2023 COASTAL MASTER PLAN
*COMMITTED TO OUR COAST*

# BARRIER ISLAND MODEL IMPROVEMENTS

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**AUGUST 21, 2020**

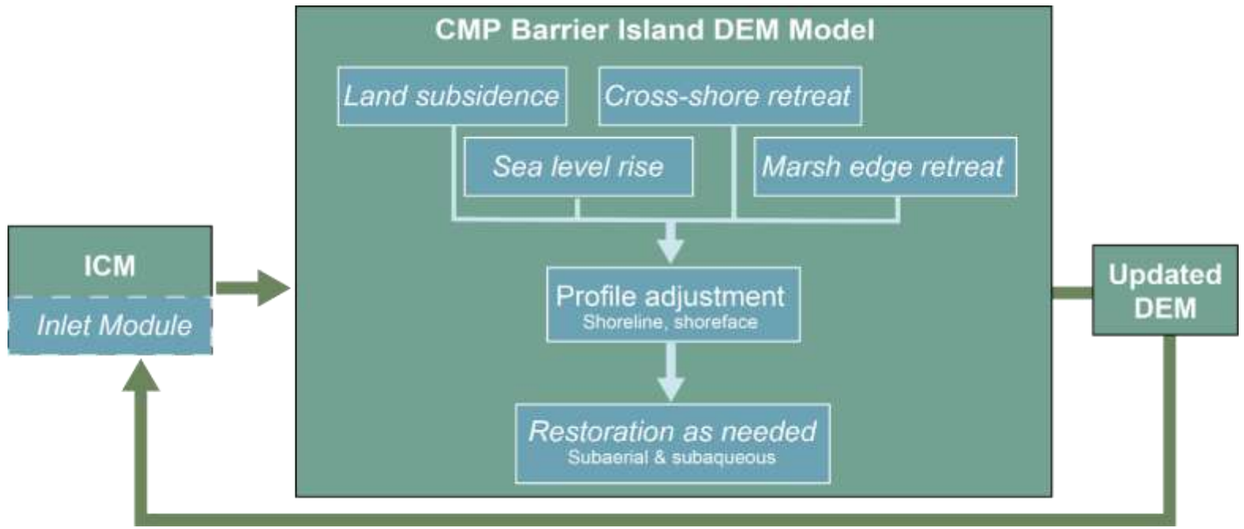
# PRESENTATION OVERVIEW

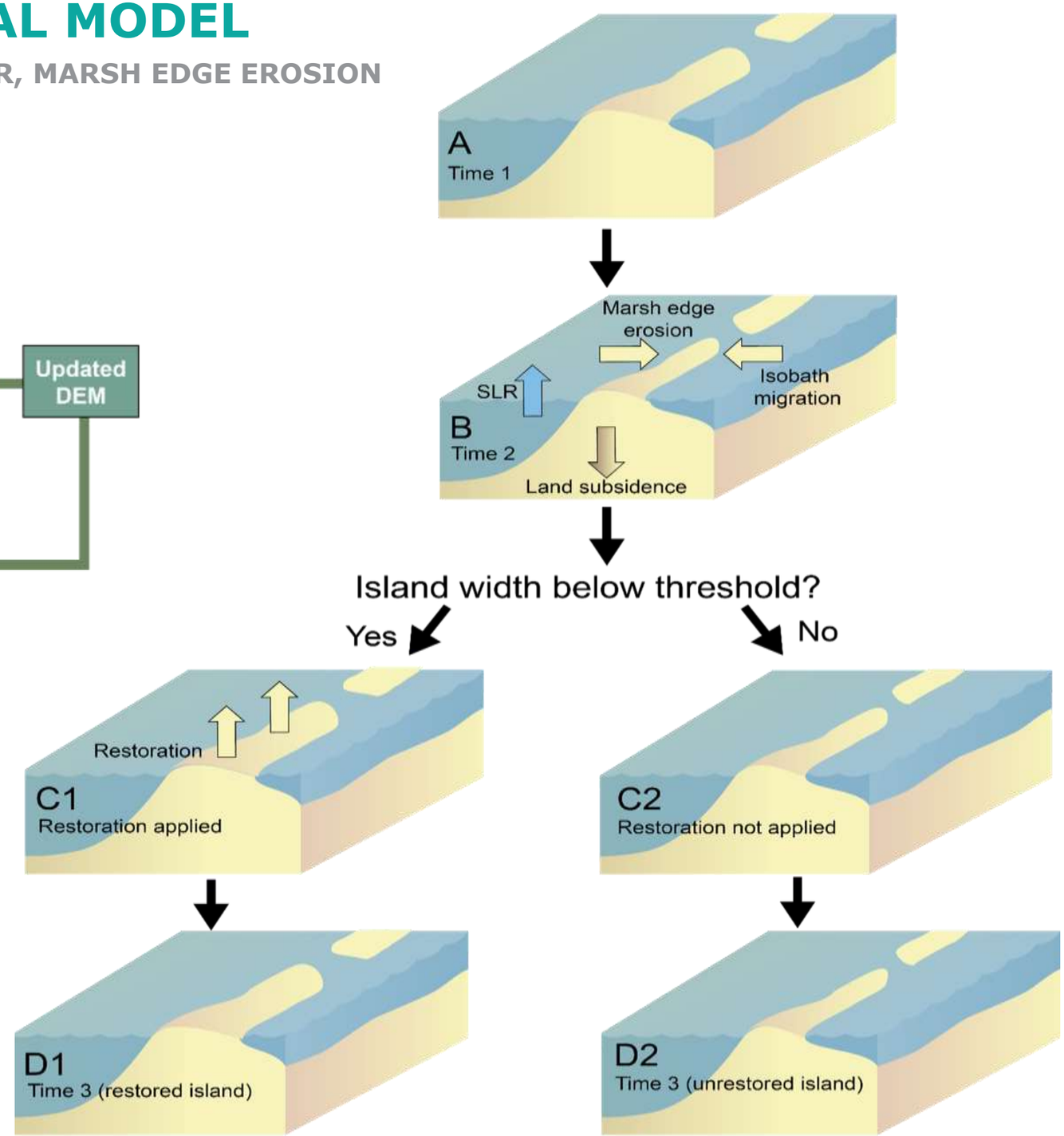
- Background
- Model Development and testing (BI-TI, BI-DEM)
  - Cross-Shore Retreat
  - Auto-Restoration
  - Sea Level Rise Modulation of Cross-Shore Retreat
- Calibration
  - Cross-Shore Retreat
  - Basin Tidal Prism and Inlets partitioning calibration

# BACKGROUND AND DEVELOPMENT

# BARRIER ISLAND CONCEPTUAL MODEL

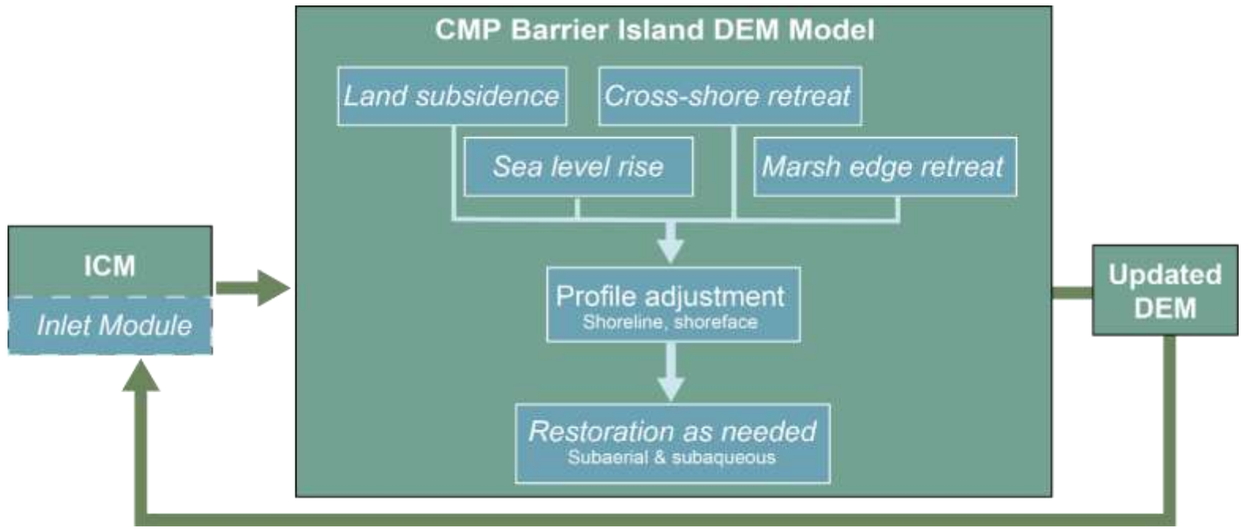
## REVISED PLAN - HISTORICAL RETREAT RATES, RSLR, MARSH EDGE EROSION



# BARRIER ISLAND CONCEPTUAL MODEL

## REVISED PLAN - HISTORICAL RETREAT RATES




- Historic cross-shore retreat rates used to evolve the entire profile (shoreface-shoreline), subaerial island, and backbarrier marsh edge erosion
- Cross-shore retreat rate modulated for sea level rise using experiments with SLR-shoreface model (Nienhuis & Lorenzo-Trueba, 2019)
- Profile elevation lowered based on subsidence. Sea level rise is passed through as water level increase from ICM-Hydro
- If island critical thresholds reached, restoration elevation template added to profiles within “restoration unit”

# BARRIER ISLAND CONCEPTUAL MODEL

## REVISED PLAN UTILIZING HISTORICAL RETREAT RATES PLUS SLR MODULATION

Cross-shore retreat

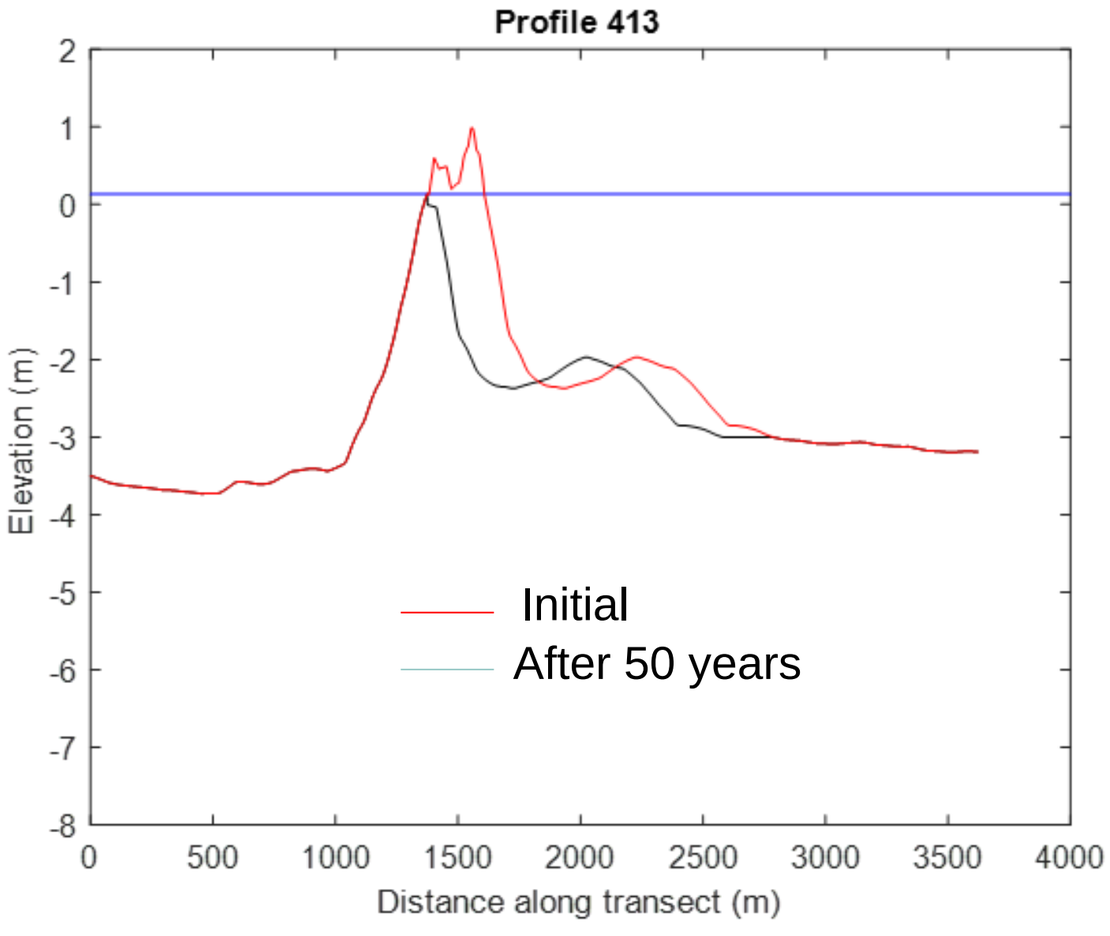
$$x_{new} = x_{old} + \left(\frac{dx}{dt}\right) * dt$$

SLR modulation term

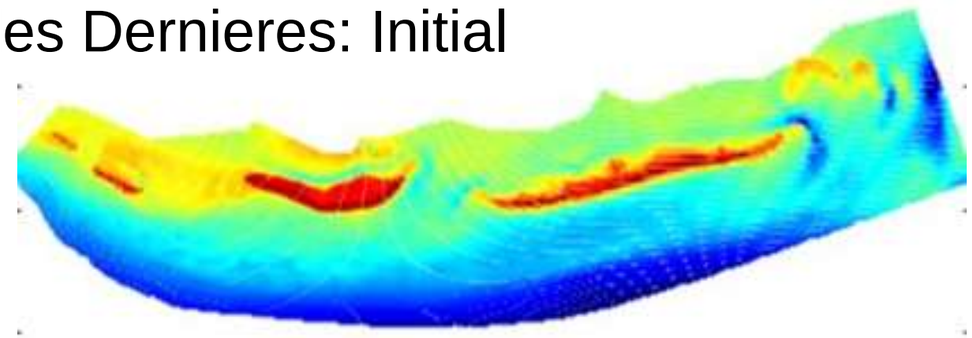
$$\frac{dx}{dt} = \alpha \left(\frac{dx}{dt}\right)$$

$\alpha$, is derived from the slope of the normalized retreat rates at different RSLR rates

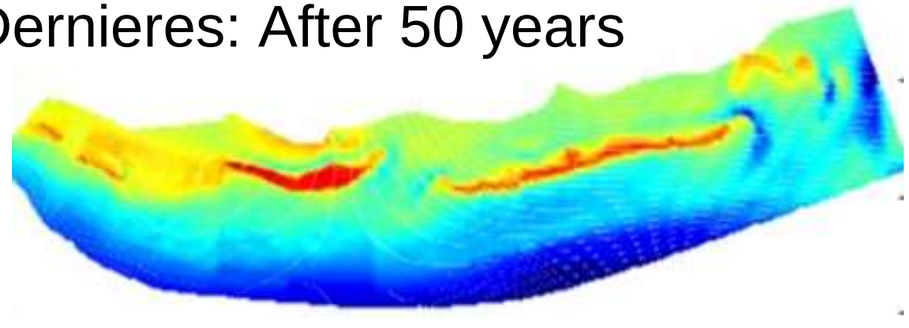
$\alpha = 1 + (slope*(RSLR_{new} - RSLR_H))$




Isles Dernieres: Initial



Isles Dernieres: After 50 years

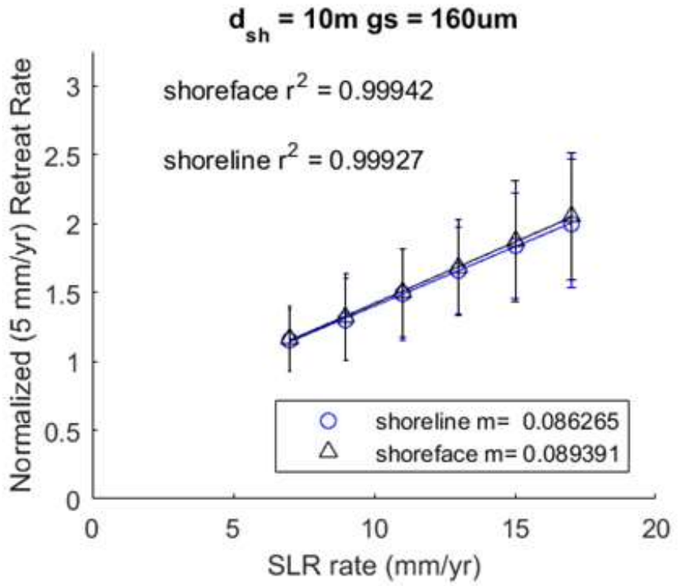


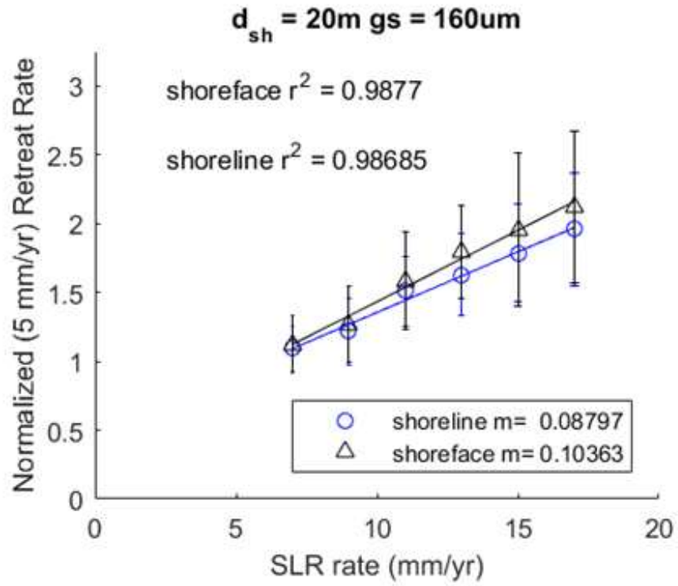
# SEA LEVEL RISE RETREAT MODULATOR

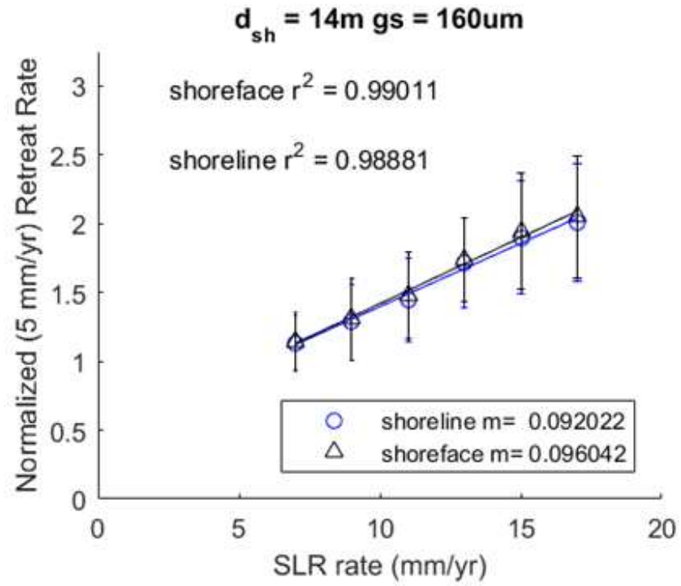
## EXPERIMENTS USING A SCHEMATIZED BARRIER RETREAT INLET MODEL EVOLUTION (BRIE)

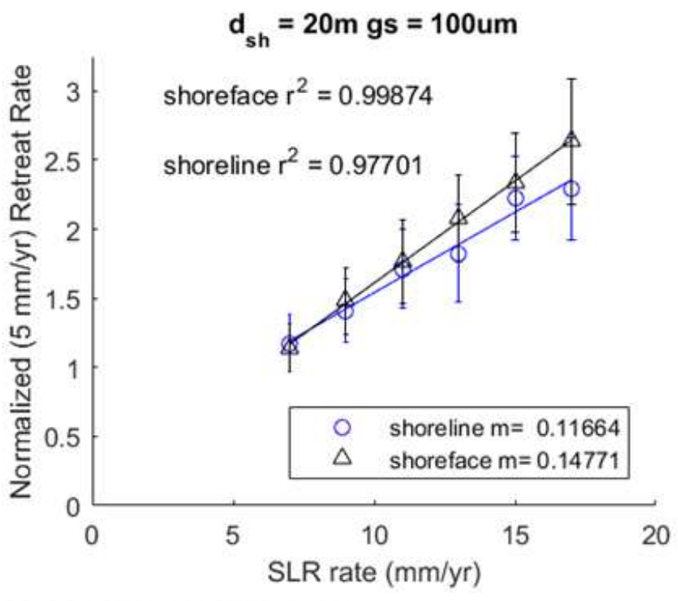
- Test combinations of grain size, shoreface depth, barrier height, and wave climate for various RSLR rates
  - These experiments were performed to test best fit with Louisiana coast at selected locations (~25-30 runs)
  - Sensitivity simulations (~190 runs) for key model parameters
- Model produces a reasonable approximation to BICM reported rates (shoreline) and Beasley et al (2019); shoreface

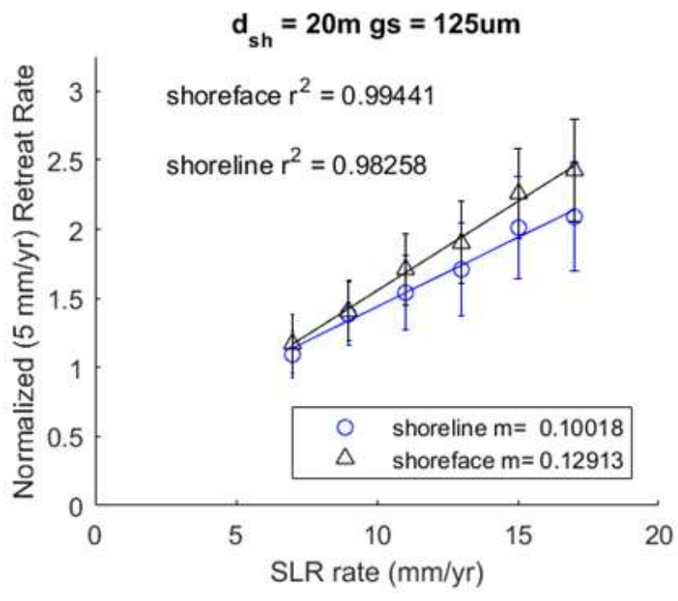
# AVERAGED, NORMALIZED RETREAT RATES (CHANDELEURS)



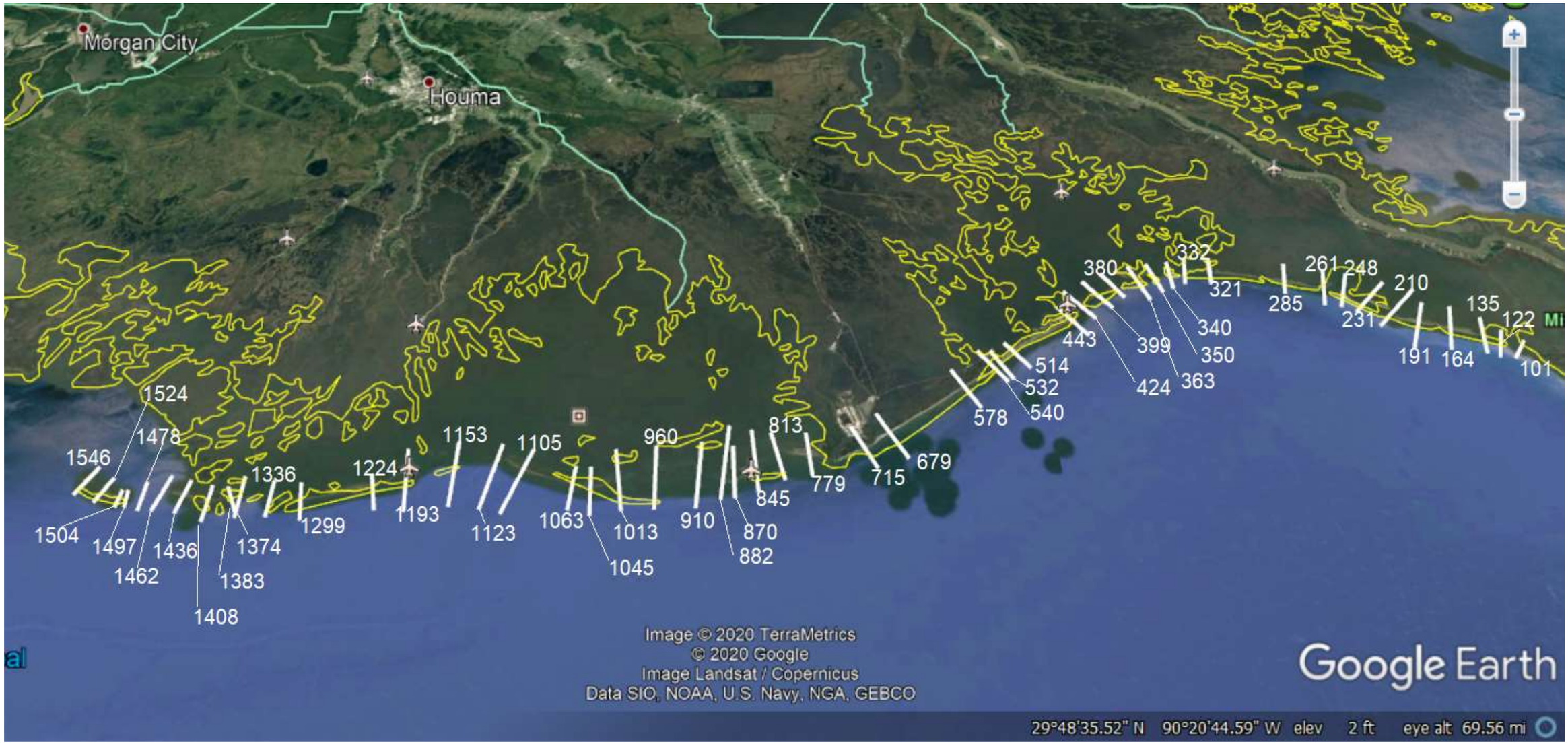




Take home: doubling of SLR, increases shoreface/shoreline retreat rates by 30-50%. At rates three-times present, retreat rates double.

Normalized by local RSLR rate for each region:
Central Coast – 9 mm/yr (NOAA)
Chandeleurs – 5 mm/yr (BICM)

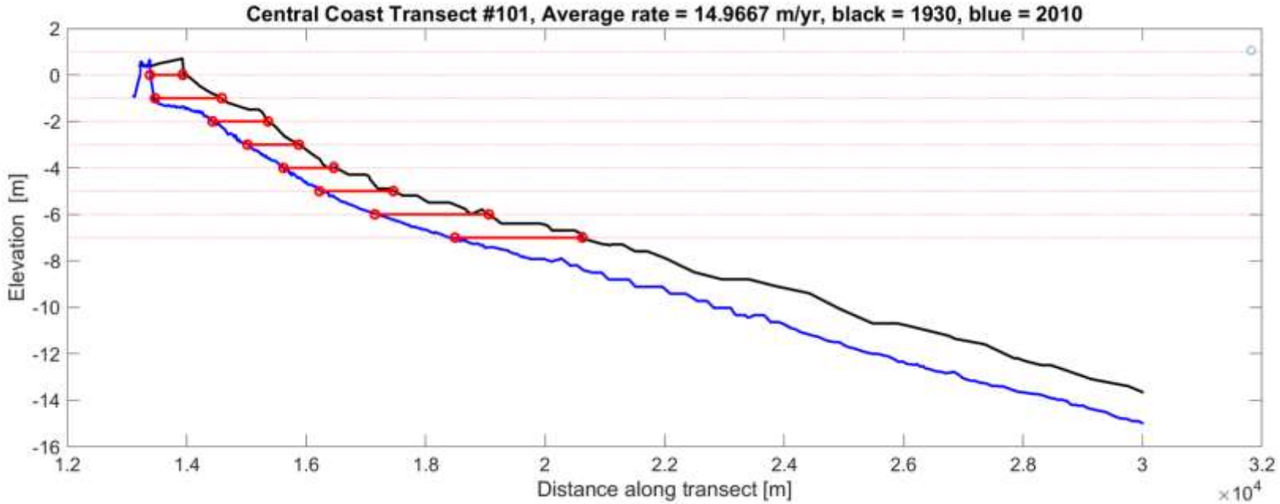
# SPATIALLY VARIABLE RETREAT RATES

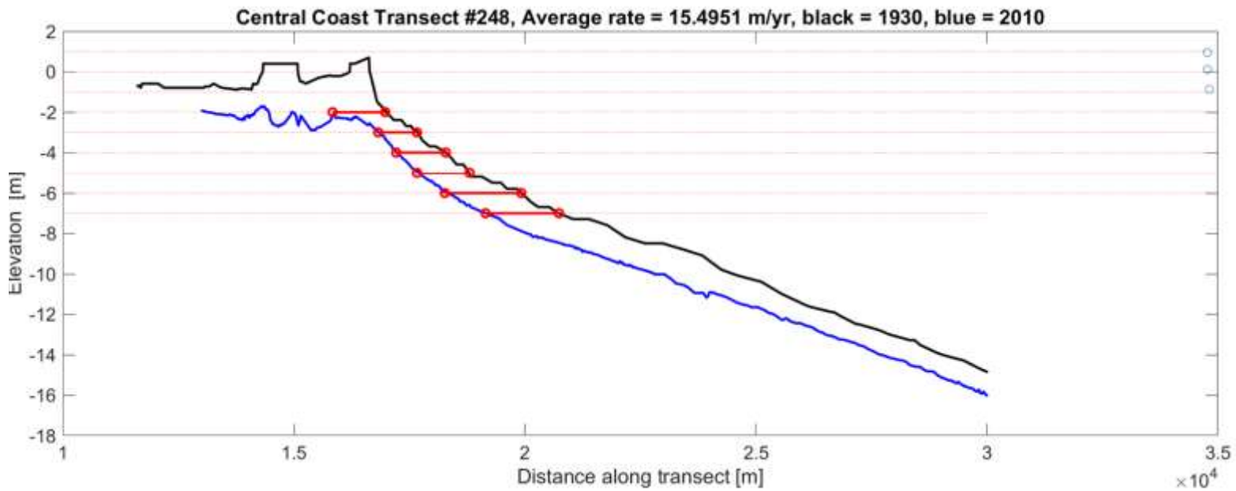
## CROSS-SHORE RETREAT RATE EVALUATION AND ALONGSHORE VARIABILITY

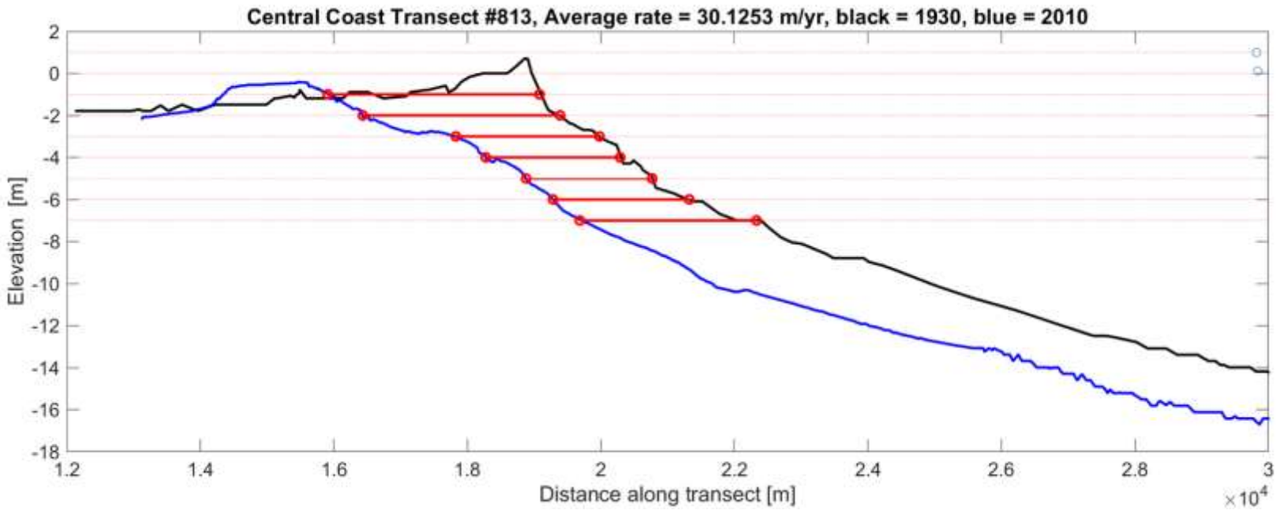


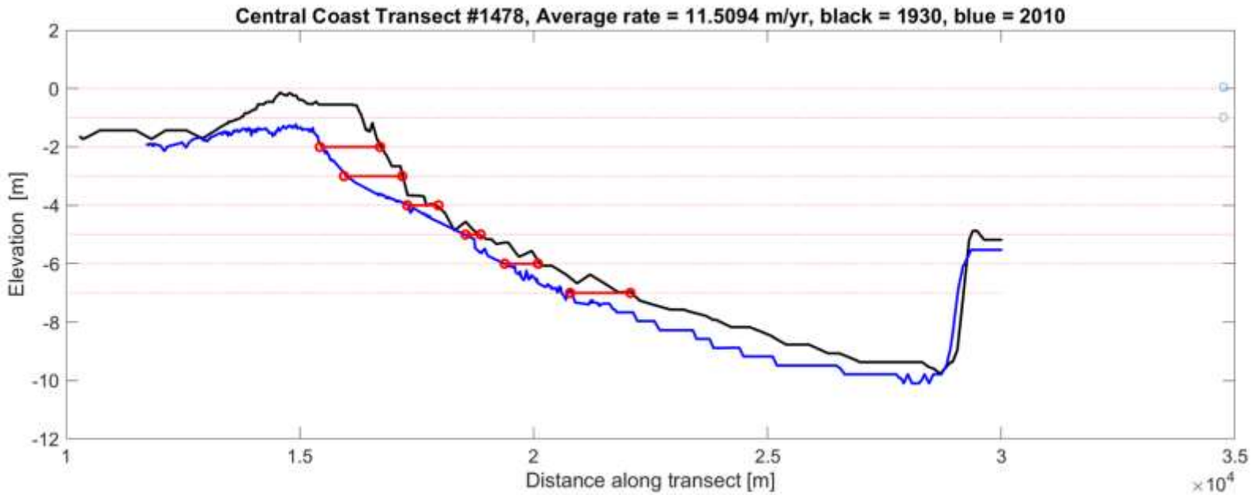

Use of "index" profiles to establish alongshore variability (rates for profiles that fall within index profiles are using interpolated rates from the two bounding index profiles

# SAMPLE INDEX PROFILE RETREAT RATES (1930-2010)



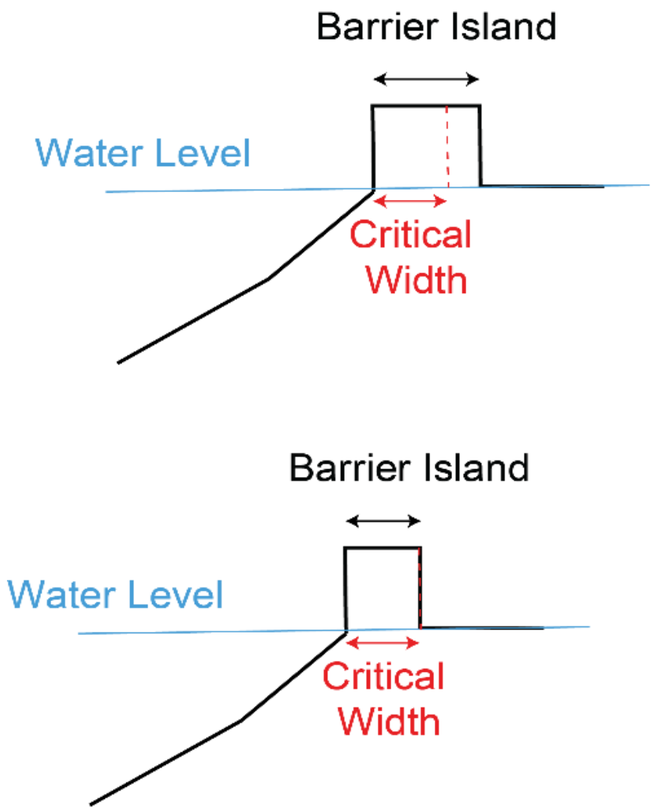



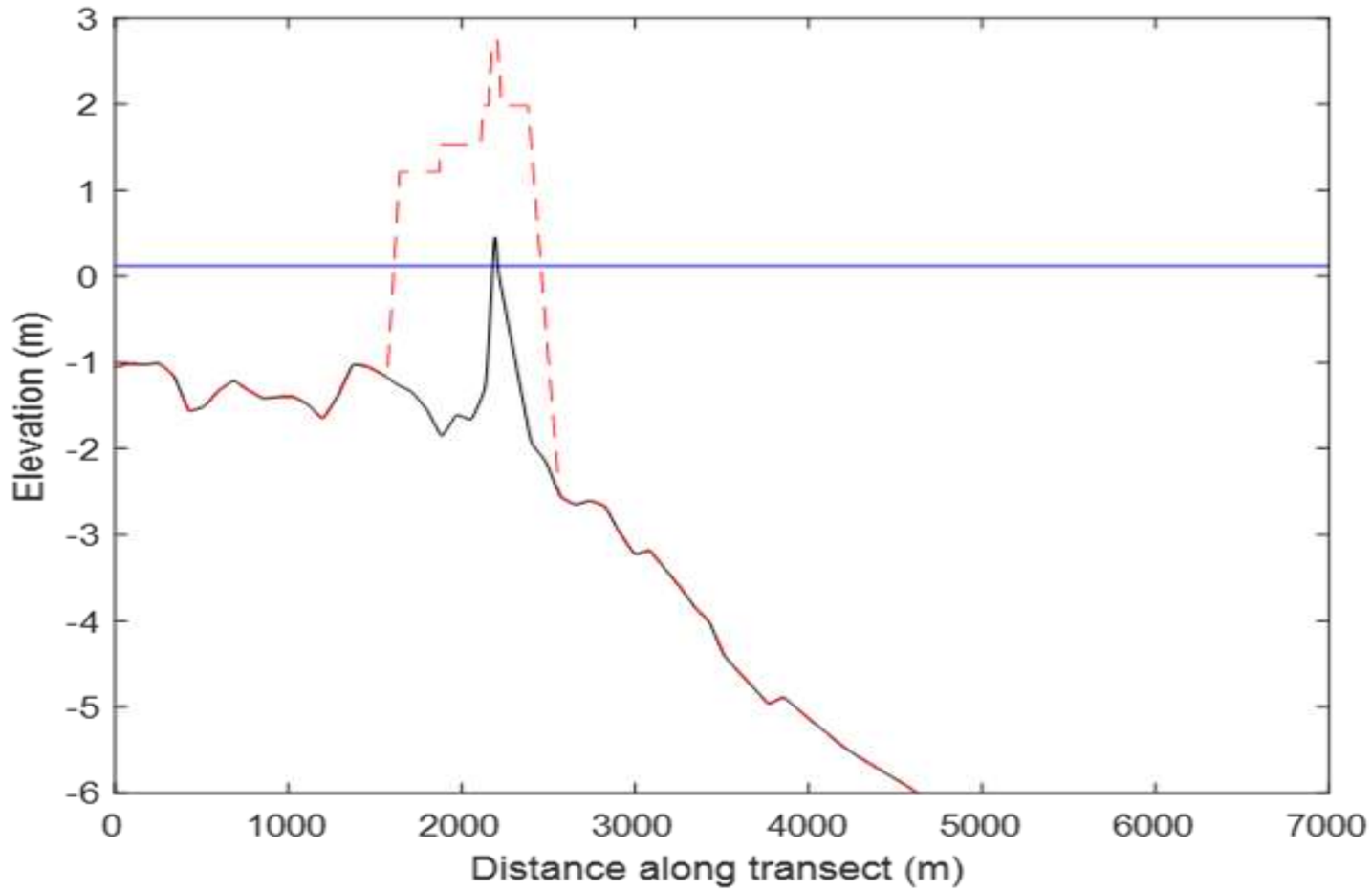




Calculation of rates includes the retreat rate from the shoreline-upper shoreface from 1930-2010, corrected for subsidence and sea level rise. Model uses the average cross-shore retreat rate. Each index profile has a unique rate (spanning across many geomorphic units), thus along the coast, every profile (non-index) has a unique retreat rate informed via interpolation.

# AUTO RESTORATION




Implementation of auto-restoration within the ICM-BI model. If the subaerial width of at least 10% of profiles within a restoration unit fall below the critical width (left), the restoration profiles is applied to all profiles within the restoration unit. For example, the subaerial width of the island in the profile on the right has fallen below the critical threshold after application of cross-shore retreat and subsidence (pre-restoration profile in black, water level shown as horizontal blue line). The barrier island restoration template is therefore applied (red dashed line), aligned so that the peak of the restored profile is above the peak of the existing island.

# AUTO RESTORATION UNITS

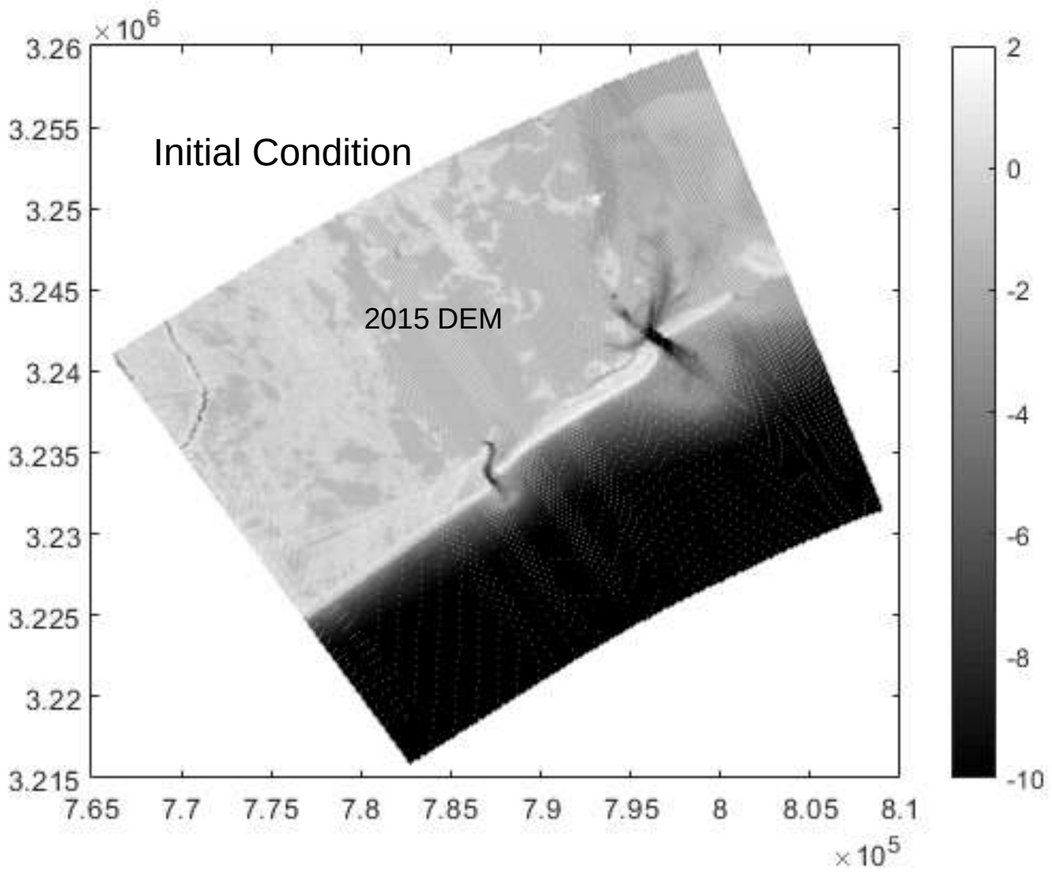
## RESTORATION UNITS HAVE UNIQUE TEMPLATES INFORMED BY E&D TEMPLATES FROM CPRA RESTORATION PROJECTS

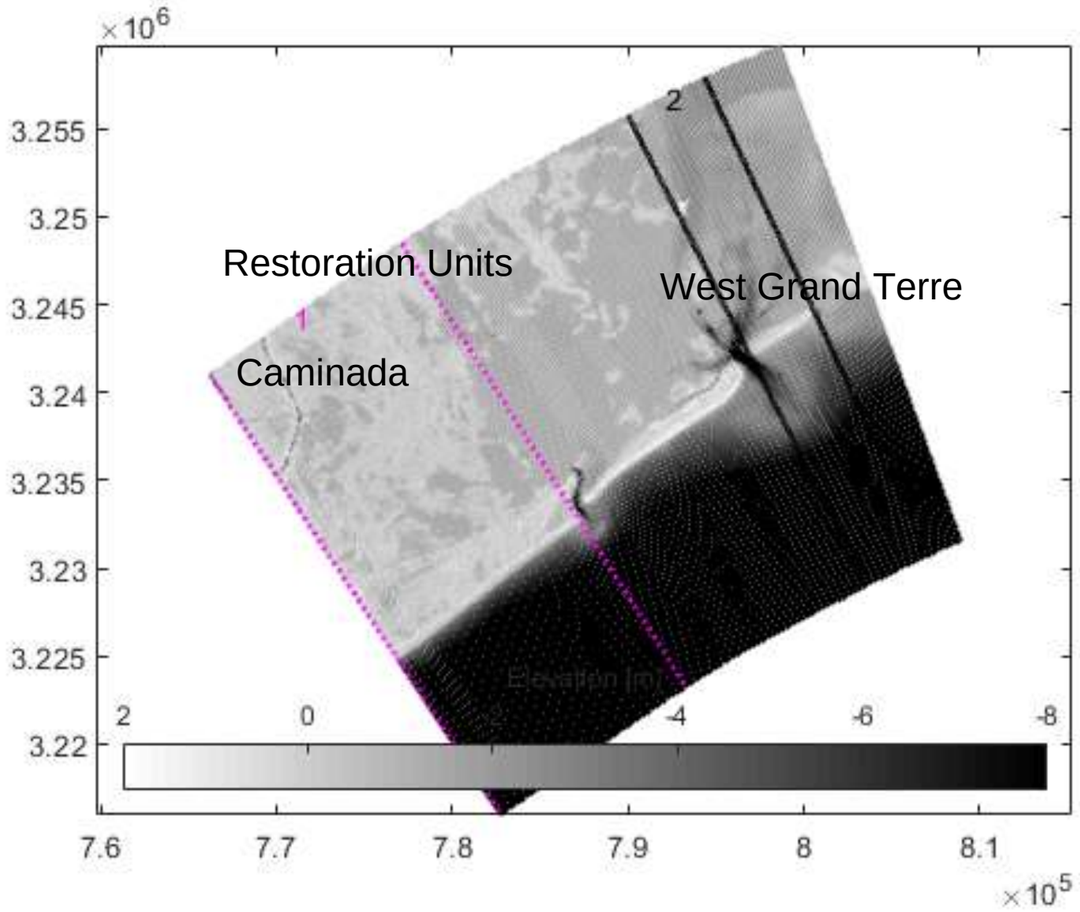

Restoration units for the Caminada Headland and Barataria model domains. Model domains are shown in white (Caminada Headland Domain to the west, Barataria Domain to the east), restoration unit delineations shown in blue. Auto-restoration was not applied to the Grand Isle unit (e.g., locked in place – non retreating barrier)

# AUTO RESTORE TESTING

**FORECAST (2015-2065)**

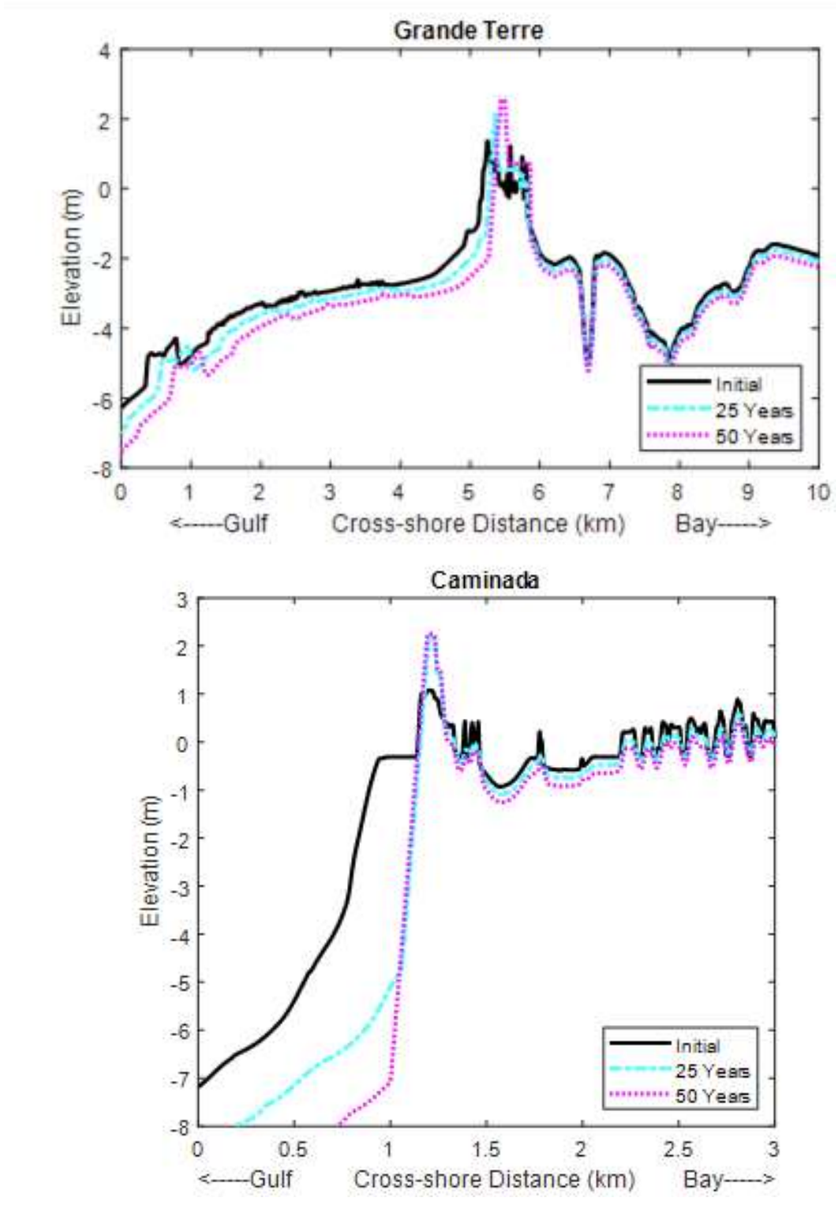
- SLR of 0.00246 m/yr (Pensacola) subsidence of 0.0067 m/yr (Grand Isle minus Pensacola); historic cross-shore retreat
- Restoration when >10% of profiles in unit are at critical threshold: 25% of restored width for barrier, crossing dune line for headland



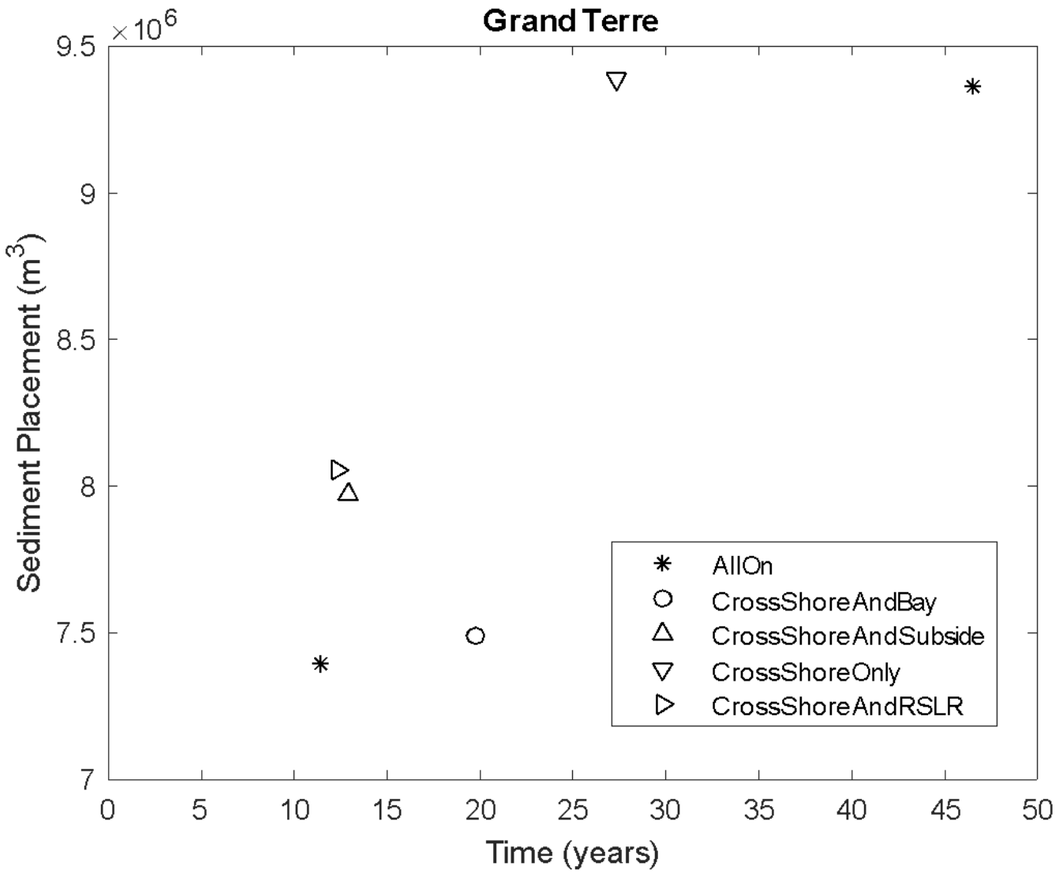
# CROSS-SHORE RETREAT, SUBSIDENCE AND SLR

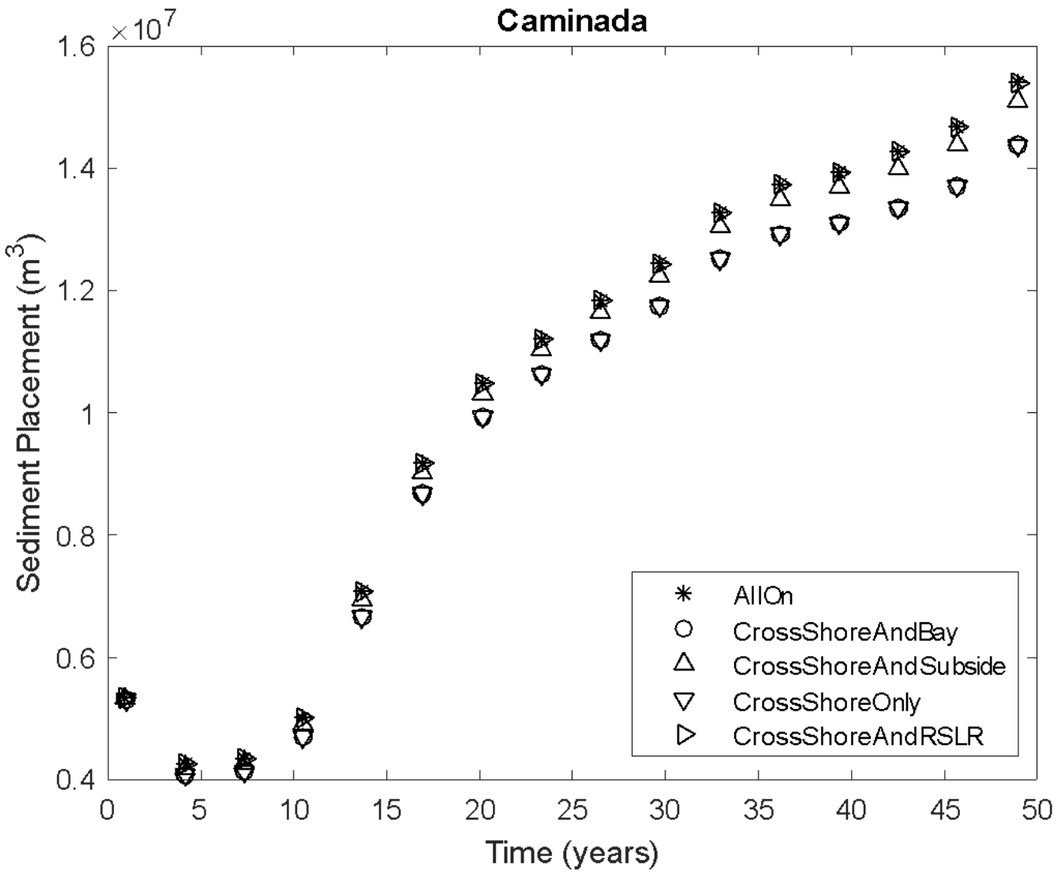
## FORECAST (2015-2065), ISLAND RETREAT VS HEADLAND STAYING IN PLACE



# CROSS-SHORE RETREAT, SUBSIDENCE AND SLR

## COMPARISON BETWEEN DIFFERENT PROCESSES AND TRACKING SAND PLACED



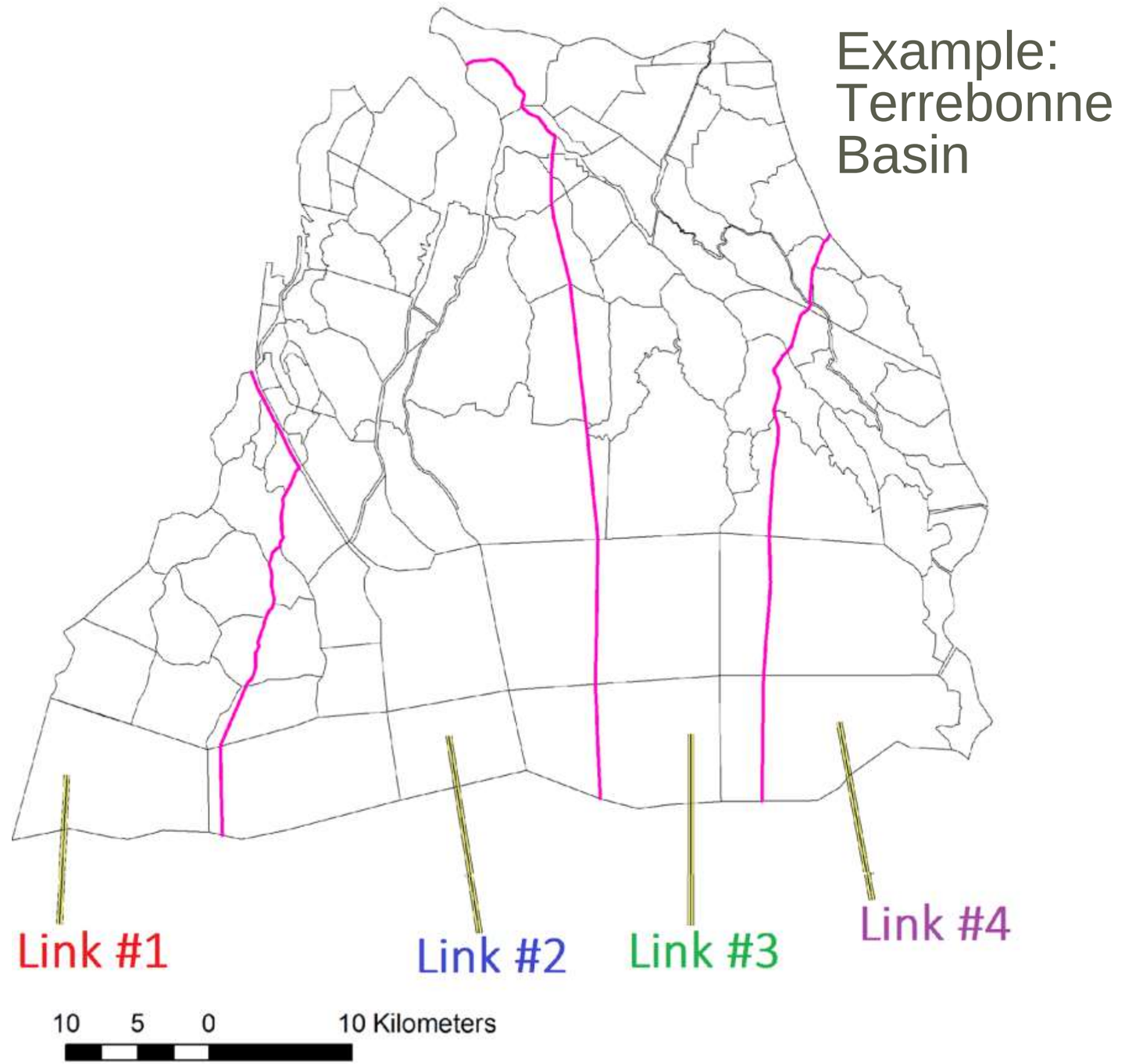



# BARRIER ISLAND TIDAL INLET (BITI) MODEL

- O’Brien–Jarrett–Marchi law is used to relate the tidal prism to the inlet cross-sectional area (D’Alpaos et al., 2009) using empirical coefficients derived for un-jettied Gulf of Mexico inlets
- Tidal inlets are represented by Type 1 links that connect the ICM-Hydro compartments to the Gulf
- Each link is pre-assigned a portion of the tidal prism in each ICM-Hydro compartment in the basin via partitioning coefficients
- Existing inlet width to depth ratios from bathymetry data are used to translate cross-sectional area to link attributes of width and depth

# BITI MODEL PARTITIONING COEFFICIENTS

- The basin area is divided between the given links.
- Partitions are drawn (initially) based on hydrologic divides.



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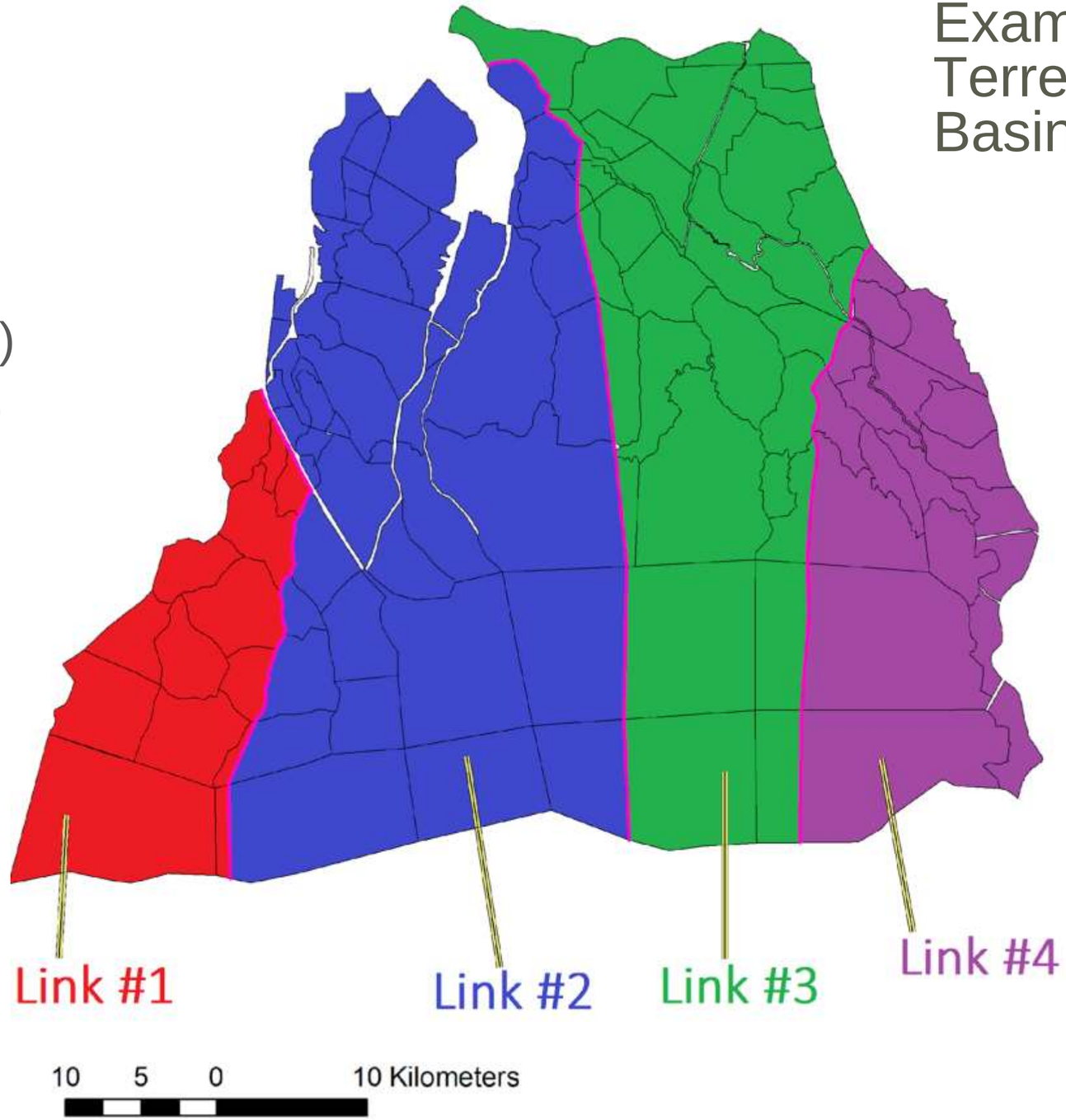
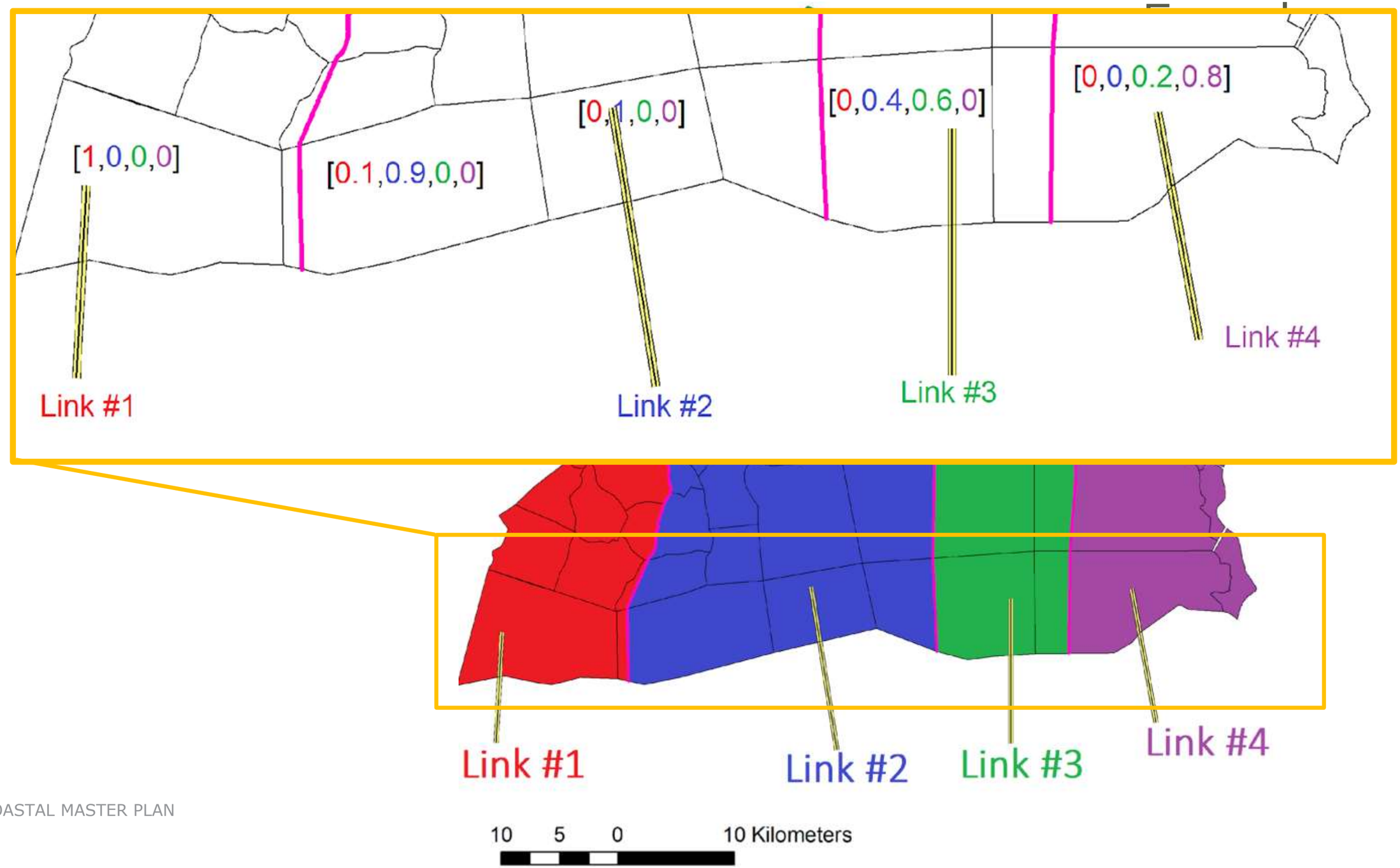


# BITI MODEL PARTITIONING COEFFICIENTS



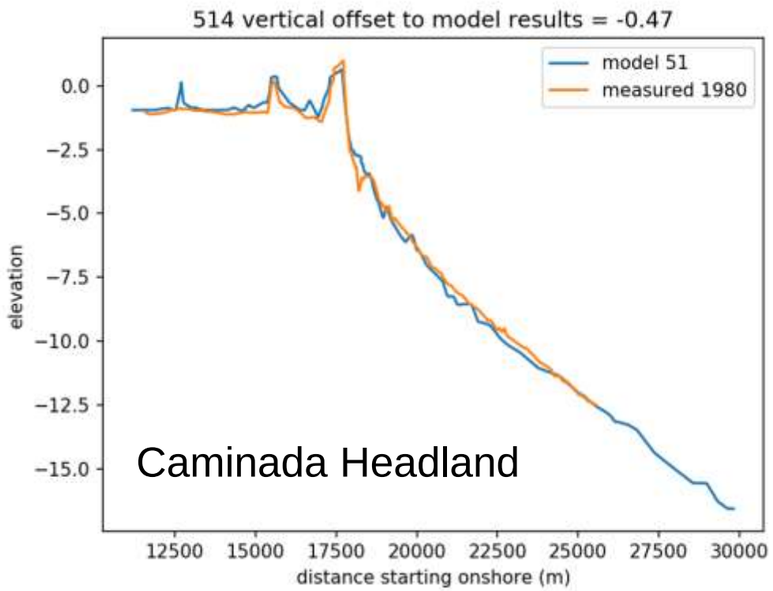
# BARRIER ISLAND TIDAL INLET (BITI) MODEL

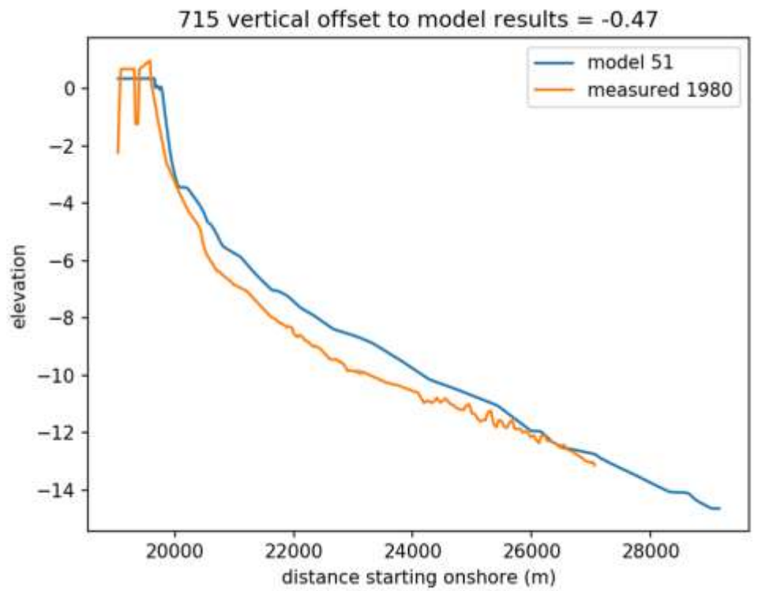
- Operates with the ICM-Python code
- To be determined in calibration and validation stage:
  - Partitioning coefficients for each ICM-Hydro compartment-link pair (using 2023 compartments and links)
  - Adjust as needed using a reduction factor for the basin tidal prism due to tidal attenuation effects

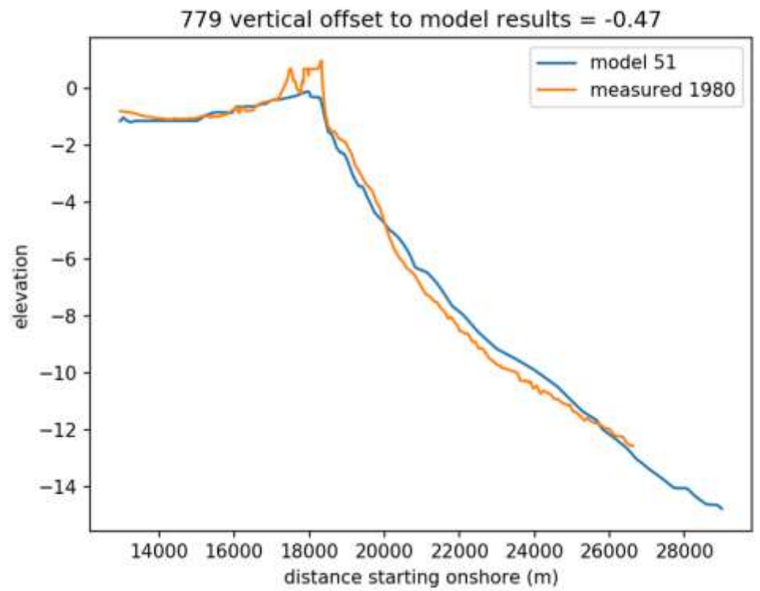
# CALIBRATION

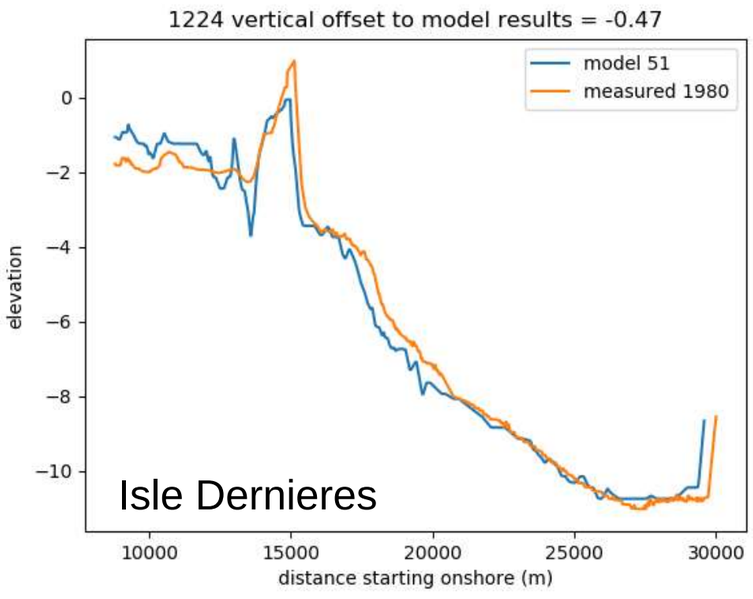
# CROSS-SHORE RETREAT CALIBRATION

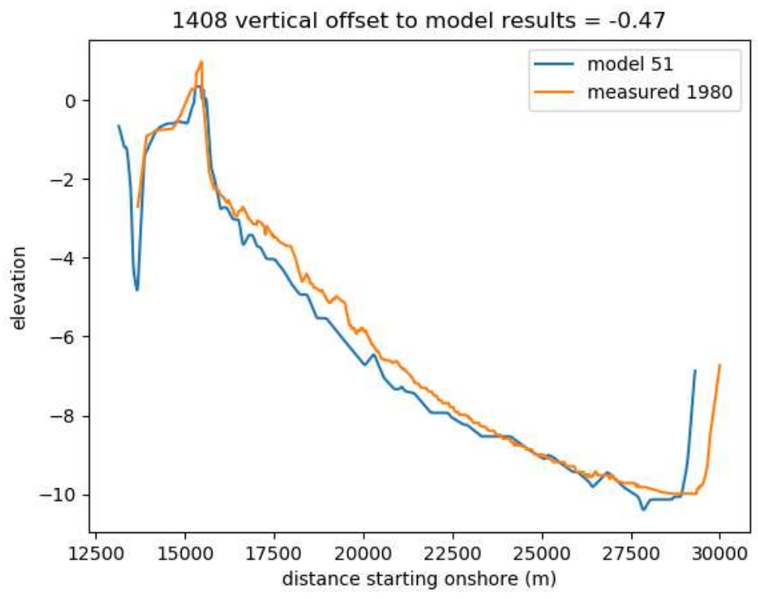
## SELECTED PERIOD FROM 1930-1980 (CENTRAL COAST)

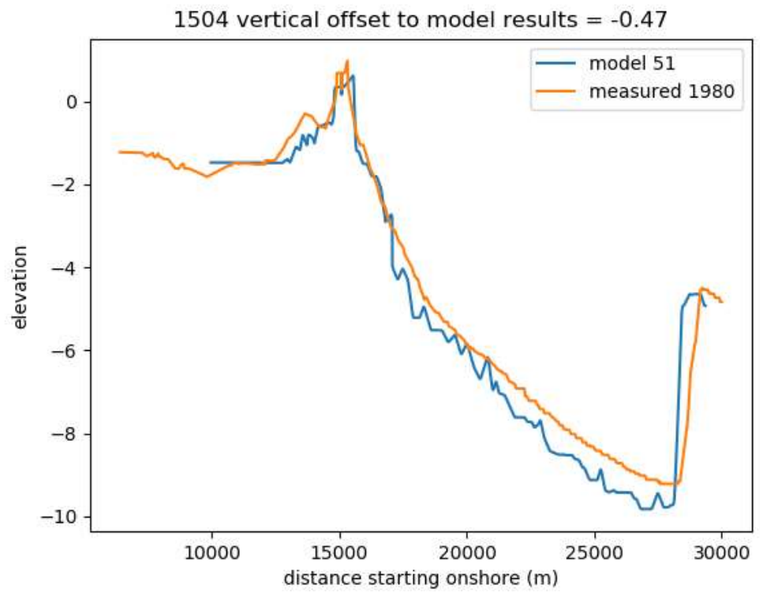


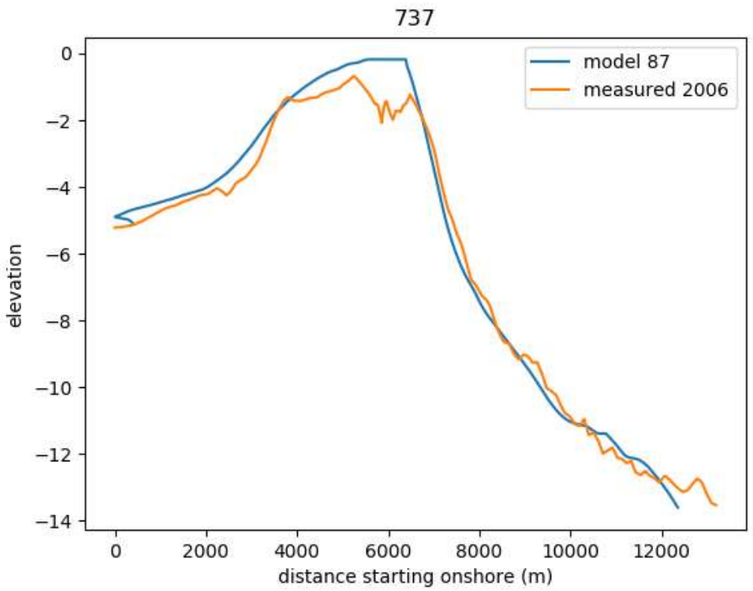



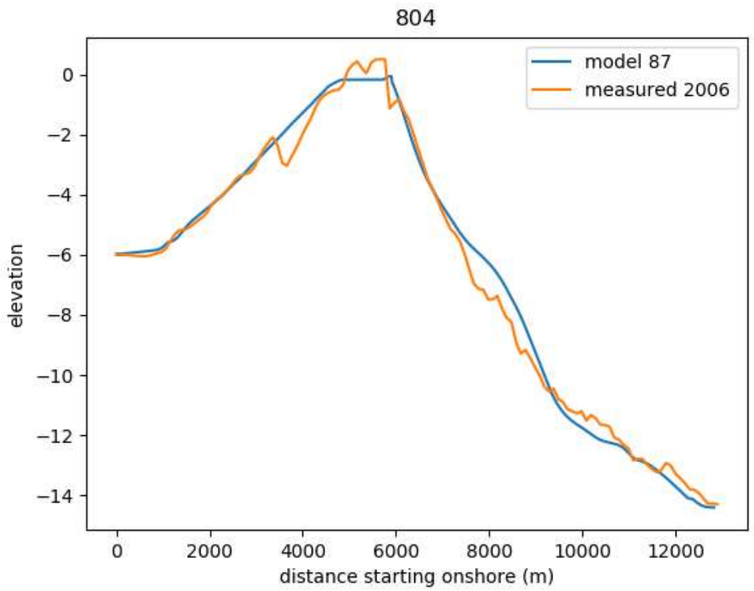



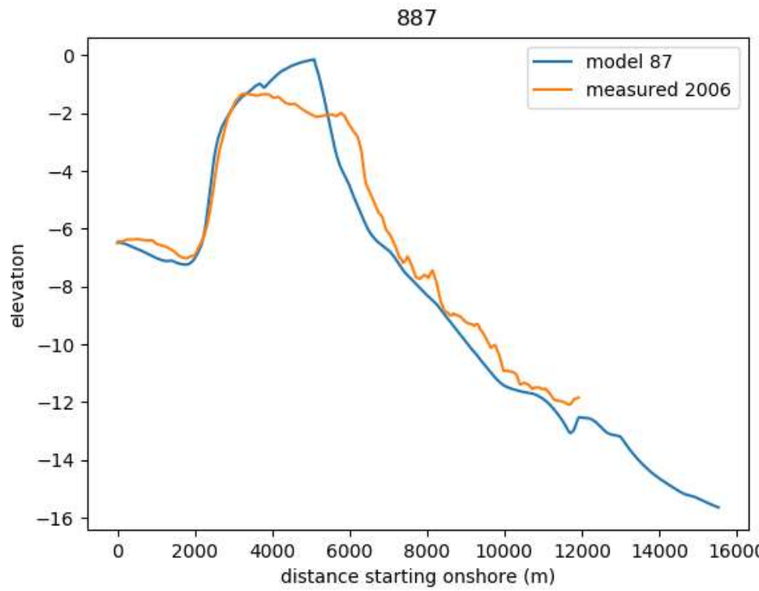



# CROSS-SHORE RETREAT CALIBRATION

## SELECTED PERIOD FROM 1920-2006 (CHANDELEUR ISLANDS)



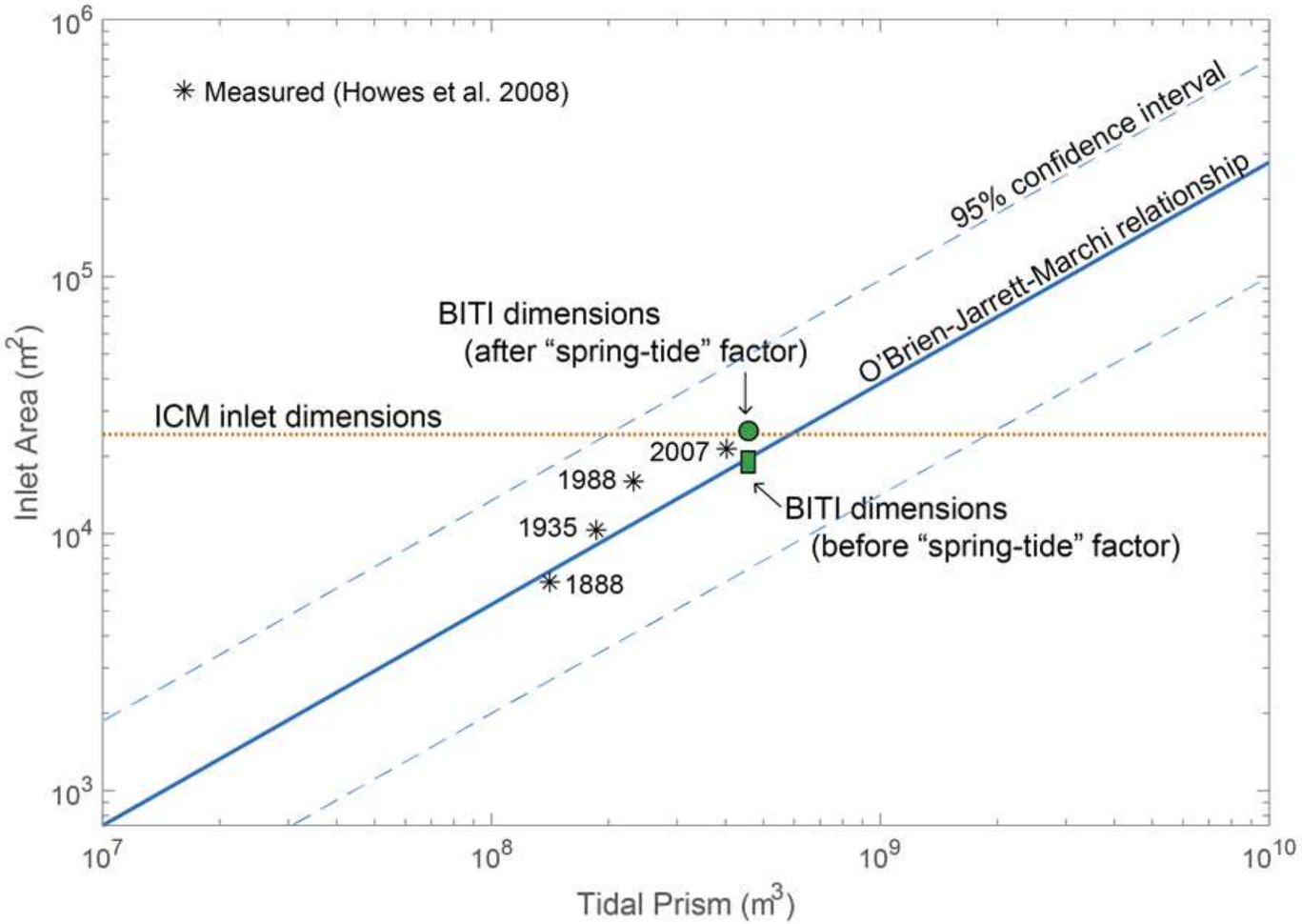



# TIDAL PRISM CALIBRATION

## CALIBRATION OF TIDAL PRISM IN BARATARIA BASIN, ISOCHRON DEVELOPMENT AND PARTITIONING COEFFICIENTS

Calibration of tidal prism in the the Barataria Basin using observations

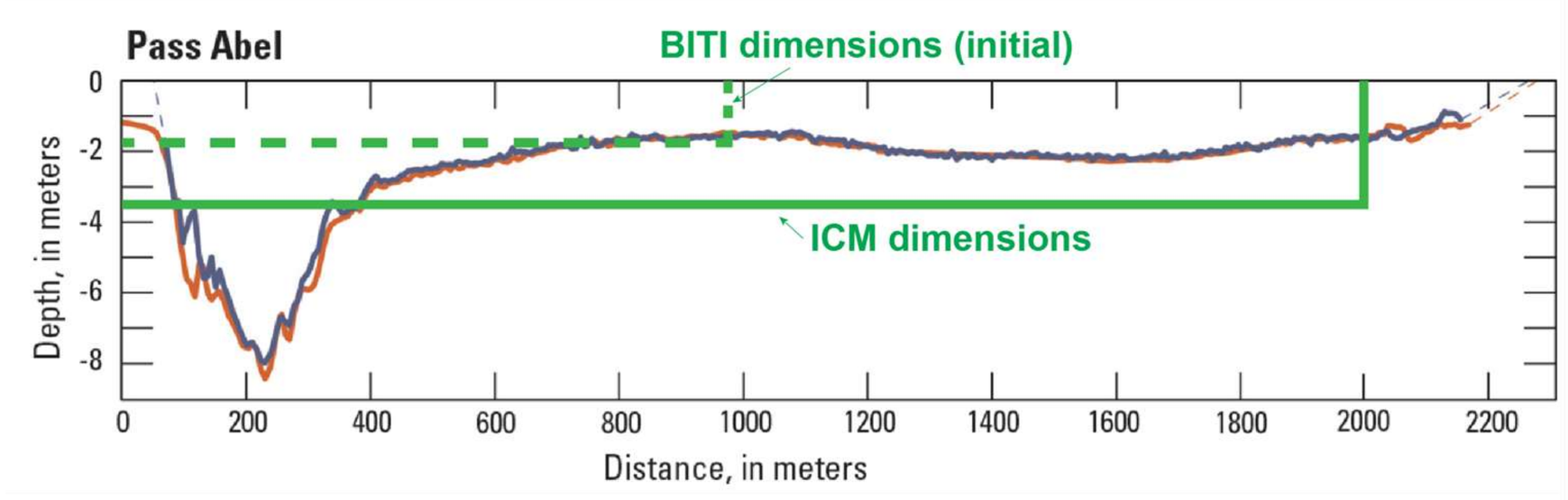


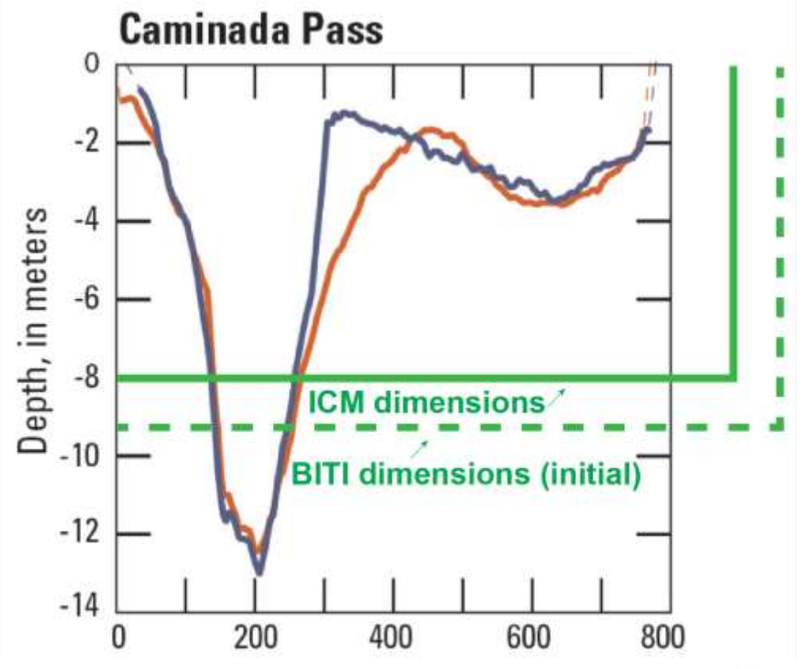

Tidal Prism volumes from historic estimates using cross-sectional area (1888-1988), and ADCP measurements (2007)

# TIDAL PRISM CALIBRATION

## CALIBRATION OF TIDAL PRISM IN BARATARIA BASIN, ISOCHRON DEVELOPMENT AND PARTITIONING COEFFICIENTS

- The initial partitioning coefficients are used to produce initial inlet dimensions to compare to ICM inlet dimensions (note: using mean tidal range for tidal prism)
  - the tidal prism through Pass Abel was underestimated
  - the tidal prism through Caminada Pass was overestimated



# TIDAL PRISM CALIBRATION

## CALIBRATION OF TIDAL PRISM IN BARATARIA BASIN, ISOCHRON DEVELOPMENT AND PARTITIONING COEFFICIENTS

- Consult the map of ICM-Hydro compartments, and adjust the partitioning coefficients to “re-route” the tidal prism accordingly
- Repeat the partitioning coefficients until all the inlets in the same basin exhibit departure from the ICM dimensions by the same factor (or “spring-tide factor”)
- Multiply the area by the spring-tide factor