Utrecht University

EGU2023

The Timing of Decreasing Coastal Flood Protection Due to Sea-Level Rise

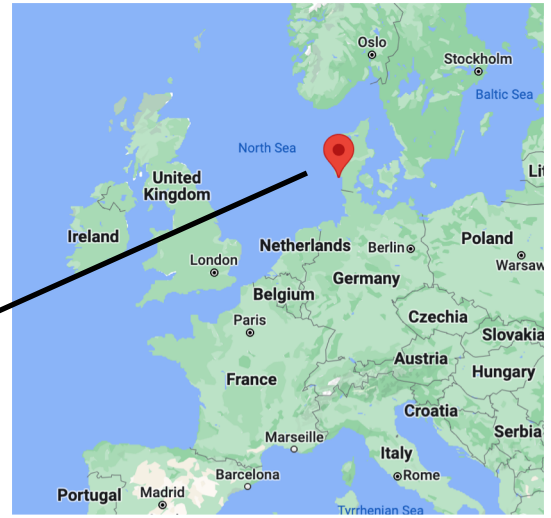
Tim Hermans, Víctor Malagón-Santos, Caroline Katsman, Robert Jane, D.J. Rasmussen, Marjolijn Haasnoot, Gregory Garner, Robert Kopp, Michael Oppenheimer & Aimée Slangen

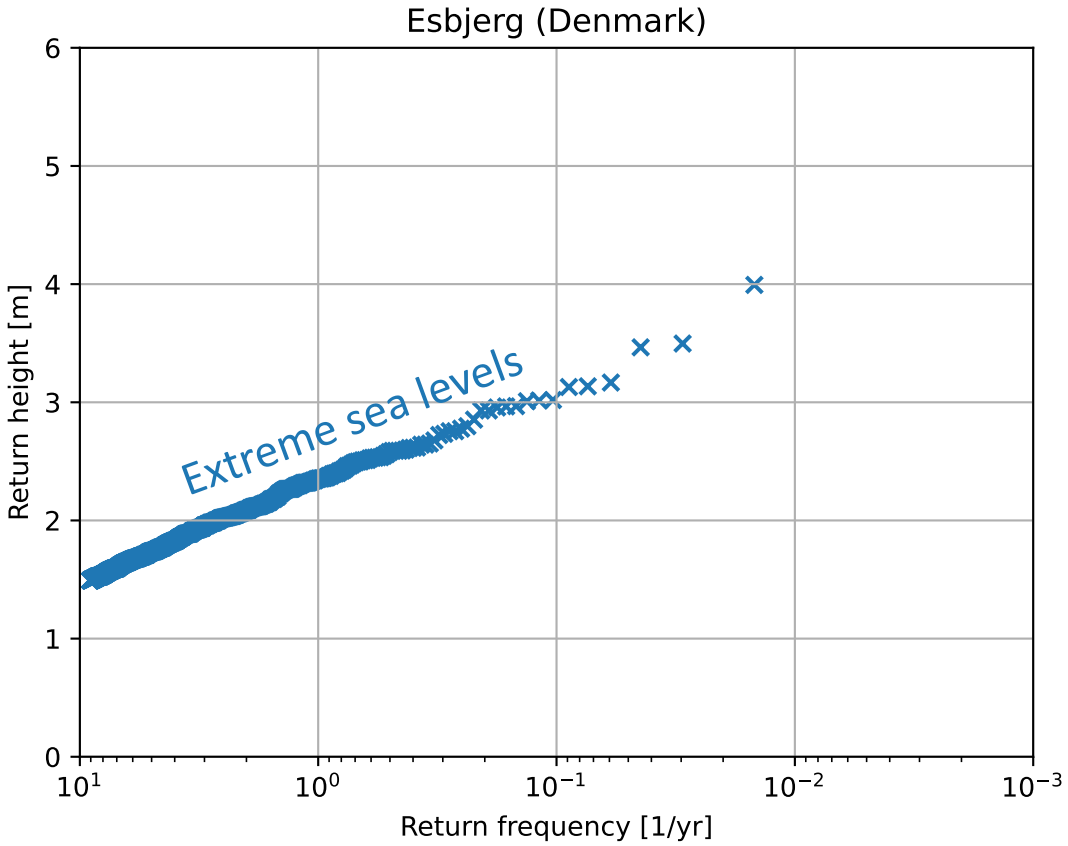
E-mail: t.h.j.hermans@uu.nl
Postdoctoral researcher @ Utrecht University (IMAU)

Frequency amplification of extreme sea levels

- GESLA3 tide gauge data
- Peak-over-threshold analysis

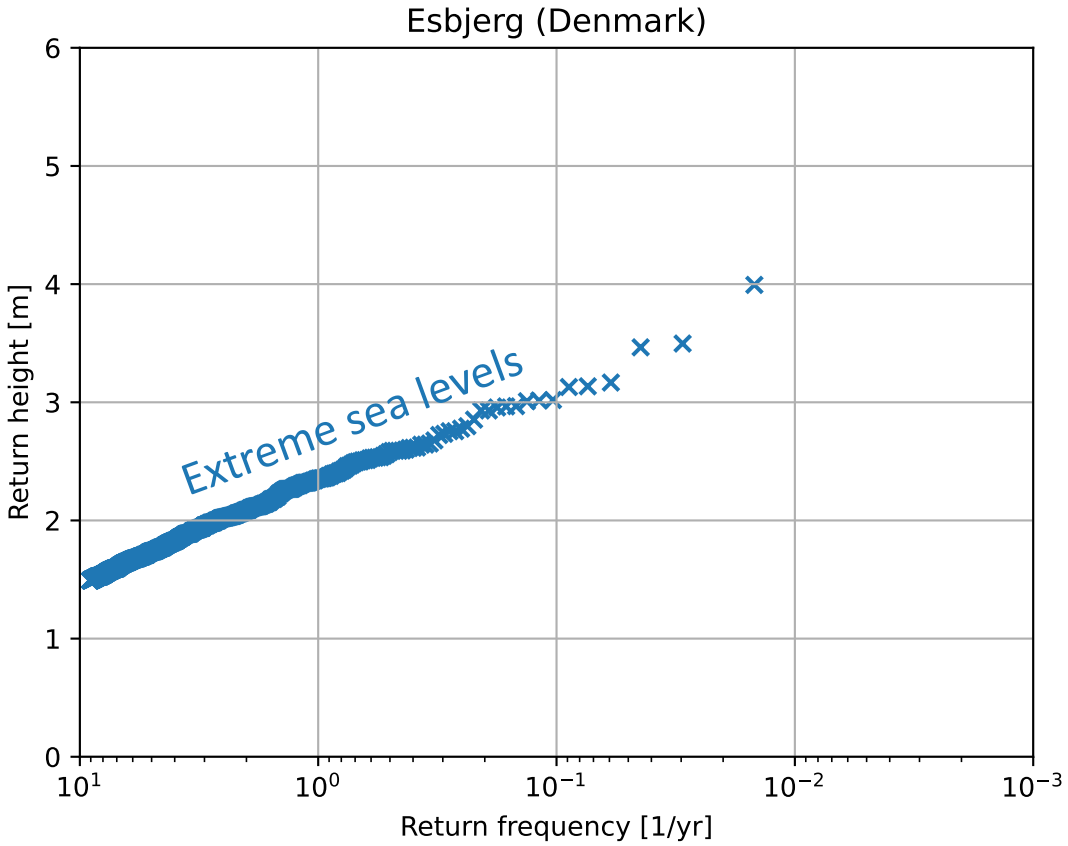
Esbjerg (Denmark)





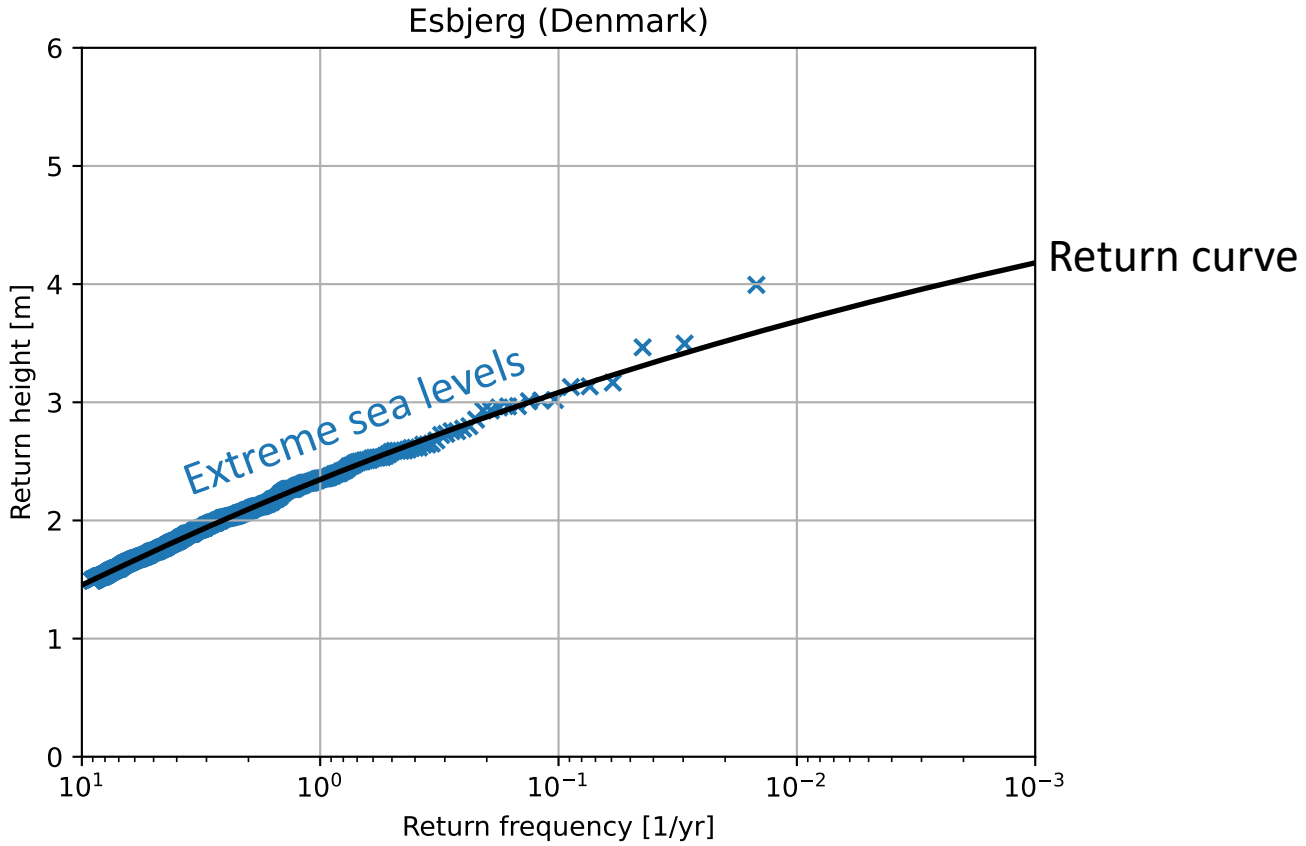
Frequency amplification of extreme sea levels

- GESLA3 tide gauge data
- Peak-over-threshold analysis



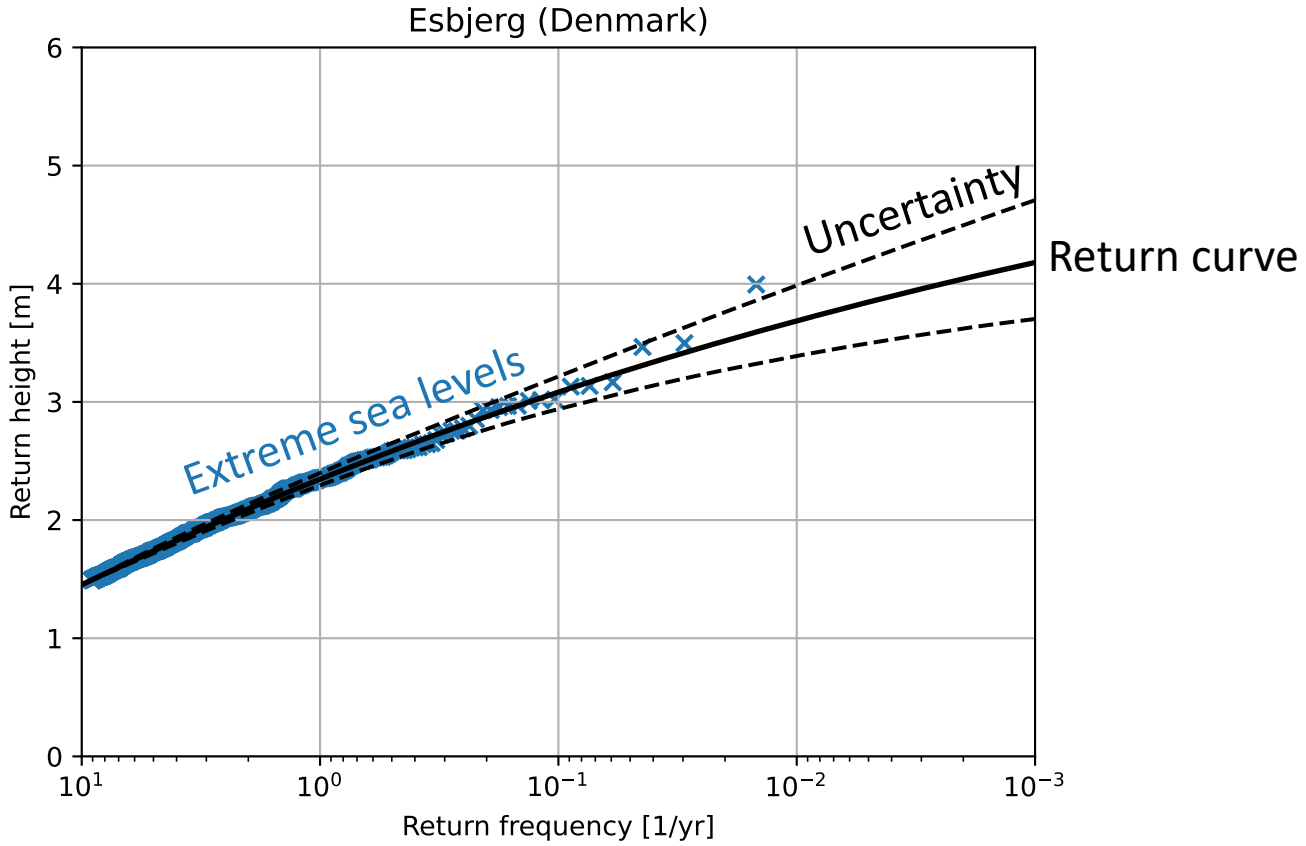
Frequency amplification of extreme sea levels

- GESLA3 tide gauge data
- Peak-over-threshold analysis



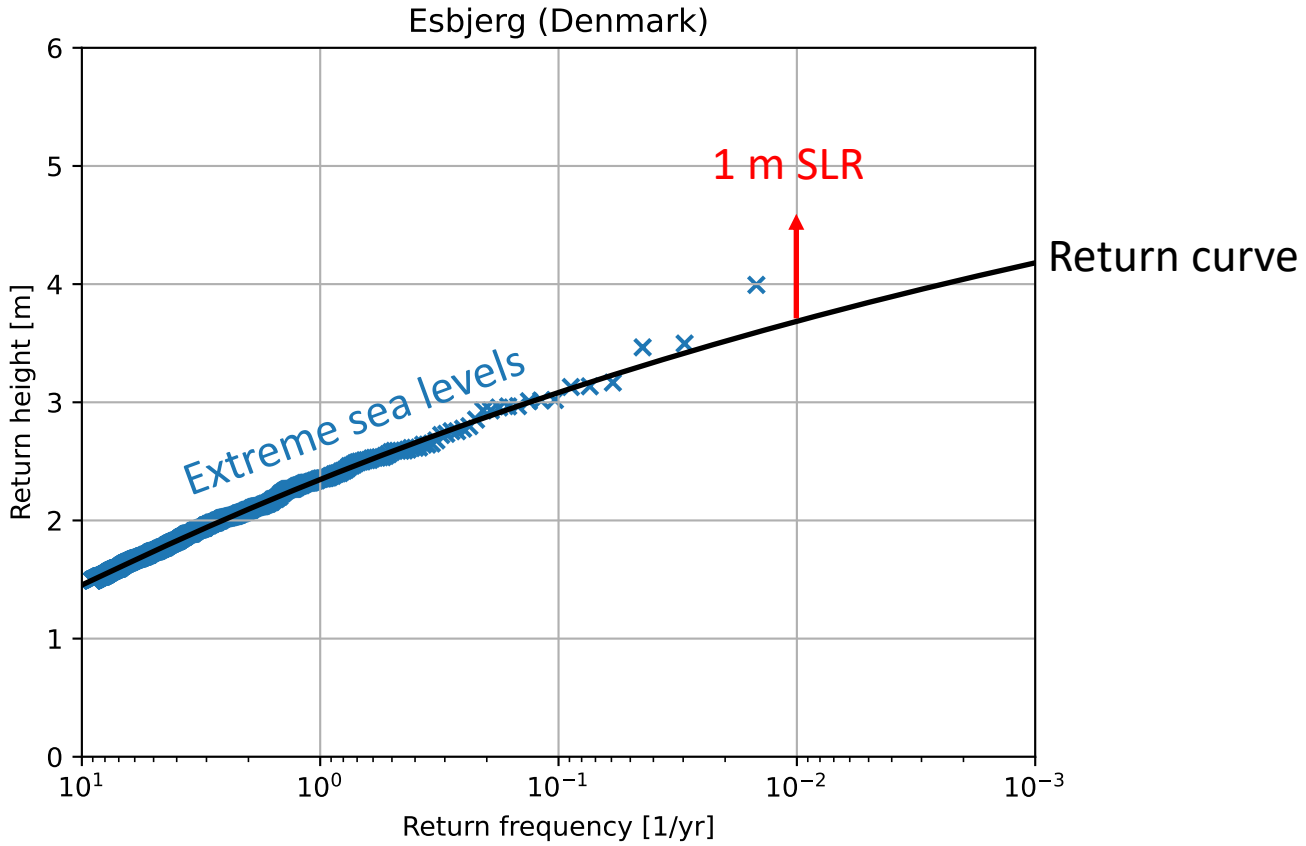
Frequency amplification of extreme sea levels

- GESLA3 tide gauge data
- Peak-over-threshold analysis



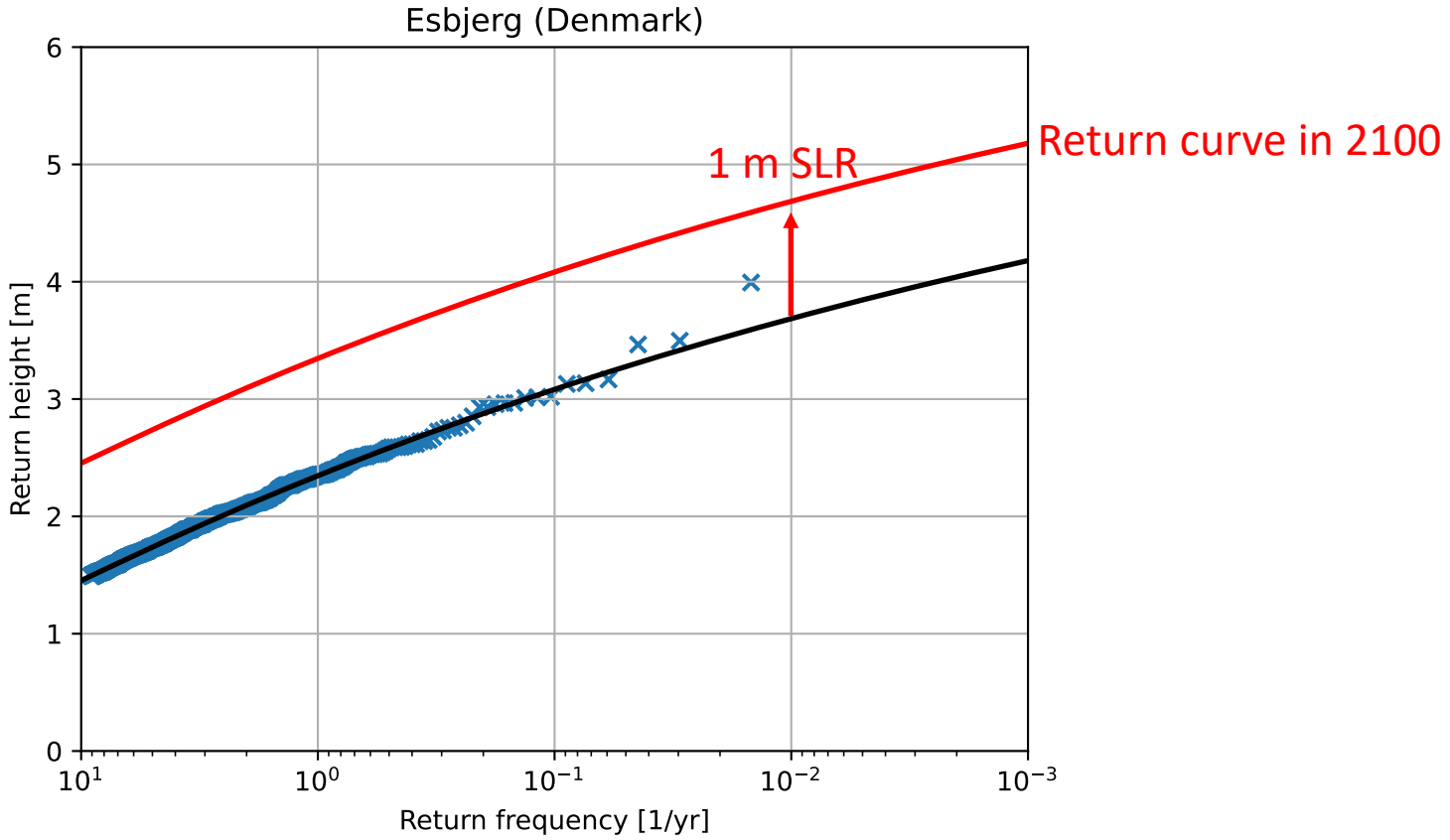
Frequency amplification of extreme sea levels

- GESLA3 tide gauge data
- Peak-over-threshold analysis



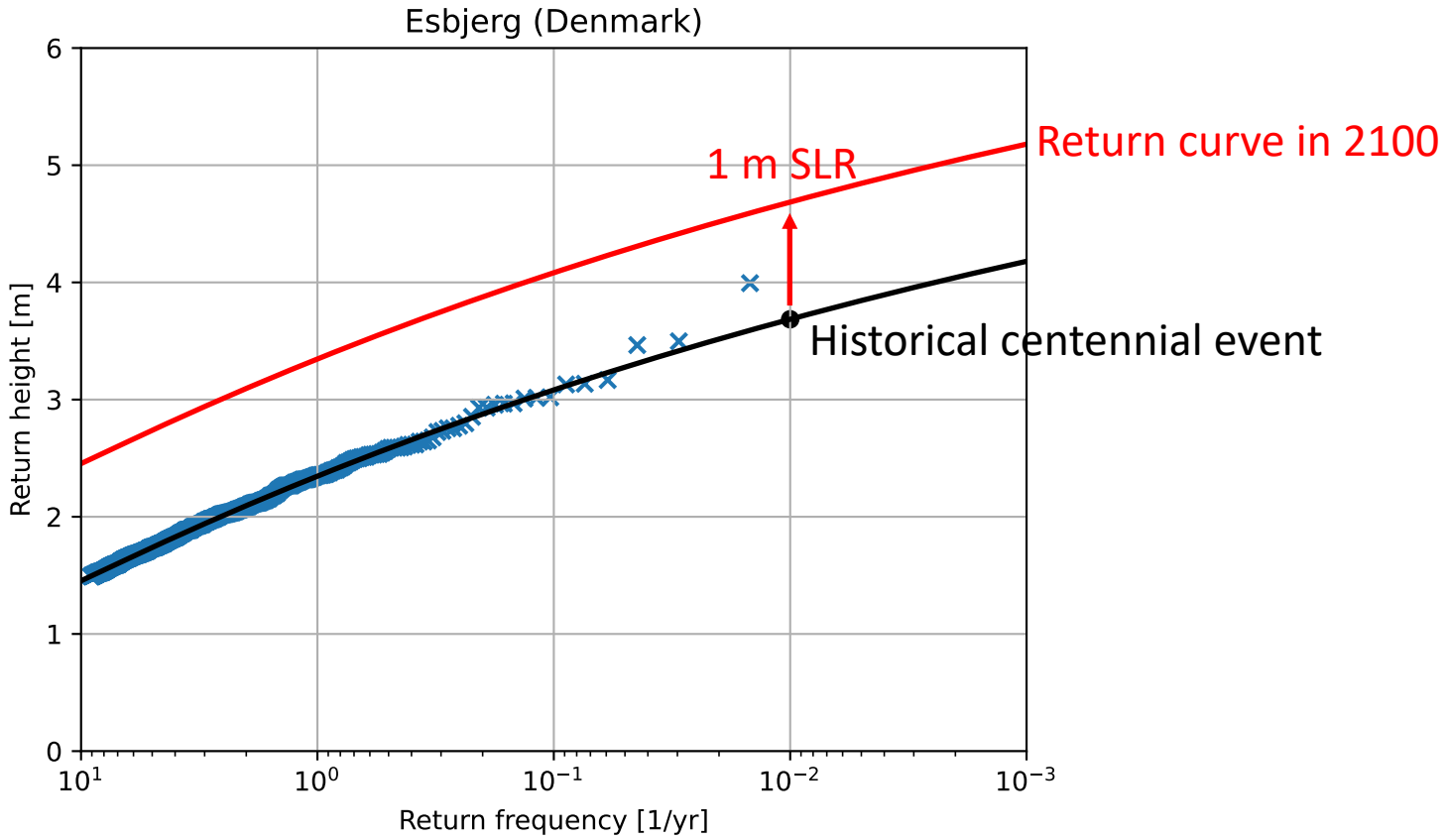
Frequency amplification of extreme sea levels

- GESLA3 tide gauge data
- Peak-over-threshold analysis



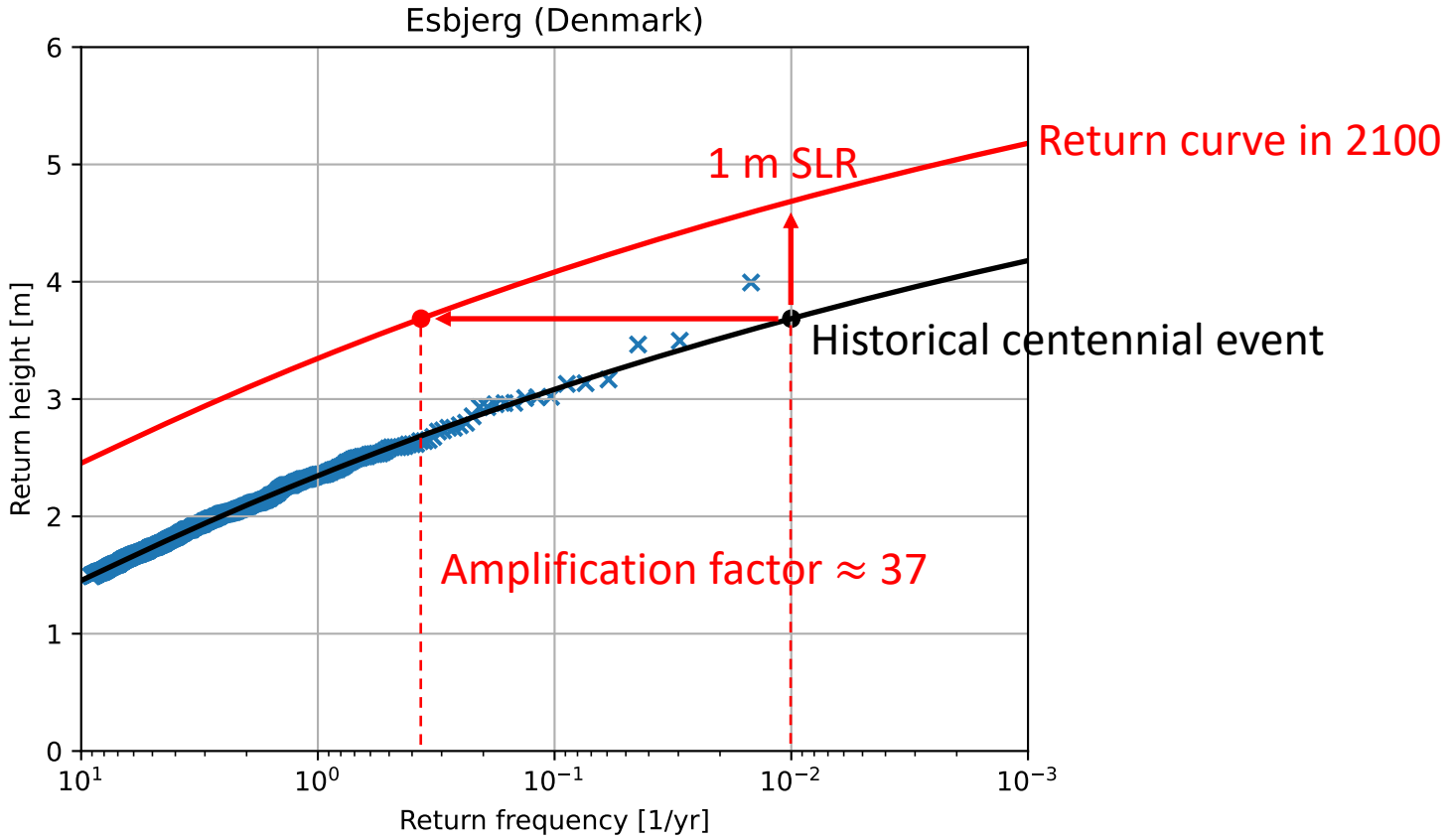
Frequency amplification of extreme sea levels

- GESLA3 tide gauge data
- Peak-over-threshold analysis

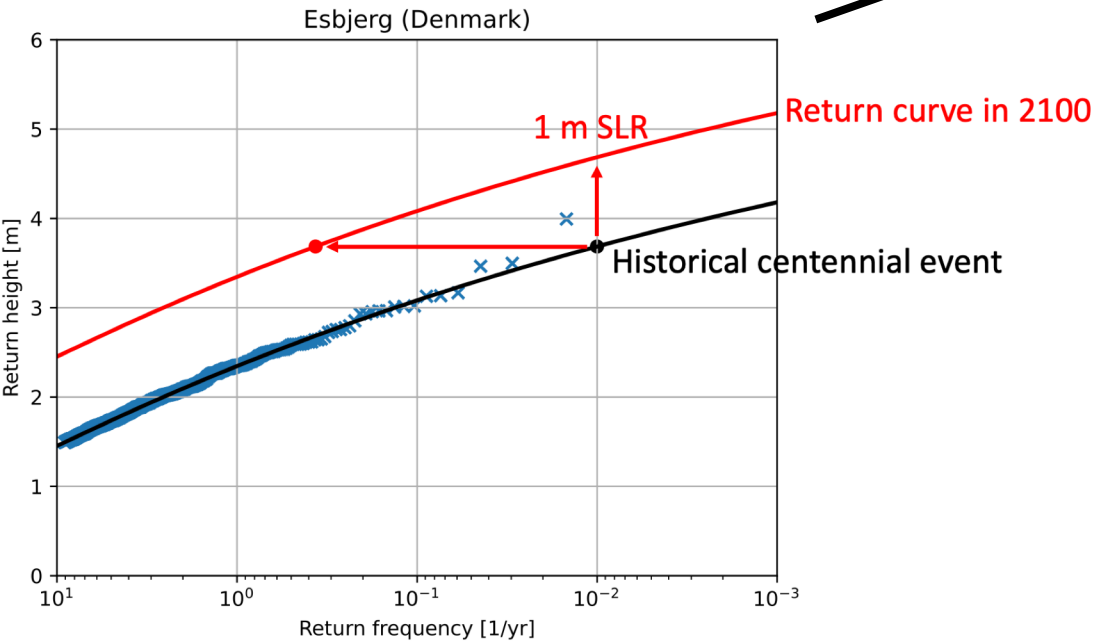


Frequency amplification of extreme sea levels

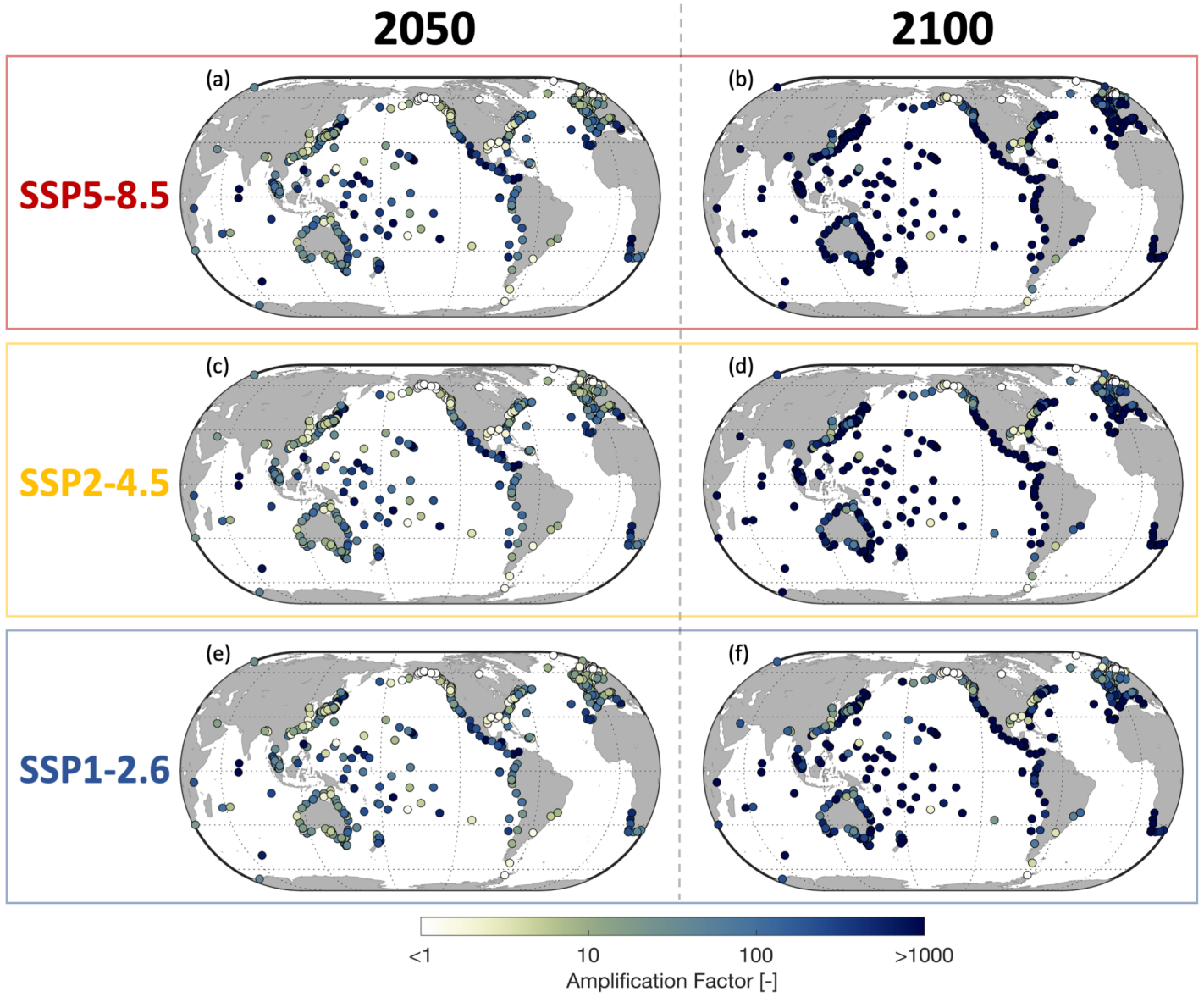
- GESLA3 tide gauge data
- Peak-over-threshold analysis



Frequency amplification of extreme sea levels

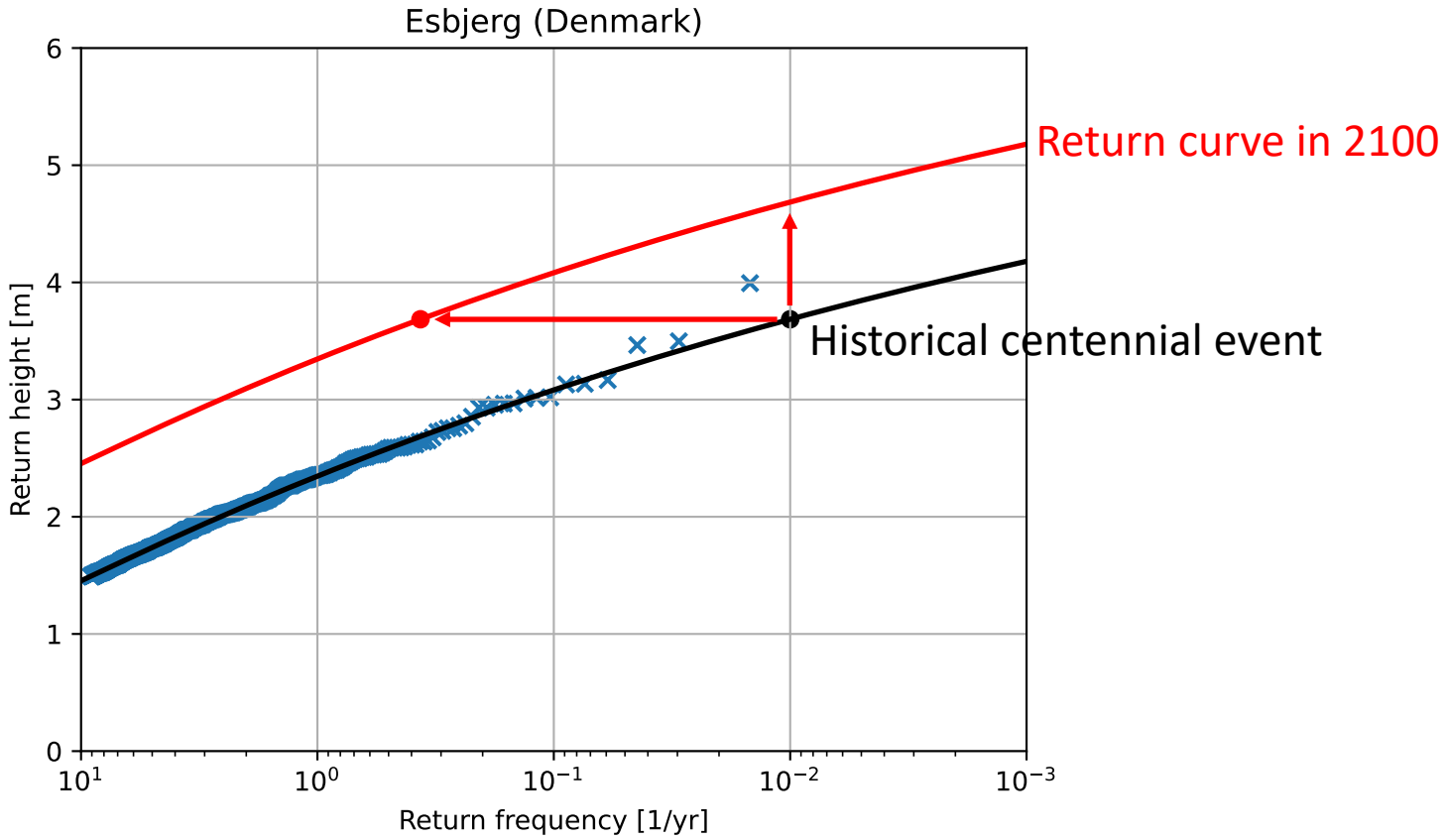


e.g., IPCC AR6



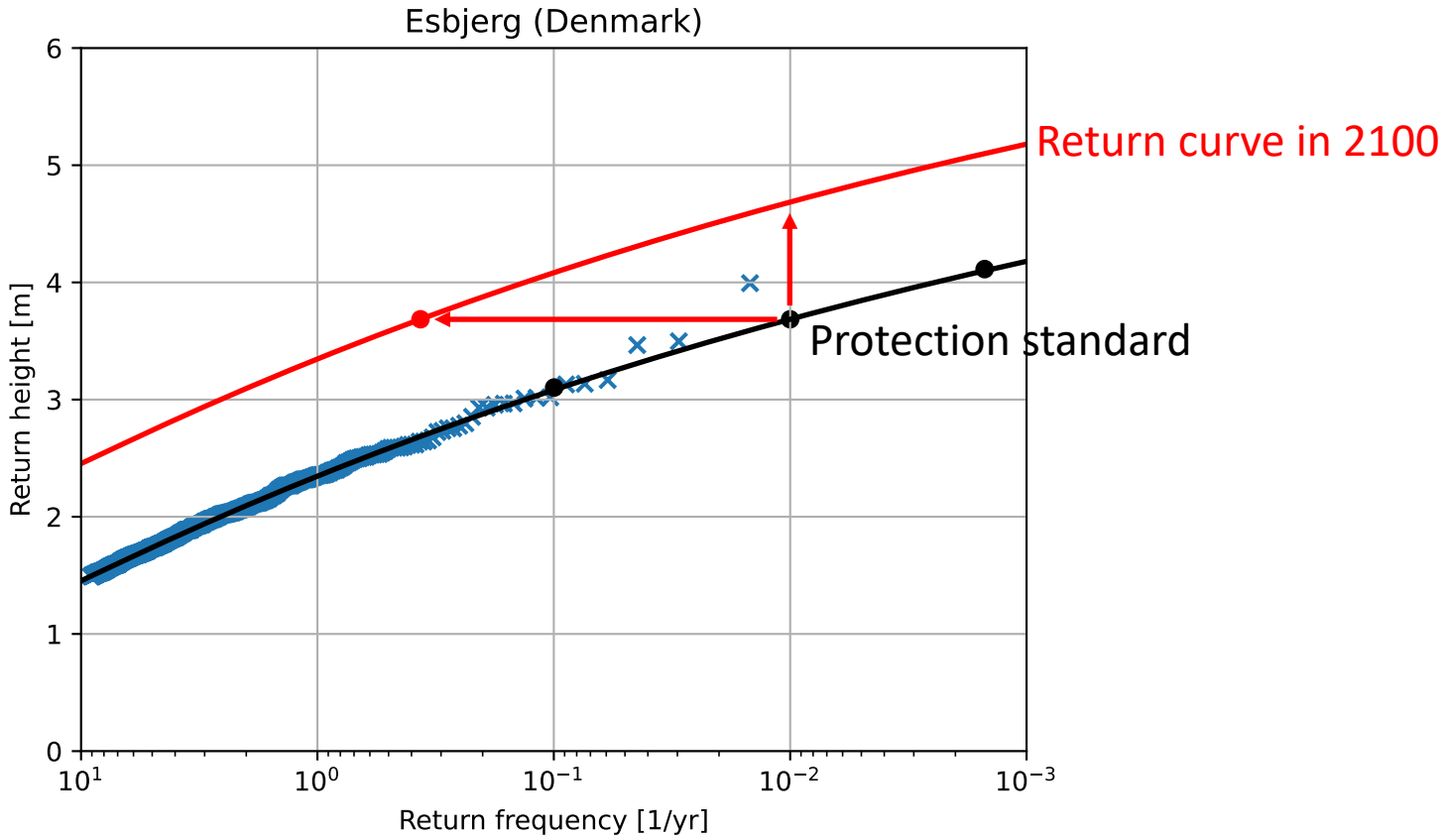
Relevance of the historical centennial event?

- Estimated protection standards FLOPROS (Tiggeloven et al., 2020)



Relevance of the historical centennial event?

- Estimated protection standards FLOPROS (Tiggeloven et al., 2020)
- Amplification factor → Decrease in degree of protection

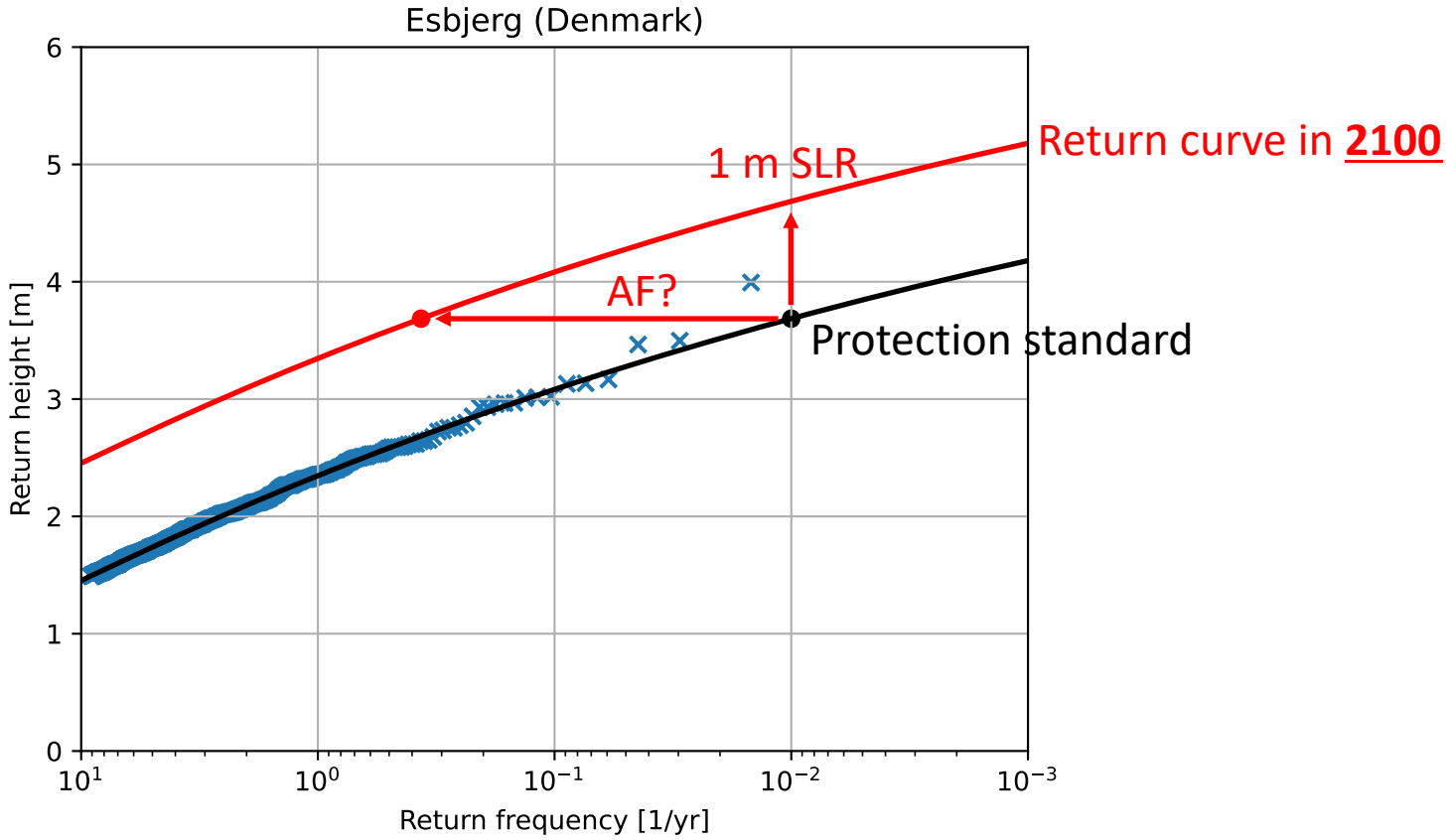


“When?” instead of “How much”?

How much more frequently exceeded in 2100?

→

When *N* times as frequently exceeded?

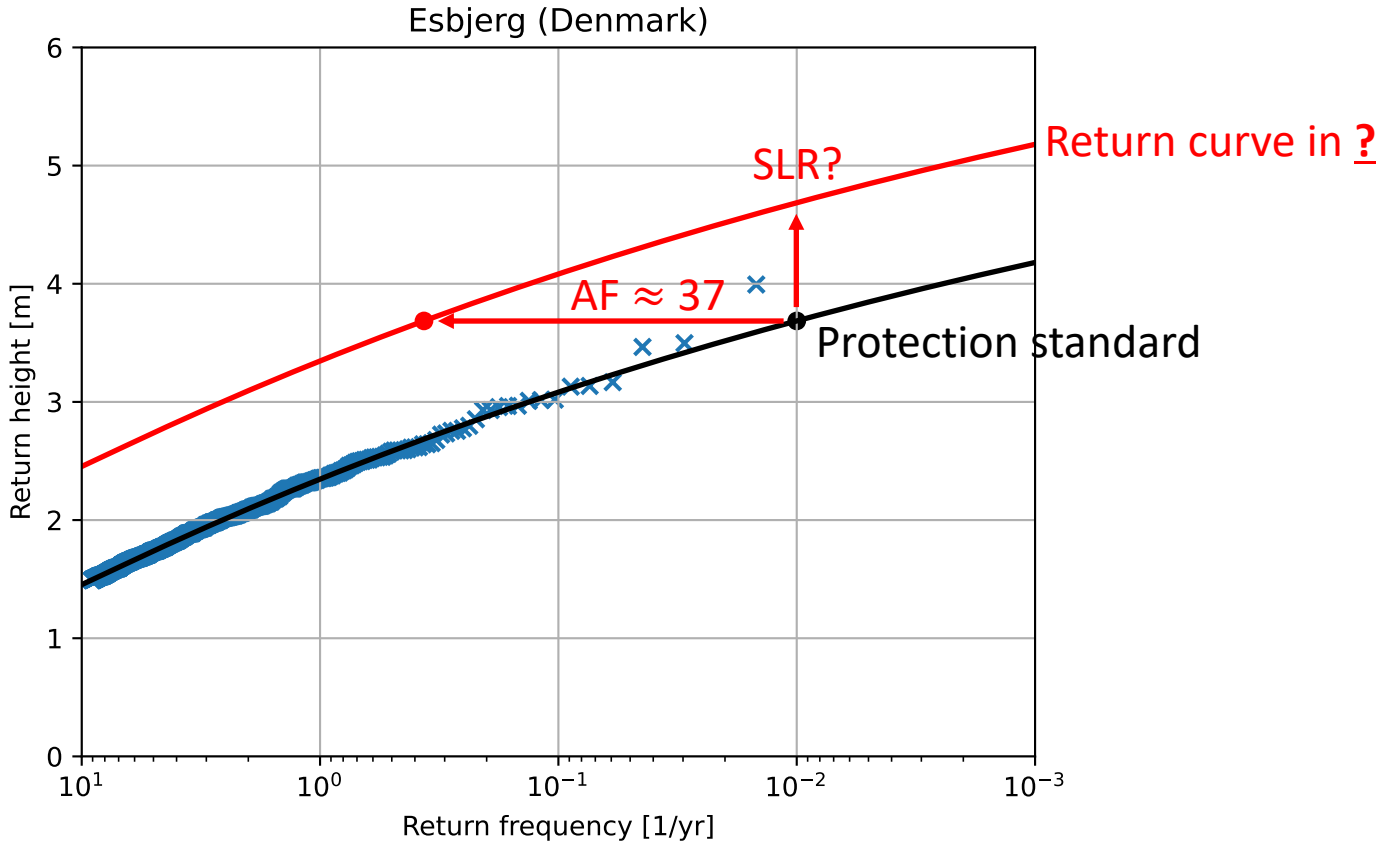


“When?” instead of “How much”?

How much more frequently exceeded in 2100?

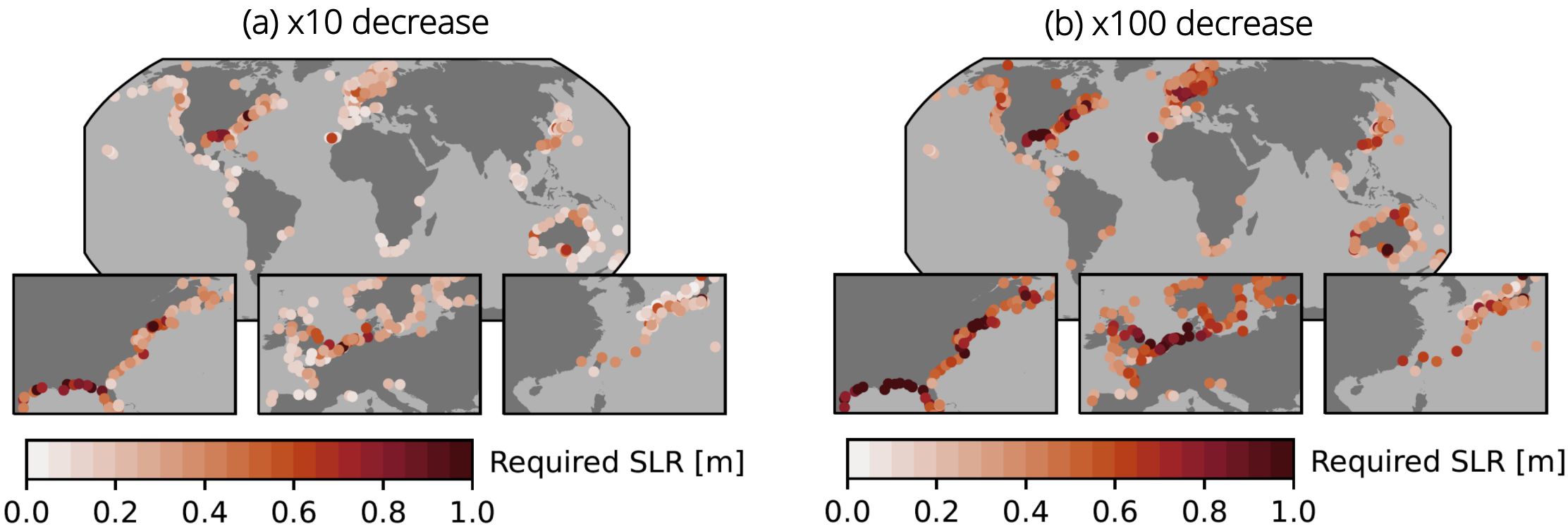
→

When *N* times as frequently exceeded?



Sea-level rise ‘required’ for protection decreases

- Larger where extremes are more variable (steeper curves)
- Uncertainty from extreme value analysis

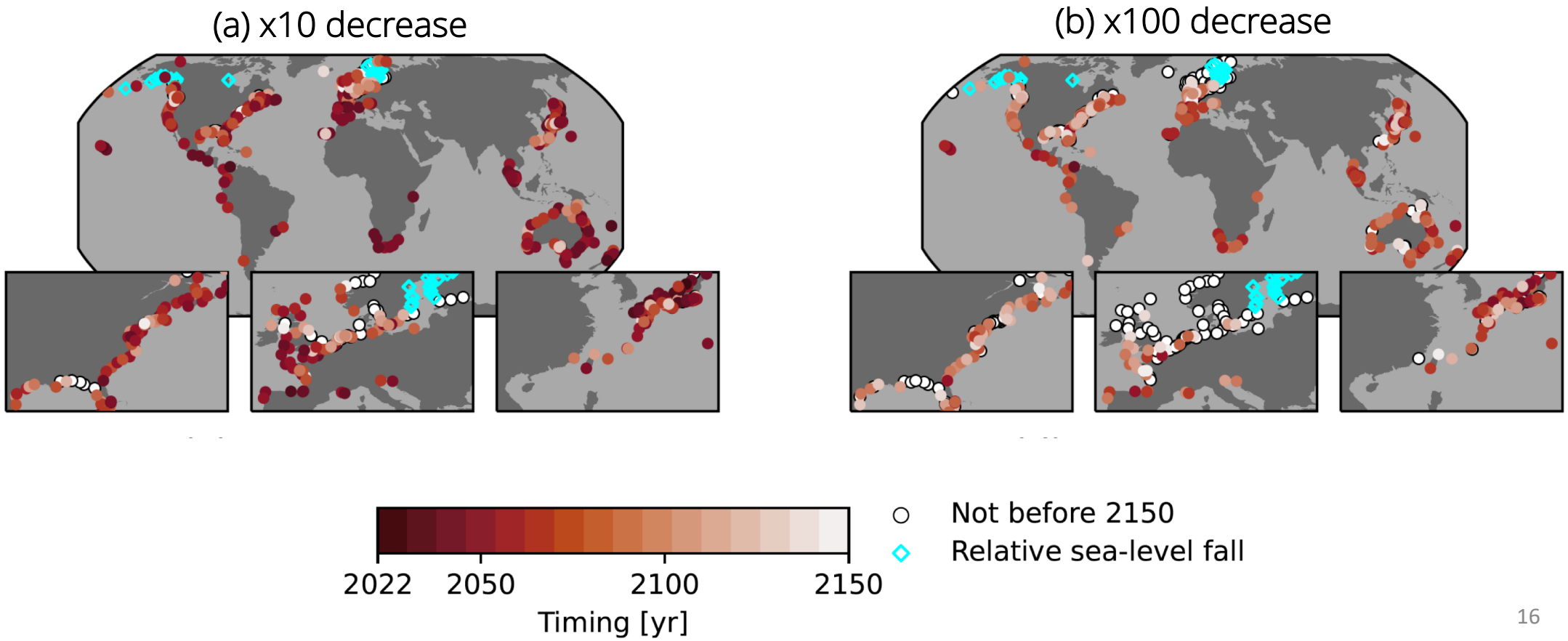


~90% of locations require 0.5m or less (Esbjerg: 0.64 m)

Timing of protection decreases

- Using relative sea-level projections from IPCC AR6
- Uncertainty propagation

SSP1-2.6



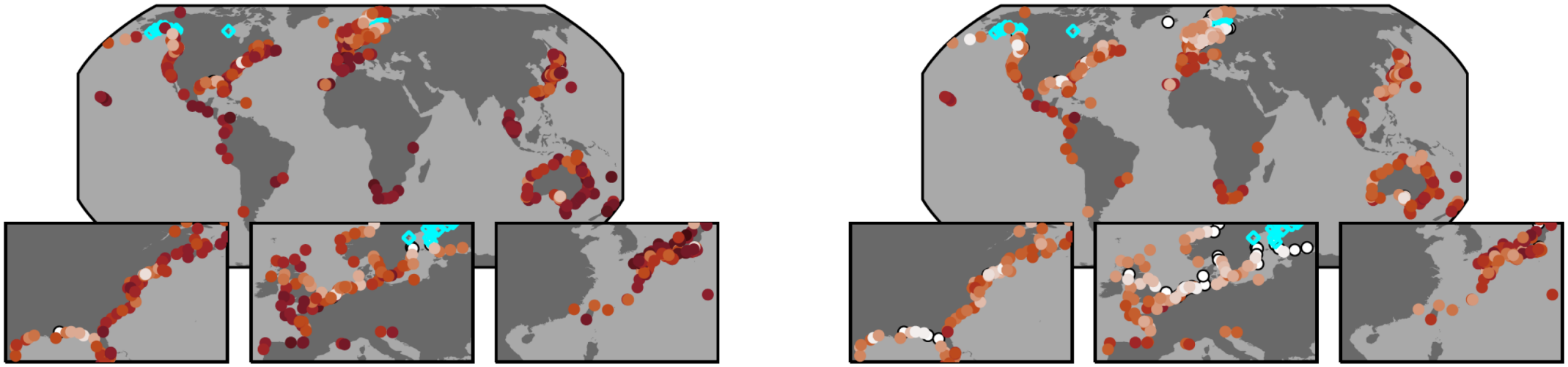
Timing of protection decreases

- Using relative sea-level projections from IPCC AR6
- Uncertainty propagation

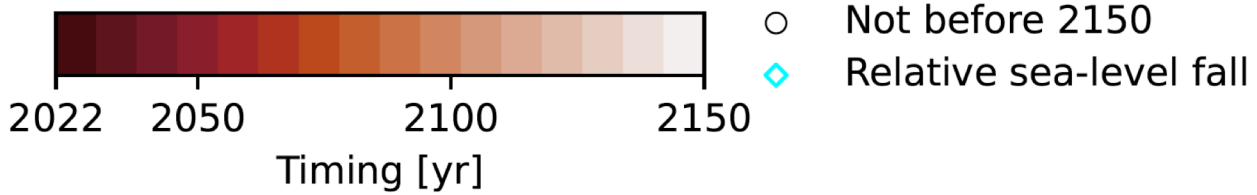
SSP3-7.0

(a) x10 decrease

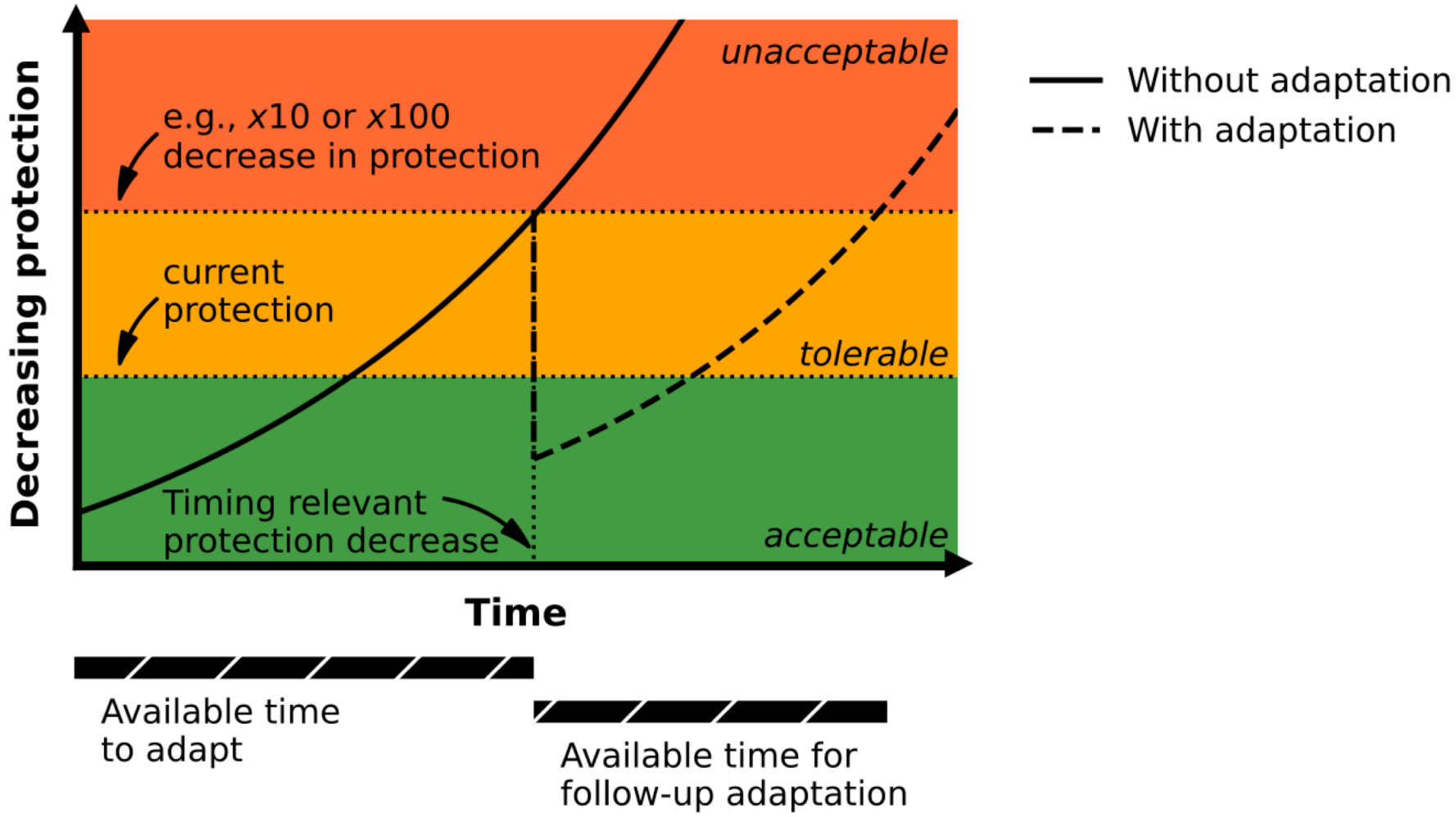
(b) x100 decrease



within next 30 years at ~28% (Esbjerg in 2112)

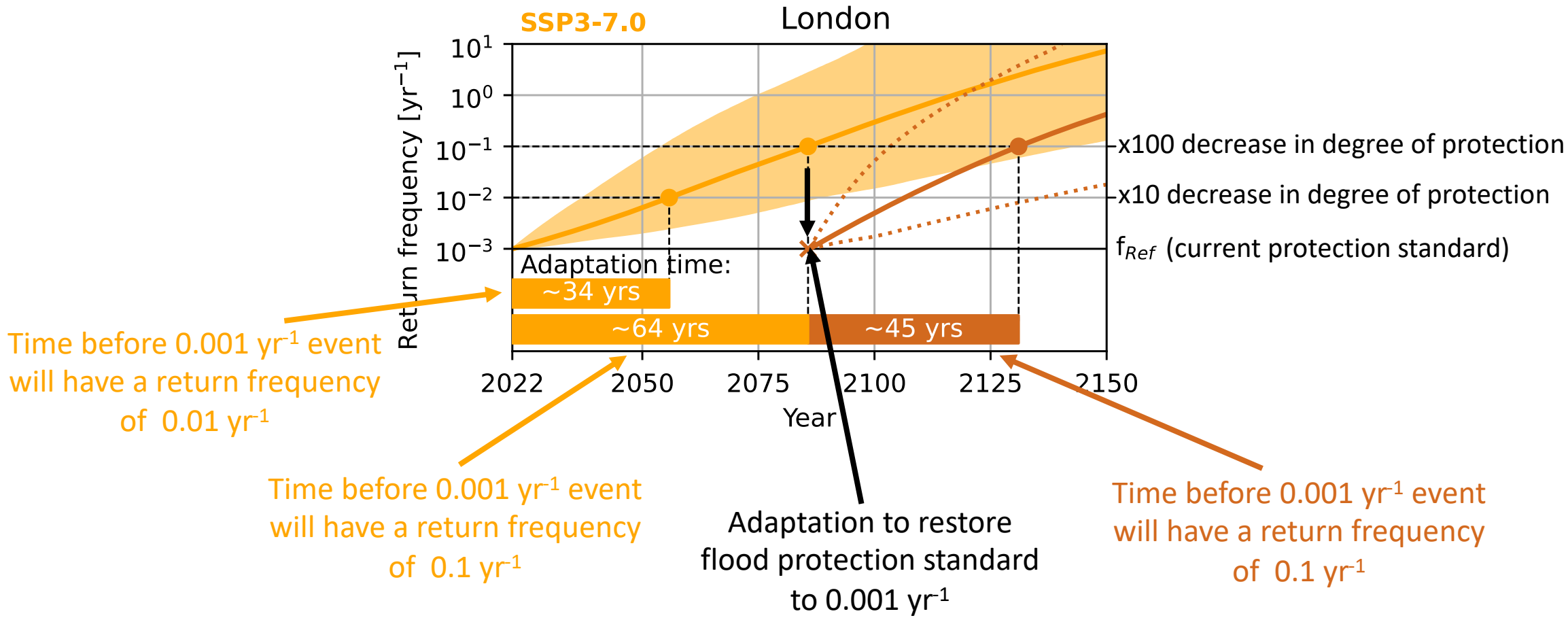


Available adapation time



Increasingly less time before decreases in protection

- Available adaptation time decreases as sea-level rise accelerates



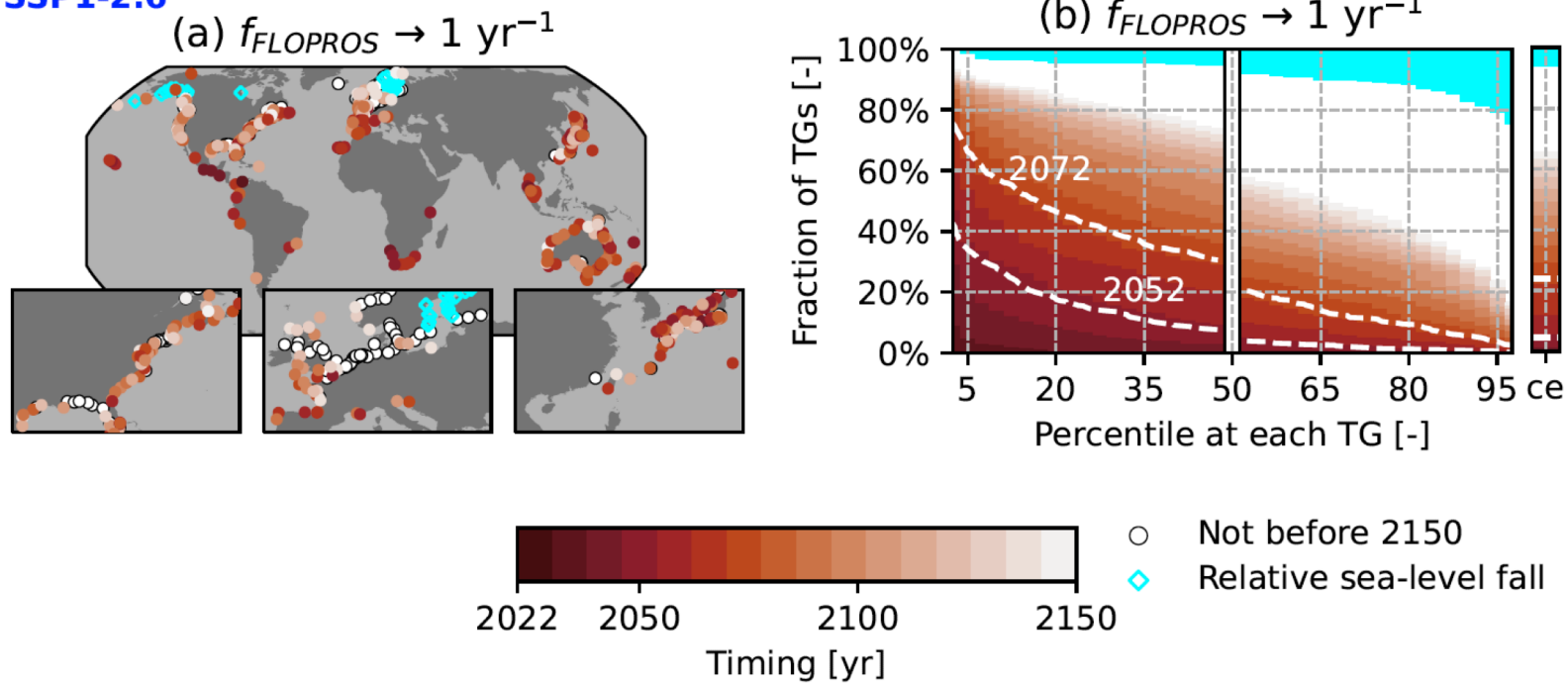
Summary

- Revisited frequency amplification of extreme sea levels
- Provides adaptation planners information on useful lifetime & available lead times
- Further research could:
  - incorporate dynamic changes in extremes
  - project timing at ungauged locations
  - apply the method locally

Hermans et al. (2023), The timing of decreasing coastal flood protection due to sea-level rise. *Nat. Clim. Chang.* **13**, 359–366. https://doi.org/10.1038/s41558-023-01616-5

Back-up

SSP1-2.6



SSP3-7.0