

The impact of climate extremes on northern and southern hemisphere seasonal ecosystem productivity over four decades to 2018

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SUPPLEMENTARY MATERIAL

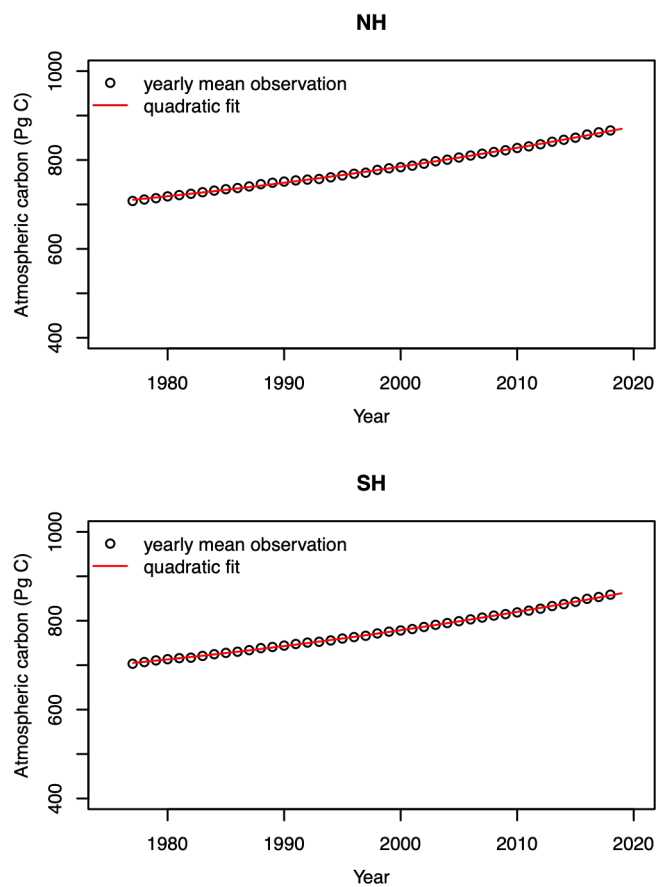


Figure S1. Quadratic equation fits to the yearly mean atmospheric carbon observations for the northern (NH) and southern hemisphere (SH) for the years 1977 to 2018. NH observations were from Mauna Loa (MLO, 20°N), Hawaii. SH observations were from Kennaook/Cape Grim (CGO, 41°S), Tasmania, Australia. The quadratic equation for the NH was: atmospheric carbon= $111,500 - 115\text{year} + 0.0296\text{year}^2$. The quadratic equation for the SH was atmospheric carbon= $105,900 - 109\text{year} + 0.0282\text{year}^2$.

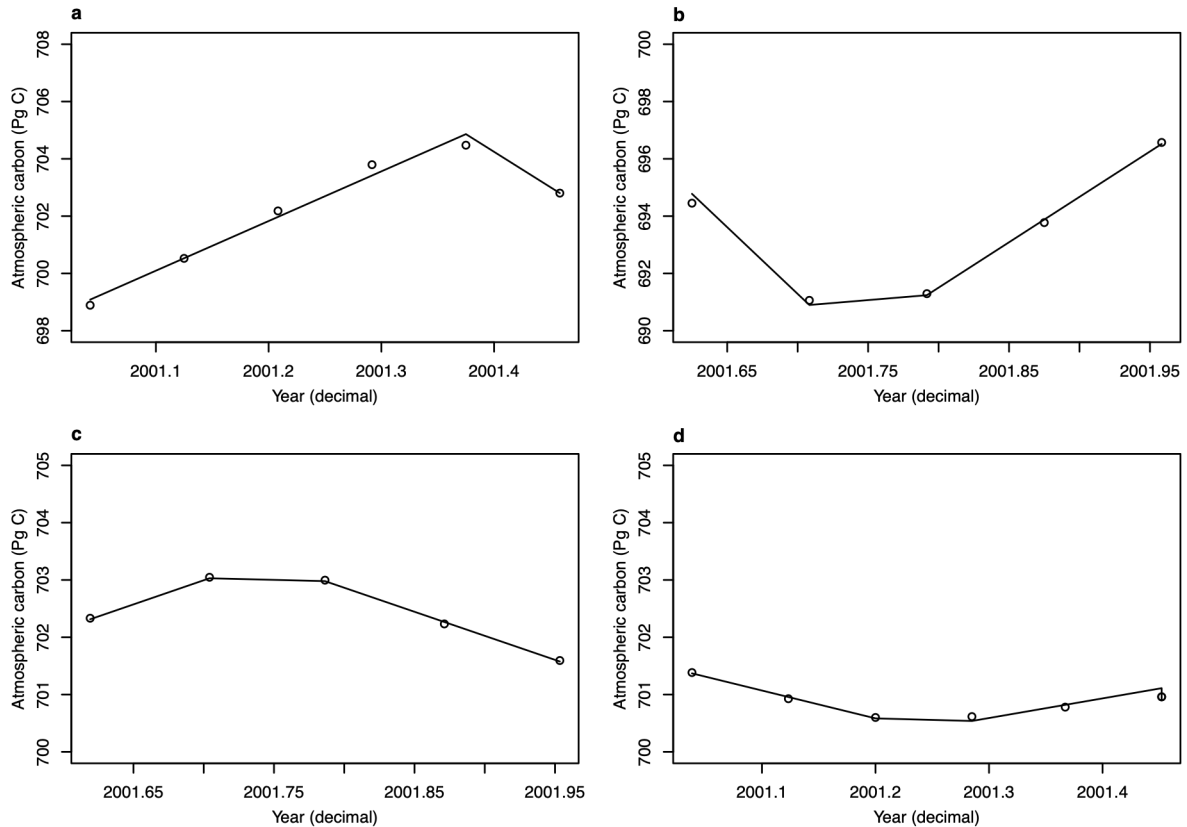


Figure S2. An example of the segmented linear model fit to monthly atmospheric C observations (with yearly mean anthropogenic increases removed) for the year 2001 in the northern (a, b) and southern hemispheres (c, d). For the Northern hemisphere, the observations were separated into the first and last 6 months of the year with the first half of the year capturing the peak (~May) in atmospheric release (equivalent to the end of the ecosystem C release period), and the second half of the year capturing the trough (~September) in atmospheric release (equivalent to the start of the ecosystem C uptake period). For the southern hemisphere, the second half of the year capturing the peak (~July) in atmospheric release (equivalent to the end of the ecosystem C release period), and the first half of the year capturing the trough (~February) in atmospheric release (equivalent to the start of the ecosystem C uptake period). The linear model fit between peak and trough was used to calculate the seasonal C uptake rate, and that rate multiplied by the timespan between the peak and trough provided the amount of seasonal C uptake. Similarly, the linear model fit between the trough and peak was used to calculate the seasonal C release rate, and that rate multiplied by the timespan between the trough and peak provided the amount of seasonal C release. Seasonal C uptake minus seasonal C release provided the net seasonal productivity (NSP).

Table S1. Linear regression statistical parameters of the seasonal carbon exchange variable response to year (yr) or Southern Oscillation Index (SOI) using data for the years of 1977 to 2018. Abbreviations: NH, Northern Hemisphere; SH, Southern Hemisphere; NSP, net seasonal productivity. All variables have 40 degrees of freedom.

Variable	Intercept	Slope	F-statistic	r^2	P-value
NH uptake rate (Tg C d ⁻¹ yr ⁻¹)	-105	0.118	0.881	-0.003	0.354
SH uptake rate (Tg C d ⁻¹ yr ⁻¹)	54.9	-0.0213	0.125	-0.0218	0.726
NH release rate (Tg C d ⁻¹ yr ⁻¹)	27.4	0.0196	0.0501	-0.0237	0.824
SH release rate (Tg C d ⁻¹ yr ⁻¹)	27.6	-0.00439	0.00336	-0.0249	0.954
NH uptake span (d yr ⁻¹)	86.1	0.0192	0.0338	-0.0241	0.855
SH uptake span (d yr ⁻¹)	-3.68	0.114	0.0691	-0.0232	0.794
NH release span (d yr ⁻¹)	279	-0.0195	0.0273	-0.0243	0.870
SH release span (d yr ⁻¹)	27.6	-0.00439	0.00336	-0.0249	0.954
NH uptake (Pg C yr ⁻¹)	-17.4	0.0169	1.83	0.0199	0.184
SH uptake (Pg C yr ⁻¹)	2	0.00003	0.0009	-0.0250	0.976
NH release (Pg C yr ⁻¹)	12.7	0.00165	0.00715	-0.0248	0.933
SH release (Pg C yr ⁻¹)	-6.62	0.00456	0.183	-0.0203	0.671
NH NSP (Pg C yr ⁻¹)	-30.1	0.0152	0.531	-0.0116	0.471
SH NSP (Pg C yr ⁻¹)	-6.12	0.00313	0.0235	-0.0244	0.879
NH uptake (Pg C SOI ⁻¹)	16.3	-0.253	2.63	0.0381	0.113
SH uptake (Pg C SOI ⁻¹)	2.71	0.328	3.76	0.063	0.0597
NH release (Pg C SOI ⁻¹)	16	-0.766	12.8	0.223	0.00094
SH release (Pg C SOI ⁻¹)	2.6	-0.218	2.73	0.0405	0.106
NH NSP (Pg C SOI ⁻¹)	0.273	0.513	4.13	0.071	0.0488
SH NSP (Pg C SOI ⁻¹)	0.12	0.546	5.05	0.0898	0.0303