Tree-related Microhabitat (TreM) spatial patterns in European beech-dominated forests

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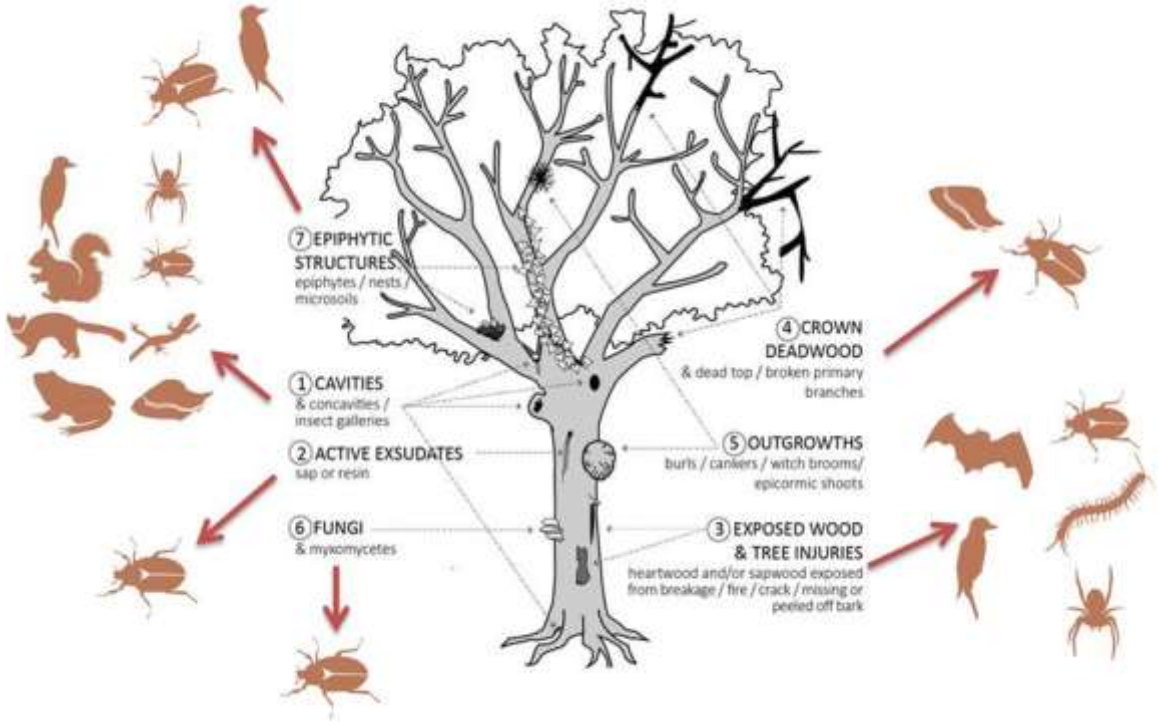
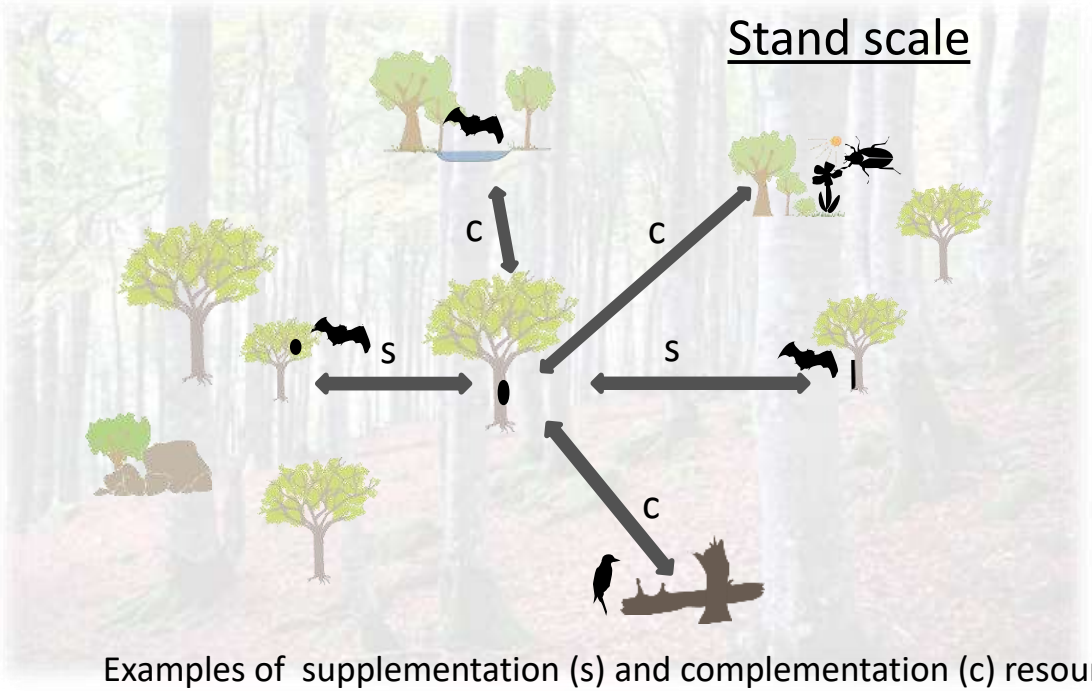
A TreM is a specific above-ground tree morphological singularity

- **distinct, well delineated structure**
- **borne by standing living or dead trees**
- **essential substrate or life-site for taxa**
- **encompassing decaying wood (=saproxylic TreM) or not (=epixylic TreM)**

Drawings L. Apfelbacher

TReMs are key features for many taxa and participate in a complex functional habitat network in species life cycles





Examples of supplementation (s) and complementation (c) resources

- By harvesting TreM-bearing trees, **management impacts both TreM density and diversity** (e.g. Larrieu & Cabanettes 2012)
- We observe **poorer communities of TreM-dwelling taxa in managed stands** (e.g. Bouget et al. AC 2014)

- Is this lower biodiversity due to a lower TreM supply only or also to **changes in spatial distribution pattern**?

Are spatial distribution patterns of TreMs different in harvested stands compared to unharvested ones?

Hypothesis 1: TreM distribution is spatially structured in old-growth forests (>100 years)

Hypothesis 2: The spatial distribution of TreMs is mainly driven by the spatial distribution of tree dbh

Hypothesis 3: Management affects these patterns by controlling dbh range, density and location of TreM-bearing trees

An analysis focusing on beech-dominated stands, recently harvested or not

International standardized TreM database: 267 sites, 1492 plots, 86 754 trees, 17 TreM groups

- **Beech-dominated** (>50% trees) **stands**

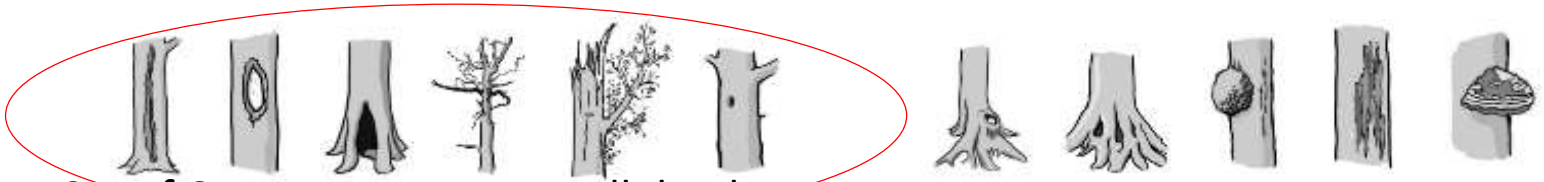
Tree coordinates
>20 trees/plot
>10 TreM/plots

- **2 time categories since the last harvest**

< 50 y: managed forest
> 100 y: old-growth forest

55 sites, 408 plots (0.05-1ha),
20346 living and standing dead trees

11TreM-subgroups
selected from Larrieu et al. EI 2018

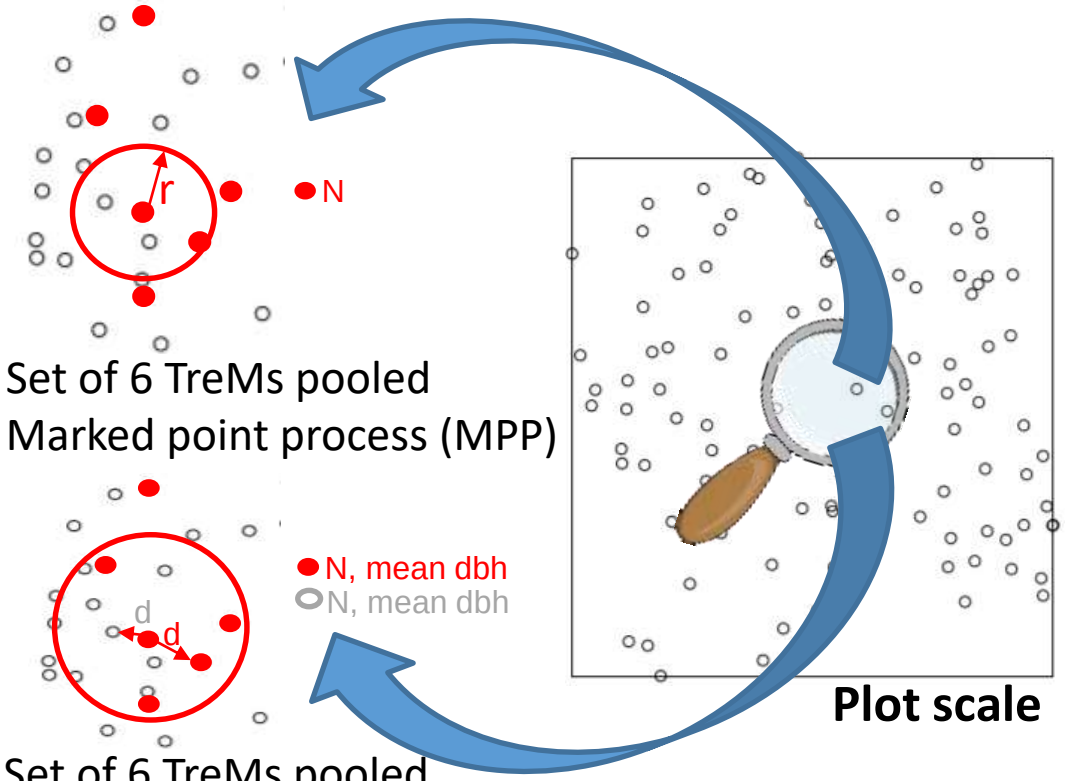


Set of 6 TreMs common to all databases

L. Apfelbacher

A multi-scale exploratory analysis

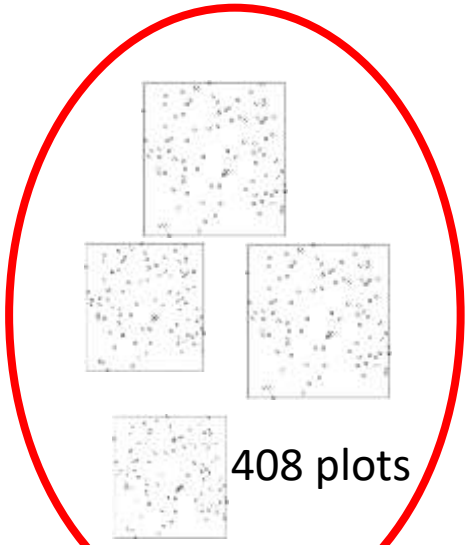
Harvested and unharvested stands



Plot scale

- Set of 6 TreMs pooled
- Marked point process (MPP)

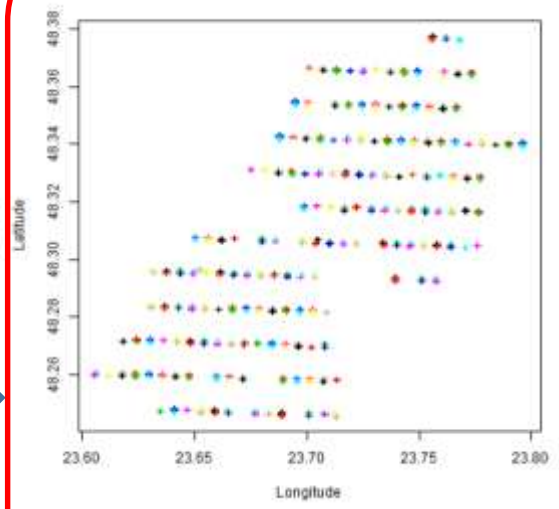
- Set of 6 TreMs pooled
- 11 individual TreMs
- Binomial GLM
- Y (tree bears at least a TreM)~dbh+ 6 variables describing neighbourhood



Plot-grouping scale

- Set of 6 TreMs pooled
- Binomial GLM
- Y (tree bears at least a TreM)~dbh+site+site-plot +time since the last harvest

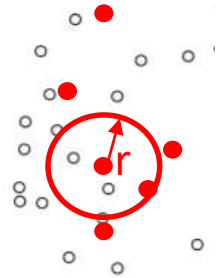
Unharvested forest



Forest scale (Uholka, OGF)

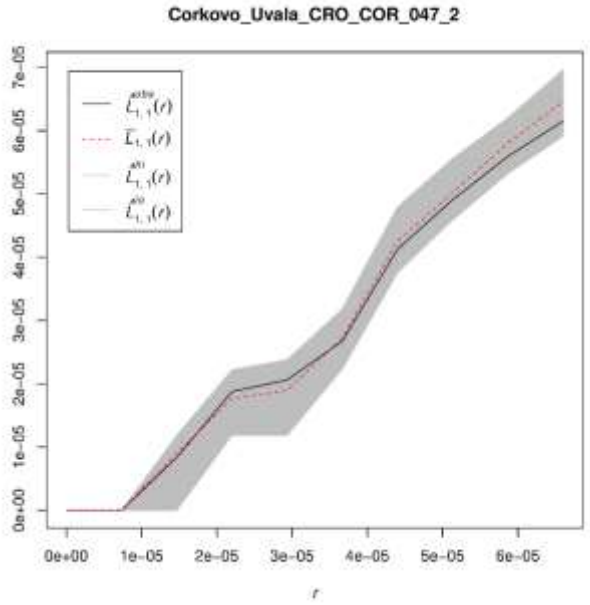
- 8 individual TreMs
- Binomial GLM/GLMM
- 266 x 500m²-plots

No consistent spatial pattern, neither in managed nor in old growth forests

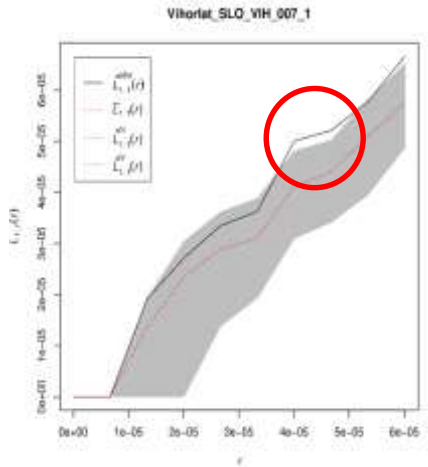


MPP without control of the spatial structure for dbh

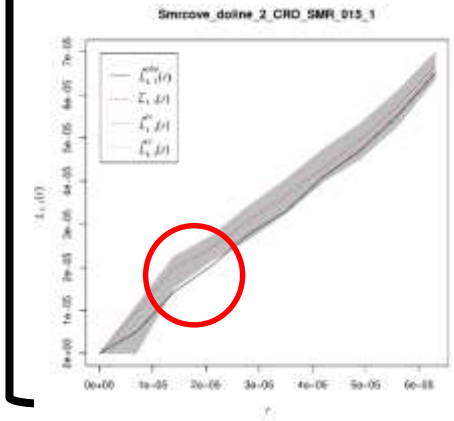
General case



and very rarely…



Aggregation of TreM-bearing trees



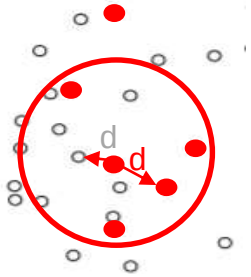
Repulsion

- - - - - random distribution of the TreM-bearing trees

Confidence interval

L1,1 (r) function: counts the nb of TreM-bearing trees in the r-radius disc

Neighbourhood features have a significant effect on TreM bearing tree occurrence



GLM binomial
Y=tree bears a TreM or not

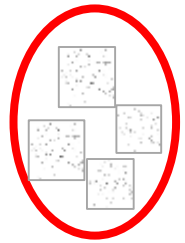
for **50 % of the plots in Managed forest**

+ 10% of variance explained by neighbourhood (in addition to dbh)

for **25% of the plots in Old-growth forest**

+ 18% of variance explained by neighbourhood (in addition to dbh)

The effect of dbh on TreM occurrence depends on both TreM and forest status

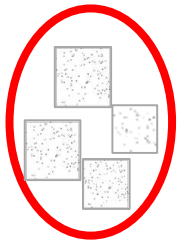


GLM binomial
Y=tree bears a TreM or not

TreM	Old Growth Forests	Dbh effect	Managed forest
	+ for 97% of the plots	=	+ for 100% of the plots
	+ for 52% of the plots	+ → +	+ for 88% of the plots
	- for 65% of the plots	- → +	+ for 94% of the plots

% var. explained by plot:dbh >> % var. explained by dbh

Local conditions are the main driver of TreM occurrence

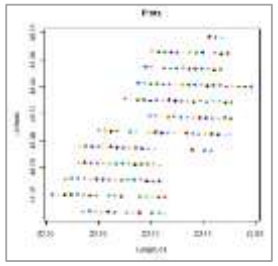


GLM binomial
Y=tree bears a TreM or not

- **dbh ***, but low explanatory power** (3%)
- Time since the last harvest (dbh*time) ***, medium explanatory power (17%)
- Site (dbh*site)***, high explanatory power (36%)
- **Site-plot (dbh*site-plot)***, the highest explanatory power (42%)**

Same trend observed at the individually TreM level!

In addition to dbh, plot features matters for explaining the occurrence of most of the TreMs

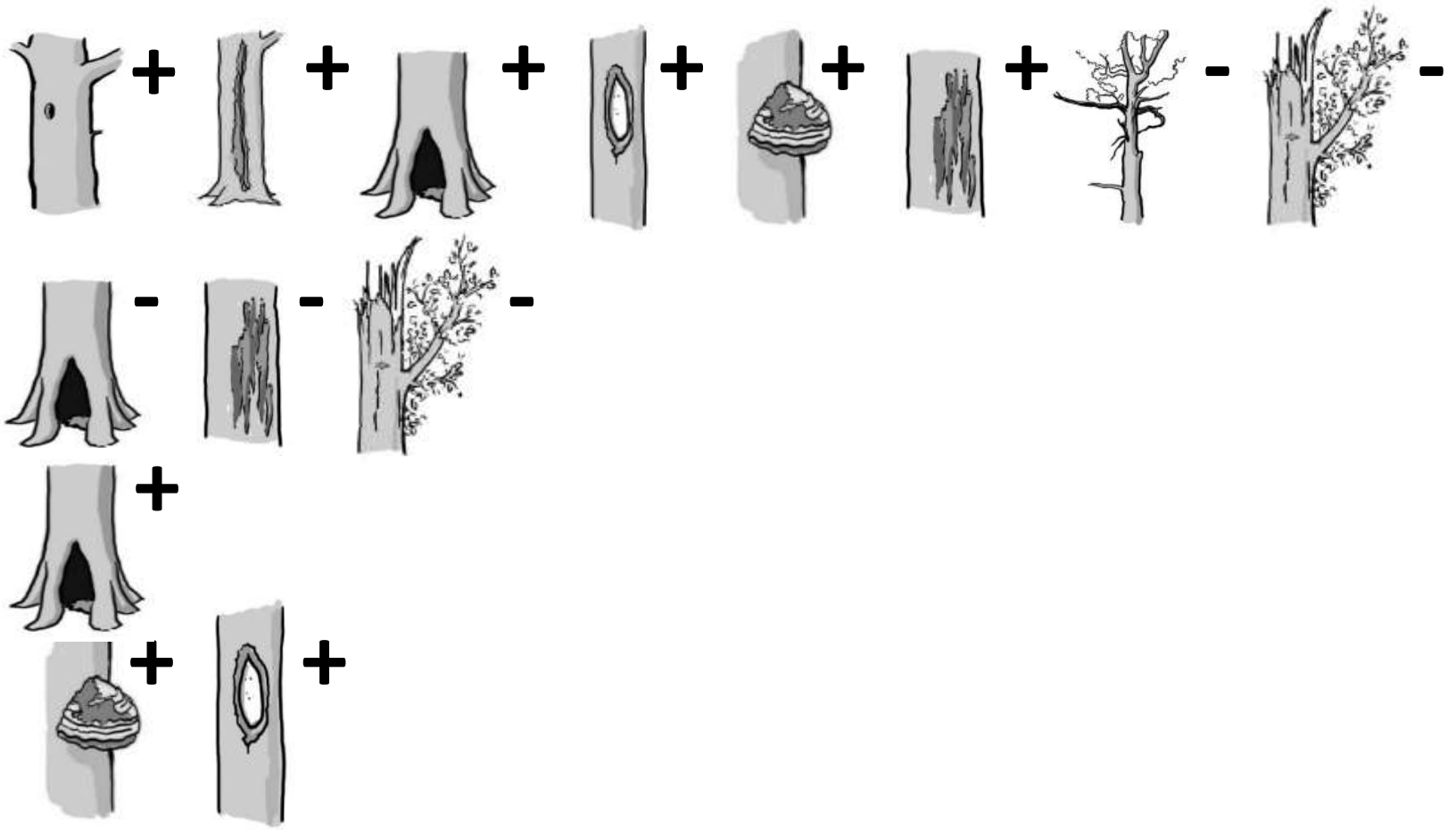


GLM & GLMM, binomial
Y=tree bears a TreM or not

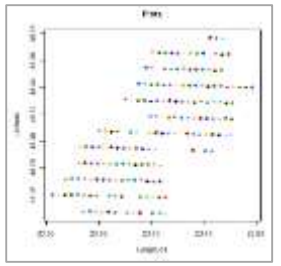
Drivers

- **DBH**
- **Plot features**
  - **canopy cover**
  - **slope**
  - **elevation**

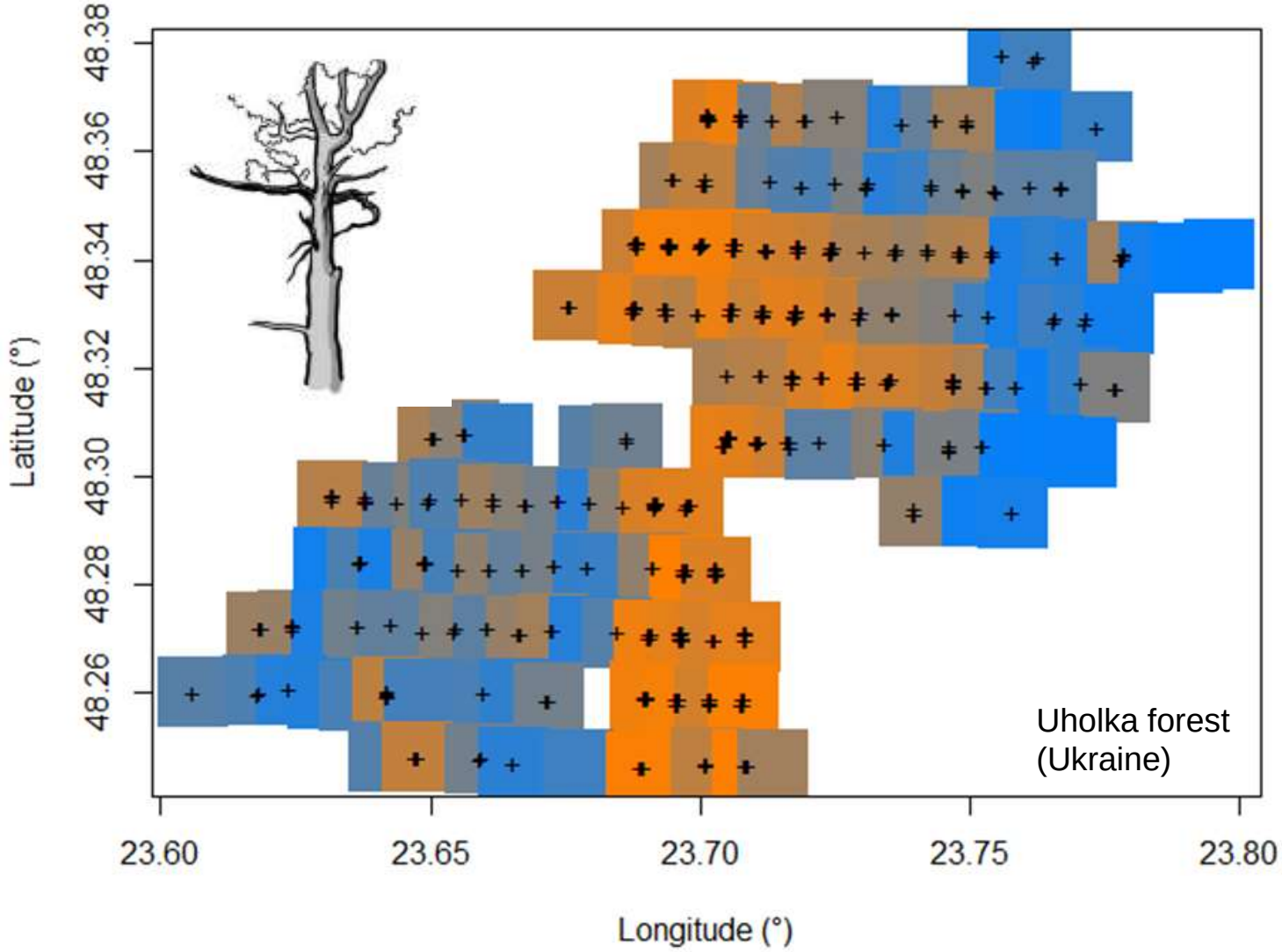
TreMs



Crown deadwood is mostly driven by a spatially-autocorrelated plot random effect



Bayesian CAR



posteriori residual variation of crown deadwood occurrence

Distance decay=260m

In a nutshell

- **Tree dbh spatial distribution is not a consistent surrogate within plot** for TreM spatial distribution **in old-growth forests**
- **Strong effect of local conditions** on TreM spatial structuration
- **Management influences the way TreM spatialization occurs** (mainly by changing relationship between TreM and dbh)

Thanks for your attention