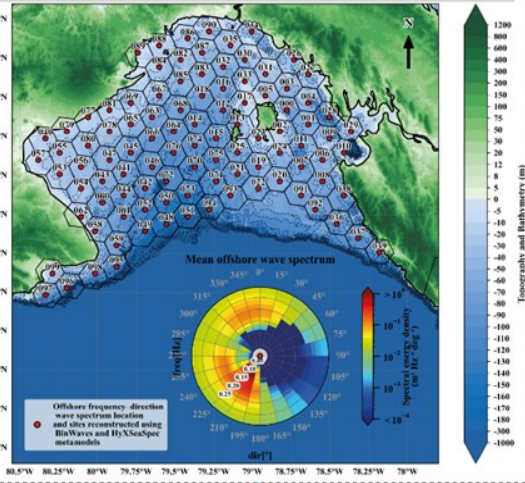


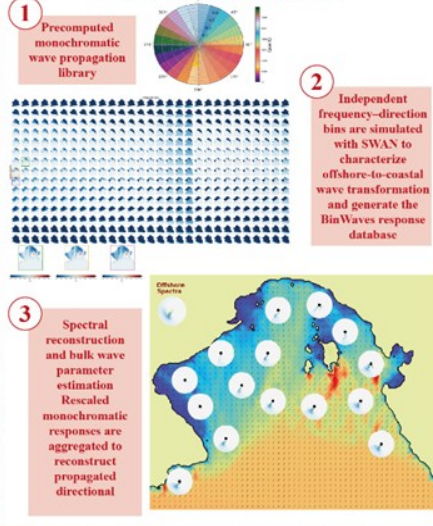


# WHAT WE DID?

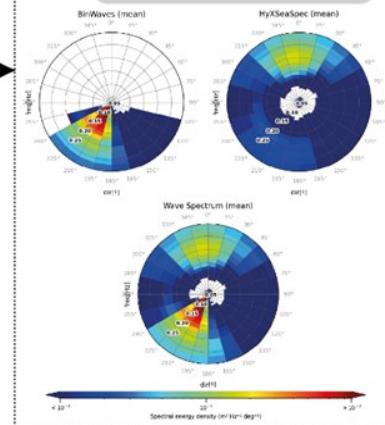
Hexagonal sampling mesh defining 100 reconstruction nodes within the Gulf of Panama; the inset shows the mean offshore directional wave spectrum used as swell boundary forcing



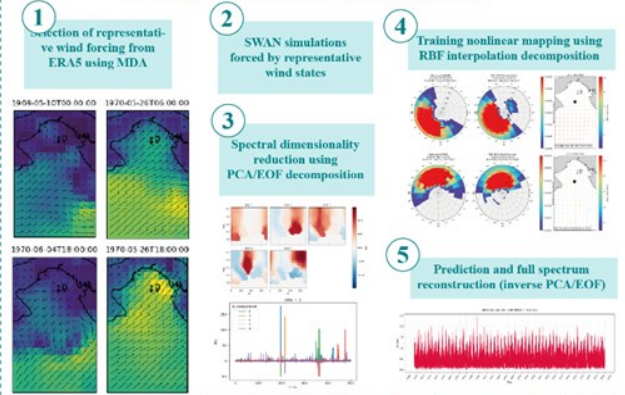
Swell downscaling using BinWaves



Combination of swell and wind-sea spectra for full directional spectrum reconstruction



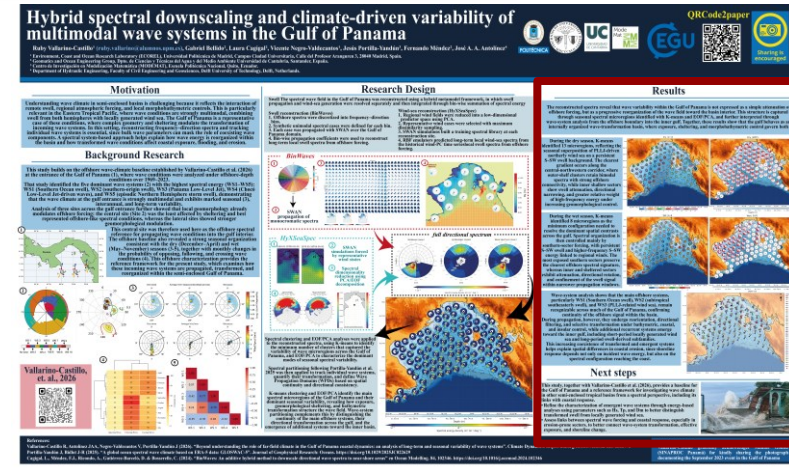
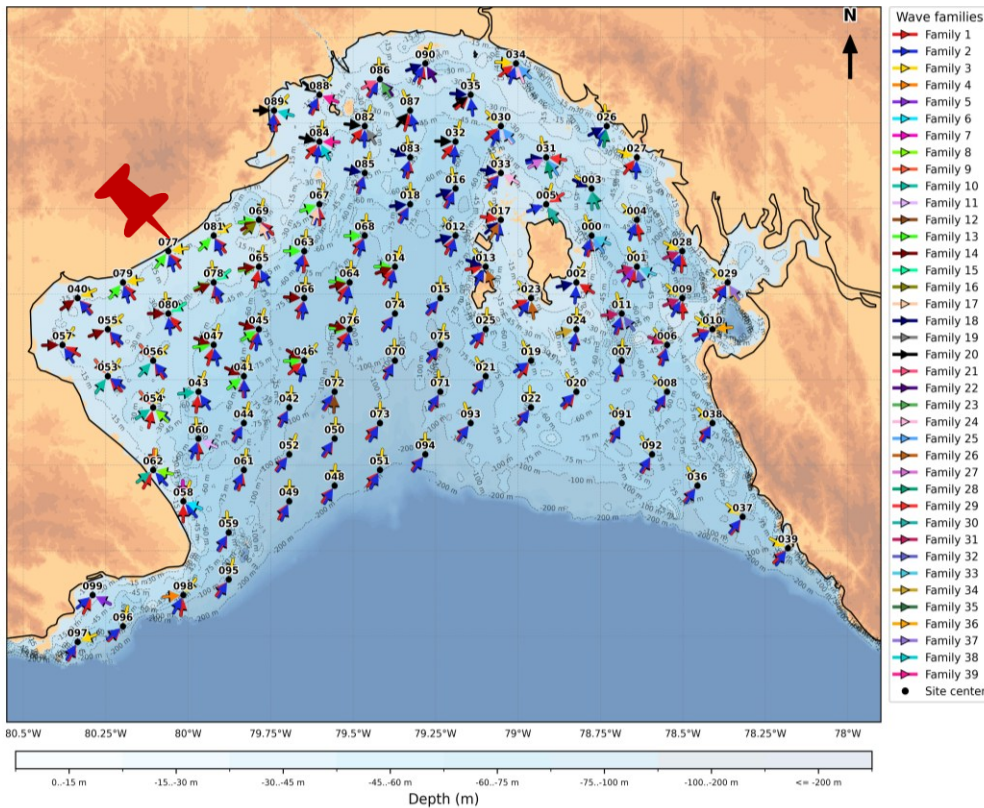
Wind-sea spectral reconstruction using HyXSeaSpec



- Reconstructed long-term frequency-direction wave spectra inside the Gulf of Panama using a hybrid metamodel framework.
- Combined offshore swell propagation (BinWaves) and regional wind-sea reconstruction (HyXSeaSpec).
- Applied K-means + EOF/PCA to identify seasonal spectral microregions.
- Applied spectral partitioning to track wave-system persistence and transformation across the basin.

# MAIN FINDINGS + IMPLICATIONS

**The Gulf of Panama does not simply attenuate offshore wave forcing: the dominant wave families (i.e., wave systems) entering the basin are progressively transformed toward the coast through directional reorientation, selective filtering, and spectral reorganization.**



- **Dry season: stronger imprint of northerly wind sea over a persistent S–SW swell background.**
- **Wet season: stronger southern-sector forcing, with S–SW swell and wind sea dominating the basin.**
- **Coastal response is controlled not only by wave-energy magnitude, but also by the spectral configuration of the wave field reaching the shoreline.**

