

Modelos de lógica difusa en el estudio de interacciones bióticas y su efecto en la distribución parapátrica de las víboras de la Península Ibérica



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Distribution of species



→ Factors that affect their survival and reproduction ←

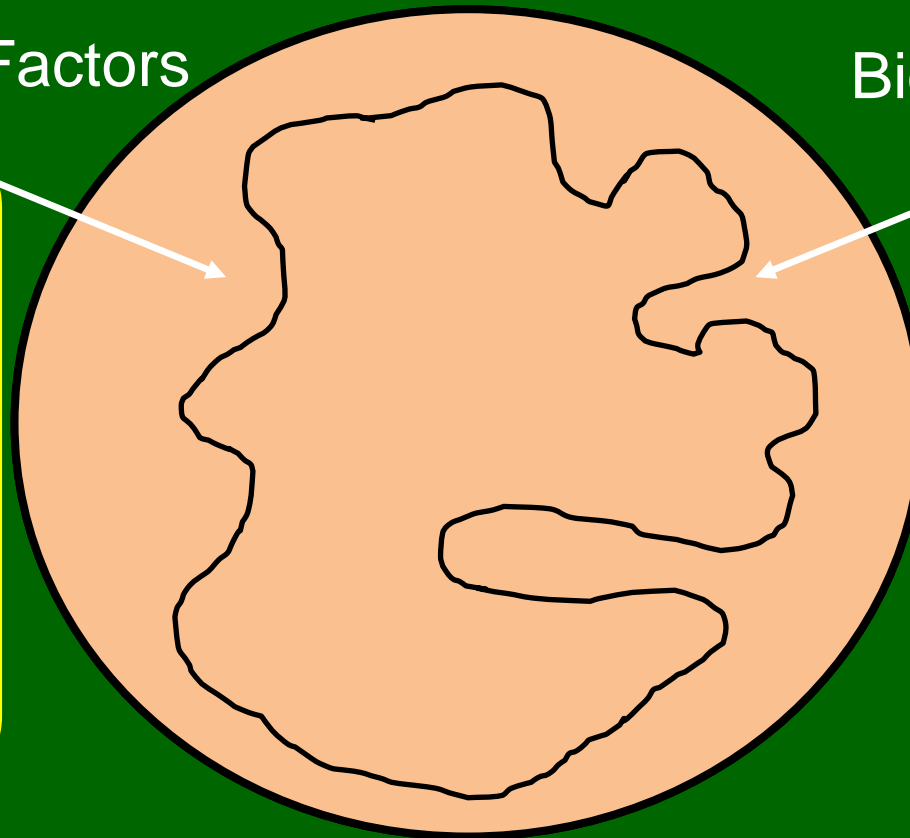
Environmental Factors

Clima

Geographic
Barriers

Topography

Hydrology



Biological factors







Population
Dynamic

Evolutionary
History

**Biological
interactions**

How the environment affect the biological interactions?

Case 1	Unfavourable Environment $F < 0.2$	1 or 2 spp.	Environmental Exclusion
Case 2	Favourable Environment $F > 0.8$	2 spp.	Sympatric Coexistence
Case 3	Intermediate Environmental Favourability $0.2 < F < 0.8$	1 or 2 spp.	Competitive Exclusion

-  To explain the distribution of the Iberian vipers
-  To identify the environmentally favourable areas
-  To analyse the favourability of the interactions for each pair of species
 -  To identify likely areas of competitive exclusion
 -  To identify likely areas of sympatric coexistence
 -  To identify likely areas of environmental exclusion

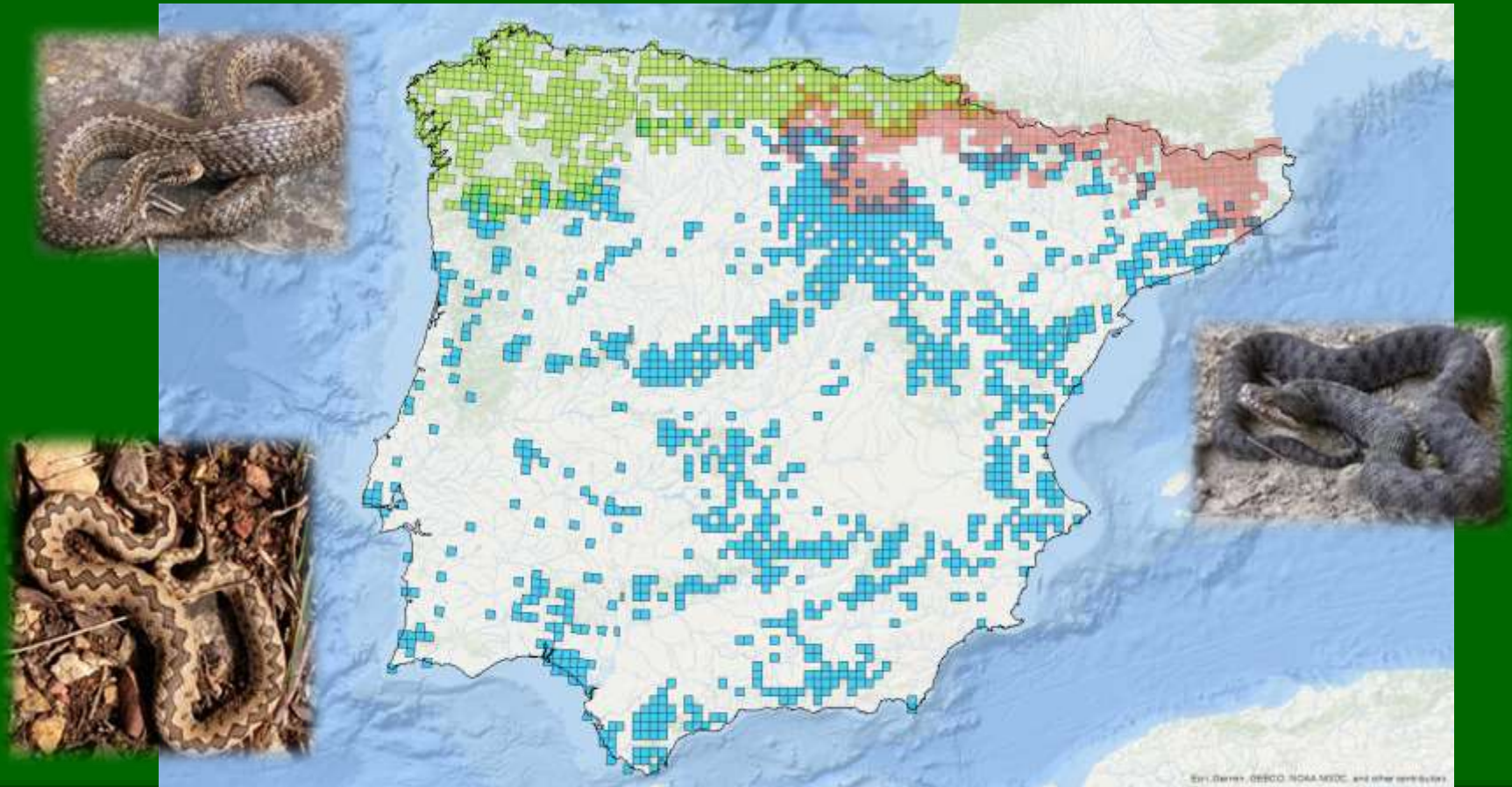
Data collection:

Atlas: Loureiro *et al* 2008

AHE database

Personal data

} Presences/Absences Matrix



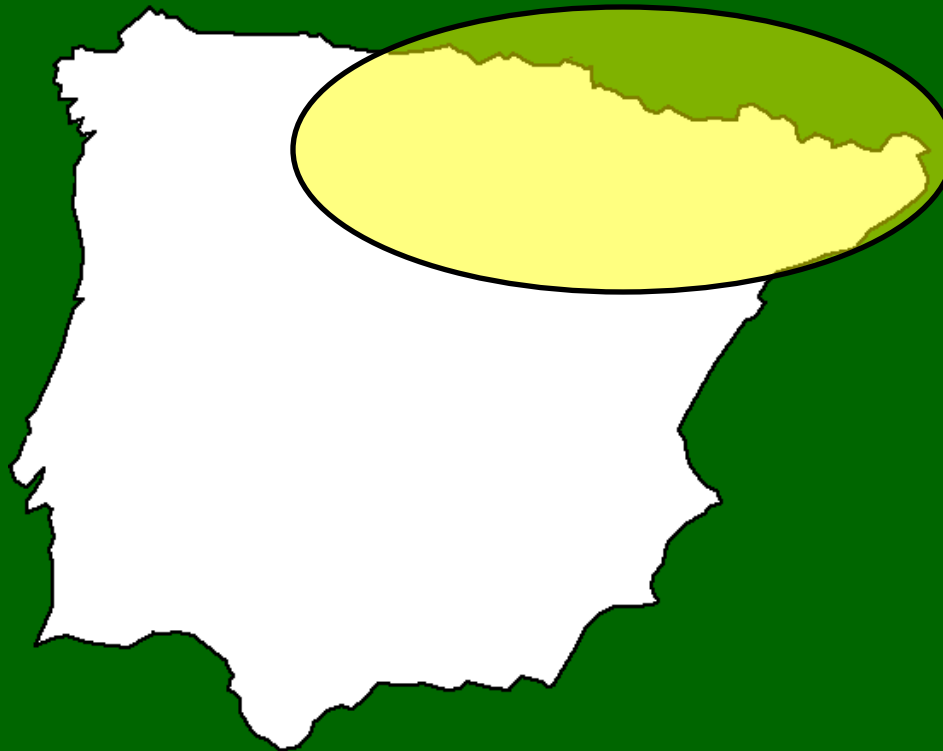
METHODOLOGY

Variables

Climatic	Energy availability	Mean annual temperature Mean temperature in January Mean temperature in July Mean nº days with min temperature <0 °C Mean nº days with min temperature >20 °C Mean nº days with max temperature >25 °C	Mean nº days with fog Potential evapotranspiration insolation Solar irradiation (Direct) Solar irradiation (Global)
	Water availability	Mean annual precipitation Mean nº days with precipitation >0.1 mm Mean nº days with precipitation >1 mm Mean nº days with precipitation >10 mm	Mean nº days with precipitation >30 mm Real evapotranspiration Mean humidity in July Mean humidity in January
Non-climatic	Topography	Altitude	Slope
	Human activity	Distance to roads Mean population density Proportion of area occupied by artificial areas	Maximum population density Minimum population density
	Land-cover	Proportion of area occupied by pastures	Proportion of area occupied by coniferous forest
		Proportion of area occupied by crops	Proportion of area occupied by rocks
		Proportion of area occupied by scrubs	Proportion of area occupied by sands
Proportion of area occupied by sparse vegetation		Proportion of area occupied by snow	
Proportion of area occupied by mixed forest	Proportion of area occupied by inland water bodies		
Proportion of area occupied by oak forest	Proportion of area occupied by marine water bodies		

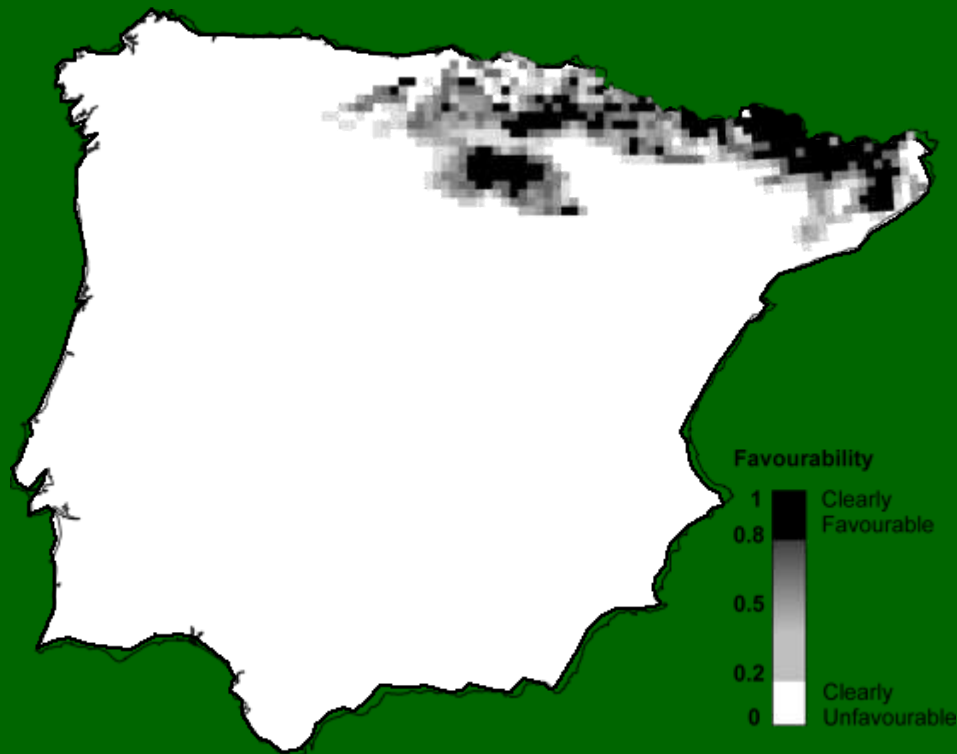
1st $F_{\text{spatial}} \leftarrow$ latitude and longitude combinations

→ To select the Relevant Space ($F_{\text{spatial}} > 0.2$)



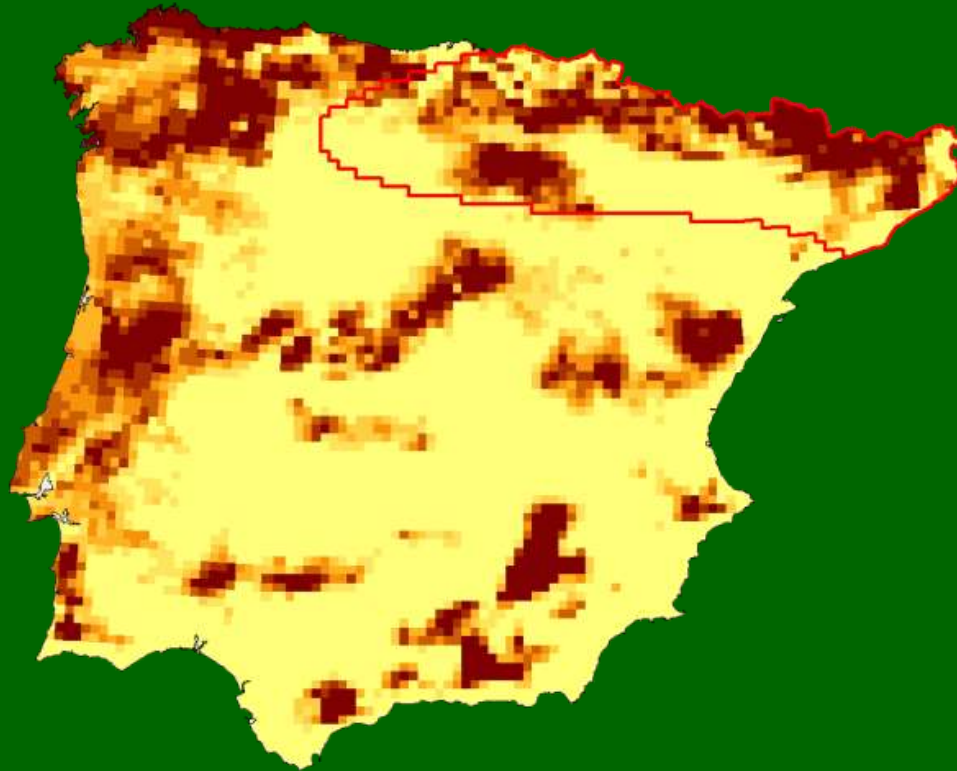
2nd $F_{\text{environmental}}$ ← environmental variables

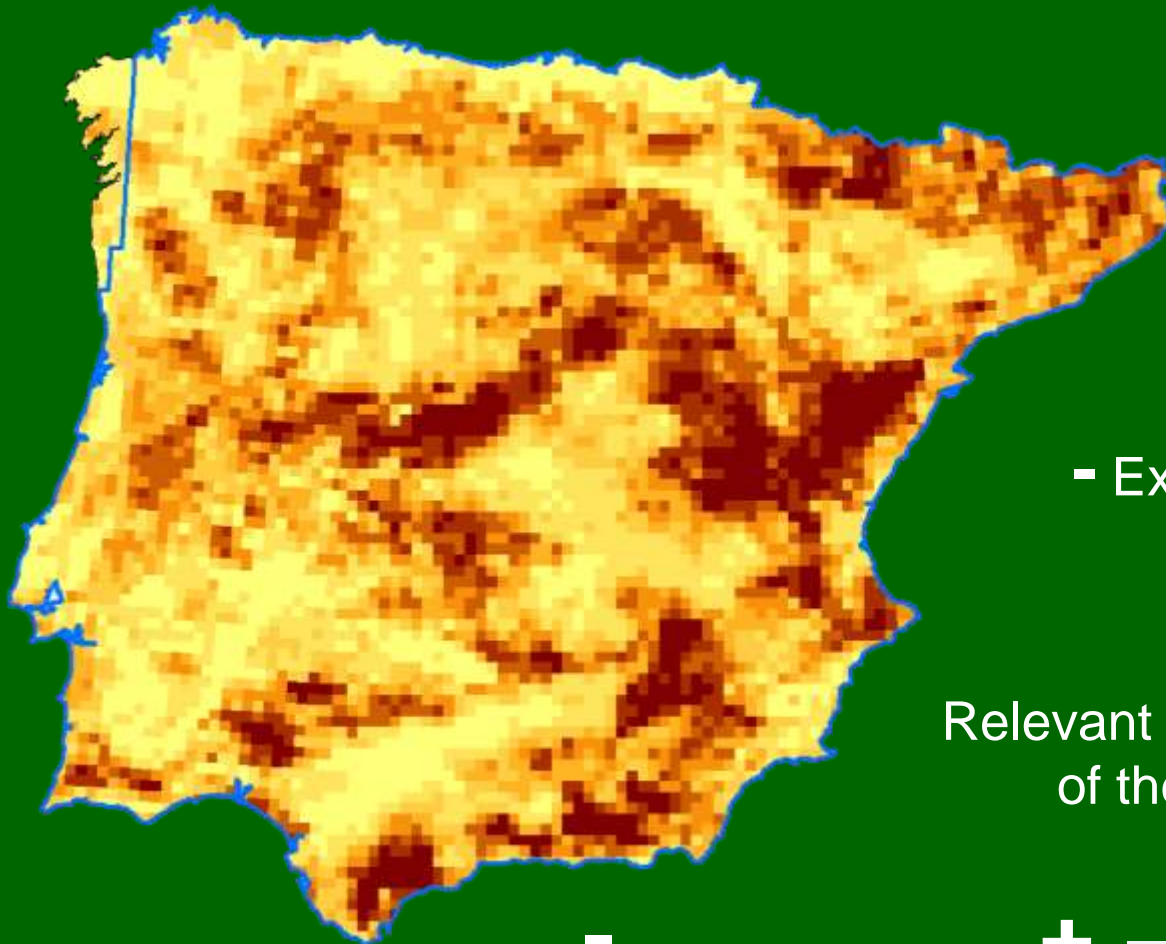
→ To obtain the current distribution model



3rd F_{complete} ← extrapolation to the whole Iberian Peninsula

→ To detect potential favorable environmental areas





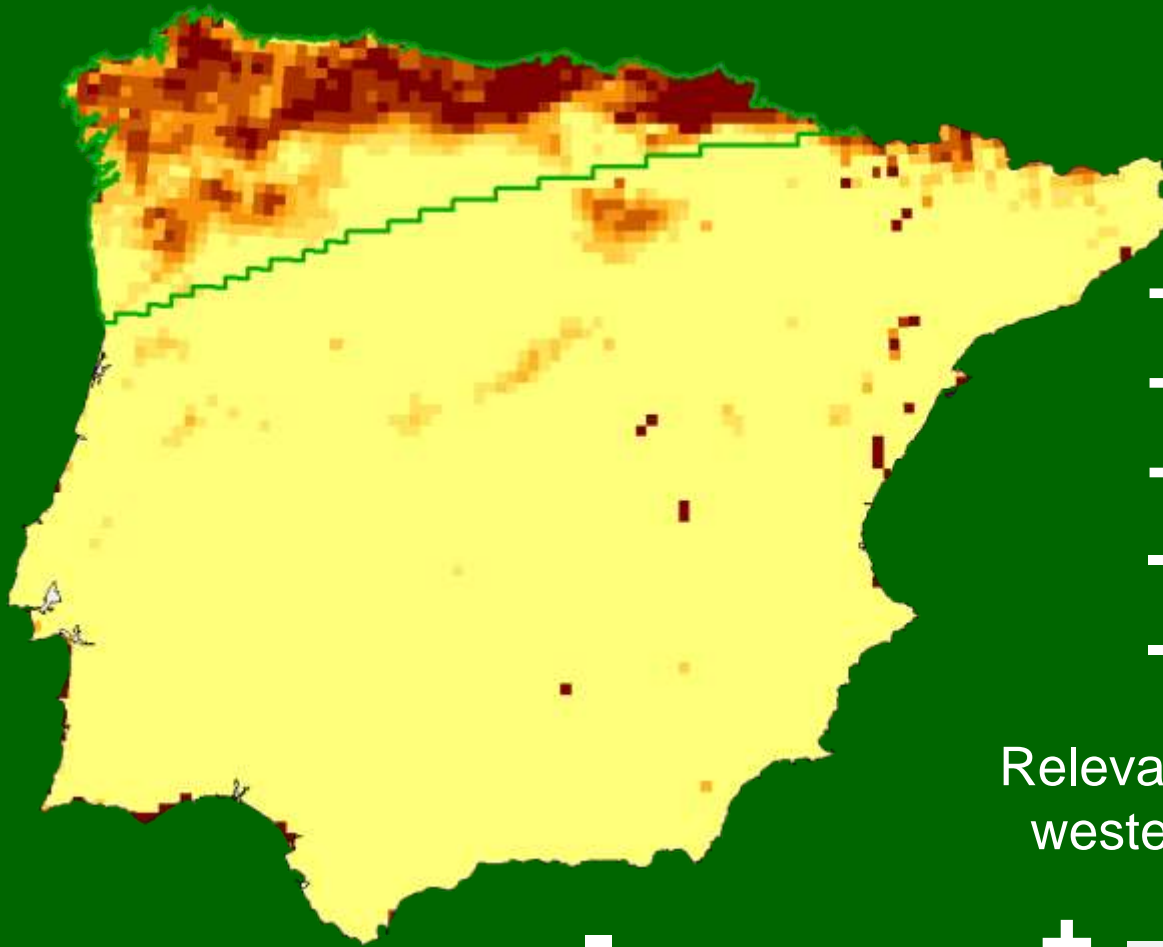
Vipera latastei

- + High lands & Valleys
- + Solar irradiance
- Extreme hot & cold places
- Crop & Grazing zones

Relevant Space almost the whole of the Iberian Peninsula



Relevant Space

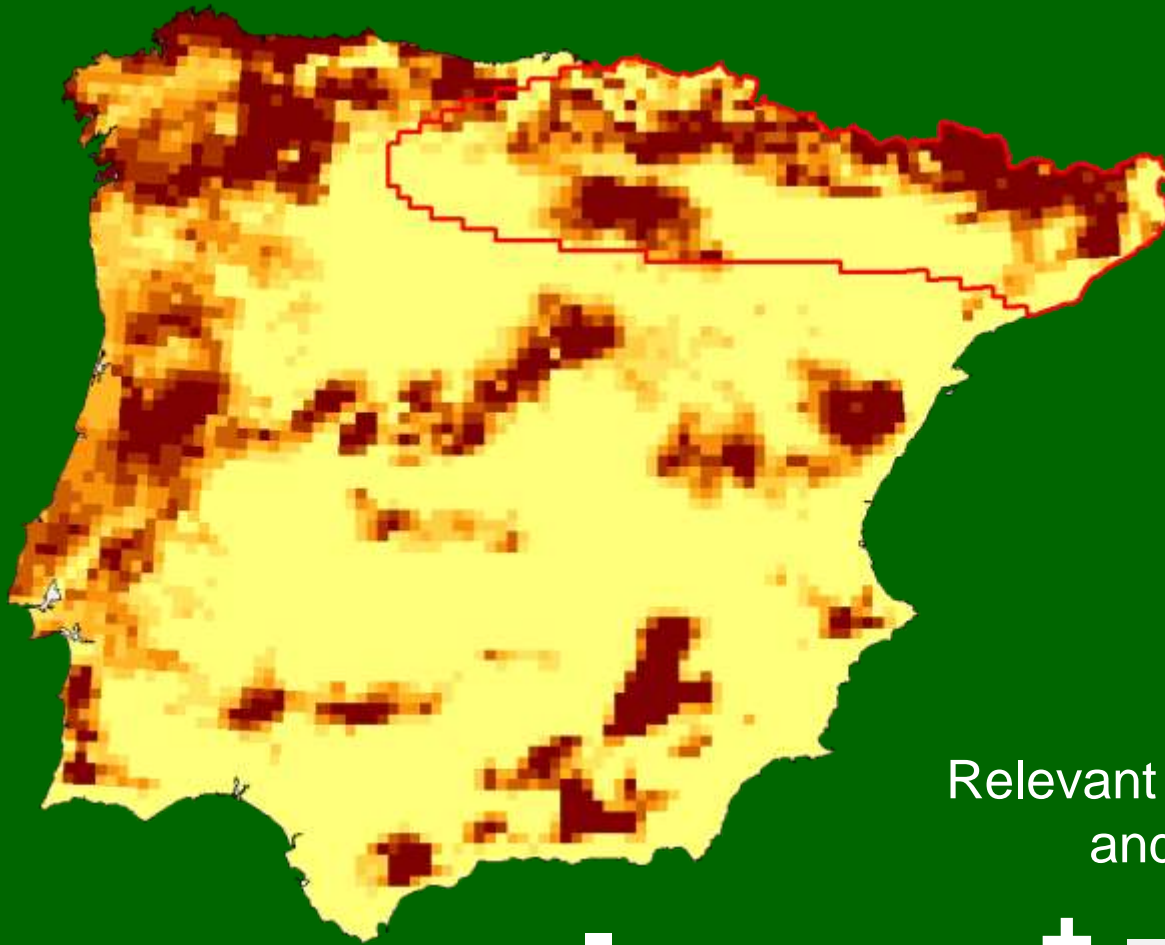


Vipera seoanei

- + Valleys & low mountains
- + Sand & Pasture zones
- + High humidity
- Crop zones
- High Irradiance

Relevant Space in the north-western Iberian Peninsula

Relevant Space



Vipera aspis

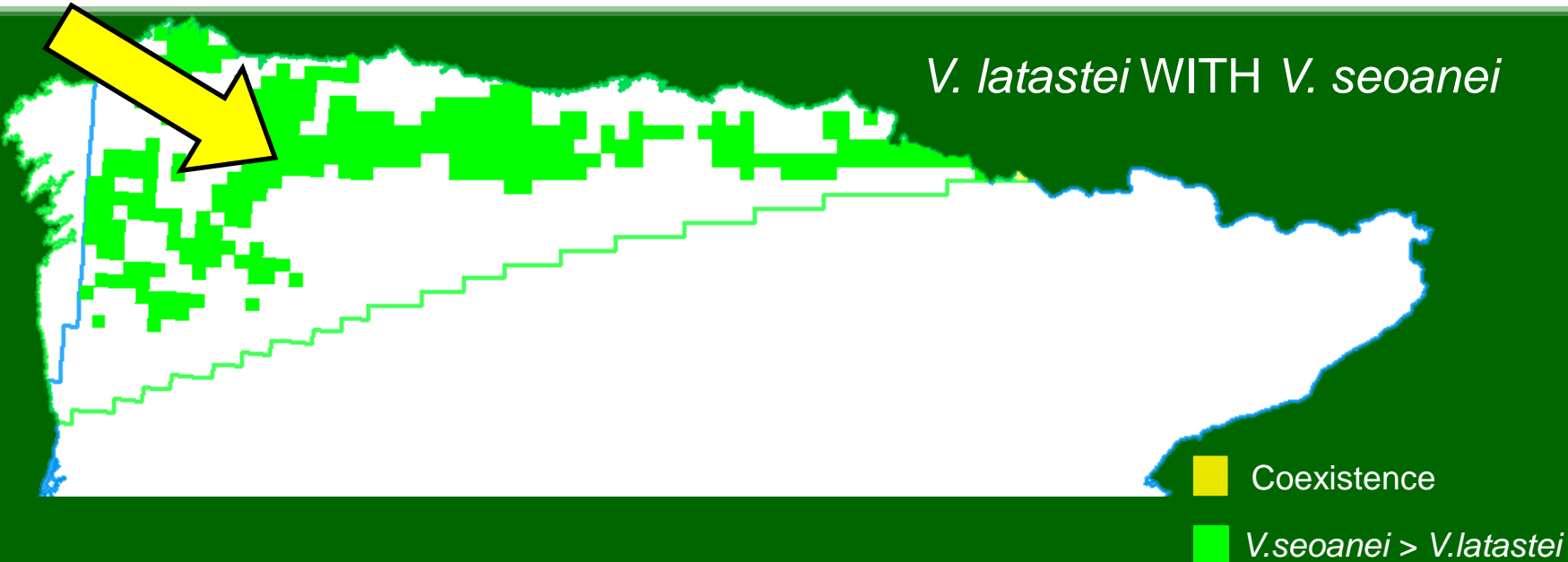
- + High lands
- + Natural forest
- + Solar irradiance
- Extreme cold places
- Grazing zones

Relevant Space in the north, pre- and Pyrenean region



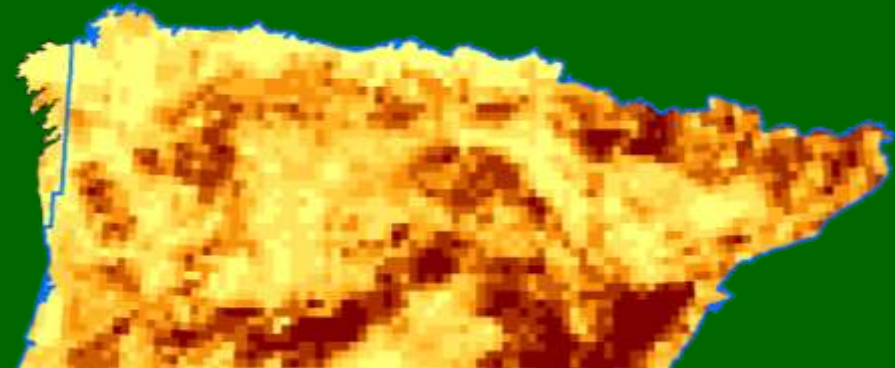
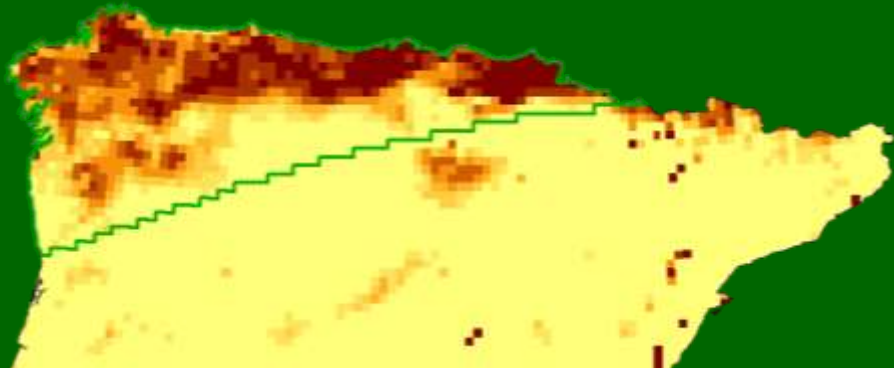
Relevant Space

V. latastei WITH *V. seoanei*

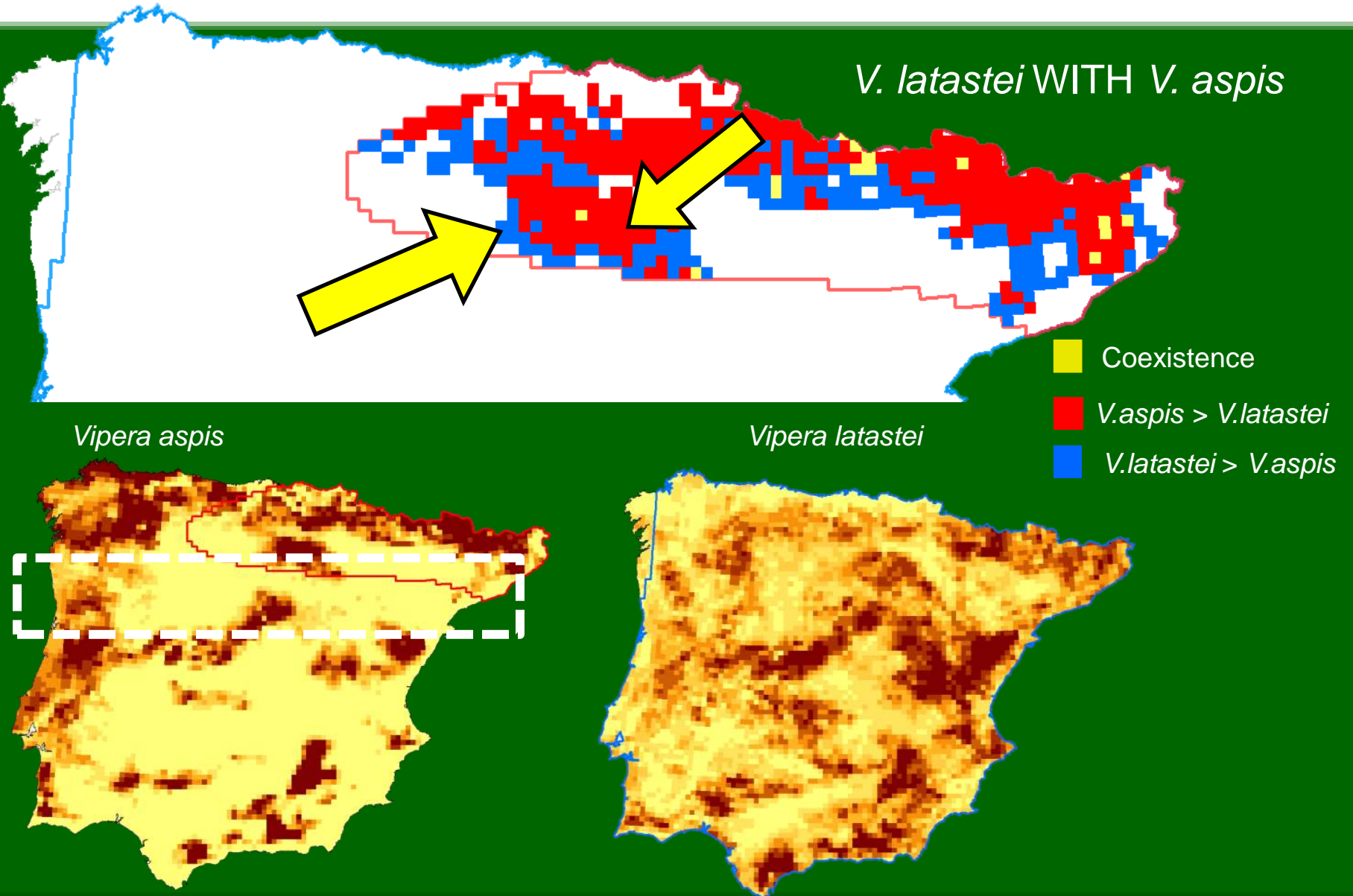


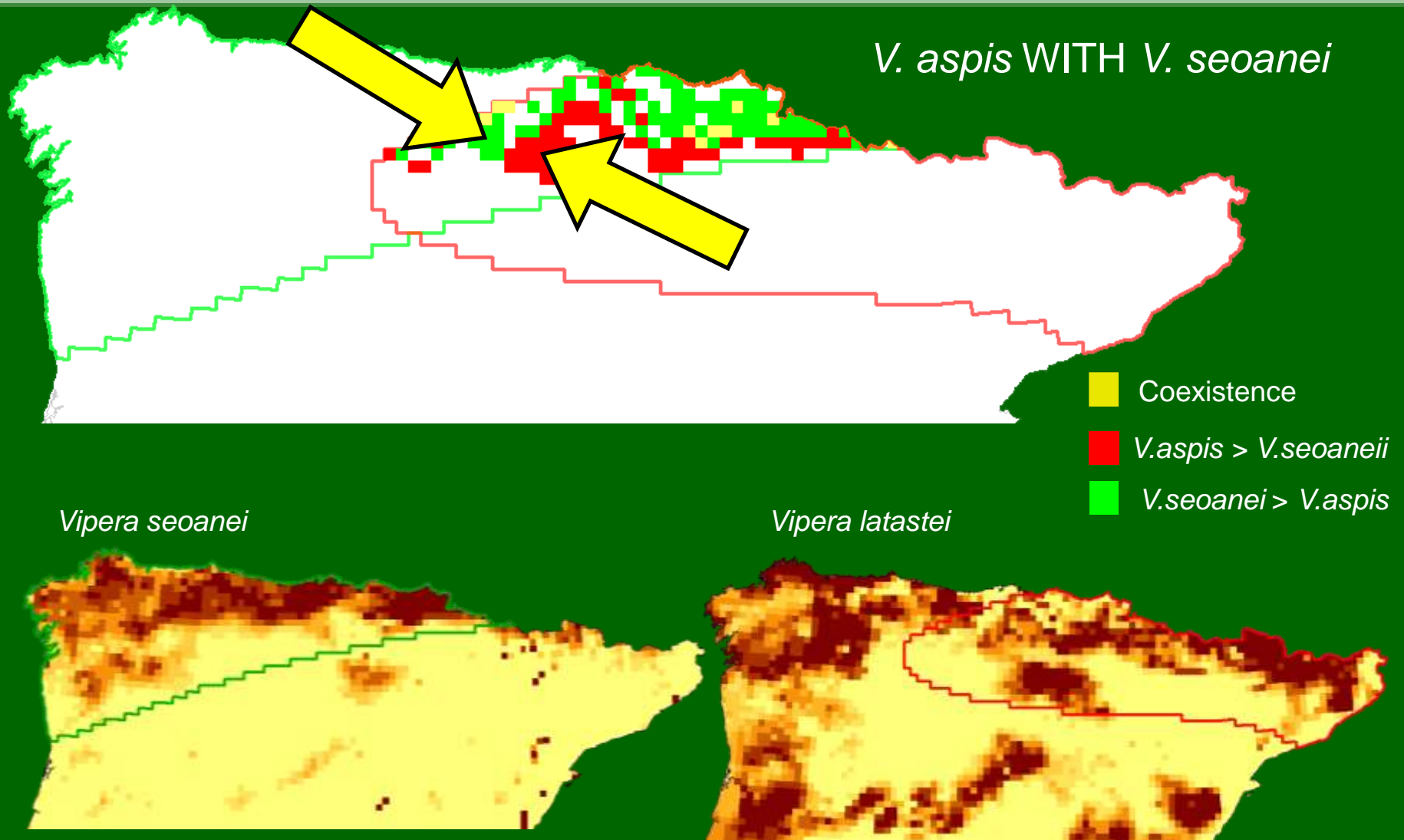
Vipera seoanei

Vipera latastei







RESULTS & DISCUSSION









In the Iberian Peninsula...

-  Distributions of *Vipera* species are explained by a few number of environmental variables into their relevant space.
-  *Vipera seoanei* distribution is conditioned by the humidity
-  *Vipera aspis* distribution by the humidity and the solar irradiation
-  *Vipera latastei* distribution by the high solar irradiation

The expansion out of their relevant space could be difficult due to...

-  **Competitive exclusion** in the north by *V.aspis* and *V.seoanei* for *V.latastei*.
-  **Environmental exclusion** of the south and **competitive exclusion** by *V.aspis* for *V.seoanei*.
-  **Environmental exclusion** of the southern Pyrenees region and **competitive exclusion** by *V.latastei* in the south and *V.seoanei* in the east for *V.aspis*.

 The biogeographic study of the biological interactions and their link with the environment sheds light in the understanding of the Parapatry.



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**Thank you for
your attention**

We want to thank all the people who collaborate with the AHE and APH, for their enormous contribution that benefited this project.

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Any question?

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