

How can statistics protect us against extreme sea levels resulting from climate change?

Eleanor D'Arcy
Lancaster University

1. About me
2. Statistics
3. Statistical Modelling
4. Extreme Sea Level Estimation



We are pleased to announce Katherine Whyte, Craig Anderson and Eleanor D'Arcy as our William Guy Lecturers for 2023-24. They will engage with schoolchildren across the UK to highlight the importance of stats in combating climate change. Find out more: ow.ly/LOvy500Tpks



- **Volunteer roles**
- **Named in honour of William Augustus Guy**
- **Theme: *Climate change and environmental statistics.***
- **Engage with schoolchildren across the UK to highlight the importance of statistics in combating climate change**

- A **PhD** is a doctoral research degree and the highest level of academic qualification you can achieve.
- A **PhD** degree normally takes between three and four years of full-time work to complete.
- You'll research and write a **thesis** offering an original contribution to your subject.

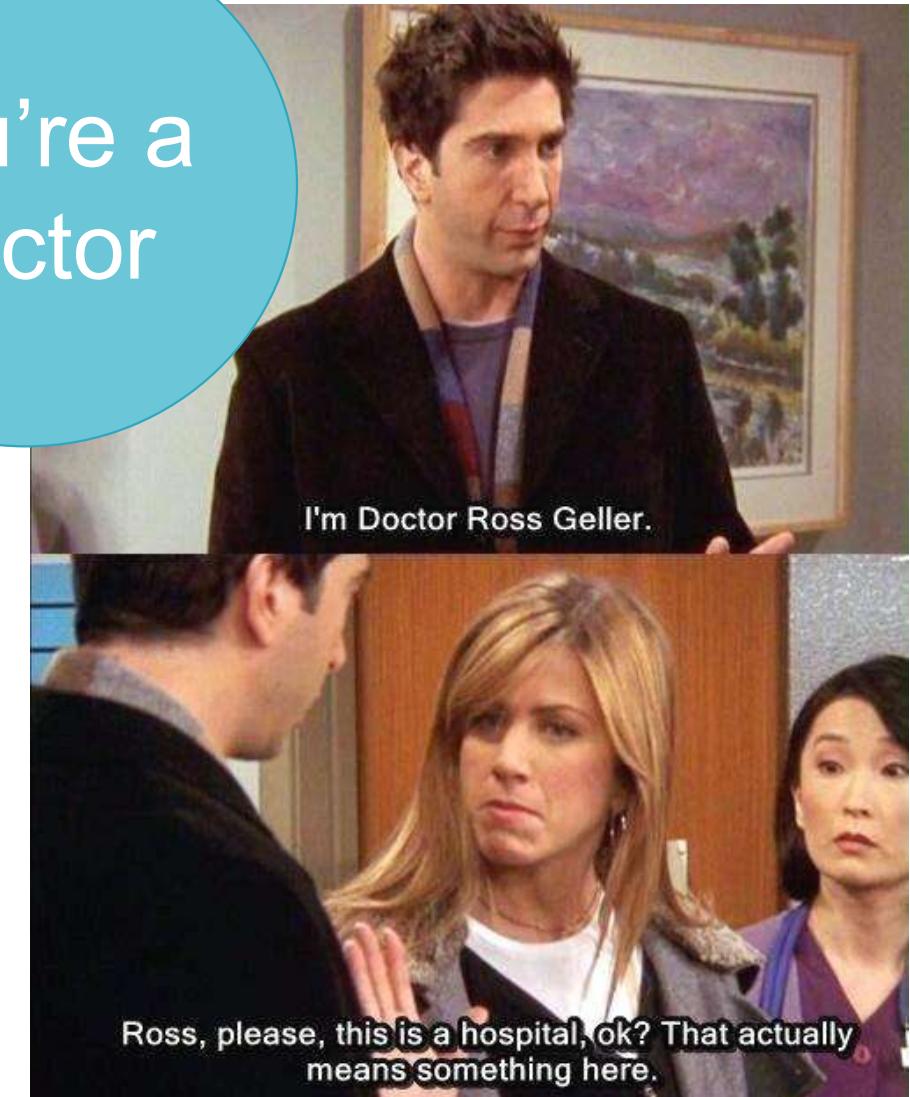
You get paid

Publish research

You're a doctor

Personal development

Present at conferences



2014-16

Sixth
Form

A levels

- Maths
- Further Maths
- Physics
- Geography

2016-19

University

Degree

BSc Mathematics
Lancaster Uni



2019-20

Masters

Masters

MRes Statistics
Lancaster Uni



2020-24

PhD

PhD

Environmental
Statistics
Lancaster Uni



WG
lecturer

Student
support

Teach

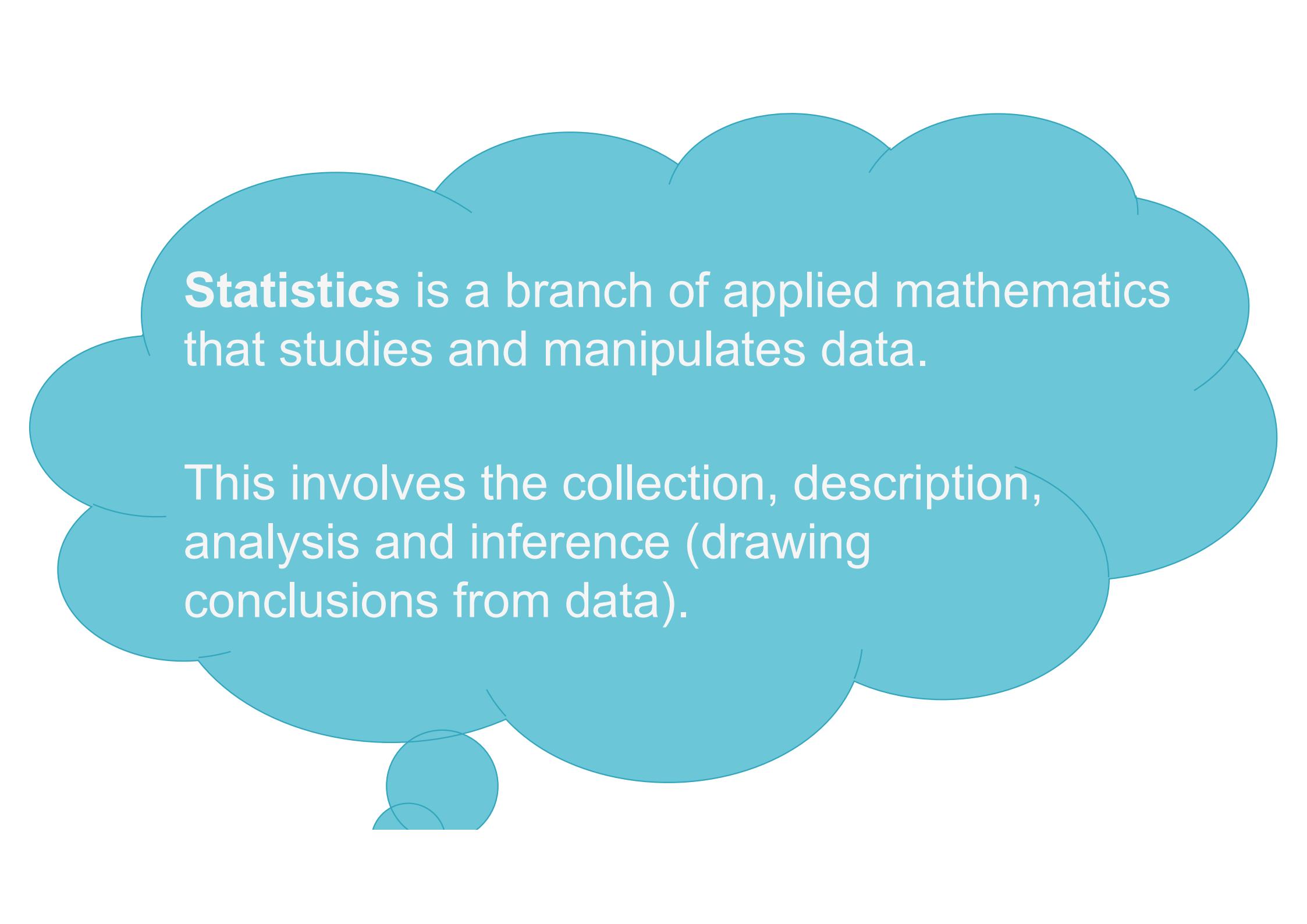
Industry
visits

Womens+
network

Athena Swan
representative

Interns

Organise
conferences



Statistics is a branch of applied mathematics that studies and manipulates data.

This involves the collection, description, analysis and inference (drawing conclusions from data).

Statistics

Record of production goods and services Neuroscience
Stock market data analysis Quality department of a company
Sports Robotics Medical records Weather forecasting
Health care departments Sales tracking Budgeting and finance
Pandemic analysis Travel and tourism Population record
Political campaigns Banking Business statistics Educational data
Aerospace Cryptocurrency Research and analysis
Artificial intelligent devices Transportation Data science
Information technology Machine learning Computer Science

Mean

The average
of all the data

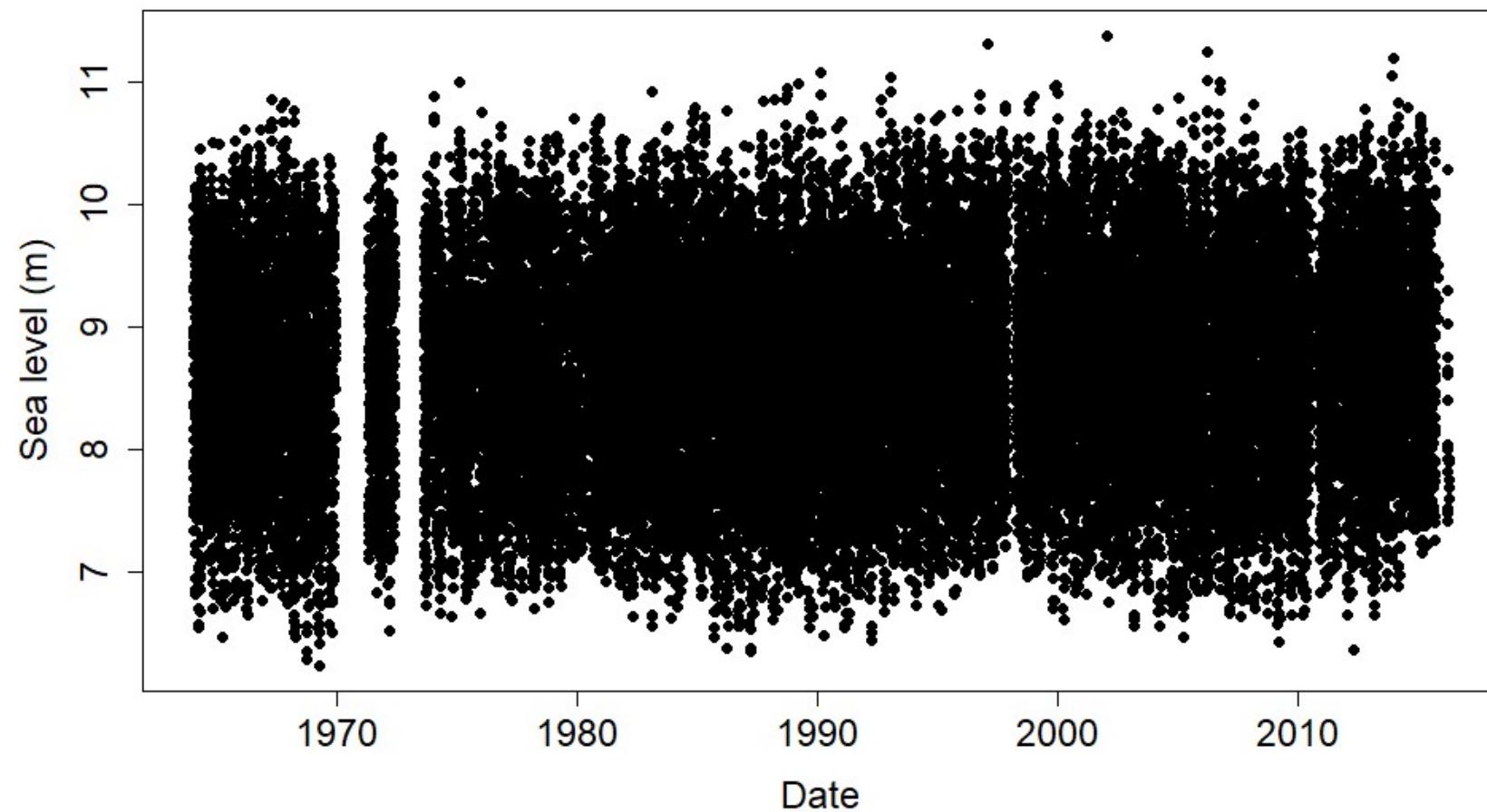
Mode

The most
common number

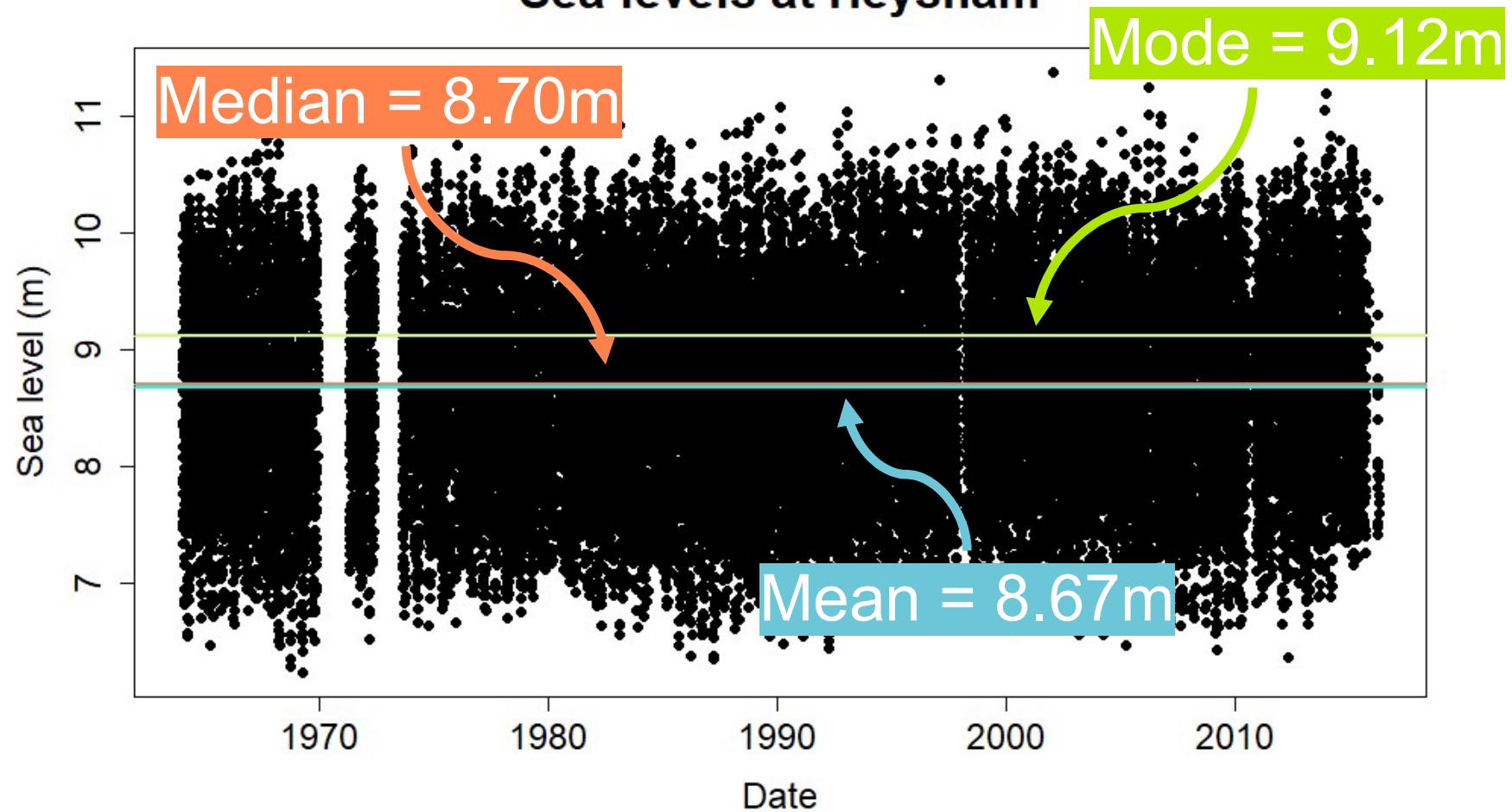
Median

The middle
number, when
in order

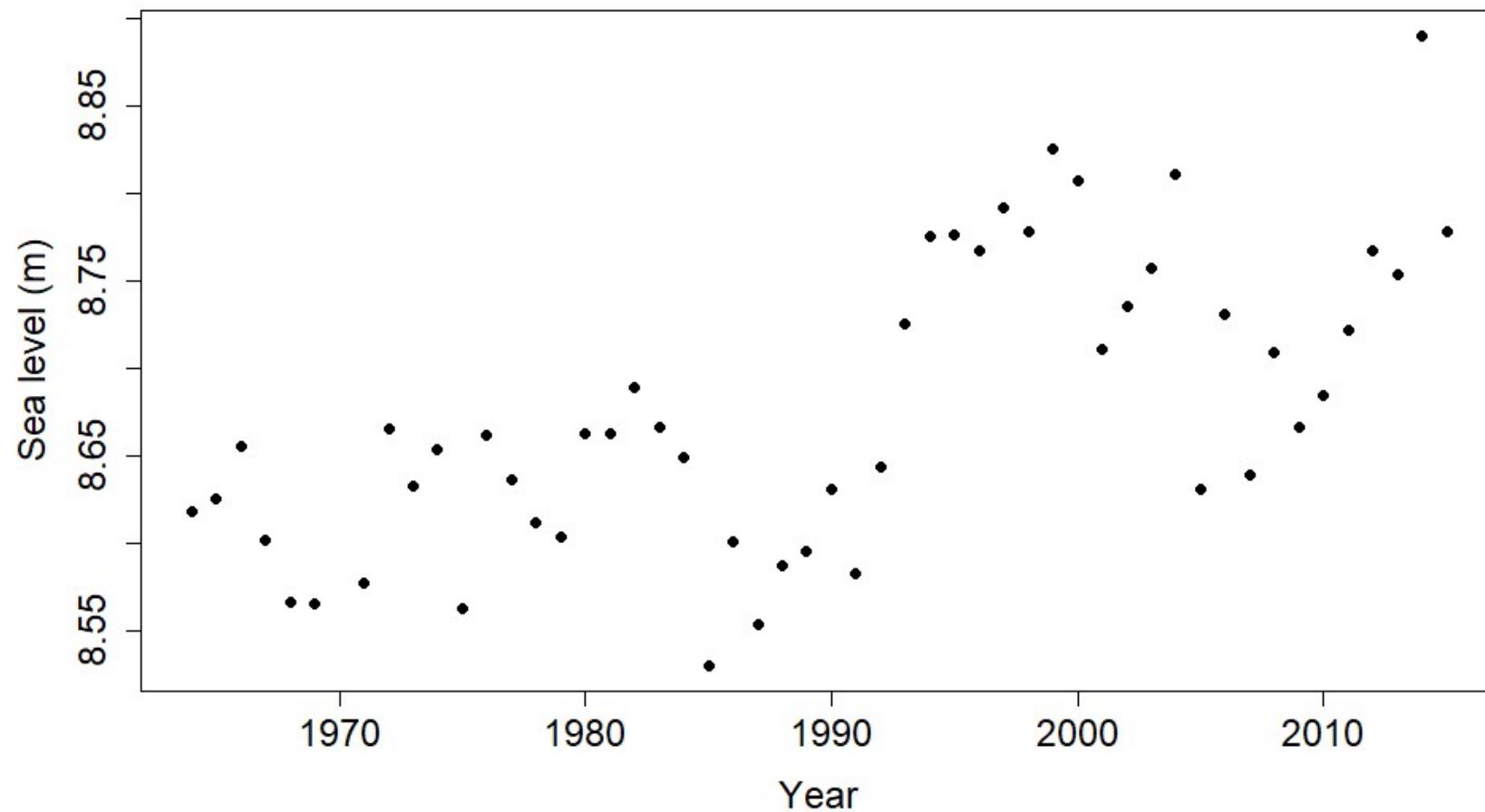
Sea levels at Heysham

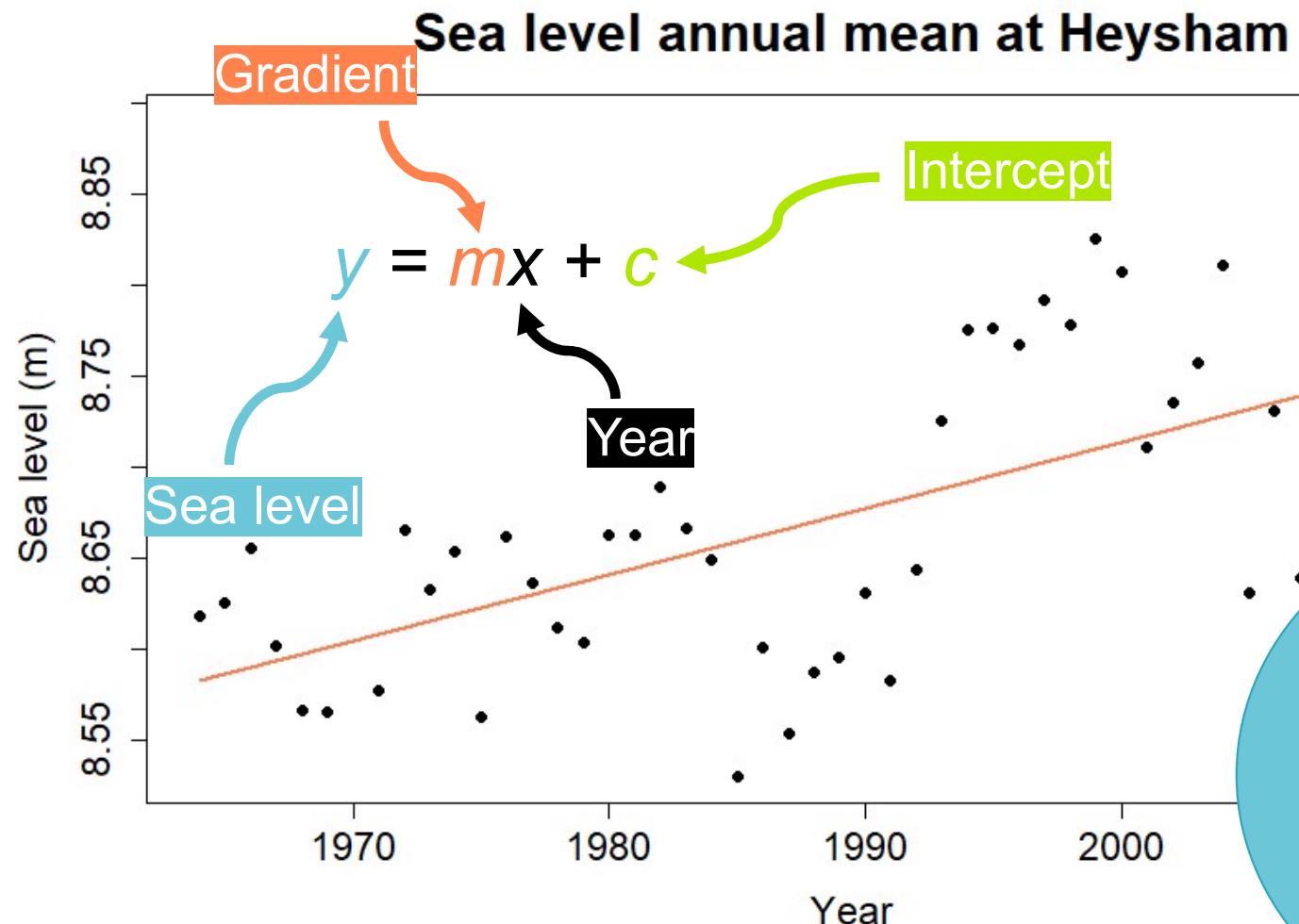


Sea levels at Heysham



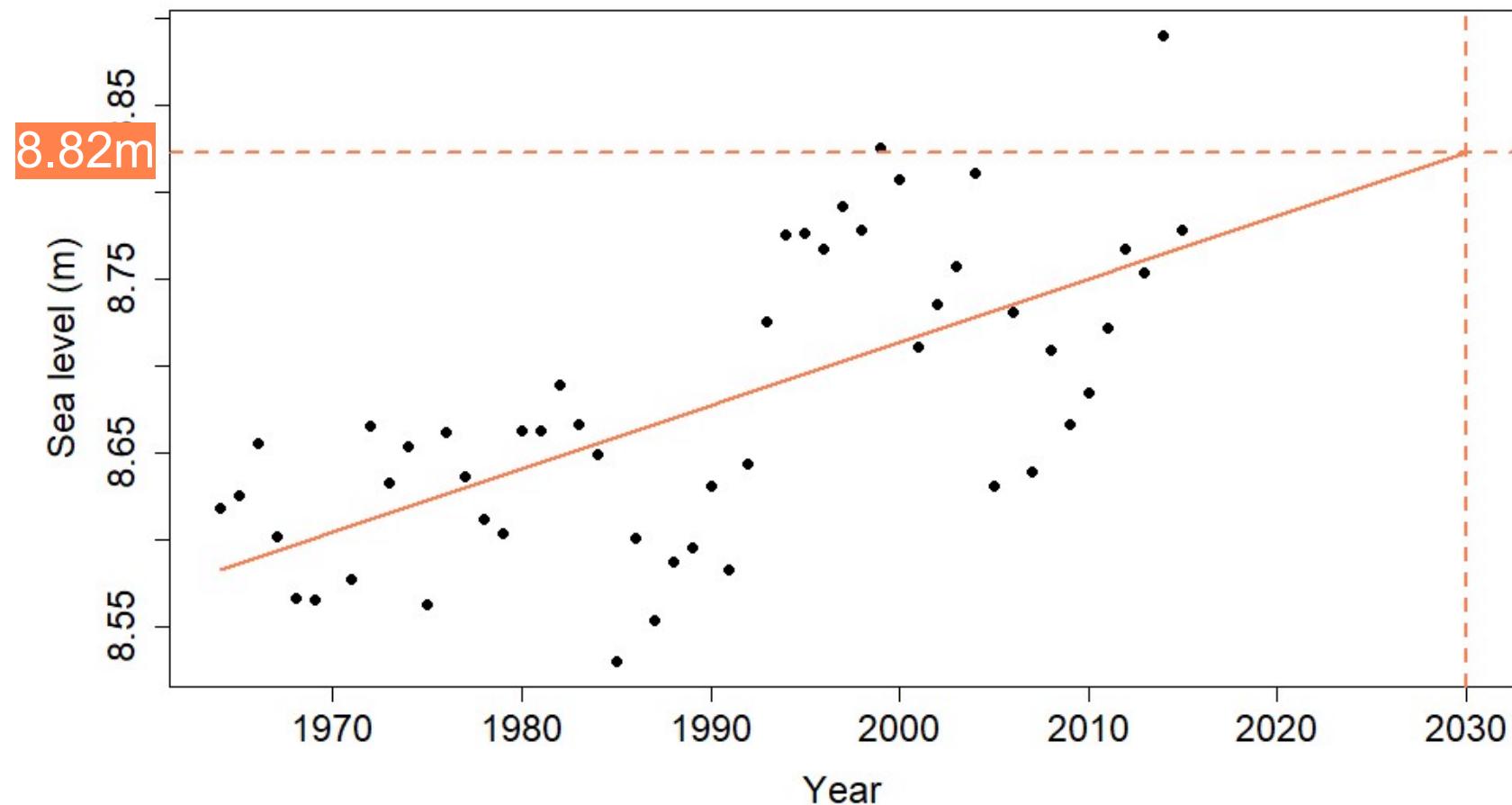
Sea level annual mean at Heysham



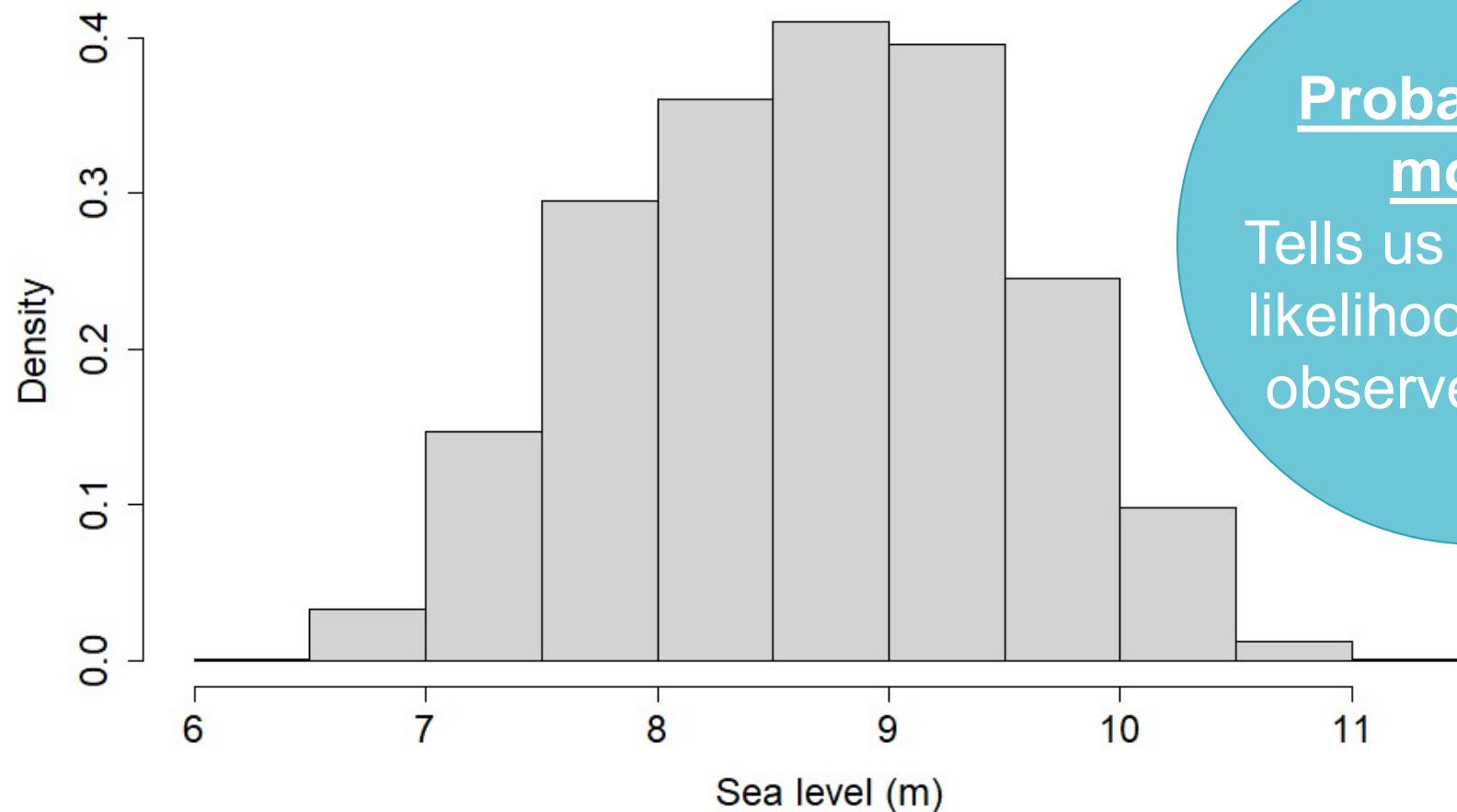


Linear model
Use a straight line to represent the relationship between two variables

Sea level annual mean at Heysham



Histogram of sea levels at Heysham

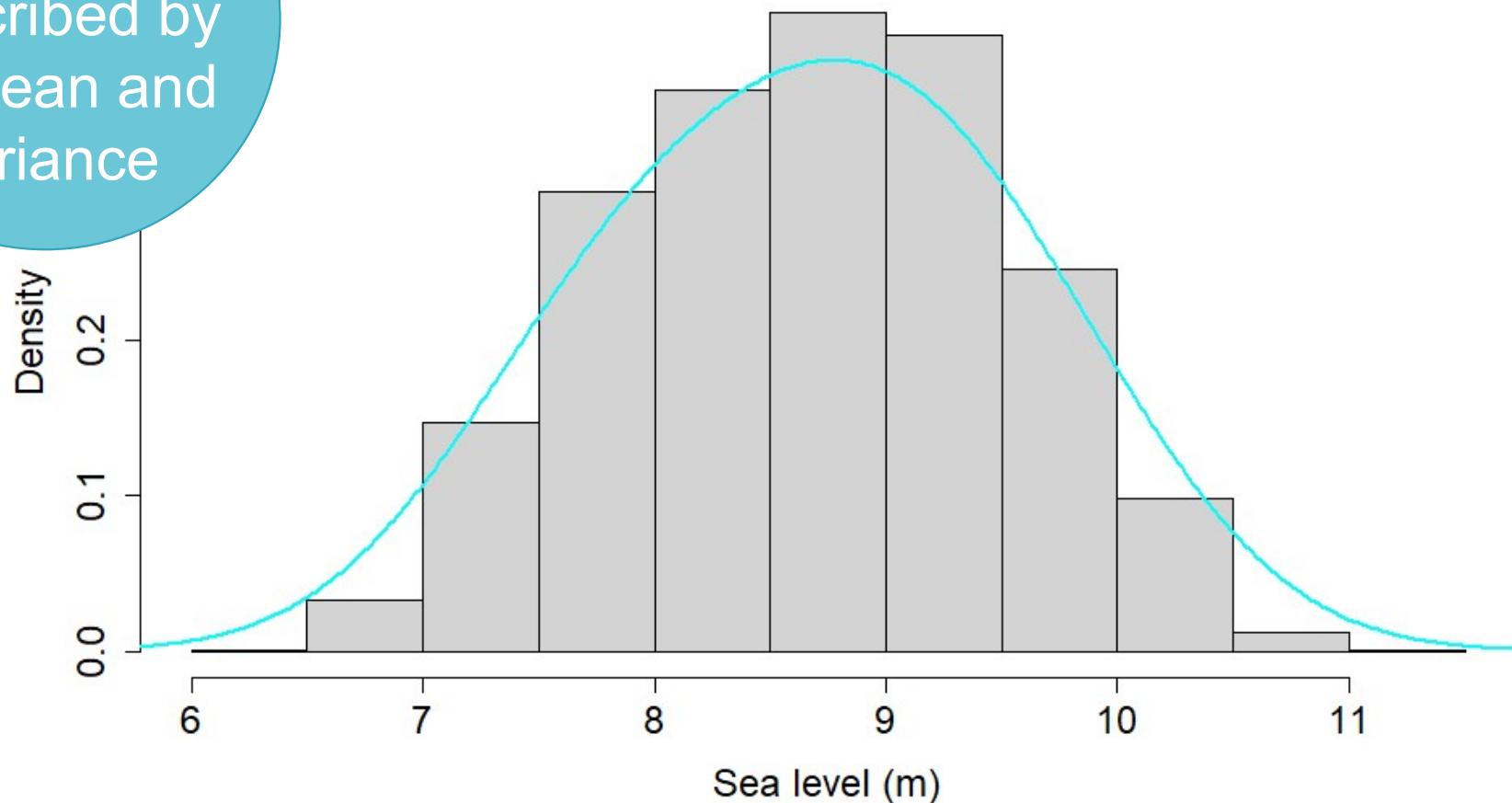


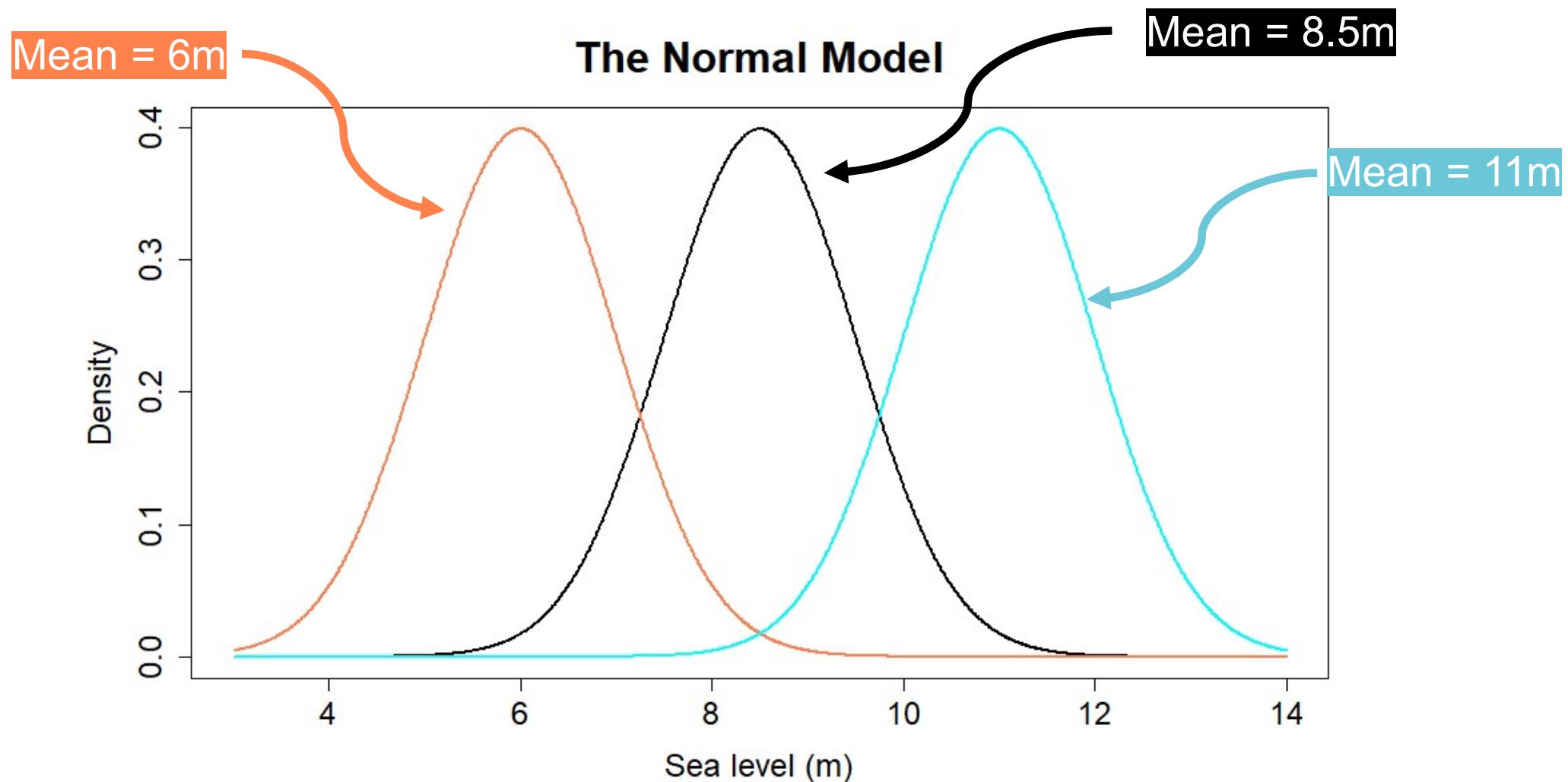
Probabilistic model
Tells us about the likelihood that we observe a value

Normal Model

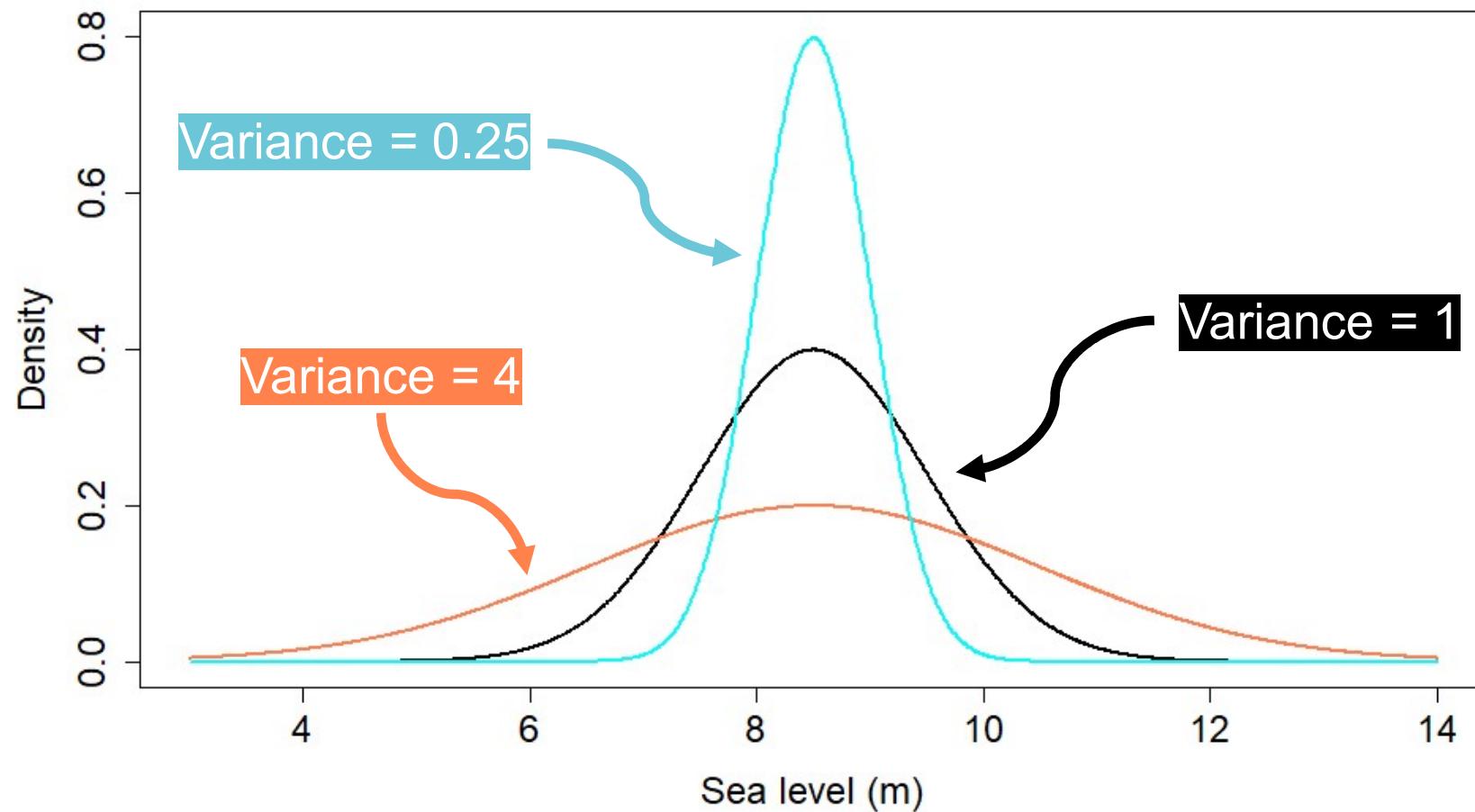
Described by
its mean and
variance

Histogram of sea levels at Heysham

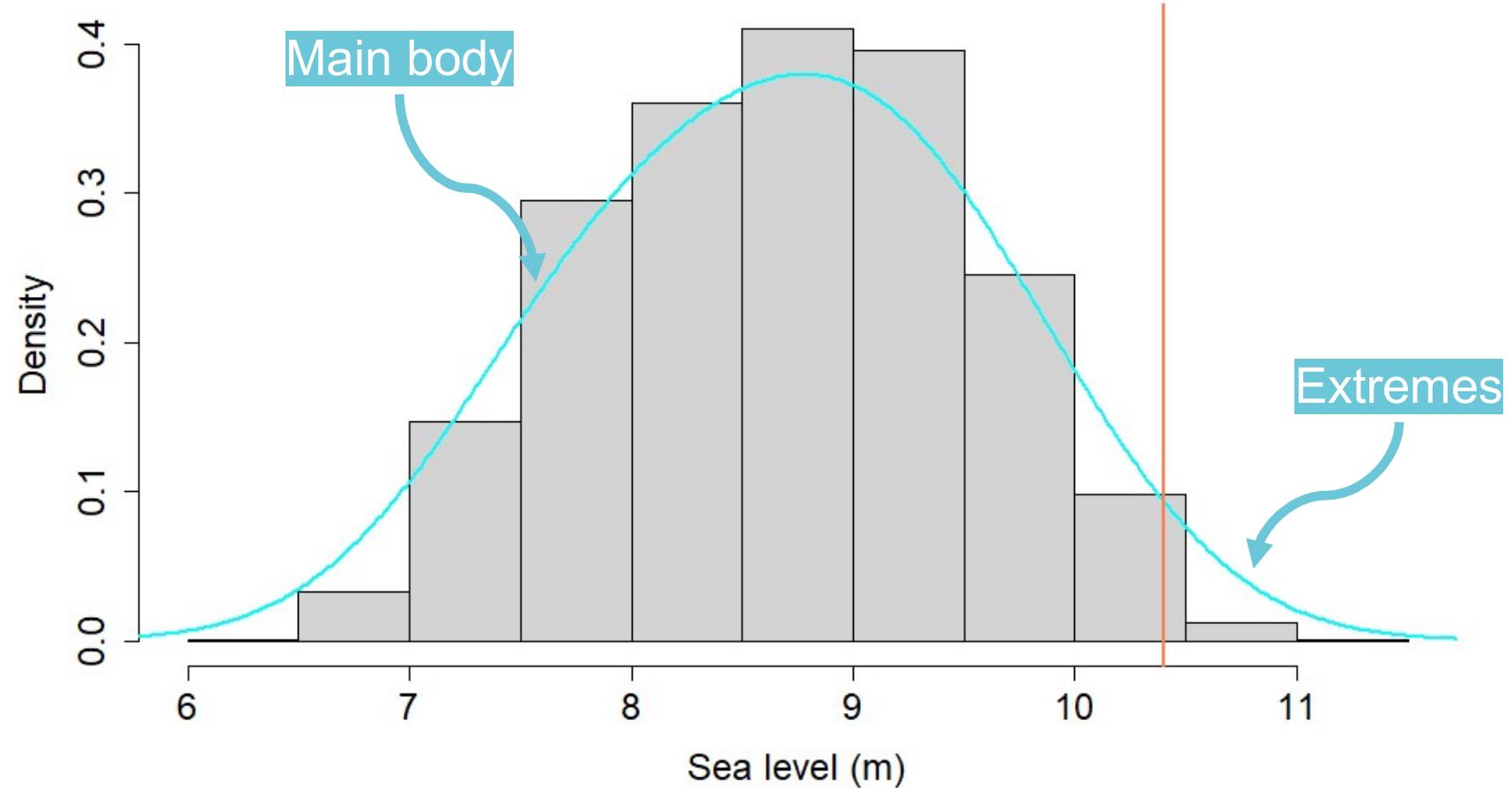




The Normal Model



Histogram of sea levels at Heysham

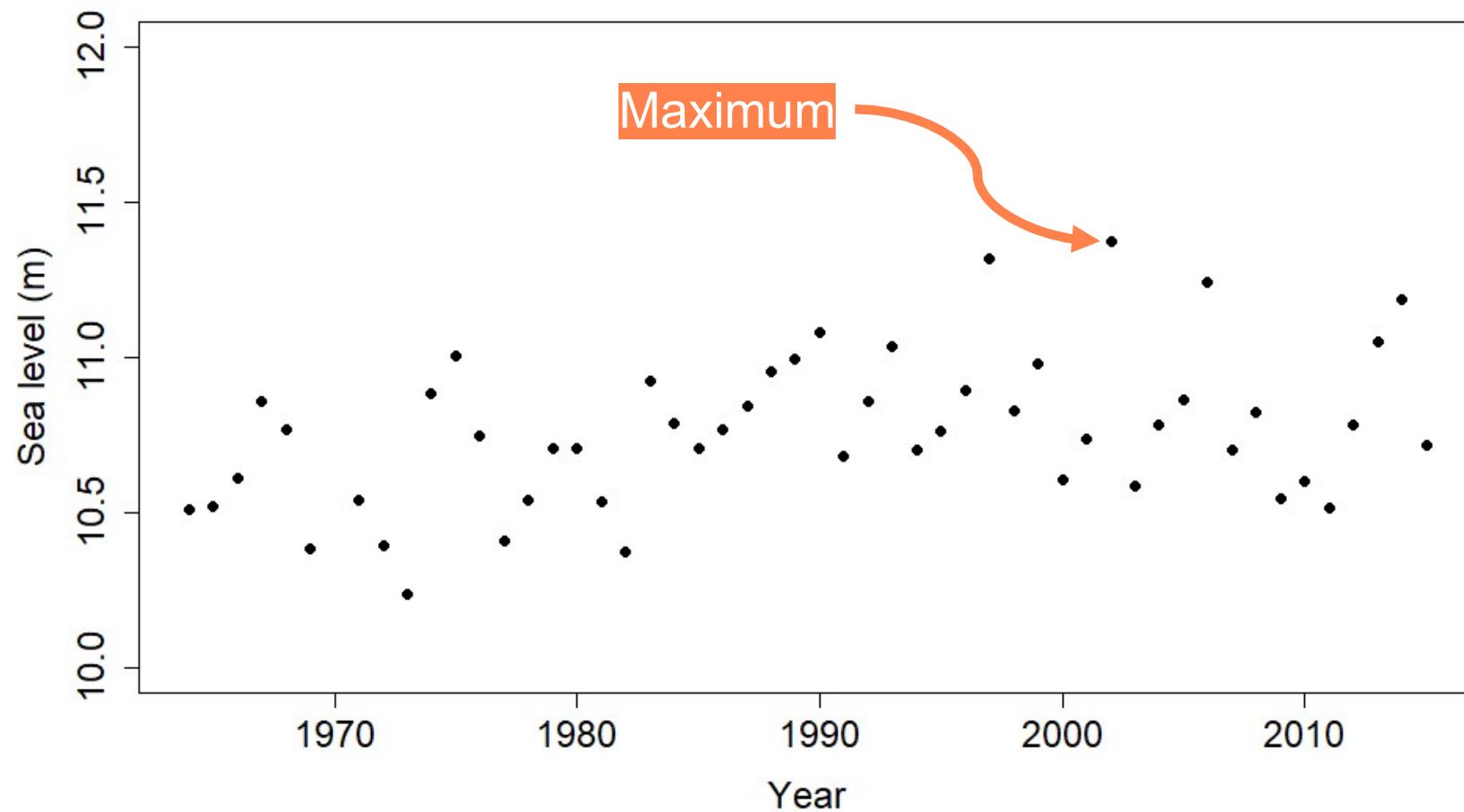


Sea wall

A solid barrier designed to prevent sea levels reaching inland and causing flooding



Sea level annual max at Heysham

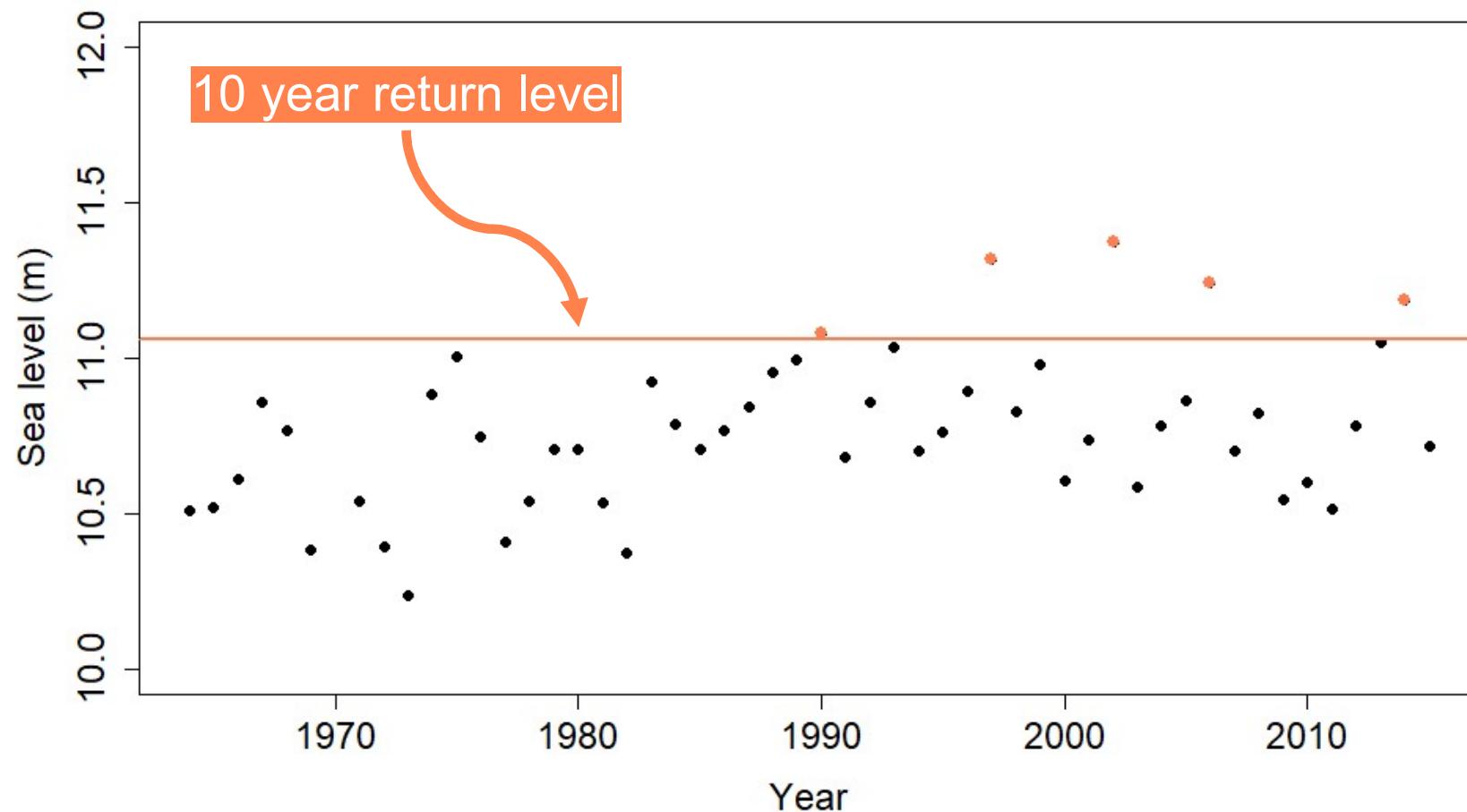




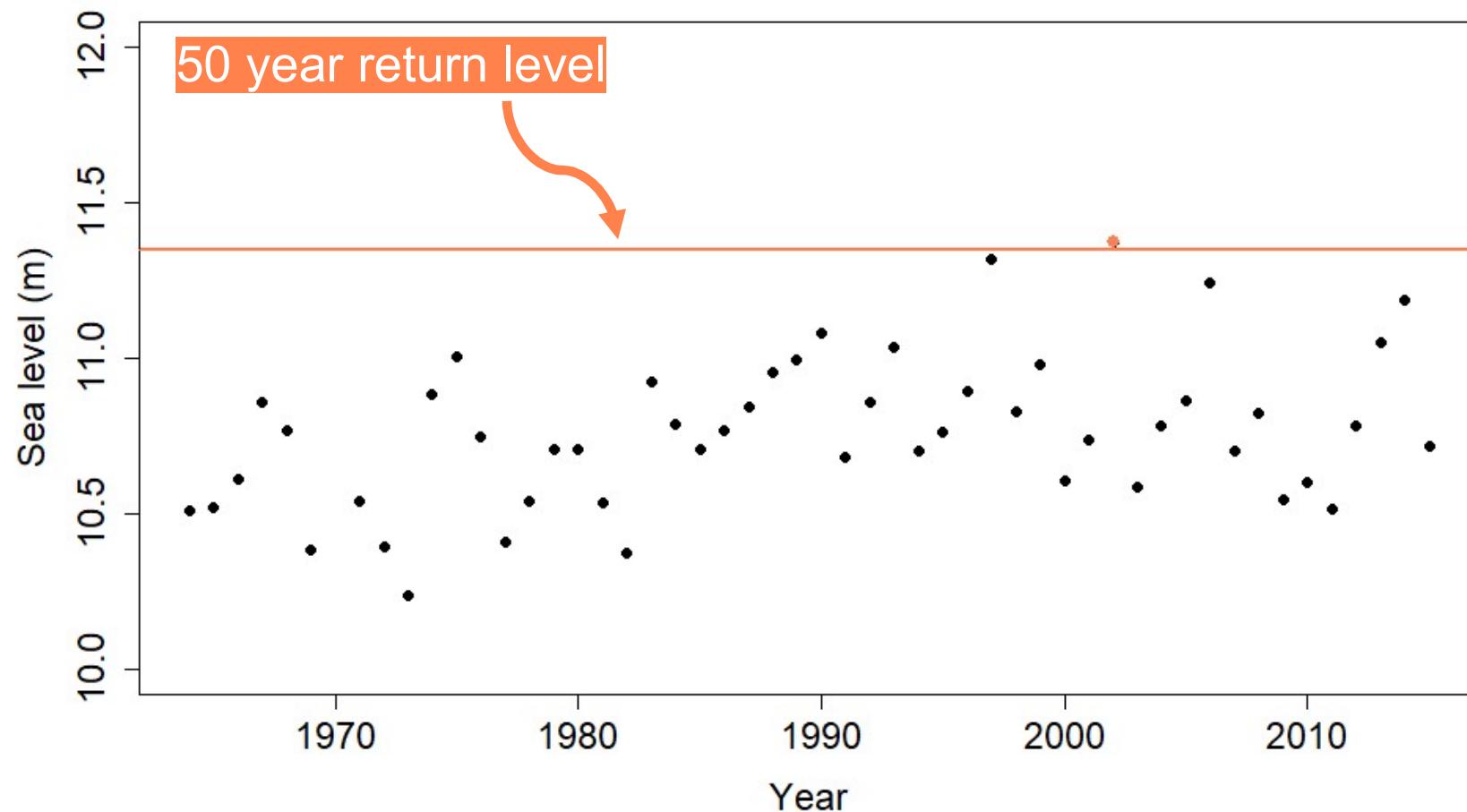
A **return level** is the sea level we expect to be exceeded once every X years.

We call X the **return period**.

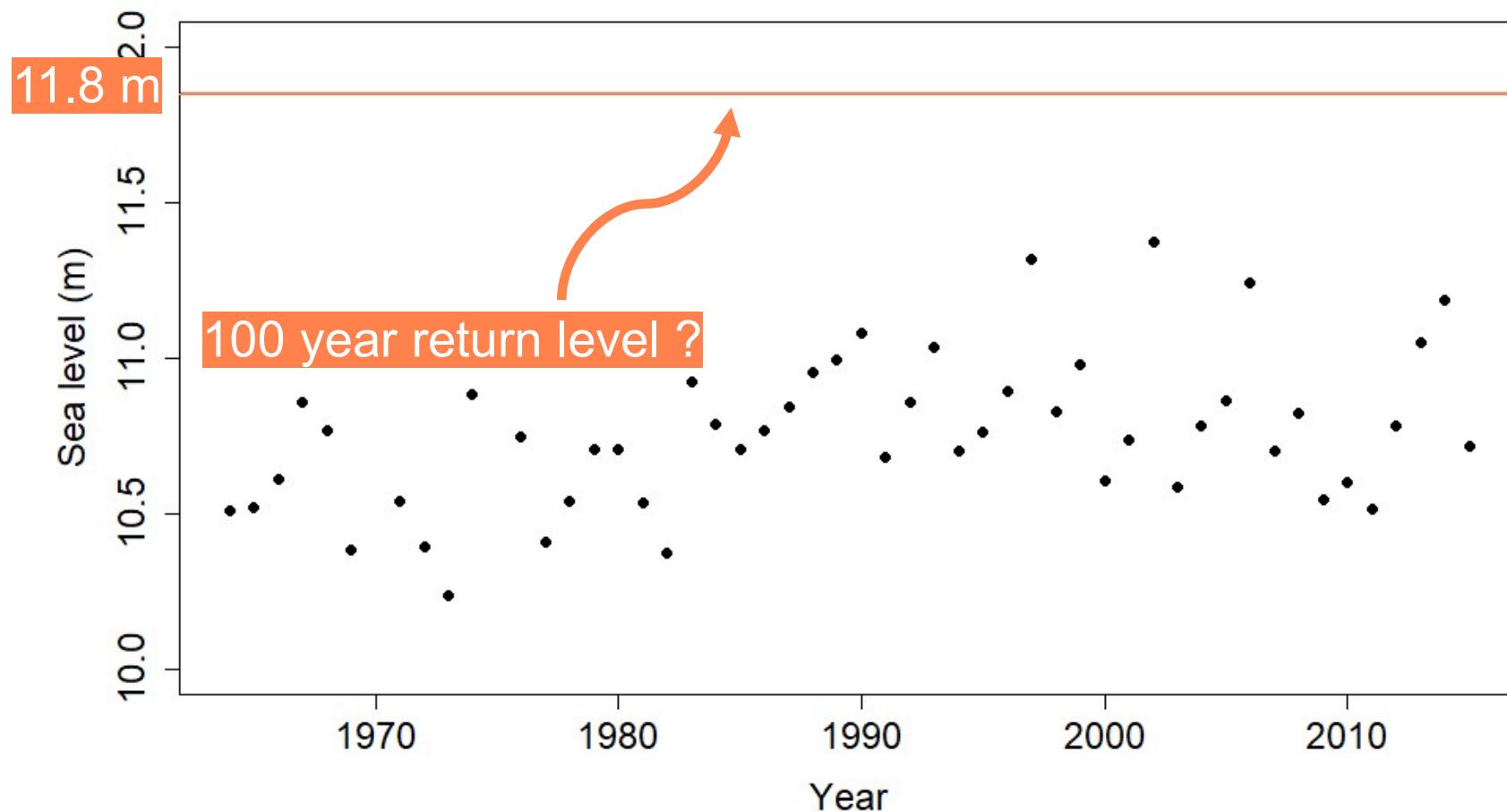
Sea level annual max at Heysham



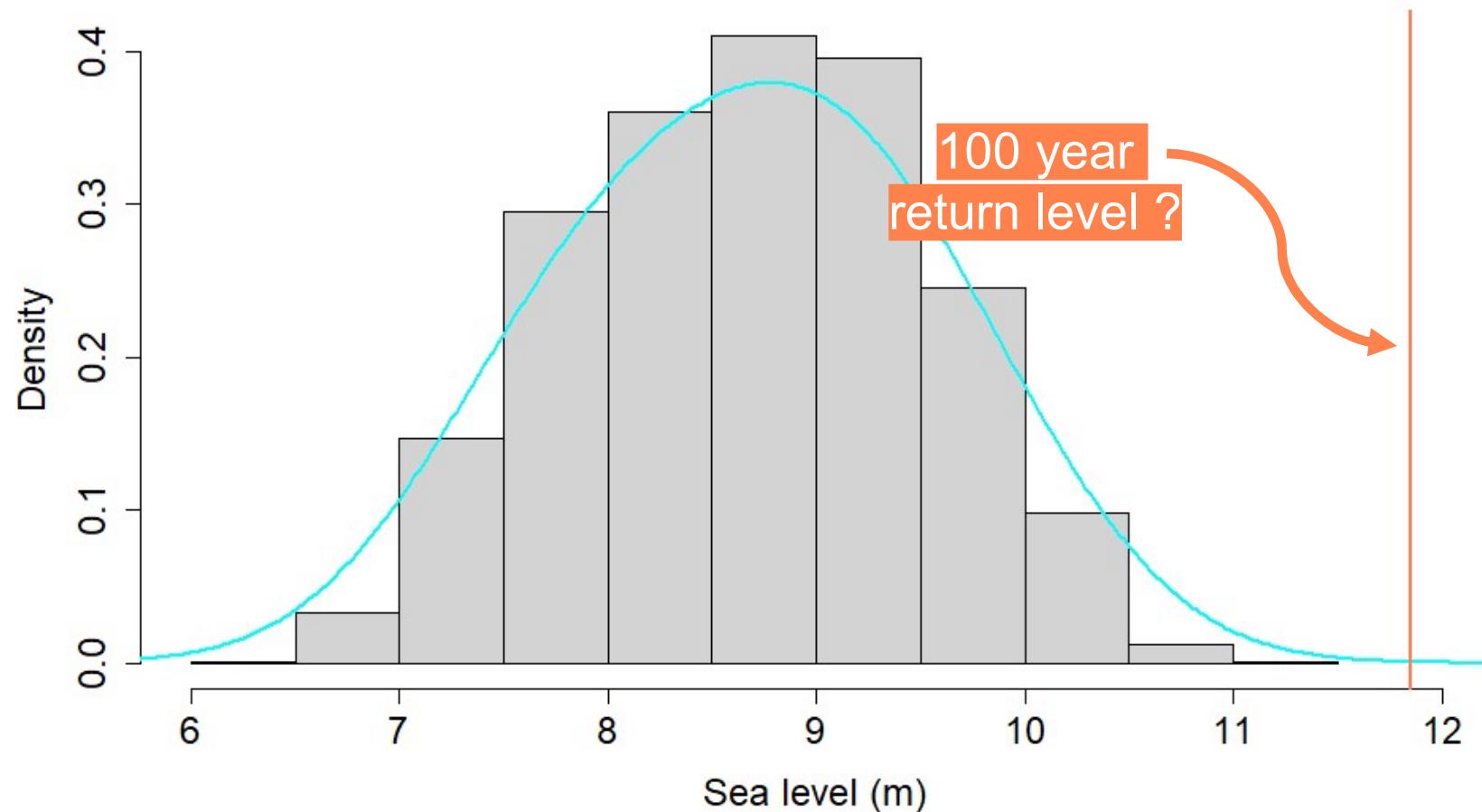
Sea level annual max at Heysham



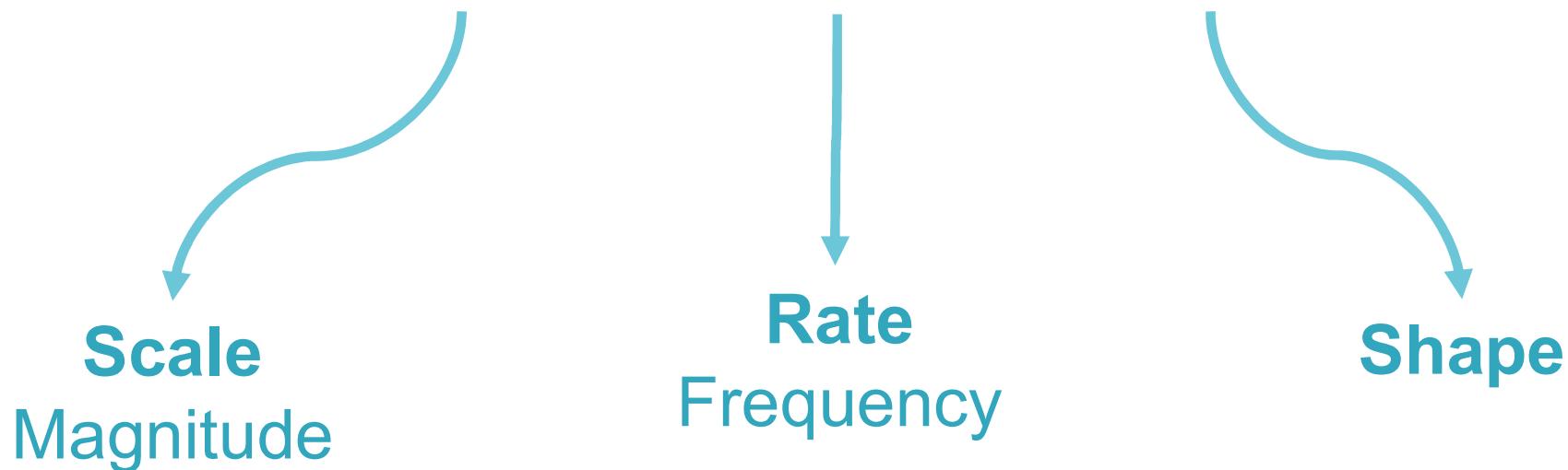
Sea level annual max at Heysham



Histogram of sea levels at Heysham



Extreme Value Model





Oceanographers



Seismologists



Meteorologists

Statisticians

Climatologists



Hydrologists



Predictable rise and
fall of the sea surface
driven astronomically

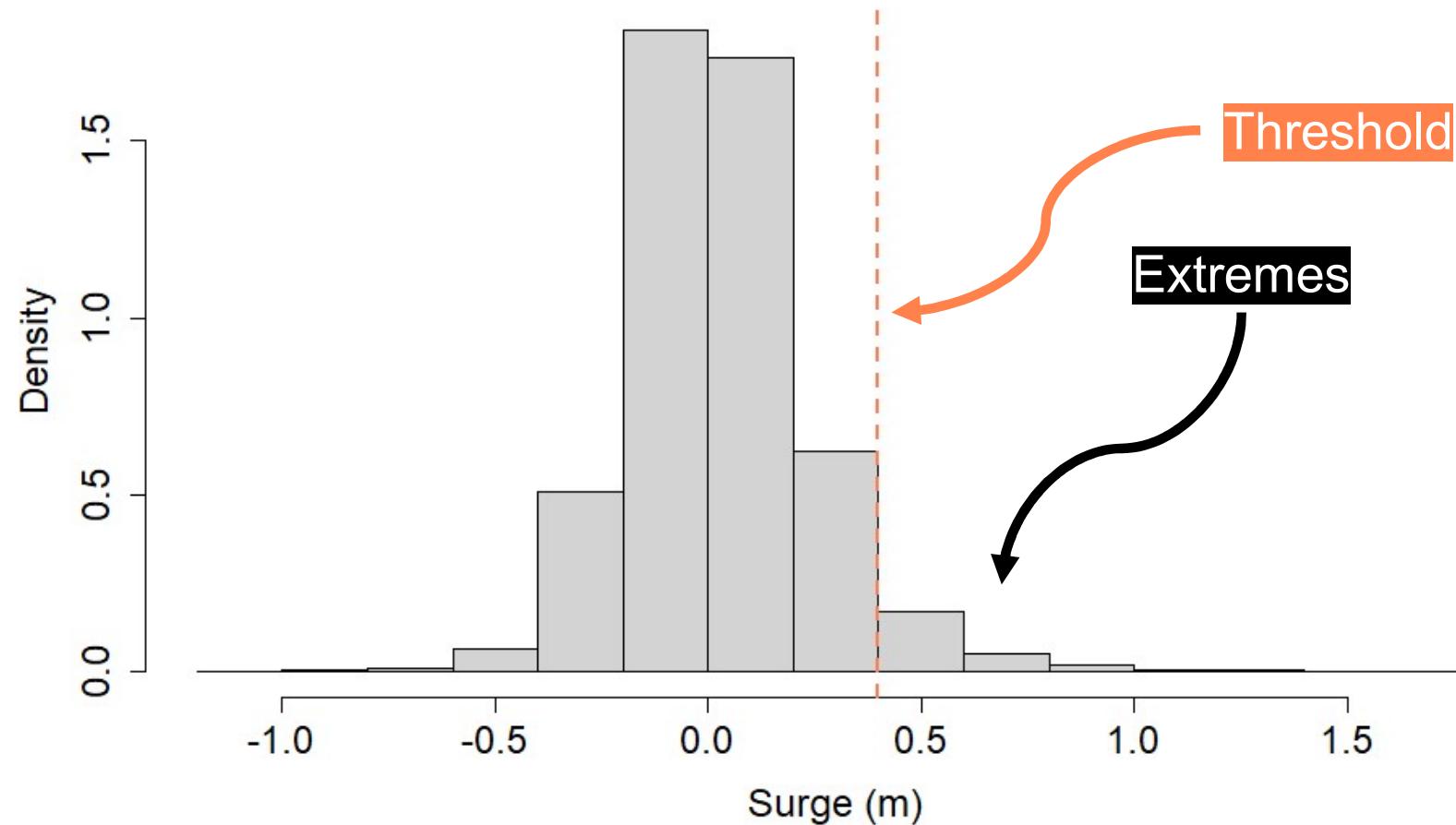


Sea level = Tide + Surge

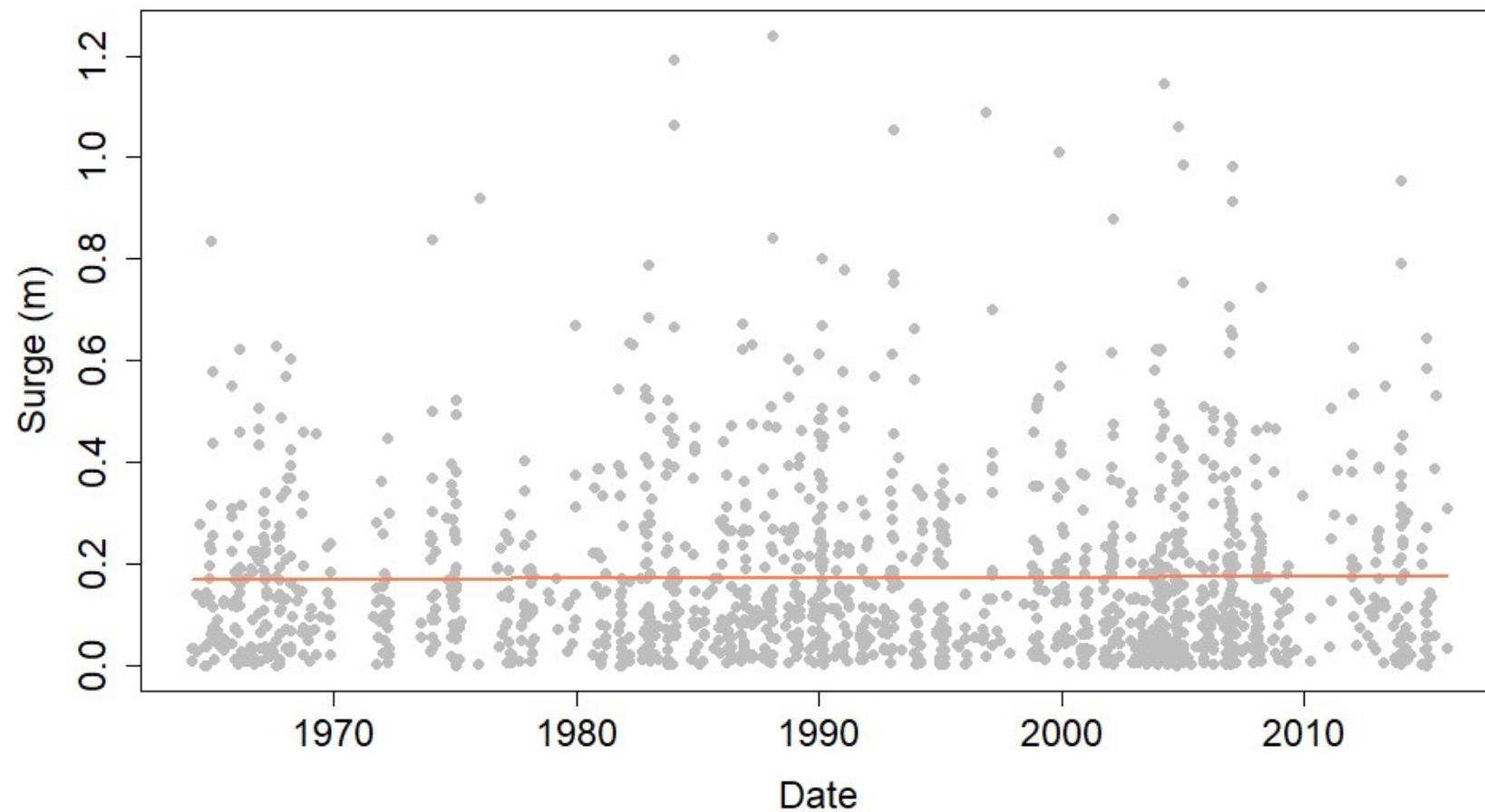
Short term sea
level changes caused
by the weather



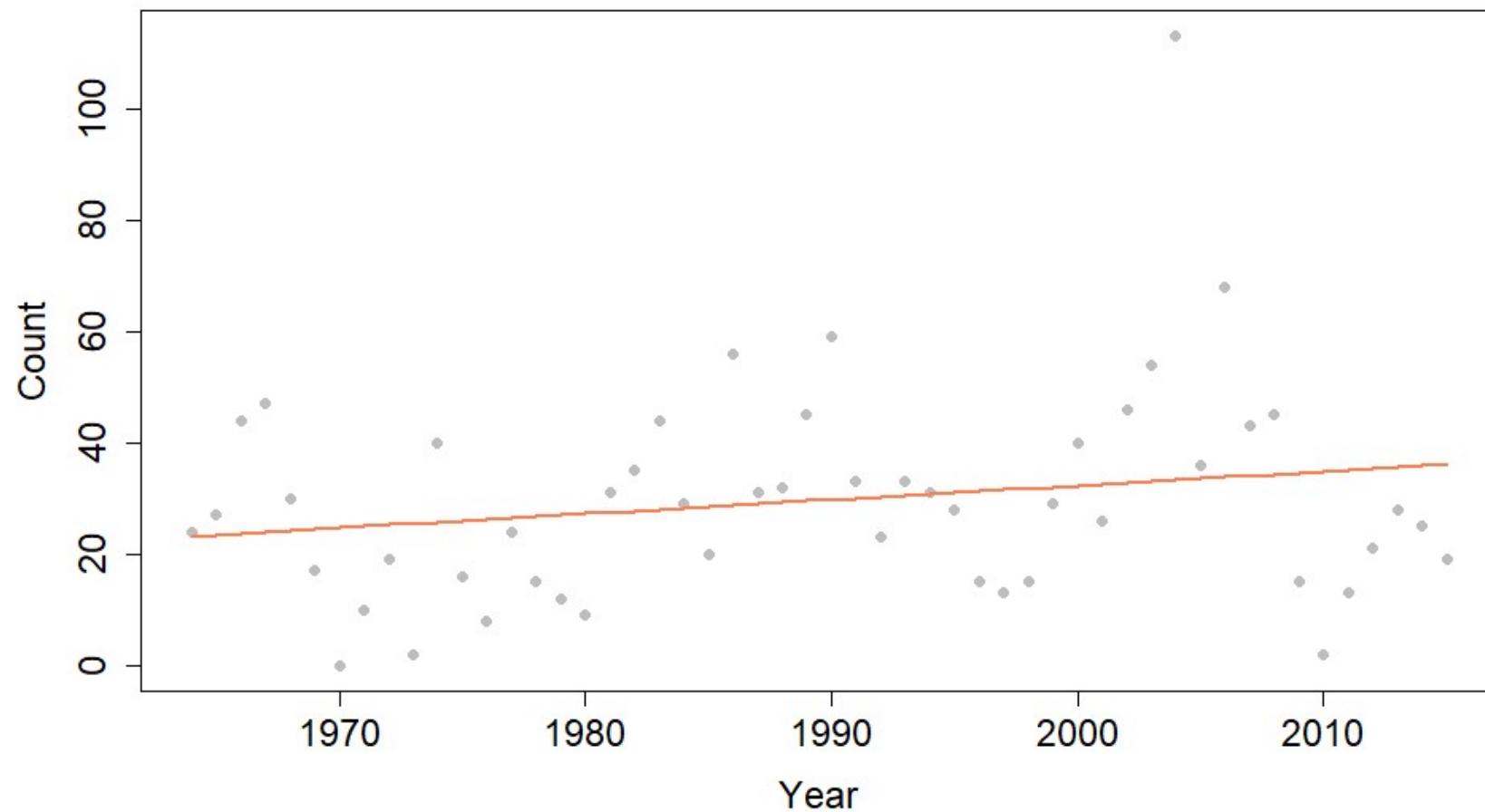
Histogram of Surge at Heysham



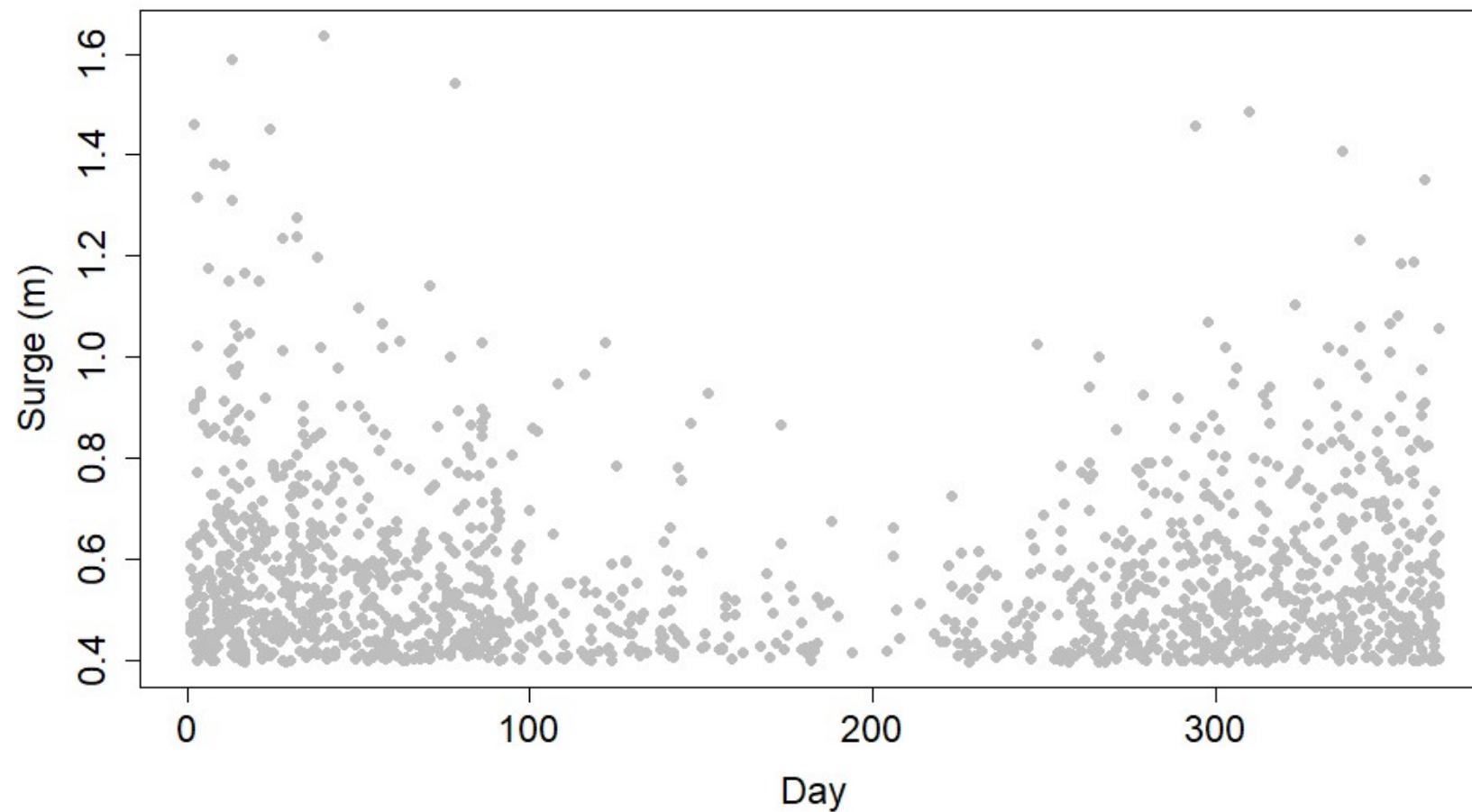
Magnitude



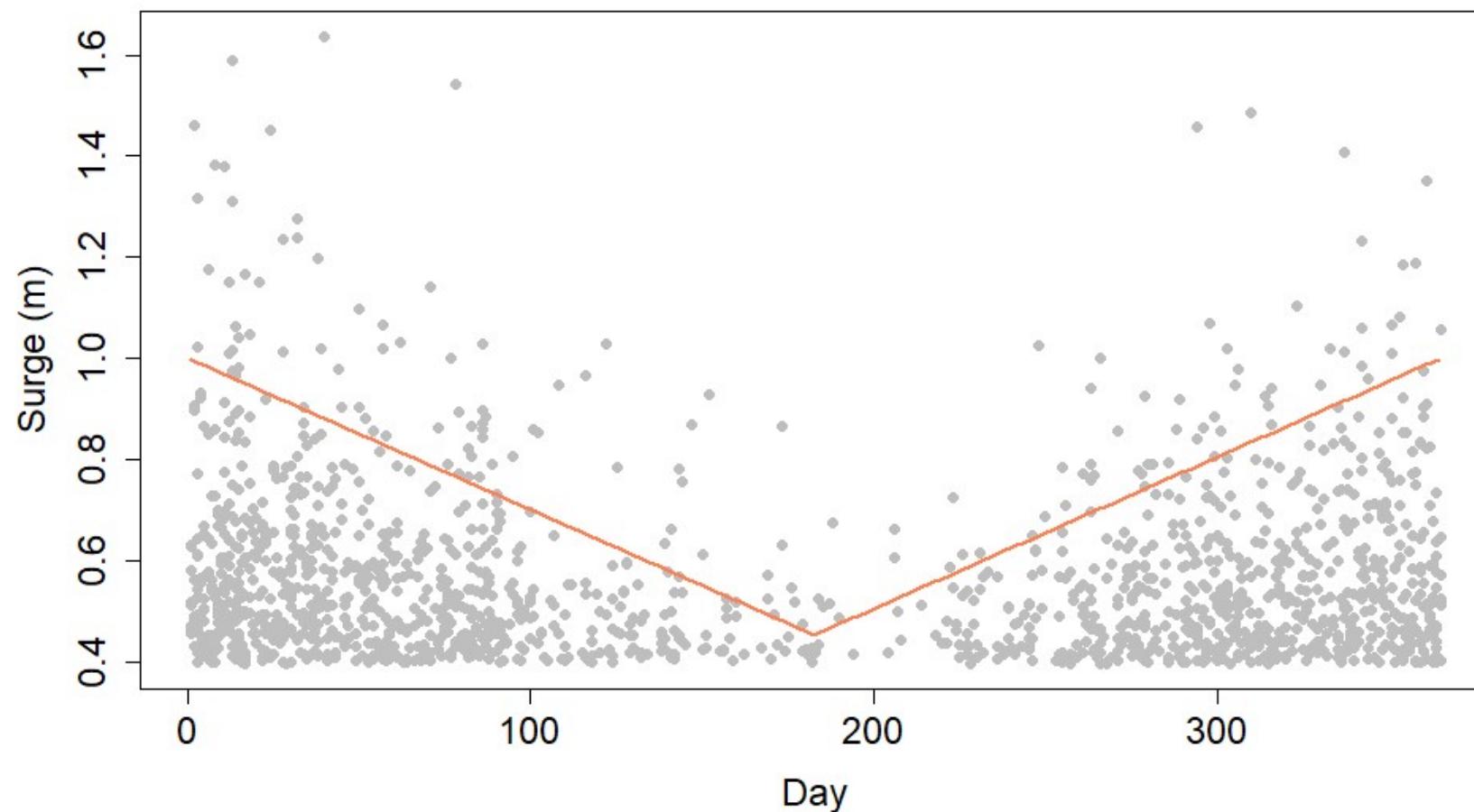
Frequency



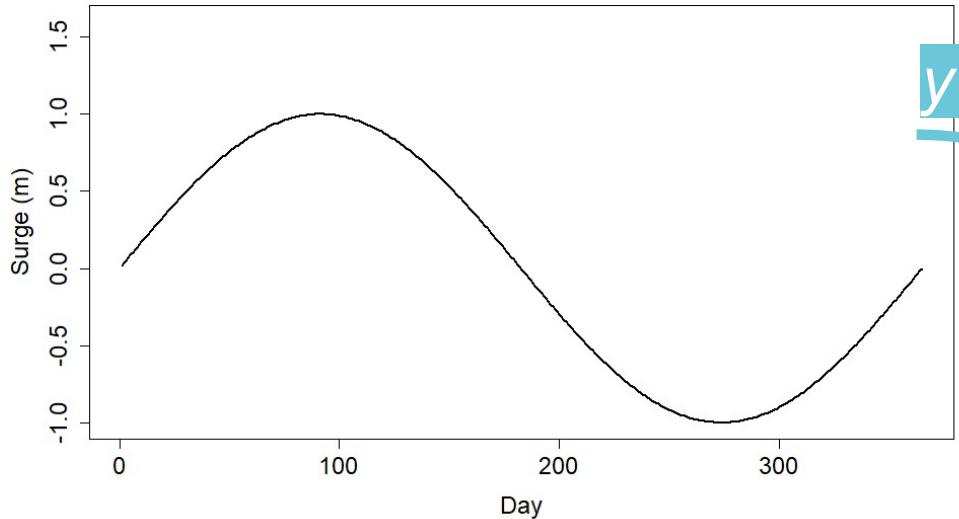
Seasonality - Magnitude



Seasonality - Magnitude

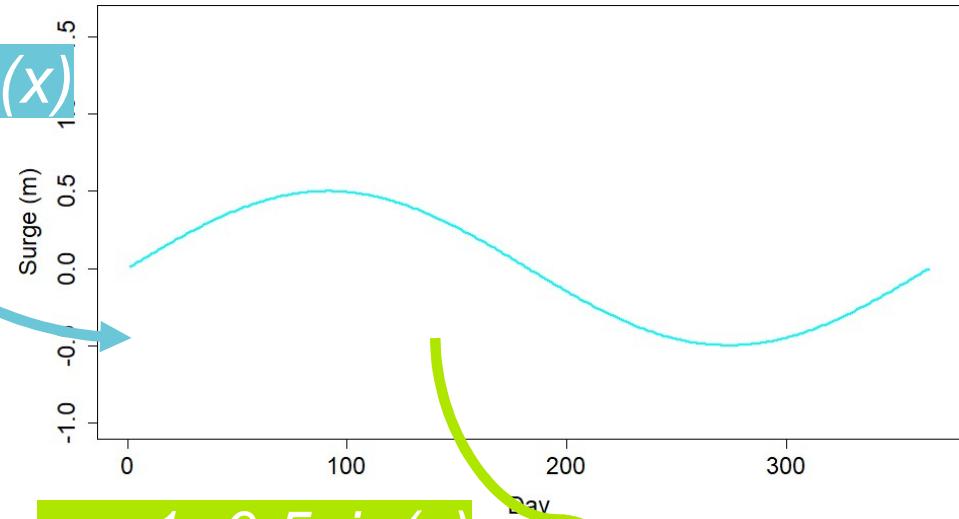


Sine wave



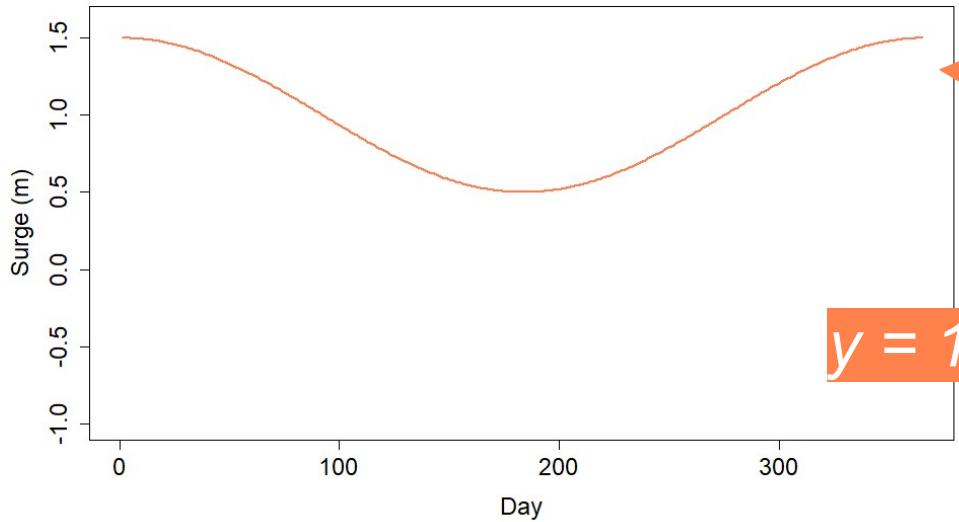
$$y = 0.5\sin(x)$$

Sine wave



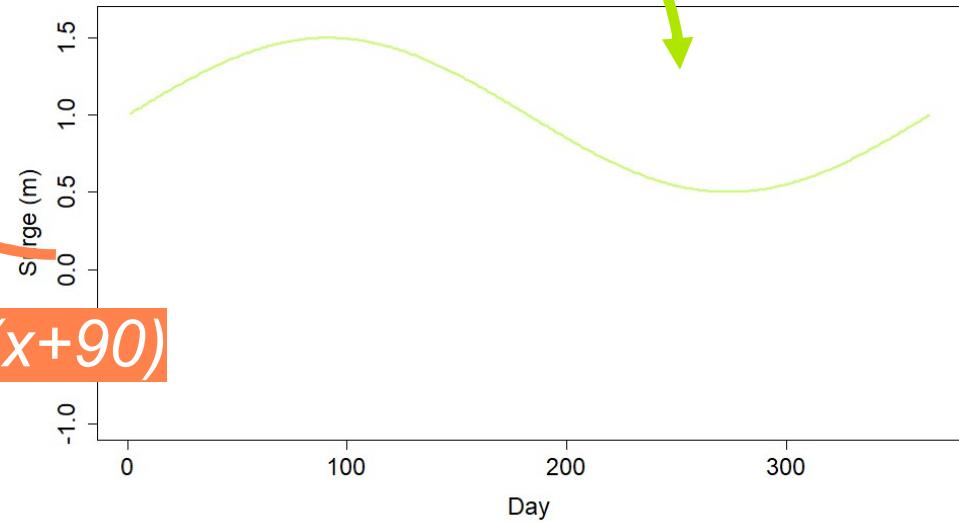
$$y = 1 + 0.5\sin(x)$$

Sine wave

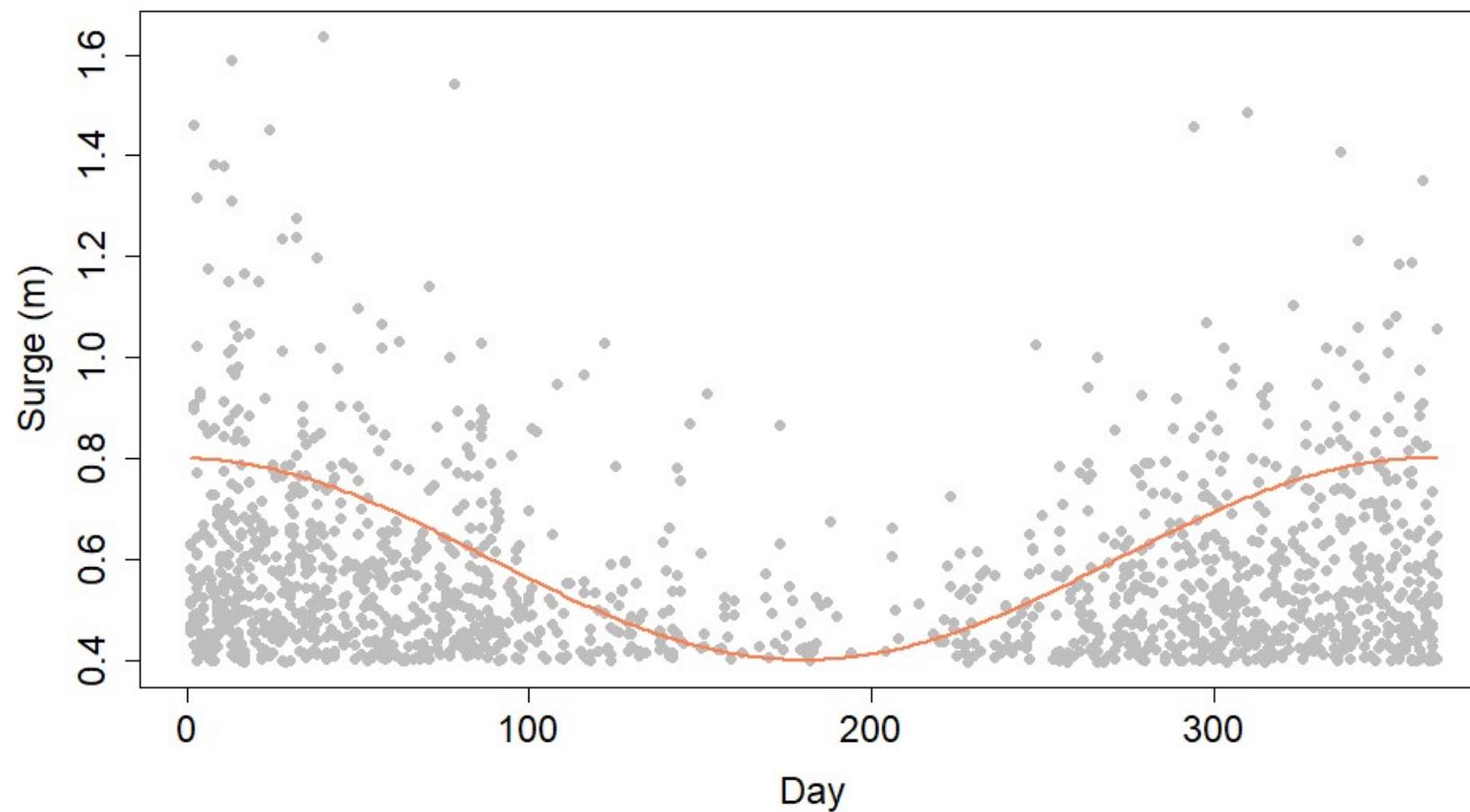


$$y = 1 + 0.5\sin(x+90)$$

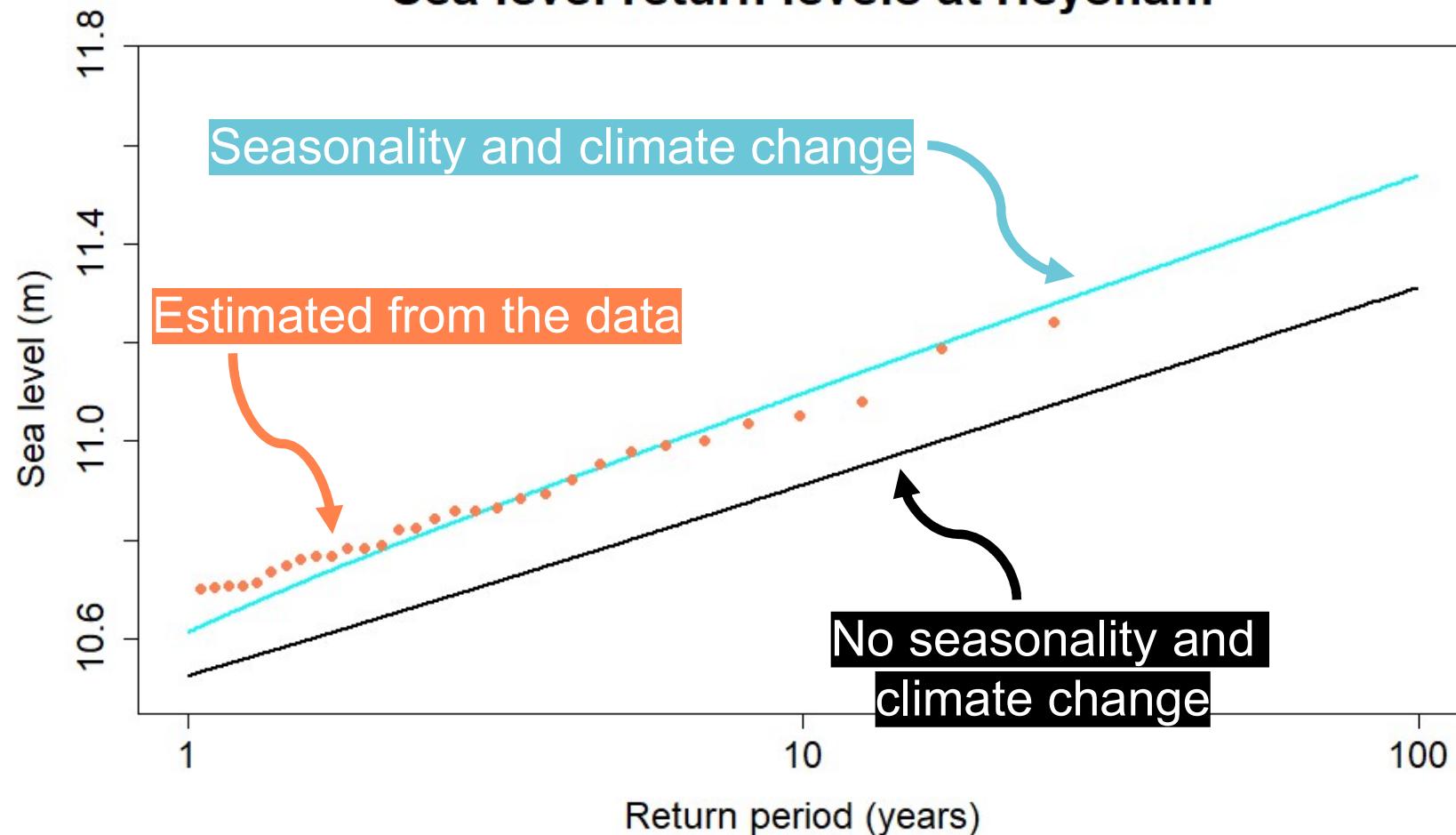
Sine wave



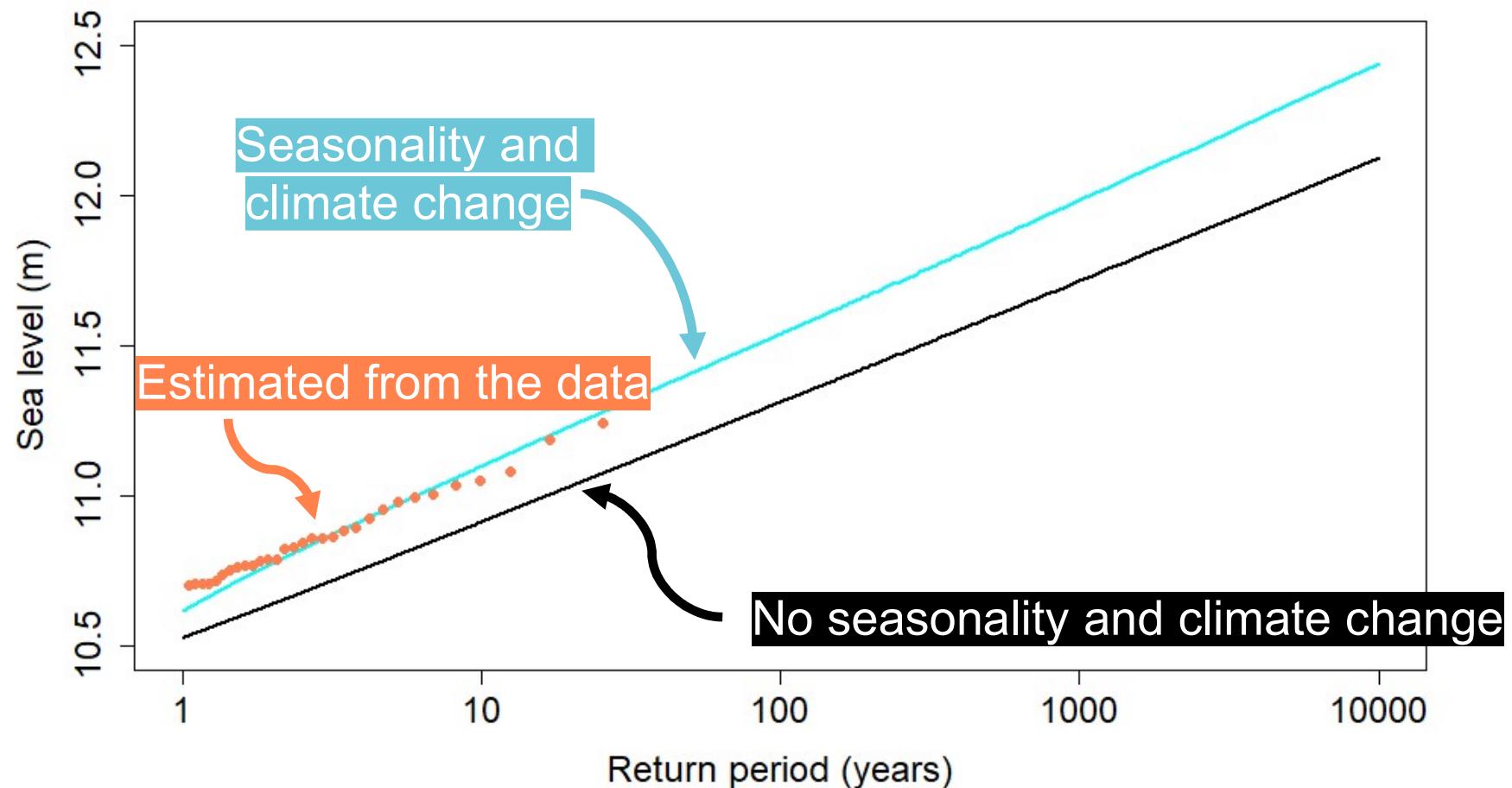
Seasonality - Magnitude



Sea level return levels at Heysham



Sea level return levels at Heysham





Thank you and good luck!

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