APPENDIX G

Potential Effects of Proposed Borrow Areas on Wave Propagation

Wrightsville Beach Coastal Storm Risk Management

Emergency Repair – Evaluation of Borrow Area Alternatives

New Hanover County, North Carolina

JANUARY 2023

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Draft: **Effects of potential borrow areas on wave propagation at Wrightsville Beach, North Carolina**

by Grace Maze

INTRODUCTION: The USACE Wilmington District (SAW) conducted a wave assessment for five proposed borrow areas near Wrightsville Beach, North Carolina. The nearshore borrow area (Borrow Area B) was evaluated for three different dredge depths. Wrightsville Beach (34°12'30.60"N 77°47'47.04"W) is located northeast of Masonboro Inlet. The excavation of these sites will cause changes in the nearshore bathymetry, which will affect the wave transformation in the area. An assessment of the effects these borrow areas have on the nearshore wave propagation will help evaluate each potential borrow area site. To complete this assessment, the STeady-state WAVE (STWAVE) model (Smith et al. 2001, Massey et al. 2011), which is a phase-averaged spectral model for wave generation, propagation and transformation, was used to simulate wave transformation in the Wrightsville Beach area.

STWAVE: STWAVE is a steady-state spectral wave model for nearshore wave generation, propagation, transformation, and dissipation. STWAVE numerically solves the steady-state conservation of spectral wave action along backward-traced wave rays:

$$\left(C_g\right)_i \frac{\partial}{\partial x_i} \frac{C C_g \cos \alpha E(\sigma, \theta)}{\sigma} = \sum \frac{S}{\sigma} \qquad (1)$$

Where *i* is tensor notation for *x*- and *y*- components, C_g is group celerity, θ is wave direction, C is wave celerity, σ is wave angular frequency, E is wave energy density, and S is energy source and sink terms. Source and sink mechanisms include surf-zone wave breaking, wind input, wave-wave interaction, whitecapping, and bottom friction. STWAVE is formulated on a Cartesian grid, with the x-axis oriented in the cross shore direction (I) and the y-axis oriented alongshore (J), generally parallel with the shoreline. Angles are measured counterclockwise from the grid x-axis.

GRID DEVELOPMENT: In order to capture the effects of each borrow area, four STWAVE grids were developed, which extended alongshore from Rich's Inlet to Carolina Beach and seaward to a depth of 90 ft. (25 m). The Cartesian grid resolution of all eight grids was approximately 164 ft. (50 m) and is comprised of 448 cells in the cross-shore direction (I) and 849 cells in the alongshore direction (J). The projection of the grid is in State Plane North Carolina (FIPS 3200), with a vertical datum relative to NAVD88 (meters). The properties of all eight STWAVE domains are provided in Table 1.

Table 1. STWAVE Grid Properties

Horizontal Projection	Vertical Projection	Grid Origin (x,y) [m]	Azimuth [deg]	Δx/Δy [ft]	Number of Cells	
					I	J
State Plane North Carolina FIPS 3900	NAVD88	(752251.0, 58662.0.0)	145	164	448	849

The outlines of the potential borrow area sites are shown in Figure 1. The five borrow areas include Borrow Area B, which is the most onshore borrow area site and is located near Masonboro Inlet. This area has three proposed excavation depths, -23 ft, -28 ft and -33 ft, each of which were run for analysis. Borrow Area C is located offshore from Borrow Area B and is the most westward of the potential borrow areas. Borrow Area C has a proposed excavation depth of -58 ft. Borrow Area D is located to the east of Borrow Area C with a proposed excavation depth of -58 ft. Borrow Area E is located to the southeast of Borrow Area D and also has a proposed excavation depth of -58 ft. Borrow Area F is the eastern most borrow area with a proposed excavation depth of -58 ft. The topography and bathymetry data to populate the STWAVE domain were obtained from the National Center for Environmental Information 1/9 arc second DEM. The bathymetry was modified for each proposed borrow area site by deepening each site to the proposed dredge depth as described above and shown in Figure 1. Depictions of the modified depths as represented in the STWAVE domains are included in Appendix A.

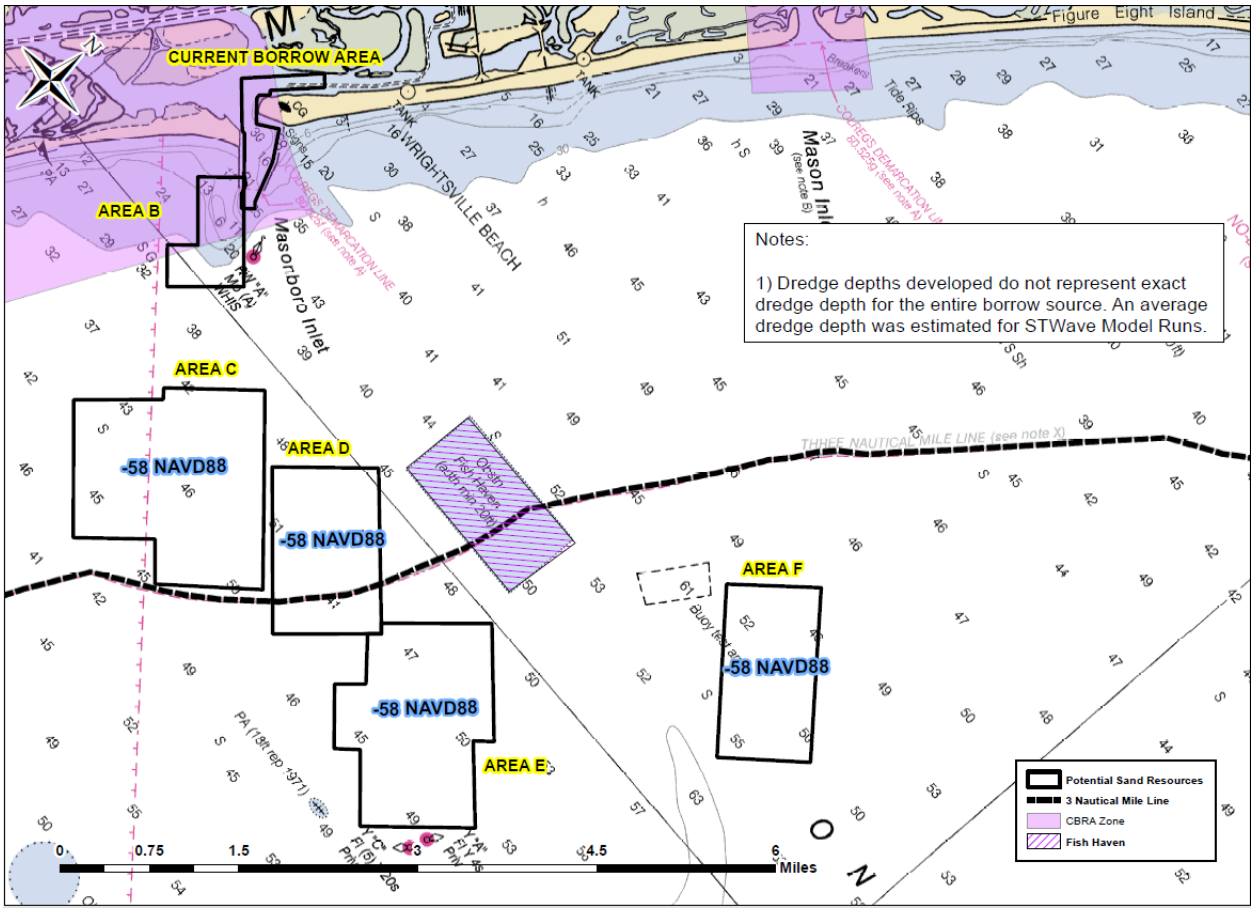


Figure 1: Dredge depths (shown in blue green) of the four potential borrow areas offshore of Wrightsville Beach, NC. Area B has 3 potential dredge depths (not shown).

OFFSHORE BOUNDARY SPECTRA: To determine the boundary forcing conditions for STWAVE a wave assessment was conducted for the Wrightsville Beach area, to capture the mean monthly, maximum monthly and extreme events using the wave data from the Wave Information Study (WIS) hindcast. The hindcast data provide a record of 37 years, from 1980 to 2017. Stations 63296 and 63298 were chosen as the primary stations of interest due to their close proximity to Wrightsville Beach. Figure 2 shows the wave rose for WIS 63298.

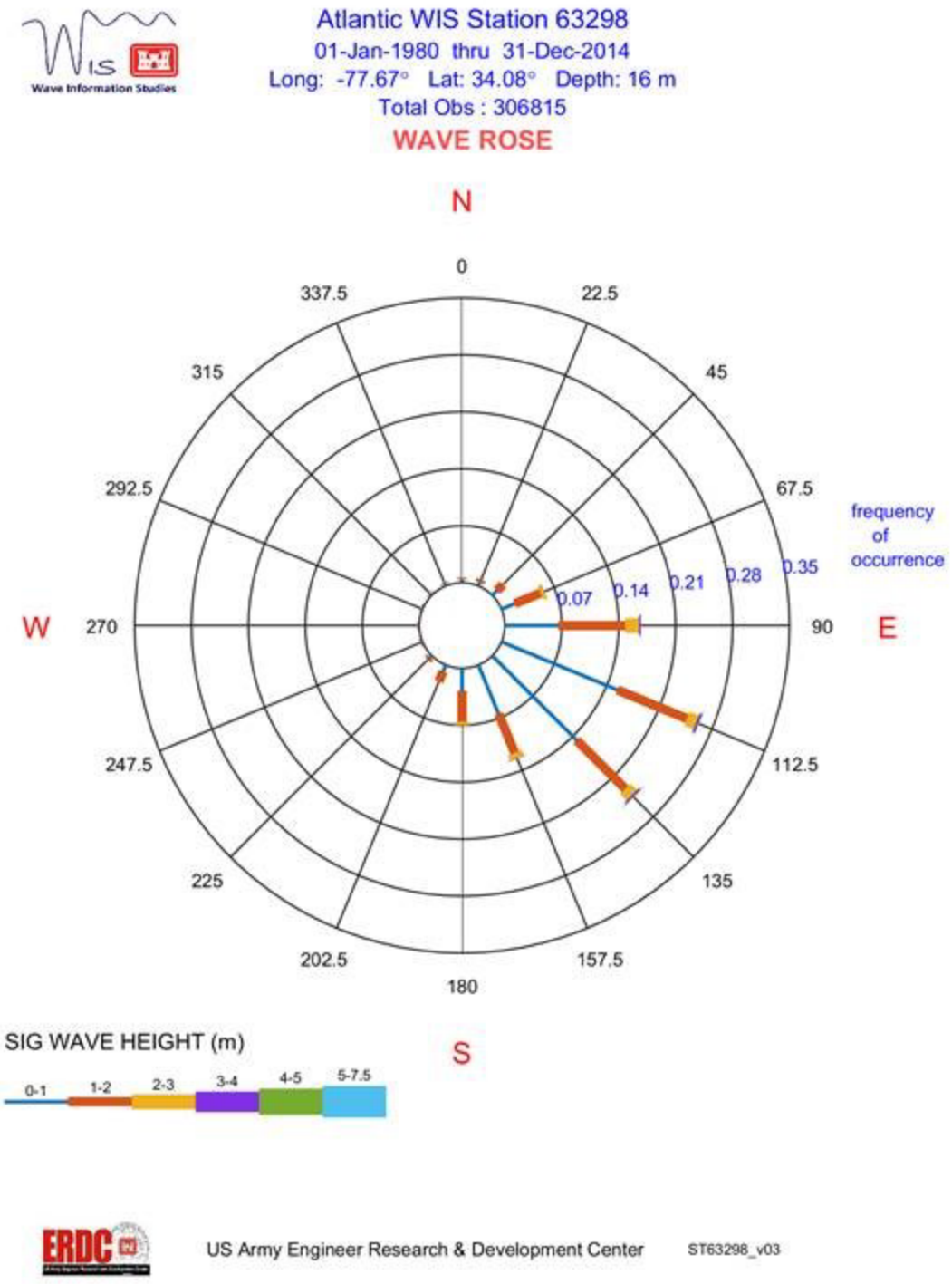


Figure 2: Wave Rose for WIS 63298.

A comparison of the mean monthly wave heights and the max monthly wave heights for all four seasons for both stations is included in Appendix B. These histograms show that

the mean monthly wave height, across all seasons, is less than 5.9 ft. (1.8 m) with the most frequent mean monthly wave height at approximately 3.6 ft. (1.1m). The histograms also show that the most frequent max monthly wave height is approximately 8.9 ft. (2.7 m).

A comparison of the mean monthly wave periods and the max monthly wave periods show that the average max monthly wave period is approximately 9.6 seconds and the average mean monthly wave period is approximately 8.7 seconds.

The extreme plots for both stations are shown in Appendix C. For station 63296, the extreme wave heights range from 18.47 to 20.11 ft. (5.63 to 6.13 m) for the top 10 events with peak wave periods ranging from 11-17 seconds. For station 63298, the top 10 extreme events contained wave heights ranging from 18.47 to 20.18 ft. (5.63 to 6.15 m) with peak periods of 11 to 17 seconds.

Onshore propagation for the area is between 50 and 200 degrees.

In order to encompass the climate of the area nine conditions were identified for inclusion as boundary forcing for STWAVE. The chosen conditions, shown in Table 2, included a mean monthly condition composed of a wave height of 3.67 ft. (1.12 m) with an 8.77-sec. period, and a max monthly condition with an 8.92 ft. (2.72 m) wave height and 9.60-sec. period. Also chosen was the highest extreme event, which occurred for WIS station 63298, and had a 20.18 ft. (6.15 m) wave height and a 14.56-sec. period. Both the mean and maximum monthly condition spectra were simulated with a mean direction ranging from 50 to 200 degrees (relative to true north), for a total of four directions, and the extreme event was simulated at 114 degrees (as occurred in the extreme event).

Table 2: *STWAVE Conditions for Simulation*

	Wave Height (ft)	**Period (sec)**	**Direction (deg)**	**Number of STWAVE Simulations:**
Mean Monthly	3.67	8.77	50°, 100°, 150°, 200°	4
Max Monthly	8.92	9.60	50°, 100°, 150°, 200°	4
Extreme Event	20.18	14.56	114°	1
Total number of STWAVE simulations per borrow area:				**9**

The resolved spectra for each condition was represented by 35 frequency bands, ranging from 0.37 Hz (2.7 sec) to 0.03 Hz (33.3 sec), and 72 angle bands, from an

angle of 0 degrees to 355 degrees with respect to the x-axis. Frequency and angular resolution were 0.01 Hz and 5 degrees, respectively.

MODEL EXECUTION: Each STWAVE simulation conducted used the full-plane mode of STWAVE to allow for wave generation and transformation in a 360-degree plane. The full-plane version of STWAVE uses an iterative solution process that requires user-defined convergence criteria to signal a suitable solution. Boundary spectra information is propagated from the boundary throughout the domain and iteratively executes until it reaches a convergent state. The convergence criteria includes the maximum number of iterations to perform per time-step, the relative difference in significant wave height between iterations, and the minimum percent of cells that must satisfy the convergence criteria (i.e., have values less than the relative difference.) Convergence parameters were selected based on a previous study by Massey et al. (2011) in which the sensitivity of the solution to the final convergence criteria was examined. The relative difference and minimum percent of cells were set as (0.1, 100.0) and (0.1, 99.8) for the initial and final iterations, respectively. The maximum number of initial and final iterations was set to a value of 20 iterations.

Twelve locations were identified within the STWAVE grid to save significant wave height, peak period, mean period and mean wave direction from each of the 9 wave conditions simulated. The x y coordinates and water depths of these locations are included in Table 3 and depicted in Figure 3.

The model bathymetry includes the jetty structures around Masonboro Inlet, however none of the properties associated with the jetty are included. In addition, the model does not account for tidal currents, wind, and the changes these would inflict on the wave climate.

Table 3: Location of Save Points inside STWAVE domain

	x [m]	**y [m]**	**h[m]**		**x [m]**	**y [m]**	**h[m]**
pt1	718510	47762	1.4	**pt7**	720506	50888	1.8
pt2	718995	48261	1.0	**pt8**	721206	51979	1.5
pt3	719533	48258	7.0	**pt9**	721783	53016	1.0
pt4	719102	48652	10.1	**pt10**	722341	53985	1.2
pt5	719234	49058	1.0	**pt11**	722904	54748	2.9
pt6	719821	49846	1.5	**pt12**	723515	55609	1.0

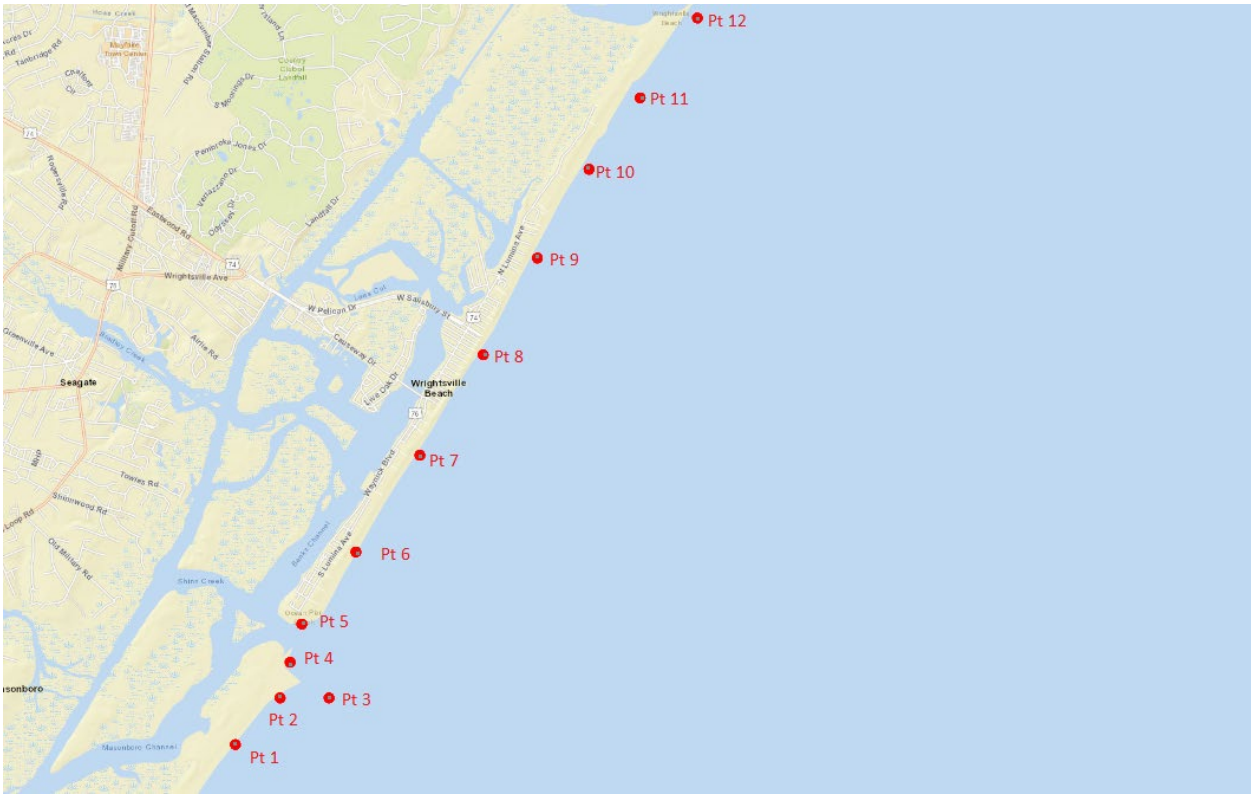


Figure 3: Save point locations

Changes in wave heights were analyzed along the shore line at the 1 m depth contour with a spacing of 500 m. Analysis points are shown in Figure 4.

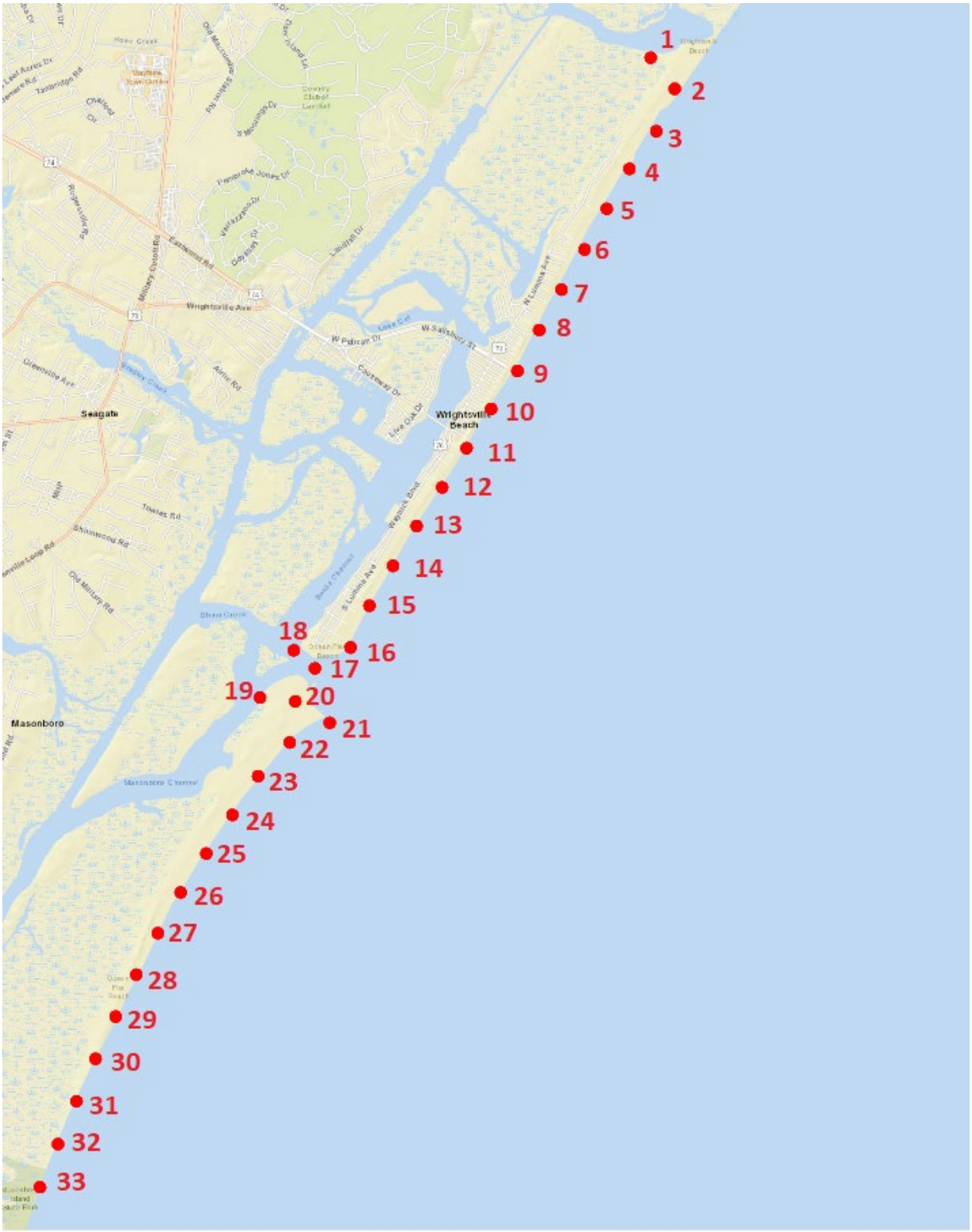


Figure 4: Analysis locations at 1m depth contour

RESULTS: Three types of figures were generated for each borrow area and boundary condition: a spectral wave height plot (Appendix D), a spectral wave height difference plot (Appendix E), and a plot depicting the significant wave height, mean period, peak period, and STWAVE wave angle, at each save point for each condition (Appendix F). The changes in wave heights along the 1 m contour are show in in Appendix G.

Mean Monthly Condition: The mean monthly wave condition, 3.67 ft. wave height and 8.77 sec. period, showed, as expected, the least effects caused by the borrow areas. Due to the low energy of this condition, the differences in depth caused by the excavation of the borrow areas will be minimal compared to the higher energy events. Overall, each borrow area site increased and decreased the wave heights on average ~0.5 ft. in the area of each site, with increases occurring on the perimeter and decreases in the center, except for the nearshore Borrow Area B, shown in Figure 5. The greatest increase in wave height impact was observed at Borrow Area B dredged to 23 ft with waves in the 150 direction, with increases in wave height up to 4.96 ft. The greatest decrease in wave height was observed at Borrow Area B dredged to 33 ft with waves in the 200 direction, with decreases of ~3 ft. The decrease most significantly affected the center of the borrow area, while the increases affected perimeter of the borrow area radiating to Masonboro Island and the southern end of Wrightsville Beach. The farthest borrow area, Borrow Area F had the least effects on the wave height. The results showed only slight increases and decreases of less than 0.5ft, which were widely distributed from the borrow area site.

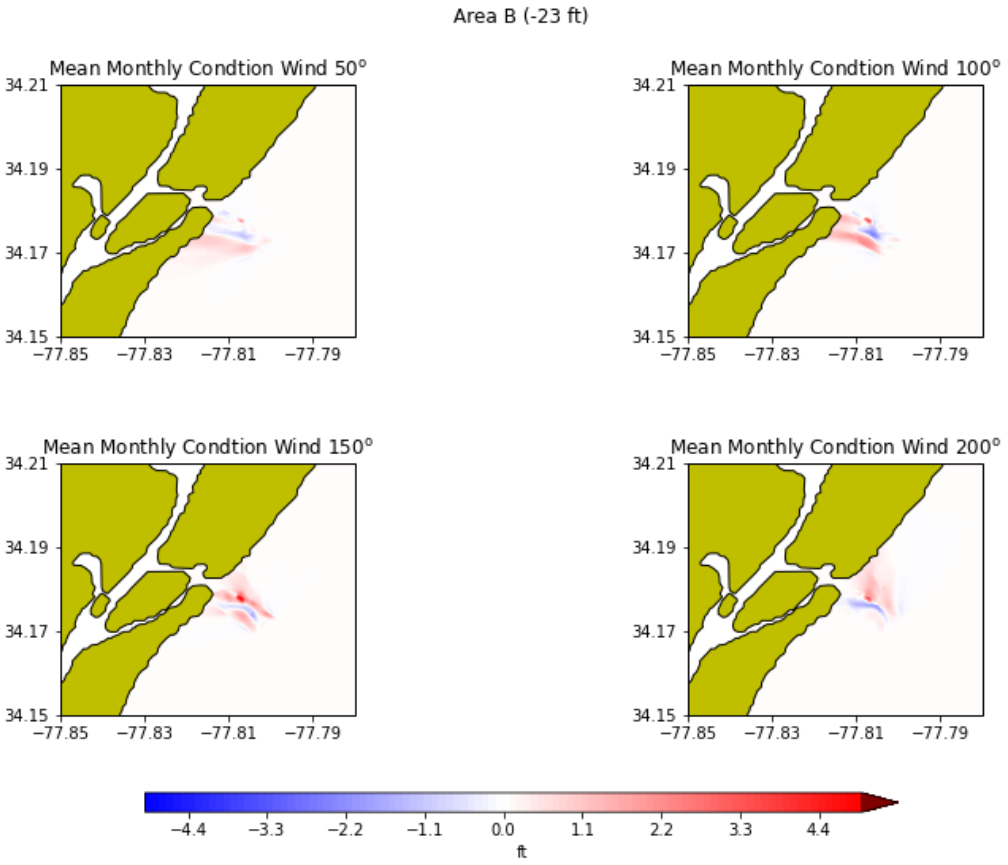


Figure 5: Mean monthly condition at Borrow Area B dredged to 23 ft. Warm tones indicate increases in wave height when compared to the no borrow are simulations and cool tones represent decreases in wave height.

The save point locations provide similar results as shown in the above difference plot with most increases and decreases being ~0.5 ft. for all wave directions and borrow area sites. Under the 50° wave direction, minimal changes in wave height were observed at all point locations. Under the 100 ° wave direction, Borrow Area B dredged to 28 and 33 feet showed increases in wave heights up to 0.25 feet at location 3. The 150° wave direction showed increases in wave heights up to 0.75 feet from Borrow Area B dredged to 28 and 33 feet and increases in wave heights up to 0.1 feet at location 4. Finally, under the 200° wave direction, Borrow Area B dredged to 23 feet showed an increase in wave heights of 0.5 feet, Borrow Area B dredged to 28 feet showed an increase in wave heights of 0.37 feet, and Borrow Area B dredged to 33 feet showed an increase of 0.28 feet at location 3. Along the 1 m depth contour Borrow Area B dredged to 23 ft showed the largest wave height increase of 0.298 ft while Borrow Area C showed the smallest increase of 0.05 ft.

Max Monthly Condition: The max monthly condition, 8.92 ft. wave height and 9.60 sec. period, showed greater effects on the wave heights due to the presence of the borrow

area sites when compared to the mean monthly condition. Overall, the locations of the increases and decreases were similar to what was observed under the mean monthly condition, but the magnitude and extent of the difference is greater. Under the max monthly condition, on average increases and decreases of ~1 ft were observed due to the borrow area sites, except for Borrow Area B, Figure 6. The nearshore Borrow Area B dredged to 23 ft with 150º wave direction showed an increase in wave height up to 1.2 ft. Borrow Area B dredged to 28 ft with 50º wave direction showed a decrease in wave height up to 2.82 ft. The farthest borrow area, Borrow Area F, showed the smallest increase and decrease in wave height, with maximum changes of less than 1.0 ft.

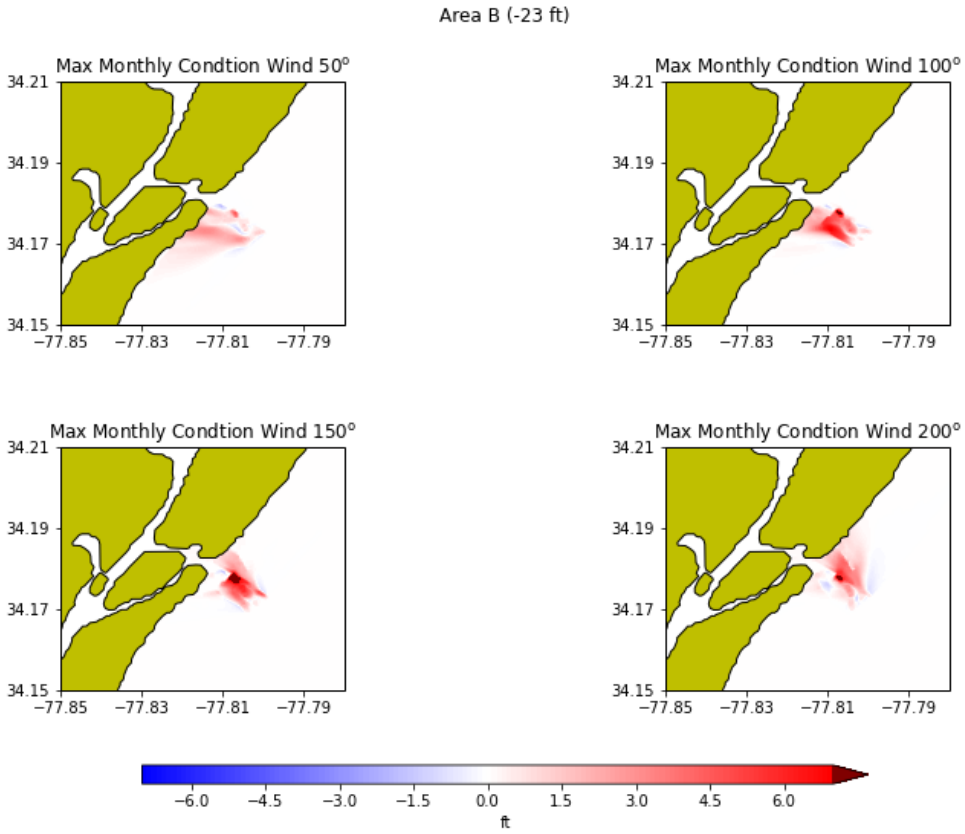


Figure 6: Max Monthly Condition at Borrow Area B dredged to 23 ft. Warm tones indicate increases in wave height when compared to the no borrow are simulations and cool tones represent decreases in wave height.

The save point locations show differences only from Borrow Area B at all dredge depths. Under the 50° wave direction, increases in wave heights at point 3 are minimal, less than 0.02 feet. Under the 100° wave direction, Borrow Area B dredged to 33 feet showed the maximum wave height increases of 0.52 feet at location 3. Under the 150° wave direction, Borrow Area B dredged to 28 feet showed the maximum wave height increase of 1.81 feet at location 3. Under the 200° wave direction, Borrow Area B

dredged to 23 feet showed the maximum wave height increase of 1.23 feet at location 3. All other borrow areas showed a decrease in wave height of ~0.35 feet at location 3. Along the shoreline Borrow Area B dredged to 33 ft showed the largest increase of 0.443 ft while Borrow Area F showed the smallest increase of 0.002 ft.

Extreme Event Condition: The extreme event condition, 20.18 ft. wave height, 14.56 sec. period and 114° mean direction, showed the greatest effects due to the borrow area sites. However, for most of the borrow area sites, these effects were isolated at the borrow area and had very little effect on the coastline, as shown in Figure 7. Under the extreme condition, all of the borrow area sites show increases in the wave height of ~2.1 ft. or greater. However, the Central borrow area site shows the greatest increase of up to ~16.0 ft. and Borrow Area F shows the widest distribution of wave height increases (~2.1 ft.). The deepening of these area compared to their surrounding allow the waves to propagate further inshore before breaking, which is most likely the cause for the observed increases under this condition.

Due to the isolation of the effects at the borrow area sites and their lack of propagation onshore, Borrow Area B was the only location to show changes at the save point locations. Borrow Area B dredged to 33 feet showed the maximum increase in wave height of 0.71 feet at location 3. Along the shore Borrow Area B dredged to 33 ft showed the largest increase of 0.143 ft while Borrow Areas C and F showed the smallest increase of 0.001 ft.

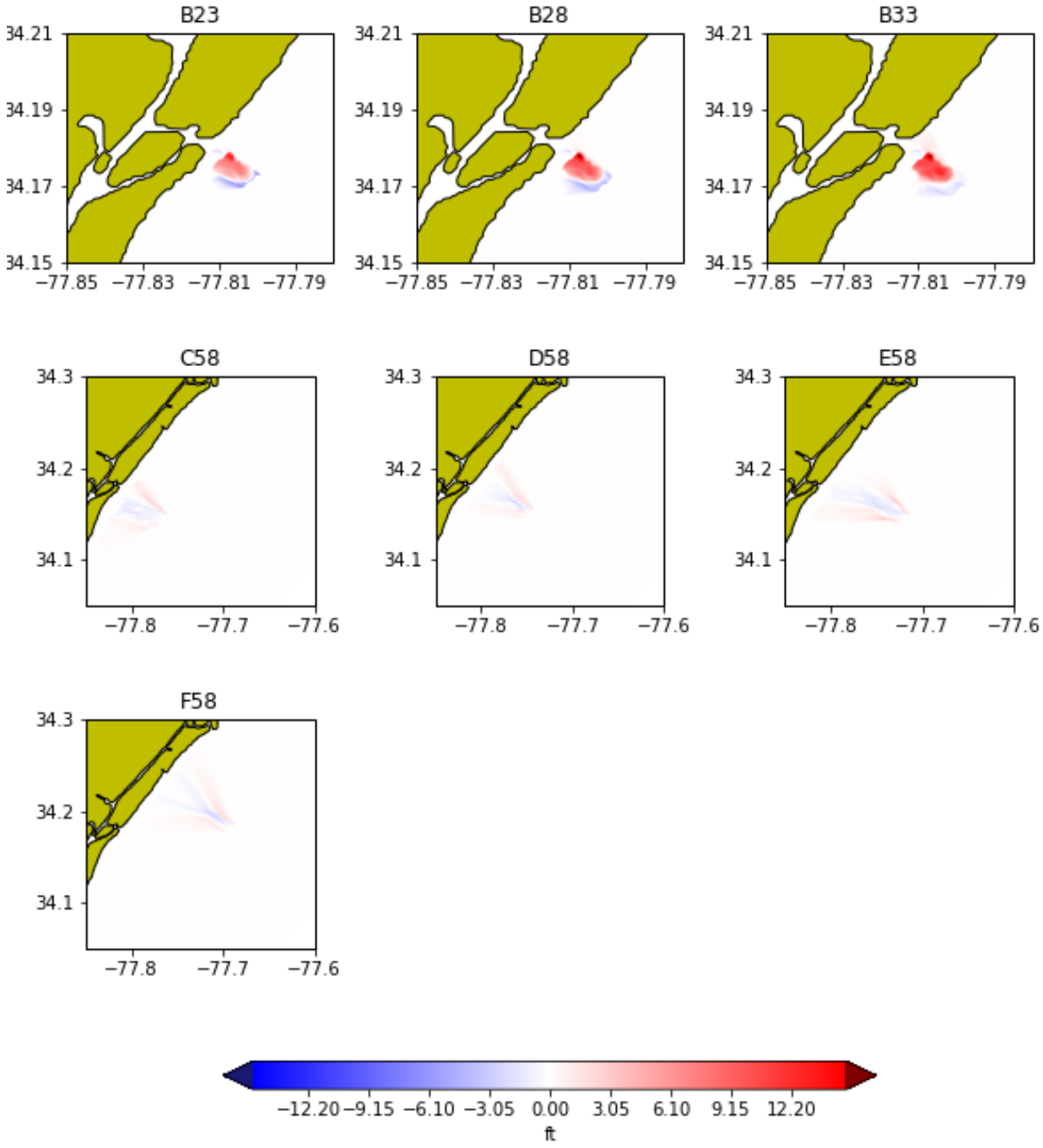


Figure 7: Extreme Event Condition at all seven borrow areas. Warm tones indicate increases in wave height when compared to the no borrow are simulations and cool tones represent decreases in wave height.

SUMMARY: The effects of the four borrow areas were investigated offshore of Wrightsville Beach, NC using the STWAVE nearshore model. Nine identified conditions were selected to represent the mean monthly, max monthly and extreme event in the

area, based on the 39-year record at the offshore WIS stations 63296 and 63298. The mean monthly condition showed the lowest impacts on wave heights due to the borrow areas with decreases of ~0.5 ft. in the offshore borrow area and increases in ~0.5 ft. in the perimeters, with increases up to ~5 ft and decreases up to ~3 ft for the nearshore borrow area. Borrow Area F showed the least amount of effects under this condition and the Borrow Area B dredged to 23 ft showed the greatest effects. Under the max monthly condition, the offshore borrow area sites showed increases and decreases in the wave heights of ~1.0 ft. with an increase of up to ~12.25 ft. at Borrow Area B. Borrow Area F showed the least effects under this condition as well. The extreme event condition showed the greatest decreases and increases due to the borrow areas. Borrow Area B showed the greatest increases under the extreme event; while the Borrow Area F continued to have the least effect on wave heights.

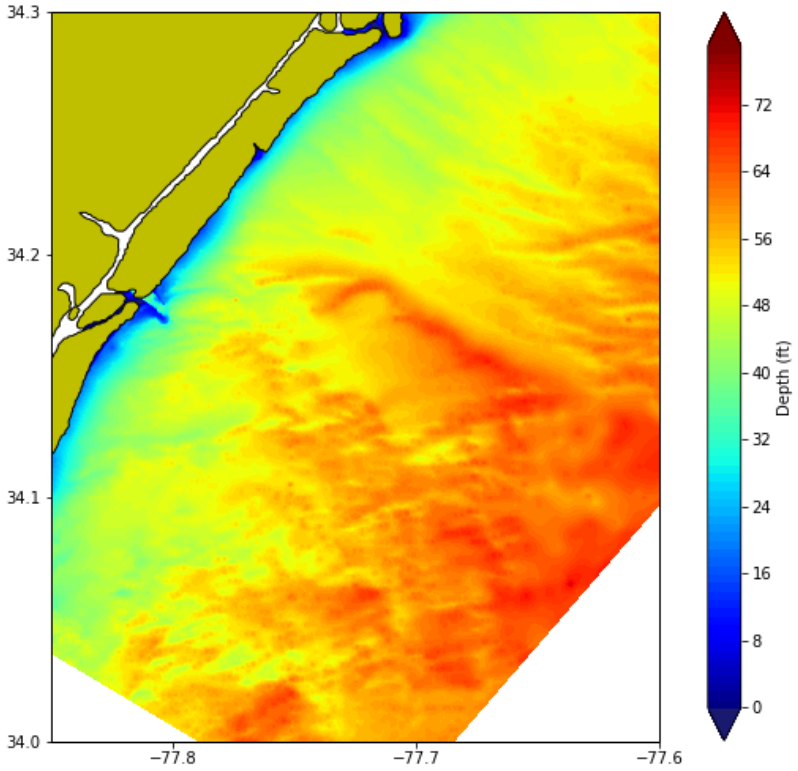
REFERENCES:

Massey, T.C., M.E. Anderson, J.M. Smith, J. Gomez, and R. Jones. 2011. *STWAVE: Steady-state spectral wave model user's manual for STWAVE, version 6.0*. ERDC/CHL SR-11-1. U.S. Army Engineering Research and Development Center, Vicksburg, MS**.**

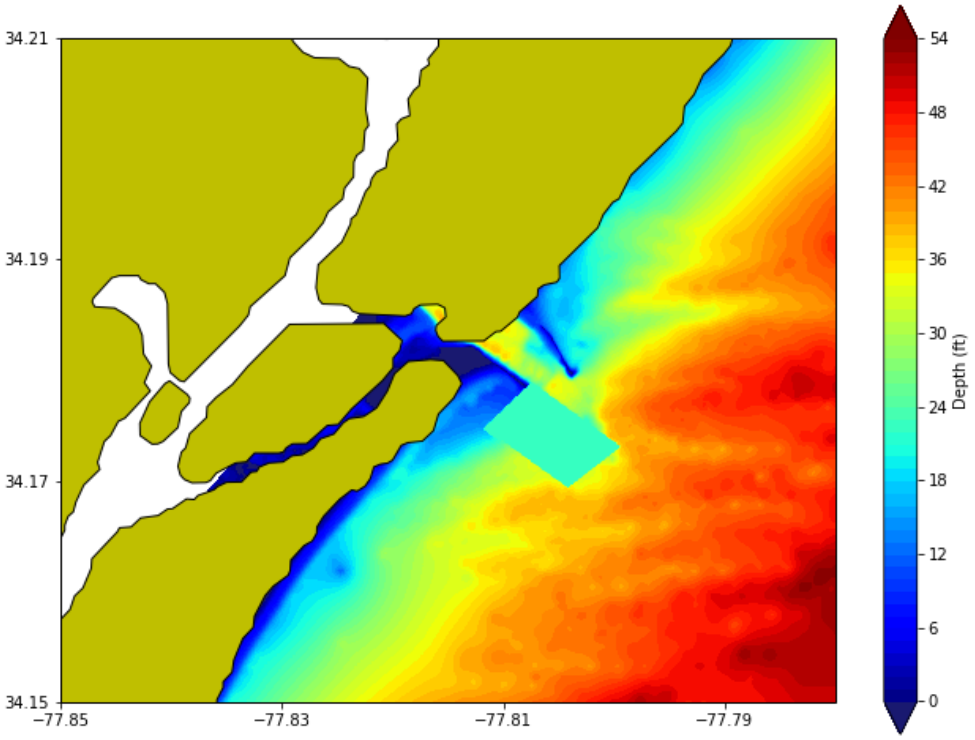
Smith, J. M., A. R. Sherlock, and D. T. Resio. 2001. STWAVE: Steady-state spectral wave model, user's guide for STWAVE version 3.0, ERDC/CHL SR-01-01, US Army Engineer Research and Development Center, Vicksburg, MS, 80 pp.

Appendix A— Depth Changes in Grid

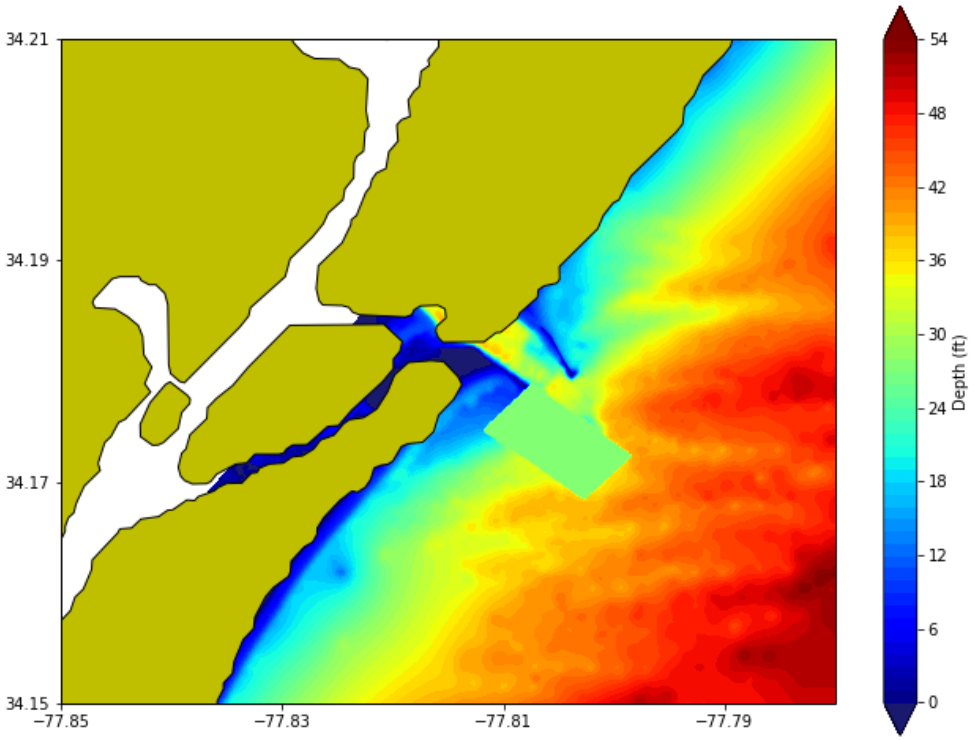
Base Condition Bathymetry



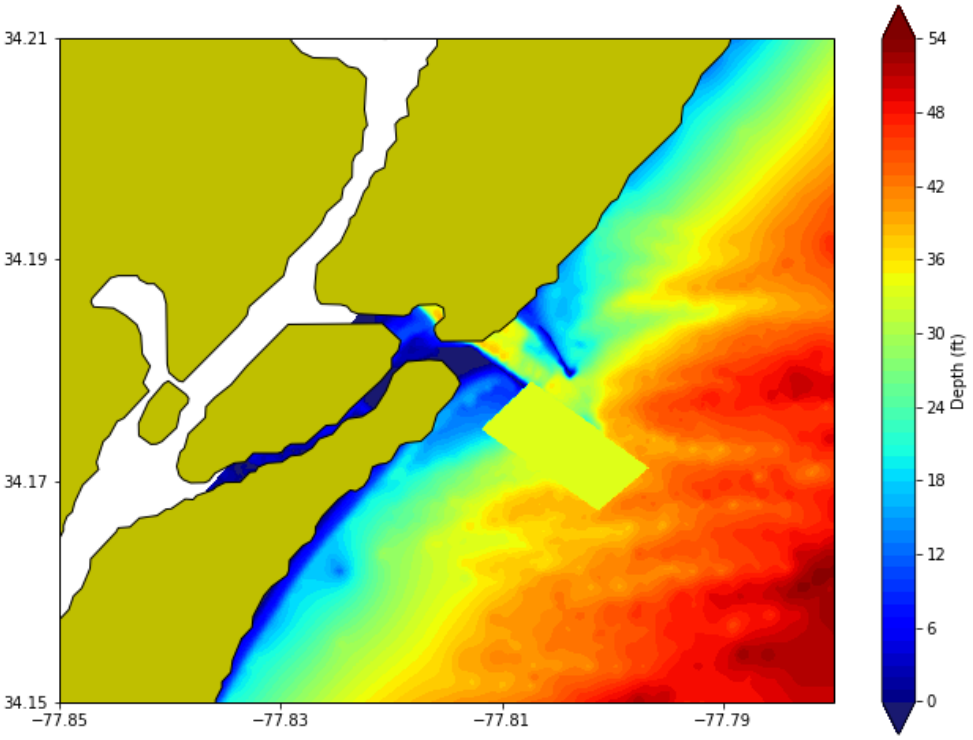
Borrow Area B (23 ft) Modified Bathymetry



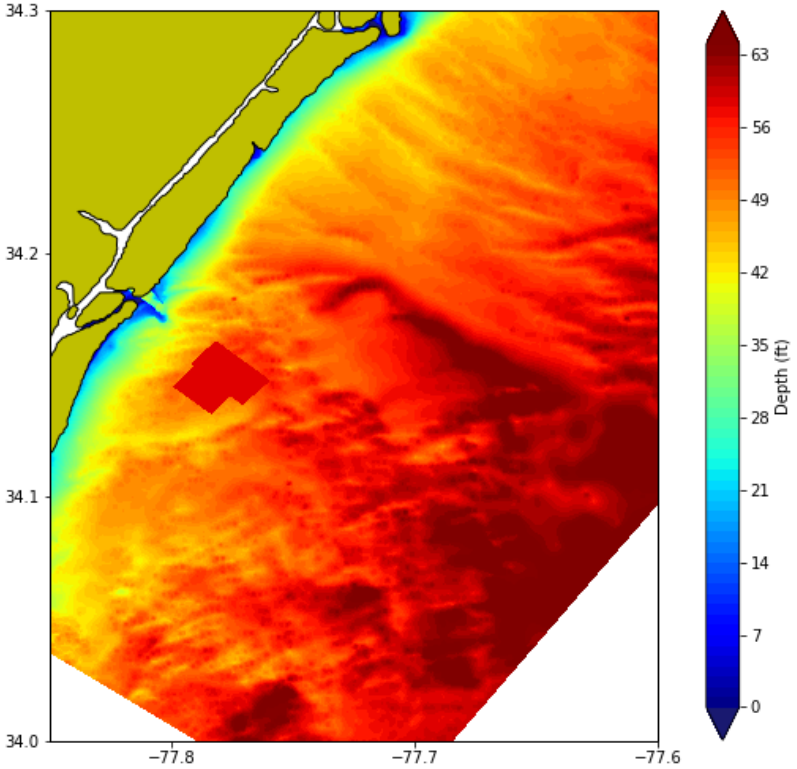
Borrow Area B (28 ft) Modified Bathymetry



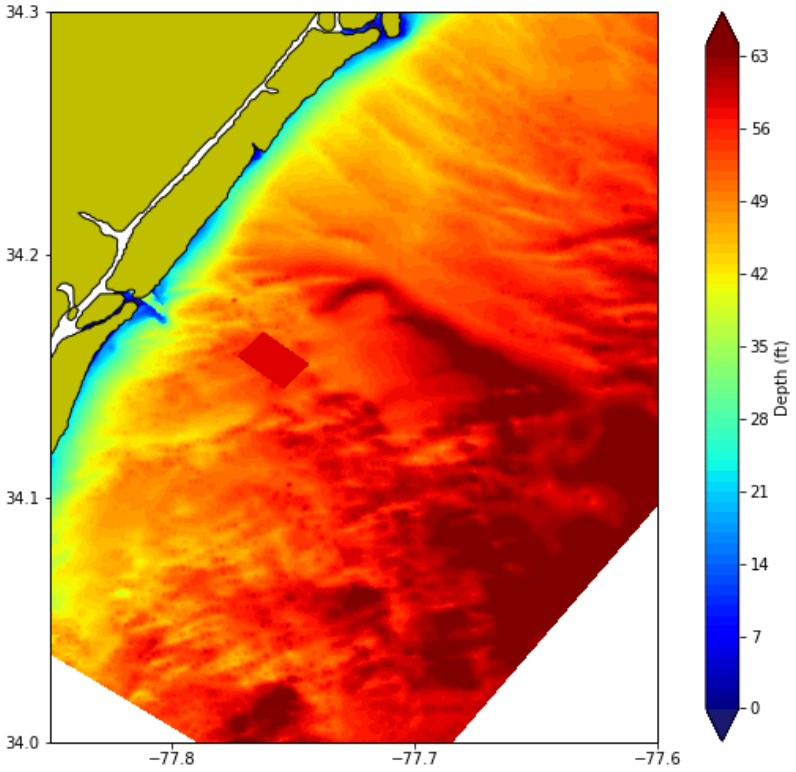
Borrow Area B (33 ft) Modified Bathymetry



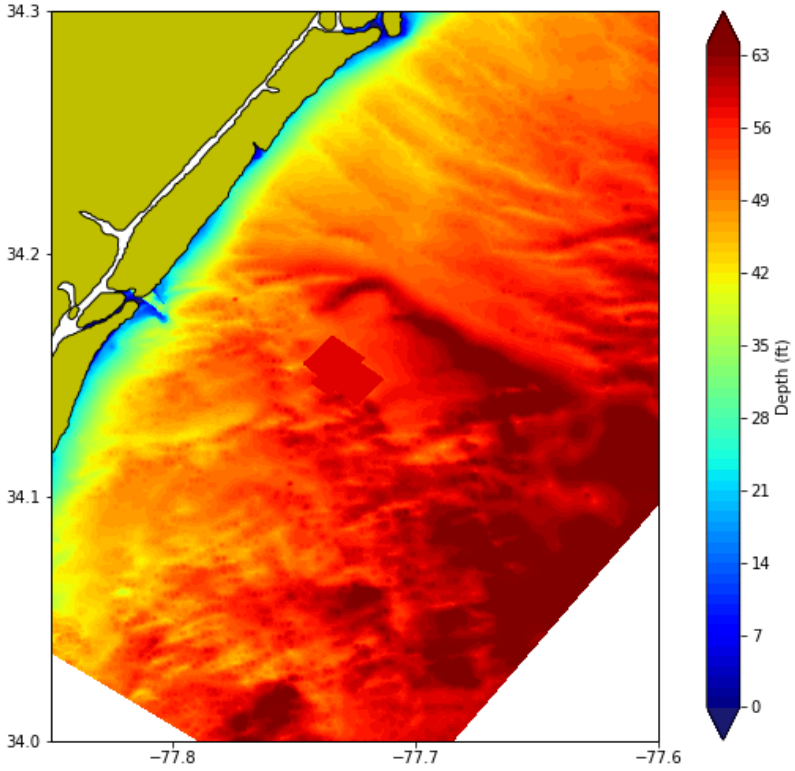
Borrow Area C (58 ft) Modified Bathymetry



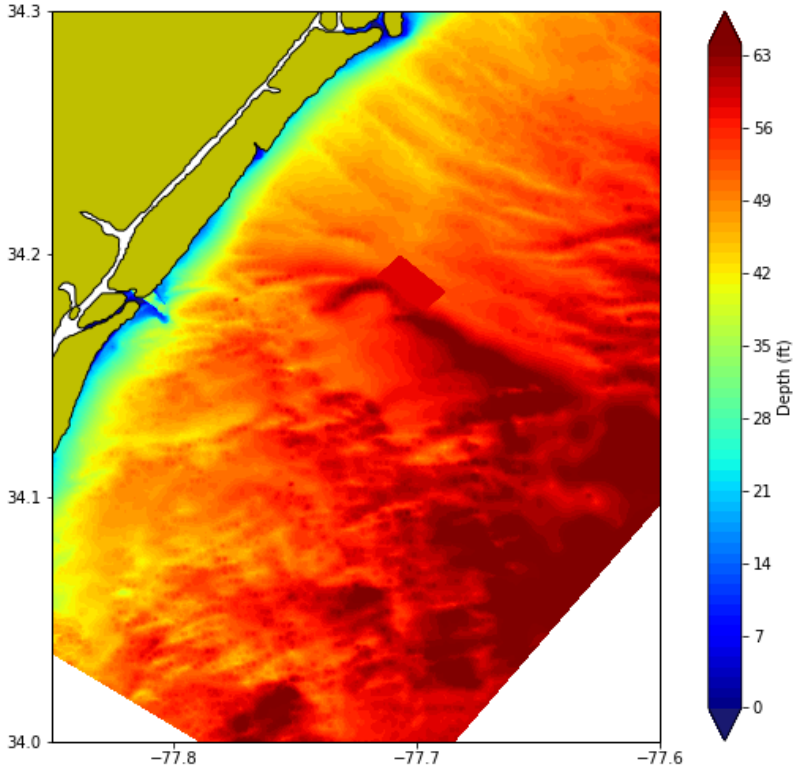
Borrow Area D (58 ft) Modified Bathymetry



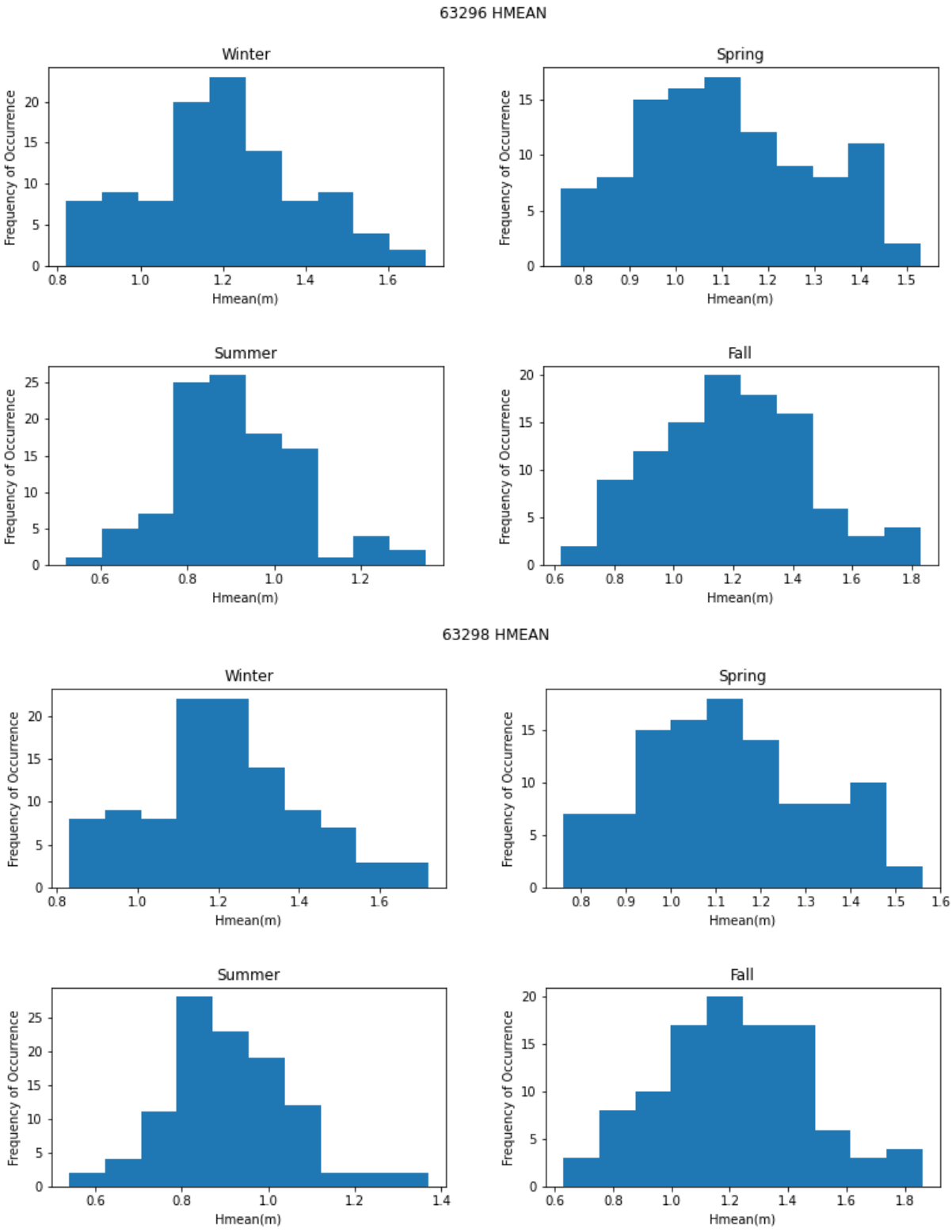
Borrow Area E (58 ft) Modified Bathymetry



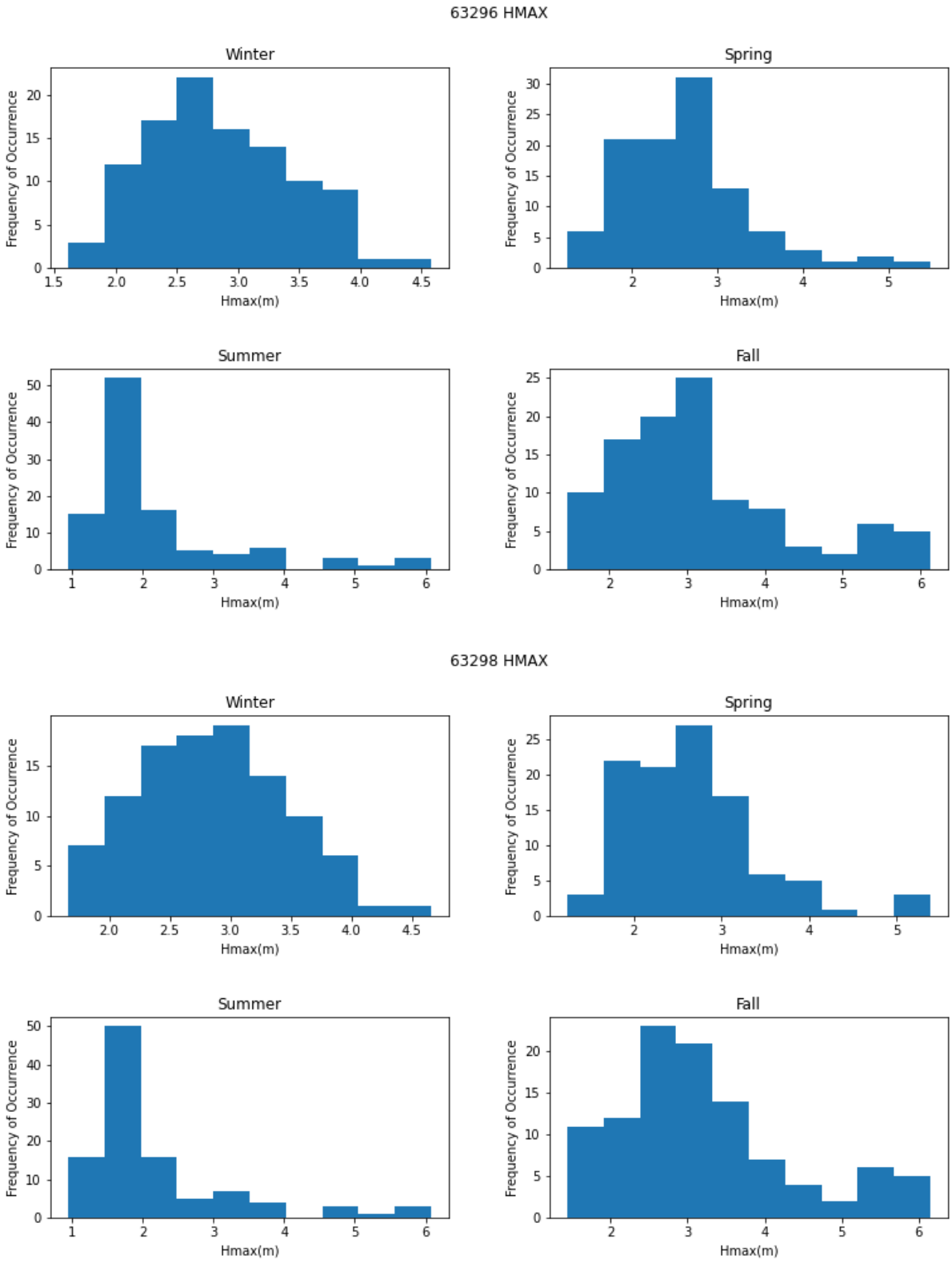
Borrow Area F (58 ft) Modified Bathymetry



Appendix B—Seasonal Wave Height Statistics



The frequency of occurrence for the mean monthly wave conditions from 1980 to 2017



The frequency of occurrence for the max monthly wave conditions from 1980 to 2017

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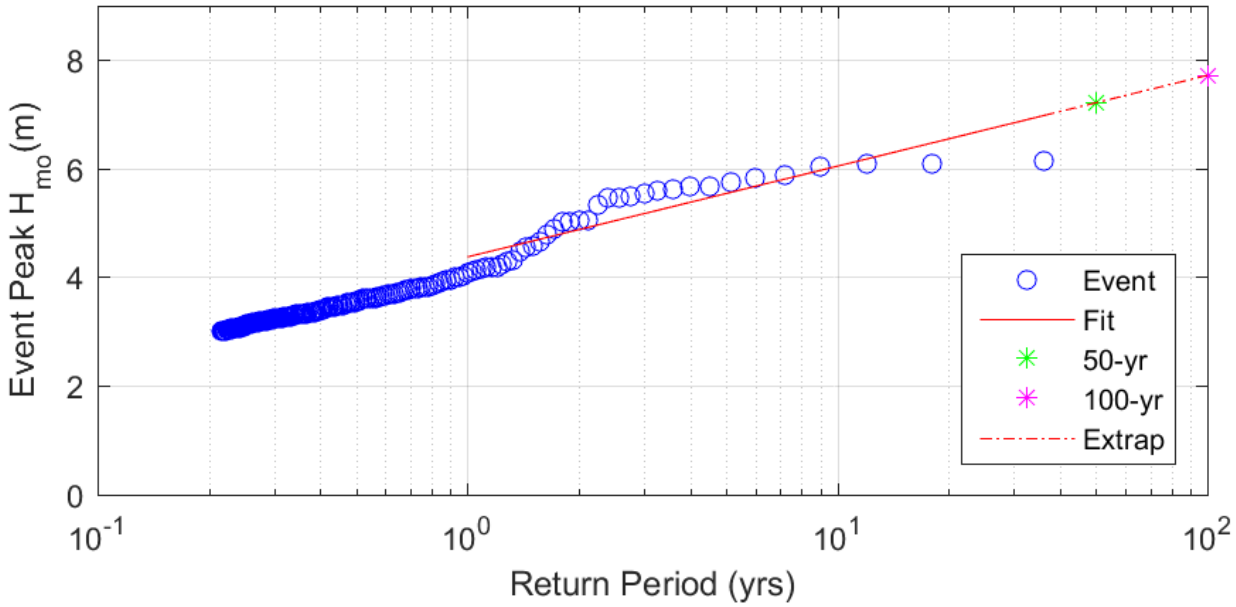
Appendix C—Extremal Analysis

Extremal Analysis WIS Station 63296

Storm Event Return Period of 35-yr (1980-2014) Wave Hindcast
Atlantic Station 63296 : Lat: 34.167° Lon:-77.583° Depth: 16m
Linear Fit to top 35 events: H_{mo} = 4.3721 + 0.72679 • ln [Return Period(yrs)]



Top 10 events based on Peak H_{mo}

Event	Date/Time(UTC)	H_{mo}	T_p	θ_{mean}	Event	Date/Time(UTC)	H_{mo}	T_p	θ_{mean}
1	1996/09/06 00:00	6.13	15.66	118.0	6	1984/09/12 00:00	5.84	11.60	118.0
2	1999/09/16 06:00	6.09	15.17	119.0	7	2008/09/06 08:00	5.76	14.20	148.0
3	1996/07/12 18:00	6.08	13.51	119.0	8	2011/08/27 01:00	5.67	16.15	135.0
4	1998/08/26 20:00	6.05	14.63	112.0	9	1985/09/27 00:00	5.66	16.90	131.0
5	1989/09/22 03:00	5.88	16.41	133.0	10	2010/09/03 01:00	5.63	17.16	131.0

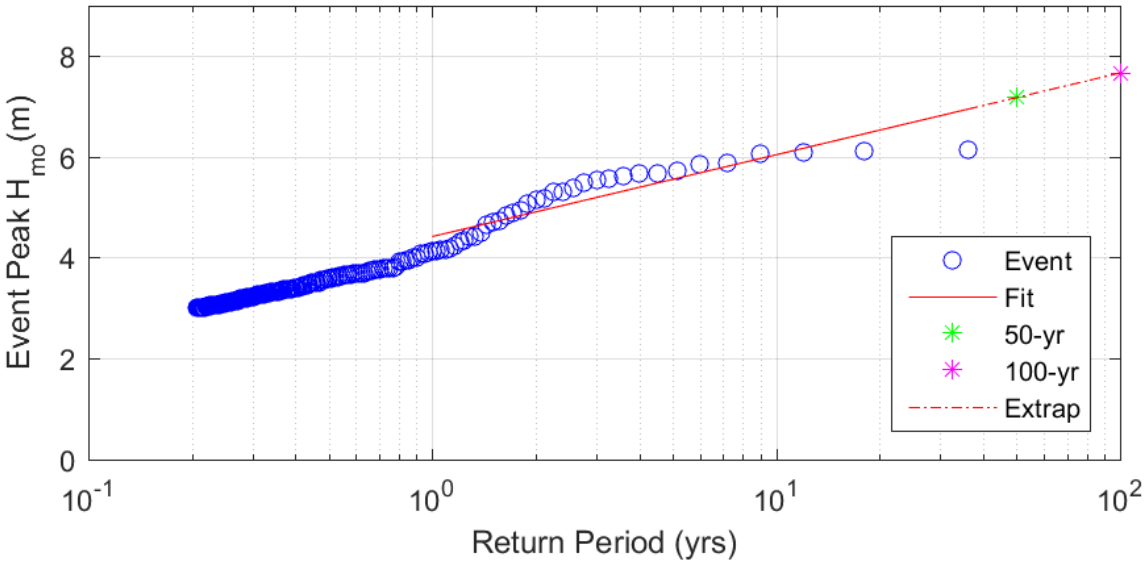
An event is defined as any period when H_{mo} > 3.00m

θ_{mean} is direction that waves are arriving from

US Army Engineer Research & Development Center ST63296_v03

Extremal Analysis WIS Station 63298

Storm Event Return Period of 35-yr (1980-2014) Wave Hindcast
Atlantic Station 63298 : Lat: 34.083° Lon:-77.667° Depth: 16m
Linear Fit to top 35 events: H_{mo} = 4.4192 + 0.70539 • ln [Return Period(yrs)]



Top 10 events based on Peak H_{mo}

Event	Date/Time(UTC)	H_{mo}	T_p	θ_{mean}	Event	Date/Time(UTC)	H_{mo}	T_p	θ_{mean}
1	1999/09/16 06:00	6.15	14.56	114.0	6	1984/09/11 23:00	5.85	11.02	114.0
2	1996/09/05 23:00	6.12	15.68	108.0	7	2008/09/06 07:00	5.73	14.18	141.0
3	1996/07/12 18:00	6.08	13.28	117.0	8	2010/09/03 01:00	5.67	17.24	128.0
4	1998/08/26 20:00	6.07	14.65	108.0	9	1985/09/27 00:00	5.66	16.87	128.0
5	1989/09/22 03:00	5.87	16.26	129.0	10	2011/08/27 01:00	5.63	16.10	132.0

An event is defined as any period when H_{mo} > 3.00m

θ_{mean} is direction that waves are arriving from

US Army Engineer Research & Development Center

ST63298_v03

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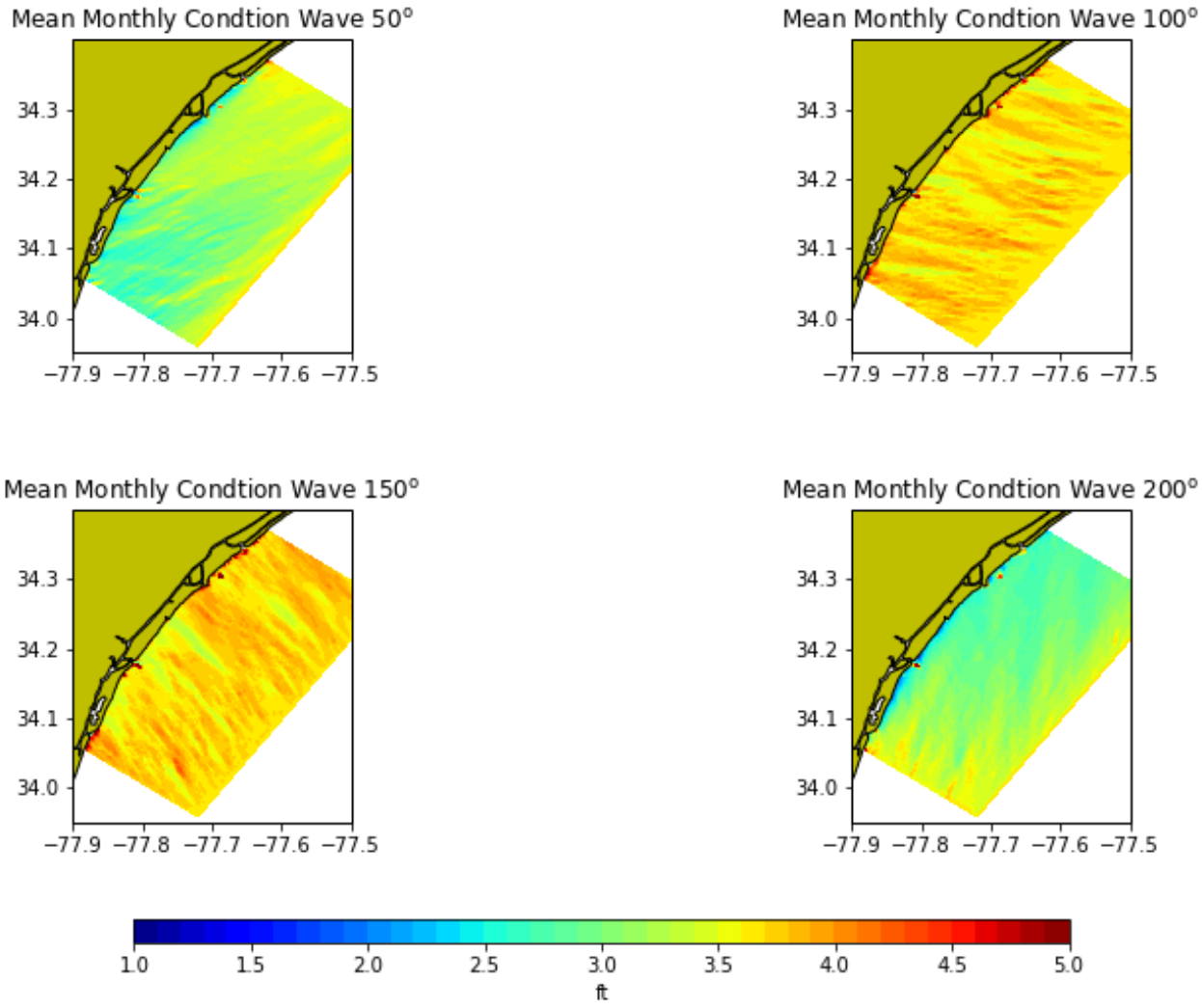
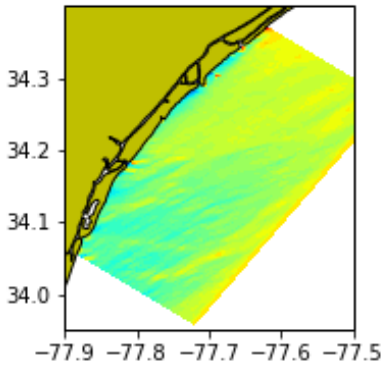
Appendix D—Spectral Wave Height Plots

Base

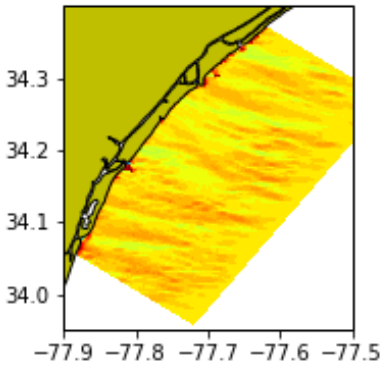


Area B (-23 ft)

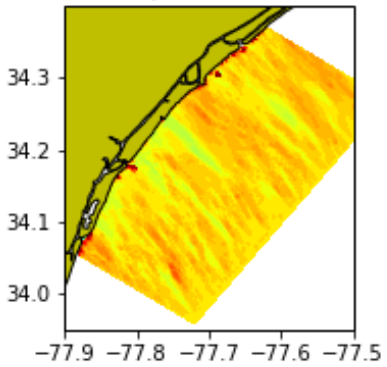
Mean Monthly Condtion Wave 50°



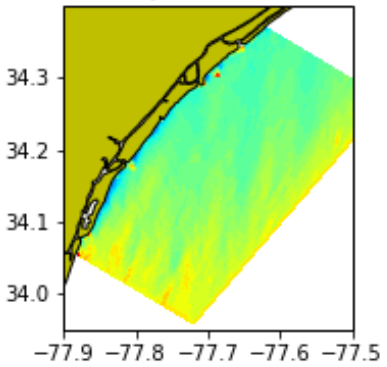
Mean Monthly Condtion Wave 100°

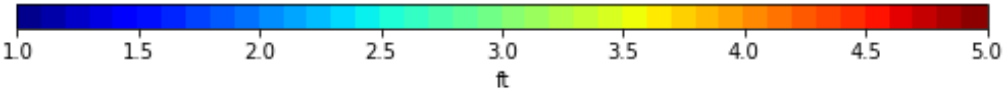


Mean Monthly Condtion Wave 150°



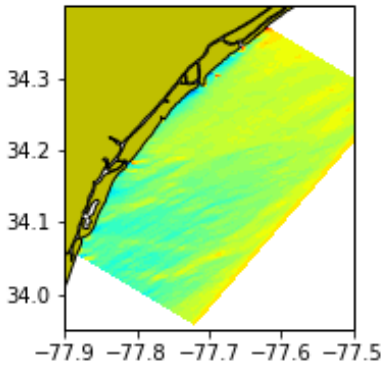
Mean Monthly Condtion Wave 200°



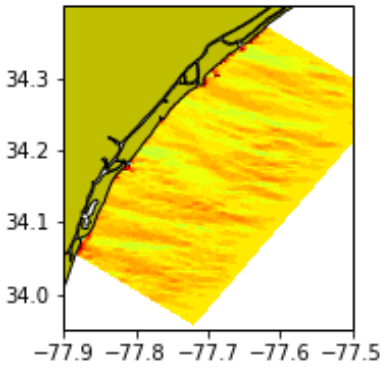


Area B (-28 ft)

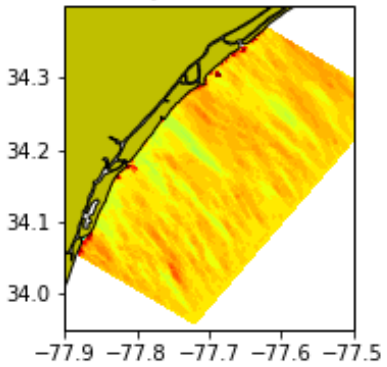
Mean Monthly Condtion Wave 50°



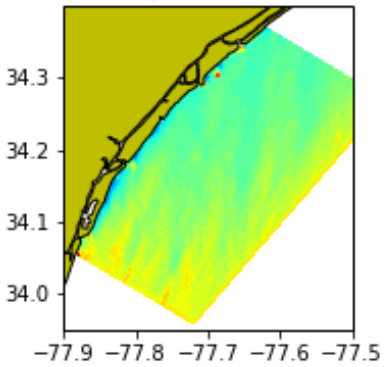
Mean Monthly Condtion Wave 100°

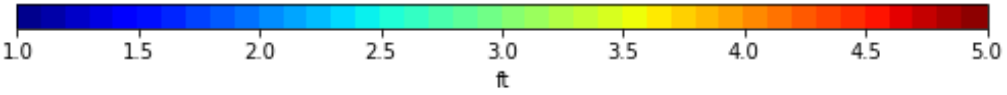


Mean Monthly Condtion Wave 150°



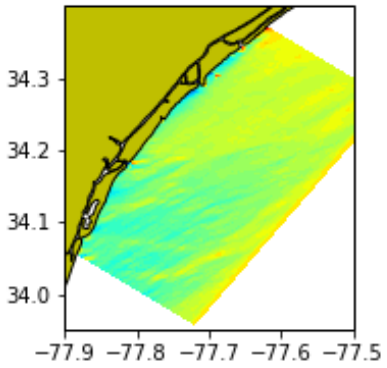
Mean Monthly Condtion Wave 200°



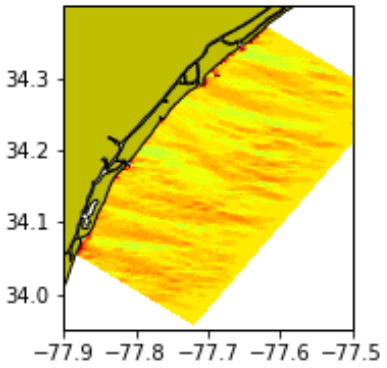


Area B (-33 ft)

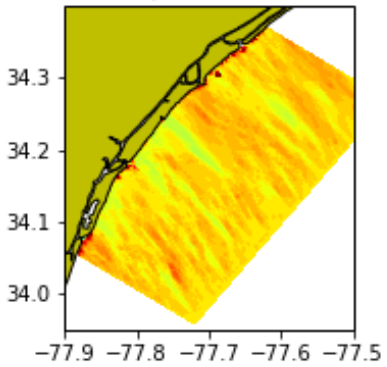
Mean Monthly Condtion Wave 50°



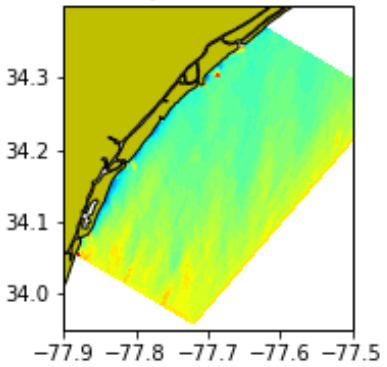
Mean Monthly Condtion Wave 100°

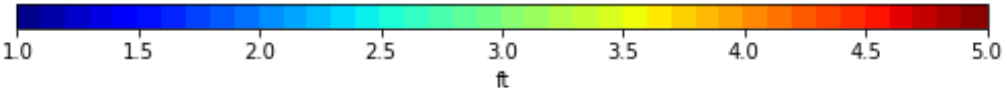


Mean Monthly Condtion Wave 150°

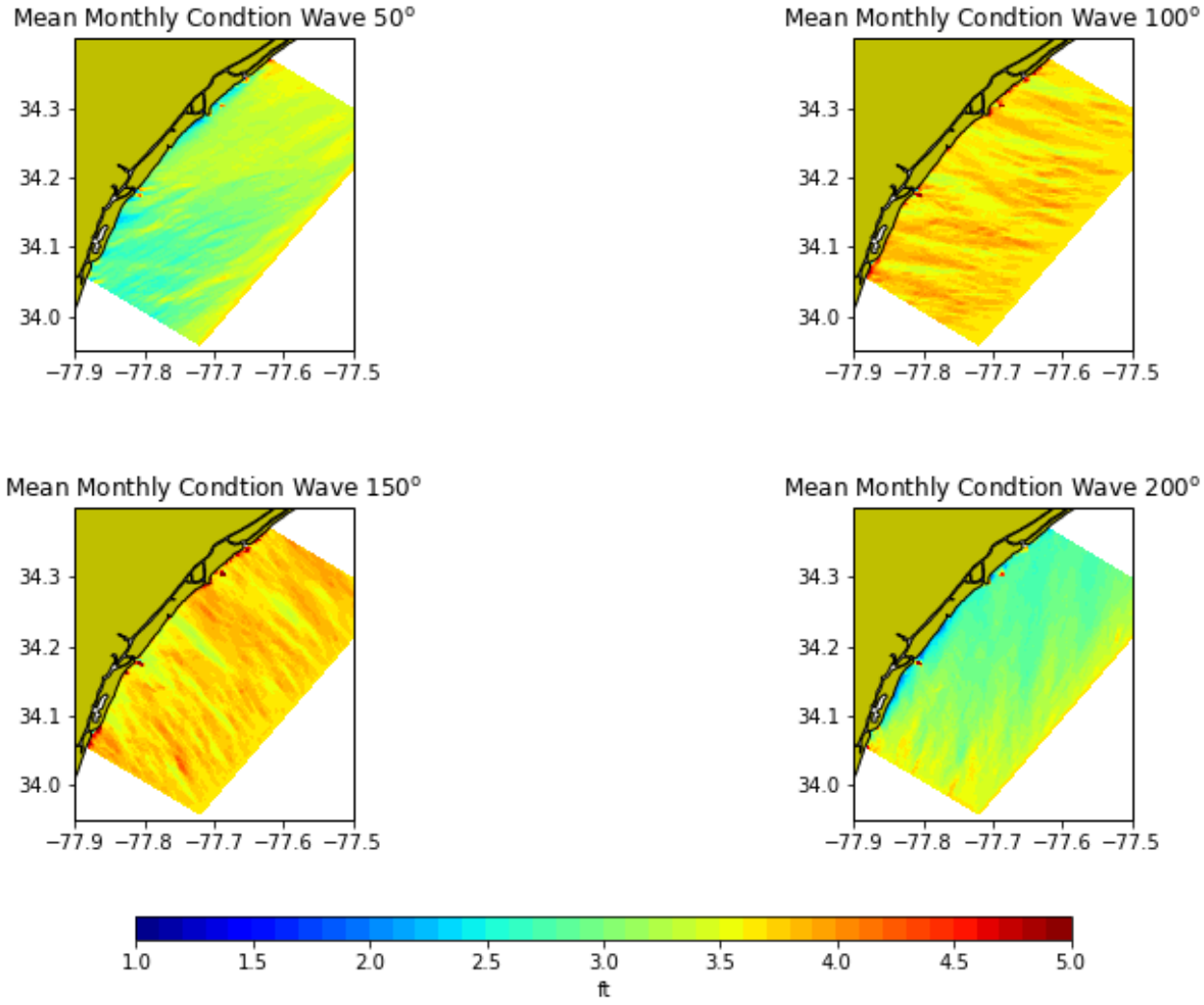


Mean Monthly Condtion Wave 200°



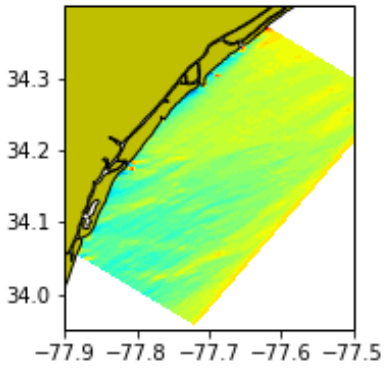


Area C (-58 ft)

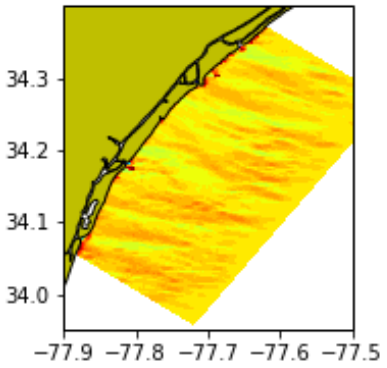

Mean Monthly Condtion Wave 50°
Mean Monthly Condtion Wave 100°
Mean Monthly Condtion Wave 150°
Mean Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
−77.9 −77.8 −77.7 −77.6 −77.5
1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
ft

Area D (-58 ft)

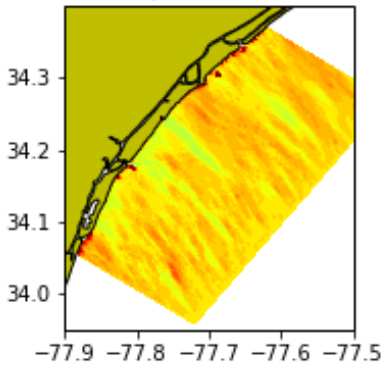
Mean Monthly Condtion Wave 50°



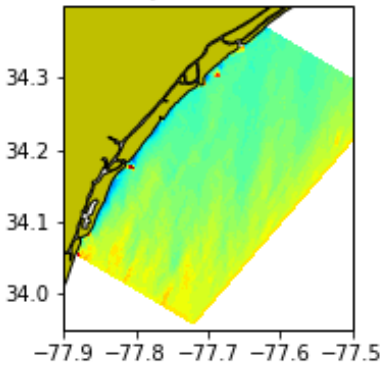
Mean Monthly Condtion Wave 100°

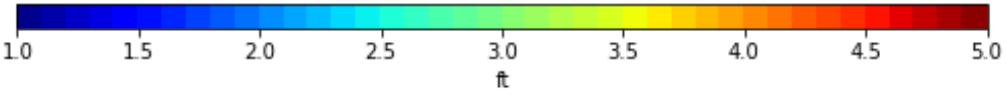


Mean Monthly Condtion Wave 150°



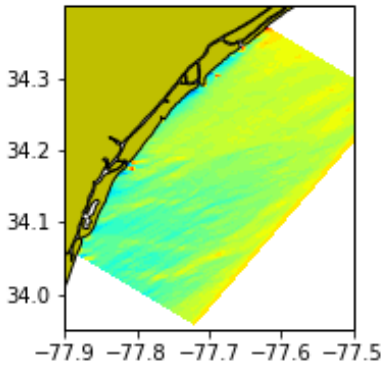
Mean Monthly Condtion Wave 200°



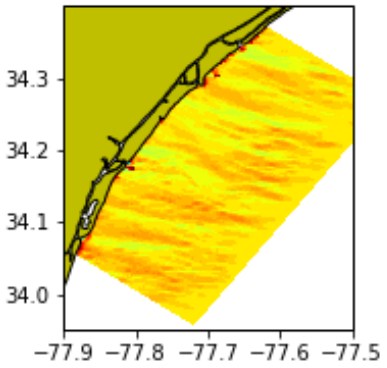


Area E (-58 ft)

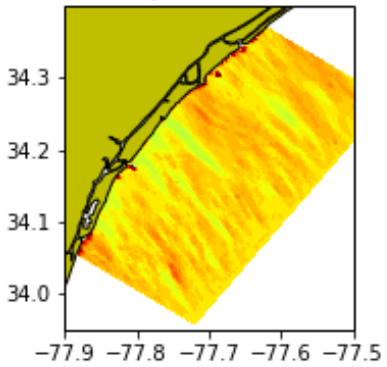
Mean Monthly Condtion Wave 50°



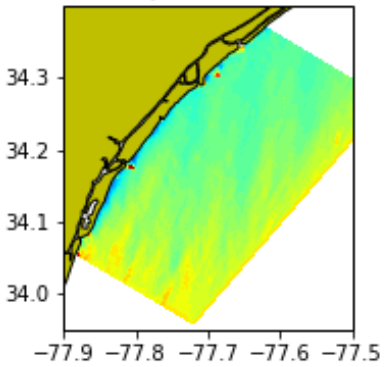
Mean Monthly Condtion Wave 100°

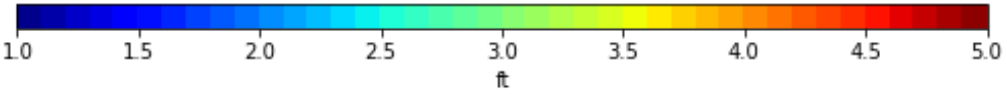


Mean Monthly Condtion Wave 150°



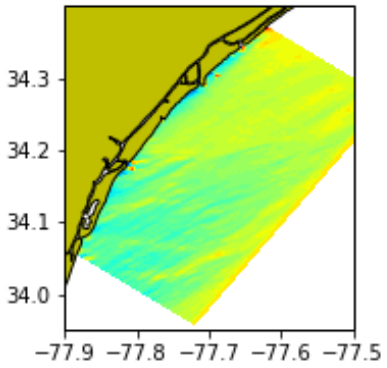
Mean Monthly Condtion Wave 200°



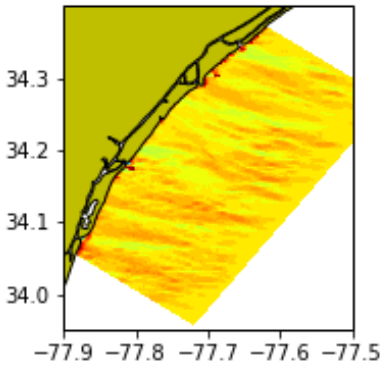


Area F (-58 ft)

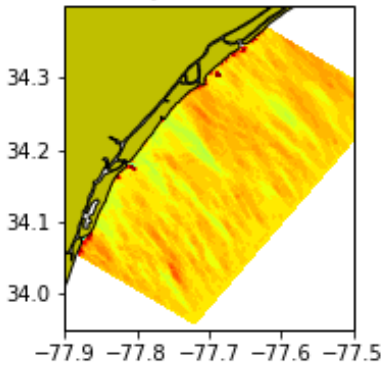
Mean Monthly Condtion Wave 50°



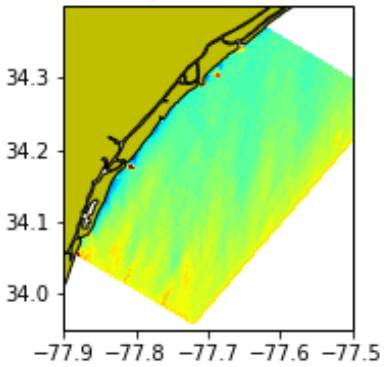
Mean Monthly Condtion Wave 100°

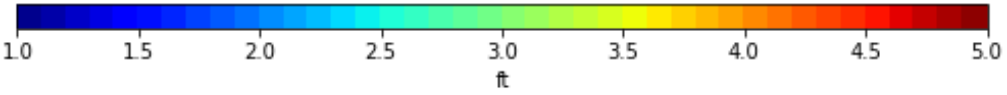


Mean Monthly Condtion Wave 150°

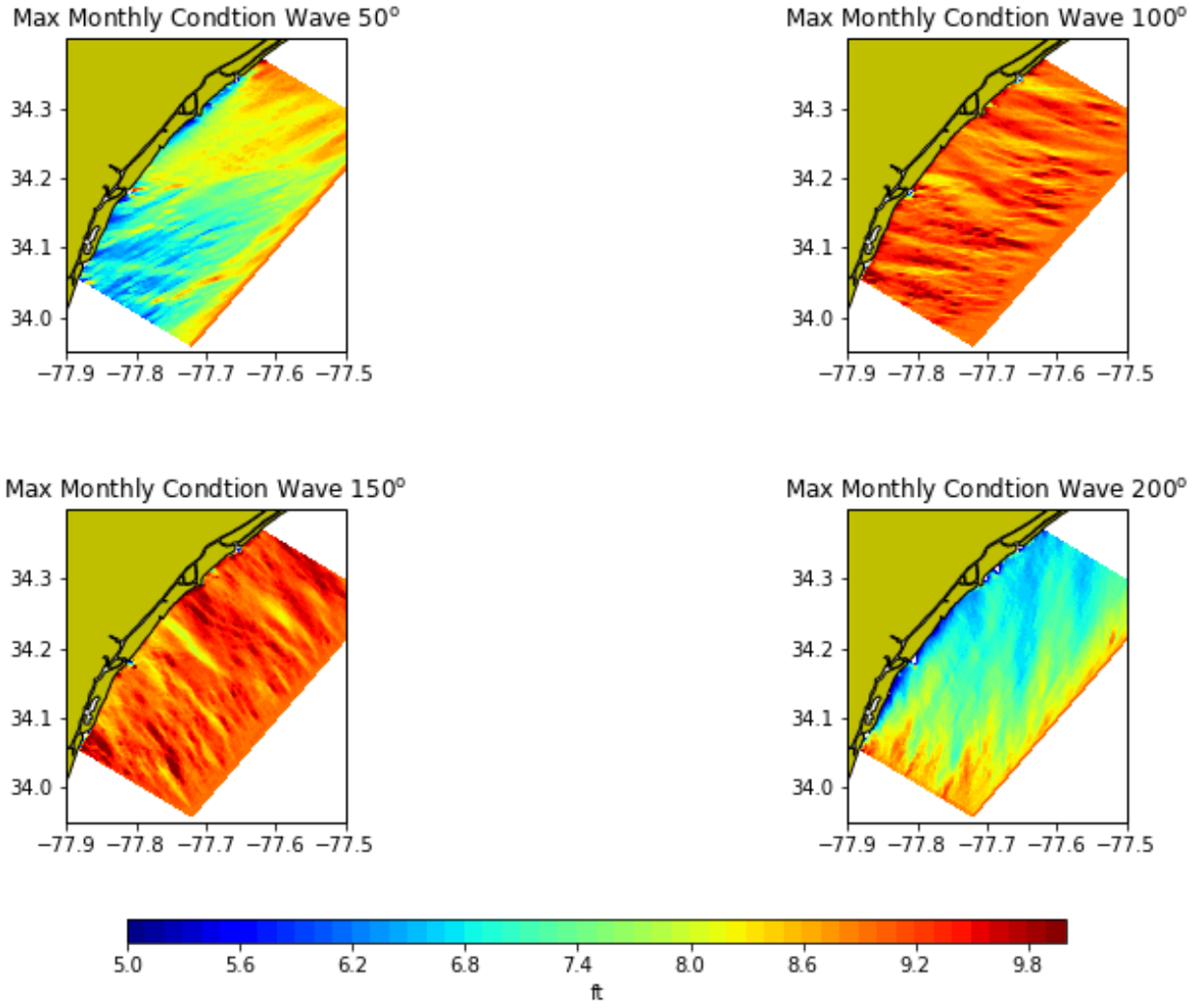


Mean Monthly Condtion Wave 200°



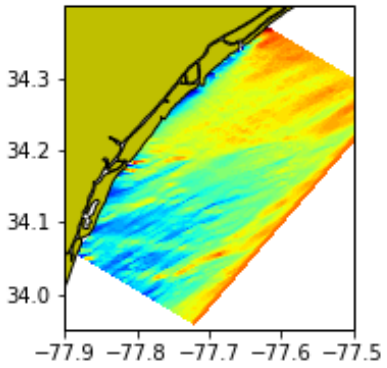


Base

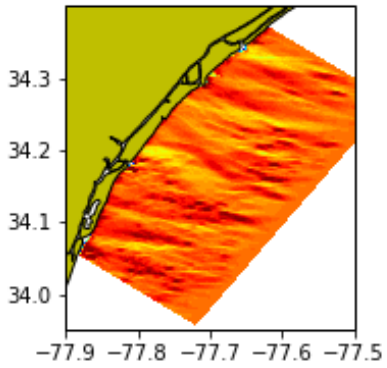

Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
−77.9 −77.8 −77.7 −77.6 −77.5
5.0 5.6 6.2 6.8 7.4 8.0 8.6 9.2 9.8
ft

Area B (-23 ft)

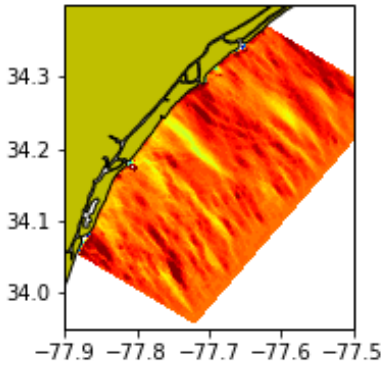
Max Monthly Condtion Wave 50°



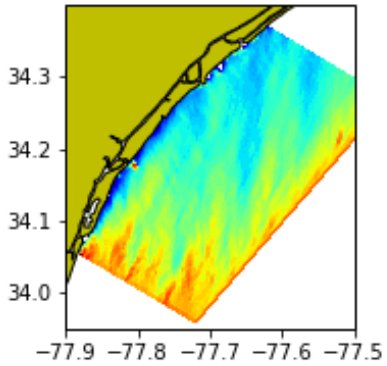
Max Monthly Condtion Wave 100°

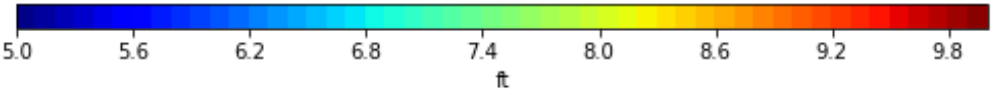


Max Monthly Condtion Wave 150°

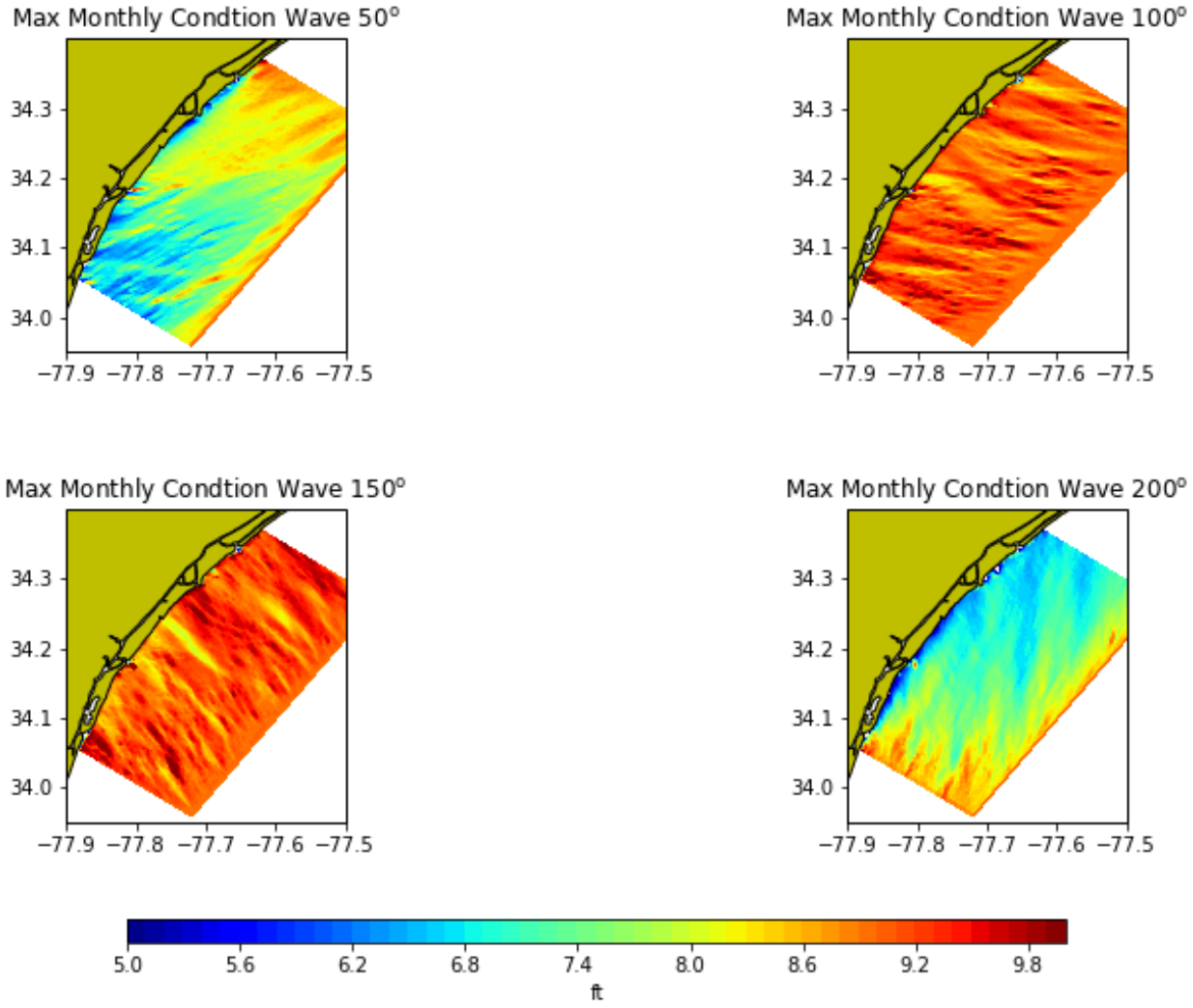


Max Monthly Condtion Wave 200°



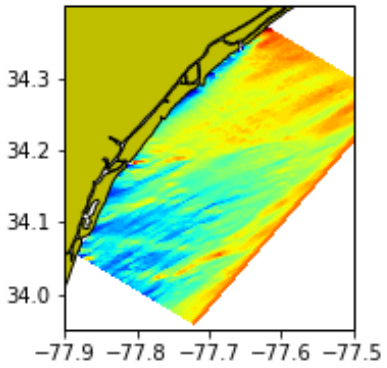


Area B (-28 ft)

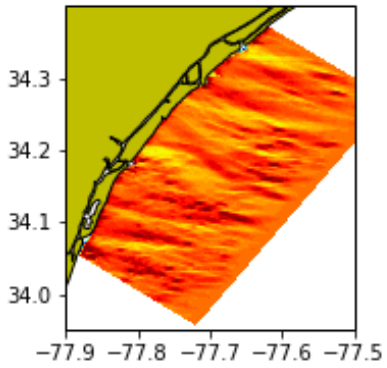

Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
−77.9 −77.8 −77.7 −77.6 −77.5
5.0 5.6 6.2 6.8 7.4 8.0 8.6 9.2 9.8
ft

Area B (-33 ft)

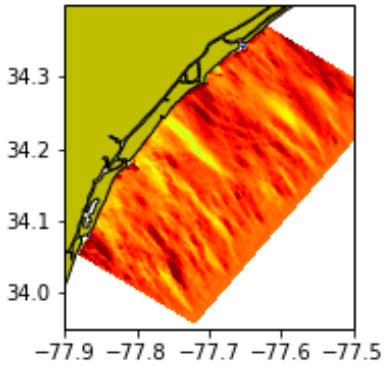
Max Monthly Condtion Wave 50°



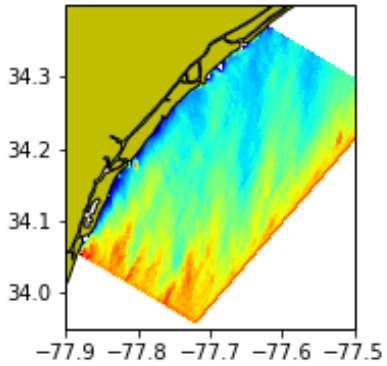
Max Monthly Condtion Wave 100°

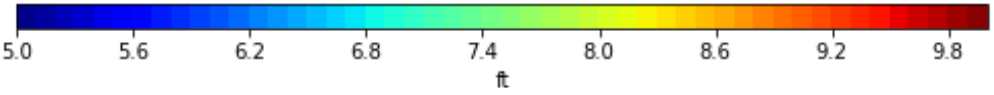


Max Monthly Condtion Wave 150°

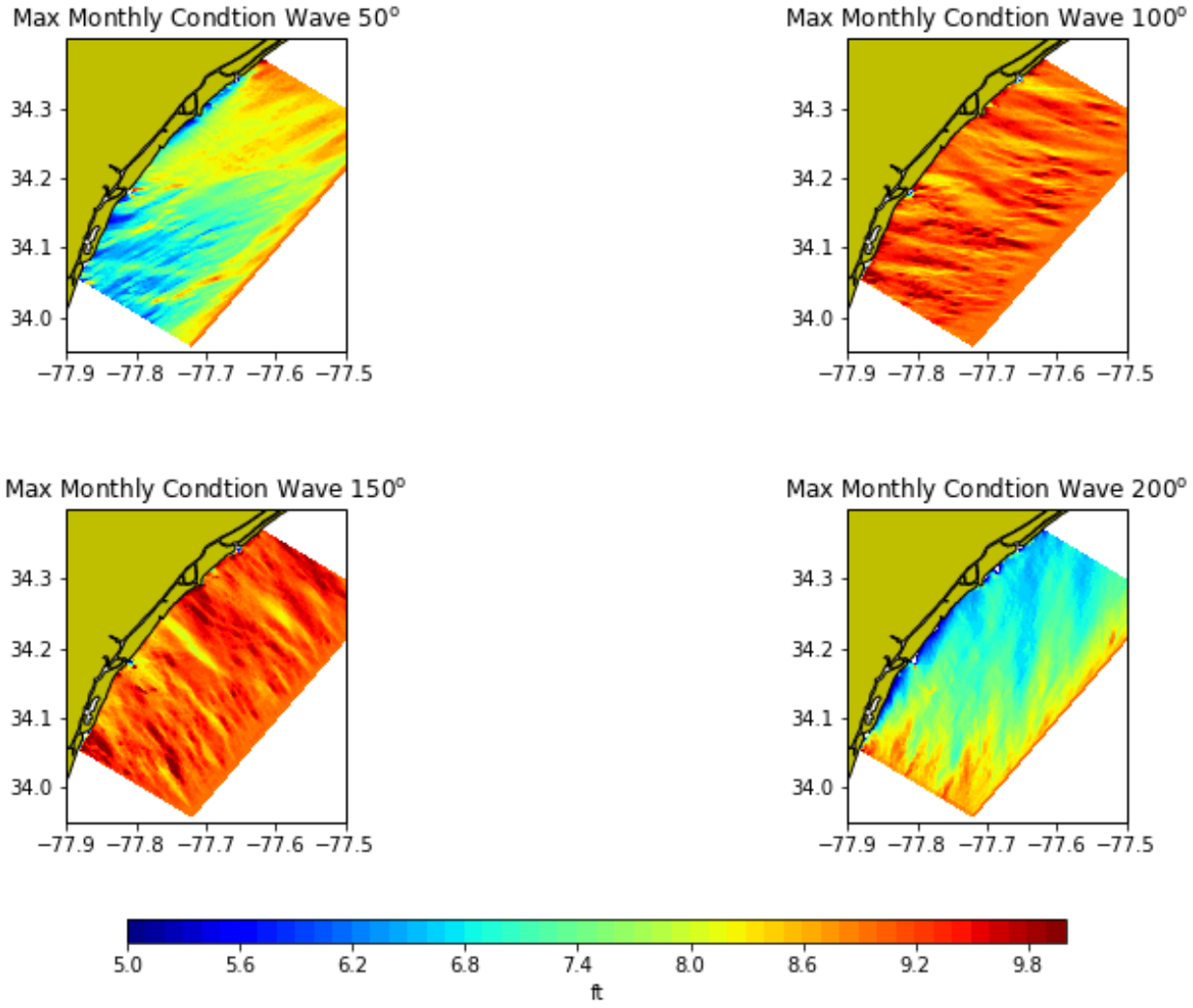


Max Monthly Condtion Wave 200°

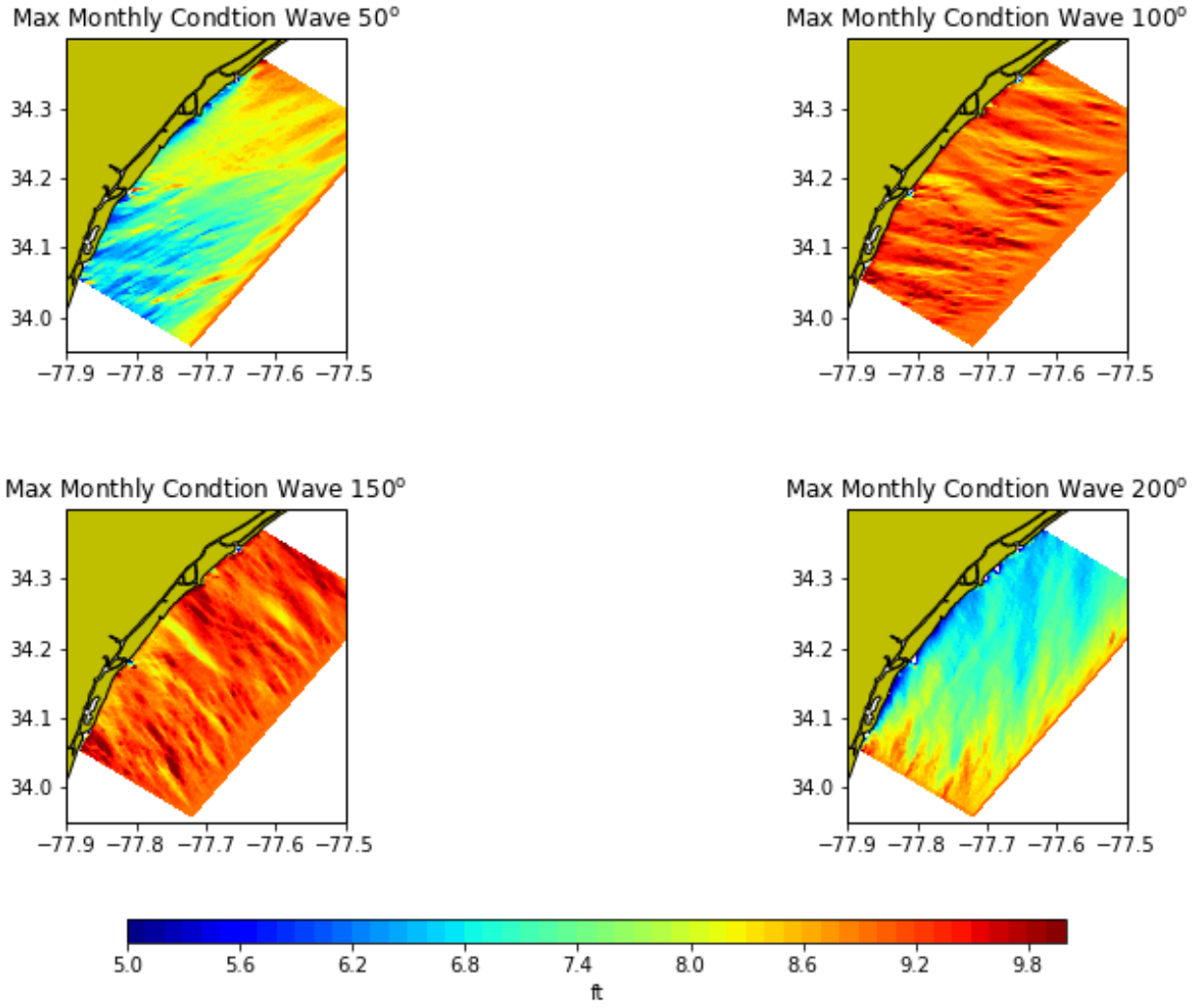




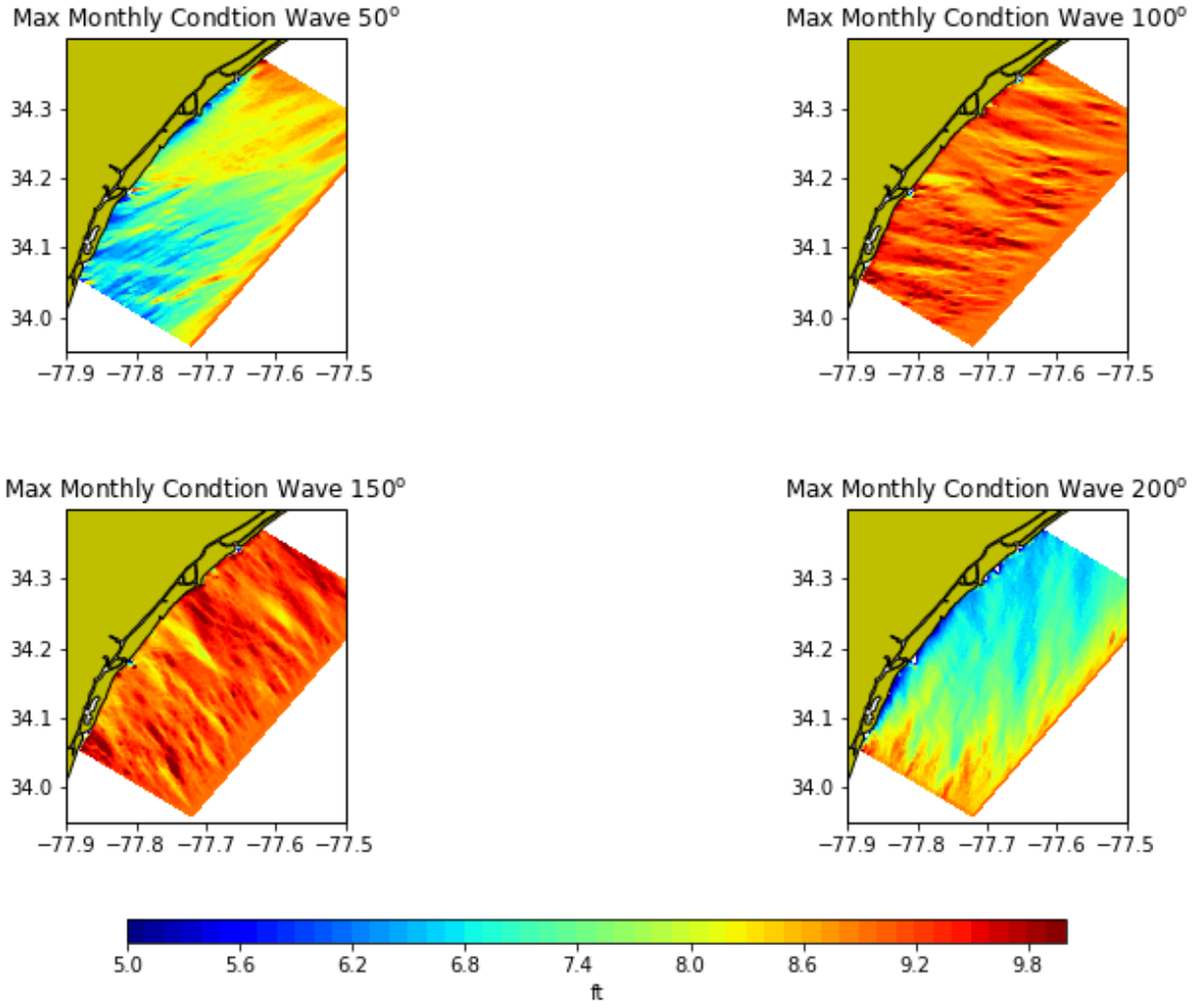
Area C (-58 ft)

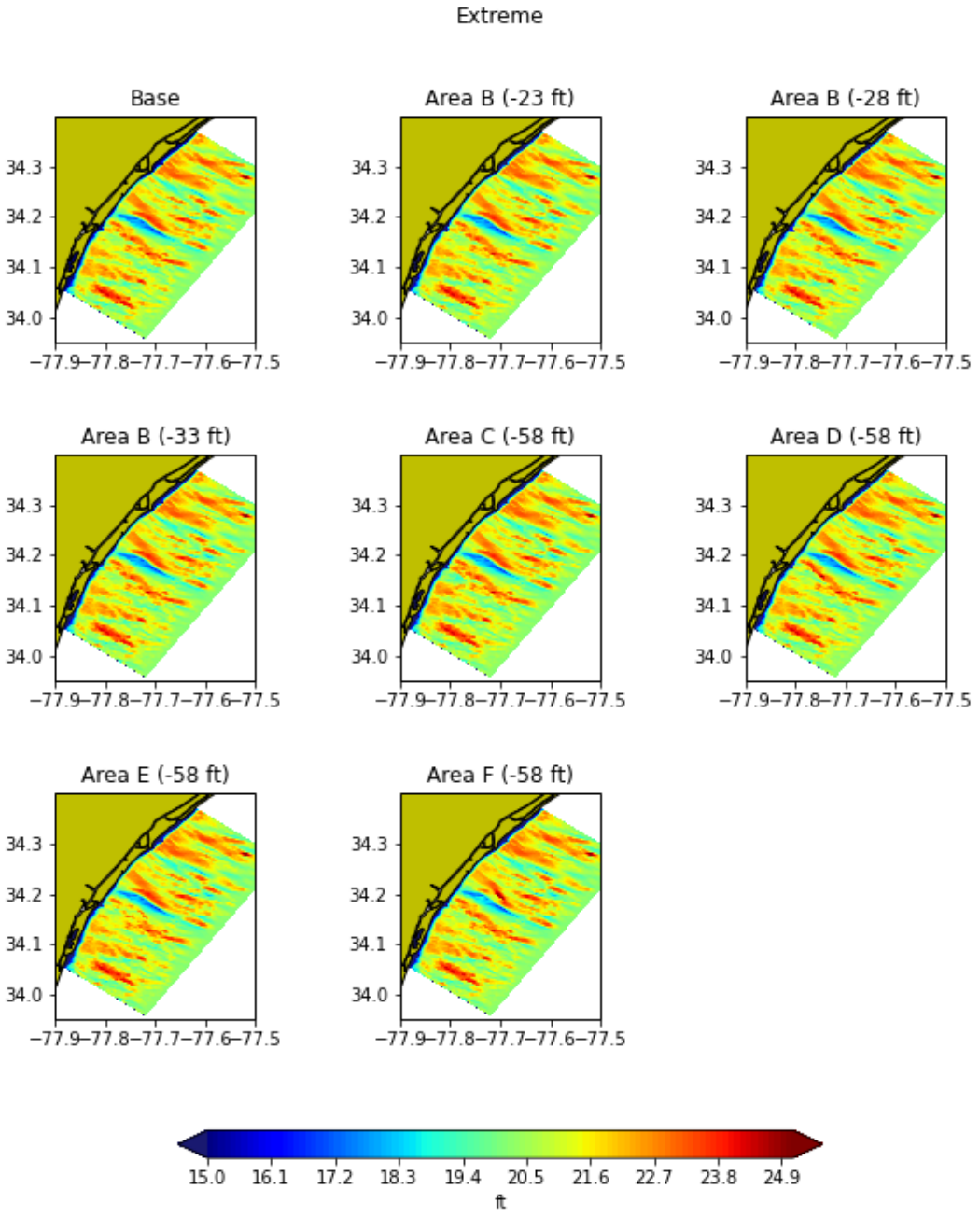

Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
−77.9 −77.8 −77.7 −77.6 −77.5
5.0 5.6 6.2 6.8 7.4 8.0 8.6 9.2 9.8
ft

Area D (-58 ft)

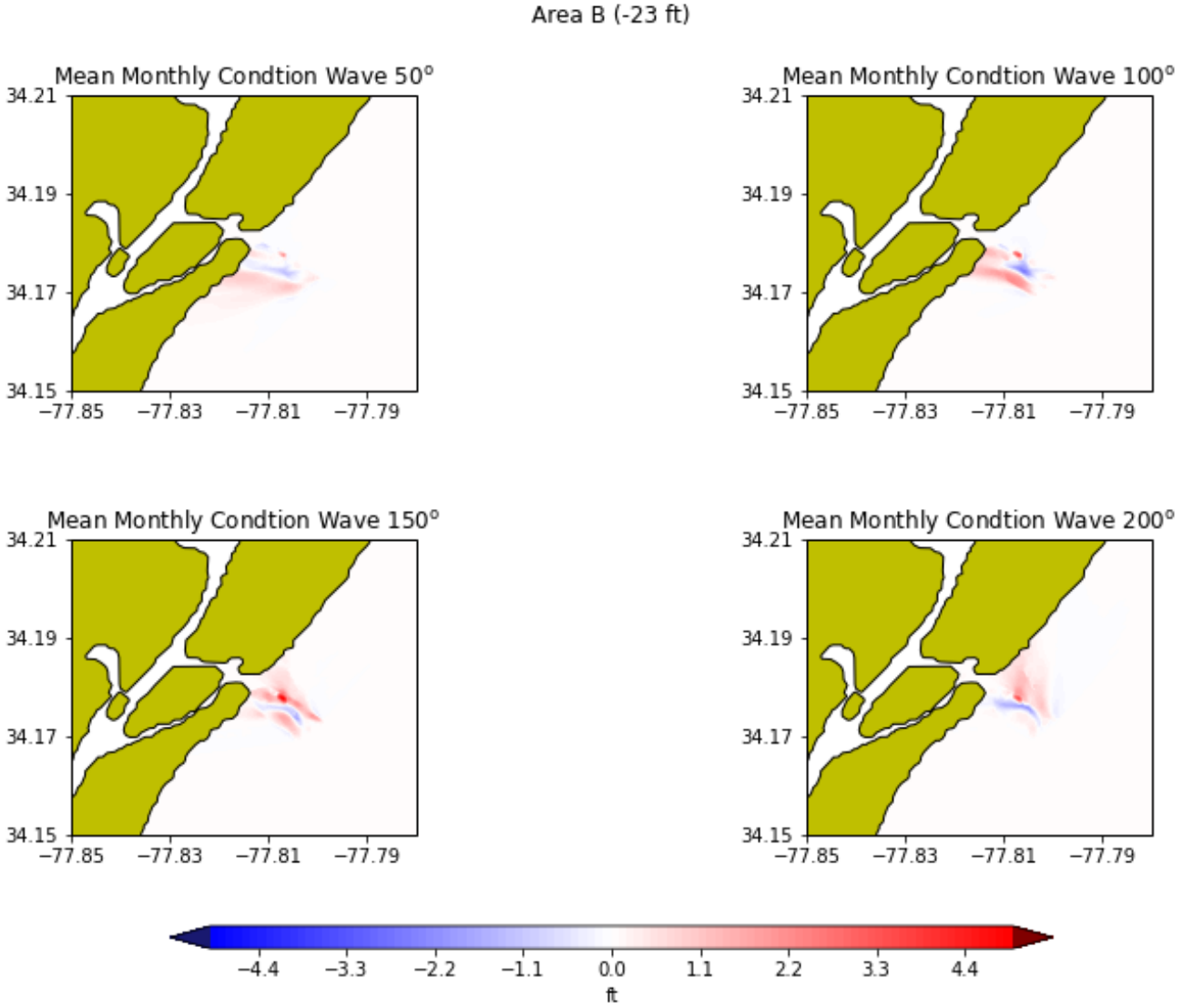

Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
−77.9 −77.8 −77.7 −77.6 −77.5
5.0 5.6 6.2 6.8 7.4 8.0 8.6 9.2 9.8
ft

Area F (-58 ft)

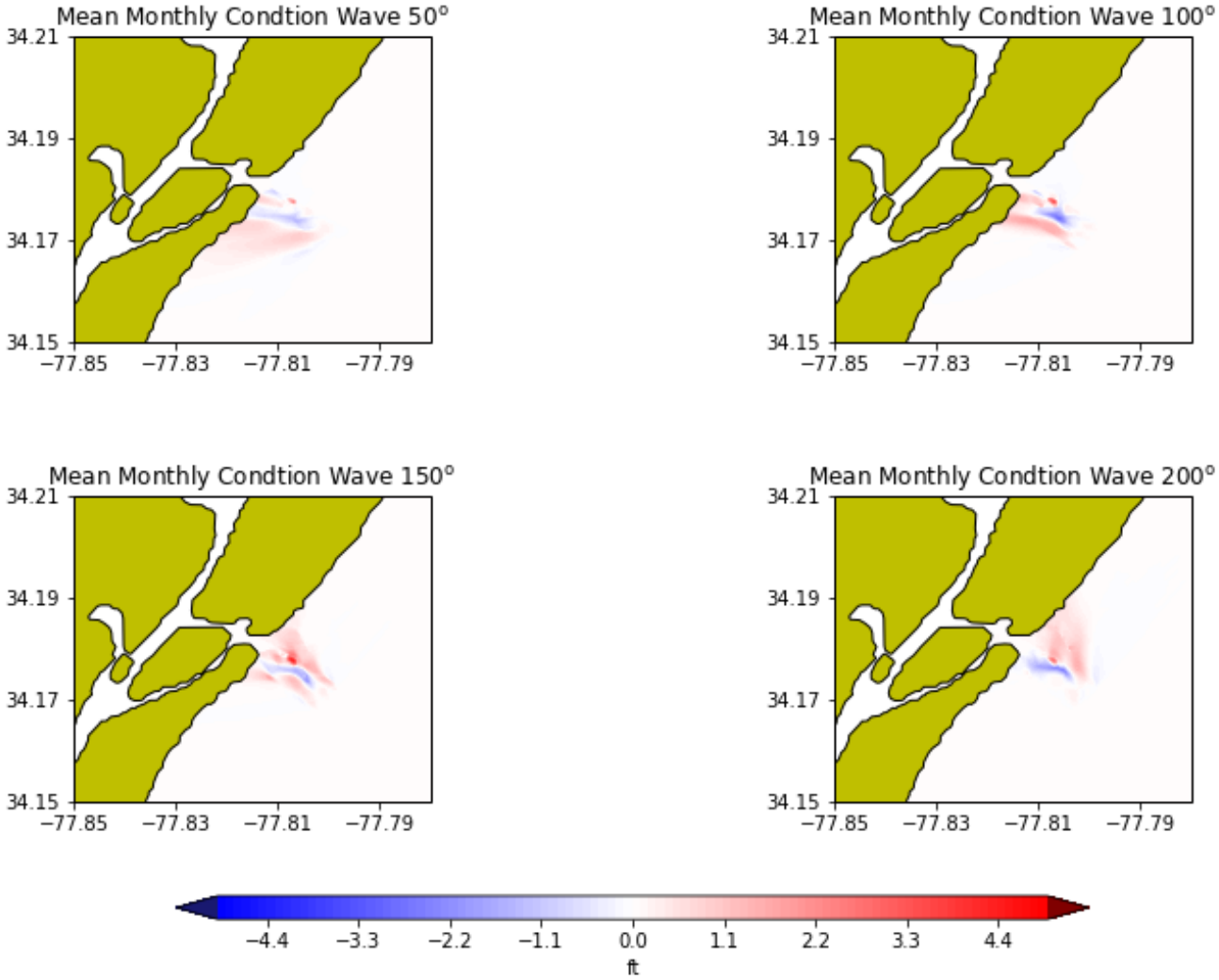

Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
−77.9 −77.8 −77.7 −77.6 −77.5
5.0 5.6 6.2 6.8 7.4 8.0 8.6 9.2 9.8
ft


Extreme
Base
Area B (-23 ft)
Area B (-28 ft)
Area B (-33 ft)
Area C (-58 ft)
Area D (-58 ft)
Area E (-58 ft)
Area F (-58 ft)
34.3
34.2
34.1
34.0
−77.9−77.8−77.7−77.6−77.5
15.0
16.1
17.2
18.3
19.4
20.5
21.6
22.7
23.8
24.9
ft

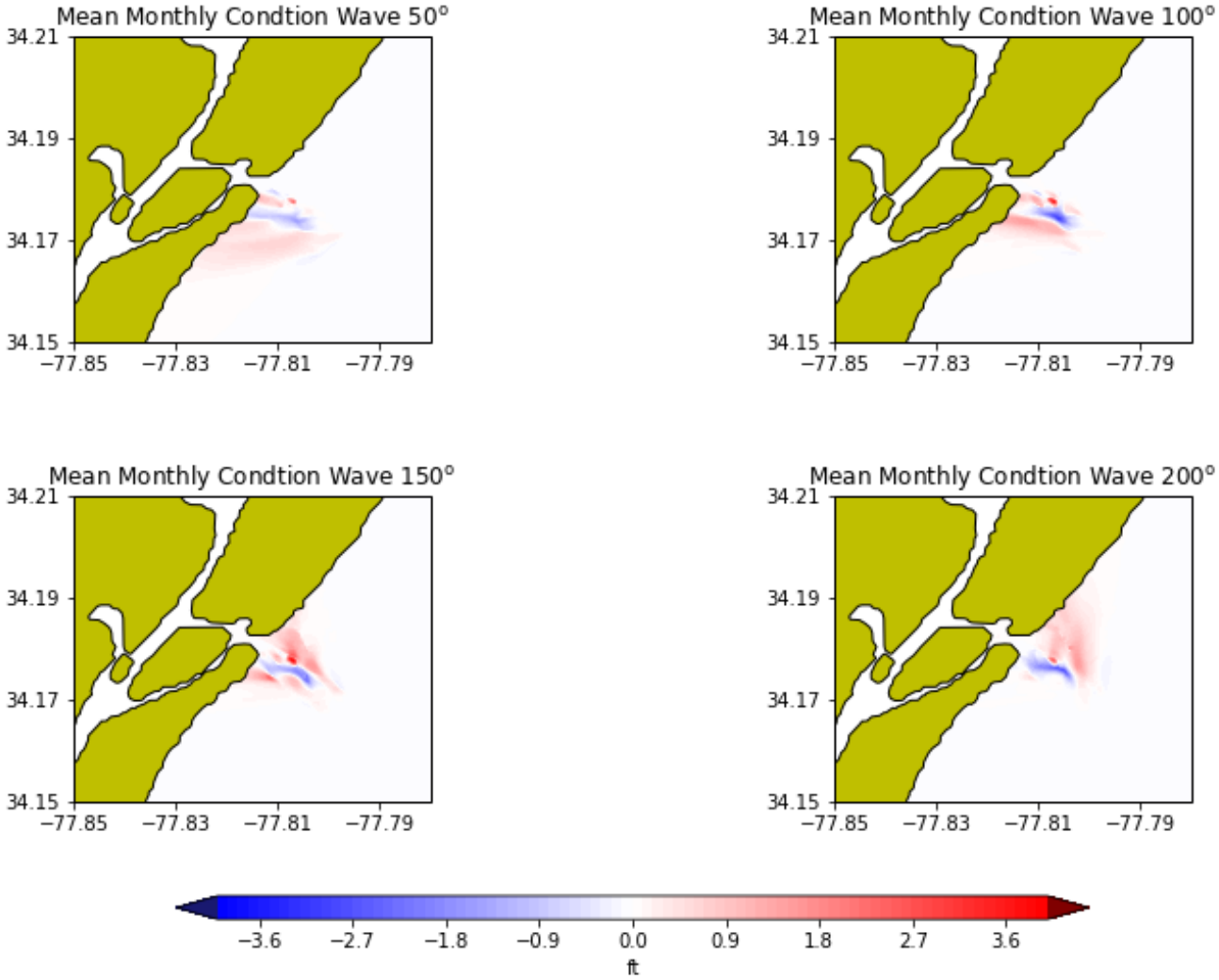
Appendix E—Difference Wave Height Plots



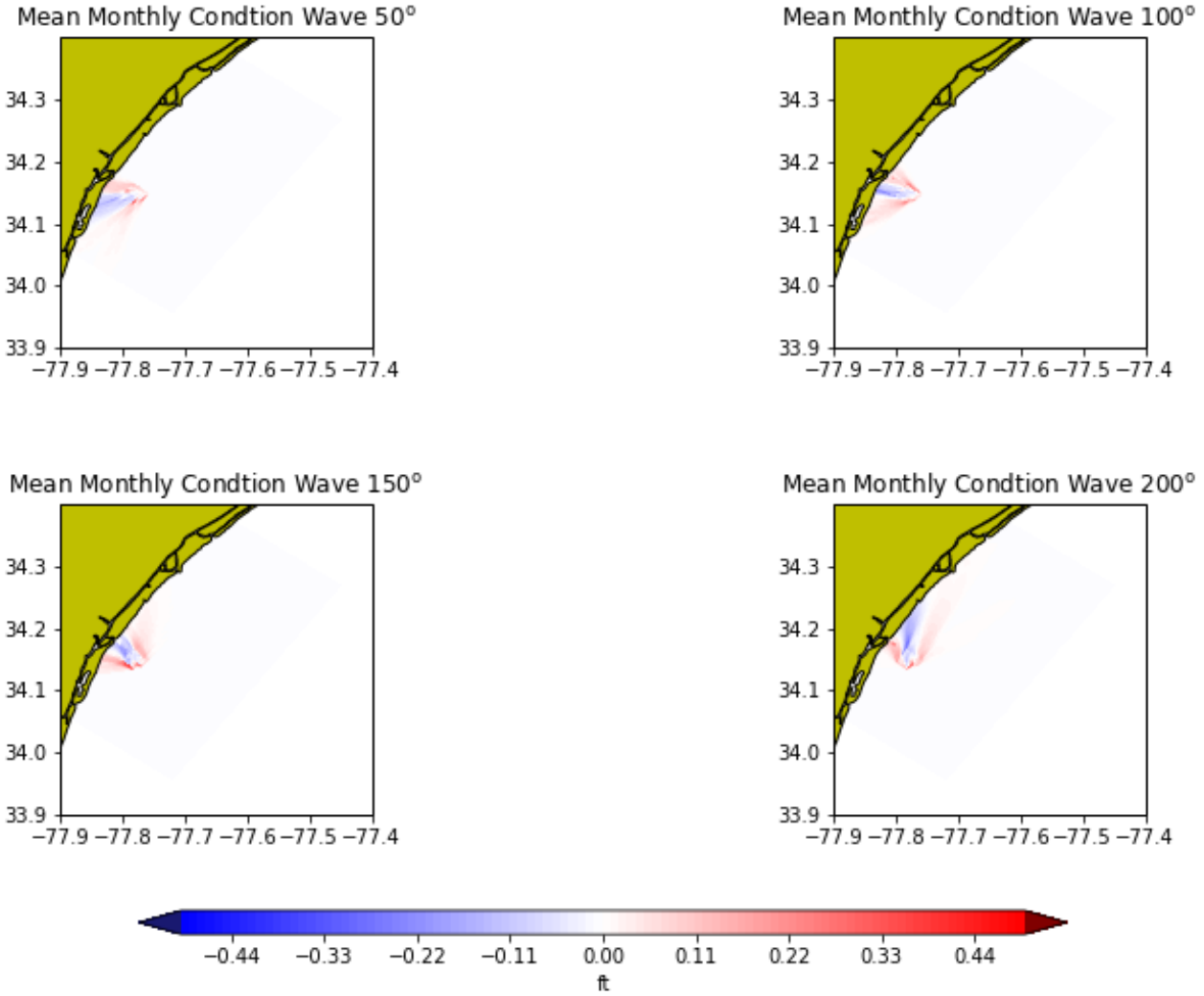
Area B (-28 ft)


Mean Monthly Condtion Wave 50°
Mean Monthly Condtion Wave 100°
Mean Monthly Condtion Wave 150°
Mean Monthly Condtion Wave 200°
34.21
34.19
34.17
34.15
−77.85
−77.83
−77.81
−77.79
−4.4
−3.3
−2.2
−1.1
0.0
1.1
2.2
3.3
4.4
ft

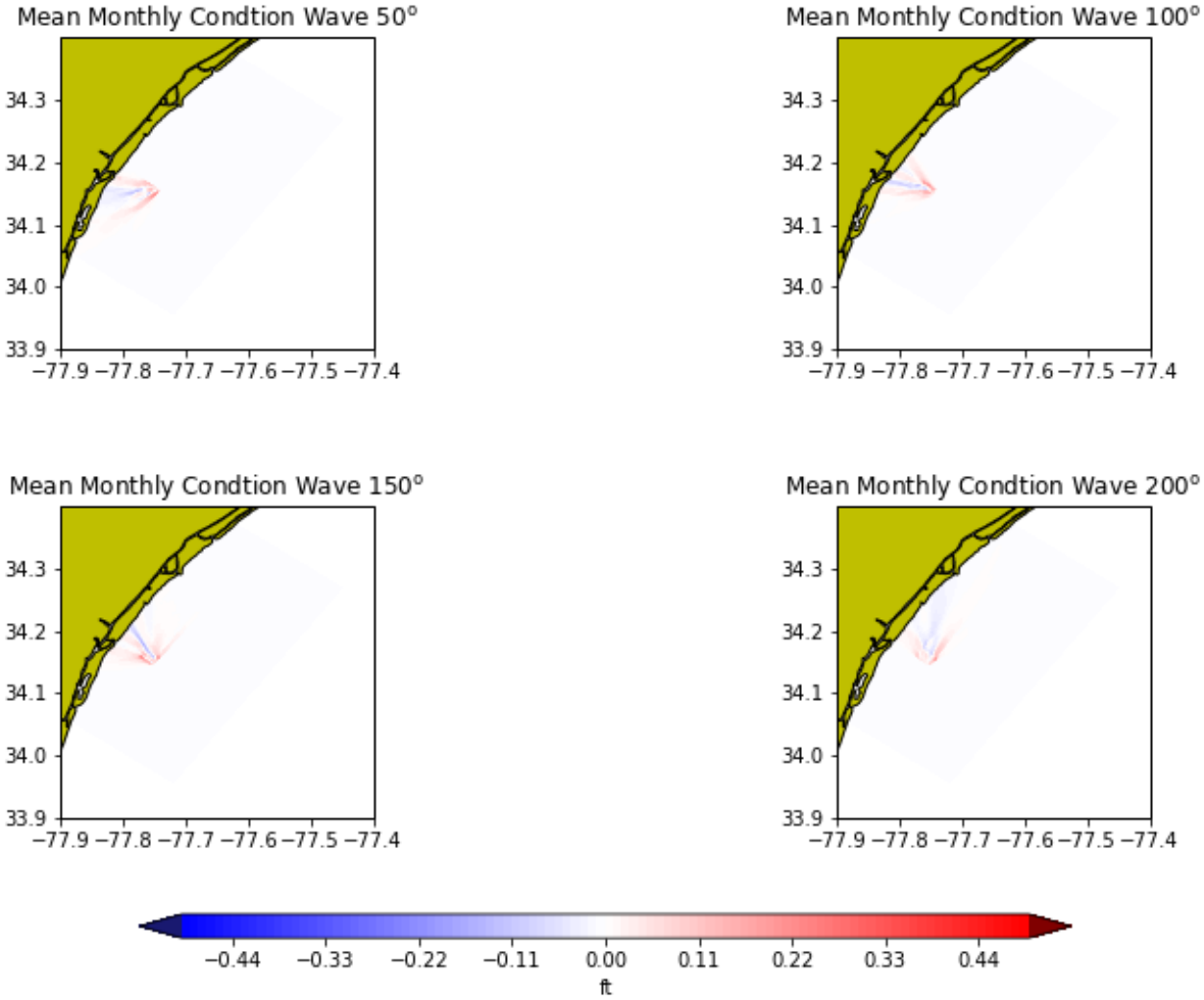
Area B (-33 ft)

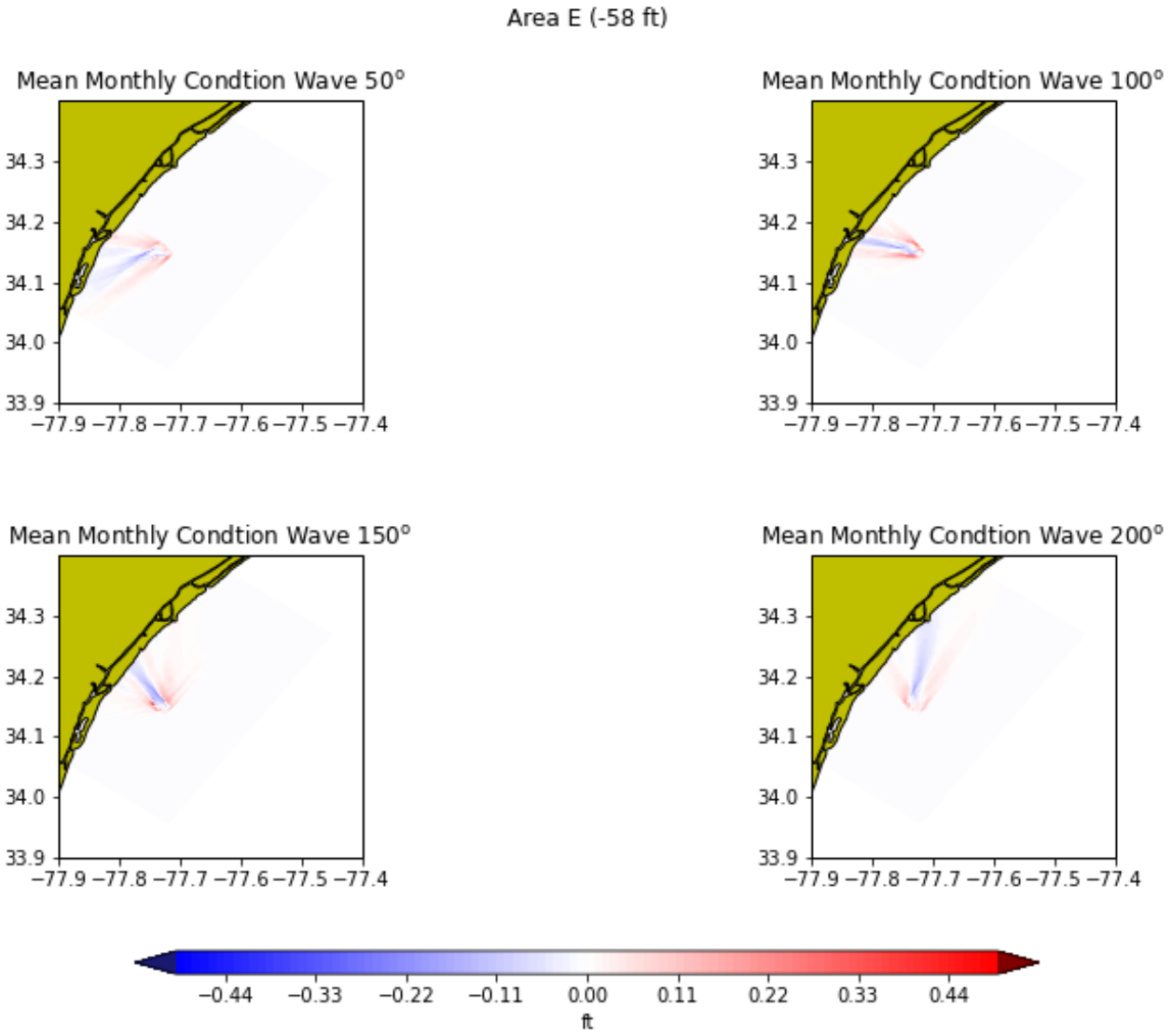

Mean Monthly Condtion Wave 50°
Mean Monthly Condtion Wave 100°
Mean Monthly Condtion Wave 150°
Mean Monthly Condtion Wave 200°
34.21
34.19
34.17
34.15
−77.85
−77.83
−77.81
−77.79
−3.6
−2.7
−1.8
−0.9
0.0
0.9
1.8
2.7
3.6
ft

Area C (-58 ft)

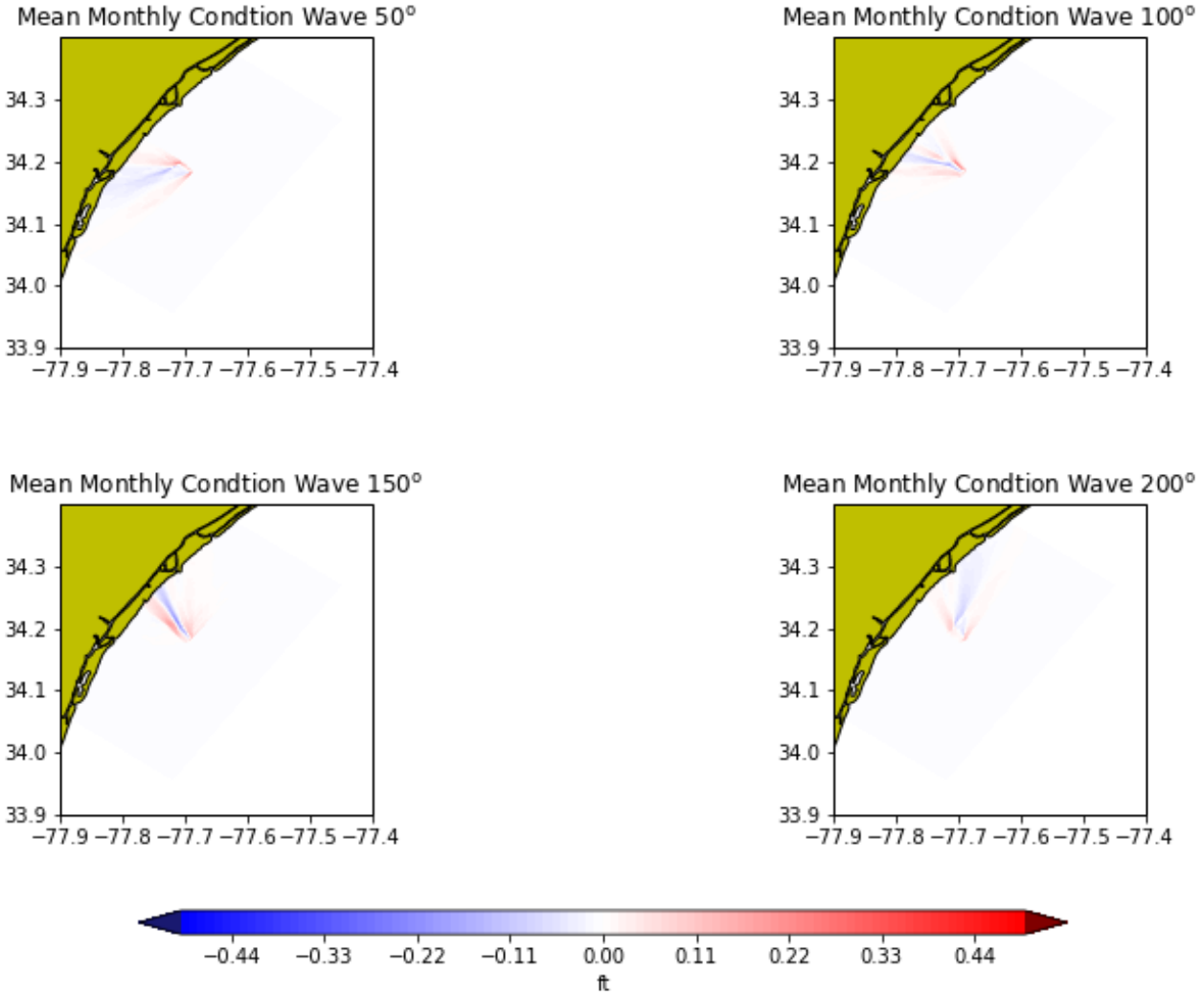

Mean Monthly Condtion Wave 50°
Mean Monthly Condtion Wave 100°
Mean Monthly Condtion Wave 150°
Mean Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
33.9
−77.9 −77.8 −77.7 −77.6 −77.5 −77.4
−0.44 −0.33 −0.22 −0.11 0.00 0.11 0.22 0.33 0.44
ft

Area D (-58 ft)

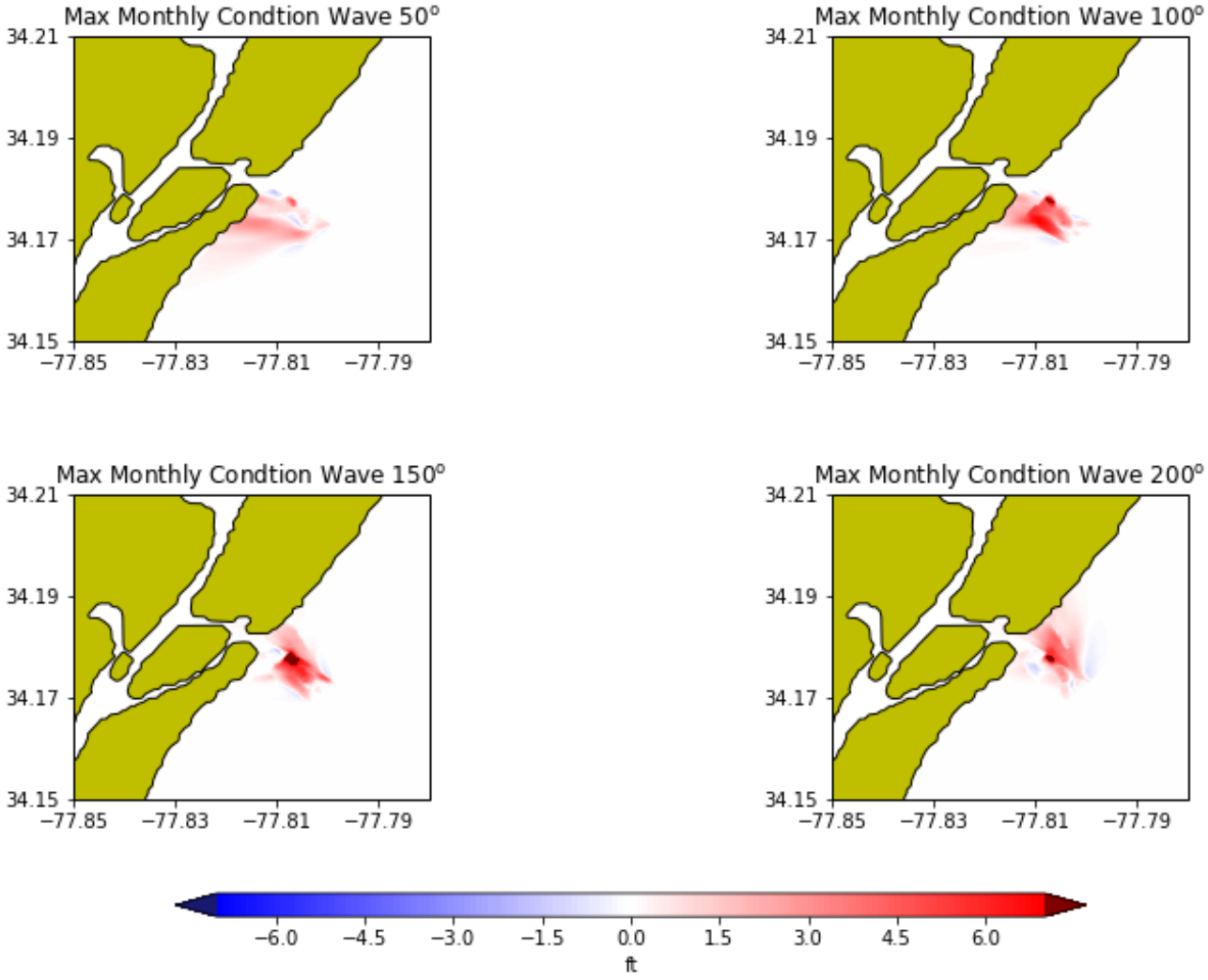

Mean Monthly Condtion Wave 50°
Mean Monthly Condtion Wave 100°
Mean Monthly Condtion Wave 150°
Mean Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
33.9
−77.9 −77.8 −77.7 −77.6 −77.5 −77.4
−0.44 −0.33 −0.22 −0.11 0.00 0.11 0.22 0.33 0.44
ft


Area E (-58 ft)
Mean Monthly Condtion Wave 50°
Mean Monthly Condtion Wave 100°
Mean Monthly Condtion Wave 150°
Mean Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
33.9
−77.9 −77.8 −77.7 −77.6 −77.5 −77.4
−0.44 −0.33 −0.22 −0.11 0.00 0.11 0.22 0.33 0.44
ft

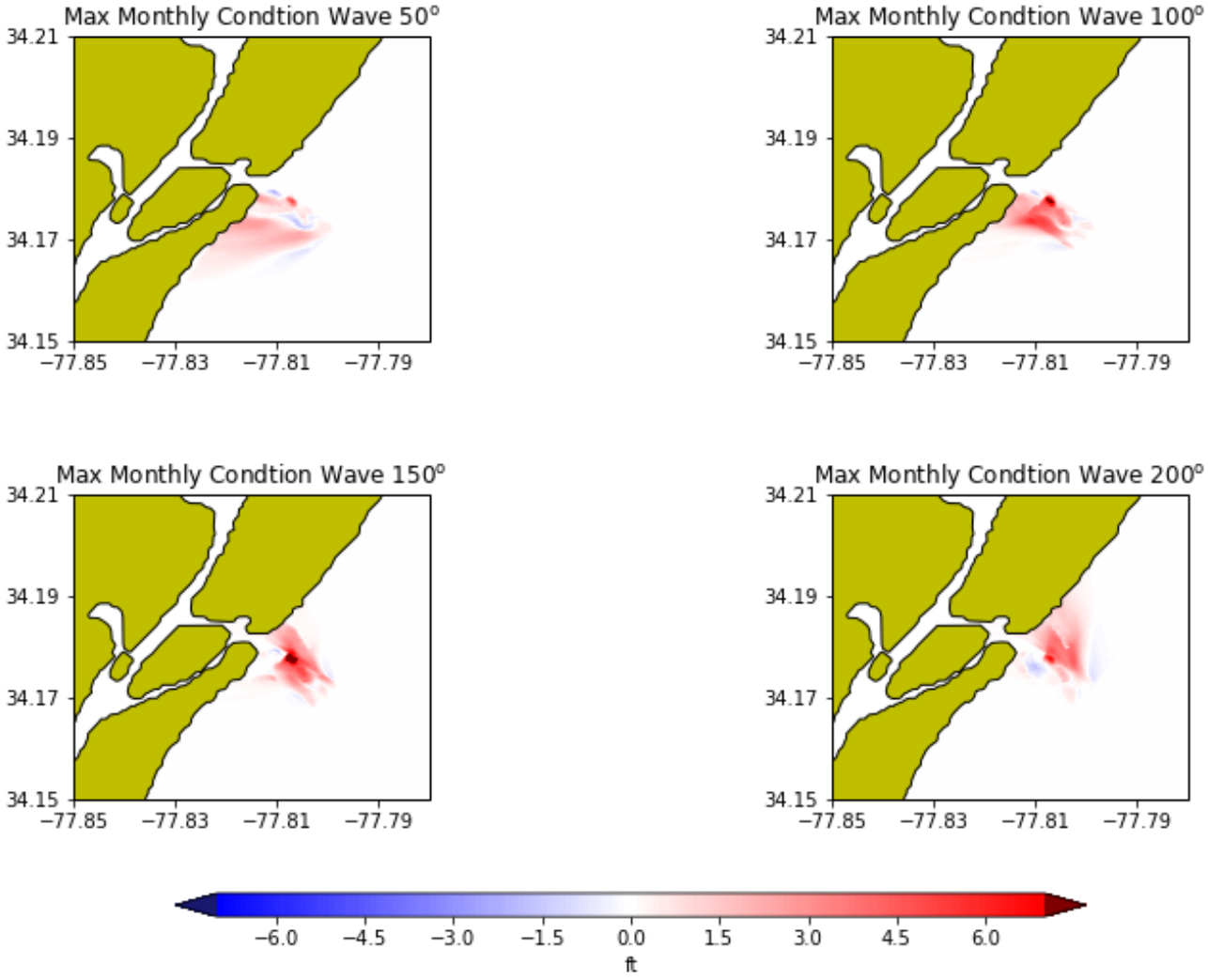
Area F (-58 ft)


Mean Monthly Condtion Wave 50°
Mean Monthly Condtion Wave 100°
Mean Monthly Condtion Wave 150°
Mean Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
33.9
−77.9 −77.8 −77.7 −77.6 −77.5 −77.4
−0.44 −0.33 −0.22 −0.11 0.00 0.11 0.22 0.33 0.44
ft

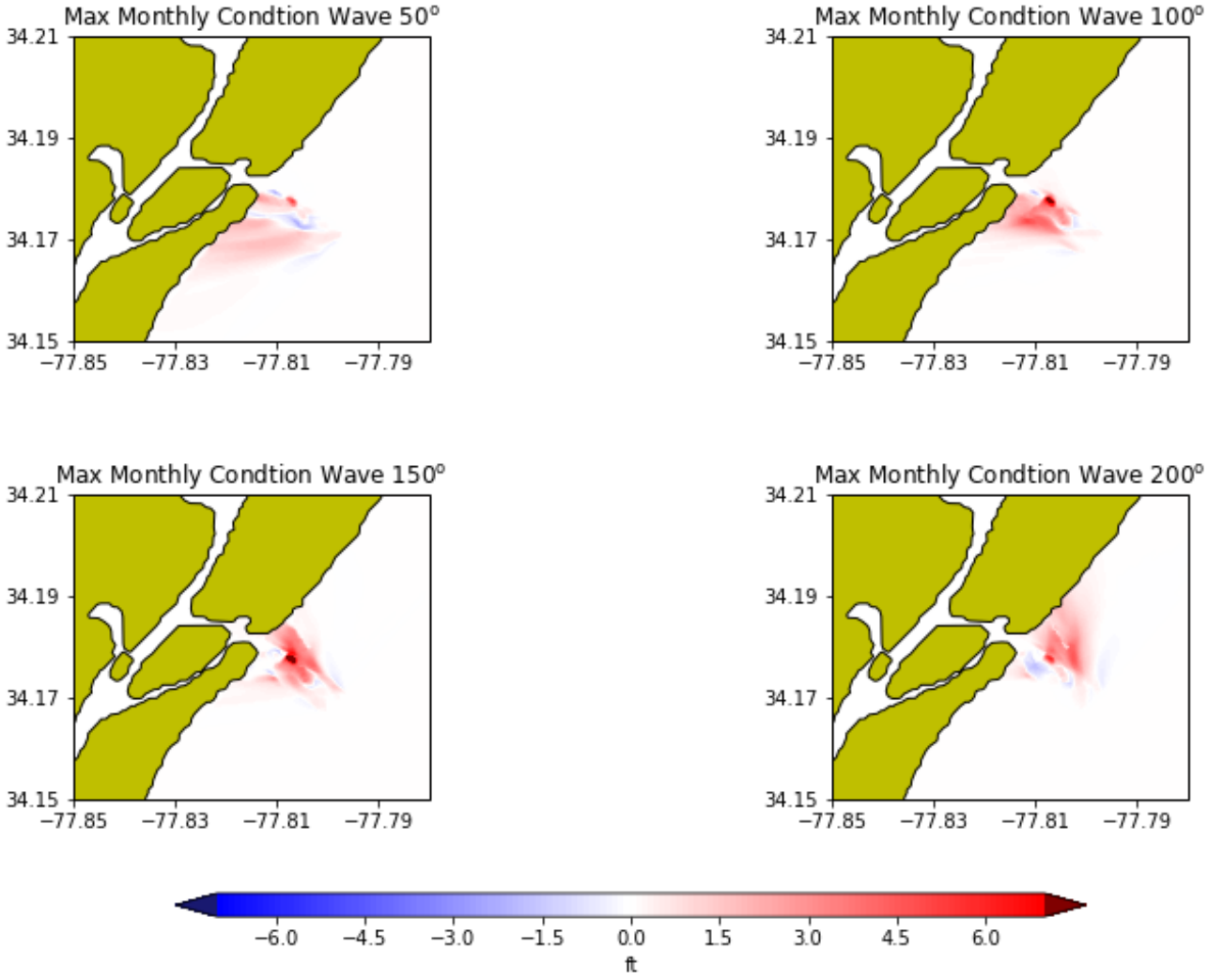
Area B (-23 ft)


Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.21
34.19
34.17
34.15
−77.85
−77.83
−77.81
−77.79
−6.0
−4.5
−3.0
−1.5
0.0
1.5
3.0
4.5
6.0
ft

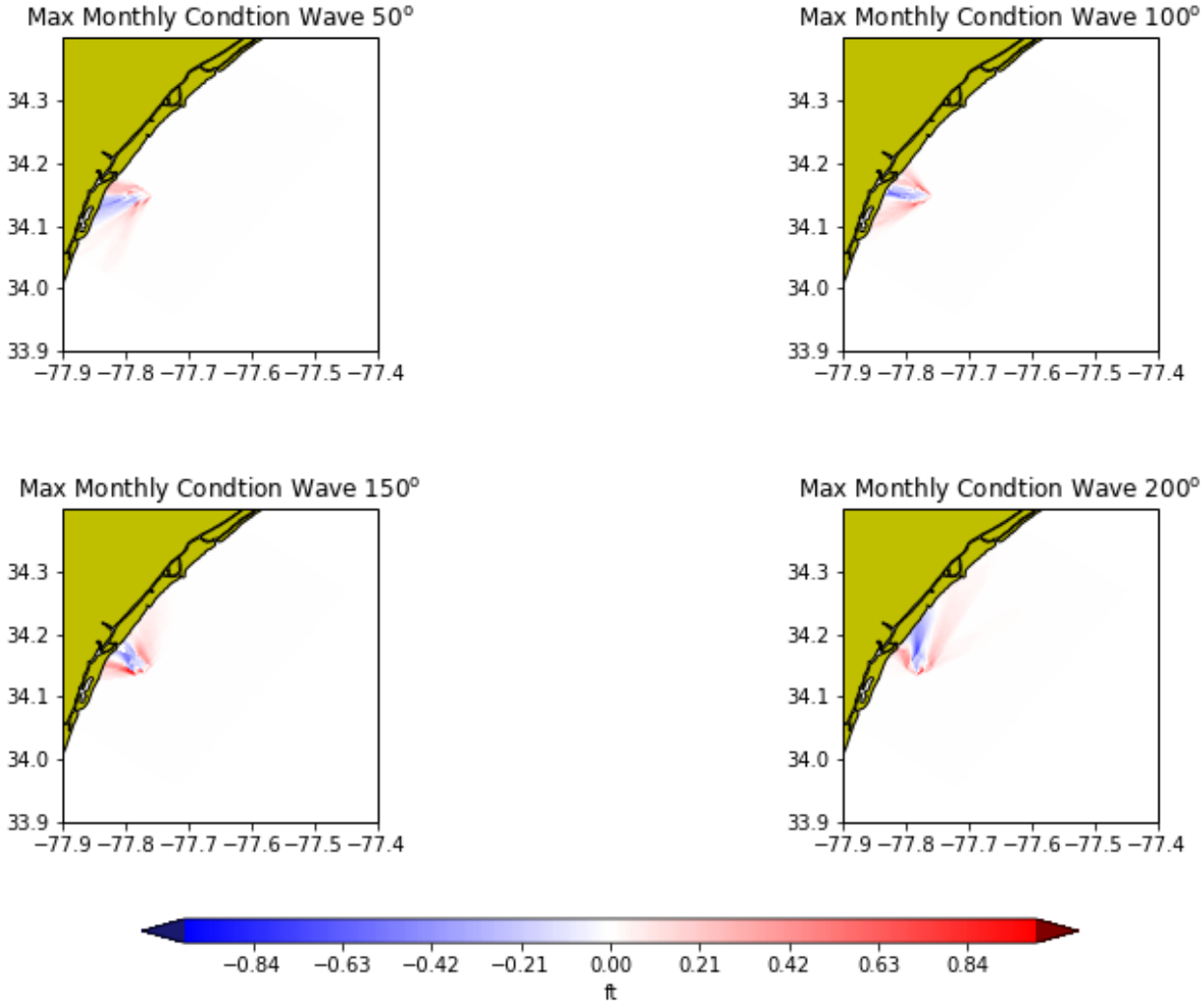
Area B (-28 ft)


Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.21
34.19
34.17
34.15
−77.85
−77.83
−77.81
−77.79
−6.0
−4.5
−3.0
−1.5
0.0
1.5
3.0
4.5
6.0
ft

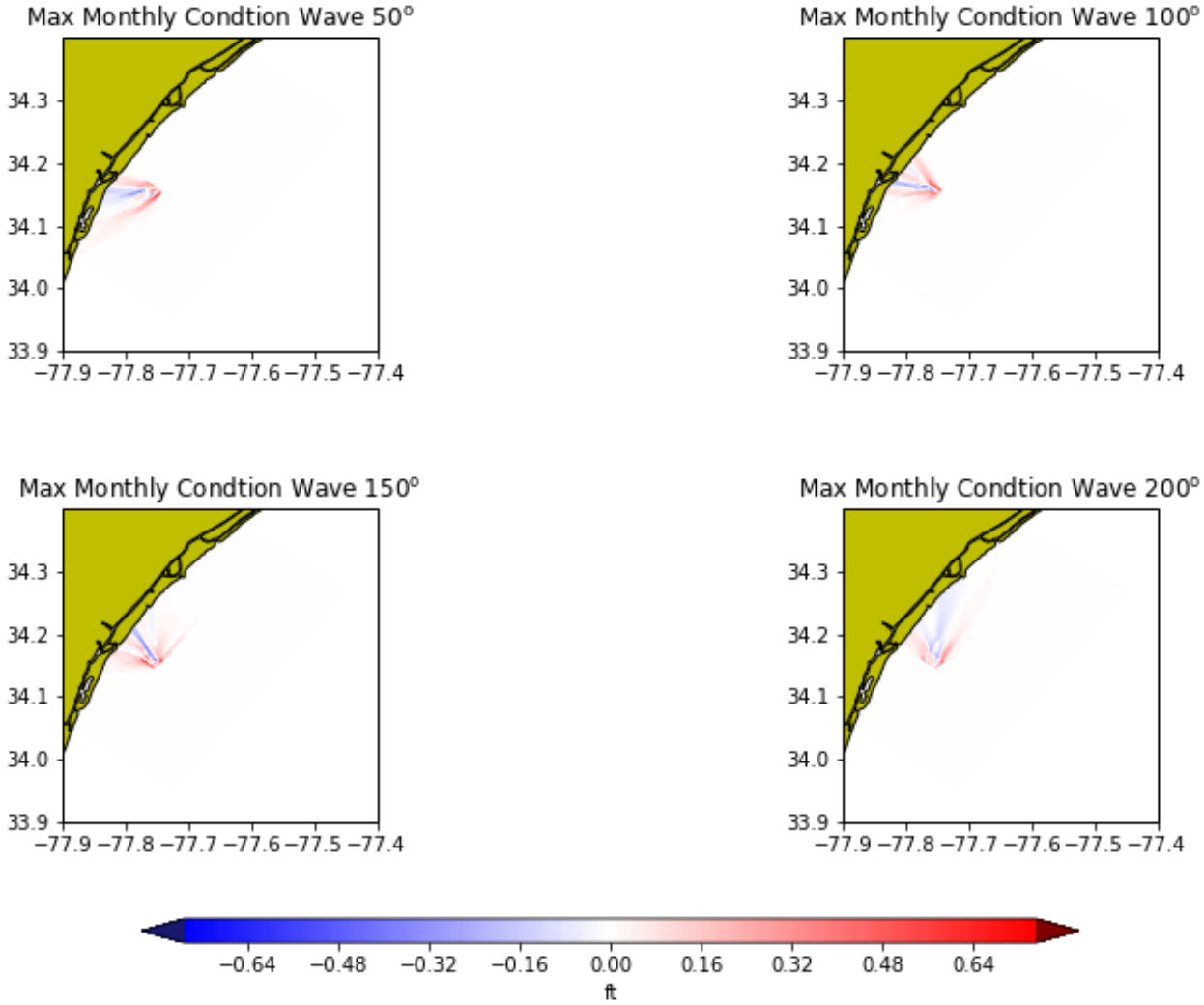
Area B (-33 ft)


Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.21
34.19
34.17
34.15
−77.85
−77.83
−77.81
−77.79
−6.0
−4.5
−3.0
−1.5
0.0
1.5
3.0
4.5
6.0
ft

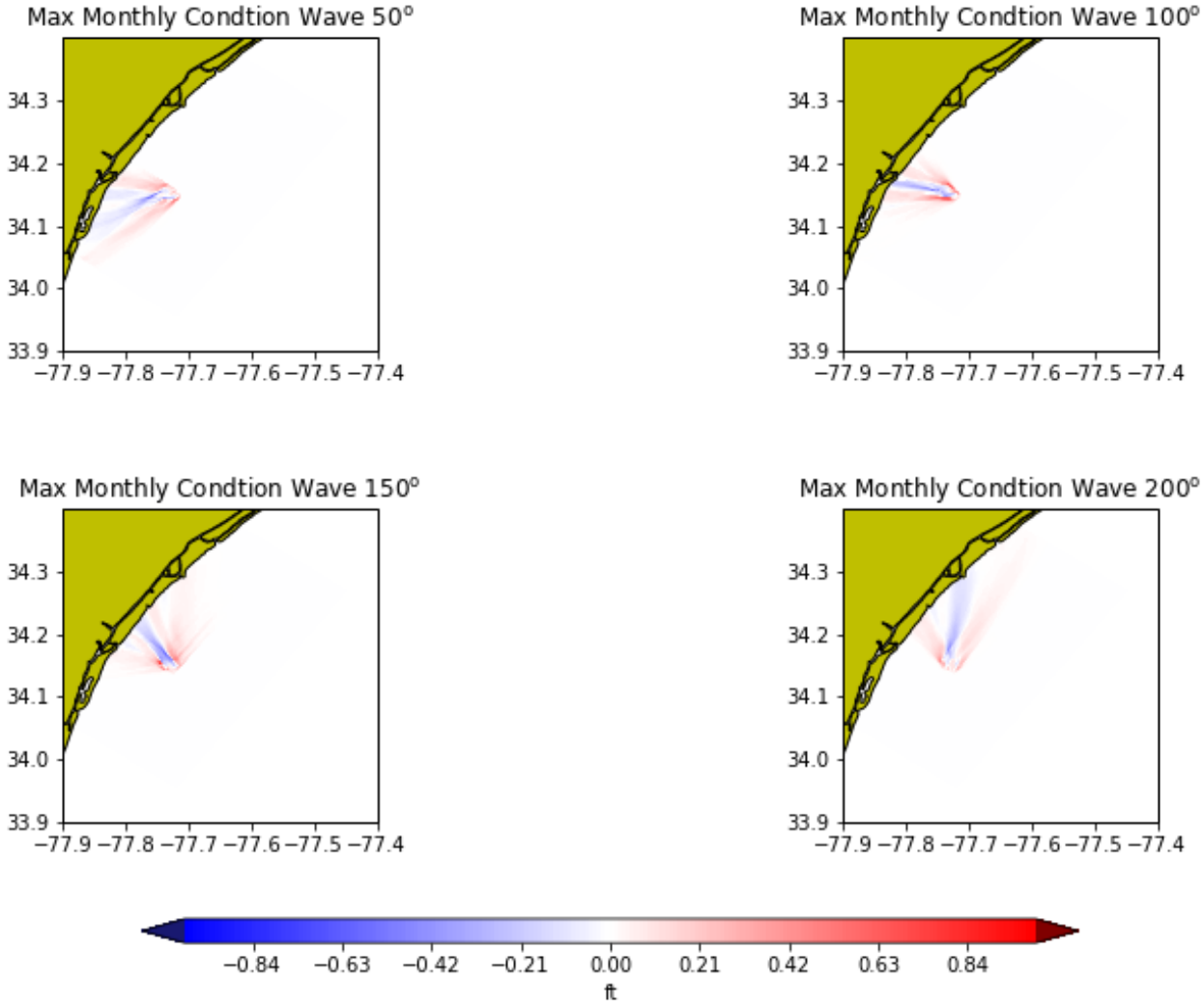
Area C (-58 ft)


Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
33.9
−77.9 −77.8 −77.7 −77.6 −77.5 −77.4
−0.84 −0.63 −0.42 −0.21 0.00 0.21 0.42 0.63 0.84
ft

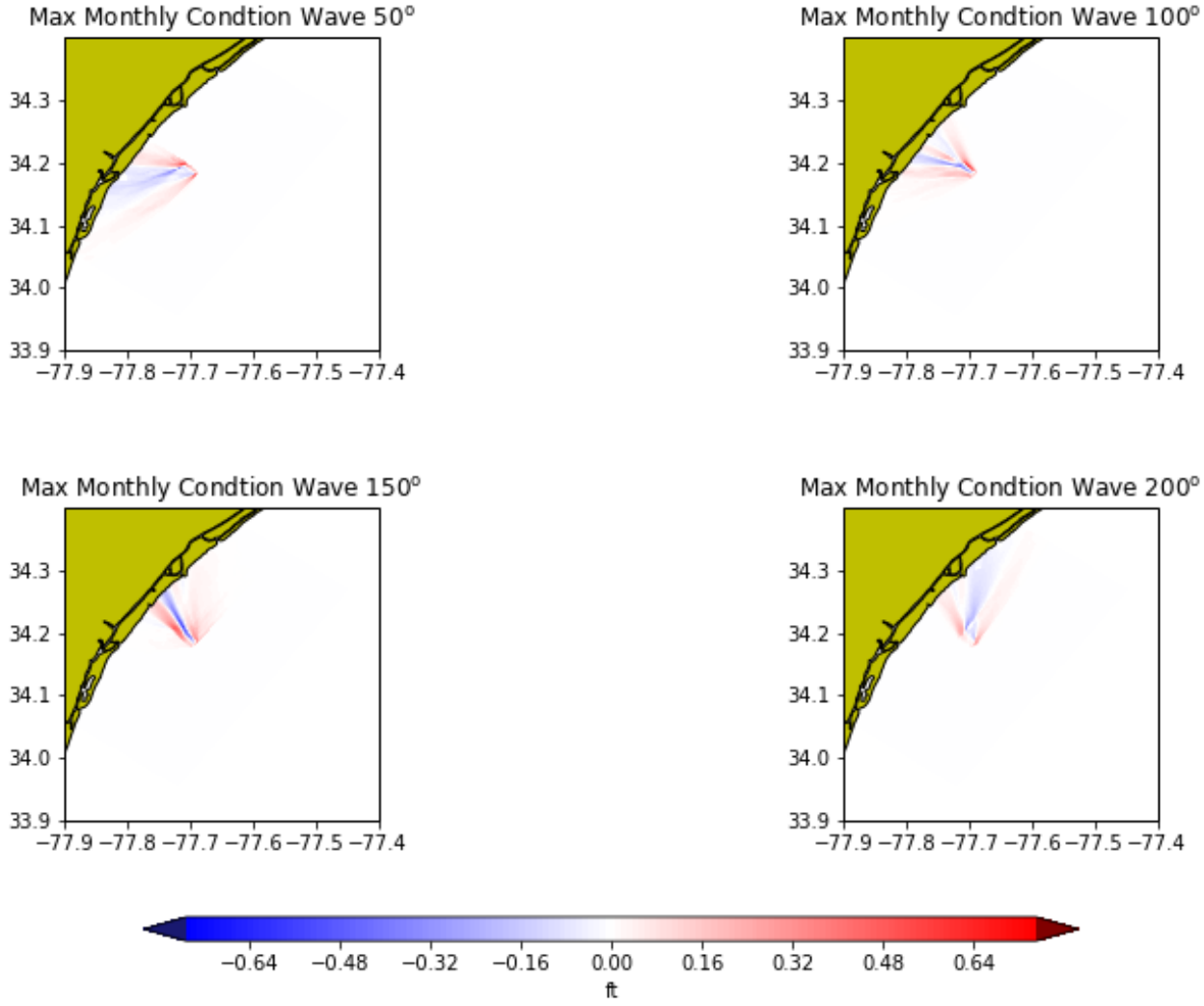
Area D (-58 ft)

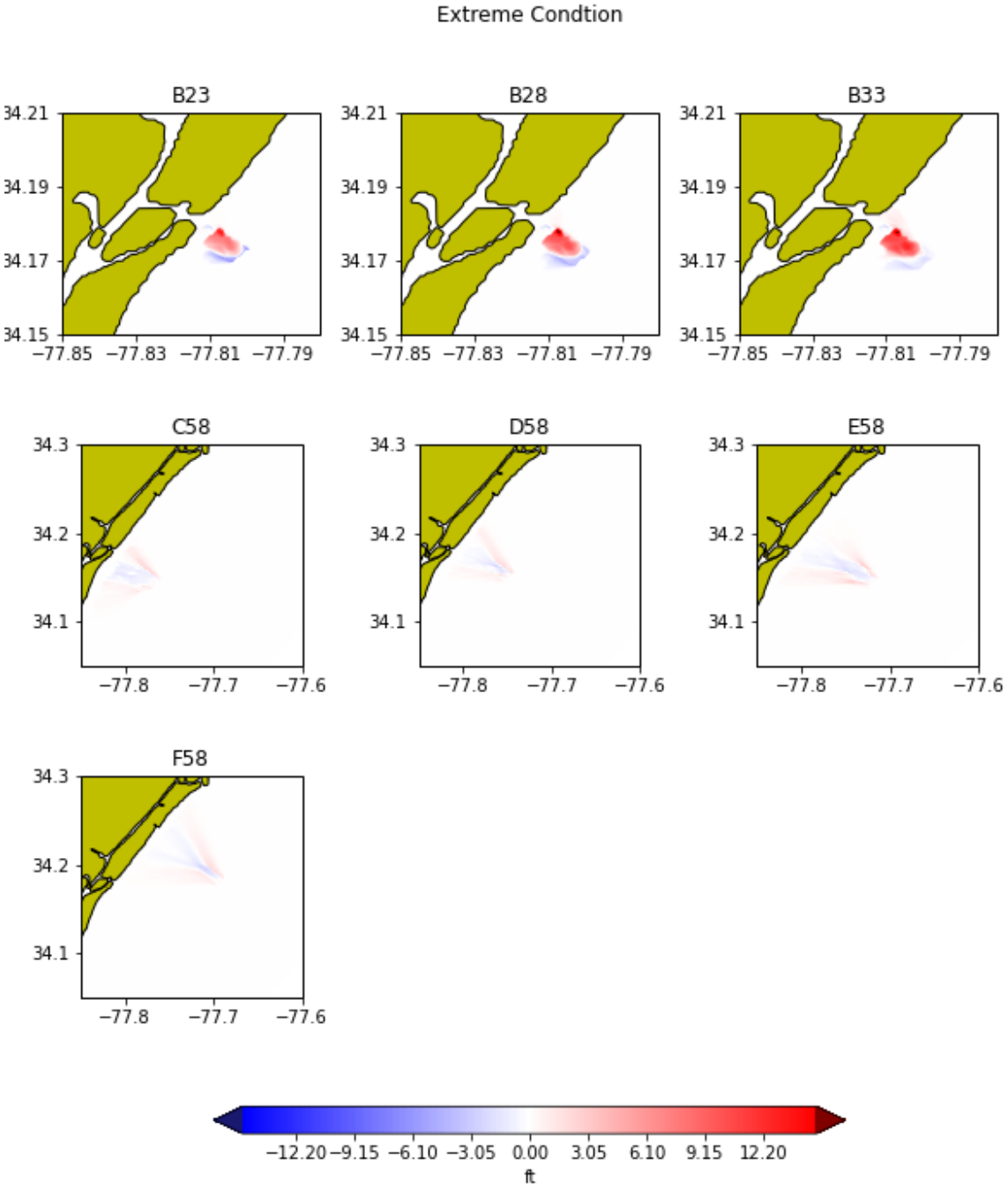

Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
33.9
−77.9 −77.8 −77.7 −77.6 −77.5 −77.4
−0.64 −0.48 −0.32 −0.16 0.00 0.16 0.32 0.48 0.64
ft

Area E (-58 ft)

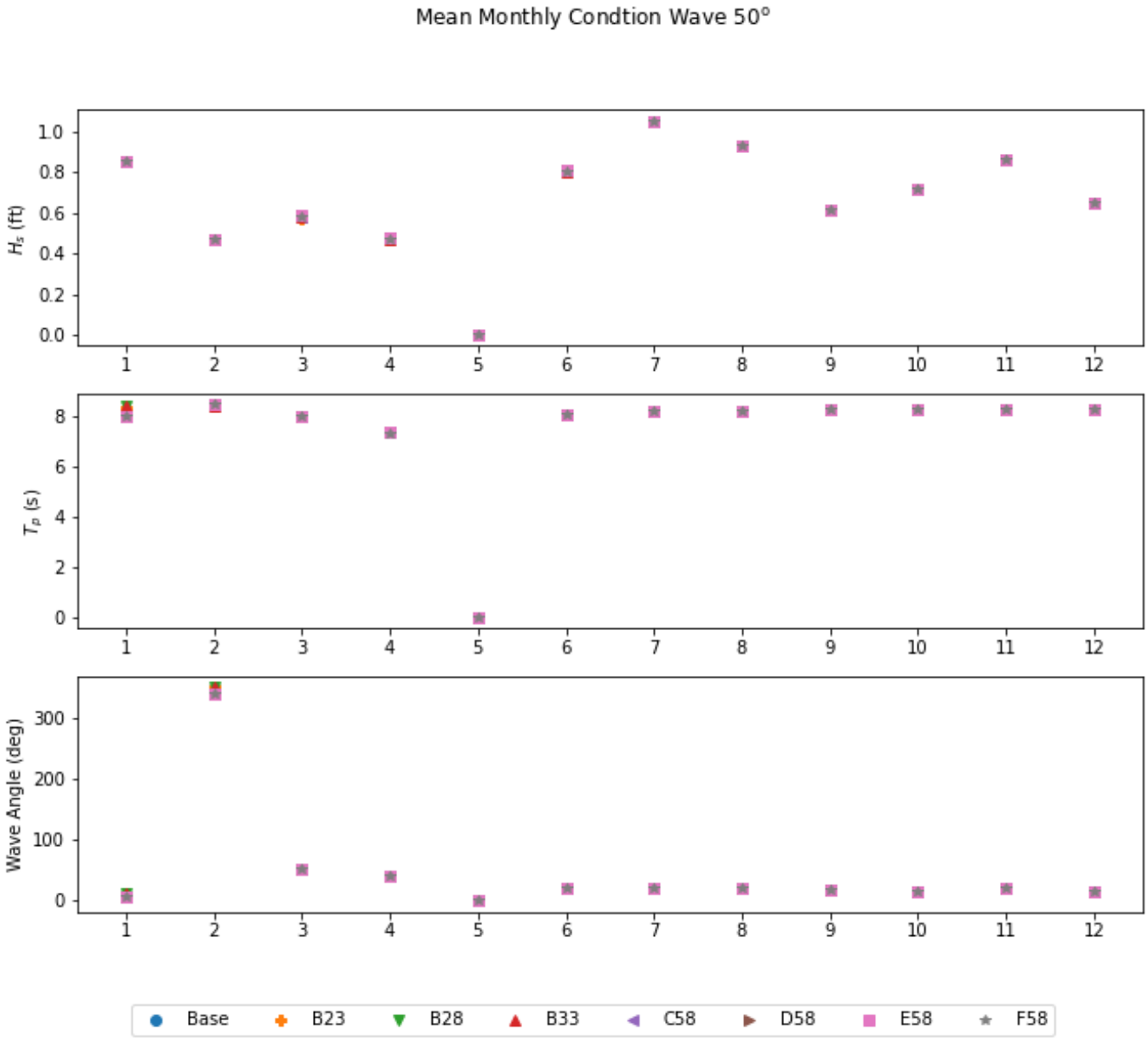

Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
33.9
−77.9 −77.8 −77.7 −77.6 −77.5 −77.4
−0.84 −0.63 −0.42 −0.21 0.00 0.21 0.42 0.63 0.84
ft

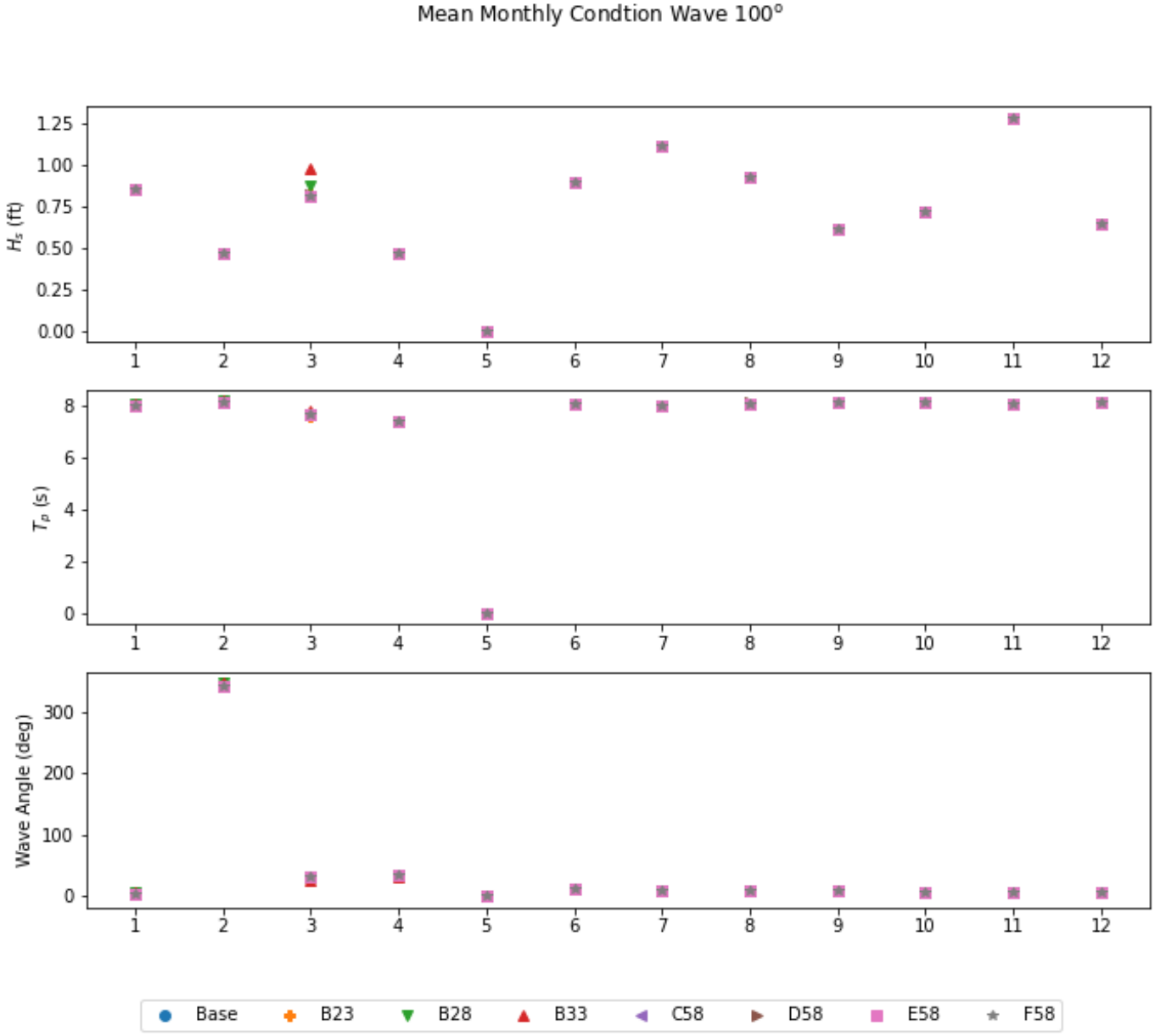
Area F (-58 ft)

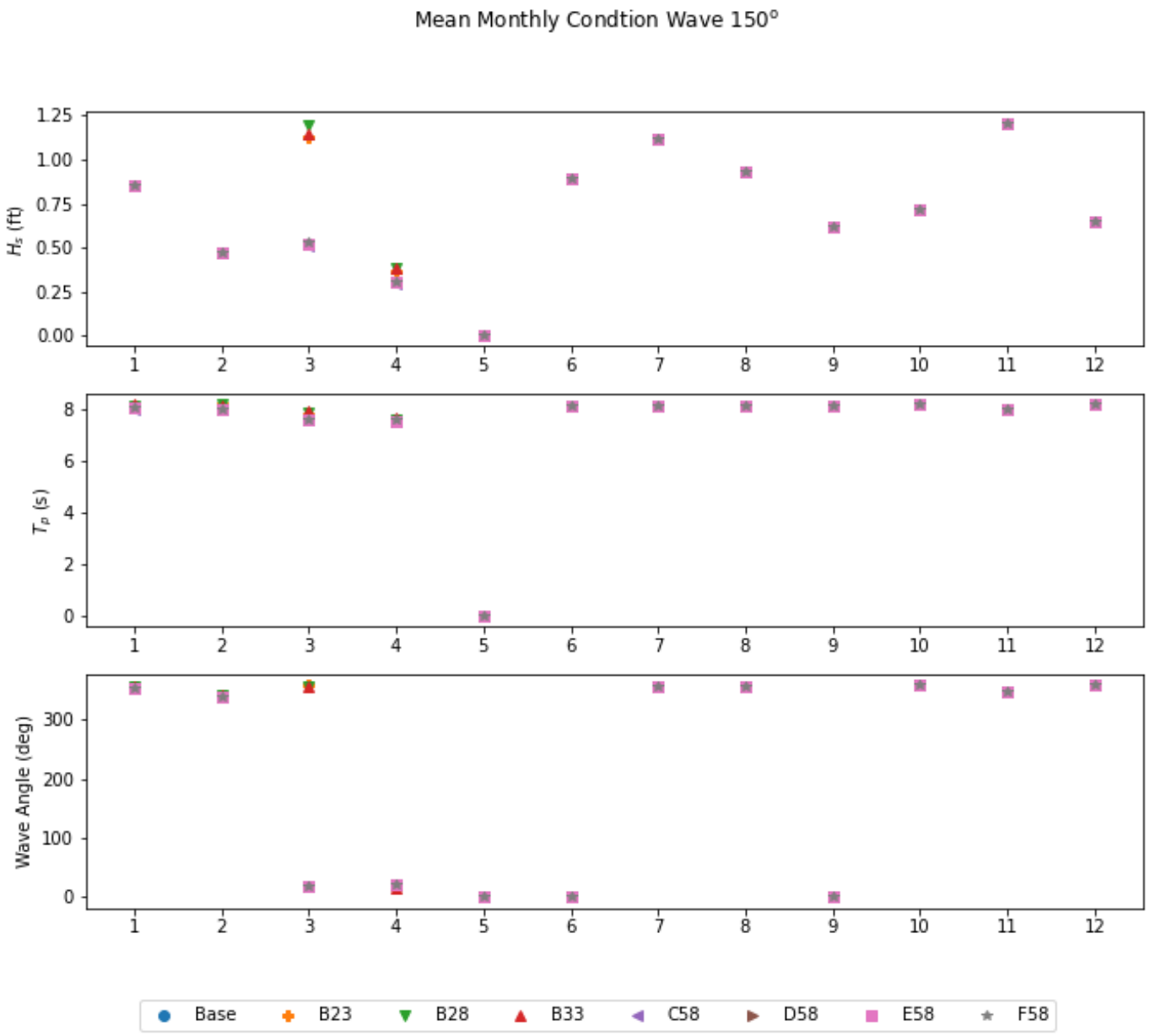

Max Monthly Condtion Wave 50°
Max Monthly Condtion Wave 100°
Max Monthly Condtion Wave 150°
Max Monthly Condtion Wave 200°
34.3
34.2
34.1
34.0
33.9
−77.9 −77.8 −77.7 −77.6 −77.5 −77.4
−0.64 −0.48 −0.32 −0.16 0.00 0.16 0.32 0.48 0.64
ft

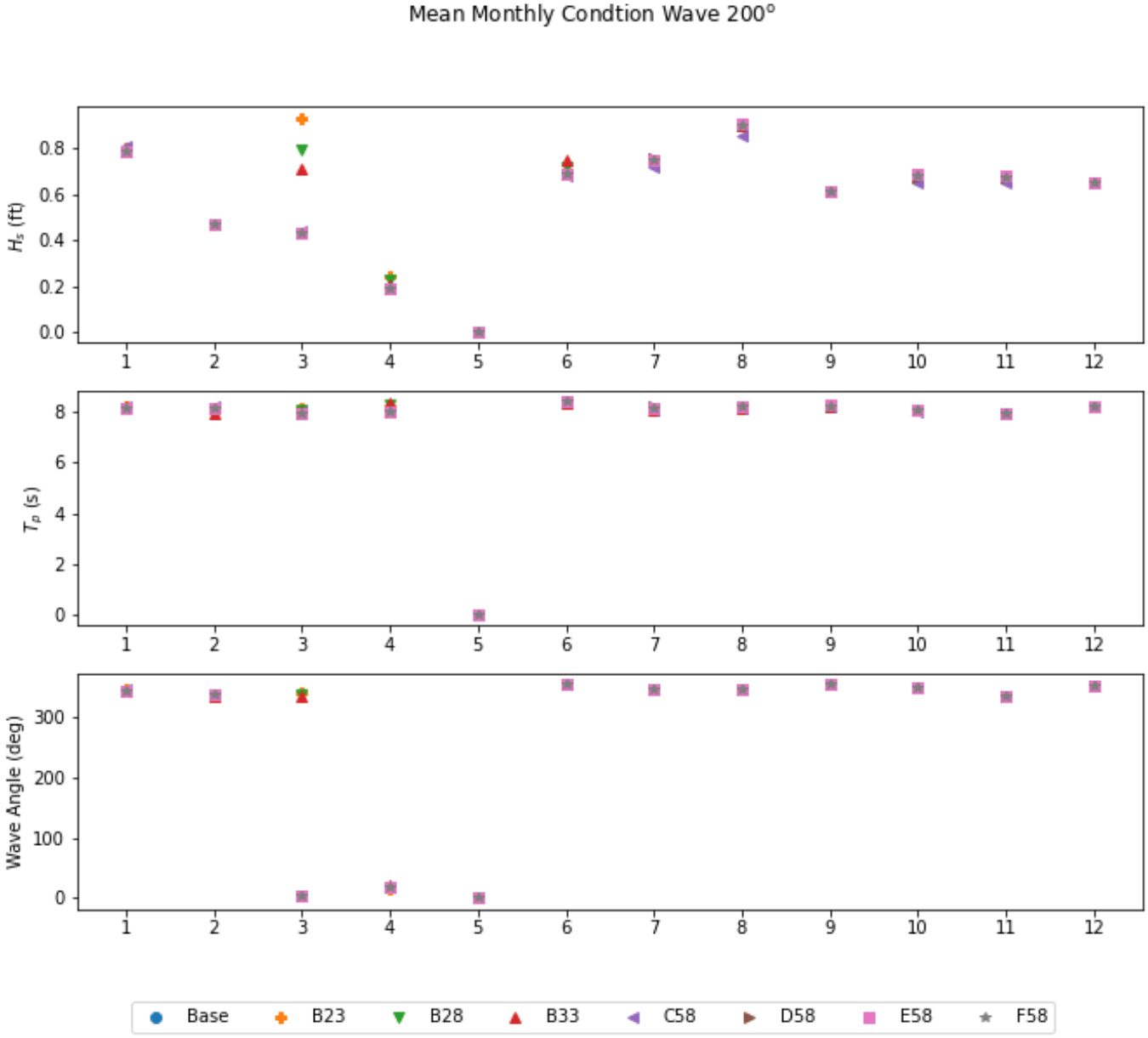

Extreme Condtion
B23
B28
B33
C58
D58
E58
F58
34.21
34.19
34.17
34.15
34.3
34.2
34.1
−77.85
−77.83
−77.81
−77.79
−77.8
−77.7
−77.6
−12.20
−9.15
−6.10
−3.05
0.00
3.05
6.10
9.15
12.20
ft

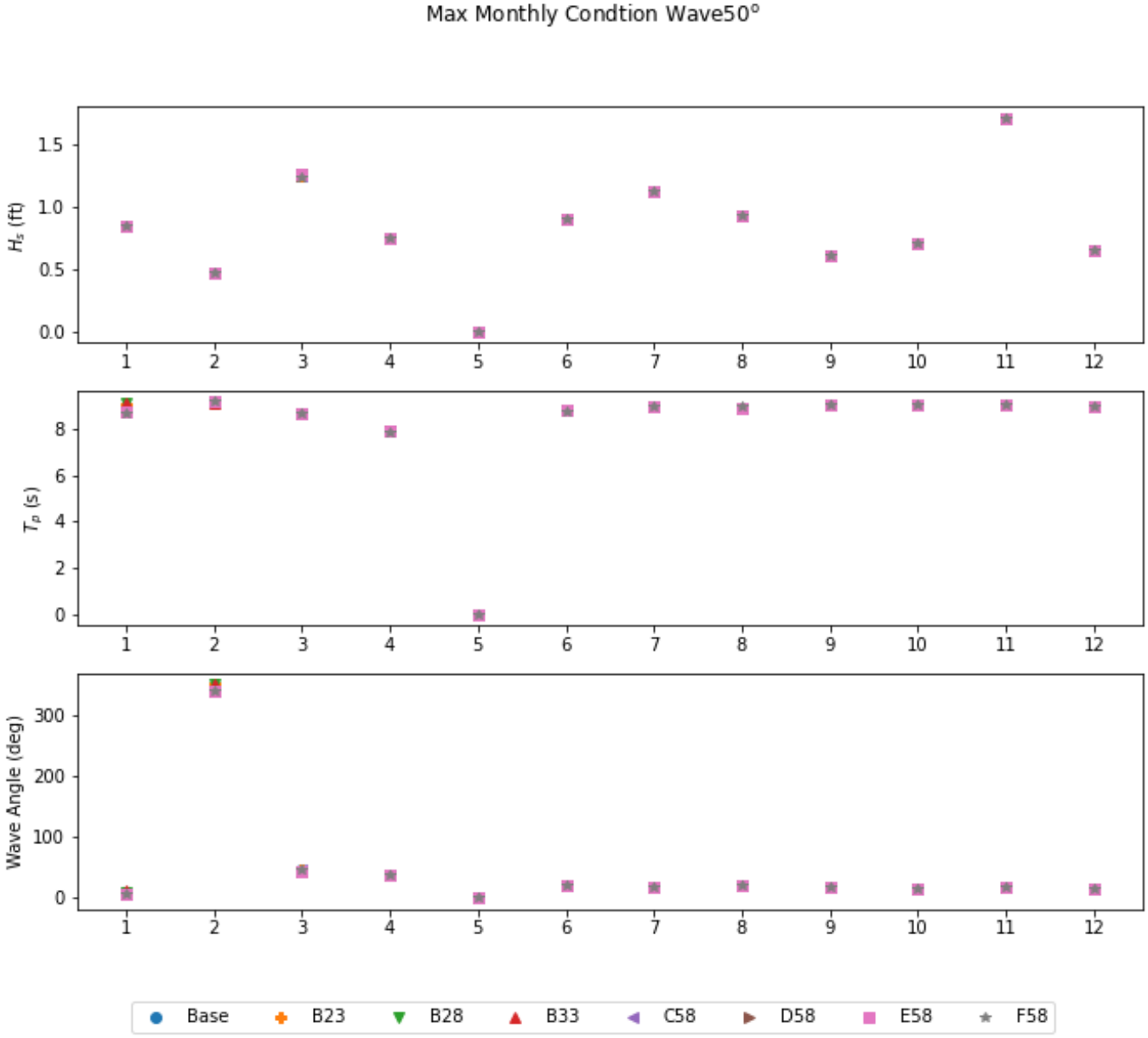
Appendix F—Save Point plots

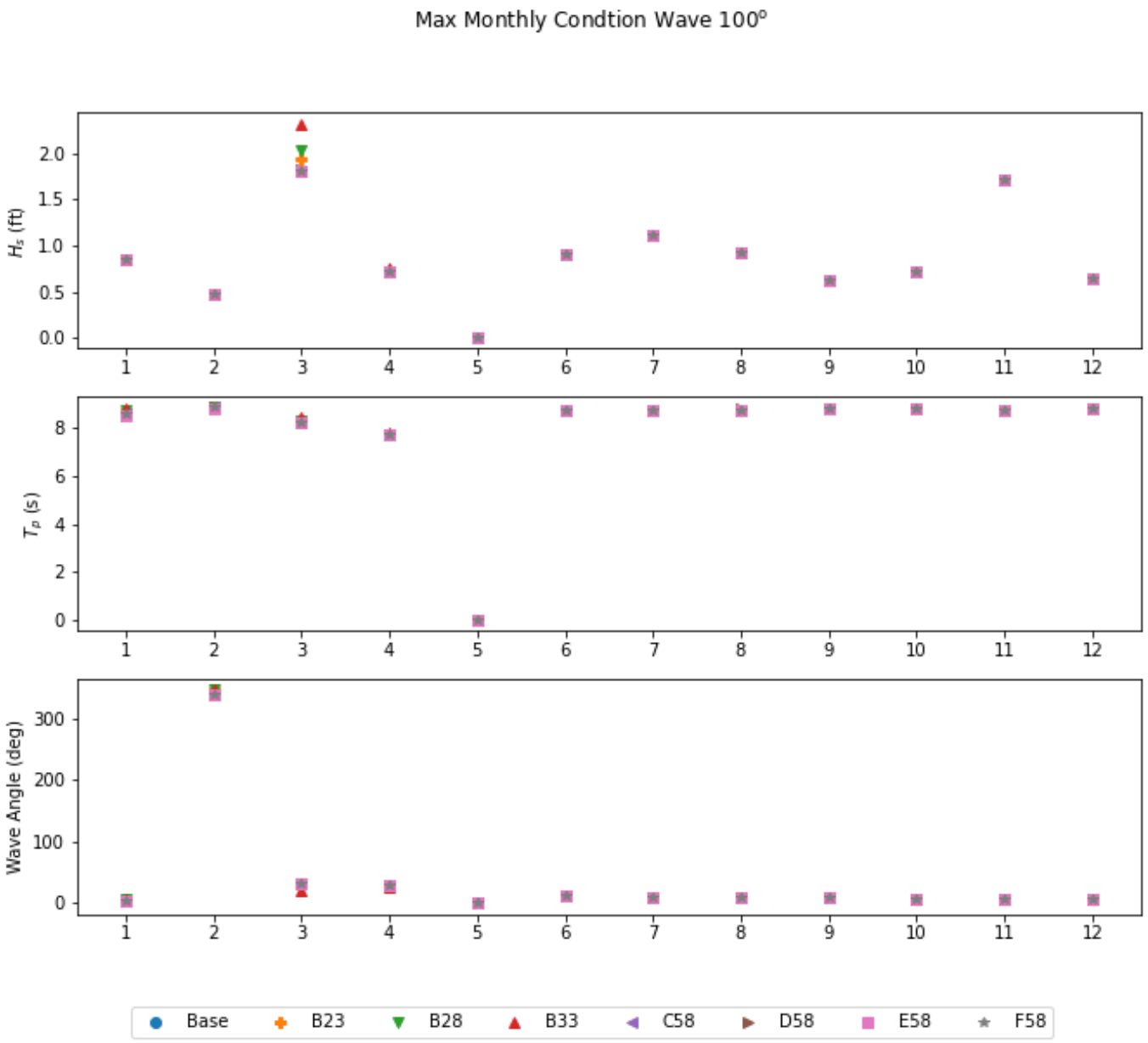

Mean Monthly Condtion Wave 50°
H_s (ft)
T_p (s)
Wave Angle (deg)
Base
B23
B28
B33
C58
D58
E58
F58

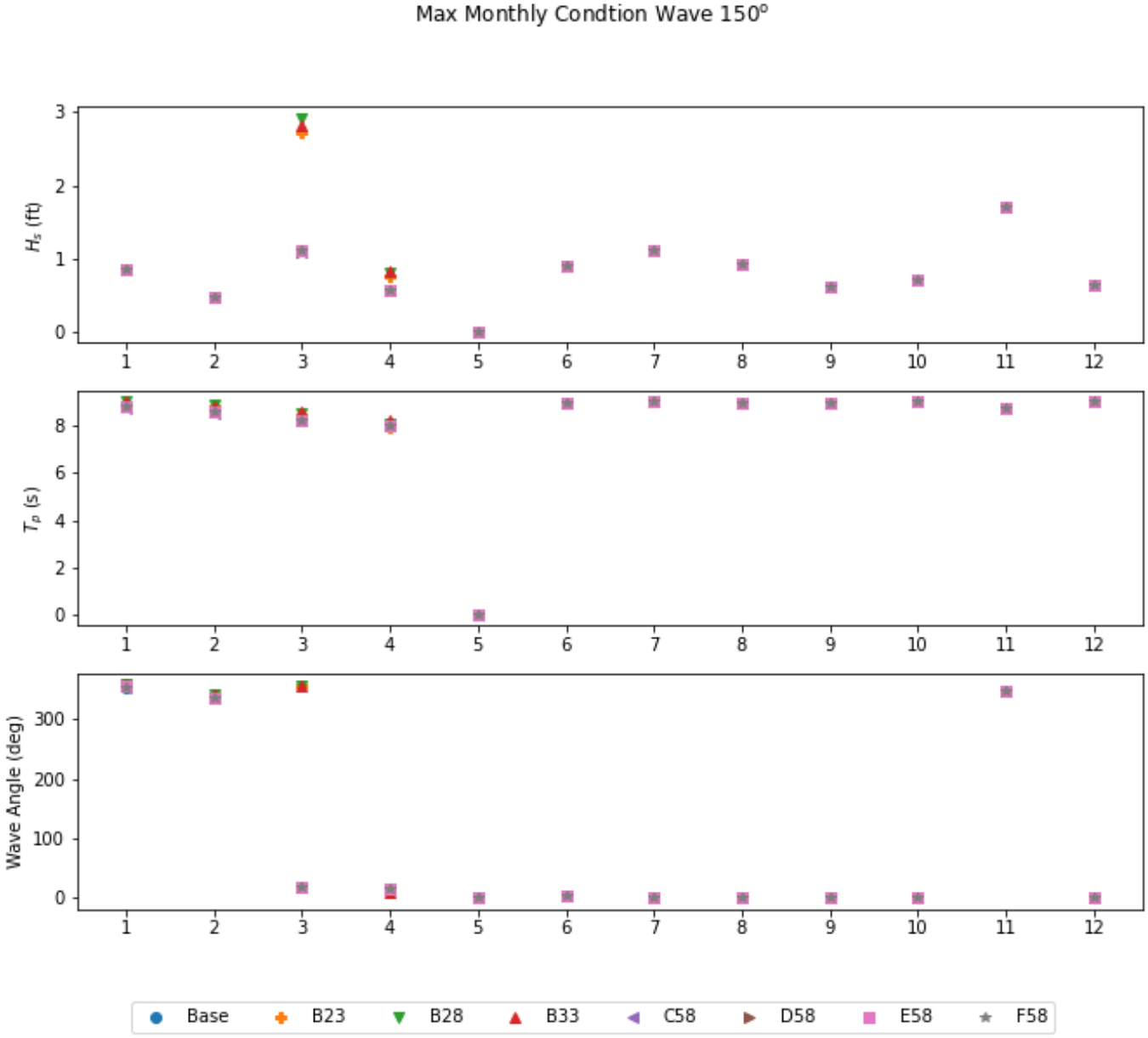

Mean Monthly Condtion Wave 100°
H_s (ft)
1.25
1.00
0.75
0.50
0.25
0.00
T_p (s)
8
6
4
2
0
Wave Angle (deg)
300
200
100
0
1
2
3
4
5
6
7
8
9
10
11
12
Base
B23
B28
B33
C58
D58
E58
F58

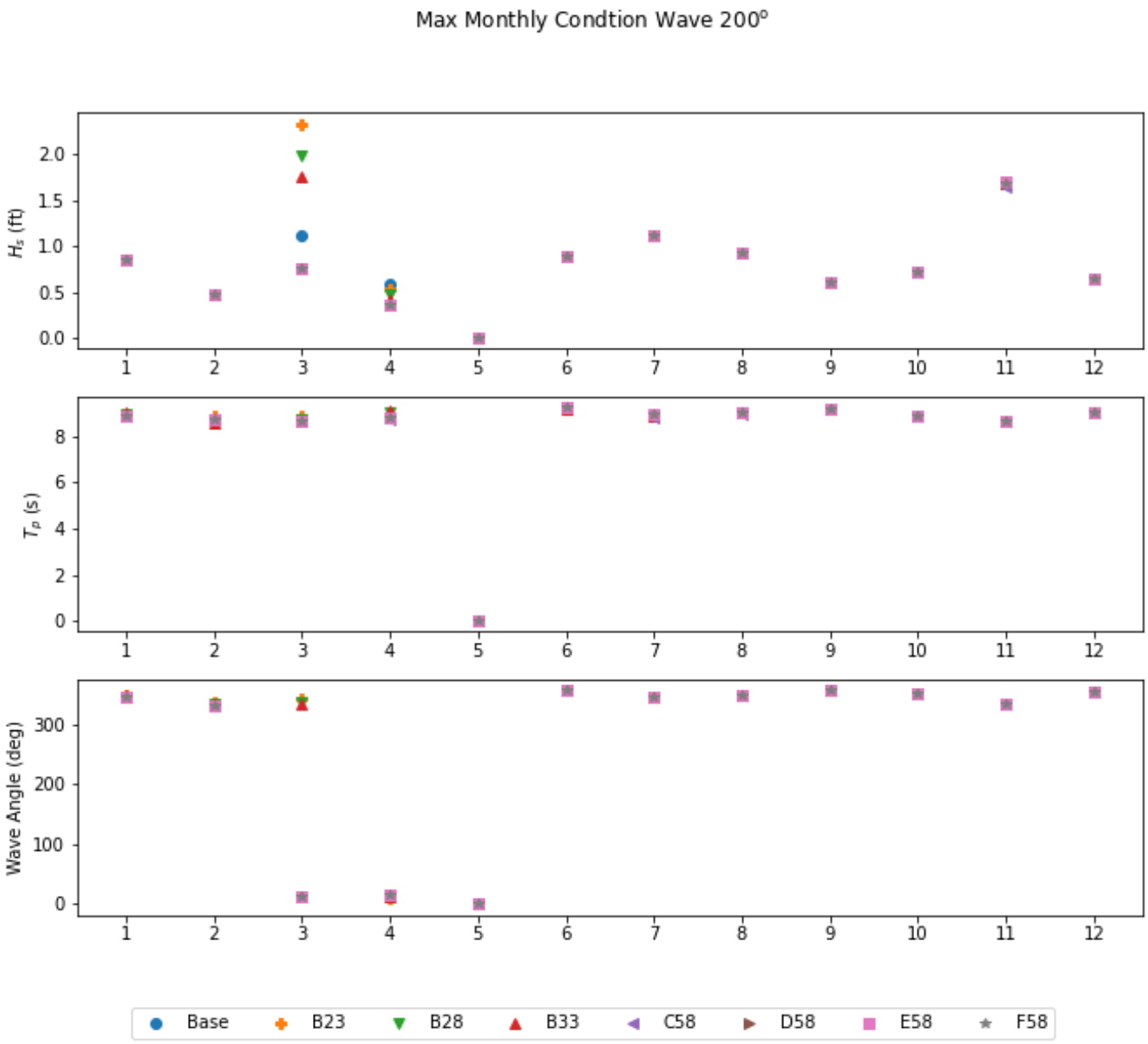

Mean Monthly Condtion Wave 150°
H_s (ft)
1.25
1.00
0.75
0.50
0.25
0.00
T_p (s)
8
6
4
2
0
Wave Angle (deg)
300
200
100
0
1
2
3
4
5
6
7
8
9
10
11
12
Base
B23
B28
B33
C58
D58
E58
F58

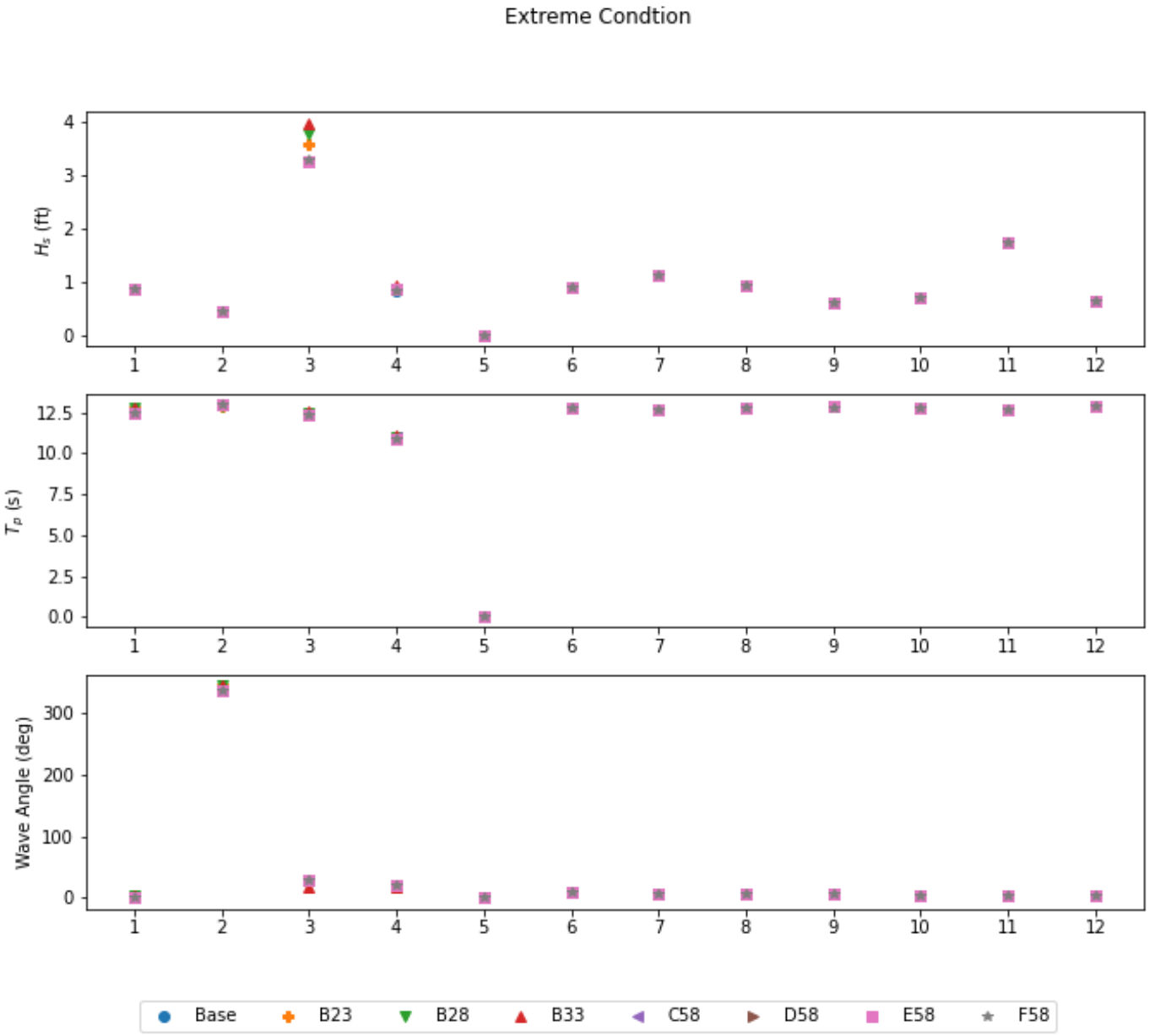

Mean Monthly Condtion Wave 200°
H_s (ft)
0.0
0.2
0.4
0.6
0.8
T_p (s)
0
2
4
6
8
Wave Angle (deg)
0
100
200
300
1
2
3
4
5
6
7
8
9
10
11
12
Base
B23
B28
B33
C58
D58
E58
F58


Max Monthly Condtion Wave50°
H_s (ft)
T_p (s)
Wave Angle (deg)
Base
B23
B28
B33
C58
D58
E58
F58


Max Monthly Condtion Wave 100°
H_s (ft)
T_p (s)
Wave Angle (deg)
Base
B23
B28
B33
C58
D58
E58
F58


Max Monthly Condtion Wave 150°
H_s (ft)
T_p (s)
Wave Angle (deg)
Base
B23
B28
B33
C58
D58
E58
F58


Max Monthly Condtion Wave 200°
H_s (ft)
T_p (s)
Wave Angle (deg)
Base
B23
B28
B33
C58
D58
E58
F58


Extreme Condtion
H_s (ft)
T_p (s)
Wave Angle (deg)
Base
B23
B28
B33
C58
D58
E58
F58

Appendix G—1 m Depth Contour Wave Height Change Tables

Table 4. Wave Height Change (ft) at 1m depth Contour for Borrow Area B dredged to 23 ft.

	50 Mean	100 Mean	150 Mean	200 Mean	50 Max	100 Max	150 Max	200 Max	Extreme
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	-0.004	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	-0.009	0.000	0.000	0.000	-0.001	0.000
14	-0.001	0.000	0.000	-0.003	0.000	0.000	0.000	-0.001	0.000
15	-0.001	0.000	0.000	0.043	0.000	0.000	0.000	-0.001	0.000
16	-0.001	0.000	0.001	0.013	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.007	0.010	0.000	0.000	0.020	0.025	0.000
18	-0.005	-0.009	0.105	0.298	-0.002	0.002	0.363	0.435	0.023
19	0.000	0.000	0.032	0.064	0.001	0.001	0.066	0.123	0.001
20	0.000	0.000	0.017	0.017	0.000	0.001	0.052	0.052	0.002
21	-0.304	-0.278	0.084	-0.024	-0.660	-0.270	-0.208	0.000	-0.417
22	0.023	0.014	0.002	-0.003	0.004	-0.001	0.003	0.001	0.000
23	0.004	0.001	0.001	0.014	0.003	0.001	0.001	0.001	0.001
24	0.097	0.000	0.000	-0.001	-0.002	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
26	0.025	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
27	0.005	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
28	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 5. Wave Height Change (ft) at 1m depth contour for Borrow Area B dredged to 28 ft.

	50 Mean	100 Mean	150 Mean	200 Mean	50 Max	100 Max	150 Max	200 Max	Extreme
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	-0.001	0.000
13	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	-0.001	0.000
14	-0.001	0.000	0.000	0.015	0.000	0.000	0.000	-0.001	0.000
15	-0.001	0.000	0.000	0.072	0.000	0.000	0.000	-0.001	0.000
16	-0.001	0.000	0.001	0.013	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.009	0.010	0.000	0.000	0.024	0.019	0.002
18	-0.005	-0.009	0.138	0.234	-0.002	0.004	0.411	0.342	0.064
19	0.000	0.000	0.044	0.068	0.001	0.001	0.085	0.089	0.006
20	0.000	0.000	0.022	0.017	0.000	0.001	0.065	0.037	0.008
21	-0.330	-0.333	0.049	-0.083	-0.752	-0.413	-0.181	0.000	-0.439
22	0.024	0.010	0.001	-0.003	0.004	-0.001	0.002	0.000	0.000
23	0.004	0.001	0.001	-0.001	0.003	0.002	0.002	0.001	0.001
24	0.125	0.000	0.000	-0.001	-0.001	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
26	0.033	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.000
27	-0.004	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
28	-0.003	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
29	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 6. Wave Height Change (ft) at 1m depth contour for Borrow Area B dredged to 33 ft.

	50 Mean	100 Mean	150 Mean	200 Mean	50 Max	100 Max	150 Max	200 Max	Extreme
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.002	0.000	0.000	0.000	-0.001	0.000
13	0.000	0.000	0.000	0.021	0.000	0.000	0.000	-0.001	0.000
14	-0.001	0.000	0.000	0.053	0.000	0.000	0.000	-0.001	0.000
15	-0.001	0.000	0.000	0.093	0.000	0.000	0.000	-0.001	0.000
16	-0.001	0.000	0.001	0.012	0.000	0.000	0.000	0.000	0.000
17	0.000	0.001	0.009	0.009	0.000	0.002	0.024	0.010	0.007
18	-0.005	0.000	0.159	0.154	-0.002	0.036	0.443	0.225	0.143
19	0.000	0.002	0.046	0.059	0.001	0.007	0.086	0.045	0.023
20	0.000	0.001	0.022	0.015	0.000	0.007	0.065	0.018	0.028
21	-0.288	-0.269	-0.013	-0.126	-0.677	-0.454	-0.162	0.000	-0.430
22	0.025	0.005	0.000	-0.002	0.004	-0.002	0.002	0.000	0.000
23	0.004	0.001	0.002	0.001	0.003	0.002	0.002	0.001	0.001
24	0.126	0.001	0.000	-0.002	0.000	0.000	0.000	0.000	0.000
25	0.001	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
26	0.042	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.000
27	0.010	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
28	0.032	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
29	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 7. Wave Height Change (ft) at 1m depth contour for Borrow Area C.

	50 Mean	100 Mean	150 Mean	200 Mean	50 Max	100 Max	150 Max	200 Max	Extreme
1	0.000	0.000	0.000	-0.021	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	-0.024	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	-0.018	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.002	-0.013	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.004	-0.024	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.002	-0.014	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.002	-0.021	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	-0.054	0.000	0.000	0.000	-0.001	0.000
10	0.000	0.000	0.005	-0.043	0.000	0.000	0.000	-0.001	0.000
11	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	-0.001	0.000
12	0.000	0.000	0.000	-0.036	0.000	0.000	0.000	-0.001	0.000
13	0.000	0.000	0.000	-0.045	0.000	0.000	0.000	-0.001	0.000
14	0.000	0.000	0.000	-0.015	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	-0.004	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	-0.002	0.001	0.000	-0.001	-0.001	0.001	-0.001
18	0.000	0.002	-0.022	0.009	0.000	-0.005	-0.009	0.003	0.001
19	0.000	0.001	-0.009	0.005	0.000	-0.002	-0.004	0.002	-0.002
20	0.000	0.000	-0.003	0.001	0.000	-0.001	-0.003	0.002	0.000
21	0.003	0.006	-0.016	0.026	0.002	-0.002	-0.001	0.000	0.000
22	0.004	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.000
24	0.020	0.000	-0.001	0.017	0.000	0.000	-0.001	0.000	0.000
25	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.029	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000
27	0.030	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
28	0.050	-0.001	0.001	0.006	0.000	-0.001	0.000	0.000	0.000
29	-0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
30	-0.057	0.000	0.000	0.006	-0.001	0.000	0.000	0.000	0.000
31	-0.071	0.000	0.000	0.004	-0.002	0.000	0.000	0.000	0.000
32	-0.081	0.000	0.000	0.006	-0.001	0.000	0.000	0.000	0.000
33	-0.073	0.000	0.000	0.008	-0.001	0.000	0.000	0.000	0.000

Table 8. Wave Height Change (ft) at the 1m depth contour for Borrow Area D.

	50 Mean	100 Mean	150 Mean	200 Mean	50 Max	100 Max	150 Max	200 Max	Extreme
1	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.002	-0.002	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.004	-0.005	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.001	-0.002	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	-0.001	-0.002	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	-0.028	0.004	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.016	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.001	-0.001	0.000	0.000	0.000	-0.001	0.000	0.001
18	0.001	0.003	-0.004	0.002	-0.001	-0.001	-0.004	0.002	0.004
19	0.001	0.003	-0.006	0.001	0.000	-0.001	-0.005	0.003	0.003
20	0.000	0.002	-0.002	0.000	0.000	0.000	-0.002	0.001	0.001
21	0.010	-0.003	0.000	0.000	0.006	-0.002	0.000	0.000	0.000
22	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	-0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	-0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	-0.039	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	-0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	-0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	-0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	-0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	-0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 9. Wave Height Change (ft) at 1m depth contour for Borrow Area E.

	50 Mean	100 Mean	150 Mean	200 Mean	50 Max	100 Max	150 Max	200 Max	Extreme
1	0.000	0.000	0.000	-0.008	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	-0.005	0.004	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	-0.012	0.008	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	-0.005	0.003	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	-0.009	0.004	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	-0.009	0.009	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
14	0.002	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
15	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.001	0.000	-0.001	0.000	0.000	-0.001	-0.001	0.000	0.001
18	0.003	0.002	-0.006	0.000	-0.001	-0.002	-0.005	0.000	0.005
19	0.002	0.001	-0.006	0.000	-0.001	-0.002	-0.005	0.001	0.003
20	0.001	0.001	-0.002	0.000	-0.001	-0.001	-0.003	0.000	0.002
21	0.013	-0.010	0.001	0.000	0.008	-0.001	0.000	0.000	0.000
22	0.020	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	-0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	-0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	-0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	-0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	-0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 10. Wave Height Change (ft) at 1m depth contour for Borrow Area F.

	50 Mean	100 Mean	150 Mean	200 Mean	50 Max	100 Max	150 Max	200 Max	Extreme
1	0.000	0.000	-0.001	0.000	0.000	0.000	-0.001	0.000	0.000
2	-0.001	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000
7	0.002	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000
8	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.014	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	-0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	-0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	-0.005	0.005	0.001	0.000	0.001	0.002	0.001	0.000	0.001
19	-0.003	0.004	0.001	0.000	0.002	0.001	0.001	0.000	0.001
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	-0.002	0.002	0.000	0.000	0.001	0.001	0.000	0.000	0.001
22	-0.008	0.000	0.000	0.000	-0.008	0.000	0.000	0.000	0.000
23	-0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	-0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	-0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	-0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	-0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	-0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	-0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	-0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000