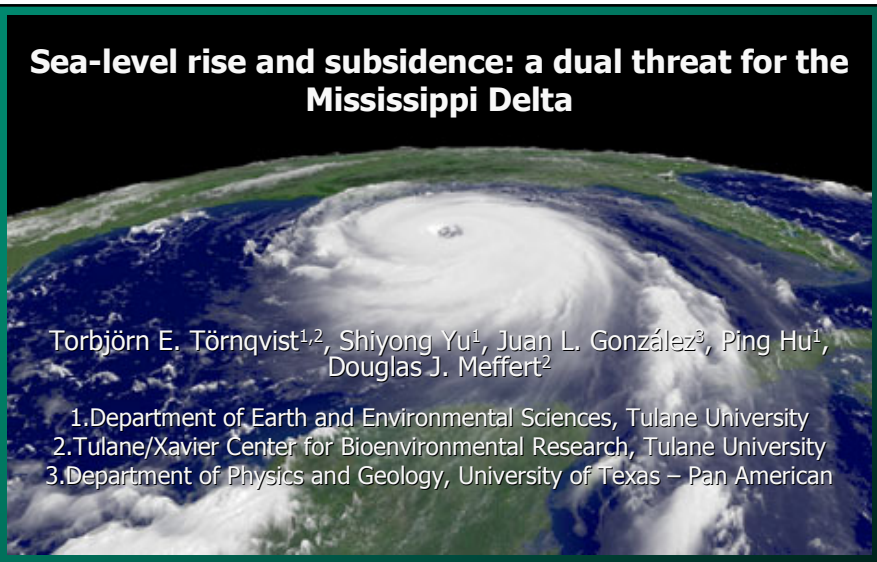
Sea-level rise and subsidence: a dual threat for the Mississippi Delta



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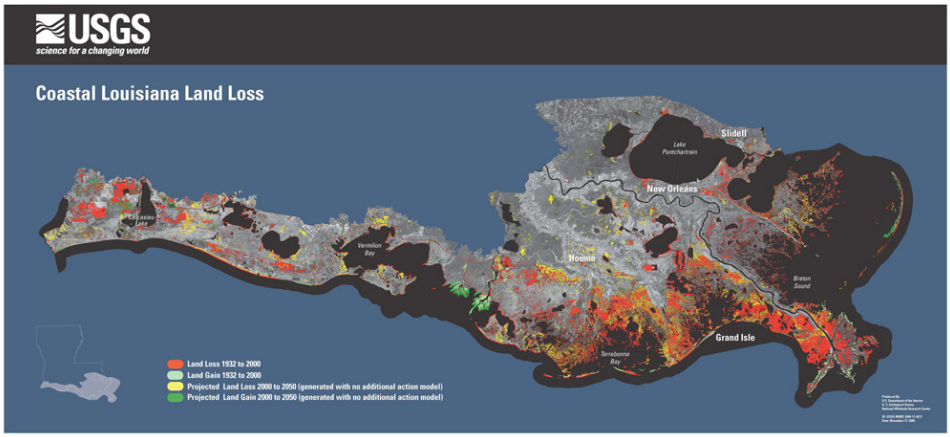
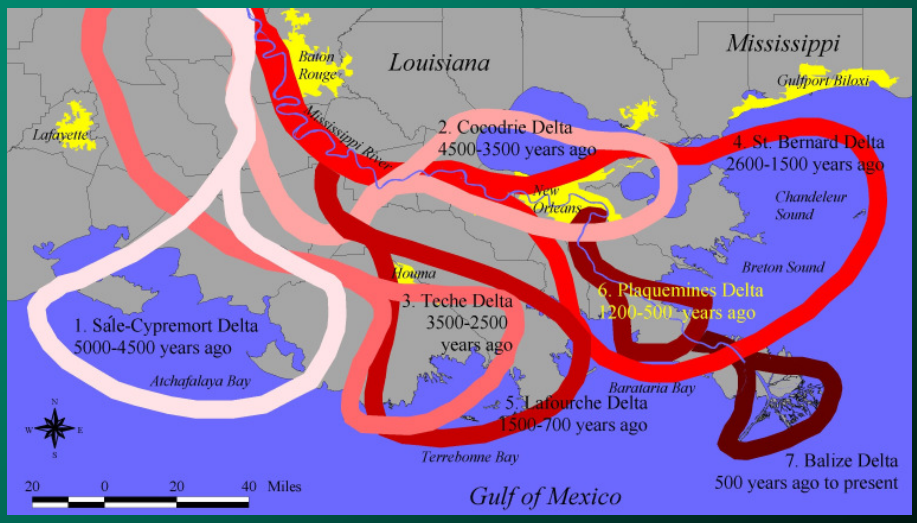
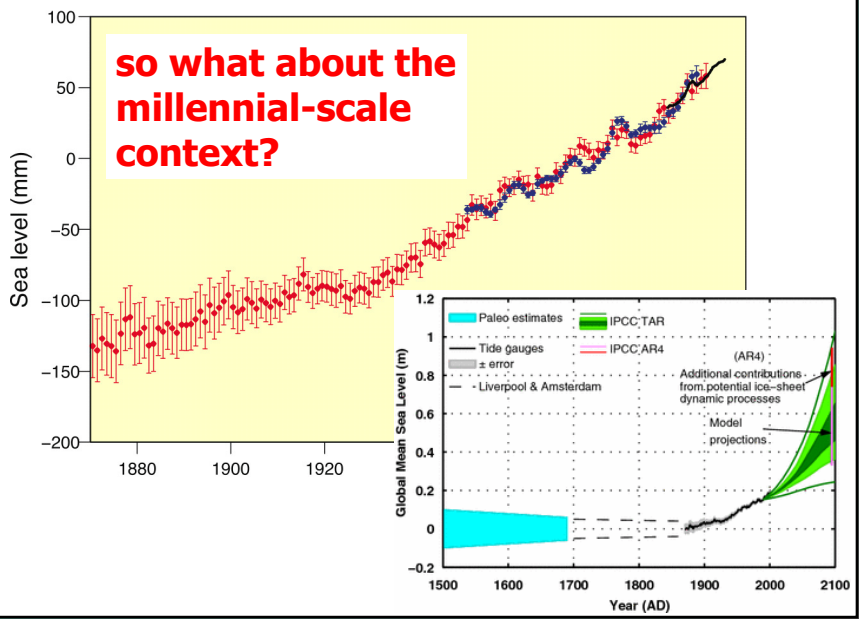
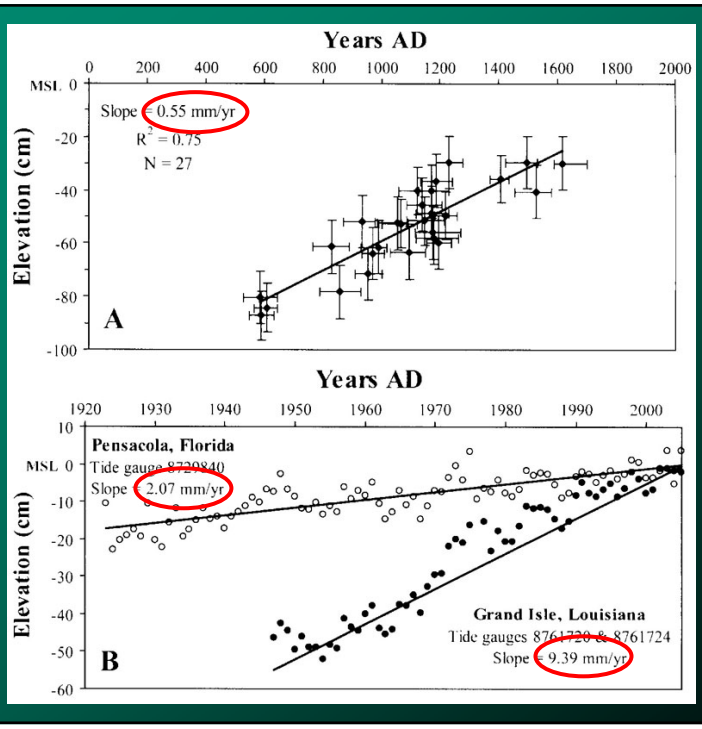
Tulane University



Composite Recent Deltas



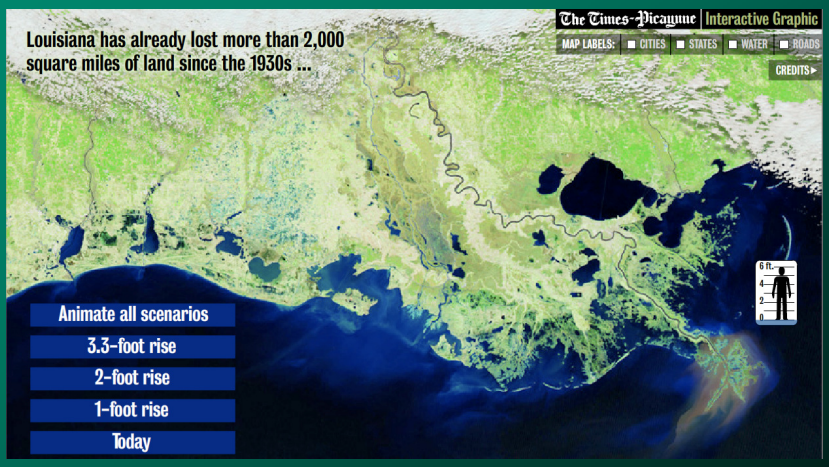




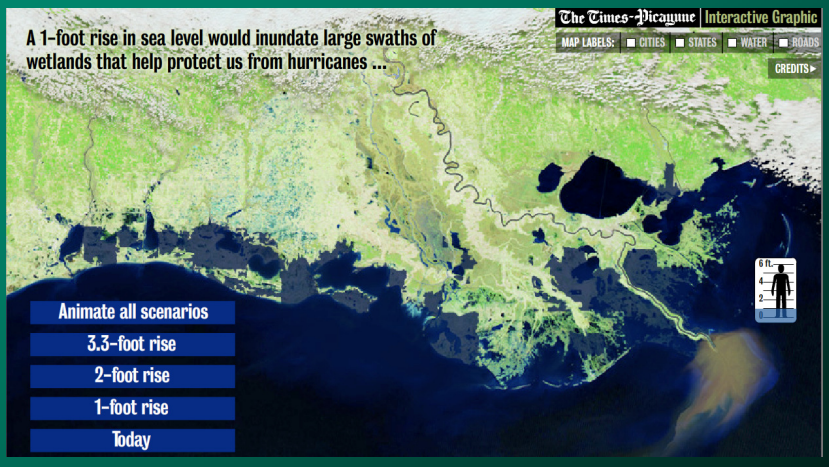
Deltaic subsidence as a 4-dimensional problem…

- Subsidence rates vary in **space**, potentially over very short distances (e.g., tens of meters)
- Subsidence rates vary as a function of **depth**; the nature of this function can vary substantially across space (rates are always highest at the surface!)
- Subsidence rates can vary through **time**, depending on the driving processes

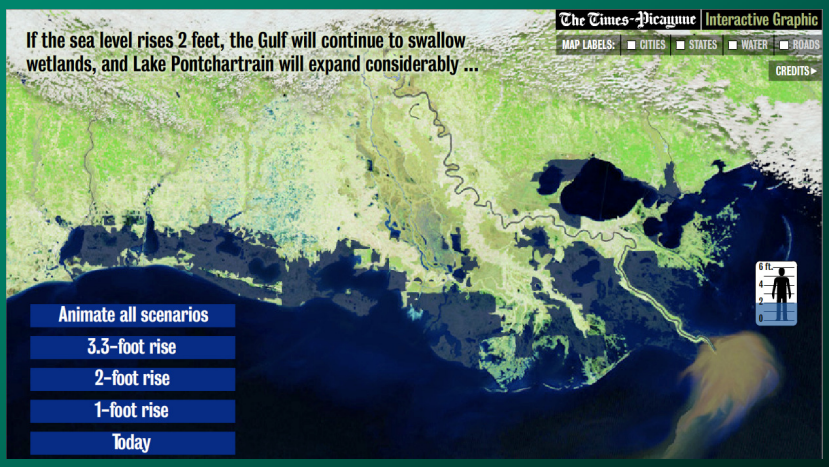
Coastal Louisiana Land Water Interface - Today



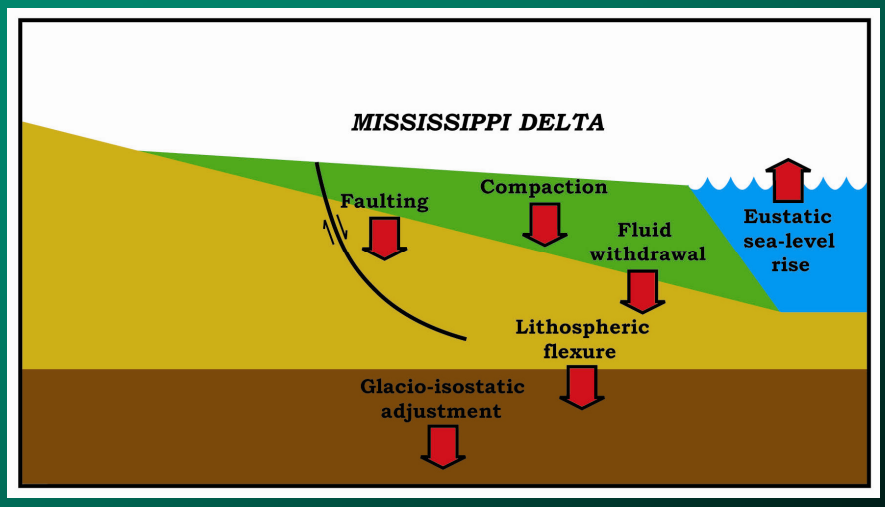
Coastal Louisiana Land Water Interface – 1 Foot Sea Level Rise

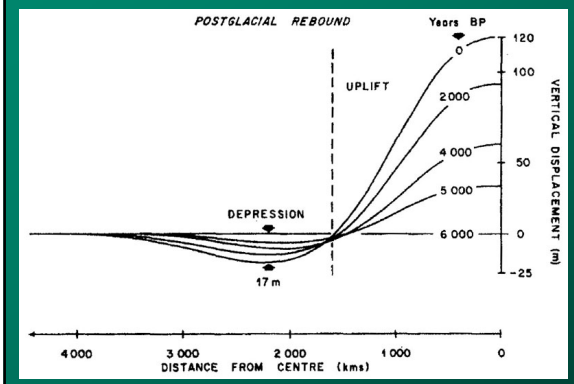


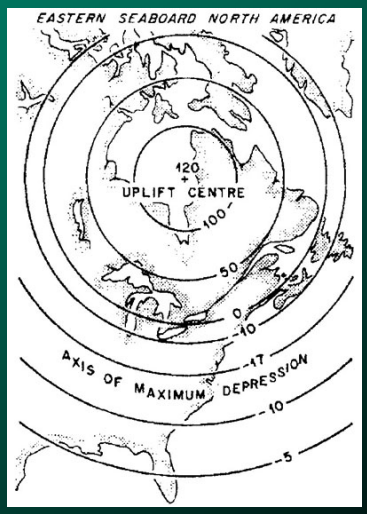
Coastal Louisiana Land Water Interface – 2 Foot Sea Level Rise



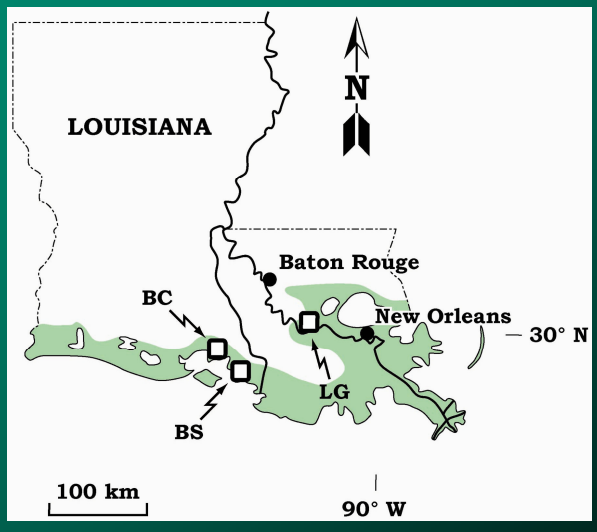
Coastal Louisiana Land Water Interface – 3 Foot Sea Level Rise

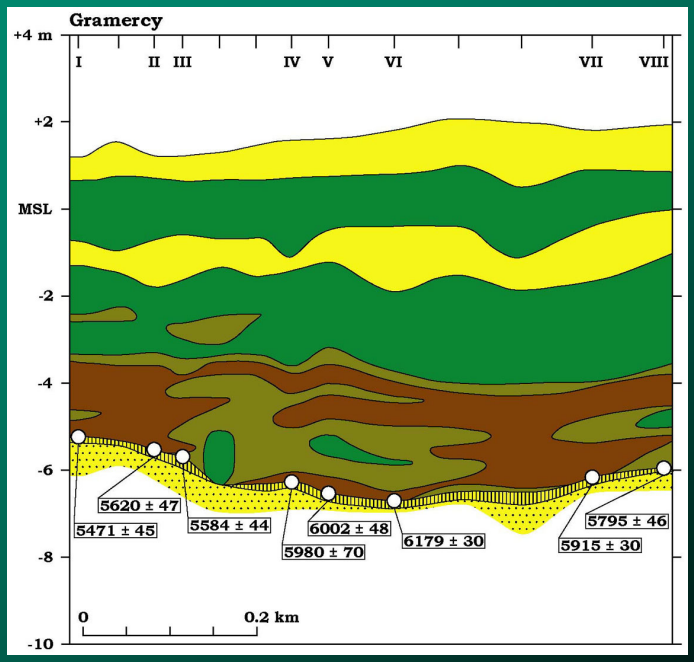


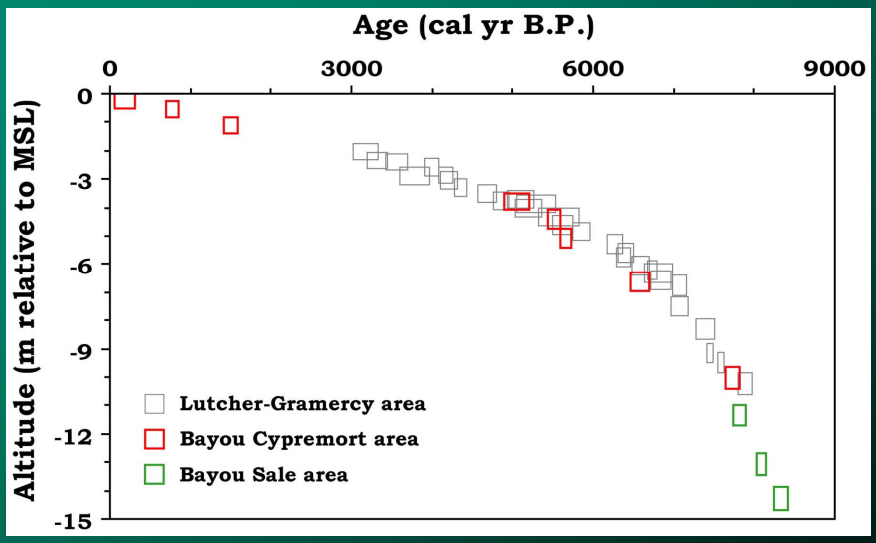


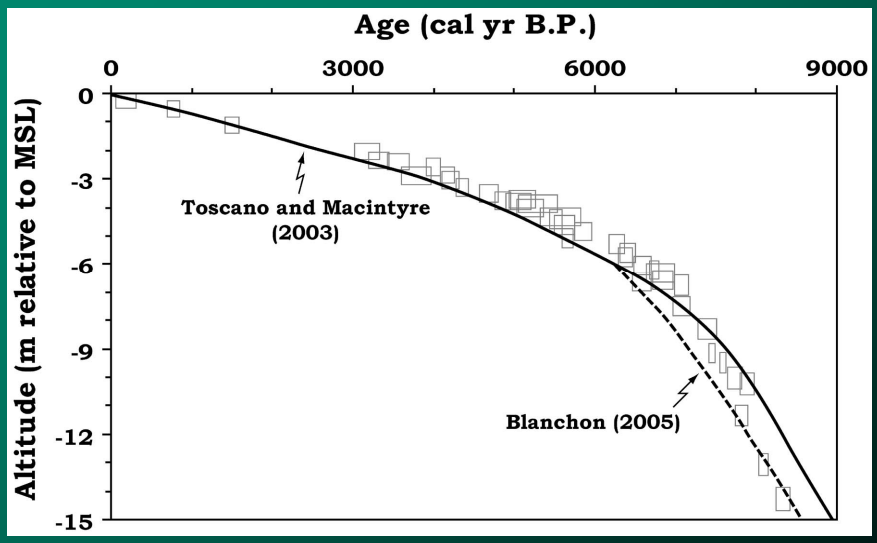


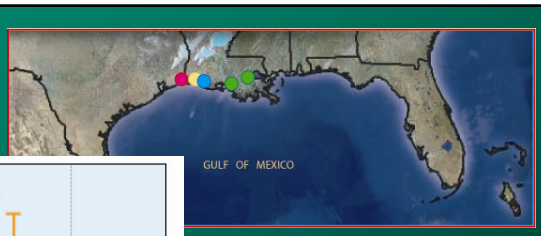
Walcott (1972)

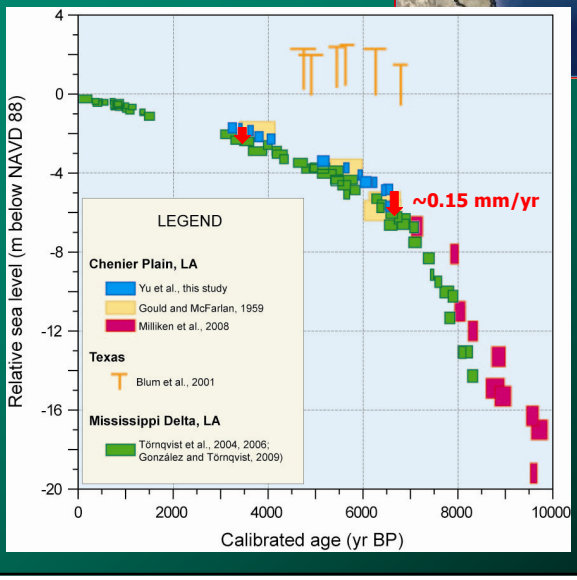

LOUISIANA
N
Baton Rouge
BC
New Orleans
30° N
LG
BS
100 km
90° W

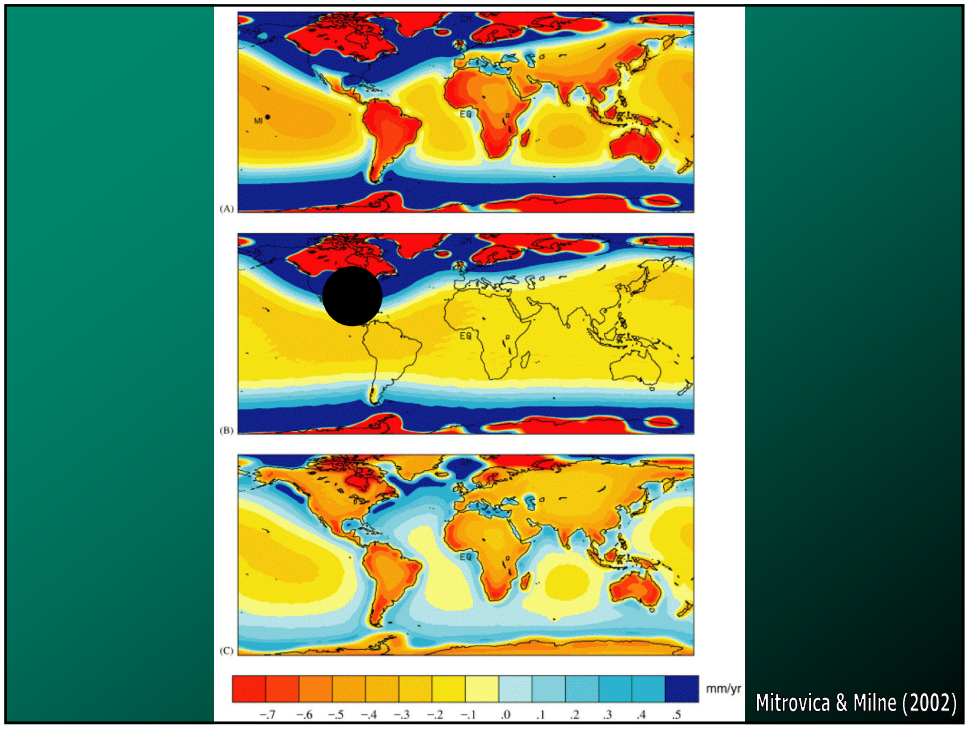

Gramercy
+4 m
+2
MSL
-2
-4
-6
-8
-10
I
II
III
IV
V
VI
VII
VIII
5620 ± 47
5471 ± 45
5584 ± 44
5980 ± 70
6002 ± 48
6179 ± 30
5795 ± 46
5915 ± 30
0
0.2 km

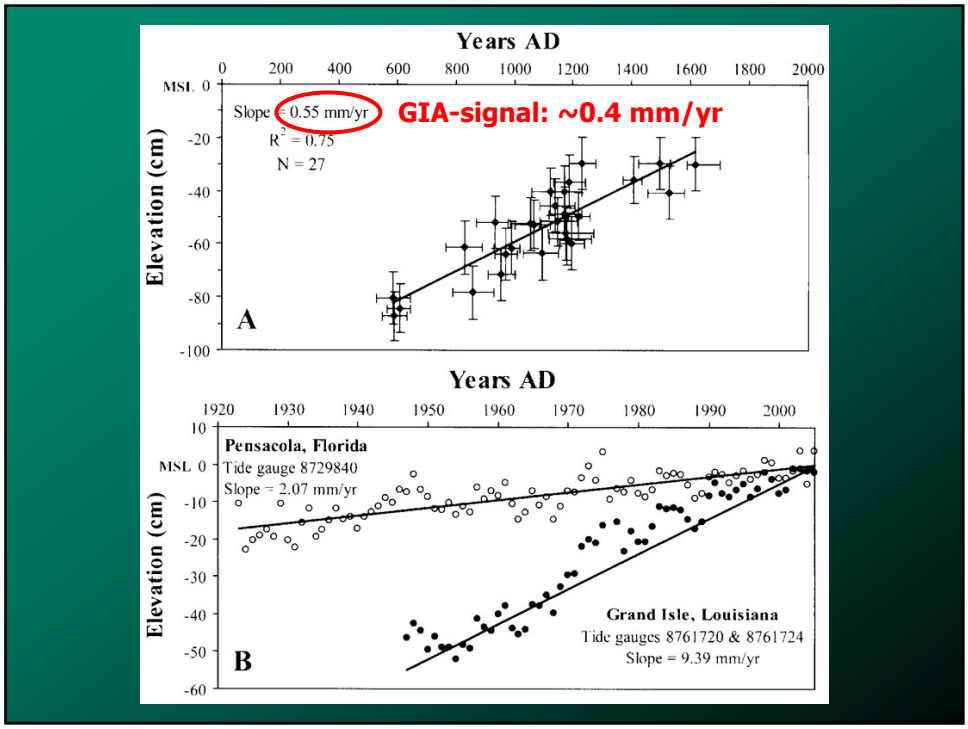

Age (cal yr B.P.)
0
3000
6000
9000
0
-3
-6
-9
-12
-15
Altitude (m relative to MSL)
Lutcher-Gramercy area
Bayou Cypremort area
Bayou Sale area

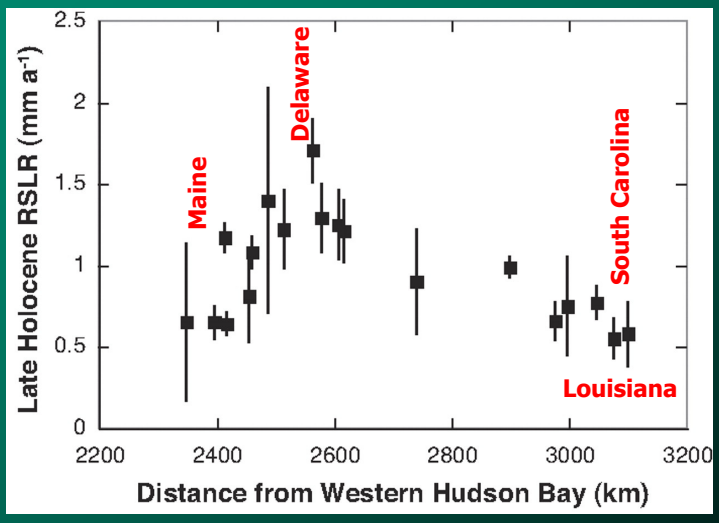

Age (cal yr B.P.)
0
3000
6000
9000
Altitude (m relative to MSL)
0
-3
-6
-9
-12
-15
Toscano and Macintyre
(2003)
Blanchon (2005)


GULF OF MEXICO

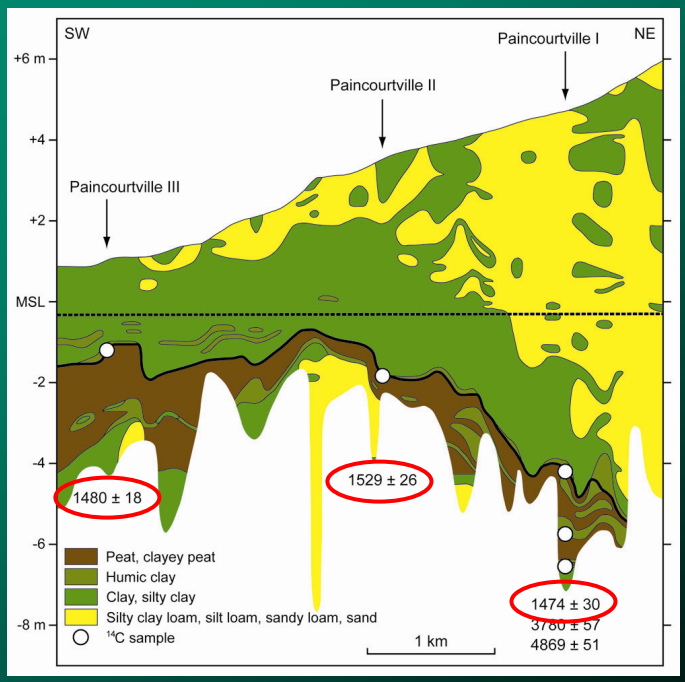

Relative sea level (m below NAVD 88)
4
0
-4
-8
-12
-16
-20
0
2000
4000
6000
8000
10000
Calibrated age (yr BP)
~0.15 mm/yr
LEGEND
Chenier Plain, LA
Yu et al., this study
Gould and McFarlan, 1959
Milliken et al., 2008
Texas
Blum et al., 2001
Mississippi Delta, LA
Törnqvist et al., 2004, 2006;
González and Törnqvist, 2009)

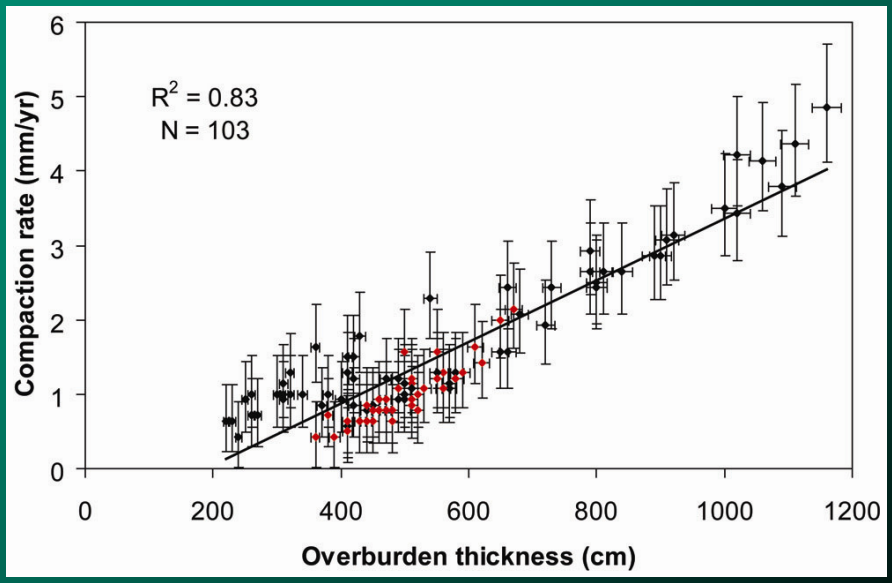

(A)
(B)
(C)
EQ
mm/yr
−.7 −.6 −.5 −.4 −.3 −.2 −.1 .0 .1 .2 .3 .4 .5
Mitrovica & Milne (2002)


Years AD
0 200 400 600 800 1000 1200 1400 1600 1800 2000
MSL 0
-20
-40
-60
-80
-100
Elevation (cm)
Slope = 0.55 mm/yr
R² = 0.75
N = 27
GIA-signal: ~0.4 mm/yr
A
Years AD
1920 1930 1940 1950 1960 1970 1980 1990 2000
10
MSL 0
-10
-20
-30
-40
-50
-60
Elevation (cm)
Pensacola, Florida
Tide gauge 8729840
Slope = 2.07 mm/yr
Grand Isle, Louisiana
Tide gauges 8761720 & 8761724
Slope = 9.39 mm/yr
B



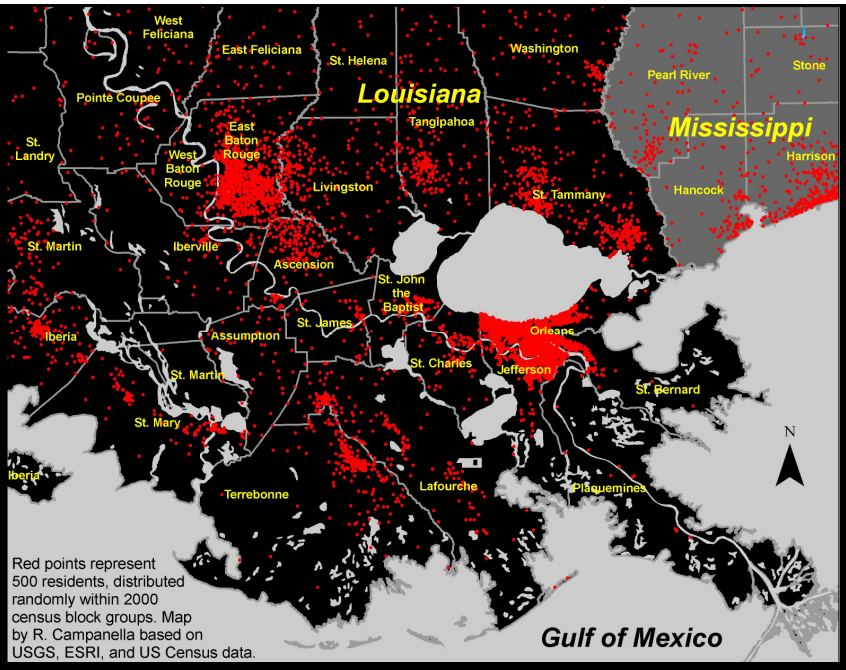
Engelhart et al. (2009)



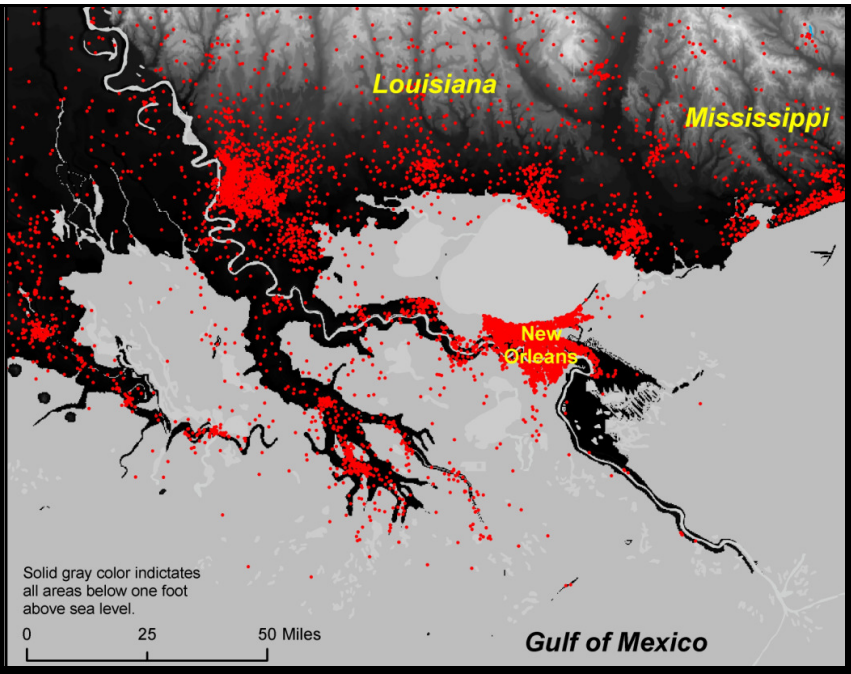


Conclusions…

- The effect of deltaic sediment loading leads to subsidence rates in the Mississippi Delta of ~0.15 mm yr^{-1} relative to the Chenier Plain
- The common, long-term process that drives lithospheric subsidence throughout the Gulf of Mexico is glacial isostatic adjustment (~0.4 mm yr^{-1})
- Compaction contributes at least an order of magnitude more to subsidence than deeper lithospheric processes (~1.5 - 5 mm yr^{-1})
- Accelerated sea-level rise is becoming an increasingly more important threat; the West Antarctic Ice Sheet is a particular concern for the US Gulf Coast



From **Campanella, R**. *Geographies of New Orleans: Urban Fabrics Before the Storm*. Center for Louisiana Studies, University of Louisiana at Lafayette, August 2006.



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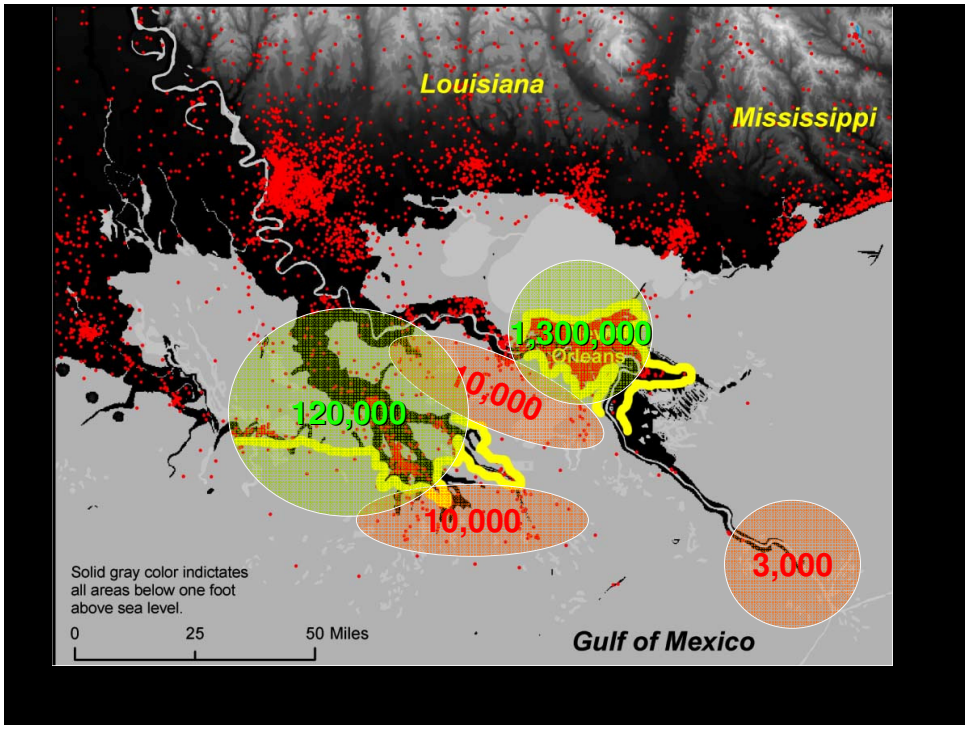

Conclusions (cont'd)...

- More investments in non-structural measures are critical.
  - •20-30,000 likely to be relocated in the next 10 years.
  - •120,000 perhaps to be relocated in the next 50 years.
  - •re-examine "permanent" vs. temporary buildings in rural coastal areas.

- Urban systems are resilient when their contextual natural environments are resilient.

Photo credit: Keith Pezzoli

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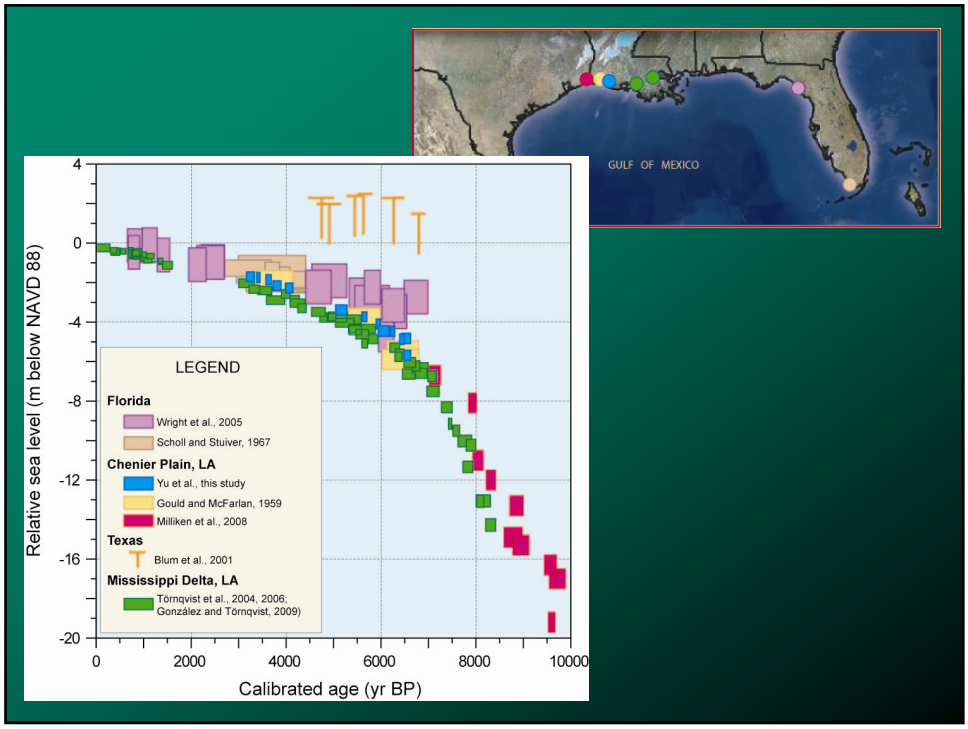
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