

Tweed Annual Wave Climate Report

May 2024 – April 2025

Prepared by: Queensland Government Hydraulics Laboratory
Department of the Environment, Tourism
Science and Innovation for Tweed Sand Bypassing

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October 2025

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Introduction

This wave climate summary is one of a series of technical wave reports prepared annually by the Queensland Government Hydraulics Laboratory (QGH) of the Department of the Environment, Tourism, Science and Innovation (DETSI) for the Tweed Sand Bypassing Project (TSB). This report presents wave measurements recorded from 01 May 2024 to 30 April 2025 by 2 Datawell Waverider (DWR4) buoys deployed off Tweed Heads. The data recorded covers all the seasonal variations for one year including the 2024–2025 cyclone season. No corrections for refraction, diffraction or shoaling have been applied to the wave measurements.

The reporting year aligns with the Tweed Sand Bypassing Project's environmental monitoring reporting requirements, and for seasonal referencing in an annual context: winter is the period from 01 May to 31 October and, summer is the period from 01 November to 30 April. Summer, in this context, is also representative of the Australian cyclone season. Significant meteorological events were identified using a peak-over-threshold approach at the 95th percentile of H_s . Events consisting of ≥ 3 hours above threshold and lasting at least 6 hours, and any exceedance gaps under 48 hours were merged into a single event.

Table 1 Description of wave parameters

Parameter	Description
H_s	Significant wave height (time domain), the average of the highest third of the waves in the record.
H_{max}	The highest individual wave in the record (time domain).
T_z	The average period of all zero up-crossing waves in the record (time domain).
T_p	The wave period corresponding to the peak of the energy density spectrum (frequency domain).
D_p	The direction that peak period (T_p) waves are coming (in ° True North). i.e., the direction where the waves with the most energy in a wave record are coming from.
SST	The sea surface temperature (in ° Celsius) obtained by a sensor mounted in the bottom of the buoy.

Occasionally, data gaps are present in the record, primarily caused by either equipment failures or transmission errors from the buoy to the shore receiver. Transmission errors most often result from radio interference or buoy tilting, which introduces low-frequency noise. All half-hourly wave records undergo quality-control checks and erroneous data is removed, resulting in short data gaps; longer data gaps can occur if there is malfunction of the wave buoy or the recording equipment. Overall data return for the 2024–2025 report year for Tweed Heads and the Tweed Offshore buoy is 99.16 per cent and 98.39 per cent respectively.

Table 2 Monthly Data Coverage (%) for Report Year

Station	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Avg
Tweed Heads	99.9	100	100	100	100	99.9	93.6	96.9	100	100	99.6	99.9	99.2
Tweed Offshore	99.9	100	99.9	100	99.9	100	92.9	96.2	99.7	99.7	94.0	98.4	98.4



Figure 1 Location of the Tweed Heads and Tweed Offshore wave monitoring sites.

Table 3 Wave Monitoring Deployment Details for Report Year 2024–2025

Site	Latitude	Longitude	Estimated Depth (m)	Deployment Date	Removal Date
Tweed Heads	28° 10.678' S	153° 34.608' E	25	10/10/2023	16/10/2024
Tweed Offshore	28° 12.800' S	153° 40.813' E	60	08/11/2023	24/07/2024
Tweed Offshore	28° 12.771' S	153° 40.830' E	60	24/07/2024	Current
Tweed Heads	28° 10.655' S	153° 34.588' E	25	16/10/2024	Current

#

Tweed Heads

Details of Data Collection – [Tweed Heads Wave Monitoring Station](#)

Description	Report Year 2024–2025	All Data 1995–2025
Maximum possible analysis (last record – first record):	365 days	30.3 years
Total days/years used in analysis:	361.94 days	29.37 years
Data gaps in analysis:	3.06 days	0.93 years
Number of records used in analysis:	17,373	46,7604

Table 4 Tweed Heads: monthly wave height summary

Month	Mean H_s (m)	Min H_s (m)	Max H_s (m)	Mean D_p (° TN)	90% range of H_s (m)	Days $H_s \geq 2$ m	Days $H_s \leq 0.75$ m	Date (dd) where $H_s > 3$ m
May-24	1.35	0.84	2.19	108	0.9–1.9	6	0	
Jun-24	0.97	0.50	2.29	106	0.6–1.5	1	16	
Jul-24	1.25	0.39	2.87	100	0.6–2.1	10	11	
Aug-24	1.31	0.41	3.21	91	0.7–2.7	7	10	13 14
Sep-24	1.15	0.52	3.77	101	0.7–2.6	4	15	27 28
Oct-24	1.18	0.58	2.19	95	0.8–1.7	2	5	
Nov-24	1.20	0.57	2.20	82	0.7–1.8	2	10	
Dec-24	1.09	0.51	2.29	95	0.6–1.8	3	12	
Jan-25	1.13	0.63	2.48	102	0.8–1.7	4	7	
Feb-25	1.51	0.91	2.33	95	1.1–2.0	7	0	
Mar-25	1.92	0.62	5.41	89	0.8–4.3	13	3	02 03 04 05 06 07 08 09 29
Apr-25	1.45	0.70	3.08	103	0.8–2.3	11	3	18

Table 5 Tweed Heads: mean and weighted mean (W-Mean) for wave height (H_s) and peak direction (D_p)

	Report Year: 2024–2025				All Data			
Month	Mean H_s (m)	W-Mean H_s (m)	Mean D_p (° TN)	W-Mean D_p (° TN)	Mean H_s (m)	W-Mean H_s (m)	Mean D_p (° TN)	W-Mean D_p (° TN)
May	1.35	1.40	108	108	1.27	1.46	100	92
Jun	0.97	1.03	107	106	1.20	1.37	102	97
Jul	1.25	1.40	100	96	1.17	1.32	103	99
Aug	1.31	1.52	92	85	1.08	1.23	99	96
Sep	1.15	1.36	103	108	1.11	1.20	93	92
Oct	1.18	1.23	97	94	1.16	1.28	94	92
Nov	1.20	1.27	83	83	1.13	1.20	93	94
Dec	1.09	1.19	96	95	1.16	1.29	92	91
Jan	1.13	1.20	103	103	1.32	1.46	93	90
Feb	1.51	1.54	95	94	1.44	1.57	95	93
Mar	1.92	2.39	89	82	1.46	1.64	94	89
Apr	1.45	1.57	103	100	1.36	1.48	98	95
May–Apr	1.29	1.49	98	93	1.24	1.39	97	93

Weighted Mean $H_s = (\sum(H_s^{2.5})/N)^{0.4}$, Weighted Mean Direction = $\sum(H_s^{2.5} * D_p) / \sum H_s^{2.5}$

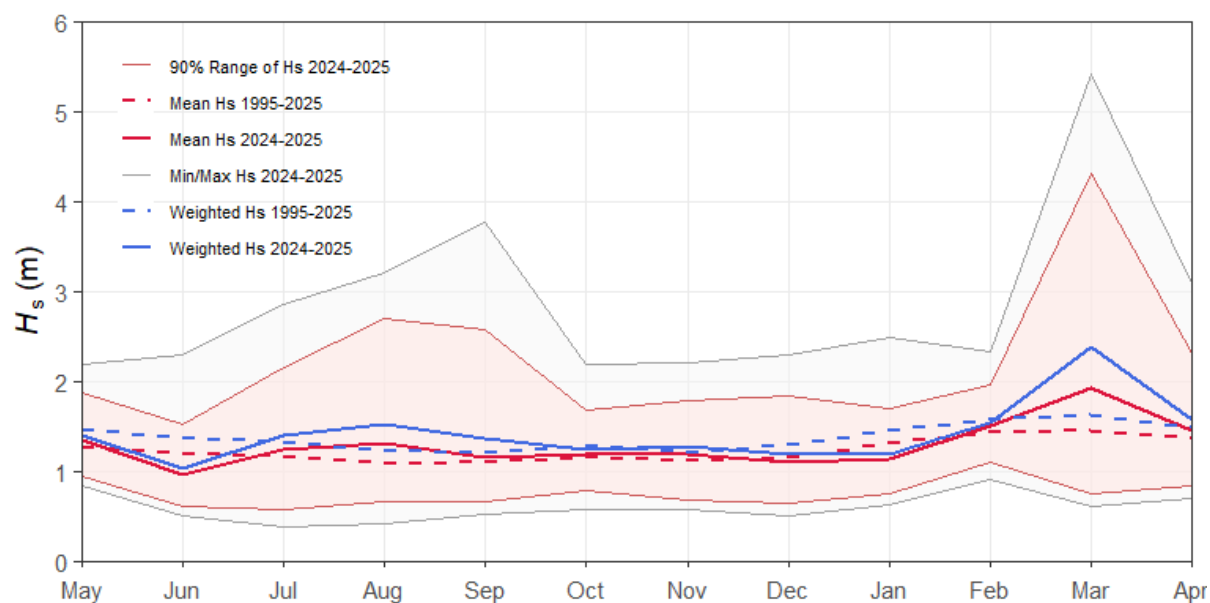


Figure 2 Tweed Heads: monthly mean and weighted mean H_s for the reporting year and all data

Table 6 Tweed Heads: highest ranked waves per event

Rank	Date (H_s)	H_s (m)	Date (H_{max})	H_{max} (m)
1	03/05/1996 01:00	7.52	02/05/1996 14:30	13.07
2	28/01/2013 08:30	6.71	28/01/2013 09:00	11.83
3	14/12/2020 08:30	6.41	14/12/2020 04:00	11.80
4	06/03/2004 01:00	6.07	05/03/2004 23:30	11.09
5	21/05/2009 19:30	5.63	06/03/2025 07:30	10.05
6	04/06/2016 19:30	5.57	30/06/2005 06:30	9.94
7	01/05/2015 22:30	5.47	05/06/2016 00:30	9.83
8	06/03/2025 08:00	5.41	22/05/2009 07:00	9.72
9	03/01/2022 03:30	5.33	04/03/2006 12:00	9.62
10	24/05/1999 05:00	5.23	25/03/1998 22:30	9.51

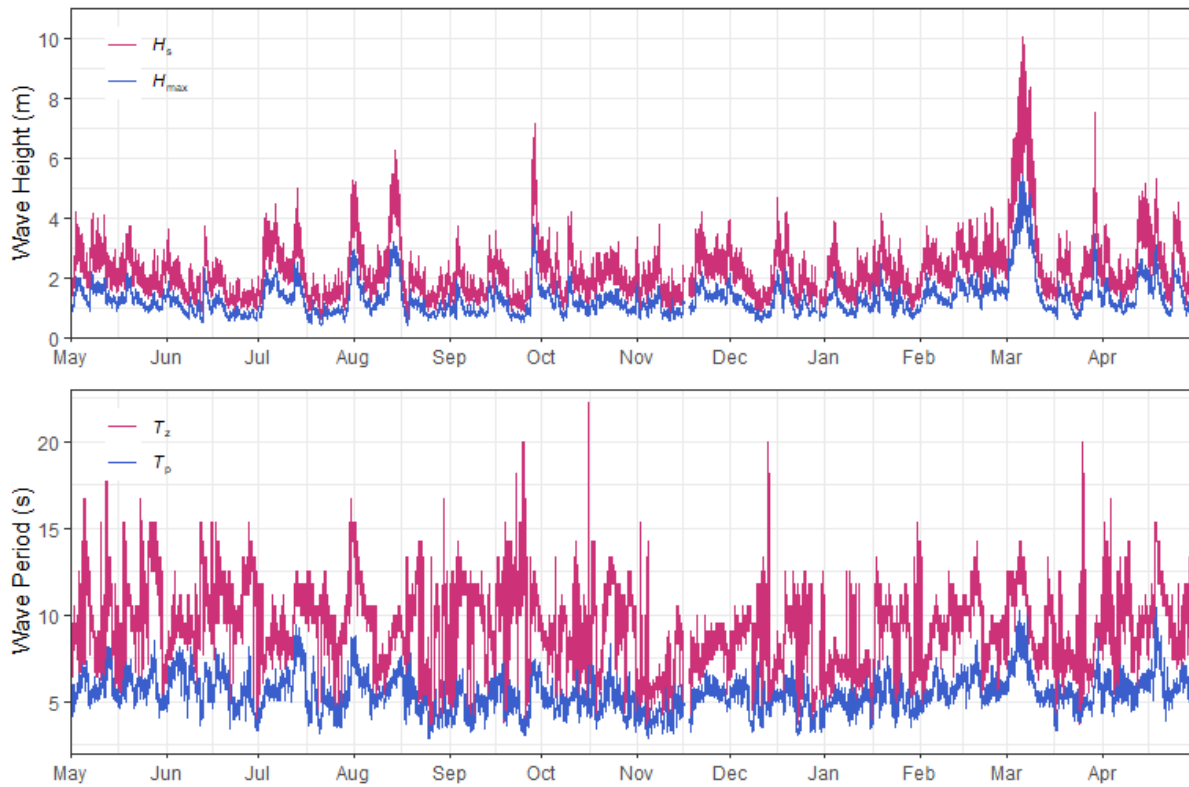


Figure 3 Tweed Heads: wave height (H_s and H_{max} , top) and wave period (T_p and T_z bottom)

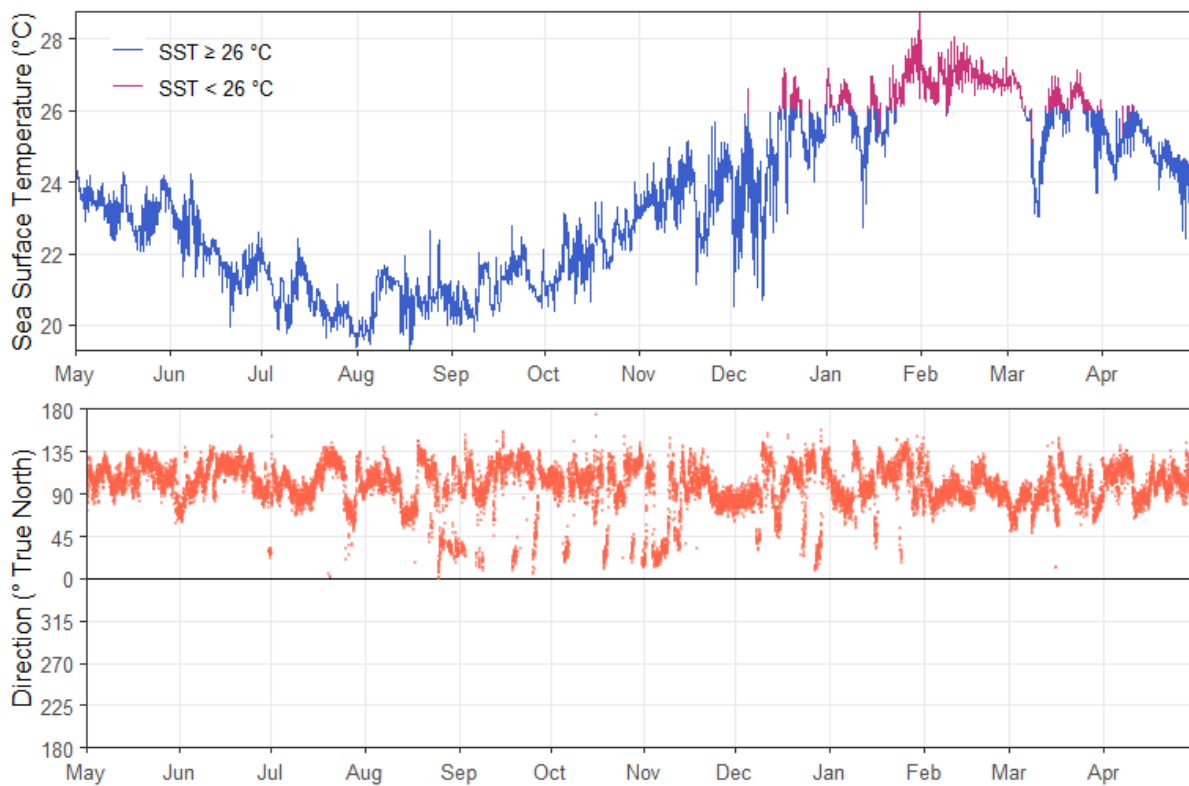


Figure 4 Tweed Heads: sea surface temperature (SST, top), and wave direction (D_p , bottom)

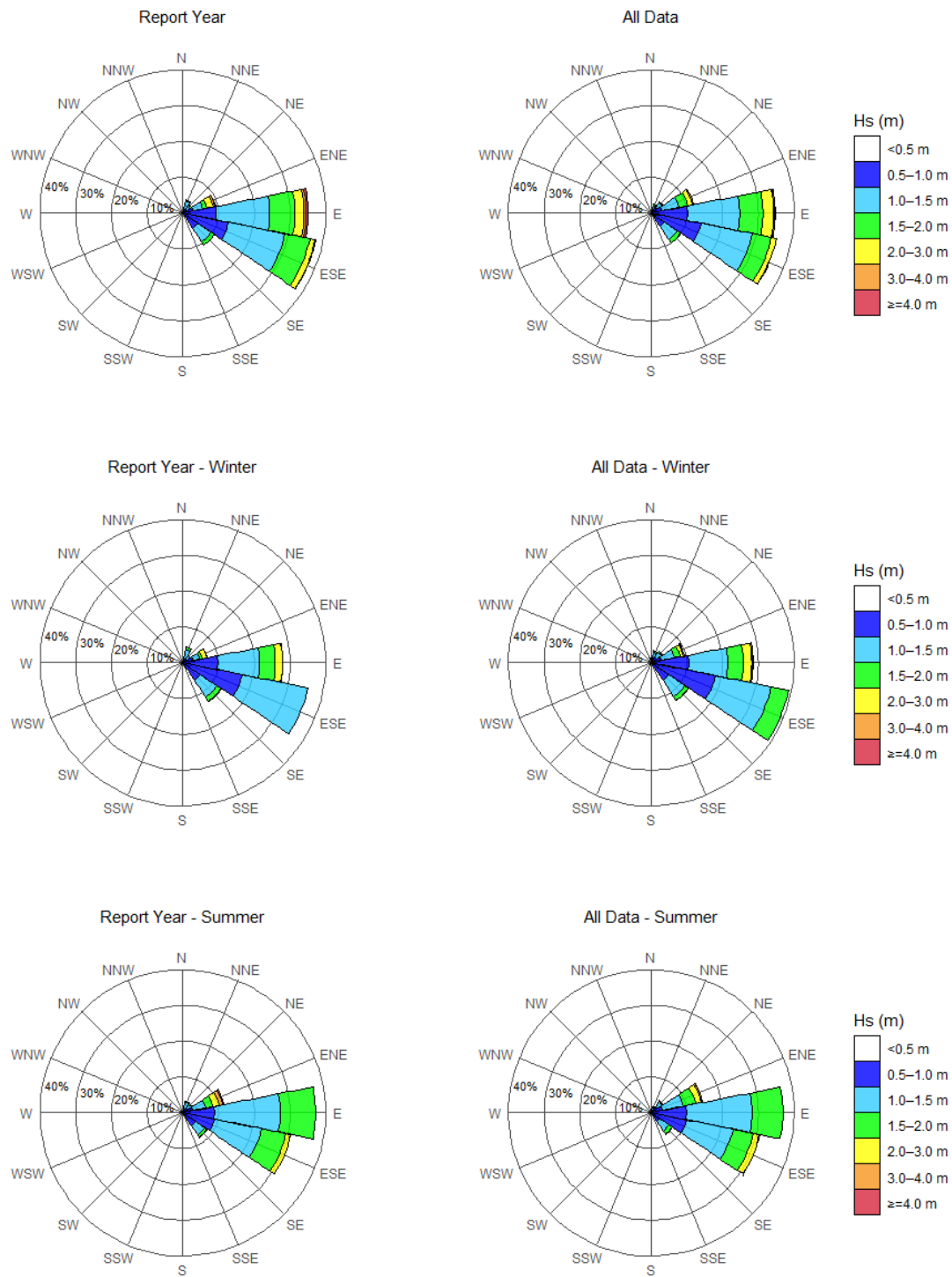


Figure 5 Tweed Heads: directional wave roses for H_s . Each band denotes the percentage frequency of recorded waves

Table 7 Tweed Heads: significant meteorological events

#	Start Time	End Time	Duration (h)	Date of Peak H_s	Peak H_s (m)	H_{max} (m)	D_p (° TN)	T_p (s)
1	06/07/2024 05:30	06/07/2024 20:00	15.0	06/07/2024 05:30	2.29	3.47	108.7	5.92
2	12/07/2024 16:30	13/07/2024 20:30	28.5	13/07/2024 09:00	2.49	4.41	80.7	8.74
3	30/07/2024 22:30	02/08/2024 01:00	51.0	01/08/2024 04:30	2.96	4.75	93.1	8.14
4	12/08/2024 12:30	15/08/2024 19:30	79.5	13/08/2024 21:30	3.21	4.39	61.2	6.88
5	27/09/2024 14:30	29/09/2024 13:30	47.5	28/09/2024 11:30	3.77	6.54	97.2	7.16
6	19/01/2025 00:00	19/01/2025 08:00	8.5	19/01/2025 05:00	2.48	3.95	99.6	6.14
7	22/02/2025 01:30	24/02/2025 05:00	52.0	24/02/2025 00:30	2.33	4.37	89.7	6.47
8	01/03/2025 15:00	10/03/2025 09:30	211.0	06/03/2025 08:00	5.41	9.33	73.2	9.11
9	28/03/2025 23:30	30/03/2025 05:00	30.0	29/03/2025 15:30	3.46	7.53	64.0	6.29
10	12/04/2025 15:30	15/04/2025 22:30	79.5	13/04/2025 23:00	2.64	4.24	86.7	6.58
11	18/04/2025 02:00	19/04/2025 03:00	25.5	18/04/2025 12:00	3.08	5.02	90.7	10.12
12	24/04/2025 04:30	25/04/2025 23:00	43.0	24/04/2025 05:30	2.55	3.65	116.4	6.26

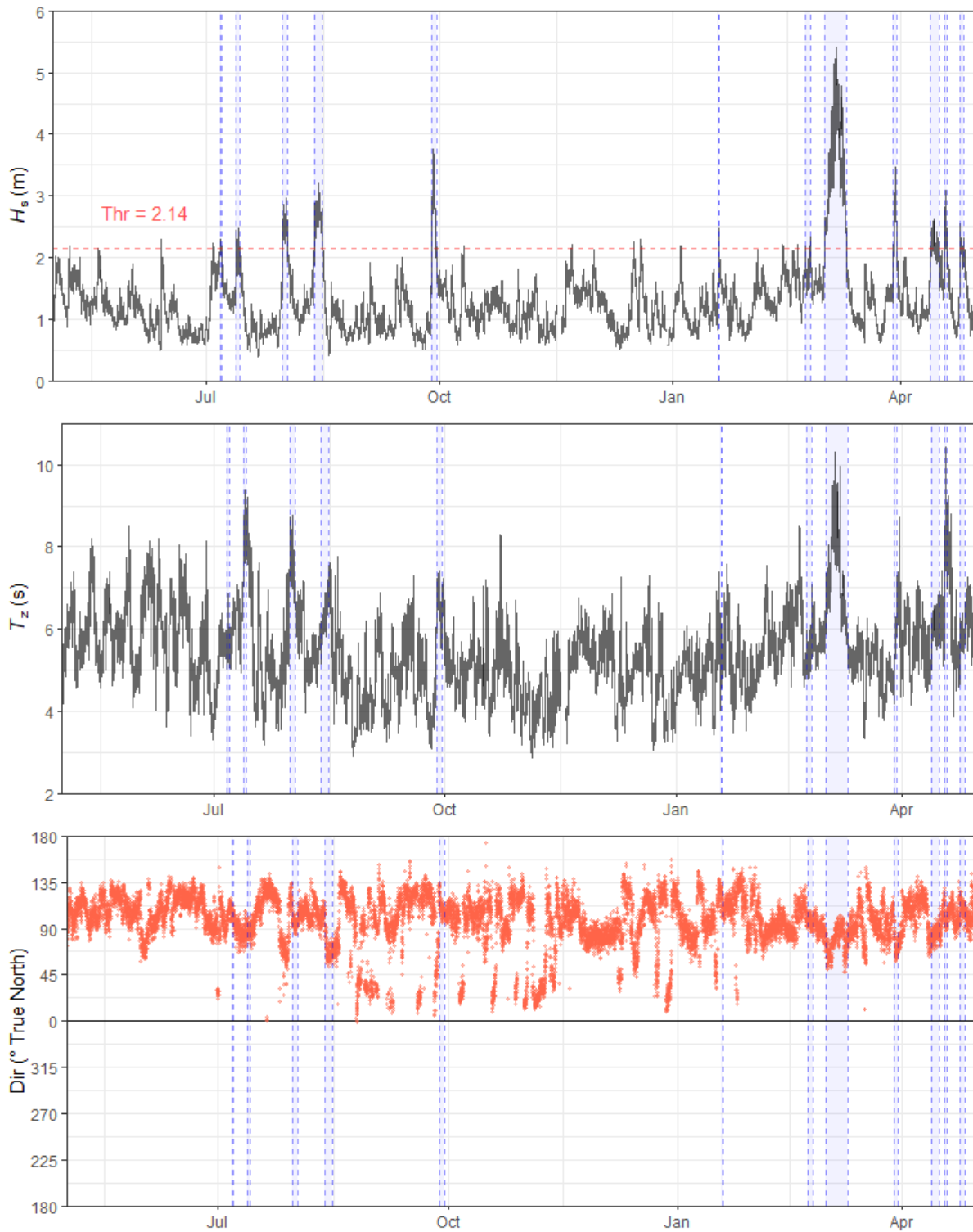


Figure 6 Tweed Heads: significant wave height (H_s , top) wave period (T_z , middle), and wave direction (D_p , bottom), with storms overlain in blue lines (threshold = 2.14 m)

Tweed Offshore

Details of data collection – [Tweed Offshore Wave Monitoring Station](#)

Description	Report Year 2024–2025	All Data 2020–2025
Maximum possible analysis (last record – first record):	365 days	5.25 years
Total days/years used in analysis:	359.1 days	5.07 years
Data gaps in analysis:	5.9 days	0.18 years
Number of records used in analysis:	17,237	91,783

Table 8 Tweed Offshore: monthly wave height summary

Month	Mean H_s (m)	Min H_s (m)	Max H_s (m)	Mean D_p (° TN)	90% range of H_s (m)	Days H_s ≥ 2 m	Days H_s ≤ 0.75 m	Date (dd) where H_s > 3 m
May-24	1.83	0.98	3.49	136	1.2–2.9	19	0	02 07 18 19 20
Jun-24	1.29	0.61	2.85	129	0.7–2.0	8	8	
Jul-24	1.61	0.59	3.58	122	0.8–2.7	11	6	31
Aug-24	1.58	0.49	3.52	114	0.8–3.0	11	6	01 02 12 13 14 15
Sep-24	1.60	0.65	5.66	136	0.8–3.7	12	5	13 15 16 27 28 29
Oct-24	1.55	0.74	2.99	128	0.9–2.4	13	2	
Nov-24	1.37	0.60	2.74	99	0.8–2.2	5	3	
Dec-24	1.40	0.67	5.63	120	0.8–2.5	7	4	18 19
Jan-25	1.42	0.68	3.62	126	0.8–2.4	10	2	18 19
Feb-25	1.71	1.00	3.01	107	1.2–2.3	16	0	17
Mar-25	2.20	0.73	7.58	103	0.8–5.9	18	2	02 03 04 05 06 07 08 09 17 18 29 30
Apr-25	1.90	0.82	3.70	128	1.1–2.9	22	0	13 16 17 18 24

Table 9 Tweed Offshore: mean and weighted mean (W-Mean) for wave height (H_s) and peak direction (D_p)

	Report Year: 2024–2025				All Data			
Month	Mean H_s (m)	W-Mean H_s (m)	Mean D_p (° TN)	W-Mean D_p (° TN)	Mean H_s (m)	W-Mean H_s (m)	Mean D_p (° TN)	W-Mean D_p (° TN)
May	1.83	1.93	136	141	1.81	1.92	125	130
Jun	1.29	1.40	129	135	1.37	1.50	132	137
Jul	1.61	1.79	122	122	1.64	1.86	127	123
Aug	1.58	1.80	114	109	1.38	1.53	123	126
Sep	1.60	2.00	136	146	1.54	1.75	118	131
Oct	1.55	1.65	128	132	1.58	1.75	121	125
Nov	1.37	1.46	99	103	1.37	1.48	113	128
Dec	1.40	1.60	120	138	1.56	1.88	121	125
Jan	1.42	1.54	126	136	1.70	1.85	115	120
Feb	1.71	1.76	107	112	1.77	1.90	115	121
Mar	2.20	2.91	103	103	1.84	2.16	119	116
Apr	1.90	2.03	128	125	1.75	1.92	127	123
May-Apr	1.62	1.88	121	122	1.62	1.82	122	124

$$\text{Weighted Mean } H_s = \left(\sum (H_s^{2.5}) / N \right)^{0.4}, \text{Weighted Mean Direction} = \sum (H_s^{2.5} * D_p) / \sum H_s^{2.5}$$

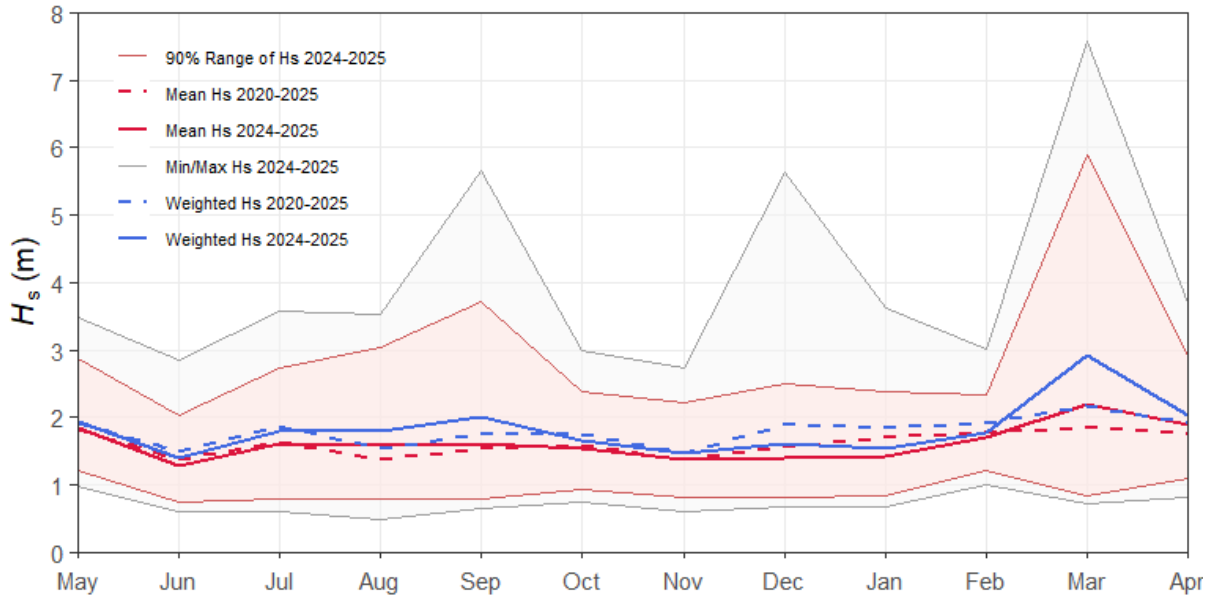


Figure 7 Tweed Offshore: monthly mean and weighted mean H_s for the reporting year and all data

Table 10 Tweed Offshore: highest ranked waves per event

Rank	Date (H_s)	H_s (m)	Date (H_{max})	H_{max} (m)
1	05/03/2025 09:00	7.58	07/03/2025 04:30	13.91
2	14/12/2020 07:30	7.48	14/12/2020 08:30	12.00
3	28/09/2024 11:30	5.66	04/02/2022 20:30	10.69
4	19/12/2024 03:00	5.63	27/09/2024 16:30	10.39
5	02/12/2022 08:30	5.25	02/12/2022 16:30	9.41
6	22/07/2022 17:30	5.24	19/12/2024 03:00	9.21
7	03/01/2022 04:30	4.89	22/07/2022 20:30	9.20
8	27/10/2023 23:30	4.83	27/10/2023 17:00	9.04
9	04/02/2022 20:30	4.78	21/03/2024 17:00	8.86
10	20/01/2022 21:30	4.69	28/12/2021 05:00	8.63

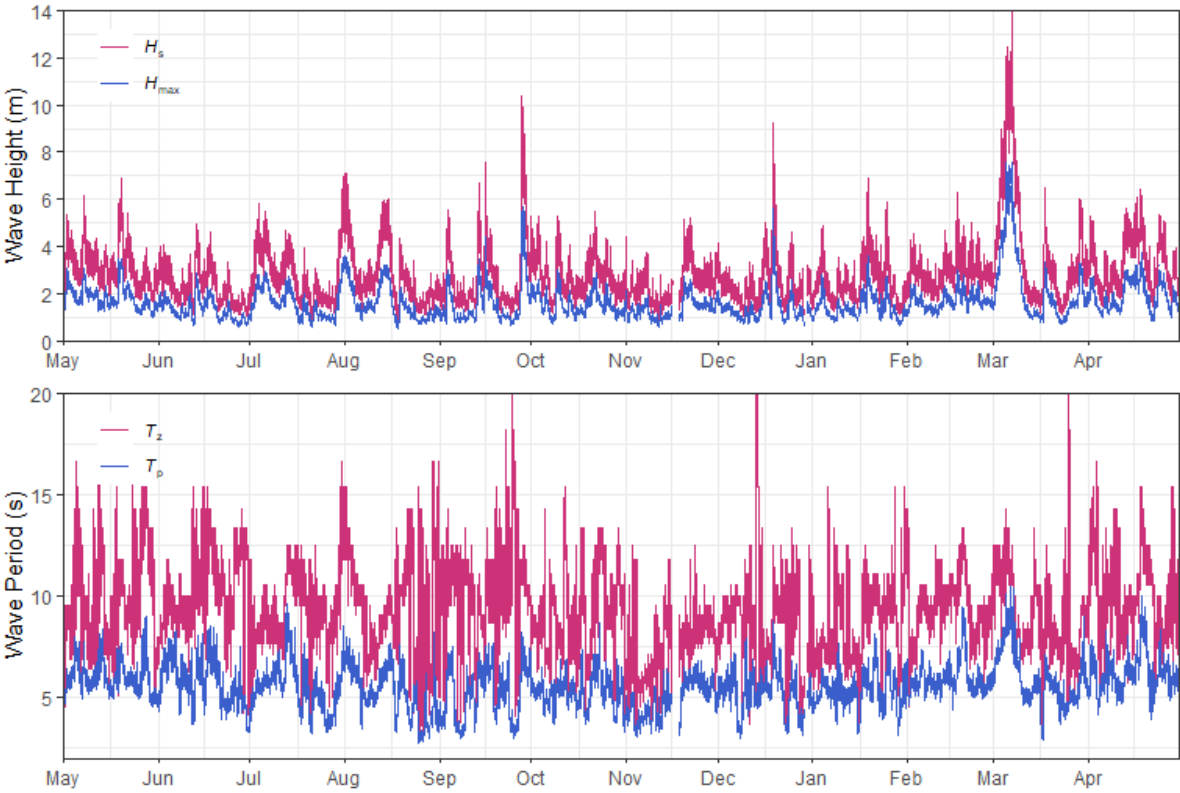


Figure 8 Tweed Offshore: wave height (H_s and H_{max} , top) and wave period (T_p and T_z bottom)

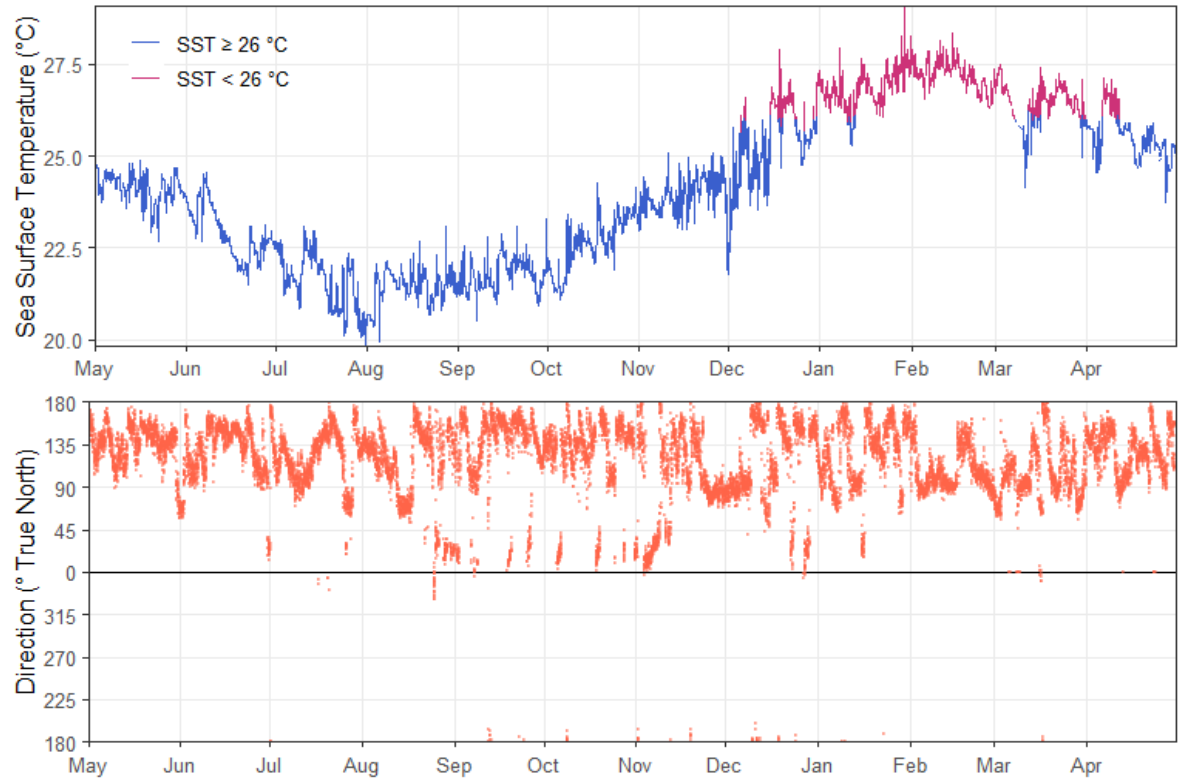


Figure 9 Tweed Offshore: sea surface temperature (SST, top), and wave direction (D_p , bottom)

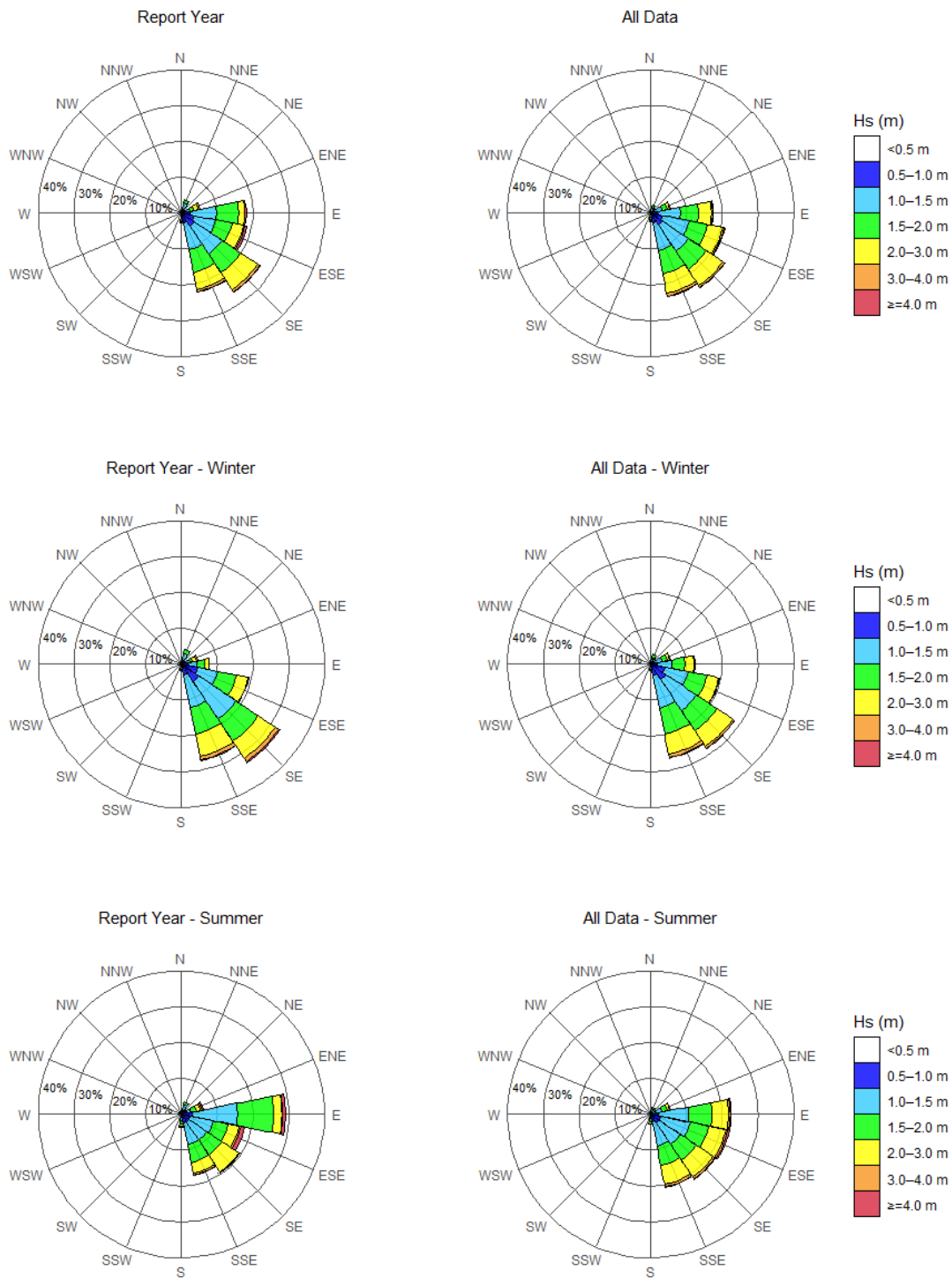


Figure 10 Tweed Offshore: directional wave roses for H_s . Each band denotes the percentage frequency of recorded waves

Table 11 Tweed Offshore: significant meteorological events

#	Start Time	End Time	Duration (h)	Date of Peak H_s	Peak H_s (m)	H_{max} (m)	D_p (° TN)	T_p (s)
1	02/05/2024 00:30	02/05/2024 13:30	13.5	02/05/2024 00:30	3.03	4.72	160.8	6.42
2	07/05/2024 09:30	07/05/2024 21:00	12.0	07/05/2024 14:00	3.03	4.76	160.2	7.28
3	18/05/2024 19:30	20/05/2024 05:30	34.5	19/05/2024 18:30	3.49	5.94	152.0	7.01
4	30/07/2024 20:00	02/08/2024 10:30	63.0	31/07/2024 21:30	3.58	5.99	123.3	7.03
5	12/08/2024 16:30	15/08/2024 12:30	68.5	14/08/2024 13:30	3.22	5.22	69.9	6.00
6	13/09/2024 14:00	16/09/2024 07:30	66.0	15/09/2024 22:00	4.43	6.95	166.0	7.52
7	27/09/2024 13:30	29/09/2024 09:30	44.5	28/09/2024 11:30	5.66	8.14	137.2	7.98
8	18/12/2024 18:00	19/12/2024 23:00	29.5	19/12/2024 03:00	5.63	9.21	171.7	8.74
9	18/01/2025 19:30	19/01/2025 07:00	12.0	19/01/2025 01:30	3.62	6.92	152.6	6.59
10	02/03/2025 07:30	09/03/2025 23:30	184.5	05/03/2025 09:00	7.58	12.04	110.7	10.06
11	17/03/2025 18:00	18/03/2025 06:00	12.5	17/03/2025 21:30	3.35	6.27	177.2	6.56
12	29/03/2025 05:00	30/03/2025 01:00	20.5	29/03/2025 18:30	3.25	5.39	67.2	6.19
13	13/04/2025 04:00	19/04/2025 01:00	141.5	18/04/2025 10:30	3.70	5.15	108.7	9.76
14	24/04/2025 04:30	25/04/2025 22:00	42.0	24/04/2025 04:30	3.17	4.76	132.9	7.51

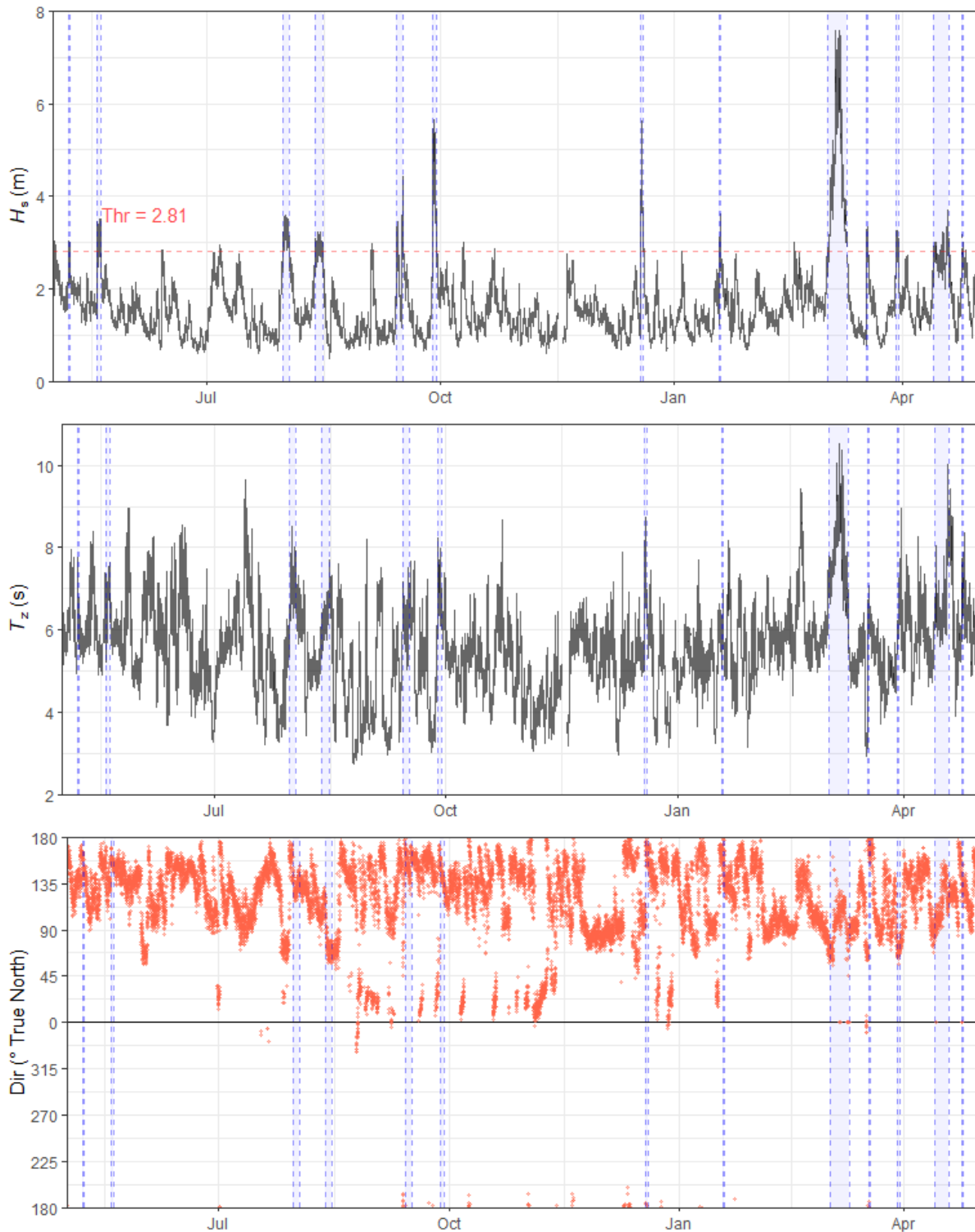


Figure 11 Tweed Offshore: significant wave height (H_s), wave period (T_z), and wave direction (D_p), with storms identified using the peak over threshold method highlighted in blue (threshold = 2.81 m).

Appendix A – Published Reports in this Series

#	Report	Report Number	Report Period
1	Tweed Heads Wave Climate Summary 2006–2007	Report No. 2007.1	01 May 2006 – 30 April 2007
2	Tweed Heads Wave Climate Summary 2007–2008	Report No. 2008.1	01 May 2007 – 30 April 2008
3	Tweed Heads Wave Climate Summary 2008–2009	Report No. 2009.1	01 May 2008 – 30 April 2009
4	Tweed Heads Wave Climate Summary 2009–2010	Report No. 2010.1	01 May 2009 – 30 April 2010
5	Tweed Heads Wave Climate Summary 2010–2011	Report No. 2011.1	01 May 2010 – 30 April 2011
6	Tweed Heads Wave Climate Summary 2011–2012	Report No. 2012.1	01 May 2011 – 30 April 2012
7	Tweed Heads Wave Climate Summary 2012–2013	Report No. 2013.1	01 May 2012 – 30 April 2013
8	Tweed Heads Wave Climate Summary 2013–2014	Report No. 2014.1	01 May 2013 – 30 April 2014
9	Tweed Heads Wave Climate Summary 2014–2015	Report No. 2015.1	01 May 2014 – 30 April 2015
10	Tweed Heads Wave Climate Summary 2015–2016	Report No. 2016.1	01 May 2015 – 30 April 2016
11	Tweed Heads Wave Climate Summary 2016–2017	Report No. 2017.1	01 May 2016 – 30 April 2017
12	Tweed Heads Wave Climate Summary 2017–2018	Report No. 2018.1	01 May 2017 – 30 April 2018
13	Tweed Heads Wave Climate Summary 2018–2019	Report No. 2019.1	01 May 2018 – 30 April 2019
14	Tweed Heads Wave Climate Summary 2019–2020	Report No. 2020.1	01 May 2019 – 30 April 2020
15	Tweed Heads Wave Climate Summary 2020–2021	Report No. 2021.1	01 May 2020 – 30 April 2021
16	Tweed Heads Wave Climate Summary 2021–2022	Report No. 2022.1	01 May 2021 – 30 April 2022
17	Tweed Heads Wave Climate Summary 2022–2023	Report No. 2023.1	01 May 2022 – 30 April 2023
18	Tweed Heads Wave Climate Summary 2023–2024	Report No. 2024.1	01 May 2023 – 30 April 2024

DELIVERING
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