Channel Infilling: Calculations with the CMS

Example* for Humboldt Bay, California

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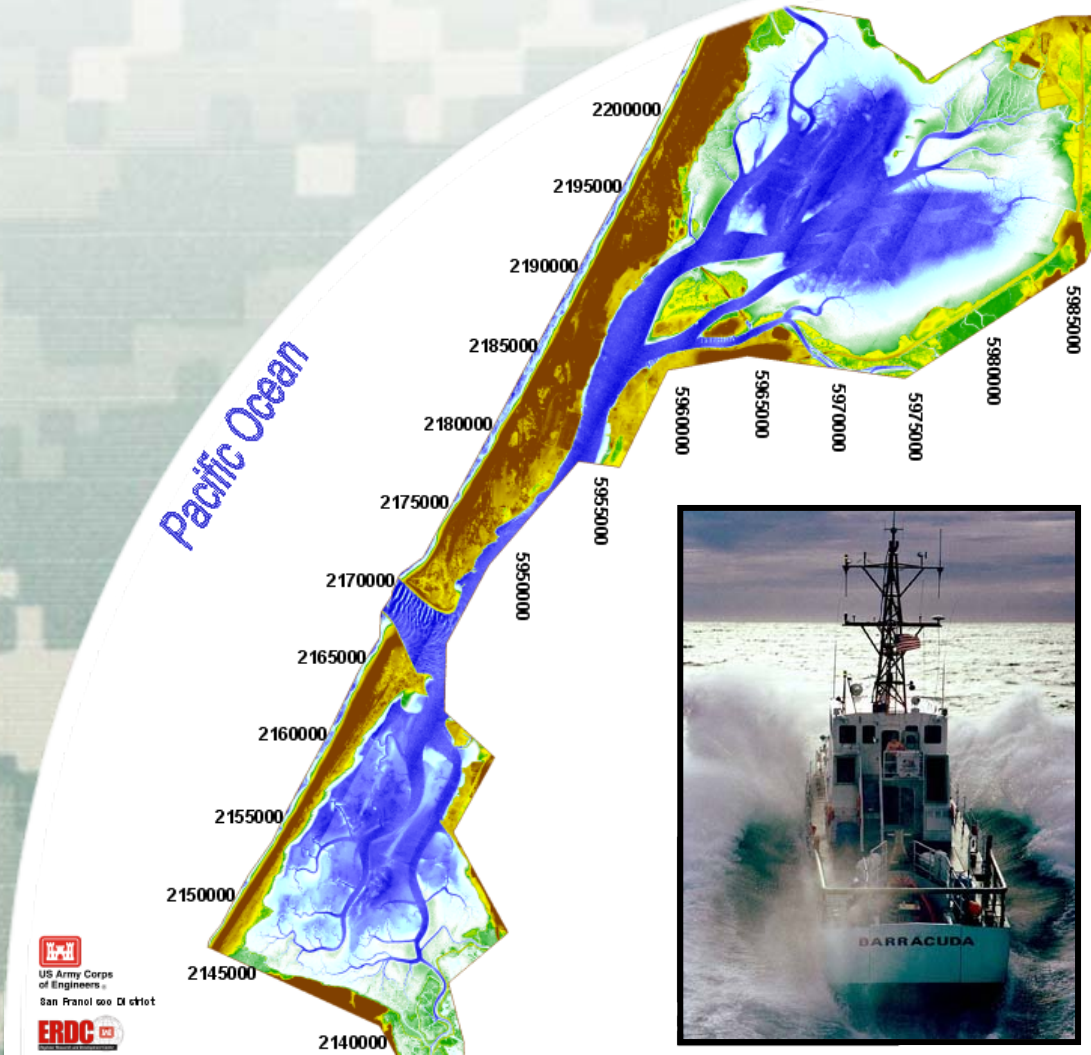

* Caveat: for instructional use, not for engineering design!

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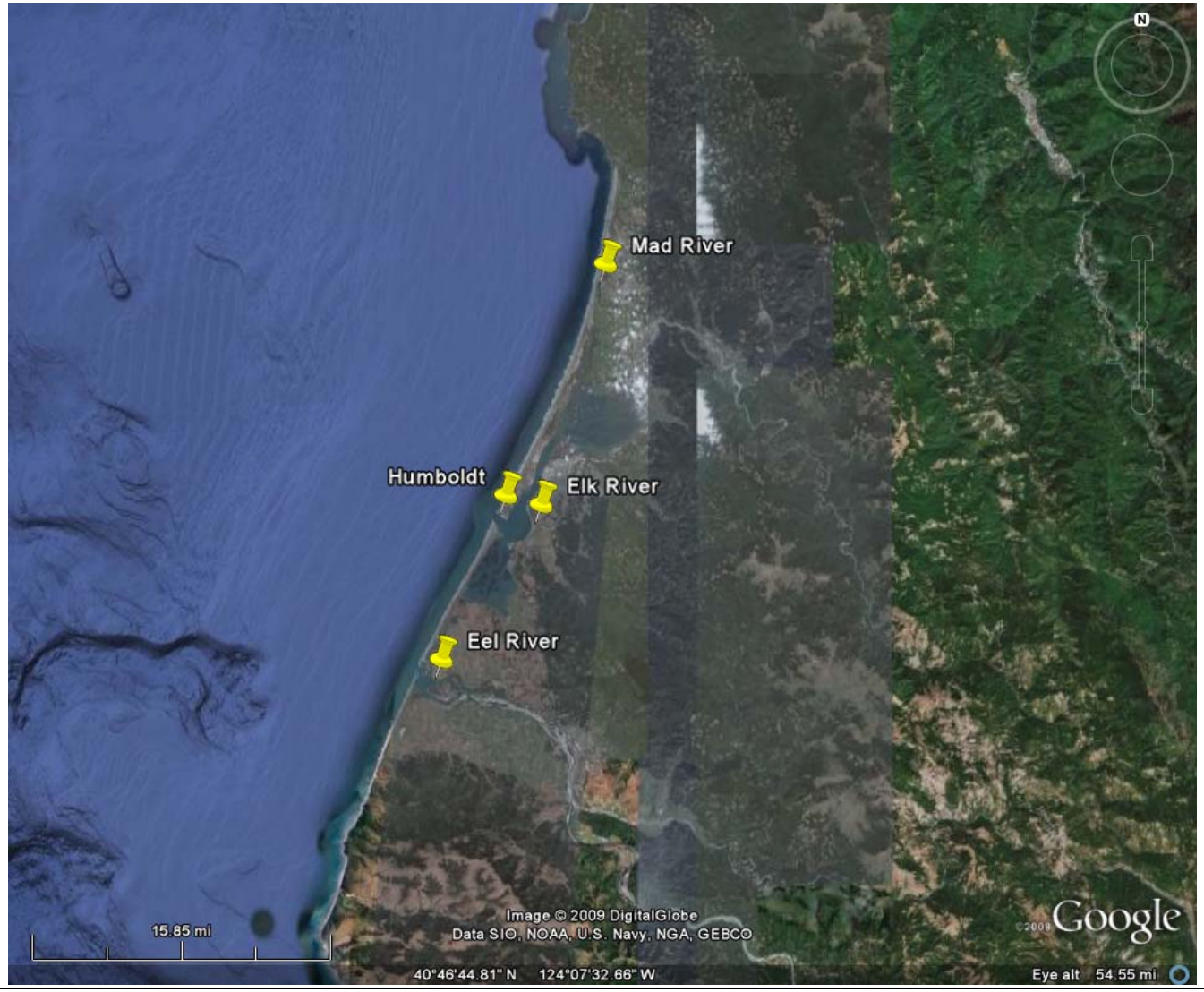
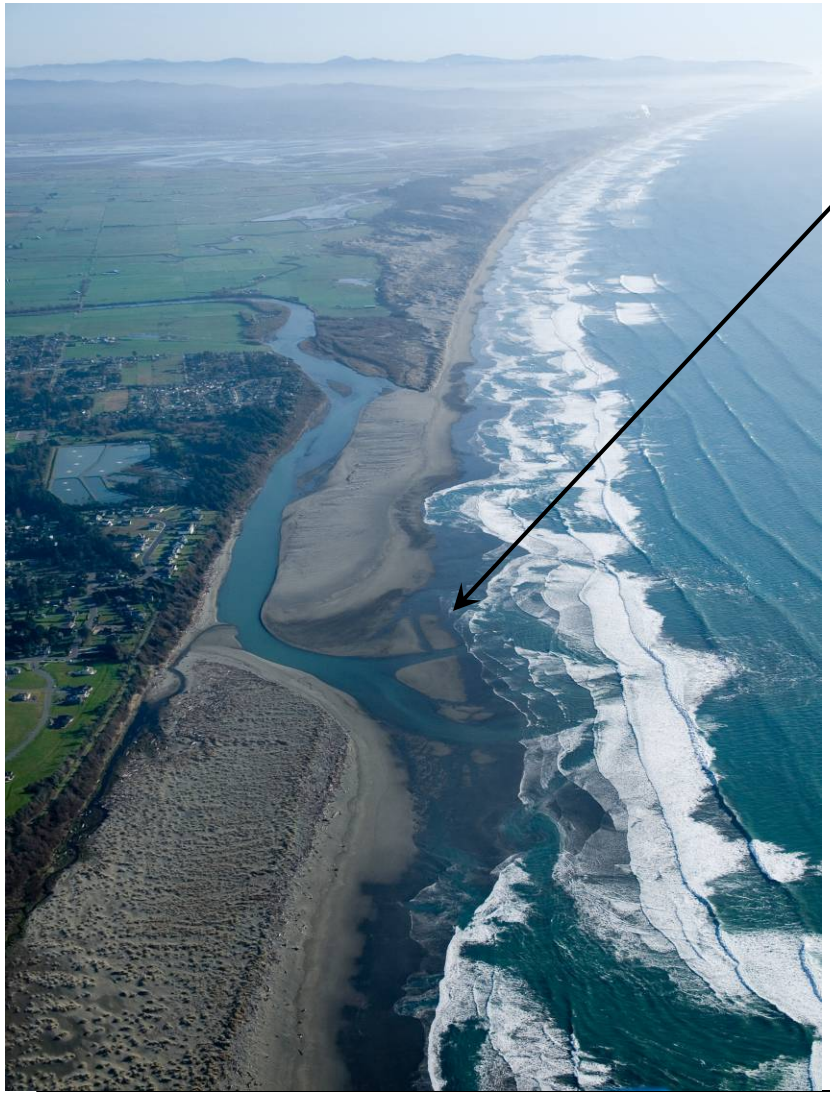
Humboldt Bay: Overview

- Largest waves in the continental United States
- Complex wave climate
  - Southern hemispheric swell
  - Storms from north
- Tide
  - Tidal Prism (4 x 10^9 cu ft; Jarrett 1976)
  - Semi-diurnal tide
  - Semi-diurnal tidal range – 5 ft; Diurnal tidal range – 7 ft
- Deep-draft channel, 48 ft entrance bar (mllw)
  - Entrance channel annual maintenance approximately 700,000– 900,000 cu yd/year
  - Dredged sand placed offshore of North Spit

Geographic Orientation

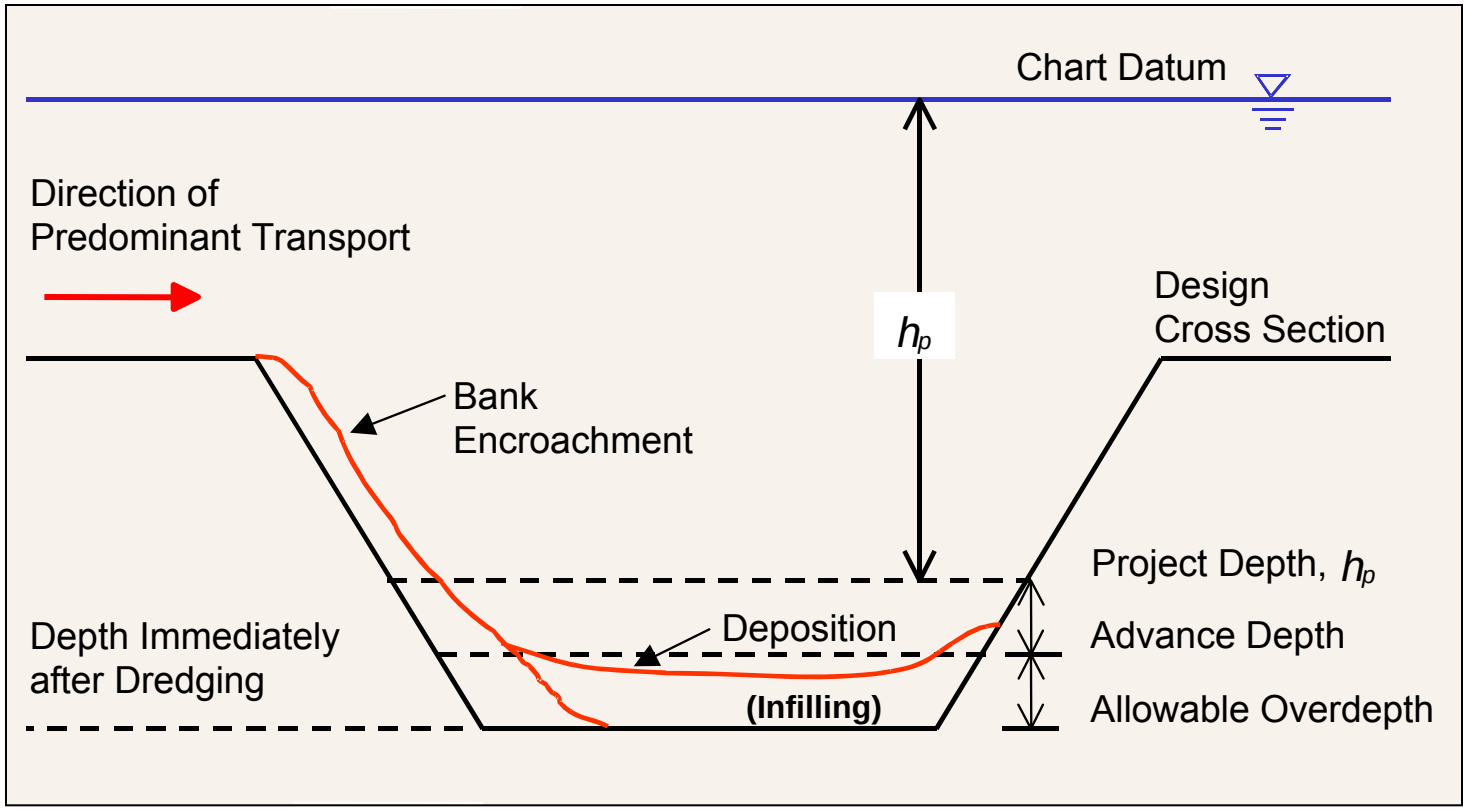


Morphologic Evidence for Long-term Longshore Transport to the North



- Mad River mouth migrates to north
- Eel River mouth migrates to north
- Ebb-tidal delta skewed to north
- Tip shoal off south jetty limits depth and needs to be dredged

Channel Shoaling Terminology



Shoaling = Bank Encroachment + Deposition

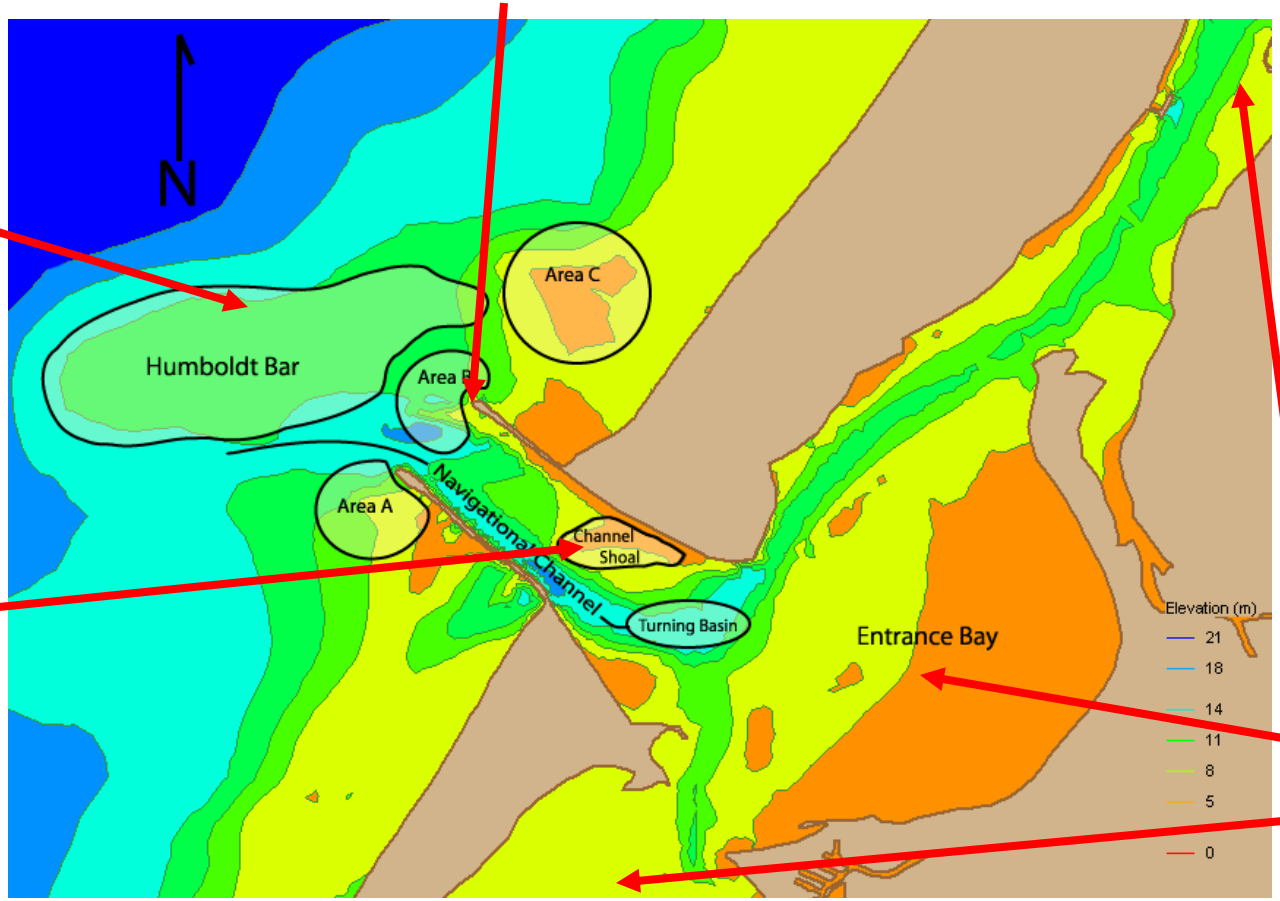
Terminology

Humboldt Bay Example

Jetty Tip Shoal

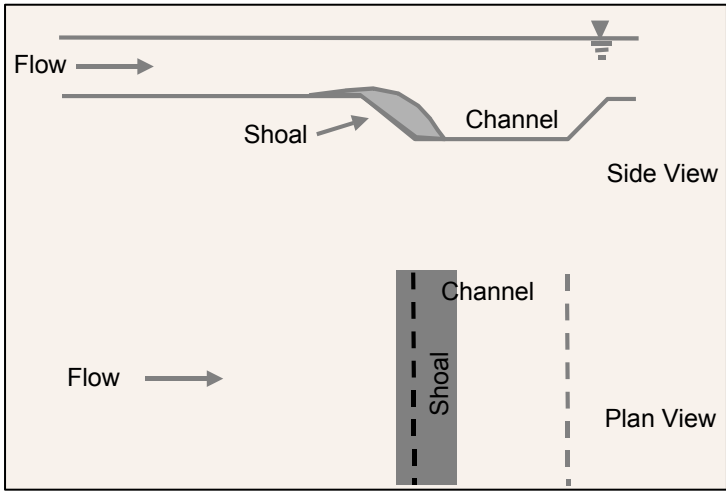
Ebb Tidal Delta

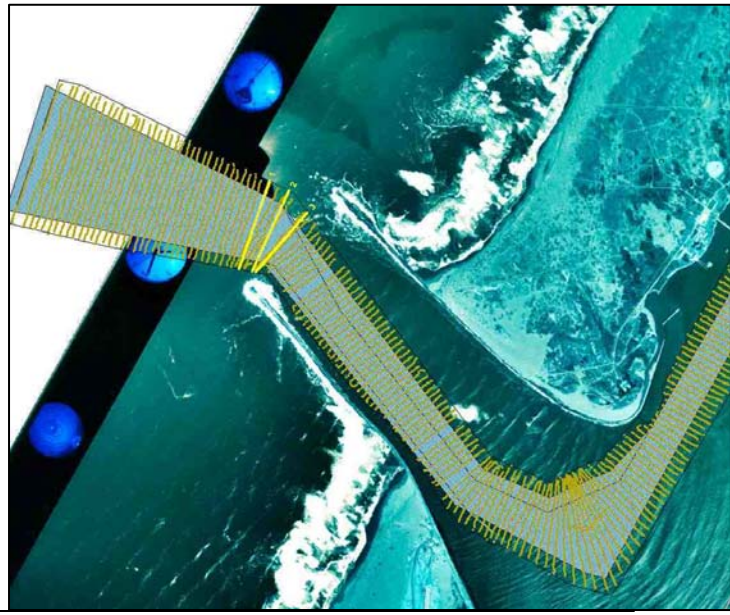
Channel Shoal



Flood Tidal Deltas

Channel Shoaling Overview



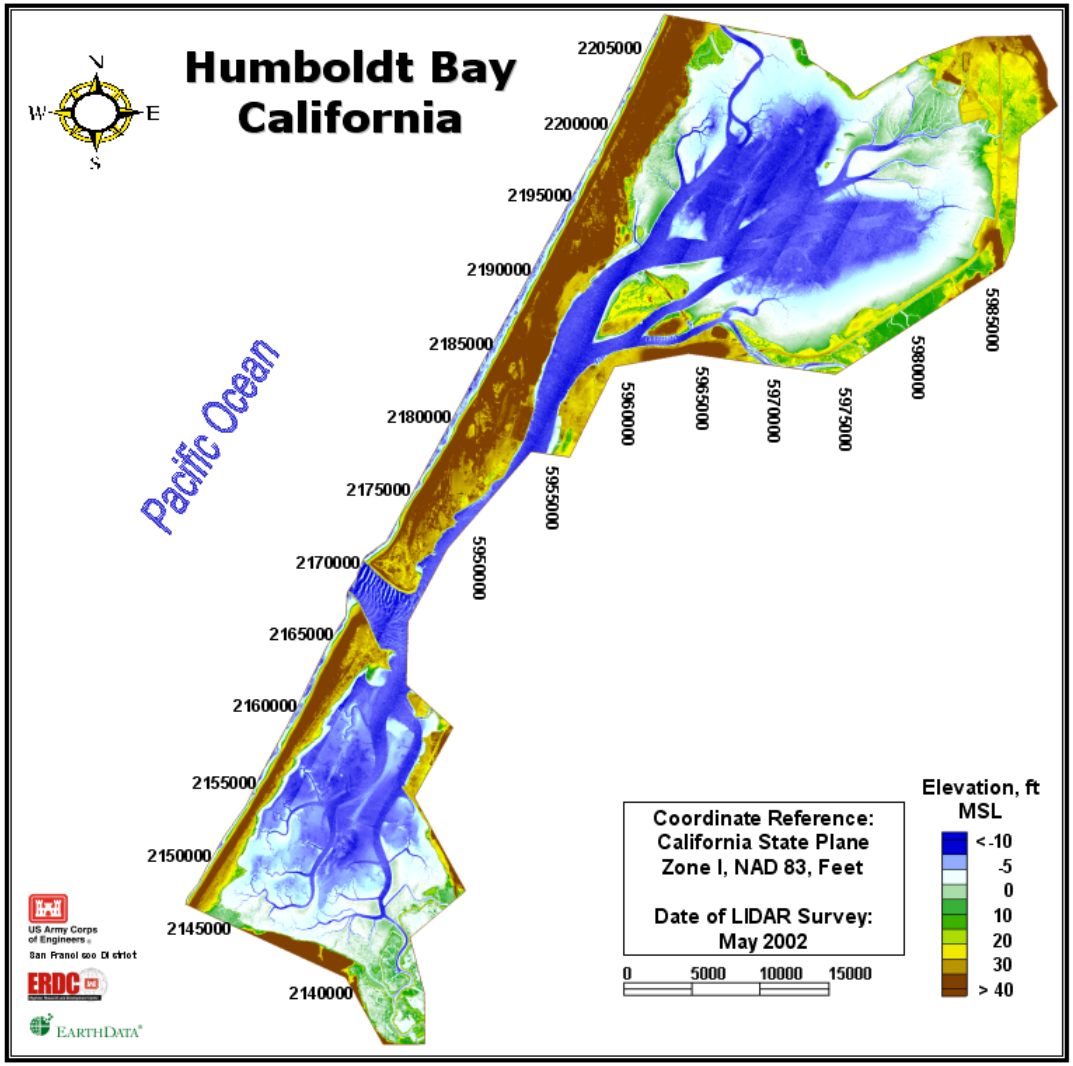


“Entrance Bay” – Diffraction dominated

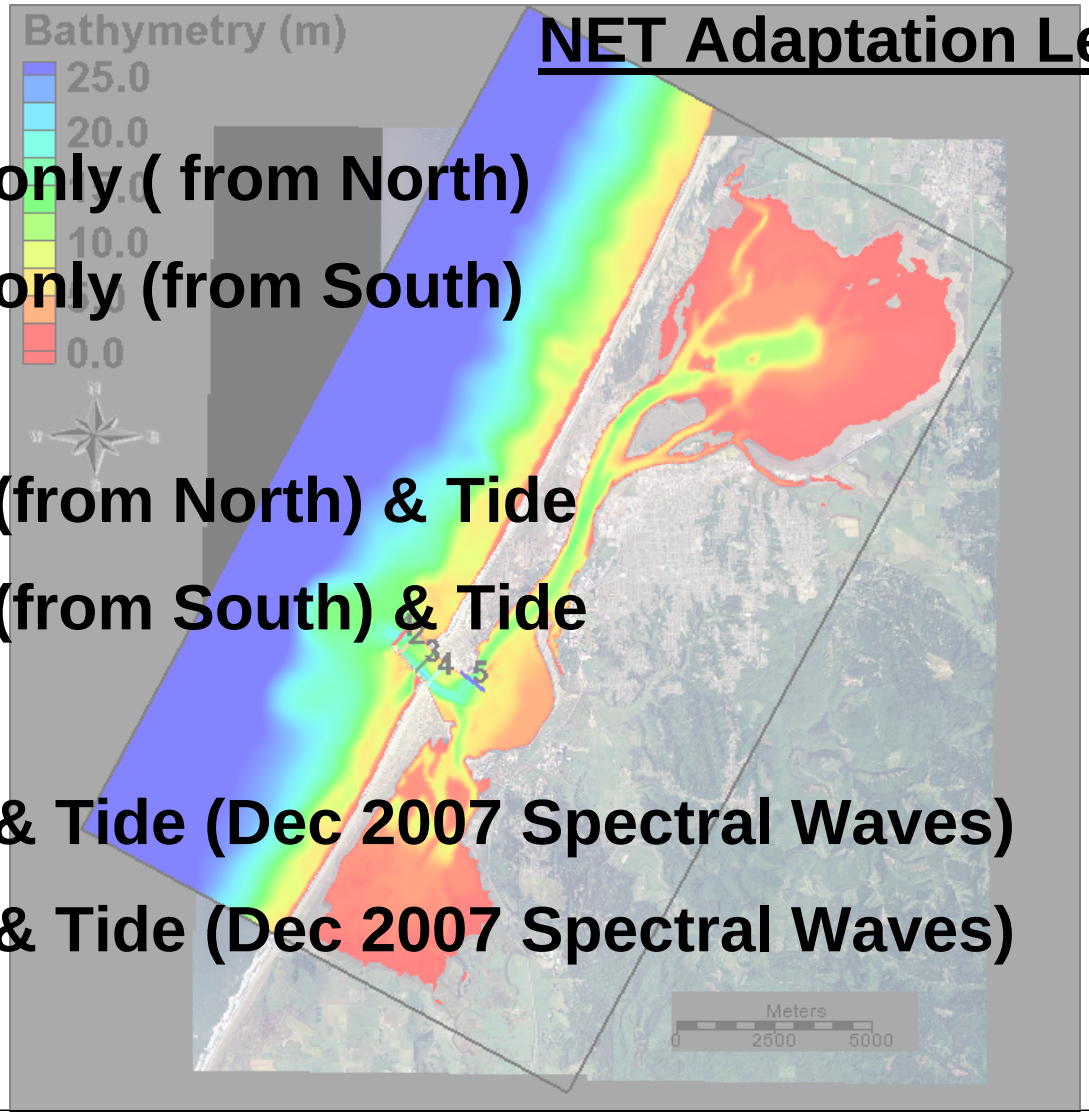
Note channel shoal; a large feature

CMS Setup for Humboldt Bay Entrance

- Bay Bathymetry Obtained with LIDAR at Low Tide - 2002
- Combined with Corps channel surveys, the LIDAR provides excellent representation of estuary morphology and channelization
- Implicit model; 3-month simulation, 9 hr CPU time

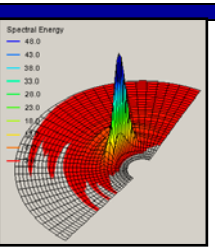


Sensitivity Tests with CMS: Channel Shoaling



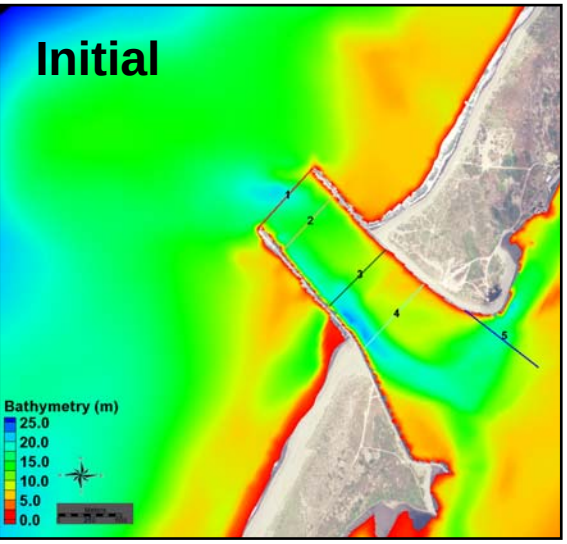
Test	NET Adaptation Length (AL)
A) Waves only (from North)	10 m
B) Waves only (from South)	10 m
C) Waves (from North) & Tide	10 m
D) Waves (from South) & Tide	10 m
E) Waves & Tide (Dec 2007 Spectral Waves)	5 m
F) Waves & Tide (Dec 2007 Spectral Waves)	20 m

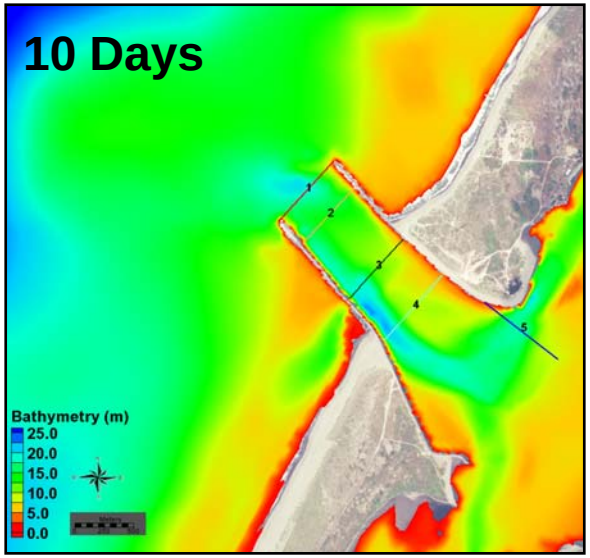
Morphology Change: Tests A & B (waves only)

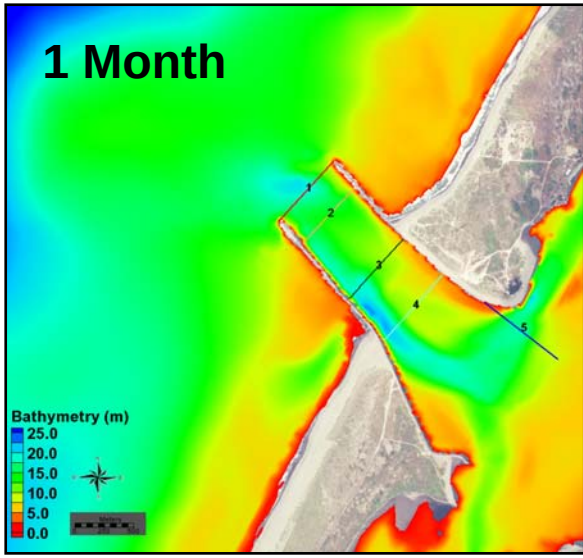


Waves from N

A)







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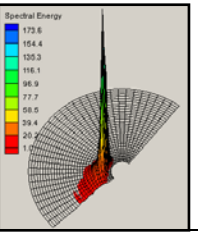
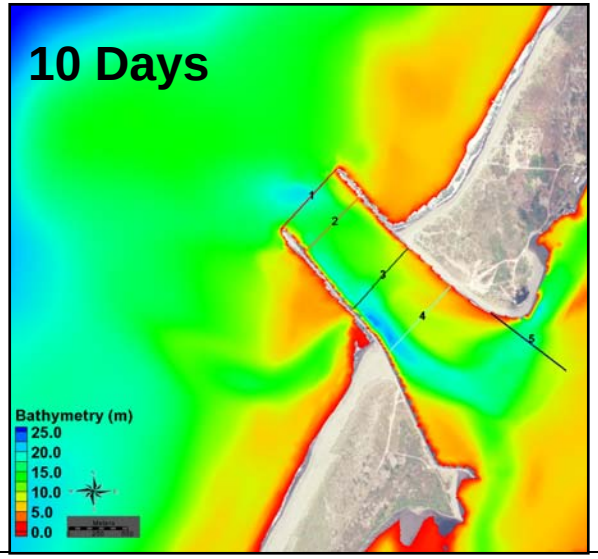
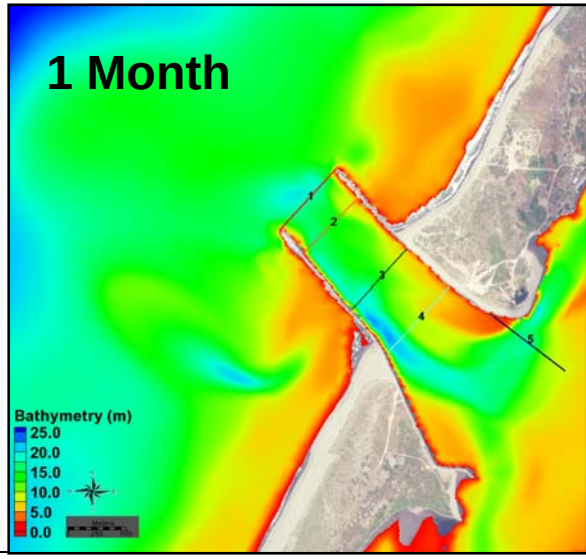
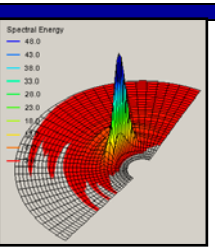


Waves from S



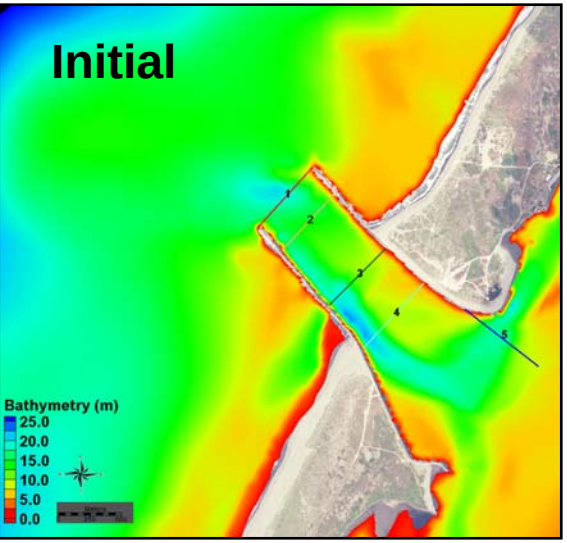


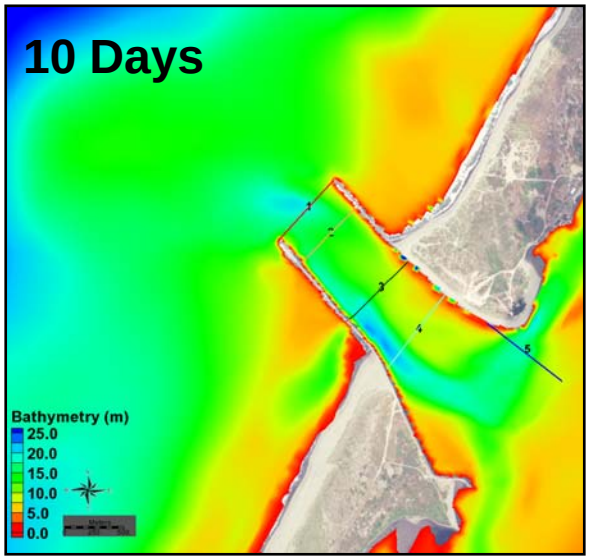
Morphology Change: Test C & D (waves & tide)

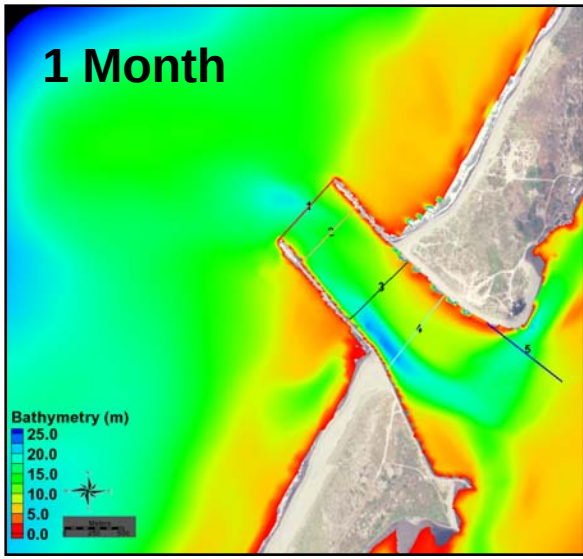


Waves from N

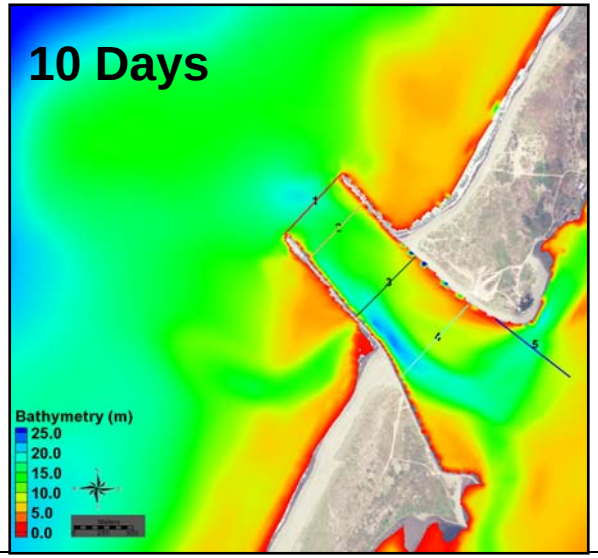
C)

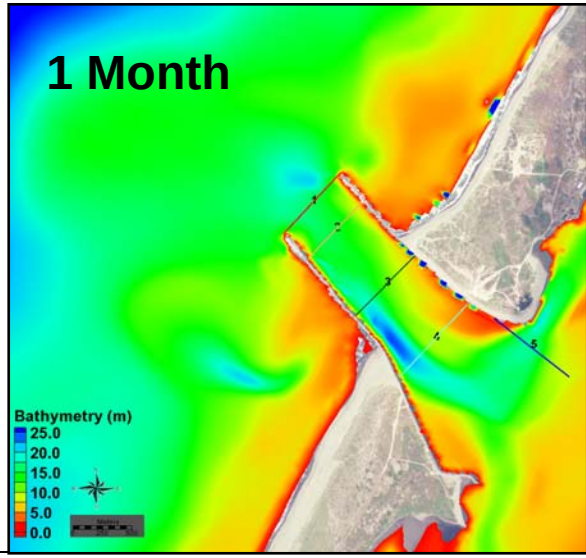


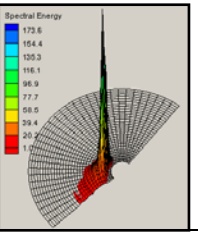




D)



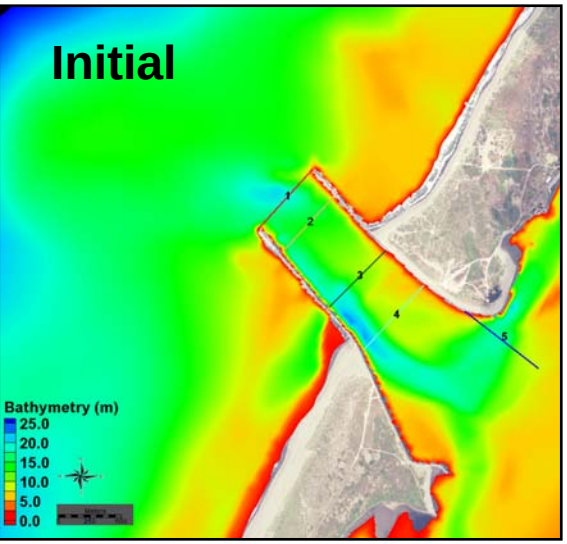


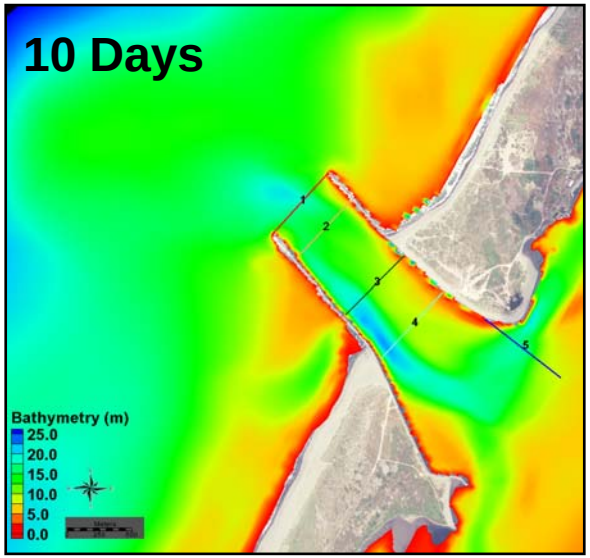


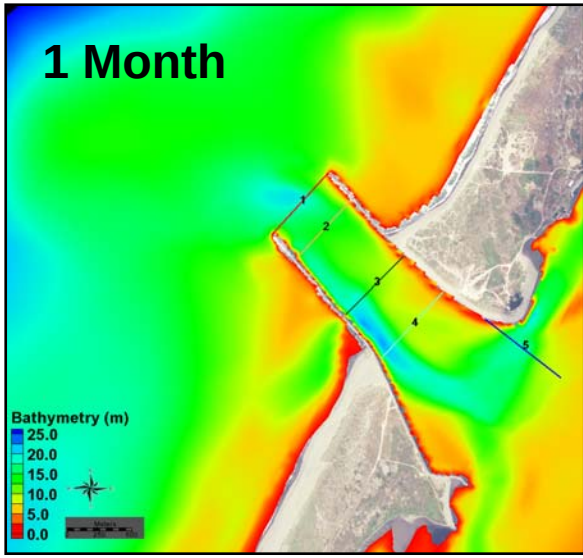
Waves from S

Morphology Change: Test E & F (time-varying waves)

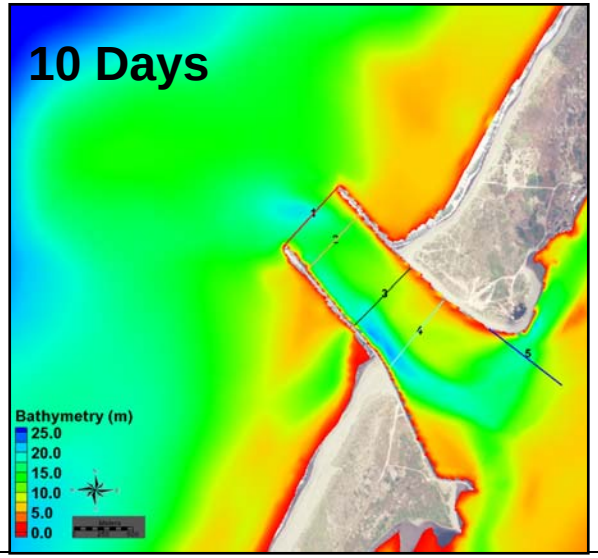
Spectral waves, AL = 5 m, E)

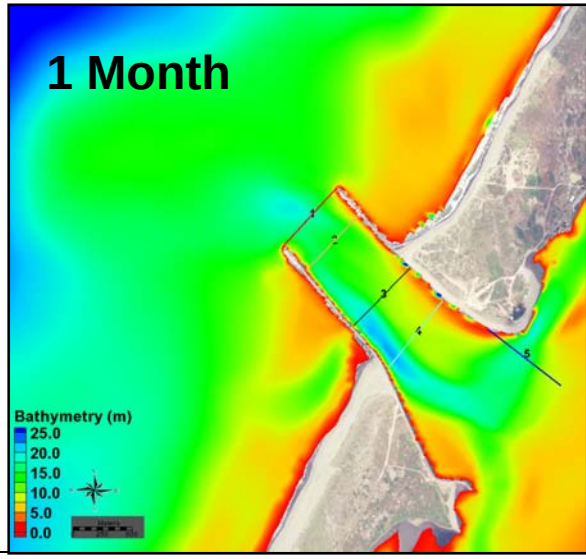






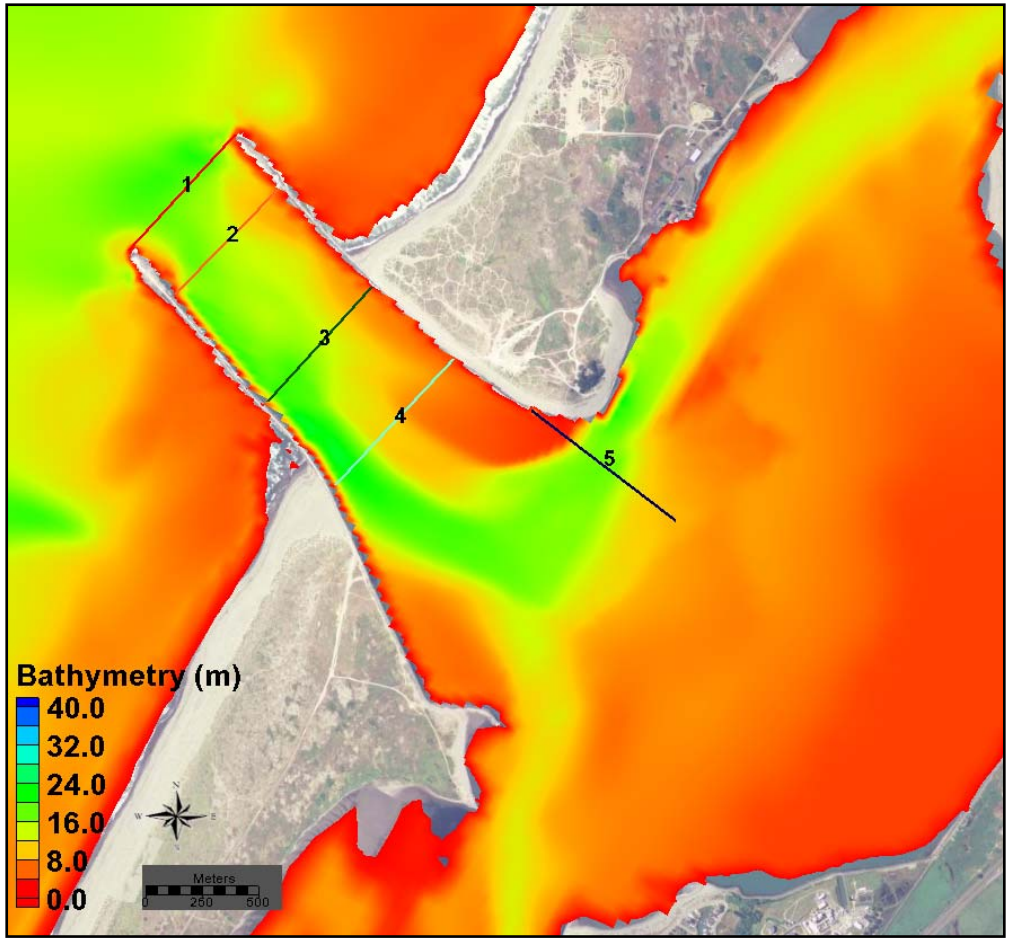
Spectral waves, AL = 20 m, F)



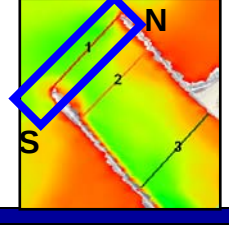


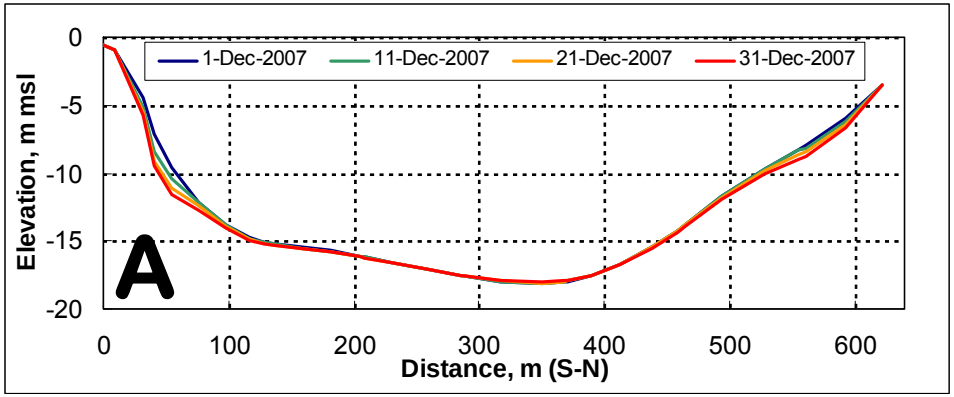
Extracted Channel Cross-sections

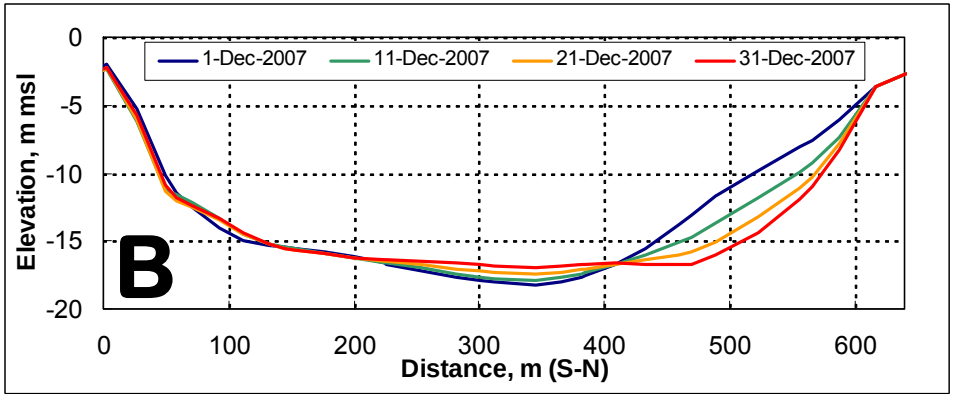
- A & B – Waves Only
- C & D – Waves & Tide
- E & F – Adapt. Length 5 m & 20m

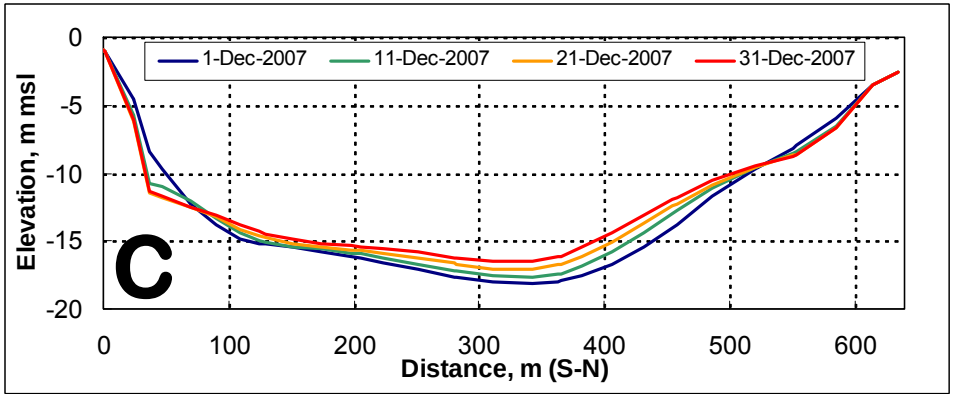


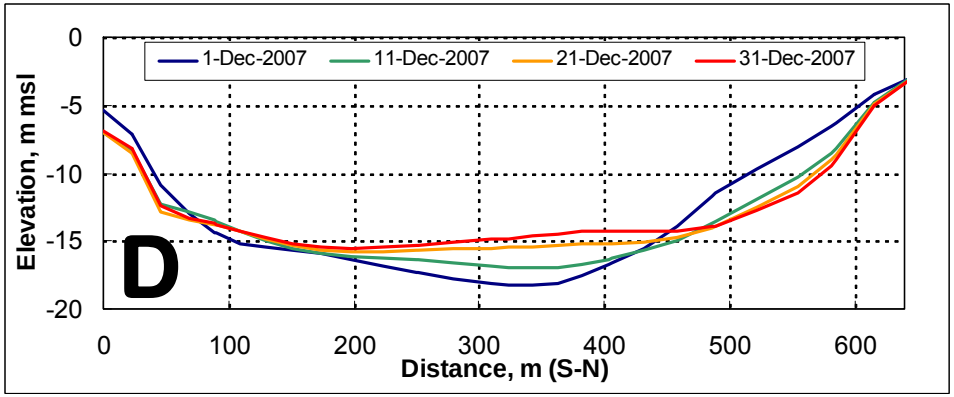
Channel Cross Section 1

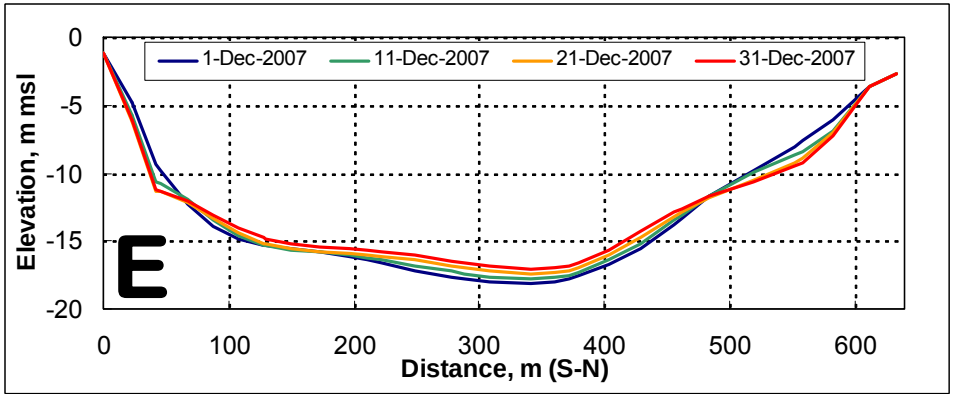


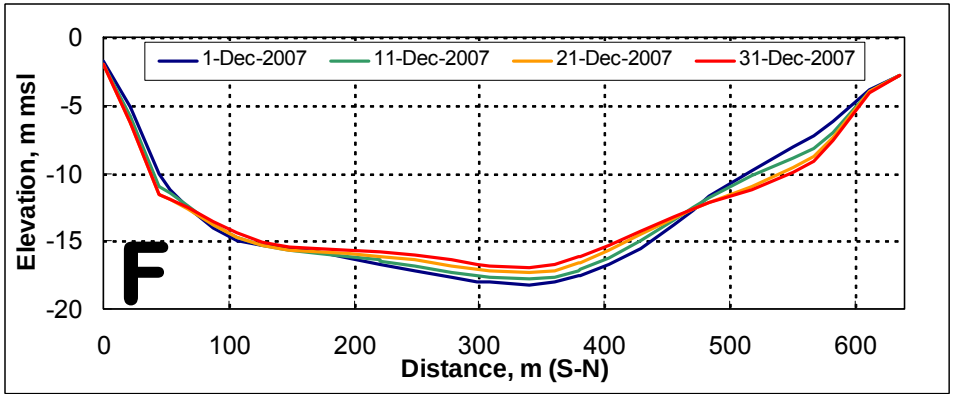




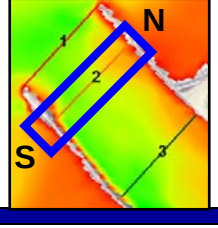


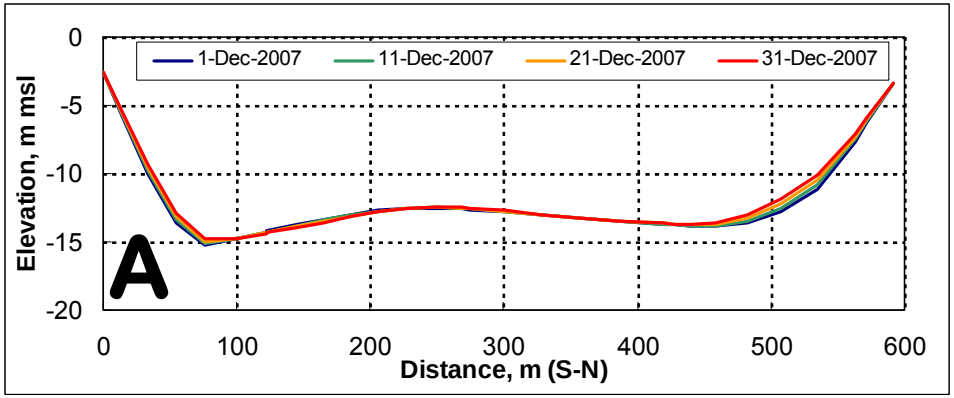


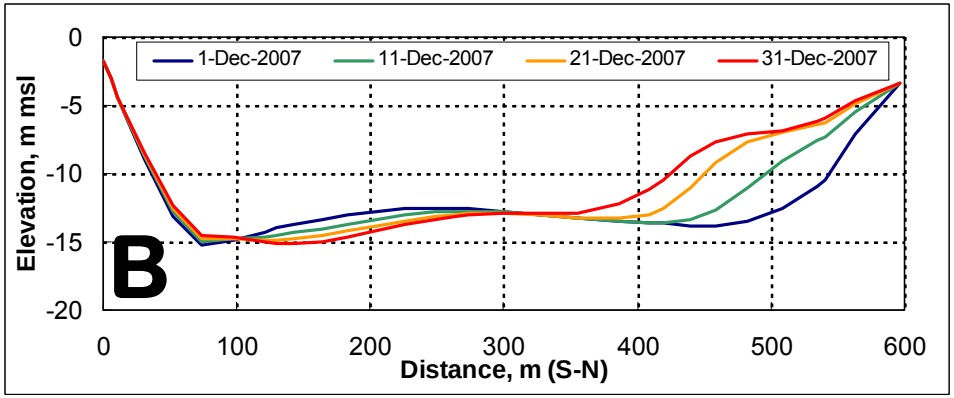


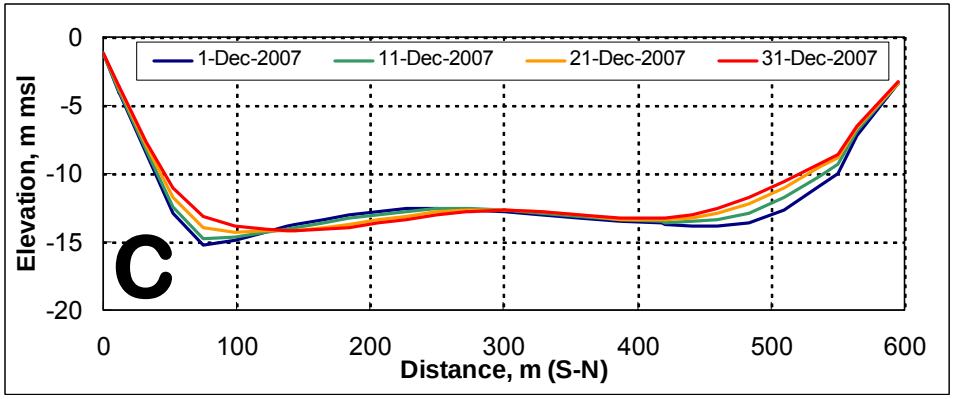


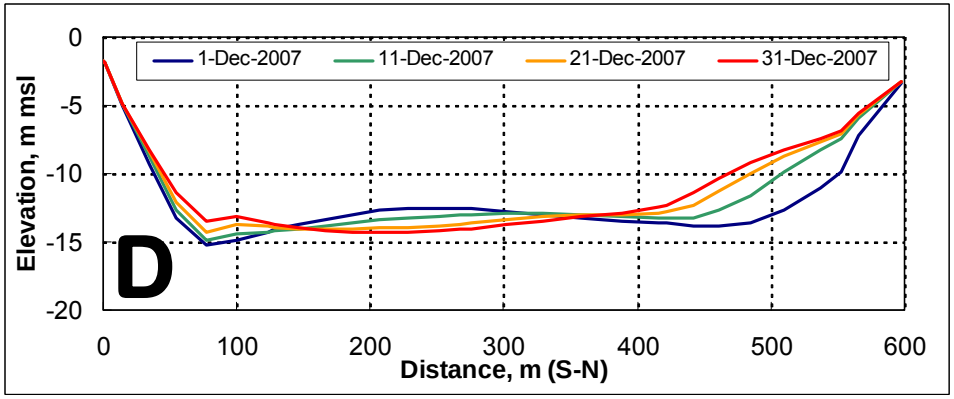
Channel Cross Section 2

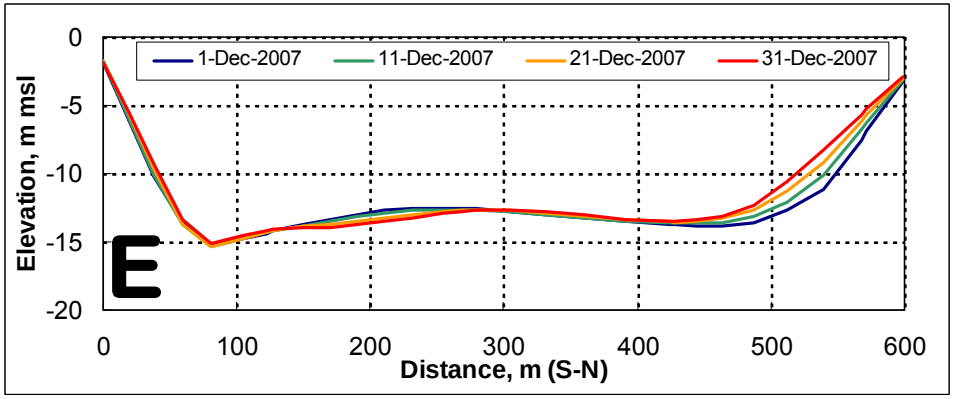


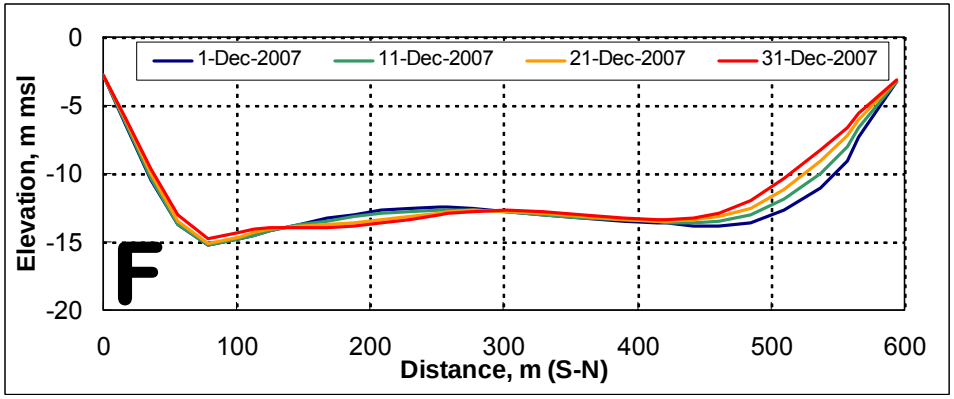




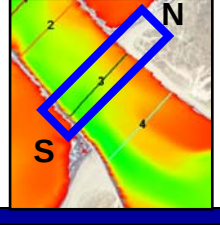


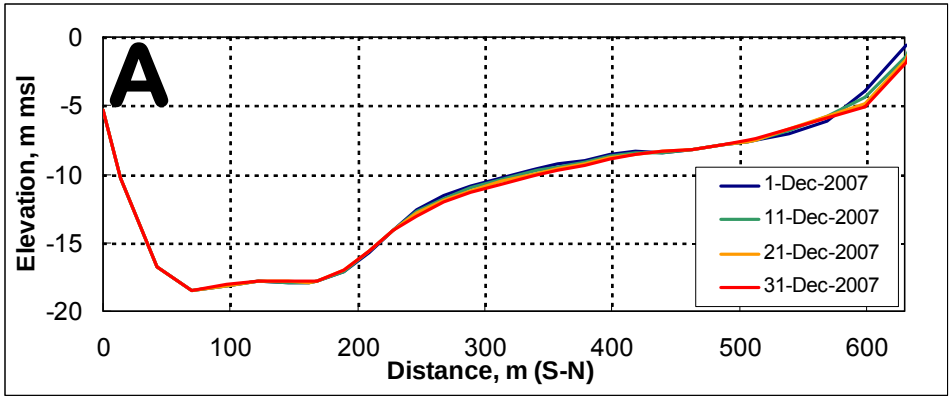


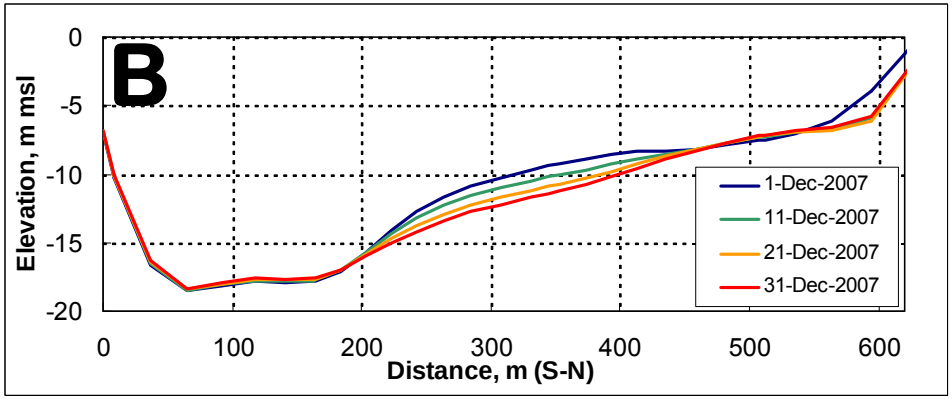


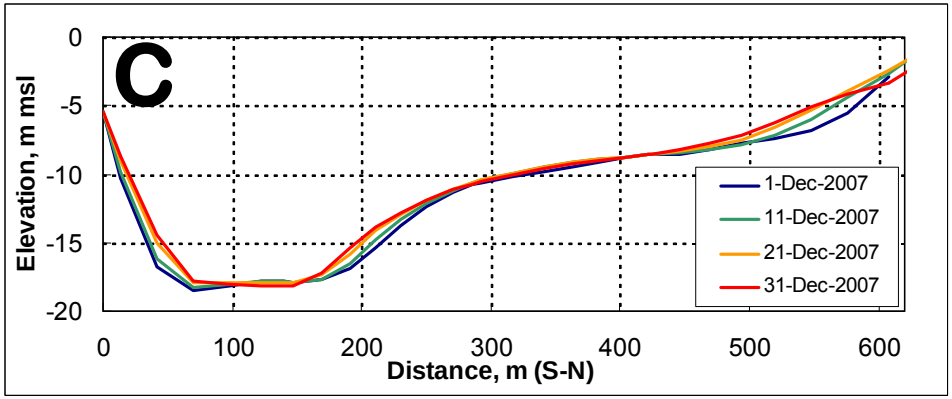


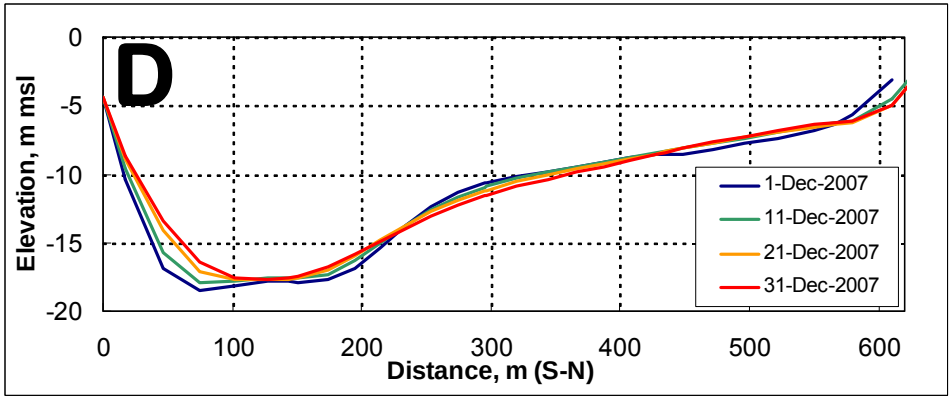
Channel Cross Section 3

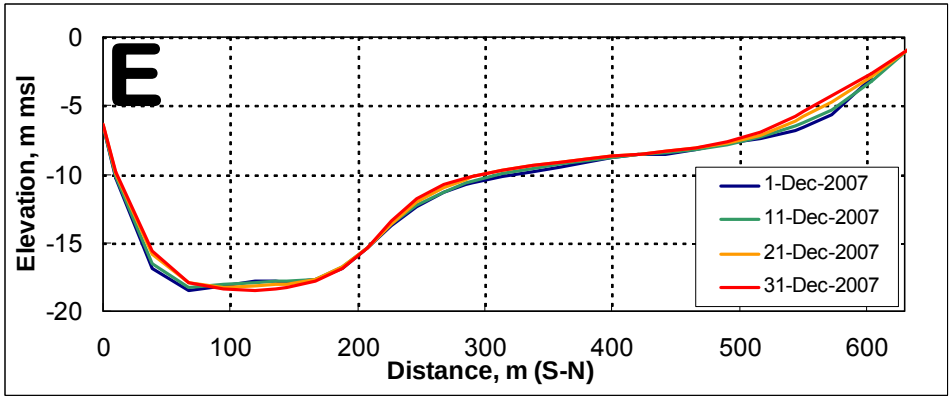


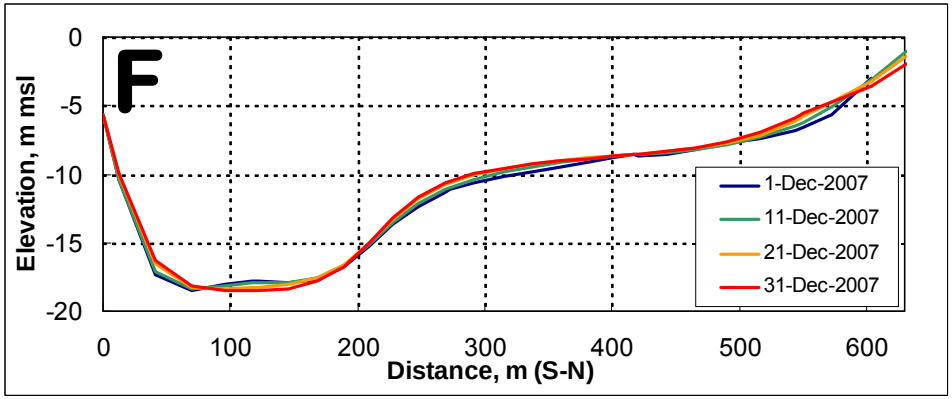




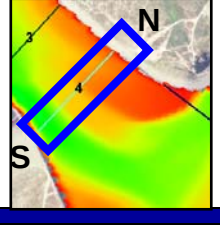


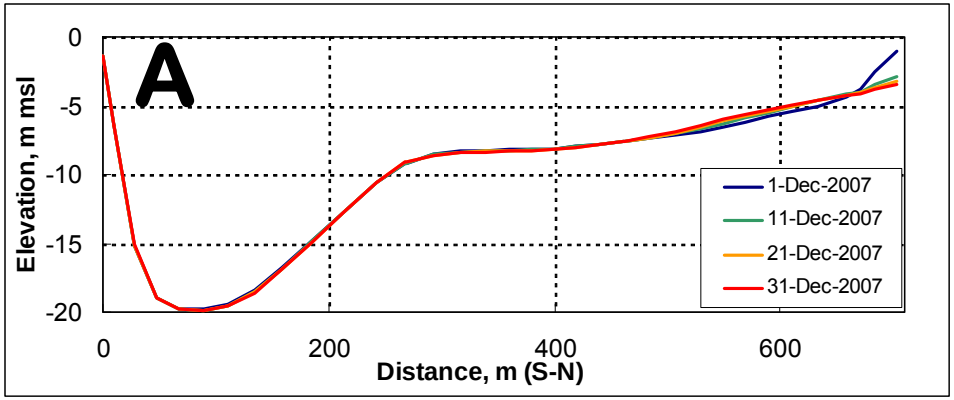


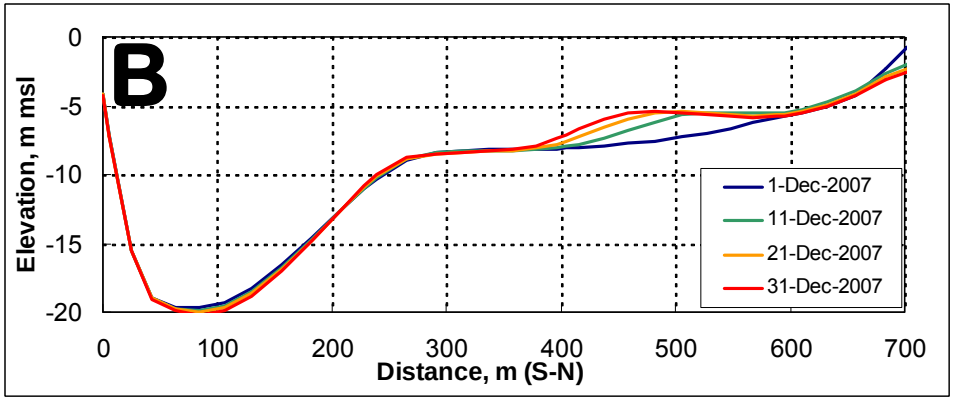


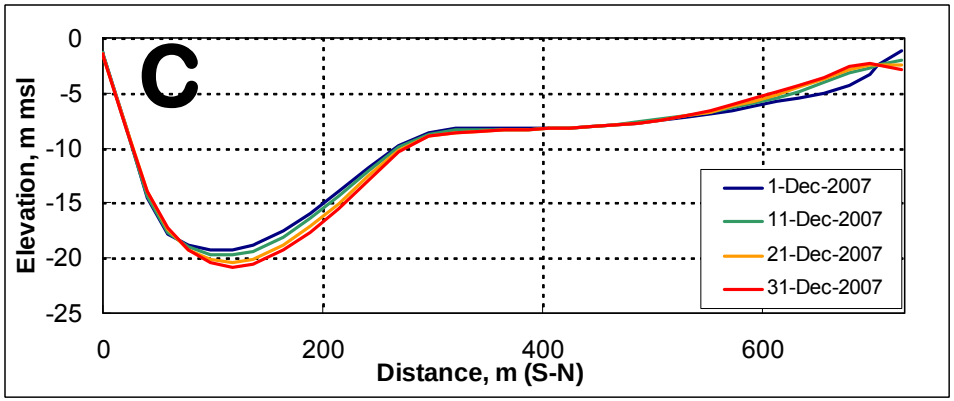


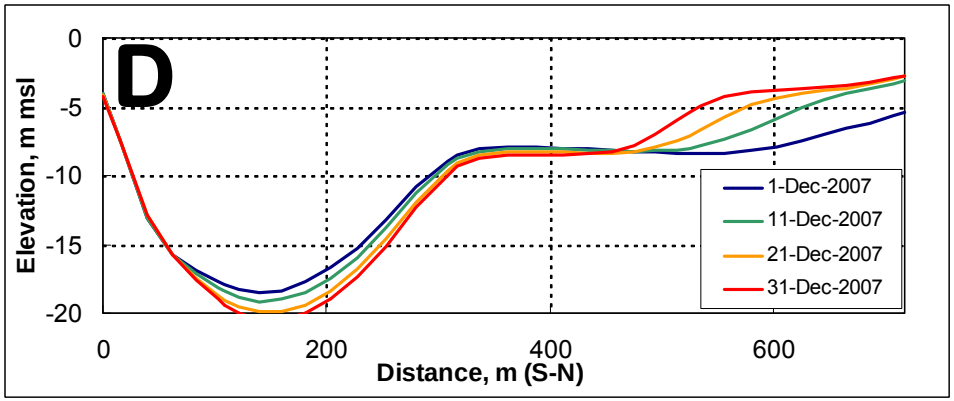
Channel Cross Section 4

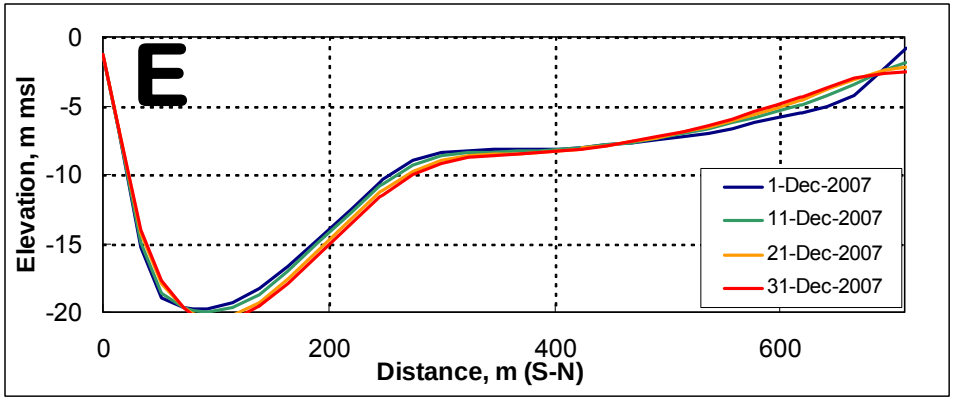


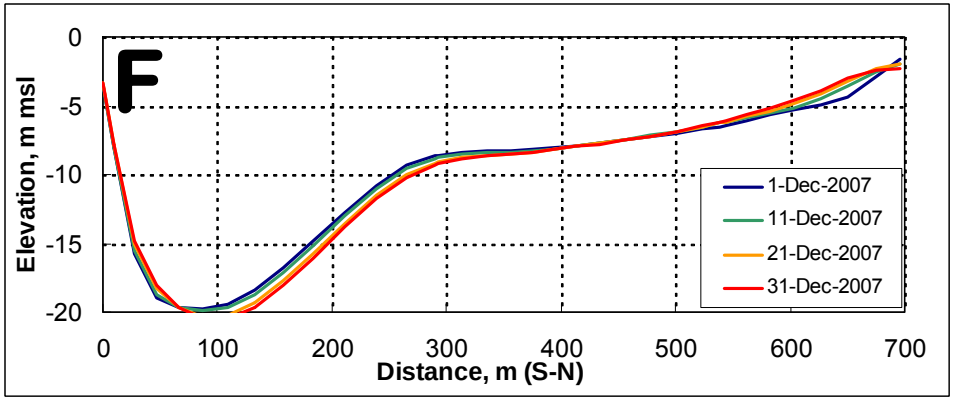




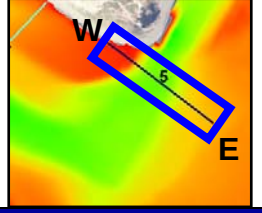


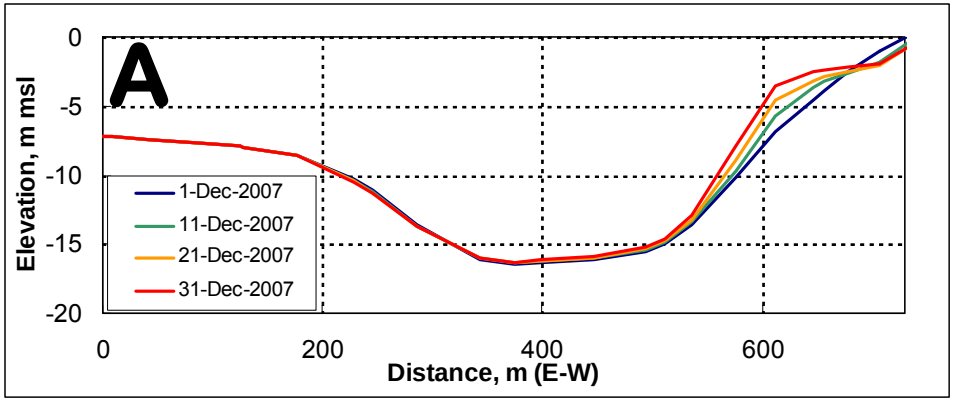


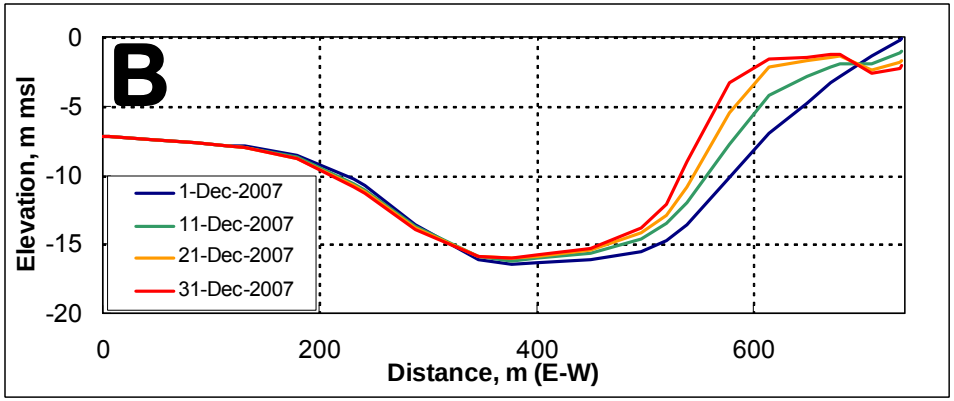


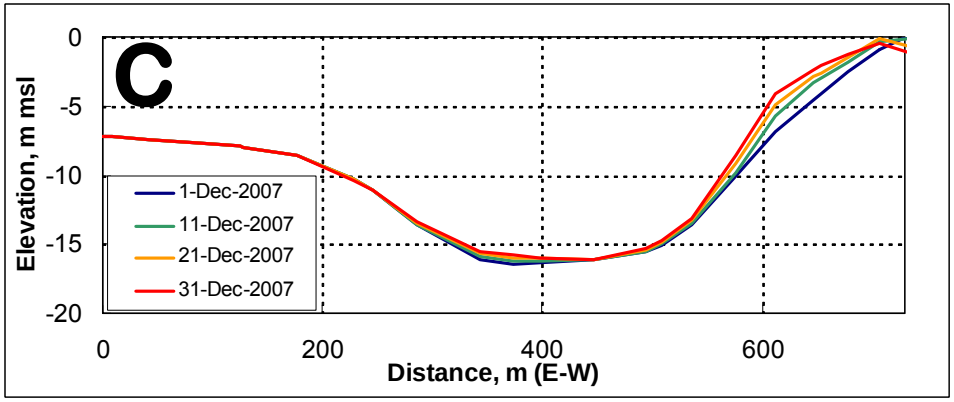


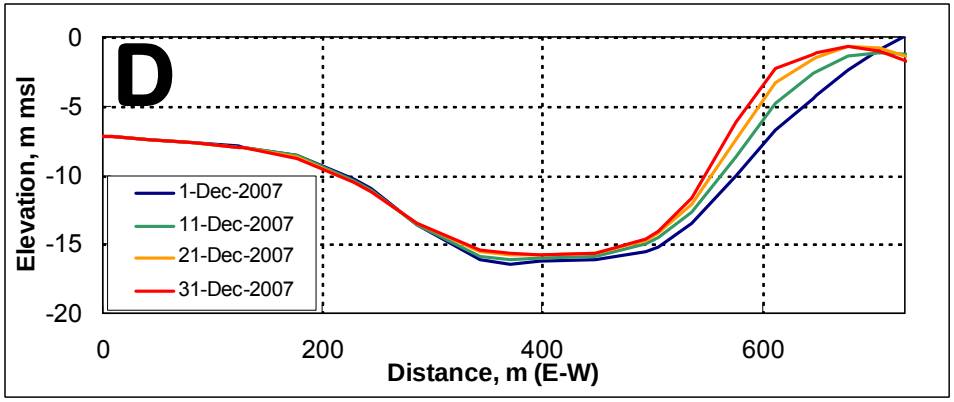
Channel Cross Section 5

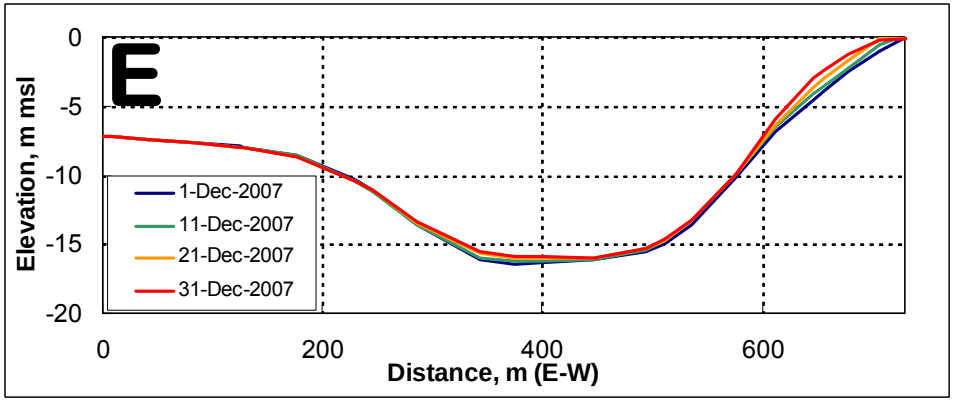


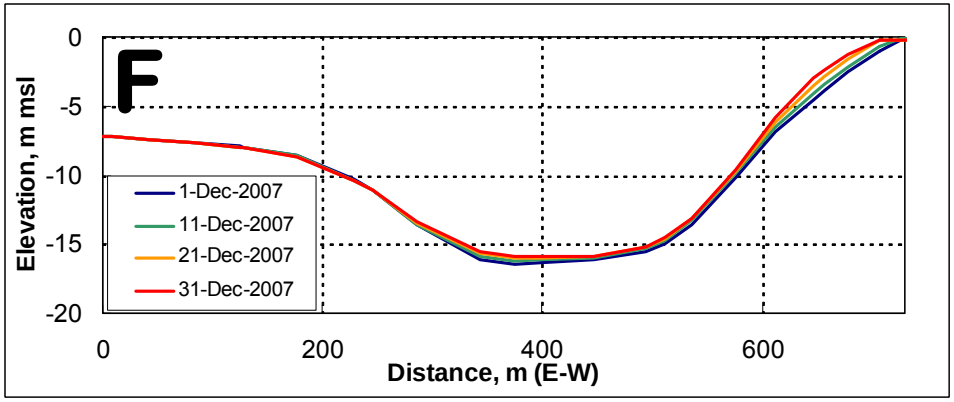












Summary of Cross Section Views

- North vs South Waves
  - Sediment at jetty tips eroded: north waves-south jetty; south waves-north jetty
  - CS 1-3: Waves from north sheltered, little change; south waves with higher energy (period) modify the channel shoal
  - CS 4&5: large volume of sand accumulated near turning basin under south waves
- Waves Only vs Waves & Current
  - More smoothing and redistribution near jetty tips with current
    - South channel (thalweg) deposition at CS 2&3
  - CS 4&5 redistribute the sand closer to the north side with current
    - South channel (thalweg) is scoured in response
- Dec 2007 Spectral Waves & Current
  - Little appreciable sedimentation under realistic waves for a 1-month simulation; more even distribution
  - Adaptation lengths of 5,10, and 20 m produced similar results
  - 5 m AL results advected sediment less

Conclusions

- The Humboldt application provided an example of clearly defined morphologic features that hinder navigation
- The CMS can quantify ebb delta morphology change and channel shoal migration patterns
- Simple calculations can be made with the CMS to better define dominant driving forces responsible for channel infilling patterns and predict future changes to an engineered channel
  - CMS is a key tool for making engineering decisions supported by a physics based, numerical model