



# Sea Level SpaceWatch Phase 2

## Product analysis and validation

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Oceanography Centre**

NATURAL ENVIRONMENT RESEARCH COUNCIL

## Aim

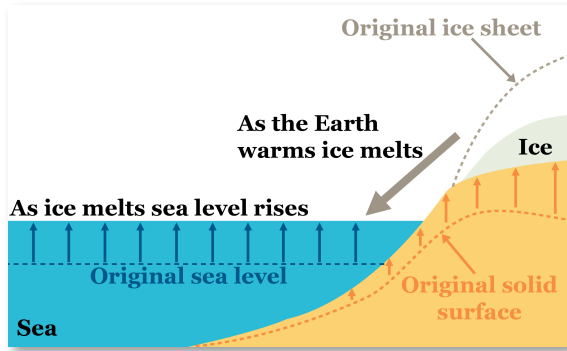
- To assess the **performance** of the new **coastal satellite altimetry** product based on ALES around the UK coast.
- To characterize the **annual cycle** of sea level and the **inter-annual variability**.

**Assessment:** comparison against tide gauge observations along the UK coast decomposing sea level into their different temporal components over the period 2002-2015:

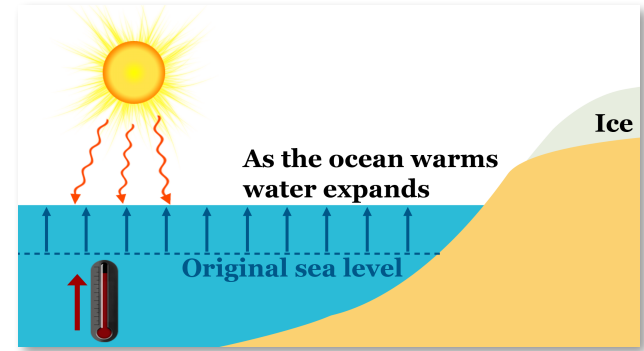
- Seasonal cycle
- Inter-annual variability

# What causes the coastal sea level to change?

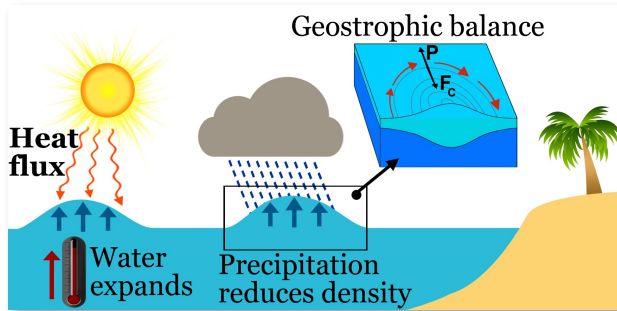
**Global mean sea level (GMSL)** changes are the result of:



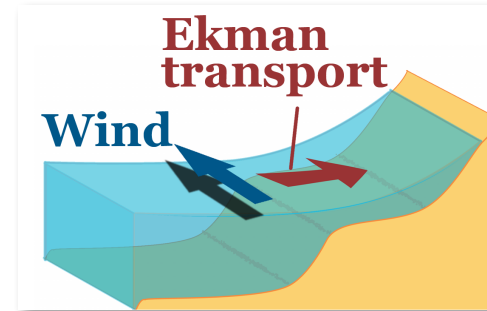
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**Regional sea level changes** are the result of **GMSL** plus:



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# Bayesian regression

Regression model with auto-correlated errors:

$$y_t = \mathbf{x}_t^\top \boldsymbol{\beta} + r_t \quad (1)$$

$$r_t = \rho r_{t-1} + e_t, \quad e_t \sim \mathcal{N}(0, \sigma_e^2) \quad (2)$$

By substituting (2) in (1):

$$y_t - \rho y_{t-1} = \mathbf{x}_t^\top \boldsymbol{\beta} - \mathbf{x}_{t-1}^\top \boldsymbol{\beta} \rho + e_t \quad (3)$$

$\theta$  : unknown parameters

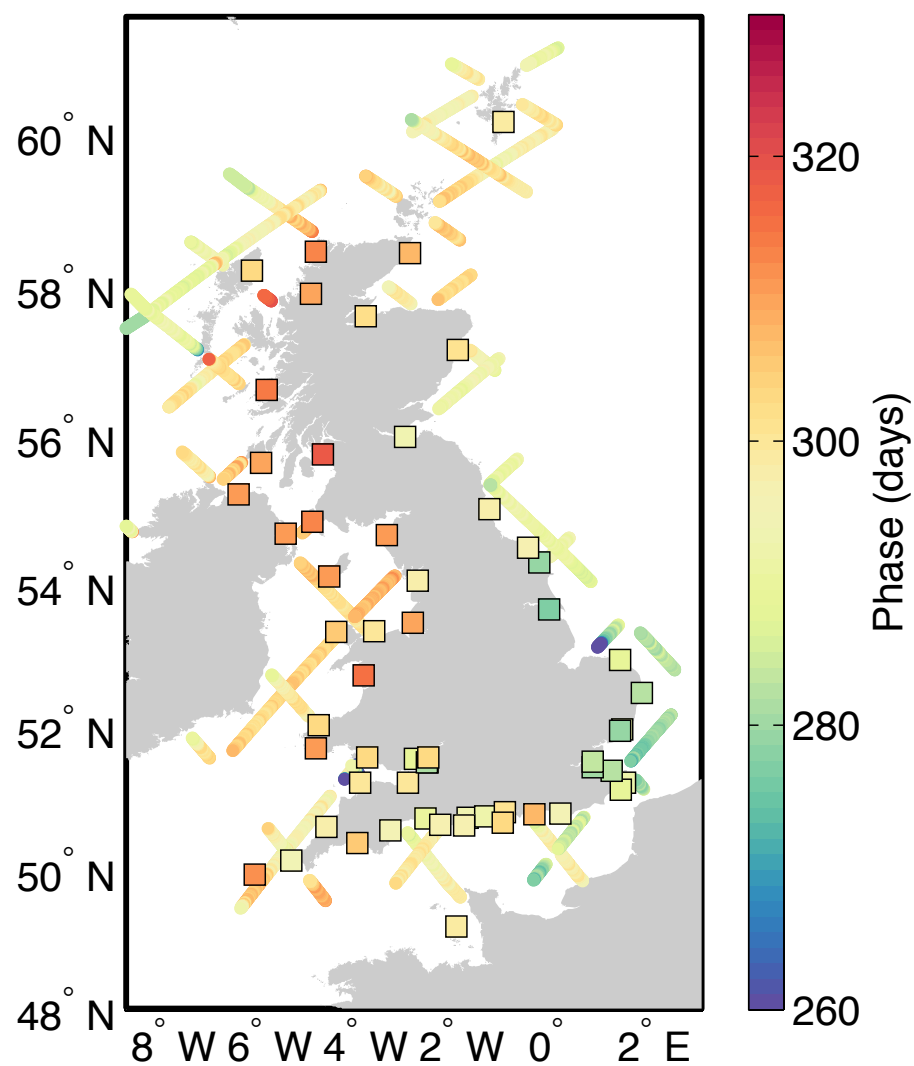
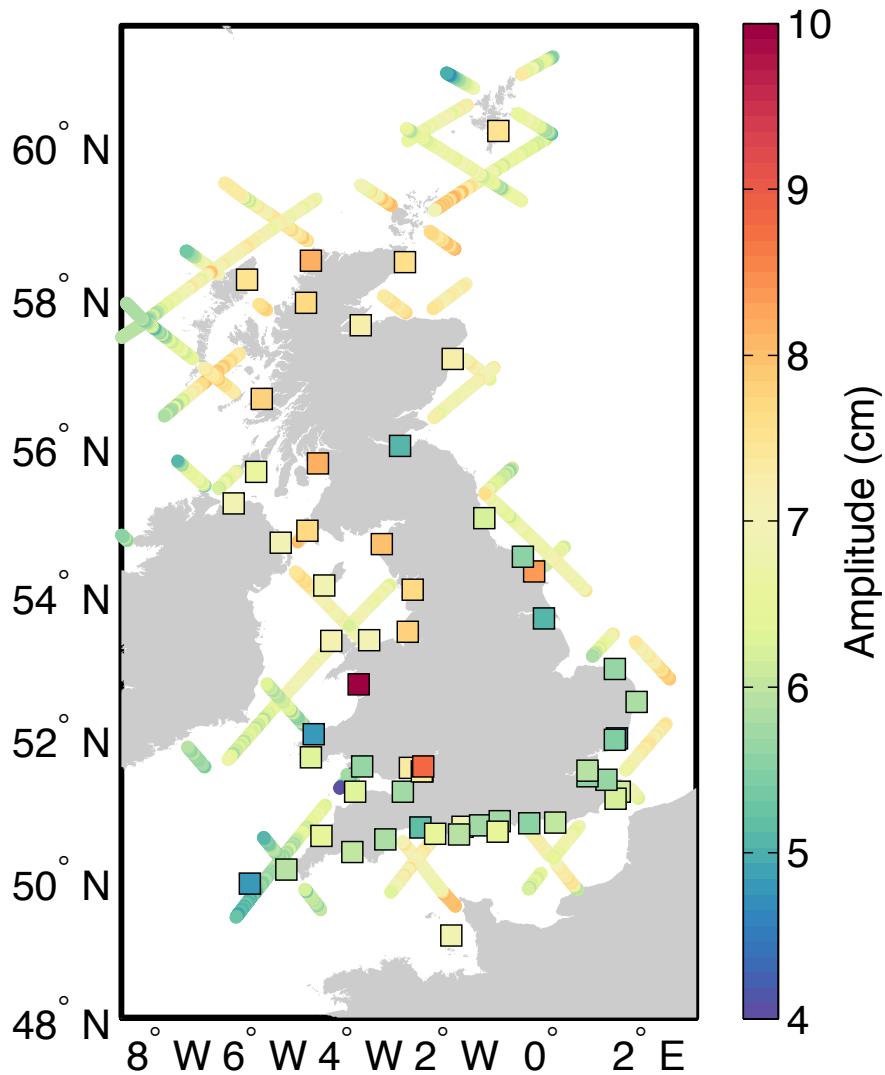
**Our goal is to compute the posterior  $p(\theta | y_{1:T})$**

Samples can be obtained via **Gibbs sampling**

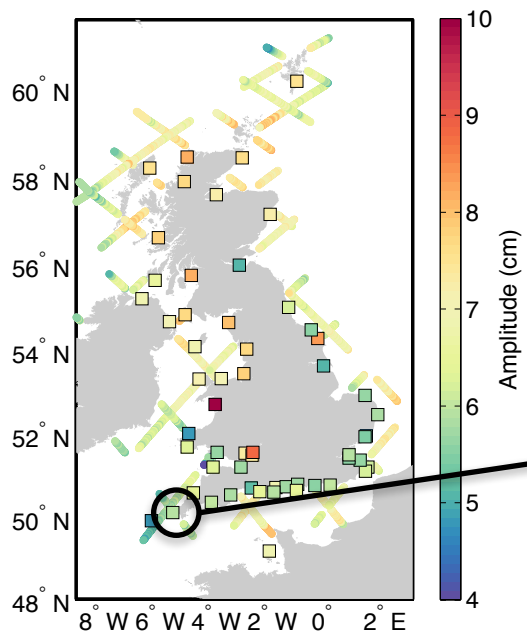
# Annual amplitude and phase for the period 2002-2015

## Annual amplitude

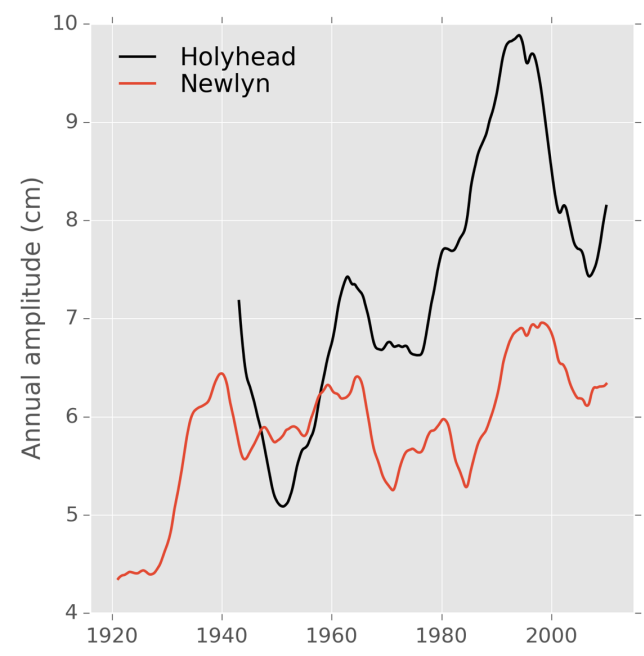
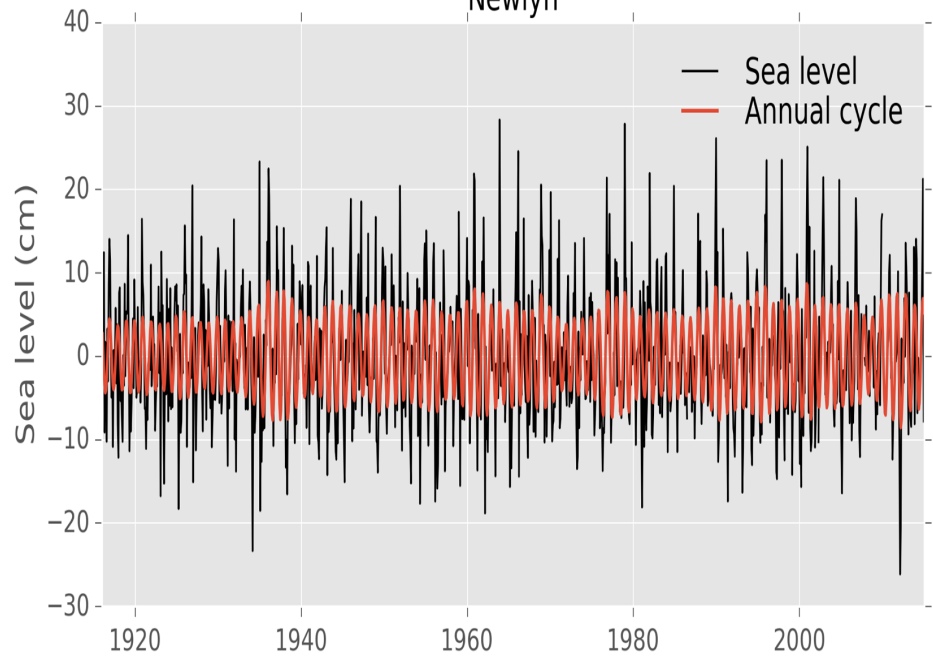
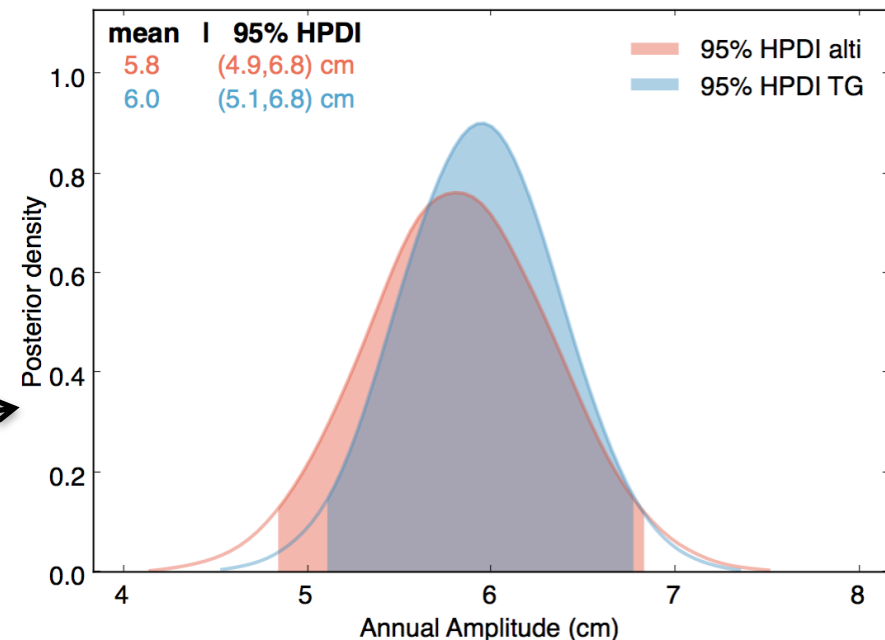
## Annual phase



# Annual amplitude and phase for the period 2002-2015



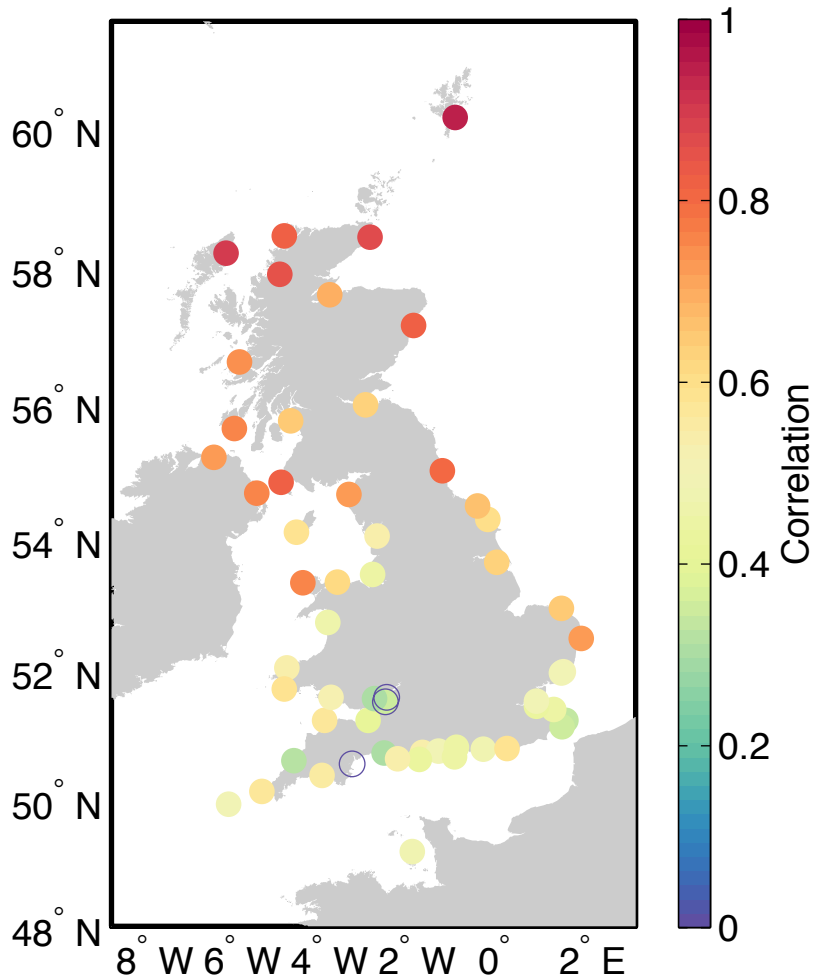
Newlyn



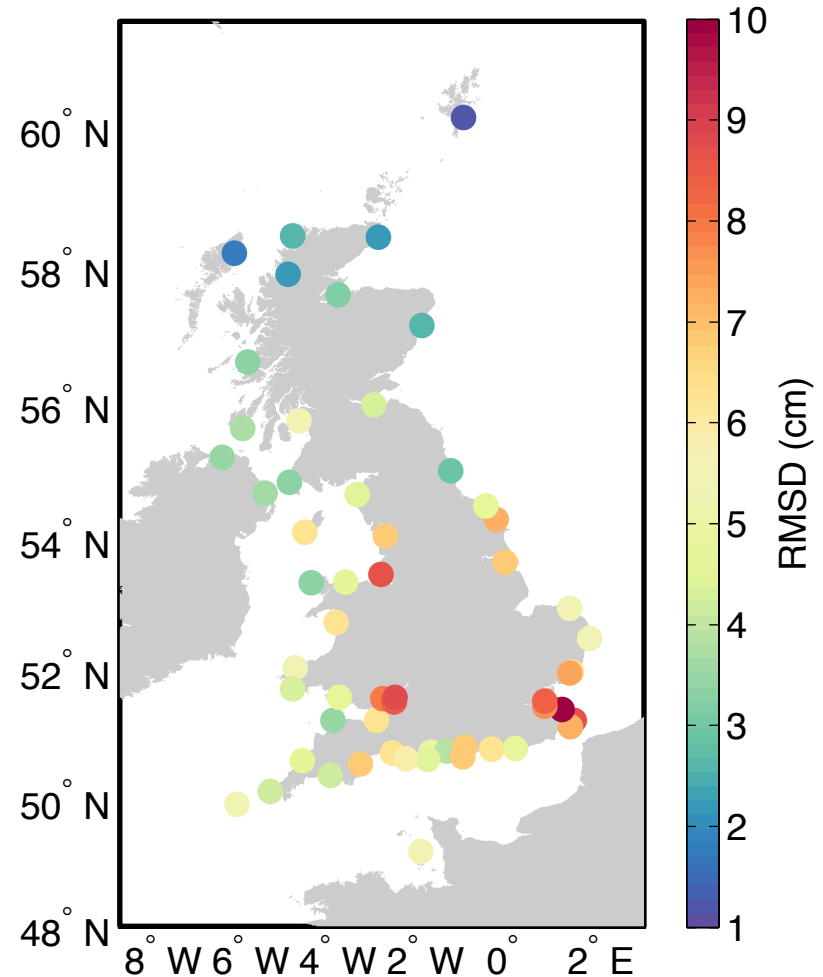
# Intra-annual variability

## Comparison of altimetry and tide gauges over 2002-2015

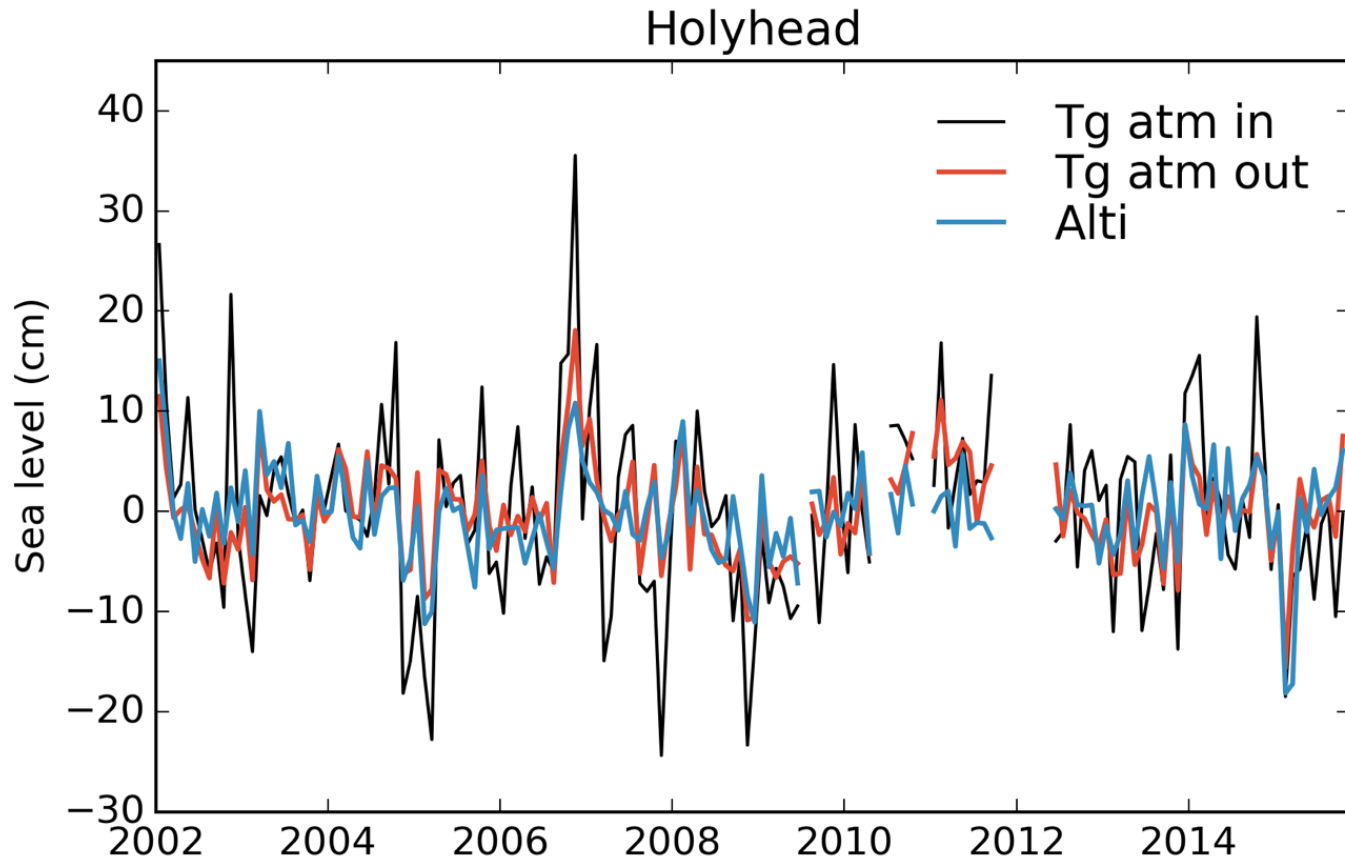
### Correlation



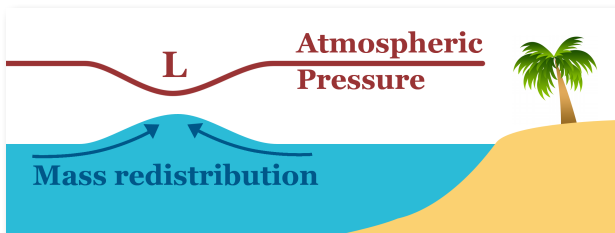
### RMSD



# Intra-annual variability



## Inverse barometer



## Correlation

Atm in 0.57

Atm out 0.75

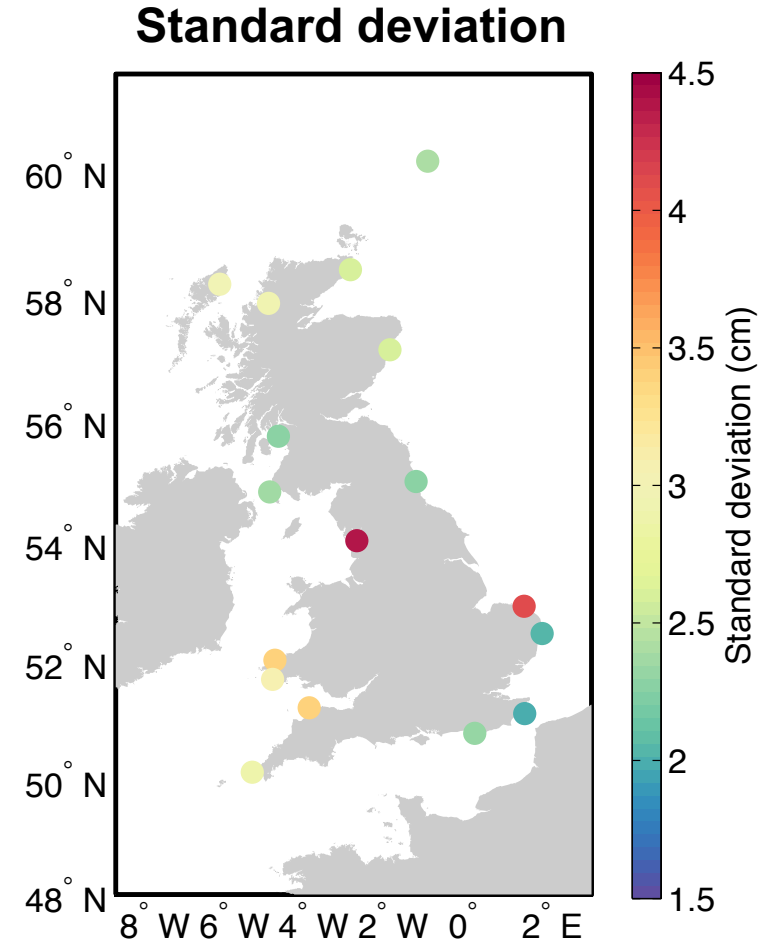
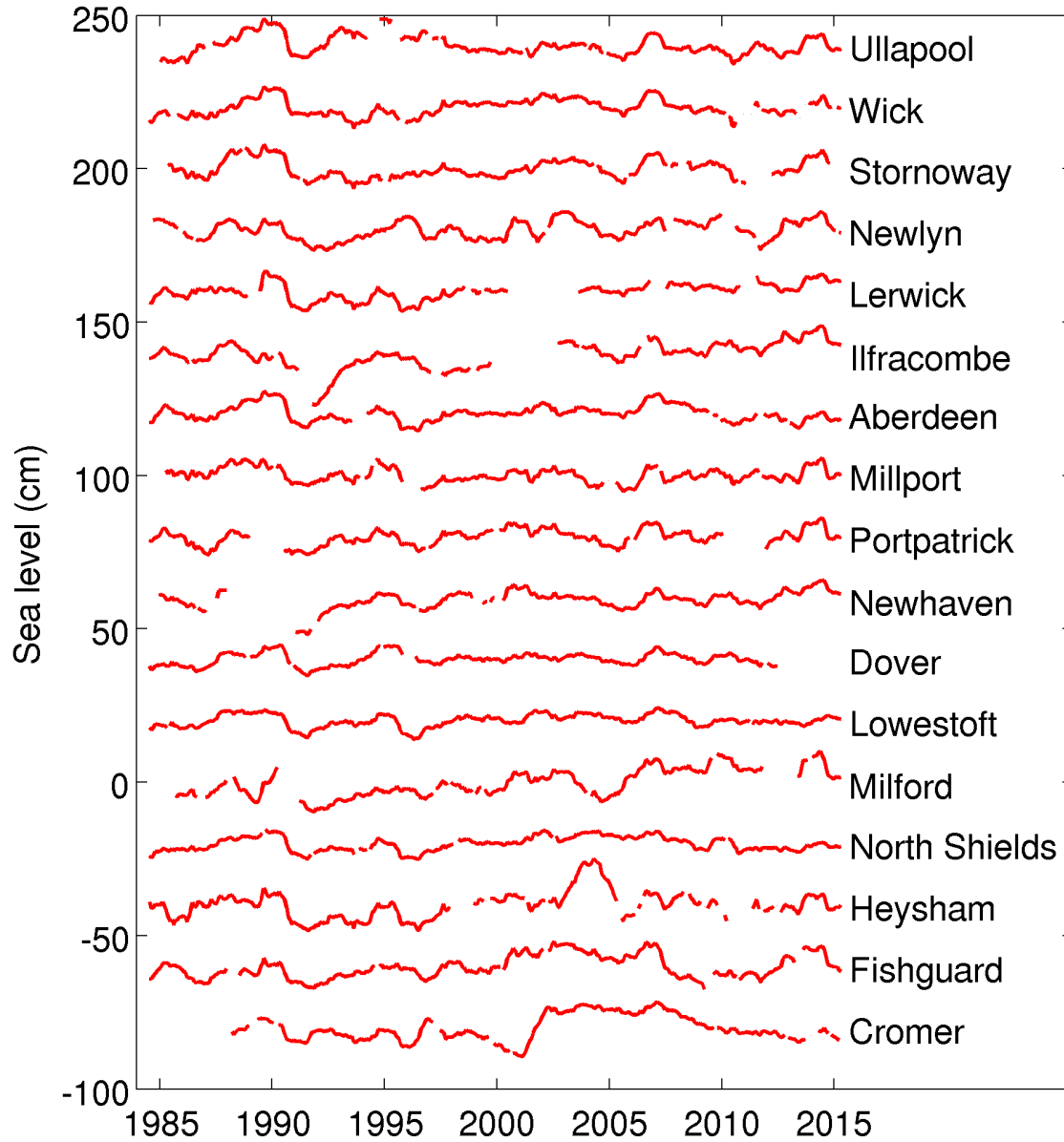
## RMSD

Atm in 7.7 cm

Atm out 3.3 cm



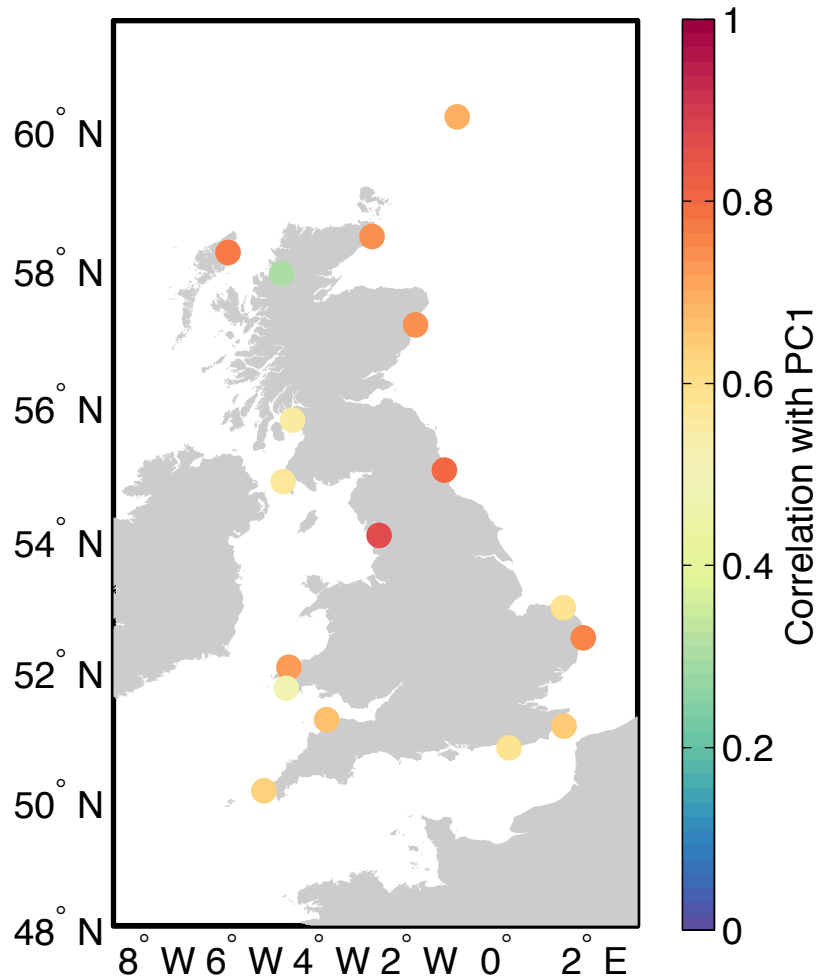
# Interannual variability from tide gauges for 1984-2015



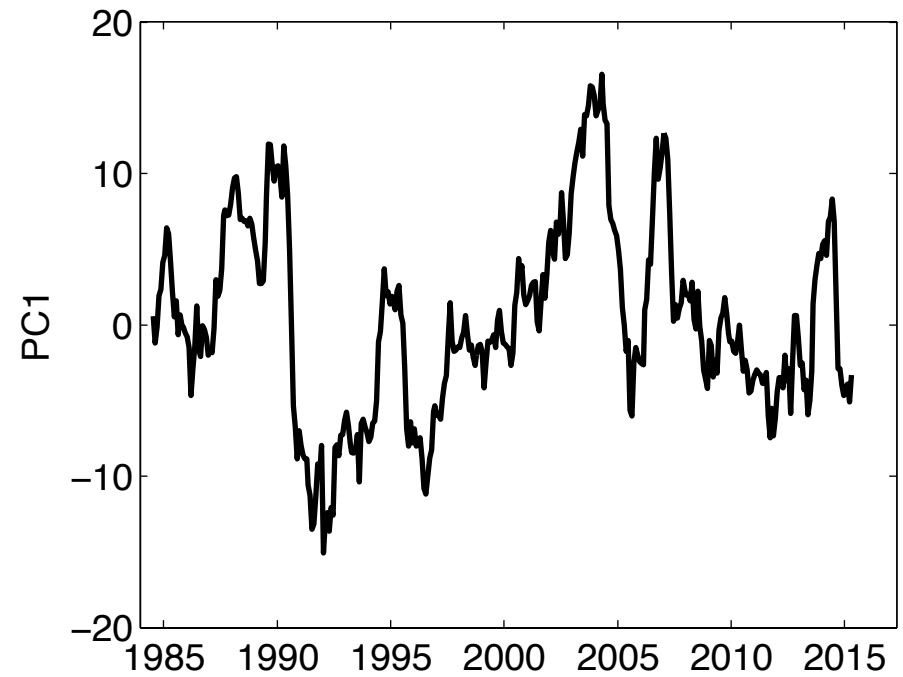
# Interannual variability from tide gauges for 1984-2015

**EOF1 explains 52% of the variance**

**Correlation with time series of EOF1**

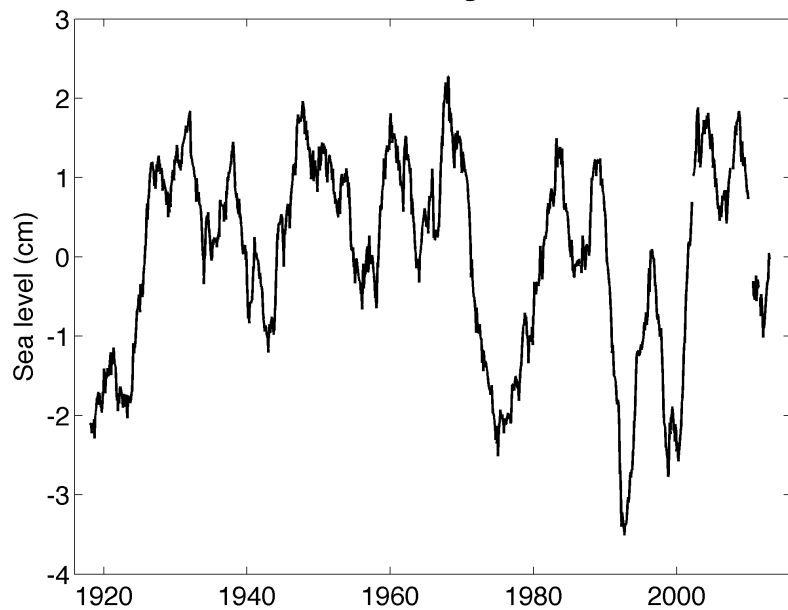


**Time series of EOF1**

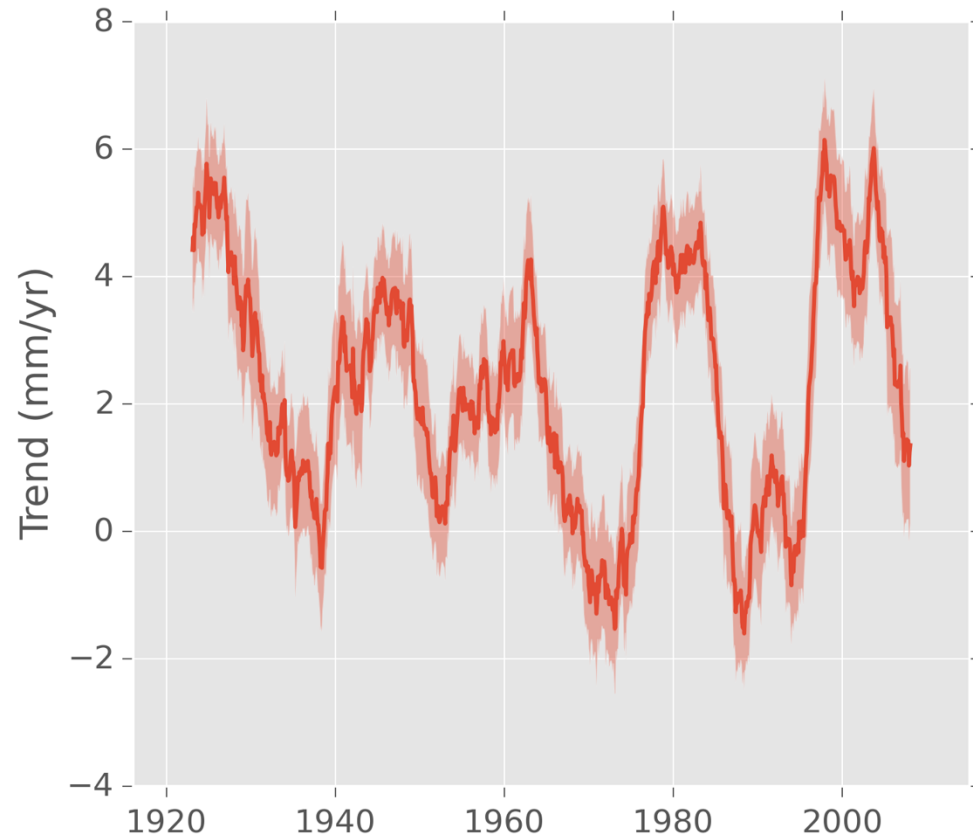


# Effect of interannual variability on trends

## Low-pass filtered IB-corrected sea level at Newlyn



## Overlapping 14-year trends



## Conclusions and remarks

- Estimates of the **amplitude** and **phase** of the annual cycle from altimetry and the tide gauges are **consistent** at most stations.
- The **annual cycle** peaks between early October in the south-east and early November in the west coast and has an amplitude ranging from 5 to 9 cm.
- There is **good agreement** between the detrended deseasoned sea level from altimetry and that from the tide gauges, with a mean correlation and RMSD of 0.57 and 5.3 cm, respectively
- **Interannual variability** is highly coherent along the UK coast and has a standard deviation ranging from 2 to 4 cm.
- Important to apply the **IB correction** to the tide gauge data for consistency with altimetry, but also to reduce uncertainties in the estimates of the trends.
- Important to be aware of the **impact of interannual variability on decadal trends**.