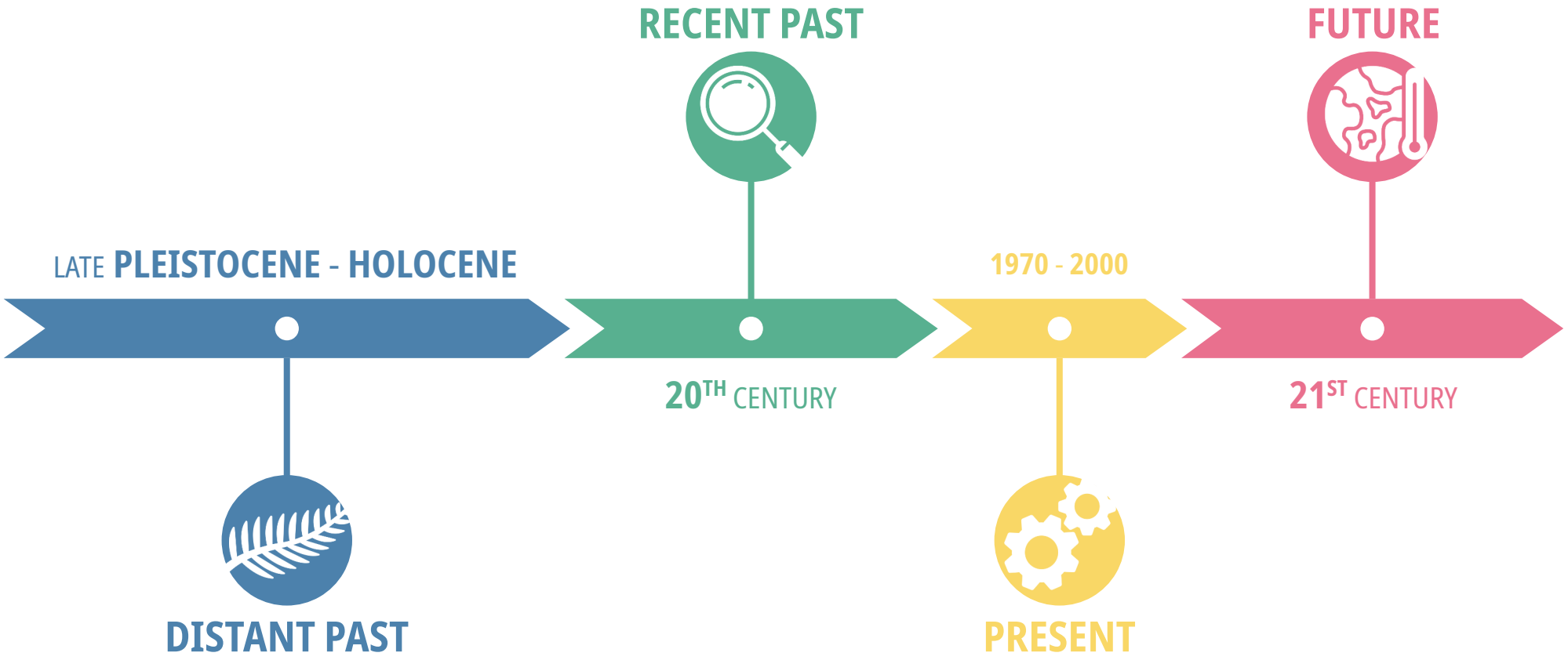
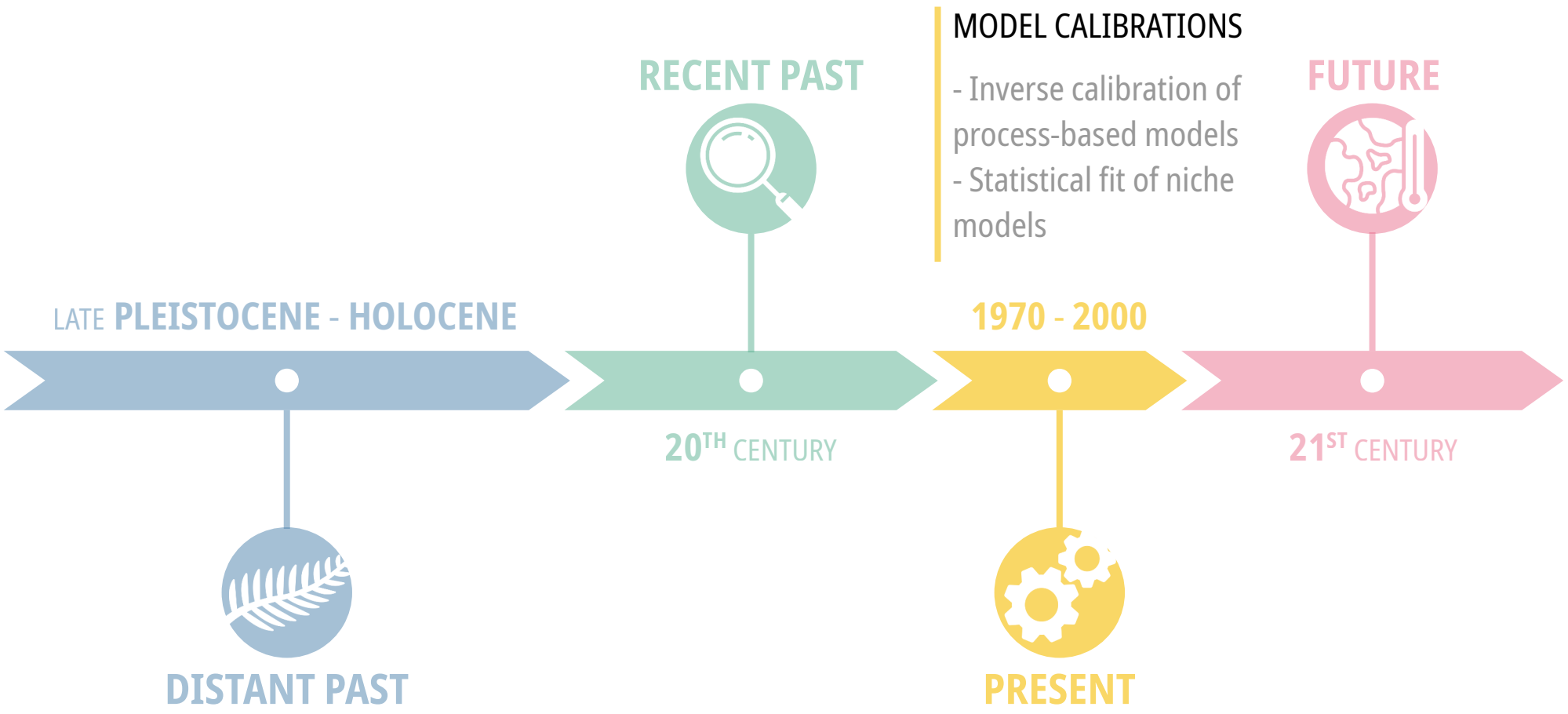
Third team meeting

Assessing the robustness and uncertainty of species distribution model projections

02/06/2023


LATE PLEISTOCENE - HOLOCENE
DISTANT PAST
RECENT PAST
20TH CENTURY
1970 - 2000
PRESENT
FUTURE
21ST CENTURY


MODEL CALIBRATIONS
- Inverse calibration of process-based models
- Statistical fit of niche models
RECENT PAST
FUTURE
LATE PLEISTOCENE - HOLOCENE
1970 - 2000
20TH CENTURY
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Inverse calibration of process-based models

- models: **PHENOFIT, CASTANEA**

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- models: **PHENOFIT, CASTANEA**

- climate data: **ERA5-Land**

- occurrence records: **EU-Forest** (+GBIF, WOODIV)

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- paper published in **Methods in Ecology and Evolution**

Received: 30 November 2022 | Accepted: 20 April 2023

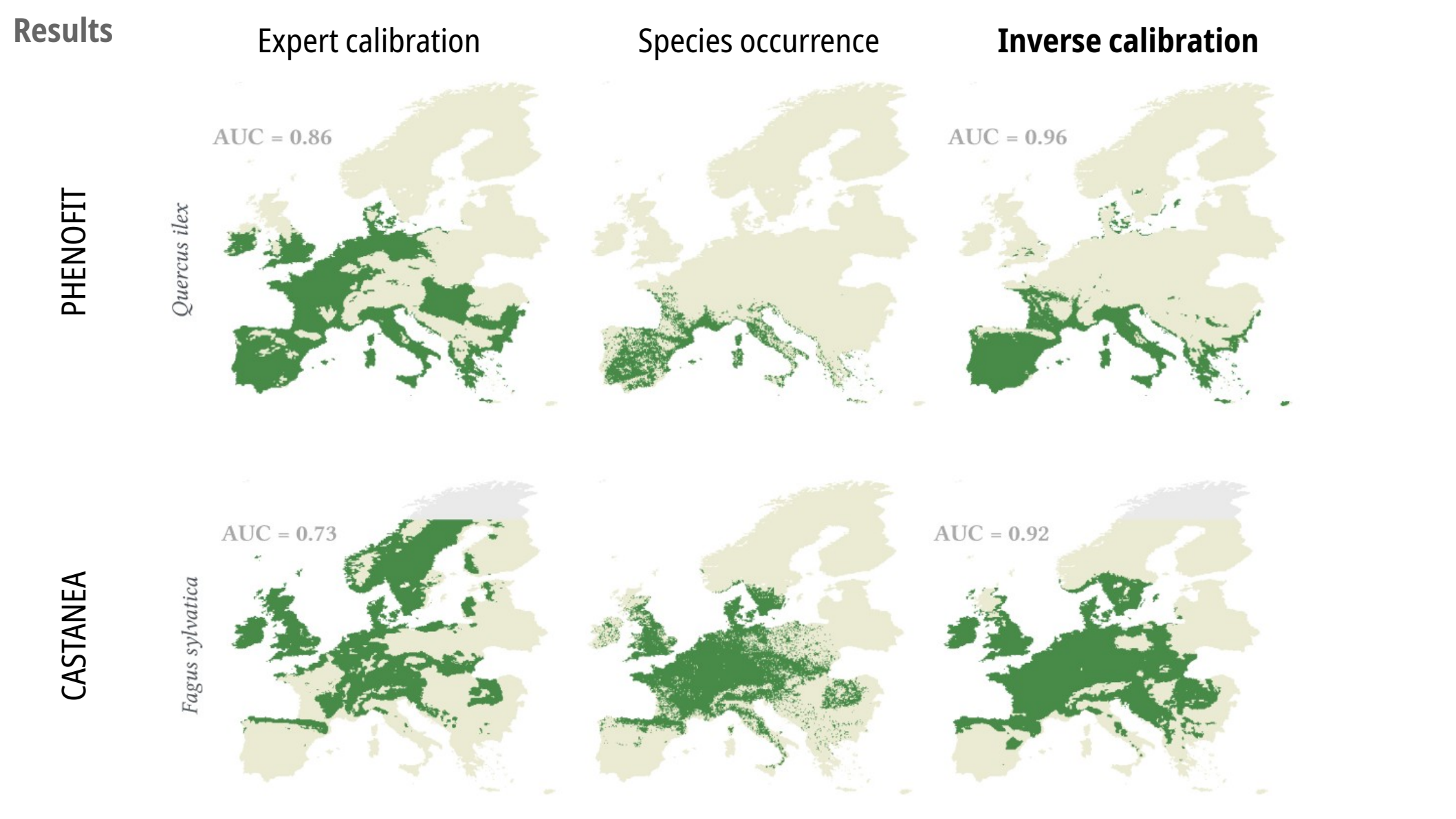
DOI: 10.1111/2041-210X.14119

Methods in Ecology and Evolution

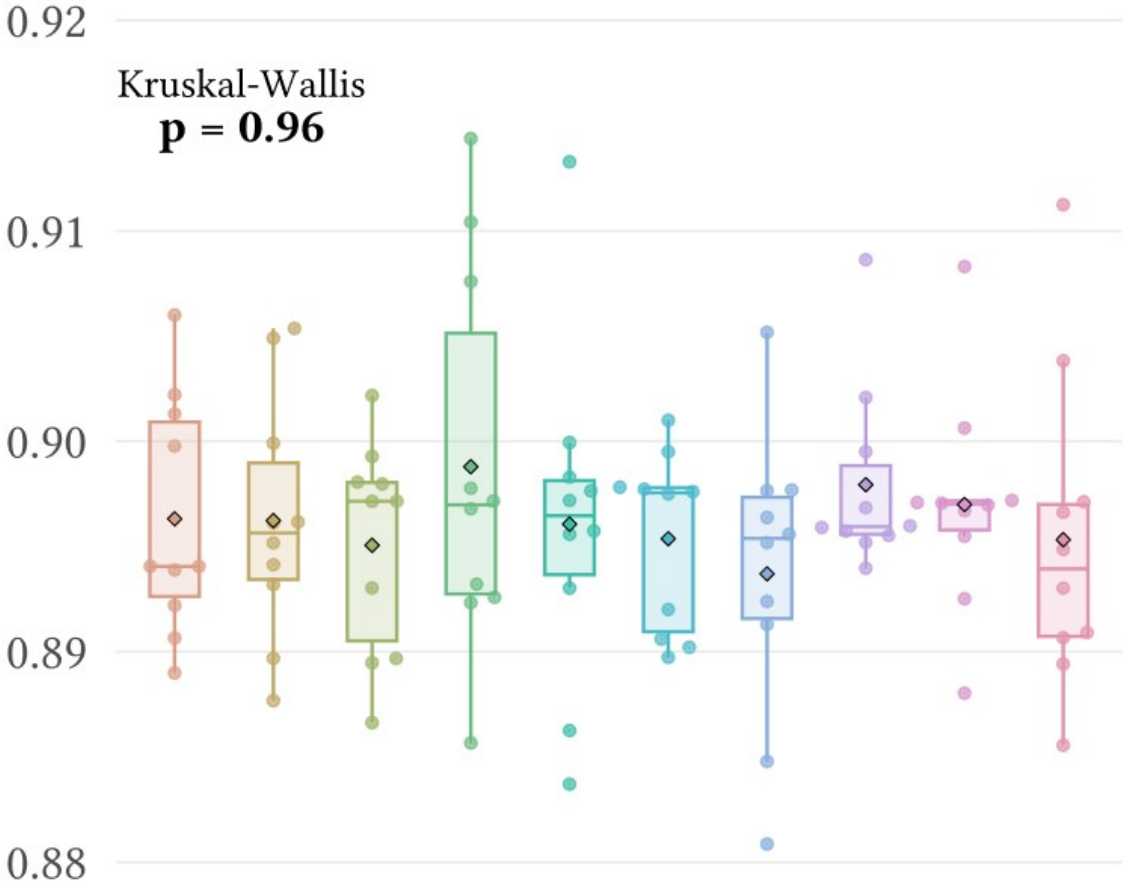
RESEARCH ARTICLE

Estimating process-based model parameters from species distribution data using the evolutionary algorithm CMA-ES

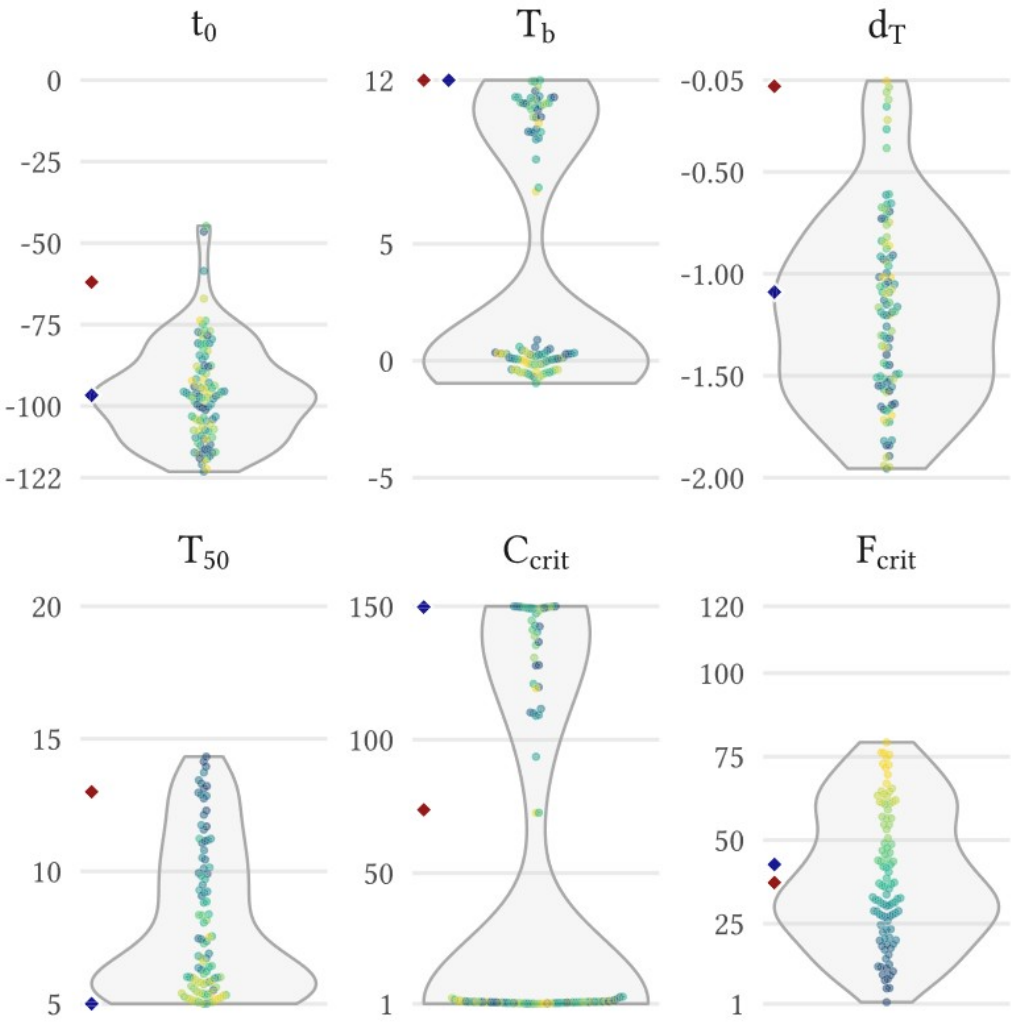
Results


Expert calibration
Species occurrence
Inverse calibration
PHENOFIT
CASTANEA
Quercus ilex
AUC = 0.86
AUC = 0.96
Fagus sylvatica
AUC = 0.73
AUC = 0.92

Results



Results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-75
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-122
T_b
12
5
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-5
d_T
-0.05
-0.50
-1.00
-1.50
-2.00
T_{50}
20
15
10
5
C_{crit}
150
100
50
1
F_{crit}
120
100
75
50
25
1

Calibration of niche models

- ***presence-only*** approach, *Valavi et al. (2022)*

- models: GLM with lasso penalty, GAM, BRT, RandomForest
(+ biomod et Maxent)

Ecological Monographs, 92(1), 2022, e01486

Predictive performance of presence-only species distribution models: a benchmark study with reproducible code

Roozbeh Valavi,[1,3] Gurutzeta Guillera-Arroita,[2] José J. Lahoz-Monfort,[2] and Jane Elith[2]

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GDD >5°C April-September (**growth**)
total precipitation (**accumulated water**)
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+ soil: pH, water holding capacity

- occurrence data: **EU-Forest** (+GBIF, WOODIV)
+ background points: « *sampled irrespective of the location of species records* »

Calibration of niche models

- ***5-fold environmental block cross-validation*** to estimate errors

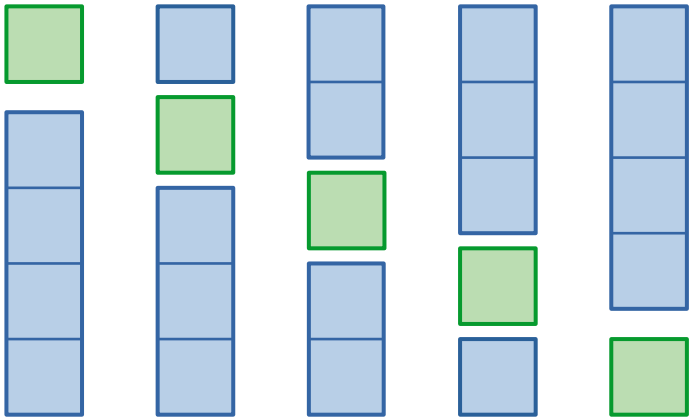
Calibration of niche models

- 5-fold environmental block cross-validation to estimate errors

Calibration of niche models

- 5-fold environmental block cross-validation to estimate errors

training set
testing set



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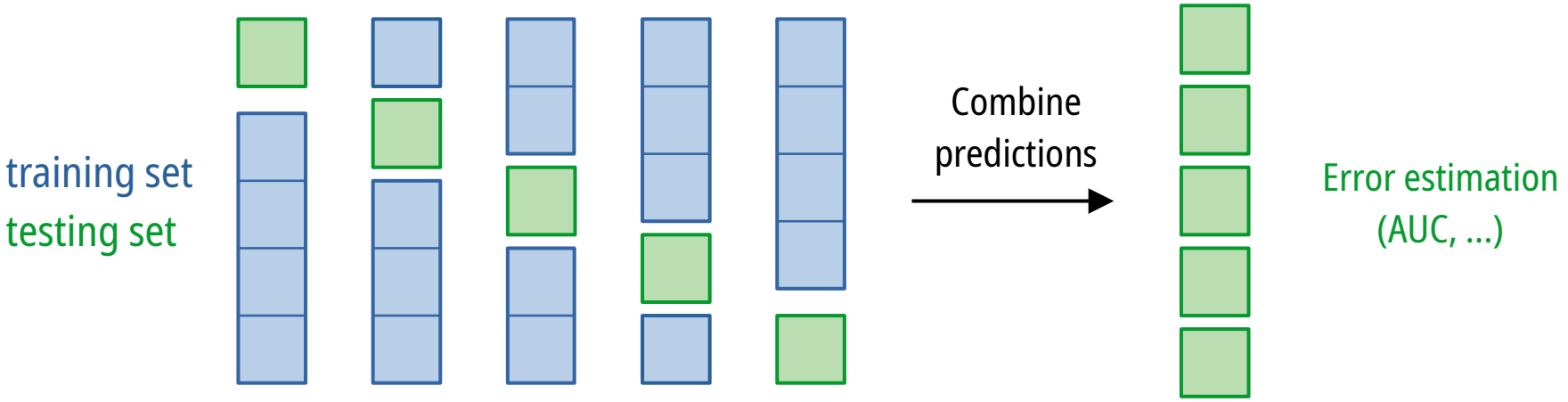

Calibration of niche models

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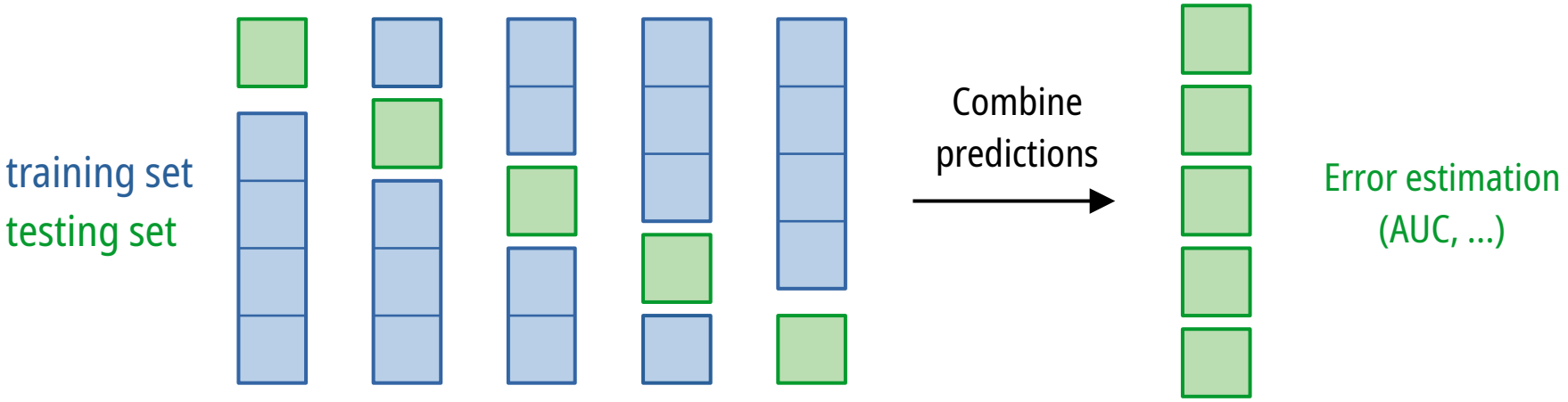
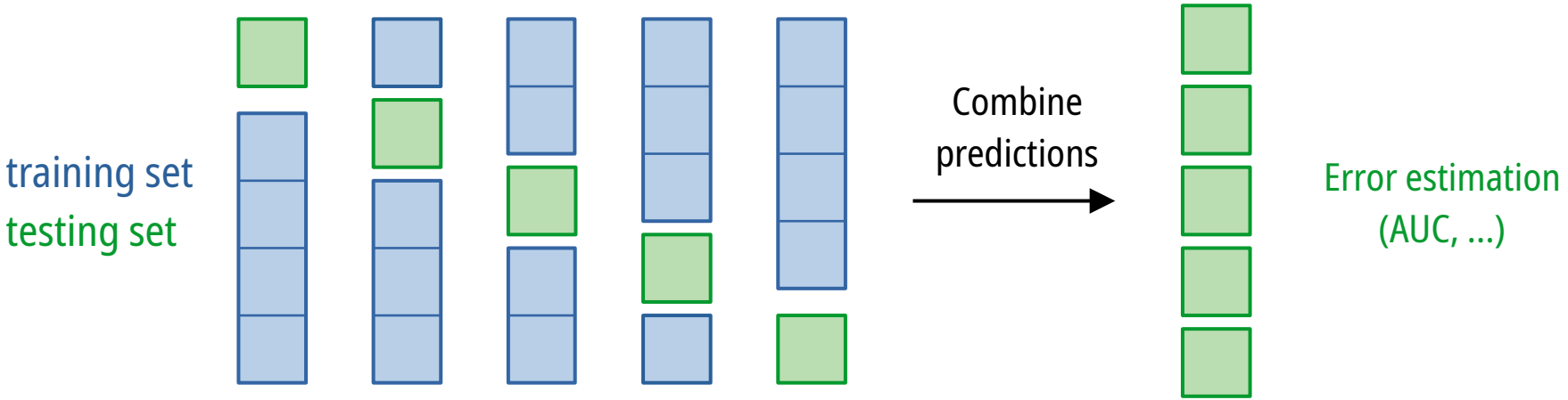


- ***final model*****:** all the available data used to fit the model

« *favours final prediction quality over perfect accuracy of error estimates* » (*Roberts et al. 2017*)

Calibration of niche models

- ***5-fold environmental block cross-validation*** to estimate errors



- ***final model*****:** all the available data used to fit the model

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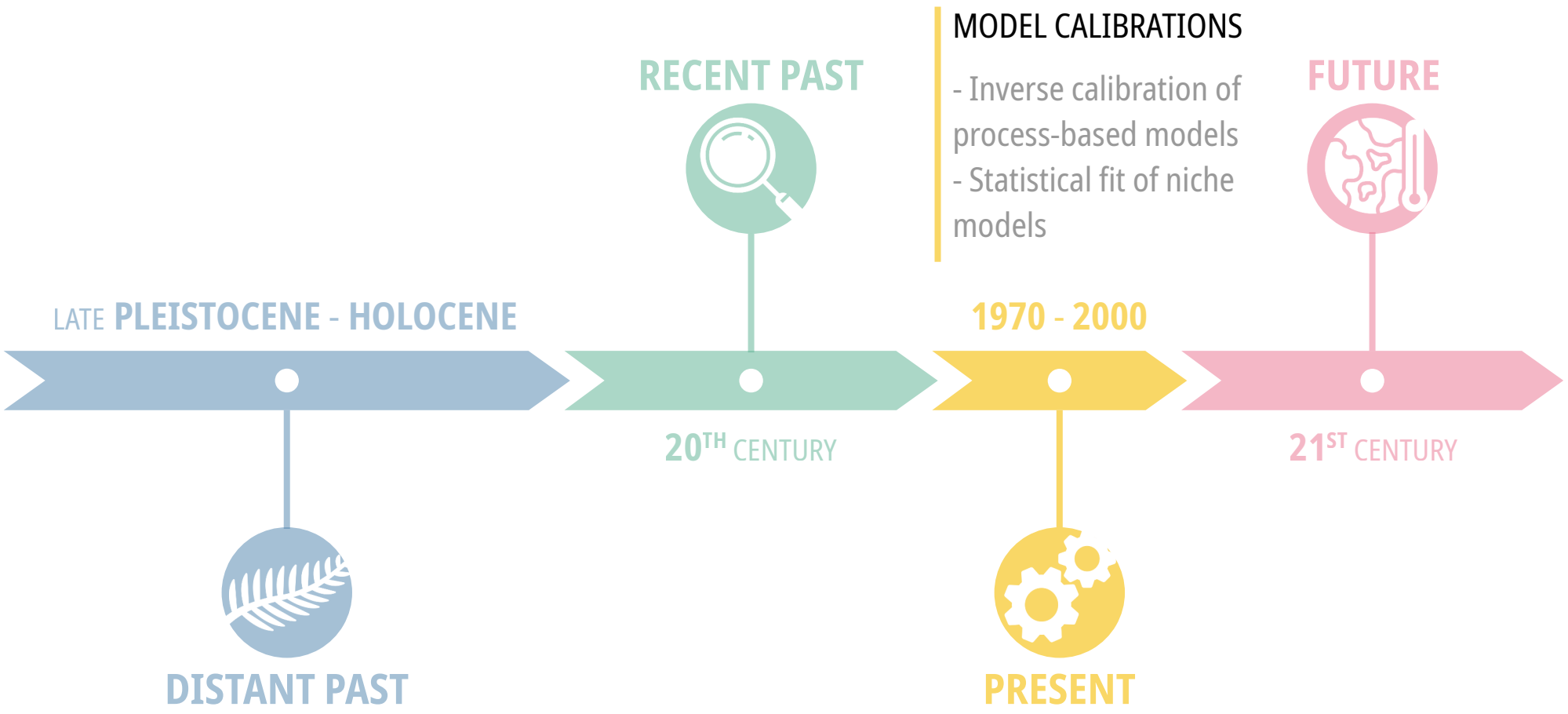
Over-estimated
AUC

Calibration of niche models

Fagus sylvatica

	Lasso GLM	GAM	Random Forest	BRT
« True » AUC	0.68	0.79	0.81	0.79
Over-estimated AUC	0.92	0.93	0.99	0.96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LESSONS FROM THE PAST

- Comparison of models' predictions to pollen records
- Identify the strengths and weaknesses of each model

MODEL CALIBRATIONS

- Inverse calibration of process-based models
- Statistical fit of niche models

LATE **PLEISTOCENE - HOLOCENE**

DISTANT PAST

RECENT PAST

20TH CENTURY

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Paleoclimate

- **Monthly data** from **HadCM3B** general circulation model simulations

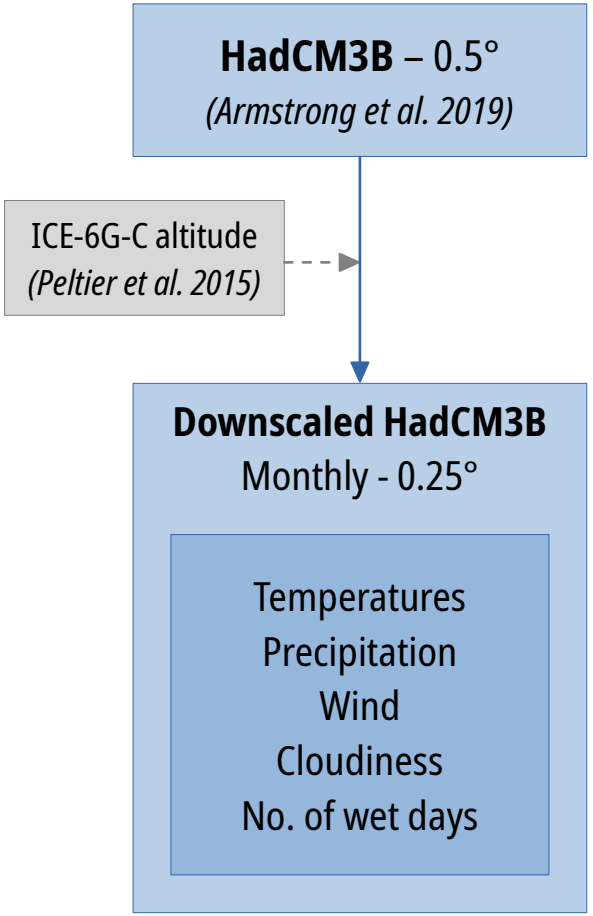
- 0.5° spatial resolution, bias corrected

- Collaboration with E. Armstrong (Univ. of Bristol), who generated specific variables for the project

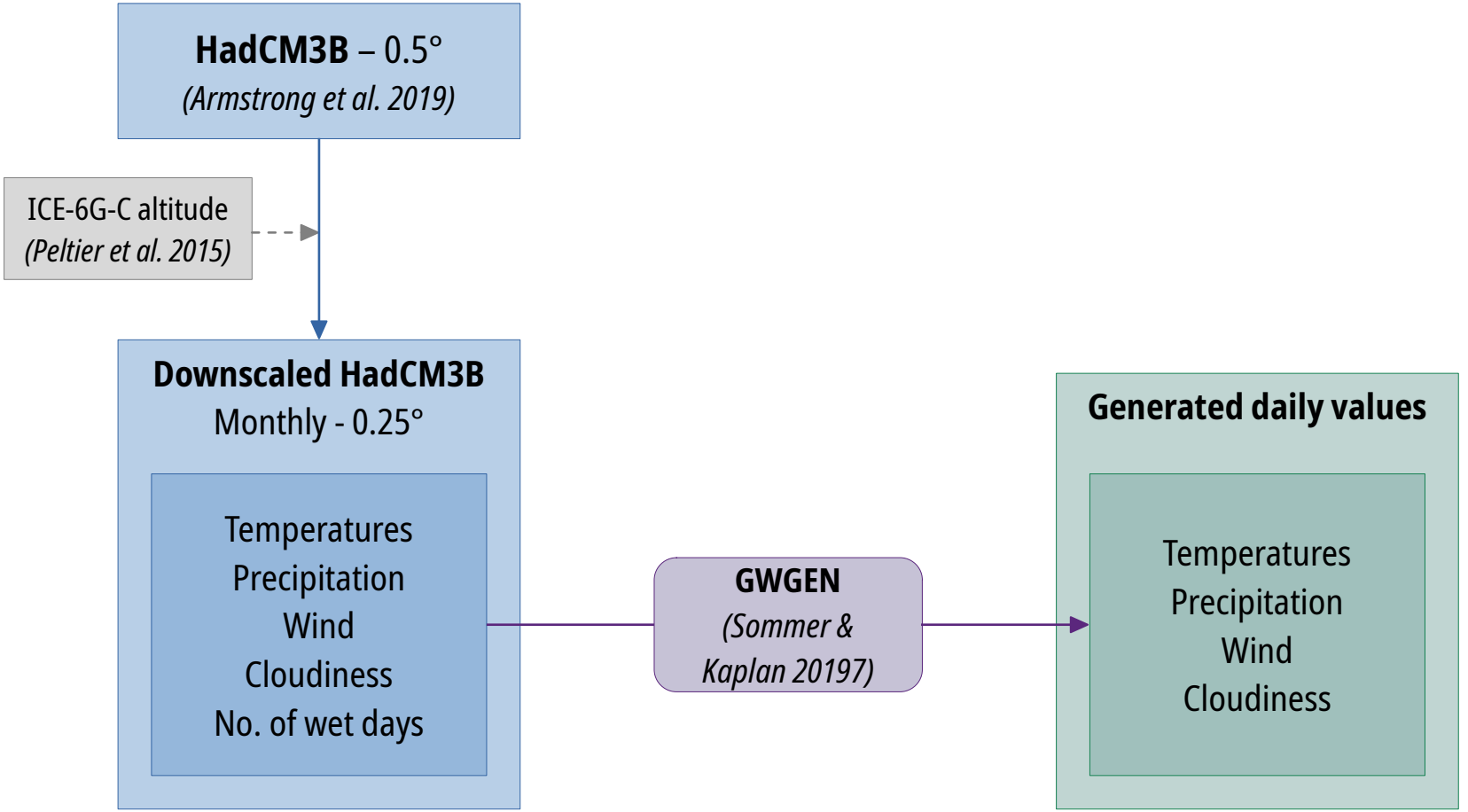
Paleoclimate

HadCM3B – 0.5°
(Armstrong et al. 2019)

Paleoclimate



Paleoclimate



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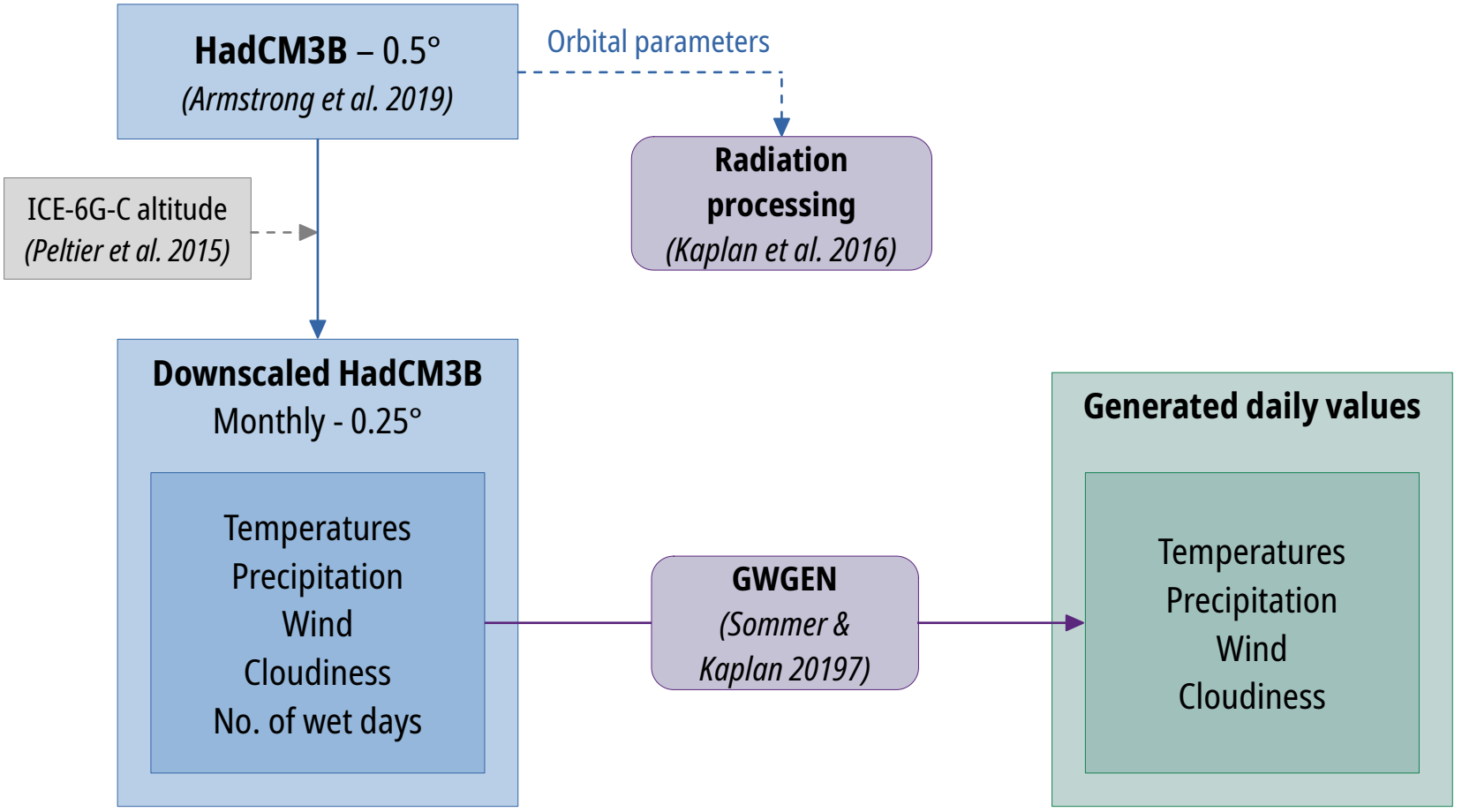
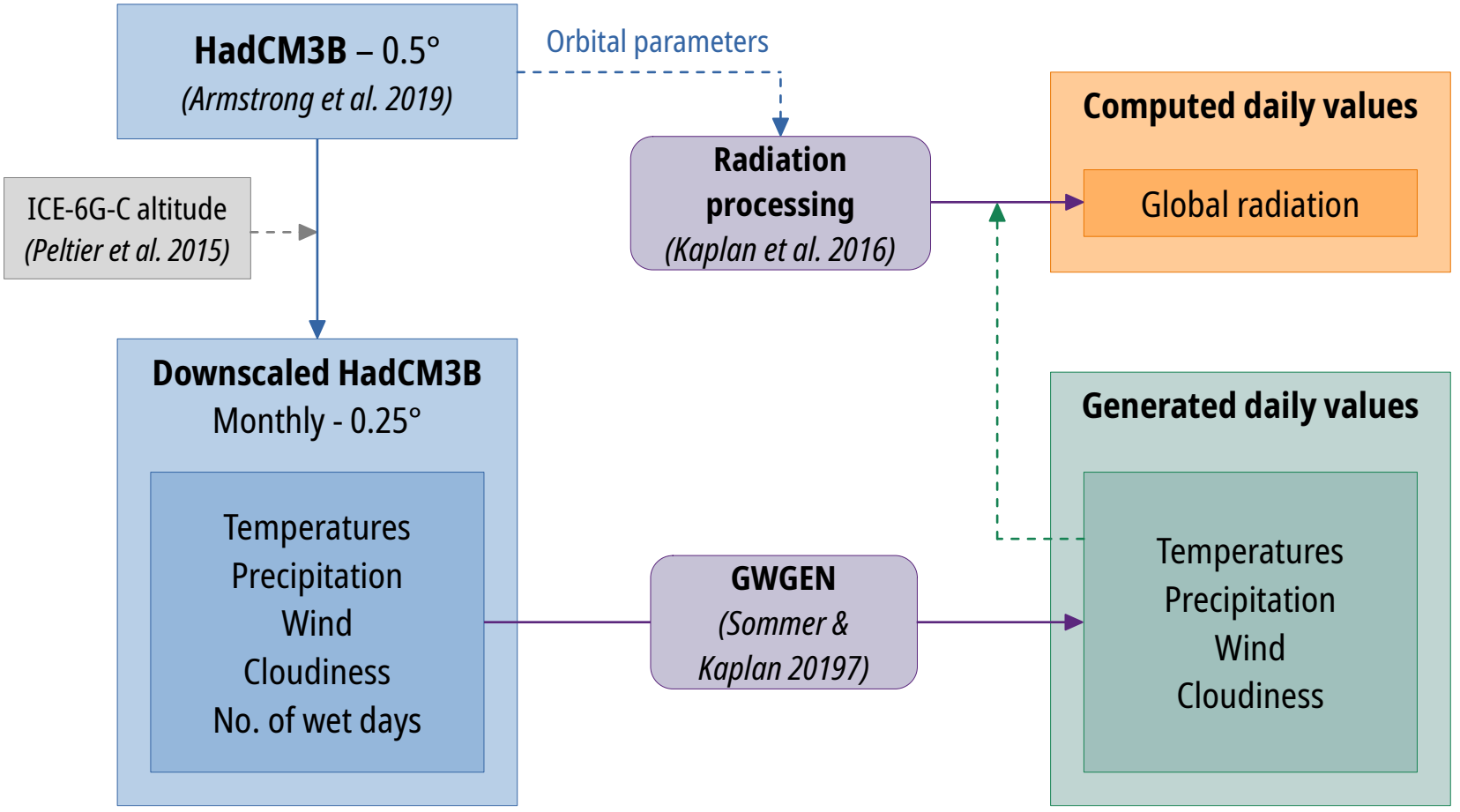


Paleoclimate



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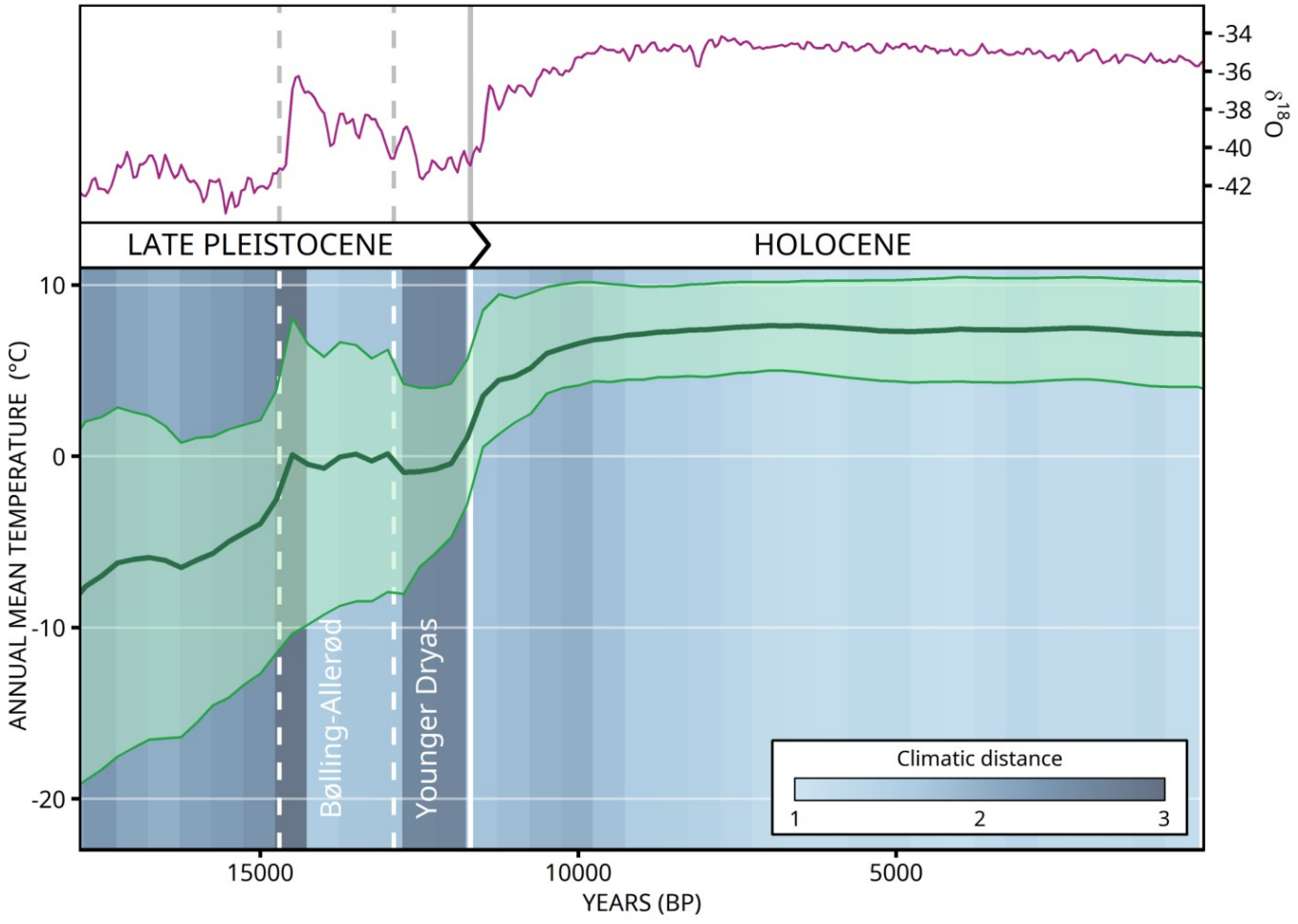
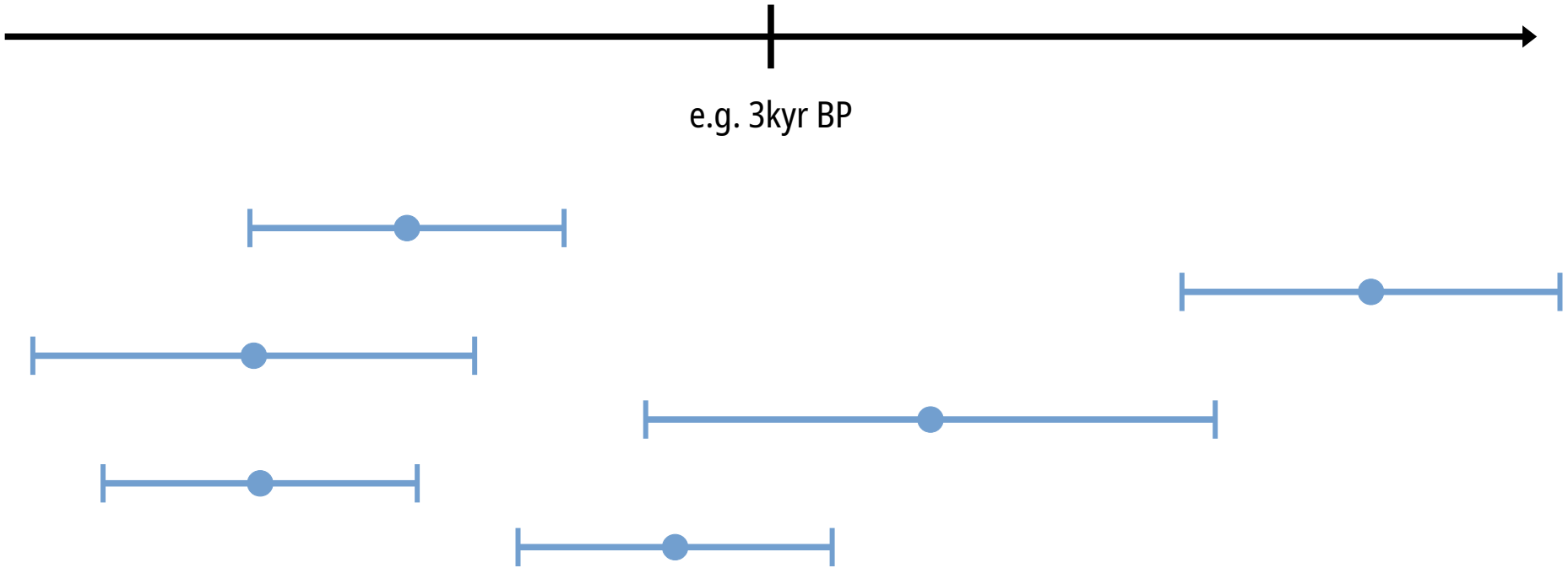
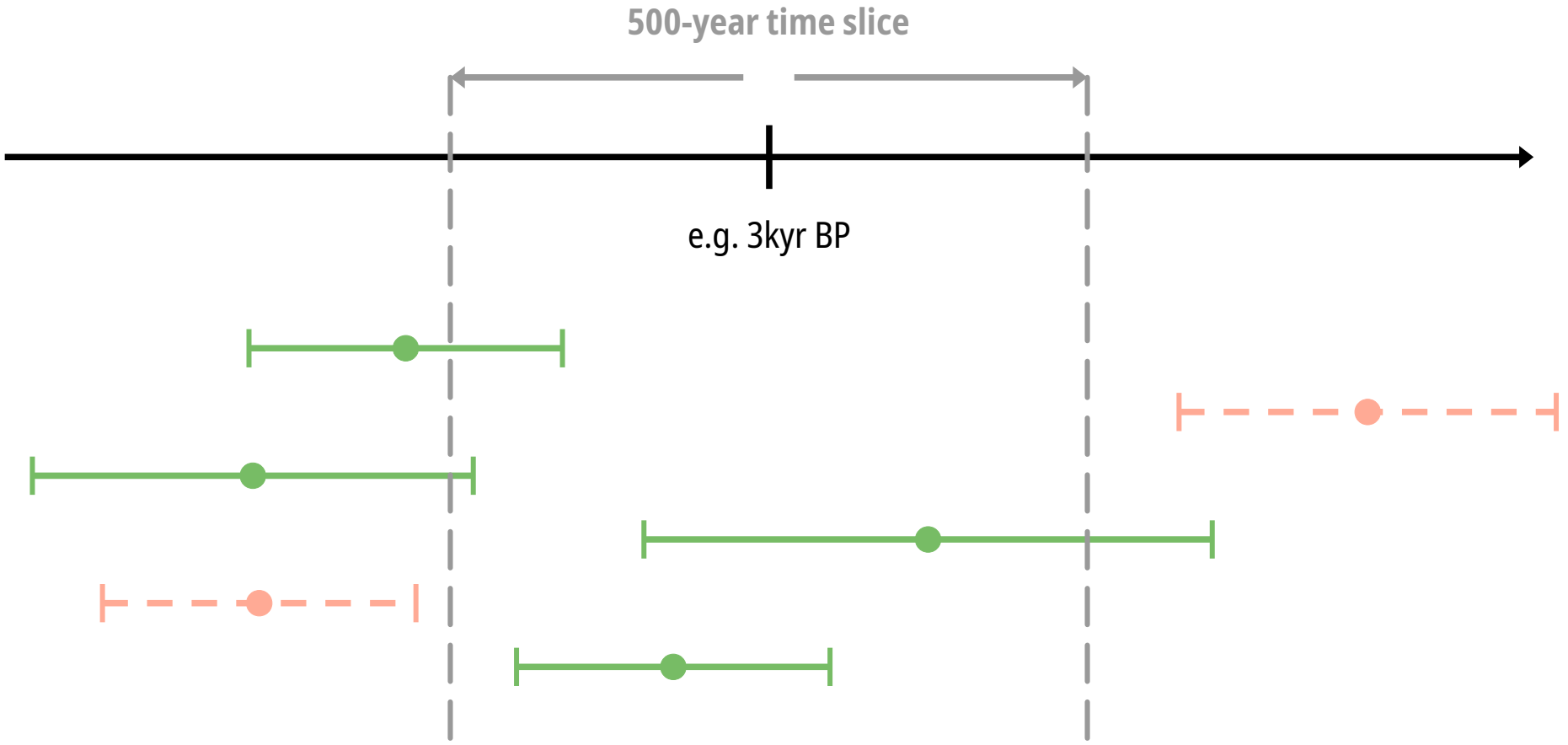


Temporal coverage per pollen site



Multiple samples within the same site

Temporal coverage per pollen site



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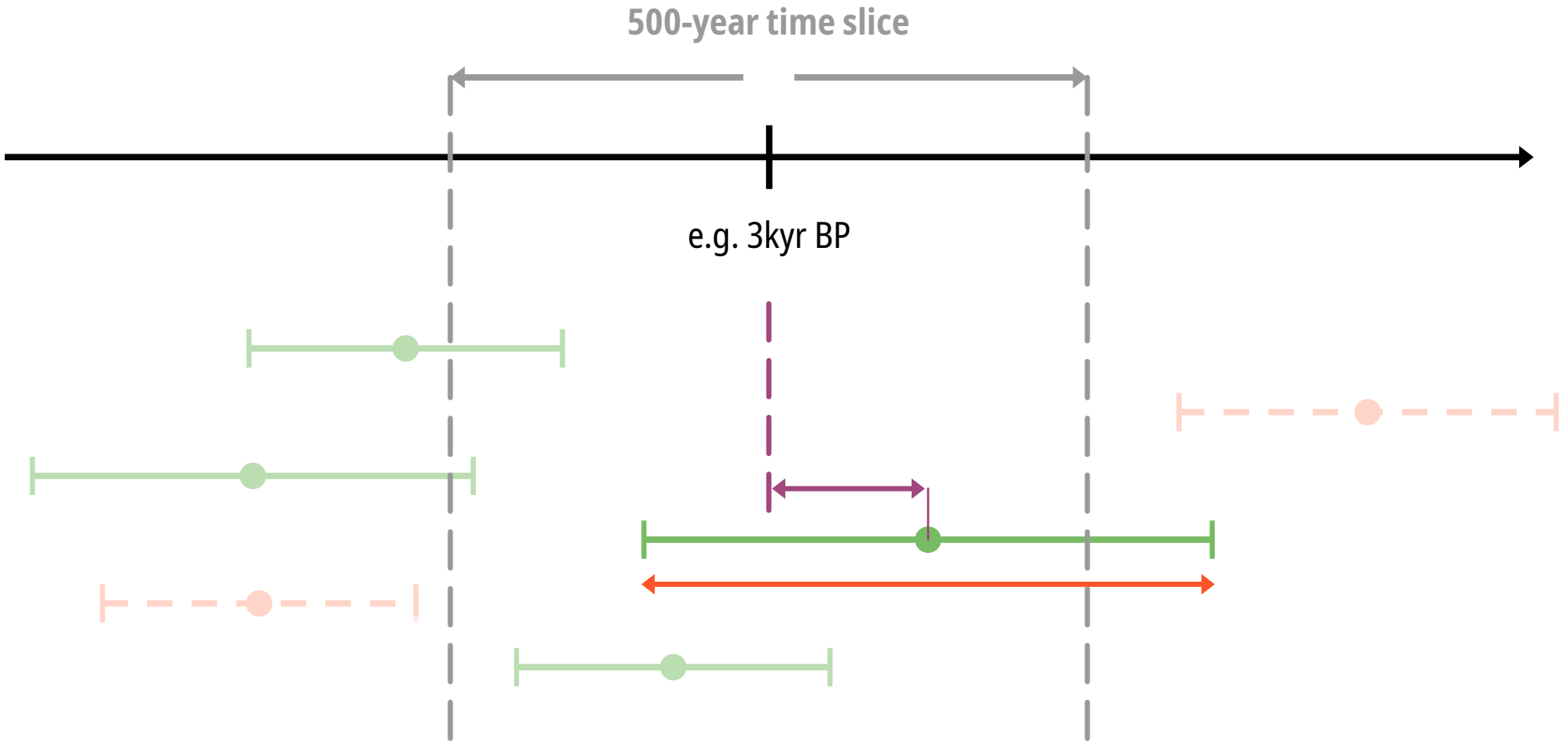
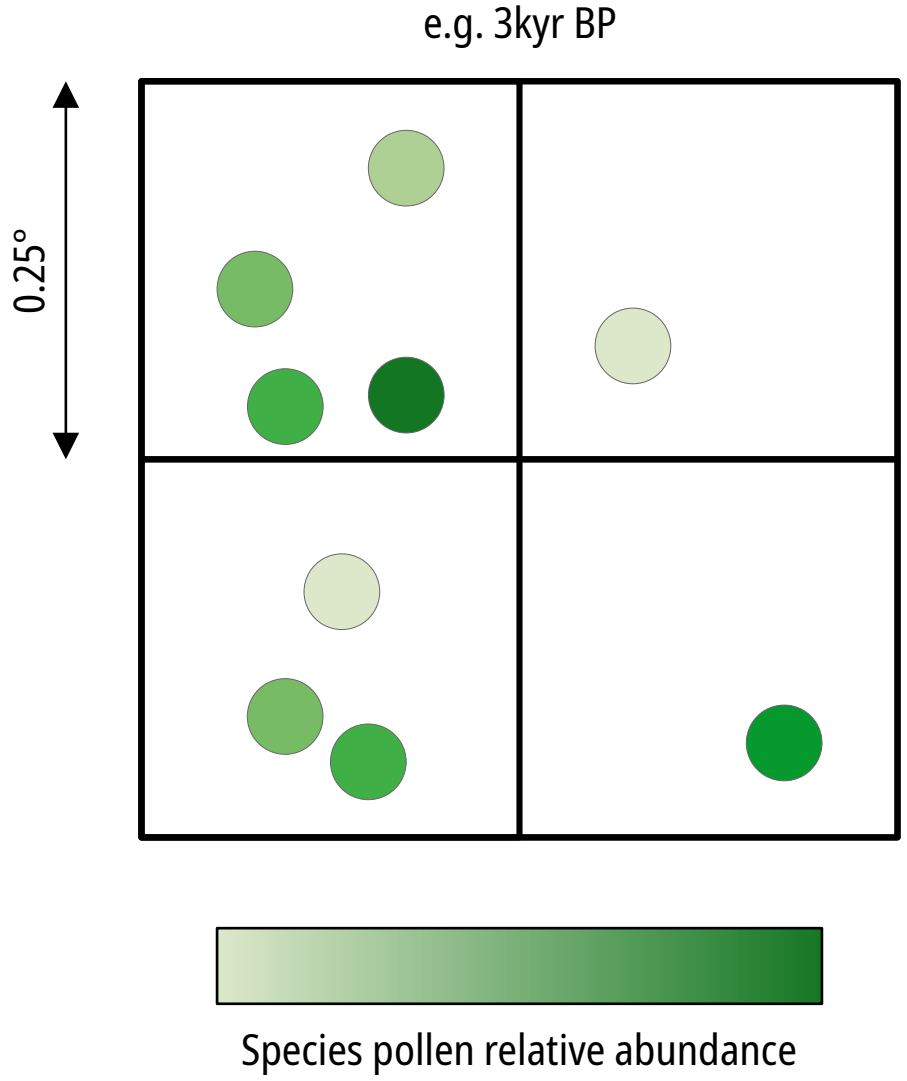
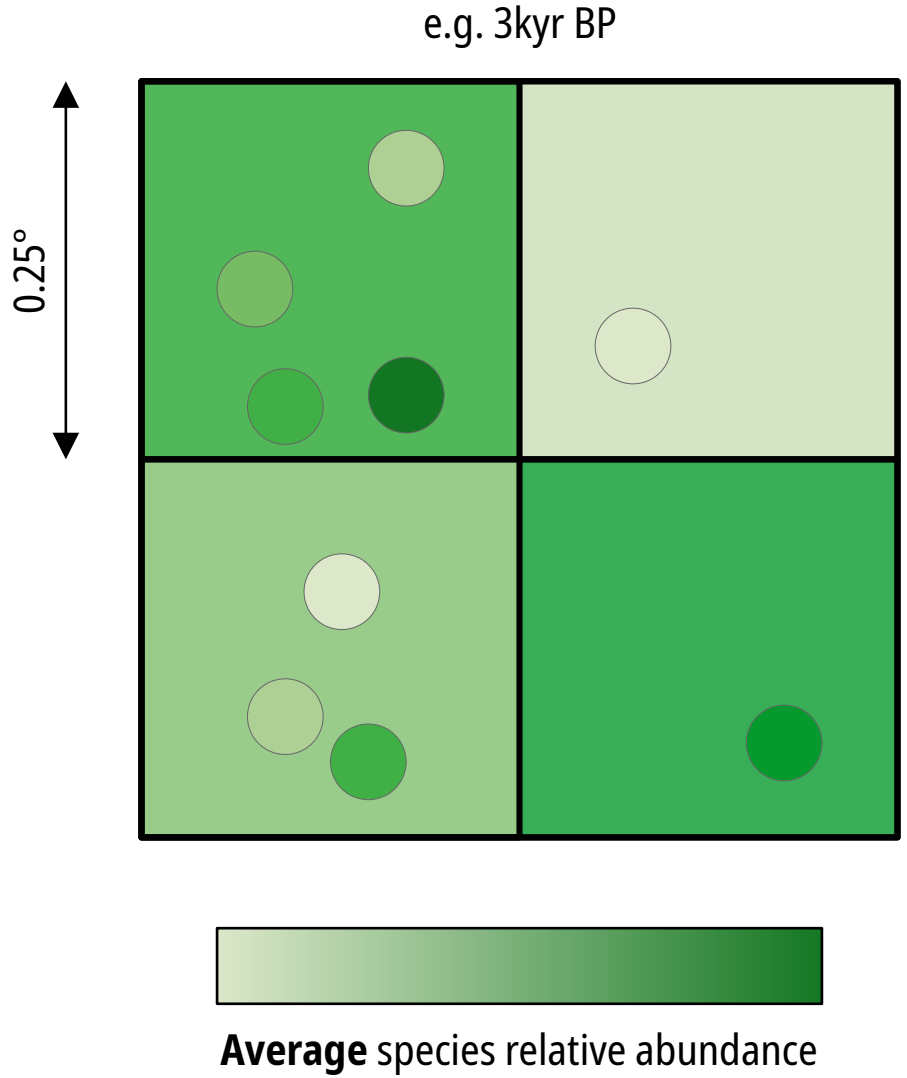


Weighted mean of pollen counts, taking into account both **uncertainty** and **time distance**

Spatial upscaling

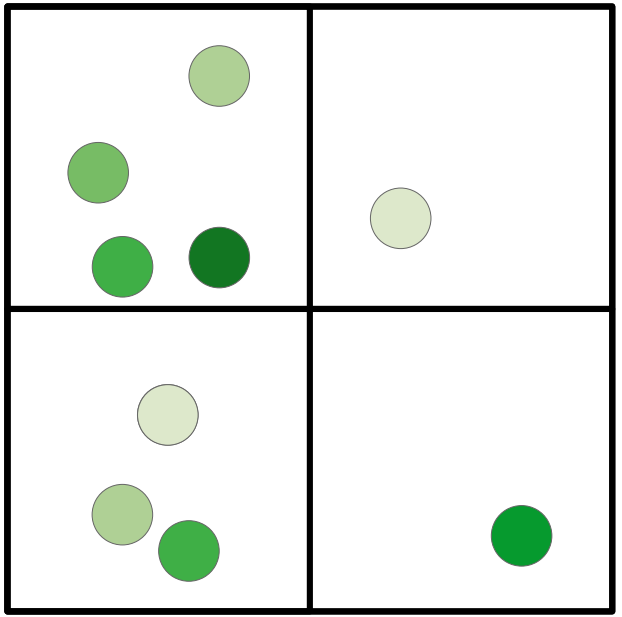


Spatial upscaling: relative abundance

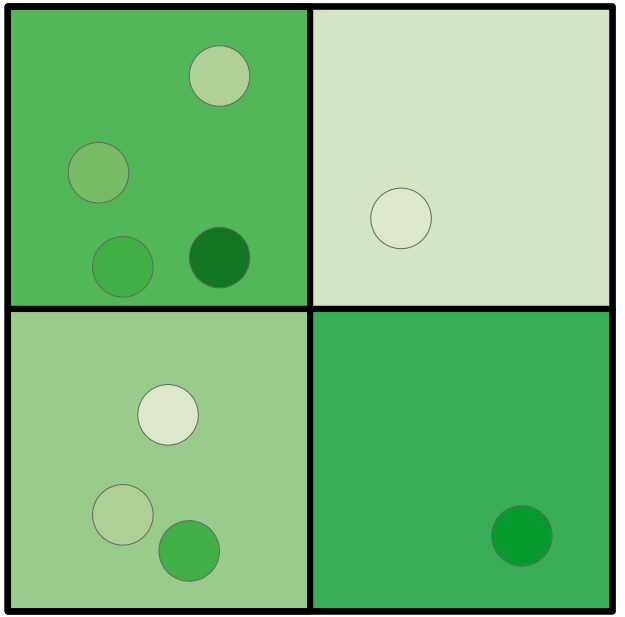


Spatial upscaling: presence/absence

« one is enough »



average presence



Presence threshold

Spatial upscaling: presence/absence

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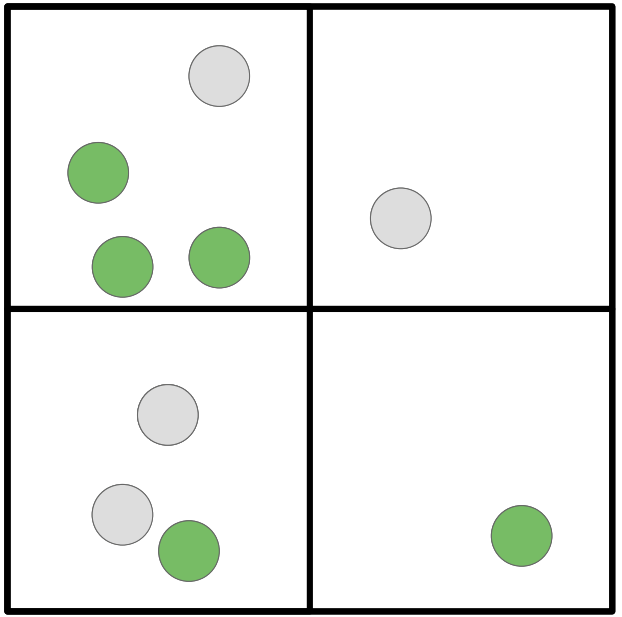

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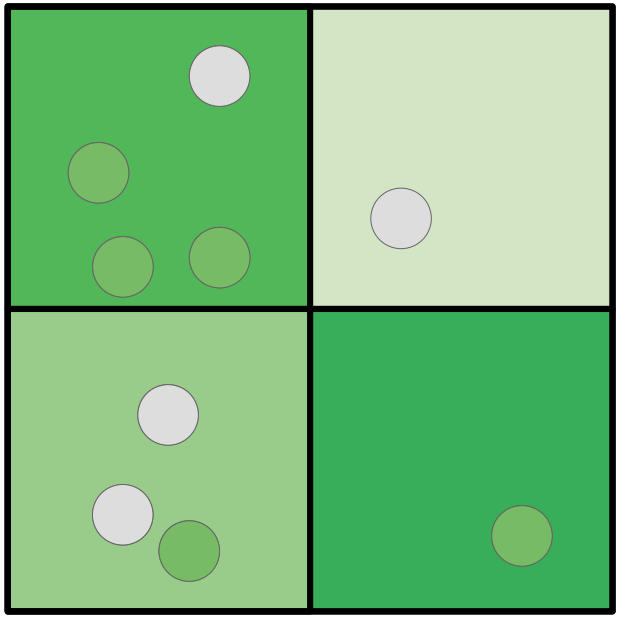

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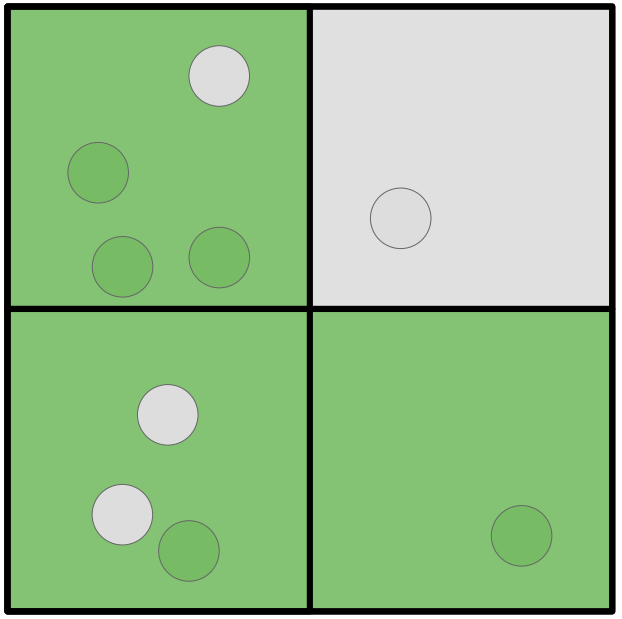

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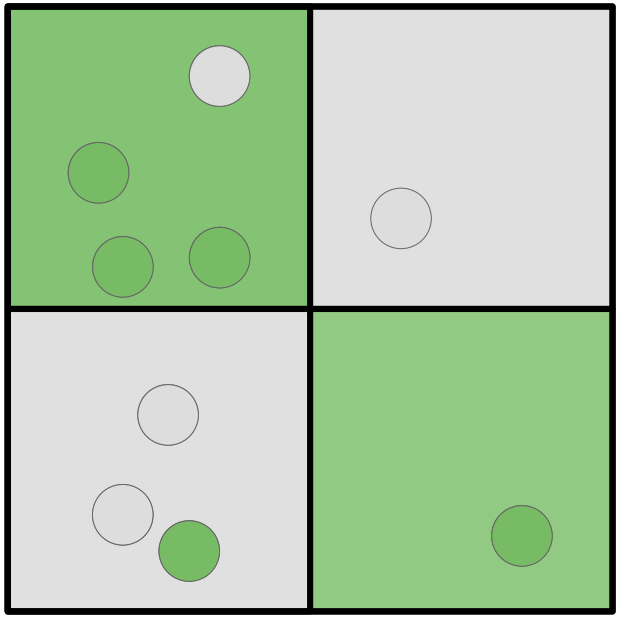
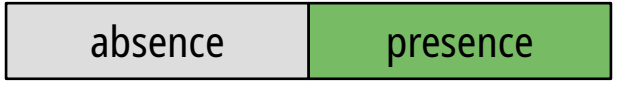
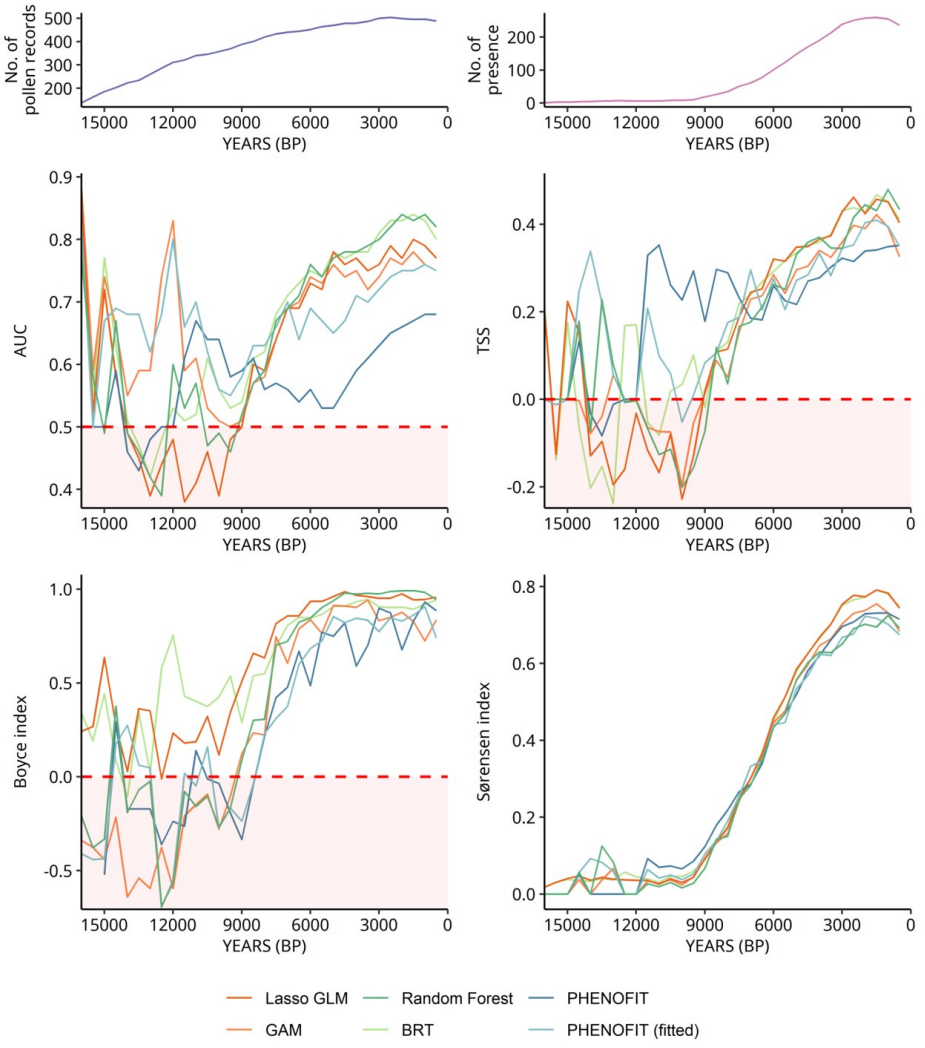




First paleosimulations



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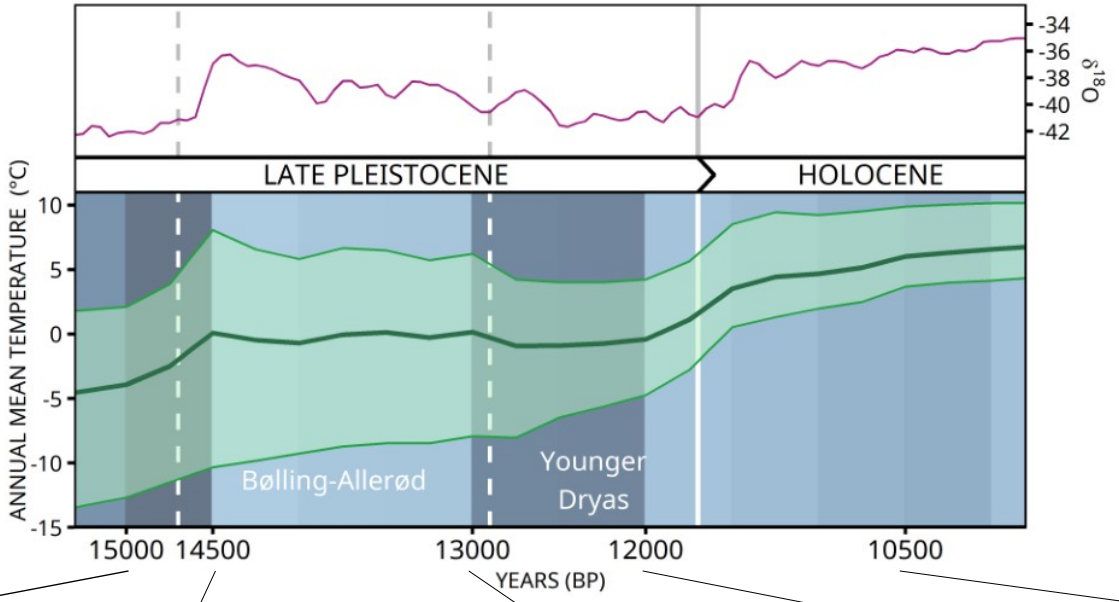
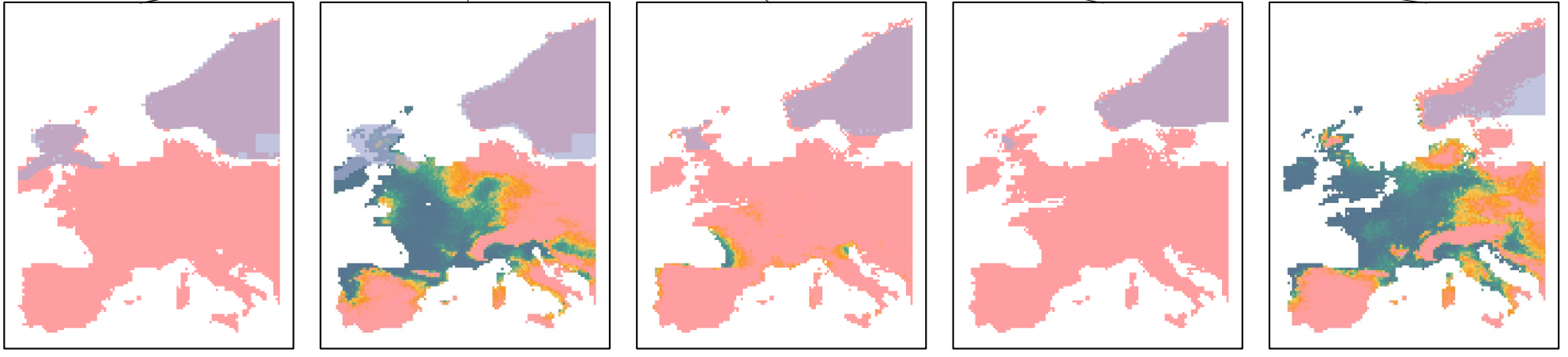


PHENOFIT



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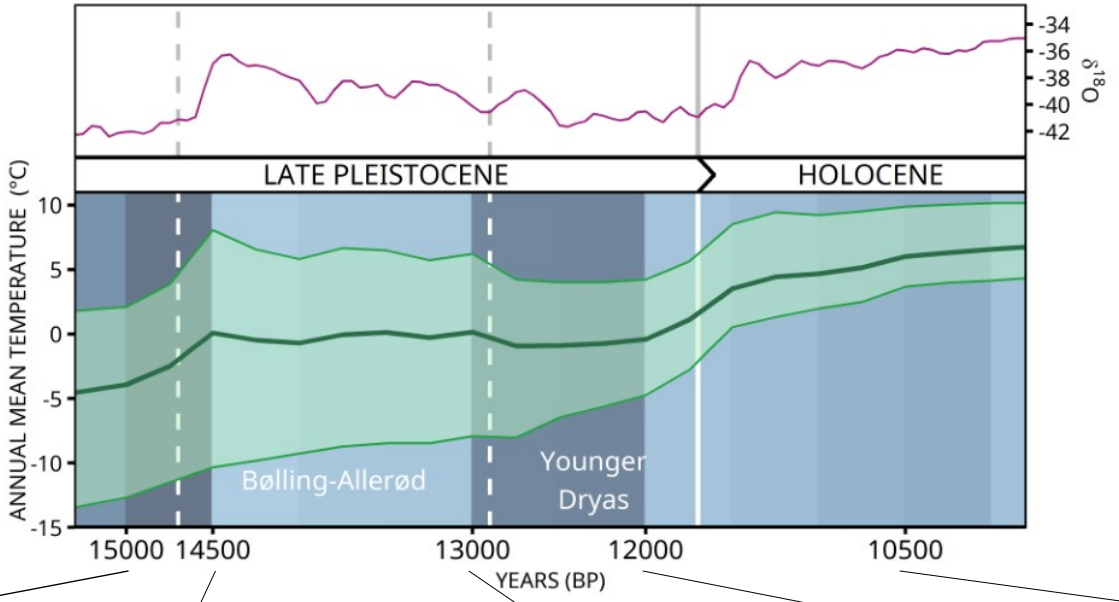
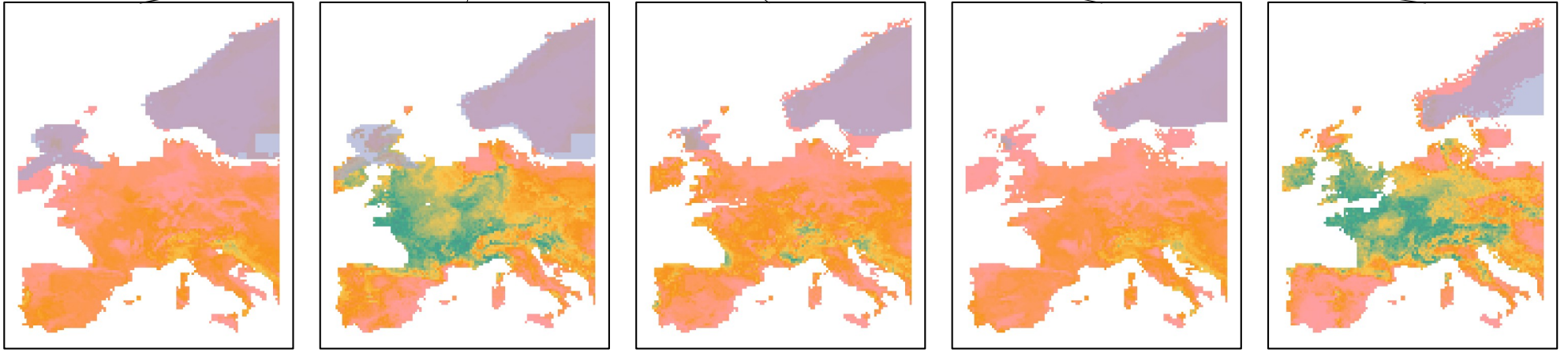


Random Forest



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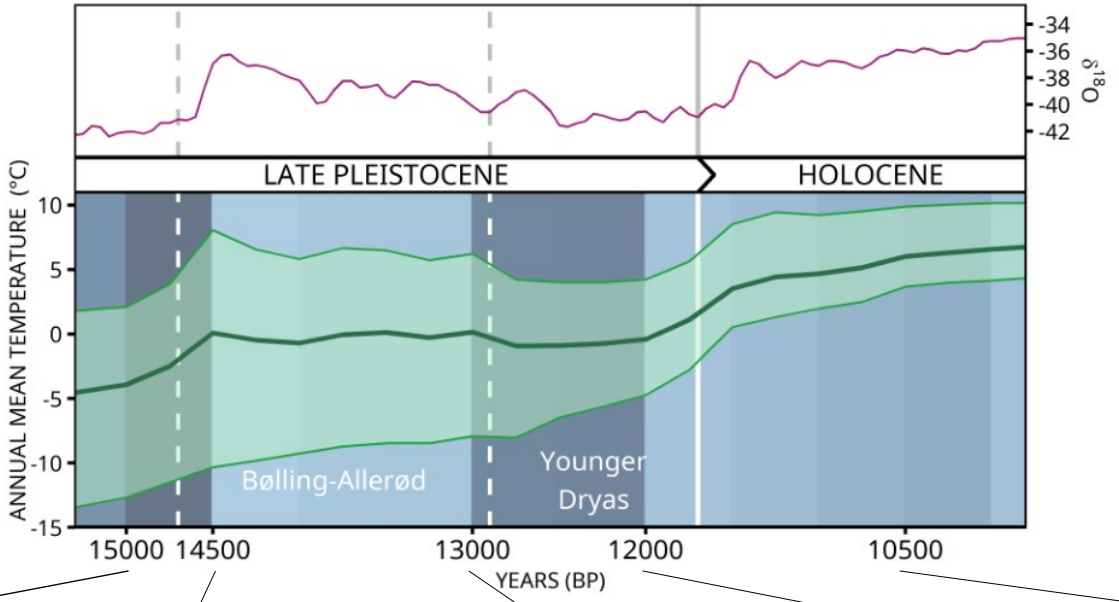
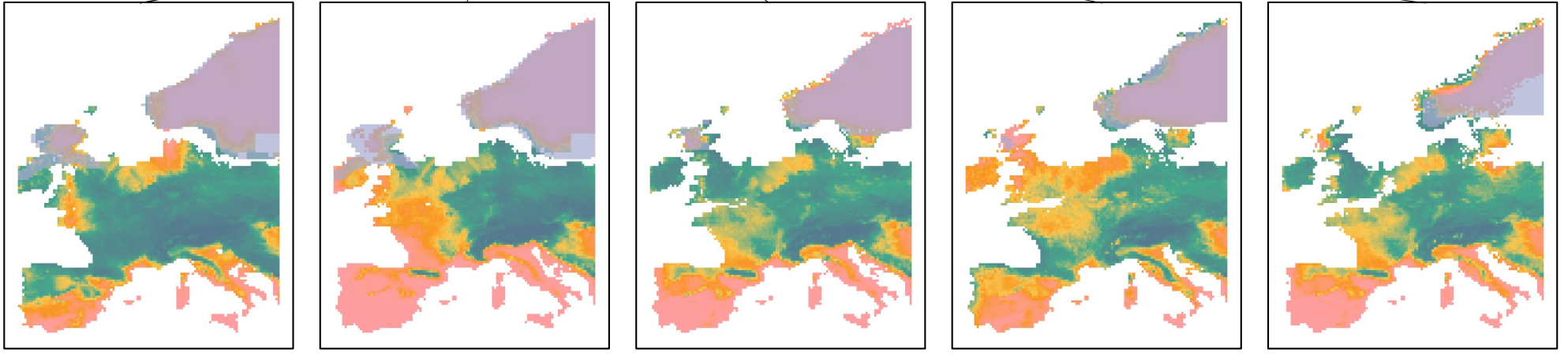


Lasso GLM



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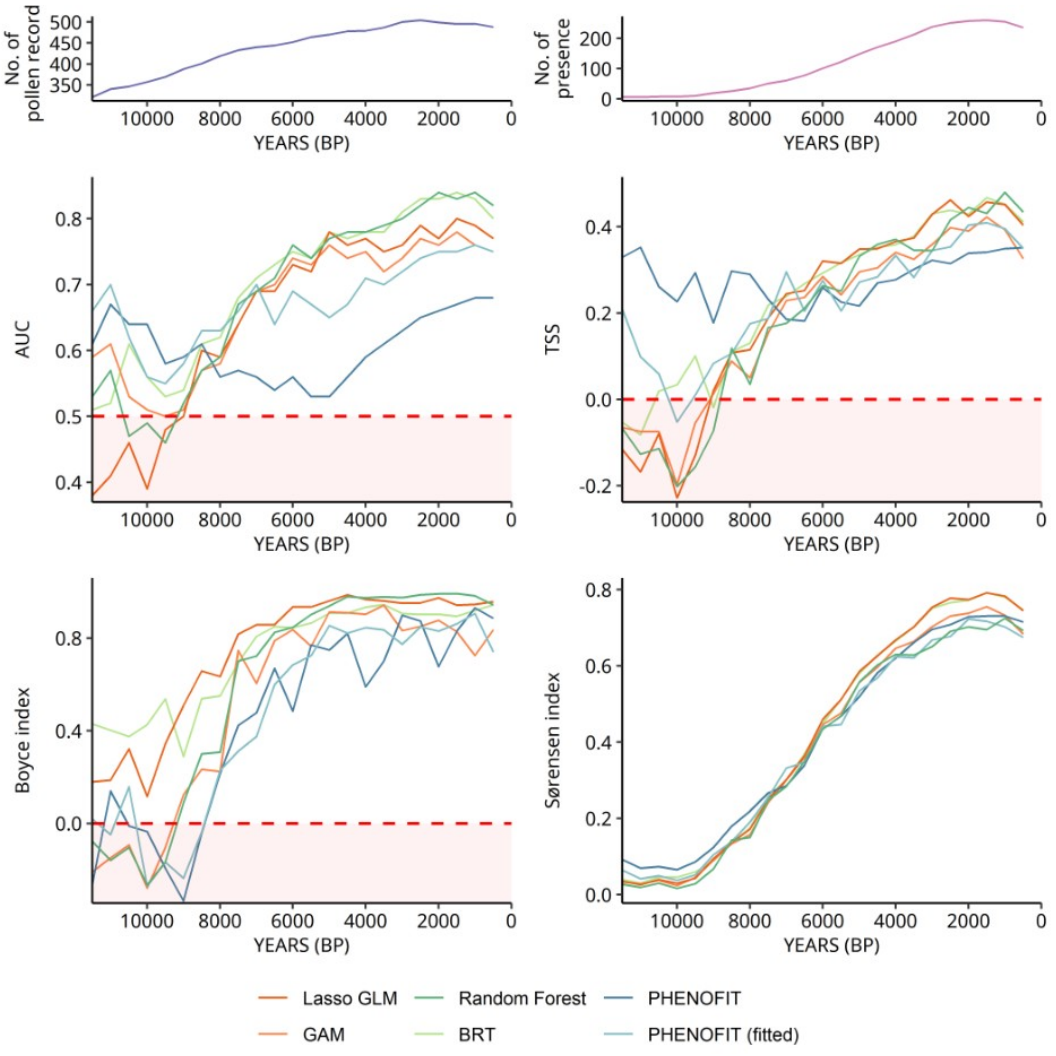
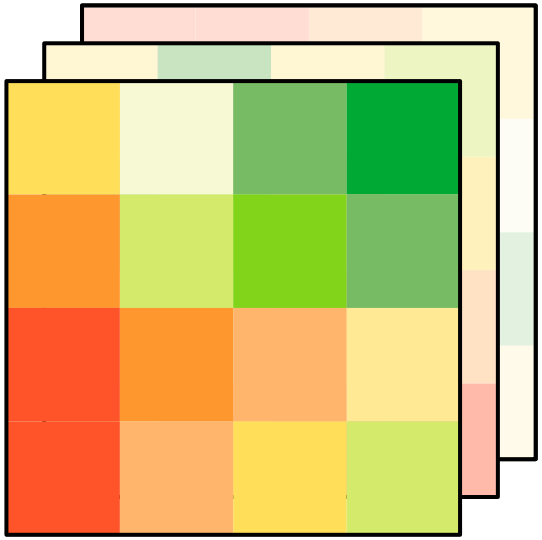


Novelty metrics: climatic distance

PAST CLIMATE

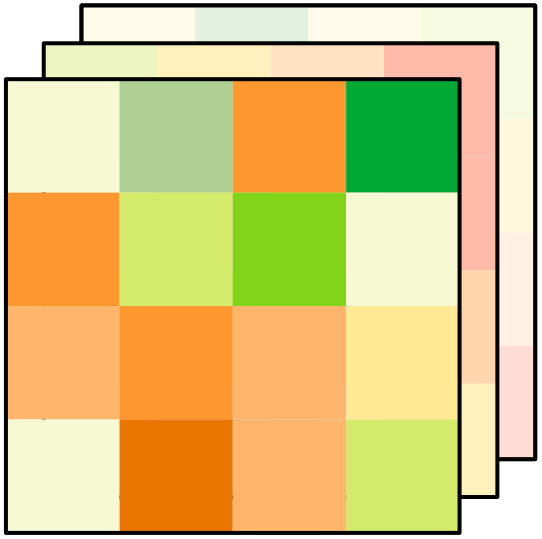
e.g. 9000 years BP



N predictors

BASELINE CLIMATE

1970 - 2000



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Novelty metrics: climatic distance

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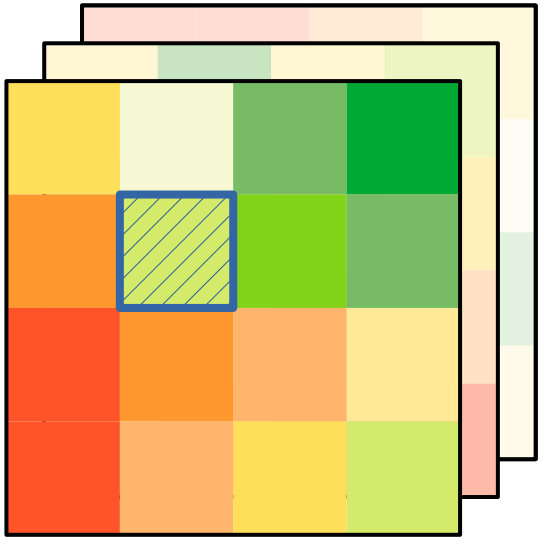
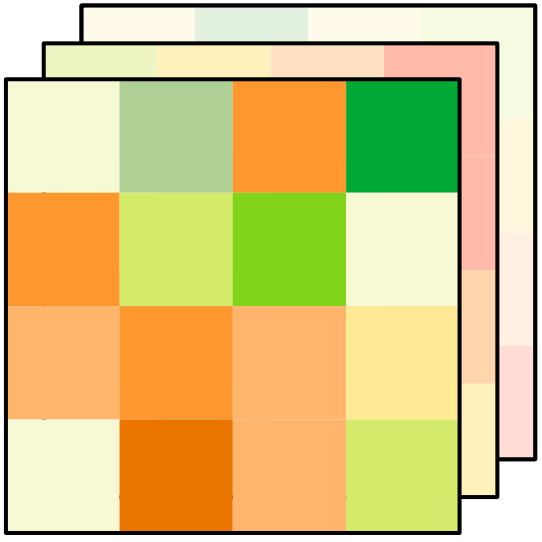


BASELINE CLIMATE

1970 - 2000



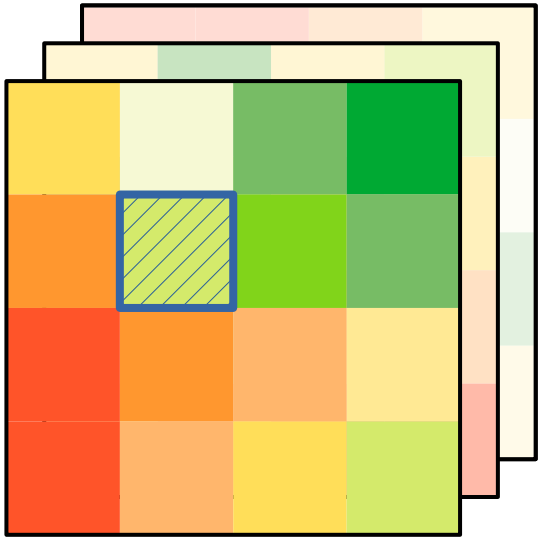
From each cell:

{ ; ; ... }

Novelty metrics: climatic distance

PAST CLIMATE

e.g. 9000 years BP



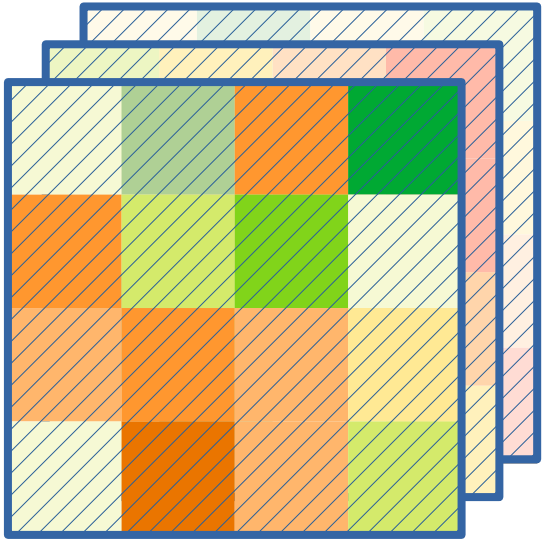
Minimum

Euclidean distance

(N-dimensional)

BASELINE CLIMATE

1970 - 2000



From each cell:

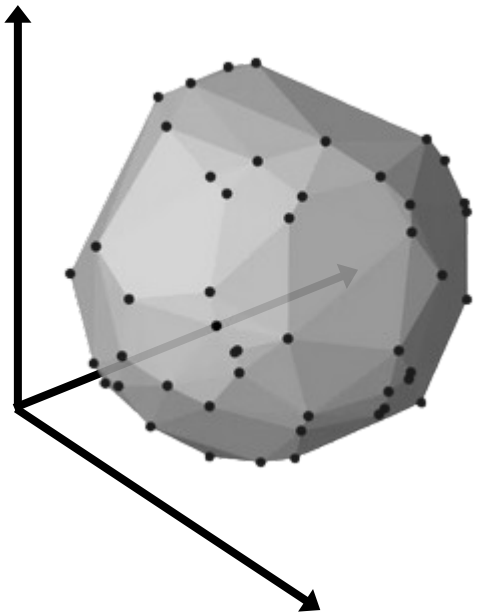
{ ; ; ... }

To the set of all cells
in the calibration period

Novelty metrics: hypervolume similarity

PAST CLIMATE

e.g. 9000 years BP

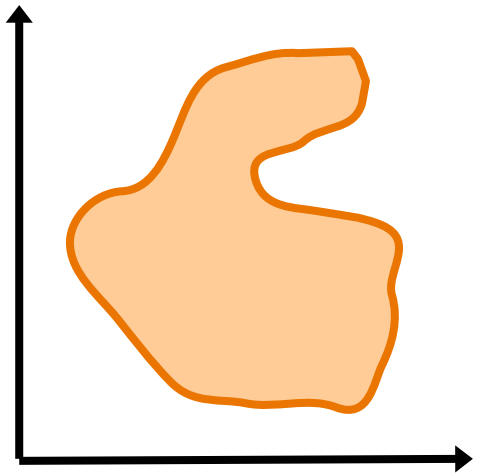


N-dimensional hypervolume

Novelty metrics: hypervolume similarity

PAST CLIMATE

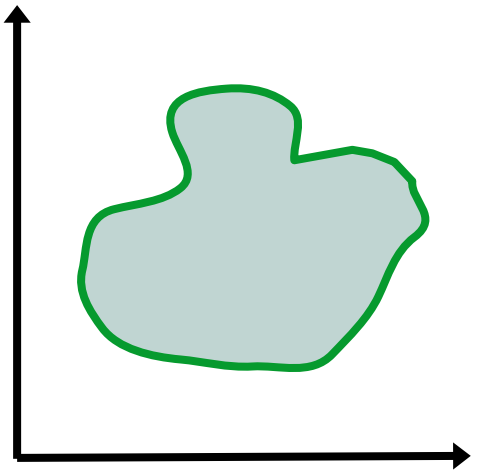
e.g. 9000 years BP



N-dimensional hypervolume

BASELINE CLIMATE

1970 - 2000

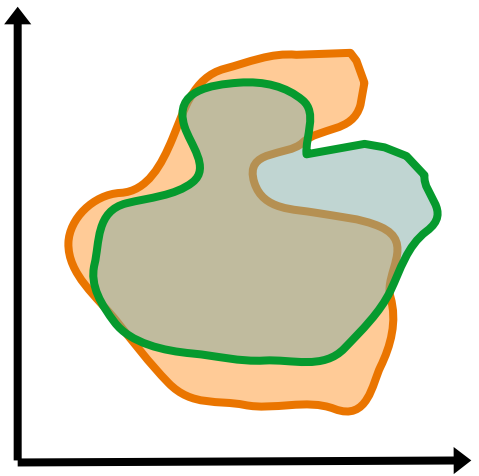


N-dimensional hypervolume

Novelty metrics: hypervolume similarity

PAST CLIMATE
e.g. 9000 years BP

BASELINE CLIMATE
1970 - 2000

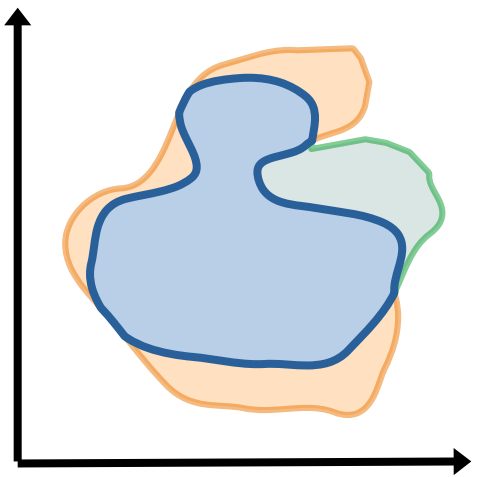


Novelty metrics: hypervolume similarity

PAST CLIMATE
e.g. 9000 years BP

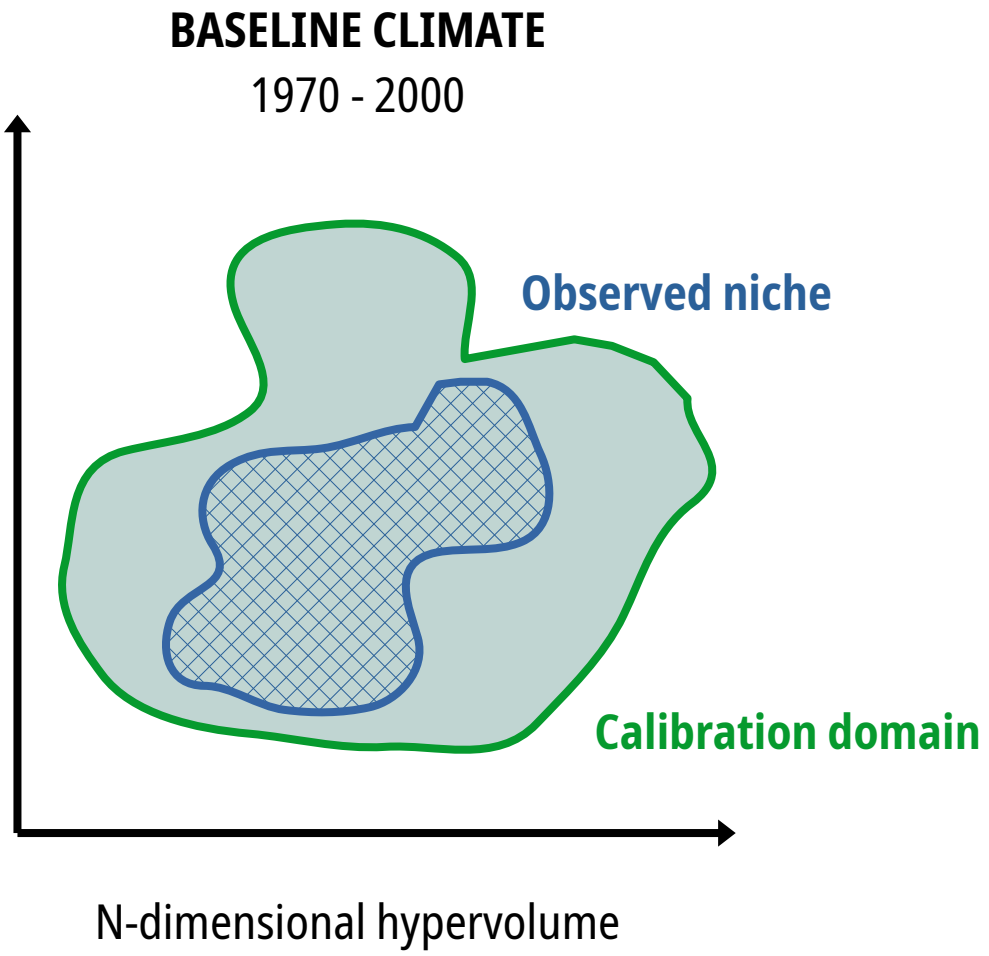
BASELINE CLIMATE
1970 - 2000

Hypervolume overlap

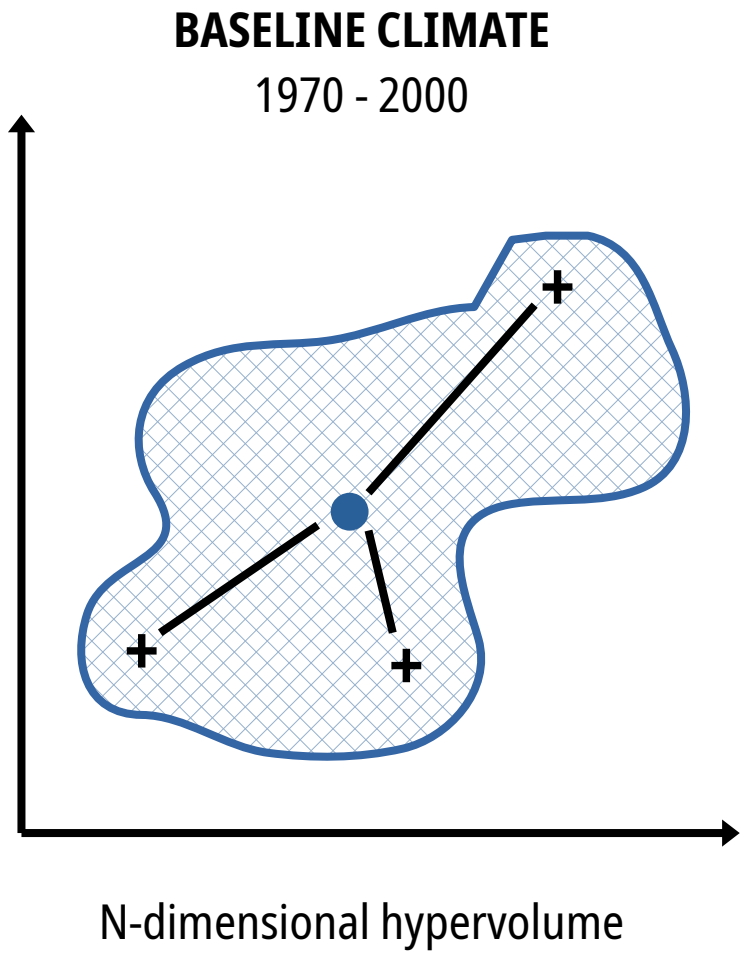


(Sørensen similarity)

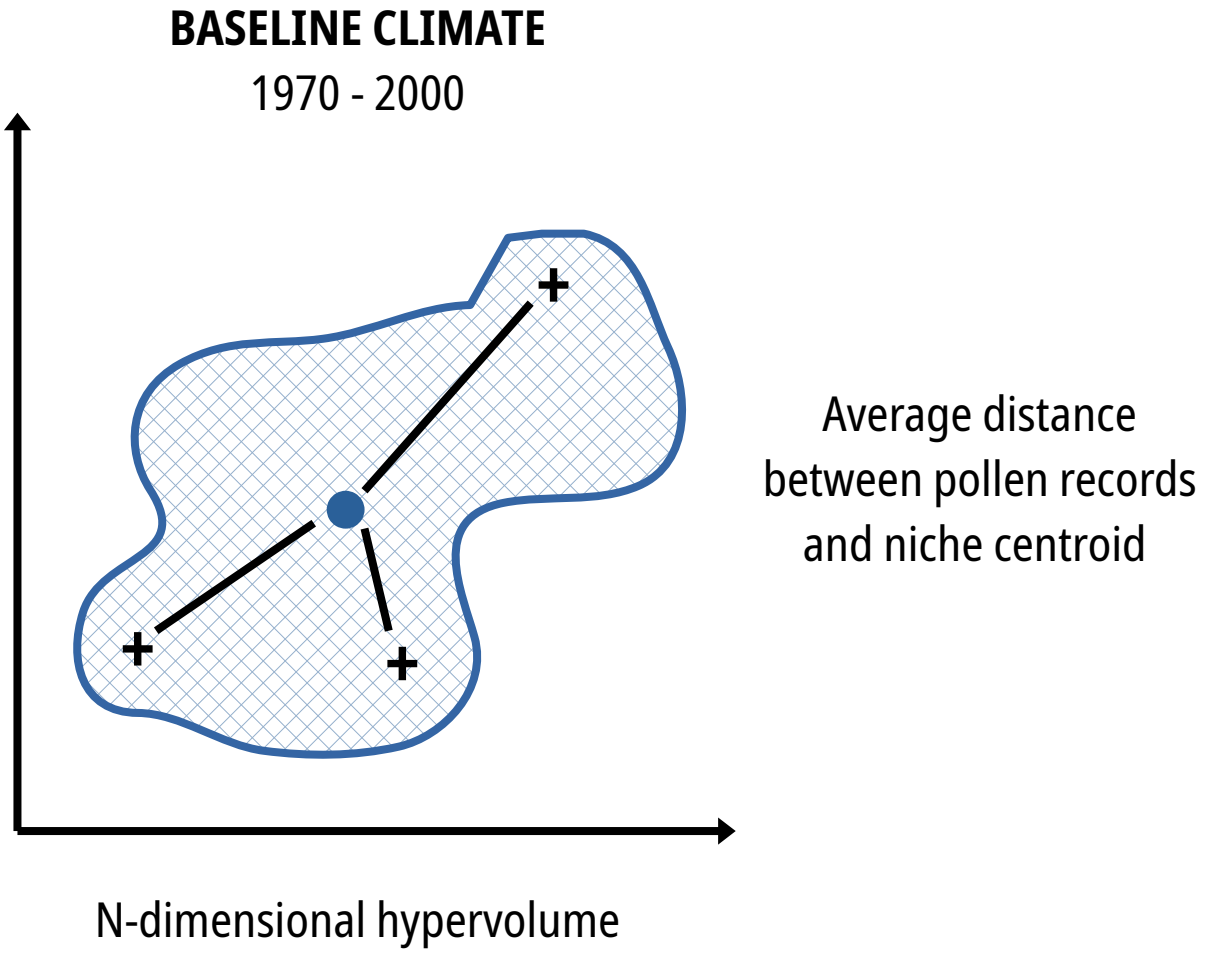
Novelty metrics: average distance to niche centroid



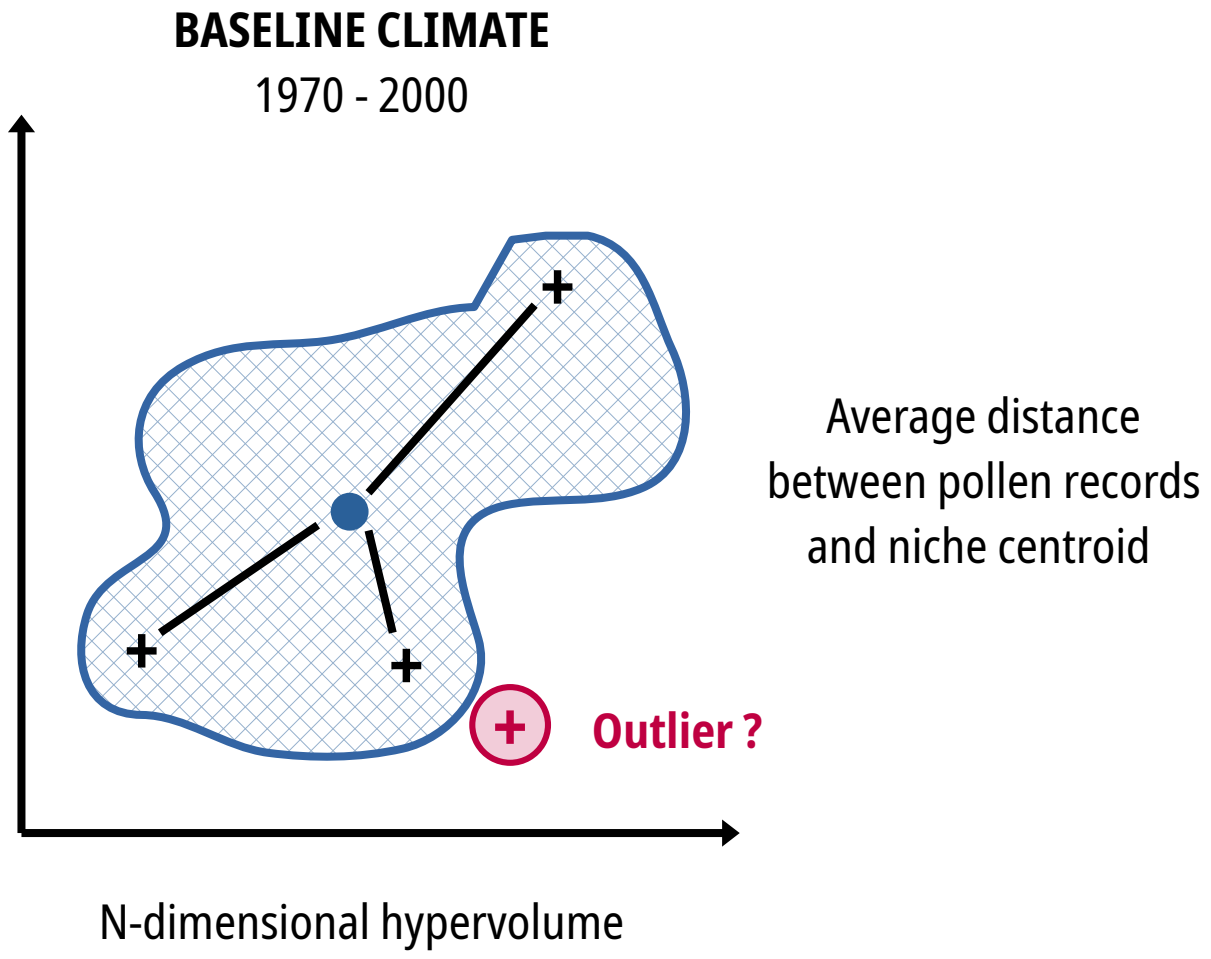
Novelty metrics: average distance to niche centroid



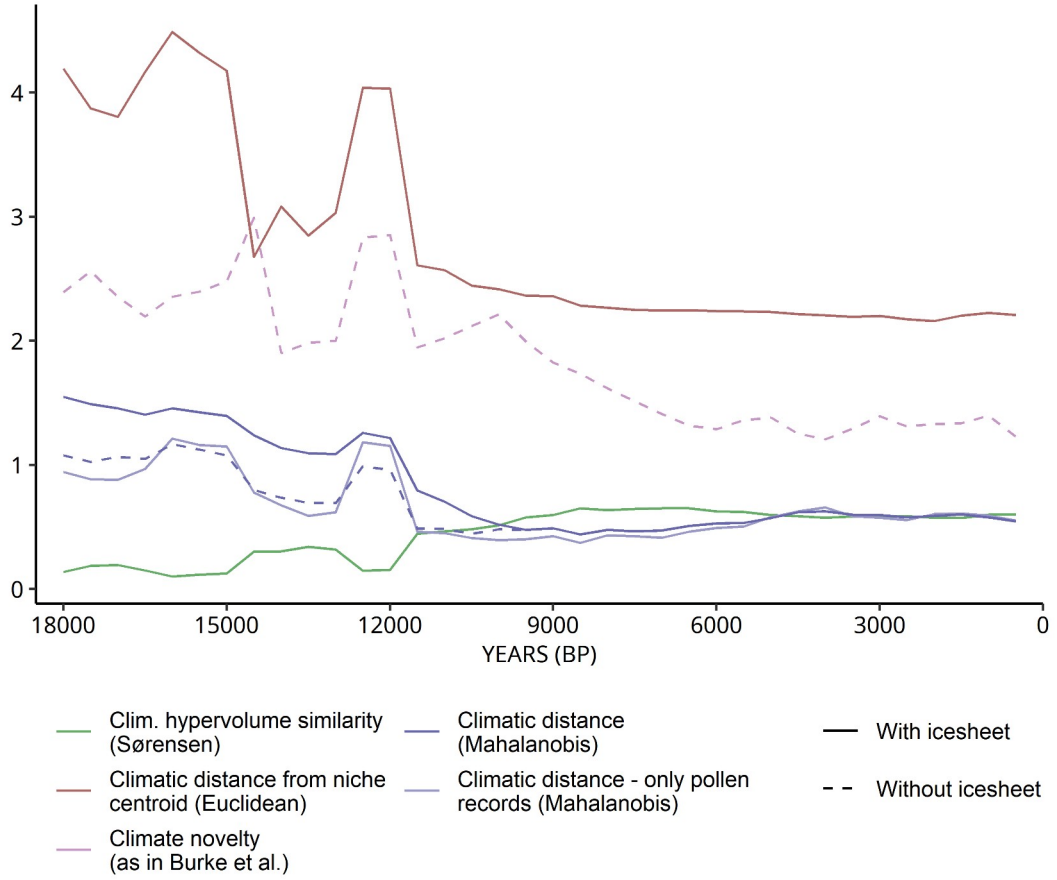
Novelty metrics: average distance to niche centroid



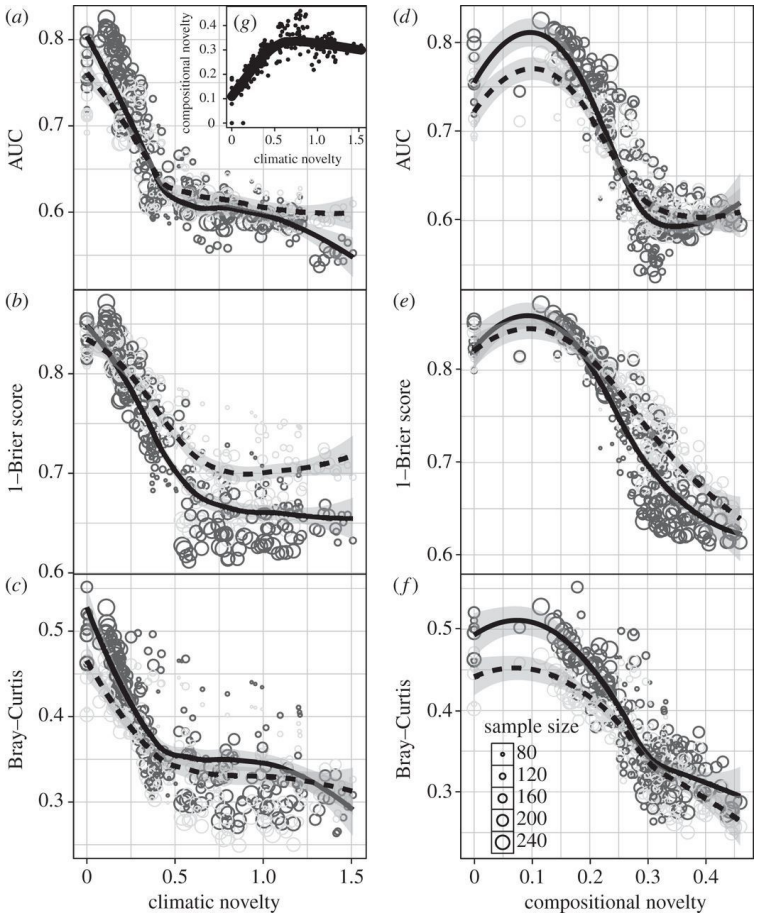
Novelty metrics: average distance to niche centroid



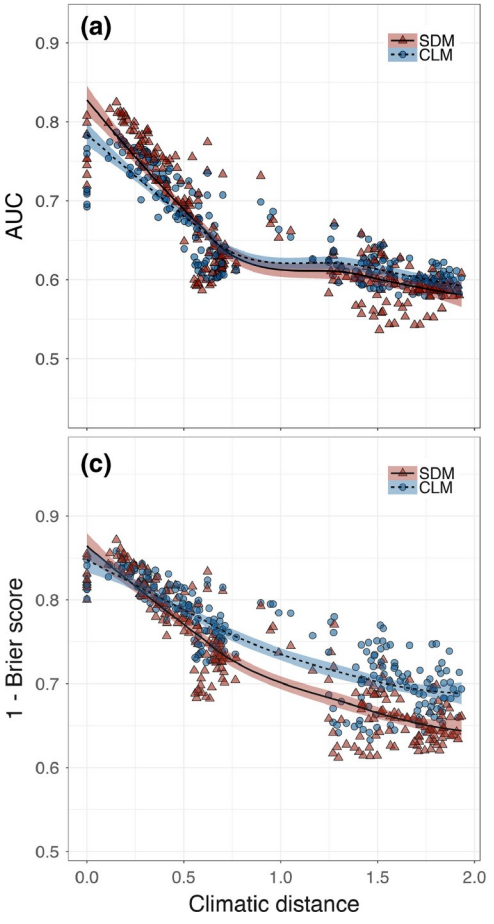
Novelty metrics



Model performance against novelty: previous studies



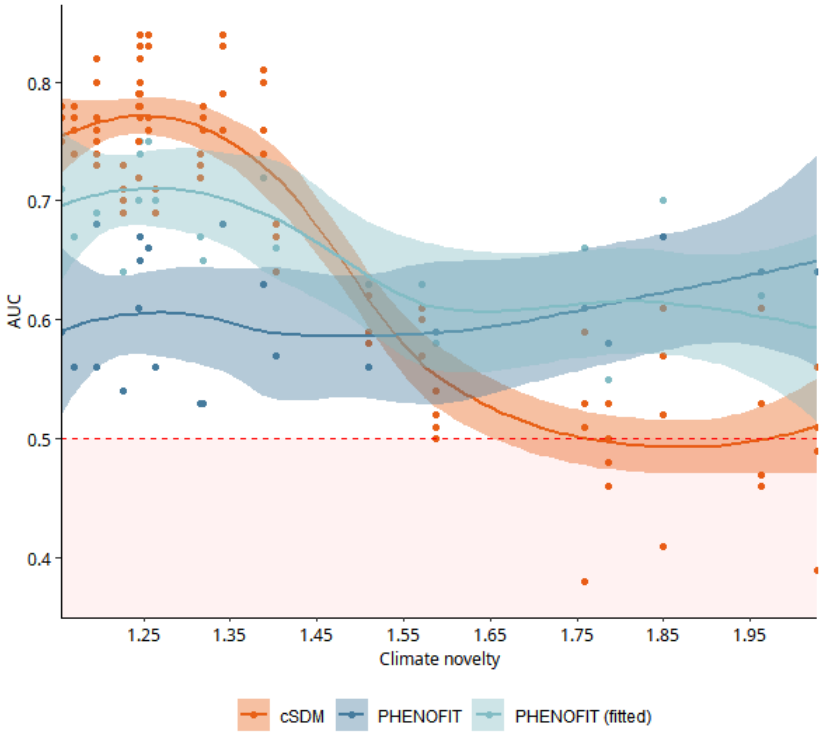
Maguire et al. (2016)

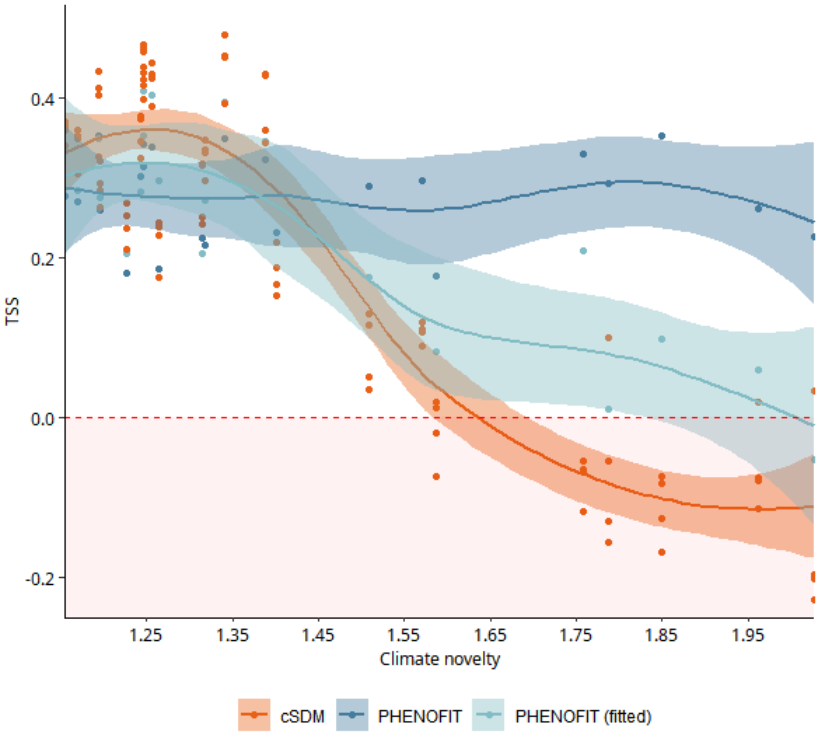


Fitzpatrick et al. (2018)

Model performance against novelty: preliminary results

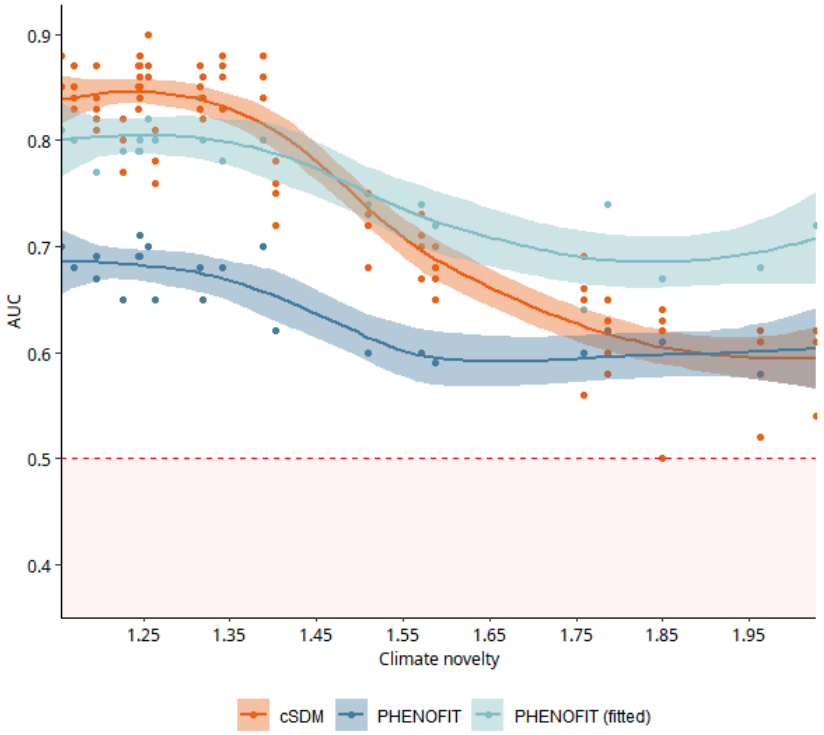
Fagus sylvatica

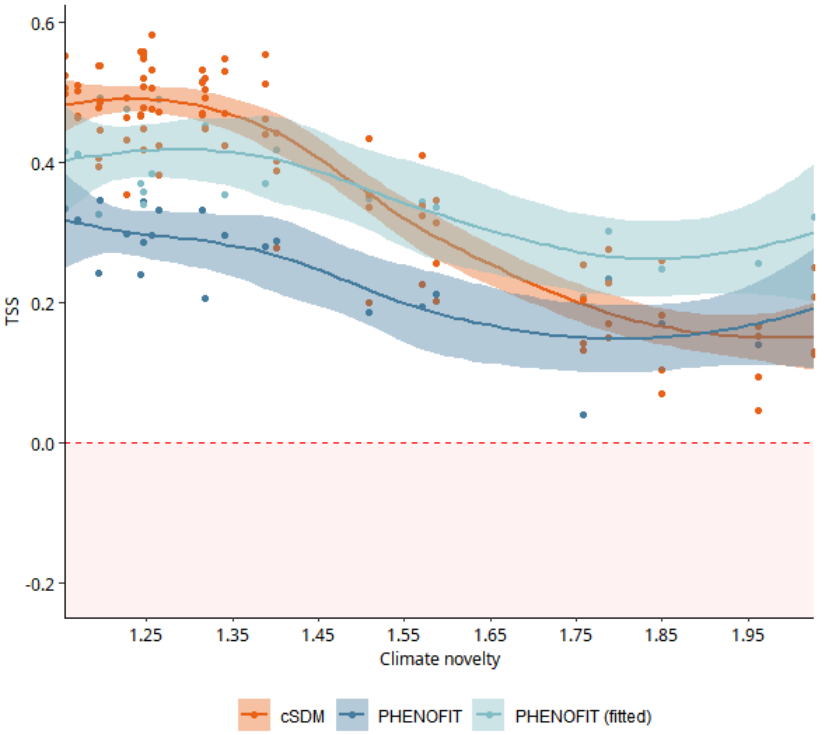




Model performance against novelty: preliminary results

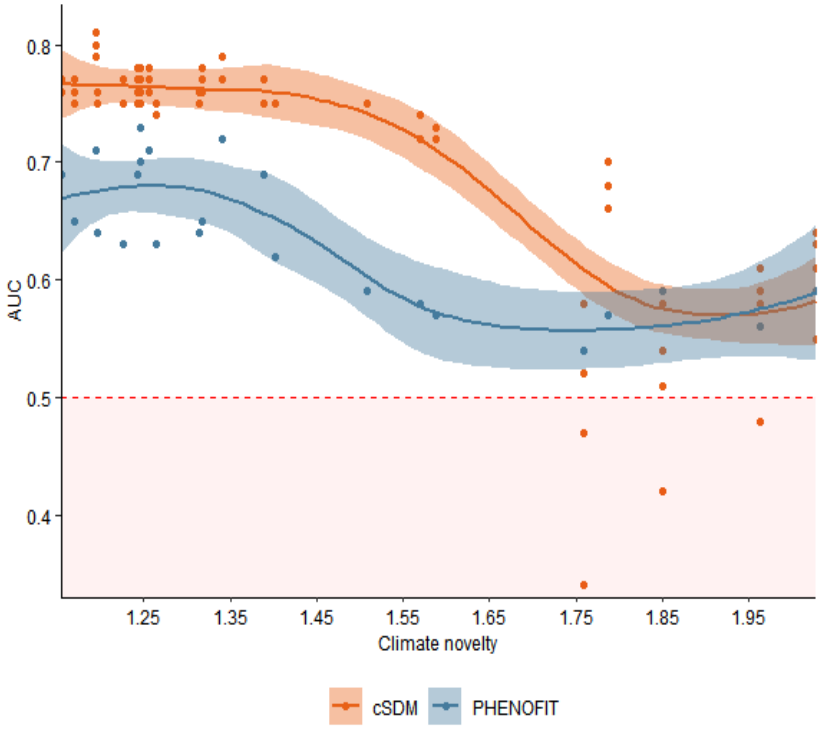
Abies alba

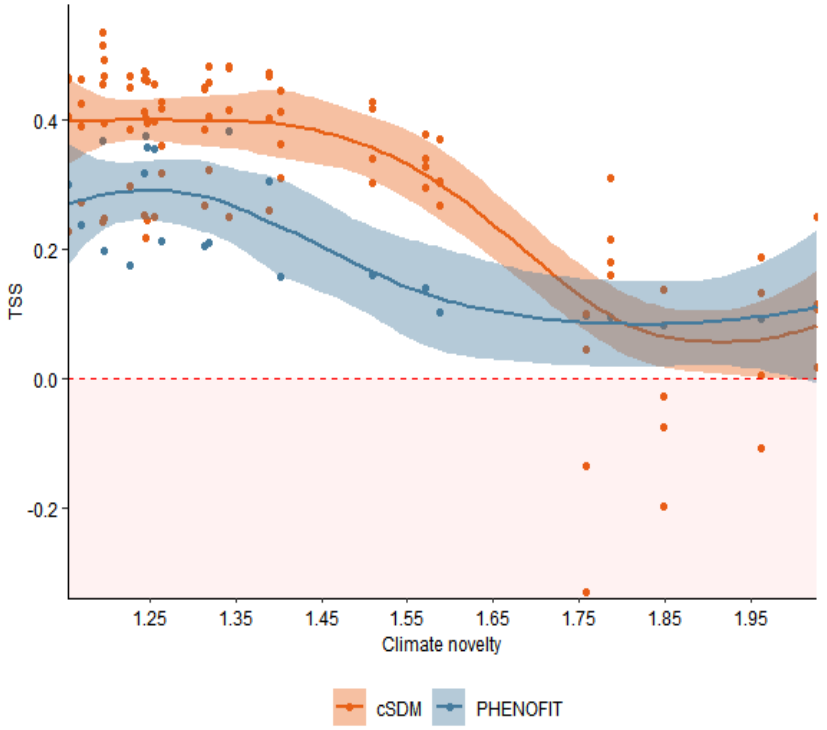




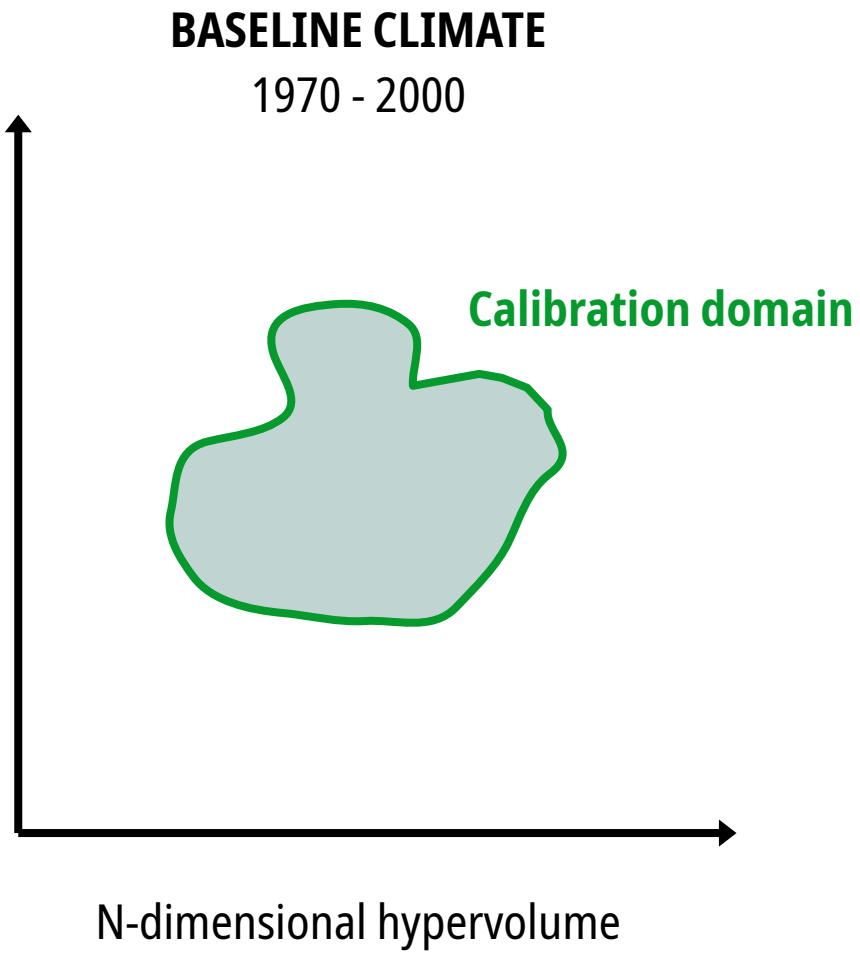
Model performance against novelty: preliminary results

Quercus (deciduous)



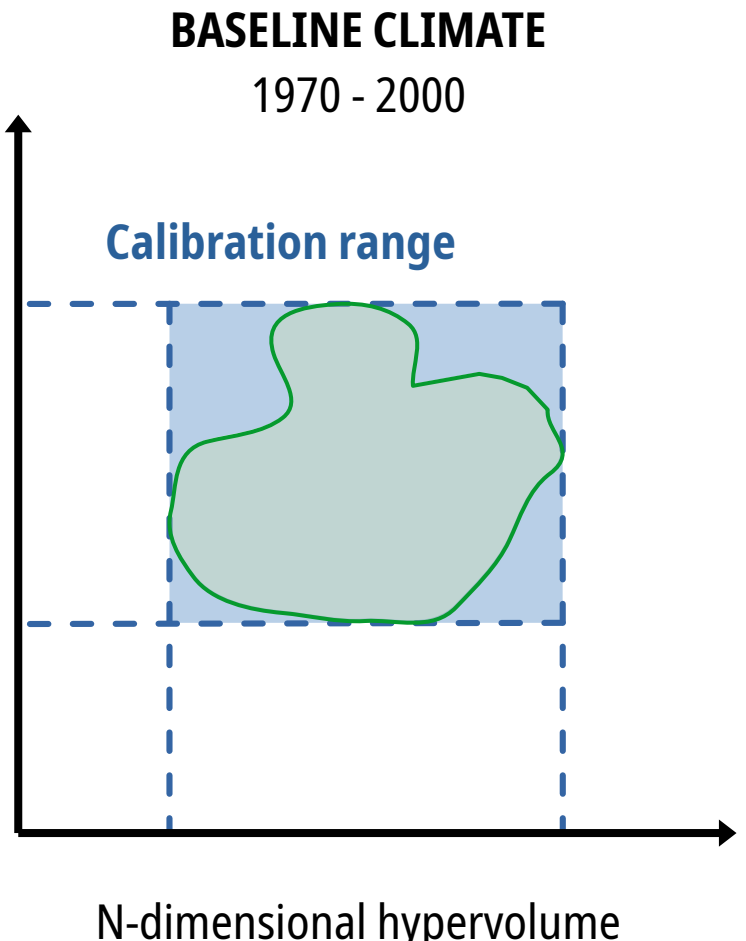


Response curves in different conditions



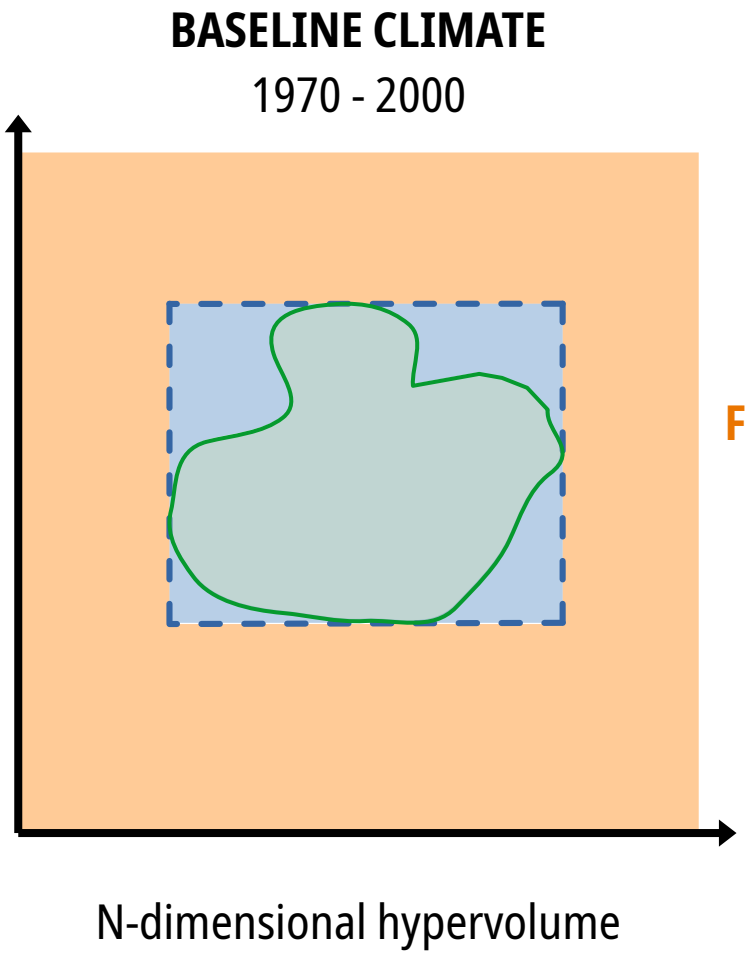
Qiao et al. (2019)

Response curves in different conditions



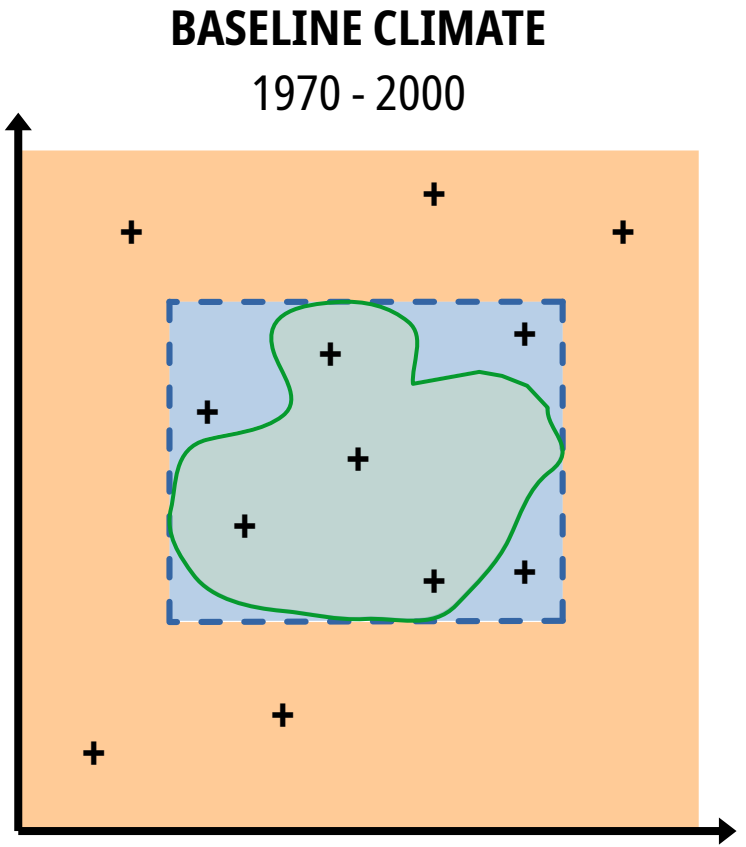
Qiao et al. (2019)

Response curves in different conditions



Qiao et al. (2019)

Response curves in different conditions



Qiao et al. (2019)

Response curves in different conditions