



Max Planck Institut
for Biogeochemistry



EVALUATING THE POTENTIAL OF DESIS TO INFER PLANT TAXONOMICAL AND FUNCTIONAL DIVERSITIES IN EUROPEAN FORESTS

J. Pacheco-Labrador, U. Weber, X. Ma, M. D. Mahecha, N. Carvalhais, C. Wirth, A. Huth, F. J. Bohn, G. Kraemer, Uta Heiden, FunDivEUROPE members, M. Migliavacca

**Max Planck Institute for Biogeochemistry
Department Biogeochemical Integration
Biosphere-Atmosphere Interactions and Experimentation Group**

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DLR

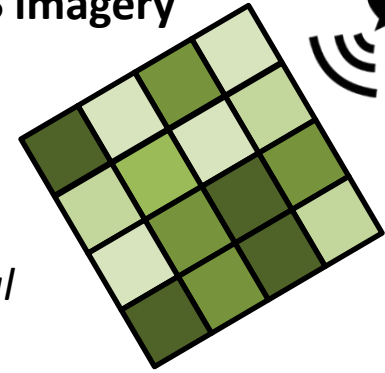
1. Remote Sensing of Plant Biodiversity

- Spectral Variation Hypothesis (Palmer 2002)

Species community



RS imagery



Variability

*Species,
Traits*

Spectral

Taxonomic Diversity Metrics (TDM)

Functional Diversity Metrics (FDM)

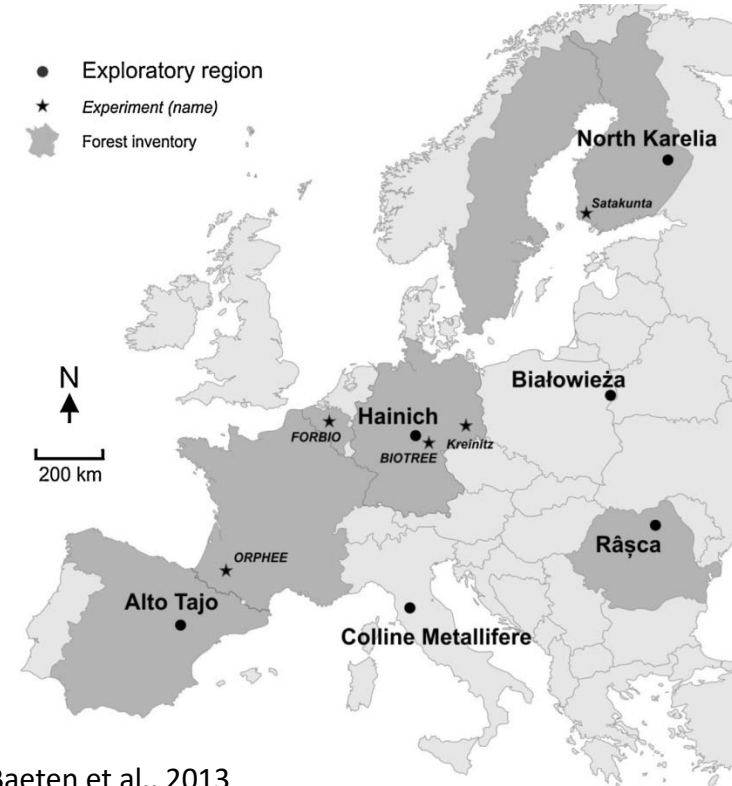
1. Remote Sensing of Plant Biodiversity

... at MPI

- ***oBEF-Accross2***: *Monitoring biodiversity from space: exploring the potentials of ESA's Copernicus and German national EO missions (DLR)*
- **AO EBioIDEA**: *Enhancing Biodiversity Inventories with DESIS Imagery Analysis (DLR)*

2. FunDivEUROPE Network & Data

- Mature forests in 6 European countries
 - 28-43 plots
 - 30 x 30 m
 - *Exploration of diversity-ecosystem functioning relationships*
 - Only 3 countries foliar traits
 - Finland out of DESIS footprint
 - » Romania & Spain



2. FunDivEUROPE Network & Data

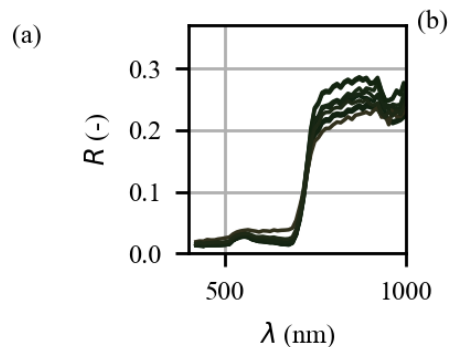
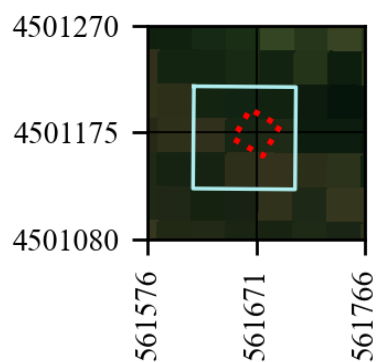
Field data

Taxonomic data
Species
Abundances
Structural Traits
Diameter at breast height (m)
Crown cross-sectional area (CCSA, cm ²)
Tree height (h_c , m)
Leaf Area Index (LAI, m ² m ⁻²) <i>Per Plot</i>
Leaf Traits
Nitrogen concentration (N_{mass} , %)
Carbon concentration (C_{mass} , %)
Leaf area (l_a , mm ²)
Specific leaf area (SLA, mm ² /mg)
Leaf dry matter concentration (LDMC, mg/g)

DESI data

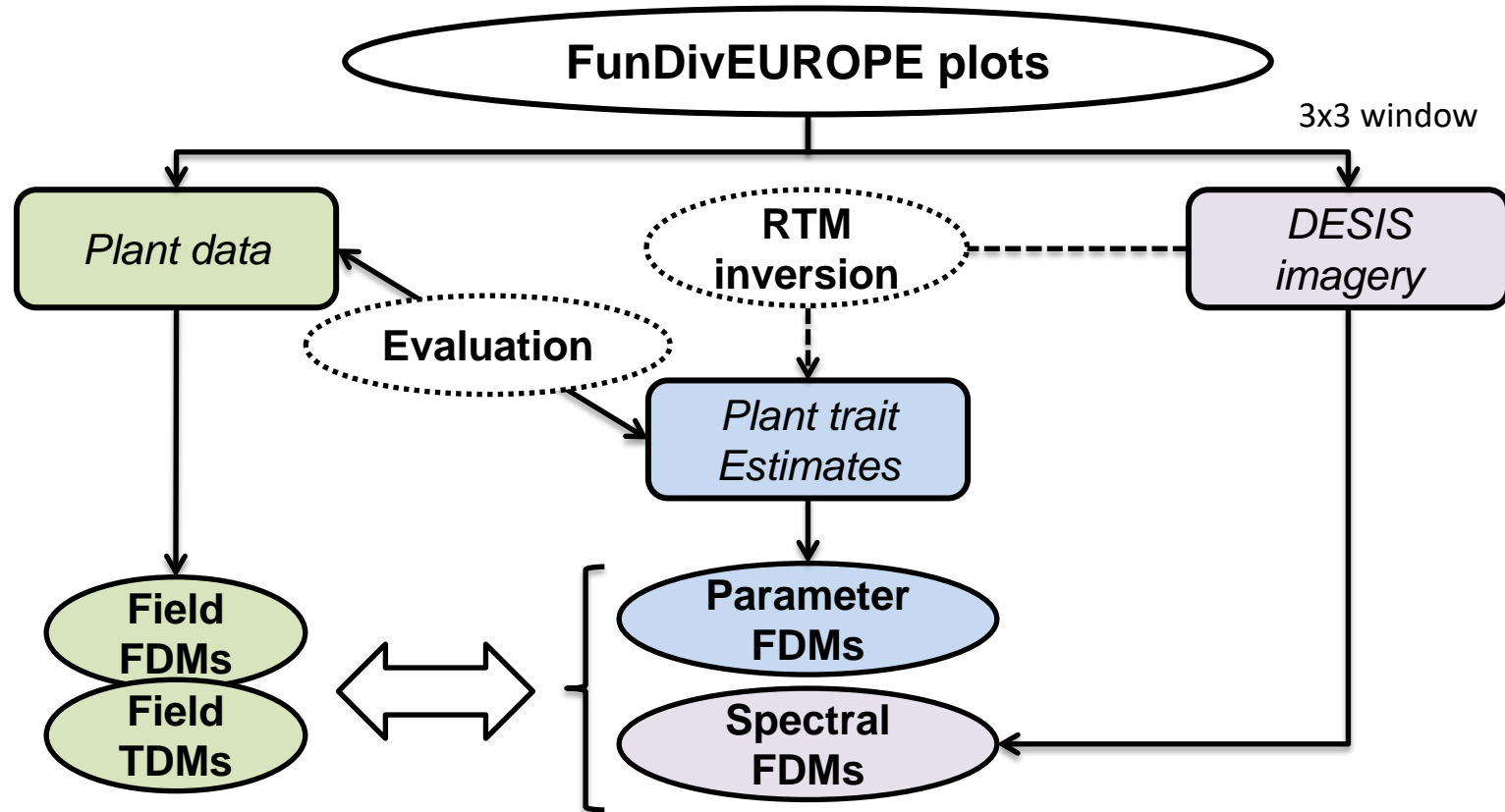
AO EBioIDEA

Country	Date	n	θ_{sun}	θ_{view}	$\Delta\phi$	AOT
Spain	2020-Jun-29 10:11	16	30.8	23.8	6.6	0.266
Romania	2020-Jun-29 07:02	11	45.9	2.1	3.7	0.275



DESI ROI over a FunDivEUROPE site in Spain

3. Methods



3. Methods

- Taxonomic metrics
 - Species Richness
 - Shannon Index
- Functional diversity metrics (Laliberté & Legendre (2010))
 - *FRic*: Functional Richness (convex-hull volume)
 - *FEve*: Homogeneity of the distribution
 - *FDiv*: Divergence of traits

3. Methods

– *FDis*: Dispersion

- weighted mean distance to the centroid

– *RaoQ*: Rao's quadratic entropy (Q)

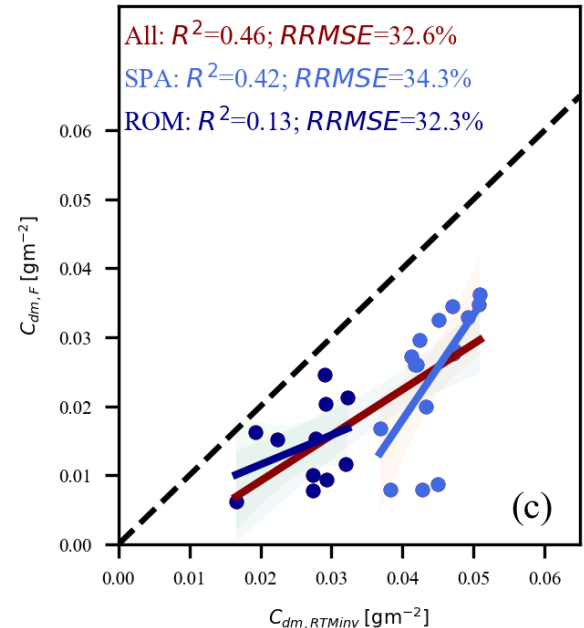
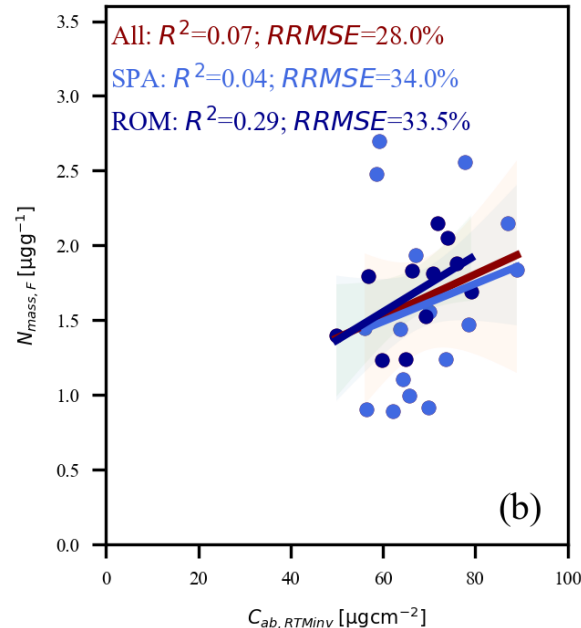
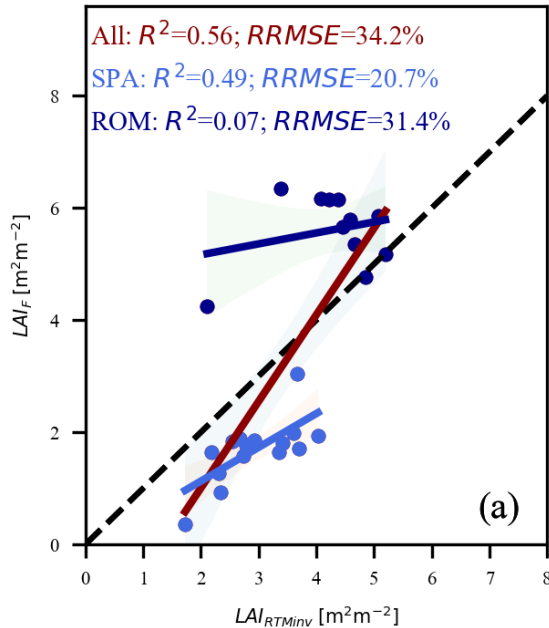
- weighted mean distance between species traits
- Parametric (Rocchini et al., 2021)
 - $\alpha \in [0, \infty]$

$$Q_\alpha = \begin{cases} \alpha \rightarrow 0, Q_0 = \sqrt[N^2]{\prod_{i,j=1}^N d_{ij}} & \text{geometric} \\ \alpha = 1, Q_1 = Q = \sum_{i,j=1}^N \frac{1}{N^2} d_{ij} & \text{arithmetic} \\ \alpha = 2, Q_2 = \sqrt{\sum_{i,j=1}^N \frac{1}{N^2} d_{ij}^2} & \text{quadratic} \\ \alpha = 3, Q_3 = \sqrt[3]{\sum_{i,j=1}^N \frac{1}{N^2} d_{ij}^3} & \text{cubic} \\ \alpha \rightarrow \infty, Q_{\alpha \rightarrow \infty} = \max d_{ij} & \text{max}_d \end{cases}$$

Rocchini et al., 2021

4. Results

- Evaluation of RTM parameters estimates

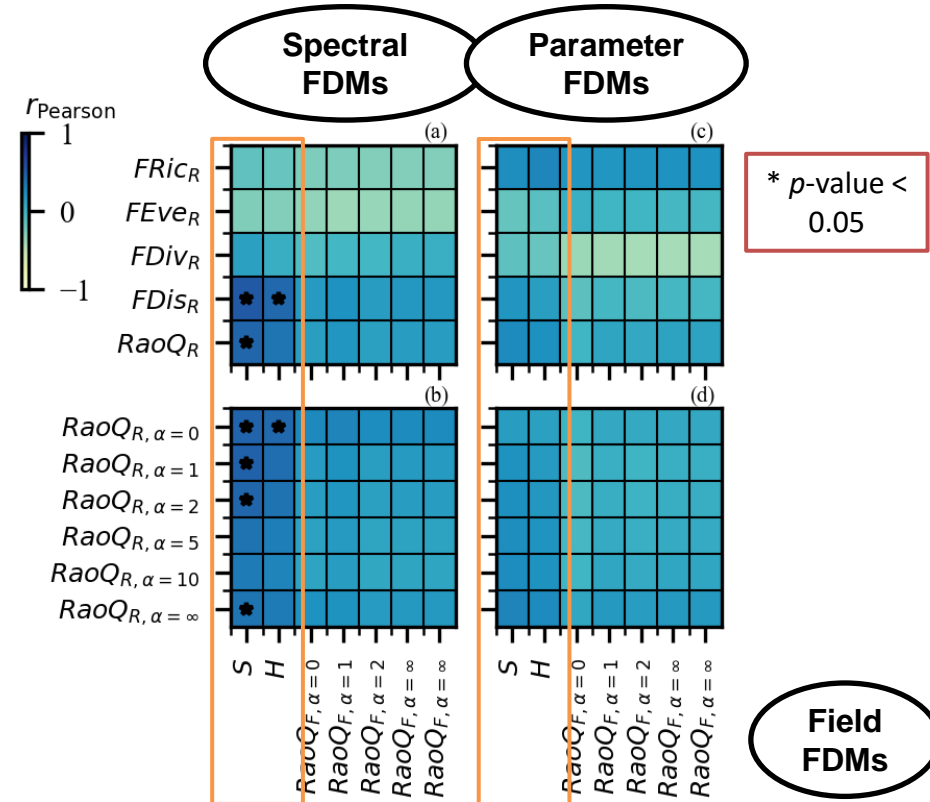


4. Results

- Comparison between biodiversity estimates

– Field TDMs

- Only spectral FDMs achieve significant correlations
- Spatial mismatch?

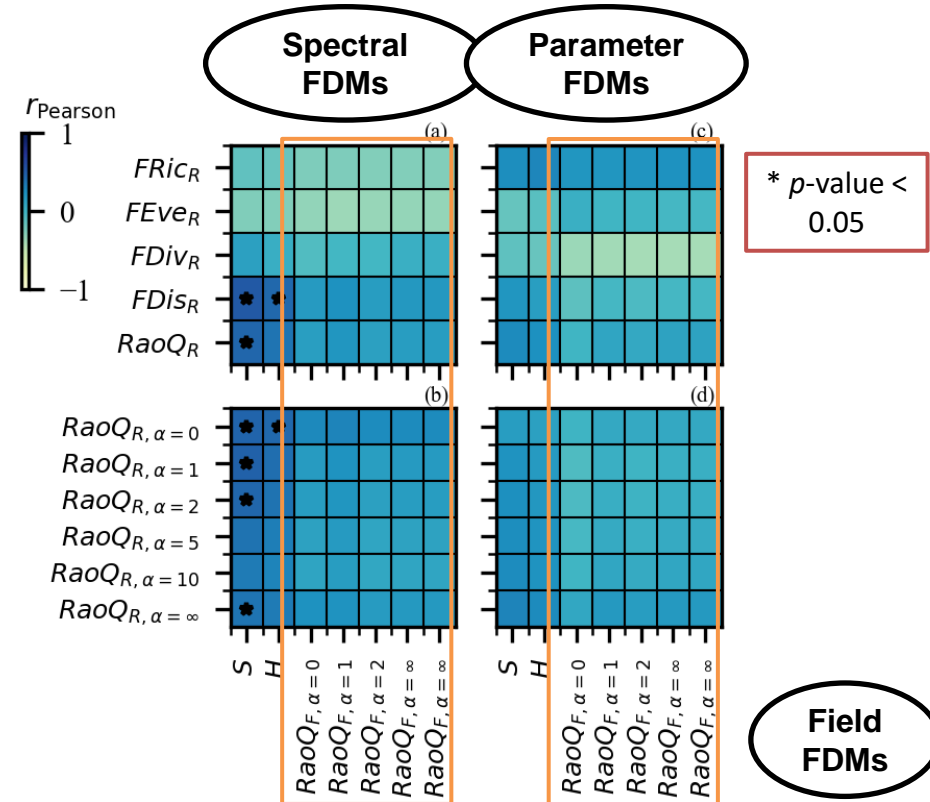


4. Results

- Comparison between biodiversity estimates

– Field FDMs

- None
- Uncertainties?
- Spatial mismatch?
- Variable mismatch?



5. Conclusions

- DESIS achieves significant correlations with field taxonomic diversity using reflectance, but not parameter estimates
- Validation/evaluation of plant diversity products from spaceborne hyperspectral imagers (~30 m) will require:
 - Large (30 m x 3 x 3) field plots or vicarious estimates (hyperspectral airborne)
 - Field sampling of variables controlling light interaction
- Fusion of multi-resolution data should be explored

Thanks a lot!

QUESTIONS AND SUGGESTIONS