

# Sea level variability in the English Channel

Isabel Araújo<sup>1</sup> and David Pugh<sup>2</sup>

[ixa@noc.soton.ac.uk](mailto:ixa@noc.soton.ac.uk)

<sup>1</sup> formerly NOCs, currently at ABPmer

<sup>2</sup> POL & Liverpool University

# Outline of work

Aim: analyse long-term sea level variations in the English channel and investigate if there is evidence of increase in storminess as a result of climate change.

by looking separately at **sea level** components:

$$z(t) = Z_0(t) + X(t) + Y(t) + XY(t) \quad (\text{Pugh \& Faull, 1983})$$

= **Mean Sea Level (MSL) + Tides + Non-tidal residual**

# *The English Channel*

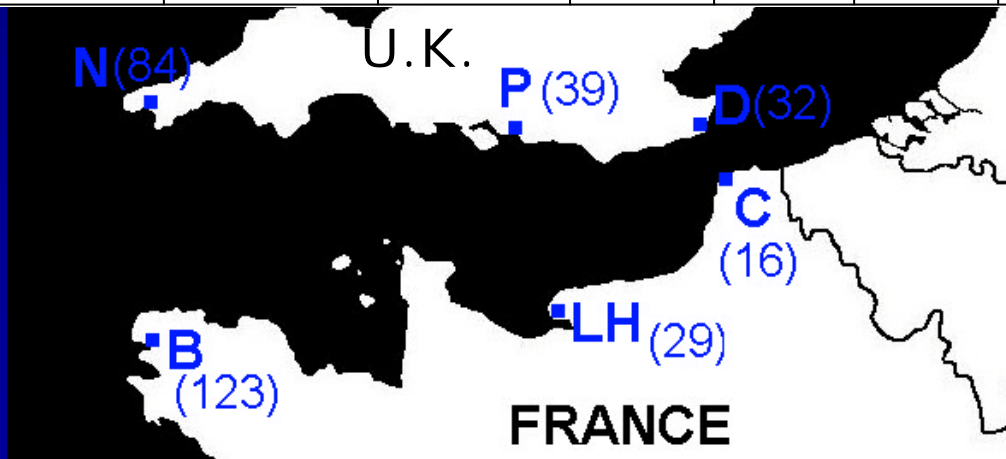


Tides: M2 dominant

Tidal range: ~ 3m for English coast and up to 11m for the French coast.

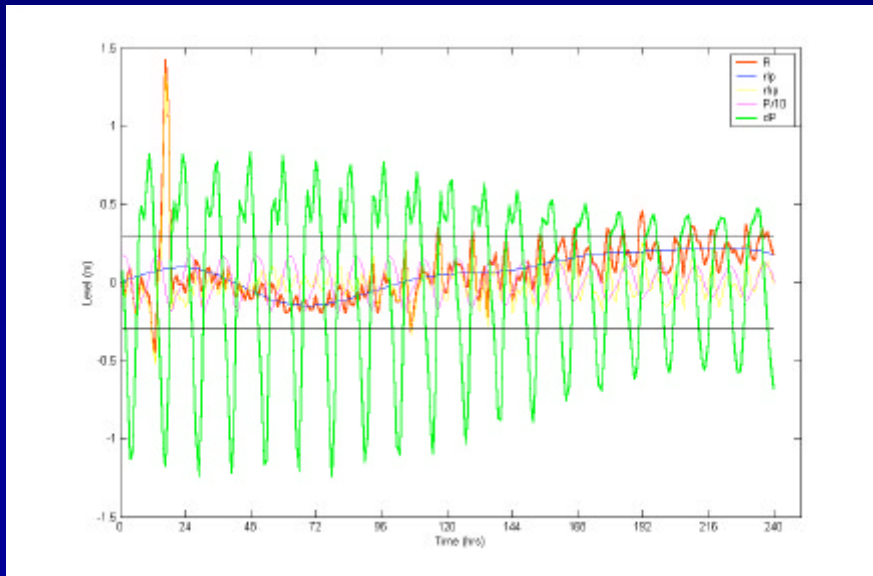
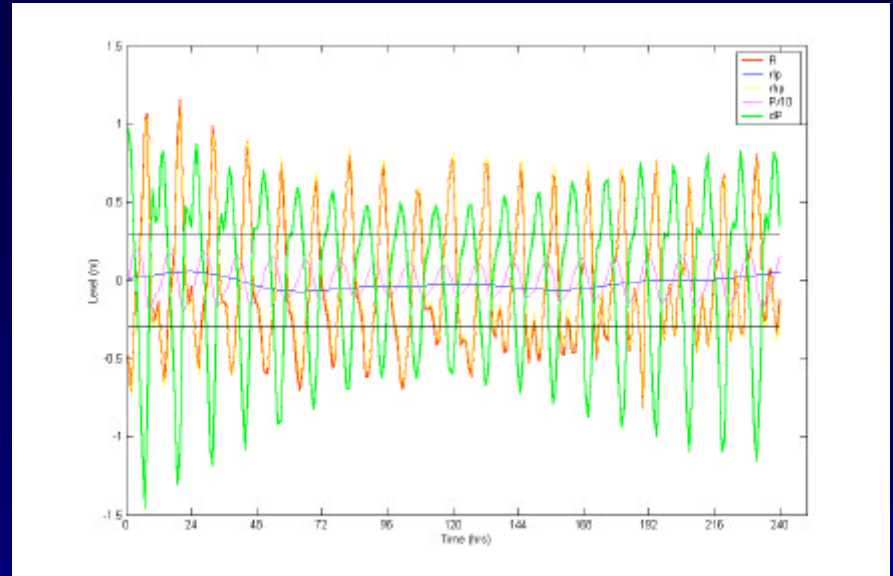
Net eastwards flow through the Strait of Dover.

Port	Coord.	Data available (years)	Data used (years)	start	end	Source
Newlyn, U.K.	50°06'N 5°32'W	85	84	1915	2000	BODC
Portsmouth, U.K.	50°48'N 1°06'W	39	39	1962	1997	ABPmer
Dover, U.K.	51°06'N 1°19'E	40	32	1961	1999	BODC
Calais, France	50°58'N 1°51'E	16	16	1965	2000	SHOM
Le Havre, France	49°29'N 0°07'W	31	29	1938	2000	SHOM
Brest, France	48°23'N 4°29'W	131	123	1862	2000	SHOM

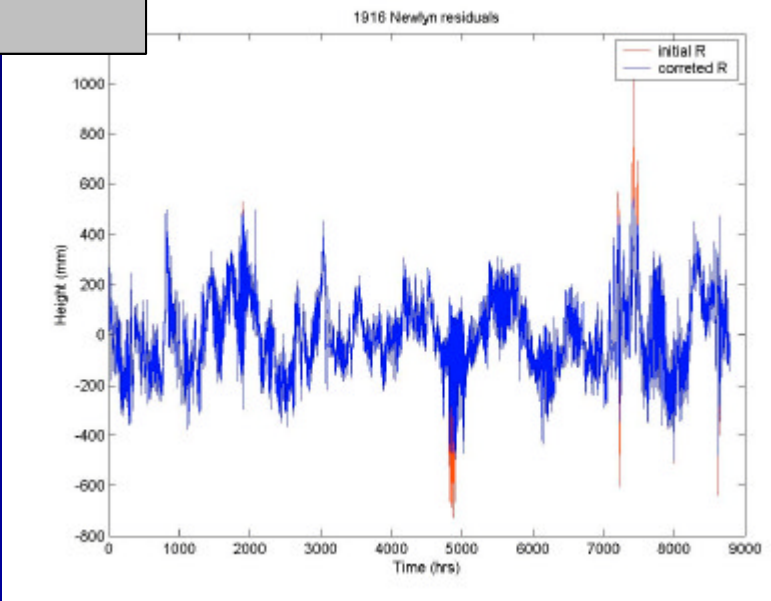
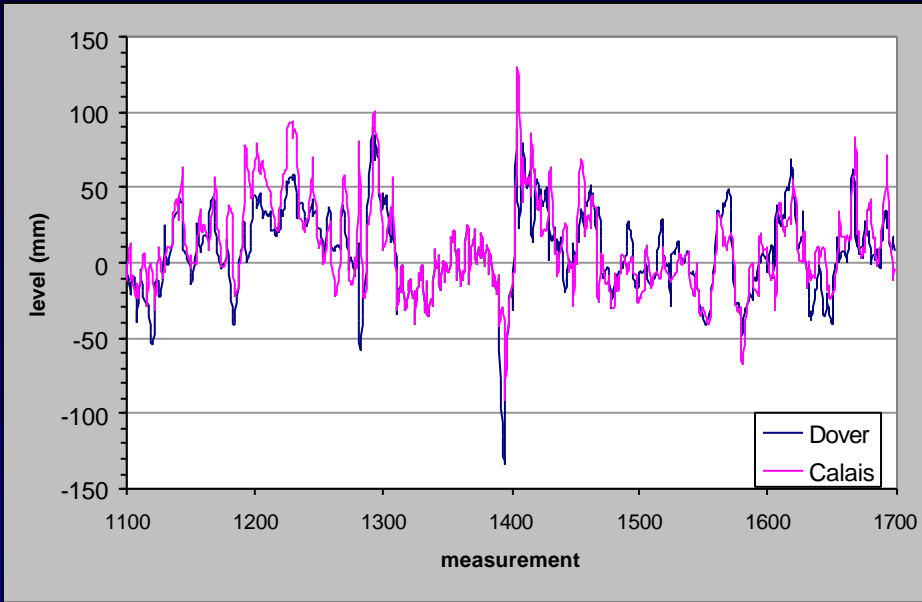


# Editing procedure

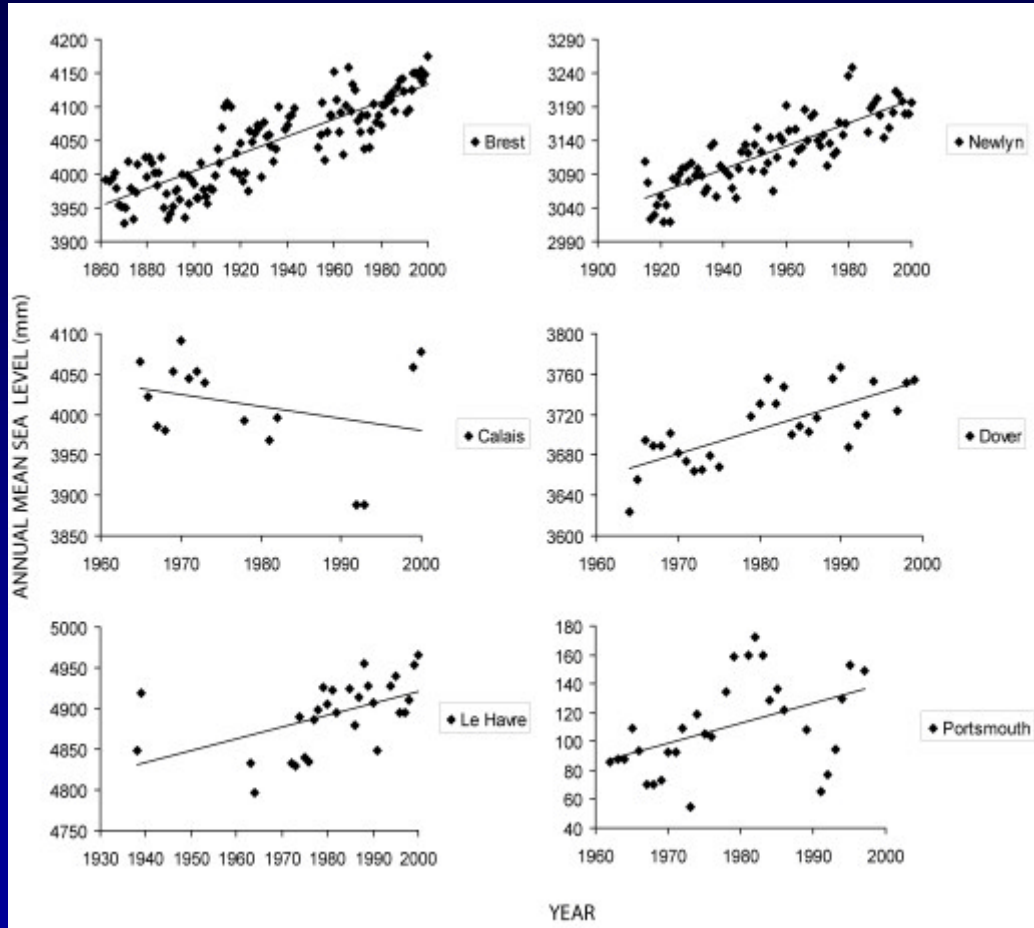
Careful editing was carried out to remove worst effects of timing errors, well blockages and general mistakes in data processing.



- R residual level
- rlp Low pass filter
- rhp High pass filter
- P/10 predicted level
- dp

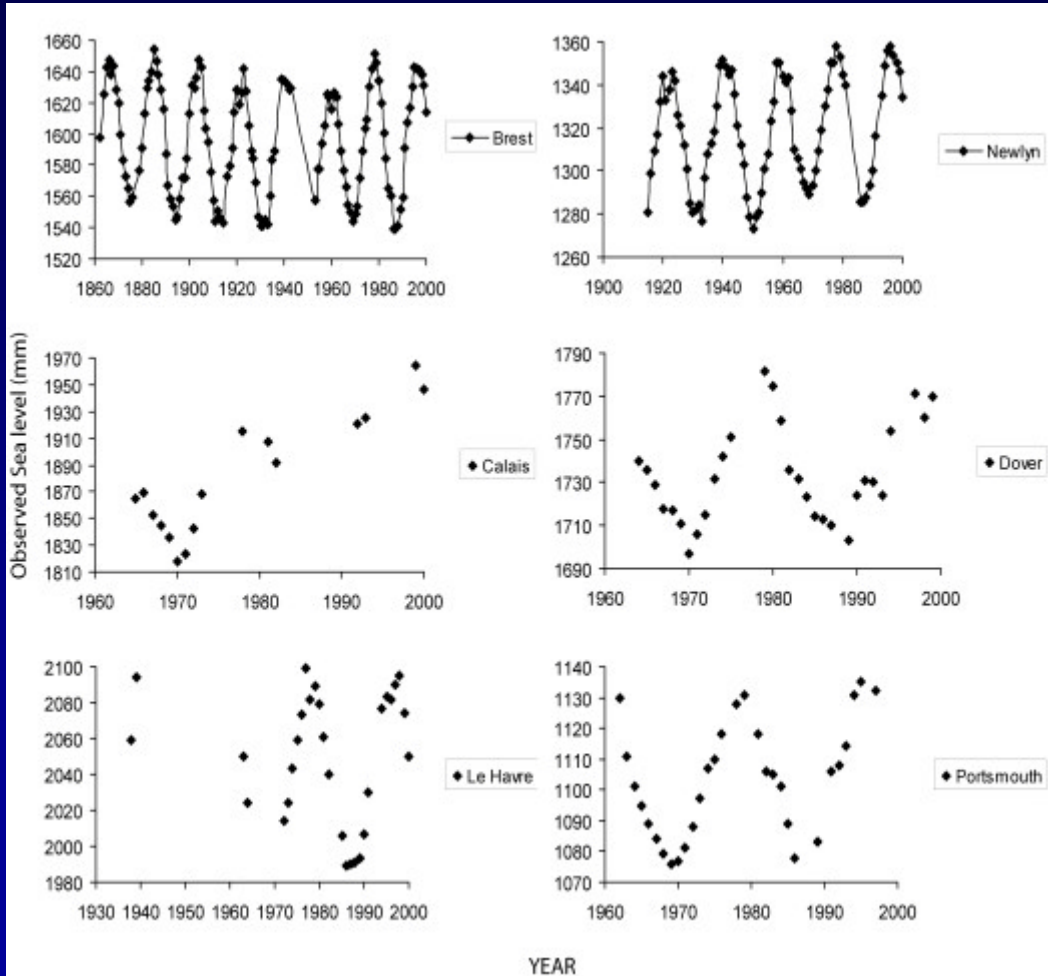


# Annual mean sea level



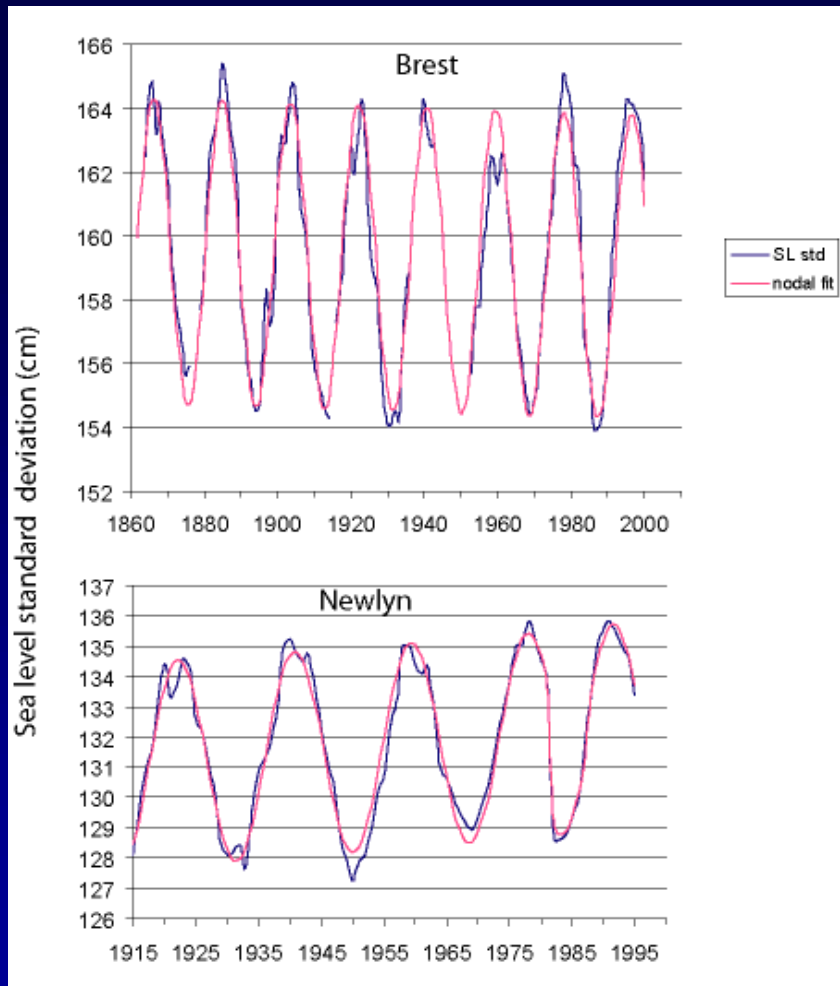
	Trend (mm/yr)	Standard error
<b>Brest</b>	<b>1.29</b>	<b>0.07</b>
<b>Newlyn</b>	<b>1.73</b>	<b>0.13</b>
<b>Calais</b>	<b>-1.48</b>	<b>1.30</b>
<b>Dover</b>	<b>2.44</b>	<b>0.42</b>
<b>Le Havre</b>	<b>1.44</b>	<b>0.47</b>
<b>Portsmouth</b>	<b>1.37</b>	<b>0.52</b>

# Observed Sea Level standard deviations



	Trend (mm/yr)	Standard error
Brest	-0.04	0.08
Newlyn	0.24	0.11
Calais	3.32	0.46
Dover	0.68	0.38
Le Havre	-0.16	0.51
Portsmouth	0.63	0.32



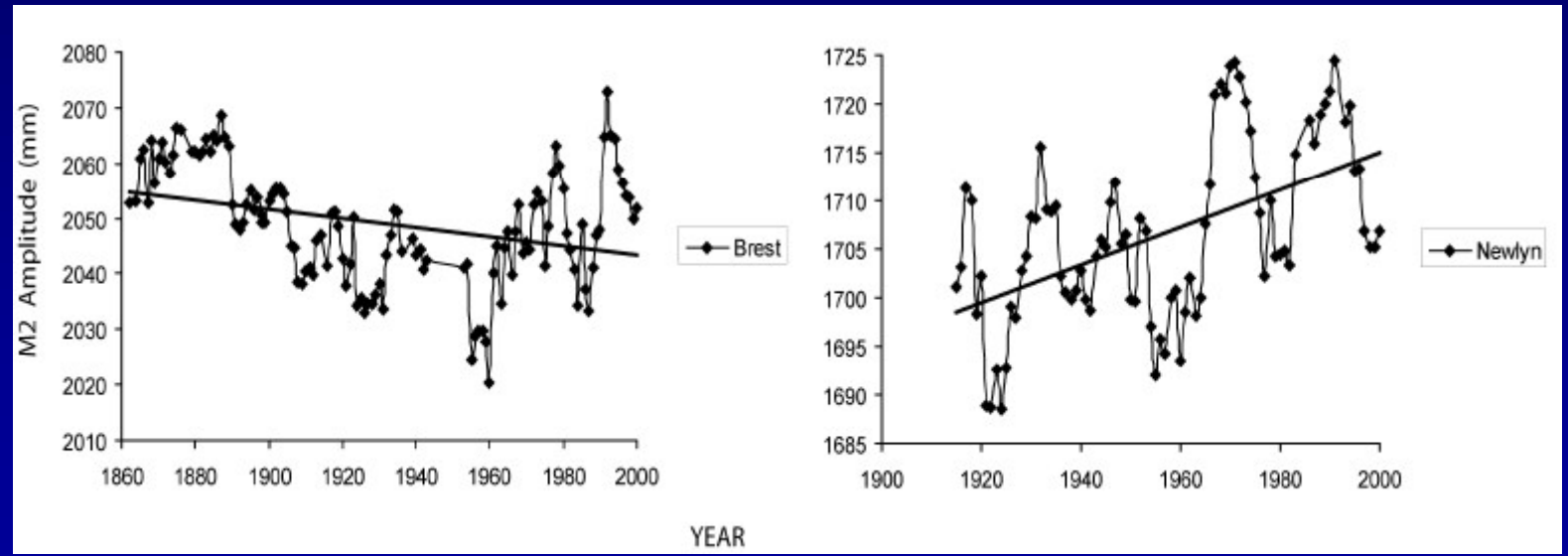


**18.6-year nodal fit to total observed sea level standard deviation results, for Brest and Newlyn.** There is an upward trend in the Newlyn nodal fit, whilst Brest has a very small downward trend.

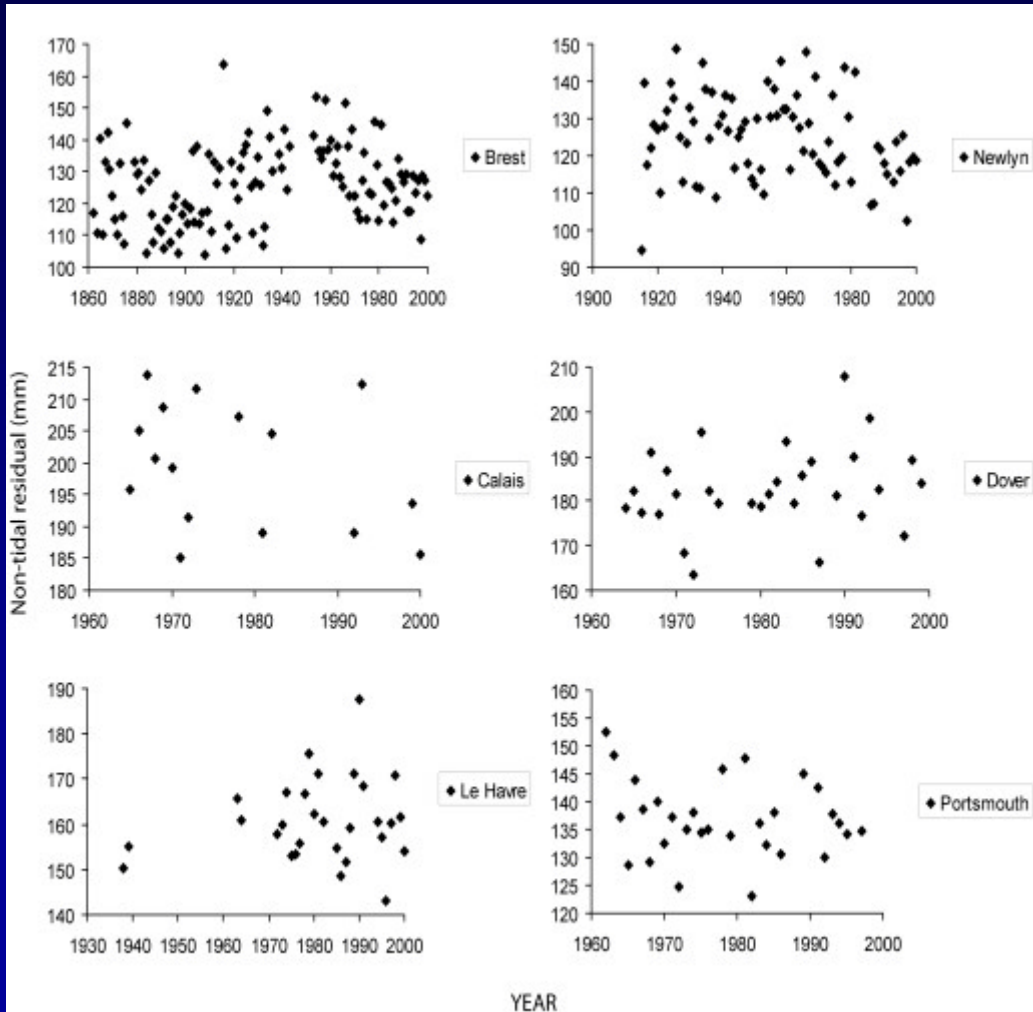
# Tides:

## M2 Amplitude

	Trend (mm/yr)	Standard error
Brest	-0.08	0.02
Newlyn	0.20	0.04
Calais	1.50	0.44
Dover	-0.93	0.29
Le Havre	0.11	0.14
Portsmouth	0.21	0.13

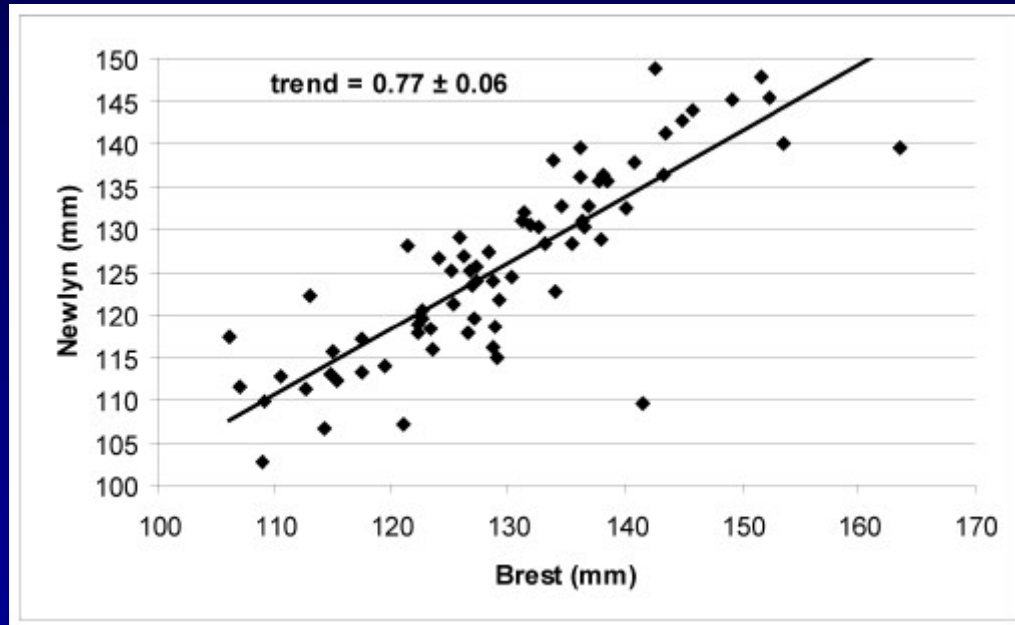


# Non-tidal residuals



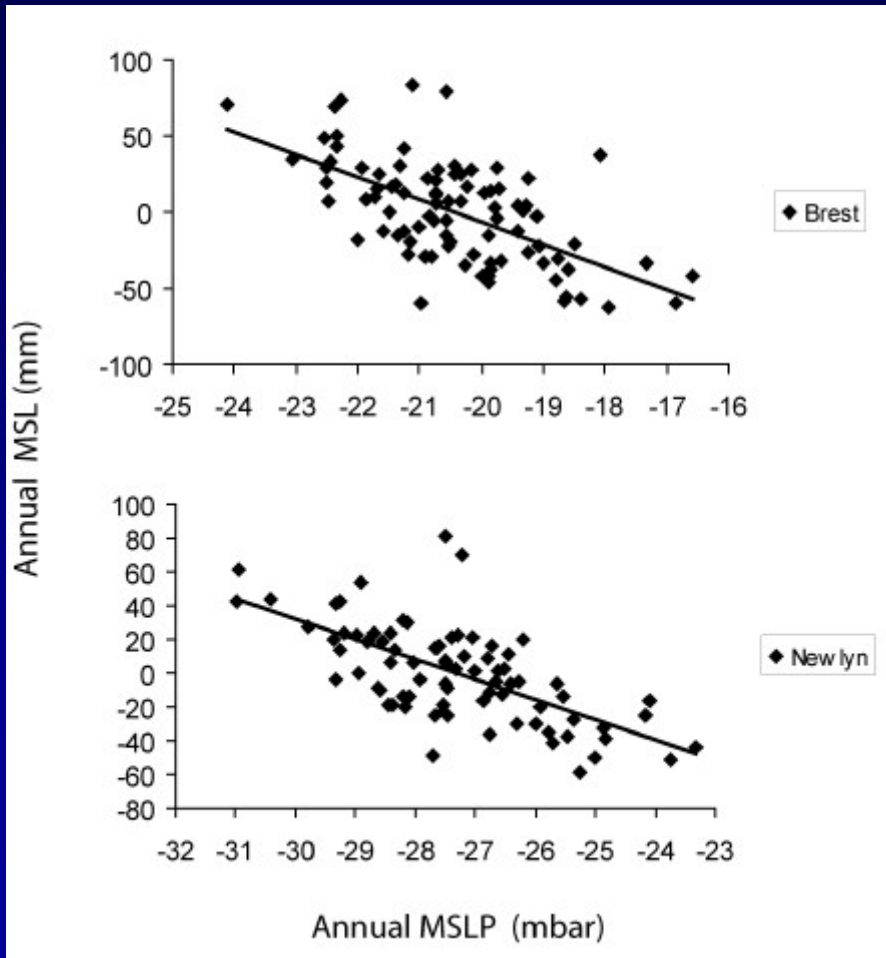
	Trend (mm/yr)	Standard error
<b>Brest</b>	<b>0.06</b>	<b>0.03</b>
<b>Newlyn</b>	<b>-0.11</b>	<b>0.05</b>
<b>Calais</b>	<b>-0.26</b>	<b>0.21</b>
<b>Dover</b>	<b>0.20</b>	<b>0.16</b>
<b>Le Havre</b>	<b>0.14</b>	<b>0.10</b>
<b>Portsmouth</b>	<b>-0.13</b>	<b>0.12</b>

## Correlation between annual residual standard deviation at Brest and Newlyn

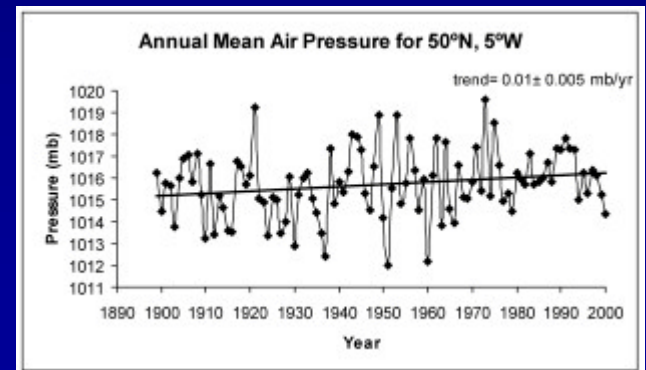


Good correlation illustrates significance of residual sea levels after careful editing.

# Correlation between annual MSL and annual MSLP



	Trend (mm/yr)	Standard error
Brest	-14.16	2.07
Newlyn	-11.67	1.48
Calais	-17.28	11.46
Dover	-8.47	3.40
Le Havre	-15.03	5.59
Portsmouth	-10.50	3.93



## Sea level components and the NAO index

	<b>MSL vs. NAO</b> (mm/unit NAO index)	<b>Detrended SL vs. NAO</b> (mm/unit NAO index)	<b>NTRstd vs. NAO</b> (mm/unit NAO index)	<b>Winter NTRstd vs. winter NAO</b> (mm/unit winter NAO)
<b>Brest</b>	<b>-21.4 ± 11.7</b>	<b>-12.1 ± 6.2</b>	<b>-1.6 ± 2.4</b>	<b>0.4 ± 1.0</b>
<b>Newlyn</b>	<b>-25.5 ± 12.2</b>	<b>-20.9 ± 6.5</b>	<b>-1.3 ± 2.6</b>	<b>-0.9 ± 1.2</b>
<b>Calais</b>	<b>-64.2 ± 31.8</b>	<b>-47.6 ± 32.2</b>	<b>1.7 ± 5.8</b>	<b>6.0 ± 2.3</b>
<b>Dover</b>	<b>21.8 ± 13.7</b>	<b>2.4 ± 9.6</b>	<b>9.4 ± 3.3</b>	<b>2.4 ± 1.4</b>
<b>Le Havre</b>	<b>-9.6 ± 17.1</b>	<b>-5.7 ± 14.8</b>	<b>7.5 ± 3.0</b>	<b>-0.5 ± 2.1</b>
<b>Portsmouth</b>	<b>7.0 ± 14.3</b>	<b>-4.3 ± 12.7</b>	<b>-3.2 ± 3.0</b>	<b>1.7 ± 1.6</b>

# Conclusions

- **Work confirms a general rise in MSL in the English Channel.**
- **No long-term regional trends were found either in tides or in sea level residuals related to storms.**
- **Substantial inter-annual variability is present in all records.**

- **Inverted barometer effect (annual) is observed at all stations, with a slight enhancement at Newlyn and Brest.**
- **Correlation of non-tidal residual with NAO index values proved weak.**
- **Continuous improvement and investment in monitoring of parameters involved in sea level changes is essential.**



# Acknowledgements



We are grateful to generations of tide gauge operators and staff who made the data available.