Tides – Frequently Asked Questions

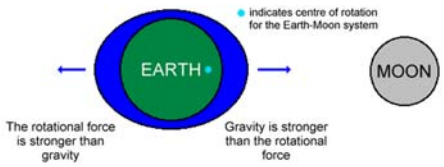
What is a tide?

A tide is the regular and predictable movement of water caused by astronomical phenomena - the way the Earth, Moon and Sun move in relation to each other and the effect of gravity. These are the values that you can see in tide tables.

What causes tides?

Tides are caused by the effect of gravity in the Earth-Moon-Sun system, and the movement of those three bodies. Consider just the Moon for a minute, and imagine the Earth completely covered in water. There would be two bulges of water - one towards the Moon and another on the opposite side. The rise and fall in sea-level is caused by the Earth rotating on its axis underneath these bulges of water.

There are two tides a day because it passes under two bulges for each rotation (24 hours). This is called the lunar tide.



The Sun also creates two bulges of water called the solar tide - this is about a third the size of the lunar tide.

Two Bulges? What causes the one on the side away from the Moon?

Most people think the Moon rotates round the Earth. In reality, the Earth and the Moon rotate about a common centre just inside the Earth's surface (indicated by the light blue dot on the diagram). At this common centre, the two forces acting: gravity towards the Moon and a rotational force away from the Moon are perfectly in balance. They have to be otherwise the Earth and Moon would not stay in this orbit.

The 'tide-generating' force is the difference between these two forces. On the surface of the Earth nearest the Moon, gravity is greater than the rotational force, and so there is a net force towards the Moon causing a bulge towards the Moon. On the opposite side of the Earth, gravity is less as it is further from the Moon, so the rotational force is dominant. Hence there is a net force away from the Moon. It is this that creates the second bulge away from the Moon.

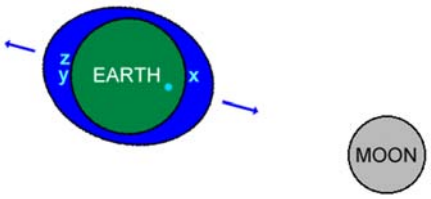
On the surface of the Earth, the horizontal tide generating forces are more important than the vertical forces in generating the tidal bulges.

Why are the tides not the same all round the coast of Britain?

You might expect that as Britain passes under the bulge of water, time of high water would be roughly the same for all points on the coast, but it isn't. The problem is caused by the land that 'gets in the way' of the moving water. As the Earth rotates, the water has to move to generate the high tides but because of the shape of coastlines and the variation in sea depth (bathymetry), there is a lag. Every location has a unique coastline and bathymetry - which gives each location its unique tidal pattern.

How often do high tides occur?

In UK waters, approximately every 12 hours 25 minutes. You may wonder why it is not exactly 12 hours, but you must remember that the Moon is also orbiting around the Earth. By the time a point on the Earth's surface has rotated from point **x** to point **y** (12 hours) the Moon has also moved a small amount, so the Earth has to rotate for an extra 25 minutes from point **y** to point **z** to be under the high water bulge.



What are spring tides and neap tides?

When the Earth, Moon and Sun are in line (during new and full Moon), the bulges of water caused by the Moon and Sun occur in the same place on the Earth's surface. The lunar tide and the solar tide are reinforcing each other - which leads to higher than average high tides,

and lower than average low tides. These are called spring tides.

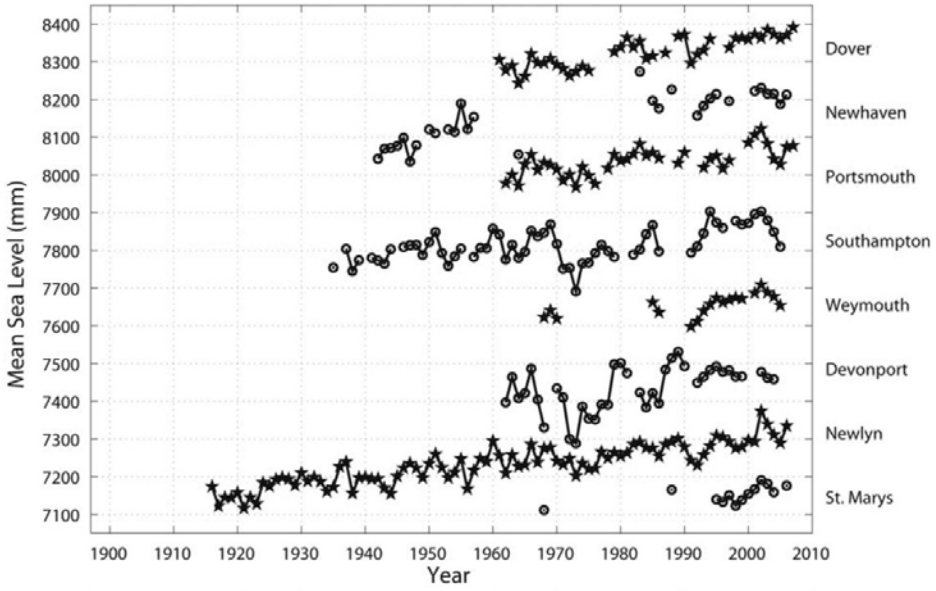
When the Earth, Moon and Sun form a right angle (at 90°) the high water caused by the lunar tide coincides with the low water of the solar tide. This produces lower than average high waters and higher than average low waters which are called neap tides. They occur approximately 7 days after spring tides.

How far ahead can the tide be predicted?

As we know the position of the Moon and the Sun very accurately, we are able to compute the tides many years ahead (or into the past).

Are there always two high tides a day?

No. Although most places in Britain experience approximately two high tides a day, there are some places which experience a double-high water (e.g. Southampton) or double-low water (e.g. Portland). This is caused by the shape of the coastline and the water depth. In some parts of the world there is just one high and low tide each day (e.g. Karumba, Australia), or even a mixed tide (changes between one and two tides per day at different times in the spring-neap cycle.)



The diagrams below show a typical tidal curve for Liverpool (a fairly sinusoidal shape) and Southampton (which had a more complex tidal pattern).

Do the tides follow a repeated pattern?

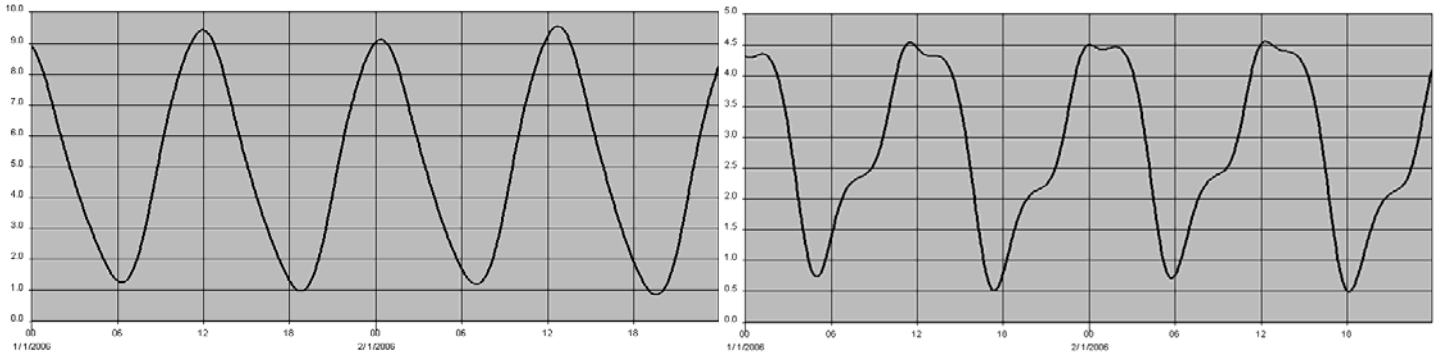
No. There are similarities - for example every 18.6 years, we experience larger than average tides - but they never actually repeat.

Do the planets have any affect on the tides?

Negligible. The effect of Venus is 0.0054% that of the Moon. For most places this corresponds to an effect of less than 0.1mm so in reality we don't worry too much about it.

Where can I obtain actual sea level data?

Sea level data recorded at UK tide gauge stations are kept by the



Left: a typical tidal curve for Liverpool ; Right: the more complex tidal curve experienced at Southampton.

National Oceanography Centre
Marine Data Products

British Oceanographic Data Centre (www.bodc.ac.uk). The National Oceanographic Centre (NOC) developed the UK's National Tide Gauge Network on behalf of the Environment Agency.

Where can I find data on long term sea level change in the UK?

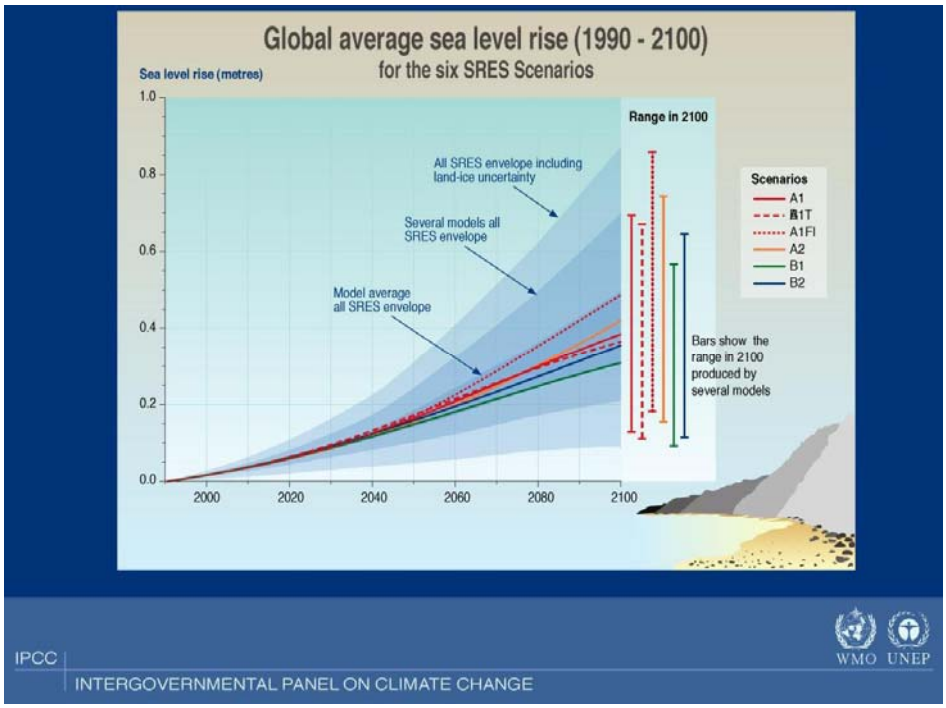
Monthly and annual mean values of sea level measured at UK sites since the 19th century are retained by the international Permanent Service for Mean Sea Level (PSMSL) which is based at the NOC.

The graph above shows the change in mean sea level for various locations in the English Channel.

How often do tsunamis affect the UK?

Not very often, as the Atlantic has fewer tsunamis in general than the Pacific or Indian Oceans, and it is difficult to identify small tsunamis without the otherwise energetic tide gauge records. However, two famous examples in the historical record may be quoted.

Storegga landslip - Along the coasts of the northern North Sea, Norwegian Sea and north eastern Atlantic ocean a very prominent sand layer was originally thought to have been deposited by a storm surge. More recently, it has been attributed to a large tsunami circa 7,100 years ago.



Lisbon earthquake (1755) - probably the most destructive tsunami in Europe during historical times occurred on 1st November 1755. An earthquake (now know as the Lisbon Earthquake) took place 200 km offshore from Portugal. The subsequent tsunami destroyed a large part of Lisbon and raised sea levels at Newlyn (Cornwall, UK) by up to 3 metres in ten minutes.

How much has global sea level risen in the past 100 years, how much will it rise in the next 100 and why is it rising anyway?

Global-average sea level is believed to have risen by between 10-20 cm during the past century and best estimates are that it will rise by approximately 50cm or more in the next 100 years. Rising sea levels are largely a consequence of the thermal expansion of the ocean, melting of low latitude glaciers (Alps, Rockies etc.) and many other factors, each of which are reviewed every few years by the Intergovernmental Panel on Climate Change (IPCC).

Where are the highest tides in the world?

Here are the top 7 mean spring tidal ranges around the world:

12.9m: Bay of Fundy, Nova Scotia
12.5m: Ungava Bay, Quebec
12.3m: Avonmouth, United Kingdom
11.4m: Granville, France
10.4m: Rio Gallegos, Argentina
9.6m: St. Helier, Channel Islands
9.2m: Cook Inlet, Alaska, USA

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