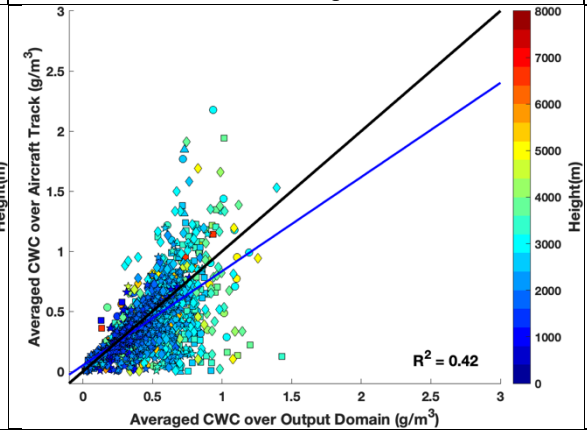


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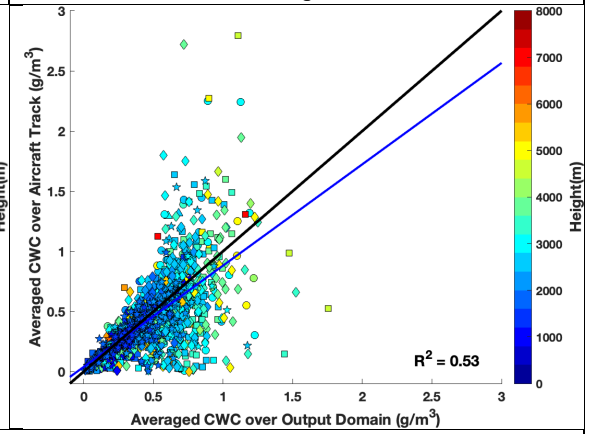
Slow Speed



Moderate Speed

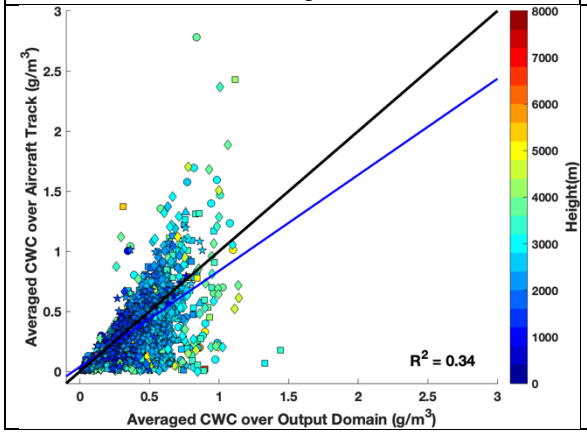


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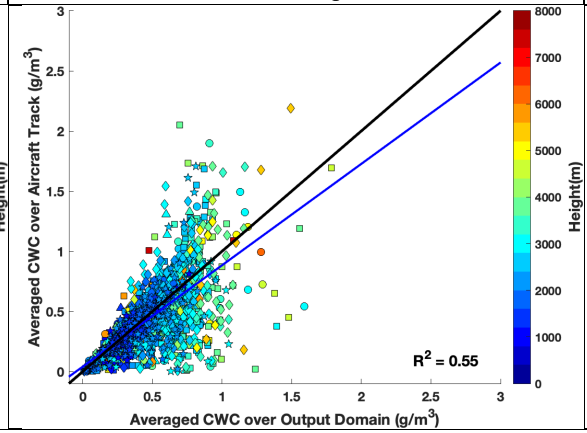


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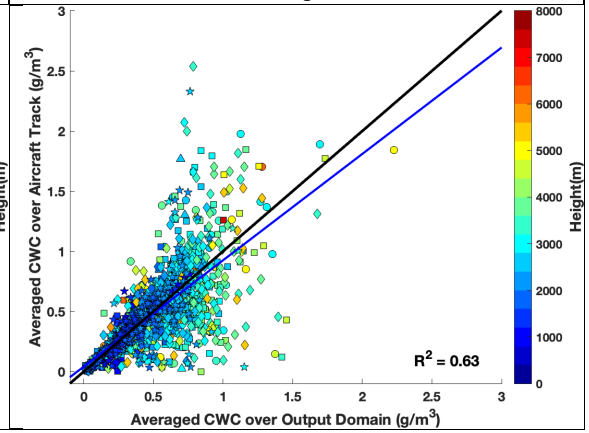
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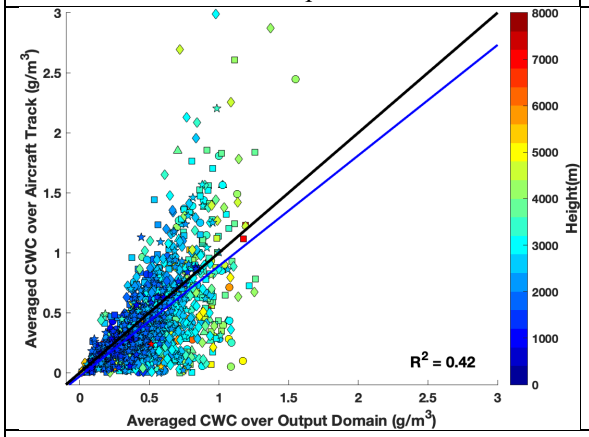
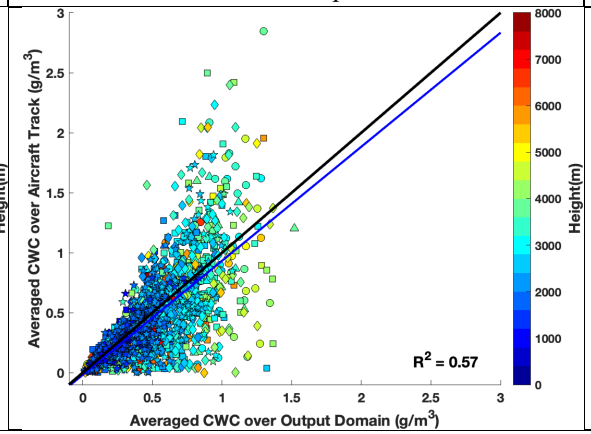
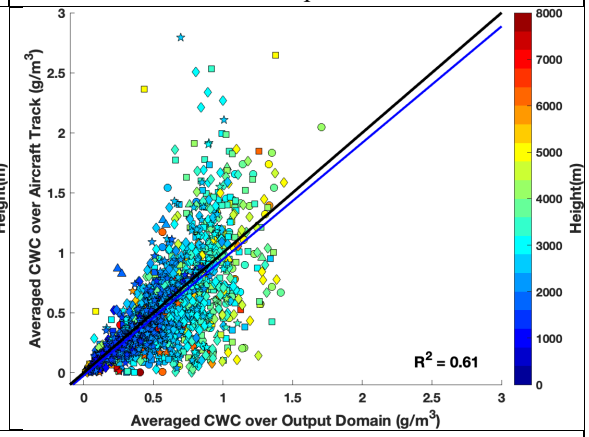
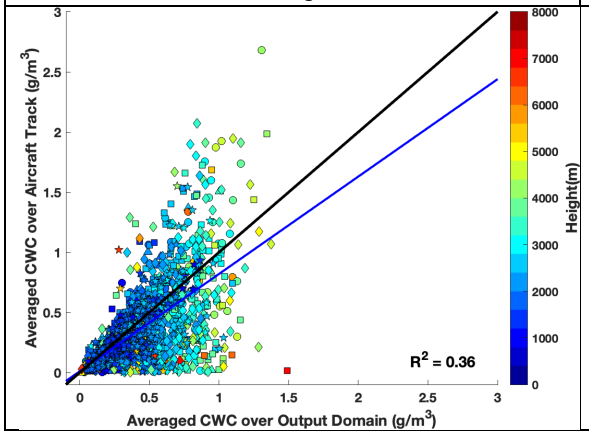
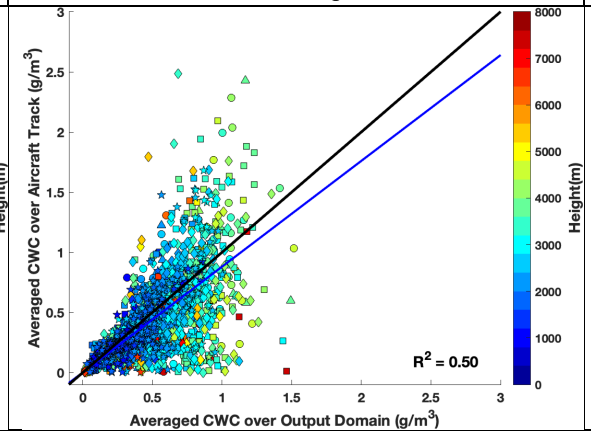
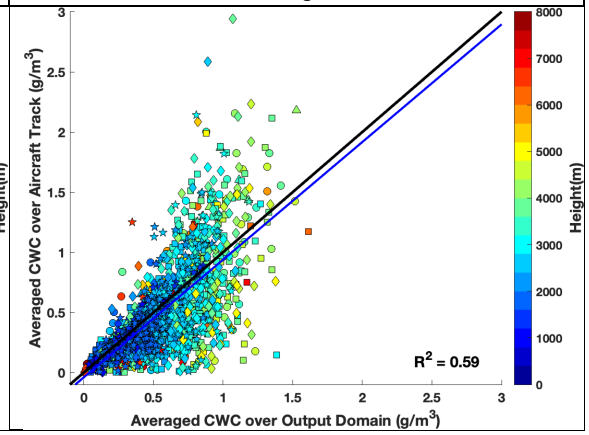


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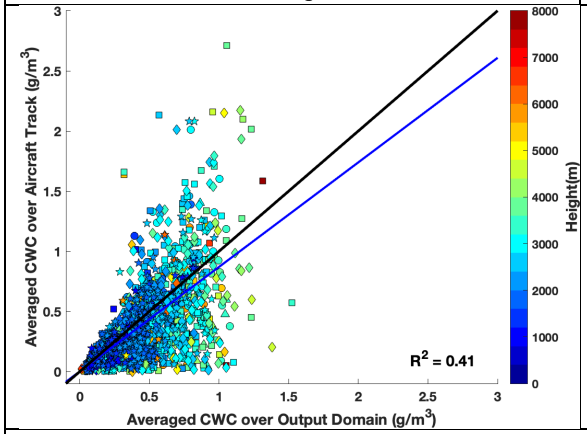
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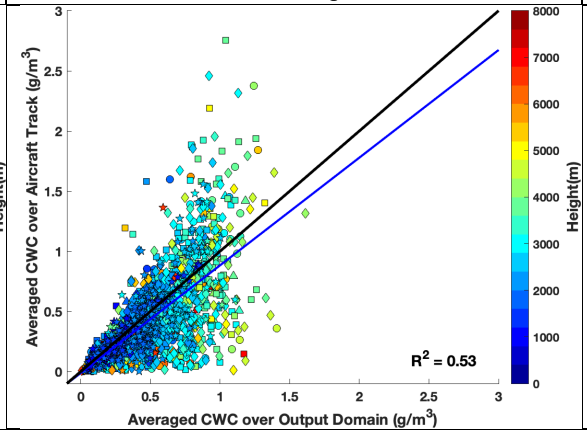
Vertical Profile: Sine wave		
Horizontal Pattern: Circle		
Slow Speed	Moderate Speed	Fast Speed
		
Horizontal Pattern: Diagonal		
Slow Speed	Moderate Speed	Fast Speed
		

Horizontal Pattern: Straight

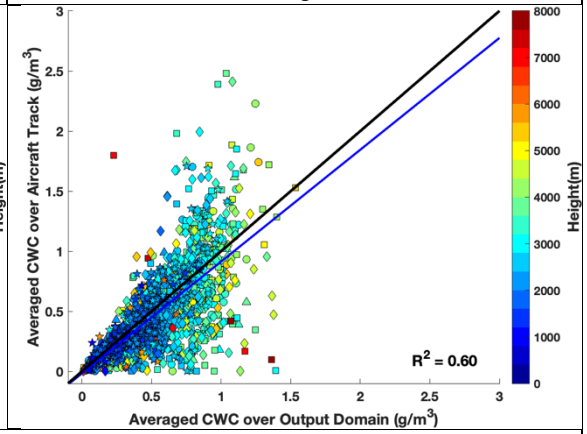
Slow Speed



Moderate Speed

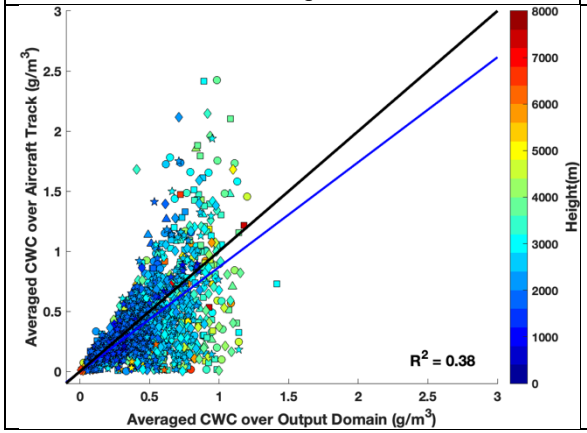


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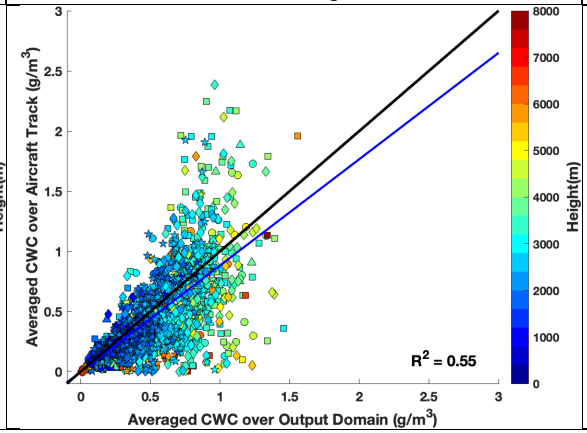


Horizontal Pattern: Combo

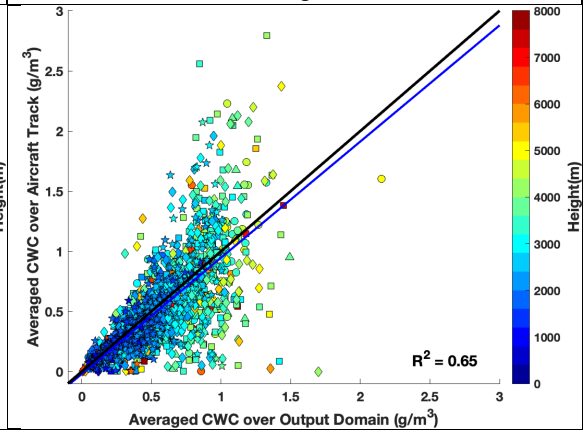
Slow Speed



Moderate Speed



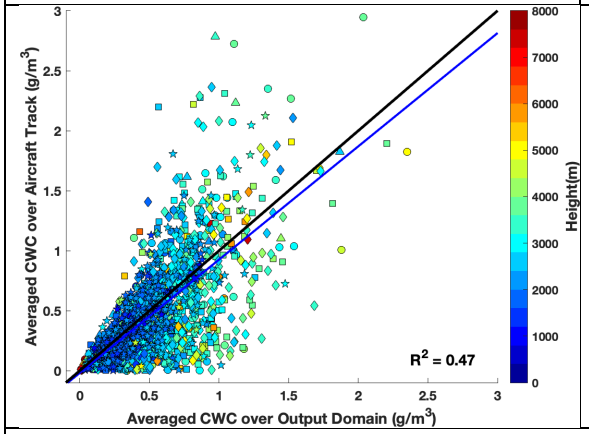
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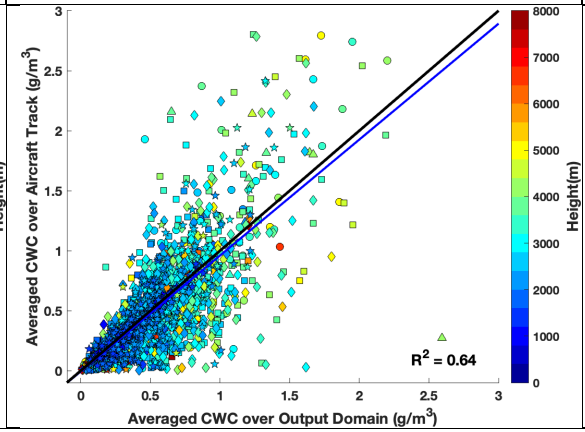
Vertical Profile: Staircase

Horizontal Pattern: Circle

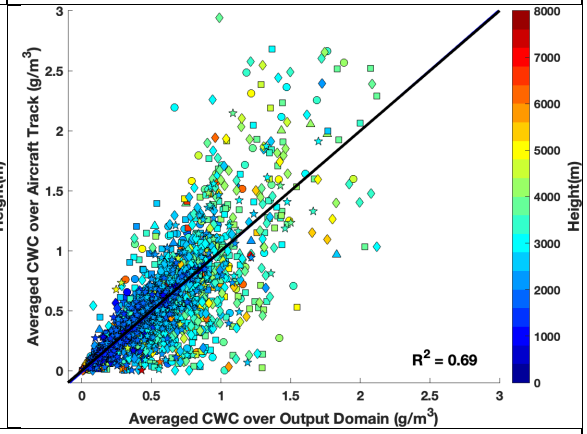
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Moderate Speed

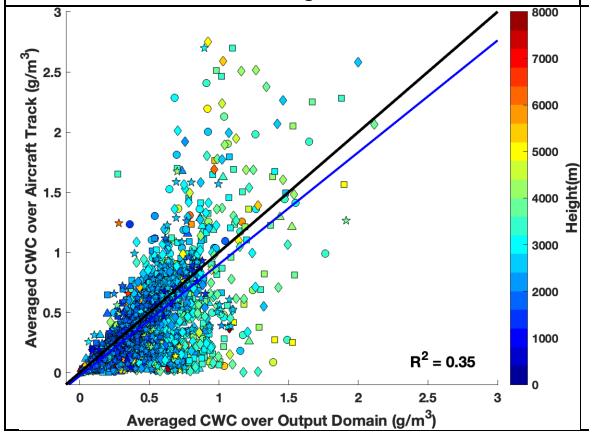


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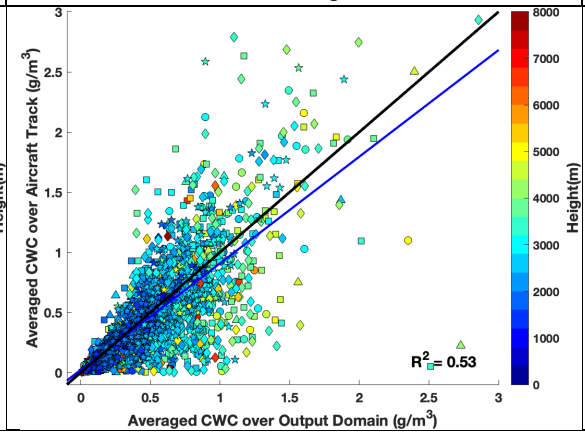


Horizontal Pattern: Diagonal

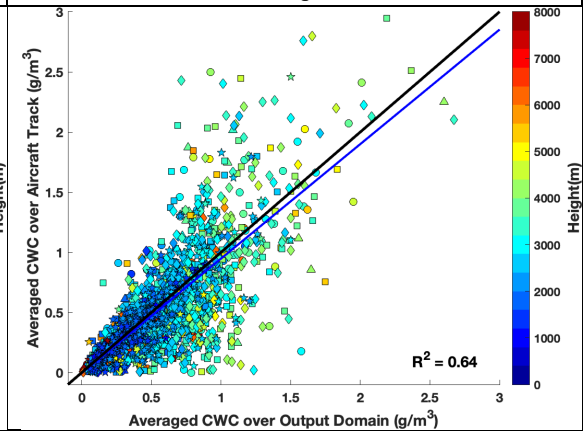
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Moderate Speed

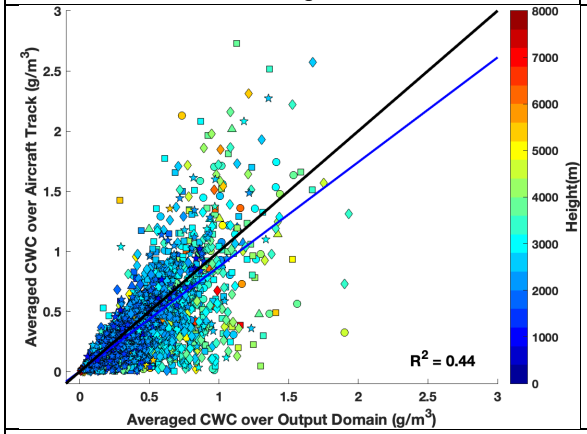


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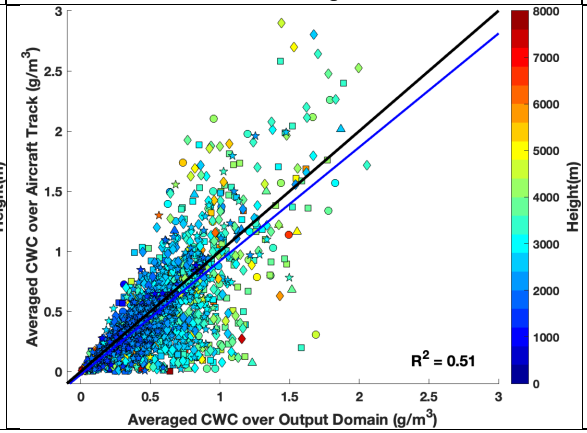


Horizontal Pattern: Straight

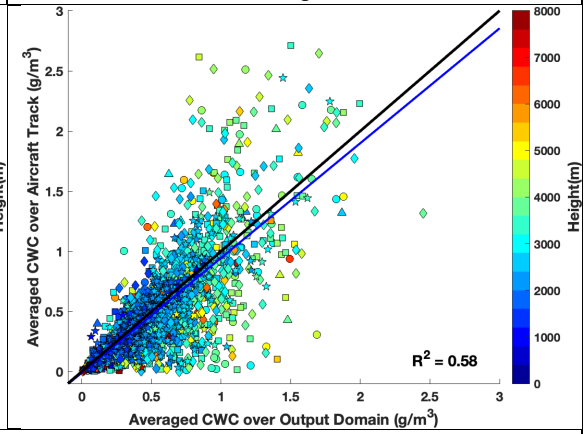
Slow Speed



Moderate Speed

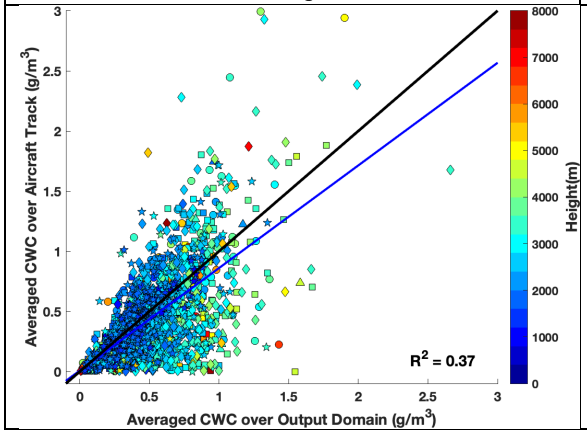


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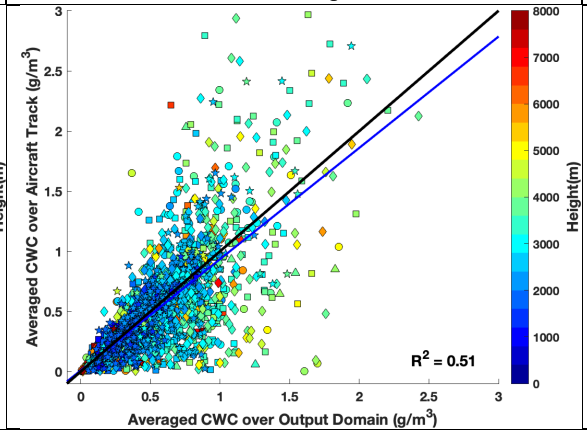


Horizontal Pattern: Combo

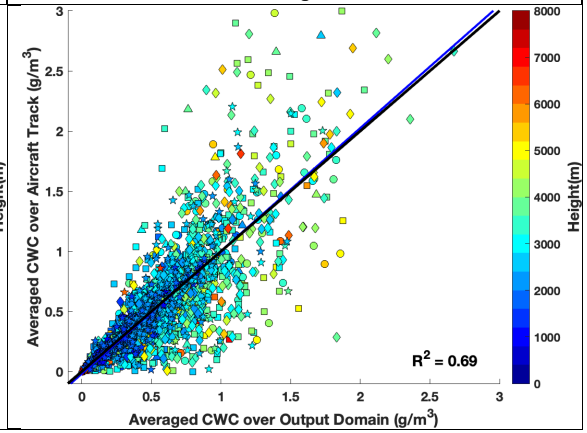
Slow Speed



Moderate Speed



Fast Speed



Sampling Strategy: Zigzag

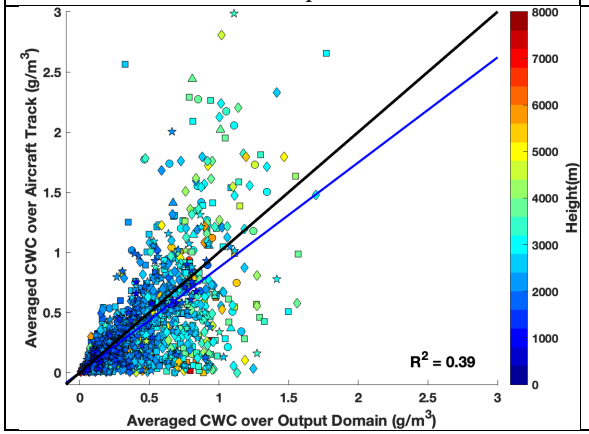
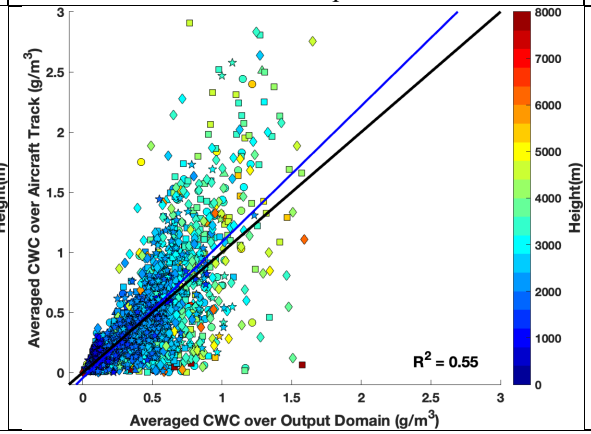
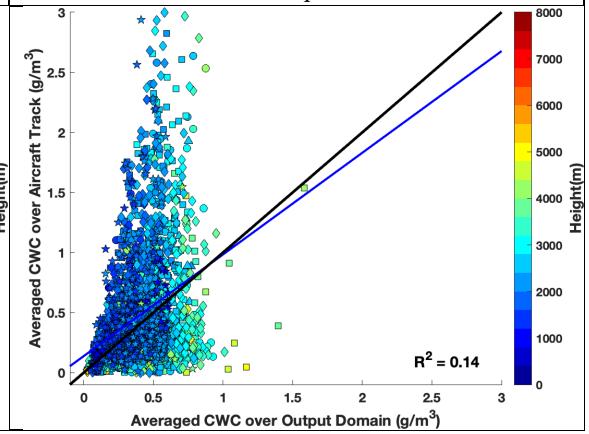
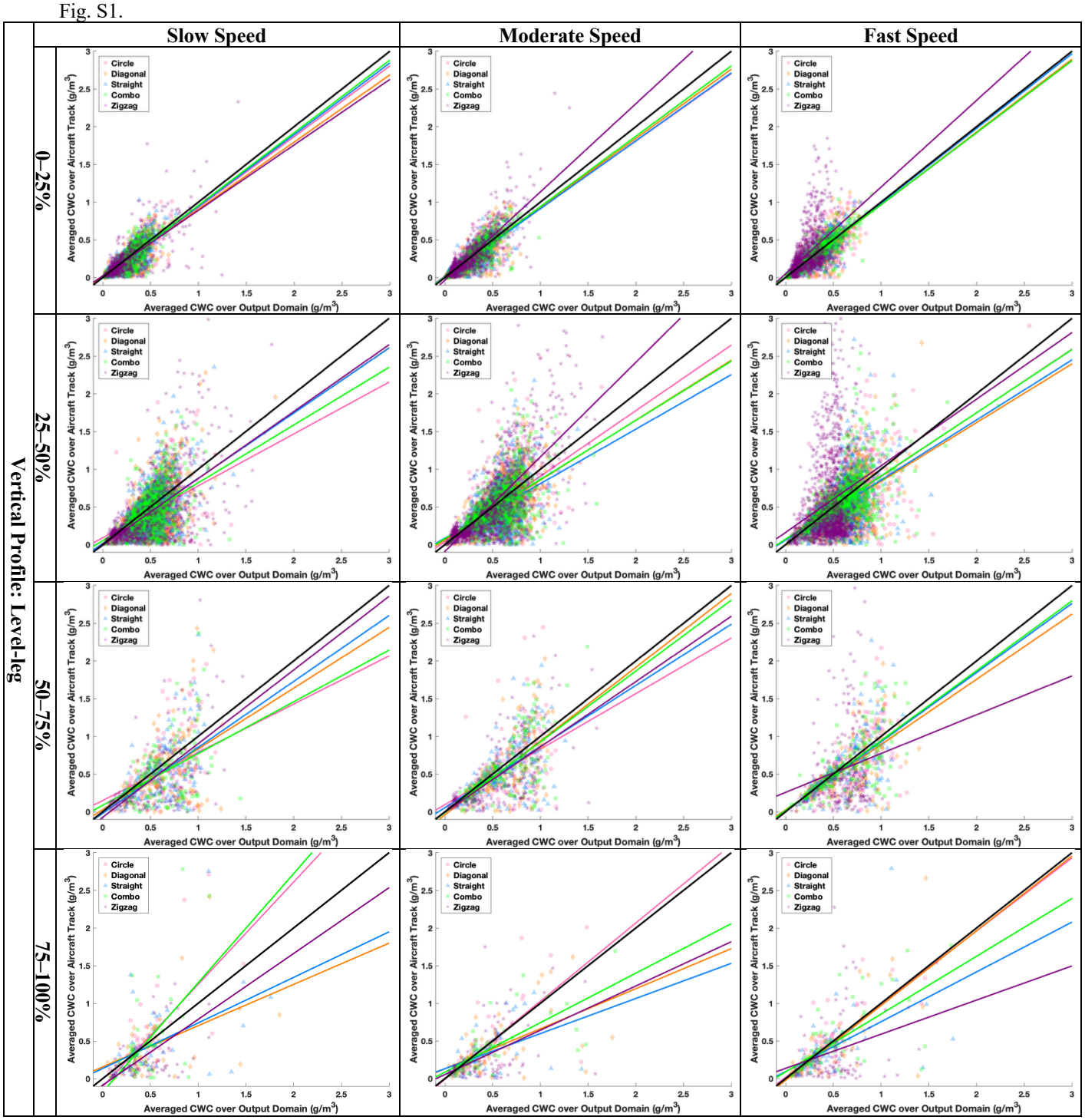
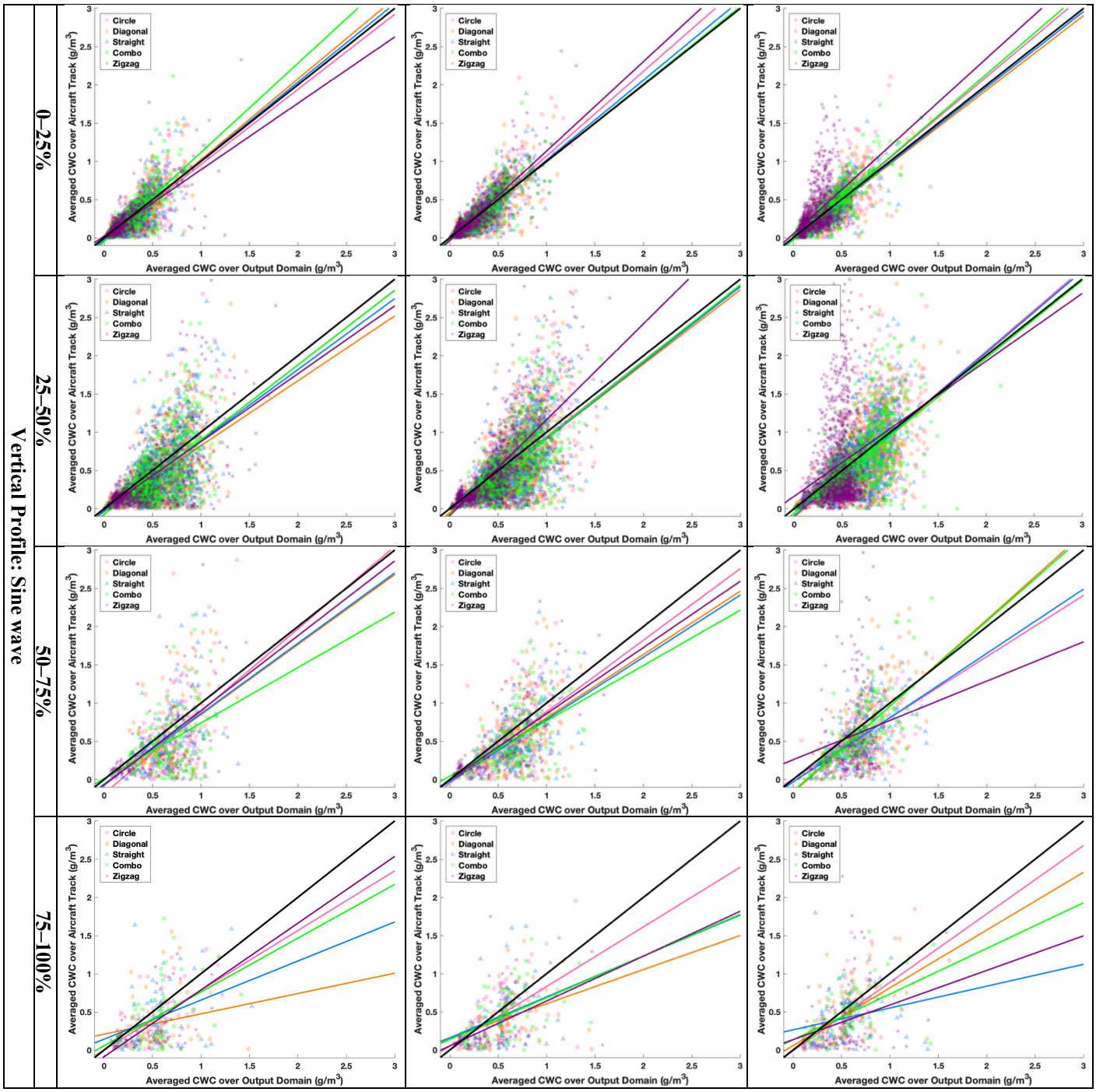
Slow Speed	Moderate Speed	Fast Speed
		

Figure S2. Scatter plots comparing aircraft-sampled and domain-averaged CWC for cases grouped by cloud fraction (CF) categories. The x-axis shows domain-mean CWC over the vertical layers intersected by the aircraft trajectory, and the y-axis shows trajectory-averaged CWC. Colors and symbols indicate different horizontal sampling patterns, and the black line denotes the 1:1 reference line. The zigzag pattern is plotted together for comparison but represents an independent trajectory type rather than a horizontal-vertical combination. The plotting method follows that used in Fig. S1.




Vertical Profile: Sine wave
0–25%
25–50%
50–75%
75–100%
Circle
Diagonal
Straight
Combo
Zigzag
Averaged CWC over Aircraft Track (g/m3)
Averaged CWC over Output Domain (g/m3)

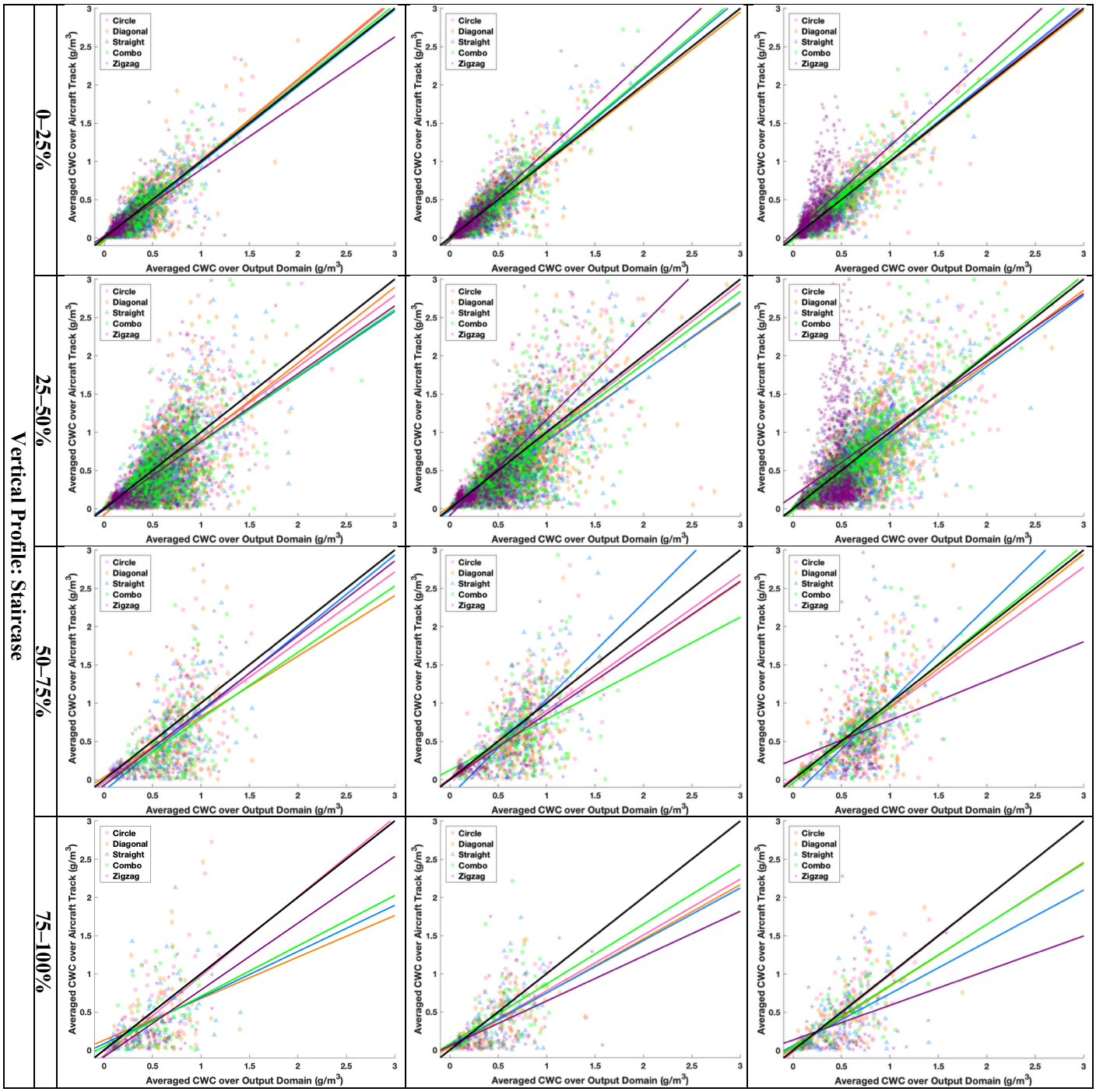

Vertical Profile: Staircase
0–25%
25–50%
50–75%
75–100%
Circle
Diagonal
Straight
Combo
Zigzag
Averaged CWC over Aircraft Track (g/m3)
Averaged CWC over Output Domain (g/m3)

Table S1. Summary statistics of simulated cloud-base and cloud-top heights for all analyzed LASSO cases.

Date	Cloud Base (m)				Cloud Top (m)			
	Min	Max	Mean	STD	Min	Max	Mean	STD
20150606	1698.21	2167.86	1996.90	148.75	1972.36	7541.67	2682.00	1530.43
20150609	2034.38	2441.74	2292.46	106.63	2441.74	5064.68	4148.28	634.49
20150627	1873.71	2217.42	2108.62	94.28	2145.53	2849.50	2595.47	210.96
20150801	1000.87	3977.13	1230.67	487.68	1158.20	5347.84	4199.13	1057.31
20150829	876.91	1421.27	1258.67	172.77	1931.69	2653.03	2305.08	169.72
20160518	937.69	1647.33	1354.10	236.57	1450.45	2599.41	2296.27	287.28
20160530	1032.03	1375.44	1175.79	110.54	5535.42	8944.48	7070.01	1071.53
20160610	1677.42	2479.79	2236.73	223.35	2571.03	5682.86	4140.61	1264.47
20160611	1647.54	2088.10	1955.26	145.33	2588.13	6058.92	4046.85	1022.84
20160614	3128.33	5232.15	4136.59	583.55	3427.78	9110.73	6152.88	1493.96
20160619	1252.38	1906.96	1671.27	203.20	2699.49	4000.37	3439.44	237.80
20160625	1737.08	2351.33	2156.94	187.07	2338.42	2737.55	2503.52	85.20
20160716	1532.56	2556.94	2102.13	310.30	2678.66	6305.39	4705.42	1119.31
20160719	1736.24	2241.04	2015.58	155.41	2435.43	4048.08	3433.98	375.75
20160720	1982.36	2452.42	2308.26	146.86	2635.56	4052.02	3549.74	380.95
20160818	911.94	1476.76	1291.07	190.34	1736.62	2450.42	2101.59	186.66
20160819	1466.79	2054.52	1864.99	170.25	4377.22	6217.73	5232.77	511.97
20160830	971.89	1559.37	1315.25	184.93	1620.46	5815.24	4271.72	795.09
20170403	902.99	1577.86	1334.88	210.30	1477.28	1908.13	1693.58	108.60
20170405	1380.17	1860.65	1665.12	165.70	3410.50	5181.89	4318.52	546.76
20170509	1545.99	1982.99	1861.03	137.25	2043.73	2819.15	2517.13	207.50
20170524	1385.20	1613.11	1504.16	76.58	1613.11	1964.32	1809.01	95.21
20170527	1695.74	2820.03	2574.91	247.11	1875.53	6319.00	3636.53	987.07
20170605	1220.37	1755.04	1561.56	162.15	4153.08	4955.49	4478.91	183.22
20170609	1460.40	1873.89	1725.75	128.09	2191.06	3334.64	2719.07	312.74
20170614	1520.60	2852.35	2332.27	421.86	2607.15	6686.39	5295.94	881.68
20170626	1790.00	2350.17	2181.72	164.03	4349.36	5217.63	4836.96	214.23
20170627	1314.62	2427.92	1928.99	340.95	5295.17	7271.10	6175.01	549.28
20170629	1498.92	2145.45	1998.51	175.40	1529.27	2205.05	2032.59	178.49
20170630	693.46	3040.37	1351.29	579.68	6061.14	9826.15	8358.77	1041.97
20170704	1122.49	1500.40	1339.95	124.57	1675.77	5947.67	2909.96	1839.30
20170705	1064.90	1836.68	1574.75	233.01	2776.05	3428.09	3068.90	180.51
20170709	1743.27	2053.71	1956.38	99.59	1834.27	2386.78	2132.33	165.78
20170712	2030.07	2217.20	2177.23	50.79	2060.34	3364.40	2904.24	387.11
20170716	1403.21	2207.30	1940.81	253.70	3239.04	4601.80	3878.25	334.20
20170717	1738.67	2486.55	2236.79	228.13	2760.90	4216.43	3592.42	411.62

20170719	1857.81	2384.82	2200.52	157.86	2192.54	2922.24	2574.05	167.51
20170720	2189.78	2836.07	2617.93	200.78	2311.24	4552.33	4006.60	584.99
20170721	2248.42	2836.22	2615.99	190.88	3140.34	5275.07	4512.37	438.04
20170725	1740.02	2364.24	2157.40	198.95	2408.61	3545.76	3338.28	211.42
20170728	1125.14	1619.29	1436.77	138.68	3245.76	6404.76	5005.15	796.56
20170802	1432.54	2152.76	1873.44	226.91	3364.69	4442.11	3921.73	288.43
20170826	908.25	1438.59	1245.29	169.29	3885.86	4683.39	4325.56	176.24
20170828	1630.68	2204.59	1996.78	171.79	2204.38	2715.24	2500.80	138.25
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20170923	1639.88	2229.34	2012.29	184.48	2186.08	3970.38	3285.41	565.30
20170924	1306.28	1924.80	1682.43	192.84	3612.25	5350.43	4331.93	413.99
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20180522	1523.58	2232.98	1936.20	225.50	2398.93	5464.06	4166.72	782.21
20180523	1674.37	2202.55	2009.86	169.36	4509.34	6307.57	5421.87	458.50
20180529	3492.96	4091.09	3724.04	208.19	4900.03	6399.02	5996.42	293.73
20180530	1798.95	5325.14	2141.11	674.50	1830.13	8095.82	5359.67	2134.33
20180531	2115.10	2357.94	2213.03	78.82	2174.32	2598.66	2444.22	132.69
20180606	1652.59	2664.91	2258.59	320.24	2677.39	5632.53	4255.99	824.44
20180618	1312.55	1904.42	1730.74	166.56	2348.77	5019.75	3680.21	550.31
20180619	1488.99	2202.19	1916.57	222.86	2158.04	5743.94	2624.21	774.38
20180704	1372.29	1901.91	1649.02	174.18	1555.26	2413.48	2155.37	258.54
20180705	1370.89	1966.08	1748.86	193.40	3456.17	4503.49	3827.98	233.43
20180707	1402.16	2234.52	1856.64	259.60	3641.07	5631.86	4859.72	533.12
20180709	1674.16	1963.02	1872.59	88.69	2917.75	3929.23	3480.77	283.75
20180710	1432.33	1905.70	1735.04	134.79	4532.15	9225.38	6826.71	1347.59
20180711	1860.33	2336.56	2161.35	136.59	4740.13	10021.99	6861.75	1356.44
20180712	1861.89	2305.79	2153.49	141.76	5245.07	7944.14	6571.86	623.70
20180731	1452.49	1825.41	1732.32	108.05	3509.46	4757.98	4186.44	270.00
20180811	1519.53	2165.16	1949.73	230.28	1641.22	6302.48	4295.75	1063.56
20180901	1945.78	2315.44	2174.83	91.72	1975.94	2434.08	2242.09	108.73
20180911	940.22	1682.65	1384.32	223.87	2365.25	2856.30	2575.48	107.11
20180914	1248.70	1534.22	1446.83	88.00	3041.22	4380.54	3563.86	315.54
20180916	1424.97	1830.37	1668.78	119.85	2064.65	6632.68	5171.03	1326.92
20180917	1366.03	1740.05	1602.70	115.84	1739.86	4557.33	3422.99	653.30
20180918	1580.61	1894.40	1797.62	99.63	3102.13	5206.06	3887.77	336.37
20181001	1128.53	1929.75	1668.20	247.65	2807.65	3252.44	2989.80	101.96
20181002	1340.05	1991.63	1750.90	190.38	2657.96	8096.90	6249.16	2154.03
20190404	320.24	749.06	537.96	158.93	1137.19	1476.66	1372.08	89.88

20190506	171.02	1505.87	586.82	288.68	3722.26	9132.60	7146.70	1659.39
20190512	2200.73	2577.16	2406.02	94.79	2349.31	3410.76	3184.68	234.63
20190517	1274.41	1340.44	1303.15	15.61	1792.31	2037.21	1900.57	78.19
20190607	1303.60	1677.39	1545.54	113.86	1849.21	2917.39	2490.27	294.28
20190612	1535.15	2053.69	1889.08	145.87	2498.77	3044.93	2822.73	135.66
20190617	1124.85	1471.43	1353.94	112.09	2021.57	2529.33	2277.24	129.98
20190626	1190.92	1834.92	1599.60	195.59	1864.68	2946.02	2166.06	345.94
20190701	1427.79	1710.46	1624.87	82.99	2035.07	3374.72	2684.48	319.56
20190704	1125.78	1623.47	1451.79	152.29	1187.18	2202.81	1832.09	266.66
20190707	881.22	1468.79	1271.11	180.96	2927.57	4278.82	3750.84	272.19
20190709	1250.63	1785.45	1599.43	173.50	1433.99	4278.89	1888.56	436.86
20190714	1124.77	1680.03	1492.54	175.16	2468.92	3216.39	3000.93	147.69
20190804	1032.05	1407.35	1285.64	120.33	2960.20	3982.16	3710.95	225.89
20190805	1402.57	1897.13	1723.28	160.53	1897.04	3375.29	2938.35	287.02
20190901	727.37	1102.78	982.23	115.45	850.10	2447.29	1783.50	523.23
20190929	817.74	1161.67	1040.94	113.13	1466.24	6417.79	3631.91	1613.68

Table S2. Statistical metrics describing sampling representativeness across different cloud fraction (CF) categories and sampling configurations.

CF Category	Vertical Profile	Speed	Horizontal Pattern	Slope	Intercept ($g\ m^{-3}$)	*r*
0–25% (39 cases)	Level-leg	Slow	Circle	0.94	-0.01	0.76
			Diagonal	0.89	0.01	0.72
			Straight	0.95	-0.01	0.75
			Combo	0.96	-0.01	0.74
		Moderate	Circle	0.90	0.02	0.82
			Diagonal	0.92	0.01	0.82
			Straight	0.90	0.01	0.80
			Combo	0.93	0.01	0.84
		Fast	Circle	0.96	0.01	0.86
			Diagonal	0.97	0.00	0.85
			Straight	0.99	0.00	0.85
			Combo	0.95	0.01	0.87
	Sine wave	Slow	Circle	0.98	-0.02	0.77
			Diagonal	1.05	-0.03	0.76
			Straight	1.03	-0.02	0.77
			Combo	1.16	-0.05	0.80
		Moderate	Circle	1.11	-0.04	0.85
			Diagonal	1.01	-0.01	0.84
			Straight	1.04	-0.03	0.86
			Combo	1.01	-0.01	0.85
		Fast	Circle	1.06	-0.02	0.88
			Diagonal	0.97	-0.01	0.87
			Straight	0.99	-0.01	0.89
			Combo	1.09	-0.03	0.89
	Staircase	Slow	Circle	1.05	-0.04	0.78
			Diagonal	1.06	-0.04	0.75
			Straight	1.00	-0.02	0.78
			Combo	1.02	-0.03	0.79
		Moderate	Circle	1.01	-0.01	0.87
			Diagonal	0.98	0.00	0.84
			Straight	1.06	-0.04	0.82
			Combo	1.07	-0.03	0.84
		Fast	Circle	1.01	-0.01	0.89
			Diagonal	0.99	-0.01	0.88
			Straight	1.03	-0.02	0.86
			Combo	1.08	-0.02	0.90
	Zigzag	Slow		0.87	0.02	0.71
		Moderate		1.17	-0.04	0.80
		Fast		1.15	0.05	0.60

CF Category	Vertical Profile	Speed	Horizontal Pattern	Slope	Intercept (g m^{-3})	*r*
25–50% (42 cases)	Level-leg	Slow	Circle	0.69	0.09	0.43
			Diagonal	0.87	0.01	0.46
			Straight	0.86	0.01	0.45
			Combo	0.77	0.05	0.46
		Moderate	Circle	0.87	0.04	0.63
			Diagonal	0.79	0.06	0.62
			Straight	0.72	0.09	0.47
			Combo	0.78	0.08	0.58
		Fast	Circle	0.84	0.06	0.68
			Diagonal	0.78	0.06	0.60
			Straight	0.80	0.06	0.57
			Combo	0.84	0.07	0.67
	Sine wave	Slow	Circle	1.00	-0.08	0.55
			Diagonal	0.85	-0.03	0.52
			Straight	0.93	-0.04	0.53
			Combo	0.98	-0.07	0.55
		Moderate	Circle	0.99	-0.05	0.67
			Diagonal	0.97	-0.05	0.60
			Straight	0.99	-0.08	0.61
			Combo	1.00	-0.08	0.66
		Fast	Circle	1.08	-0.09	0.70
			Diagonal	1.07	-0.11	0.68
			Straight	1.07	-0.09	0.68
			Combo	1.01	-0.06	0.71
	Staircase	Slow	Circle	0.93	-0.02	0.63
			Diagonal	0.99	-0.08	0.52
			Straight	0.86	0.01	0.56
			Combo	0.87	0.00	0.53
		Moderate	Circle	0.98	-0.01	0.74
			Diagonal	0.88	0.03	0.65
			Straight	0.91	-0.03	0.62
			Combo	0.95	0.00	0.63
		Fast	Circle	1.03	-0.03	0.80
			Diagonal	0.96	-0.01	0.76
			Straight	0.93	0.00	0.68
			Combo	1.03	-0.03	0.77
	Zigzag	Slow		0.89	-0.01	0.61
		Moderate		1.25	-0.09	0.75
		Fast		0.88	0.16	0.22

CF Category	Vertical Profile	Speed	Horizontal Pattern	Slope	Intercept (g m^{-3})	*r*
50–75% (7 cases)	Level-leg	Slow	Circle	0.64	0.15	0.38
			Diagonal	0.81	0.03	0.39
			Straight	0.87	-0.02	0.47
			Combo	0.69	0.08	0.41
		Moderate	Circle	0.74	0.09	0.59
			Diagonal	0.98	-0.04	0.68
			Straight	0.81	0.05	0.57
			Combo	0.94	-0.01	0.66
		Fast	Circle	0.92	0.01	0.74
			Diagonal	0.87	0.03	0.67
			Straight	0.92	0.01	0.70
			Combo	0.93	0.02	0.71
	Sine wave	Slow	Circle	1.08	-0.19	0.52
			Diagonal	0.91	-0.07	0.33
			Straight	0.92	-0.06	0.53
			Combo	0.72	0.01	0.26
		Moderate	Circle	0.94	-0.05	0.53
			Diagonal	0.83	-0.02	0.47
			Straight	0.81	-0.03	0.54
			Combo	0.72	0.04	0.50
		Fast	Circle	0.80	0.01	0.55
			Diagonal	1.13	-0.17	0.65
			Straight	0.84	-0.03	0.64
			Combo	1.11	-0.15	0.69
	Staircase	Slow	Circle	0.92	-0.04	0.52
			Diagonal	0.79	0.03	0.41
			Straight	1.03	-0.15	0.59
			Combo	0.87	-0.07	0.39
		Moderate	Circle	0.89	0.01	0.70
			Diagonal	0.86	0.00	0.55
			Straight	1.27	-0.22	0.64
			Combo	0.67	0.12	0.40
		Fast	Circle	0.92	0.02	0.71
			Diagonal	1.00	-0.04	0.60
			Straight	1.24	-0.22	0.67
			Combo	1.04	-0.05	0.74
	Zigzag	Slow		0.98	-0.07	0.58
		Moderate		0.87	-0.01	0.64
		Fast		0.51	0.26	0.16

CF Category	Vertical Profile	Speed	Horizontal Pattern	Slope	Intercept (g m^{-3})	*r*
75–100% (3 cases)	Level-leg	Slow	Circle	1.36	-0.11	0.61
			Diagonal	0.55	0.15	0.40
			Straight	0.60	0.13	0.53
			Combo	1.45	-0.18	0.40
		Moderate	Circle	1.04	-0.01	0.74
			Diagonal	0.53	0.13	0.59
			Straight	0.47	0.13	0.50
			Combo	0.66	0.09	0.82
		Fast	Circle	0.97	0.02	0.82
			Diagonal	0.99	-0.02	0.70
			Straight	0.66	0.09	0.70
			Combo	0.77	0.09	0.71
	Sine wave	Slow	Circle	0.78	0.00	0.54
			Diagonal	0.27	0.21	0.27
			Straight	0.51	0.14	0.34
			Combo	0.70	0.06	0.46
		Moderate	Circle	0.78	0.05	0.52
			Diagonal	0.45	0.16	0.52
			Straight	0.54	0.16	0.45
			Combo	0.55	0.14	0.49
		Fast	Circle	0.90	-0.01	0.66
			Diagonal	0.76	0.06	0.63
			Straight	0.29	0.26	0.42
			Combo	0.60	0.13	0.51
	Staircase	Slow	Circle	1.04	-0.07	0.61
			Diagonal	0.54	0.13	0.32
			Straight	0.60	0.08	0.62
			Combo	0.66	0.05	0.41
		Moderate	Circle	0.73	0.04	0.69
			Diagonal	0.71	0.04	0.70
			Straight	0.69	0.06	0.51
			Combo	0.78	0.08	0.65
		Fast	Circle	1.01	-0.02	0.77
			Diagonal	0.81	0.03	0.72
			Straight	0.68	0.06	0.62
			Combo	0.80	0.05	0.76
	Zigzag	Slow		0.87	-0.09	0.45
		Moderate		0.59	0.05	0.47
		Fast		0.45	0.14	0.19

Table S3. Comparison of sampling representativeness for the moderate-speed zigzag configuration across the two LASSO domain sizes. The 2015–2016 cases correspond to the 14.4 × 14.4 km Alpha 2 domain, while the 2017–2019 cases correspond to the 25 × 25 km Version 1 domain. Annual results are also provided to illustrate variability within the larger-domain configuration.

Period	Domain size	Case Number	*r*	nBias	nRMSE	Sample mean (g m^{-3})	Domain mean (g m^{-3})
2015–2016	14.4 × 14.4 km	18	0.67	-0.01	0.79	0.41	0.41
2017–2019	25 × 25 km	73	0.76	0.03	0.75	0.42	0.41
2015	14.4 × 14.4 km	5	0.76	0.02	0.67	0.35	0.34
2016	14.4 × 14.4 km	13	0.64	-0.02	0.81	0.43	0.43
2017	25 × 25 km	30	0.74	0.04	0.76	0.43	0.41
2018	25 × 25 km	26	0.74	0.03	0.76	0.49	0.47
2019	25 × 25 km	17	0.80	0.00	0.66	0.34	0.34