BioSpace25 - Biodiversity insight from Space
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Soil carbon predictions across the landscape using remotely-sensed canopy structure measurements in southern Amazonia

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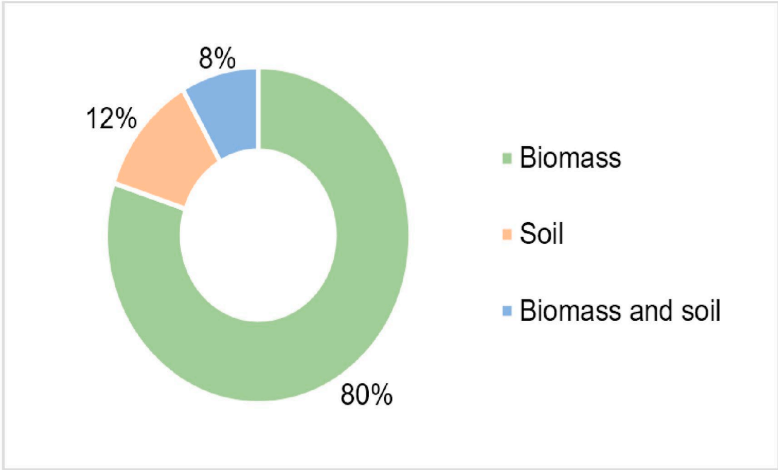
Soils carbon stocks need to be studied

- Soils account for 33-72% of total Amazonian carbon stocks
- Uncertainties in soil organic carbon (SOC) stocks are very large compared to above-ground stocks
- This leads to inaccurate carbon models
- Soil carbon is under threat, but we do not know the possible extent of losses



Components evaluated in studies published and indexed in the Scopus database, related to biomass and carbon stock in the Amazon Region.
Emmanoella Costa Guaraná Araujo et al. (2023)

Feldpausch et al. 2012; Gatti et al. 2021; Steffen et al. 2018; Lal 2004; Osono, Azuma, and Hirose 2014; Pan et al. 2011; Moquedace et al. 2024; Cerri et al. 2007; Frey et al. 2014; Kauffman et al. 2018; Gomes et al., 2019; Vasques et al., 2017

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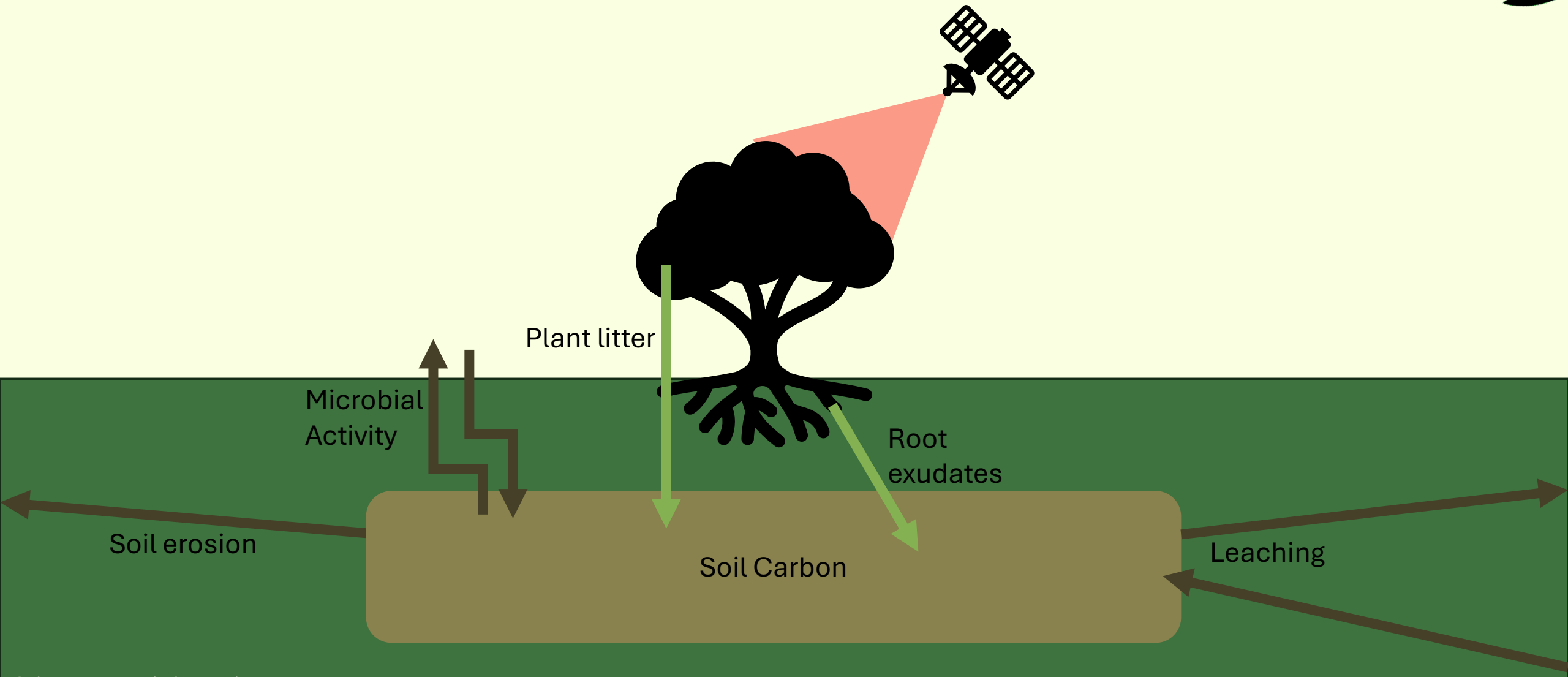
How could soil carbon models be improved?



Soil carbon predictions using remotely-sensed canopy structure

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Varying levels of data accessibility.

Increasing Detail

Freely available

-SoilGrids

-Sentinel-2

-Hydrosheds

-MapBiomas

-Copernicus DEM

-GEDI

Remotely sensed

-Airborne Lidar

In field

-Soil samples

-Hemispherical photos

Increasing accessibility

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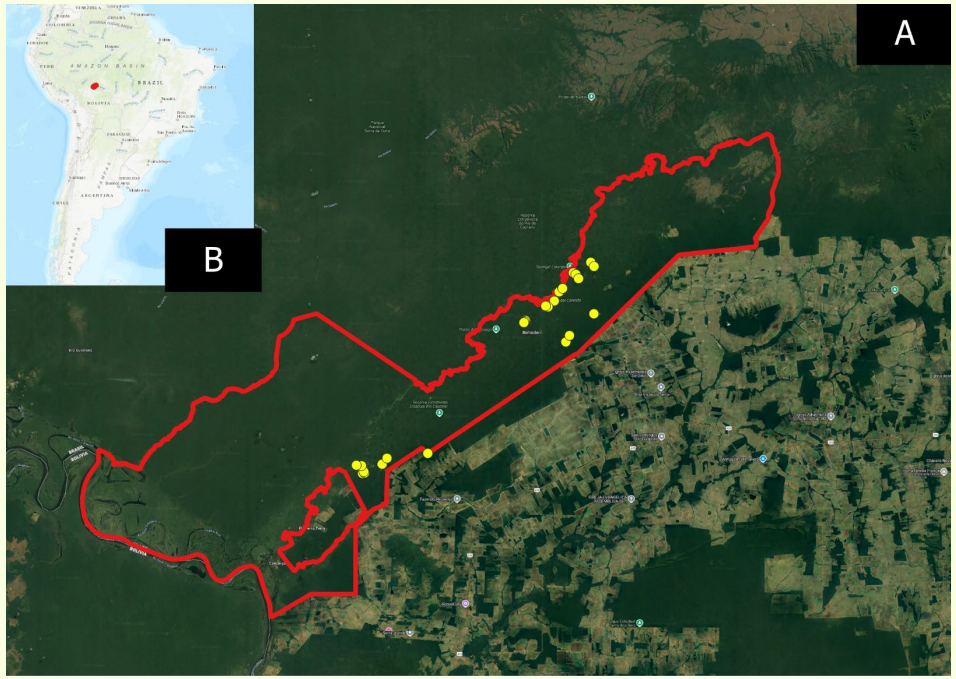
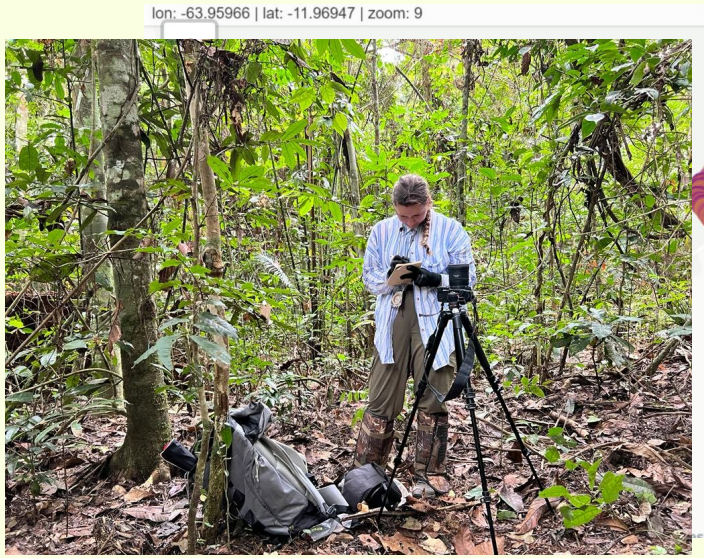
Research questions

(1) What impact does the introduction of forest canopy metrics make to soil carbon models?

(2) How performant are soil carbon models using different types of input predictors?





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Model construction

Performance metrics: RMSE, MAE and Time

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At all 3 data levels the models including the forest canopy structure metrics perform better than the models without.

Data level	In Field data		Remote Sensing Data		Freely Available Data	
Canopy metrics	Present	Absent	Present	Absent	Present	Absent
MAE	0.06	1.18	1.10	1.35	1.14	1.44

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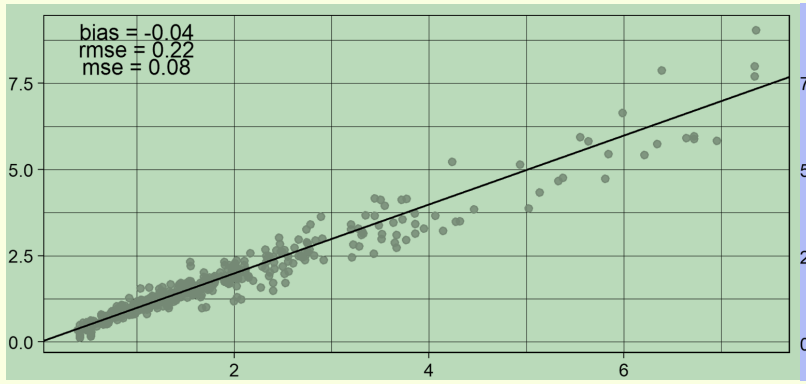
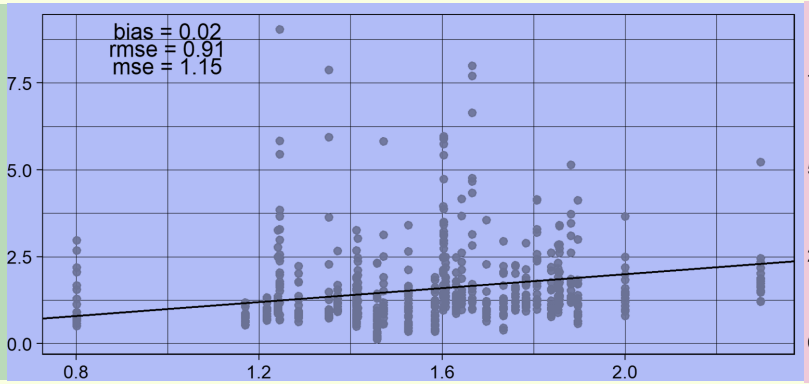
The model including in field data had the best predictive accuracy but still included canopy metrics in the key variables.

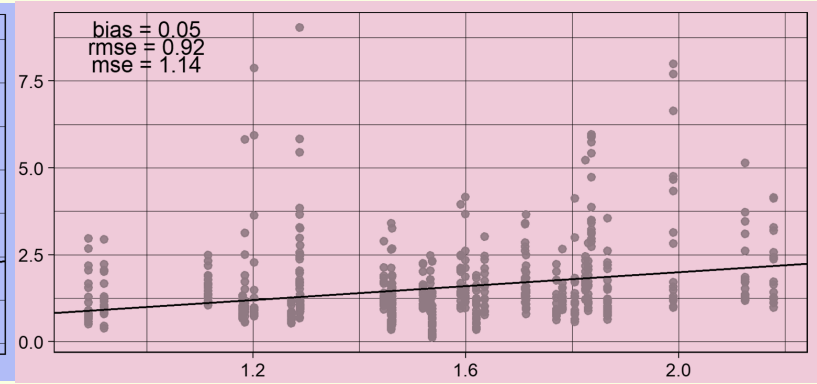
In field data



Remote Sensing



Freely available



Observed

modelled

Key Variables:

-Plant Area Index,
-Bulk density,
-Canopy cover,
-Entropy,
-Previous degradation,
-Plant area volume density,
-%N,
-Soil Ph,
-Canopy height.

Key Variables:

-Canopy cover,
-Plant area index,
-Plant area volume density,
-Height above mean height,
-Sand Content,
-Foliage Height Diversity,
-Canopy height.

Key Variables:

-Bulk density,
-Clay content,
-Plant area volume density,
-Canopy cover

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Primary conclusions.

1. The inclusion of forest structure metrics improves predictive accuracy of soil carbon models

2. While the model including in field data performs the best, there is little difference between airborne remote sensing and satellite remote sensing

3. Key predictors highlighted by all three models are: Canopy cover and Plant Area Volume Density

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Future plans and recommendations

- **Evaluate the mechanistic relationships between some of these key variables and Soil Carbon** to better understand how the environments could be protected.
- **Identify additional variables and sensors that could further develop the model** so that it can be applied on larger scales- this includes upcoming missions discussed yesterday.
- **Advocate for the use of satellite remote sensing with soil Carbon models** to make them more accurate and informative.
- **Encourage policies concerning carbon monitoring to include accurate measurements of soil stocks**. So that this massive stock is not overlooked.

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