iDiv
German Centre
for Integrative
Biodiversity Research

sDiv-Workshop: Plant trait-environment relationships across the world's biomes

March 6th-9th 2013

Biocity, Deutscher Platz 5a, 04103 Leipzig

sDiv

Plant trait-environment relationships worldwide
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iDiv German Centre for Integrative Biodiversity Research

sDiv

Protocol

(compiled by Helge Bruelheide with additions from Oliver Purschke)

This protocol summarizes the outcome of the workshop and defines the agenda for the next months. The protocol is complemented by
- a draft for a letter to owners of vegetation plot databases (Letter to contributors.docx)
- description of data properties of vegetation plots (Description of data properties.docx)
- sPlot rules on data sharing (sPlot-Rules.doc)

Main goals of the workshop

The main objective of the workshop was to assess the relative importance of macroclimate in explaining trait variation in local plant communities worldwide. The sDiv working group's aim was to answer the following main questions: (i) To which extent are relationships between traits preserved across environmental gradients worldwide, irrespective of macro climate? (ii) To which degree is the effect of local abiotic drivers mediated by climate?

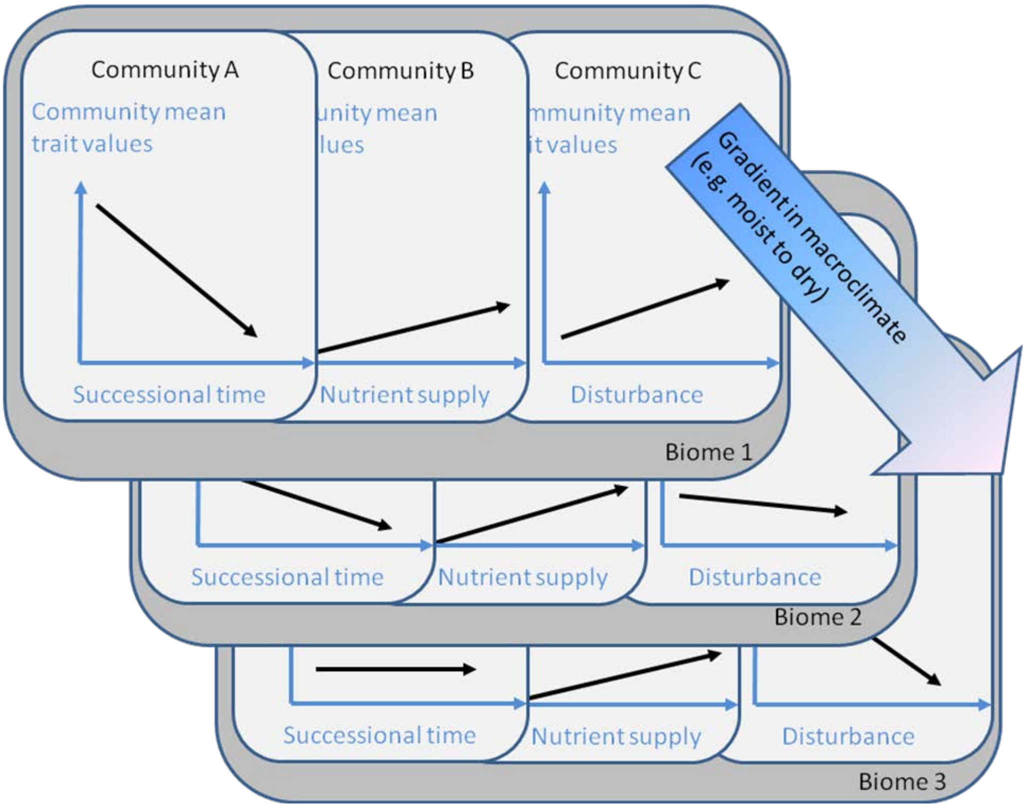

Table 1. Participants

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Fig. 1. Participants Front (L-R): Richard Field, Vanessa Minden, Valério Pillar, Jürgen Dengler, Sylvia Haider, Colleen Webb, Franzika Schrodt, Milan Chytry, Miguel Mahecha, Nathan Swenson, Jens Kattge; Middle (L-R): Thomas Hickler, Ingolf Kühn, Simon Scheiter, Michael Kleyer, Oliver Tackenberg, Oliver Purschke, Helge Bruelheide, Florian Jansen, Stefan Klotz, Jan Leps, Ute Jandt; Back (L-R): Christine Römermann, Jonathan Lenoir, Marco Schmidt, Brody Sandel, Marten Winter; not on the picture: Yue Lin, Erik Welk, Christian Wirth

General issues

After an introductory round of all participants and their field of expertise, the overall goal of the workshop was shortly laid out by Helge Bruelheide. The ensuing discussion on how to link trait da) with the environment via the species composition of plots) first focused on data availability.

1. Most concerns were expressed on whether there were sufficient **environmental descriptors** (header data) in the vegetation plot databases. Even taking all the 6636 plots from the German Vegetation Reference Database (GVRD) together, for which soil pH values are available, does not guarantee that they have been measured with the same methodology. The situation is more severe for other soil variables.

Many plot databases worldwide do not even contain simple site factors. Generally available are only slope, aspect and geographical coordinates.

It was recognized by the participants that the workshop should deal with two sets of potentially available data separately: on the one hand, globally available plot data with lacking environmental data, on the other hand, regional datasets with information on local drivers such as soil, disturbance and climate, usually obtained from coordinated projects, in which data have been measured consistently. The two options represent a trade-off between global coverage and functional detail. After discussing pros and cons, there was an agreement that we should not give up the idea to link global vegetation databases to traits because knowledge of the exact position of plots allows to link them to globally interpolated climate data, such as the WorldClim dataset, and to establish climate-trait relationships. There might also be the option to make use of aspect information to estimate water supply of plots. Finally, with ever increasing remote sensing information new environmental factors might become available, such as climatic variability of a period of years or estimation of human impacts (as a measure of disturbance). It was pointed out that the most valuable piece of informationinvegetation plot databases is species co-occurrence, showing which species interact with each other. The group later decided to form two subgroups surveying the data availability and possible approaches for these two types of data. The aim would be to produce datasets, balanced for plot number across regions.

There was also a discussion on which types of vegetation the group should focus. The general impression was that grassland and forests would both be formations that can be found worldwide. Thus, gradients for a certain environmental driver might be found in all biomes, such as successional age in forests or land use intensity in grasslands. It was also decided, as these two formations are characterized by different drivers, that the most appropriate approach would be to keep forests and grasslands separate in subsequent analyses.

2. Similar concerns were expressed on trait data. In particular, only a few plant traits are available for a substantial number of species. In the TRY databases this would only be the case for about six traits. Thus, gap filling algorithms would have to be considered to cover the traits for the majority of species in the plot databases. The group agreed that a first step should be to produce a global overview on the amount of available traits for different vegetation databases.

3. The group also devoted time for discussing statistical approaches. It was pointed out that the high number of plots usually available in vegetation databases is to be expected to give significant results, which however, might not be ecologically meaningful. Nevertheless, randomization approaches will be needed to detect departures from randomness in vegetation - trait relationships.

At the beginning of the Day 2, Oliver Purschke introduced some of the core topics to be discussed during the workshop, such as issues related to (i) concept development, (ii) vegetation/trait data bases and (iii) data analysis. For efficiency reasons, and according to the main topics, most of the discussions took place in three outbreak groups (with frequent exchange of results between groups):

1st discussion group: Concept development; linking the research questions to theory (Simon Scheiter, Vanessa Minden, Helge Bruelheide, Valério Pillar, Richard Field, Thomas Hickler, Sylvia Haider, Oliver Tackenberg, Colleen Webb)

Questions dealt with:

Environmental filtering vs. limiting similarity? Which environmental variables would qualify as environmental filters? Which traits respond to which gradients?

The group considered interactions between traits to be central for our understanding of community assembly rules. They discussed the JEDI model, which predicts how many trait combinations can coexist in a given environment. The discussion group decided that this model was too complex to derive hypotheses for this vegetation-trait workshop. However, in principle, in a benign environment more trait combinations should be possible. Thus, as a central question for the topic of the workshop, the theory group identified the idea that a benign climate allows for more trait combinations, because no trait is filtered away by a harsh environment. This gave rise to the following hypothesis that found the theory group to be the most intriguing:

A more benign (and climatically constant) environment results in higher trait variation (FD), while a more unfavorable environment (and climatically variable) results in a directed change in community weighted mean trait values (CWM) (Fig. 2).

Among all different trait combinations, the group in particular discussed leaf deciduousness x SLA, life form x SLA, height x SLA (as proxy for the length of the light gradient in a community), seed mass x height and seed mass x SLA (Table 2). Concerns were expressed that not all available traits should be used, simply because they are there but only those for which we have a hypothesis. There was a discussion of whether we need a trait by trait hypothesis or whether traits might also be combined in a joint hypothesis (as in a FD measure that includes several traits).

The physiological background of traits was discussed while SLA, LDMC, leaf nitrogen content (LNC) and leaf area reflect the leaf economics spectrum (LES), height, seed weight and life form mainly describe the plant species' reproductive strategy. Thus, in addition to the metabolic axis (LES), there is a size axis in traits. As the relationships between traits differ between woody and non-woody species, the decision to include both forests and grasslands in the global survey aimed at by this group was considered a very good decision.

Preferred traits to be used would be those related to LHS (leaf SLA, height and seed mass), describing leaf construction costs, competitive ability and number of seeds per reproductive unit. In addition, photosynthetic pathway, stem dry matter content (SDMC, in grasslands) or wood density (WD, in forests), leaf life span, LNC, leaf C to N ratio, LPC, leaf area, clonality, life form, life span, pollination syndromes and seed bank might be available. A trait group generally missing are root characteristics, such as rooting depth, mycorrhizal status, etc. The group also discussed whether phylogenetic information on species should be included. Although this approach was generally considered to be very promising, the group decided not to include phylogenetics at this stage.

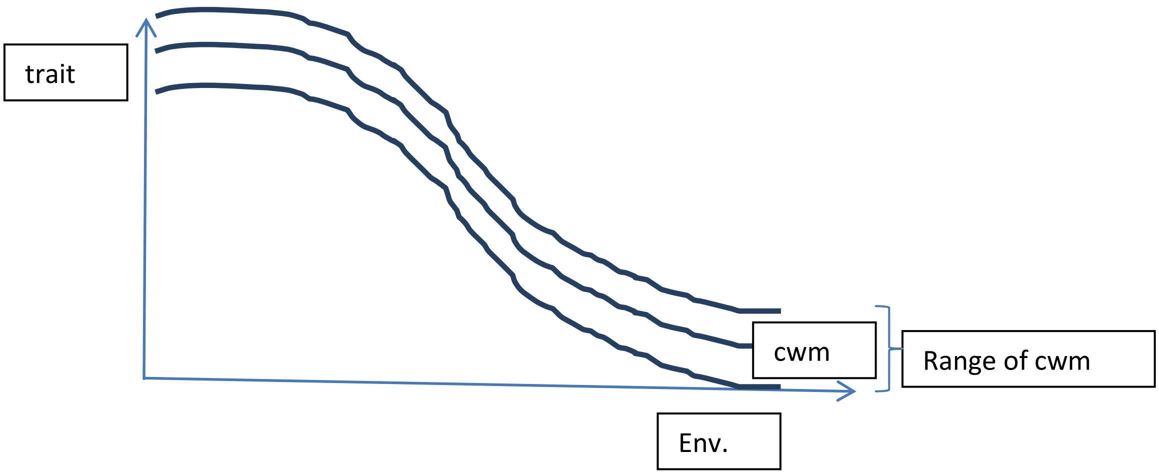

Fig. 2. Hypothesized relationships between abiotic conditions (Env.) and the functional trait composition of communities (CWM – community-mean-trait values; Range of cwm – trait variation or functional diversity). Note that the range of cwm (or functional diversity (FD)) may be used as a proxy for biotic interactions between species (e.g. niche overlap or specialization).

Table 2. Our research questions will focus on (i) responses of single traits (mean values and variation) to macroclimate, abiotic variability and disturbance, (ii) partitioning of trait variability, based on within-plot (alpha) and species pool (gamma) components (beta diversity), to obtain between-community functional trait turnover (beta diversity) between plots, and (iii) trait interactions (including interactions between mean values and trait variability, e.g. with increasing plant height seed mass will show a greater variability.

	Macroclimate	Abiotic variability	Disturbance	Biotic interactions	Species pool
SLA					
Seed mass					
Height					
Leaf habit x SLA					

Height x SLA					
Height x seed mass					

Questions, according to Table 2, to be addressed by the data analysis group (Group 3):

1) How does climate affect traits like SLA, canopy height etc.?

2) How does abiotic variability (seasonality, disturbance) affect traits?

3) How do biotic interactions (competition etc.) affect traits?

4) Species pool determines how communities are assembled and determines the trait composition of a community?

It was mentioned that despite a lack of change in mean trait values, functional strategies might differ (Scheiter et al. 2013). With respect to the idea of describing community assembly by environmental filtering or limiting similarity, it was questioned whether limiting similarity is actually operating at the plot scale, or whether only the scale of the local neighborhood should be considered. One argument to apply the concept to the plots scale was that the species in a community have been co-existing next to each other since a long time. Then, the group also discussed which traits should show limiting similarity. It was suggested that in grasslands regeneration traits show a higher limiting similarity than vegetative traits. It was also pointed out that limiting similarity is an unpaid extinction debt.

The group then discussed how to measure a more benign environment. In principle, three environmental factors might be identified:

- Measure of climatic favorability: length of growing season (either limited by cold or drought). Length of the growing season was considered the main factor determining potential annual production.
- Measure of climatic constancy:
  seasonality (difference between cold and warm or dry and moist season)
- Measure of disturbance:
  Difference between CWM height (from traits) and actually observed height (from header data of the plots). Height as a trait is both a function of competition intensity and disturbance. If height as a trait is considered, it can be compared with the observed height in the plot as included in the header data (compare reality with potential). Thus, CWM of height minus realized height might be an index for disturbance. However, this might only make sense in forests. A problem would be selective logging. It has also been suggested to use maximum height of all the species' trait values

in a plot instead of CWM.

Alternatively, a measure of disturbance might also be derived from the life form spectrum of a plot.

The theory group also touched the issue of how to measure FD, how to scale individual trait values, whether to log- or not-log-transform trait values.

The plenum then discussed to which degree height might be used as predictor for disturbance

- **Height x SLA**: taller/higher communities are more structured than lower communities, thus have a steeper light gradient, and there should be a gradient in SLA
- **Height x seed mass**: height in forests substitute for forest degradation; height as measure of disturbance: seed mass should be related to disturbance and thus indirectly to height

In the plenum, the group discussed whether temporal variability increases of decreases trait variation and whether the decision of what is a benign environment is strongly scale-dependent. It was also argued that the hypothesis of a higher trait variation in a more benign environment does not necessarily need to be true. It might also be that a higher variation is created when traits might shift from their optimum values, which might also be the case if species are growing on the edge of their niche requirements. Then, it was pointed out that different drivers might result in the same trait patters. For example, disturbance in temperate grasslands might result in the same trait pattern as a short growing season.

2nd group: Vegetation plot/trait database issues (e.g. data harmonization, synonymies, ownership) (Michael Kleyer, Jens Kattge, Jürgen Dengler, Florian Jansen, Marco Schmidt, Ute Jandt, Brody Sandel, Stefan Klotz, Jonathan Lenoir, Milan Chytry)

As a main task this discussion group dentified the potential content of a common database. The metadata to be obtained before assembling plot data from other databases should include a list of the databases' contents, including information on database owner, region, number of plots, formations and available traits.

The database group discussed which biomes should be represented. There was the unanimous opinion that the optimal data set should cover all continents and biomes, comprise forests and grasslands, include a large variation within biomes.

Plots should meet minimum criteria to be included (see the document produced in this discussion group: Description of data properties.docx). In particular, geographical (GPS) coordinates should be available, with an accuracy of up to 1 km. The species included should comprise all vascular plant species (i.e. not only woody species). The group discussed whether to include plots that don’t have a complete plant census (e.g. tropical tree censuses, or arctic plots that exclude lichens and bryophytes). In general, it was agreed to limit the analyses to vascular plants, as traits are poorly defined on bryophytes and lichens, and the data will often be missing anyway.

Abundance might be measured as cover or abundance of individuals (above a defined dbh threshold). Plot size should be stated (max. 1000 m^2), as well as date/year of the record (allowing to exclude too early records). The group voted for keeping all header data that is available. There might be also vegetation records where a measure of disturbance has been included in the header data.

The group was very aware of data shortcomings such as partial incompleteness and incomplete species determinations.

In general, the information on the formation should be given (forest or grassland). If this information is not included it would have to be derived based on the growth forms of the plants present.

The optimal dataset would include the following:

- Prioritizing: cover all continents and biomes, cover both forest and grassland plots, disturbance gradient, largest possible variation in species composition and environmental factors., (GPS) coordinates, full vascular plant species lists (probably not possible e.g. for tropical forests)
- Minimum requirements: accuracy (ask from providers)up to 1km, coordinates, cover data in transformable scale or percentages (or individuals as in tropical forest plots), plot size (if available), maximum plot size 1000m^2[slicing not excluding], date or year of survey
- no minimum requirement for environmental data

To be able to proceed with acquiring data, the database group worked on a draft of a data sharing agreement, addressing the issues of data ownership and co-authorships. The final product of this discussion is attached to this protocol (sPlot-Rules.doc). The data sharing agreement also profited from the protocols used in the Fluxnet network (Data policy of Lathuile Fluxnet data). The general feeling was that obtaining data from European countries should not be a problem as similar data ownership agreements are already in place for the European Vegetation Archive (EVA). Particular points that were emphasized also in the ensuing general discussion was that no access should be granted to outside of the group. In contrast, inside the group full open access should be provided. Data owners who have contributed to the database will be invited to become co-authors. A system of proposal of research projects will be installed, similar to the TRY mechanism. It should be made clear that proposals must have synthesis character, and thus, have to focus on a global or continental scale), avoiding overlap with individual project aims.

Among many potential database owners to be included, the forest dynamics plot (FDP) network of tropical plots was considered of major importance.

In the plenum, the group also discussed how data contributions of single databases should be handled. One suggestion was to mention the database owners always as a group and list individual names in an electronic appendix (as done in the Fluxnet community: "The Fluxnet group author"). Everybody contributing more than a threshold would be invited to become a co-author. The role of the custodians at iDiv would be overruled by single data owners who contributed substantially to the synthesis project.

For approaching database owners, the group wrote a letter to owners of vegetation plot databases (Letter to contributors.docx). This letter should be sent around with a technical description which type of data would be needed (Description of data properties.docx), the data sharing agreement and property rights argument (sPlot rules on data sharing, sPlot-Rules.doc) and an outline of the planned paper (not yet done).

It should be made clear that the data requested will initially only be used for addressing the initial questions. Data might then be kept for further questions, which then should be decided by the whole consortium. All contributors should all agree on the data use for the initial questions.

The data providers should be asked for the degree of naturalness (natural, semi-natural, anthropogenic), type of vegetation (forest, shrubland, grassland, wetland, desert, sparsely vegetated cold desert and transitions). Examples and definitions should be given. For tropical forest plots, minimal dbh should be provided. Vegetation height, total cover, slope and aspect should be provided.

With respect to the traits it was discussed whether gap filling approaches should be used. It might be interesting to explore the possibility to impute gaps in site x environment matrix. A distinction should be made between trait measurements that were taken from vegetation plots and mean values taken from databases (such as TRY). The attempt should be made to keep trait means separately if they come from the plot or if they came from “somewhere”. However, in general, the group was not against using mean trait values from databases.

The group also discussed the way the different taxonomic concepts in the databases might be handled. A concept-based nomenclature was shortly discussed but dismissed as being unfeasible at this stage. Instead, the most practical way would be to produce a list of matched species. As a basis "The plant list" might be used.

Another issue in data assembly would be how to combine header data of different structure and how to - transform cover classes into percentages.

A key feature a common database should have is the reproducibility of data assimilation. This means that workflows are programmed in a way that new data (after contributing databases have been updated) can be assembled automatically.

Vegetation plot/trait database at the regional scale

On the second day of group discussion, the database discussion group split into one exploring the possibilities and requirements of a common global dataset, while another group discussed the possibilities to compile more detailed regional datasets on a global scale.

Such regional studies might comprise gradients from low to high disturbance, from low to high degree of complexity, from low to high intensity of land use as well as from early to late successional stages. After reviewing available data of which the participants knew of (in particular Michael Kleyer, see Table 3), it became clear that such regional studies would not be available in all biomes. However, the group decided with such a combined dataset, this would not be an obstacle. Then, successional series appeared to be the most frequently analysed environmental gradient (Table 3).

Table 3. Overview over regional studies (compiled by Michael Kleyer and Helge Bruelheide). Red names are datasets for which we have incomplete information.

No.	Dataowner	VegpoltDB	Driving factors	Land use intensity	Climate	Succession	Ferti-liza-tion	Availa-bility	#plots	Region	Continent	Biome	Biome
1	Hans Cornelissen?	bogs, Tundra,	Climate, groundwater					?	?	Abisko	Alaska	Artic	
2	Ove Eriksson, Sarah Cousins	meadows, forests		1	0	0	0	Vista	14	Stockholm	Europe	Boreal / Temperate	bor
3	NINA , Gabriela	pastures,	land use	1	0	0	0	Vista	30	Norway	Europe	Boreal	bor
4	Pakeman	fields,	land use	1	0	0	0	Vista	20	Hebrides	Europe	Temperate	tem
5	Kleyer	fields, pastures, meadows,	land use, disturbance, nutrients	1	0	0	0	Sequester	50	N-Germany	Europe	Temperate	tem
6	?? Markus Fischer	pastures, meadows,	land use intensity	1	0	0	0	Exploratories	150	Germany	Europe	Temperate	tem
7	Peter Poschlod, Chr. Römerman	pastures, meadows, abandonded pastures	succession, mowing intensity, grazing, mulching, burning	1	0	1	0	?	?	S-Germany	Europe	Temperate	tem
8	Jan Leps	meadows	?	0	0	0	1	Vista		Czech Republic	Europe	Temperate	
9	S Lavorel	pastures, meadows,	succession	1	0	0	0	Vista	50?	Alpine France	Europe	Temperate	tem
10	Garnier	pastures,	succession	0	0	1	0	Vista	30	S-France	Europe	Med	st
11	Grünzweig	pastures, meadows, dwarf	land use, disturbance, nutrients	1	0	0	0	Sequester	50	Israel	Near-East	Med	sub
12	S Diaz	pastures,	succession	0	0	1	0	?	?	Argentina	S-America	?	sub
13	V. Pillar	grassland	fertilization, grazing intensity	1	0	0	1	?	?	Brazil	S-America	Med/Sub-tropical	sub
13	V. Pillar	Forest	succession	0	0	1	0	?	?	Brazil	S-America	Med/Sub-tropical	sub
14	Bruelheide	?	secondary forest succession, diversity	0	0	1	0	BEF China	?	China	Asia	Sub-tropical	sub
15	Kleyer / Hemp	Fields,	land use, climate	1	0	0	0	KiLI	20	Tansania	Africa	Tropical	tro
16	Violle?	?						?	?	Amazonia	S-America	Tropical	tro
17	Bendix	Rainforest	disturbed - intact	1	0	0	0	?	?	Ecuador	S-America	Tropical	tro
18	Mason	Temperate rainforest	secondary forest succession	0	0	1	0			New Zealand	New Zealand	Sub-tropical	sub
19	Schmidt	Succession e	Succession, mowing intensity, fertilization	1	0	1	1			Germany	Europe		tem
20	Saatkamp, Arne (Marseille)	Crau	grazing intensity	1	0	0	0			France	Europe		sub
21	Wesche	Mongolia	grazing exclosure, fertilzation	1	0	0	1						tem
22	Bernhardt-Römermann, Markus	Bavaria	fertilization in forests	0	0	0	1			Germany	Europe		tem
23	Minden	North Sea	Succession in salt marshes	0	0	1	0			Germany	Europe		tem
24	Leuschner	Sulawesi	Forest edge-centre	1	0	0	0			Indonesia	Asia		tro
25	Wesuls, Dirk	Biota S-Afric	Land use	1	0	0	0						
	Klotz	UFZ	Old field succession, grassland succession	0	0	1	1		5 x 5 sub	Halle, Bayreuth	Europe	Temperate	tem

To proceed with a combined regional dataset it was discussed whether we should only ask for a subset of the available data (e.g. n=10 plots). However, with a reliable data sharing policy in place, many database owners might also bring in all their data.

Important environmental variables that would have to be included would also include soil depth, as this would be a good proxy for plant available water, in combination with precipitation and potential evapotranspiration, as derived from global climate data. Similarly, frost periods should be known to be able to calculate the length of the growing season. Nutrient availability might be estimated from measurements of K, P, C/N, pH and $CaCO_3$ concentrations. Disturbance might be estimated from the biomass removed at a single disturbance event and frequency of that event.

3rd group: Data analysis approaches (Christine Römermann, Oliver Purschke, Jan Leps, Miguel D. Mahecha, Franzika Schrodt, Ingolf Kühn, Nathan Swenson, Marten Winter)

The data analysis group addressed the following questions: Which remote sensing information is available? If appropriate data are available, how to do resampling to obtain balanced datasets? How to include trait interactions? Concentrate on few traits or try to be more comprehensive in trait coverage?

The data analysis group discussed linear vs. non-linear models. The group discussed whether to use means (unweighted across resident species) vs. community weighted means (CWM) vs. functional diversity (FD), based on single or multiple traits.

The synthesis group found it also interesting to derive diversity patterns from the plot information. Questions asked might be how α-diversity scales with γ-diversity, which would be derived from the sum of species occurring in all plots of a certain region. This would require to aggregate plot data on a level of geographic grid cells. If such a aggregation is done, CWM trait values could be compared within the same cell (which would allow for variance partitioning). In addition, γ-diversity derived from plots could be compared with complete species lists from the same region.

The great potential of including remote sensing data were discussed, and the possibilities explored. Even by now there are data available on grazing intensity in grasslands (FAO, gridded data). The group identified a great potential on assessing interannual variability from remote sensing as a driver of FD. A basis might be the variability in the fraction of acquired photosynthetically active radiation (fAPAR, Fig. 3).

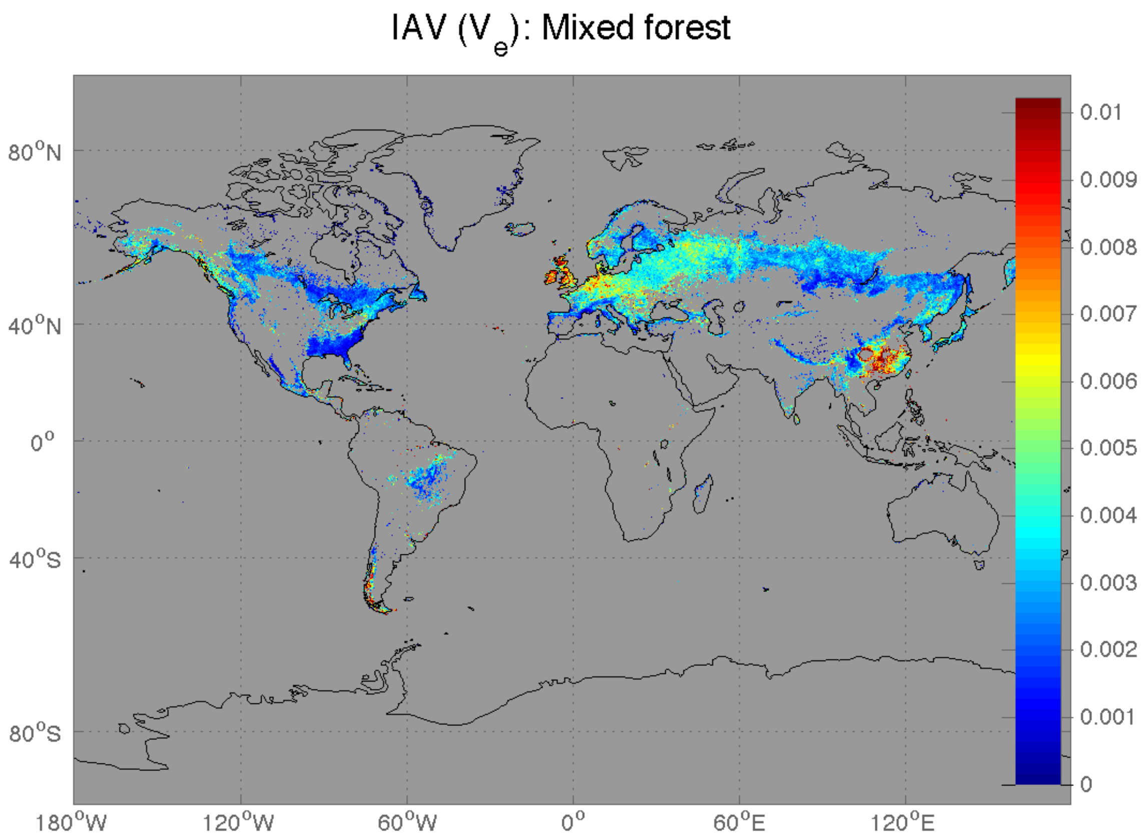

Fig. 3. Interannual variability (IAV) in the fraction of acquired photosyntheticallyactive radiation (FAPAR) for mixed forests, provided by Migual Mahecha. Resolution is 0.25° , as obtained from MODIS. This type of data is available for other vegetation types as well.

In addition to interannual variability in fAPAR, global extremes in gross primary production (GPP) derived based on anomalies in fAPAR over 30 years might be used (Zscheidler et al. 2013).

Because plant communities can represent several life forms, it was further discussed that we may consider analyzing plant trait-environmental relationships within life forms (McIntyre et al. 1999).

The synthesis group discussed the possibilities to compare trade-offs at the species level (e.g. SLA - C/N) with putative trade-offs at the community level. However, it was felt that at the community level trade-offs cannot be detected but only community strategies.

As a main tool to analyse trait-environment relationships the group recommended path analysis (by structural equation modelling, SEMs).

The synthesis group also touched the the potential of machine learning approaches. Franziska Schrodt suggested to use the recently developed approach of graph valued regression (Liu et al. 2010), a method based on classification and regression trees (CART) where at each node of the tree a covariance graph is produced (Fig. 4). This method might be used to analyse trait-interrelationships. Geographical coordinates would enter the model as a two-dimensional covariate. The result might also deliver a new type of global plant functional groups.

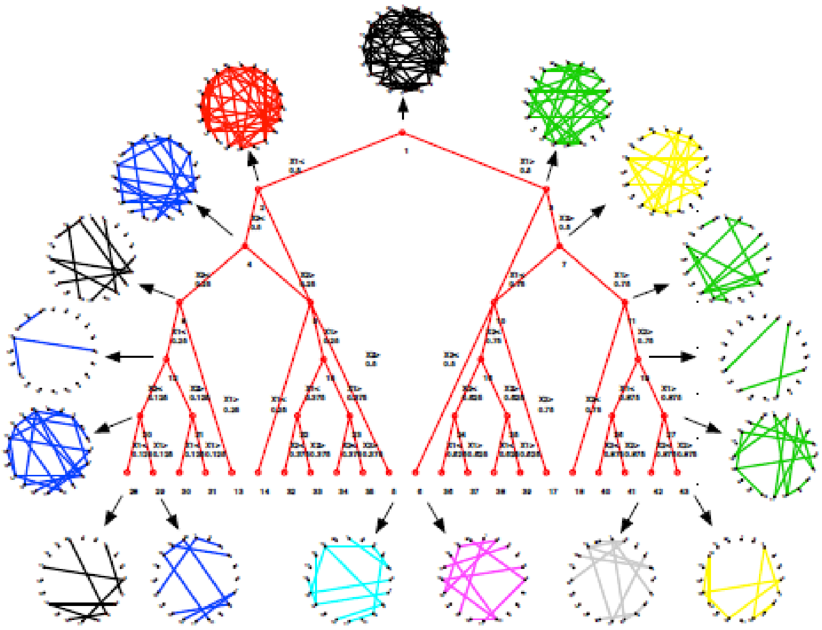

Fig. 4. Dyadic tree based on “Graph-optimized CART” (Go-CART). The algorithm proceeds as in CARTs (classification and regression trees), but at each leaf of the tree a graph is estimated. For the graph test data from meteorological stations were used, with 15 meteorological factors measured for each month, including levels of CO2, CH4, H2, CO, average temperature (TMP) and diurnal temperature range (DTR), minimum temperate (TMN), maximum temperature (TMX), precipitateon (PRE), vapor (VAP),cloud cover (CLD), wet days (WET), frost days (FRS), global solar radiation (GLO), and direct solar radiation (DIR). Arrows between factors show relationships between factors. From Fig. 1a from Liu et al. (2010).

Resampling was discussed, and the group agreed that stratified resampling (as done already in the groups of Milan Chytry and Helge Bruelheide) would be the most appropriate strategy.

CWM were considered appropriate to analyze ecological relationships at the community level. According to the resource ratio hypothesis, the trait values of the dominant species in the community should be weighted by the species' abundance also reflect ecological relationships between communities.

Important plenary decisions

1. The sDiv working group "Plant trait-environment relationships across the world’s biomes" will now call itself "sPlot".

2. Following a suggestion of the database discussion group, the workshop members agreed on establishing a steering committee. The task of the steering committee is to coordinate the progress of the workshop and the establishment of the common global database. As members were suggested: Helge Bruelheide, Valerio Pillar, Jens Kattge, Brody Sandel and Milan Chytry. They were elected unanimously by the members of this working group.

3. The group also agreed on potential papers:

1st paper: This should include all data contributors and be solely descriptive as the first TRY paper, Kattge et al. 2011). It was decided that Jens Kattge and Jürgen Dengler should take the lead here.

2nd paper: The objective is to bridge four different scales of climate variability, the short-term variation in climate (intra-annual), the inter-annual variation, the scale of decades (describing the return intervals of extremes) and the long-term perspective (inter-glacial periods). For those scales, different hypotheses might be asked (Fig. 5). Theories to be touched would include energy dynamics, tolerance, richness-area, age-stability, metabolic theory, niche evolution, storage effect, intermediate disturbance hypothesis, environmental heterogeneity. A central question might be how trait variation (FD) scales with CWM and how does this depend on climate drivers. The analyses should be done trait by trait (not merging different traits in FD) and separately by vegetation types (forests and grasslands). It was decided that Oliver Purschke should take the lead here.

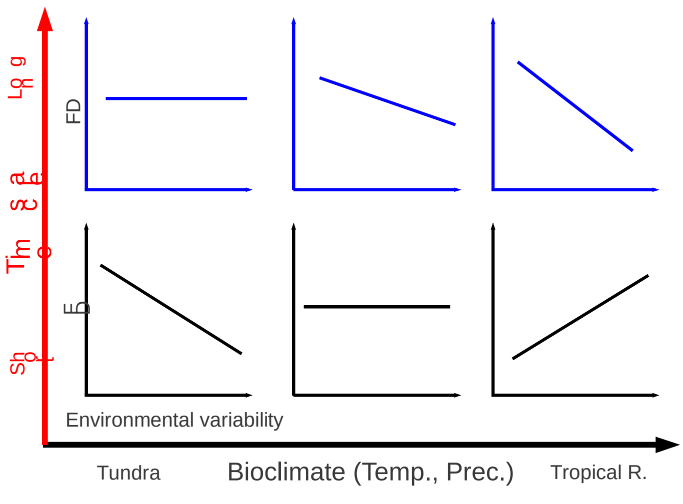

Fig. 5. Hypothesized relationship between functional diversity (or trait variability, FD) and variability in environmental conditions (e.g. fAPAR, see Fig. 3) across time scales and (y-axis) and bioclimatic zones (x-axis). For instance, at short time scales, e.g. intra-annual (lower panel (in black)), functional diversity is expected to decrease with increasing environmental variability, but only within the Tundra zone, while within the tropical rain forest region, FD is predicted to increase with increasing environmental variability. In contrast, at long time scales, e.g. inter-glacial periods, the relationship between FD and environmental variability is expected to become increasingly negative from the Tundra towards the Tropical Rain forest biome.

3rd paper. A paper on the regional data sets (no detailed description yet, however, Michael Kleyer should take the lead).

Additional paper ideas should be formulated and sent to the steering committee.

4. The next sPlot workshop will be in March 2014. Until then, iDiv should be asked to provide part of a post-doc position to work on the common database, prepare the next workshop and write a sDiv workshop proposal for this workshop. In the next workshop, the newly appointed iDiv professorships should be involved, in particular those on synthesis and theory. In addition, the yDiv PhD students working in this field should be asked to join.

Remaining tasks

- write the protocol (done, Helge Bruelheide and Oliver Purschke)

- set up a drop box for document exchange (done, Oliver Purschke). This drop box should also be used to exchange pdfs of own papers relevant to the field.

- devise by-laws for the steering committee (how to be elected, who can change the rules etc.) (-> the steering committee)

- circulate, discuss and finalize the data sharing agreement. The data sharing agreement has to be adapted to the regional datasets.

- hire a part-time post-doc.

- establish a test data set with selected data from plot and trait databases, calculate overlap with traits. This test data set could be used to test for relationships in the first graph.

- set up a common plant species list for all databases to be included.

- discuss with the Biodiversity Informatics Unit (BIU) of iDiv, how to get support for establishing the database. It might be possible to ask Bexis for help to establish a system of name matching. In addition, the help of a programmer would be appreciated to set up the database.

- for the regional data set, the list of potential contributors should be completed.

- set up a web service for data download. The web site should also handle access rights.

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