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Global Analysis of Temporal Clusters of Storm Surges

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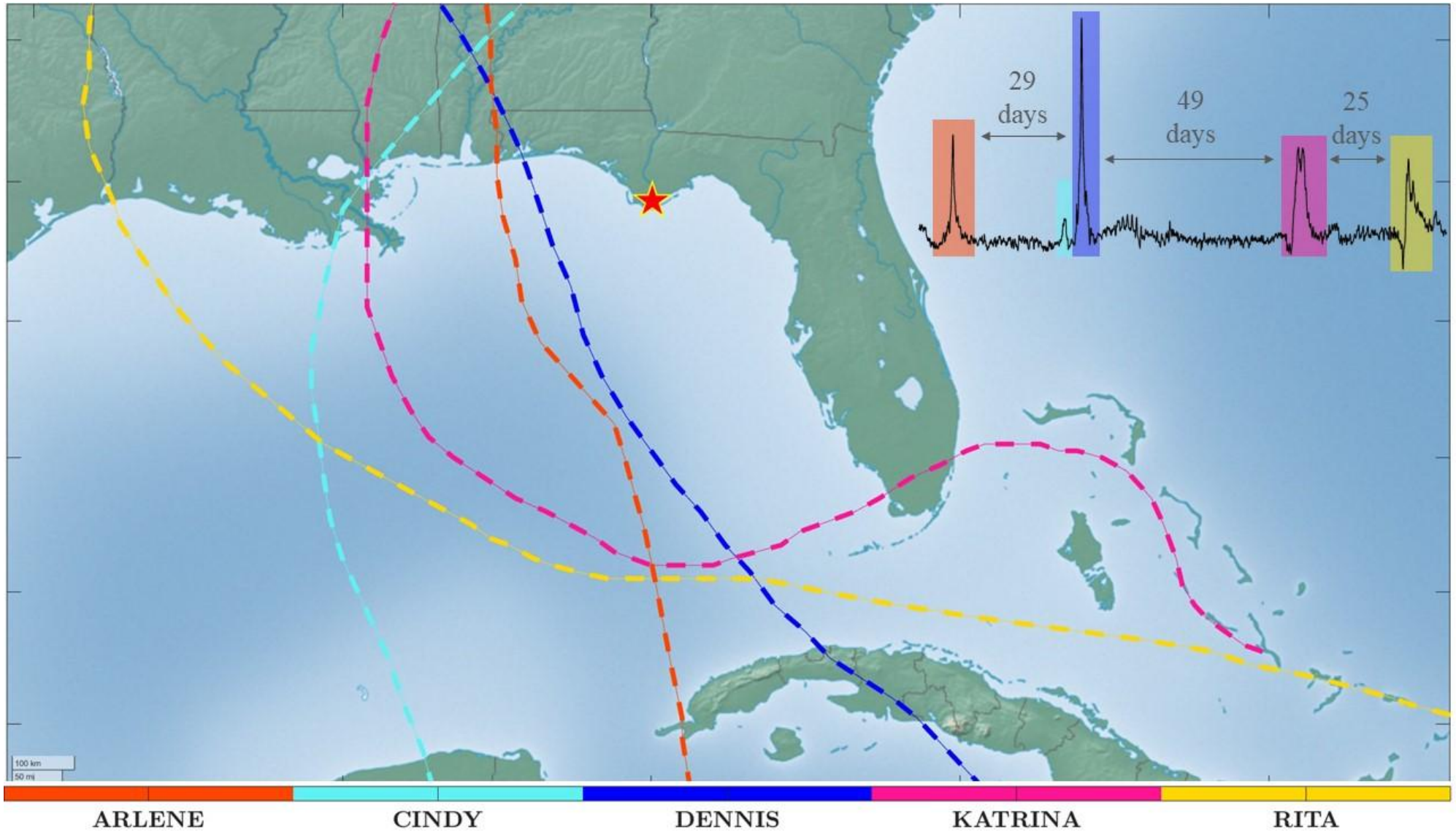
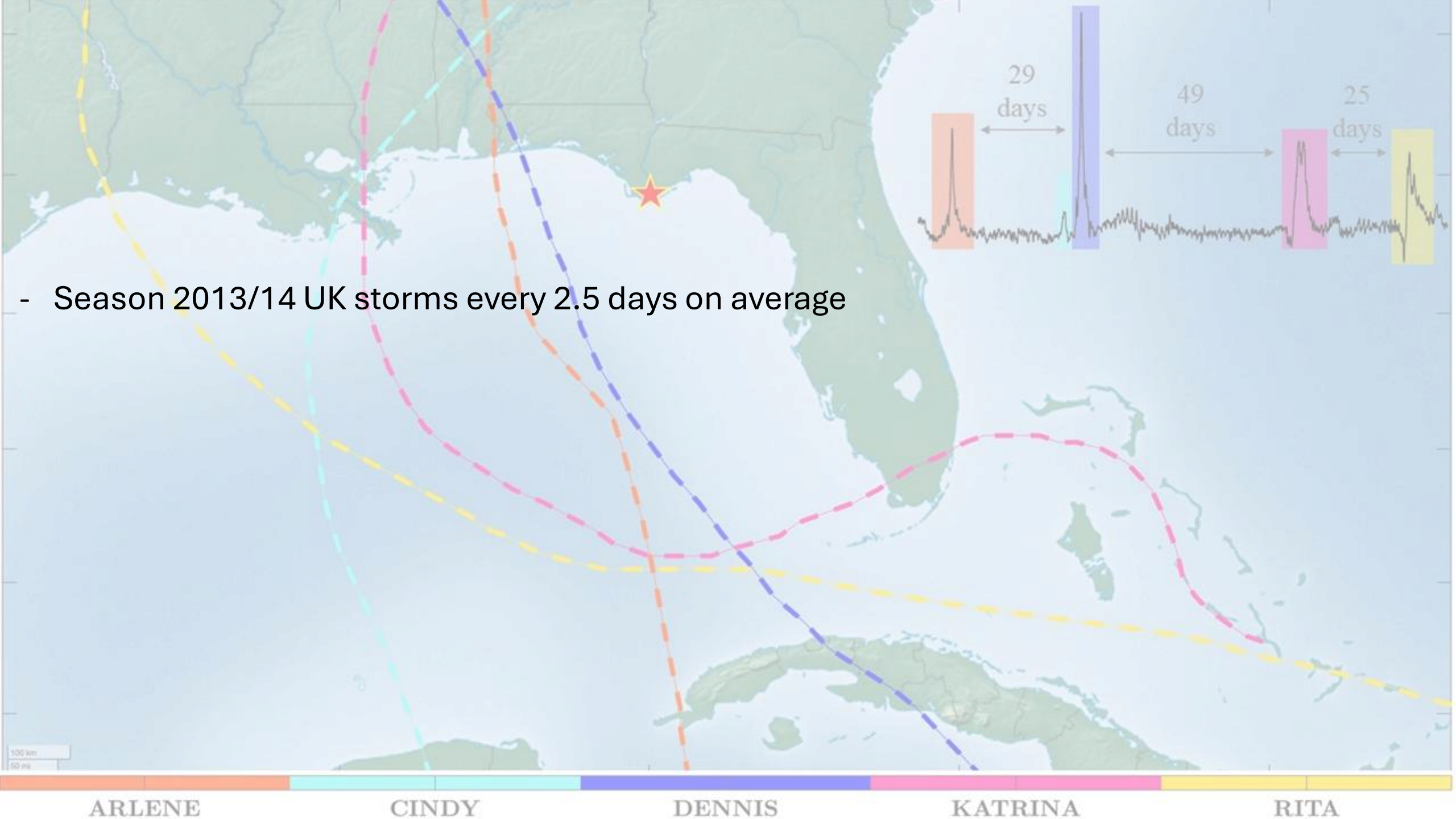
What is temporal clustering?





- Season 2013/14 UK storms every 2.5 days on average

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- Season 2004/22 Florida, 43 days apart

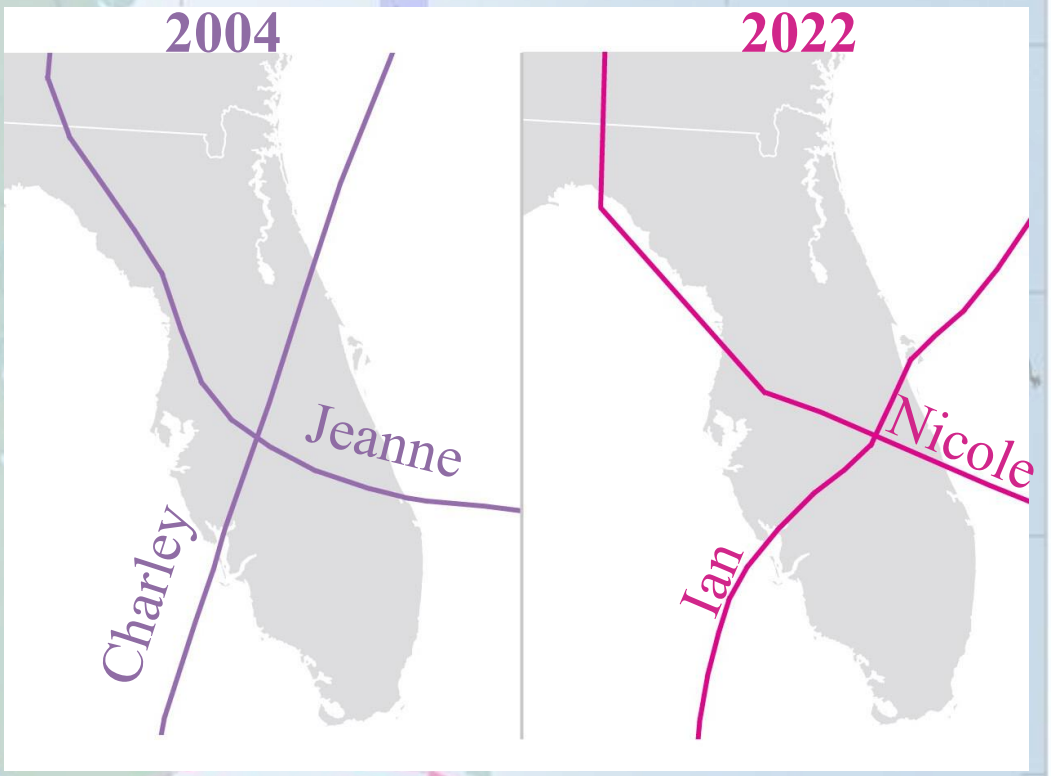

Figure from the Washington Post

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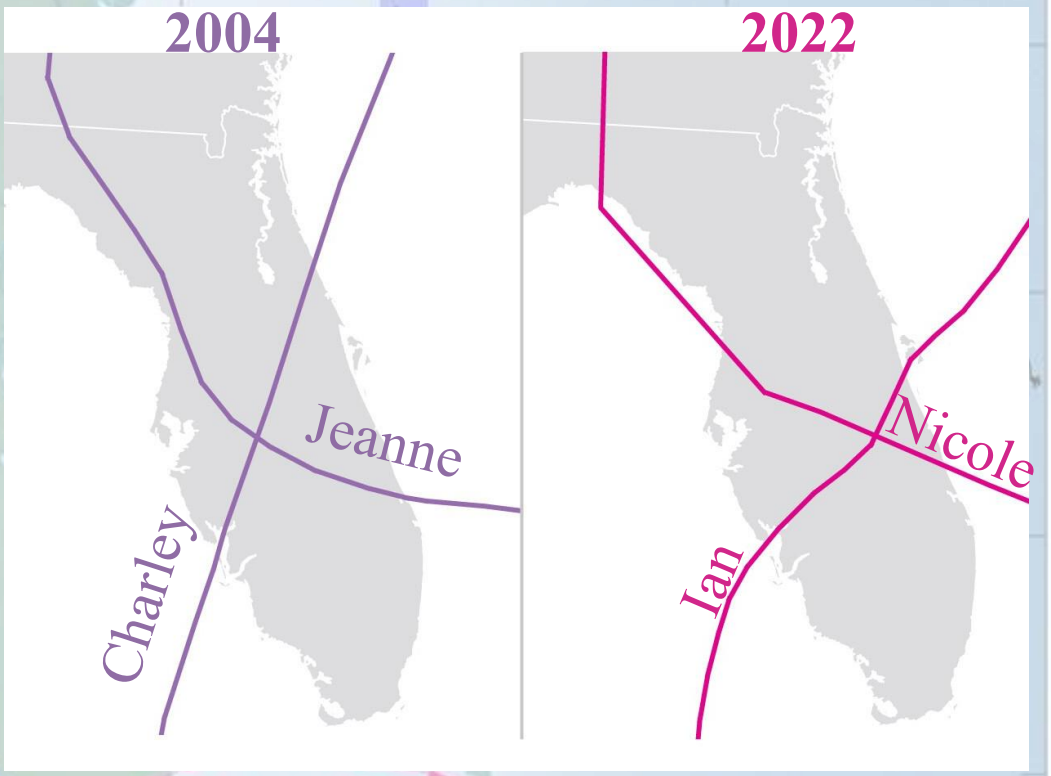

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- Karunarathna et al. (2014): “moderate storms can resemble the **beach erosion** caused by a single extreme event."

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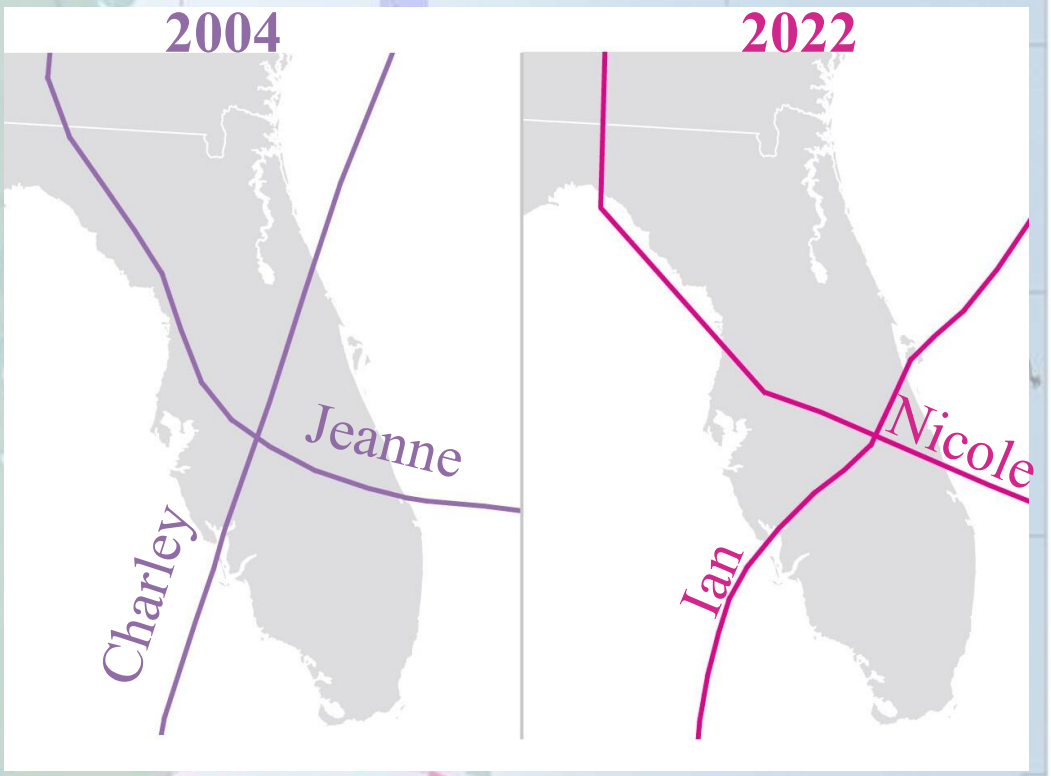

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- Mumby et al., 2011: Clustering gives natural ecosystem extended **calm periods** to recover

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Objectives

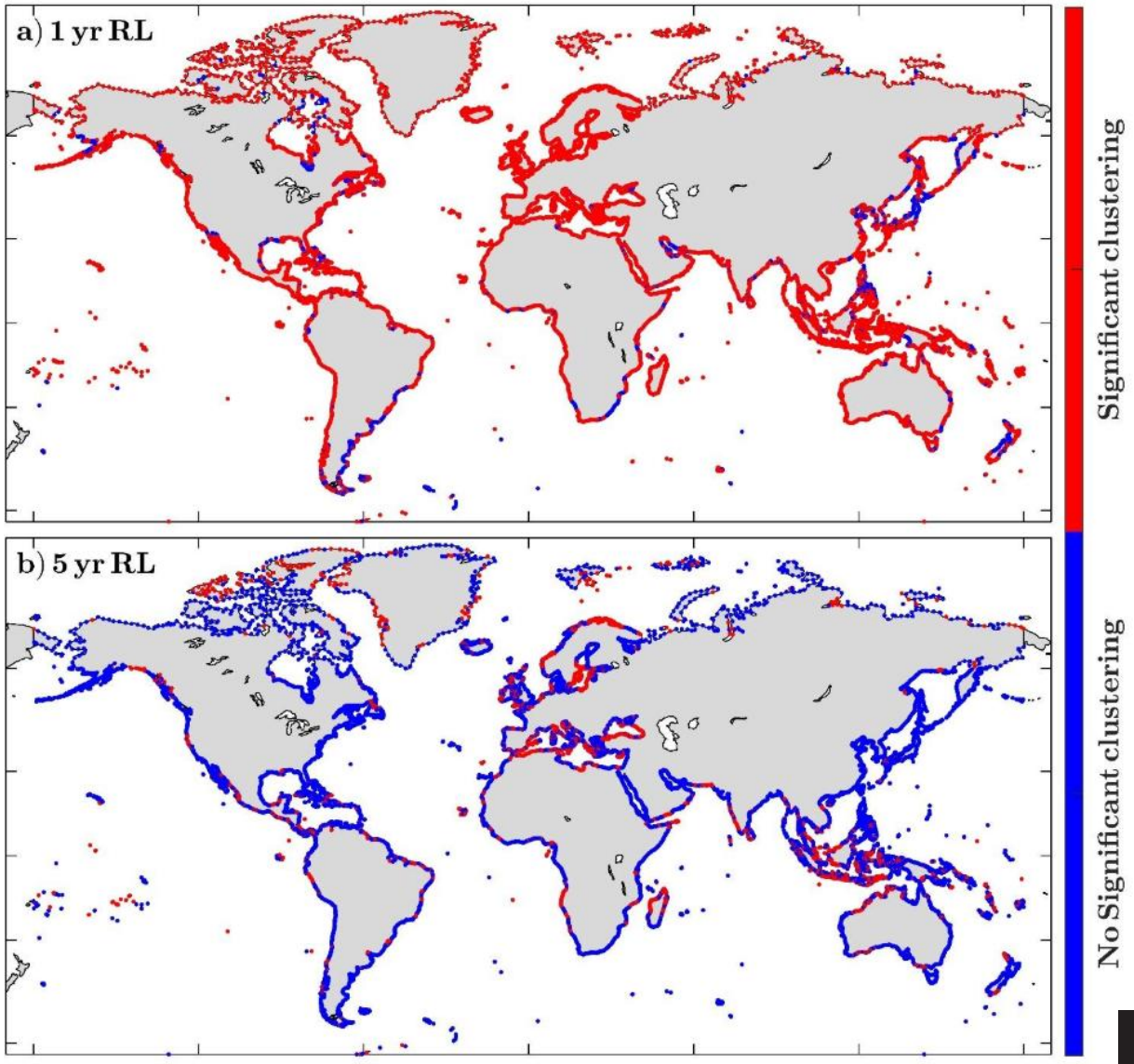
- Locate **geographical hotspots** of temporal clustering, and their frequency using **in-situ observations.**
- Compare these results to those obtained using **model data.**
- Evaluate the **Poisson distribution** assumption.

Data

- Coastal **tide gauges** with 20-yrs of records between 1979-2018 (527 points for validation) from the GESLA-3 dataset.
- Storm surges from the Coastal Dataset for the Evaluation for Climate Impact 2020 (**CoDEC**) all grid points (18,719).

Framework

- How significant is the temporal clustering compared to a **Poisson distribution**?
- **Ripley's K Index** indicates the tendency towards temporal clustering in the series.
- We assess the **sensitivity** towards **threshold** (1 to 5-yr RL) and **clustering duration** (from 15 days to 2 years).



Sites where the Poisson assumption is not satisfied

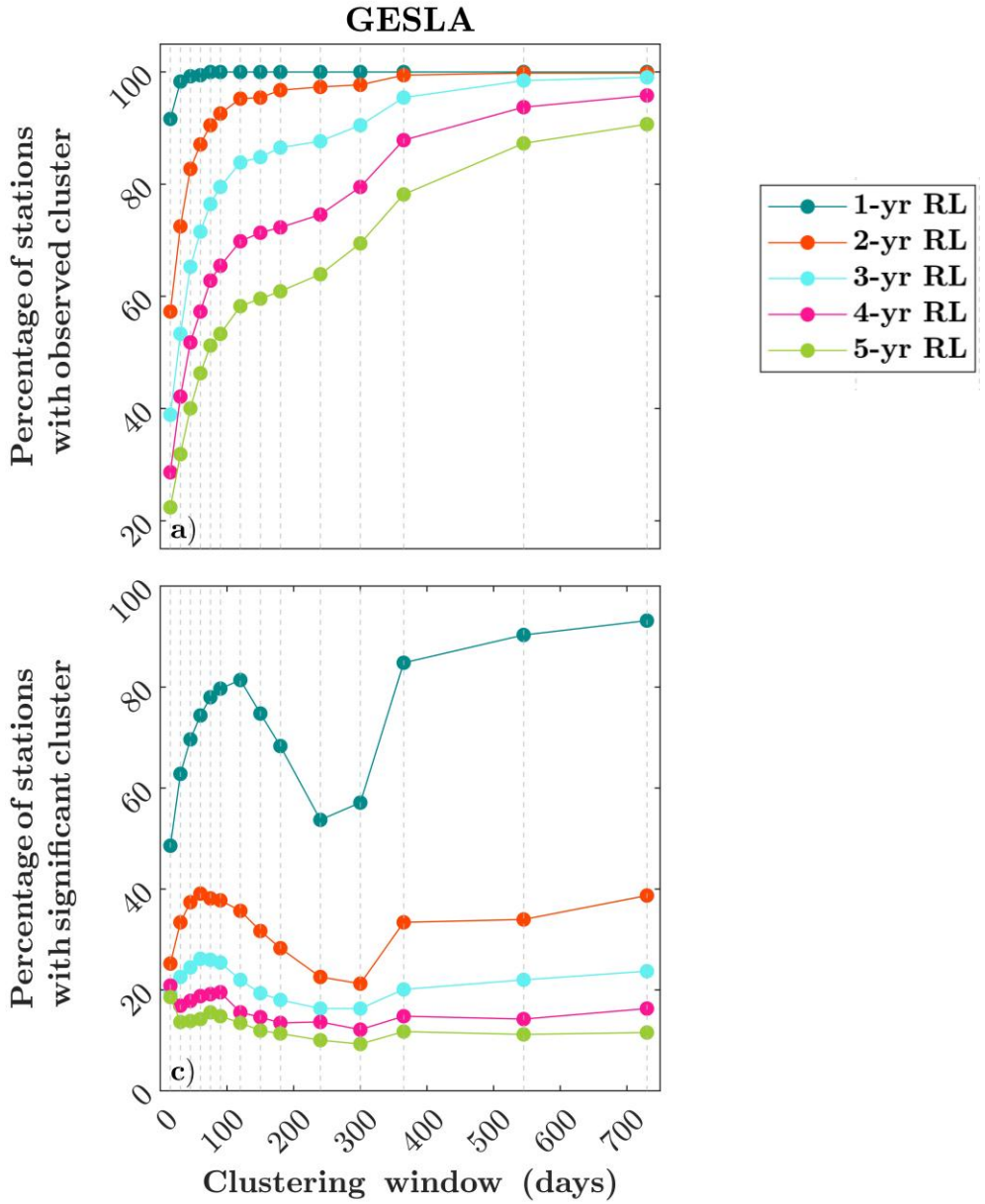
Results: Validation

Observed Clusters

- **Decreases** with the thresholds and for longer clustering windows
- **Exponential** but **not steadily** decay

Significant Clusters

- Certain windows are more **prone to clusters**
- **General behavior** consistent globally



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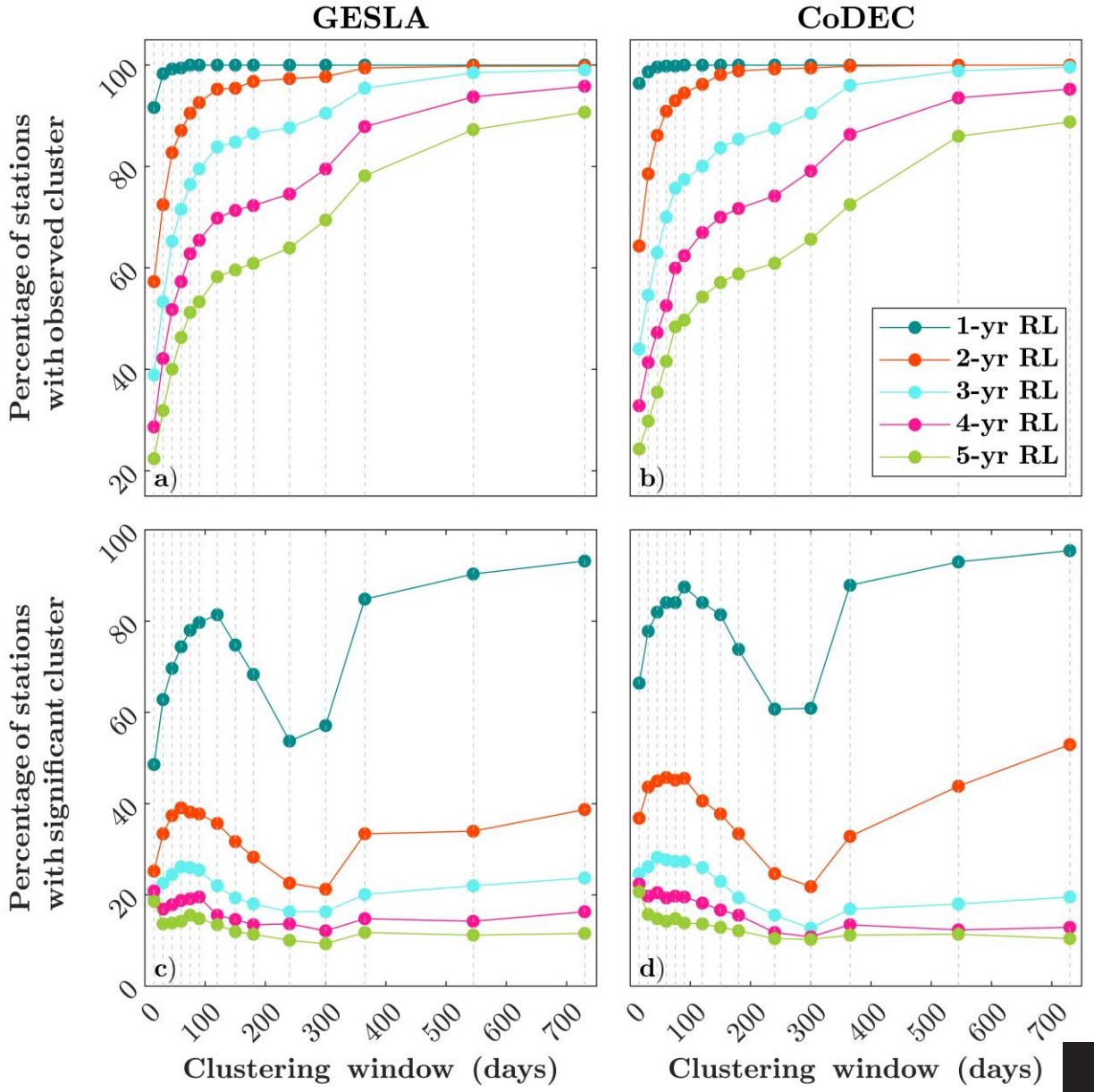
CoDEC

- Able to reproduce general behavior

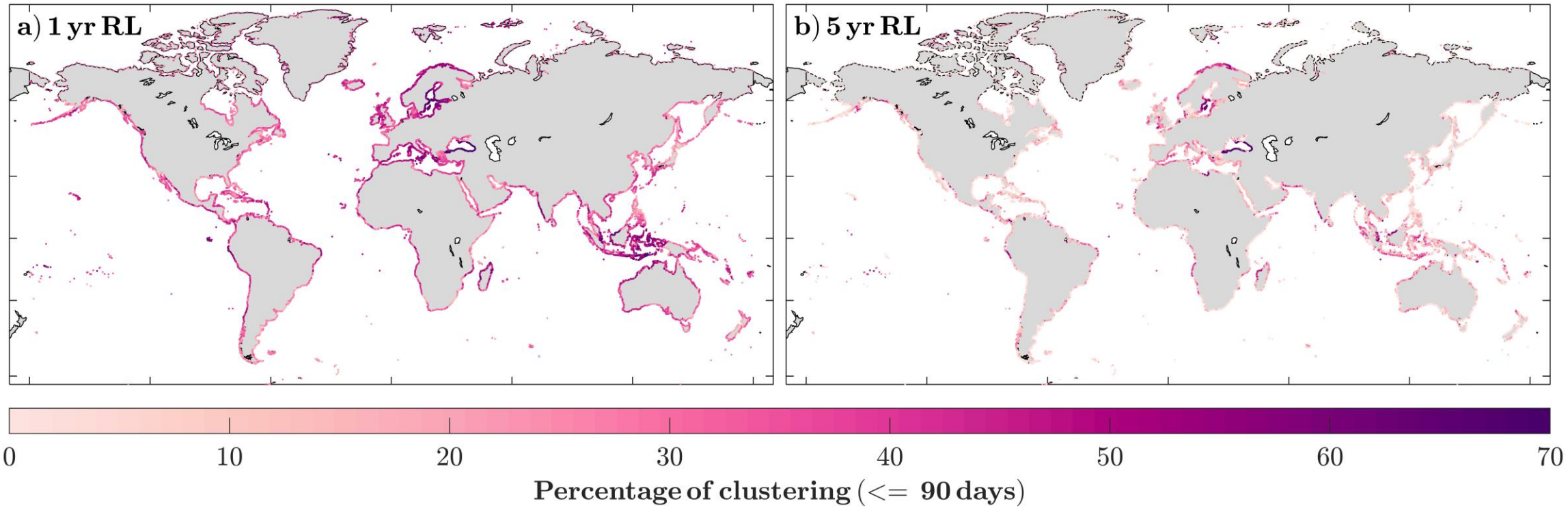


Results: Global Analysis

❖ Temporal clusters of storm surges at the **global scale**, using all CoDEC points.

Percentage of clustering

$$\frac{\text{\# of events within 90 days}}{\text{total \# of events}}$$



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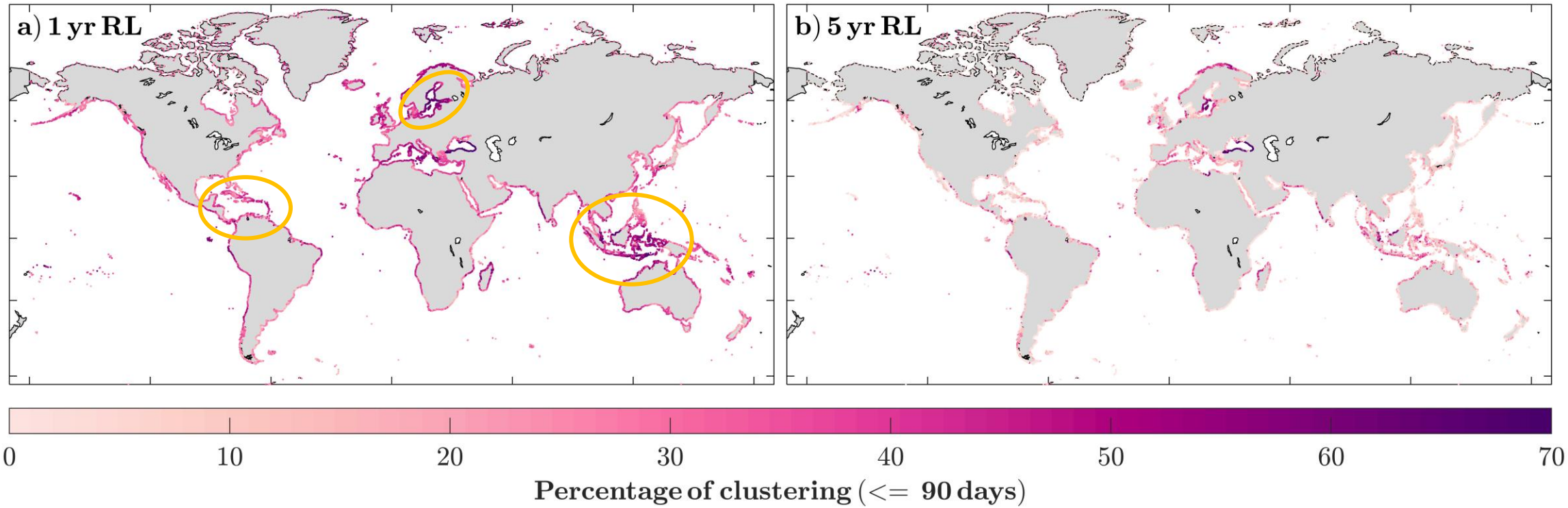
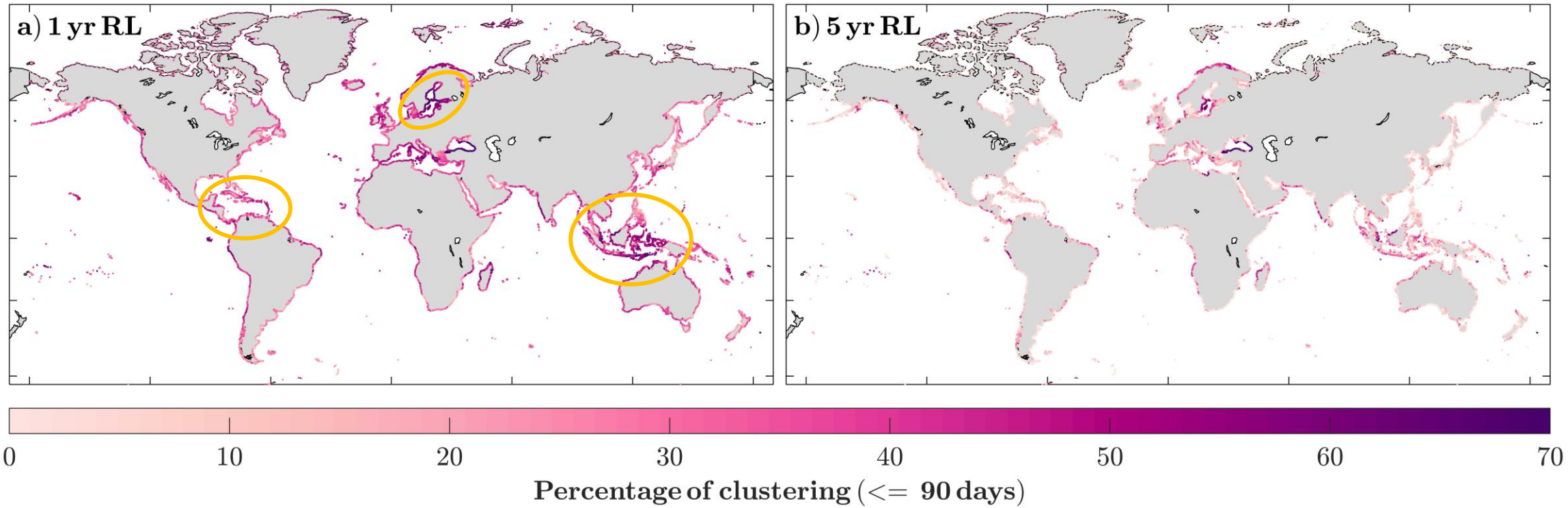


Results: Global Analysis

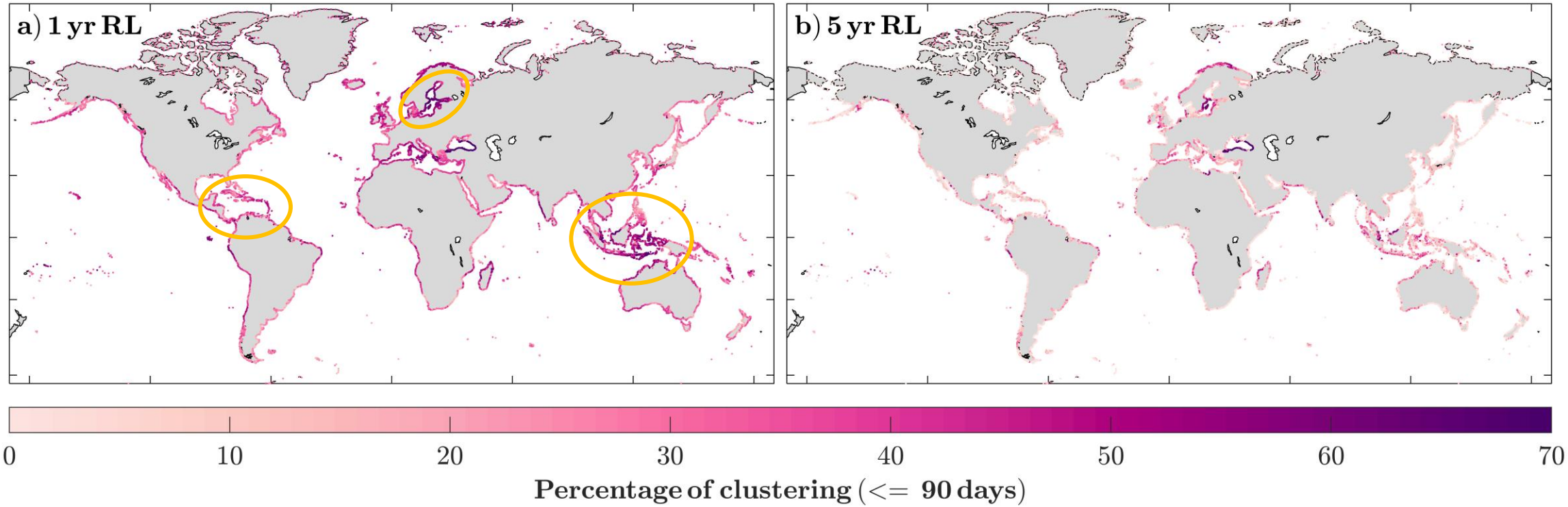
Events that belong to a cluster → **39 %** → **14 %**



Results: Global Analysis

Events that belong to a cluster → 39 % → 14 %

Poisson Estimation → 10 % → 2.5 %



Inter-Arrival Time

Short-term Clustering

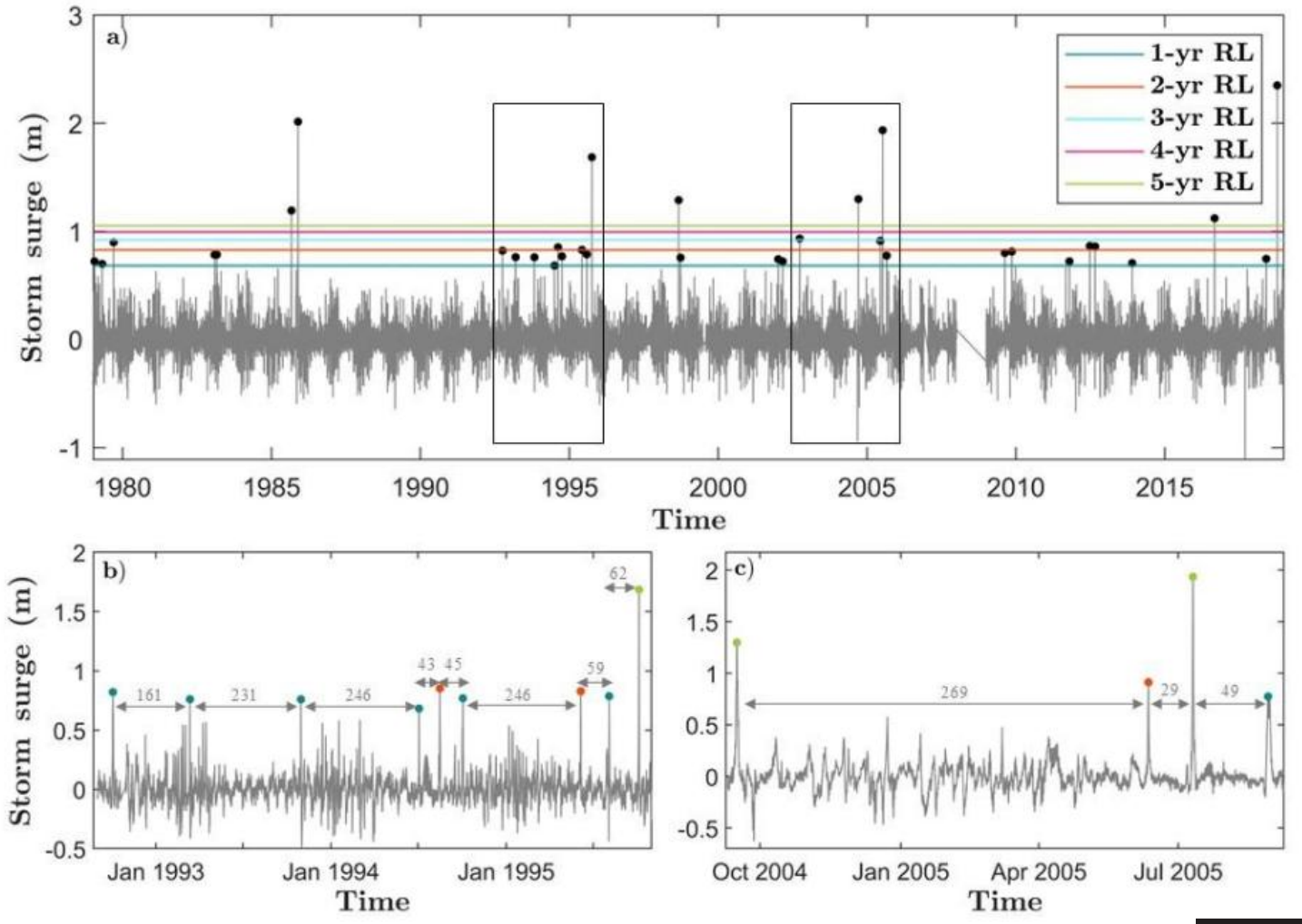
↓

Time between **consecutive events**

Recovery Time

↓

Time between **consecutive clusters**



Inter-Arrival Time

Short-term Clustering

↓

Time between **consecutive events**

↓

< 180 days

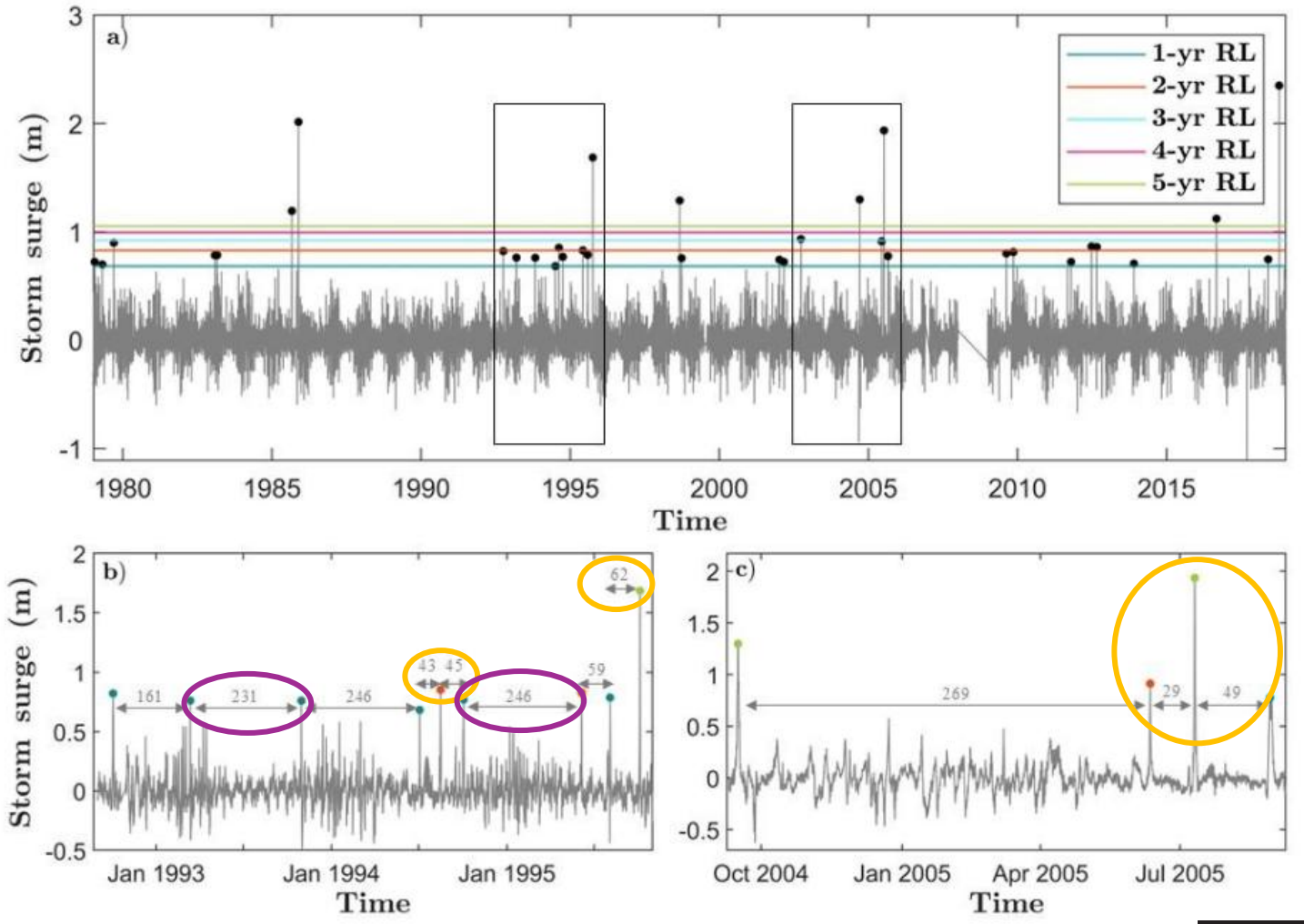
Recovery Time

↓

Time between **consecutive clusters**

↓

> 180 days



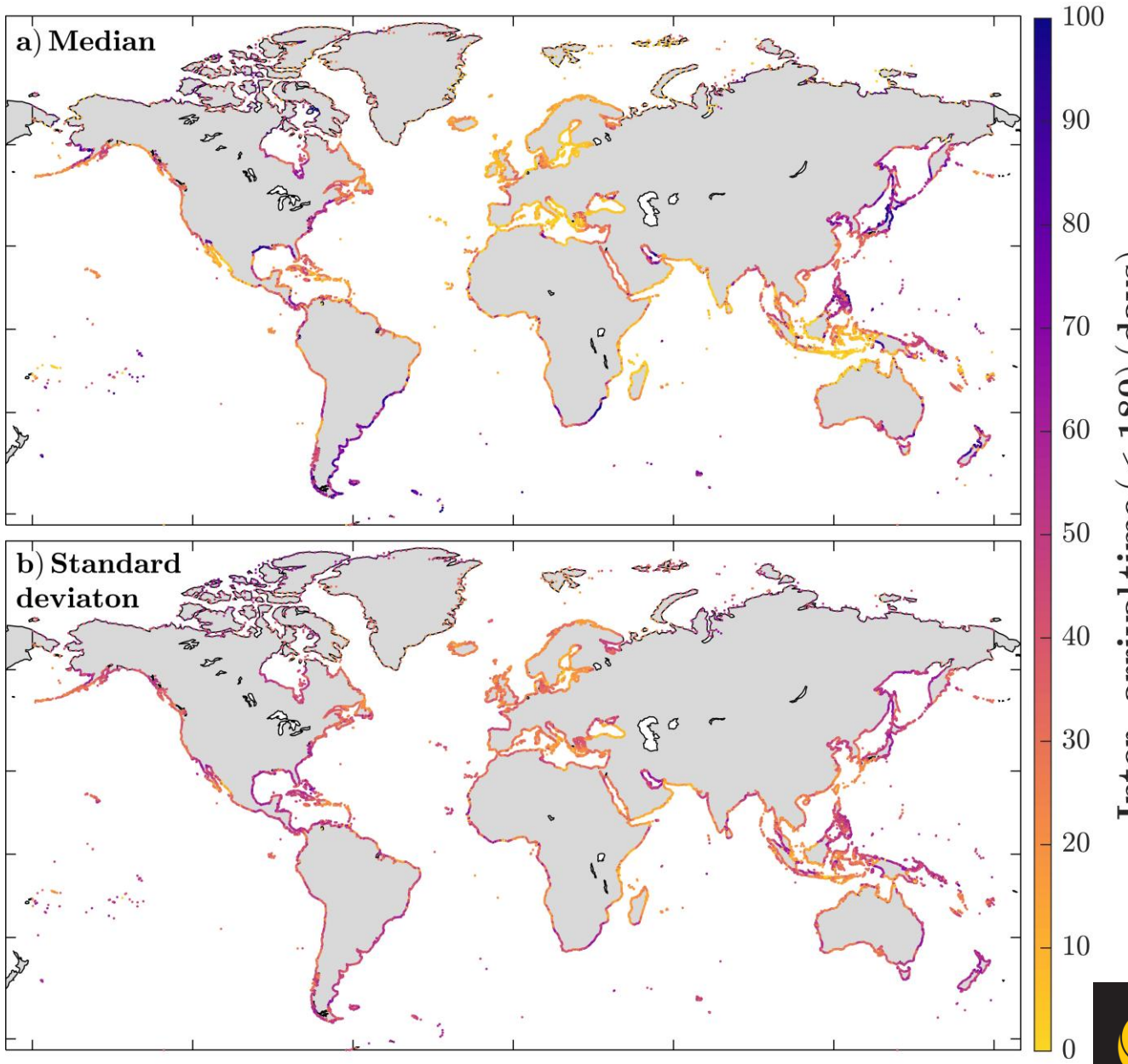
Inter-Arrival Time

Short-term Clustering

Time between two **consecutive events**

Average inter-arrival time → **26 days**

Poisson Estimation → **90 days**



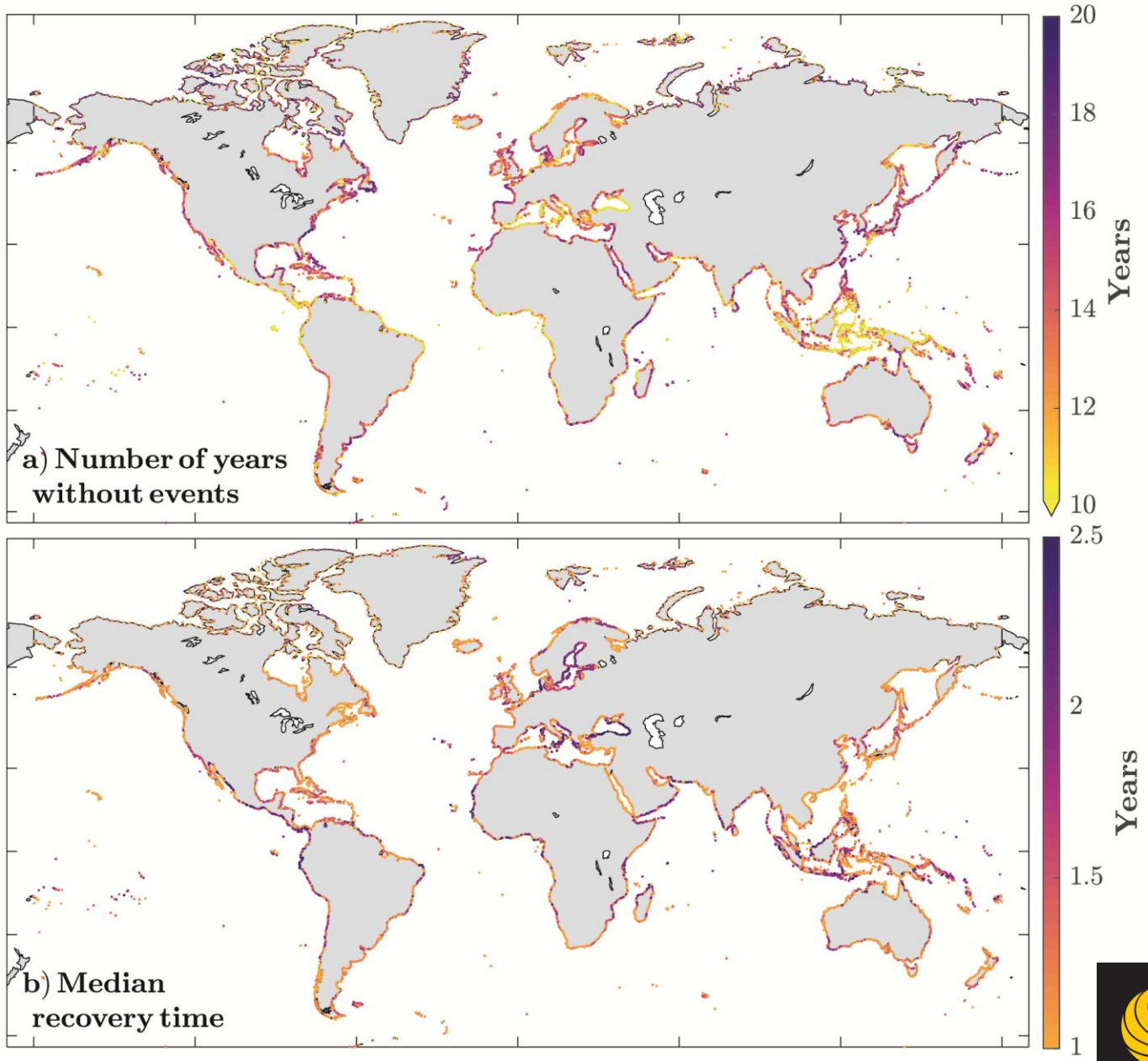
Inter-Arrival Time

Recovery time

Time between two **consecutive clusters**

Average recovery time → **1.5 years**

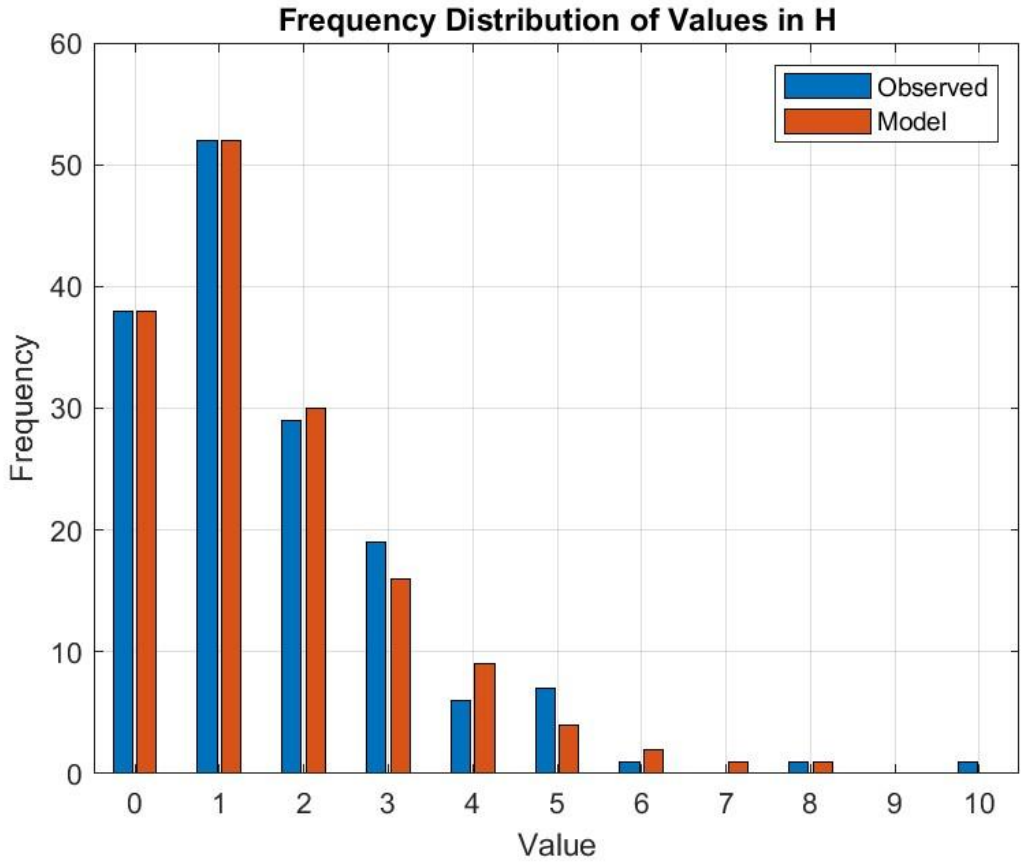
Number of Inactive Seasons → **13 years**



Work in Progress

Martín A, Jane R, Enriquez AR, Wahl T. **Global analysis of temporal clusters of storm surges**. *Cambridge Prisms: Coastal Futures*. 2025;3:e17. doi:10.1017/cft.2025.10008

- Review of existing **count models** for **overdisperesed data.**
- New model to improve and simplify prediction of seasonal counts.



Thank You!

Paper Acess