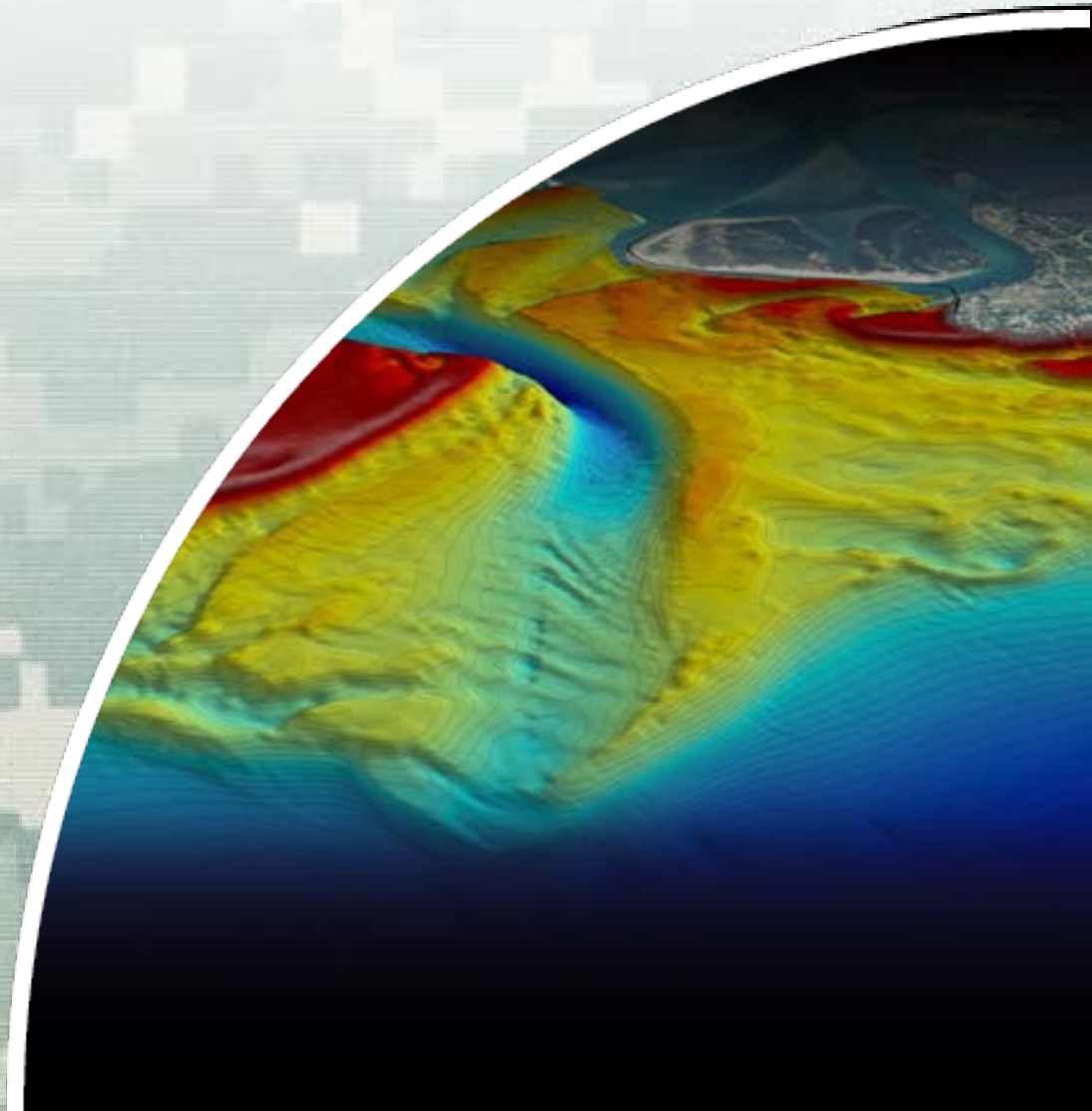
3D Lidar Tools/Methods

Lauren Dunkin

John McCormick

RSM workshop
August 11, 2011



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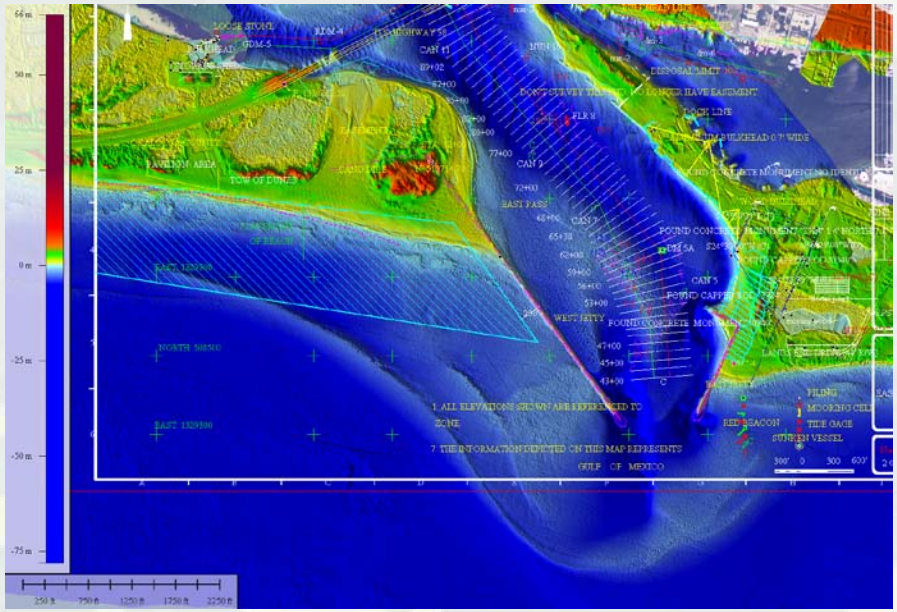
Outline

- Motivation
- New metrics and analysis methods to improve predictions of coastal evolution and hazards
- Tools to assist with RSM for
  - Vulnerability assessments
  - Shore protection
  - Sediment Pathways
    - Inlet and Ebb shoal features
  - Channel Condition
  - Flood risk management
- Next Steps



Motivation

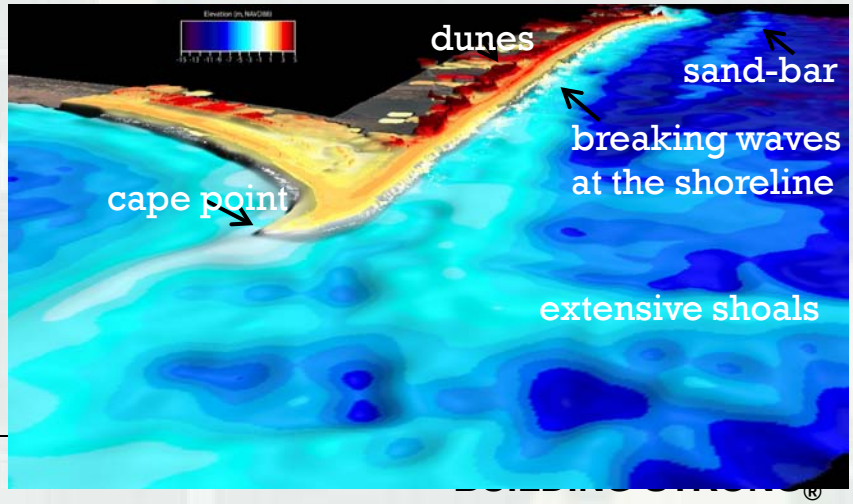
- Address need for tools/methods to utilize 3D spatial data

  One of the top FY11 Statement of Needs (SONs) for the Navigation Research Area Review Group was “Three-Dimensional Quantitative Analysis Tools for Morphology and Navigation Channel Assessment.”

- 3D spatial data under utilized by coastal engineers for RSM, coastal risk assessment, and navigation

Metrics for Coastal Evolution and Hazards

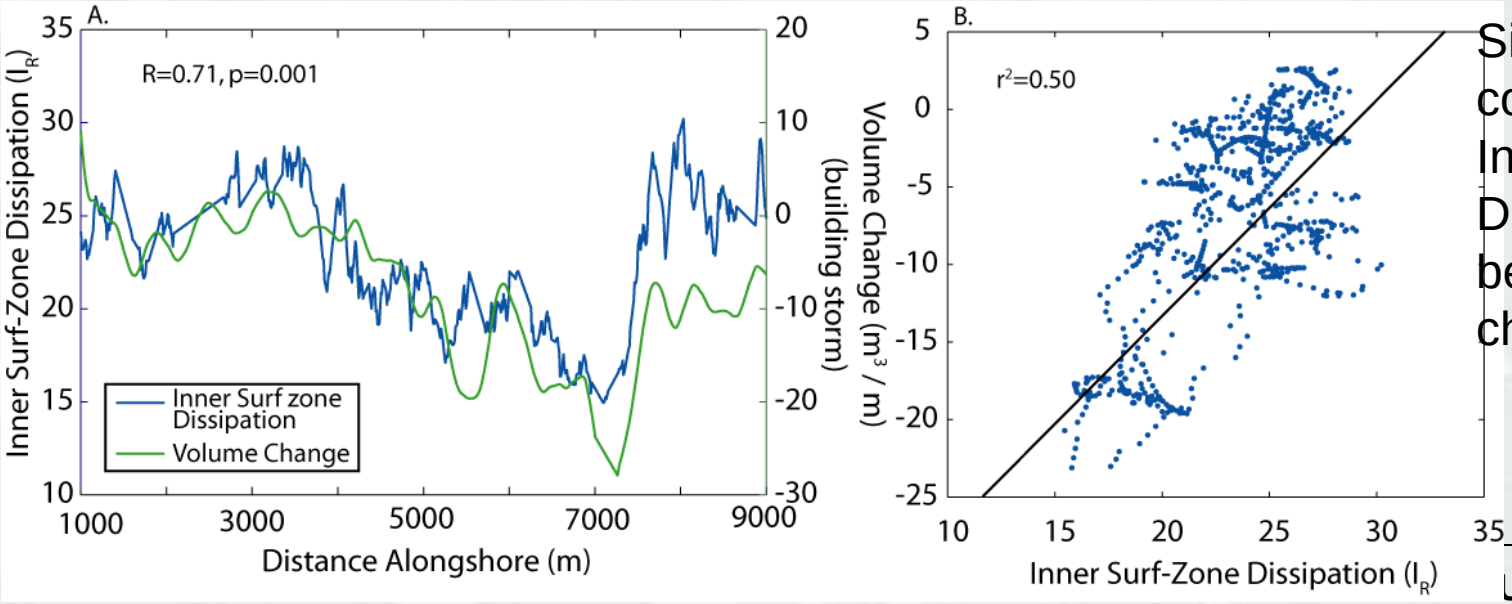
- CLARIS – Coastal Lidar and Radar Imaging System – mobile remote sensing system designed to observe beach topography, nearshore bathymetry, surf-zone morphology, and runup <u>during storm events</u>
- Metrics to identify areas that experience the largest amounts of during-storm erosion and/or post-storm accretion
  - Inner surf-zone dissipation,
  - swash zone morphology,
  - alongshore bathymetric steepness,
  - shoreline curvature,
  - surf-zone wave steepness



CLARIS merged topographic and bathymetric surface: Cape Hatteras, NC

Metrics for Coastal Evolution and Hazards

- During-storm observations provide meaningful predictions for coastal planners of vulnerability before storms arrive
- Metrics need to be converted into useful quantities that can be applied to available data before-storms (e.g. NCMP topography and bathymetry data)
- Compare metrics with shoreline change rates to determine vulnerability



Significant correlation between Inner Surf-Zone Dissipation and beach volume change

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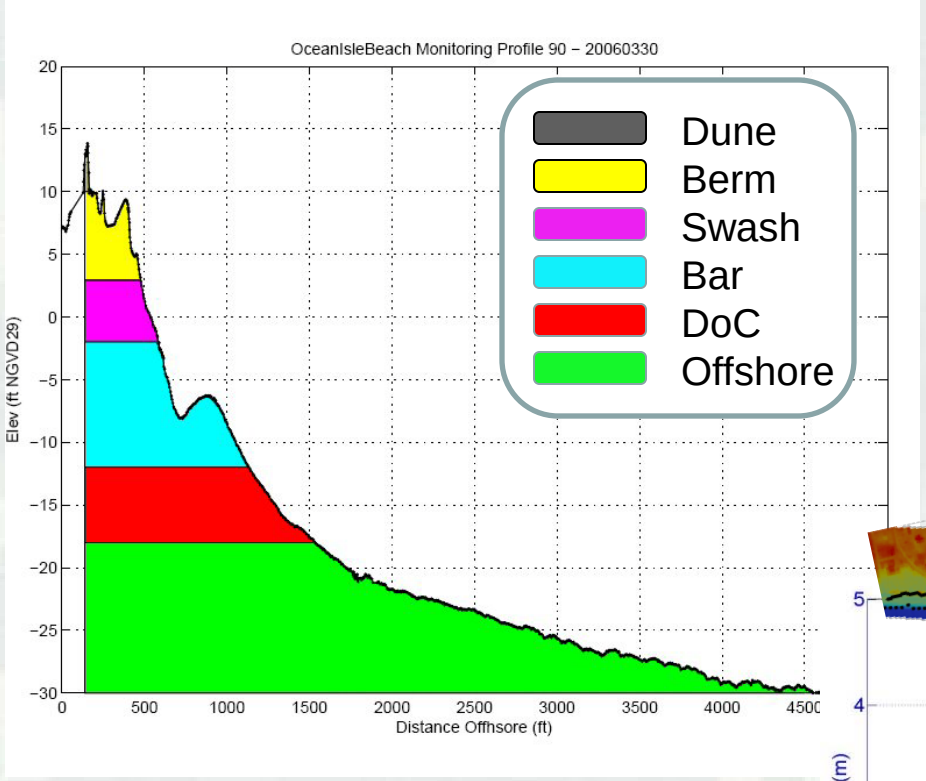
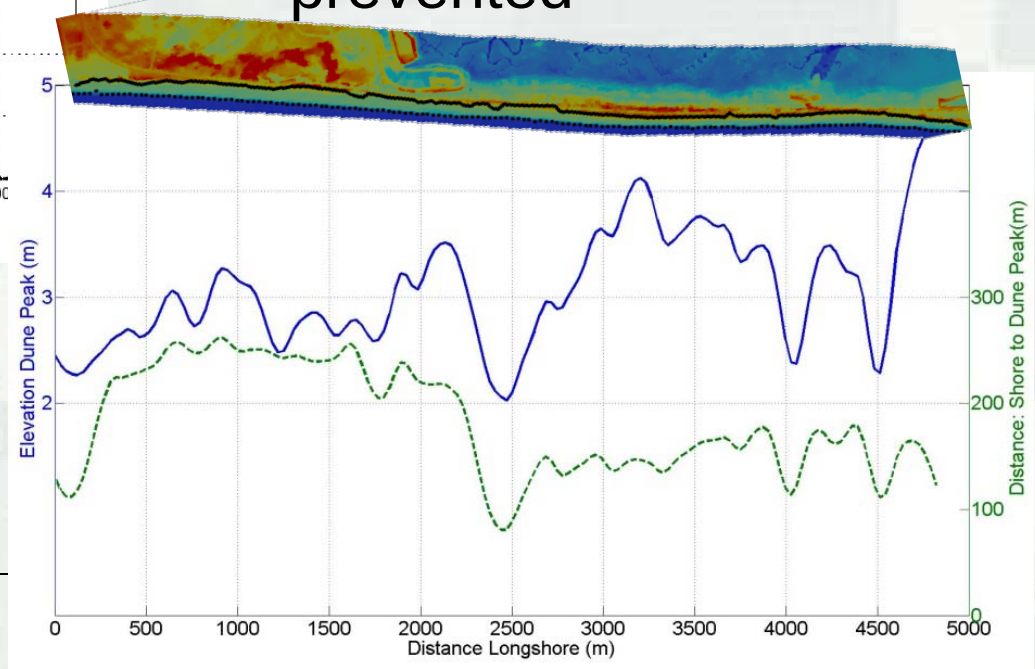
Beach Profile – feature extraction

- Automated Feature Extraction
  - Monitoring project performance – volumetric and contour change
  - Identifying re-nourishment requirements
  - Determine storm damages prevented



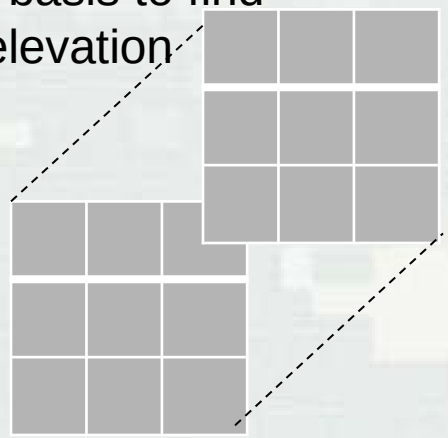


- Metrics used to identify areas of vulnerability (narrow beach width or low primary dune elevation)

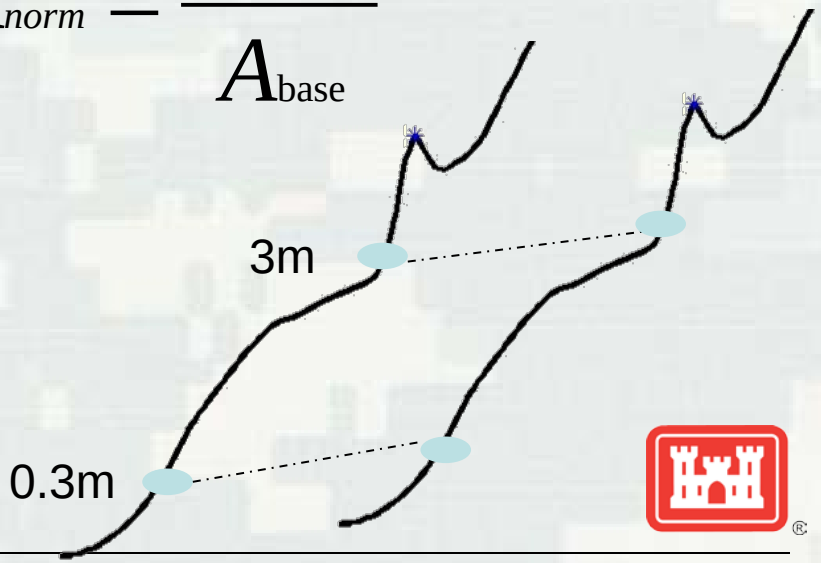
Monitoring

- Cell by cell analysis
  - Base: minimum elevation extracted from all surveys
- Metrics extracted from profiles for 0.3m contour and 3m contour
- Area of all surveys normalized with the area of the minimum base
- Contouring- horizontal shifts and area- sediment movement

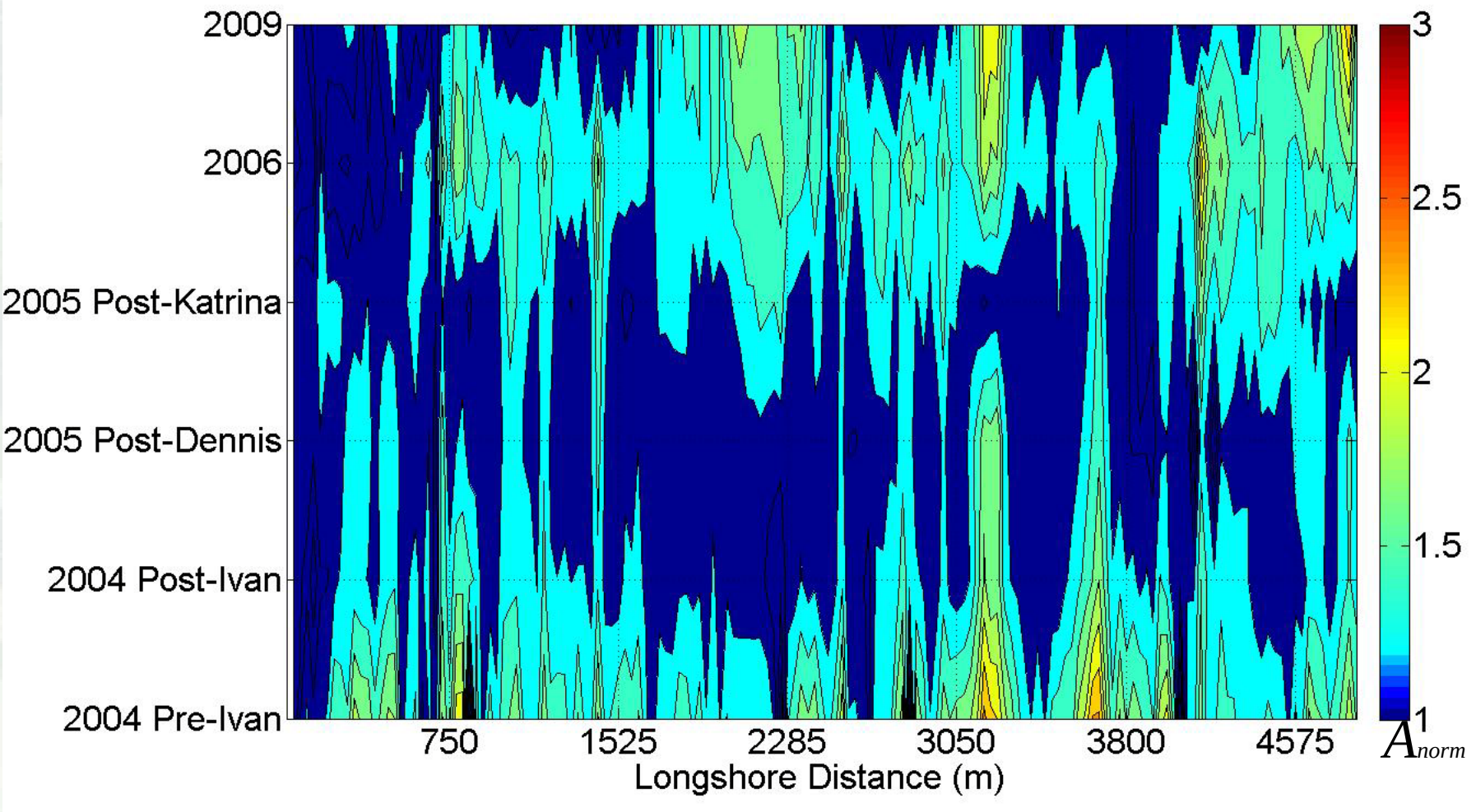
Compare all surveys on a cell by cell basis to find minimum elevation



$$A_{norm} = \frac{A_{surveys}}{A_{base}}$$



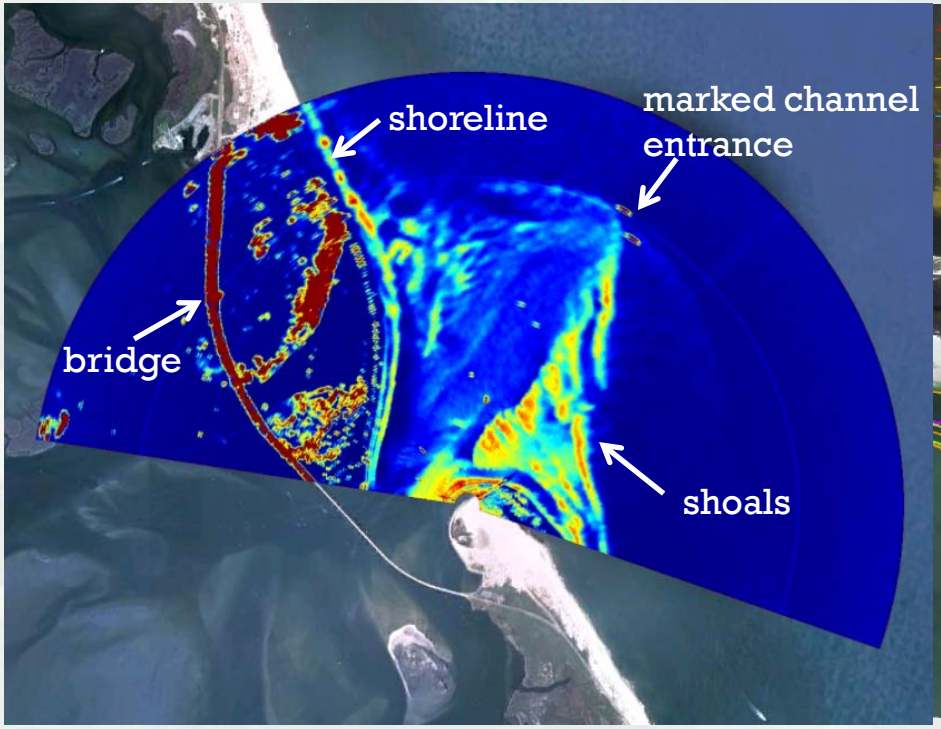
Monitoring

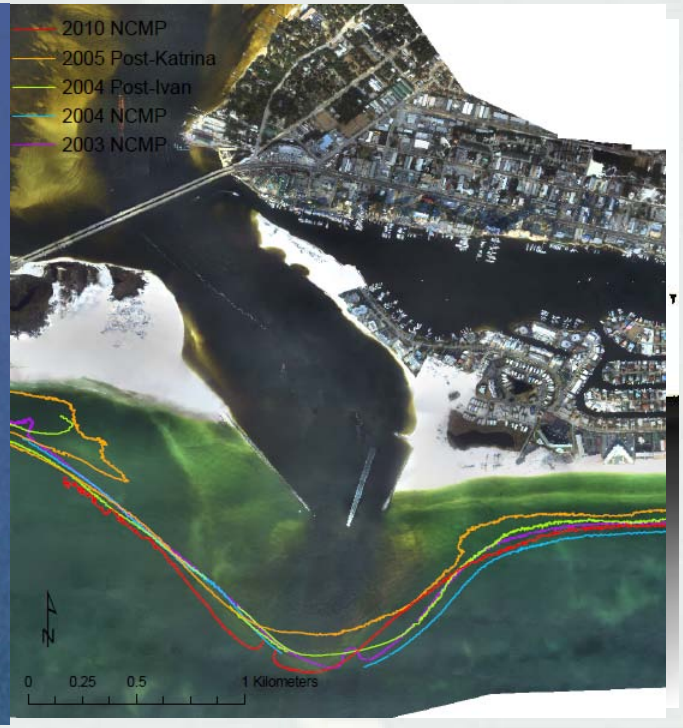


Multiple lidar surveys show areas that are close to minimum base elevation – indicator for vulnerability

Inlet Features

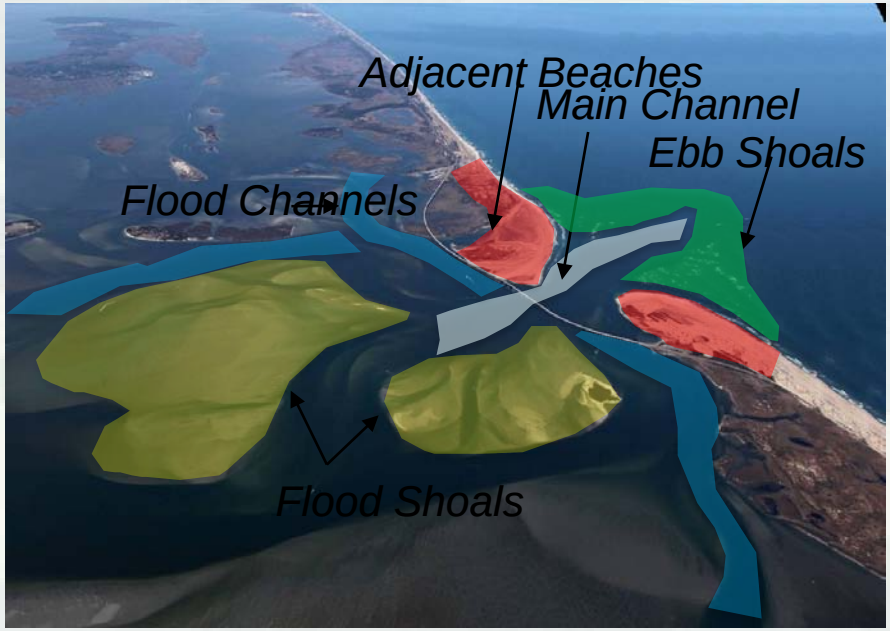
- Feature Extraction
  - Ebb shoal – bounds of the bypassing bar and attachment bar
  - Used to identify sediment pathways
- Problem- manual digitizing is laborious and subjective





Sediment Pathways

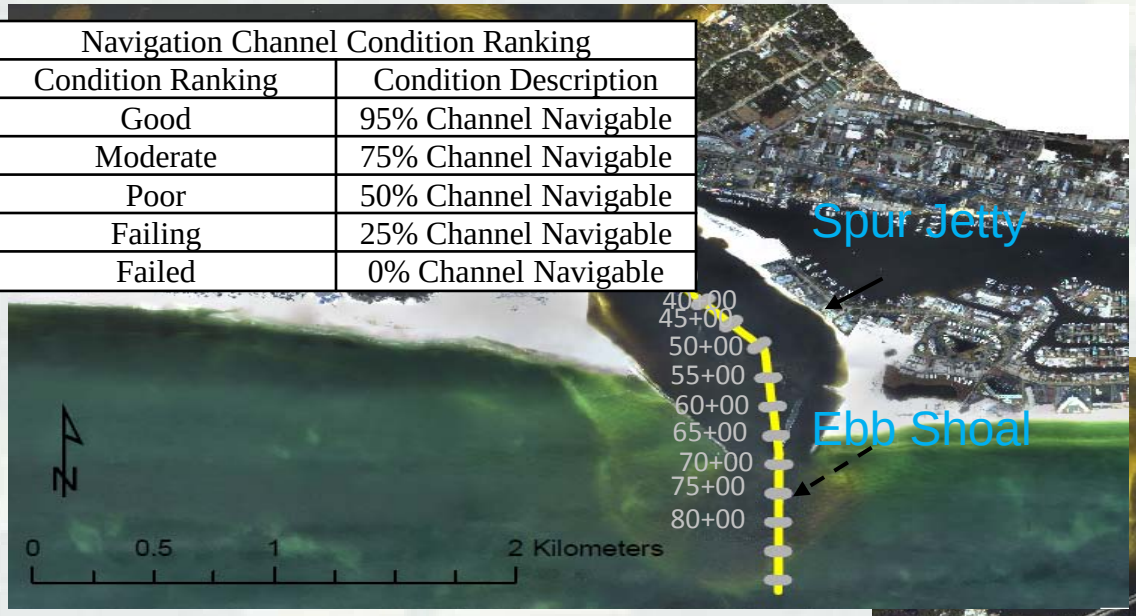
- Quantify amount of sediment entering/leaving system
  - Sediment budget
- Automated extraction of sediment volumes from lidar data to identify sediment pathways
- Delineate morphological cells

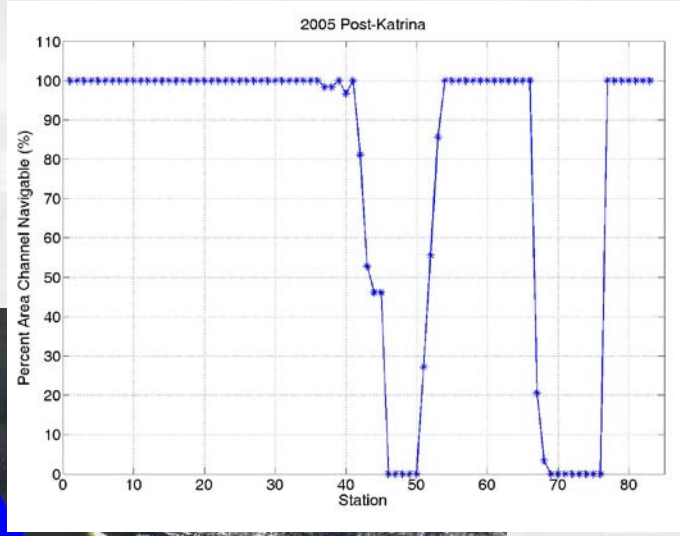


Cells: Inlet and ebb shoal

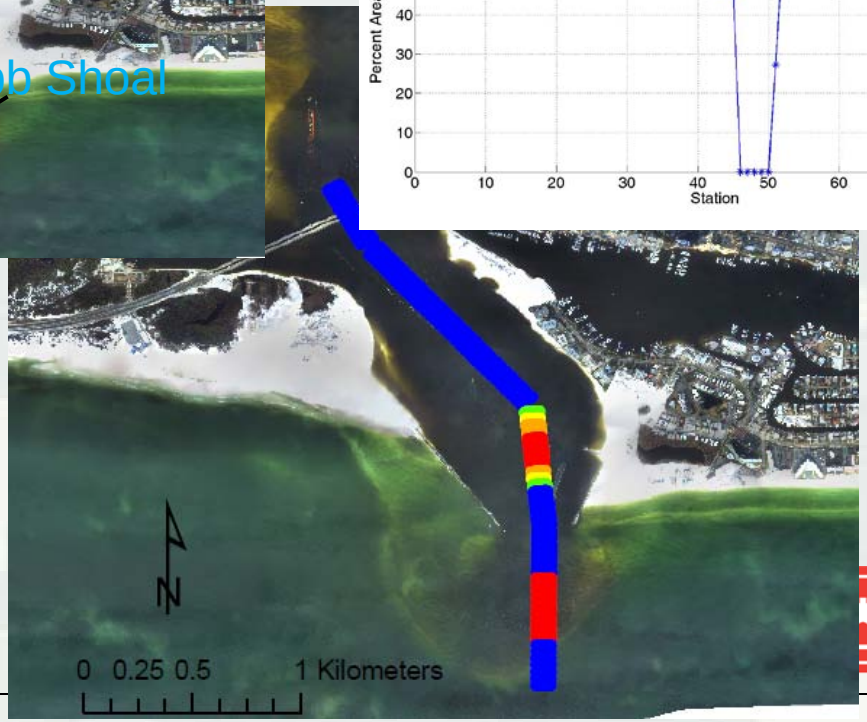
Channel Condition

Navigation Channel Condition Ranking	
Condition Ranking	Condition Description
Good	95% Channel Navigable
Moderate	75% Channel Navigable
Poor	50% Channel Navigable
Failing	25% Channel Navigable
Failed	0% Channel Navigable





- Determine navigability
- Identify areas of concern



Coastal Landcover Classification

- elevation and thematic data elements essential for capturing BOTH geomorphic and land cover characteristics in a data fusion approach
  - important for capturing frictional characteristics (i.e. Manning's N) critical for storm surge and hydrologic modeling
- coastal zone is highly dynamic, requiring consistent and temporally frequent land cover information

Manning n Value
0.04
0.07
0.034
0.04
0.012
0.04
0.05
0.12
0.02

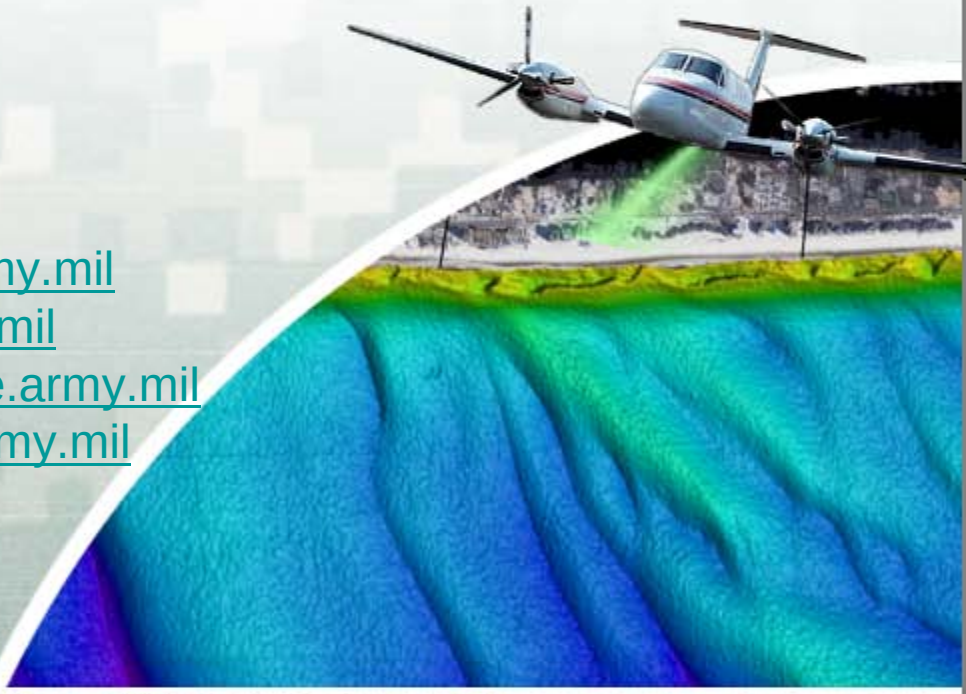
Tools/Methods –Next Steps

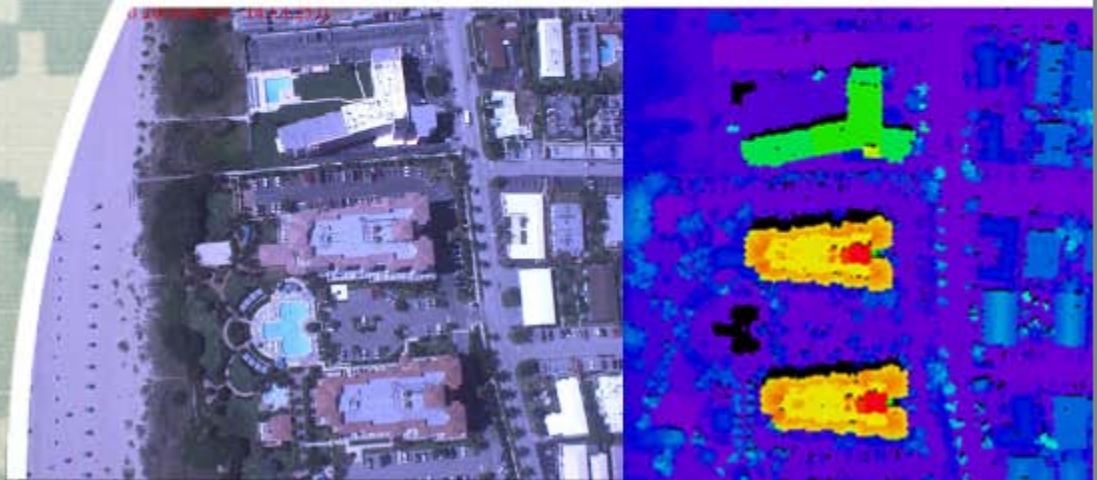
- Provide meaningful predictions for coastal planners of vulnerability before storms arrive
  - Convert metrics into useful quantities that can be applied to available data before-storms
- Performance metrics for beach nourishment, channel and ebb shoal conditions
- Ebb Shoal – refine process to automate the delineation of features
- Provide input into numerical models for morphological and coastal hazards analysis

Joint Airborne Lidar Bathymetry
Technical Center of eXpertise

Thank You!

Lauren Dunkin: lauren.m.dunkin@usace.army.mil
Kate Brodie: katherine.brodie@usace.army.mil
John McCormick: john.w.mccormick@usace.army.mil
Jesse McNinch: jesse.e.mcninch@usace.army.mil





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