Quantifying State Dependent Uncertainty of Nearshore Morphodynamic Modelling

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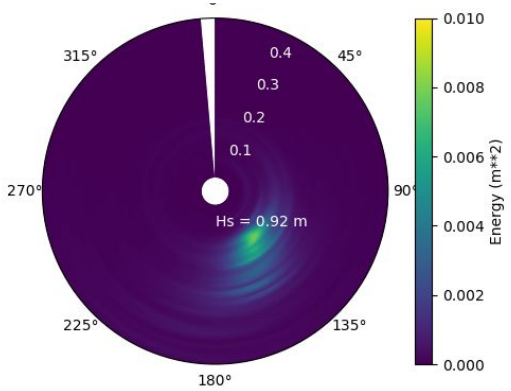
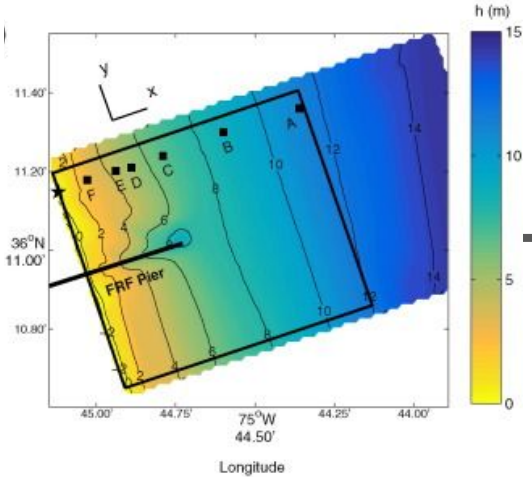
U.S. ARMY ENGINEER RESEARCH AND DEVELOPMENT CENTER ERDC

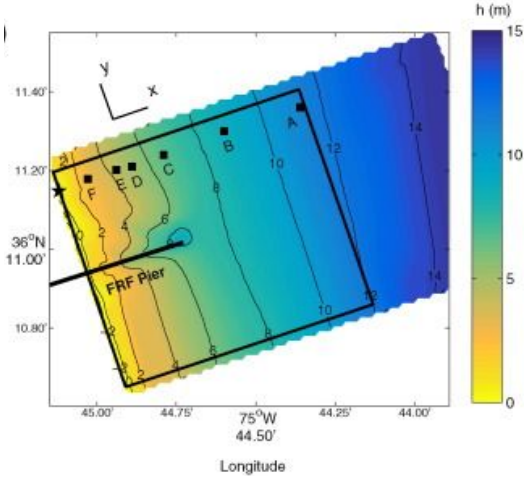
TONIGHT NOV 5		Showers Early	--/41°	30%
TUE NOV 6		Partly Cloudy	56°/37°	10%
WED NOV 7		Sunny	55°/29°	10%

12am	6-10ft	★★★★★	56%
3am	8-12ft	★★★★★	95%
6am	7-12ft	★★★★★	95%
9am	7-11ft	★★★★★	100%
Noon	7-10ft	★★★★★	100%
3pm	6-10ft	★★★★★	100%
6pm	6-9ft	★★★★★	100%
9pm	5-8ft	★★★★☆	95%


315°
45°
270°
90°
225°
135°
180°
0.4
0.3
0.2
0.1
Hs = 0.92 m
0.010
0.008
0.006
0.004
0.002
0.000
Energy (m**2)

X Beach


h (m)
15
10
5
0
y
x
11.40'
11.20'
36°N
11.00'
10.80'
A
B
C
D
E
F
FRF Pier
45.00'
44.75'
75°W
44.50'
44.25'
44.00'
Longitude


h (m)
15
10
5
0
y
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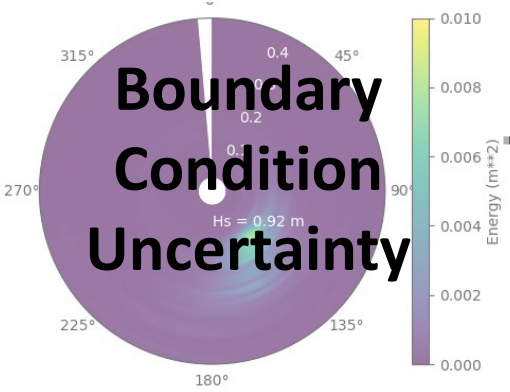
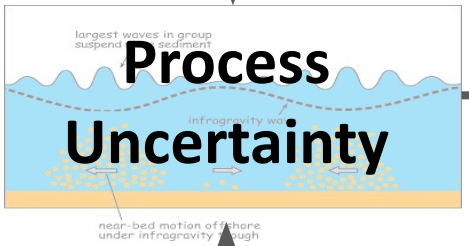
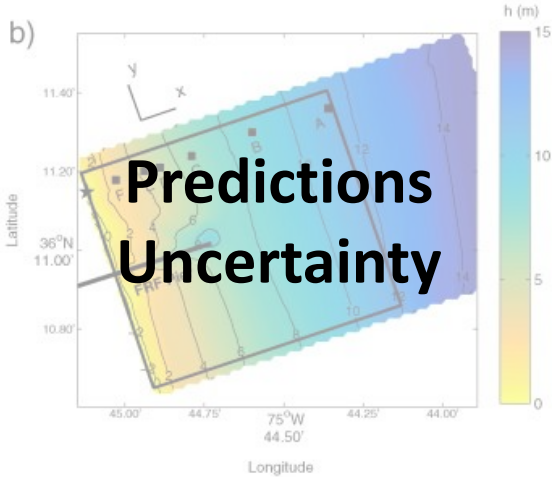


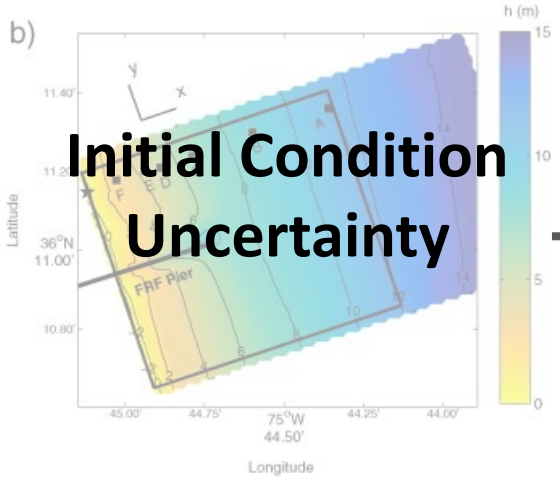
Boundary Condition Uncertainty



Process Uncertainty

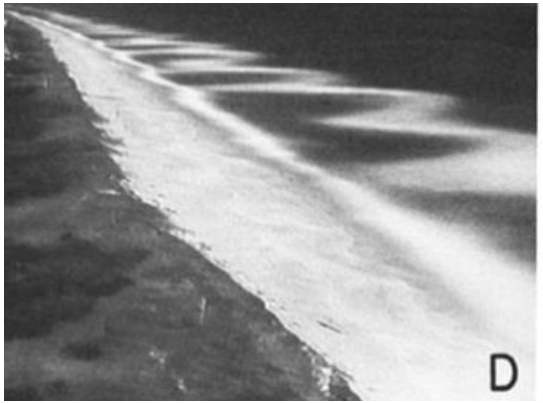


Predictions Uncertainty



Initial Condition Uncertainty

Defining Beach States



Categorization scheme:

- Longshore variability
- Trough continuity

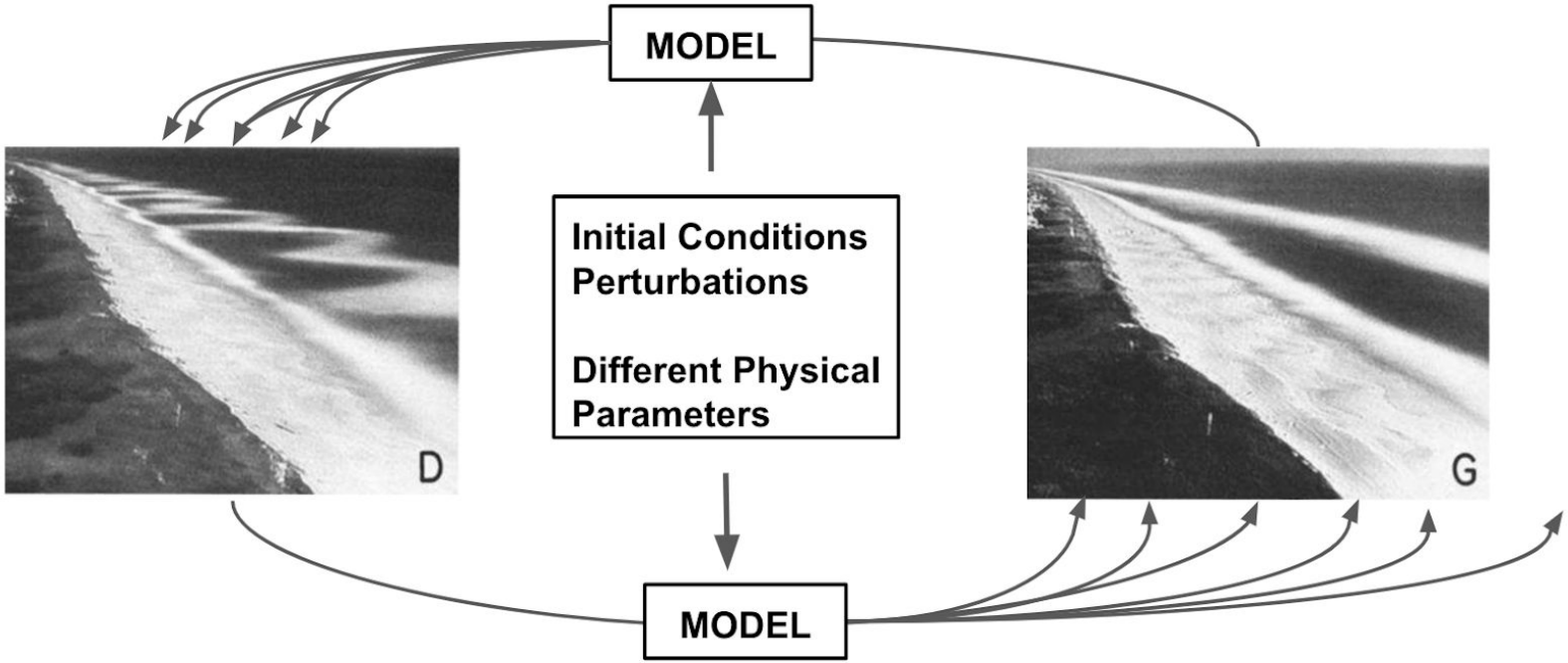
State transitions occur due to incident wave conditions

Lippman and Holman, 1990

Hypothesis:

Different beach transitions generate different levels of uncertainty

Lippman and Holman, 1990

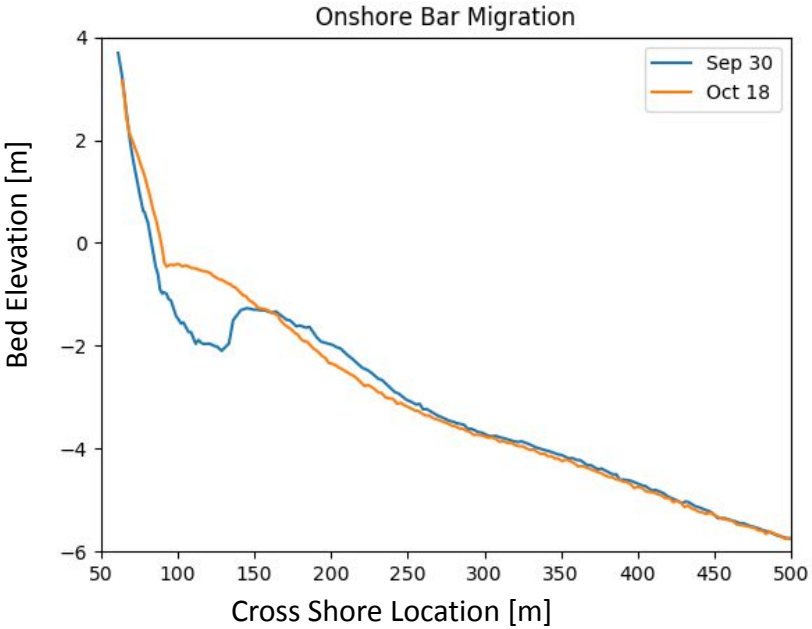


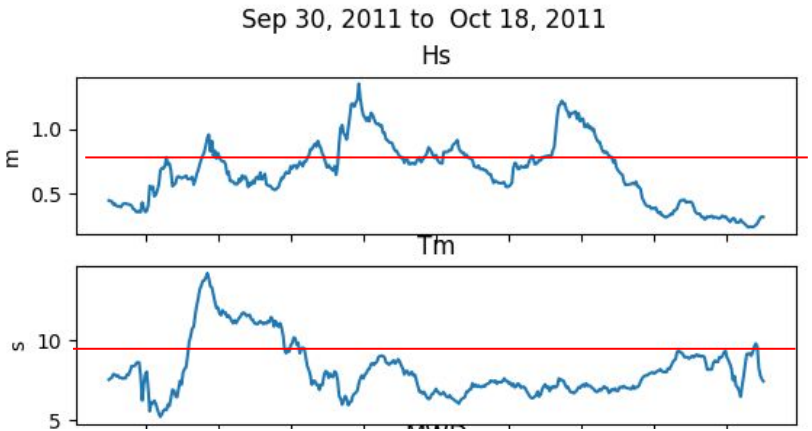
Ensembles generated by perturbations in initial conditions to assess initial conditions uncertainty.

Ensembles generated by different physical parameters to asses process uncertainty.

Lippman and Holman, 1990

1D Beach State Transition: Onshore Bar Migration





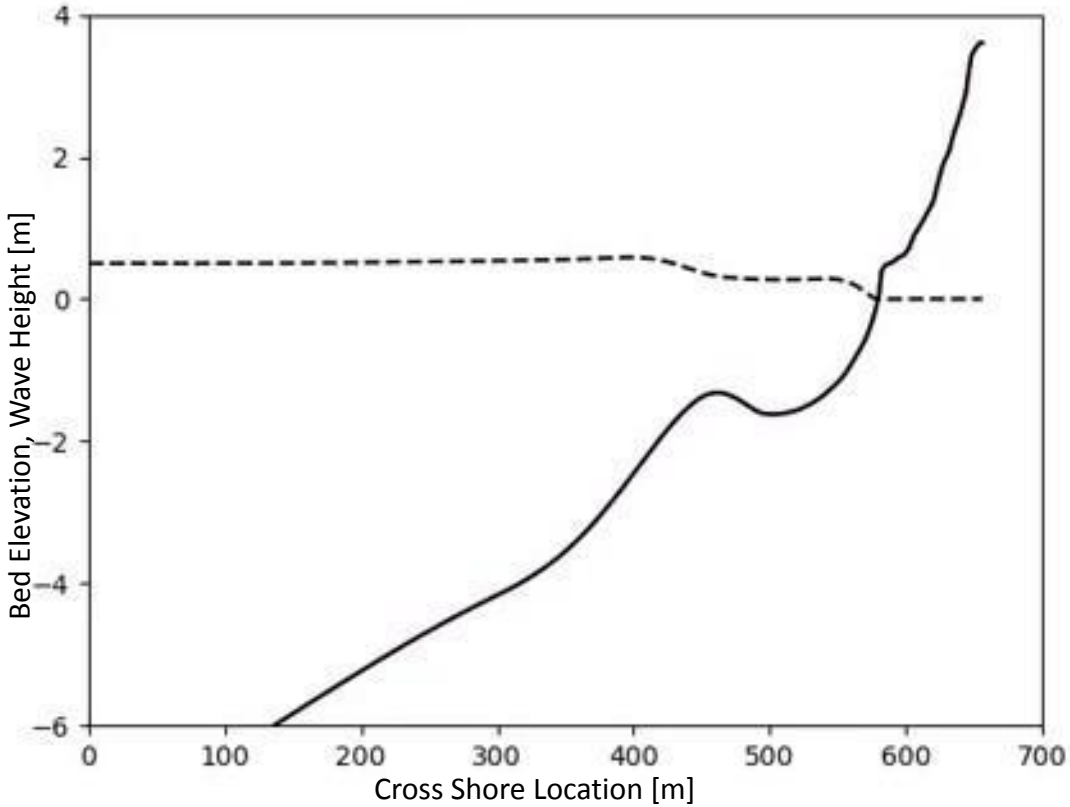
Onshore Bar Migration Simulation

Constant forcing conditions
- JONSWAP spectrum
- Mean Hs: 0.7 m
- Mean Tm: 8s

Two week simulation

Morphological acceleration factor 6

Facua 0.4

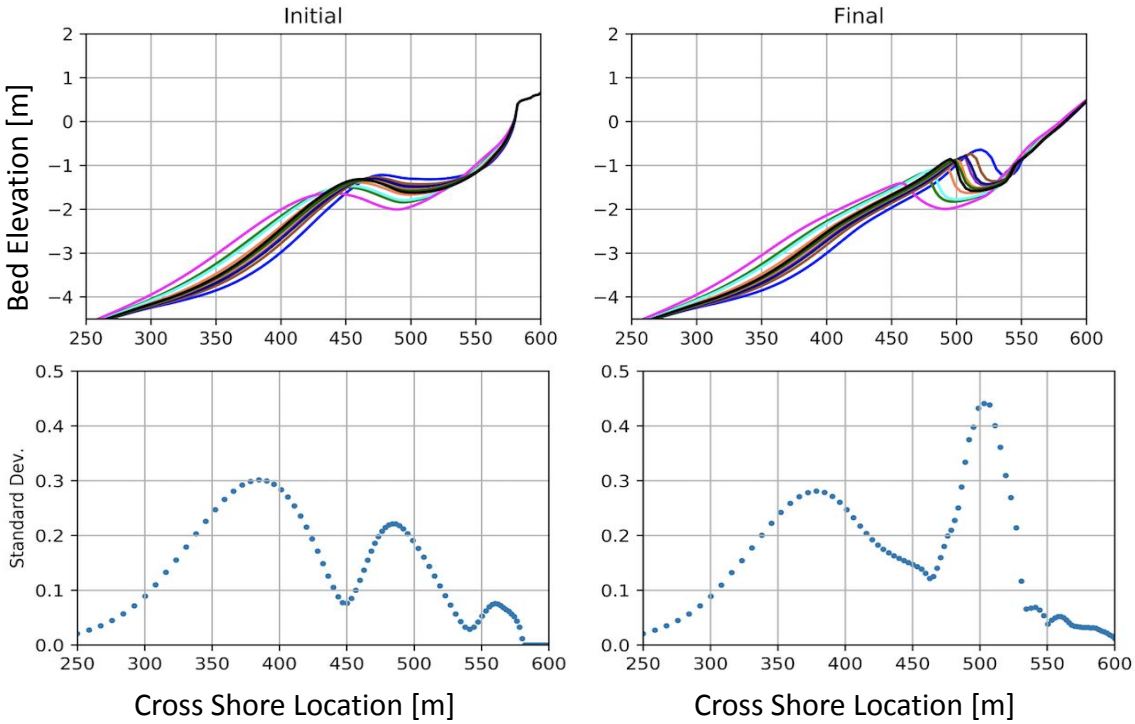


Preliminary Results: Bar Position

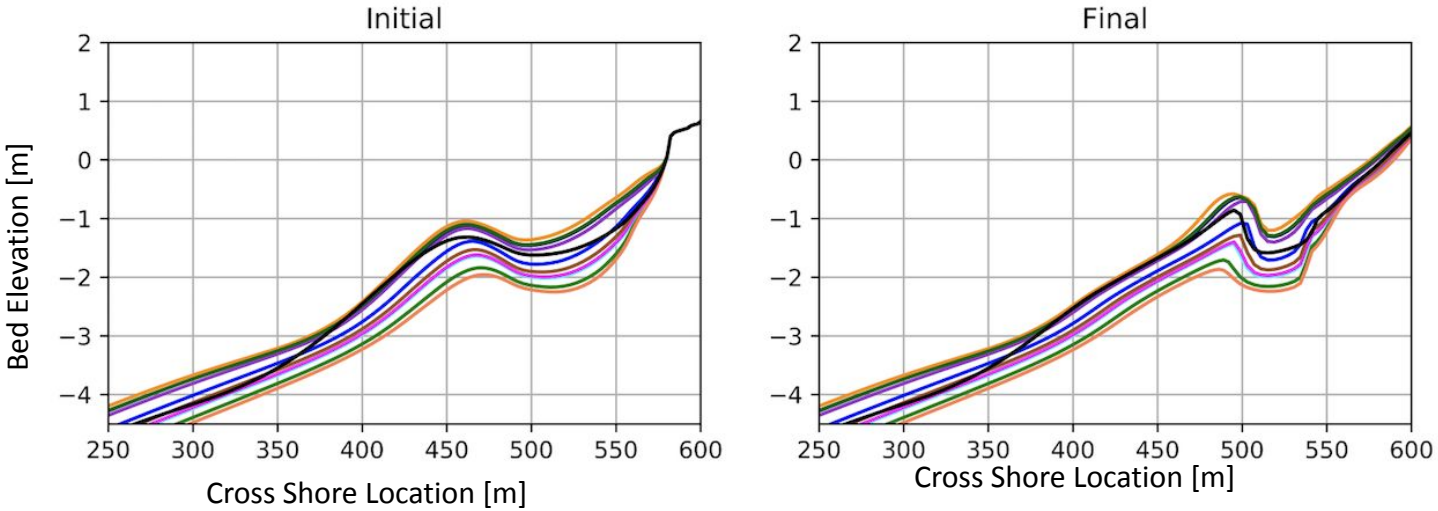
General shape - movement onshore of sediment towards an asymmetrical bar consistent

Variability moves to bar crest

Differences in relative bar crest position:
Bar crest movement accelerates shoreward



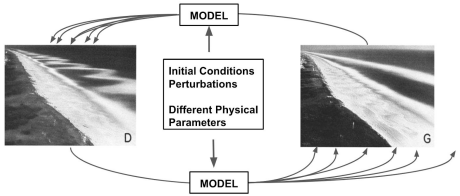
Preliminary Results: Mean Bar Height



Differences in bar shape

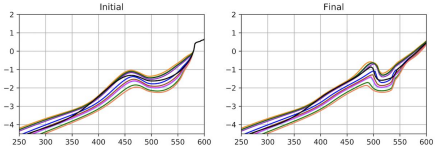
- -Deeper bars have more symmetrical shape
- -Asymmetry increases with shallower bars
- -Shallowest bars have rounded crests (vs. pointy)

Conclusions



- Quantification of model uncertainty through ensemble generation of beach state transitions for idealized scenarios.
  - Ensemble generation via perturbations of initial conditions

- Developing quantification methods for variability analysis
  - Bar shape (asymmetry/skewness)
  - Relative changes in bar crest position

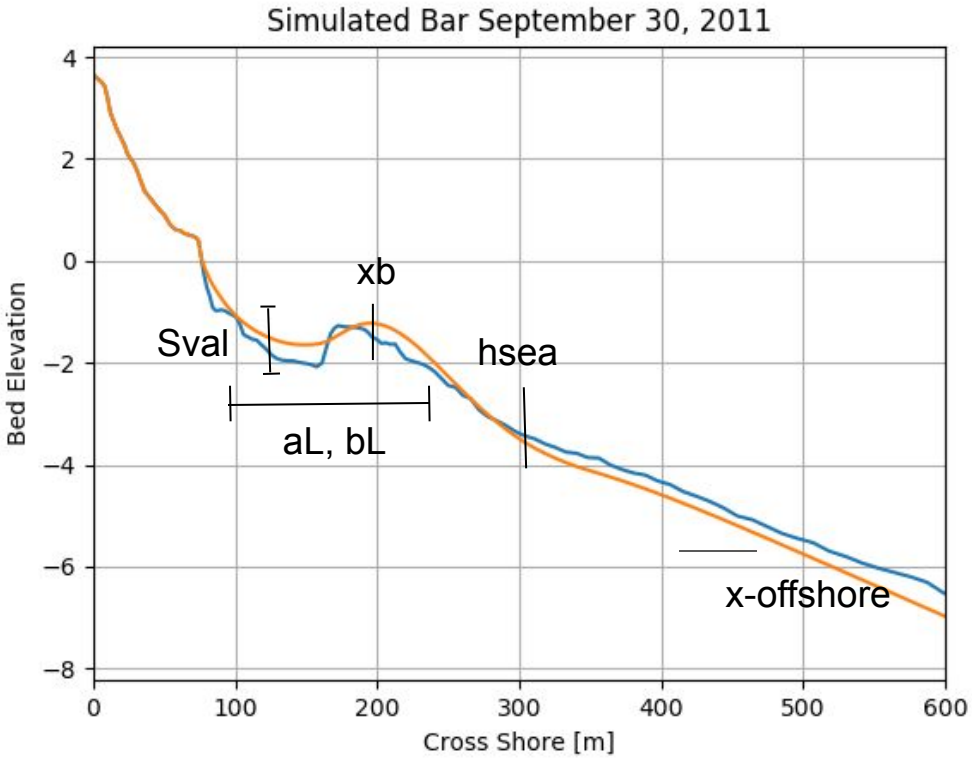


Future Work

- Development of 1-D offshore bar migration case
- Development of process uncertainty ensemble generation
- Future work - 2D beach transitions

Uncertainty Resolution: Any Questions?

Parameterized Bar



$$h(x,t) = h_0(x) + h_{bar}(h_0,t)$$

$$h_{bar}(h_0,t) = -S(h_0)R(t)\cos[\theta(h_0) - \psi(t)]$$

Six Parameters

- Seaward location of bar movement (hsea)
- Bar amplitude (Sval)
- Bar crest location (xb)
- Bar wavelength (aL, bL)
- Mean bar position (x_)