BioSpace25 - Biodiversity insight from Space
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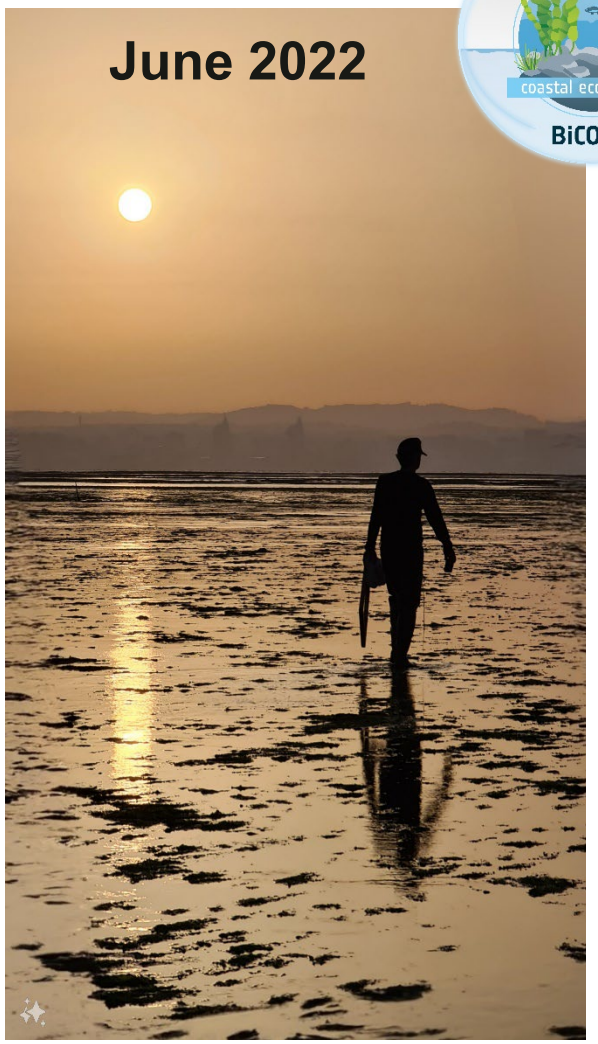
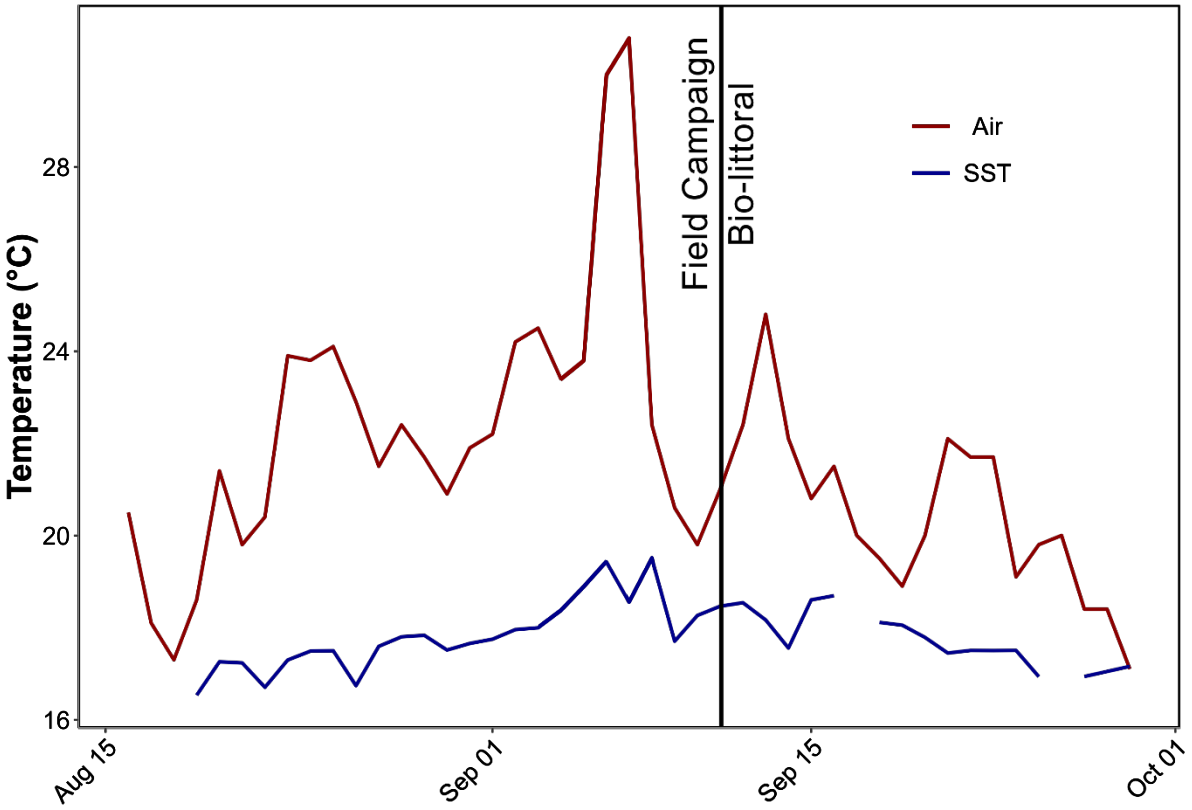
Impact of Marine and Atmospheric Heatwaves on Intertidal Seagrass: Experimental Spectroradiometry and Satellite-Based Insights

Simon Oiry, Bede Ffinian Rowe Davies, Phillipe Rosa, Augustin Debly, Maria Laura Zoffoli, Anne-Laure Barillé, Nicolas Harin, Pierre Gernez, Laurent Barillé

Introduction



Introduction



Introduction

What's in the litterature ?

scientific reports

OPEN

Physiological and morphological effects of a marine heatwave on the seagrass *Cymodocea nodosa*

Alizé Deguette[1], Isabel Barrote[1,2,3] & João Silva[1,3]

Vol. 435: 83–95, 2011 | MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser | Published August 22
doi: 10.3354/meps09213

Effects of a simulated heat wave on photophysiology and gene expression of high- and low-latitude populations of *Zostera marina*

Gidon Winters[1,*], Peter Nelle[1], Birgit Fricke[1], Gisep Rauch[1], Thorsten B. H. Reusch[1,2]

Contents lists available at ScienceDirect

Marine Environmental Research

journal homepage: http://www.elsevier.com/locate/marenvrev

ELSEVIER

Heat wave intensity can vary the cumulative effects of multiple environmental stressors on *Posidonia oceanica* seedlings

LIMNOLOGY and OCEANOGRAPHY

ASLO

Limnol. Oceanogr. 66, 2021, 4112–4124
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doi: 10.1002/lno.11947

Chronically elevated sea surface temperatures revealed high susceptibility of the eelgrass *Zostera marina* to winter and spring warming

Yvonne Sawall[1,2*] Maysa Ito[1,3] Christian Pansch[1,4]

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[4]Environmental and Marine Biology, Åbo Akademi University, Åbo, Finland

On subtidal *Zostera marina* and *Cymodosea nodosa*:

- Highly vulnerable to elevated sea temperatures in winter and spring, leading to early flowering, high mortality, and reduced biomass.
- Photosynthetic activity rises during HWs but diminishes during recovery, impairing performance and reducing leaf biomass.
- Responses vary greatly between species…
- …and within a single species across latitudes.

What about *Zostera noltei* ?

Impact on the reflectance ?

Impact of Extreme Atmospheric temperature ?

Introduction
Hypothesis & Objectives

Heatwaves alter the spectral reflectance of *Zostera noltei* seagrass. This change can be detected using remote sensing technique.

- Evaluate the direct impact of heatwave-induced **thermal stress** on the reflectance of *Zostera noltei* through **controlled experiments**.
- Develop a **spectral index** for detecting stress-induced changes in seagrass coloration.
- To apply findings from experimental reflectance changes to **satellite-based** remote sensing, assessing the spatial extent and temporal dynamics of an heatwave event that occurs in September 2021, in Quiberon, on seagrass meadows.

Material & Methods

Experiment

Intertidal chambers

Allow to control :

- Air Temperature
- Water Temperature
- Tide cycle
- Photoperiod and light intensity

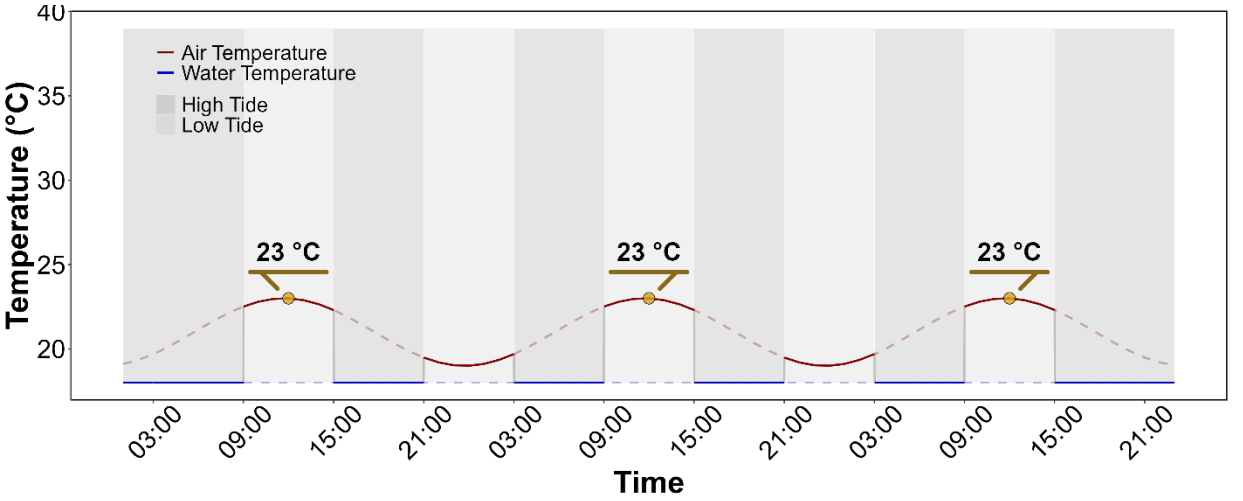
Measurement of hyperspectral signature of samples

Material & Methods

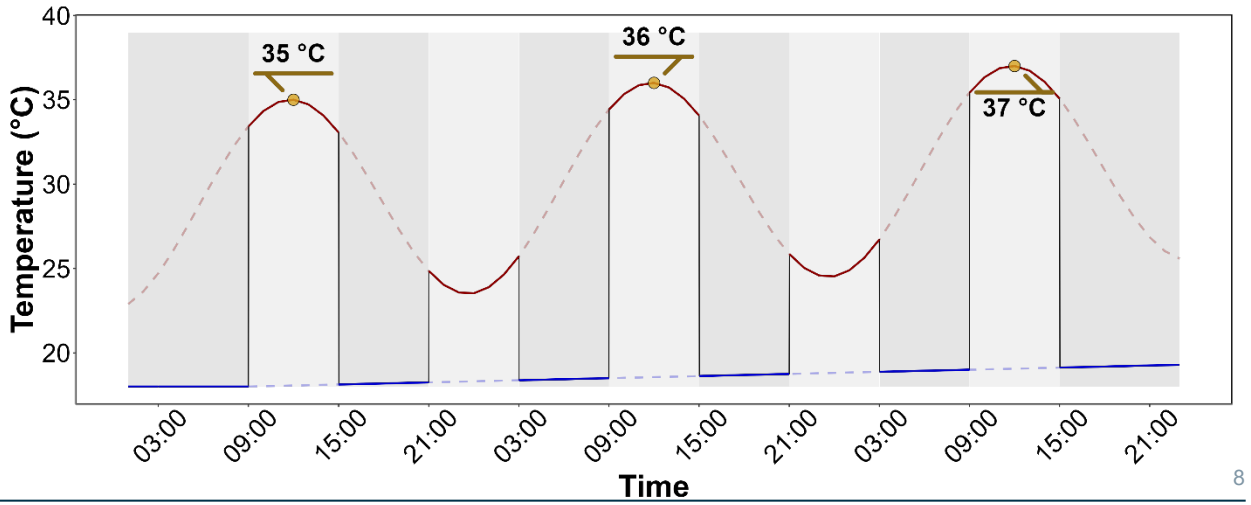
Experiment

Seagrasses inside of a chamber

Control

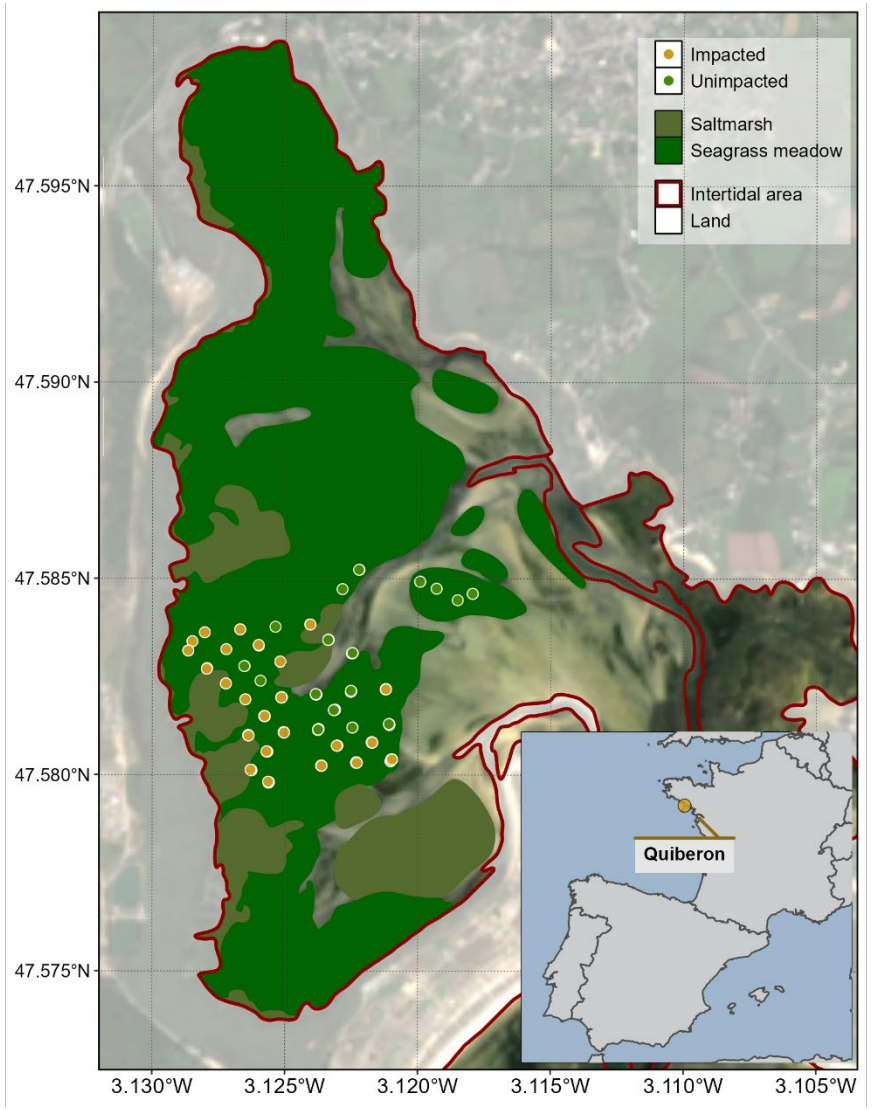


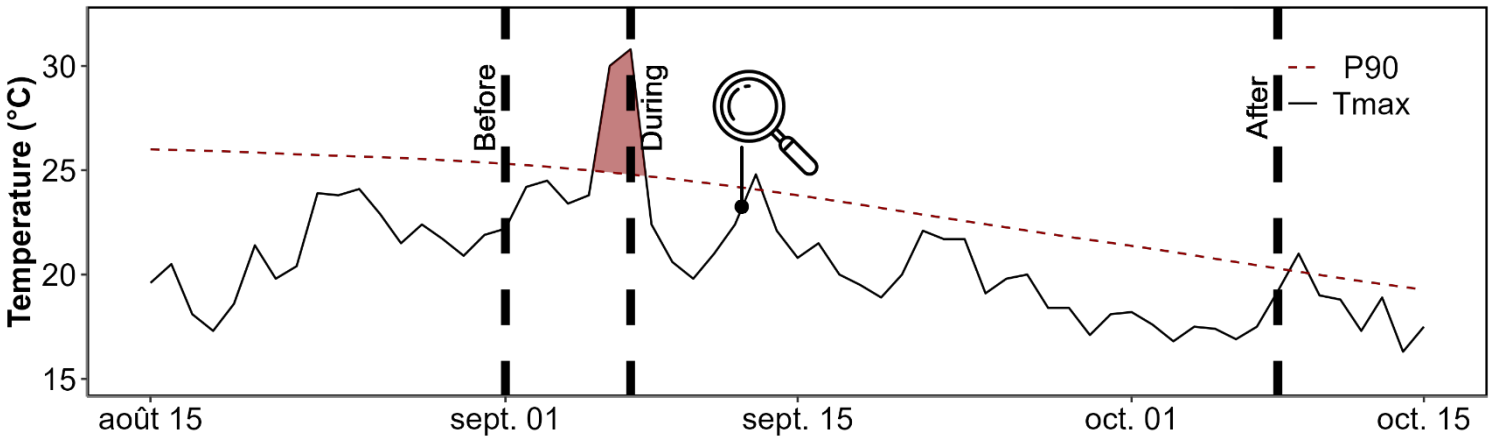
Treatment



Material & Methods

Sentinel-2 satellite mapping



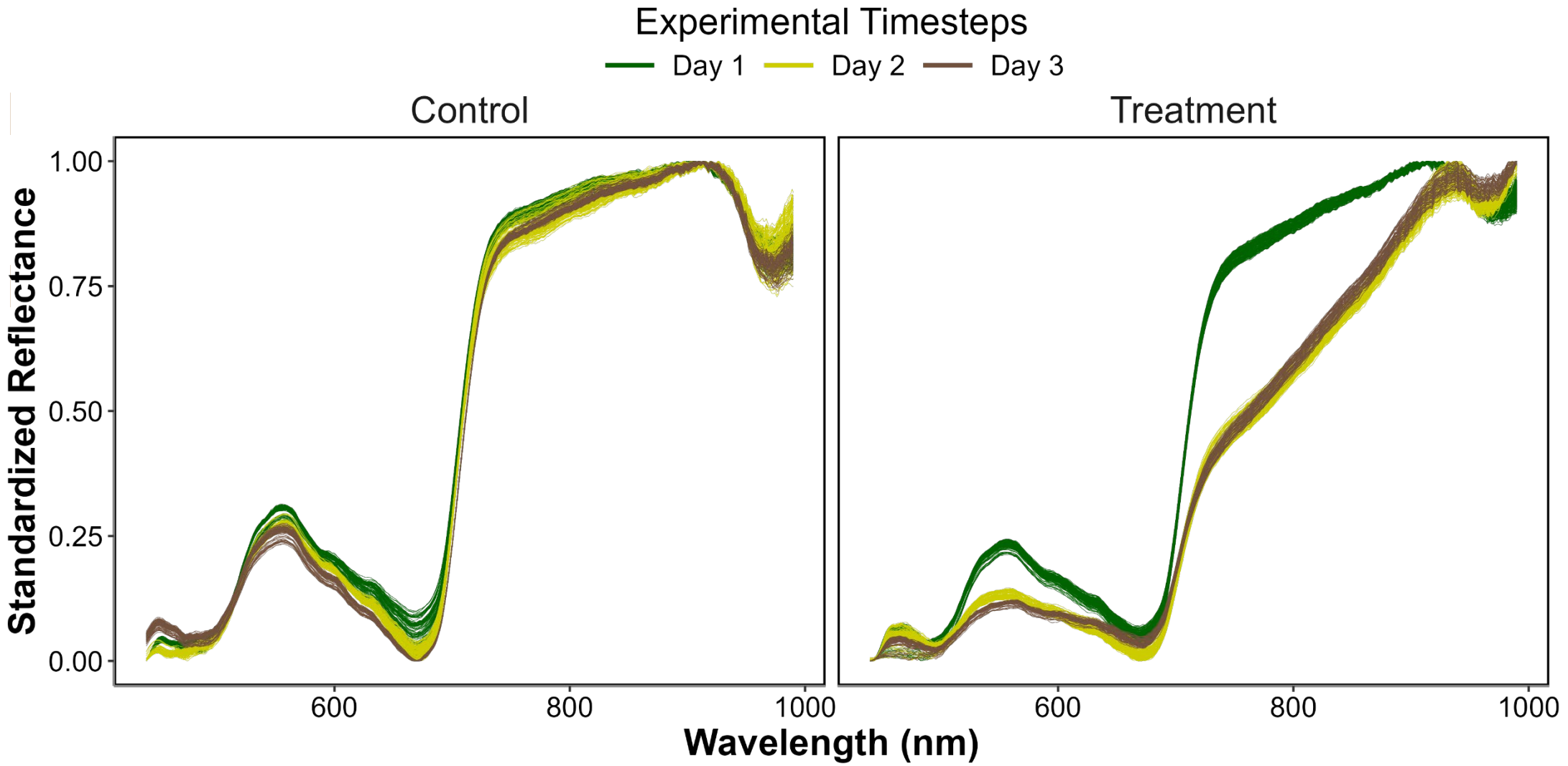


Field campaign on the 11th of September

- Spectral shape
- $NDVI = \frac{R(NIR)-R(Red)}{R(NIR)+R(Red)}$
- $GLI = \frac{2*R(Green)-R(Red)-R(Blue)}{2*R(Green)+R(Red)+R(Blue)}$

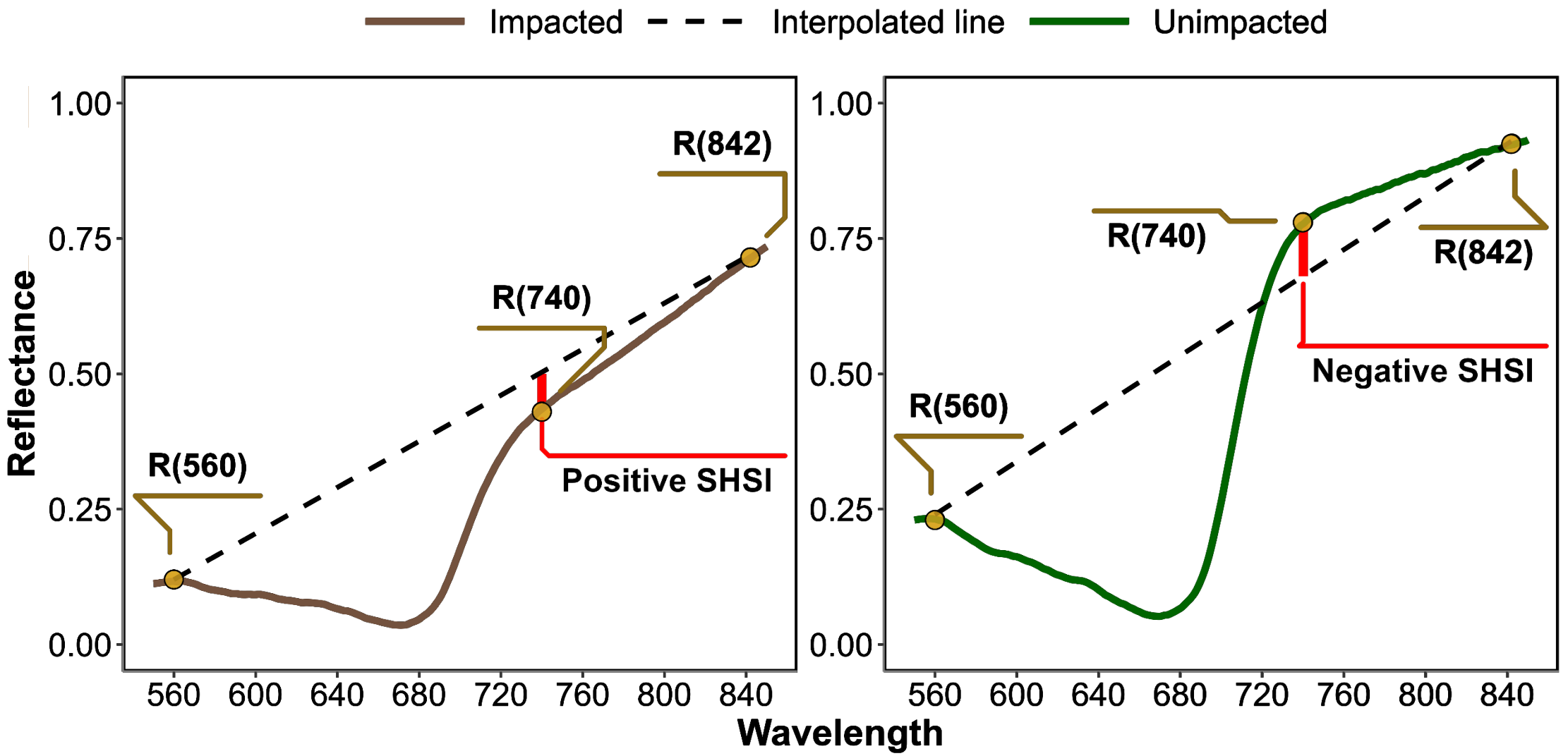
Results

Experiment – Spectral signatures



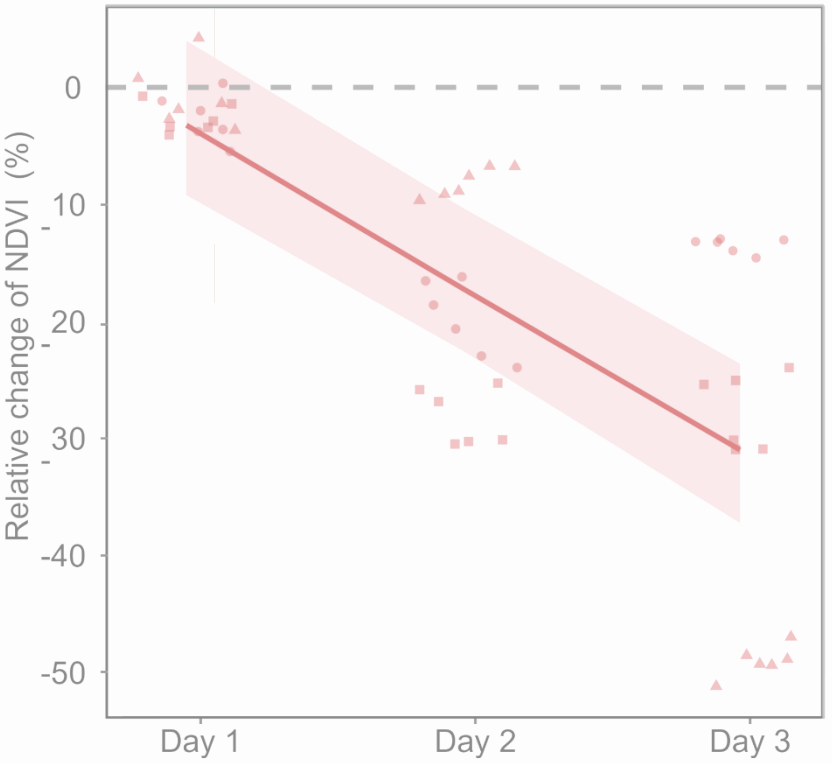
Results

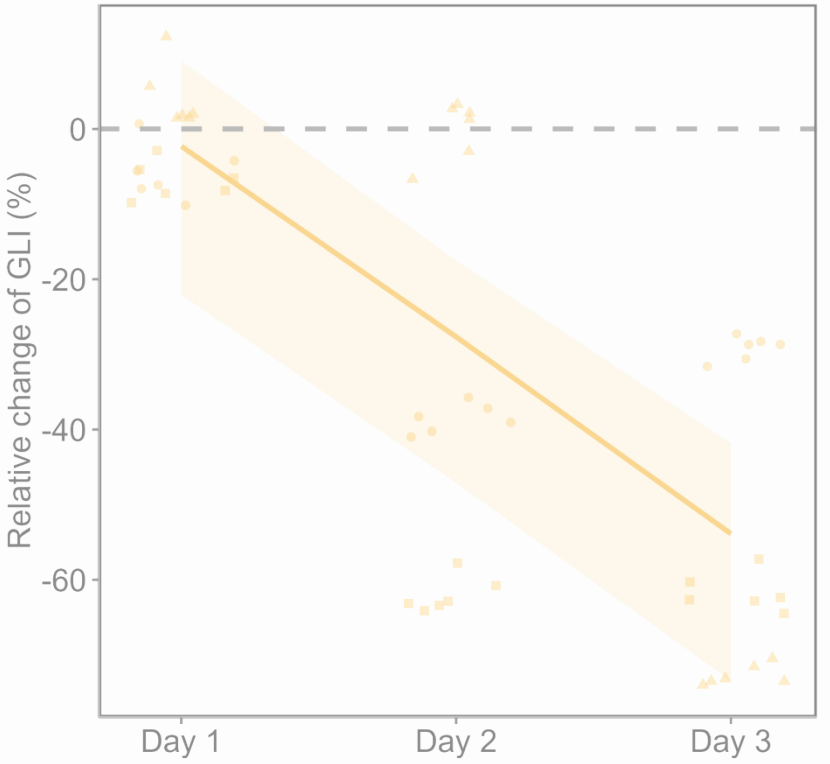
Experiment – SHSI

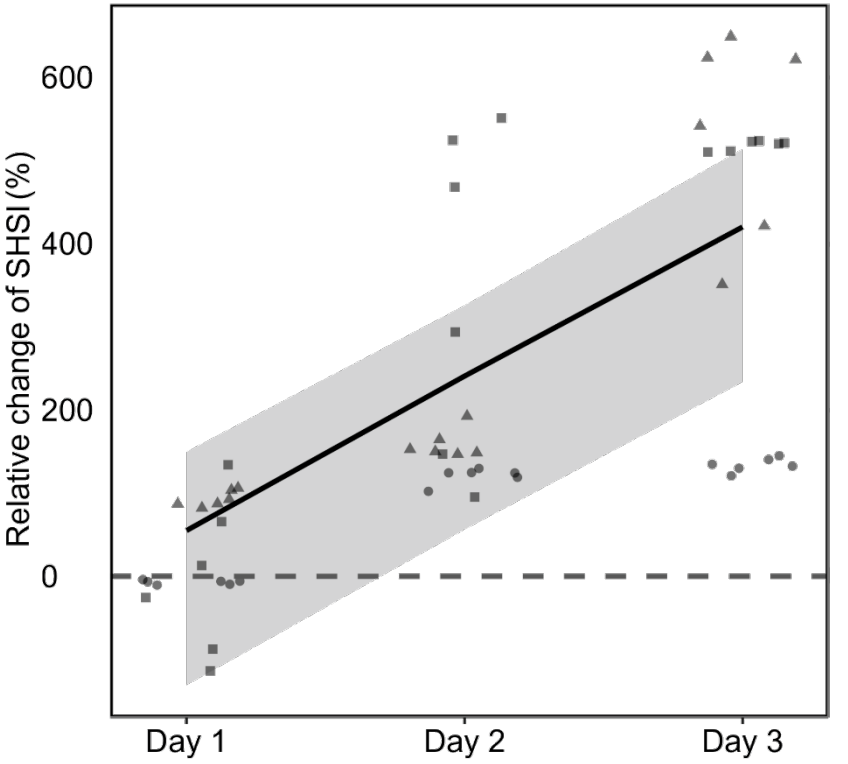


Results

Experiment – Evolution of Indices







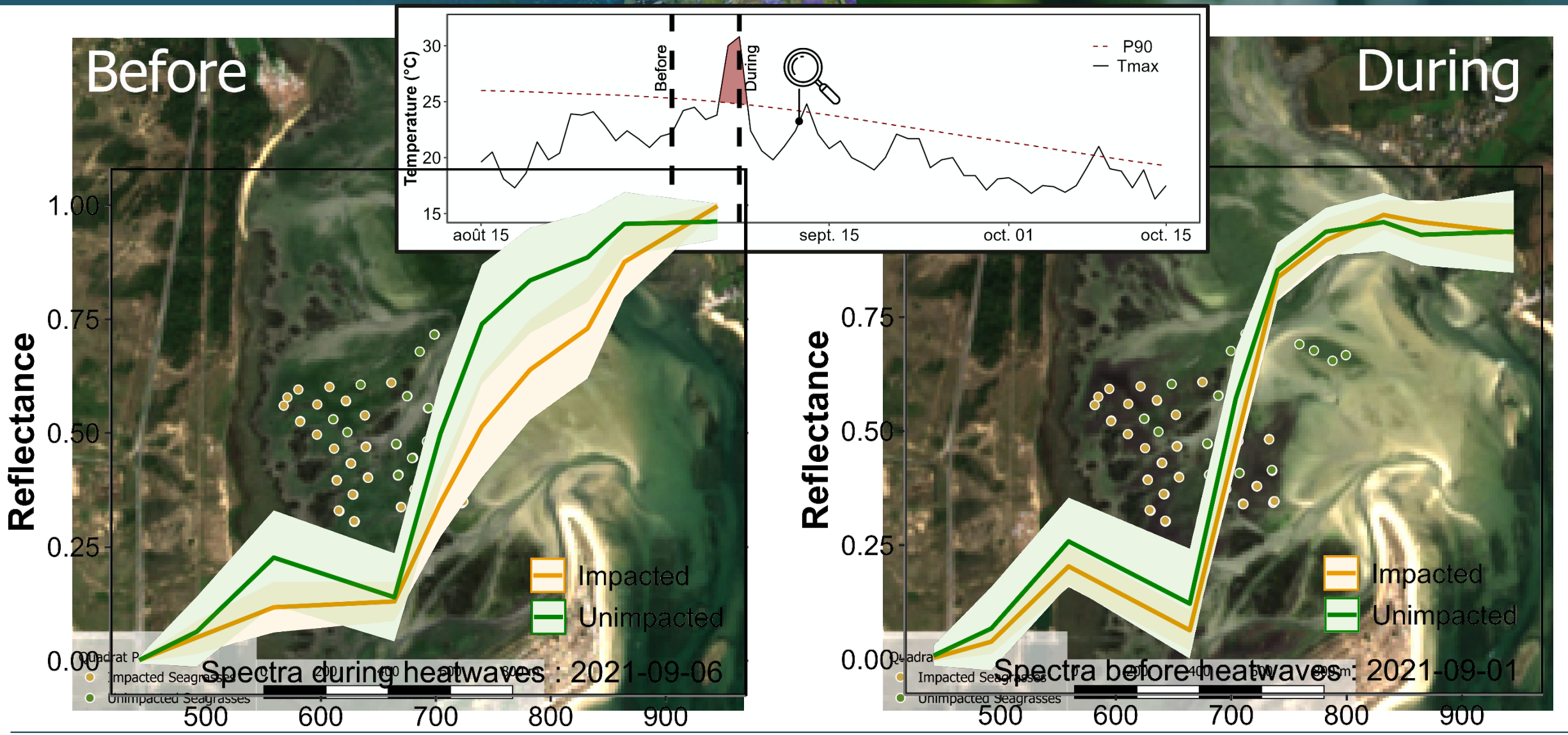
NDVI : - 31 %

GLI : - 54 %

SHSI : + 420 %

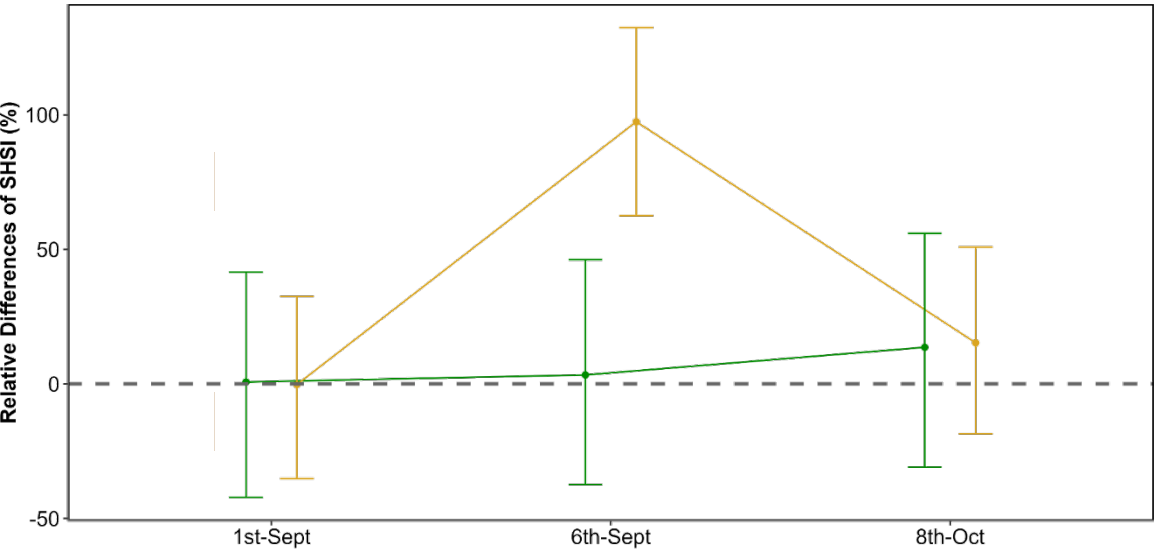
Results

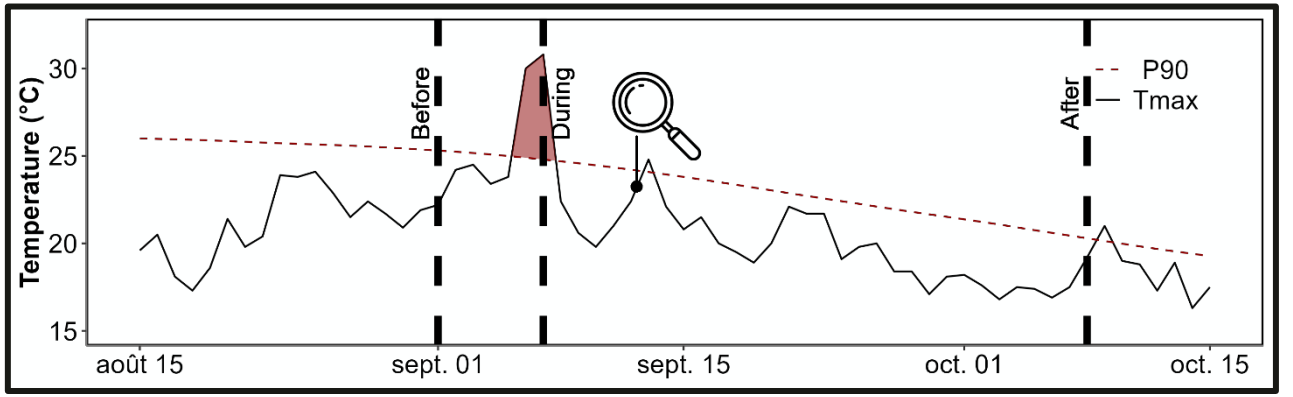
Satellite – Spectral signatures

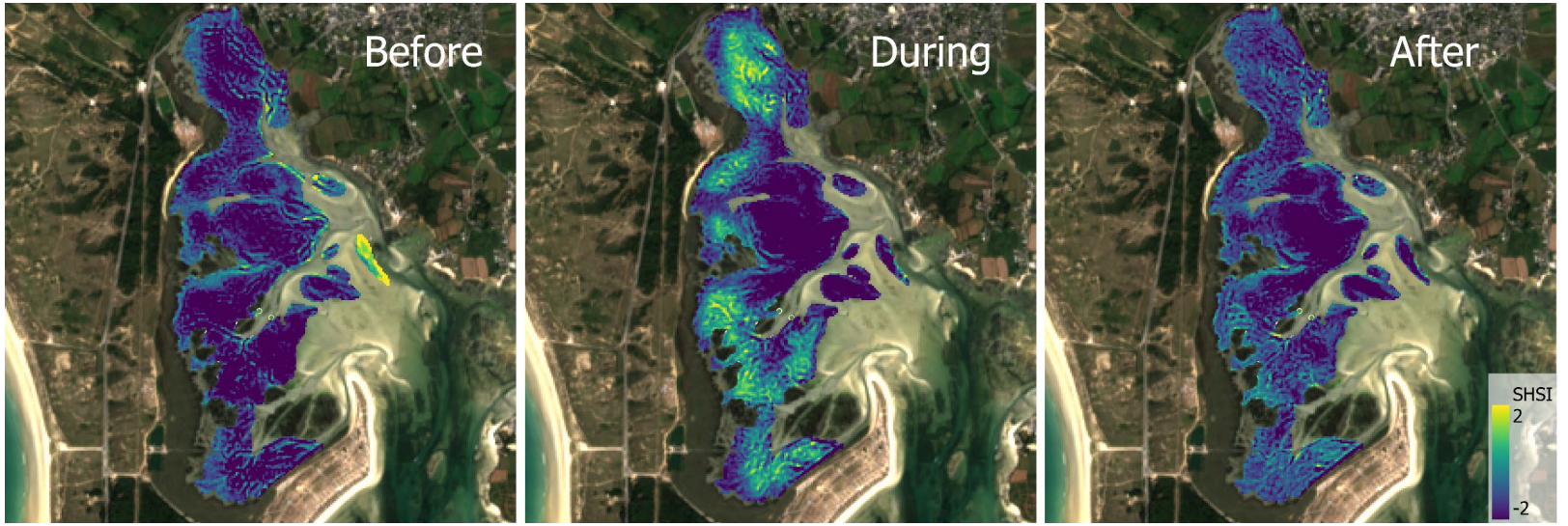


Results

Satellite – SHSI

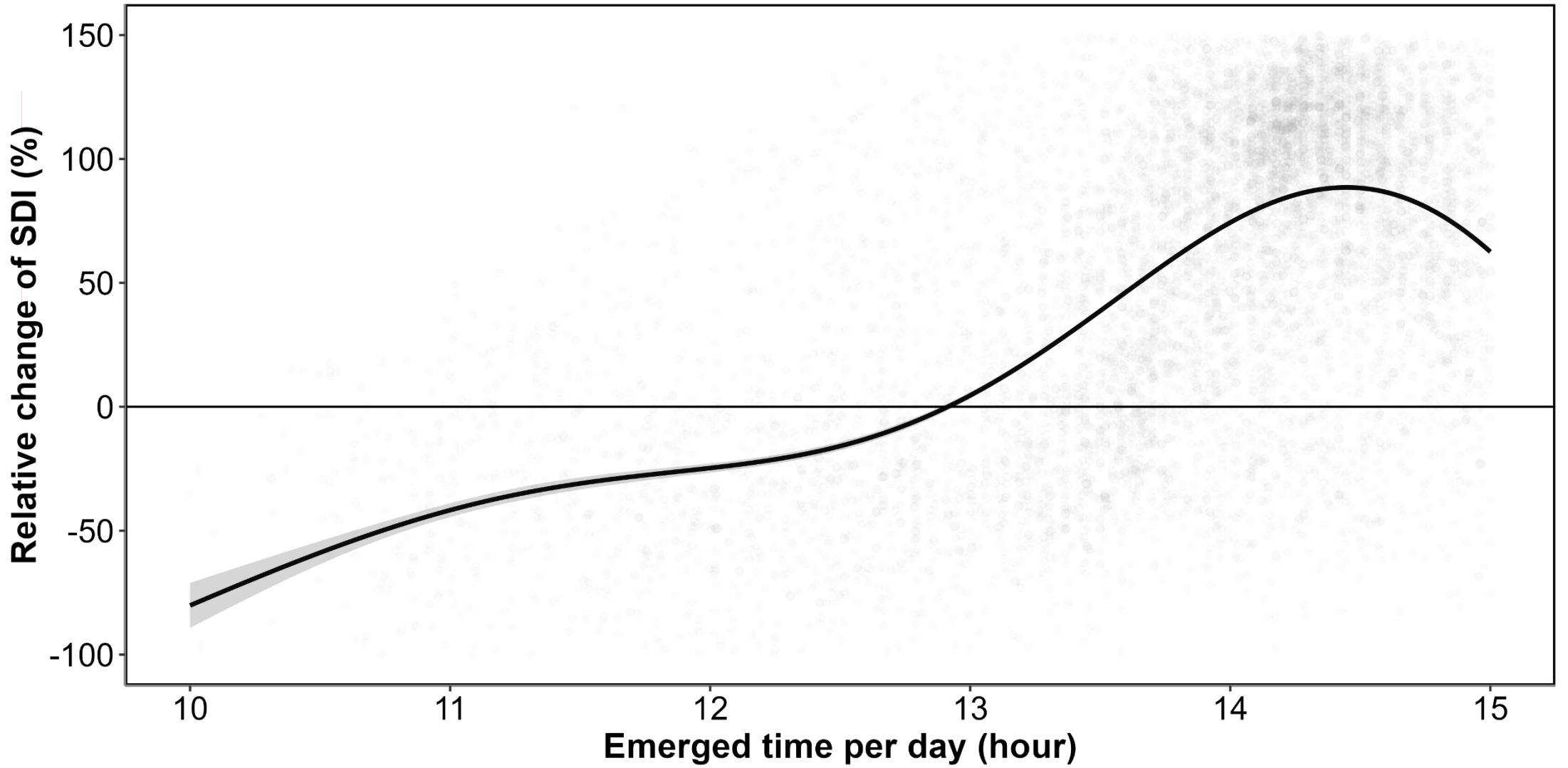






Results

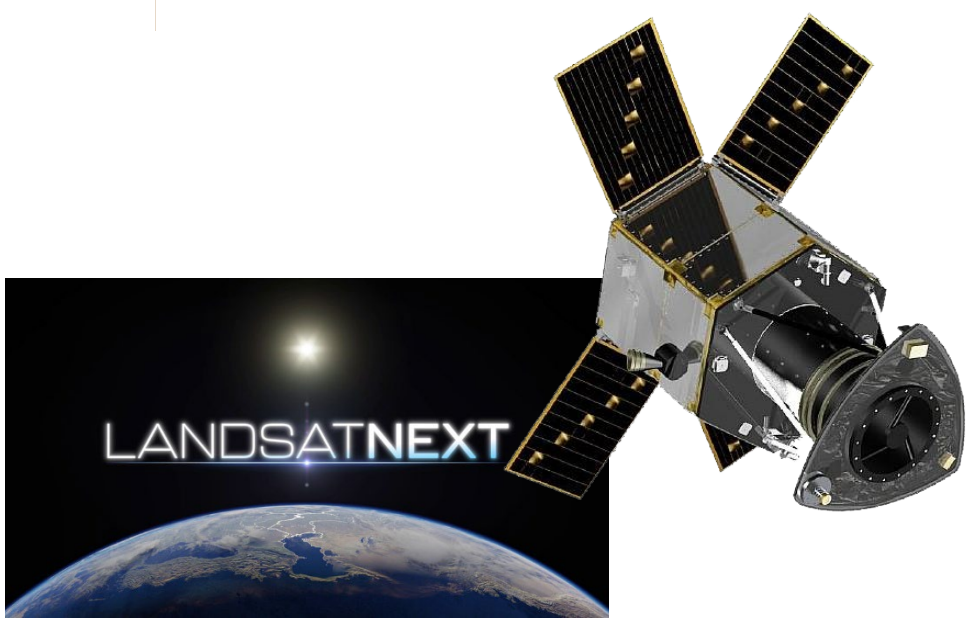
Satellite – Emersion Time

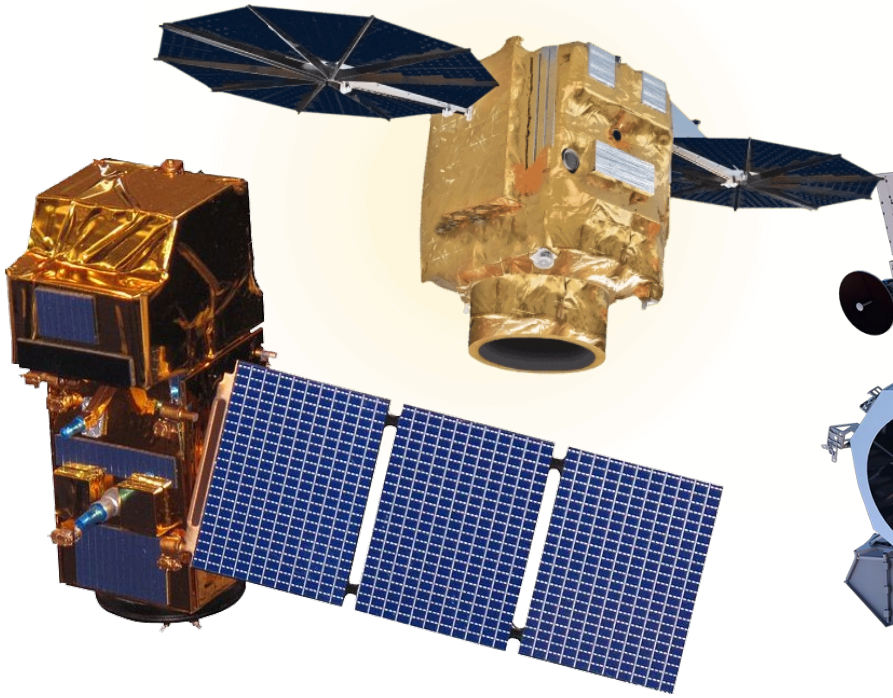


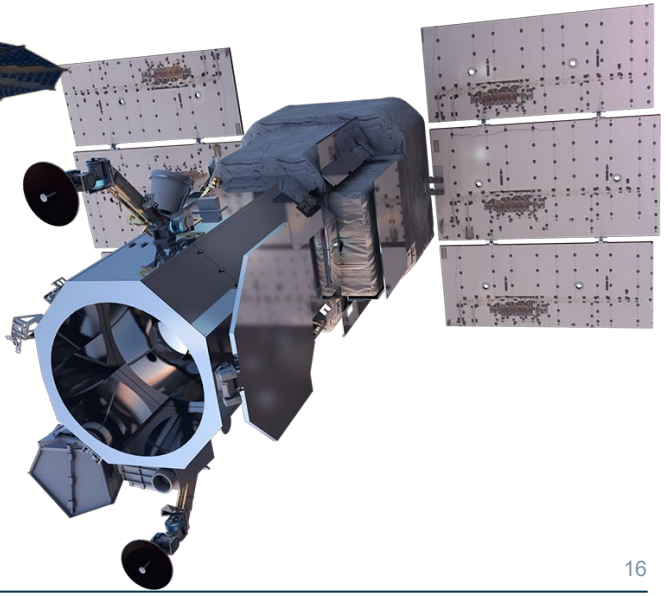
Discussion & Conclusion

Mapping Impacted meadows

- Seagrasses impacted by heatwave have a distinct spectral signature (drops at 560 and 740nm)
- Possible to detect seagrass thermal stress using satellite remote sensing, using the SHSI
  - Designed to be used by most space missions (Sentinel-2, Pleiades-Neo, WorldView-3, SkySat, GeoSat-2…)…
  - … but also by future missions (Sentinel-2 Next Generation, Landsat Next…)





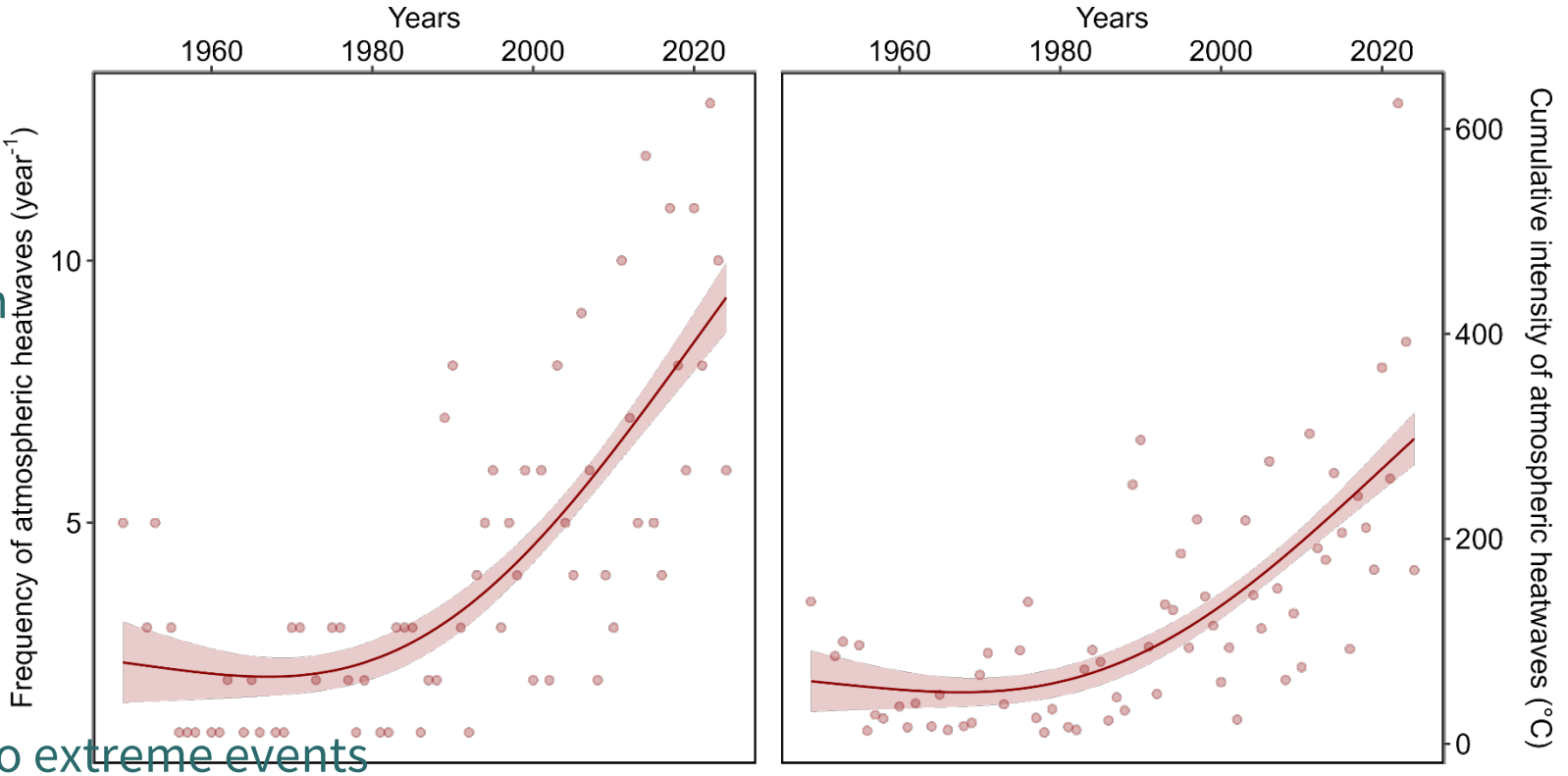


Discussion & Conclusion

Heatwaves in a Global Warming Context

- Rapid **global** escalation of HW frequency, intensity and duration (Devi et al., 2024; Russo and Domeisen, 2023)…

… as observed **locally** in Quiberon



- Impact on seagrass resilience to extreme events

Thank you !

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