

An impact-based assessment of riverine flooding from compound events at the global scale

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Acknowledgements:

Hiroaki Ikeuchi (University of Tokyo)

Anaïs Couasnon (IVM, VU Amsterdam)

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Hessel Winsemius (TU Delft, Deltares)

Compound Flooding

Thailand floods: Bangkok 'impossible to protect'

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Bangladesh cyclone kills hundreds

At least 600 people are reported to have died after a powerful cyclone smashed into Bangladesh's coast, levelling villages and uprooting trees.

Hundreds of thousands of people were



When multiple flood drivers combine to affect flood impact

adapted from Zscheischler et al. (2018) - NCC

Aerial footage shows flooding in some Bangkok districts

STORYLINE > HURRICANE HARVEY



The Martinez family evacuates the apartment complex they live in on August 30, 2017 near the Energy Corridor of west Houston, Texas. © Erich Schlegel / Getty Images

Intro: Global Flood Modelling Status Quo

Fluvial



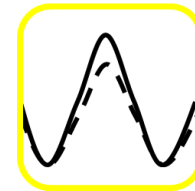
runoff



flood hazard

OR

Coastal



surge



flood hazard

Intro: Global Flood Modelling Compound Flood Events

Fluvial

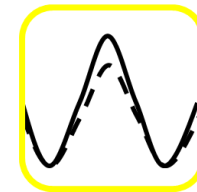
AND

Coastal

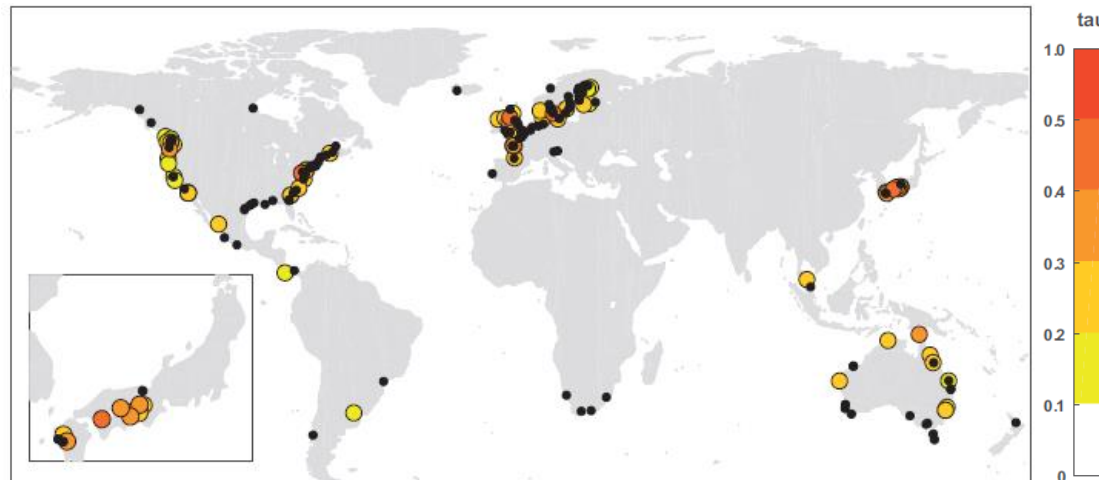


runoff

← dependence →

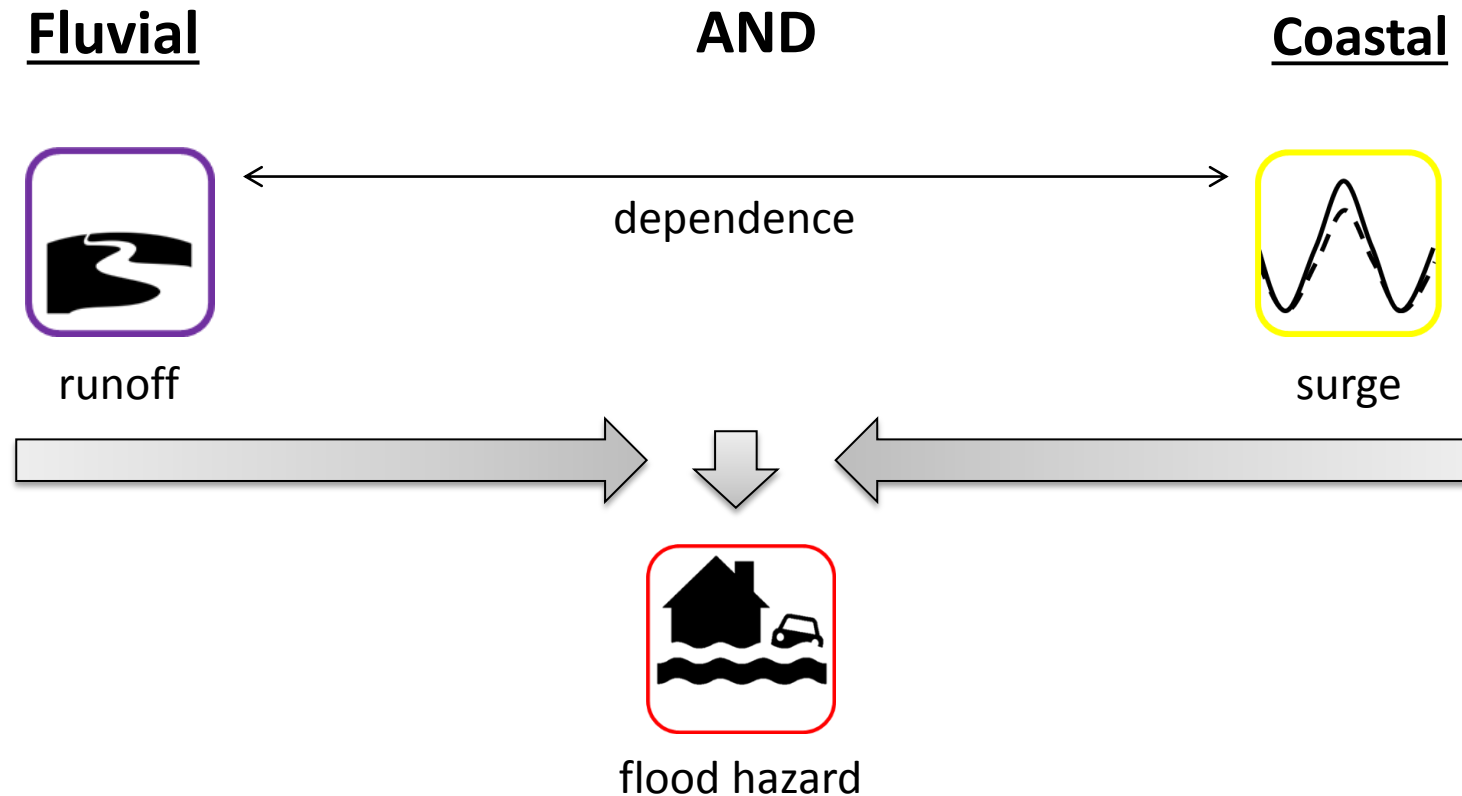


surge



Ward et al. (2018) - ERL

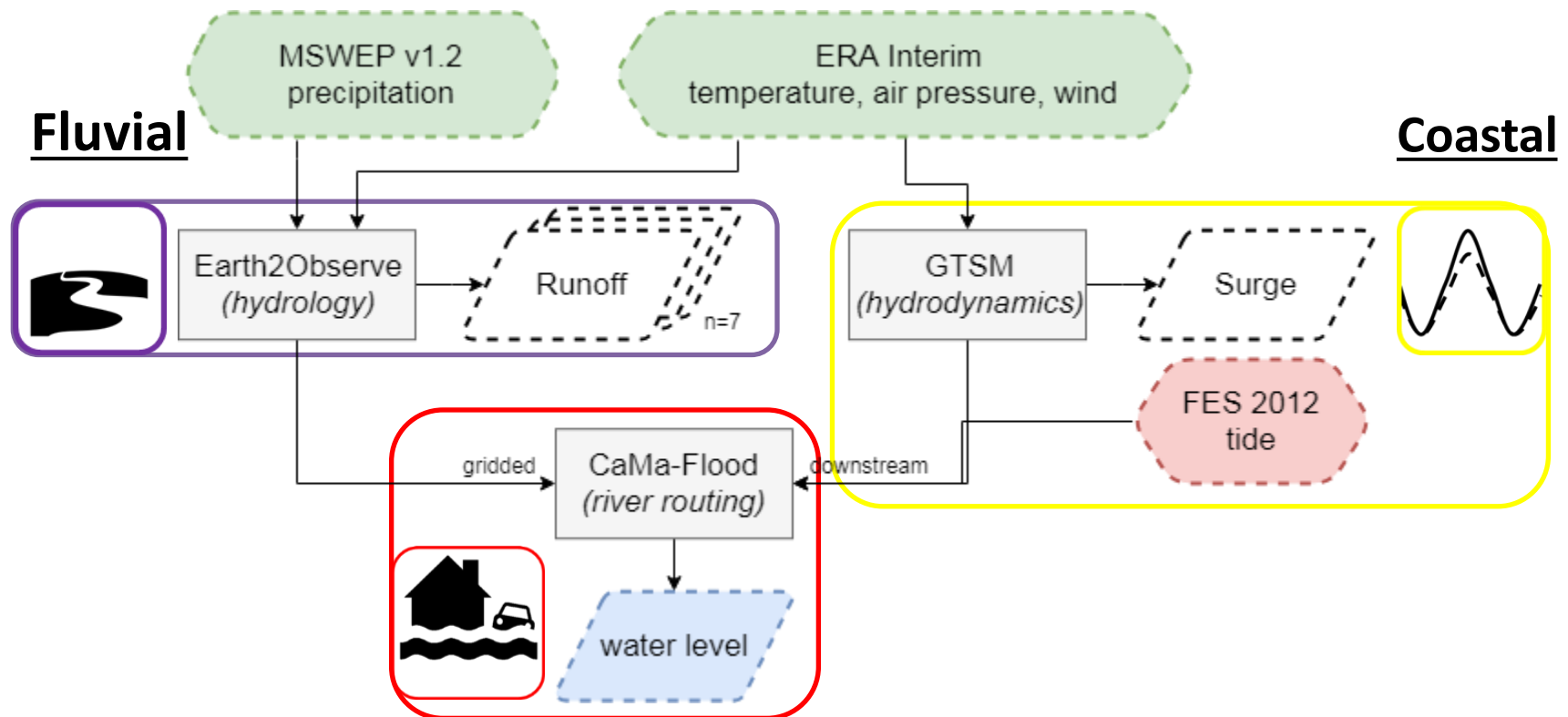
Aim



- To map the impact of compound flooding at the global scale

Methods

Experiment setup



Builds on Ikeuchi et al. (2017) - JAMES

Methods

CaMa-Flood – GTSM coupling



East coast USA

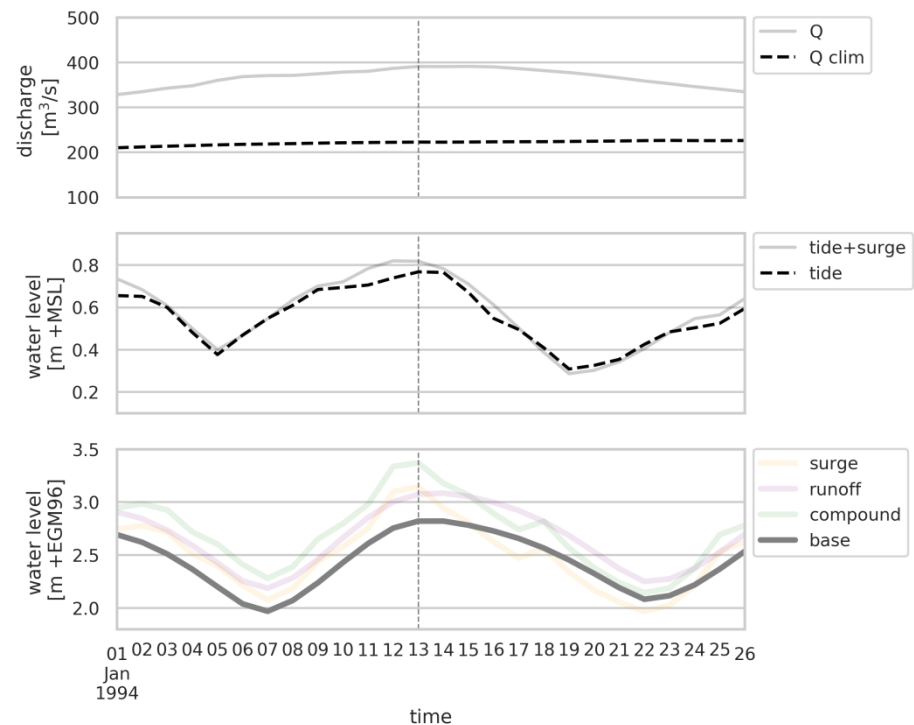
- Min catchment size 10km²
- With valid GTSM cell within 75km

Methods

Compound Flood Index (CFI)

- Based on simulations with single and compound flood drivers

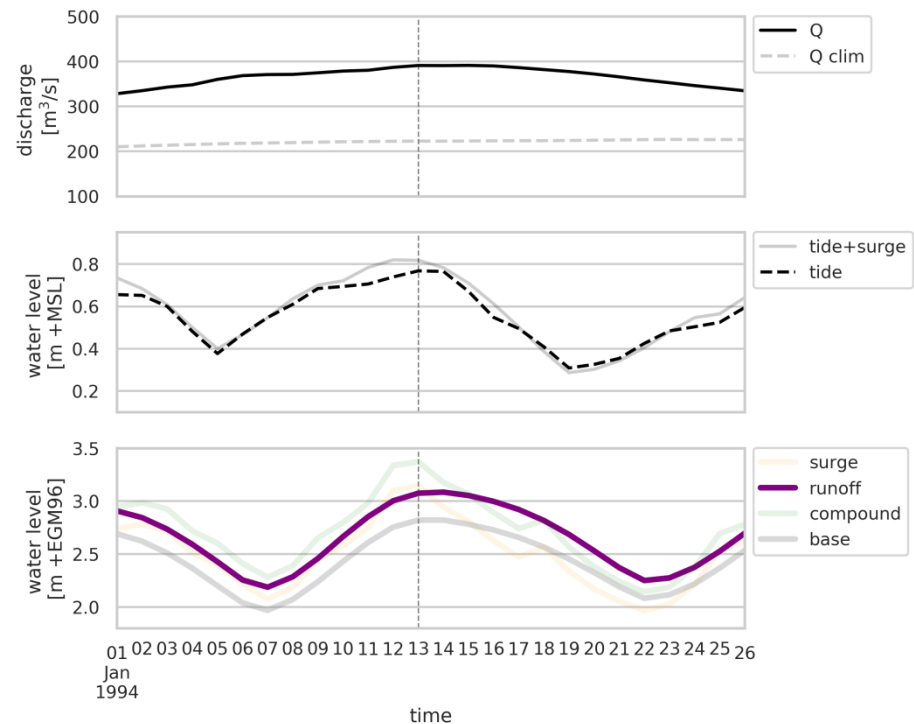
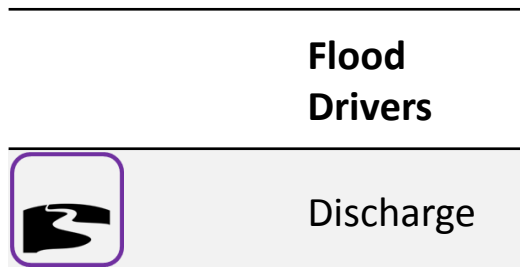
**Flood
Drivers**



Methods

Compound Flood Index (CFI)

- Based on simulations with single and compound flood drivers



Methods

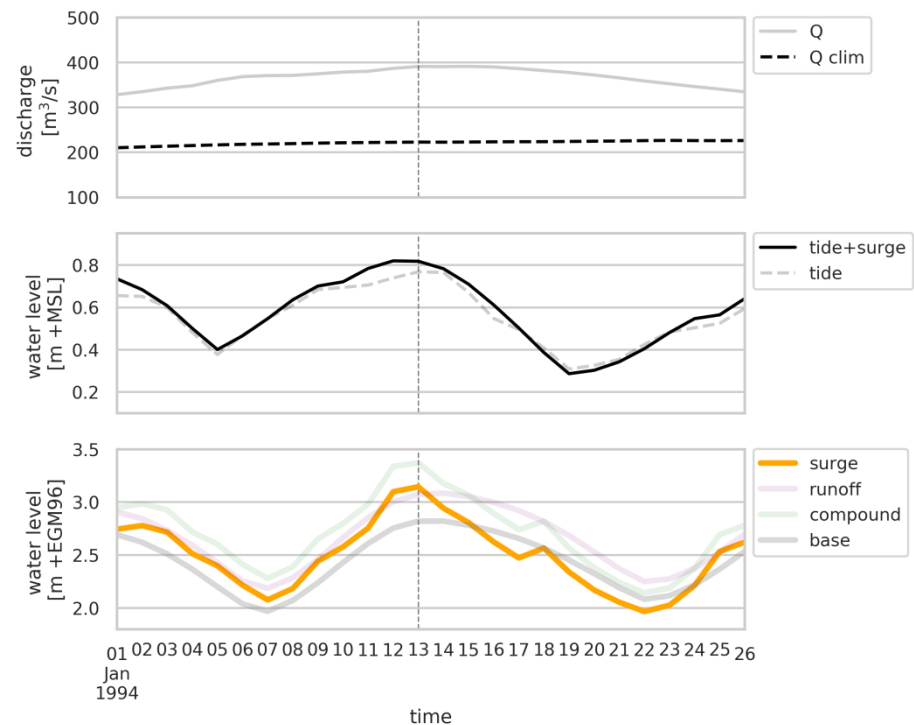
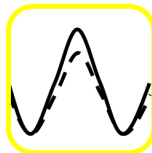
Compound Flood Index (CFI)

- Based on simulations with single and compound flood drivers

Flood Drivers



Surge



Methods

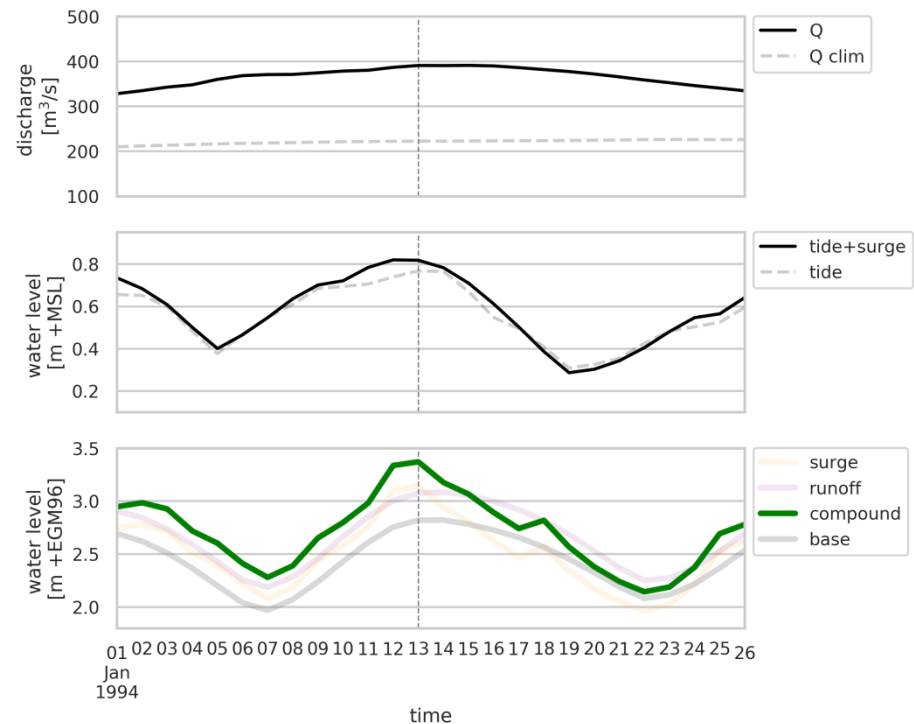
Compound Flood Index (CFI)

- Based on simulations with single and compound flood drivers

Flood
Drivers



Compound



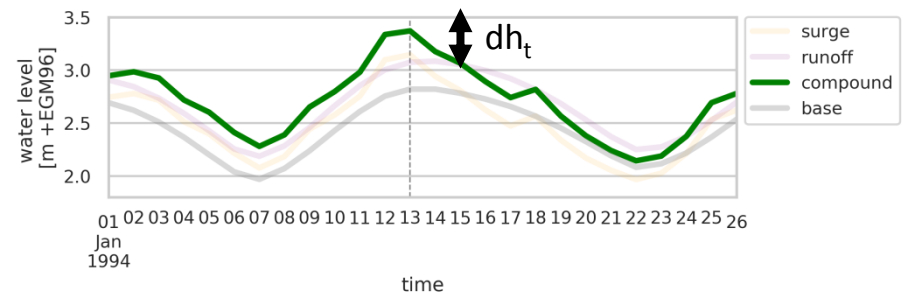
Methods

Compound Flood Index (CFI)

- CFI_{peaks} : relative change in water level peaks due to surge-discharge interactions
- Focus on water level peaks (above 95th percentile)

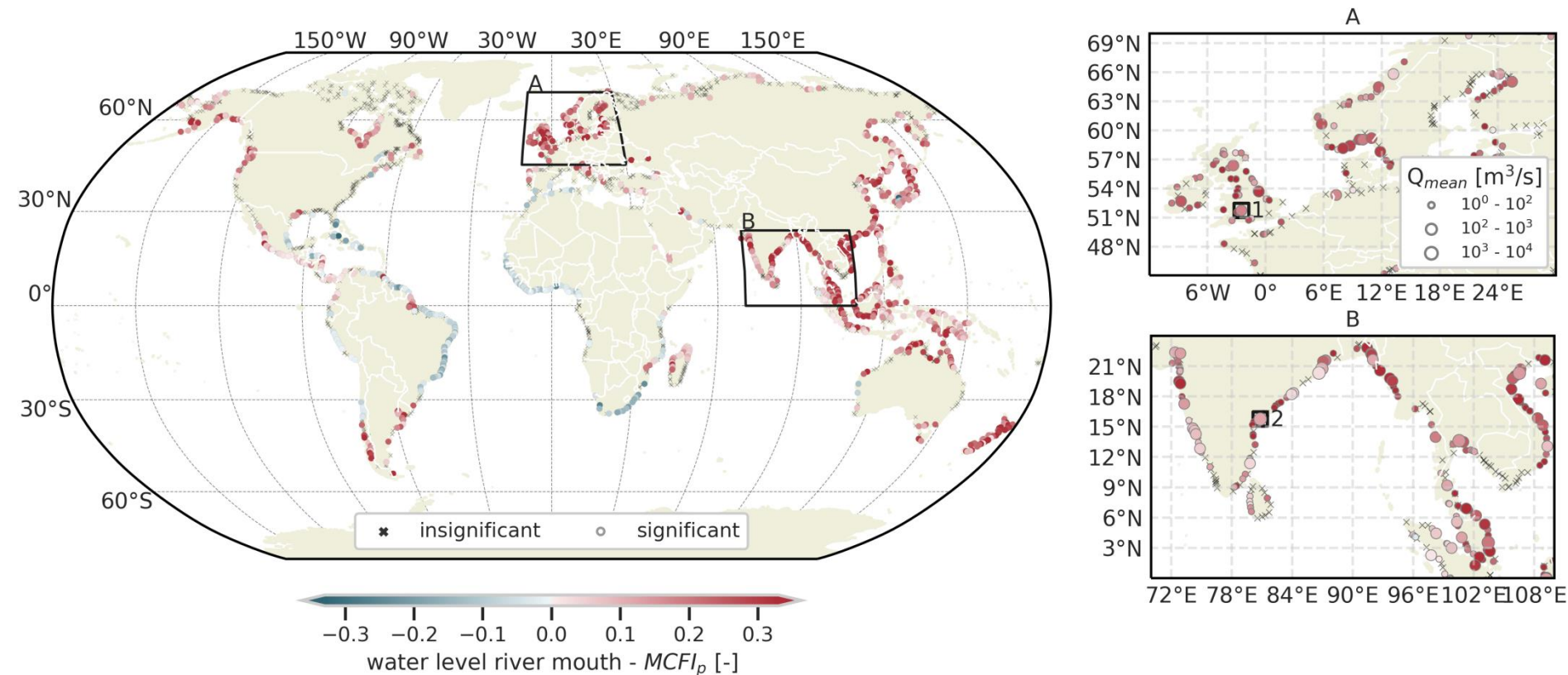
Flood Drivers	
	Discharge
	Surge
	Compound

$$I_{CF}(t) = \frac{dh_t}{\sigma_h} = \frac{h_{compound,t} - \max[h_{surge,t}, h_{discharge,t}]}{\sigma_h}$$



Results

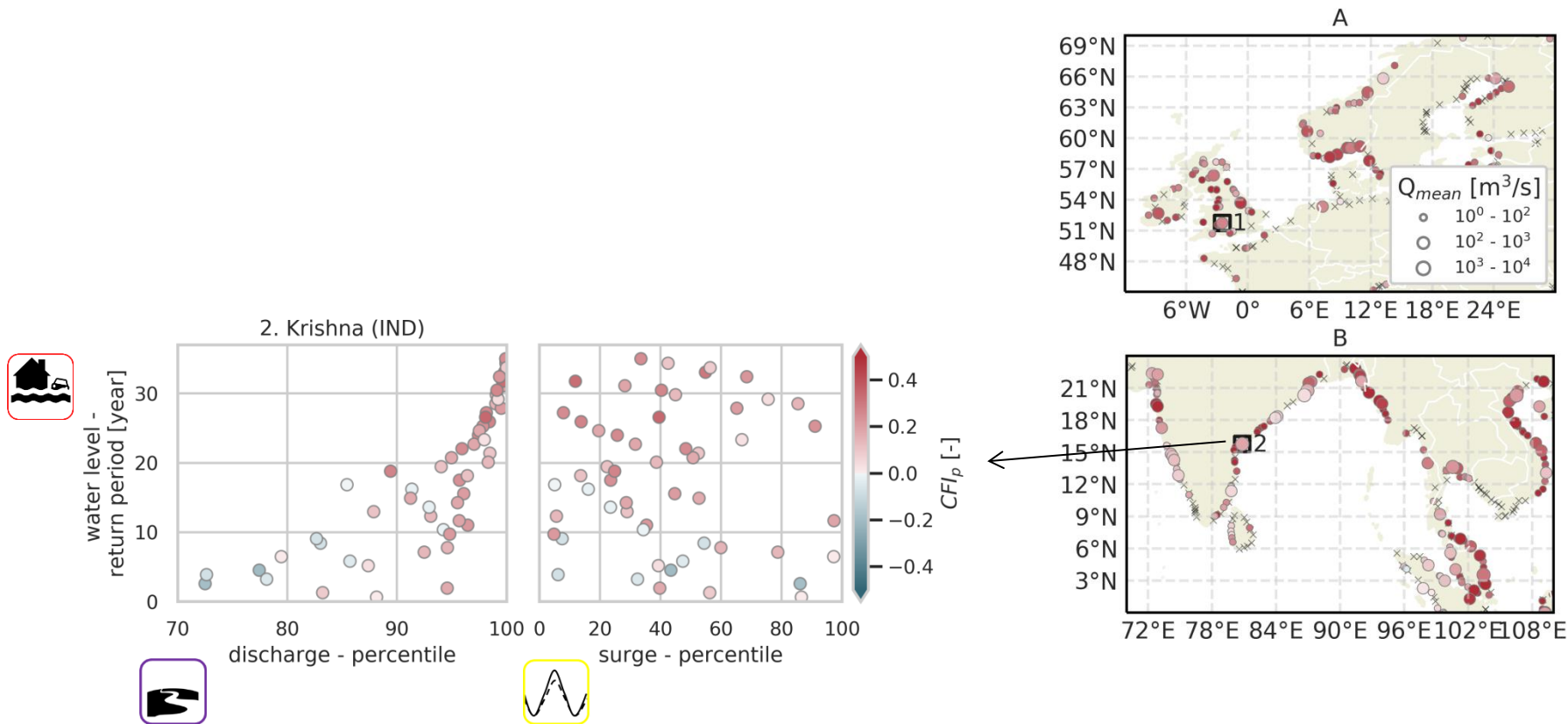
Compound Flood Index (CFI)



- Ensemble mean of time averaged CFI_{peaks}
- For water level at the river mouth ($n = 2705$)
- ~50% significant, of which 70% positive

Results

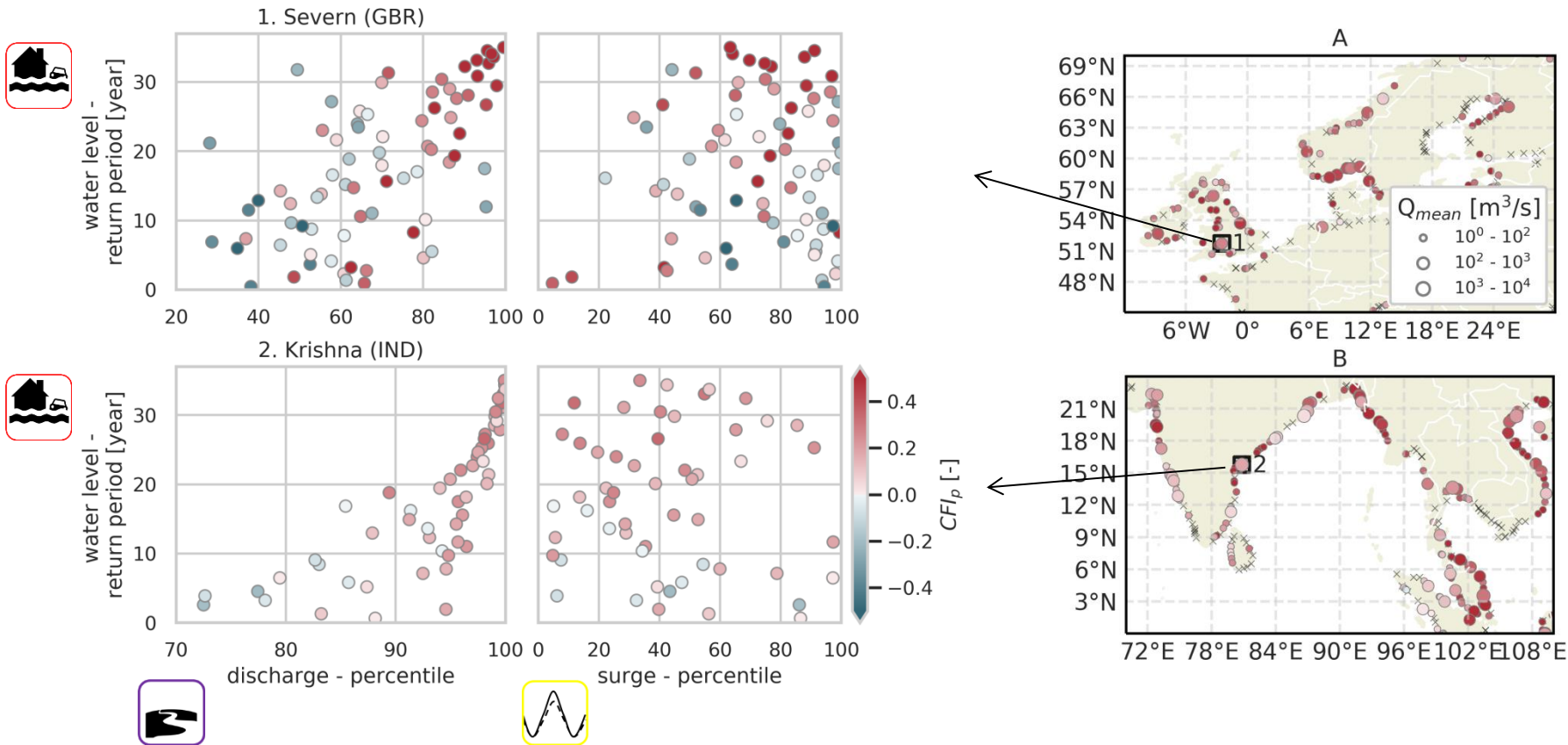
Compound Flood Index (CFI)



- CFI_{peaks} of single model (W3RA)
- H_{peaks} also at low surge/discharge perc.

Results

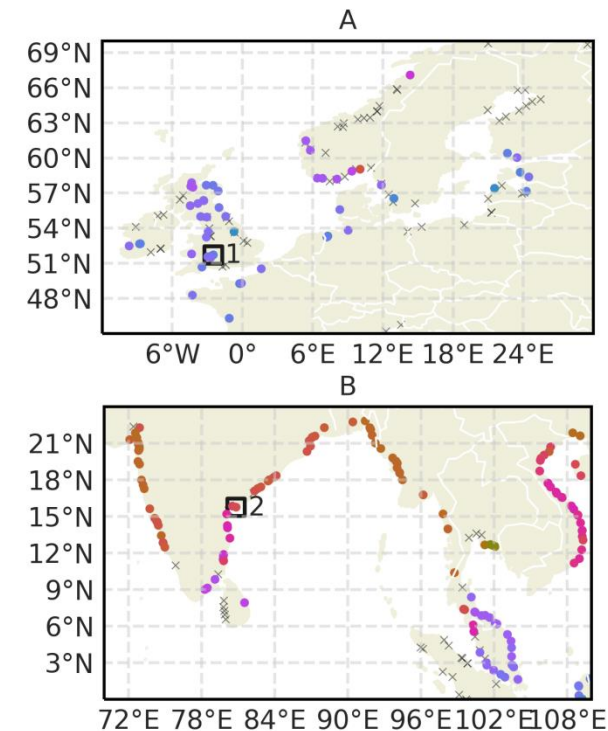
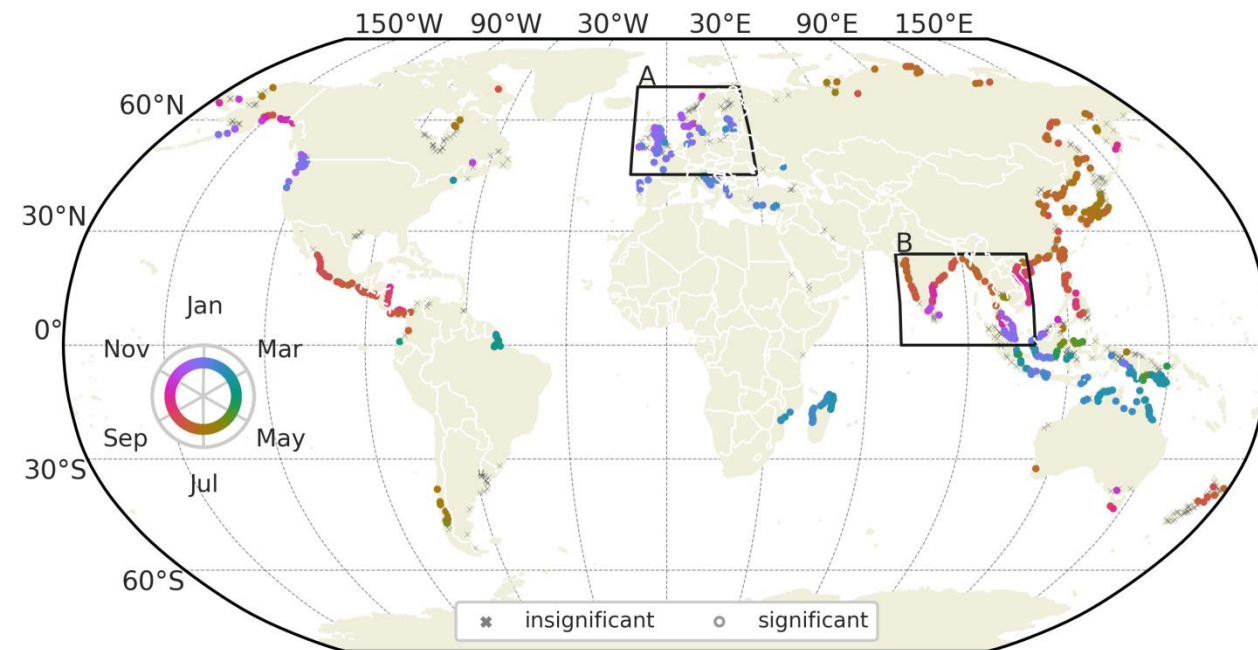
Compound Flood Index (CFI)



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Results

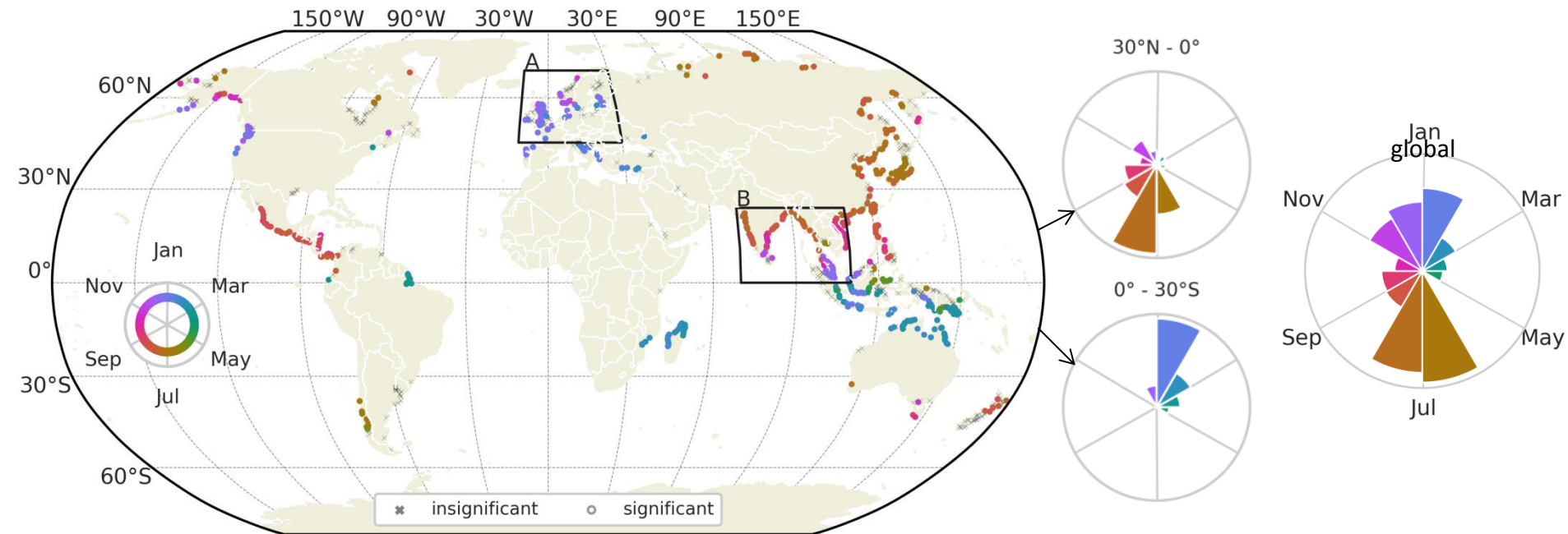
CFI Seasonality



- For statistical significant positive CFI_{peaks}
- Seasonality ensemble mean annual max. CFI_{peaks}

Results

CFI Seasonality



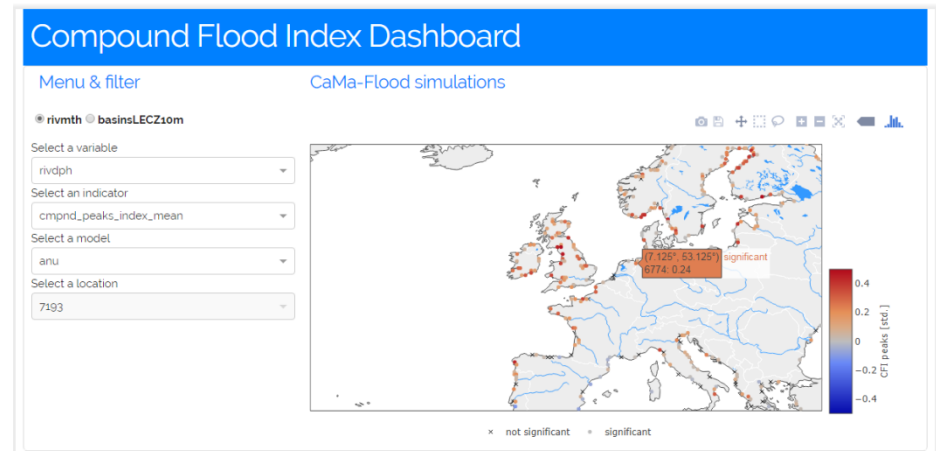
- Strong spatial patterns of CFI_{peaks} seasonality

Conclusions and next steps

- ✓ Successfully mapped hotspots of compound events based on their impact
- ✓ ~50% of river mouth locations significant, of which 70% positive CFI_{peaks}
- ✓ Clear spatial patterns in seasonality of an. max CFI_{peaks}

- ❑ Analyze difference in flood depth (instead of water levels)
- ❑ Local models with more details (e.g. estuarine bathymetry) in hotspot areas to improve analysis

Questions?



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