

Supplementary Material

Fire responses to the 2010 and 2015/2016 Amazonian droughts

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1 Absolute Values of the Rainfall, Temperature, Active Fire and Carbon Dioxide Emission (CO₂) Monthly Data

The Supplementary Table 1, 2, 3 and 4 present the absolute values of rainfall, temperature, active fire and CO₂ emission monthly data, respectively.

Supplementary Table 1. Mean of monthly rainfall data from CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) product, considering all pixels within the Brazilian Amazonia biome. In addition, monthly means (M) and standard deviations (SD) are presented, spanning 2006 to 2016.

Monthly Rainfall (mm month ⁻¹)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	289	283	300	296	245	132	107	79	96	138	186	208
2007	231	252	326	275	212	116	102	82	90	147	164	254
2008	305	280	343	257	236	127	96	81	99	137	178	281
2009	299	308	336	294	240	175	87	73	78	120	135	240
2010	268	238	258	281	196	117	106	71	74	139	184	241
2011	301	319	320	288	225	113	88	67	94	167	181	204
2012	314	304	315	244	172	105	104	67	93	138	176	226
2013	283	333	319	267	231	129	122	107	117	152	229	211
2014	261	326	347	285	243	130	84	94	86	140	193	205
2015	269	245	343	259	218	111	82	69	57	93	126	160
2016	217	199	342	248	182	116	99	80	115	146	186	289
M±SD	276±29	281±41	323±25	272±18	218±24	125±18	98±12	79±12	91±17	138±18	176±26	229±36

Supplementary Table 2. Mean of monthly surface temperature data from MODIS MOD11C3 product, considering all pixels within the Brazilian Amazonia biome. In addition, monthly means (M) and standard deviations (SD) spanning 2006 to 2016 are presented.

	Monthly Temperature (°C month ⁻¹)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	27.2	27.0	27.0	26.8	25.7	26.7	27.2	28.6	29.4	29.6	28.7	27.5
2007	27.3	27.8	27.4	26.8	26.2	26.9	27.2	28.7	29.4	29.6	29.3	27.6
2008	26.9	26.9	26.7	27.0	26.1	26.6	28.0	29.1	29.4	29.8	29.5	27.7
2009	26.8	27.0	27.0	26.6	26.4	26.2	27.5	28.8	29.7	29.9	29.5	28.1
2010	27.7	28.1	28.1	27.5	26.9	27.3	27.8	29.0	30.2	30.3	29.1	28.0
2011	26.9	27.0	27.0	26.8	26.5	27.0	27.9	29.2	29.6	29.5	28.4	28.0
2012	26.9	27.0	27.0	27.1	26.8	26.9	27.5	29.5	30.1	30.2	29.8	28.2
2013	27.3	27.4	27.8	27.2	26.8	26.9	27.2	28.1	29.3	29.5	28.8	27.9
2014	27.5	27.1	27.2	27.1	26.7	27.1	27.7	29.2	29.9	30.1	29.7	28.7
2015	27.9	27.8	27.8	27.4	27.0	27.4	28.2	29.8	30.9	31.2	30.4	29.6
2016	28.8	28.8	28.1	27.7	27.1	27.2	28.5	29.4	29.3	29.8	28.9	27.8
M±SD	27.3±0.4	27.3±0.4	27.3±0.4	27.0±0.3	26.5±0.4	26.9±0.3	27.6±0.3	29.0±0.5	29.8±0.5	30.0±0.5	29.3±0.6	28.1±0.6

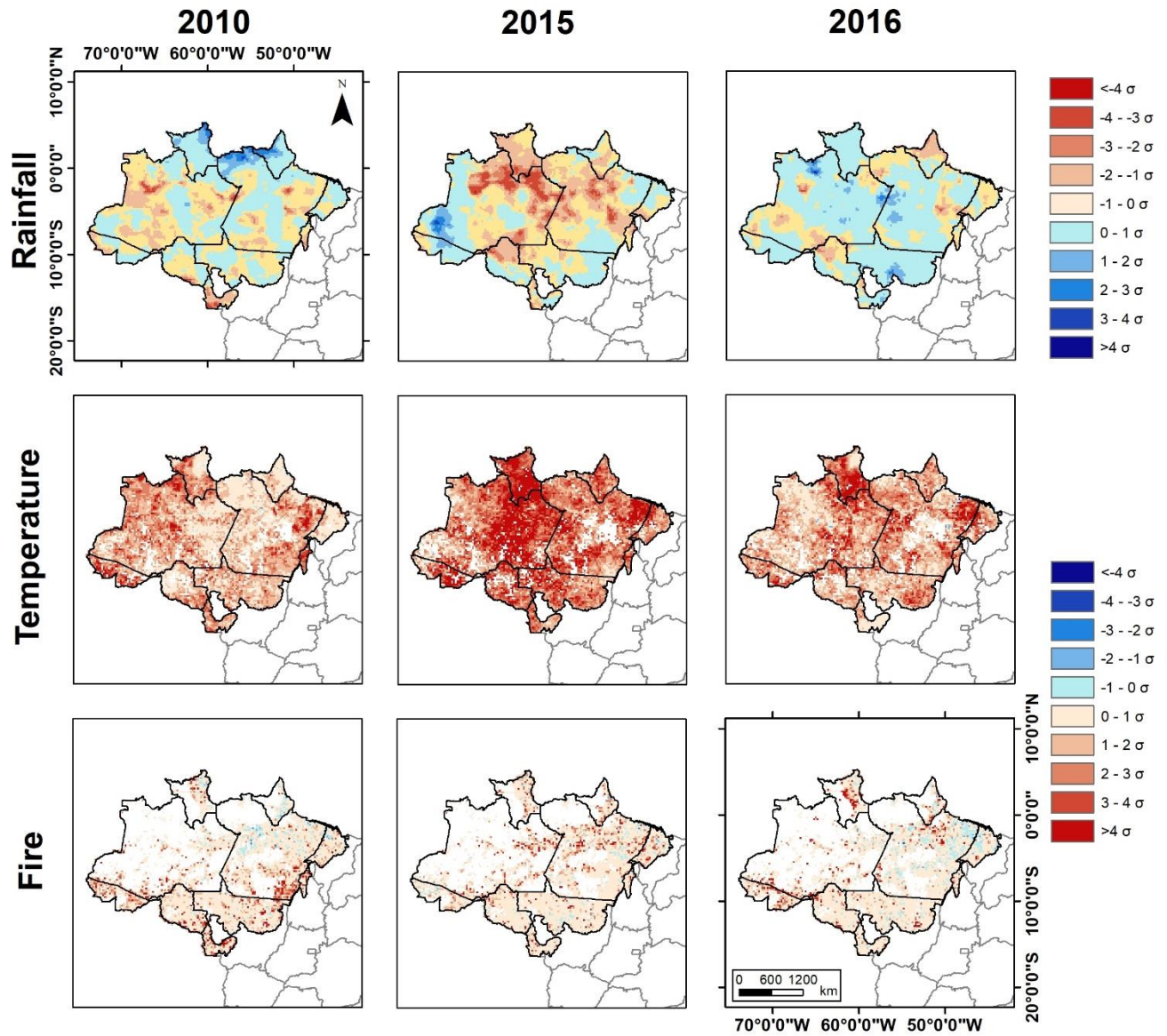
Supplementary Table 3. Count of monthly active fire data from MODIS MCD14ML product, considering all active fires within the Brazilian Amazonia biome. In addition, monthly means (M) and standard deviations (SD) spanning 2006 to 2016 are presented.

	Monthly Active Fire (count month ⁻¹)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	393	207	204	142	216	904	2793	16,509	25,864	7534	7452	3311
2007	438	621	481	130	260	1218	2295	23,340	37,589	13,350	6562	1761
2008	235	132	241	103	68	366	2316	9748	11,482	10,547	5955	1988
2009	208	65	97	77	139	349	659	3636	7507	7203	7918	2159
2010	461	406	224	99	250	639	2320	23,885	22,465	5837	4537	1578
2011	183	54	34	71	171	362	729	3196	7506	3633	3259	2281
2012	287	113	70	44	164	519	1042	9480	11,275	5354	4593	1792
2013	305	38	115	54	184	317	678	3274	6229	3613	2203	2543
2014	417	145	309	92	105	518	936	9011	7981	5491	4320	2455
2015	503	305	92	133	59	419	1009	9151	12,319	8311	6624	4382
2016	1881	511	795	153	165	439	2287	8228	8500	5739	4084	1595
M±SD	483±454	236±189	242±214	100±35	162±63	550±265	1551±797	10,860±7021	14,429±9509	6965±2791	5228±1718	2350±803

Supplementary Table 4. Carbon Dioxide (CO₂) Monthly Emission from GEFEDv4 (<http://www.globalfiredata.org>), considering the Brazilian Amazonia biome delimitation. In addition, monthly means (M) and standard deviations (SD) spanning 2006 to 2016 are presented.

	Monthly CO ₂ Emission (Tg month ⁻¹)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	0.546	0.274	0.759	0.534	0.764	2.685	8.439	48.924	44.324	6.102	4.081	1.960
2007	0.800	2.151	3.842	1.103	2.618	4.765	8.433	86.218	127.836	20.871	4.488	0.839
2008	0.303	0.323	0.689	0.463	0.605	1.572	6.995	35.691	24.834	10.693	4.322	1.206
2009	0.263	0.247	0.310	0.326	1.102	2.237	2.869	10.663	13.958	8.586	7.195	1.940
2010	0.832	2.066	1.216	1.515	2.432	2.484	9.826	117.955	85.402	6.552	2.144	0.843
2011	0.189	0.134	0.230	0.570	1.312	1.502	2.762	12.273	14.645	1.770	1.115	1.608
2012	0.435	0.476	1.276	1.003	2.125	3.091	3.506	41.697	48.364	6.567	6.529	2.211
2013	0.437	0.380	1.278	0.529	2.793	3.337	3.218	13.428	14.659	2.865	1.417	1.799
2014	0.633	0.378	0.914	0.819	2.859	3.288	3.693	39.621	26.936	9.743	4.476	2.950
2015	1.051	0.943	1.028	0.824	1.141	1.938	2.500	38.118	58.110	19.235	13.176	8.514
2016	7.020	0.867	3.903	1.249	1.666	2.382	6.958	22.489	23.141	13.791	7.813	3.786
M±SD	1.1±1.9	0.7±0.7	1.4±1.2	0.8±0.4	1.8±0.8	2.7±0.9	5.4±2.6	42.5±31.5	43.8±34.0	9.7±5.9	5.2±3.3	2.5±2.1

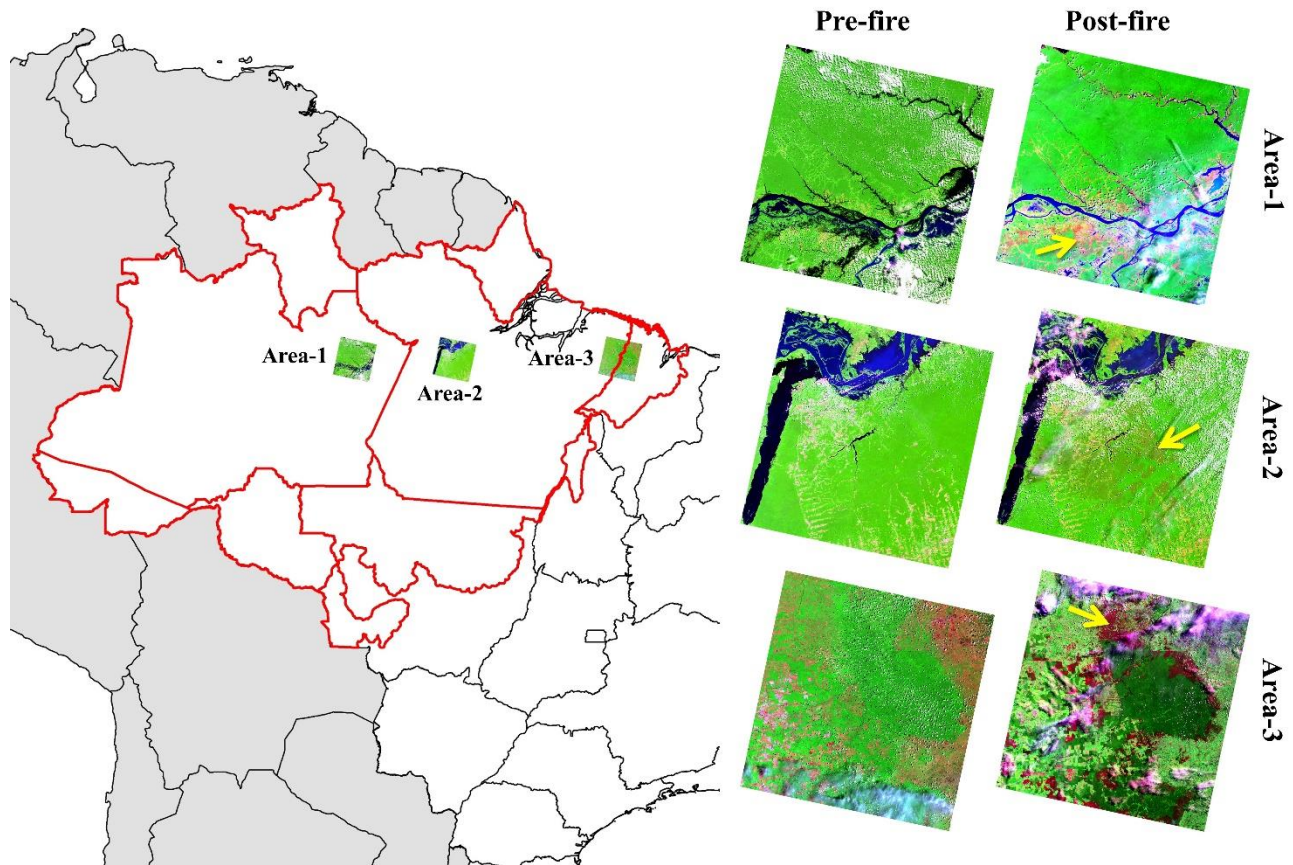
2 Annual Rainfall, Temperature and Fire Anomalies



Supplementary Figure 1. The first row of the figure shows the annual spatial pattern of rainfall anomalies for year the 2010, 2015 and 2016. The second row of the figure shows the annual spatial pattern of temperature anomalies for the year 2010, 2015 and 2016. The last row of the figure shows the annual spatial pattern of fire anomalies for the year 2010, 2015 and 2016. The anomaly calculation method is available in the main document.

3 Example of Wildfires during the 2015/2016 Amazonian Droughts

To compose the Supplementary Figure 2 we selected three areas in the north region of the Brazilian Amazonia biome. In these regions, extensive forest fires occurred during the 2015/2016 drought. We consider two dates for collected the Landsat-8 OLI imageries (<https://earthexplorer.usgs.gov/>), the first one before the fire event, and the other after the fire event.

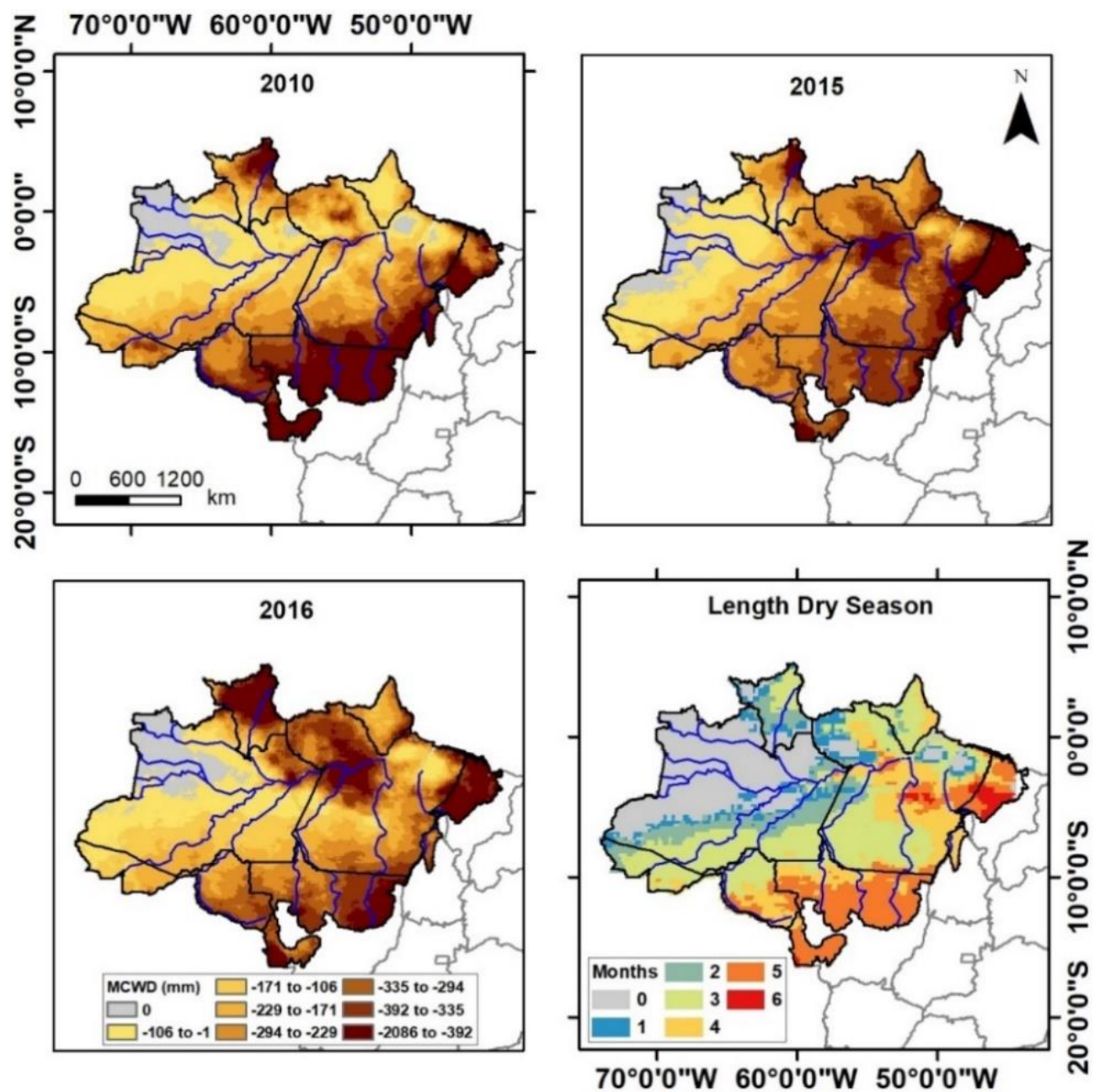


Supplementary Figure 2. Areas impacted by forest fires during the 2015/2016 drought in the Brazilian Amazonia biome. RGB composite: Shortwave Infrared 1 in Red, Near Infrared in Green and Red in Blue. In green are the old-growth and regrowth forests, in magenta the deforested areas and in purple the burned forests (indicated by the yellow arrows). The Area-1 corresponds to the Landsat Scene 230/62 (the pre-fire image was acquired on July 12, 2013, while the post-fire image was acquired on November 23, 2015). The Area-2 corresponds to the Landsat Scene 227/62 (the pre-fire image was acquired on August 14, 2015, while the post-fire image was acquired on August 16, 2016). The Area-3 corresponds to the Landsat Scene 222/62 (the pre-fire image was acquired on April 12, 2014, while the post-fire image was acquired on April 16, 2016).

4 Maximum Cumulative Water Deficit for 2010 and 2015/2016 Amazonian Drought

In Supplementary Figure 3, we show the Maximum Cumulative Water Deficit (MCWD; Aragão et al., 2007) calculated for the years 2010, 2015 and 2016 (Campanharo and Silva Junior, 2019), and the length dry season (Moura et al., 2015). We use the Equation 1 (Aragão et al., 2007) to calculate MCWD pixel by pixel, using the CHIRPS monthly rainfall time series (2006-2016) (Funk et al., 2015). In the Equation 1, Aragão et al. (2007) consider that onset and duration of the dry season in the Amazonia are defined by the approximation that moist tropical forests have a mean evapotranspiration (E) of 100 mm month⁻¹ (Rocha et al., 2004; Shuttleworth et al., 1989; Von Randow et al., 2004). Thus, when the monthly rainfall (P) for each month (n) is lower than E , the vegetation enters water deficit (WD). Then, the MCWD was calculated by selecting the minimum value of the CWD reached for each pixel within of a given year (i,j).

$$\left\{ \begin{array}{l} \textbf{If } WD_{n-1(i,j)} - E_{(i,j)} + P_{n(i,j)} < 0; \\ \textbf{Then } WD_{n(i,j)} = WD_{n-1(i,j)} - E_{(i,j)} + P_{n(i,j)}; \\ \textbf{Else } WD_{n(i,j)} = 0. \end{array} \right. \quad (1)$$



Supplementary Figure 3. The first three figures on the panel are the Maximum Cumulative Water Deficit (MCWD) for the years 2010, 2015 and 2016, respectively. The last figure in the panel is the spatial distribution of the length dry season within the Brazilian Amazonia biome. The length dry season was obtained from Moura et al. (2015), and was defined based on the rainfall threshold of 100 mm month⁻¹.

5 Supplementary References

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