Supplemental Information
for
Turbulent Mixing in the Benthic Biolayer of Streams

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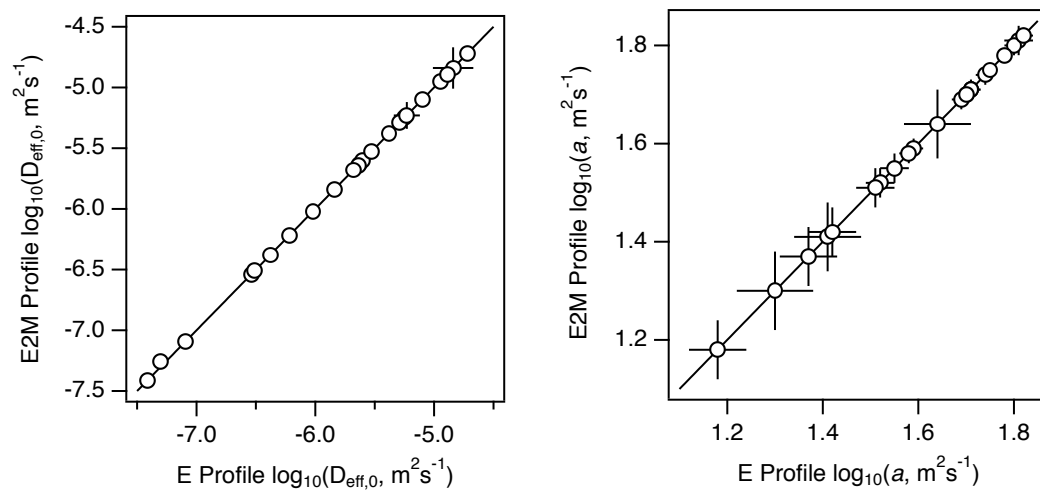
Figure S1. Log-transformed (**a**) effective diffusivities and (**b**) inverse depth scales inferred from the E2M and E Profile models. Diagonal line represents a perfect 1:1 correspondence.

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Table S1. Summary of key parameters for each experiment in Chandler et al.

Experiment Identifier	d_g (mm)	u_* (m s⁻¹)	K (m²) $\times10^{-10}$	Re_K	$C_{w,0}$, $C_{s,0}$ (ppb)	θ	V_w (m³) $\times10^{-3}$	h_w (m)	Sensors excluded	t_{final} (s)
20110330	5	0.04	112	4.31	2.3, 100	0.39	1.8	0.25	FOF1	3290
20110331	5	0.04	97	4.00	4.4, 100	0.39	1.8	0.25	FOF1	2670
20110418	5	0.04	116	4.34	3.6, 111	0.39	1.8	0.25	FOF1	6050
20110516	5	0.03	107	3.08	1.8, 104	0.39	1.9	0.26	FOF1	9160
20110523*	5	0.03	102	3.08	2.2, 108	0.39	1.9	0.26	None	2609
20110426	5	0.02	103	2.01	3.3, 104	0.39	1.8	0.25	FOF1, FOF6	6039
20110531*	5	0.02	102	2.02	2.9, 102	0.39	1.9	0.26	FOF1, FOF5	7320
20110524*	5	0.015	103	1.54	2.4, 99	0.39	1.9	0.26	None	14000
20110610*	5	0.015	108	1.60	2.8, 107	0.39	1.9	0.26	FOF6	7299
20110527*	5	0.01	109	1.05	2.1, 102	0.39	1.9	0.26	FOF1, FOF5	9000
20110613*	5	0.01	109	1.04	1.7, 100	0.39	1.9	0.26	None	44000
20110504	1.85	0.03	20.7	1.36	N/A	0.39	1.8	0.25	Cyclops, FOF1	Not analyzed
20110507	1.85	0.03	20.3	1.35	1.7, 104	0.39	1.9	0.26	None	42000
20110401	1.85	0.02	21.1	0.91	1.1, 100	0.39	1.8	0.25	None	55000
20110405	1.85	0.02	20.6	0.89	1.2, 103	0.39	1.8	0.25	None	60000
20110509	1.85	0.015	20.2	0.69	2.1, 106	0.39	1.9	0.26	FOF2	80000
20110517	1.85	0.015	19.6	0.68	1.1, 100	0.39	1.9	0.26	None	111000
20110420	1.85	0.01	20.4	0.45	1.3, 100	0.39	1.8	0.25	FOF1, FOF6	300000
20110428	1.85	0.01	20.3	0.44	1.2, 92	0.39	1.8	0.25	N/A	330000
20110602*	0.625	0.015	3.15	0.27	0, 105	0.38	1.9	0.26	N/A	667000
20110616	0.625	0.015	3.18	0.27	0.75, 99.8	0.38	1.9	0.26	N/A	667000
20110409	0.625	0.01	3.20	0.18	0.38, 97.7	0.38	1.9	0.26	N/A	800000
20110624	0.625	0.01	3.20	0.18	1.3, 103	0.38	1.9	0.26	FOF1, FOF6	630000
20110809	0.35	0.015	1.70	0.20	0.96, 100.5	0.38	1.9	0.26	Not Recorded	600000
20110728**	0.35	0.01	1.10	0.10	N/A	0.38	1.9	0.26	Missing data	Not analyzed
20110715	0.15	0.01	0.46	0.06	N/A	0.38	1.9	0.26	FOF1, FOF4	Not analyzed

*FOF5 and FOF6 positions swapped; **FOF1 and FOF2 positions swapped
(FOF=fiber optic fluorometer; Cyclops=water column fluorometer); grey rows not analyzed in this study.

Table S2. Results of optimizing the C Profile model using water column measurements.

Experiment ID	$\mu_{\log_{10}\left(D_{\text{eff},0},\, \text{m}^2\text{s}^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(D_{\text{eff},0},\, \text{m}^2\text{s}^{-1}\right)}$	p-value	RMSE	AICC	R^2
20110330	-5.41 ± 0.02	4.3×10^{-49}	1.55	116	0.9886
20110331	-5.26 ± 0.01	4.5×10^{-55}	0.963	87	0.9968
20110418	-5.72 ± 0.03	7.0×10^{-46}	2.22	138	0.9817
20110516	-5.79 ± 0.03	6.2×10^{-48}	1.95	130	0.9831
20110523	-5.48 ± 0.02	1.0×10^{-53}	0.979	88	0.9943
20110426	-5.98 ± 0.02	3.0×10^{-55}	0.82	77.4	0.9957
20110531	-5.92 ± 0.02	1.8×10^{-55}	0.87	80.9	0.9955
20110524	-6.08 ± 0.02	1.7×10^{-50}	1.44	111	0.9888
20110610	-6.08 ± 0.02	8.2×10^{-55}	0.842	79	0.9948
20110527	-6.08 ± 0.02	3.7×10^{-55}	0.862	81	0.9944
20110613	-6.47 ± 0.03	1.5×10^{-47}	2.17	136	0.9777
20110504	Not Analyzed				
20110507	-6.47 ± 0.03	1.4×10^{-47}	2.21	137	0.9776
20110401	-6.68 ± 0.04	3.1×10^{-46}	2.33	140	0.9681
20110405	-6.67 ± 0.03	3.4×10^{-48}	2.13	135	0.9768
20110509	-6.98 ± 0.03	2.8×10^{-50}	1.58	117	0.9840
20110517	-6.95 ± 0.03	3.3×10^{-49}	1.90	128	0.9782
20110420	-7.54 ± 0.03	2.3×10^{-50}	1.69	121	0.9793
20110428	-7.40 ± 0.03	1.3×10^{-49}	1.91	129	0.9777
20110602	-7.76 ± 0.03	2.9×10^{-50}	1.99	131	0.9725
20110616	-7.79 ± 0.03	9.77×10^{-50}	1.90	128	0.9734
20110409	-8.10 ± 0.03	1.9×10^{-52}	1.24	103	0.9794
20110624	-8.00 ± 0.02	1.2×10^{-54}	1.09	94.9	0.9881
20110809	-7.96 ± 0.02	4.1×10^{-57}	0.887	82.4	0.9915
20110728	Not Analyzed				
20110715	Not Analyzed				

Table S3. Results of optimizing the C Profile model using sediment column measurements.

Experiment ID	$\mu_{\log_{10}\left(D_{\mathrm{eff},0},\, \mathrm{m^2s^{-1}}\right)}$ $\pm\sigma_{\log_{10}\left(D_{\mathrm{eff},0},\, \mathrm{m^2s^{-1}}\right)}$	p-value	RMSE	AICC	R^2
20110330	-5.12 ± 0.1	3.3×10^{-63}	25.9	752	0.8452
20110331	-5.23 ± 0.07	9.2×10^{-73}	21.5	713	0.9124
20110418	-5.15 ± 0.11	5.3×10^{-59}	26.2	753	0.8307
20110516	-5.52 ± 0.11	3.1×10^{-63}	28.5	767	0.8243
20110523	-5.30 ± 0.06	1.0×10^{-53}	21.9	906	0.9090
20110426	-5.64 ± 0.10	6.1×10^{-54}	25.8	565	0.8696
20110531	-5.59 ± 0.12	4.9×10^{-49}	28.1	575	0.8235
20110524	-6.08 ± 0.07	2.9×10^{-96}	22.1	907	0.8999
20110610	-5.75 ± 0.07	2.6×10^{-78}	19.7	708	0.9150
20110527	-6.00 ± 0.08	4.1×10^{-60}	23.3	553	0.9090
20110613	-6.25 ± 0.07	9.5×10^{-94}	20.6	893	0.8072
20110504	Not Analyzed				
20110507	-6.27 ± 0.08	9.9×10^{-92}	23.1	916	0.8695
20110401	-6.72 ± 0.06	1.8×10^{-104}	20.2	889	0.9204
20110405	-6.64 ± 0.07	8.2×10^{-100}	22.3	909	0.8981
20110509	-6.77 ± 0.05	6.3×10^{-94}	16.0	675	0.9527
20110517	-6.97 ± 0.07	1.3×10^{-102}	21.9	905	0.9027
20110420	-7.29 ± 0.11	8.5×10^{-58}	27.2	571	0.8420
20110428	-7.40 ± 0.08	4.0×10^{-97}	23.7	921	0.8693
20110602	-7.66 ± 0.06	1.0×10^{-112}	19.7	884	0.9169
20110616	-7.79 ± 0.06	8.2×10^{-112}	20.0	887	0.9212
20110409	-7.80 ± 0.04	5.6×10^{-127}	13.6	810	0.9539
20110624	-7.16 ± 0.16	5.2×10^{-58}	36.1	805	0.7077
20110809	-7.51 ± 0.12	8.5×10^{-70}	36.1	802	0.7764
20110728	Not Analyzed				
20110715	Not Analyzed				

Table S4. Results of optimizing the E Profile model using water column measurements.

Experiment ID	$\mu_{\log_{10}\left(D_{eff,0},\, m^2s^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(D_{eff,0},\, m^2s^{-1}\right)}$	$\mu_{\log_{10}\left(a,\, m^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(a,\, m^{-1}\right)}$	p-values*	RMSE	AICC	R^2
20110330	-4.72 ± 0.06	1.52 ± 0.03	$<10^{-10}$	0.45	44.4	0.9990
20110331	-4.95 ± 0.04	1.18 ± 0.06	$<10^{-10}$	0.51	51.6	0.9991
20110418	-4.84 ± 0.17	1.64 ± 0.07	$<10^{-10}$	1.20	103	0.9947
20110516	-4.89 ± 0.06	1.59 ± 0.02	$<10^{-10}$	0.418	39.7	0.9992
20110523	-5.10 ± 0.06	1.37 ± 0.06	$<10^{-10}$	0.511	52	0.9984
20110426	-5.63 ± 0.06	1.41 ± 0.07	$<10^{-10}$	0.48	47.5	0.9985
20110531	-5.60 ± 0.06	1.30 ± 0.08	$<10^{-10}$	0.54	54.6	0.9983
20110524	-5.38 ± 0.06	1.55 ± 0.03	$<10^{-10}$	0.40	37.1	0.9991
20110610	-5.64 ± 0.05	1.51 ± 0.04	$<10^{-10}$	0.33	25.7	0.9992
20110527	-5.68 ± 0.05	1.42 ± 0.05	$<10^{-10}$	0.40	36.8	0.9988
20110613	-5.25 ± 0.04	1.70 ± 0.01	$<10^{-10}$	0.20	-4.34	0.9998
20110504	Not Analyzed					
20110507	-5.29 ± 0.06	1.69 ± 0.02	$<10^{-10}$	0.344	28.0	0.9995
20110401	-5.23 ± 0.11	1.81 ± 0.03	$<10^{-10}$	0.46	45.7	0.9987
20110405	-5.53 ± 0.06	1.71 ± 0.02	$<10^{-10}$	0.31	22.3	0.9995
20110509	-6.02 ± 0.05	1.74 ± 0.02	$<10^{-10}$	0.25	9.69	0.9996
20110517	-5.84 ± 0.04	1.71 ± 0.01	$<10^{-10}$	0.20	-4.46	0.9998
20110420	-6.38 ± 0.05	1.80 ± 0.02	$<10^{-10}$	0.23	4.93	0.9996
20110428	-6.22 ± 0.06	1.71 ± 0.02	$<10^{-10}$	0.27	14.0	0.9995
20110602	-6.54 ± 0.03	1.75 ± 0.01	$<10^{-10}$	0.16	-19.0	0.9998
20110616	-6.51 ± 0.03	1.78 ± 0.01	$<10^{-10}$	0.21	-0.68	0.9997
20110409	-7.09 ± 0.04	1.82 ± 0.02	$<10^{-10}$	0.181	-10.4	0.9996
20110624	-7.30 ± 0.02	1.70 ± 0.01	$<10^{-10}$	0.125	-32.7	0.9998
20110809	-7.41 ± 0.03	1.58 ± 0.02	$<10^{-10}$	0.162	-17.2	0.9997
20110728	Not Analyzed					
20110715	Not Analyzed					

*both parameters have p-values less than the indicated value.

Table S5. Results of optimizing the E Profile model using sediment column measurements.

Experiment ID	$\mu_{\log_{10}\left(D_{eff,0},\,m^2 s^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(D_{eff,0},\,m^2 s^{-1}\right)}$	$\mu_{\log_{10}\left(a,\,m^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(a,\,m^{-1}\right)}$	p-values*	RMSE	AICC	R^2
20110330	-4.22 ± 0.16	1.62 ± 0.05	$<10^{-10}$	15.49	675	0.9423
20110331	-4.37 ± 0.11	1.63 ± 0.04	$<10^{-10}$	10.42	601	0.9795
20110418	-3.85 ± 0.13	1.73 ± 0.03	$<10^{-10}$	10.5	609	0.9728
20110516	-4.09 ± 0.19	1.75 ± 0.04	$<10^{-10}$	12.3	635	0.9674
20110523	-4.65 ± 0.10	1.58 ± 0.04	$<10^{-10}$	13.9	816	0.9636
20110426	-4.82 ± 0.15	1.70 ± 0.05	$<10^{-10}$	15.5	506	0.9530
20110531	-4.30 ± 0.21	1.83 ± 0.05	$<10^{-10}$	14.6	498	0.9525
20110524	-5.07 ± 0.11	1.73 ± 0.03	$<10^{-10}$	11.2	772	0.9746
20110610	-5.17 ± 0.12	1.65 ± 0.06	$<10^{-10}$	12.0	631	0.9686
20110527	-5.41 ± 0.13	1.61 ± 0.06	$<10^{-10}$	15.5	506	0.9593
20110613	-5.11 ± 0.10	1.73 ± 0.03	$<10^{-10}$	8.64	721	0.9790
20110504	Not Analyzed					
20110507	-5.33 ± 0.11	1.65 ± 0.03	$<10^{-10}$	11.2	774	0.9692
20110401	-5.85 ± 0.10	1.68 ± 0.03	$<10^{-10}$	10.4	758	0.9791
20110405	-5.57 ± 0.12	1.74 ± 0.03	$<10^{-10}$	11.2	773	0.9743
20110509	-6.01 ± 0.12	1.61 ± 0.05	$<10^{-10}$	10.6	611	0.9792
20110517	-5.98 ± 0.11	1.73 ± 0.03	$<10^{-10}$	10.62	763	0.9771
20110420	-6.00 ± 0.16	1.84 ± 0.04	$<10^{-10}$	10.17	455	0.9780
20110428	-5.57 ± 0.18	1.90 ± 0.03	$<10^{-10}$	8.83	726	0.9819
20110602	-6.84 ± 0.09	1.69 ± 0.03	$<10^{-10}$	10.0	751	0.9785
20110616	-6.95 ± 0.08	1.68 ± 0.03	$<10^{-10}$	8.58	720	0.9855
20110409	N/A	N/A	N/A	N/A	N/A	N/A
20110624	N/A	N/A	N/A	N/A	N/A	N/A
20110809	-7.57 ± 0.34	1.68 ± 0.19	$<10^{-10}$	39.6	822	0.7209
20110728	Not Analyzed					
20110715	Not Analyzed					

*both parameters have p-values less than the indicated value; N/A=not available because the optimization algorithm did not converge.

Table S6. Results of optimizing the E2M Profile model using water column measurements, and assuming that $D'_m = 10^{-9.88}$ m^2 s^{-1}.

Experiment ID	$\mu_{\log_{10}\left(D_{eff,0},\, m^2 s^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(D_{eff,0},\, m^2 s^{-1}\right)}$	$\mu_{\log_{10}\left(a,\, m^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(a,\, m^{-1}\right)}$	p-values*	RMSE	AICC	R^2
20110330	-4.72 ± 0.06	1.52 ± 0.03	$<10^{-10}$	0.45	44.4	0.9990
20110331	-4.95 ± 0.04	1.18 ± 0.06	$<10^{-10}$	0.51	51.6	0.9991
20110418	-4.84 ± 0.17	1.64 ± 0.07	$<10^{-10}$	1.20	103	0.9947
20110516	-4.89 ± 0.06	1.59 ± 0.02	$<10^{-10}$	0.418	39.7	0.9992
20110523	-5.10 ± 0.06	1.37 ± 0.06	$<10^{-10}$	0.511	52	0.9984
20110426	-5.63 ± 0.06	1.41 ± 0.07	$<10^{-10}$	0.48	47.5	0.9985
20110531	-5.60 ± 0.06	1.30 ± 0.08	$<10^{-10}$	0.54	54.6	0.9983
20110524	-5.38 ± 0.06	1.55 ± 0.03	$<10^{-10}$	0.40	37.1	0.9991
20110610	-5.64 ± 0.04	1.51 ± 0.04	$<10^{-10}$	0.33	25.7	0.9992
20110527	-5.68 ± 0.05	1.42 ± 0.05	$<10^{-10}$	0.40	36.8	0.9988
20110613	-5.25 ± 0.04	1.70 ± 0.01	$<10^{-10}$	0.20	-4.34	0.9998
20110504	Not Analyzed					
20110507	-5.29 ± 0.06	1.69 ± 0.02	$<10^{-10}$	0.344	28.0	0.9995
20110401	-5.23 ± 0.11	1.81 ± 0.03	$<10^{-10}$	0.46	46	0.9987
20110405	-5.53 ± 0.06	1.71 ± 0.02	$<10^{-10}$	0.31	22.3	0.9995
20110509	-6.02 ± 0.05	1.74 ± 0.02	$<10^{-10}$	0.25	9.69	0.9996
20110517	-5.84 ± 0.04	1.71 ± 0.01	$<10^{-10}$	0.20	-4.46	0.9998
20110420	-6.38 ± 0.05	1.80 ± 0.02	$<10^{-10}$	0.23	4.93	0.9996
20110428	-6.22 ± 0.06	1.71 ± 0.02	$<10^{-10}$	0.27	14.0	0.9995
20110602	-6.54 ± 0.03	1.75 ± 0.01	$<10^{-10}$	0.16	-19.0	0.9998
20110616	-6.51 ± 0.05	1.78 ± 0.01	$<10^{-10}$	0.21	-0.68	0.9997
20110409	-7.09 ± 0.04	1.82 ± 0.016	$<10^{-10}$	0.181	-10.4	0.9996
20110624	-7.26 ± 0.02	1.70 ± 0.01	$<10^{-10}$	0.125	-32.7	0.9998
20110809	-7.41 ± 0.03	1.58 ± 0.02	$<10^{-10}$	0.162	-17.2	0.9997
20110728	Not Analyzed					
20110715	Not Analyzed					

*both parameters have *p*-values less than the indicated value; N/A=not available because the optimization algorithm did not converge.

Table S7. Results of optimizing the C2E Profile model using water column measurements.

Experiment ID	$\mu_{\log_{10}\left(D_{\text{eff},0},\ \text{m}^2\text{s}^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(D_{\text{eff},0},\ \text{m}^2\text{s}^{-1}\right)}$	$\mu_{\log_{10}\left(a,\ \text{m}^{-1}\right)}$ $\pm\sigma_{\log_{10}\left(a,\ \text{m}^{-1}\right)}$	$\mu_{\log_{10}\left(\ell_t,\ \text{m}\right)}$ $\pm\sigma_{\log_{10}\left(\ell_t,\ \text{m}\right)}$	p-values *	RMSE	AICC	R^2
20110330	-5.06 ± 0.04	1.77 ± 0.10	-1.32 ± 0.08	$< 10^{-10}$	0.332	28.7	0.9995
20110331	-5.14 ± 0.02	2.36 ± 0.68	-0.97 ± 0.10	< 0.01	0.323	27.1	0.9996
20110418	-5.27 ± 0.13	1.91 ± 0.26	-1.34 ± 0.21	$< 10^{-5}$	1.11	101	0.9954
20110516	-5.34 ± 0.03	1.81 ± 0.05	-1.30 ± 0.05	$< 10^{-20}$	0.247	11.0	0.9997
20110523	-5.32 ± 0.02	2.23 ± 0.44	-1.15 ± 0.10	$< 10^{-4}$	0.348	31.6	0.9993
20110426	-5.84 ± 0.02	2.72 ± 1.16	-1.14 ± 0.13	< 0.05	0.332	28.7	0.9993
20110531	-5.79 ± 0.03	2.39 ± 0.85	-1.10 ± 0.14	< 0.01	0.402	40.2	0.9990
20110524	-5.78 ± 0.01	2.05 ± 0.08	-1.20 ± 0.03	$< 10^{-19}$	0.167	-12.5	0.9998
20110610	-5.89 ± 0.02	2.01 ± 0.18	-1.34 ± 0.08	$< 10^{-10}$	0.223	4.97	0.9996
20110527	-5.93 ± 0.01	3.06 ± 1.19	-1.08 ± 0.07	< 0.02	0.183	-6.97	0.9997
20110613	-5.83 ± 0.02	1.82 ± 0.02	-1.38 ± 0.02	$< 10^{-30}$	0.09	-50.6	0.999996
20110504	Not Analyzed						
20110507	-5.84 ± 0.04	1.84 ± 0.04	-1.39 ± 0.05	$< 10^{-20}$	0.224	5.05	0.9998
20110401	-6.10 ± 0.02	2.22 ± 0.07	-1.21 ± 0.03	$< 10^{-21}$	0.233	7.47	0.9997
20110405	-6.13 ± 0.02	1.92 ± 0.03	-1.33 ± 0.03	$< 10^{-27}$	0.145	-21.1	0.9999
20110509	-6.54 ± 0.01	2.0 ± 0.03	-1.39 ± 0.02	$< 10^{-29}$	0.10	-40.4	0.9999
20110517	-6.37 ± 0.02	1.84 ± 0.02	-1.43 ± 0.03	$< 10^{-28}$	0.096	-45.6	0.9999
20110420	-6.57 ± 0.49	1.80 ± 0.03	-2.12 ± 1.23	< 0.2	0.23	7.2	0.9996
20110428	-6.70 ± 0.08	1.77 ± 0.04	-1.53 ± 0.11	$< 10^{-12}$	0.11	11.59	0.9996
20110602	-6.95 ± 0.09	1.78 ± 0.02	-1.69 ± 0.13	$< 10^{-12}$	0.15	-19.2	0.9998
20110616	-7.18 ± 0.02	1.95 ± 0.02	-1.39 ± 0.03	$< 10^{-28}$	0.112	-36.5	0.9999
20110409	-7.39 ± 0.15	1.85 ± 0.04	-1.89 ± 0.3	$< 10^{-6}$	0.178	-8.65	0.9996
20110624	-7.56 ± 0.03	1.79 ± 0.03	-1.68 ± 0.06	$< 10^{-19}$	0.099	-44.0	0.9999
20110809	-7.70 ± 0.02	1.82 ± 0.05	-1.48 ± 0.05	$< 10^{-22}$	0.102	-42.4	0.9999
20110728	Not Analyzed						
20110715	Not Analyzed						

*all three parameters have p-values less than the indicated value