

POST-FIRE RECOVERY ESTIMATION OF RECURRENTLY BURNED VEGETATION ACROSS MEDITERRANEAN REGIONS WORLDWIDE

Tiago Ermitão ^(1,2), Célia Gouveia ^(1,2), Ana Bastos ^(3,4) Ana Russo ^(2,5)

⁽¹⁾ Portuguese Institute for Sea and Atmosphere, Lisbon, Portugal ⁽²⁾ Dom Luiz Institute, University of Lisbon, Lisbon, Portugal ⁽³⁾ Max-Planck Institute for Biogeochemistry, Jena, Germany ⁽⁴⁾ Institute for Earth System Science and Remote Sensing, Leipzig University, Leipzig, Germany ⁽⁵⁾ Associate Laboratory TERRA, CEF – Forest Research Centre, School of Agriculture, University of Lisbon, Lisbon, Portugal (Mail: tmrsilva@ciencias.ulisboa.pt)

1. OBJECTIVES AND MAIN RESEARCH QUESTIONS

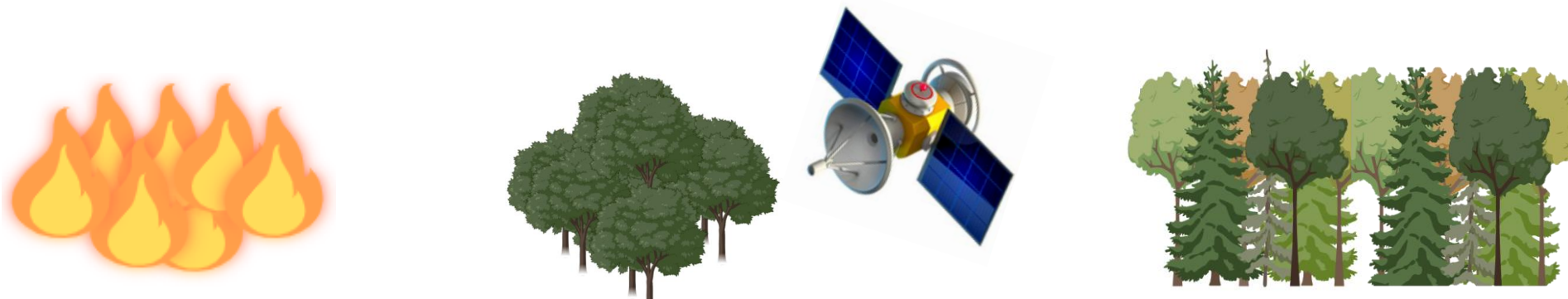
Provide a framework of how post-fire recovery dynamics of vegetation following recurrent fires over Mediterranean ecosystems worldwide based on **remotely-sensed data**. Based on a statistical model, we aim to address the following three research questions:

- Can remotely-sensed products of vegetation and burned areas suitable to monitor the post-fire vegetation recovery across Mediterranean ecosystems?
- Are the recovery processes of fire-prone Mediterranean ecosystems being impacted by recurrent fires in recent years?
- How does pre-fire conditions of these ecosystems influence fire severity, and in turn, how does fire severity modulate the recovery rate of burned vegetation?

2. DATA AND METHODS

- Burned Areas (BA) from MODIS
- Enhanced Vegetation Index (EVI) from MODIS
- Land Cover from ESACCI

PERIOD 2001-2022

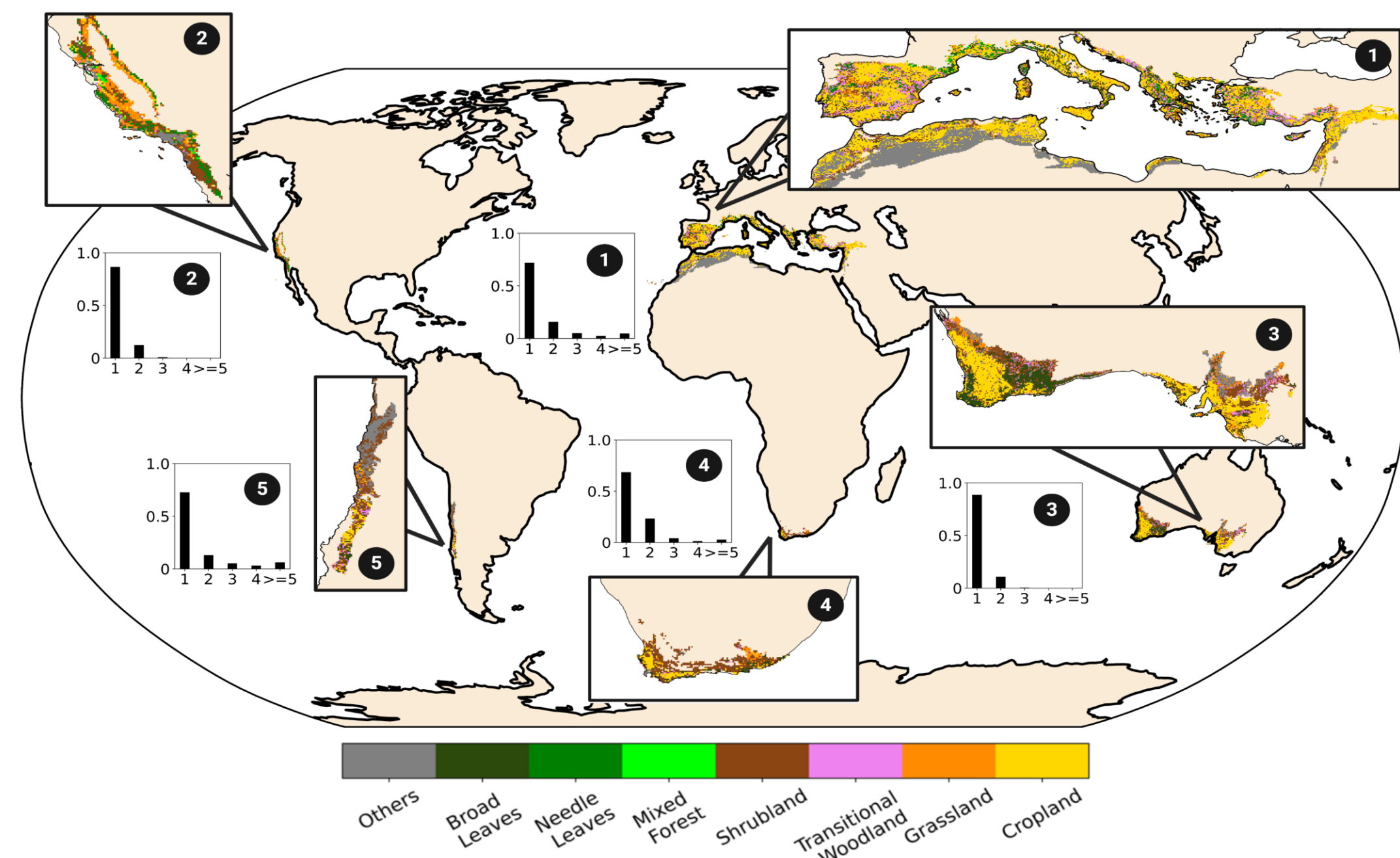


BA MODIS
MCD64A1 v6.1

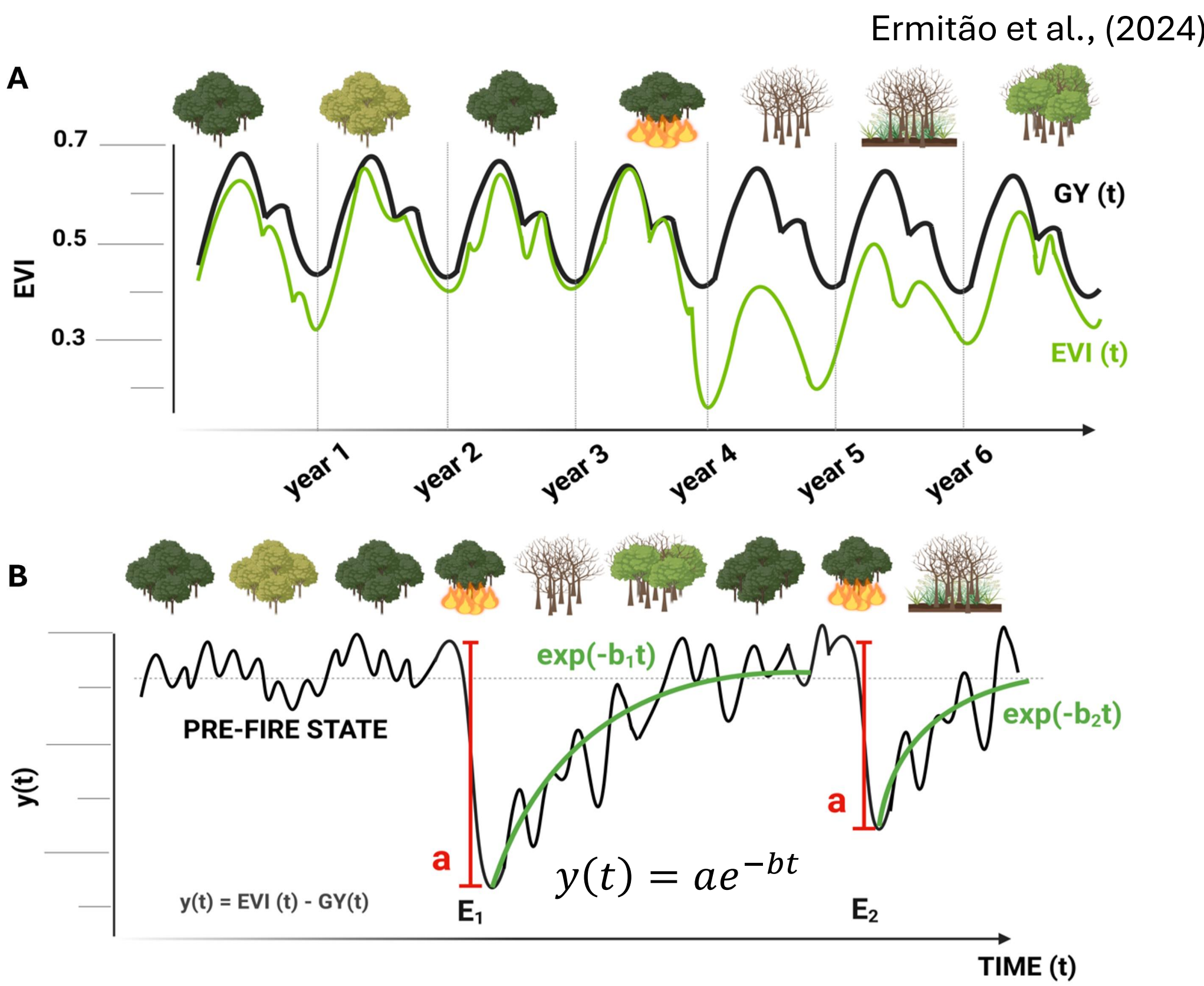
EVI MODIS
MOD13A1 v6.1

ESACCI
V2.1.1

STUDY AREA



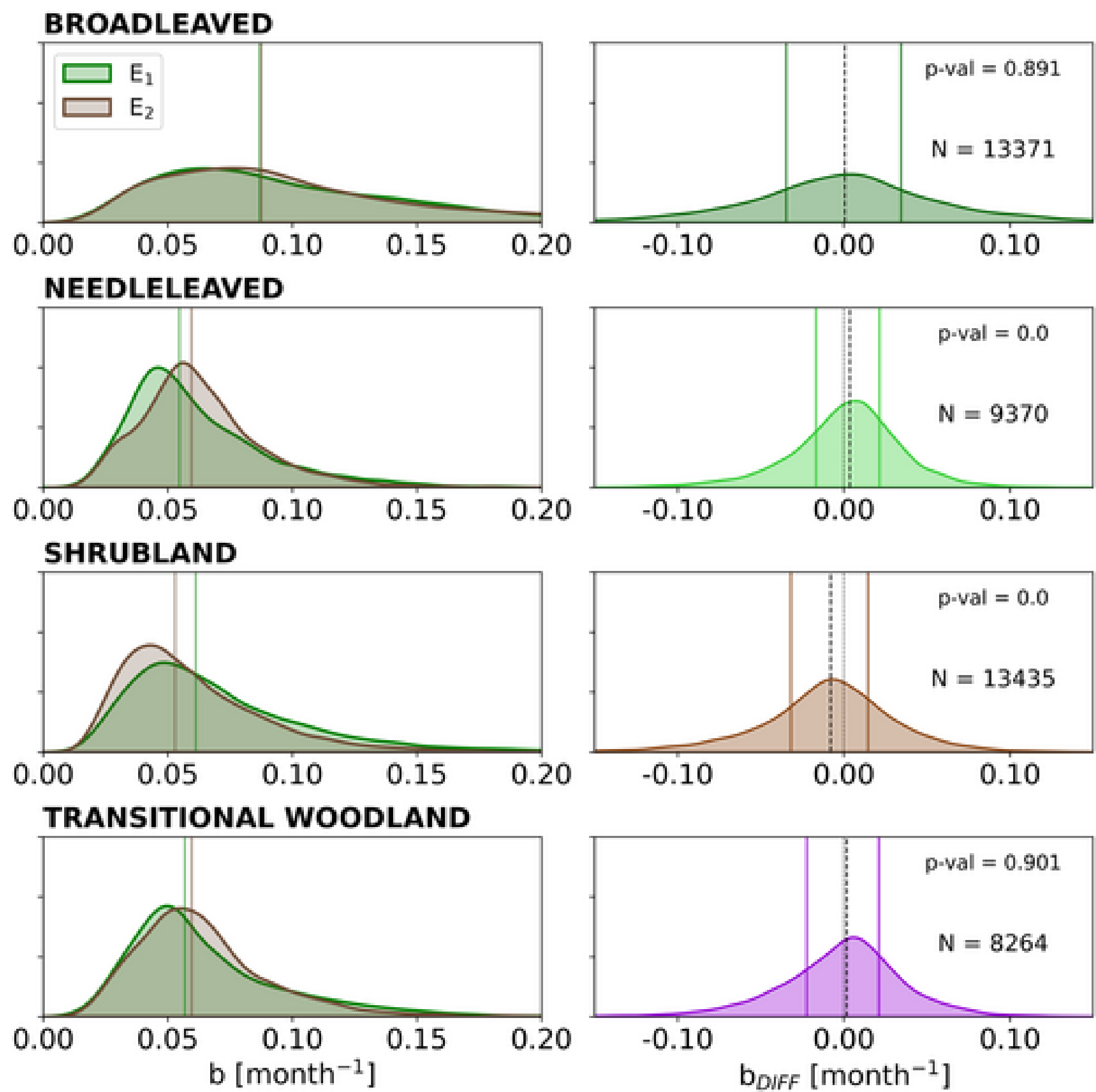
STATISTICAL MODEL



- We apply a mono-parametric statistical model to a time-series of EVI (panel A) that evaluates the **recovery rate** of vegetation greenness over regions that burned **twice** (panel B).
- We analyse the recovery rate, and the impact of pre-fire vegetation state and fire severity, separately for the following land covers: Broad-leaved forests (BL), Needle-leaved forests (NL), Shrublands (Shb) and Transitional Woodlands (TW).

3. RESULTS

RECOVERY RATE



BL tend to show **faster** mean recovery times (0.08 month^{-1}) as well as larger variability in recovery rates than the other vegetation types.

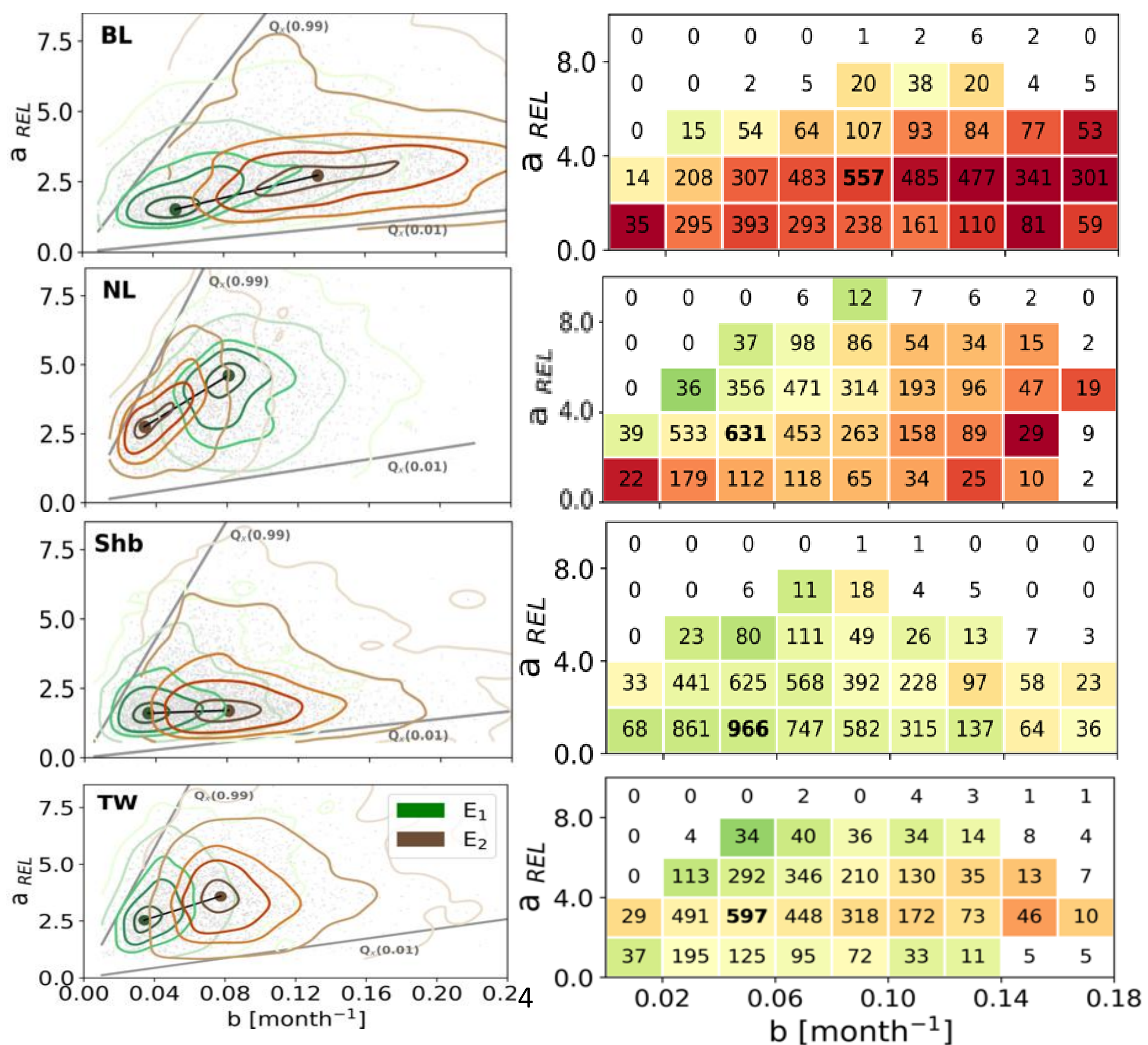
On average, *NL* generally show **faster** recovery following E_2 than E_1 by 0.005 month^{-1} , as given by the mean value of the pairwise differences.

Shb pixels recover **faster** after E_1 than E_2 by 0.008 month^{-1} .

For *BL* and *TW*, the median differences are not statistically significant, indicating that E_1 and E_2 distributions are very similar.

Broad spread of b_{DIFF} distributions can indicate that **marked differences** in recovery rates between the two events have occurred.

FIRE SEVERITY AND PRE-FIRE STATE



Distribution of the points suggests a **marked dependence** of recovery rate on the relative fire severity.

Strong sensitivity of recovery rates to relative severity in the most severe fires (99th quantile of a_{REL}) for all vegetation types (*higher slopes*). For the least severe fires (1st quantile of a_{REL}), the recovery rates show **low sensitivity** to relative fire severity (*lower slopes*).

Strongly **negative values** of $y(t)_{\text{PRE-FIRE}}$ tend to be associated with **faster** recovery rates. Closer to ideal seasonal cycle values of $y(t)_{\text{PRE-FIRE}}$ tend to be associated with **more severe** fires and **slower** recovery rates.

FINAL REMARKS

- Good** performance of the proposed methodology, enhancing the value of **remote sensing**, with a **time-series approach**, to assess fire recovery.
- Mean recovery rate tends to be **faster** after the **first event** than the second event, although we detect large variability between recovery rates.
- Fire severity modulates the recovery of vegetation, as recovery rates are enhanced with **increasing** severity.
- More severe** fires are followed by very **slow** recovery, and these events are strongly associated with **high** values of pre-fire greenness.

REFERENCES

Gouveia, C., DaCamara, C. C., & Trigo, R. M. (2010). Post-fire vegetation recovery in Portugal based on spot/vegetation data. *Natural Hazards and Earth System Sciences*, 10(4), 673-684.
Bastos, A., Gouveia, C. M., DaCamara, C. C., & Trigo, R. M. (2011). Modelling post-fire vegetation recovery in Portugal. *Biogeosciences*, 8(12), 3593-3607.
Ermitão, T., Gouveia, C. M., Bastos, A., & Russo, A. C. (2024). Recovery Following Recurrent Fires Across Mediterranean Ecosystems. *Global Change Biology*, 30(12), e70013.