Geography Department

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Spaceborne hyperspectral data for mapping and monitoring biodiversity in the Brazilian Cerrado

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Background

Motivation

- Earth observation data have great potential for characterising biodiversity patterns
- Hyperspectral data collected at repeated times are suitable for characterising complex ecological systems
- The Brazilian Cerrado is highly dynamic, heterogeneous and largely understudied, although it constitutes a global biodiversity hotspot

Objectives

- Use time series of hyperspectral (EO-1 Hyperion) and multispectral (Landsat) data to monitor spatial transitions in woody plant communities transitions
- Assess trade-offs between spectral and temporal domains of remote sensing for describing spatial biodiversity patterns

Data Analysis

Study area & data

- Two study sites in protected areas of the Cerrado (Figure 1)
- Field data:
  - Allometric measures and species identification
  - Above-ground carbon stock calculated
  - Species data aggregated to the family level
  - Pixels with over 75% samping coverage: 70 (PESA) and 49 (PETR)

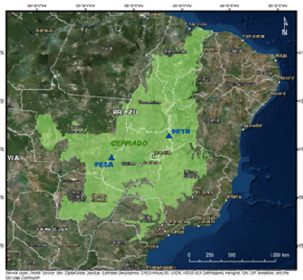

Figure 1 - Study sites in the Brazilian Cerrado: Parque Estadual da Serra Azul (PESA); and Parque Estadual de Terra Ronca (PETR).

- Remote sensing data:
  - Time series of Landsat data: 112 time steps
    - Tasseled Cap Greenness, Wetness and Brightness calculated
    - Phenological metrics derived (nine metrics per index)
  - Time series of EO-1 Hyperion data: eight (PESA) and five (PETR) time steps
    - Band subset stacked (83 bands per scene)

Methods

- Model tree community transitions with Sparse Generalized Dissimilarity Modelling (SGDM; Leitão et al., 2015)
- Carbon stock as proxy for abundance
- SGDM built on:
  - Incremental time-series of EO-1 Hyperion data (TS)
  - Incremental time-series of EO-1 Hyperion data combined with Landsat-based phenological metrics (TS+P)
- Comparison of model performances (LOO cross validation) and assessment of trade-offs (temporal vs. spectral)

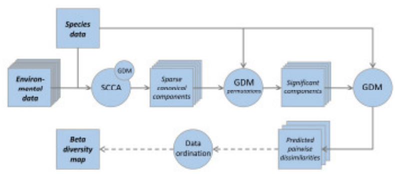

Figure 2 - Schematic representation of the SGDM (Leitão et al., 2015)

Results & Discussion

Model Results

	# of time steps	1	2	3	4	5	6	7	8
Study site	# of variables	83 (+27)	166 (+27)	249 (+27)	332 (+27)	415 (+27)	498 (+27)	581 (+27)	664 (+27)
PESA	TS	66.737	56.176	58.171	64.851	69.375	63.741	72.128	61.190
	TS + P	63.923	60.424	56.089	58.984	64.648	68.743	62.771	69.656
PETR	TS	1.113	18.114	12.990	11.974	9.636	-	-	-
	TS + P	16.453	2.873	17.526	17.368	10.468	-	-	-

Table 1 - SGDM cross-validated model performances (r^2) for both study sites: PESA and PETR. TS refers to the EO1 Hyperion time series and TS+P refers to this time series combined with Landsat based phenological metrics.

- Results varied greatly between study sites:
  - Model performances (r^2) in PESA varied between 56.2 and 72.1% and in PETR between 1.1 and 18.1% (Table 1)
  - Increasing Hyperion time series generally delivered improved model performances for PESA but not so for PETR (Figure 3)
- Phenological information added to Hyperion time series did not consistently improved model performances
  - Best performing models do not include phenology

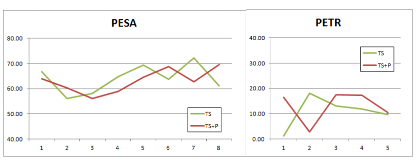

Figure 3 - SGDM model performance with incrementing EO1 Hyperion time series. TS refers to the time series and TS+P refers to it combined with Landsat based phenological metrics.

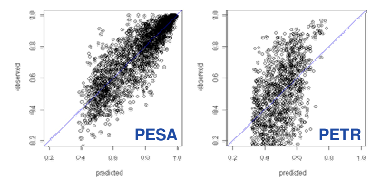

Figure 2 – Scatterplot of the predicted vs. observed dissimilarities of the best model for each site: two time steps and no phenology for PESA; and seven time steps and no phenology for PETR

Discussion

- Time series of spaceborne hyperspectral imagery are suitable for systematically monitor changes in plant community patterns (in space and time)
- No need for dense time series, probably depending on time of acquisition
- Further studies are needed to assess complementary or synergetic integration with phenological information derived from wall-to-wall multispectral data

Reference

Leitão, P.J., Schwieder, M., Suess, S., Catry, I., Milton, E.J., Moreira, F., Osborne, P.E., Pinto, M.J., van der Linden, S., Hostert, P. 2015. Mapping beta diversity from space: Sparse Generalised Dissimilarity Modelling (SGDM) for analysing high-dimensional data. *Methods in Ecology and Evolution*, **6**: 764-771. doi: 10.1111/2041-210X.12378

Acknowledgements

EnMAP Hyperspectral Imager

rede ComCerrado

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