Louisiana’s 2012 Coastal Master Plan

PREDICTIVE MODELING:
BARRIER SHORELINE MORPHOLOGY MODEL

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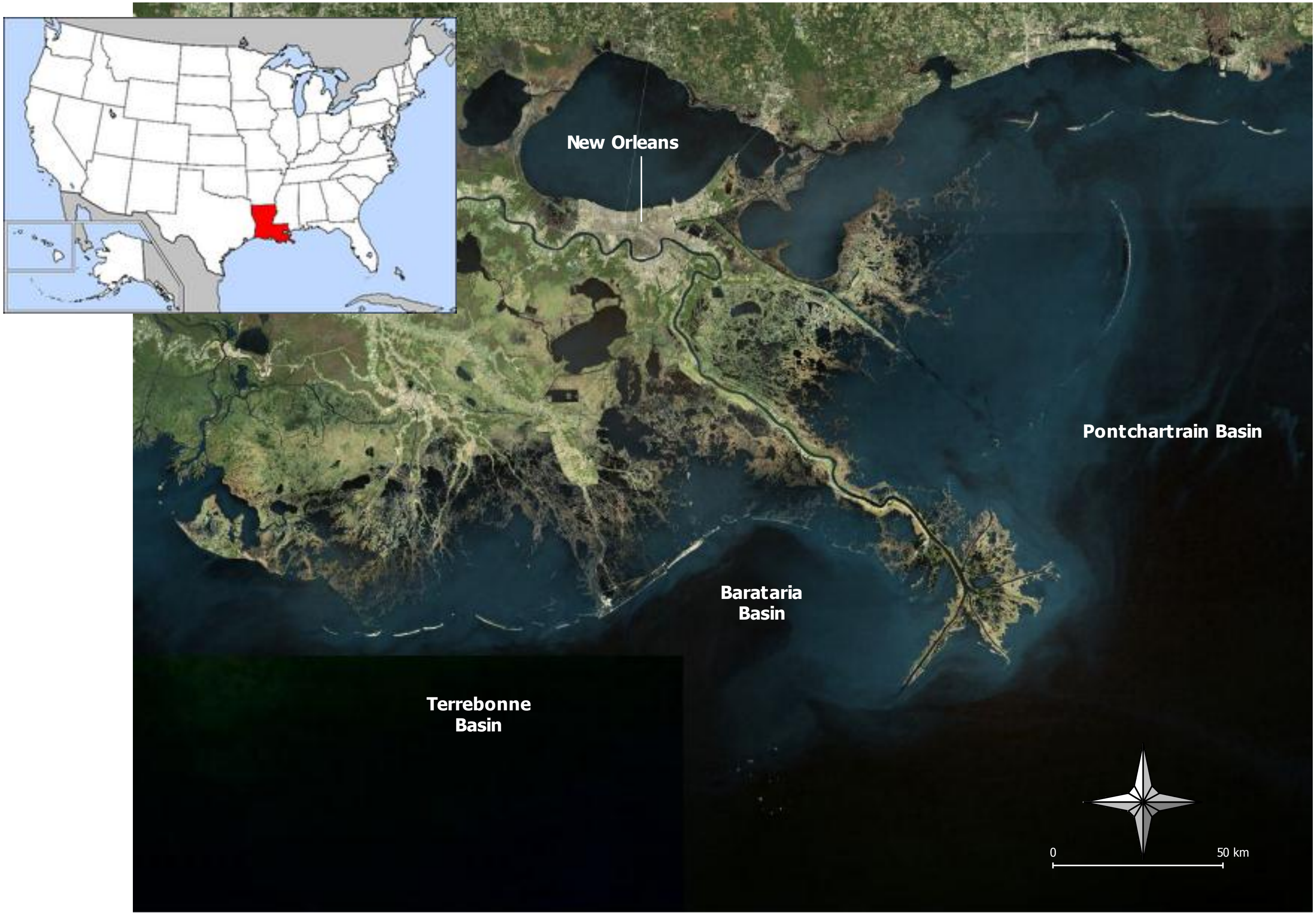
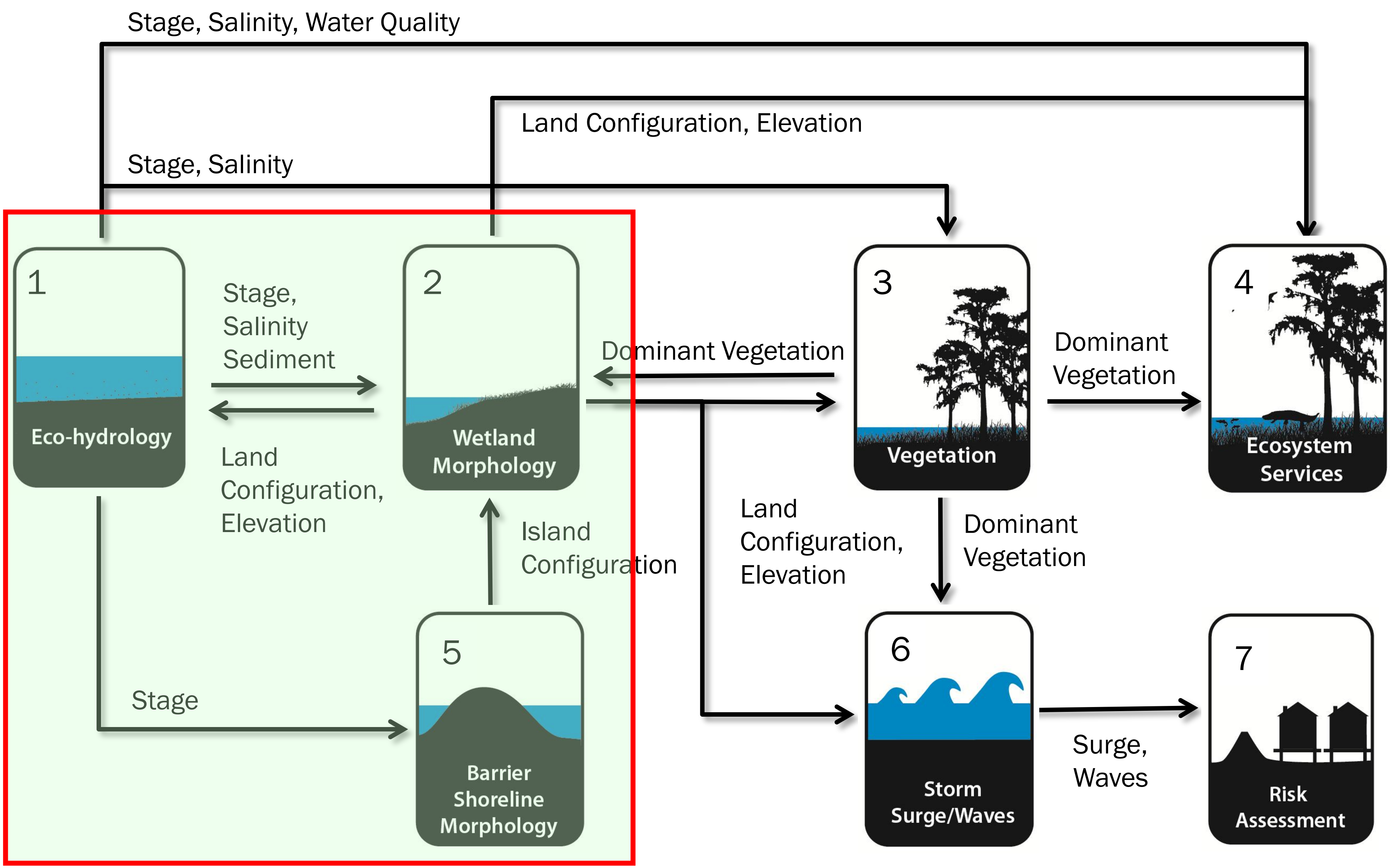
Team Members

Mark Kulp	Team Lead (Scientific Input and direction)
Ioannis Georgiou	Barrier and Tidal Inlet Morphology and Dynamics (Direction of cross-shore evolution and barrier migration components. Model development and scientific input)
Dallon Weathers	Barrier and Inlet Morphology (Model development, I/O, Project implementation etc.)
Zoe Hughes	Barrier and Inlet Morphology and Dynamics (Model development and scientific input)
Duncan FitzGerald	Inlet Morphology (Direction of inlet and ebb delta morphology components and scientific input)
Abby Sallenger	Input data, early stage model development input

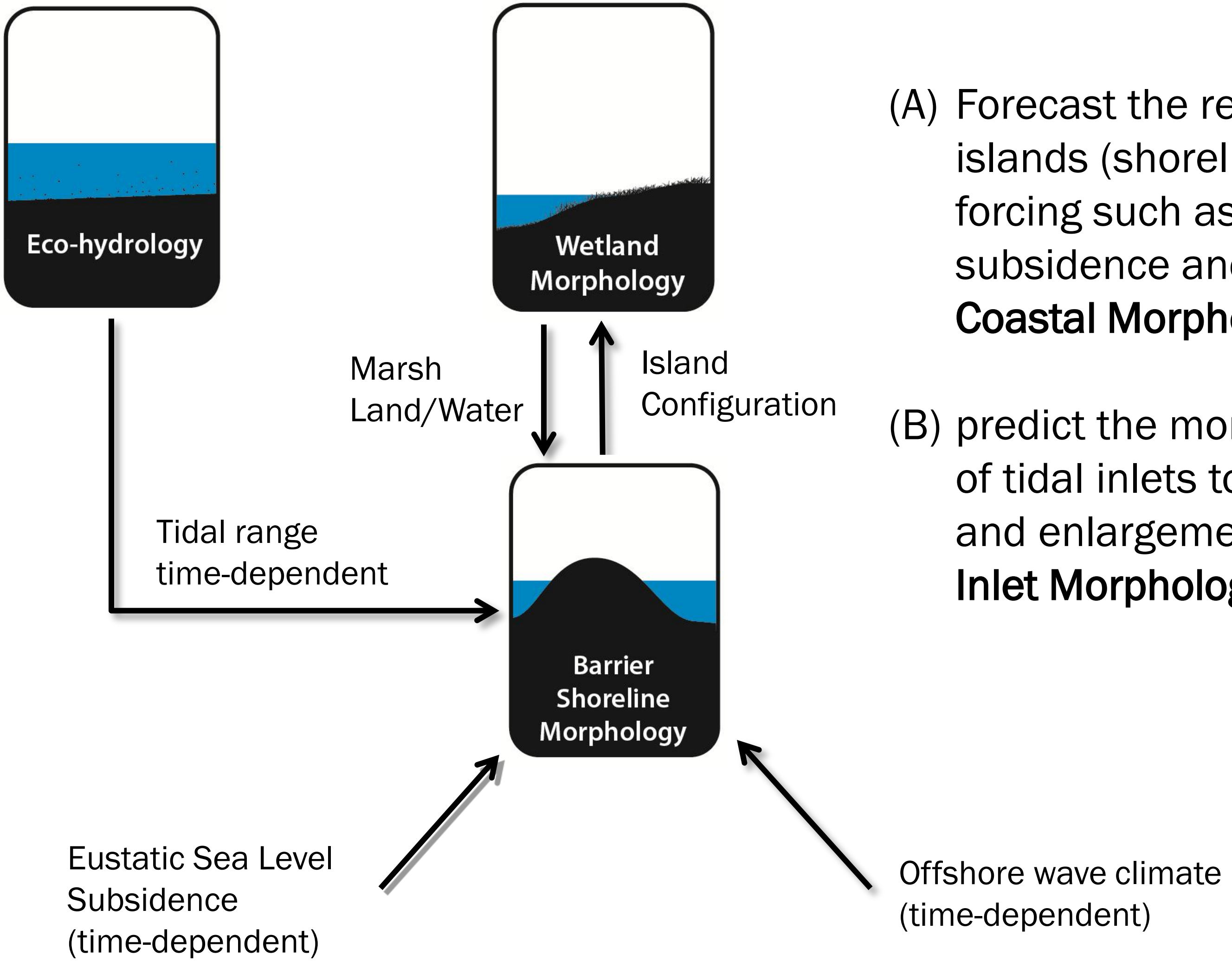
Location Overview



Modeling in a Systems Context



MODEL OVERVIEW (general input output)



(A) Forecast the response of barrier islands (shorelines) to long-term forcing such as sea-level-rise, subsidence and wave climate
Coastal Morphology Model (CMM)

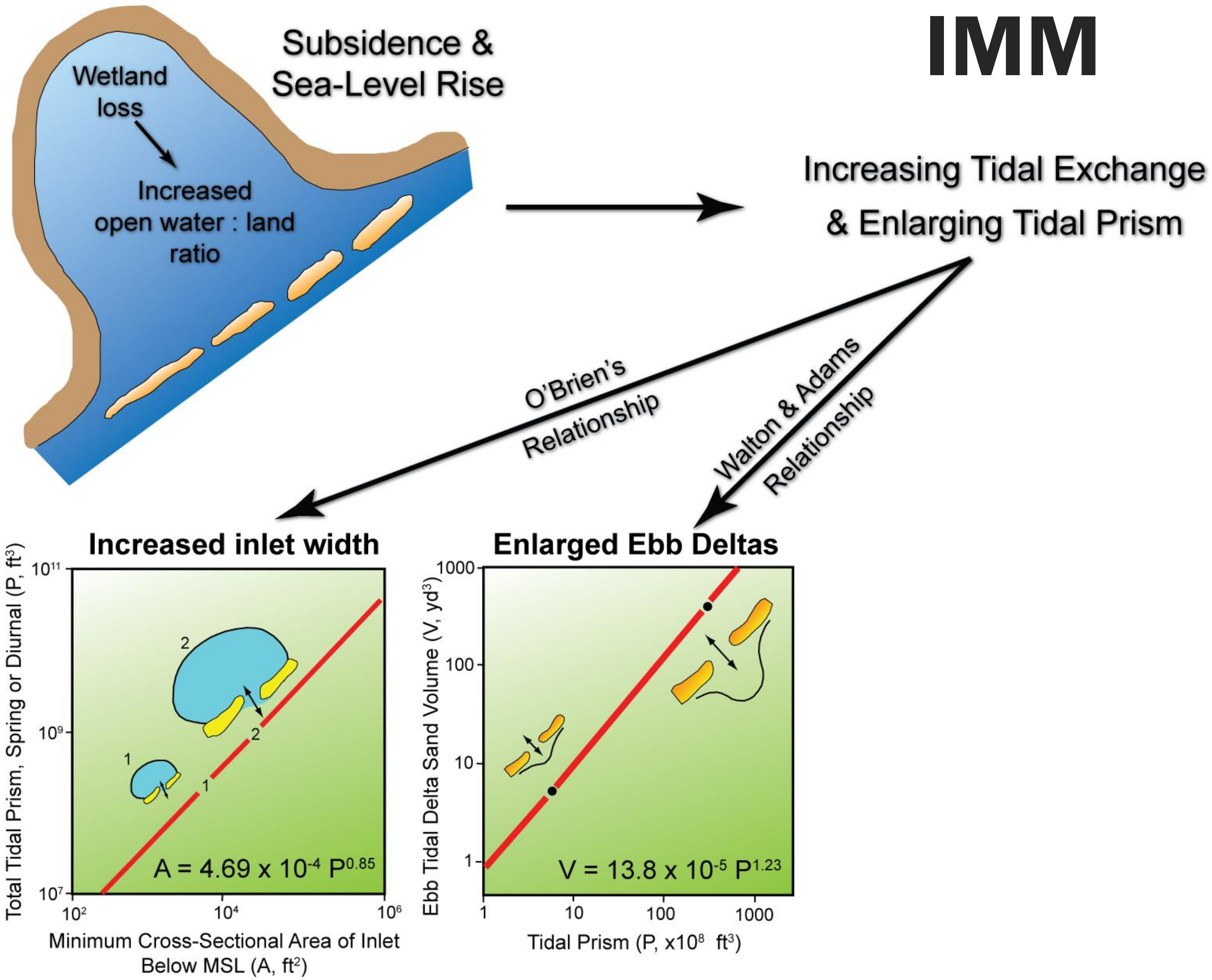
(B) predict the morphological response of tidal inlets to interior wetland loss and enlargement of tidal prism
Inlet Morphology Model (IMM)

Model Assumptions

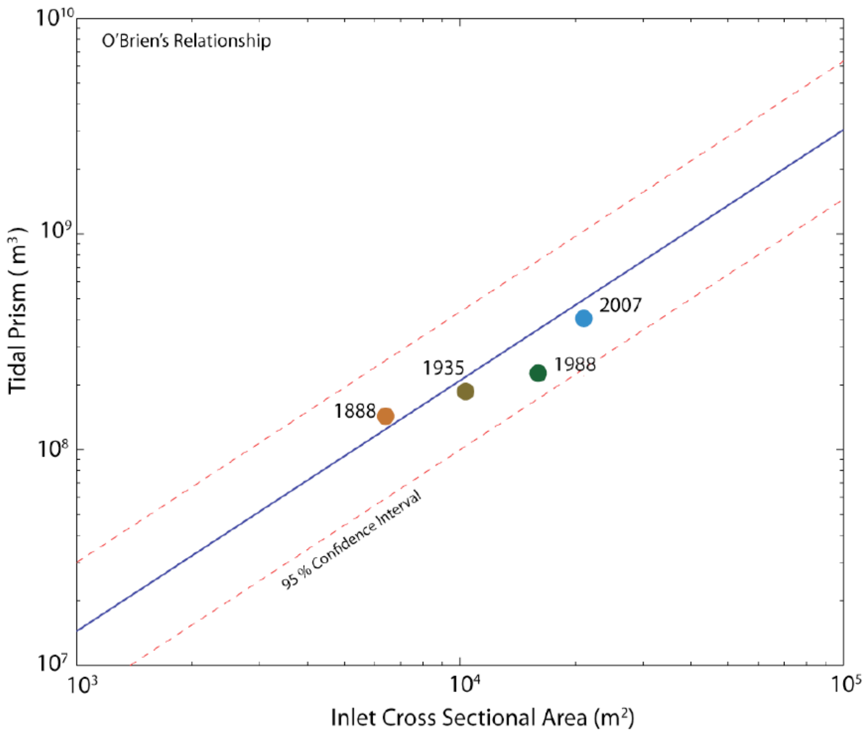
- Inlet morphology is assumed to obey equilibrium relationships (O'Brien, 1969; Jarrett, 1976).
- Small inlets are treated (from eco-hydrology) as cumulative area, rather than individually (Howes, 2009 showed that this represents a reasonable assumption).
- Initial bathymetry and topography are somewhat dated (bathymetry from BICM – 2006/2007, while topography from 2010).
- Offshore wave climate (20 years of data) derived from the Wave Information Studies (WIS) does not include individual storms (Hubert and Brooks, 1992).
- Furthermore, the resulting transport from waves is treated using a probability for a given year (using hourly data) which can further exclude a individual storm induced transport and resulting morphology from that event.
- Wave transformations (from deepwater to nearshore) are minimal, therefore minimizing the ability to capture local reversals.
- The presence of a closure depth (from List et al., 1997), and changes outside this depth (or below wave base) are not considered (i.e. lower shoreface response).
- Inside the closure depth, processes are geometric, and retain historic shape (ie, nearshore bar dynamics, overwash fans etc are not individually simulated.

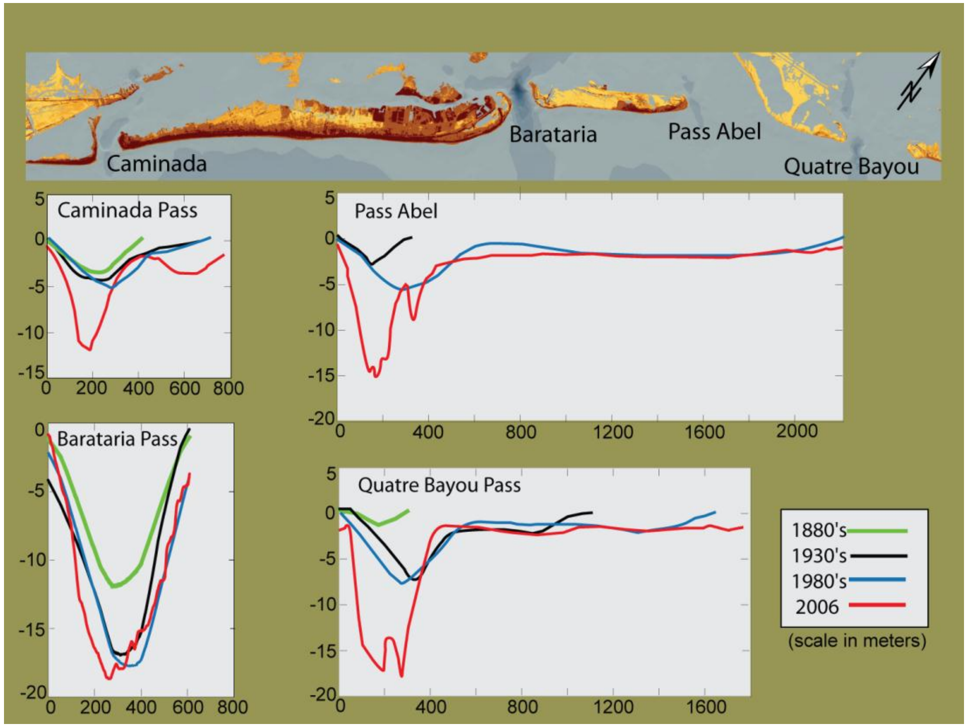
MODEL OVERVIEW

IMM



MODEL OVERVIEW

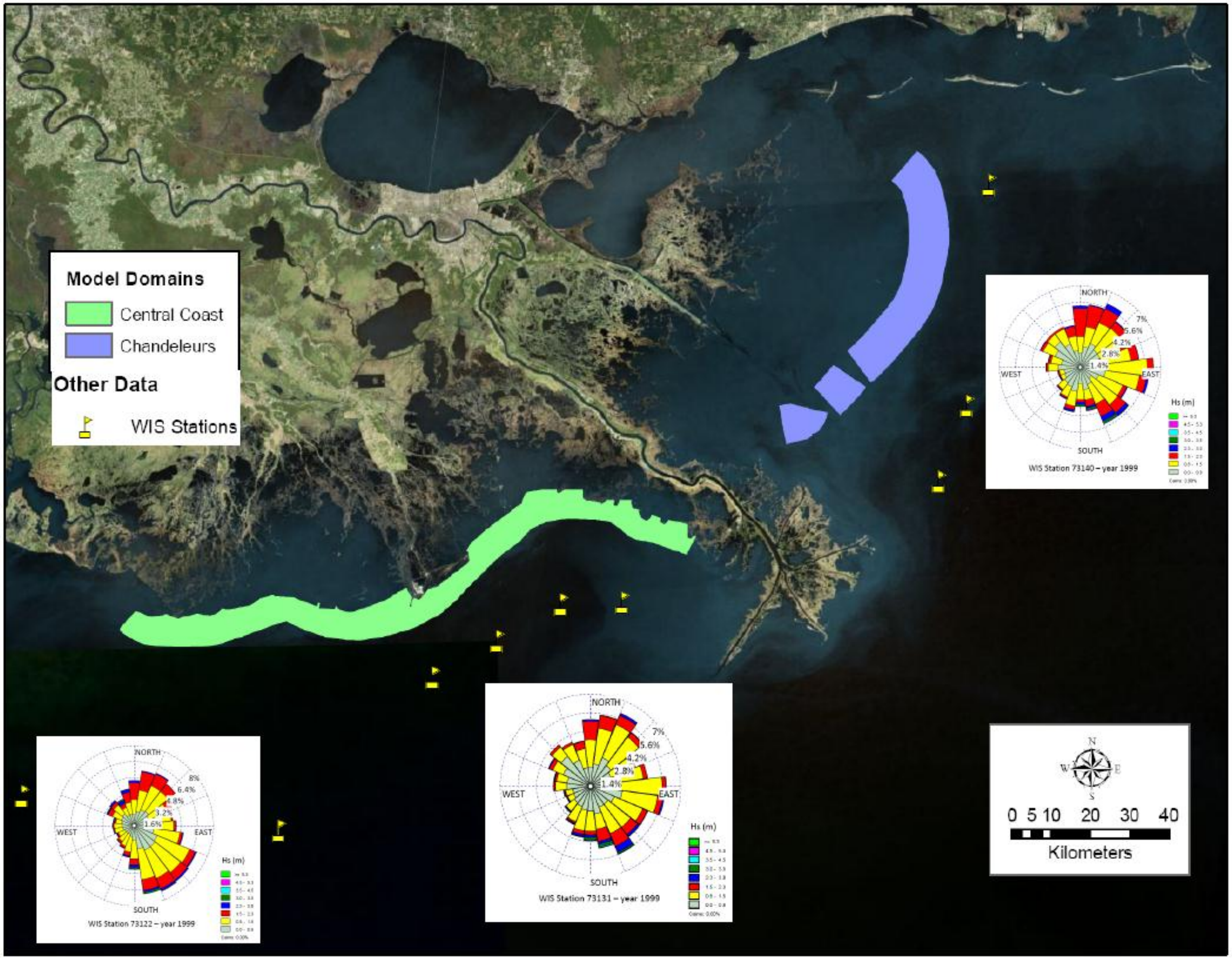




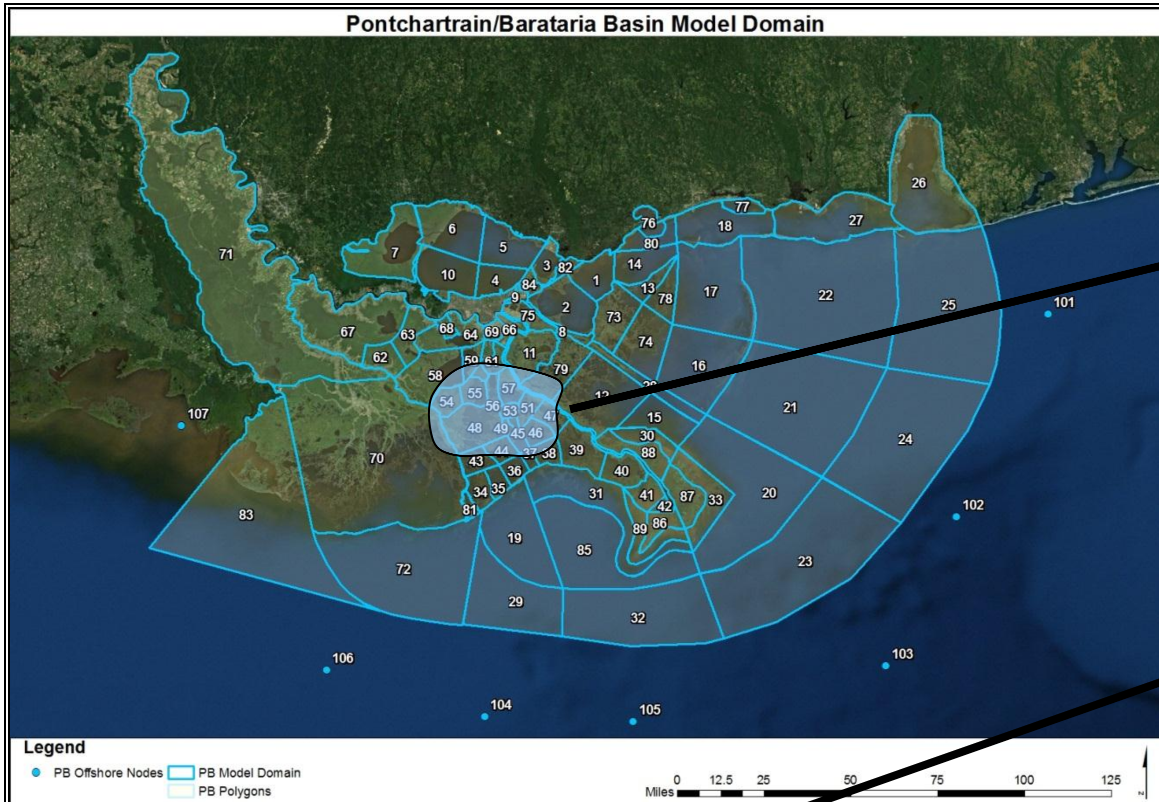
The historical increase in tidal prism and cumulative area for the Barataria Basin Inlets. (from Howes, 2009; tidal prism data for 1888-1988 from List (1997) & Suhayda (1997)

Historical morphological changes in tidal inlet throat morphology between 1880 and 2006. (from FitzGerald et al, 2007, and Miner et al 2009; data for 1880 – 1980 from List et al., 1994)

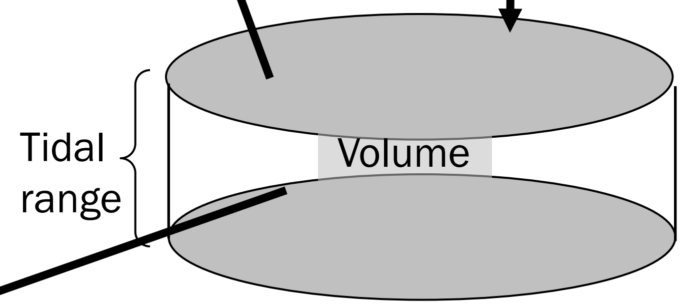
MODELING DOMAIN (IMM and CMM)



MODEL MECHANICS (IMM)



$$P = \sum_{i=1}^{n} (\max|T_{range}| * A_b)$$

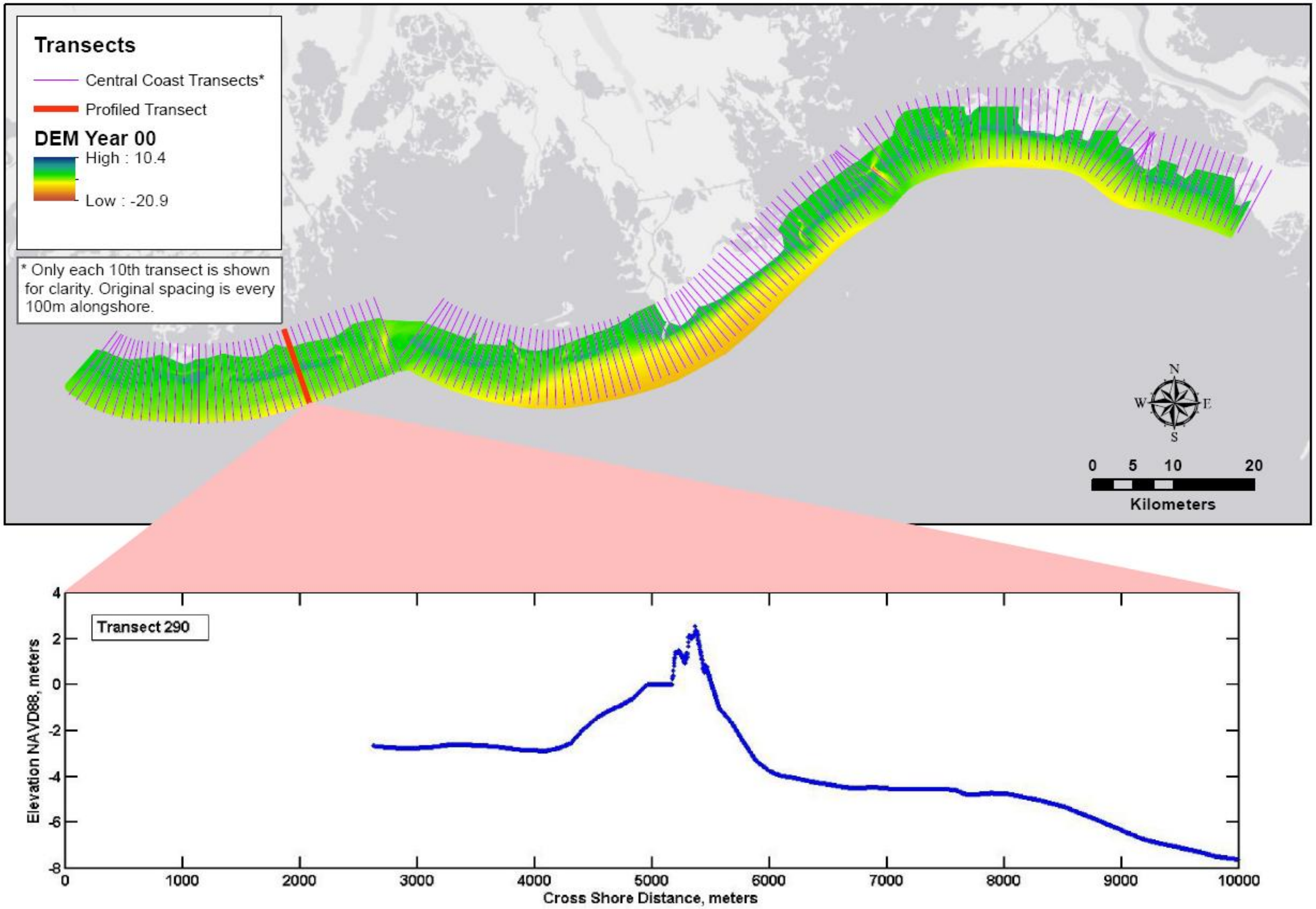


$$A = kP^a$$

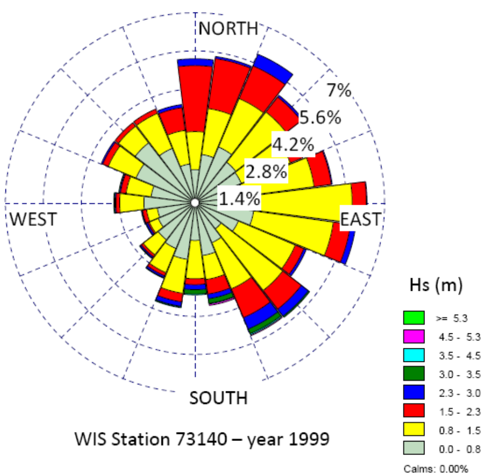
(We use *k* and *a* for non-jettied Gulf coast inlets; and report 95% confidence to the eco-hydrology.

The new inlet cross sectional area, *A*, is reported as % change, from present to 25 years).

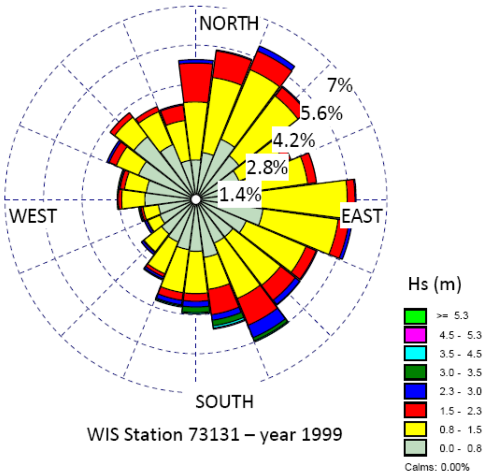
MODEL MECHANICS (CMM) – quasi 2D approach)



MODEL MECHANICS (CMM)



WIS Station 73140 – year 1999



WIS Station 73131 – year 1999

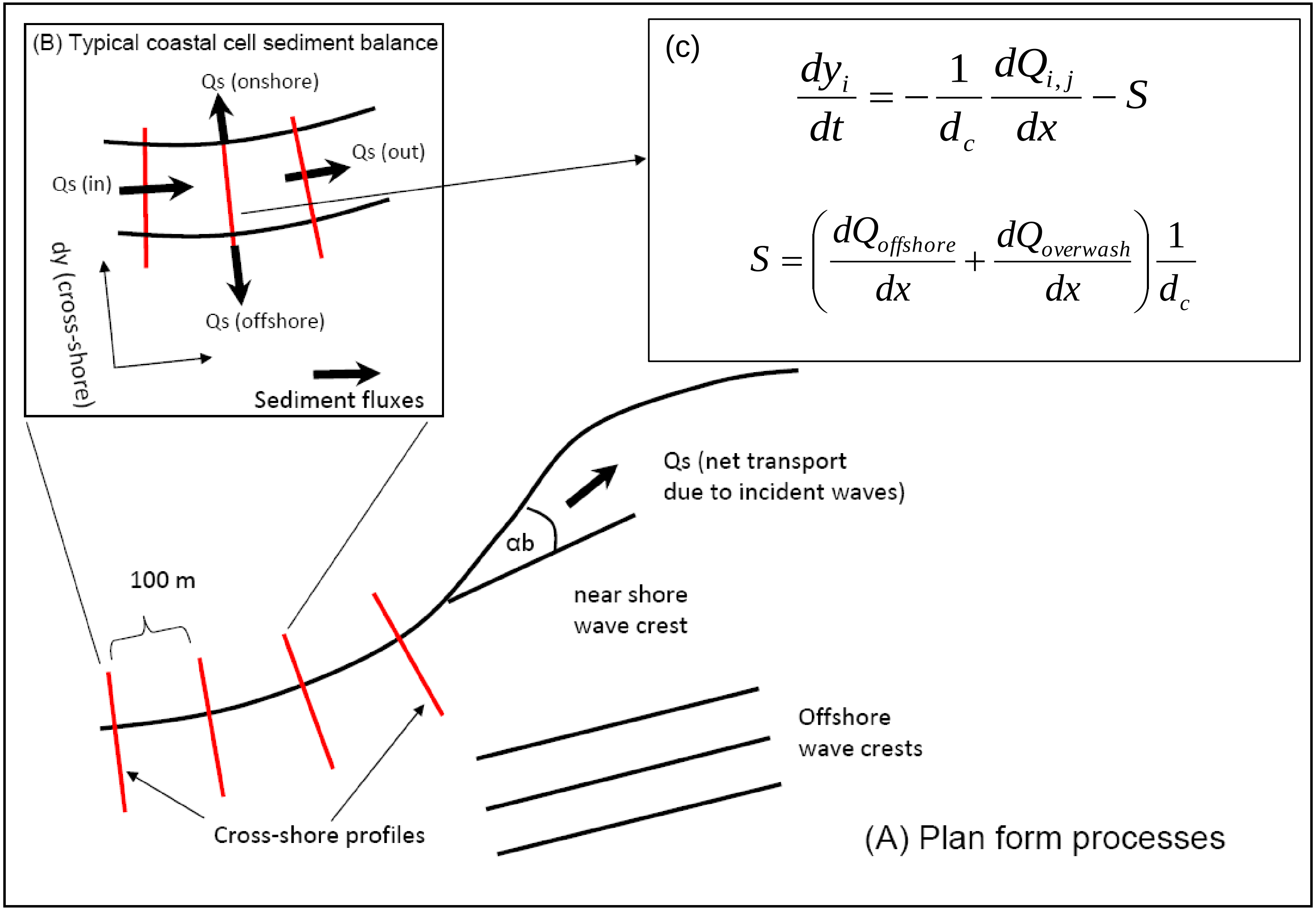
20 years of hourly data (1989-1999)

For a given group of waves with wave heights with magnitude *i* approaching from direction *j*, the probability of those waves occurring in one year is *Pi,j*.

(7 magnitudes, and 24 directions)

$$Q_{i,j} = P_{i,j}\left[\sum_{i=1}^{7}\sum_{i=1}^{24}[K\frac{\rho(g^{0.5})}{16k^{0.5}(\rho_s-\rho)(1-n)}H_{rms}^{(\frac{5}{2})}\cos(\alpha b)^{\frac{1}{4}}\sin(2\alpha b)]\right]$$

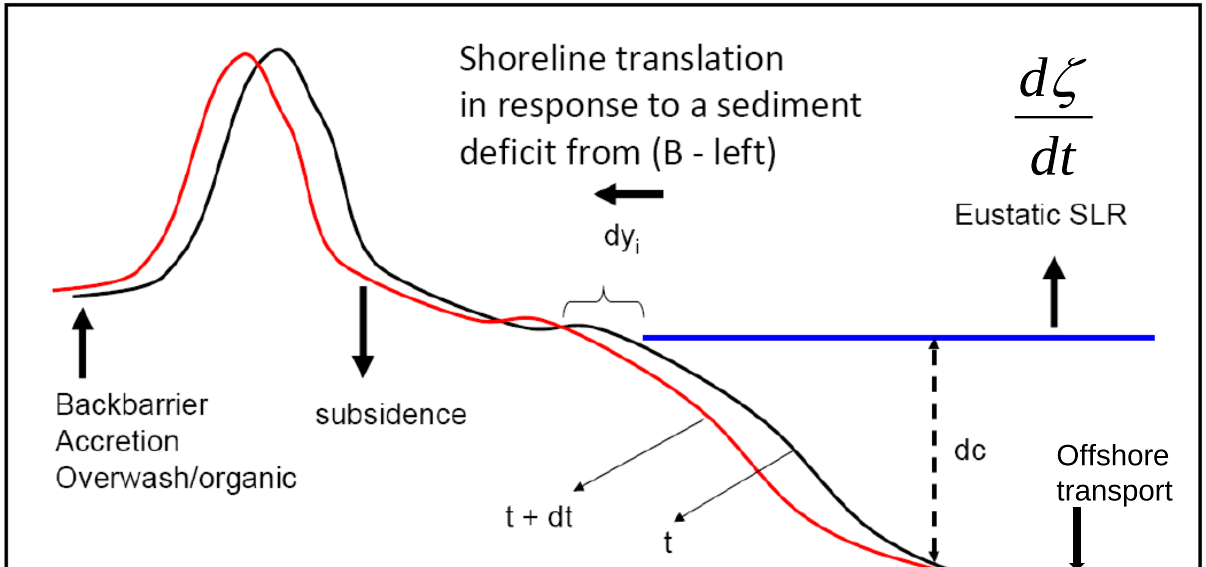
MODEL MECHANICS (CMM)



$$\frac{dy_i}{dt} = -\frac{1}{d_c}\frac{dQ_{i,j}}{dx} - S$$

$$S = \left(\frac{dQ_{offshore}}{dx} + \frac{dQ_{overwash}}{dx}\right)\frac{1}{d_c}$$

MODEL MECHANICS (CMM)



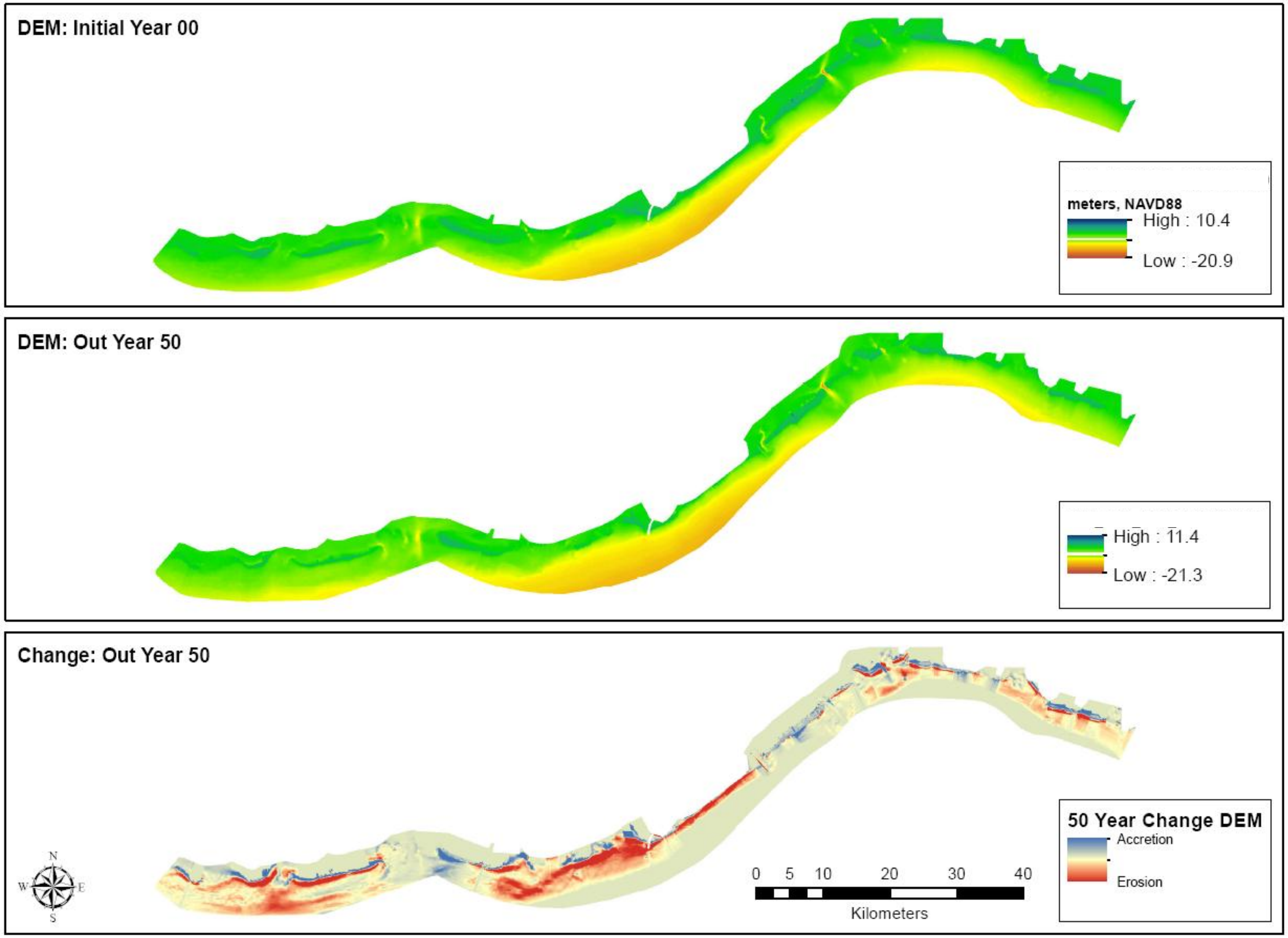
(C) Typical profile response/processes

$$\frac{dy_i}{dt} = -\frac{1}{d_c}\frac{dQ_{i,j}}{dx} - S$$

$$\frac{dh}{dt} = -\frac{dSub}{dt} + \frac{dAcr}{dt}$$

$$S = \left(\frac{dQ_{offshore}}{dx} + \frac{dQ_{overwash}}{dx}\right)\frac{1}{d_c}$$

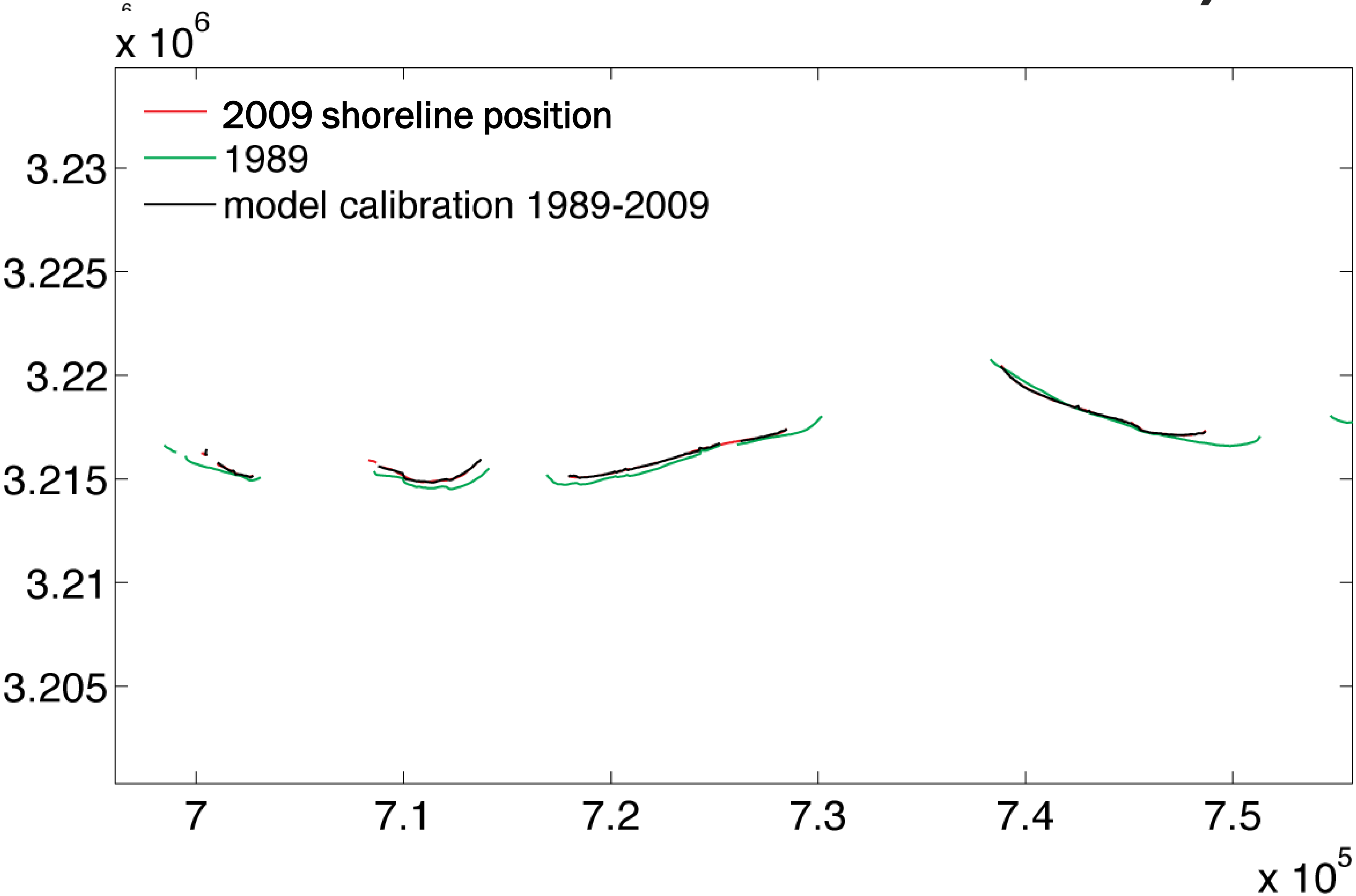
MODEL MECHANICS (CMM - integration)



Results from CMM and IMM are spatially interpolated to generate a DEM

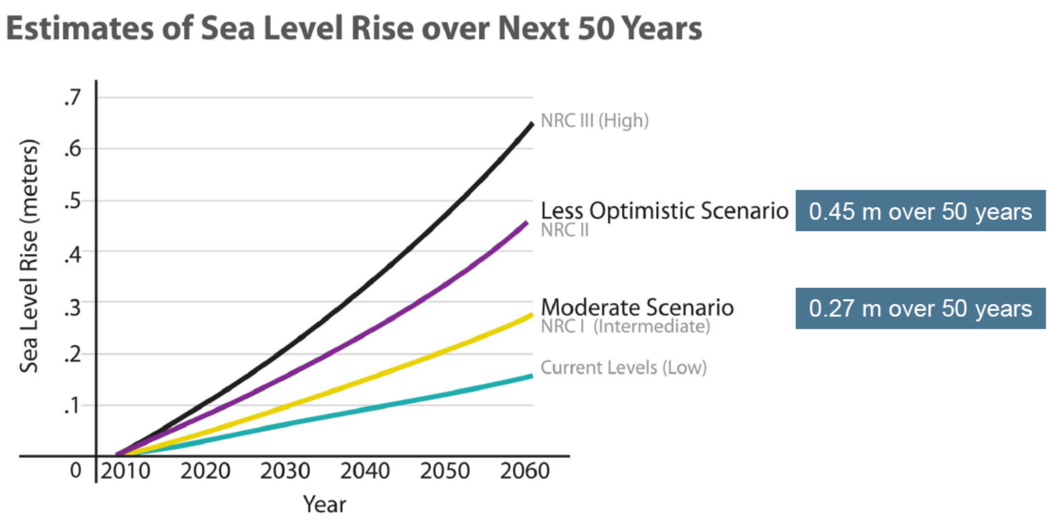
Model initial condition (initial bathymetry - upper panel), and simulated model results after 50 years of simulation for the moderate scenario along the central coast (middle panel). The resulting accretion or erosion is shown in the lower panel.

MODEL CALIBRATION (Central Coast)



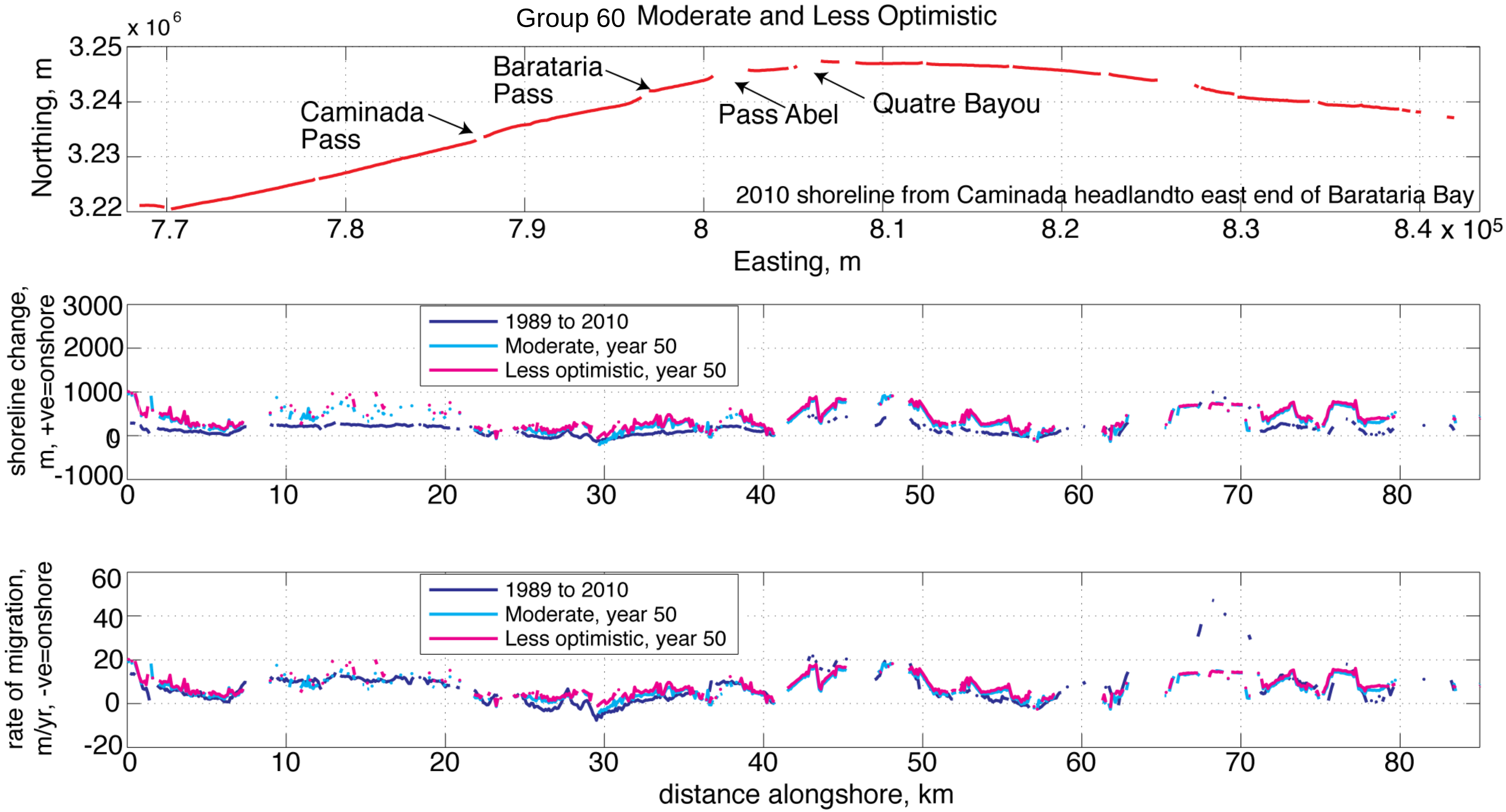
MODEL OUTPUT and SOME RESULTS

- **Legend**
- **Moderate Scenario**
- **Less Optimistic Scenario**
- **G60 is future without action (i.e. no projects – fwoa)**
- **G61 – or Barataria Pass to Sandy Point**



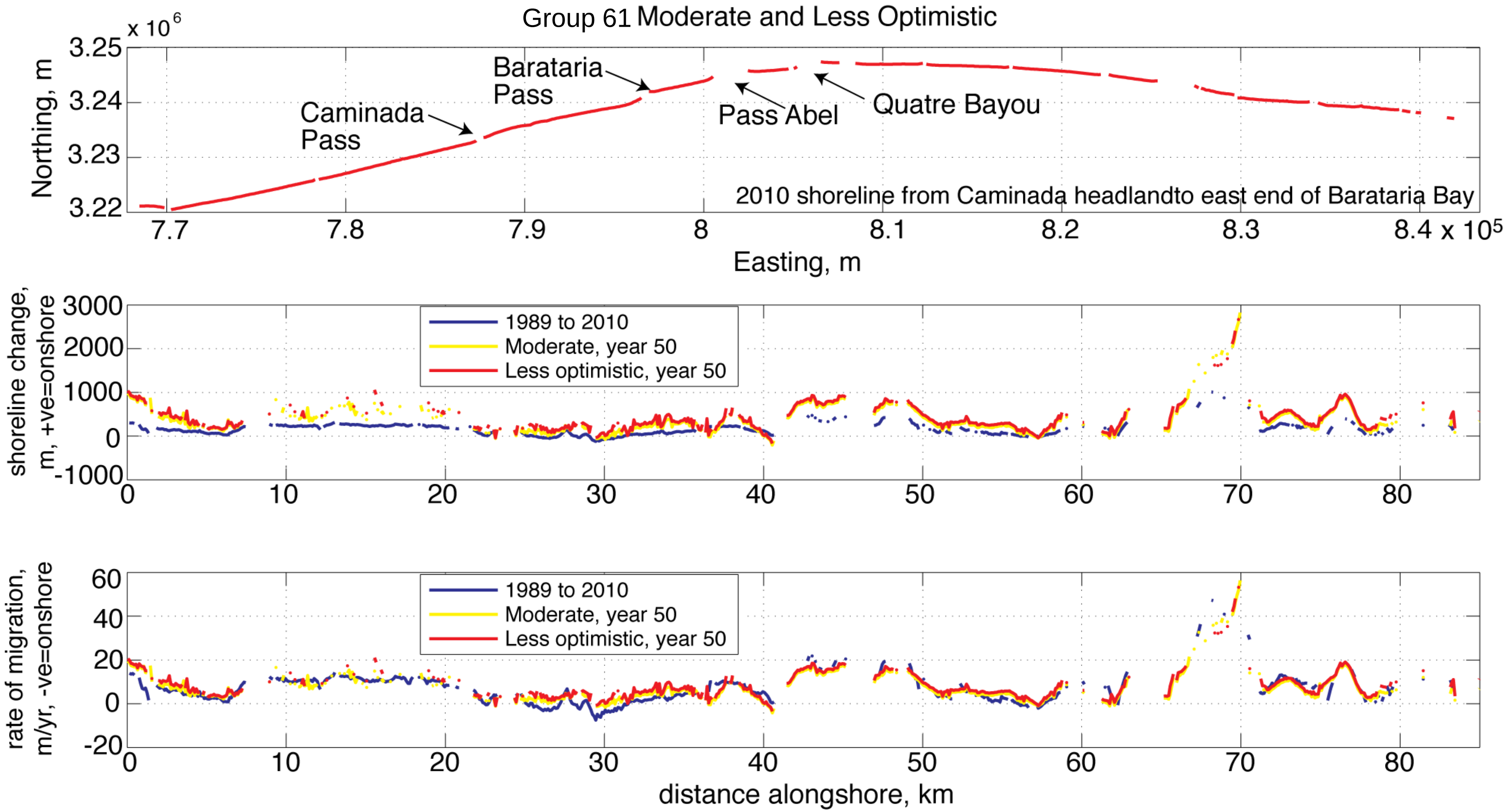
On-going analysis is incorporating new research in climate change
and evaluating a scenario of 0.78 m over 50 years

RESULTS (model shoreline evolution)



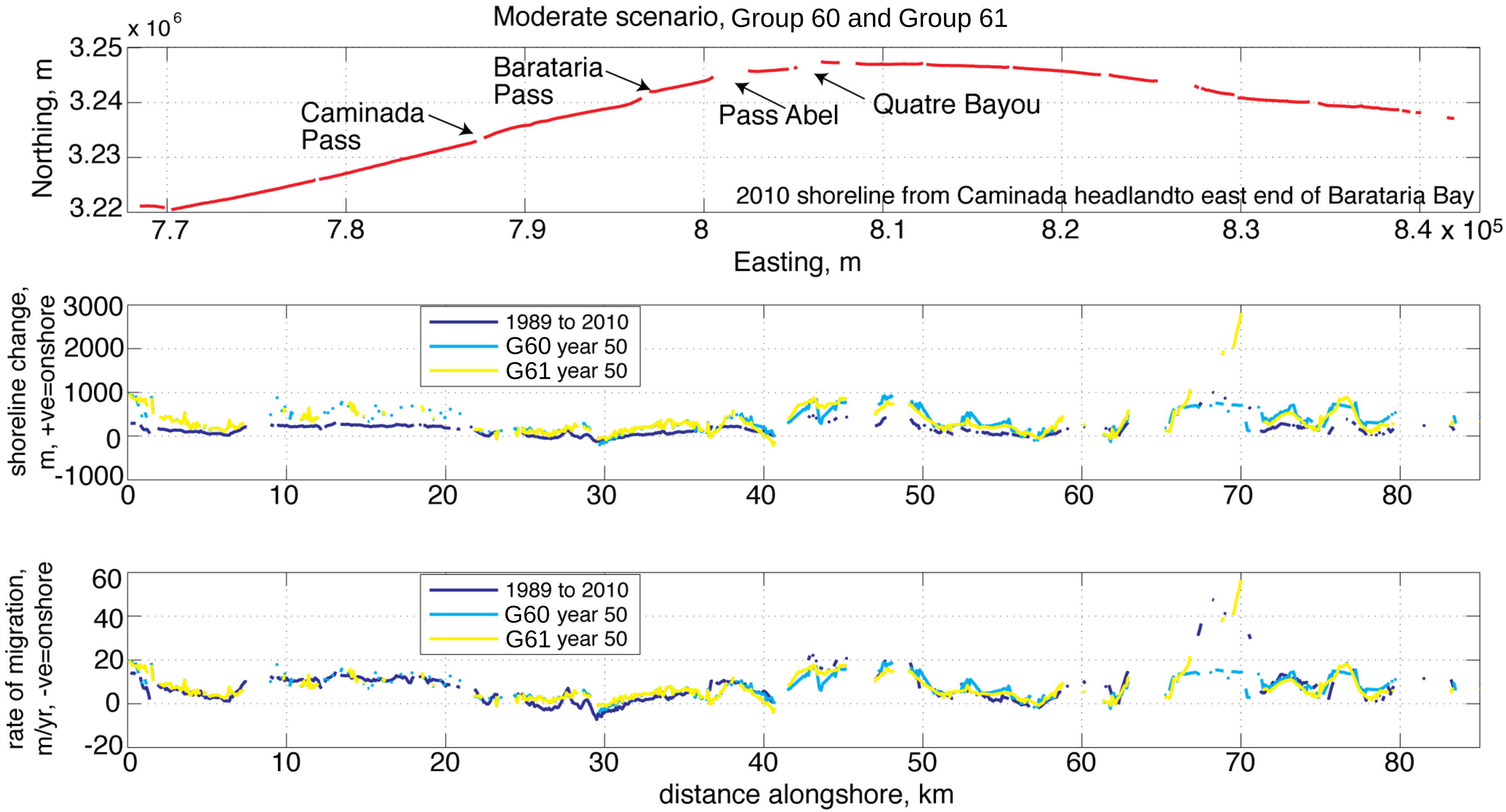
Group 60 is future without action

RESULTS (model shoreline evolution)



Group 61 is with projects from Barataria Pass to Sandy Point

RESULTS (model shoreline evolution)



SUMMARY RESULTS

Table 1. Central Coast – System wide Sediment Loss

G60 Moderate				G60 Less Optimistic			
	Gain (million m^3)	Loss (million m^3)	Net Change (million m^3)		Gain (million m^3)	Loss (million m^3)	Net Change (million m^3)
25	44.5	-477.9	-433.4	25	40.7	-583.9	-543.2
50	42.8	-452.7	-409.9	50	39.6	-564.2	-524.6

G61 Moderate				G61 Less Optimistic			
	Gain (million m^3)	Loss (million m^3)	Net Change (million m^3)		Gain (million m^3)	Loss (million m^3)	Net Change (million m^3)
25	55.2	-475.6	-420.4	25	52.1	-583.4	-531.3
50	53.9	-454.5	-400.6	50	53.9	-565.6	-511.7

Table 2. Central Coast – System wide Barrier subareal area

G60 Time	Barrier Area km^2 Moderate	Less Optimistic	G61 Time	Barrier Area km^2 Moderate	Less Optimistic
0	45.3	45.3	0	61.7	61.7
25	38.1	36.3	25	55.2	53.7
50	32.7	29.3	50	50.4	47.2


Thank You!