# Pakiri Hindcast Metocean Study

## Wind, wave and current ambient and extreme statistics

Report prepared for JACOBS and McCallum Bros Ltd

August 2019

MetOcean SOLUTIONS

# Document History

## Versions

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## Distribution

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# 1. Introduction

JACOBS and McCallum Bros Ltd has commissioned MetOcean Solutions (MOS, subsidiary of Meteorological Service of New Zealand Ltd) to provide a summary of metocean conditions offshore Pakiri, New Zealand (Figure 1.1, Table 1.1). An overview of the metocean conditions is required to provide an initial characterisation of the environment from a marine operability perspective, plus identify potential hazards and document the important aspects of the environmental conditions that may require further attention.

Numerical hindcasting techniques are the primary source of oceanographic and meteorological data used in preparing this report, and a brief summary of the data sources is provided in Section 2. Results for the site specific wind conditions are provided in Section 3. The wave climate is detailed in Section 4. The current climate is described in Section 5. Workability statistics are given in Section 6. Extreme statistics are reported in Section 7. Metocean statistics for the period Nov 2018 – Jun 2019 are compared to the long term statistics in Section 8. Analytical methods are described in Section 9 and the references cited are listed in the final Section 10.

Note that the standard oceanographic directional conventions are applied in this report, with waves and winds reported in the 'coming from' directional reference.

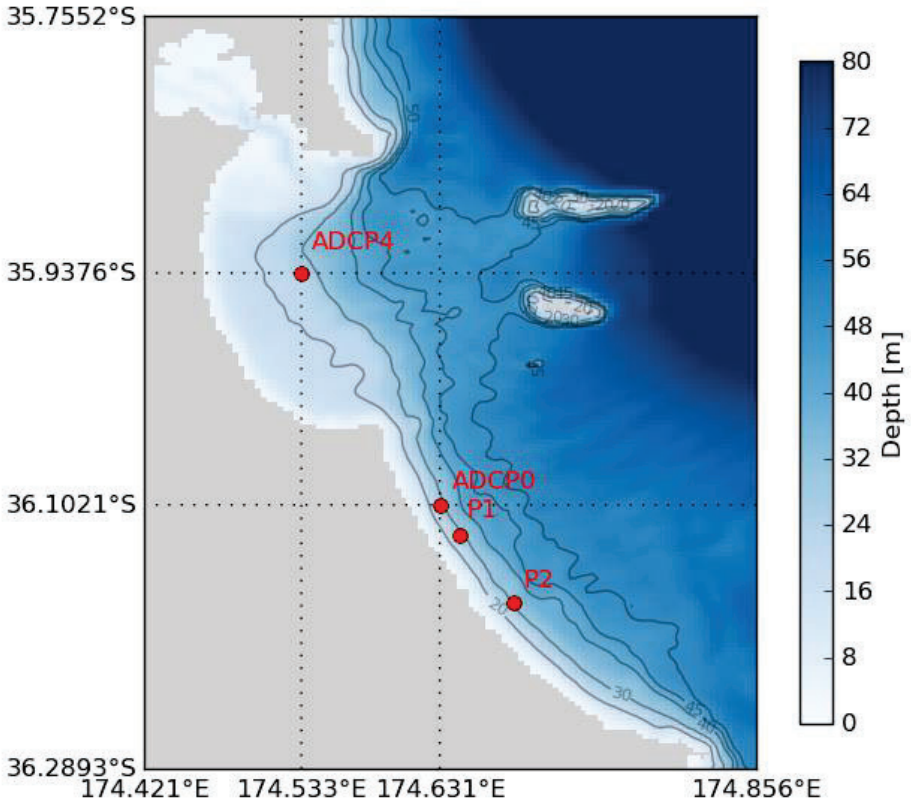


*Figure 1.1* *Map showing the area of interest and the representative sites P1 and P2 offshore Pakiri, New Zealand. Also shown are the current validation sites ADCP0 and ADCP4.*

*Table 1.1* *Coordinates and approximate water depth at the representative data reporting and validation sites.*

| Site | World Geodetic System 1984 (WGS84) | | Water depth (m) |
|---|---|---|---|
| | Longitude | Latitude | |
| **P1** | 174.645715° E | 36.123430° S | 29 |
| **P2** | 174.683809°E | 36.171665° S | 32 |
| **ADCP0** | 174.631300° E | 36.102070° S | 25 |
| **ADCP4** | 174.533060° E | 35.937560° S | 25 |

# 2. Metocean datasources

## 2.1. Wind data

The near surface wind and visibility fields were prescribed by a 38-year regional atmospheric hindcast carried out by MOS. The WRF (Weather Research and Forecasting) model was established over all New Zealand at hourly intervals and 12 km resolution with a nested domain over central regions at 4 km resolution. The hindcast was specifically tuned to provide highly accurate marine wind fields for metocean studies around New Zealand.

The WRF model boundaries were sourced from the CFSR (Climate Forecast System Reanalysis) dataset distributed by NOAA (Saha et al., 2010).

Validation of the WRF reanalysis has been undertaken at various locations around New Zealand.

## 2.2. Wave data

Directional wave spectra within the Hauraki Gulf have been defined from a 40-year period (1979–2018) high-resolution SWAN (Simulating WAves Nearshore) wave hindcast. First, a global scale wave hindcast was produced by MetOcean Solutions Ltd using the WW3 (WAVEWATCH III) model with a resolution of 0.5° by 0.5° applying the source terms parameterizations of Ardhuin et al. (2010). The CFSR wind field was used for wind forcing and the Tolman and Chalikov (1996) physics options were applied in the model configuration. No wave height data assimilation was performed on this hindcast. These hindcast data were extracted at 3-hour intervals and were used to prescribe spectral boundaries for a regional New Zealand North Island SWAN wave model domain (at 0.04° by 0.04° resolution, i.e. approximately 4 km). Finally, a high resolution nest of the Hauraki Gulf (at 0.008° by 0.008° resolution, i.e. approximately 800 m) has been implemented and run over 37 years. Both SWAN model domains are illustrated in Figure 2.1.

SWAN is a third generation ocean wave propagation model which solves the spectral action density balance equation (Booij et al., 1999). The model simulates the growth, refraction and decay of each frequency-direction component of the complete sea state, providing a realistic description of the wave field as it changes in time and space. Physical processes that are modelled include the generation of waves by surface wind, dissipation by white-capping, resonant nonlinear interaction between the wave components, bottom friction and depth limited breaking dissipation. A detailed description of the model equations, parameterisations and numerical

schemes can be found in Holthuijsen et al. (2007) and in the SWAN documentation[1]. SWAN was configured with 23 frequency bins and 36 directional bins.

SWAN was run with wind fields specified from the WRF model as described in Section 2.1. Model depths were constructed from a combination of several surveys which include multibeam, single beam, LiDAR, Electronic Nautical Charts (ENCs), obtained from different organisations (including councils, NIWA, LINZ and the Department of Conservation).

[1] http://swanmodel.sourceforge.net/online_doc/online_doc.htm

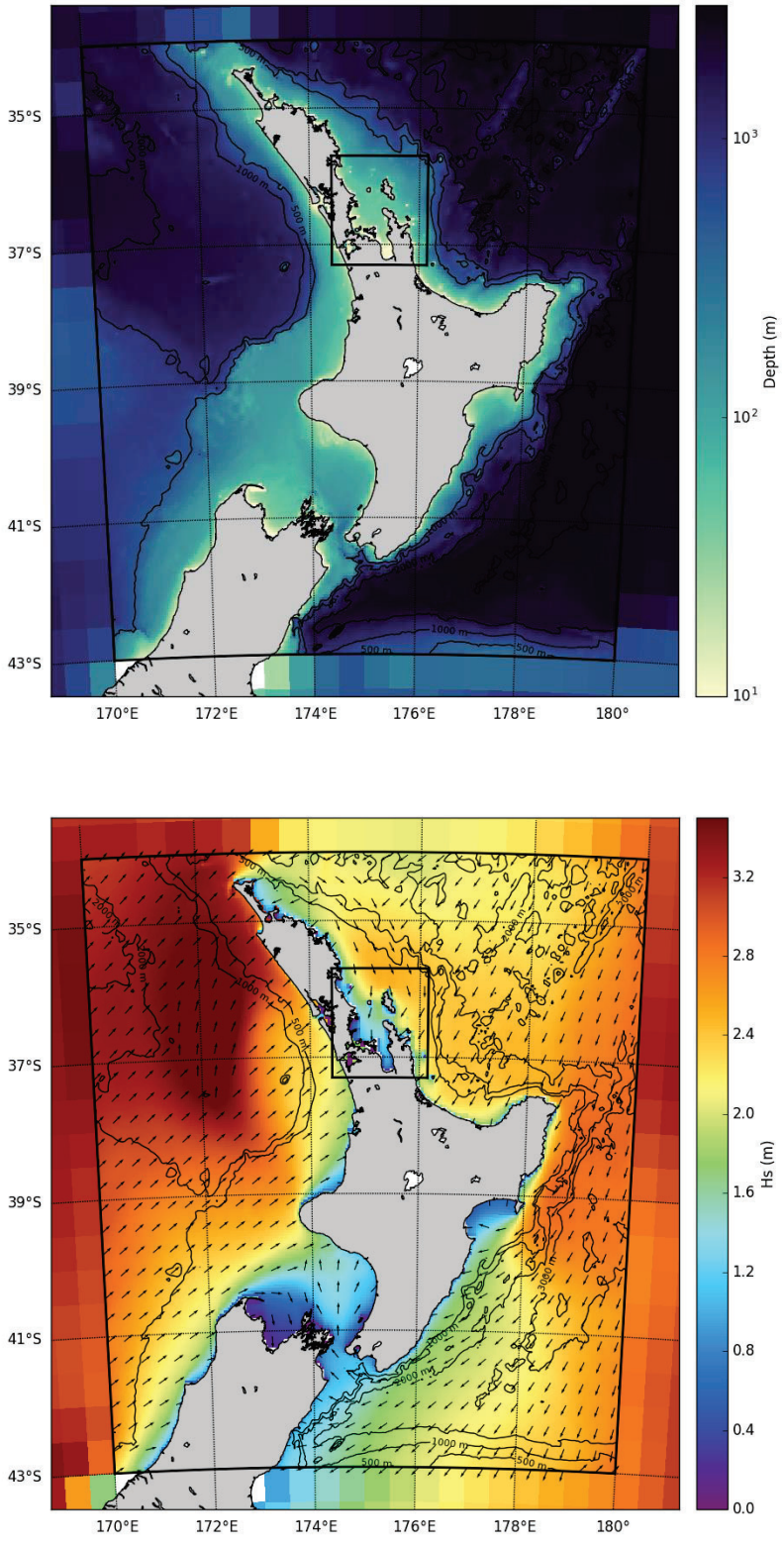


*Figure 2.1. Snapshots of (top) model depths and (bottom) significant wave height from the regional NZ North Island 4-km SWAN domain on 01 January 2012, shown within the area delimited by the outer black rectangle. Model data from the 0.5° global wave model are shown outside of this area. Extension of high resolution Hauraki Gulf 800-m SWAN nest is shown by the inner black rectangle.*

## 2.3. Current data

A 19-year (Jan 2000 – Jun 2018) hindcast was performed using the ROMS hydrodynamic model version 3.7 (Haidvogel 2008) to characterise the tidal and residual shelf scale circulation regime of the Hauraki Gulf. The application of the ROMS model at regional scale fully captures the interaction of the wind and tidal circulation with the morphology of the Hauraki Gulf. This modelling tool has been used widely in the scientific and commercial consultancy communities for a wide range of ocean basin at regional and coastal scales.

ROMS has a curvilinear horizontal coordinate system and solves the hydrostatic, primitive equations subject to a free-surface condition. It is a state-of-the-art model widely used for regional and coastal dynamics assessment. Its terrain-following vertical coordinate system results in accurate modelling of shelf seas with variable bathymetry, allowing the vertical resolution to be inversely proportional to the local depth. Besides tidal and wind-driven currents, ROMS resolves frontal structures and baroclinic pressure gradients quite well. Vertical mixing may be resolved by different separate turbulent closure schemes, that are flexible to shallow and deep water dynamics. These features make ROMS particularly well-adapted for the modelling of regional hydrodynamic systems and ROMS is one of the hydrodynamic models most used for regional study applications. It is a modern code which captures sub-, meso- and macro-scale hydrodynamic mechanisms while maintaining robustness, accuracy and numerical stability.

The ROMS model data was used to calculate ambient and extreme residual (non-tidal) current and surge statistics reported in this study.

### ROMS model domains

The hindcast setup was configured with a three-level nesting approach to best transfer the energy gradually from larger to smaller coastal scales, and to properly resolve the flow associated with local and remote forcing, both essential for the resultant currents in the area of interest. The open boundary conditions that were imposed to the highest level nest (NZ) consisted of tri-dimensional velocity, temperature, salinity and sea surface height fields derived from the 6-hourly Climate Forecast System Reanalysis (CFSR) product (Saha et al., 2010) from the National Centers for Environmental Prediction (NCEP), which consisted of a 0.5 degree global reanalysis with comprehensive data assimilation.

The larger scale ROMS nest encompassed the entire New Zealand area with 7 km horizontal resolution, the goal of which was to absorb the basin scale circulation estimated by the CFSR global reanalysis, thus avoiding a large parent-to-child resolution step. This domain, called NZ hereinafter, was able to more adequately capture the oceanic circulation and its variability. The second domain (HRKI) covered the entire Hauraki Gulf and continental shelf surrounding the area of interest with a

horizontal resolution of 1.7 km. With this grid spacing, the local bathymetry was more accurately captured resulting in fine scale representation of the local coastal currents. The third domain (Pakiri) covers the northern Hauraki Gulf including the area of interest with a much higher resolution (350 m), and resolved the detailed, local wind-driven and tidal circulation, producing accurate currents and thermohaline fields to support the subsequent local scale hydrodynamic models.

The 3D flow and thermohaline fields were transferred from the top level domains to the refined ones by the offline one-way nesting technique commonly used with ROMS.CFSR 3D fields were fed to NZ at 6-hourly intervals and NZ-HRKI and HRKI / Pakiri ROMS at 3-hourly intervals.

All ROMS domains were submitted to spin-up phases prior to the 19-year hindcast period to allow the adjustment of the coarser initial conditions to higher resolution and its better represented bathymetry. The spin-up times were hierarchically established according to the main scales that each one was required to resolve. This information, along with all other relevant information for each of the hydrodynamic model domains considered for this study, is summarised in Table 2.1. The bathymetry for the ROMS grids was derived from electronic navigation charts and field data whenever available.

*Table 2.1 ROMS model nests configurations.*

| Model Settings | NZ | HRKI | Pakiri |
|---|---|---|---|
| **Horizontal Resolution** | 8 km (0.08° x 0.06°) | 1.7 km (0.02° x 0.02°) | 400-300 m (0.004° x 0.003°) |
| **Dimension** | 3D | 3D | 3D |
| **Vertical layers** | 30 | 19 | N.A. |
| **Tidal forcing** | No | No | Yes |
| **Meteo forcing** | MSL WRF NZRA | MSL WRF NZRA | MSL WRF NZRA |

## ROMS model validation

The final hydrodynamic hindcast product was validated against co-temporal current time series obtained from measured data at locations ADCP4 and ADCP0 as illustrated in *Figure 2.2*.

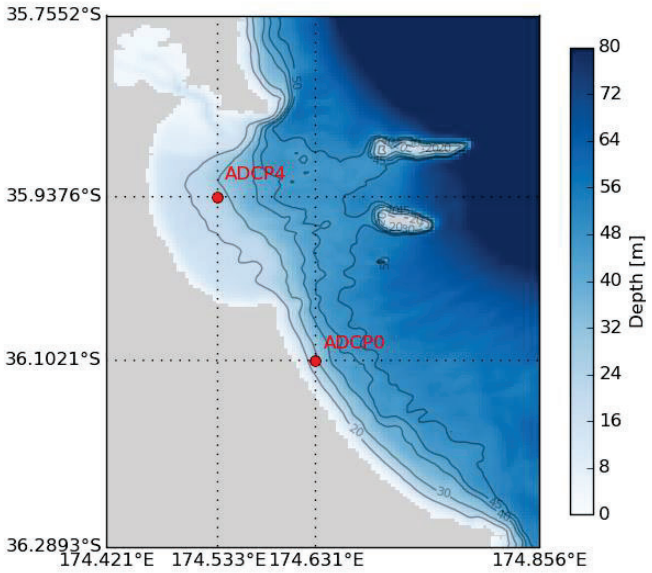


*Figure 2.2. Bathymetry map showing the measurement locations.*

Modelled and measured current time series were vertically-averaged from 5 to 25 m depth and re-sampled to 1-hour intervals for a consistent time-domain comparison of total, non-tidal and tidal currents. The tidal flow was obtained from a harmonic decomposition. A 30-hour low-pass filter was applied to separate the non-tidal flow from the total signal. This approach was used in order to reduce potential noise contamination from the t due to the short time extent of the measured current data used for the analysis.

Although the period covered by the measurements are not long enough to assess the model performance throughout all possible weather scenarios, results from modelled and measured depth-averaged currents comparison indicate the model resolves faithfully the circulation regime at both locations (*Figure 2.3*-*Figure 2.8*). Flow orientation and direction are reasonably well reproduced by the model, as shown on the Rose plots (*Figure 2.5*-*Figure 2.6*). The model generally underestimates the current magnitudes by approximately 30% (*Figure 2.3*-*Figure 2.4*), which in part is due to non-tidal (residual) flow forced by strong wind events not being well replicated and an overall underestimation of the tidal magnitudes.

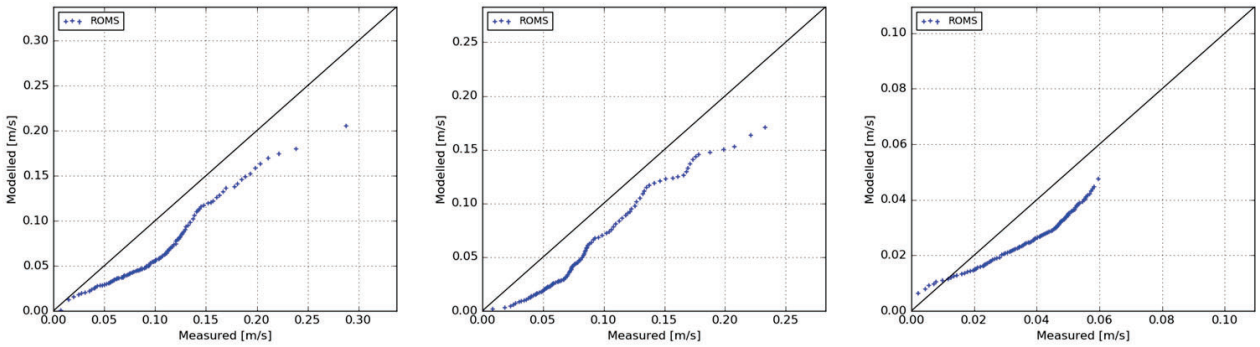


*Figure 2.3. Quantile-Quantile plots of the measured and modelled total (left), non-tidal (center) and tidal (right) depth-averaged current speed at location ADCP4 (12 June – 13 July 2016).*

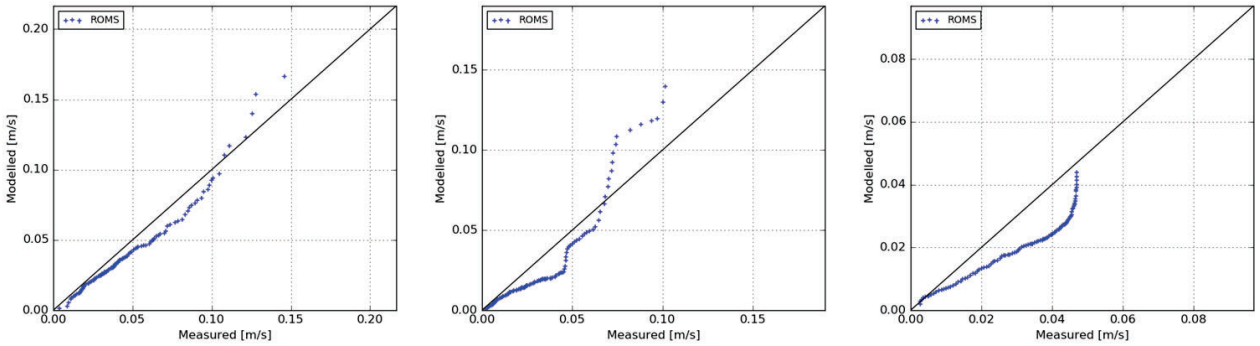


*Figure 2.4. Quantile-Quantile plots of the measured and modelled total (left), non-tidal (center) and tidal (right) depth-averaged current speed at location ADCP0 (20 – 31 May 2019).*

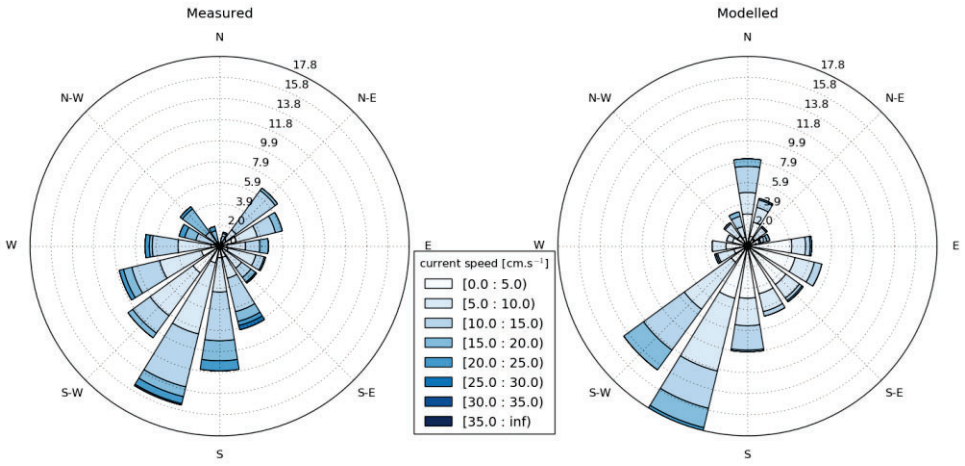


*Figure 2.5. Measured (left) and modelled (right) total depth-averaged current rose at location ADCP4 (12 June – 13 July 2016).*

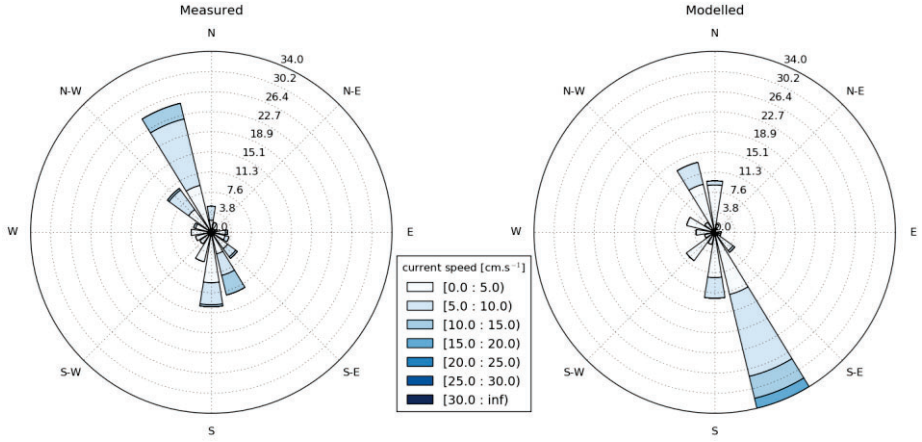


*Figure 2.6. Measured (left) and modelled (right) total depth-averaged current rose at location ADCP0 (20 – 31 May 2019).*

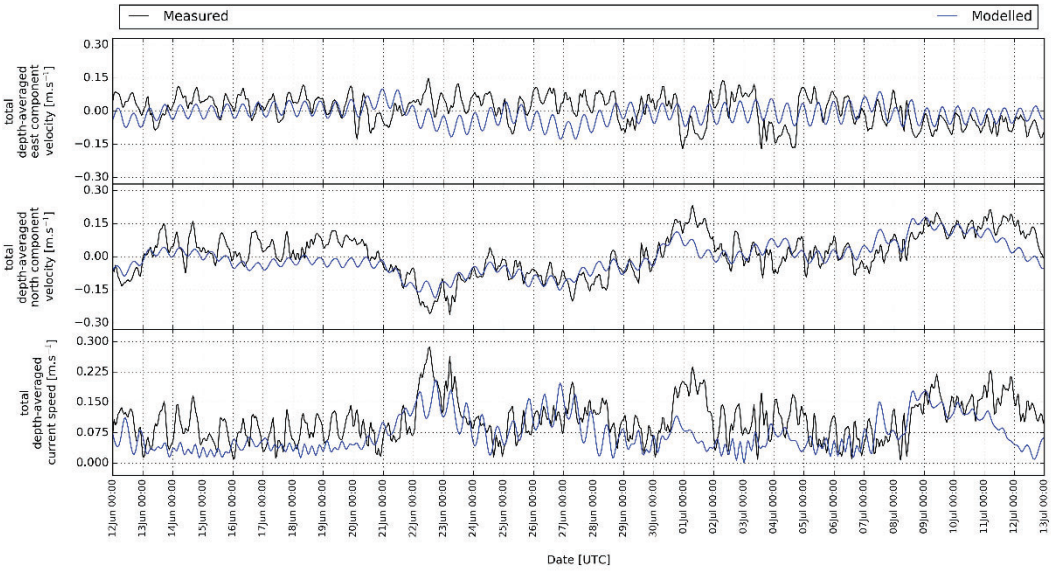


*Figure 2.7. Time series of modelled (blue) and measured (black) total depth-averaged current velocity at location ADCP4 (12 June – 13 July 2016).*

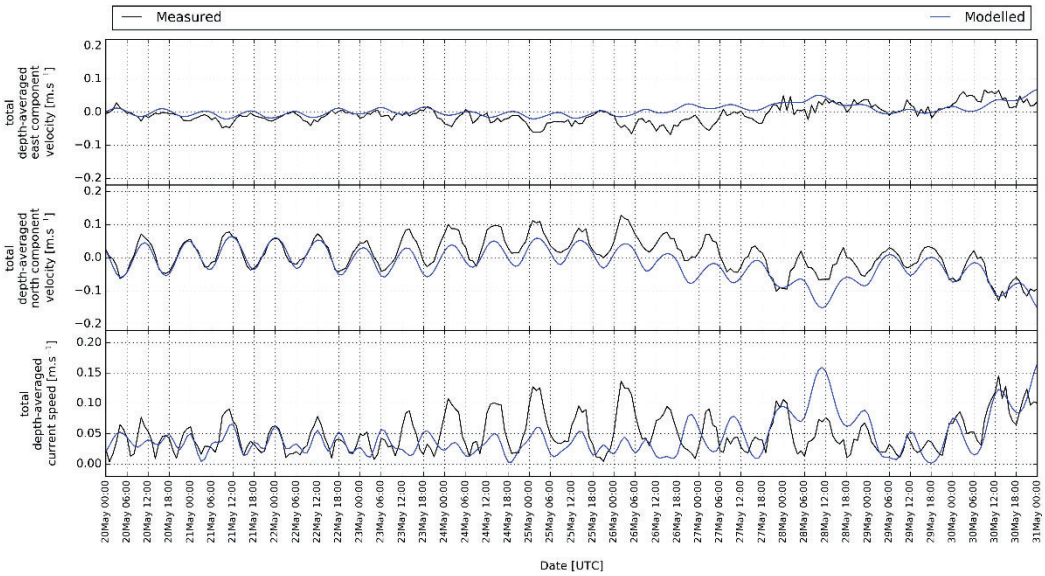


*Figure 2.8. Time series of modelled (blue) and measured (black) total depth-averaged current velocity at location ADCP0 (20 – 31 May 2019).*

# 3. Wind climate

## 3.1. P1

A summary of the wind speed statistics for the 10-minute mean at 10 m elevation at P1 is provided in Table 3.1.

The monthly and annual 10-min wind speed exceedance probabilities are provided in Table 3.2, and indicate the wind speeds exceeding 18 $m.s^{-1}$ can occur throughout the year, with March having the highest occurrence of strong wind events at P1.

The annual joint probability distribution of the wind speed and direction is presented in Table 3.3.

The annual and monthly non-exceedance persistence probabilities for 10-min wind speed at P1 (Table 3.4 to Table 3.15) can be used to estimate the operational uptime for tasks with wind speed limitations of variable duration. For example, at P1 on average in February, wind speeds are less than 4.0 $m.s^{-1}$ for durations of 36 hours and greater for 1.43% of the time (Table 3.5).

The monthly and annual 10-min wind roses are illustrated in Figure 3.1, showing the annual predominance of winds coming mainly from the WSW quadrants.

*Table 3.1 Annual and monthly 10-min wind speed statistics at P1.*

| Period (01 Jan 1979 – 31 Dec 2018) | 10-min wind speed statistics (1) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10-min wind speed (m/s) | | | Exceedance percentile for 10-min wind speed (m/s) | | | | | | | | | Main (4) Direction(s) |
| | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 20.96 | 6.03 | 2.90 | 0.80 | 1.78 | 2.53 | 5.76 | 8.31 | 9.78 | 11.24 | 13.03 | 14.12 | NE SW |
| **February** | 19.19 | 5.88 | 2.85 | 0.70 | 1.68 | 2.35 | 5.64 | 8.08 | 9.58 | 10.86 | 12.85 | 14.14 | E SW |
| **March** | 25.43 | 6.10 | 2.95 | 0.78 | 1.77 | 2.48 | 5.86 | 8.40 | 9.89 | 11.28 | 13.31 | 14.32 | E SW |
| **April** | 21.49 | 6.01 | 2.88 | 0.87 | 1.75 | 2.46 | 5.73 | 8.33 | 9.79 | 11.21 | 12.76 | 13.76 | SW |
| **May** | 21.57 | 6.44 | 3.03 | 0.85 | 1.83 | 2.62 | 6.18 | 8.93 | 10.51 | 11.79 | 13.28 | 14.35 | SW W |
| **June** | 24.44 | 6.84 | 3.25 | 0.94 | 1.96 | 2.84 | 6.52 | 9.42 | 11.10 | 12.81 | 14.57 | 15.82 | SW W |
| **July** | 24.38 | 7.01 | 3.48 | 0.98 | 2.06 | 2.92 | 6.51 | 9.67 | 11.77 | 13.69 | 15.59 | 16.73 | SW W |
| **August** | 20.58 | 6.77 | 3.22 | 1.03 | 2.03 | 2.84 | 6.38 | 9.29 | 11.15 | 12.76 | 14.47 | 15.55 | SW W |
| **September** | 22.17 | 6.79 | 3.16 | 0.88 | 2.01 | 2.82 | 6.55 | 9.29 | 10.90 | 12.45 | 14.27 | 15.66 | SW W |
| **October** | 20.93 | 6.74 | 2.99 | 0.91 | 2.06 | 2.88 | 6.58 | 9.20 | 10.74 | 11.97 | 13.43 | 14.29 | SW W |
| **November** | 19.96 | 6.52 | 2.93 | 0.94 | 2.09 | 2.81 | 6.31 | 8.86 | 10.30 | 11.66 | 13.23 | 14.62 | SW W |
| **December** | 20.54 | 6.04 | 2.80 | 0.82 | 1.88 | 2.65 | 5.80 | 8.25 | 9.79 | 11.09 | 12.60 | 13.75 | N SW W |
| **Winter**(3) | 24.44 | 6.87 | 3.32 | 0.98 | 2.02 | 2.87 | 6.47 | 9.46 | 11.34 | 13.08 | 14.91 | 16.12 | SW W |
| **Spring** | 22.17 | 6.69 | 3.03 | 0.91 | 2.05 | 2.84 | 6.48 | 9.12 | 10.66 | 12.05 | 13.66 | 14.86 | SW W |
| **Summer**(2) | 20.96 | 5.98 | 2.85 | 0.78 | 1.78 | 2.51 | 5.73 | 8.23 | 9.72 | 11.07 | 12.84 | 13.98 | E SW |
| **Autumn** | 25.43 | 6.19 | 2.96 | 0.83 | 1.78 | 2.51 | 5.92 | 8.56 | 10.10 | 11.48 | 13.12 | 14.21 | SW |
| **All** | 25.43 | 6.43 | 3.07 | 0.87 | 1.90 | 2.66 | 6.14 | 8.84 | 10.47 | 11.98 | 13.77 | 14.98 | SW W |

Notes: (1) All statistics derived from hindcast wind data (10-min mean at 10 m AMSL) for the period 01 January 1979 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the winds approach.

*Table 3.2 Monthly and annual 10-min wind speed exceedance probabilities (%) at P1.*

| $U_{10min}$ (m/s) | Exceedance (%) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **annual** |
| **>0** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **>2** | 93.58 | 92.87 | 93.63 | 93.31 | 93.98 | 94.80 | 95.25 | 95.20 | 95.01 | 95.28 | 95.45 | 94.33 | 94.40 |
| **>4** | 74.15 | 72.87 | 74.65 | 74.75 | 77.57 | 80.67 | 80.97 | 80.20 | 80.77 | 81.61 | 79.74 | 75.43 | 77.80 |
| **>6** | 46.57 | 44.71 | 47.94 | 46.00 | 52.59 | 56.53 | 56.65 | 55.10 | 57.21 | 57.59 | 54.37 | 46.77 | 51.87 |
| **>8** | 22.70 | 20.71 | 23.38 | 22.96 | 29.16 | 32.83 | 33.38 | 31.33 | 32.45 | 31.76 | 28.92 | 21.94 | 27.66 |
| **>10** | 8.97 | 8.10 | 9.50 | 9.00 | 12.86 | 15.94 | 17.88 | 15.44 | 14.81 | 14.14 | 11.62 | 8.95 | 12.29 |
| **>12** | 3.49 | 2.83 | 3.75 | 3.42 | 4.45 | 7.03 | 9.23 | 7.04 | 6.26 | 4.95 | 4.08 | 2.78 | 4.96 |
| **>14** | 1.10 | 1.07 | 1.27 | 0.88 | 1.26 | 2.83 | 4.28 | 2.66 | 2.28 | 1.23 | 1.36 | 0.82 | 1.76 |
| **>16** | 0.37 | 0.30 | 0.41 | 0.27 | 0.32 | 0.85 | 1.64 | 0.75 | 0.82 | 0.23 | 0.40 | 0.21 | 0.55 |
| **>18** | 0.13 | 0.06 | 0.15 | 0.08 | 0.06 | 0.26 | 0.55 | 0.21 | 0.21 | 0.06 | 0.14 | 0.06 | 0.17 |
| **>20** | 0.03 | 0.00 | 0.07 | 0.03 | 0.01 | 0.06 | 0.27 | 0.05 | 0.04 | 0.02 | 0.00 | 0.03 | 0.05 |
| **>22** | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.01 | 0.08 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 |
| **>24** | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Table 3.3 Annual joint probability distribution (in %) of the wind speed and wind direction at P1.*

| U10min (m/s) | Wind direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| >0<=2 | 0.72 | 0.75 | 0.65 | 0.45 | 0.62 | 0.93 | 0.82 | 0.65 | 5.59 | 100.00 |
| >2<=4 | 1.97 | 2.20 | 1.93 | 1.55 | 1.98 | 3.11 | 2.16 | 1.71 | 16.61 | 94.40 |
| >4<=6 | 2.66 | 2.33 | 2.36 | 2.21 | 2.70 | 6.07 | 4.32 | 3.28 | 25.93 | 77.80 |
| >6<=8 | 2.50 | 2.03 | 2.35 | 1.70 | 1.51 | 6.45 | 4.73 | 2.94 | 24.21 | 51.87 |
| >8<=10 | 2.02 | 1.40 | 1.68 | 1.13 | 0.67 | 3.51 | 3.35 | 1.60 | 15.36 | 27.66 |
| >10<=12 | 1.35 | 0.84 | 1.05 | 0.62 | 0.25 | 1.22 | 1.36 | 0.64 | 7.33 | 12.29 |
| >12<=14 | 0.69 | 0.57 | 0.57 | 0.38 | 0.08 | 0.30 | 0.43 | 0.18 | 3.20 | 4.96 |
| >14<=16 | 0.24 | 0.28 | 0.29 | 0.17 | 0.02 | 0.08 | 0.09 | 0.04 | 1.21 | 1.76 |
| >16<=18 | 0.07 | 0.09 | 0.11 | 0.06 | 0.01 | 0.01 | 0.02 | 0.01 | 0.38 | 0.55 |
| >18<=20 | 0.02 | 0.03 | 0.05 | 0.01 | * | * | * | * | 0.11 | 0.17 |
| >20<=22 | 0.01 | 0.01 | 0.01 | 0.01 | - | - | - | * | 0.04 | 0.05 |
| >22<=24 | * | * | * | 0.01 | - | - | - | - | 0.01 | 0.01 |
| >24<=26 | - | * | - | * | - | - | - | - | | |
| Total | 12.25 | 10.53 | 11.05 | 8.30 | 7.84 | 21.68 | 17.28 | 11.05 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 3.4 Annual and monthly non-exceedance persistence (%) for wind speed below 2.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 1.16 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Feb** | 1.71 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Mar** | 1.56 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Apr** | 2.54 | 0.93 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 |
| **May** | 2.42 | 1.21 | 0.18 | 0.10 | 0.00 | 0.00 | 0.00 |
| **Jun** | 2.02 | 0.90 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Jul** | 1.39 | 0.36 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Aug** | 1.68 | 0.66 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Sep** | 1.67 | 0.47 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Oct** | 1.20 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Nov** | 0.70 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Dec** | 0.52 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **annual** | 1.56 | 0.45 | 0.05 | 0.01 | 0.00 | 0.00 | 0.00 |

*Table 3.5 Annual and monthly non-exceedance persistence (%) for wind speed below 4.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **6** | **12** | **18** | **24** | **36** | **48** | **72** |
| **Jan** | 18.55 | 10.60 | 5.23 | 2.77 | 1.34 | 0.34 | 0.00 |
| **Feb** | 20.09 | 12.71 | 6.88 | 3.62 | 1.43 | 0.33 | 0.33 |
| **Mar** | 18.80 | 13.11 | 7.49 | 3.98 | 2.34 | 1.65 | 0.29 |
| **Apr** | 19.56 | 14.33 | 9.33 | 6.73 | 3.80 | 1.90 | 0.30 |
| **May** | 17.35 | 13.28 | 9.22 | 7.39 | 3.63 | 1.37 | 0.00 |
| **Jun** | 14.49 | 10.35 | 7.40 | 5.47 | 2.67 | 1.78 | 0.60 |
| **Jul** | 14.70 | 10.48 | 6.94 | 4.90 | 2.49 | 1.12 | 0.72 |
| **Aug** | 14.17 | 9.52 | 5.73 | 3.22 | 1.88 | 0.74 | 0.00 |
| **Sep** | 13.82 | 9.74 | 5.76 | 3.67 | 1.82 | 0.38 | 0.00 |
| **Oct** | 13.00 | 8.06 | 3.64 | 1.65 | 0.62 | 0.00 | 0.00 |
| **Nov** | 13.98 | 7.48 | 3.17 | 1.58 | 0.74 | 0.60 | 0.00 |
| **Dec** | 16.92 | 8.97 | 4.12 | 1.98 | 0.33 | 0.17 | 0.00 |
| **annual** | 16.42 | 10.88 | 6.35 | 4.01 | 2.00 | 0.92 | 0.19 |

*Table 3.6 Annual and monthly non-exceedance persistence (%) for wind speed below 6.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **6** | **12** | **18** | **24** | **36** | **48** | **72** |
| **Jan** | 48.94 | 43.69 | 35.72 | 30.92 | 25.01 | 17.41 | 9.56 |
| **Feb** | 50.66 | 46.30 | 38.94 | 33.44 | 26.73 | 16.28 | 9.71 |
| **Mar** | 47.44 | 42.06 | 36.18 | 31.62 | 25.83 | 18.25 | 9.12 |
| **Apr** | 49.85 | 44.65 | 39.97 | 35.59 | 29.28 | 21.57 | 12.54 |
| **May** | 42.88 | 39.18 | 35.74 | 31.91 | 26.60 | 21.85 | 13.34 |
| **Jun** | 39.29 | 35.58 | 31.32 | 28.24 | 22.56 | 16.84 | 7.68 |
| **Jul** | 38.72 | 33.85 | 29.74 | 26.38 | 19.97 | 14.50 | 7.79 |
| **Aug** | 40.31 | 35.47 | 29.63 | 26.15 | 19.34 | 13.13 | 5.14 |
| **Sep** | 37.63 | 32.34 | 26.76 | 22.48 | 18.69 | 14.08 | 7.73 |
| **Oct** | 37.58 | 31.53 | 24.42 | 19.38 | 14.59 | 9.85 | 5.46 |
| **Nov** | 40.30 | 33.79 | 25.29 | 21.69 | 15.62 | 9.51 | 4.49 |
| **Dec** | 47.98 | 41.74 | 33.05 | 27.03 | 21.57 | 13.85 | 6.81 |
| **annual** | 43.62 | 38.64 | 32.60 | 28.28 | 22.73 | 16.11 | 8.94 |

*Table 3.7 Annual and monthly non-exceedance persistence (%) for wind speed below 8.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 74.96 | 72.31 | 68.22 | 64.72 | 60.63 | 52.99 | 43.66 |
| **Feb** | 76.91 | 74.56 | 71.93 | 68.86 | 64.99 | 58.80 | 48.85 |
| **Mar** | 74.32 | 71.74 | 68.82 | 66.89 | 62.76 | 59.81 | 48.95 |
| **Apr** | 74.44 | 71.40 | 69.42 | 67.00 | 63.39 | 56.64 | 47.73 |
| **May** | 67.51 | 64.98 | 62.16 | 59.60 | 54.26 | 48.03 | 39.94 |
| **Jun** | 63.94 | 61.63 | 58.58 | 56.06 | 49.77 | 43.39 | 32.56 |
| **Jul** | 63.83 | 60.72 | 57.73 | 54.83 | 47.94 | 43.04 | 31.84 |
| **Aug** | 65.90 | 63.18 | 60.45 | 57.72 | 51.81 | 44.66 | 31.49 |
| **Sep** | 64.48 | 61.04 | 56.57 | 52.93 | 47.26 | 42.08 | 32.25 |
| **Oct** | 65.00 | 62.02 | 56.49 | 53.18 | 47.91 | 39.80 | 28.58 |
| **Nov** | 68.12 | 63.82 | 57.66 | 53.37 | 47.73 | 40.06 | 30.50 |
| **Dec** | 76.01 | 73.30 | 68.66 | 64.01 | 60.55 | 51.46 | 40.41 |
| **annual** | 69.73 | 66.98 | 63.53 | 60.50 | 55.88 | 49.84 | 40.11 |

*Table 3.8 Annual and monthly non-exceedance persistence (%) for wind speed below 10.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **6** | **12** | **18** | **24** | **36** | **48** | **72** |
| **Jan** | 90.18 | 89.47 | 88.65 | 87.60 | 85.32 | 82.39 | 77.31 |
| **Feb** | 91.34 | 90.43 | 89.56 | 88.47 | 87.52 | 85.25 | 80.91 |
| **Mar** | 89.49 | 88.73 | 87.51 | 86.32 | 84.79 | 82.15 | 78.09 |
| **Apr** | 90.01 | 88.93 | 88.34 | 87.65 | 85.80 | 82.64 | 76.39 |
| **May** | 85.57 | 84.28 | 82.64 | 81.36 | 78.63 | 74.19 | 68.22 |
| **Jun** | 82.35 | 80.31 | 78.69 | 77.76 | 74.27 | 70.44 | 60.68 |
| **Jul** | 80.21 | 78.84 | 77.04 | 75.31 | 71.08 | 67.44 | 59.38 |
| **Aug** | 82.97 | 81.45 | 79.84 | 78.31 | 75.24 | 70.86 | 60.98 |
| **Sep** | 83.39 | 81.68 | 79.82 | 77.98 | 73.05 | 67.47 | 59.29 |
| **Oct** | 84.67 | 82.82 | 80.57 | 78.80 | 74.97 | 70.58 | 62.03 |
| **Nov** | 87.53 | 85.71 | 83.45 | 82.23 | 79.17 | 74.02 | 65.88 |
| **Dec** | 90.14 | 88.98 | 87.66 | 86.63 | 84.35 | 80.74 | 76.15 |
| **annual** | 86.52 | 85.30 | 84.03 | 82.94 | 80.50 | 77.14 | 71.42 |

*Table 3.9 Annual and monthly non-exceedance persistence (%) for wind speed below 12.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 96.14 | 95.93 | 95.71 | 95.57 | 95.25 | 94.49 | 92.13 |
| **Feb** | 96.92 | 96.67 | 96.55 | 96.29 | 95.75 | 95.41 | 93.87 |
| **Mar** | 95.90 | 95.70 | 95.43 | 95.04 | 94.41 | 93.50 | 91.45 |
| **Apr** | 96.20 | 95.64 | 95.35 | 94.86 | 94.30 | 93.00 | 90.42 |
| **May** | 94.98 | 94.46 | 94.06 | 93.33 | 92.24 | 91.10 | 87.33 |
| **Jun** | 92.33 | 91.70 | 91.25 | 90.31 | 88.57 | 86.63 | 81.49 |
| **Jul** | 89.78 | 89.00 | 88.41 | 87.54 | 85.92 | 83.39 | 76.59 |
| **Aug** | 92.23 | 91.74 | 90.69 | 89.88 | 88.11 | 86.80 | 81.60 |
| **Sep** | 93.07 | 92.49 | 91.63 | 90.94 | 89.74 | 86.61 | 82.10 |
| **Oct** | 94.53 | 93.89 | 93.11 | 92.25 | 91.18 | 88.13 | 84.44 |
| **Nov** | 95.54 | 95.24 | 94.52 | 94.08 | 93.43 | 91.98 | 89.49 |
| **Dec** | 97.05 | 96.68 | 96.11 | 95.51 | 94.98 | 94.27 | 92.46 |
| **annual** | 94.57 | 94.19 | 93.79 | 93.30 | 92.66 | 91.58 | 89.16 |

*Table 3.10 Annual and monthly non-exceedance persistence (%) for wind speed below 14.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 98.65 | 98.59 | 98.41 | 98.41 | 98.41 | 98.26 | 97.82 |
| **Feb** | 98.83 | 98.71 | 98.57 | 98.48 | 98.38 | 98.38 | 97.96 |
| **Mar** | 98.57 | 98.46 | 98.30 | 98.30 | 98.19 | 98.03 | 97.64 |
| **Apr** | 99.00 | 98.96 | 98.79 | 98.79 | 98.57 | 98.41 | 98.16 |
| **May** | 98.57 | 98.42 | 98.31 | 98.17 | 98.06 | 97.77 | 96.96 |
| **Jun** | 96.91 | 96.47 | 96.24 | 96.07 | 95.66 | 94.56 | 93.07 |
| **Jul** | 95.16 | 94.97 | 94.81 | 94.52 | 93.89 | 93.34 | 90.40 |
| **Aug** | 97.07 | 96.84 | 96.78 | 96.56 | 95.64 | 94.88 | 93.54 |
| **Sep** | 97.44 | 97.33 | 96.88 | 96.72 | 96.30 | 94.77 | 93.54 |
| **Oct** | 98.69 | 98.63 | 98.57 | 98.28 | 97.83 | 97.25 | 95.70 |
| **Nov** | 98.53 | 98.53 | 98.42 | 98.26 | 98.04 | 97.76 | 96.82 |
| **Dec** | 99.08 | 99.05 | 99.00 | 98.92 | 98.92 | 98.48 | 98.10 |
| **annual** | 98.06 | 97.95 | 97.85 | 97.76 | 97.66 | 97.51 | 97.07 |

*Table 3.11 Annual and monthly non-exceedance persistence (%) for wind speed below 16.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.58 | 99.58 | 99.53 | 99.53 | 99.43 | 99.43 | 99.43 |
| **Feb** | 99.68 | 99.63 | 99.57 | 99.49 | 99.26 | 99.26 | 98.77 |
| **Mar** | 99.56 | 99.56 | 99.56 | 99.48 | 99.48 | 99.48 | 99.48 |
| **Apr** | 99.71 | 99.64 | 99.64 | 99.64 | 99.53 | 99.36 | 99.36 |
| **May** | 99.65 | 99.55 | 99.55 | 99.47 | 99.47 | 99.47 | 99.47 |
| **Jun** | 99.10 | 99.02 | 99.02 | 98.95 | 98.75 | 98.58 | 98.18 |
| **Jul** | 98.18 | 98.08 | 98.02 | 97.94 | 97.63 | 97.21 | 95.98 |
| **Aug** | 99.14 | 99.04 | 98.99 | 98.99 | 98.68 | 98.53 | 98.17 |
| **Sep** | 99.08 | 99.08 | 98.98 | 98.68 | 98.68 | 98.21 | 97.13 |
| **Oct** | 99.77 | 99.77 | 99.77 | 99.77 | 99.77 | 99.77 | 99.34 |
| **Nov** | 99.60 | 99.60 | 99.60 | 99.60 | 99.60 | 99.47 | 98.76 |
| **Dec** | 99.78 | 99.78 | 99.73 | 99.73 | 99.73 | 99.58 | 99.37 |
| **annual** | 99.41 | 99.39 | 99.36 | 99.32 | 99.31 | 99.28 | 99.21 |

*Table 3.12 Annual and monthly non-exceedance persistence (%) for wind speed below 18.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 |
| **Feb** | 99.94 | 99.94 | 99.89 | 99.89 | 99.89 | 99.89 | 99.65 |
| **Mar** | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 |
| **Apr** | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.74 |
| **May** | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 |
| **Jun** | 99.72 | 99.69 | 99.64 | 99.64 | 99.54 | 99.38 | 99.17 |
| **Jul** | 99.39 | 99.35 | 99.29 | 99.29 | 99.29 | 99.29 | 99.09 |
| **Aug** | 99.79 | 99.79 | 99.79 | 99.79 | 99.79 | 99.79 | 99.61 |
| **Sep** | 99.76 | 99.76 | 99.76 | 99.76 | 99.76 | 99.60 | 99.18 |
| **Oct** | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.76 |
| **Nov** | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.68 | 99.68 |
| **Dec** | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 |
| **annual** | 99.82 | 99.82 | 99.81 | 99.81 | 99.81 | 99.81 | 99.81 |

*Table 3.13 Annual and monthly non-exceedance persistence (%) for wind speed below 20.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 |
| **Apr** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **May** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Jun** | 99.94 | 99.94 | 99.89 | 99.89 | 99.79 | 99.79 | 99.79 |
| **Jul** | 99.70 | 99.63 | 99.63 | 99.63 | 99.63 | 99.63 | 99.63 |
| **Aug** | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 |
| **Sep** | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 |
| **Oct** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **Nov** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Dec** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **annual** | 99.95 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 |

*Table 3.14 Annual and monthly non-exceedance persistence (%) for wind speed below 22.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 |
| **Apr** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **May** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Jun** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Jul** | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 |
| **Aug** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Sep** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Oct** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nov** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Dec** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **annual** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

*Table 3.15 Annual and monthly non-exceedance persistence (%) for wind speed below 24.0 m/s at P1.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **Apr** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **May** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Jun** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Jul** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Aug** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Sep** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Oct** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nov** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Dec** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **annual** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

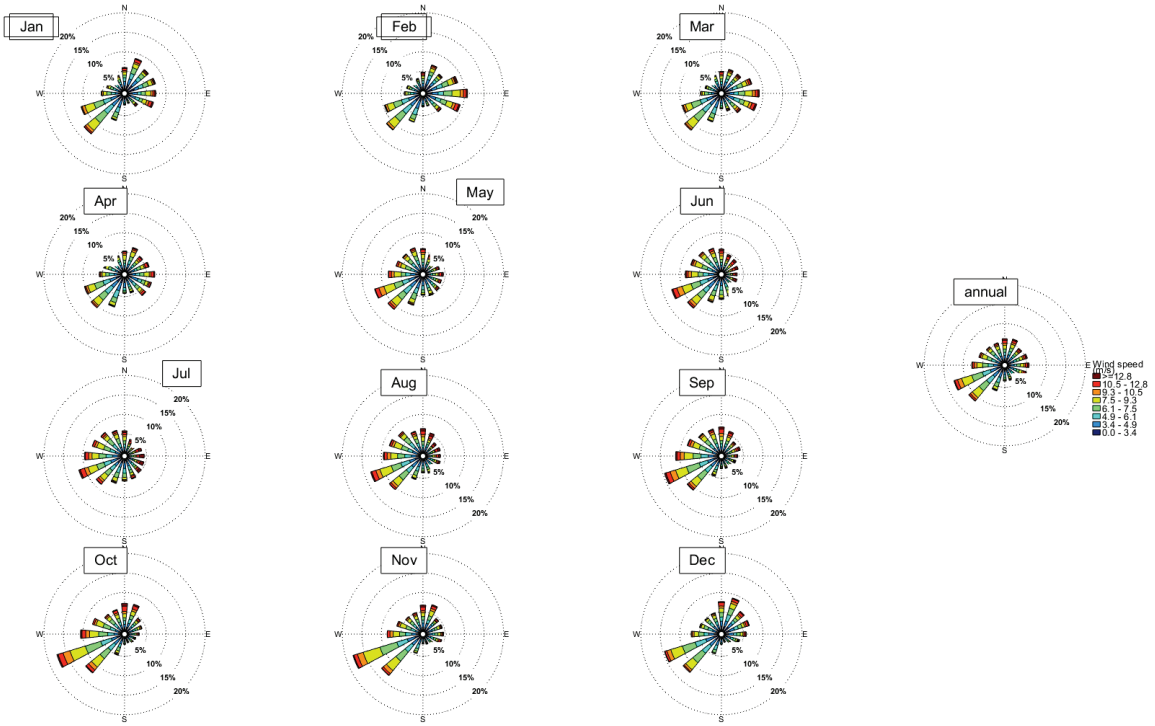


*Figure 3.1 Monthly and annual wind rose plot (10-minute mean at 10 m AMSL) at P1. Sectors indicate the direction from which the winds blow.*

## 3.2. P2

A summary of the wind speed statistics for the 10-minute mean at 10 m elevation at P2 is provided in Table 3.16.

The monthly and annual 10-min wind speed exceedance probabilities are provided in Table 3.17, and indicate the wind speeds exceeding 18 $m.s^{-1}$ can occur throughout the year, with March having the highest occurrence of strong wind events at P2.

The annual joint probability distribution of the wind speed and direction is presented in Table 3.18.

The annual and monthly non-exceedance persistence probabilities for 10-min wind speed at P2 (Table 3.19 to Table 3.30) can be used to estimate the operational uptime for tasks with wind speed limitations of variable duration. For example, at P2 on average in February, wind speeds are less than 4.0 $m.s^{-1}$ for durations of 36 hours and greater for 3.18% of the time (Table 3.20).

The monthly and annual 10-min wind roses are illustrated in Figure 3.2, showing the annual predominance of winds coming mainly from the SW quadrants.

*Table 3.16 Annual and monthly 10-min wind speed statistics at P2.*

| Period (01 Jan 1979 – 31 Dec 2018) | 10-min wind speed statistics (1) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10-min wind speed (m/s) | | | Exceedance percentile for 10-min wind speed (m/s) | | | | | | | | | Main (4) Direction(s) |
| | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 20.24 | 5.83 | 2.81 | 0.89 | 1.79 | 2.51 | 5.51 | 8.06 | 9.51 | 10.99 | 12.74 | 13.69 | NE SW |
| **February** | 18.46 | 5.69 | 2.76 | 0.82 | 1.72 | 2.35 | 5.39 | 7.80 | 9.33 | 10.61 | 12.50 | 13.76 | E SW |
| **March** | 24.84 | 5.91 | 2.86 | 0.77 | 1.78 | 2.47 | 5.65 | 8.11 | 9.61 | 11.05 | 12.91 | 13.94 | E SW |
| **April** | 21.42 | 5.83 | 2.80 | 0.81 | 1.74 | 2.44 | 5.50 | 8.08 | 9.54 | 10.94 | 12.43 | 13.51 | SW |
| **May** | 21.05 | 6.28 | 2.98 | 0.87 | 1.83 | 2.57 | 5.97 | 8.74 | 10.31 | 11.51 | 13.10 | 14.04 | SW W |
| **June** | 23.61 | 6.67 | 3.20 | 0.94 | 1.96 | 2.80 | 6.34 | 9.24 | 10.89 | 12.60 | 14.26 | 15.45 | SW W |
| **July** | 23.37 | 6.84 | 3.41 | 0.92 | 2.06 | 2.88 | 6.31 | 9.44 | 11.54 | 13.39 | 15.24 | 16.39 | SW W |
| **August** | 20.54 | 6.59 | 3.17 | 0.96 | 1.95 | 2.76 | 6.19 | 9.13 | 10.91 | 12.50 | 14.21 | 15.22 | SW W |
| **September** | 21.74 | 6.63 | 3.11 | 0.82 | 1.88 | 2.78 | 6.38 | 9.09 | 10.70 | 12.24 | 14.05 | 15.38 | SW W |
| **October** | 20.24 | 6.56 | 2.92 | 1.03 | 2.09 | 2.84 | 6.37 | 8.98 | 10.48 | 11.77 | 13.15 | 13.95 | SW W |
| **November** | 19.93 | 6.33 | 2.86 | 1.00 | 2.09 | 2.80 | 6.10 | 8.63 | 10.09 | 11.42 | 12.95 | 14.24 | SW W |
| **December** | 19.89 | 5.86 | 2.72 | 0.93 | 1.91 | 2.62 | 5.56 | 8.01 | 9.51 | 10.81 | 12.34 | 13.36 | N SW W |
| **Winter**(3) | 23.61 | 6.70 | 3.26 | 0.94 | 2.00 | 2.82 | 6.29 | 9.27 | 11.09 | 12.80 | 14.62 | 15.77 | SW W |
| **Spring** | 21.74 | 6.51 | 2.97 | 0.95 | 2.01 | 2.81 | 6.28 | 8.89 | 10.41 | 11.81 | 13.36 | 14.55 | SW W |
| **Summer**(2) | 20.24 | 5.79 | 2.76 | 0.86 | 1.80 | 2.49 | 5.49 | 7.95 | 9.45 | 10.82 | 12.52 | 13.62 | E SW |
| **Autumn** | 24.84 | 6.01 | 2.89 | 0.81 | 1.79 | 2.49 | 5.71 | 8.32 | 9.85 | 11.23 | 12.82 | 13.87 | SW |
| **All** | 24.84 | 6.26 | 3.00 | 0.88 | 1.89 | 2.64 | 5.93 | 8.62 | 10.24 | 11.73 | 13.47 | 14.66 | SW W |

Notes: (1) All statistics derived from hindcast wind data (10-min mean at 10 m AMSL) for the period 01 January 1979 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the winds approach.

*Table 3.17 Monthly and annual 10-min wind speed exceedance probabilities (%) at P2.*

| $U_{10min}$ (m/s) | Exceedance (%) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **annual** |
| **>0** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **>2** | 93.74 | 93.02 | 93.60 | 93.36 | 93.89 | 94.91 | 95.34 | 94.75 | 94.46 | 95.31 | 95.44 | 94.46 | 94.36 |
| **>4** | 72.27 | 71.21 | 73.11 | 73.19 | 75.82 | 79.19 | 80.01 | 78.68 | 79.76 | 80.24 | 78.49 | 73.75 | 76.33 |
| **>6** | 42.96 | 41.04 | 44.87 | 42.60 | 49.63 | 54.26 | 54.17 | 52.52 | 55.10 | 55.16 | 51.32 | 43.26 | 48.95 |
| **>8** | 20.47 | 18.21 | 20.88 | 20.76 | 27.42 | 30.92 | 31.76 | 29.24 | 30.46 | 29.33 | 26.29 | 20.07 | 25.52 |
| **>10** | 7.87 | 7.17 | 8.26 | 8.11 | 11.74 | 14.68 | 16.86 | 14.51 | 13.31 | 12.48 | 10.47 | 7.79 | 11.13 |
| **>12** | 2.90 | 2.62 | 3.37 | 2.85 | 3.80 | 6.31 | 8.45 | 6.33 | 5.55 | 4.31 | 3.70 | 2.51 | 4.40 |
| **>14** | 0.80 | 0.84 | 0.96 | 0.70 | 1.02 | 2.36 | 3.76 | 2.25 | 2.02 | 0.95 | 1.09 | 0.70 | 1.46 |
| **>16** | 0.33 | 0.20 | 0.33 | 0.25 | 0.20 | 0.74 | 1.23 | 0.60 | 0.69 | 0.20 | 0.29 | 0.18 | 0.44 |
| **>18** | 0.11 | 0.02 | 0.09 | 0.05 | 0.03 | 0.21 | 0.47 | 0.17 | 0.17 | 0.07 | 0.07 | 0.06 | 0.13 |
| **>20** | 0.01 | 0.00 | 0.05 | 0.02 | 0.01 | 0.06 | 0.24 | 0.02 | 0.02 | 0.01 | 0.00 | 0.00 | 0.04 |
| **>22** | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.01 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| **>24** | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Table 3.18 Annual joint probability distribution (in %) of the wind speed and wind direction at P2.*

| U10min (m/s) | Wind direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| >0<=2 | 0.70 | 0.71 | 0.60 | 0.46 | 0.64 | 0.96 | 0.89 | 0.67 | 5.63 | 100.00 |
| >2<=4 | 2.08 | 2.23 | 2.06 | 1.65 | 2.45 | 3.39 | 2.39 | 1.79 | 18.04 | 94.36 |
| >4<=6 | 2.83 | 2.31 | 2.50 | 2.40 | 2.87 | 6.75 | 4.67 | 3.06 | 27.39 | 76.33 |
| >6<=8 | 2.49 | 1.92 | 2.41 | 1.68 | 1.49 | 5.82 | 4.93 | 2.69 | 23.43 | 48.95 |
| >8<=10 | 1.97 | 1.34 | 1.64 | 1.10 | 0.60 | 2.74 | 3.39 | 1.60 | 14.38 | 25.52 |
| >10<=12 | 1.25 | 0.83 | 0.99 | 0.60 | 0.22 | 0.82 | 1.38 | 0.64 | 6.73 | 11.13 |
| >12<=14 | 0.64 | 0.53 | 0.54 | 0.36 | 0.07 | 0.21 | 0.41 | 0.17 | 2.93 | 4.40 |
| >14<=16 | 0.22 | 0.24 | 0.24 | 0.14 | 0.02 | 0.04 | 0.08 | 0.04 | 1.02 | 1.46 |
| >16<=18 | 0.06 | 0.08 | 0.09 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.32 | 0.44 |
| >18<=20 | 0.01 | 0.02 | 0.03 | 0.02 | * | - | * | * | 0.08 | 0.13 |
| >20<=22 | 0.01 | 0.01 | 0.01 | 0.01 | - | - | - | - | 0.04 | 0.04 |
| >22<=24 | - | * | * | 0.01 | - | - | - | - | 0.01 | 0.01 |
| >24<=26 | - | - | - | * | - | - | - | - | | |
| Total | 12.26 | 10.22 | 11.11 | 8.48 | 8.37 | 20.74 | 18.15 | 10.67 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 3.19 Annual and monthly non-exceedance persistence (%) for wind speed below 2.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 1.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Feb** | 1.49 | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Mar** | 1.52 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Apr** | 2.56 | 0.77 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 |
| **May** | 2.57 | 1.13 | 0.33 | 0.11 | 0.00 | 0.00 | 0.00 |
| **Jun** | 2.22 | 0.88 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Jul** | 1.47 | 0.47 | 0.09 | 0.09 | 0.00 | 0.00 | 0.00 |
| **Aug** | 2.08 | 0.76 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Sep** | 2.11 | 0.69 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Oct** | 1.25 | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Nov** | 0.92 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Dec** | 0.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **annual** | 1.65 | 0.47 | 0.05 | 0.02 | 0.00 | 0.00 | 0.00 |

*Table 3.20 Annual and monthly non-exceedance persistence (%) for wind speed below 4.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **6** | **12** | **18** | **24** | **36** | **48** | **72** |
| **Jan** | 20.71 | 12.82 | 6.26 | 3.33 | 1.54 | 0.34 | 0.00 |
| **Feb** | 21.94 | 15.61 | 9.67 | 5.85 | 3.18 | 0.83 | 0.39 |
| **Mar** | 20.70 | 15.03 | 8.99 | 5.59 | 2.79 | 1.97 | 0.00 |
| **Apr** | 20.95 | 15.76 | 11.11 | 7.82 | 4.71 | 2.35 | 0.58 |
| **May** | 18.94 | 14.43 | 10.65 | 8.79 | 5.08 | 1.72 | 0.90 |
| **Jun** | 15.60 | 11.69 | 8.51 | 6.58 | 3.90 | 2.64 | 0.89 |
| **Jul** | 15.36 | 11.70 | 7.98 | 5.34 | 2.92 | 1.44 | 0.45 |
| **Aug** | 16.11 | 11.04 | 7.25 | 4.40 | 2.80 | 0.53 | 0.00 |
| **Sep** | 14.82 | 10.83 | 6.76 | 4.40 | 2.15 | 0.39 | 0.00 |
| **Oct** | 14.32 | 9.80 | 5.00 | 3.06 | 1.35 | 0.37 | 0.00 |
| **Nov** | 15.12 | 8.57 | 3.69 | 2.10 | 0.82 | 0.54 | 0.32 |
| **Dec** | 18.78 | 10.51 | 5.11 | 2.70 | 0.72 | 0.00 | 0.00 |
| **annual** | 17.92 | 12.48 | 7.68 | 5.09 | 2.73 | 1.16 | 0.36 |

*Table 3.21 Annual and monthly non-exceedance persistence (%) for wind speed below 6.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 52.78 | 48.30 | 39.95 | 34.99 | 29.30 | 22.05 | 11.84 |
| **Feb** | 54.79 | 50.79 | 44.51 | 39.31 | 32.83 | 23.94 | 14.83 |
| **Mar** | 51.05 | 46.45 | 40.55 | 36.20 | 30.50 | 24.25 | 13.98 |
| **Apr** | 53.77 | 49.68 | 44.76 | 41.28 | 34.19 | 26.22 | 18.61 |
| **May** | 46.36 | 42.53 | 39.54 | 36.18 | 30.54 | 26.53 | 16.99 |
| **Jun** | 41.89 | 38.15 | 34.42 | 31.02 | 25.14 | 19.31 | 10.97 |
| **Jul** | 41.90 | 37.30 | 33.06 | 29.31 | 22.28 | 17.88 | 10.02 |
| **Aug** | 42.85 | 38.89 | 33.51 | 29.97 | 22.49 | 16.31 | 8.00 |
| **Sep** | 39.99 | 34.70 | 29.93 | 25.54 | 21.75 | 16.54 | 10.02 |
| **Oct** | 40.22 | 34.80 | 27.86 | 23.44 | 17.63 | 12.68 | 6.46 |
| **Nov** | 43.90 | 38.07 | 30.11 | 25.17 | 19.72 | 12.74 | 7.45 |
| **Dec** | 52.07 | 46.96 | 38.50 | 33.17 | 27.53 | 20.00 | 10.97 |
| **annual** | 46.92 | 42.49 | 36.77 | 32.58 | 26.85 | 20.53 | 12.63 |

*Table 3.22 Annual and monthly non-exceedance persistence (%) for wind speed below 8.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 77.26 | 75.02 | 71.75 | 68.89 | 65.24 | 59.32 | 49.15 |
| **Feb** | 80.10 | 78.32 | 76.05 | 73.66 | 70.27 | 64.87 | 57.23 |
| **Mar** | 77.00 | 75.01 | 72.71 | 70.95 | 67.29 | 64.20 | 55.26 |
| **Apr** | 76.92 | 74.27 | 72.41 | 70.24 | 66.59 | 61.57 | 51.68 |
| **May** | 69.36 | 66.82 | 64.26 | 62.18 | 56.68 | 51.54 | 42.17 |
| **Jun** | 65.85 | 63.44 | 61.05 | 58.91 | 53.37 | 47.02 | 35.60 |
| **Jul** | 65.41 | 62.51 | 60.31 | 57.63 | 51.07 | 45.69 | 34.09 |
| **Aug** | 67.89 | 65.27 | 62.67 | 59.86 | 54.70 | 47.85 | 34.44 |
| **Sep** | 66.92 | 63.67 | 59.40 | 55.92 | 50.36 | 45.09 | 34.59 |
| **Oct** | 67.73 | 64.89 | 59.40 | 56.86 | 51.73 | 44.44 | 33.42 |
| **Nov** | 71.31 | 67.61 | 61.52 | 58.24 | 52.02 | 44.24 | 34.22 |
| **Dec** | 77.99 | 75.40 | 71.45 | 68.21 | 65.28 | 56.96 | 46.49 |
| **annual** | 72.07 | 69.55 | 66.57 | 64.07 | 59.68 | 54.02 | 44.53 |

*Table 3.23 Annual and monthly non-exceedance persistence (%) for wind speed below 10.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 91.36 | 90.83 | 89.92 | 89.15 | 87.68 | 85.32 | 80.07 |
| **Feb** | 92.42 | 91.73 | 90.84 | 90.12 | 88.84 | 87.03 | 82.93 |
| **Mar** | 91.01 | 90.33 | 89.52 | 88.63 | 87.23 | 84.59 | 81.11 |
| **Apr** | 91.01 | 90.23 | 89.47 | 88.68 | 86.84 | 84.14 | 78.68 |
| **May** | 86.94 | 85.84 | 84.32 | 82.84 | 80.41 | 76.70 | 71.20 |
| **Jun** | 83.50 | 81.44 | 79.98 | 79.15 | 76.54 | 72.44 | 63.98 |
| **Jul** | 81.53 | 80.25 | 78.38 | 76.36 | 73.31 | 69.01 | 60.36 |
| **Aug** | 83.97 | 82.75 | 81.01 | 79.63 | 76.51 | 72.55 | 62.88 |
| **Sep** | 85.15 | 83.79 | 82.02 | 80.11 | 75.77 | 70.93 | 63.24 |
| **Oct** | 86.21 | 84.79 | 82.61 | 80.61 | 77.07 | 73.70 | 66.64 |
| **Nov** | 88.67 | 87.20 | 85.21 | 84.51 | 81.74 | 77.13 | 70.35 |
| **Dec** | 91.52 | 90.58 | 89.25 | 88.37 | 86.97 | 82.86 | 78.29 |
| **annual** | 87.80 | 86.80 | 85.57 | 84.58 | 82.55 | 79.55 | 74.29 |

*Table 3.24 Annual and monthly non-exceedance persistence (%) for wind speed below 12.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 96.78 | 96.58 | 96.30 | 96.30 | 96.10 | 95.79 | 92.84 |
| **Feb** | 97.18 | 97.02 | 96.90 | 96.57 | 95.99 | 95.65 | 94.29 |
| **Mar** | 96.37 | 96.06 | 95.90 | 95.67 | 94.85 | 94.41 | 92.86 |
| **Apr** | 96.75 | 96.16 | 95.99 | 95.57 | 95.26 | 94.06 | 92.39 |
| **May** | 95.74 | 95.28 | 94.90 | 94.32 | 93.44 | 92.57 | 89.11 |
| **Jun** | 93.16 | 92.43 | 92.16 | 91.22 | 90.00 | 87.94 | 84.03 |
| **Jul** | 90.57 | 89.92 | 89.61 | 88.89 | 86.79 | 83.93 | 77.92 |
| **Aug** | 92.97 | 92.46 | 92.01 | 91.15 | 89.39 | 88.08 | 83.20 |
| **Sep** | 93.83 | 93.34 | 92.60 | 91.52 | 90.51 | 87.82 | 84.20 |
| **Oct** | 95.15 | 94.79 | 94.05 | 93.32 | 92.15 | 89.50 | 85.79 |
| **Nov** | 95.99 | 95.62 | 94.85 | 94.49 | 93.97 | 92.81 | 90.02 |
| **Dec** | 97.30 | 97.14 | 96.69 | 96.17 | 95.64 | 94.94 | 93.76 |
| **annual** | 95.17 | 94.82 | 94.54 | 94.10 | 93.54 | 92.61 | 90.48 |

*Table 3.25 Annual and monthly non-exceedance persistence (%) for wind speed below 14.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.10 | 99.07 | 99.07 | 99.00 | 98.90 | 98.90 | 98.70 |
| **Feb** | 99.00 | 98.88 | 98.82 | 98.73 | 98.63 | 98.63 | 98.19 |
| **Mar** | 98.95 | 98.81 | 98.64 | 98.64 | 98.53 | 98.53 | 98.34 |
| **Apr** | 99.21 | 99.10 | 98.99 | 98.99 | 98.77 | 98.60 | 98.38 |
| **May** | 98.86 | 98.79 | 98.79 | 98.64 | 98.52 | 98.37 | 97.96 |
| **Jun** | 97.48 | 97.06 | 97.01 | 97.01 | 96.58 | 95.64 | 94.58 |
| **Jul** | 95.80 | 95.63 | 95.45 | 95.16 | 94.73 | 93.90 | 91.57 |
| **Aug** | 97.48 | 97.29 | 97.29 | 97.07 | 96.34 | 95.60 | 94.28 |
| **Sep** | 97.75 | 97.71 | 97.26 | 97.19 | 96.67 | 95.45 | 94.64 |
| **Oct** | 98.99 | 98.89 | 98.89 | 98.74 | 98.62 | 98.20 | 96.72 |
| **Nov** | 98.81 | 98.81 | 98.76 | 98.68 | 98.36 | 98.23 | 97.54 |
| **Dec** | 99.24 | 99.20 | 99.20 | 99.12 | 99.12 | 98.98 | 98.63 |
| **annual** | 98.40 | 98.31 | 98.25 | 98.21 | 98.10 | 97.98 | 97.72 |

*Table 3.26 Annual and monthly non-exceedance persistence (%) for wind speed below 16.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.63 | 99.63 | 99.58 | 99.58 | 99.58 | 99.58 | 99.58 |
| **Feb** | 99.76 | 99.76 | 99.63 | 99.63 | 99.40 | 99.40 | 98.92 |
| **Mar** | 99.64 | 99.64 | 99.64 | 99.56 | 99.56 | 99.56 | 99.56 |
| **Apr** | 99.73 | 99.65 | 99.65 | 99.65 | 99.55 | 99.39 | 99.39 |
| **May** | 99.80 | 99.73 | 99.73 | 99.65 | 99.65 | 99.65 | 99.65 |
| **Jun** | 99.22 | 99.22 | 99.17 | 99.09 | 98.90 | 98.74 | 98.33 |
| **Jul** | 98.65 | 98.56 | 98.56 | 98.48 | 98.05 | 97.89 | 97.26 |
| **Aug** | 99.31 | 99.21 | 99.16 | 99.16 | 99.06 | 99.06 | 98.51 |
| **Sep** | 99.23 | 99.23 | 99.23 | 98.93 | 98.93 | 98.63 | 97.51 |
| **Oct** | 99.80 | 99.80 | 99.80 | 99.80 | 99.80 | 99.80 | 99.13 |
| **Nov** | 99.70 | 99.70 | 99.70 | 99.70 | 99.70 | 99.56 | 99.33 |
| **Dec** | 99.81 | 99.81 | 99.76 | 99.76 | 99.76 | 99.63 | 99.63 |
| **annual** | 99.53 | 99.51 | 99.50 | 99.47 | 99.45 | 99.44 | 99.39 |

*Table 3.27 Annual and monthly non-exceedance persistence (%) for wind speed below 18.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.85 | 99.85 | 99.85 | 99.85 | 99.85 | 99.85 | 99.85 |
| **Feb** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **Mar** | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 |
| **Apr** | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 |
| **May** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **Jun** | 99.79 | 99.75 | 99.70 | 99.70 | 99.60 | 99.45 | 99.24 |
| **Jul** | 99.49 | 99.46 | 99.46 | 99.46 | 99.46 | 99.46 | 99.25 |
| **Aug** | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 |
| **Sep** | 99.82 | 99.82 | 99.82 | 99.82 | 99.82 | 99.67 | 99.24 |
| **Oct** | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.75 |
| **Nov** | 99.93 | 99.85 | 99.85 | 99.85 | 99.85 | 99.70 | 99.70 |
| **Dec** | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 |
| **annual** | 99.87 | 99.85 | 99.85 | 99.85 | 99.85 | 99.85 | 99.85 |

*Table 3.28 Annual and monthly non-exceedance persistence (%) for wind speed below 20.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 |
| **Apr** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **May** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Jun** | 99.94 | 99.94 | 99.94 | 99.94 | 99.84 | 99.84 | 99.84 |
| **Jul** | 99.71 | 99.64 | 99.64 | 99.64 | 99.64 | 99.64 | 99.64 |
| **Aug** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **Sep** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **Oct** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Nov** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Dec** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **annual** | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 |

*Table 3.29 Annual and monthly non-exceedance persistence (%) for wind speed below 22.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 |
| **Apr** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **May** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Jun** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Jul** | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 |
| **Aug** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Sep** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Oct** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nov** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Dec** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **annual** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

*Table 3.30 Annual and monthly non-exceedance persistence (%) for wind speed below 24.0 m/s at P2.*

| U10min (m/s) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Apr** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **May** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Jun** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Jul** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Aug** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Sep** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Oct** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nov** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Dec** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **annual** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

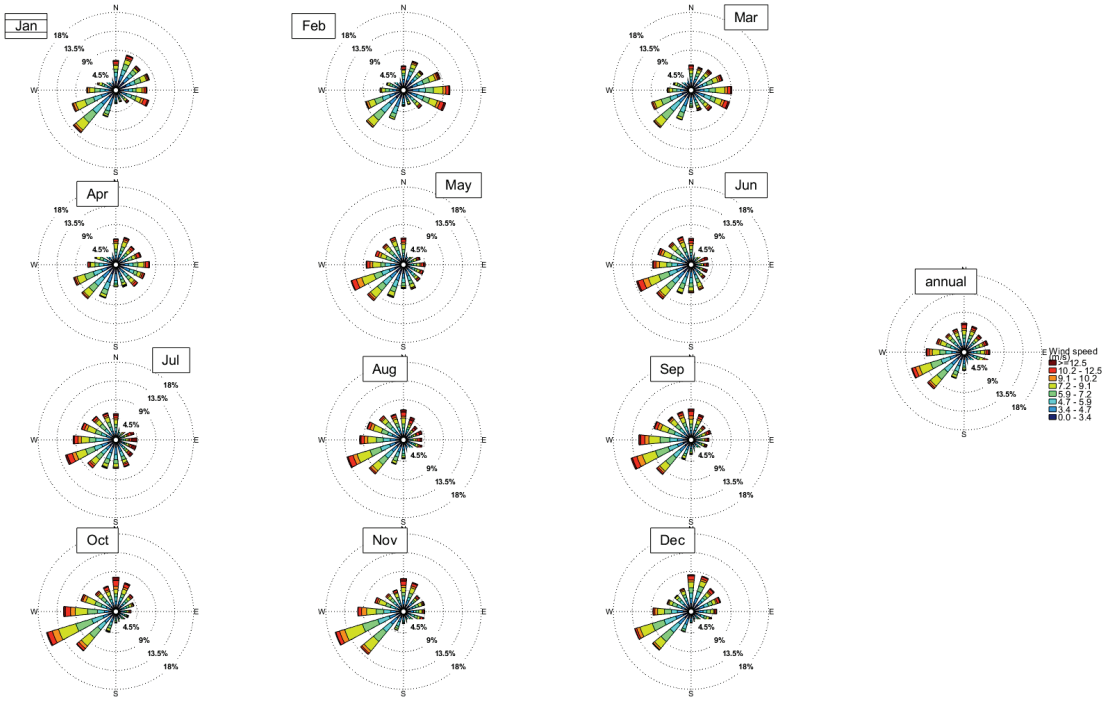


*Figure 3.2 Monthly and annual wind rose plot (10-minute mean at 10 m AMSL) at P2. Sectors indicate the direction from which the winds blow.*

# 4. Wave climate

## 4.1. P1

A summary of the total significant wave height statistics ($H_s$) at P1 is provided in Table 4.1. Summary of significant wave height statistics for swell and windseas components are provided in Table 4.2 and Table 4.3 respectively. Details on the partitioning method for sea and swell components are presented in Section 8.2.

The annual joint probability distribution of the total significant wave height and mean wave direction at peak energy is presented in Table 4.4.
The annual joint probability distribution of the total significant wave height and peak period is presented in Table 4.5.

The annual and monthly non-exceedance persistence probabilities for total significant wave height at P1 (Table 4.6 to Table 4.18) can be used to estimate the operational uptime for tasks with wind speed limitations of variable duration. For example, at P1 on average in February, total significant wave heights are less than 0.5 m for durations of 36 hours and greater for 5.51% of the time (Table 4.7).

Wave roses for the monthly and annual total significant wave height are presented in Figure 4.1, showing the predominance of waves incoming from the ENE sector.

*Table 4.1 Annual and monthly total significant wave height statistics at P1.*

| Period (01 Jan 1979 – 31 Dec 2018) | Total significant wave height statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total significant wave height (m) | | | | Exceedance percentile for total significant wave height (m) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.25 | 5.10 | 0.97 | 0.52 | 0.33 | 0.41 | 0.48 | 0.85 | 1.28 | 1.62 | 1.96 | 2.51 | 2.84 | NE |
| **February** | 0.25 | 4.38 | 1.01 | 0.51 | 0.34 | 0.44 | 0.52 | 0.89 | 1.33 | 1.64 | 1.98 | 2.48 | 2.91 | NE E |
| **March** | 0.19 | 5.23 | 1.01 | 0.56 | 0.31 | 0.42 | 0.49 | 0.86 | 1.36 | 1.69 | 2.04 | 2.66 | 3.06 | NE E |
| **April** | 0.14 | 5.20 | 0.94 | 0.56 | 0.25 | 0.34 | 0.39 | 0.81 | 1.29 | 1.65 | 2.07 | 2.55 | 2.85 | NE E |
| **May** | 0.10 | 5.14 | 0.89 | 0.59 | 0.19 | 0.27 | 0.33 | 0.73 | 1.24 | 1.66 | 2.07 | 2.59 | 2.98 | NE E |
| **June** | 0.10 | 5.97 | 0.96 | 0.70 | 0.19 | 0.26 | 0.32 | 0.75 | 1.40 | 1.92 | 2.35 | 2.97 | 3.42 | NE E |
| **July** | 0.08 | 6.37 | 1.02 | 0.79 | 0.19 | 0.28 | 0.34 | 0.77 | 1.46 | 2.05 | 2.75 | 3.44 | 3.83 | NE E |
| **August** | 0.13 | 5.49 | 0.94 | 0.67 | 0.21 | 0.29 | 0.34 | 0.75 | 1.30 | 1.80 | 2.34 | 3.00 | 3.41 | NE E |
| **September** | 0.09 | 5.20 | 0.90 | 0.61 | 0.22 | 0.30 | 0.35 | 0.73 | 1.26 | 1.68 | 2.09 | 2.68 | 3.24 | NE E |
| **October** | 0.15 | 4.70 | 0.81 | 0.51 | 0.23 | 0.29 | 0.34 | 0.66 | 1.12 | 1.51 | 1.88 | 2.29 | 2.58 | N NE E |
| **November** | 0.14 | 5.56 | 0.83 | 0.53 | 0.25 | 0.33 | 0.37 | 0.68 | 1.13 | 1.48 | 1.82 | 2.35 | 2.77 | NE E |
| **December** | 0.23 | 4.97 | 0.92 | 0.50 | 0.30 | 0.39 | 0.44 | 0.79 | 1.22 | 1.53 | 1.86 | 2.43 | 2.71 | NE |
| **Winter**(3) | 0.08 | 6.37 | 0.97 | 0.72 | 0.19 | 0.27 | 0.33 | 0.76 | 1.38 | 1.91 | 2.47 | 3.18 | 3.62 | NE E |
| **Spring** | 0.09 | 5.56 | 0.85 | 0.55 | 0.23 | 0.30 | 0.35 | 0.69 | 1.17 | 1.55 | 1.93 | 2.43 | 2.84 | N NE E |
| **Summer**(2) | 0.23 | 5.10 | 0.97 | 0.51 | 0.32 | 0.41 | 0.47 | 0.84 | 1.28 | 1.60 | 1.93 | 2.48 | 2.84 | NE |
| **Autumn** | 0.10 | 5.23 | 0.95 | 0.57 | 0.23 | 0.33 | 0.39 | 0.81 | 1.29 | 1.67 | 2.07 | 2.59 | 2.97 | NE E |
| **All** | 0.08 | 6.37 | 0.93 | 0.60 | 0.23 | 0.32 | 0.38 | 0.78 | 1.28 | 1.68 | 2.09 | 2.70 | 3.14 | NE E |

Notes: (1) All statistics derived from hindcast wave data for the period 01 January 1979 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the waves approach.

*Table 4.2 Annual and monthly significant swell wave height statistics at P1.*

| Period (01 Jan 1979 – 31 Dec 2018) | Significant swell wave height statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Significant swell wave height (m) | | | | Exceedance percentile for significant swell wave height (m) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.14 | 3.94 | 0.59 | 0.35 | 0.20 | 0.25 | 0.28 | 0.49 | 0.77 | 1.03 | 1.35 | 1.68 | 1.85 | NE |
| **February** | 0.14 | 3.13 | 0.63 | 0.35 | 0.19 | 0.25 | 0.29 | 0.54 | 0.83 | 1.09 | 1.29 | 1.60 | 1.87 | NE E |
| **March** | 0.10 | 4.01 | 0.61 | 0.39 | 0.17 | 0.24 | 0.28 | 0.50 | 0.84 | 1.07 | 1.34 | 1.70 | 2.03 | NE E |
| **April** | 0.07 | 3.98 | 0.55 | 0.39 | 0.14 | 0.19 | 0.22 | 0.43 | 0.79 | 1.05 | 1.32 | 1.67 | 1.96 | NE E |
| **May** | 0.04 | 4.12 | 0.49 | 0.40 | 0.07 | 0.11 | 0.14 | 0.36 | 0.70 | 0.99 | 1.29 | 1.67 | 1.99 | NE E |
| **June** | 0.02 | 4.97 | 0.53 | 0.49 | 0.06 | 0.10 | 0.13 | 0.36 | 0.78 | 1.17 | 1.54 | 1.94 | 2.32 | NE E |
| **July** | 0.03 | 5.34 | 0.58 | 0.58 | 0.06 | 0.09 | 0.12 | 0.37 | 0.87 | 1.33 | 1.76 | 2.33 | 2.69 | NE E |
| **August** | 0.06 | 4.44 | 0.52 | 0.45 | 0.09 | 0.13 | 0.15 | 0.37 | 0.75 | 1.05 | 1.37 | 1.91 | 2.37 | NE E |
| **September** | 0.03 | 4.15 | 0.47 | 0.42 | 0.07 | 0.11 | 0.13 | 0.34 | 0.67 | 0.94 | 1.29 | 1.66 | 2.15 | NE E |
| **October** | 0.06 | 3.42 | 0.39 | 0.31 | 0.08 | 0.11 | 0.13 | 0.28 | 0.55 | 0.79 | 1.03 | 1.39 | 1.57 | NE E |
| **November** | 0.07 | 4.51 | 0.43 | 0.34 | 0.10 | 0.14 | 0.17 | 0.32 | 0.59 | 0.81 | 1.03 | 1.39 | 1.65 | NE E |
| **December** | 0.08 | 3.79 | 0.54 | 0.33 | 0.16 | 0.21 | 0.25 | 0.44 | 0.71 | 0.95 | 1.17 | 1.50 | 1.71 | NE |
| **Winter**(3) | 0.02 | 5.34 | 0.54 | 0.51 | 0.07 | 0.11 | 0.14 | 0.37 | 0.79 | 1.18 | 1.58 | 2.07 | 2.50 | NE E |
| **Spring** | 0.03 | 4.51 | 0.43 | 0.36 | 0.08 | 0.12 | 0.14 | 0.31 | 0.60 | 0.85 | 1.12 | 1.47 | 1.74 | NE E |
| **Summer**(2) | 0.08 | 3.94 | 0.58 | 0.35 | 0.18 | 0.24 | 0.27 | 0.49 | 0.78 | 1.03 | 1.27 | 1.60 | 1.80 | NE |
| **Autumn** | 0.04 | 4.12 | 0.55 | 0.40 | 0.09 | 0.15 | 0.20 | 0.44 | 0.78 | 1.04 | 1.32 | 1.68 | 1.99 | NE E |
| **All** | 0.02 | 5.34 | 0.53 | 0.41 | 0.08 | 0.13 | 0.17 | 0.41 | 0.74 | 1.02 | 1.33 | 1.72 | 2.06 | NE E |

Notes: (1) All statistics derived from hindcast wave data for the period 01 January 1979 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the waves approach.

*Table 4.3 Annual and monthly significant sea wave height statistics at P1.*

| Period (01 Jan 1979 – 31 Dec 2018) | Significant sea wave height statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Significant sea wave height (m) | | | | Exceedance percentile for significant sea wave height (m) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.13 | 3.29 | 0.73 | 0.44 | 0.20 | 0.28 | 0.32 | 0.62 | 0.99 | 1.28 | 1.63 | 2.10 | 2.34 | N NE E |
| **February** | 0.13 | 3.18 | 0.76 | 0.43 | 0.23 | 0.31 | 0.36 | 0.65 | 1.03 | 1.30 | 1.66 | 2.10 | 2.43 | NE E |
| **March** | 0.08 | 3.39 | 0.77 | 0.47 | 0.19 | 0.28 | 0.33 | 0.63 | 1.05 | 1.38 | 1.72 | 2.15 | 2.42 | NE E |
| **April** | 0.08 | 3.35 | 0.73 | 0.46 | 0.14 | 0.22 | 0.28 | 0.62 | 1.00 | 1.33 | 1.71 | 2.12 | 2.36 | NE E |
| **May** | 0.05 | 3.33 | 0.71 | 0.49 | 0.12 | 0.20 | 0.25 | 0.57 | 0.99 | 1.35 | 1.75 | 2.20 | 2.47 | N NE E |
| **June** | 0.06 | 3.61 | 0.76 | 0.56 | 0.12 | 0.19 | 0.24 | 0.59 | 1.09 | 1.54 | 2.01 | 2.49 | 2.71 | N NE |
| **July** | 0.03 | 3.48 | 0.80 | 0.61 | 0.12 | 0.21 | 0.26 | 0.60 | 1.10 | 1.67 | 2.27 | 2.68 | 2.87 | N NE E |
| **August** | 0.06 | 3.29 | 0.75 | 0.55 | 0.14 | 0.21 | 0.26 | 0.58 | 1.05 | 1.51 | 2.01 | 2.46 | 2.66 | N NE |
| **September** | 0.06 | 3.27 | 0.74 | 0.51 | 0.15 | 0.24 | 0.28 | 0.59 | 1.02 | 1.40 | 1.83 | 2.29 | 2.61 | N NE |
| **October** | 0.05 | 3.23 | 0.68 | 0.45 | 0.16 | 0.23 | 0.27 | 0.55 | 0.94 | 1.28 | 1.65 | 2.07 | 2.30 | N NE |
| **November** | 0.09 | 3.26 | 0.68 | 0.45 | 0.17 | 0.25 | 0.29 | 0.55 | 0.94 | 1.26 | 1.59 | 2.09 | 2.39 | N NE |
| **December** | 0.10 | 3.29 | 0.71 | 0.44 | 0.18 | 0.26 | 0.31 | 0.59 | 0.96 | 1.26 | 1.62 | 2.00 | 2.35 | N NE |
| **Winter**(3) | 0.03 | 3.61 | 0.77 | 0.58 | 0.13 | 0.20 | 0.25 | 0.59 | 1.08 | 1.56 | 2.10 | 2.55 | 2.76 | N NE |
| **Spring** | 0.05 | 3.27 | 0.70 | 0.47 | 0.16 | 0.24 | 0.28 | 0.56 | 0.97 | 1.32 | 1.69 | 2.16 | 2.42 | N NE |
| **Summer**(2) | 0.10 | 3.29 | 0.74 | 0.44 | 0.20 | 0.28 | 0.33 | 0.62 | 0.99 | 1.28 | 1.64 | 2.07 | 2.37 | N NE E |
| **Autumn** | 0.05 | 3.39 | 0.73 | 0.47 | 0.14 | 0.23 | 0.29 | 0.61 | 1.01 | 1.35 | 1.72 | 2.16 | 2.42 | N NE E |
| **All** | 0.03 | 3.61 | 0.73 | 0.49 | 0.15 | 0.23 | 0.29 | 0.60 | 1.01 | 1.37 | 1.78 | 2.28 | 2.55 | N NE E |

Notes: (1) All statistics derived from hindcast wave data for the period 01 January 1979 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the waves approach.

*Table 4.4 Annual joint probability distribution (in %) of the total significant wave height and mean wave direction at peak energy at P1.*

| Hs (m) | Mean wave direction at peak energy (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| >0<=0.5 | 1.04 | 14.45 | 4.89 | 0.35 | 0.13 | 0.72 | 0.56 | 0.21 | 22.35 | 100.00 |
| >0.5<=1 | 4.78 | 27.98 | 9.86 | 0.75 | 0.03 | 0.09 | 0.29 | 0.47 | 44.25 | 77.66 |
| >1<=1.5 | 2.25 | 13.36 | 3.95 | 0.25 | - | - | * | 0.05 | 19.86 | 33.42 |
| >1.5<=2 | 0.85 | 5.40 | 1.38 | 0.09 | - | - | - | * | 7.72 | 13.56 |
| >2<=2.5 | 0.26 | 2.24 | 0.61 | 0.01 | - | - | - | - | 3.12 | 5.84 |
| >2.5<=3 | 0.07 | 1.10 | 0.29 | * | - | - | - | - | 1.46 | 2.72 |
| >3<=3.5 | 0.01 | 0.54 | 0.14 | * | - | - | - | - | 0.69 | 1.25 |
| >3.5<=4 | * | 0.28 | 0.04 | - | - | - | - | - | 0.32 | 0.56 |
| >4<=4.5 | - | 0.11 | 0.01 | - | - | - | - | - | 0.12 | 0.24 |
| >4.5<=5 | - | 0.05 | 0.01 | - | - | - | - | - | 0.06 | 0.12 |
| >5<=5.5 | - | 0.02 | 0.01 | - | - | - | - | - | 0.03 | 0.05 |
| >5.5<=6 | - | 0.01 | * | - | - | - | - | - | 0.01 | 0.01 |
| >6<=6.5 | - | * | * | - | - | - | - | - | | |
| Total | 9.26 | 65.54 | 21.19 | 1.45 | 0.16 | 0.81 | 0.85 | 0.73 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 4.5 Annual joint probability distribution (in %) of the total significant wave height and peak period at P1.*

| Hs (m) | Peak period (s) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2-4** | **4-6** | **6-8** | **8-10** | **10-12** | **12-14** | **14-16** | **16-18** | **18-20** | **20-22** | **Total** | **Exceed%** |
| **>0<=0.5** | 2.14 | 0.70 | 1.77 | 9.24 | 5.39 | 1.73 | 0.81 | 0.33 | 0.10 | 0.03 | 22.24 | 100.00 |
| **>0.5<=1** | 2.31 | 4.66 | 7.98 | 17.84 | 7.85 | 2.46 | 0.79 | 0.26 | 0.08 | 0.01 | 44.24 | 77.66 |
| **>1<=1.5** | * | 4.57 | 3.35 | 7.24 | 3.43 | 0.99 | 0.25 | 0.03 | 0.01 | - | 19.87 | 33.42 |
| **>1.5<=2** | - | 1.49 | 1.84 | 2.22 | 1.55 | 0.52 | 0.08 | 0.01 | * | - | 7.71 | 13.56 |
| **>2<=2.5** | - | 0.04 | 1.56 | 0.71 | 0.55 | 0.21 | 0.03 | * | - | - | 3.10 | 5.84 |
| **>2.5<=3** | - | - | 0.77 | 0.35 | 0.26 | 0.08 | 0.01 | * | - | - | 1.47 | 2.72 |
| **>3<=3.5** | - | - | 0.19 | 0.31 | 0.13 | 0.05 | * | * | * | - | 0.68 | 1.25 |
| **>3.5<=4** | - | - | 0.02 | 0.21 | 0.06 | 0.02 | * | * | - | - | 0.31 | 0.56 |
| **>4<=4.5** | - | - | * | 0.08 | 0.03 | 0.01 | - | - | - | - | 0.12 | 0.24 |
| **>4.5<=5** | - | - | - | 0.03 | 0.03 | 0.01 | - | - | - | - | 0.07 | 0.12 |
| **>5<=5.5** | - | - | - | 0.01 | 0.02 | * | - | - | - | - | 0.03 | 0.05 |
| **>5.5<=6** | - | - | - | * | 0.01 | * | - | - | - | - | 0.01 | 0.01 |
| **>6<=6.5** | - | - | - | - | * | - | - | - | - | - | | |
| **Total** | 4.45 | 11.46 | 17.48 | 38.24 | 19.31 | 6.08 | 1.97 | 0.63 | 0.19 | 0.04 | 100.00 | |
| **>Exceed%** | 99.90 | 95.45 | 83.99 | 66.50 | 28.25 | 8.92 | 2.85 | 0.88 | 0.24 | 0.04 | | |

Notes: * represents less than 0.005%.

*Table 4.6 Annual and monthly non-exceedance persistence (%) for significant wave height below 0.0 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Feb** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Mar** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Apr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **May** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Jun** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Jul** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Aug** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Sep** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Oct** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Nov** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Dec** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **annual** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Table 4.7 Annual and monthly non-exceedance persistence (%) for significant wave height below 0.5 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **6** | **12** | **18** | **24** | **36** | **48** | **72** |
| **Jan** | 11.76 | 11.03 | 10.02 | 9.23 | 7.21 | 5.36 | 2.99 |
| **Feb** | 8.28 | 7.59 | 6.91 | 6.20 | 5.51 | 4.14 | 2.32 |
| **Mar** | 10.44 | 9.48 | 8.81 | 8.16 | 7.26 | 5.59 | 3.08 |
| **Apr** | 20.52 | 19.55 | 18.78 | 17.94 | 15.70 | 13.76 | 8.83 |
| **May** | 27.01 | 26.14 | 24.77 | 23.37 | 20.27 | 18.77 | 14.00 |
| **Jun** | 29.01 | 27.92 | 26.86 | 25.76 | 23.33 | 20.50 | 14.58 |
| **Jul** | 24.54 | 23.64 | 22.44 | 20.56 | 17.83 | 14.24 | 9.93 |
| **Aug** | 26.64 | 25.64 | 24.52 | 22.71 | 18.89 | 15.07 | 9.62 |
| **Sep** | 26.50 | 25.42 | 24.11 | 23.23 | 20.15 | 17.70 | 11.15 |
| **Oct** | 31.28 | 29.68 | 27.01 | 25.11 | 21.32 | 17.95 | 11.26 |
| **Nov** | 28.10 | 26.34 | 24.42 | 22.51 | 18.31 | 13.43 | 7.89 |
| **Dec** | 16.18 | 14.90 | 13.76 | 13.13 | 10.05 | 7.31 | 3.55 |
| **annual** | 21.79 | 20.77 | 19.60 | 18.43 | 15.83 | 13.34 | 8.81 |

*Table 4.8 Annual and monthly non-exceedance persistence (%) for significant wave height below 1.0 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 63.47 | 62.42 | 61.08 | 60.60 | 58.31 | 55.48 | 50.51 |
| **Feb** | 58.75 | 58.01 | 56.79 | 56.19 | 53.64 | 51.16 | 43.89 |
| **Mar** | 60.88 | 60.14 | 59.38 | 58.18 | 56.27 | 54.59 | 50.02 |
| **Apr** | 64.32 | 63.66 | 63.00 | 62.08 | 60.00 | 57.34 | 52.31 |
| **May** | 68.64 | 68.26 | 67.39 | 66.81 | 65.23 | 63.04 | 57.79 |
| **Jun** | 65.54 | 64.81 | 63.52 | 62.71 | 59.73 | 57.64 | 52.42 |
| **Jul** | 63.31 | 62.73 | 61.83 | 61.03 | 57.69 | 54.64 | 48.97 |
| **Aug** | 66.51 | 66.04 | 65.20 | 64.24 | 62.26 | 59.50 | 52.01 |
| **Sep** | 67.50 | 66.68 | 65.76 | 64.75 | 62.05 | 59.01 | 52.09 |
| **Oct** | 74.14 | 73.56 | 73.09 | 71.95 | 70.06 | 67.65 | 61.34 |
| **Nov** | 73.61 | 72.72 | 71.85 | 70.90 | 68.75 | 65.73 | 59.67 |
| **Dec** | 67.16 | 66.32 | 64.70 | 64.21 | 62.57 | 60.42 | 54.76 |
| **annual** | 66.26 | 65.69 | 64.85 | 64.18 | 62.28 | 60.17 | 55.33 |

*Table 4.9 Annual and monthly non-exceedance persistence (%) for significant wave height below 1.5 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 87.12 | 86.80 | 86.67 | 86.34 | 85.29 | 84.01 | 81.21 |
| **Feb** | 86.31 | 85.96 | 85.30 | 84.86 | 83.93 | 83.44 | 80.67 |
| **Mar** | 84.58 | 84.13 | 83.80 | 82.89 | 81.22 | 80.41 | 77.85 |
| **Apr** | 86.52 | 86.18 | 86.00 | 85.75 | 84.30 | 83.16 | 80.59 |
| **May** | 87.19 | 86.94 | 86.69 | 86.22 | 84.77 | 84.30 | 82.17 |
| **Jun** | 82.34 | 82.03 | 81.71 | 81.21 | 80.54 | 78.36 | 74.55 |
| **Jul** | 80.57 | 80.24 | 79.71 | 79.39 | 78.14 | 75.83 | 70.77 |
| **Aug** | 84.58 | 84.28 | 83.98 | 83.39 | 82.01 | 81.10 | 77.64 |
| **Sep** | 86.44 | 86.25 | 85.77 | 84.85 | 83.60 | 81.63 | 76.70 |
| **Oct** | 89.59 | 89.20 | 88.90 | 88.26 | 87.43 | 86.10 | 82.86 |
| **Nov** | 90.45 | 90.08 | 89.28 | 89.02 | 88.61 | 87.98 | 85.42 |
| **Dec** | 88.91 | 88.64 | 88.04 | 87.88 | 87.44 | 85.76 | 83.82 |
| **annual** | 86.26 | 86.03 | 85.73 | 85.40 | 84.63 | 83.69 | 81.52 |

*Table 4.10 Annual and monthly non-exceedance persistence (%) for significant wave height below 2.0 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 95.30 | 95.19 | 95.14 | 95.14 | 94.68 | 94.40 | 92.68 |
| **Feb** | 95.08 | 94.97 | 94.90 | 94.74 | 94.47 | 94.31 | 93.46 |
| **Mar** | 94.48 | 94.45 | 94.40 | 94.32 | 93.69 | 93.24 | 91.04 |
| **Apr** | 94.21 | 94.04 | 93.93 | 93.93 | 93.21 | 92.92 | 91.66 |
| **May** | 94.23 | 94.14 | 93.97 | 93.59 | 93.17 | 93.03 | 91.34 |
| **Jun** | 91.11 | 90.82 | 90.66 | 90.34 | 89.45 | 88.79 | 86.56 |
| **Jul** | 89.36 | 89.20 | 89.03 | 88.87 | 88.17 | 87.27 | 83.68 |
| **Aug** | 92.56 | 92.41 | 92.24 | 92.16 | 91.29 | 89.93 | 88.36 |
| **Sep** | 94.23 | 94.17 | 93.87 | 93.71 | 92.88 | 92.12 | 89.31 |
| **Oct** | 96.03 | 95.97 | 95.72 | 95.65 | 94.99 | 94.52 | 92.36 |
| **Nov** | 96.25 | 96.10 | 95.98 | 95.81 | 95.49 | 95.16 | 94.28 |
| **Dec** | 96.04 | 95.93 | 95.56 | 95.49 | 95.15 | 95.15 | 94.73 |
| **annual** | 94.08 | 94.01 | 93.92 | 93.85 | 93.61 | 93.31 | 92.15 |

*Table 4.11 Annual and monthly non-exceedance persistence (%) for significant wave height below 2.5 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 97.85 | 97.81 | 97.75 | 97.75 | 97.54 | 97.40 | 96.71 |
| **Feb** | 98.04 | 97.95 | 97.89 | 97.73 | 97.46 | 97.29 | 97.07 |
| **Mar** | 97.49 | 97.49 | 97.42 | 97.42 | 97.30 | 97.01 | 96.82 |
| **Apr** | 97.53 | 97.29 | 97.18 | 97.11 | 96.77 | 96.27 | 95.82 |
| **May** | 97.64 | 97.60 | 97.60 | 97.43 | 97.43 | 96.67 | 96.49 |
| **Jun** | 95.89 | 95.84 | 95.67 | 95.50 | 95.38 | 94.57 | 92.96 |
| **Jul** | 93.62 | 93.59 | 93.47 | 93.47 | 93.04 | 92.76 | 90.55 |
| **Aug** | 95.88 | 95.85 | 95.79 | 95.79 | 95.26 | 94.95 | 94.09 |
| **Sep** | 97.34 | 97.26 | 97.07 | 97.07 | 96.84 | 96.20 | 94.64 |
| **Oct** | 98.71 | 98.67 | 98.62 | 98.62 | 98.39 | 98.06 | 97.12 |
| **Nov** | 98.48 | 98.43 | 98.38 | 98.22 | 97.99 | 97.99 | 97.57 |
| **Dec** | 98.22 | 98.17 | 98.02 | 97.87 | 97.87 | 97.71 | 97.52 |
| **annual** | 97.23 | 97.19 | 97.13 | 97.11 | 97.06 | 96.98 | 96.69 |

*Table 4.12 Annual and monthly non-exceedance persistence (%) for significant wave height below 3.0 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.30 | 99.30 | 99.30 | 99.23 | 99.12 | 99.12 | 98.90 |
| **Feb** | 99.12 | 99.12 | 99.00 | 98.81 | 98.81 | 98.81 | 98.13 |
| **Mar** | 98.82 | 98.82 | 98.77 | 98.77 | 98.77 | 98.77 | 98.53 |
| **Apr** | 99.25 | 99.22 | 99.17 | 99.09 | 98.86 | 98.68 | 98.68 |
| **May** | 99.00 | 99.00 | 98.95 | 98.95 | 98.75 | 98.75 | 98.39 |
| **Jun** | 98.02 | 97.98 | 97.82 | 97.73 | 97.63 | 97.29 | 96.66 |
| **Jul** | 96.28 | 96.17 | 96.05 | 96.05 | 95.81 | 95.67 | 94.32 |
| **Aug** | 97.90 | 97.81 | 97.81 | 97.64 | 97.55 | 97.41 | 97.23 |
| **Sep** | 98.65 | 98.65 | 98.60 | 98.52 | 98.52 | 98.36 | 97.68 |
| **Oct** | 99.70 | 99.70 | 99.70 | 99.62 | 99.62 | 99.62 | 98.99 |
| **Nov** | 99.32 | 99.32 | 99.32 | 99.32 | 99.19 | 99.19 | 98.72 |
| **Dec** | 99.35 | 99.31 | 99.31 | 99.31 | 99.12 | 98.95 | 98.95 |
| **annual** | 98.73 | 98.71 | 98.68 | 98.68 | 98.66 | 98.65 | 98.61 |

*Table 4.13 Annual and monthly non-exceedance persistence (%) for significant wave height below 3.5 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.78 | 99.78 | 99.78 | 99.78 | 99.78 | 99.78 | 99.78 |
| **Feb** | 99.66 | 99.66 | 99.53 | 99.53 | 99.31 | 99.31 | 98.80 |
| **Mar** | 99.48 | 99.48 | 99.43 | 99.43 | 99.43 | 99.43 | 99.43 |
| **Apr** | 99.70 | 99.70 | 99.70 | 99.70 | 99.59 | 99.42 | 99.42 |
| **May** | 99.58 | 99.54 | 99.54 | 99.54 | 99.54 | 99.54 | 99.54 |
| **Jun** | 99.08 | 99.05 | 98.93 | 98.84 | 98.73 | 98.73 | 98.31 |
| **Jul** | 98.09 | 98.02 | 98.02 | 98.02 | 97.92 | 97.77 | 96.42 |
| **Aug** | 99.17 | 99.06 | 98.95 | 98.95 | 98.95 | 98.80 | 98.80 |
| **Sep** | 99.29 | 99.29 | 99.29 | 99.21 | 99.21 | 99.05 | 98.86 |
| **Oct** | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.73 |
| **Nov** | 99.69 | 99.69 | 99.69 | 99.69 | 99.69 | 99.55 | 99.31 |
| **Dec** | 99.70 | 99.70 | 99.70 | 99.70 | 99.59 | 99.59 | 99.59 |
| **annual** | 99.43 | 99.41 | 99.40 | 99.40 | 99.40 | 99.40 | 99.36 |

*Table 4.14 Annual and monthly non-exceedance persistence (%) for significant wave height below 4.0 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 |
| **Feb** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.72 |
| **Mar** | 99.73 | 99.73 | 99.73 | 99.73 | 99.73 | 99.73 | 99.73 |
| **Apr** | 99.87 | 99.87 | 99.87 | 99.87 | 99.87 | 99.87 | 99.68 |
| **May** | 99.82 | 99.78 | 99.78 | 99.78 | 99.78 | 99.78 | 99.78 |
| **Jun** | 99.54 | 99.54 | 99.54 | 99.46 | 99.36 | 99.36 | 98.94 |
| **Jul** | 99.19 | 99.19 | 99.19 | 99.19 | 99.09 | 99.09 | 98.88 |
| **Aug** | 99.72 | 99.72 | 99.72 | 99.72 | 99.72 | 99.72 | 99.52 |
| **Sep** | 99.63 | 99.59 | 99.59 | 99.51 | 99.51 | 99.51 | 99.30 |
| **Oct** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **Nov** | 99.81 | 99.81 | 99.81 | 99.81 | 99.81 | 99.67 | 99.67 |
| **Dec** | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 |
| **annual** | 99.76 | 99.75 | 99.75 | 99.75 | 99.75 | 99.75 | 99.75 |

*Table 4.15 Annual and monthly non-exceedance persistence (%) for significant wave height below 4.5 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 |
| **Apr** | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 |
| **May** | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 |
| **Jun** | 99.79 | 99.79 | 99.79 | 99.79 | 99.69 | 99.69 | 99.50 |
| **Jul** | 99.58 | 99.53 | 99.53 | 99.53 | 99.53 | 99.53 | 99.53 |
| **Aug** | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 |
| **Sep** | 99.85 | 99.85 | 99.85 | 99.85 | 99.85 | 99.85 | 99.63 |
| **Oct** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Nov** | 99.86 | 99.86 | 99.86 | 99.86 | 99.86 | 99.70 | 99.70 |
| **Dec** | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 |
| **annual** | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 |

*Table 4.16 Annual and monthly non-exceedance persistence (%) for significant wave height below 5.0 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 |
| **Apr** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **May** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **Jun** | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 |
| **Jul** | 99.75 | 99.75 | 99.75 | 99.75 | 99.75 | 99.75 | 99.75 |
| **Aug** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **Sep** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **Oct** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nov** | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.73 |
| **Dec** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **annual** | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 | 99.95 |

*Table 4.17 Annual and monthly non-exceedance persistence (%) for significant wave height below 5.5 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Apr** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **May** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Jun** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **Jul** | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 |
| **Aug** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Sep** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Oct** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nov** | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.74 |
| **Dec** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **annual** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |

*Table 4.18 Annual and monthly non-exceedance persistence (%) for significant wave height below 6.0 m at P1.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| Jan | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Feb | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Mar | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Apr | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| May | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Jun | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Jul | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| Aug | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Sep | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Oct | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Nov | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Dec | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| annual | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

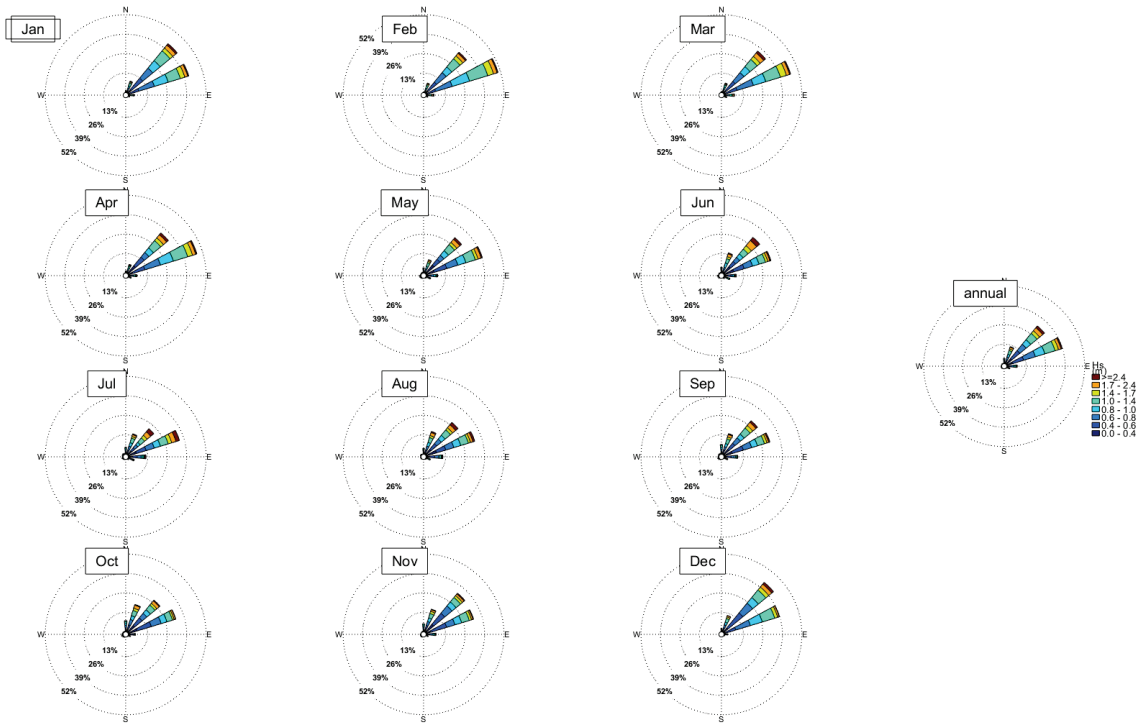


*Figure 4.1 Monthly and annual wave rose plot for the total significant wave height at P1. Sectors indicate the direction from which waves approach.*

## 4.2. P2

A summary of the total significant wave height statistics ($H_s$) at P2 is provided in Table 4.19. Summary of significant wave height statistics for swell and windseas components are provided in Table 4.20 and Table 4.21 respectively. Details on the partitioning method for sea and swell components are presented in Section 8.2.

The annual joint probability distribution of the total significant wave height and mean wave direction at peak energy is presented in Table 4.22.
The annual joint probability distribution of the total significant wave height and peak period is presented in Table 4.23.

The annual and monthly non-exceedance persistence probabilities for total significant wave height at P2 (Table 4.24 to Table 4.36) can be used to estimate the operational uptime for tasks with wind speed limitations of variable duration. For example, at P2 on average in February, total significant wave heights are less than 0.5 m for durations of 36 hours and greater for 5.56% of the time (Table 4.25).

Wave roses for the monthly and annual total significant wave height are presented in Figure 4.2, showing the predominance of waves incoming from the NE sector.

*Table 4.19 Annual and monthly total significant wave height statistics at P2.*

| Period (01 Jan 1979 – 31 Dec 2018) | Total significant wave height statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total significant wave height (m) | | | | Exceedance percentile for total significant wave height (m) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.25 | 5.24 | 0.98 | 0.52 | 0.33 | 0.42 | 0.48 | 0.85 | 1.29 | 1.62 | 1.97 | 2.51 | 2.86 | NE |
| **February** | 0.24 | 4.47 | 1.02 | 0.51 | 0.35 | 0.44 | 0.52 | 0.90 | 1.33 | 1.65 | 1.97 | 2.49 | 2.95 | NE E |
| **March** | 0.19 | 5.18 | 1.01 | 0.57 | 0.32 | 0.42 | 0.49 | 0.87 | 1.36 | 1.70 | 2.06 | 2.65 | 3.05 | NE E |
| **April** | 0.14 | 5.30 | 0.95 | 0.56 | 0.26 | 0.34 | 0.39 | 0.82 | 1.30 | 1.65 | 2.10 | 2.58 | 2.89 | NE E |
| **May** | 0.10 | 5.18 | 0.90 | 0.60 | 0.19 | 0.28 | 0.34 | 0.75 | 1.25 | 1.68 | 2.09 | 2.59 | 3.05 | NE E |
| **June** | 0.09 | 6.02 | 0.97 | 0.72 | 0.18 | 0.26 | 0.32 | 0.77 | 1.42 | 1.96 | 2.39 | 3.04 | 3.48 | NE E |
| **July** | 0.08 | 6.31 | 1.04 | 0.80 | 0.19 | 0.28 | 0.34 | 0.79 | 1.48 | 2.07 | 2.75 | 3.46 | 3.87 | NE E |
| **August** | 0.14 | 5.55 | 0.95 | 0.67 | 0.21 | 0.29 | 0.35 | 0.76 | 1.33 | 1.83 | 2.36 | 3.02 | 3.45 | NE E |
| **September** | 0.09 | 5.22 | 0.92 | 0.62 | 0.22 | 0.30 | 0.36 | 0.75 | 1.28 | 1.70 | 2.12 | 2.71 | 3.29 | N NE E |
| **October** | 0.14 | 4.71 | 0.82 | 0.52 | 0.23 | 0.30 | 0.34 | 0.67 | 1.14 | 1.53 | 1.92 | 2.34 | 2.62 | N NE E |
| **November** | 0.16 | 5.49 | 0.84 | 0.53 | 0.25 | 0.33 | 0.39 | 0.69 | 1.14 | 1.50 | 1.84 | 2.35 | 2.82 | NE E |
| **December** | 0.21 | 5.08 | 0.93 | 0.51 | 0.31 | 0.39 | 0.45 | 0.80 | 1.23 | 1.55 | 1.87 | 2.46 | 2.74 | NE |
| **Winter**(3) | 0.08 | 6.31 | 0.99 | 0.73 | 0.19 | 0.28 | 0.33 | 0.77 | 1.41 | 1.94 | 2.50 | 3.21 | 3.65 | NE E |
| **Spring** | 0.09 | 5.49 | 0.86 | 0.56 | 0.23 | 0.31 | 0.36 | 0.70 | 1.19 | 1.57 | 1.97 | 2.47 | 2.89 | N NE E |
| **Summer**(2) | 0.21 | 5.24 | 0.97 | 0.51 | 0.32 | 0.42 | 0.48 | 0.85 | 1.29 | 1.61 | 1.95 | 2.49 | 2.86 | NE |
| **Autumn** | 0.10 | 5.30 | 0.96 | 0.58 | 0.24 | 0.33 | 0.40 | 0.82 | 1.31 | 1.68 | 2.08 | 2.60 | 3.01 | NE E |
| **All** | 0.08 | 6.31 | 0.94 | 0.60 | 0.23 | 0.32 | 0.38 | 0.79 | 1.29 | 1.69 | 2.12 | 2.72 | 3.18 | NE E |

Notes: (1) All statistics derived from hindcast wave data for the period 01 January 1979 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the waves approach.

*Table 4.20 Annual and monthly significant swell wave height statistics at P2.*

| Period (01 Jan 1979 – 31 Dec 2018) | Significant swell wave height statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Significant swell wave height (m) | | | | Exceedance percentile for significant swell wave height (m) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.14 | 4.23 | 0.60 | 0.36 | 0.21 | 0.25 | 0.29 | 0.50 | 0.77 | 1.04 | 1.36 | 1.71 | 1.91 | NE |
| **February** | 0.14 | 3.25 | 0.63 | 0.35 | 0.20 | 0.26 | 0.30 | 0.54 | 0.84 | 1.09 | 1.31 | 1.62 | 1.91 | NE E |
| **March** | 0.10 | 4.11 | 0.62 | 0.40 | 0.17 | 0.25 | 0.29 | 0.51 | 0.84 | 1.08 | 1.36 | 1.77 | 2.11 | NE E |
| **April** | 0.08 | 4.14 | 0.56 | 0.40 | 0.15 | 0.20 | 0.23 | 0.44 | 0.78 | 1.05 | 1.33 | 1.70 | 2.06 | NE E |
| **May** | 0.04 | 4.19 | 0.50 | 0.41 | 0.07 | 0.11 | 0.14 | 0.37 | 0.71 | 0.99 | 1.30 | 1.70 | 2.05 | NE E |
| **June** | 0.02 | 5.06 | 0.54 | 0.51 | 0.07 | 0.11 | 0.14 | 0.36 | 0.79 | 1.20 | 1.60 | 2.05 | 2.42 | NE E |
| **July** | 0.03 | 5.27 | 0.58 | 0.58 | 0.06 | 0.10 | 0.12 | 0.38 | 0.88 | 1.36 | 1.77 | 2.38 | 2.77 | NE E |
| **August** | 0.06 | 4.54 | 0.53 | 0.46 | 0.09 | 0.13 | 0.15 | 0.38 | 0.76 | 1.07 | 1.40 | 1.99 | 2.42 | NE E |
| **September** | 0.03 | 4.31 | 0.48 | 0.43 | 0.06 | 0.11 | 0.14 | 0.35 | 0.67 | 0.95 | 1.29 | 1.75 | 2.22 | NE E |
| **October** | 0.05 | 3.46 | 0.39 | 0.32 | 0.08 | 0.11 | 0.14 | 0.29 | 0.55 | 0.79 | 1.06 | 1.42 | 1.60 | NE E |
| **November** | 0.07 | 4.45 | 0.43 | 0.34 | 0.10 | 0.15 | 0.17 | 0.33 | 0.59 | 0.82 | 1.05 | 1.42 | 1.64 | NE E |
| **December** | 0.09 | 3.95 | 0.54 | 0.34 | 0.17 | 0.22 | 0.26 | 0.45 | 0.71 | 0.95 | 1.21 | 1.53 | 1.81 | NE |
| **Winter**(3) | 0.02 | 5.27 | 0.55 | 0.52 | 0.07 | 0.11 | 0.14 | 0.38 | 0.80 | 1.20 | 1.62 | 2.13 | 2.56 | NE E |
| **Spring** | 0.03 | 4.45 | 0.43 | 0.37 | 0.08 | 0.12 | 0.15 | 0.32 | 0.60 | 0.85 | 1.13 | 1.52 | 1.80 | NE E |
| **Summer**(2) | 0.09 | 4.23 | 0.59 | 0.35 | 0.19 | 0.24 | 0.28 | 0.49 | 0.77 | 1.03 | 1.29 | 1.64 | 1.87 | NE |
| **Autumn** | 0.04 | 4.19 | 0.56 | 0.41 | 0.10 | 0.16 | 0.20 | 0.44 | 0.78 | 1.05 | 1.33 | 1.73 | 2.07 | NE E |
| **All** | 0.02 | 5.27 | 0.53 | 0.42 | 0.09 | 0.14 | 0.17 | 0.41 | 0.74 | 1.03 | 1.35 | 1.78 | 2.12 | NE E |

Notes: (1) All statistics derived from hindcast wave data for the period 01 January 1979 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the waves approach.

*Table 4.21 Annual and monthly significant sea wave height statistics at P2.*

| Period (01 Jan 1979 – 31 Dec 2018) | Significant sea wave height statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Significant sea wave height (m) | | | | Exceedance percentile for significant sea wave height (m) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.13 | 3.28 | 0.74 | 0.44 | 0.20 | 0.28 | 0.32 | 0.63 | 0.99 | 1.29 | 1.64 | 2.08 | 2.30 | N NE E |
| **February** | 0.12 | 3.15 | 0.77 | 0.43 | 0.23 | 0.32 | 0.36 | 0.65 | 1.03 | 1.30 | 1.65 | 2.08 | 2.43 | NE E |
| **March** | 0.08 | 3.35 | 0.77 | 0.46 | 0.20 | 0.28 | 0.33 | 0.64 | 1.05 | 1.37 | 1.71 | 2.13 | 2.44 | NE E |
| **April** | 0.08 | 3.34 | 0.73 | 0.46 | 0.15 | 0.22 | 0.28 | 0.63 | 1.01 | 1.34 | 1.70 | 2.10 | 2.34 | N NE E |
| **May** | 0.05 | 3.33 | 0.72 | 0.49 | 0.13 | 0.20 | 0.25 | 0.58 | 1.01 | 1.37 | 1.76 | 2.21 | 2.46 | N NE E |
| **June** | 0.06 | 3.59 | 0.77 | 0.57 | 0.12 | 0.18 | 0.24 | 0.60 | 1.11 | 1.56 | 2.02 | 2.49 | 2.72 | N NE E |
| **July** | 0.03 | 3.47 | 0.81 | 0.61 | 0.12 | 0.21 | 0.26 | 0.62 | 1.12 | 1.67 | 2.25 | 2.65 | 2.84 | N NE E |
| **August** | 0.06 | 3.27 | 0.76 | 0.55 | 0.14 | 0.21 | 0.26 | 0.59 | 1.07 | 1.52 | 2.02 | 2.46 | 2.66 | N NE E |
| **September** | 0.06 | 3.27 | 0.75 | 0.51 | 0.14 | 0.24 | 0.28 | 0.61 | 1.05 | 1.42 | 1.85 | 2.30 | 2.62 | N NE |
| **October** | 0.07 | 3.19 | 0.69 | 0.46 | 0.17 | 0.24 | 0.28 | 0.56 | 0.96 | 1.30 | 1.67 | 2.10 | 2.31 | N NE |
| **November** | 0.09 | 3.22 | 0.69 | 0.45 | 0.17 | 0.25 | 0.29 | 0.57 | 0.95 | 1.28 | 1.63 | 2.07 | 2.42 | N NE |
| **December** | 0.10 | 3.27 | 0.72 | 0.44 | 0.18 | 0.26 | 0.31 | 0.60 | 0.97 | 1.28 | 1.64 | 2.03 | 2.37 | N NE |
| **Winter**(3) | 0.03 | 3.59 | 0.78 | 0.58 | 0.13 | 0.20 | 0.26 | 0.61 | 1.10 | 1.58 | 2.10 | 2.55 | 2.75 | N NE E |
| **Spring** | 0.06 | 3.27 | 0.71 | 0.47 | 0.17 | 0.24 | 0.28 | 0.58 | 0.99 | 1.34 | 1.71 | 2.17 | 2.45 | N NE |
| **Summer**(2) | 0.10 | 3.28 | 0.74 | 0.44 | 0.20 | 0.28 | 0.33 | 0.63 | 1.00 | 1.29 | 1.64 | 2.06 | 2.36 | N NE E |
| **Autumn** | 0.05 | 3.35 | 0.74 | 0.47 | 0.15 | 0.23 | 0.29 | 0.62 | 1.02 | 1.36 | 1.72 | 2.14 | 2.41 | N NE E |
| **All** | 0.03 | 3.59 | 0.74 | 0.49 | 0.15 | 0.24 | 0.29 | 0.61 | 1.03 | 1.38 | 1.79 | 2.27 | 2.55 | N NE E |

Notes: (1) All statistics derived from hindcast wave data for the period 01 January 1979 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the waves approach.

*Table 4.22 Annual joint probability distribution (in %) of the total significant wave height and mean wave direction at peak energy at P2.*

| Hs (m) | Mean wave direction at peak energy (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| >0<=0.5 | 0.98 | 14.18 | 4.43 | 0.26 | 0.28 | 0.51 | 0.63 | 0.14 | 21.41 | 100.00 |
| >0.5<=1 | 5.04 | 28.90 | 9.22 | 0.44 | 0.05 | 0.24 | 0.28 | 0.31 | 44.48 | 78.59 |
| >1<=1.5 | 2.47 | 14.24 | 3.37 | 0.12 | - | 0.04 | * | * | 20.24 | 34.12 |
| >1.5<=2 | 0.93 | 5.75 | 1.11 | 0.03 | - | * | - | - | 7.82 | 13.88 |
| >2<=2.5 | 0.32 | 2.42 | 0.50 | * | - | - | - | - | 3.24 | 6.06 |
| >2.5<=3 | 0.09 | 1.18 | 0.25 | - | - | - | - | - | 1.52 | 2.81 |
| >3<=3.5 | 0.02 | 0.56 | 0.12 | - | - | - | - | - | 0.70 | 1.29 |
| >3.5<=4 | * | 0.28 | 0.03 | - | - | - | - | - | 0.31 | 0.59 |
| >4<=4.5 | * | 0.13 | 0.01 | - | - | - | - | - | 0.14 | 0.27 |
| >4.5<=5 | - | 0.06 | 0.01 | - | - | - | - | - | 0.07 | 0.13 |
| >5<=5.5 | - | 0.03 | 0.01 | - | - | - | - | - | 0.04 | 0.05 |
| >5.5<=6 | - | 0.01 | * | - | - | - | - | - | 0.01 | 0.01 |
| >6<=6.5 | - | * | * | - | - | - | - | - | | |
| Total | 9.85 | 67.74 | 19.06 | 0.85 | 0.33 | 0.79 | 0.91 | 0.45 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 4.23 Annual joint probability distribution (in %) of the total significant wave height and peak period at P2.*

| Hs (m) | Peak period (s) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2-4** | **4-6** | **6-8** | **8-10** | **10-12** | **12-14** | **14-16** | **16-18** | **18-20** | **20-22** | **Total** | **Exceed%** |
| **>0<=0.5** | 1.79 | 0.81 | 1.86 | 8.70 | 5.25 | 1.58 | 0.77 | 0.37 | 0.14 | 0.04 | 21.31 | 100.00 |
| **>0.5<=1** | 2.26 | 4.64 | 8.32 | 17.49 | 8.17 | 2.32 | 0.76 | 0.35 | 0.13 | 0.03 | 44.47 | 78.59 |
| **>1<=1.5** | * | 4.66 | 3.82 | 7.18 | 3.31 | 0.97 | 0.26 | 0.03 | 0.01 | * | 20.24 | 34.12 |
| **>1.5<=2** | - | 1.40 | 2.04 | 2.31 | 1.43 | 0.54 | 0.09 | 0.01 | * | - | 7.82 | 13.88 |
| **>2<=2.5** | - | 0.03 | 1.60 | 0.75 | 0.59 | 0.21 | 0.04 | 0.01 | - | - | 3.23 | 6.06 |
| **>2.5<=3** | - | - | 0.75 | 0.38 | 0.28 | 0.09 | 0.01 | * | - | - | 1.51 | 2.81 |
| **>3<=3.5** | - | - | 0.20 | 0.32 | 0.13 | 0.05 | * | * | * | * | 0.70 | 1.29 |
| **>3.5<=4** | - | - | 0.02 | 0.21 | 0.06 | 0.03 | * | * | * | - | 0.32 | 0.59 |
| **>4<=4.5** | - | - | * | 0.10 | 0.04 | 0.01 | * | * | - | - | 0.15 | 0.27 |
| **>4.5<=5** | - | - | - | 0.03 | 0.03 | 0.01 | - | - | - | - | 0.07 | 0.13 |
| **>5<=5.5** | - | - | - | 0.01 | 0.02 | 0.01 | - | - | - | - | 0.04 | 0.05 |
| **>5.5<=6** | - | - | - | * | 0.01 | * | - | - | - | - | 0.01 | 0.01 |
| **>6<=6.5** | - | - | - | - | * | * | - | - | - | - | | |
| **Total** | 4.05 | 11.54 | 18.61 | 37.48 | 19.32 | 5.82 | 1.93 | 0.77 | 0.28 | 0.07 | 100.00 | |
| **>Exceed%** | 99.90 | 95.85 | 84.32 | 65.71 | 28.22 | 8.90 | 3.08 | 1.13 | 0.36 | 0.07 | | |

Notes: * represents less than 0.005%.

*Table 4.24 Annual and monthly non-exceedance persistence (%) for significant wave height below 0.0 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Feb** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Mar** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Apr** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **May** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Jun** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Jul** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Aug** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Sep** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Oct** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Nov** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Dec** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **annual** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Table 4.25 Annual and monthly non-exceedance persistence (%) for significant wave height below 0.5 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 10.98 | 10.18 | 8.91 | 8.12 | 6.84 | 5.00 | 1.55 |
| **Feb** | 8.00 | 7.46 | 6.91 | 6.16 | 5.56 | 4.40 | 2.58 |
| **Mar** | 10.10 | 9.54 | 8.65 | 7.94 | 7.12 | 5.46 | 3.15 |
| **Apr** | 19.71 | 18.80 | 18.09 | 17.29 | 15.14 | 13.40 | 8.94 |
| **May** | 26.44 | 25.46 | 24.15 | 23.15 | 20.43 | 18.64 | 14.62 |
| **Jun** | 28.00 | 27.04 | 25.89 | 24.99 | 22.80 | 20.27 | 12.41 |
| **Jul** | 24.01 | 22.94 | 21.39 | 19.82 | 17.29 | 13.87 | 9.83 |
| **Aug** | 25.87 | 25.04 | 23.49 | 21.94 | 18.59 | 15.69 | 9.83 |
| **Sep** | 24.91 | 23.90 | 22.41 | 21.57 | 18.48 | 16.58 | 9.74 |
| **Oct** | 29.85 | 27.94 | 26.05 | 24.10 | 21.01 | 17.65 | 10.12 |
| **Nov** | 26.30 | 24.32 | 22.79 | 20.48 | 16.24 | 12.59 | 7.21 |
| **Dec** | 14.82 | 13.66 | 12.40 | 11.92 | 8.88 | 6.67 | 3.28 |
| **annual** | 20.85 | 19.84 | 18.65 | 17.59 | 15.22 | 13.02 | 8.34 |

*Table 4.26 Annual and monthly non-exceedance persistence (%) for significant wave height below 1.0 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 63.33 | 62.58 | 61.03 | 60.40 | 57.74 | 54.53 | 50.85 |
| **Feb** | 58.26 | 57.39 | 56.47 | 55.57 | 53.29 | 50.15 | 44.26 |
| **Mar** | 60.12 | 59.71 | 58.89 | 58.10 | 55.84 | 54.62 | 49.30 |
| **Apr** | 64.23 | 63.38 | 62.62 | 61.81 | 59.85 | 56.89 | 51.50 |
| **May** | 67.63 | 67.20 | 66.74 | 65.86 | 64.05 | 61.26 | 55.75 |
| **Jun** | 64.71 | 64.01 | 63.05 | 61.77 | 59.34 | 57.50 | 52.71 |
| **Jul** | 62.48 | 61.92 | 61.08 | 60.19 | 56.25 | 52.75 | 47.93 |
| **Aug** | 65.30 | 64.76 | 64.00 | 63.10 | 61.16 | 58.57 | 49.94 |
| **Sep** | 66.40 | 65.59 | 64.61 | 63.78 | 61.11 | 57.92 | 50.89 |
| **Oct** | 73.42 | 72.74 | 72.15 | 71.12 | 69.02 | 65.84 | 59.62 |
| **Nov** | 72.79 | 72.09 | 70.91 | 70.26 | 68.55 | 65.31 | 58.61 |
| **Dec** | 66.63 | 65.84 | 64.28 | 63.97 | 62.20 | 60.24 | 54.24 |
| **annual** | 65.55 | 64.99 | 64.18 | 63.53 | 61.65 | 59.24 | 54.31 |

*Table 4.27 Annual and monthly non-exceedance persistence (%) for significant wave height below 1.5 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 87.02 | 86.83 | 86.71 | 86.30 | 85.25 | 84.02 | 81.09 |
| **Feb** | 86.02 | 85.61 | 84.95 | 84.76 | 83.82 | 83.47 | 81.17 |
| **Mar** | 84.62 | 84.32 | 83.76 | 83.12 | 81.54 | 80.42 | 77.77 |
| **Apr** | 86.56 | 86.39 | 85.95 | 85.52 | 84.29 | 83.17 | 79.66 |
| **May** | 86.73 | 86.42 | 86.24 | 85.61 | 85.06 | 83.24 | 81.08 |
| **Jun** | 81.81 | 81.48 | 81.37 | 80.78 | 79.75 | 77.54 | 73.93 |
| **Jul** | 80.26 | 79.92 | 79.46 | 79.13 | 77.77 | 76.09 | 70.51 |
| **Aug** | 84.27 | 83.98 | 83.69 | 83.14 | 81.66 | 80.43 | 77.33 |
| **Sep** | 85.96 | 85.77 | 85.30 | 84.46 | 83.08 | 81.12 | 76.57 |
| **Oct** | 89.29 | 89.05 | 88.53 | 88.14 | 87.22 | 85.90 | 82.42 |
| **Nov** | 89.89 | 89.57 | 88.78 | 88.46 | 87.70 | 86.88 | 83.79 |
| **Dec** | 88.29 | 88.01 | 87.52 | 87.45 | 86.46 | 84.92 | 82.60 |
| **annual** | 85.94 | 85.74 | 85.42 | 85.12 | 84.33 | 83.36 | 81.14 |

*Table 4.28 Annual and monthly non-exceedance persistence (%) for significant wave height below 2.0 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 95.17 | 95.13 | 95.13 | 95.06 | 94.73 | 94.13 | 92.54 |
| **Feb** | 95.02 | 94.95 | 94.89 | 94.73 | 94.46 | 94.09 | 93.44 |
| **Mar** | 94.39 | 94.35 | 94.35 | 94.28 | 93.53 | 93.09 | 91.15 |
| **Apr** | 94.19 | 94.08 | 93.97 | 93.88 | 93.14 | 92.84 | 91.34 |
| **May** | 93.96 | 93.86 | 93.64 | 93.26 | 92.86 | 92.71 | 90.53 |
| **Jun** | 90.45 | 90.24 | 89.92 | 89.85 | 88.61 | 88.10 | 85.61 |
| **Jul** | 89.10 | 88.90 | 88.72 | 88.48 | 87.86 | 87.11 | 83.05 |
| **Aug** | 92.24 | 92.05 | 91.78 | 91.63 | 90.61 | 89.54 | 88.19 |
| **Sep** | 93.84 | 93.70 | 93.39 | 93.06 | 92.47 | 91.57 | 88.53 |
| **Oct** | 95.67 | 95.61 | 95.27 | 95.19 | 94.64 | 93.88 | 91.21 |
| **Nov** | 96.27 | 96.09 | 95.96 | 95.89 | 95.57 | 95.25 | 94.35 |
| **Dec** | 95.89 | 95.78 | 95.42 | 95.33 | 94.99 | 94.99 | 94.12 |
| **annual** | 93.86 | 93.79 | 93.68 | 93.60 | 93.37 | 93.04 | 91.82 |

*Table 4.29 Annual and monthly non-exceedance persistence (%) for significant wave height below 2.5 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 97.91 | 97.87 | 97.74 | 97.74 | 97.64 | 97.50 | 96.81 |
| **Feb** | 98.02 | 97.89 | 97.82 | 97.74 | 97.47 | 97.30 | 97.07 |
| **Mar** | 97.41 | 97.41 | 97.28 | 97.28 | 97.17 | 96.88 | 96.69 |
| **Apr** | 97.51 | 97.31 | 97.20 | 97.12 | 96.78 | 96.47 | 96.28 |
| **May** | 97.57 | 97.54 | 97.49 | 97.40 | 97.27 | 96.50 | 96.50 |
| **Jun** | 95.63 | 95.50 | 95.39 | 95.23 | 95.11 | 94.12 | 92.73 |
| **Jul** | 93.59 | 93.56 | 93.44 | 93.44 | 93.02 | 92.88 | 90.68 |
| **Aug** | 95.68 | 95.68 | 95.62 | 95.62 | 94.86 | 94.22 | 93.57 |
| **Sep** | 97.18 | 97.15 | 96.91 | 96.91 | 96.68 | 96.03 | 94.24 |
| **Oct** | 98.58 | 98.51 | 98.46 | 98.46 | 98.23 | 97.73 | 97.01 |
| **Nov** | 98.42 | 98.38 | 98.31 | 98.16 | 97.93 | 97.93 | 97.50 |
| **Dec** | 98.08 | 98.01 | 97.90 | 97.67 | 97.67 | 97.51 | 97.09 |
| **annual** | 97.14 | 97.10 | 97.02 | 97.00 | 96.95 | 96.85 | 96.62 |

*Table 4.30 Annual and monthly non-exceedance persistence (%) for significant wave height below 3.0 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.28 | 99.25 | 99.25 | 99.17 | 99.07 | 99.07 | 98.84 |
| **Feb** | 99.09 | 99.09 | 98.98 | 98.80 | 98.70 | 98.70 | 98.21 |
| **Mar** | 98.84 | 98.84 | 98.79 | 98.79 | 98.79 | 98.79 | 98.36 |
| **Apr** | 99.21 | 99.18 | 99.12 | 99.05 | 98.82 | 98.64 | 98.64 |
| **May** | 98.90 | 98.90 | 98.84 | 98.84 | 98.64 | 98.64 | 98.28 |
| **Jun** | 97.91 | 97.83 | 97.72 | 97.54 | 97.54 | 97.20 | 96.57 |
| **Jul** | 96.23 | 96.13 | 96.13 | 96.13 | 95.88 | 95.60 | 94.03 |
| **Aug** | 97.84 | 97.75 | 97.75 | 97.67 | 97.43 | 97.43 | 97.06 |
| **Sep** | 98.55 | 98.55 | 98.50 | 98.42 | 98.18 | 98.02 | 97.11 |
| **Oct** | 99.70 | 99.70 | 99.70 | 99.62 | 99.62 | 99.62 | 98.99 |
| **Nov** | 99.29 | 99.29 | 99.22 | 99.22 | 99.09 | 99.09 | 98.62 |
| **Dec** | 99.31 | 99.27 | 99.27 | 99.27 | 99.08 | 98.91 | 98.91 |
| **annual** | 98.69 | 98.67 | 98.64 | 98.64 | 98.60 | 98.59 | 98.50 |

*Table 4.31 Annual and monthly non-exceedance persistence (%) for significant wave height below 3.5 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.73 | 99.73 | 99.73 | 99.73 | 99.73 | 99.73 | 99.73 |
| **Feb** | 99.67 | 99.67 | 99.55 | 99.45 | 99.34 | 99.34 | 98.80 |
| **Mar** | 99.44 | 99.41 | 99.41 | 99.41 | 99.31 | 99.31 | 99.31 |
| **Apr** | 99.69 | 99.69 | 99.69 | 99.69 | 99.58 | 99.58 | 99.40 |
| **May** | 99.50 | 99.46 | 99.46 | 99.46 | 99.46 | 99.46 | 99.46 |
| **Jun** | 99.05 | 99.05 | 98.93 | 98.84 | 98.73 | 98.73 | 98.31 |
| **Jul** | 98.08 | 97.99 | 97.99 | 97.99 | 97.90 | 97.58 | 96.22 |
| **Aug** | 99.07 | 98.99 | 98.89 | 98.89 | 98.89 | 98.74 | 98.74 |
| **Sep** | 99.23 | 99.23 | 99.23 | 99.16 | 99.16 | 98.99 | 98.80 |
| **Oct** | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.72 |
| **Nov** | 99.67 | 99.67 | 99.67 | 99.67 | 99.54 | 99.54 | 99.31 |
| **Dec** | 99.70 | 99.70 | 99.70 | 99.70 | 99.60 | 99.60 | 99.60 |
| **annual** | 99.40 | 99.38 | 99.37 | 99.37 | 99.37 | 99.37 | 99.33 |

*Table 4.32 Annual and monthly non-exceedance persistence (%) for significant wave height below 4.0 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.89 | 99.89 | 99.89 | 99.89 | 99.89 | 99.89 | 99.89 |
| **Feb** | 99.95 | 99.95 | 99.95 | 99.95 | 99.85 | 99.85 | 99.59 |
| **Mar** | 99.70 | 99.70 | 99.70 | 99.70 | 99.61 | 99.61 | 99.61 |
| **Apr** | 99.87 | 99.87 | 99.87 | 99.87 | 99.87 | 99.87 | 99.68 |
| **May** | 99.78 | 99.70 | 99.70 | 99.70 | 99.70 | 99.70 | 99.70 |
| **Jun** | 99.47 | 99.47 | 99.41 | 99.41 | 99.31 | 99.31 | 98.88 |
| **Jul** | 99.14 | 99.14 | 99.14 | 99.14 | 99.03 | 99.03 | 98.57 |
| **Aug** | 99.68 | 99.68 | 99.62 | 99.62 | 99.62 | 99.62 | 99.42 |
| **Sep** | 99.53 | 99.53 | 99.53 | 99.45 | 99.45 | 99.45 | 99.25 |
| **Oct** | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| **Nov** | 99.80 | 99.80 | 99.80 | 99.80 | 99.80 | 99.66 | 99.66 |
| **Dec** | 99.86 | 99.86 | 99.86 | 99.86 | 99.86 | 99.86 | 99.86 |
| **annual** | 99.72 | 99.72 | 99.72 | 99.72 | 99.70 | 99.70 | 99.70 |

*Table 4.33 Annual and monthly non-exceedance persistence (%) for significant wave height below 4.5 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 | 99.93 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 | 99.83 |
| **Apr** | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.74 |
| **May** | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 |
| **Jun** | 99.78 | 99.78 | 99.78 | 99.78 | 99.68 | 99.68 | 99.48 |
| **Jul** | 99.55 | 99.51 | 99.51 | 99.51 | 99.51 | 99.51 | 99.51 |
| **Aug** | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 | 99.90 |
| **Sep** | 99.84 | 99.84 | 99.84 | 99.84 | 99.84 | 99.84 | 99.63 |
| **Oct** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Nov** | 99.86 | 99.86 | 99.86 | 99.86 | 99.86 | 99.70 | 99.70 |
| **Dec** | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 |
| **annual** | 99.87 | 99.87 | 99.87 | 99.87 | 99.87 | 99.87 | 99.87 |

*Table 4.34 Annual and monthly non-exceedance persistence (%) for significant wave height below 5.0 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 | 99.92 |
| **Apr** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **May** | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 |
| **Jun** | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 |
| **Jul** | 99.77 | 99.77 | 99.77 | 99.77 | 99.77 | 99.77 | 99.77 |
| **Aug** | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 |
| **Sep** | 99.96 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 |
| **Oct** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nov** | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.91 | 99.73 |
| **Dec** | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 | 99.98 |
| **annual** | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 | 99.94 |

*Table 4.35 Annual and monthly non-exceedance persistence (%) for significant wave height below 5.5 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| Jan | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Feb | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Mar | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Apr | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| May | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Jun | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 | 99.97 |
| Jul | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 | 99.88 |
| Aug | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| Sep | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Oct | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Nov | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Dec | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| annual | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

*Table 4.36 Annual and monthly non-exceedance persistence (%) for significant wave height below 6.0 m at P2.*

| Hs (m) | Duration (hours) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Jan** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Feb** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Mar** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Apr** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **May** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Jun** | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| **Jul** | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 | 99.96 |
| **Aug** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Sep** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Oct** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nov** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Dec** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **annual** | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

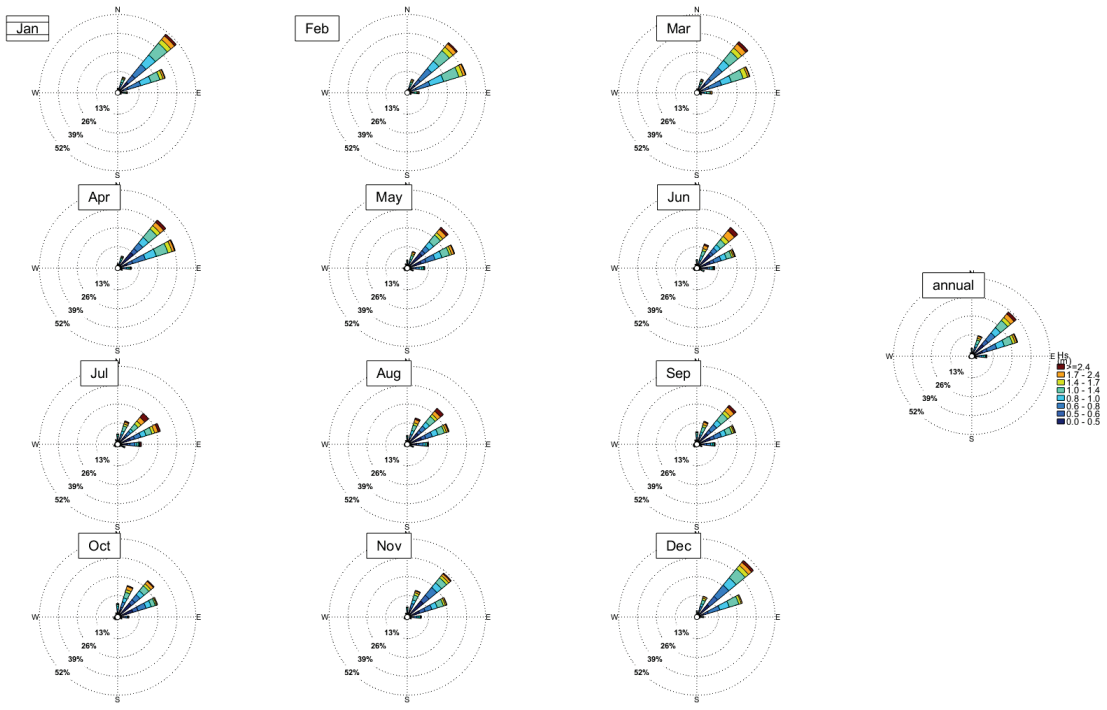


*Figure 4.2 Monthly and annual wave rose plot for the total significant wave height at P2. Sectors indicate the direction from which waves approach.*

# 5. Current climate

## 5.1. P1

A summary of the surface, mid-depth and near-bottom non-tidal current speed statistics at P1 are provided in Table 5.1, Table 5.2 and Table 5.3 respectively.

The annual joint probability distribution of the non-tidal surface, mid-depth and near-bottom current speed and direction is presented from Table 5.4 to Table 5.6.

The annual joint probability distribution of tidal depth-averaged current speed and direction is presented in Table 5.7, with the corresponding rose provided in Figure 5.1.

*Table 5.1 Annual and monthly surface non-tidal current speed statistics at P1.*

| Period (01 Jan 2000 – 31 Dec 2018) | Surface current speed statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface current speed (m/s) | | | | Exceedance percentile for surface current speed (m/s) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.00 | 0.50 | 0.13 | 0.07 | 0.01 | 0.03 | 0.04 | 0.12 | 0.19 | 0.23 | 0.27 | 0.32 | 0.36 | SE NW |
| **February** | 0.00 | 0.59 | 0.12 | 0.07 | 0.01 | 0.02 | 0.04 | 0.10 | 0.17 | 0.21 | 0.25 | 0.31 | 0.36 | SE NW |
| **March** | 0.00 | 0.52 | 0.10 | 0.07 | 0.01 | 0.02 | 0.03 | 0.09 | 0.15 | 0.20 | 0.24 | 0.30 | 0.33 | SE NW |
| **April** | 0.00 | 0.52 | 0.09 | 0.07 | 0.01 | 0.01 | 0.02 | 0.08 | 0.14 | 0.18 | 0.22 | 0.27 | 0.32 | SE S NW |
| **May** | 0.00 | 0.45 | 0.10 | 0.07 | 0.01 | 0.02 | 0.02 | 0.08 | 0.15 | 0.19 | 0.24 | 0.28 | 0.30 | SE S NW |
| **June** | 0.00 | 0.57 | 0.10 | 0.07 | 0.01 | 0.02 | 0.03 | 0.09 | 0.16 | 0.20 | 0.25 | 0.29 | 0.32 | SE S |
| **July** | 0.00 | 0.82 | 0.12 | 0.10 | 0.01 | 0.02 | 0.03 | 0.10 | 0.18 | 0.24 | 0.30 | 0.38 | 0.47 | SE S |
| **August** | 0.00 | 0.60 | 0.11 | 0.07 | 0.01 | 0.02 | 0.03 | 0.10 | 0.17 | 0.21 | 0.26 | 0.30 | 0.34 | SE S |
| **September** | 0.00 | 0.57 | 0.12 | 0.08 | 0.01 | 0.03 | 0.04 | 0.11 | 0.18 | 0.22 | 0.27 | 0.32 | 0.37 | SE |
| **October** | 0.00 | 0.49 | 0.13 | 0.07 | 0.01 | 0.03 | 0.04 | 0.12 | 0.18 | 0.23 | 0.26 | 0.31 | 0.35 | E SE |
| **November** | 0.00 | 0.51 | 0.13 | 0.07 | 0.01 | 0.03 | 0.04 | 0.12 | 0.18 | 0.23 | 0.27 | 0.32 | 0.35 | E SE |
| **December** | 0.00 | 0.57 | 0.13 | 0.08 | 0.01 | 0.03 | 0.05 | 0.12 | 0.19 | 0.23 | 0.27 | 0.33 | 0.36 | E SE |
| **Winter**(3) | 0.00 | 0.82 | 0.11 | 0.08 | 0.01 | 0.02 | 0.03 | 0.09 | 0.17 | 0.22 | 0.27 | 0.33 | 0.38 | SE S |
| **Spring** | 0.00 | 0.57 | 0.13 | 0.07 | 0.01 | 0.03 | 0.04 | 0.11 | 0.18 | 0.23 | 0.27 | 0.32 | 0.35 | E SE |
| **Summer**(2) | 0.00 | 0.59 | 0.13 | 0.08 | 0.01 | 0.03 | 0.04 | 0.12 | 0.18 | 0.22 | 0.27 | 0.32 | 0.36 | SE NW |
| **Autumn** | 0.00 | 0.52 | 0.10 | 0.07 | 0.01 | 0.02 | 0.02 | 0.08 | 0.15 | 0.19 | 0.23 | 0.28 | 0.32 | SE S NW |
| **All** | 0.00 | 0.82 | 0.12 | 0.08 | 0.01 | 0.02 | 0.03 | 0.10 | 0.17 | 0.22 | 0.26 | 0.31 | 0.35 | SE NW |

Notes: (1) All statistics derived from hindcast current data for the period 01 January 2000 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the currents is going to.

*Table 5.2 Annual and monthly mid-depth non-tidal current speed statistics at P1.*

| Period (01 Jan 2000 – 31 Dec 2018) | Mid-depth current speed statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mid-depth current speed (m/s) | | | | Exceedance percentile for mid-depth current speed (m/s) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.00 | 0.31 | 0.06 | 0.04 | 0.01 | 0.01 | 0.02 | 0.05 | 0.10 | 0.12 | 0.15 | 0.18 | 0.20 | N SE S NW |
| **February** | 0.00 | 0.37 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.05 | 0.09 | 0.12 | 0.14 | 0.18 | 0.20 | N SE S NW |
| **March** | 0.00 | 0.32 | 0.06 | 0.05 | 0.00 | 0.01 | 0.01 | 0.04 | 0.09 | 0.12 | 0.15 | 0.19 | 0.22 | N SE S NW |
| **April** | 0.00 | 0.30 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.11 | 0.13 | 0.17 | 0.19 | N SE S NW |
| **May** | 0.00 | 0.28 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.05 | 0.09 | 0.12 | 0.14 | 0.17 | 0.19 | SE S NW |
| **June** | 0.00 | 0.32 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.05 | 0.10 | 0.12 | 0.15 | 0.17 | 0.19 | SE S NW |
| **July** | 0.00 | 0.59 | 0.07 | 0.06 | 0.00 | 0.01 | 0.01 | 0.06 | 0.11 | 0.14 | 0.18 | 0.24 | 0.31 | SE S NW |
| **August** | 0.00 | 0.39 | 0.07 | 0.05 | 0.00 | 0.01 | 0.02 | 0.06 | 0.10 | 0.13 | 0.15 | 0.18 | 0.21 | SE S |
| **September** | 0.00 | 0.39 | 0.07 | 0.05 | 0.00 | 0.01 | 0.02 | 0.06 | 0.10 | 0.13 | 0.15 | 0.19 | 0.22 | SE S |
| **October** | 0.00 | 0.31 | 0.07 | 0.04 | 0.01 | 0.01 | 0.02 | 0.06 | 0.11 | 0.13 | 0.15 | 0.18 | 0.19 | SE S |
| **November** | 0.00 | 0.34 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 | 0.06 | 0.10 | 0.13 | 0.16 | 0.18 | 0.20 | SE S NW |
| **December** | 0.00 | 0.42 | 0.06 | 0.04 | 0.01 | 0.01 | 0.02 | 0.05 | 0.09 | 0.12 | 0.15 | 0.19 | 0.21 | N SE S NW |
| **Winter**(3) | 0.00 | 0.59 | 0.07 | 0.05 | 0.00 | 0.01 | 0.01 | 0.05 | 0.10 | 0.13 | 0.16 | 0.20 | 0.23 | SE S |
| **Spring** | 0.00 | 0.39 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 | 0.06 | 0.10 | 0.13 | 0.15 | 0.18 | 0.21 | SE S NW |
| **Summer**(2) | 0.00 | 0.42 | 0.06 | 0.04 | 0.00 | 0.01 | 0.02 | 0.05 | 0.09 | 0.12 | 0.15 | 0.18 | 0.21 | N SE S NW |
| **Autumn** | 0.00 | 0.32 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.09 | 0.12 | 0.14 | 0.17 | 0.20 | N SE S NW |
| **All** | 0.00 | 0.59 | 0.06 | 0.05 | 0.00 | 0.01 | 0.01 | 0.05 | 0.10 | 0.12 | 0.15 | 0.18 | 0.21 | SE S NW |

Notes: (1) All statistics derived from hindcast current data for the period 01 January 2000 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the currents is going to.

*Table 5.3 Annual and monthly near-bottom non-tidal current speed statistics at P1.*

| Period (01 Jan 2000 – 31 Dec 2018) | Near-bottom current speed statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Near-bottom current speed (m/s) | | | | Exceedance percentile for near-bottom current speed (m/s) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.00 | 0.27 | 0.04 | 0.03 | 0.00 | 0.01 | 0.01 | 0.04 | 0.06 | 0.09 | 0.10 | 0.14 | 0.16 | N S NW |
| **February** | 0.00 | 0.32 | 0.04 | 0.03 | 0.00 | 0.01 | 0.01 | 0.03 | 0.06 | 0.08 | 0.11 | 0.14 | 0.17 | N S |
| **March** | 0.00 | 0.27 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.07 | 0.10 | 0.12 | 0.15 | 0.17 | N SE S |
| **April** | 0.00 | 0.26 | 0.05 | 0.03 | 0.00 | 0.01 | 0.01 | 0.04 | 0.07 | 0.10 | 0.11 | 0.14 | 0.17 | N SE S |
| **May** | 0.00 | 0.25 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.05 | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | N SE S |
| **June** | 0.00 | 0.30 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.05 | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | N SE S |
| **July** | 0.00 | 0.51 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 | 0.05 | 0.10 | 0.13 | 0.16 | 0.21 | 0.26 | N SE S |
| **August** | 0.00 | 0.33 | 0.06 | 0.04 | 0.00 | 0.01 | 0.02 | 0.05 | 0.09 | 0.11 | 0.13 | 0.16 | 0.18 | SE S |
| **September** | 0.00 | 0.34 | 0.06 | 0.04 | 0.01 | 0.01 | 0.02 | 0.06 | 0.09 | 0.12 | 0.14 | 0.16 | 0.18 | SE S |
| **October** | 0.00 | 0.26 | 0.06 | 0.04 | 0.00 | 0.01 | 0.02 | 0.05 | 0.09 | 0.11 | 0.13 | 0.16 | 0.17 | S |
| **November** | 0.00 | 0.30 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.10 | 0.12 | 0.15 | 0.18 | N S |
| **December** | 0.00 | 0.36 | 0.04 | 0.03 | 0.00 | 0.01 | 0.01 | 0.04 | 0.06 | 0.08 | 0.10 | 0.13 | 0.17 | N S |
| **Winter**(3) | 0.00 | 0.51 | 0.06 | 0.04 | 0.00 | 0.01 | 0.02 | 0.05 | 0.09 | 0.12 | 0.14 | 0.17 | 0.20 | N SE S |
| **Spring** | 0.00 | 0.34 | 0.06 | 0.04 | 0.00 | 0.01 | 0.02 | 0.05 | 0.09 | 0.11 | 0.13 | 0.16 | 0.18 | S |
| **Summer**(2) | 0.00 | 0.36 | 0.04 | 0.03 | 0.00 | 0.01 | 0.01 | 0.04 | 0.06 | 0.08 | 0.10 | 0.14 | 0.17 | N S |
| **Autumn** | 0.00 | 0.27 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.10 | 0.12 | 0.15 | 0.17 | N SE S |
| **All** | 0.00 | 0.51 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.11 | 0.13 | 0.16 | 0.18 | N SE S |

Notes: (1) All statistics derived from hindcast current data for the period 01 January 2000 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the currents is going to.

*Table 5.4 Annual joint probability distribution (in %) of the surface non-tidal current speed and direction at P1.*

| Ures (m/s) | Direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| **>0<=0.05** | 2.61 | 2.02 | 2.48 | 3.80 | 2.79 | 1.60 | 1.58 | 2.77 | 19.65 | 100.00 |
| **>0.05<=0.1** | 3.02 | 2.52 | 4.07 | 7.21 | 3.73 | 2.08 | 2.47 | 4.15 | 29.25 | 80.41 |
| **>0.1<=0.15** | 1.98 | 1.52 | 3.21 | 7.22 | 2.97 | 1.74 | 2.06 | 3.15 | 23.85 | 51.17 |
| **>0.15<=0.2** | 0.97 | 0.48 | 1.46 | 5.44 | 2.05 | 0.59 | 1.05 | 2.30 | 14.34 | 27.25 |
| **>0.2<=0.25** | 0.34 | 0.07 | 0.45 | 3.35 | 1.19 | 0.13 | 0.30 | 1.39 | 7.22 | 12.94 |
| **>0.25<=0.3** | 0.12 | 0.01 | 0.10 | 1.59 | 0.55 | 0.01 | 0.09 | 0.72 | 3.19 | 5.71 |
| **>0.3<=0.35** | 0.03 | - | 0.02 | 0.68 | 0.25 | - | 0.02 | 0.45 | 1.45 | 2.52 |
| **>0.35<=0.4** | 0.01 | - | * | 0.20 | 0.08 | - | * | 0.27 | 0.56 | 1.06 |
| **>0.4<=0.45** | * | - | - | 0.07 | 0.03 | - | - | 0.16 | 0.26 | 0.51 |
| **>0.45<=0.5** | * | - | - | 0.02 | 0.01 | - | - | 0.08 | 0.11 | 0.24 |
| **>0.5<=0.55** | - | - | - | 0.01 | 0.01 | - | - | 0.05 | 0.07 | 0.13 |
| **>0.55<=0.6** | - | - | - | - | * | - | - | 0.02 | 0.02 | 0.06 |
| **>0.6<=0.65** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.04 |
| **>0.65<=0.7** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.02 |
| **>0.7<=0.75** | - | - | - | - | - | - | - | * | | 0.01 |
| **>0.75<=0.8** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.01 |
| **>0.8<=0.85** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.01 |
| **Total** | 9.08 | 6.62 | 11.79 | 29.59 | 13.66 | 6.15 | 7.57 | 15.55 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 5.5 Annual joint probability distribution (in %) of the mid-depth non-tidal current speed and direction at P1.*

| Ures (m/s) | Direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **337.5-22.5** | **22.5-67.5** | **67.5-112.5** | **112.5-157.5** | **157.5-202.5** | **202.5-247.5** | **247.5-292.5** | **292.5-337.5** | **Total** | **Exceed%** |
| **>0<=0.05** | 7.04 | 2.75 | 2.94 | 10.70 | 11.10 | 3.17 | 3.03 | 7.82 | 48.55 | 100.00 |
| **>0.05<=0.1** | 4.42 | 0.12 | 0.13 | 10.00 | 11.80 | 0.23 | 0.21 | 6.32 | 33.23 | 51.54 |
| **>0.1<=0.15** | 1.18 | * | - | 4.13 | 5.22 | 0.01 | 0.01 | 2.67 | 13.22 | 18.29 |
| **>0.15<=0.2** | 0.27 | - | - | 1.15 | 1.21 | * | - | 1.08 | 3.71 | 5.02 |
| **>0.2<=0.25** | 0.04 | - | - | 0.16 | 0.17 | - | - | 0.54 | 0.91 | 1.32 |
| **>0.25<=0.3** | 0.01 | - | - | 0.02 | 0.01 | - | - | 0.20 | 0.24 | 0.41 |
| **>0.3<=0.35** | * | - | - | * | * | - | - | 0.10 | 0.10 | 0.17 |
| **>0.35<=0.4** | - | - | - | - | - | - | - | 0.03 | 0.03 | 0.07 |
| **>0.4<=0.45** | - | - | - | - | - | - | - | 0.02 | 0.02 | 0.04 |
| **>0.45<=0.5** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.02 |
| **>0.5<=0.55** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.01 |
| **>0.55<=0.6** | - | - | - | - | - | - | - | * | | |
| **Total** | 12.96 | 2.87 | 3.07 | 26.16 | 29.51 | 3.41 | 3.25 | 18.80 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 5.6 Annual joint probability distribution (in %) of the near-bottom non-tidal current speed and direction at P1.*

| Ures (m/s) | Direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| >0<=0.05 | 9.31 | 4.13 | 3.55 | 10.71 | 14.38 | 3.79 | 2.87 | 6.71 | 55.45 | 100.00 |
| >0.05<=0.1 | 6.43 | 0.72 | 0.30 | 5.13 | 16.41 | 0.51 | 0.14 | 3.06 | 32.70 | 44.64 |
| >0.1<=0.15 | 2.06 | 0.06 | * | 0.81 | 5.50 | 0.04 | 0.01 | 0.97 | 9.45 | 11.88 |
| >0.15<=0.2 | 0.62 | * | - | 0.10 | 0.72 | - | * | 0.40 | 1.84 | 2.40 |
| >0.2<=0.25 | 0.16 | - | - | 0.01 | 0.03 | - | - | 0.17 | 0.37 | 0.57 |
| >0.25<=0.3 | 0.04 | - | - | - | * | - | - | 0.09 | 0.13 | 0.20 |
| >0.3<=0.35 | 0.01 | - | - | - | - | - | - | 0.03 | 0.04 | 0.07 |
| >0.35<=0.4 | 0.01 | - | - | - | - | - | - | 0.01 | 0.02 | 0.04 |
| >0.4<=0.45 | * | - | - | - | - | - | - | 0.01 | 0.01 | 0.02 |
| >0.45<=0.5 | - | - | - | - | - | - | - | * | | |
| >0.5<=0.55 | - | - | - | - | - | - | - | * | | |
| Total | 18.64 | 4.91 | 3.85 | 16.76 | 37.04 | 4.34 | 3.02 | 11.45 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 5.7 Annual joint probability distribution (in %) of the depth-averaged tidal current speed and direction at P1.*

| Ures (m/s) | Direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| 0-0.02 | 8.40 | 1.24 | 1.59 | 13.27 | 7.22 | 1.20 | 1.58 | 14.88 | 49.38 | 100.00 |
| 0.02-0.04 | 0.16 | - | - | 24.87 | 0.14 | - | - | 24.94 | 50.11 | 50.62 |
| 0.04-0.06 | - | - | - | 0.43 | - | - | - | 0.08 | 0.51 | 0.51 |
| Total | 8.56 | 1.24 | 1.59 | 38.57 | 7.36 | 1.20 | 1.58 | 39.90 | 100.00 | |

Notes: * represents less than 0.005%.

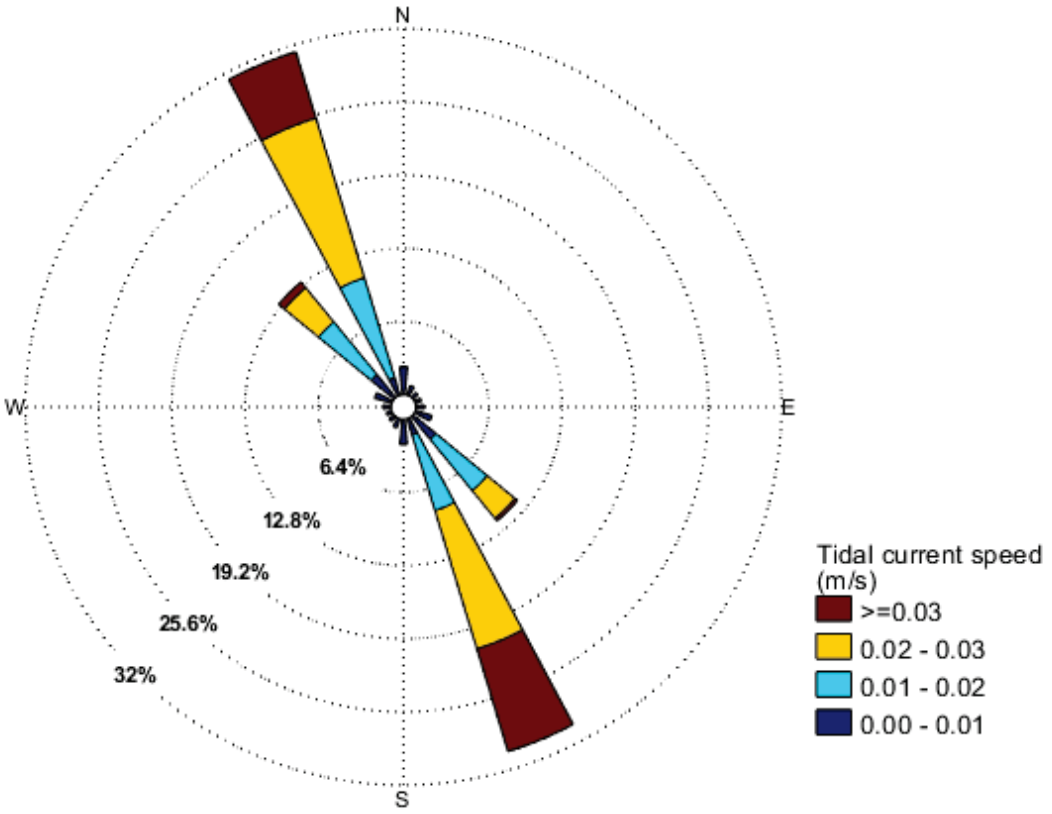


*Figure 5.1 Tidal current rose at P1. Sectors indicate the direction to which the current is flowing.*

## 5.2. P2

A summary of the surface, mid-depth and near-bottom non-tidal current speed statistics at P2 are provided in Table 5.8, Table 5.9 and Table 5.10 respectively.

The annual joint probability distribution of the non-tidal surface, mid-depth and near-bottom current speed and direction is presented from Table 5.11 to Table 5.13.

The annual joint probability distribution of tidal depth-averaged current speed and direction is presented in Table 5.14, with the corresponding rose provided in Figure 5.2.

*Table 5.8 Annual and monthly surface non-tidal current speed statistics at P2.*

| Period (01 Jan 2000 – 31 Dec 2018) | Surface current speed statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface current speed (m/s) | | | | Exceedance percentile for surface current speed (m/s) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.00 | 0.51 | 0.13 | 0.07 | 0.01 | 0.03 | 0.04 | 0.12 | 0.19 | 0.23 | 0.27 | 0.32 | 0.36 | SE NW |
| **February** | 0.00 | 0.53 | 0.12 | 0.07 | 0.01 | 0.02 | 0.03 | 0.11 | 0.17 | 0.21 | 0.26 | 0.32 | 0.36 | SE NW |
| **March** | 0.00 | 0.55 | 0.10 | 0.07 | 0.01 | 0.02 | 0.03 | 0.09 | 0.15 | 0.20 | 0.23 | 0.29 | 0.32 | SE NW |
| **April** | 0.00 | 0.50 | 0.09 | 0.07 | 0.01 | 0.01 | 0.02 | 0.08 | 0.14 | 0.18 | 0.22 | 0.27 | 0.30 | SE NW |
| **May** | 0.00 | 0.44 | 0.11 | 0.07 | 0.01 | 0.02 | 0.02 | 0.09 | 0.17 | 0.21 | 0.25 | 0.29 | 0.32 | SE |
| **June** | 0.00 | 0.57 | 0.11 | 0.08 | 0.01 | 0.02 | 0.03 | 0.10 | 0.17 | 0.22 | 0.26 | 0.30 | 0.34 | SE |
| **July** | 0.00 | 0.79 | 0.13 | 0.09 | 0.01 | 0.02 | 0.03 | 0.11 | 0.19 | 0.25 | 0.30 | 0.36 | 0.44 | SE |
| **August** | 0.00 | 0.58 | 0.12 | 0.08 | 0.01 | 0.02 | 0.03 | 0.11 | 0.18 | 0.23 | 0.26 | 0.30 | 0.33 | SE |
| **September** | 0.00 | 0.56 | 0.13 | 0.08 | 0.01 | 0.03 | 0.04 | 0.12 | 0.19 | 0.24 | 0.28 | 0.33 | 0.38 | E SE |
| **October** | 0.00 | 0.48 | 0.13 | 0.08 | 0.01 | 0.03 | 0.04 | 0.12 | 0.19 | 0.24 | 0.28 | 0.32 | 0.35 | E SE |
| **November** | 0.00 | 0.46 | 0.13 | 0.07 | 0.01 | 0.03 | 0.04 | 0.12 | 0.19 | 0.23 | 0.27 | 0.32 | 0.35 | E SE |
| **December** | 0.00 | 0.55 | 0.13 | 0.08 | 0.01 | 0.03 | 0.05 | 0.12 | 0.19 | 0.23 | 0.27 | 0.33 | 0.36 | E SE |
| **Winter**(3) | 0.00 | 0.79 | 0.12 | 0.08 | 0.01 | 0.02 | 0.03 | 0.11 | 0.18 | 0.23 | 0.27 | 0.33 | 0.36 | SE |
| **Spring** | 0.00 | 0.56 | 0.13 | 0.08 | 0.01 | 0.03 | 0.04 | 0.12 | 0.19 | 0.24 | 0.28 | 0.32 | 0.36 | E SE |
| **Summer**(2) | 0.00 | 0.55 | 0.13 | 0.07 | 0.01 | 0.03 | 0.04 | 0.12 | 0.18 | 0.23 | 0.27 | 0.32 | 0.36 | SE NW |
| **Autumn** | 0.00 | 0.55 | 0.10 | 0.07 | 0.01 | 0.02 | 0.02 | 0.09 | 0.15 | 0.20 | 0.24 | 0.28 | 0.32 | SE NW |
| **All** | 0.00 | 0.79 | 0.12 | 0.08 | 0.01 | 0.02 | 0.03 | 0.11 | 0.18 | 0.22 | 0.27 | 0.32 | 0.35 | SE NW |

Notes: (1) All statistics derived from hindcast current data for the period 01 January 2000 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the currents is going to.

*Table 5.9 Annual and monthly mid-depth non-tidal current speed statistics at P2.*

| Period (01 Jan 2000 – 31 Dec 2018) | Mid-depth current speed statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mid-depth current speed (m/s) | | | | Exceedance percentile for mid-depth current speed (m/s) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.00 | 0.29 | 0.06 | 0.04 | 0.01 | 0.01 | 0.02 | 0.05 | 0.09 | 0.12 | 0.14 | 0.18 | 0.20 | SE S NW |
| **February** | 0.00 | 0.33 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.05 | 0.09 | 0.12 | 0.15 | 0.18 | 0.21 | SE S NW |
| **March** | 0.00 | 0.35 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.11 | 0.14 | 0.18 | 0.21 | SE NW |
| **April** | 0.00 | 0.27 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.11 | 0.14 | 0.17 | 0.18 | SE NW |
| **May** | 0.00 | 0.27 | 0.06 | 0.05 | 0.00 | 0.01 | 0.01 | 0.05 | 0.10 | 0.14 | 0.16 | 0.19 | 0.20 | SE NW |
| **June** | 0.00 | 0.31 | 0.07 | 0.05 | 0.00 | 0.01 | 0.02 | 0.06 | 0.11 | 0.14 | 0.16 | 0.19 | 0.21 | SE NW |
| **July** | 0.00 | 0.53 | 0.08 | 0.06 | 0.00 | 0.01 | 0.02 | 0.07 | 0.12 | 0.16 | 0.19 | 0.23 | 0.28 | SE NW |
| **August** | 0.00 | 0.37 | 0.08 | 0.05 | 0.01 | 0.01 | 0.02 | 0.07 | 0.12 | 0.14 | 0.16 | 0.18 | 0.20 | SE |
| **September** | 0.00 | 0.36 | 0.07 | 0.05 | 0.00 | 0.01 | 0.02 | 0.06 | 0.12 | 0.14 | 0.17 | 0.20 | 0.23 | SE |
| **October** | 0.00 | 0.29 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 | 0.06 | 0.11 | 0.14 | 0.16 | 0.19 | 0.21 | SE S NW |
| **November** | 0.00 | 0.31 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 | 0.05 | 0.10 | 0.13 | 0.16 | 0.18 | 0.20 | SE S NW |
| **December** | 0.00 | 0.40 | 0.06 | 0.04 | 0.01 | 0.01 | 0.02 | 0.05 | 0.09 | 0.12 | 0.15 | 0.18 | 0.21 | SE S NW |
| **Winter**(3) | 0.00 | 0.53 | 0.08 | 0.05 | 0.00 | 0.01 | 0.02 | 0.07 | 0.12 | 0.14 | 0.17 | 0.20 | 0.23 | SE NW |
| **Spring** | 0.00 | 0.36 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 | 0.06 | 0.11 | 0.14 | 0.16 | 0.19 | 0.21 | SE S NW |
| **Summer**(2) | 0.00 | 0.40 | 0.06 | 0.04 | 0.00 | 0.01 | 0.02 | 0.05 | 0.09 | 0.12 | 0.15 | 0.18 | 0.20 | SE S NW |
| **Autumn** | 0.00 | 0.35 | 0.06 | 0.05 | 0.00 | 0.01 | 0.01 | 0.04 | 0.09 | 0.12 | 0.15 | 0.18 | 0.20 | SE NW |
| **All** | 0.00 | 0.53 | 0.07 | 0.05 | 0.00 | 0.01 | 0.02 | 0.05 | 0.10 | 0.13 | 0.16 | 0.19 | 0.21 | SE NW |

Notes: (1) All statistics derived from hindcast current data for the period 01 January 2000 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the currents is going to.

*Table 5.10 Annual and monthly near-bottom non-tidal current speed statistics at P2.*

| Period (01 Jan 2000 – 31 Dec 2018) | Near-bottom current speed statistics (1) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Near-bottom current speed (m/s) | | | | Exceedance percentile for near-bottom current speed (m/s) | | | | | | | | | Main (4) Direction(s) |
| | min | max | mean | std | p1 | p5 | p10 | p50 | p80 | p90 | p95 | p98 | p99 | |
| **January** | 0.00 | 0.26 | 0.05 | 0.03 | 0.00 | 0.01 | 0.01 | 0.04 | 0.07 | 0.09 | 0.11 | 0.14 | 0.17 | N SE S NW |
| **February** | 0.00 | 0.29 | 0.04 | 0.03 | 0.00 | 0.01 | 0.01 | 0.03 | 0.07 | 0.09 | 0.11 | 0.14 | 0.17 | N SE S NW |
| **March** | 0.00 | 0.26 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.10 | 0.12 | 0.15 | 0.17 | N SE S NW |
| **April** | 0.00 | 0.30 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.10 | 0.12 | 0.15 | 0.17 | N SE S |
| **May** | 0.00 | 0.24 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.05 | 0.10 | 0.13 | 0.15 | 0.17 | 0.19 | N SE S |
| **June** | 0.00 | 0.29 | 0.07 | 0.04 | 0.01 | 0.01 | 0.02 | 0.06 | 0.10 | 0.13 | 0.14 | 0.17 | 0.19 | SE S |
| **July** | 0.00 | 0.47 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 | 0.07 | 0.11 | 0.14 | 0.17 | 0.20 | 0.25 | SE S |
| **August** | 0.00 | 0.32 | 0.07 | 0.04 | 0.01 | 0.01 | 0.02 | 0.07 | 0.11 | 0.13 | 0.14 | 0.17 | 0.18 | SE S |
| **September** | 0.00 | 0.33 | 0.07 | 0.04 | 0.00 | 0.01 | 0.02 | 0.06 | 0.11 | 0.13 | 0.15 | 0.18 | 0.20 | SE S |
| **October** | 0.00 | 0.24 | 0.07 | 0.04 | 0.00 | 0.01 | 0.02 | 0.06 | 0.11 | 0.13 | 0.15 | 0.17 | 0.18 | SE S |
| **November** | 0.00 | 0.28 | 0.06 | 0.04 | 0.00 | 0.01 | 0.02 | 0.05 | 0.09 | 0.12 | 0.14 | 0.17 | 0.18 | SE S NW |
| **December** | 0.00 | 0.35 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.07 | 0.09 | 0.11 | 0.15 | 0.17 | N SE S NW |
| **Winter**(3) | 0.00 | 0.47 | 0.07 | 0.05 | 0.01 | 0.01 | 0.02 | 0.06 | 0.11 | 0.13 | 0.15 | 0.18 | 0.20 | SE S |
| **Spring** | 0.00 | 0.33 | 0.07 | 0.04 | 0.00 | 0.01 | 0.02 | 0.06 | 0.10 | 0.13 | 0.15 | 0.17 | 0.19 | SE S |
| **Summer**(2) | 0.00 | 0.35 | 0.05 | 0.03 | 0.00 | 0.01 | 0.01 | 0.04 | 0.07 | 0.09 | 0.11 | 0.14 | 0.17 | N SE S NW |
| **Autumn** | 0.00 | 0.30 | 0.05 | 0.04 | 0.00 | 0.01 | 0.01 | 0.04 | 0.08 | 0.11 | 0.13 | 0.16 | 0.18 | N SE S NW |
| **All** | 0.00 | 0.47 | 0.06 | 0.04 | 0.00 | 0.01 | 0.01 | 0.05 | 0.09 | 0.12 | 0.14 | 0.17 | 0.19 | SE S NW |

Notes: (1) All statistics derived from hindcast current data for the period 01 January 2000 to 31 December 2018.
(2) Summer: April to September.
(3) Winter: October to March.
(4) Main directions are those with greater than 15% occurrence and represent directions from which the currents is going to.

*Table 5.11 Annual joint probability distribution (in %) of the surface non-tidal current speed and direction at P2.*

| Ures (m/s) | Direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| **>0<=0.05** | 2.15 | 1.73 | 2.44 | 4.01 | 2.26 | 1.39 | 1.69 | 2.93 | 18.60 | 100.00 |
| **>0.05<=0.1** | 2.41 | 2.29 | 3.73 | 7.75 | 2.72 | 2.09 | 2.52 | 3.99 | 27.50 | 81.46 |
| **>0.1<=0.15** | 1.57 | 1.50 | 3.47 | 7.69 | 2.56 | 1.70 | 2.25 | 3.09 | 23.83 | 53.96 |
| **>0.15<=0.2** | 0.77 | 0.50 | 2.00 | 6.58 | 1.70 | 0.58 | 1.25 | 2.18 | 15.56 | 30.08 |
| **>0.2<=0.25** | 0.21 | 0.07 | 0.75 | 4.30 | 0.90 | 0.11 | 0.46 | 1.30 | 8.10 | 14.54 |
| **>0.25<=0.3** | 0.06 | * | 0.21 | 2.21 | 0.42 | 0.02 | 0.15 | 0.69 | 3.76 | 6.44 |
| **>0.3<=0.35** | 0.01 | * | 0.04 | 1.00 | 0.12 | - | 0.03 | 0.42 | 1.62 | 2.66 |
| **>0.35<=0.4** | * | - | 0.01 | 0.31 | 0.05 | - | 0.01 | 0.23 | 0.61 | 1.04 |
| **>0.4<=0.45** | * | - | * | 0.09 | 0.01 | - | * | 0.13 | 0.23 | 0.43 |
| **>0.45<=0.5** | - | - | - | 0.03 | * | - | - | 0.06 | 0.09 | 0.19 |
| **>0.5<=0.55** | - | - | - | 0.01 | * | - | - | 0.03 | 0.04 | 0.09 |
| **>0.55<=0.6** | - | - | - | * | - | - | - | 0.02 | 0.02 | 0.05 |
| **>0.6<=0.65** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.03 |
| **>0.65<=0.7** | - | - | - | - | - | - | - | * | | 0.01 |
| **>0.7<=0.75** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.01 |
| **>0.75<=0.8** | - | - | - | - | - | - | - | * | | |
| **Total** | 7.18 | 6.09 | 12.65 | 33.98 | 10.74 | 5.89 | 8.36 | 15.09 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 5.12 Annual joint probability distribution (in %) of the mid-depth non-tidal current speed and direction at P2.*

| Ures (m/s) | Direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **337.5-22.5** | **22.5-67.5** | **67.5-112.5** | **112.5-157.5** | **157.5-202.5** | **202.5-247.5** | **247.5-292.5** | **292.5-337.5** | **Total** | **Exceed%** |
| **>0<=0.05** | 5.38 | 2.40 | 3.19 | 12.90 | 7.79 | 2.64 | 3.29 | 8.81 | 46.40 | 100.00 |
| **>0.05<=0.1** | 2.23 | 0.08 | 0.25 | 17.11 | 4.22 | 0.17 | 0.35 | 7.81 | 32.22 | 53.68 |
| **>0.1<=0.15** | 0.31 | * | * | 10.60 | 1.05 | * | * | 3.09 | 15.05 | 21.42 |
| **>0.15<=0.2** | 0.03 | - | - | 3.53 | 0.18 | - | - | 1.19 | 4.93 | 6.33 |
| **>0.2<=0.25** | - | - | - | 0.61 | 0.02 | - | - | 0.43 | 1.06 | 1.41 |
| **>0.25<=0.3** | - | - | - | 0.07 | - | - | - | 0.16 | 0.23 | 0.34 |
| **>0.3<=0.35** | - | - | - | 0.01 | - | - | - | 0.05 | 0.06 | 0.11 |
| **>0.35<=0.4** | - | - | - | * | - | - | - | 0.03 | 0.03 | 0.05 |
| **>0.4<=0.45** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.02 |
| **>0.45<=0.5** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.01 |
| **>0.5<=0.55** | - | - | - | - | - | - | - | * | | |
| **Total** | 7.95 | 2.48 | 3.44 | 44.83 | 13.26 | 2.81 | 3.64 | 21.59 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 5.13 Annual joint probability distribution (in %) of the near-bottom non-tidal current speed and direction at P2.*

| Ures (m/s) | Direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| **>0<=0.05** | 7.51 | 3.53 | 4.12 | 12.81 | 9.15 | 3.13 | 3.07 | 7.77 | 51.09 | 100.00 |
| **>0.05<=0.1** | 4.79 | 0.54 | 0.54 | 13.03 | 8.06 | 0.41 | 0.25 | 4.80 | 32.42 | 49.02 |
| **>0.1<=0.15** | 1.54 | 0.03 | 0.01 | 4.85 | 4.74 | 0.04 | 0.01 | 1.62 | 12.84 | 16.54 |
| **>0.15<=0.2** | 0.35 | * | - | 0.88 | 1.20 | - | - | 0.62 | 3.05 | 3.66 |
| **>0.2<=0.25** | 0.07 | - | - | 0.08 | 0.10 | - | - | 0.23 | 0.48 | 0.62 |
| **>0.25<=0.3** | 0.01 | - | - | 0.01 | * | - | - | 0.06 | 0.08 | 0.14 |
| **>0.3<=0.35** | * | - | - | - | - | - | - | 0.03 | 0.03 | 0.06 |
| **>0.35<=0.4** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.02 |
| **>0.4<=0.45** | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.01 |
| **>0.45<=0.5** | - | - | - | - | - | - | - | * | | |
| **Total** | 14.27 | 4.10 | 4.67 | 31.66 | 23.25 | 3.58 | 3.33 | 15.15 | 100.00 | |

Notes: * represents less than 0.005%.

*Table 5.14 Annual joint probability distribution (in %) of the depth-averaged tidal current speed and direction at P2.*

| Utide (m/s) | Direction (degT) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 337.5-22.5 | 22.5-67.5 | 67.5-112.5 | 112.5-157.5 | 157.5-202.5 | 202.5-247.5 | 247.5-292.5 | 292.5-337.5 | Total | Exceed% |
| **0-0.02** | 6.16 | 0.95 | 1.24 | 7.29 | 5.58 | 0.94 | 1.25 | 7.62 | 31.03 | 100.00 |
| **0.02-0.04** | 0.76 | - | - | 20.12 | 0.63 | - | - | 24.32 | 45.83 | 68.96 |
| **0.04-0.06** | - | - | - | 12.70 | - | - | - | 10.27 | 22.97 | 23.13 |
| **0.06-0.08** | - | - | - | 0.16 | - | - | - | - | 0.16 | 0.16 |
| **Total** | 6.92 | 0.95 | 1.24 | 40.27 | 6.21 | 0.94 | 1.25 | 42.21 | 100.00 | |

Notes: * represents less than 0.005%.

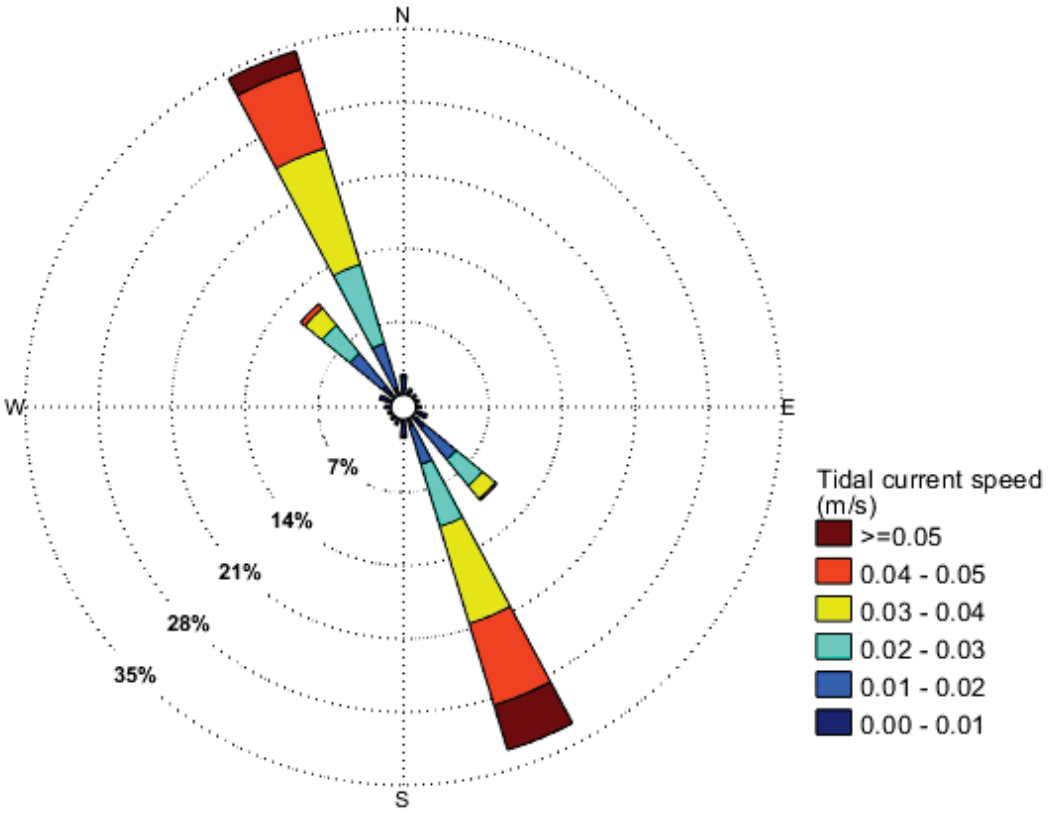


*Figure 5.2 Tidal current rose at P2. Sectors indicate the direction to which the current is flowing.*

# 6. Workability statistics

Annual and monthly workability statistics for the operational area are presented in Table 6.1 to Table 6.4 to as persistence probabilities for the following co-temporal criteria:

- Hs swell < 1.5 m and Wind speed < 25 knots (from NW to SE, clockwise) or Wind speed < 40 knots (from SE to NW, clockwise).
- Hs swell < 2.5 m and Wind speed < 25 knots (from NW to SE, clockwise) or Wind speed < 40 knots (from SE to NW, clockwise).

An example interpretation is as follows. Based on the limiting criteria indicated above, the month of February has the highest workability (Table 6.1); for durations of at least 12 consecutive hours the average workability is 97.91%.

*Table 6.1 Annual and monthly workability probabilities (% of workable time) for marine operations at P1 for several durations. Workability is based on Hs swell < 1.5 m and Wspd < 25 knots (from NW to SE, clockwise) or Wspd < 40 knots (from SE to NW, clockwise).*

| % | Duration (hours) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **> 6** | **> 12** | **> 18** | **> 24** | **> 30** | **> 36** | **> 42** | **> 48** | **> 54** | **> 60** | **> 66** | **> 72** |
| **Jan** | 97.17 | 97.02 | 96.91 | 96.76 | 96.76 | 96.64 | 96.64 | 96.48 | 96.30 | 95.88 | 95.40 | 95.40 |
| **Feb** | 98.07 | 97.91 | 97.84 | 97.58 | 97.46 | 97.18 | 97.01 | 96.46 | 96.03 | 95.79 | 95.79 | 95.79 |
| **Mar** | 97.48 | 97.39 | 97.27 | 97.11 | 97.01 | 96.50 | 96.36 | 96.20 | 96.02 | 95.81 | 95.11 | 95.11 |
| **Apr** | 97.45 | 97.13 | 97.07 | 96.99 | 96.89 | 96.76 | 96.62 | 96.29 | 96.08 | 95.86 | 94.91 | 94.91 |
| **May** | 97.50 | 97.25 | 97.18 | 96.68 | 96.48 | 96.36 | 96.22 | 96.06 | 95.66 | 95.66 | 95.44 | 95.44 |
| **Jun** | 95.93 | 95.39 | 95.26 | 95.01 | 94.90 | 94.63 | 94.18 | 93.47 | 93.08 | 92.19 | 91.95 | 91.95 |
| **Jul** | 95.09 | 94.88 | 94.52 | 94.18 | 94.07 | 93.16 | 92.84 | 91.63 | 91.23 | 90.35 | 90.10 | 88.51 |
| **Aug** | 97.17 | 96.95 | 96.82 | 96.59 | 96.07 | 95.81 | 95.38 | 94.86 | 94.67 | 94.46 | 93.99 | 92.95 |
| **Sep** | 97.98 | 97.81 | 97.48 | 97.17 | 96.73 | 96.33 | 96.04 | 95.36 | 94.77 | 93.22 | 92.26 | 91.74 |
| **Oct** | 98.91 | 98.73 | 98.37 | 98.29 | 97.98 | 97.85 | 97.55 | 96.88 | 96.51 | 96.10 | 95.15 | 94.64 |
| **Nov** | 98.95 | 98.88 | 98.69 | 98.19 | 97.66 | 97.66 | 97.23 | 97.23 | 97.23 | 97.23 | 96.26 | 95.99 |
| **Dec** | 98.42 | 98.30 | 97.99 | 97.76 | 97.76 | 97.63 | 97.48 | 97.48 | 97.10 | 96.90 | 96.90 | 96.65 |
| **Annual** | 97.53 | 97.36 | 97.26 | 97.08 | 97.01 | 96.95 | 96.79 | 96.59 | 96.41 | 96.16 | 96.00 | 95.78 |

*Table 6.2 Annual and monthly workability probabilities (% of workable time) for marine operations at P2 for several durations. Workability is based on Hs swell < 1.5 m and Wspd < 25 knots (from NW to SE, clockwise) or Wspd < 40 knots (from SE to NW, clockwise).*

| % | Duration (hours) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **> 6** | **> 12** | **> 18** | **> 24** | **> 30** | **> 36** | **> 42** | **> 48** | **> 54** | **> 60** | **> 66** | **> 72** |
| **Jan** | 97.01 | 96.73 | 96.51 | 96.51 | 96.51 | 96.38 | 96.38 | 96.38 | 96.38 | 96.18 | 95.70 | 95.44 |
| **Feb** | 97.95 | 97.80 | 97.60 | 97.52 | 97.52 | 97.12 | 96.95 | 96.76 | 96.56 | 96.10 | 96.10 | 96.10 |
| **Mar** | 97.25 | 97.14 | 97.03 | 96.87 | 96.87 | 96.25 | 95.80 | 95.80 | 95.62 | 95.20 | 94.73 | 94.22 |
| **Apr** | 97.14 | 96.75 | 96.75 | 96.67 | 96.46 | 96.21 | 96.21 | 95.86 | 95.28 | 95.06 | 94.83 | 94.83 |
| **May** | 97.42 | 97.25 | 97.25 | 96.79 | 96.39 | 96.26 | 96.11 | 95.95 | 95.57 | 95.57 | 95.10 | 95.10 |
| **Jun** | 95.38 | 95.10 | 94.93 | 94.53 | 94.42 | 94.16 | 93.69 | 92.99 | 92.20 | 91.75 | 91.51 | 91.51 |
| **Jul** | 95.00 | 94.78 | 94.50 | 94.16 | 93.83 | 93.05 | 92.59 | 92.42 | 91.65 | 90.57 | 90.07 | 89.01 |
| **Aug** | 97.07 | 96.97 | 96.91 | 96.60 | 96.19 | 96.07 | 95.36 | 94.83 | 94.64 | 94.64 | 93.94 | 92.93 |
| **Sep** | 97.67 | 97.54 | 97.22 | 96.97 | 96.76 | 96.64 | 96.33 | 95.65 | 95.25 | 94.59 | 93.63 | 93.12 |
| **Oct** | 98.61 | 98.37 | 98.00 | 97.85 | 97.54 | 97.41 | 97.12 | 96.61 | 96.22 | 96.22 | 95.28 | 94.52 |
| **Nov** | 99.06 | 99.00 | 98.87 | 98.45 | 98.04 | 97.92 | 97.46 | 97.46 | 97.46 | 97.23 | 96.51 | 96.51 |
| **Dec** | 98.25 | 98.01 | 97.75 | 97.60 | 97.49 | 97.49 | 97.49 | 97.32 | 96.75 | 96.75 | 96.53 | 96.53 |
| **Annual** | 97.34 | 97.18 | 97.09 | 96.94 | 96.85 | 96.78 | 96.62 | 96.53 | 96.29 | 96.17 | 96.03 | 95.85 |

*Table 6.3 Annual and monthly workability probabilities (% of workable time) for marine operations at P1 for several durations. Workability is based on Hs swell < 2.5 m and Wspd < 25 knots (from NW to SE, clockwise) or Wspd < 40 knots (from SE to NW, clockwise).*

| % | Duration (hours) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **> 6** | **> 12** | **> 18** | **> 24** | **> 30** | **> 36** | **> 42** | **> 48** | **> 54** | **> 60** | **> 66** | **> 72** |
| **Jan** | 99.72 | 99.64 | 99.48 | 99.48 | 99.48 | 99.48 | 99.48 | 99.32 | 99.14 | 98.92 | 98.68 | 98.43 |
| **Feb** | 99.79 | 99.54 | 99.47 | 99.19 | 99.09 | 98.66 | 98.66 | 98.47 | 98.04 | 98.04 | 98.04 | 97.76 |
| **Mar** | 99.53 | 99.46 | 99.34 | 99.25 | 99.05 | 98.67 | 98.67 | 98.51 | 98.13 | 97.92 | 97.92 | 97.92 |
| **Apr** | 99.68 | 99.20 | 99.14 | 99.14 | 99.04 | 98.92 | 98.78 | 98.44 | 98.24 | 98.02 | 97.79 | 97.79 |
| **May** | 99.73 | 99.54 | 99.48 | 99.15 | 99.05 | 98.93 | 98.63 | 98.31 | 97.72 | 97.72 | 97.72 | 97.72 |
| **Jun** | 99.50 | 99.15 | 99.09 | 99.00 | 98.89 | 98.48 | 97.87 | 96.98 | 96.59 | 96.14 | 95.90 | 95.64 |
| **Jul** | 99.15 | 98.88 | 98.53 | 98.19 | 98.08 | 97.55 | 97.39 | 96.71 | 96.51 | 95.85 | 95.12 | 93.52 |
| **Aug** | 99.33 | 99.05 | 98.92 | 98.77 | 98.46 | 98.08 | 97.65 | 97.30 | 96.92 | 96.71 | 96.23 | 95.20 |
| **Sep** | 99.66 | 99.48 | 99.15 | 98.83 | 98.49 | 98.09 | 97.80 | 97.29 | 96.69 | 95.59 | 94.63 | 93.84 |
| **Oct** | 99.88 | 99.77 | 99.35 | 99.27 | 99.07 | 98.82 | 98.53 | 97.86 | 97.67 | 97.67 | 96.50 | 95.99 |
| **Nov** | 99.82 | 99.75 | 99.62 | 99.30 | 98.98 | 98.98 | 98.25 | 98.25 | 98.25 | 98.25 | 97.77 | 97.50 |
| **Dec** | 99.77 | 99.69 | 99.33 | 99.01 | 98.90 | 98.90 | 98.75 | 98.75 | 98.37 | 98.17 | 98.17 | 98.17 |
| **Annual** | 99.65 | 99.48 | 99.37 | 99.26 | 99.20 | 99.13 | 98.95 | 98.83 | 98.65 | 98.59 | 98.40 | 98.18 |

*Table 6.4 Annual and monthly workability probabilities (% of workable time) for marine operations at P2 for several durations. Workability is based on Hs swell < 2.5 m and Wspd < 25 knots (from NW to SE, clockwise) or Wspd < 40 knots (from SE to NW, clockwise).*

| % | Duration (hours) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **> 6** | **> 12** | **> 18** | **> 24** | **> 30** | **> 36** | **> 42** | **> 48** | **> 54** | **> 60** | **> 66** | **> 72** |
| **Jan** | 99.77 | 99.66 | 99.55 | 99.55 | 99.55 | 99.55 | 99.55 | 99.55 | 99.55 | 99.33 | 99.10 | 98.85 |
| **Feb** | 99.80 | 99.60 | 99.48 | 99.21 | 99.21 | 99.07 | 99.07 | 98.88 | 98.68 | 98.45 | 98.45 | 98.45 |
| **Mar** | 99.59 | 99.46 | 99.34 | 99.26 | 99.26 | 99.01 | 98.72 | 98.55 | 98.37 | 98.17 | 98.17 | 97.92 |
| **Apr** | 99.58 | 99.20 | 99.08 | 99.00 | 98.90 | 98.90 | 98.90 | 98.56 | 98.56 | 98.34 | 98.34 | 98.34 |
| **May** | 99.74 | 99.55 | 99.55 | 99.23 | 99.12 | 99.01 | 98.70 | 98.38 | 98.00 | 98.00 | 98.00 | 98.00 |
| **Jun** | 99.36 | 99.17 | 99.06 | 98.97 | 98.87 | 98.59 | 97.98 | 97.09 | 96.71 | 96.04 | 95.80 | 95.27 |
| **Jul** | 99.09 | 98.76 | 98.48 | 98.14 | 97.92 | 97.38 | 97.23 | 97.06 | 96.28 | 95.63 | 95.14 | 93.81 |
| **Aug** | 99.43 | 99.25 | 99.07 | 98.91 | 98.71 | 98.33 | 97.76 | 97.41 | 97.03 | 97.03 | 96.55 | 95.53 |
| **Sep** | 99.65 | 99.47 | 99.28 | 99.03 | 98.92 | 98.66 | 98.36 | 97.84 | 97.45 | 97.01 | 96.29 | 95.50 |
| **Oct** | 99.95 | 99.81 | 99.43 | 99.12 | 98.91 | 98.66 | 98.52 | 98.02 | 98.02 | 98.02 | 97.09 | 96.33 |
| **Nov** | 99.89 | 99.82 | 99.77 | 99.43 | 99.22 | 99.22 | 98.63 | 98.63 | 98.63 | 98.63 | 97.92 | 97.92 |
| **Dec** | 99.81 | 99.59 | 99.33 | 99.10 | 98.90 | 98.90 | 98.90 | 98.73 | 98.16 | 98.16 | 98.16 | 98.16 |
| **Annual** | 99.66 | 99.50 | 99.42 | 99.29 | 99.26 | 99.19 | 99.06 | 98.96 | 98.85 | 98.81 | 98.69 | 98.52 |

# 7. Extreme metocean statistics

Note an arbitrary minimum number of 10 storm peaks has been was chosen for reliable distribution fitting. This results in specific directional return period values being omitted (see Section 9.3).

## 7.1. P1

The directional return period values for wind, wave and current extremes are given in Table 7.1 to Table 7.9 for 1, 10, 50 and 100-year return periods.

Contour plot of omni-directional bi-variate return period values for significant wave height and peak wave period are presented in Figure 7.1.

*Table 7.1 Annual independent omni-directional extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 18.31 | 22.13 | 24.69 | 25.78 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 19.74 | 23.95 | 26.79 | 27.98 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 21.57 | 26.29 | 29.47 | 30.82 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 23.95 | 29.34 | 32.97 | 34.51 |
| Significant wave height | $H_s$ | $m$ | 4.46 | 5.67 | 6.29 | 6.52 |
| Peak wave period | $T_p$ | $s$ | 9.61 | 10.73 | 11.25 | 11.43 |
| Maximum individual wave height | $H_{max}$ | $m$ | 8.57 | 10.59 | 11.54 | 11.91 |
| Maximum individual wave crest | $C_{max}$ | $m$ | 5.53 | 6.78 | 7.38 | 7.59 |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.51 | 0.67 | 0.78 | 0.82 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.30 | 0.41 | 0.48 | 0.51 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.26 | 0.36 | 0.43 | 0.46 |

*Table 7.2 Annual independent North extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 14.03 | 16.99 | 19.01 | 19.87 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 15.03 | 18.28 | 20.51 | 21.46 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 16.31 | 19.93 | 22.43 | 23.50 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 17.97 | 22.09 | 24.93 | 26.15 |
| Significant wave height | $H_s$ | $m$ | 2.41 | 3.10 | 3.43 | 3.54 |
| Peak wave period | $T_p$ | $s$ | 6.80 | 7.44 | 7.70 | 7.79 |
| Maximum individual wave height | $H_{max}$ | $m$ | 4.67 | 5.88 | 6.50 | 6.71 |
| Maximum individual wave crest | $C_{max}$ | $m$ | 2.96 | 3.75 | 4.14 | 4.29 |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.24 | 0.34 | 0.41 | 0.44 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.14 | 0.19 | 0.23 | 0.24 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.21 | 0.33 | 0.43 | 0.47 |

*Table 7.3 Annual independent North-East extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 14.28 | 17.96 | 20.42 | 21.46 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 15.30 | 19.36 | 22.07 | 23.22 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 16.60 | 21.15 | 24.19 | 25.49 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 18.30 | 23.48 | 26.96 | 28.43 |
| Significant wave height | $H_s$ | $m$ | 4.34 | 5.44 | 5.91 | 6.06 |
| Peak wave period | $T_p$ | $s$ | 9.70 | 10.72 | 11.11 | 11.24 |
| Maximum individual wave height | $H_{max}$ | $m$ | 8.34 | 10.30 | 11.23 | 11.57 |
| Maximum individual wave crest | $C_{max}$ | $m$ | 5.33 | 6.58 | 7.17 | 7.38 |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.17 | 0.21 | 0.25 | 0.27 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | - | - | - | - |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.08 | 0.13 | 0.18 | 0.20 |

*Table 7.4 Annual independent East extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 14.72 | 19.33 | 22.51 | 23.88 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 15.78 | 20.87 | 24.40 | 25.91 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 17.15 | 22.86 | 26.82 | 28.53 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 18.92 | 25.44 | 29.98 | 31.93 |
| Significant wave height | $H_s$ | $m$ | 2.99 | 4.66 | 5.75 | 6.20 |
| Peak wave period | $T_p$ | $s$ | 16.71 | 19.21 | 20.27 | 20.63 |
| Maximum individual wave height | $H_{max}$ | $m$ | 6.13 | 8.98 | 10.52 | 11.02 |
| Maximum individual wave crest | $C_{max}$ | $m$ | 3.91 | 5.75 | 6.75 | 7.06 |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.20 | 0.29 | 0.36 | 0.40 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | - | - | - | - |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | - | - | - | - |

*Table 7.5 Annual independent South-East extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 14.05 | 18.54 | 21.63 | 22.95 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 15.04 | 20.01 | 23.43 | 24.89 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 16.32 | 21.89 | 25.74 | 27.39 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 17.99 | 24.35 | 28.76 | 30.65 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.40 | 0.50 | 0.56 | 0.59 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.22 | 0.29 | 0.34 | 0.36 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.14 | 0.19 | 0.23 | 0.24 |

*Table 7.6 Annual independent South extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 10.57 | 14.03 | 16.25 | 17.19 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 11.25 | 15.01 | 17.45 | 18.47 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 12.12 | 16.29 | 18.98 | 20.11 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 13.25 | 17.94 | 20.98 | 22.26 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.31 | 0.38 | 0.42 | 0.44 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.20 | 0.27 | 0.31 | 0.33 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.19 | 0.23 | 0.26 | 0.28 |

*Table 7.7 Annual independent South-West extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 12.86 | 16.39 | 18.90 | 19.99 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 13.74 | 17.60 | 20.34 | 21.54 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 14.87 | 19.15 | 22.20 | 23.52 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 16.35 | 21.17 | 24.61 | 26.11 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.18 | 0.23 | 0.29 | 0.31 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | - | - | - | - |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | - | - | - | - |

*Table 7.8 Annual independent West extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 13.10 | 15.84 | 17.66 | 18.43 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 14.00 | 17.00 | 18.99 | 19.83 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 15.16 | 18.49 | 20.71 | 21.64 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 16.67 | 20.44 | 22.94 | 24.00 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.21 | 0.31 | 0.41 | 0.46 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | - | - | - | - |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | - | - | - | - |

*Table 7.9 Annual independent North-West extreme criteria for wind, wave and current at P1.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 11.58 | 14.91 | 17.16 | 18.12 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 12.35 | 15.98 | 18.45 | 19.49 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 13.33 | 17.36 | 20.09 | 21.25 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 14.61 | 19.15 | 22.23 | 23.55 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.47 | 0.71 | 0.87 | 0.95 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.30 | 0.48 | 0.60 | 0.66 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.23 | 0.43 | 0.57 | 0.63 |

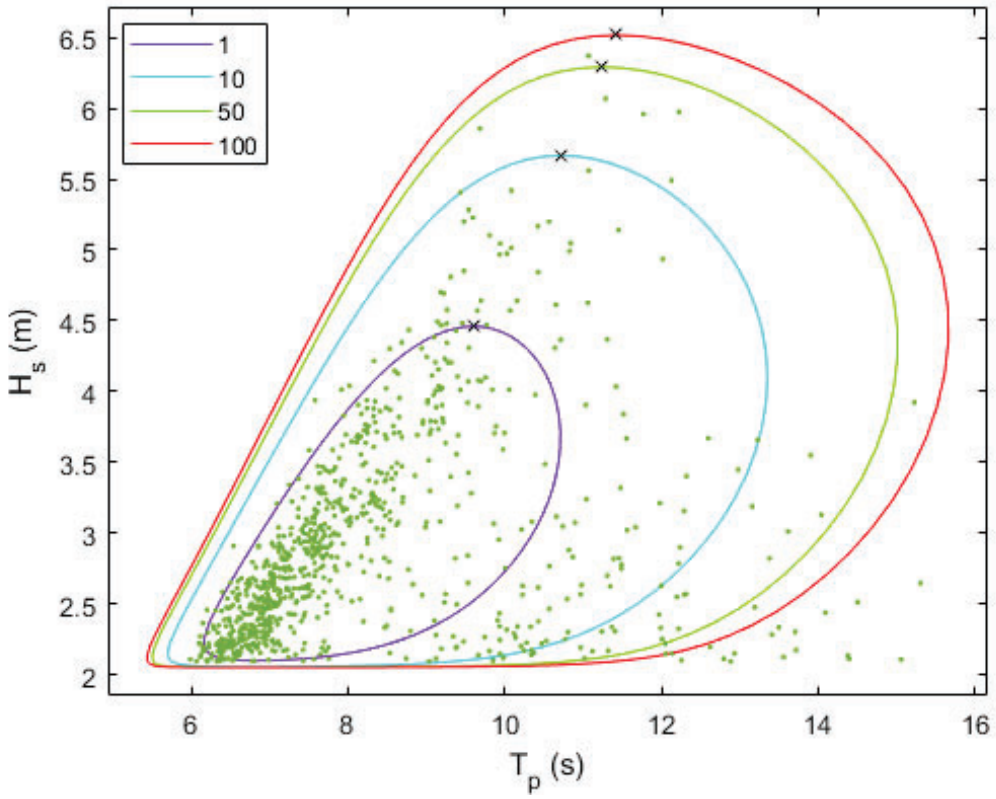


*Figure 7.1 Contour plot of omni-directional bi-variate (Hs-Tp) return period values for 1, 10, 50 and 100-year ARIs. The dark crosses correspond to the estimated deterministic Hs and associated Tp return period values for each ARI indicated in the legend at P1.*

## 7.2. P2

The directional return period values for wind, wave and current extremes are given in Table 7.10 to Table 7.18 for 1, 10, 50 and 100-year return periods.

Contour plot of omni-directional bi-variate return period values for significant wave height and peak wave period are presented in Figure 7.2.

*Table 7.10 Annual independent omni-directional extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 17.89 | 21.51 | 23.93 | 24.95 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 19.27 | 23.26 | 25.93 | 27.06 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 21.04 | 25.51 | 28.50 | 29.77 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 23.35 | 28.44 | 31.85 | 33.29 |
| Significant wave height | $H_s$ | $m$ | 4.51 | 5.74 | 6.39 | 6.62 |
| Peak wave period | $T_p$ | $s$ | 9.72 | 10.91 | 11.48 | 11.67 |
| Maximum individual wave height | $H_{max}$ | $m$ | 8.64 | 10.66 | 11.61 | 11.96 |
| Maximum individual wave crest | $C_{max}$ | $m$ | 5.59 | 6.83 | 7.42 | 7.63 |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.49 | 0.63 | 0.72 | 0.76 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.30 | 0.39 | 0.46 | 0.48 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.27 | 0.36 | 0.42 | 0.45 |

*Table 7.11 Annual independent North extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 13.87 | 16.85 | 18.87 | 19.73 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 14.84 | 18.12 | 20.35 | 21.29 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 16.10 | 19.76 | 22.25 | 23.31 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 17.74 | 21.89 | 24.72 | 25.93 |
| Significant wave height | $H_s$ | $m$ | 2.54 | 3.42 | 3.90 | 4.08 |
| Peak wave period | $T_p$ | $s$ | 6.95 | 7.79 | 8.18 | 8.32 |
| Maximum individual wave height | $H_{max}$ | $m$ | 4.89 | 6.41 | 7.21 | 7.47 |
| Maximum individual wave crest | $C_{max}$ | $m$ | 3.12 | 4.08 | 4.62 | 4.79 |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.21 | 0.33 | 0.41 | 0.45 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.10 | 0.14 | 0.18 | 0.20 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.17 | 0.25 | 0.31 | 0.33 |

*Table 7.12 Annual independent North-East extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 13.89 | 17.47 | 19.83 | 20.82 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 14.87 | 18.81 | 21.42 | 22.52 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 16.13 | 20.54 | 23.46 | 24.69 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 17.77 | 22.79 | 26.11 | 27.52 |
| Significant wave height | $H_s$ | $m$ | 4.42 | 5.55 | 6.04 | 6.20 |
| Peak wave period | $T_p$ | $s$ | 9.75 | 10.65 | 11.00 | 11.11 |
| Maximum individual wave height | $H_{max}$ | $m$ | 8.48 | 10.50 | 11.43 | 11.77 |
| Maximum individual wave crest | $C_{max}$ | $m$ | 5.38 | 6.66 | 7.24 | 7.45 |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.17 | 0.20 | 0.24 | 0.26 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | - | - | - | - |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | - | - | - | - |

*Table 7.13 Annual independent East extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 14.39 | 18.98 | 22.09 | 23.42 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 15.42 | 20.48 | 23.93 | 25.40 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 16.74 | 22.42 | 26.29 | 27.94 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 18.46 | 24.93 | 29.36 | 31.25 |
| Significant wave height | $H_s$ | $m$ | 2.85 | 4.45 | 5.47 | 5.90 |
| Peak wave period | $T_p$ | $s$ | 16.96 | 19.22 | 20.14 | 20.45 |
| Maximum individual wave height | $H_{max}$ | $m$ | 5.75 | 8.48 | 10.16 | 10.71 |
| Maximum individual wave crest | $C_{max}$ | $m$ | 3.67 | 5.46 | 6.50 | 6.84 |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.23 | 0.30 | 0.37 | 0.40 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | - | - | - | - |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | - | - | - | - |

*Table 7.14 Annual independent South-East extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 13.56 | 18.02 | 21.05 | 22.35 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 14.51 | 19.43 | 22.78 | 24.22 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 15.72 | 21.24 | 25.01 | 26.62 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 17.31 | 23.59 | 27.91 | 29.75 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.41 | 0.51 | 0.58 | 0.60 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.25 | 0.30 | 0.34 | 0.36 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.19 | 0.25 | 0.29 | 0.31 |

*Table 7.15 Annual independent South extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 10.30 | 13.88 | 16.29 | 17.31 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 10.96 | 14.85 | 17.48 | 18.60 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 11.80 | 16.10 | 19.01 | 20.26 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 12.90 | 17.73 | 21.01 | 22.41 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.27 | 0.34 | 0.38 | 0.39 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.12 | 0.18 | 0.24 | 0.28 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.20 | 0.24 | 0.28 | 0.29 |

*Table 7.16 Annual independent South-West extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 12.16 | 15.50 | 17.87 | 18.90 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 12.98 | 16.62 | 19.21 | 20.33 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 14.03 | 18.06 | 20.92 | 22.16 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 15.40 | 19.93 | 23.16 | 24.56 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.18 | 0.24 | 0.31 | 0.34 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | - | - | - | - |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | - | - | - | - |

*Table 7.17 Annual independent West extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 13.07 | 15.71 | 17.45 | 18.19 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 13.97 | 16.85 | 18.76 | 19.57 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 15.12 | 18.33 | 20.45 | 21.35 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 16.63 | 20.25 | 22.65 | 23.66 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.24 | 0.34 | 0.40 | 0.42 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | - | - | - | - |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | - | - | - | - |

*Table 7.18 Annual independent North-West extreme criteria for wind, wave and current at P2.*

| Parameter | Symbol | Units | Return period (year) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 10 | 50 | 100 |
| Hourly wind speed | $U_{1h}$ | $m.s^{-1}$ | 11.61 | 14.97 | 17.26 | 18.24 |
| 10min wind speed | $U_{10min}$ | $m.s^{-1}$ | 12.38 | 16.04 | 18.55 | 19.62 |
| 1 min wind speed | $U_{1min}$ | $m.s^{-1}$ | 13.37 | 17.43 | 20.21 | 21.40 |
| 3s wind gust | $U_{3s}$ | $m.s^{-1}$ | 14.65 | 19.23 | 22.37 | 23.72 |
| Significant wave height | $H_s$ | $m$ | - | - | - | - |
| Peak wave period | $T_p$ | $s$ | - | - | - | - |
| Maximum individual wave height | $H_{max}$ | $m$ | - | - | - | - |
| Maximum individual wave crest | $C_{max}$ | $m$ | - | - | - | - |
| Surface current speed | $U_{surf}$ | $m.s^{-1}$ | 0.45 | 0.69 | 0.87 | 0.95 |
| Mid-depth current speed | $U_{mid}$ | $m.s^{-1}$ | 0.28 | 0.43 | 0.55 | 0.60 |
| Near-bottom current speed | $U_{bot}$ | $m.s^{-1}$ | 0.23 | 0.40 | 0.53 | 0.58 |

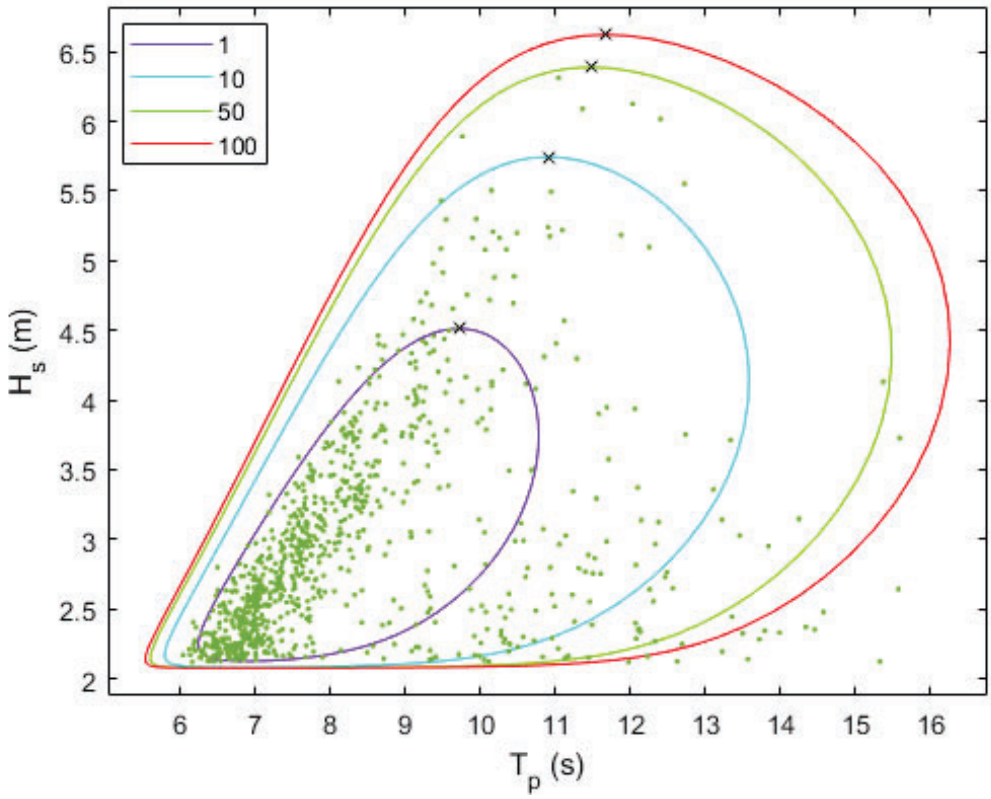


*Figure 7.2 Contour plot of omni-directional bi-variate (Hs-Tp) return period values for 1, 10, 50 and 100-year ARIs. The dark crosses correspond to the estimated deterministic Hs and associated Tp return period values for each ARI indicated in the legend at P2.*

# 8. Nov 2018 – Jun 2019

In this section, metocean statistics for the period Nov 2018 – Jun 2019 for one representative site P1 are compared to the long term statistics in Table 8.1 - Table 8.5, Figure 8.1 - Figure 8.5.

From Nov 2018 – Jun 2019, wind conditions were slightly below the averaged long term conditions from 1979-2019, while wave height conditions were significantly lower than the averaged values (Table 8.1 and Table 8.2). The maximum values for wind speed and significant wave height within the period Nov 2018 - Jun 2019 (15.50 $m.s^{-1}$ and 2.83 m, respectively) were also significantly lower than the 1-year omnidirectional ARI values (i.e. 19.74 $m.s^{-1}$ and 4.46 m, respectively, see Table 7.1).

From Nov 2018 – Jun 2019, current conditions were slightly below the averaged long term conditions from 2000-2019 at all levels through the water column (Table 8.3-Table 8.5). The maximum values for current speeds for the period Nov 2018 - Jun 2019 (0.38, 0.20 and 0.17 $m.s^{-1}$ for surface, mid-depth and near-bottom, respectively) were also significantly lower than the 1-year omnidirectional ARI values (i.e. 0.51, 0.30 and 0.26 $m.s^{-1}$, respectively, see Table 7.1).

At the studied location on the east side of NZ, storm conditions are dominated by the passage of post-tropical cyclones, typically from November to April. The weather effects from the last cyclone season (2018-2019) were less severe than the typical storm conditions at the studied location.

*Table 8.1 Comparison between the long term wind speed statistics and the recent Nov 2018 – Jun 2019 period at P1. Only the Nov-Jun period is considered for each year.*

| Parameter | Units | Period | Mean | P25 | P75 | P99 | Max |
|---|---|---|---|---|---|---|---|
| **Wind speed, $U_{10min}$** | **$m.s^{-1}$** | **1979-2019 average** | 6.22 | 4.10 | 8.02 | 14.39 | 18.92 |
| | | **Nov 2018-Jun 2019** | 5.45 | 3.43 | 7.20 | 12.45 | 15.50 |

*Table 8.2 Comparison between the long term significant wave height statistics and the recent Nov 2018 – Jun 2019 period at P1. Only the Nov-Jun period is considered for each year.*

| Parameter | Units | Period | Mean | P25 | P75 | P99 | Max |
|---|---|---|---|---|---|---|---|
| **Significant wave Height, Hs** | **m** | **1979-2019 average** | 0.94 | 0.56 | 1.15 | 2.94 | 4.30 |
| | | **Nov 2018-Jun 2019** | 0.74 | 0.51 | 0.90 | 2.04 | 2.83 |

*Table 8.3 Comparison between the long term residual surface current speed statistics and the recent Nov 2018 – Jun 2019 period at P1. Only the Nov-Jun period is considered for each year.*

| Parameter | Units | Period | Mean | P25 | P75 | P99 | Max |
|---|---|---|---|---|---|---|---|
| **Surface current speed, $U_{surf}$** | **$m.s^{-1}$** | **2000-2019 average** | 0.11 | 0.06 | 0.15 | 0.34 | 0.48 |
| | | **Nov 2018-Jun 2019** | 0.10 | 0.04 | 0.14 | 0.29 | 0.38 |

*Table 8.4 Comparison between the long term residual mid-depth current speed statistics and the recent Nov 2018 – Jun 2019 period at P1. Only the Nov-Jun period is considered for each year.*

| Parameter | Units | Period | Mean | P25 | P75 | P99 | Max |
|---|---|---|---|---|---|---|---|
| **Mid-depth current speed, $U_{mid}$** | **$m.s^{-1}$** | **2000-2019 average** | 0.06 | 0.03 | 0.08 | 0.20 | 0.29 |
| | | **Nov 2018-Jun 2019** | 0.05 | 0.02 | 0.08 | 0.16 | 0.20 |

*Table 8.5 Comparison between the long term residual near-bottom current speed statistics and the recent Nov 2018 – Jun 2019 period at P1. Only the Nov-Jun period is considered for each year.*

| Parameter | Units | Period | Mean | P25 | P75 | P99 | Max |
|---|---|---|---|---|---|---|---|
| **Near-bottom current speed, $U_{bot}$** | **$m.s^{-1}$** | **2000-2019 average** | 0.05 | 0.02 | 0.07 | 0.17 | 0.25 |
| | | **Nov 2018-Jun 2019** | 0.04 | 0.02 | 0.05 | 0.13 | 0.17 |

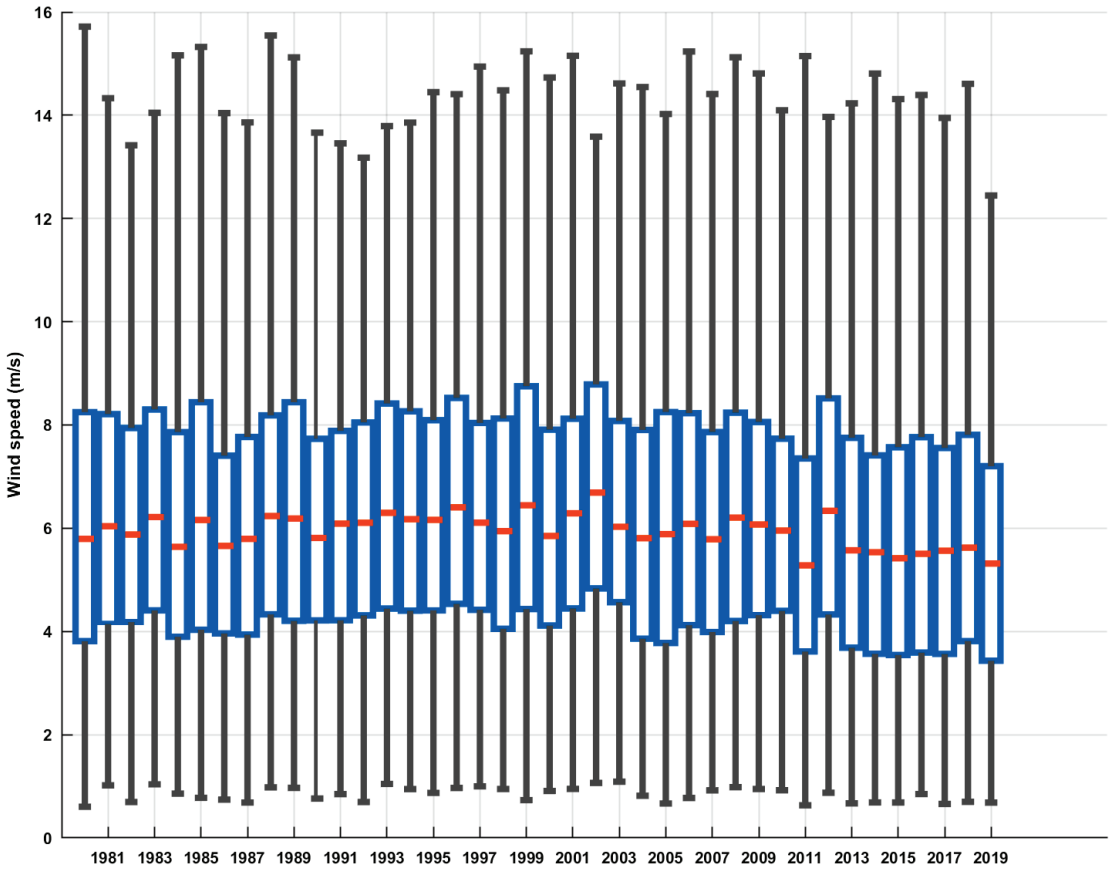


*Figure 8.1 Box plot of wind speed considering only the period Nov-Jun for each year since 1979 at P1. Each period is labelled by the year corresponding the end of the period (e.g. Nov 2018 - Jun 2019 is labelled "2019" on the x-axis). The blue boxes are delimited by the 25$^{th}$ and 75$^{th}$ percentiles of each period bin, while the red line indicates the median and the limits of the dark lines are the 1$^{st}$ and 99$^{th}$ percentiles.*

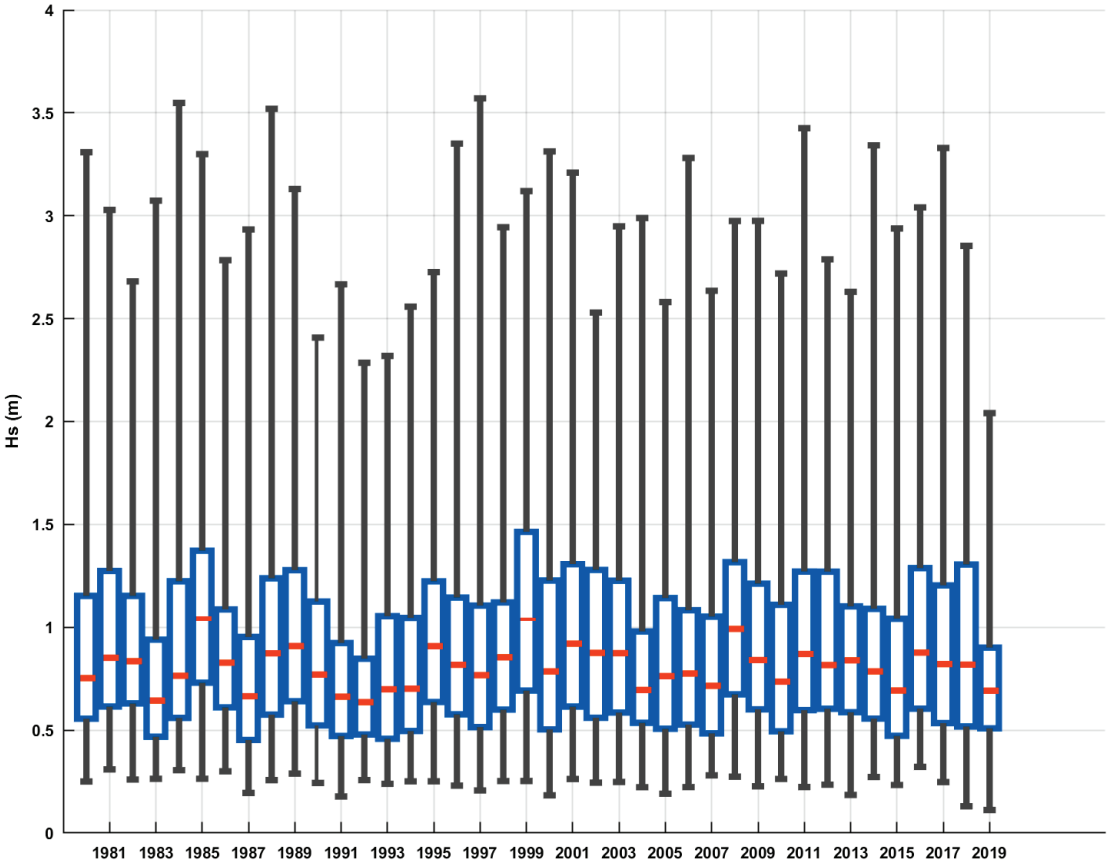


*Figure 8.2 As Figure 8.1 but for significant wave height.*

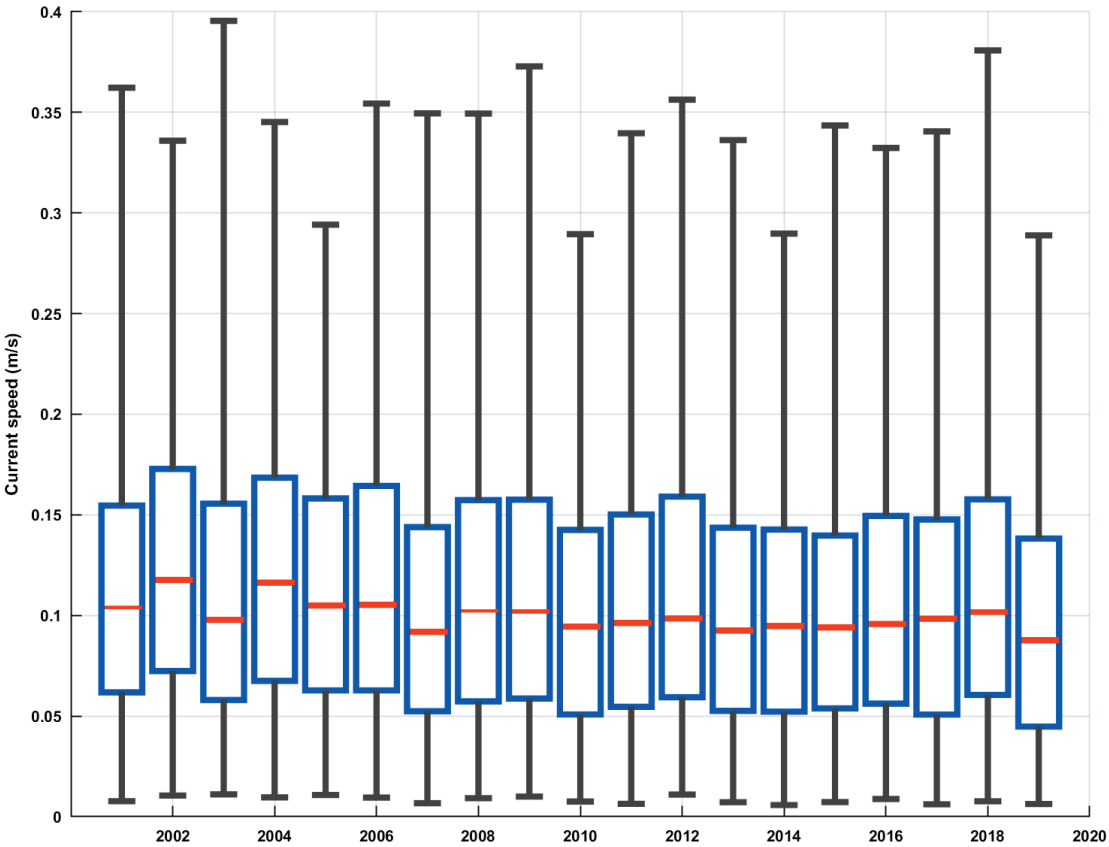


*Figure 8.3 As Figure 8.1 but for residual surface current speed.*

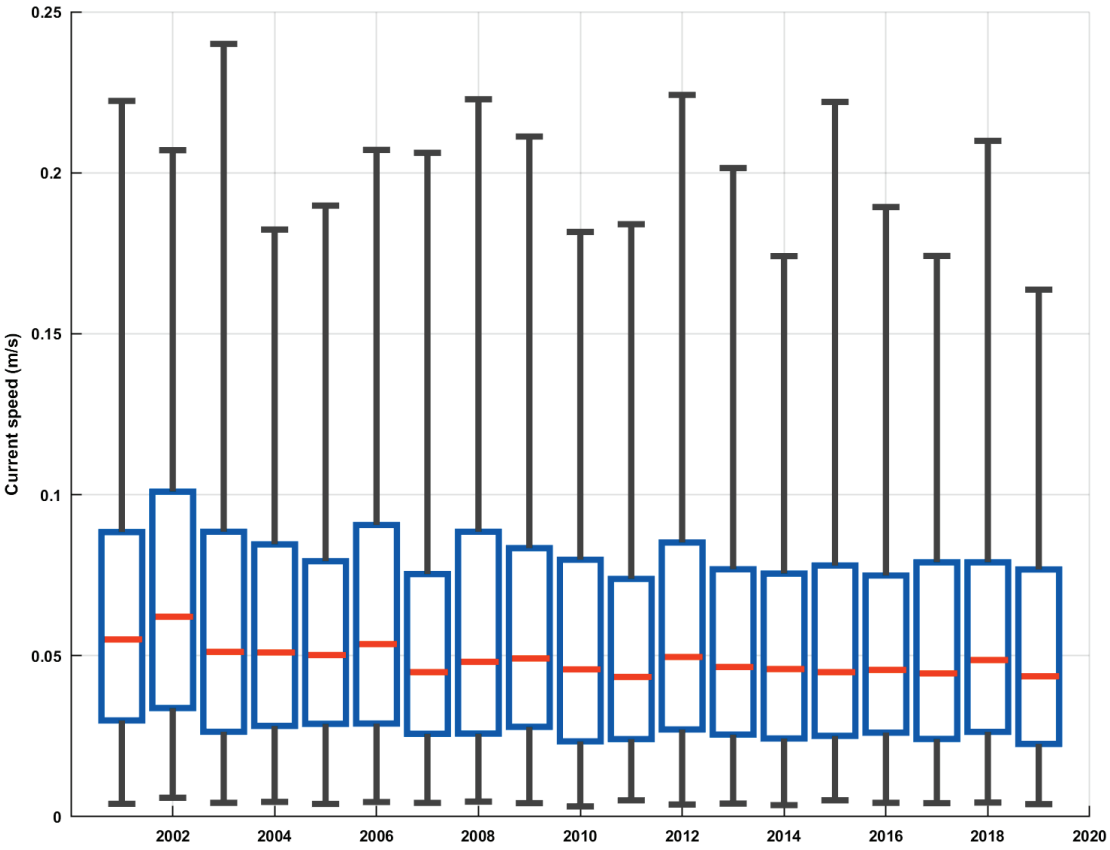


*Figure 8.4 As Figure 8.1 but for residual mid-depth current speed.*

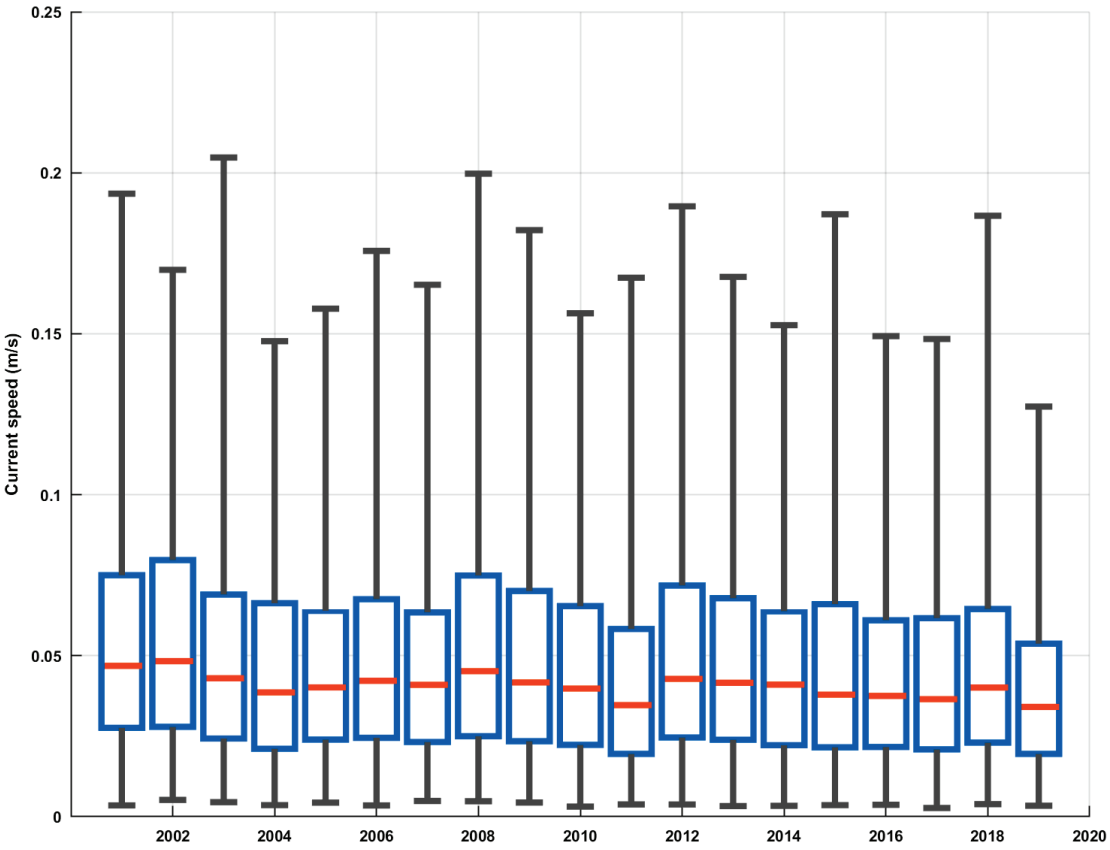


*Figure 8.5 As Figure 8.1 but for residual near-bottom current speed.*

# 9. Analytical methods

## 9.1. Wind

In order to define the design wind speeds, the 10-minute velocity means were extrapolated to shorter (i.e. 3 and 60 seconds) and longer periods (i.e. 1 hour) using the guidelines provided by ISO (2015).

## 9.2. Wave

The wave spectra were post-processed to calculate wave statistics for the total wave field, as well as for sea and swell components. The spectral partitioning method consists of a split at the frequency corresponding to 8 s period, with sea and swell assigned to the high- and low-frequency parts, respectively. For the total spectra and each partition, one-dimensional frequency spectra were defined by integrating over all directions:

$$E(f) = \int_{-\pi}^{\pi} E(f,\theta) d\theta. \tag{9.1}$$

Spectral moments were calculated as

$$m_x = \iint f^x E(f,\theta) df \, d\theta, \tag{9.2}$$

The significant wave height, Hs, mean direction at peak energy, θp, and peak wave period, Tp , are defined as:

$$H_s = 4\sqrt{m_0}, \tag{9.3}$$

$$Dpm = \tan^{-1} \frac{\int_{-\pi}^{\pi} E(f_p,\theta) \sin\theta \, d\theta}{\int_{-\pi}^{\pi} E(f_p,\theta) \cos\theta \, d\theta}, \tag{8.4}$$

$$T_p = 1/f_p, \tag{9.5}$$

where fp is the peak wave frequency of the one-dimensional spectra and En(fp,θ) is the energy contained in the peak wave frequency band. Note that Tp and θp require spectral peaks within a given partition and are not defined when peaks are not identified for that partition.

## 9.3. Extreme

Directional return period values have been calculated from the hindcast time series of wind, wave and current.

A *Peaks over Threshold* (POT) sampling method is used for event selection, applying the 95$^{th}$ percentile exceedance level as the threshold with a 24 hour window. For wind extreme value analysis (EVA), the 3-parameter Weibull distribution were applied, with Maximum Likelihood Method (MLM) used to find the best-fit of the sampled events to the model distribution. For wave EVA, the selected events were fitted to a Pareto distribution, with the location parameter fixed by the threshold and the MLM used to obtain the scale and shape parameters.

Bivariate return period values were calculated for significant wave height and peak period. The method of Repko et al. (2005) was employed, which considers the distribution of $H_s$ and wave steepness, $s$. A joint probability distribution function (PDF) is calculated by multiplying marginal distributions of $H_s$ and $s$ (thus assuming they are independent), after which the PDF is transformed back into $H_s$/ $T_p$ space. In addition, a minimum wave steepness threshold of 0.005 is applied to exclude events with very long wave periods, which are not believed to be representative of extreme conditions.

The marginal distributions for $H_s$ and $s$ are estimated by fitting the POT values to a Weibull distribution using the maximum likelihood method (as implemented in the WAFO toolbox). Contours of the return period values were constructed from the joint PDF using the Inverse FORM method (Winterstein et al., 1993) at the return year levels.

The methods used to estimate extreme maximum individual wave height ($H_{max}$) and maximum wave crest ($C_{max}$) account for the long-term uncertainty in the severity of the environment and the short-term uncertainty in the severity of the maximum wave of a given sea state, as suggested by Tromans and Vanderschuren (1995) and recommended by ISO (2015). The most probable value of the extreme individual wave height ($H_{mp}$) of each storm is obtained from the product of the Foristall distributions of individual wave height in each hindcast interval within the storm duration (Forristall, 1978; ISO, 2015). The same technique is used for the most probable value of the extreme individual wave crest ($C_{mp}$) but using the Weibull distribution with scale and shape parameters dependent on the wave steepness and the Ursell number (ISO, 2015; Forristall, 2000). Note that the resulting short-term distributions for each storm are dependent on the number of intervals with $H_s$ values near the region of maximum peak $H_s$. The uncertainty in the height and crest of the maximum wave of any storm is represented as a short-term probability distribution conditional on $H_{mp}$ and $C_{mp}$, respectively (Tromans and Vanderschuren, 1995). The long-term distributions of $H_{mp}$ and $C_{mp}$ are then fitted to Pareto distributions. Finally,

the convolutions of the short- and long-term distributions give the complete long-term distributions of $H_{max}$ and $C_{max}$ (Tromans and Vanderschuren, 1995; ISO 2015).

Note an arbitrary minimum number of 10 storm peaks has been was chosen for reliable distribution fitting. This results in specific directional return period values being omitted.

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