
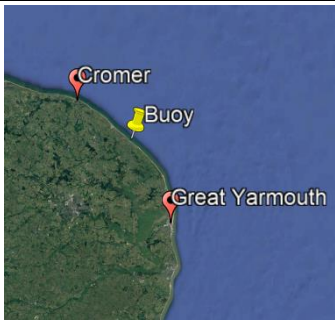


## Happisburgh Directional Waverider Buoy

<b>Location</b>			
OS	639248 E 331307 N		
WGS84	Latitude: 52° 49.58' N Longitude: 01° 32.97' E		
<b>Instrument type</b>			
Datawell Directional Waverider Mk III			
<b>Water depth</b>	~10m CD	Example buoy in situ. Photo courtesy of Fugro Marine GB Limited	Location of buoy (Google mapping, image ©2019 Landsat / Copernicus)

## Data Quality

<b>Recovery rate (%)</b>	<b>Sample interval</b>
100	30 minutes

## Monthly Averages - 2013

All times are GMT

Month	H <sub>s</sub> (m)	T <sub>p</sub> (s)	T <sub>z</sub> (s)	Dir. (°)	SST (°C)	Bimodal seas (%)	No. of days
January	0.71	6.6	4.2	91	5.2	-	31
February	0.97	6.6	4.3	75	3.9	-	28
March	1.27	7.7	4.7	53	3.8	-	31
April	0.69	6.5	3.9	86	6.6	-	30
May	0.68	6.3	4.0	85	10.9	-	31
June	0.59	5.7	3.9	71	13.7	-	30
July	0.36	5.4	3.6	67	17.6	-	31
August	0.42	5.5	3.7	108	18.7	-	31
September	0.72	6.0	4.2	110	16.4	-	30
October	0.84	6.9	4.4	98	13.6	-	31
November	0.90	7.0	4.5	104	9.3	-	30
December	0.59	7.6	4.3	92	6.7	-	31

## Monthly Averages - All Years (May 2012 – December 2019)

Month	H <sub>s</sub> (m)	T <sub>p</sub> (s)	T <sub>z</sub> (s)	Dir. (°)	SST (°C)	Bimodal seas (%)
January	0.77	7.1	4.5	101	5.8	-
February	0.72	7.1	4.3	86	4.9	-
March	0.80	7.0	4.3	93	6.1	-
April	0.69	6.4	4.0	83	8.8	-
May	0.67	6.2	4.1	82	12.0	-
June	0.59	5.9	4.0	76	15.0	-
July	0.50	5.4	3.8	90	18.0	-
August	0.48	5.4	3.8	104	18.4	-
September	0.65	6.3	4.1	92	16.4	-
October	0.75	6.6	4.3	83	13.4	-
November	0.77	6.8	4.4	90	9.8	-
December	0.67	7.2	4.4	102	7.1	-

## Storm Analysis

Date/Time	H <sub>s</sub> (m)	T <sub>p</sub> (s)	T <sub>z</sub> (s)	Dir. (°)	Water level elevation* (OD)	Tidal stage (hours re. HW)	Tidal range (m)	Tidal surge* (m)	Max. surge* (m)
10-Oct-2013 21:00:00	4.06	11.1	6.5	16	1.05	HW +2	3.40	-	-
10-Sep-2013 21:00:00	3.53	10.0	5.9	17	1.45	HW -2	3.70	-	-
06-Dec-2013 06:30:00	3.23	11.1	6.3	14	1.05	HW -2	4.50	-	-
30-Nov-2013 01:30:00	3.08	10.0	5.8	18	0.85	HW -2	2.70	-	-
11-Mar-2013 21:00:00	2.99	8.3	5.7	46	0.89	HW +3	4.10	-0.02	0.17
24-Mar-2013 17:00:00	2.98	9.1	6.3	63	1.29	HW	2.97	-0.35	-0.07
13-Oct-2013 17:00:00	2.82	8.3	5.7	46	0.75	HW +2	2.20	-	-
20-Jan-2013 14:00:00	2.66	9.1	5.5	70	1.09	HW +1	1.67	0.05	0.19
04-Apr-2013 12:00:00	2.66	7.7	5.4	56	0.85	HW -2	2.30	-	-

\* Tidal information is obtained from the National Network gauge at Cromer and/or estimated from the predicted tide levels (Admiralty Total Tide). The surge shown is the residual at the time of the highest H<sub>s</sub>. The maximum tidal surge is the large surge during the storm event.

## Annual Statistics

Year	Annual H <sub>s</sub> exceedance** (m)						Annual Maximum H <sub>s</sub>	
	0.05%	0.5%	1%	2%	5%	10%	Date	A <sub>max</sub> (m)
2012	2.89	2.52	2.25	1.95	1.48	1.16	27-Oct-2012 03:00:00	3.16
2013	3.53	2.85	2.65	2.36	1.89	1.48	10-Oct-2013 21:00:00	4.06
2014	2.68	2.22	1.95	1.67	1.37	1.14	09-Jul-2014 14:30:00	3.00
2015	3.03	2.25	2.03	1.79	1.42	1.16	21-Nov-2015 11:00:00	3.84
2016	3.36	2.51	2.35	2.08	1.70	1.35	14-Jan-2016 20:30:00	3.60
2017	2.68	2.35	2.24	2.04	1.76	1.48	28-Jun-2017 13:00:00	2.68
2018	2.88	2.47	2.19	1.93	1.53	1.18	20-Nov-2018 04:00:00	3.00
2019	3.21	2.56	2.33	2.06	1.61	1.27	27-Jan-2019 22:30:00	3.62

\*\* i.e. 5 % of the H<sub>s</sub> values measured in 2012 exceeded 1.48 m

## Significant wave height return periods

Return periods for significant wave height can be calculated since the buoy has been deployed for more than 5 years. The return periods are based on 0.5 hourly records and are calculated for periods up to 10 times the record length using a peaks-over-threshold method and Generalised Pareto Distribution (GPD).

Observation period	May 2012 to December 2019	
Return period (years)	Significant wave height (m)	Comments
0.25	2.66	No depth limitation
1	3.26	
2	3.49	
5	3.74	
10	3.89	
20	4.02	Depth-limited at MLWS
50	4.16	

## Distribution plots

The distribution of wave parameters are shown in the accompanying graphs/tables of:

- Annual time series of  $H_s$  (red line is 2.66 m storm threshold)
- Incidence of storm waves for 2013. Storm events are defined using the Peaks-over-Threshold method. The highest  $H_s$  of each storm event is shown
- Wave height exceedance each year since deployment
- Percentage of occurrence of  $H_s$ ,  $T_p$ ,  $T_z$  and Direction for 2013
- Wave rose (percentage of occurrence of direction vs.  $H_s$ ) for all measured data
- Joint distribution of all parameters for all measured data, given as percentage of occurrence

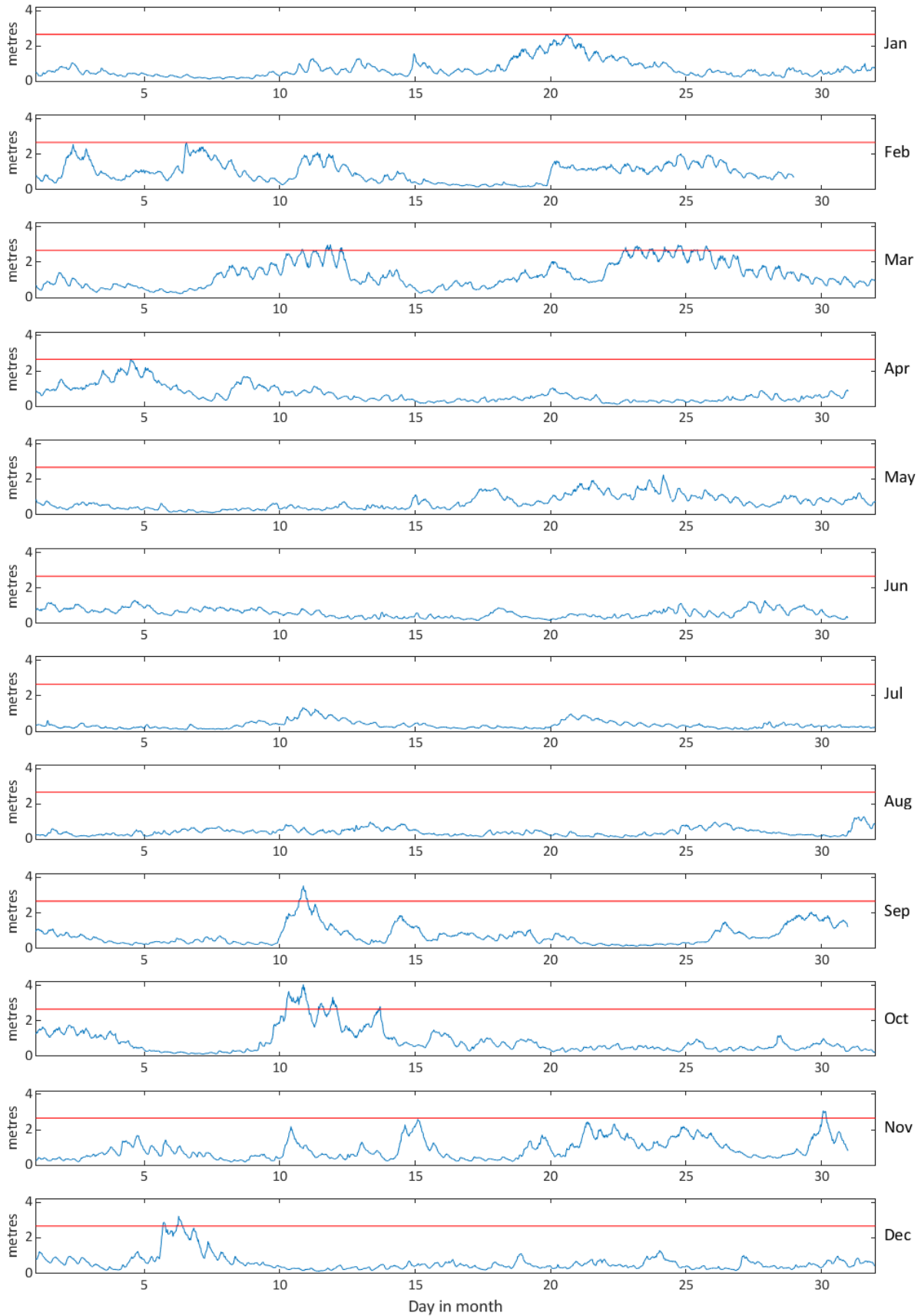
## General

The buoy, owned by the Environment Agency, was first deployed on 09 May 2012, at which time the magnetic declination at the site was 1.04° west, changing by 0.17° east per year.

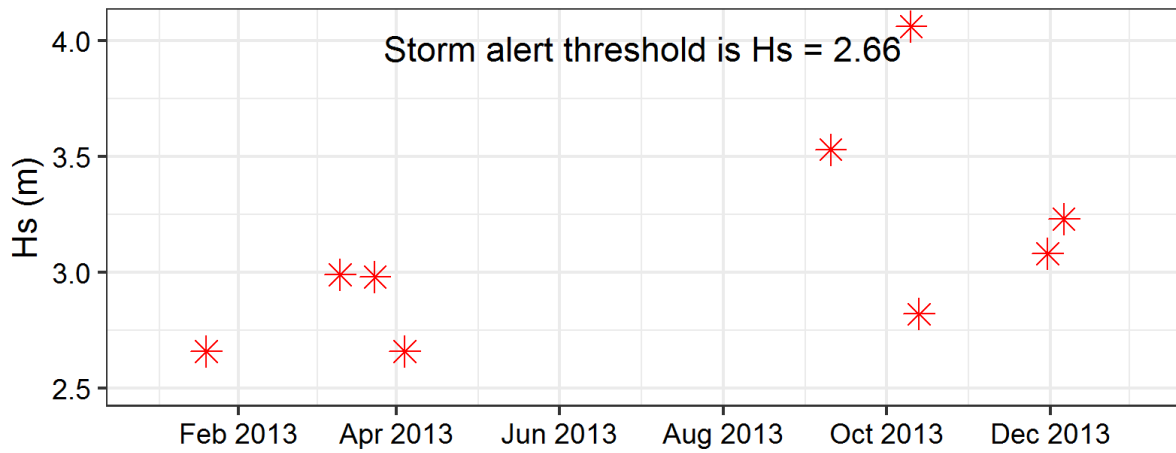
## Acknowledgements

The shore station is kindly hosted by Happisburgh RNLI Lifeboat Station.

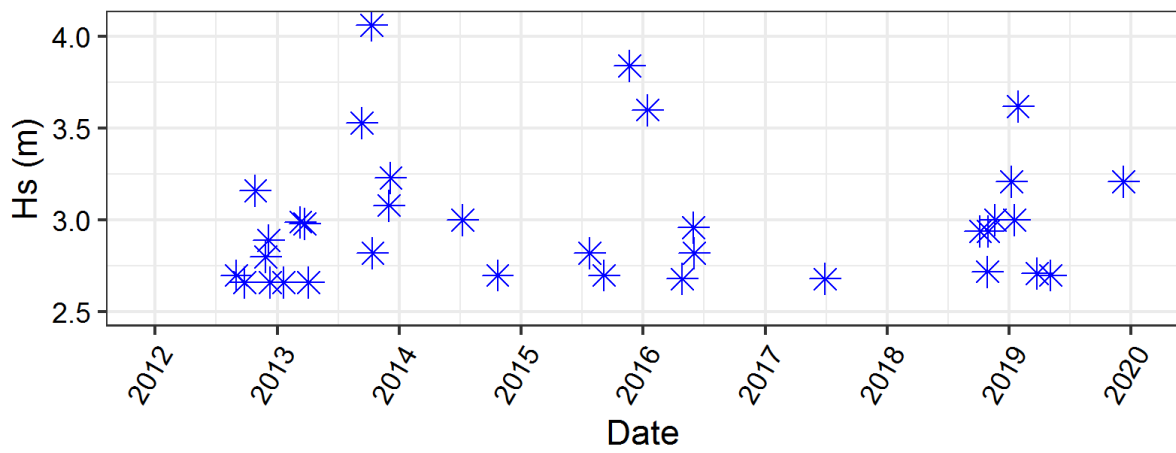
### Happisburgh - Significant Wave Height (Hs) during 2013



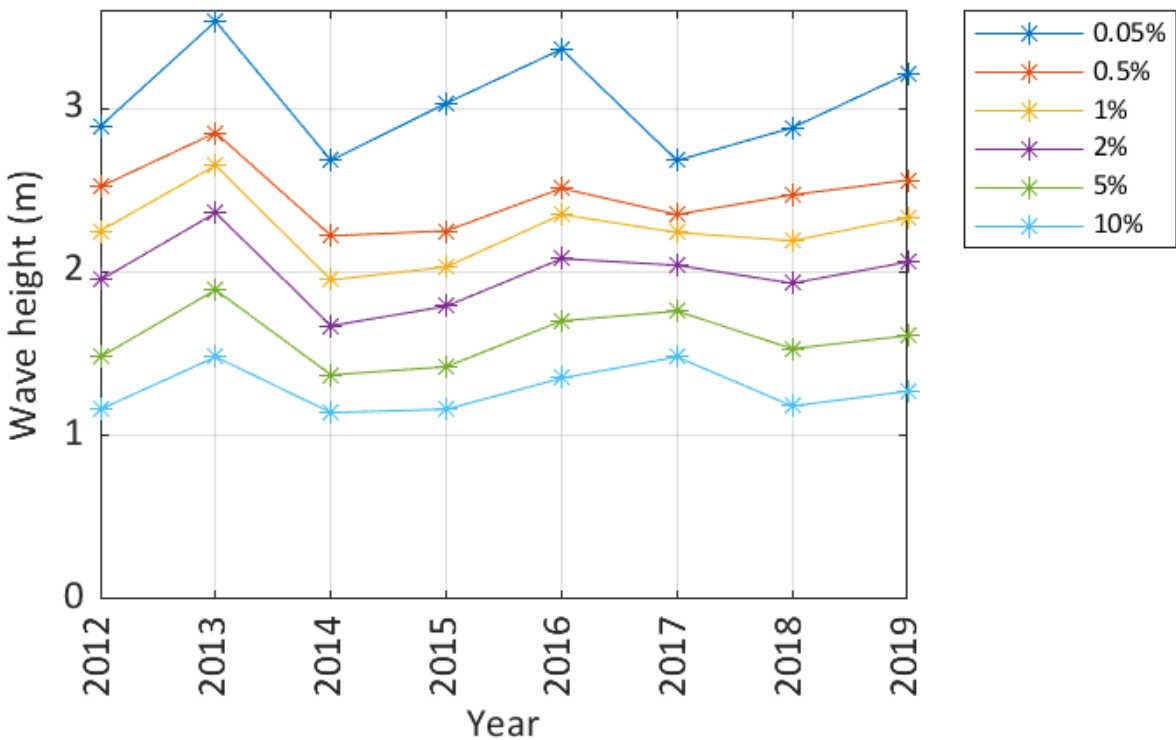
### Storms at Happisburgh during 2013



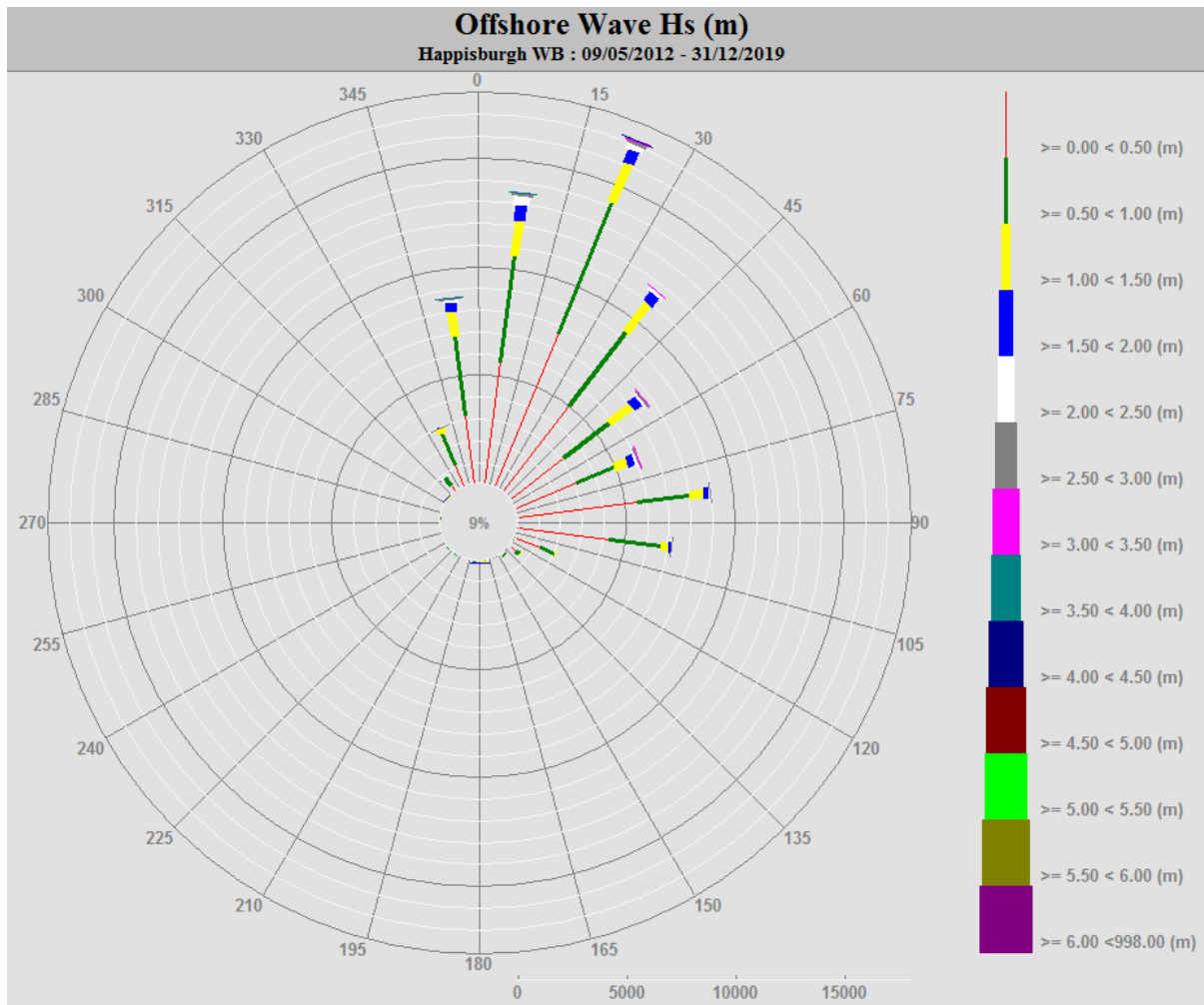
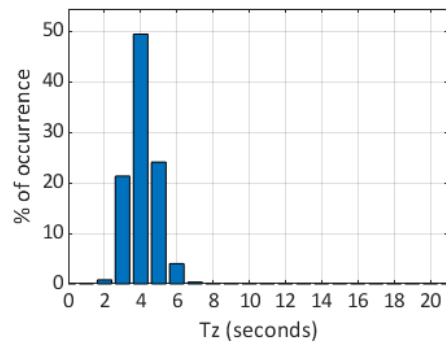
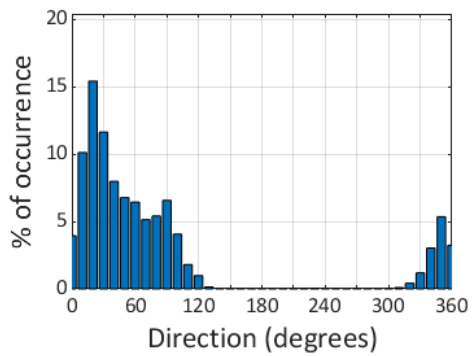
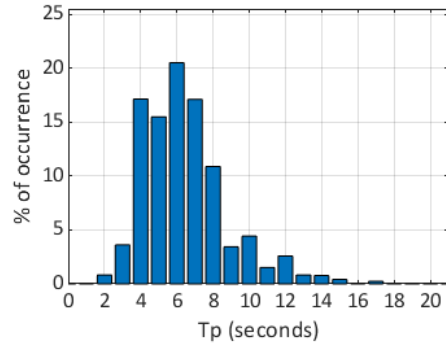
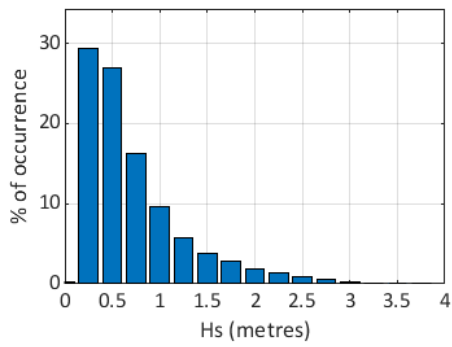
### Storms at Blakeney Overfalls - all years



### Happisburgh - Wave height exceedance (Hs)



### Happisburgh 2013



Happisburgh 2012 to 2019 - Joint distribution (% of occurrence)

