

## Supplementary Materials for

### **The gathering firestorm in southern Amazonia**

P. M. Brando\*, B. Soares-Filho, L. Rodrigues, A. Assunção, D. Morton, D. Tuchschnieder, E. C. M. Fernandes, M. N. Macedo, U. Oliveira, M. T. Coe

\*Corresponding author. Email: pbrando@uci.edu

Published 10 January 2020, *Sci. Adv.* **6**, eaay1632 (2020)  
DOI: 10.1126/sciadv.aay1632

#### **This PDF file includes:**

Fig. S1. Components of our modeling framework.

Fig. S2. Spatial-temporal changes in VPD and MCWD for three time periods compared to 2010.

Fig. S3. Projected deforestation for the southern Amazon.

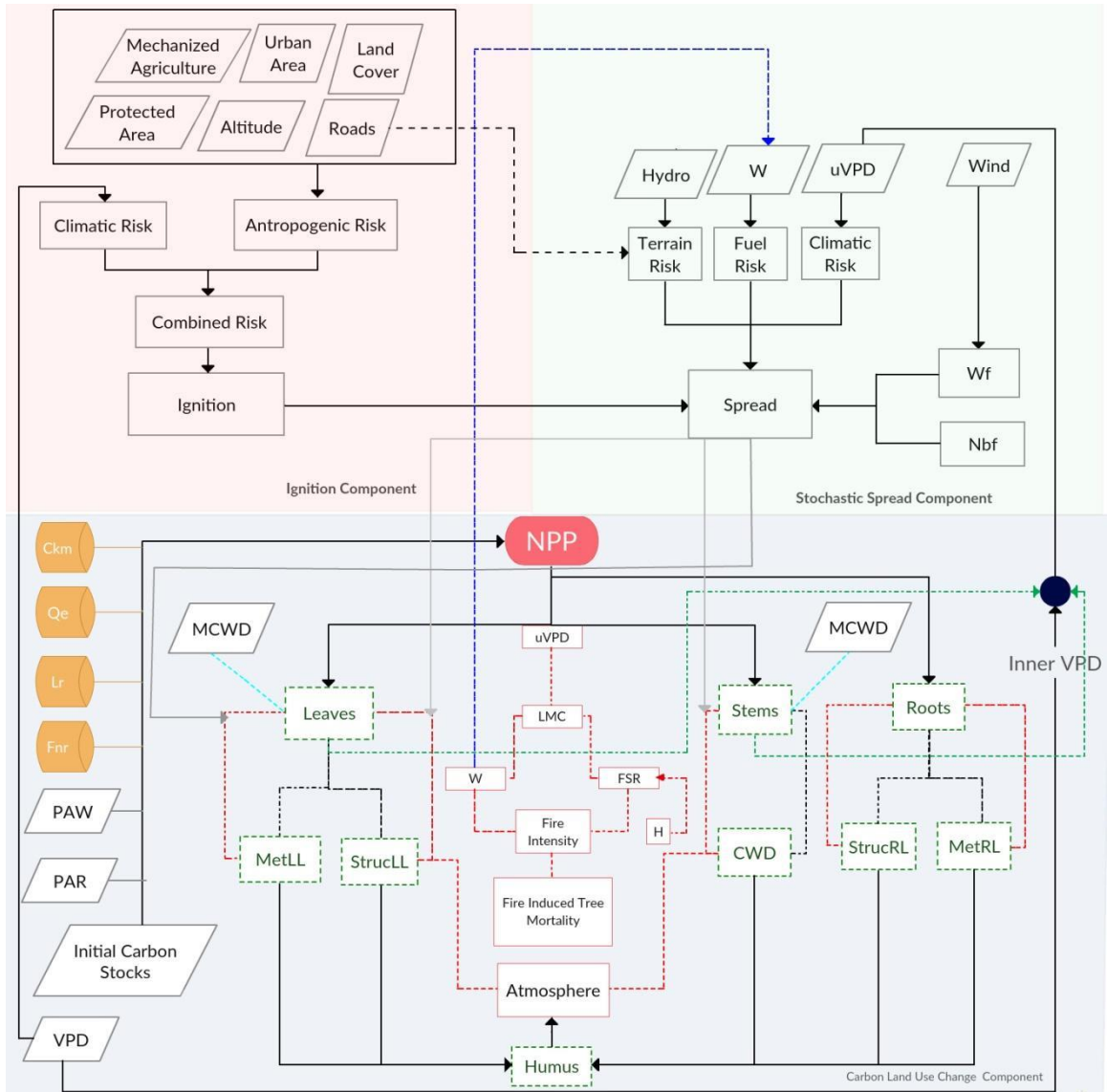
Table S1. Decadal fire-related emissions of different GHG emissions per decade from the 2000s to the 2050s.

Table S2. BA in millions of hectares for each decade and each one of the scenarios representing two deforestation (No deforestation: N; Deforestation: D) and climate pathways (RCP2.6; RCP8.5).

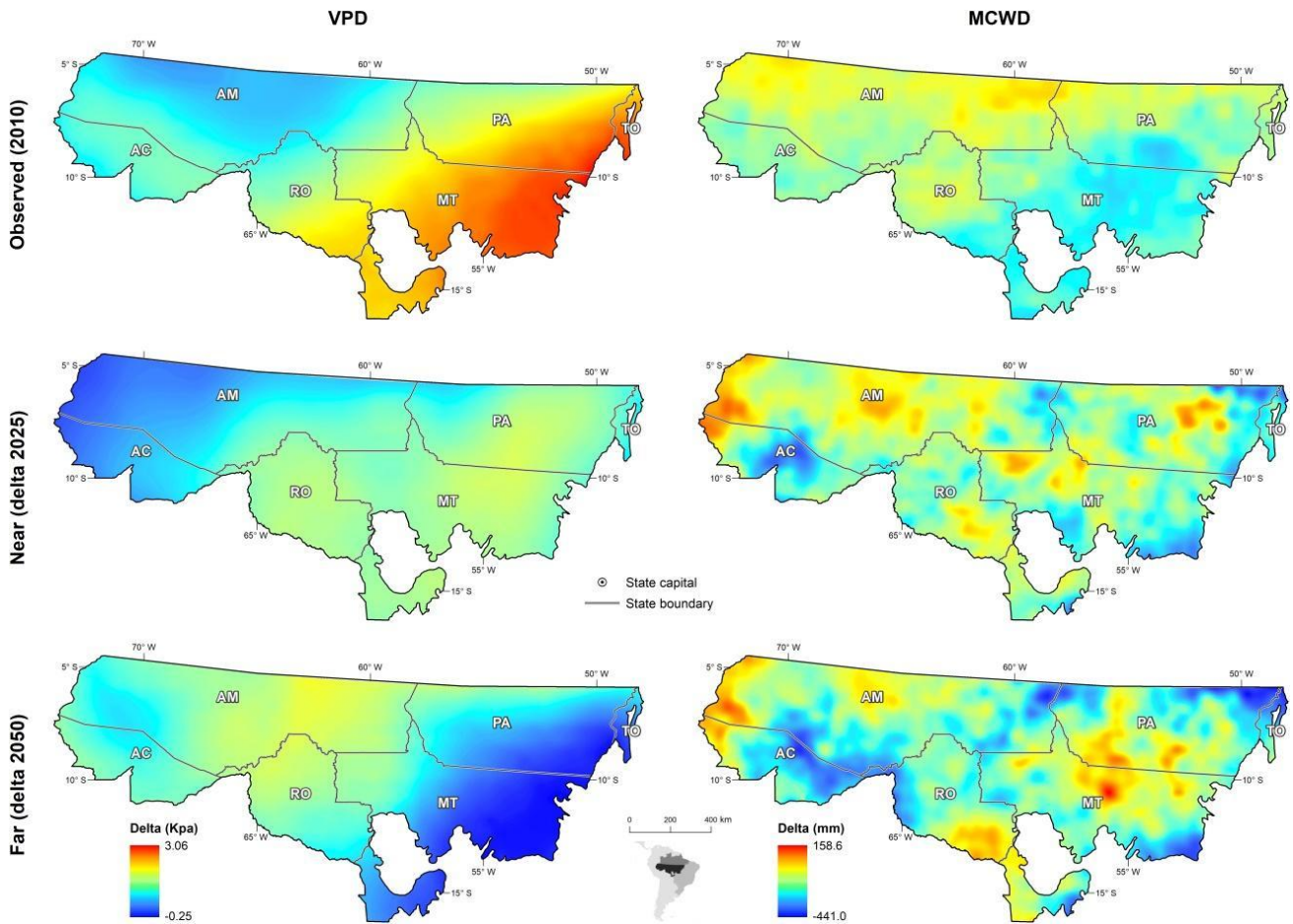
Table S3. Input variables used to run the fire ignition component of our fire model (FISC), the source of the data, and the link to download the data.

Table S4. Input variables used to run the fire spread component of our fire model (FISC), the source of the data, and the link to download the data.

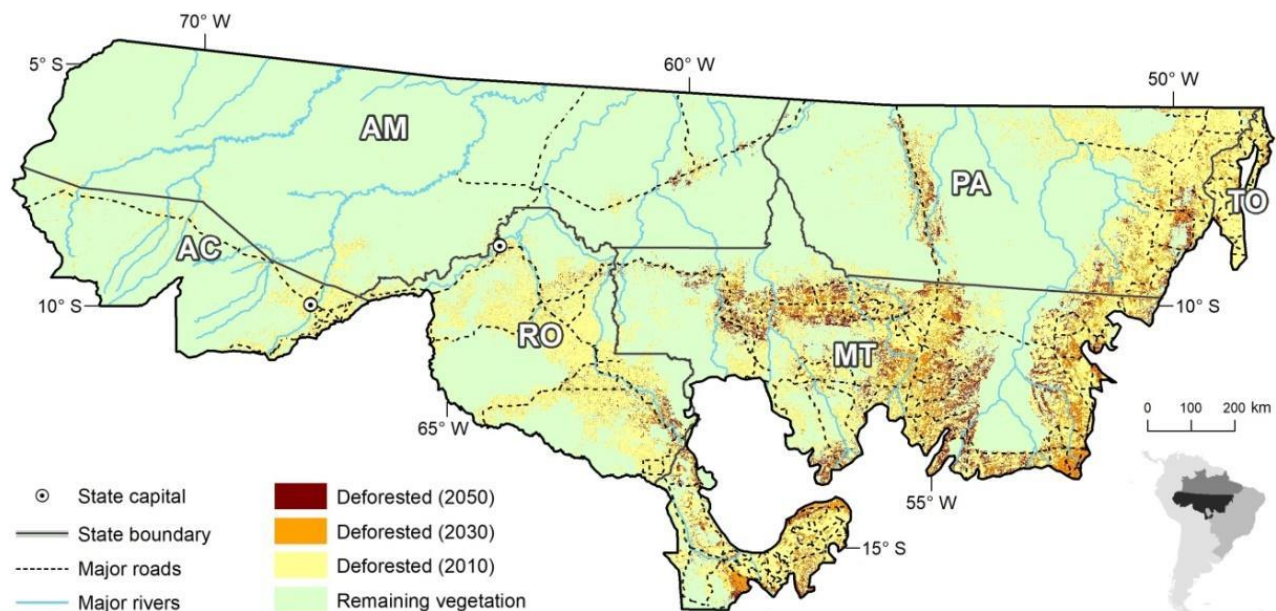
Table S5. Input variables used to run our ecosystem model (CARLUC), the source of the data, and the link to download the data.



**Fig. S1. Components of our modeling framework.** The upper left panel shows the fire ignition module of FISC. The upper right panel shows the stochastic fire spread component of FISC. The lower panel shows the main component of our carbon model (CARLUC). The following variables are included in this diagram: ydro (hydrography); uVPD (understory Vapor Pressure Deficit); W (Fuel loads); Wf (Wind factor); Nbf (Neighbor factor); Ckm (Constant factor); Qe (Quantum Efficiency); Lr (Constant factor); NPP (Net Primary Productivity); MetLL (Metabolic Leaf Litter); StrucLL (Structural Leaf Litter); CWD (Wood Debris); StrucRL (Structural Root Litter); MetRL (Metabolic Root Litter); LMC (Litter Moisture Content); and FSR (Fire Spread Rate), and MCWD (Maximum Climatological Water Deficit).



**Fig. S2. Spatial-temporal changes in VPD and MCWD for three time periods compared to 2010.** Observed VPD and MCWD were derived from Climate Research Unit (CRU – max temperature) and TRMM precipitation datasets, respectively. Upper panel: observed climate data. Mid panel: change in VPD and MCWD between 2010 and 2025. Lower panel: change in VPD and MCWD between 2010 and 2025.



**Fig. S3. Projected deforestation for the southern Amazon.** Simulations were conducted based on the Otimizagro land-use model. Deforestation was binned into three time periods: up to 2010; between 2011 and 2030; and, between 2031 and 2050.

**Table S1. Decadal fire-related emissions of different GHG emissions per decade from the 2000s to the 2050s.**

<b>Scenario (Decade)</b>	<b>CH4 (Tg)</b>	<b>CO (Tg)</b>	<b>CO2 (Tg)</b>	<b>N2O (Tg)</b>	<b>Nox (Tg)</b>	<b>Total (Tg)</b>
<b>RCP 2.6 D (2001 - 2010)</b>	153.15	168.96	1505.62	153.05	153.07	2133.85
<b>RCP 2.6 D (2011 - 2020)</b>	348.40	384.37	3425.14	348.17	348.22	4854.28
<b>RCP 2.6 D (2021 - 2030)</b>	253.45	279.62	2491.74	253.29	253.32	3531.42
<b>RCP 2.6 D (2031 - 2040)</b>	176.85	195.11	1738.68	176.74	176.76	2464.15
<b>RCP 2.6 D (2041 - 2050)</b>	246.42	271.87	2422.63	246.26	246.30	3433.47
<b>RCP 2.6 N (2001 - 2010)</b>	153.15	168.96	1505.62	153.05	153.07	2133.85
<b>RCP 2.6 N (2011 - 2020)</b>	200.50	221.20	1971.16	200.37	200.40	2793.63
<b>RCP 2.6 N (2021 - 2030)</b>	216.59	238.95	2129.29	216.44	216.47	3017.75
<b>RCP 2.6 N (2031 - 2040)</b>	127.00	140.11	1248.54	126.91	126.93	1769.49
<b>RCP 2.6 N (2041 - 2050)</b>	288.48	318.27	2836.11	288.29	288.33	4019.49
<b>RCP 8.5 D (2001 - 2010)</b>	153.15	168.96	1505.62	153.05	153.07	2133.85
<b>RCP 8.5 D (2011 - 2020)</b>	202.19	223.07	1987.76	202.06	202.08	2817.15
<b>RCP 8.5 D (2021 - 2030)</b>	182.33	201.15	1792.50	182.21	182.23	2540.42
<b>RCP 8.5 D (2031 - 2040)</b>	254.49	280.77	2501.95	254.32	254.36	3545.90
<b>RCP 8.5 D (2041 - 2050)</b>	433.67	478.44	4263.43	433.38	433.44	6042.35
<b>RCP 8.5 N (2001 - 2010)</b>	153.15	168.96	1505.62	153.05	153.07	2133.85
<b>RCP 8.5 N (2011 - 2020)</b>	149.17	164.57	1466.51	149.07	149.09	2078.42
<b>RCP 8.5 N (2021 - 2030)</b>	116.96	129.04	1149.87	116.88	116.90	1629.66
<b>RCP 8.5 N (2031 - 2040)</b>	177.74	196.09	1747.35	177.62	177.64	2476.44
<b>RCP 8.5 N (2041 - 2050)</b>	359.70	396.84	3536.28	359.46	359.51	5011.80

**Table S2. BA in millions of hectares for each decade and each one of the scenarios representing two deforestation (No deforestation: N; Deforestation: D) and climate pathways (RCP2.6; RCP8.5).**

Decade	RCP 2.6 D (Mha)	RCP 2.6 N (Mha)	RCP 8.5 D (Mha)	RCP 8.5 N (Mha)
2001 - 2010	3.6	3.6	3.6	3.6
2011 - 2020	5.2	3.7	3.8	2.3
2021 - 2030	4.8	4.0	3.7	1.8
2031 - 2040	3.4	2.3	4.4	3.1
2041 - 2050	6.0	5.3	6.8	5.9
<b>Total</b>	<b>23</b>	<b>18.9</b>	<b>22.3</b>	<b>16.7</b>

**Table S3. Input variables used to run the fire ignition component of our fire model (FISC), the source of the data, and the link to download the data.**

Variable	Source	Link
Land cover	PRODES (INPE)	<a href="http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes">http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes</a>
Roads	Landsat 5	<a href="http://pnlt.imagem-govfed.opendata.arcgis.com/">http://pnlt.imagem-govfed.opendata.arcgis.com/</a>
Urban areas	IBGE	<a href="http://downloads.ibge.gov.br/downloads_geociencias.htm">http://downloads.ibge.gov.br/downloads_geociencias.htm</a>
Altitude	SRTM	<a href="http://www.relevobr.cnpm.embrapa.br/download/">http://www.relevobr.cnpm.embrapa.br/download/</a>
Mechanized agriculture	CSR/UFGM	Under Request
Vapor Pressure deficit	NCEP/NCA R	Humidity: <a href="https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.pressure.html">https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.pressure.html</a> Temperature: <a href="http://www.cru.uea.ac.uk/cru/data/hrg/">http://www.cru.uea.ac.uk/cru/data/hrg/</a>

**Table S4. Input variables used to run the fire spread component of our fire model (FISC), the source of the data, and the link to download the data.**

Variable	Source	Link
Land cover	PRODES (INPE)	<a href="http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes">http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes</a>
Wind	Landsat 5	<a href="https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.pressure.html">https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.pressure.html</a>
Hydrography	IBGE	<a href="http://downloads.ibge.gov.br/downloads_geociencias.htm">http://downloads.ibge.gov.br/downloads_geociencias.htm</a>
Terrain	SRTM	<a href="http://www.relevobr.cnpm.embrapa.br/download/">http://www.relevobr.cnpm.embrapa.br/download/</a>
uVPD	NCEP/NCAR	<a href="https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html">https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html</a>

**Table S5. Input variables used to run our ecosystem model (CARLUC), the source of the data, and the link to download the data.**

Variable	Source	Link
PAW (Plant Available Water)	Under request (Calculated from precipitation data)	---
PAR (Photosynthetic active radiation)	GOES – 9 Satellite	<a href="https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.pressure.html">https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.pressure.html</a>
TEMP (Temperature)	NCEP/NCAR	<a href="https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html">https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html</a>
PRC (Precipitation)	TRMM/NASA	<a href="http://mirador.gsfc.nasa.gov">http://mirador.gsfc.nasa.gov</a>
VPD (Vapor Pressure Deficit)	NCEP/NCAR Reanalysis2 + CRU (Climate Research Unit)	<a href="https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html">https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html</a> <a href="http://www.cru.uea.ac.uk/data">http://www.cru.uea.ac.uk/data</a>