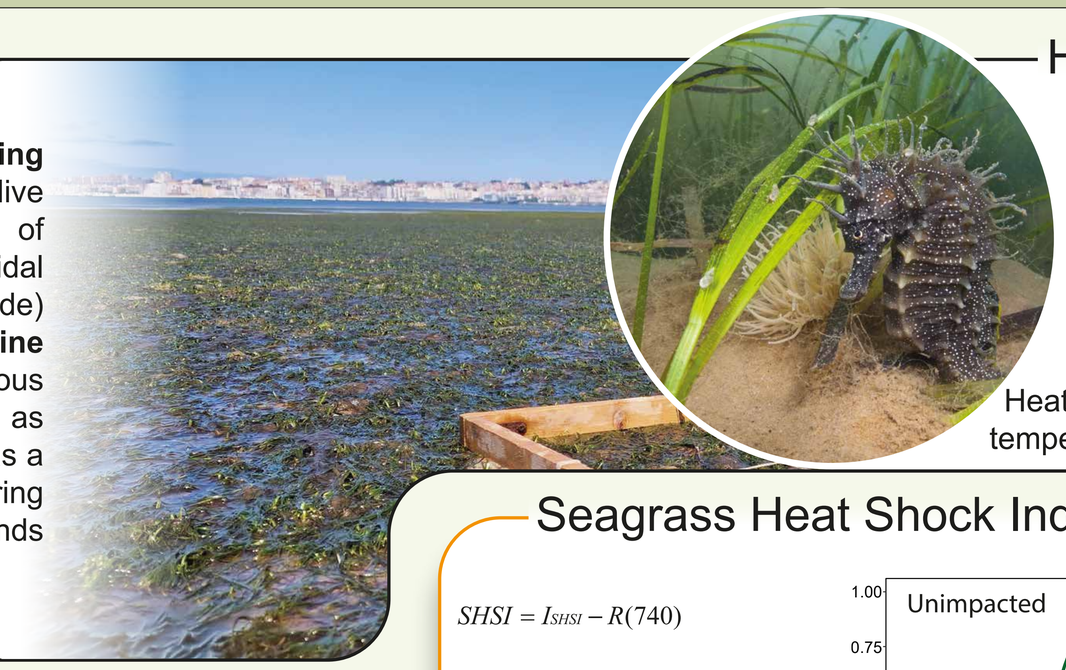
What is the impact of extreme temperatures on seagrass reflectance ?

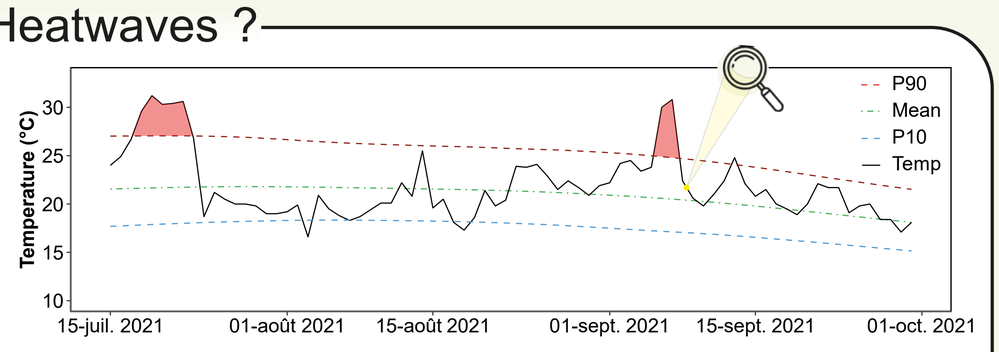
Oiry S.[1], Davies BFR.[1], Rosa P.[1], Debly A.[1], Zoffoli ML.[2], Barillé AL.[3], Harin N.[3], Román M.[1-4], Gernez P.[1], Barillé L.[1]

Seagrasses ?

Seagrasses are **flowering plants** that are adapted to live rooted in soft sediment of subtidal and intertidal (between low and high tide) habitats. They are **key marine habitats,** providing numerous **ecosystem services** such as erosion protection, acting as a carbon sink, and offering shelter and nursery grounds for many species.



Heatwaves ?



Heatwaves are prolonged episodes of **extreme warmth**, during which temperatures stay above the local **90th-percentile** threshold for at least 3 days. They can arise in the **atmosphere**, in the **ocean**, or simultaneously in both realms, sharply elevating air and/or sea-surface temperatures . It can bleach leaves, impair photosynthesis, and trigger die-offs. Heatwaves are becoming **increasingly frequent and intense**.

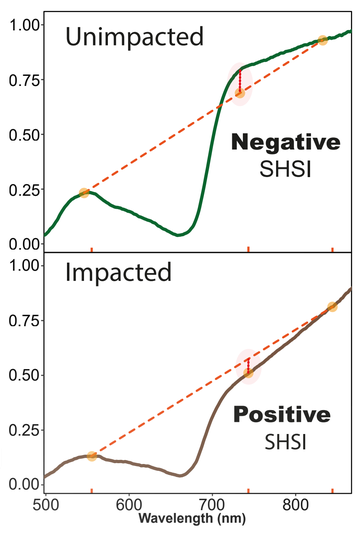
Seagrass Heat Shock Index

$$SHSI = I_{SHSI} - R(740)$$

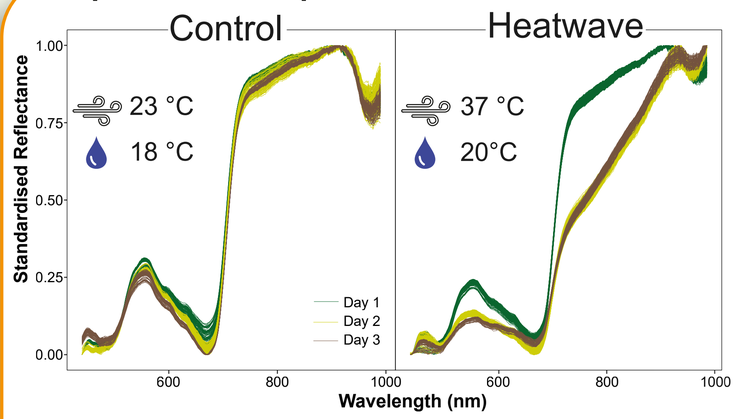
$$I_{SHSI} = R(560) + \tau[R(842) - R(560)]$$

$$\tau = \frac{740-560}{842-560} = 0.64$$

The **SHSI** can identify seagrass impacted by extreme Temperatures using reflectance values

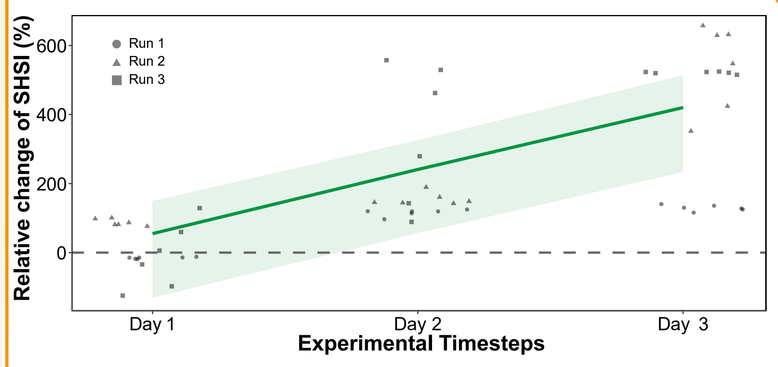


Spectral Impacts of Heatwaves



Drop of reflectance in the **green** (560 nm) and the **Red-Edge** (740 nm) part of the electromagnetic spectra

Apply the SHSI Experimentaly



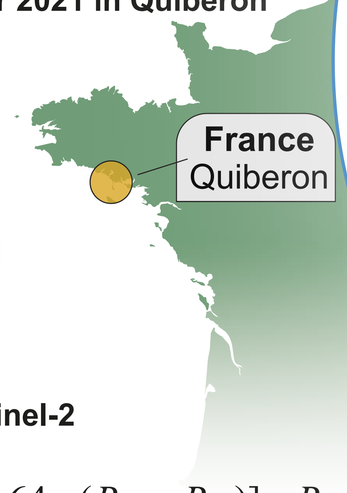
Compared to **NDVI** (Normalised Difference Vegetation Index), **GLI** (Green Leef Index) and the **2nd derivative at 665nm**, the **SHSI is the most sensitive index** to seagrass heat induced discoloration

Experiment in the laboratory

Mapping using Sentinel-2

Sentinel-2 *in-situ* mapping

Heatwave of September 2021 in Quiberon



Before:
1st of September 2021

During:
6th of September 2021

SHSI applied to Sentinel-2

$$SHSI_{sentinel-2} = [R_{B3} + 0.64 \times (R_{B8} - R_{B3})] - R_{B6}$$

Bring Home Messages

Heat-induced spectral collapse happens fast

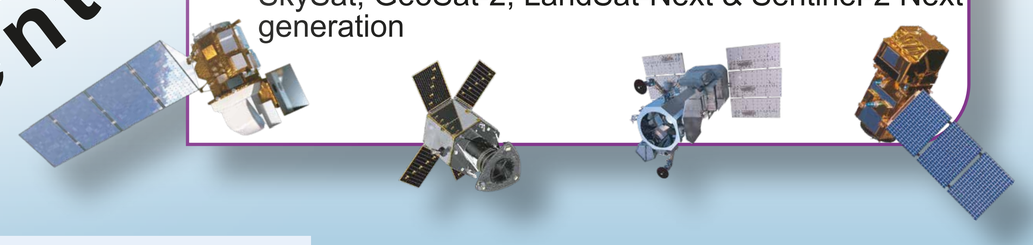
SHSI increased sharply 24h after the start of the experiment.

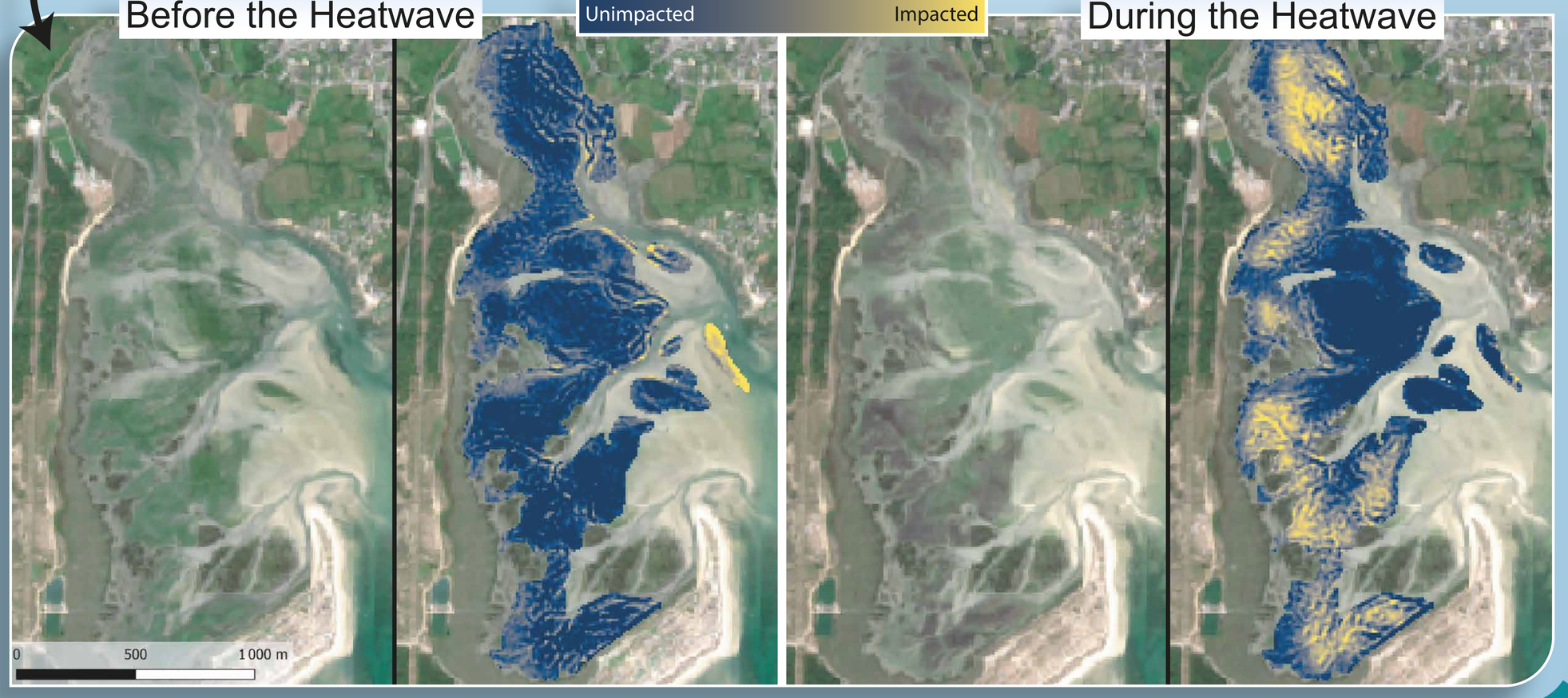
Spectral signature as a marker of physiological damage.

Drop in the Green (560 nm) linked to pigment degradation and in NIR (840nm) linked to cell wall destruction.

SHSI can map heat damage on seagrasses using satellite

Applicable to Sentinel-2, Pléiades, Wordview-3, SkySat, GeoSat-2, LandSat-Next & Sentinel-2 Next generation





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1 - Institut des Substances et Organismes de la Mer, ISOMer, Nantes Université, UR 2160, F-44000 Nantes, France
2 - Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine (CNR-ISMAR), 00133 Rome, Italy
3 - Bio-littoral, Immeuble Le Nevada, 2 Rue du Château de l'Eraudière, 44300 Nantes, France
4 - Centro de Investigación Mariña, Departamento de Ecoloxía e Bioloxía Animal, Facultade de Ciencias do Mar, Universidade de Vigo, Campus Universitario As Lagoas-Marcosende, 36310 Vigo, Spain