FORTRACK - Tracking Interactions of Tree Mortality, Functional Diversity & Ecosystem Responses to Climate Stressors with Earth Observation

https://climate.esa.int/FORTRACK/

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17/02/2026

Project Objectives

Related ITT: The project was established in response to ESA ITT ESA-EOP-SC-SC-2025-6 (ESA AO/1-12690/25/I-LR), titled "**CLIMATE-SPACE: BIODIVERSITY-CLIMATE STUDIES** - EXPRO+“

Goals of project:

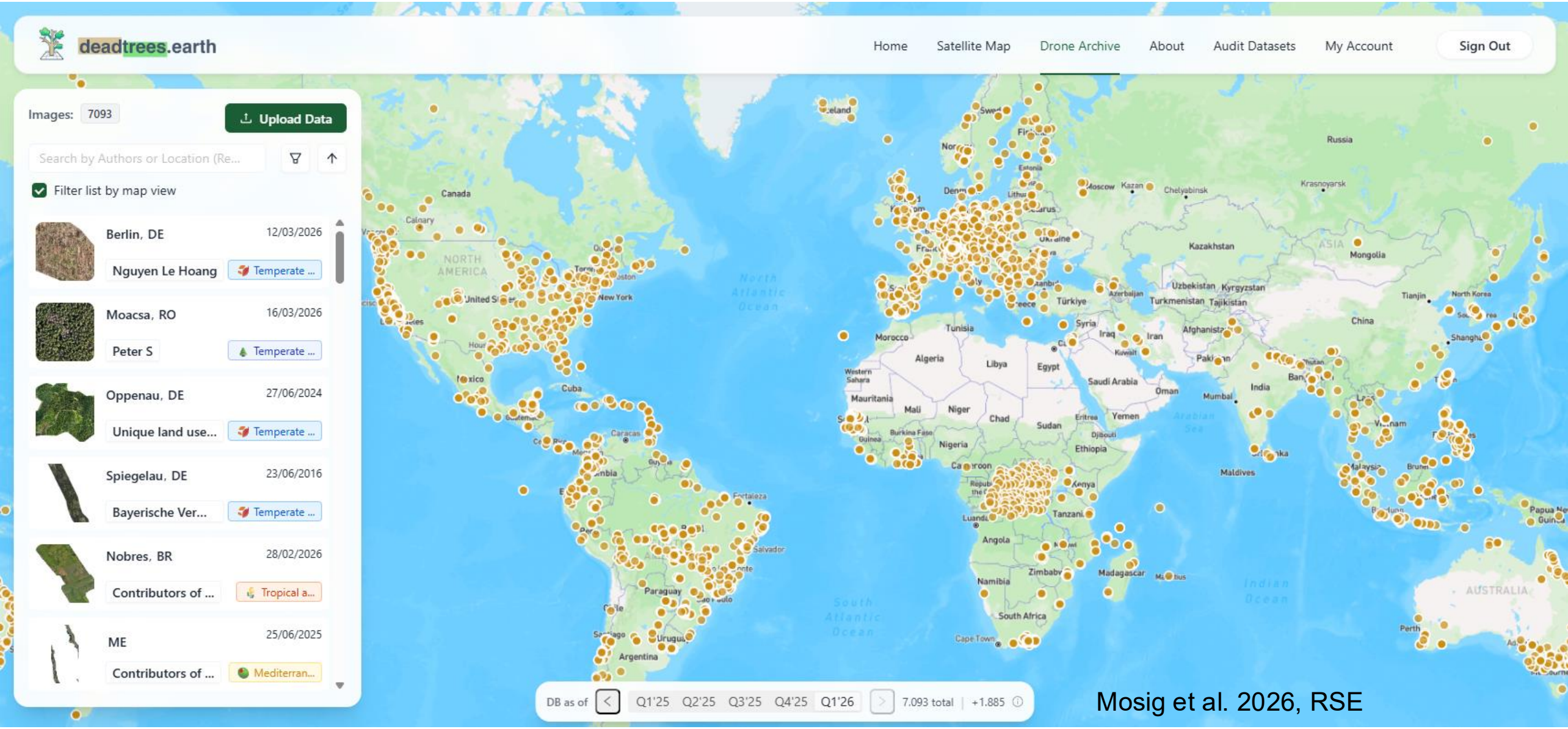
- Reveal global patterns of **functional diversity**
- Track global **tree mortality dynamics** and related **buffering effects of plant functional diversity**
- Identify **drivers of tree mortality**, including climate extremes
- Assess the **imprint of tree mortality on ecosystem fluxes** and carbon dynamics

Timeframe: October 2025 to September 2027

Connections with…

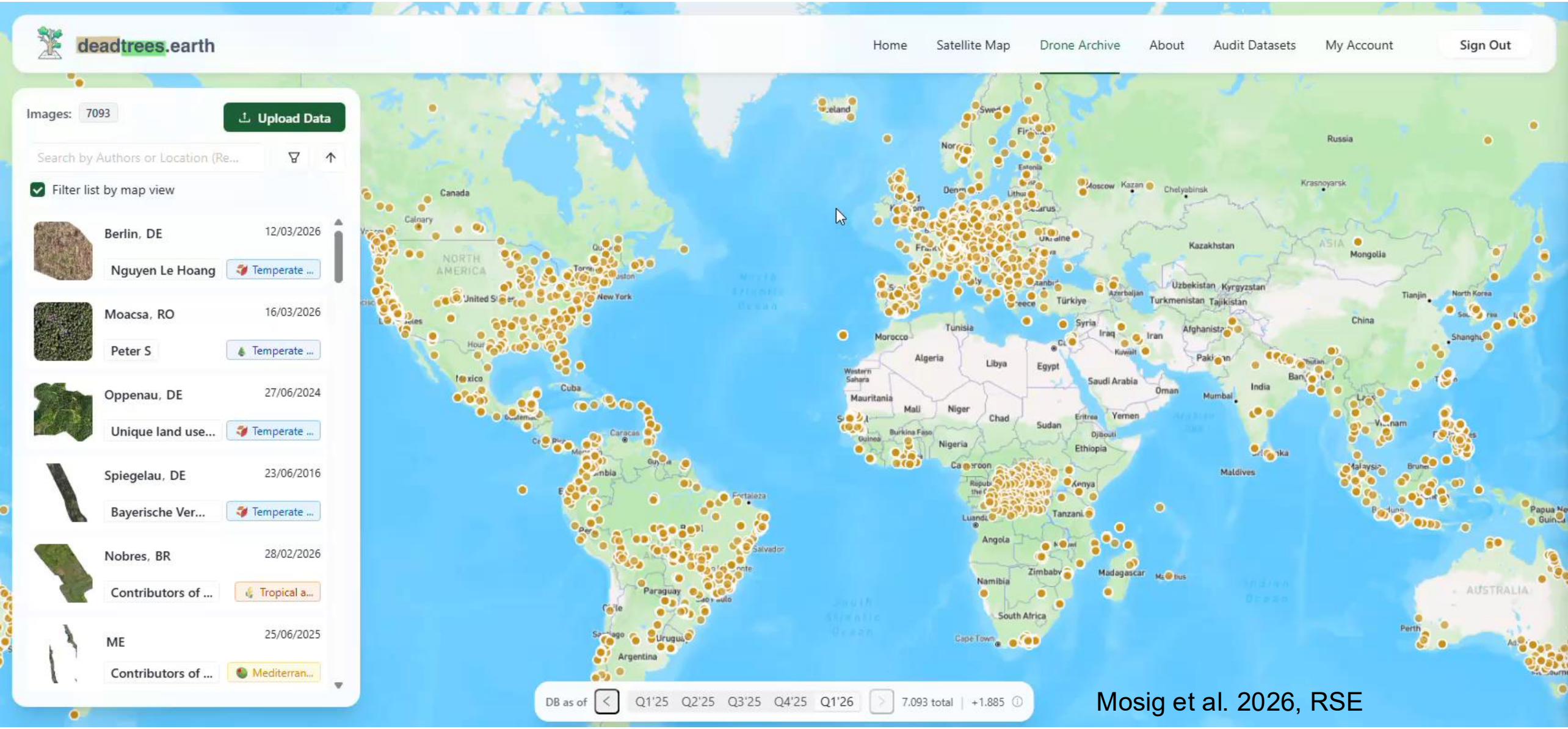
- wider community: sPlot, TRY trait database, GBIF, International Tree Mortality Network
- policy activities: Joint Research Centre (JRC), IBPES, IPCC

Tree mortality & disturbance dynamics



Mosig et al. 2026, RSE

Tree mortality & disturbance dynamics



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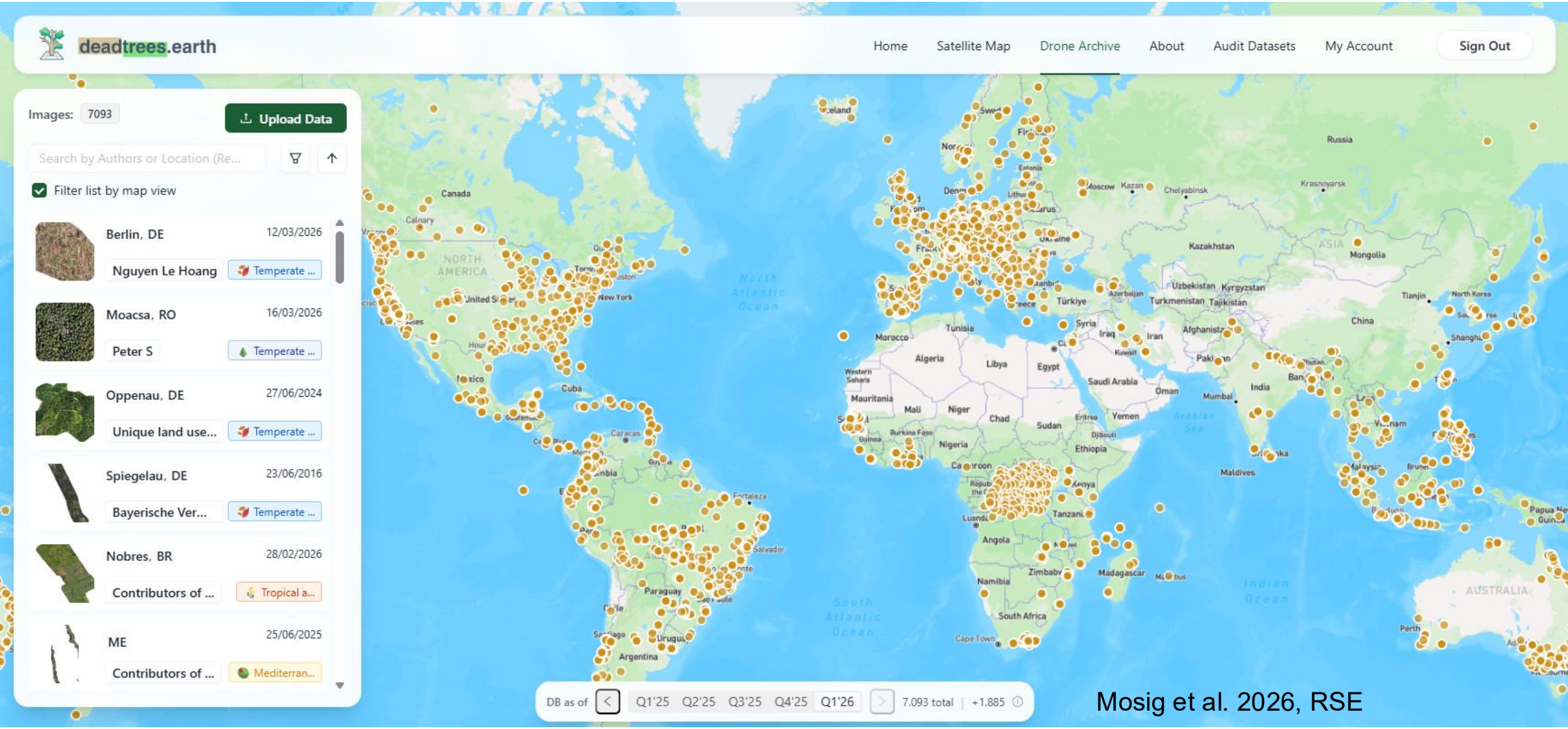

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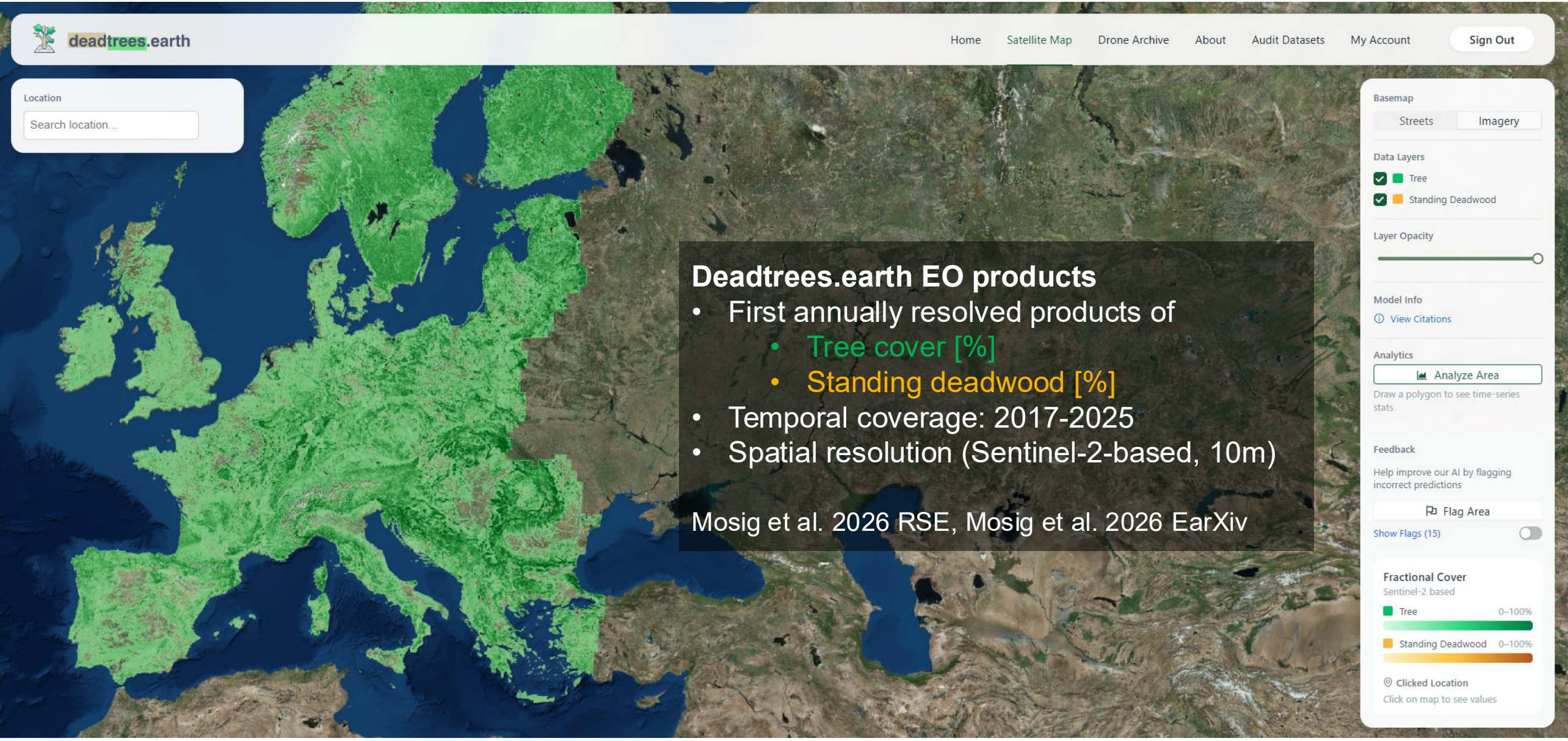
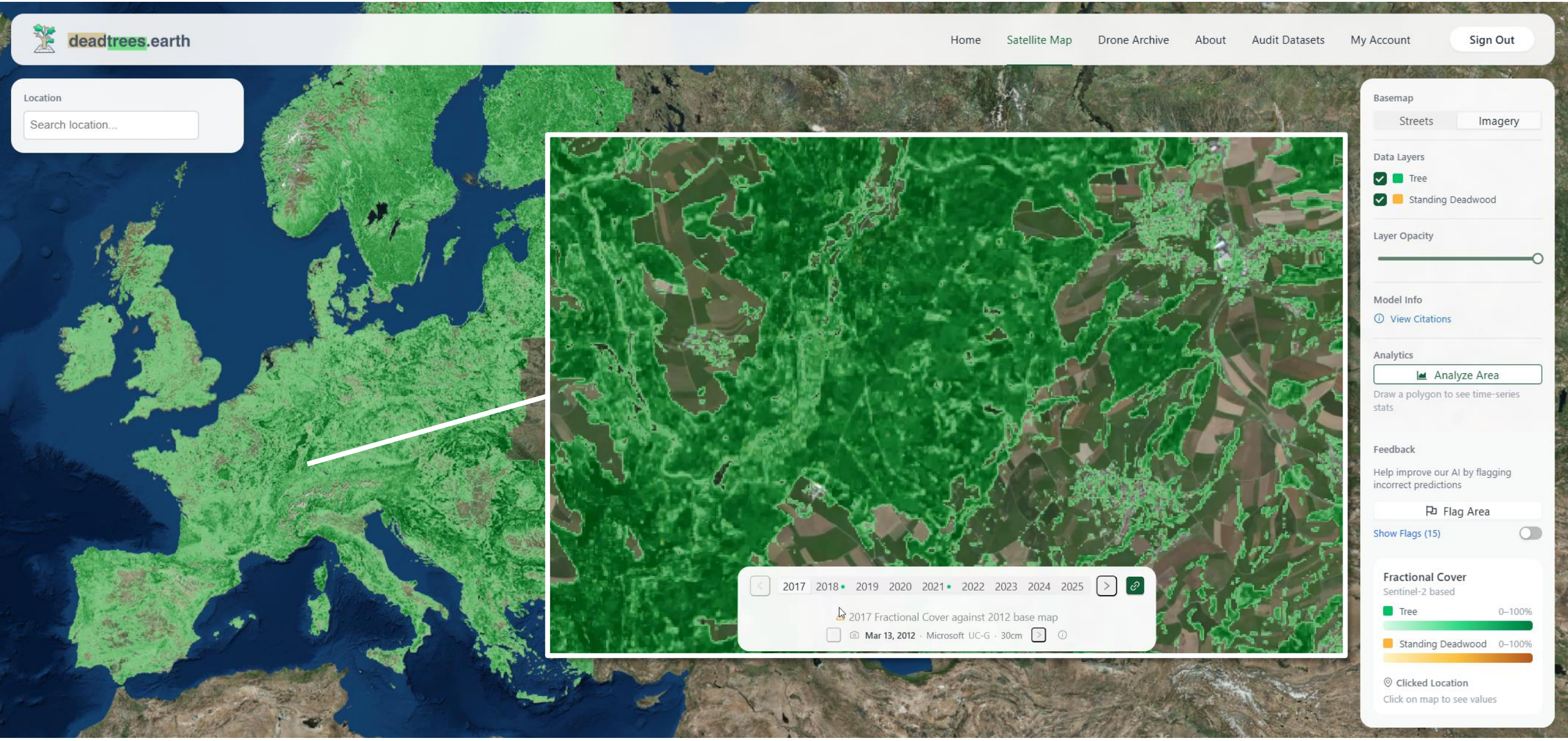


Deadtrees.earth EO products

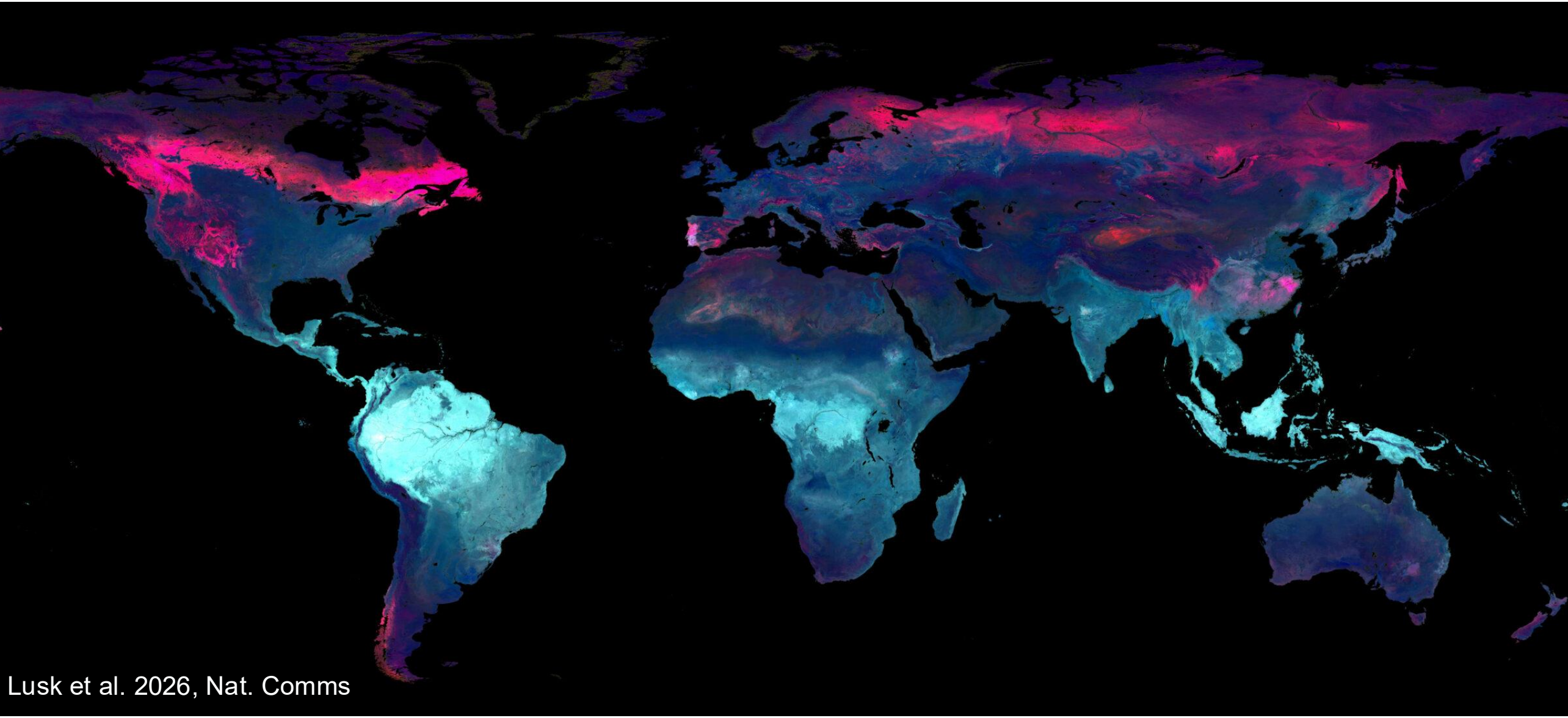
- First annually resolved products of
  - Tree cover [%]
  - Standing deadwood [%]
- Temporal coverage: 2017-2025
- Spatial resolution (Sentinel-2-based, 10m)

Mosig et al. 2026 RSE, Mosig et al. 2026 EarXiv

Tree mortality & disturbance dynamics

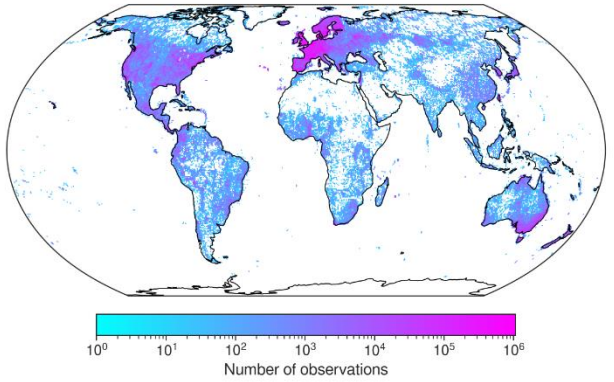


Plant functional diversity global scale

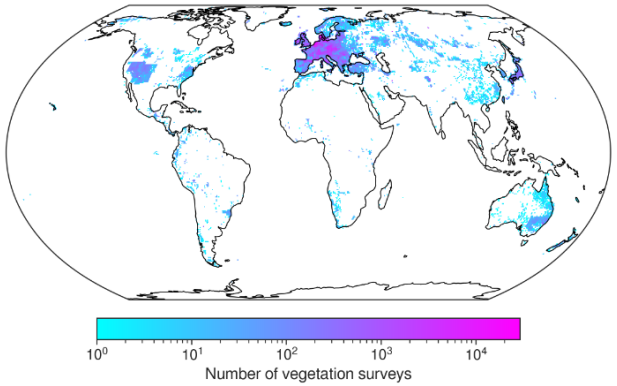


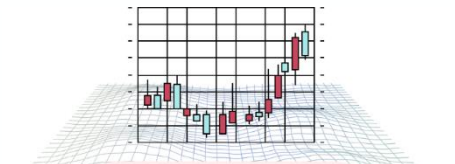
Plant functional diversity global scale

GBIF **citizen science species observations** (~340M obs.)



sPlot expert-led **vegetation surveys** (~54M obs.)

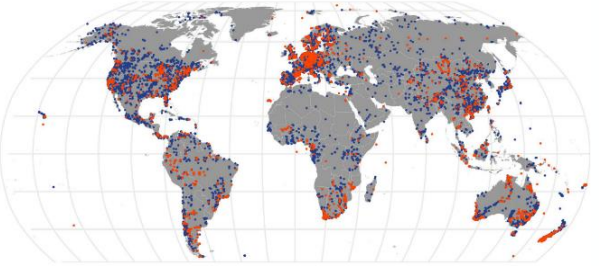




community trait information

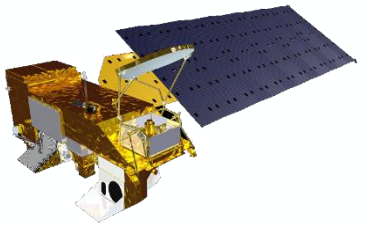
reference data

TRY **plant traits** + species name



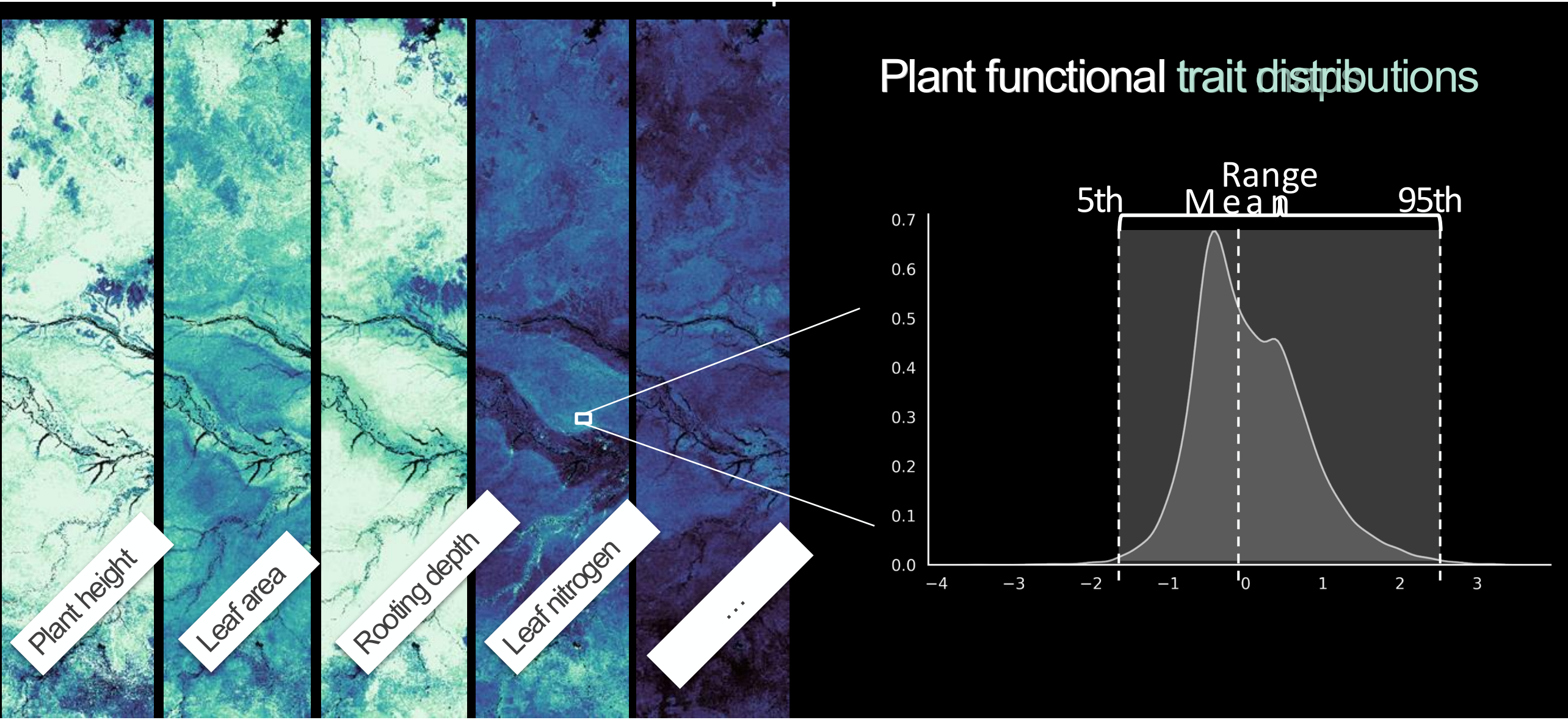
Trait	Data type	Number of requests
Leaf area per leaf dry mass (specific leaf area or 1/LMA)[a]	con	2,977 (41%)
Plant height vegetative	con	2,159 (29%)
Leaf nitrogen (N) content per leaf dry mass	con	1,938 (26%)
Leaf area[b]	con	1,676 (23%)
Plant growth form	cat	1,625 (22%)
Seed dry mass	con	1,580 (22%)
Leaf nitrogen (N) content per leaf area	con	1,221 (17%)
Leaf phosphorus (P) content per leaf dry mass	con	1,170 (16%)
Plant lifespan (longevity)	con	1,168 (16%)
Leaf dry mass per leaf fresh mass (leaf dry matter content)	con	1,147 (16%)
Leaf phenology type	cat	1,047 (14%)
Leaf carbon (C) content per leaf dry mass	con	973 (13%)
Dispersal syndrome	cat	958 (13%)
Stem specific density	con	951 (13%)
Leaf photosynthesis rate per leaf area	con	896 (12%)
Leaf dry mass (single leaf)	con	896 (12%)
Leaf photosynthesis pathway	cat	874 (12%)
Leaf thickness	con	852 (12%)
Plant nitrogen (N) fixation capacity	con	833 (11%)
Leaf carbon/nitrogen (C/N) ratio	con	817 (11%)
Plant life form sensu Raunkiaer	cat	801 (11%)
Leaf lifespan (longevity)	con	790 (11%)
Root rooting depth	con	733 (10%)
Plant growth rate	con	727 (10%)
Leaf type	cat	727 (10%)

Extrapolation with **EO products**



MODIS, WorldClim, SoilGrids, VODCA

Plant functional diversity global scale



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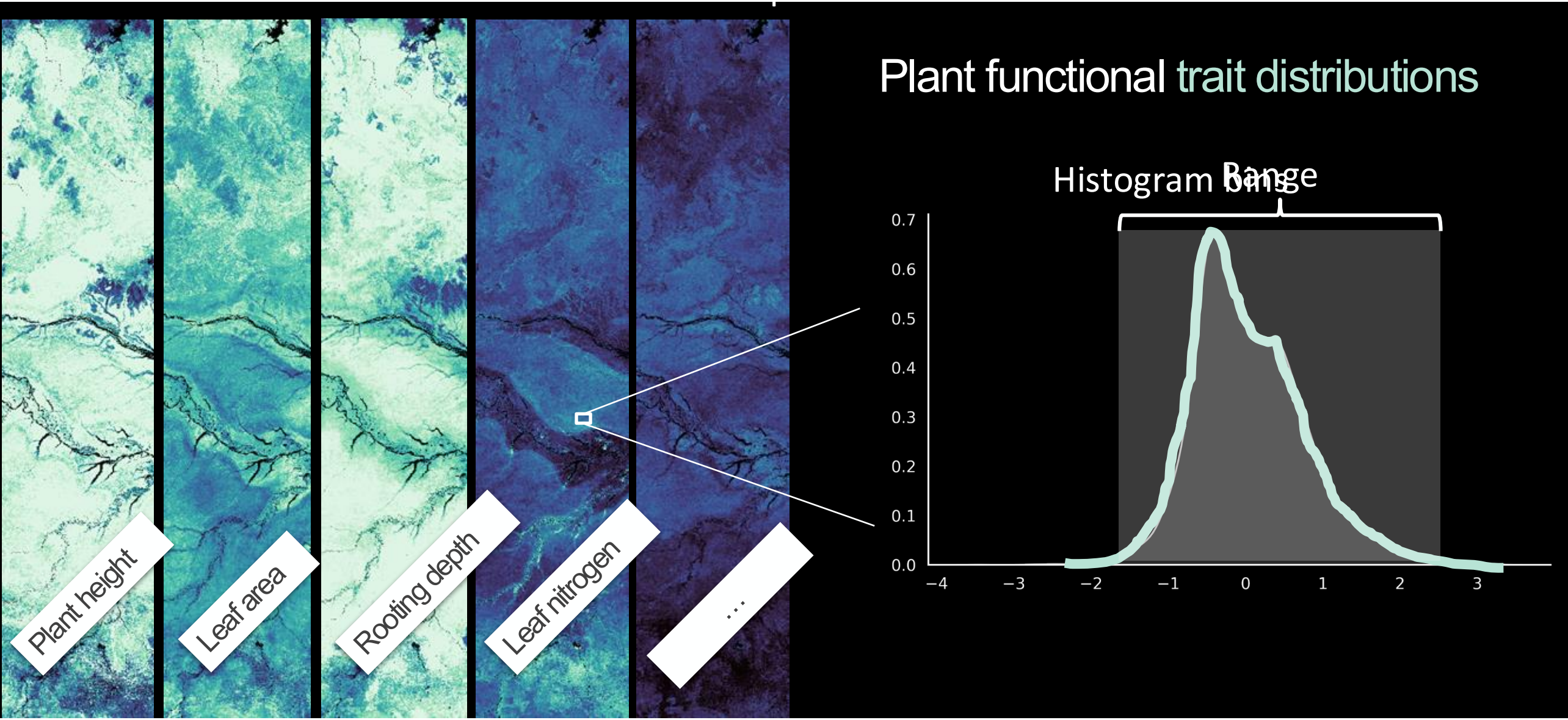

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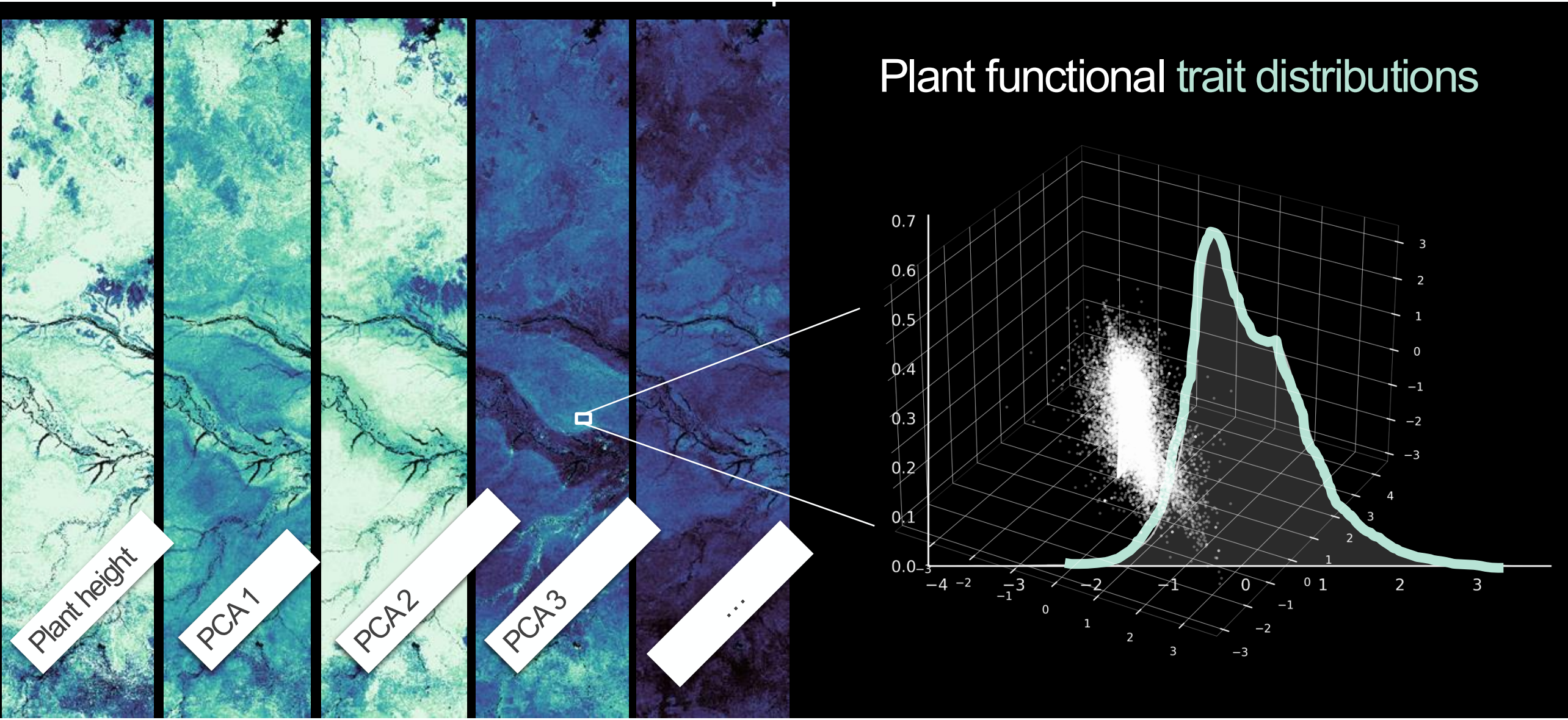

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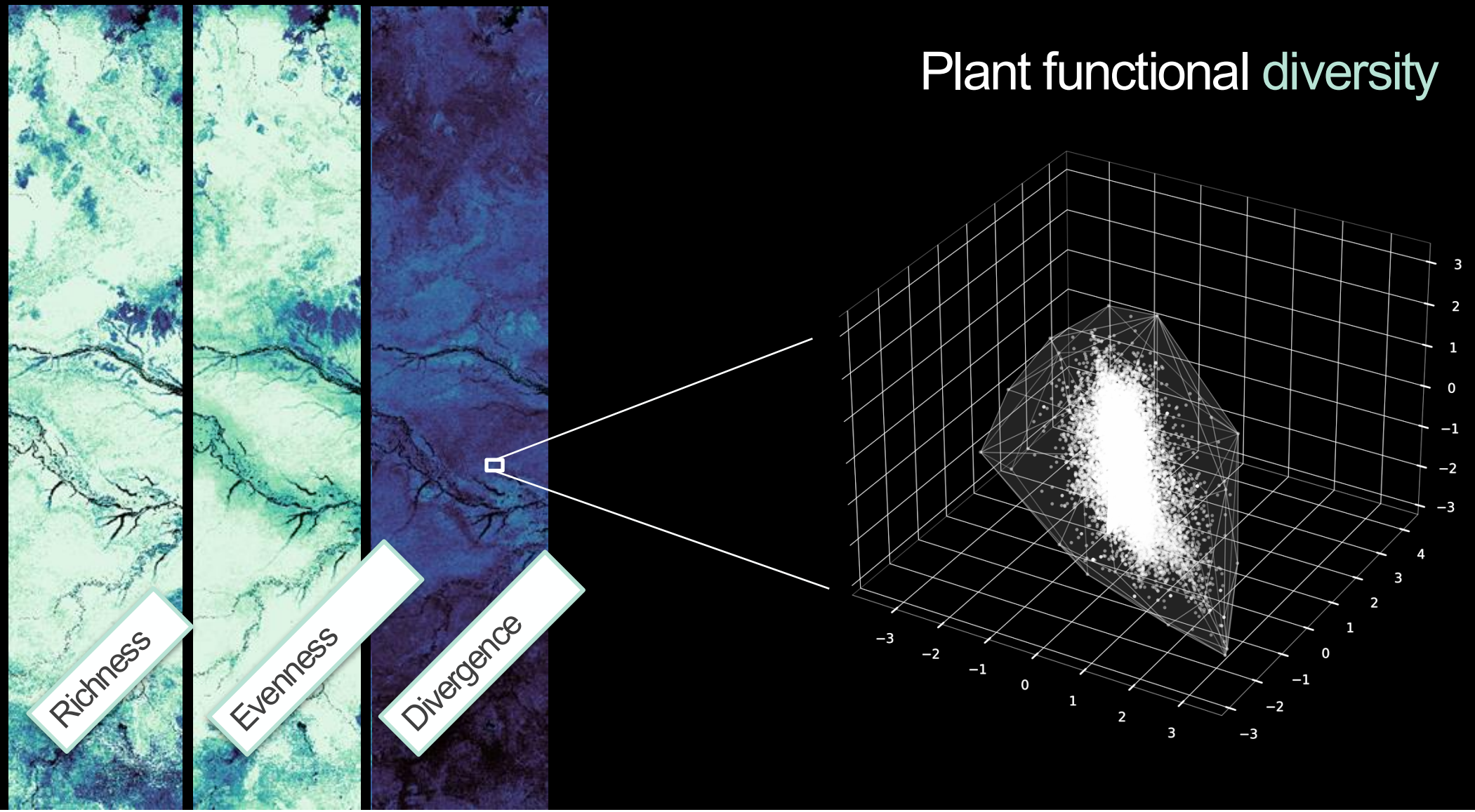

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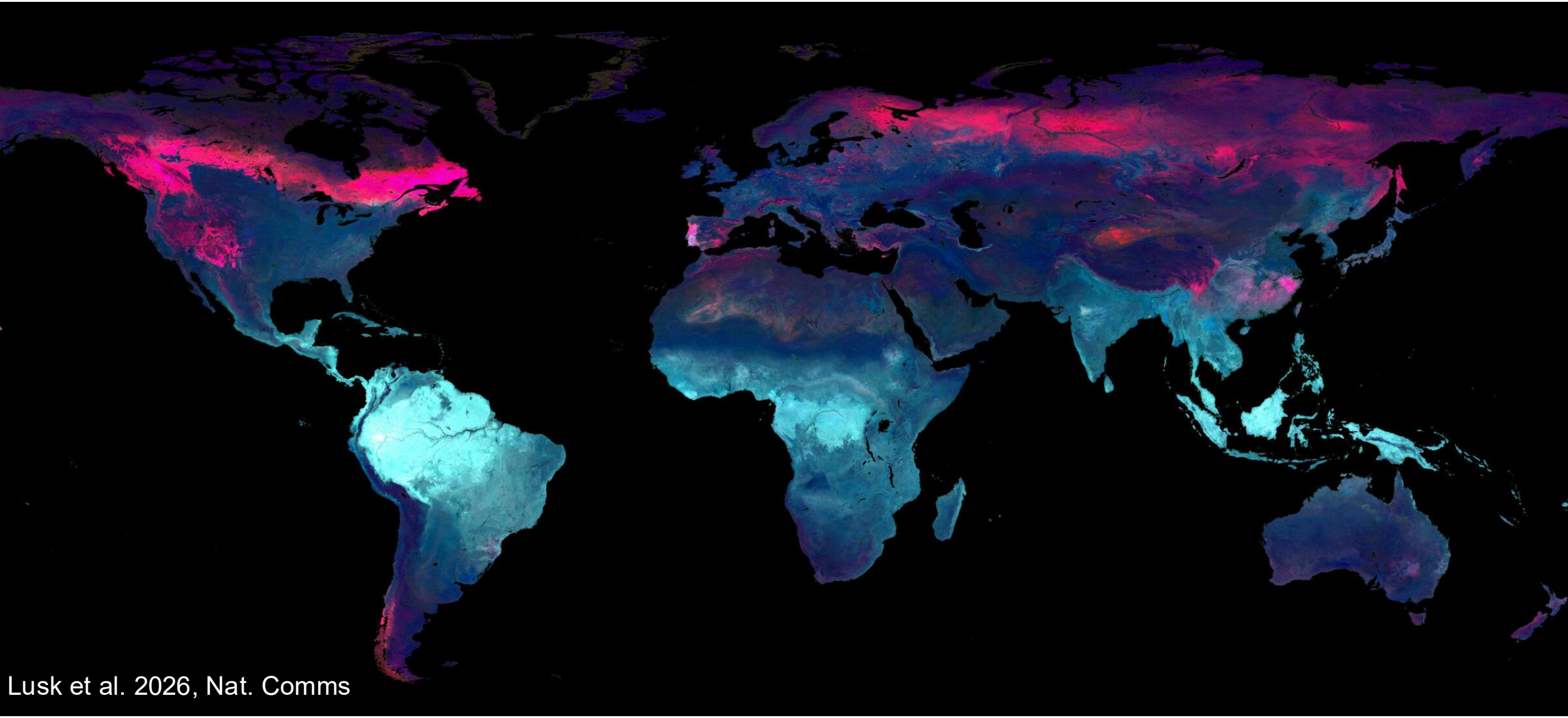
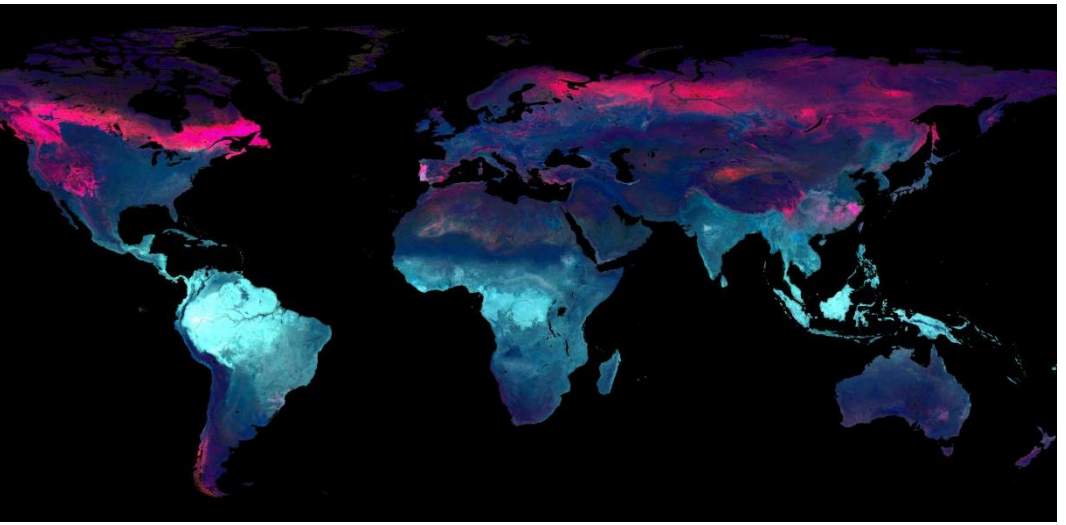
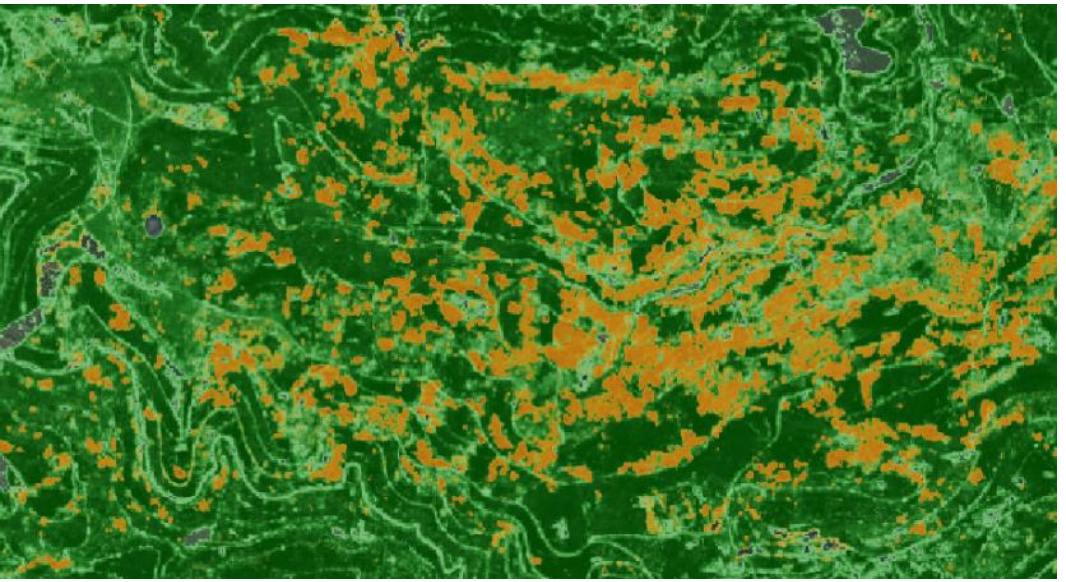


FORTRACK scientific objectives





- Map plant **functional diversity at global scale**
  - Extension to hydraulic traits
- Map global **tree mortality rates** & **hotspots**
  - Benchmark forest disturbance products
  - Relation to functional diversity
- Quantify **mortality-driven biomass loss** and CO_2 equivalents
  - Combination with ESA CCI Biomass
- Identify **Drivers of mortality**
  - Relation to climate extremes (ERA5, ECVs)
  - Buffer role of plant functional diversity
- Identify **Impacts of mortality on ecosystem functioning**
  - Assess anomalies in fluxes data (ICOS, FluxNet)

ECVs being used

Main ECVs being used

- **On (live) carbon loss:** Aboveground Biomass (ESA CCI Biomass)
- **As drivers of mortality:** Soil Moisture and Land Surface Temperature (LST), Water Vapour
- **For stratification:** Land Cover and Plant Functional Type (PFT)

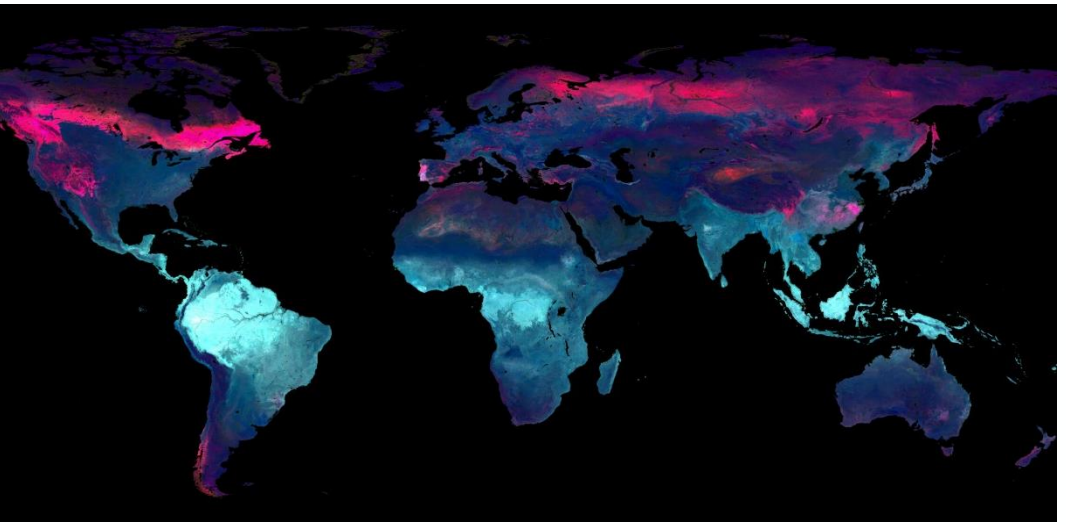
Strengths

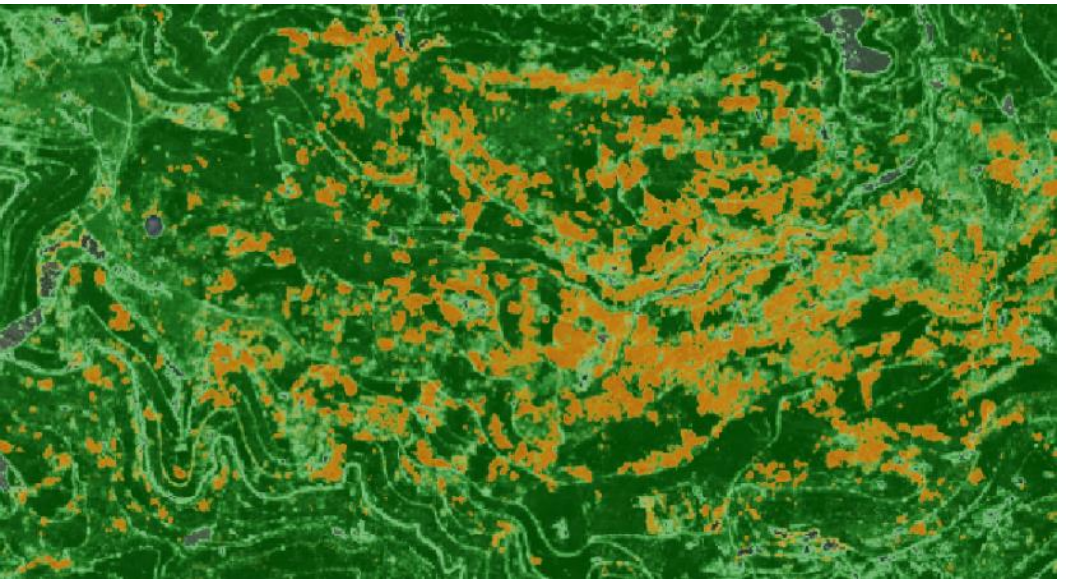
- Transparency and clean documentation, uncertainty estimates (error propagation), global coverage

Wish list for how to improve the ECVs

- More consistent **temporal coverage and extent**
- Mutual Feedback Integration: Use FORTRACK's high-resolution mortality maps to reduce uncertainties in future ESA CCI Biomass products
- Incorporate tree mortality and functional diversity candidates as ECV candidates

Results & relevance to the CCI community





Datasets in current production:

- Global functional diversity products
- Carbon loss (Mortality + ESA CCI Biomass)

Publications

- Mosig, C., Kattenborn, T., Montero Loaiza, D., Vanja-Jehle, J… Mahecha, M. (2026). **Sub-pixel mapping of disturbance and tree mortality dynamics from Sentinel-2 time series around the globe.** *EarthArXiv* (preprint).
- Lusk, D., Wolf, S., Svidzinska, D., Dormann, …Kattenborn, T. (2025). **Crowdsourced biodiversity monitoring fills gaps in global plant trait mapping**. *Nature Communications*.

Links https://deadtrees.earth/ https://planttraits.earth/ https://climate.esa.int/FORTRACK/