A New Subsidence Curve for Northern Gulf of Mexico Tide Gauges and Its Implications For Coastal Restoration

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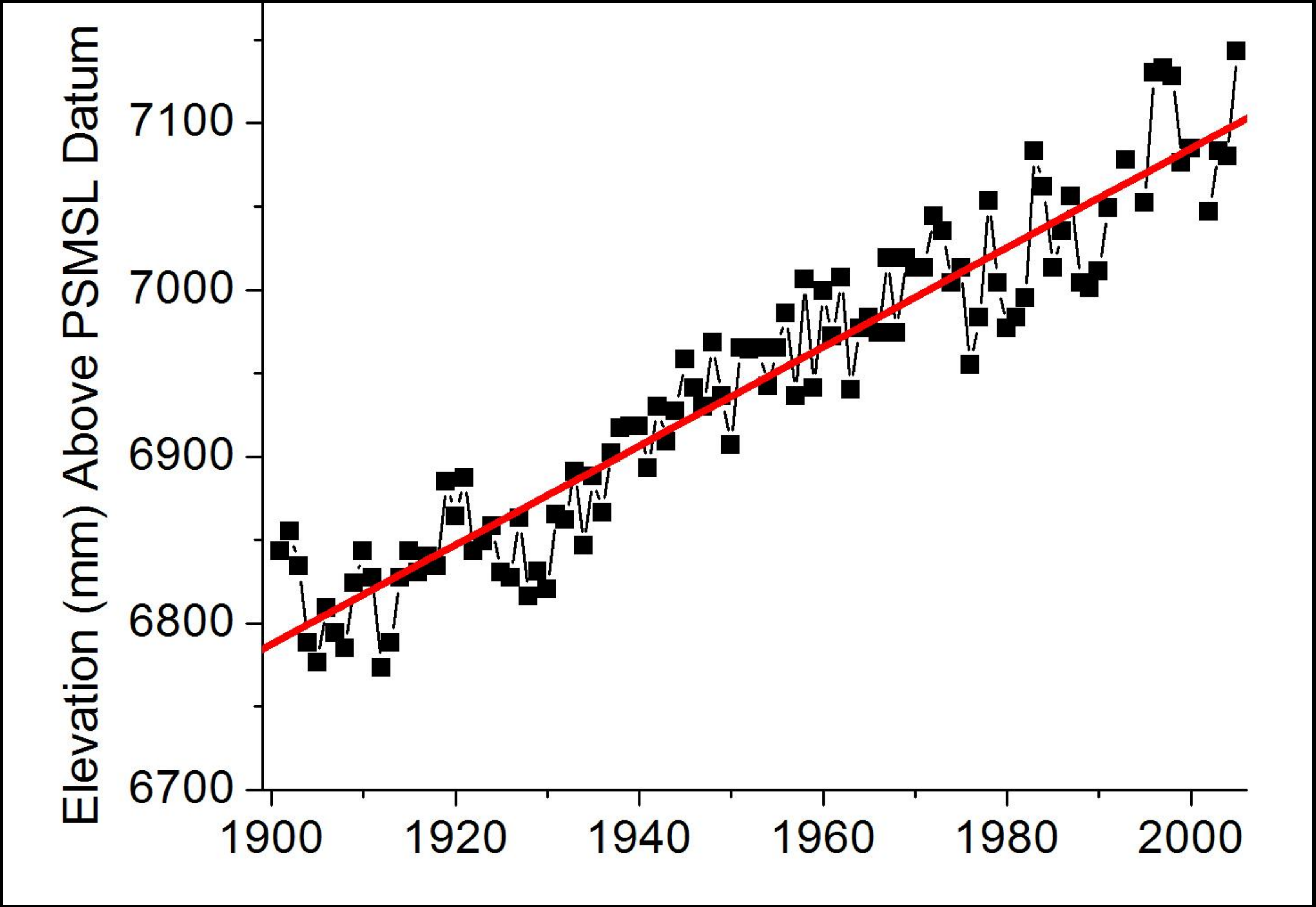
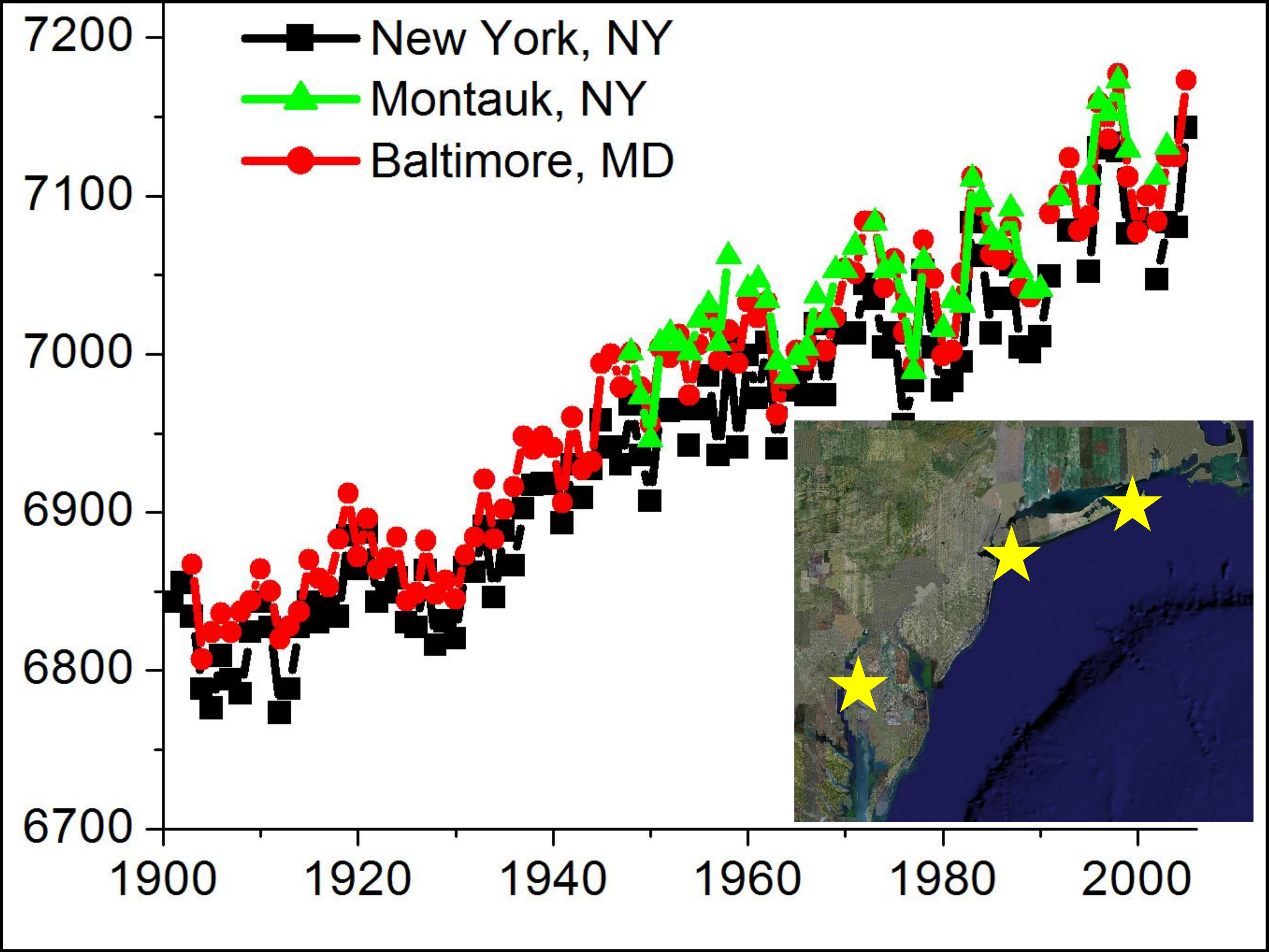
Variability and trends in the New York tide gauge



Rate of Relative Sea Level Rise = 2.8 mm yr^{-1},
Variability = 10-100 mm yr^{-1}

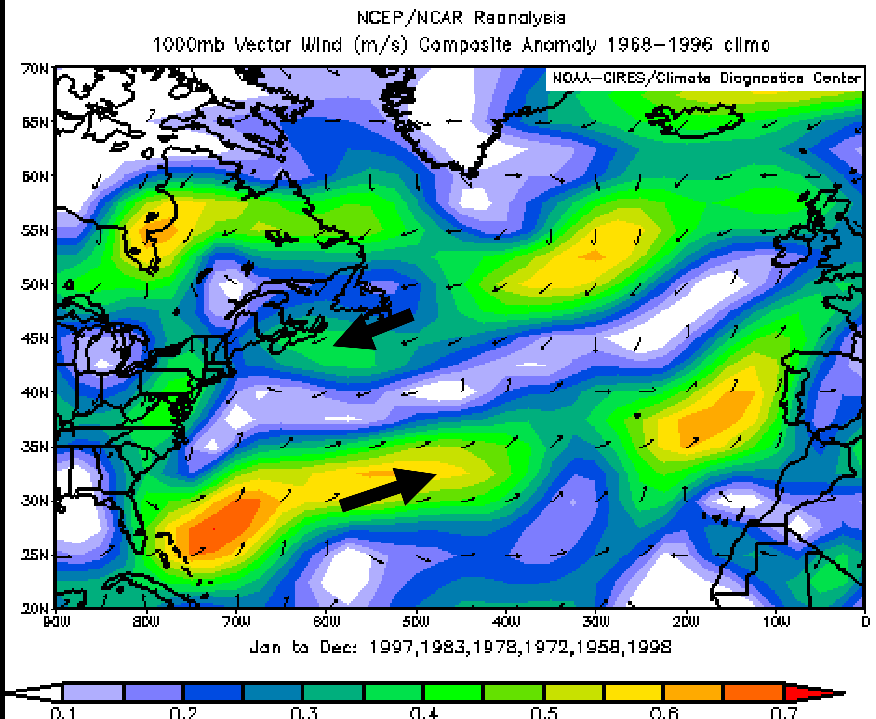
Sea Level Variability is Coherent Across Spatial Scales of 100s - 1000s km

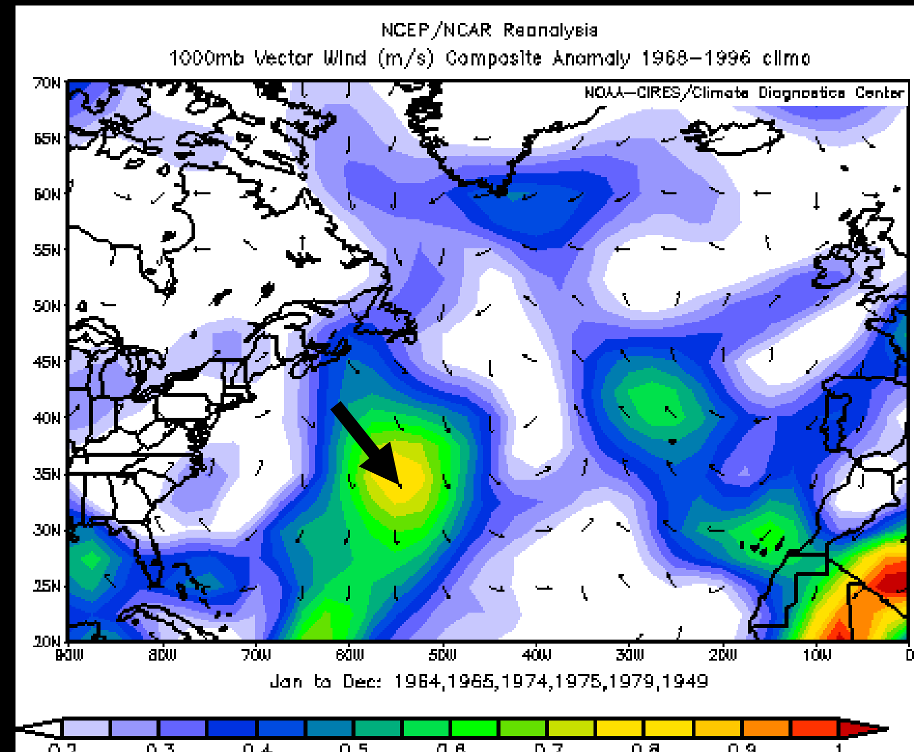


Kolker et al., (2009)

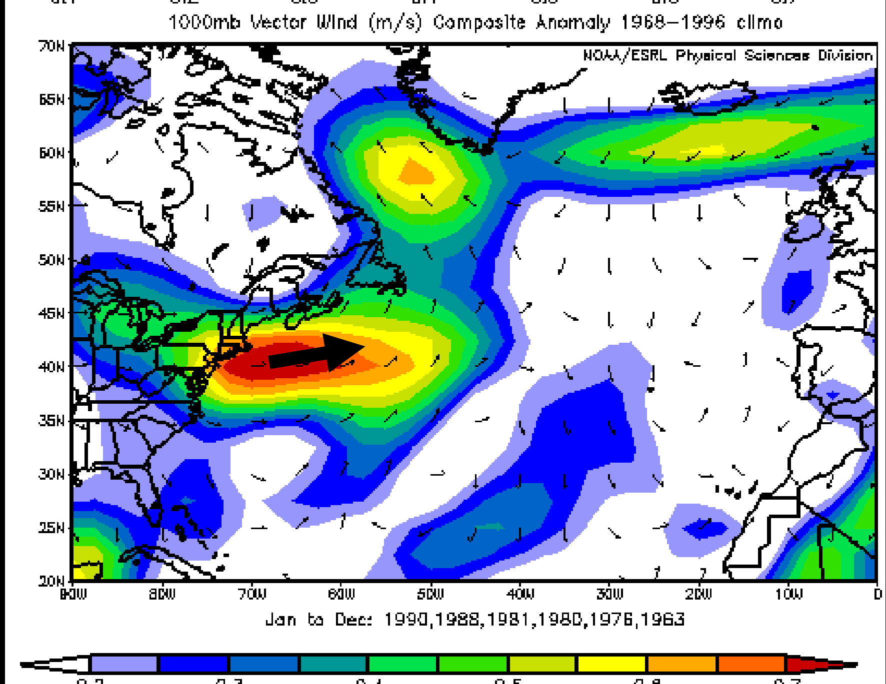
Wind anomalies when New York sea level is.....

High





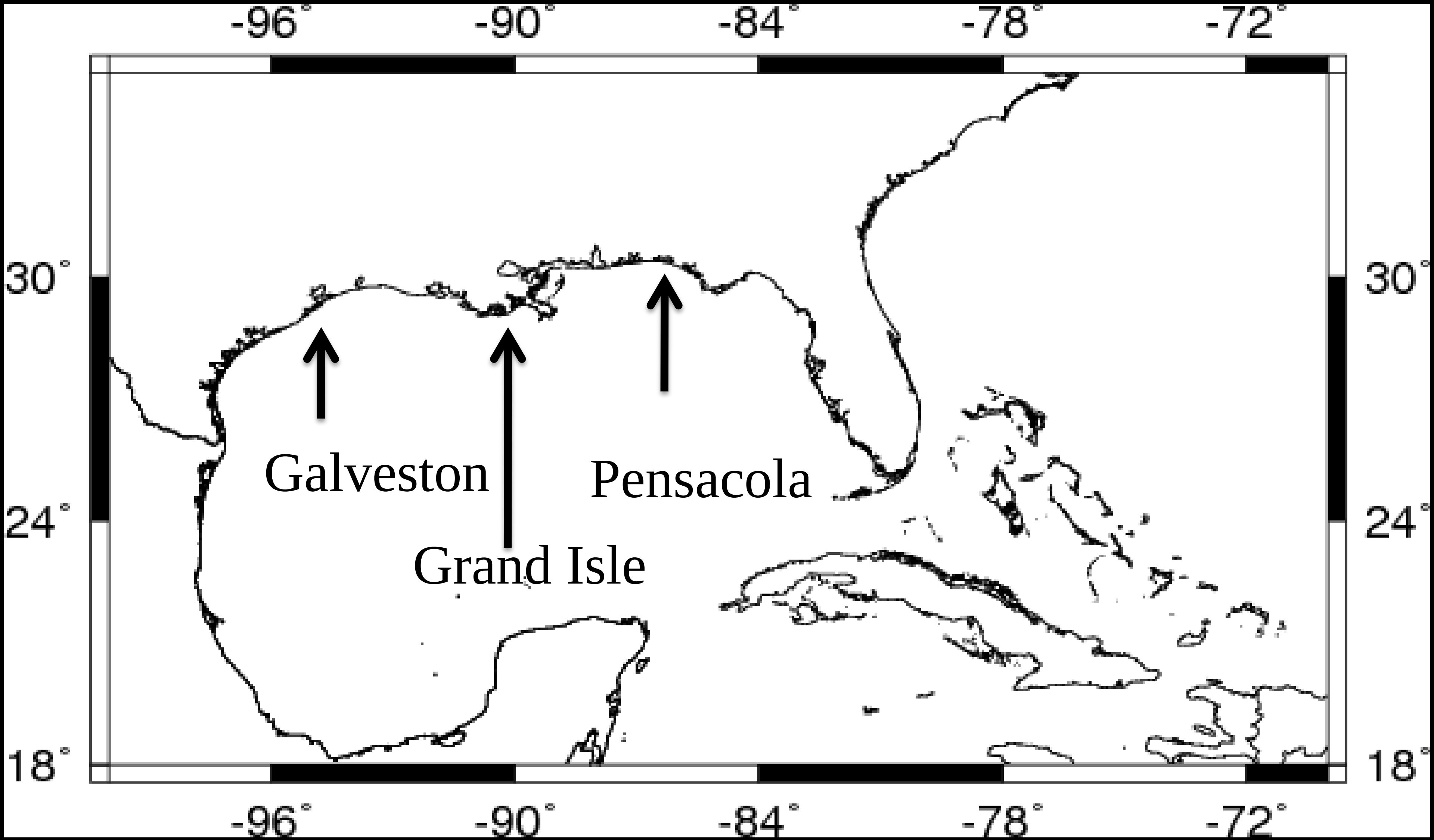
Average



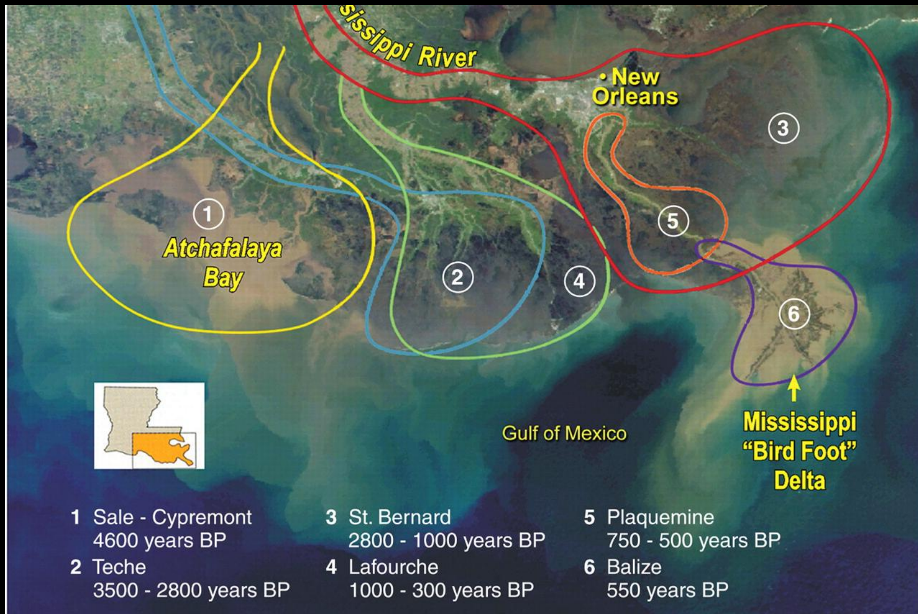
Low

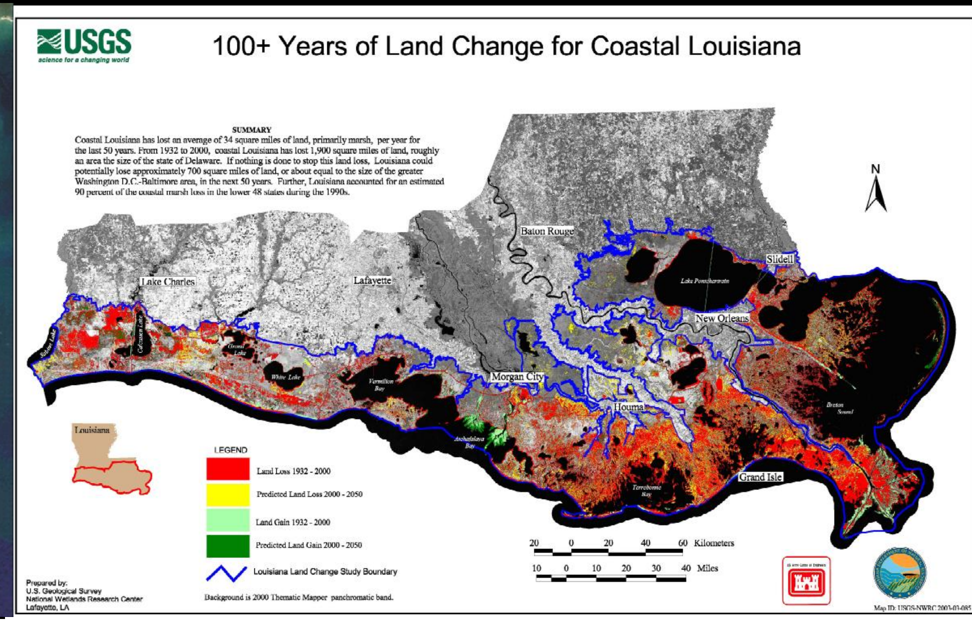
Kolker et al., (2009);
Image Source: NCEP/NCAR

Can we apply our knowledge of dynamically-driven sea level changes to the northern Gulf of Mexico?



Of the numerous drivers of wetland loss in south Louisiana, subsidence and reduced sediment loads are among the most important.





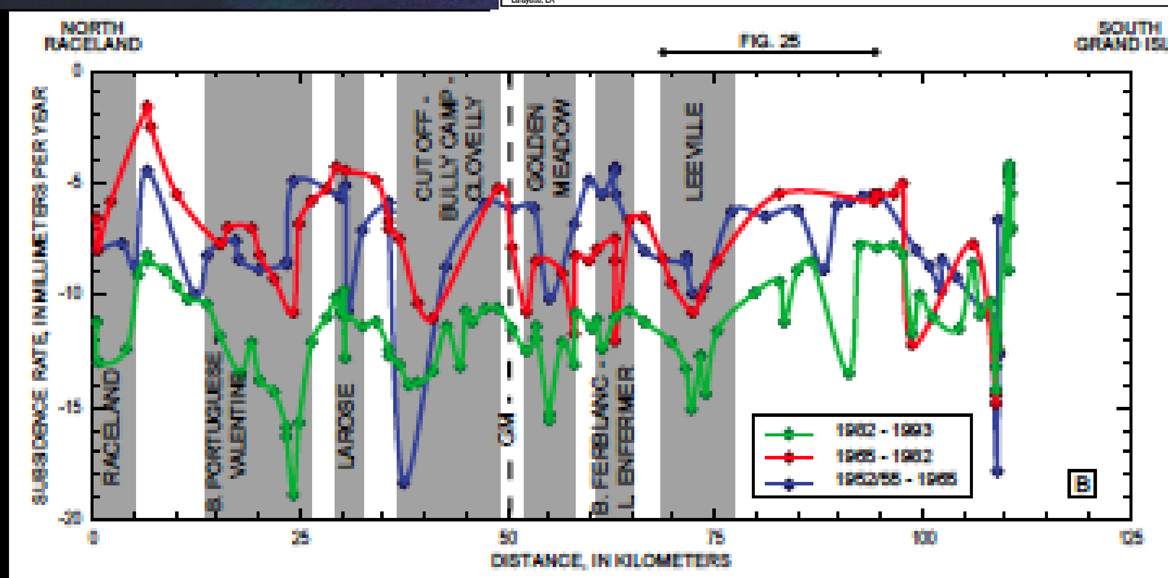
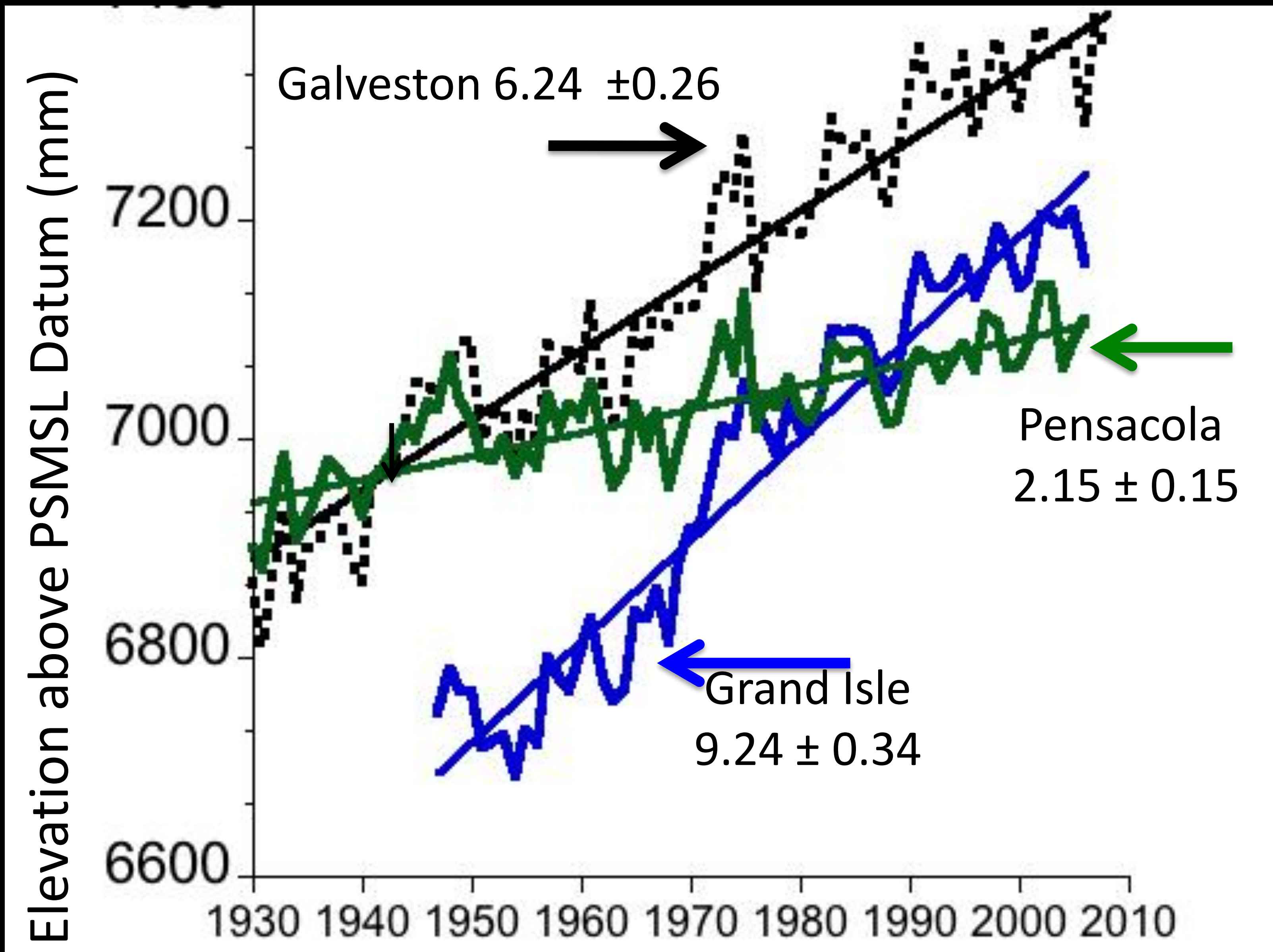
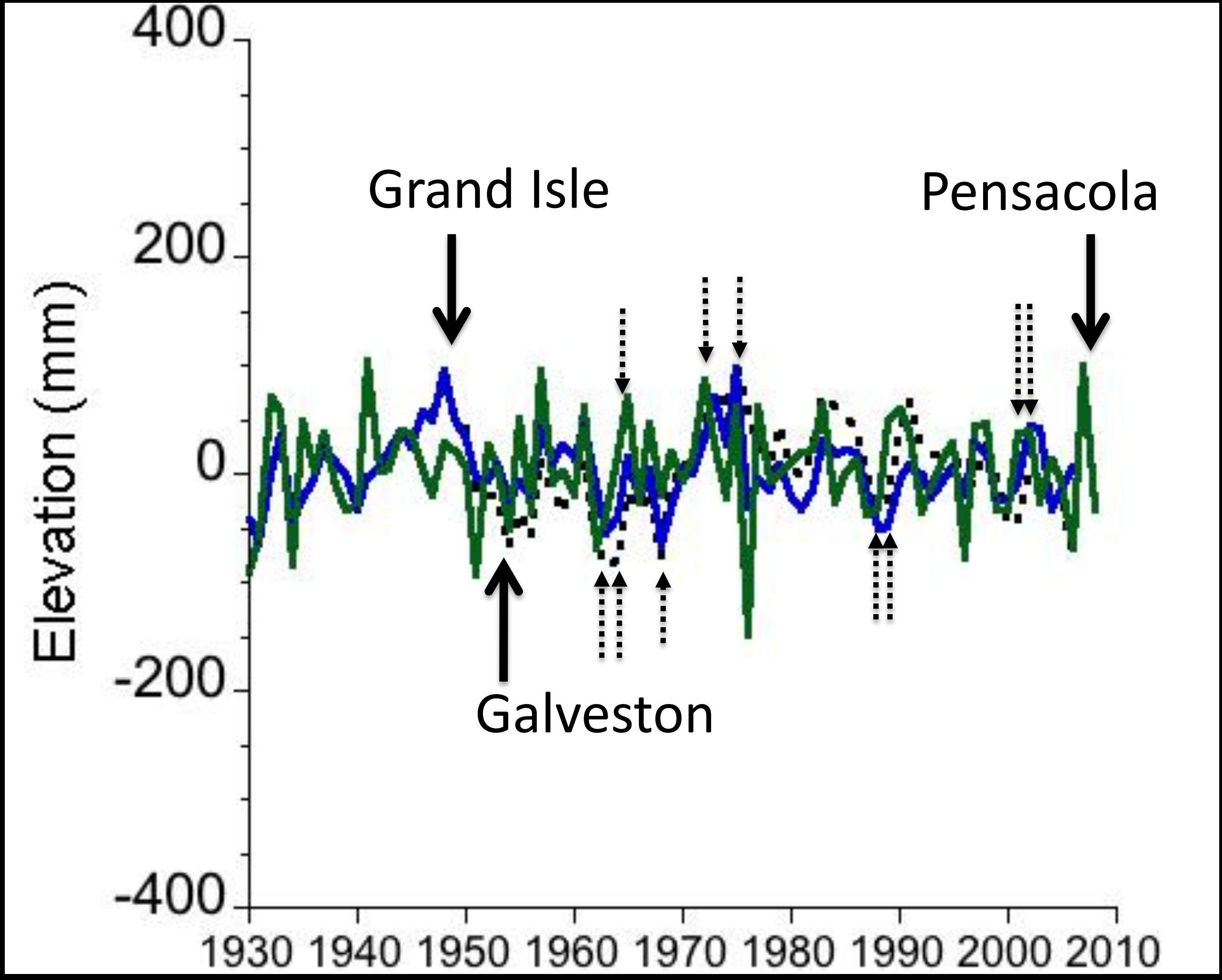


Image Sources: Top Left: Day et al., (2007), Top Right: USACE, USGS and others, Bottom: Morton et al., (2009)

Long Term Rates of Relative Sea Level Rise (mm yr^{-1}) at Three Northern Gulf of Mexico Tide Gauges

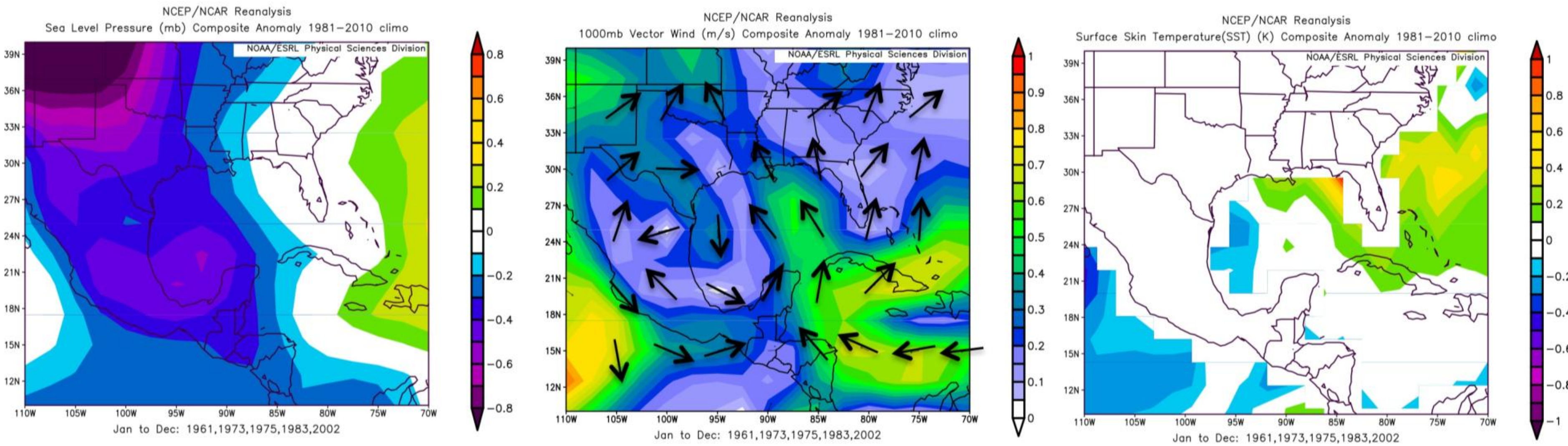


The detrended sea-level record was used to determine years of anomalously high and low sea level.

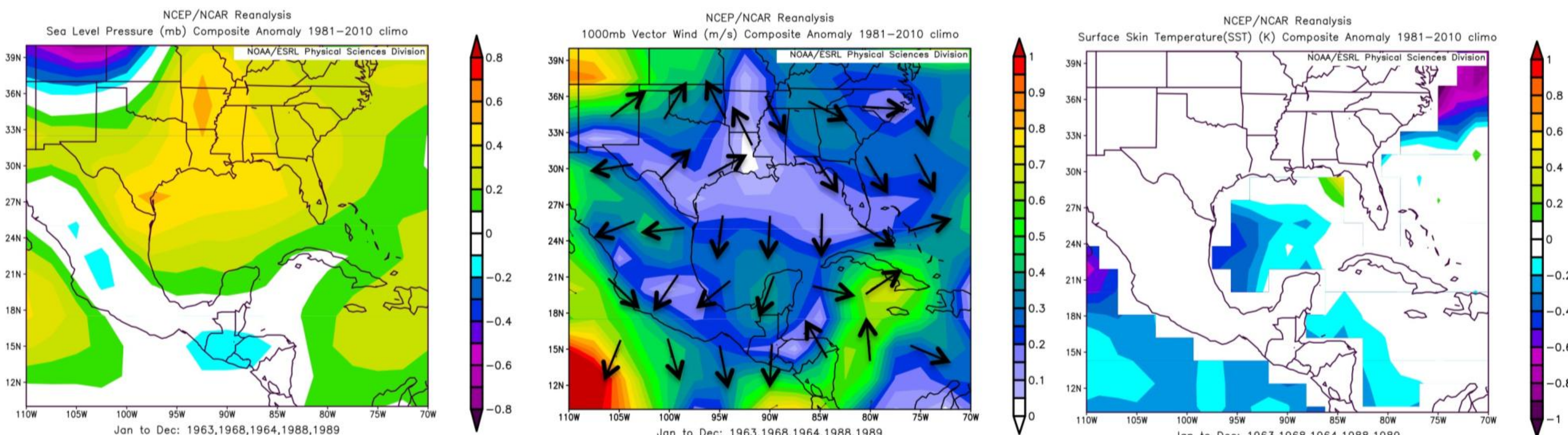


Pressure, Wind and Sea Surface Temperature Anomalies

Years With High Detrended Sea Level At Pensacola



Years With Low Detrended Sea Level At Pensacola



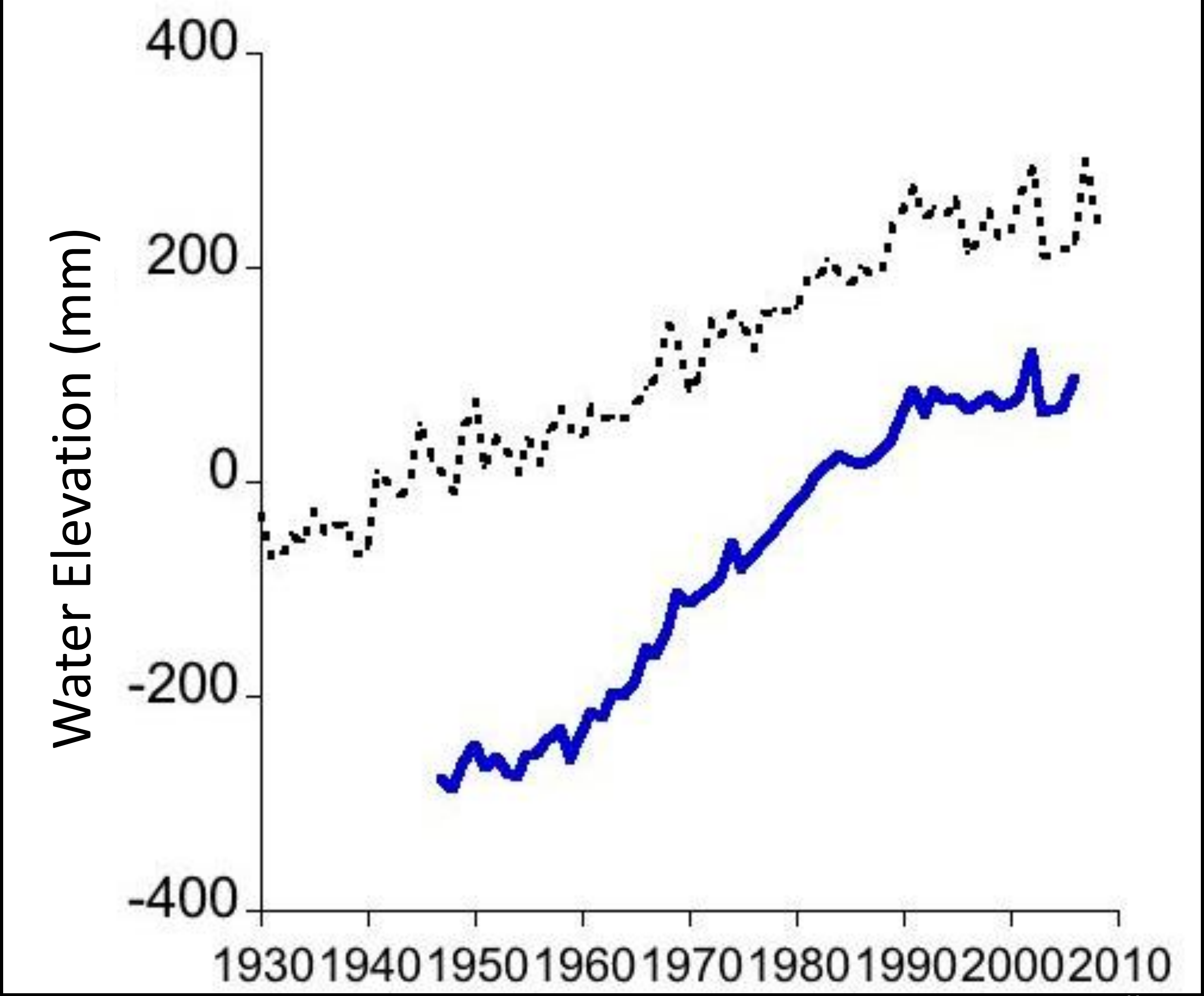
Source: Kolker et al., (2011) and NCEP/NCAR

Transforming a Relative Sea-Level Rise Record into a Subsidence Record

If we are correct that the inter-annual variability observed results from the meteorological factors presented then we can remove the correlated inter-annual variability and isolate subsidence rates at each gauge by subtracting the stable Pensacola record from the Grand Isle and Galveston gauges.

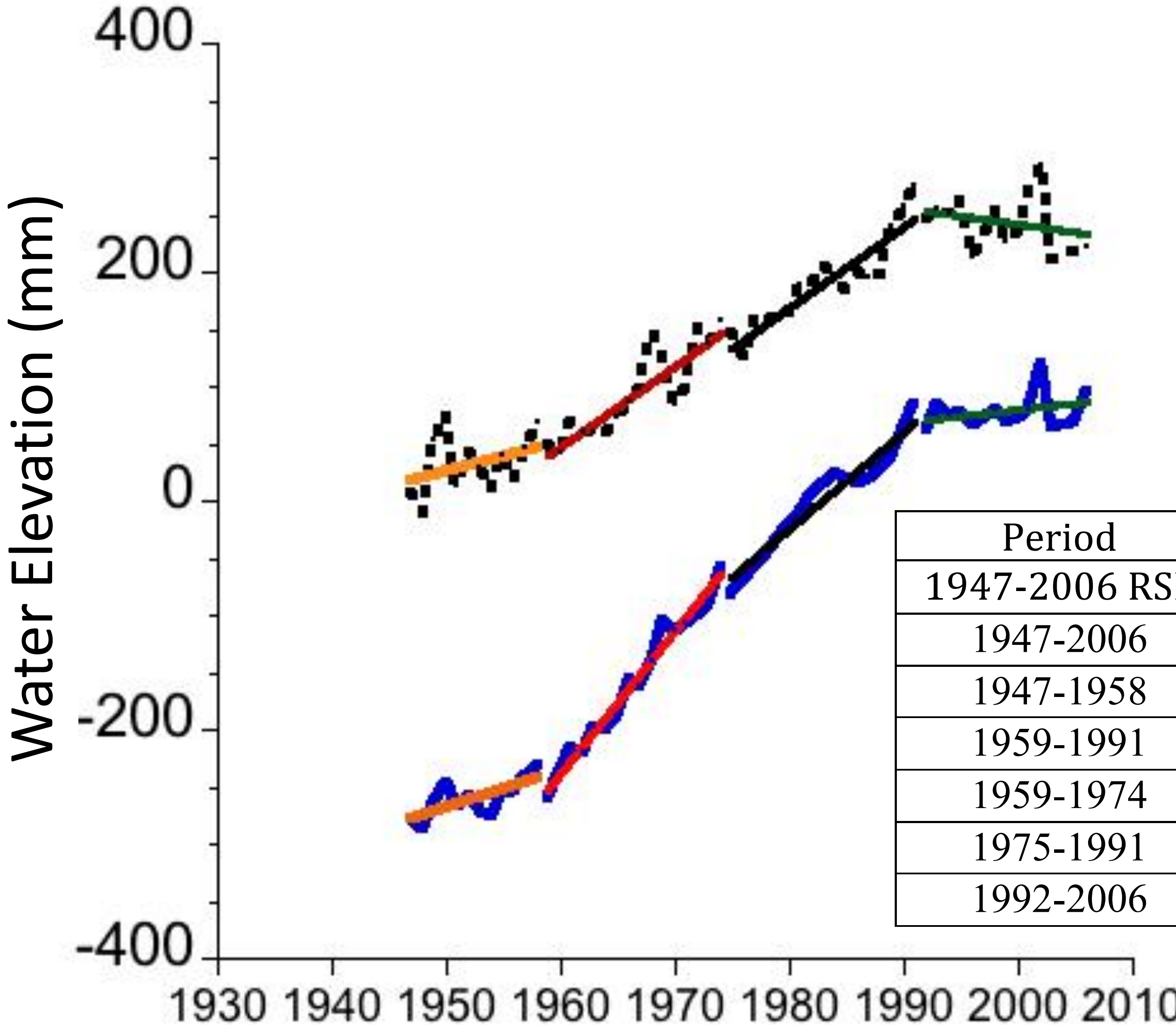
Source: Kolker et al., (2011)

Inferred Subsidence Curves for Grand Isle and Galveston



Source: Kolker et al., (2011)

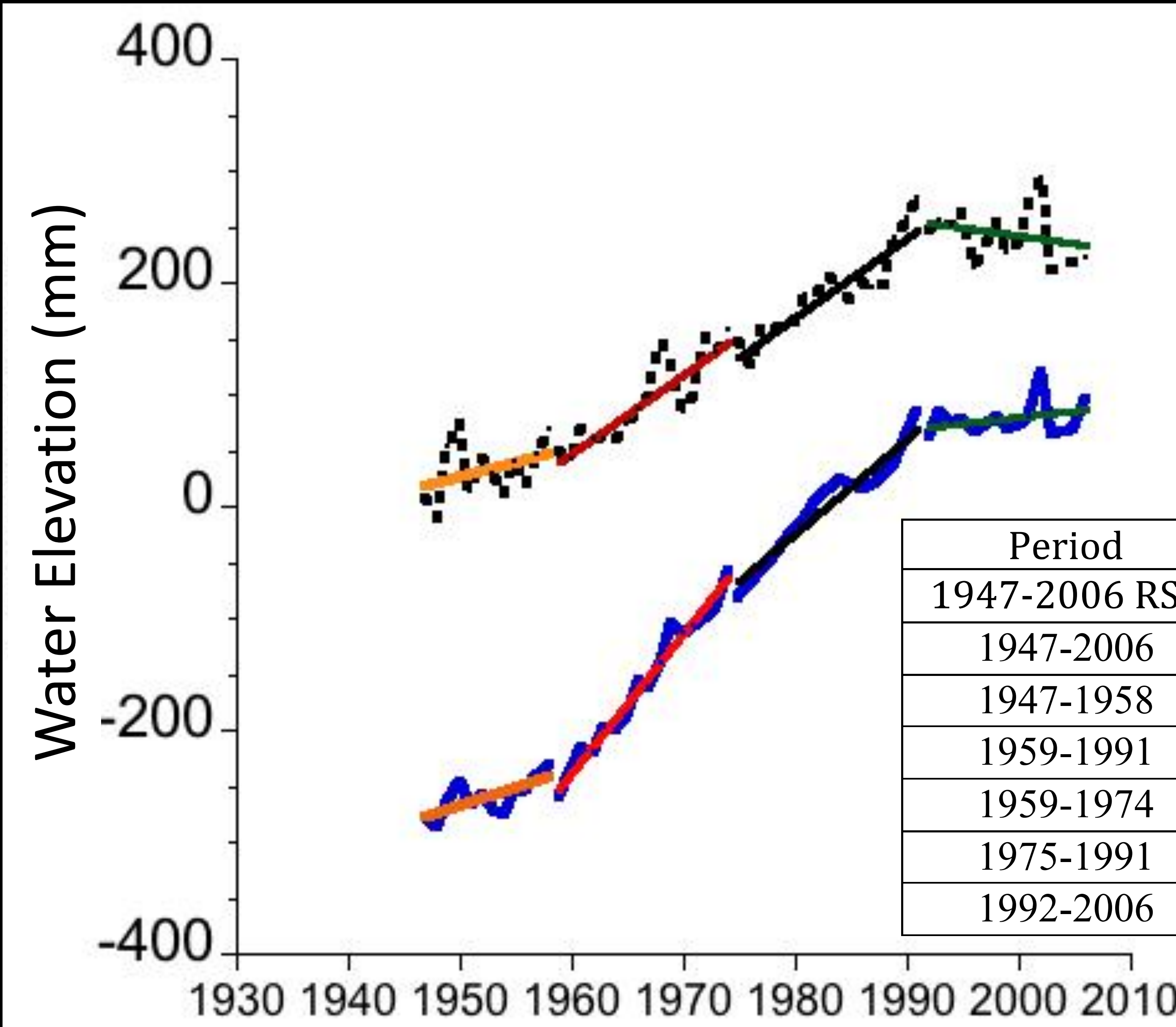
Inferred Subsidence Curves for Grand Isle and Galveston



Period	Grand Isle
1947-2006 RSL	9.27 ± 0.34
1947-2006	7.59 ± 0.23
1947-1958	3.16 ± 1.00
1959-1991	9.82 ± 0.33
1959-1974	12.64 ± 0.69
1975-1991	8.59 ± 0.75
1992-2006	1.04 ± 0.97

Source: Kolker et al., (2011)

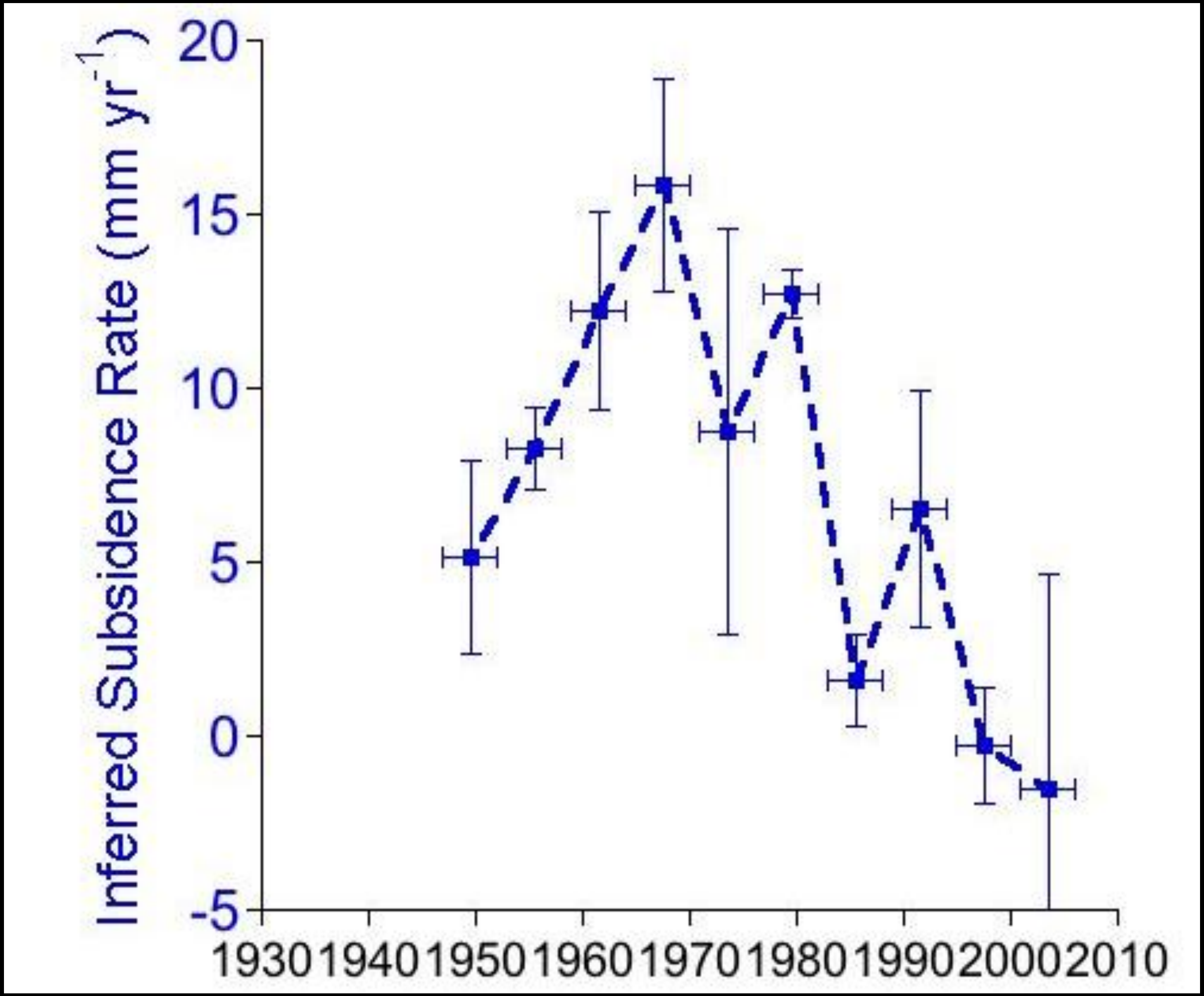
Inferred Subsidence Curves for Grand Isle and Galveston



Period	Galveston
1947-2006 RSL	6.24 ±0.26
1947-2006	4.722± 0.21
1947-1958	2.55 ±2.17
1959-1991	6.18 ±0.342
1959-1974	7.14 ±1.06
1975-1991	7.05 ± 0.87
1992-2006	-1.987 ± 1.41

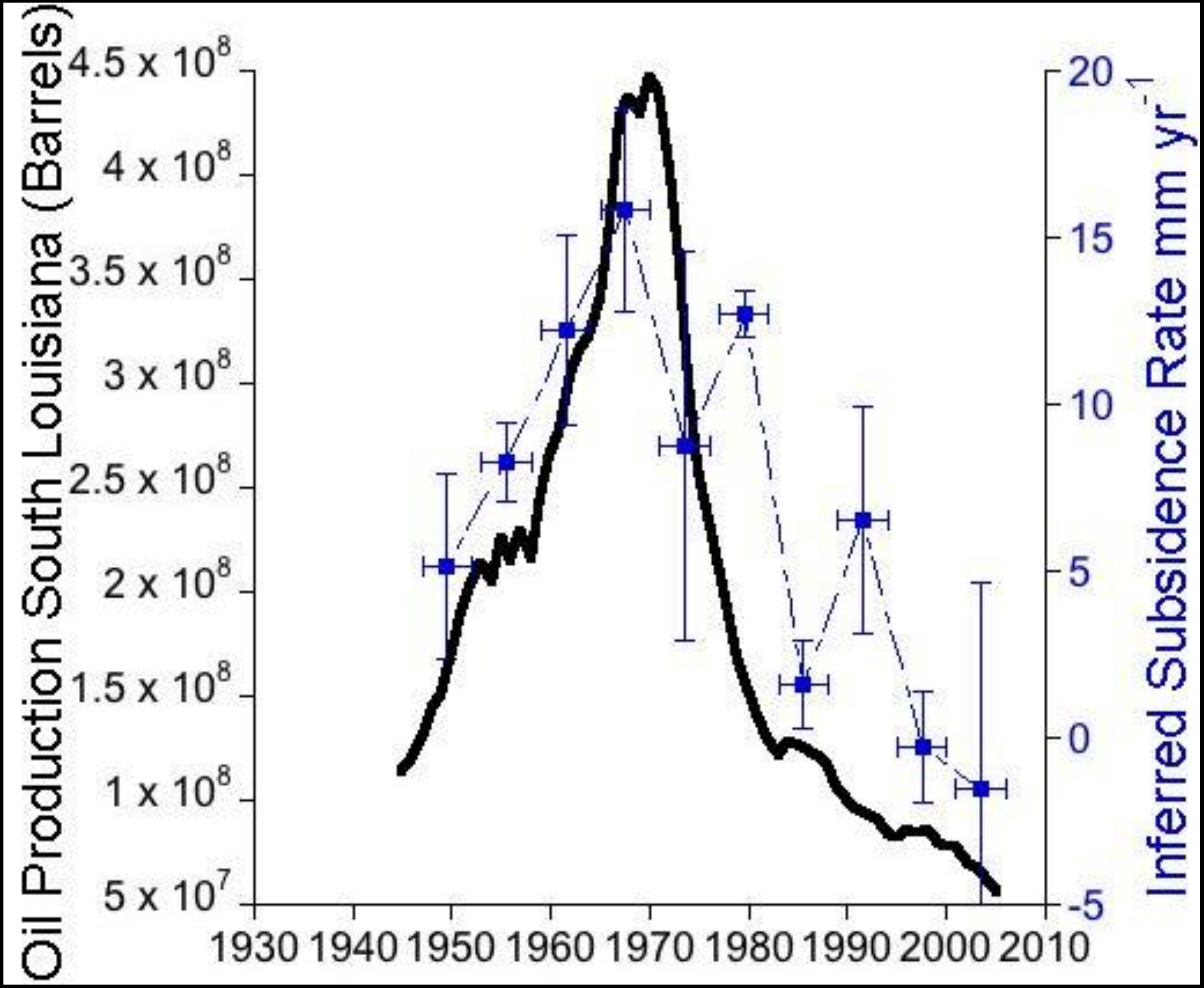
Source: Kolker et al., (2011)

Rates of subsidence were determined for 6 year intervals



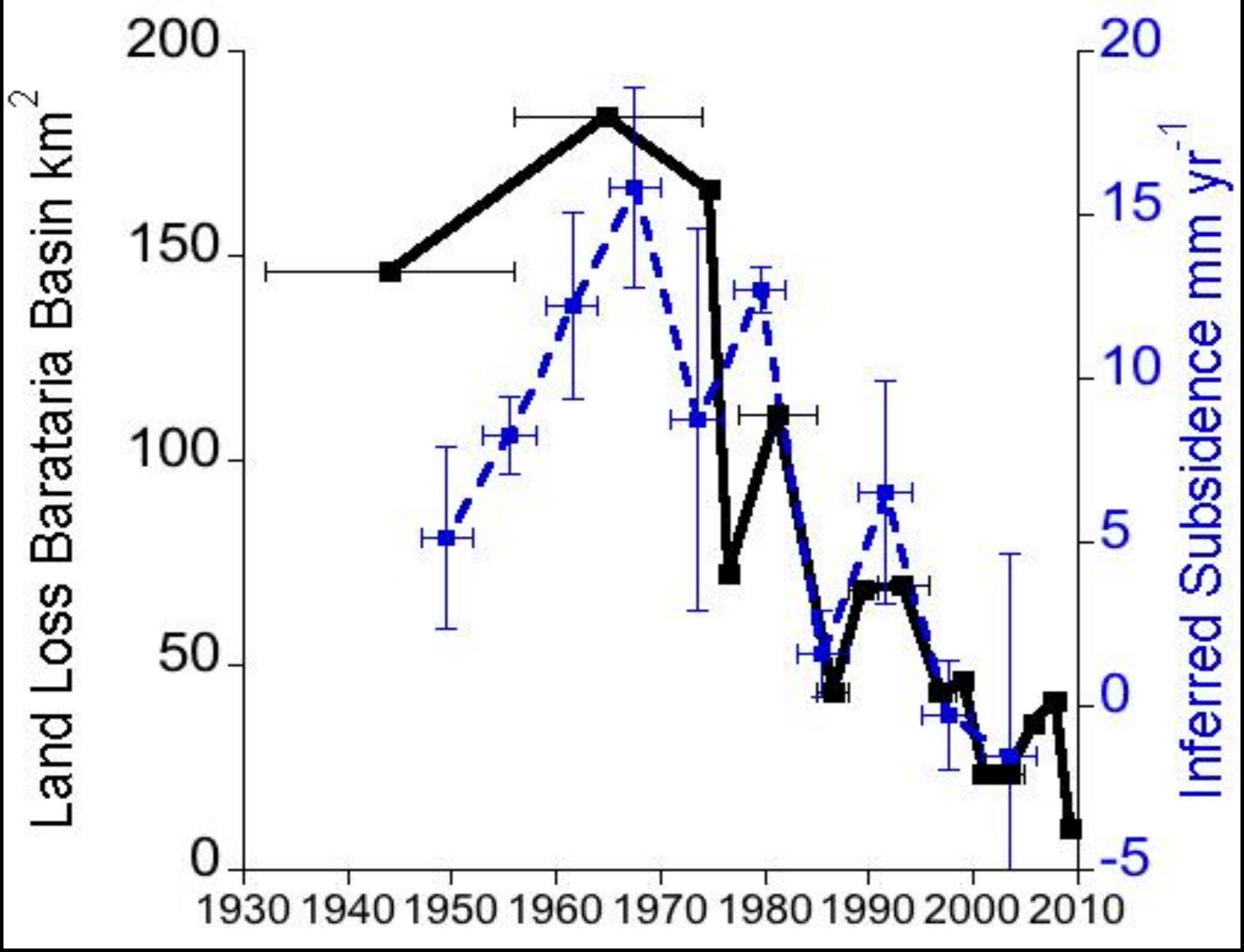
Source: Kolker et al., (2011)

One likely driver of subsidence is subsurface fluid withdrawal, which can decrease subsurface pressures, thereby altering grain-to-grain contacts in the sediments.



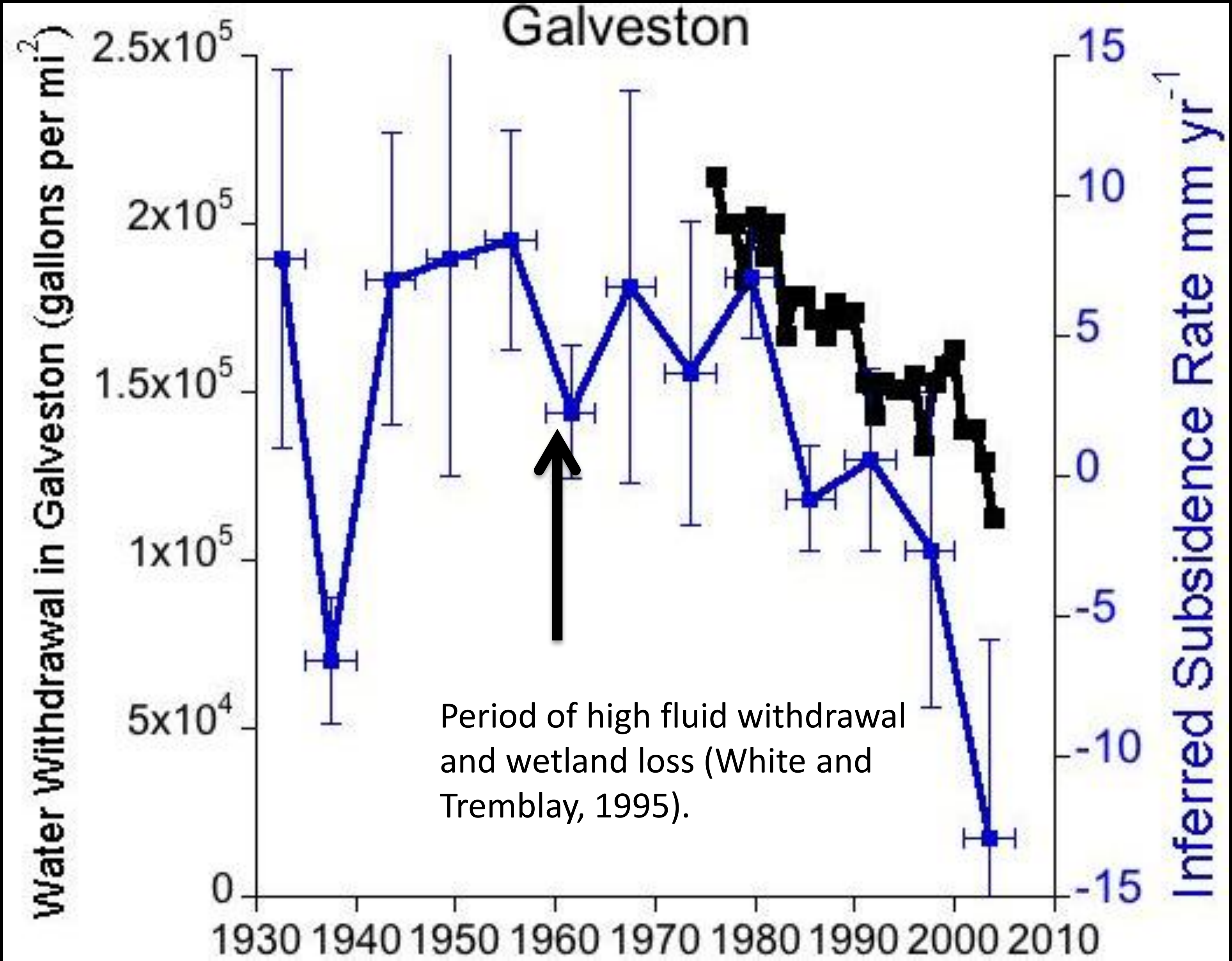
Source: Meckel (2008), Kolker et al., (2011)

Subsidence can drive wetland loss by increasing the rate of relative sea level rise, increasing the quantity of material needed for accretion.

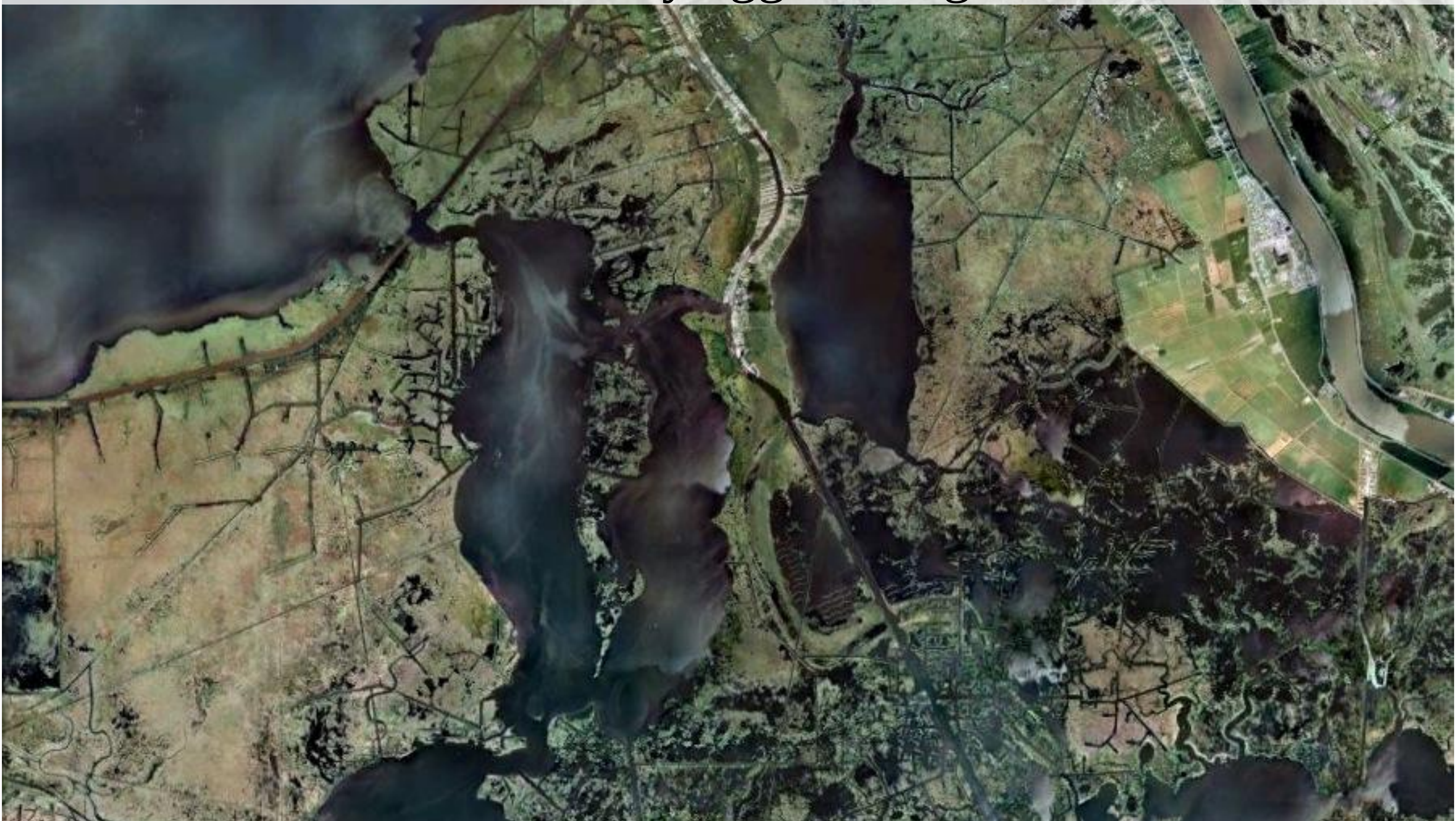


Source: Couvillion et al., (2011), Kolker et al., (2011)

In Galveston, there is also a relationship between fluid production, subsidence and wetland loss.



While canals, changes in sediment loads, altered biogeochemical pathways and invasive species are important drivers of wetland loss, subsidence lowers the resilience of these wetlands thereby aggravating wetland loss.



Summary and Implications

- By employing an understanding of the dynamical drivers of sea-level change, one can develop a new subsidence curve for selected regions of the northern Gulf of Mexico.
- Human activities in the subsurface can both positively and negatively affect both subsidence rates and near surface processes.
- Rates of subsidence in the Mississippi River Delta are likely slower now than they were in in the 1960s-1980s. This suggests that the amount of material needed for wetland accretion may be at the low-end of some restoration scenarios.

Many Thanks