Updates to a global regional frequency analysis to extreme sea levels: RFA v2

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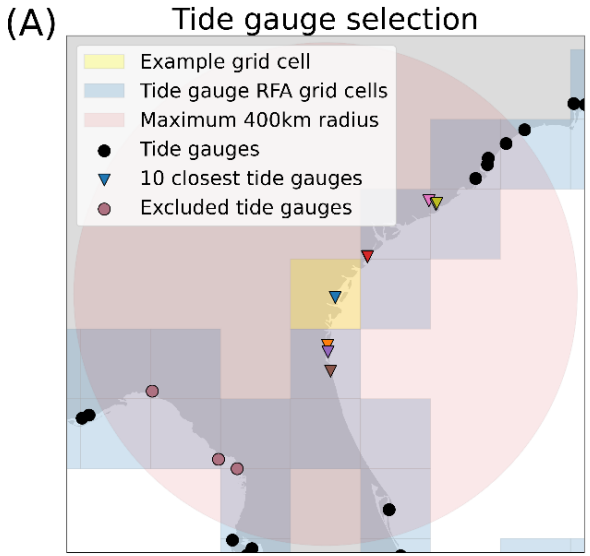
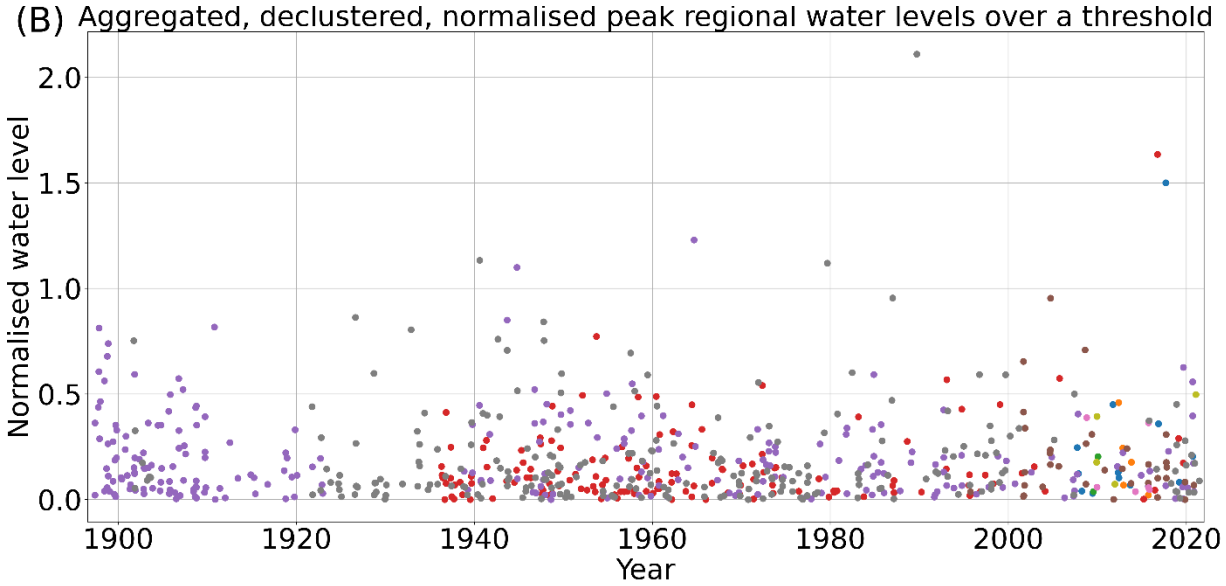
RFA v1

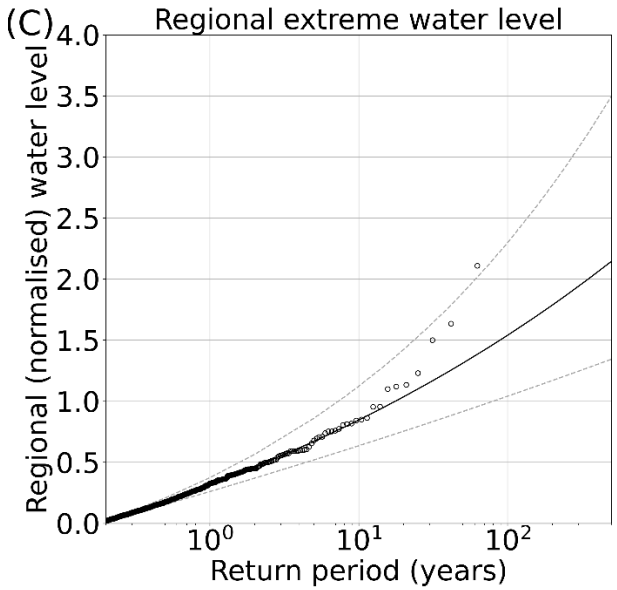
1. Group gauges
2. Test for homogeneity
3. Form regional water level record
4. Fit GPD to get regional extreme water levels
5. Denormalise regional return levels at coastline to get local extreme water levels

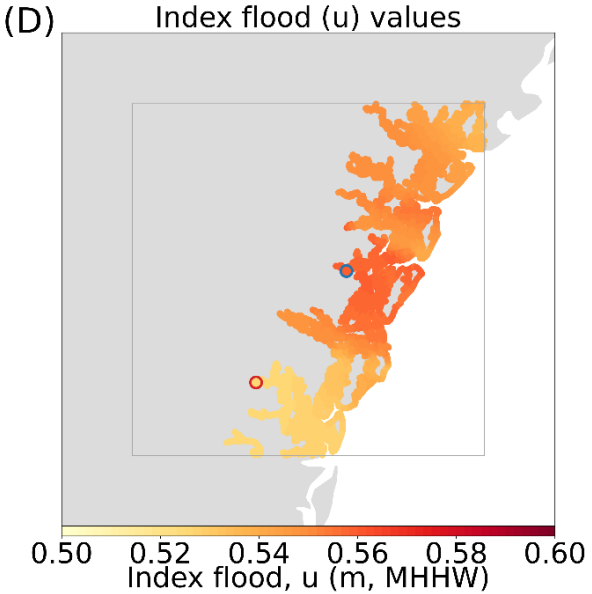
A synthesis of data resulting in global extreme sea levels from surge, waves, tides and MSL.

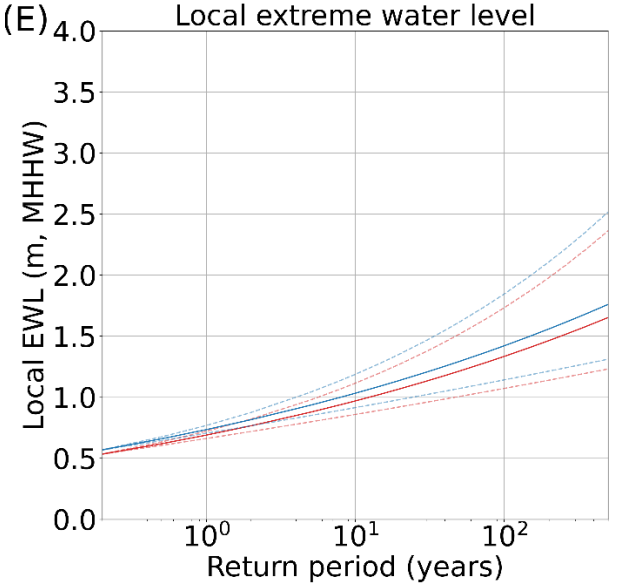
Global application of regional frequency analysis to extreme sea level (Collings *et al.*, 2024)











Key updates

Updates to the underlying data:

1. GESLA 3.1 (minor update from v3.0)
2. FES 2022
3. ERA5 waves (extended to 1940)
4. Aviso MDT

Major updates to the methods:

1. Enhanced spatial discretisation
2. Applying the TAILS threshold selection method
3. Calibrating the index flood

Minor updates to methods:

1. Estimating wave setup
2. Interpolating the index flood
3. Smoothing the regional extreme water levels

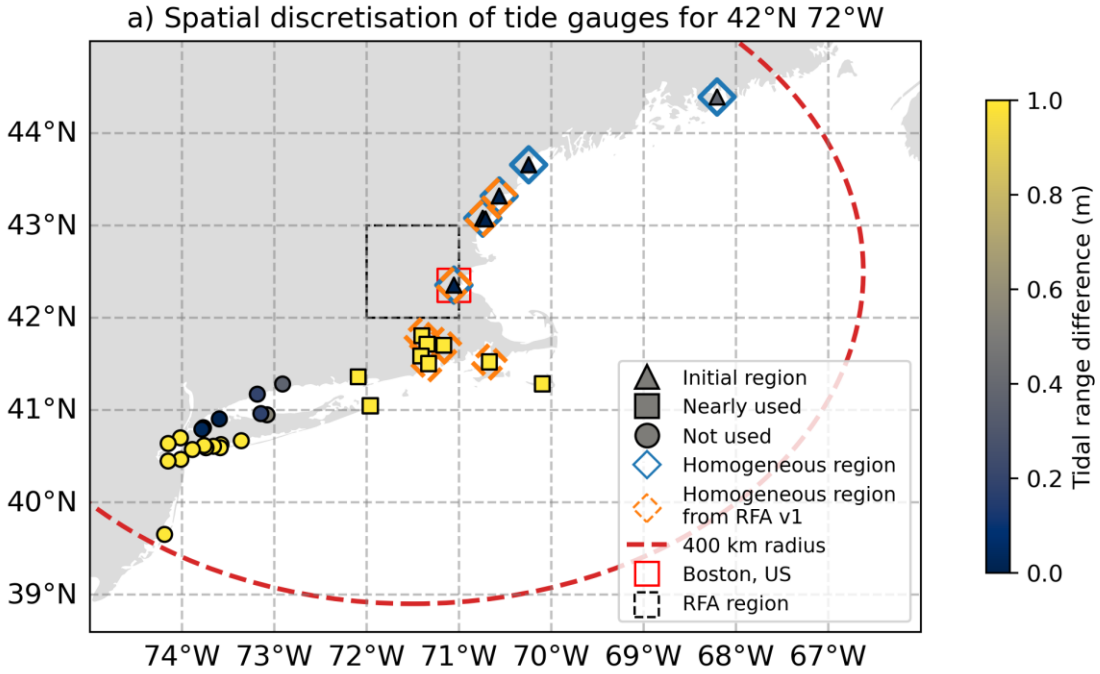
Enhanced spatial discretisation

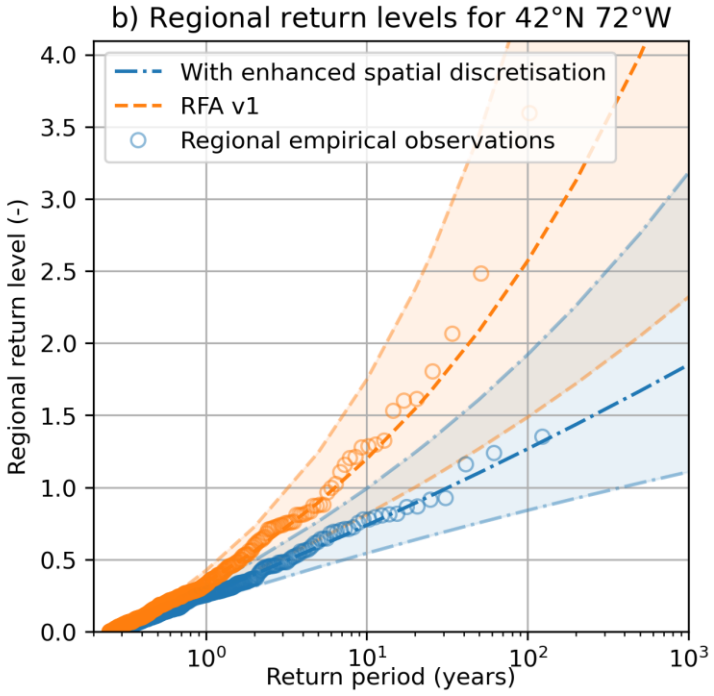
Utilising 2 new variables:

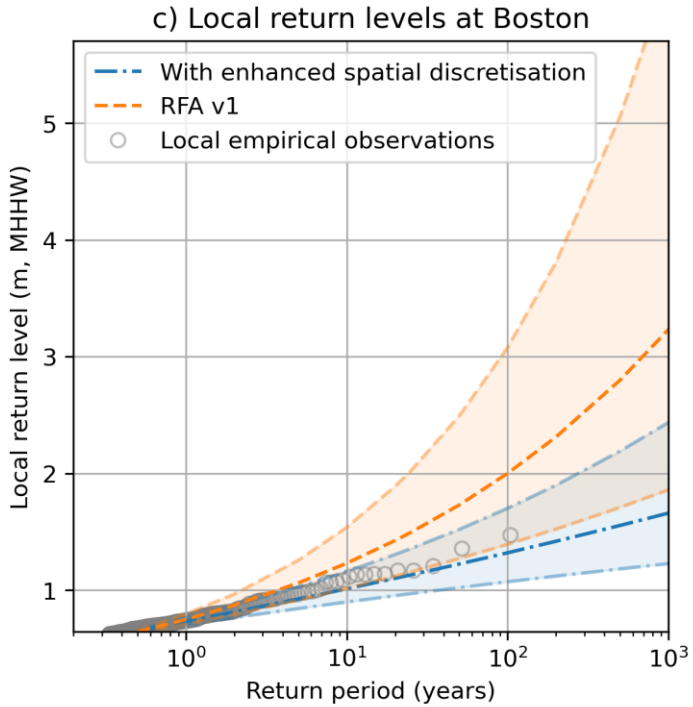
- “Over sea” distance
- Tidal range difference

Help to initially cluster records

Especially useful in regions with complex coastlines or tidal dynamics







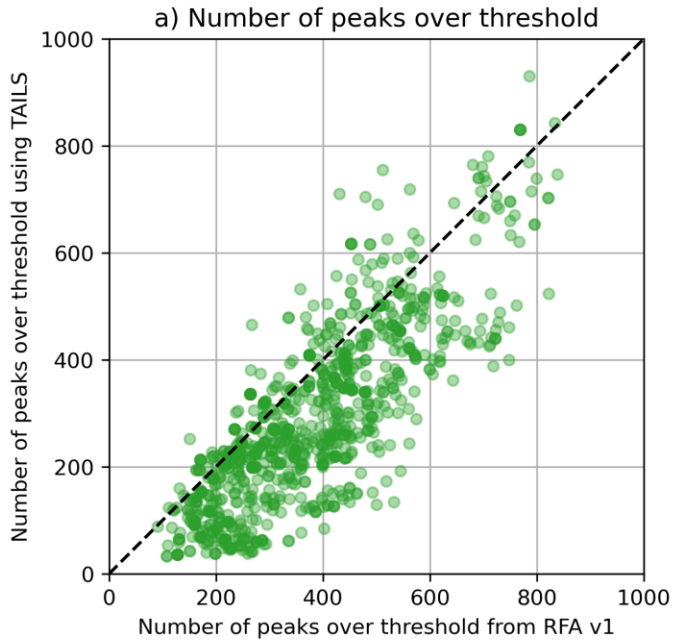
Applying the TAILS method

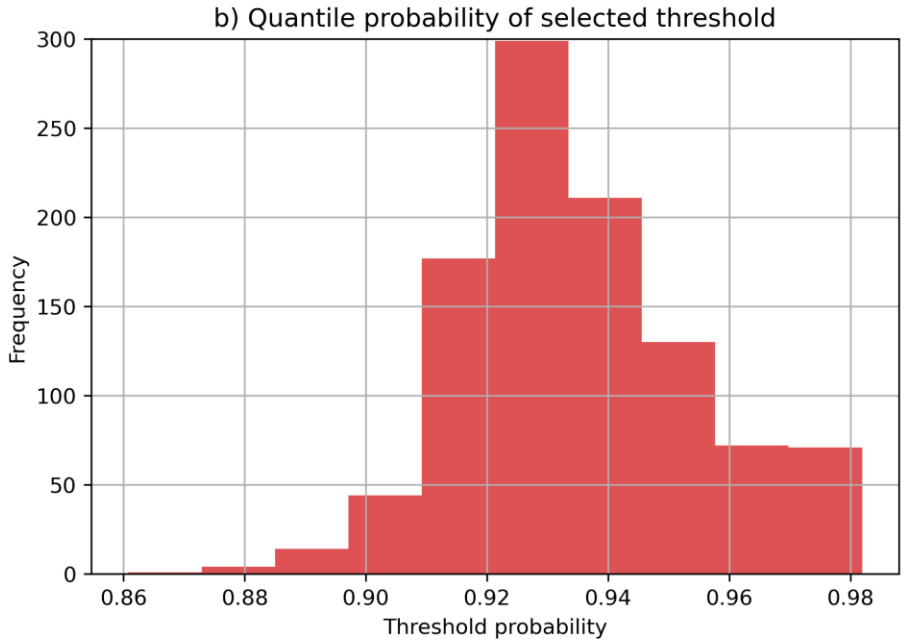
Automated threshold selection that focuses on minimising the "*expected quantile discrepancy*" with the tail of the data

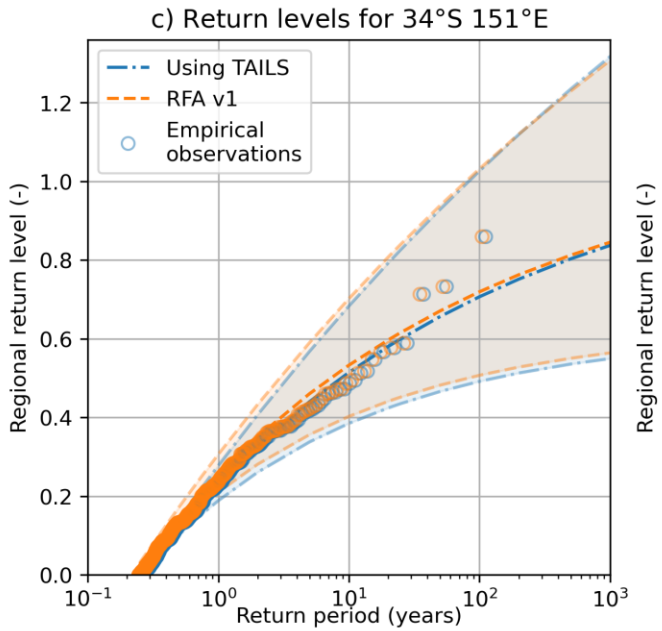
On average, this results in the a reduction in the number of events used to fit the GPD

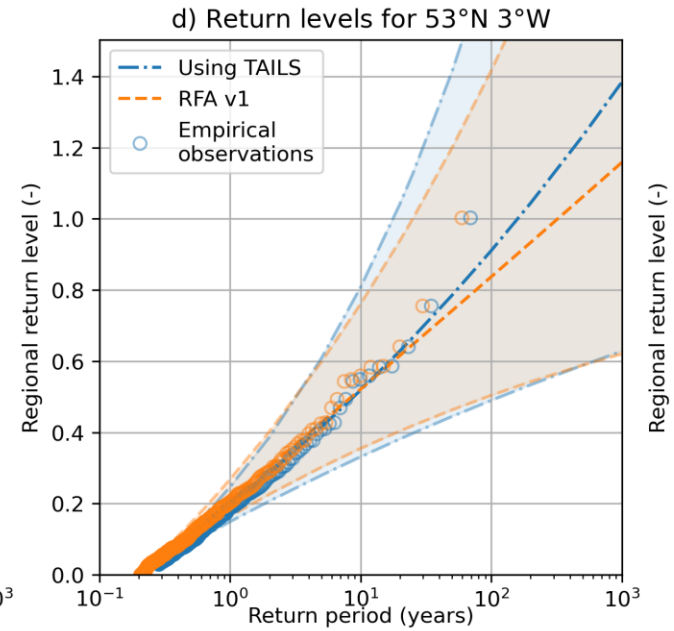
Automated tail-informed threshold selection for extreme coastal sea level – Collings *et al*., 2025 [In review]

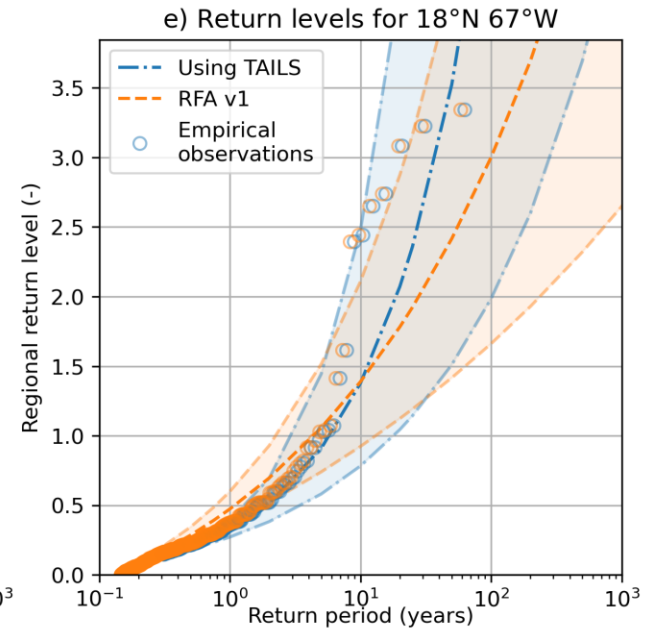
For GESLA regions









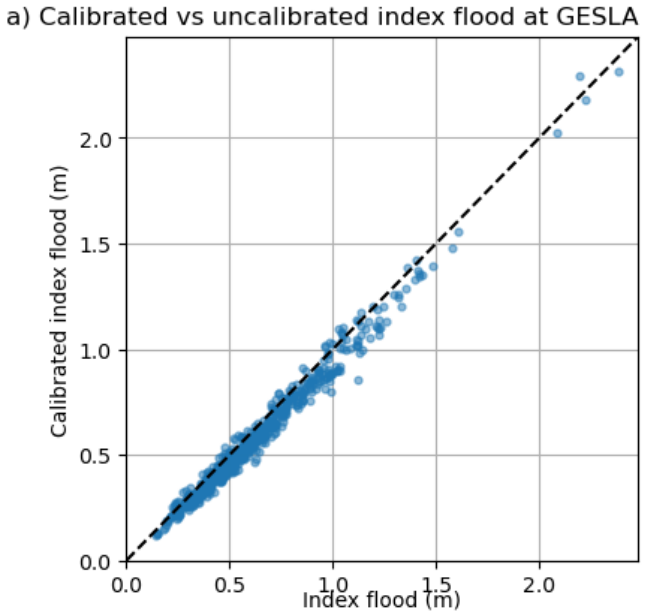


Calibrating the index flood

RFA approaches often result in return levels greater than single site analysis

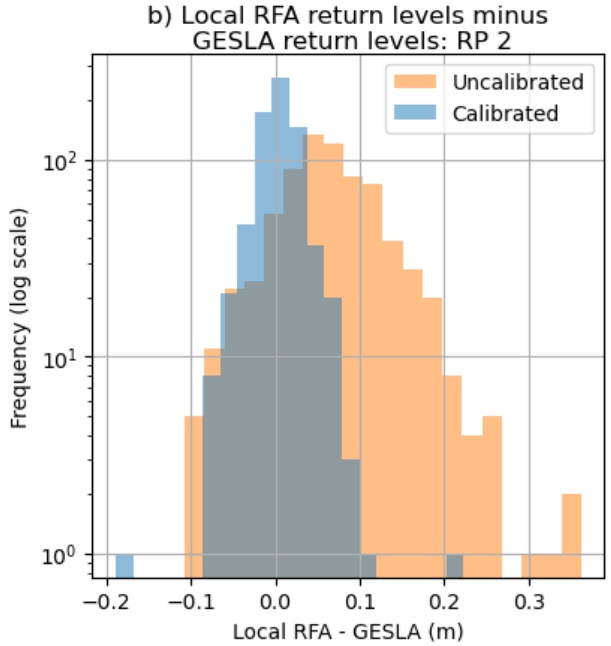
Index flood is calibrated using the non-extreme regional extreme water levels (mean of RP0.5 to RP1)

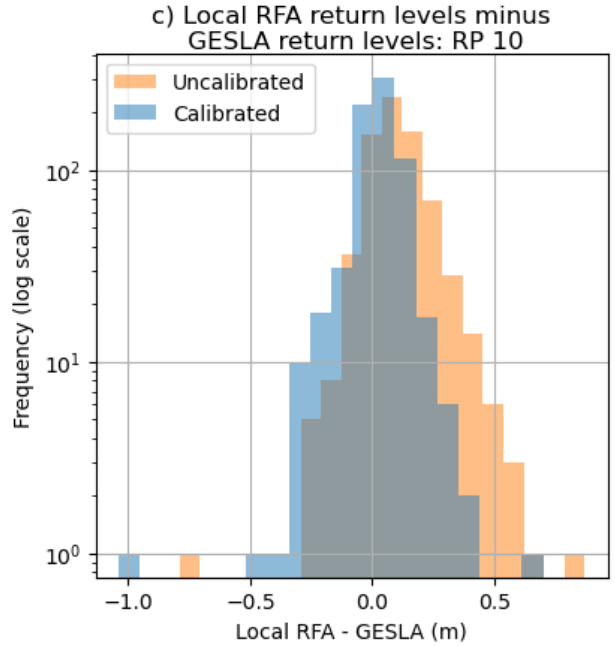
Calibration narrows the distribution of bias and centres the distribution close to 0

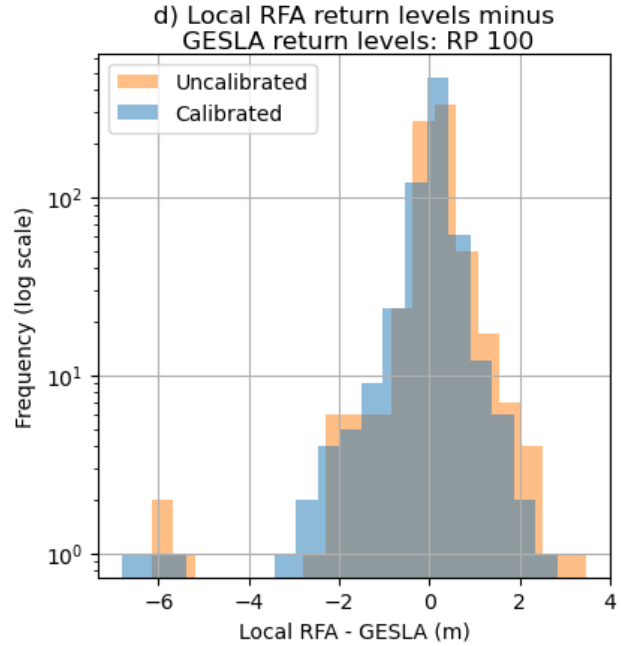


Mean values

	Calibrated (cm)	Uncalibrated (cm)
Index flood	55.7	59.6
RP2	0.5	6.7
RP10	2.3	10.6
RP100	3.3	16.3







Conclusions

- Introducing new metrics for spatial discretisation of records improves the regionalisation process
- Apply the TAILS threshold selection method to the RFA approach means we use less data on average → perhaps indicating RFA v1 was fitting GPDs to non-extreme data
- Calibrating the index flood helps to better represent the observed extreme water levels in the RFA outputs
- Overall, these additions plus updates to the input data result in more accurate, more defensible outputs

Any questions?

Want to get in touch?

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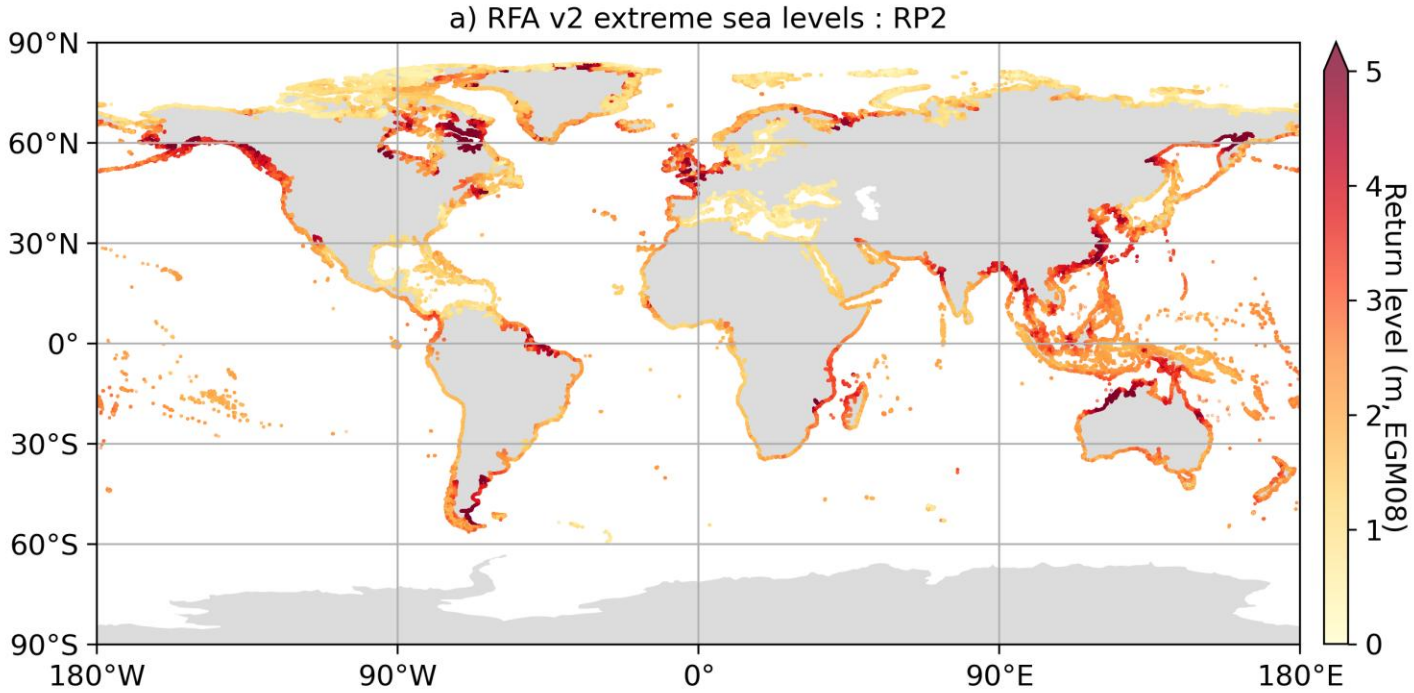
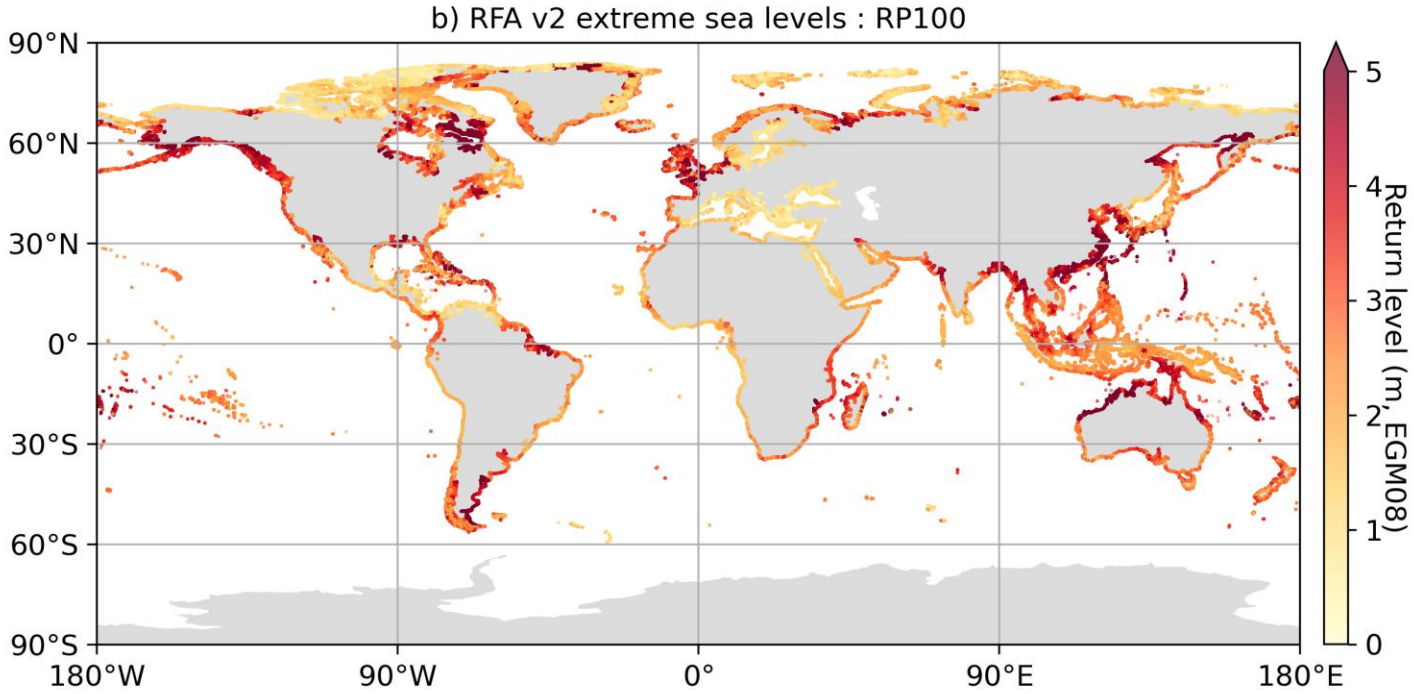
Results





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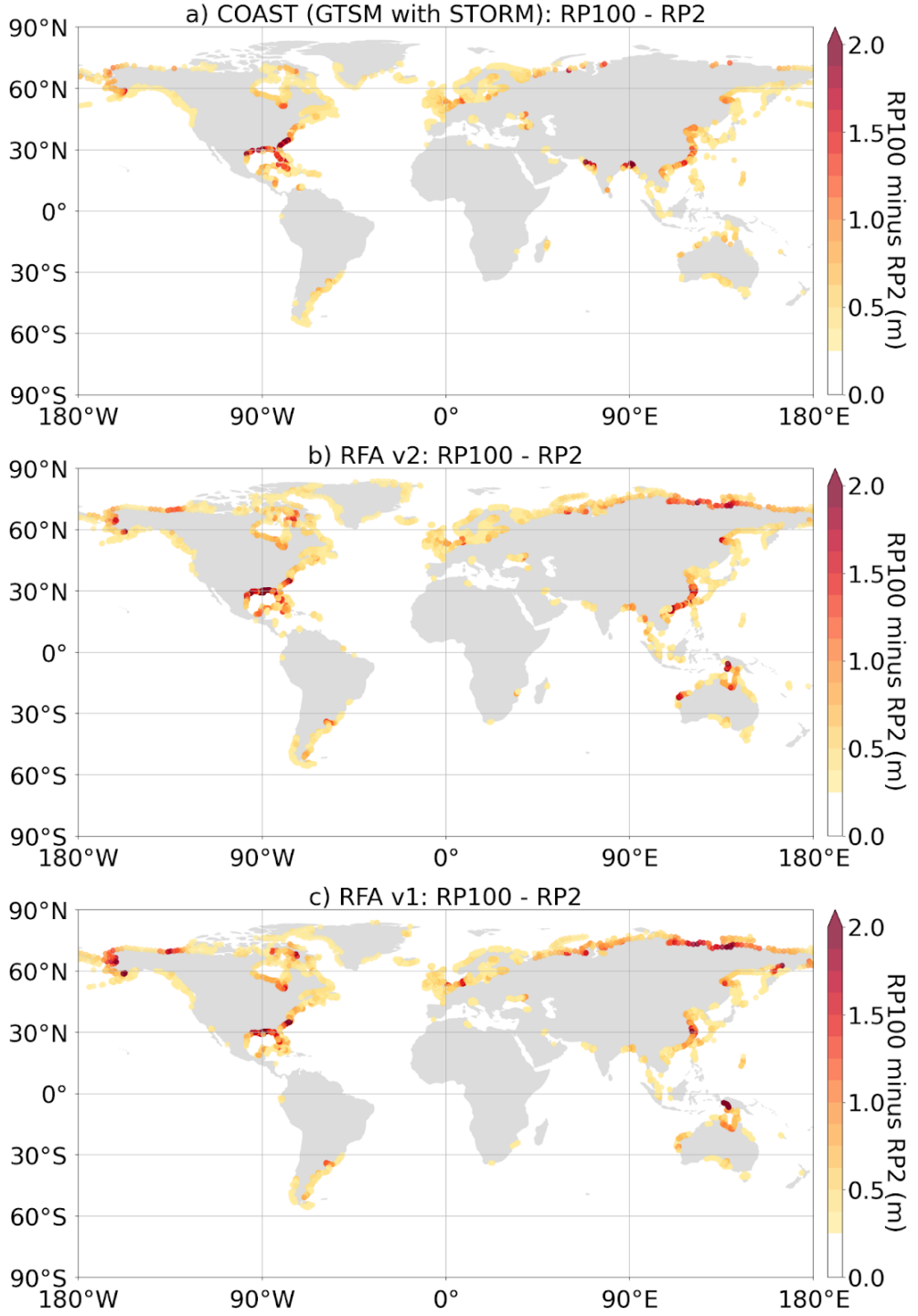
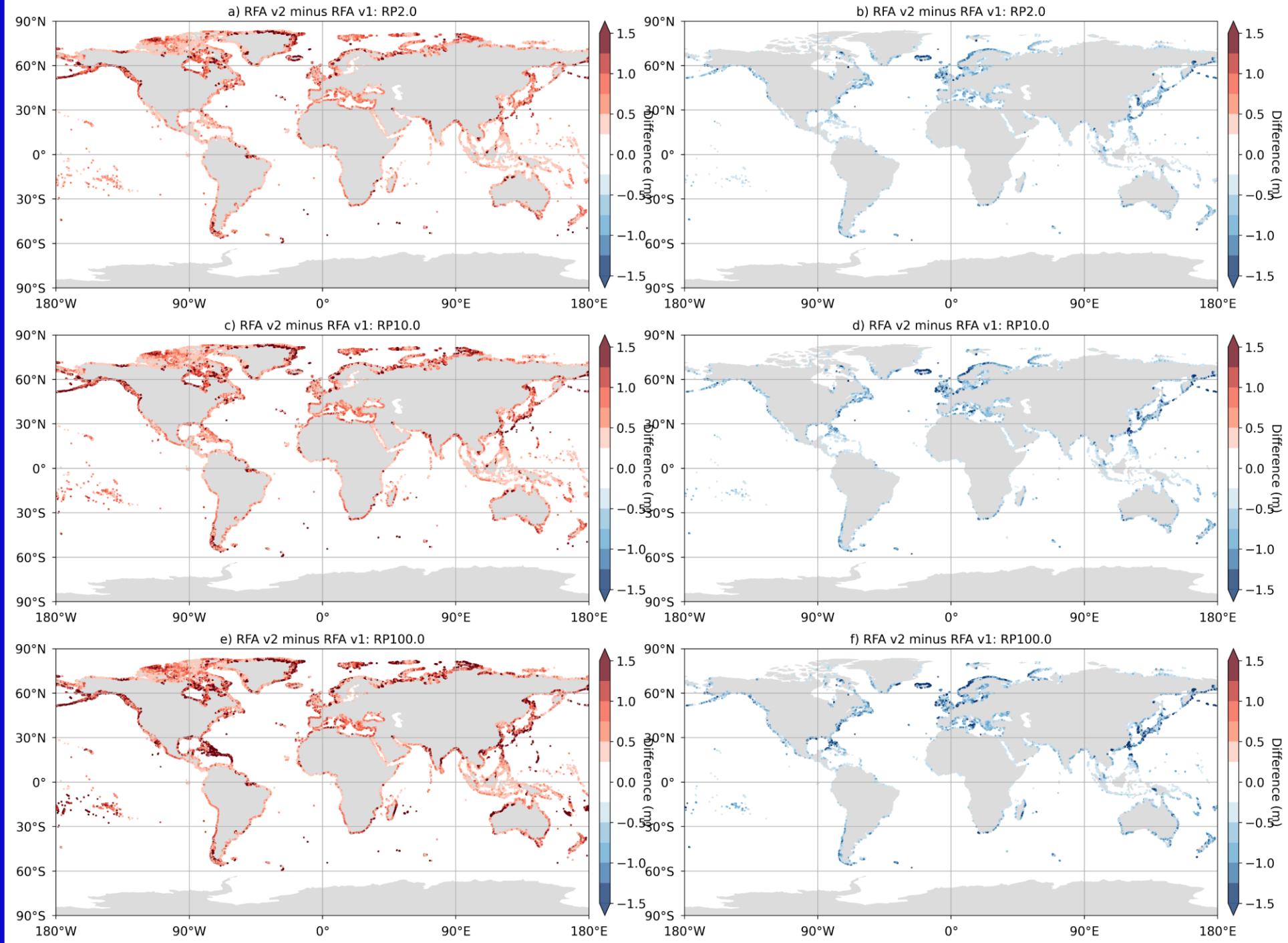


Differences to RFA v1

Return period	Mean
1	0.302
2	0.318
5	0.342
10	0.362
20	0.385
50	0.423
100	0.461
200	0.513
500	0.616
1000	0.744



Differences to RFA v1

Metric	Mean
GT	0.096
MHHW	0.051
Index flood	0.212
Datum correction	0.092