LiDAR applications for sediment transport along the MS-AL barrier chain

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Outline

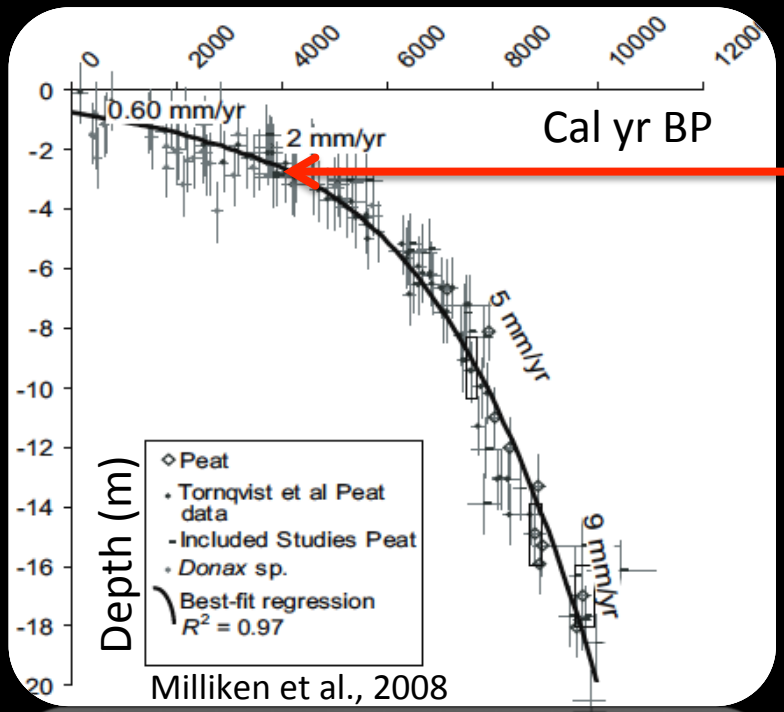
- Barrier Island background
- Primary research questions
- Methods
- Results
- Analysis
- Conclusions

Background:

Barrier Islands

Island dynamics controlled by

sediment supply, *sea-level rise* & *storms*



Milliken et al., 2008

MS-AL barriers stabilized 4.6 and 4.4 ^{14}C ka BP

SLR Rate <2 mm/yr

(Otvos & Giardino, 2004)

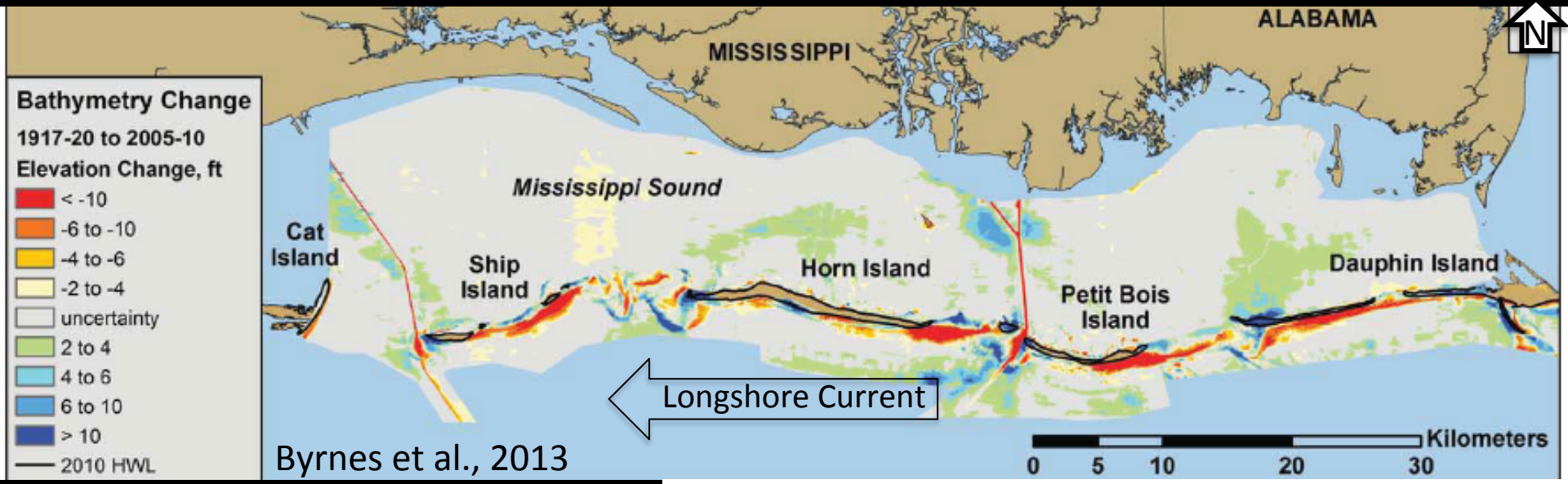
Modern Rate

4.10 +/- 0.92 mm/yr

(NOAA 2016)

Background:

Ship Island



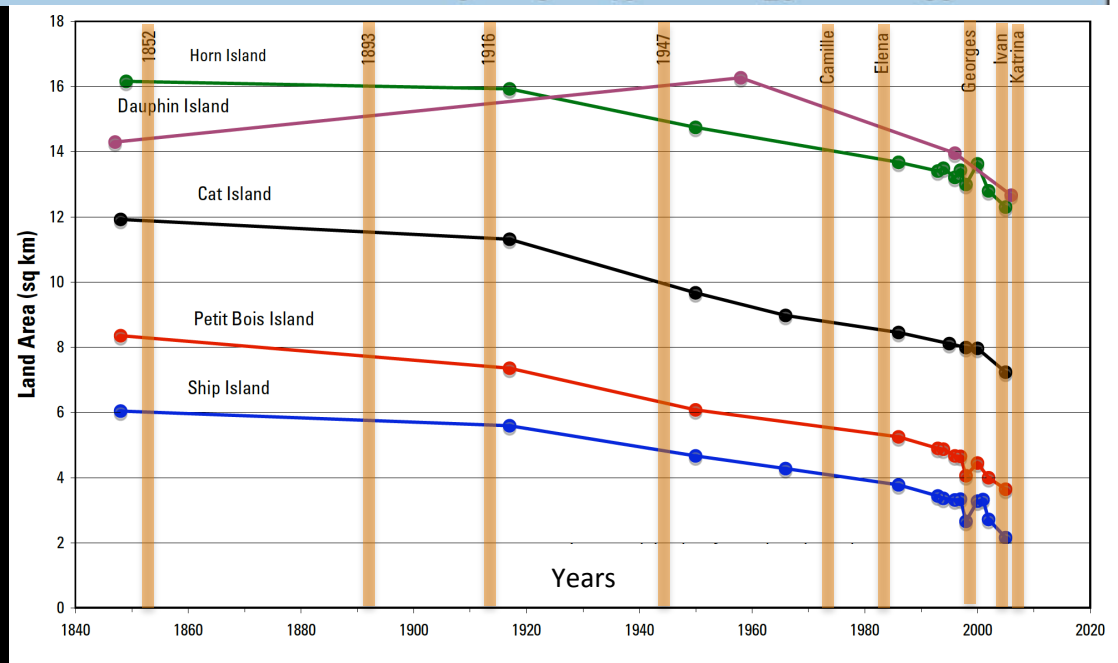
Byrnes et al., 2013

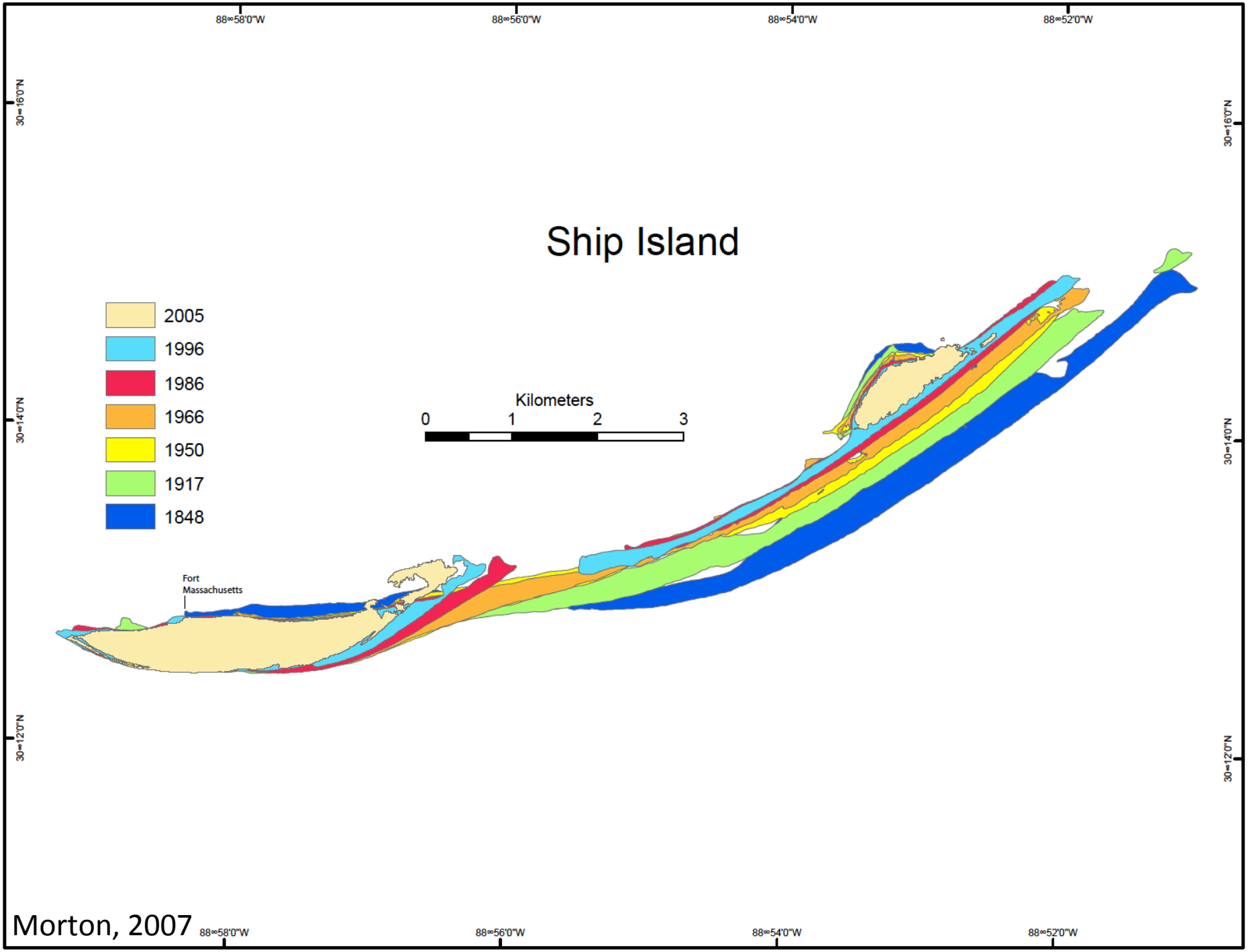
Islands approaching ***runaway transgression***

-increase SLR

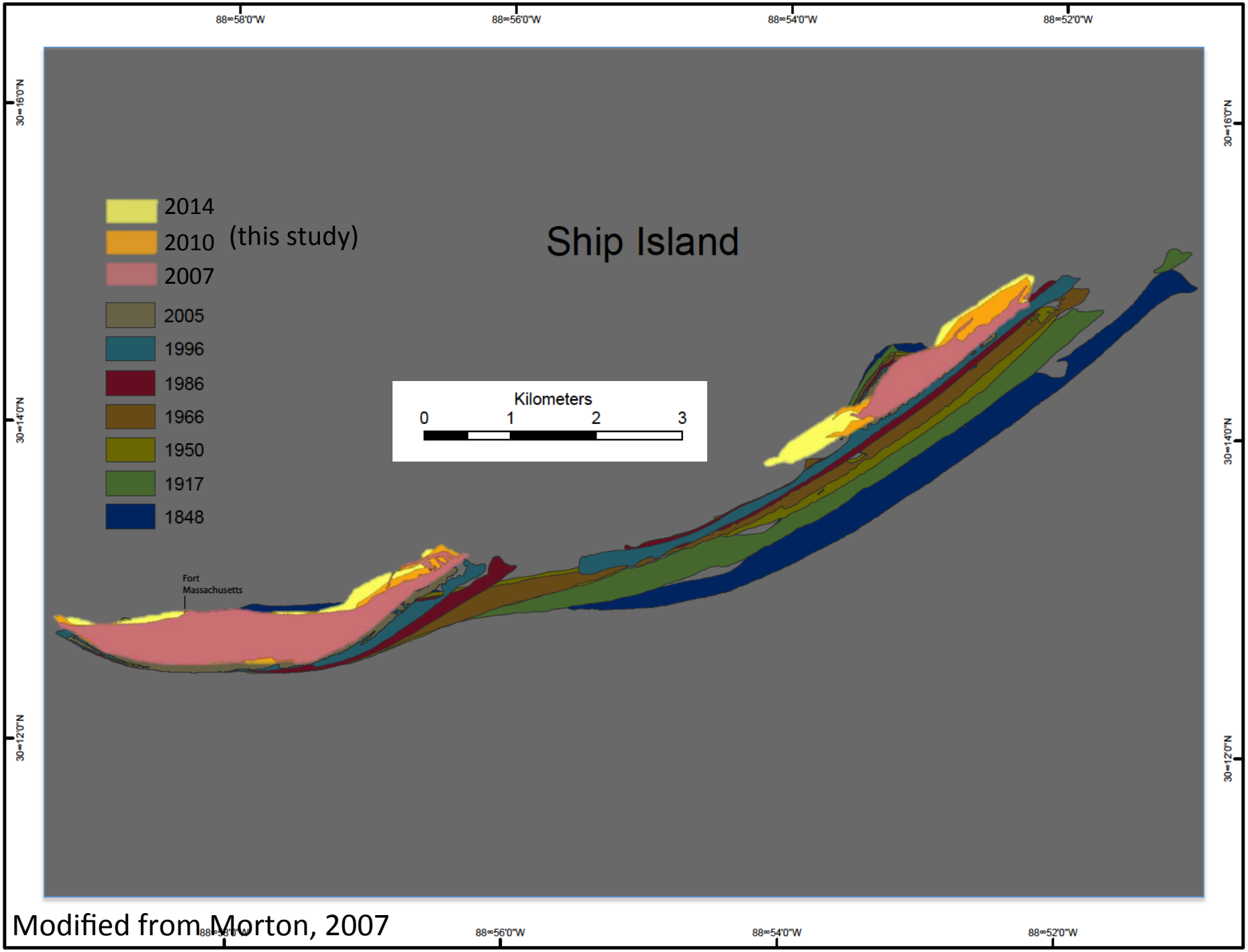
-decrease sediment

-constant/increasing storm




Ship Island
2005
1996
1986
1966
1950
1917
1848
Kilometers
0
1
2
3
Fort
Massachusetts
88°58'0"W
88°56'0"W
88°54'0"W
88°52'0"W
30°16'0"N
30°14'0"N
30°12'0"N

Morton, 2007



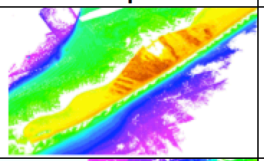
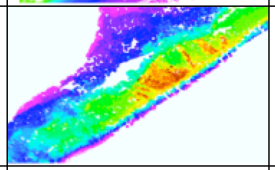
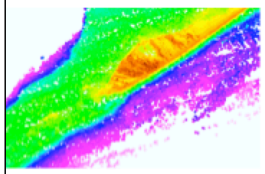
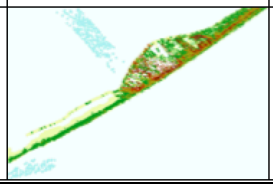
Modified from Morton, 2007

Research Questions

- LiDAR topo-bathy applications for barrier systems
  - A unique opportunity to study geomorphology
- Growth with net negative sediment budget (Byrnes et al., 2013)
  - Geomorphological Changes on meter – kilometer scale
    - Spreading out of subaerial sediments?
    - Redistribution of near-shore sediments?
    - What can island volumes tell us?

Methods

- Classification
  - Bare Earth topo and bathy
- MHW correction from NAVD 88 - VDatum
- LiDAR gridding
  - Topo & Bathy: 2004, 2007, 2012
  - 2010 Bathy & *Sparse Topo*
  - 5m^2 gridding blocks
  - Interpolated in polygon
- Errors

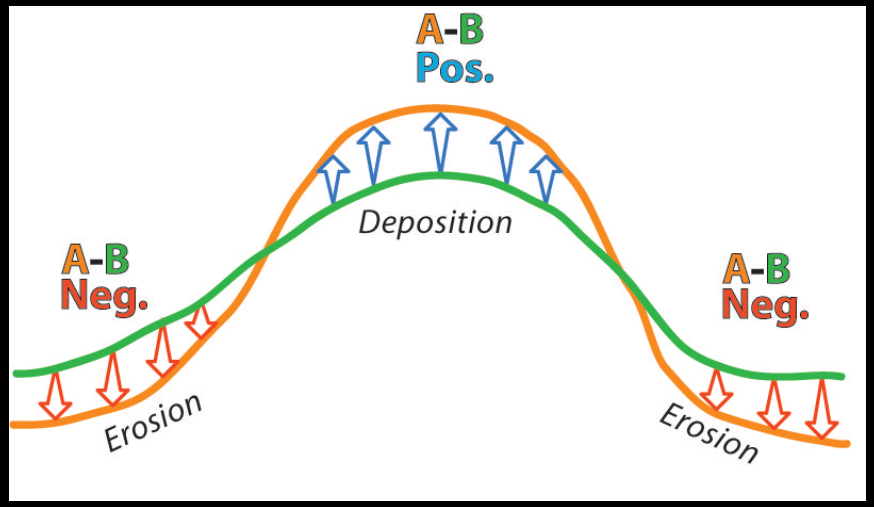
Date Collected	Topography	Bathymetry	Example Segment of East Ship Island	SOURCE	VA (cm)	HA (cm)
2012 May	Complete	Complete		USACE NCMP LiDAR Collected by JALBTCX	7.65	100
2010 April	Collected with bathy laser	Complete		USACE NCMP LiDAR Collected by JALBTCX	15	100
2007 June	Complete	Complete		USGS Coastal LiDAR NASA Wallops, USGS Coastal and Marine Geology Program, National Park Service	15	100
2004 April	Complete	Limited Coverage		USACE NCMP LiDAR Collected by JALBTCX	15	80

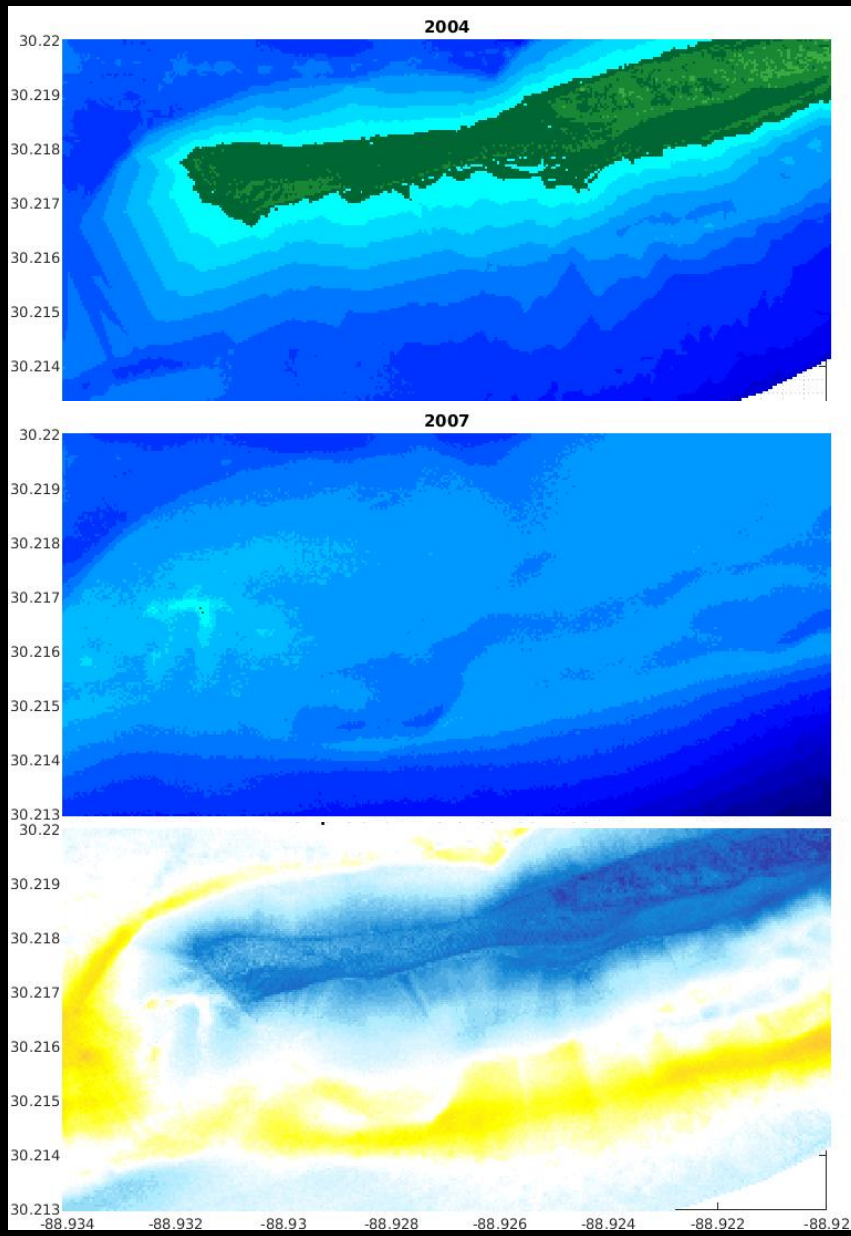
Methods

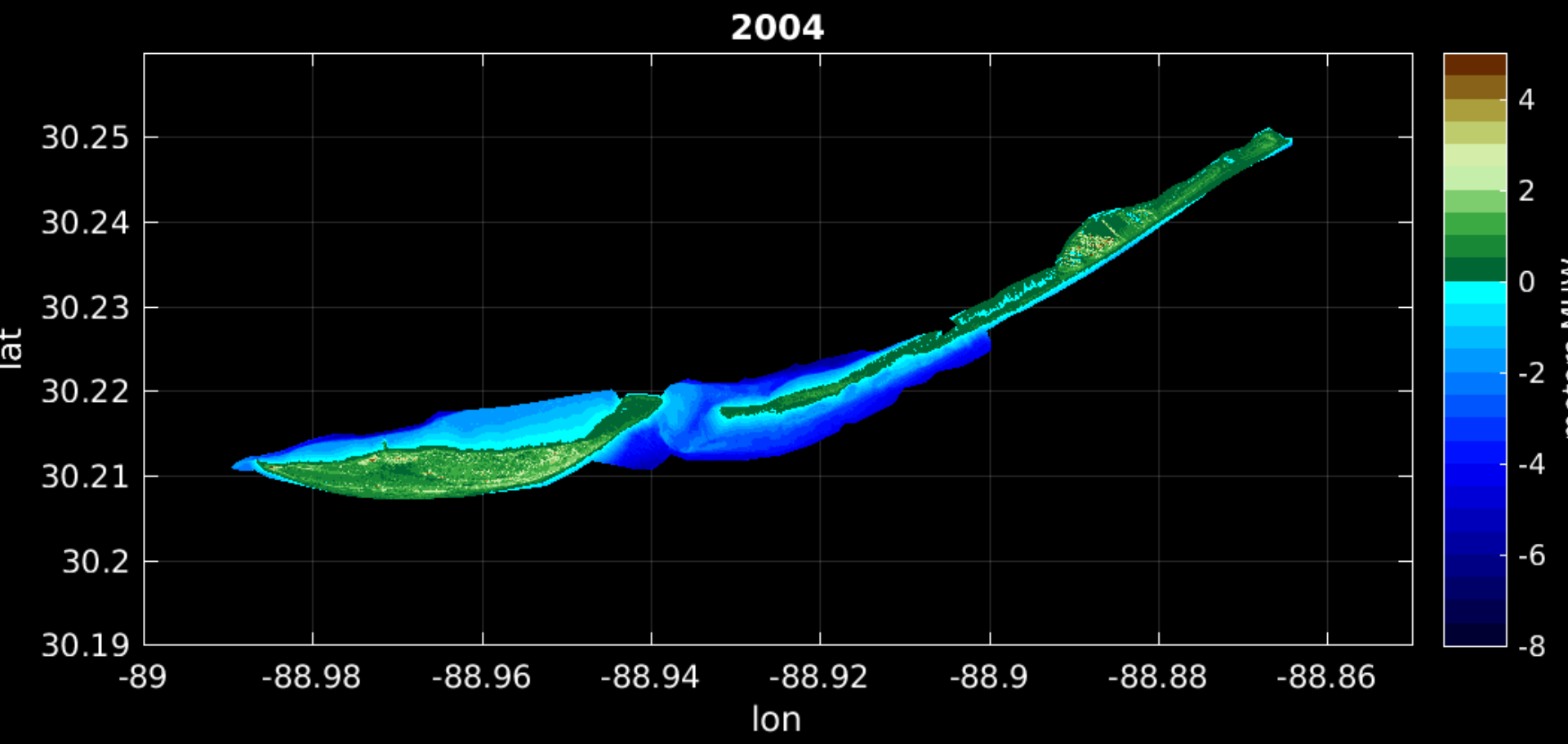
- Calculations
  - Island Area
  - Island & Water Volume

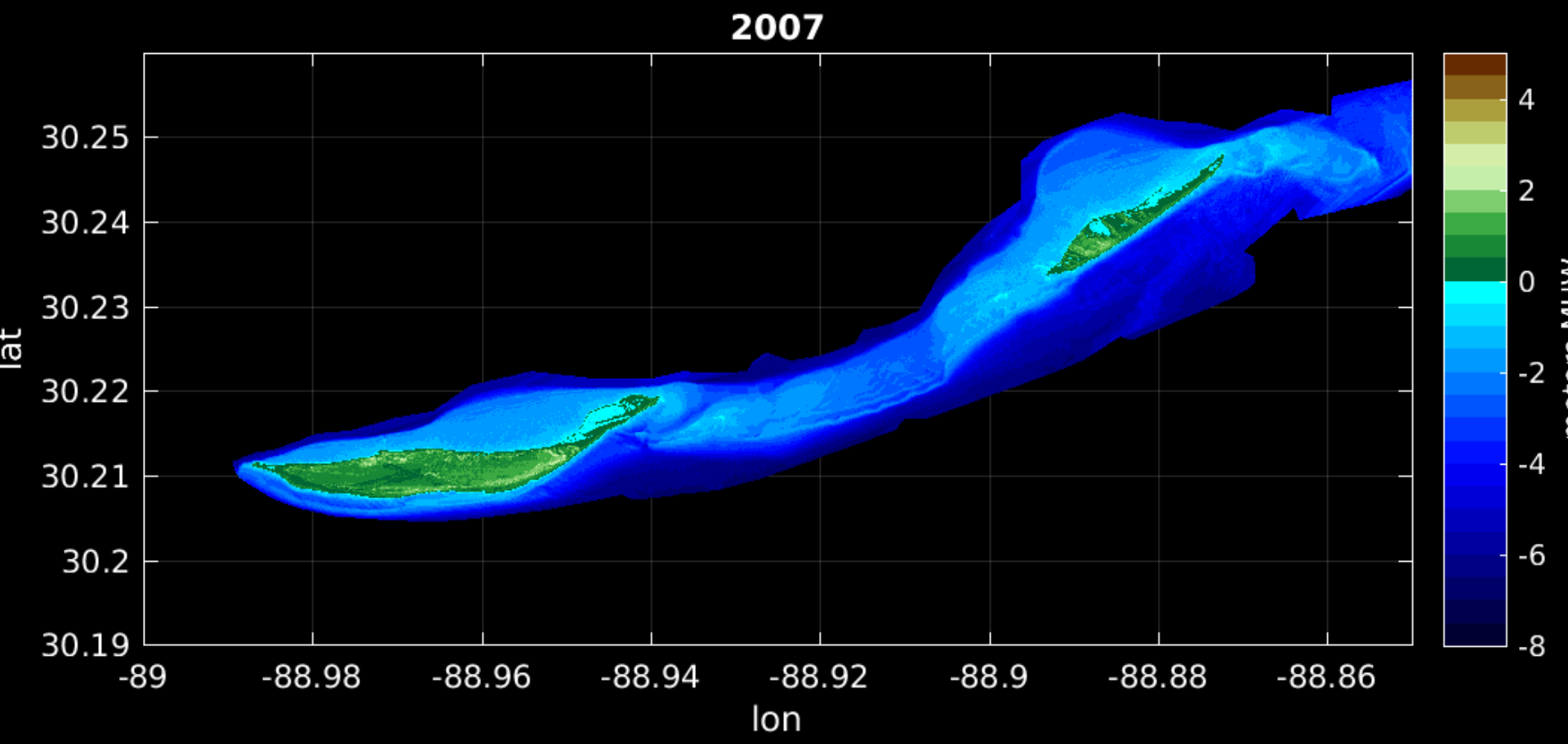
$$V_{topo} = \left(\sum Z_{gridded}\right) * A_{gridsquare}$$

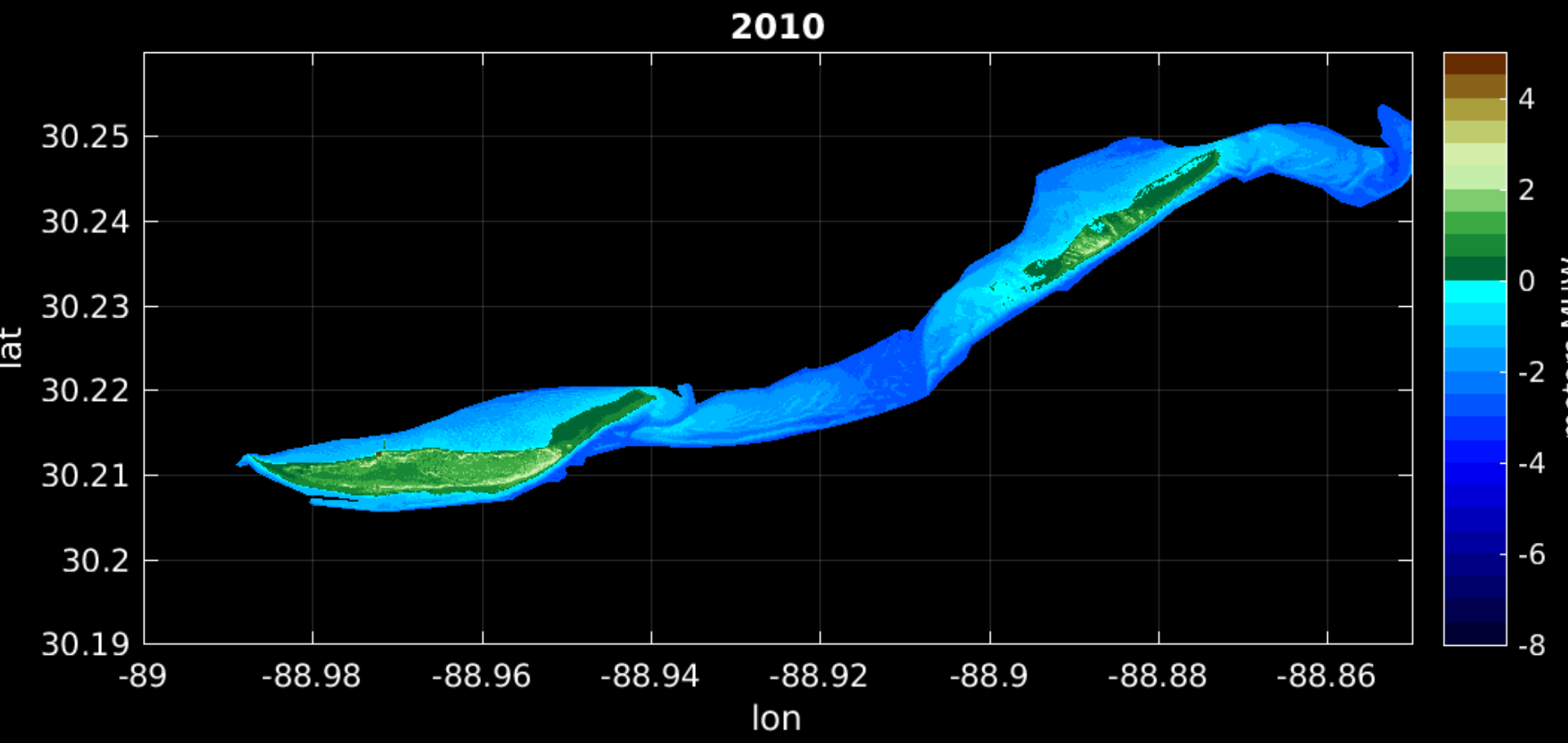
  - Difference Grids

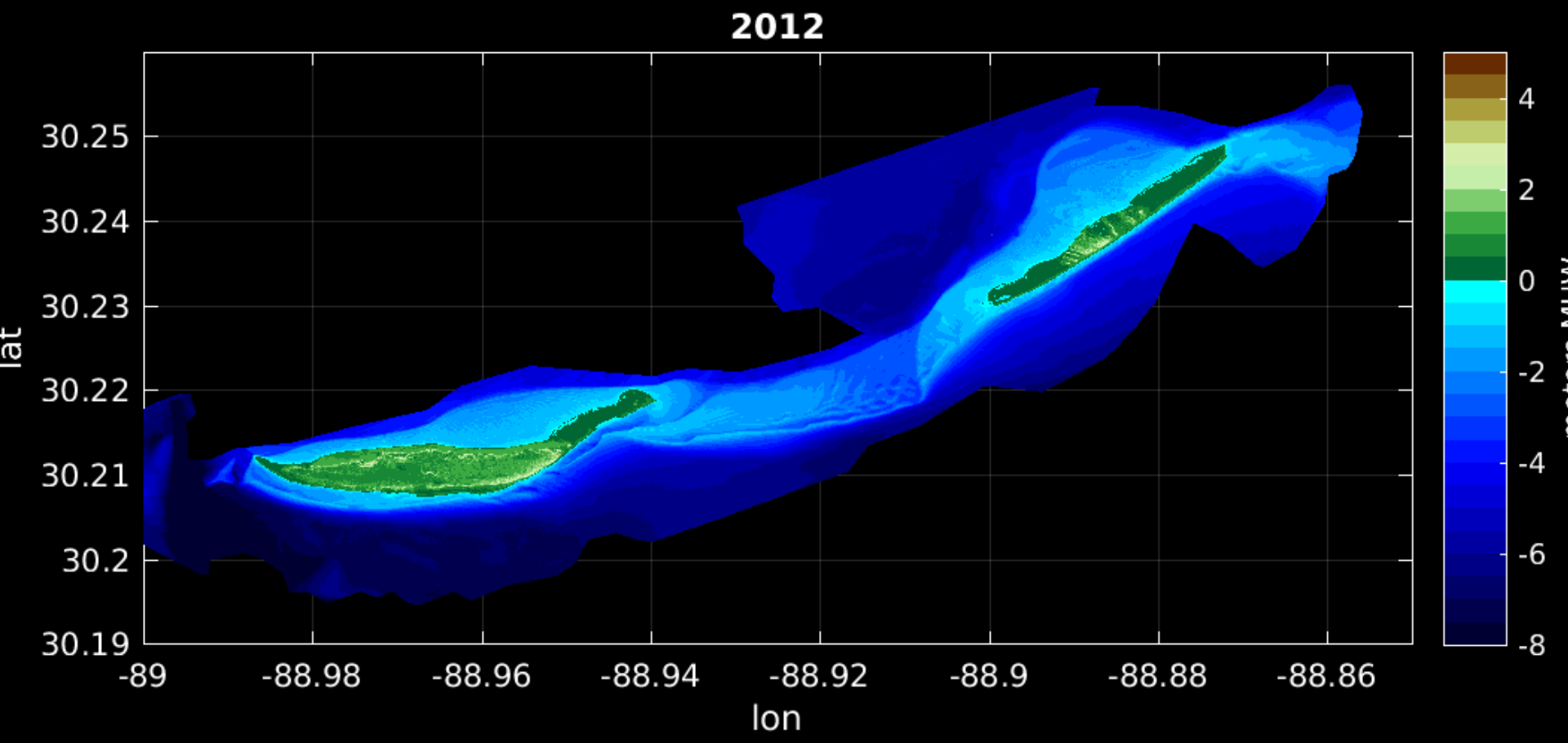




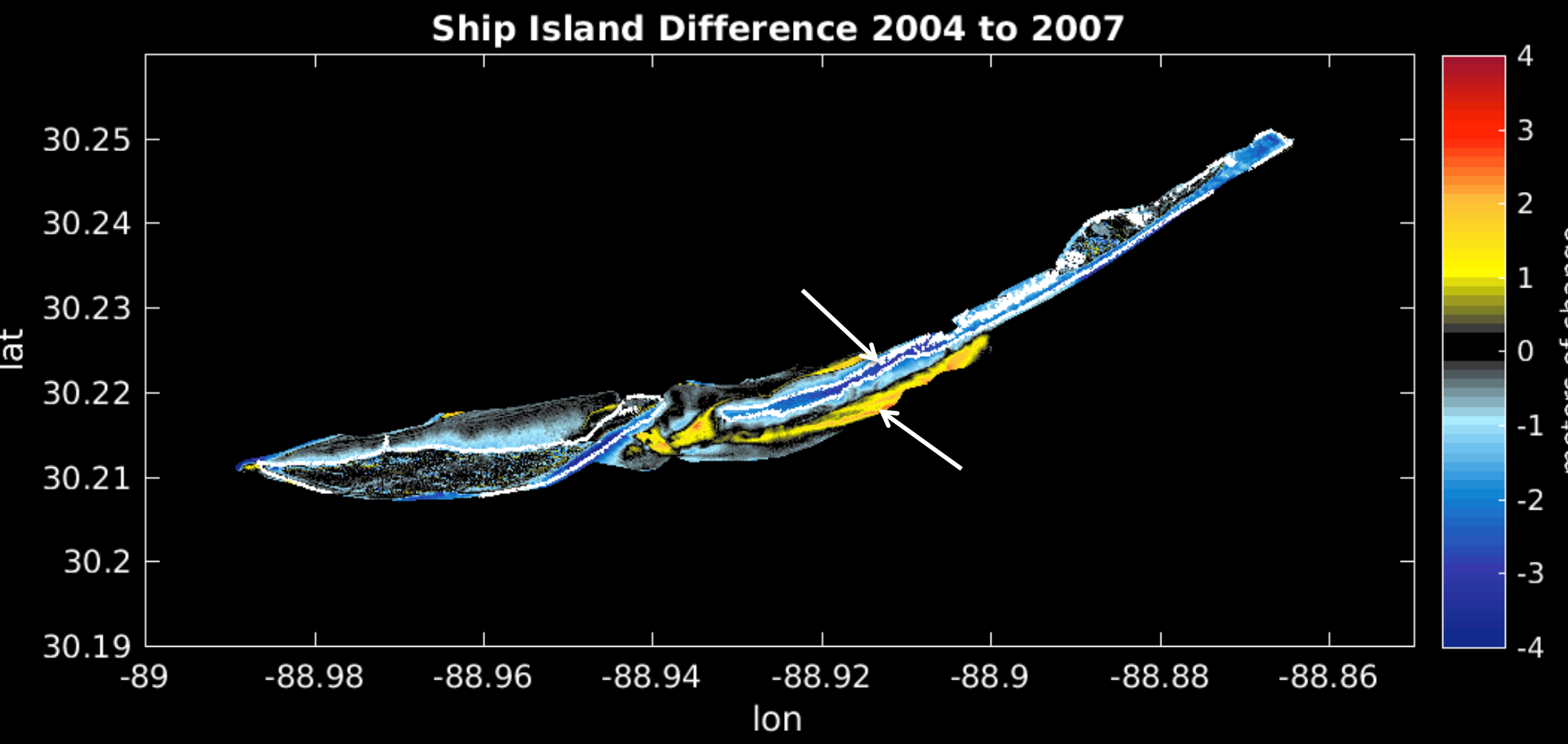

2004
30.25
30.24
30.23
30.22
30.21
30.2
30.19
lat
-89
-88.98
-88.96
-88.94
-88.92
-88.9
-88.88
-88.86
lon
4
2
0
-2
-4
-6
-8


2007
30.25
30.24
30.23
30.22
30.21
30.2
30.19
lat
-89
-88.98
-88.96
-88.94
-88.92
-88.9
-88.88
-88.86
lon
4
2
0
-2
-4
-6
-8

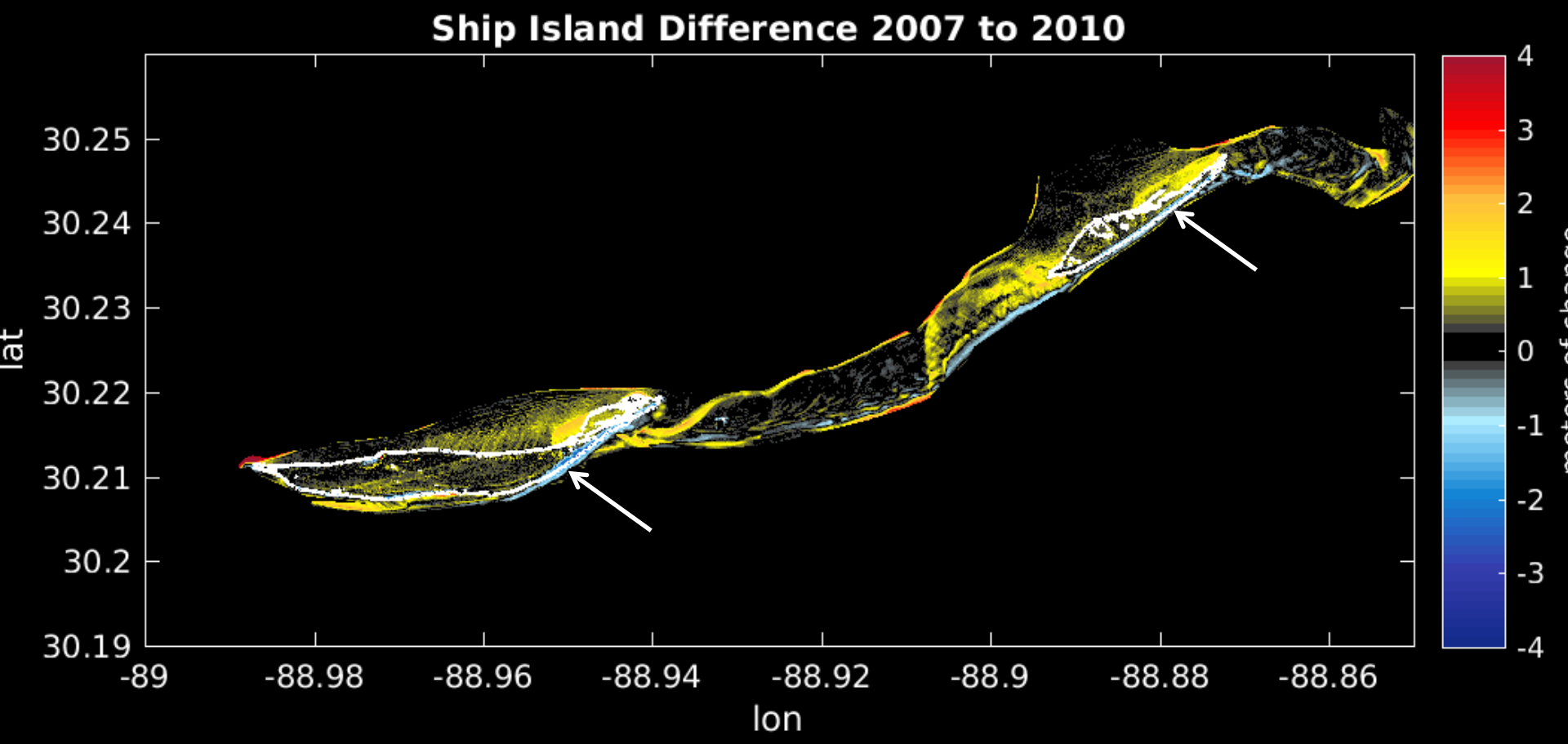

2010
30.25
30.24
30.23
30.22
30.21
30.2
30.19
lat
-89
-88.98
-88.96
-88.94
-88.92
-88.9
-88.88
-88.86
lon
4
2
0
-2
-4
-6
-8


2012
30.25
30.24
30.23
30.22
30.21
30.2
30.19
lat
-89
-88.98
-88.96
-88.94
-88.92
-88.9
-88.88
-88.86
lon
4
2
0
-2
-4
-6
-8

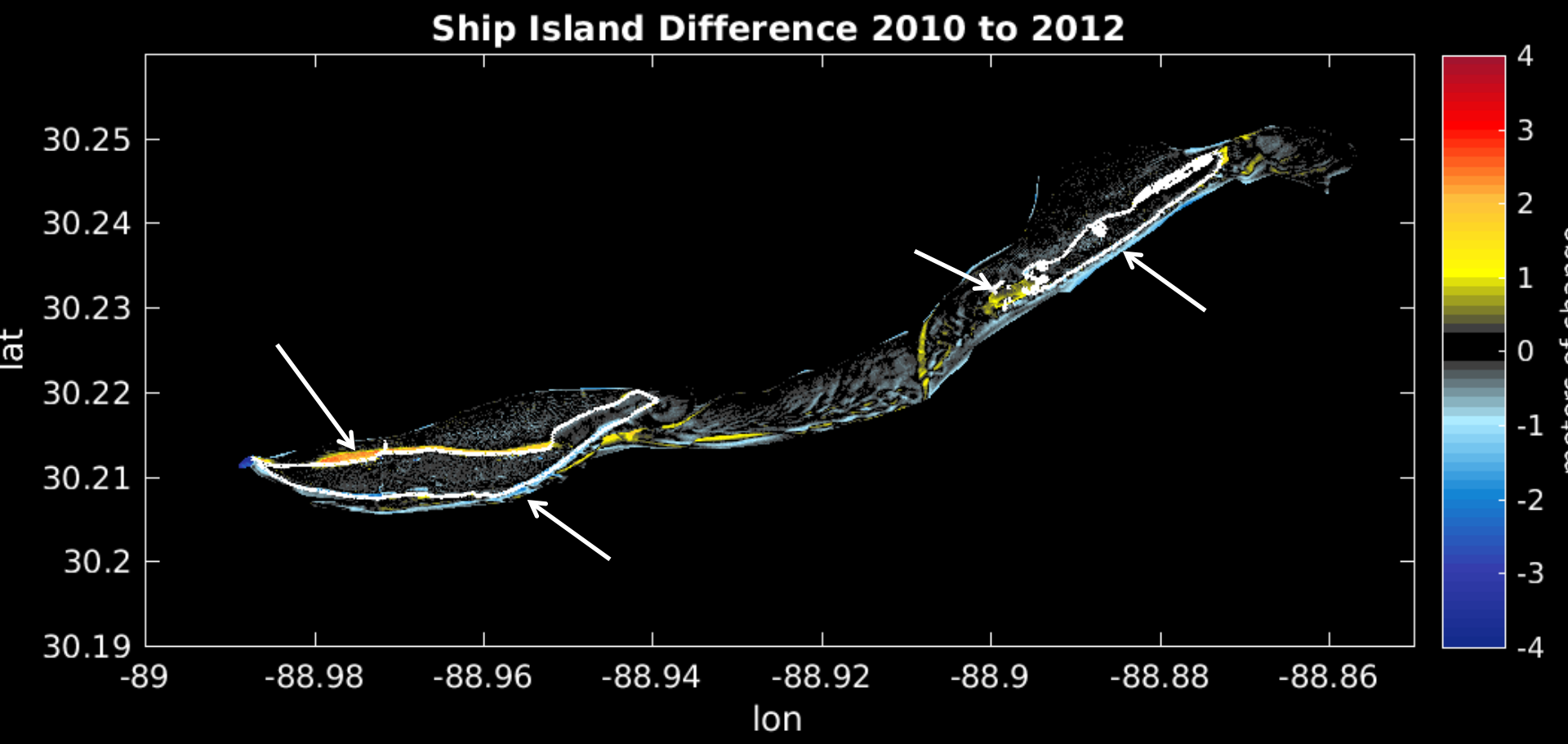
Results


Ship Island Difference 2004 to 2007
lat
30.25
30.24
30.23
30.22
30.21
30.2
30.19
-89
-88.98
-88.96
-88.94
-88.92
-88.9
-88.88
-88.86
lon
4
3
2
1
0
-1
-2
-3
-4

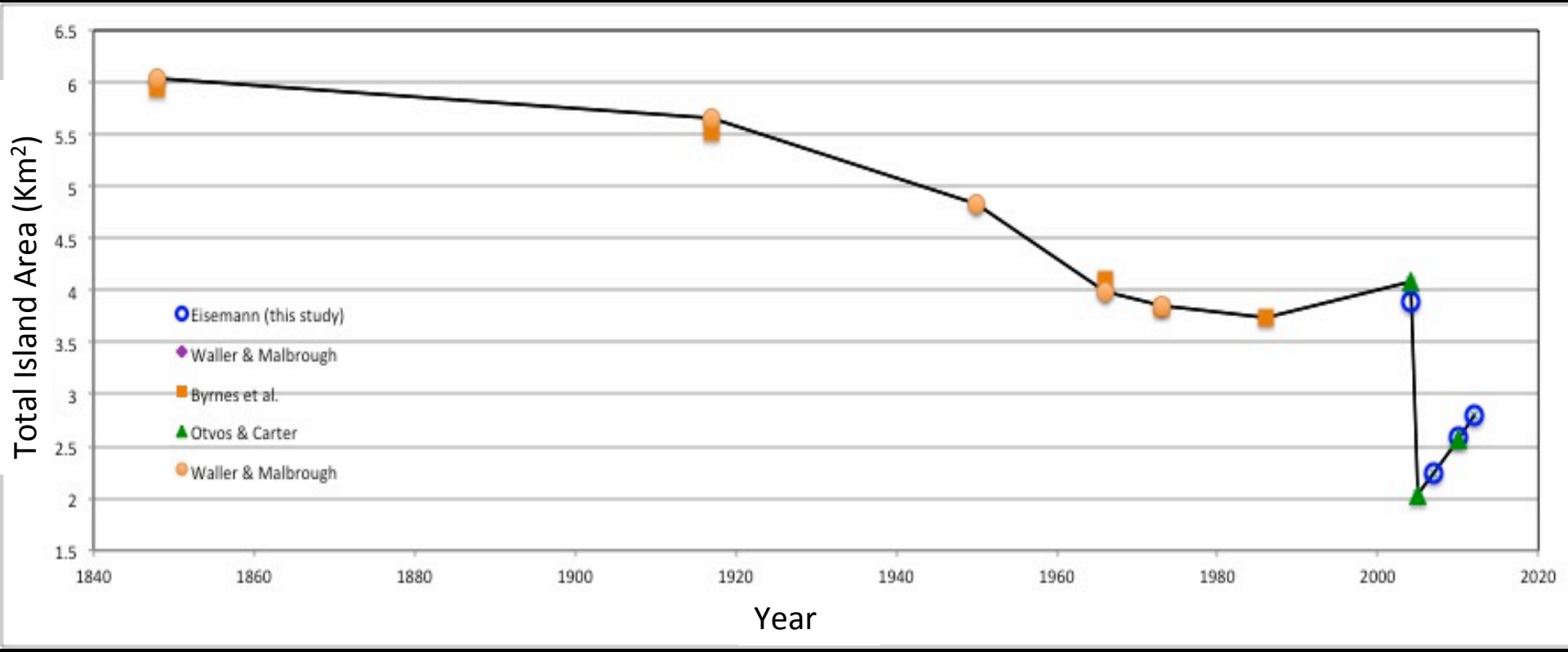
Results


Ship Island Difference 2007 to 2010
lat
30.25
30.24
30.23
30.22
30.21
30.2
30.19
-89
-88.98
-88.96
-88.94
-88.92
-88.9
-88.88
-88.86
lon
4
3
2
1
0
-1
-2
-3
-4

Results


Ship Island Difference 2010 to 2012
30.25
30.24
30.23
30.22
30.21
30.2
30.19
lat
-89
-88.98
-88.96
-88.94
-88.92
-88.9
-88.88
-88.86
lon
4
3
2
1
0
-1
-2
-3
-4

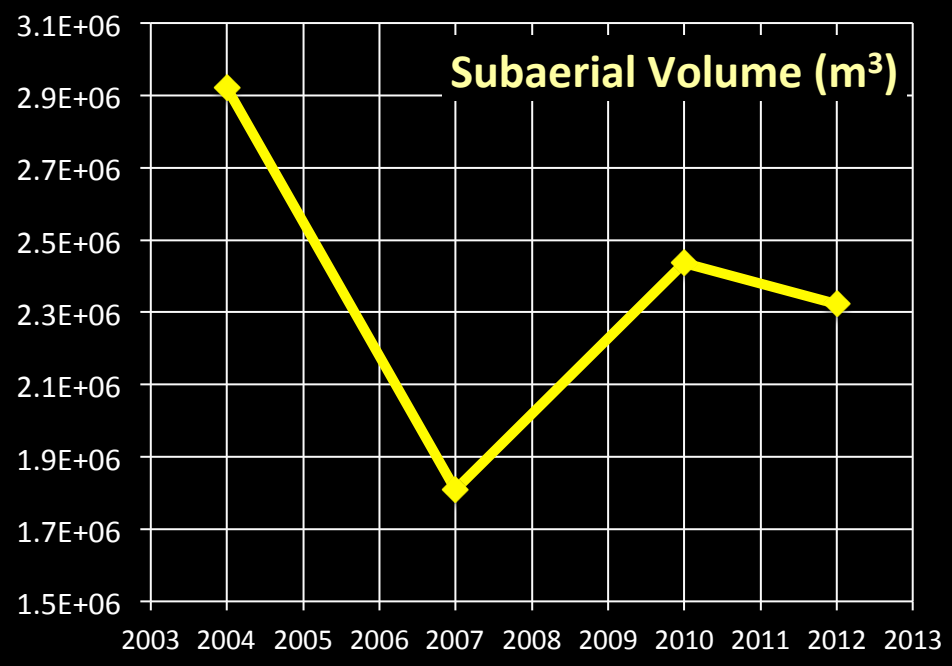
Results

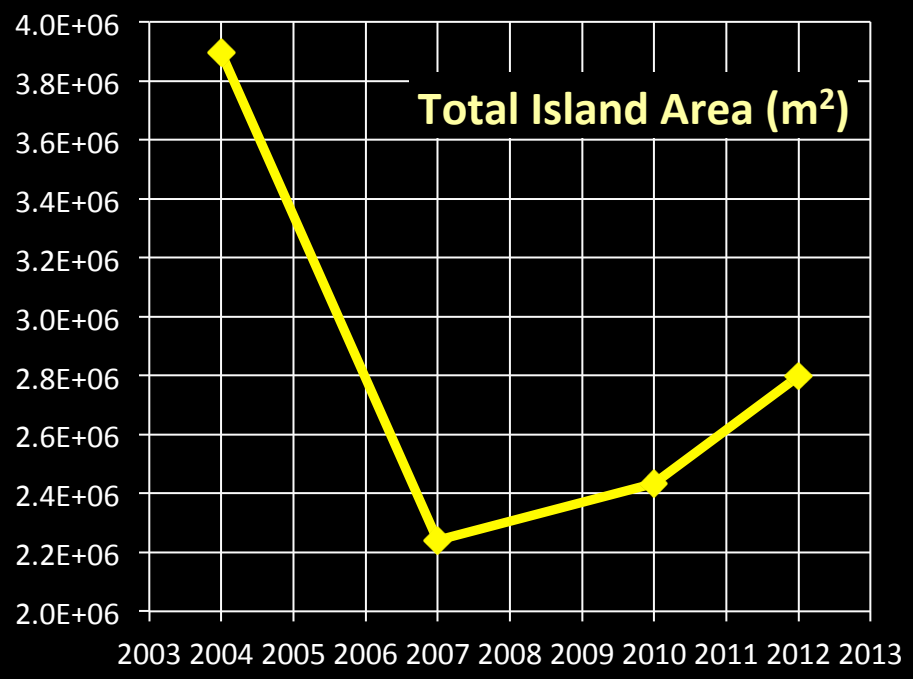

Total Island Area (Km²)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1840
1860
1880
1900
1920
1940
1960
1980
2000
2020
Year
Eisemann (this study)
Waller & Malbrough
Byrnes et al.
Otvos & Carter
Waller & Malbrough

Results

Volume error ~±1.0x10^5

Year	Isl. Area (m^2)	Volume Above MHW (m^3)	Vol/Area
2004	3.9x10^6	3.0x10^6	1.3
2007	2.2x10^6	1.8x10^6	1.2
2010	2.6x10^6	*2.4x10^6*	*1.0*
2012	2.8x10^6	2.3x10^6	1.2
2014	~3x10^6	-	-

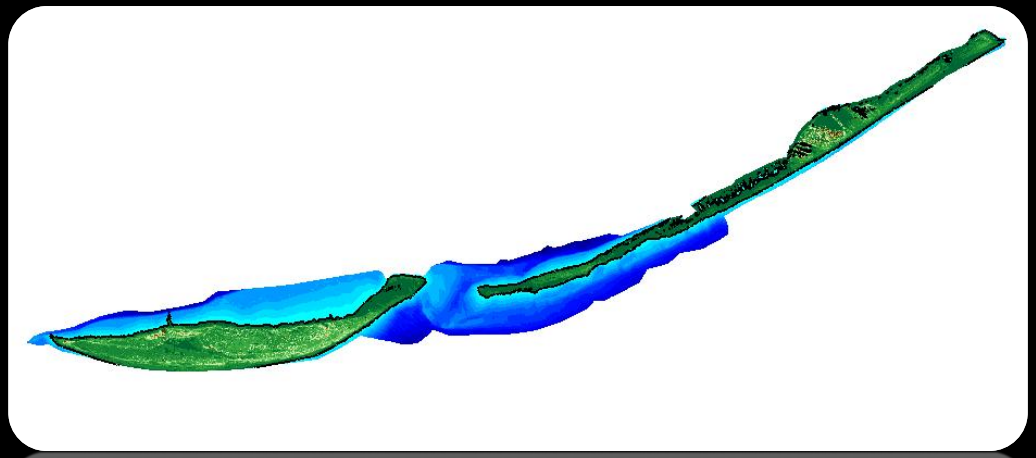




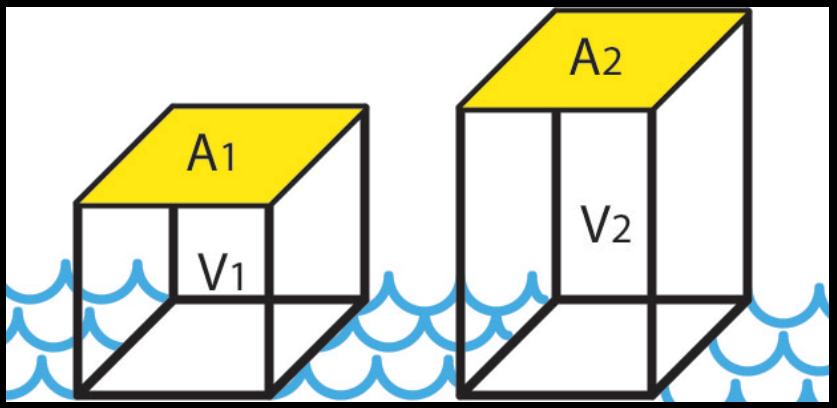
Results

within 2004 area

Year	Bathy Area (m^2)	Volume Below MHW (m^3)	Vol/Area
2004	3.8E+06	6.1×10^6	1.6
2007	5.6E+06	1.02×10^7	1.8
2010	5.5E+06	8.8×10^6	1.6
2012	5.3E+06	9.5×10^6	1.8



Analysis



Above MHW

- Area shows linear recovery trend after Katrina supported by Otvos & Carter, 2013
- *Post Katrina Island growth in area and volume*

2004 - 2007	***-4.1x10^6 m^3***	*Bathy*
	-1.1x10^6 m^3	*Topo*
	-5.2x10^6 m^3	*Total*
2007 - 2012	***5x10^5 m^3***	*Bathy*
	5X10^5 m^3	*Topo*
	1x10^6 m^3	*Total*

Volume error ~±1.0x10^5 m^3

Below MHW

- Clear patterns of erosion/deposition
- Average depths and V/A ratios variable

Both Topo & Bathy data indicate

- Severe erosion during Katrina ('04-'07)
- Quick rebound ('07-'10)
- Return to slight net-erosional ('10-'12)

Conclusions

- **LiDAR** offers much more than the typical area and bathymetric analyses

- **Erosion – Recovery – Stabilization**
  - Loss of 4.2×10^6 m^3 from system from 2004-2012
  - Ultimately recovered less than half of island volume lost to Katrina
  - Returned to slight erosional conditions

- Subaerial growth after Katrina was not a redistribution of sediment already above MHW, but **a net increase in island volume** from subaqueous.

- The **shallow platform surrounding the island** supplied island with sediment and also showed post-storm recovery.

- The most beneficial place for **sediment nourishment** would be on the platform supplying the current island growth.

thank you