

1 **Airborne eddy covariance measurements of ocean-air VOC fluxes: Distinguishing signal from noise**

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3 ***Supplementary Information***

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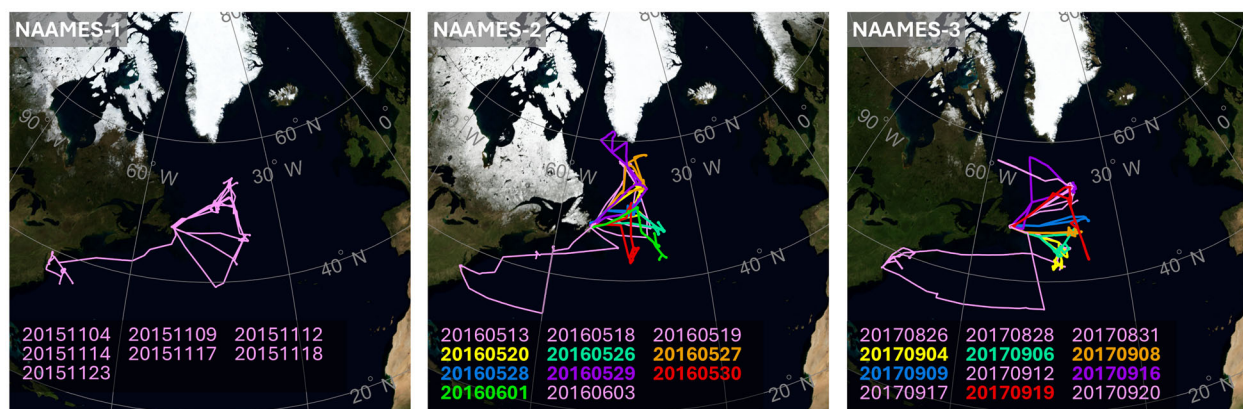


Figure S1. Flight tracks for NAAMES-1, 2, and 3. Flux-relevant flights apply the same color coding as in **Fig. 1**. Light purple shades indicate flights without suitable flux legs. No science flights were conducted during NAAMES-4 due to an aircraft mechanical issue. Imagery is © 2004 NASA Earth Observatory (Blue Marble: Next Generation).

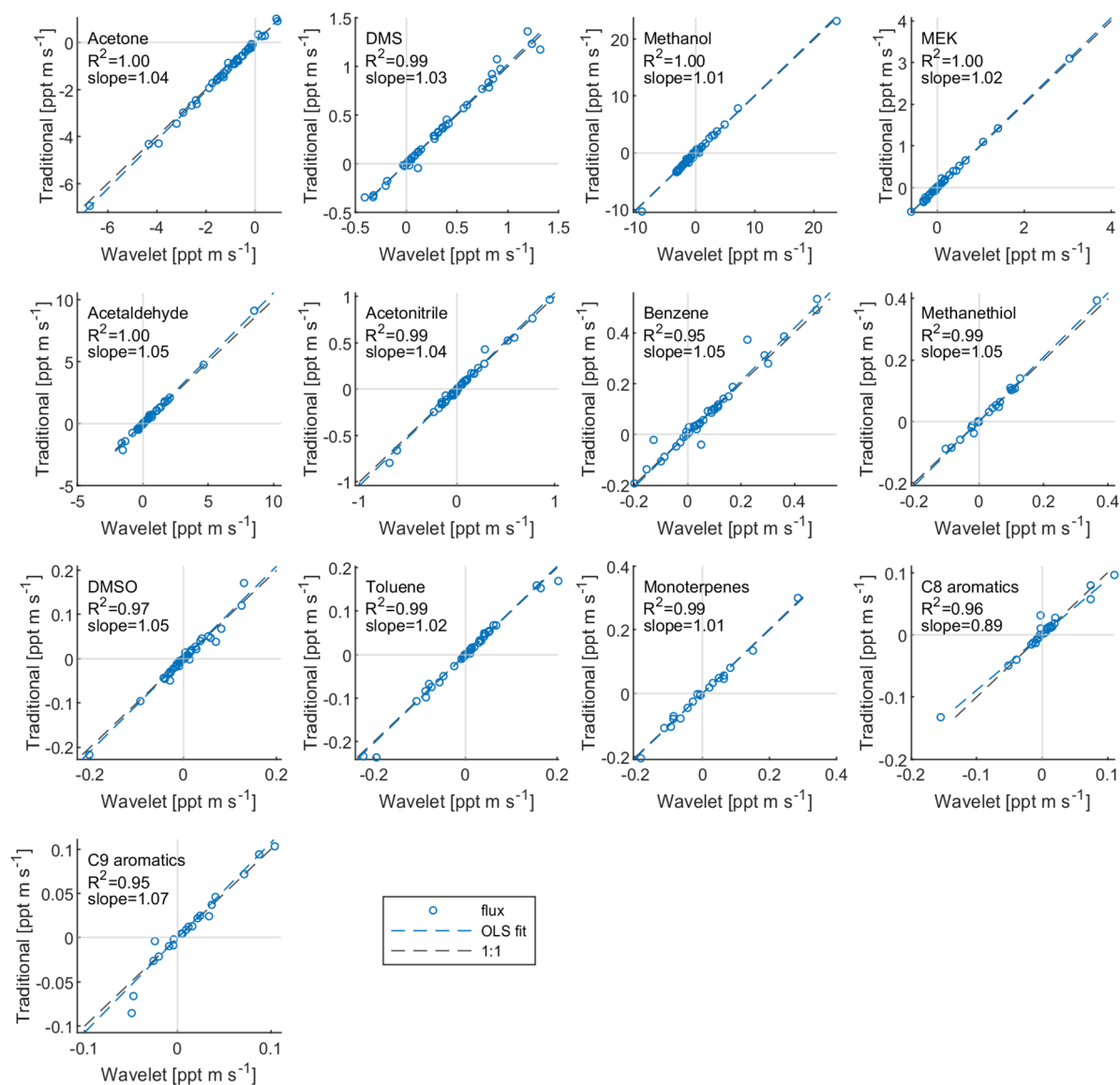
15 **Table S1.** NAAMES flux window summary

Flight	Flight leg #	Flux window [seconds past midnight UTC]	Duration	Altitude $\pm 2\sigma$ [m]	Pitch degree [min, max]	Roll degree [min, max]	Heading degree [min, max]	Airspeed [m/s]	P [hPa]	T [K]	Horizontal wind speed [m/s]	Flux leg length [m]	95% eddy scale* [m]
20160520	L1	[49540, 49790]	4'10"	145 $\pm$ 11	[0.65, 2.91]	[-2.14, 2.13]	[173.76, 181.88]	120	998	277	9	3.0 $\times$ 10 ⁴	n/a
	L2	[49870, 50206]	5'36"	142 $\pm$ 9	[0.72, 5.13]	[-3.75, 2.16]	[151.89, 157.41]	112	999	278	10	3.8 $\times$ 10 ⁴	n/a
20160526	L1	[51158, 51468]	5'10"	146 $\pm$ 21	[0.40, 4.07]	[-4.52, 4.69]	[320.04, 328.42]	142	1006	288	12	4.4 $\times$ 10 ⁴	n/a
	L2	[59880, 60415]	8'55"	196 $\pm$ 14	[0.36, 3.35]	[-3.96, 2.91]	[302.77, 308.02]	135	997	288	12	7.2 $\times$ 10 ⁴	n/a
	L3	[61280, 61720]	7'20"	198 $\pm$ 21	[-0.47, 2.72]	[-4.14, 3.67]	[301.30, 307.50]	140	994	286	11	6.2 $\times$ 10 ⁴	9-10 $\times$ 10 ³
	L4	[61834, 62008]	2'54"	126 $\pm$ 13	[-0.20, 2.40]	[-3.94, 6.05]	[301.73, 309.41]	143	1001	286	11	2.5 $\times$ 10 ⁴	n/a
	L5	[62070, 62420]	5'50"	191 $\pm$ 17	[-0.49, 2.17]	[-3.87, 4.00]	[301.13, 308.97]	140	993	285	11	4.9 $\times$ 10 ⁴	n/a
	L6	[64000, 64765]	12'45"	179 $\pm$ 25	[-0.91, 2.42]	[-7.82, 5.75]	[297.72, 306.98]	138	990	280	12	1.1 $\times$ 10 ⁵	8-9 $\times$ 10 ³
	L7	[65200, 65400]	3'20"	130 $\pm$ 15	[-0.33, 1.82]	[-6.52, 4.96]	[204.06, 209.20]	140	996	279	12	2.8 $\times$ 10 ⁴	n/a
	L1	[46400, 46758]	5'58"	137 $\pm$ 12	[0.44, 2.73]	[-2.86, 3.46]	[138.66, 143.66]	133	1003	276	14	4.8 $\times$ 10 ⁴	2-3 $\times$ 10 ⁴
	L2	[46857, 48271]	23'34"	151 $\pm$ 17	[0.23, 3.01]	[-3.99, 5.32]	[138.03, 144.24]	134	1002	276	14	1.9 $\times$ 10 ⁵	6-7 $\times$ 10 ³
	L3	[48390, 48816]	7'06"	152 $\pm$ 19	[0.29, 2.24]	[-4.65, 5.14]	[138.62, 143.58]	134	1002	276	13	5.7 $\times$ 10 ⁴	2-3 $\times$ 10 ³
	L4	[50012, 50265]	4'13"	152 $\pm$ 15	[0.05, 3.95]	[-3.19, 5.14]	[180.32, 184.77]	132	1001	277	13	3.3 $\times$ 10 ⁴	1-2 $\times$ 10 ⁴
	L1	[50120, 50610]	8'10"	143 $\pm$ 20	[0.63, 3.69]	[-3.35, 3.34]	[82.50, 89.93]	137	1010	278	6	6.7 $\times$ 10 ⁴	4-5 $\times$ 10 ³
	L2	[58430, 59600]	19'30"	145 $\pm$ 19	[-0.74, 2.03]	[-2.60, 4.67]	[26.14, 35.63]	140	1009	278	2	1.6 $\times$ 10 ⁵	9-10 $\times$ 10 ³
	L3	[60500, 60938]	7'18"	138 $\pm$ 11	[0.01, 1.63]	[-2.33, 3.48]	[40.69, 46.58]	143	1010	278	3	6.2 $\times$ 10 ⁴	3-4 $\times$ 10 ³
20160529	L1	[45380, 45900]	8'40"	140 $\pm$ 11	[0.35, 2.37]	[-1.27, 2.96]	[34.84, 38.53]	143	1006	279	6	7.5 $\times$ 10 ⁴	1-2 $\times$ 10 ⁴
	L2	[46200, 46900]	11'40"	153 $\pm$ 14	[-0.12, 2.43]	[-1.79, 4.24]	[35.35, 39.67]	143	1005	278	6	1.0 $\times$ 10 ⁵	3-4 $\times$ 10 ³
	L3	[47960, 49450]	24'50"	152 $\pm$ 13	[0.26, 2.48]	[-2.17, 4.15]	[36.07, 41.47]	141	1007	278	3	2.1 $\times$ 10 ⁵	4-5 $\times$ 10 ³
	L1	[56392, 56589]	3'17"	162 $\pm$ 18	[1.12, 3.70]	[-4.05, 3.44]	[100.82, 108.70]	118	994	283	24	2.3 $\times$ 10 ⁴	2-3 $\times$ 10 ³
20160601	L1	[55860, 57130]	21'10"	139 $\pm$ 15	[-0.47, 2.60]	[-2.16, 3.88]	[320.69, 326.61]	142	999	285	3	1.8 $\times$ 10 ⁵	1-2 $\times$ 10 ⁴
	L2	[60840, 61600]	12'40"	150 $\pm$ 19	[-0.51, 2.15]	[-3.54, 4.76]	[170.95, 180.50]	155	996	285	6	1.2 $\times$ 10 ⁵	1-2 $\times$ 10 ⁴
	L3	[62530, 63140]	10'10"	144 $\pm$ 23	[-0.54, 2.12]	[-3.10, 4.57]	[308.66, 317.12]	146	997	285	3	8.9 $\times$ 10 ⁴	1-2 $\times$ 10 ³
	L4	[65420, 66550]	18'50"	136 $\pm$ 16	[-1.16, 1.72]	[-3.54, 3.97]	[349.52, 355.78]	157	996	282	4	1.8 $\times$ 10 ⁵	4-5 $\times$ 10 ³
	L5	[67340, 67850]	8'30"	137 $\pm$ 14	[-0.55, 1.87]	[-3.73, 3.73]	[349.78, 353.69]	154	996	281	2	7.9 $\times$ 10 ⁴	7-8 $\times$ 10 ³
	L6	[68630, 69340]	11'50"	139 $\pm$ 19	[-1.16, 1.92]	[-3.05, 4.07]	[348.62, 353.78]	154	996	280	1	1.1 $\times$ 10 ⁵	n/a
20170904	L1	[51461, 51630]	2'49"	144 $\pm$ 34	[-0.14, 2.29]	[-2.95, 1.92]	[46.66, 52.18]	121	1011	292	1	2.0 $\times$ 10 ⁴	2-3 $\times$ 10 ³
20170906	L1	[44570, 45066]	8'16"	135 $\pm$ 16	[0.47, 2.93]	[-3.77, 4.55]	[142.61, 149.90]	127	1020	291	6	6.3 $\times$ 10 ⁴	8-9 $\times$ 10 ³
	L2	[45410, 45690]	4'40"	144 $\pm$ 18	[0.32, 2.25]	[-3.64, 3.54]	[51.03, 55.30]	129	1019	291	6	3.6 $\times$ 10 ⁴	n/a
	L3	[45960, 46686]	12'06"	142 $\pm$ 20	[-0.16, 4.03]	[-5.16, 5.45]	[320.08, 325.05]	124	1019	292	5	9.0 $\times$ 10 ⁴	1-2 $\times$ 10 ³
	L4	[47520, 47900]	6'20"	143 $\pm$ 19	[0.42, 2.42]	[-3.64, 3.33]	[233.28, 236.97]	121	1019	292	3	4.6 $\times$ 10 ⁴	2-3 $\times$ 10 ³
	L5	[48970, 49240]	4'30"	219 $\pm$ 15	[0.13, 2.27]	[-4.21, 2.51]	[145.33, 149.23]	133	1010	292	7	3.6 $\times$ 10 ⁴	3-4 $\times$ 10 ³
	L6	[49500, 49800]	5'00"	134 $\pm$ 19	[-1.23, 3.18]	[-5.85, 7.24]	[322.2, 327.90]	123	1020	290	2	3.7 $\times$ 10 ⁴	n/a
	L7	[56120, 56570]	7'30"	137 $\pm$ 29	[-0.67, 2.10]	[-2.15, 4.14]	[319.12, 322.72]	124	1020	293	3	5.6 $\times$ 10 ⁴	n/a
	L8	[56807, 57785]	16'18"	145 $\pm$ 27	[-1.23, 3.16]	[-7.87, 5.76]	[311.55, 322.94]	126	1018	290	5	1.2 $\times$ 10 ⁵	1-2 $\times$ 10 ⁴
20170908	L1	[49935, 50200]	4'25"	133 $\pm$ 14	[0.01, 3.52]	[-2.93, 2.57]	[338.38, 342.67]	128	1019	294	8	3.4 $\times$ 10 ⁴	1-2 $\times$ 10 ³
	L2	[58041, 58800]	12'39"	142 $\pm$ 19	[-0.92, 2.41]	[-2.13, 8.27]	[2.32, 11.88]	135	1018	293	10	1.0 $\times$ 10 ⁵	4-5 $\times$ 10 ³
20170909	L1	[53290, 53750]	7'40"	134 $\pm$ 17	[0.22, 2.35]	[-3.49, 2.89]	[185.86, 192.44]	116	1018	293	13	5.3 $\times$ 10 ⁴	1-2 $\times$ 10 ³
20170916	L1	[46136, 46375]	3'59"	147 $\pm$ 16	[0.02, 3.19]	[-2.14, 2.50]	[164.23, 166.82]	123	1001	285	10	2.9 $\times$ 10 ⁴	n/a
	L2	[54211, 54630]	6'59"	142 $\pm$ 16	[0.03, 2.64]	[-5.55, 5.20]	[310.65, 324.97]	118	1000	284	7	4.9 $\times$ 10 ⁴	2-3 $\times$ 10 ⁴
	L3	[56012, 56492]	8'00"	141 $\pm$ 19	[-0.13, 2.44]	[-3.93, 3.94]	[310.34, 317.72]	117	997	283	7	5.6 $\times$ 10 ⁴	2-3 $\times$ 10 ³
	L1	[56949, 57225]	4'36"	154 $\pm$ 23	[-0.39, 2.28]	[-3.29, 5.10]	[330.64, 342.64]	114	1012	288	10	3.1 $\times$ 10 ⁴	8-9 $\times$ 10 ³

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	L2	[58436, 58803]	6'07"	149±18	[-0.77, 2.43]	[-6.55, 4.89]	[337.99, 345.21]	112	1011	286	12	4.1×10 ⁴	9-10×10 ³
	L3	[60070, 60420]	5'50"	147±15	[-1.10, 3.14]	[-3.04, 4.14]	[336.24, 344.28]	111	1010	284	12	3.9×10 ⁴	8-9×10 ³

*From the cumulative FFT cospectral power (short to long wavelengths), with 100 s moving-average mean removal applied to the VOCs.



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18 **Figure S2.** Traditional versus wavelet-based EC fluxes for individual VOCs.

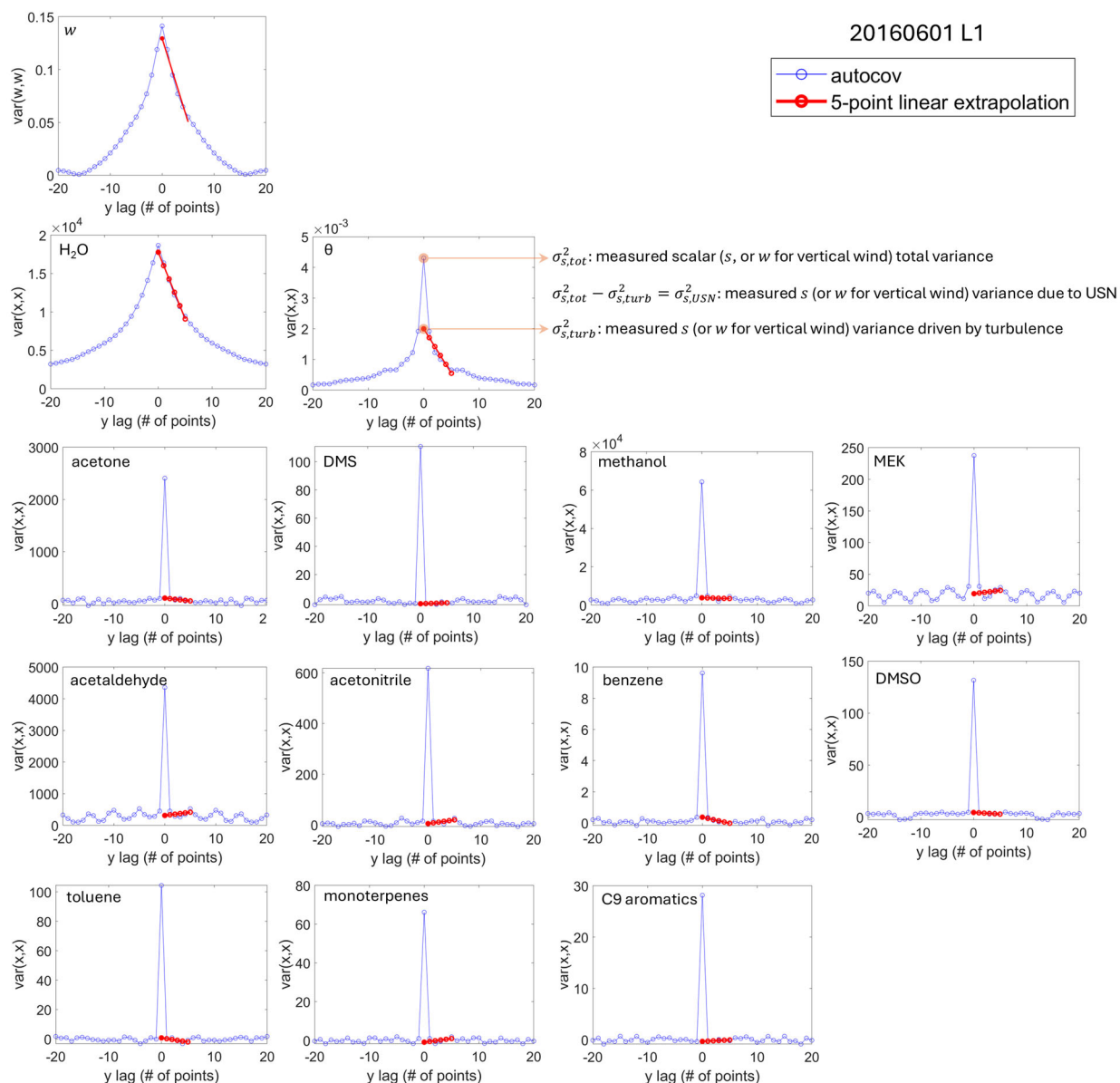


Figure S3. Autocovariance partitioning of the measured vertical wind and scalar variability. Data are shown for example flux leg 20160601 L1 and are representative of most NAAMES cases. Different y-axis scales reflect disparate scalar concentration magnitudes. Results indicate that the observed concentration variance for VOCs is largely driven by uncorrelated sensor noise (USN) rather than by atmospheric processes.

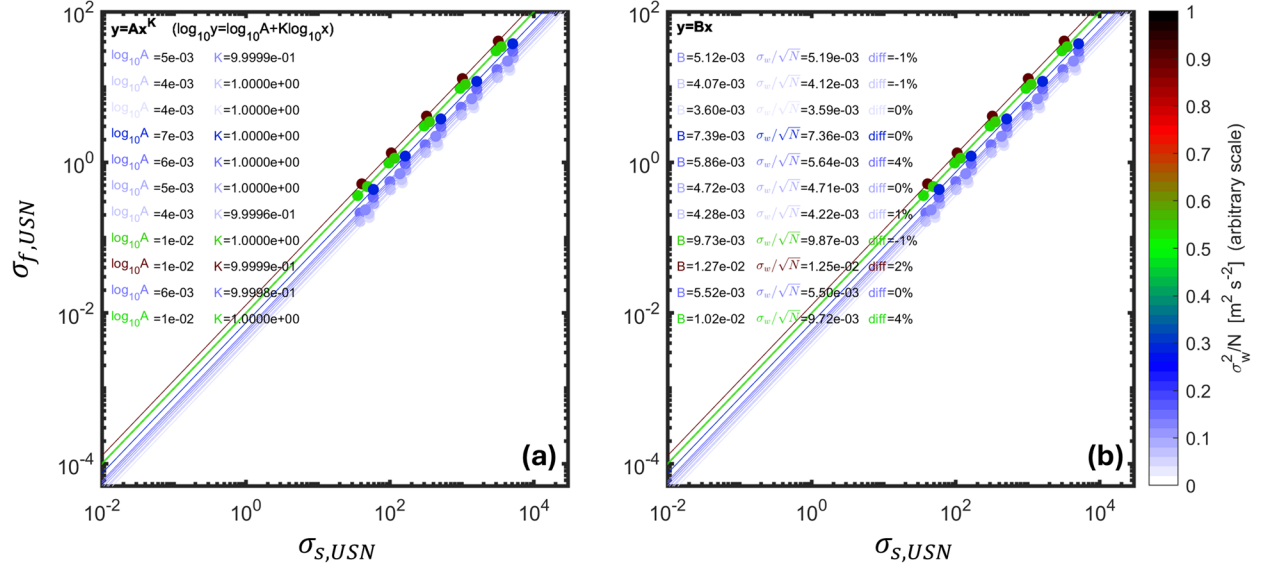


Figure S4. (a) Power linear regression between $\sigma_{f,USN}$ and $\sigma_{s,USN}$ based on the noise perturbation experiment. (b) Linear regression (with forced-zero intercept) between the same quantities. Here, $\sigma_{s,USN}$ is estimated via autocovariance analysis and $\sigma_{f,USN}$ is estimated via LLW as described in the main text. Each plotted value reflects the mean across all 500 ensemble members (standard deviations are smaller than the data points and thus not visible).

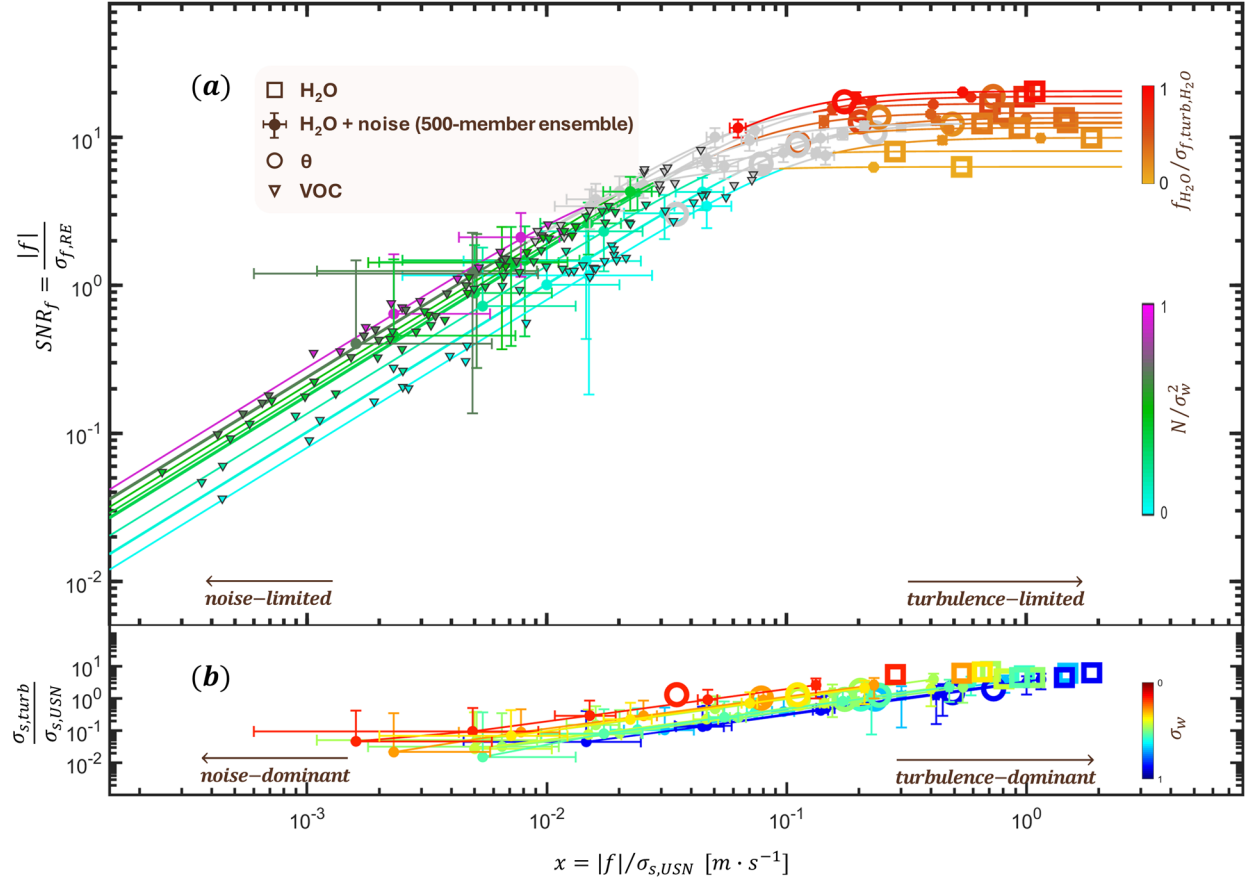


Figure S5. Same as **Fig. 7** but with panel (a) on a log-log scale.