

Supplemental Information

Intercomparison of Sensible and Latent Heat Flux Measurements from Combined Eddy Covariance, Energy Balance, and Bowen Ratio Methods Above a Grassland Prairie

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Tables S1-S5 provide regression statistics binned by seasonal and atmospheric conditions.

Table S6 compares resource considerations for the methods presented herein.

Table S1	Regression results for comparisons as a function of season or day of year (DOY). Intercepts and standard error of the regression have units of $W\ m^{-2}$. Note H_{MBR} equals H_{RES} and is thus not shown.
Table S2	Regression results for comparisons as a function of friction velocity (u^*). Intercepts and standard error of the regression have units of $W\ m^{-2}$. Note H_{MBR} equals H_{RES} and is thus not shown.
Table S3	Regression results for comparisons as a function of Bowen ratio (β). Intercepts and standard error of the regression have units of $W\ m^{-2}$. Note H_{MBR} equals H_{RES} and is thus not shown.
Table S4	Regression results for comparisons as a function of relative humidity (RH). Intercepts and standard error of the regression have units of $W\ m^{-2}$. Note H_{MBR} equals H_{RES} and is thus not shown.
Table S5	Regression results for comparisons as a function of wind direction (θ). Intercepts and standard error of the regression have units of $W\ m^{-2}$. Note H_{MBR} equals H_{RES} and is thus not shown.
Table S6	Summary of methods' instrumentation cost, maintenance effort required, power usage, or complexity of data processing.

Season (DOY)		Energy Balance	H(EBBR) vs H(EC)	H(RES) vs H(EC)	LE(EBBR) vs LE(EC)	LE(RES) vs LE(EC)	LE(MBR) vs LE(EC)
61-120	m	0.929 ± 0.010	1.146 ± 0.016	1.003 ± 0.006	0.808 ± 0.021	1.003 ± 0.028	0.706 ± 0.025
	b	19.9 ± 2.4	3.1 ± 2.4	-0.3 ± 0.9	-8.7 ± 2.3	-7.2 ± 3.0	-7.1 ± 2.8
	R ²	0.953	0.920	0.985	0.761	0.737	0.632
121-180	m	0.949 ± 0.008	0.838 ± 0.018	0.955 ± 0.020	0.986 ± 0.013	0.999 ± 0.016	0.887 ± 0.029
	b	25.5 ± 3.0	2.9 ± 2.0	-1.8 ± 2.2	3.3 ± 3.6	-3.6 ± 4.3	21.6 ± 7.8
	R ²	0.942	0.726	0.737	0.877	0.838	0.625
181-240	m	0.871 ± 0.013	0.800 ± 0.027	0.959 ± 0.012	0.979 ± 0.023	1.065 ± 0.024	0.663 ± 0.041
	b	32.6 ± 4.6	20.2 ± 3.5	0.3 ± 1.5	14.6 ± 5.4	-0.5 ± 5.7	67.9 ± 10.0
	R ²	0.903	0.629	0.927	0.780	0.791	0.268
241-300	m	0.903 ± 0.009	1.069 ± 0.019	1.001 ± 0.011	0.951 ± 0.023	1.079 ± 0.026	0.924 ± 0.029
	b	20.4 ± 2.3	0.0 ± 2.3	-3.2 ± 1.4	-1.6 ± 2.9	-6.2 ± 3.3	-0.8 ± 4.6
	R ²	0.949	0.849	0.933	0.745	0.741	0.586
301-365	m	0.975 ± 0.011	0.871 ± 0.016	0.979 ± 0.004	1.124 ± 0.028	1.119 ± 0.037	1.224 ± 0.046
	b	3.0 ± 1.5	14.5 ± 1.5	1.6 ± 0.4	-15.0 ± 1.4	-6.3 ± 1.9	-26.2 ± 2.3
	R ²	0.950	0.885	0.993	0.811	0.711	0.661
All	m	0.939 ± 0.004	0.978 ± 0.009	0.981 ± 0.006	1.022 ± 0.007	1.022 ± 0.008	0.924 ± 0.013
	b	16.9 ± 1.2	4.7 ± 1.1	-1.2 ± 0.7	-8.6 ± 1.3	-2.9 ± 1.5	-1.5 ± 2.5
	R ²	0.949	0.81	0.906	0.893	0.867	0.649
	Std. Err. of Reg.	41	40.8	27.3	43.8	49.6	80

Table S1

u^* (m s ⁻¹)		Energy Balance	H(EBBR) vs H(EC)	H(RES) vs H(EC)	LE(EBBR) vs LE(EC)	LE(RES) vs LE(EC)	LE(MBR) vs LE(EC)
0 – 0.2	m	0.853 ± 0.018	1.413 ± 0.039	1.015 ± 0.006	0.935 ± 0.034	1.163 ± 0.038	0.735 ± 0.034
	b	12.0 ± 2.8	0.7 ± 2.1	0.6 ± 0.3	-7.0 ± 3.4	-12.7 ± 3.7	-5.2 ± 3.5
	R ²	0.958	0.928	0.997	0.878	0.903	0.811
0.2 – 0.4	m	0.872 ± 0.006	1.136 ± 0.015	0.983 ± 0.010	1.063 ± 0.010	1.140 ± 0.012	0.780 ± 0.016
	b	12.3 ± 1.5	7.9 ± 1.3	0.6 ± 0.9	-11.3 ± 1.8	-5.9 ± 2.1	-4.1 ± 2.8
	R ²	0.965	0.866	0.919	0.921	0.909	0.713
0.4 – 0.6	m	0.924 ± 0.006	1.030 ± 0.015	0.993 ± 0.010	1.025 ± 0.012	1.018 ± 0.012	0.937 ± 0.023
	b	18.5 ± 2.0	2.9 ± 1.8	-2.4 ± 1.2	-8.5 ± 2.4	1.6 ± 2.4	0.0 ± 4.6
	R ²	0.952	0.817	0.902	0.873	0.869	0.610
> 0.6	m	0.998 ± 0.010	0.914 ± 0.020	0.996 ± 0.016	0.982 ± 0.015	0.934 ± 0.017	1.039 ± 0.034
	b	26.9 ± 2.3	-6.3 ± 3.2	-5.9 ± 2.6	-5.0 ± 3.5	-6.6 ± 3.8	6.2 ± 7.2
	R ²	0.935	0.753	0.848	0.857	0.820	0.598
All	m	0.939 ± 0.004	0.978 ± 0.009	0.981 ± 0.006	1.022 ± 0.007	1.022 ± 0.008	0.924 ± 0.013
	b	16.9 ± 1.2	4.7 ± 1.1	-1.2 ± 0.7	-8.6 ± 1.3	-2.9 ± 1.5	-1.5 ± 2.5
	R ²	0.949	0.81	0.906	0.893	0.867	0.649
	Std. Err. of Reg.	41	40.8	27.3	43.8	49.6	80.8

Table S2

Bowen ratio		Energy Balance	H(EBBR) vs H(EC)	H(RES) vs H(EC)	LE(EBBR) vs LE(EC)	LE(RES) vs LE(EC)	LE(MBR) vs LE(EC)
negative	m	1.054 ± 0.017	0.705 ± 0.043	1.007 ± 0.044	0.782 ± 0.012	0.779 ± 0.019	0.024 ± 0.039
	b	15.7 ± 1.1	0.8 ± 1.5	3.3 ± 1.5	-16.8 ± 0.9	-10.7 ± 1.4	-11.4 ± 1.0
	R ²	0.902	0.393	0.561	0.913	0.811	0.001
0 – 1	m	0.916 ± 0.007	0.927 ± 0.018	0.991 ± 0.015	0.984 ± 0.010	0.989 ± 0.012	0.824 ± 0.021
	b	25.4 ± 2.5	6.9 ± 2.0	3.9 ± 1.6	4.2 ± 2.6	8.0 ± 3.0	23.9 ± 5.0
	R ²	0.909	0.613	0.744	0.848	0.808	0.476
1 – 3	m	0.944 ± 0.011	1.060 ± 0.023	1.004 ± 0.007	0.983 ± 0.028	0.952 ± 0.028	1.067 ± 0.046
	b	14.7 ± 3.3	-3.2 ± 4.0	-3.2 ± 1.3	-4.7 ± 3.4	7.4 ± 3.4	-9.7 ± 5.7
	R ²	0.921	0.782	0.970	0.668	0.658	0.469
3 – 5	m	0.933 ± 0.019	1.046 ± 0.041	0.992 ± 0.016	0.965 ± 0.104	1.261 ± 0.121	0.944 ± 0.097
	b	15.3 ± 3.4	-6.0 ± 5.7	-1.5 ± 2.3	-6.3 ± 3.8	-12.3 ± 4.5	-10.7 ± 3.5
	R ²	0.967	0.889	0.979	0.518	0.580	0.554
> 5	m	1.333 ± 0.030	0.619 ± 0.023	0.982 ± 0.003	1.249 ± 0.078	-0.705 ± 0.107	2.156 ± 0.233
	b	21.6 ± 2.0	-4.3 ± 1.6	1.3 ± 0.2	-13.7 ± 0.9	-15.0 ± 1.3	-22.0 ± 2.9
	R ²	0.959	0.893	0.999	0.755	0.339	0.509
All	m	0.939 ± 0.004	0.978 ± 0.009	0.981 ± 0.006	1.022 ± 0.007	1.022 ± 0.008	0.924 ± 0.013
	b	16.9 ± 1.2	4.7 ± 1.1	-1.2 ± 0.7	-8.6 ± 1.3	-2.9 ± 1.5	-1.5 ± 2.5
	R ²	0.949	0.81	0.906	0.893	0.867	0.649
	Std. Err. Of Reg.	41	40.8	27.3	43.8	49.6	80.8

Table S3

Relative Humidity (%)		Energy Balance	H(EBBR) vs H(EC)	H(RES) vs H(EC)	LE(EBBR) vs LE(EC)	LE(RES) vs LE(EC)	LE(MBR) vs LE(EC)
0 – 20	m	0.944 ± 0.032	0.928 ± 0.051	1.019 ± 0.026	1.060 ± 0.034	0.999 ± 0.043	0.959 ± 0.051
	b	9.1 ± 7.8	9.3 ± 5.5	-4.6 ± 2.8	-6.7 ± 5.0	6.0 ± 6.4	1.2 ± 8.0
	R ²	0.912	0.794	0.949	0.920	0.865	0.789
20 – 40	m	0.904 ± 0.011	0.907 ± 0.020	0.978 ± 0.013	0.969 ± 0.014	0.989 ± 0.016	0.808 ± 0.027
	b	28.6 ± 3.8	16.6 ± 2.8	0.3 ± 1.7	1.7 ± 3.2	6.2 ± 3.7	21.2 ± 6.2
	R ²	0.894	0.707	0.878	0.859	0.825	0.534
40 – 60	m	0.943 ± 0.008	0.997 ± 0.018	0.990 ± 0.011	1.023 ± 0.013	0.992 ± 0.014	0.907 ± 0.026
	b	18.4 ± 2.9	2.1 ± 2.5	-3.3 ± 1.6	-7.5 ± 3.0	4.9 ± 3.2	2.5 ± 5.9
	R ²	0.930	0.772	0.895	0.865	0.839	0.568
60 – 80	m	0.938 ± 0.007	0.968 ± 0.017	0.975 ± 0.013	1.097 ± 0.015	1.068 ± 0.018	1.090 ± 0.027
	b	14.4 ± 1.6	4.1 ± 1.7	-1.2 ± 1.3	-17.5 ± 2.0	-9.9 ± 2.5	-20.0 ± 4.1
	R ²	0.960	0.830	0.890	0.885	0.837	0.679
80 – 100	m	0.970 ± 0.013	0.856 ± 0.025	0.952 ± 0.030	0.974 ± 0.029	0.935 ± 0.036	1.037 ± 0.038
	b	13.7 ± 1.1	-2.1 ± 1.0	-0.2 ± 1.2	-9.6 ± 1.5	-10.7 ± 1.9	-7.5 ± 2.2
	R ²	0.955	0.814	0.785	0.808	0.714	0.725
All	m	0.939 ± 0.004	0.978 ± 0.009	0.981 ± 0.006	1.022 ± 0.007	1.022 ± 0.008	0.924 ± 0.013
	b	16.9 ± 1.2	4.7 ± 1.1	-1.2 ± 0.7	-8.6 ± 1.3	-2.9 ± 1.5	-1.5 ± 2.5
	R ²	0.949	0.81	0.906	0.893	0.867	0.649
	Std. Err. Of Reg.	41	40.8	27.3	43.8	49.6	80.8

Table S4

Wind direction		Energy Balance	H(EBBR) vs H(EC)	H(RES) vs H(EC)	LE(EBBR) vs LE(EC)	LE(RES) vs LE(EC)	LE(MBR) vs LE(EC)
315° - 45° [N]	m	0.891 ± 0.008	1.165 ± 0.017	1.003 ± 0.006	0.948 ± 0.012	1.090 ± 0.016	0.645 ± 0.016
	b	26.9 ± 2.4	6.5 ± 2.3	1.1 ± 0.8	-16.6 ± 2.2	-14.6 ± 2.7	-1.0 ± 3.0
	R ²	0.944	0.870	0.978	0.895	0.877	0.682
45° - 135° [E]	m	0.888 ± 0.014	1.083 ± 0.020	0.984 ± 0.007	0.947 ± 0.019	1.038 ± 0.024	0.677 ± 0.020
	b	28.8 ± 4.2	11.4 ± 2.2	3.5 ± 0.7	-9.4 ± 3.9	-9.1 ± 4.8	11.0 ± 4.2
	R ²	0.926	0.901	0.985	0.885	0.859	0.747
135° - 225° [S]	m	0.956 ± 0.007	0.855 ± 0.013	0.970 ± 0.013	1.048 ± 0.010	1.001 ± 0.013	1.082 ± 0.023
	b	16.6 ± 2.1	-3.1 ± 1.7	-5.3 ± 1.7	3.4 ± 2.3	3.1 ± 2.8	16.1 ± 4.9
	R ²	0.948	0.784	0.825	0.897	0.847	0.667
225° - 315° [W]	m	0.960 ± 0.008	0.991 ± 0.013	0.991 ± 0.005	0.985 ± 0.012	0.989 ± 0.014	0.931 ± 0.015
	b	7.5 ± 2.0	9.7 ± 1.2	0.4 ± 0.5	-8.5 ± 1.9	0.3 ± 2.2	-13.5 ± 2.5
	R ²	0.959	0.912	0.984	0.919	0.893	0.870
All	m	0.939 ± 0.004	0.978 ± 0.009	0.981 ± 0.006	1.022 ± 0.007	1.022 ± 0.008	0.924 ± 0.013
	b	16.9 ± 1.2	4.7 ± 1.1	-1.2 ± 0.7	-8.6 ± 1.3	-2.9 ± 1.5	-1.5 ± 2.5
	R ²	0.949	0.81	0.906	0.893	0.867	0.649
	Std. Err. Of Reg.	41	40.8	27.3	43.8	49.6	80.8

Table S5

	Expense	Maintenance Effort	Raw Data Volume	Processing Complexity	Power usage	Accuracy / Precision	Recommended Use
EC	High	Moderate	High	Moderate	High	High	All fluxes All time scales
EBBR	Low	Low	Low	Low	Low	Moderate	Long-term all fluxes
MBR	Moderate	High	Moderate	High	Moderate	Low	Short-term H Long-term all fluxes
RES	Moderate	High	Moderate	High	Moderate	Moderate	Short-term H Long-term all fluxes

Table S6