

Quantifying Wave Breaking Shape and Type in the Surf-Zone Using LiDAR

Andrea Albright
Preston Hartzell
Craig Glennie
Katherine Brodie

NCALM



THE NATIONAL CENTER FOR
AIRBORNE LASER MAPPING



ERDC

Innovative solutions for a safer, better world

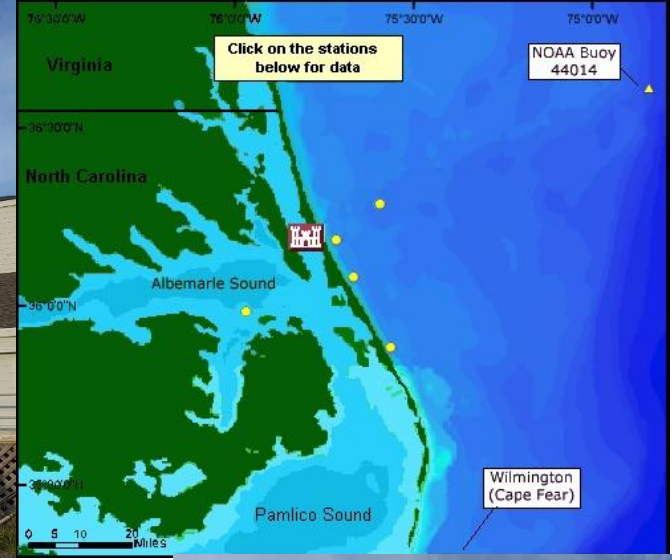
Measuring waves in the surf-zone

- Wave breaking types:
 - Spilling
 - Plunging
 - Non-breaking
- Follow the life cycle of a wave
 - Shoaling
 - Breaking
 - Broken
- Automatically detect wave breaking type
- Measure wave morphometric properties
- Quantify how wave breaking type affects coastal erosion

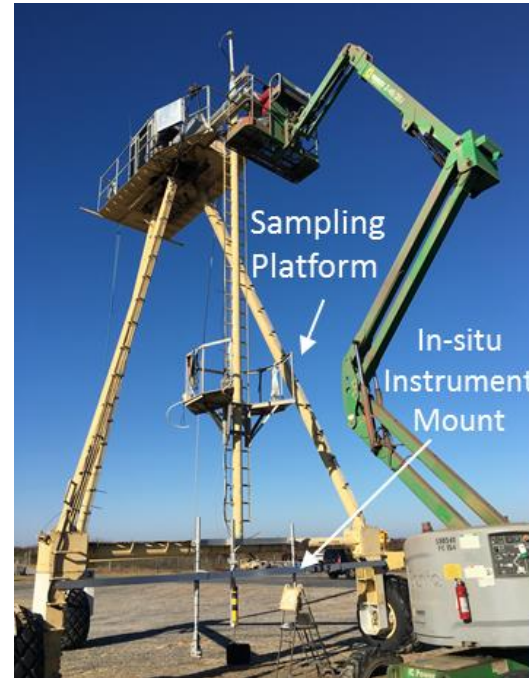


Location & Platform

US Army Corps Field Research Facility
Duck, North Carolina

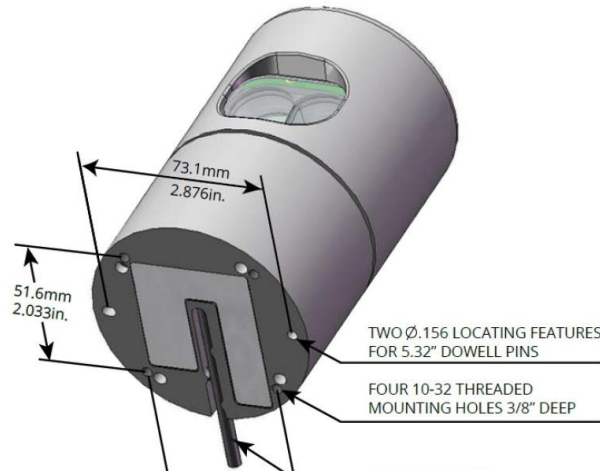


Coastal Research Amphibious Buggy (CRAB)



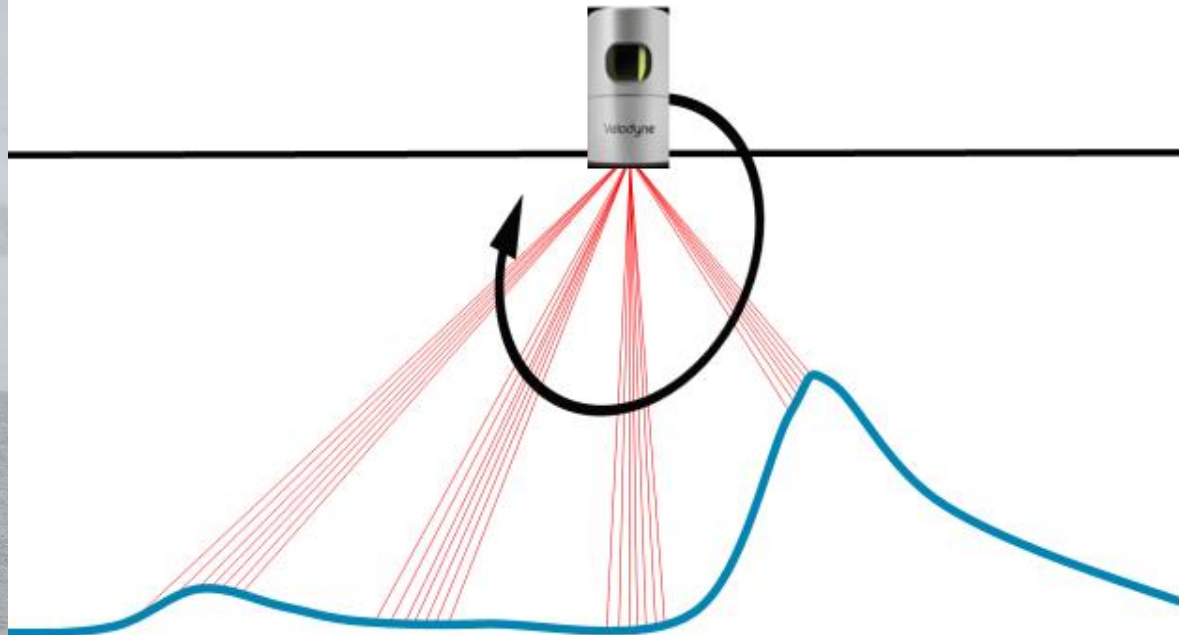


Instrument



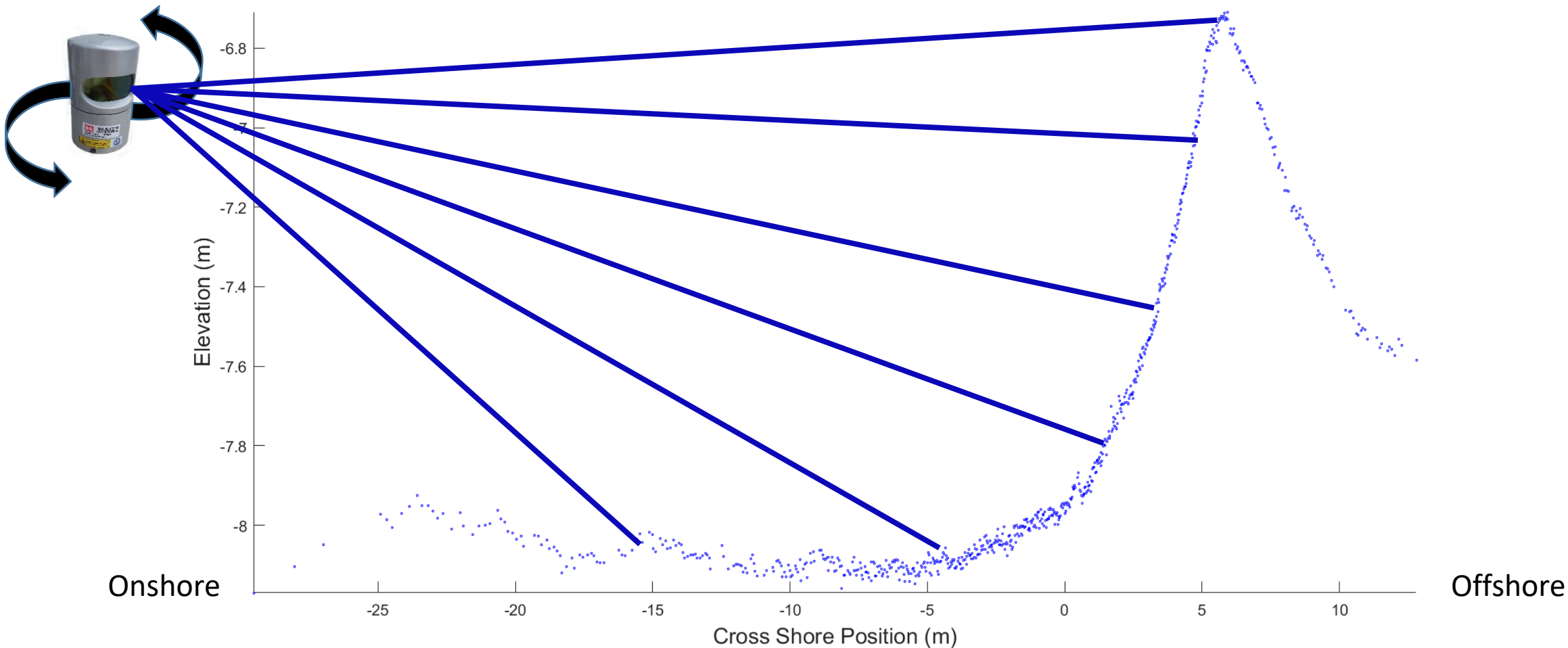
Velodyne HDL-32E

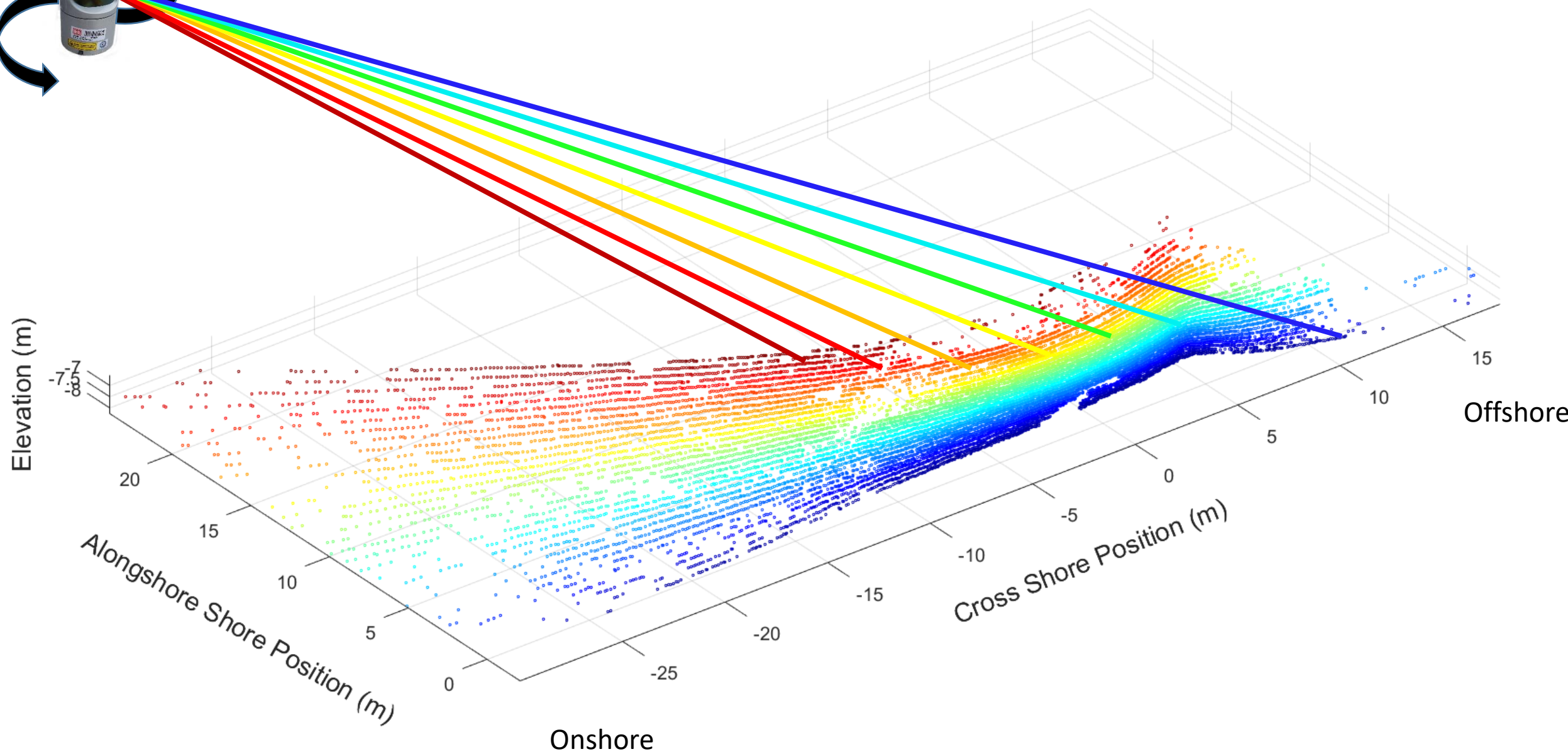
- Rotation rate: 10 Hz
- Horizontal FOV: 360°
- Vertical FOV: 41.3°
- Wavelength: 903 nm
- Nominal range: 70 m
- Firing time: 46 psec
- 700,000 laser shots/sec
- Up to 10,000 returns/sec

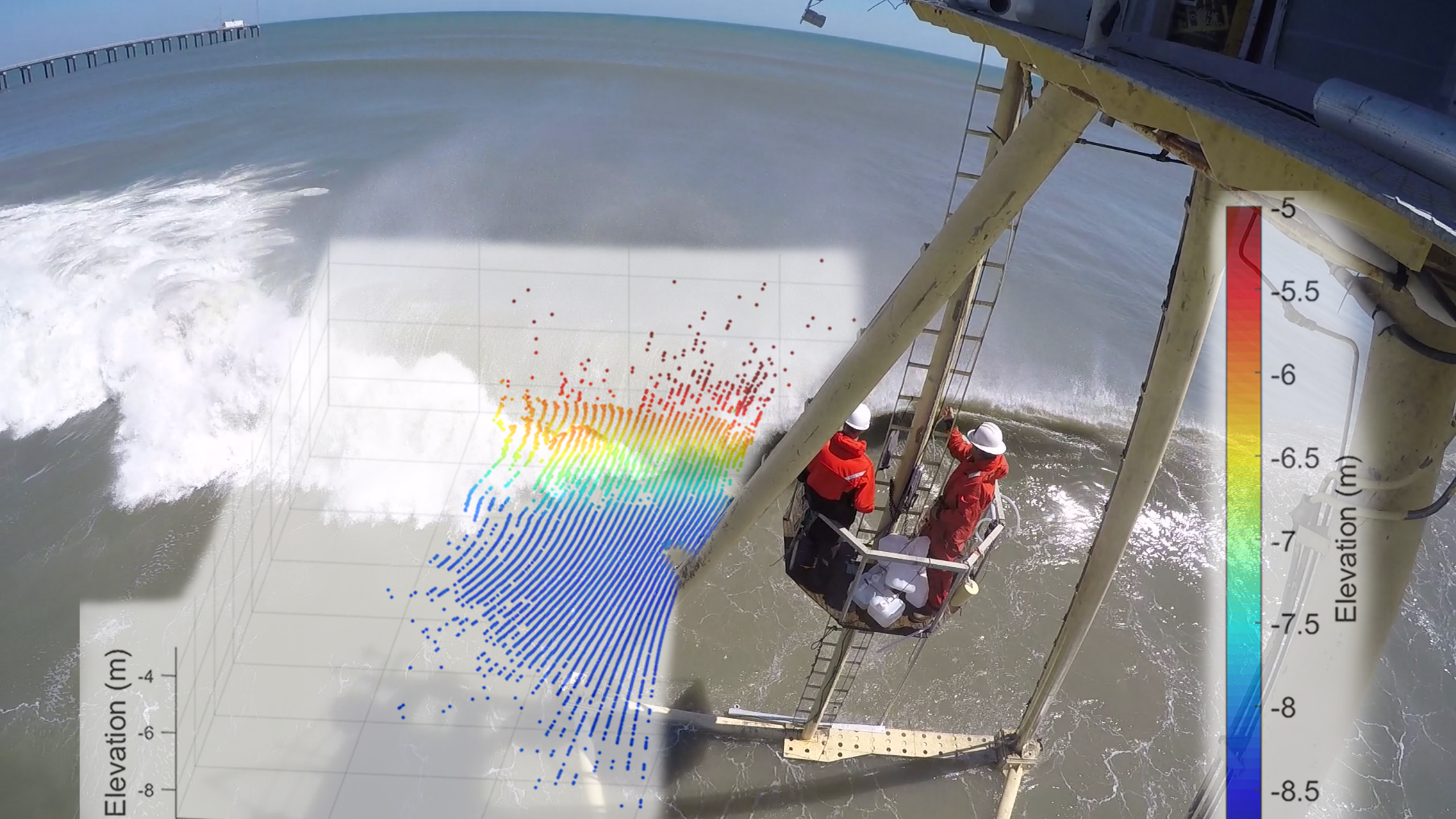


Distance

XYZ location, Time







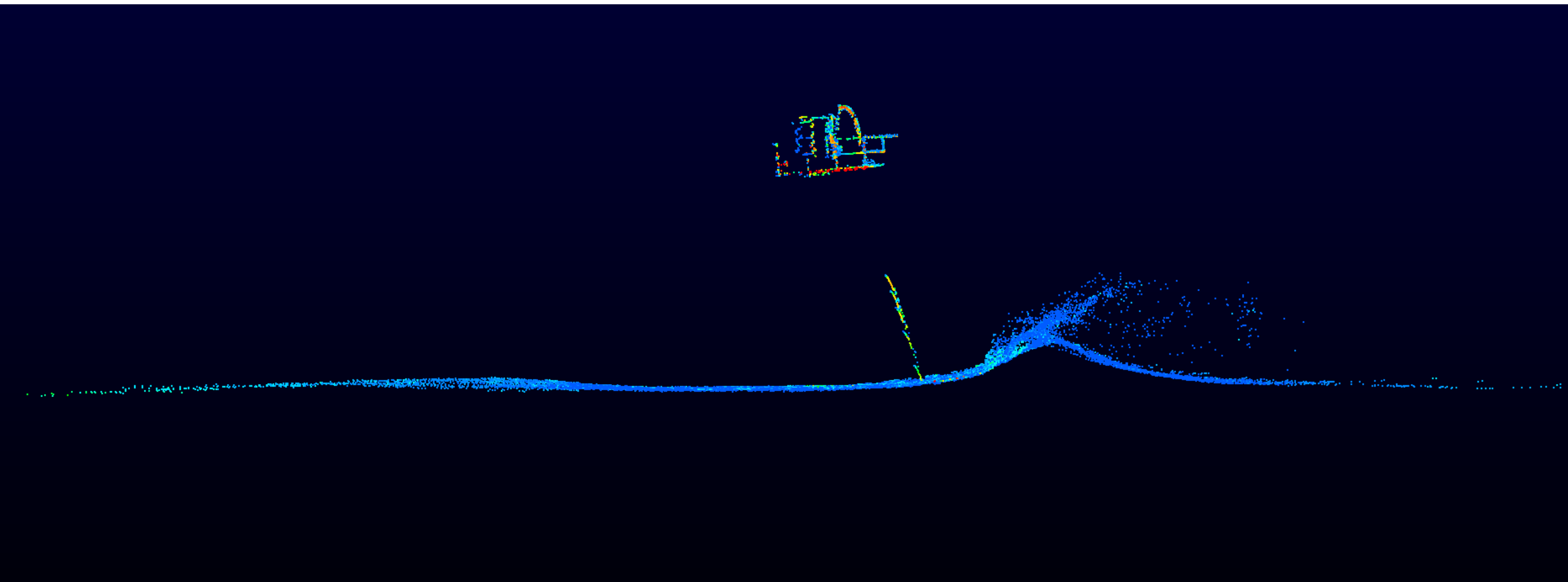
Elevation (m)

Elevation (m)
-4
-6
-8

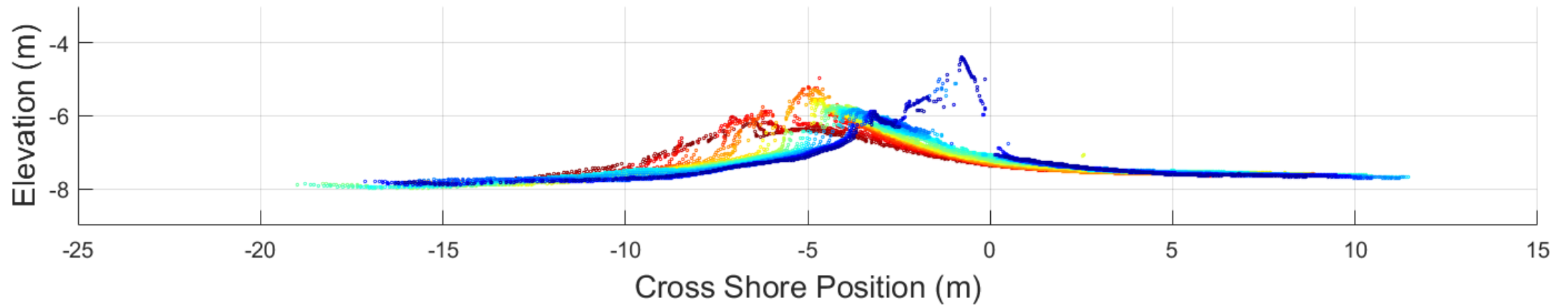
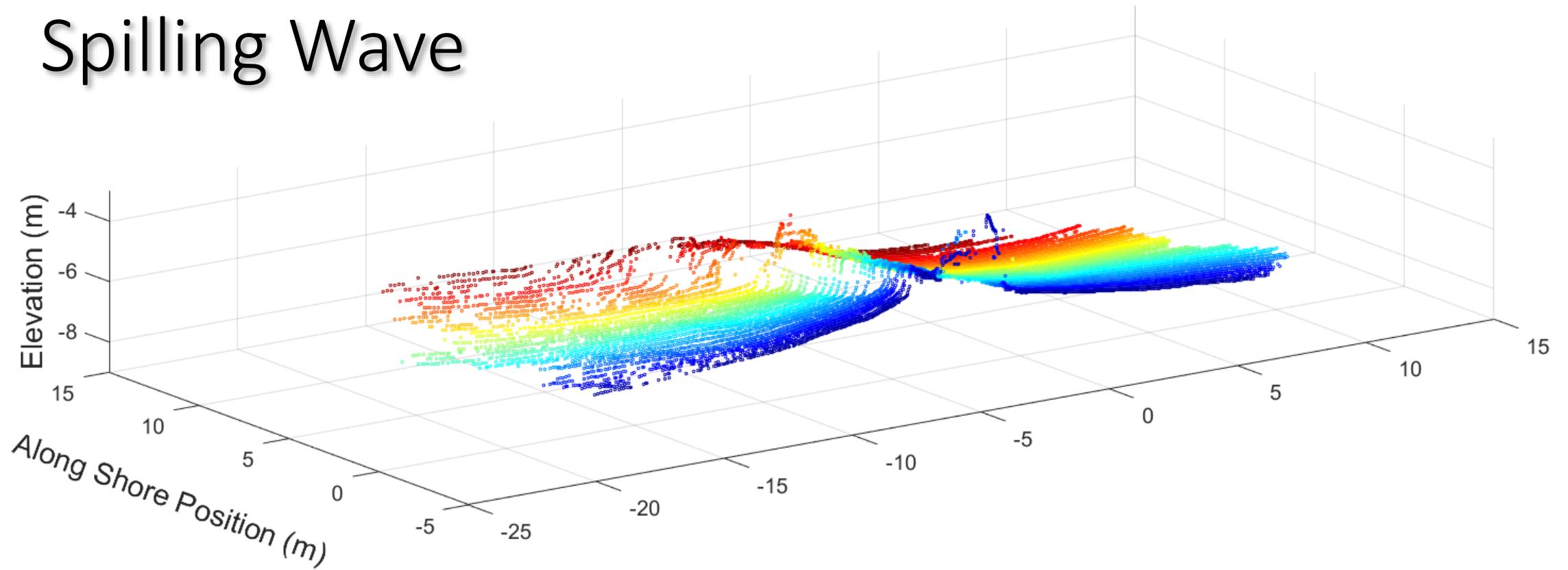
Elevation (m)

Elevation (m)
-5
-5.5
-6
-6.5
-7
-7.5
-8
-8.5

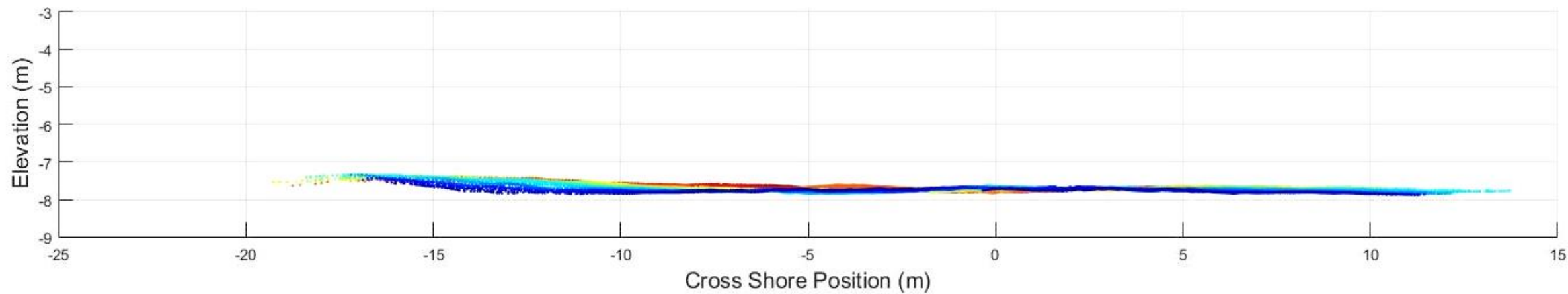
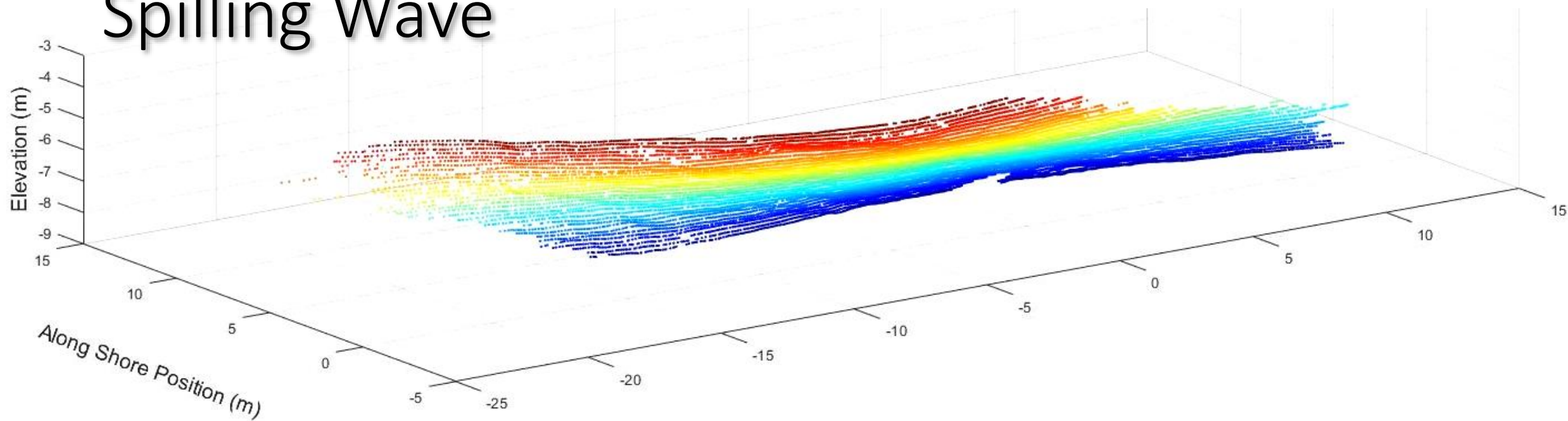
Spilling Wave



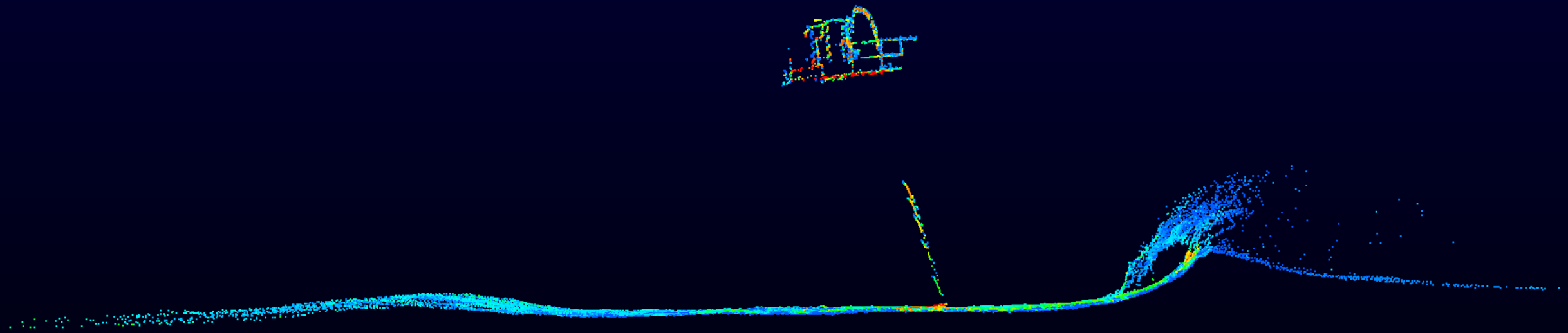
Spilling Wave



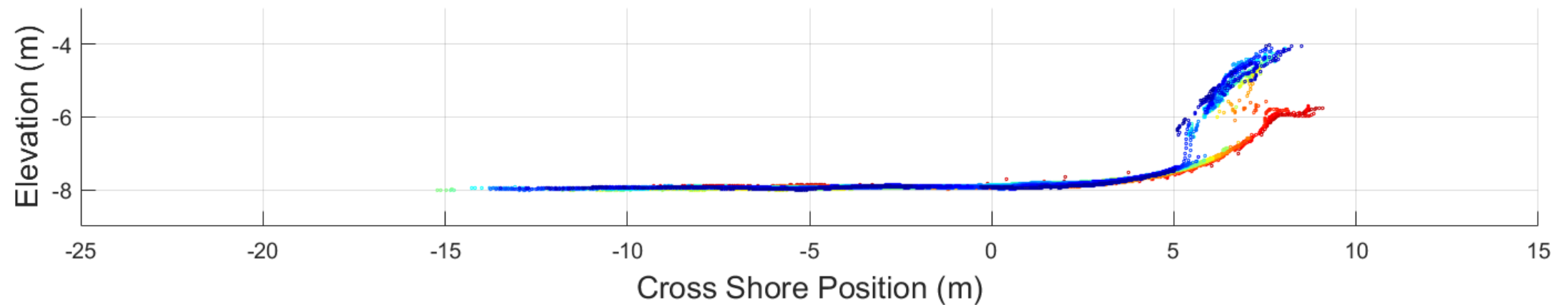
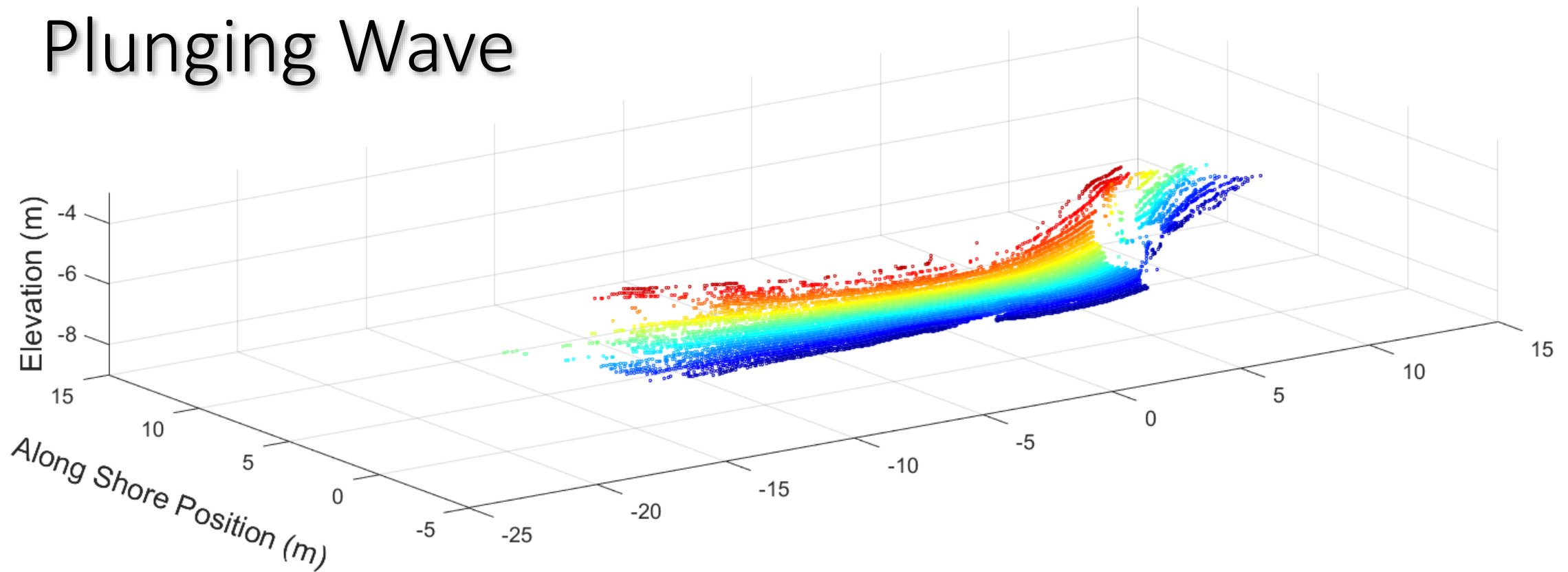
Spilling Wave



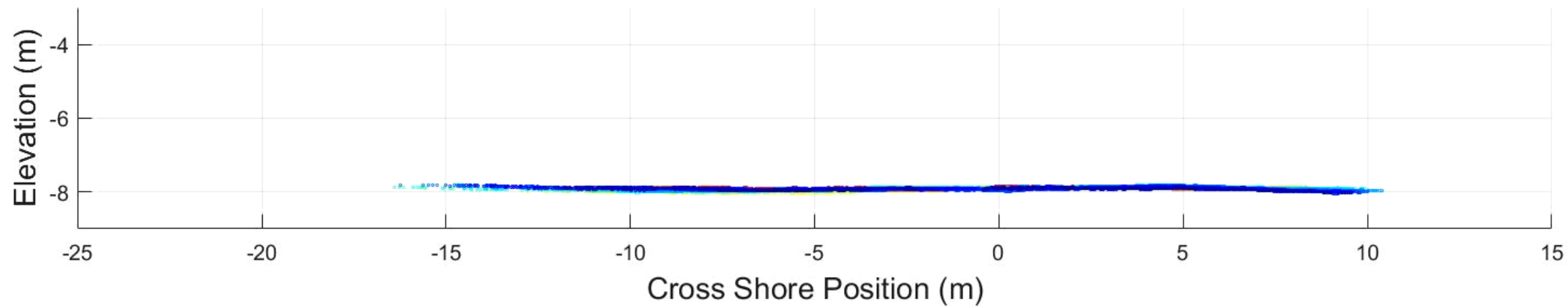
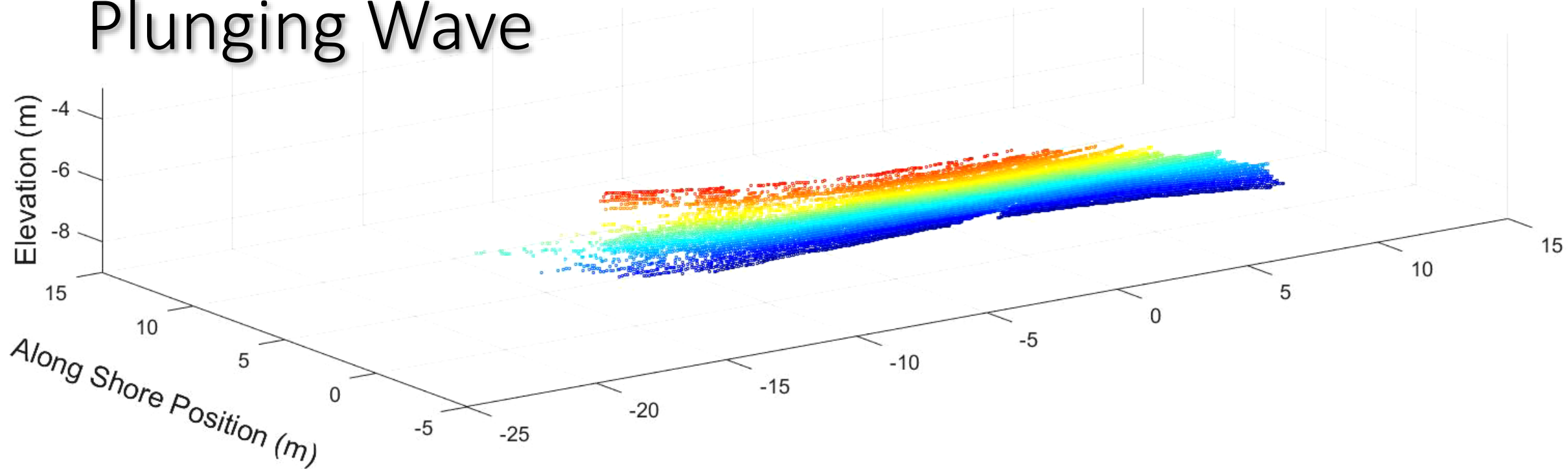
Plunging Wave



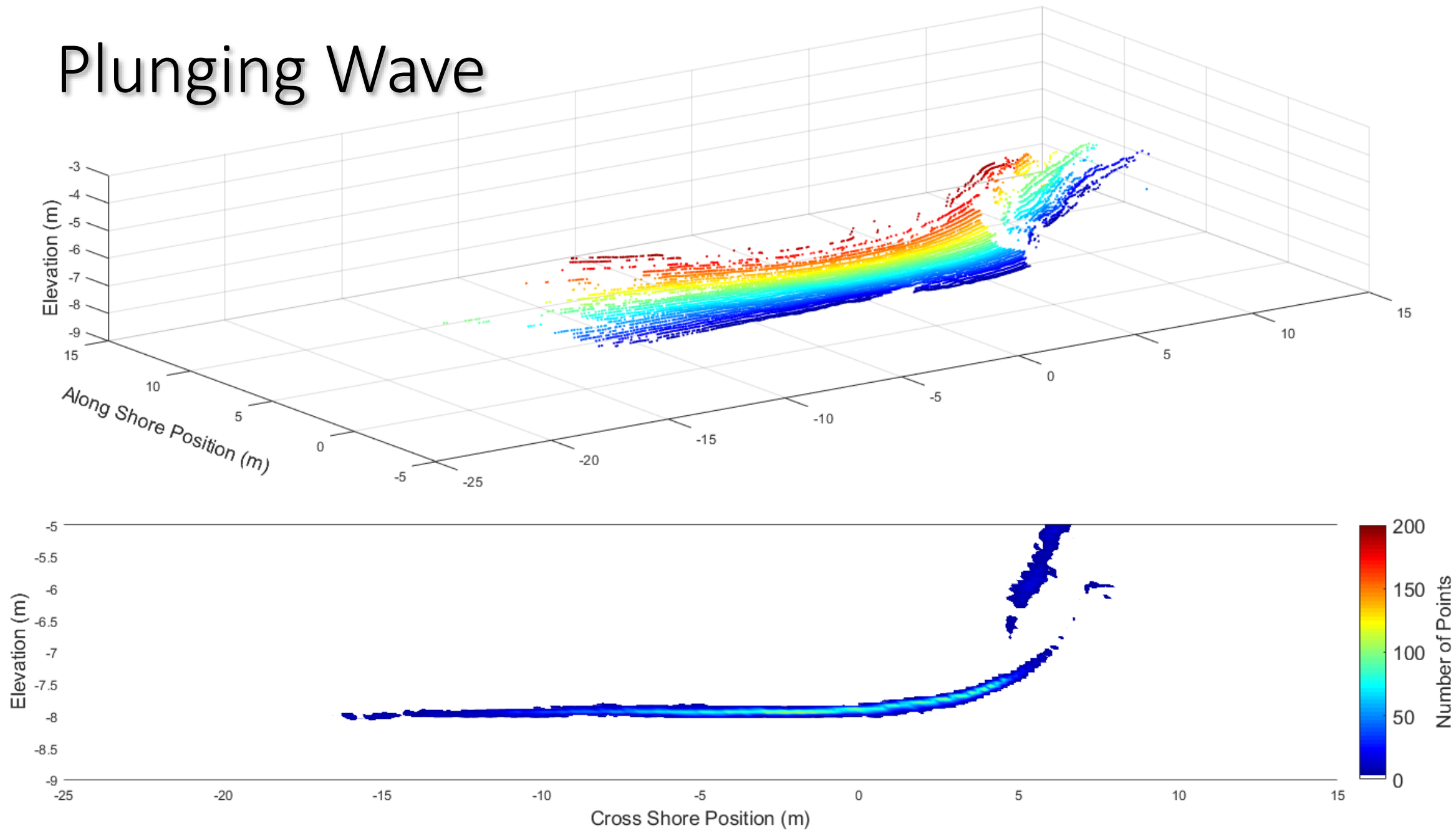
Plunging Wave



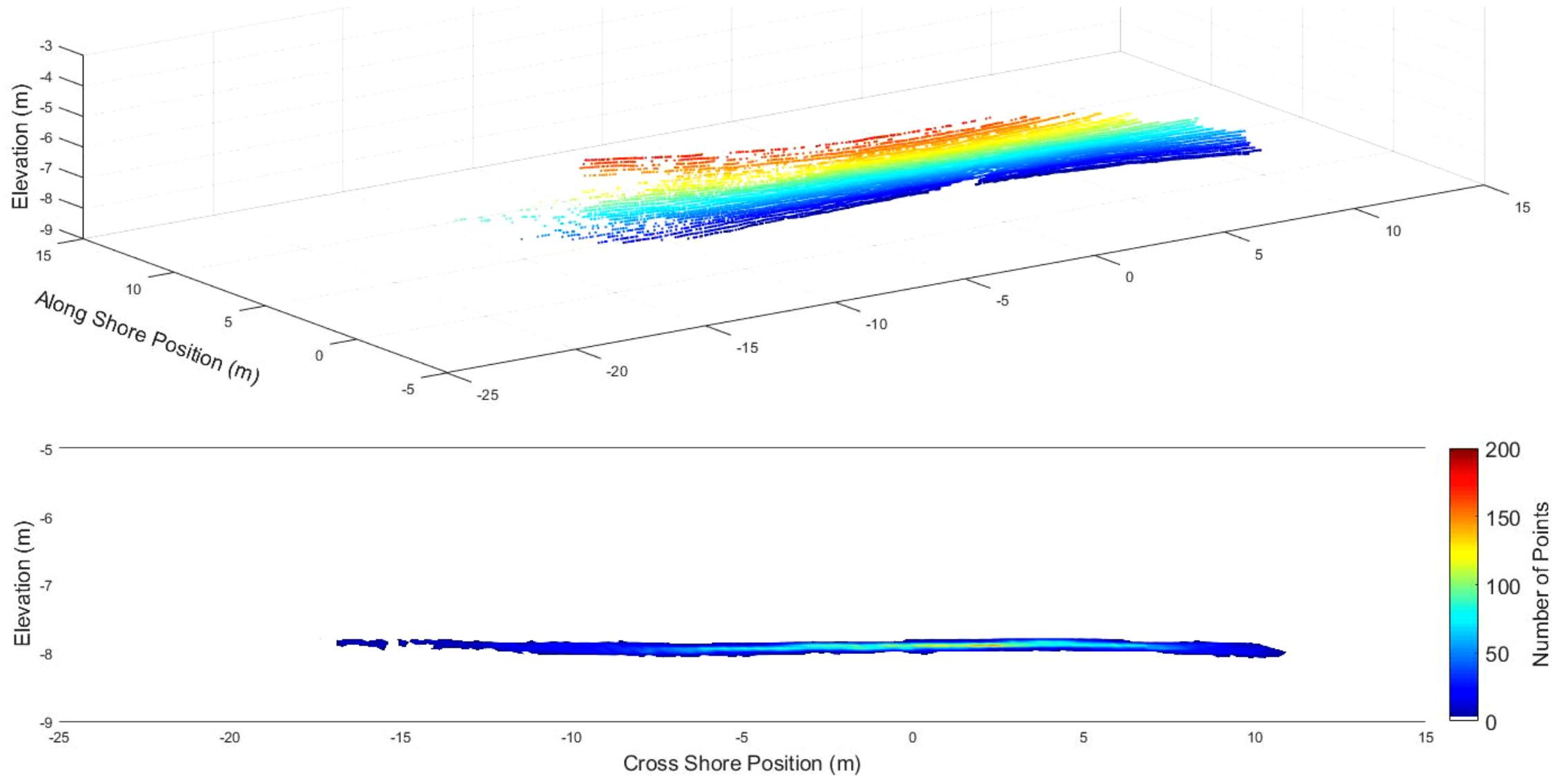
Plunging Wave

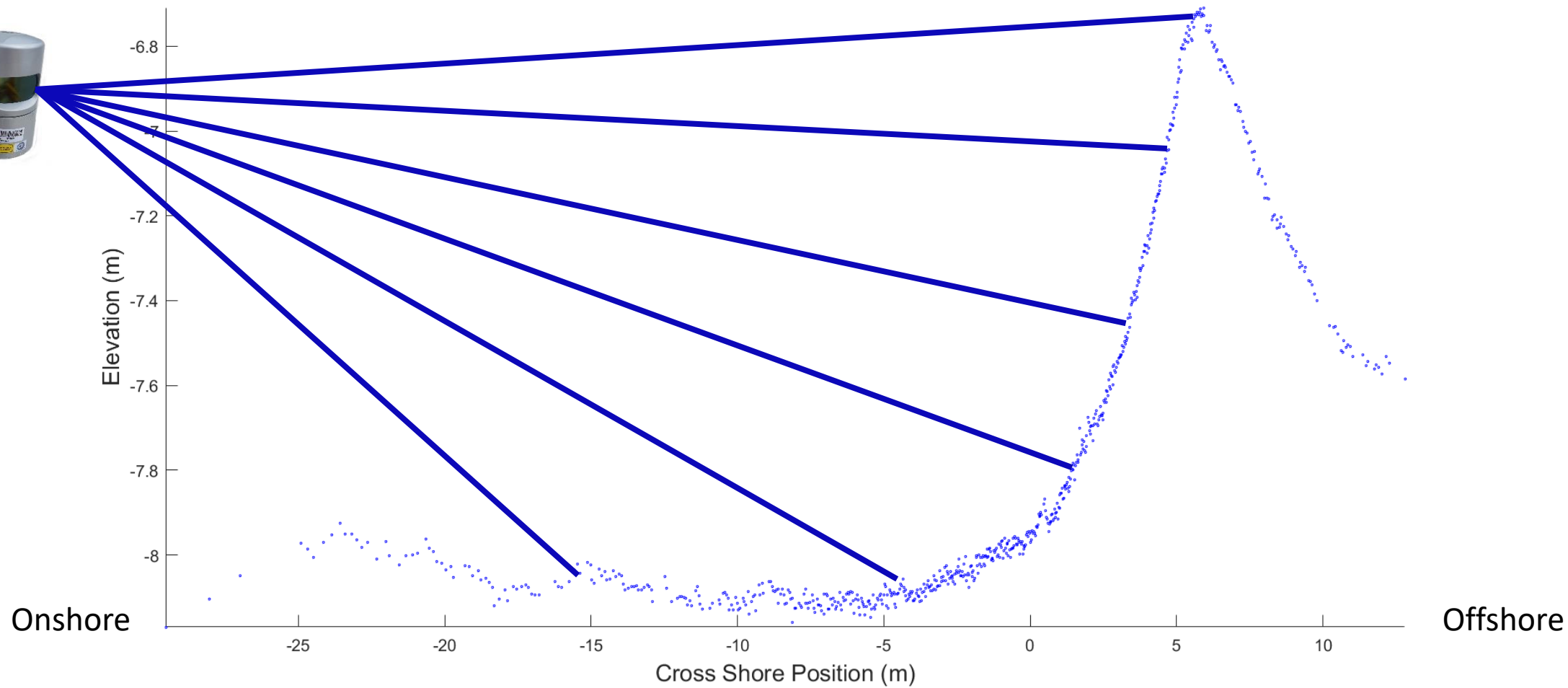


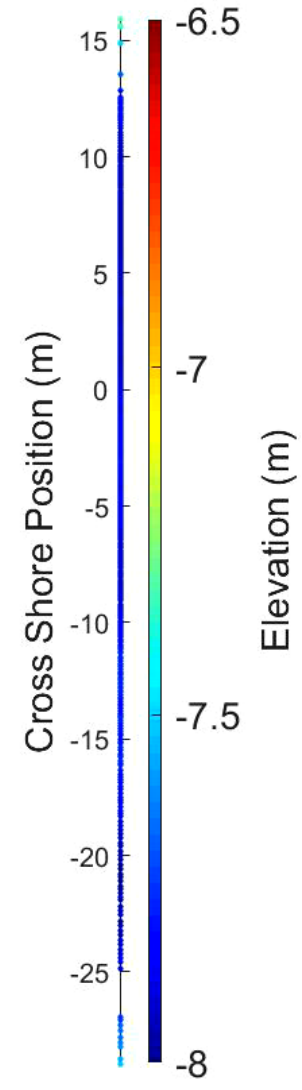
Plunging Wave

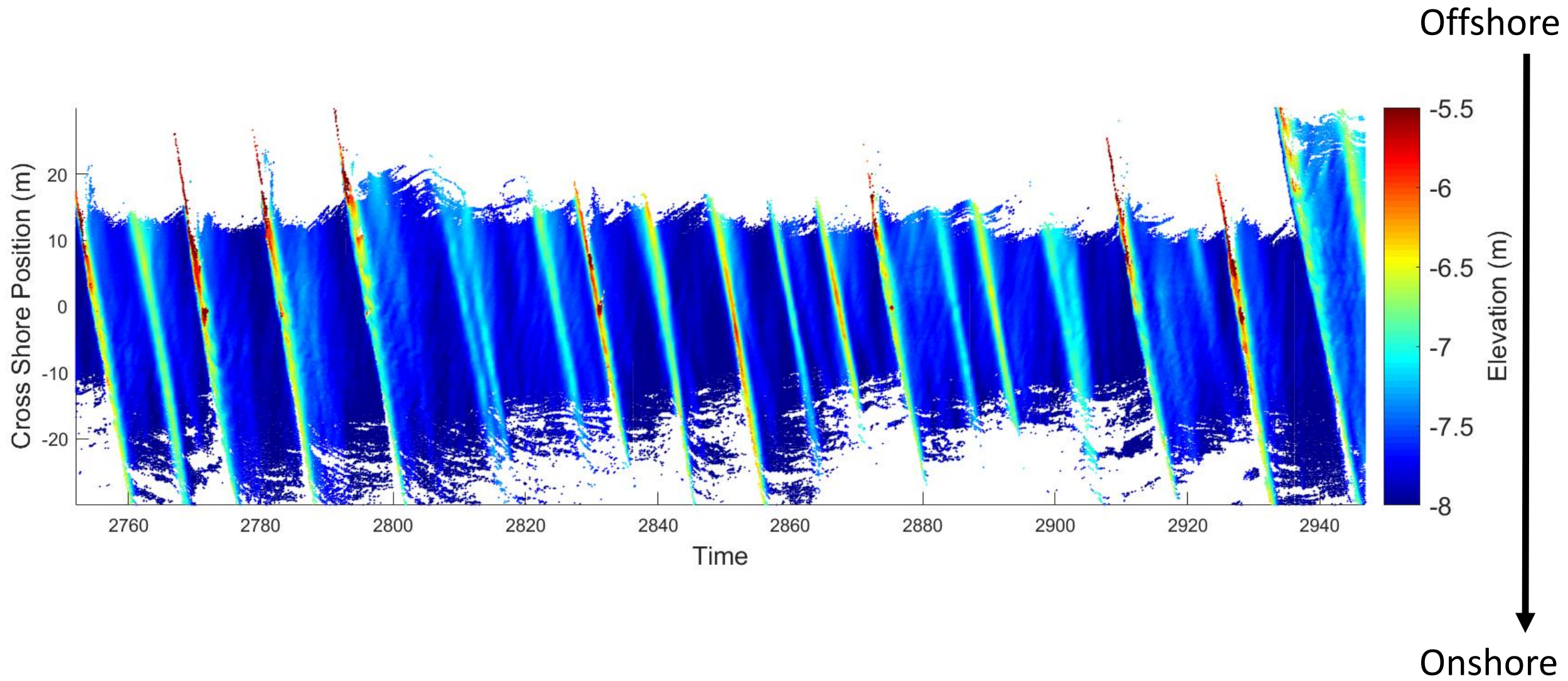


Plunging Wave



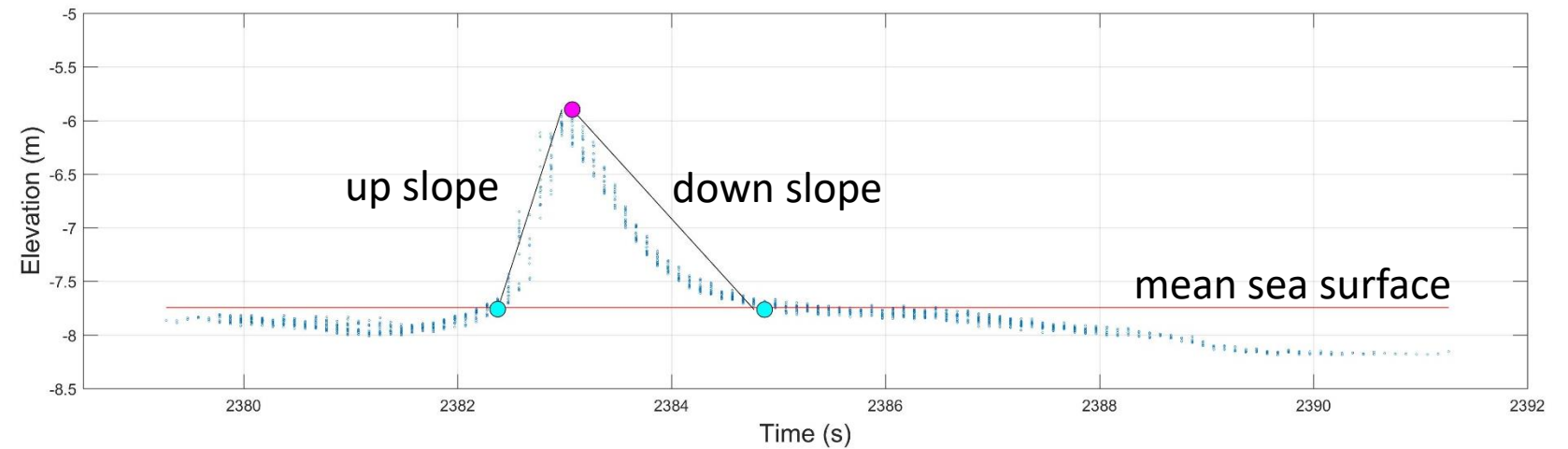
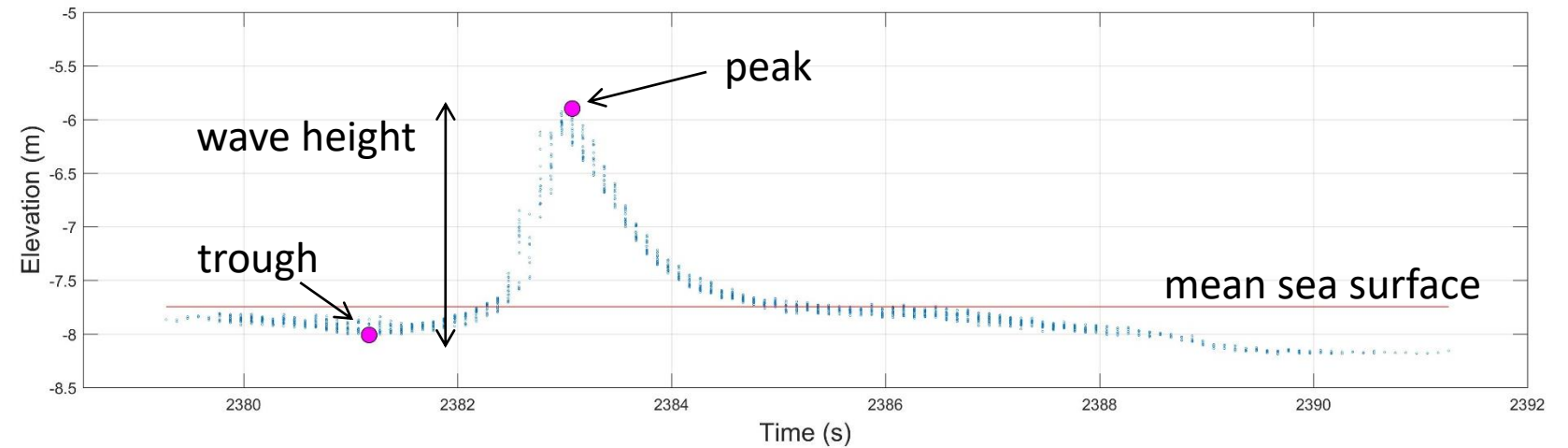




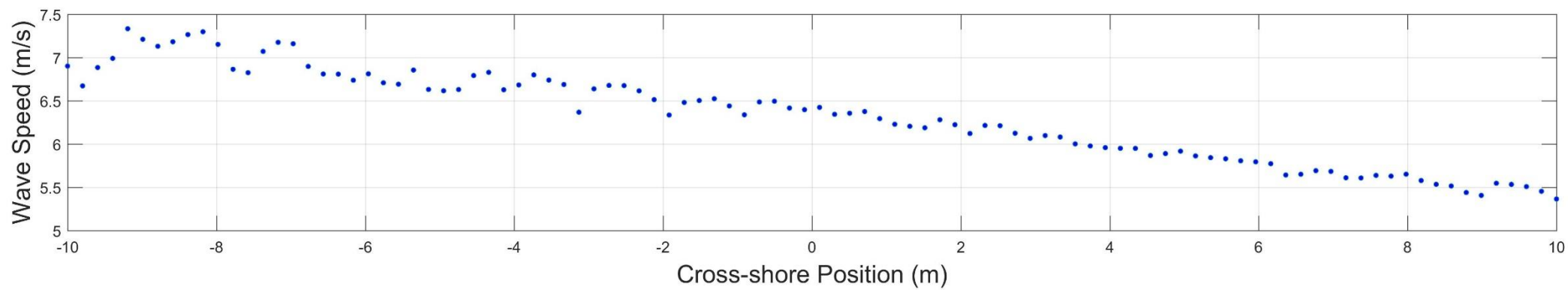
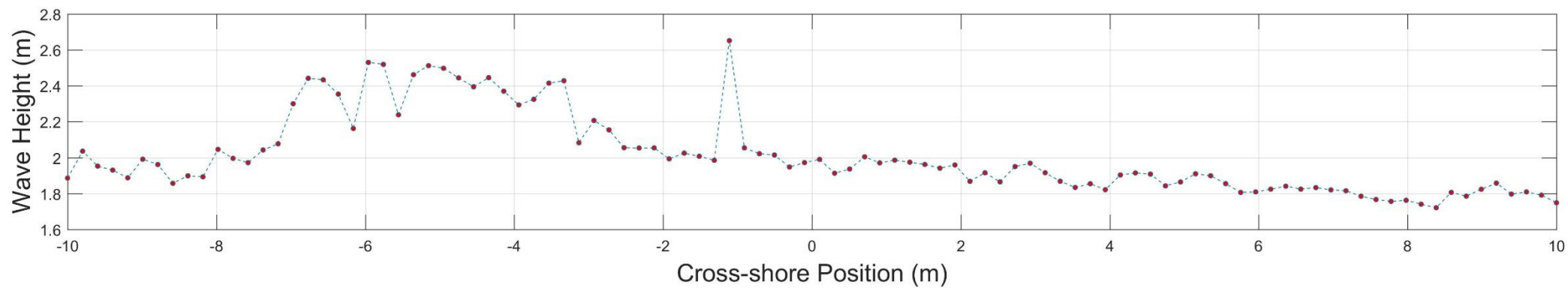
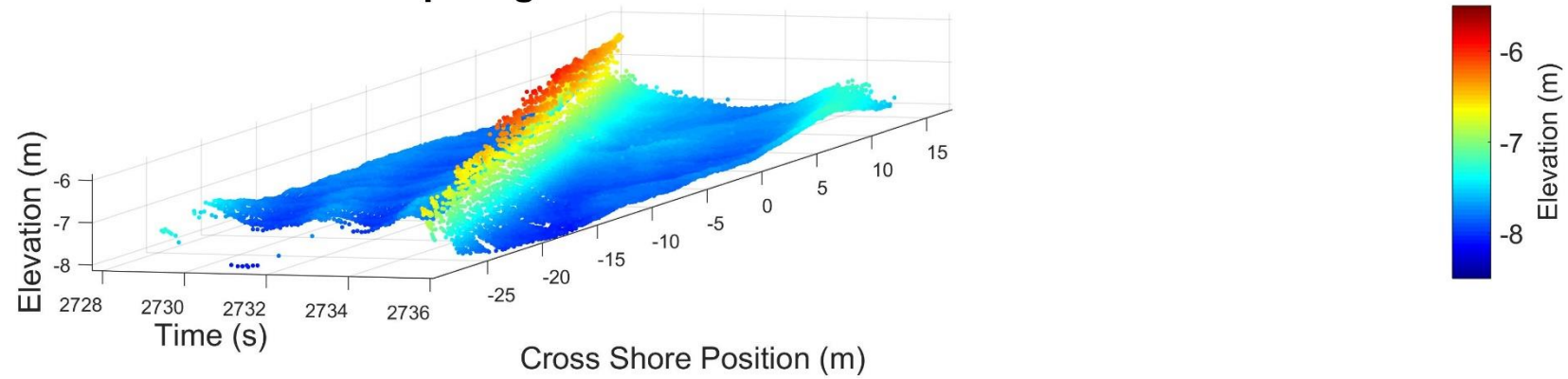


Morphometric properties

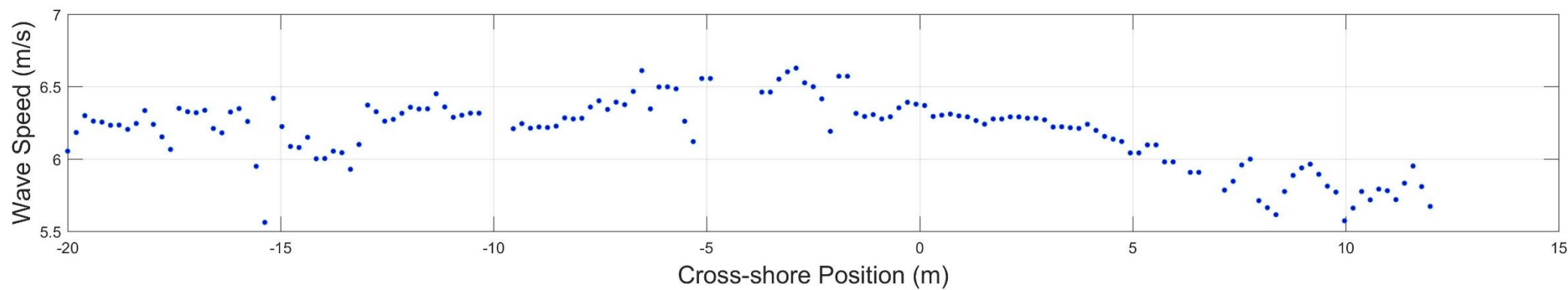
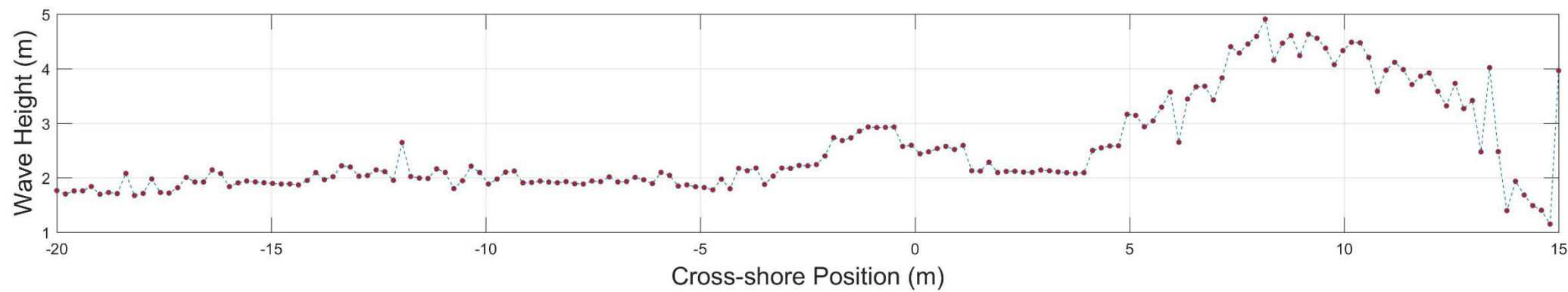
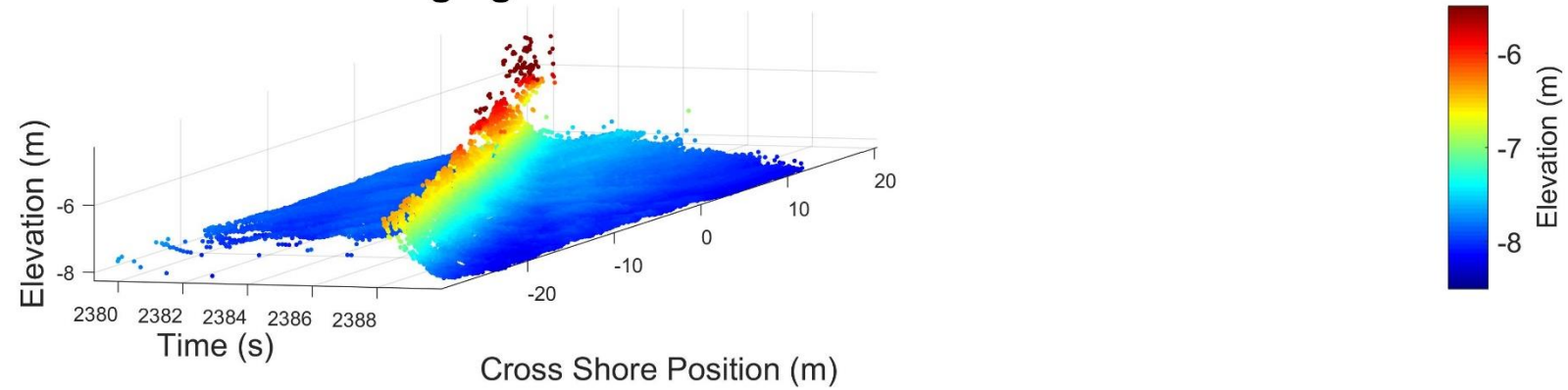
- Mean sea surface
- Wave height
- Upslope
- Downslope
- Wave Period



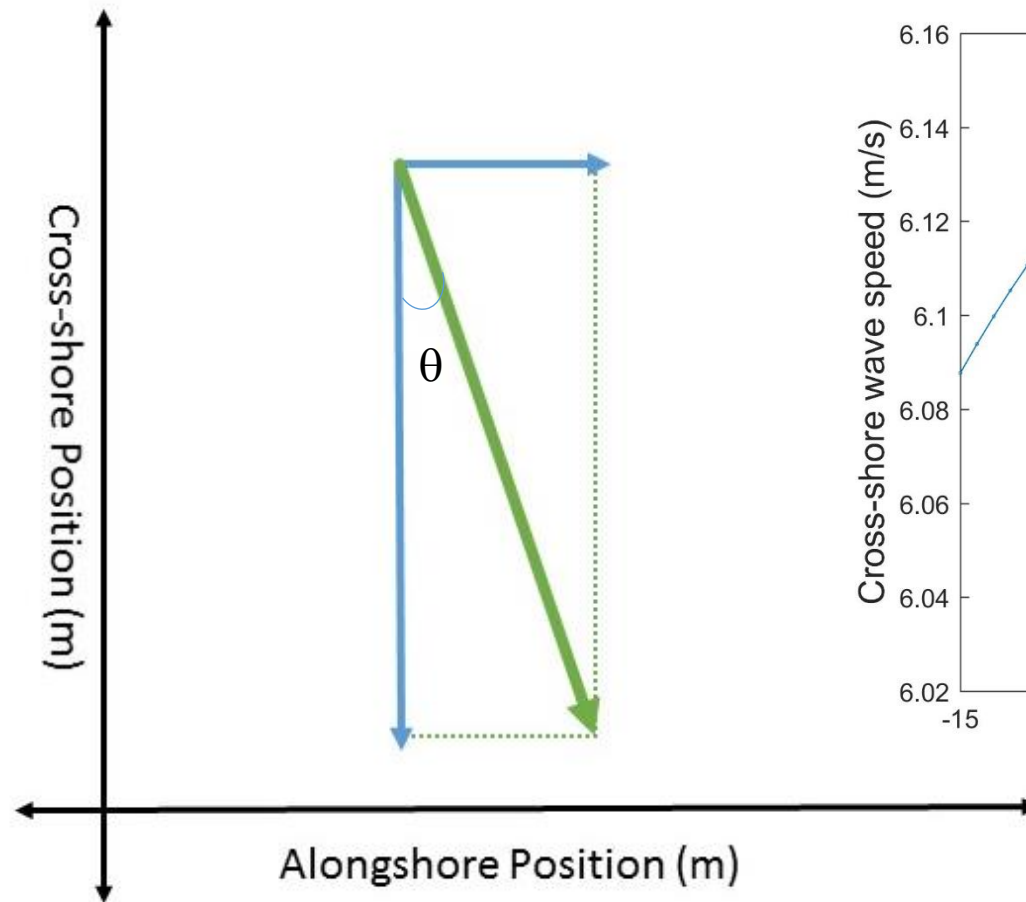
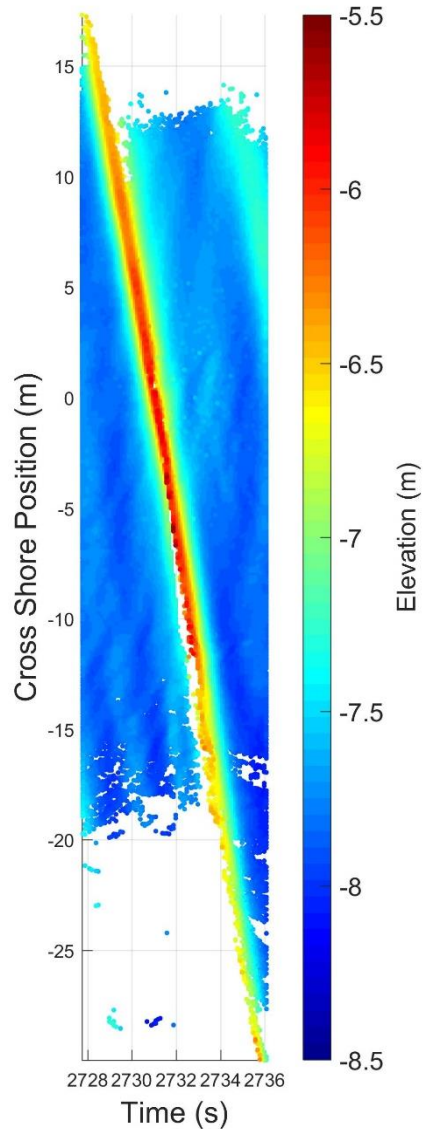
Spilling Wave



Plunging Wave

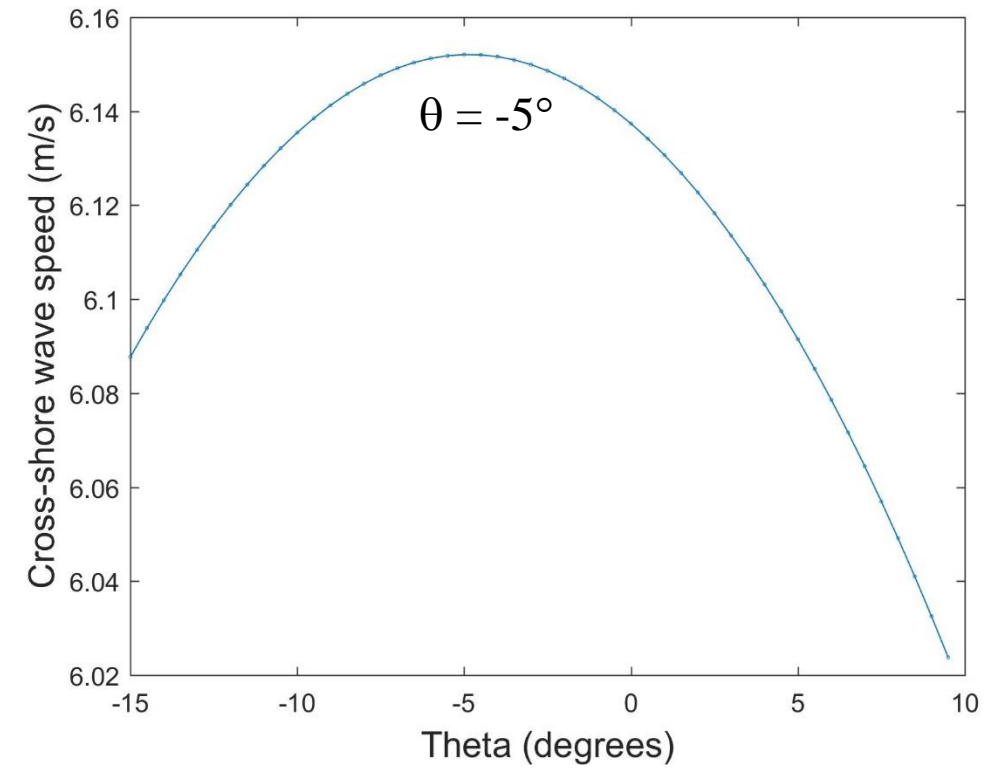


Wave Angle



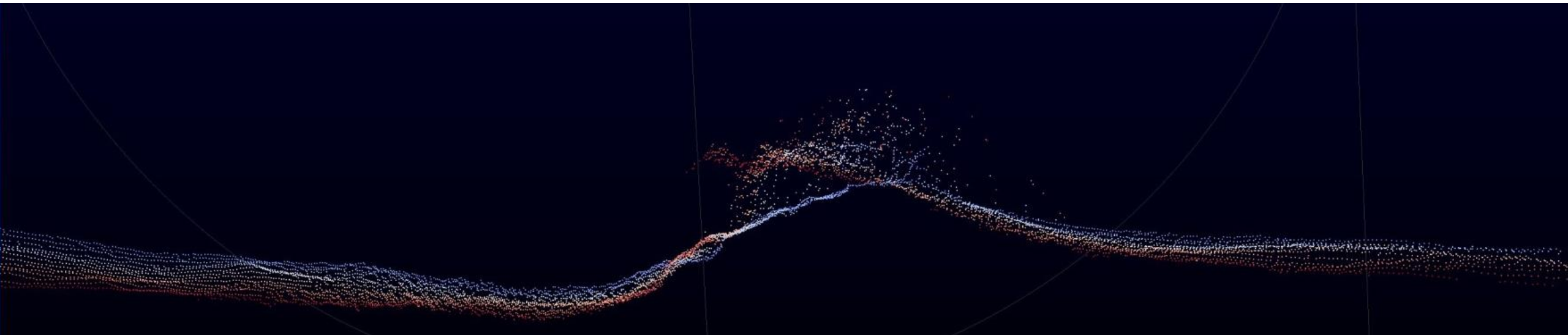
$$R(\theta) = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Wave angle with respect to the shore



Next Steps

- Other morphometric properties: upslope, downslope, skewness, asymmetry, wave period
- Find waves of different breaking types and calculate wave statistics for comparison
- Find common properties and develop classification scheme
- Plunging breakers: find void shape/size

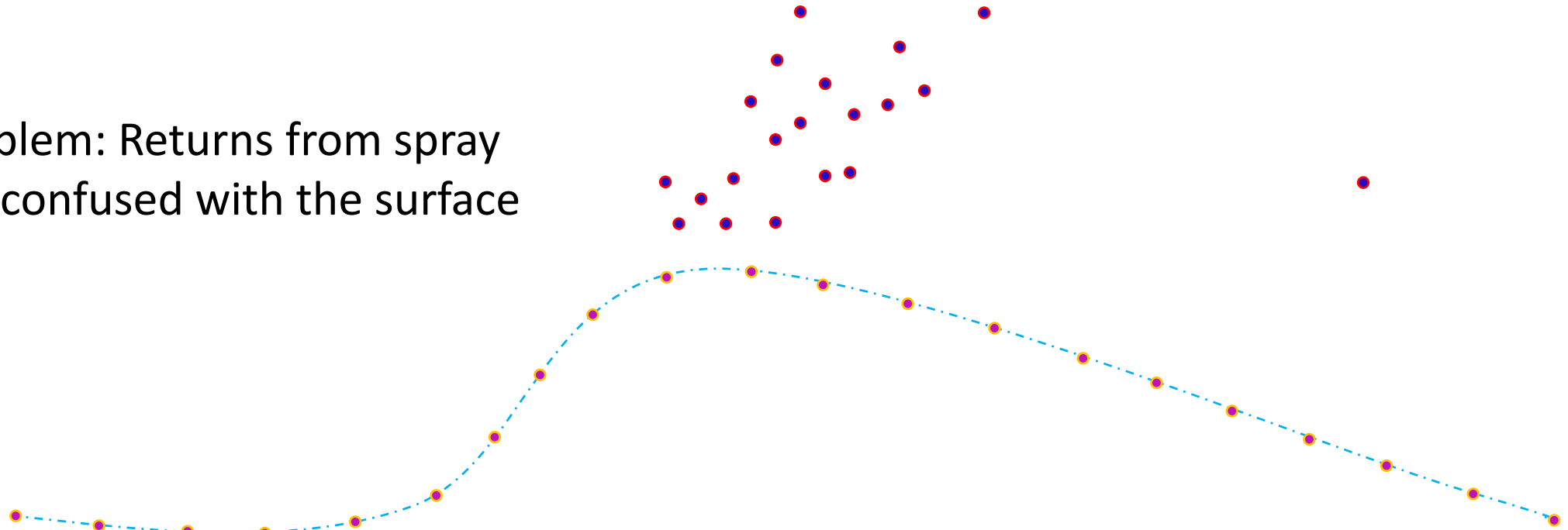


A wide-angle photograph of a sunset or sunrise over a calm body of water. The sky is filled with horizontal bands of clouds, some of which are illuminated from below by the low sun, creating a warm orange and yellow glow. The water in the foreground is still, acting as a perfect mirror for the sky and clouds above. The horizon line is a thin, dark silhouette of land or trees in the distance. The overall mood is serene and contemplative.

Questions ?

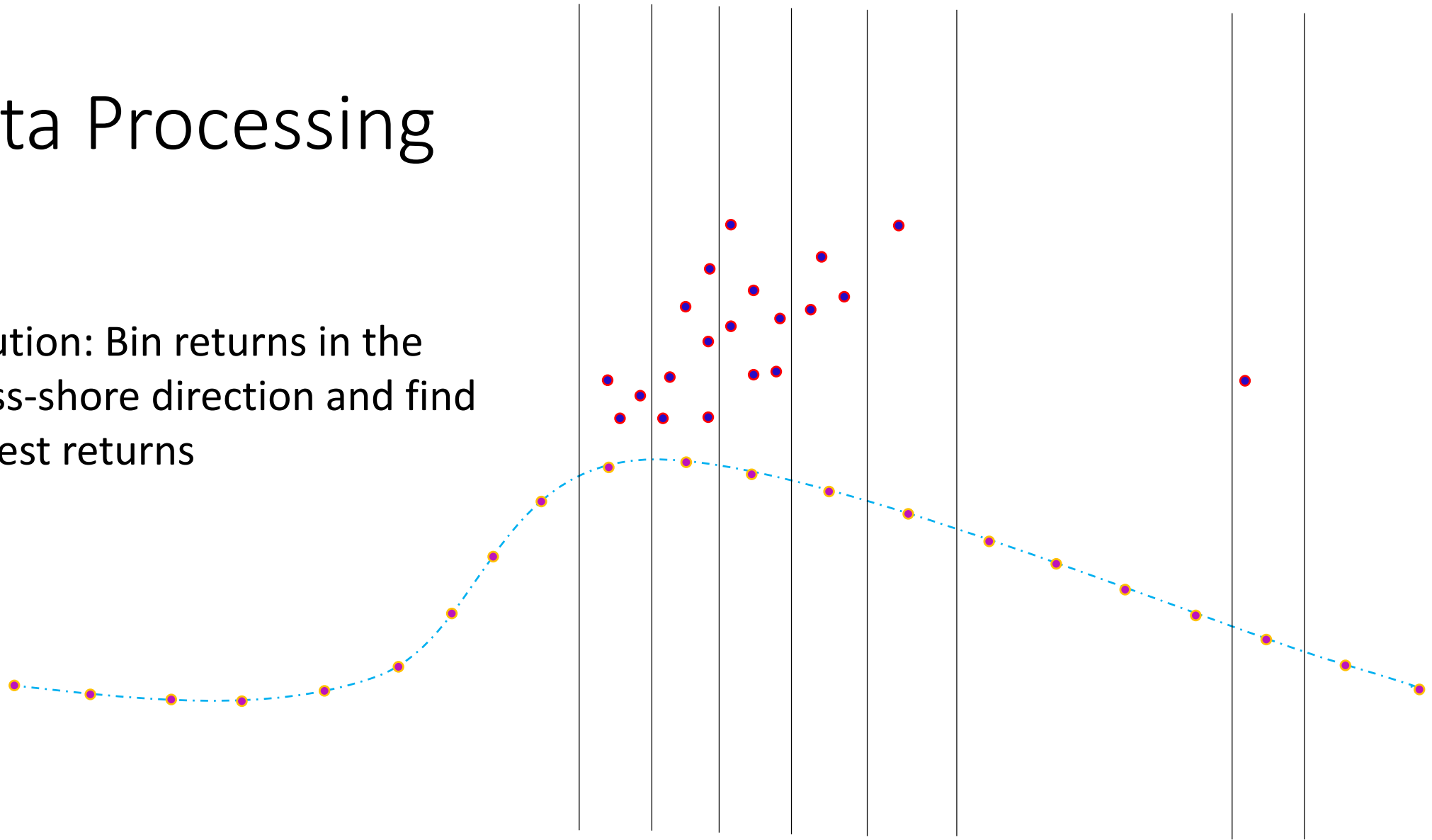
Data Processing

Problem: Returns from spray
are confused with the surface



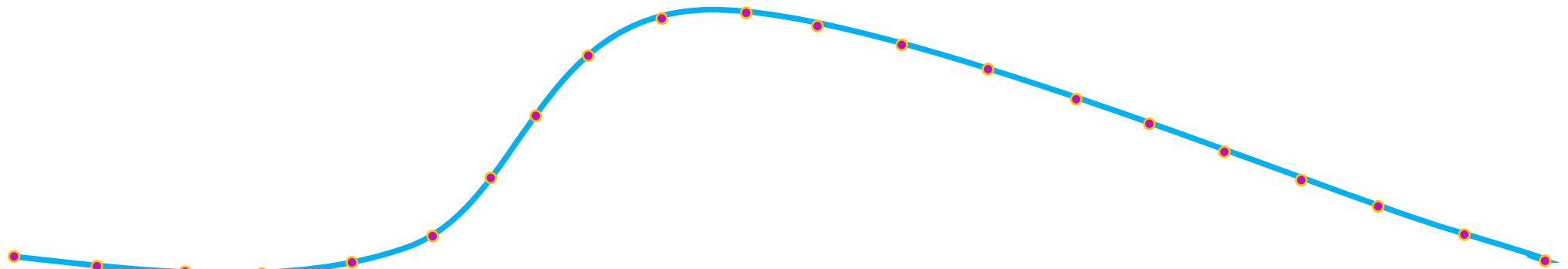
Data Processing

Solution: Bin returns in the cross-shore direction and find lowest returns

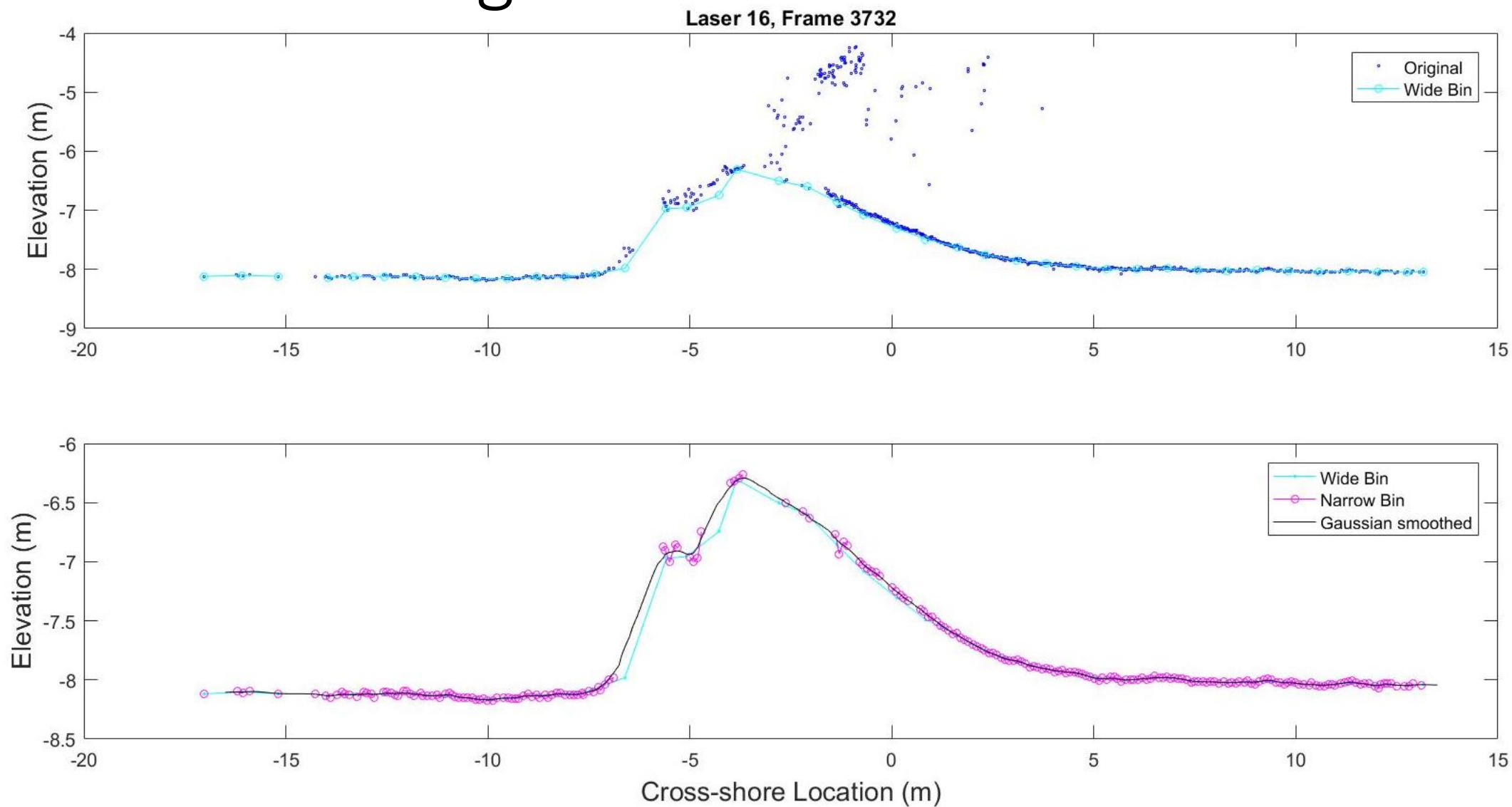


Data Processing

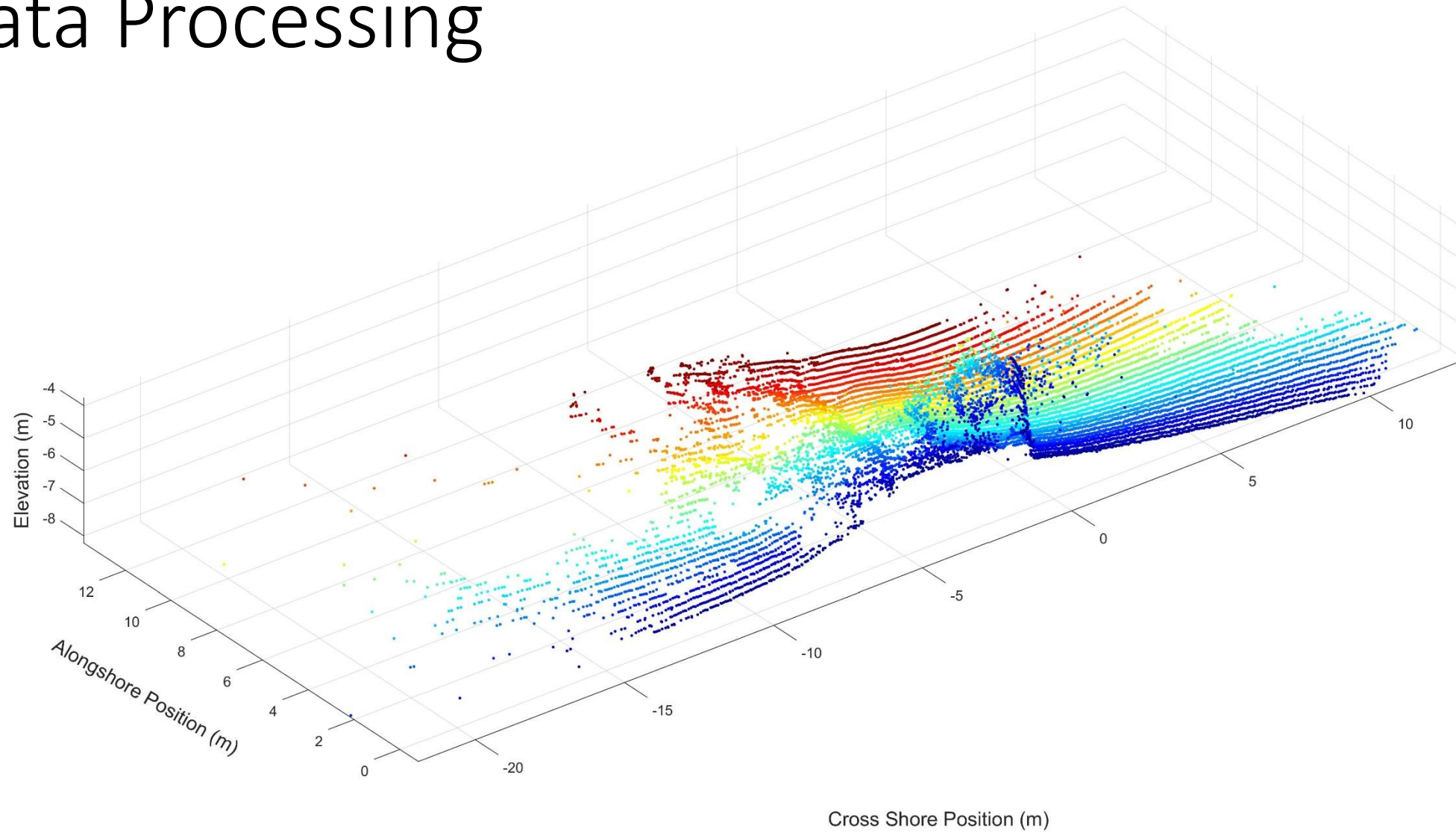
Final product: spray removed
and smoothed surface



Data Processing



Data Processing



Data Processing

