On the crest of a freak wave

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It was on 1 January 1995 that a wave over 25 metres high was recorded at the Draupner platform in the North Sea off the coast of Norway.

Ever since researchers have been attempting to understand the mechanisms which produced the 'Draupner wave' and are responsible for other abnormally large or 'freak' waves.

In Proceedings of the Royal Society A this week Thomas Adcock and Paul Taylor of Oxford University's Department of Engineering Science report that their new analysis may have the answers.

I asked Thomas about giant waves, predictions and The Poseidon Adventure…

OxSciBlog: How have people explained freak waves in the past?
Thomas Adcock: Freak waves will occur when the crests of many small waves come together to form a large wave. The random nature of waves means that this will occasionally happen – we are interested in any mechanism which will enhance this focusing.

Waves may be steered, either by currents (for instance, off South Africa) or by the sea-bed (such as near Hawaii), to produce abnormal waves. If all the waves are all moving in the same direction, then complex non-linear interactions can produce wave focusing. However, real ocean waves never all move in quite the same direction and it is a point of contention as to whether this really causes freak waves at sea.

OSB: Why is the Draupner wave interesting to study?
TA: The Draupner wave is one of few (possibly the only) instance of a high quality measurement of a freak wave in deep water. None of the mechanisms we discussed seem responsible for producing this wave.

One interesting feature is that under a large wave we expect to see a small but long and low depression (up to 1m deep) under a large wave group. Dan Walker, when a DPhil student in Oxford, found that the opposite was true for the Draupner wave. This confirms that there was something unusual about this wave.

OSB: What clues does it give to how freak waves form?
TA: The occurrence of the long low rise rather than a depression for the Draupner wave leads us to suggest the giant wave is the sum of two wave groups that were travelling at roughly right angles through each other. Mariners know that crossing sea-states are very unpleasant for the crew and potentially dangerous for ships – the wave which hit the Queen Mary in World War II, and which inspired the film The Poseidon Adventure, occurred in a crossing sea.

The idea for this paper was inspired by watching this video showing an unusual wave hitting a ship from the side. We began to think what would the consequences be if this was how the Draupner wave formed – and we realised this would explain the features which had been puzzling people about the wave.

OSB: How might your findings help to predict/mitigate their impact?
TA: Engineers and scientists are quite good at forecasting the general sea-state; Radio 4 long wave listeners will be familiar with the shipping forecast. If we can identify in which sea-states freak waves are likely then we can use this in design. For instance, if we forecast a storm in which freak waves are likely then we could route a ship around the

storm.

OSB: What further research is needed in this area?
TA: Whilst scientists understand the basic features of most sea-states fairly well, we do not really understand at a local level the physics when a sea-state changes rapidly – for example if the wind suddenly starts blowing in a different direction. What we really need is far more high quality measurements of individual large waves – without this we cannot know whether our theories are right.

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