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| **Remotely sensed and spatially explicit environmental variable selection to model soil Pyrogenic Carbon (PyC) fraction of soil Total Organic Carbon (TOC) in the Amazonia-Cerrado transition** |
| Pyrogenic carbon (PyC), a fraction of Total Soil Organic Carbon (TOC) formed through the incomplete combustion of biomass, plays a crucial role in the soil of the Amazon rainforest (Koele et al. 2017). PyC is stable due to its chemical structure and it persists in the soils for millenia (Vedovato et al., 2023), thus acting as a carbon reservoir, enhancing fertility, carbon sequestration capacity (Ziviani et al., 2022). Moreover, PyC increases the Amazon forest resistance to extreme drought (Vedovato et al. 2023) and affects species composition (Oliveira et al. 2020). PyC stock in Amazon forest soils is estimated at 1.1 Pg up to 0.3 m and 2.8 Pg up to 1 m depth (Koele et al. 2017).  PyC in the Amazonian soils is caused by ancient fires (Feldpausch et al. 2022), and to a lesser extent is deposited from soot transportation of distant fires (Silva et al. 2023; Silva et al. 2024). At the landscape scale, PyC is influenced by the mean annual temperature, exposure to oxygen, distance to fragment´s edge (Silva et al. 2023), type of vegetation, soil and terrain drainage (Oliveira et al. 2022; Carvalho et al. 2018), amongst other factors.  Global efforts for mapping the spatial distribution of PyC in the soils are highly uncertain due to the lack of detailed field data with global distribution and, more importantly, due to the high spatial variability in the PyC distribution (Koele et al, de Oliveira et al. 2022), This work, thus, aims to explore the selection of remotely sensed and spatially explicit variables representative of PyC in the southern Amazonia-Cerrado transition, expected to contribute with large scale PyC mapping.  First, 36 variables affecting PyC distribution in the Amazonian soils were compiled from seven scientific articles, published from 2015 to 2024. Then, a spatial explicit database was compiled with 19 bioclimatic variables, 10 soil structure and chemistry layers, 3 topographic features, vegetation type, distance to fragment´s edge, distance to recent fires and LiDAR biomass. A Recursive Feature Elimination (RFE) algorithm, with 10 repetitions, and trained with nine areas reporting the PyC to TOC fraction obtained from Oliveira et al. (2022), revealed that the lowest RMSE (0.01117+0.005404) was reached with the following eight variables (relative importance in parenthesis): 1) Height Above the Nearest Drainage (1.18e-04); 2) altitude from SRTM (8.58e-05); 3) precipitation of wettest month (6.54e-05); 4) annual mean temperature (3.27e-05); 5) slope (3.24e-05); 6) distance to fragment´s edge (3.17e-05); 7) topsoil pH (2.75e-05) and; 8) topsoil Nitrogen (2.69e-05).  Some variables selected with few training points are in line with the expected PyC to TOC relation for the Amazon, with topographic characteristics, climate and soil pH and N as the main potential predictors. Further analysis with more detailed field data and remotely sensed variables may support spatial modelling of PyC in the Amazonia. |