

# Defoliation, Metabolites and beyond – Understanding Trajectories to Tree Mortality

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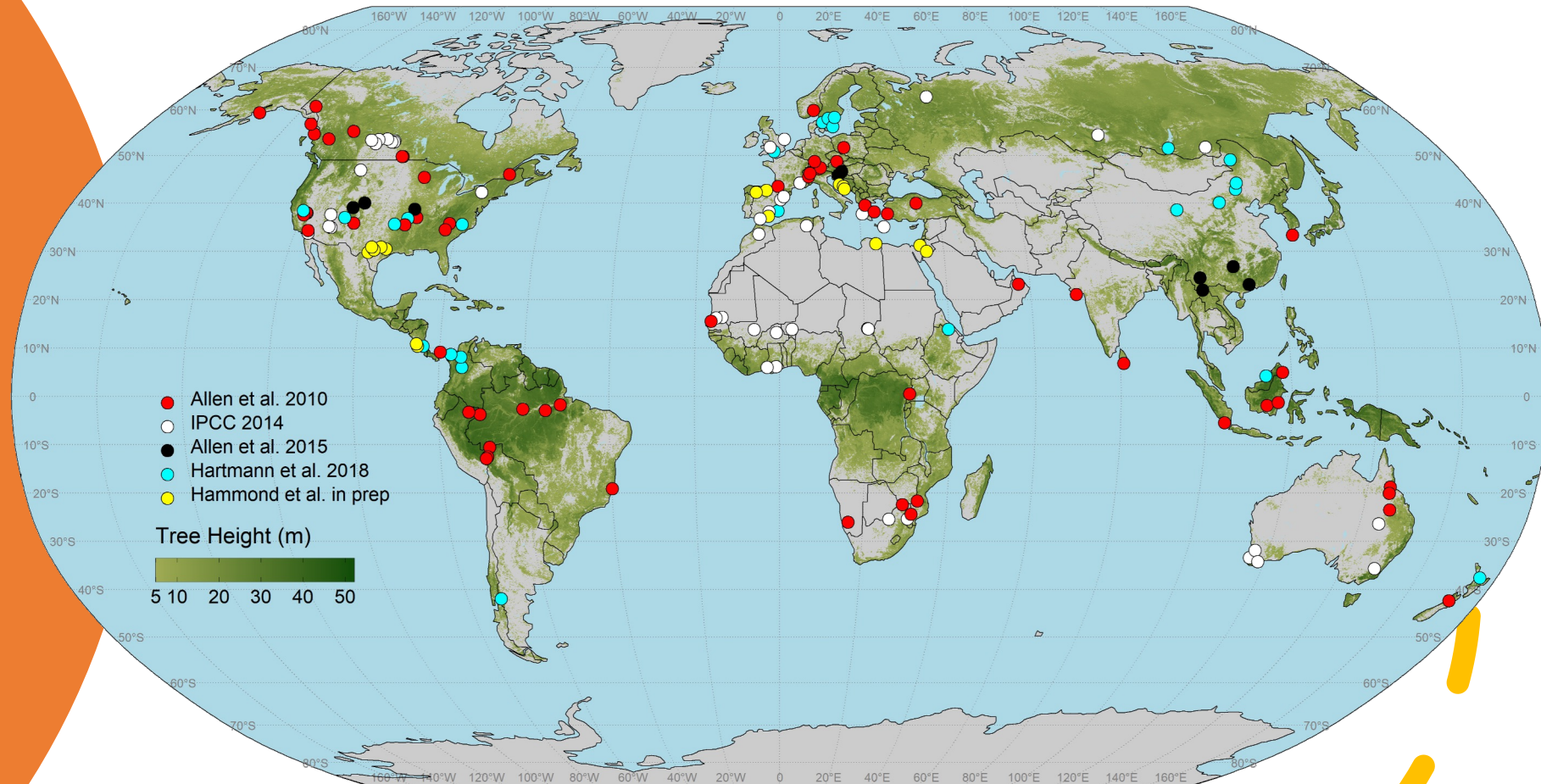
**ETH** zürich



**SWISS  
FOREST  
LAB**

# Forest Mortality is a Global Issue

Global map of documented tree mortality events related to drought and hotter temperatures

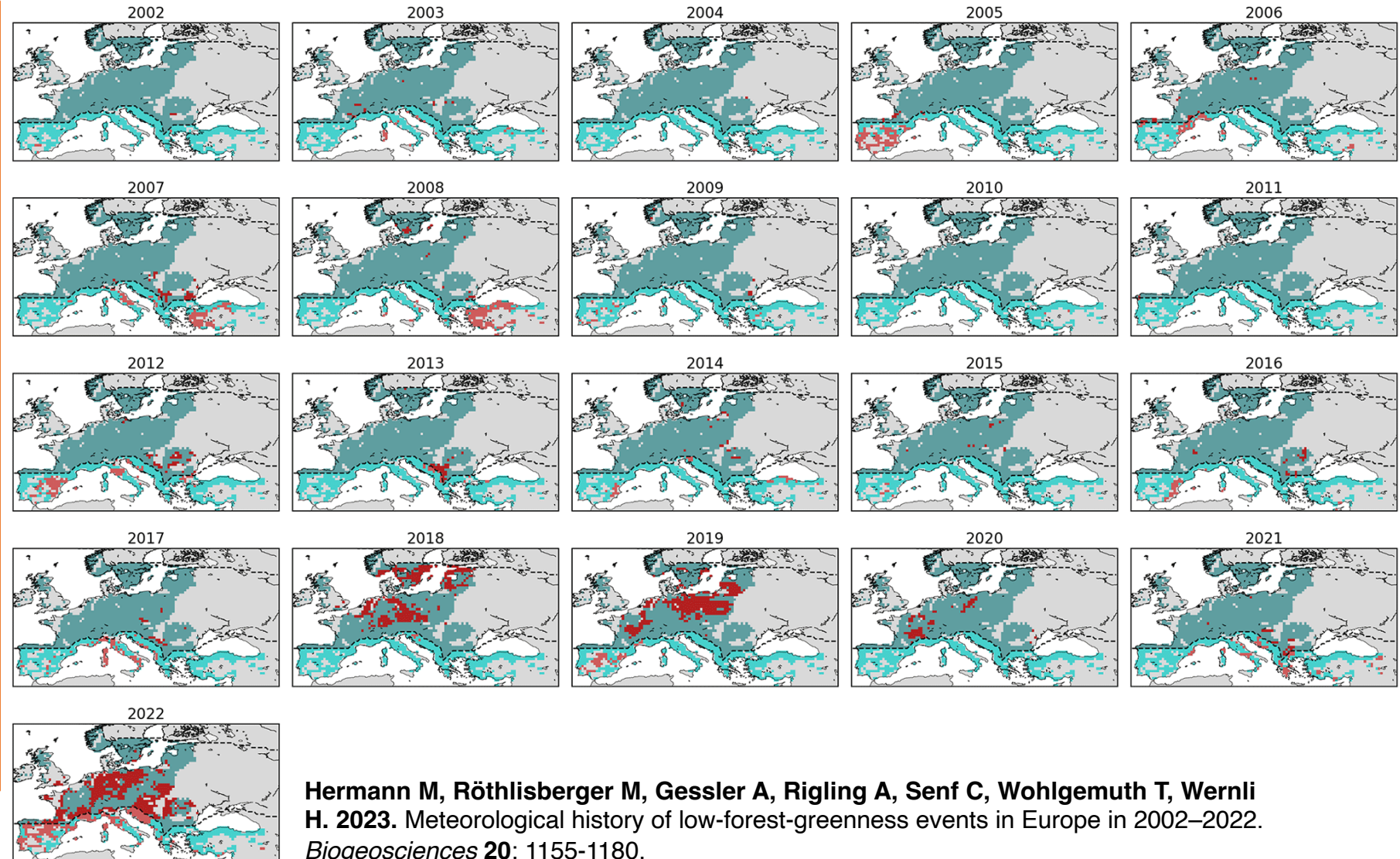


<https://www.tree-mortality.net/global-mortality/>

# ... and disturbance is increasing

Low summer NDVI anomalies  
(red) in forest grid cells from  
2002 to 2023 (MODIS)

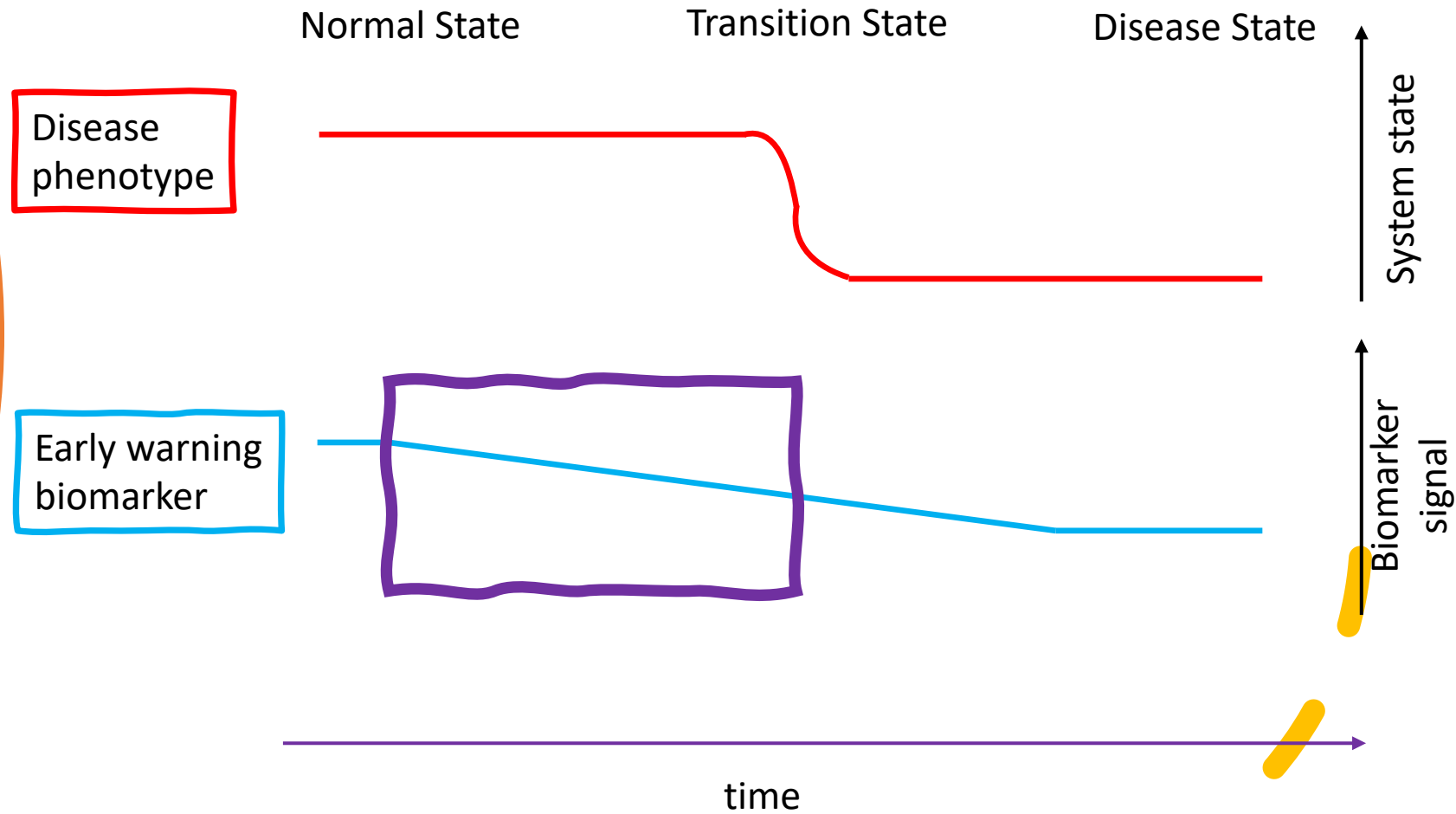
green area: temperate zone  
tourquoise area: Mediterranean



# Tree mortality

—  
can we find  
early warning  
signals?

For single trees and for stands





# Signals in defoliation

## *Tree mortality*

—  
can we find  
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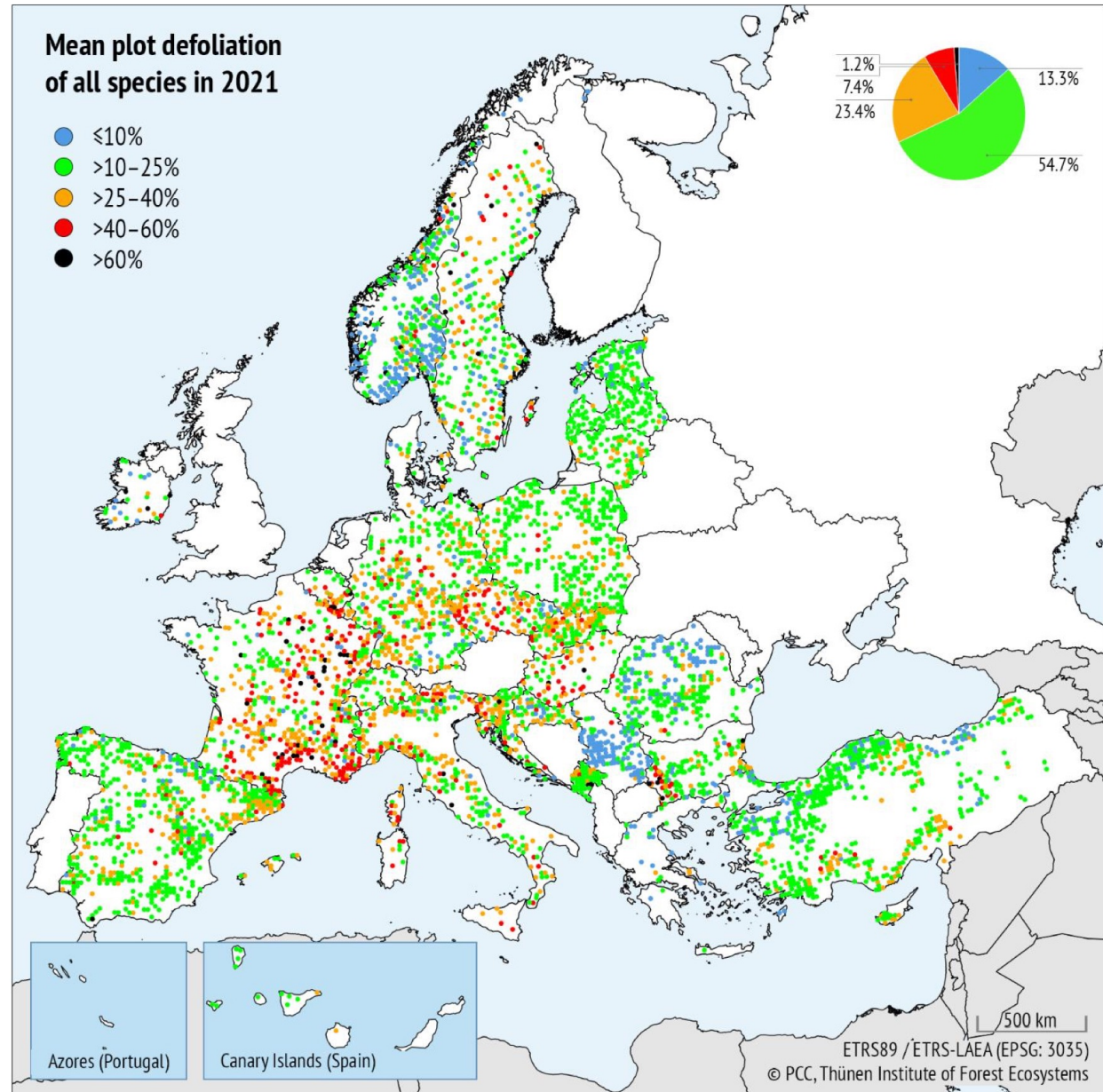
Defoliation



# Signals in defoliation

## *Tree mortality*

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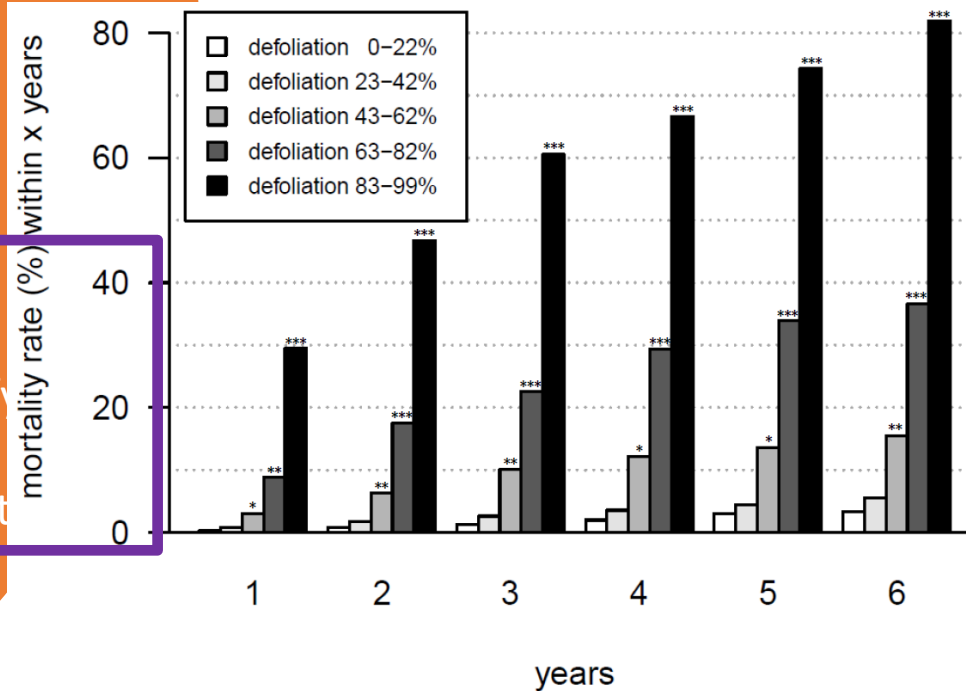
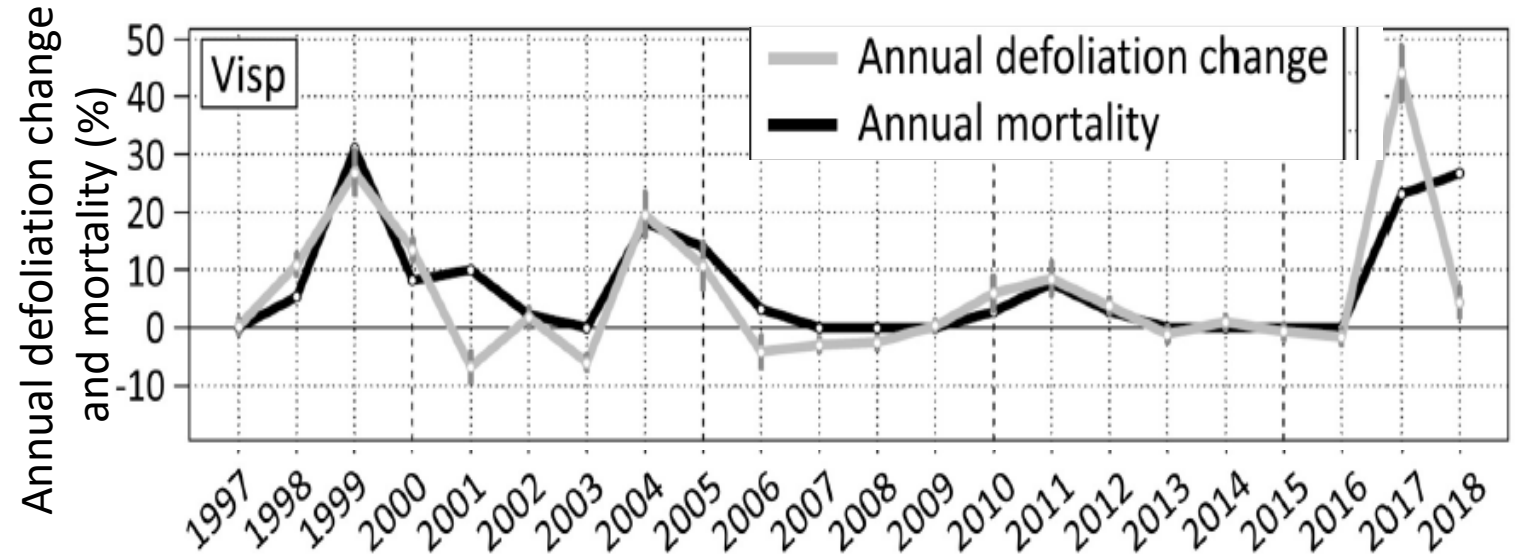
# Tree mortality

can we find early warning signals?

## Defoliation:

- Assessment of defoliation trajectories allows to quantify mortality risk in the next 1-6 years (species dependent)

Example Scots pine



Defoliation of single trees allows to estimate mortality probabilities:

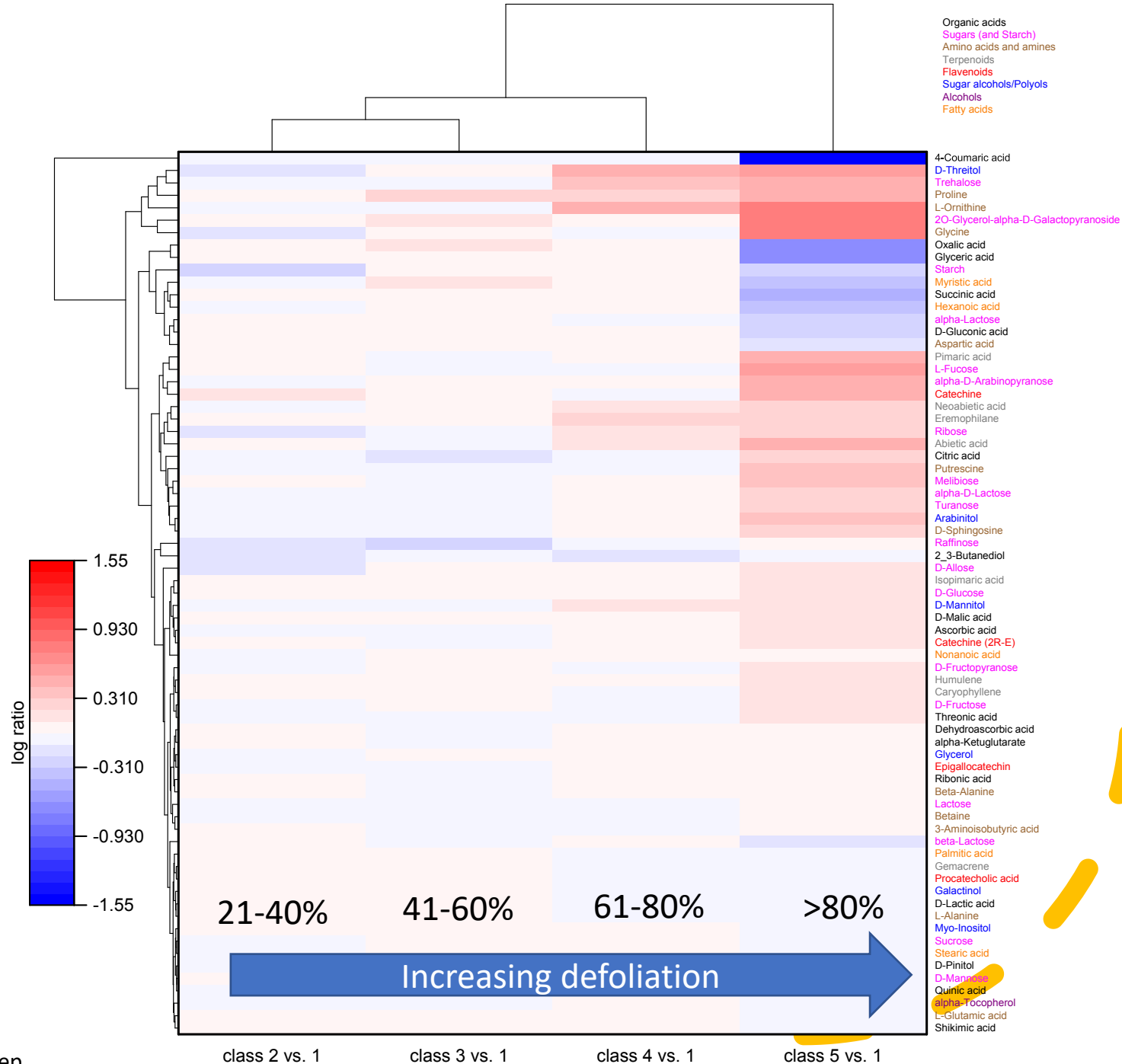
# Tree mortality

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Metabolic Markers in Needles  
of Scots Pine

Compared to undefoliated  
controls

Hunziker, Gessler et al. In prep



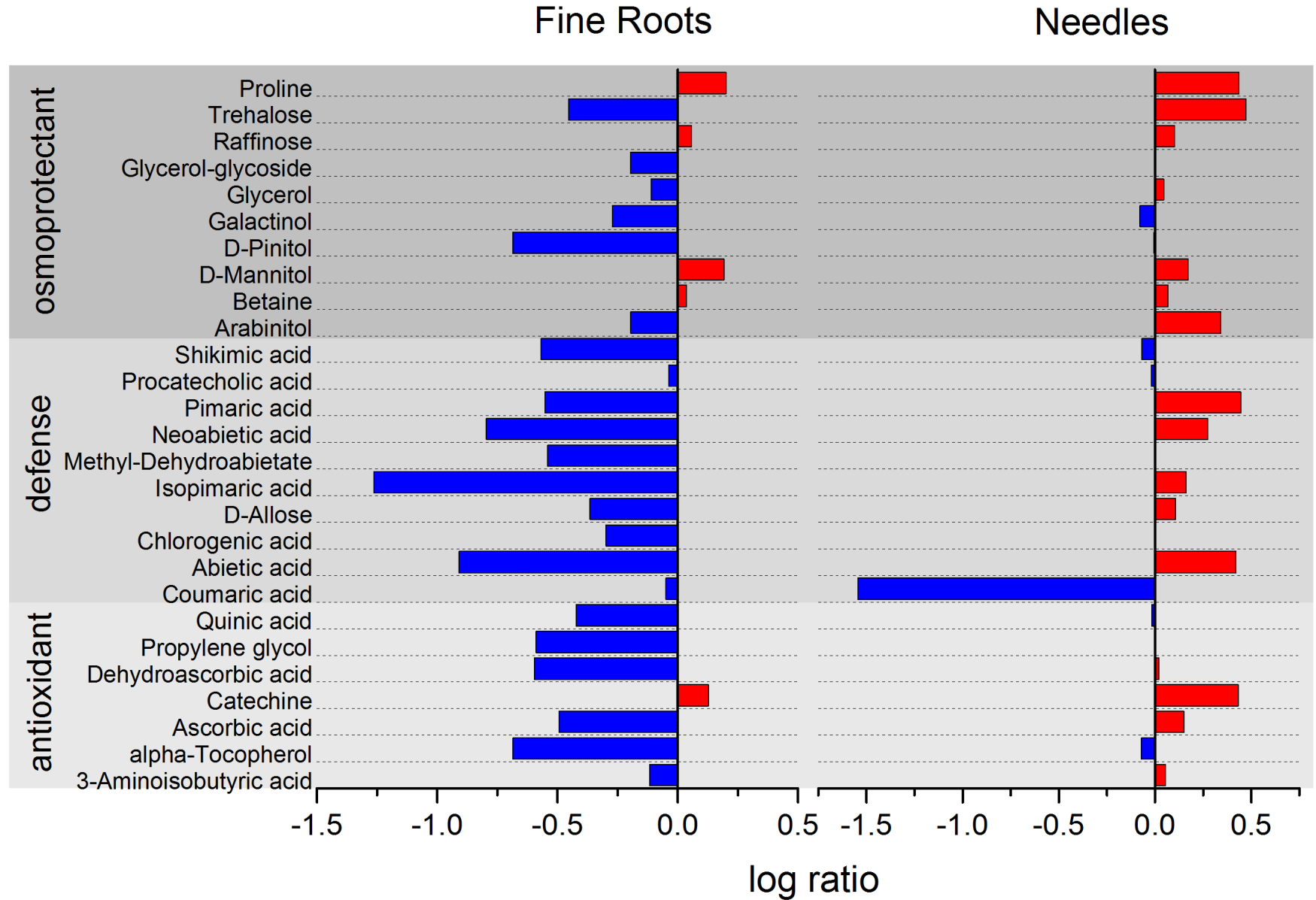


# Tree mortality

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## Metabolic Markers:

Provide mechanistic information and are related to mortality in line with defoliation



Change in >80% defoliated compared to undefoliated trees

# Remote sensing proxies for tree functioning

*PRI – the photochemical reflectance index*

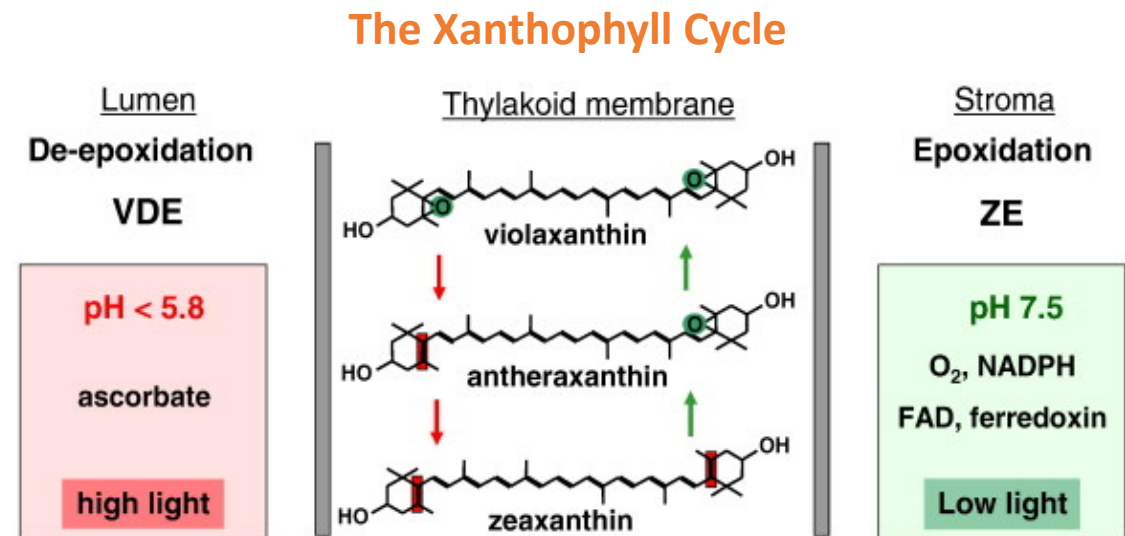
$$PRI = (R_{531nm} - R_{570nm}) / (R_{531nm} + R_{570nm})$$

*Tree mortality*

—  
can we find  
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Reflectance index

<https://doi.org/10.1016/j.bbabc.2008.09.013>



- De-epoxidation of the xanthophyll cycle
- Total carotenoid (including xanthophyll) pool



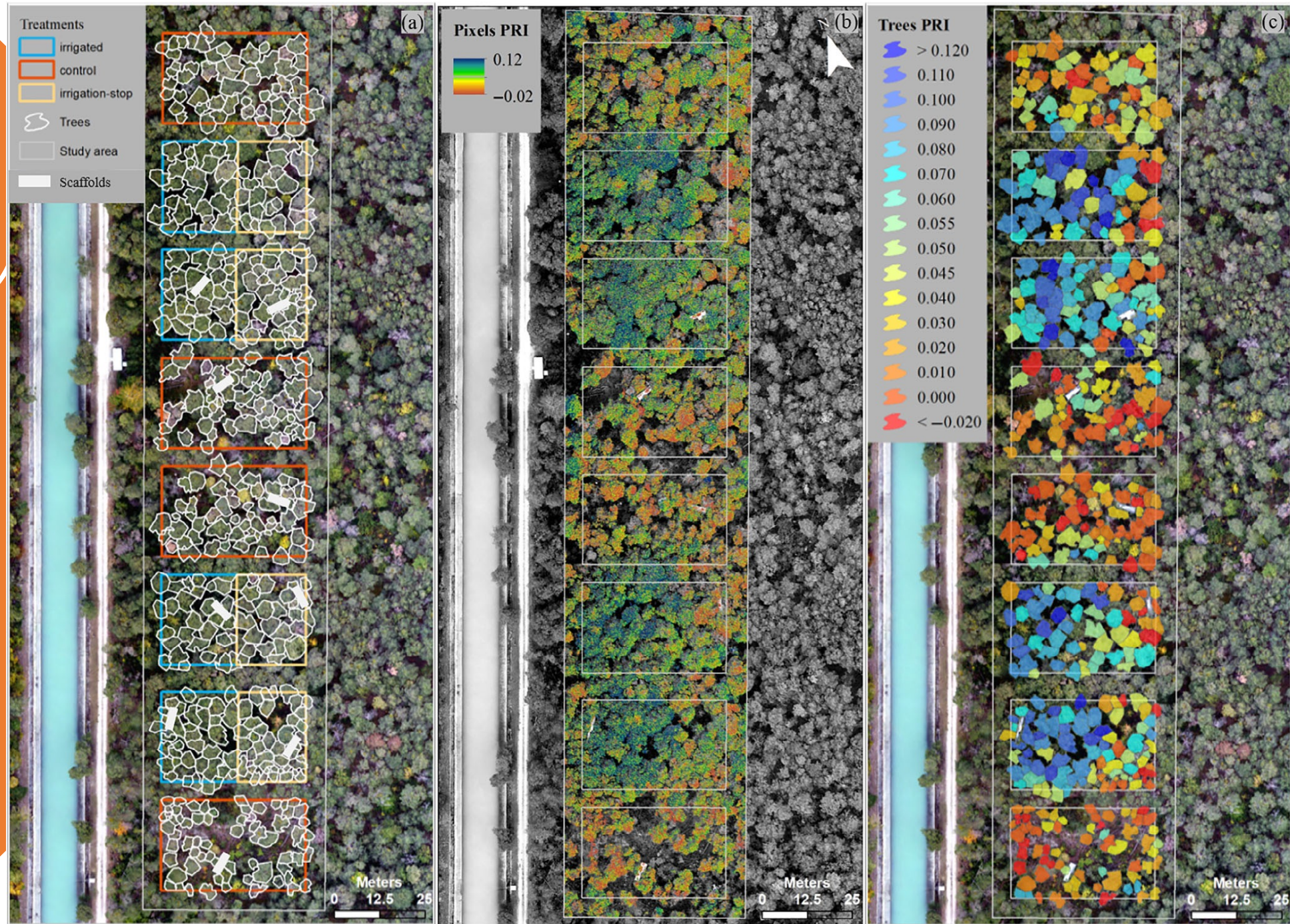
# Tree mortality

—  
can we find  
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Reflectance index



Foto: DJI.com





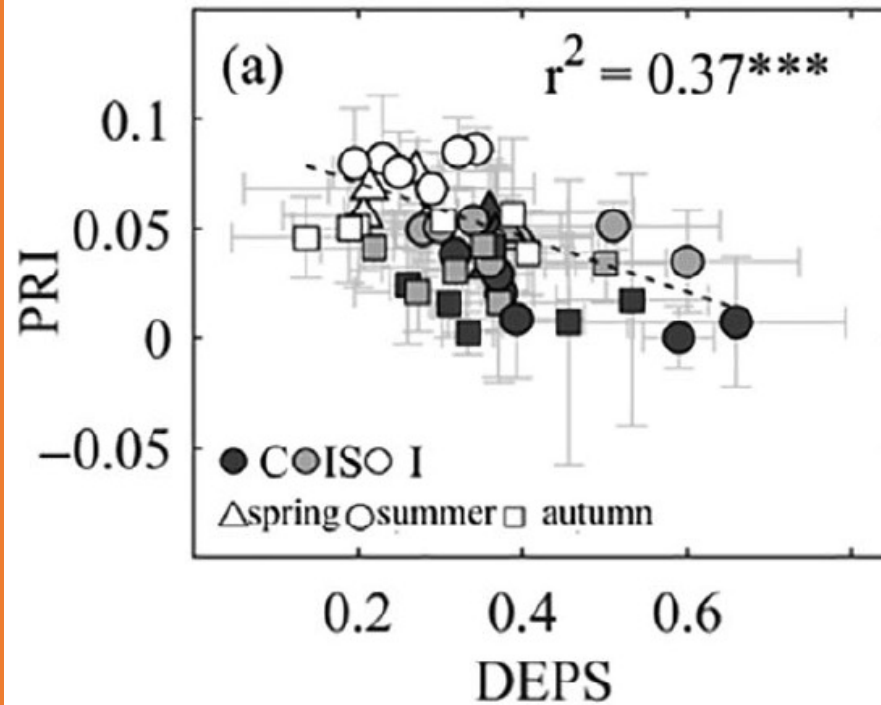
# PRI related to ground-based measurements

## *Tree mortality*

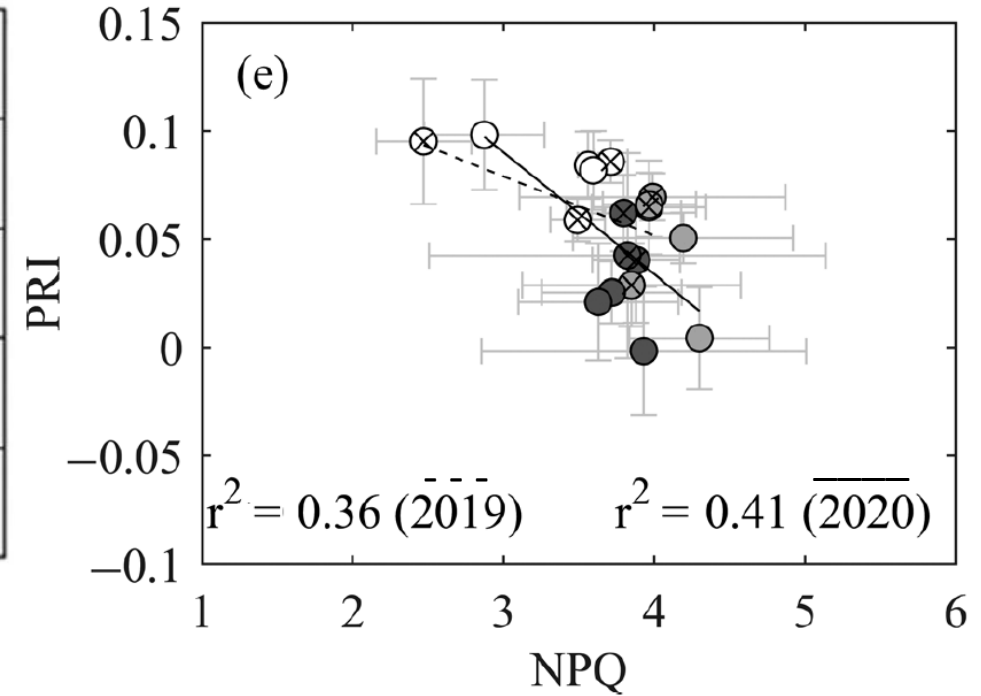
—  
can we find  
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signals?

Reflectance index

Pigments



Chlorophyll-Fluorescence





# Early warning signals for tree mortality



Defoliation trajectories help to explain mortality risk



Metabolite homeostasis – changes allow to understand mortality causes



Previsual stress assessment with reflectance indices