Root traits in the context of the TRY database

Jens Kattge, Sandra Diaz, Sandra Lavorel, Colin Prentice, Paul Leadley, Gerhard Bönisch, Arindam Banerjee, Farideh Fazayeli, Hanhuai Shan, Franziska Schrodt, Julia Joswig, Peter Reich, Christian Wirth and all members of the TRY initiative

DIVERSITAS an international programme of biodiversity science

Max Planck Institute for Biogeochemistry

iDiv

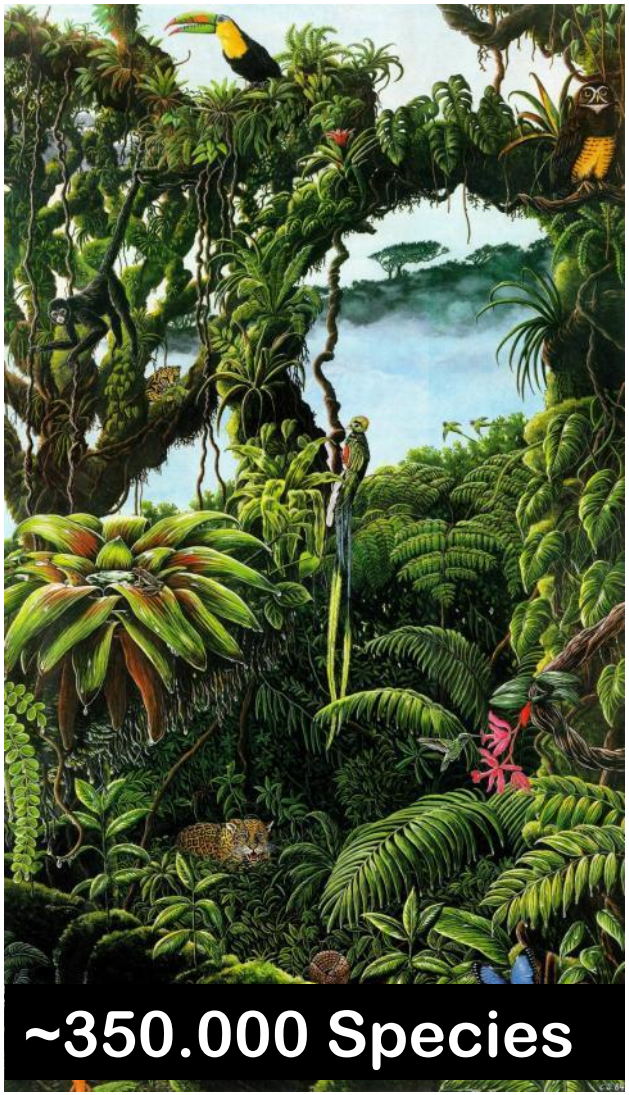
GLOBAL CHANGE IGBP International Geosphere-Biosphere Programme

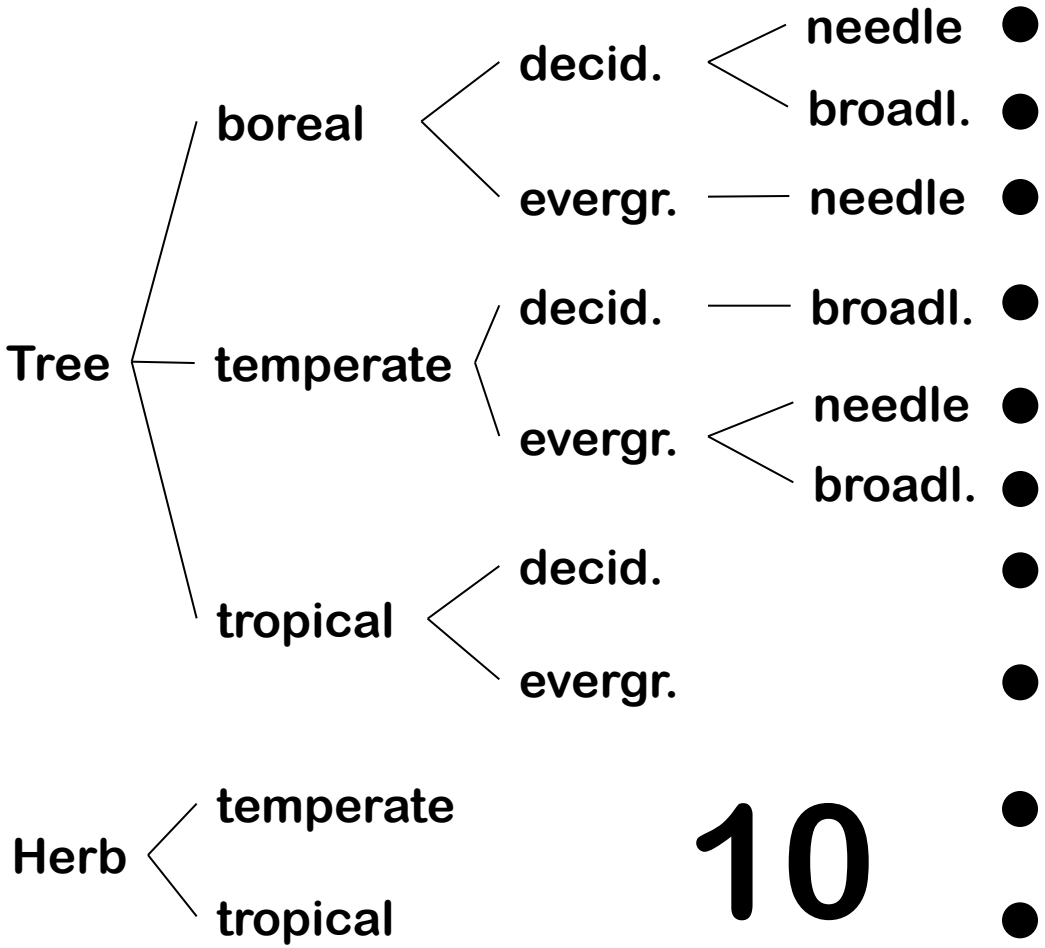
QUEST

CLIMAT ENVIRONNEMENT SOCIÉTÉ Groupement d'Intérêt Scientifique

FRB

Diversity and DGVMs





2007

Fast Track Initiative on Refining Plant Functional Classifications

Sandra Díaz
Sandra Lavorel
Colin Prentice
Paul Leadley

Christian Wirth
Gerhard Bönisch
Jens Kattge

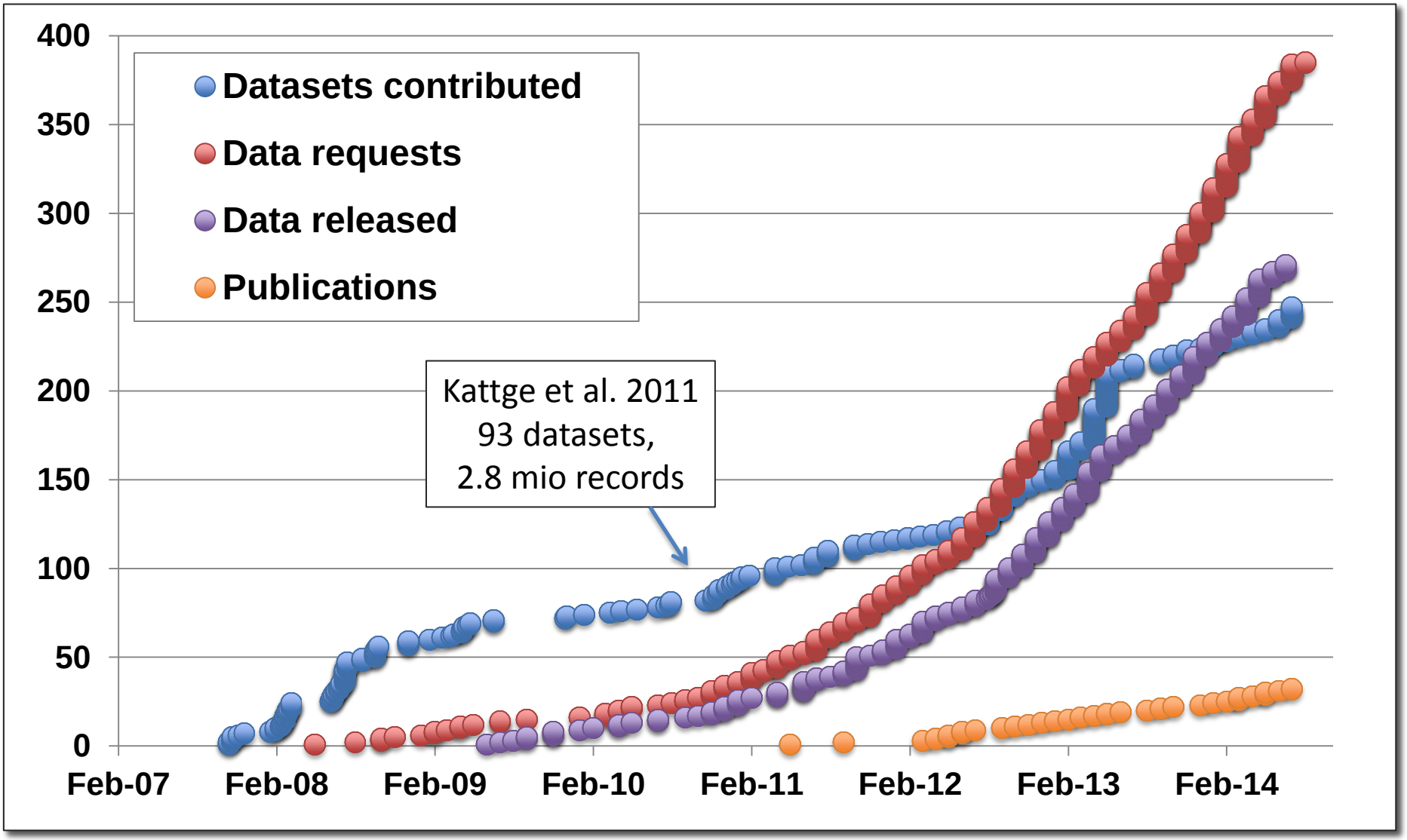
Goal: A global database of plant traits to make the data available for trait-based approaches in ecology and vegetation modeling

Incentive driven data sharing

- **Data remain intellectual property of contributors**
  - Restricted access
  - Open access (new: autumn 2014)
- **Incentives for data sharing**
  - Use of (restricted) data from the joint database
  - Potential collaboration in publications
  - References being cited

TRY

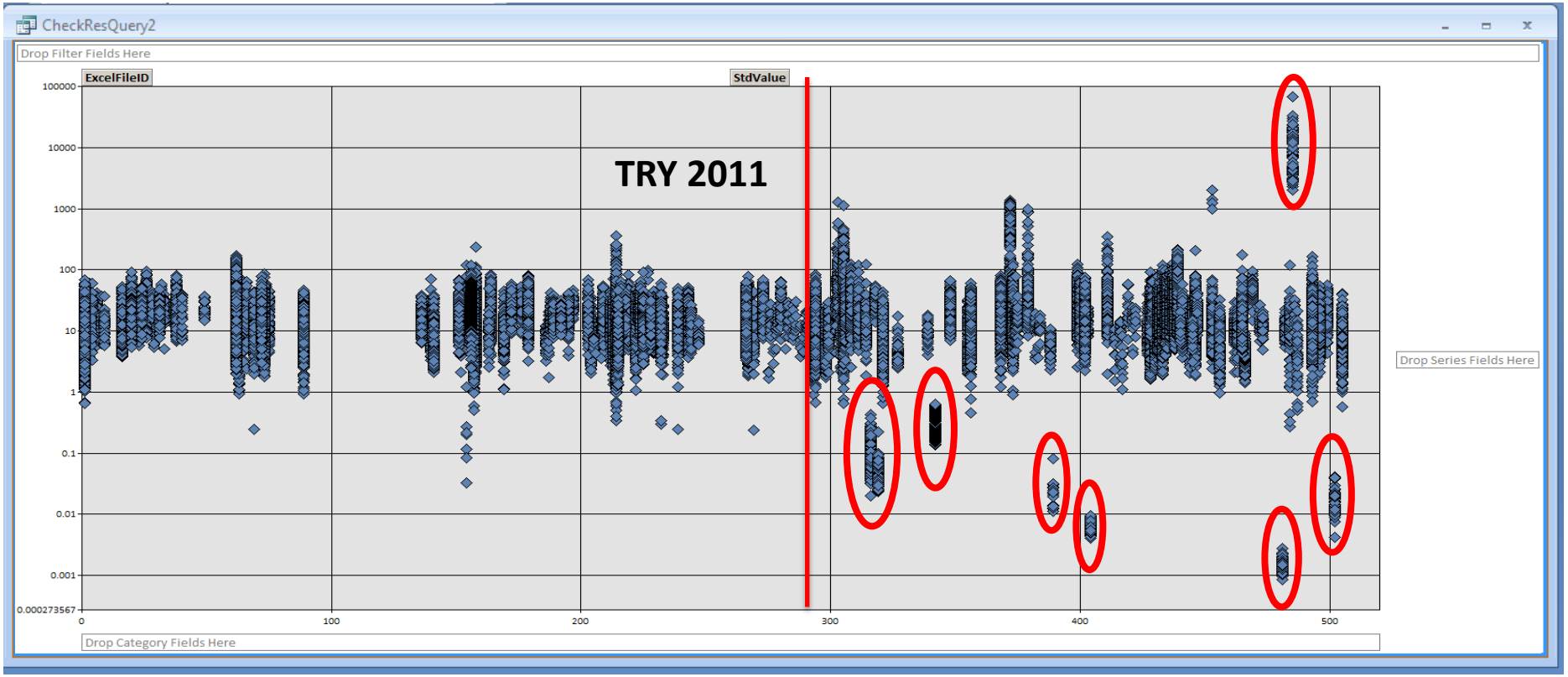
TRY has gained momentum



Data processing & quality control

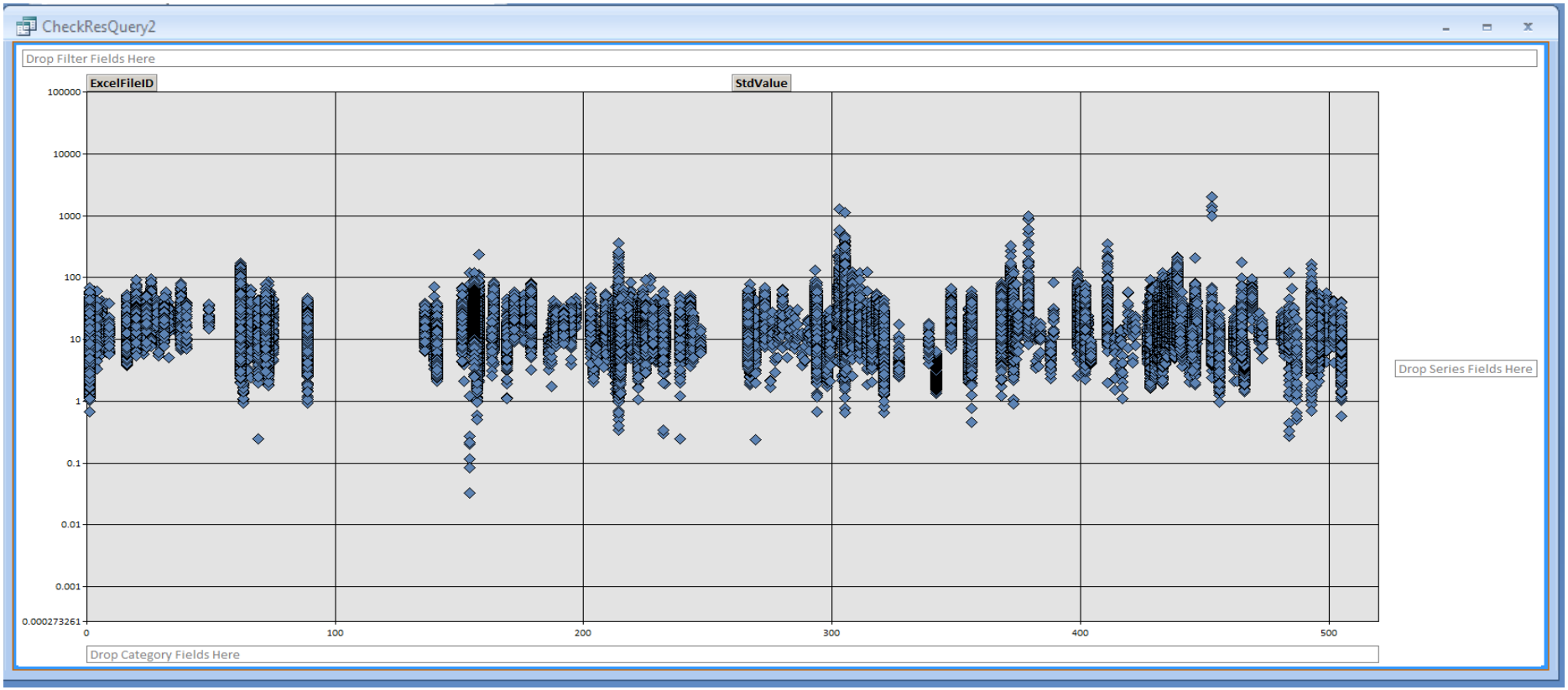
1. Data acquisition
2. Data import
3. Matching of concepts
   - Traits
   - Auxiliary data
   - Taxonomy
4. Standardization of units
5. Correction of errors (contributor's feedback)
6. Complementation of trait data
7. Identification of duplicates and outliers

Something‘s wrong here



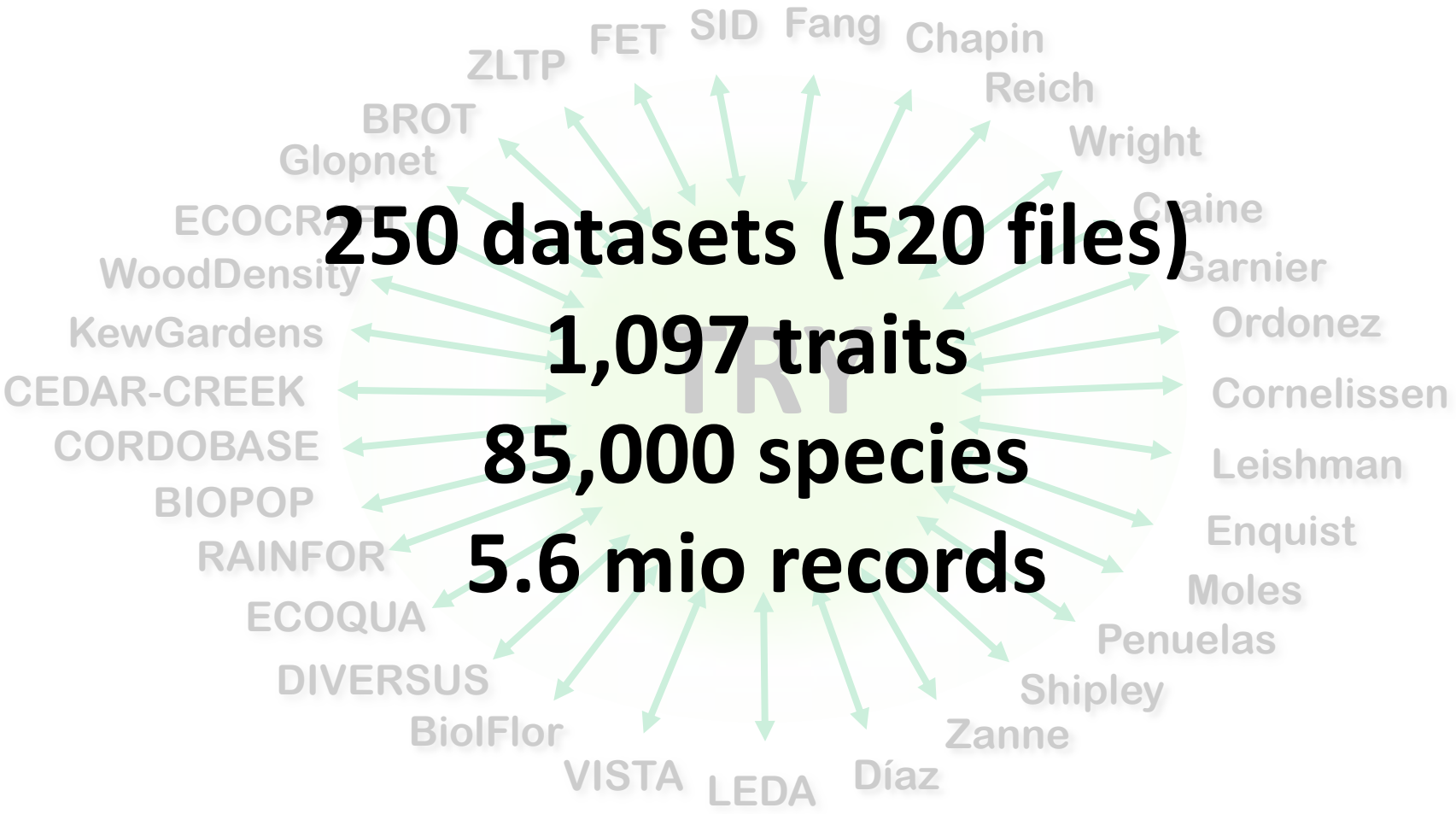
e.g. specific leaf area (~90 new files)

… after the correction of unit mismatches



TRY – a global database of plant traits

Second generation of data pooling



250 datasets (520 files)

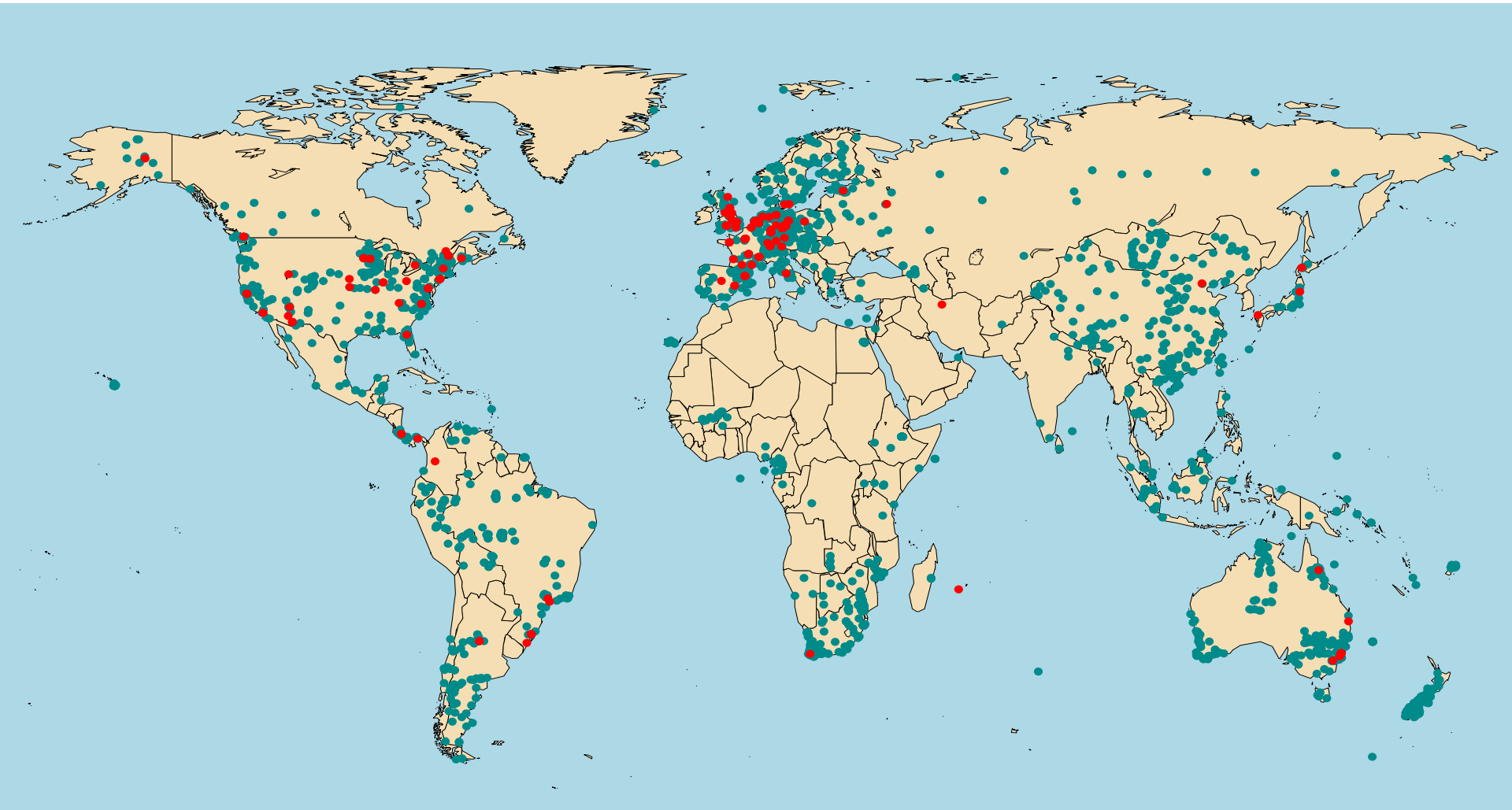
1,097 traits

85,000 species

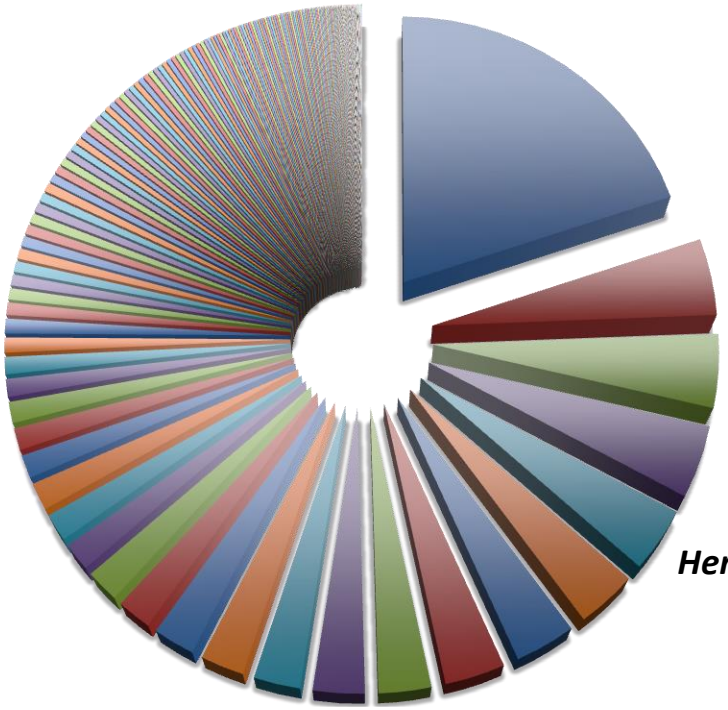
5.6 mio records

TRY – a global research network

- 167 contributing partner institutes (372 scientists)
- 14361 measurement sites

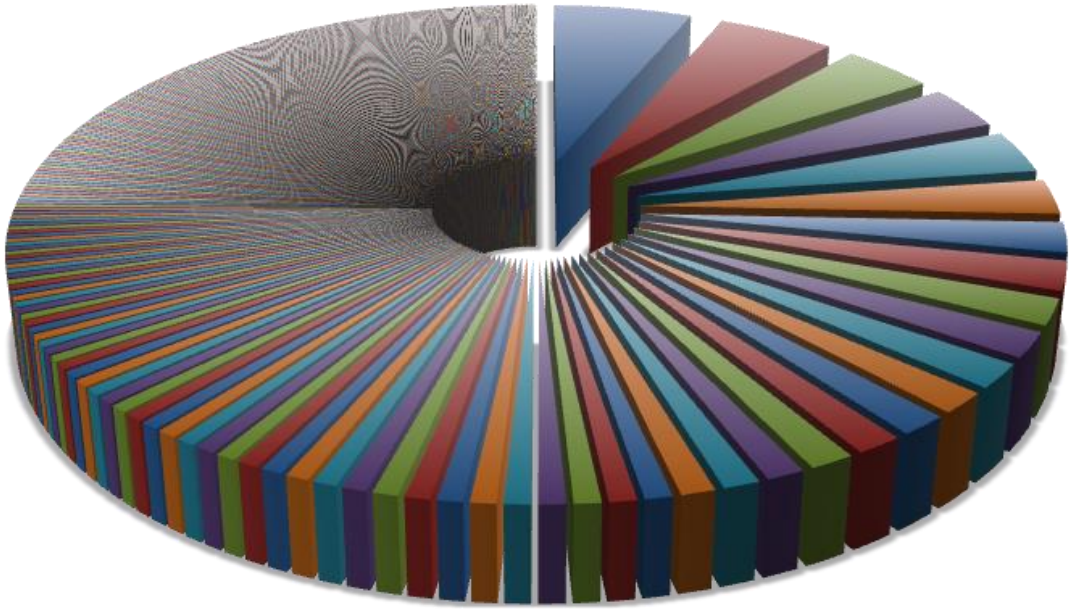


Trait records by dataset



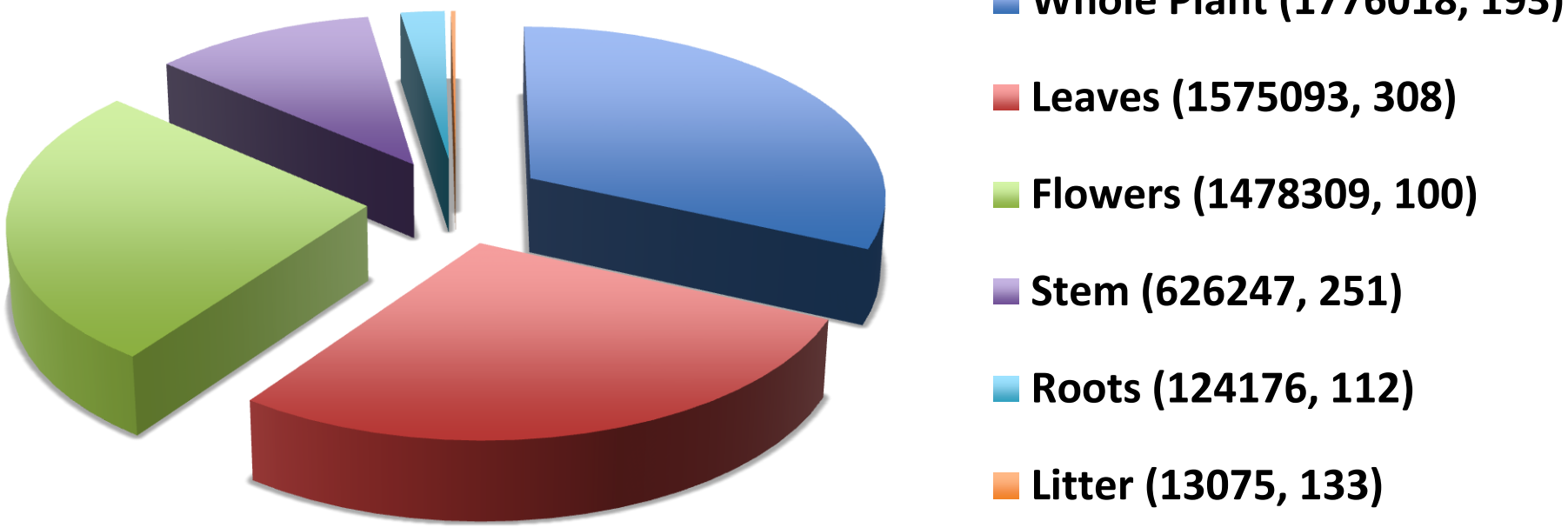
The LEDA Traitbase	1048680	Michael Kleyer
KEW Seed Information Database (SID)	238105	John Dickie
BiolFlor Database	226840	Ingolf Kühn, Stefan Klotz
VegClass CBM Global Database	223588	Andy Gillison
CLO-PLA - a database of clonal growth	***196330***	***Jitka Klimesova***
PLANTSdata	178168	Walton Green
Ecological Flora of the British Isles	***177724***	***Alastair Fitter***
The Functional Ecology of Trees (FET)	***175329***	***C. Wirth, J. Kattge***
Bridge database	***152737***	***Christopher Baraloto***
DBH and life form of Amazonian flora	***149718***	***Erika Berenguer***
BIOPOP: Traits for Nature Conservation	136053	Peter Poschlod
Chinese transect trait database	***126805***	***Sandy Harrison***
Herb water relations on moisture gradients	***121918***	***Serge Sheremetev***
Panama Plant Traits Database	101487	S. Joseph Wright
The xylem/phloem database	***98726***	***Fritz Schweingruber***
Categorical Plant Traits Database	85027	Ian Wright
Global woodiness database	***84212***	***Amy Zanne***
Plant Volatiles Database	***84170***	***Almut Arneth***
Leaf structure and chemistry	71098	Bill Shipley
D3: The Dispersal and Diaspore Database	***67487***	***Oliver Tackenberg***
Global 15N Database	65051	Joseph Craine
GLOPNET - Global Plant Trait Network	55412	Ian Wright, Peter Reich
Reich-Oleksyn Global Leaf N, P Database	53724	Peter Reich
Global Leaf Element Composition Database	***46802***	***Steven Jansen***
KEW African Plant Traits Database	46253	Don Kirkup
Leaf Physiology Database	38804	Jens Kattge, C. Wirth

Trait records by trait

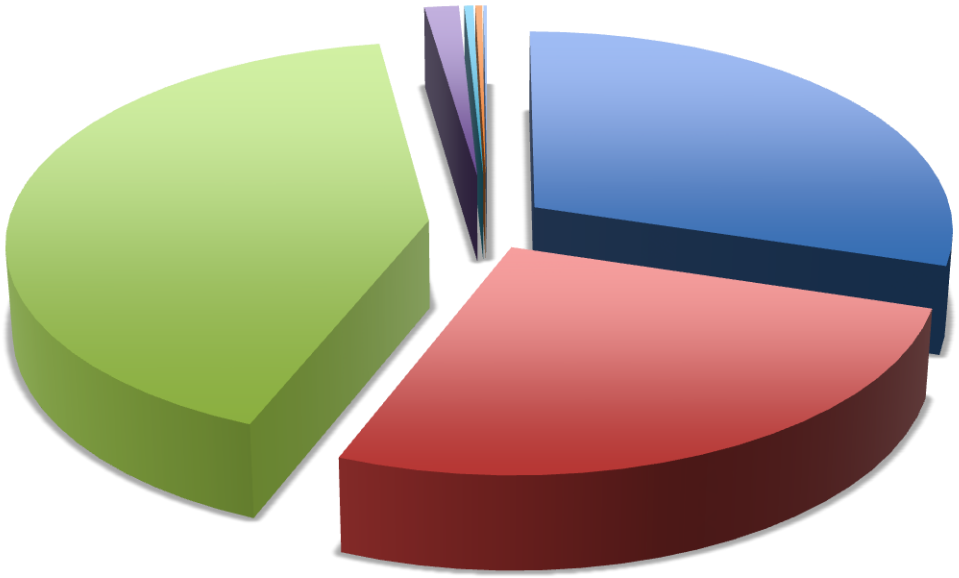


Dispersal syndrome	351826
Plant growth form	297906
Plant height	***229969***
Seed dry mass	***200770***
Dispersal unit type	195107
Dispersal unit floating capacity	159702
Specific leaf area, SLA	***137689***
Leaf area	***132172***
Stem diameter	***117567***
Leaf dry matter content, LDMC	***113031***
Plant woodiness	109148
Leaf phenology type	93358
Seedbank type	89951
Leaf dry mass	***87410***
Plant life form (Raunkiaer)	82710
Budbank height distribution	***70444***
Leaf N content per leaf dry mass	***67002***
Seed germination efficiency	***63202***
Seed (seedbank) longevity	***50959***
Plant reproductive phenology	50492

Trait records by plant parts



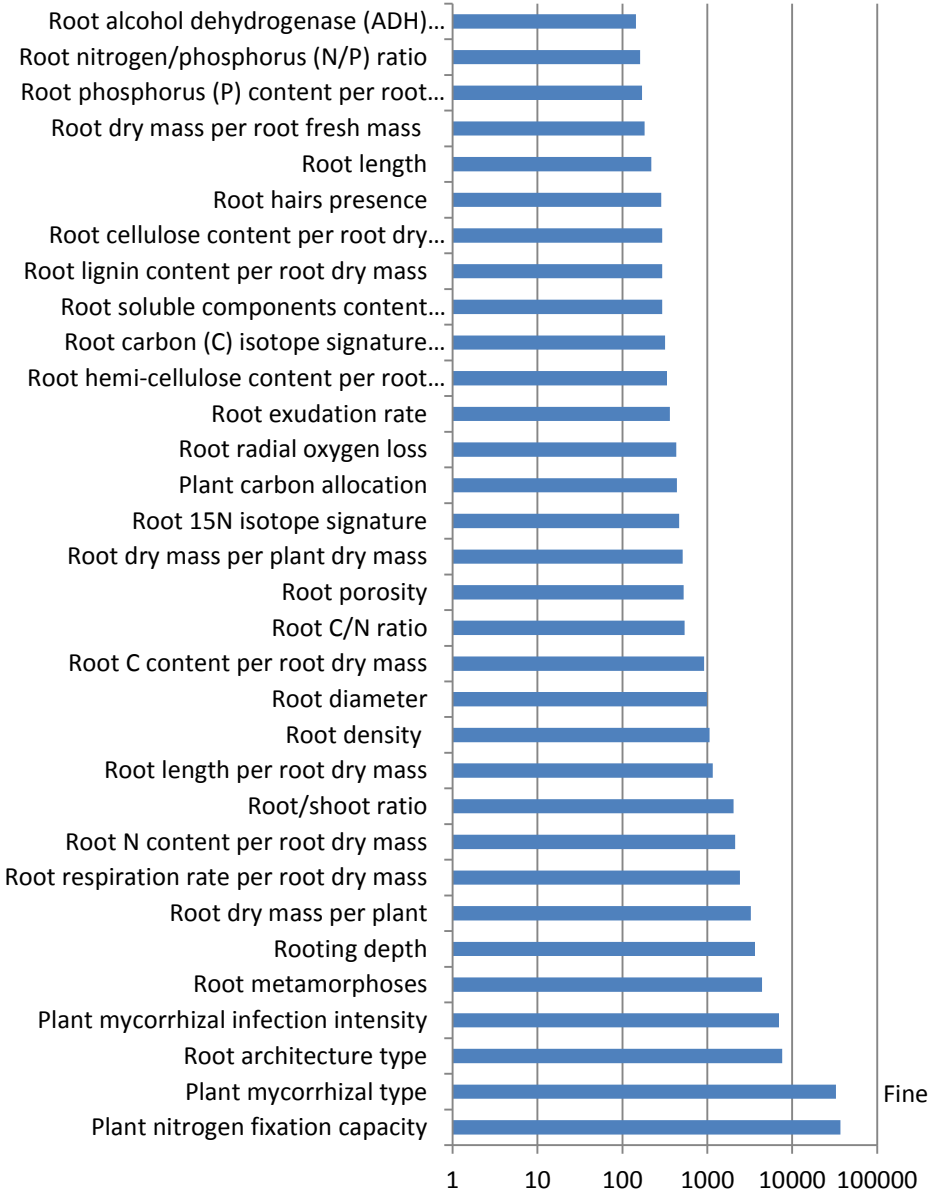
Root traits in the context of TRY



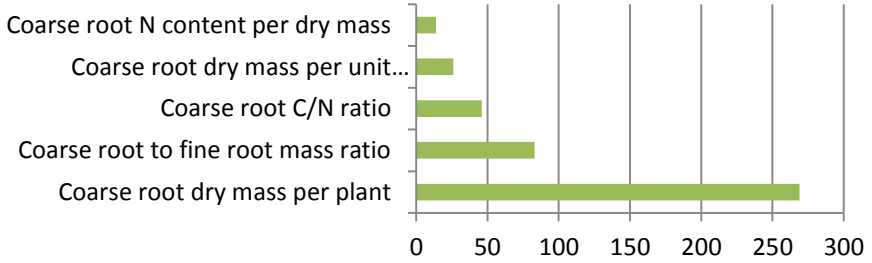
- Nitrogen fixation capacity (37081, 1)
- Mycorrhizal type (32797, 1)
- Roots in general (51959, 69)
- Fine roots (1859, 16)
- Coarse roots (480, 27)
- Coarse root CWD (371, 18)
- Fine root litter (187, 16)

Root traits – a closer look

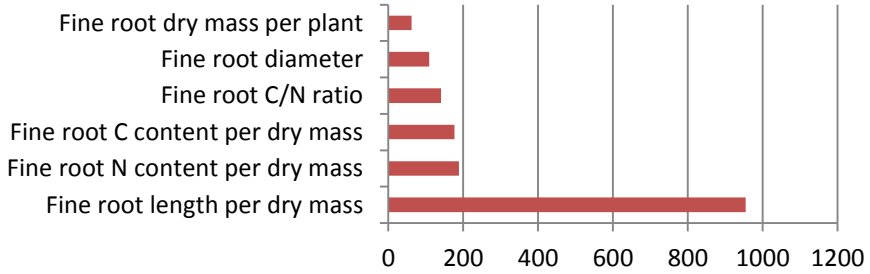
Root traits (69)



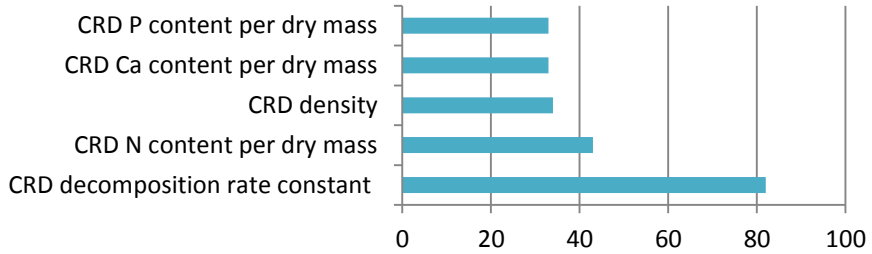
Coarse roots (27)



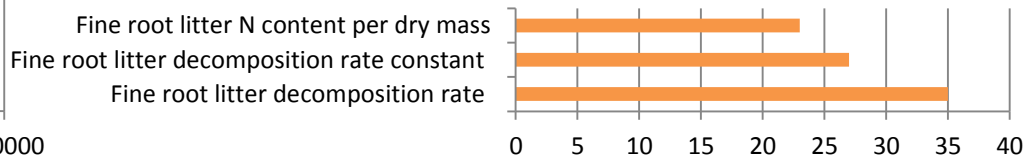
Fine roots (16)



Coarse root debris (18)



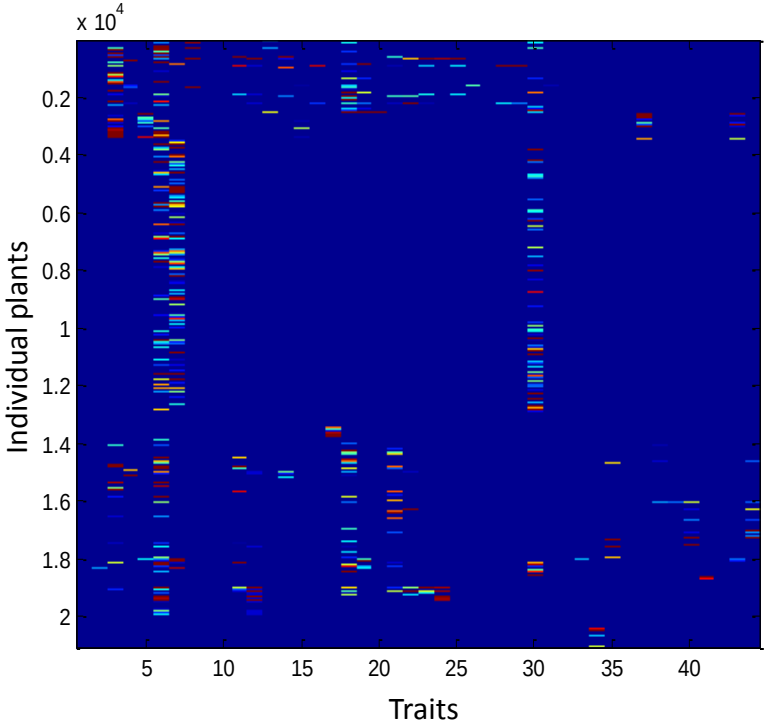
Fine root litter (16)



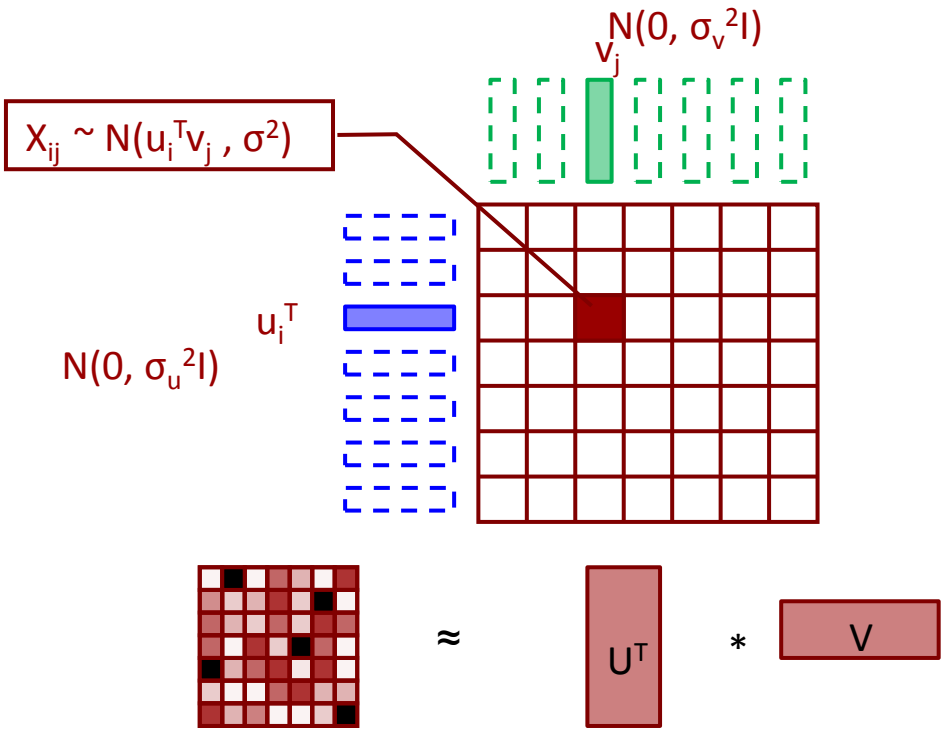
Gap-Filling of the TRY trait matrix

a cooperation of the MPI-BGC and the University of Minnesota

TRY = sparse matrix
5.6 million records on 1097 traits ×
2.2 million individuals (coverage 0.25 %)

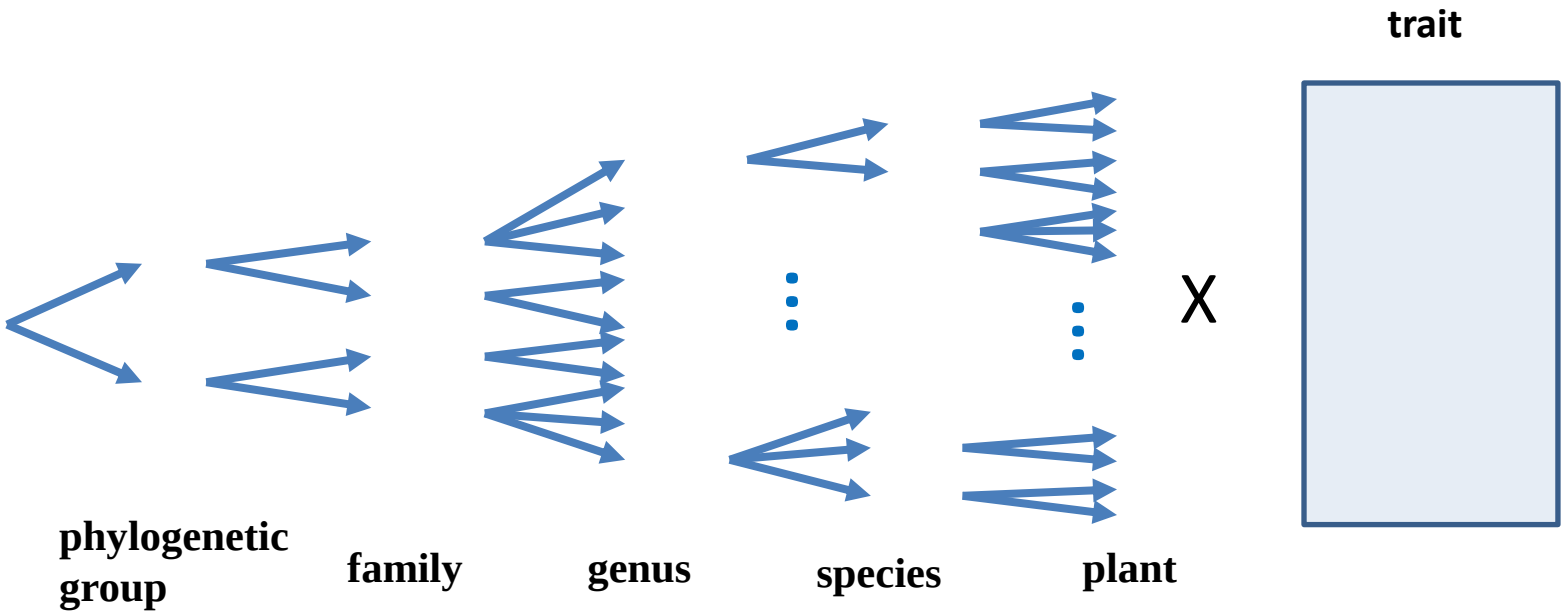


Probabilistic Matrix Factorization (PMF)



R. Salakhutdinov and A. Mnih, NIPS 2007

Taxonomic hierarchy of the plant kingdom

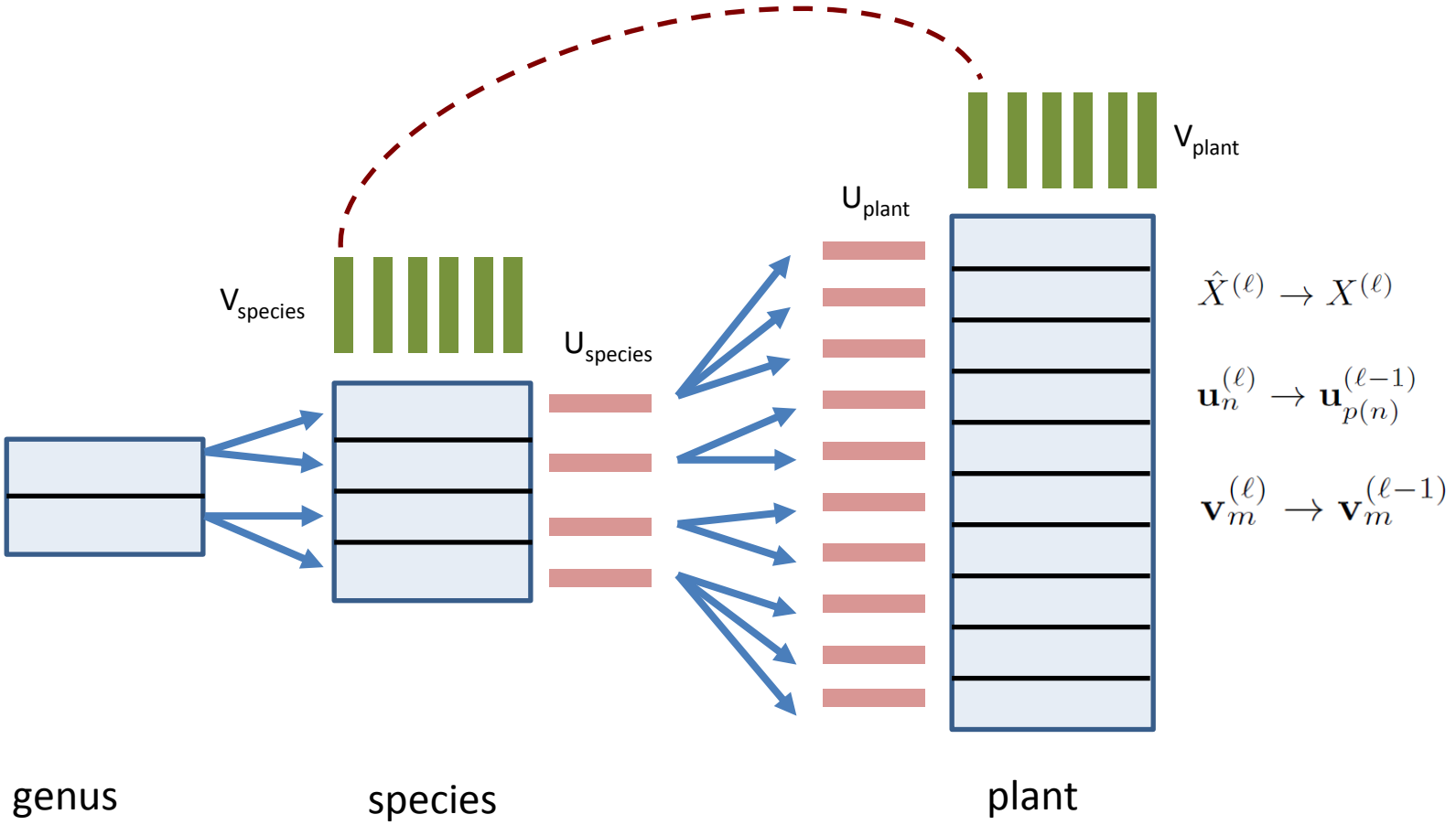


e.g. **Scots pine**

Gymnosperms **Pinaceae** **Pinus** **Pinus sylvestris**

Plant height
Rooting depth
Leaf area
Leaf Mass
LMA
LeafN content
Photosynthesis rates
etc..

Hierarchical Probabilistic Matrix Factorization

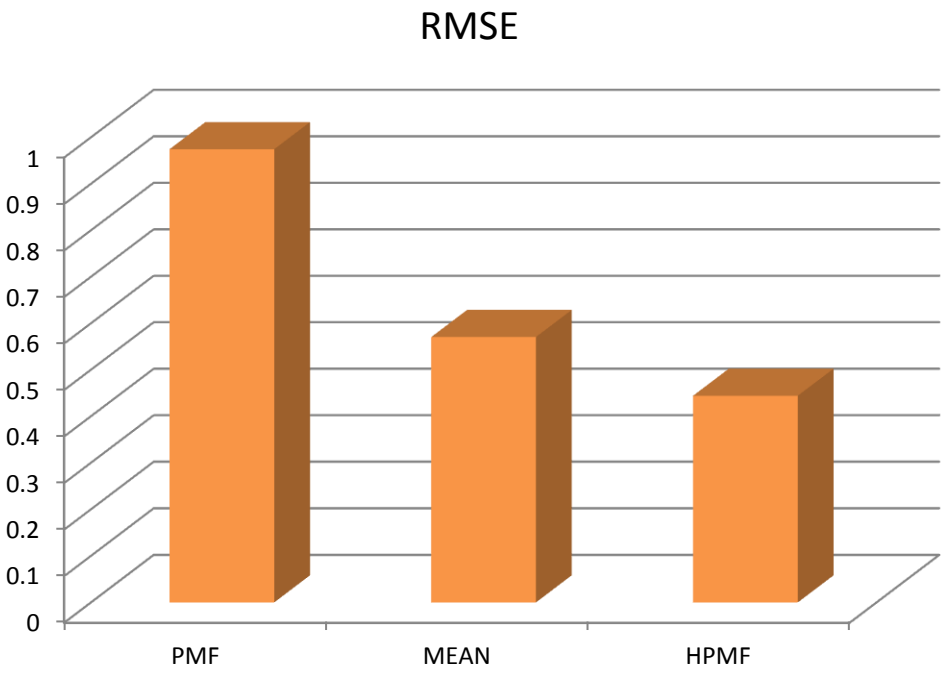


$$E = \sum_{\ell=1}^{L} \left\{ \sum_{nm} \delta_{nm}^{(\ell)} \parallel x_{nm}^{(\ell)} - \langle \mathbf{u}_n^{(\ell)}, \mathbf{v}_m^{(\ell)} \rangle \parallel_2^2 + \lambda_u \sum_n \parallel \mathbf{u}_n^{(\ell)} - \mathbf{u}_{p(n)}^{(\ell-1)} \parallel_2^2 + \lambda_v \sum_m \parallel \mathbf{v}_m^{(\ell)} - \mathbf{v}_m^{(\ell-1)} \parallel_2^2 \right\}$$

H. Shan et al., ICML 2012

HPMF compared to other algorithms

- 8 phylogenetic groups, 450 families, 7160 genera, 45824 species, 273777 plants, 443423 measurements
- 18 traits



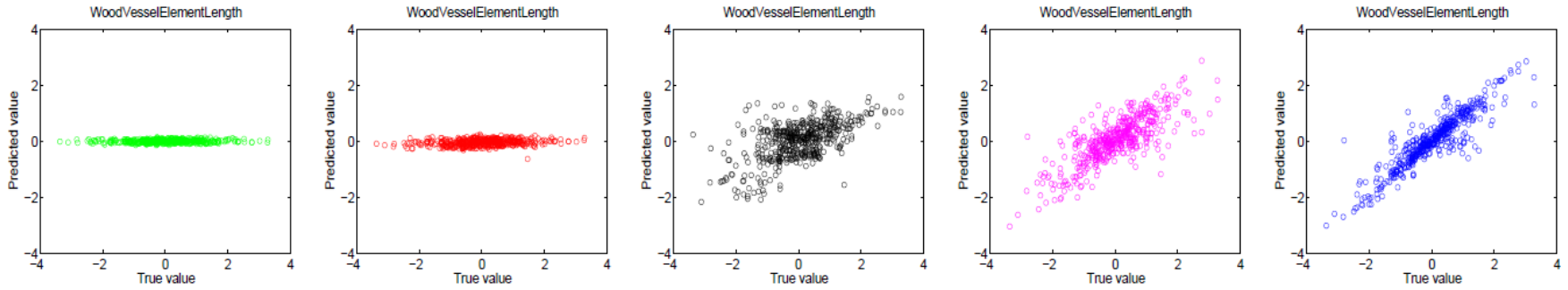
•HPMF outperforms PMF and MEAN

H. Shan et al., ICML 2012

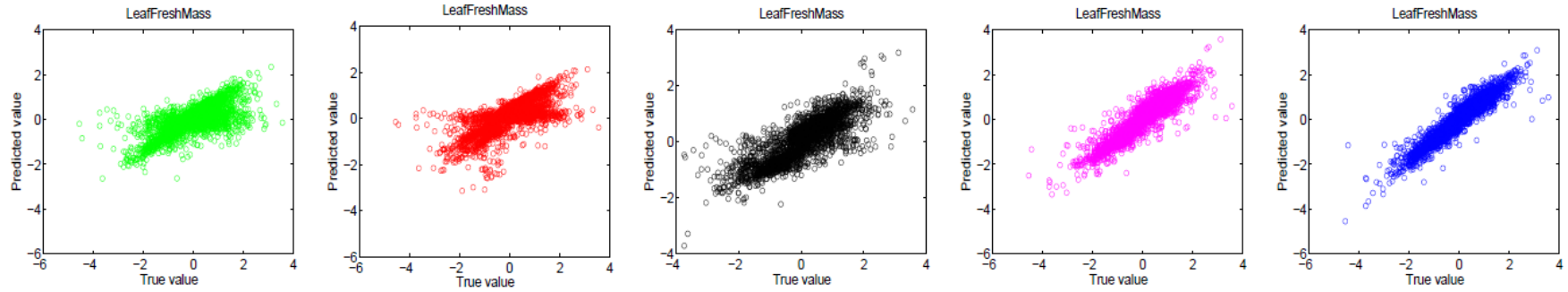
(true value, predicted value) scatter plot

Wood Vessel Element Length

no phylo. info. | phylo.-group | family | genus | species



Leaf Fresh Mass



With increasing amount of taxonomic information, the plot becomes closer to a 1:1 line

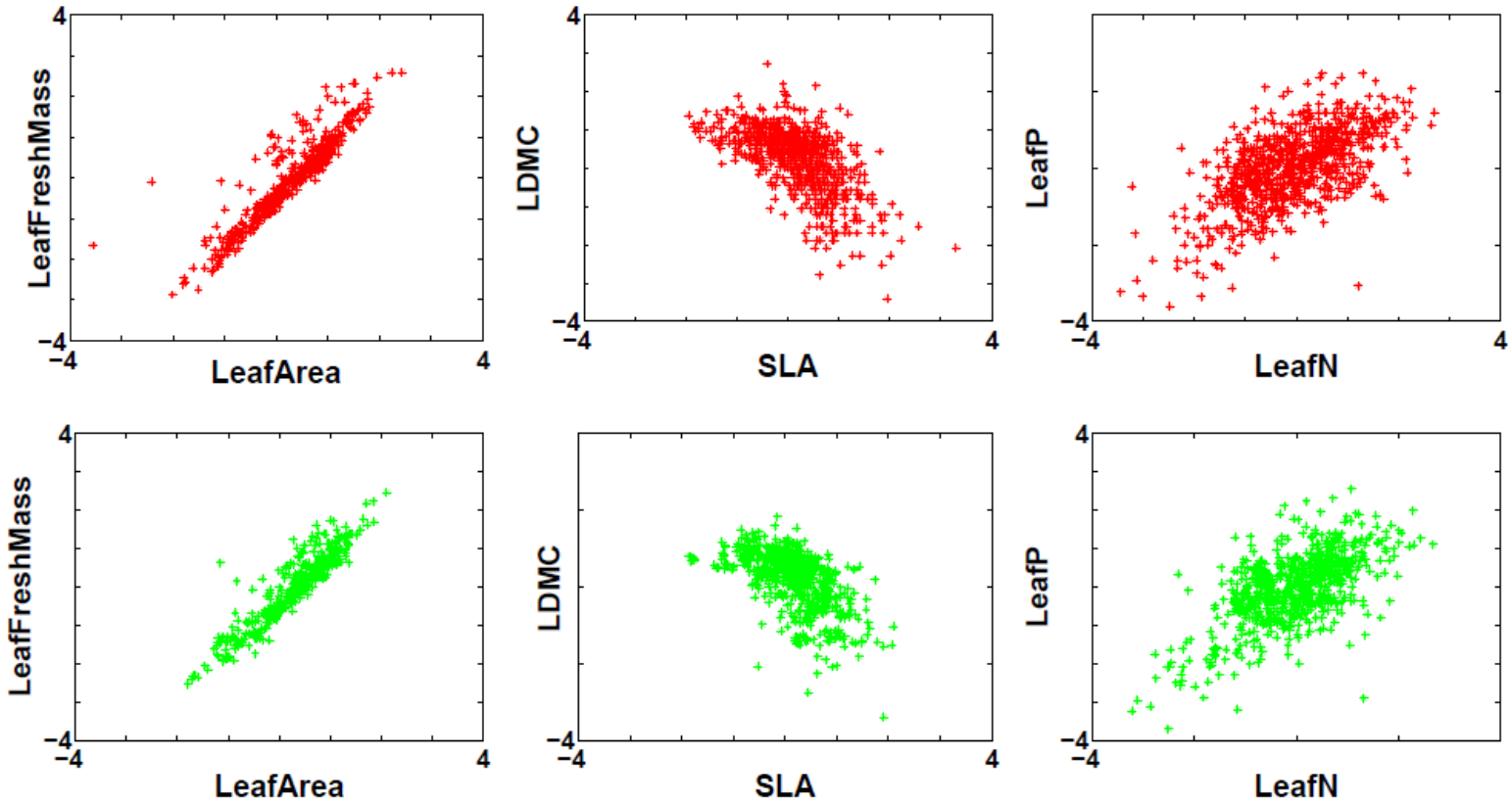
Deviations of true and predicted values indicate outliers

H. Shan et al., ICML 2012

Correlation between traits

true

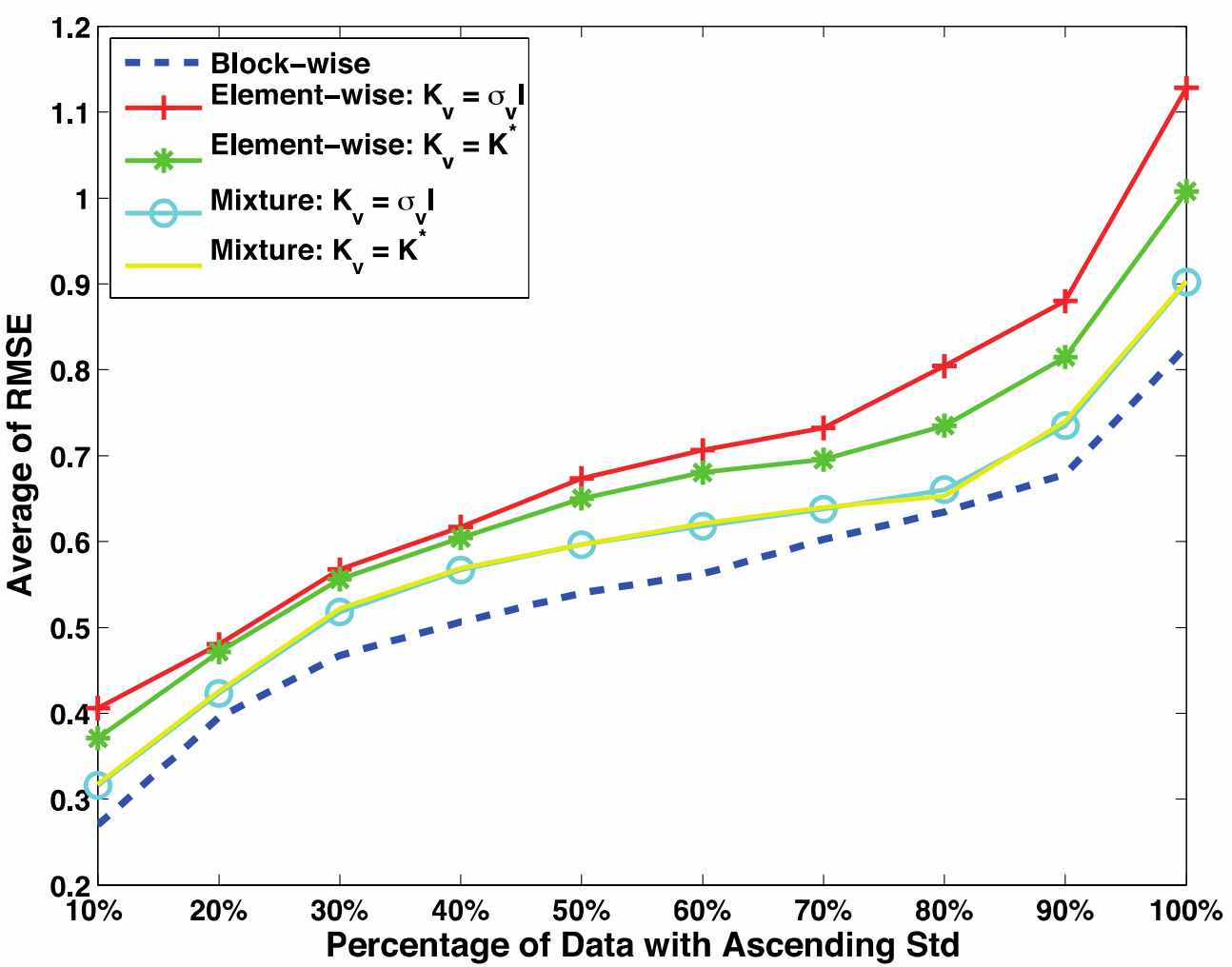
predicted



•The predicted trait correlation is close to the true plot

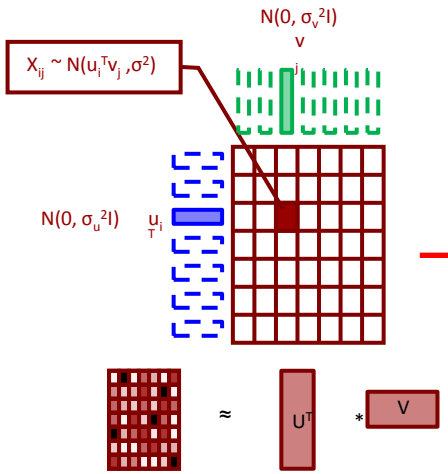
H. Shan et al., ICML 2012

Prediction error (RMSE) correlates with prediction uncertainty (Std)

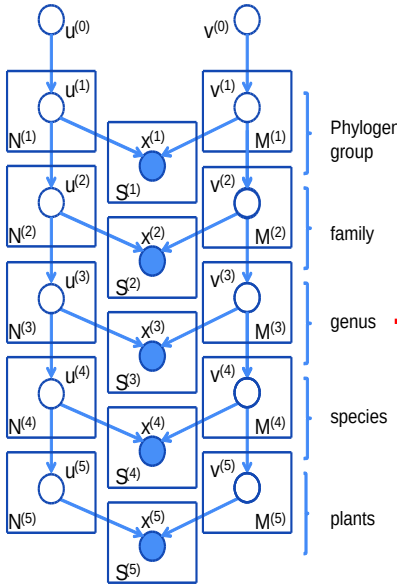


Outlook: environment informed trait prediction for vegetation modeling

a cooperation of the MPI-BGC, the University of Minnesota and the Oak Ridge National Laboratory



Probabilistic Matrix Factorization



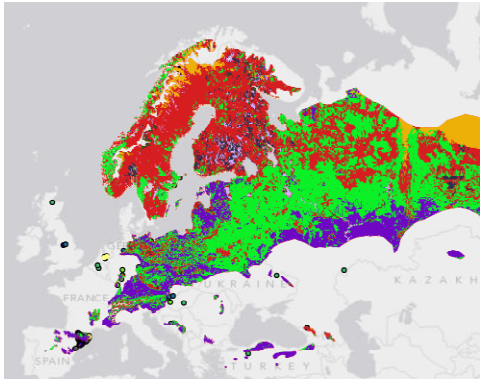
Hierarchical PMF

Environment

Climate (e.g. WorldClim)

Soil (e.g. HWSD)

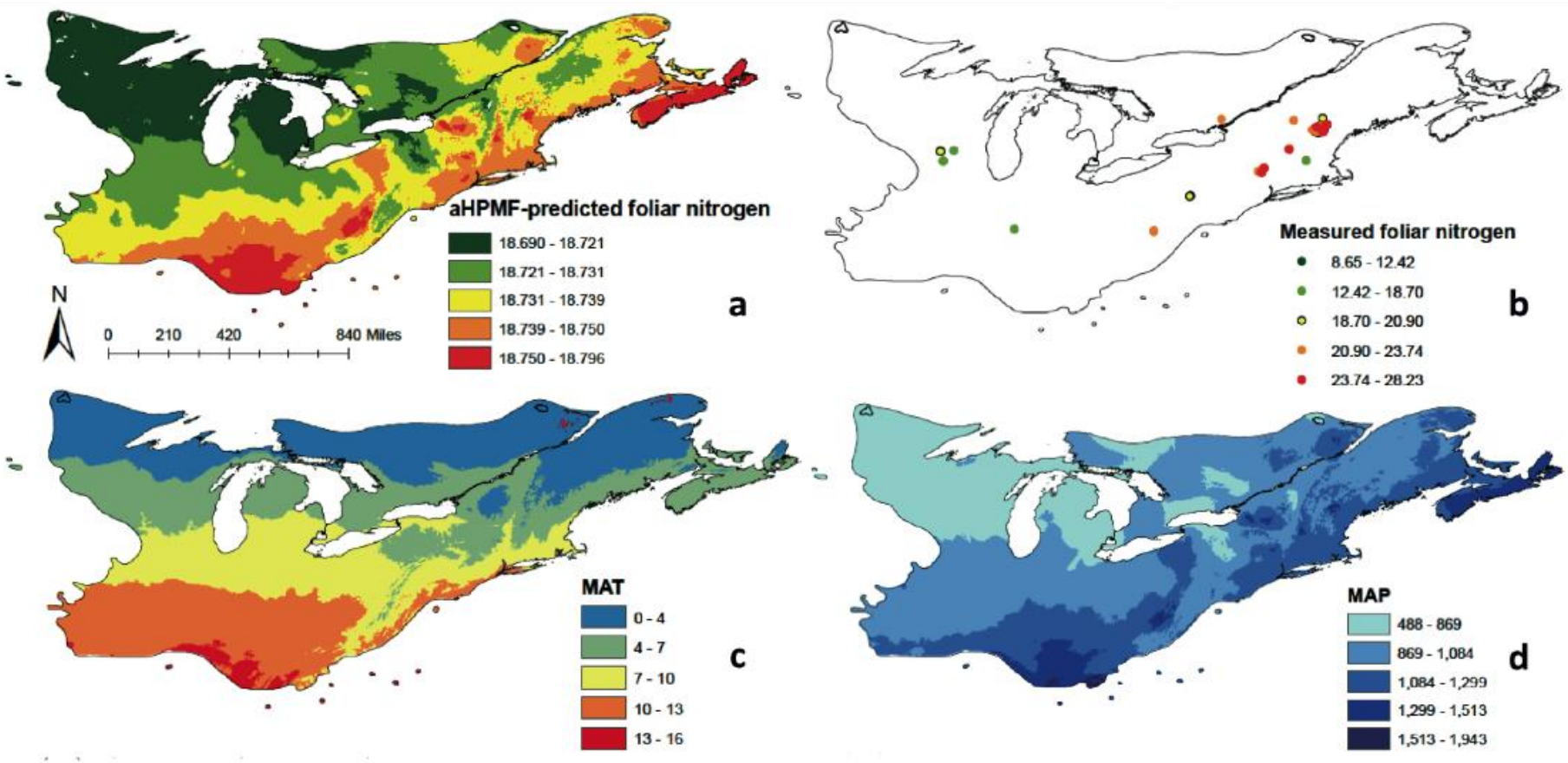
Regression against residuals or gap-filled data



Out of Sample Trait Prediction

Out of Sample Prediction

e.g. Leaf N concentration for Acer saccharum



F. Schrodt et al., GEB, in review

Summary: Root Traits in TRY

1. **Data coverage in TRY doubled** from 2.8 million trait records in 2011 to 5.6 in 2014, **major part of the data will become publicly available** (autumn 2014)
2. All plant parts are almost equally well represented, **roots are underrepresented** and split to several traits, most with few entries each
3. The unprecedented coverage of the TRY database provides **a unique opportunity for gap-filling, quality assurance and trait prediction**

Quantifying and scaling global plant trait diversity

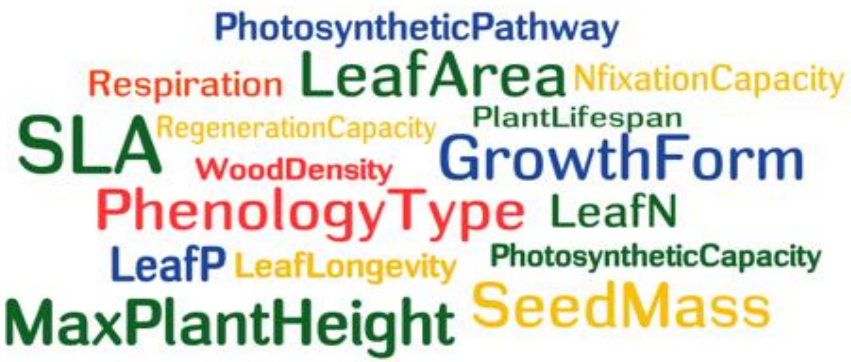
TRY is a network of vegetation scientists headed by DIVERSITAS, IGBP, the Max Planck Institute for Biogeochemistry and an international Steering Committee.

Main objectives

- Provide a global archive of plant traits
- Promote trait-based approaches in ecology and biodiversity science
- Support the design of a new generation of global vegetation models

Current state of database and network

- 3 million trait records for about 69000 plant species
- 591 participants from 207 scientific institutes worldwide
- 256 scientific projects requesting plant trait data from TRY



News

Paper published (2014-08-01)
Walker AP et al.: The relationship of leaf photosynthetic traits – Vcmax and Jmax – to leaf nitrogen, leaf phosphorus, and specific leaf area: a meta-analysis and modeling study. Ecology and Evolution (link)

Paper published (2014-06-23)
Scheffer et al.: Why trees and shrubs but rarely trubs? Trends in Ecology & Evolution. (link)

Paper published (2014-06-13)
Werner et al.: A single evolutionary innovation drives the deep evolution of symbiotic N2-fixation in angiosperms. Nature Communications. (link)

Paper published (2014-05-16)
[illegible]ples AT et al.: Which is a better predictor of [illegible]t traits: temperature or precipitation? Journal [illegible]Vegetation Science. (link)

Pa[illegible] pu[illegible] (2014-04-26)
va[illegible] Me[illegible]en[illegible]l.: Plant trait analysis delivers an [illegible]ve list of potential green roof species for [illegible]d[illegible]rranean[illegible]rance. Ecological Engineering (lin[illegible]

News Archive

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Thank you

www.try-db.org