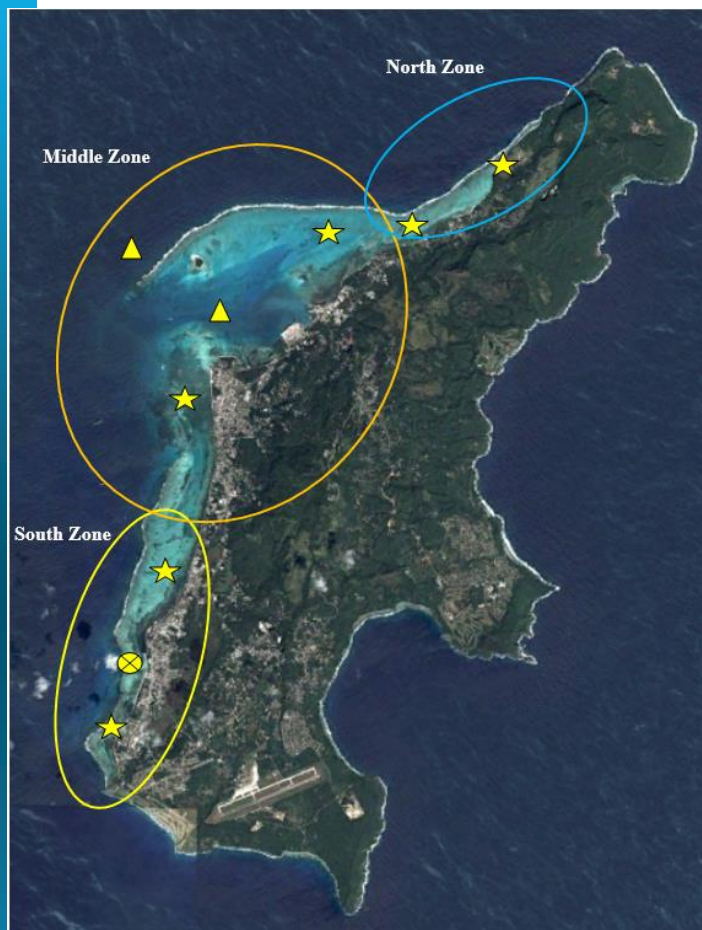


2017 Hydrodynamic Study of Saipan's Western Lagoon - Data Report

February 2018



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February 23, 2018



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1. INTRODUCTION

Saipan, an island in the Commonwealth of the Northern Mariana Islands (CNMI), is located at approximately 15° 11' north latitude and 145° 43' east longitude. The Northern Mariana Islands are a group of fourteen islands, aligned north-south in a chain 440 miles long. Saipan, the largest island in the group, is also the center of government, business and population. The island is about 12.5 miles long and 5.5 miles wide. Saipan consists of a volcanic core capped by limestone (calcareous reef rock) terraces. Limestone cliffs, which also include local deposits of volcanic origin, line the eastern, northern and southern coasts of the island. The western coast, however, is composed of a narrow coastal plain of calcareous sand, mixed with volcanic alluvium. Offshore of the west coast, there is a broad, shallow lagoon sheltered from the ocean by a barrier reef. The lagoon is broadest and deepest immediately north of American Memorial Park at Puntan Muchot where the distance from the shore to the barrier reef is about 2 miles and the maximum water depth is about 40 to 50 feet. A wide pass interrupts the barrier reef offshore and the commercial harbor and entrance channel are located in this area, taking advantage of the reef pass. To the south and north, the lagoon transitions into a fringing reef from 0.3 to 0.8 miles wide with water depths typically less than 10 feet.

Saipan's Bureau of Environmental and Coastal Quality, Division of Coastal Resource Management (BECQ-DCRM) has contracted Sea Engineering, Inc. (SEI) to conduct a hydrodynamic study of Saipan's western lagoon. The purpose of the project is to create and enhance the existing models of the hydrodynamics of the lagoon. The initial phase of the study was deployment of current meters and wave gages throughout the lagoon. The instruments provide important data on the hydrodynamic conditions in the lagoon, which will be used to calibrate a numerical hydrodynamic model of circulation and transport in the lagoon. The model will assist BECQ-DCRM with the development of sampling and protocols for marine and water quality monitoring in the lagoon.

Two Acoustic Doppler Current Profilers (ADCPs), and seven Acoustic Doppler Velocimeters (ADV) were deployed along the west side of the island to measure current and wave data. This data is used to define typical oceanographic conditions and calibrate numerical models. The deployment period was the end of June to beginning of October 2017. The project location is shown in Figure 1-1, and the instrument locations are shown in Figure 1-2, and coordinates are shown in Table 1-1.

This report presents methods and results of the instrument deployment.



Figure 1-1. Project Location Map

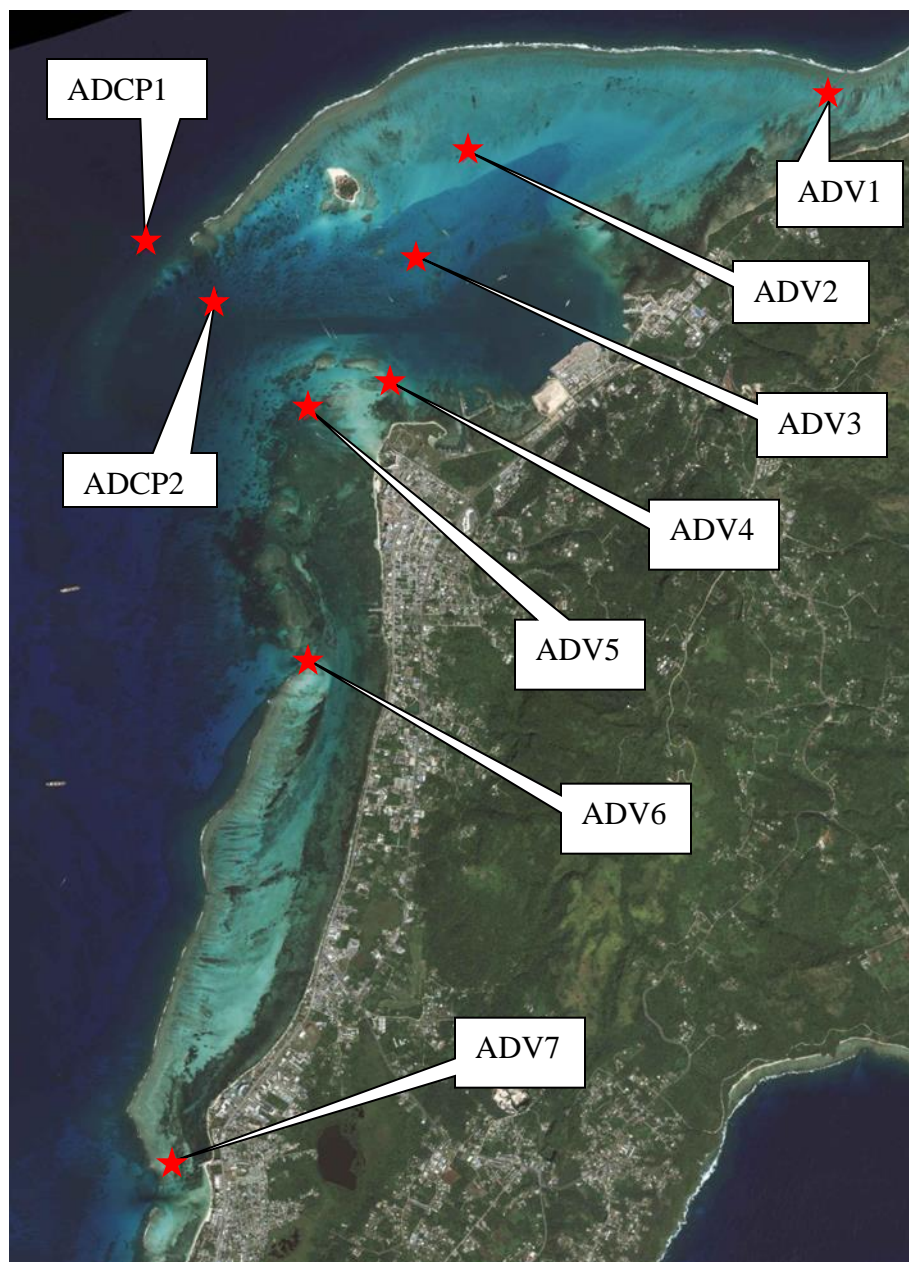


Figure 1-2. Instrument Location Map

Table 1-1. Instrument Location and Deployment Dates

| Name | Latitude | Longitude | Depth (m) | Deployed | Retrieved | Description |
|--------|---------------|----------------|-----------|-----------|------------|--|
| ADCP 1 | 15.23589756 N | 145.69362978 E | 21.77 | 6/29/2017 | 10/17/2017 | North of Garapan Harbor Entrance Channel |
| ADCP 2 | 15.23045018 N | 145.70013704 E | 11.48 | 6/29/2017 | 10/31/2017 | Garapan Harbor Entrance Channel |
| ADV 1 | 15.25019211 N | 145.75808601 E | 1.52 | 6/29/2017 | 10/18/2017 | Pau Pau Beach |
| ADV 2 | 15.24430711 N | 145.724129 E | 3.54 | 6/29/2017 | 10/18/2017 | East of Managaha Island |
| ADV 3 | 15.2344492 N | 145.71922906 E | 7.32 | 6/29/2017 | 10/18/2017 | Garapan Lagoon |
| ADV 4 | 15.22310605 N | 145.71720054 E | 2.88 | 6/30/2017 | 10/17/2017 | American Memorial Park |
| ADV 5 | 15.22064287 N | 145.70939735 E | 3.45 | 6/30/2017 | 10/17/2017 | Micro Beach/Hyatt |
| ADV 6 | 15.19759292 N | 145.7092623 E | 2.33 | 6/30/2017 | 10/17/2017 | Lighthouse Channel Entrance |
| ADV 7 | 15.15119924 N | 145.69648297 E | 0.94 | 7/1/2017 | 10/17/2017 | Sugar Dock Channel Entrance |

2. METHODS

ADCPs are marine instruments that use the Doppler effect to measure water particle movement. The instruments emit acoustic beams, and acoustic backscatter from particulates in the water column is shifted to higher and lower frequencies depending on the relative motion of the particulates to the acoustic beams. By separating the backscatter return by time, different layers of the water column can be measured. Waves can be calculated from linear wave theory using orbital velocity, measured pressure, and surface tracking. In common with all transducer-generated acoustics, the acoustic beams have associated side lobe patterns. At the sea surface, reflections of the side lobes cause noise that biases the data. As a result, the top six percent of the water column is typically not useable data. For this project, two 600kHz Teledyne Workhorse Sentinel ADCPs were used.

ADVs are marine instruments that collect high-resolution velocity and pressure data in rapidly changing environments. The instrument integrates Doppler velocity measurements with additional sensors such as temperature, pressure, tilt and a compass. Using Nortek PUV software for processing, wave height, period, spectra and directional estimates can be made based off of the pressure and orbital velocities recorded in the unit. For this project seven Nortek Vector 3D current meters were used.

The instrument data are recorded only in International Standard (SI) units. Instrument settings for the deployment included the following:

ADCP1: 600kHz Workhorse Sentinel

- Deployed: June 29, 2017
- Recovered: October 17, 2017
- Mean Depth: 21.77 meters
- Bin interval: 0.5 meters
- Sampling Rate:
 - Current Ensemble Interval: 20 minutes
 - Current Samples per Ensemble: 200
 - Current Sample Rate: .66 Hz
 - Wave Ensemble Interval: 60 min
 - Wave Samples per Ensemble 2136
 - Wave Sample Rate: 2 Hz
- Velocity Accuracy: 0.3% of relative water velocity, ± 3.0 mm/s
- Minimum Wave Height: 0.2 meters

ADCP2: 600kHz Workhorse Sentinel

- Deployed: June 29, 2017
- Recovered: October 31, 2017
- Mean Depth: 11.48 meters
- Bin interval: 0.5 meters
- Sampling Rate:
 - Current Ensemble Interval: 20 minutes
 - Current Samples per Ensemble: 200
 - Current Sample Rate: .66 Hz
 - Wave Ensemble Interval: 60 min
 - Wave Samples per Ensemble 2136
 - Wave Sample Rate: 2 Hz
- Velocity Accuracy: 0.3% of relative water velocity ± 3.0 mm/s
- Minimum Wave Height: 0.2 meters

ADV1: Vector 3D Current Meter

- Deployed: June 29, 2017
- Recovered: October 18, 2017
- Mean Depth: 1.52 meters
- Sampling Rate:
 - Sample Rate: 2 Hz
 - Burst Interval: 3600 s
 - Samples Per Burst: 2048
- Velocity Accuracy: $\pm 0.5\%$ of relative water velocity ± 1.0 mm/s
- Minimum Wave Height: 1 mm

ADV2: Vector 3D Current Meter

- Deployed: June 29, 2017
- Recovered: October 18, 2017
- Mean Depth: 3.54 meters
- Sampling Rate:
 - Sample Rate: 2 Hz
 - Burst Interval: 3600 s
 - Samples Per Burst: 2048
- Velocity Accuracy: $\pm 0.5\%$ of relative water velocity ± 1.0 mm/s
- Minimum Wave Height: 1 mm

ADV3: Vector 3D Current Meter

- Deployed: June 29, 2017
- Recovered: October 18, 2017
- Mean Depth: 7.32 meters
- Sampling Rate:
 - Sample Rate: 2 Hz
 - Burst Interval: 3600 s
 - Samples Per Burst: 2048
- Velocity Accuracy: $\pm 0.5\%$ of relative water velocity ± 1.0 mm/s
- Minimum Wave Height: 1 mm

ADV4: Vector 3D Current Meter

- Deployed: June 30, 2017
- Recovered: October 17, 2017
- Mean Depth: 2.88 meters
- Sampling Rate:
 - Sample Rate: 2 Hz
 - Burst Interval: 3600 s
 - Samples Per Burst: 2048
- Velocity Accuracy: $\pm 0.5\%$ of relative water velocity ± 1.0 mm/s
- Minimum Wave Height: 1 mm

ADV5: Vector 3D Current Meter

- Deployed: June 30, 2017
- Recovered: October 17, 2017
- Mean Depth: 3.45 meters
- Sampling Rate:
 - Sample Rate: 2 Hz
 - Burst Interval: 3600 s
 - Samples Per Burst: 2048
- Velocity Accuracy: $\pm 0.5\%$ of relative water velocity ± 1.0 mm/s
- Minimum Wave Height: 1 mm

ADV6: Vector 3D Current Meter

- Deployed: June 30, 2017
- Recovered: October 17, 2017
- Mean Depth: 2.33 meters
- Sampling Rate:
 - Sample Rate: 2 Hz
 - Burst Interval: 3600 s
 - Samples Per Burst: 2048
- Velocity Accuracy: $\pm 0.5\%$ of relative water velocity ± 1.0 mm/s
- Minimum Wave Height: 1 mm

ADV7: Vector 3D Current Meter

- Deployed: July 1, 2017
- Recovered: October 17, 2017
- Mean Depth: 0.94 meters
- Sampling Rate:
 - Sample Rate: 2 Hz
 - Burst Interval: 3600 s
 - Samples Per Burst: 2048
- Velocity Accuracy: $\pm 0.5\%$ of relative water velocity ± 1.0 mm/s
- Minimum Wave Height: 1 mm

3. CURRENT DATA

The measured current data is presented by time series plots of the east and north directed velocity components, and current roses. The roses show the statistical distribution of the current velocity by direction, and are further broken down into surface, mid depth and bottom layers of the water column for ADCP data. Every rose has a corresponding table (histogram) showing the percent occurrence of current velocity from 16 directional sectors of 22.5 degrees. Current direction is defined as the direction flow is going toward (oceanographic convention); for example, a current flowing from due west to east would have the direction of east, or the compass direction 90° from north.

ADCP1

At ADCP1, the time series (Figure 3-1), current roses (Figure 3-2 to Figure 3-4) and histograms (Table 3-1 to Table 3-3) show the flow oscillates along the coast (as is typical for tidal driven flow) with a predominately south-southwest flow apparent in the middle and lower water column. The average velocity ranges from 0.20 m/s near the surface to 0.12 m/s near the bottom. The maximum record velocity at ADCP1 was 0.62 m/s near the surface and mid-water column.

ADCP2

The currents at ADCP2 flow in a primarily west to southwest direction throughout the entire water column. This flow pattern is likely due to the western lagoon draining through the main channel. ADCP2 is located on the northern side of the channel. The measured data are presented in time series plots (Figure 3-5), current roses (Figure 3-6 to Figure 3-8), and histograms (Table 3-4 to Table 3-6). The average velocity ranges from 0.20 m/s at the surface to 0.12 m/s at the bottom. The maximum record velocity at ADCP2 was 0.81 m/s at the surface.

ADV1

ADV1 is located approximately 3.4 km northeast of the harbor where the lagoon significantly narrows. The currents measured at ADV1 flow primarily to west. The average current was 0.16 m/s, with a maximum recorded current of 0.50 m/s. The recorded time series at this location is shown in Figure 3-9. The current rose and corresponding histogram are shown in Figure 3-10 and Table 3-7, respectively.

ADV2

The currents measured at ADV2 flow to the south southeast approximately 80% of the time. The average current was 0.12 m/s, with a maximum recorded current of 0.52 m/s. The recorded time series at this location is presented in Figure 3-11. The current rose and corresponding histogram are shown in Figure 3-12 and Table 3-8, respectively.

ADV3

The currents measured at ADV3 flow to the south nearly 80% of the time. The average current was 0.08 m/s, with a maximum recorded current of 0.32 m/s. Current velocities for this ADV were relatively low, most likely because this ADV was situated in a water depth of 7m (24 ft), significantly deeper than the other ADVs. The recorded time series at this location is shown in Figure 3-13. The current rose and corresponding histogram are shown in Figure 3-14 and Table 3-9 respectively.

ADV4

The currents measured at ADV4 flow primarily to the west southwest. The average current was 0.05 m/s, with a maximum recorded current of 0.20 m/s. The recorded time series at this location is shown in Figure 3-15. The current rose and corresponding histogram are shown in Figure 3-16 and Table 3-10 respectively.

ADV5

The currents measured at ADV5 were weak, with a slight predominance of flow to the south to west directions. The average current was 0.03 m/s, with a maximum recorded current of 0.16 m/s. The recorded time series at this location is shown in Figure 3-17. The current rose and corresponding histogram are shown in Figure 3-18 and Figure 3-11, respectively.

ADV6

The currents measured at ADV6 are bimodal, with flow to the east and northwest. Prevailing week flow is to the east, while strong wave driven flow is to the northwest. The average current was 0.18 m/s, with a maximum recorded current of 1.17 m/s. The recorded time series at this location is shown in Figure 3-19. The current rose, and corresponding histogram are shown in Figure 3-20 and Table 3-12, respectively.

ADV7

The currents measured at ADV7 flow primarily to the west southwest. The average current was 0.09 m/s, with a maximum recorded current of 0.48 m/s. The recorded time series at this location is shown in Figure 3-21. The current rose and corresponding histogram are shown in Figure 3-22 and Table 3-13, respectively.

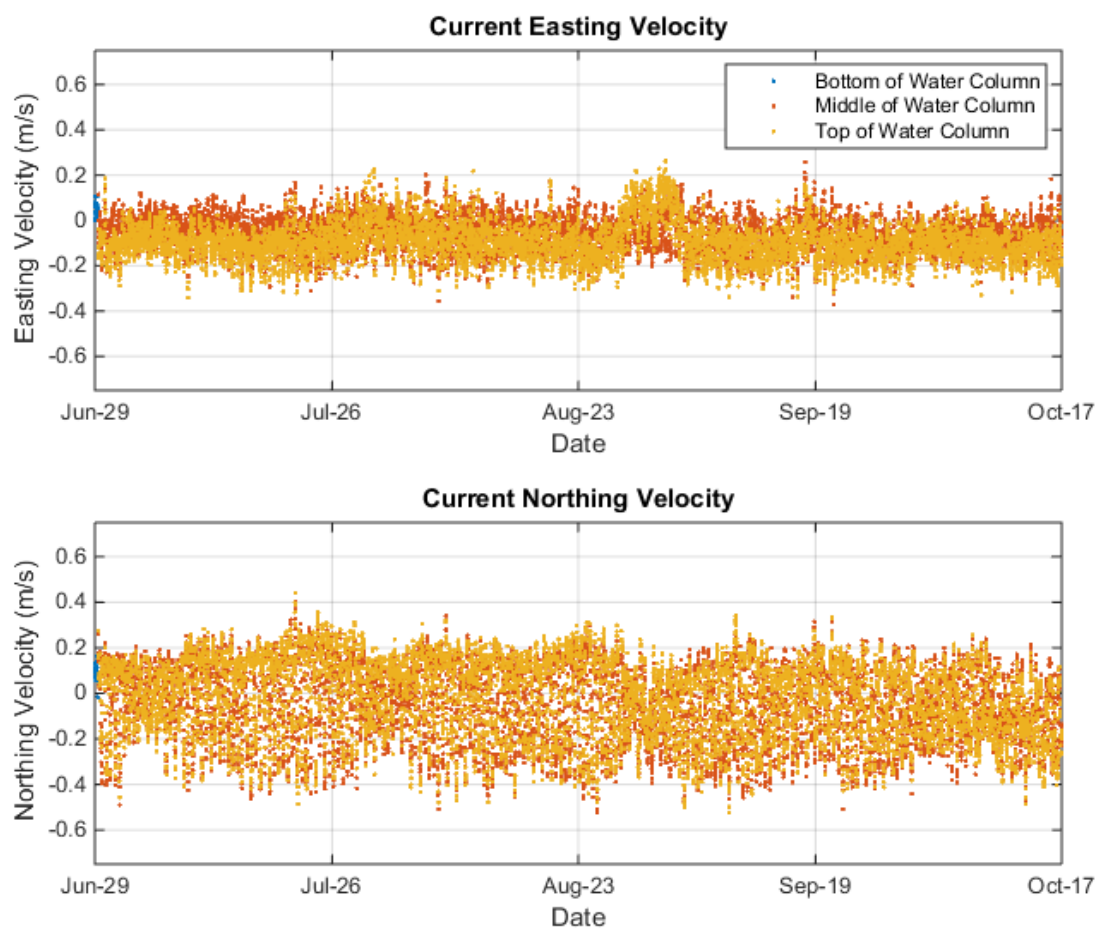


Figure 3-1. ADCP 1 current time series

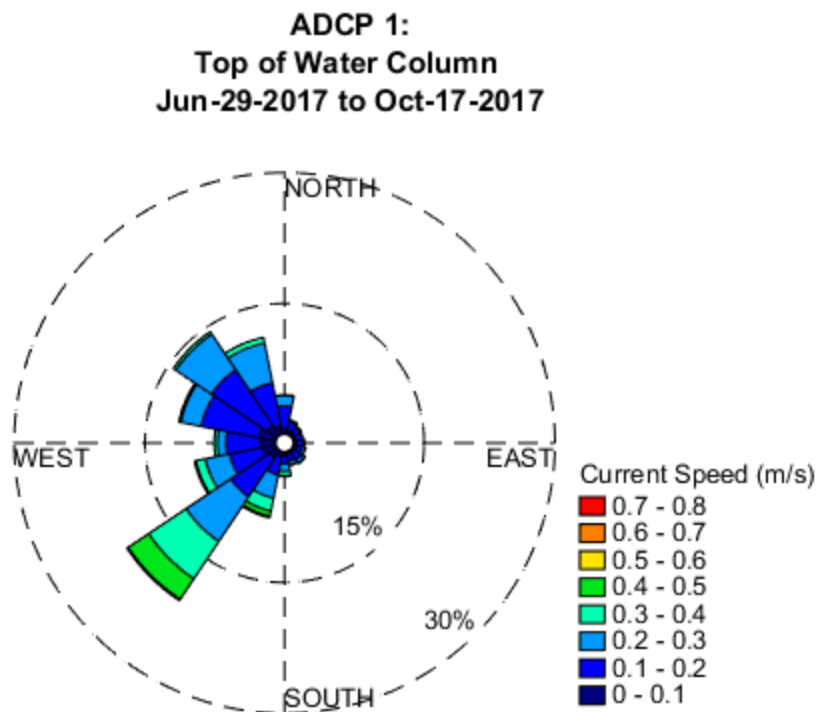


Figure 3-2. ADCP 1 top of water column current rose

Table 3-1. ADCP 1 top of water column current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|--------------|------|------|------|------|------|-------|------|-------|------|-------|-------|-------|------|-------|-------|-------|---------|
| 0-0.1 | 0.63 | 0.43 | 0.42 | 0.27 | 0.40 | 0.44 | 0.34 | 0.21 | 0.45 | 0.54 | 1.04 | 1.50 | 1.67 | 2.02 | 1.44 | 1.01 | 12.82 |
| 0.1-0.2 | 2.61 | 1.06 | 0.78 | 0.83 | 0.75 | 0.62 | 1.01 | 0.92 | 0.92 | 2.17 | 5.37 | 3.93 | 4.04 | 6.72 | 7.64 | 5.04 | 44.42 |
| 0.2-0.3 | 1.19 | 0.18 | 0.14 | 0.08 | 0.16 | 0.38 | 0.47 | 0.45 | 0.86 | 2.73 | 6.21 | 2.83 | 0.96 | 2.37 | 4.91 | 4.64 | 28.56 |
| 0.3-0.4 | 0.05 | 0.03 | | | | 0.04 | 0.05 | 0.08 | 0.52 | 1.52 | 5.11 | 1.09 | 0.39 | 0.24 | 0.35 | 0.66 | 10.12 |
| 0.4-0.5 | 0.03 | | | | | | | | 0.08 | 0.59 | 2.83 | 0.19 | 0.01 | | | | 3.73 |
| 0.5-0.6 | | | | | | | | | 0.01 | 0.16 | 0.18 | | | | | | 0.35 |
| 0.6-0.7 | | | | | | | | | | 0.01 | | | | | | | 0.01 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 4.51 | 1.69 | 1.34 | 1.17 | 1.31 | 1.48 | 1.87 | 1.67 | 2.84 | 7.73 | 20.74 | 9.54 | 7.07 | 11.35 | 14.35 | 11.34 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.17 | 0.14 | 0.13 | 0.14 | 0.13 | 0.15 | 0.16 | 0.17 | 0.21 | 0.25 | 0.27 | 0.19 | 0.15 | 0.16 | 0.18 | 0.19 | 0.20 |
| StDev | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.07 | 0.10 | 0.11 | 0.11 | 0.09 | 0.07 | 0.06 | 0.06 | 0.07 | 0.09 |
| Min | 0.04 | 0.04 | 0.02 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 |
| Max | 0.45 | 0.36 | 0.25 | 0.29 | 0.26 | 0.35 | 0.33 | 0.38 | 0.54 | 0.62 | 0.57 | 0.49 | 0.42 | 0.38 | 0.39 | 0.39 | 0.62 |

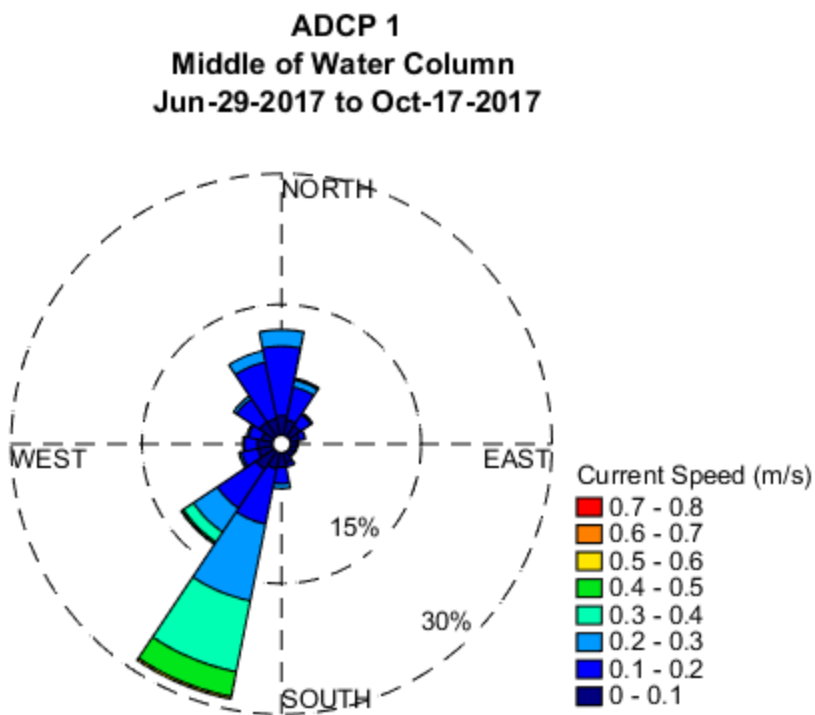


Figure 3-3. ADCP 1 middle of water column current rose

Table 3-2. ADCP 1 middle of water column current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|-------|------|------|------|------|-------|------|-------|------|-------|-------|-------|------|-------|------|-------|---------|
| 0-0.1 | 2.25 | 1.83 | 1.54 | 1.10 | 0.78 | 0.75 | 0.76 | 1.23 | 1.65 | 1.91 | 2.51 | 1.76 | 1.78 | 1.34 | 2.02 | 1.96 | 25.16 |
| 0.1-0.2 | 7.96 | 3.83 | 1.50 | 0.68 | 0.11 | 0.09 | 0.03 | 0.44 | 1.91 | 6.45 | 5.35 | 1.91 | 1.49 | 1.52 | 3.18 | 6.59 | 43.04 |
| 0.2-0.3 | 1.88 | 0.82 | 0.24 | 0.03 | | | | 0.05 | 0.56 | 9.02 | 3.28 | 0.29 | 0.16 | 0.25 | 0.43 | 1.34 | 18.35 |
| 0.3-0.4 | 0.03 | 0.20 | | | | | | | 0.01 | 8.26 | 1.39 | 0.04 | | | | | 9.93 |
| 0.4-0.5 | | 0.01 | | | | | | | | 2.90 | 0.27 | | | | | | 3.18 |
| 0.5-0.6 | | | | | | | | | | 0.29 | 0.04 | | | | | | 0.33 |
| 0.6-0.7 | | | | | | | | | | | 0.01 | | | | | | 0.01 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 12.11 | 6.69 | 3.28 | 1.81 | 0.90 | 0.83 | 0.78 | 1.72 | 4.13 | 28.83 | 12.86 | 3.99 | 3.44 | 3.11 | 5.63 | 9.89 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.15 | 0.14 | 0.11 | 0.09 | 0.06 | 0.06 | 0.06 | 0.08 | 0.12 | 0.27 | 0.19 | 0.12 | 0.10 | 0.12 | 0.12 | 0.14 | 0.17 |
| StDev | 0.05 | 0.07 | 0.06 | 0.05 | 0.03 | 0.03 | 0.02 | 0.04 | 0.06 | 0.11 | 0.10 | 0.06 | 0.05 | 0.06 | 0.05 | 0.05 | 0.10 |
| Min | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Max | 0.31 | 0.43 | 0.29 | 0.29 | 0.14 | 0.14 | 0.13 | 0.24 | 0.32 | 0.58 | 0.62 | 0.35 | 0.28 | 0.28 | 0.28 | 0.28 | 0.62 |

ADCP 1
Bottom of Water Column
Jun-29-2017 to Oct-17-2017

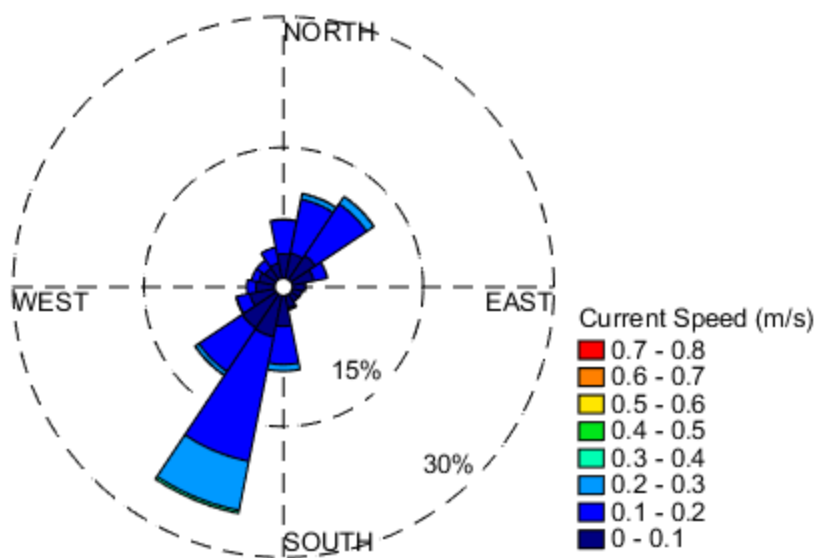


Figure 3-4. ADCP 1 bottom of water column current rose

Table 3-3. ADCP 1 bottom of water column current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|--------------|------|------|-------|------|------|-------|------|-------|------|-------|-------|-------|------|-------|------|-------|---------|
| 0-0.1 | 2.78 | 2.93 | 3.35 | 2.53 | 1.48 | 1.15 | 1.07 | 1.44 | 3.50 | 4.81 | 4.69 | 2.93 | 2.15 | 1.91 | 1.59 | 1.77 | 40.06 |
| 0.1-0.2 | 3.92 | 6.31 | 7.10 | 1.55 | 0.05 | 0.01 | | 0.24 | 4.38 | 14.57 | 5.97 | 1.55 | 1.07 | 0.83 | 1.12 | 1.84 | 50.54 |
| 0.2-0.3 | 0.06 | 0.64 | 1.00 | 0.04 | | | | | 0.76 | 5.75 | 0.53 | 0.09 | | 0.01 | 0.01 | 0.03 | 8.92 |
| 0.3-0.4 | | 0.05 | 0.04 | | | | | | 0.01 | 0.34 | 0.04 | | | | | | 0.48 |
| 0.4-0.5 | | | | | | | | | | | | | | | | | 0.00 |
| 0.5-0.6 | | | | | | | | | | | | | | | | | 0.00 |
| 0.6-0.7 | | | | | | | | | | | | | | | | | 0.00 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 6.76 | 9.94 | 11.48 | 4.12 | 1.53 | 1.16 | 1.07 | 1.68 | 8.65 | 25.47 | 11.23 | 4.57 | 3.22 | 2.75 | 2.73 | 3.64 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.11 | 0.13 | 0.13 | 0.09 | 0.05 | 0.04 | 0.04 | 0.06 | 0.12 | 0.16 | 0.11 | 0.09 | 0.09 | 0.08 | 0.09 | 0.10 | 0.12 |
| StDev | 0.04 | 0.05 | 0.05 | 0.04 | 0.03 | 0.02 | 0.02 | 0.03 | 0.06 | 0.06 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.06 |
| Min | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Max | 0.22 | 0.35 | 0.34 | 0.21 | 0.13 | 0.10 | 0.10 | 0.16 | 0.31 | 0.39 | 0.37 | 0.25 | 0.19 | 0.21 | 0.23 | 0.22 | 0.39 |

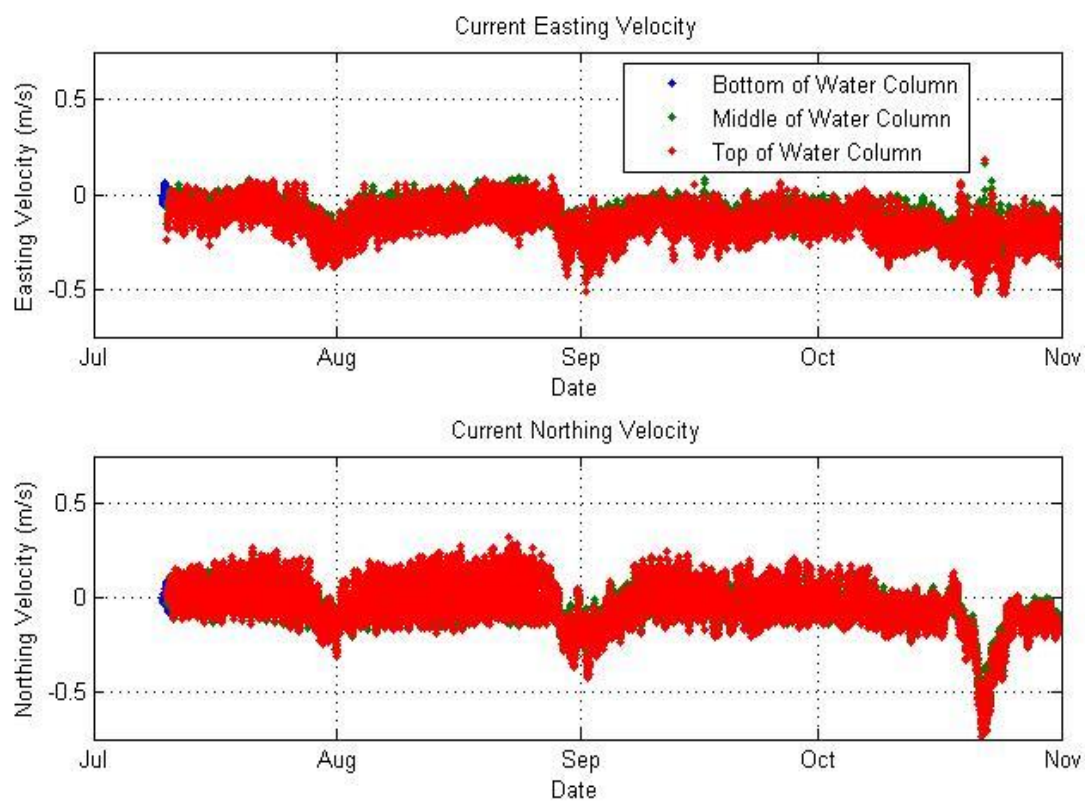


Figure 3-5. ADCP 2 current time series

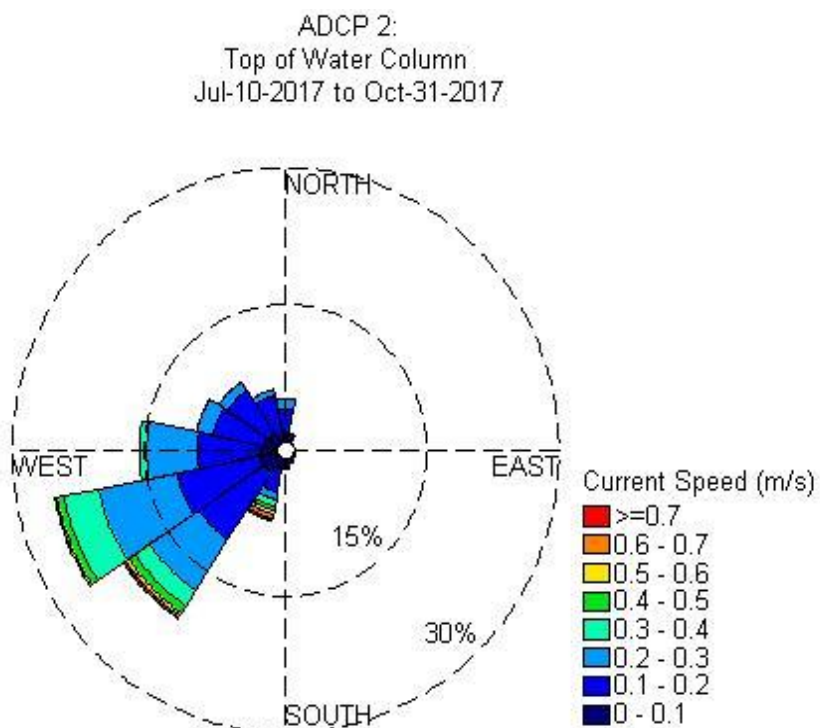


Figure 3-6. ADCP 2 top of water column current rose

Table 3-4. ADCP 2 top of water column current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|------|-------|------|-------|-------|-------|-------|-------|------|-------|---------|
| 0-0.1 | 0.33 | 0.17 | 0.02 | | 0.04 | 0.11 | 0.15 | 0.34 | 0.36 | 1.08 | 1.88 | 1.95 | 1.75 | 1.53 | 1.21 | 0.74 | 11.67 |
| 0.1-0.2 | 3.21 | 0.67 | | | | | 0.01 | 0.13 | 0.56 | 2.58 | 8.91 | 9.61 | 7.26 | 5.89 | 5.69 | 4.42 | 48.96 |
| 0.2-0.3 | 1.09 | 0.10 | | | | | | | 0.02 | 0.83 | 6.67 | 9.07 | 5.78 | 1.84 | 1.17 | 0.66 | 27.24 |
| 0.3-0.4 | 0.01 | | | | | | | | 0.05 | 0.75 | 2.04 | 4.01 | 0.85 | 0.02 | | | 7.73 |
| 0.4-0.5 | | | | | | | | | 0.02 | 0.43 | 0.90 | 0.81 | | | | | 2.16 |
| 0.5-0.6 | | | | | | | 0.01 | 0.02 | 0.42 | 0.39 | 0.25 | | | | | | 1.09 |
| 0.6-0.7 | | | | | | | | 0.01 | 0.50 | 0.25 | 0.01 | | | | | | 0.77 |
| 0.7-0.8 | | | | | | | | | 0.26 | 0.11 | | | | | | | 0.37 |
| 0.8-0.9 | | | | | | | | | 0.01 | | | | | | | | 0.01 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 4.65 | 0.94 | 0.02 | 0.00 | 0.04 | 0.11 | 0.16 | 0.49 | 1.06 | 6.86 | 21.14 | 25.71 | 15.64 | 9.29 | 8.07 | 5.82 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.17 | 0.14 | 0.07 | 0.00 | 0.06 | 0.06 | 0.06 | 0.09 | 0.14 | 0.27 | 0.22 | 0.22 | 0.18 | 0.16 | 0.15 | 0.15 | 0.20 |
| StDev | 0.05 | 0.05 | 0.03 | 0.00 | 0.00 | 0.02 | 0.03 | 0.09 | 0.11 | 0.20 | 0.12 | 0.09 | 0.07 | 0.05 | 0.05 | 0.04 | 0.10 |
| Min | 0.03 | 0.04 | 0.05 | 0.00 | 0.05 | 0.03 | 0.03 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.03 | 0.01 | 0.02 | 0.01 |
| Max | 0.32 | 0.27 | 0.09 | 0.00 | 0.06 | 0.09 | 0.11 | 0.60 | 0.61 | 0.81 | 0.78 | 0.61 | 0.39 | 0.31 | 0.27 | 0.26 | 0.81 |

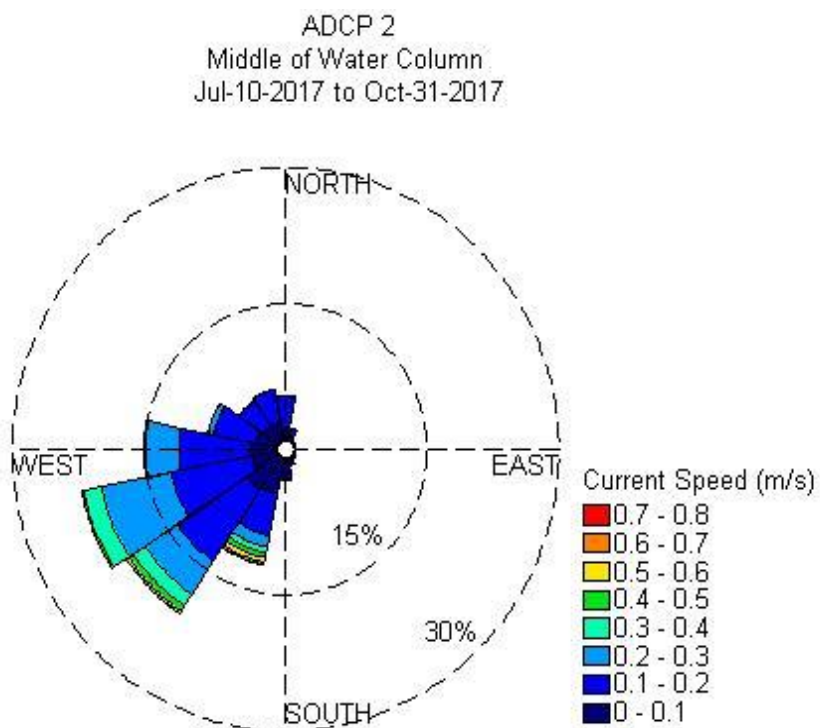


Figure 3-7. ADCP 2 middle of water column current rose

Table 3-5. ADCP 2 middle of water column current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|------|-------|------|-------|-------|-------|-------|-------|------|-------|---------|
| 0-0.1 | 1.37 | 0.56 | 0.16 | 0.15 | 0.07 | 0.12 | 0.31 | 0.71 | 1.73 | 3.99 | 4.34 | 2.90 | 2.86 | 2.43 | 2.09 | 2.00 | 25.79 |
| 0.1-0.2 | 3.45 | 0.83 | 0.04 | | | | 0.05 | 0.06 | 0.49 | 4.65 | 9.44 | 9.34 | 8.26 | 4.91 | 3.33 | 3.66 | 48.49 |
| 0.2-0.3 | 0.15 | 0.02 | | | | | | | 0.04 | 1.31 | 4.39 | 8.07 | 3.80 | 0.64 | 0.04 | 0.04 | 18.50 |
| 0.3-0.4 | | | | | | | | | 0.06 | 0.65 | 1.55 | 2.05 | 0.20 | | | | 4.50 |
| 0.4-0.5 | | | | | | | | | 0.07 | 0.52 | 0.69 | 0.21 | | | | | 1.48 |
| 0.5-0.6 | | | | | | | | 0.01 | 0.04 | 0.54 | 0.29 | | | | | | 0.88 |
| 0.6-0.7 | | | | | | | | | 0.02 | 0.27 | 0.01 | | | | | | 0.31 |
| 0.7-0.8 | | | | | | | | | | 0.04 | | | | | | | 0.04 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 4.97 | 1.42 | 0.20 | 0.15 | 0.07 | 0.12 | 0.36 | 0.79 | 2.45 | 11.96 | 20.71 | 22.56 | 15.12 | 7.98 | 5.45 | 5.69 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.12 | 0.11 | 0.06 | 0.04 | 0.04 | 0.05 | 0.06 | 0.06 | 0.11 | 0.18 | 0.18 | 0.20 | 0.16 | 0.13 | 0.11 | 0.11 | 0.16 |
| StDev | 0.04 | 0.04 | 0.04 | 0.01 | 0.02 | 0.02 | 0.03 | 0.07 | 0.11 | 0.15 | 0.10 | 0.08 | 0.06 | 0.05 | 0.04 | 0.04 | 0.09 |
| Min | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.01 | 0.02 | 0.01 |
| Max | 0.25 | 0.20 | 0.13 | 0.06 | 0.07 | 0.09 | 0.12 | 0.58 | 0.65 | 0.74 | 0.62 | 0.46 | 0.36 | 0.27 | 0.22 | 0.22 | 0.74 |

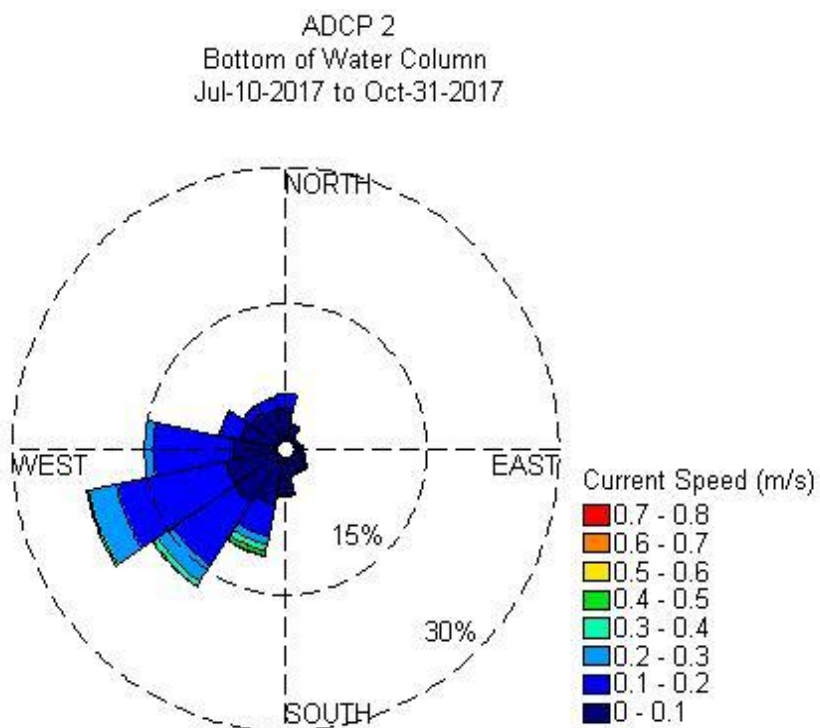


Figure 3-8. ADCP 2 bottom of water column current rose

Table 3-6. ADCP 2 bottom of water column histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|------|-------|------|-------|-------|-------|-------|-------|------|-------|---------|
| 0-0.1 | 3.55 | 1.28 | 0.52 | 0.58 | 0.92 | 1.30 | 1.95 | 1.87 | 3.30 | 5.15 | 5.99 | 5.89 | 4.98 | 4.28 | 3.88 | 3.53 | 48.96 |
| 0.1-0.2 | 1.53 | 0.56 | 0.02 | | | 0.05 | 0.06 | 0.09 | 0.52 | 3.57 | 8.37 | 12.67 | 9.09 | 2.34 | 1.01 | 1.30 | 41.19 |
| 0.2-0.3 | | | | | | | | | 0.12 | 0.93 | 2.11 | 3.24 | 0.93 | 0.04 | | | 7.37 |
| 0.3-0.4 | | | | | | | | | 0.12 | 0.71 | 0.64 | 0.23 | | | | | 1.71 |
| 0.4-0.5 | | | | | | | | | 0.06 | 0.54 | 0.07 | | | | | | 0.67 |
| 0.5-0.6 | | | | | | | | | 0.01 | 0.09 | | | | | | | 0.10 |
| 0.6-0.7 | | | | | | | | | | | | | | | | | 0.00 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 5.08 | 1.84 | 0.54 | 0.58 | 0.92 | 1.35 | 2.01 | 1.95 | 4.13 | 10.99 | 17.18 | 22.04 | 15.01 | 6.66 | 4.88 | 4.83 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.08 | 0.08 | 0.04 | 0.04 | 0.04 | 0.05 | 0.06 | 0.06 | 0.09 | 0.15 | 0.14 | 0.14 | 0.12 | 0.09 | 0.08 | 0.08 | 0.12 |
| StDev | 0.04 | 0.04 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.08 | 0.11 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 | 0.03 | 0.07 |
| Min | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Max | 0.19 | 0.19 | 0.12 | 0.07 | 0.09 | 0.13 | 0.13 | 0.13 | 0.54 | 0.58 | 0.47 | 0.40 | 0.29 | 0.23 | 0.18 | 0.17 | 0.58 |

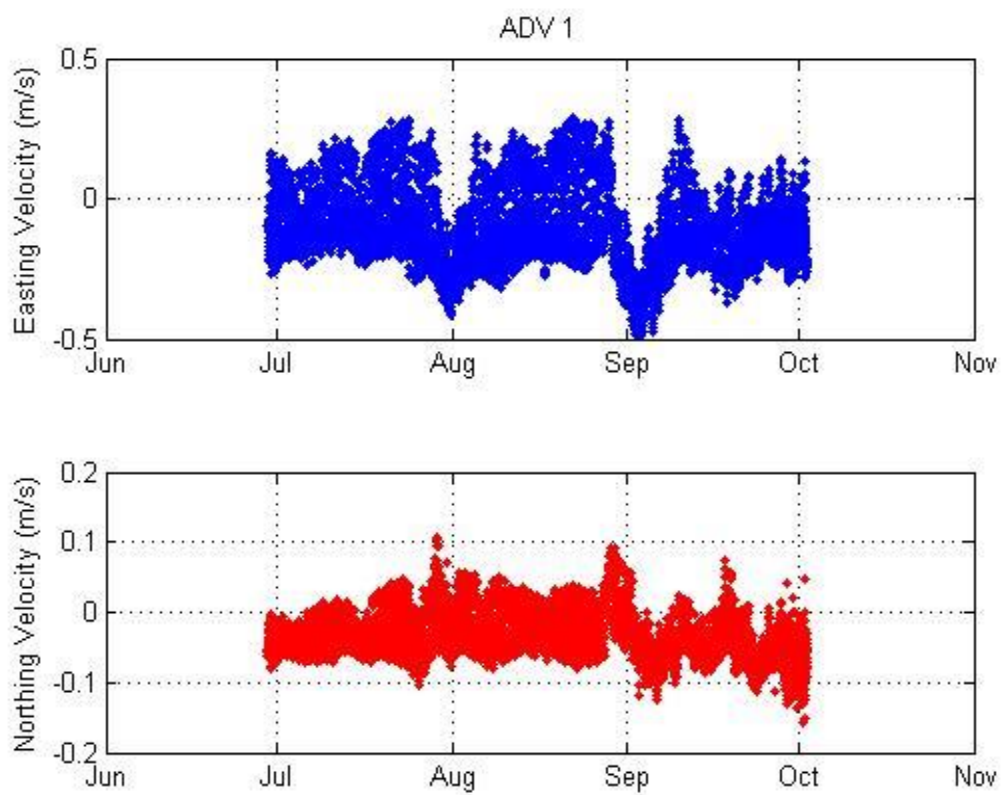


Figure 3-9. ADV 1 current time series

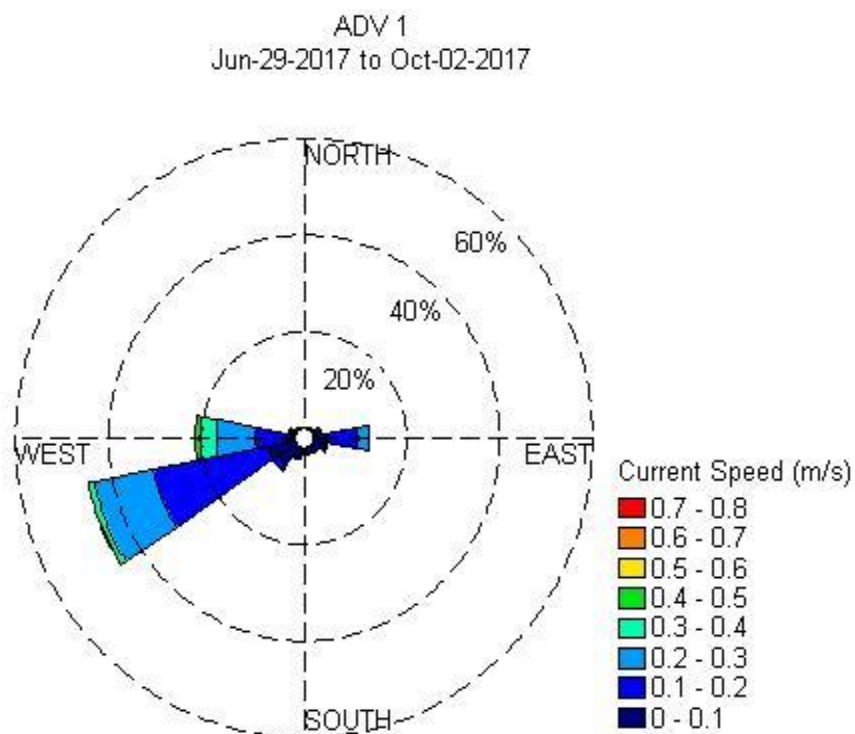


Figure 3-10. ADV 1 current rose

Table 3-7. ADV 1 current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|--------------|------|------|------|------|-------|-------|------|-------|------|-------|------|-------|-------|-------|------|-------|---------|
| 0-0.1 | 0.30 | 0.16 | 0.37 | 0.89 | 2.70 | 2.90 | 1.62 | 1.36 | 1.36 | 2.43 | 4.46 | 5.84 | 1.66 | 0.89 | 0.47 | 0.26 | 27.67 |
| 0.1-0.2 | 0.02 | 0.04 | 0.08 | 0.77 | 6.87 | 0.22 | 0.02 | | 0.02 | 0.12 | 1.58 | 25.18 | 6.79 | 0.67 | 0.06 | 0.04 | 42.47 |
| 0.2-0.3 | | | | 0.12 | 2.45 | | | | | | 0.08 | 12.85 | 8.39 | 0.02 | | | 23.90 |
| 0.3-0.4 | | | | | | | | | | | | 1.30 | 3.57 | | | | 4.87 |
| 0.4-0.5 | | | | | | | | | | | | 0.08 | 1.01 | | | | 1.09 |
| 0.5-0.6 | | | | | | | | | | | | | | | | | 0.00 |
| 0.6-0.7 | | | | | | | | | | | | | | | | | 0.00 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.32 | 0.20 | 0.45 | 1.78 | 12.02 | 3.12 | 1.64 | 1.36 | 1.38 | 2.55 | 6.12 | 45.25 | 21.41 | 1.58 | 0.53 | 0.30 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.05 | 0.05 | 0.08 | 0.11 | 0.15 | 0.07 | 0.05 | 0.04 | 0.04 | 0.05 | 0.08 | 0.17 | 0.23 | 0.10 | 0.07 | 0.06 | 0.16 |
| StDev | 0.03 | 0.04 | 0.03 | 0.06 | 0.06 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.04 | 0.06 | 0.09 | 0.04 | 0.03 | 0.03 | 0.08 |
| Min | 0.01 | 0.00 | 0.03 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.02 | 0.02 | 0.00 |
| Max | 0.11 | 0.11 | 0.14 | 0.26 | 0.29 | 0.16 | 0.11 | 0.07 | 0.12 | 0.13 | 0.21 | 0.42 | 0.50 | 0.25 | 0.12 | 0.11 | 0.50 |

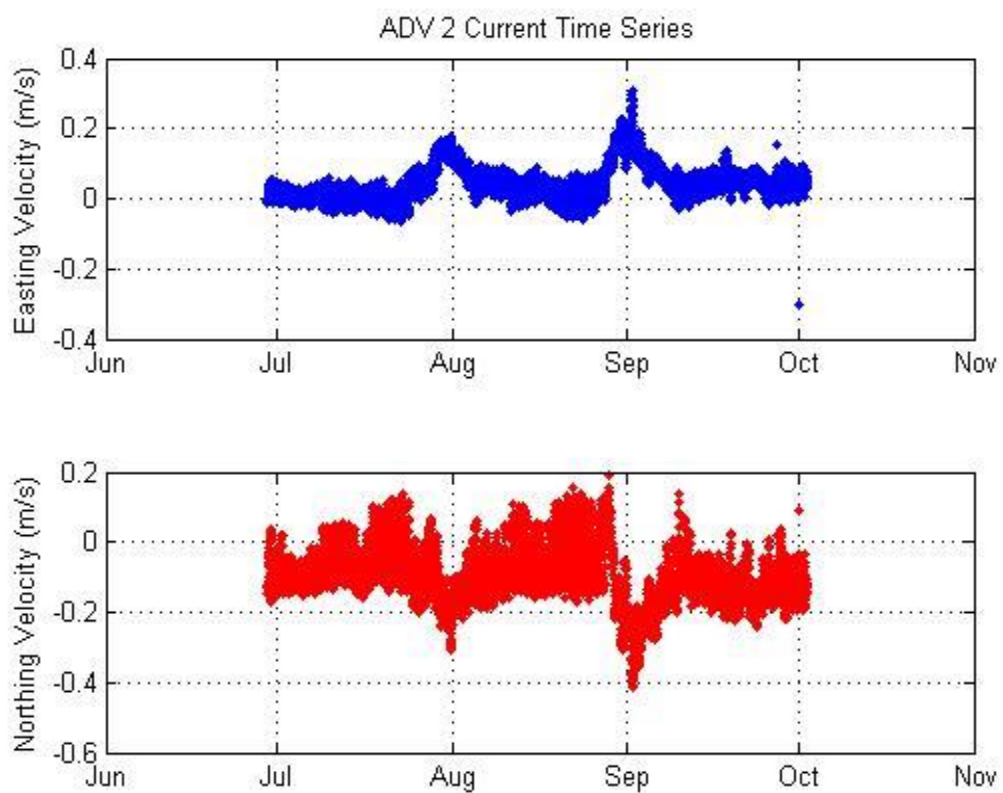


Figure 3-11. ADV 2 current time series

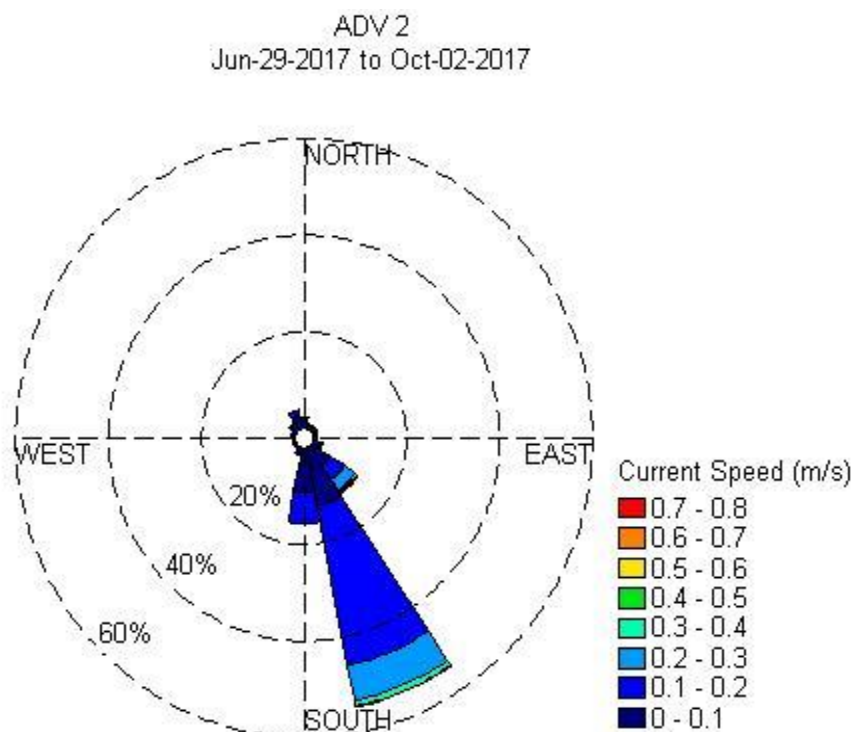


Figure 3-12. ADV 2 current rose

Table 3-8. ADV 2 current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|-------|-------|-------|-------|------|-------|------|-------|------|-------|--------|
| 0-0.1 | 1.78 | 0.78 | 0.82 | 0.48 | 0.84 | 1.62 | 4.78 | 12.29 | 9.27 | 1.66 | 0.50 | 0.52 | 0.44 | 0.72 | 1.72 | 2.94 | 41.16 |
| 0.1-0.2 | 0.58 | 0.18 | 0.26 | 0.38 | 0.10 | 0.40 | 3.56 | 33.68 | 6.36 | | | | | | | 1.00 | 46.51 |
| 0.2-0.3 | | 0.02 | | | | 0.04 | 2.74 | 7.38 | | | | | | | | | 10.19 |
| 0.3-0.4 | | | | | | | 0.56 | 1.20 | | | | | | 0.02 | | | 1.78 |
| 0.4-0.5 | | | | | | | 0.18 | 0.16 | | | | | | | | | 0.34 |
| 0.5-0.6 | | | | | | | 0.02 | | | | | | | | | | 0.02 |
| 0.6-0.7 | | | | | | | | | | | | | | | | | 0.00 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 2.36 | 0.98 | 1.08 | 0.86 | 0.94 | 2.06 | 11.85 | 54.71 | 15.63 | 1.66 | 0.50 | 0.52 | 0.44 | 0.74 | 1.72 | 3.94 | 100.00 |

| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
|-------|------|------|------|------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|---------|
| Mean | 0.07 | 0.07 | 0.07 | 0.08 | 0.05 | 0.07 | 0.15 | 0.14 | 0.09 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.07 | 0.12 |
| StDev | 0.03 | 0.05 | 0.05 | 0.04 | 0.04 | 0.05 | 0.10 | 0.06 | 0.04 | 0.02 | 0.02 | 0.01 | 0.02 | 0.05 | 0.02 | 0.03 | 0.07 |
| Min | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| Max | 0.16 | 0.21 | 0.20 | 0.16 | 0.15 | 0.21 | 0.52 | 0.49 | 0.19 | 0.08 | 0.06 | 0.05 | 0.06 | 0.31 | 0.10 | 0.15 | 0.52 |

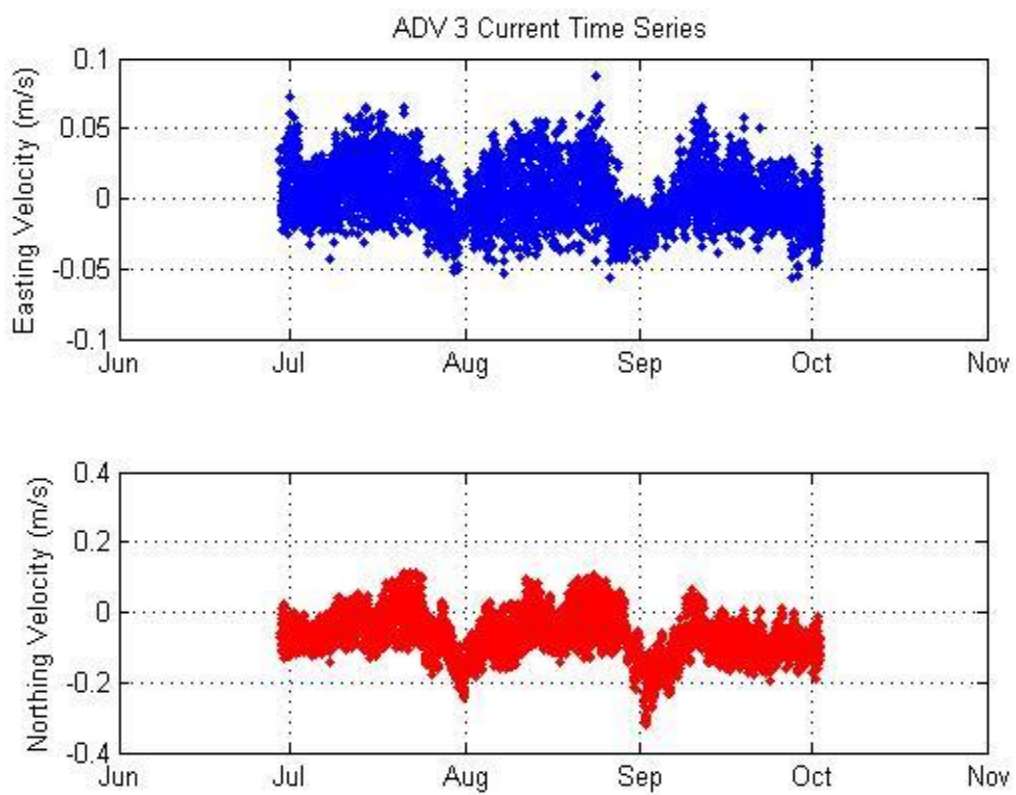


Figure 3-13. ADV 3 current time series

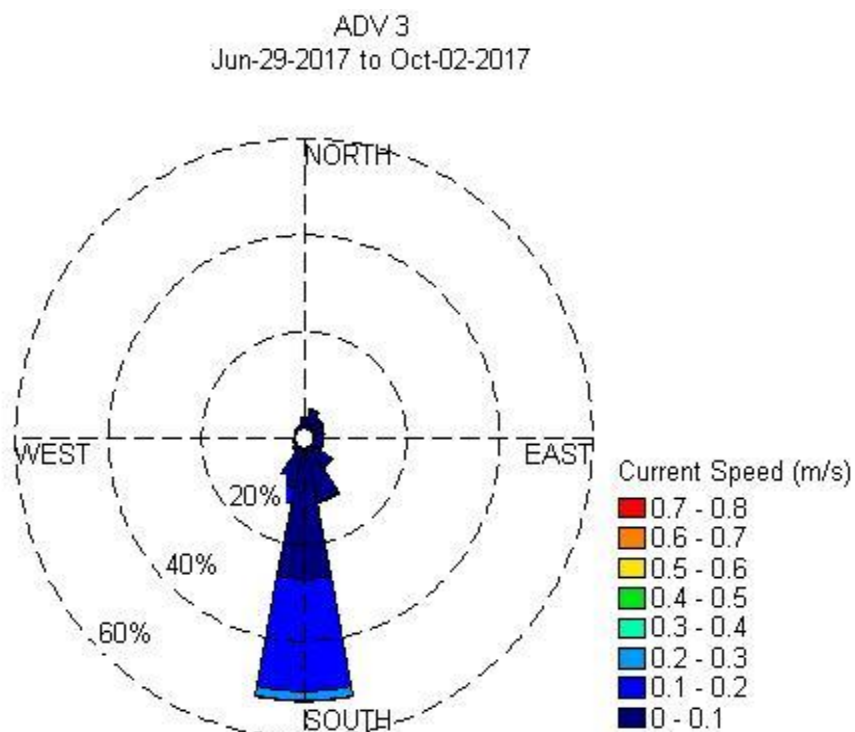


Figure 3-14. ADV 3 current rose

Table 3-9. ADV 3 current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|--------------|------|------|------|------|------|-------|------|-------|-------|-------|------|-------|------|-------|------|-------|---------|
| 0-0.1 | 2.04 | 3.97 | 2.90 | 2.36 | 1.99 | 2.17 | 5.38 | 11.24 | 27.11 | 8.56 | 1.05 | 0.45 | 0.19 | 0.15 | 0.36 | 0.69 | 70.61 |
| 0.1-0.2 | 0.17 | 0.13 | 0.06 | | | | | 0.41 | 23.19 | 3.32 | | | | | | | 27.28 |
| 0.2-0.3 | | | | | | | | | 1.95 | | | | | | | | 1.95 |
| 0.3-0.4 | | | | | | | | | 0.15 | | | | | | | | 0.15 |
| 0.4-0.5 | | | | | | | | | | | | | | | | | 0.00 |
| 0.5-0.6 | | | | | | | | | | | | | | | | | 0.00 |
| 0.6-0.7 | | | | | | | | | | | | | | | | | 0.00 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 2.21 | 4.10 | 2.96 | 2.36 | 1.99 | 2.17 | 5.38 | 11.65 | 52.40 | 11.88 | 1.05 | 0.45 | 0.19 | 0.15 | 0.36 | 0.69 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.06 | 0.05 | 0.04 | 0.04 | 0.03 | 0.03 | 0.04 | 0.06 | 0.11 | 0.08 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 | 0.08 |
| StDev | 0.03 | 0.02 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.05 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.05 |
| Min | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 |
| Max | 0.11 | 0.12 | 0.12 | 0.07 | 0.07 | 0.07 | 0.09 | 0.13 | 0.32 | 0.18 | 0.08 | 0.05 | 0.04 | 0.03 | 0.04 | 0.06 | 0.32 |

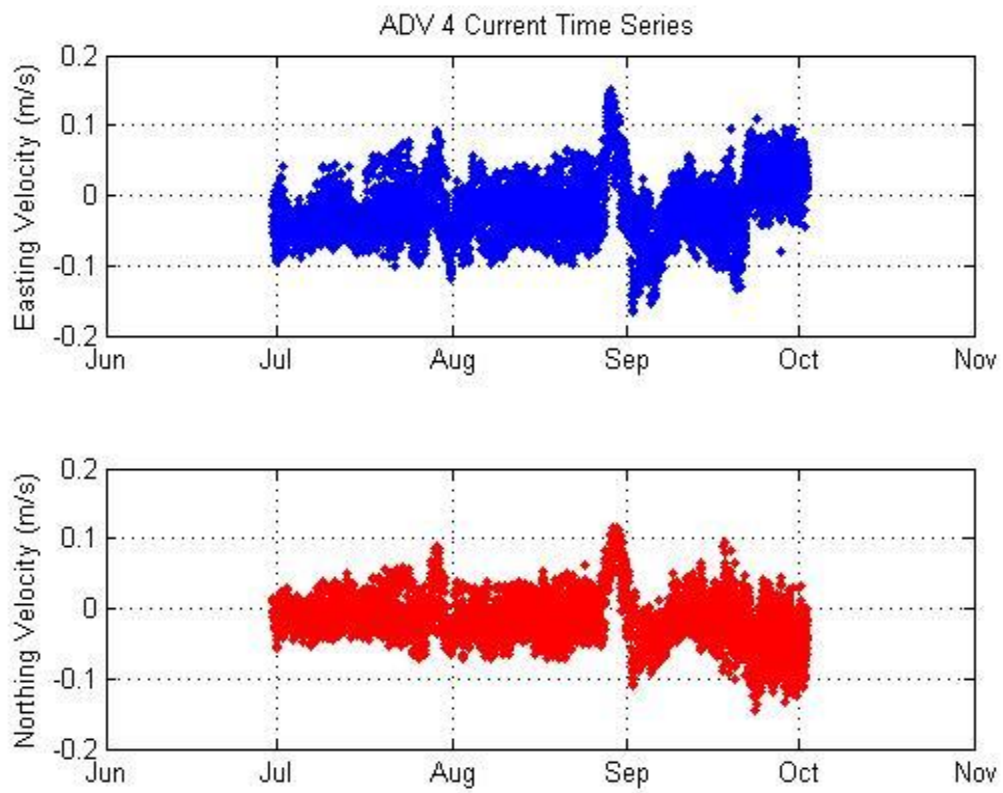


Figure 3-15. ADV 4 current time series

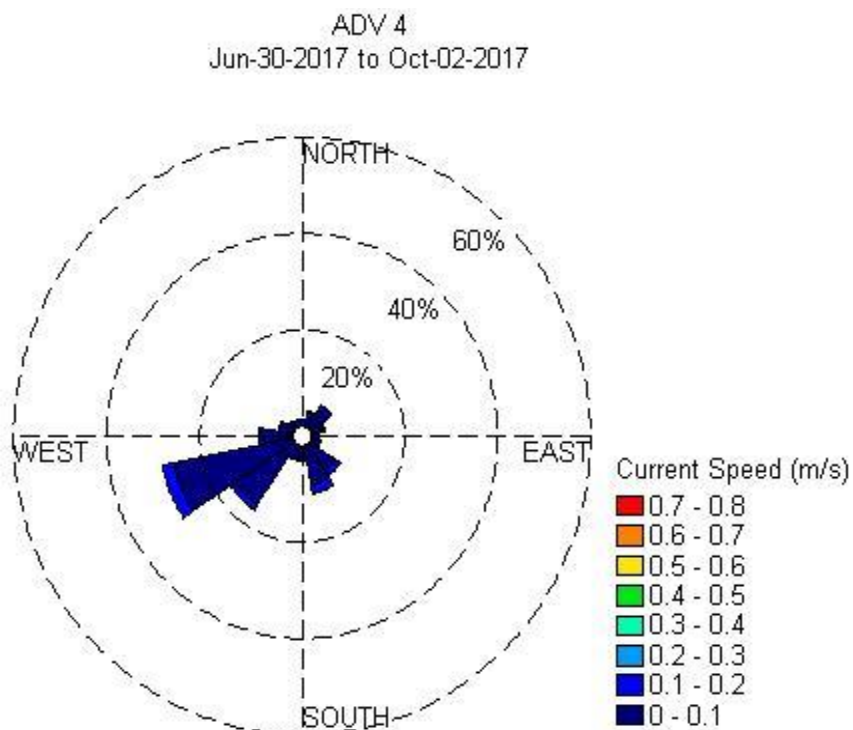


Figure 3-16. ADV 4 current rose

Table 3-10. ADV 4 current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|------|-------|------|-------|-------|-------|------|-------|------|-------|---------|
| 0-0.1 | 1.50 | 3.15 | 4.55 | 2.43 | 1.44 | 2.07 | 6.58 | 8.43 | 3.19 | 3.13 | 15.25 | 26.13 | 7.26 | 3.19 | 1.68 | 1.47 | 91.45 |
| 0.1-0.2 | | 0.11 | 0.98 | 0.52 | | 0.02 | 1.36 | 1.72 | 0.08 | | 1.17 | 2.50 | 0.06 | 0.02 | 0.02 | | 8.55 |
| 0.2-0.3 | | | | | | | | | | | | | | | | | 0.00 |
| 0.3-0.4 | | | | | | | | | | | | | | | | | 0.00 |
| 0.4-0.5 | | | | | | | | | | | | | | | | | 0.00 |
| 0.5-0.6 | | | | | | | | | | | | | | | | | 0.00 |
| 0.6-0.7 | | | | | | | | | | | | | | | | | 0.00 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 1.50 | 3.26 | 5.53 | 2.96 | 1.44 | 2.09 | 7.94 | 10.15 | 3.27 | 3.13 | 16.42 | 28.63 | 7.32 | 3.21 | 1.69 | 1.47 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.03 | 0.04 | 0.06 | 0.05 | 0.02 | 0.03 | 0.07 | 0.07 | 0.04 | 0.02 | 0.05 | 0.06 | 0.04 | 0.03 | 0.03 | 0.02 | 0.05 |
| StDev | 0.02 | 0.03 | 0.04 | 0.04 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 |
| Min | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Max | 0.10 | 0.13 | 0.18 | 0.17 | 0.08 | 0.11 | 0.17 | 0.14 | 0.15 | 0.10 | 0.20 | 0.20 | 0.12 | 0.12 | 0.13 | 0.09 | 0.20 |

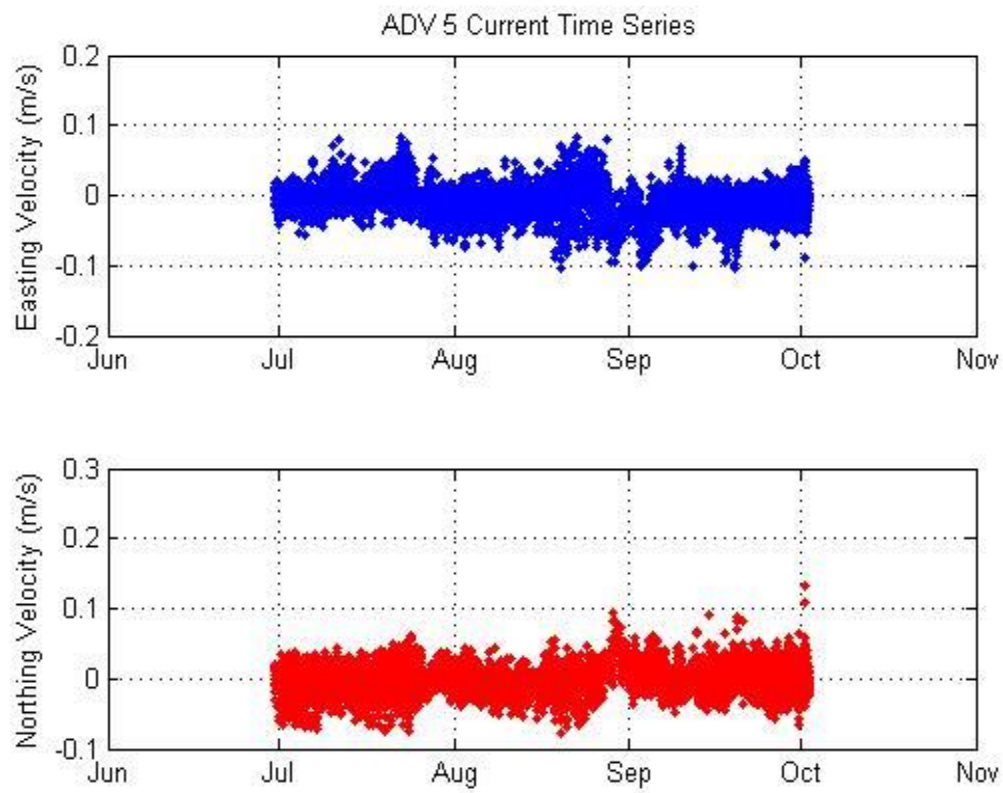


Figure 3-17. ADV 5 current time series

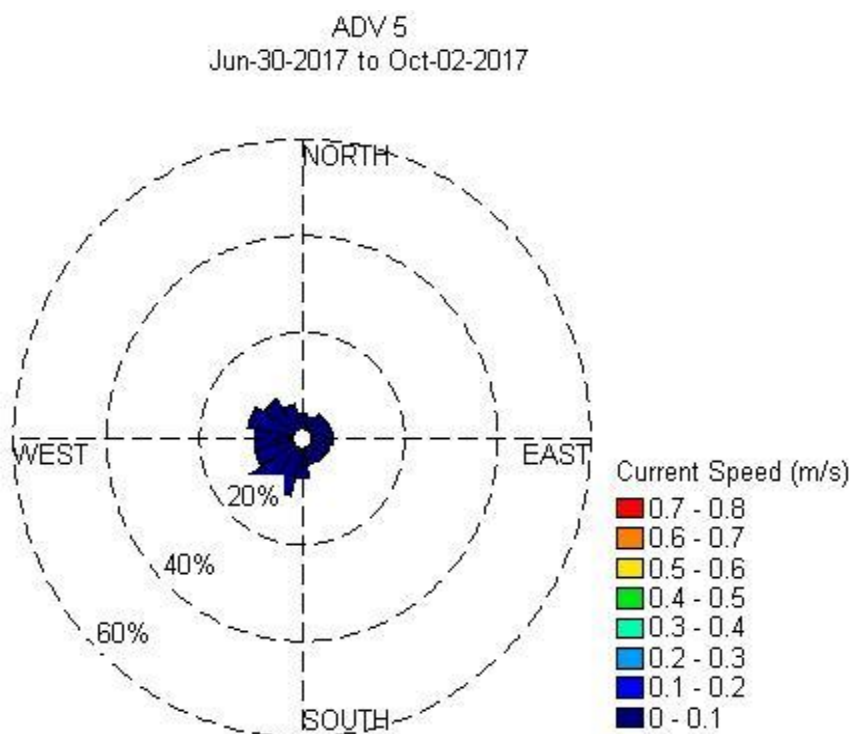


Figure 3-18. ADV 5 current rose

Table 3-11. ADV 5 current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|------|-------|------|-------|-------|-------|------|-------|------|-------|--------|
| 0-0.1 | 3.15 | 2.69 | 4.20 | 4.36 | 4.52 | 4.06 | 3.86 | 3.55 | 6.12 | 10.08 | 13.59 | 8.39 | 8.27 | 9.82 | 7.77 | 5.22 | 99.66 |
| 0.1-0.2 | 0.02 | | | | | | | | | | 0.04 | 0.04 | 0.02 | 0.10 | 0.08 | 0.04 | 0.34 |
| 0.2-0.3 | | | | | | | | | | | | | | | | | 0.00 |
| 0.3-0.4 | | | | | | | | | | | | | | | | | 0.00 |
| 0.4-0.5 | | | | | | | | | | | | | | | | | 0.00 |
| 0.5-0.6 | | | | | | | | | | | | | | | | | 0.00 |
| 0.6-0.7 | | | | | | | | | | | | | | | | | 0.00 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 3.17 | 2.69 | 4.20 | 4.36 | 4.52 | 4.06 | 3.86 | 3.55 | 6.12 | 10.08 | 13.63 | 8.43 | 8.29 | 9.92 | 7.85 | 5.26 | 100.00 |

| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
|-------|------|------|------|------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|---------|
| Mean | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.01 | 0.01 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.03 | 0.03 |
| StDev | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Min | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Max | 0.11 | 0.05 | 0.08 | 0.08 | 0.08 | 0.09 | 0.04 | 0.04 | 0.07 | 0.08 | 0.11 | 0.11 | 0.10 | 0.11 | 0.16 | 0.11 | 0.16 |

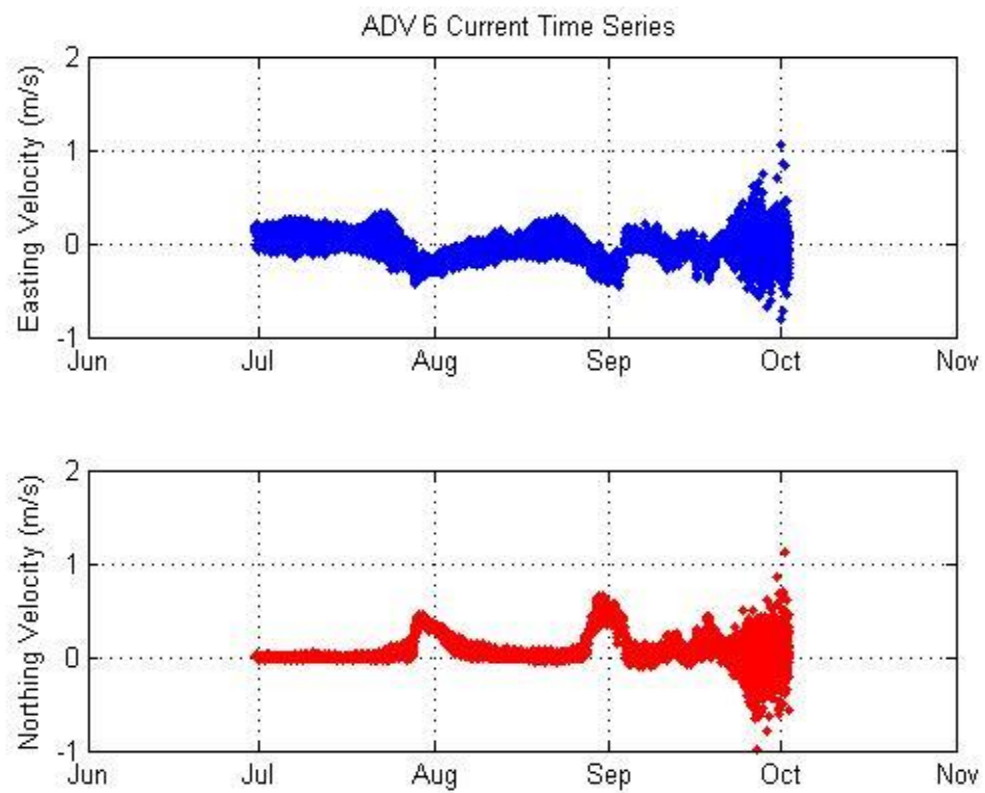


Figure 3-19. ADV 6 current time series

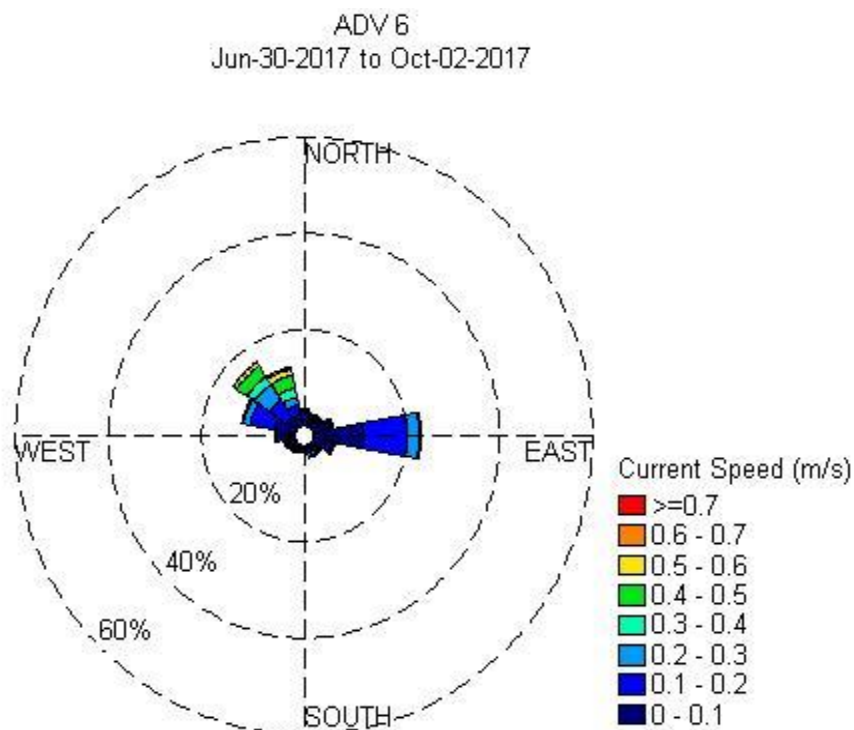


Figure 3-20. ADV 6 current rose

Table 3-12. ADV 6 current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|------|------|------|------|-------|-------|------|-------|------|-------|------|-------|------|-------|-------|-------|---------|
| 0-0.1 | 1.37 | 1.13 | 1.21 | 2.95 | 10.65 | 2.88 | 1.13 | 0.85 | 0.45 | 0.54 | 0.82 | 1.37 | 3.06 | 4.51 | 2.71 | 2.45 | 38.07 |
| 0.1-0.2 | 1.34 | 0.69 | 0.76 | 0.76 | 9.50 | 1.09 | 0.65 | 0.63 | 0.52 | 0.43 | 0.46 | 0.46 | 0.67 | 5.38 | 4.21 | 2.04 | 29.59 |
| 0.2-0.3 | 0.45 | 0.54 | 0.48 | 0.32 | 2.50 | 0.58 | 0.48 | 0.80 | 0.22 | 0.28 | 0.24 | 0.33 | 0.35 | 1.43 | 3.91 | 1.63 | 14.55 |
| 0.3-0.4 | 0.15 | 0.20 | 0.39 | 0.32 | 0.28 | 0.11 | 0.24 | 0.19 | 0.17 | 0.22 | 0.24 | 0.20 | 0.28 | 0.19 | 1.95 | 1.97 | 7.09 |
| 0.4-0.5 | 0.13 | 0.11 | 0.07 | 0.07 | 0.06 | 0.04 | 0.13 | 0.06 | 0.11 | 0.06 | 0.07 | 0.06 | 0.04 | 0.07 | 2.60 | 2.73 | 6.40 |
| 0.5-0.6 | 0.11 | 0.11 | 0.04 | 0.02 | 0.07 | 0.07 | | 0.07 | 0.09 | 0.04 | 0.07 | 0.07 | 0.04 | 0.07 | 0.95 | 1.26 | 3.10 |
| 0.6-0.7 | 0.19 | 0.02 | | 0.02 | 0.02 | 0.02 | | 0.06 | 0.04 | | 0.04 | | 0.02 | 0.02 | 0.02 | 0.45 | 0.89 |
| 0.7-0.8 | | | | | | | | 0.02 | | 0.04 | | 0.02 | | | 0.02 | 0.04 | 0.13 |
| 0.8-0.9 | | 0.02 | 0.02 | 0.04 | | | | | | | | | 0.02 | | | | 0.09 |
| 0.9-1.0 | | | | | | 0.02 | | | | | | | | | | | 0.02 |
| 1.0-1.1 | | | | | 0.02 | | | | | 0.02 | 0.02 | | | | | | 0.06 |
| 1.1+ | | | | | | | | | | | | | | | | 0.02 | 0.02 |
| Total | 3.73 | 2.82 | 2.97 | 4.49 | 23.10 | 4.81 | 2.63 | 2.67 | 1.60 | 1.61 | 1.97 | 2.52 | 4.47 | 11.67 | 16.36 | 12.58 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.18 | 0.18 | 0.17 | 0.12 | 0.12 | 0.12 | 0.15 | 0.19 | 0.21 | 0.20 | 0.18 | 0.14 | 0.11 | 0.13 | 0.25 | 0.30 | 0.18 |
| StDev | 0.16 | 0.15 | 0.14 | 0.13 | 0.08 | 0.12 | 0.12 | 0.15 | 0.16 | 0.18 | 0.18 | 0.15 | 0.12 | 0.08 | 0.15 | 0.19 | 0.15 |
| Min | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Max | 0.65 | 0.87 | 0.89 | 0.88 | 1.06 | 0.92 | 0.49 | 0.72 | 0.65 | 1.04 | 1.04 | 0.80 | 0.80 | 0.63 | 0.73 | 1.17 | 1.17 |

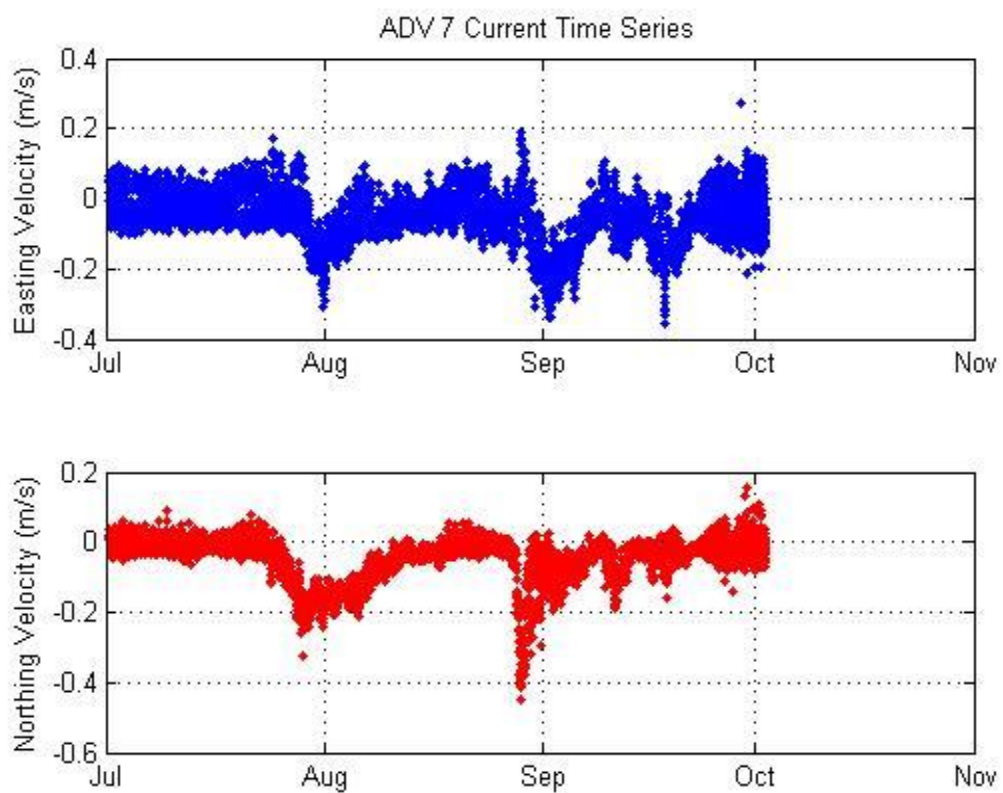


Figure 3-21. ADV 7 current time series

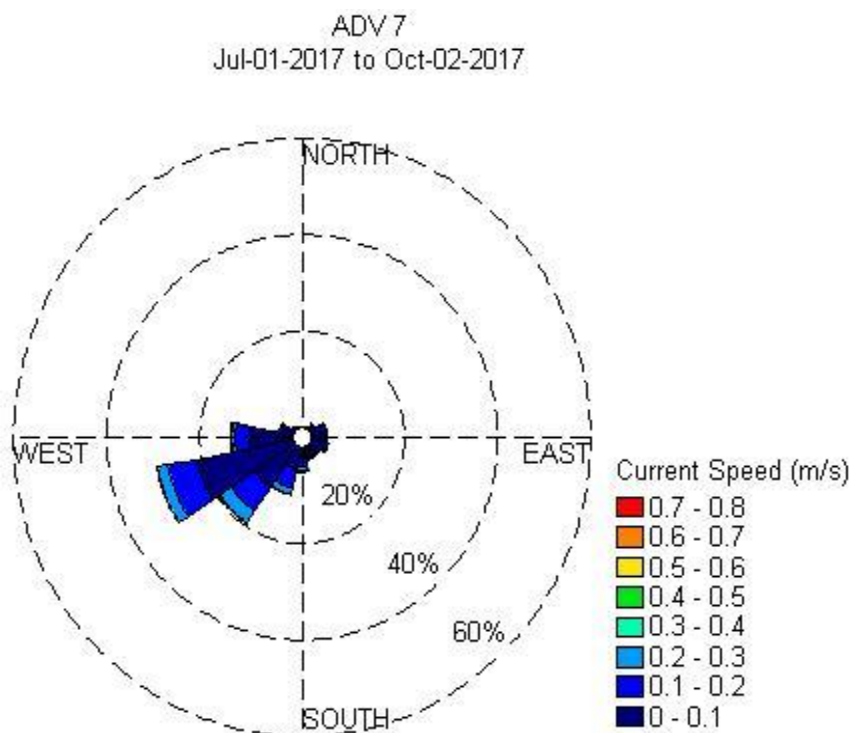


Figure 3-22. ADV 7 current rose

Table 3-13. ADV 7 current histogram

| V (m/s)\Dir | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|------|-------|------|-------|-------|-------|-------|-------|------|-------|---------|
| 0-0.1 | 0.27 | 0.35 | 1.32 | 3.29 | 3.12 | 3.51 | 2.26 | 1.85 | 2.34 | 4.50 | 10.36 | 21.15 | 9.31 | 2.40 | 0.64 | 0.27 | 66.93 |
| 0.1-0.2 | 0.02 | | 0.08 | 0.16 | 0.19 | 0.25 | 0.35 | 0.37 | 1.71 | 4.15 | 5.98 | 6.29 | 3.04 | 0.64 | 0.10 | | 23.33 |
| 0.2-0.3 | | | | | 0.02 | | 0.02 | 0.14 | 0.82 | 1.36 | 3.00 | 2.26 | 0.78 | 0.02 | | | 8.41 |
| 0.3-0.4 | | | | | | | | 0.23 | 0.25 | 0.08 | 0.18 | 0.14 | 0.31 | | | | 1.19 |
| 0.4-0.5 | | | | | | | | 0.12 | 0.02 | | | | | | | | 0.14 |
| 0.5-0.6 | | | | | | | | | | | | | | | | | 0.00 |
| 0.6-0.7 | | | | | | | | | | | | | | | | | 0.00 |
| 0.7-0.8 | | | | | | | | | | | | | | | | | 0.00 |
| 0.8-0.9 | | | | | | | | | | | | | | | | | 0.00 |
| 0.9-1.0 | | | | | | | | | | | | | | | | | 0.00 |
| 1.0-1.1 | | | | | | | | | | | | | | | | | 0.00 |
| 1.1+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.29 | 0.35 | 1.40 | 3.45 | 3.33 | 3.76 | 2.63 | 2.71 | 5.14 | 10.09 | 19.51 | 29.83 | 13.44 | 3.06 | 0.74 | 0.27 | 100.00 |
| | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | Overall |
| Mean | 0.04 | 0.03 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.11 | 0.12 | 0.11 | 0.11 | 0.09 | 0.09 | 0.07 | 0.04 | 0.02 | 0.09 |
| StDev | 0.04 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.12 | 0.09 | 0.07 | 0.07 | 0.06 | 0.07 | 0.04 | 0.04 | 0.01 | 0.07 |
| Min | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Max | 0.16 | 0.09 | 0.11 | 0.13 | 0.28 | 0.15 | 0.21 | 0.48 | 0.40 | 0.36 | 0.34 | 0.34 | 0.35 | 0.23 | 0.17 | 0.05 | 0.48 |

4. WAVE DATA

Wave data recorded by the ADCPs and ADVs are presented by time series plots of significant wave height (H_s), peak period (T_p), and peak direction (D_p). The statistical distribution for wave height and period are described by roses and histograms. Unlike currents, the wave direction is defined as the direction from which the waves are propagating; for example, a wave propagating from due west to east would have the direction of west, or the compass direction 270° from north. Wave parameter data was recovered and processed for the entire deployment duration for both ADCPs, however a drop in battery voltage reduced the sampling interval in the ADVs toward the end of the deployment period, resulting in minor loss of recorded wave data. Table 4-1 lists the duration of wave data recording in the ADV instruments

Table 4-1. ADV wave data recording interval

| Name | Start Data | End Data |
|-------|------------|-----------|
| ADV 1 | 6/29/2017 | 9/25/2017 |
| ADV 2 | 6/29/2017 | 9/26/2017 |
| ADV 3 | 6/29/2017 | 9/30/2017 |
| ADV 4 | 6/30/2017 | 9/10/2017 |
| ADV 5 | 6/30/2017 | 9/26/2017 |
| ADV 6 | 6/30/2017 | 9/21/2017 |
| ADV 7 | 7/1/2017 | 9/24/2017 |

ADCP1

The wave data from ADCP1 shows that the waves primarily approach from the north and west. The average wave height was 2.6 ft, largest recorded significant wave height was 9.25 ft and the average peak period was 8.6 seconds, on August 30 (Figure 4-1 to Figure 4-3 and Table 4-1 and Table 4-2). Two significant wave events impacted the west coast of Saipan during the deployment period. From July 28 - 30, wave heights exceeded 5 feet, possibly due to typhoons Nuru and Nesat which were active in the area at the time. During August 28-30, wave heights exceeded 8 feet and were believed to be from typhoon Hato and severe tropical storm Pakhar. These wave events are easily visible as distinct peaks on all of the time series records of the instruments.

ADCP2

The wave data from ADCP2 indicates that the waves primarily approach from the southwest to northwest directions, which is consistent with ADCP2's partially sheltered location inside the lagoon entrance channel. The average wave height was 2.26 ft, the largest recorded significant wave height was 8.76 ft and the average peak period was 9.6 seconds. In addition to the wave events seen at ADCP1, there was a large wave event during October 17-20 believed to be from typhoon Lan. All other ADCPs and ADVs were already recovered when this swell event hit, so this was the only instrument that recorded this event (Figure 4-4 to Figure 4-6 and Table 4-4 and Table 4-5).

ADV1

The wave data from ADV1 indicates that the waves almost exclusively approach from the north. The average wave height was 0.43 ft, the largest recorded significant wave height was 1.08 ft and the average of the peak period was 3.3 seconds while the average of the mean period was 10.6 seconds. The peak period represents the wave period associated with the most energetic waves occurring at the location, which on the reef flat, consist of shallow water, high frequency small waves. The mean period includes longer period water level increases associated wave surges and surf beat likely associated with wave groups and sets. Only peak period results will be presented for ADV2 - ADV7 because the peak period presents the typically occurring waves at the sites. Mean period was included for ADV1 to demonstrate the longer period pulses that were also recorded in the lagoon in addition to the short period waves (Figure 4-7 to Figure 4-10, and Table 4-6 to Table 4-8).

ADV2

The wave data from ADV2 shows waves approaching from two distinct directions: south southwest and east northeast. The average wave height was 0.63 ft, largest recorded significant wave height was 1.97 ft and the average of the peak period was 3.5 seconds (Figure 4-11 to Figure 4-13 and Table 4-9 and Table 4-10).

ADV3

The wave data from ADV3 indicates waves predominantly approaching from west southwest, which is aligned with the entrance to the lagoon. The average wave height was 1.52 ft, largest recorded significant wave height was 4.00 ft and the average of the peak period was 3.2 seconds (Figure 4-14 to Figure 4-16 and Table 4-11 and Table 4-12).

ADV4

The wave data from ADV4 shows waves predominantly approaching from the north to northeast. The average wave height was 0.57 ft, largest recorded significant wave height was 1.64 ft and the average of the peak period was 3.0 seconds (Figure 4-17 to Figure 4-19 and Table 4-13 and Table 4-14).

ADV5

The waves measured at ADV5 were predominantly from the northwest. The average wave height was 1.15 ft, largest recorded significant wave height was 4.99 ft and the average of the peak period was 4.5 seconds (Figure 4-20 to Figure 4-22 and Table 4-15 and Table 4-16).

ADV6

The wave data from ADV6 indicates that waves predominantly approach from the west northwest. The average wave height was 0.67 ft, largest recorded significant wave height was 4.23 ft and the average of the peak period was 3.3 seconds (Figure 4-23 to Figure 4-25 and Table 4-17 and Table 4-18).

ADV7

The wave data recorded at ADV7 indicates that waves predominantly approach from the southwest to west direction. ADV7 was located in very shallow water, therefore wave heights were small. The average wave height was 0.49 ft, largest recorded significant wave height was

1.51 ft and the average of the peak period was 4.1 seconds (Figure 4-26 to and Table 4-19 and Table 4-20).

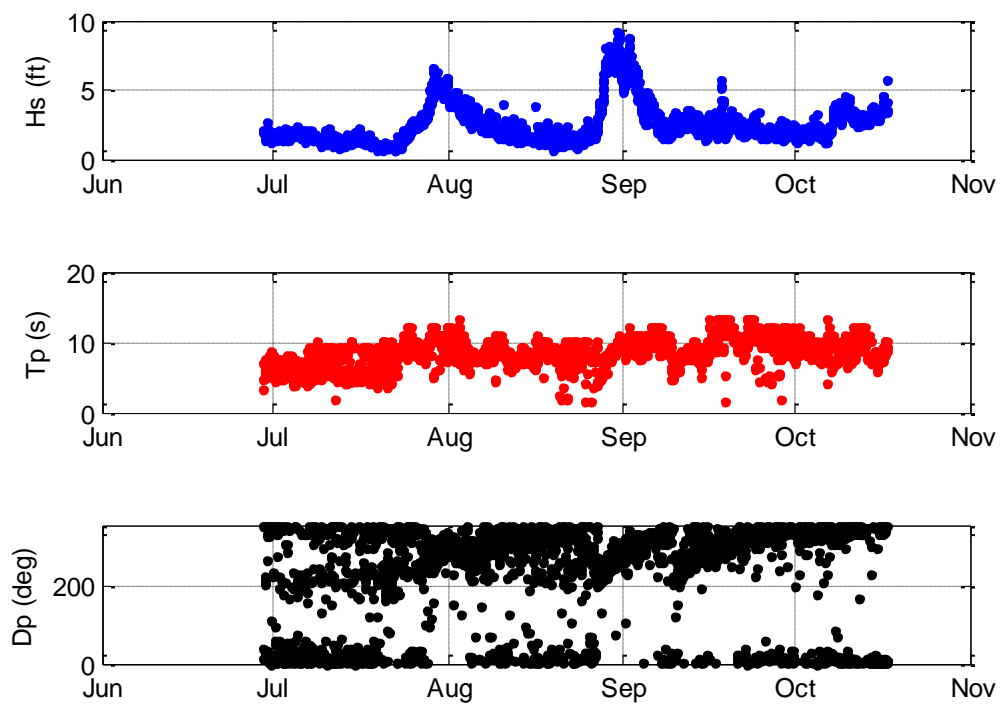


Figure 4-1. ADCP 1 time series peak wave parameters

ADCP 1 (Jun 2017 - Oct 2017): Wave Height (ft)

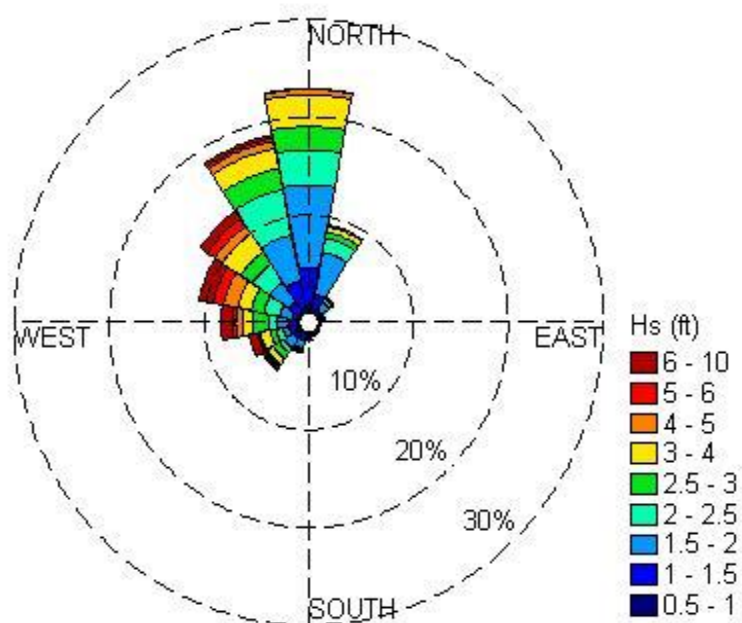


Figure 4-2. ADCP 1 wave height rose

Table 4-2. ADCP 1 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|-------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 0.5-1.0 | 0.6 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.3 | 0.4 | 0.1 | 0.0 | 0.1 | 0.6 | 2.99 |
| 1.0-1.5 | 4.0 | 1.8 | 0.4 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.4 | 0.8 | 0.6 | 0.7 | 0.9 | 0.8 | 1.4 | 2.7 | 14.82 |
| 1.5-2.0 | 8.4 | 4.4 | 1.1 | 0.3 | 0.1 | 0.0 | 0.0 | 0.1 | 0.2 | 0.8 | 1.2 | 0.7 | 1.3 | 1.3 | 2.4 | 4.8 | 27.17 |
| 2.0-2.5 | 3.6 | 1.5 | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.6 | 0.7 | 1.0 | 1.8 | 2.2 | 4.7 | 17.04 |
| 2.5-3.0 | 2.4 | 0.6 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.8 | 0.6 | 1.6 | 1.3 | 1.5 | 2.2 | 11.45 |
| 3.0-4.0 | 3.2 | 0.6 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.2 | 0.7 | 1.0 | 1.1 | 1.5 | 2.3 | 2.1 | 12.99 |
| 4.0-5.0 | 0.6 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.7 | 1.5 | 1.0 | 0.8 | 5.21 |
| 5-6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.4 | 1.1 | 0.9 | 0.3 | 3.08 |
| 6-8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.9 | 0.9 | 1.4 | 0.8 | 0.2 | 4.49 |
| 8+ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.2 | 0.1 | 0.1 | 0.77 |
| Total | 22.90 | 9.23 | 2.14 | 0.73 | 0.34 | 0.26 | 0.34 | 0.47 | 0.90 | 2.18 | 4.83 | 5.43 | 8.24 | 10.76 | 12.73 | 18.54 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 2.13 | 1.93 | 1.80 | 2.36 | 2.01 | 2.62 | 2.26 | 2.31 | 1.45 | 1.74 | 2.64 | 3.21 | 3.36 | 3.67 | 3.04 | 2.33 | 2.60 |
| StDev | 0.81 | 0.66 | 0.47 | 1.42 | 1.10 | 1.84 | 1.08 | 1.40 | 0.59 | 0.64 | 1.54 | 2.04 | 1.97 | 1.88 | 1.61 | 1.13 | 1.49 |
| Min | 0.75 | 0.66 | 0.89 | 1.31 | 0.75 | 0.69 | 0.89 | 0.95 | 0.72 | 0.89 | 0.72 | 0.79 | 0.95 | 0.92 | 0.72 | 0.72 | 0.66 |
| Max | 5.77 | 4.53 | 3.25 | 7.45 | 3.90 | 5.45 | 3.87 | 5.71 | 3.28 | 3.51 | 8.01 | 9.06 | 9.12 | 9.25 | 8.17 | 8.83 | 9.25 |

ADCP 1 (Jun 2017 - Oct 2017): Wave Period (s)

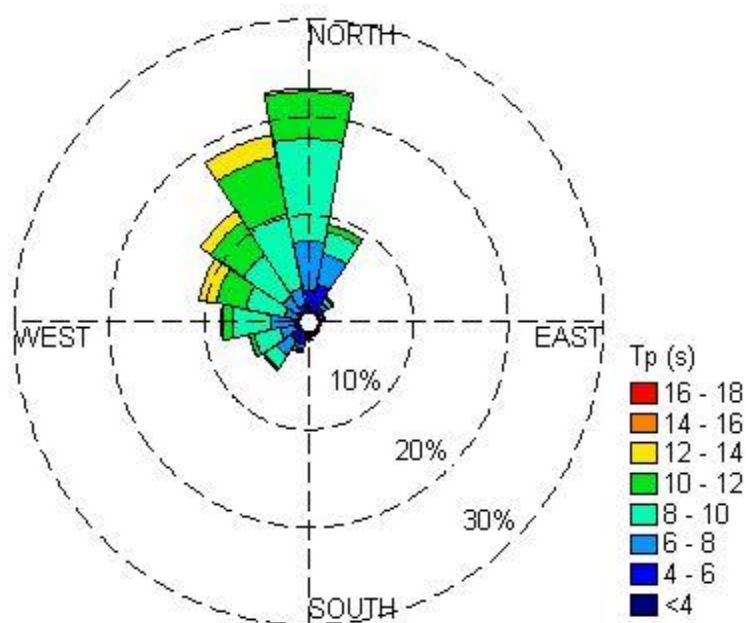


Figure 4-3. ADCP 1 wave period rose

Table 4-3. ADCP 1 wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|-------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 1.5-4 | 0.2 | 0.1 | 0.1 | | | | | 0.0 | | 0.1 | | | | | 0.0 | 0.1 | 0.90 |
| 4-6 | 2.0 | 2.8 | 0.7 | 0.1 | 0.0 | | 0.1 | 0.1 | 0.5 | 1.2 | 1.2 | 0.4 | 0.4 | 0.1 | 0.3 | 0.6 | 10.64 |
| 6-8 | 5.1 | 3.2 | 0.6 | 0.4 | 0.1 | 0.0 | 0.1 | 0.2 | 0.2 | 0.5 | 1.9 | 1.6 | 2.6 | 1.5 | 2.0 | 1.8 | 21.74 |
| 8-10 | 10.5 | 2.3 | 0.6 | 0.2 | 0.1 | 0.2 | 0.0 | 0.2 | 0.2 | 0.3 | 1.6 | 2.8 | 4.0 | 4.2 | 5.0 | 7.7 | 39.81 |
| 10-12 | 4.8 | 0.7 | 0.2 | | 0.1 | 0.0 | 0.0 | | | 0.0 | 0.1 | 0.5 | 1.1 | 3.2 | 4.1 | 6.0 | 20.97 |
| 12-14 | 0.3 | 0.0 | | | | | | | | | 0.0 | 0.0 | 0.2 | 1.8 | 1.3 | 2.2 | 5.94 |
| 14-16 | | | | | | | | | | | | | | | | | 0.00 |
| 16-18 | | | | | | | | | | | | | | | | | 0.00 |
| 18-20 | | | | | | | | | | | | | | | | | 0.00 |
| 20 + | | | | | | | | | | | | | | | | | 0.00 |
| Total | 22.90 | 9.23 | 2.14 | 0.73 | 0.34 | 0.26 | 0.34 | 0.47 | 0.90 | 2.18 | 4.83 | 5.43 | 8.24 | 10.76 | 12.73 | 18.54 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 8.5 | 7.1 | 6.9 | 7.2 | 8.2 | 8.9 | 6.3 | 7.2 | 6.2 | 6.0 | 7.3 | 8.1 | 8.4 | 9.7 | 9.5 | 9.6 | 8.6 |
| StDev | 1.7 | 1.9 | 2.1 | 1.3 | 1.5 | 1.0 | 2.5 | 1.8 | 1.7 | 1.7 | 1.5 | 1.5 | 1.5 | 1.7 | 1.8 | 1.8 | 2.0 |
| Min | 1.7 | 1.6 | 1.8 | 5.0 | 5.7 | 7.3 | 1.9 | 4.6 | 3.8 | 2.2 | 4.1 | 3.6 | 4.3 | 5.2 | 1.7 | 1.7 | 1.6 |
| Max | 13.4 | 12.1 | 10.2 | 8.8 | 10.2 | 10.2 | 10.2 | 9.4 | 9.4 | 10.2 | 12.1 | 12.1 | 12.1 | 13.4 | 13.4 | 13.4 | 13.4 |

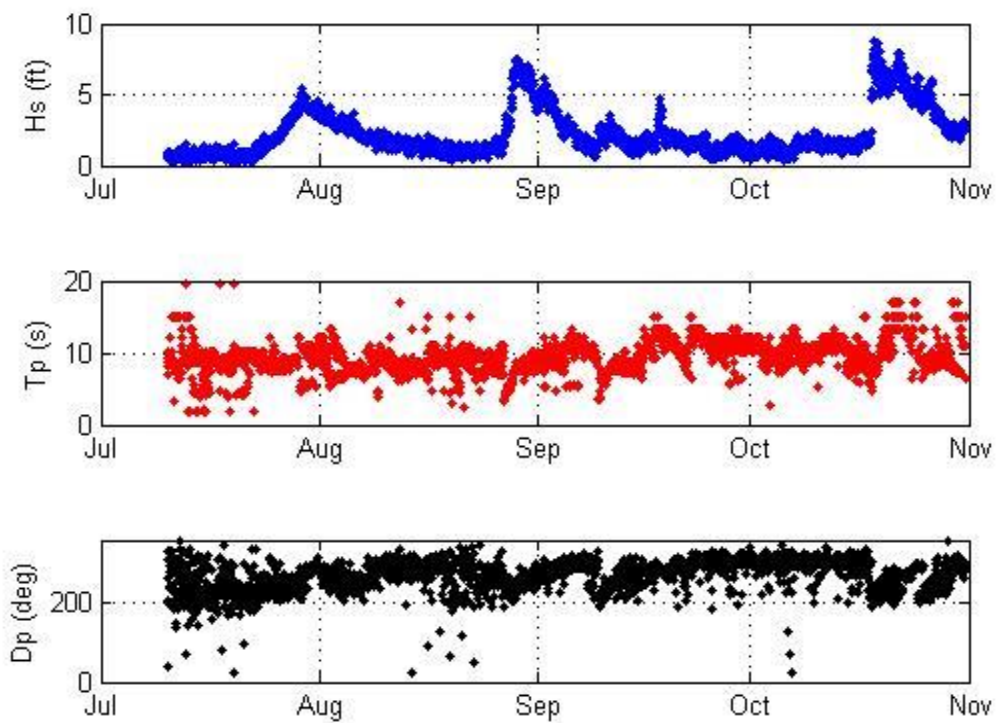


Figure 4-4. ADCP 2 time series peak wave parameters

ADCP 2 (Jul 2017 - Oct 2017): Wave Height (ft)

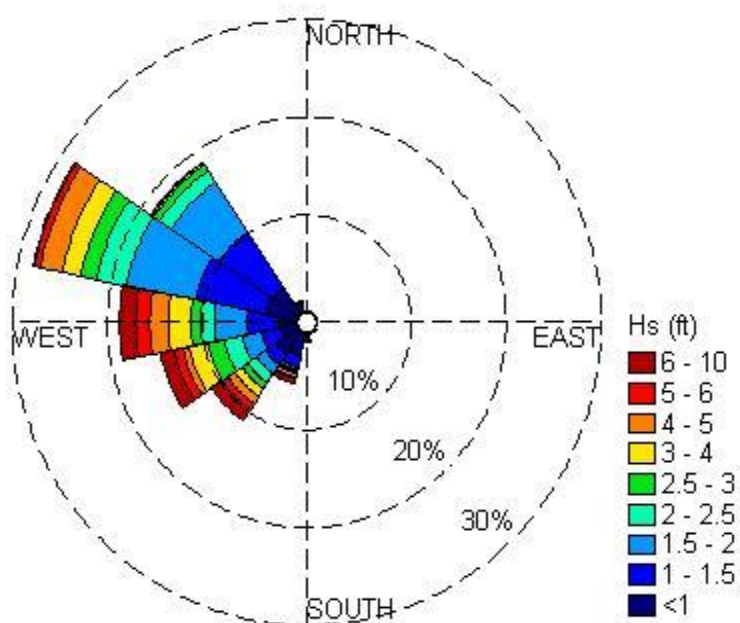


Figure 4-5. ADCP 2 wave height rose

Table 4-4. ADCP 2 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 0.0-0.5 | 0.0 | | | | | | 0.1 | 0.0 | 0.2 | 0.5 | 0.6 | 0.3 | 0.3 | 0.5 | 0.1 | 0.0 | 2.74 |
| 0.5-1.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | | 0.1 | 0.1 | 0.5 | 1.9 | 2.3 | 1.5 | 1.7 | 2.9 | 3.3 | 0.6 | 15.06 |
| 1.0-1.5 | | 0.0 | | | | 0.0 | 0.0 | | 0.2 | 1.2 | 1.3 | 2.1 | 3.3 | 7.6 | 6.8 | 0.3 | 22.76 |
| 1.5-2.0 | | 0.0 | | 0.1 | | | | | | 0.3 | 1.1 | 2.1 | 3.5 | 7.5 | 6.1 | 0.3 | 20.89 |
| 2.0-2.5 | 0.0 | | | | 0.0 | | | | | 0.2 | 1.1 | 2.0 | 1.4 | 3.2 | 1.4 | | 9.32 |
| 2.5-3.0 | | | | | | | | 0.1 | 0.2 | 0.8 | 1.8 | 1.1 | 1.7 | 0.7 | | | 6.24 |
| 3.0-4.0 | | | | | | | | | | 0.9 | 2.0 | 2.4 | 2.0 | 0.2 | | | 7.51 |
| 4.0-5.0 | | | | | | | | | | 0.4 | 0.9 | 0.7 | 1.9 | 2.4 | 0.1 | | 6.31 |
| 5-6 | | | | | | | | | | 0.2 | 0.7 | 0.9 | 1.5 | 0.6 | 0.1 | | 3.91 |
| 6-8 | | | | | | | | | | 0.5 | 1.3 | 1.5 | 1.7 | 0.2 | | | 5.11 |
| 8+ | | | | | | | | | | 0.1 | 0.1 | | | | | | 0.15 |
| Total | 0.15 | 0.11 | 0.08 | 0.11 | 0.11 | 0.04 | 0.19 | 0.11 | 0.94 | 5.37 | 11.04 | 14.69 | 18.71 | 28.36 | 18.75 | 1.24 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 1.10 | 1.27 | 0.52 | 1.36 | 1.19 | 1.08 | 0.62 | 0.63 | 0.88 | 1.99 | 2.76 | 2.82 | 2.89 | 2.05 | 1.51 | 1.07 | 2.26 |
| StDev | 0.84 | 0.57 | 0.00 | 0.32 | 0.73 | 0.00 | 0.24 | 0.16 | 0.59 | 2.02 | 2.14 | 1.81 | 1.85 | 1.19 | 0.61 | 0.38 | 1.63 |
| Min | 0.49 | 0.62 | 0.52 | 0.98 | 0.75 | 1.08 | 0.46 | 0.46 | 0.36 | 0.33 | 0.33 | 0.33 | 0.30 | 0.33 | 0.43 | 0.49 | 0.30 |
| Max | 2.33 | 1.71 | 0.52 | 1.57 | 2.03 | 1.08 | 1.05 | 0.75 | 2.66 | 8.66 | 8.76 | 7.94 | 7.87 | 7.15 | 5.64 | 1.94 | 8.76 |

ADCP 2 (Jul 2017 - Oct 2017): Wave Period (s)

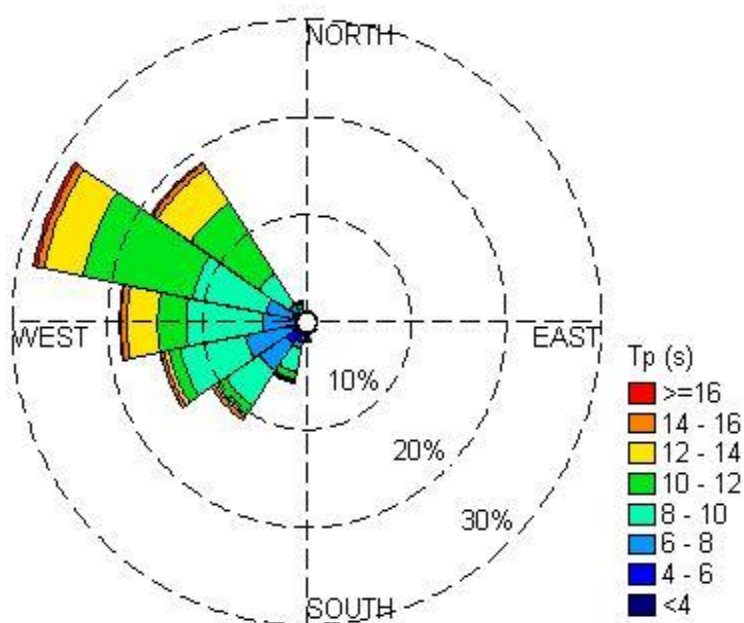


Figure 4-6. ADCP 2 wave period rose

Table 4-5. ADCP 2 wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 1.5-4 | | | | | | | 0.0 | | 0.2 | 0.3 | 0.3 | 0.2 | | 0.0 | 0.0 | | 0.94 |
| 4-6 | | | | | 0.0 | | | | 0.0 | 0.8 | 1.3 | 0.5 | 0.3 | 0.5 | 0.3 | | 3.79 |
| 6-8 | | | 0.1 | | | | 0.0 | | 0.1 | 0.6 | 3.4 | 4.9 | 3.3 | 2.9 | 0.9 | 0.0 | 16.30 |
| 8-10 | 0.0 | | | 0.0 | 0.0 | | 0.1 | 0.1 | 0.5 | 2.5 | 4.3 | 7.0 | 8.0 | 7.8 | 3.9 | 0.5 | 34.71 |
| 10-12 | 0.1 | 0.0 | | | | 0.0 | 0.0 | 0.0 | 0.1 | 0.8 | 1.1 | 1.2 | 3.0 | 11.8 | 8.7 | 0.5 | 27.27 |
| 12-14 | | 0.0 | | | | | | | | 0.2 | 0.3 | 0.5 | 3.2 | 4.2 | 4.2 | 0.3 | 12.89 |
| 14-16 | 0.0 | | | 0.0 | 0.0 | | | | 0.0 | 0.2 | 0.5 | 0.4 | 0.6 | 0.7 | 0.6 | 0.0 | 3.19 |
| 16-18 | | | | | | | | | | 0.0 | | | 0.2 | 0.4 | 0.2 | | 0.79 |
| 18-20 | | 0.0 | | 0.0 | | | | | | | | 0.0 | | | | | 0.11 |
| 20 + | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.15 | 0.11 | 0.08 | 0.11 | 0.11 | 0.04 | 0.19 | 0.11 | 0.94 | 5.37 | 11.04 | 14.69 | 18.71 | 28.36 | 18.75 | 1.24 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 11.4 | 14.7 | 7.3 | 14.6 | 9.1 | 10.2 | 7.8 | 9.6 | 8.0 | 8.4 | 8.2 | 8.5 | 9.7 | 10.2 | 10.7 | 10.5 | 9.6 |
| StDev | 2.4 | 4.3 | 0.6 | 5.1 | 5.5 | 0.0 | 3.5 | 1.5 | 2.8 | 2.8 | 2.3 | 1.9 | 2.2 | 2.0 | 1.9 | 1.8 | 2.3 |
| Min | 9.4 | 11.1 | 6.9 | 9.4 | 4.1 | 10.2 | 1.9 | 8.2 | 1.9 | 2.0 | 1.8 | 1.9 | 5.0 | 3.8 | 2.0 | 7.7 | 1.8 |
| Max | 14.9 | 19.5 | 7.7 | 19.5 | 14.9 | 10.2 | 11.1 | 11.1 | 14.9 | 16.9 | 14.9 | 19.5 | 16.9 | 16.9 | 16.9 | 14.9 | 19.5 |

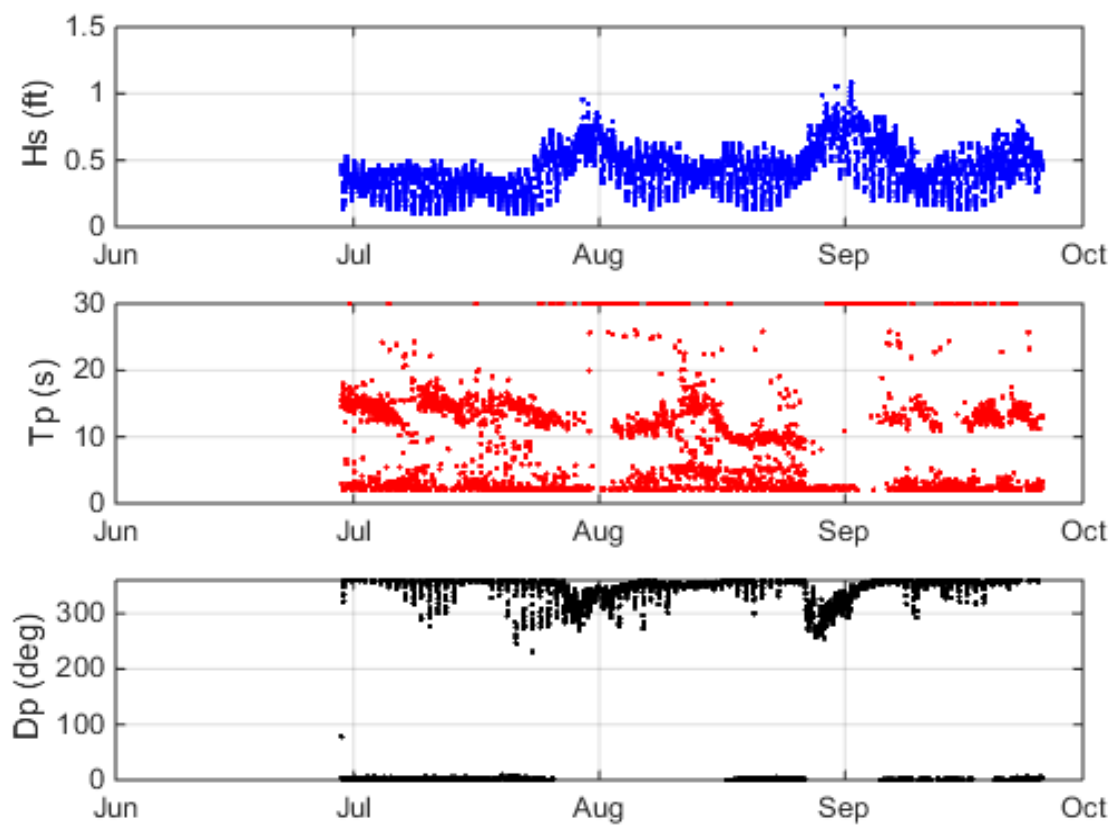


Figure 4-7. ADV 1 time series mean wave parameters

ADV 1 (Jun 2017 - Sep 2017): Wave Height (ft)

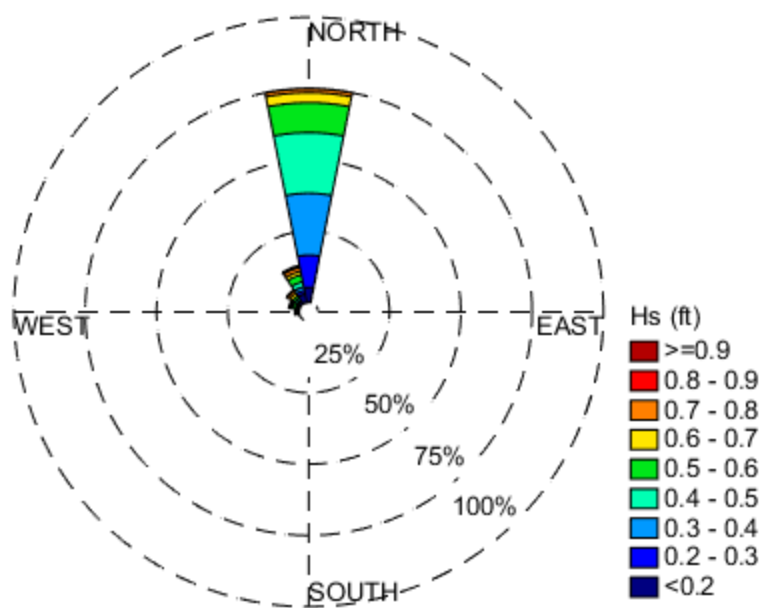


Figure 4-8. ADV 1 wave height rose

Table 4-6. ADV 1 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|-------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 0-0.5 | 59.6 | | | 0.0 | | | | | | | 0.0 | 0.0 | 0.4 | 1.6 | 2.5 | 7.4 | 71.67 |
| 0.5-1.0 | 15.5 | | | | | | | | | | | 0.1 | 1.1 | 2.2 | 3.5 | 5.7 | 28.12 |
| 1.0-1.5 | | | | | | | | | | | | | | 0.0 | 0.0 | 0.1 | 0.21 |
| 1.5-2.0 | | | | | | | | | | | | | | | | | 0.00 |
| 2.0-2.5 | | | | | | | | | | | | | | | | | 0.00 |
| 2.5-3.0 | | | | | | | | | | | | | | | | | 0.00 |
| 3.0-4.0 | | | | | | | | | | | | | | | | | 0.00 |
| 4.0-5.0 | | | | | | | | | | | | | | | | | 0.00 |
| 5.0+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 75.06 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.14 | 1.58 | 3.84 | 6.06 | 13.27 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 0.41 | 0.00 | 0.00 | 0.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.49 | 0.55 | 0.51 | 0.52 | 0.45 | 0.43 |
| StDev | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 0.22 | 0.22 | 0.22 | 0.23 | 0.16 |
| Min | 0.10 | 0.00 | 0.00 | 0.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Max | 0.95 | 0.00 | 0.00 | 0.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.79 | 0.98 | 1.05 | 1.05 | 1.08 | 1.08 |

ADV 1 (Jun 2017 - Sep 2017): Wave Period (s)

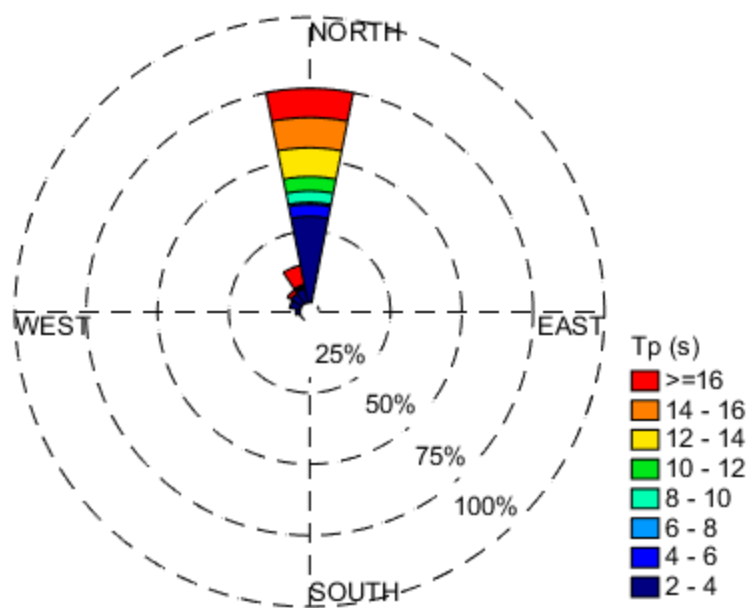


Figure 4-9. ADV 1 mean wave period rose

Table 4-7. ADV 1 mean wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|-------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| <4 | 30.1 | | | | | | | | | | 0.0 | 0.1 | 1.6 | 3.7 | 4.4 | 4.9 | 44.94 |
| 4-6 | 4.2 | | | | | | | | | | | | | | | 0.2 | 4.38 |
| 6-8 | 0.8 | | | | | | | | | | | | | | | 0.0 | 0.82 |
| 8-10 | 4.0 | | | | | | | | | | | | | | 0.0 | 0.0 | 4.05 |
| 10-12 | 5.0 | | | | | | | | | | | | | | | 0.6 | 5.66 |
| 12-14 | 10.1 | | | | | | | | | | | | | | 0.0 | 0.4 | 10.56 |
| 14-16 | 10.6 | | | 0.0 | | | | | | | | | | | | 0.2 | 10.82 |
| 16-18 | 1.8 | | | | | | | | | | | | | | | 0.0 | 1.84 |
| 18-20 | 0.5 | | | | | | | | | | | | | | | 0.1 | 0.64 |
| 20 + | 7.9 | | | | | | | | | | | | | 0.1 | 1.6 | 6.7 | 16.29 |
| Total | 75.06 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.14 | 1.58 | 3.84 | 6.06 | 13.27 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 10.1 | 0.0 | 0.0 | 15.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 2.2 | 2.2 | 2.9 | 9.5 | 17.4 | 10.6 |
| StDev | 8.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 4.3 | 12.2 | 13.0 | 9.7 |
| Min | 2.1 | 0.0 | 0.0 | 15.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 |
| Max | 30.0 | 0.0 | 0.0 | 15.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 2.4 | 2.7 | 30.0 | 30.0 | 30.0 | 30.0 |

ADV 1 (Jun 2017 - Sep 2017): Wave Period (s)

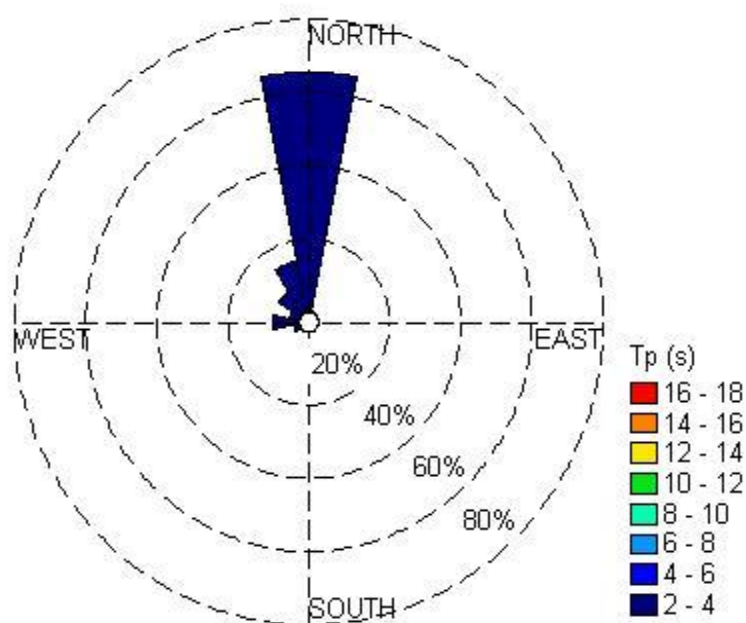


Figure 4-10. ADV 1 peak wave period rose

Table 4-8. ADV 1 peak wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|-------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| <4 | 65.6 | 0.5 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 1.6 | 7.4 | 2.9 | 7.3 | 14.4 | 0.0 | 99.93 |
| 4-6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.07 |
| 6-8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 8-10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 10-12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 12-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 14-16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 18-20 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 20 + | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| Total | 65.61 | 0.47 | 0.02 | 0.07 | 0.02 | 0.02 | 0.00 | 0.05 | 0.00 | 0.05 | 0.14 | 1.60 | 7.35 | 2.85 | 7.33 | 14.40 | 100.00 |

| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------|
| Mean | 3.3 | 3.2 | 3.3 | 3.4 | 3.1 | 3.0 | 0.0 | 3.0 | 0.0 | 3.0 | 2.8 | 2.6 | 2.8 | 2.9 | 3.3 | 3.3 | 3.3 |
| StDev | 0.2 | 0.2 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 |
| Min | 2.8 | 2.9 | 3.3 | 3.3 | 3.1 | 3.0 | 0.0 | 3.0 | 0.0 | 3.0 | 2.4 | 2.4 | 2.3 | 2.5 | 2.7 | 2.8 | 2.3 |
| Max | 4.0 | 3.5 | 3.3 | 3.4 | 3.1 | 3.0 | 0.0 | 3.0 | 0.0 | 3.0 | 3.0 | 3.0 | 3.5 | 3.4 | 4.0 | 4.1 | 4.1 |

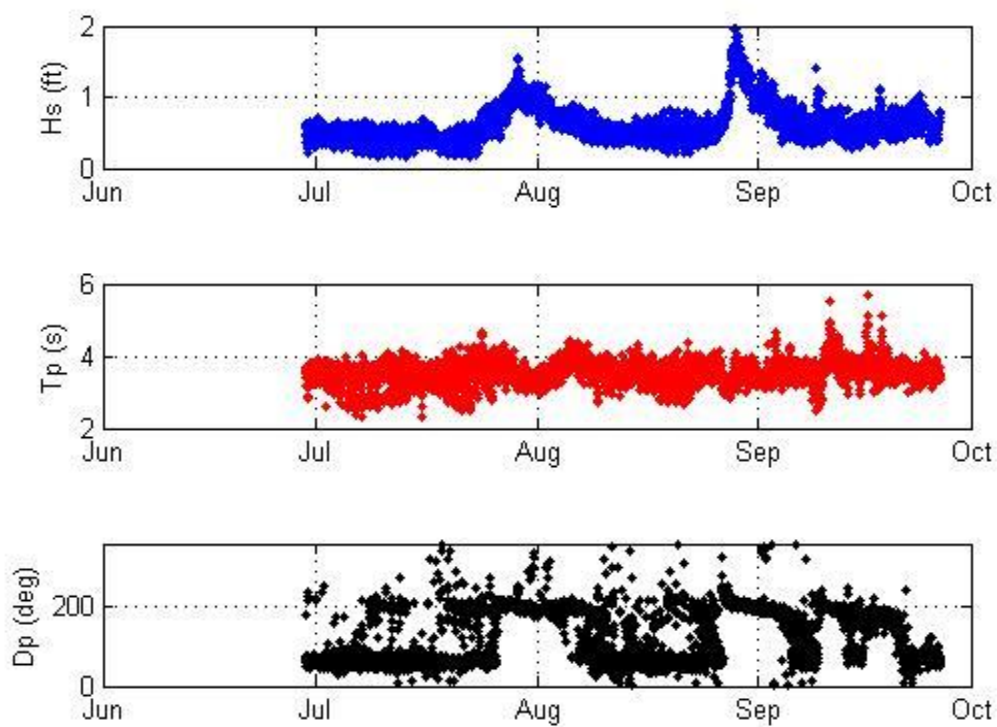


Figure 4-11. ADV 2 time series peak wave parameters

ADV 2 (Jun 2017 - Sep 2017): Wave Height (ft)

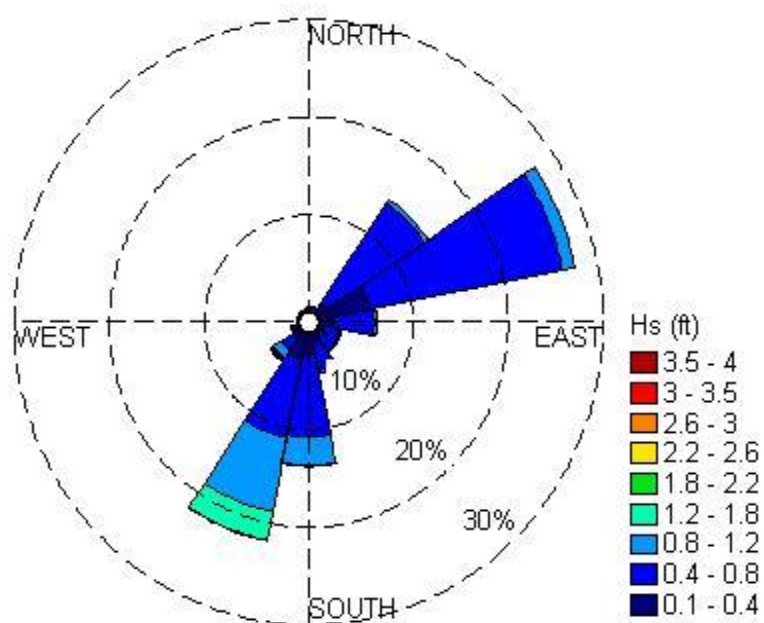


Figure 4-12. ADV 2 wave height rose

Table 4-9. ADV 2 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|------|------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 0-0.5 | 0.2 | 0.3 | 5.1 | 12.5 | 2.7 | 1.0 | 1.0 | 1.8 | 4.0 | 4.5 | 1.2 | 0.3 | 0.1 | 0.0 | 0.1 | 0.0 | 34.87 |
| 0.5-1.0 | 0.3 | 0.4 | 9.1 | 15.1 | 3.4 | 1.6 | 1.7 | 2.6 | 9.0 | 11.2 | 2.0 | 0.4 | 0.1 | 0.2 | 0.1 | 0.0 | 57.10 |
| 1.0-1.5 | 0.0 | | | 0.0 | 0.0 | | | 0.0 | 0.7 | 5.2 | 0.5 | 0.1 | | 0.0 | 0.0 | 0.2 | 6.89 |
| 1.5-2.0 | | | | | | | | | | 1.0 | 0.1 | 0.0 | | | | | 1.14 |
| 2.0-2.5 | | | | | | | | | | | | | | | | | 0.00 |
| 2.5-3.0 | | | | | | | | | | | | | | | | | 0.00 |
| 3.0-4.0 | | | | | | | | | | | | | | | | | 0.00 |
| 4.0-5.0 | | | | | | | | | | | | | | | | | 0.00 |
| 5.0+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.49 | 0.65 | 14.15 | 27.59 | 6.19 | 2.57 | 2.64 | 4.34 | 13.75 | 21.85 | 3.85 | 0.91 | 0.23 | 0.26 | 0.28 | 0.26 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 0.69 | 0.53 | 0.55 | 0.53 | 0.54 | 0.55 | 0.57 | 0.56 | 0.65 | 0.82 | 0.70 | 0.66 | 0.58 | 0.76 | 0.74 | 0.99 | 0.63 |
| StDev | 0.23 | 0.12 | 0.12 | 0.14 | 0.17 | 0.17 | 0.17 | 0.19 | 0.22 | 0.35 | 0.35 | 0.34 | 0.31 | 0.29 | 0.28 | 0.38 | 0.26 |
| Min | 0.43 | 0.33 | 0.23 | 0.16 | 0.23 | 0.20 | 0.20 | 0.20 | 0.20 | 0.16 | 0.16 | 0.23 | 0.20 | 0.33 | 0.36 | 0.33 | 0.16 |
| Max | 1.21 | 0.85 | 0.98 | 1.02 | 1.41 | 0.92 | 0.98 | 1.02 | 1.28 | 1.97 | 1.87 | 1.51 | 0.98 | 1.18 | 1.18 | 1.35 | 1.97 |

ADV 2 (Jun 2017 - Sep 2017): Wave Period (s)

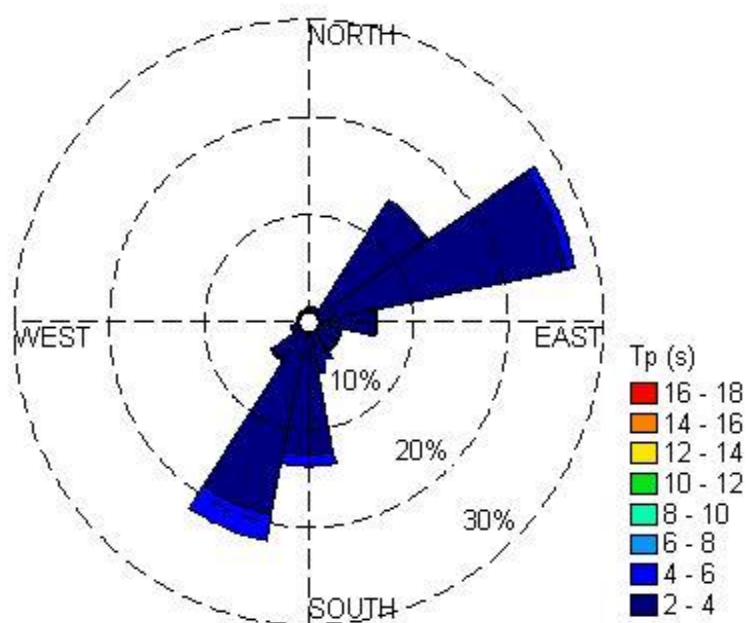


Figure 4-13. ADV 2 Peak wave period rose

Table 4-10. ADV 2 peak wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|------|------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| <4 | 0.5 | 0.6 | 13.8 | 26.7 | 6.0 | 2.5 | 2.6 | 4.3 | 12.6 | 19.1 | 3.5 | 0.9 | 0.2 | 0.3 | 0.3 | 0.3 | 94.19 |
| 4-6 | | 0.0 | 0.3 | 0.9 | 0.2 | 0.1 | 0.0 | 0.0 | 1.2 | 2.7 | 0.3 | | | | | | 5.81 |
| 6-8 | | | | | | | | | | | | | | | | | 0.00 |
| 8-10 | | | | | | | | | | | | | | | | | 0.00 |
| 10-12 | | | | | | | | | | | | | | | | | 0.00 |
| 12-14 | | | | | | | | | | | | | | | | | 0.00 |
| 14-16 | | | | | | | | | | | | | | | | | 0.00 |
| 16-18 | | | | | | | | | | | | | | | | | 0.00 |
| 18-20 | | | | | | | | | | | | | | | | | 0.00 |
| 20 + | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.49 | 0.65 | 14.15 | 27.59 | 6.19 | 2.57 | 2.64 | 4.34 | 13.75 | 21.85 | 3.85 | 0.91 | 0.23 | 0.26 | 0.28 | 0.26 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 3.2 | 3.5 | 3.6 | 3.6 | 3.5 | 3.5 | 3.5 | 3.5 | 3.6 | 3.6 | 3.3 | 3.1 | 3.1 | 3.2 | 3.3 | 3.3 | 3.5 |
| StDev | 0.1 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 |
| Min | 3.1 | 3.0 | 3.0 | 2.8 | 2.3 | 2.7 | 2.5 | 2.6 | 2.5 | 2.5 | 2.5 | 2.8 | 2.8 | 3.1 | 3.2 | 3.1 | 2.3 |
| Max | 3.4 | 4.2 | 4.4 | 4.3 | 4.2 | 4.3 | 4.2 | 4.3 | 5.7 | 5.5 | 4.7 | 3.6 | 3.2 | 3.6 | 3.5 | 3.6 | 5.7 |

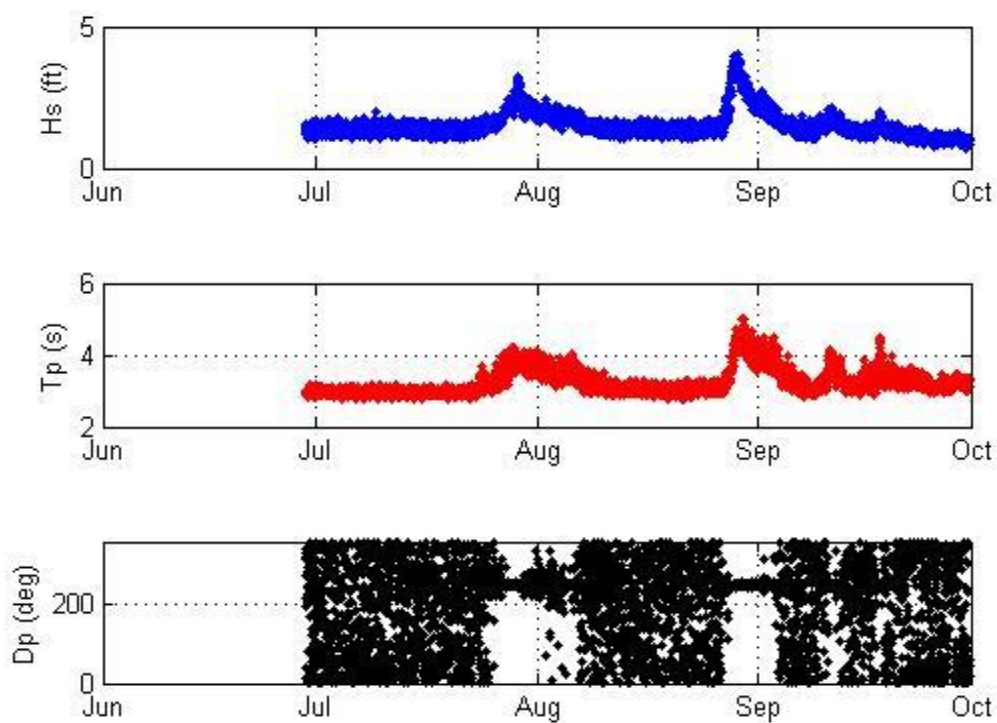


Figure 4-14. ADV 3 time series peak wave parameters

ADV 3 (Jun 2017 - Sep 2017): Wave Height (ft)

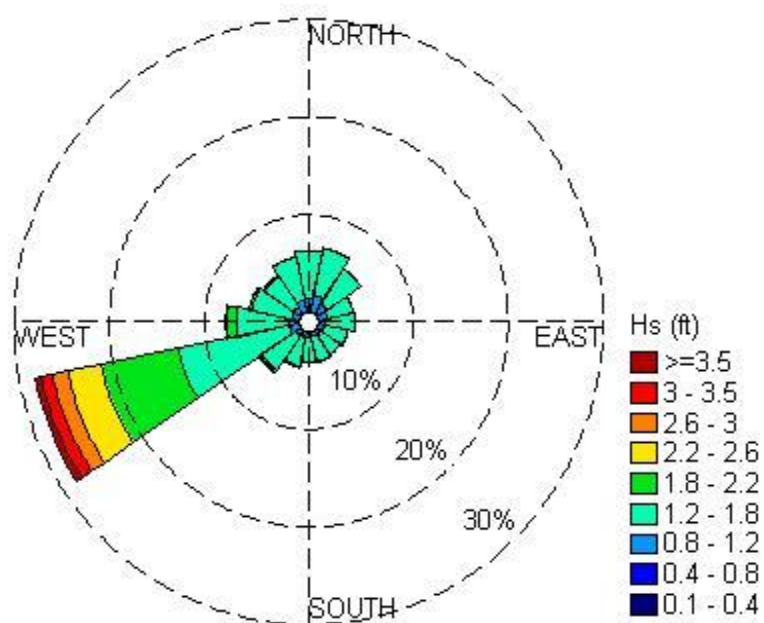


Figure 4-15. ADV 3 wave height rose

Table 4-11. ADV 3 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| 0-0.5 | | | | | | | | | | | | | | | | | 0.00 |
| 0.5-1.0 | 0.3 | 0.4 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 3.06 |
| 1.0-1.5 | 5.0 | 5.3 | 4.1 | 3.2 | 3.1 | 2.5 | 2.5 | 2.4 | 2.4 | 3.1 | 3.5 | 6.5 | 4.8 | 3.9 | 3.6 | 4.4 | 60.41 |
| 1.5-2.0 | 1.0 | 1.1 | 1.2 | 0.4 | 0.6 | 0.5 | 0.4 | 0.6 | 0.6 | 0.5 | 1.5 | 10.7 | 2.1 | 1.2 | 1.0 | 1.1 | 24.54 |
| 2.0-2.5 | | | | 0.0 | | | | 0.0 | | 0.0 | 0.2 | 7.0 | 0.6 | 0.1 | 0.0 | | 7.93 |
| 2.5-3.0 | | | | | | | | | | | 0.0 | 2.1 | 0.0 | | | | 2.19 |
| 3.0-4.0 | | | | | | | | | | | | 1.8 | | | | | 1.83 |
| 4.0-5.0 | | | | | | | | | | | | 0.0 | | | | | 0.04 |
| 5.0+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 6.34 | 6.74 | 5.58 | 3.80 | 3.89 | 3.22 | 2.99 | 3.19 | 3.08 | 3.75 | 5.31 | 28.34 | 7.75 | 5.40 | 4.80 | 5.81 | 100.00 |

| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|---------|
| Mean | 1.32 | 1.32 | 1.34 | 1.30 | 1.33 | 1.32 | 1.34 | 1.35 | 1.35 | 1.36 | 1.43 | 1.94 | 1.46 | 1.38 | 1.36 | 1.33 | 1.52 |
| StDev | 0.18 | 0.20 | 0.18 | 0.17 | 0.17 | 0.19 | 0.17 | 0.17 | 0.18 | 0.19 | 0.25 | 0.58 | 0.30 | 0.21 | 0.20 | 0.18 | 0.44 |
| Min | 0.69 | 0.72 | 0.85 | 0.82 | 0.89 | 0.75 | 0.85 | 0.92 | 0.85 | 0.89 | 0.79 | 0.85 | 0.89 | 0.85 | 0.85 | 0.89 | 0.69 |
| Max | 1.77 | 1.97 | 1.74 | 2.00 | 1.84 | 1.84 | 1.80 | 2.10 | 1.97 | 2.07 | 2.53 | 4.00 | 2.59 | 2.13 | 2.39 | 1.84 | 4.00 |

ADV 3 (Jun 2017 - Sep 2017): Wave Period (s)

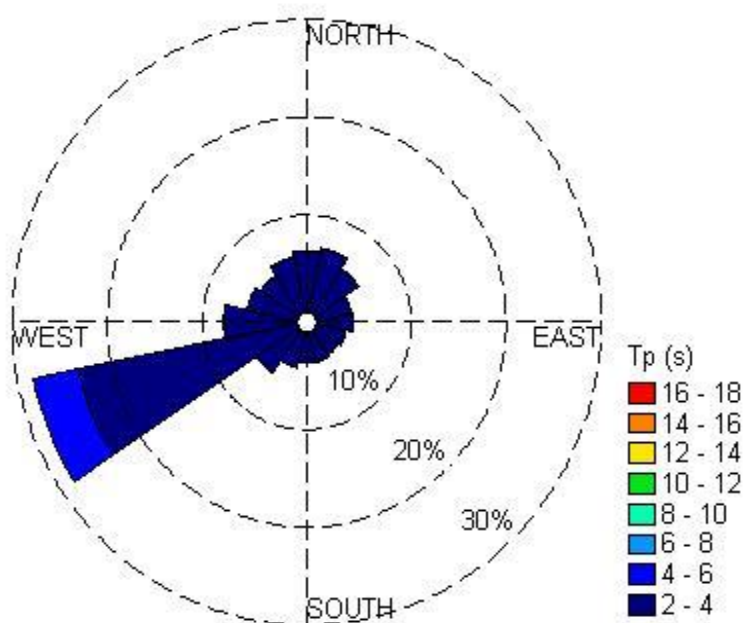


Figure 4-16. ADV 3 peak wave period rose

Table 4-12. ADV 3 peak wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| <4 | 6.3 | 6.7 | 5.6 | 3.8 | 3.9 | 3.2 | 3.0 | 3.2 | 3.1 | 3.8 | 5.3 | 23.4 | 7.7 | 5.4 | 4.8 | 5.8 | 95.06 |
| 4-6 | | | | | | | | | | | 0.0 | 4.9 | 0.0 | | | | 4.94 |
| 6-8 | | | | | | | | | | | | | | | | | 0.00 |
| 8-10 | | | | | | | | | | | | | | | | | 0.00 |
| 10-12 | | | | | | | | | | | | | | | | | 0.00 |
| 12-14 | | | | | | | | | | | | | | | | | 0.00 |
| 14-16 | | | | | | | | | | | | | | | | | 0.00 |
| 16-18 | | | | | | | | | | | | | | | | | 0.00 |
| 18-20 | | | | | | | | | | | | | | | | | 0.00 |
| 20 + | | | | | | | | | | | | | | | | | 0.00 |
| Total | 6.34 | 6.74 | 5.58 | 3.80 | 3.89 | 3.22 | 2.99 | 3.19 | 3.08 | 3.75 | 5.31 | 28.34 | 7.75 | 5.40 | 4.80 | 5.81 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.0 | 3.1 | 3.1 | 3.1 | 3.6 | 3.2 | 3.1 | 3.1 | 3.1 | 3.2 |
| StDev | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 |
| Min | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Max | 3.7 | 3.7 | 3.6 | 3.6 | 3.6 | 3.6 | 3.5 | 3.5 | 3.5 | 3.7 | 4.0 | 5.0 | 4.5 | 3.7 | 3.8 | 3.7 | 5.0 |

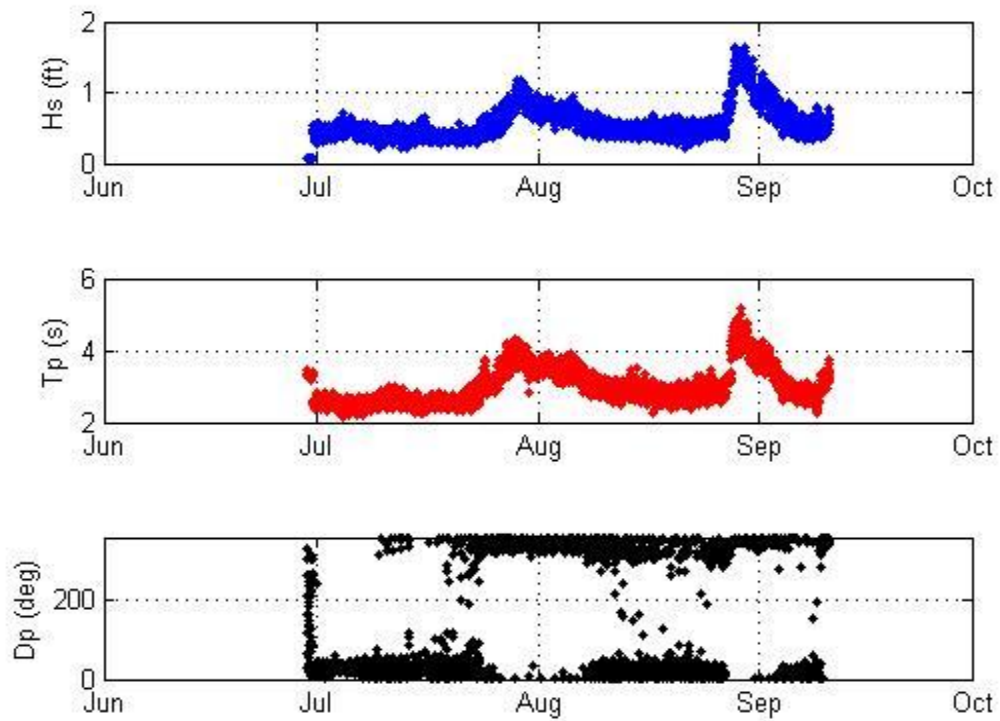


Figure 4-17. ADV 4 time series peak wave parameters

ADV 4 (Jun 2017 - Sep 2017): Wave Height (ft)

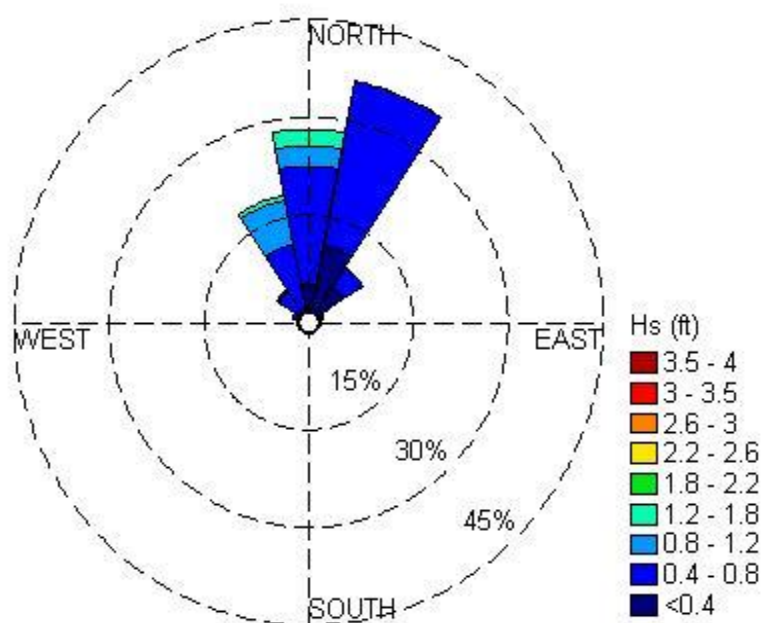


Figure 4-18. ADV 4 wave height rose

Table 4-13. ADV 4 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|-------|-------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 0-0.5 | 10.7 | 27.4 | 7.4 | 0.8 | 0.3 | 0.3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.3 | 0.3 | 0.4 | 1.4 | 2.1 | 52.13 |
| 0.5-1.0 | 13.8 | 8.8 | 1.2 | 0.0 | | | | | | | 0.0 | | 0.1 | 0.7 | 3.1 | 13.6 | 41.47 |
| 1.0-1.5 | 3.4 | | | | | | | | | | | | | | | 2.7 | 6.07 |
| 1.5-2.0 | 0.3 | | | | | | | | | | | | | | | 0.0 | 0.34 |
| 2.0-2.5 | | | | | | | | | | | | | | | | | 0.00 |
| 2.5-3.0 | | | | | | | | | | | | | | | | | 0.00 |
| 3.0-4.0 | | | | | | | | | | | | | | | | | 0.00 |
| 4.0-5.0 | | | | | | | | | | | | | | | | | 0.00 |
| 5.0+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 28.17 | 36.25 | 8.67 | 0.82 | 0.34 | 0.26 | 0.11 | 0.23 | 0.06 | 0.17 | 0.14 | 0.31 | 0.40 | 1.16 | 4.48 | 18.42 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 0.65 | 0.46 | 0.41 | 0.37 | 0.29 | 0.30 | 0.13 | 0.30 | 0.21 | 0.25 | 0.23 | 0.23 | 0.39 | 0.53 | 0.56 | 0.78 | 0.57 |
| StDev | 0.30 | 0.09 | 0.10 | 0.10 | 0.17 | 0.15 | 0.15 | 0.20 | 0.21 | 0.20 | 0.23 | 0.17 | 0.20 | 0.09 | 0.15 | 0.22 | 0.24 |
| Min | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.03 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.36 | 0.07 | 0.07 | 0.03 |
| Max | 1.64 | 0.85 | 0.79 | 0.52 | 0.49 | 0.46 | 0.36 | 0.49 | 0.36 | 0.49 | 0.56 | 0.49 | 0.66 | 0.85 | 0.95 | 1.64 | 1.64 |

ADV 4 (Jun 2017 - Sep 2017): Wave Period (s)

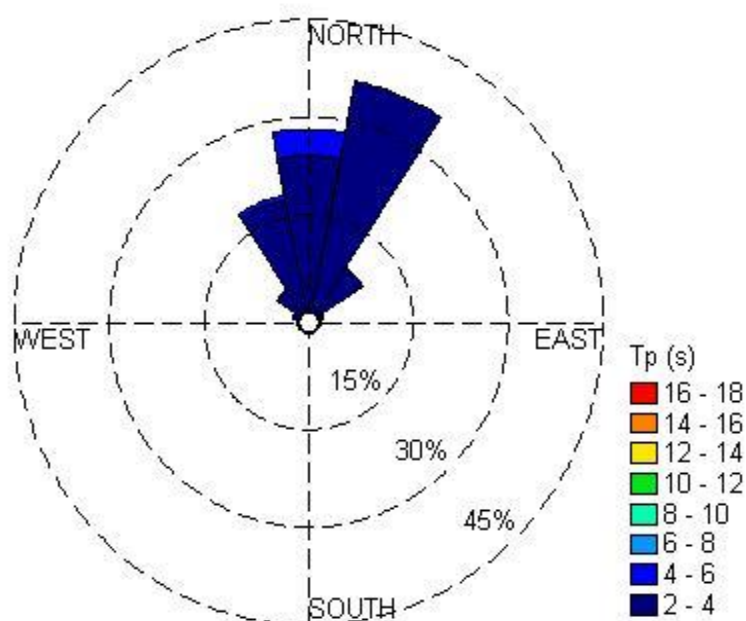


Figure 4-19. ADV 4 peak wave period rose

Table 4-14. ADV 4 peak wave histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|-------|-------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| <4 | 24.1 | 36.3 | 8.7 | 0.8 | 0.3 | 0.3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.3 | 0.4 | 1.2 | 4.5 | 17.7 | 95.21 |
| 4-6 | 4.0 | | | | | | | | | | | | | | | 0.8 | 4.79 |
| 6-8 | | | | | | | | | | | | | | | | | 0.00 |
| 8-10 | | | | | | | | | | | | | | | | | 0.00 |
| 10-12 | | | | | | | | | | | | | | | | | 0.00 |
| 12-14 | | | | | | | | | | | | | | | | | 0.00 |
| 14-16 | | | | | | | | | | | | | | | | | 0.00 |
| 16-18 | | | | | | | | | | | | | | | | | 0.00 |
| 18-20 | | | | | | | | | | | | | | | | | 0.00 |
| 20 + | | | | | | | | | | | | | | | | | 0.00 |
| Total | 28.17 | 36.25 | 8.67 | 0.82 | 0.34 | 0.26 | 0.11 | 0.23 | 0.06 | 0.17 | 0.14 | 0.31 | 0.40 | 1.16 | 4.48 | 18.42 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 3.3 | 2.6 | 2.5 | 2.7 | 2.9 | 2.8 | 3.2 | 3.0 | 3.0 | 3.0 | 3.2 | 2.9 | 3.0 | 3.0 | 3.1 | 3.4 | 3.0 |
| StDev | 0.6 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.4 | 0.3 | 0.4 | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 |
| Min | 2.3 | 2.2 | 2.2 | 2.3 | 2.4 | 2.4 | 2.6 | 2.5 | 2.6 | 2.4 | 2.8 | 2.4 | 2.7 | 2.6 | 2.4 | 2.5 | 2.2 |
| Max | 5.2 | 3.5 | 3.4 | 3.3 | 3.4 | 3.4 | 3.4 | 3.4 | 3.4 | 3.3 | 3.4 | 3.4 | 3.3 | 3.4 | 3.8 | 4.6 | 5.2 |

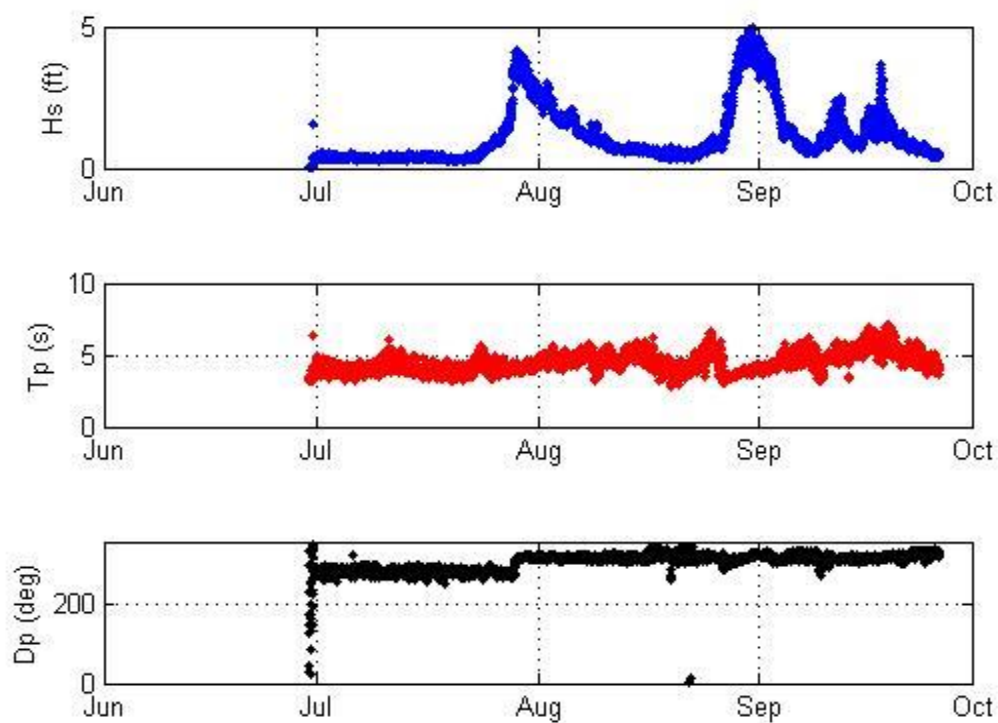


Figure 4-20. ADV 5 time series wave parameters

ADV 5 (Jun 2017 - Sep 2017): Wave Height (ft)

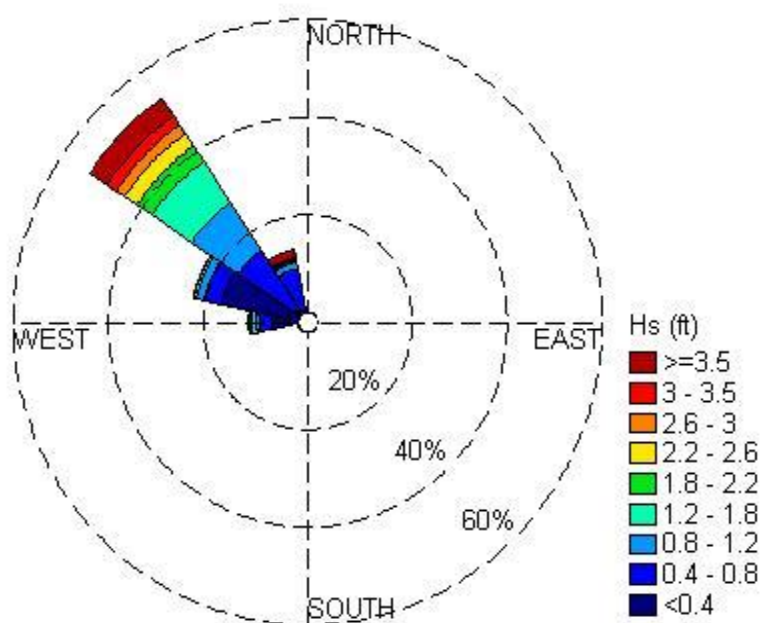


Figure 4-21. ADV 5 wave height rose

Table 4-15. ADV 5 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 0-0.5 | 0.0 | 0.1 | 0.0 | | 0.0 | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 7.1 | 19.2 | 2.6 | 3.3 | 32.73 |
| 0.5-1.0 | | | | | | | | | | | | | 1.3 | 2.1 | 19.5 | 7.1 | 30.05 |
| 1.0-1.5 | | | | | | | | | | | | | 0.9 | 0.9 | 11.1 | 0.7 | 13.52 |
| 1.5-2.0 | | | | | | | | | | 0.0 | | | 0.6 | 0.3 | 6.7 | 0.0 | 7.64 |
| 2.0-2.5 | | | | | | | | | | | | | 0.2 | 0.0 | 3.8 | 0.0 | 4.09 |
| 2.5-3.0 | | | | | | | | | | | | | 0.1 | | 2.8 | | 2.87 |
| 3.0-4.0 | | | | | | | | | | | | | 0.3 | 0.0 | 4.8 | 1.5 | 6.63 |
| 4.0-5.0 | | | | | | | | | | | | | | | 1.8 | 0.6 | 2.47 |
| 5.0+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.05 | 0.09 | 0.02 | 0.00 | 0.02 | 0.00 | 0.05 | 0.09 | 0.05 | 0.07 | 0.05 | 0.12 | 10.51 | 22.60 | 53.14 | 13.14 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 0.25 | 0.13 | 0.03 | 0.00 | 0.03 | 0.00 | 0.03 | 0.03 | 0.03 | 0.55 | 0.03 | 0.28 | 0.70 | 0.46 | 1.54 | 1.16 | 1.15 |
| StDev | 0.30 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.89 | 0.00 | 0.23 | 0.67 | 0.29 | 1.04 | 1.21 | 1.02 |
| Min | 0.03 | 0.03 | 0.03 | 0.00 | 0.03 | 0.00 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Max | 0.46 | 0.43 | 0.03 | 0.00 | 0.03 | 0.00 | 0.03 | 0.03 | 0.03 | 1.57 | 0.03 | 0.49 | 3.51 | 3.48 | 4.92 | 4.99 | 4.99 |

ADV 5 (Jun 2017 - Sep 2017): Wave Period (s)

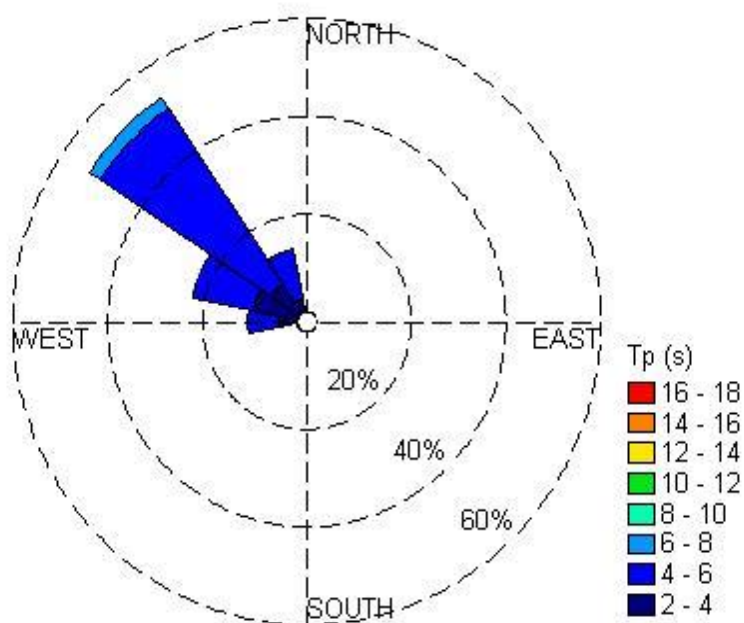


Figure 4-22. ADV 5 peak wave period rose

Table 4-16. ADV 5 peak wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| <4 | 0.0 | 0.1 | 0.0 | | 0.0 | | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 3.9 | 9.6 | 7.2 | 2.8 | 23.96 |
| 4-6 | 0.0 | 0.0 | | | | | | | | | | 0.0 | 6.6 | 13.0 | 43.3 | 10.3 | 73.24 |
| 6-8 | | | | | | | | | | 0.0 | | | | 0.0 | 2.7 | 0.0 | 2.80 |
| 8-10 | | | | | | | | | | | | | | | | | 0.00 |
| 10-12 | | | | | | | | | | | | | | | | | 0.00 |
| 12-14 | | | | | | | | | | | | | | | | | 0.00 |
| 14-16 | | | | | | | | | | | | | | | | | 0.00 |
| 16-18 | | | | | | | | | | | | | | | | | 0.00 |
| 18-20 | | | | | | | | | | | | | | | | | 0.00 |
| 20 + | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.05 | 0.09 | 0.02 | 0.00 | 0.02 | 0.00 | 0.05 | 0.09 | 0.05 | 0.07 | 0.05 | 0.12 | 10.51 | 22.60 | 53.14 | 13.14 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 3.8 | 3.5 | 3.4 | 0.0 | 3.3 | 0.0 | 3.5 | 3.3 | 3.3 | 4.4 | 3.4 | 3.5 | 4.1 | 4.1 | 4.7 | 4.5 | 4.5 |
| StDev | 0.5 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 1.8 | 0.0 | 0.3 | 0.5 | 0.4 | 0.7 | 0.6 | 0.7 |
| Min | 3.5 | 3.2 | 3.4 | 0.0 | 3.3 | 0.0 | 3.4 | 3.3 | 3.3 | 3.3 | 3.4 | 3.3 | 2.9 | 3.0 | 3.1 | 3.0 | 2.9 |
| Max | 4.2 | 4.0 | 3.4 | 0.0 | 3.3 | 0.0 | 3.5 | 3.4 | 3.4 | 6.4 | 3.4 | 4.0 | 5.6 | 6.1 | 7.1 | 6.4 | 7.1 |

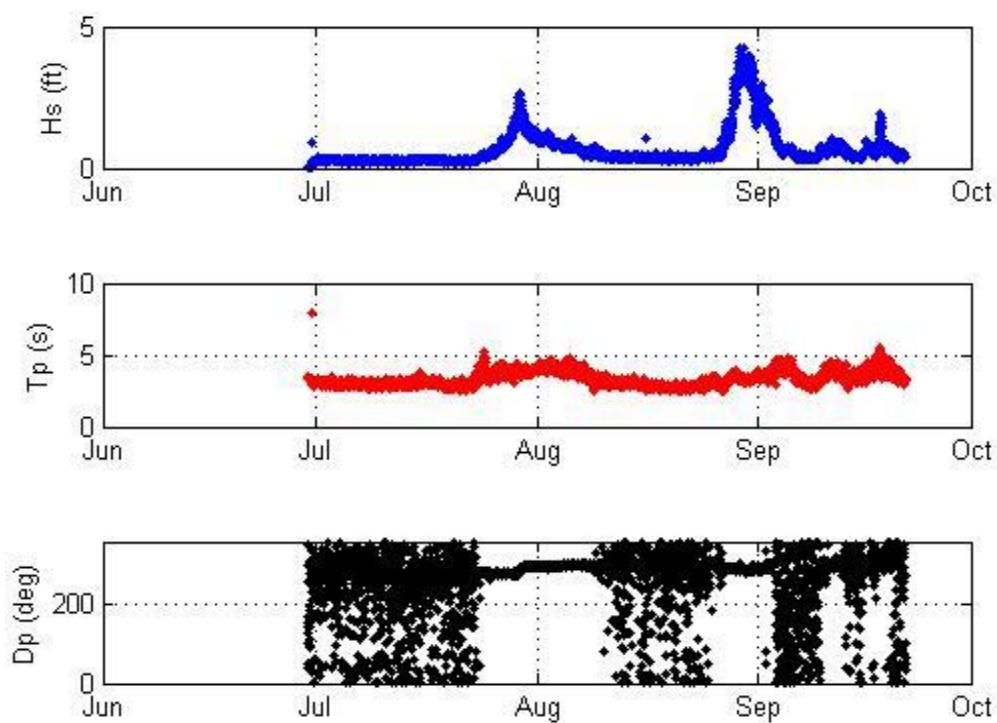


Figure 4-23. ADV 6 time series peak wave parameters

ADV 6 (Jun 2017 - Sep 2017): Wave Height (ft)

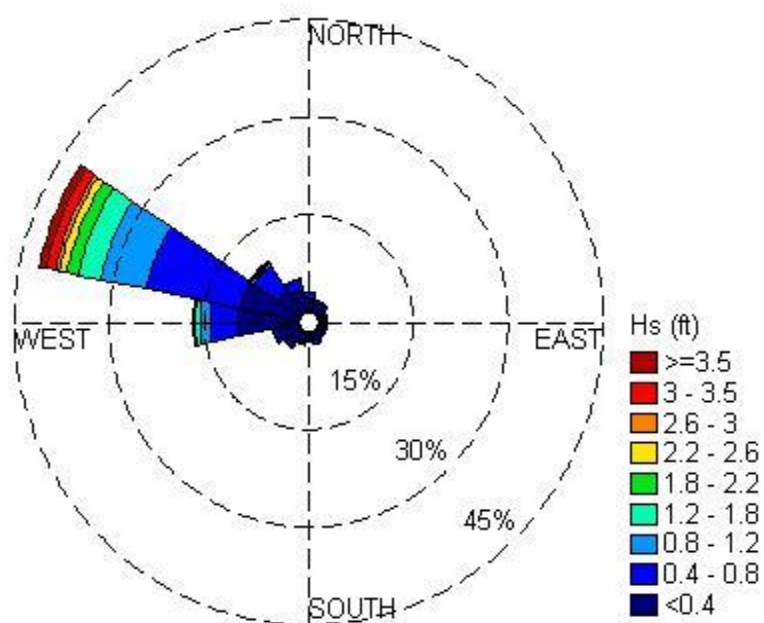


Figure 4-24. ADV 6 wave height rose

Table 4-17. ADV 6 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| 0-0.5 | 2.6 | 1.7 | 1.6 | 1.1 | 1.0 | 1.2 | 1.4 | 1.8 | 1.4 | 1.9 | 2.9 | 4.0 | 11.9 | 15.3 | 5.9 | 4.5 | 60.01 |
| 0.5-1.0 | 0.6 | 0.4 | 0.5 | 0.4 | 0.2 | 0.3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.3 | 0.2 | 3.2 | 13.9 | 3.4 | 0.8 | 24.95 |
| 1.0-1.5 | 0.1 | | | | | 0.0 | | | | | | | 0.9 | 4.8 | 0.3 | | 6.07 |
| 1.5-2.0 | | | 0.0 | | 0.0 | | | | | | | | 0.7 | 2.6 | 0.1 | 0.0 | 3.47 |
| 2.0-2.5 | | | | | | | | | | | | | 0.1 | 1.7 | 0.0 | | 1.83 |
| 2.5-3.0 | | | | | | | | | | | | | 0.0 | 1.0 | | | 0.99 |
| 3.0-4.0 | | | | | | | | | | | | | 0.0 | 2.6 | | | 2.60 |
| 4.0-5.0 | | | | | | | | | | | | | | 0.0 | 0.0 | | 0.07 |
| 5.0+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 3.20 | 2.13 | 2.11 | 1.51 | 1.24 | 1.51 | 1.51 | 2.01 | 1.54 | 2.06 | 3.17 | 4.24 | 16.77 | 41.87 | 9.81 | 5.33 | 100.00 |

| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|---------|
| Mean | 0.40 | 0.39 | 0.40 | 0.37 | 0.40 | 0.39 | 0.35 | 0.36 | 0.34 | 0.34 | 0.34 | 0.34 | 0.51 | 0.99 | 0.51 | 0.38 | 0.67 |
| StDev | 0.19 | 0.18 | 0.21 | 0.14 | 0.26 | 0.19 | 0.14 | 0.16 | 0.13 | 0.12 | 0.13 | 0.11 | 0.39 | 0.86 | 0.33 | 0.16 | 0.66 |
| Min | 0.03 | 0.07 | 0.03 | 0.20 | 0.03 | 0.03 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.03 | 0.07 | 0.07 | 0.07 | 0.07 | 0.03 |
| Max | 1.38 | 0.98 | 1.77 | 0.75 | 1.84 | 1.02 | 0.79 | 0.95 | 0.85 | 0.72 | 0.92 | 0.92 | 3.22 | 4.23 | 4.23 | 1.64 | 4.23 |

ADV 6 (Jun 2017 - Sep 2017): Wave Period (s)

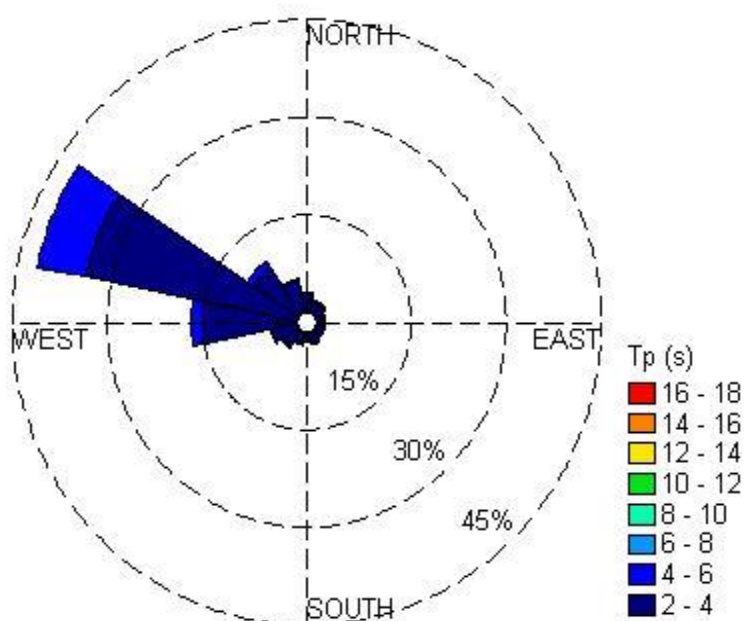


Figure 4-25. ADV 6 peak wave period rose

Table 4-18. ADV 6 peak wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| <4 | 2.9 | 1.9 | 1.9 | 1.3 | 1.1 | 1.3 | 1.4 | 1.8 | 1.4 | 2.0 | 2.9 | 4.1 | 15.0 | 34.1 | 8.6 | 5.0 | 87.02 |
| 4-6 | 0.3 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 1.7 | 7.7 | 1.2 | 0.3 | 12.96 |
| 6-8 | | | | | | | | | | | | 0.0 | | | | | 0.02 |
| 8-10 | | | | | | | | | | | | | | | | | 0.00 |
| 10-12 | | | | | | | | | | | | | | | | | 0.00 |
| 12-14 | | | | | | | | | | | | | | | | | 0.00 |
| 14-16 | | | | | | | | | | | | | | | | | 0.00 |
| 16-18 | | | | | | | | | | | | | | | | | 0.00 |
| 18-20 | | | | | | | | | | | | | | | | | 0.00 |
| 20 + | | | | | | | | | | | | | | | | | 0.00 |
| Total | 3.20 | 2.13 | 2.11 | 1.51 | 1.24 | 1.51 | 1.51 | 2.01 | 1.54 | 2.06 | 3.17 | 4.24 | 16.77 | 41.87 | 9.81 | 5.33 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 3.2 | 3.2 | 3.2 | 3.3 | 3.2 | 3.2 | 3.1 | 3.1 | 3.2 | 3.1 | 3.1 | 3.0 | 3.3 | 3.5 | 3.3 | 3.1 | 3.3 |
| StDev | 0.5 | 0.5 | 0.4 | 0.6 | 0.4 | 0.5 | 0.4 | 0.5 | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.5 | 0.5 | 0.4 | 0.5 |
| Min | 2.5 | 2.6 | 2.7 | 2.6 | 2.7 | 2.5 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.5 | 2.4 | 2.6 | 2.6 | 2.4 |
| Max | 4.6 | 4.4 | 4.6 | 4.7 | 4.3 | 4.6 | 4.2 | 4.4 | 4.7 | 4.5 | 4.9 | 7.9 | 4.8 | 5.5 | 5.0 | 4.5 | 7.9 |

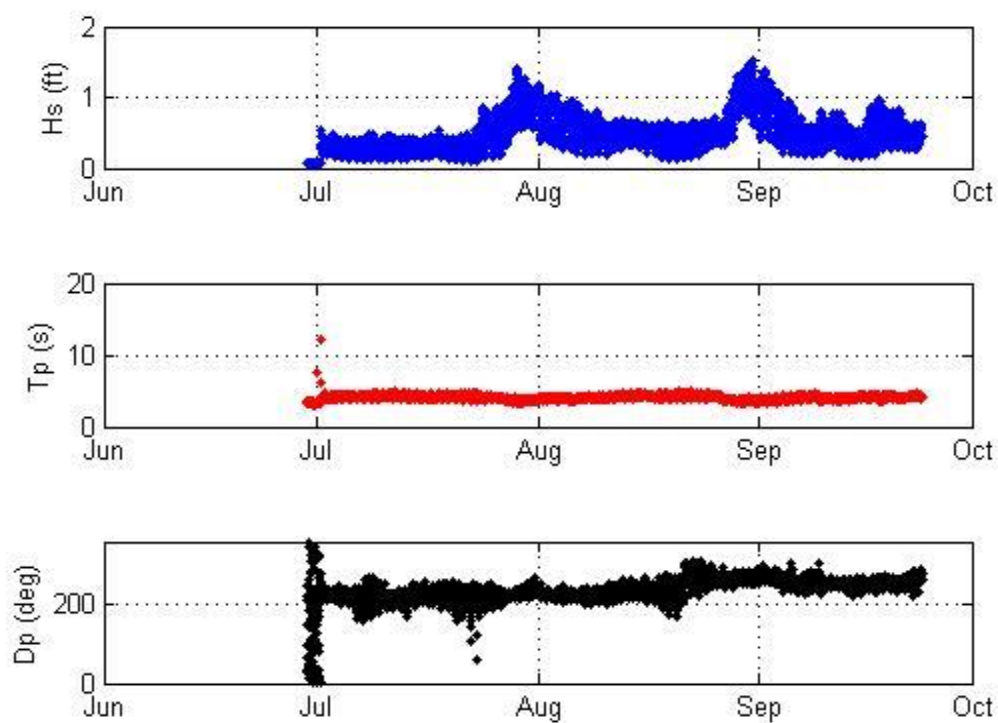


Figure 4-26. ADV 7 time series peak wave parameters

ADV 7 (Jun 2017 - Sep 2017): Wave Height (ft)

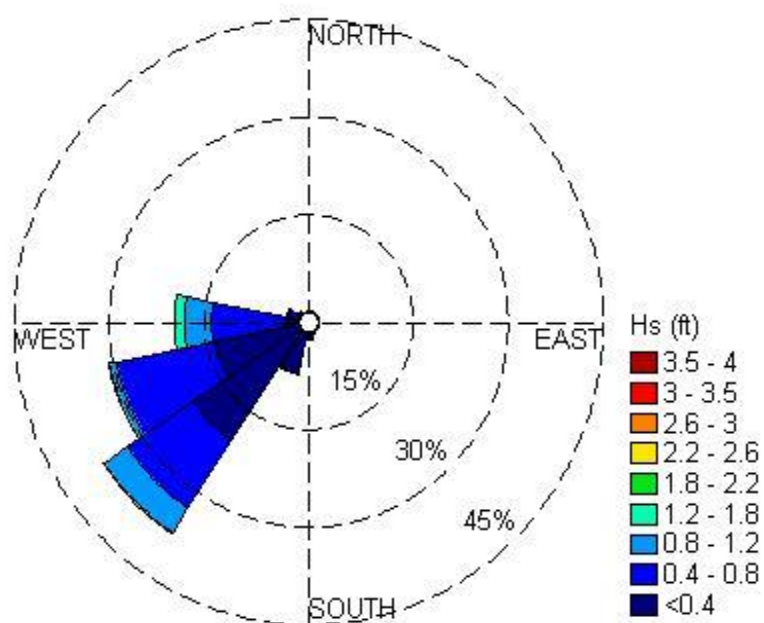


Figure 4-27. ADV 7 wave height rose

Table 4-19. ADV 7 wave height histogram

| Hs (ft)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|-------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| 0-0.5 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.4 | 1.2 | 6.6 | 24.4 | 20.3 | 5.3 | 0.7 | 0.2 | 0.0 | 60.29 |
| 0.5-1.0 | 0.0 | | | | | | | | | | 11.9 | 9.8 | 10.7 | 1.2 | 0.3 | | 34.00 |
| 1.0-1.5 | | | | | | | | | | | 1.2 | 0.6 | 3.6 | 0.2 | | | 5.68 |
| 1.5-2.0 | | | | | | | | | | | | | 0.0 | | | | 0.02 |
| 2.0-2.5 | | | | | | | | | | | | | | | | | 0.00 |
| 2.5-3.0 | | | | | | | | | | | | | | | | | 0.00 |
| 3.0-4.0 | | | | | | | | | | | | | | | | | 0.00 |
| 4.0-5.0 | | | | | | | | | | | | | | | | | 0.00 |
| 5.0+ | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.14 | 0.22 | 0.14 | 0.12 | 0.22 | 0.19 | 0.12 | 0.41 | 1.18 | 6.65 | 37.54 | 30.65 | 19.74 | 2.05 | 0.58 | 0.05 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 0.14 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.10 | 0.13 | 0.21 | 0.48 | 0.46 | 0.70 | 0.60 | 0.40 | 0.07 | 0.49 |
| StDev | 0.19 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.01 | 0.03 | 0.04 | 0.07 | 0.24 | 0.18 | 0.28 | 0.25 | 0.23 | 0.00 | 0.26 |
| Min | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.03 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.03 |
| Max | 0.52 | 0.07 | 0.07 | 0.10 | 0.07 | 0.10 | 0.10 | 0.13 | 0.20 | 0.49 | 1.41 | 1.48 | 1.51 | 1.44 | 0.66 | 0.07 | 1.51 |

ADV 7 (Jun 2017 - Sep 2017): Wave Period (s)

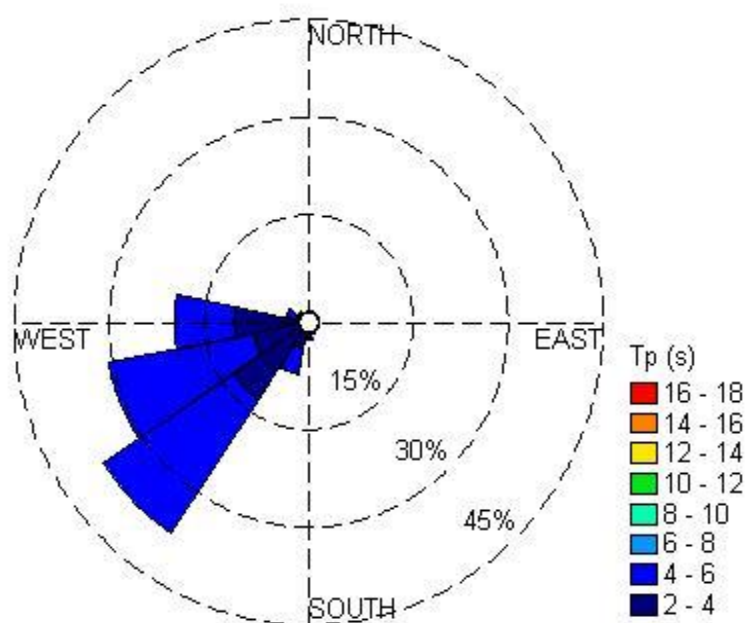


Figure 4-28. ADV 7 peak wave period rose

Table 4-20. ADV 7 peak wave period histogram

| Tp (s)\Dir | 0.0 | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 | 180.0 | 202.5 | 225.0 | 247.5 | 270.0 | 292.5 | 315.0 | 337.5 | Total |
|------------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| <4 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.3 | 0.7 | 2.6 | 12.8 | 7.4 | 10.3 | 0.6 | 0.2 | 0.0 | 36.14 |
| 4-6 | | | | | | | | 0.1 | 0.5 | 4.0 | 24.8 | 23.2 | 9.4 | 1.5 | 0.4 | | 63.79 |
| 6-8 | | | | | | | | | | 0.0 | 0.0 | | | | | | 0.05 |
| 8-10 | | | | | | | | | | | | | | | | | 0.00 |
| 10-12 | | | | | | | | | | | | | | | | | 0.00 |
| 12-14 | 0.0 | | | | | | | | | | | | | | | | 0.02 |
| 14-16 | | | | | | | | | | | | | | | | | 0.00 |
| 16-18 | | | | | | | | | | | | | | | | | 0.00 |
| 18-20 | | | | | | | | | | | | | | | | | 0.00 |
| 20 + | | | | | | | | | | | | | | | | | 0.00 |
| Total | 0.14 | 0.22 | 0.14 | 0.12 | 0.22 | 0.19 | 0.12 | 0.41 | 1.18 | 6.65 | 37.54 | 30.65 | 19.74 | 2.05 | 0.58 | 0.05 | 100.00 |
| | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | Overall |
| Mean | 4.8 | 3.4 | 3.3 | 3.4 | 3.3 | 3.4 | 3.4 | 3.7 | 3.9 | 4.0 | 4.1 | 4.2 | 4.0 | 4.2 | 4.2 | 3.2 | 4.1 |
| StDev | 3.6 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.4 | 0.6 | 0.0 | 0.3 |
| Min | 3.1 | 3.3 | 3.2 | 3.2 | 3.2 | 3.3 | 3.3 | 3.2 | 3.0 | 3.2 | 3.2 | 3.1 | 3.3 | 3.1 | 3.2 | 3.2 | 3.0 |
| Max | 12.2 | 3.5 | 3.4 | 3.7 | 3.4 | 3.8 | 3.6 | 4.0 | 4.4 | 7.7 | 6.1 | 4.9 | 4.9 | 4.8 | 4.8 | 3.2 | 12.2 |