

BioSpace25 - Biodiversity insight from Space
10 - 14 February 2025 | ESA-ESRIN | Frascati - Italy

Satellite-derived biodiversity effects on the functioning and multifunctionality of ecosystems at global eddy covariance sites

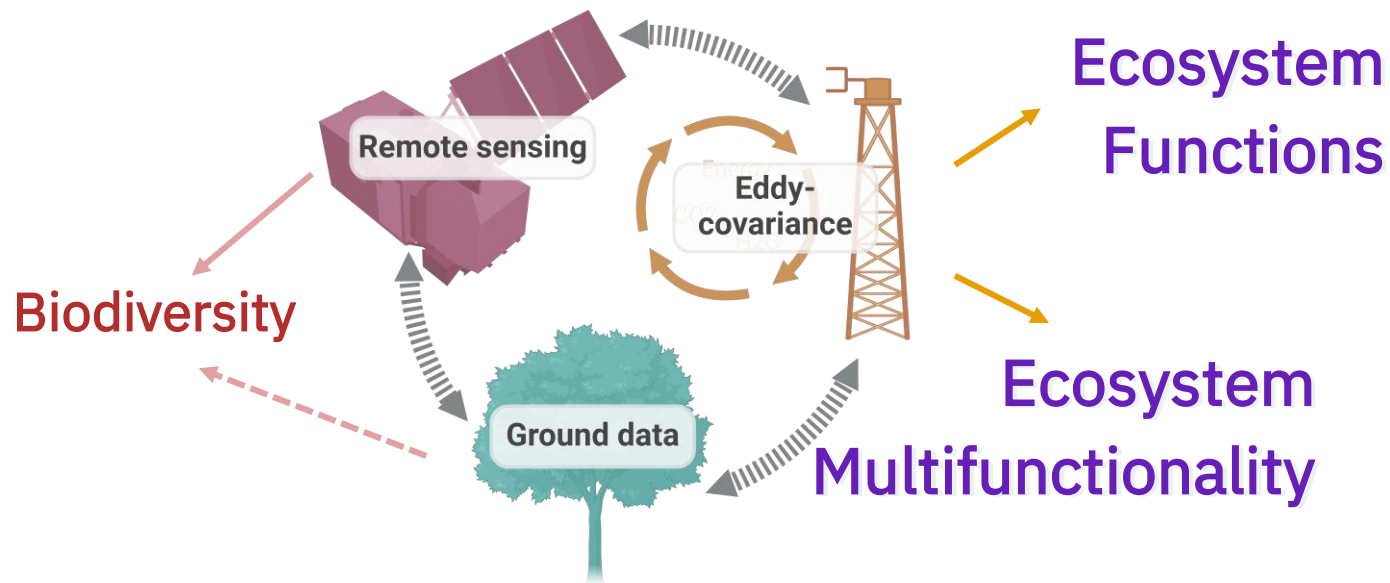
Ulisse Gomasasca^{1,2}, G. Duveiller¹, J. Pacheco-Labrador³, A. Cescatti⁴, C. Wirth^{1,2,5}, M. Reichstein^{1,5}, M. Migliavacca⁴

* Scan the QR-code or contact me at: ugomar@bgc-jena.mpg.de

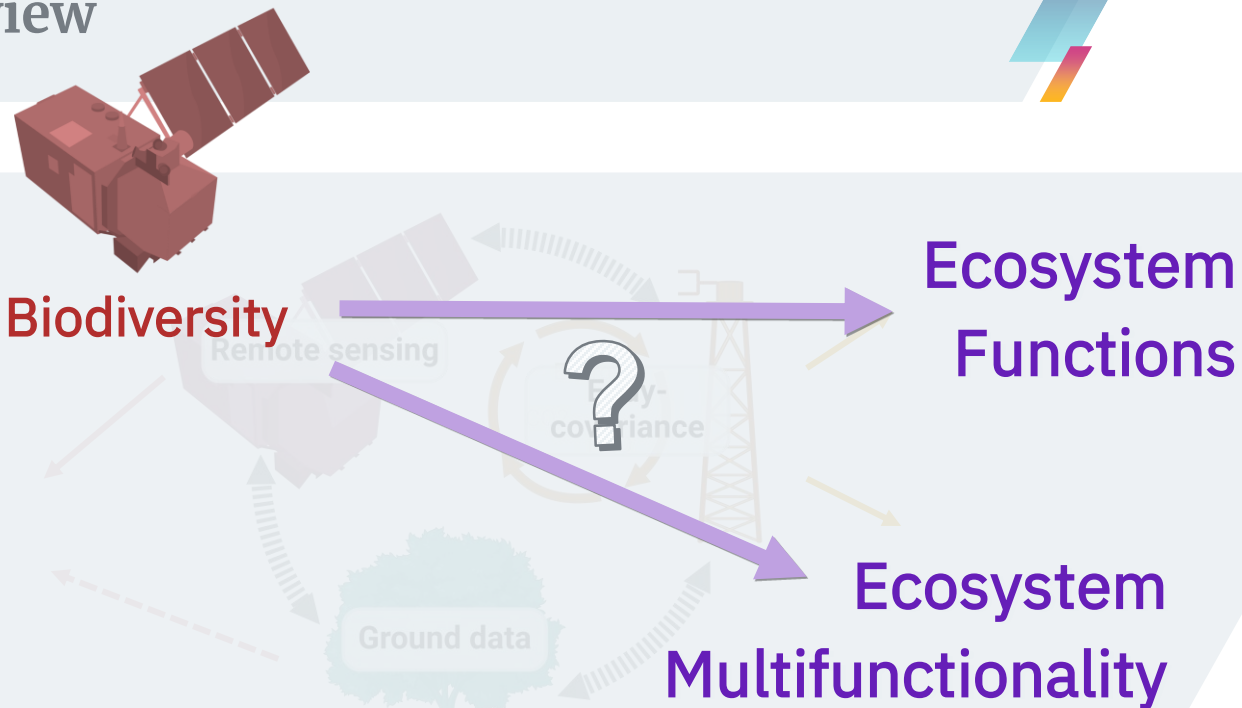
¹ Max Planck Institute for Biogeochemistry, Germany. ² Institute of Biology, Leipzig University, Germany. ³ Environmental Remote Sensing and Spectroscopy Laboratory (SpecLab), Spanish National Research Council, Spain. ⁴ European Commission, Joint Research Centre, Italy. ⁵ German Centre for Integrative Biodiversity Research (iDiv), Germany.



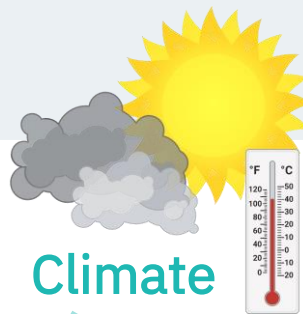
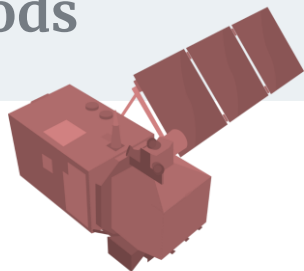
Overview



Overview



Methods



Biodiversity

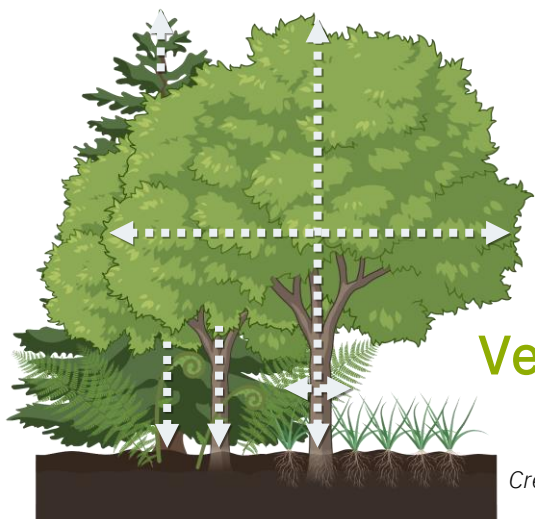
Climate



METHOD
multi-model
inference



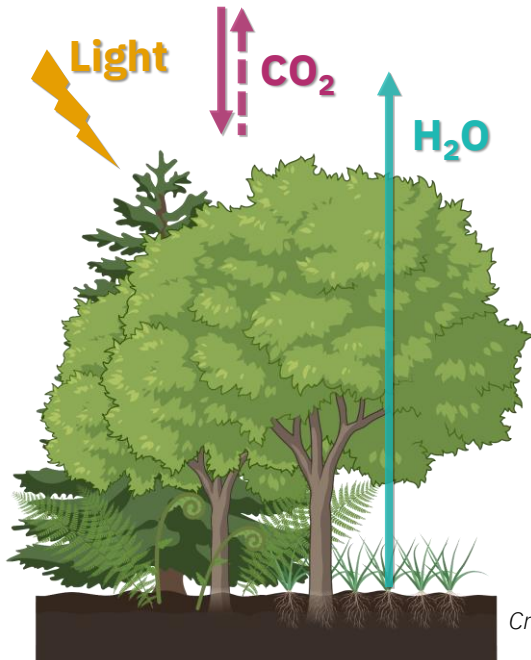
Ecosystem Functions
Ecosystem
Multifunctionality



Vegetation structure



Ecosystem Functions

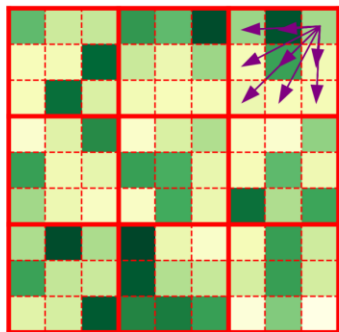


- ☀ Maximum Net Ecosystem Productivity (NEP_{max})
- ☀ Photosynthetic capacity (GPP_{sat})
- ☀ Carbon Use Efficiency (CUE_{eco})
- ☀ Surface conductance (Gs_{max})
- ☀ Water Use Efficiency (WUE)
- ☀ “Summarized”: **Multifunctionality**

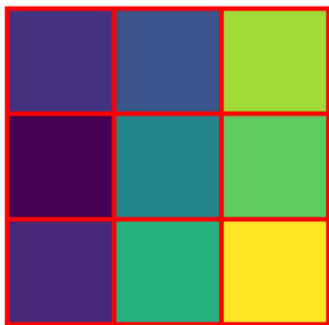
Biodiversity metrics

- ☀ **Rao's Q**: difference between spectral values in 3x3 pixel windows (Rocchini et al., 2017, Pacheco-Labrador et al., 2023)

$$\text{Rao}Q = \sum_{i,j} p_i p_j d_{ji} = \sum_{i,j} \frac{1}{N^2} d_{ji}$$

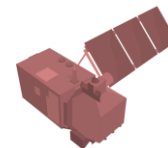


Spectral traits



Rao Q

- ☀ From Sentinel 2 at 20 m



- ☀ All bands (visible, NIR)

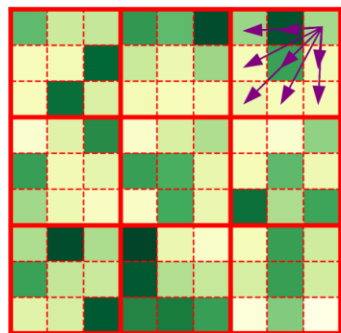
- ☀ $\text{NDVI} = \frac{\text{NIR} - \text{red}}{\text{NIR} + \text{red}}$

- ☀ $\text{NIRv} = \frac{\text{NIR}}{\text{NDVI}}$

Biodiversity metrics

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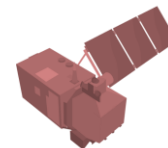


Spectral traits



Rao Q

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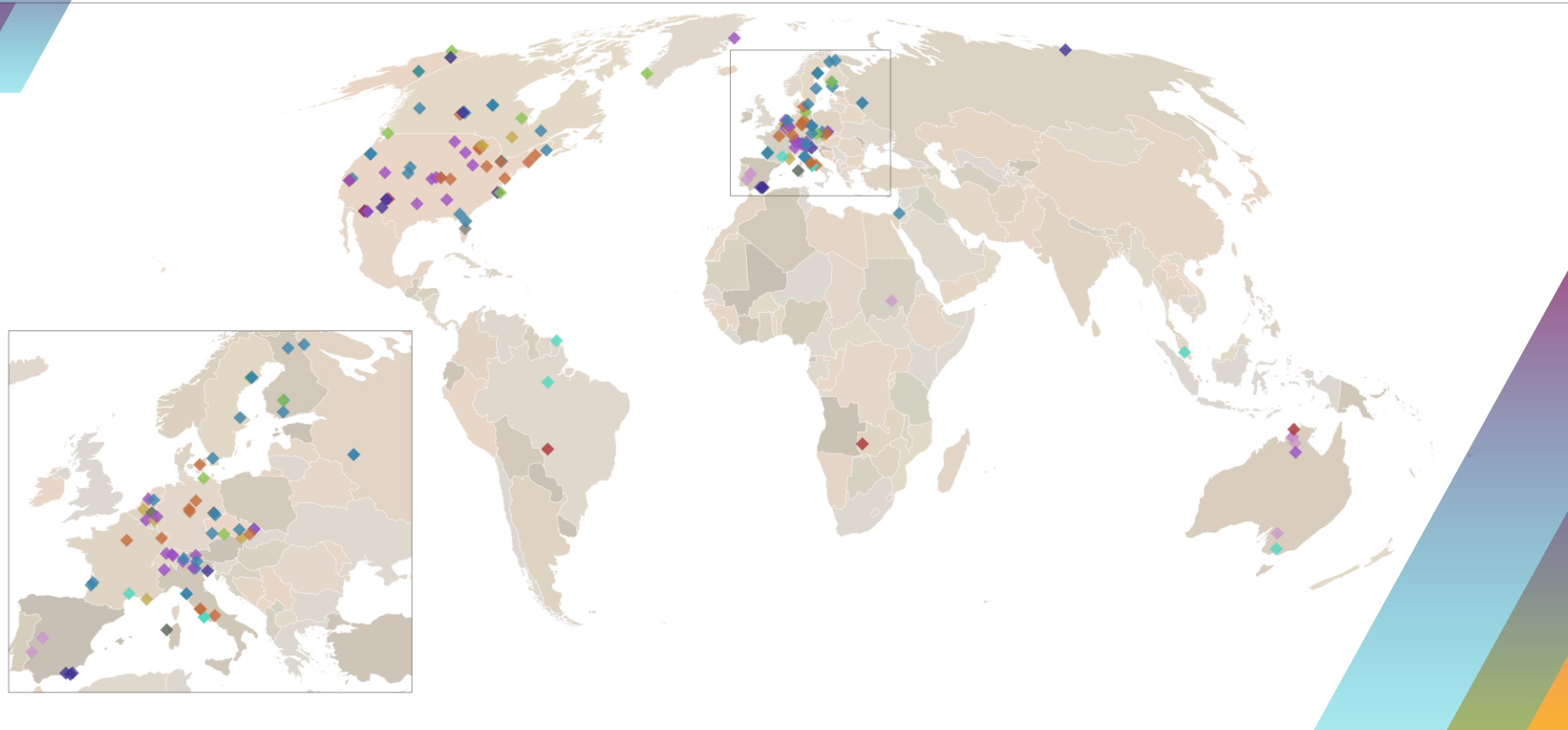


- ☀ All bands (visible, NIR)

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- ☀ $\text{NIRv} = \frac{\text{NIR}}{\text{NDVI}}$

Global dataset

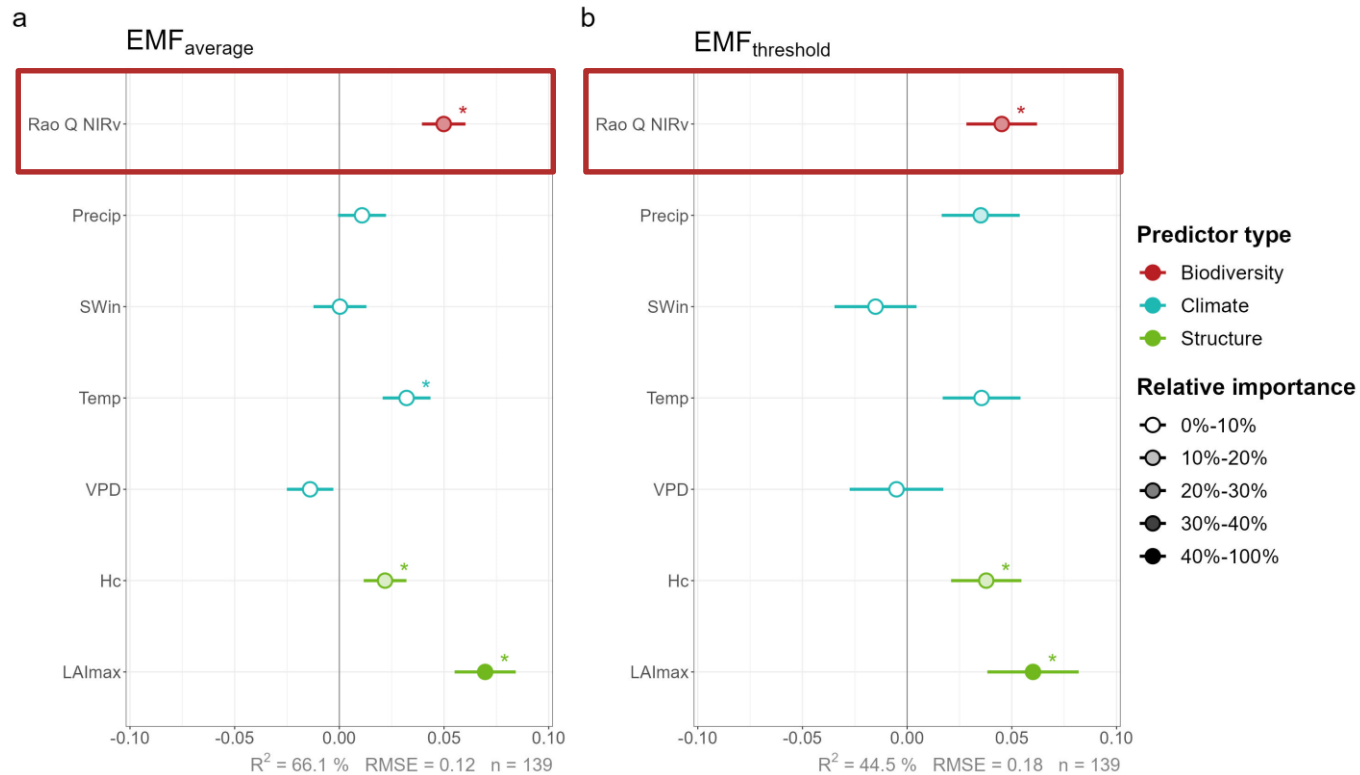


IGBP class: ◆ CSH ◆ DBF ◆ EBF ◆ ENF ◆ GRA ◆ MF ◆ OSH ◆ SAV ◆ WET ◆ WSA

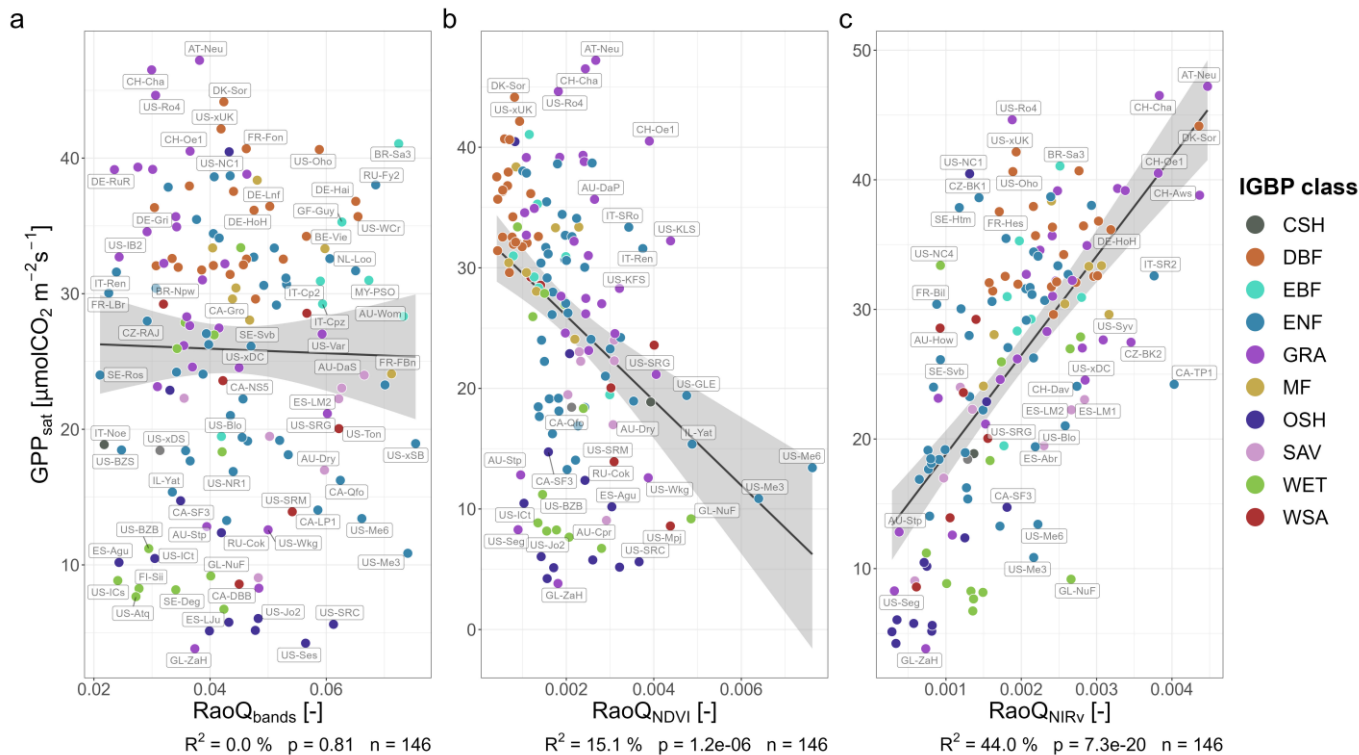
Biodiversity – Ecosystem Functions



Biodiversity – Multifunctionality



Rao Q: choice of vegetation index



Summary

☀ Biodiversity generally positively affects ecosystem functions and multifunctionality at the ecosystem scale

☀ Spectral heterogeneity (Rao Q) can characterize the global B-EF relationship ($\text{NIRv} > \text{NDVI}$)

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Satellite remote sensing reveals the footprint of biodiversity on multiple ecosystem functions across the NEON eddy covariance network

Ulisse Gomasasca^{1,2,*}, Gregory Duveiller^{1,†}, Javier Pacheco-Labrador^{1,3}, Guido Ceccherini⁴, Alessandro Cescatti⁴, Marco Girardello⁴, Jacob A Nelson¹, Markus Reichstein^{1,5}, Christian Wirth^{1,2,5} and Mirco Migliavacca⁴

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[Environmental Research: Ecology, Volume 3, Number 4](#)

[Focus on Spatial Analysis of Biodiversity Patterns](#)

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- Stability of functions
 - Spatialize approach
- } Next steps...

Recommendations for usable RS proxies of biodiversity:

1. Integrated ground measurements of functional + structural + compositional biodiversity to test RS proxies
2. High spatiotemporal resolution of RS measurements
3. Long timeseries of consistent RS data

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References

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<https://doi.org/10.1111/2041-210X.14163>

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