Modeling Sediment Transport Along the Upper Texas Coast

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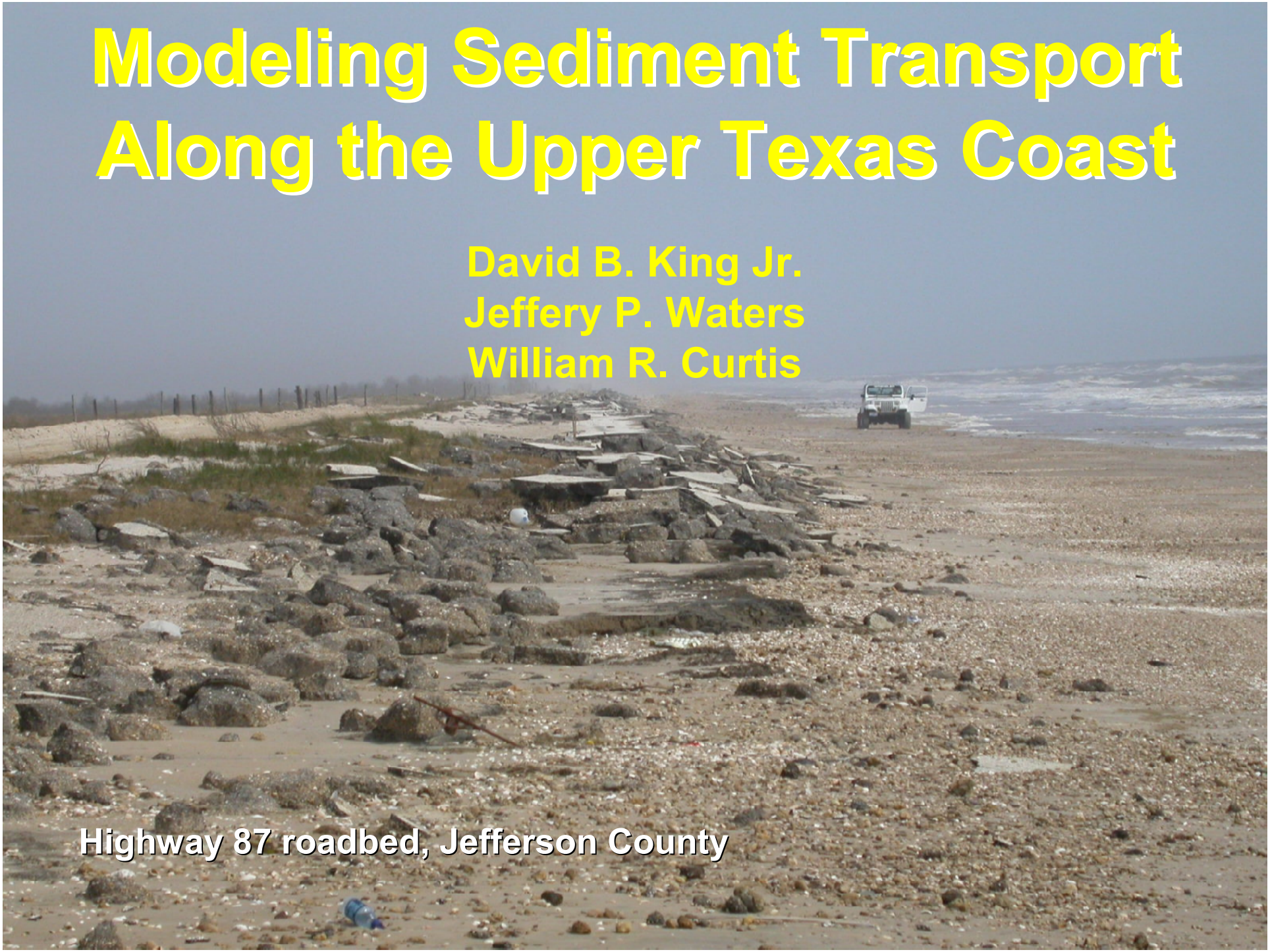
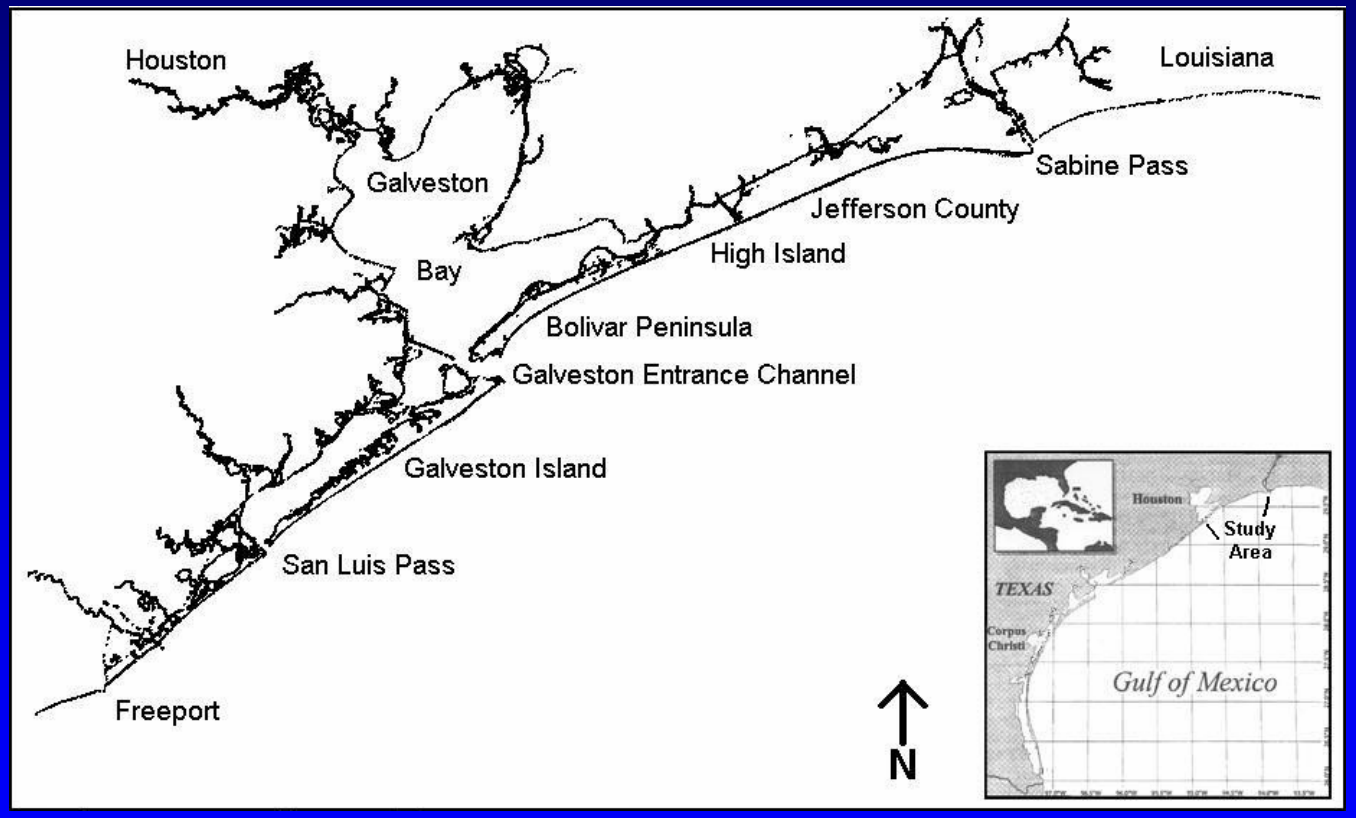


Highway 87 roadbed, Jefferson County

Galveston District – Corps of Engineers
Sabine Pass to San Luis Pass
Shoreline Erosion Feasibility Study



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ERDC's Role in the Feasibility Study

- WIS wave hindcast
- ADCIRC water level and currents
- Sediment Budget
- SBEACH storm-induced beach changes
- STWAVE / GENESIS longterm shoreline change modeling

Status

Current

- Develop numerical modeling tools to predict shoreline change
- Use these tools to evaluate design alternatives for erosion control, storm damage reduction, and environmental restoration

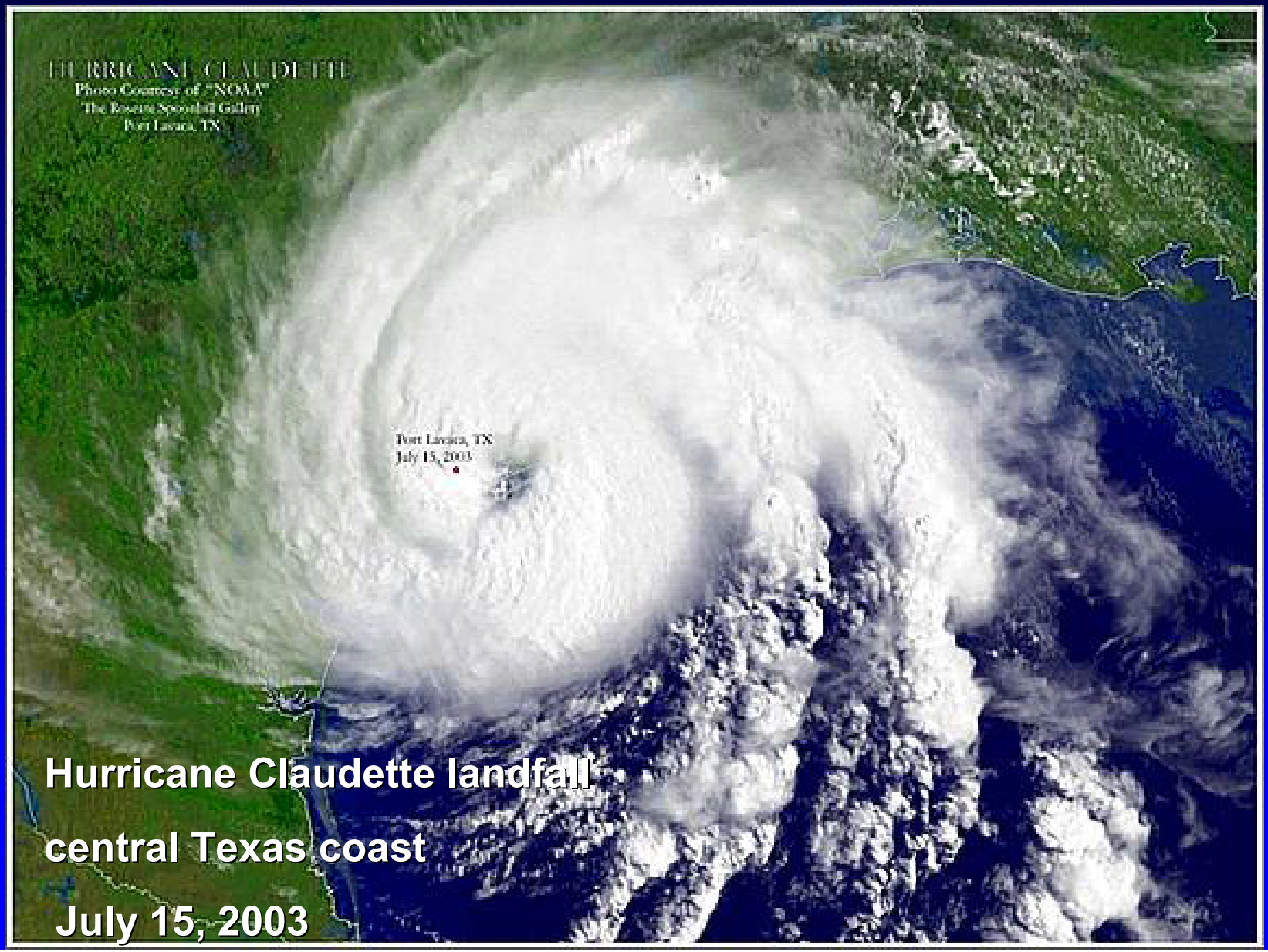
Near Future

- Final design refinement and optimization

SBEACH
(Storm-induced BEAch CHange)

- Numerical Model for simulating cross-shore beach change
- Intended use is to predict short-term beach profile response to storms

SBEACH Calibration



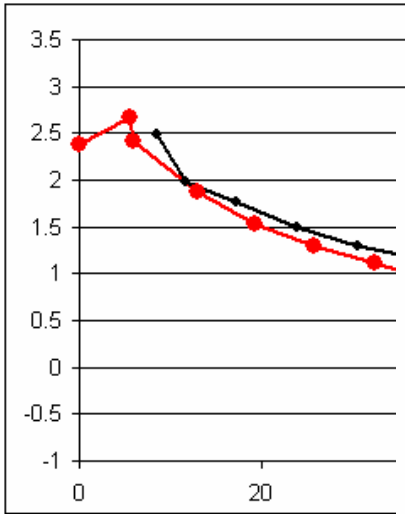
Hurricane Claudette landfall

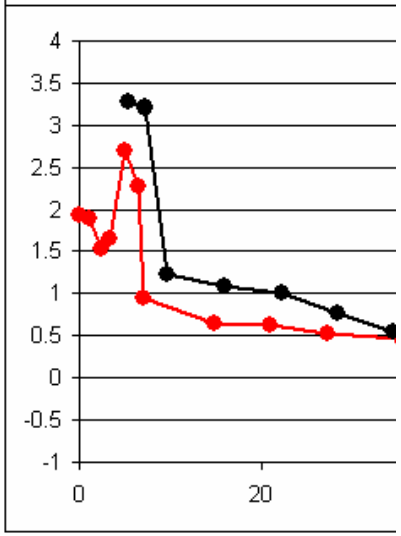
central Texas coast

July 15, 2003

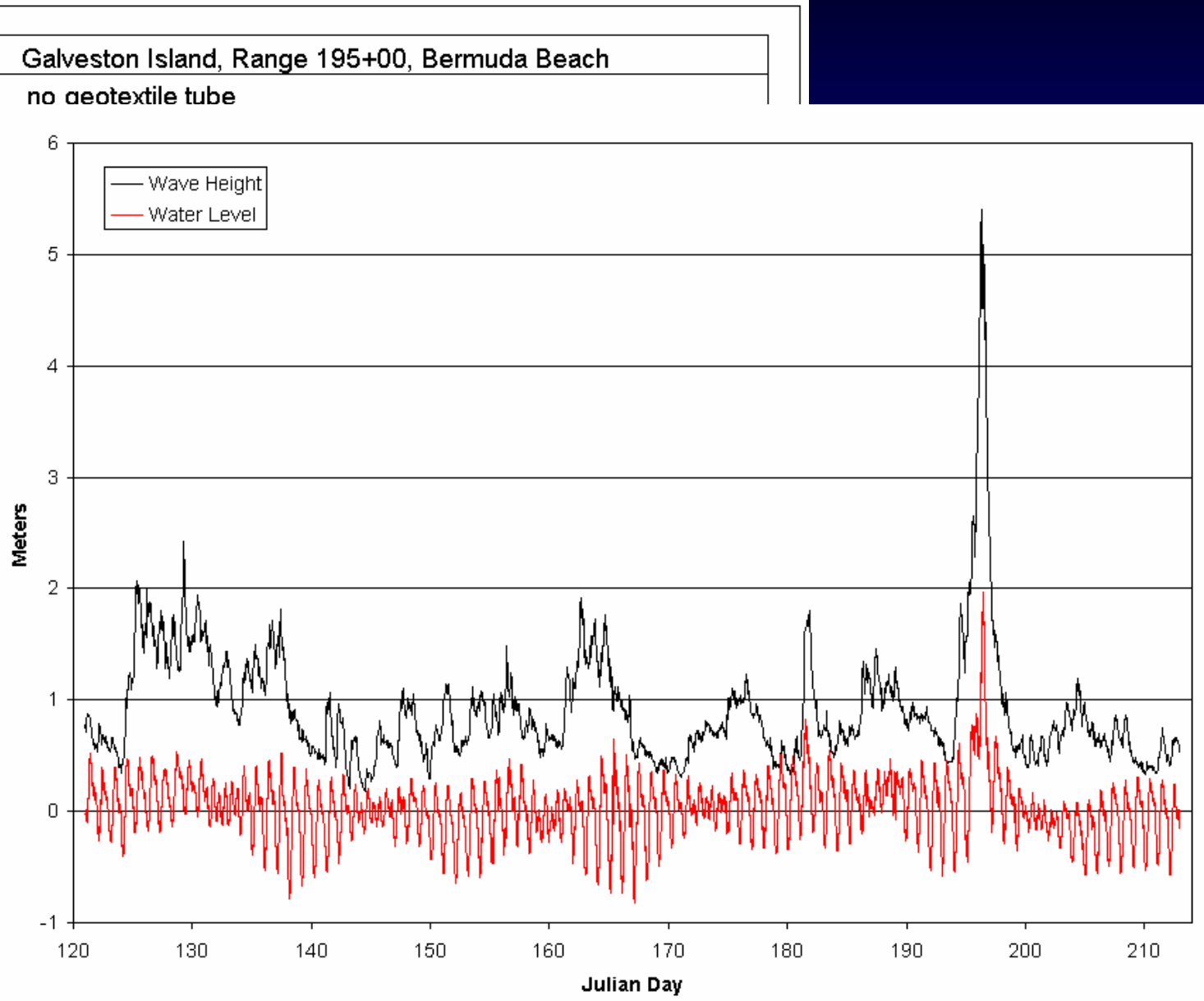
Hurricane Claudette Beach Erosion

Data Inputs



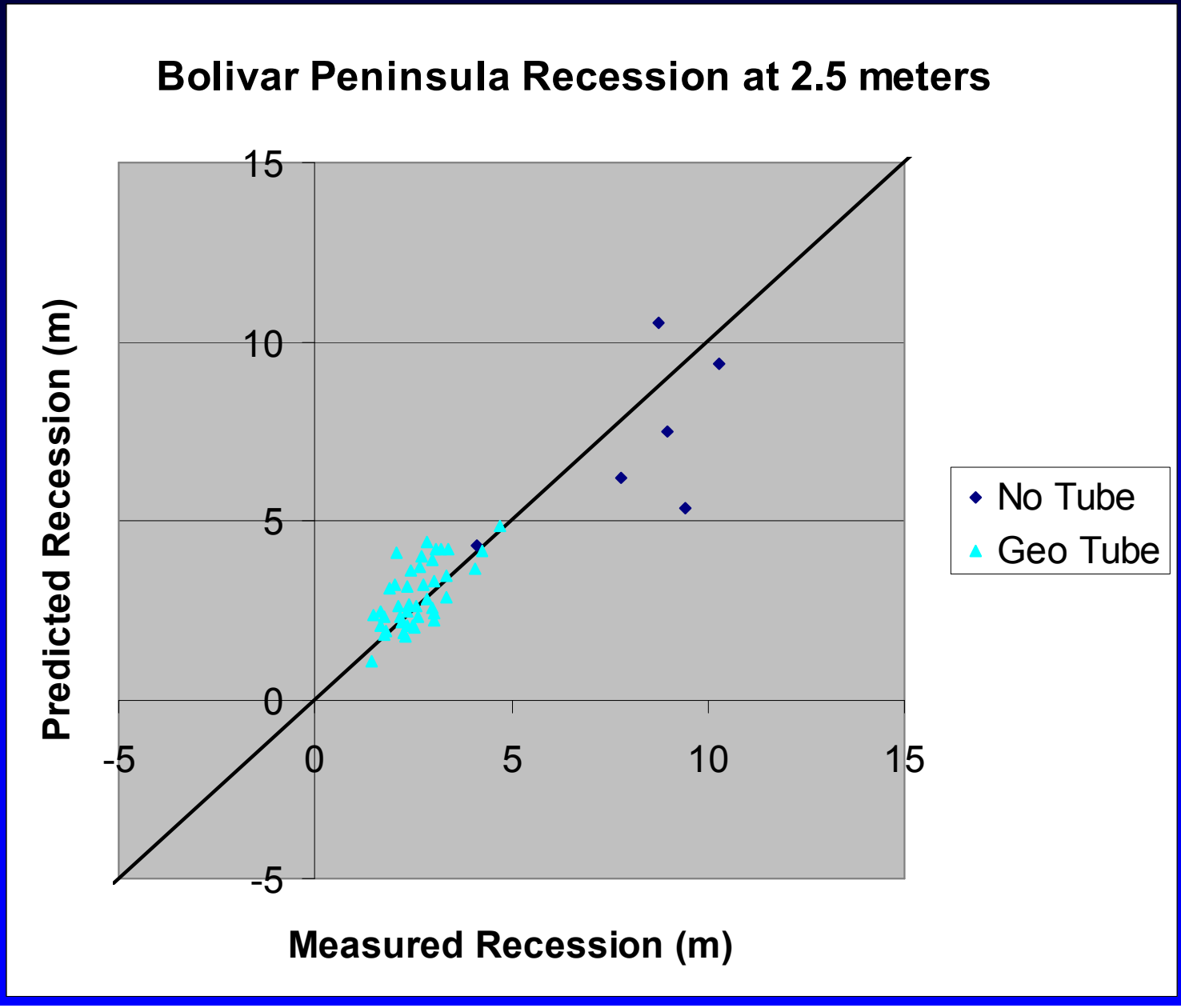


Pre- and Post



Waves and Water Levels

Example Result



GENESIS
(GENEralized model for SImulating Shoreline change)

- Numerical Model for simulating along-shore beach change
- Intended use is to predict long-term shoreline evolution

GENESIS Calibration

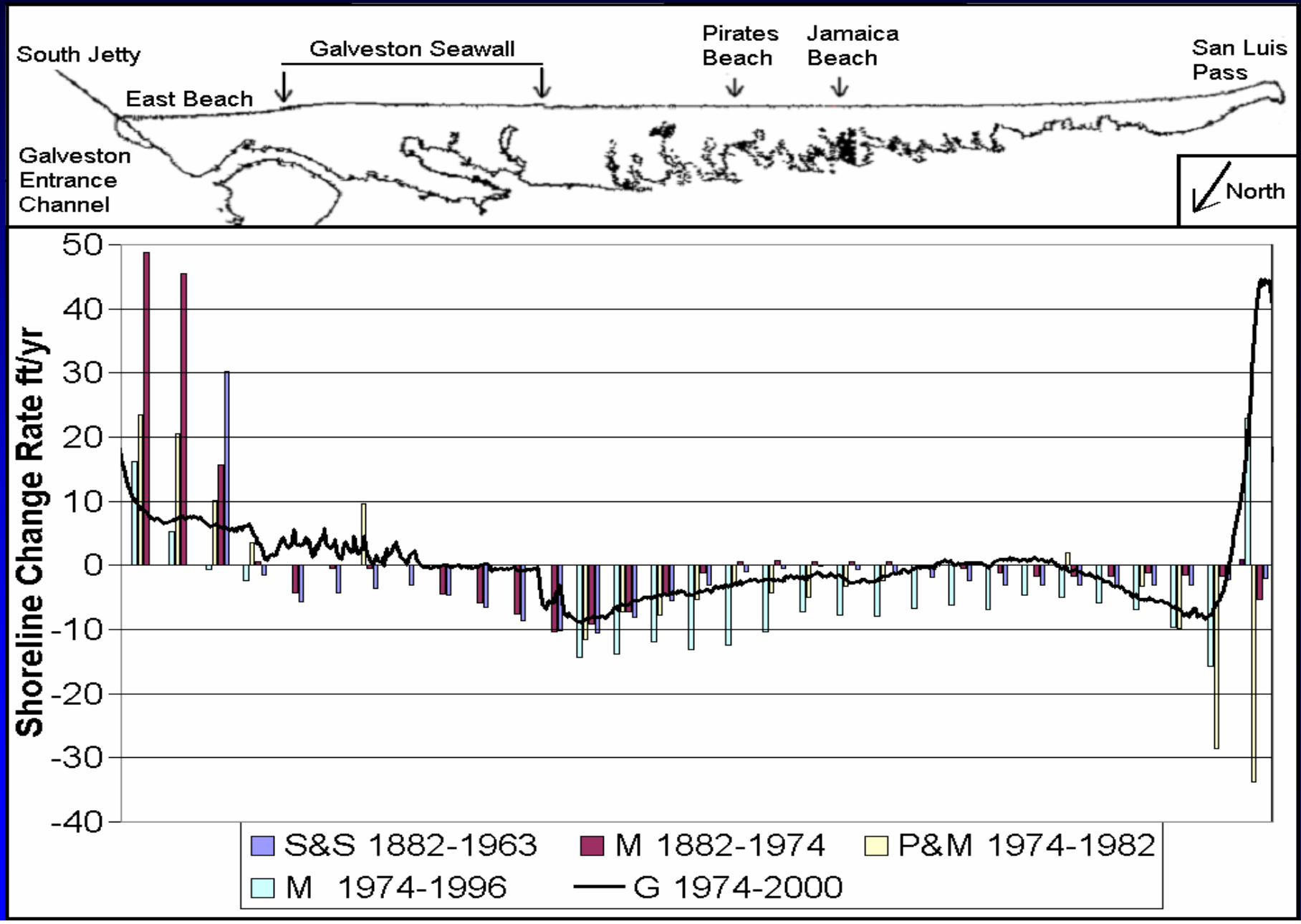
Tools

- STWAVE - transforms offshore waves to near-breaking depths
- GENESIS - predicts longshore transport rates and long term beach evolution

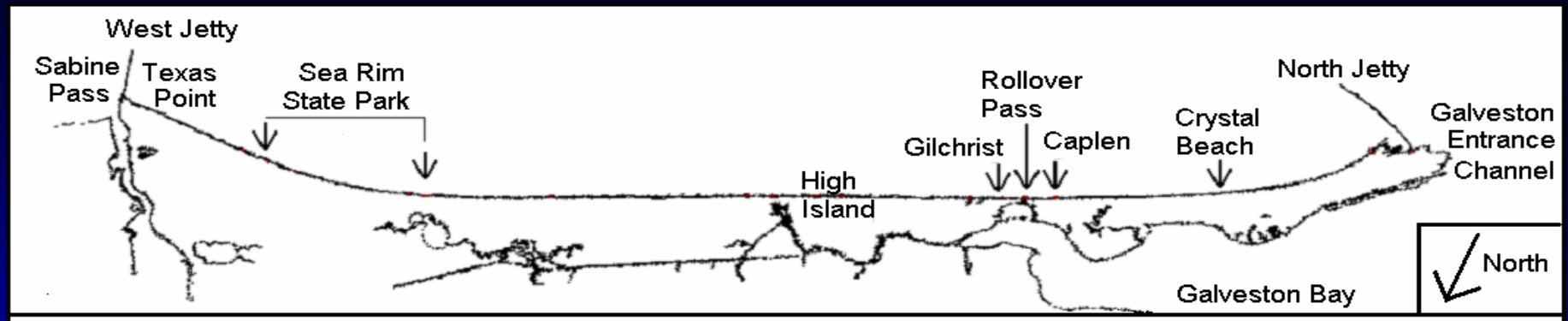
Data

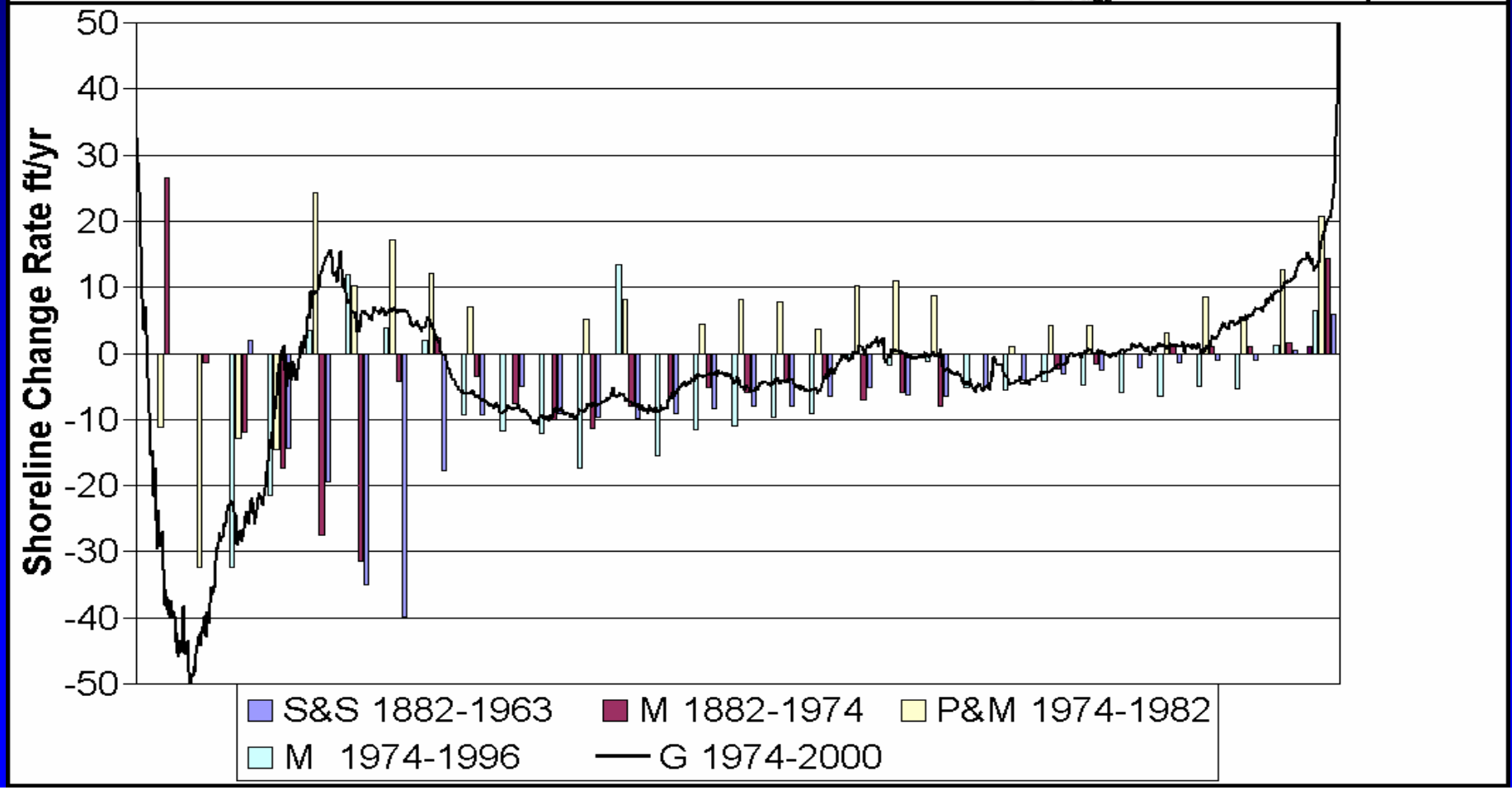
- WIS hindcast waves
- WIS windfields
- NOS Bathymetry
- Texas BEG shorelines and change rates

Shoreline Change Rates - Galveston Island



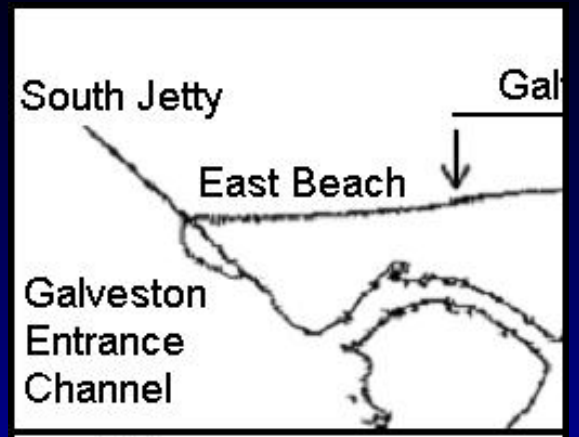
Shoreline Change Rates – High Island

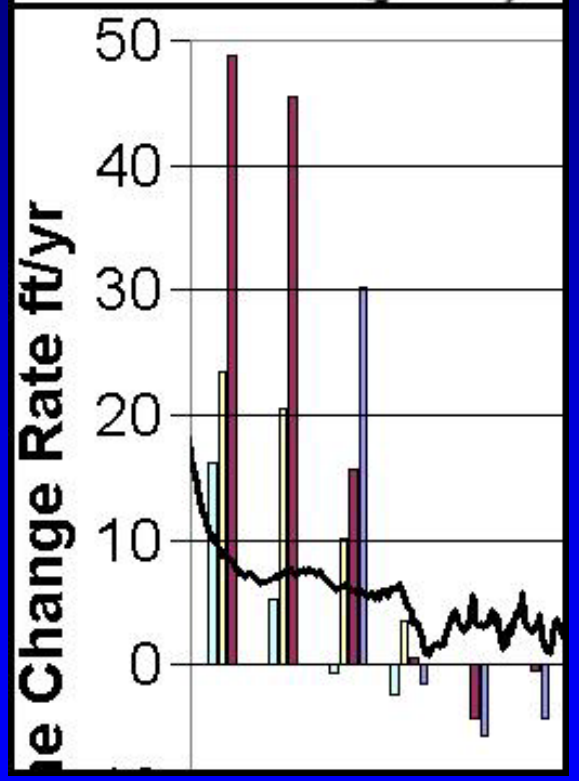




Differences in Change Rates

- Differences in shoreline definitions
- Errors in the data and the analysis procedure
- Natural variations in the shoreline change rate at different times





Published Transport Rates

- Published reports indicate net transport is to the southwest along all or almost all of the study area.
- Net rates are generally within the 30,000 – 150,000 m^3/yr range to the southwest.

Bales, J. D. and Holley, E. R. (1989). Sand transport in Texas tidal inlet, *JWPCO Eng*, 115 (4), 427-443.

Hall, G. L. (1975). Sediment transport processes in the nearshore waters adjacent to Galveston Island and Bolivar Peninsula, Ph. D. diss., Texas A&M.

Mason, C. (1981). "Hydraulics and stability of five Texas inlets," Misc Paper CERC-81-1.

Prather, S. H. and Sorensen, R. M. (1972). "An investigation of Rollover Pass, Bolivar Peninsula, Texas,". TAMU-SG-72-202.

U.S. Army Corps of Engineers. (1983). "Galveston County shore erosion study, Feasibility report on beach erosion

West End of Galveston Seawall

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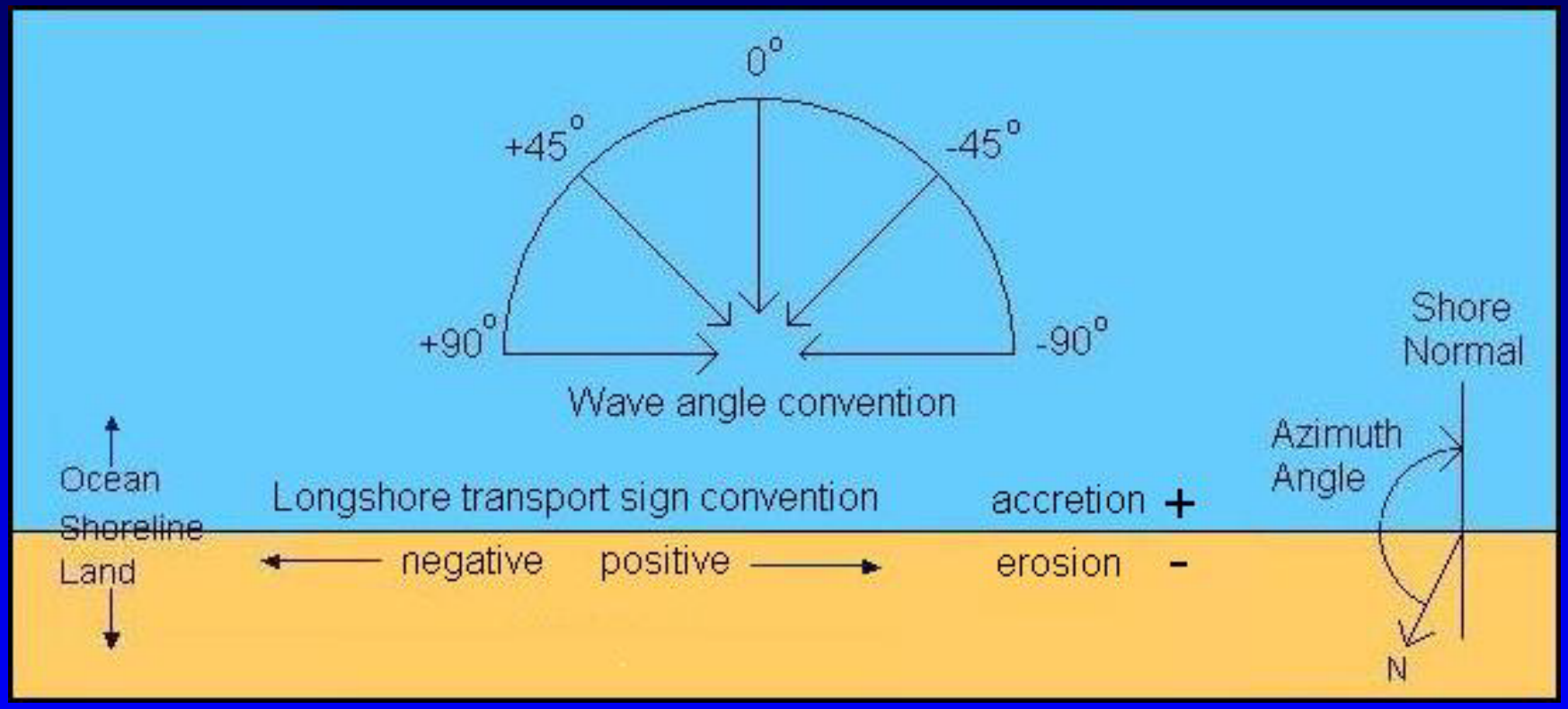
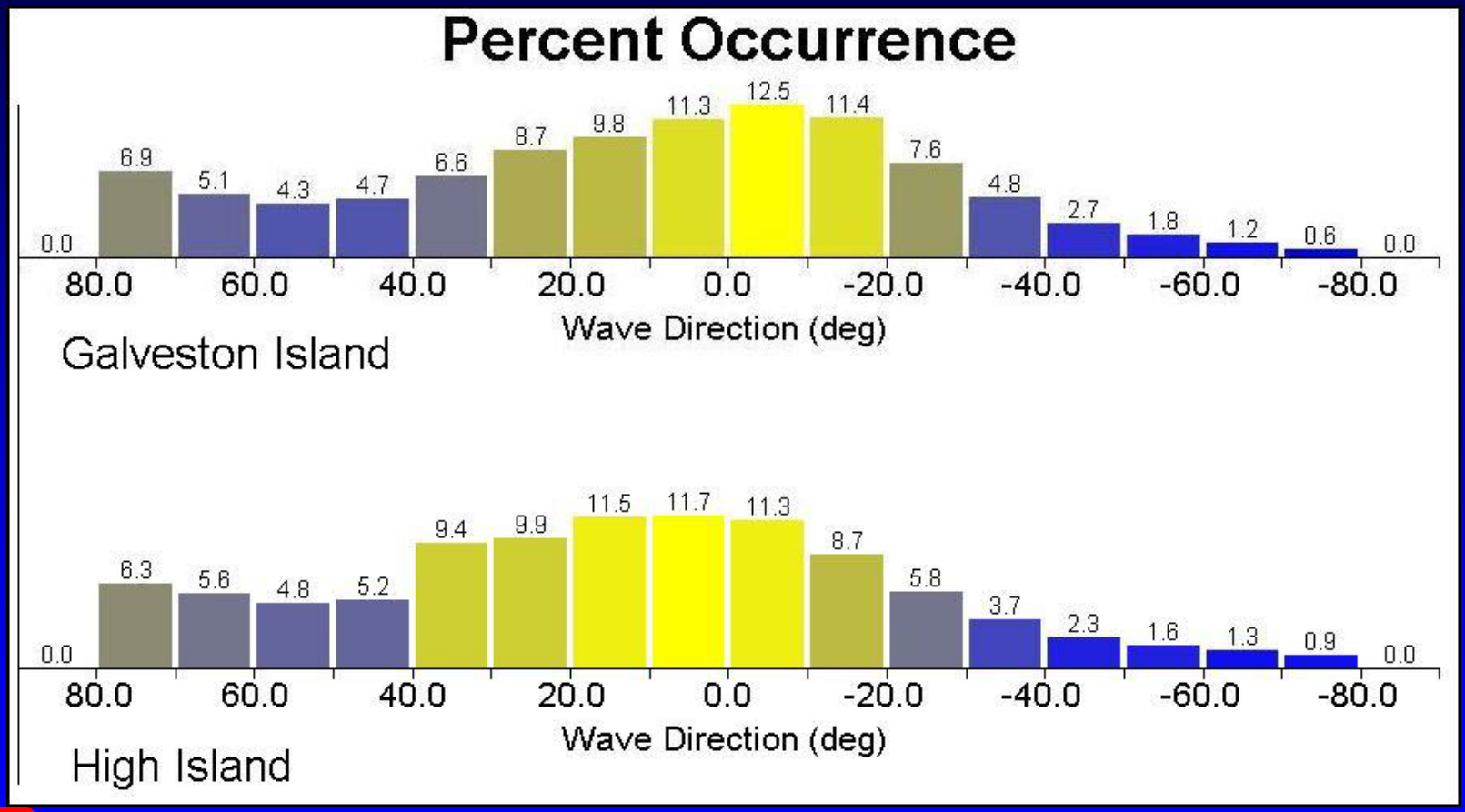
Angle and Sign Convention



Wave Angles


Percent Occurrence
0.0
6.9
5.1
4.3
4.7
6.6
8.7
9.8
11.3
12.5
11.4
7.6
4.8
2.7
1.8
1.2
0.6
0.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
Wave Direction (deg)
Galveston Island
0.0
6.3
5.6
4.8
5.2
9.4
9.9
11.5
11.7
11.3
8.7
5.8
3.7
2.3
1.6
1.3
0.9
0.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
Wave Direction (deg)
High Island

Preliminary Transport Calculations

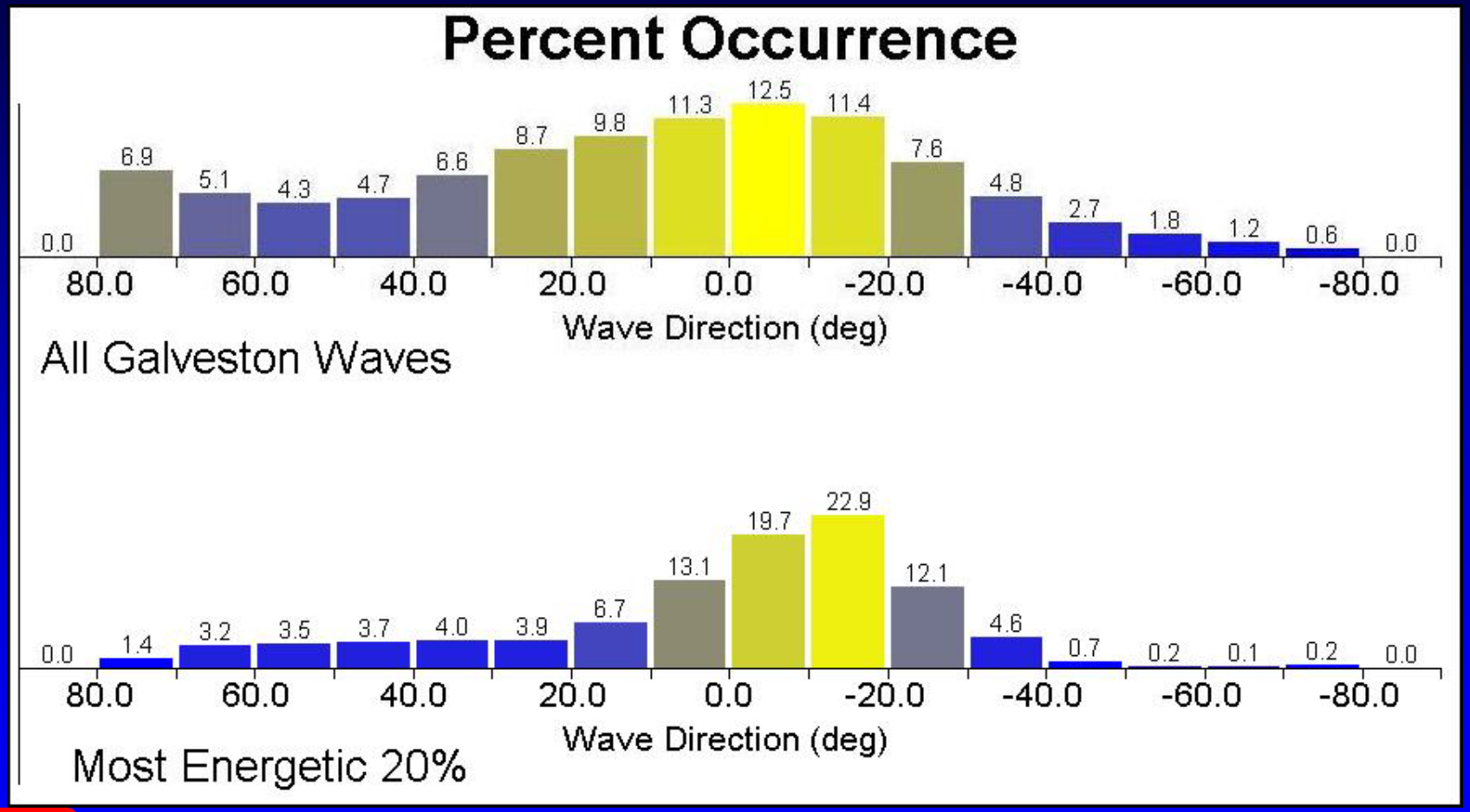
- Use offshore WIS wave data – 10 years of hourly data
- Remove offshore traveling waves
- Simple Snell's Law transformation to breaking depth
- Transport rate from "CERC" formula

Net longshore sediment transport rate results:

High Island – 75,000 m^3/yr to southwest

Galveston Island – 135,000 m^3/yr to northeast

High Energy Wave Angles



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Solution Attempts

- Earlier WIS hindcast 1976-1995
- NOAA Buoy 42035 data (off Galveston)
- Different definitions of wave angle and period
- Influence of coastal currents

Nothing shifted the direction of net transport on Galveston Island to the southwest . . .

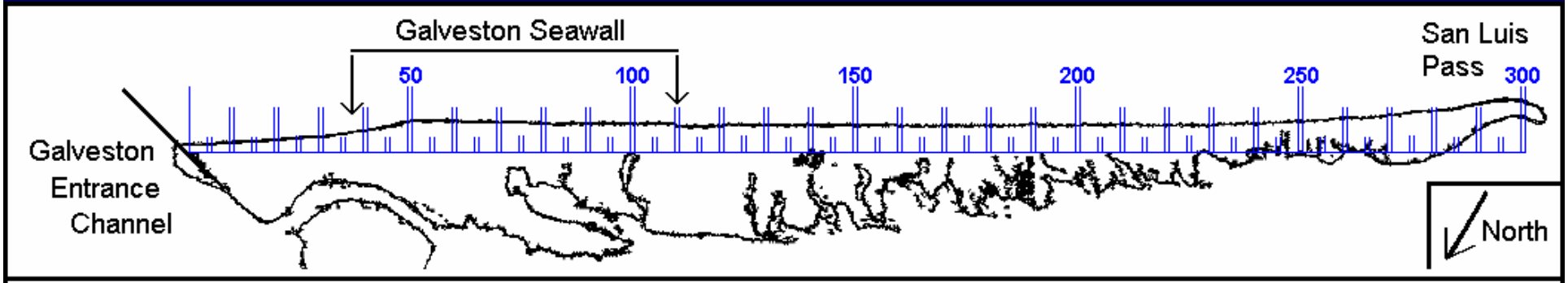
until we investigated the influence of local winds.

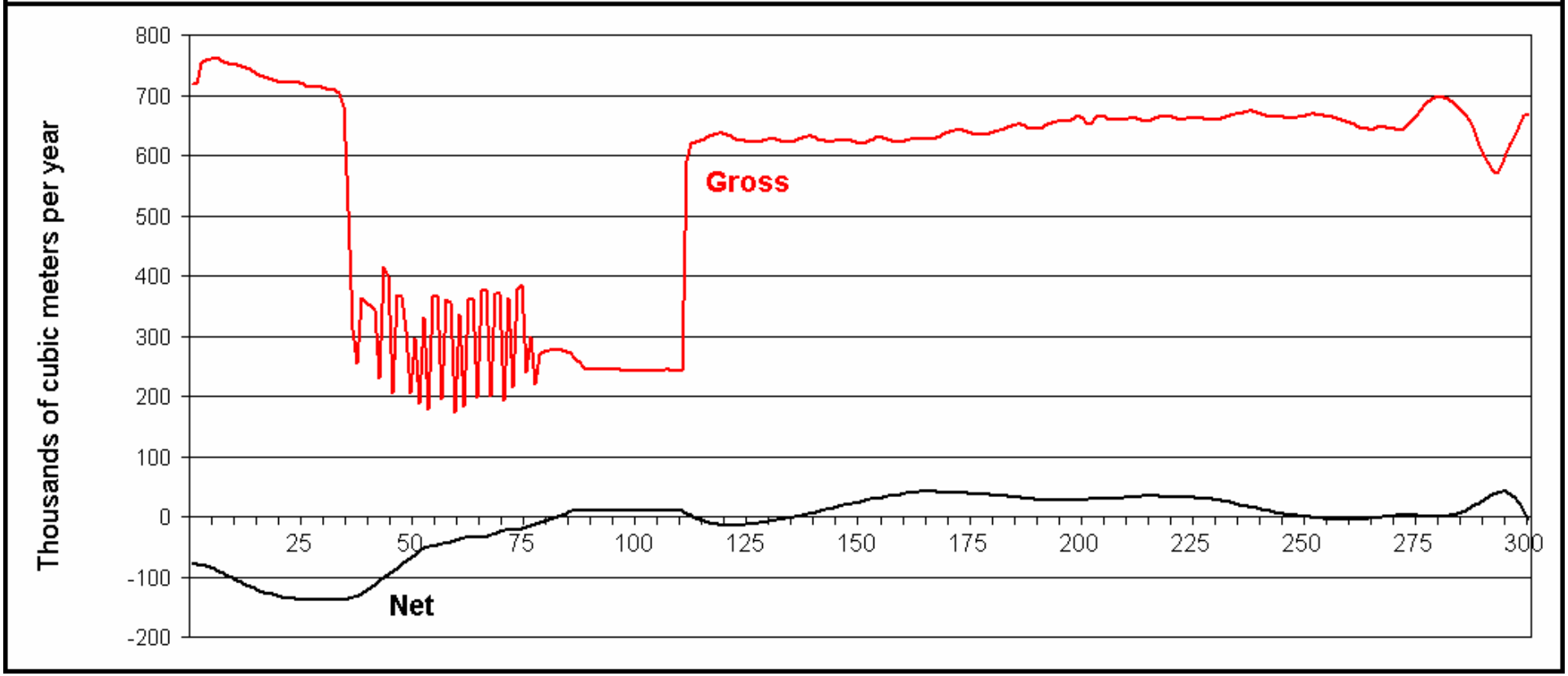
Local Wind Effects

- Affects wave transformations (STWAVE).
- Modifies surfzone currents (GENESIS).

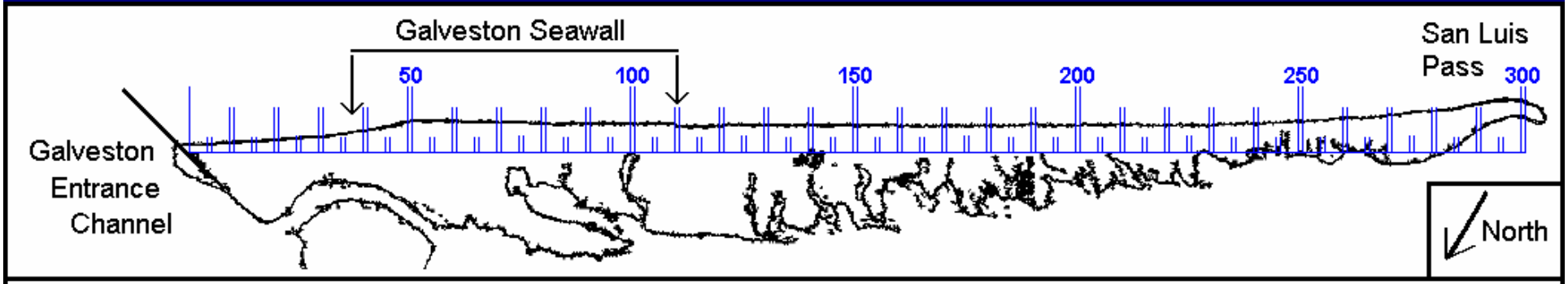
Including both requires modifications to both STWAVE and GENESIS standard procedures.

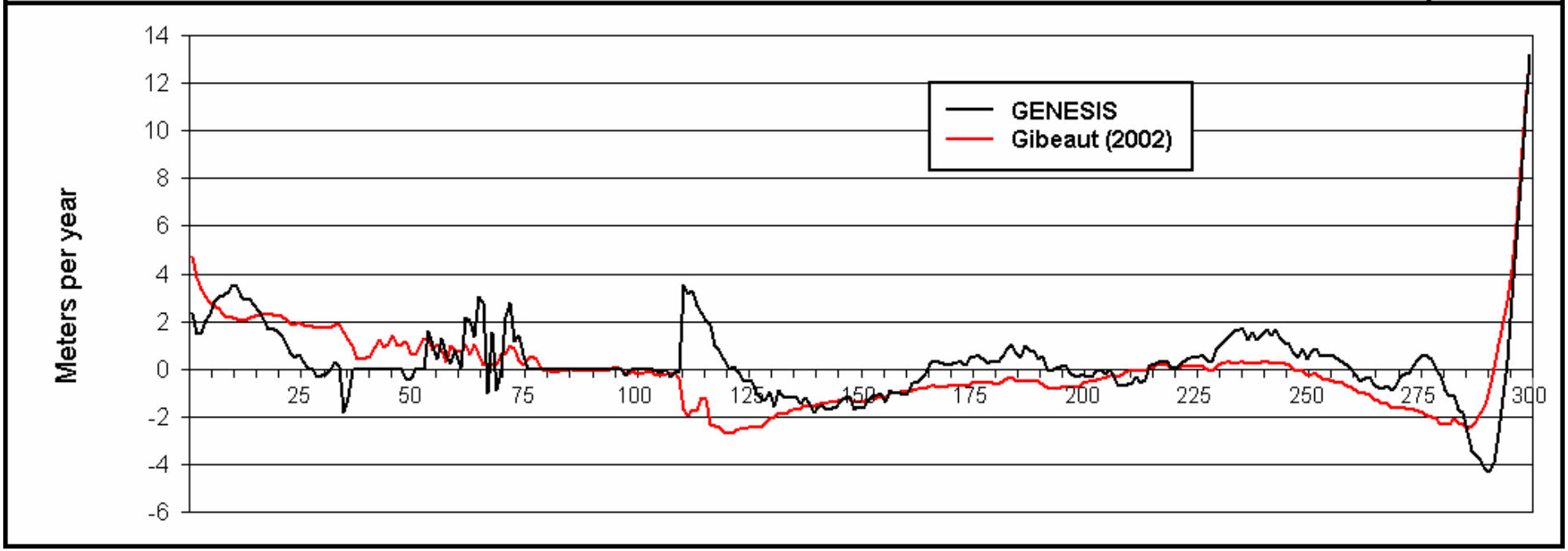
Net and Gross Transport Rates Galveston Island





Shoreline Change Rate
Galveston Island





Calibration Results

- Local winds are important in transport rate calculations
- 600-700 K gross and 0-40 K m^3/yr net transport to southwest along West Galveston Island
- 500 K gross and 50-100 K m^3/yr net transport to southwest along central portion of High Island
- Net transport reversals to the northeast at East Beach on Galveston Island and near Sea Rim State Park in Jefferson County

Current Activities

- Using SBEACH to look at the effects of storms on a suite of beachfill alternatives
- These data are being used by economic and environmental modelers to narrow the range of optimal alternatives