An Ecological Index for Arthropod Habitats in the Circum-Sicilian islands using Convection Permitting data

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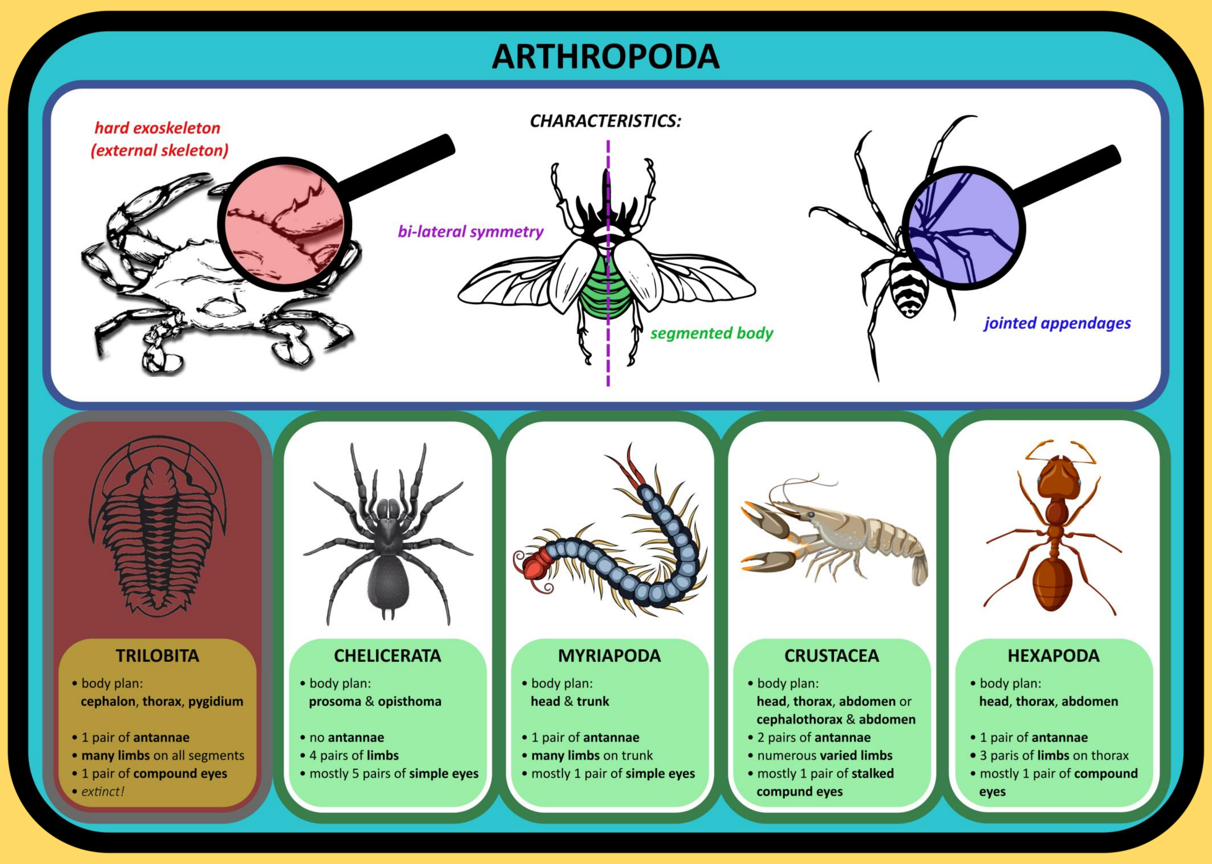


image designed using arthropod images from Freepik.com and Pinclipart.com

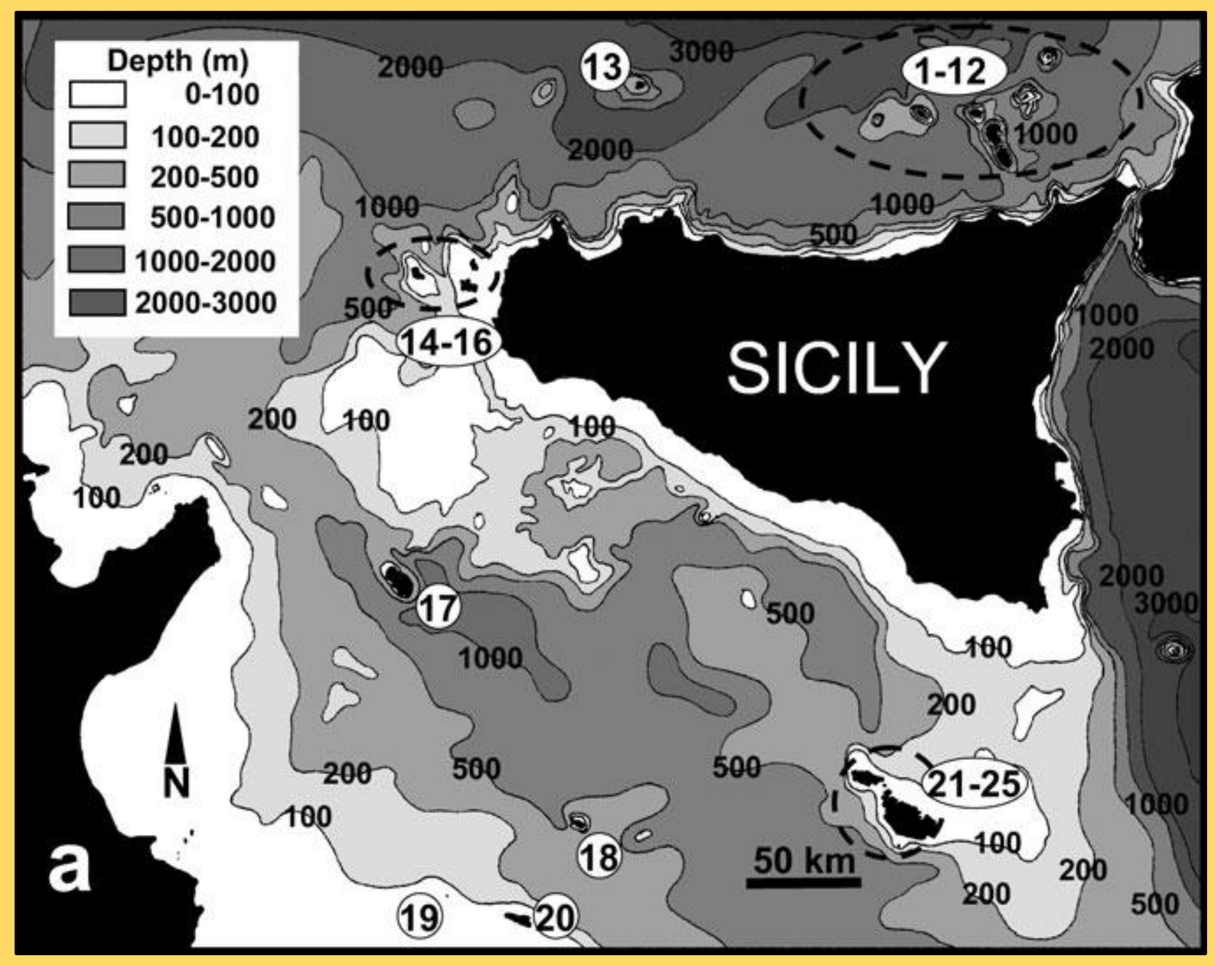
About PALEOSIM

PALEOclimate modelling of Small Islands in the Mediterranean and possible impacts on arthropod habitats is a Marie Skłodowska-Curie Actions Postdoctoral Fellowship focusing on climate impacts on **arthropod habitats** of **small islands**.

Arthropods play vital roles in the ecosystem (e.g., pollinators, decomposers), and thus act as indicators of ecosystem integrity. The group is made up of over 1.2 million described species, of which over 1 million are mostly insects (Minelli et al., 2013).

Recently, the anthropogenic impact on ecosystems has been devastating, especially in vulnerable regions such as the Mediterranean Basin and its numerous small islands. Thus, PALEOSIM focuses on the 25 small islands surrounding Sicily, the **Circum-Sicilian Islands**.

[1-12] **Aeolian Islands**, [13] Ustica, [14-16] **Aegadian Islands**, [17] Pantelleria, [18-20] **Pelagie Islands**, [21-25] **Maltese Islands** (Fattorini, 2011)

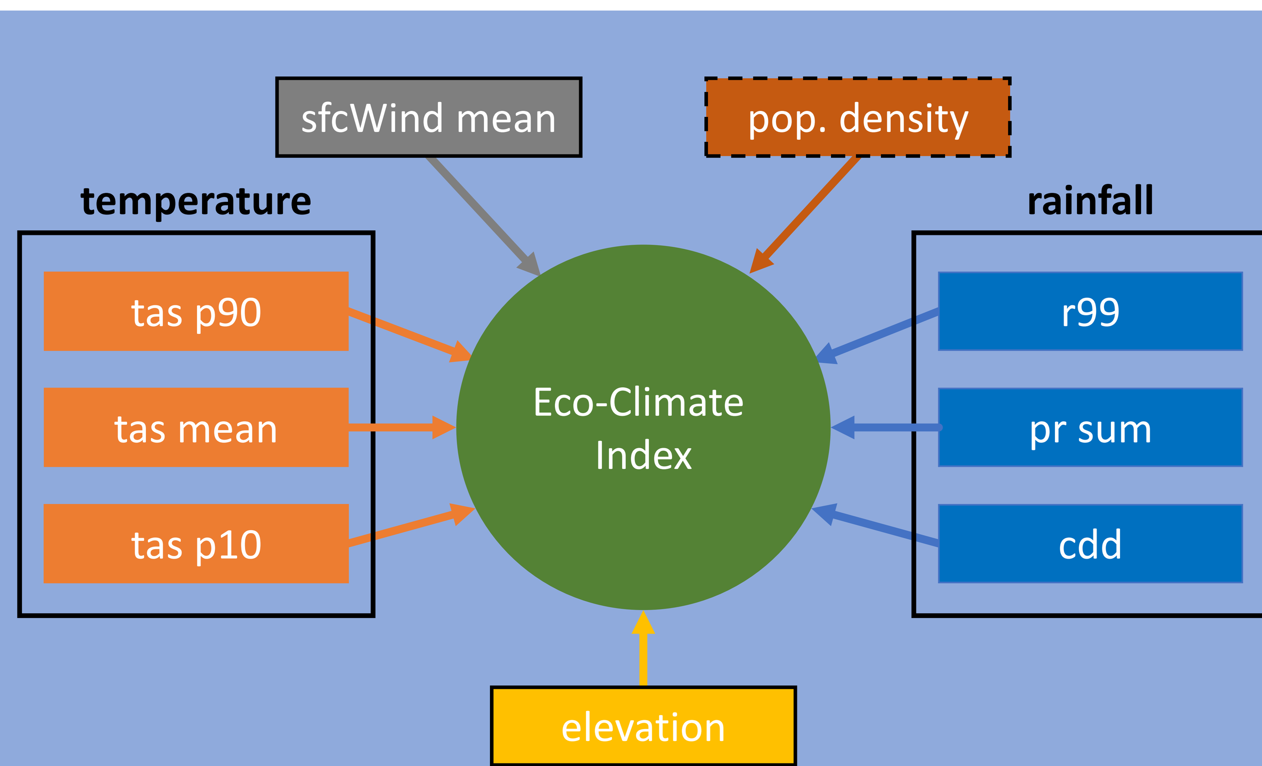


Ecological Niche Model

Assumption: **the location where the living organism is observed has a climatology that is acceptable to that organism**. Hence, one can use the climatology at observation locations to assess the preferred habitat.

Example: **Astaut's Blue** (*Polyommatus celina*)

- 8 climate indices (x_i) identified that may affect *P. celina*
- n=631 Research Grade *P. celina* observations (iNaturalist, n.d.)
- N=8 bootstrapping (Efron, 1979) for resampling to n=~5000
- Statistics for x_i extracted from n sampling locations:
  - mean (μ_i), standard deviation (σ_i), min and max (after removal of outliers (Carling, 2000; Wilcox, 2022)



The **ideality of climate conditions** (C_i) can be defined as

$$C_i = \begin{cases} 1, & \text{if } x_i - \mu_i = 0\sigma_i \\ 1 - \left|{}^{d}/_{L}\right|, & \text{if } x_i - \mu_i = d\sigma_i \\ 0, & \text{if } x_i - \mu_i = L\sigma_i \end{cases}$$

Using a **standardized distance**, $d = \frac{x_i - \mu_i}{\sigma_i}$

$$C_i = 1 - \left|\frac{x_i - \mu_i}{\sigma_i}\right| \frac{1}{L}$$

Defining the limit of L as

$$d_{max} = \left|\frac{x_{max} - \mu_i}{\sigma_i}\right|, \quad d_{min} = \left|\frac{x_{min} - \mu_i}{\sigma_i}\right| \quad \text{and } L = \max(d_{max}, d_{min})$$

C_i are combined into an **Eco-Climate Index**

$$E_s = C_{tasp90} \times C_{r99} \times \cdots \times C_{elevation}$$

Convection Permitting Simulations

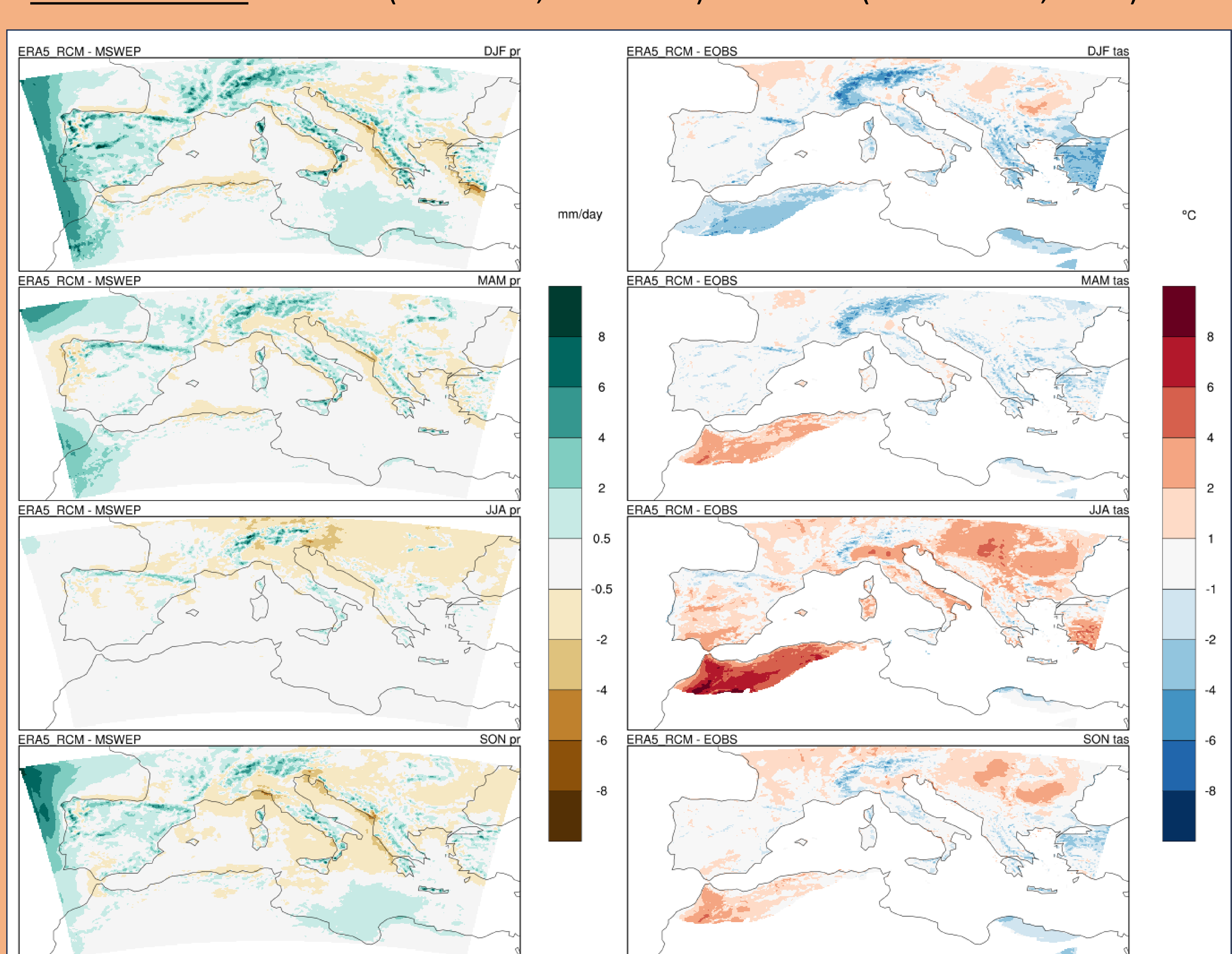
Regional Model: RegCM5.0 (Giorgi et al., 2023)

Global Data: ERA5 1995-1999 (Hersbach et al. 2020)

Intermediate Domain: 12km CORDEX-Europe (Giorgi et al. 2009)

CP Domain: 3km West/Center Mediterranean

Reference Data: MSWEP (Schneider, et al 2013) and EOBS (Cornes et al, 2018)



Upcoming Simulations

historical & ssp3 GCMs: MPI-ESM1-2-HR, EC-Earth3-Veg, NorESM2-MM

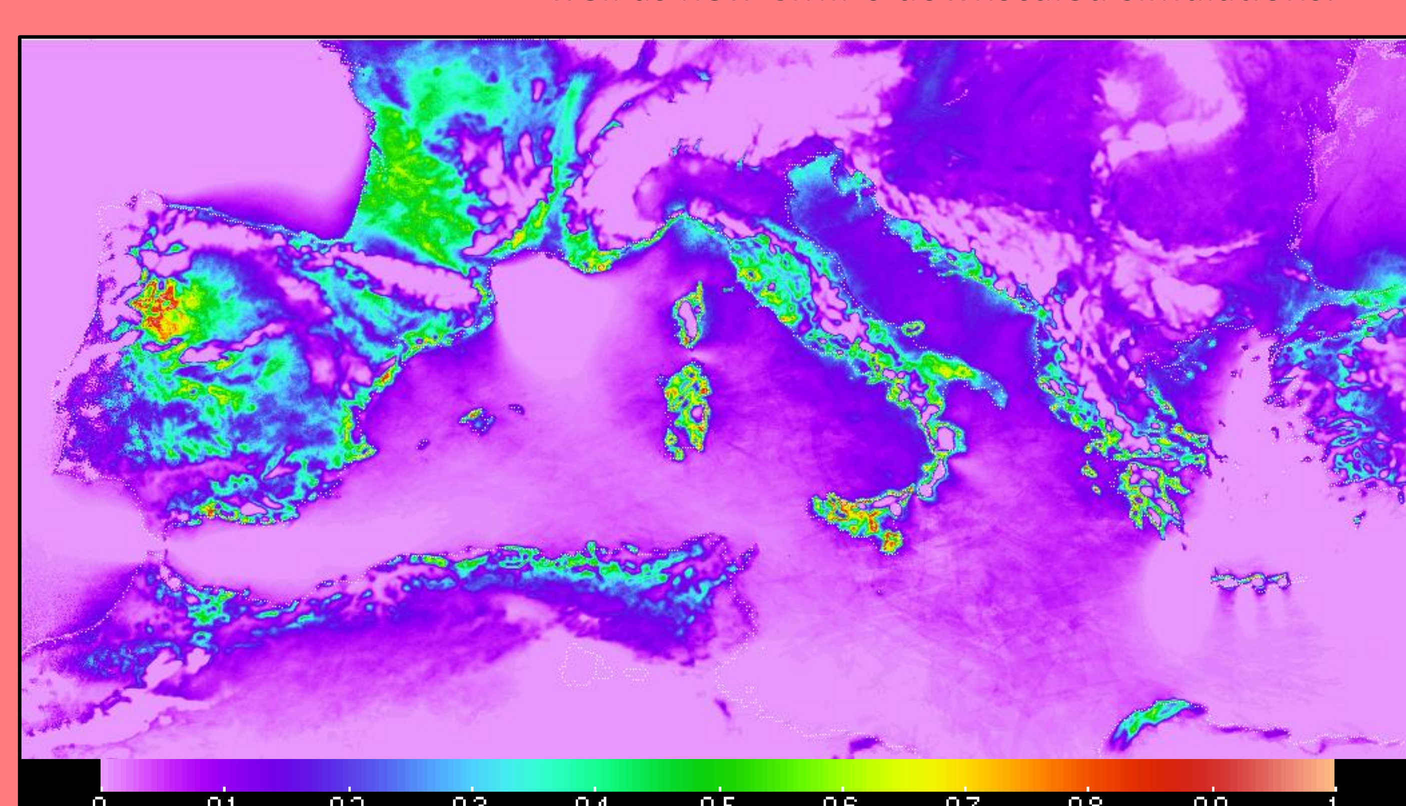
paleoclimate GCMs: MPI-ESM1-2-LR, MIROC-ES2L, IPSL-CM6A-LR

Preliminary Results & Upcoming Experiments

The E_s results suggest that values approaching 1 are ideal habitats for *P. celina*.

Hight E_s do not imply that *P. celina* can be found in all areas with high E_s but that these conditions may be favourable (*Note: Human population density has not been factored in this experiment*).

Upcoming experiments will explore E_s of different species using observation and reanalysis data-sets, as well as new CMIP6 downscaled simulations.



More Information

Project website: https://www.um.edu.mt/projects/paleosim/

Project fb page: https://www.facebook.com/paleosim.msca/

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