Analysing extreme sea levels on the Finnish coast using Block Maxima and Peak Over Threshold approaches

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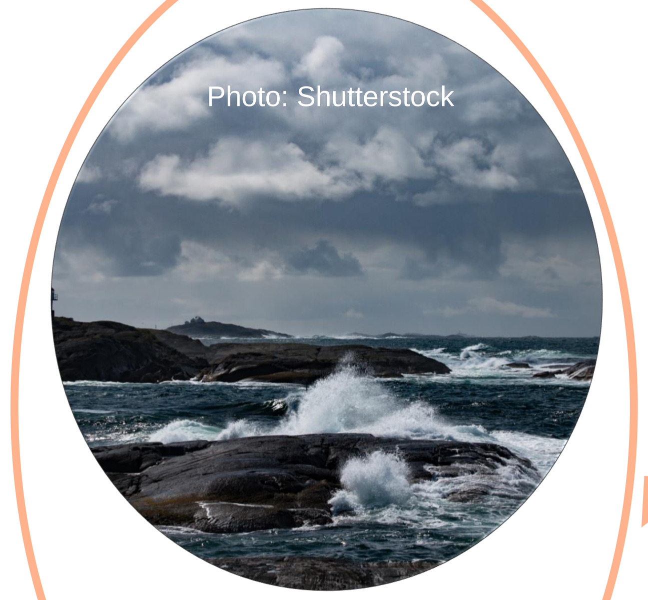
Background: factors causing sea level variations on the Finnish coast

Wind waves

- fetch
- topography of the seabed
- islands
- seasonal ice cover

Long-term mean sea level changes

- global mean sea level rise
- post-glacial land uplift
- Baltic Sea water balance



Short-term sea level variations

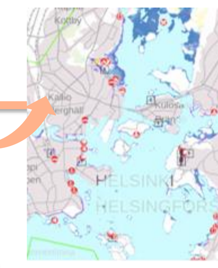
- wind and air pressure
- Baltic Sea water balance
- Seiche
- Tides, ice cover

Research question of this study

How sensitive are the Finnish coast return level estimates of the short-term sea level variability to the choice of sampling method and distribution function?

Motivation

Improve coastal flood risk estimates in Finland to be utilized e.g., in coastal building planning, supporting nuclear power plant safety, and as a basis of flood maps.



Sampling methods

Block Maxima (BM)

- Data is sorted into blocks of one year long (August to July)
- Annual maxima are calculated if less than 10% of the 4-hourly observations is missing within a year
- Generalized Extreme Value (GEV) distribution is fitted to the annual sea level maxima

Peak Over Threshold (POT)

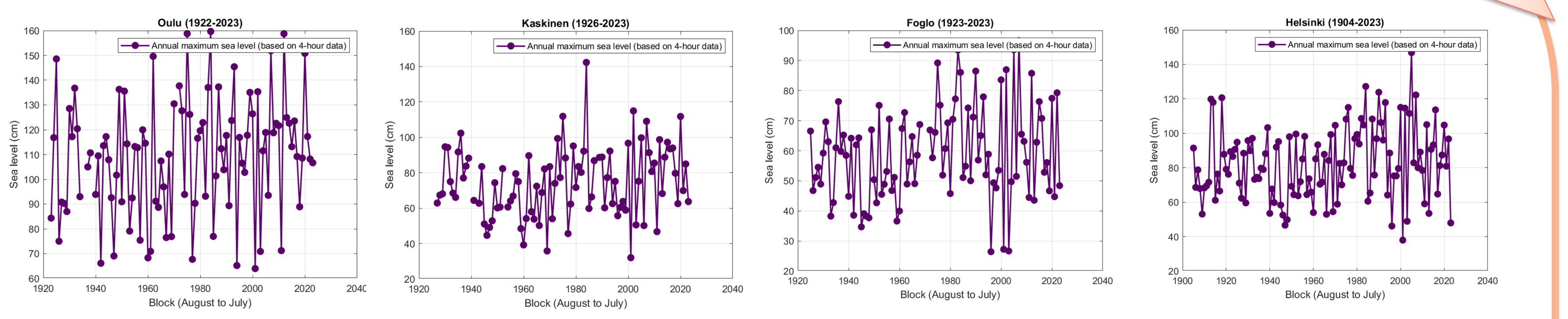
- Sea levels exceeding threshold of 99.7th percentile are selected from the 4-hourly data
- Independent events are separated using declustering time of t_d = 1.5 days as a first approximation
- Generalized Pareto Distribution (GPD) is fitted to the maxima of these events

Data

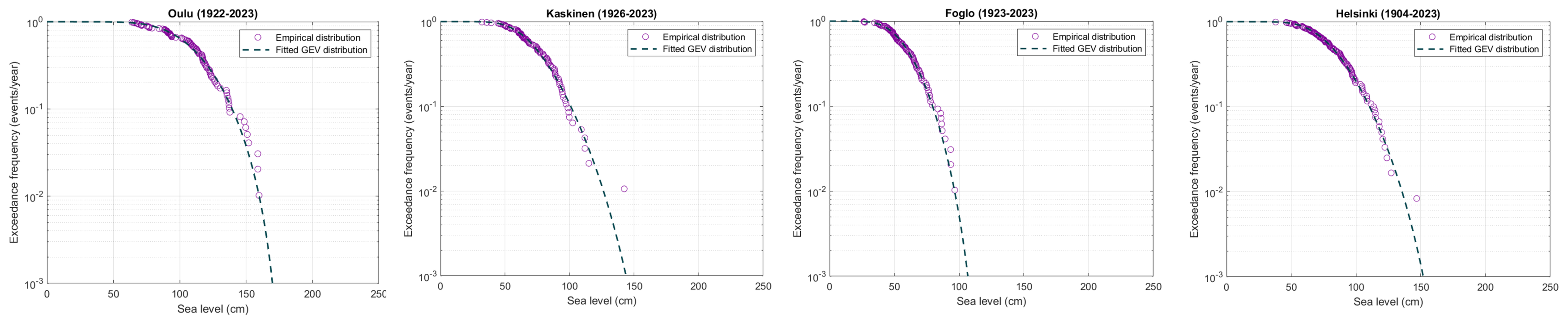
Length of time series: ~100 years of observations of 13 tide gauges along Finnish coast
Resolution of data: 4h interval
Detrending of data: Before applying sampling methods, linear trend (including land uplift + mean sea level rise) is subtracted

Results

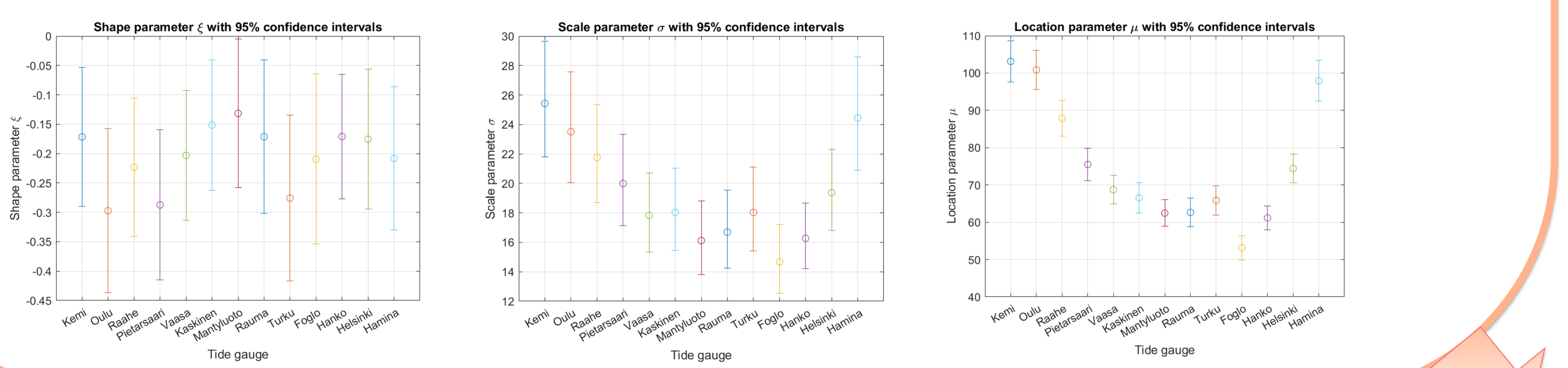
Detrended annual sea level maxima



Fitted Generalized Extreme Value (GEV) distributions

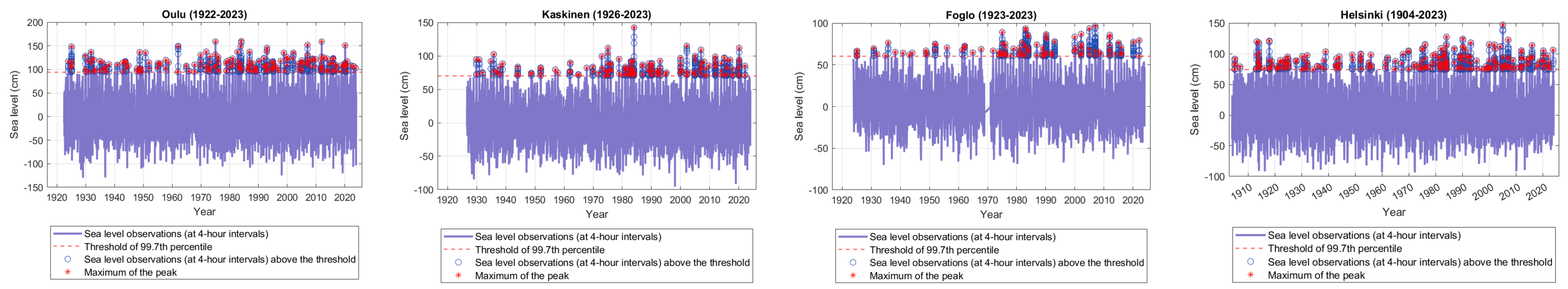


GEV parameters (shape ξ, scale σ and location μ)

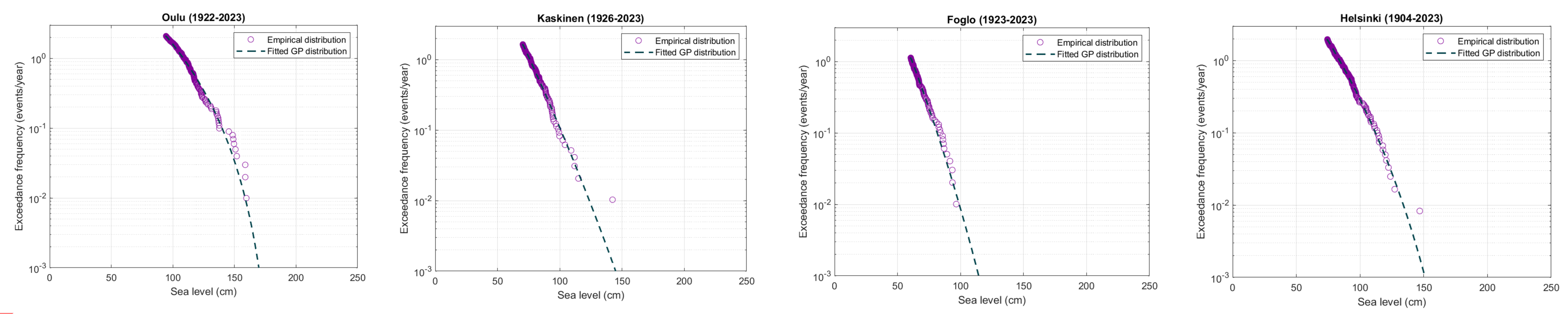


Results

Sea level maxima above the selected threshold (99.7th percentile)



Fitted Generalized Pareto Distributions (GPDs)



Tide gauge	Return level (cm)					
Exceedance frequency	1/20a		1/50a		1/100a	
	BM	POT	BM	POT	BM	POT
Oulu (a)	147	147	155	154	160	159
Kaskinen (b)	110	108	120	117	126	124
Föglö (c)	86	87	92	94	97	99
Helsinki (d)	119	119	129	128	136	134

Next steps

1) Calculate confidence intervals for the fits
2) Apply r-largest value/yr approach to BM method
3) Determine declustering time objectively using *extremal index* in POT method
4) Test the effect of different declustering times and thresholds.

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