forests

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Article

Relationship Between Biomass Burning Emissions and Deforestation in Amazonia Over the Last Two Decades

Supplementary Materials

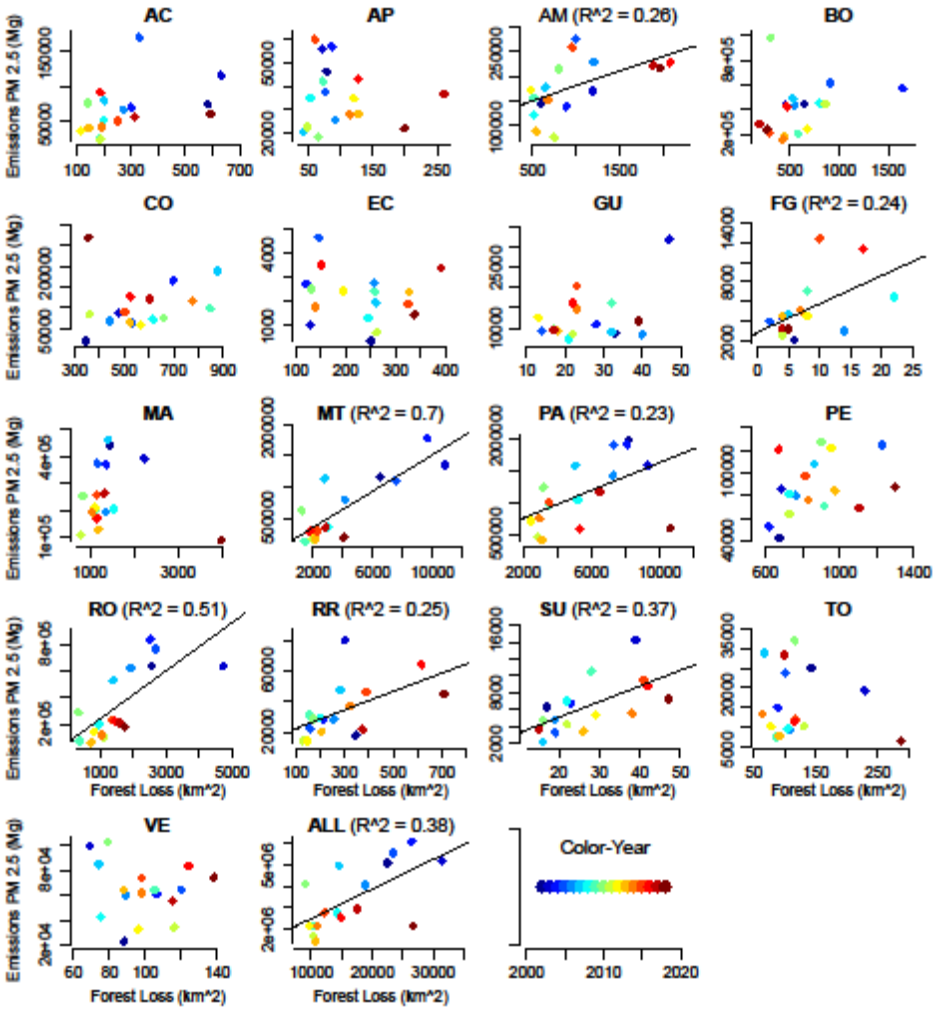

Figure S1. Relationship between annual $PM_{2.5}$ emitted from biomass burning and annual deforestation in the 17 Amazonian countries/states from 2002 to 2018. AC = Acre, AP = Amapá, AM = Amazonas, BO = Bolivia, CO = Colombia, EC = Ecuador, GU = Guiana, FG = French Guiana, MA = Maranhão, MT = Mato Grosso, PA = Pará, PE = Peru, RO = Rondônia, RR = Roraima, SU = Suriname, TO = Tocantins, VE = Venezuela, and ALL = Amazonia.

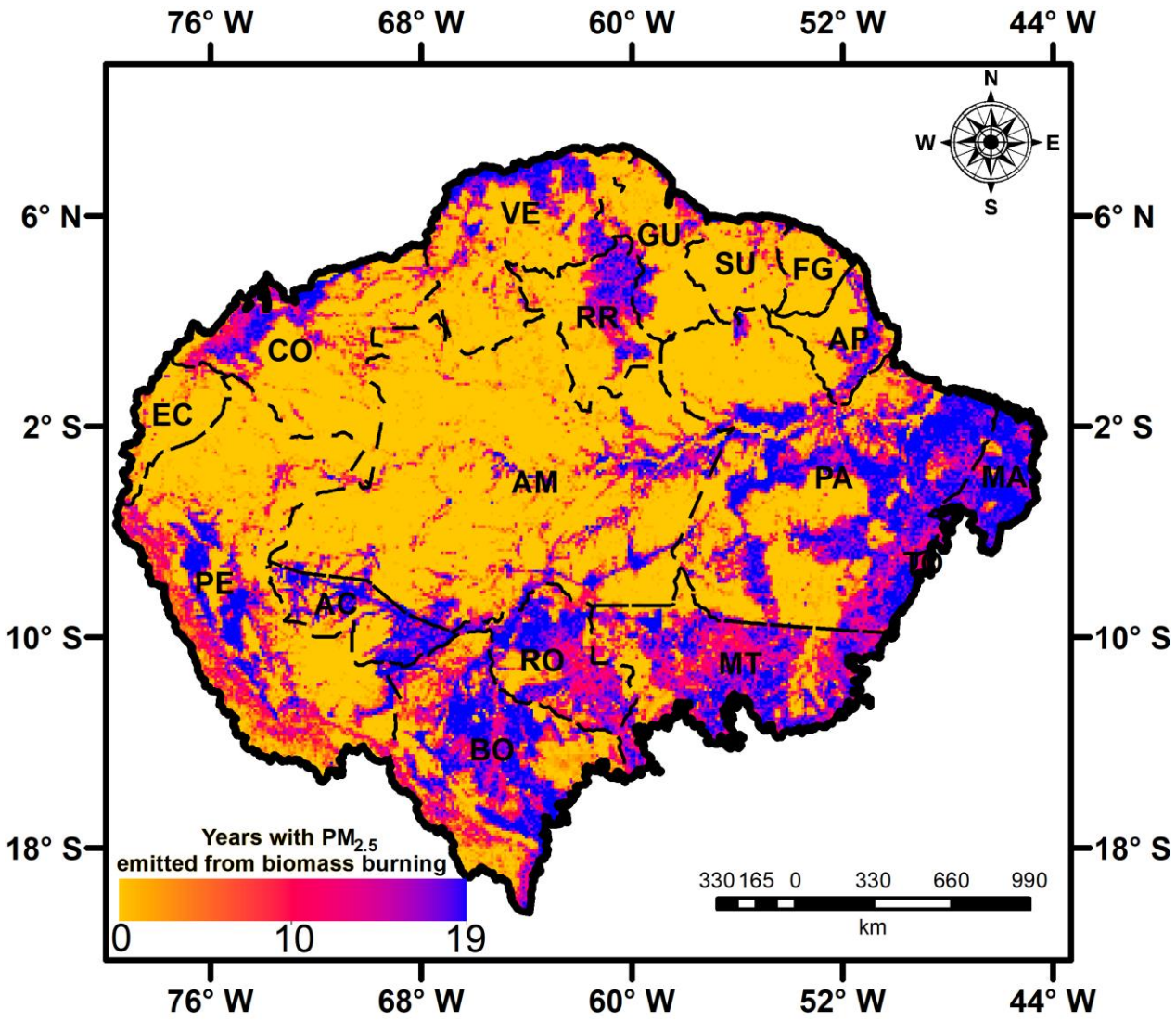

Figure S2. Number of years when emission of $PM_{2.5}$ associated with biomass burning was detected in Amazonia during the 2002-2020 period. Estimates were obtained using the 3BEM_FRP model at the spatial resolution of 0.1°.

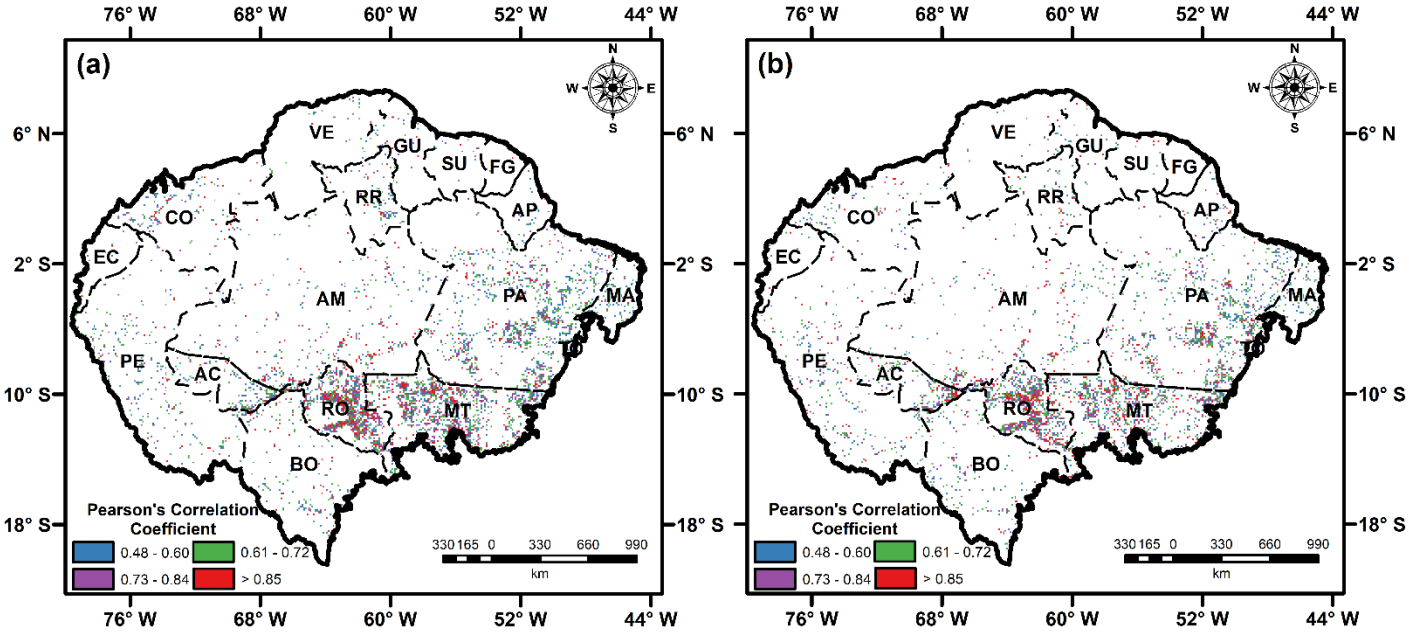

Figure S3. Pearson's correlation coefficient between the pair of variables $PM_{2.5}$ emitted from biomass burning and 1-year lagged deforestation **(a),** and between $PM_{2.5}$ emitted from biomass burning and 2-years lagged deforestation **(b)** in Amazonia. Only statistically significant pixels are shown in this figure. BO = Bolivia, CO = Colombia, EC = Ecuador, FG = French Guiana, GU = Guiana, PE = Peru, SU = Suriname, VE = Venezuela, AC = Acre, AM = Amazonas, AP = Amapá, MA = Maranhão, MT = Mato Grosso, RO = Rondônia, RR = Roraima, PA = Pará, and TO = Tocantins.

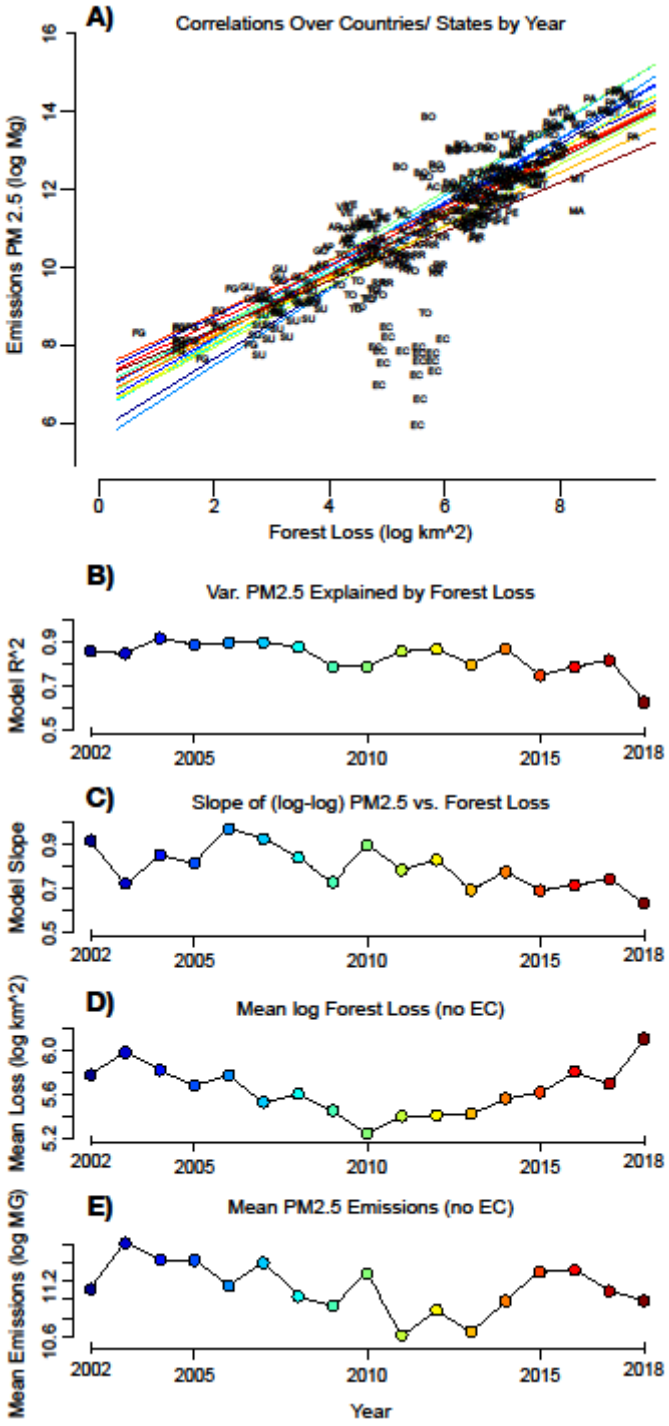

Figure S4. By-year correlations between $PM_{2.5}$ emitted from biomass burning and deforestaion on the country/state level data **(a),** variance of $PM_{2.5\ 5}$ emitted from biomass burning explained by deforestation **(b)**, slope of $PM_{2.5\ 5}$ emitted from biomass burning vs. deforestation **(c)**. Correlations were best on a log-log not regular scale (heteroskedasticity on the residuals). Ecuador (EC) was a low deforestation outlier and therefore was excluded to focus on the major deforestation countries/states in **(d)** and **(e)**.

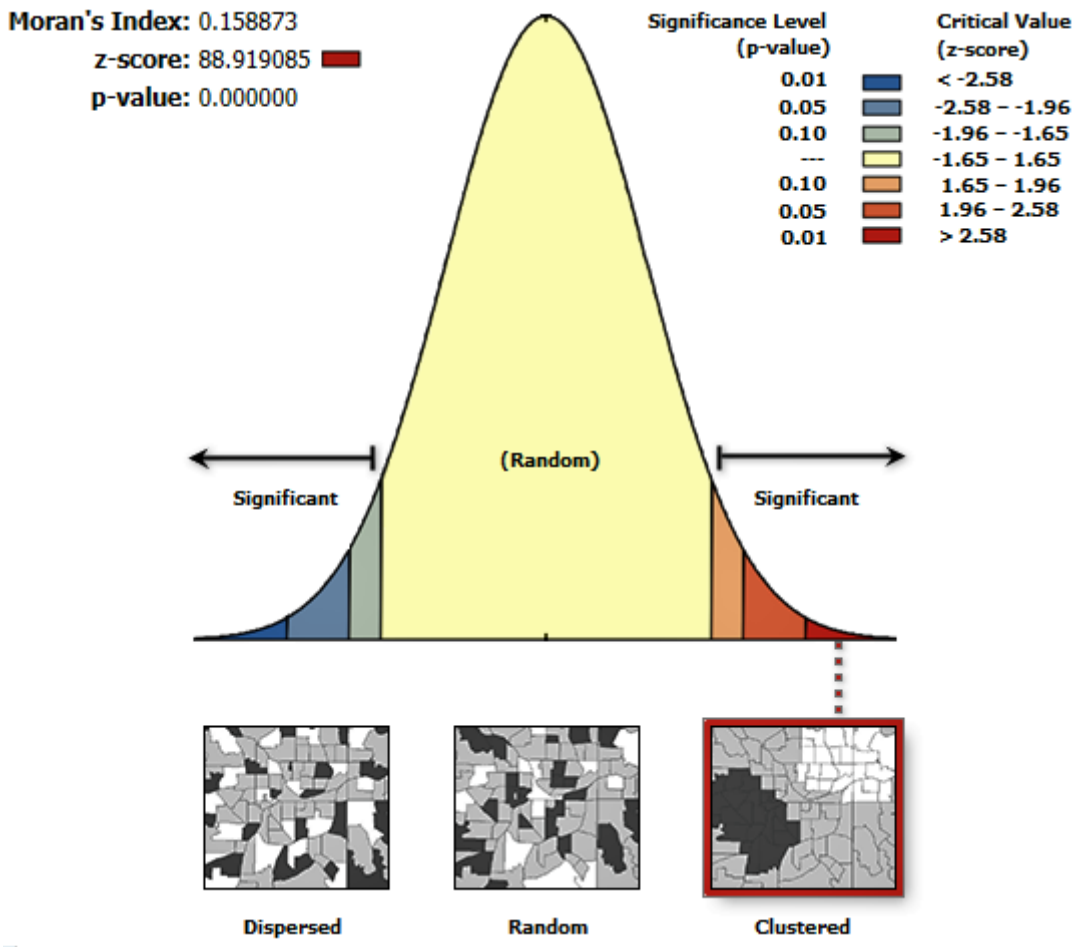

Figure S5. Global Moran´s Index representing the correlation in space between $PM_{2.5}$ emitted from biomass burning and deforestation in Amazonia. We have considered only three years -highest emission (2004), lowest emission (2009), and closest to the overall average (2017)- to calculate the index in order to not control autocorrelation. Only above-zero emission grid cells were considered. Given the z-score of 88.919, there is a less than 1% probability that this clustered pattern could be the result of random chance.

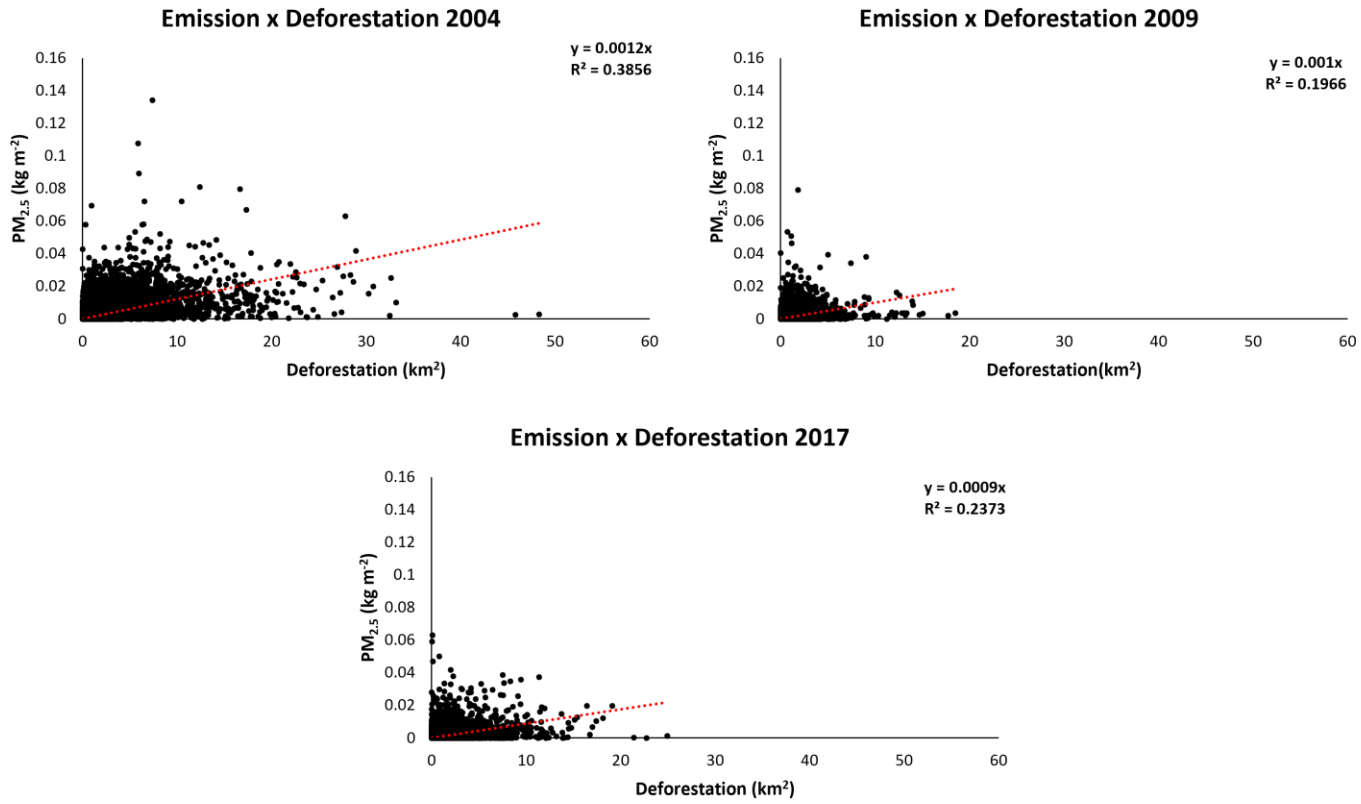

Figure S6. Relationship between $PM_{2.5}$ emitted from biomass burning and deforestation in Amazonia. Only above-zero emission and deforestation grid cells were considered in this figure. We have considered only three years -highest emission (2004), lowest emission (2009), and closest to the overall average (2017)- in order to highlight that R^2 values were highest in the year of highest deforestation (2004) and lowest in the year of lowest deforestation (2009).

Table S1. Fine particulate matter with diameter less than 2.5 μm ($PM_{2.5}$) emission factors adopted in previous versions of 3BEM_FRP, in 3BEM_FRP version 1.8.3 when estimating global $PM_{2.5}$ associated with biomass burning emissions, and in 3BEM_FRP version 1.8.3 when estimating $PM_{2.5}$ associated with biomass burning in South America.

$PM_{2.5}$ Emission Factors (g kg^{-1})			
Land Use and Land Cover	3BEM_FRP (Previous Versions)	3BEM_FRP 1.8.3 (Global)	3BEM_FRP 1.8.3 (South America)
Tropical Forest	9.1	8.3	9.4
Extratropical Forest	13	15.7	15.7
Savanna / Grassland	4.9	7.5	4.0
Pasture / Croplands	4.9	7.5	4.0