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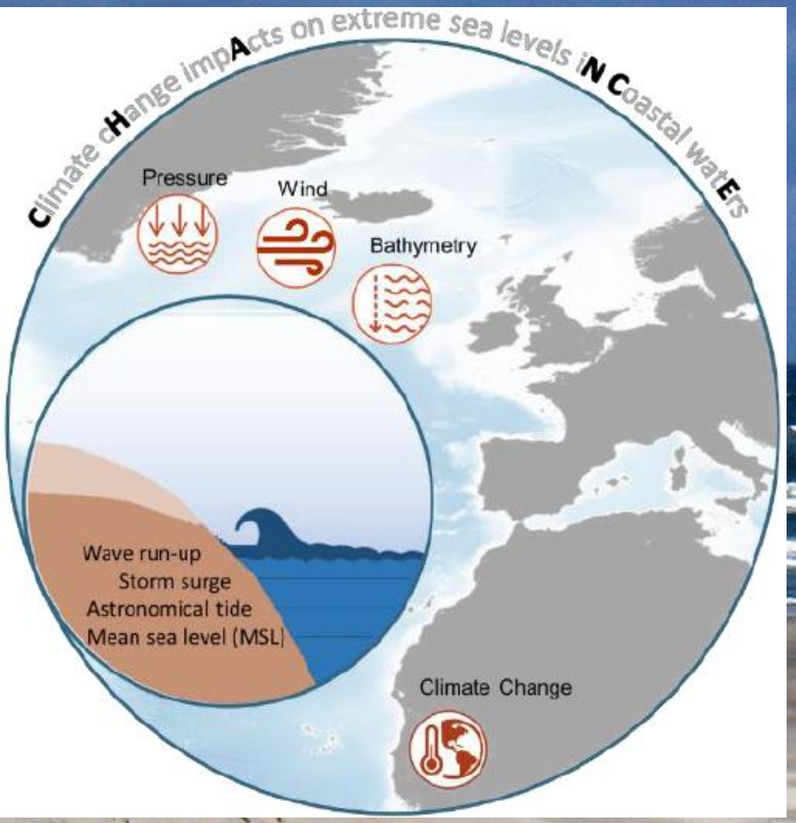
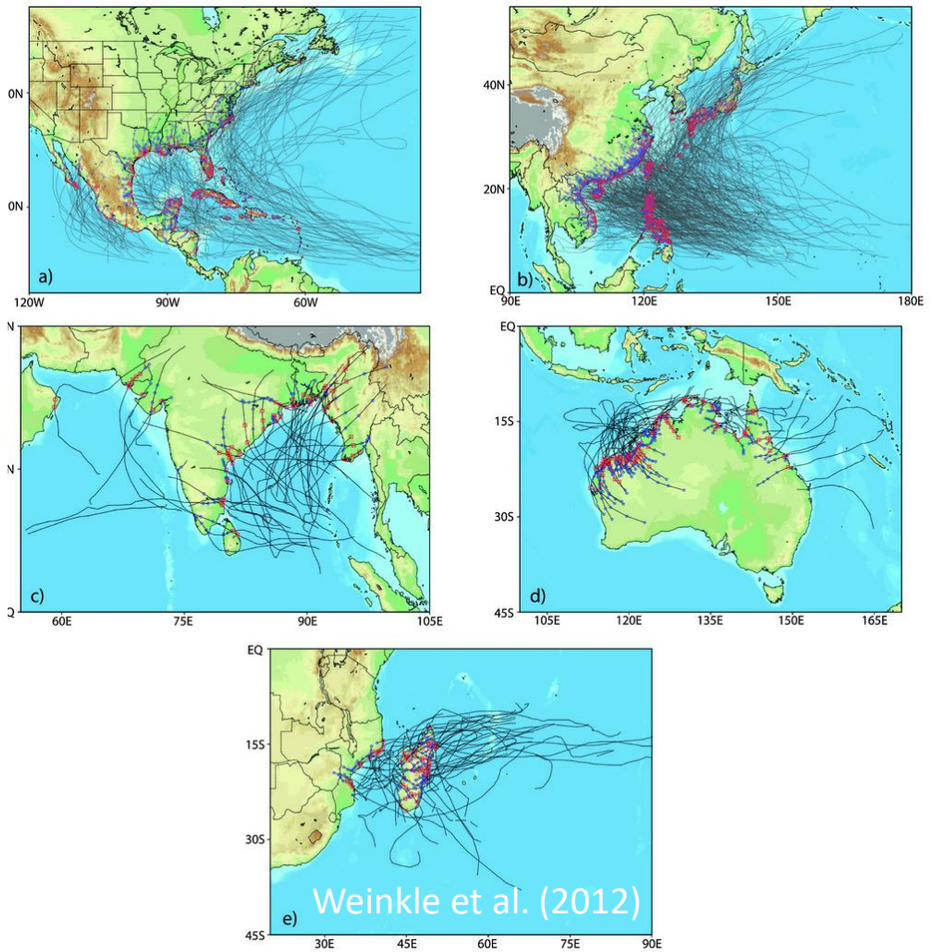
IVM Institute for Environmental Studies



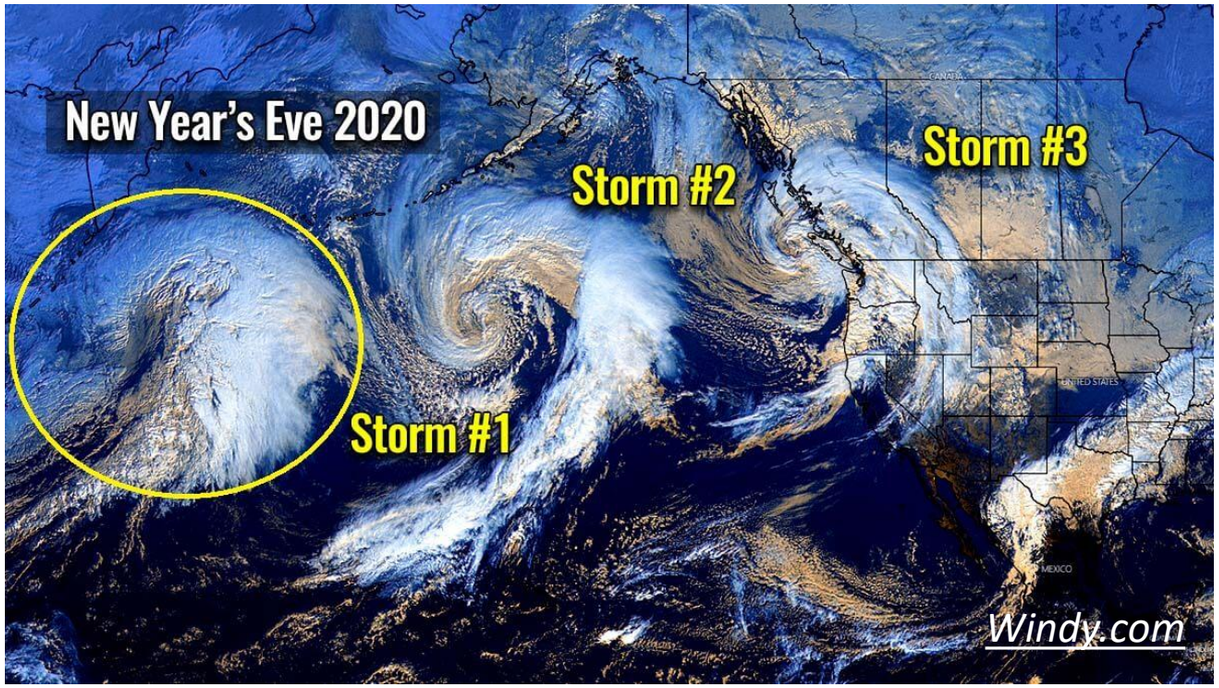
Global analysis of storm surge seasonality

Ayoola Apolola, Philip J. Ward, Wiebke Jäger, Timothy Tiggeloven, José A. Á. Antolínez, and Sanne Muis

Global analysis of storm surge seasonality



7-30 tropical cyclones make landfall each year

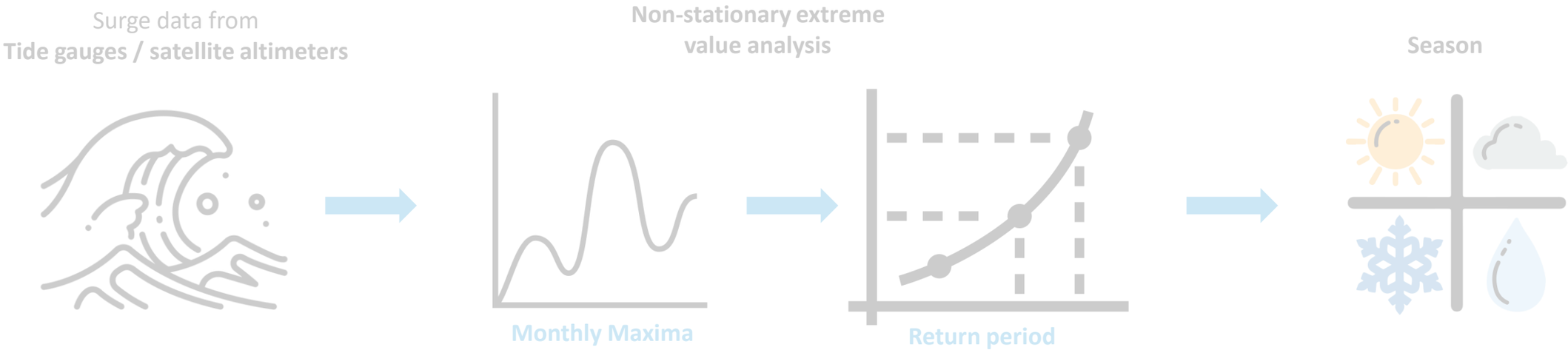


Extra-tropical cyclones are far **more frequent than tropical cyclones.**

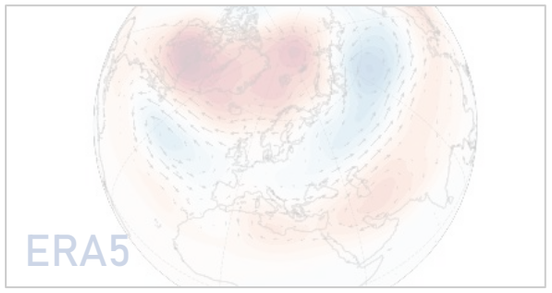
Traditional assessment:

Limitations:

- Limited information by focusing on specific return periods;
- Observational dataset have spatial and temporal limitations.



Motivation:



Muis et al. (2020)

To close this knowledge gap,

- We investigate the **seasonality of storm surges at the global scale with the GTSM data**.

- We employ **directional statistics to assess the number of storm surge seasons, their length, and the peak of the season.**

Methodology: Directional statistics

1. GTSM Surge residuals (1980 -2018)

Station 1

Station 2

•

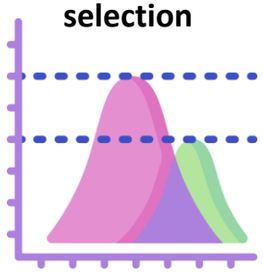
•

Station 43119

Quality checks

Filtering

2. Extreme value selection



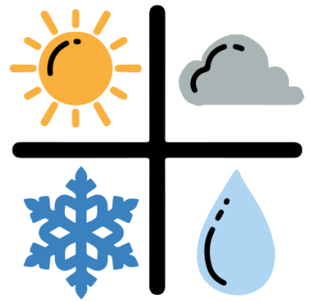
Surge peaks

3. Dates of the selected surge peaks

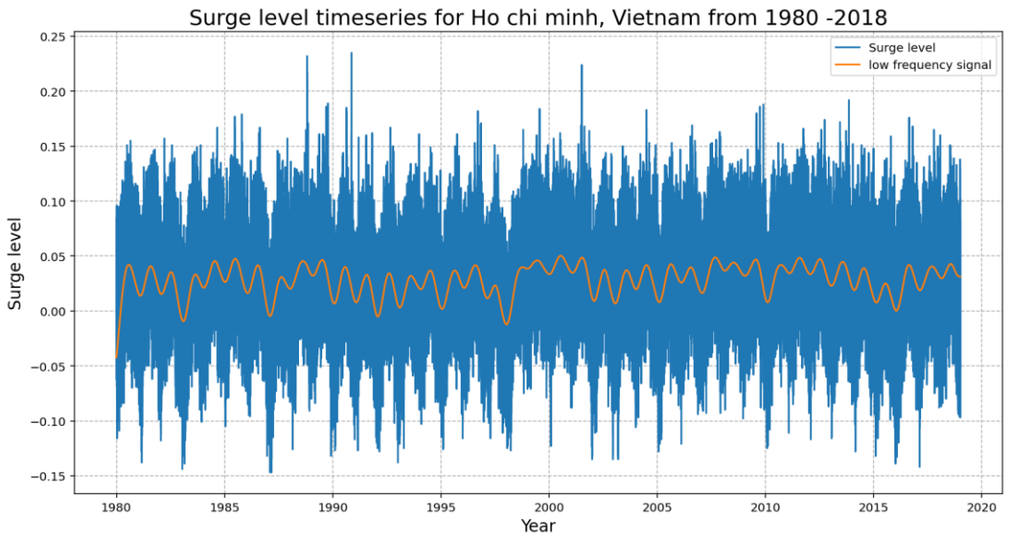
Circular uniformity test

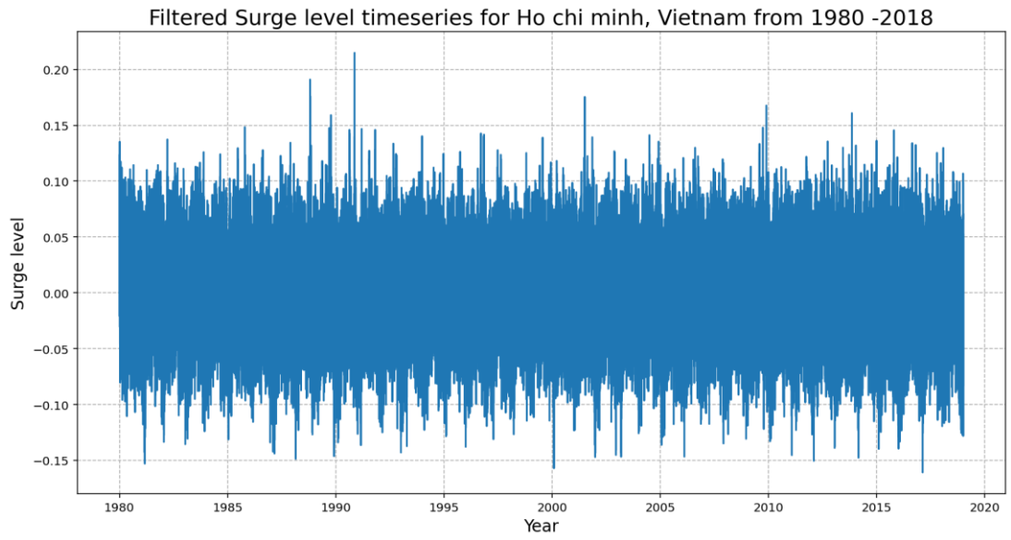
Mixture model of the Von Mises-Fisher distribution

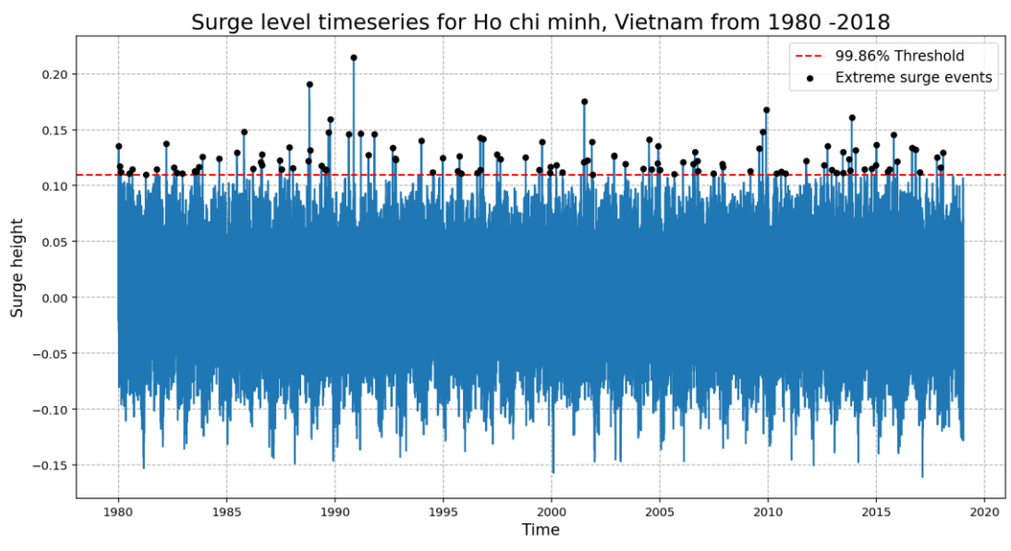
4. Identification of the storm surge season



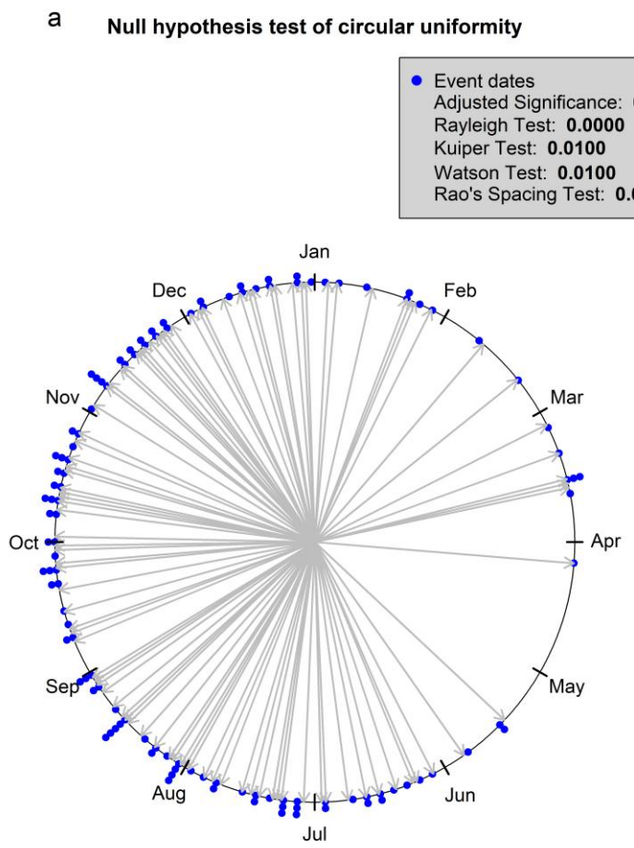
Method Application: Directional statistics





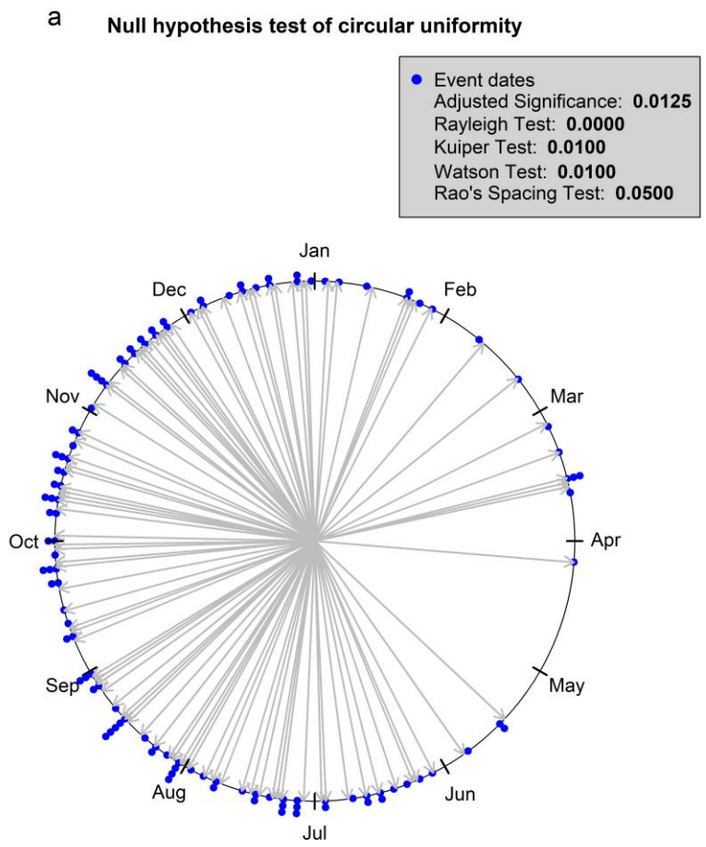


Method Application: Circular uniformity test

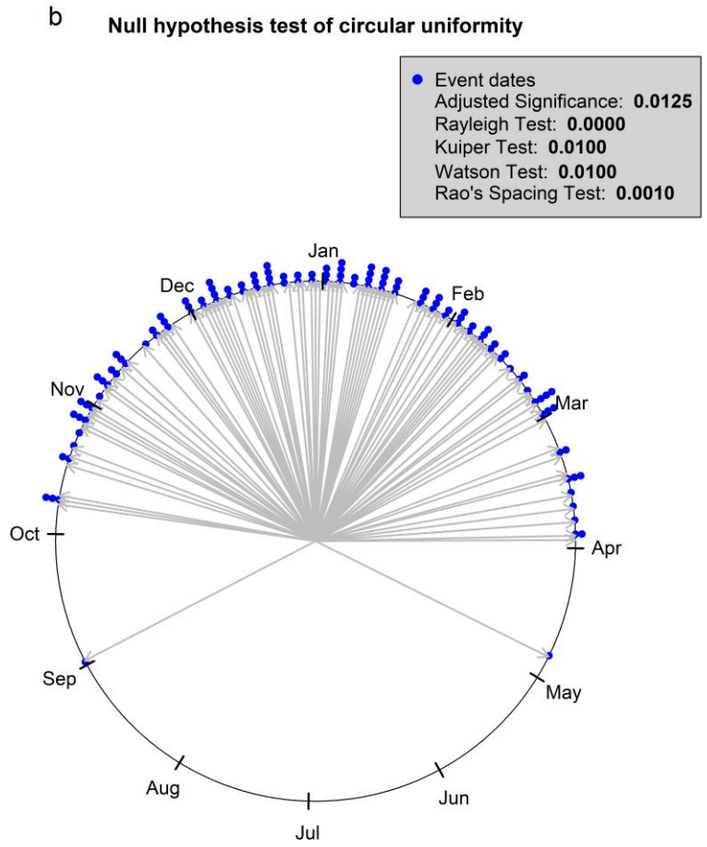


Method Application: Circular uniformity test

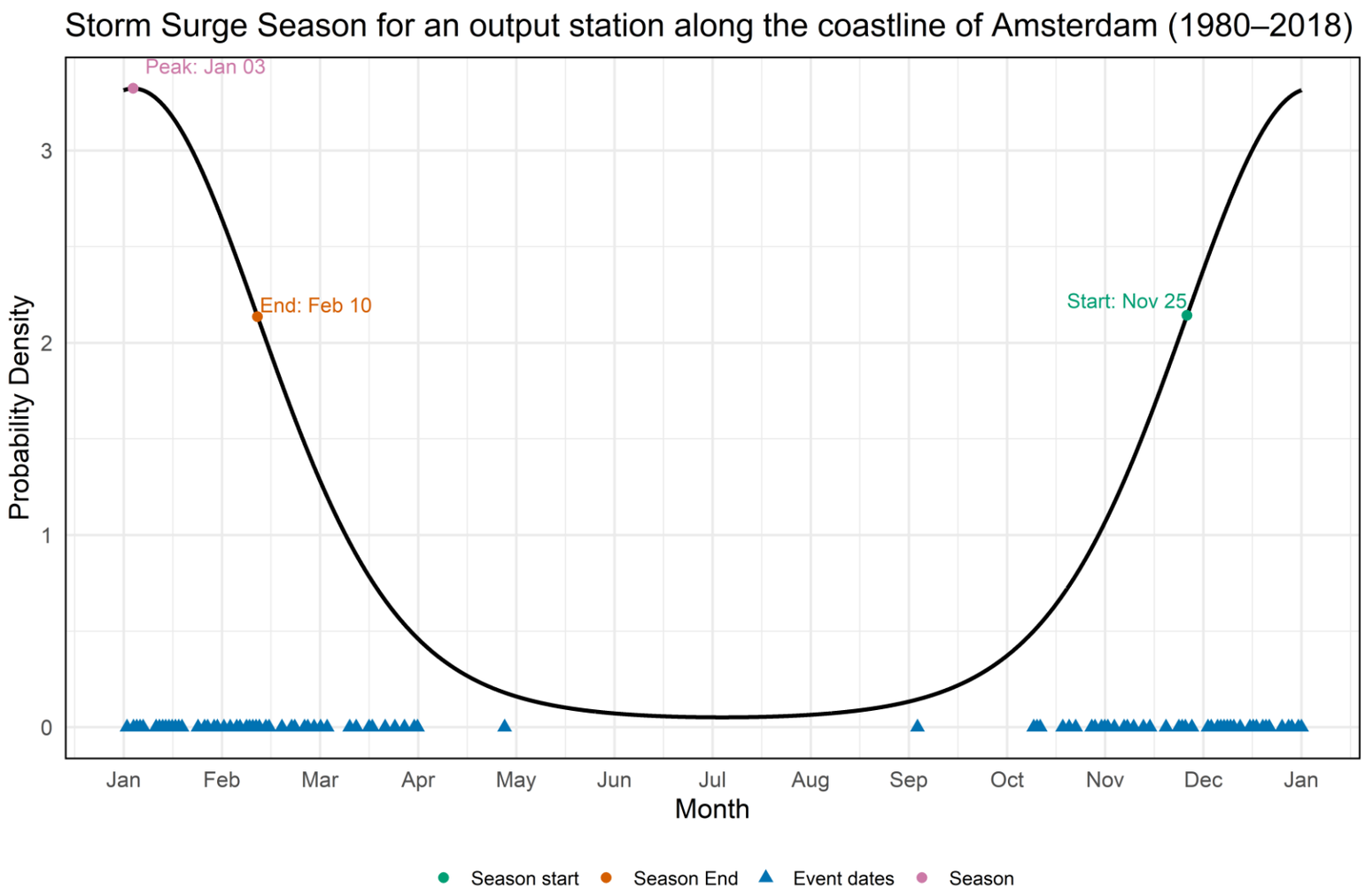
a



b

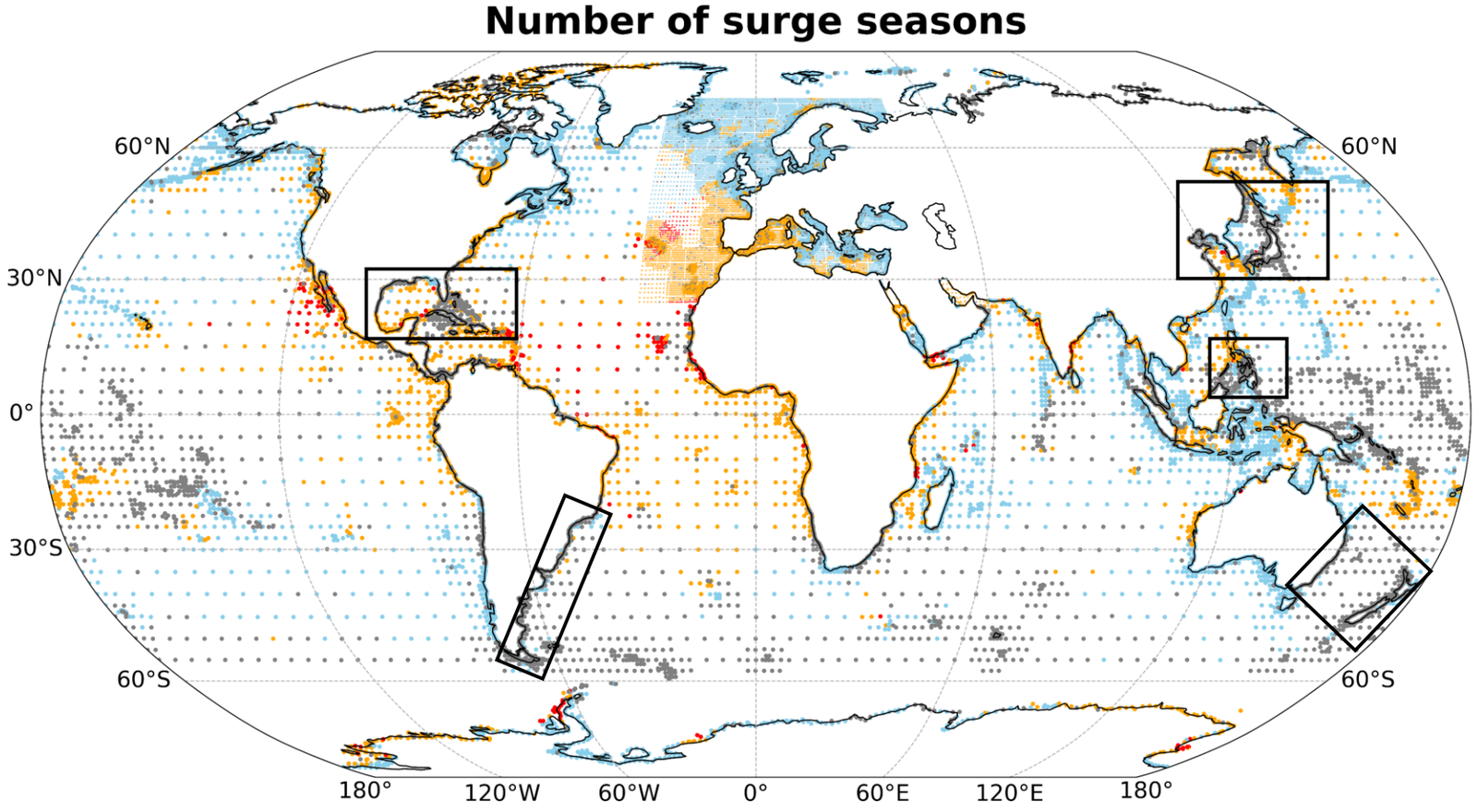


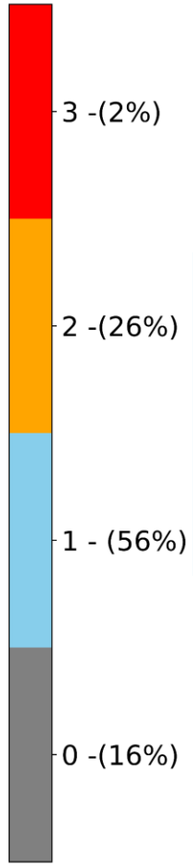
Von-Mises Fisher Distribution:



- **Model component with the lowest BIC, represents the number of seasons.**

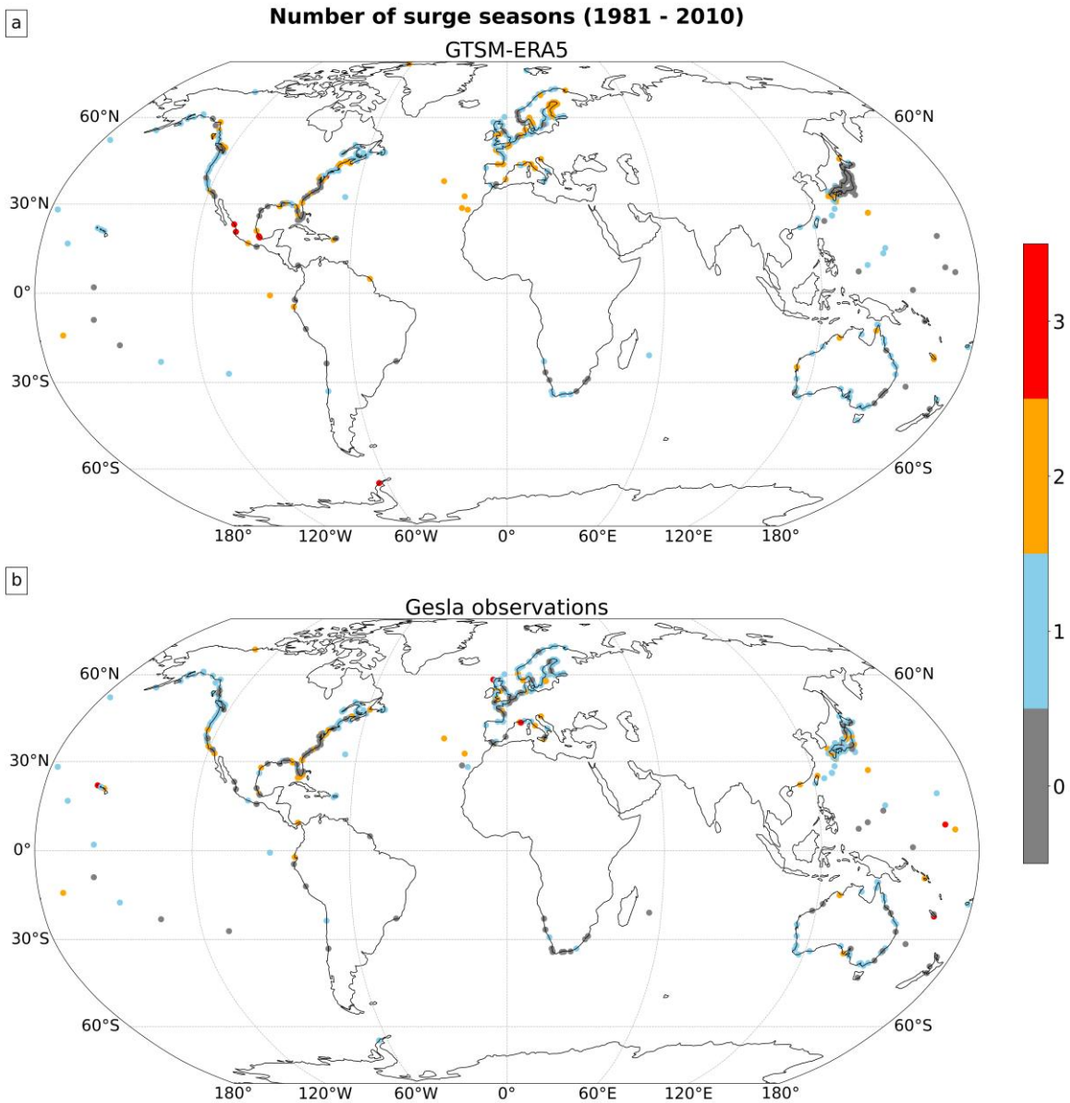
Result: characteristics of the storm surge season

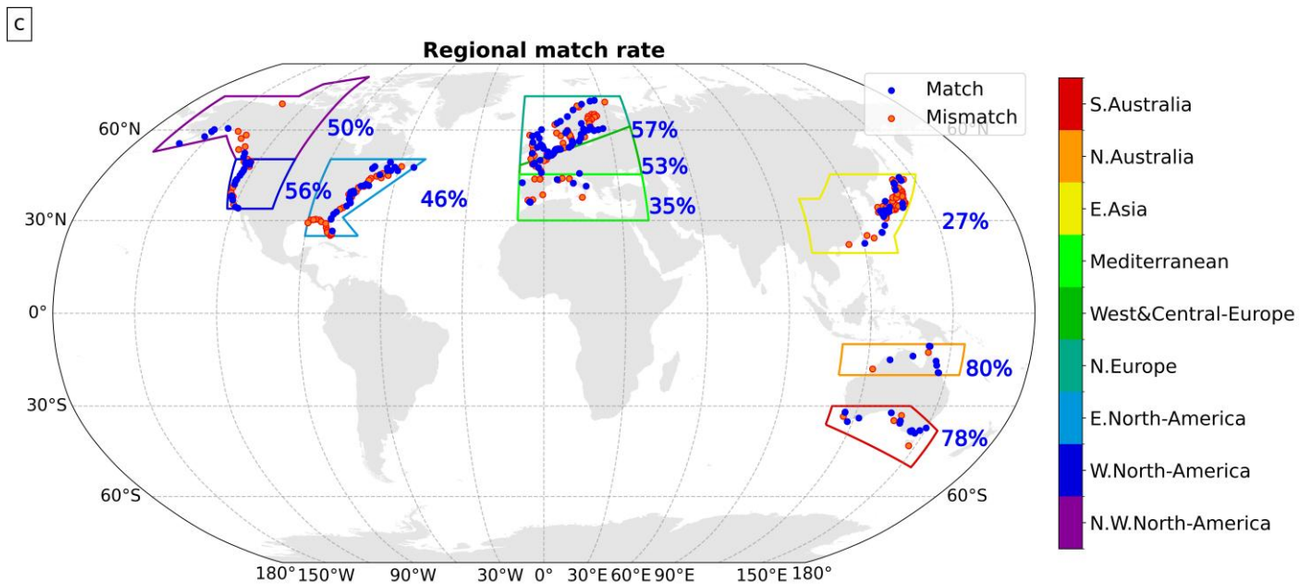




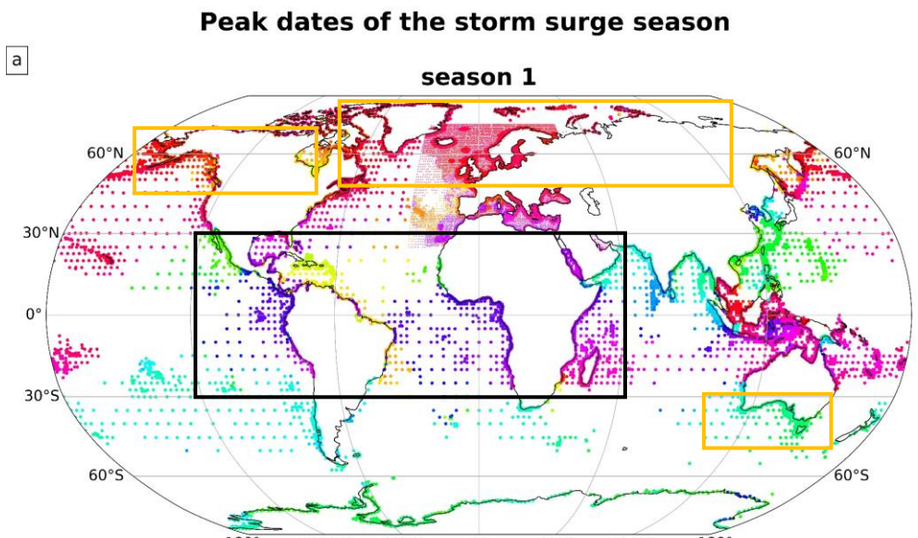
- **Nearly half of the global coastal stations, predominantly in tropical and subtropical regions, either lack a distinct surge season or experience heightened surge activity across multiple periods.**

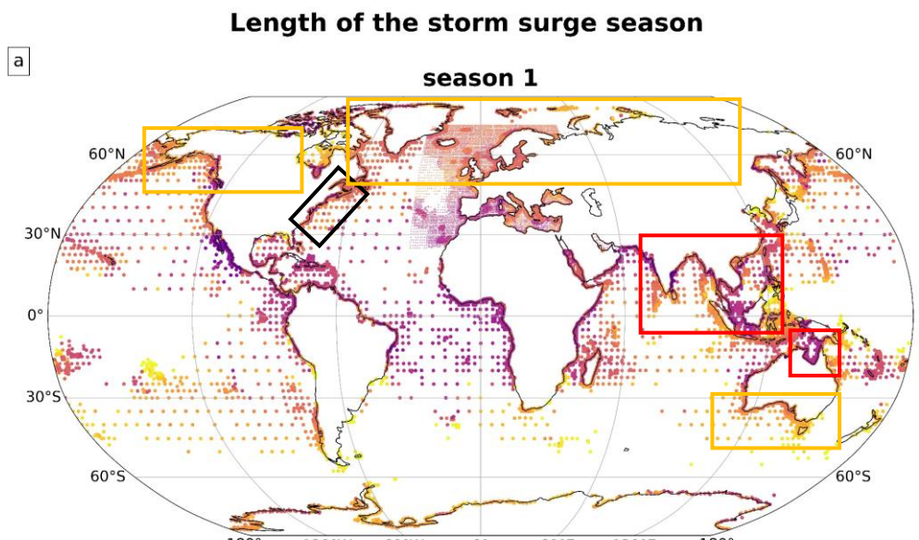
Result: characteristics of the storm surge season- validation



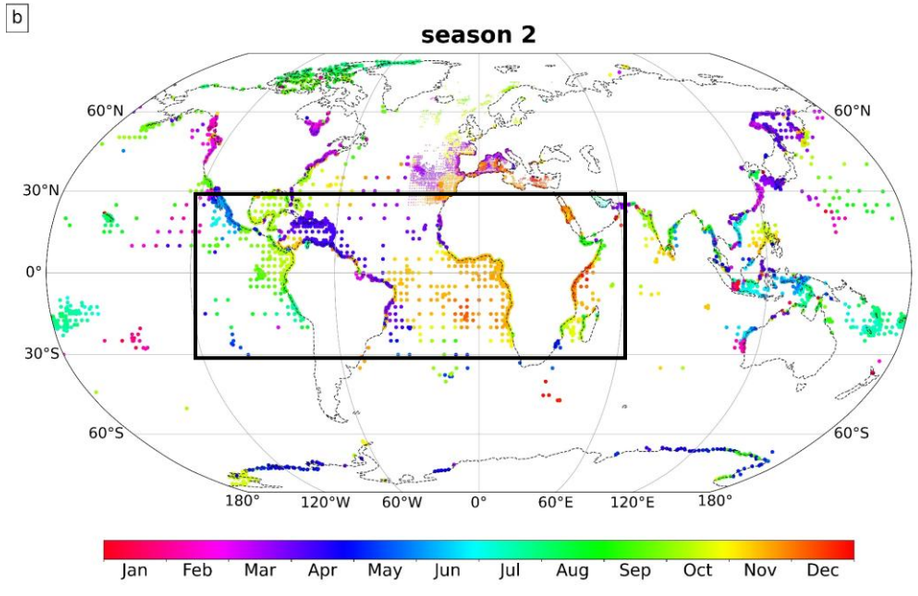


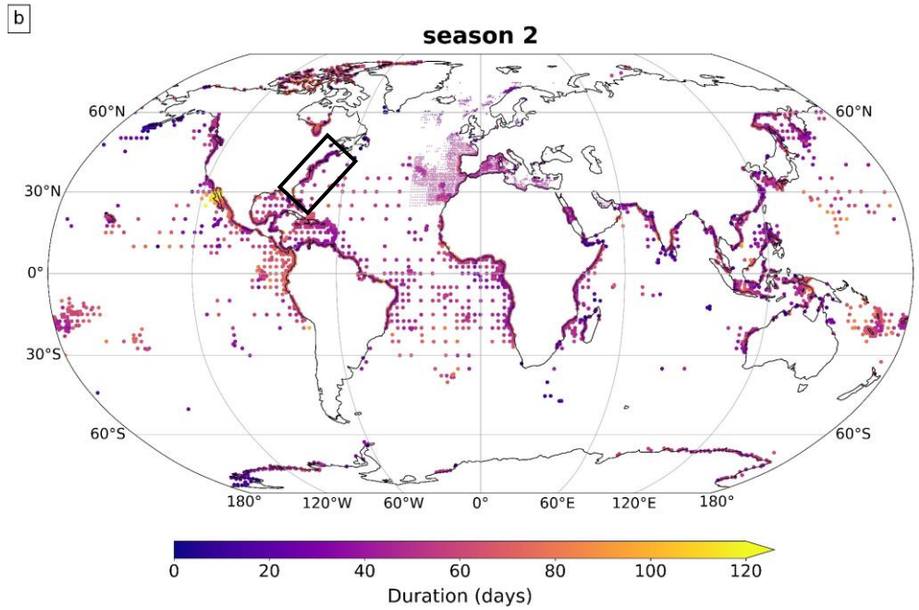
Result: characteristics of the storm surge season





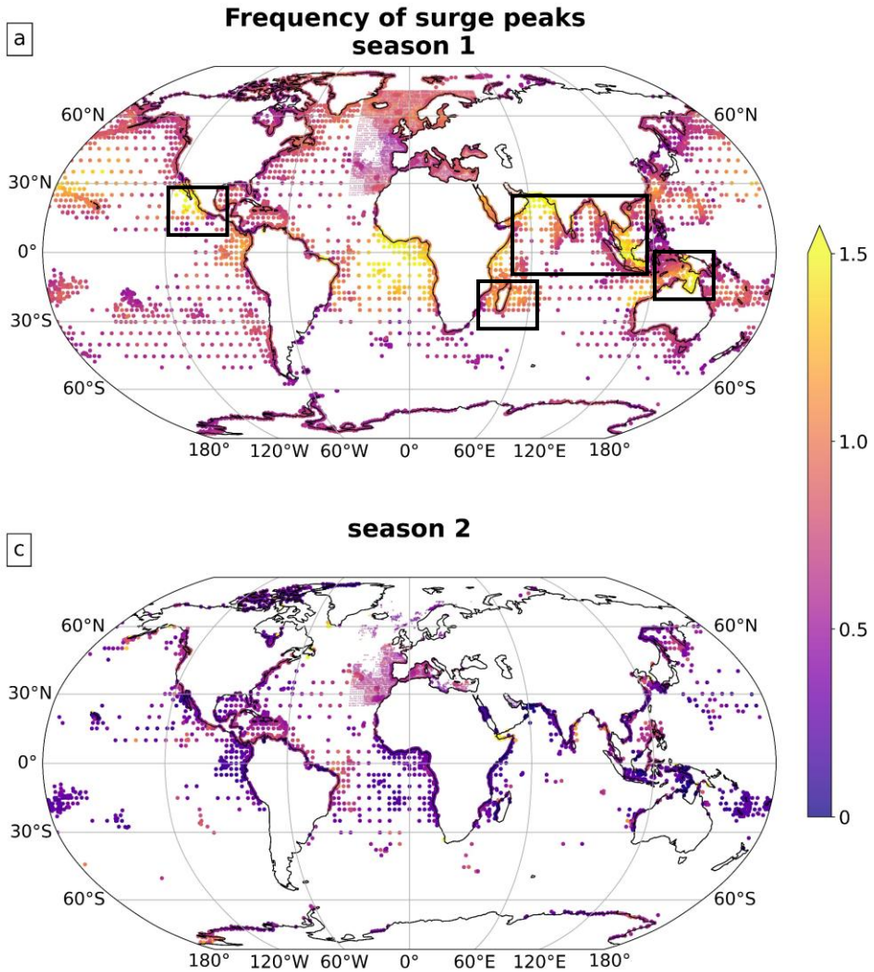
- **The seasonality of storm surges follows a consistent large-scale pattern linked to regional atmospheric variables.**

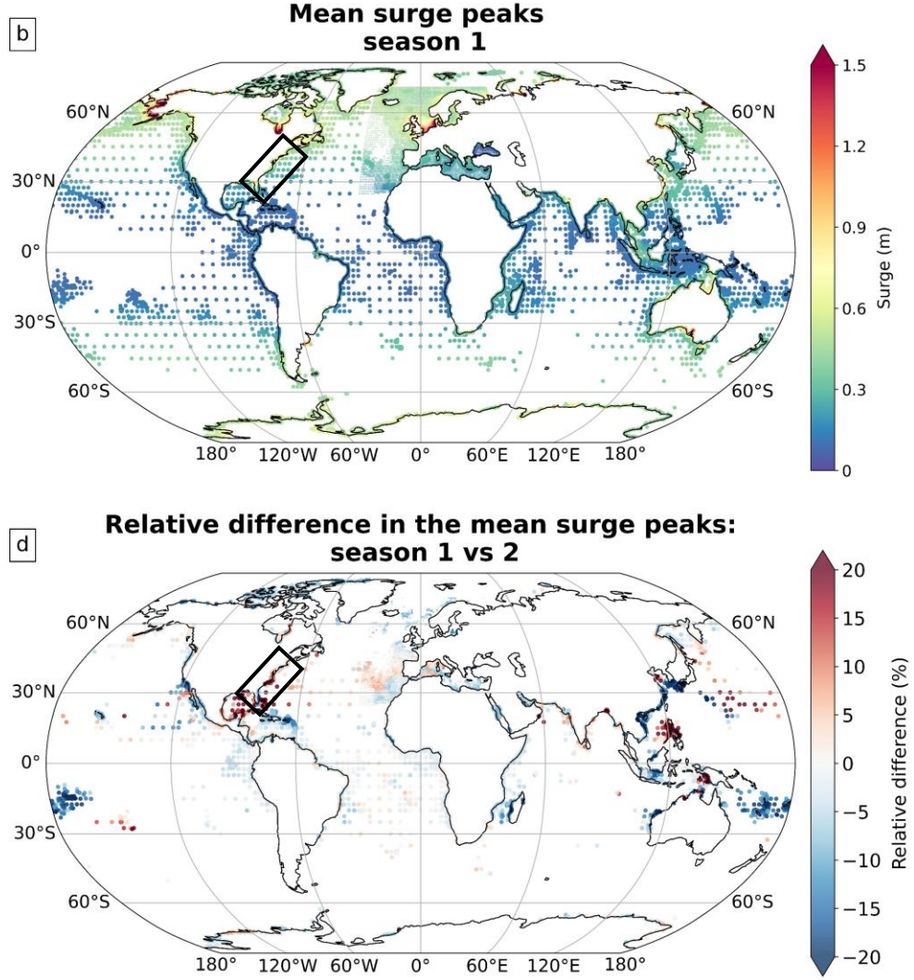




- **Differences in the length of surge seasons are minimal in regions with bimodal surge seasons, except the East coast of the USA.**

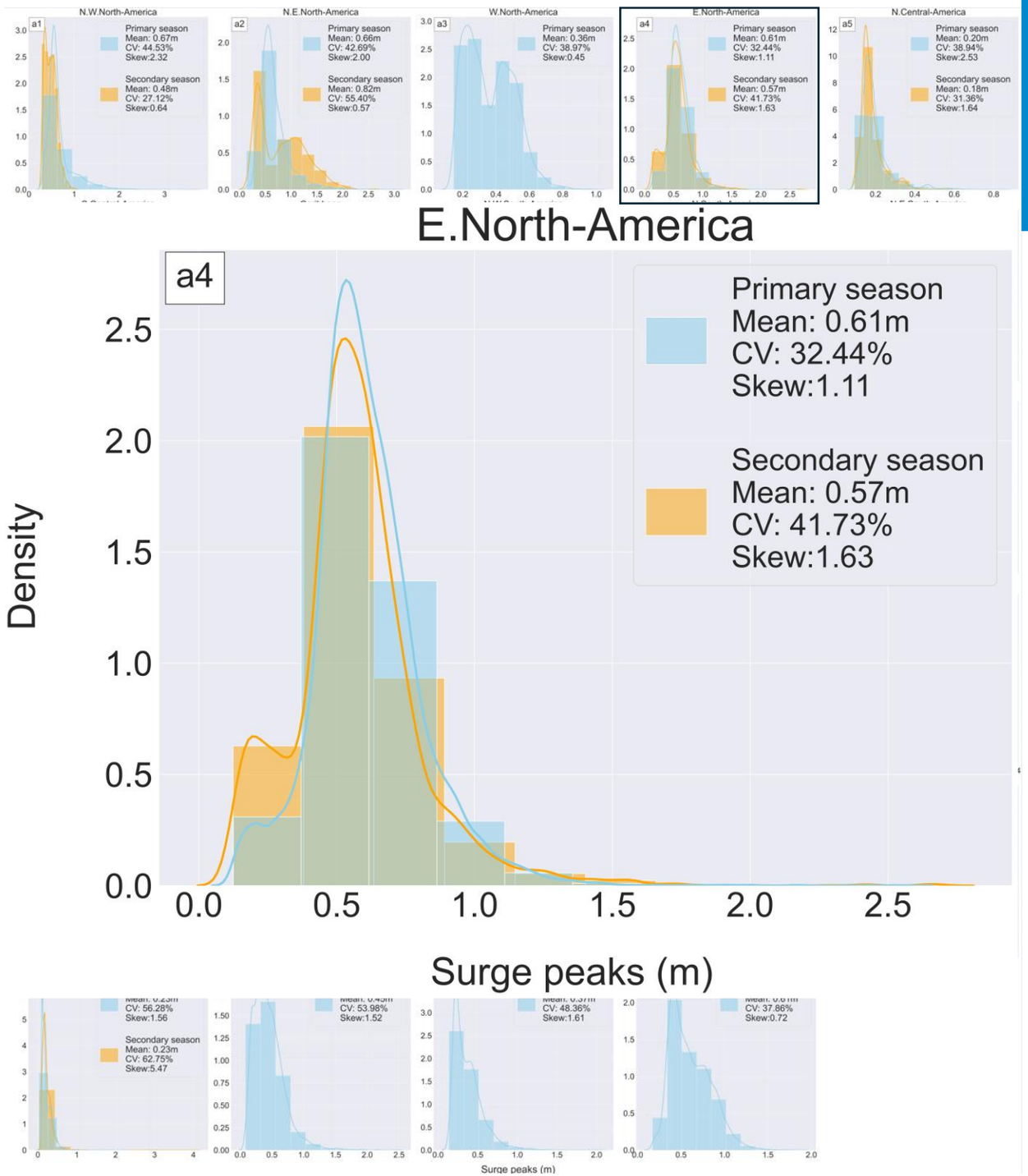
Result: frequency and magnitude of seasonal storm surge peaks





- **Despite the higher frequency of midlatitude storms on the east coast of the united states, storms surges associated with tropical cyclones are more intense.**

Regional seasonal distribution of storm surge peak



- **Surge peaks in the tropical cyclone season may return higher surge levels for rare events than when the two seasons are combined, as the inclusion of the lower skew may reduce the overall tail heaviness**

Summary

- Extreme storm surge season is **not confined to a single, well-defined period across the globe**.

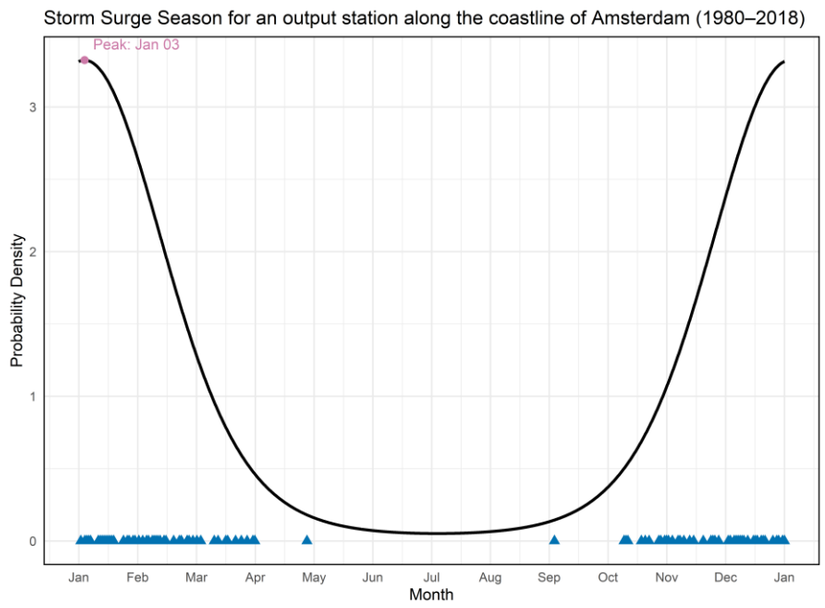
- Seasonality of storm surges, globally, **is strongest in the tropical cyclone-prone coastlines of India, Madagascar and Pakistan**.

- Seasonal distribution of surge peaks **varies by region** and **reflects the associated risks of the underlying storm regime.**

Thank you for your attention

Method Application: Mixture model of the Von Mises-Fisher distribution

1



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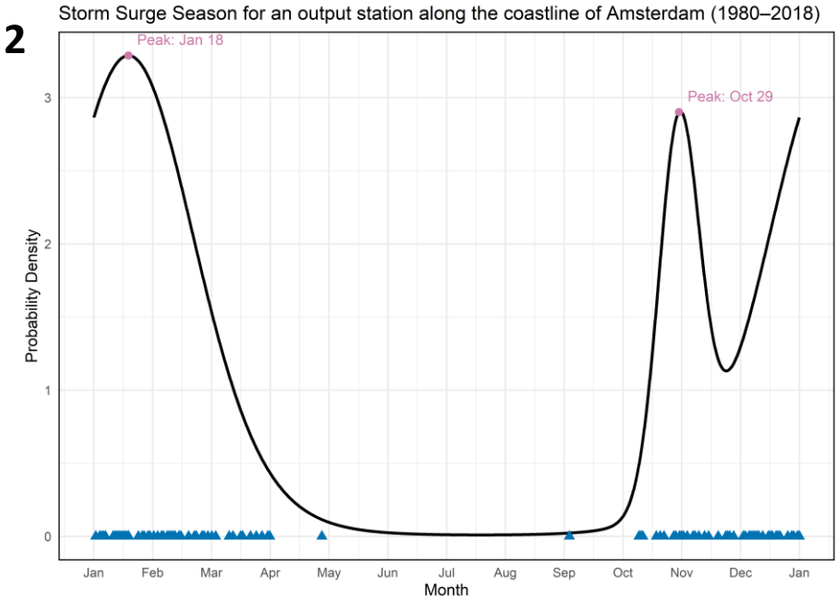

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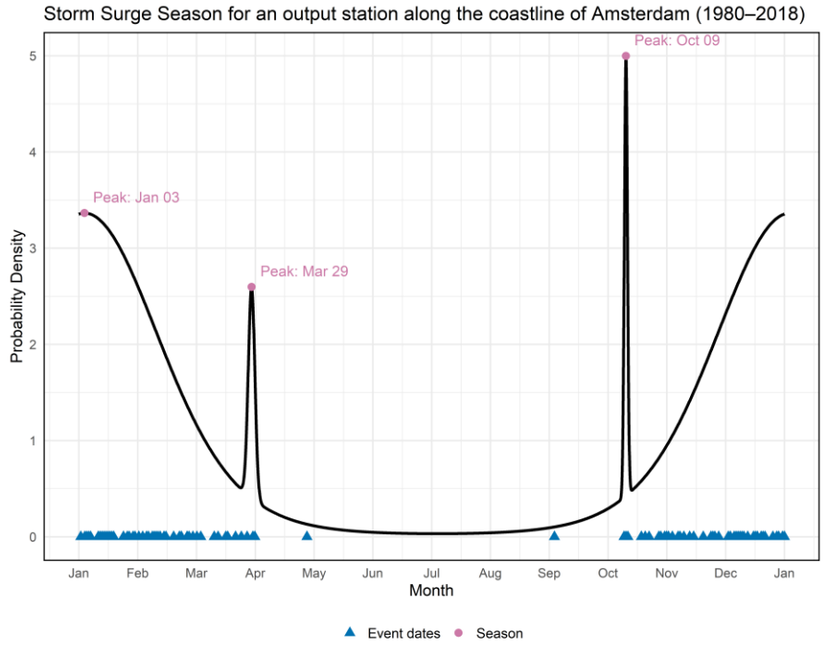

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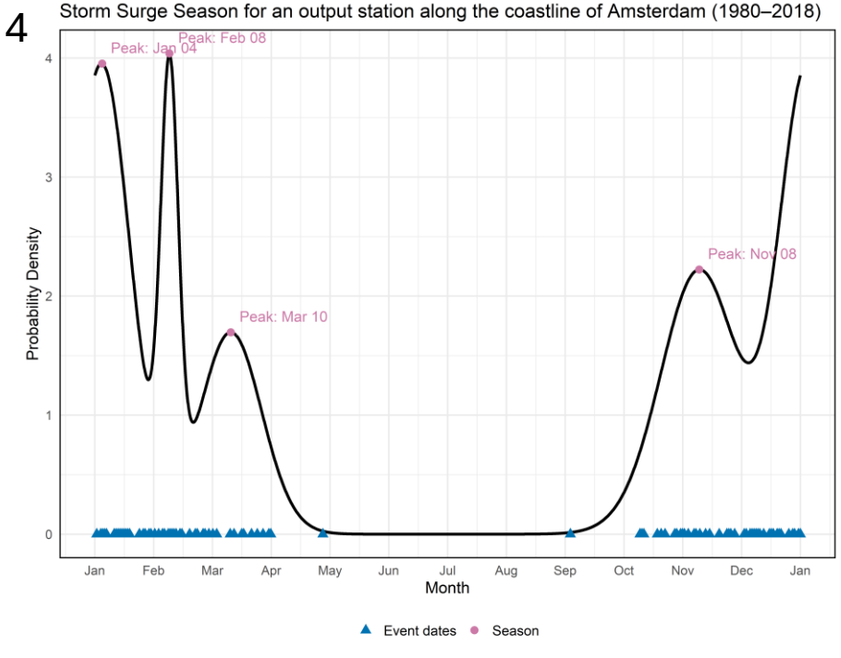

- **The number of components determines how many distributions the mixture model fits to the underlying data.**