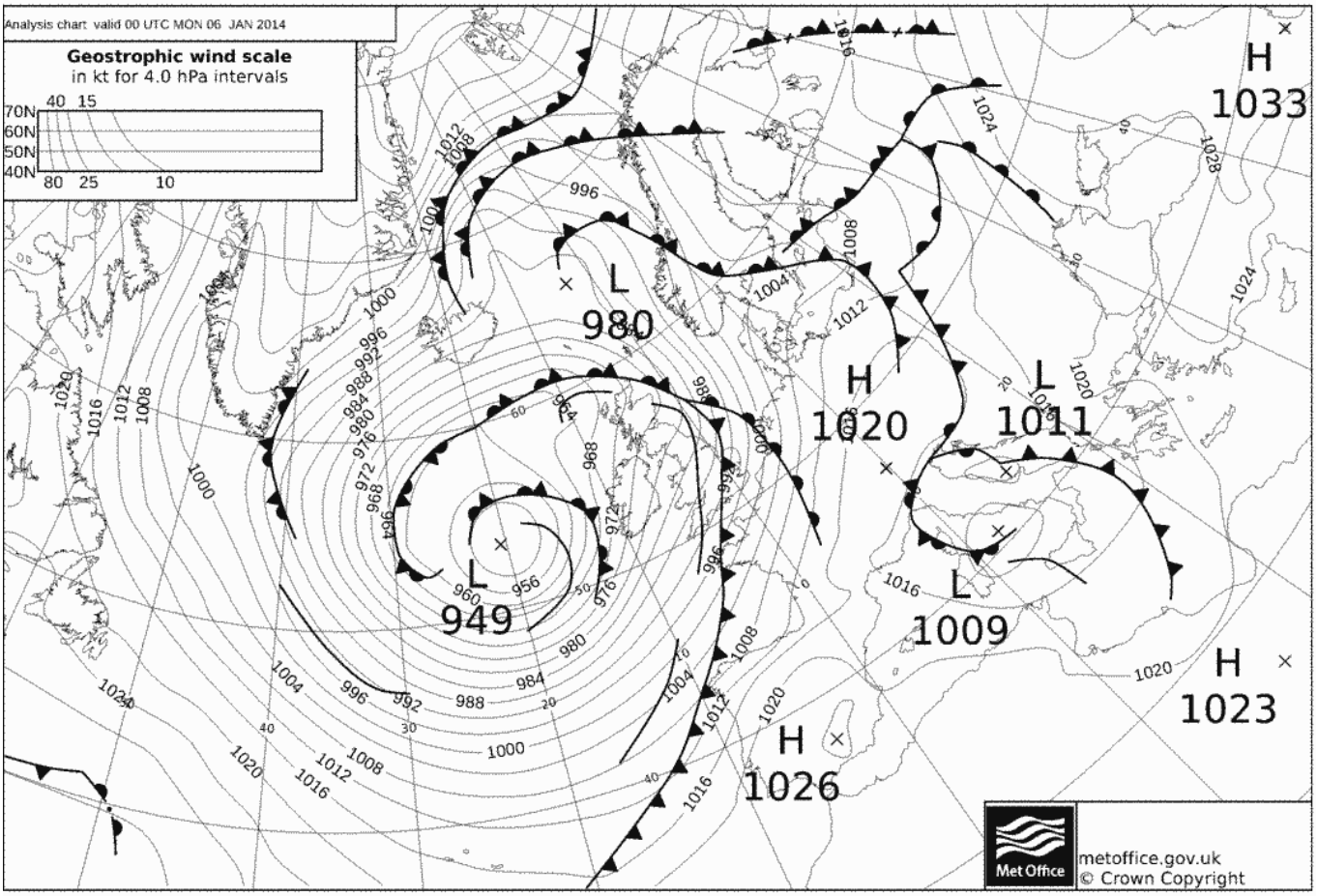
Cornwall - Damaging Swell of 6th January 2014

On 6th January a very large and powerful swell arrived in Cornwall. It had been generated in mid Atlantic by a large, deep depression which had been giving a prolonged period of westerly gales across almost the full width of the Atlantic, particularly around 50 degrees north.



There was extensive damage particularly, but not exclusively, along the north Cornwall coast. The swells seemed enormously damaging considering their size. The peak significant wave height at Sevenstones was 9 - 10 metres. This size of swell occurs typically once or twice a year, in fact the swell height at Sevenstones was virtually identical to that on 27th December 2013. A significantly larger swell, 11 metres, has a return period of 5 years, and on March 10th 2008 the swell reached 12 metres!

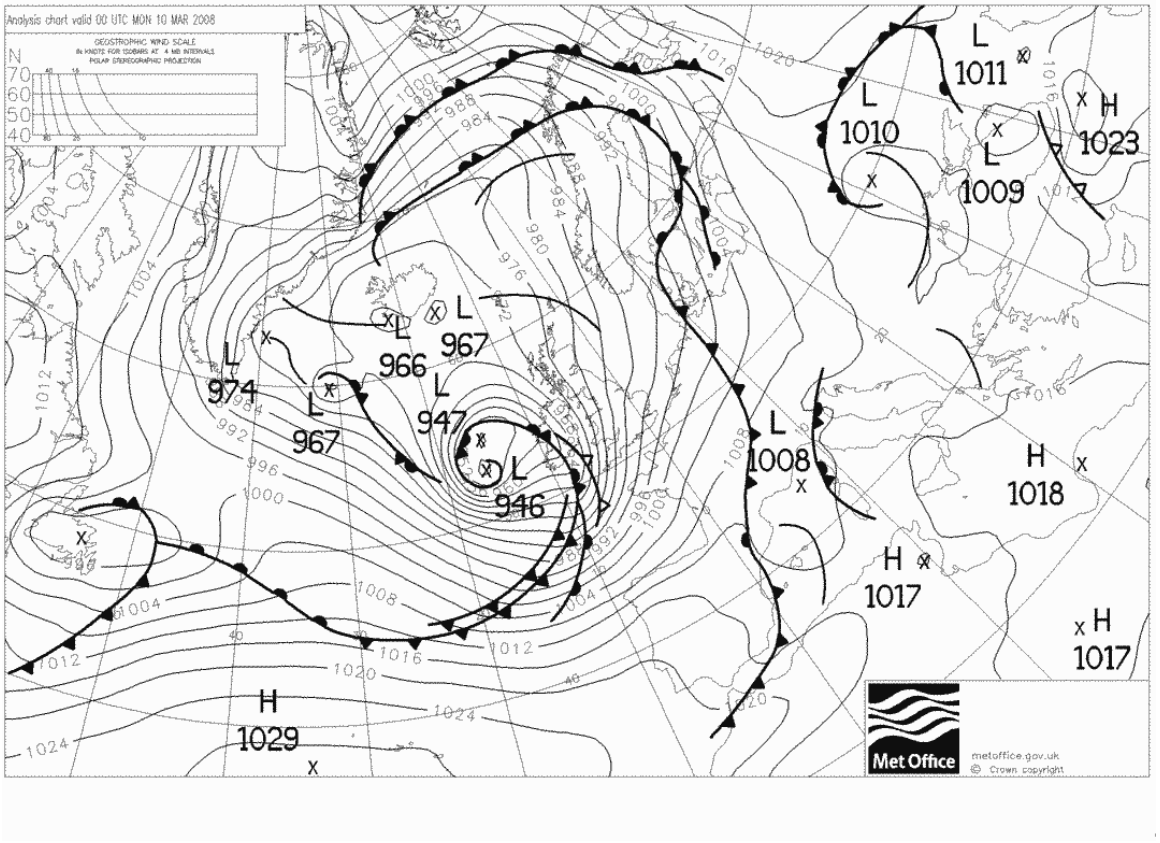
In Cornwall the wind was also not exceptional on 6th January. The maximum gusts were in the region of 65-70mph and less than 50mph at my station in Penzance. In the 2008 event I recorded 73mph, and considerable storm damage due to the wind resulted.

So why, on this occasion, was so much damage done by the sea? An important factor was the fact that the waves were, having been formed well away in mid Atlantic, long period and fast moving. Such waves are subject to considerable focusing, resulting in some exceptional breaking waves at times. Norman Lynagh kindly supplied me with the following information:-

Numerical modelling shows that the peak energy period has been up to 16-18 seconds. In deep water this gives a crest-to-crest wavelength of 400-500 metres. In 100m water depth the crest-to-crest wavelength would be around 350-450m while in 20m waterdepth the crest-to-crest wavelength would be 200-250m. Such long waves with a significant height of 10m or so are immensely powerful. It's a situation that occurs only very rarely in the south of England.

The speed of waves is governed by their wavelength. When a swell is first generated all sorts of wavelengths are generated at the same time. As the swells move away from the generation area the wavelengths sort themselves out, the faster, powerful waves in front. The first storm waves to arrive have the most punch to them and can do the most damage. In the recent event these powerful first waves arrived, certainly as far as Cornwall is concerned, around high tide.

In 2008 the period was still up to 14 seconds and the tide height was similar. However, it does appear that in the recent event the swell decreased **less** as it worked it's away along the north coast than is normally the case. The severity of the 2008 event decreased rapidly eastwards due to the depression (see 10th March synoptic chart below) diving south eastward across south-west England.



The January 6th storm came after 2 weeks of large seas, with the wind always in much the same direction. As a result 'beach top' sand levels were already low on many of the beaches exposed to this direction, beach profiles tend to steepen with offshore winds and flatten with onshore winds. In theory the sand removed from the top of the beach is dropped near where the waves break at low tide, the sand bar then giving some protection, though in reality the situation is never that simple. The low upper beach sand levels, and elevated high tides, would have allowed some very large waves to break near shore.

It is likely that the recent prolonged spell of quite stormy weather had weakened some sea defences, leaving them vulnerable. Also, sadly, some sea defences were not maintained as you would expect. The sea wall at Lamorna was badly damaged in 2004, and 10 years on little had been done, the recent storm extending the damage.

This is not to take away just how destructive the evening high tide of 5th, and the morning high tide of 6th were. At Perranporth there was a 12-15 feet cliff in the sand cut out at the high tide limit just in front of the Watering Hole in just these two tides. The wind was not a directly onshore NW, the direction you would normally expect to be most erosive, but from a relatively sheltered WSW direction.

It may be that the extreme erosion in this case was due to concave refraction. Normally the headland to the west of Perranporth offers some protection, but these very long wavelength storm waves refract to a greater extent than smaller wavelength swells. Concave refracting (focusing) may well have occurred just to the east of the headland. It is interesting that Towan beach, Newquay, in a similar position to the east of Pentire was similarly badly hit. The road to the Blue Reef Aquarium was badly damaged.

On January 6th I was at Sennen observing the conditions, here are a couple of photographs.

As is normal the larger waves come in sets, but at around 09:50 there were two consecutive waves significantly larger than any others in the previous 30 minutes or so, causing a big reaction from the crowd of onlookers. These occasional ‘supersets’ are a not unusual feature and are down to constructive interference of 2 different wavelength swells, very well known to surfers. As the data buoys measure significant wave height averaged over a period of 20 minutes, these supersets, even if they hit the buoy, would only have a minimal affect on the significant wave height. However, it may well be that on this occasion they were responsible for some of the extreme damage. As well as some man made features, such as the ‘Pepper Pot’ on the end of Portreath pier, a number of natural coastal features have been significantly changed by the storm.

It was lucky the event happened 3 days after the spring tide, when the astronomical tides at Newquay were 0.6m greater! Bad though it was it could have been worse, so by no means the ‘Perfect Storm’. Makes you think.

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