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Enabling Delta Life

Normal Wave Climate Study – MS Barrier Islands

Evaluation of Barrier Island Restoration

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USACE - Mobile District

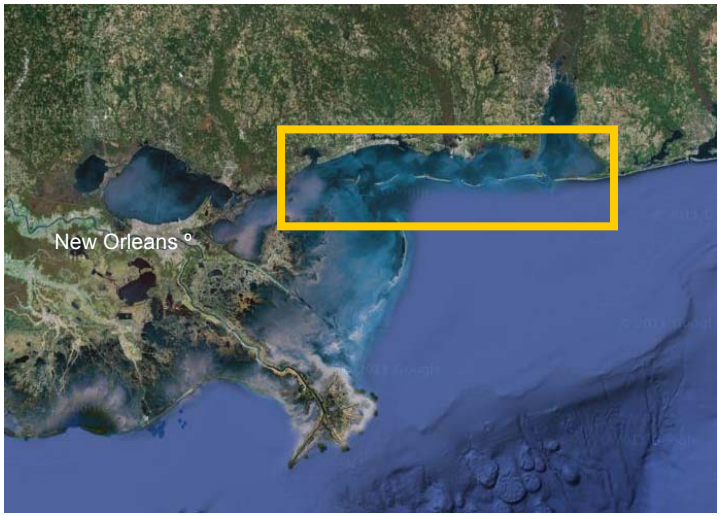
Mississippi Coastal Improvement Program

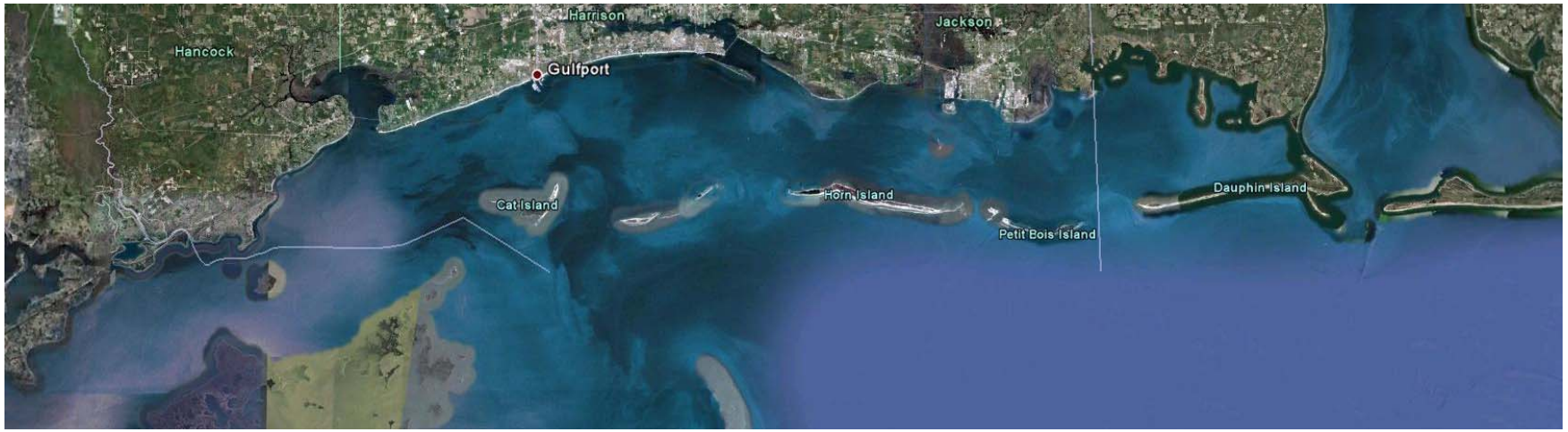
MsCIP

Introduction

Content of presentation

- Introduction to MsCIP
- Nearshore wave transformation modelling
- Preliminary sediment budget results
- Conclusions





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Introduction

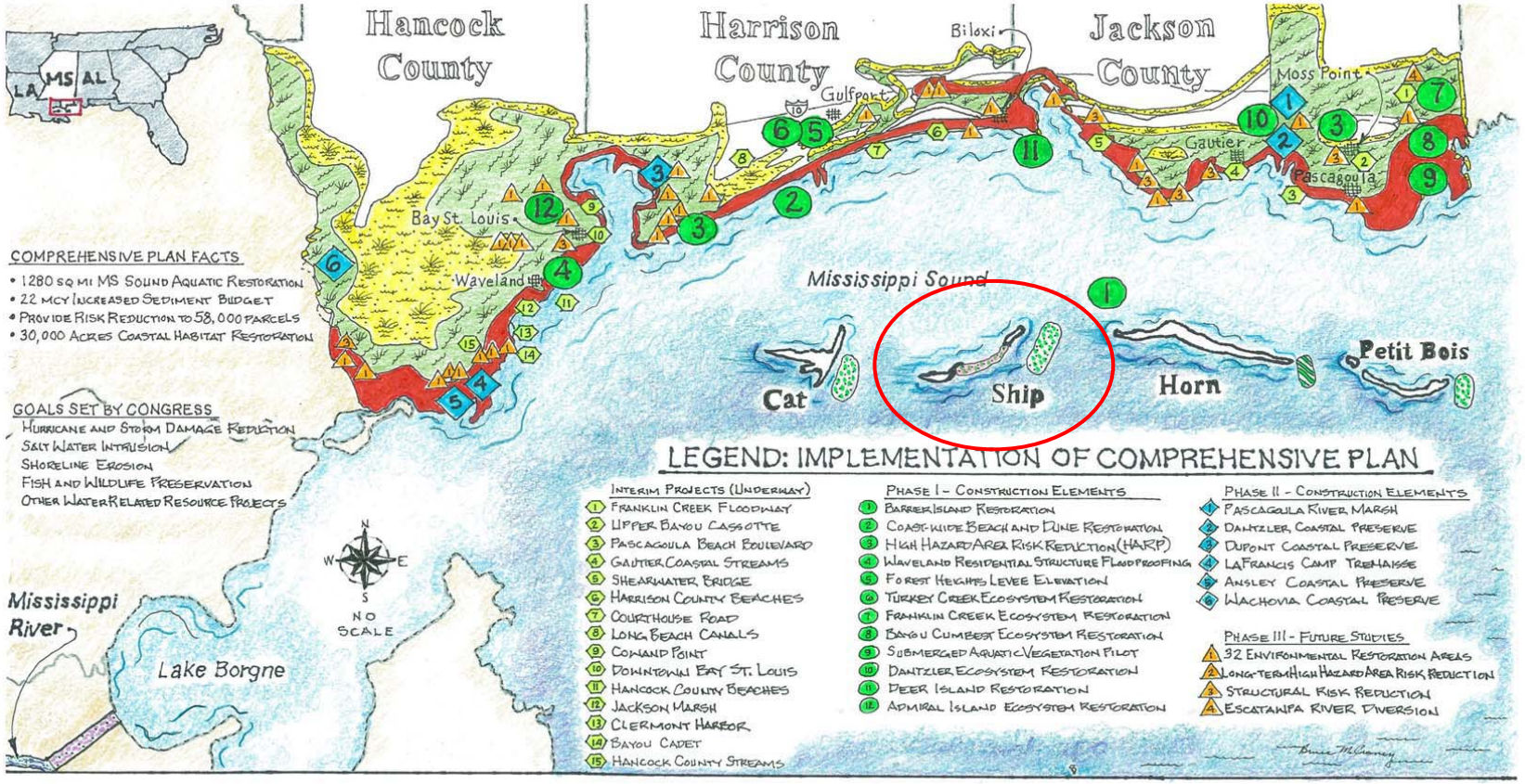
Mississippi Coastal Improvement Program (MsCIP)

"Make coastal Mississippi more resilient and less susceptible to risk from hurricanes and storm surges"

System-wide objectives:

- Reduce loss of life caused by hurricane and storm surge
- Reduce damages caused by hurricane and storm surge
- Restore 10,000 acres of marine and coastal habitat
- Manage salinities within the western Mississippi Sound
- Reduce erosion to barrier islands and mainland

Introduction



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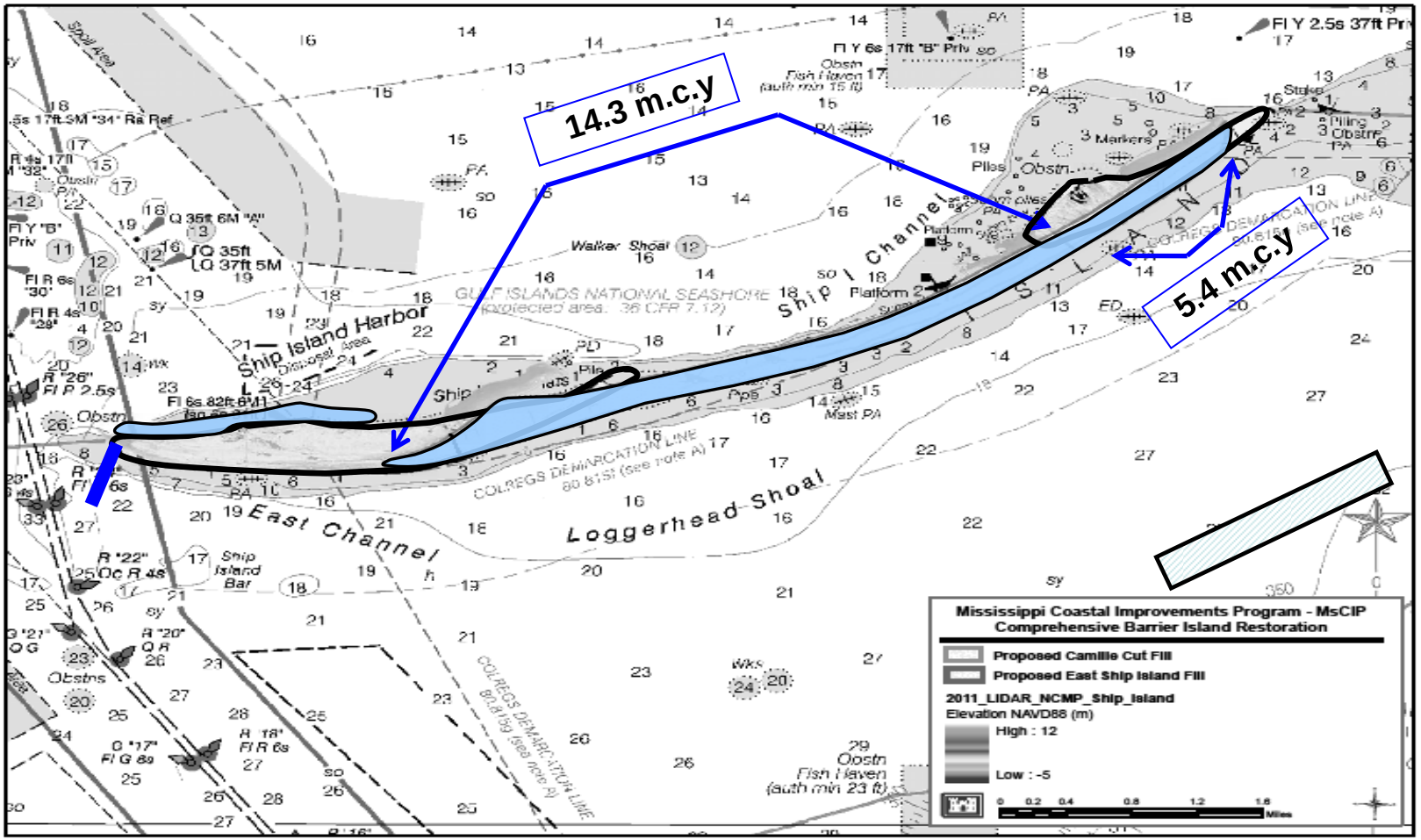
Introduction

Ship Island pre-Katrina (1997)

Introduction

Restoration design of Ship Island



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Introduction

Motivation

1. Insufficient understanding of sediment pathways in barrier system
2. Lack of insight in relative contribution of hurricanes / normal conditions to sediment transports

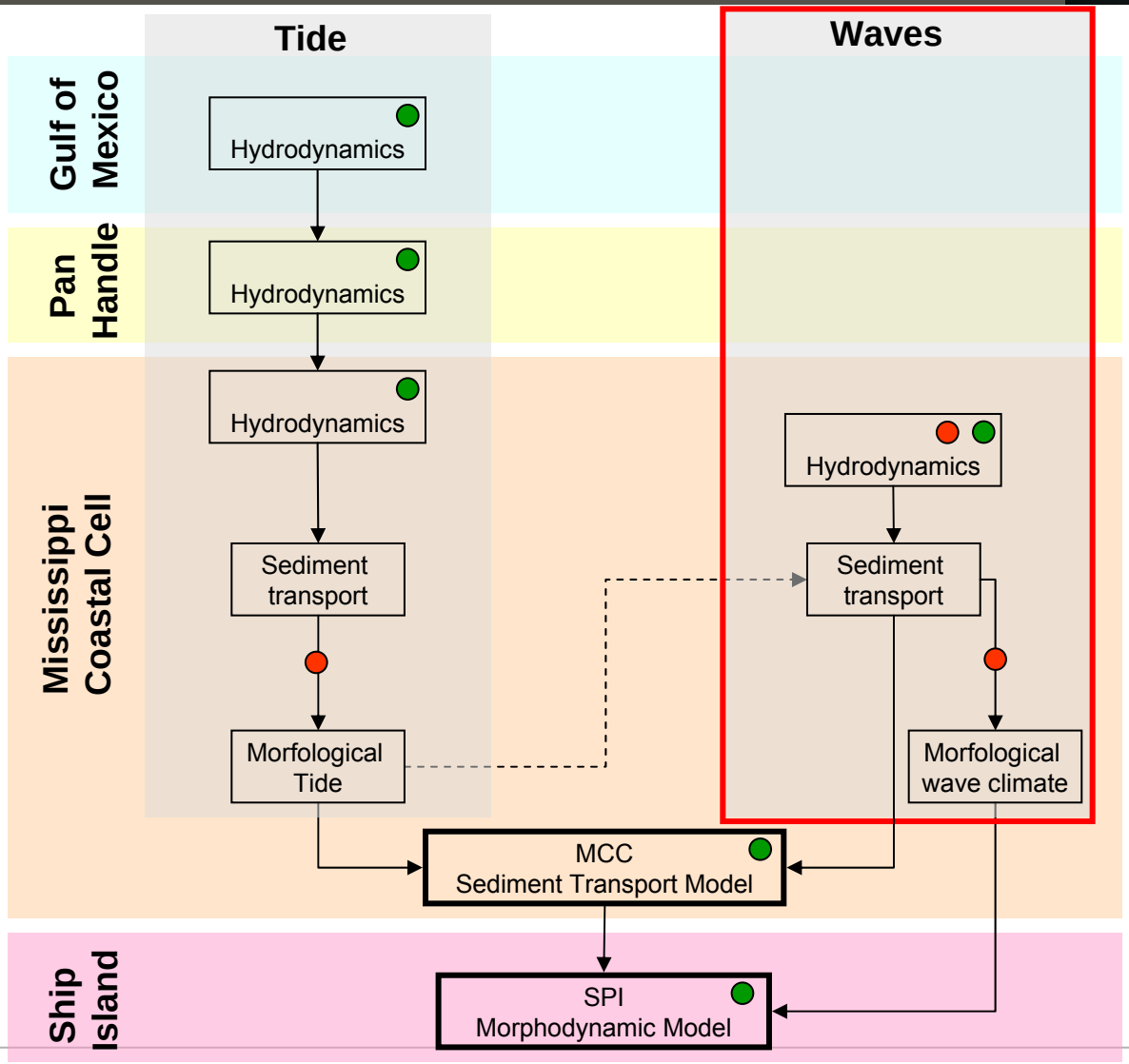
→ needed for design of borrow areas / nourishments / coastal structures

Objectives of study

- Establish sediment budget for MS barrier island system
- Evaluate restoration alternatives for Ship Island
- Transfer of modelling tools to USACE

→ complementary to other MsCIP studies
(hurricane impact - ERDC & sediment budget - M.Byrnes)
→ focus on average conditions (excl. hurricanes / tropical storms)
→ work in progress

Modeling Approach



mean wave climate downscaling

1. offshore wave climate validation
2. formulation of offshore scenarios
3. nearshore transformation
4. reconstruction and validation of nearshore wave climate

5. nearshore wave climate reduction using opti

Key models

Calibration / Validation

Reduction

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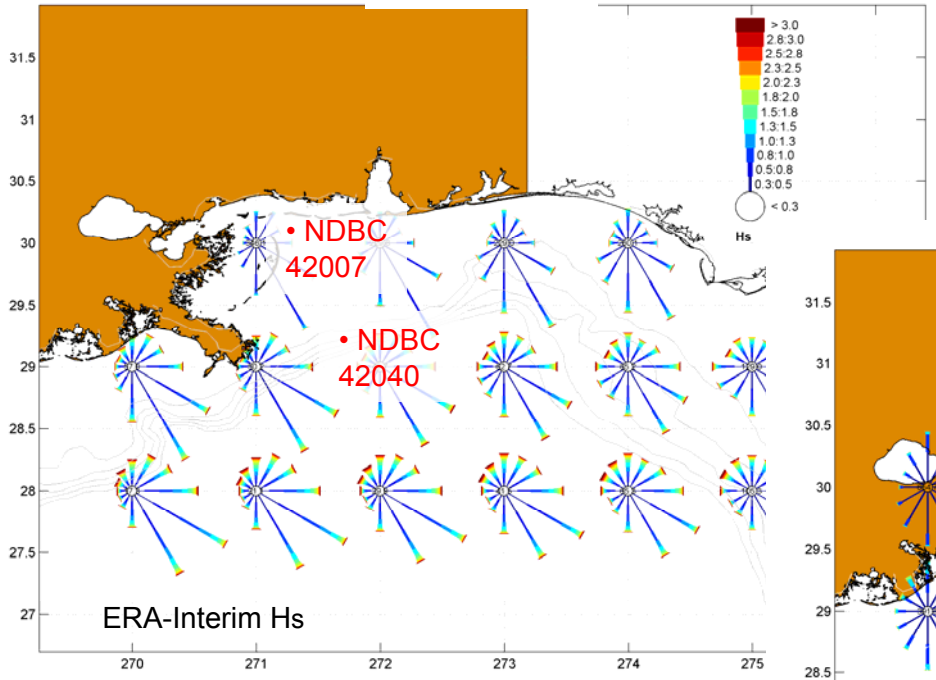
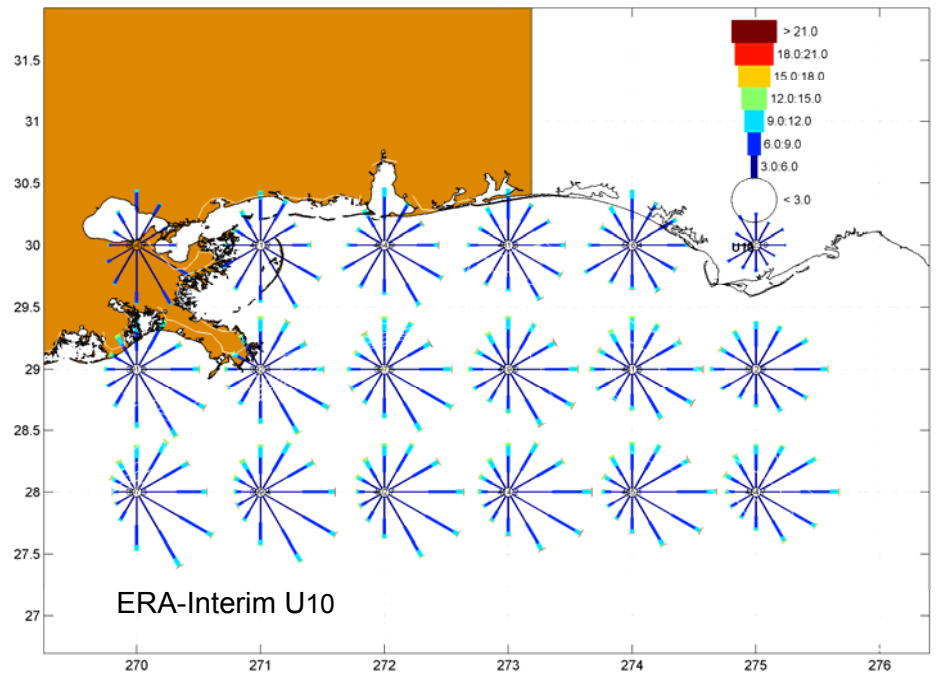
Wave climate transformation

1. Offshore wave climate validation





- ERA-Interim: 1x1º, 6hr interval, 1989 – 2010
- NDBC buoys 42007 and 42040: 2001 – 2009

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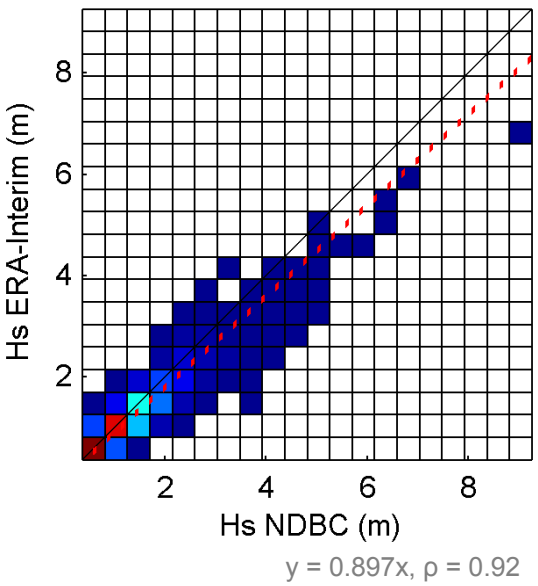
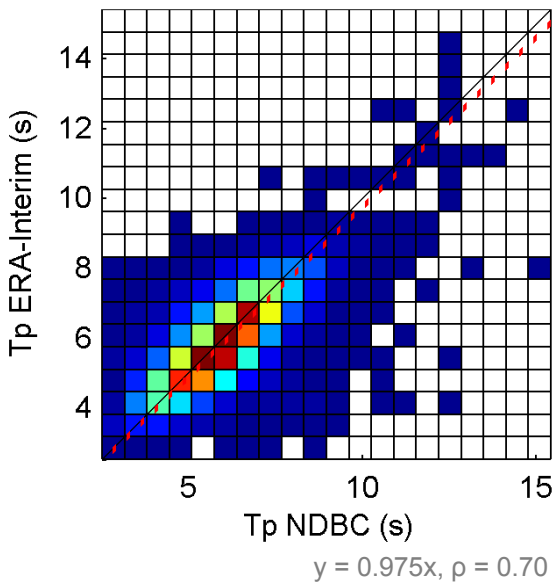
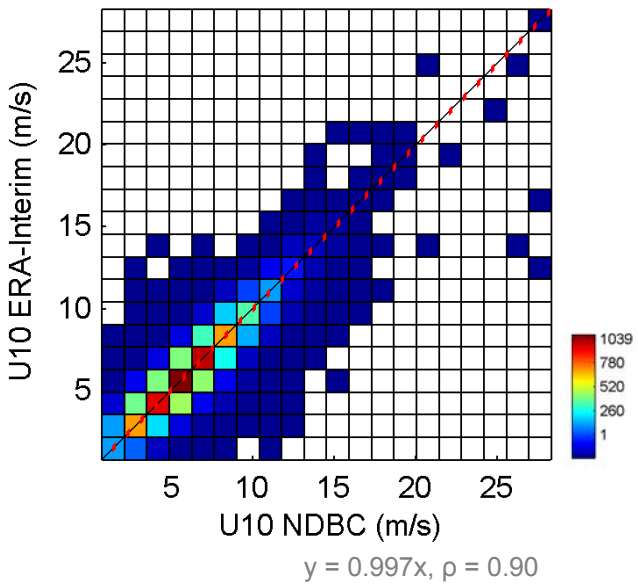
Wave climate transformation

1. Offshore wave climate validation

Buoy 42040







- ERA-Interim T_p, Dir, U_{10}, U_{dir}: good agreement with NDBC data
- ERA-Interim H_s: approx. 10% lower than NDBC data → directional sector / wave height dependent correction factor applied

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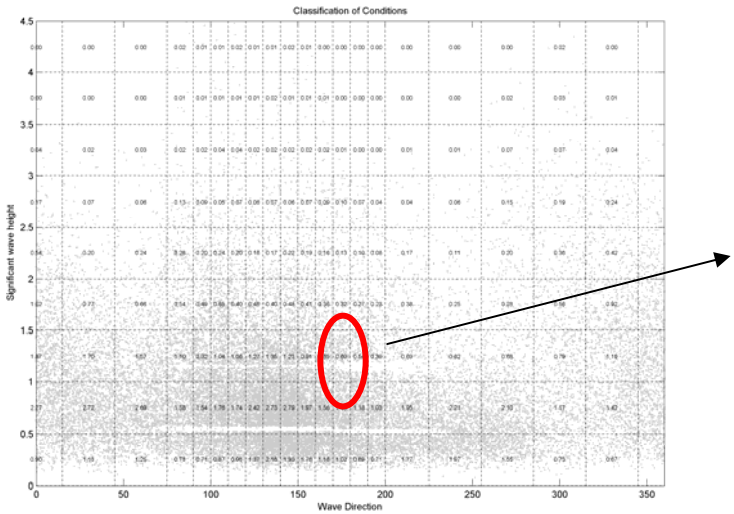
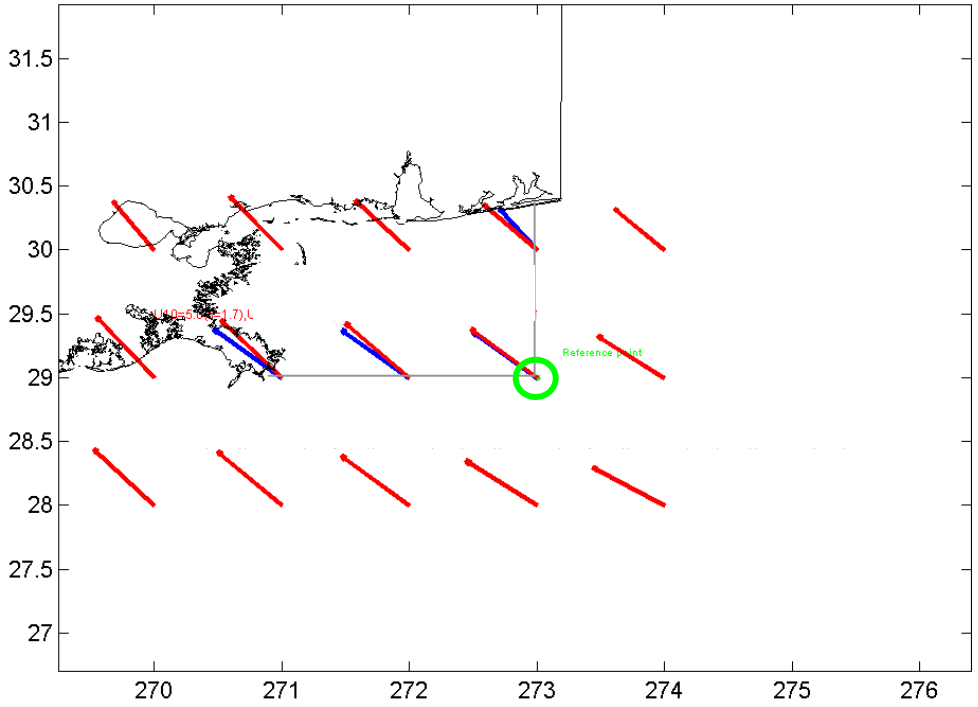
Wave climate transformation

2. Definition of offshore scenarios

- hurricane conditions filtered out
- joint probability matrix (Hs–Dir) for reference location → classification into 165 bins
- for each bin: conditions in support points based on simultaneous occurence with ref. location
- scenario → input for swan





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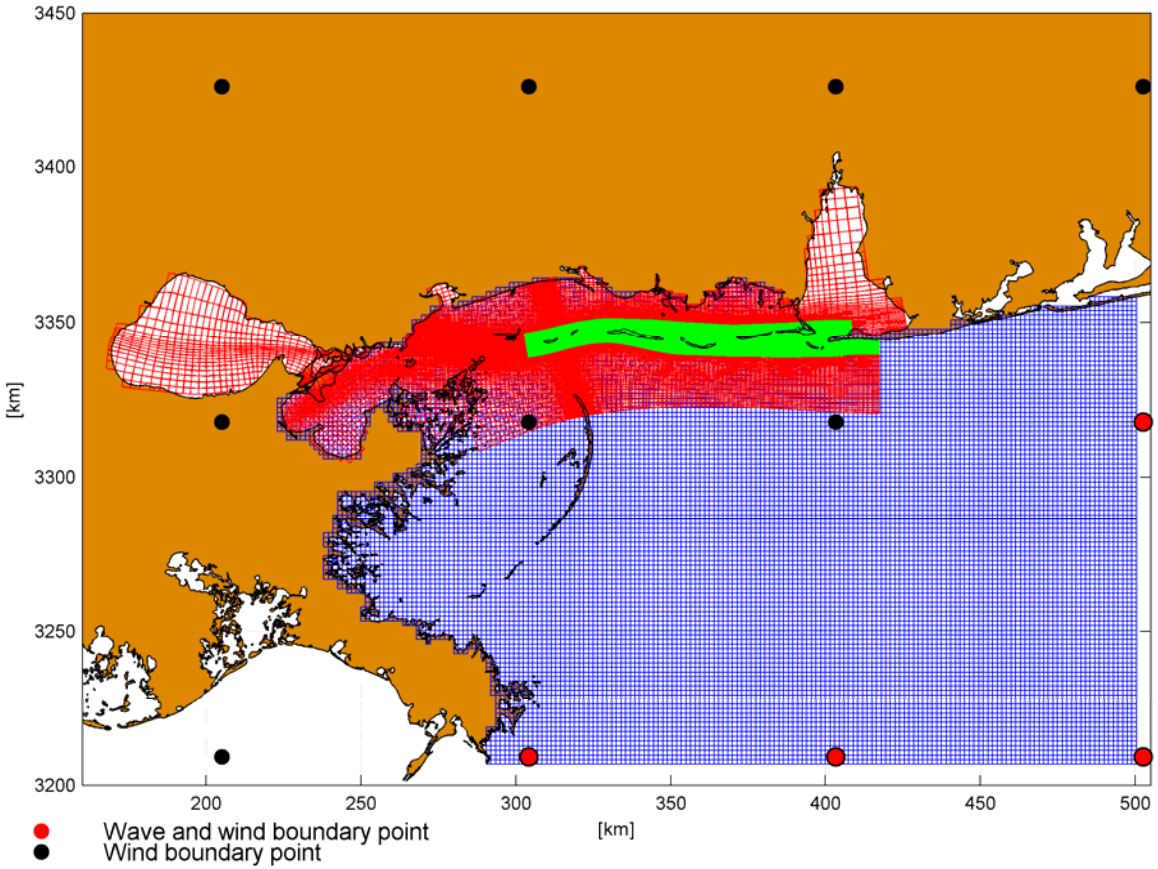
Wave climate transformation

3. Nearshore transformation



Overall	~1.5 x 1.5 km
MCC-coarse	~250 x 100 m
MCC-littoral	~ 10 x 50 m

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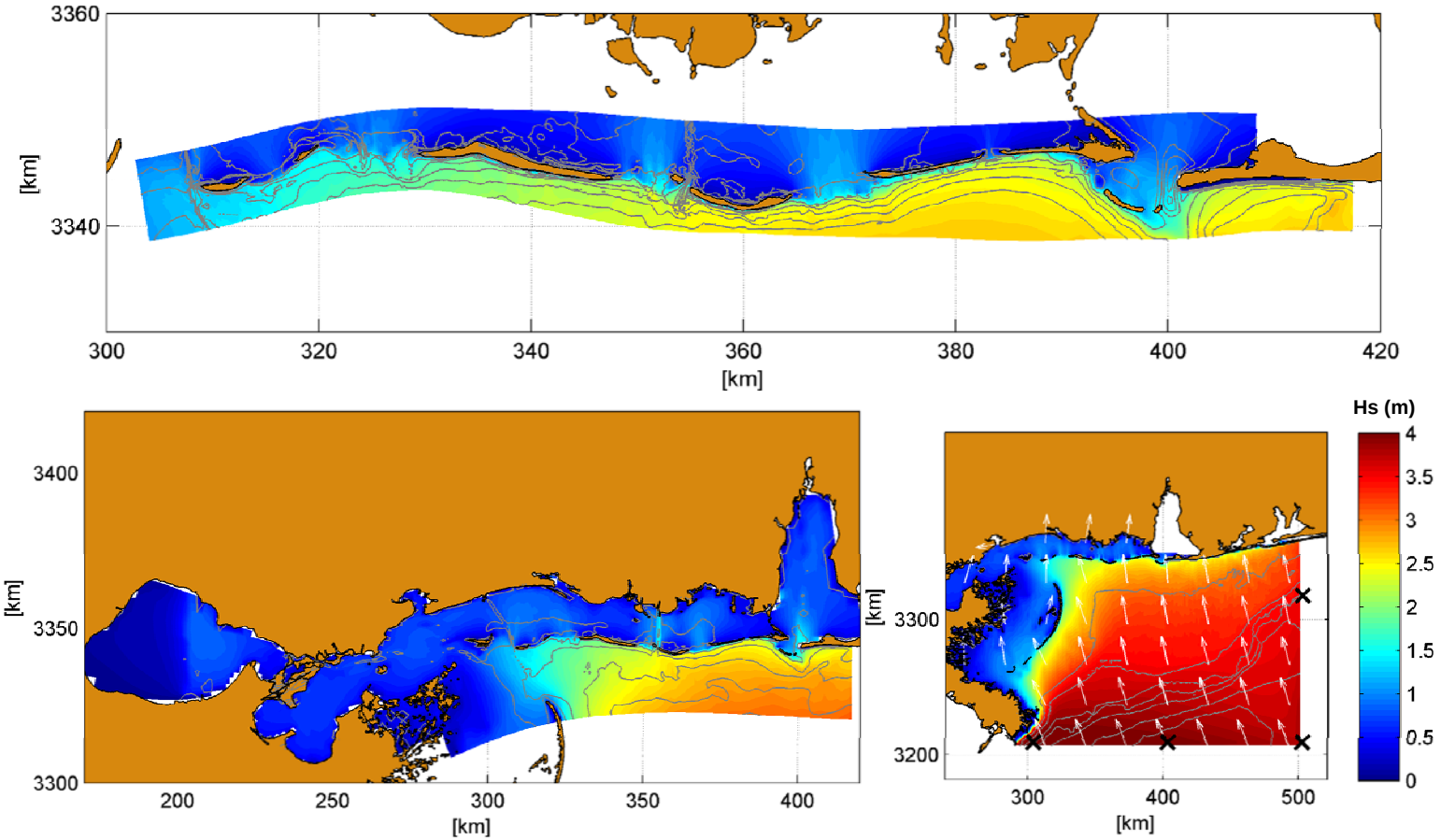
Wave climate transformation

Step 3: Nearshore transformation



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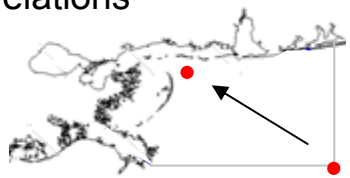
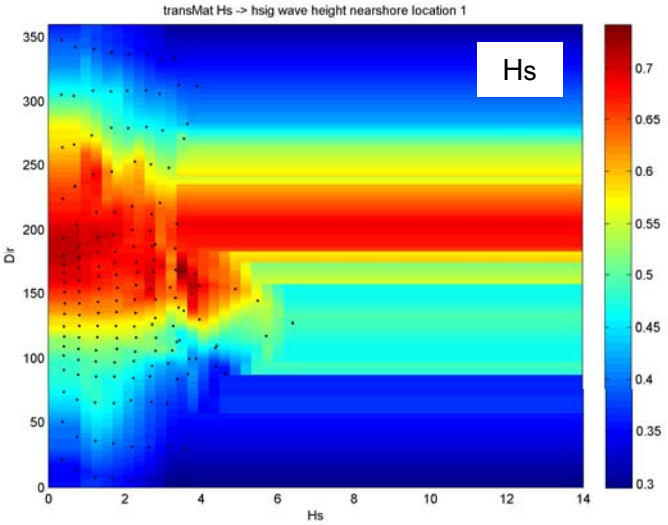
Wave climate transformation

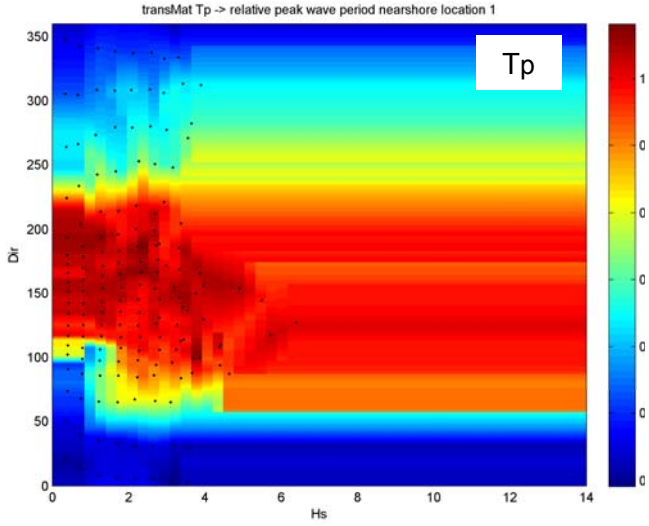
Step 3: Nearshore transformation

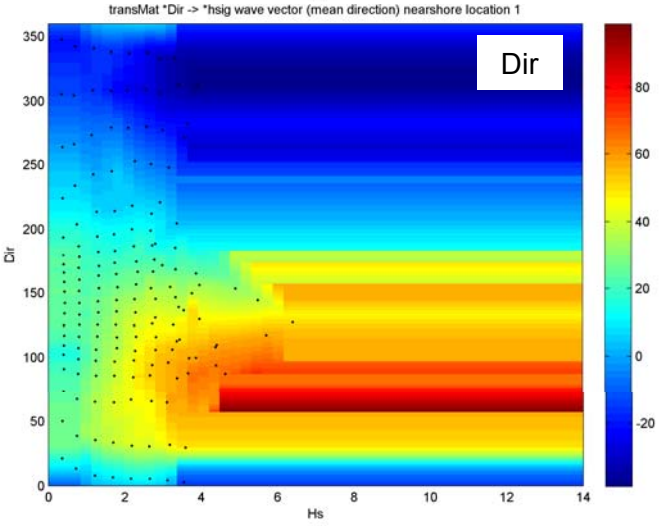
• Construction of transformation matrix describing the relation between boundary point and nearshore location

• Timeseries reconstruction by transforming offshore timeseries to nearshore through found relations









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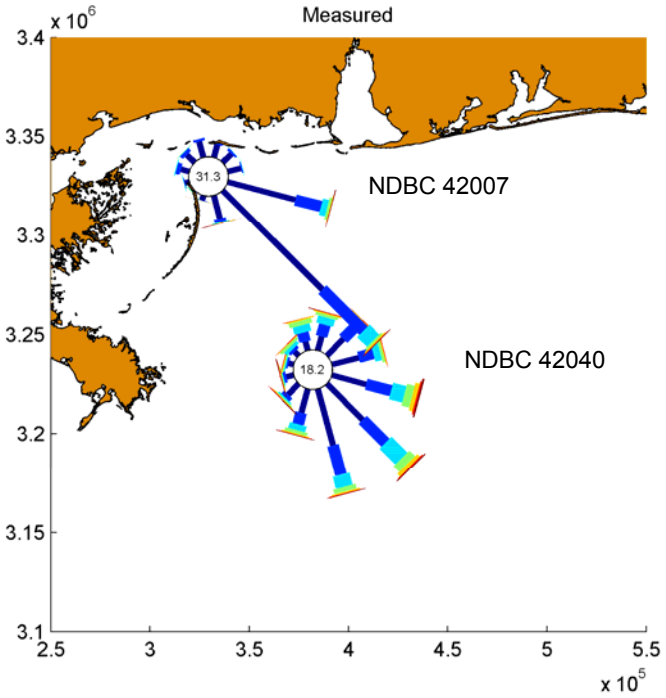
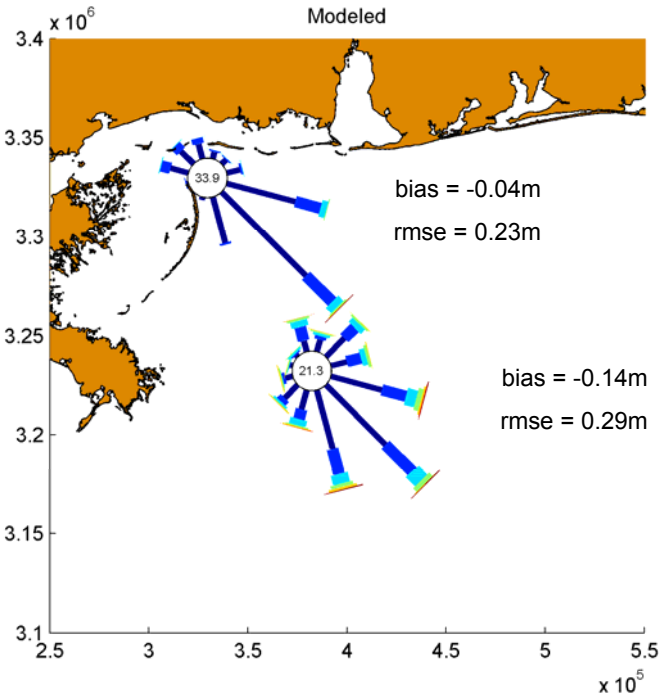
Wave climate transformation

Step 4: model validation - offshore





- reconstructed time series for period 2001-2009 at NDBC buoy locations

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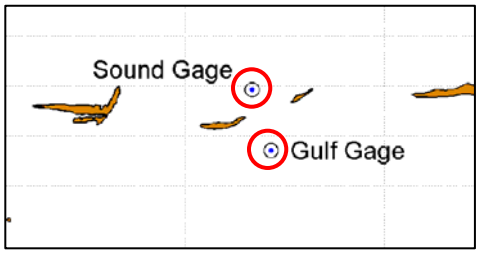
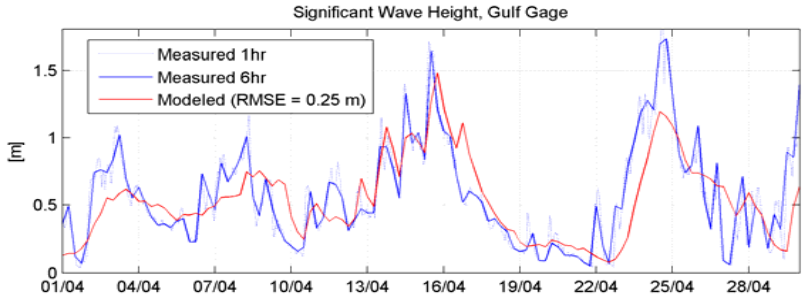
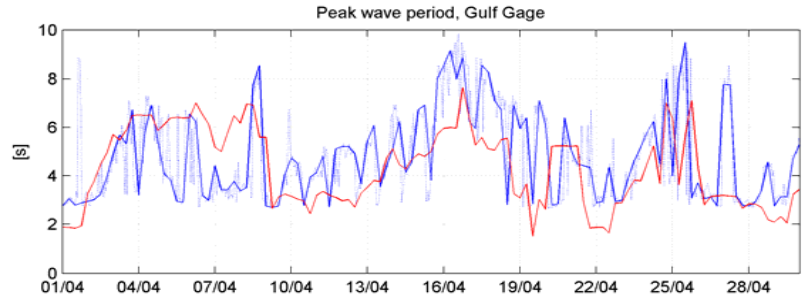
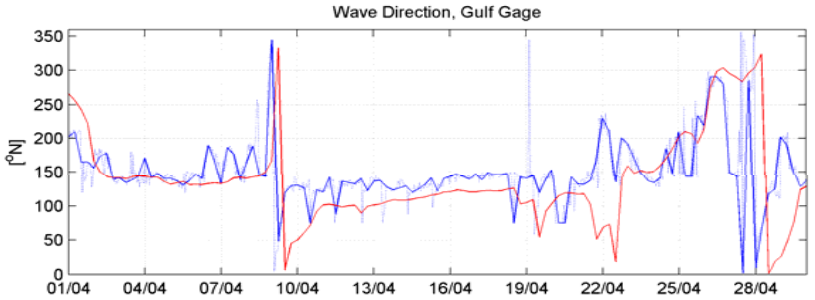
Wave climate transformation

Step 4: model validation - nearshore









- reconstructed time series for April 2010 at wave gauges

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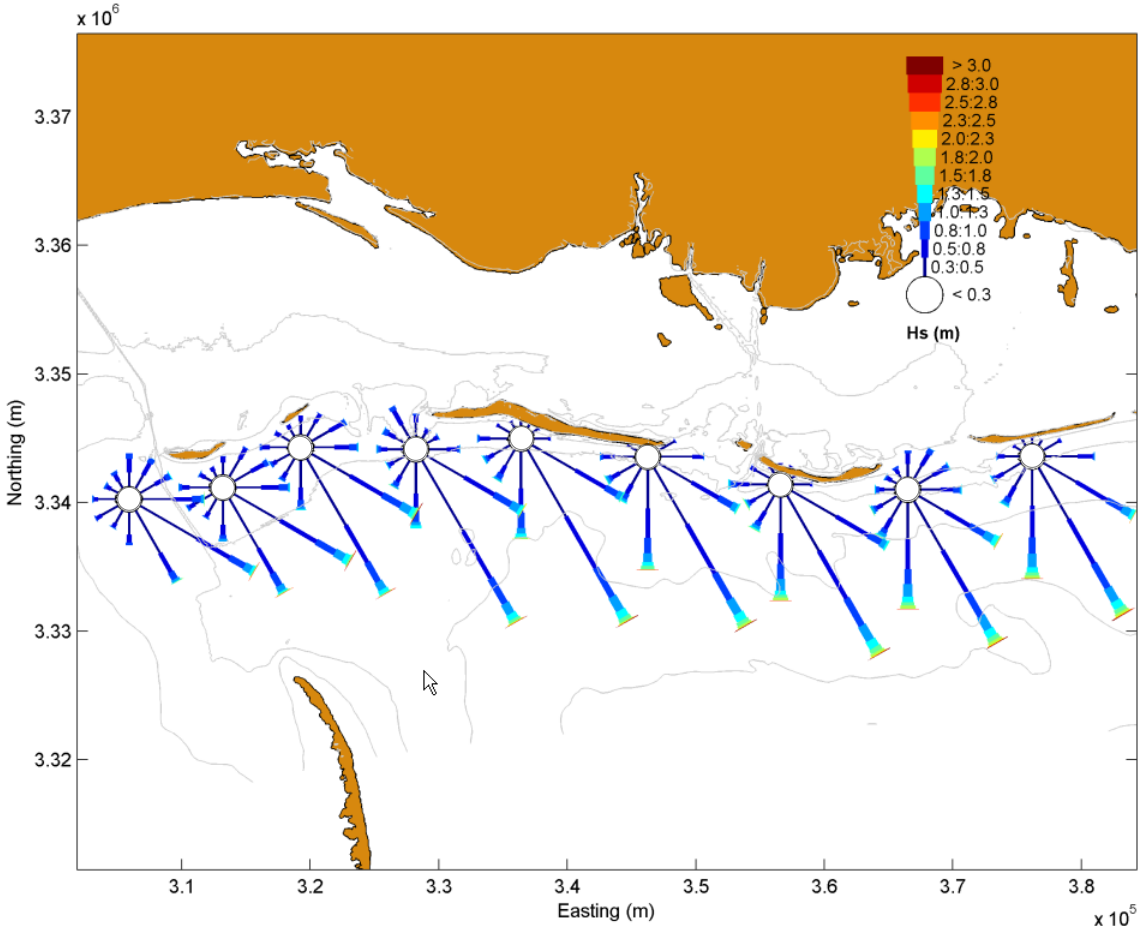
Wave climate transformation

From offshore wave climate to sediment budget



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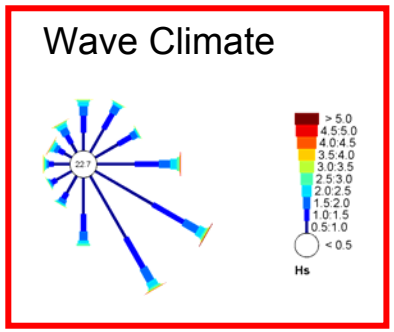
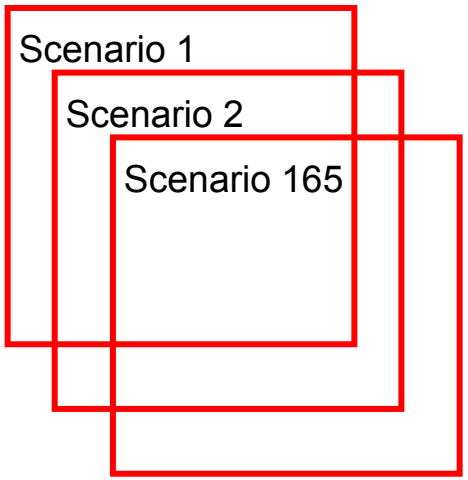
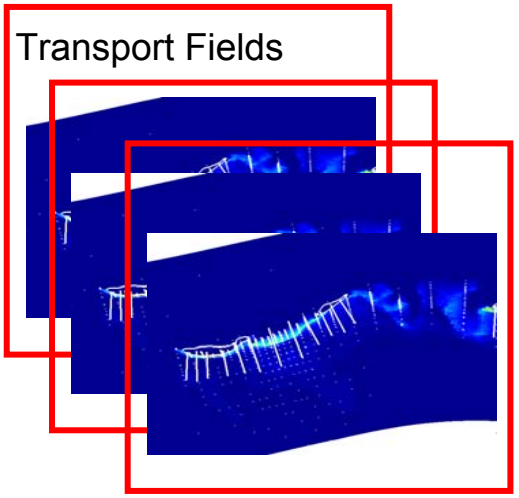
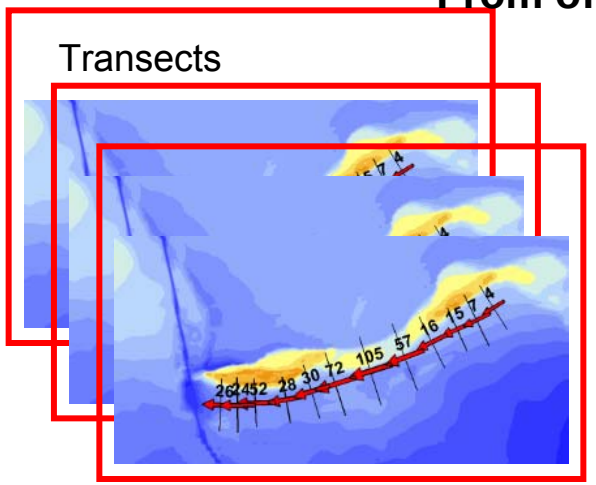
Towards annual transports…

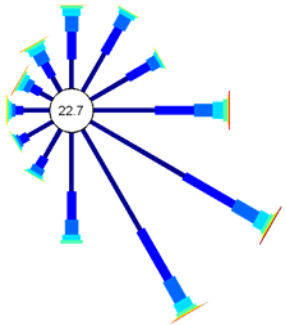


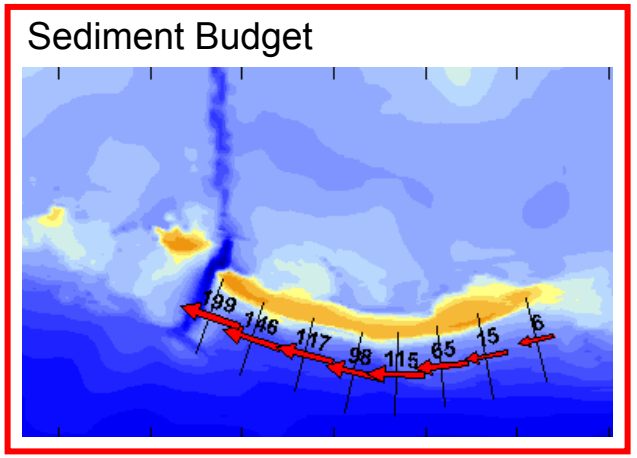




From offshore wave climate to sediment budget







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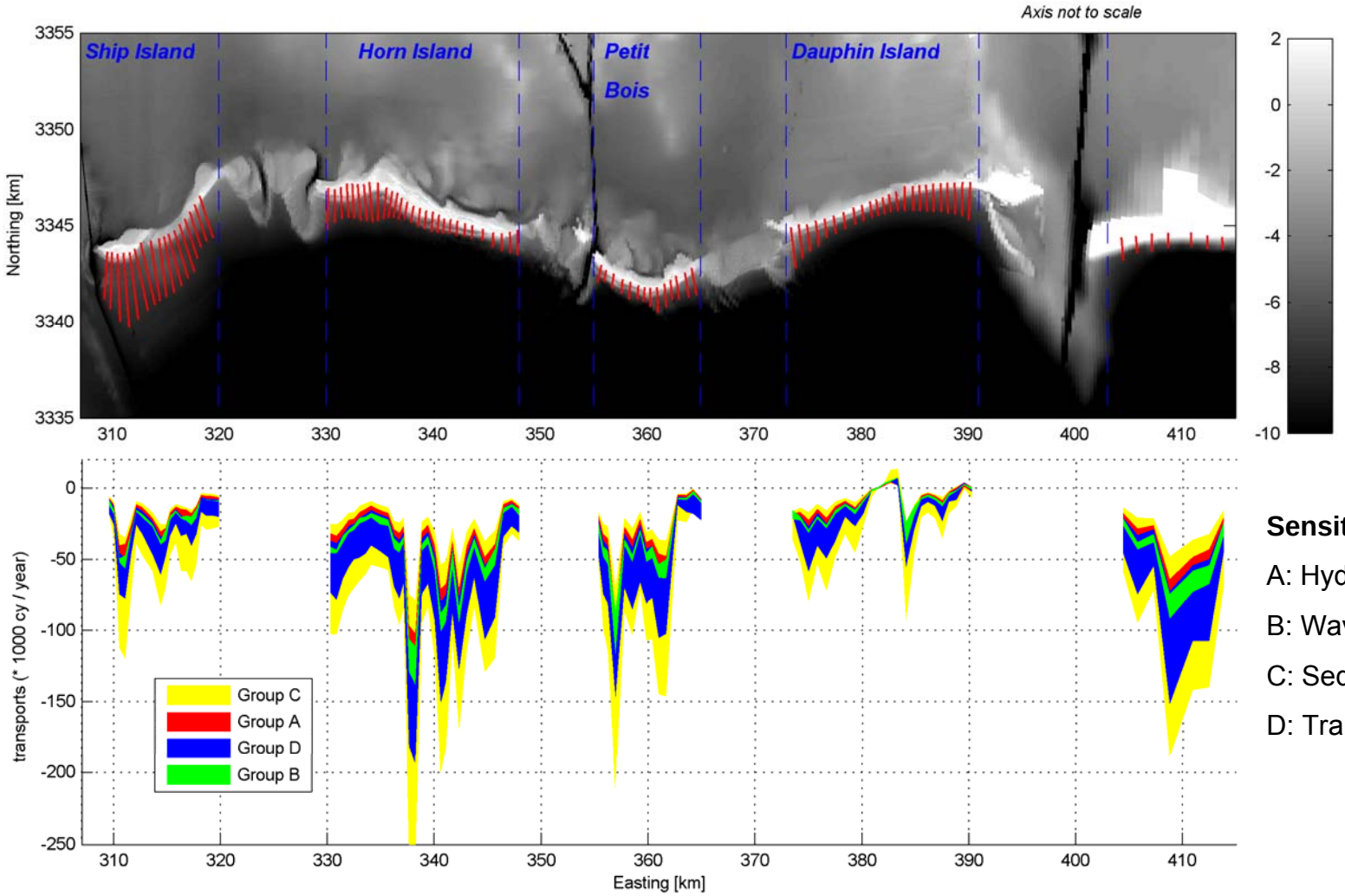
Towards annual transports…



Sensitivities

A: Hydrodynamics ~5%

B: Waves ~5-10%

C: Sediment D_{50} ~80-100%

D: Transport form. ~50-100%

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Conclusions

Conclusions

- Nearshore wave climate at MS barrier islands determined from ERA-Interim data. Validation of wave model against measurements shows good performance
- Multiple downscaling techniques applied to reduce effort for morphological computations
- Coupled flow-wave model used to determine annual sediment transport rates
- First sediment budget results show realistic transport patterns and limited sensitivity to wave parameters compared to other model settings

Outlook

- Include spatially varying sediment characteristics and fine tune sediment transport formulation
- Further downscaling of wave climate for morphodynamic evaluation of restoration alternatives

Thanks for your attention

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