

The National Conference on Beach Preservation Technology
– St. Augustine Beach, Florida

Estero Barriers Regional Inlet Management Study,
Lee County, FL
– 3DCSTM Morphology Modeling

Yong Chen*, Ph.D, P.E., Tim Blankenship*, P.E., Kevin Bodge**, Ph.D, P.E.,
Jeff Shelden*, P.E., Jacqueline Brower*, Ph.D, P.E.
*Moffatt & Nichol, **Olsen

February 8, 2024



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Presentation Outline

1. Project Background

- Project location
- Project objective
- Methodology
- Data collection
- Regional numerical modeling

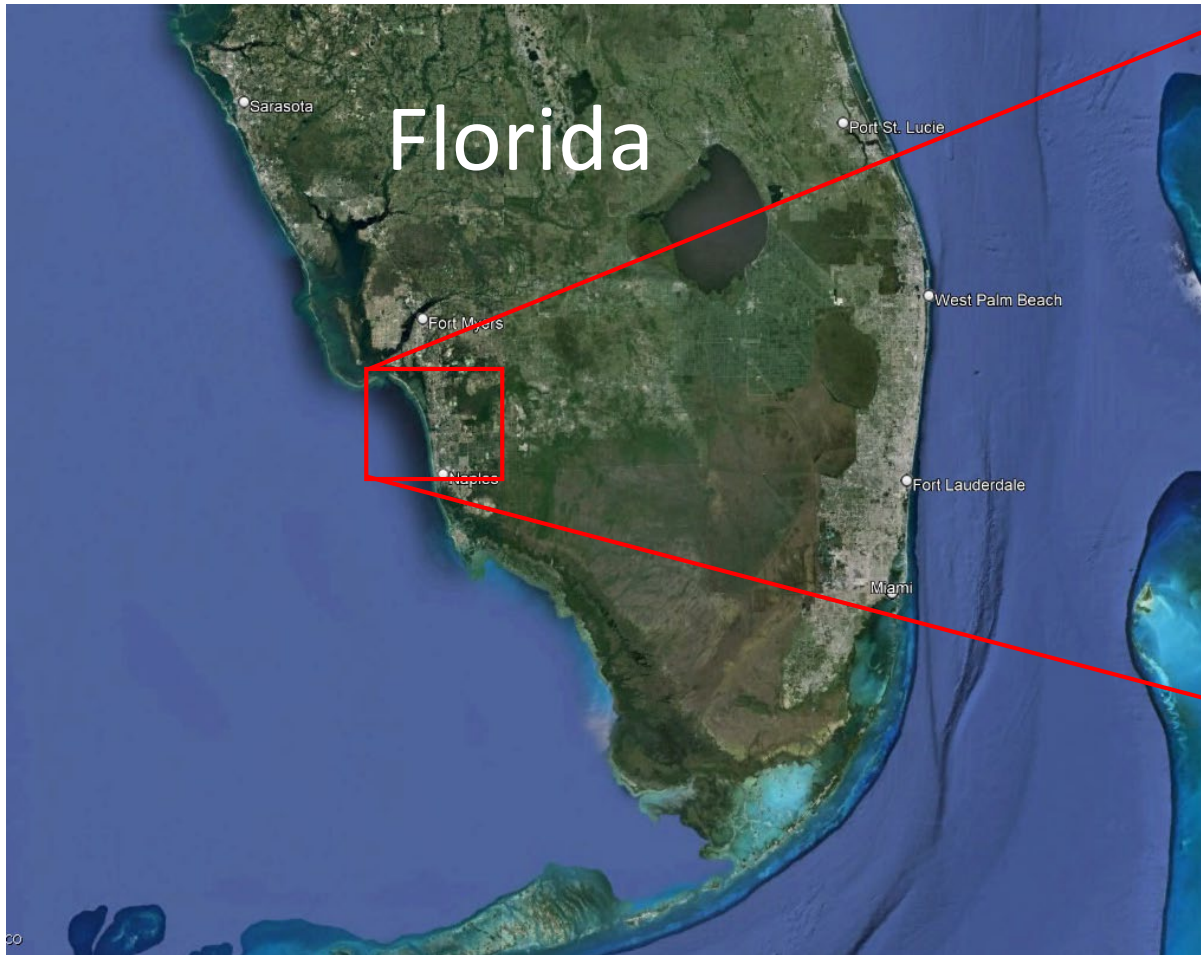
2. 3DCSTM modeling

- Hydrodynamic model calibration
- Wave model calibration
- Morphology model calibration
- Application

3. Sediment budget analysis



Project Background - Project Location



- Located in Lee County, west coast of Florida



Project Background - Project Objective

To **develop sediment budgets** for three interdependent Estero Barrier inlets within southern Lee County and to evaluate strategies of inlet sediment management, which will result in balancing the sediment budget between the inlets and adjacent beaches pursuant to the requirements of Section 161.142, Florida Statutes.

Project challenge - three interdependent Estero Barrier inlets

Project Background - Project Methodology

1. Review historical data

- Winds, waves, water levels, currents, sediment data and bathymetry
- Physical processes and existing studies

2. Collect new data

- Waves, water levels, currents

3. Coastal numerical modeling

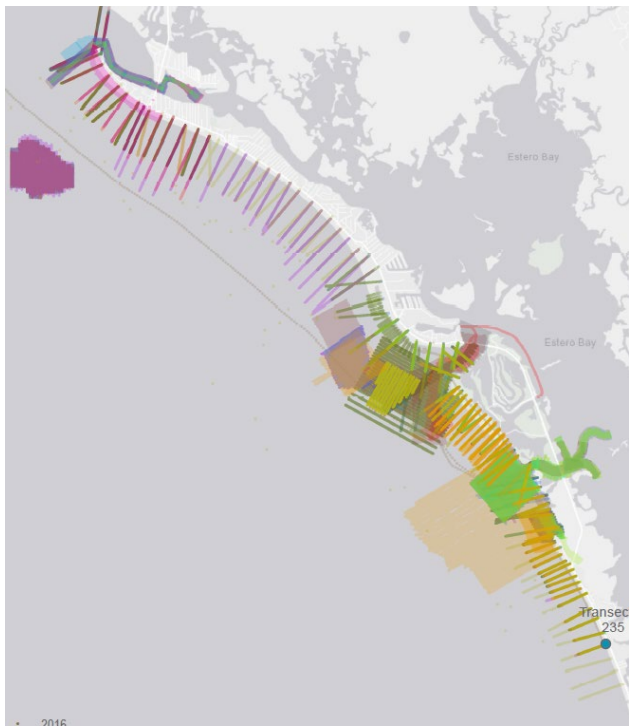
- Regional hydrodynamic model – Mike 21
- Regional spectral wave model – Mike 21
- Local shoreline change model - LITLINE
- Local morphology model – Delft3D, 3DCSTM

4. Sediment budget analysis

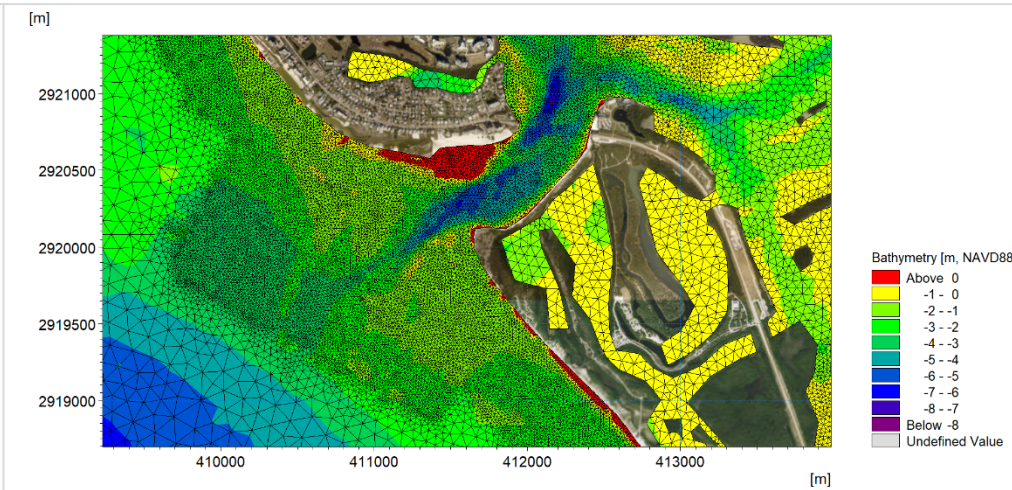
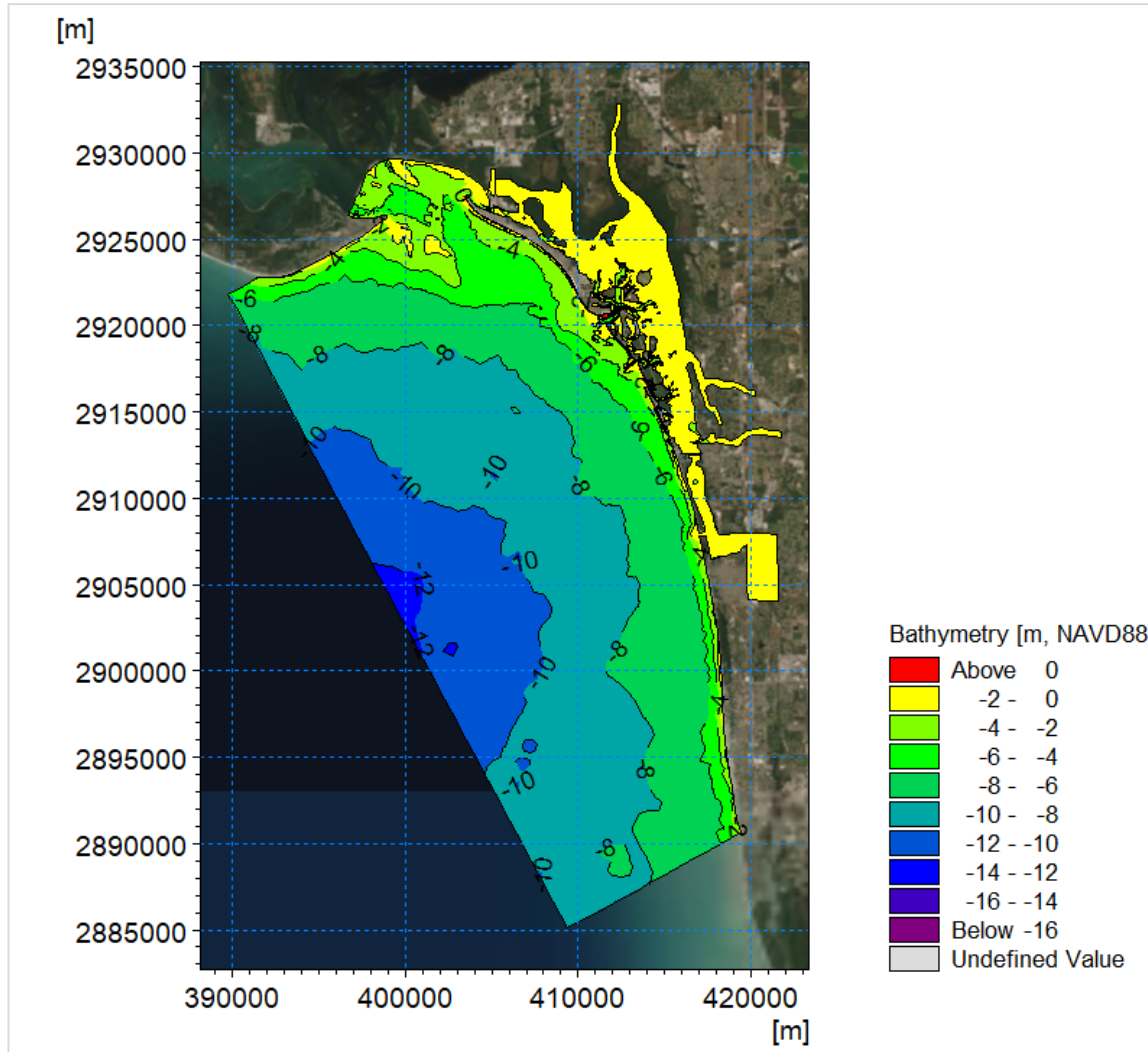


Project Background - Data Collection

- Historical profiles: 2001 - 2020
- Water Levels: 6 gages, 30 days
- ADCP (Wave and current): 5 stations, 30 days
- Purpose: model calibration

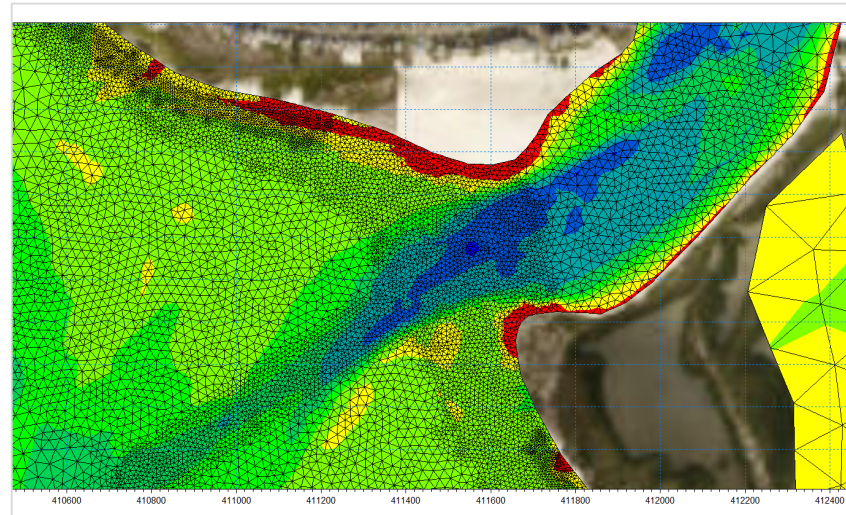
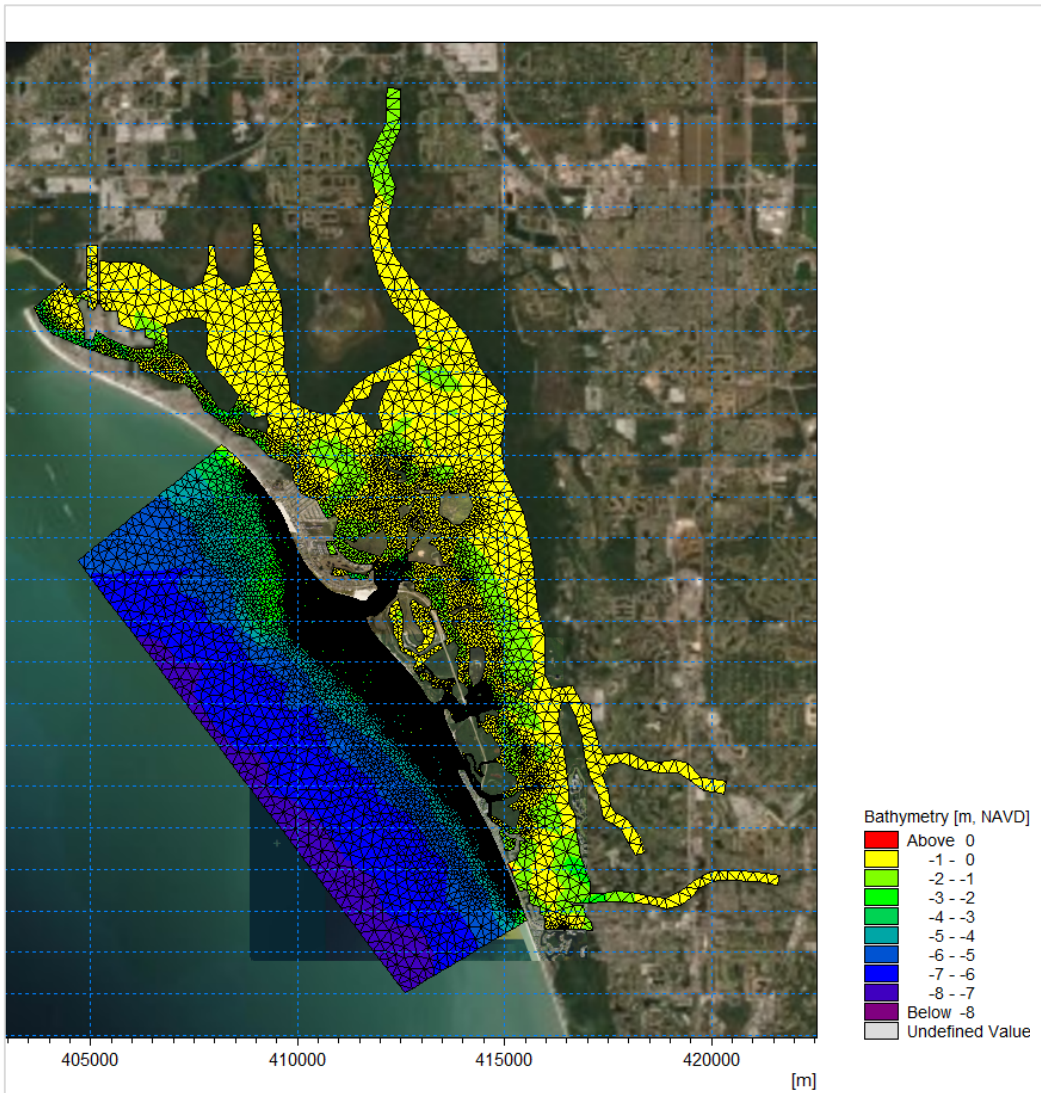


Project Background - Regional Coastal Numerical Modeling



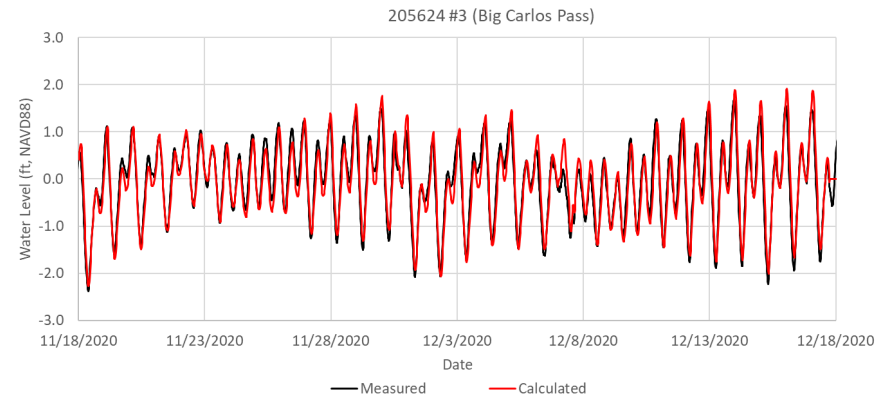
- Regional Mike 21 spectral wave model
- Regional Mike 21 hydrodynamic model
- Model calibration
- Long-term time series wave transformation from offshore to nearshore area
- Provide open boundary conditions for local models

3DCSTM Modeling – Model Domain



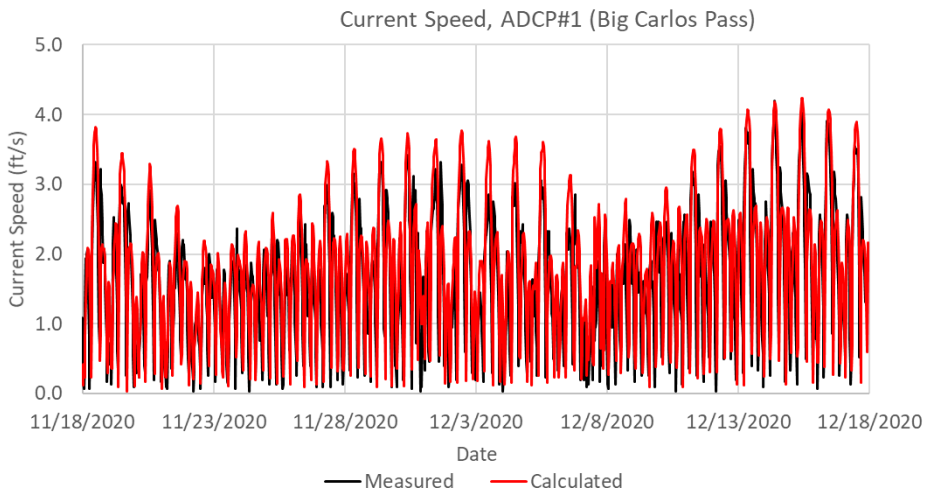
1. 3DCSTM model: 3D, flexible mesh, one single model grid, accuracy, efficiency
2. Model domain: cover entire Estero Bay area and three passes
3. 3D: 5 layers
4. More than 105,000 elements
5. Model resolution: approximately 1,600 feet offshore, approximately 20 to 30 feet at project site

3DCSTM Modeling – Hydrodynamic Model Calibration



Water Level

Location	MAE [ft]	RMSE [ft]	R	BSS
RBR #1 (Matanza Pass)	0.19	0.23	0.97	0.92
RBR #2 (Bay)	0.26	0.32	0.95	0.84
RBR #3 (Big Carlos Pass)	0.23	0.28	0.93	0.87
RBR #4 (New Pass)	0.28	0.34	0.90	0.81
RBR #5 (Big Hickory Pass)	0.31	0.37	0.88	0.76
RBR #6 (Bridge Site)	0.15	0.19	0.94	0.88



Current speed

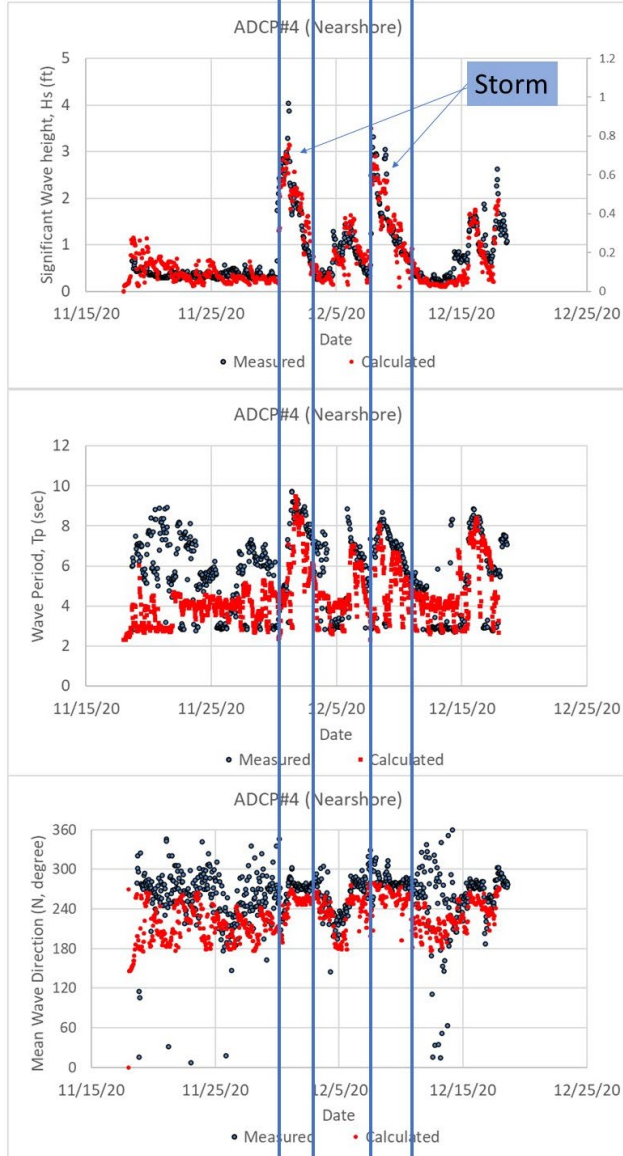
Location	MAE [ft/sec]	RMSE [ft/sec]	R	BSS
ADCP #1 (Big Carlos Pass)	0.67	0.83	0.62	0.80
ADCP #2 (New Pass)	0.49	0.66	0.80	0.86
ADCP #3 (Big Hickory Pass)	0.30	0.36	0.35	0.74

MAE – Mean absolute error, RMSE – Root mean square error

R – Correlation coefficient, BSS – Brier Skill Score

Good agreements between calculated and measured data

3DCSTM Modeling – Wave Model Calibration



Item	Location	MAE [unit]	RMSE [unit]	R	BSS
ADCP#1 (Big Carlos Pass)	Significant wave height [ft]	0.20	0.28	0.63	0.54
	Peak wave period [sec]	1.68	2.15	0.20	0.76
ADCP#2 (New Pass)	Significant wave height [ft]	0.24	0.32	0.77	0.68
	Peak wave period [sec]	1.57	1.98	0.44	0.79
ADCP#4 (Nearshore)	Significant wave height [ft]	0.22	0.31	0.90	0.91
	Peak wave period [sec]	1.69	2.17	0.38	0.86

MAE – Mean absolute error, RMSE – Root mean square error

R – Correlation coefficient, BSS – Brier Skill Score

Good agreements between calculated and measured data

3DCSTM Modeling – Morphology Model Calibration

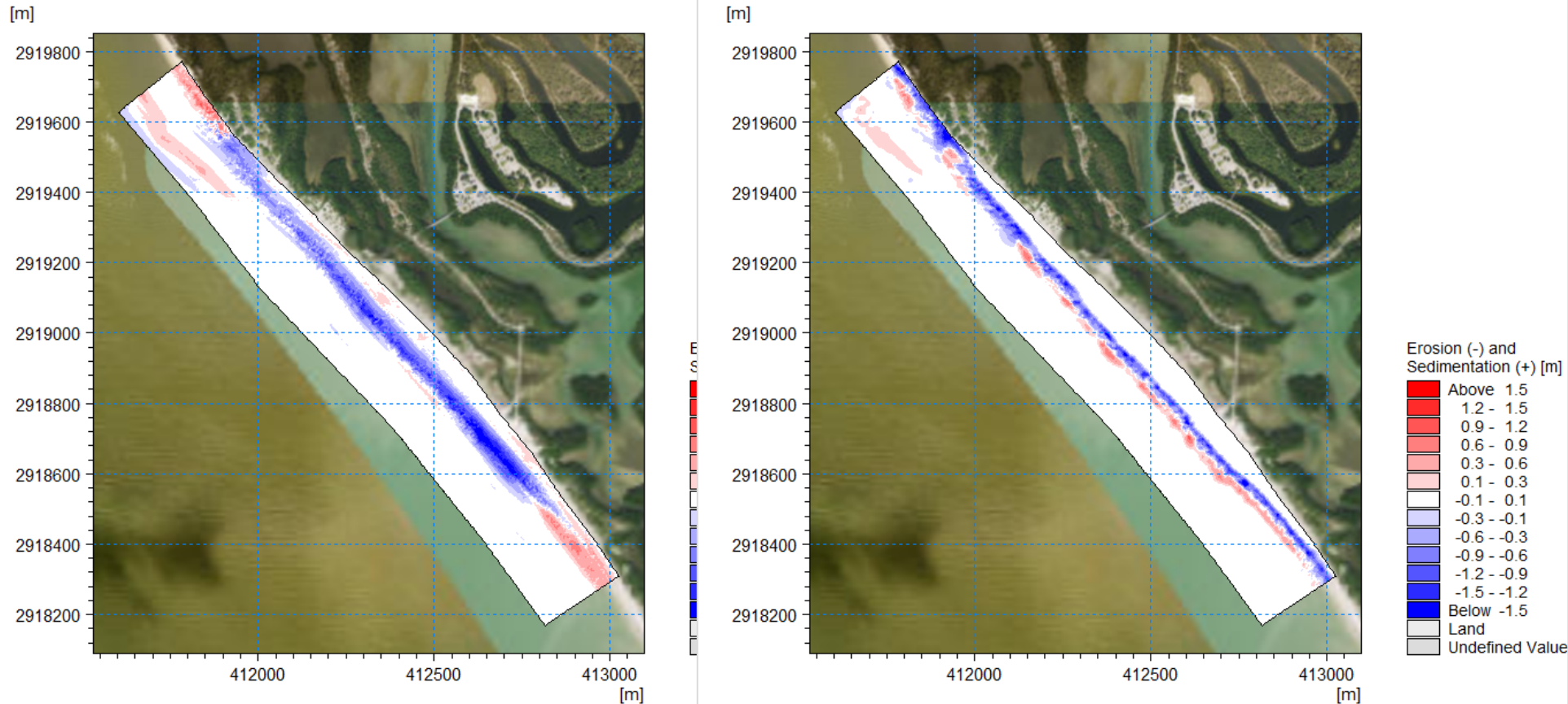


- Loves key beach
- Bonita Beach
- Big Carlos Pass ebb shoal

3DCSTM Modeling – Morphology Model Calibration

Loves Key Beach

Jan. 2015 – Jun. 2016



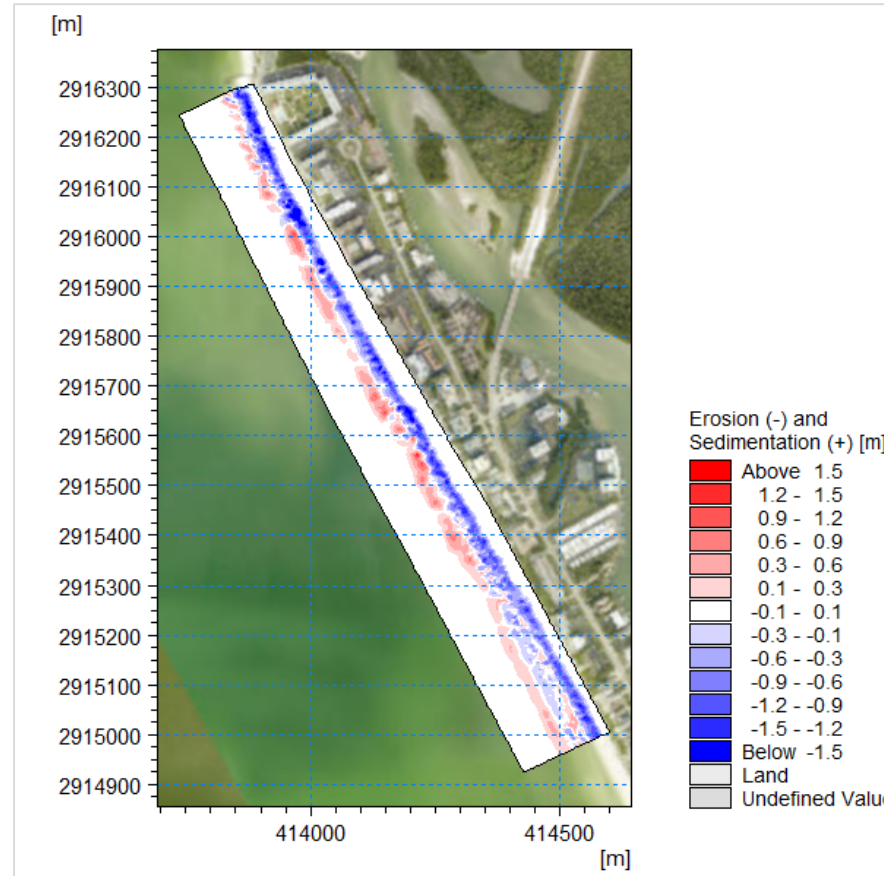
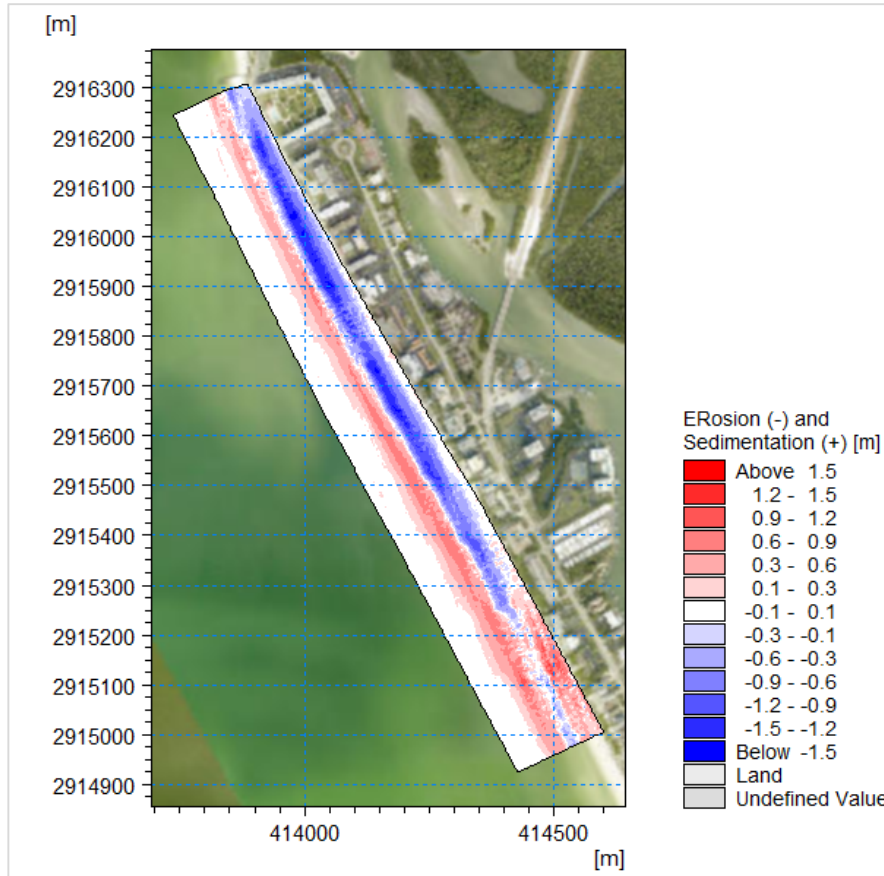
Measured bed level changes

Calculated bed level changes

3DCSTM Modeling – Morphology Model Calibration

Bonita Beach

Jan. 2015 – Jun. 2016

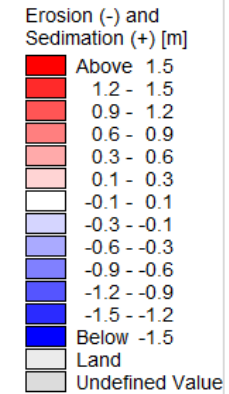
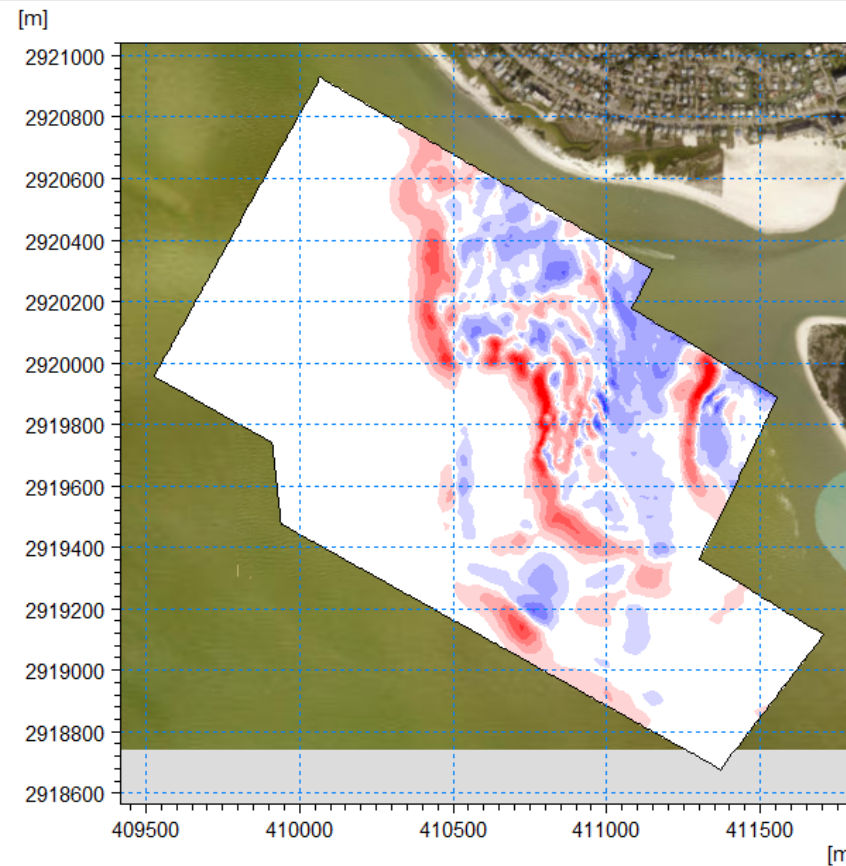
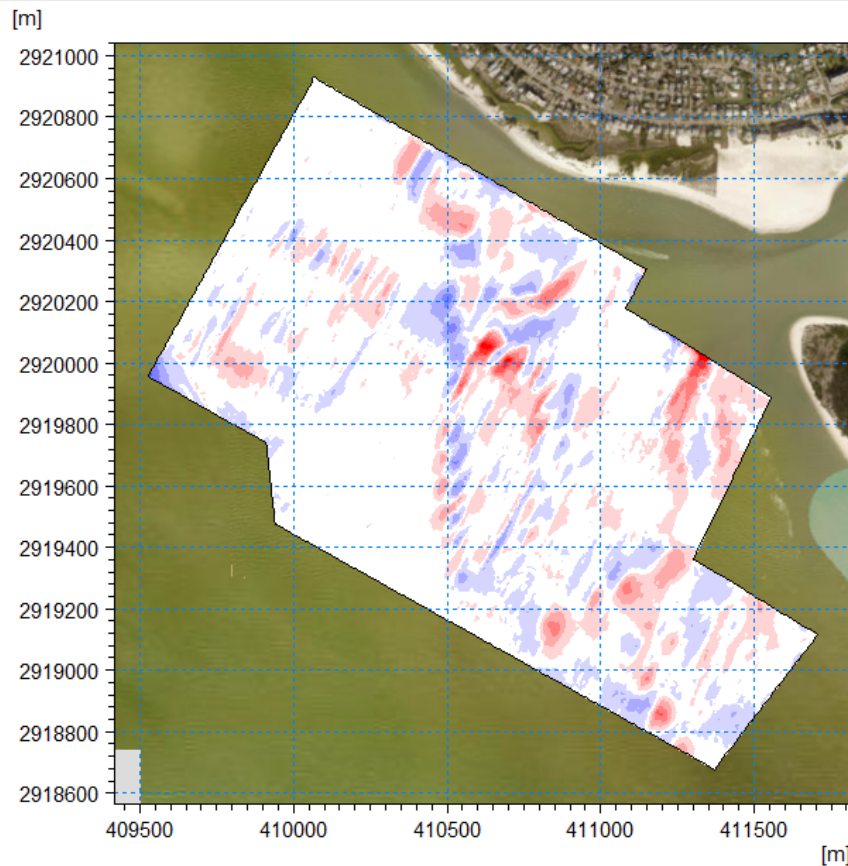


Measured bed level changes

Calculated bed level changes

3DCSTM Modeling – Morphology Model Calibration

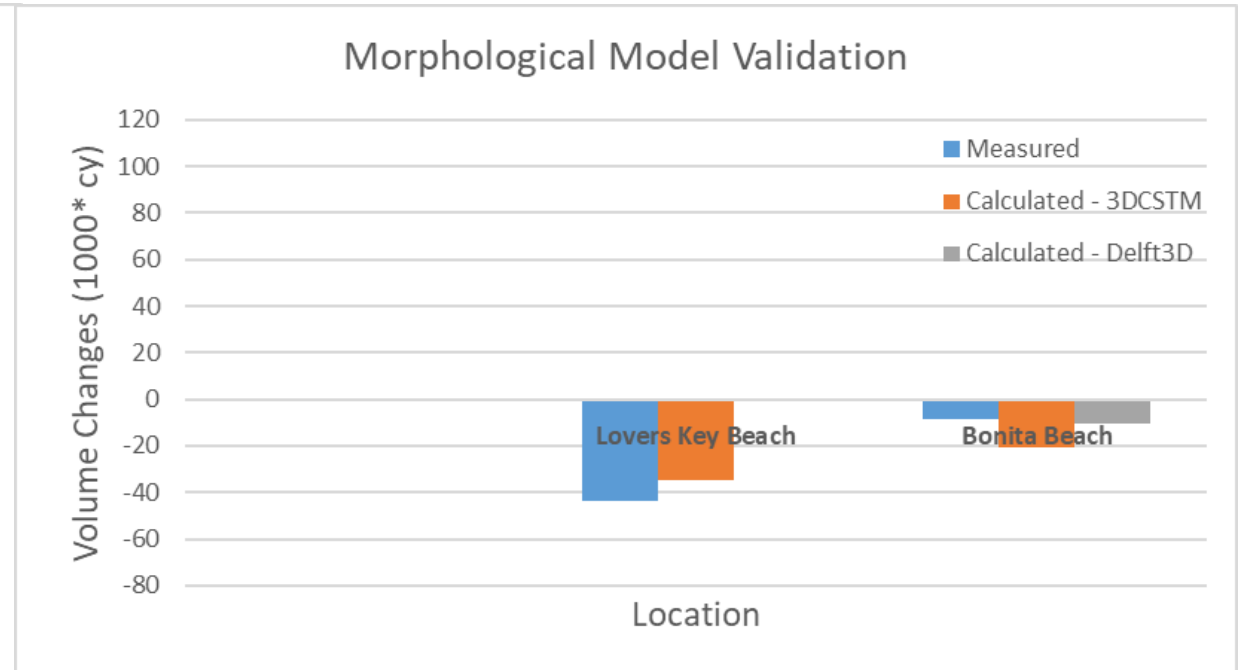
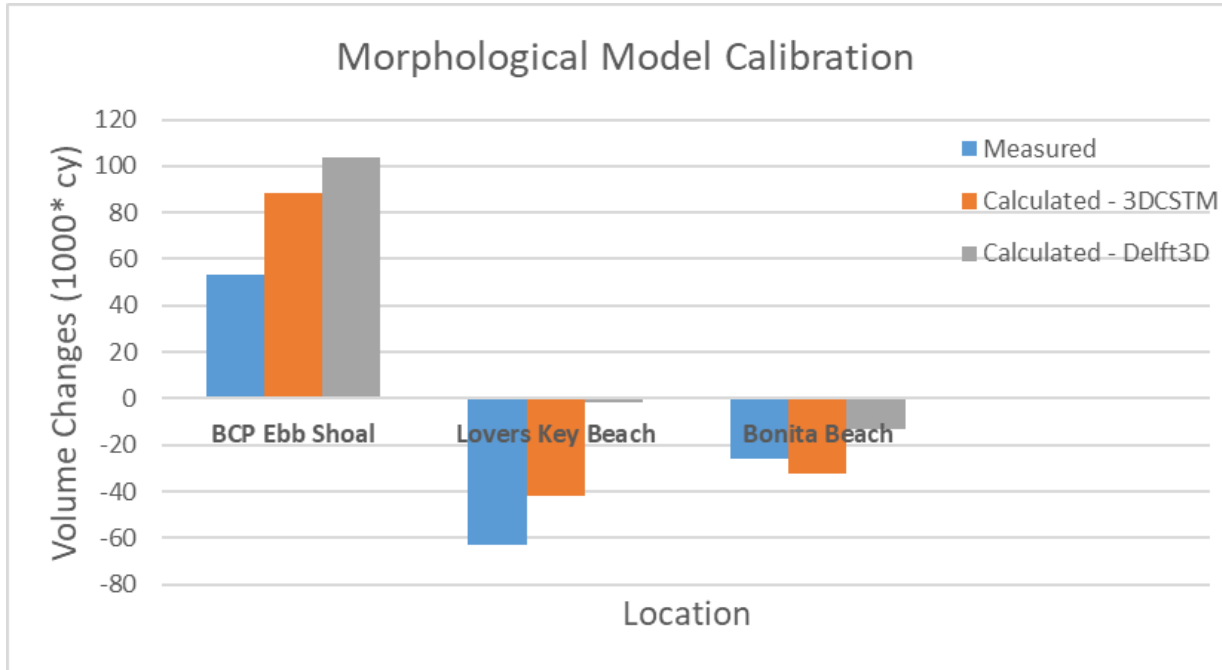
Big Carlos Pass Ebb Shoal
Jan. 2015 – Jun. 2016)



Measured bed level changes

Calculated bed level changes

3DCSTM Modeling – Morphology Model Calibration



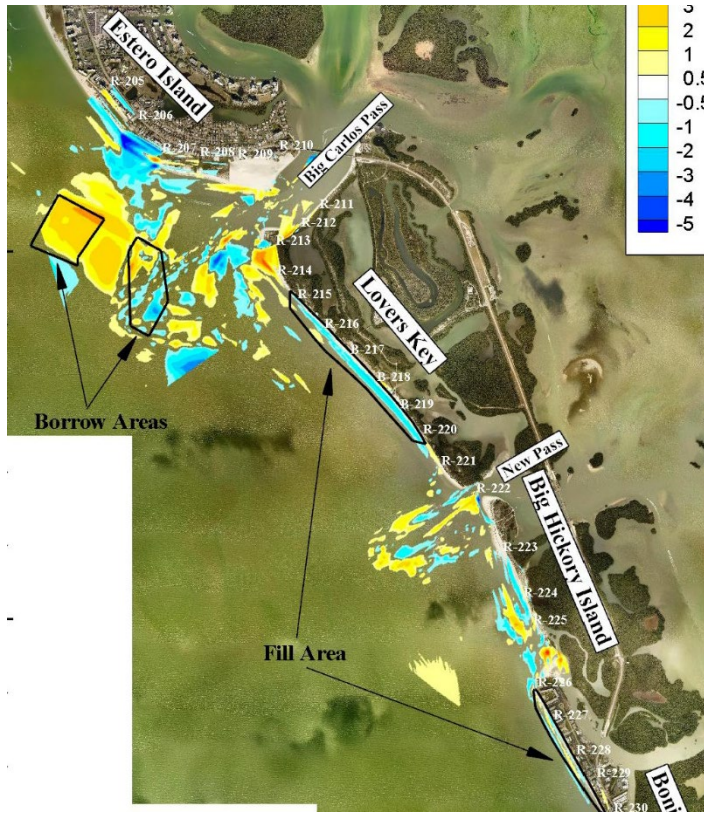
Model calibration: Jan. 2015 – Jun. 2016

Model validation: Oct. 2017 – Jul. 2018

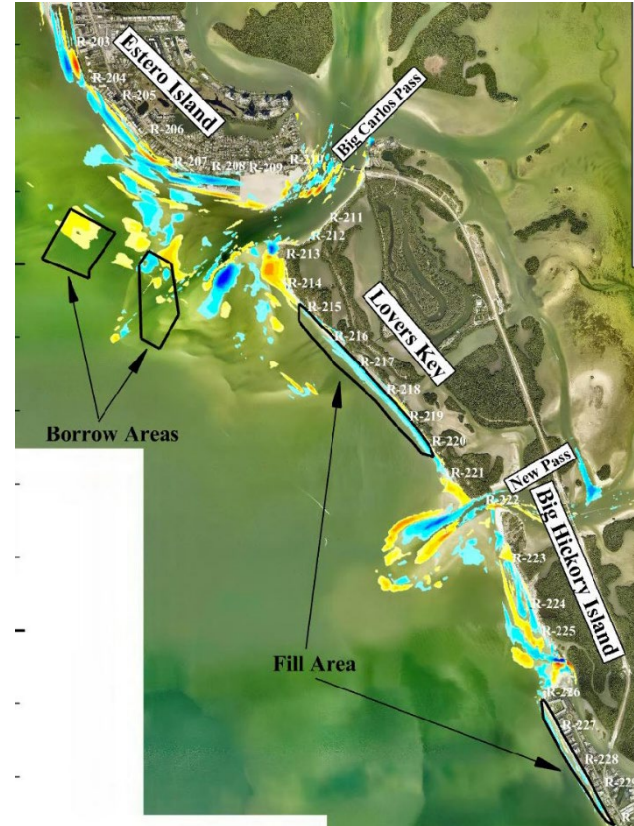
Delft3D model: almost no volume change at Lovers Key Beach



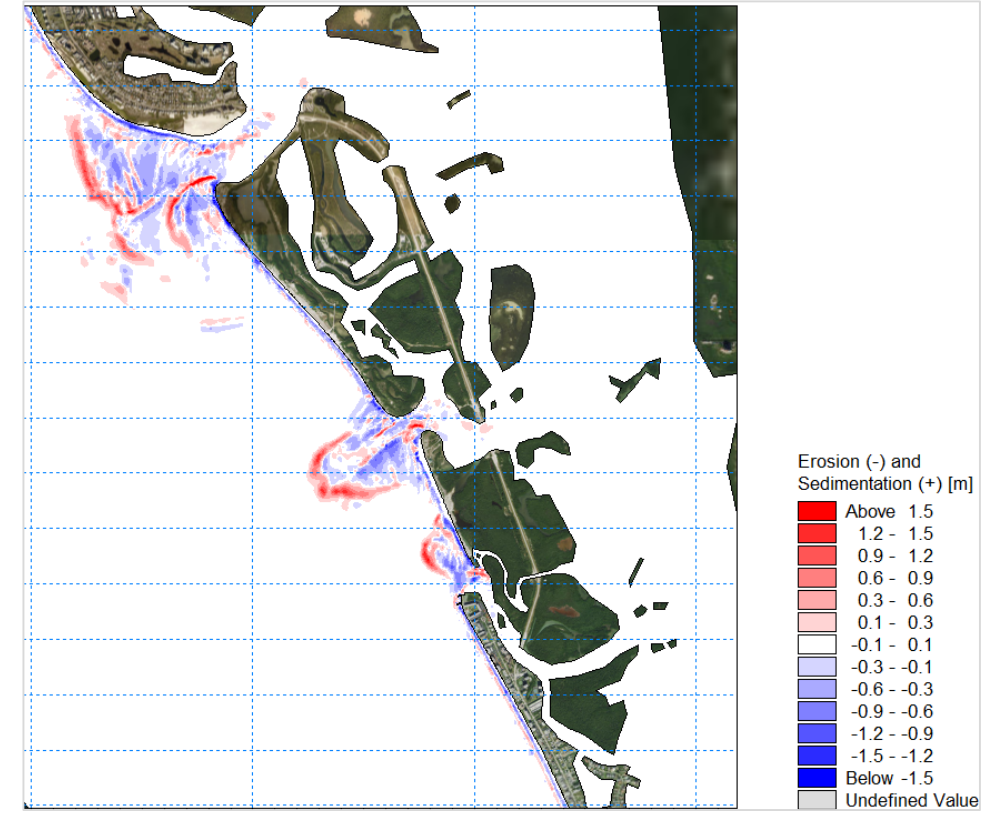
3DCSTM Modeling – Bed Level Change Pattern



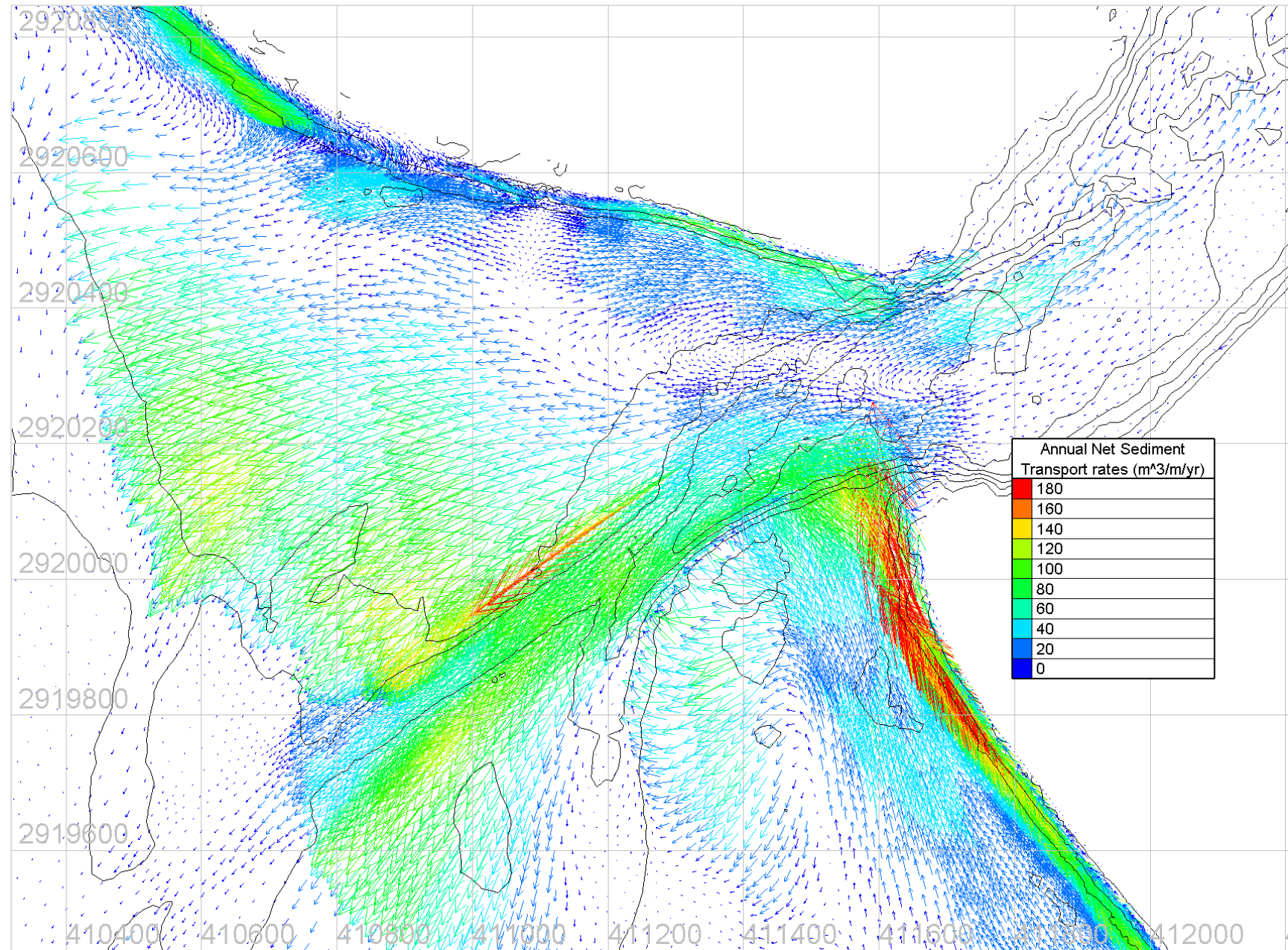
Measured bed level change
2018 –2019



Measured bed level change
2020 –2021

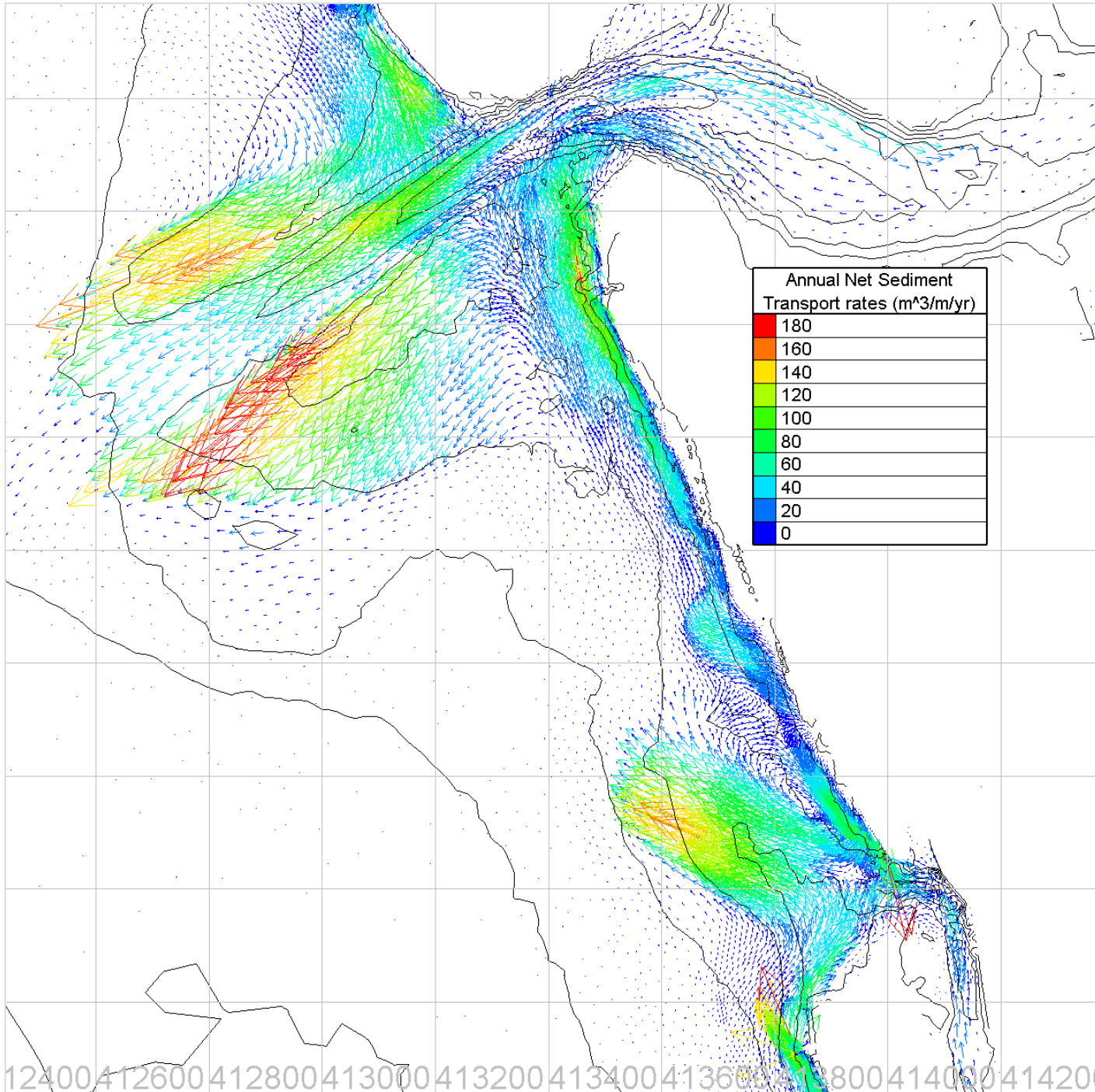


Calculated annual bed level change (2013)



Annual net sediment transport rates:

- Big Carlos Pass
- Where the eroded material go?
- Where the deposited material come from?

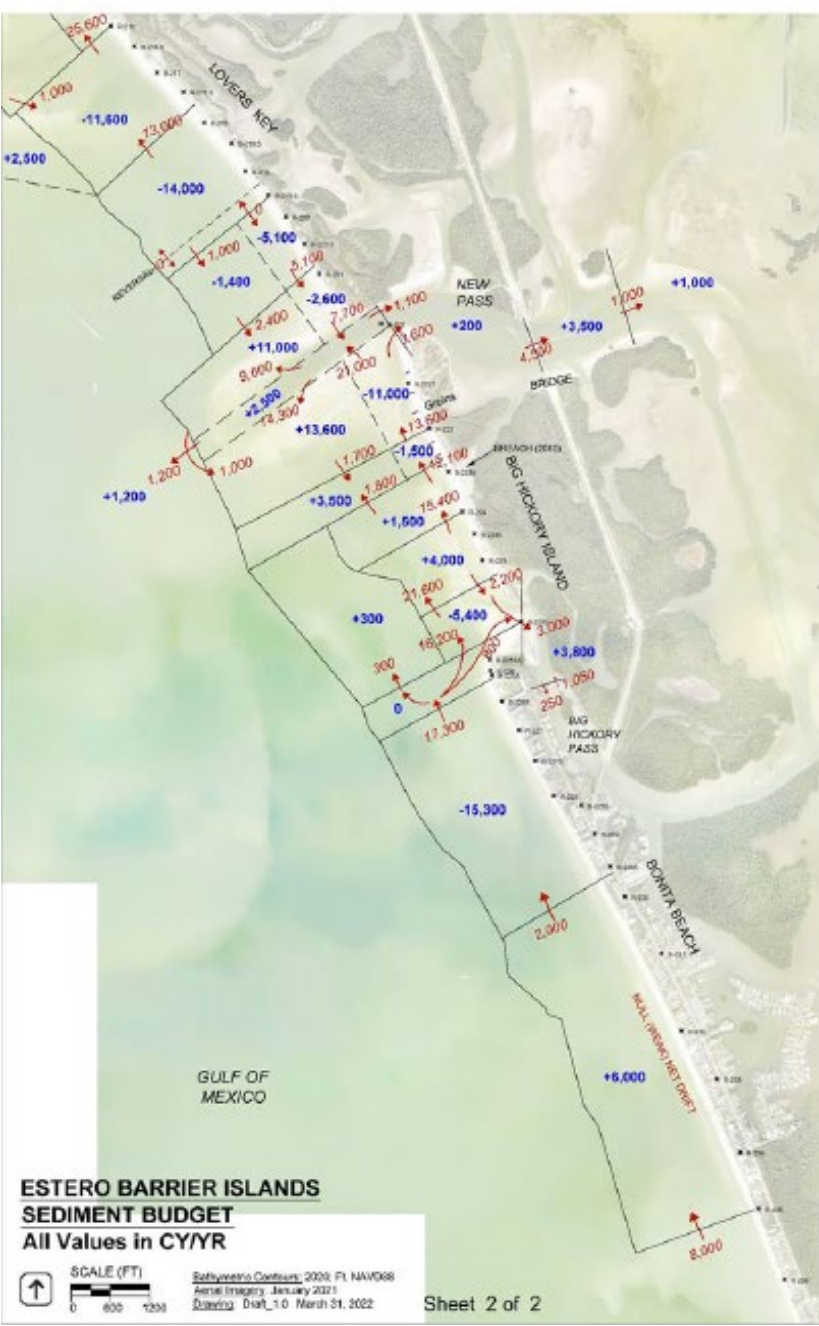
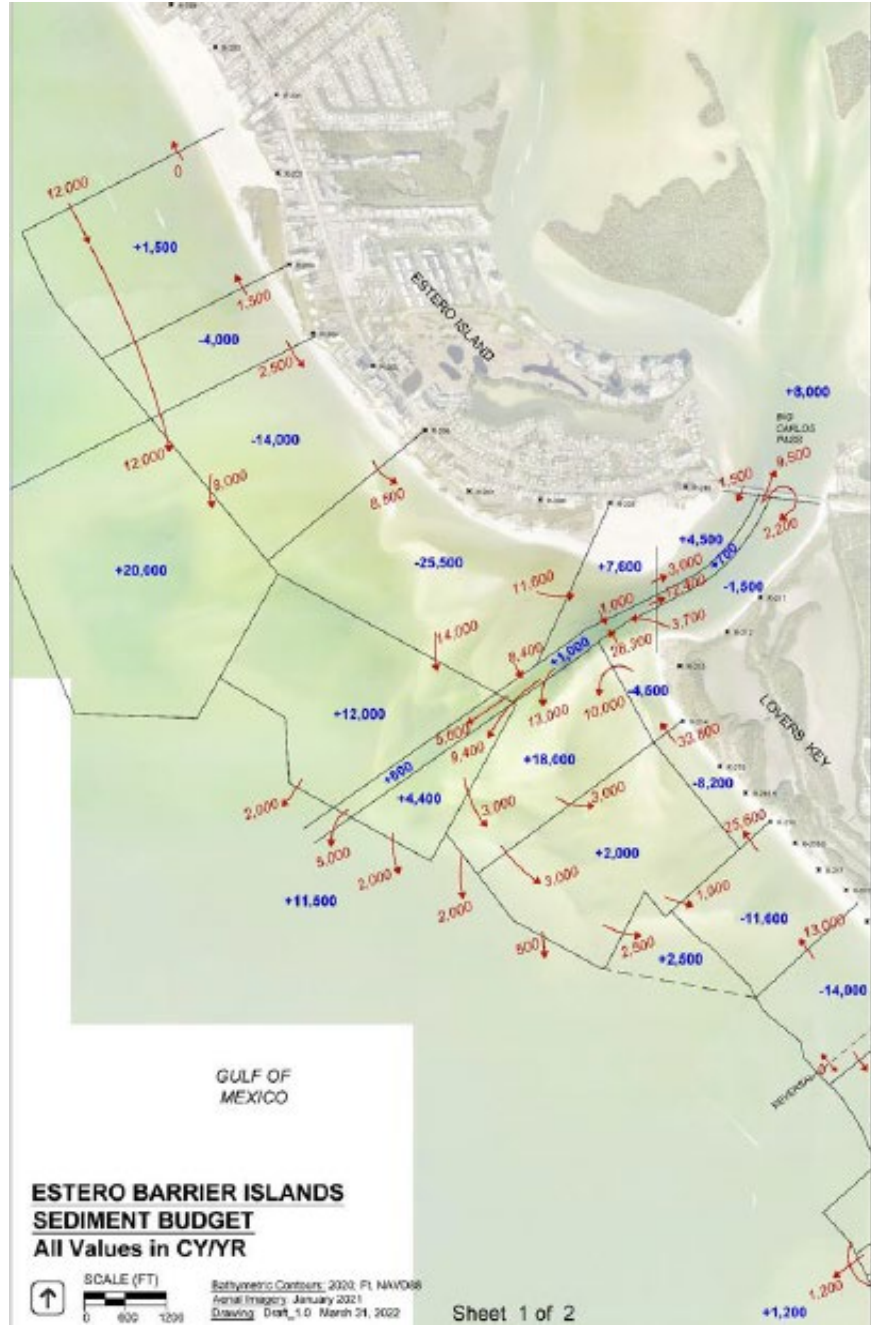


Annual net sediment transport rates:

- New pass
- Where the eroded material go?
- Where the deposited material come from?

Sediment Budget Analysis

1. Dr. Kevin Bodge (Olsen)
2. Provide detailed sediment budget in 3 passes, along 4 beaches, and at flood shoal and ebb shoal
3. Sediment budget analysis was based on data:
 - Historical volume changes
 - Annual sediment transport rates from LITLINE shoreline model
 - Annual net sediment transport rates from 3DCSTM model





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