UK Sea Level Variability from Tide Gauge Data

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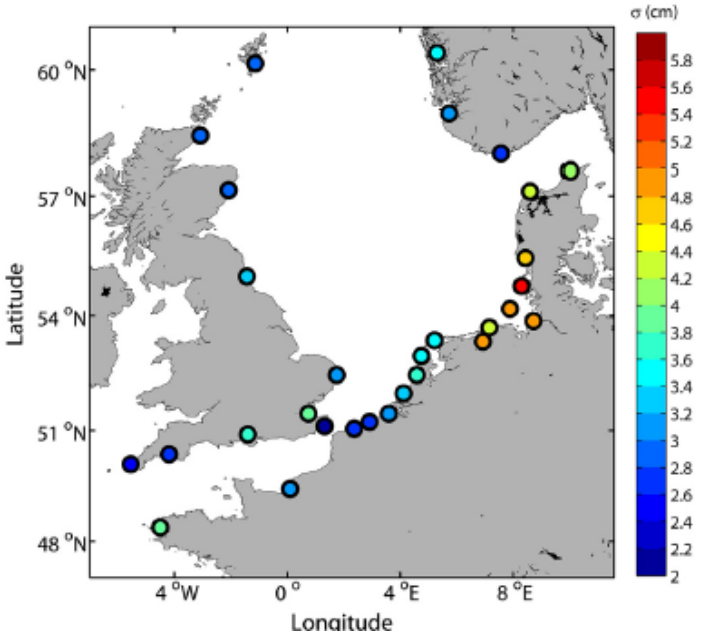
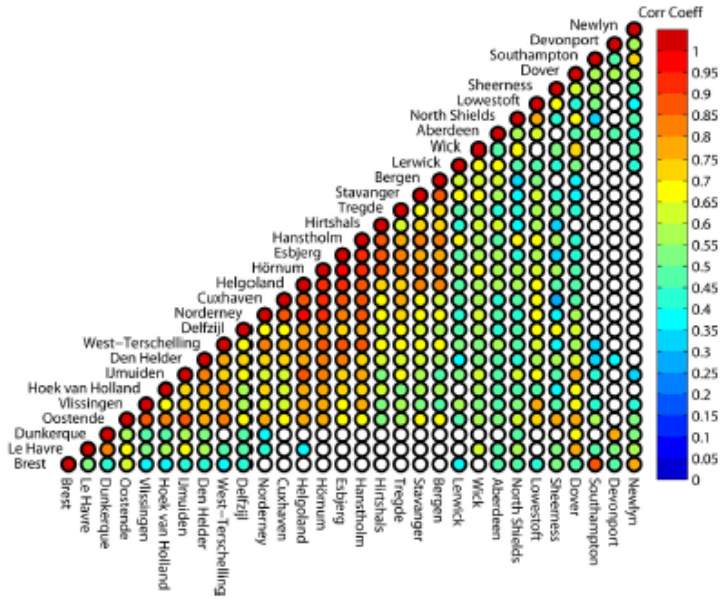
UK Sea Level Variability from Tide Gauge Data

Sea levels vary on different timescales due to different processes e.g.

- Waves
- Tides
- Seiches
- Surges
- Seasonal changes
- Atmospheric variability
- Long-term trends

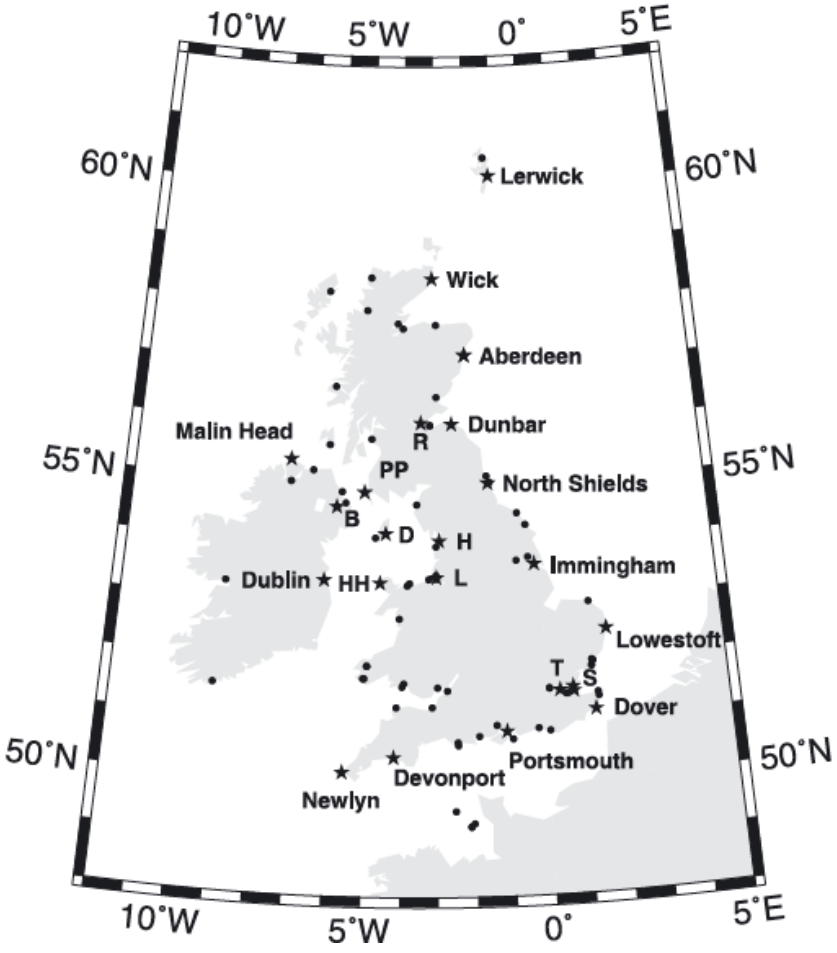
UK Interannual Sea Level Variability



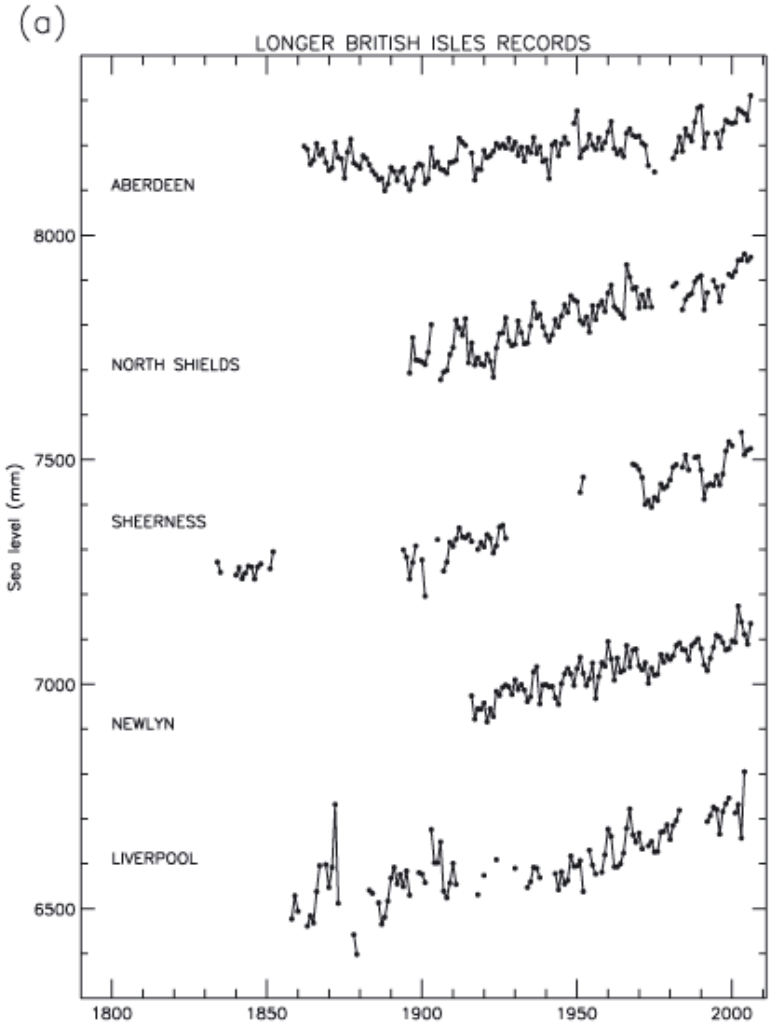


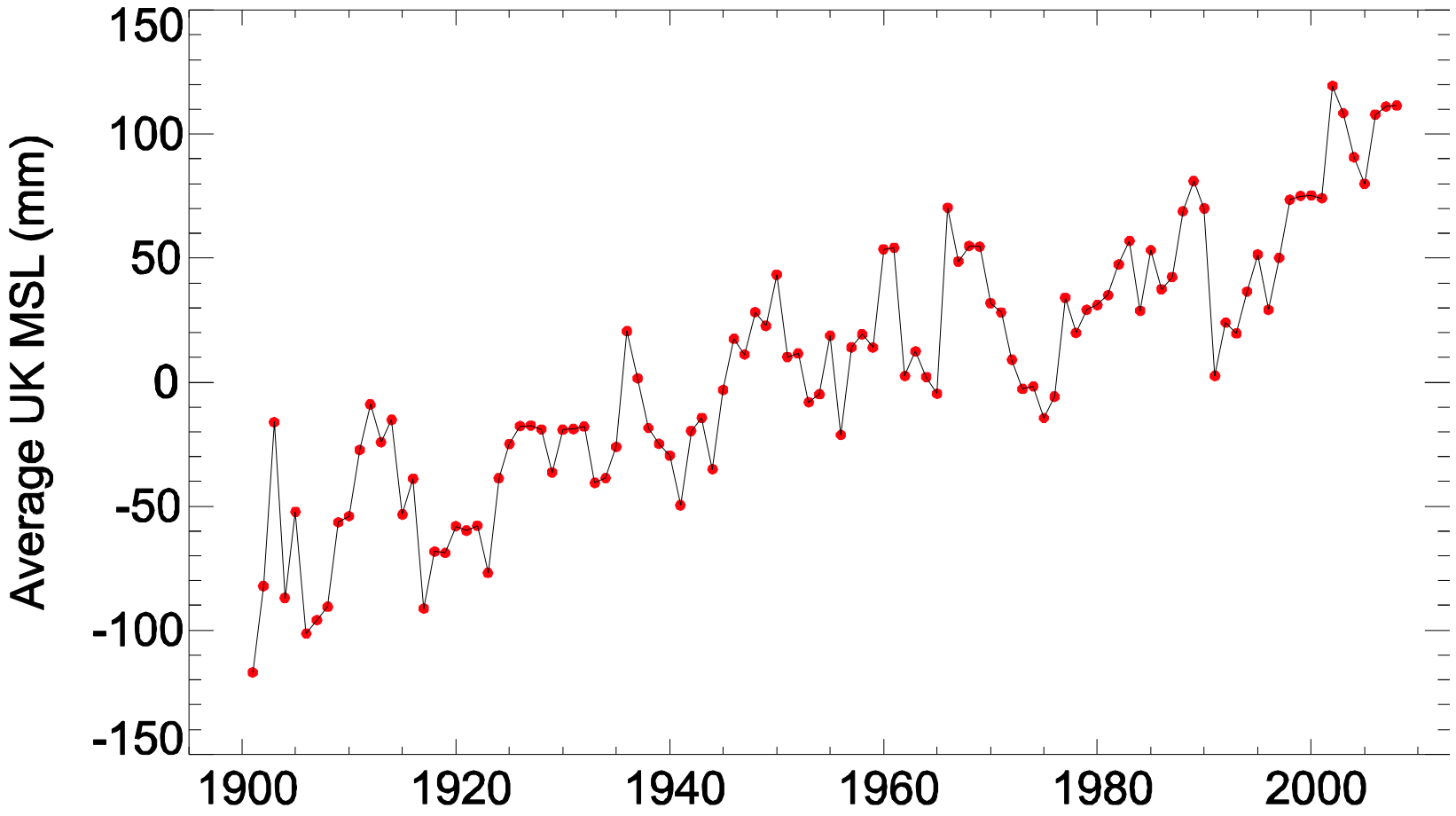
UK tide gauge data noisy, but spatial coherence of interannual variability has been identified between stations e.g. (Wahl et al., 2013)

Much of the work on MSL trends has taken advantage of that coherence, computing ‘sea level indices’ (i.e. average time series of MSL in a region) to eliminate unwanted variability from data.

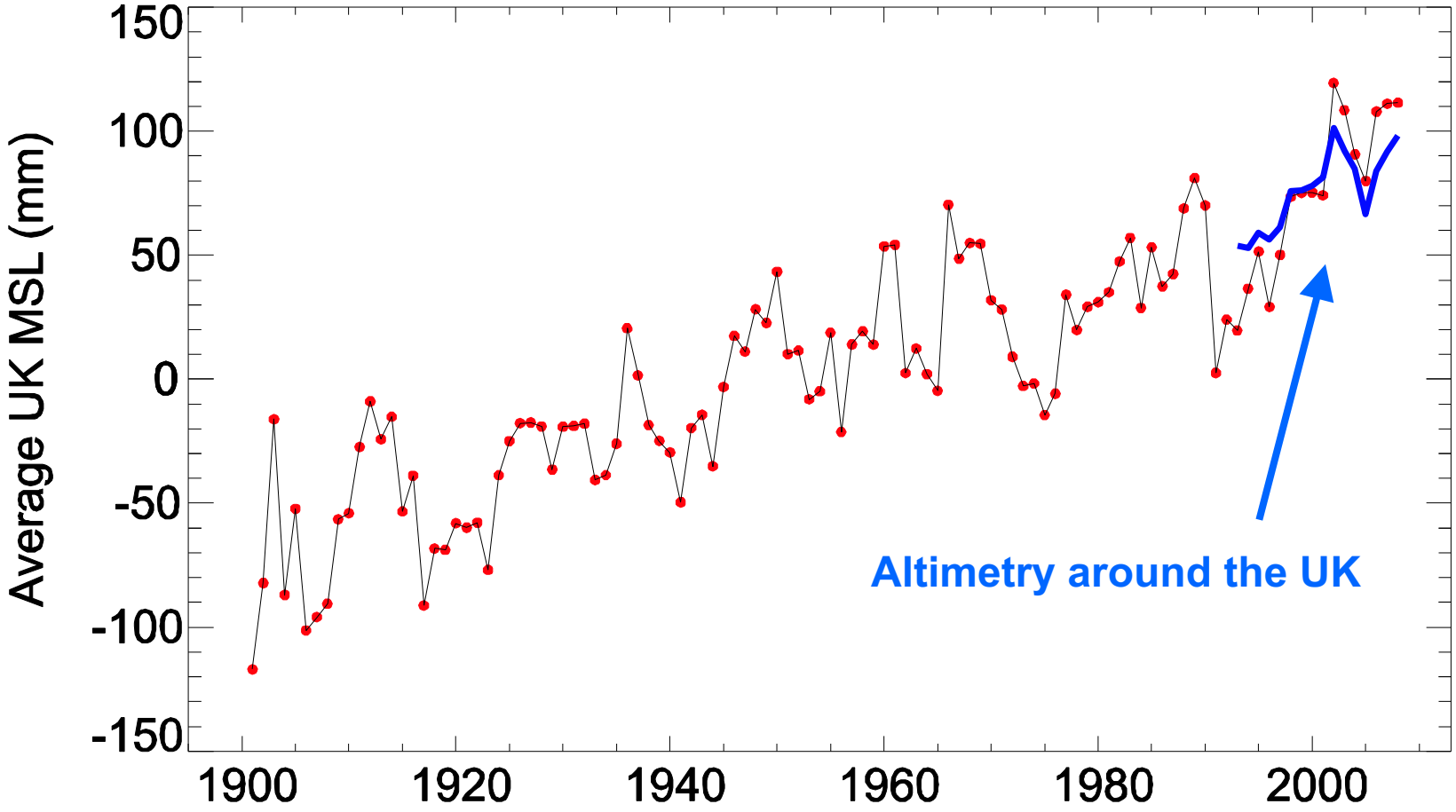


(Woodworth et al., 2009)

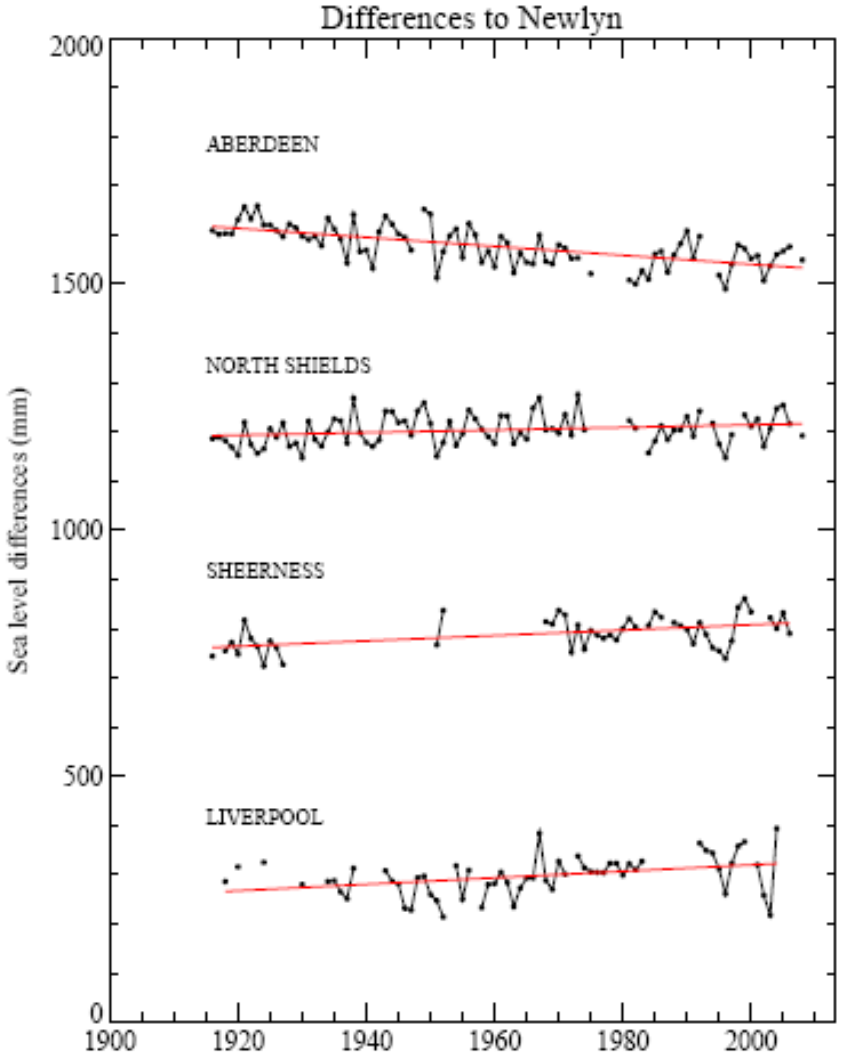


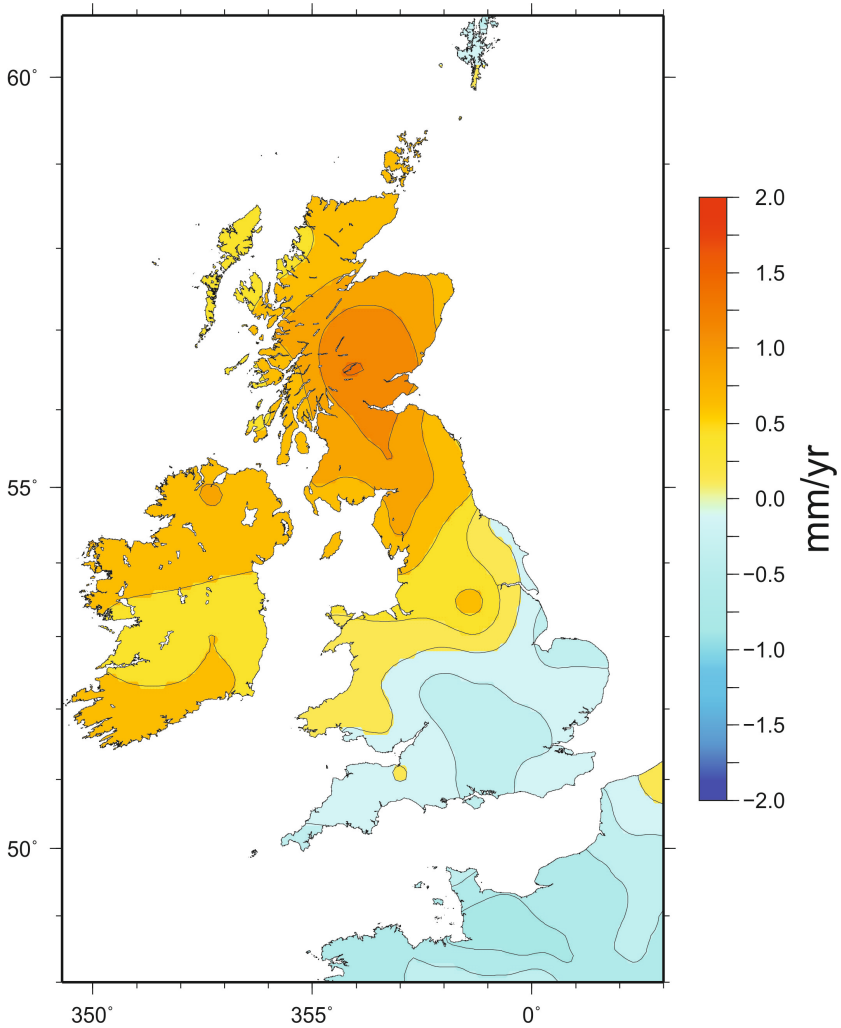


Average UK Mean Sea Level Change: 1.4 mm/year for the 20th century
(updated from Woodworth et al., 2009)



Altimetry means T/P/J data only from a box around the UK

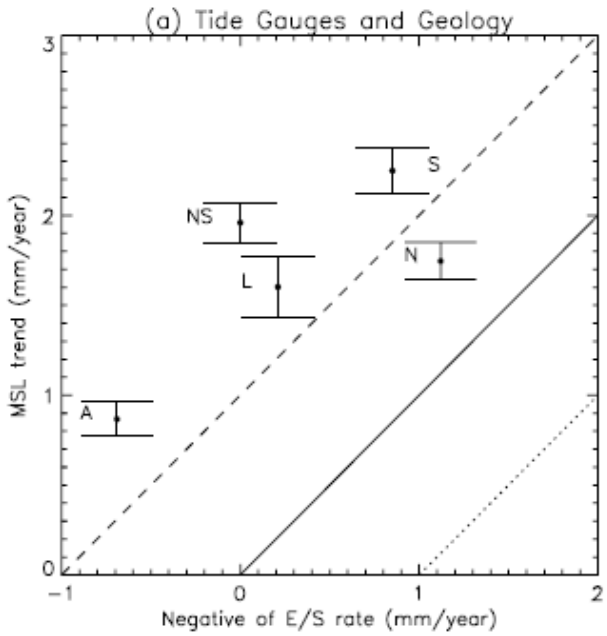




Importance of geology: Woodworth et al., 2016

20th Century Rates of UK Sea Level Change (Woodworth et al., 2009)

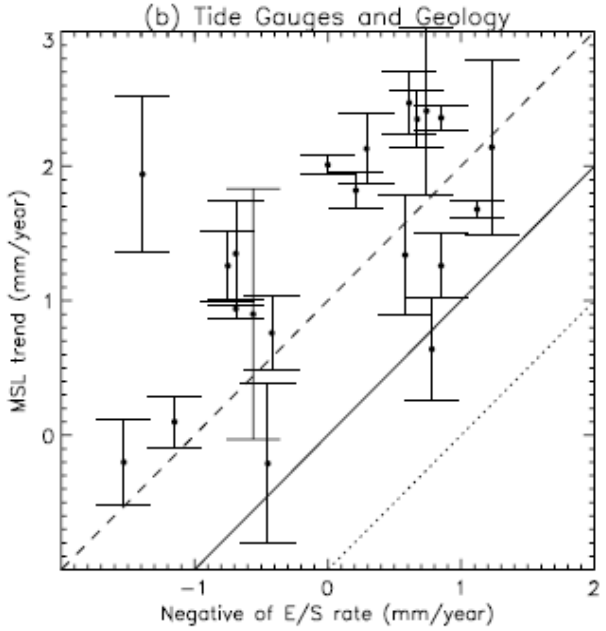
TG



Geology

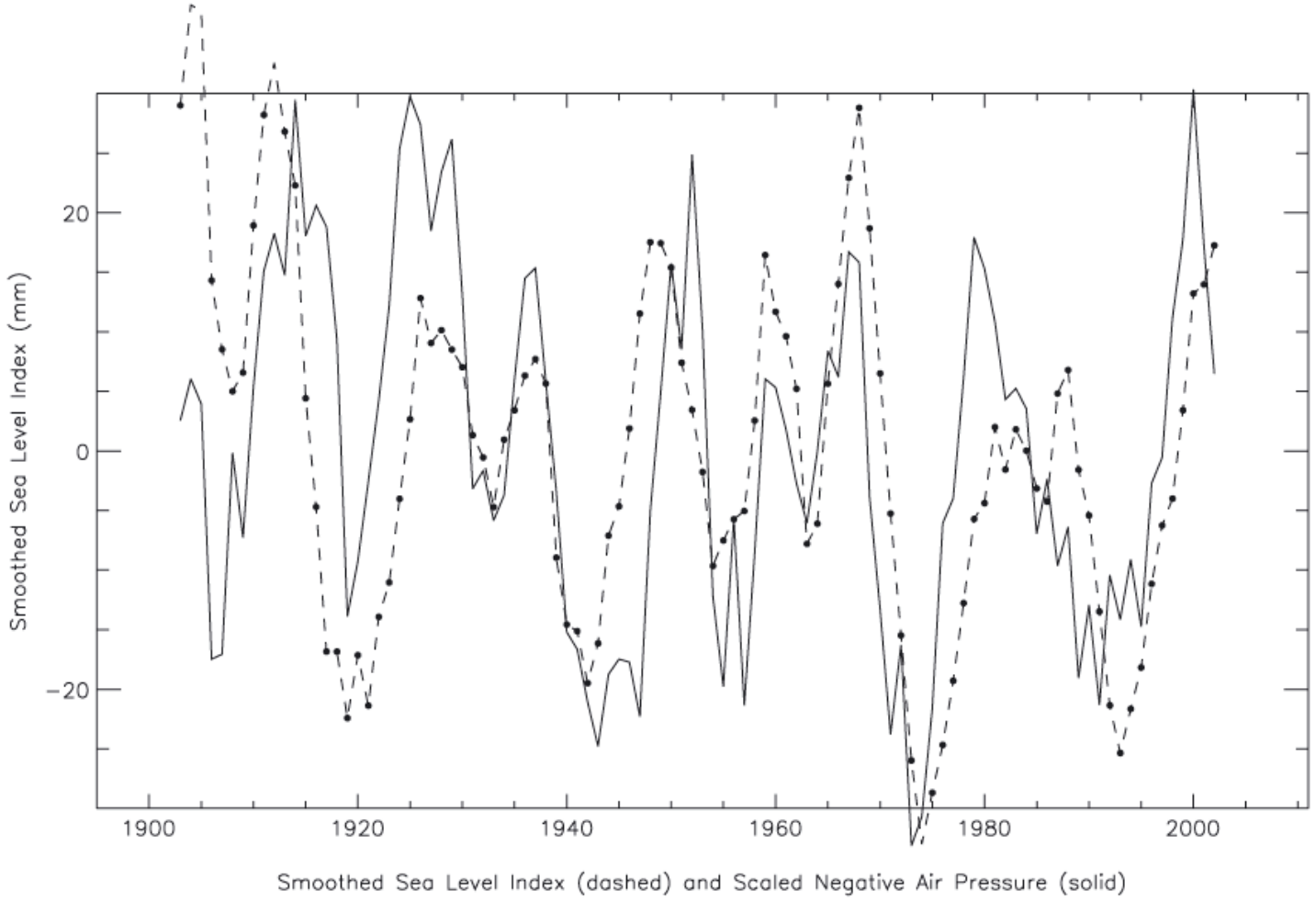
5 Long Records
(TG measured rates)

TG



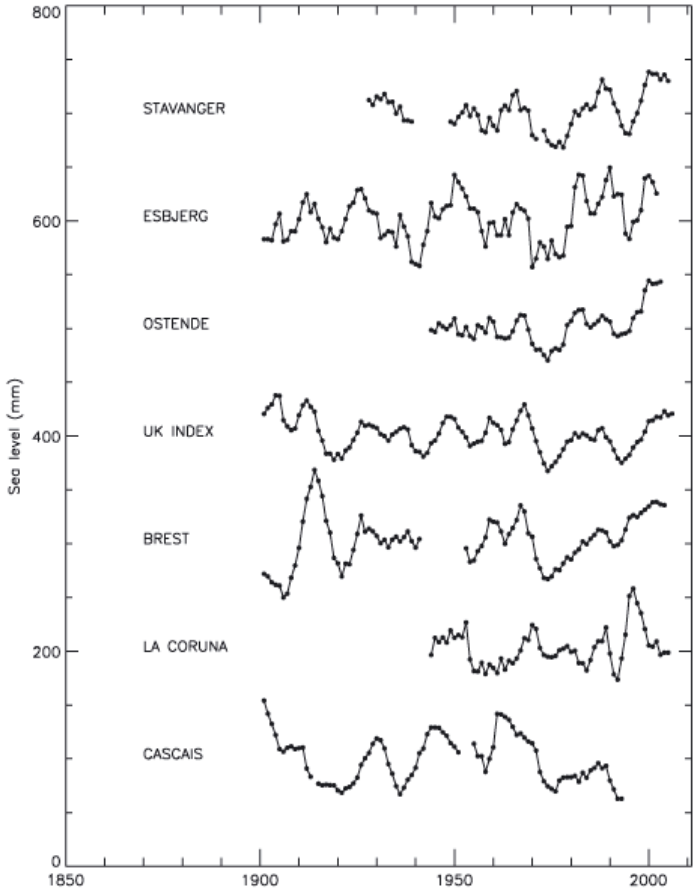
Geology

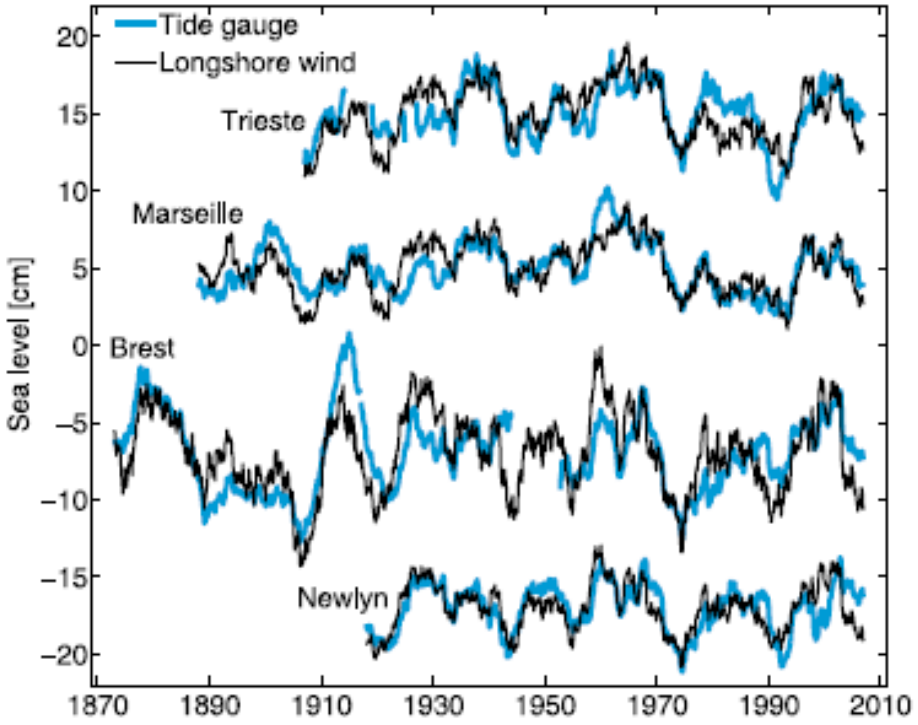
21 Short Records
(TG rates inferred by regression)



What forces the coherent variability described by the UK Sea Level Index? It is clearly related to air pressure, but differs from the inverse barometer: by a factor of ~3.

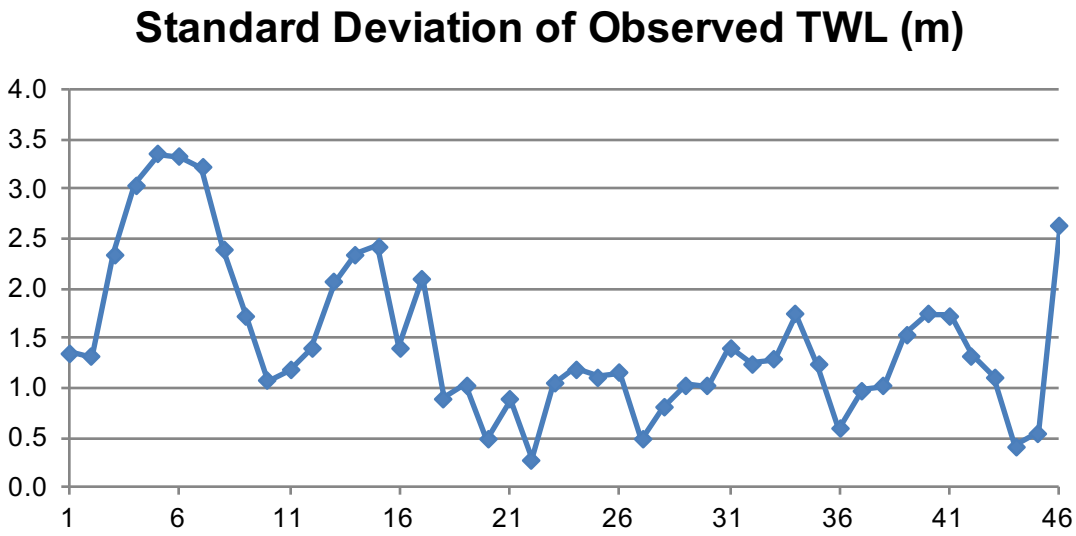
Much of the variability is coherent with that along a long stretch of the European coastline.



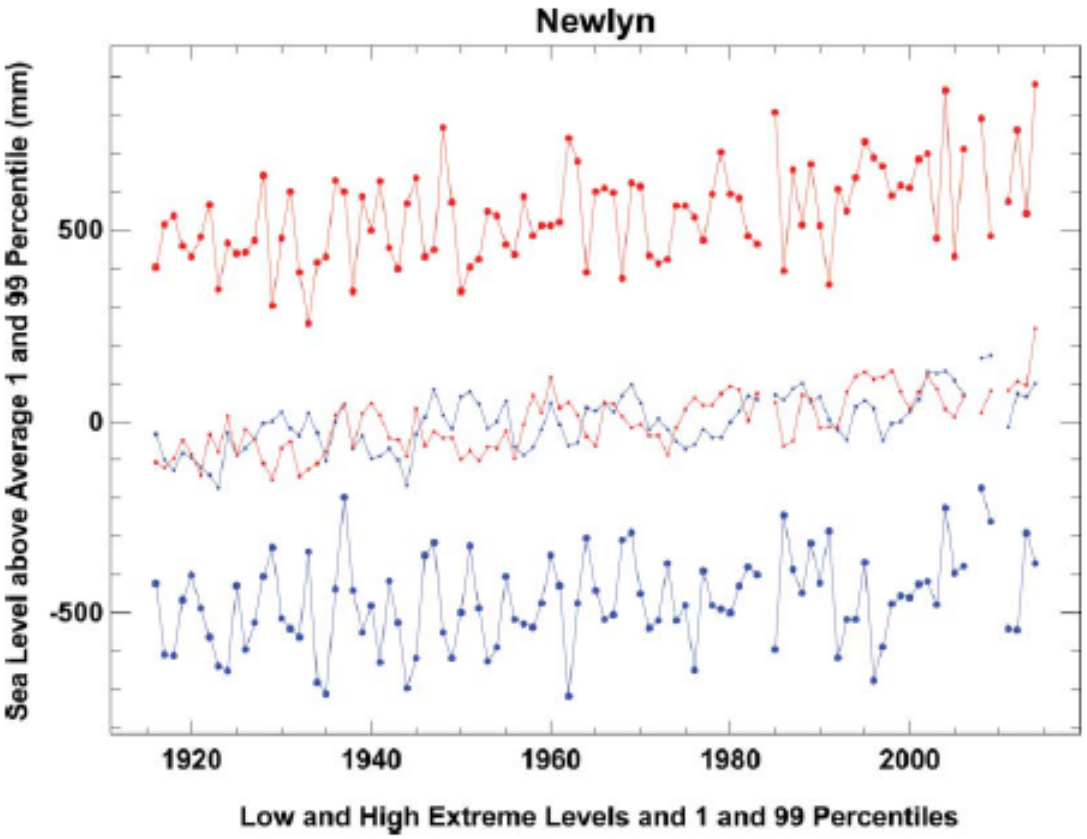


Much of the UK MSL interannual variability (for Newlyn at least) can be related to longshore flows (Calafat et al., 2012 JGR)

Higher Frequency Variability - Tides



Mean Tidal Range has been found to be increasing, though estimates differ.



MARINE GEODESY
2016, VOL. 0, NO. 0, 1–26
http://dx.doi.org/10.1080/01490419.2015.1121175

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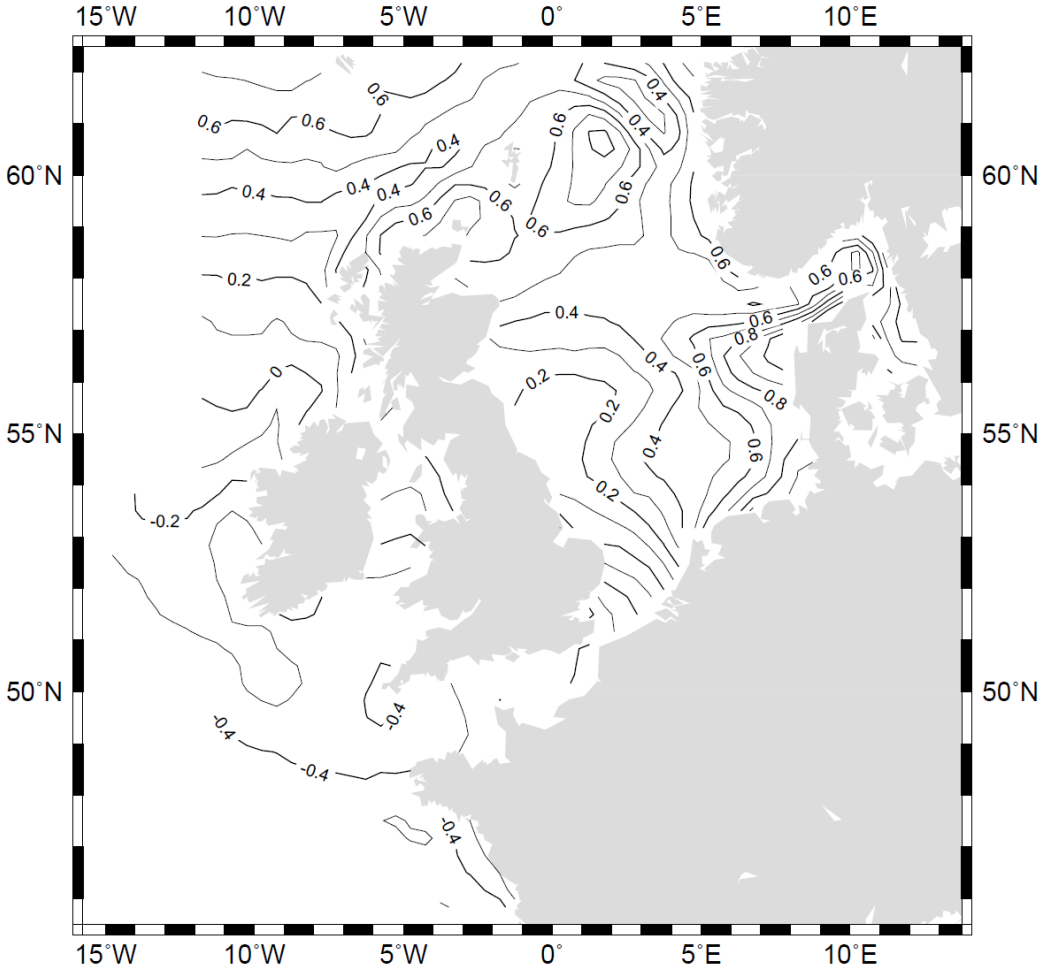
A Century of Sea Level Measurements at Newlyn, Southwest England

E. Bradshaw[a], P.L. Woodworth[b], A. Hibbert[b], L.J. Bradley[b], D.T. Pugh[b], C. Fane[c] and R.M. Bingley[d]

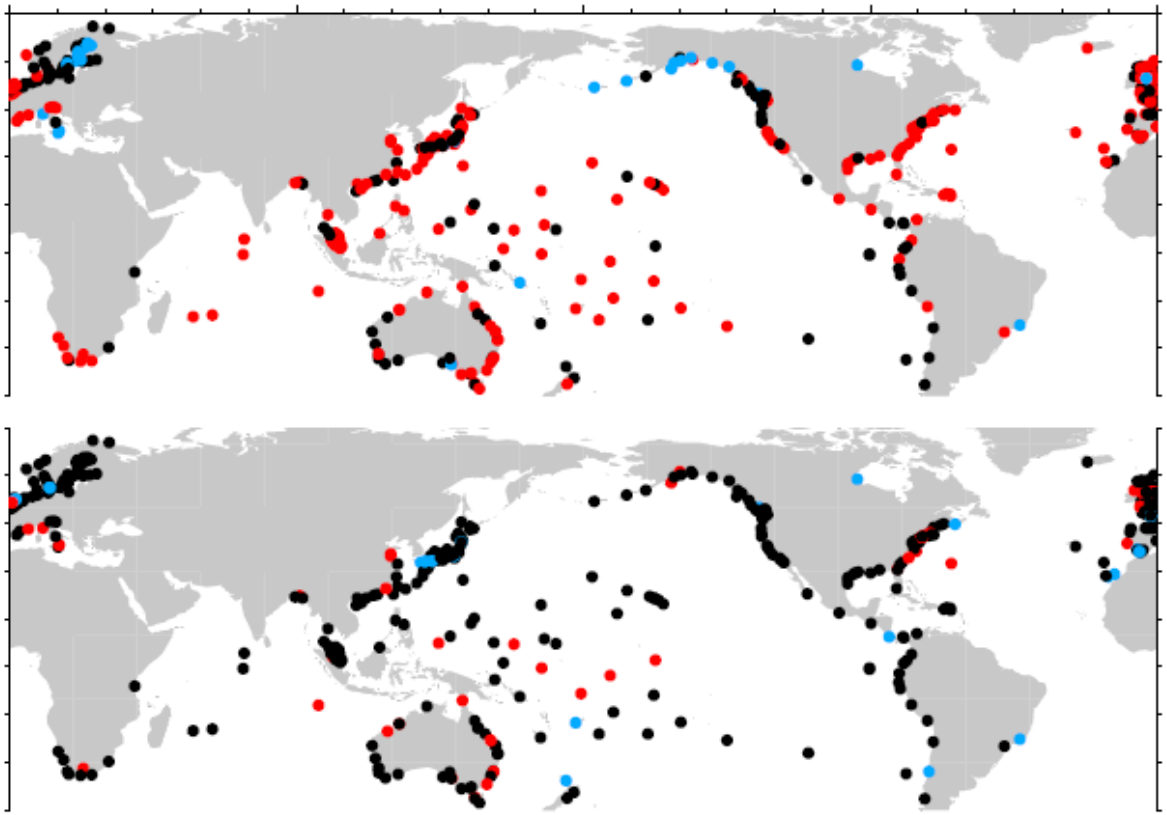
Storm Surge Variability

Storm surges contribute to MSL variability (via the Inverse Barometer Effect and winds) but, unlike in the German Bight for example, they have not contributed much to MSL trends.

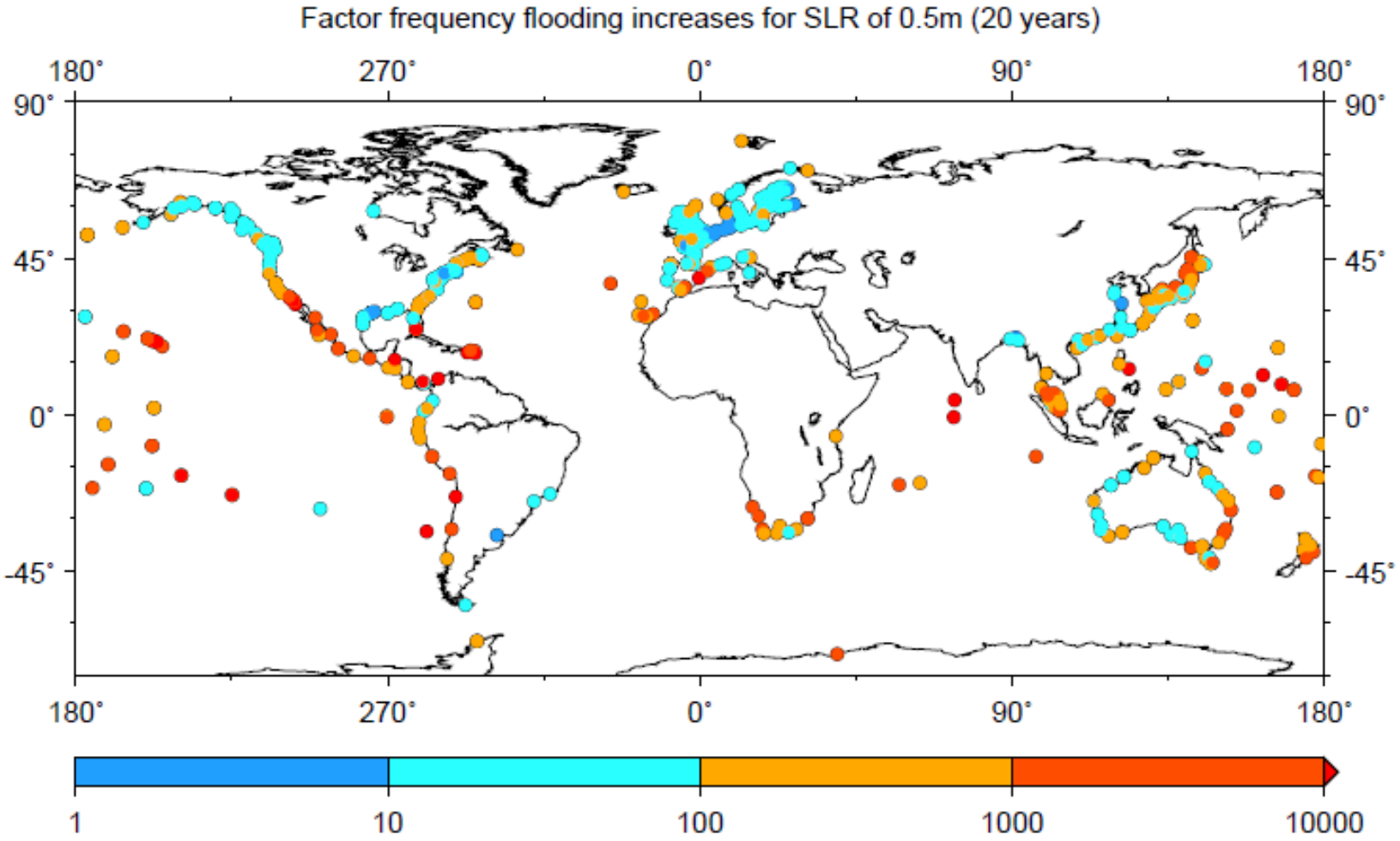
Woodworth et al. (1999) showed MSL trends from surge model for 1955-94 (mm/year)to be small around the UK.



Are changes in extreme levels related to changes in MSL?

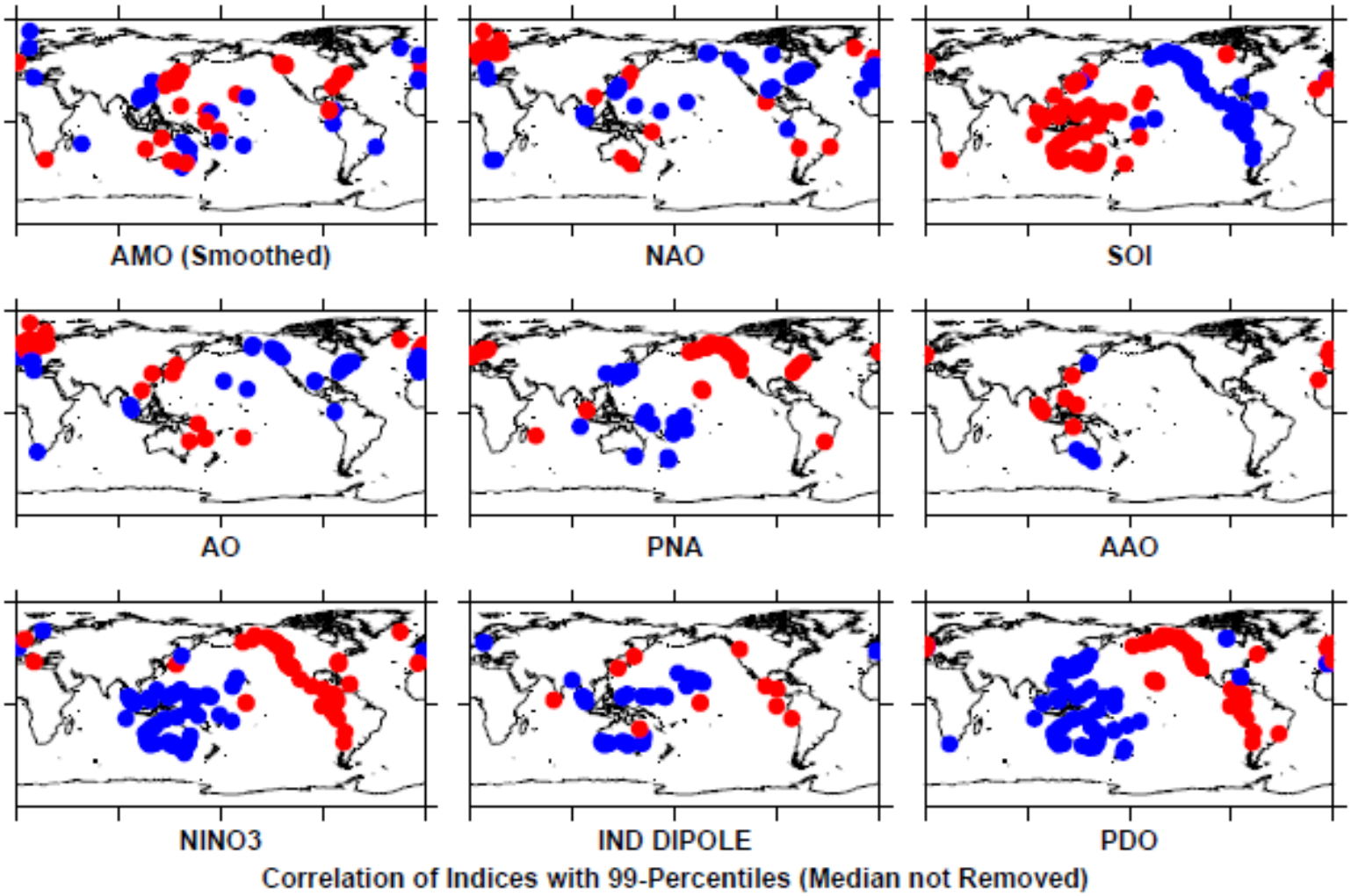


Menendez and Woodworth (2010 updated),Trends in 99-percentile sea levels for 1970-on from Global Extreme Sea Level Analysis-2 (GESLA-2) (top) as measured, (bottom) after median sea level removed each year.



The UK and NW Europe would experience a change of flood risk of ‘only’ 10-100 for a 0.5m sea level rise.

Are changes in extremes related to climate indices?



Summary

- A large part of UK sea level variability is coherent, at least regionally.
- This can be exploited to derive long term relative sea level trends (~1.4 mm/y)
- Variability is linked to atmospheric variability (pressure, winds and climate modes)
- Increased extreme levels largely due to increased MSL
- Mean Tidal Range is increasing.