

1 **Supplementary Material**

2 **for**

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4 **Small anomalies in dry-season greenness and chlorophyll fluorescence for Amazon moist**  
5 **tropical forests during El Niño and La Niña**

6  
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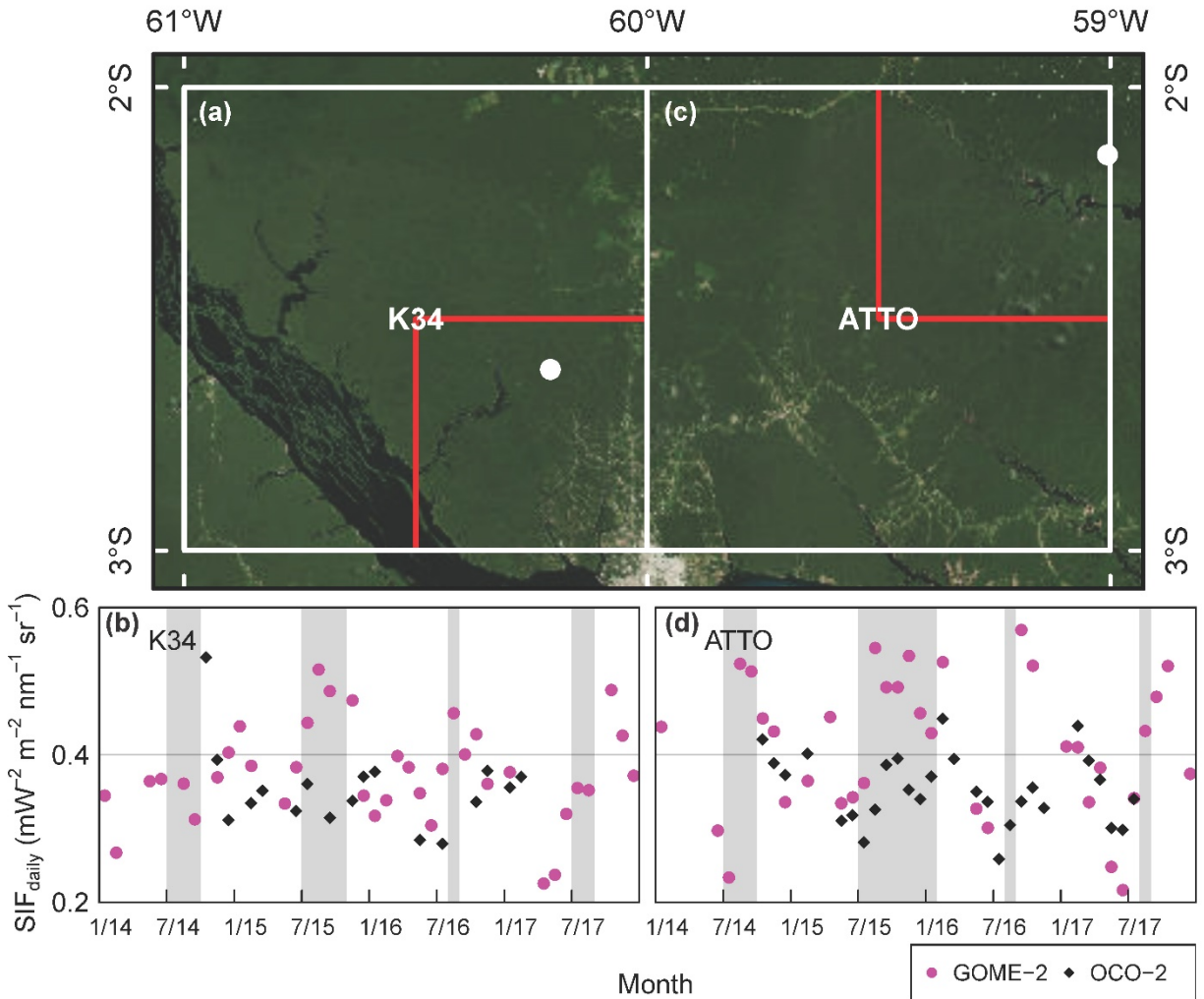
25

26 **Text S1**

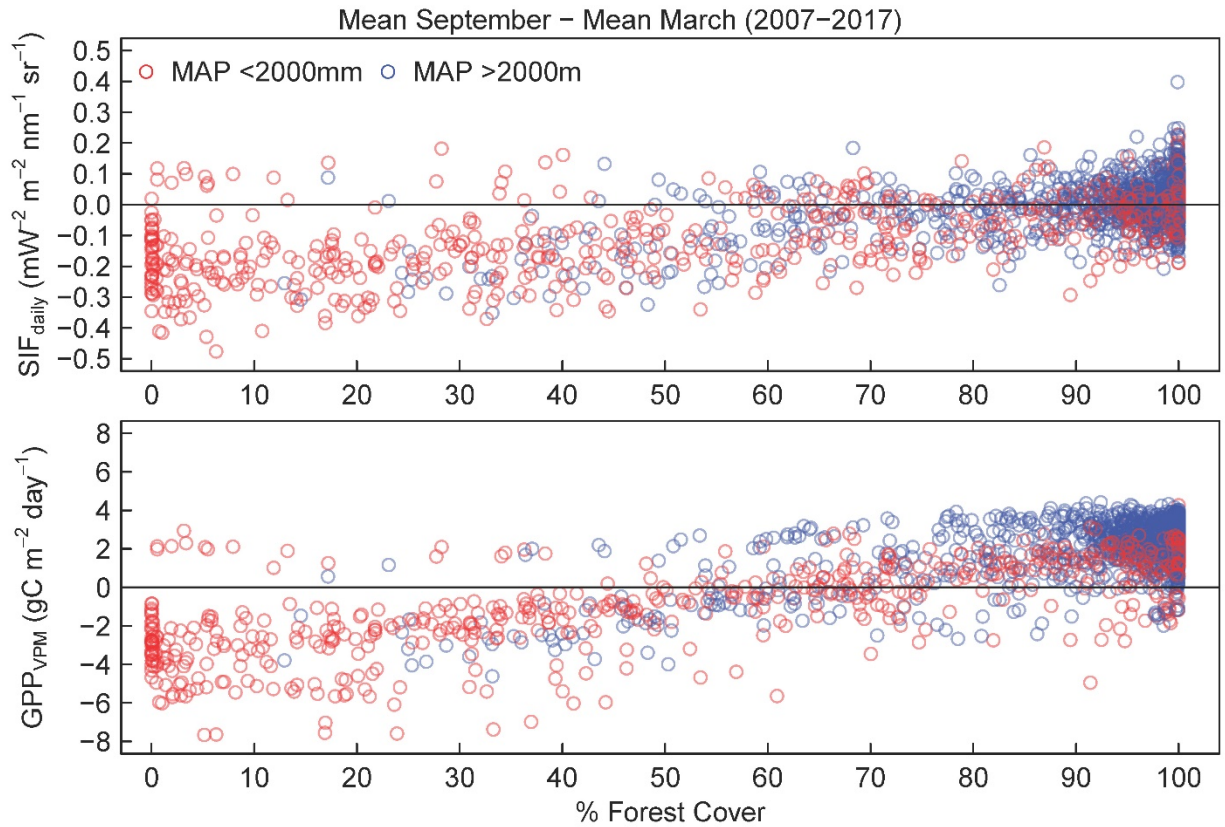
27 The original, unfiltered GOME-2 SIF data (including negative values) were used in all data  
28 analysis as instructed in the GOME-2 Read Me file at:

29 [https://avdc.gsfc.nasa.gov/pub/data/satellite/MetOp/GOME\\_F/README\\_GOME-F\\_v27.pdf](https://avdc.gsfc.nasa.gov/pub/data/satellite/MetOp/GOME_F/README_GOME-F_v27.pdf).

30 For better visualization of the GOME-2 SIF data in Figure S1, we used three thresholds to exclude  
31 outliers most likely affected by noise: SIF must 1) not be less than 0.2 ( $0.2 \leq \text{SIF}$ ); 2) not be less  
32 than 50% of the previous and subsequent SIF value ( $\text{SIF}_{t-1} \times 0.5 \leq \text{SIF}_t \leq \text{SIF}_{t+1} \times 0.5$ ); and 3)  
33 not be more than 150% of the previous and subsequent SIF value ( $\text{SIF}_{t-1} \times 1.5 \geq \text{SIF}_t \geq \text{SIF}_{t+1} \times$   
34 1.5). If  $\text{SIF}_t$  could not be determined because  $\text{SIF}_{t-1}$  and/or  $\text{SIF}_{t+1}$  observations were poor quality  
35 or missing, then the nearest good observation was used in the threshold (e.g.,  $\text{SIF}_{t-2}$  and/or  $\text{SIF}_{t+2}$ ).



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 37 **Figure S1. Satellite imagery and observations of SIF for two Amazon forest gridcells during**  
 38 **2014-2017.** In (a) and (c), the white boxes are 1° OCO-2 gridcells, the red boxes are 0.5° GOME-  
 39 2 gridcells, and the white dots are the approximate locations of the eddy covariance towers. Shaded  
 40 areas in (b) and (d) are dry months with <100 mm of precipitation. GOME-2 SIF data in the charts  
 41 (b, d) were aggregated to 1° to match the footprint of OCO-2.



42  
 43 **Figure S2. The difference between mean September SIF and GPP and mean March SIF and**  
 44 **GPP 2007-2017 for all gridcells in the Amazon Basin.** Positive values indicate that SIF or GPP  
 45 was higher on average in September. Negative values indicate that SIF or GPP was higher on  
 46 average in March. Only gridcells that were consistently >80% or <80% were used.  
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48 **Table S1. Summary of the two study sites.** The site name, latitude, and longitude of each eddy  
 49 tower. The percentage of forest cover within each 0.5° (GOME-2) and 1.0° (OCO-2) pixel, and  
 50 the net change in forest cover over the study period (2007-2017).

Site	Latitude	Longitude	2017 Forest Cover 0.5° (% Δ 2007-17)	2017 Forest Cover 1° (% Δ 2007-17)
ATTO	-2.1458	-59.006	99.3% (+0.1%)	99.2% (-0.2%)
K34	-2.609	-60.209	96.2% (-0.1%)	88.4% (-0.3%)

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52 **Table S2. One-sample t-test results for September in the 2008 La Niña and 2010 El Niño and**  
 53 **the percentage difference between normal and ENSO event for SIF, GPP, EVIn, and NDVIn.**  
 54 One-sample t-tests were conducted to determine if the difference between September SIF, GPP,  
 55 EVIn, and NDVIn during the ENSO phases and the mean for all remaining Septembers was  
 56 significantly different from zero. The distributions were illustrated in Fig. 4.

Amazon Basin								
September	ENSO	Gridcells (n)	$\Delta$	95% CI	t-value	p-value	Norm	% $\Delta$
2007 SIF	2007- 2008 La Niña	1960	-0.045	-0.05, -0.04	-15.70	<0.001	0.41	-10.98%
2007 GPP		195434	-0.434	-0.44, -0.43	-250.57	<0.001	11.84	-3.67%
2007 EVIn		188637	-0.017	-0.018, -0.017	-395.13	<0.001	0.437	-3.89%
2007 NDVIn		188639	-0.014	-0.014, -0.014	-202.4	<0.001	0.737	-1.90%
2009 SIF	2009- 2010 El Niño	1967	0.049	0.04, 0.05	18.81	<0.001	0.41	11.95%
2009 GPP		195436	0.49	0.49, 0.49	304.89	<0.001	11.84	4.14%
2009 EVIn		193787	0.012	0.012, 0.012	250.07	<0.001	0.437	2.75%
2009 NDVIn		193777	0.014	0.14, 0.14	195.16	<0.001	0.737	1.90%
Gridcells >80% Forest and >2000mm MAP								
2007 SIF	2007- 2008 La Niña	1169	-0.031	-0.04, -0.02	-9.20	<0.001	0.466	-6.65%
2007 GPP		109376	-0.548	-0.55, -0.54	-253.94	<0.001	8.68	-6.31%
2007 EVIn		108004	-0.019	-0.19, -0.19	-501.46	<0.001	0.487	-3.90%
2007 NDVIn		108004	-0.012	-0.013, -0.013	-229.79	<0.001	0.818	-1.47%
2009 SIF	2009- 2010 El Niño	1166	0.041	0.04, 0.05	13.24	<0.001	0.466	8.80%
2009 GPP		109379	0.502	0.50, 0.51	252.05	<0.001	8.68	5.78%
2009 EVIn		109120	0.009	0.009, 0.009	260.59	<0.001	0.487	1.85%
2009 NDVIn		109120	0.006	0.006, 0.006	158.82	<0.001	0.818	0.73%

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59 **Table S3. One-sample t-test results for September in the 2011 La Niña and 2016 El Niño and**  
60 **the percentage difference between normal and ENSO event for SIF, GPP, EVIn, and NDVIn.**  
61 One-sample t-tests were conducted to determine if the difference between September SIF, GPP,  
62 EVIn, and NDVIn during the ENSO phases and the mean for all remaining Septembers was  
63 significantly different from zero. The distributions were illustrated in Fig. 5.

Amazon Basin								
September	ENSO	Gridcells (n)	$\Delta$	95% CI	t-value	p-value	Norm	% $\Delta$
2010 SIF	2010- 2011 La Niña	1966	-0.047	-0.05, -0.04	-18.89	<0.001	0.41	-11.46%
2010 GPP		195434	-0.025	-0.029, -0.022	-13.90	<0.001	11.84	-0.21%
2010 EVIn		193009	-0.021	-0.021, -0.021	-395.20	<0.001	0.437	-4.81%
2010 NDVIn		193012	-0.025	-0.025, -0.025	-325.26	<0.001	0.737	-3.39%
2015 SIF	2015- 2016 El Niño	1967	0.006	0.01, 0.01	3.01	<0.01	0.41	1.46%
2015 GPP		195431	0.389	0.39, 0.39	218.16	<0.001	11.84	3.29%
2015 EVIn		193639	0.002	0.002, 0.002	37.02	<0.001	0.437	0.46%
2015 NDVIn		193633	0.008	0.007, 0.008	122.82	<0.001	0.737	1.09%
Gridcells >80% Forest and >2000mm MAP								
2010 SIF	2010- 2011 La Niña	1164	-0.045	-0.05, -0.04	-15.38	<0.001	0.466	-9.66%
2010 GPP		109378	0.107	0.102, 0.111	46.53	<0.001	8.68	1.23%
2010 EVIn		108643	-0.019	-0.019, -0.019	-441.16	<0.001	0.487	-3.90%
2010 NDVIn		108643	-0.019	-0.019, -0.019	-373.66	<0.001	0.818	-2.32%
2015 SIF	2015- 2016 El Niño	1156	0.007	0.001, 0.01	2.74	<0.01	0.466	1.50%
2015 GPP		109377	0.434	0.429, 0.439	183.64	<0.001	8.68	5.00%
2015 EVIn		109092	-0.002	-0.002, -0.002	-60.80	<0.001	0.487	-0.41%
2015 NDVIn		109092	0.005	0.005, 0.005	136.17	<0.001	0.818	0.61%

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66 **Table S4. One-sample t-test results for dry season during the 2008 La Niña and 2010 El Niño**  
67 **and the percentage difference between normal and ENSO event for SIF, GPP, EVIn, and**  
68 **NDVIn.** One-sample t-tests were conducted to determine if the difference between dry-season  
69 (June through October) SIF, GPP, EVIn, and NDVIn during the ENSO phases and the mean for  
70 all remaining dry seasons was significantly different from zero. The distributions were illustrated  
71 in Fig. 6.

Amazon Basin								
Dry Season	ENSO	Gridcells (n)	$\Delta$	95% CI	t-value	p-value	Norm	% $\Delta$
2007 SIF	2007- 2008 La Niña	1967	-0.002	-0.004, 0.001	-1.28	0.202	0.388	-0.52%
2007 GPP		195436	-0.231	-0.23, -0.23	-209.02	<0.001	6.824	-3.39%
2007 EVIn		194285	-0.011	-0.011, -0.011	-339.39	<0.001	0.445	-2.47%
2007 NDVIn		194012	-0.006	-0.006, -0.006	-129.65	<0.001	0.758	-0.79%
2009 SIF	2009- 2010 El Niño	1967	0.026	0.02, 0.03	21.61	<0.001	0.388	6.70%
2009 GPP		195437	0.189	0.19, 0.19	178.75	<0.001	6.824	2.77%
2009 EVIn		194279	0.005	0.005, 0.005	155.23	<0.001	0.445	1.12%
2009 NDVIn		194226	0.006	0.006, 0.006	111.99	<0.001	0.758	0.79%
Gridcells with >80% Forest and >2000mm MAP								
2007 SIF	2007- 2008 La Niña	1148	0.003	0.001, 0.006	-2.02	0.043	0.43	0.70%
2007 GPP		109378	-0.321	-0.32, -0.32	-235.23	<0.001	7.777	-4.13%
2007 EVIn		109213	-0.013	-0.013, -0.013	-515.31	<0.001	0.487	-2.67%
2007 NDVIn		108946	-0.006	-0.006, -0.006	-221.46	<0.001	0.829	-0.72%
2009 SIF	2009- 2010 El Niño	1148	0.023	0.02, 0.03	15.50	<0.001	0.43	5.35%
2009 GPP		109379	0.127	0.12, 0.13	100.58	<0.001	7.777	1.63%
2009 EVIn		108808	0.004	0.003, 0.004	146.21	<0.001	0.487	0.82%
2009 NDVIn		108731	<0.001	<0.001, <0.001	9.27	<0.001	0.829	0.12%

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74 **Table S5. One-sample t-test results for dry season during the 2011 La Niña and 2016 El Niño**  
75 **and the percentage difference between normal and ENSO event for SIF, GPP, EVIn, and**  
76 **NDVIn.** One-sample t-tests were conducted to determine if the difference between dry-season  
77 (June through October) SIF, GPP, EVIn, and NDVIn during the ENSO phases and the mean for  
78 all remaining dry seasons was significantly different from zero. The distributions were illustrated  
79 in Fig. 7.

Amazon Basin								
Dry Season	ENSO	Gridcells (n)	$\Delta$	95% CI	t-value	p-value	Norm	% $\Delta$
2010 SIF	2010- 2011 La Niña	1967	-0.009	-0.01, -0.01	-7.70	<0.001	0.388	-2.32%
2010 GPP		195436	-0.005	-0.01, -0.01	-3.98	<0.001	6.824	-0.07%
2010 EVIn		194706	-0.011	-0.011, -0.011	-286.27	<0.001	0.445	-2.47%
2010 NDVIn		194767	-0.014	-0.014, -0.013	-255.42	<0.001	0.758	-1.85%
2015 SIF	2015- 2016 El Niño	1967	-0.014	-0.01, -0.01	-12.89	<0.01	0.388	-3.61%
2015 GPP		195432	0.151	0.15, 0.15	132.74	<0.001	6.824	2.21%
2015 EVIn		193862	-0.002	-0.002, 0.001	-41.80	<0.001	0.445	-0.45%
2015 NDVIn		193764	0.002	0.002, 0.002	45.9	<0.001	0.758	0.26%
Gridcells with >80% Forest and >2000mm MAP								
2010 SIF	2010- 2011 La Niña	1148	-0.006	-0.01, -0.01	-3.90	<0.001	0.43	-1.40%
2010 GPP		109379	0.006	0.003, 0.008	4.53	<0.001	7.777	0.08%
2010 EVIn		109100	-0.009	-0.009, -0.009	-361.62	<0.001	0.487	-1.85%
2010 NDVIn		109087	-0.009	-0.009, -0.009	-335.81	<0.001	0.829	-1.09%
2015 SIF	2015- 2016 El Niño	1148	-0.019	-0.02, 0.02	-14.46	<0.001	0.43	-4.42%
2015 GPP		109379	0.211	0.21, 0.21	143.67	<0.001	7.777	2.71%
2015 EVIn		108804	-0.004	-0.005, -0.004	-185.03	<0.001	0.487	-0.82%
2015 NDVIn		108618	<0.001	<0.001, <0.001	7.05	<0.001	0.829	0.12%

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