

From parameters to traits

Or

Why should ORCHIDEE
care about functional
ecology ?

Which parameters can be found In ORCHIDEE ?

Whole model

Numerical parameters
Physical constants

Ex : Discretization layers

Vegetation form (grass, tree)

Empirical parameters
Ex :

PFT /Species

Trait-based
wood density,
SLA,
LeafN

Empirical
Hydrol_humcste
(root profile)

Stress (0-1)

What is wrong with the current parameterization & How can we improve model parameterization ?

In ORCHIDEE

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Numerical parameters
Physical constants

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In functional ecology

One group of parameters where we can make progress :
The case of **Functional Traits**

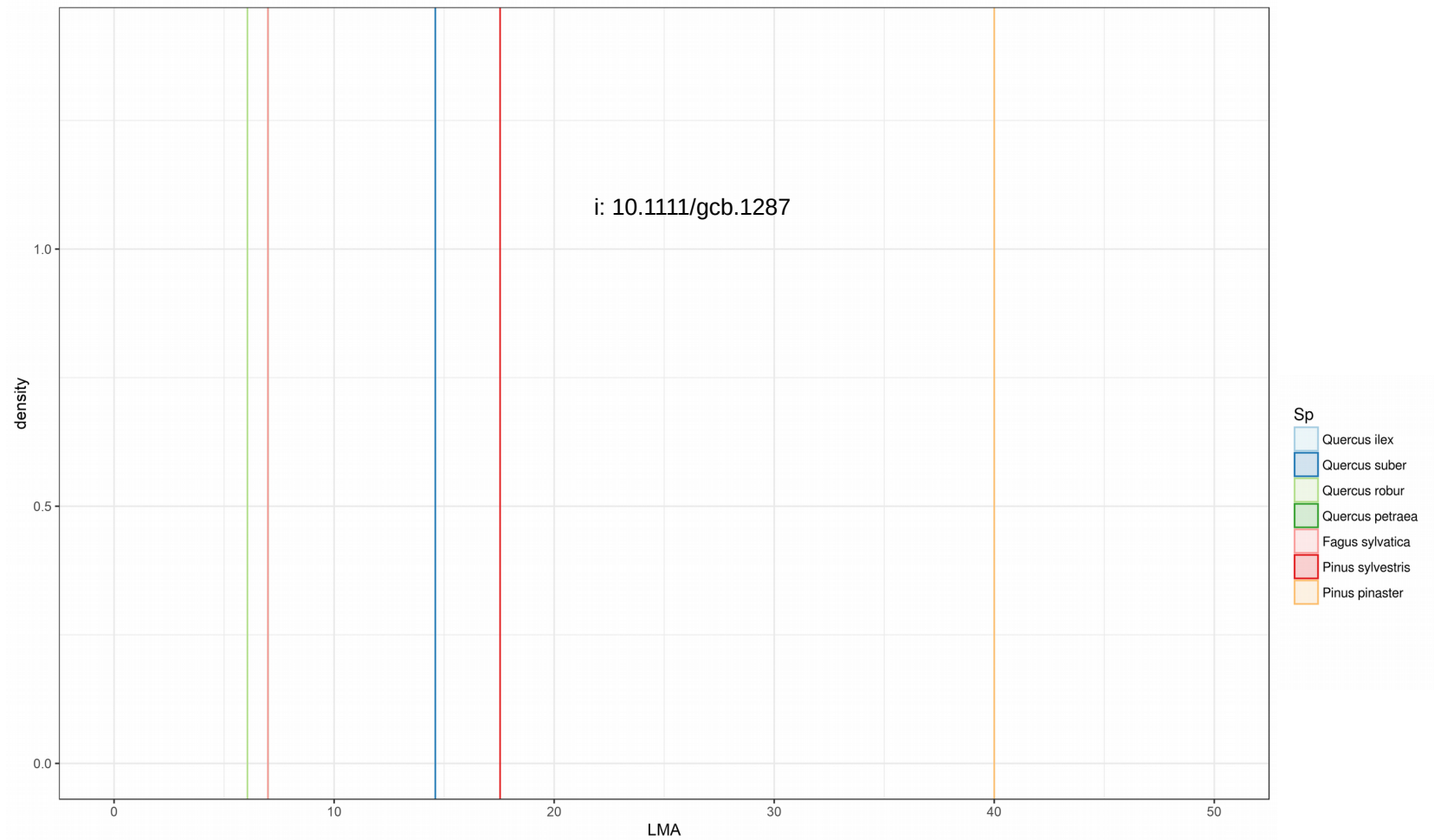
Traits

Ex : wood density,
SLA,
LeafN

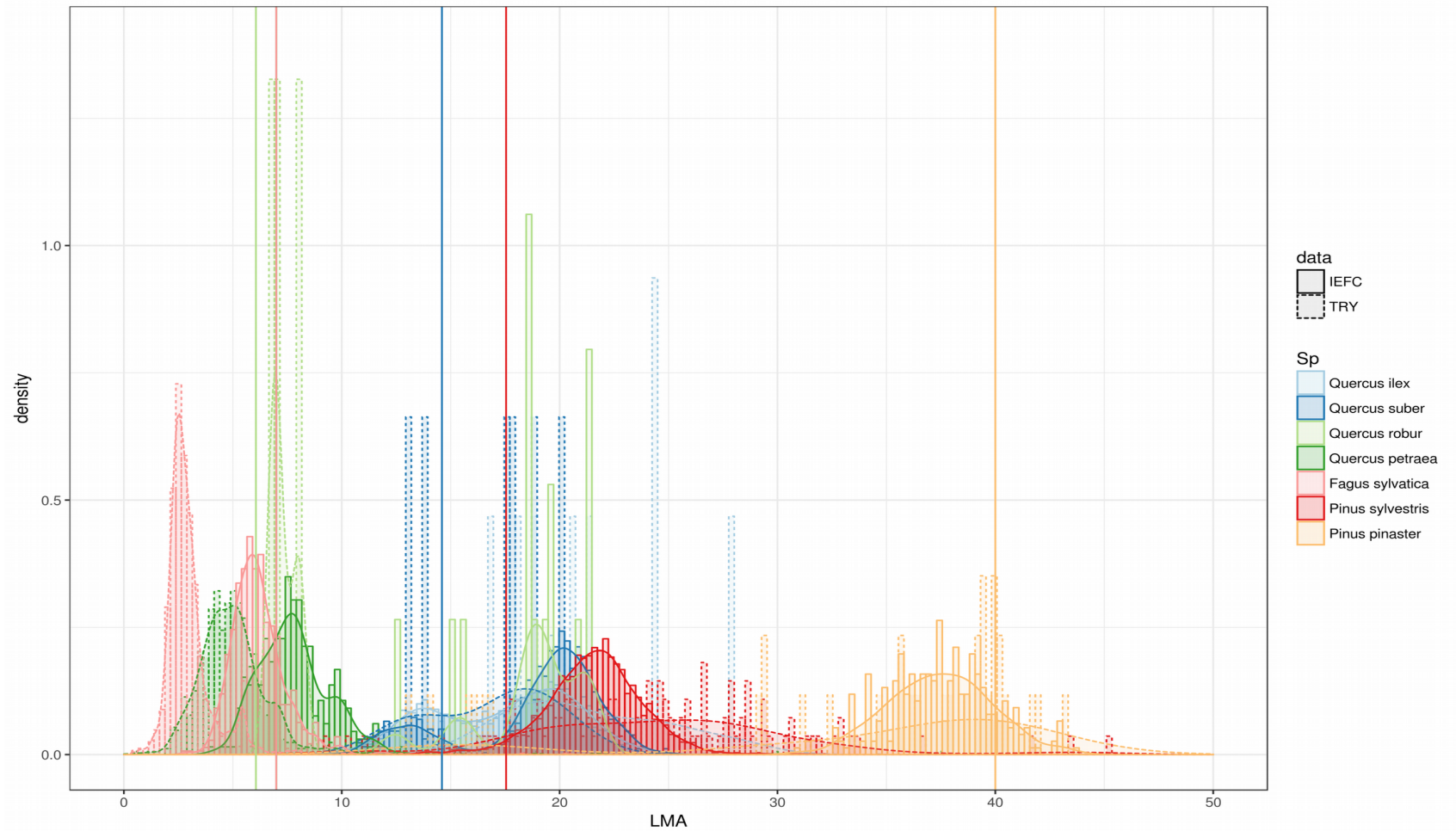
Root architecture
SRL (specific root length)
Stomatal closure
Loss of conductivity

....

In ORCHIDEE



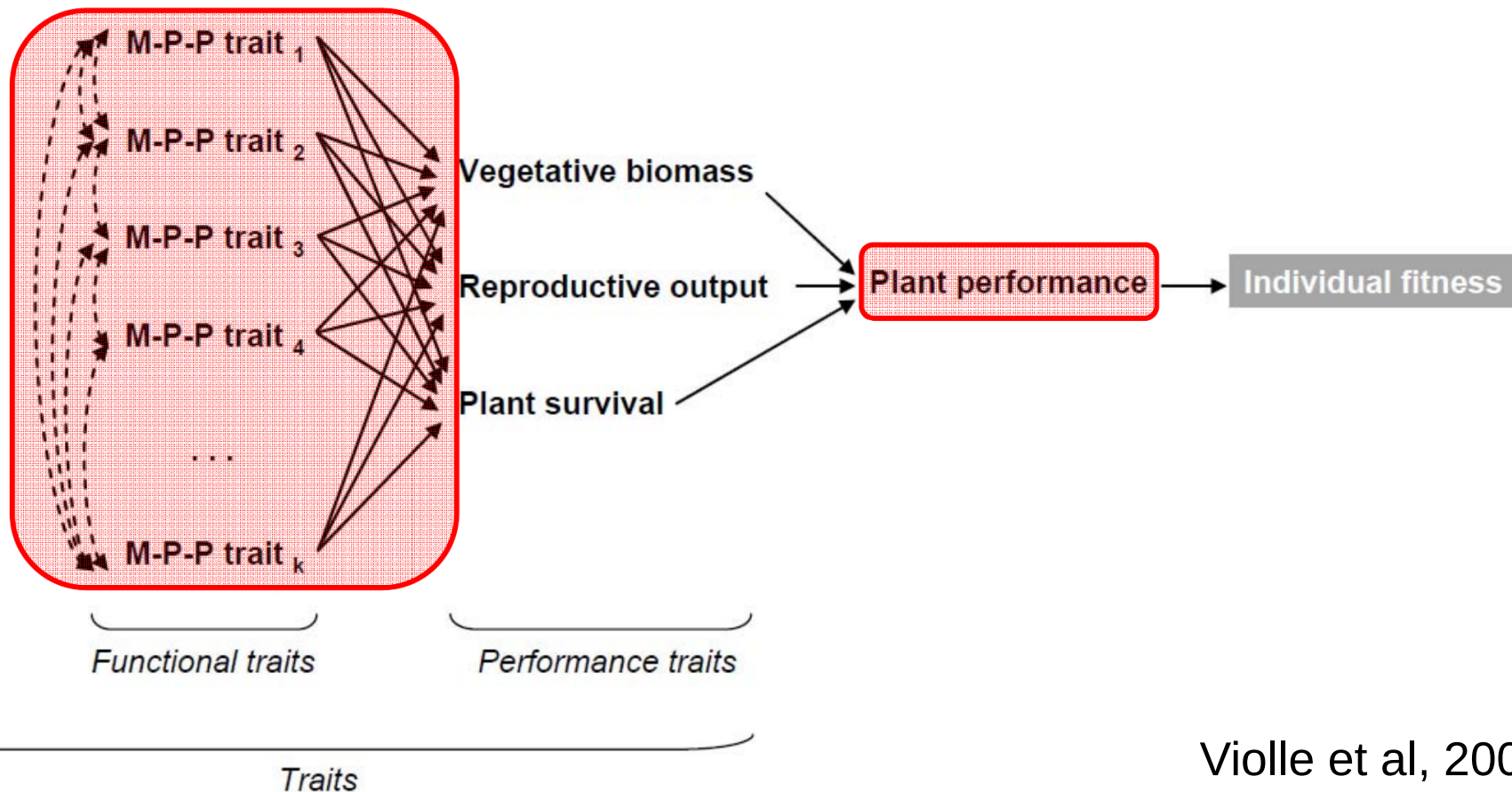
In functional ecology



What is a functional trait ?

Any morphological, physiological or phenological feature **measurable at the individual level**, from the cell to the whole-organism level, without reference to the environment or any other level of organization.

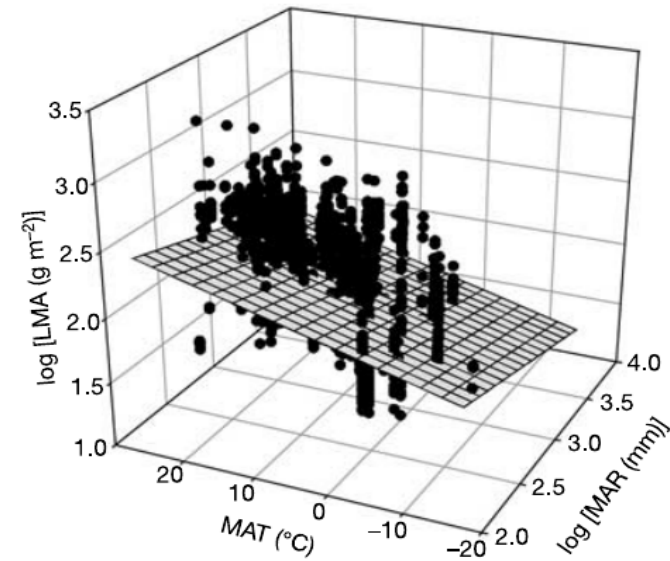
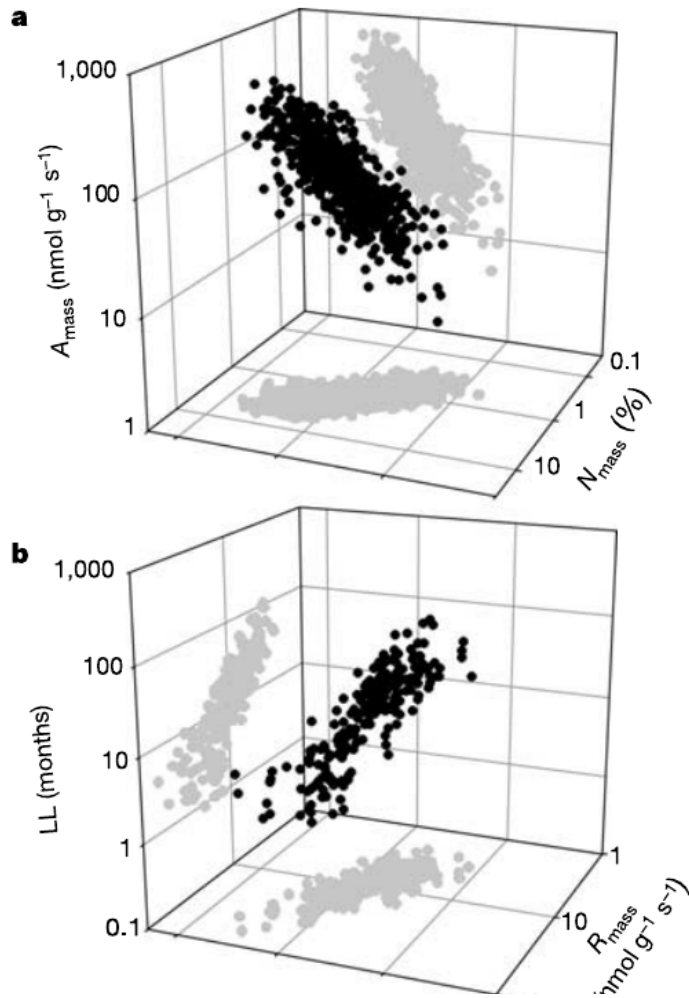
It is **functional** if it affects **fitness** indirectly via its effects on growth, reproduction and survival.



What do we know about traits ?

Trade-offs and environmental control

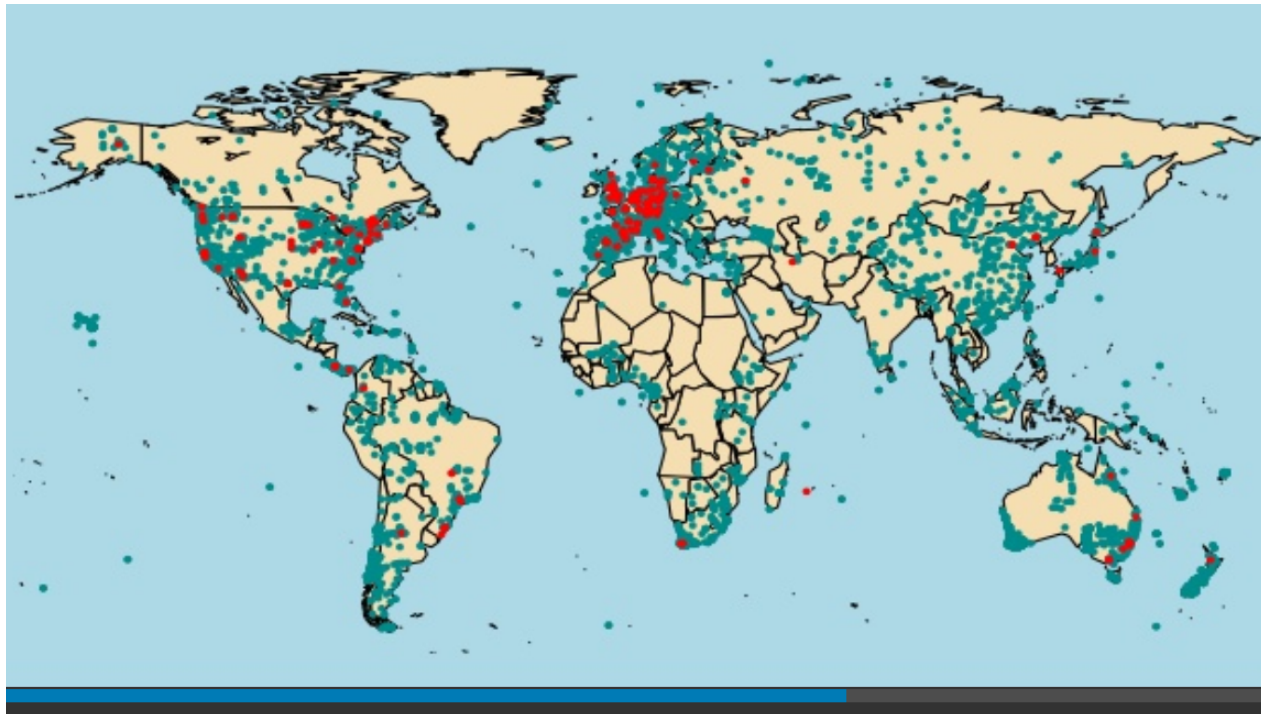
Example of the leaf economic spectrum



Why ignoring trait variability is a problem ?

- Including acclimation and adaptation processes
- Dynamic vegetation : Accounting for non-random species turnover
- Quantifying vegetation-environment feedbacks
- Quantifying impacts of biodiversity on ecosystem functioning and climate

We now have access to a huge database of worldwide observations
The TRY database



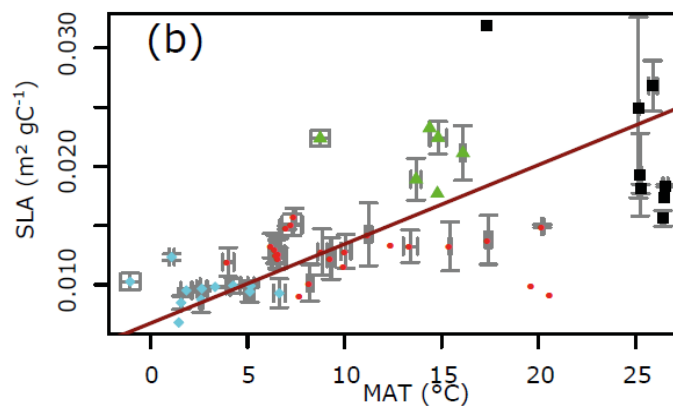
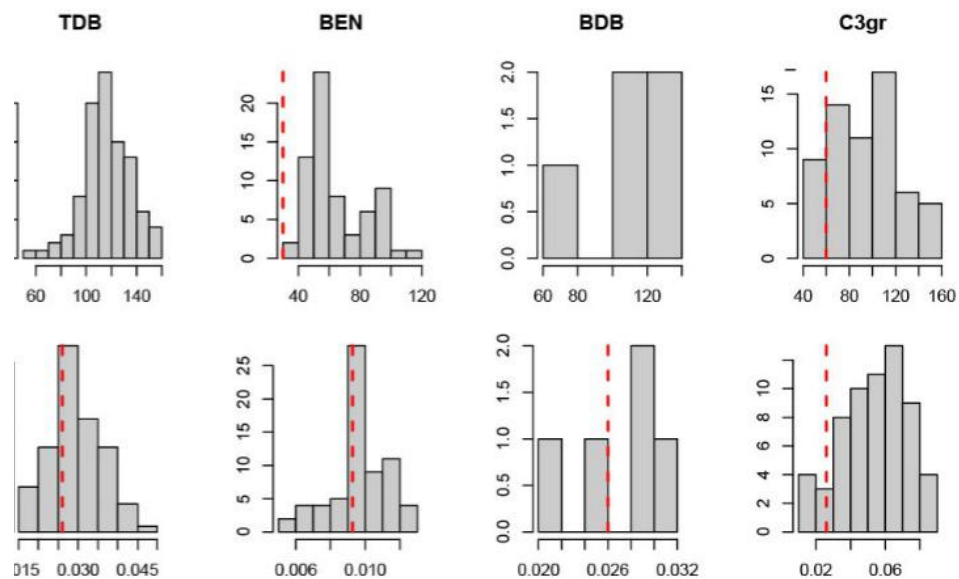
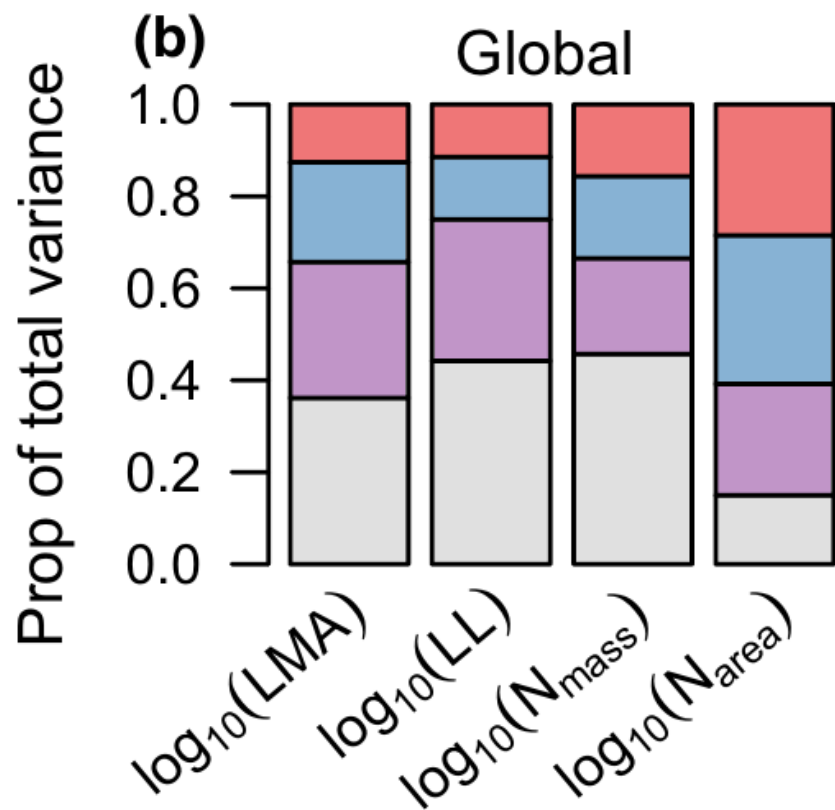
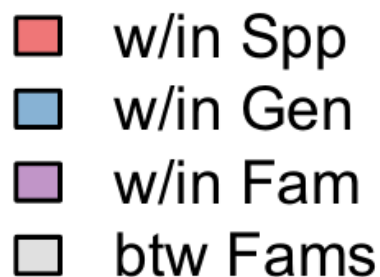
Why using trait data in ORCHIDEE ?

1) Better calibration of existing trait-related parameters

	A	B	C	D	E	F	G	H	BL	BM	BN
						PFT2					
	Trait Name	Trait ID	Units	2.5%	50%	97.5%	nbdata	value type	NB TOT	checked	?
3	Plant growth form	42		qual	qual	qual	9340	orig	73524	FALSE	
4	Photosynthetic pathway	22		qual	qual	qual	245	orig	17363	FALSE	
5	Leaf nitrogen (N) content per leaf dry mass	14	mg/g	9,00175	19,89018	36,3	7448	std	32496	FALSE	
6	Leaf area per leaf dry mass (specific leaf area, SLA)	11	mm ² mg ⁻¹	5,4	11,9050563205	29,4006393082	13293	std	65422	FALSE	
7	Plant height	18	m	6	20	38,6962136318	10712	std	84334	FALSE	
8	Leaf area	1	mm ²	201,8805	6134,95	65047,575	10558	std	49467	FALSE	
9	Plant nitrogen fixation capacity	8		0	0	7	3317	orig	13015	FALSE	
10	Leaf nitrogen (N) isotope signature (delta 15N)	78	per mill	-2,35	3,341120283	8,59	5120	std	10380	FALSE	
11	Leaf dry mass per leaf fresh mass (Leaf dry matter content, LDMC)	47	g/g	0,1883146631	0,3707360862	0,5177088213	5423	std	47088	FALSE	
12	Plant lifespan (longevity)	59	year						23097	FALSE	
13	Plant mycorrhizal type	7		qual	qual	qual	2023	orig	12396	FALSE	
14	Leaf dry mass	55	mg	84	487	5245,0083933195	17701	std	49918	FALSE	
15	Leaf carbon (C) content per leaf dry mass	13	mg/g	362,53290805	488,9019095	541,678963625	4012	std	14797	FALSE	
16	Plant tolerance to frost	31							6197	FALSE	
17	Leaf thickness	46	mm	0,13	0,2253	0,43515	17435	std	24185	FALSE	
18	Leaf photosynthesis rate per leaf area	53	micro mol m ⁻²	2,019	6,9	16,3194720497	619	std	5730	FALSE	
19	Leaf nitrogen (N) content per leaf area	50	g m ⁻²	0,9053860246	1,93	3,3841772236	4215	std	13029	FALSE	
20	Leaf phosphorus (P) content per leaf dry mass	15	mg/g	0,33097	0,7377532943	2,0158073673	2830	std	14161	FALSE	
21	Plant reproductive phenology timing	335							16700	FALSE	
22	Leaf density	48	g cm ⁻³	0,1658113374	0,3369820224	0,565279648	4129	std	7964	FALSE	
23	Leaf carbon/nitrogen (C/N) ratio	146	g/g	12,4536707624	21,7233009709	39,5282814348	536	std	5525	FALSE	
24	Plant tolerance to drought	30							1679	FALSE	
25	Leaf distribution along the shoot axis (arrangement type)	16							14924	FALSE	
26	Leaf carbon (C) isotope signature (delta 13C)	89	per mill	-35,19	-32,04664227	-27,9102969392	3135	orig	4471	FALSE	
27	Plant tolerance to fire	318							3581	FALSE	
28	Plant life form (Raunkiaer life form)	343		1	3	4	104	orig	18758	FALSE	

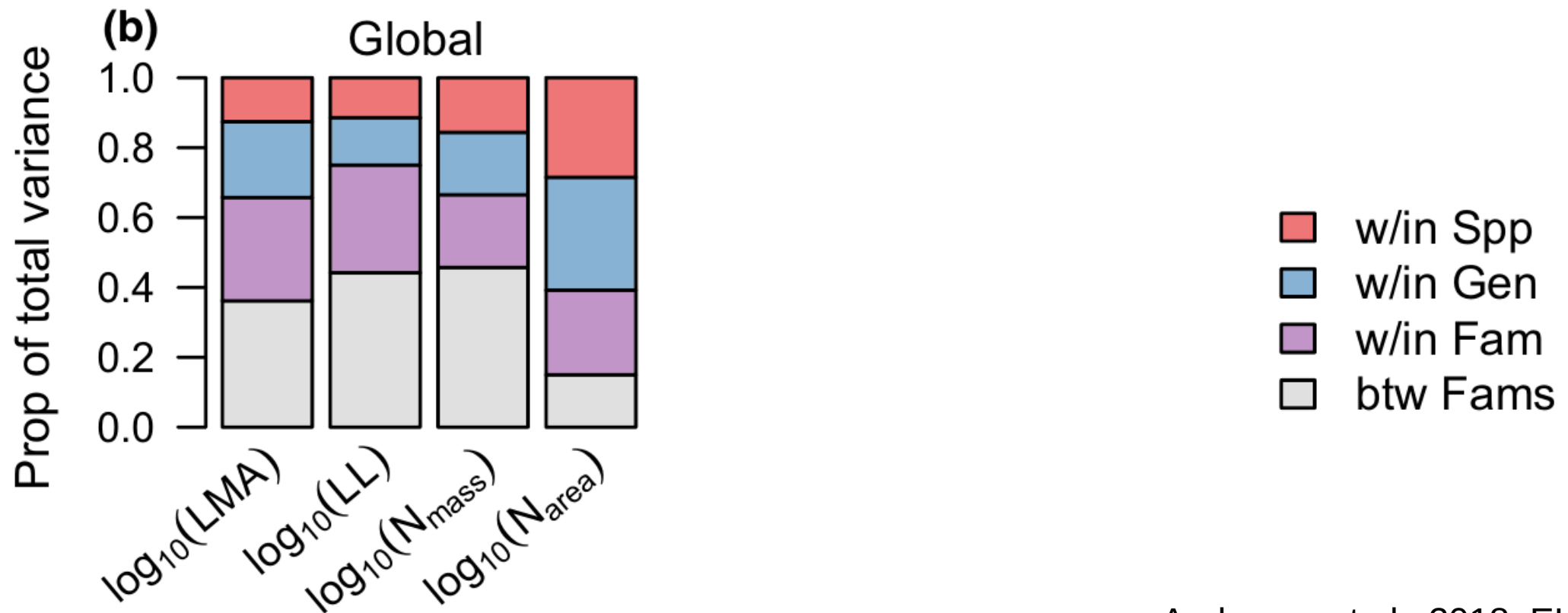
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- 1) Better calibration of existing trait-related parameters
- 2) Improving parameter optimization and reduce equifinality risks : additional constraints (trade-offs), range and direction of variation



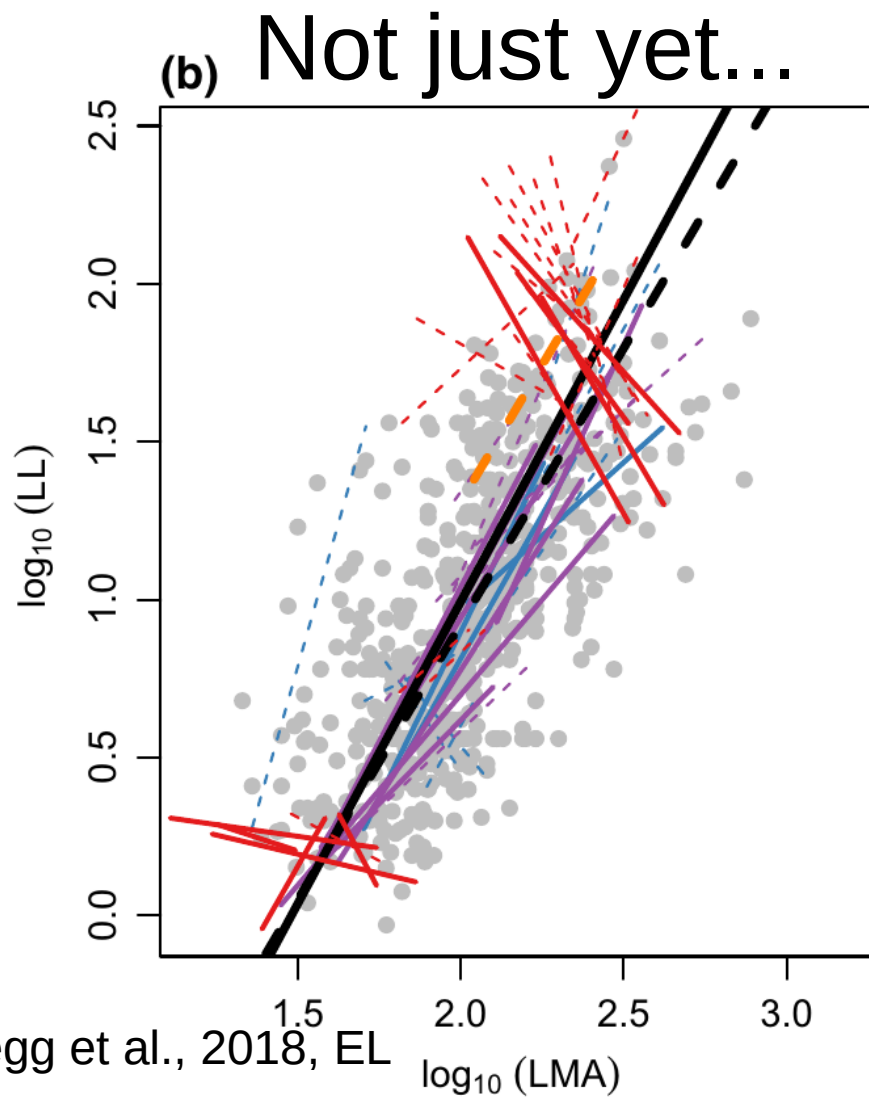
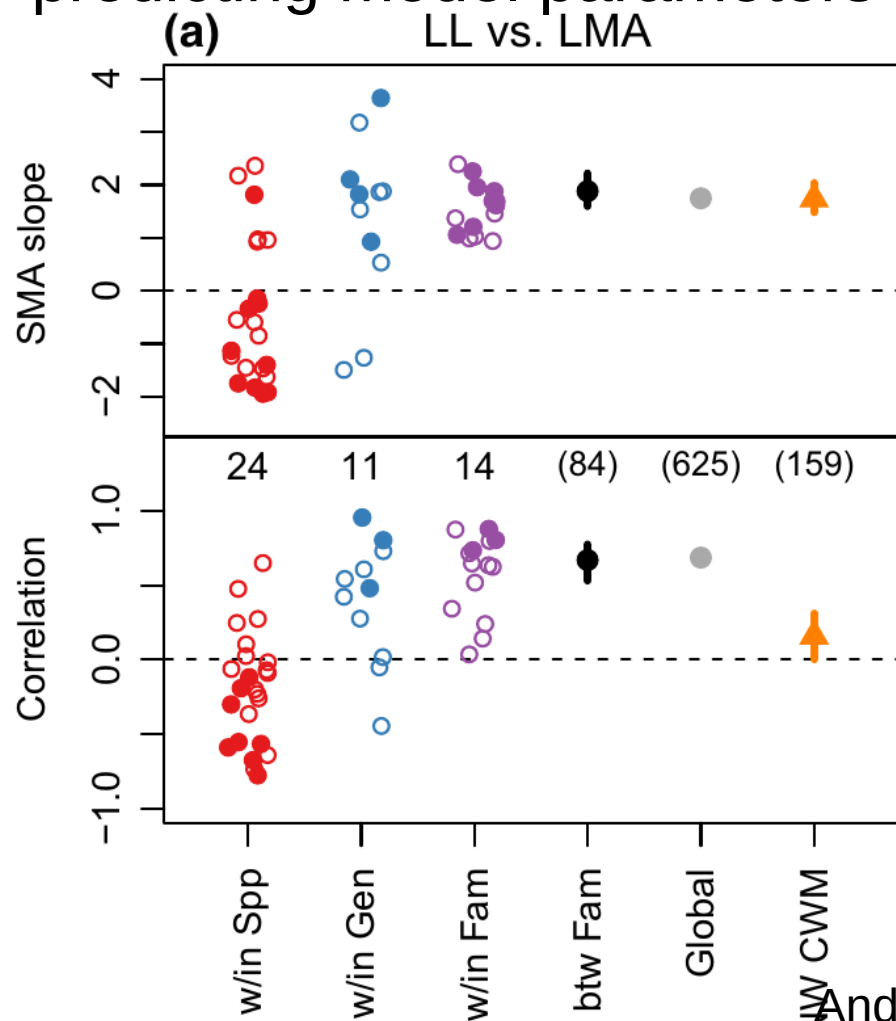
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- => predicting model parameters ?



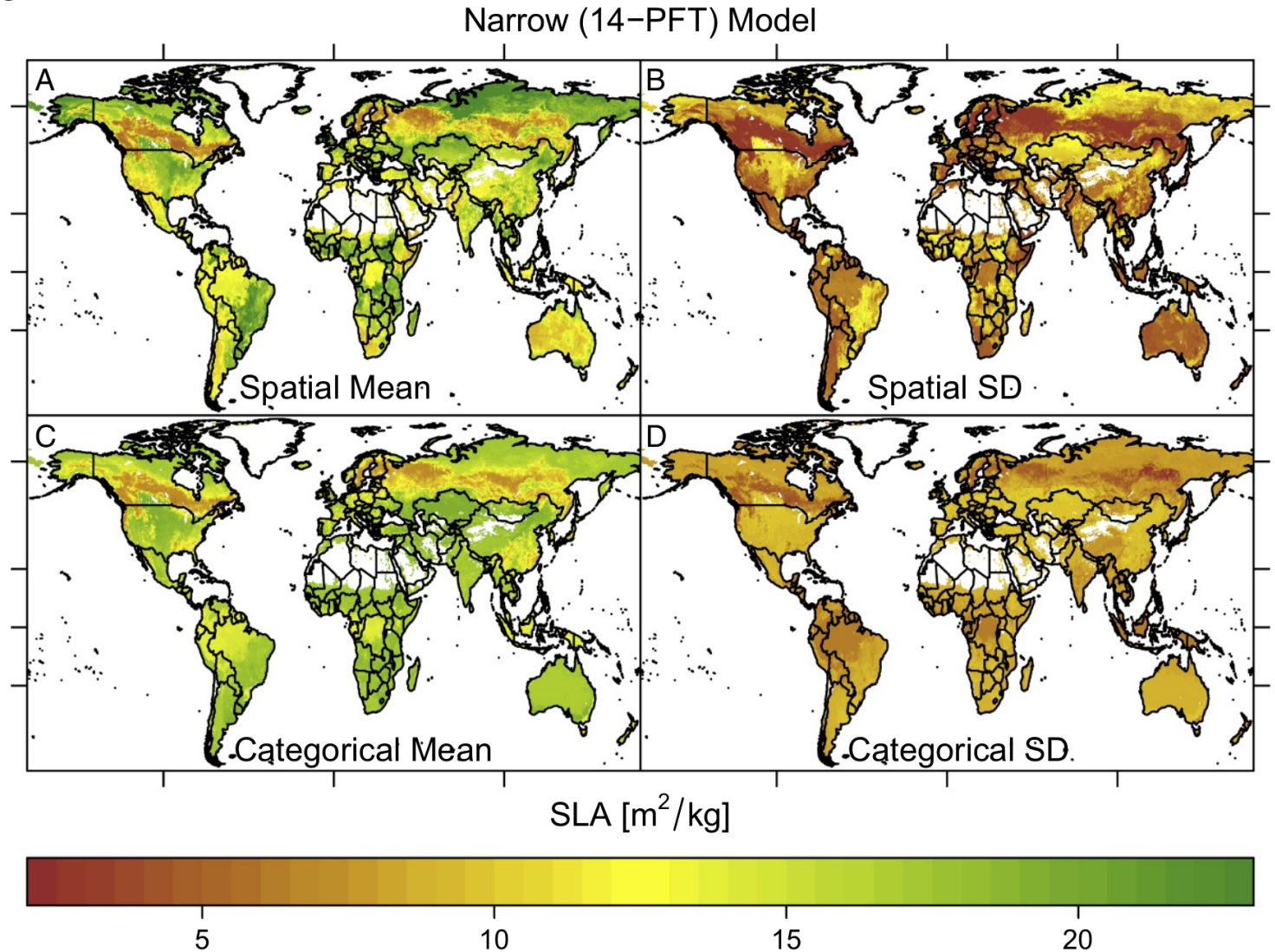
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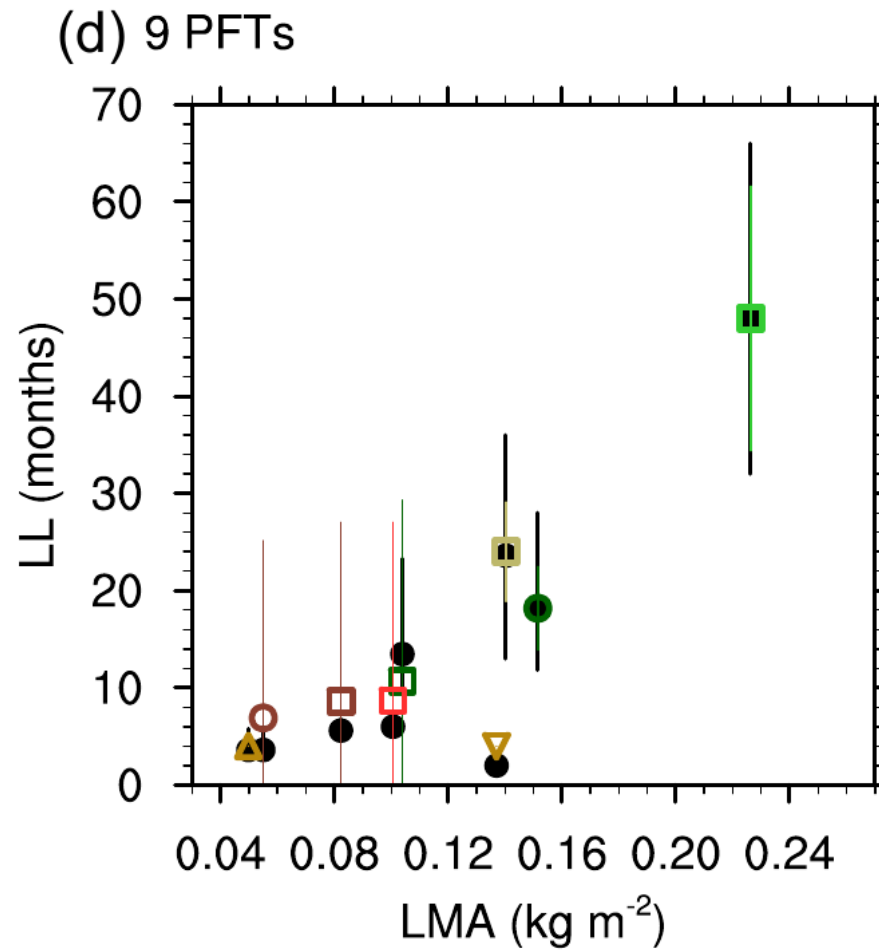
How to add trait variability in ORCHIDEE?

Offline, only spatial variability with maps of traits



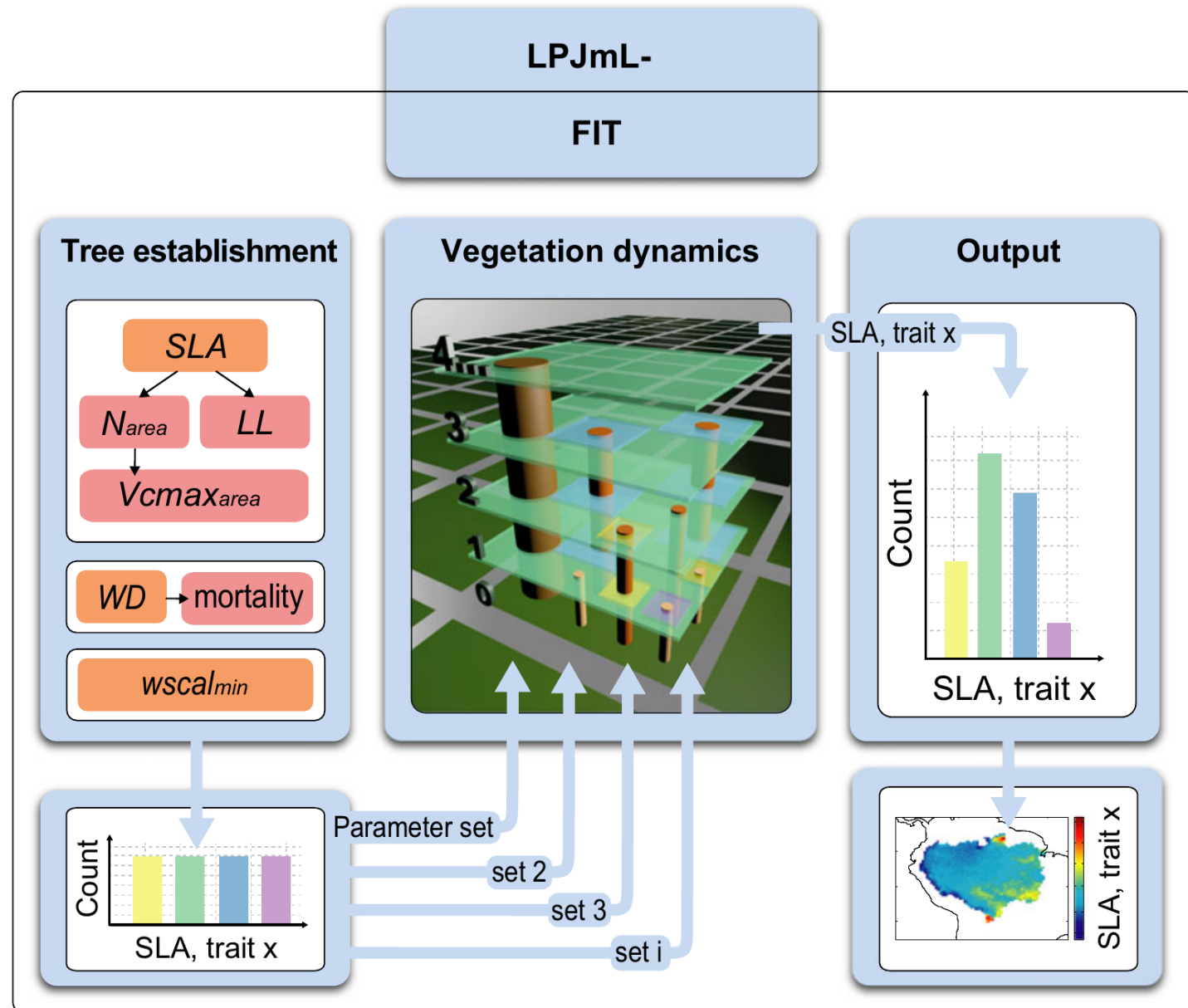
How to add trait variability in ORCHIDEE?

JULES : Simple traits
trade-offs



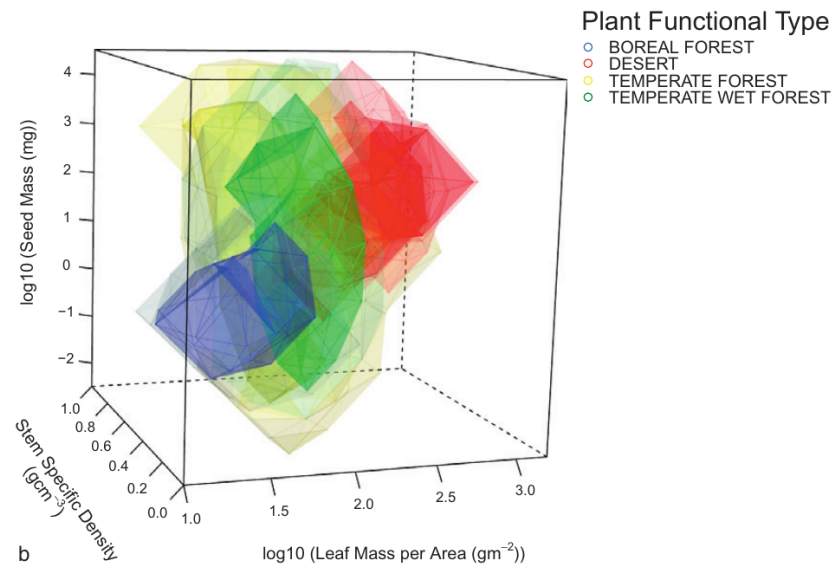
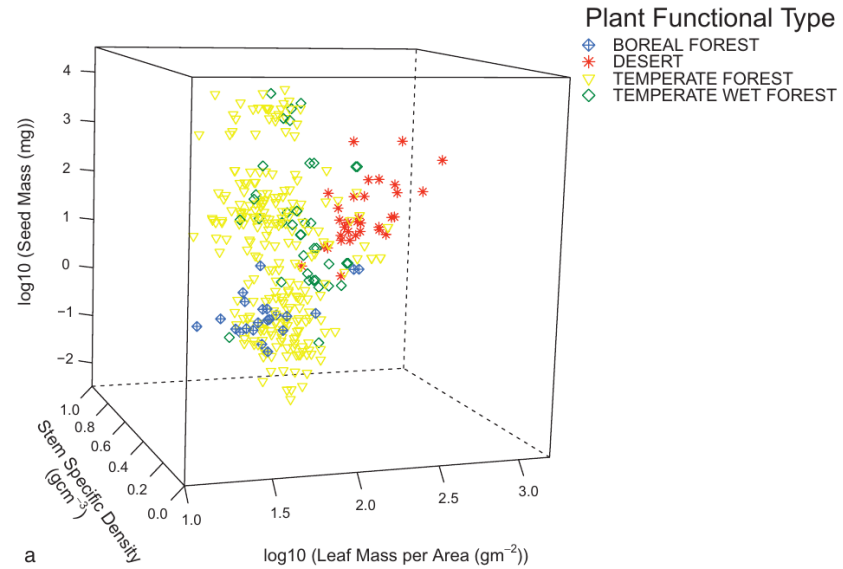
How to add trait variability in ORCHIDEE?

LPJmL-FIT: individuals with sets of traits, (also aDGVM2, JEDi...)



How to add trait variability in ORCHIDEE?

Fully traits-based
approach for vegetation
distribution
(Van Bodegom et al
2011)



Challenges and opportunities for a trait approach in LSMs & in ORCHIDEE (depend on level of trait integration)

- Avoid model-specific parameters as possible, promote the use of trait-based parameters.
- Better calibration (existing databases, known ecological properties, trade-offs)
- Perform systematic sensitivity/uncertainty analysis to spot « problematic » parameters ?
- Assimilating spatial maps of parameters
- Can we replace model-specific parameters with now well measured traits (Root profile for example)? How ?
- Simulating with distributions of parameters?