Supporting Information

for

"Fusion-based hypoxia estimates: combining geostatistical and mechanistic models of dissolved oxygen variability"

by

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consisting of

10 sections with 22 figures and 5 tables in 27 pages.

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SI-1: Comparison of windspeeds from Buoys and POWER

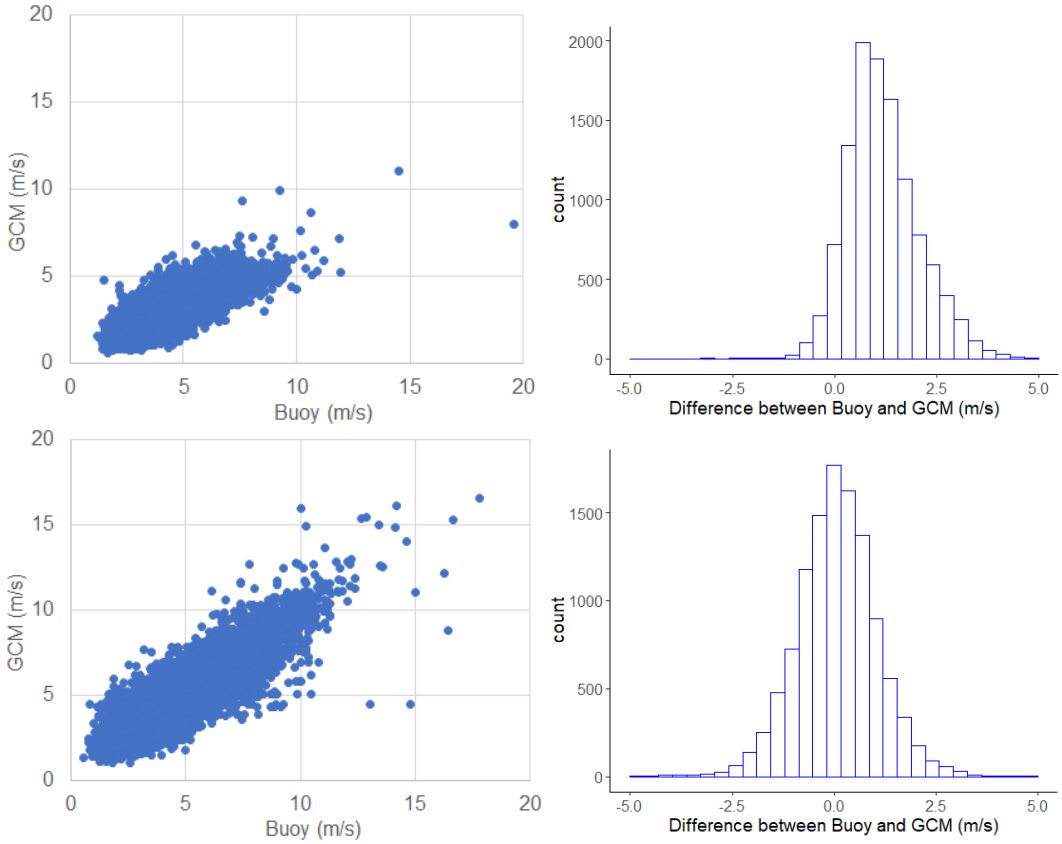

Figure S1. Comparison of wind speeds from POWER (GCM) and Buoy data (left) and histogram of difference between Buoy and GCM data (right). Figures on top are data collected from Buoy on the west end of the study area (Sabine Pass, Texas-SRST2). Figures on bottom are data collected from Buoy on the east end of the study area (Southwest Pass, Louisiana-BURL1). The Buoy data are retrieved from National Data Buoy Center (NDBC) archives.

SI-2: Shelf wide wind speeds from POWER and hypoxia extent from ROMS model

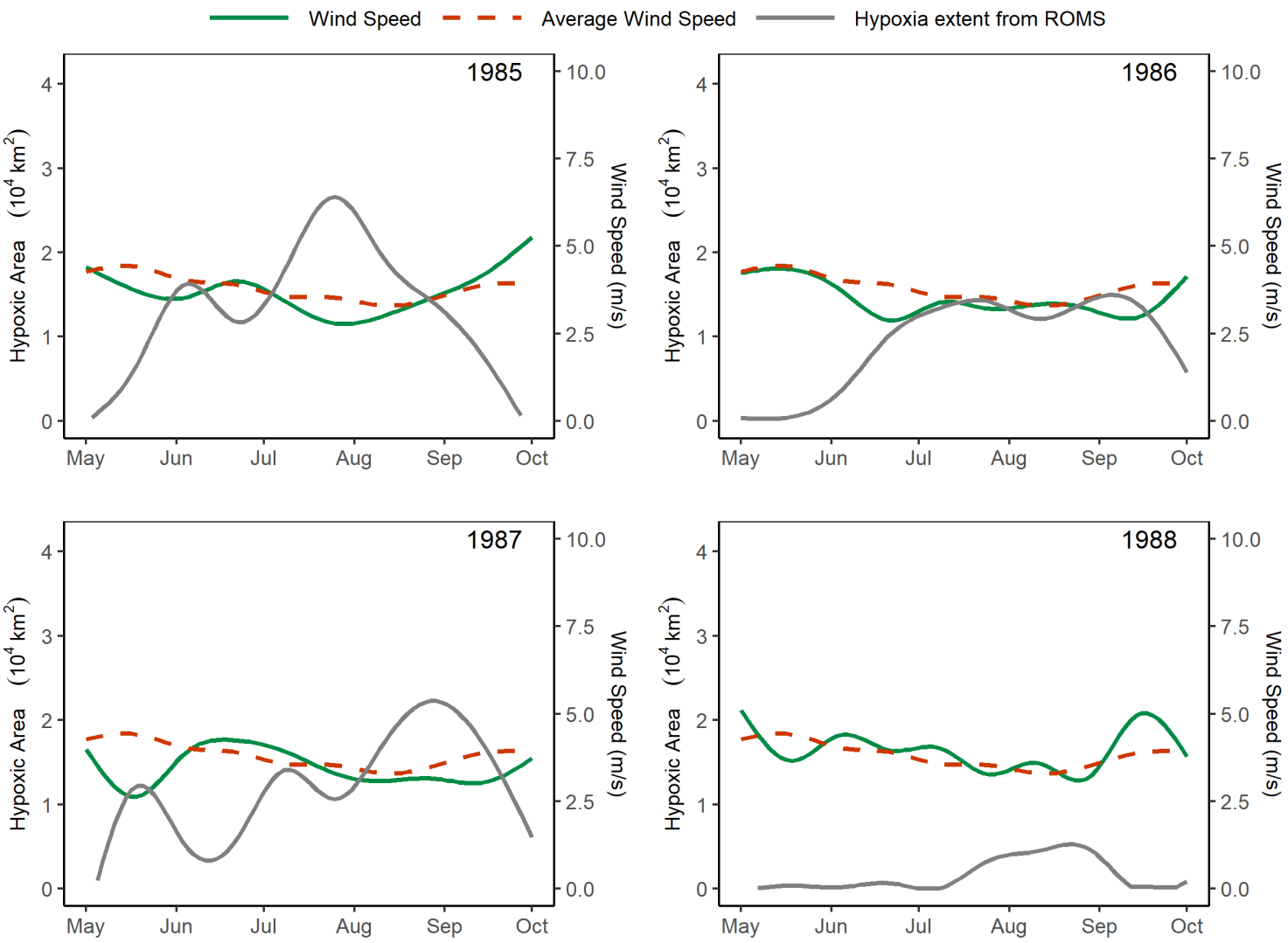

Figure S2A. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 1985-1988

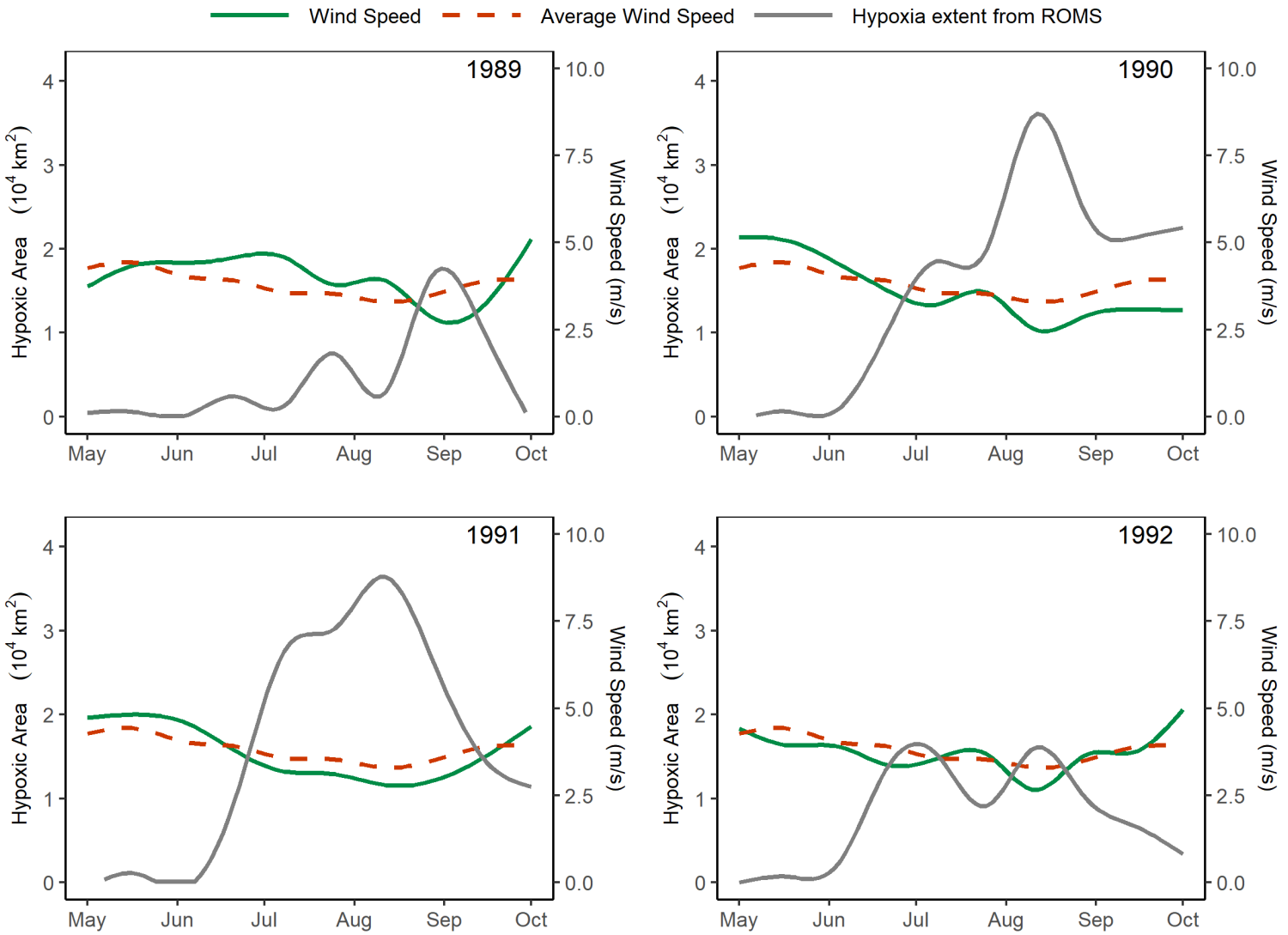

Figure S2B. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 1989-1992

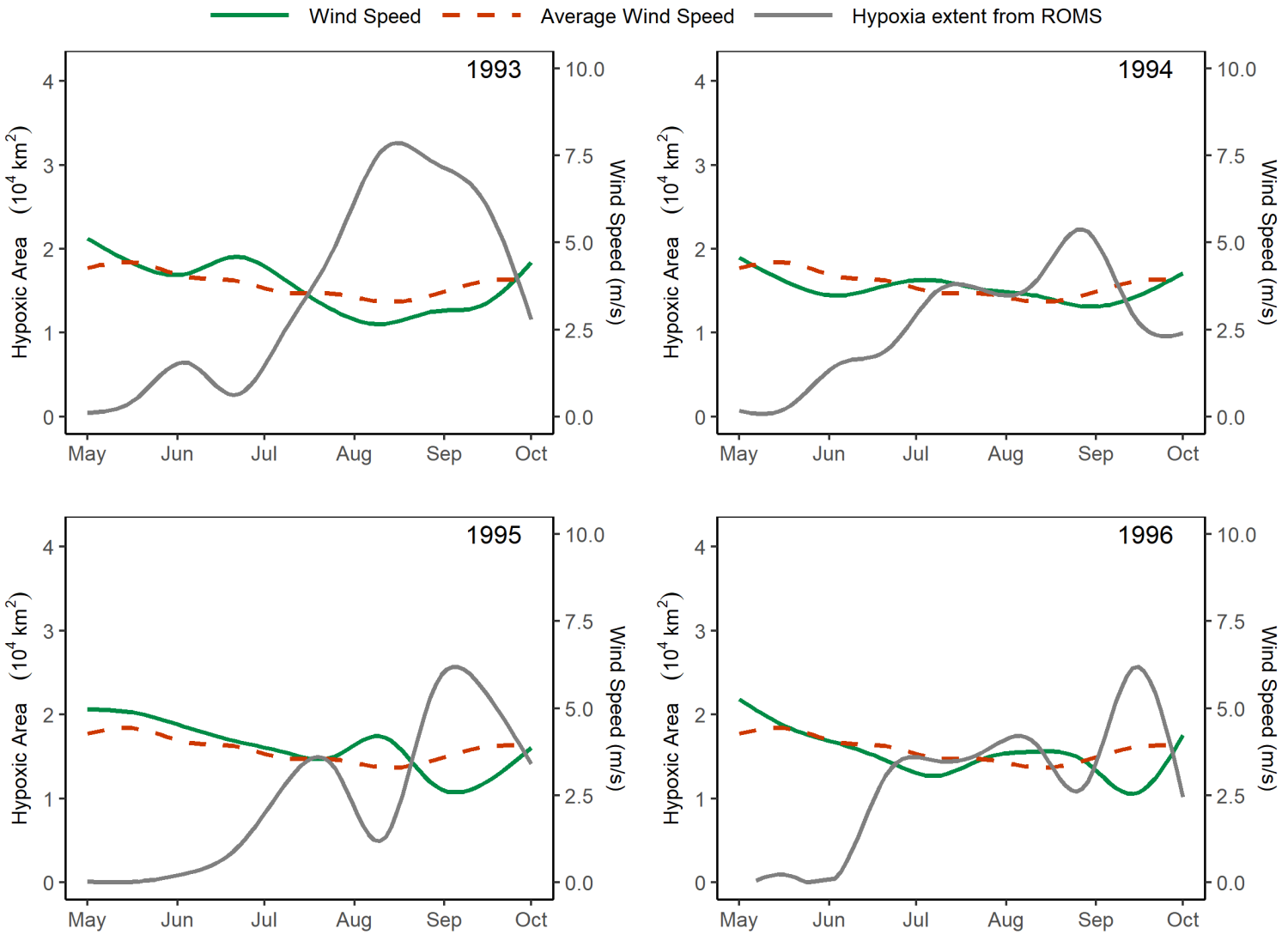

Figure S2C. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 1993-1996

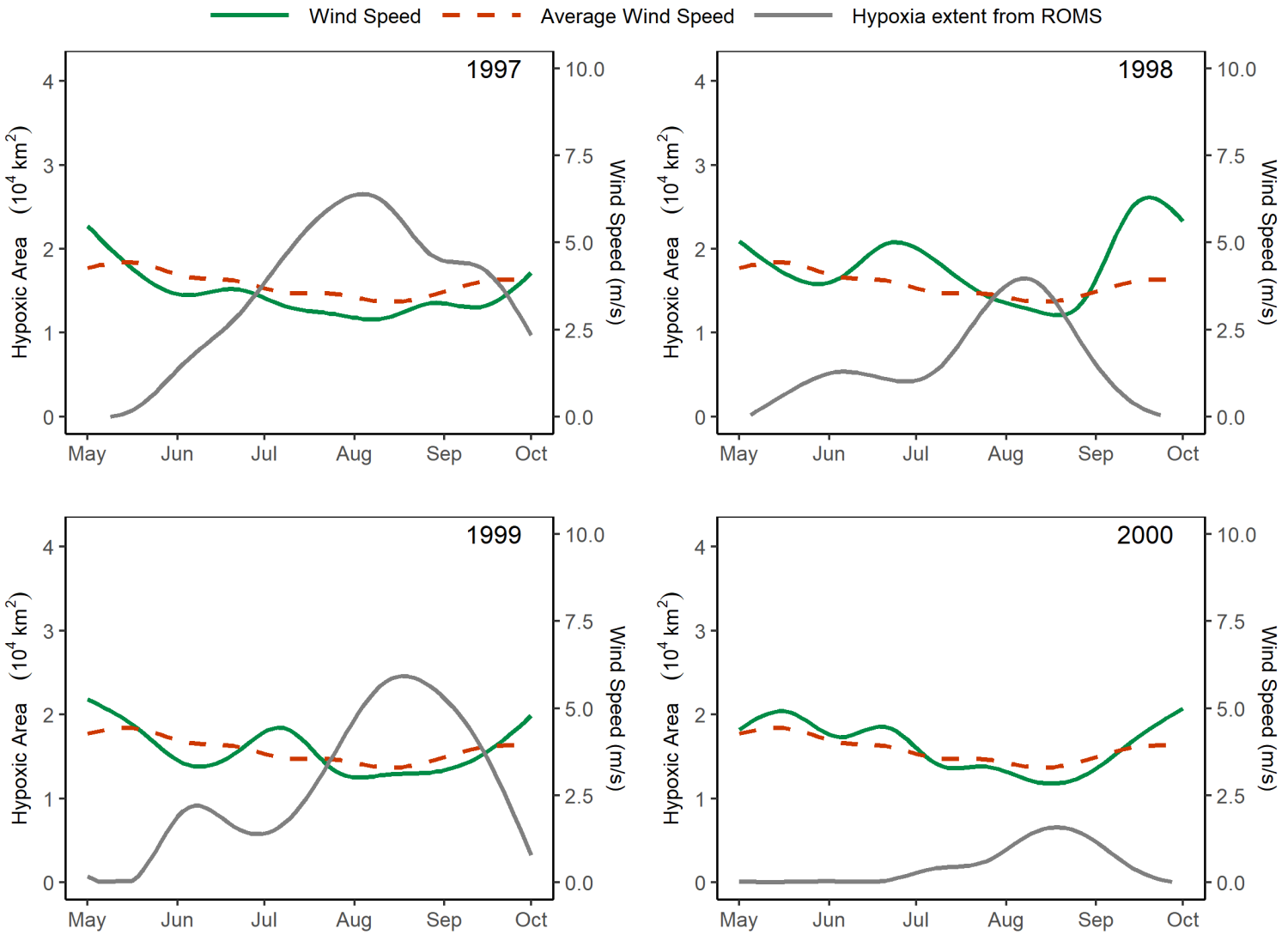

Figure S2D. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 1997-2000

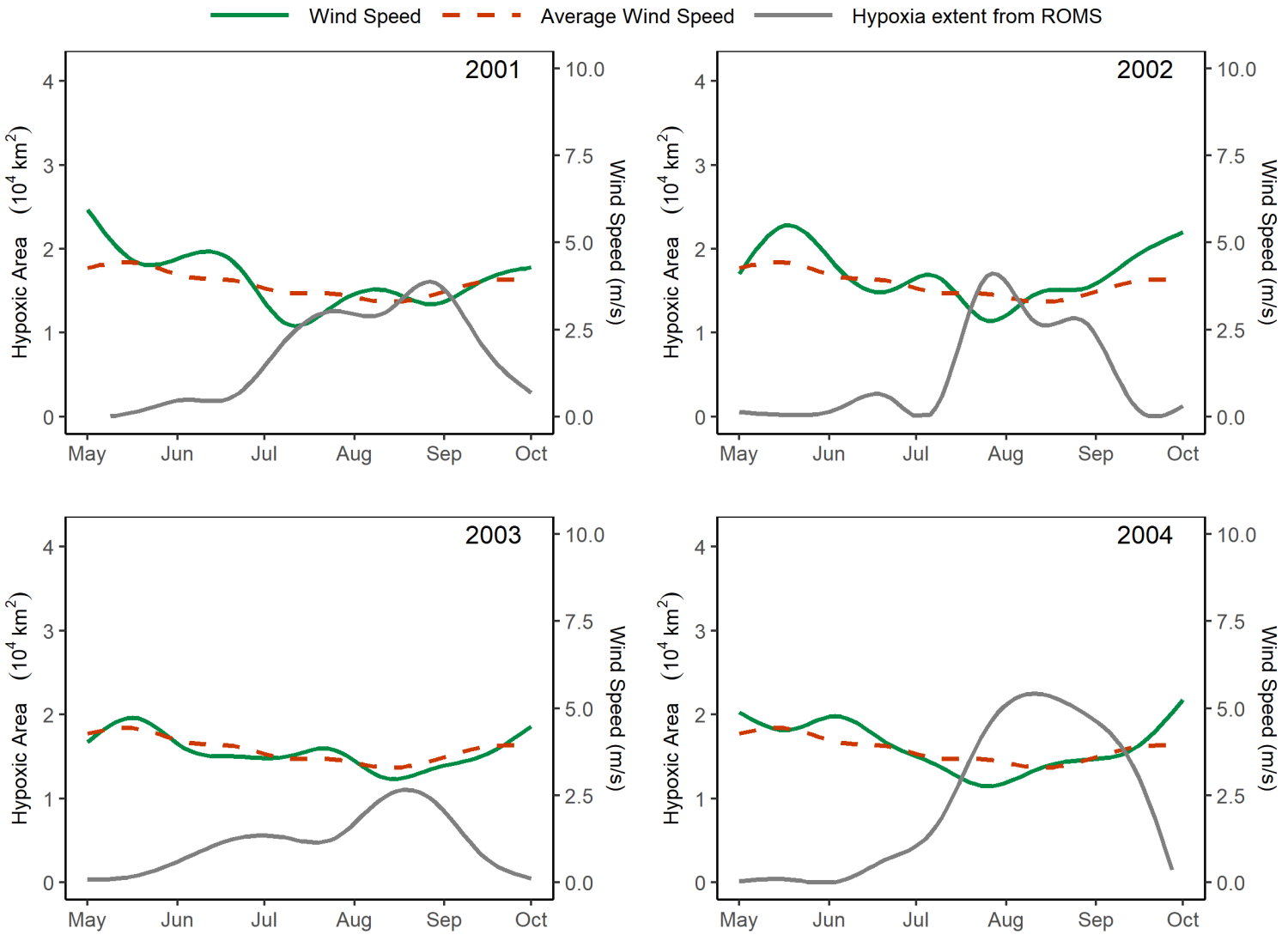

Figure S2E. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 2001-2004

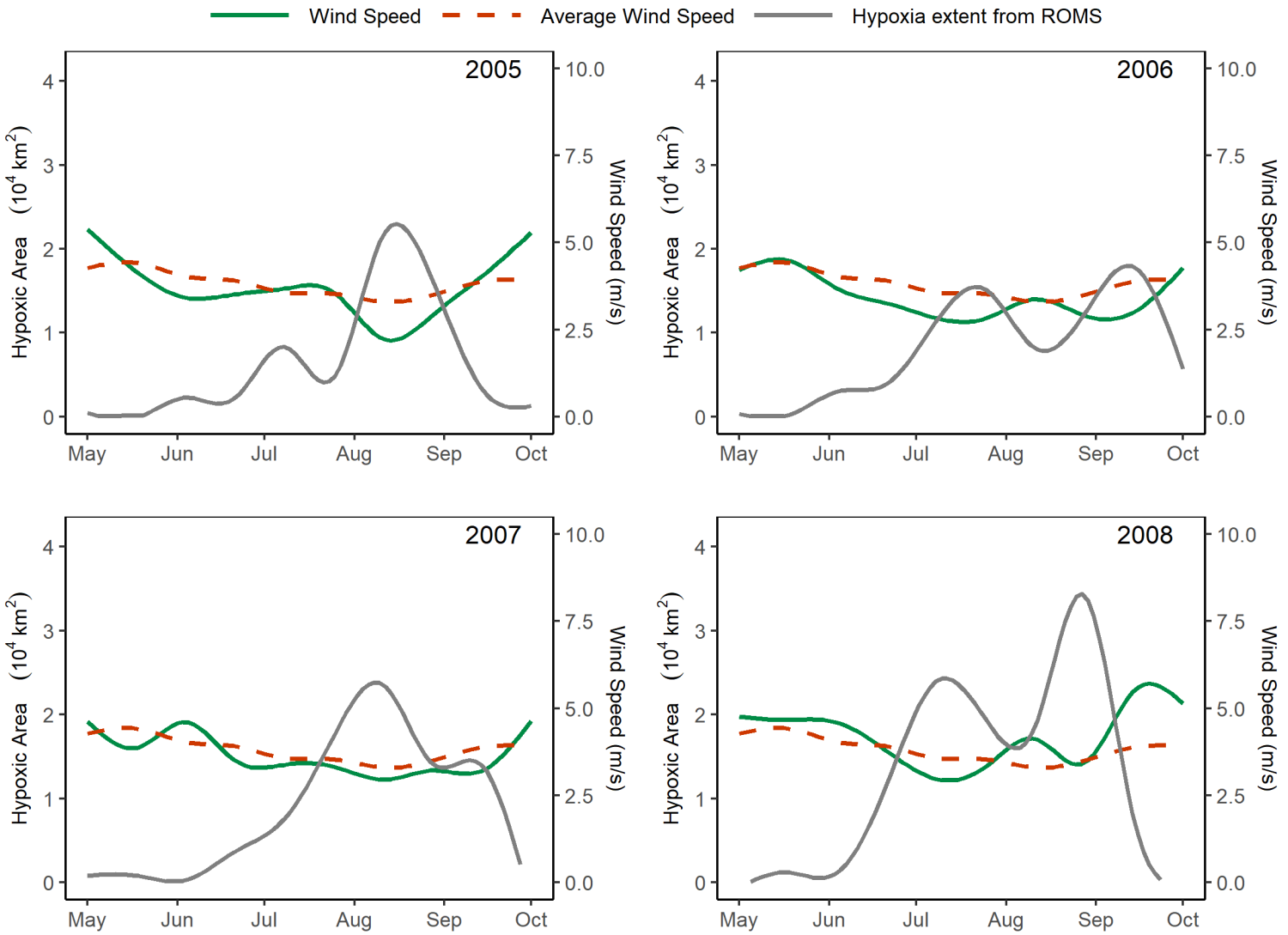

Figure S2F. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 2005-2008

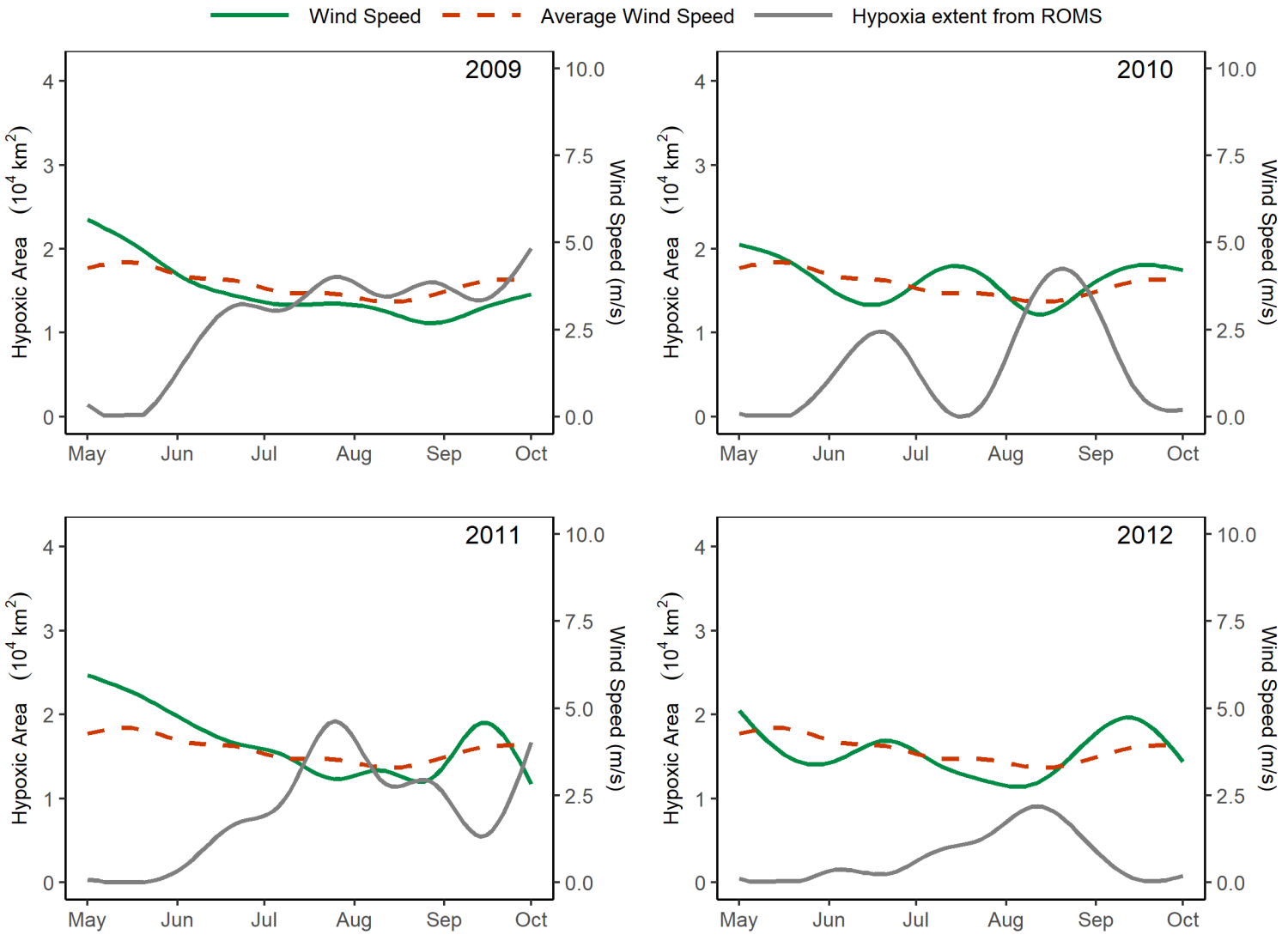

Figure S2G. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 2009-2012

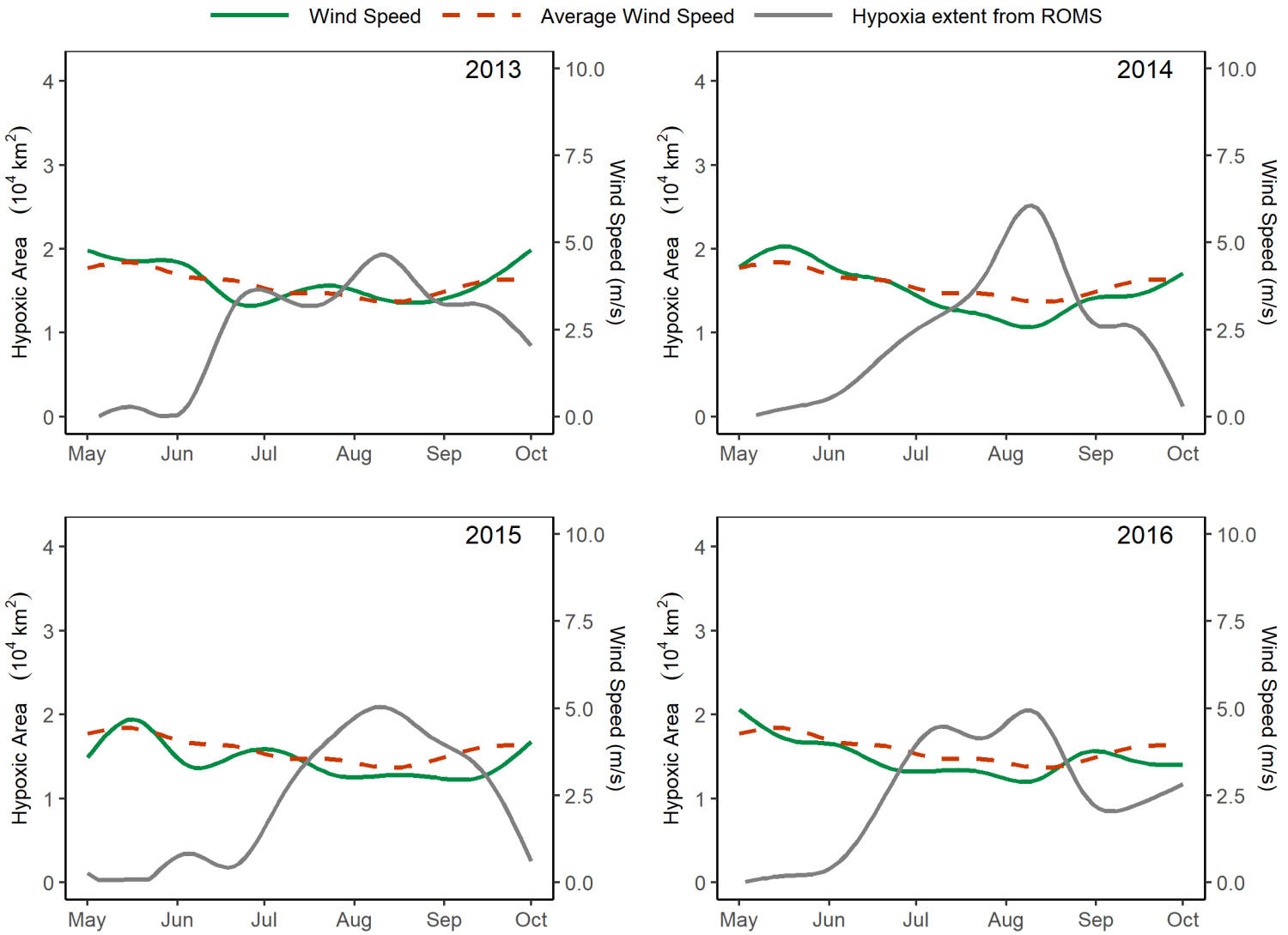

Figure S2H. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 2013-2016

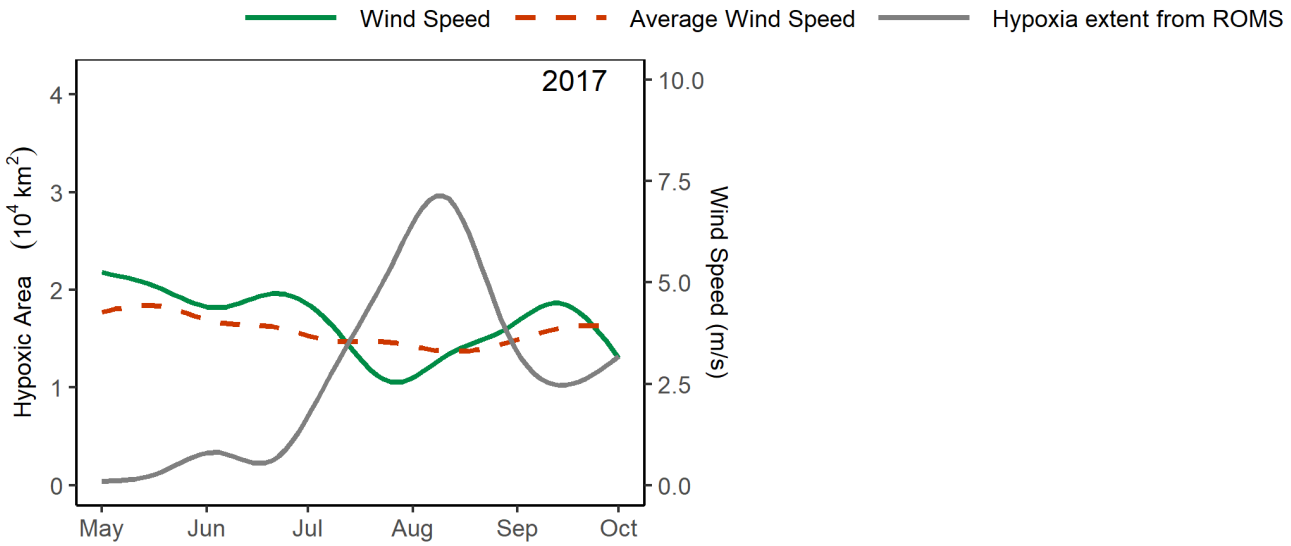

Figure S2I. Daily shelfwide wind speeds compared to multi-year averages and hypoxic area obtained from ROMS model from 2017

SI-3: Spatial-temporal lag calculation

Spatial lag $(s_{i,j}, \text{km}) = \sqrt{(\alpha * s_{yy})^2 + s_{xx}^2}$

Where α is spatial anisotropy and s_{yy} is the distance between two observations (i and j) along North-South direction and s_{xx} is the distance between two observations along East-West direction.

Temporal lag ($t_{i,j}$, days) = t_i - t_j

Where t_i and t_j are the dates on which observations i and j were collected.

SI-4: BIC scores and R^2 for example variable combinations tested

Variables Used											BIC score	R^2
N	E	D	D^2	T	T^2	W_{28}^2	DO'	S_{strat}	--	--	7872	0.358
N	E	D	D^2	T	T^2	W_{21}^2	DO'	S_{strat}	--	--	7873	0.355
N	E	D	D^2	T	T^2	W_{28}^2	DO'	DO'^{2}	S_{strat}	--	7874	0.359
N	E	D	D^2	T	T^2	W_{28}	W_{28}^2	DO'	S_{strat}	--	7876	0.356
N	E	D	D^2	T	T^2	W_{21}^2	DO'	DO'^{2}	S_{strat}	--	7876	0.357
N	E	D	D^2	T	T^2	W_{28}^2	DO'	--	--	--	7885	0.357
N	E	D	D^2	T	T^2	W_{21}^2	DO'	--	--	--	7886	0.354
N	E	D	D^2	T	T^2	DO'	S_{strat}	--	--	--	7888	0.333
N	E	D	D^2	T	T^2	W_{14}^2	DO'	--	--	--	7889	0.351
N	E	D	D^2	T	T^2	DO'	--	--	--	--	7903	0.331
N	E	D	D^2	T	T^2	W_{28}^2	--	--	--	--	7991	0.326
N	E	D	D^2	T	T^2	W_{21}^2	--	--	--	--	7992	0.325
N	E	D	D^2	T	T^2	--	--	--	--	--	8095	0.287

SI-5: Yearly intercepts (β, mgL^{-1}) and associated standard errors (σ_β, mgL^{-1}) from models M18, V1, V2 and V3.

year	V3		V1		V2		M18	
	β	σ_β	β	σ_β	β	σ_β	β	σ_β
1985	4.25	0.53	4.86	0.54	4.06	0.56	4.84	0.58
1986	4.13	0.59	4.90	0.59	4.00	0.61	4.97	0.63
1987	4.12	0.63	5.20	0.61	3.99	0.66	5.35	0.66
1988	6.14	0.70	7.24	0.69	6.30	0.74	7.69	0.75
1989	4.35	0.76	5.49	0.76	4.28	0.80	5.72	0.81
1990	4.32	0.60	5.29	0.59	4.08	0.63	5.30	0.63
1991	4.60	0.59	5.29	0.60	4.28	0.62	5.16	0.64
1992	4.74	0.35	5.34	0.34	4.67	0.35	5.42	0.35
1993	3.64	0.39	4.52	0.37	3.45	0.40	4.55	0.38
1994	4.33	0.42	5.28	0.39	4.23	0.43	5.41	0.42
1995	3.56	0.48	4.54	0.46	3.36	0.50	4.60	0.50
1996	3.83	0.45	4.56	0.45	3.69	0.47	4.62	0.48
1997	3.50	0.44	4.18	0.44	3.31	0.46	4.15	0.47
1998	3.78	0.43	5.00	0.37	3.63	0.44	5.17	0.38
1999	3.97	0.39	4.84	0.36	3.84	0.40	4.94	0.38
2000	4.96	0.38	5.76	0.36	5.06	0.39	6.08	0.38
2001	4.48	0.38	5.35	0.35	4.47	0.39	5.57	0.37
2002	4.26	0.38	5.09	0.36	4.31	0.39	5.37	0.37
2003	4.52	0.35	5.33	0.33	4.44	0.36	5.47	0.34
2004	4.02	0.36	4.80	0.34	3.97	0.36	4.95	0.35
2005	4.04	0.35	4.82	0.33	4.00	0.36	5.00	0.34
2006	4.82	0.32	5.32	0.31	4.79	0.32	5.41	0.32
2007	4.36	0.33	5.01	0.32	4.29	0.34	5.11	0.33
2008	3.51	0.39	4.33	0.37	3.40	0.40	4.44	0.39
2009	4.67	0.37	5.38	0.36	4.61	0.38	5.51	0.38
2010	3.70	0.43	4.79	0.39	3.64	0.44	5.01	0.41
2011	3.64	0.38	4.52	0.35	3.55	0.39	4.67	0.37
2012	4.39	0.35	5.09	0.34	4.44	0.36	5.32	0.35
2013	4.28	0.41	5.06	0.40	4.17	0.43	5.16	0.42
2014	4.43	0.40	5.19	0.39	4.34	0.42	5.30	0.41
2015	4.53	0.51	5.39	0.51	4.48	0.53	5.56	0.54
2016	3.77	0.45	4.36	0.45	3.64	0.47	4.38	0.48
2017	3.47	0.59	4.90	0.54	3.25	0.62	5.04	0.58

SI-6: Trend coefficients (β) and associated standard errors (σ_β) of normalized BIC-selected trend variables from all model versions.

Variable	M18		V1		V2		V3	
	β	σ_β	β	σ_β	β	σ_β	β	σ_β
E	-0.605	0.060	-0.559	0.057	-0.487	0.057	-0.453	0.055
N	-0.270	0.057	-0.245	0.055	-0.259	0.054	-0.239	0.053
D	-2.519	0.114	-2.535	0.114	-2.468	0.117	-2.485	0.116
D^2	2.639	0.112	2.657	0.112	2.480	0.113	2.503	0.113
T	0.131	0.090	0.131	0.084	0.088	0.084	0.089	0.080
T^2	0.482	0.086	0.233	0.091	0.368	0.080	0.172	0.086
WS_{28}^2	-	-	0.412	0.069	-	-	0.331	0.066
DO'	-	-	-	-	0.227	0.027	0.218	0.027
S_{strat}	-	-	-	-	-0.142	0.030	-0.139	0.030

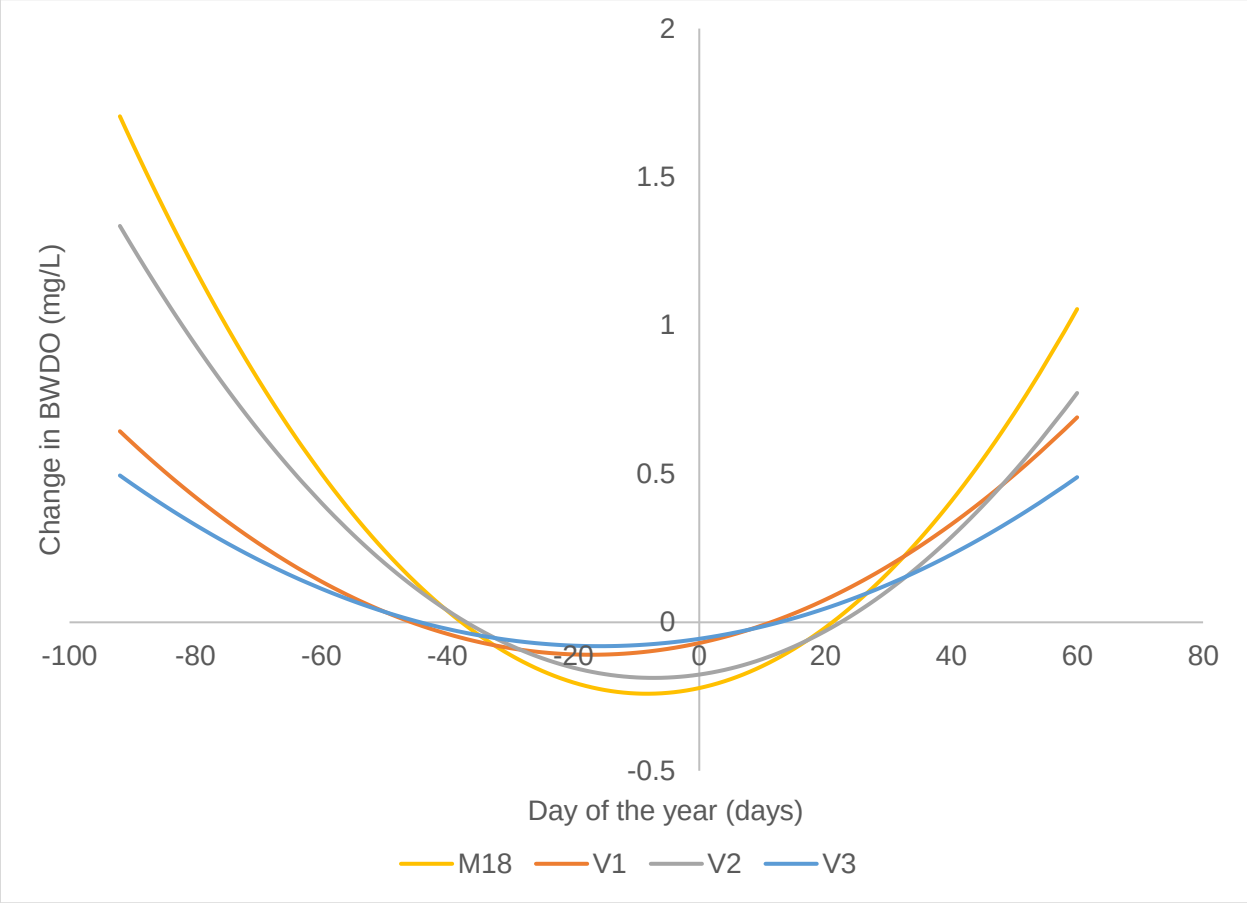

Fig S6: Temporal trend between BWDO and day of the year (centered on August 1st, day 0). Note that this is just one component of the deterministic trend function (xβ) and geostatistical model (eq 1); other factors such as wind speed and ROMS DO also inform temporal variability.

SI-7: Geostatistical covariance function parameters σ_ε^2 (nugget), σ_η^2 (partial sill), $\sigma_\varepsilon^2 + \sigma_\eta^2$ (total sill), α (spatial anisotropy ratio, east-west to north-south), a (spatial range parameter), b and (temporal range parameter) of all model versions.

Parameters	M18	V1	V2	V3
σ_ε^2 ($mg^2 L^{-2}$)	0.49	0.49	0.50	0.49
σ_η^2 ($mg^2 L^{-2}$)	2.57	2.44	2.34	2.26
$\sigma_\varepsilon^2 + \sigma_\eta^2$ ($mg^2 L^{-2}$)	3.06	2.93	2.84	2.76
a (km)	63.54	58.63	57.92	54.89
b (days)	8.92	8.37	8.34	7.91
α	2.26	2.26	2.21	2.21

SI-8: Daily estimates of hypoxia from models M18, V1, V2, and V3 for years 1985-2017

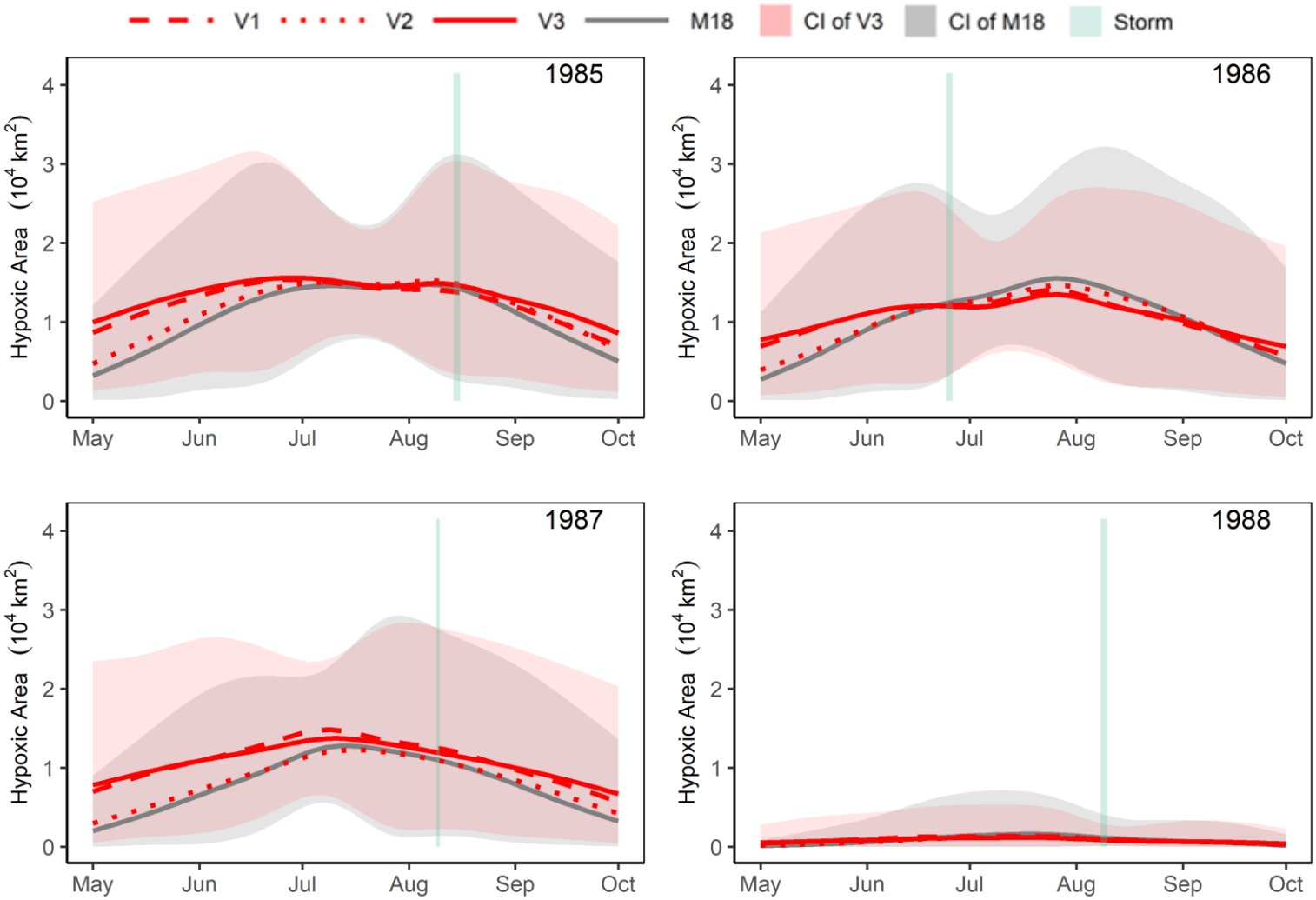

Figure S8A. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 1985-1988

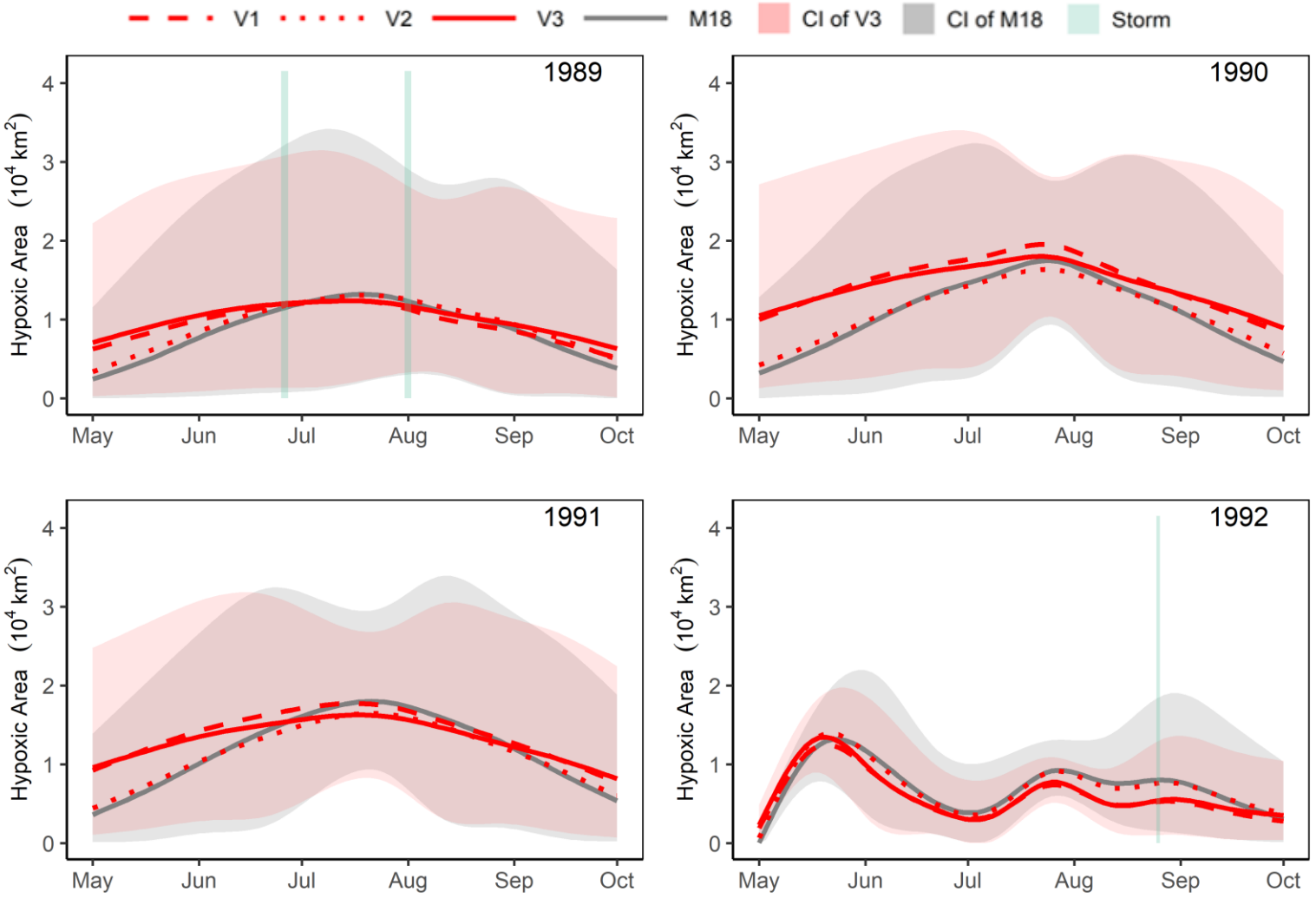

Figure S8B. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 1989-1992

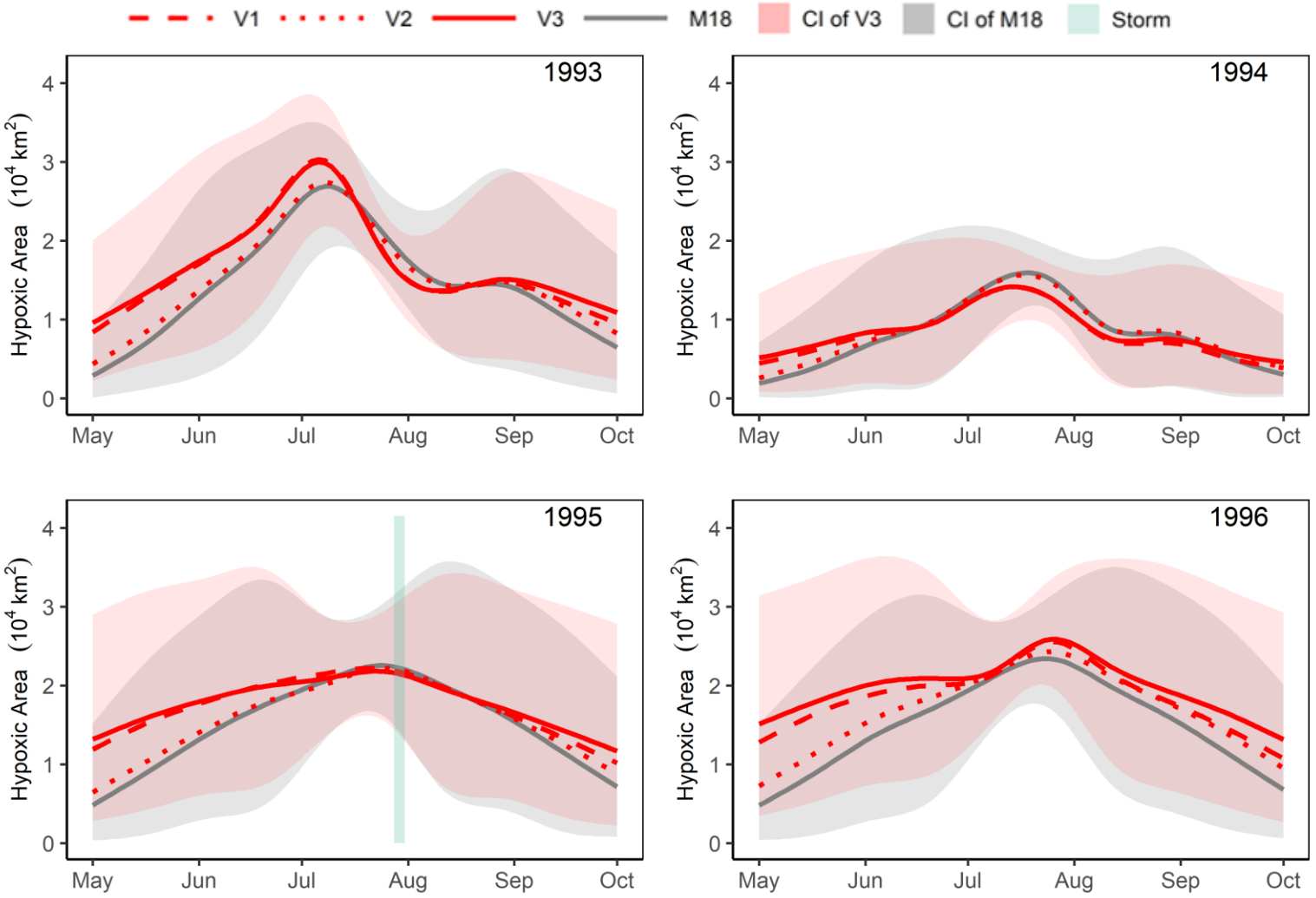

Figure S8C. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 1993-1996

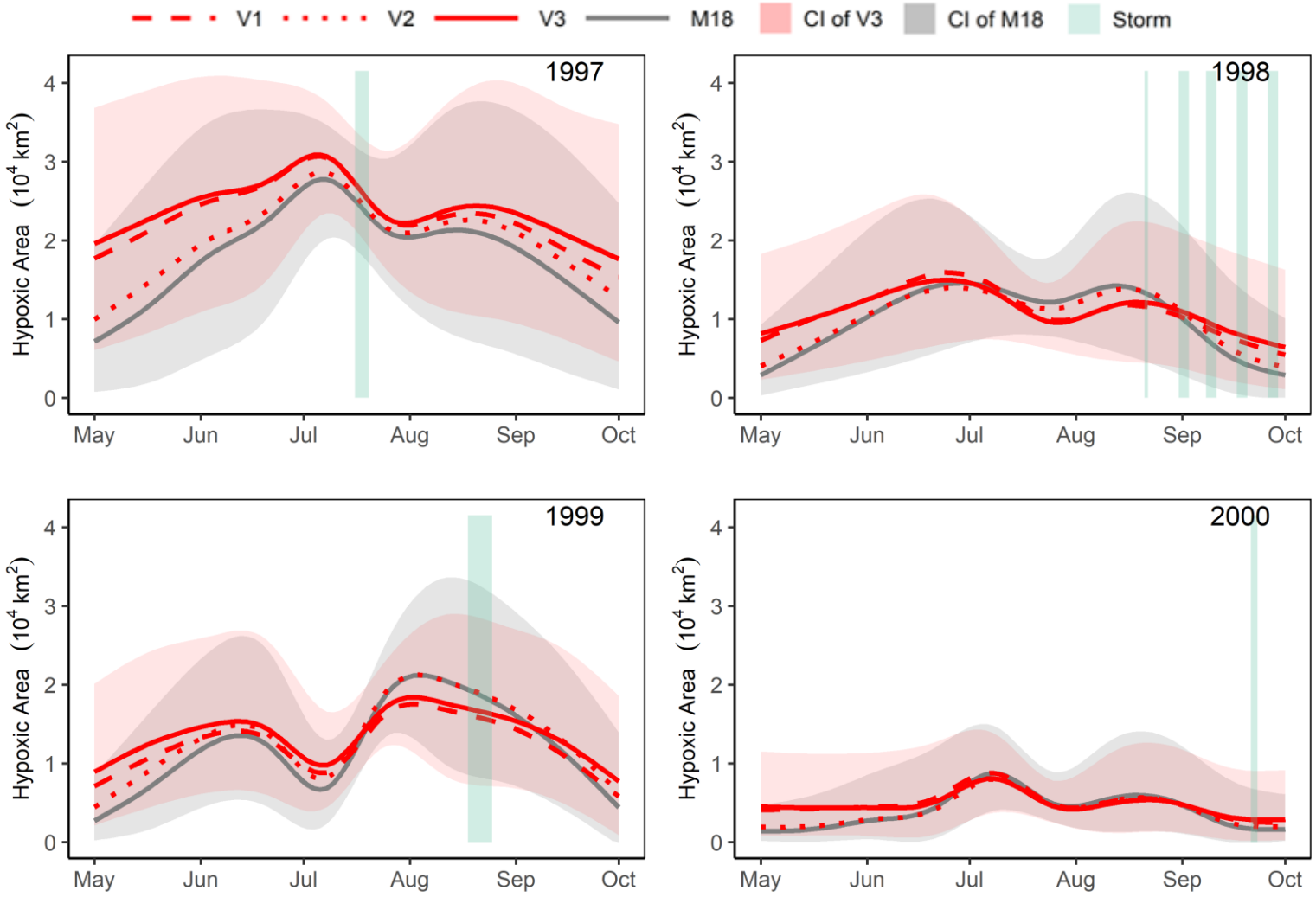

Figure S8D. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 1997-2000

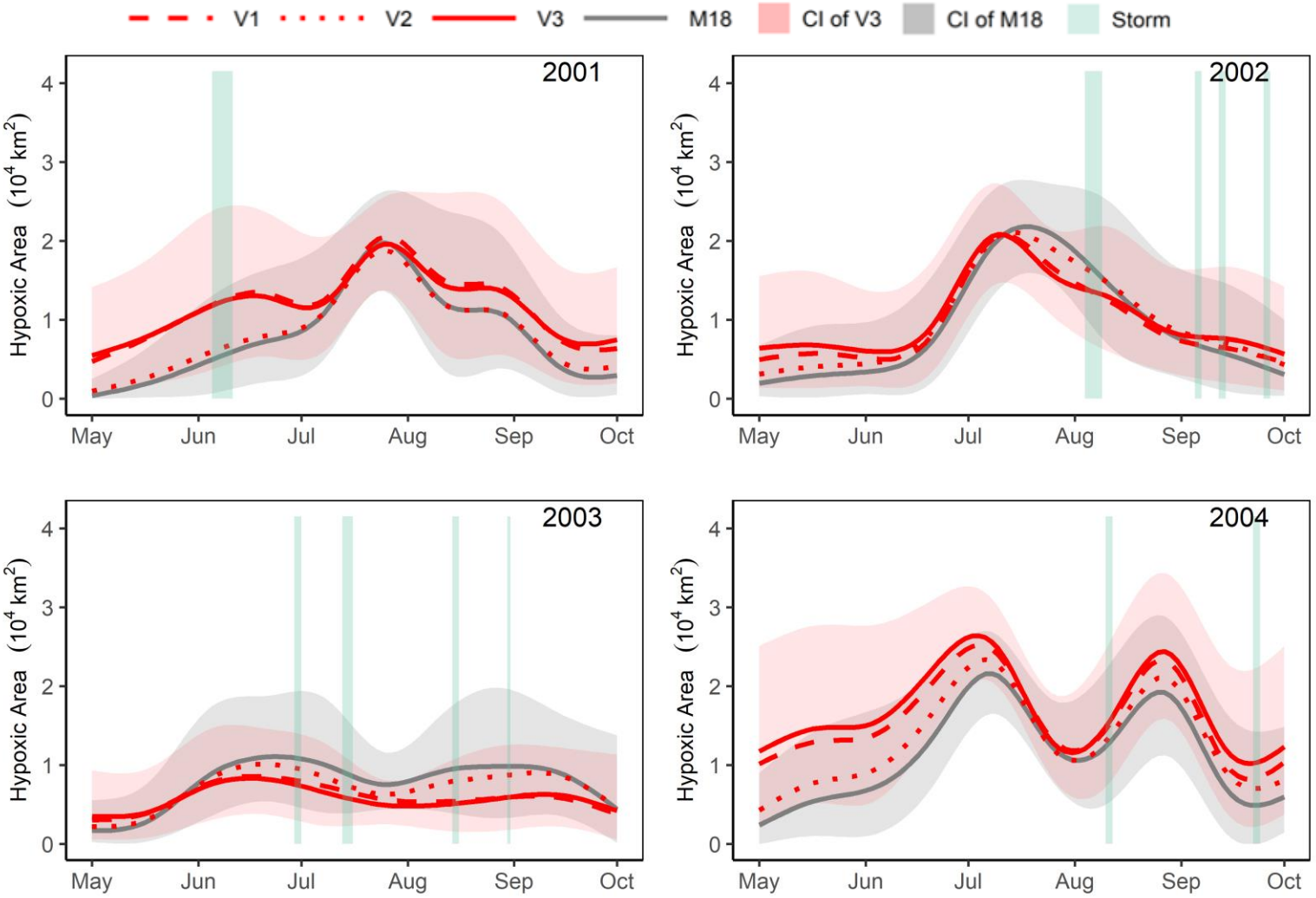

Figure S8E. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 2001-2004

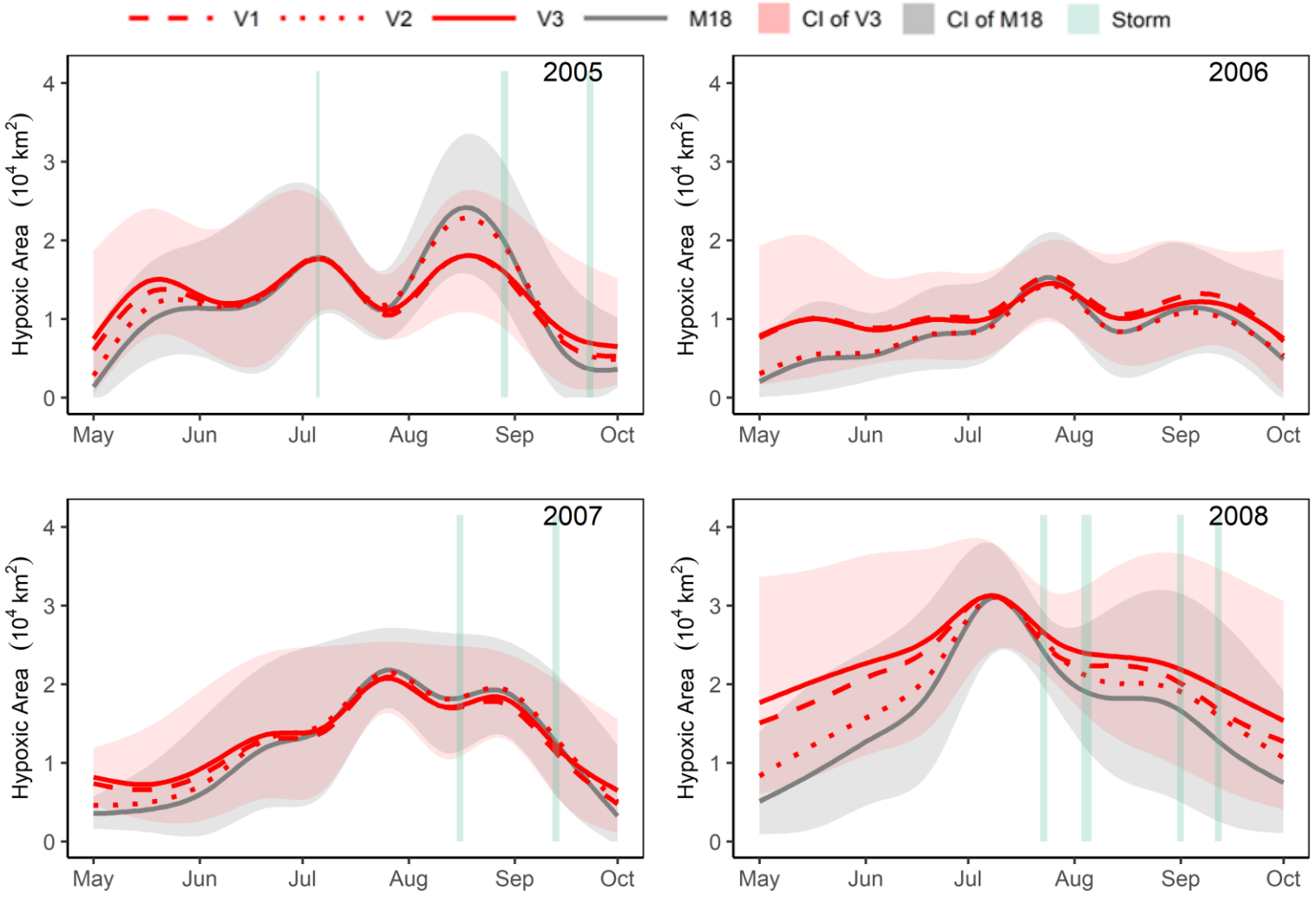

Figure S8F. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 2005-2008

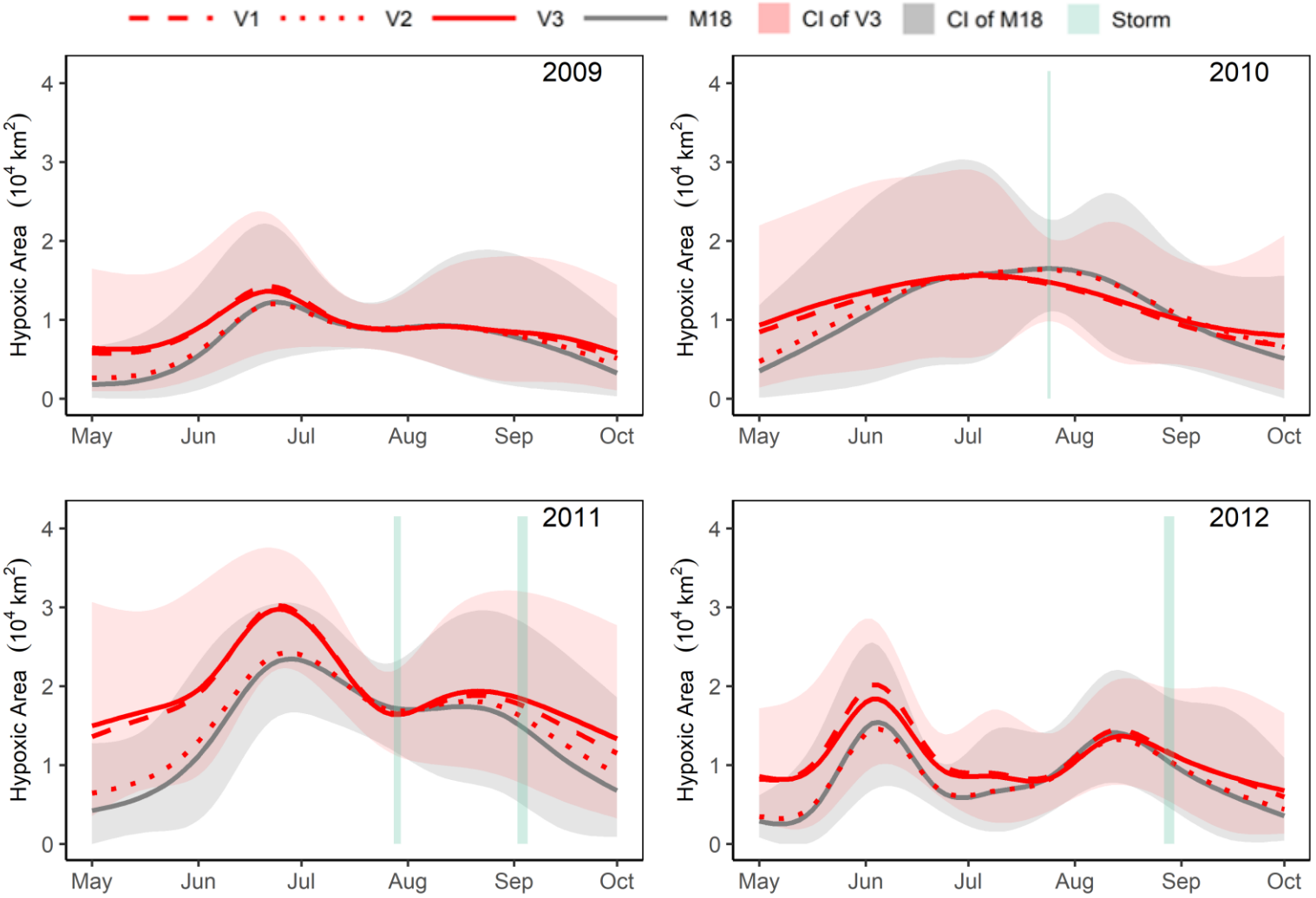

Figure S8G. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 2009-2012

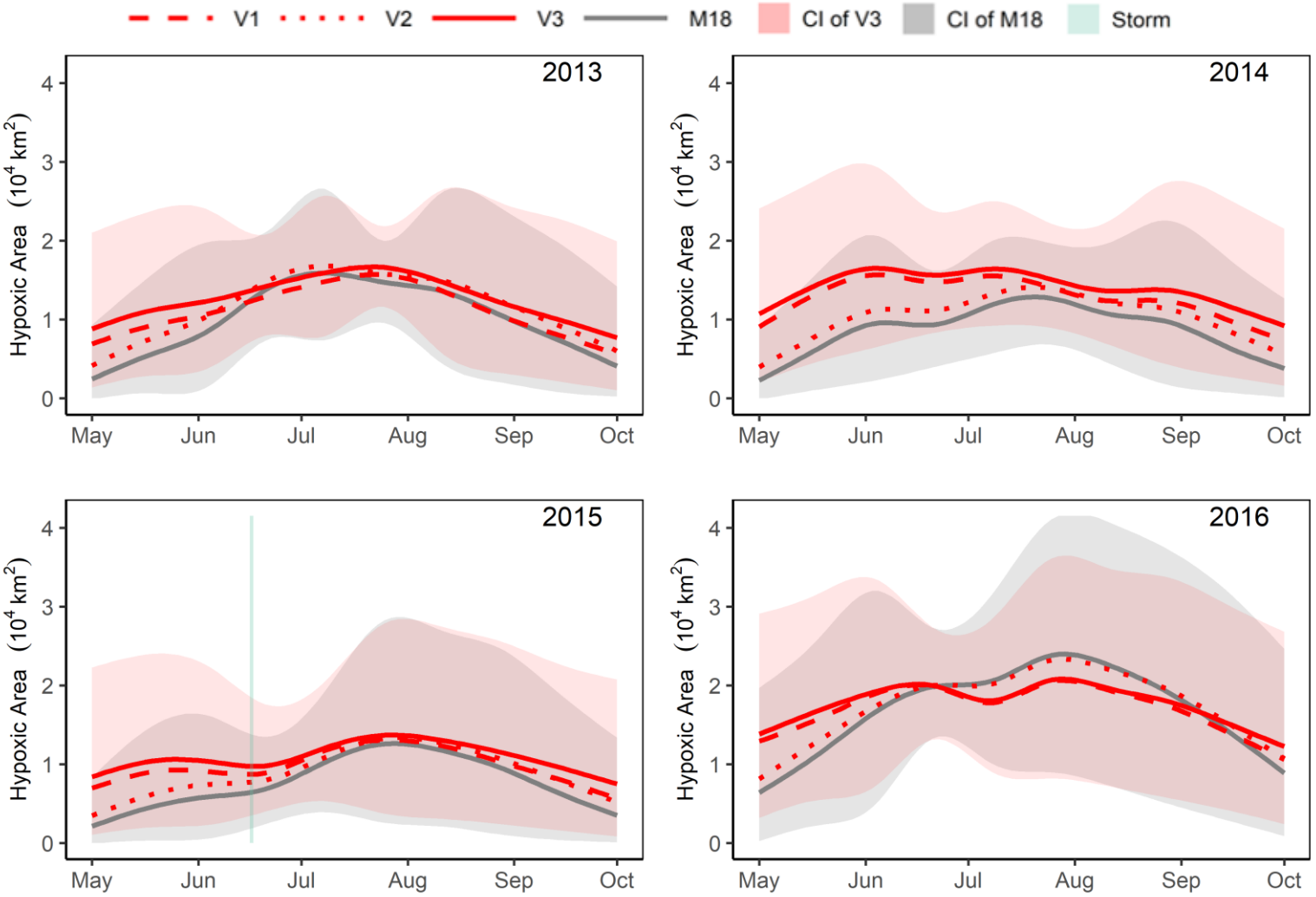

Figure S8H. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 2013-2016

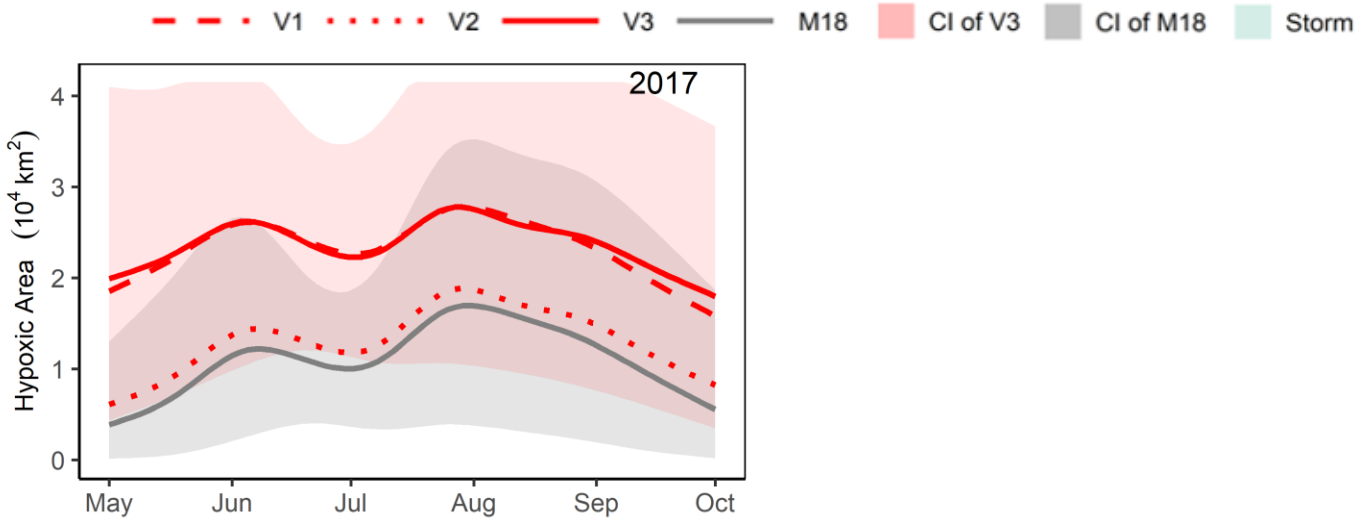

Figure S8I. Daily estimates (at 3-day intervals) of hypoxic extent and their 95% CI (confidence intervals) across the summer for 2017

SI-9: Coefficient of variations (C_v) of daily hypoxic area from each month of all models

Month	M18	V1	V2	V3
May	0.725	0.547	0.632	0.506
June	0.470	0.414	0.437	0.396
July	0.299	0.288	0.289	0.282
August	0.423	0.409	0.401	0.391
September	0.649	0.577	0.582	0.530

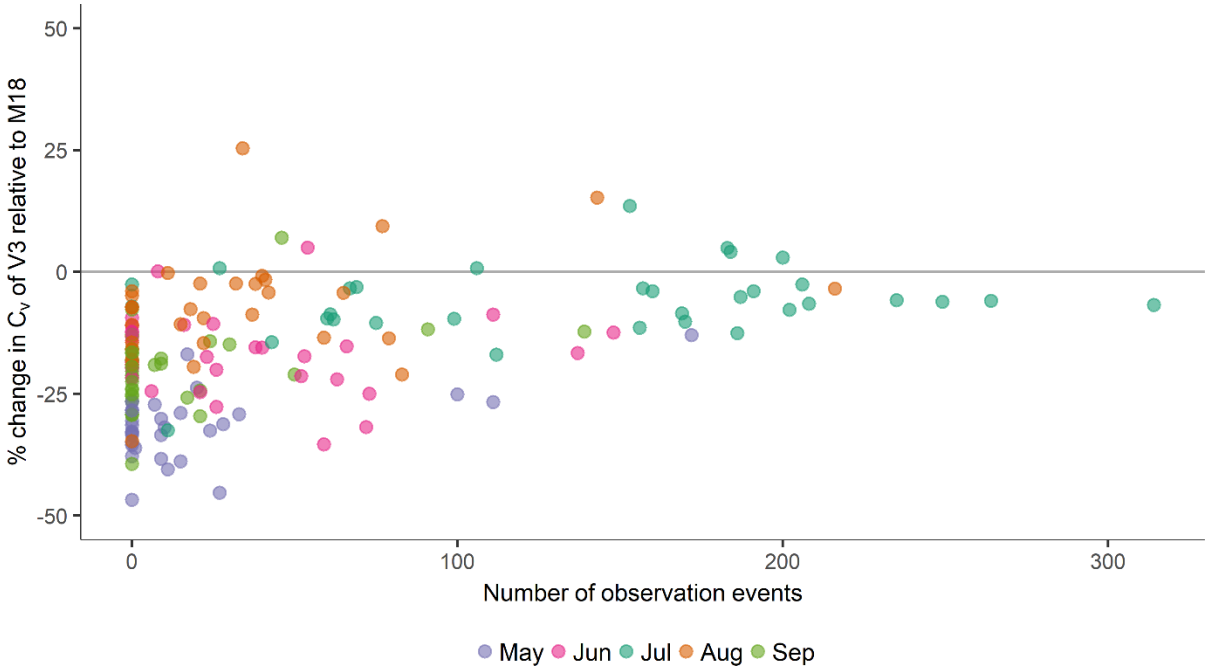

Figure S9. Change in C_v of V3 relative to M18 compared to number of observation events categorized by month (below zero indicates a reduction in uncertainty).

(change = {C_v of V3 – C_v of M18}/ C_v of M18)

SI-10: Comparisons of estimates and coefficients of variations of summer aggregates from V3 to M18

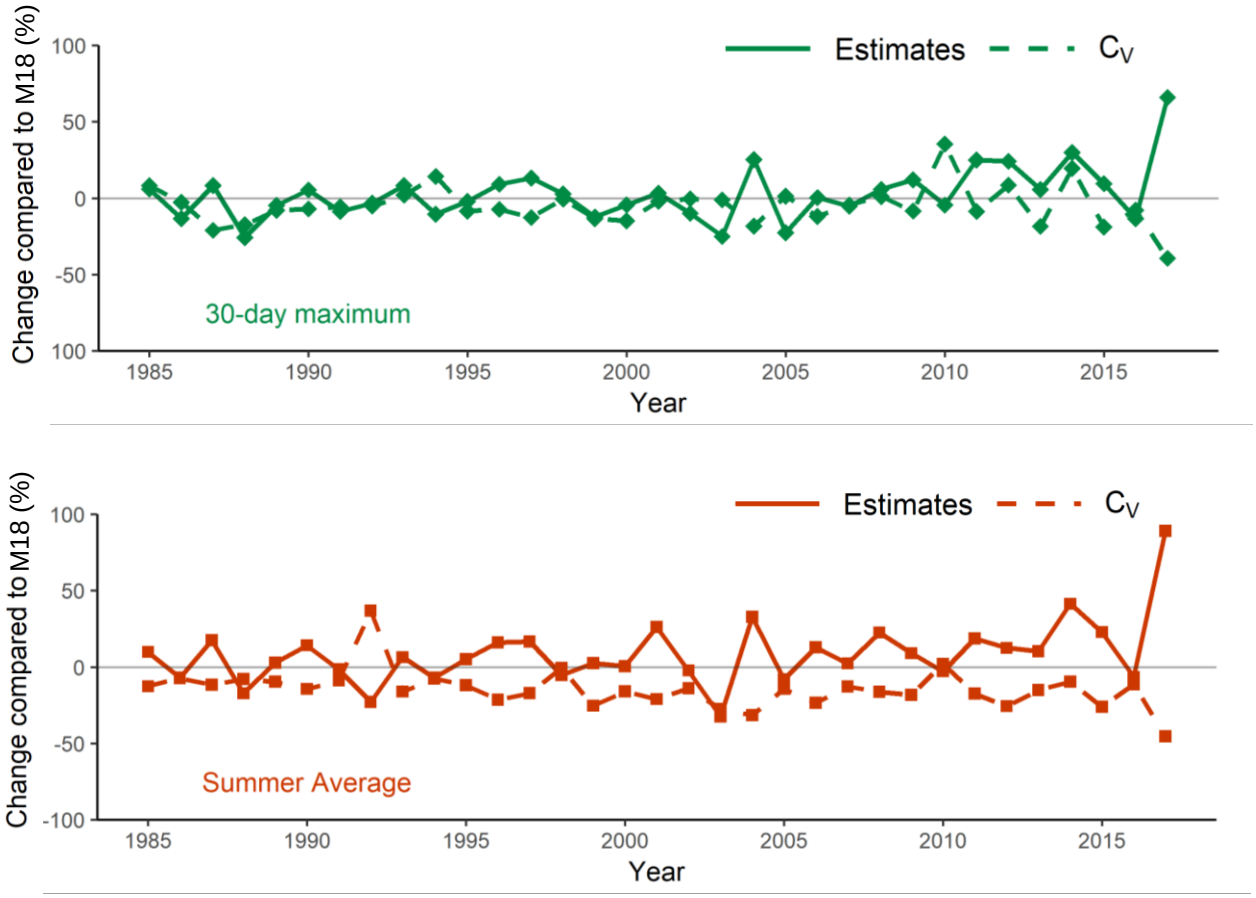

Figure S10. Changes in estimated values and uncertainty of 30-day maximum and summer average hypoxic extent from V3 compared to estimates from M18
(Change = {V3 – M18}/M18)