Onslow Bay, NC

Regional Sediment Transport Analysis using GenCade

by
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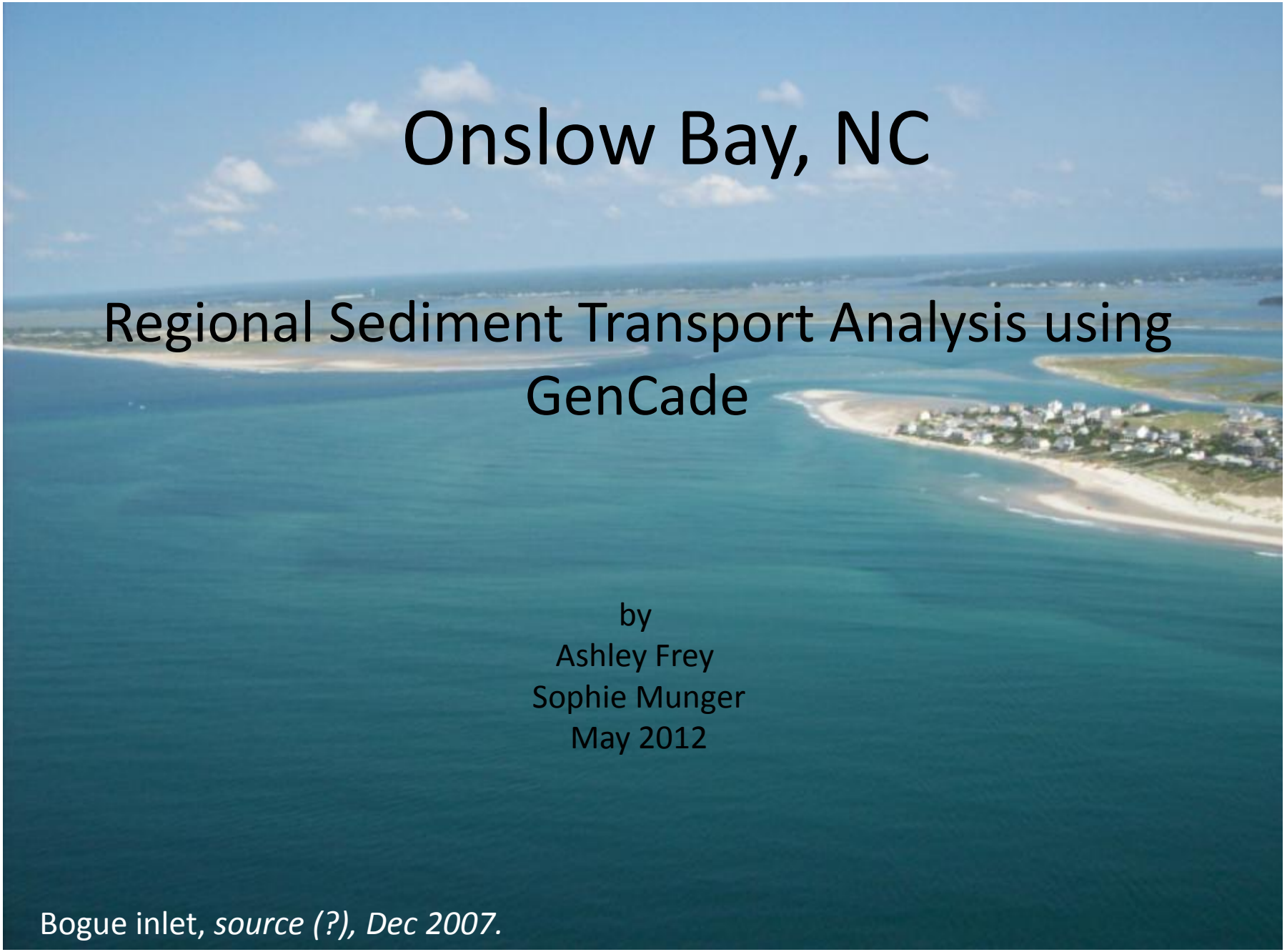
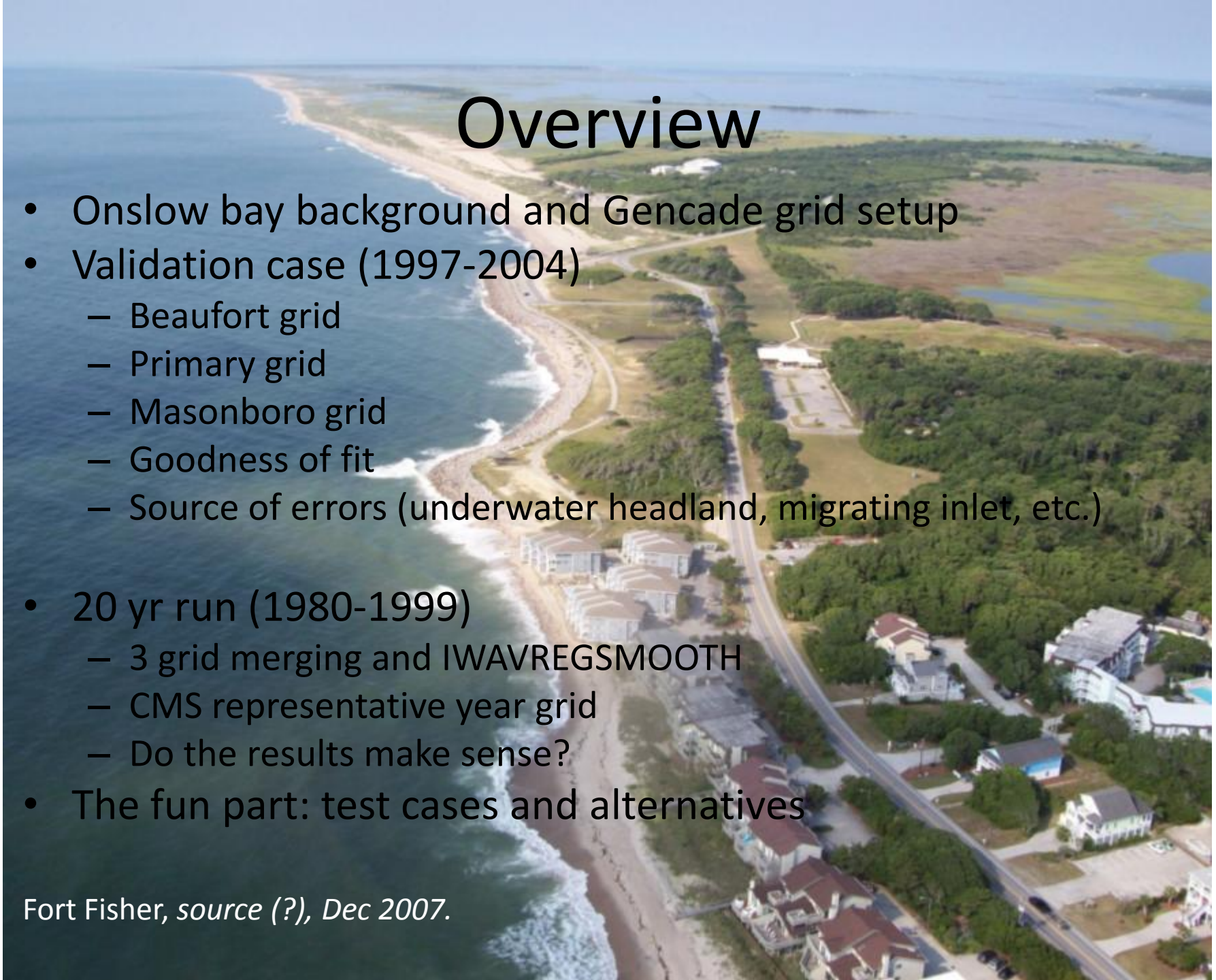
May 2012



Bogue inlet, *source (?), Dec 2007.*

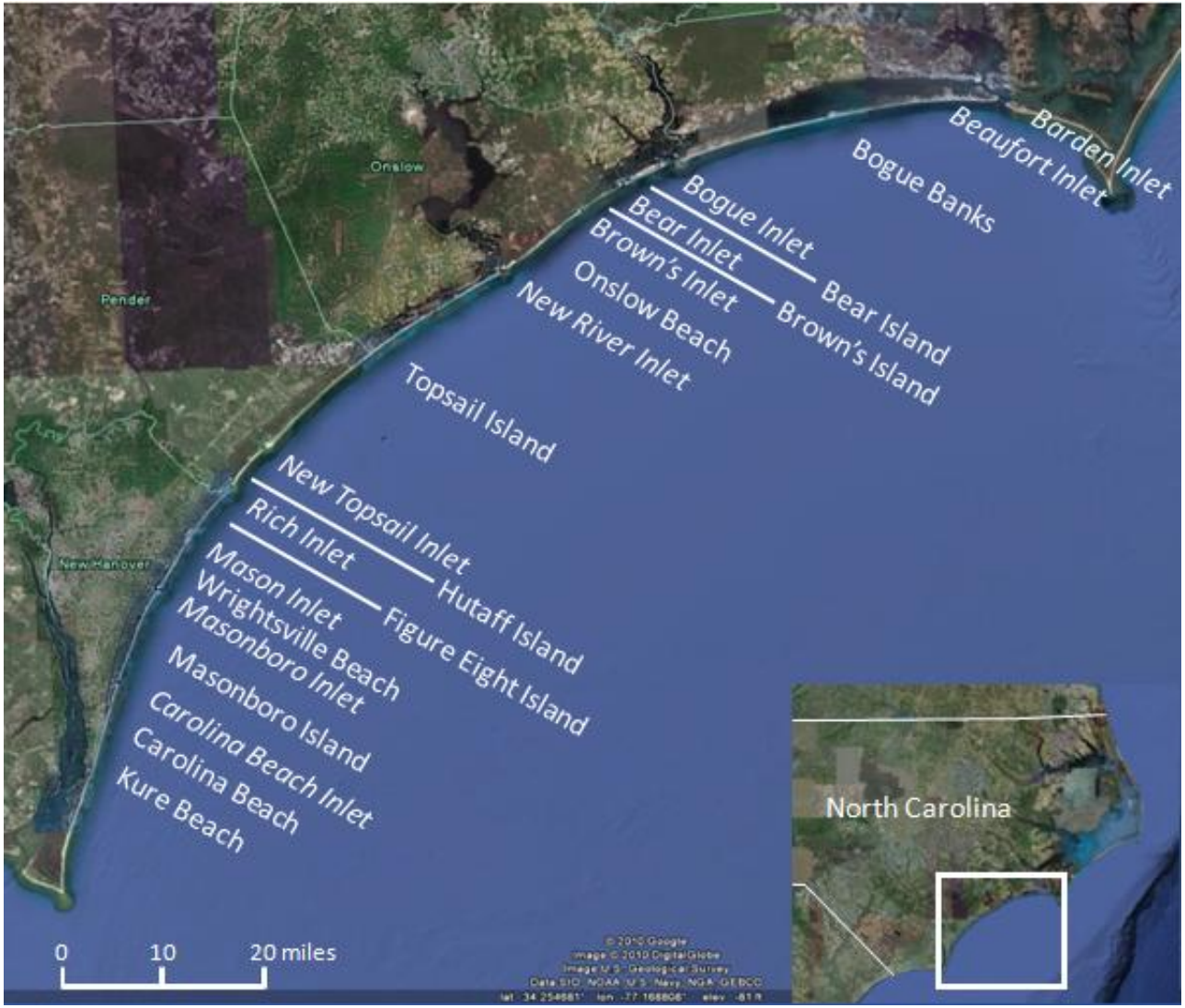
Overview

- Onslow bay background and Gencade grid setup
- Validation case (1997-2004)
  - Beaufort grid
  - Primary grid
  - Masonboro grid
  - Goodness of fit
  - Source of errors (underwater headland, migrating inlet, etc.)
- 20 yr run (1980-1999)
  - 3 grid merging and IWAVREGSMOOTH
  - CMS representative year grid
  - Do the results make sense?
- The fun part: test cases and alternatives

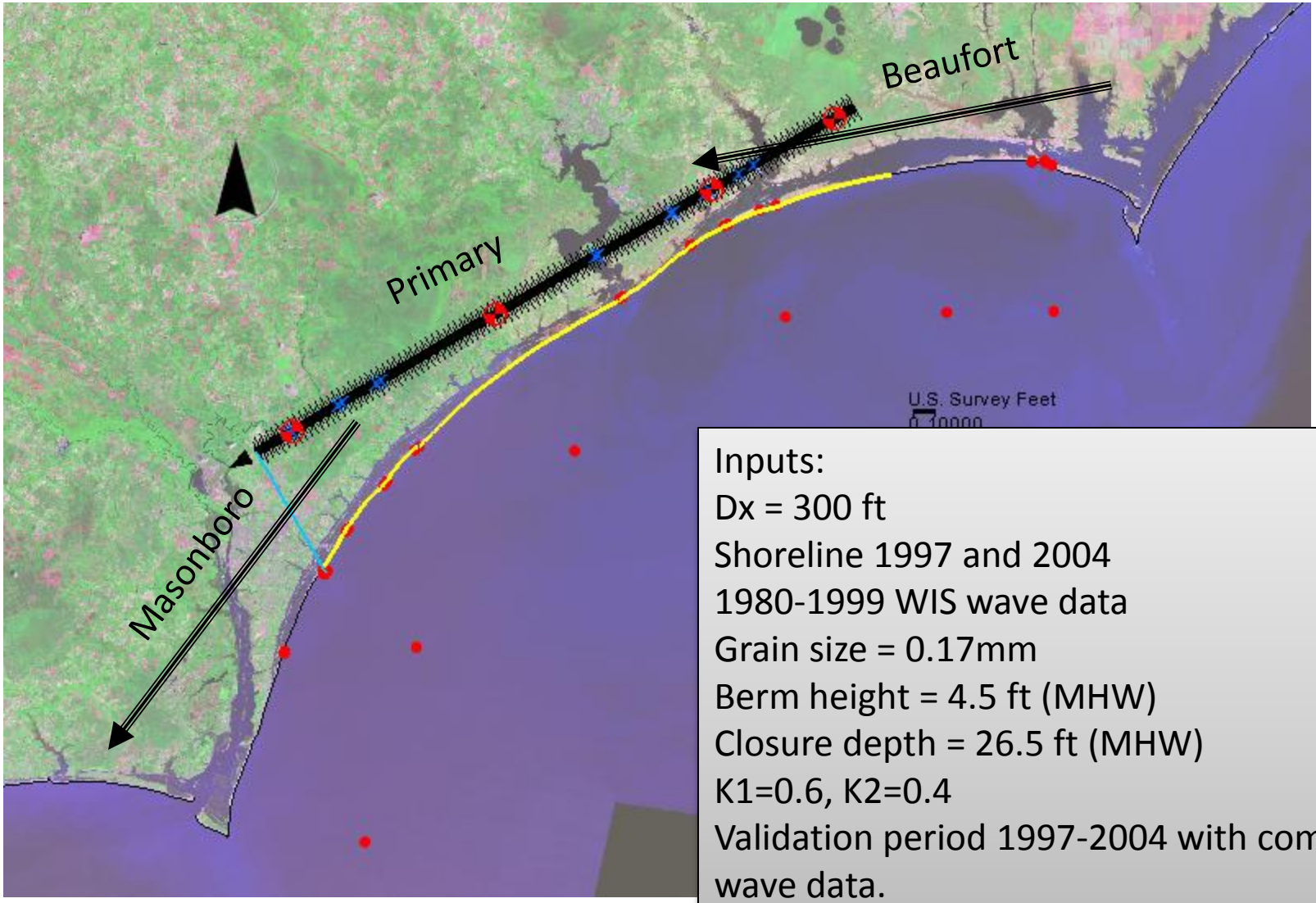


Fort Fisher, *source (?), Dec 2007.*

Onslow Bay, NC
11 inlets, 9 unstructured, 110 miles (175 km)



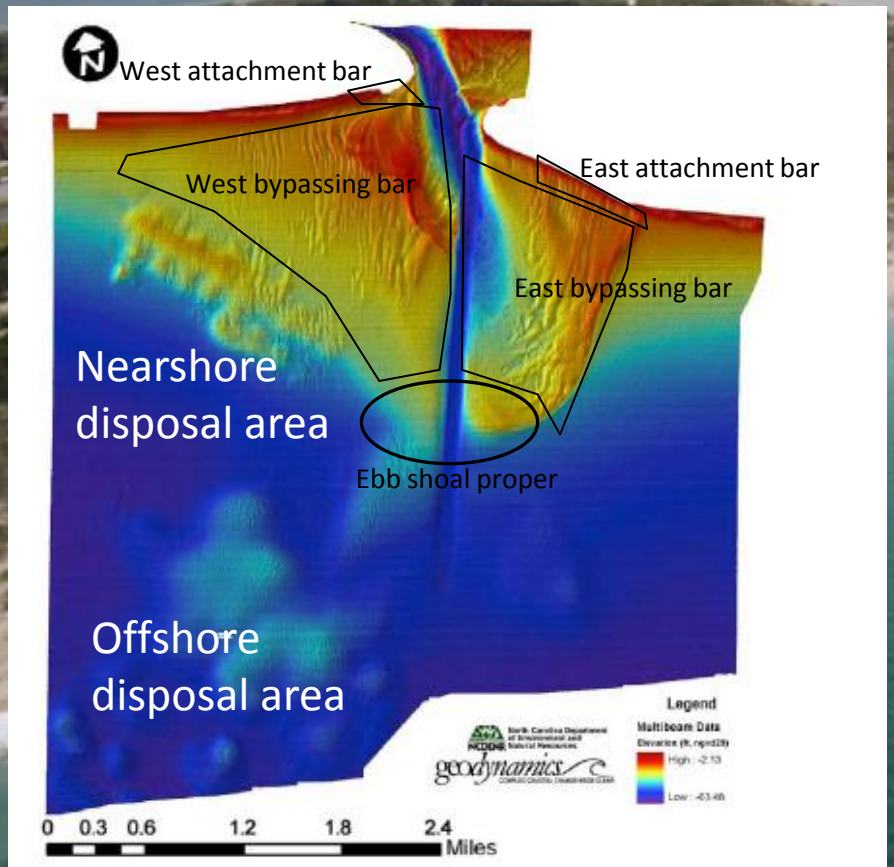
3 Grids



Inputs:
Dx = 300 ft
Shoreline 1997 and 2004
1980-1999 WIS wave data
Grain size = 0.17mm
Berm height = 4.5 ft (MHW)
Closure depth = 26.5 ft (MHW)
K1=0.6, K2=0.4
Validation period 1997-2004 with composite wave data.

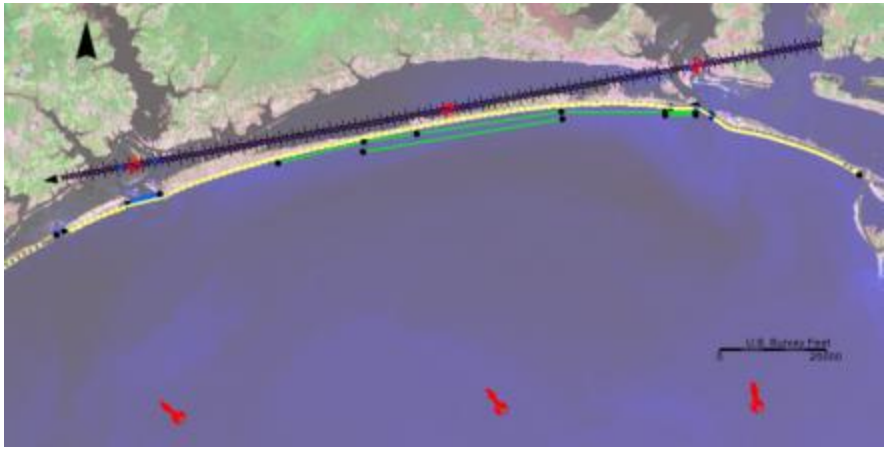
Beaufort inlet

4000 ft (1.2km)



- Estimated ebb shoal volume 1900 is 58.4 Mcy
- Estimated ebb shoal volume 2004 is 37.4 Mcy
- Channel depth 1900 is 15ft (MLW). Since 1994 is 47 ft.
- Yearly average maintenance dredging 1 Mcy all disposed offshore until 1997.

Beaufort Grid and setup for validation case 1997-2004



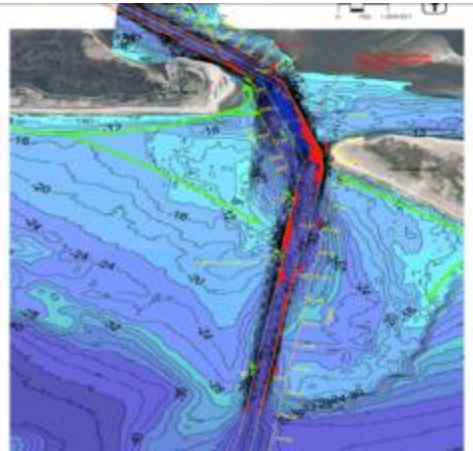
Interpolate shoal volume for 1997 using yearly shoal change calculate by Olsen, 2006

Used USACE published beach fill volume.

Use yearly maintenance dredging record and split volume into East and West bypassing bars.

Beach Location	Date	Added Berm width (ft)
Fort Macon	2002	37.0
Pine Knoll Shores	2002	40.0
Indian Beach	2002	57.0
Emerald Isle (phase 2)	2003	51.0

	Outer channel dredging (cy)	From west byp. bar (70%, cy)	From east byp. bar (30%, cy)
1997	267,655	187,359	80,297
1998	2,240,267	1,568,187	672,080
1999	1,040,919	728,643	312,276
2000	1,701,659	1,191,161	510,498
2001	834,645	584,252	250,394
2002	861,074	602,752	258,322
2003	1,144,987	801,491	343,496
2004	813,119	569,183	243,936
Yearly average:	1,113,041	779,128	333,912



Statistics/ skills scores on calculated shorelines

http://cirp.usace.army.mil/wiki/Statistics

Brier Skill Score

The Bier Skill Score (BSS) is given by

$$BSS = 1 - \frac{\left\langle (x_m - x_c)^2 \right\rangle}{\left\langle (x_m - x_0)^2 \right\rangle} \quad (1)$$

where x_m is the measured or observed values, x_c is the calculated values, x_0 is the initial measured values and the angled brackets indicate averaging. The BSS ranges between negative infinity and one. A BSS value of 1 indicates a perfect agreement between measured and calculated values. Scores equal to or less than 0 indicates that Initial measured ue is as or more accurate than the calculated values.

Root-Mean-Squared Error

The Root-Mean-Squared Error (RMSE) also referred to as Root-Mean-Squared Deviation (RMSD) is defined as

$$RMSE = \sqrt{\left\langle (x_m - x_c)^2 \right\rangle} \quad (3)$$

where where x_m is the measured or observed values, x_c is the calculated values, and the angled brackets indicate averaging. The RMSE has the same units as the measured and calculated data.

Correlation coefficient is defined as

Correlation is a measure of the strength and direction of a linear relationship between two variables. The correlation coefficient R is defined as

$$R = \frac{\langle x_m x_c \rangle - \langle x_m \rangle \langle x_c \rangle}{\sqrt{\langle x_m^2 \rangle - \langle x_m \rangle^2} \sqrt{\langle x_c^2 \rangle - \langle x_c \rangle^2}} \quad (7)$$

Shoreline change

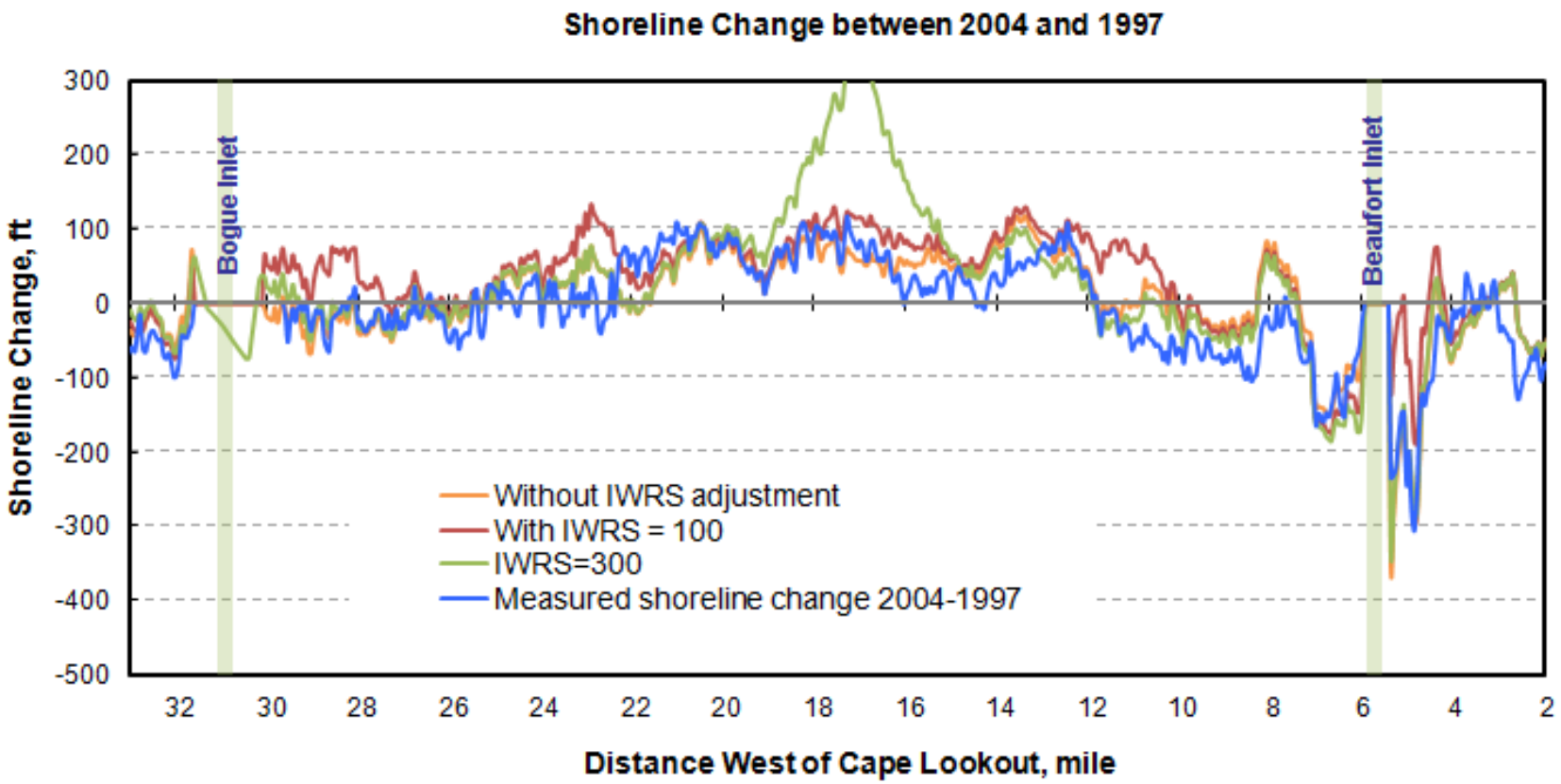
where where x_m is the measured or observed values, x_c is the calculated values, and the angled brackets indicate averaging. A correlation of 1 indicates a perfect one-to-one linear relationship and -1 indicates a negative relationship. The square of the correlation coefficient describes how much of the variance between two variables is described by a linear fit.

Bias

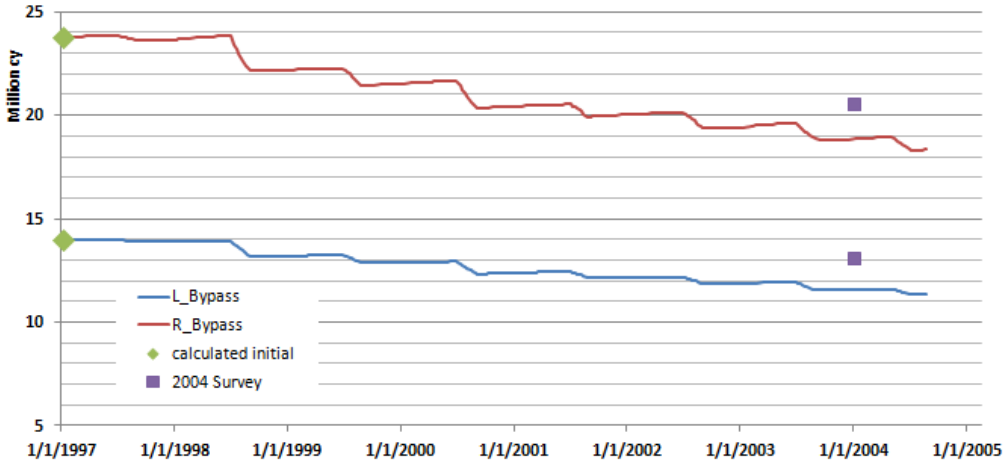
The bias is a measure of the over or under estimation and is defined as

$$B = \langle x_c - x_m \rangle \quad (8)$$

where x_m is the measured or observed values, x_c is the calculated values, and the angled brackets indicate averaging. The bias is a measure of the over or

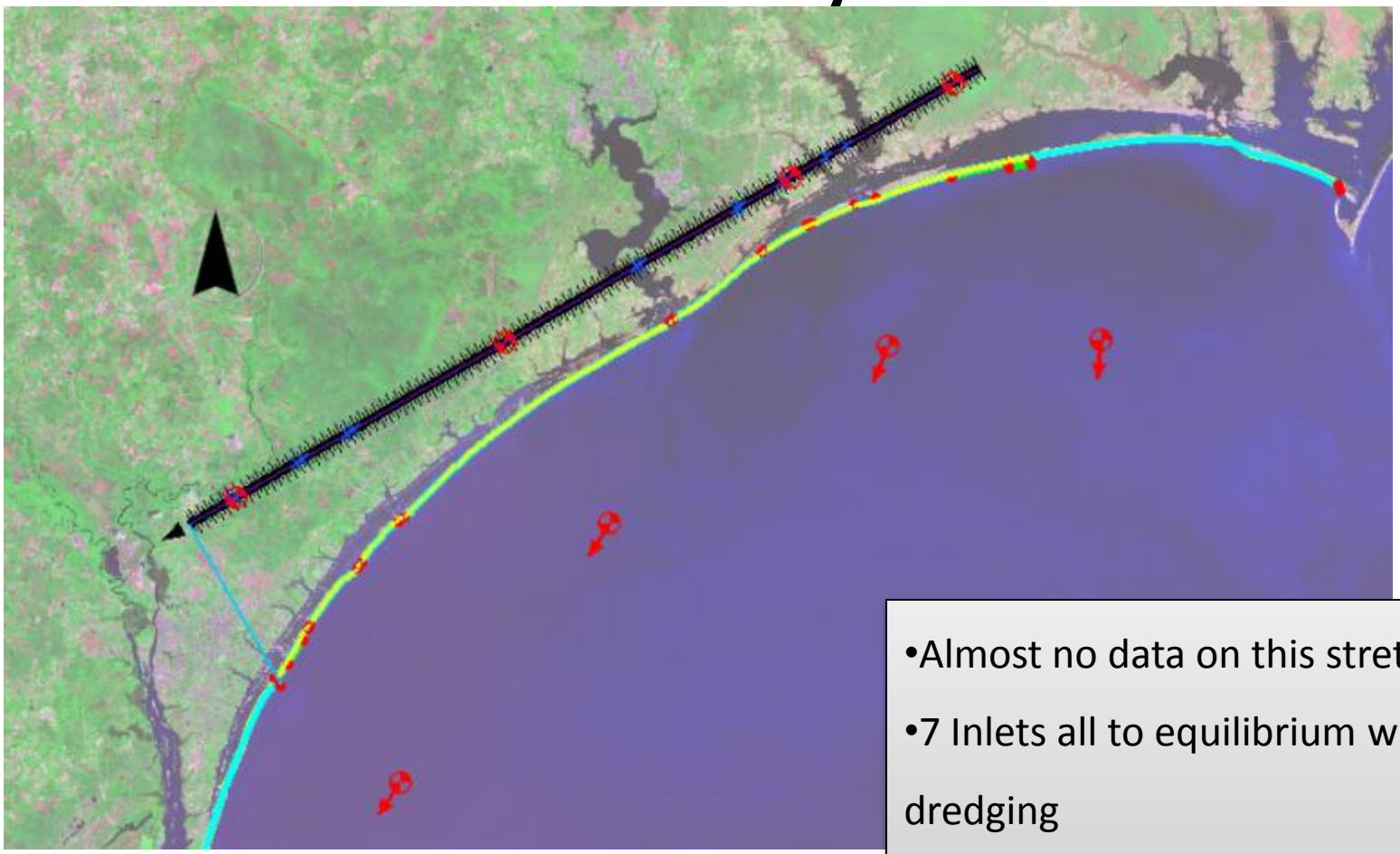


Left and right bypassing bar volume evolution and comparison with 2004 survey at Beaudfort Inlet

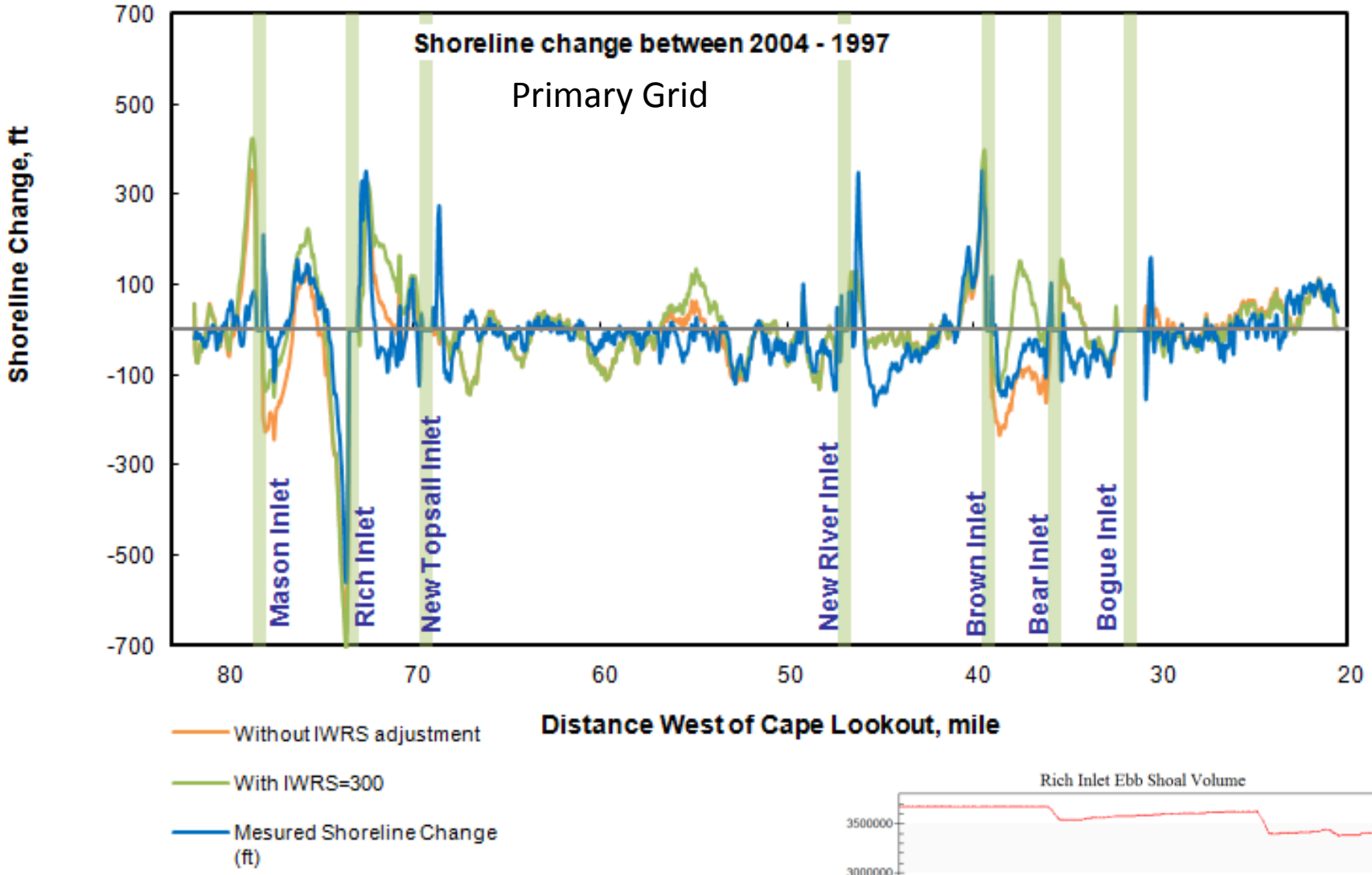


		No IWRS	W IWRS k1=0.6
Final Shoreline			
	BBS	0.63	0.28
	RMSE (ft)	16.50	37.60
	Biais (ft)	40.48	56.9
Shrl Change	R2	0.83	0.78

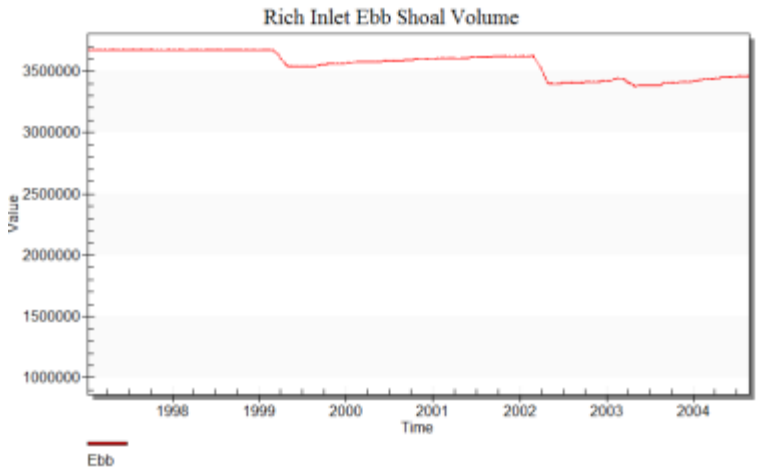
Primary Grid



- Almost no data on this stretch of coast
- 7 Inlets all to equilibrium with no dredging
- Include 3 Beach fills on Bogue banks
- Gated BC at Masonboro north jetty
- Dredging of Rich inlet



		No IWRS	w/ IWRS k1=0.6
Final Shoreline			
	BBS	0.35	0.15
	RMSE (ft)	-4.08	12.94
	Biais (ft)	56.53	64.60
Shrl Change	R2	0.67	0.64



Masonboro Grid

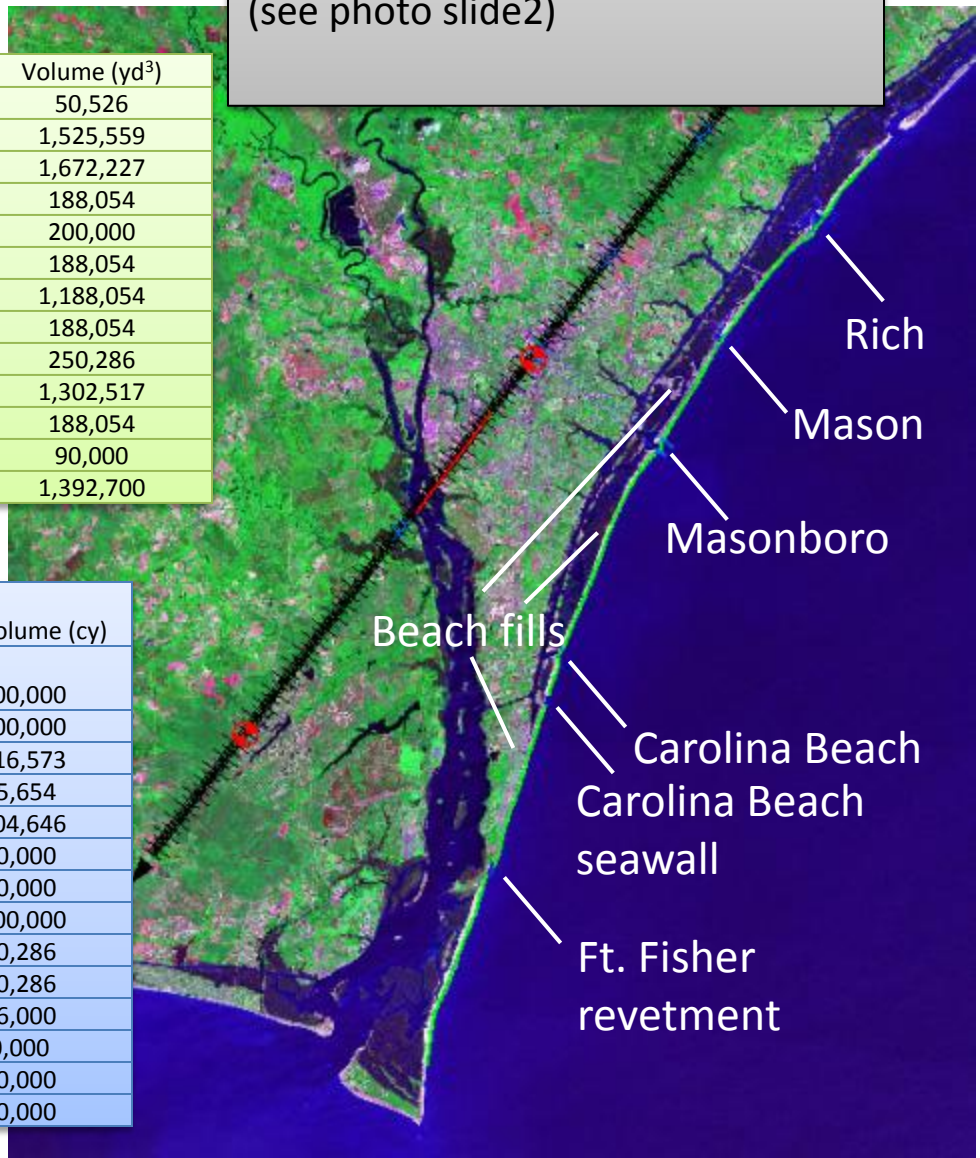
-4 inlets
-Masonboro with north weir jetty
-Dredging of Rich, Masonboro and Carolina beach inlets
-Seawall for Fort Fisher revetment (see photo slide2)

Dredging Events in Southern Onslow Bay (1997-2004)

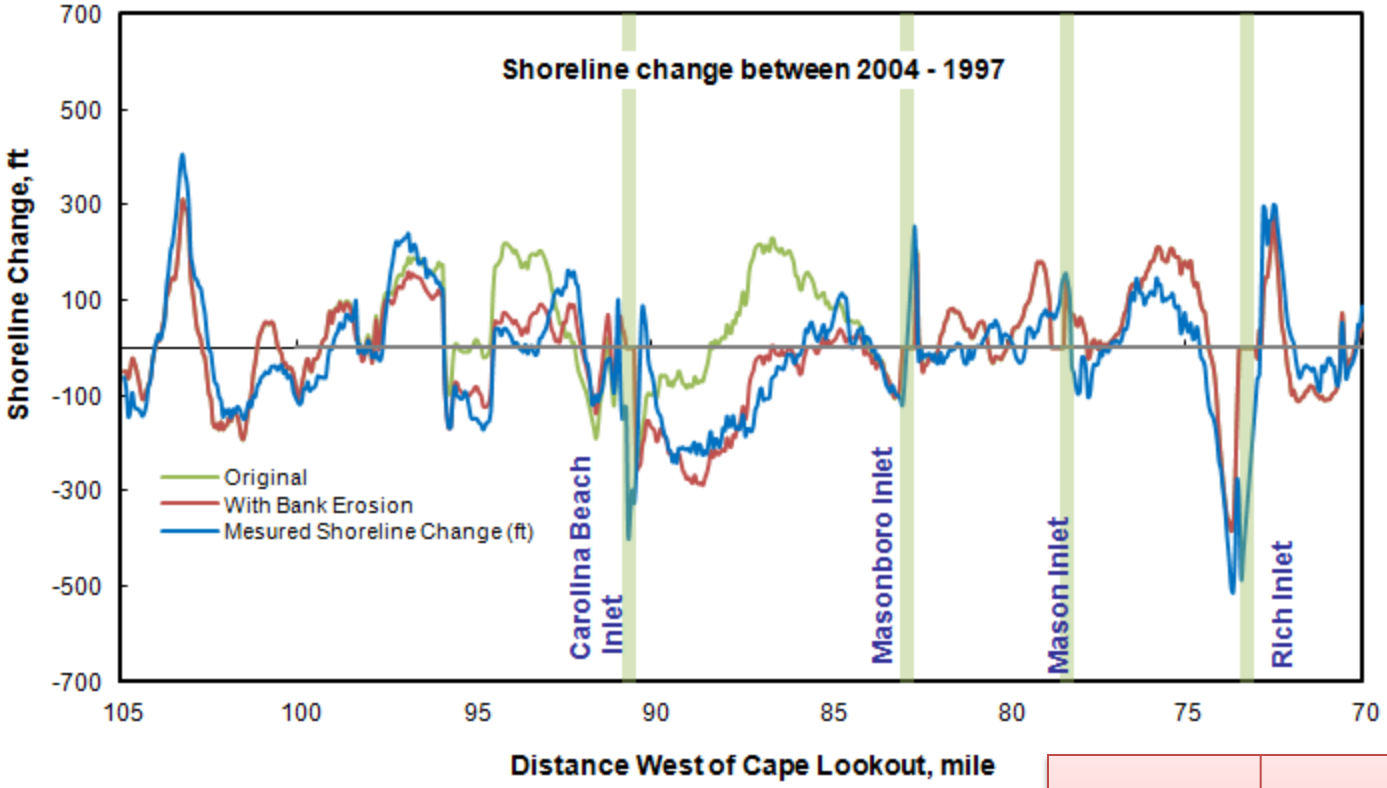
Inlet	Beginning Date	Ending Date	Shoal to be Mined	Volume (yd^3)
Carolina Beach Inlet	9/1/1997	12/31/1997	Ebb	50,526
Carolina Beach Inlet	3/1/1998	4/30/1998	Ebb	1,525,559
Masonboro Inlet	3/5/1998	4/29/1998	Ebb	1,672,227
Carolina Beach Inlet	3/1/1999	4/30/1999	Ebb	188,054
Rich Inlet	3/1/1999	4/30/1999	Ebb	200,000
Carolina Beach Inlet	3/1/2000	4/30/2000	Ebb	188,054
Carolina Beach Inlet	3/1/2001	4/30/2001	Ebb	1,188,054
Carolina Beach Inlet	3/1/2002	4/30/2002	Ebb	188,054
Rich Inlet	3/1/2002	4/30/2002	Ebb	250,286
Masonboro Inlet	4/30/2002	6/30/2002	Ebb	1,302,517
Carolina Beach Inlet	3/1/2003	4/30/2003	Ebb	188,054
Rich Inlet	3/1/2003	4/30/2003	Ebb	90,000
Carolina Beach Inlet	3/1/2004	4/30/2004	Ebb	1,392,700

Beach fill Events in Southern Onslow Bay (1997-2004)

Location	Start Date	End Date	Added Berm Width (ft)	Total Volume (cy)
Kure Beach	6/15/1997	11/30/1997	159.68	3,300,000
Kure Beach	3/1/1998	4/30/1998	58.06	1,200,000
Wrightsville Beach	3/5/1998	4/29/1998	95.34	1,116,573
Masonboro Island	3/5/1998	4/29/1998	40.33	555,654
Carolina Beach	4/15/1998	6/1/1998	94.52	1,204,646
Figure Eight Island	3/1/1999	4/30/1999	38.71	200,000
Figure Eight Island	3/1/1999	4/30/1999	38.71	200,000
Carolina Beach	4/30/2001	6/30/2001	78.47	1,000,000
Figure Eight Island	3/1/2002	4/30/2002	48.44	250,286
Figure Eight Island	3/1/2002	4/30/2002	48.44	250,286
Wrightsville Beach	4/30/2002	6/30/2002	67.97	796,000
Figure Eight Island	3/1/2003	4/30/2003	17.42	90,000
Kure Beach	3/1/2004	4/30/2004	9.19	190,000
Carolina Beach	4/30/2004	6/30/2004	53.36	680,000



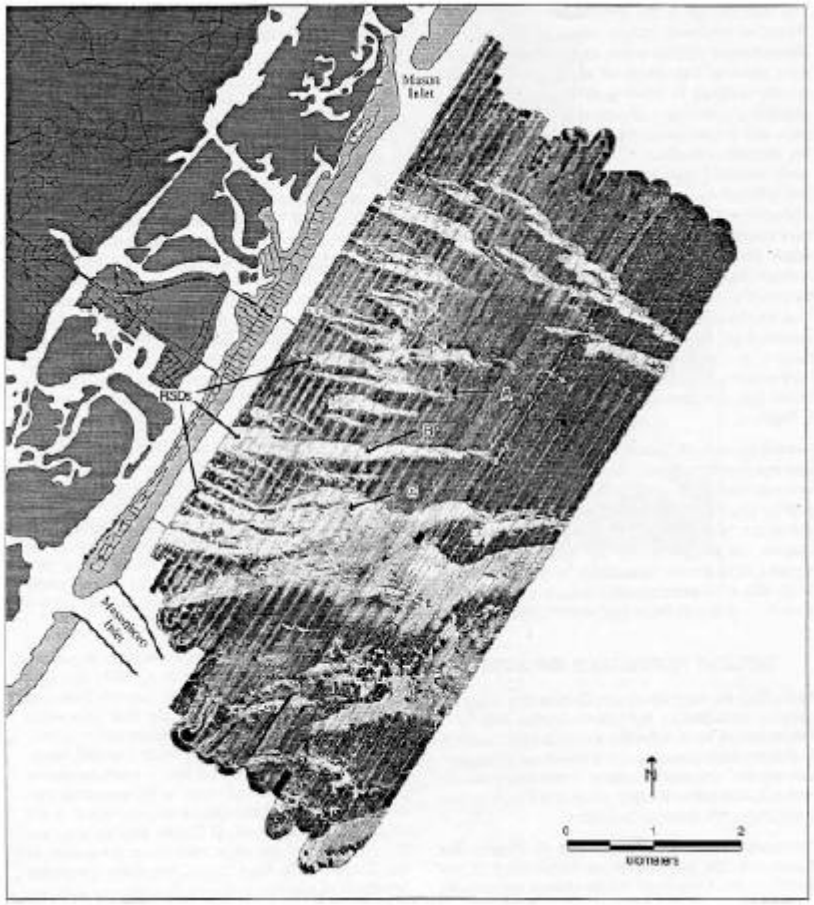
Masonboro Shoreline Change



		Masonboro	
		Original	w/ bank erosion
Final Shoreline			
	BBS	0.25	0.71
	RMSE (ft)	45.62	6.62
	Biais (ft)	107.43	67.0
Shrl Change	R2	0.62	0.62

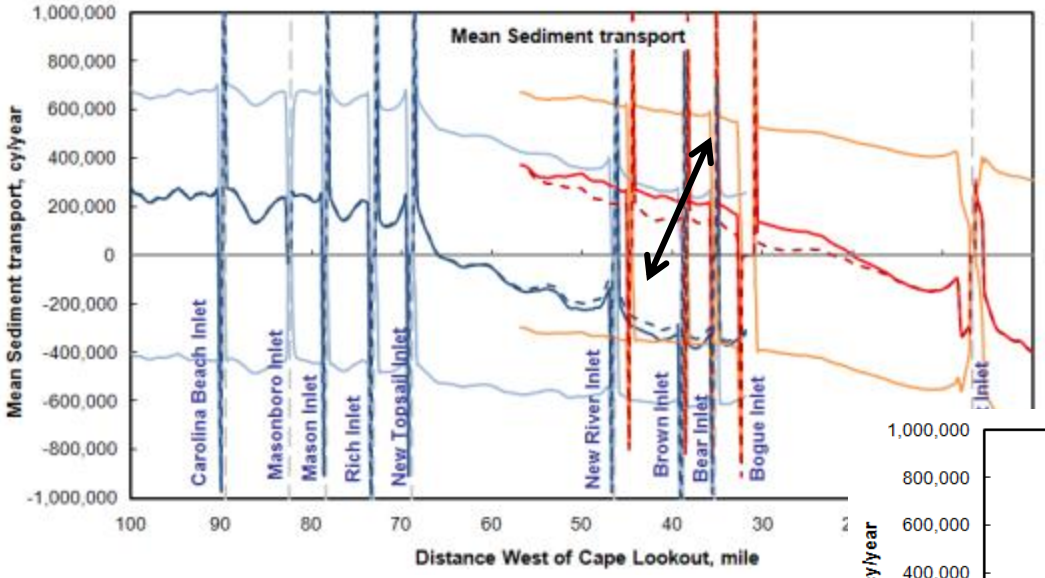
Source of errors

- Composite wave input
- Migrating inlet, channel reorientation.
- Underwater headland and rocky outcrops.

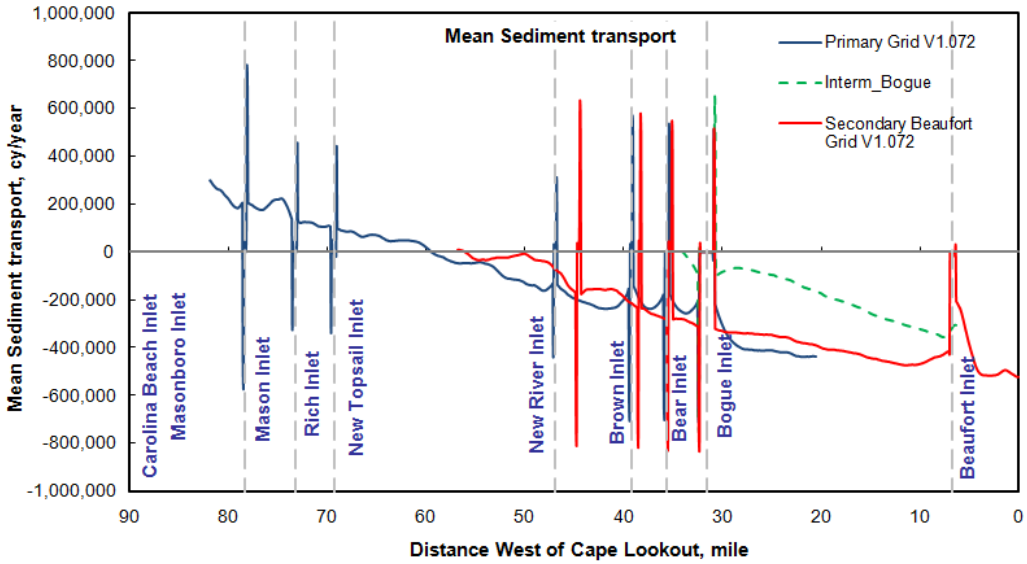


20 yr run – Average mean Sed. Transport across 3 grid

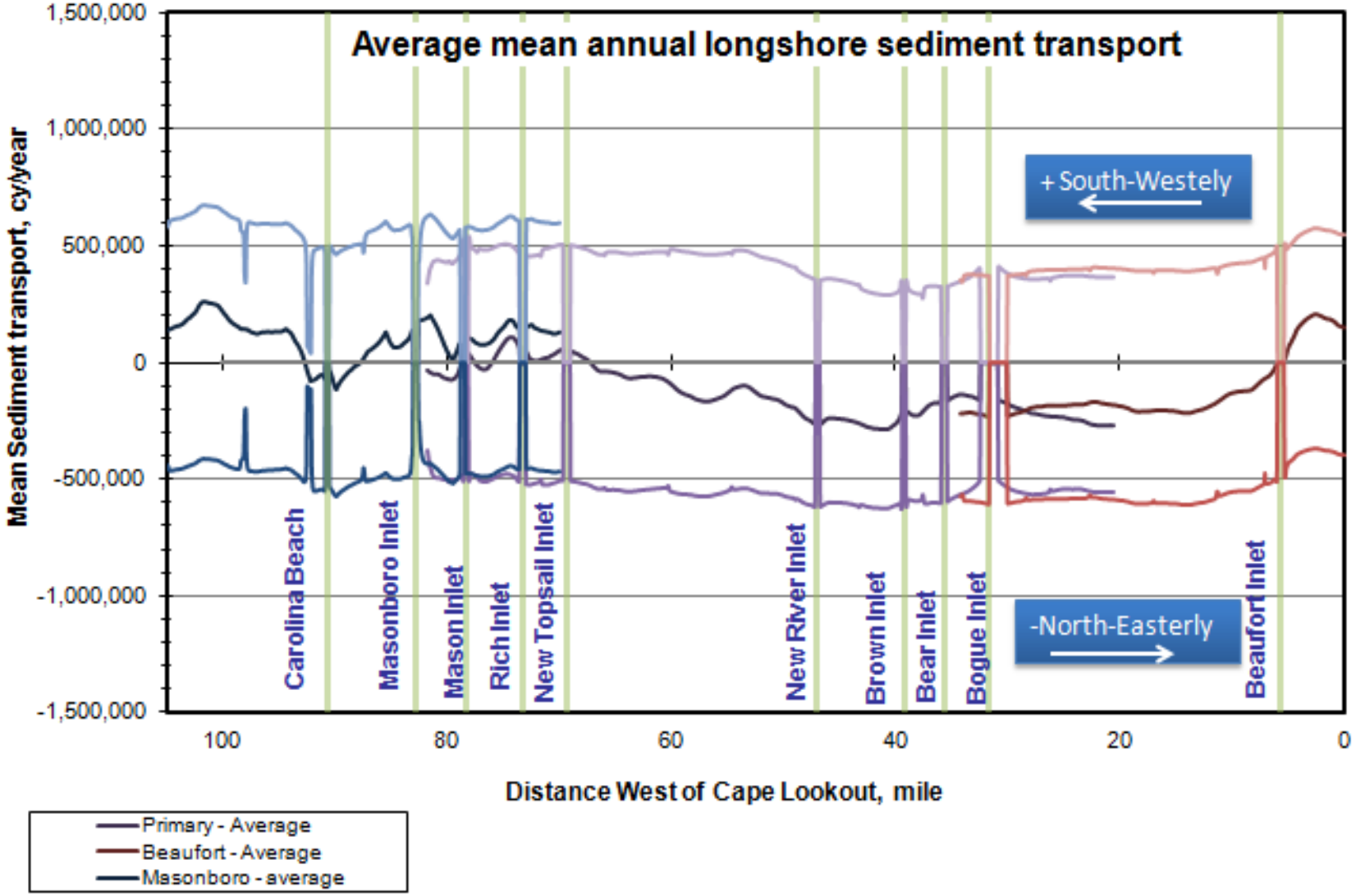
Previous mean transport results show large offset at grid overlap (those are old results)

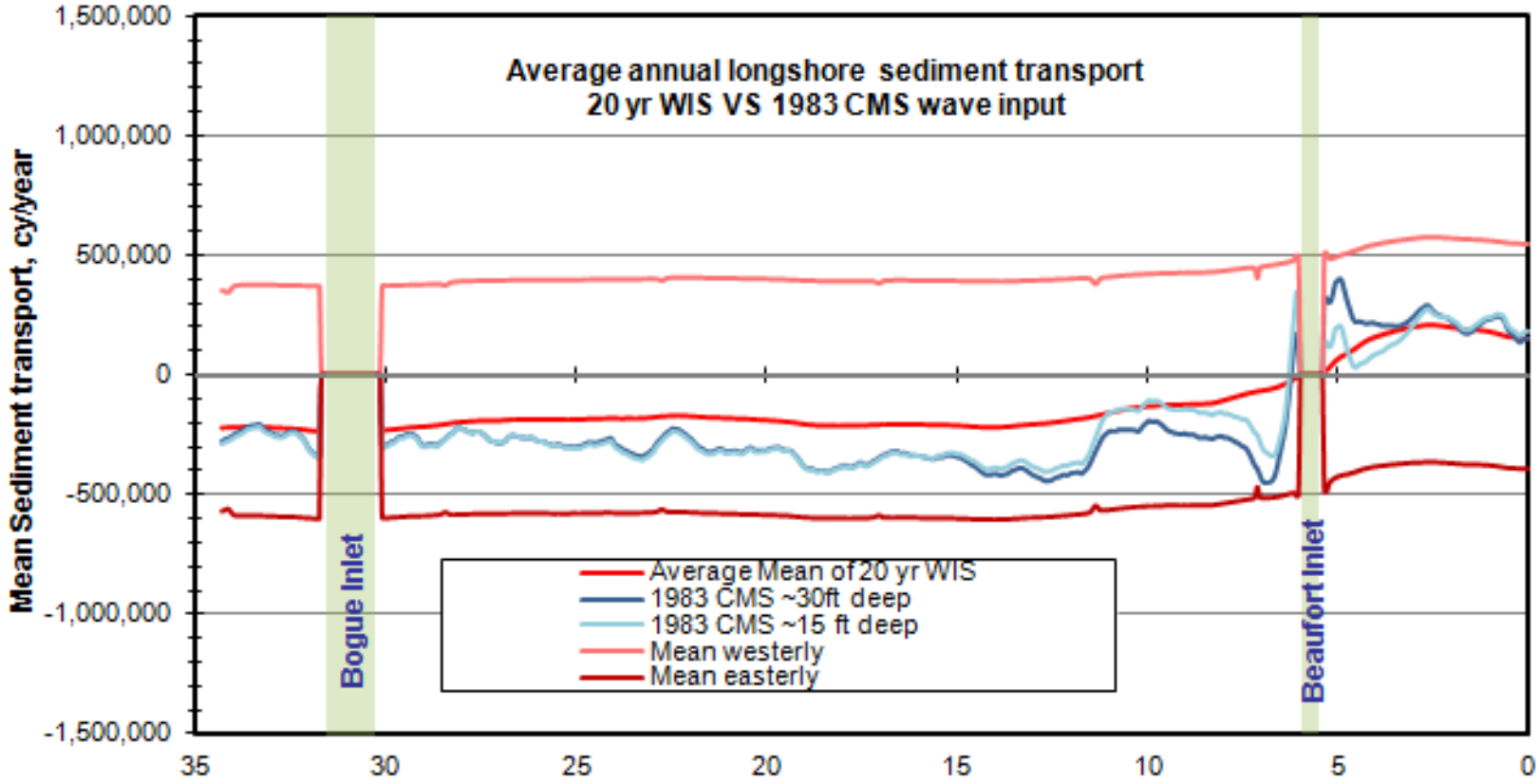


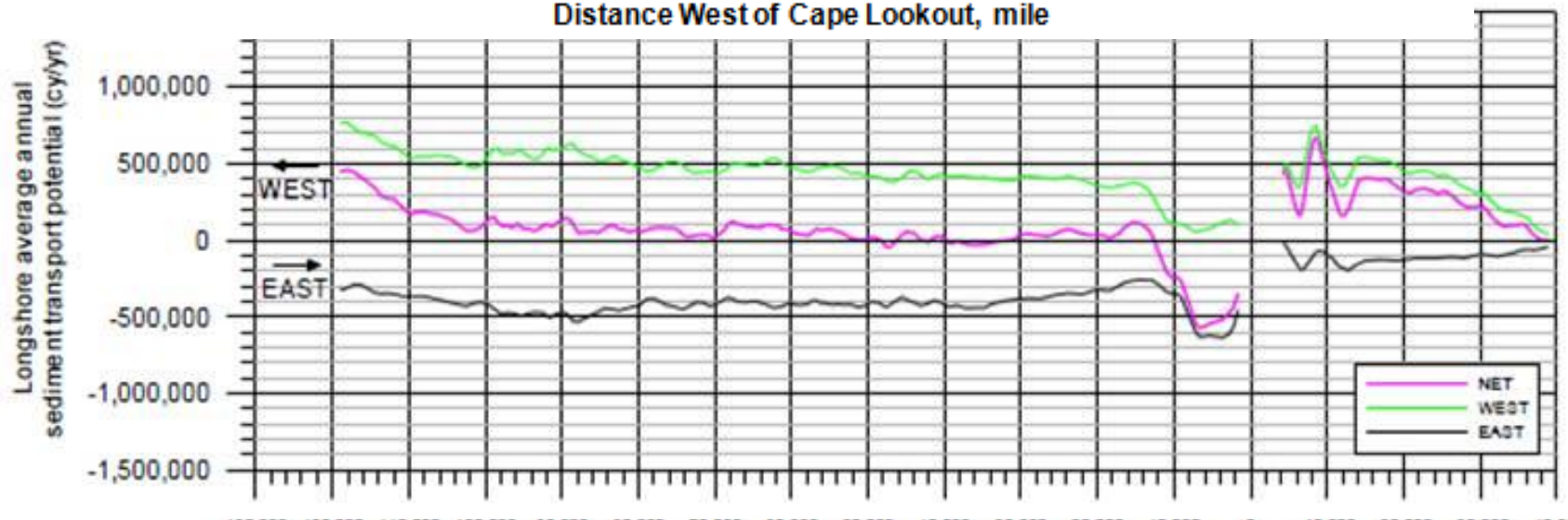
When performing wave rotation (using difference in grids azimuth) transport at Beaufort grid is wrong.



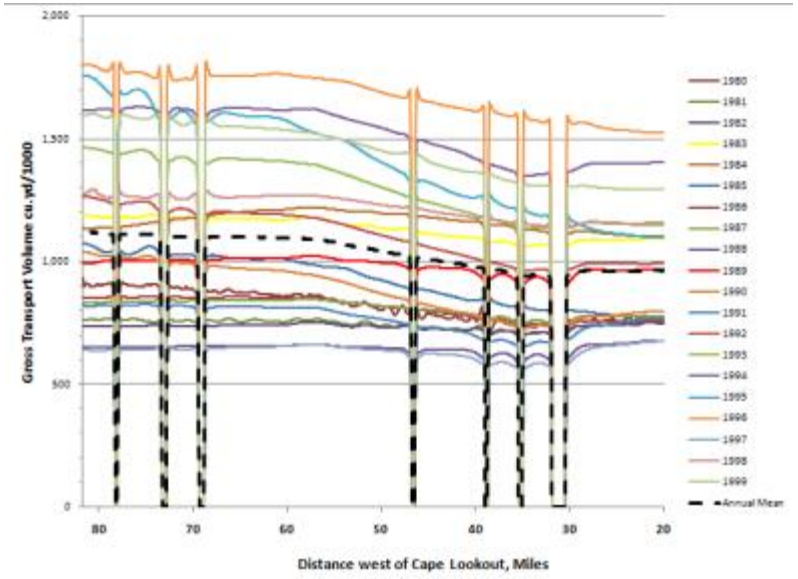
20 yr- Run: average mean sed. transport using IWAVREGSMOOTH adjustments

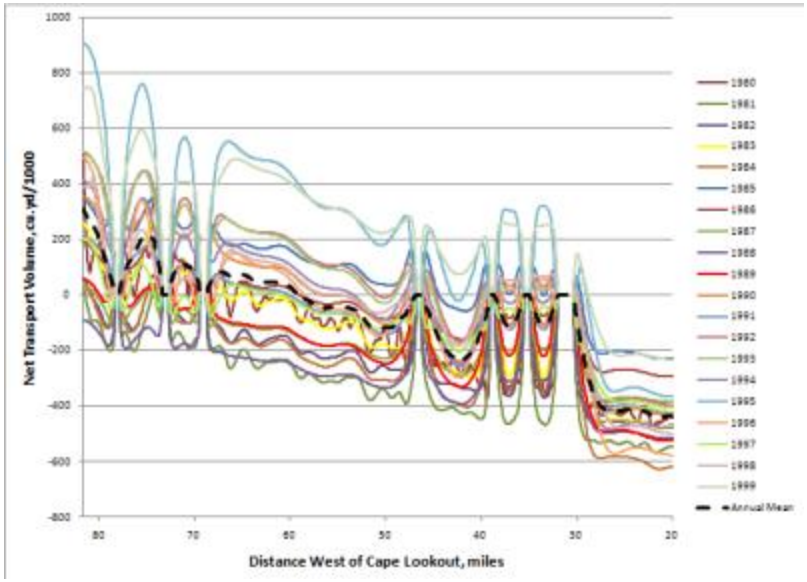



Average annual longshore sediment transport
20 yr WIS VS 1983 CMS wave input
Mean Sediment transport, cy/year
1,500,000
1,000,000
500,000
0
-500,000
-1,000,000
-1,500,000
Bogue Inlet
Beaufort Inlet
Average Mean of 20 yr WIS
1983 CMS ~30ft deep
1983 CMS ~15 ft deep
Mean westerly
Mean easterly
35
30
25
20
15
10
5
0
Distance West of Cape Lookout, mile
Banks


Longshore average annual sediment transport potential (cy/yr)
1,000,000
500,000
0
-500,000
-1,000,000
-1,500,000
WEST
EAST
NET
WEST
EAST

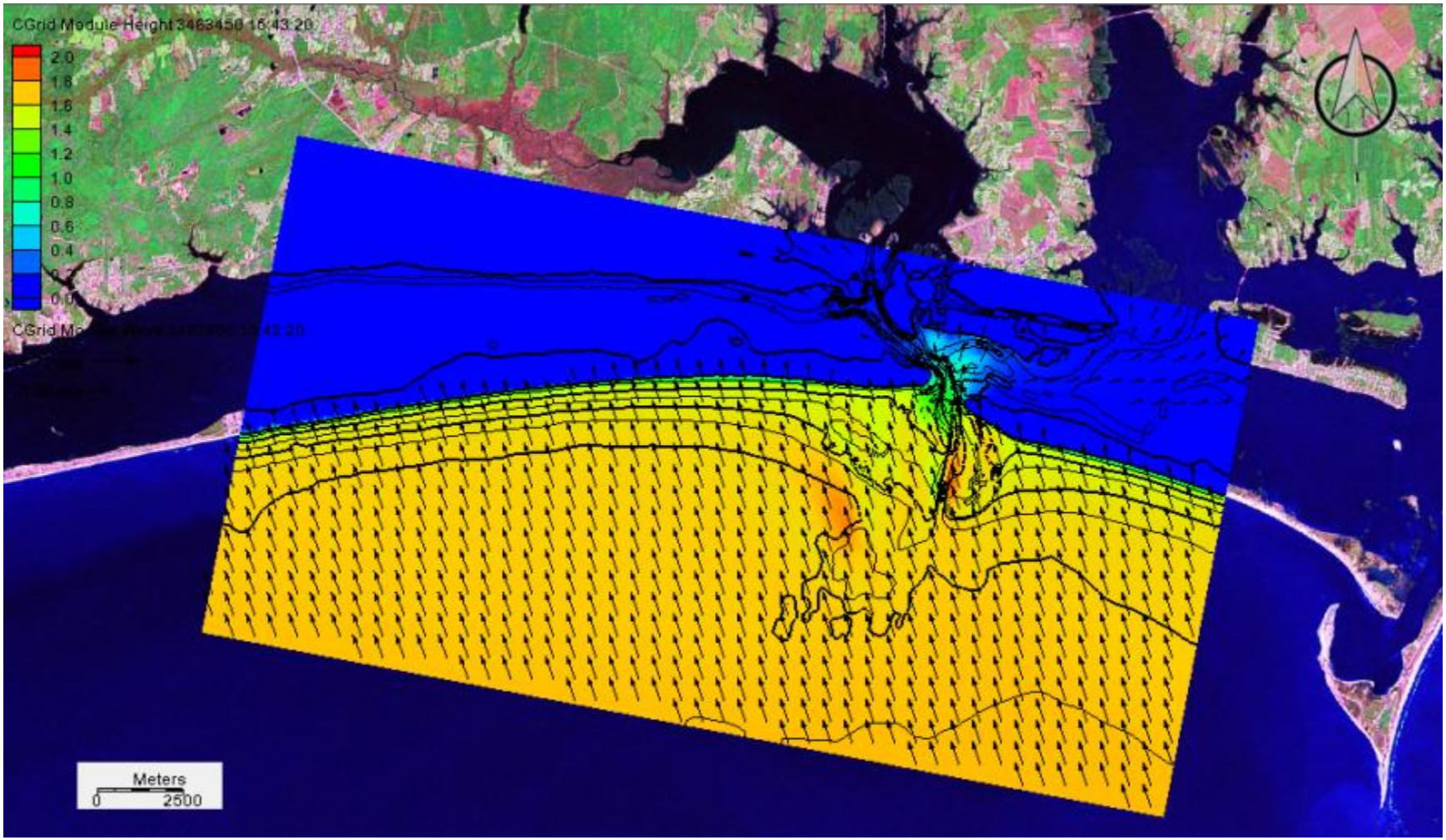
Representative year
Comparing gross, left/right, and net mean annual transport to the average.



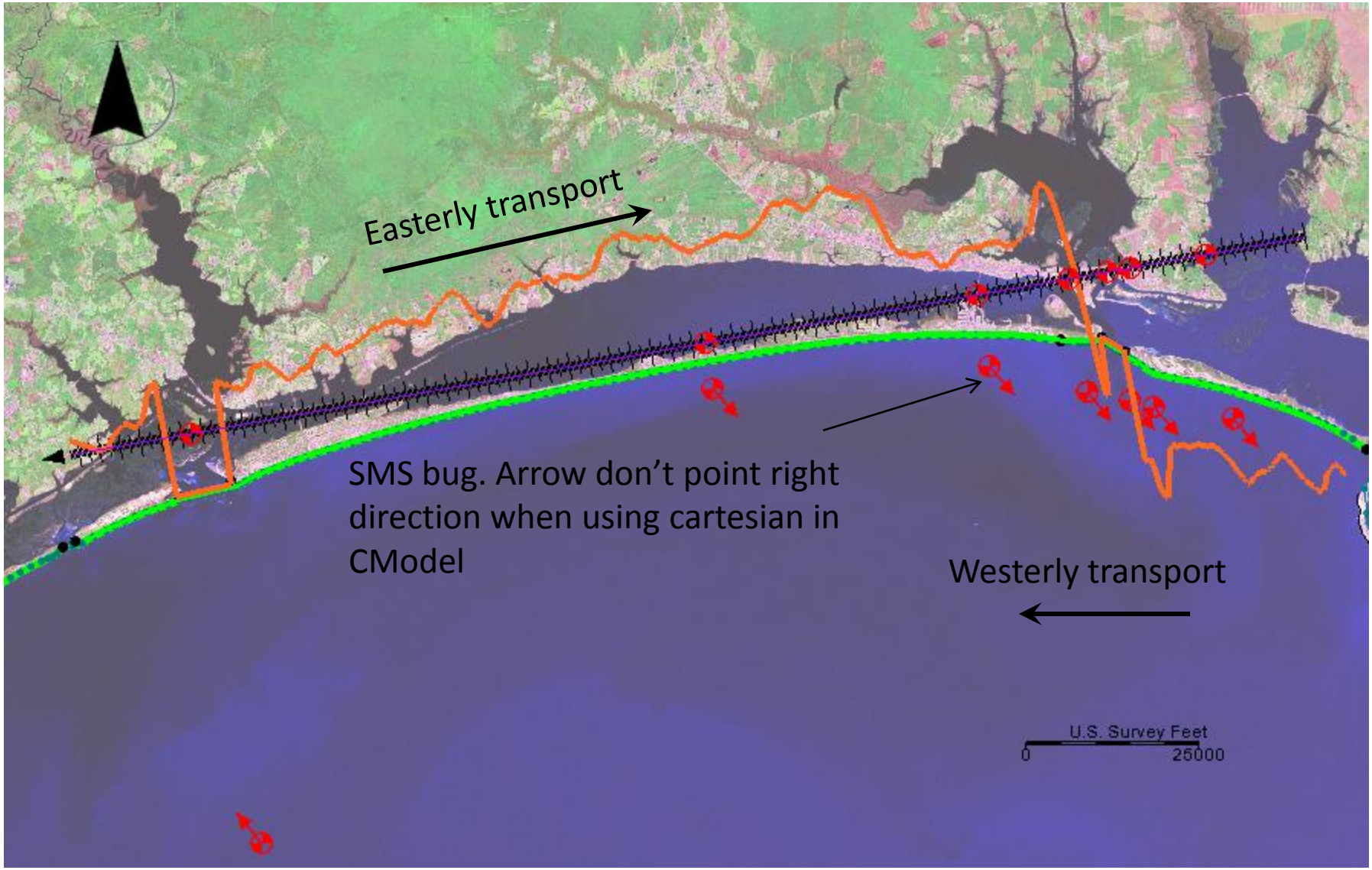


Dash = mean, yellow=1983
Disregard results was run with old version.

CMS Wave extended grid

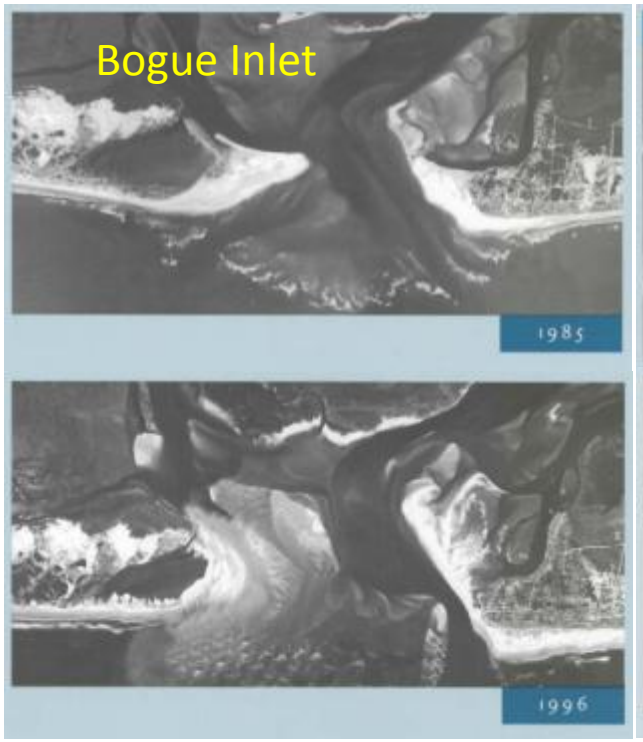


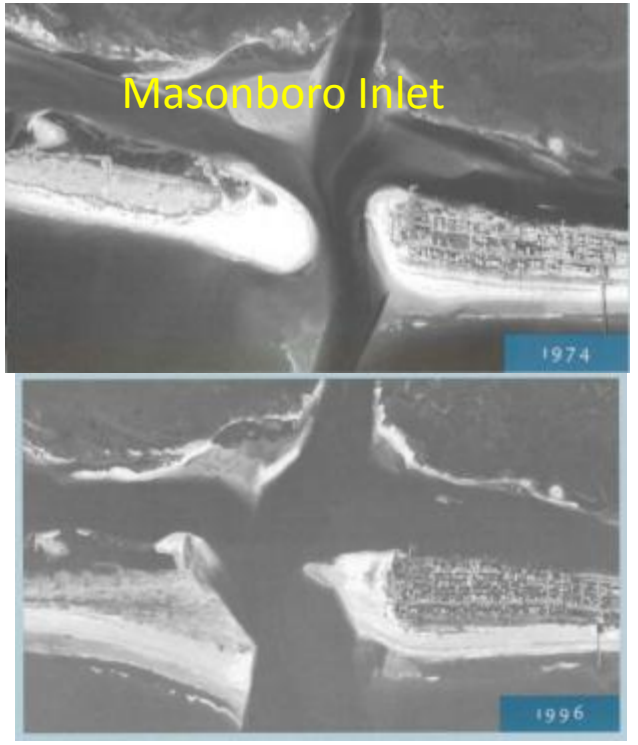
1983 CMS Mean Annual Transport



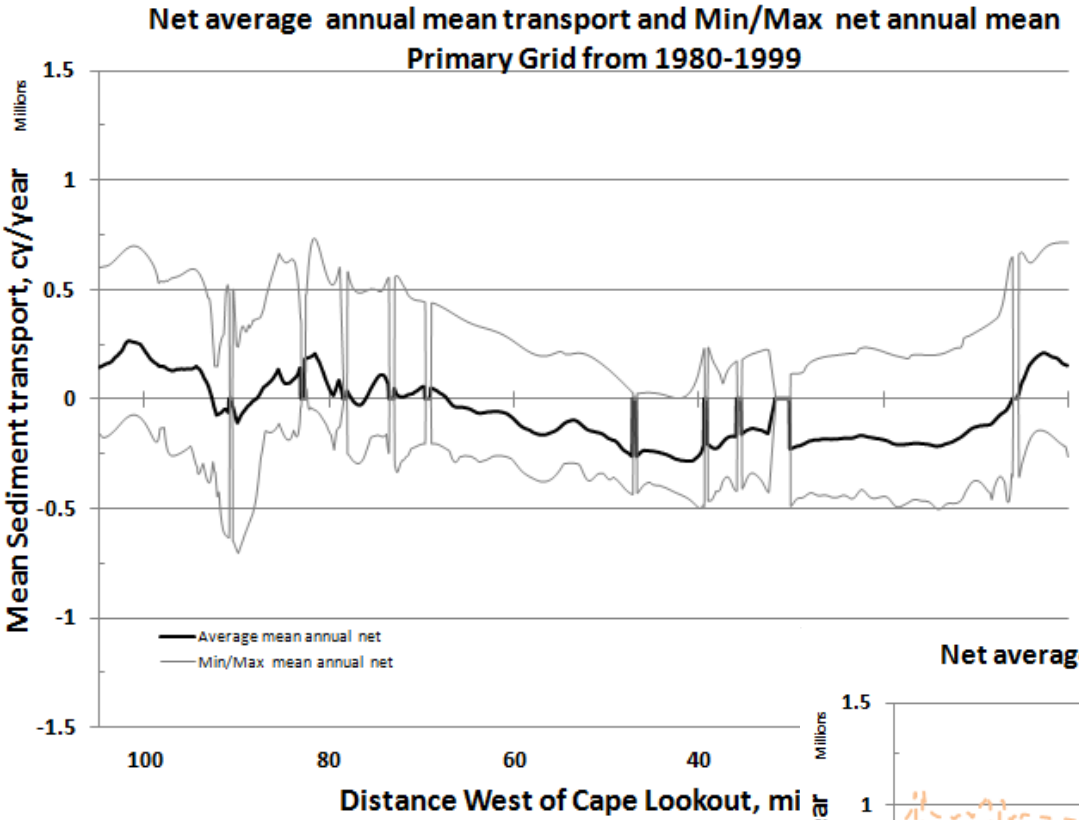
Direction of transport and variability

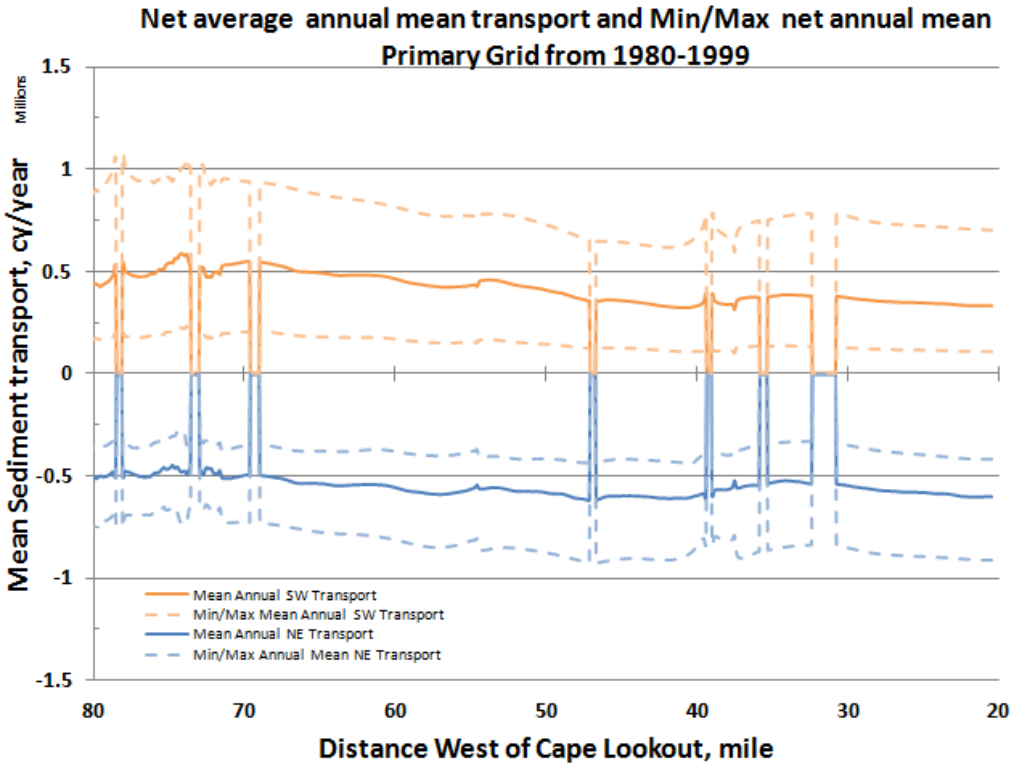
- Most of the inlet don't have obvious updrift/downdrift side or shift from year to year.





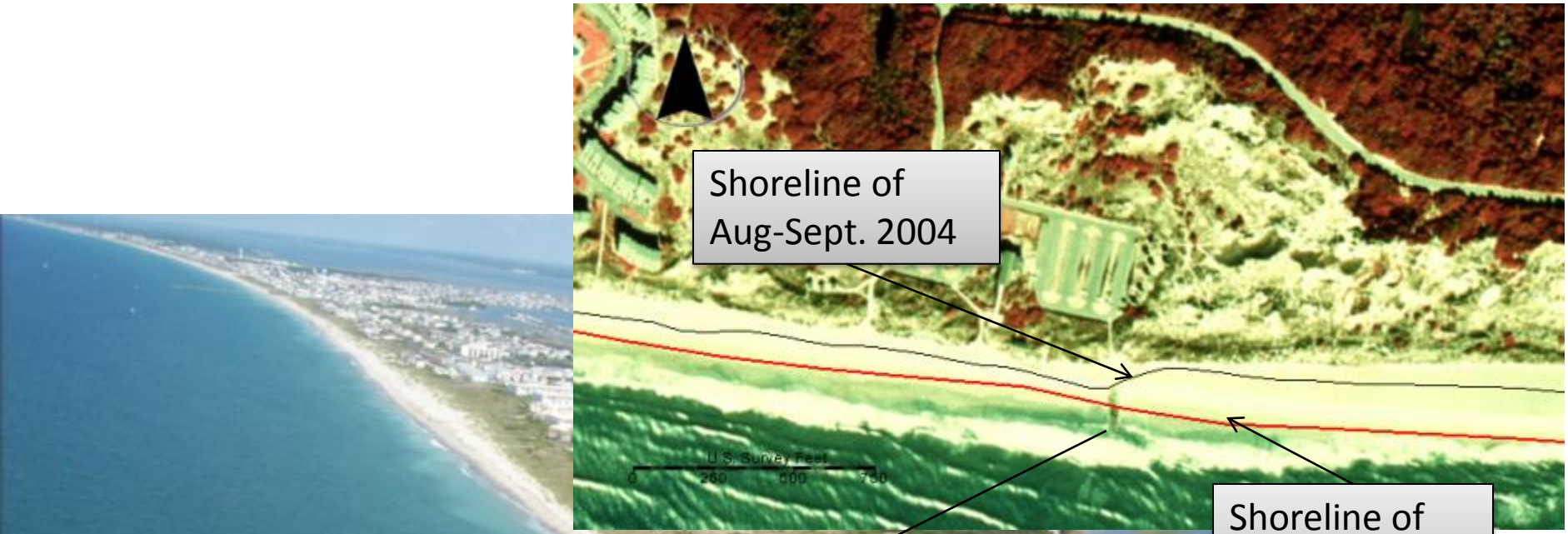
Inter-annual variability





Seasonal Variability

- Coming soon…

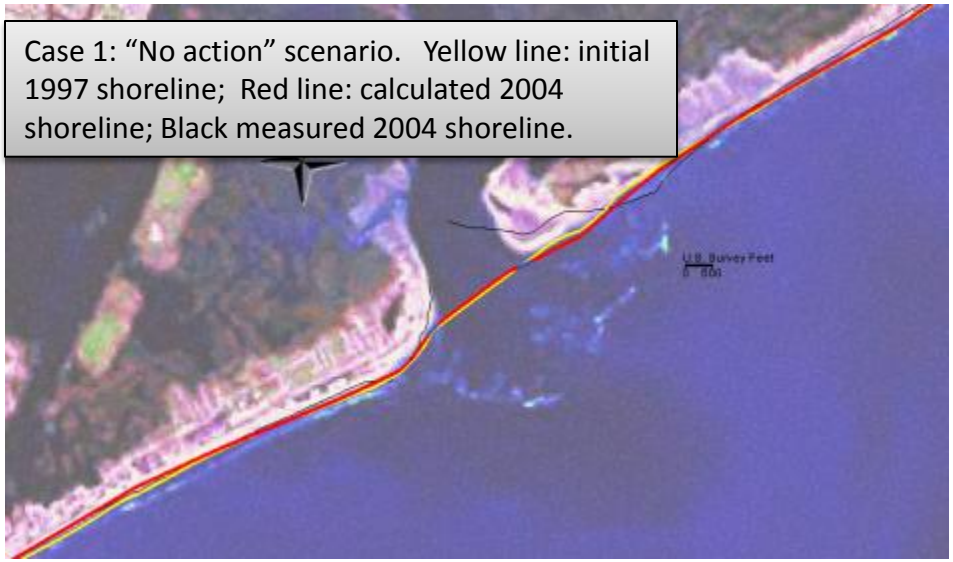


Shoreline of
January 1997,

small groin (parking lot)
just west of Fort Macon

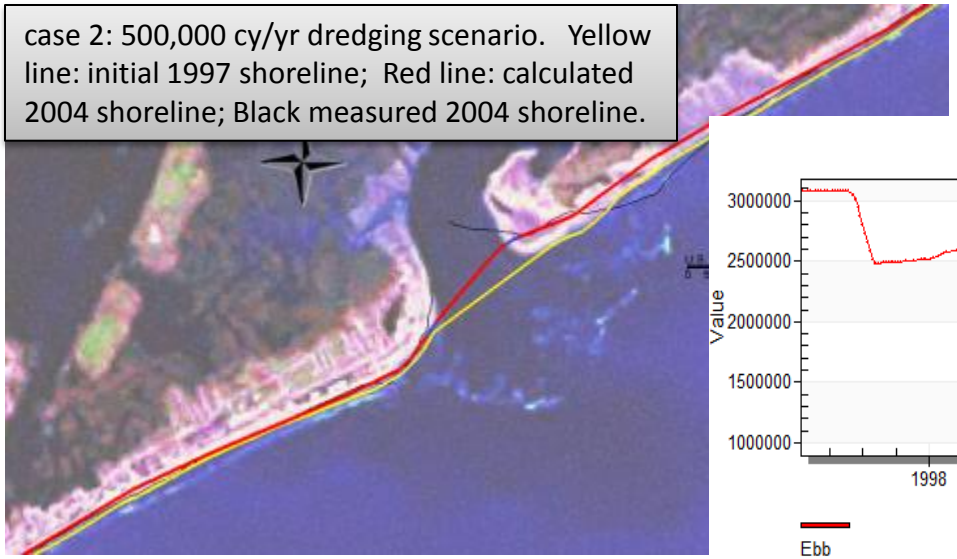
December 2007

Test cases and alternatives
New River inlet

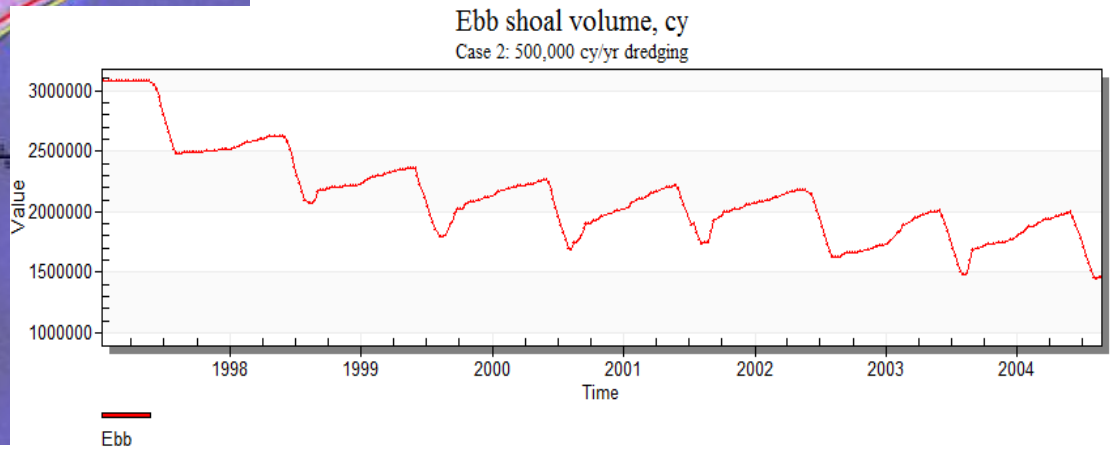


Case 1: “No action” scenario. Yellow line: initial 1997 shoreline; Red line: calculated 2004 shoreline; Black measured 2004 shoreline.

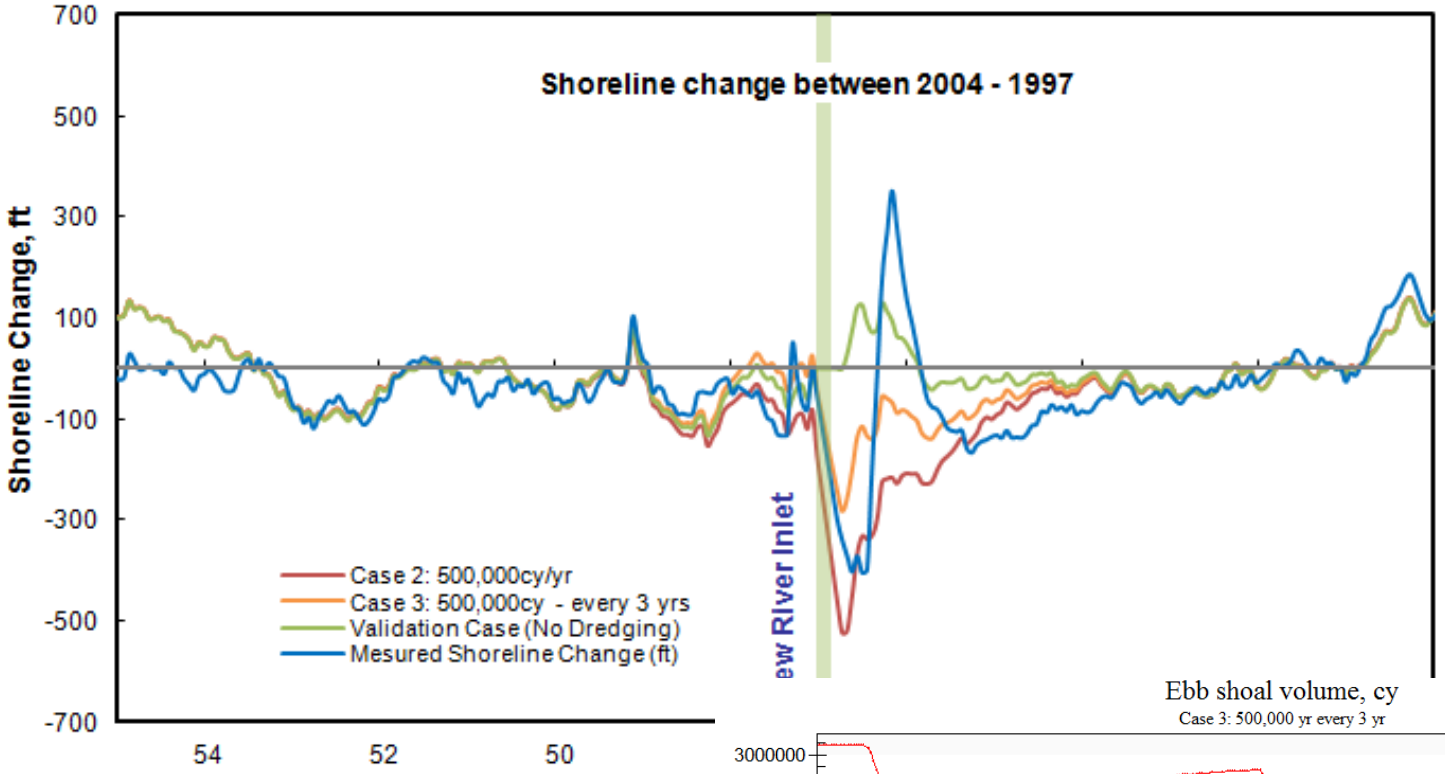
Complaints of erosion of the SW bank since beginning of maintenance dredging in 1962



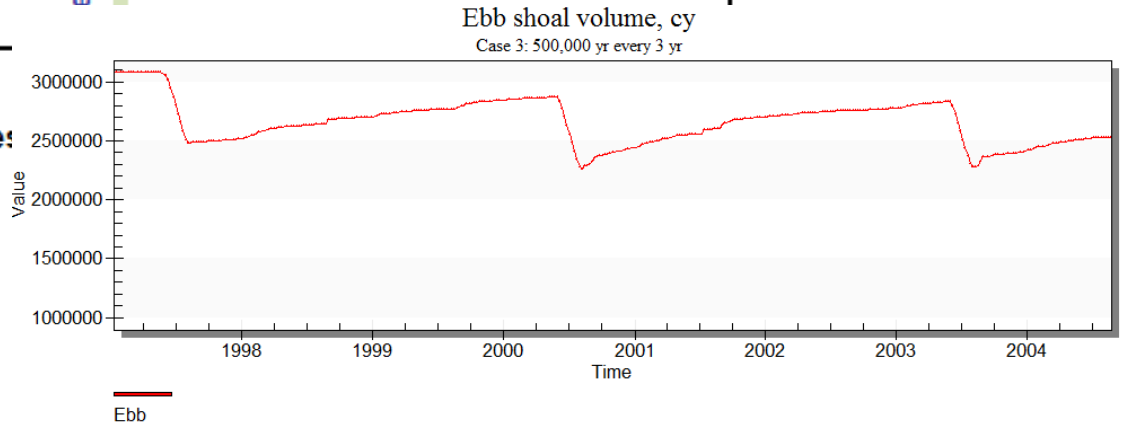
case 2: 500,000 cy/yr dredging scenario. Yellow line: initial 1997 shoreline; Red line: calculated 2004 shoreline; Black measured 2004 shoreline.



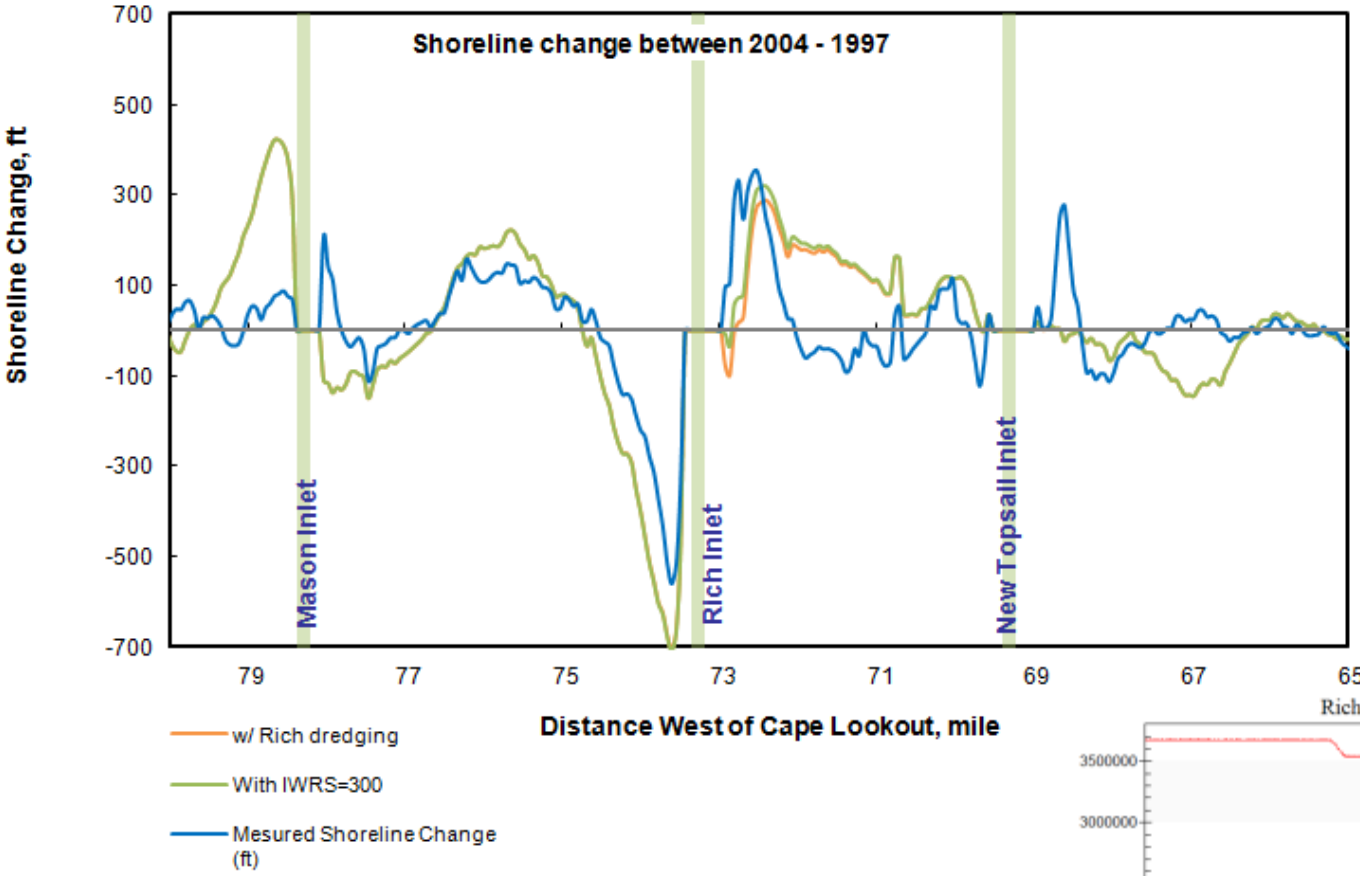
New River Inlet Alternatives
Case 3 : 500,000 cy every 3 years

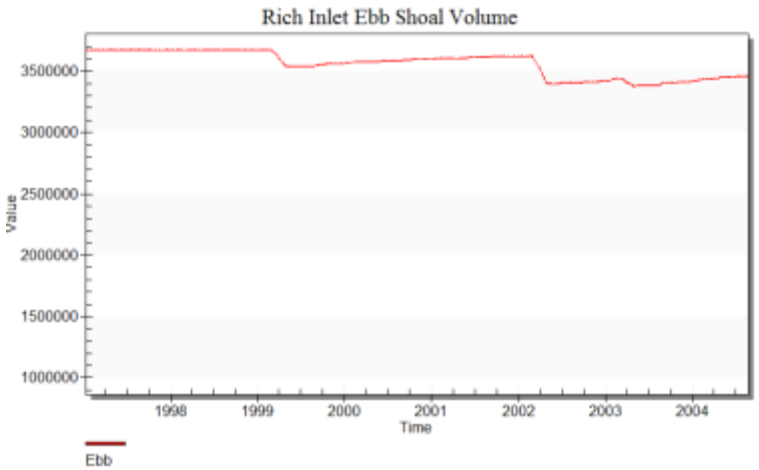


Case 3 show almost no impact on the SW bank.

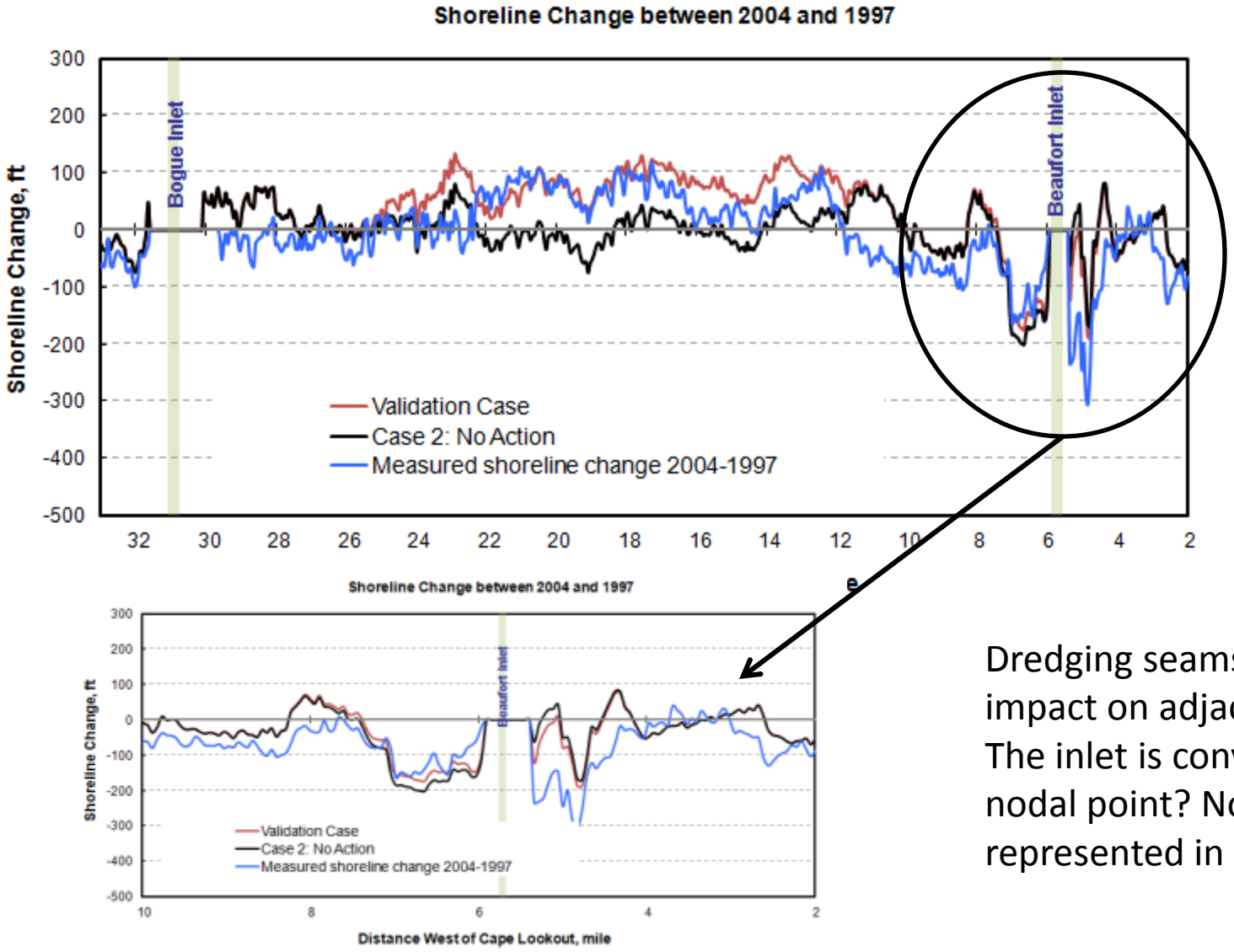


Rich Dredging





Beaufort Inlet No Action Case



Dredging seams to have no impact on adjacent banks. The inlet is convergent nodal point? Not well represented in GenCade?


The end
Mason Inlet