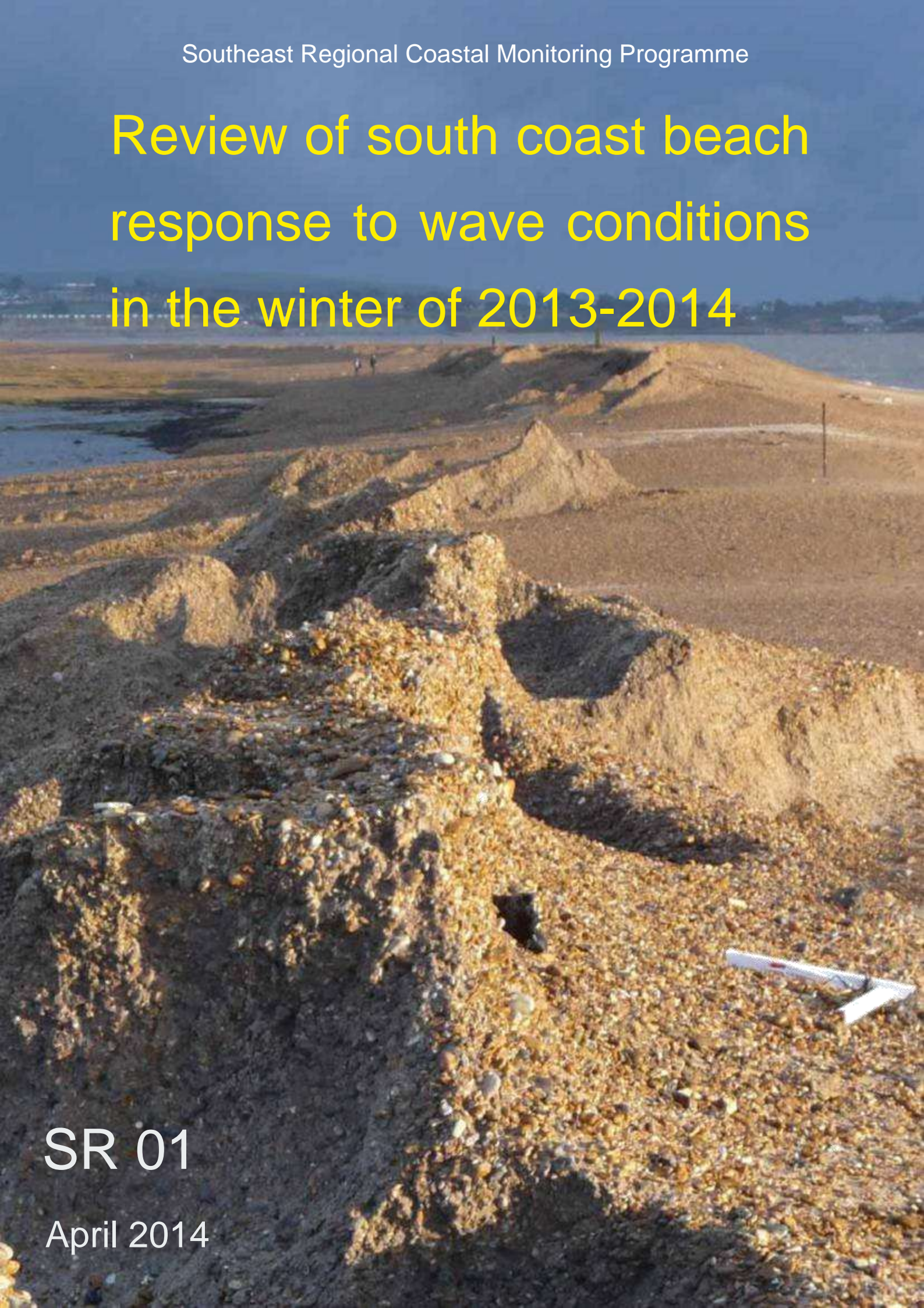


Southeast Regional Coastal Monitoring Programme

Review of south coast beach response to wave conditions in the winter of 2013-2014

SR 01

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Review of south coast beach response to wave conditions in the winter of 2013-2014

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Channel Coastal Observatory

Summary

This report examines the regional beach erosion patterns and wave conditions arising during the winter, compared to previous years. Comparisons are also made with previously calculated extreme events, which are used to define standards of service, along the southeast coastline. The implications for financial planning within the Medium Term Plan are highlighted. The report covers the extents of the Southern and Southeast Coastal Groups, with data drawn from the regional coastal monitoring programmes.

1.1 Introduction

During the winter of 2013-2014 the southern coast of England was exposed to an unusual and prolonged combination of severe storms. Although the state-of-the-nation flood defence assessment ordered by the Government is expected to address flood defence structures, it is not believed to include the beach management sites *i.e.* the beaches themselves. However, such beaches are the primary sea defence along a significant proportion of the southeast, in all about 190 km of frontage. Furthermore, the beaches are the focus for significant coastal expenditure in the southeast.

Whilst detailed assessment has not been possible at all sites, the observed trends at the locations analysed (Figure 1) are considered to be representative of the patterns observed at most sites where beach management forms the primary method of protection.



Figure 1: Locations of beach management sites assessed in this report

1.2 Wave climate

Wave conditions at the beach management sites are measured using wave buoys.

Many sites in central southern England experienced between 5 and 7 storms during the winter period (October 2013 to February 2014), as shown in Figure 2. A "storm" is defined here as having wave heights above that which would be expected, on average, once a year *i.e.* the 1 year return period.

• 50% of all the storms measured during the last 10 years occurred in 2013/14



Figure 2: Frequency and distribution of storms exceeding the 1:1 year return period

Furthermore, not only were there many more storms during this winter (Figure 2), but they were also larger storms than occurred in previous years. For example, a number of storms exceeded 1 in 10 years, or 1 in 50 years return periods¹, as shown in Figure 3.

Two-page summary reports for the wave conditions at each site are presented in Section 2.

As a note of caution, calculation of the longer return periods (e.g. 1 in 50 years) can be skewed by a few storms clustered together, especially where the measurements span only a few years. Preliminary calculations suggest that if the recent stormy period is included, what is defined now as a 1 in 50 year storm would be considered a 1 in 15 year storm at many of the locations.

This demonstrates the need for long term records in order to calculate extreme return periods, and shows how misleading old statistics can be.

¹ Based on wave extremes calculated from buoy deployment to 2102

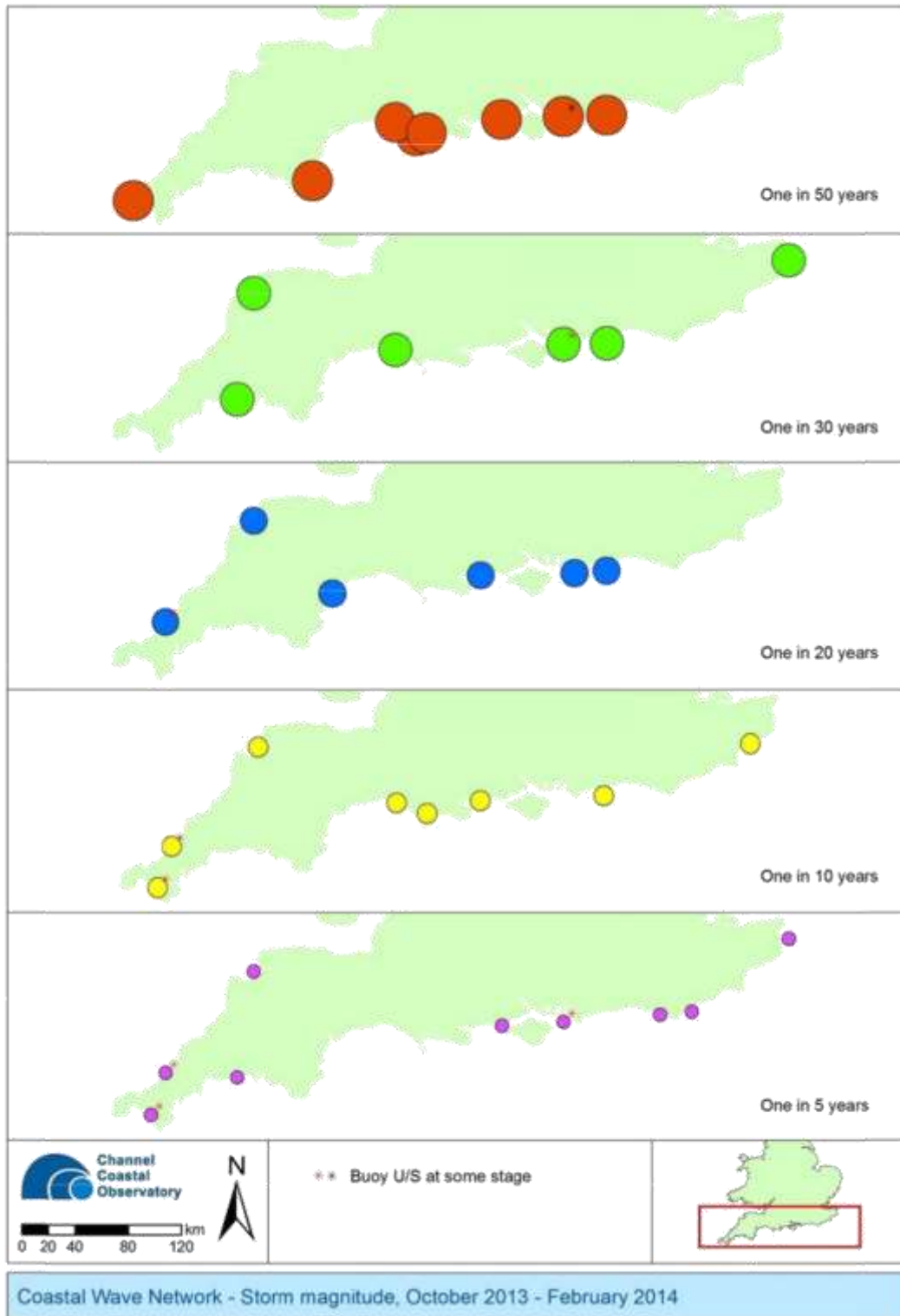


Figure 3: Distribution of storms exceeding the 1.5 year return period between October 2013 and February 2014

1.3 Beach erosion

The sequence of storms this winter has had a considerable impact on many of the beaches. Although not all beaches in the region are analysed in detail, the results of beach monitoring given in this report are considered to be widely representative.

A summary showing the beach erosion for winter 2013/2014, compared with cumulative change measured over several years (typically 10 years) is given in Table 1. More detail for each beach site analysed can be found in the site reports in Section 3.

Site	2013/14 erosion (-) or accretion (+) (m ³)	Long term erosion (-) or accretion (+) (m ³)	Long term monitoring period	Frontage length surveyed (km)
Kent				
Oldstairs	-21,000	-7,500*	2003 to 2013	0.7
East Sussex				
Eastbourne	-35,000	-10,000*	2003 to 2012	3.7
Seaford	-30,000	-1,400*	2003 to 2013	4.2
West Sussex				
Elmer	-18,000	+6,200	2008 to 2013	1.6
Pagham	+51,000	+162,000	2003 to 2013	3.8
Medmerry ²	-85,000	-35,000*	2003 to 2013	0.9
Hampshire				
Hayling Island	-7,300	+9,300*	2003 to 2013	1.3
Hurst Spit	-47,000	-16,000*	2003 to 2013	1.8
Dorset				
Bournemouth	-144,000	-24,000*	2010 to 2013	4.5
Sandbanks	-30,000	-18,000	2007 to 2013	1.3
Ringstead	-2,100	+3,200	2007 to 2013	0.5
Preston Beach	-8,100	-1,800*	2007 to 2013	2.3
Weymouth	-7,300	+33,000	2003 to 2013	1.9
Chiswell	-40,000	+16,000	2006 to 2013	0.7

Table 1: Beach change volumes during winter storms, compared to longer term volume * denotes net change after recycling management

² Affected by breach engineering works

The alarming erosion rates of the past winter reflect a combination of the intensity and the clustering of the storms. During a typical winter, storms are more widely spaced (in time), allowing time for natural recovery of the beaches, particularly the upper beach. However, during the winter 2013/2014 a string of severe storms occurred in just a few weeks; sometimes the beach had less than a week's recovery period before the next storm, and hence each storm was working on a progressively weakened beach.

The following key points summarise the regional conclusions:

- ***Erosion rates greater than 25 times the annual average were observed at numerous sites***
- ***Large scale erosion was found at all the sites analysed, except one. Average beach volume losses of 25,000 m³ per km of coastline length were typical³***
- ***More than 470,000 m³ losses in total were observed across just 25 km of frontage***
- ***Beach management covers some 190 km in southeast England***
- ***Losses were highly variable due to differences in beach orientation and the number/size of storms***
- ***Beach losses were lower at some sites where supply of beach material is limited, with the result that at some sites the beach was completely stripped from the bedrock***
- ***Some sites which had been generally accreting over 10 years experienced large scale erosion***
- ***The pattern at all sites analysed, except for one, is of accelerated erosion or a change from accretion to large scale erosion***
- ***At some sites, the sediment loss is likely to be temporary, and natural processes are expected to partially rebuild the beaches***

³ At beaches where there was enough material to permit this level of erosion

1.4 Financial planning of scheme management

In general, the southeast coast is heavily managed, with beach management schemes covering significant stretches of coastline. The implication of the winter storms is that beach management schemes which usually require regular beach recharge or recycling have needed significantly more beach operations than usual, in order to maintain the beach at an adequate standard of service (examples in Table 2).

Winter 2013-2014 beach management operations	
Site	Winter operations
Folkestone	5 times the usual recycling operations this winter
Pevensy	Near continuous recycling from November to February
Eastbourne	4 times the usual replenishment volume was needed to restore beach to pre-storm condition
Hayling Island	4 times normal beach operations to maintain beach
Hurst Spit	5 times normal maintenance recycling

Table 2: Additional beach management operations during winter period 2013/14

In addition, at sites where replenishment is planned in the future, many are likely to require action sooner than was previously planned, up to 5 to 10 years earlier in some cases. This impacts significantly on the spend profile outlined in the Medium Term Plan. In summary, it is recommended that:

- ***The timing of all beach management schemes identified in the MTP be reviewed and where necessary re-phased***
- ***The volumes of material required for recycling or recharge are re-assessed for each scheme; this is likely to increase immediate demand by at least 1,000,000 m³***
- ***Provision is made for the supply of additional beach recharge material to allow sites to return to the previous level of service, which is now significantly reduced at many locations***

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Cover photograph: Andrew Colenutt, Hurst Spit, 15 February 2014	

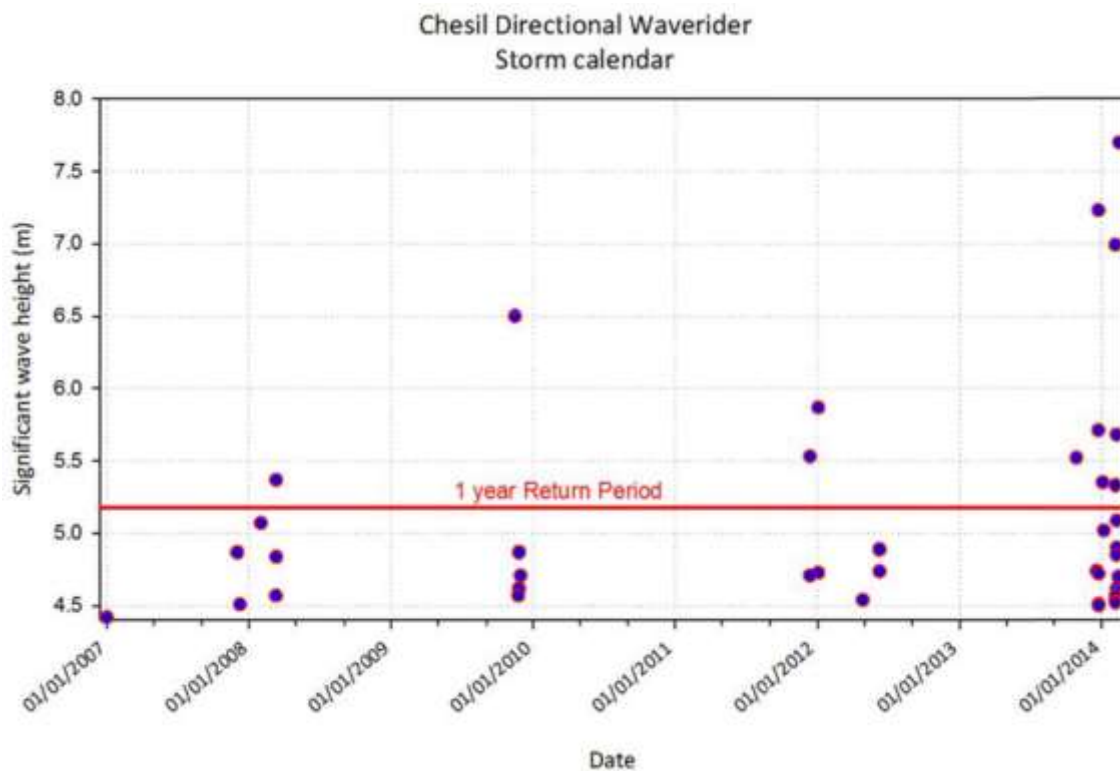
Section 2 - Coastal Wave Network Storm Report

Introduction

This report contains a summary of storm wave conditions measured at each of the Waverider buoy locations in southern England, particularly for the extended period of storms from October 2013 to February 2014.

The Storm Calendar shows all the storms measured at a site since the buoy was deployed, and can show at a glance both how extreme the storms were and whether they were clustered together.

The example Storm Calendar shown below is from Chesil Beach; each dot on the graph represents the highest wave conditions in each individual storm e.g. on 14 November 2009, average wave height was 6.5 m at the peak of the storm⁴. On 14 February 2014, the average wave height was 7.7 m at the storm peak.



The 1 year Return Period represents the wave conditions which can be expected on average once a year *i.e.* wave heights of 5.2 m (Hs) can be expected at Chesil once a year on average. However, in

⁴ Note that the significant wave height (Hs) shown is the average of the highest one-third of waves measured in a 30 minute period - it does not represent the highest single wave (Hmax), which can be twice the Hs.

general, beaches can be modified quite significantly by 3 or 4 lower storms in an average year; these are the dots shown below the red line on the graph.

Other Return Periods can be calculated, as a rule of thumb, for up to 10 times the length of time the buoy has been deployed. At Chesil, for example, the buoy has been deployed more than 5 years, so 50 year Return Periods can be calculated.

The storm at Chesil on 14 February 2014 had a Return Period of greater than 1 in 50 years *i.e.* wave heights of 7.7 m Hs can be expected on average once in 50 years.

Storm Calendars and Return Periods have been calculated for the nearshore Waverider buoy sites in southern England. The Return Periods for the storms experienced at each site during the storm season October 2013 to February 2014 are shown in the Table below.

- Week beginning 28 Oct 13 was the St Jude's storm (28 October 2013)
- Week beginning 23 Dec 13 encompassed the Christmas Eve storms
- Week beginning 03 Feb 14 spanned the extended stormy period from 5 - 8 February
- Week beginning 10 Feb 14 included the St Valentine's storm

Waves were clearly breaking over the buoys during many of these storms and several of the buoys were damaged by these exceptional conditions, including Porthleven, Chesil and Perranporth. Tor Bay Waverider was cut from its moorings and later drifted eastwards and was found washed up on Chesil Beach (the data was later recovered from the buoy).



Tor Bay Waverider buoy, washed up on Chesil Beach. Photo courtesy of Fugro EMU Limited

Storm season October 2013 - February 2014

	October	November				December				January					February	
Week beginning	28 Oct	04 Nov	11 Nov	18 Nov	25 Nov	02 Dec	09 Dec	16 Dec	23 Dec	30 Dec	06 Jan	13 Jan	20 Jan	27 Jan	03 Feb	10 Feb
Goodwin Sands	5							1	30		1				1	1
Folkestone	1								1						10	
Pevensey Bay	5														1	1
Seaford	1								5						1	5
Rustington	20								50	1					10	30
Bracklesham Bay	1								1	1					1	20
Hayling Island	5														50	30
Sandown Bay									1	1	1				1	1
Milford-on-Sea	5								1	1					5	50
Boscombe								1	1	10					20	1
Weymouth										10					50	1
Chesil	1								50	1					50	50
West Bay	1								30						50	10
Dawlish															20	1
Tor Bay																
Start Bay															50	50
Looe Bay									5		1				30	30
Porthleven									5	10	5					
Penzance									1						50	
Perranporth	10								5					20		
Bideford	10								30	20	10			5	30	
Minehead	1			1												1
Weston Bay																

50 >= 1:50 year Return Period
 30 >= 1:30 years
 20 >= 1:20 years
 10 >= 1:10 years
 5 >= 1:5 years
 1 >= 1:1 year
 Buoy U/S

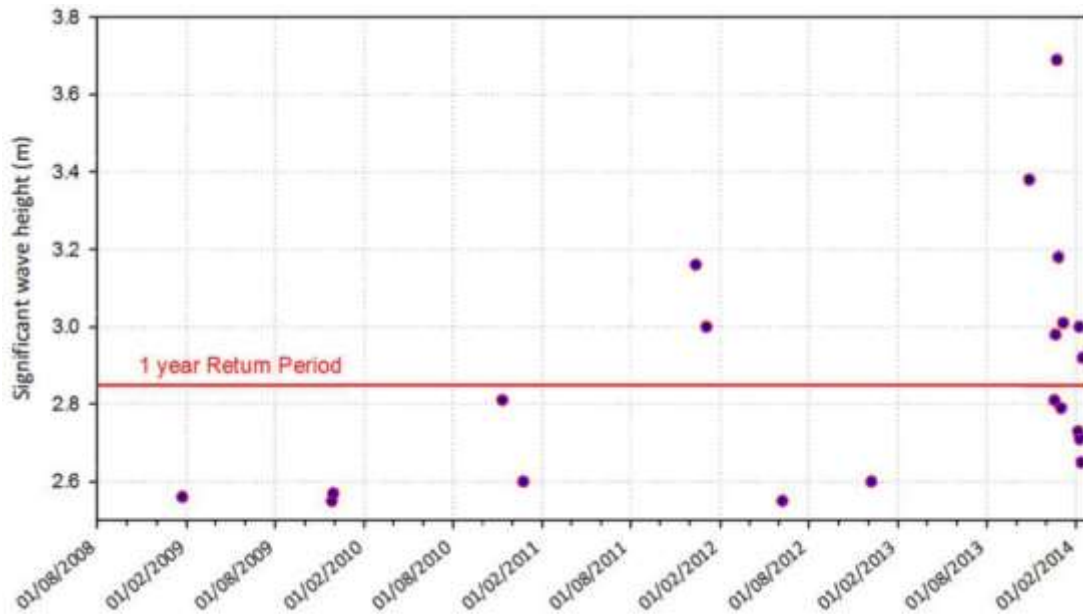
Storm report for Goodwin Sands, Kent

Wave conditions are measured with a buoy moored about 6 km off Deal, in a about 10m CD water depth. The buoy has been in place for 5 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2008, 9 individual storms have exceeded the 1 year Return Period. 7 of those storms (78 %) occurred between October 2013 and February 2014.



Storm calendar for Goodwin Sands. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms since 2008 are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2008 to 2012.

Highest storms at Goodwin Sands		
Date	Wave height (metres)	Return Period
24/12/2013	3.69	Greater than 1 in 30 years
28/10/2013	3.38	> 1 in 5 years
27/12/2013	3.18	> 1 in 5 years
13/12/2011	3.16	> 1 in 3 years
06/01/2014	3.01	> 1 in 2 years
03/01/2012	3.00	> 1 in 2 years
08/02/2014	3.00	> 1 in 2 years
21/12/2013	2.98	> 1 in 1 year
15/02/2014	2.92	> 1 in 1 year

Storms exceeding 1 year Return Period at Goodwin Sands since deployment in 2008. Those occurring during the storm season October 2013 to February 2014 are shaded pink

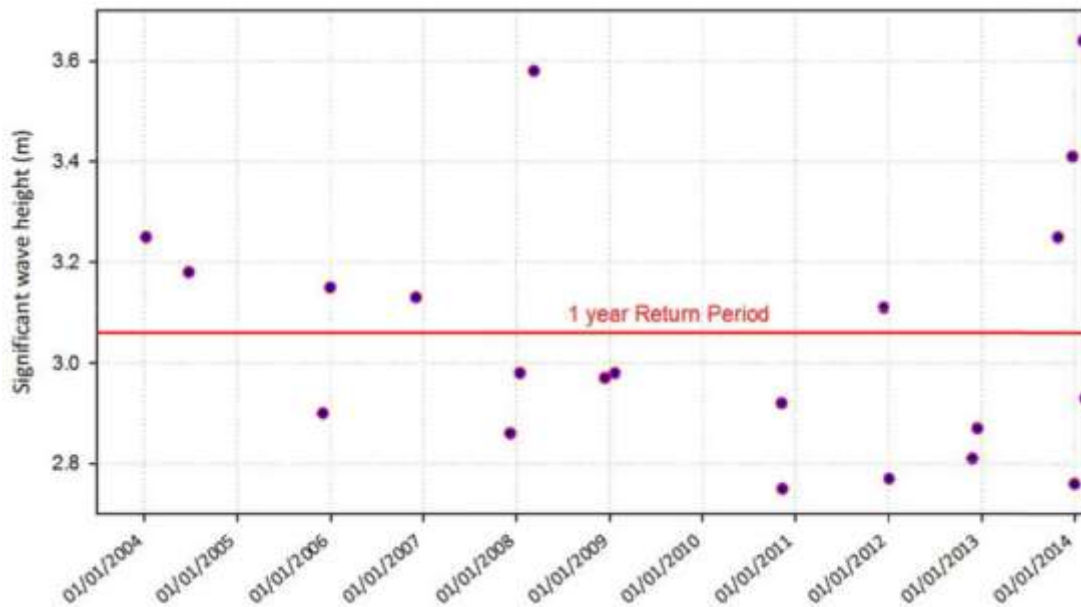
Storm report for Folkestone, Kent

Wave conditions are measured with a buoy moored about 700 m off Folkestone, in about 10 m CD water depth. The buoy has been in place for 10 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2003, 9 individual storms have exceeded the 1 year Return Period. 3 of those storms (33 %) occurred between October 2013 and February 2014.



Storm calendar for Folkestone. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

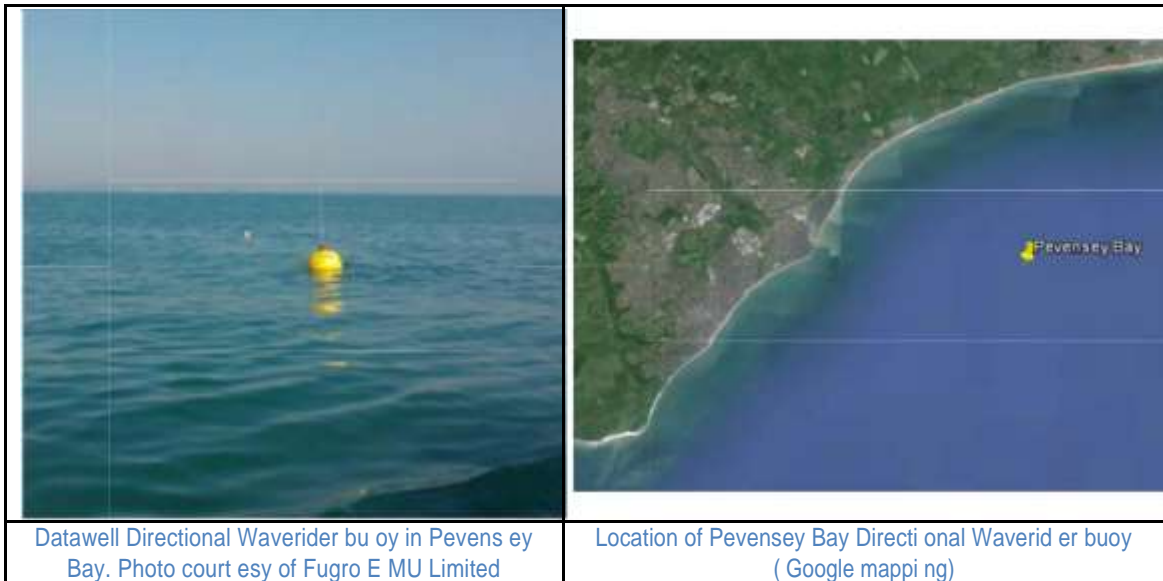
The individual storms since 2003 are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2003 to 2012.

Highest storms at Folkestone		
Date	Wave height (metres)	Return Period
05/02/2014	3.64	Greater than 1 in 10 years
10/03/2008	3.58	> 1 in 5 years
24/12/2013	3.41	> 1 in 3 years
08/01/2004	3.25	> 1 in 2 years
28/10/2013	3.25	> 1 in 2 years
23/06/2004	3.18	> 1 in 1 year
30/12/2005	3.15	> 1 in 1 year
03/12/2006	3.13	> 1 in 1 year
13/12/2011	3.11	> 1 in 1 year

Storms exceeding 1 year Return Period at Folkestone since deployment in 2003. Those occurring during the storm season October 2013 to February 2014 are shaded pink

Storm report for Pevensey Bay, East Sussex

Wave conditions are measured with a buoy moored about 5 km off Pevensey, in about 10 m CD water depth. The buoy has been in place for 10 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2003, 14 individual storms have exceeded the 1 year Return Period. 3 of those storms (21 %) occurred between October 2013 and February 2014.



Storm calendar for Pevensey Bay. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms since 2003 are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2003 to 2012.

Highest storms at Pevensy Bay		
Date	Wave height (metres)	Return Period
28/10/2013	4.44	Greater than 1 in 5 years
13/01/2011	4.42	> 1 in 5 years
13/12/2011	4.42	> 1 in 5 years
15/02/2014	4.26	> 1 in 3 years
18/01/2007	4.23	> 1 in 3 years
02/11/2003	4.18	> 1 in 2 years
08/11/2010	4.13	> 1 in 2 years
03/12/2006	4.10	1 in 2 years
11/11/2010	4.02	> 1 in 1 year
05/02/2014	4.00	> 1 in 1 year
13/12/2008	3.97	> 1 in 1 year
15/01/2008	3.96	> 1 in 1 year
31/01/2004	3.92	> 1 in 1 year
10/03/2008	3.89	1 in 1 year

Storms exceeding 1 year Return Period at Pevensy Bay since deployment in 2003. Those occurring during the storm season October 2013 to February 2014 are shaded pink

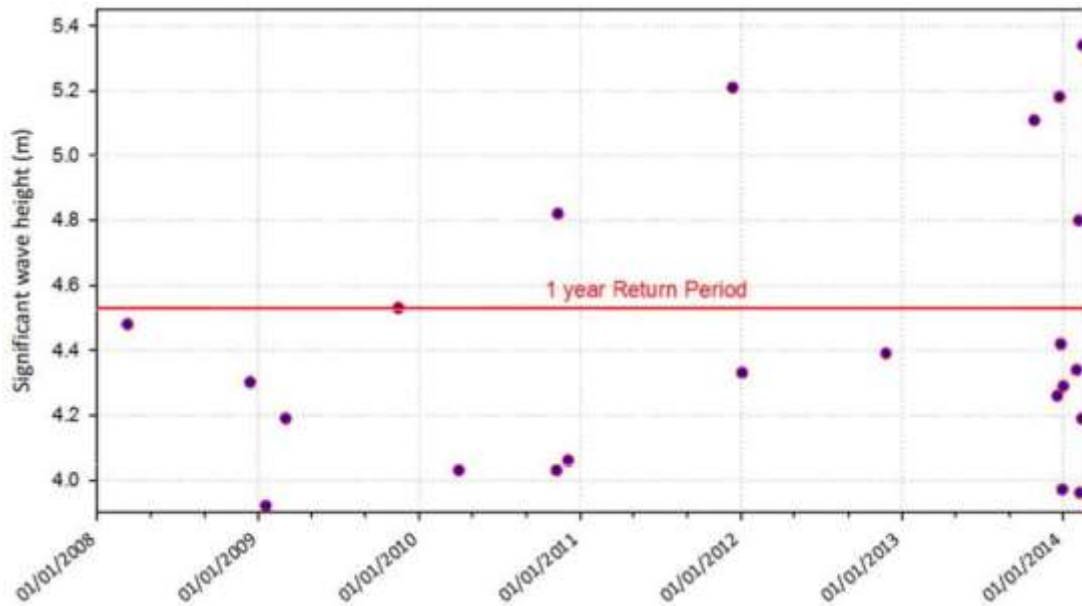
Storm report for Seaford, East Sussex

Wave conditions are measured with a buoy moored about 1 km off Seaford, in about 10 m CD water depth. The buoy has been in place for 5 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2008, 7 individual storms have exceeded the 1 year Return Period. 4 of those storms (57 %) occurred between October 2013 and February 2014.



Storm calendar for Seaford. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms since 2008 are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2008 to 2012.

Highest storms at Seaford		
Date	Wave height (metres)	Return Period
14/02/2014	5.34	Greater than 1 in 5 years
13/12/2011	5.21	> 1 in 5 years
24/12/2013	5.18	> 1 in 5 years
28/10/2013	5.11	> 1 in 3 years
11/11/2010	4.82	> 1 in 2 years
05/02/2014	4.80	> 1 in 1 year
14/11/2009	4.53	1 in 1 year

Storms exceeding 1 year Return Period at Seaford since deployment in 2008. Those occurring during the storm season October 2013 to February 2014 are shaded pink

Storm report for Rustington, West Sussex

Wave conditions are measured with a buoy moored about 7 km off Rustington, in about 10 m CD water depth. The buoy has been in place for 10 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2003, 11 individual storms have exceeded the 1 year Return Period. 6 of those storms (55 %) occurred between October 2013 and February 2014.



Storm calendar for Rustington. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms since 2003 are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2003 to 2012.

Highest storms at Rustington		
Date	Wave height (metres)	Return Period
24/12/2013	5.46	Greater than 1 in 50 years
15/02/2014	4.97	> 1 in 30 years
28/10/2013	4.82	> 1 in 20 years
03/12/2006	4.81	1 in 20 years
05/02/2014	4.72	> 1 in 10 years
13/12/2011	4.55	> 1 in 5 years
18/01/2007	4.32	> 1 in 3 years
12/02/2014	4.18	> 1 in 1 year
08/01/2004	4.17	> 1 in 1 year
13/12/2008	4.01	> 1 in 1 year
01/01/2014	4.01	> 1 in 1 year

Storms exceeding 1 year Return Period at Rustington since deployment in 2003. Those occurring during the storm season October 2013 to February 2014 are shaded pink

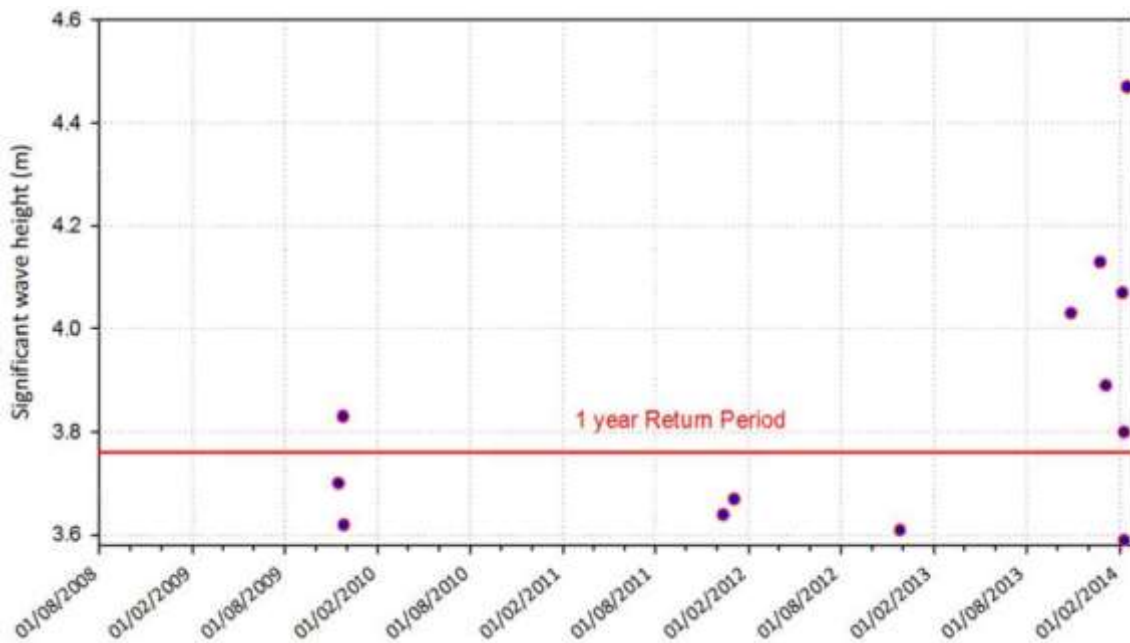
Storm report for Bracklesham Bay, West Sussex

Wave conditions are measured with a buoy moored about 2km off Medmerry, in about 10 m CD water depth. The buoy has been in place for 5 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2008, 7 individual storms have exceeded the 1 year Return Period. 6 of those storms (86 %) occurred between October 2013 and February 2014.



Storm calendar for Bracklesham Bay. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms since 2008 are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2008 to 2012.

Highest storms at Bracklesham Bay		
Date	Wave height (metres)	Return Period
15/02/2014	4.47	Greater than 1 in 20 years
24/12/2013	4.13	> 1 in 3 years
05/02/2014	4.07	> 1 in 3 years
28/10/2013	4.03	> 1 in 2 years
03/01/2014	3.89	> 1 in 1 year
23/11/2009	3.83	> 1 in 1 year
08/02/2014	3.80	> 1 in 1 year

Storms exceeding 1 year Return Period at Bracklesham Bay since deployment in 2008. Those occurring during the storm season October 2013 to February 2014 are shaded pink

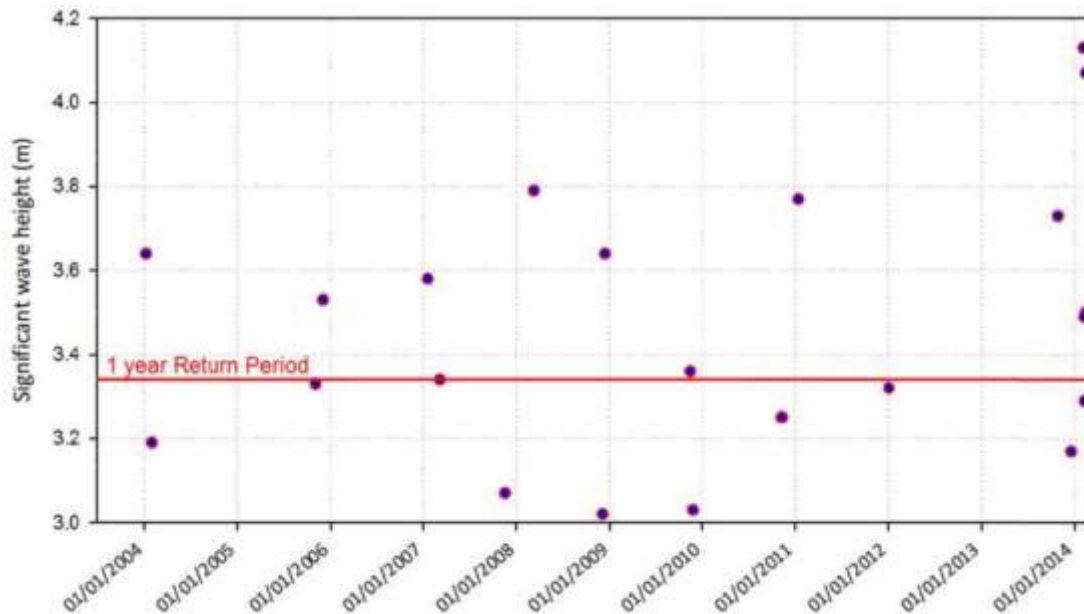
Storm report for Hayling Island, Hampshire

Wave conditions are measured with a buoy moored about 4.7 km off Hayling Island, in about 10 m CD water depth. The buoy has been in place for 10 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2003, 13 individual storms have exceeded the 1 year Return Period. 5 of those storms (38 %) occurred between October 2013 and February 2014.



Storm calendar for Hayling Island. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

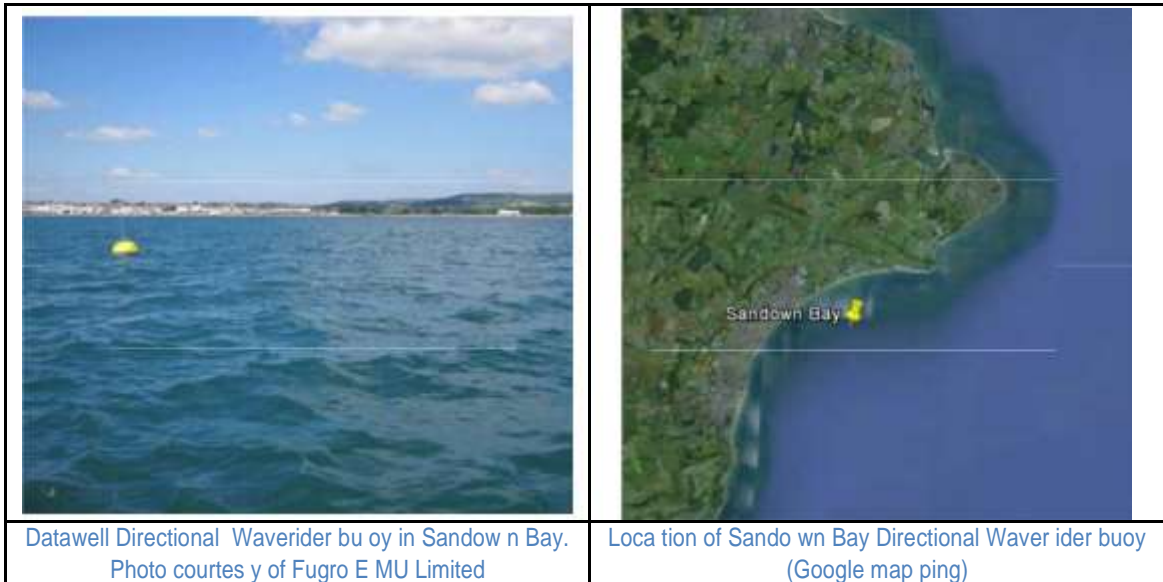
The individual storms since 2003 are ranked in the table below, together with the Return Period (this season's storms are shaded pink, note that the Waverider was U/S between 20 Dec and 11 Jan). The Return Period statistics were last calculated for the period 2003 to 2012.

Highest storms at Hayling Island		
Date	Wave height (metres)	Return Period
05/02/2014	4.13	1 in 50 years
15/02/2014	4.07	Greater than 1 in 30 years
10/03/2008	3.79	> 1 in 5 years
13/01/2011	3.77	> 1 in 5 years
28/10/2013	3.73	> 1 in 5 years
08/01/2004	3.64	> 1 in 3 years
13/12/2008	3.64	> 1 in 3 years
18/01/2007	3.58	1 in 3 years
02/12/2005	3.53	> 1 in 2 years
12/02/2014	3.50	> 1 in 2 years
08/02/2014	3.49	1 in 2 years
14/11/2009	3.36	> 1 in 1 year
06/03/2007	3.34	1 in 1 year

Storms exceeding 1 year Return Period at Hayling Island since deployment in 2003. Those occurring during the storm season October 2013 to February 2014 are shaded pink

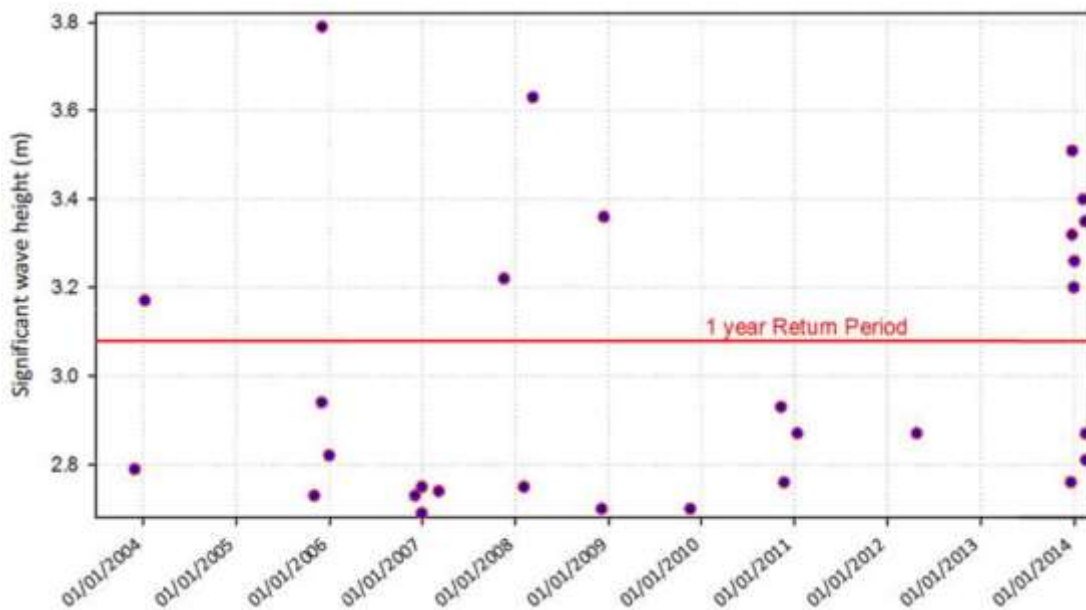
Storm report for Sandown Bay, Isle of Wight

Wave conditions are measured with a buoy moored about 1.2 km off Sandown, in about 10 m CD water depth. The buoy has been in place for 10 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2003, 11 individual storms have exceeded the 1 year Return Period. 6 of those storms (55%) occurred between October 2013 and February 2014.



Storm calendar for Sandown Bay. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

The individual storms since 2003 are ranked in Table 1, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2003 to 2012.

Highest storms at Sandown Bay		
Date	Wave height (metres)	Return Period
02/12/2005	3.79	Greater than 1 in 10 years
10/03/2008	3.63	> 1 in 5 years
24/12/2013	3.51	> 1 in 3 years
05/02/2014	3.40	> 1 in 3 years
13/12/2008	3.36	> 1 in 2 years
12/02/2014	3.35	> 1 in 2 years
23/12/2013	3.32	> 1 in 2 years
01/01/2014	3.26	> 1 in 1 year
18/11/2007	3.22	> 1 in 1 year
30/12/2013	3.20	> 1 in 1 year
08/01/2004	3.17	> 1 in 1 year

Storms exceeding 1 year Return Period at Sandown Bay since deployment in 2003. Those occurring during the storm season October 2013 to February 2014 are shaded pink

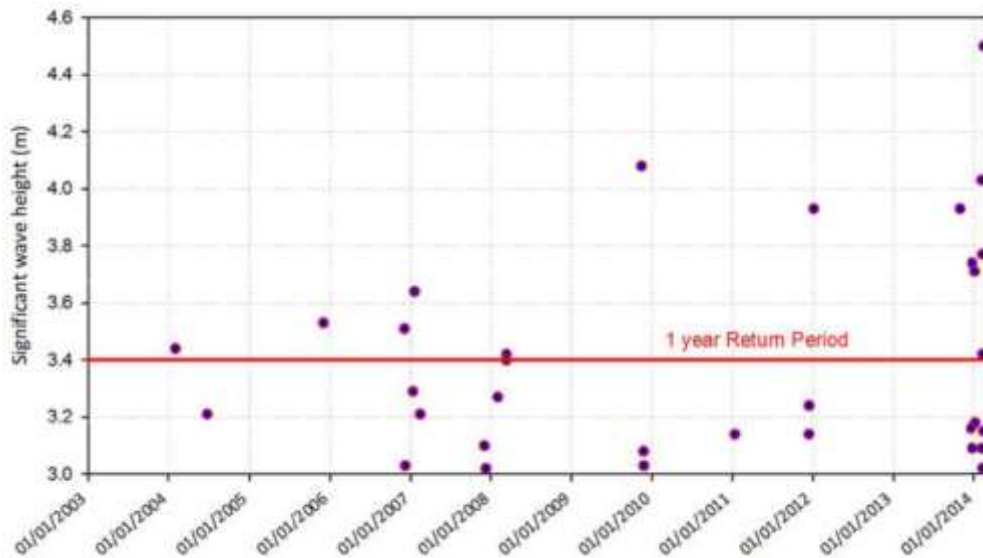
Storm report for Milford-on-Sea, Hampshire

Wave conditions are measured with a buoy moored about 1.4 km off Milford-on-Sea, in approx. 10- 12 m CD water depth.

	
<p>Datawell Directional Waverider buoy off Milford-on-Sea. Photo courtesy of Fugro EMU Limited</p>	<p>Location of Milford Directional Waverider buoy (Google mapping)</p>

In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach on average once a year *i.e.* the 1 year Return Period.

Since 2003, 15 individual storms have exceeded the 1 year Return Period. 7 of those storms (47%) occurred between October 2013 and February 2014



Storm calendar for Milford-on-Sea. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

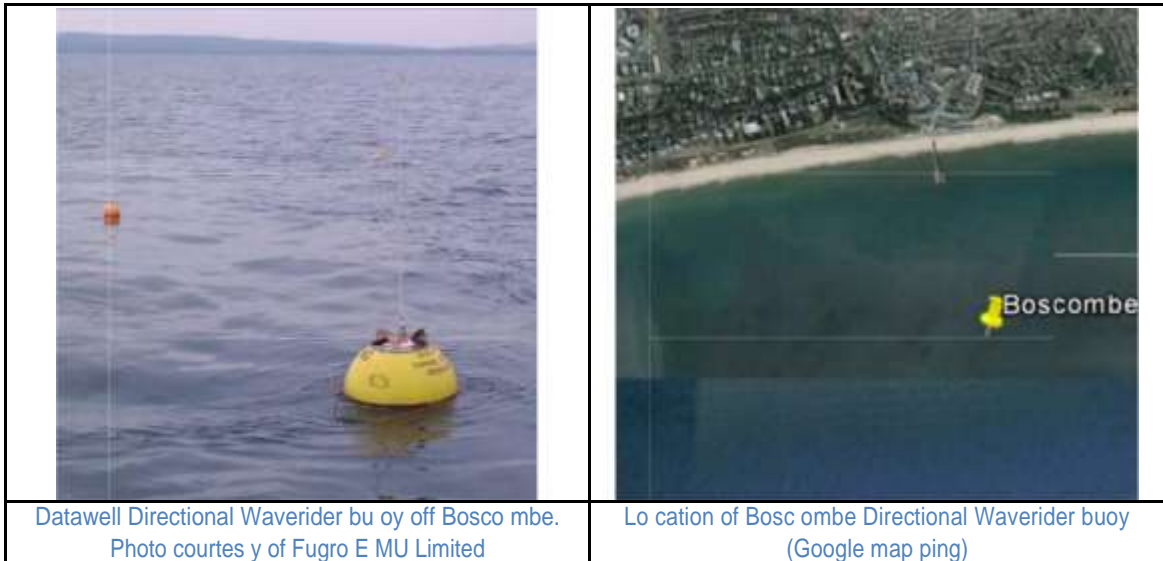
The individual storms since 2003 are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2003 to 2012.

Highest storms at Milford-on-Sea since 2003		
Date	Wave height (metres)	Return Period
14/02/2014	4.5	1 in 50 years
14/11/2009	4.1	1 in 10 years
05/02/2014	4.0	Greater than 1 in 5 years
03/01/2012	3.9	1 in 5 years
28/10/2013	3.9	1 in 5 years
08/02/2014	3.8	> 1 in 3 years
24/12/2013	3.7	1 in 3 years
03/01/2014	3.7	1 in 3 years
18/01/2007	3.6	1 in 2 years
02/12/2005	3.5	> 1 in 1 year
03/12/2006	3.5	> 1 in 1 year
31/01/2004	3.4	1 in 1 year
10/03/2008	3.4	1 in 1 year
08/02/2014	3.4	1 in 1 year
10/03/2008	3.4	1 in 1 year

Storms exceeding 1 year Return Period at Milford-on-Sea since 2003. Those occurring during the storm season October 2013 to February 2014 are shaded pink

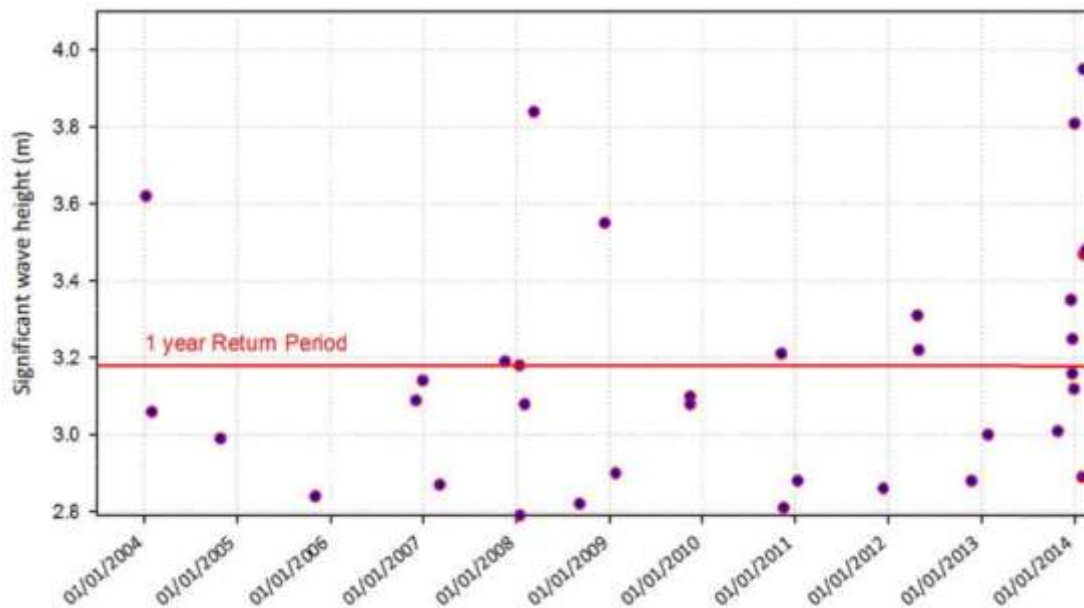
Storm report for Boscombe, Dorset

Wave conditions are measured with a buoy moored about 350m off Boscombe, in about 10 m CD water depth. The buoy has been in place for 10 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2003, 15 individual storms have exceeded the 1 year Return Period. 7 of those storms (47%) occurred between October 2013 and February 2014.



Storm calendar for Boscombe. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

The individual storms since 2003 are ranked in Table 1, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2003 to 2012.

Highest storms at Boscombe		
Date	Wave height (metres)	Return Period
05/02/2014	3.95	Greater than 1 in 20 years
10/03/2008	3.84	> 1 in 10 years
01/01/2014	3.81	> 1 in 10 years
08/01/2004	3.62	> 1 in 5 years
13/12/2008	3.55	> 1 in 3 years
14/02/2014	3.48	> 1 in 3 years
05/02/2014	3.47	1 in 3 years
12/02/2014	3.47	1 in 3 years
18/12/2013	3.35	> 1 in 1 year
25/04/2012	3.31	> 1 in 1 year
24/12/2013	3.25	> 1 in 1 year
30/04/2012	3.22	> 1 in 1 year
08/11/2010	3.21	> 1 in 1 year
18/11/2007	3.19	> 1 in 1 year
13/01/2008	3.18	1 in 1 year

Storms exceeding 1 year Return Period at Boscombe since deployment in 2003. Those occurring during the storm season October 2013 to February 2014 are shaded pink

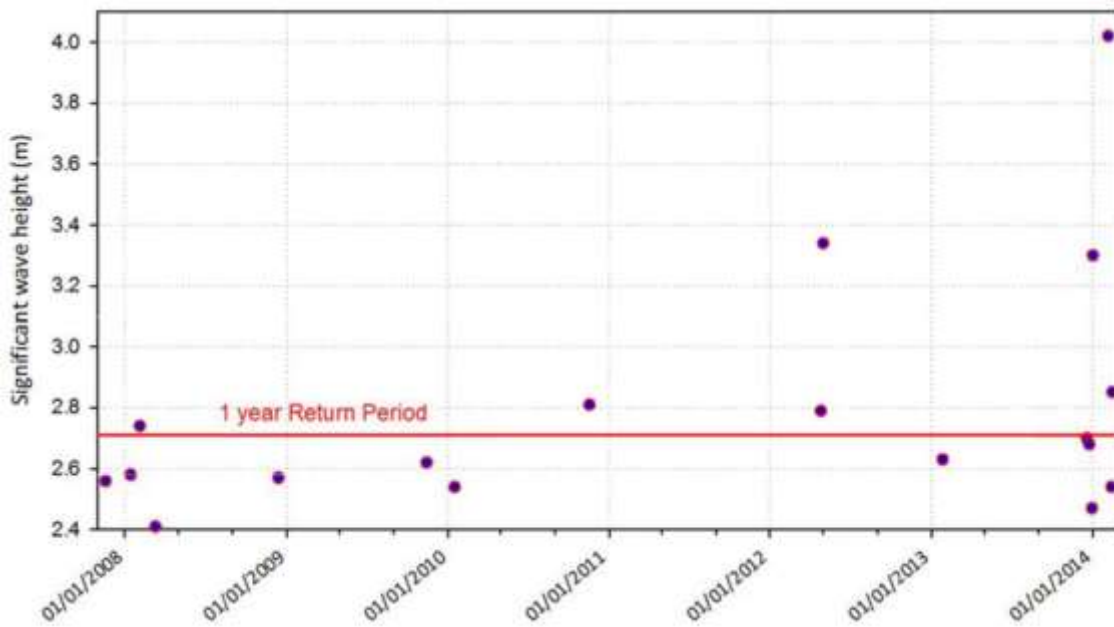
Storm report for Weymouth Bay, Dorset

Wave conditions are measured with a buoy moored about 1.5 km off Weymouth, in about 10 m CD water depth. The buoy has been in place for 7 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2007, 7 individual storms have exceeded the 1 year Return Period. 3 of those storms (43 %) occurred between October 2013 and February 2014.



Storm calendar for Weymouth. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

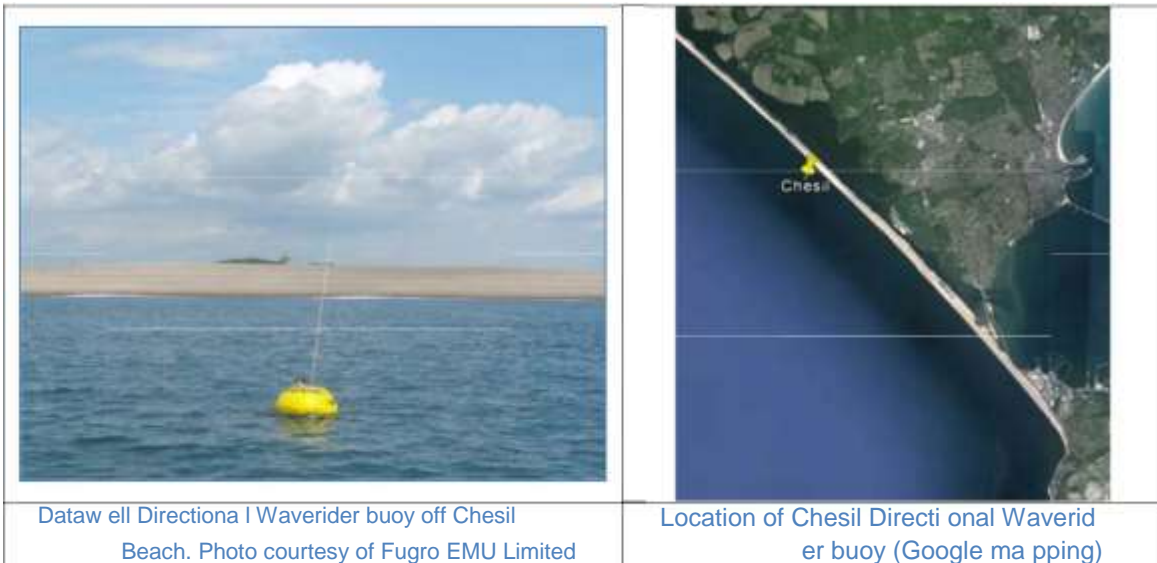
The individual storms since 2007 are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2007 to 2012.

Highest storms at Weymouth		
Date	Wave height (metres)	Return Period
05/02/2014	4.02	Greater than 1 in 50 years
30/04/2012	3.34	> 1 in 20 years
01/01/2014	3.30	> 1 in 10 years
14/02/2014	2.85	> 1 in 1 year
17/11/2010	2.81	> 1 in 1 year
25/04/2012	2.79	> 1 in 1 year
03/02/2008	2.74	> 1 in 1 year

Storms exceeding 1 year Return Period at Weymouth since deployment in 2007. Those occurring during the storm season October 2013 to February 2014 are shaded pink

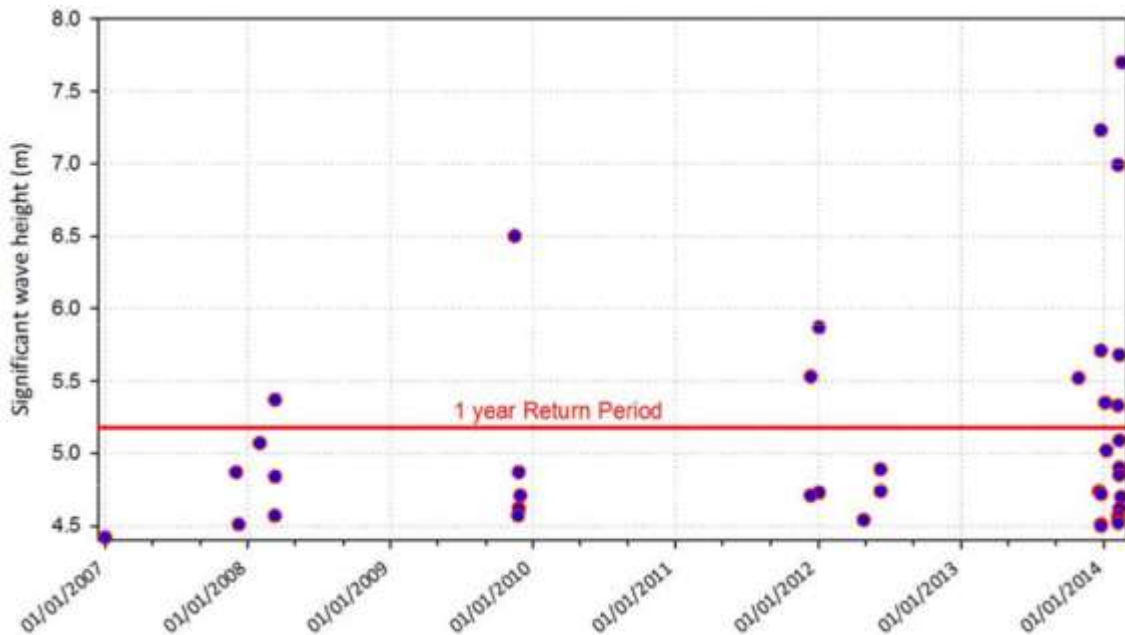
Storm report for Chesil, Dorset

Wave conditions are measured with a buoy moored about 350 m off Chesil Beach, adjacent to The Fleet, in about 12 m CD water depth. The buoy has been in place for 7 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2007, 12 individual storms have exceeded the 1 year Return Period. 8 of those storms (67%) occurred between October 2013 and February 2014.



Storm calendar for Chesil. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink).

The last time the Return Period statistics were calculated suggests that the 3 highest storms are classified as greater than 1 in 50 year events. The statistics will be revised in the light of the new measurements.

Highest storms at Chesil		
Date	Wave height (metres)	Return Period
14/02/2014	7.70	Greater than 1 in 50 years
24/12/2013	7.23	> 1 in 50 years
05/02/2014	6.99	> 1 in 50 years
14/11/2009	6.50	> 1 in 10 years
03/01/2012	5.87	> 1 in 2 years
23/12/2013	5.71	> 1 in 2 years
08/02/2014	5.68	> 1 in 2 years
12/12/2011	5.53	> 1 in 2 years
28/10/2013	5.52	> 1 in 2 years
10/03/2008	5.37	> 1 in 1 year
03/01/2014	5.35	> 1 in 1 year
05/02/2014	5.33	> 1 in 1 year

Storms exceeding 1 year Return Period at Chesil since deployment in 2007. Those occurring during the storm season October 2013 to February 2014 are shaded pink

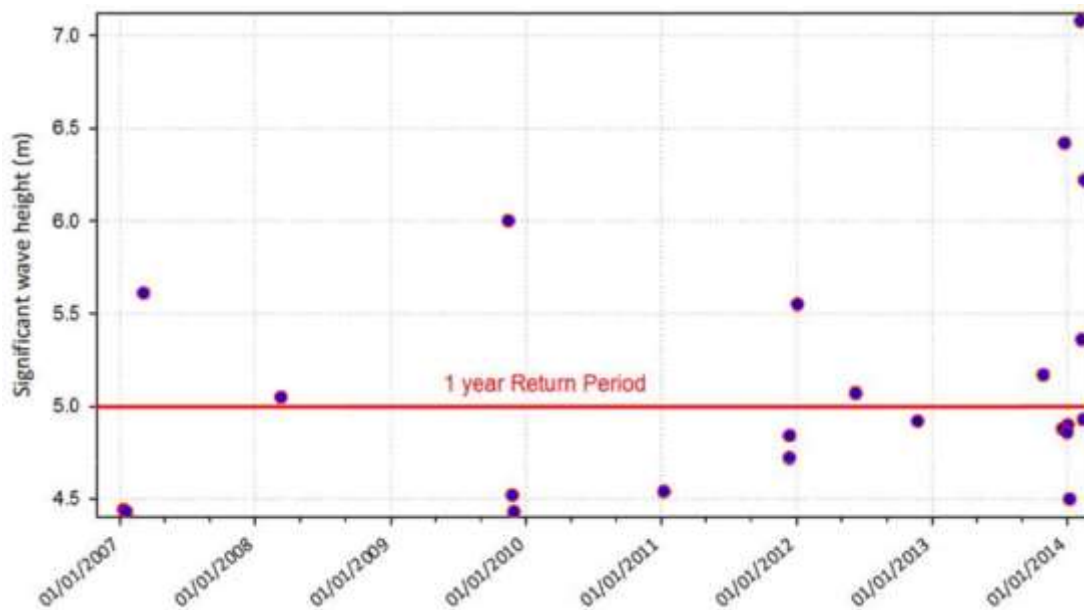
Storm report for West Bay, Dorset

Wave conditions are measured with a buoy moored about 1.2 km off West Bay, in about 10 m CD water depth. The buoy has been in place for 7 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2006, 10 individual storms have exceeded the 1 year Return Period. 5 of those storms (50%) occurred between October 2013 and February 2014.



Storm calendar for West Bay. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

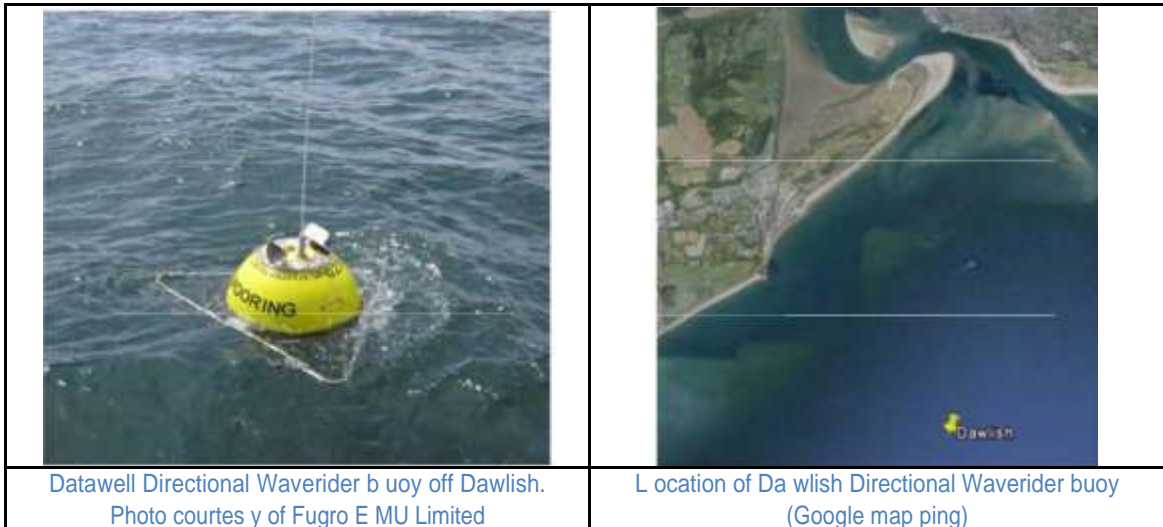
The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2007 to 2012.

Highest storms at West Bay		
Date	Wave height (metres)	Return Period
05/02/2014	7.08	Greater than 1 in 50 years
24/12/2013	6.42	> 1 in 30 years
15/02/2014	6.22	> 1 in 10 years
14/11/2009	6.00	> 1 in 10 years
06/03/2007	5.61	> 1 in 3 years
03/01/2012	5.55	> 1 in 3 years
08/02/2014	5.36	> 1 in 2 years
28/10/2013	5.17	> 1 in 1 year
07/06/2012	5.07	> 1 in 1 year
10/03/2008	5.05	> 1 in 1 year

Storms exceeding 1 year Return Period at West Bay since deployment in 2006. Those occurring during the storm season October 2013 to February 2014 are shaded pink.

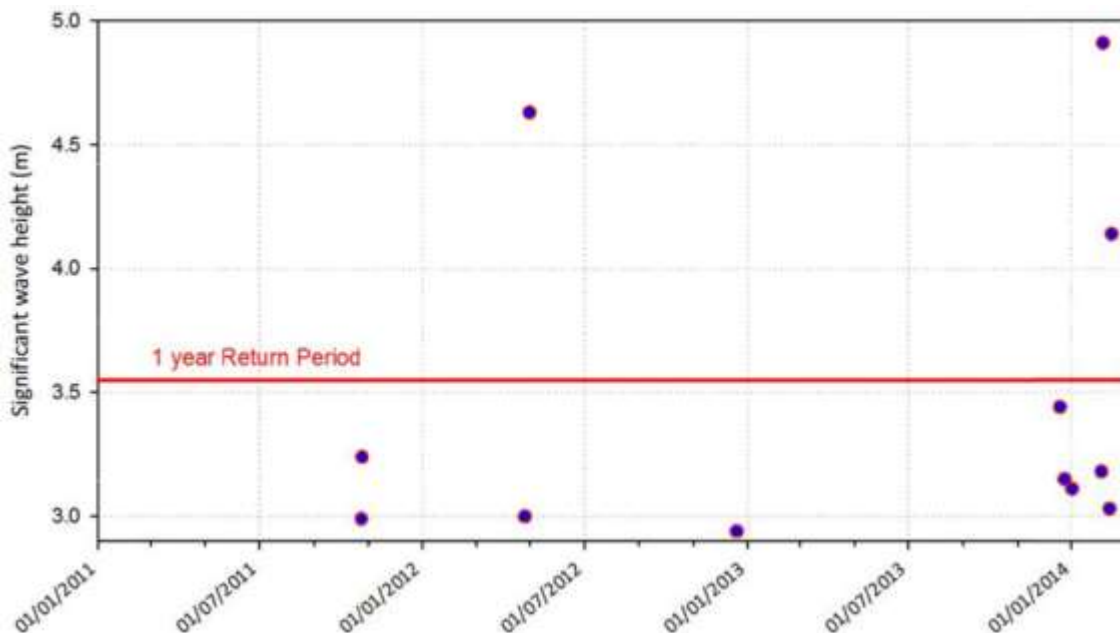
Storm report for Dawlish, Devon

Wave conditions are measured with a buoy moored about 2.3 km off Dawlish, in about 10 m CD water depth. The buoy has been in place for 3 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2011, 3 individual storms have exceeded the 1 year Return Period. 2 of those storms (68 %) occurred between October 2013 and February 2014.



Storm calendar for Dawlish. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

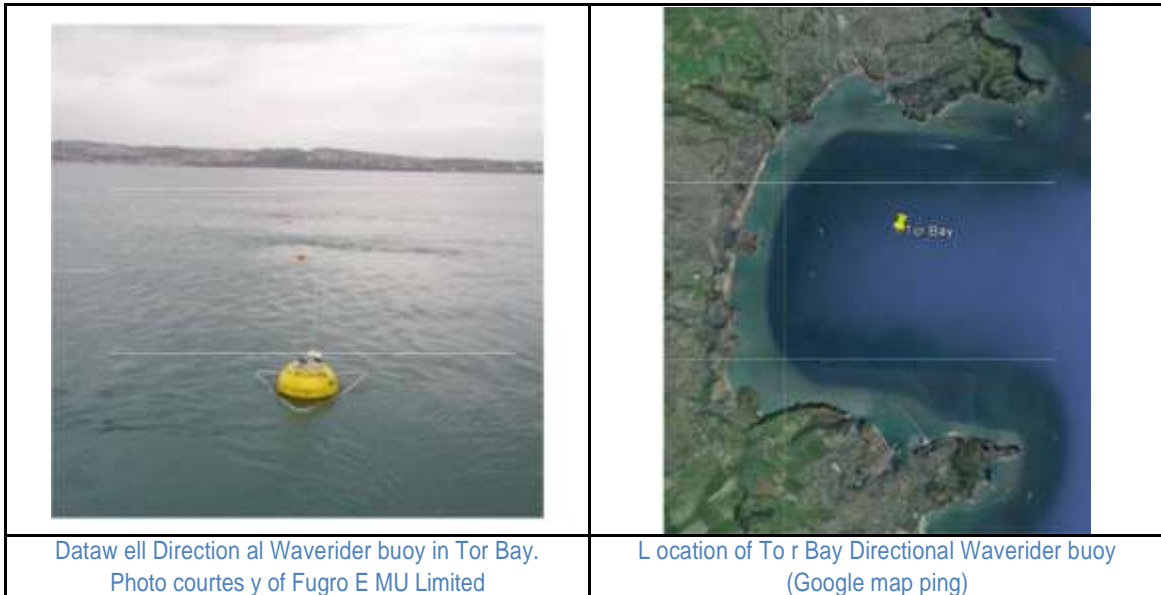
The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2011 to 2012.

Highest storms at Dawlish		
Date	Wave height (metres)	Return Period
05/02/2014	4.91	Greater than 1 in 20 years
30/04/2012	4.63	> 1 in 10 years
14/02/2014	4.14	> 1 in 3 years

Storms exceeding 1 year Return Period at Dawlish since deployment in 2011. Those occurring during the storm season October 2013 to February 2014 are shaded pink

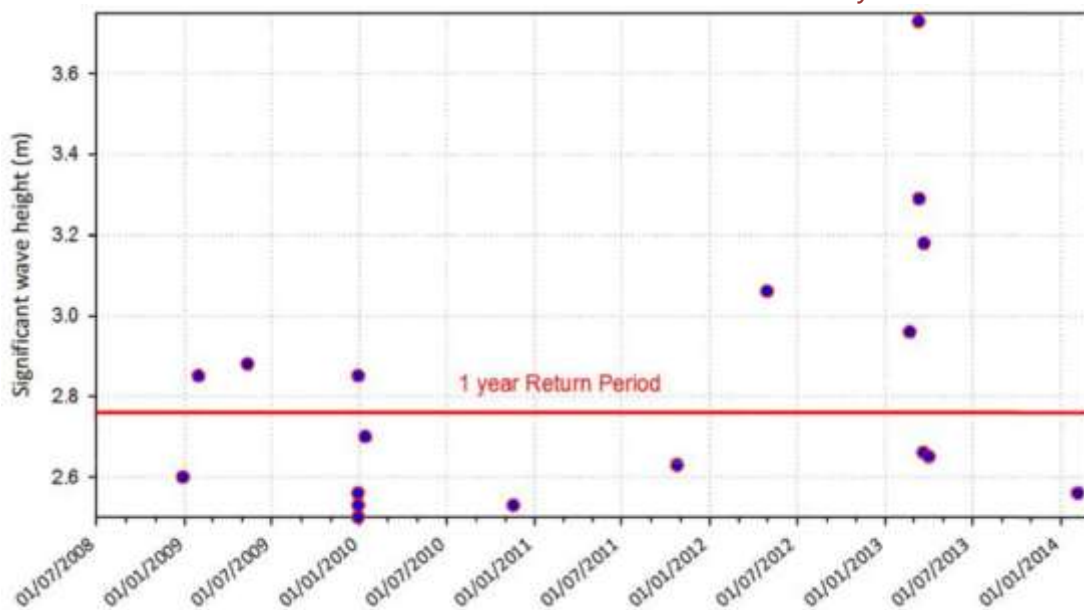
Storm report for Tor Bay, Devon

Wave conditions are measured with a buoy moored about 3 km off Paignton, in about 10 m CD water depth. The buoy has been in place for 5 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2008, 8 individual storms have exceeded the 1 year Return Period. No storms occurred between October 2013 and February 2014.



Storm calendar for Tor Bay. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2008 to 2012.

Highest storms at Tor Bay		
Date	Wave height (metres)	Return Period (years)
11/03/2013	3.73	Greater than 1 in 30 years
12/03/2013	3.29	> 1 in 20 years
22/03/2013	3.18	> 1 in 10 years
29/04/2012	3.06	> 1 in 5 years
20/02/2013	2.96	> 1 in 3 years
12/05/2009	2.88	1 in 2 years
29/01/2009	2.85	> 1 in 1 year
29/12/2009	2.85	> 1 in 1 year

Storms exceeding 1 year Return Period at Tor Bay since deployment in 2008. Those occurring during the storm season October 2013 to February 2014 are shaded pink

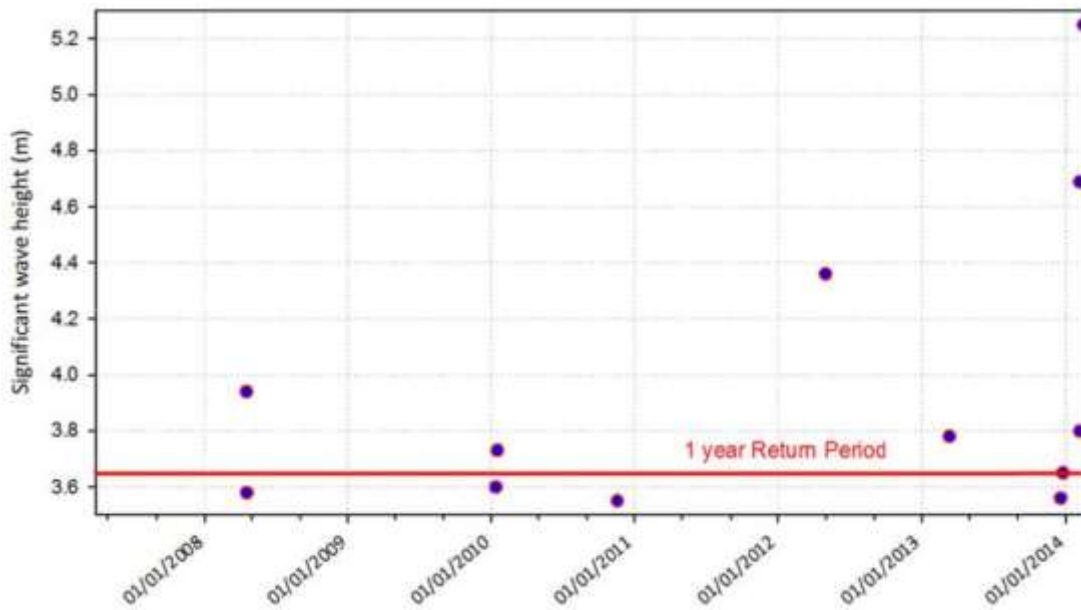
Storm report for Start Bay, Devon

Wave conditions are measured with a buoy moored about 1.5 km off Slapton Sands, in about 10 m CD water depth. The buoy has been in place for 6 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2007, 7 individual storms have exceeded the 1 year Return Period. 3 of those storms (43 %) occurred between October 2013 and February 2014.



Storm calendar for Start Bay. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

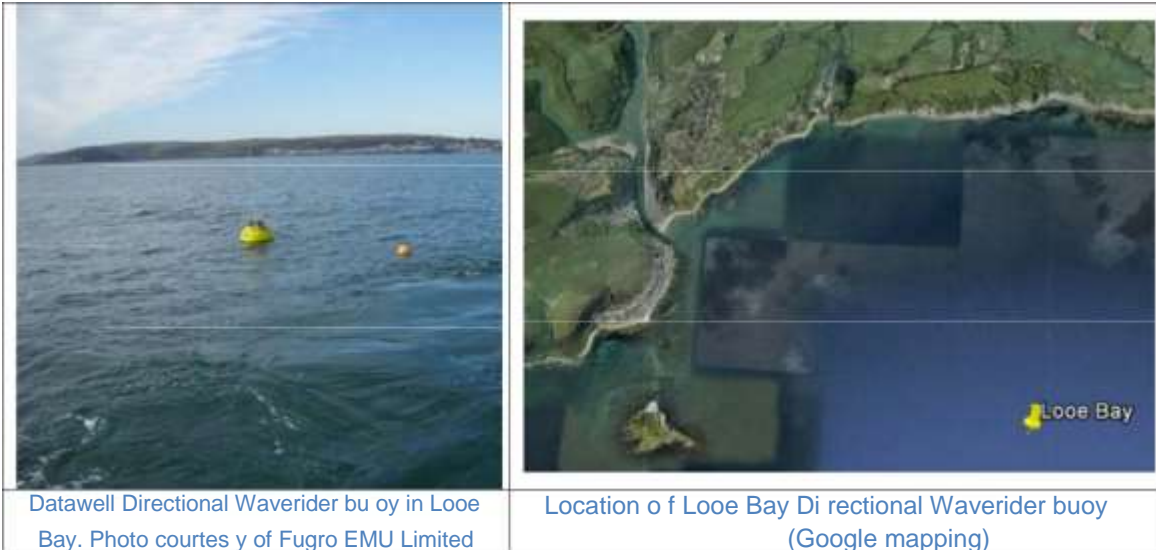
The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2007 to 2012.

Highest storms at Start Bay		
Date	Wave height (metres)	Return Period
14/02/2014	5.25	Greater than 1 in 50 years
04/02/2014	4.69	> 1 in 50 years
30/04/2012	4.36	> 1 in 10 years
17/04/2008	3.94	> 1 in 2 years
05/02/2014	3.80	> 1 in 1 year
11/03/2013	3.78	> 1 in 1 year
16/01/2010	3.73	> 1 in 1 year

Storms exceeding 1 year Return Period at Start Bay since deployment in 2007. Those occurring during the storm season October 2013 to February 2014 are shaded pink

Storm report for Looe Bay, Cornwall

Wave conditions are measured with a buoy moored about 3 km off Looe, in about 10 m CD water depth. The buoy has been in place for 4 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2009, 9 individual storms have exceeded the 1 year Return Period. 6 of those storms (67%) occurred between October 2013 and February 2014.



Storm calendar for Looe Bay. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

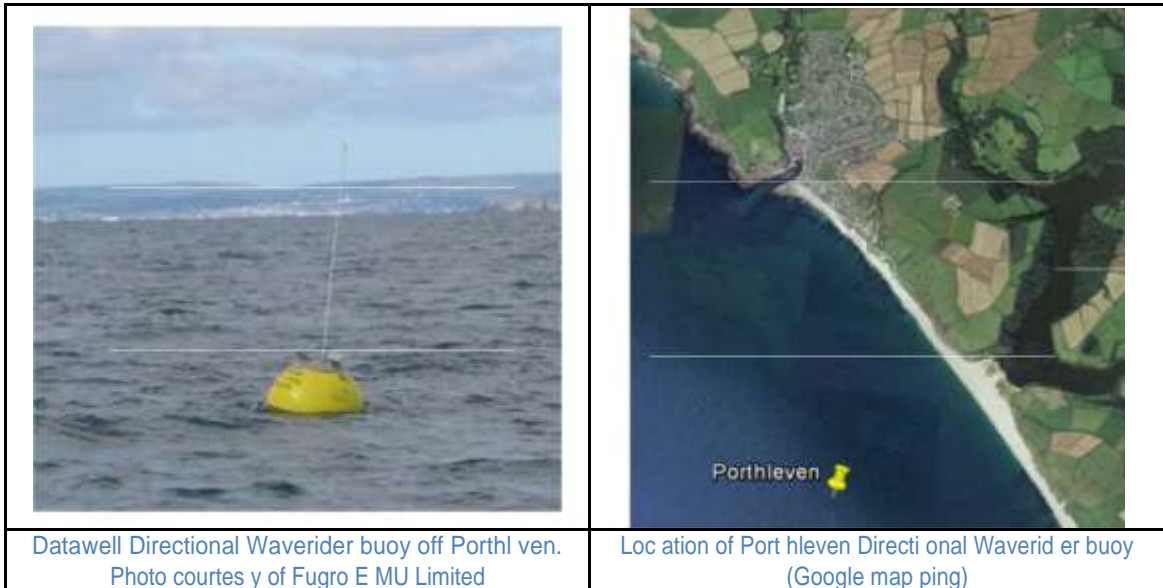
The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2009 to 2012.

Highest storms at Looe Bay		
Date	Wave height (metres)	Return Period
14/02/2014	7.32	> 1 in 30 years
05/02/2014	7.09	> 1 in 30 years
23/12/2013	5.53	> 1 in 5 years
22/11/2012	4.99	1 in 2 years
07/06/2012	4.88	> 1 in 1 year
16/01/2010	4.82	> 1 in 1 year
12/02/2014	4.77	> 1 in 1 year
08/02/2014	4.74	> 1 in 1 year
06/01/2014	4.71	> 1 in 1 year

Storms exceeding 1 year Return Period at Looe Bay since deployment in 2009. Those occurring during the storm season October 2013 to February 2014 are shaded pink

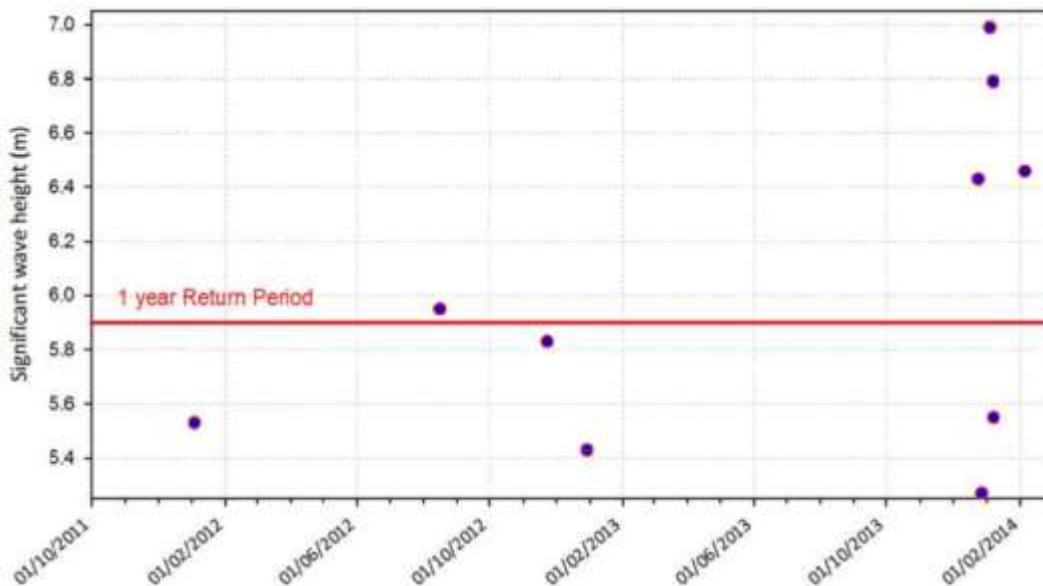
Storm report for Porthleven, Cornwall

Wave conditions are measured with a buoy moored about 1 km off Loe Bar, Porthleven, in about 12 m CD water depth. The buoy has been in place for 2 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2011, 5 individual storms have exceeded the 1 year Return Period. 4 of those storms (80 %) occurred between October 2013 and February 2014. Note that the buoy was badly damaged and ceased working during the 5 February 2014 storm.



Storm calendar for Porthleven. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2011 to 2012 (note that due to the short record length, the longest Return Period which can be calculated is 10 years).

Highest storms at Porthleven		
Date	Wave height (metres)	Return Period
03/01/2014	6.99	Greater than 1 in 10 years
06/01/2014	6.79	> 1 in 5 years
05/02/2014	6.46	> 1 in 3 years
23/12/2013	6.43	> 1 in 3 years
15/08/2012	5.95	> 1 in 1 year

Storms exceeding 1 year Return Period at Porthleven since deployment in 2011. Those occurring during the storm season October 2013 to February 2014 are shaded pink

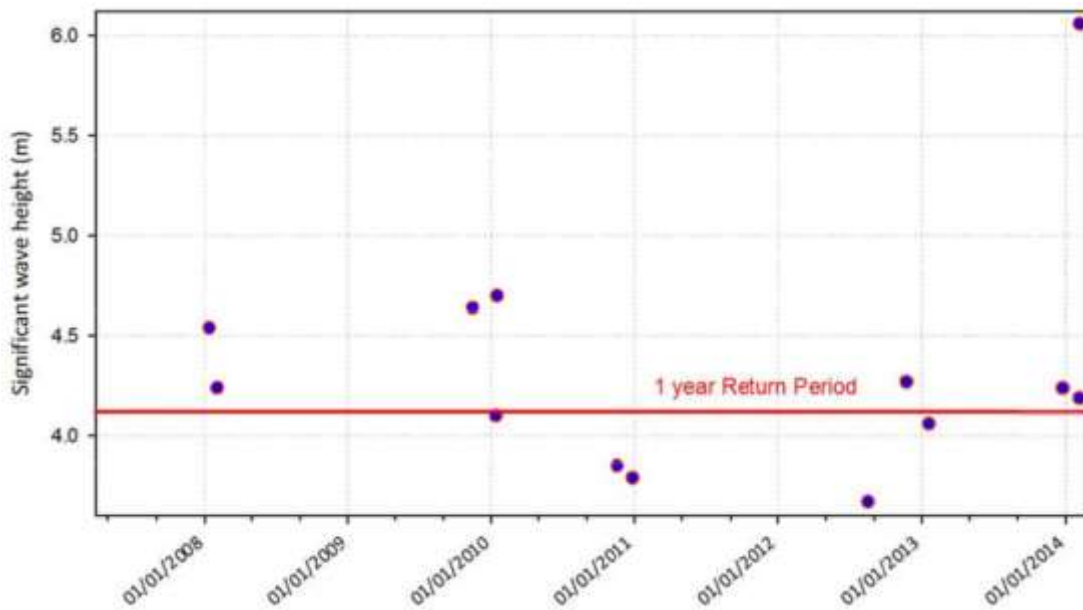
Storm report for Penzance Bay, Cornwall

Wave conditions are measured with a buoy moored about 1.5 km off Penzance in about 10 m CD water depth. The buoy has been in place for 6 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2007, 9 individual storms have exceeded the 1 year Return Period. 4 of those storms (44 %) occurred between October 2013 and February 2014.



Storm calendar for Penzance Bay. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2007 to 2012.

Highest storms at Penzance		
Date	Wave height (metres)	Return Period
04/02/2014	6.06	Greater than 1 in 50 years
16/01/2010	4.70	> 1 in 3 years
13/11/2009	4.64	> 1 in 3 years
13/01/2008	4.54	> 1 in 2 years
22/11/2012	4.27	> 1 in 1 year
03/02/2008	4.24	> 1 in 1 year
23/12/2013	4.24	> 1 in 1 year
24/12/2013	4.24	> 1 in 1 year
03/02/2014	4.19	> 1 in 1 year

Storms exceeding 1 year Return Period at Penzance Bay since deployment in 2007. Those occurring during the storm season October 2013 to February 2014 are shaded pink

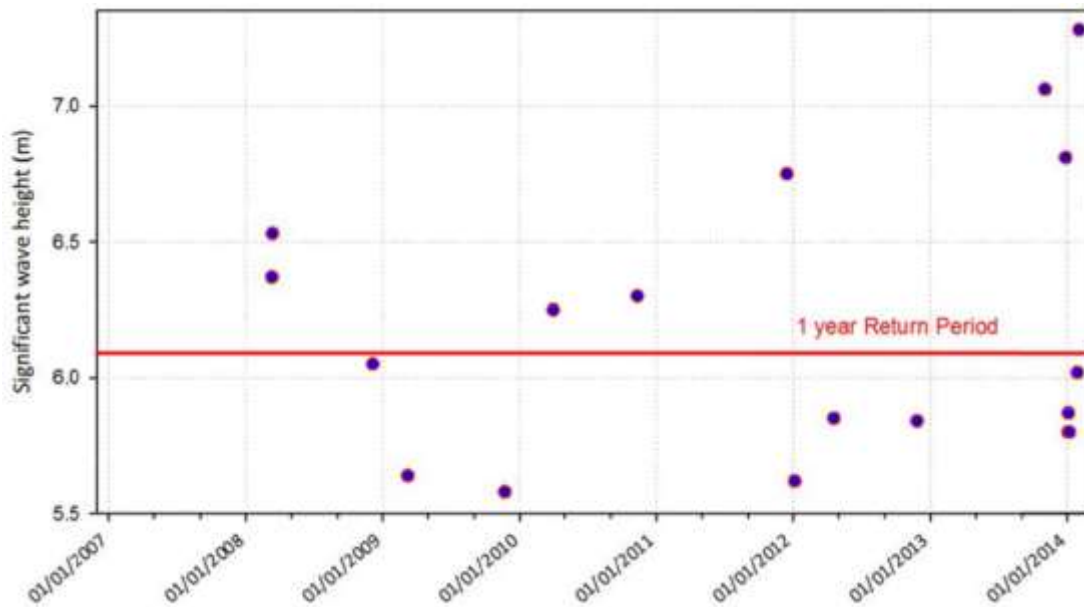
Storm report for Perranporth, Cornwall

Wave conditions are measured with a buoy moored about 1.5 km off Perranporth, in about 10 m CD water depth. The buoy has been in place for 6 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2007, 8 individual storms have exceeded the 1 year Return Period. 3 of those storms (38 %) occur red between October 2013 and February 2014. Note that the buoy came adrift during the 8 February 2014 storm.



Storm calendar for Perranporth. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2007 to 2012.

Highest storms at Perranporth		
Date	Wave height (metres)	Return Period
01/02/2014	7.28	Greater than 1 in 20 years
02/11/2013	7.06	> 1 in 10 years
27/12/2013	6.81	> 1 in 5 years
15/12/2011	6.75	> 1 in 5 years
12/03/2008	6.53	> 1 in 3 years
10/03/2008	6.37	> 1 in 2 years
11/11/2010	6.30	> 1 in 1 year
31/03/2010	6.25	> 1 in 1 year

Storms exceeding 1 year Return Period at Perranporth since deployment in 2007. Those occurring during the storm season October 2013 to February 2014 are shaded pink

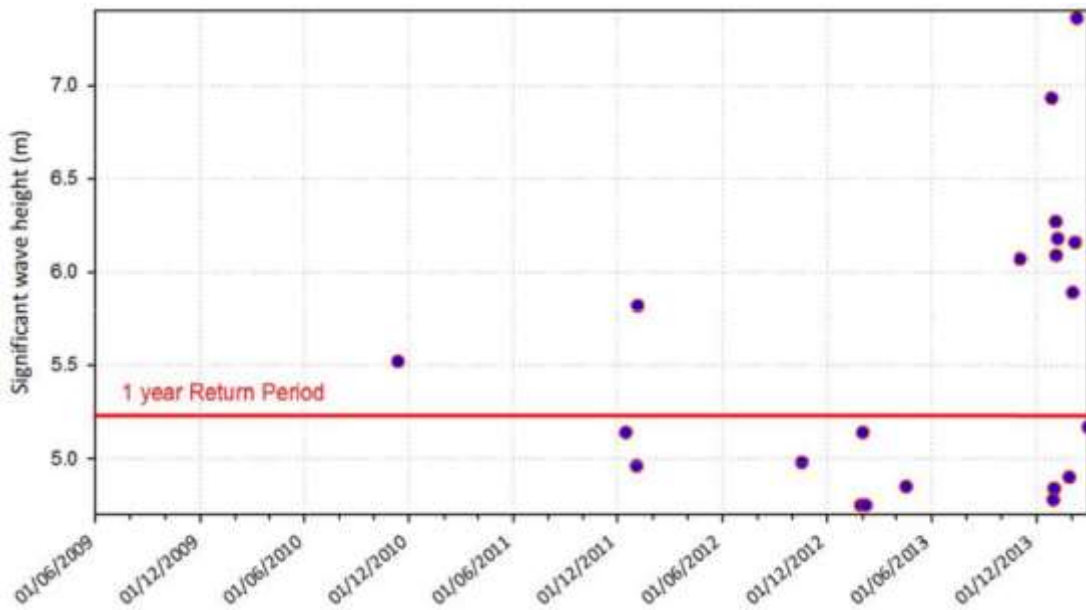
Storm report for Bideford Bay, Devon

Wave conditions are measured with a buoy moored about 3 km off Bideford, in about 10 m CD water depth. The buoy has been in place for 4 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2009, 10 individual storms have exceeded the 1 year Return Period. 8 of those storms (80 %) occurred between October 2013 and February 2014.



Storm calendar for Bideford Bay. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2009 to 2012.

Highest storms at Bideford Bay		
Date	Wave height (metres)	Return Period
09/02/2014	7.36	Greater than 1 in 30 years
27/12/2013	6.93	> 1 in 30 years
03/01/2014	6.27	> 1 in 20 years
06/01/2014	6.18	> 1 in 10 years
05/02/2014	6.16	> 1 in 10 years
04/01/2014	6.09	> 1 in 10 years
02/11/2013	6.07	> 1 in 10 years
01/02/2014	5.89	> 1 in 5 years
04/01/2012	5.82	> 1 in 5 years
11/11/2010	5.52	> 1 in 2 years

Storms exceeding 1 year Return Period at Bideford Bay since deployment in 2009. Those occurring during the storm season October 2013 to February 2014 are shaded pink

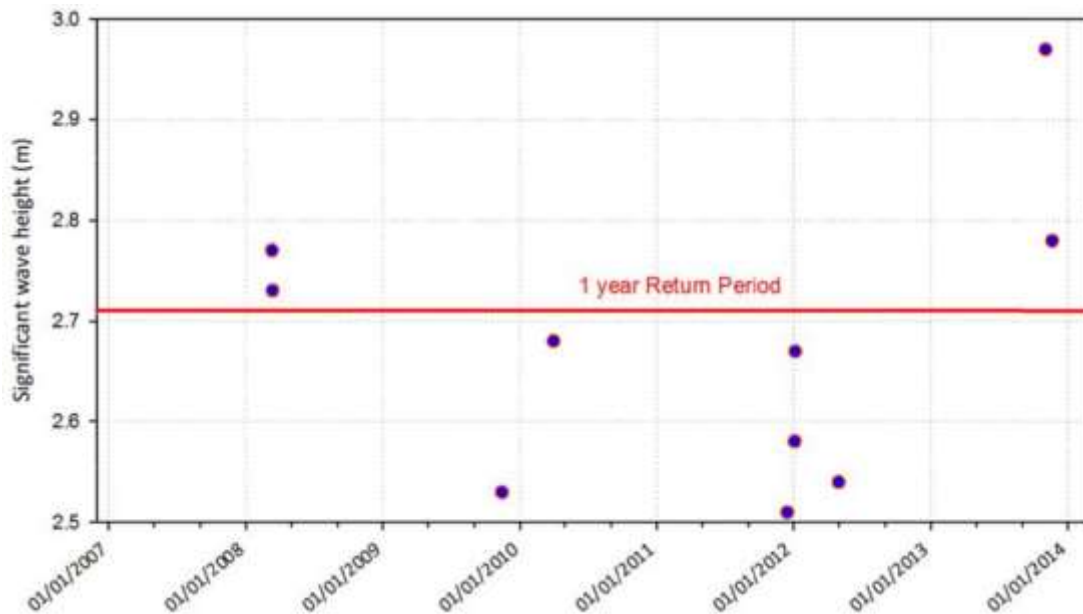
Storm report for Minehead, Somerset

Wave conditions are measured with a buoy moored about 1.3 km off Minehead, in about 10 m CD water depth. The buoy has been in place for 6 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2007, 4 individual storms have exceeded the 1 year Return Period. 2 of those storms (50 %) occurred between October 2013 and February 2014.



Storm calendar for Minehead. Each dot on the graph represents the highest significant wave height (Hs) of the individual storm

The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2007 to 2012.

Highest storms at Minehead		
Date	Wave height (metres)	Return Period
02/11/2013	2.97	Greater than 1 in 3 years
20/11/2013	2.78	> 1 in 1 year
10/03/2008	2.77	> 1 in 1 year
12/03/2008	2.73	> 1 in 1 year

Storms exceeding 1 year Return Period at Minehead since deployment in 2007. Those occurring during the storm season October 2013 to February 2014 are shaded pink

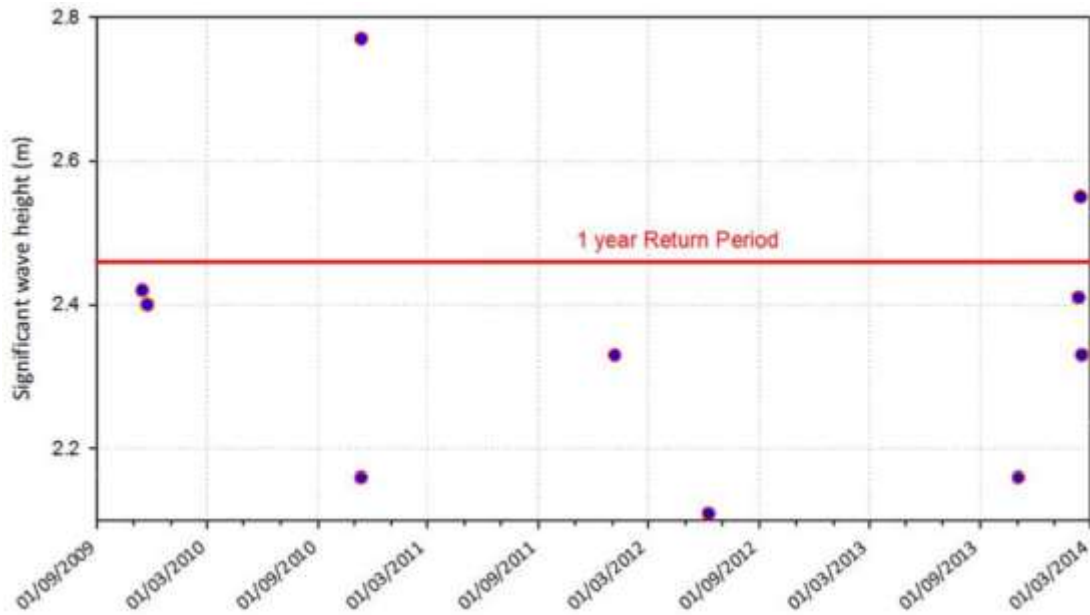
Storm report for Weston Bay, Somerset

Wave conditions are measured with a buoy moored about 2.5 km off Weston-super-Mare, in about 10 m CD water depth. The buoy has been in place for 4 years.



In an average year, there are usually 3 or 4 storms which have some impact on the beach; these are indicated in the graph below. The red line shows the wave height which a storm is likely to reach once a year, in an average year *i.e.* the 1 year Return Period.

Since 2009, 2 individual storms have exceeded the 1 year Return Period. 1 of those storms (50 %) occurred between October 2013 and February 2014.



Storm calendar for Weston Bay. Each dot on the graph represents the highest significant wave height (H_s) of the individual storm

The individual storms are ranked in the table below, together with the Return Period (this season's storms are shaded pink). The Return Period statistics were last calculated for the period 2009 to 2012.

Highest storms at Weston Bay		
Date	Wave height (metres)	Return Period
12/11/2010	2.77	Greater than 1 in 3 years
12/02/2014	2.55	> 1 in 1 year

Storms exceeding 1 year Return Period at Weston Bay since deployment in 2009. Those occurring during the storm season October 2013 to February 2014 are shaded pink

Section 3 - Beach change monitoring

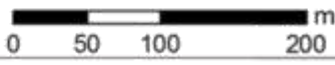
Surveys conducted over the winter of 2013-2014 have been compared with changes measured over a long term, typically from surveys in 2003 and 2013. The 2013 survey is then compared with post- storm surveys.

The beach change plots have been determined using two different methods. Where detailed beach surveys are available, it is possible to compare the two survey volumes over the entire area, as well as highlighting exactly where the erosion or accretion has occurred. The plots show the measured change, colour-coded with blue indicating accretion, and red showing erosion. The plots show firstly the quantity and location of erosion/accretion over the longer term period and secondly, the change over the winter 2013/14 period.

At sites where less detailed data is available, beach profiles are used to calculate changes, by assuming that a profile represents a certain length of coastline; a good approximation of volumes can be determined by this method.



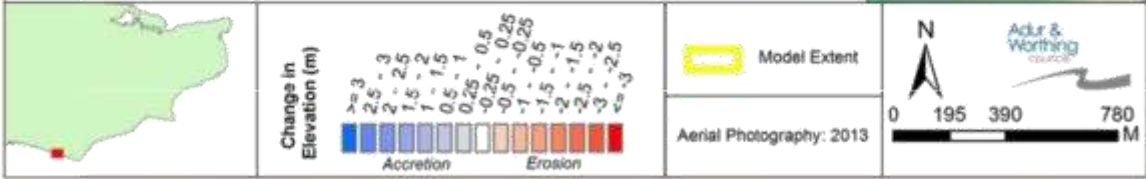
Aerial Photography: 2013



4bS06 - Oldstairs Bay

Derived from profile data

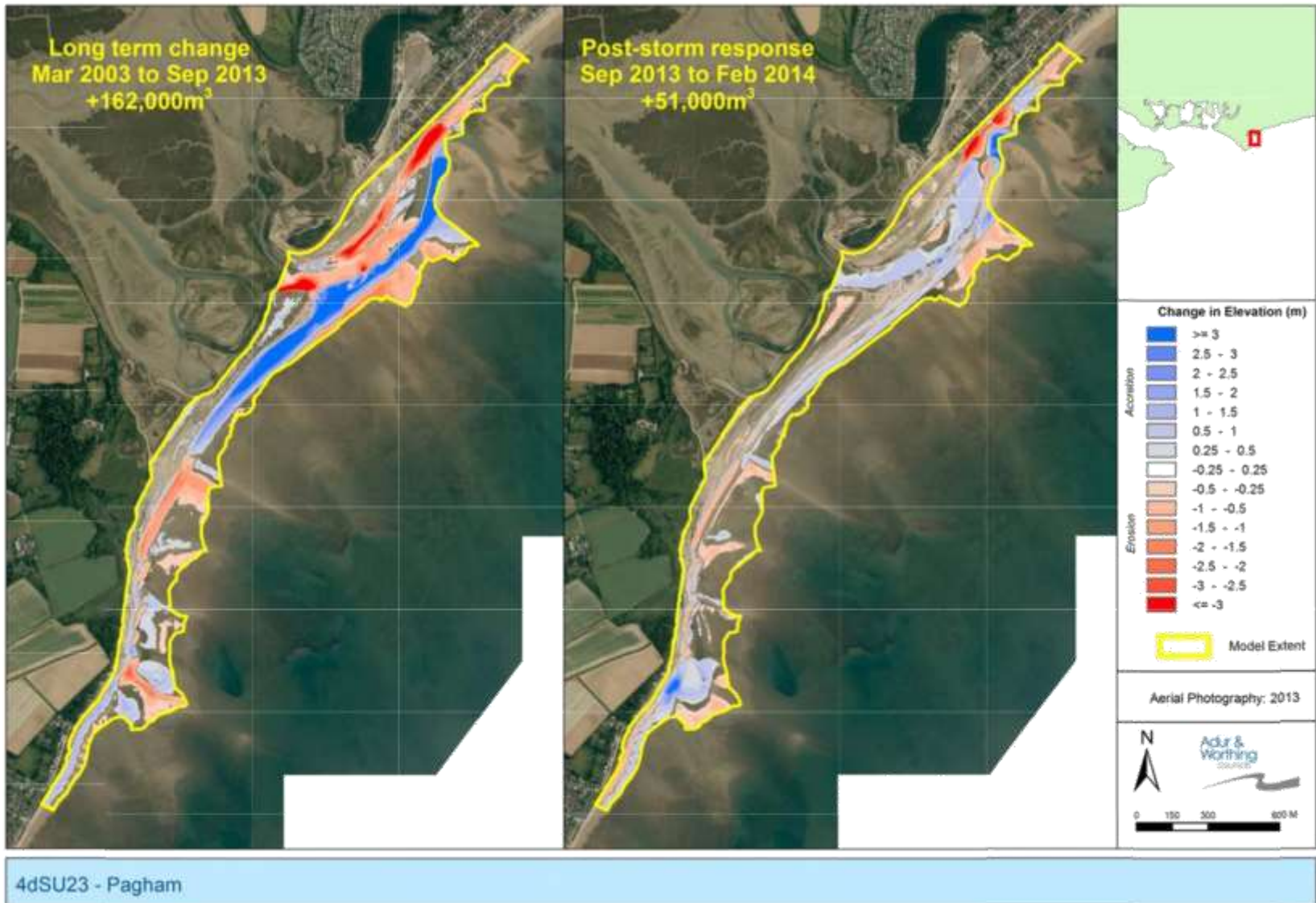




4dSU06 - Seaford

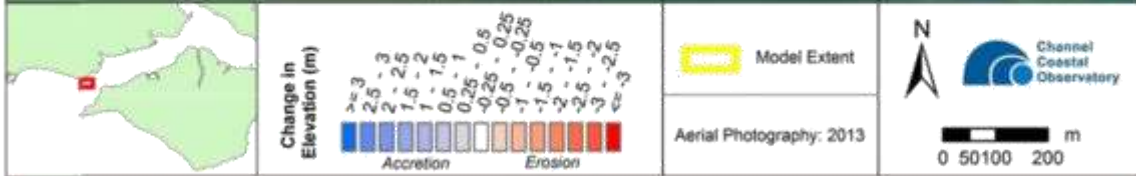
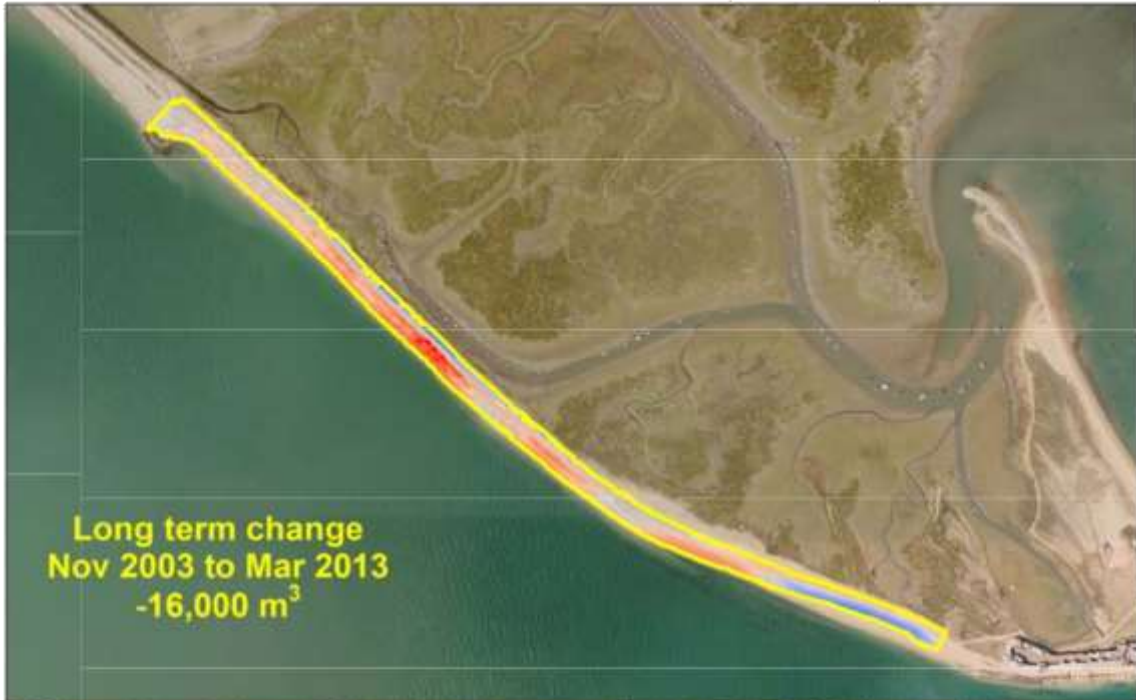


4dSU20 - Elmer

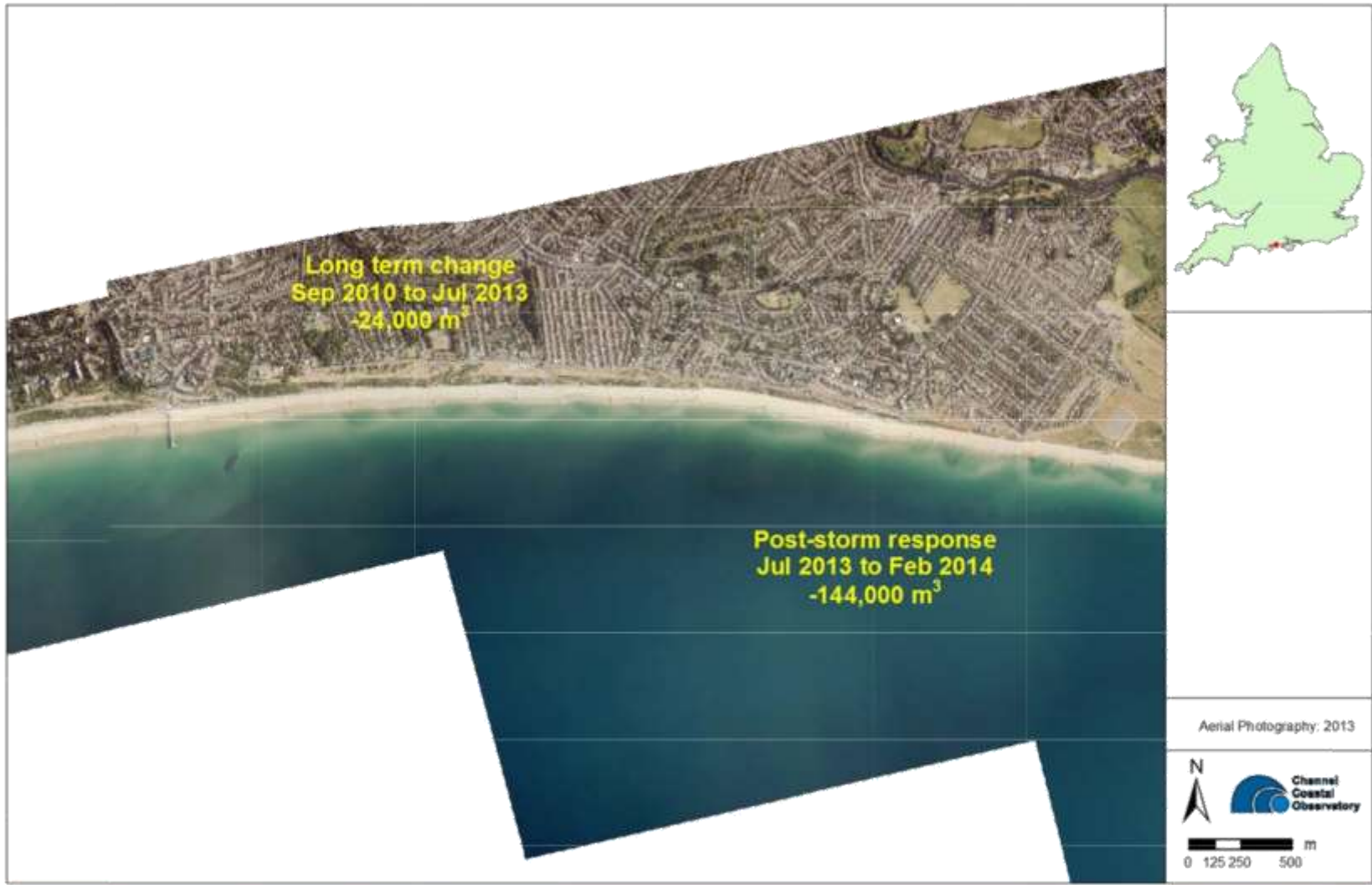






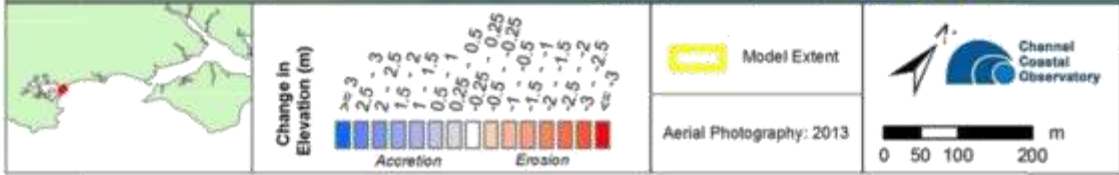


5fSU01 - Hurst Spit



5fSU11 - Bournemouth (Boscombe Pier to Southbourne)

Derived from profile data



5fSU11 - Shore Rd (Sandbanks)







5gSU14-15 - Weymouth

Derived from profile data

