Supplementary Material for

Strong temporal variation in treefall and branchfall rates in a tropical forest is explained by rainfall: results from five years of monthly drone data for a 50-ha plot

Text S1, Tables S1-S3, and Figures S1-S8.

Text S1. Imagery processing

We horizontally aligned all orthomosaics and canopy surface elevation models to the first set (2 October 2014) using the centers of *Attalea* palms as manual control points. We resampled elevation models to a 1m resolution and clipped them using the polygon of the 50 ha plot plus an extension of 25 m. We differenced surface elevation models for successive dates to obtain a raster of the canopy height changes for the associated interval. We assumed that the true median change in elevation between successive dates was zero and that any nonzero median elevation change for successive dates reflected systematic error in the vertical coordinates on one or both dates. We thus corrected rasters of canopy height changes for vertical positioning errors by subtracting off the median observed elevation model difference.

Table S1. The mean, minimum, maximum, and the 25th, 50th, and 75th percentiles of interval length in days, number and area of canopy disturbances, and the respective monthly rates (i.e., per 30-day period). For these calculations, we included only the area of canopy disturbances inside the BCI 50-ha plot (including parts of canopy disturbances centered outside the plot), and we excluded the long interval between 24 September 2015 and 18 May 2016.

	mean	min	25%	50%	75%	max
Interval length (days)	35.8	14	26.2	31.5	36.8	91
Number (n)	19.7	2	7.2	10	17.2	214
Number (n mo^{-1})	16.7	2.7	7.3	10.5	14.2	152.9
Area (m^2)	1091.4	52.5	310.5	558.1	1099.1	11257.2
Area (m^2 mo^{-1})	916	75	329.7	499	822.8	8040.9

Table S2. Rainfall events in mm per hour above than the 99.4th percentile that occurred during the measurement period. Bold corresponds to the measurement interval with the highest disturbance rate (June 1 to July 13 2016).

Time	Rainfall (mm hour$^{-1)}$
2015-10-06 16:00	43.4
2015-10-19 17:00	37.3
2015-10-19 18:00	45.0
2016-04-27 14:00	59.4
2016-06-17 06:00	**41.7**
2016-06-23 01:00	**41.9**
2016-06-30 14:00	**49.3**
2016-07-04 10:00	**36.1**
2016-07-15 20:00	40.1
2016-10-11 17:00	79.0
2016-10-30 18:00	72.1
2017-05-03 14:00	54.6
2017-05-31 21:00	43.7
2018-03-23 13:00	36.8
2018-05-13 05:00	36.8
2018-05-29 14:00	44.7
2018-06-09 15:00	36.3
2018-06-23 15:00	36.1
2018-07-25 14:00	41.7
2018-08-09 14:00	42.9
2018-10-01 22:00	50.3
2018-10-12 14:00	52.3
2019-05-19 13:00	45.7
2019-08-28 13:00	37.8
2019-09-30 07:00	49.0

Table S3. Parameter values and delta AIC values for maximum likelihood fits of exponential, power and Weibull probability density functions to size distributions for canopy disturbances larger than 2 m^2, 5 m^2, 10 m^2 and 25 m^2. Delta AIC is the difference in AIC from the best model. The best-fit models for each dataset, and those within 2 delta AIC of the best model, are highlighted in bold.

Minimum size (m^2)	Distribution	λ	k	Delta AIC
2	**Exponential**	**0.018**		**0.00**
2	Power	0.924		568.91
2	**Weibull**	**55.860**	**1.030**	**1.00**
5	Exponential	0.019		4.04
5	Power	1.146		343.92
5	**Weibull**	**48.776**	**0.917**	**0.00**
10	Exponential	0.020		17.96
10	Power	1.392		186.44
10	**Weibull**	**41.002**	**0.817**	**0.00**
25	Exponential	0.020		62.45
25	Power	1.963		16.50
25	**Weibull**	**6.745**	**0.448**	**0.00**

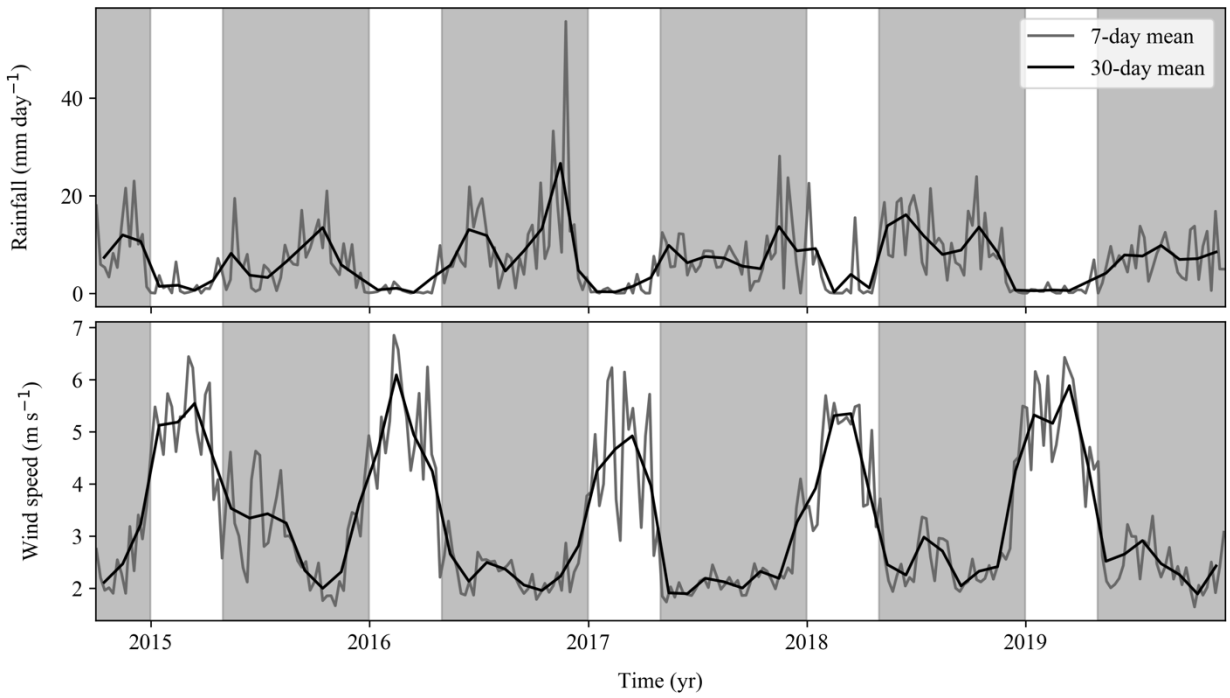

Figure S1. Temporal variation in running means of total rainfall and 15-min maximum wind speed measured on Barro Colorado Island during the study period. Gray shading indicates the wet seasons (May to December) of each year.

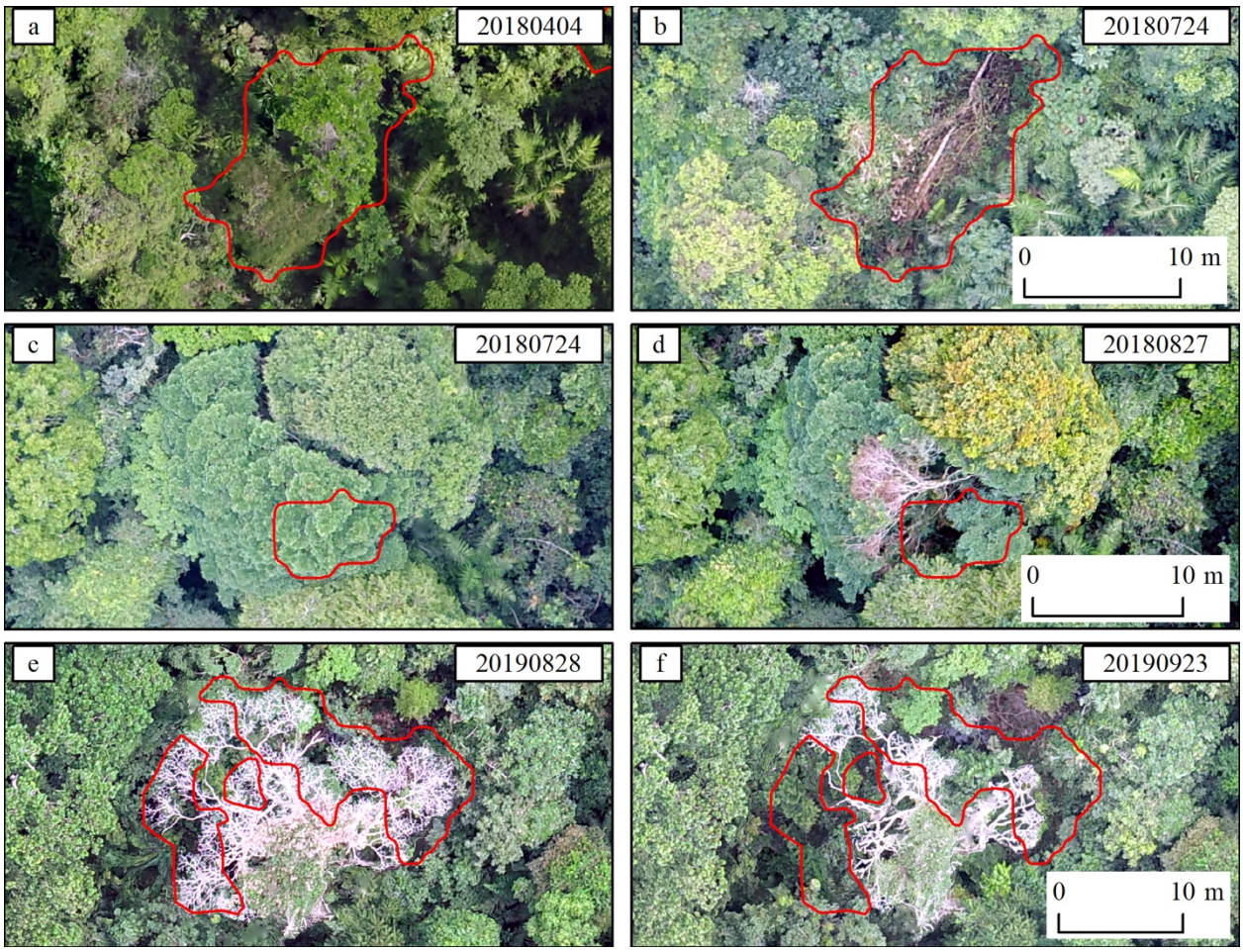

Figure S2. Orthomosaic imagery before and after new canopy disturbances (indicated by red polygons) classified as a treefall (a,b), a branchfall (c,d), and disintegration of a standing dead tree (e,f).

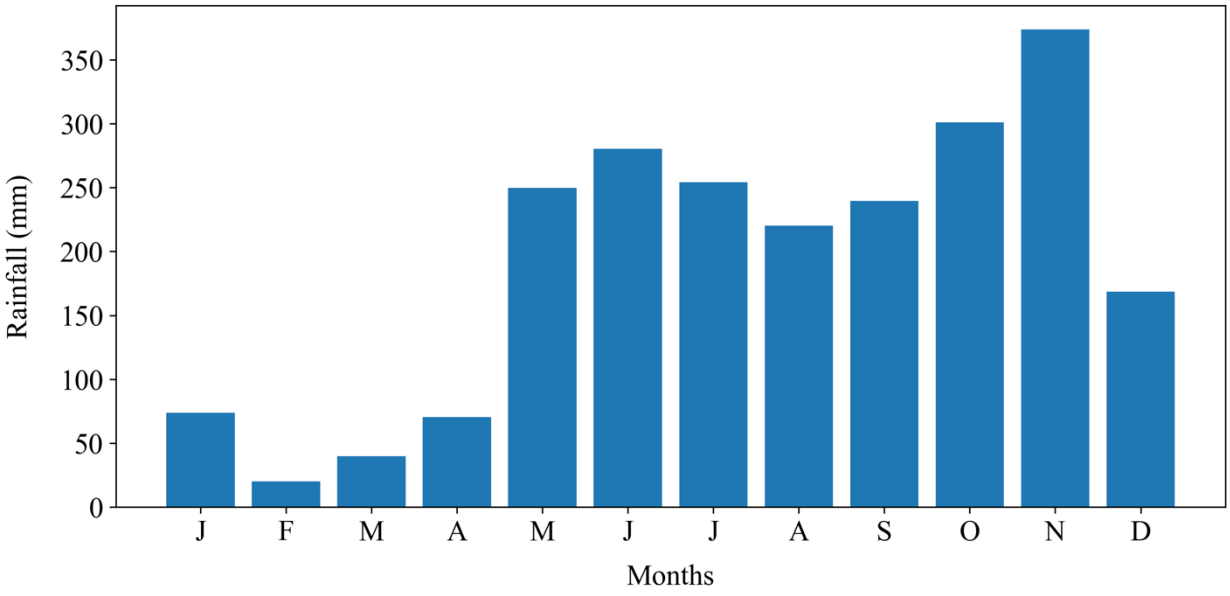

Figure S3. Mean monthly rainfall measured on Barro Colorado Island during the study period.

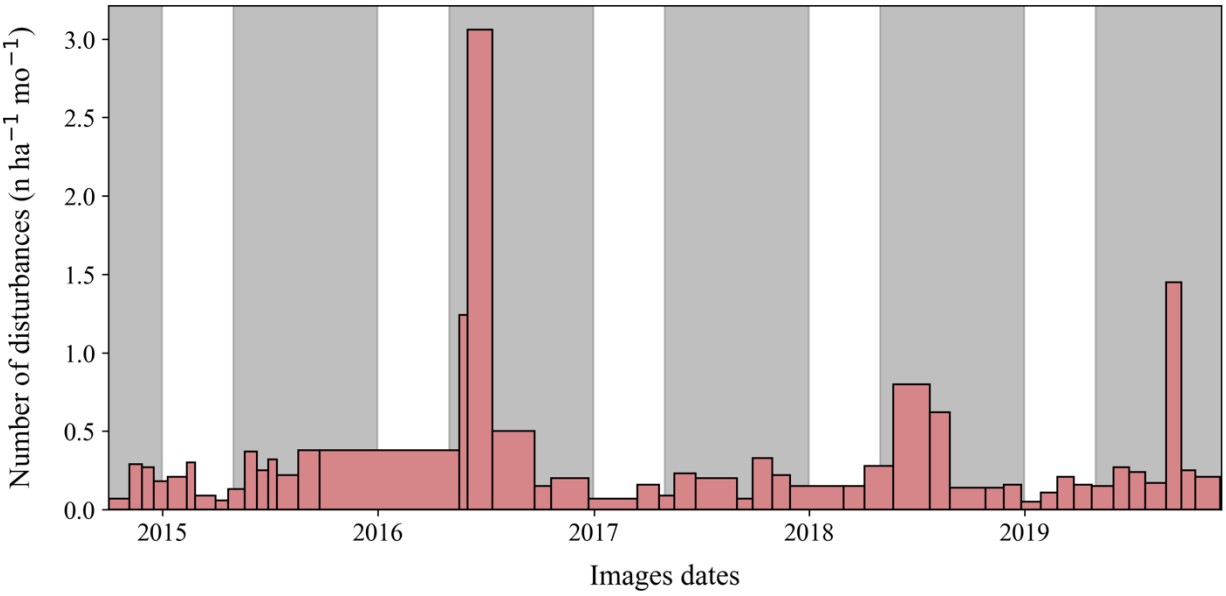

Figure S4. Temporal variation in canopy disturbance rates in the 50 ha plot on Barro Colorado Island, Panama, across measurement intervals. Gray shading indicates the wet seasons (May to December) of each year and ticks on the x axis indicate the first day of each year. Rates are shown in units of number of gaps per hectare per month (i.e., per 30 days). Note that the total area of each rectangle is proportional to the total number of canopy disturbances during that measurement interval.

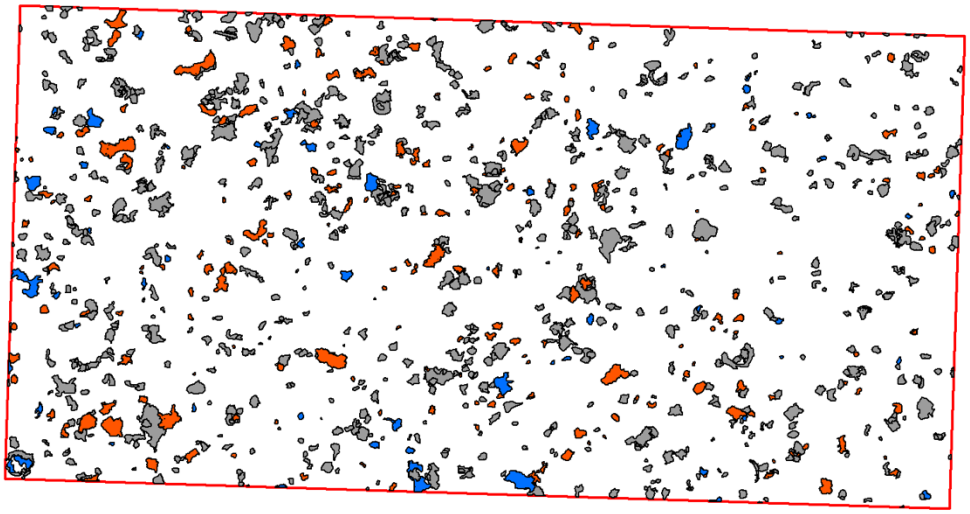

Figure S5. Map of canopy disturbances on the 50 ha plot (red rectangle, 1000 x 500 m) on Barro Colorado Island, Panama, from 2 October 2014 to 28 November 2019, with disturbance areas represented in gray. Canopy disturbances associated with the two periods having the highest disturbance rates, those between 1 June and 13 July, 2016 and between 28 August and 23 September, 2019, are represented in red and blue, respectively.

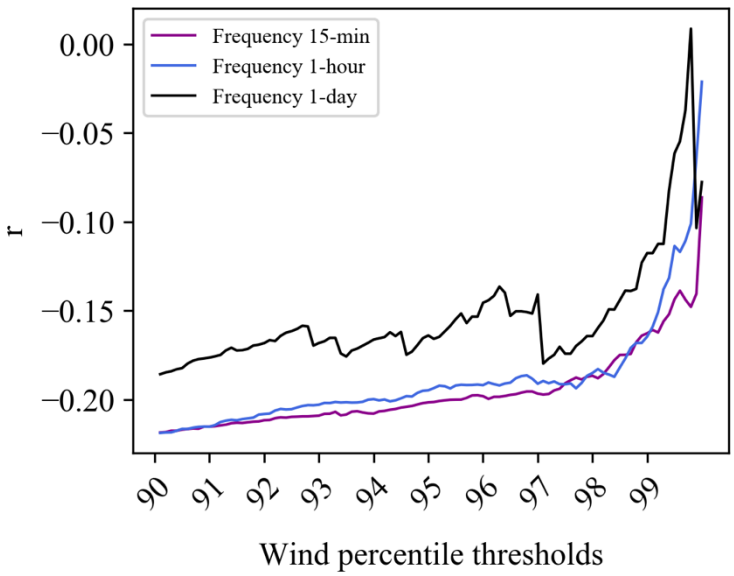

Figure S6. Relation of temporal variation in canopy disturbance rates to the frequency of extreme horizontal windspeed events. Variation in Pearson correlation values (y-axis) between the canopy disturbance rate and the frequency of high maximum windspeed events depending on the temporal grain (colors) and percentile threshold (x axis) for defining extreme maximum windspeed events.

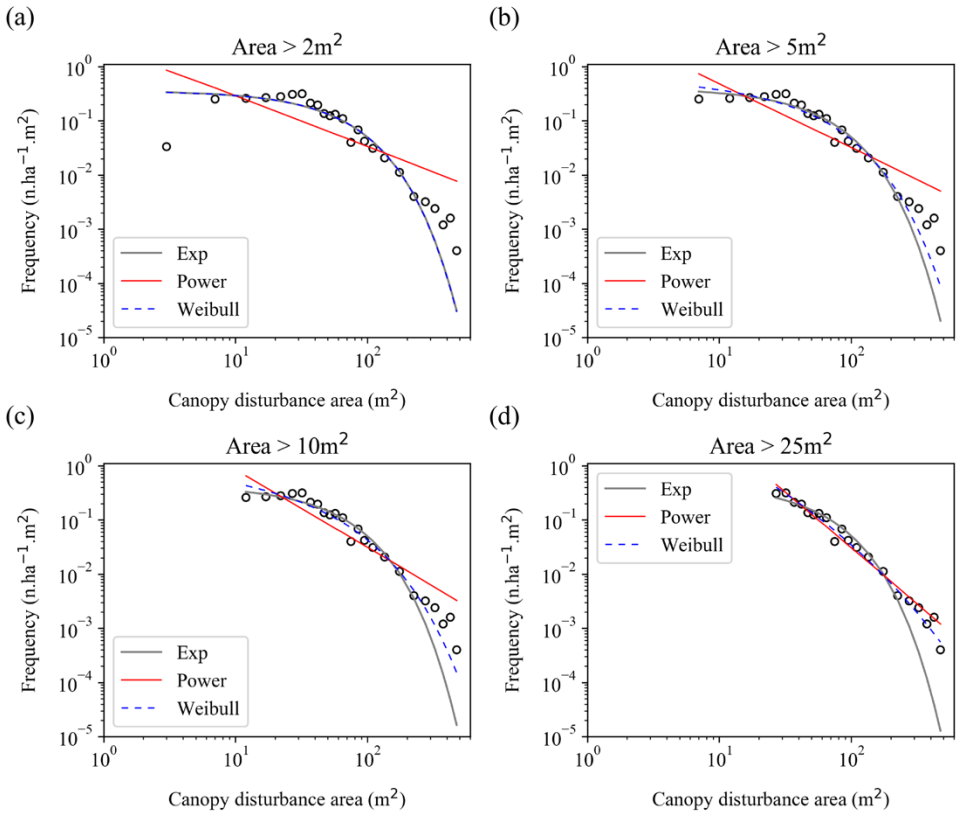

Figure S7. Observed size distributions for canopy disturbances larger than 2 m^2, 5 m^2, 10 m^2 and 25 m^2, together with maximum likelihood fits under three alternative functional forms.

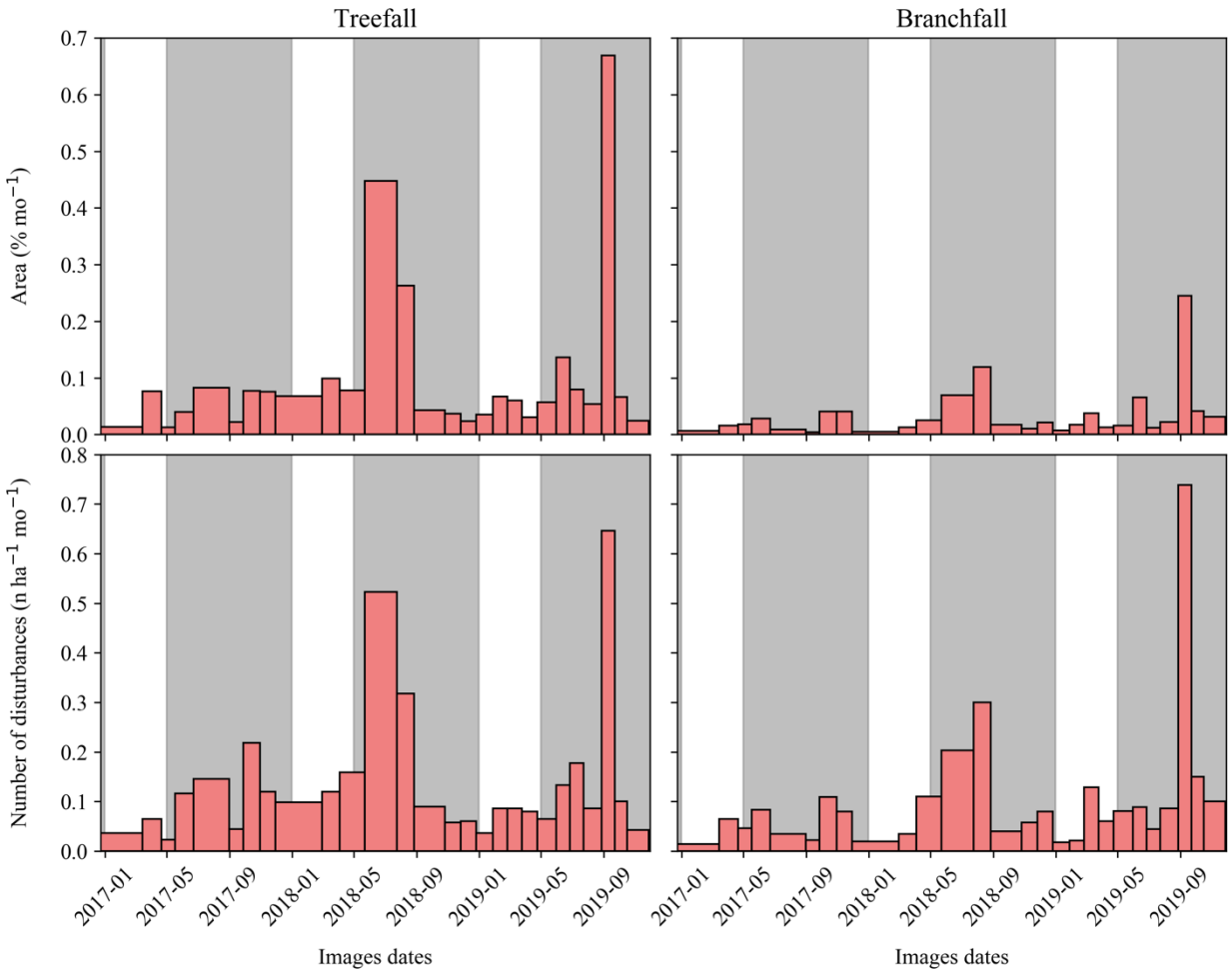

Figure S8. Temporal variation in treefall (left) and branchfall (right) rates in the 50 ha plot on Barro Colorado Island, Panama, evaluated in terms of area disturbed (upper panels) and the number of disturbances (bottom panels) across intervals. Gray shading indicates the wet seasons (May 1 to December 31) of each year.