Marine Ecological Modelling Global Climate Change

Principles of Ecological Niche Modelling

Jorge Assis, PhD // jmassis@ualg.pt // jorgemfa.medium.com
2022, Centre of Marine Sciences, University of Algarve

Ecological Niche Modelling**

Process of using **computer algorithms to estimate and predict** the **relationship between the distribution of biodiversity and the environmental conditions**.

Provides insights about **species environmental tolerances and habitat preferences**, and allows **making spatial predictions** of geographical distributions.

** also known as environmental niche modelling, species distribution modelling, habitat distribution modelling, …

Main approaches in ENM

Mechanistic modelling

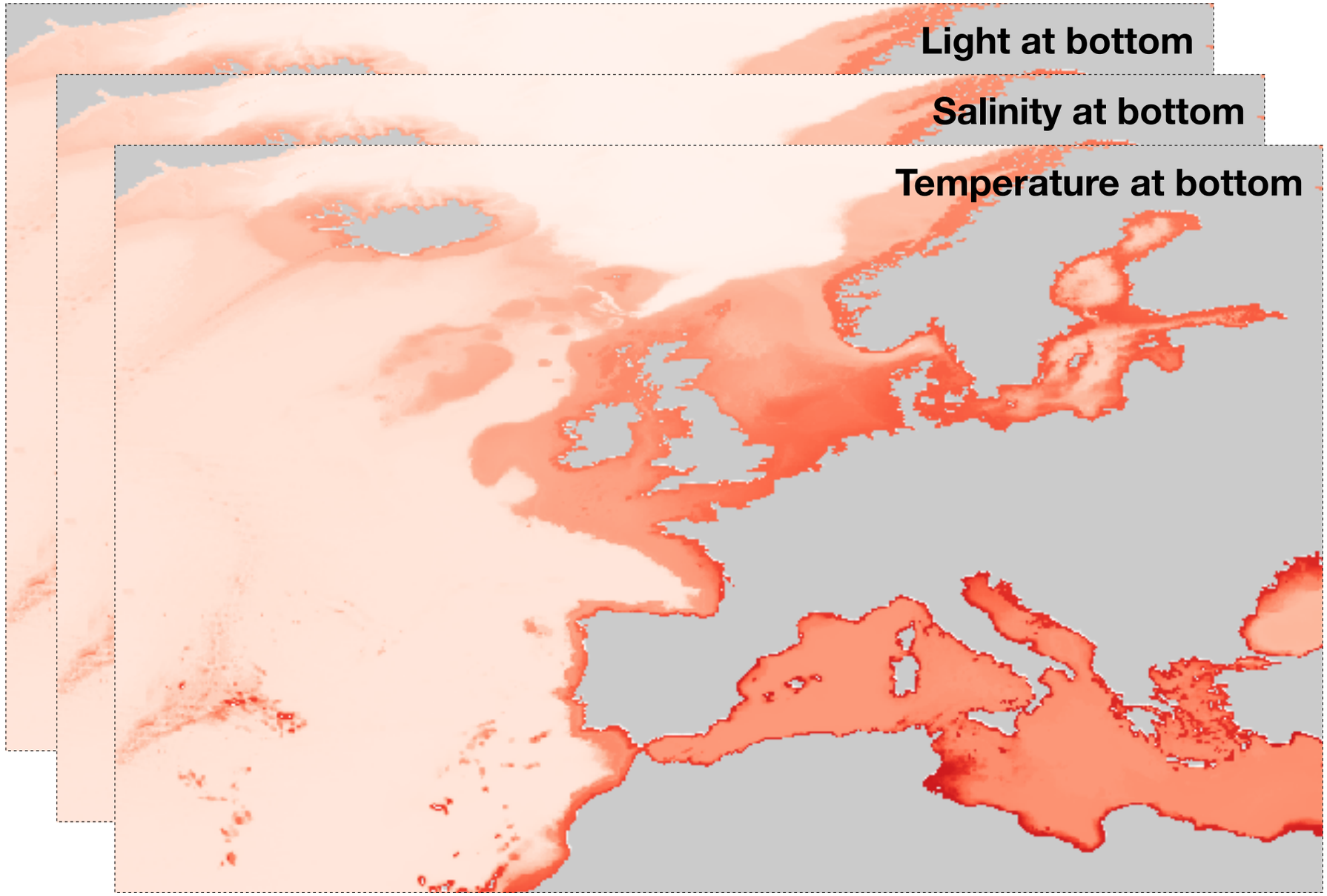
Uses **information about the physiological response of species to environmental conditions.**

(e.g., needs data on the effect of temperature on species survival; not always available).

Correlative modelling

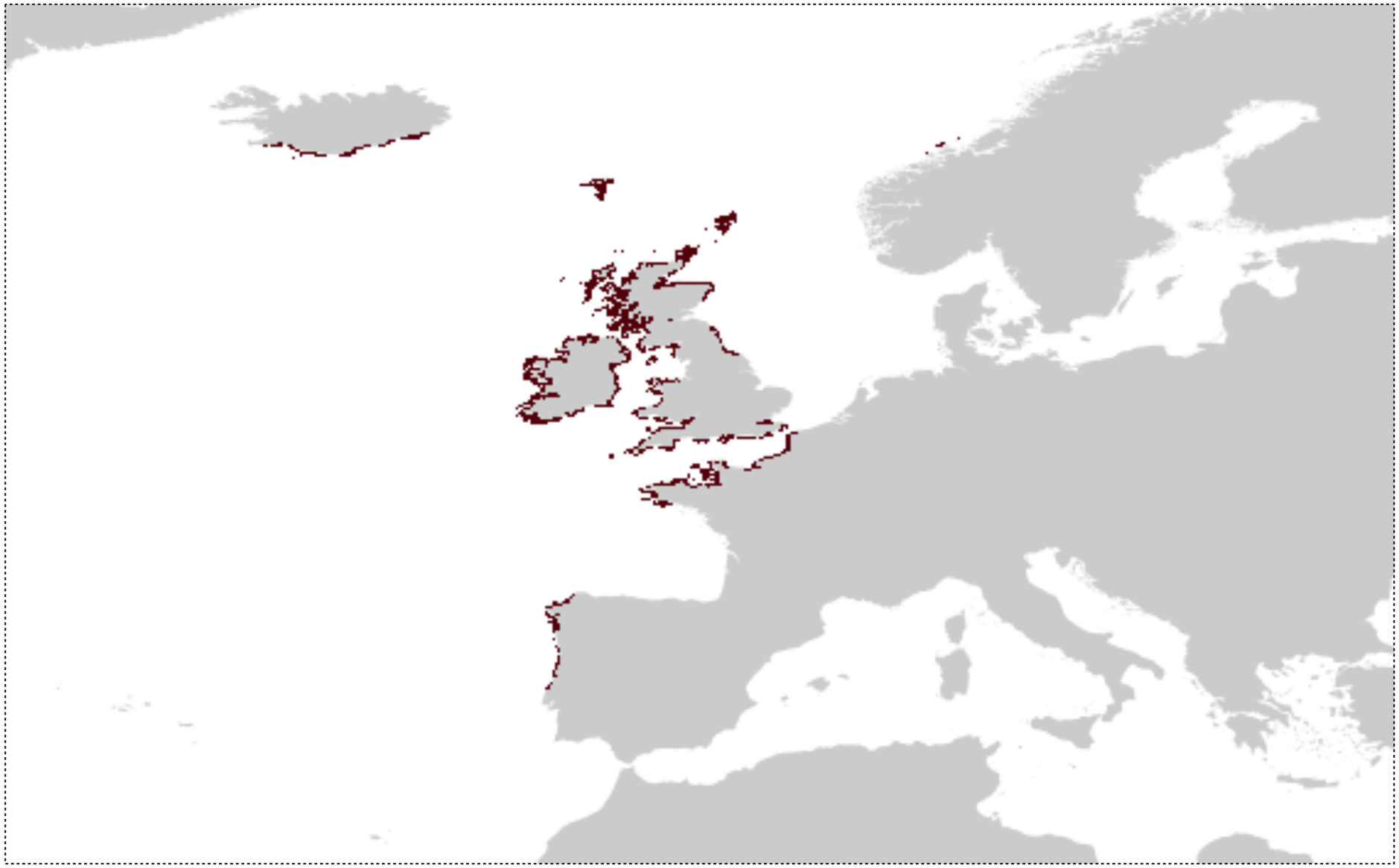
Based on the statistical **correlation between presence records and the environment**, under the assumption that the **distribution of a species is an indicator of its environmental requirements.**

(i.e., niche theory; the fact that a species occurs is a particular place is linked to its tolerance to the conditions of such place).



Mechanistic distribution models

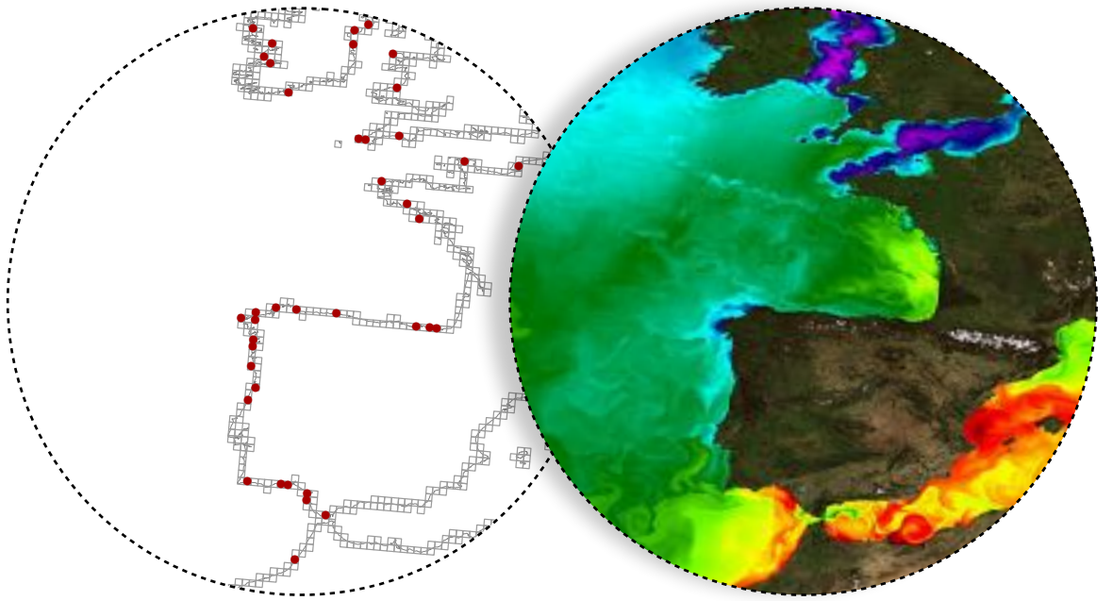
Built by **reclassifying environmental gradients with tolerance limits inferred from physiological experiments**.



Mechanistic distribution models

A straightforward approach to predict the distribution of species.

Presence = [**Light** > 5 E.m^{2}.year^{-1}] ∩ [5°C <= **Temperature** <= 20.5°C]



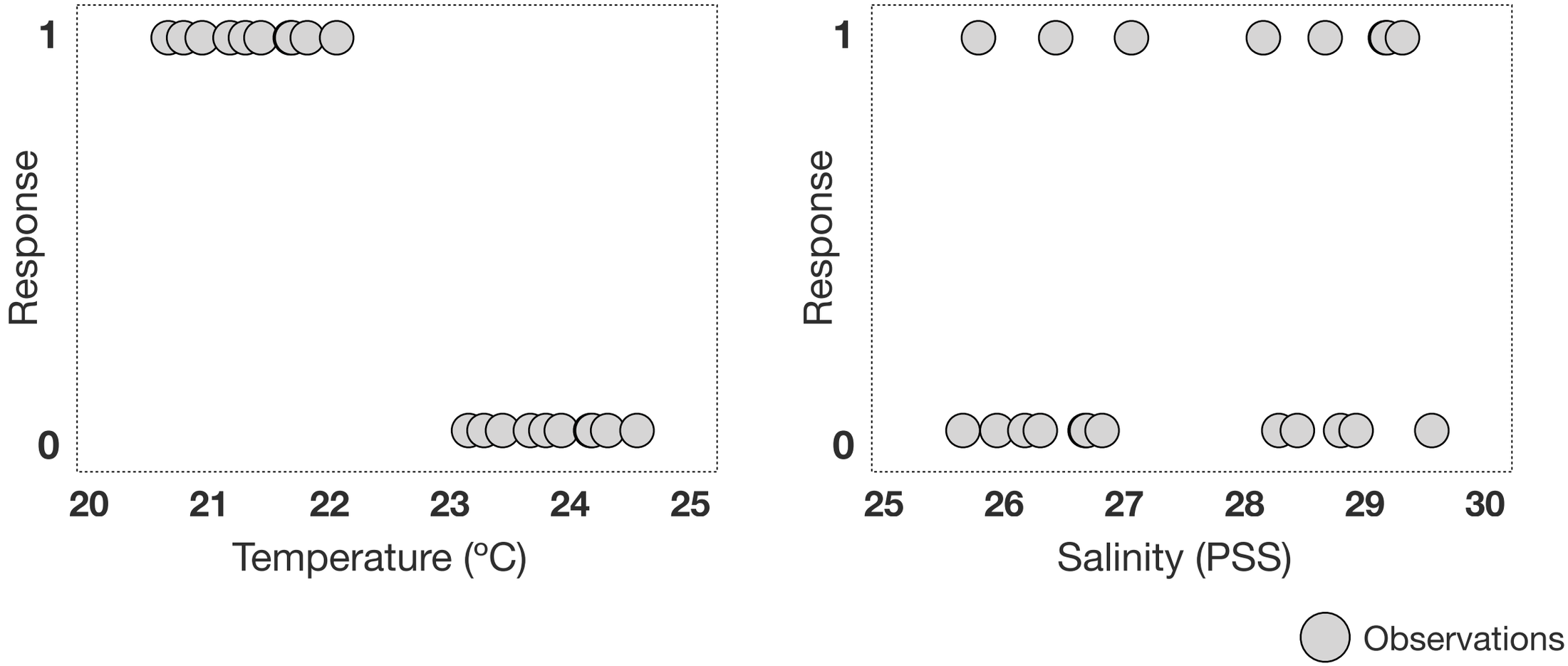
Occurrence **Environment**

Resp	TempMax	Nitrate	Salinity
1	21	3	27
1	22	2	28
1	21	3	30
1	20	3	26
1	21	2	26
1	22	2	26
0	23	1	27
0	24	0	30
0	23	0	28
0	25	1	27
0	23	0	26
0	23	0	26

Data for modelling

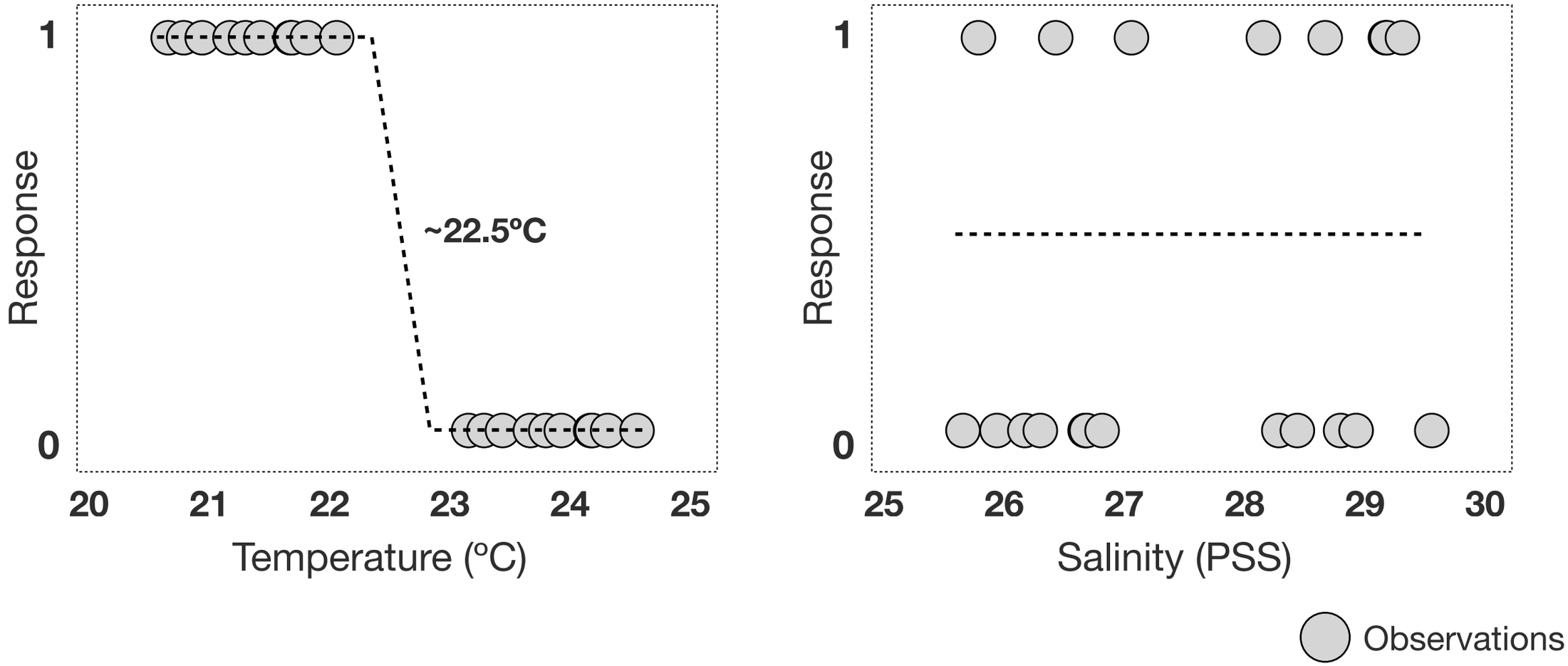
Correlative distribution models

Describe the **statistical relationship between distribution records and environmental conditions at those sites.** The **models should be evaluated for “ecological realism” - consistency with ecological knowledge of limiting factors** and species response curves.



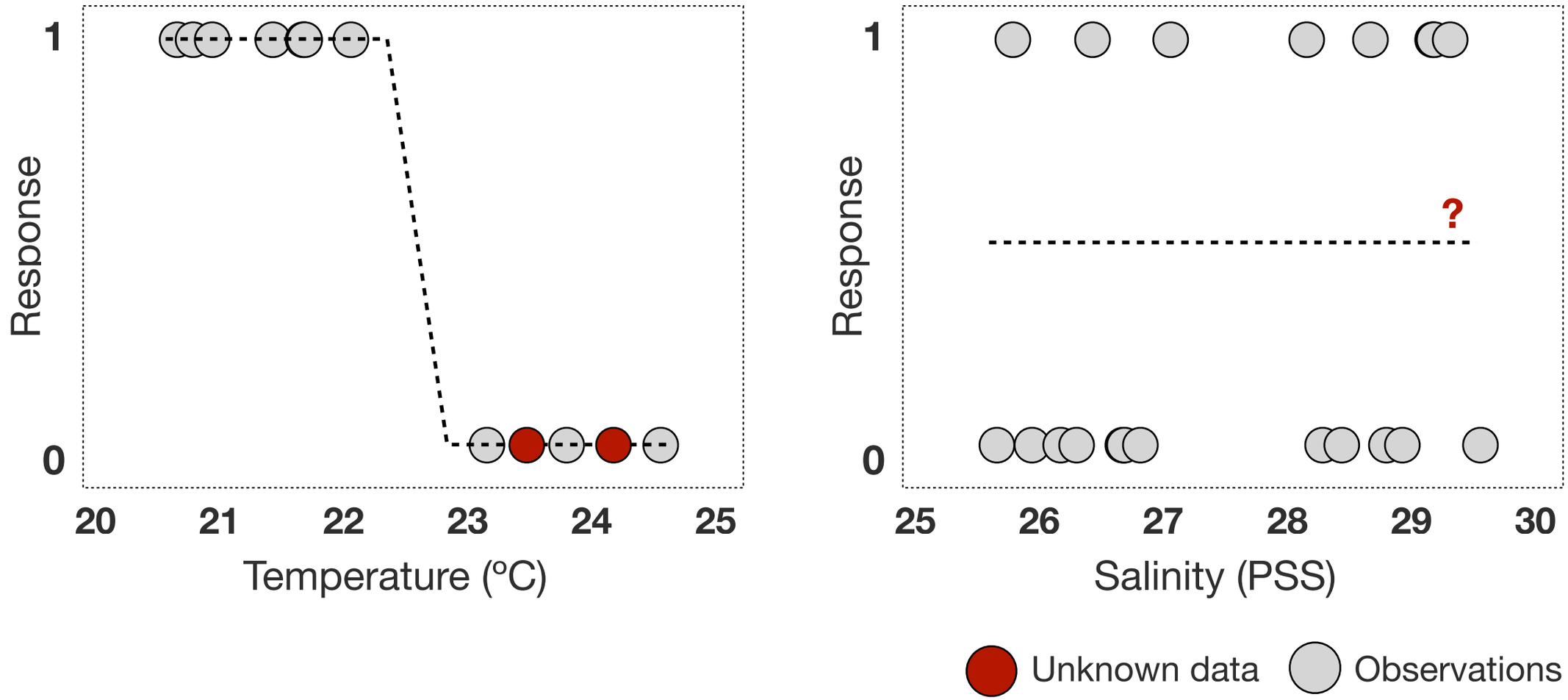
Correlative distribution models

Describe the **statistical relationship between distribution records and environmental conditions at those sites.** The **models should be evaluated for "ecological realism" - consistency with ecological knowledge of limiting factors** and species response curves.



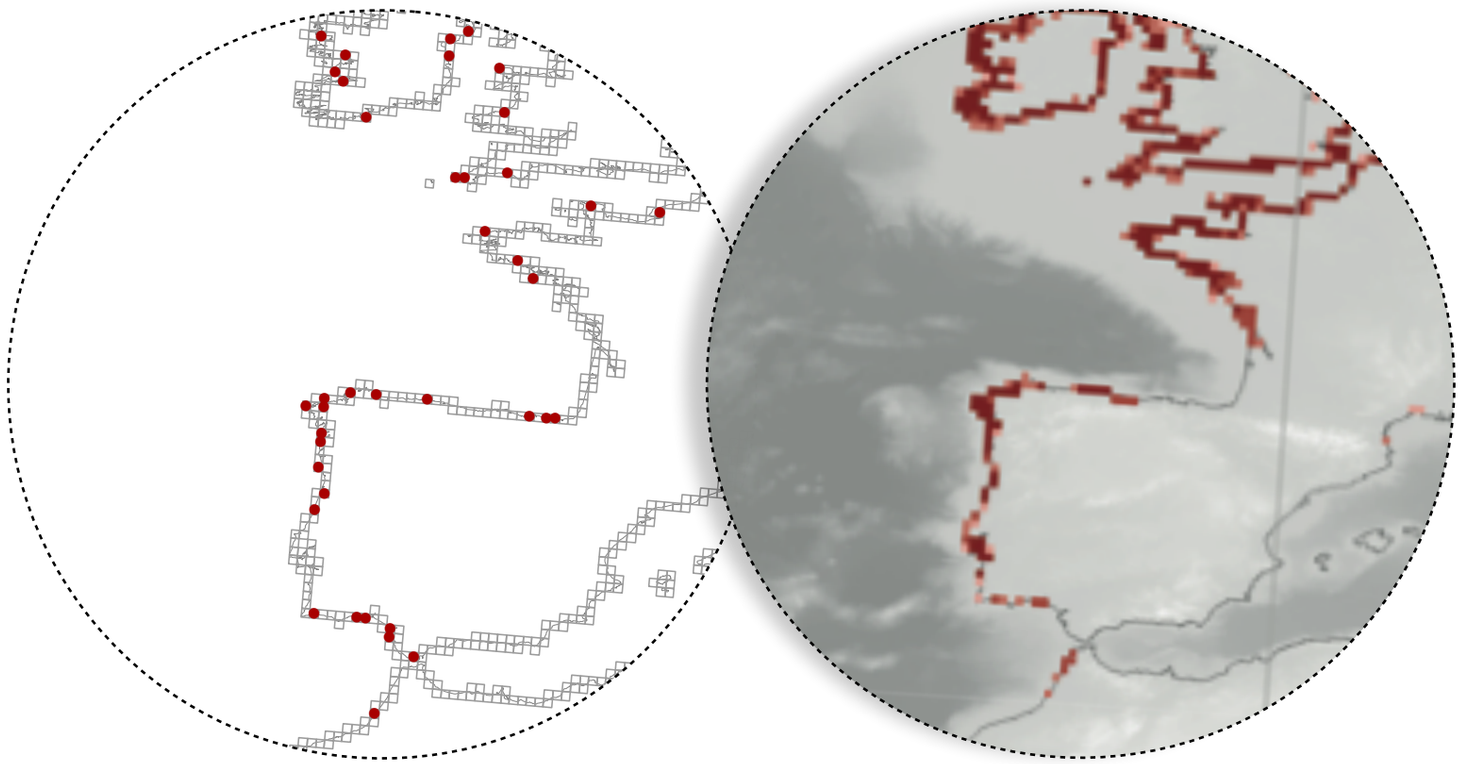
Correlative distribution models

Describe the **statistical relationship between distribution records and environmental conditions at those sites**. The **models should be evaluated for "ecological realism" - consistency with ecological knowledge of limiting factors** and species response curves.



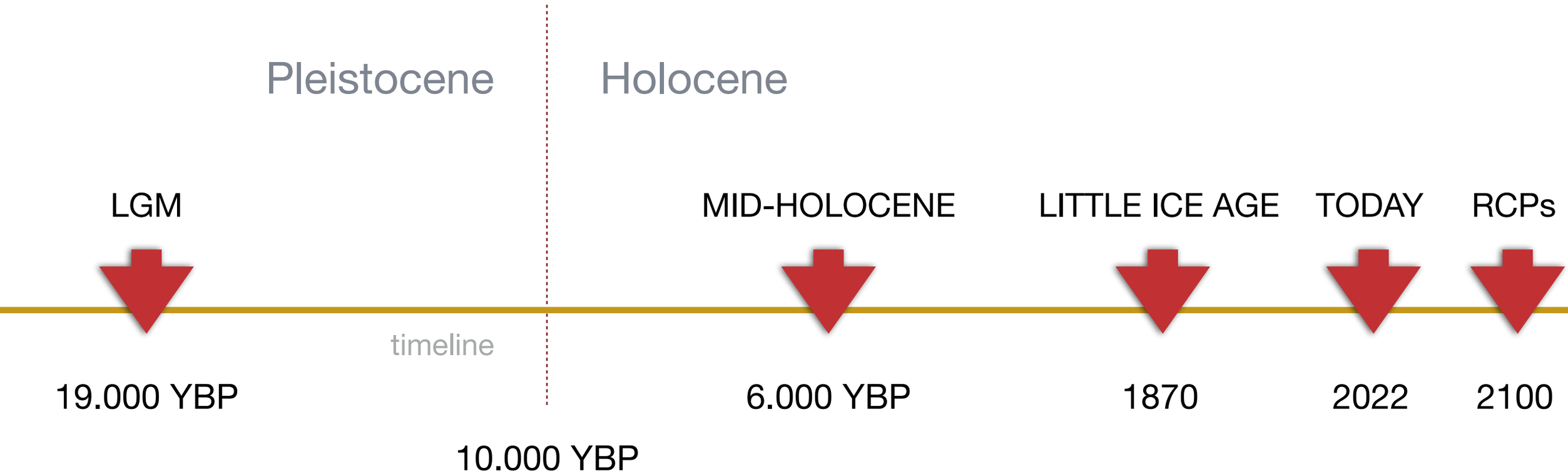
If a model can explain the relationship between distribution records and environmental variables, we can **make predictions to unknown samples (unsurveilled regions)**.

e.g., Temp. = 23.5ºC or 24.5ºC, response is 0 (i.e., absence).



By making predictions to unknown samples we can make maps of the likelihood of finding a species.

e.g., **From scattered records to continuous distribution surfaces**.



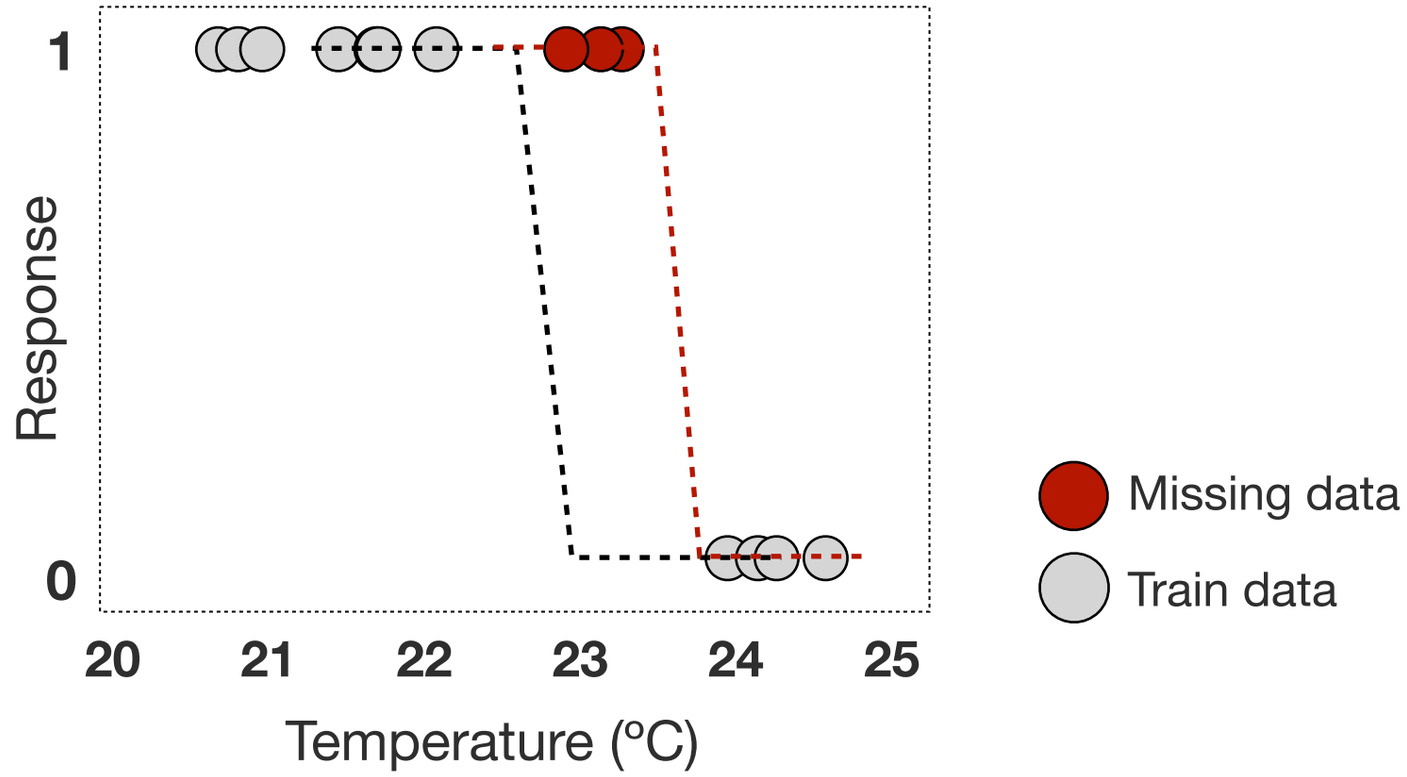
Model-based transferability

Made to **unsurveilled geographic or temporal domains**.

Corrective models can identify the **niche of a species only if the records used to fit the models cover the distribution of the species**.

When mapped, it represents the **potential distribution or the habitat suitability**.

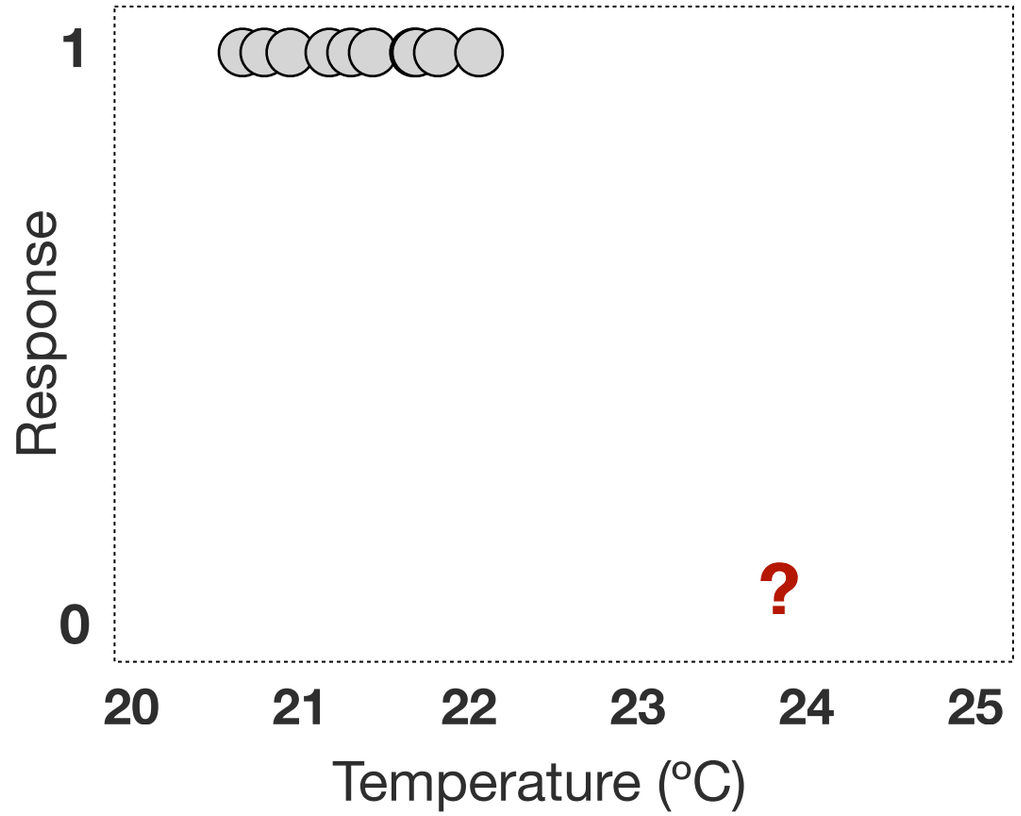
If records are insufficient, the models do not identify the fundamental niche; **the model fits only to the portion of the niche that is represented by the observed records** (truncated niche).



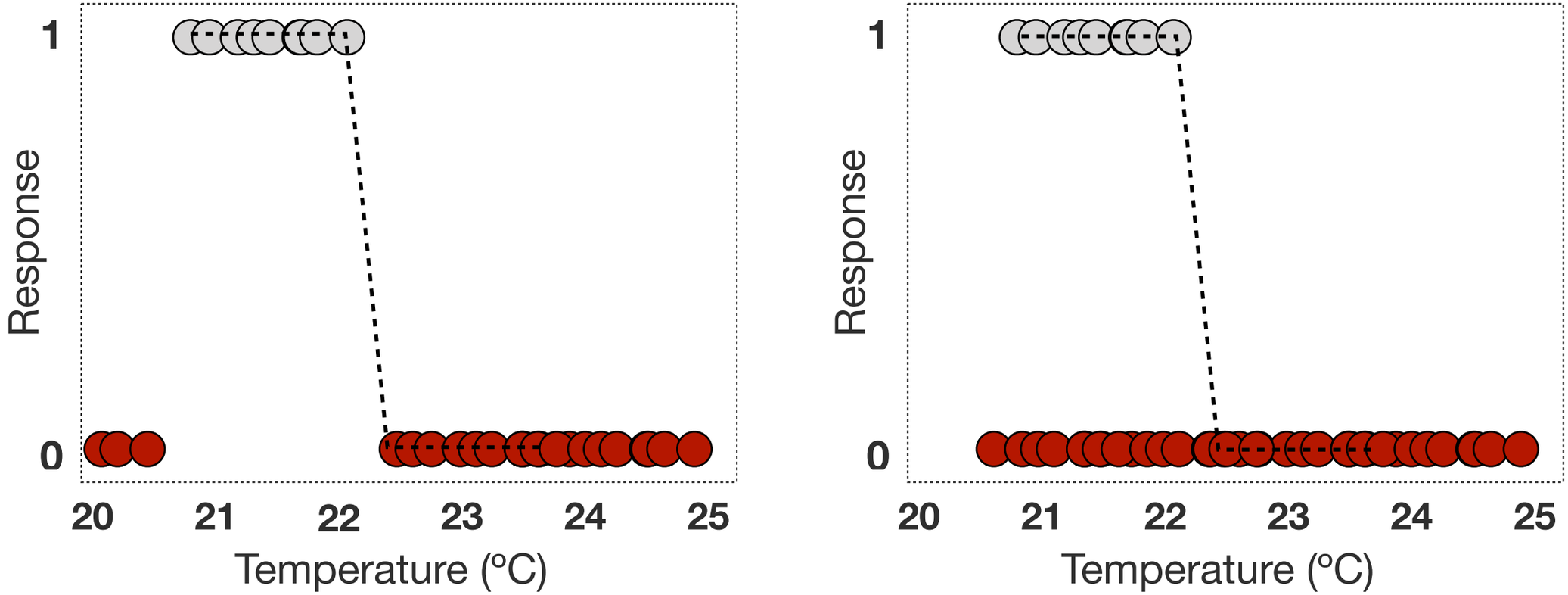
Corrective models can identify the **niche of a species only if the records used to fit the models cover the distribution of the species**.

When mapped, it represents the **potential distribution or the habitat suitability**.

If records are insufficient, the models do not identify the fundamental niche; **the model fits only to the portion of the niche that is represented by the observed records** (truncated niche).



Correlative models infer the **relationship between the occurrence of biodiversity and the environment**, but **absence records are often unavailable** or unknown, leading to **presence-only datasets** and to the need of developing **presence-only models**.



Models based on ‘pseudo-absences’, generated from the **study area where occurrences do not exist**. Any regression or machine learning algorithm can be implemented (e.g., GLM and BRT).

Models based on ‘background’, generated from the entire study area. Focus on **how the environment where the species occurs relates to the environment across** the rest of **the study area** (e.g., MaxEnt).