WEATHER BRIEFING

CHRIS TIBBS EXPLAINS METEOTSUNAMIS

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The Balearic Islands were hit by a relatively small tsunami on 16 July this year when 1-2m waves flooded beaches and ports. Tragically a German holidaymaker was washed out to sea and drowned. Yachts in harbours were damaged and moorings broken and at least one large powerboat ended up on a beach. It was reported that the event lasted for two hours.

Ciutadella, on the western end of Menorca, along with ports in Mallorca were affected. Although we do not associate tsunamis with the Mediterranean. this was not a unique event in this area. In Catalan Spanish the name Rissaga is used to describe the phenomena.

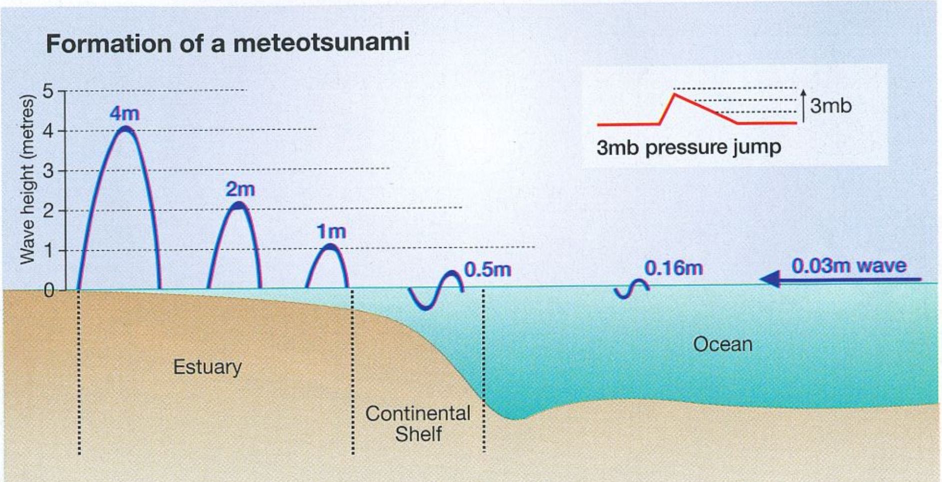
Although a tsunami occurred there were no reports of undersea earthquakes, volcanoes, or landslides that create the devastating tsunamis that we occasionally see in the Pacific and Indian Oceans. In this case the tsunami was triggered by meteorological conditions.

Meteorological tsunamis or meteotsunamis were first described in the 1930s with the term meteorological tsunami being first used in the '60s. They are found around the world and, while still not completely understood, destructive events like this one are quite rare.

Meteotsunamis have been recognised and documented particularly in enclosed waters of the Mediterranean, Adriatic Sea, and the Great Lakes. There was one documented along the English Channel (June 2011), which caused flooding on the causeway to St Michael's Mount and a wave swept up the Yelm River in Devon like the Severn Bore. Although generally considered local phenomena, there have been cases where the same meteotsunami has extended over 1,000km.

The main driving force of a meteotsunami is a moving atmospheric disturbance: this needs to give a change in surface pressure in the region of 2-5mb over a 10-minute period. This is likely to be caused by a thunderstorm or large squall, the passage of a front – which would most likely be a cold front – or an atmospheric gravity wave.

Such a change in pressure would only give a change in water level of 0.02-0.05m (1mb gives 1cm change) so it needs additional forces to make this wave grow into a more destructive event. The moving direction and speed of the atmospheric system must be equal to the local shallow water wave speed and direction. Then it is the continental shelf and the slope topography that determines if the wave will build, and if all factors coincide the waves will build. Furthermore the geography of the bays and harbours will have an additional effect in focusing the waves. Deep narrow bays and inlets tend to get the higher waves.



How a meteotsunami forms: a 3mb pressure jump over the ocean causes a 0.03m wave. As it travels, this increases in height by resonance until, finally, at the head of an estuary it can reach up to 5m high

Seiches, or standing waves, and meteotsunamis are often grouped together but are two different events. Seiches occur in enclosed or semi-enclosed bodies of water where strong winds and rapid changes in pressure push water to one end of the body of water. When the wind eases the water rebounds to the other boundary then continues to oscillate between the two. This can last for hours or even days before the energy dissipates.

This is different from the meteotsunami generated by a change in pressure rather than by a strong wind. However, to complicate things further the meteotsunami can create a seiche motion in narrow bays or harbours with waves bouncing back and forth. There is a technical difference between the waves as seiches are standing waves whilst meteotsunamis are progressive waves.

Meteotsunamis are probably more widespread than we think as they go largely unrecorded and the majority are small and insignificant. Since the devastating seismic tsunamis in the Indian Ocean 2004 and Japan in 2011 there has been a large increase in research and observations to better understand and warn for tsunamis. This has led to an increased frequency of measurement of water levels, which is picking up smaller events.

Although meteotsunamis are generally small in nature and restricted to local events as they lack the energy of the seismic tsunami, there have been some significant examples in the past with the largest recorded wave height of 5.9m in Vela Luka (Croatia) in 1978 and one of 4m in Ciutadella Harbour in 2006. Both of these caused significant damage to boats and property. As with the more familiar seismic tsunami the first sign of the arrival of the tsunami is receding water, which can ground vessels in the harbour before the arrival of the first wave.

Can they be predicted?

Forecasting these events is still in its infancy and falls into four areas:

- Identifying atmospheric conditions favourable for development.
- Real-time detection of these conditions
- High resolution tide gauges
- Numerical modelling.

The Spanish meteorological service has a forecast based on identifying suitable atmospheric conditions and there is an experimental model called the Balearic Rissaga Forecasting System (BRIFS, at www.socib.eu). It will be a while before a good forecasting and detection system comes into effect and until it does there will always be a small risk of getting caught in one of these events. Over the next few years we'll hear more about them as detection and forecasting techniques improve. ■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