



GLDD CSD Cutterhead Motion Investigation – Add. 1

GREAT LAKES DREDGE & DOCK CORPORATION

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GREAT LAKES DREDGE & DOCK CORPORATION

Outline

These slides are an addendum to the **"CSD Cutterhead Motion Investigation"** slides

Changes from initial investigation:

- Expanded **Carolina** dataset to include data from **89 individual dates** ranging from 5/12/20 to 9/30/20
- Expanded **Texas** dataset to include data from **127 individual dates** ranging from 4/23/20 to 10/13/20
- All data used still corresponds to 72584 Charleston Entrance Channel (Contract 2)
- Both dredges share same wave buoy data (represented on 1-hr time intervals)
- Incorporates Delay Tracker data to provide context behind downtime

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Outline

Instantaneous motion was not investigated for a few reasons including:

1) **Datasets are too large** (5 GB total) for current compute infrastructure to work with at once (processed in batches)
2) **Date range too large** to really care for instantaneous motion
3) Instantaneous residuals on 5-second intervals **not relevant** to wave buoy data aggregated over 1-hr intervals

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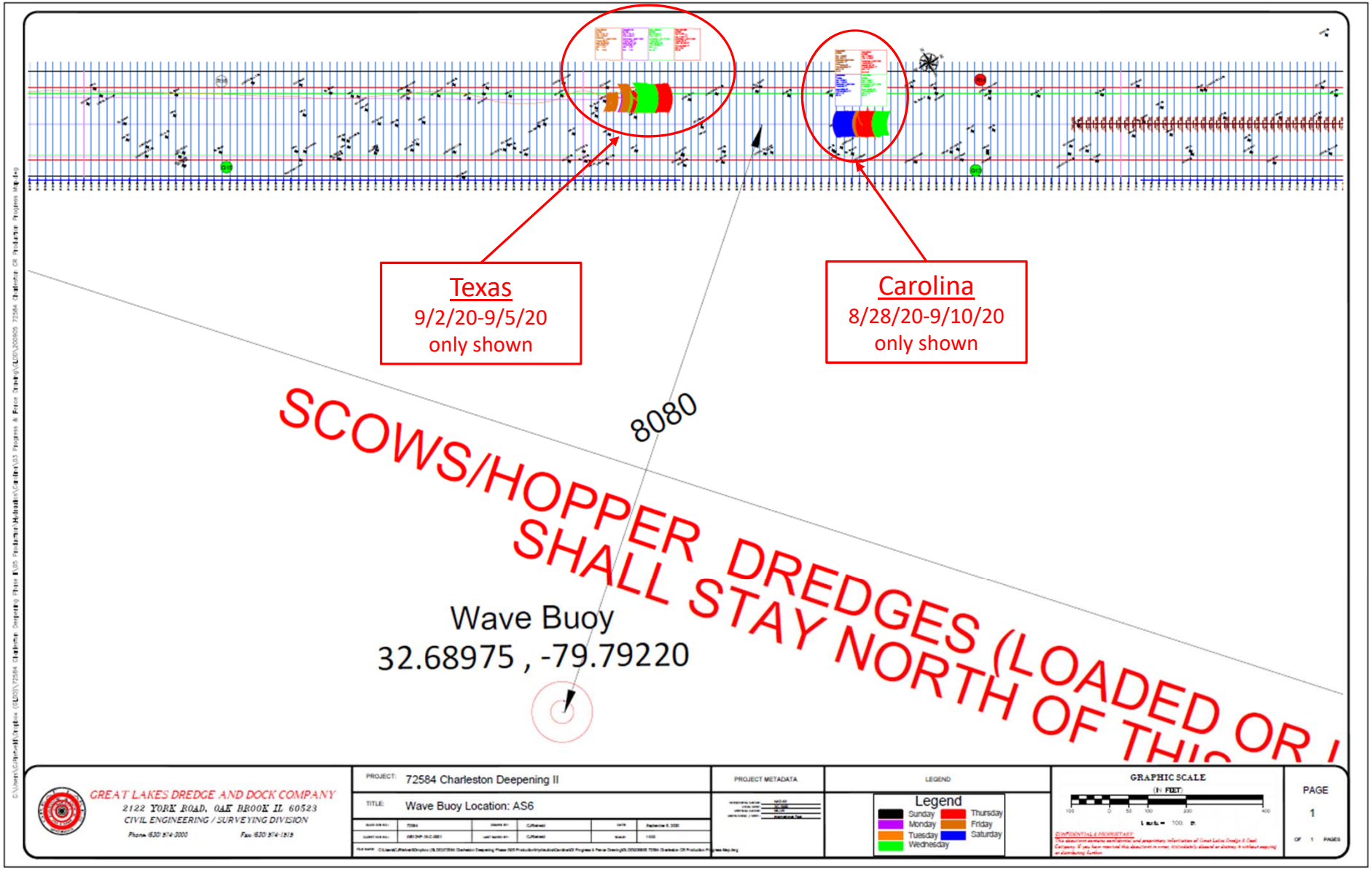
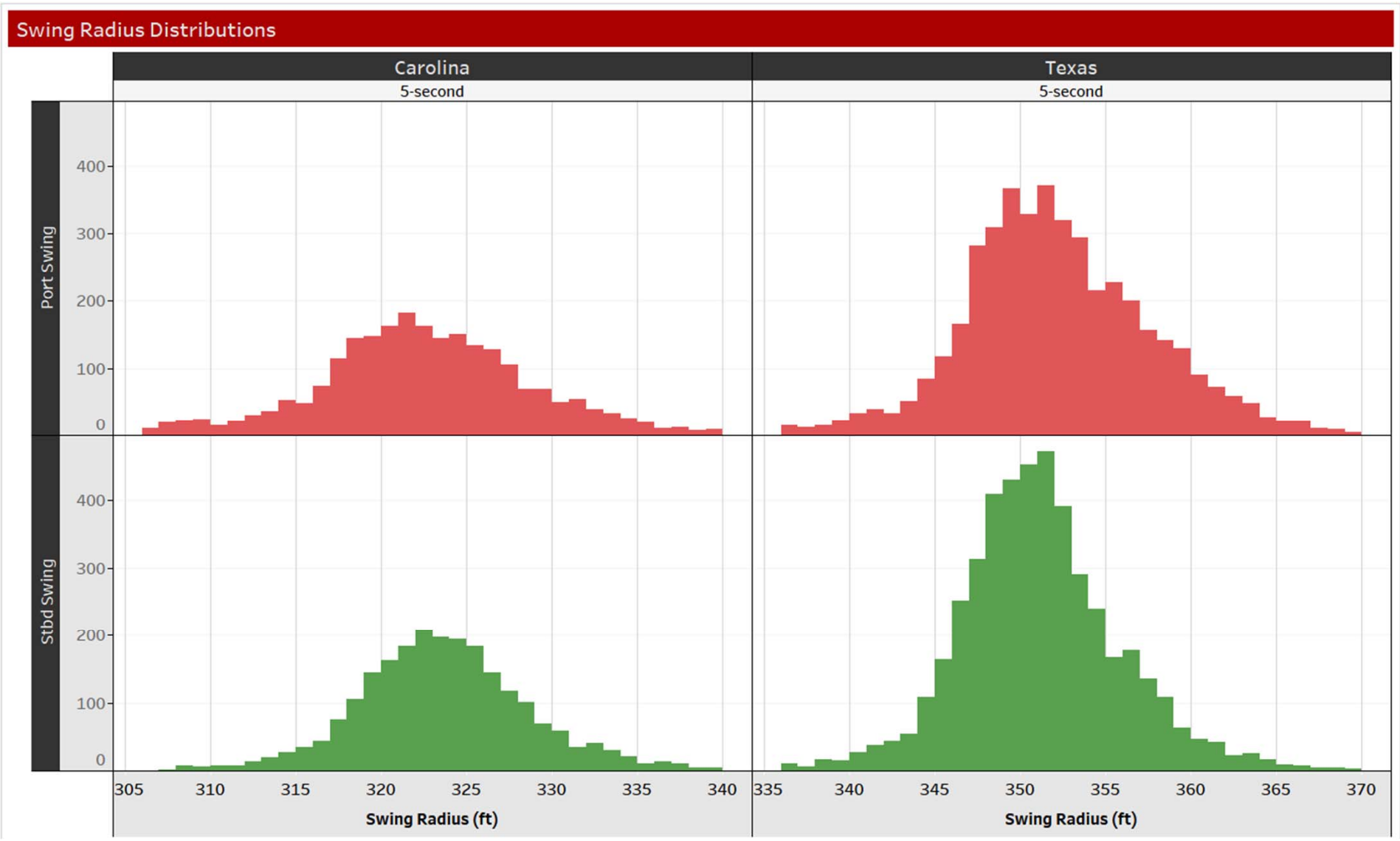
Outline

Moreover, the **initial study was a good Proof of Concept** to show the validity of the model (i.e. a vast majority of time the residual standard deviations calculated are consistent with the variation seen across a given swing no matter what data logging frequency is used).

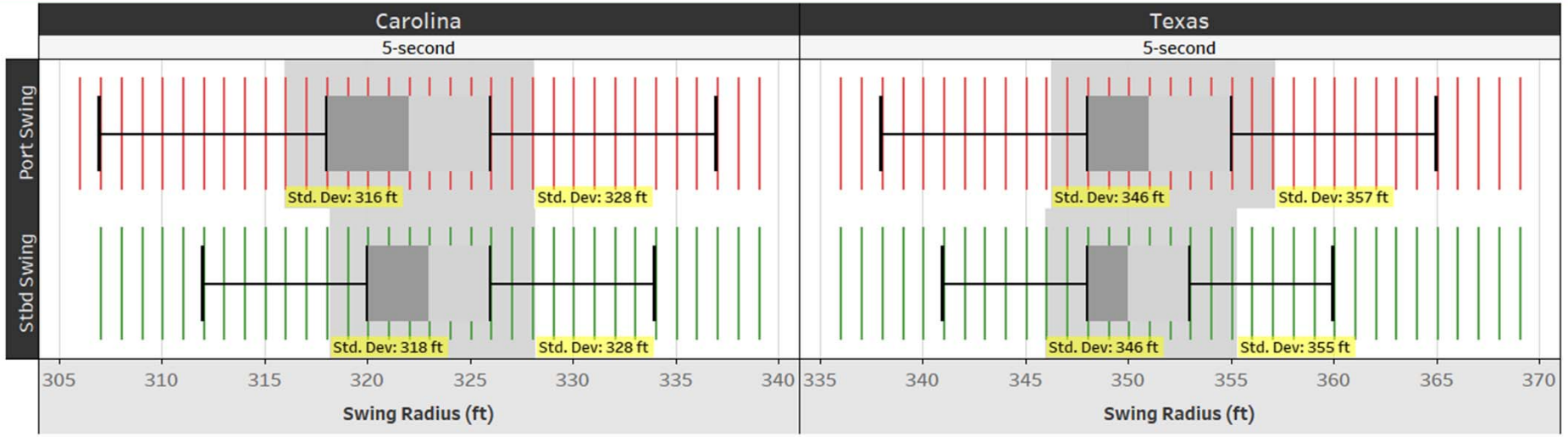
Therefore the **aggregated statistics** can be used to **reliably represent the data across a single swing**, allowing for the "same" data to be represented by only 9.7 MB (99.8% compression)

That being said, the model and processes still have their weaknesses and can use improvements. This includes **improving the quality of the data** from its source (i.e. re-calibrating/improving calibrations, removing latency). Data is still analyzed post-process to verify reliability upheld.


Texas
9/2/20-9/5/20
only shown
Carolina
8/28/20-9/10/20
only shown
8080
SCOWS/HOPPER DREDGES (LOADED OR
SHALL STAY NORTH OF THI
Wave Buoy
32.68975 , -79.79220
GREAT LAKES DREDGE AND DOCK COMPANY
2122 YORK ROAD, OAK BROOK IL 60523
CIVIL ENGINEERING / SURVEYING DIVISION
PROJECT: 72584 Charleston Deepening II
TITLE: Wave Buoy Location: AS6
PROJECT METADATA
LEGEND
Legend
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
GRAPHIC SCALE
PAGE
1


Swing Radius Distributions
Carolina
Texas
5-second
5-second
Port Swing
Stbd Swing
400
300
200
100
0
305
310
315
320
325
330
335
340
335
340
345
350
355
360
365
370
Swing Radius (ft)
Swing Radius (ft)
CSD Phase Id
Port Swing
Stbd Swing
MaxRadTX
370
MinRadTX
335
MaxRadIL
300
MinRadIL
270
MaxRadCR
340
MinRadCR
305

Swing Radius Dist BoxPlots



CSD Phase Id

- Port Swing
- Stbd Swing

MaxRadTX
370

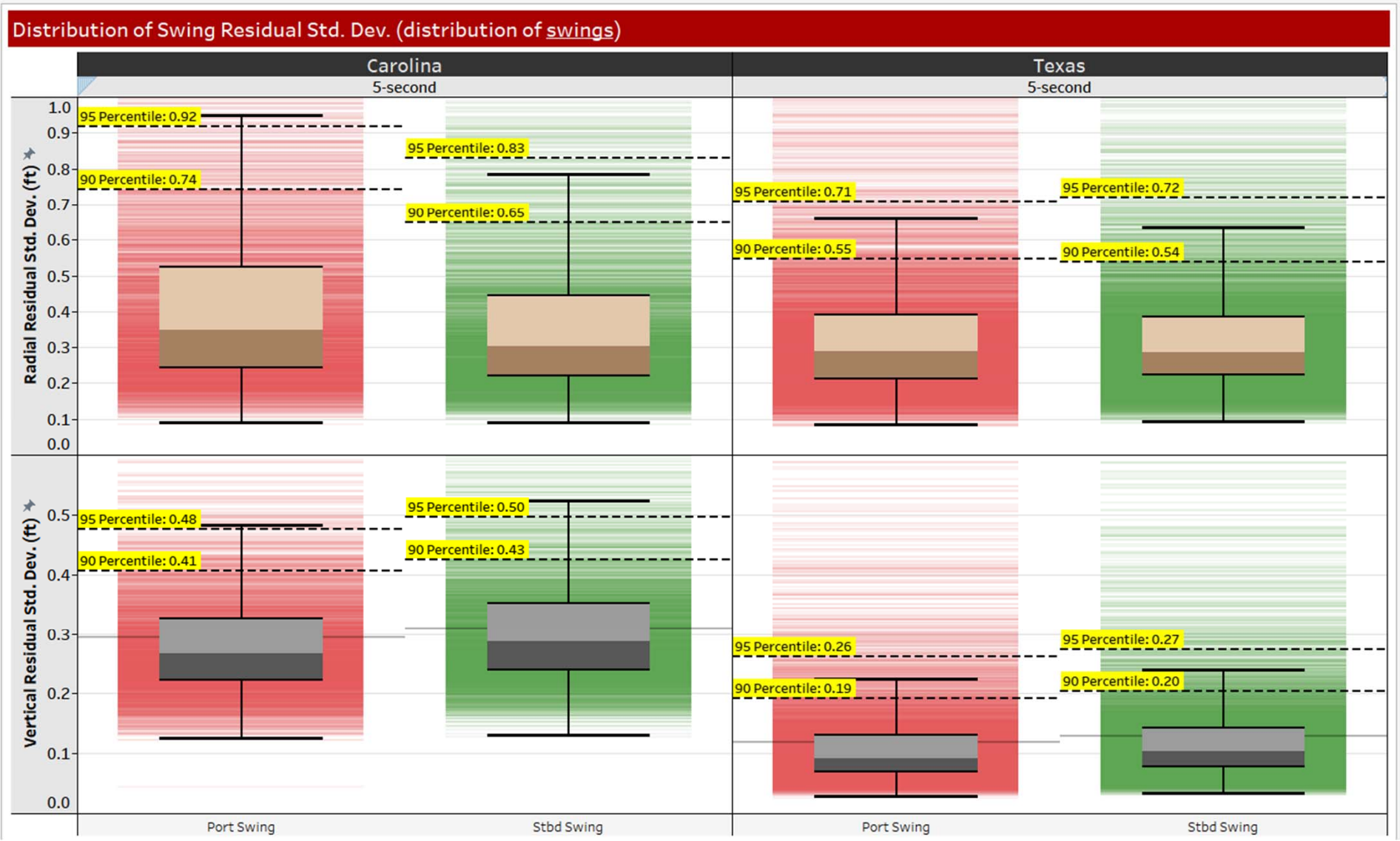
MinRadTX
335

MaxRadIL
300

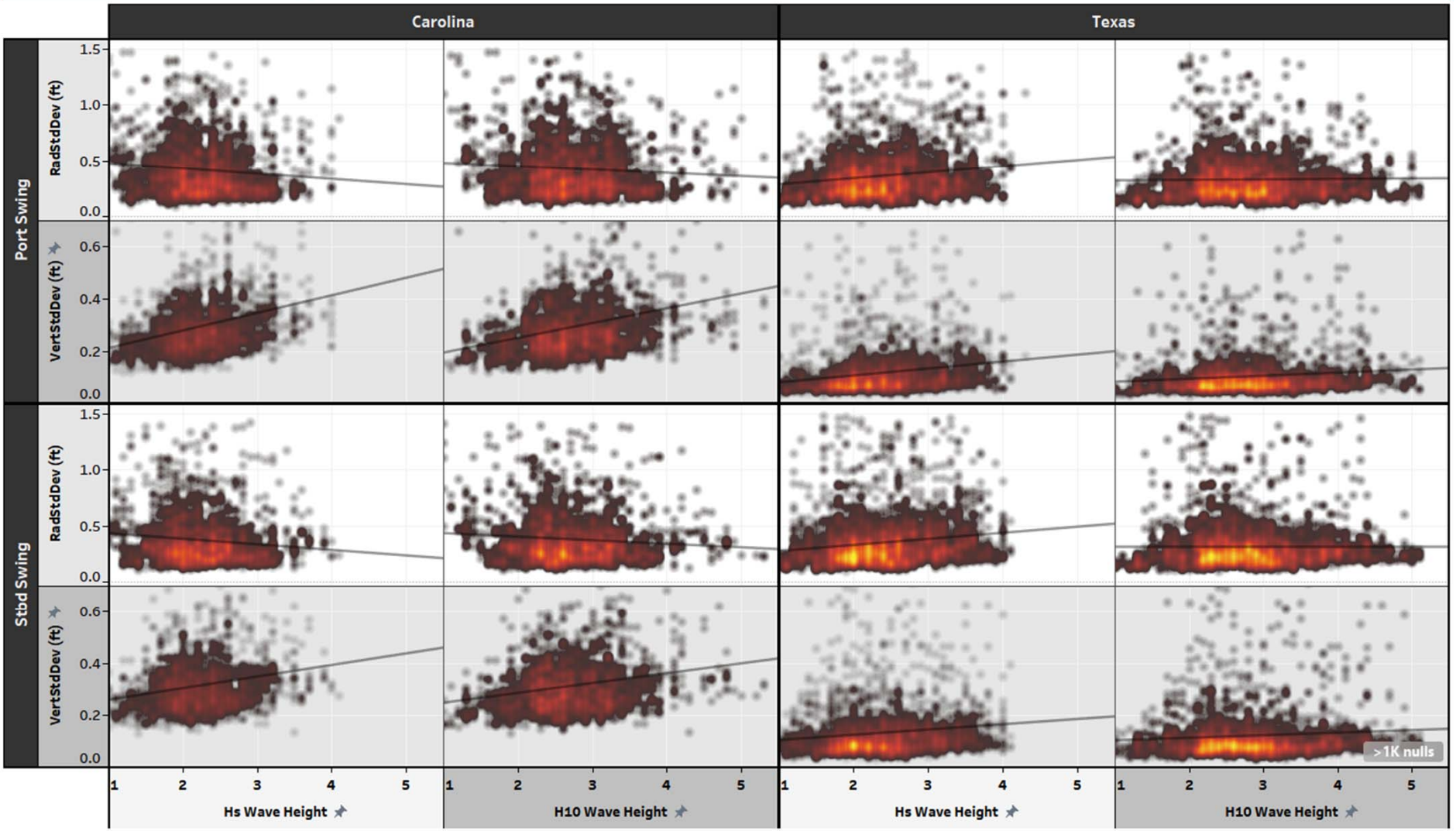
MinRadIL
270

MaxRadCR
340

MinRadCR
305


Distribution of Swing Residual Std. Dev. (distribution of swings)
Carolina
5-second
Texas
5-second
Radial Residual Std. Dev. (ft)
95 Percentile: 0.92
90 Percentile: 0.74
95 Percentile: 0.83
90 Percentile: 0.65
95 Percentile: 0.71
90 Percentile: 0.55
95 Percentile: 0.72
90 Percentile: 0.54
Vertical Residual Std. Dev. (ft)
95 Percentile: 0.48
90 Percentile: 0.41
95 Percentile: 0.50
90 Percentile: 0.43
95 Percentile: 0.26
90 Percentile: 0.19
95 Percentile: 0.27
90 Percentile: 0.20
Port Swing
Stbd Swing
Port Swing
Stbd Swing
Phase Duration
3.00
14.00
Vert Std Dev
0.000
1.500
Rad Std Dev
0.000
1.500
CSD Phase Id
Port Swing
Stbd Swing

Cutter Motion vs vs Wave Height



Phase Duration
3.00 14.00

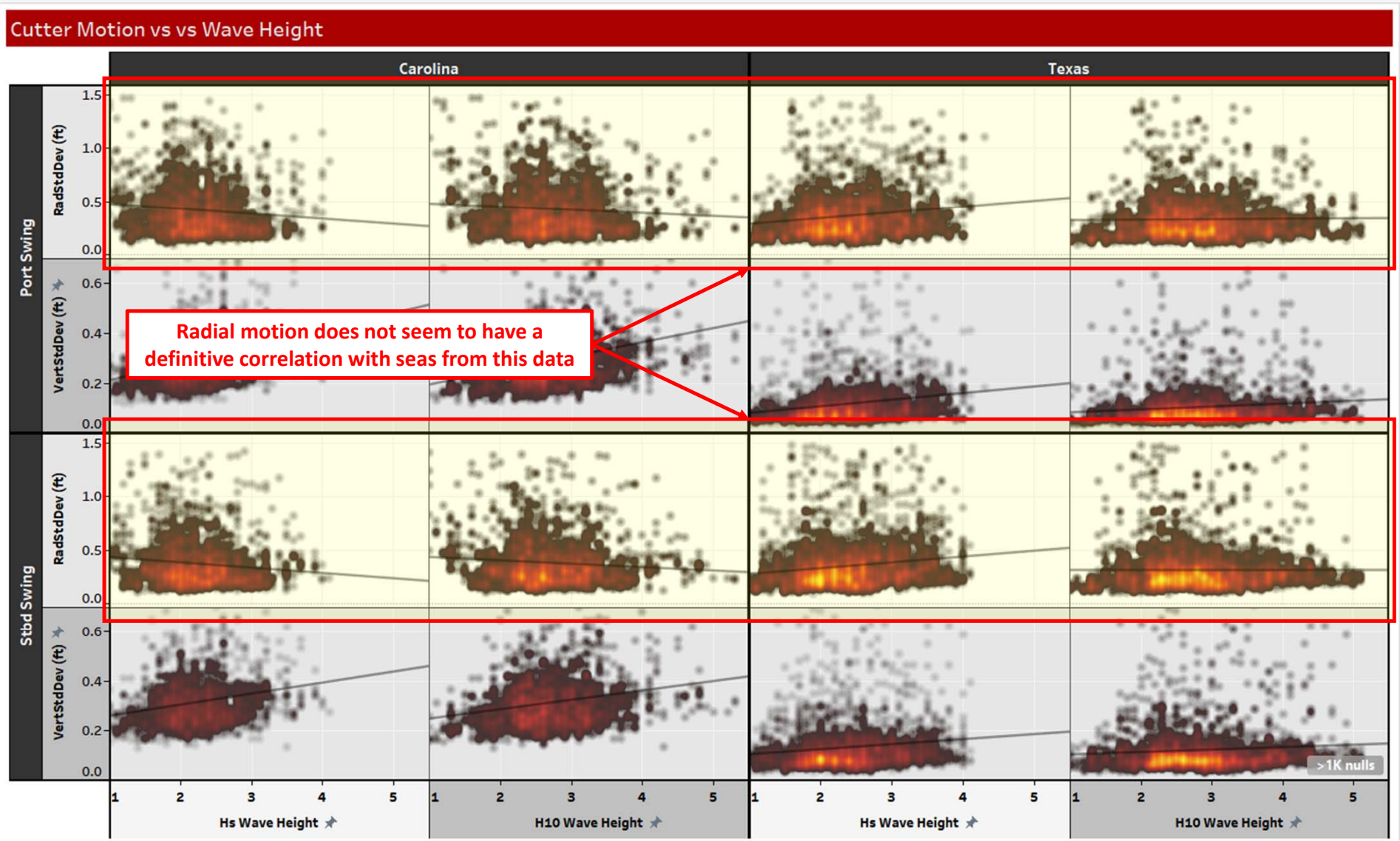
Vert Std Dev
0.000 1.500

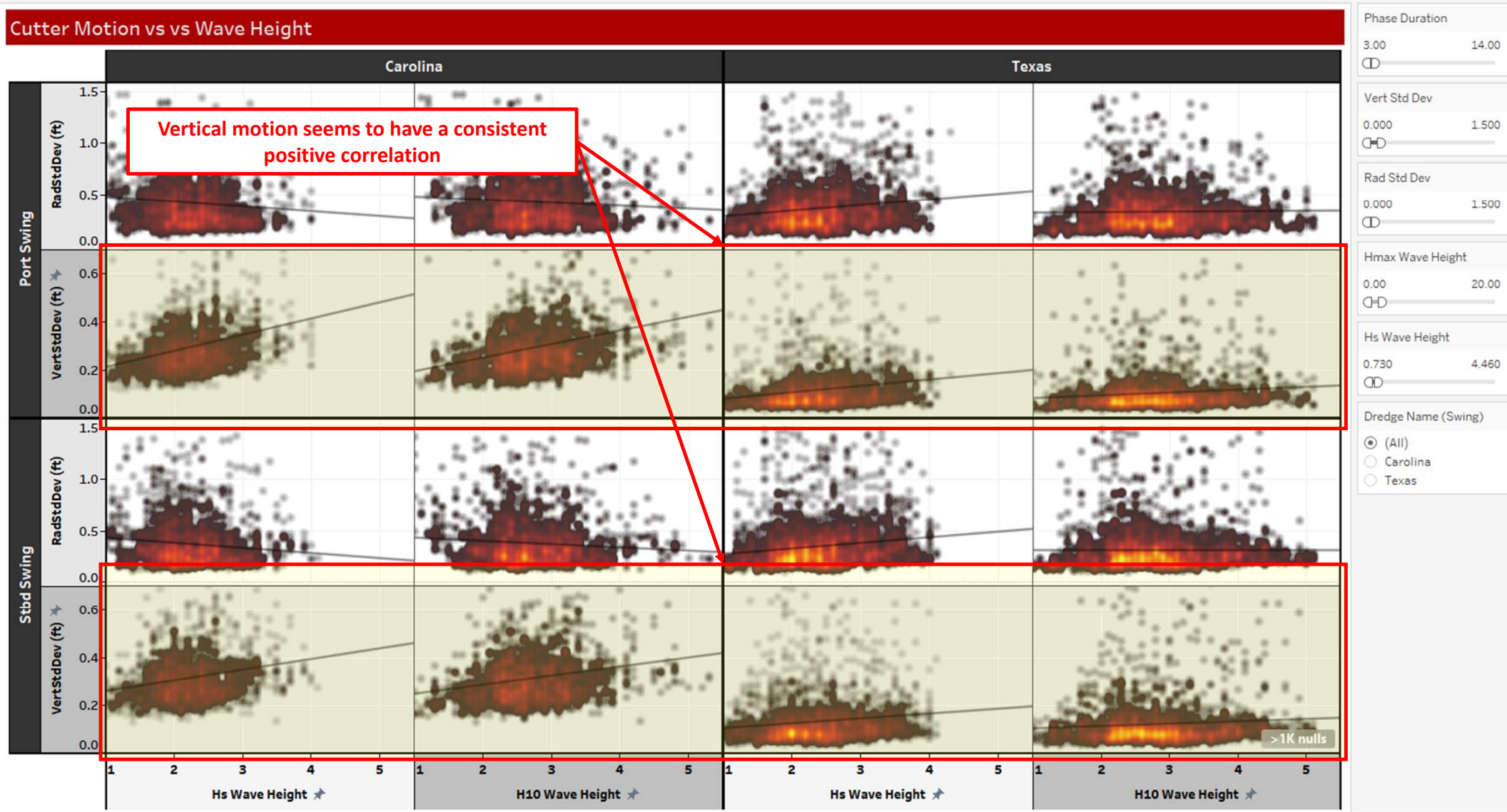
Rad Std Dev
0.000 1.500

Hmax Wave Height
0.00 20.00

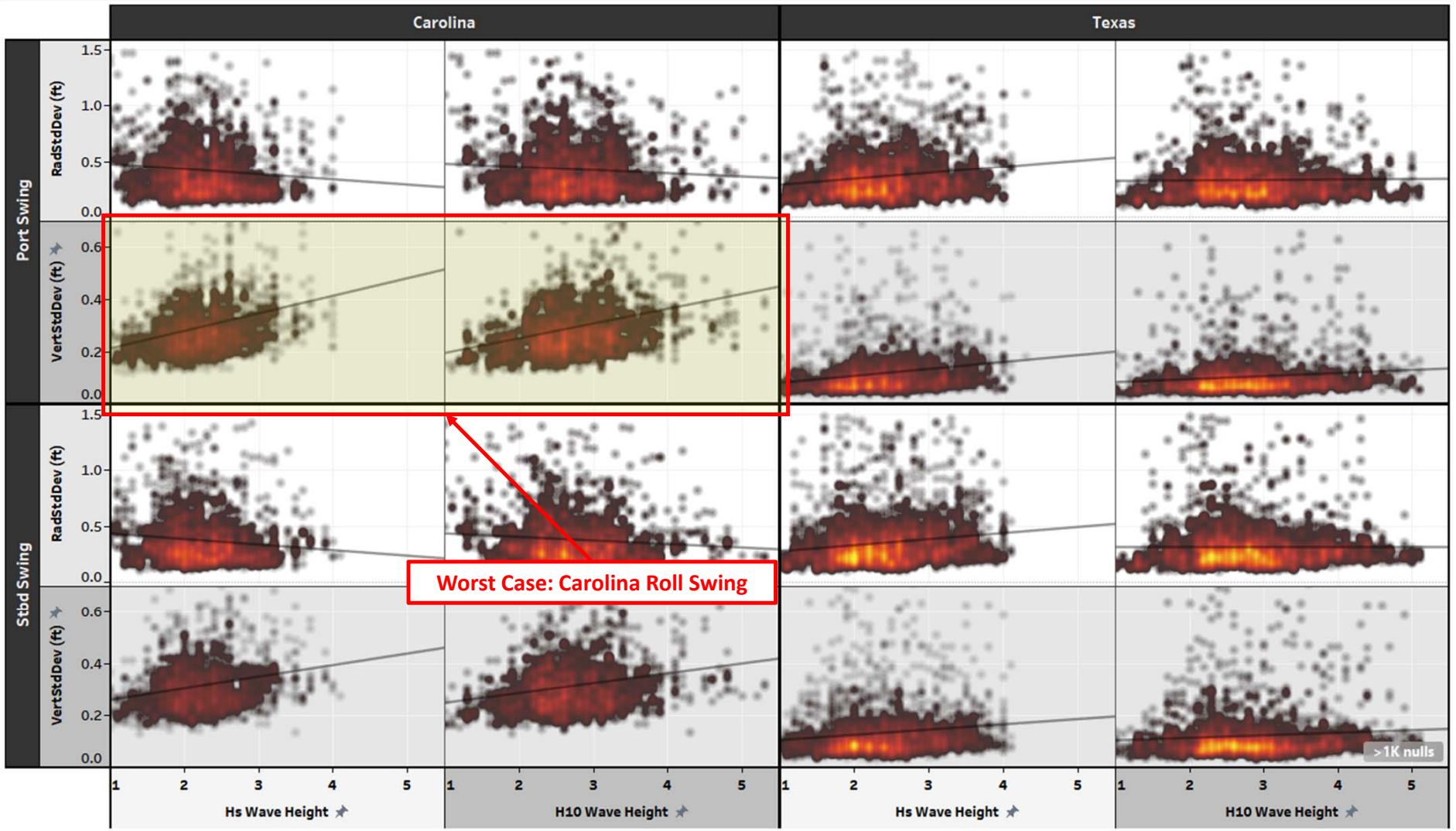
Hs Wave Height
0.730 4.460

Dredge Name (Swing)
- (All)
- Carolina
- Texas


Cutter Motion vs vs Wave Height
Carolina
Texas
Port Swing
Stbd Swing
RadStdDev (ft)
VertStdDev (ft)
Radial motion does not seem to have a definitive correlation with seas from this data
Hs Wave Height
H10 Wave Height
>1K nulls
Phase Duration
3.00
14.00
Vert Std Dev
0.000
1.500
Rad Std Dev
0.000
1.500
Hmax Wave Height
0.00
20.00
Hs Wave Height
0.730
4.460
Dredge Name (Swing)
(All)
Carolina
Texas


Cutter Motion vs vs Wave Height
Carolina
Texas
Port Swing
Stbd Swing
RadStdDev (ft)
VertStdDev (ft)
Vertical motion seems to have a consistent positive correlation
Hs Wave Height
H10 Wave Height
>1K nulls
Phase Duration
3.00
14.00
Vert Std Dev
0.000
1.500
Rad Std Dev
0.000
1.500
Hmax Wave Height
0.00
20.00
Hs Wave Height
0.730
4.460
Dredge Name (Swing)
(All)
Carolina
Texas

Cutter Motion vs vs Wave Height



Phase Duration
3.00 14.00

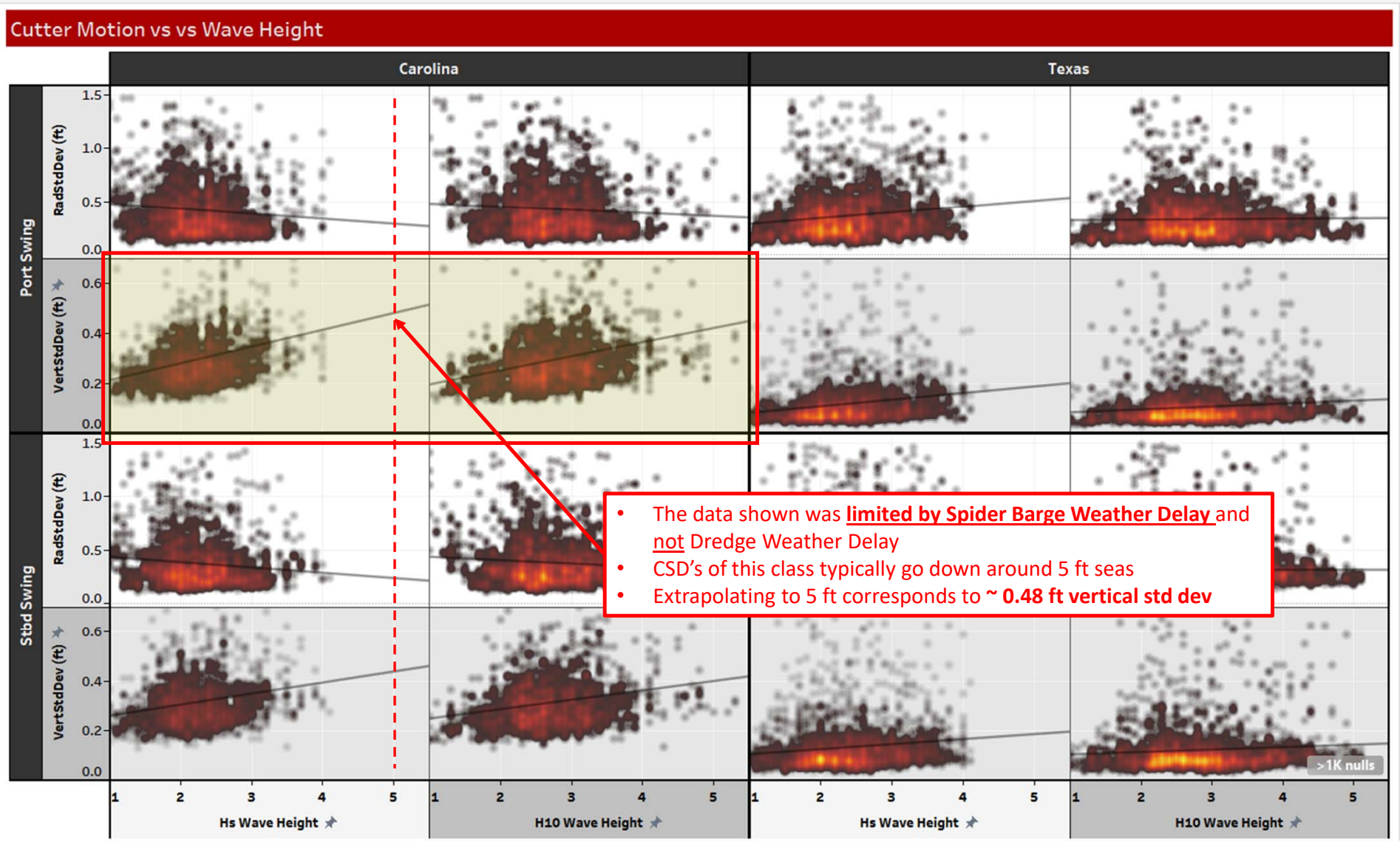
Vert Std Dev
0.000 1.500

Rad Std Dev
0.000 1.500

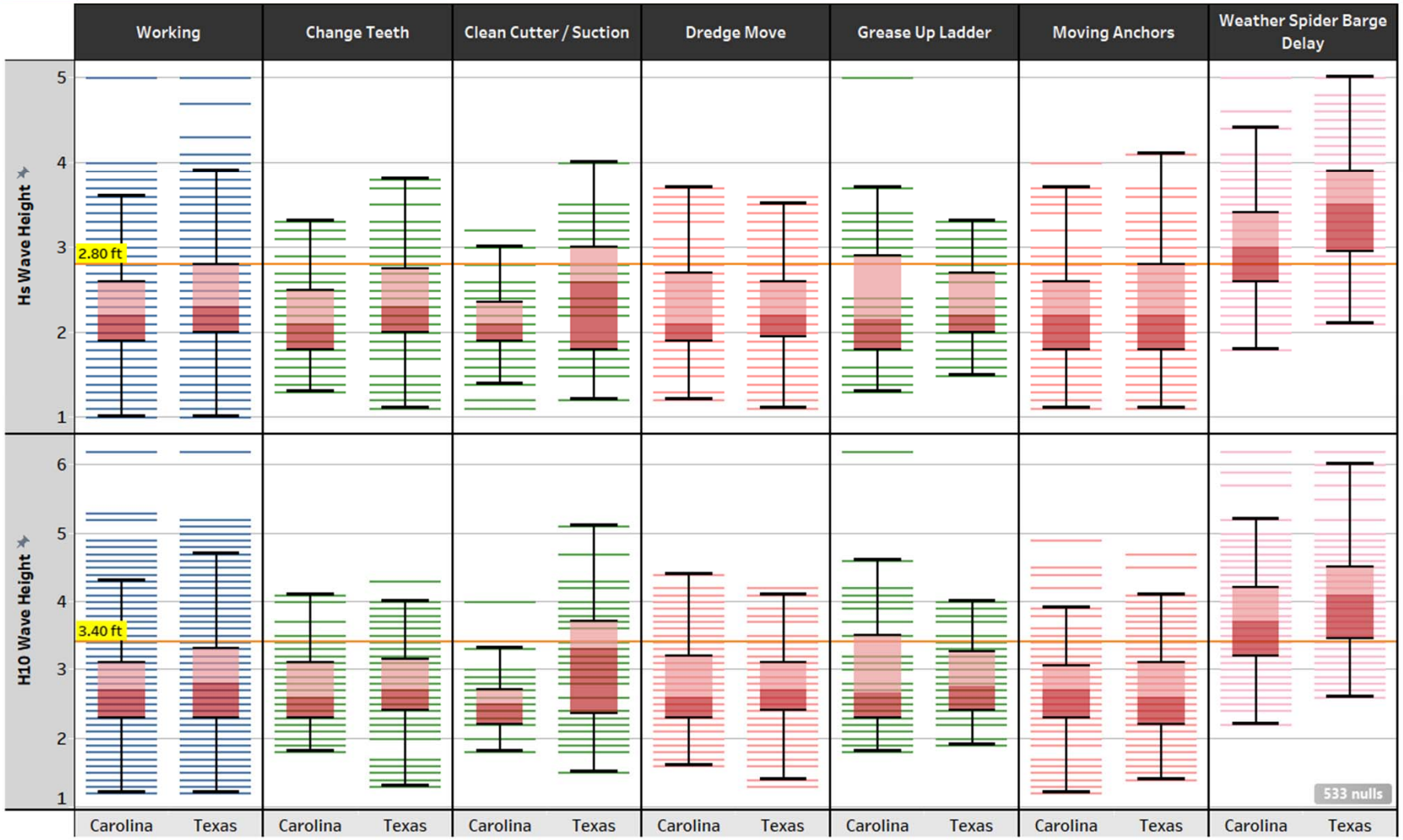
Hmax Wave Height
0.00 20.00

Hs Wave Height
0.730 4.460

Dredge Name (Swing)
- (All)
- Carolina
- Texas


Cutter Motion vs vs Wave Height
Carolina
Texas
Port Swing
Stbd Swing
RadStdDev (ft)
VertStdDev (ft)
Hs Wave Height
H10 Wave Height
>1K nulls
• The data shown was limited by Spider Barge Weather Delay and not Dredge Weather Delay
• CSD's of this class typically go down around 5 ft seas
• Extrapolating to 5 ft corresponds to ~ 0.48 ft vertical std dev
Phase Duration
3.00
14.00
Vert Std Dev
0.000
1.500
Rad Std Dev
0.000
1.500
Hmax Wave Height
0.00
20.00
Hs Wave Height
0.730
4.460
Dredge Name (Swing)
(All)
Carolina
Texas

Wave Height vs Delay Subcategory

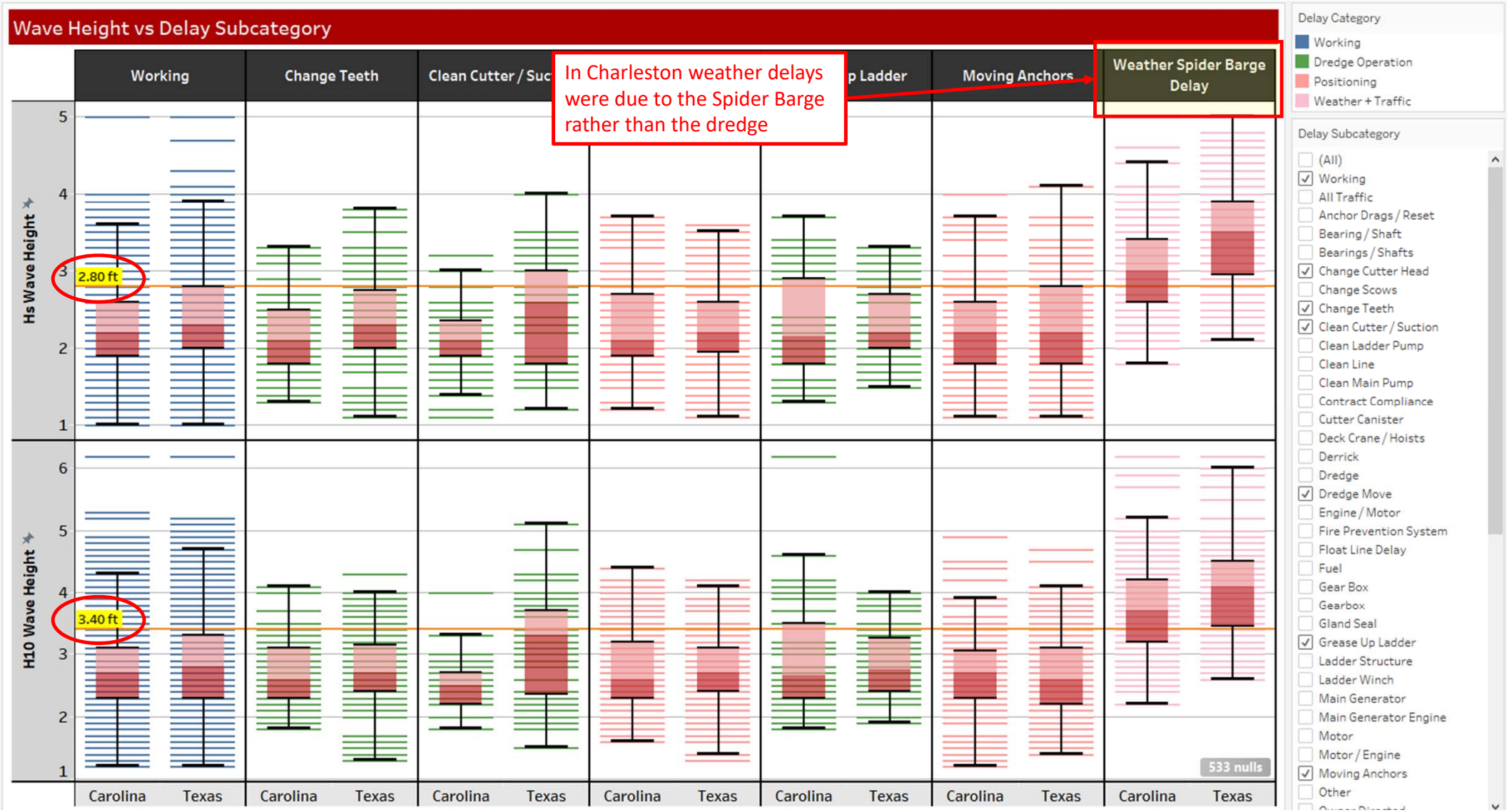


Delay Category

- Working
- Dredge Operation
- Positioning
- Weather + Traffic

Delay Subcategory

- [ ] (All)
- [x] Working
- [ ] All Traffic
- [ ] Anchor Drags / Reset
- [ ] Bearing / Shaft
- [ ] Bearings / Shafts
- [x] Change Cutter Head
- [ ] Change Scows
- [x] Change Teeth
- [x] Clean Cutter / Suction
- [ ] Clean Ladder Pump
- [ ] Clean Line
- [ ] Clean Main Pump
- [ ] Contract Compliance
- [ ] Cutter Canister
- [ ] Deck Crane / Hoists
- [ ] Derrick
- [ ] Dredge
- [x] Dredge Move
- [ ] Engine / Motor
- [ ] Fire Prevention System
- [ ] Float Line Delay
- [ ] Fuel
- [ ] Gear Box
- [ ] Gearbox
- [ ] Gland Seal
- [x] Grease Up Ladder
- [ ] Ladder Structure
- [ ] Ladder Winch
- [ ] Main Generator
- [ ] Main Generator Engine
- [ ] Motor
- [ ] Motor / Engine
- [x] Moving Anchors
- [ ] Other


Wave Height vs Delay Subcategory
Working
Change Teeth
Clean Cutter / Suc
p Ladder
Moving Anchors
Weather Spider Barge Delay
In Charleston weather delays were due to the Spider Barge rather than the dredge
Hs Wave Height
2.80 ft
H10 Wave Height
3.40 ft
533 nulls
Carolina
Texas
Delay Category
Working
Dredge Operation
Positioning
Weather + Traffic
Delay Subcategory
(All)
Working
All Traffic
Anchor Drags / Reset
Bearing / Shaft
Bearings / Shafts
Change Cutter Head
Change Scows
Change Teeth
Clean Cutter / Suction
Clean Ladder Pump
Clean Line
Clean Main Pump
Contract Compliance
Cutter Canister
Deck Crane / Hoists
Derrick
Dredge
Dredge Move
Engine / Motor
Fire Prevention System
Float Line Delay
Fuel
Gear Box
Gearbox
Gland Seal
Grease Up Ladder
Ladder Structure
Ladder Winch
Main Generator
Main Generator Engine
Motor
Motor / Engine
Moving Anchors
Other