PROJECTION OF EXTREME MARINE CLIMATE IN COASTAL AREAS USING STATISTICAL DOWNSCALING

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MOTIVATION

The understanding of extreme wave climate at different scales is an essential issue, spetially in the last years, when the climate change has became a hot-topic. Natural processes such as sediment transport or distribution of benthic organism, coastal management including the analysis of flooding risk, design of maritime works, ship routing or offshore industries are some examples of natural and socioeconomic activities depending on extreme wave climate variability. It is well-known nowadays that the seasonal-to-interannual varibility of ocean climate is linked to the anomalies of the atmosphere circulation (Izaguirre et al. 2010). Using synoptic climatology we link weather types with the extreme marine climate in a coastal location. The methodology developed allow to project the extreme marine climate to different IPCC climate change scenarios.

OBJECTIVES

- Classifying the North Atlantic weather types using different clustering techniques (SOM, K-means…).
- Developing a methodology to study the extreme marine climate variability combining state-of-the-art extreme value models and synoptic climatology.
- Developing a methodology to project extreme marine climate to different climate change scenarios, considering different IPCC-AR4 GCM models.
- Application to different coastal locations, focusing in the North Atlantic. Example Coruña site.

DATA

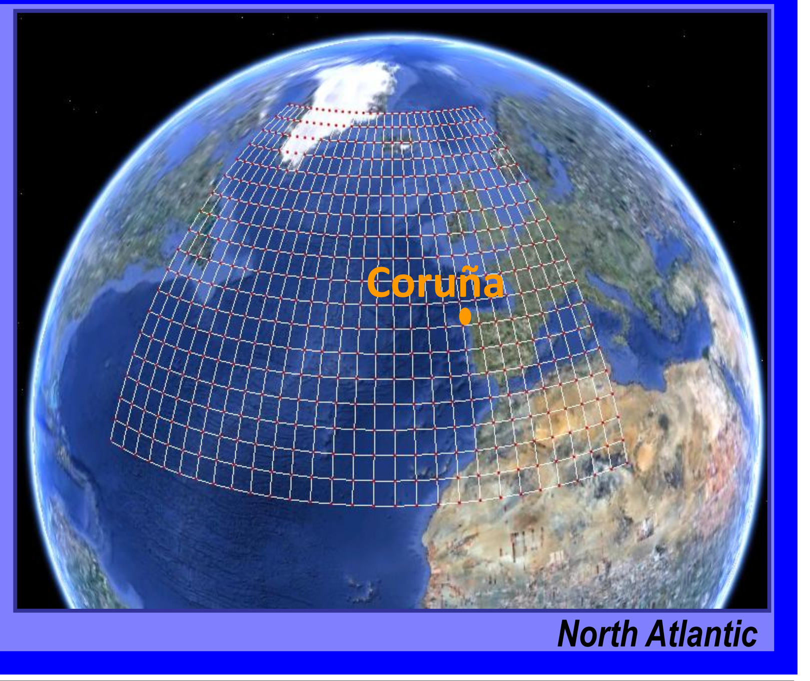
SLP data

Sea level pressure (SLP): is the geophysical variable used to explain the state of the atmosphere. It is also directly link with wave climate and used to explain interannual wave climate variability (Izaguirre et al., 2010)

NCEP/NCAR
60 years (January 1948-December 2008)
6-hourly fields
2.5º longitude x 2.5º latitude (grid)

Wave data

GOW reanalysis data (IH Cantabria)
60 years (January 1948-December 2008)
Hourly register
1º longitude x 1.5º latitude (grid)



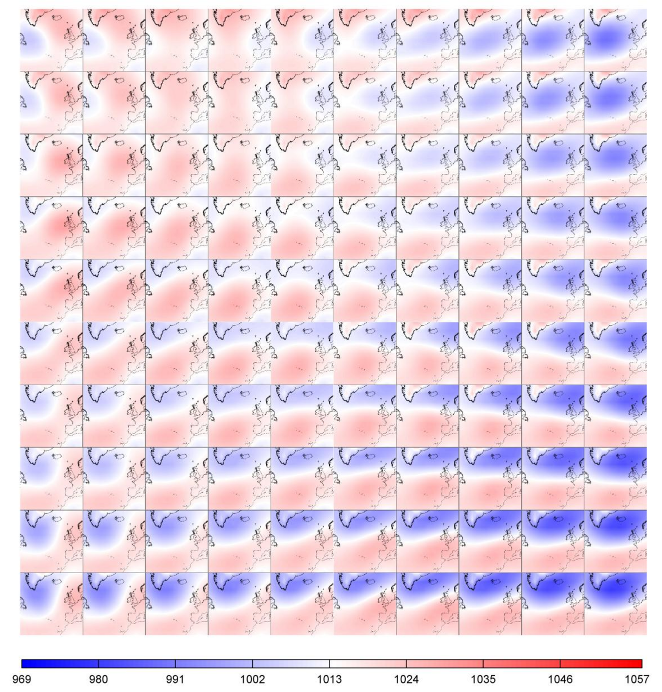
METHODOLOGY AND RESULTS

NORTH ATLANTIC WEATHER TYPES

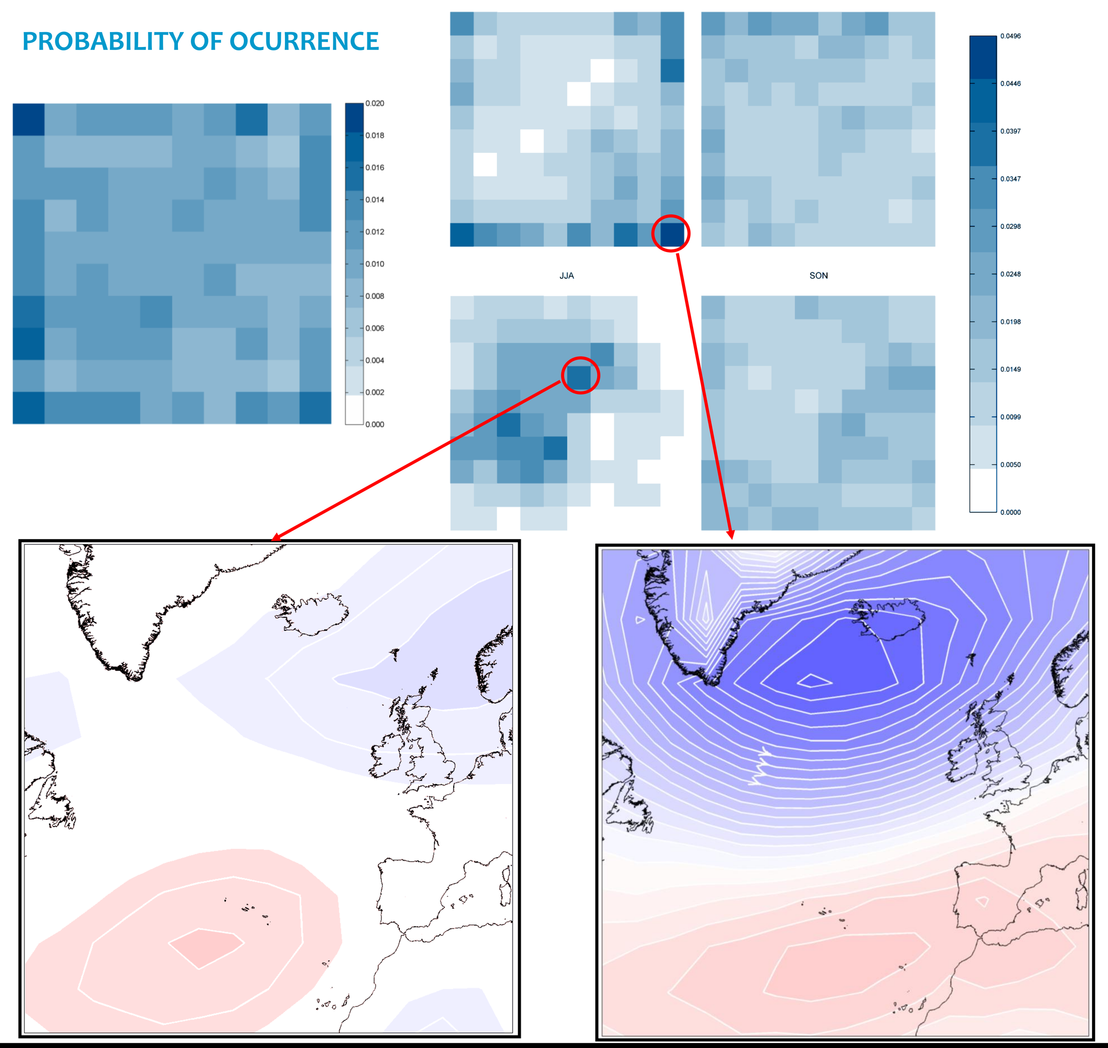
SPATIAL SCALE: Basin Size; Generation area

TEMPORAL SCALE: Temporal dependence. *Alves (2006)*; North Atlantic: 3 days ⟶ SLP_{3dias}

PRINCIPAL COMPONENT ANALYSIS ⟶ SELF-ORGANIZING MAPS (SOM)

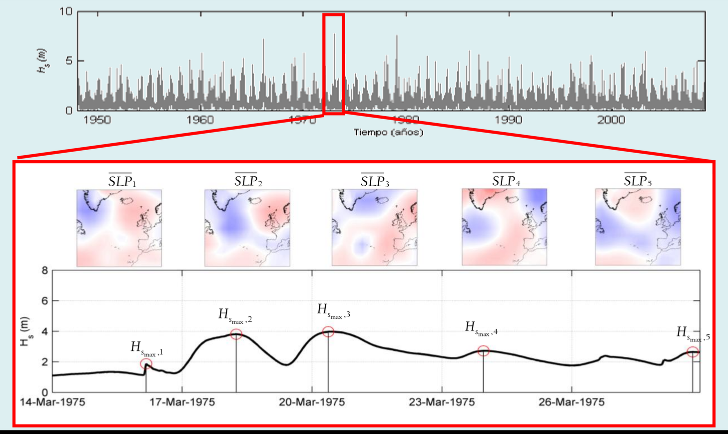


PROBABILITY OF OCURRENCE

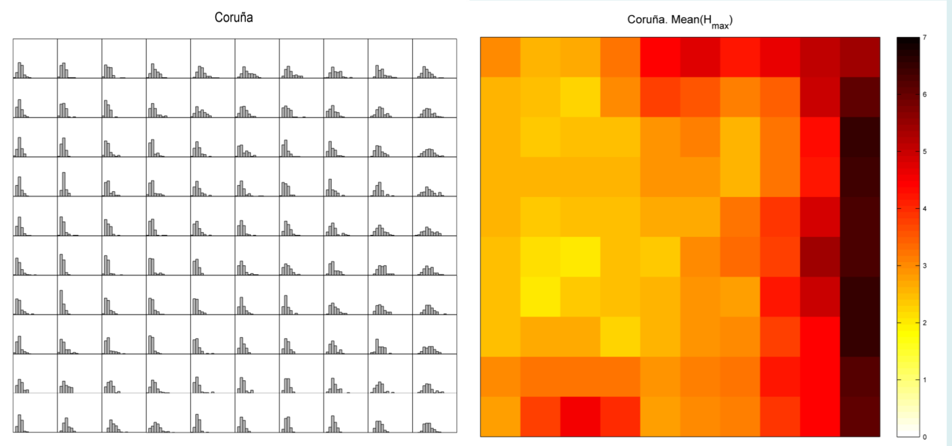


GEV MODEL

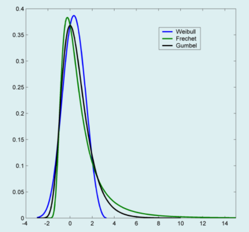
Wave maxima



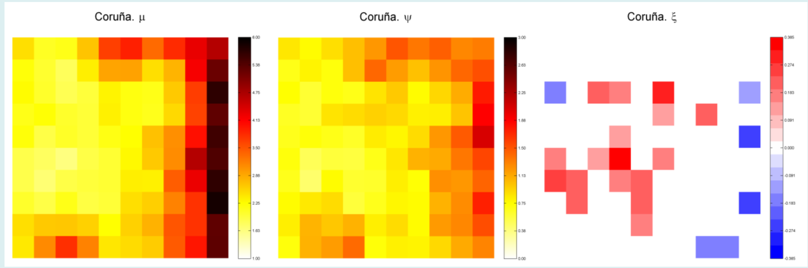
Wave projection in SOM lattice



GEV fit

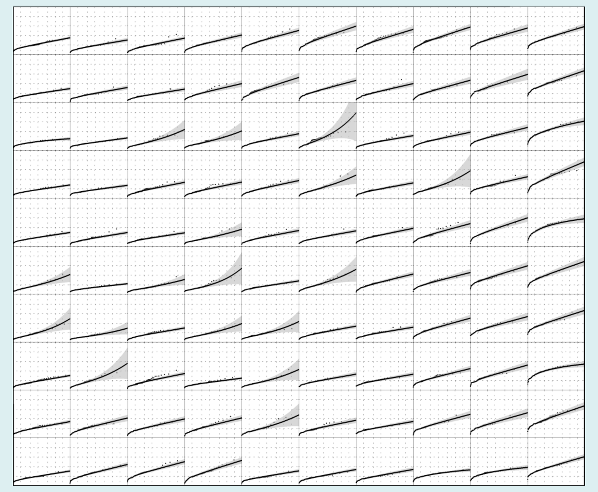


$$F(x;\theta)=\exp\left\{-\left[1+\xi\left(\frac{x-\mu}{\psi}\right)\right]^{-1/\xi}\right\}$$



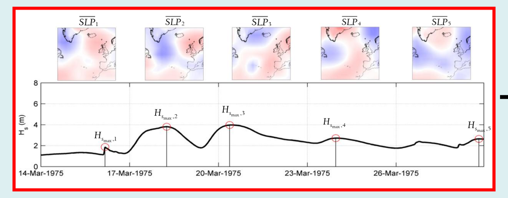
$\mu \rightarrow$ *location*
$\psi \rightarrow$ *scale*
$\xi \rightarrow$ *shape*

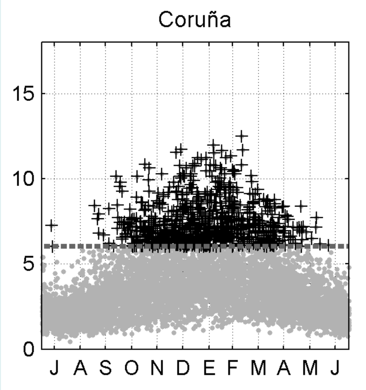
Extreme wave climate



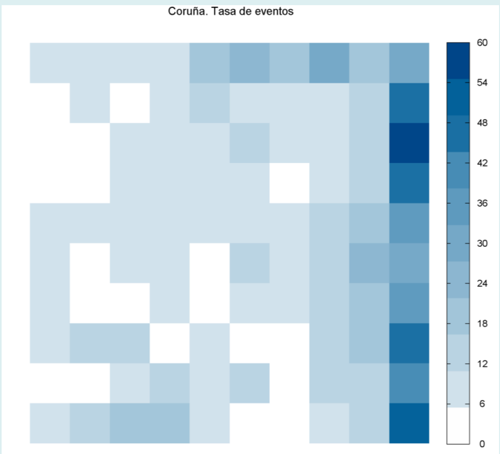
GENERALIZED PARETO-POISSON MODEL

Extreme events: POT





Wave projection in SOM lattice. Pareto fit



Events rate:

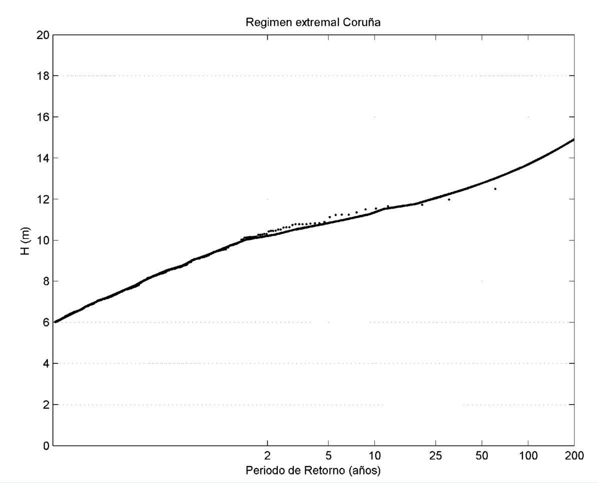
$$\upsilon=\upsilon_1+\upsilon_2+\ldots+\upsilon_n$$

$$F(y;\sigma,\xi)=\begin{cases}1-\left(1+\frac{\xi y}{\sigma}\right)^{-1/\xi} & \text{si } \xi\neq 0\\ 1-\exp\left(-\frac{y}{\sigma}\right) & \text{si } \xi=0\end{cases}$$

Extreme wave climate

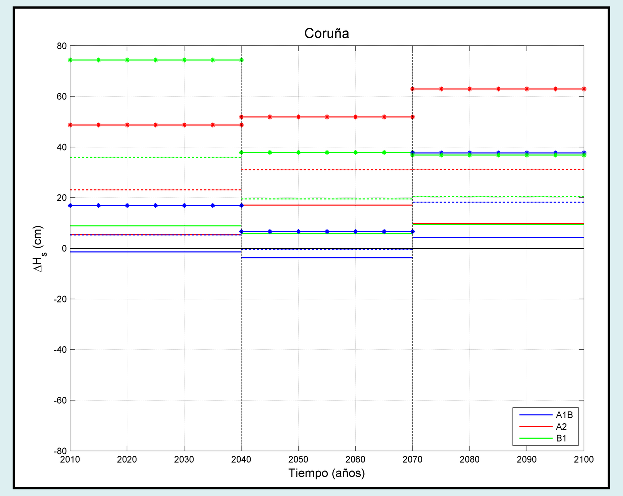
$$F(H)=\sum \upsilon_i\cdot F_i(H)$$

$$R=\frac{1}{\upsilon}\left(\frac{1}{1-F_{total}(y)}\right)$$



IPCC-AR4 projections

A2
A1B
B1



CONCLUSIONS

- This work provides a new approach of the extreme wave climate variability using synoptic climatology.
- A synoptic climatology of the North Atlantic area has been performed using SOM analysis with principal components of monthly SLP.
- Two methodologies based on the Generalized Extreme Value (GEV) for block maxima and the Pareto-Poisson model for exceedances over a threshold (POT) and clustering techniques are presented to study the extreme wave climate.
- The methodology based on Generalized Pareto model allows to project the extreme marine climate to different climate change scenarios, considering different IPCC-AR4 GCM models.

References:

Izaguirre, C., F.J. Méndez, M. Menéndez, A. Luceño and I.J. Losada 2010, Extreme wave climate variability in southern Europe using satellite data, J. Geophys. Res., 115, C04009, doi:10.1029/2009JC005802

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