

# Calculated and Mapped Depths of Closure Along the U.S. Coastlines Using WIS Hindcast Data

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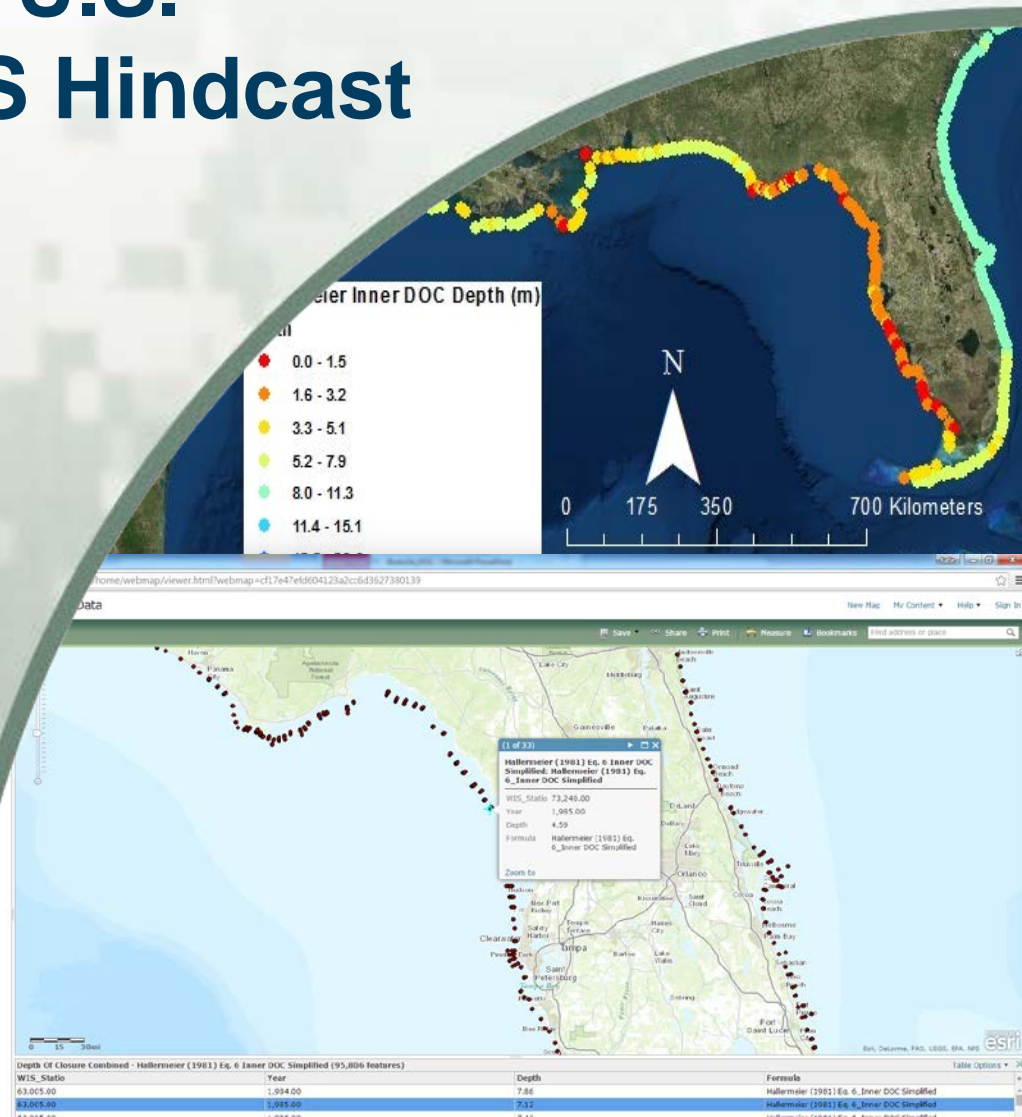
Brian C. McFall, PhD, PE

USACE ERDC-CHL

October 15, 2015



US Army Corps  
of Engineers®



- A tool is being developed to allow user to view mapped Depths of Closure across the U.S. coastlines
- Illustrates the seaward extent of sediment transport
- Tool will aid coastal planners and engineers in designing coastal projects



# Depth of Closure

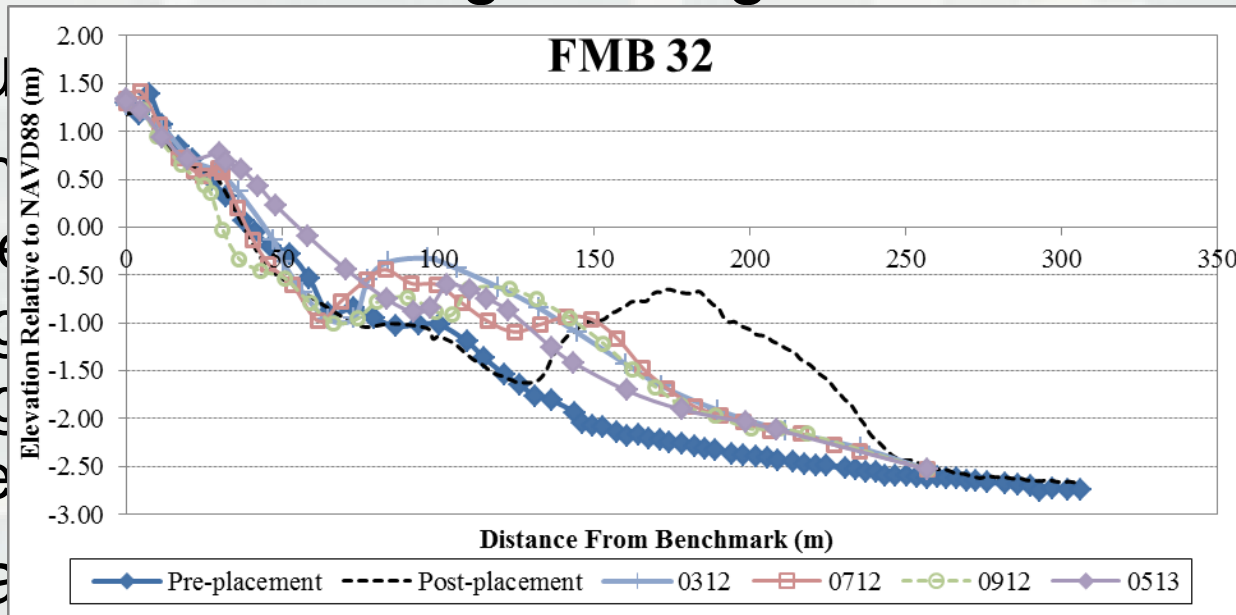


- Depth of Closure (DOC) is an important concept used in coastal engineering

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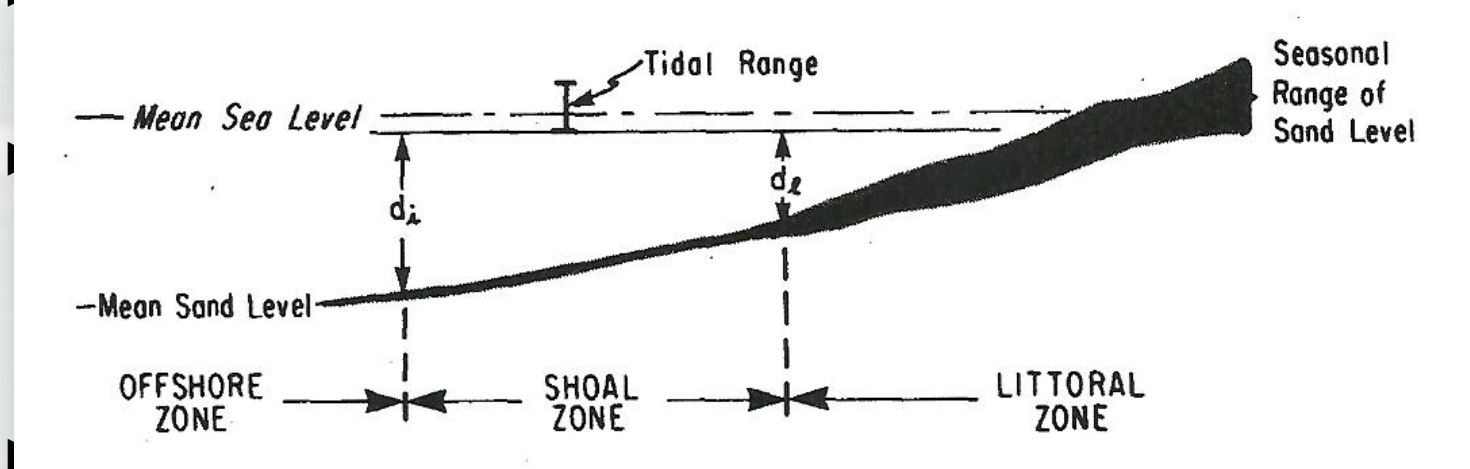


# Depth of Closure



- Hallermeier (1978, 1981)

► First theoretical definition of DOC using wave tank



- The seaward limit of the shoal zone, where wave shoaling is the dominant process and bed agitation remains relatively moderate

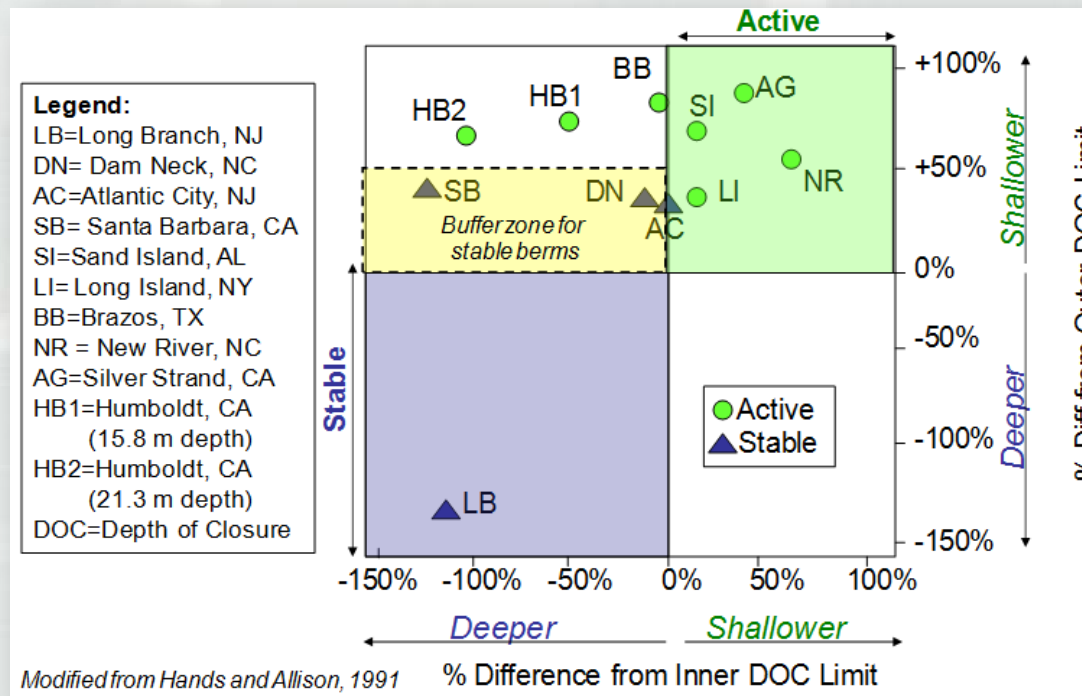
- Birkemeier (1985) later revised



# Depth of Closure



- Applied often in coastal sciences
- Web Application was initially intended for use in nearshore placement projects



## Hallermeier (1978,1981)

Inner limit

$$d_l = 2.28H_e - 68.5\left(\frac{H_e^2}{gT_e^2}\right)$$

$$H_e = \bar{H}_s + 5.6\sigma_s$$

$$d_l = 2\bar{H}_s + 11\sigma_s$$

Outer Limit

$$d_i = (\bar{H}_s - 0.3\sigma_s) \bar{T}_s \left(\frac{g}{5000D}\right)^{0.5}$$

## Birkemeier (1985)

$$d_l = 1.75H_e - 57.9\left(\frac{H_e^2}{gT_e^2}\right)$$

$$d_l = 1.57H_e$$

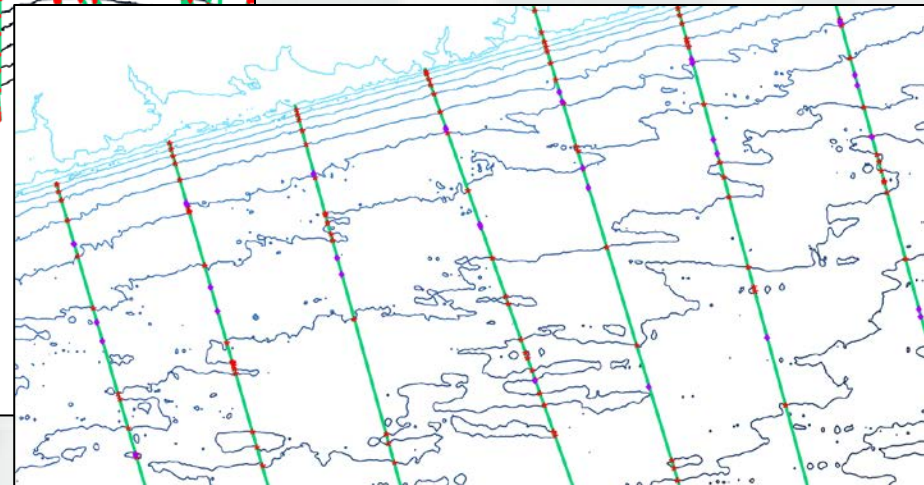
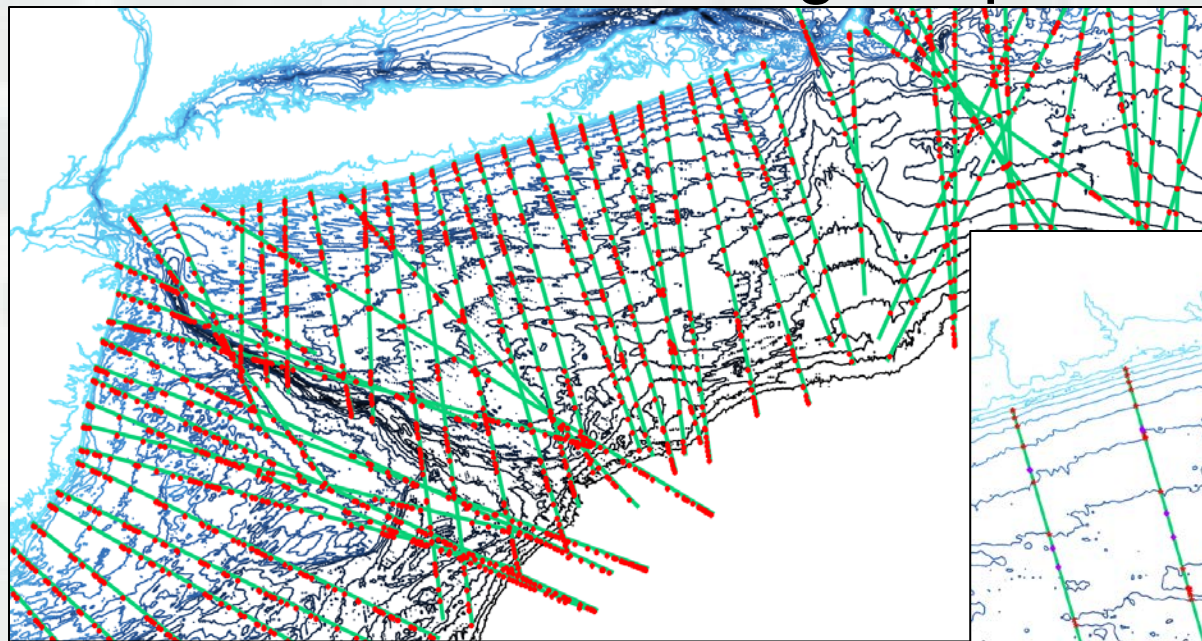




- WIS hindcast wave data were downloaded to calculate DOC
- Snell's Law was used to shoal waves into certain depth based **Coastline** **Depth** ts for each coast line
 

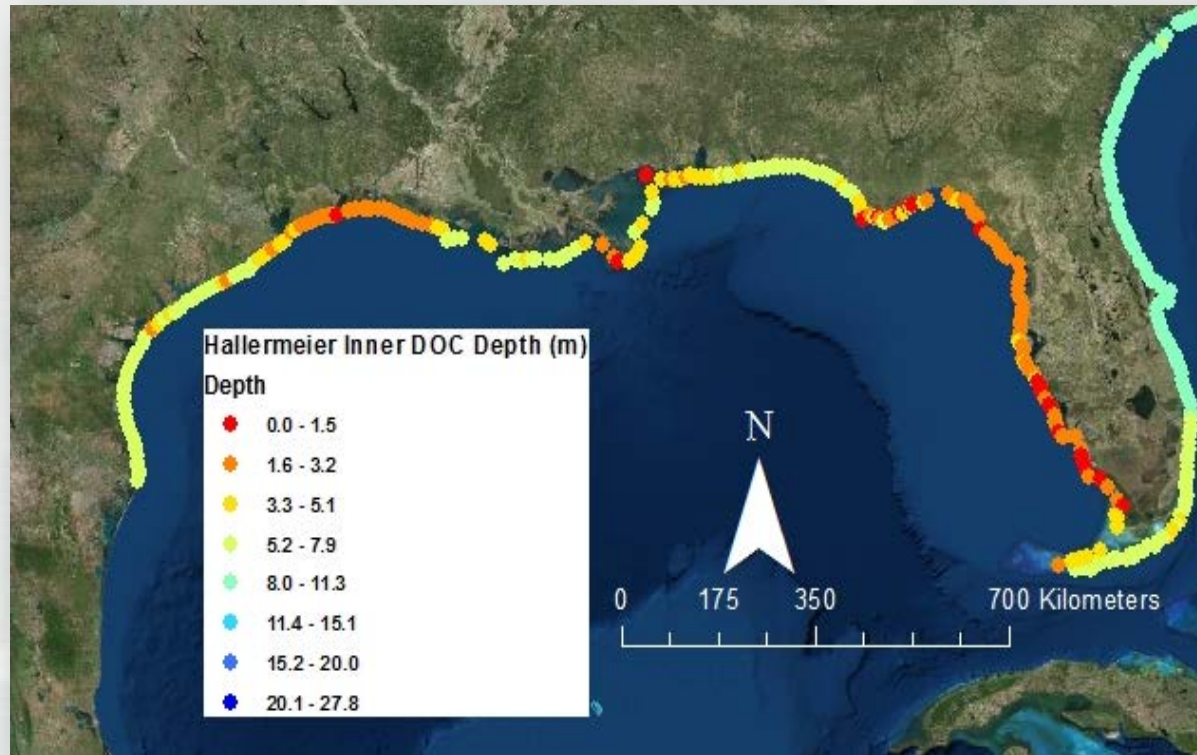
Coastline	Depth
Pacific	15.2 m [50 ft]
Atlantic	12.2 m [40 ft]
Gulf	9.1 m [30 ft]
Great Lakes	9.1 m [30 ft]
- Calculated wave heights
  - ▶  $H_e, H_s, H_{mean}$
- Calculated Hallermeier (1978, 1981) Inner, Outer (using 0.15 mm, 0.2 mm, 0.3 mm)
- Calculated Birkemeier (1985), simplified

- DOCs calculated for each year on record as well as entire record
- Created profiles extending from WIS station to shoreline and found intersections with contours
- Placed DOCs along the profiles





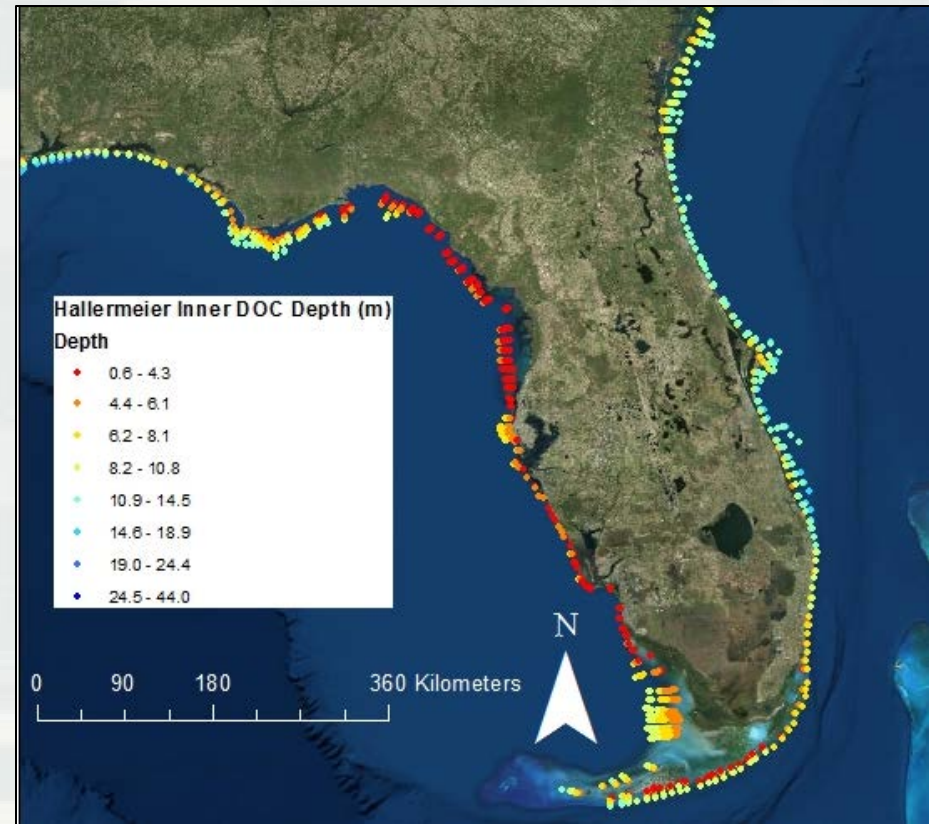
# Overall Trends



- Regional trends based on 20 year dataset



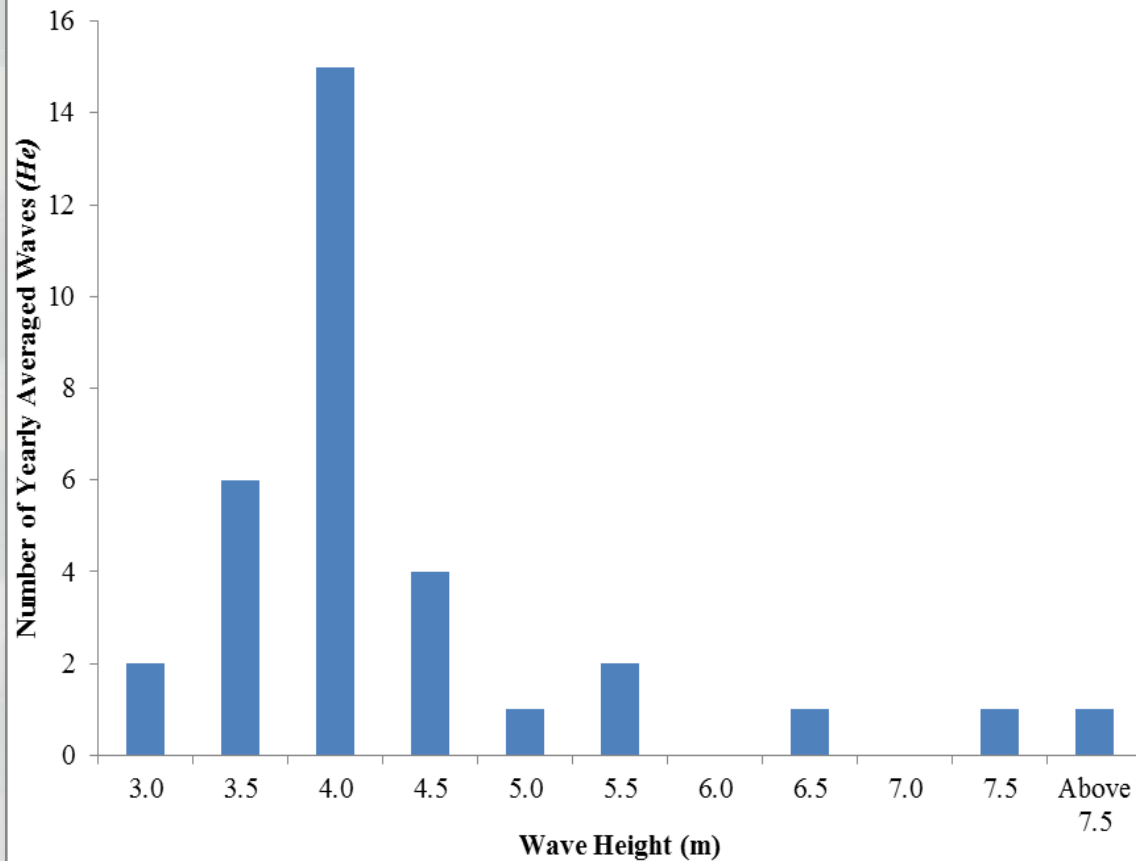
- Yearly calculated DOCs
- Project specific zones of depth of closure
- Allows the user to view minimum, maximum, and mode of DOCs
- Determine yearly trends



# Wave Statistics



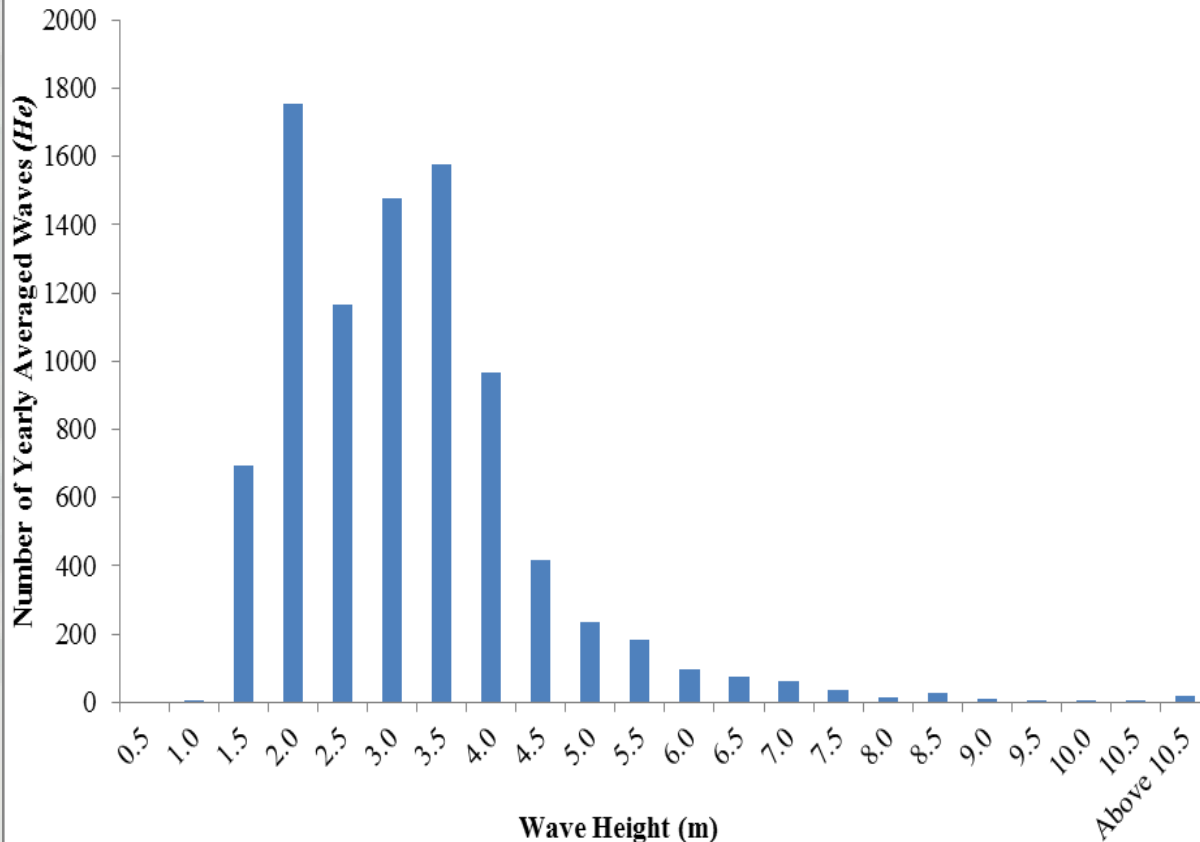
## 33 Years of $H_e$ Data for WIS Station 73002



- Entire data set for WIS Station 73002
- Most frequent waves are in the 4 m range



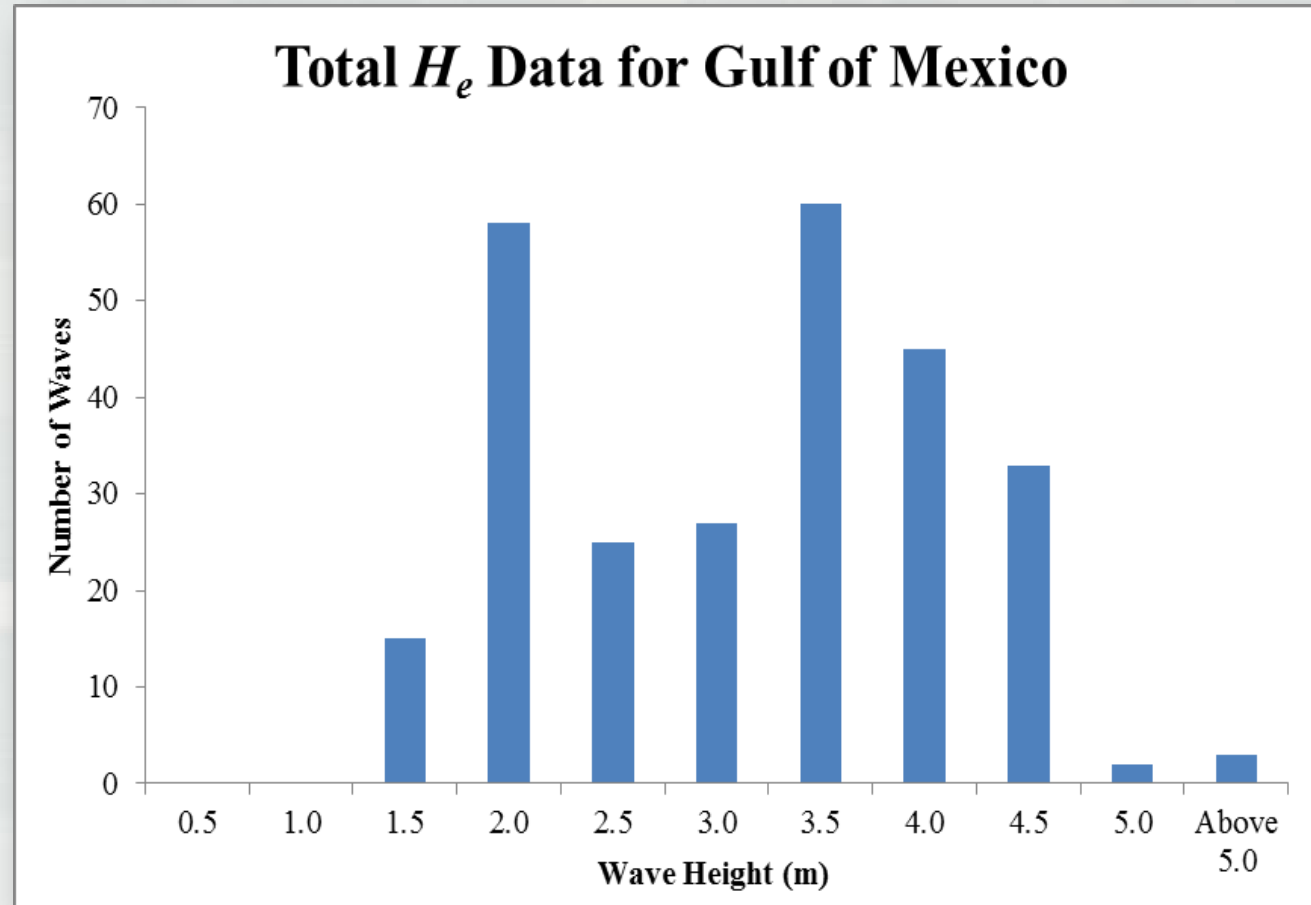
## 33 Years of $H_e$ Data in the Gulf of Mexico



- Entire data set for all stations in the Gulf of Mexico
- Most frequent waves are in 2-4 m range



- Determine trends using total  $H_e$  data across entire Gulf of Mexico
- Most frequent waves are in 2-4.5 m range





# Static Database



**US Army Corps of Engineers**  
CIRP - Coastal Inlets Research Program

**US Depth of Closure Information**

Depth of closure (DOC) is an important concept used in coastal engineering. The DOC is a theoretical depth along a beach profile where sediment transport is very small or non-existent, dependent on wave height and period, and occasionally, sediment grain size. More specifically, Kraus et al. (1998) state that the "depth of closure for a given or characteristic time interval is the most landward depth seaward of which there is no significant change in bottom elevation and no significant net sediment transport between the nearshore and the offshore." Often the DOC is used in coastal engineering design for projects such as beach and nearshore berm nourishments, and jetty and navigation channel designs. The dataset provided here estimates DOCs for all of the coast lines of the United States, including the Great Lakes, using the USAACE Wave Information Study (WIS) wave hindcast data. A draft CHETN detailing methods used to produce the dataset is provided as well.

Click the area of interest

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Links to files:

- Alaska region Depth of Closure
- Atlantic region Depth of Closure
- Great Lakes Depth of Closure
- Gulf of Mexico Depth of Closure
- Southwest Depth of Closure

	A	B	C	D	E	F	G	H	I
1	X		WIS_Station	Depth (m)	Formula				
2		-97.1258	25.7925	73016	8.64 Hallermeier (1981) Eq. 2_Inner DOC_All				
3		-97.1186	25.8675	73017	8.53 Hallermeier (1981) Eq. 2_Inner DOC_All				
4		-97.1216	25.9325	73018	8.53 Hallermeier (1981) Eq. 2_Inner DOC_All				
5		-97.1369	26.0089	73019	8.48 Hallermeier (1981) Eq. 2_Inner DOC_All				
6		-97.1454	26.0762	73020	8.42 Hallermeier (1981) Eq. 2_Inner DOC_All				
7		-97.1608	26.1671	73021	8.35 Hallermeier (1981) Eq. 2_Inner DOC_All				
8		-97.1704	26.2459	73022	8.30 Hallermeier (1981) Eq. 2_Inner DOC_All				
9		-97.1862	26.3219	73023	8.32 Hallermeier (1981) Eq. 2_Inner DOC_All				
10		-97.2061	26.3924	73024	8.32 Hallermeier (1981) Eq. 2_Inner DOC_All				
11		-97.2326	26.4786	73025	8.07 Hallermeier (1981) Eq. 2_Inner DOC_All				
12		-97.2553	26.5458	73026	8.16 Hallermeier (1981) Eq. 2_Inner DOC_All				
13		-97.2890	26.6332	73027	7.98 Hallermeier (1981) Eq. 2_Inner DOC_All				
14		-97.3167	26.7206	73028	7.91 Hallermeier (1981) Eq. 2_Inner DOC_All				
15		-97.3436	26.8216	73029	7.80 Hallermeier (1981) Eq. 2_Inner DOC_All				
16		-97.3581	26.8992	73030	7.84 Hallermeier (1981) Eq. 2_Inner DOC_All				
17		-97.3668	26.9813	73031	7.72 Hallermeier (1981) Eq. 2_Inner DOC_All				
18		-97.3679	27.0218	73032	7.50 Hallermeier (1981) Eq. 2_Inner DOC_All				
19		-97.3650	27.1051	73033	7.61 Hallermeier (1981) Eq. 2_Inner DOC_All				
20		-97.3546	27.1911	73034	7.51 Hallermeier (1981) Eq. 2_Inner DOC_All				
21		-97.3353	27.2791	73035	7.36 Hallermeier (1981) Eq. 2_Inner DOC_All				
22		-97.3027	27.3818	73036	7.14 Hallermeier (1981) Eq. 2_Inner DOC_All				
23		-97.2416	27.5156	73037	7.17 Hallermeier (1981) Eq. 2_Inner DOC_All				
24		-97.1836	27.6255	73038	7.25 Hallermeier (1981) Eq. 2_Inner DOC_All				
25		-97.1558	27.6744	73039	7.04 Hallermeier (1981) Eq. 2_Inner DOC_All				
26		-97.0626	27.8012	73040	7.15 Hallermeier (1981) Eq. 2_Inner DOC_All				

<http://cirp.usace.army.mil/products/depth-of-closure.php>





# Static Map



USACE Geospatial Portal - x

https://geoplatform.usace.army.mil/home/webmap/viewer.html?webmap=cf17e47efd604123a2cc6d3627380139

GeoSpatial Portal US Army Corps of Engineers

## DoC\_WIS\_Station Data

New Map My Content Help Sign In

Details Add Basemap Save Share Print Measure Bookmarks Find address or place

**Contents**

- Depth Of Closure Combined
  - WIS Station Cumulative 20 Totals
  - WIS Station Yearly Totals
    - Birkemeier CEM Eq 3-12
    - Birkemeier (1985) Eq. 2
    - Hallermeier (1981) Eq. 2 Inner DOC
    - Hallermeier (1981) Eq. 6 Inner DOC Simplified
    - Hallermeier (1981) Eq. 7 Outer DOC 0.15 mm
    - Hallermeier (1981) Eq. 7 Outer DOC 0.2 mm
    - Hallermeier (1981) Eq. 7 Outer DOC 0.3 mm

Topographic

(1 of 33)

**Hallermeier (1981) Eq. 6 Inner DOC Simplified; Hallermeier (1981) Eq. 6\_Inner DOC Simplified**

WIS\_Statio 73,240.00

Year 1,985.00

Depth 4.59

Formula Hallermeier (1981) Eq. 6\_Inner DOC Simplified

Zoom to

Depth of Closure Combined - Hallermeier (1981) Eq. 6 Inner DOC Simplified (95,806 features)

WIS_Statio	Year	Depth	Formula
63,005.00	1,984.00	7.86	Hallermeier (1981) Eq. 6_Inner DOC Simplified
63,005.00	1,985.00	7.12	Hallermeier (1981) Eq. 6_Inner DOC Simplified
63,005.00	1,986.00	7.42	Hallermeier (1981) Eq. 6_Inner DOC Simplified
63,005.00	1,987.00	7.01	Hallermeier (1981) Eq. 6_Inner DOC Simplified
63,005.00	1,988.00	7.69	Hallermeier (1981) Eq. 6_Inner DOC Simplified
63,005.00	1,989.00	7.41	Hallermeier (1981) Eq. 6_Inner DOC Simplified
63,005.00	1,990.00	7.18	Hallermeier (1981) Eq. 6_Inner DOC Simplified



- Interactive map
  - ▶ User will choose grain size, more specific location
- DOC contouring
- Wave statistics histograms
- Add Sediment Mobility Tool for nearshore berm siting (McFall)
  - ▶ Scoping level tool that describes frequency of sediment mobility and general transport direction based on waves, grain size, and depth of placement

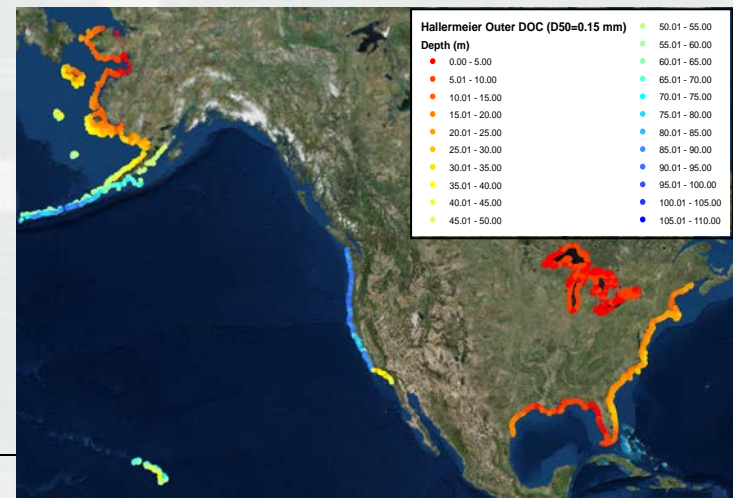
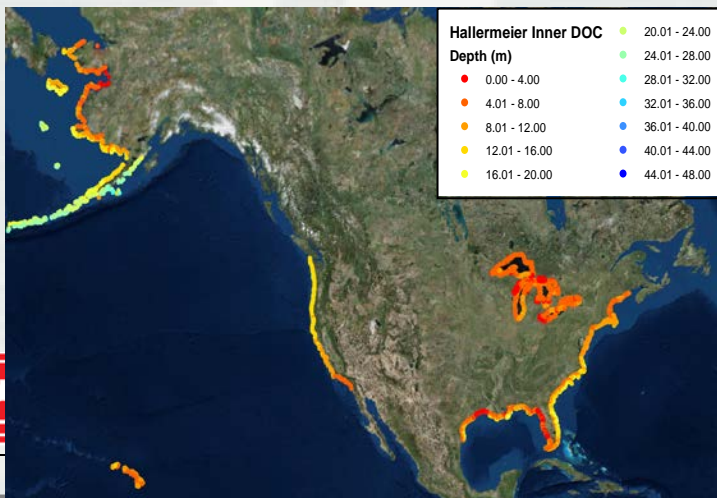


# Summary



<http://cirp.usace.army.mil/products/depth-of-closure.php>

<https://geoplatform.usace.army.mil/home/webmap/viewer.html>



BUILD



world