

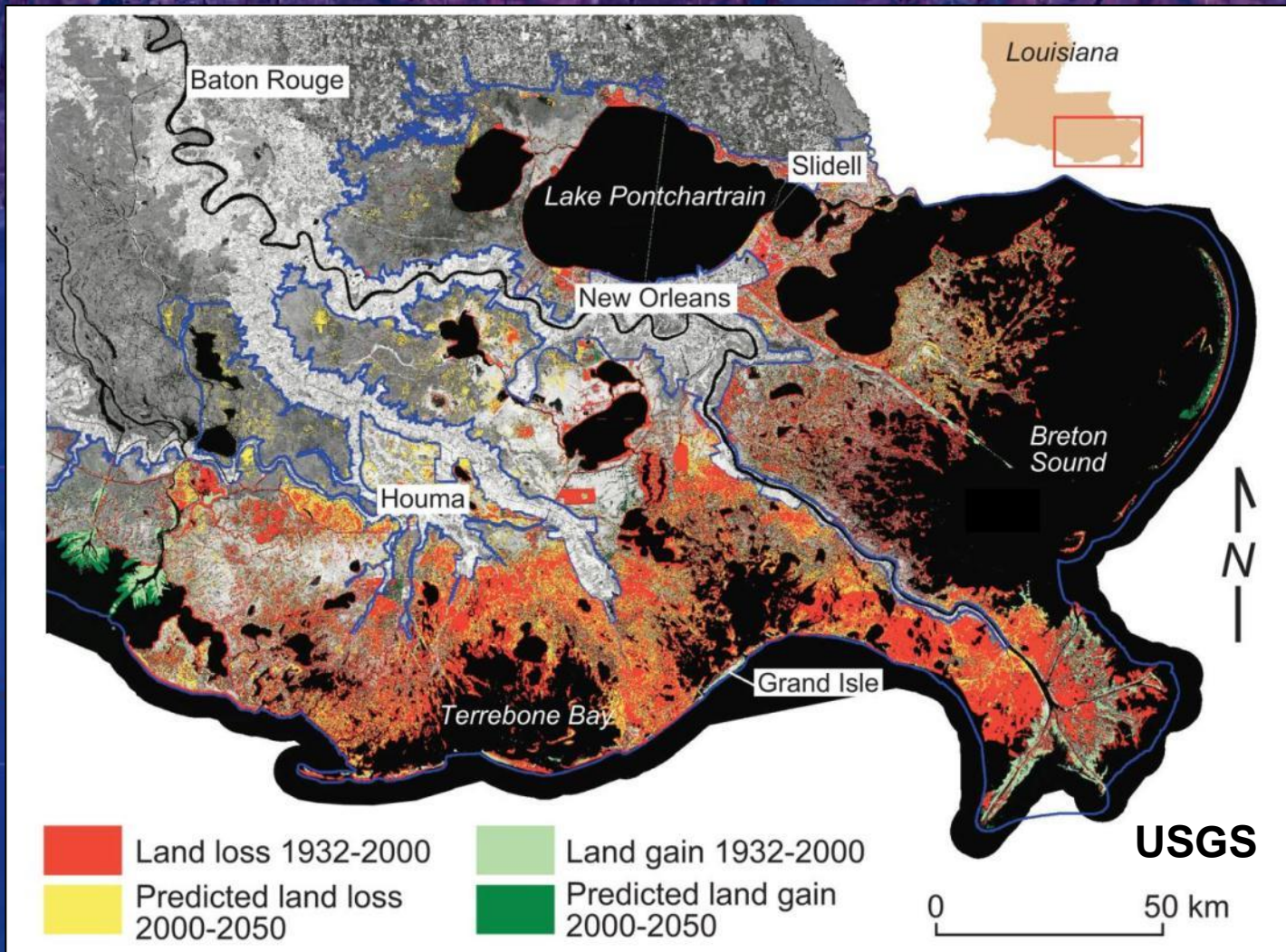
Land Loss in the Mississippi Delta: Important Role of River Diversions

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Louisiana State University**


Louisiana's Coastal Land Loss: A Regional Geology Problem

Mississippi Delta Land Loss and Gain



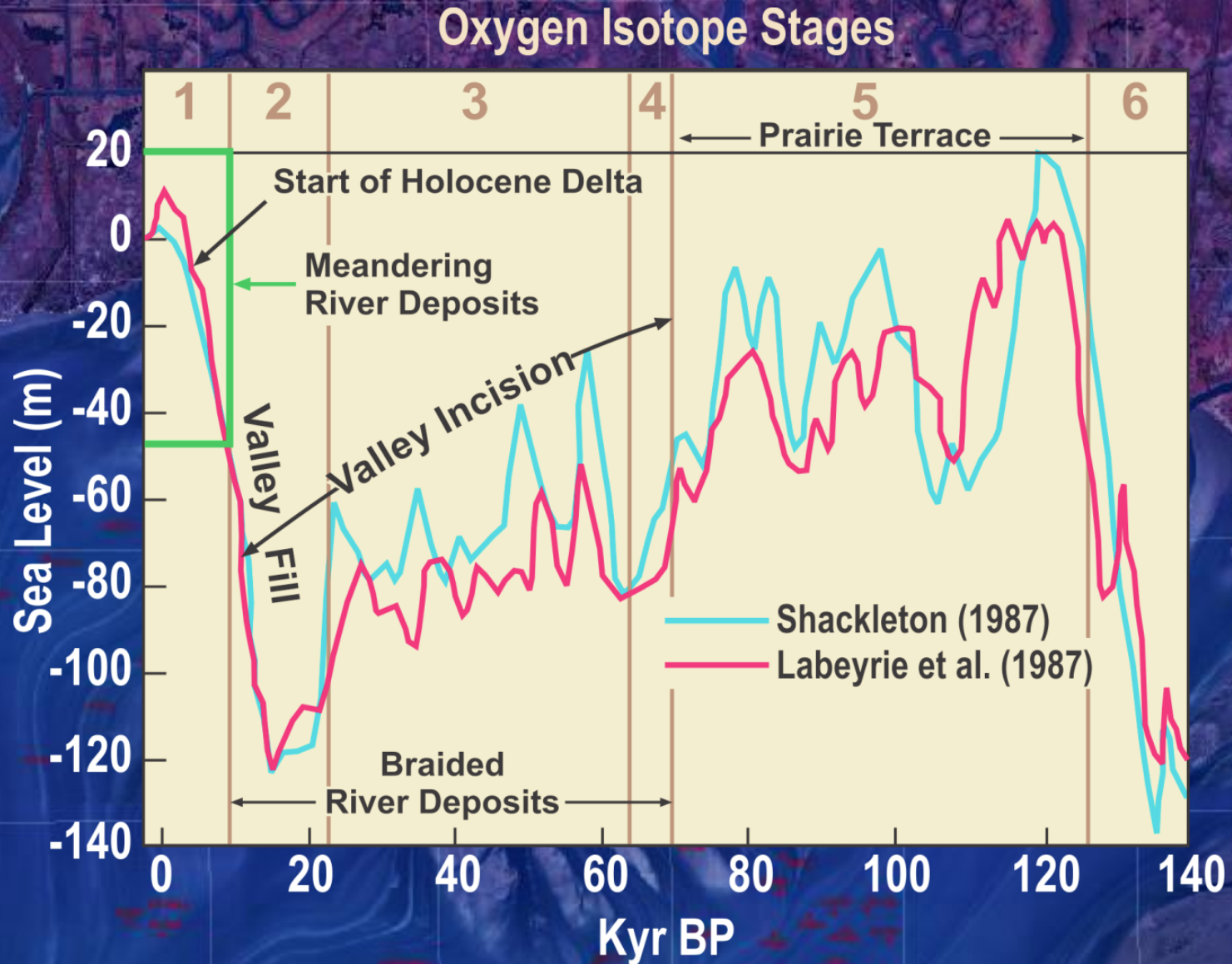
Key Geologic Factors in Land Loss

- **Crustal Downwarping**
- **Compaction-Dewatering of Young Deposits**
- **Faulting**
- **Decreasing Sediment Supply-Increasing Accommodation**

A satellite map of the Mississippi Alluvial Valley and Delta region. The image shows a winding river system (the Mississippi River) flowing from the top left towards the bottom right, where it meets the Gulf of Mexico. The surrounding land is a mix of green and brown, indicating different vegetation and land use. The Gulf of Mexico is visible in the bottom right corner, appearing as a dark blue area.

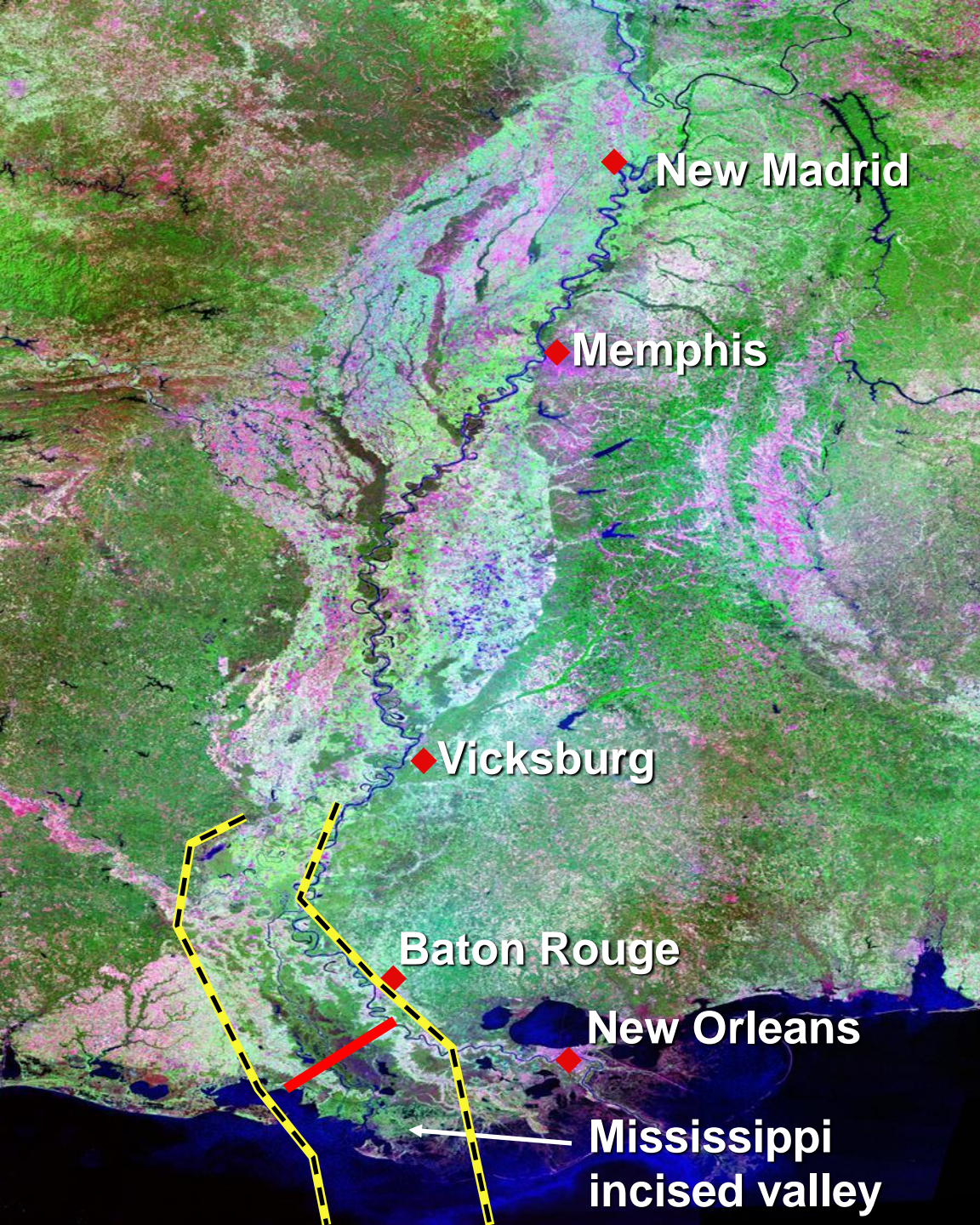
Climate and Sea Level Change: Drivers of Late Quaternary Mississippi Alluvial Valley and Delta Geology

Sea Level History

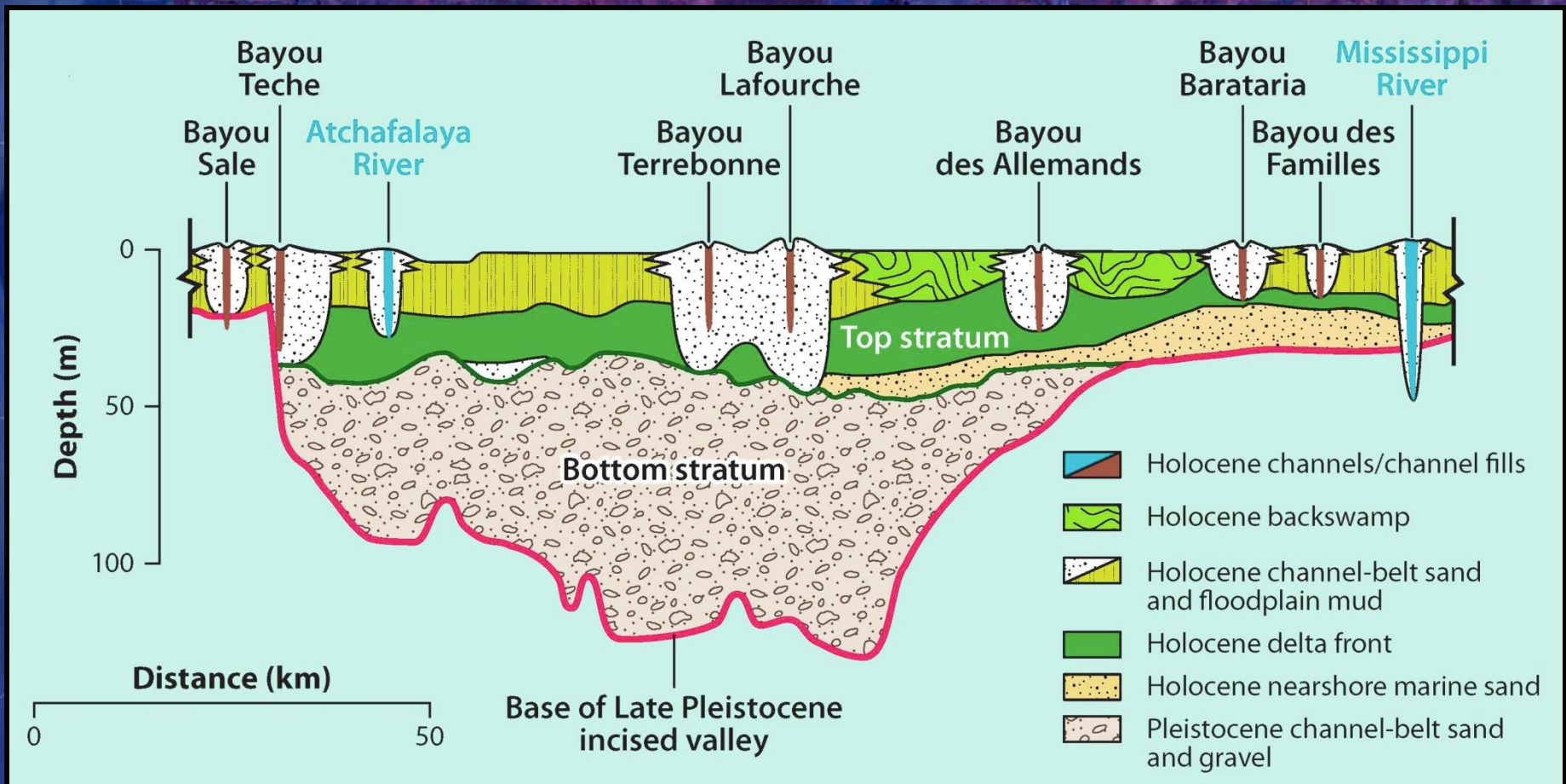


The Lower Mississippi River and Delta

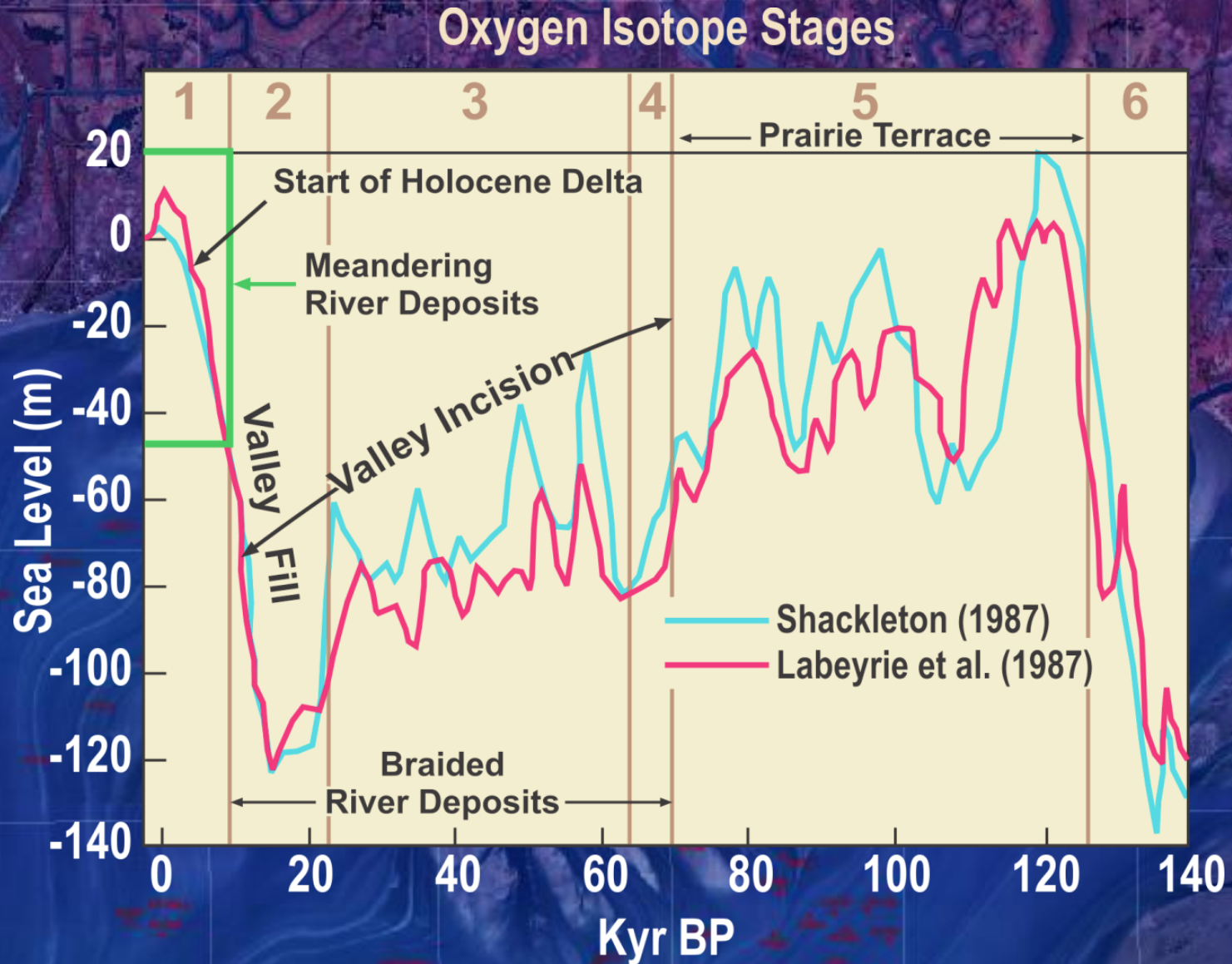
- Glacial-period braided streams within incised valley
- Holocene valley filling and delta construction
- Valley fill reflects interactions between climate and sea-level change



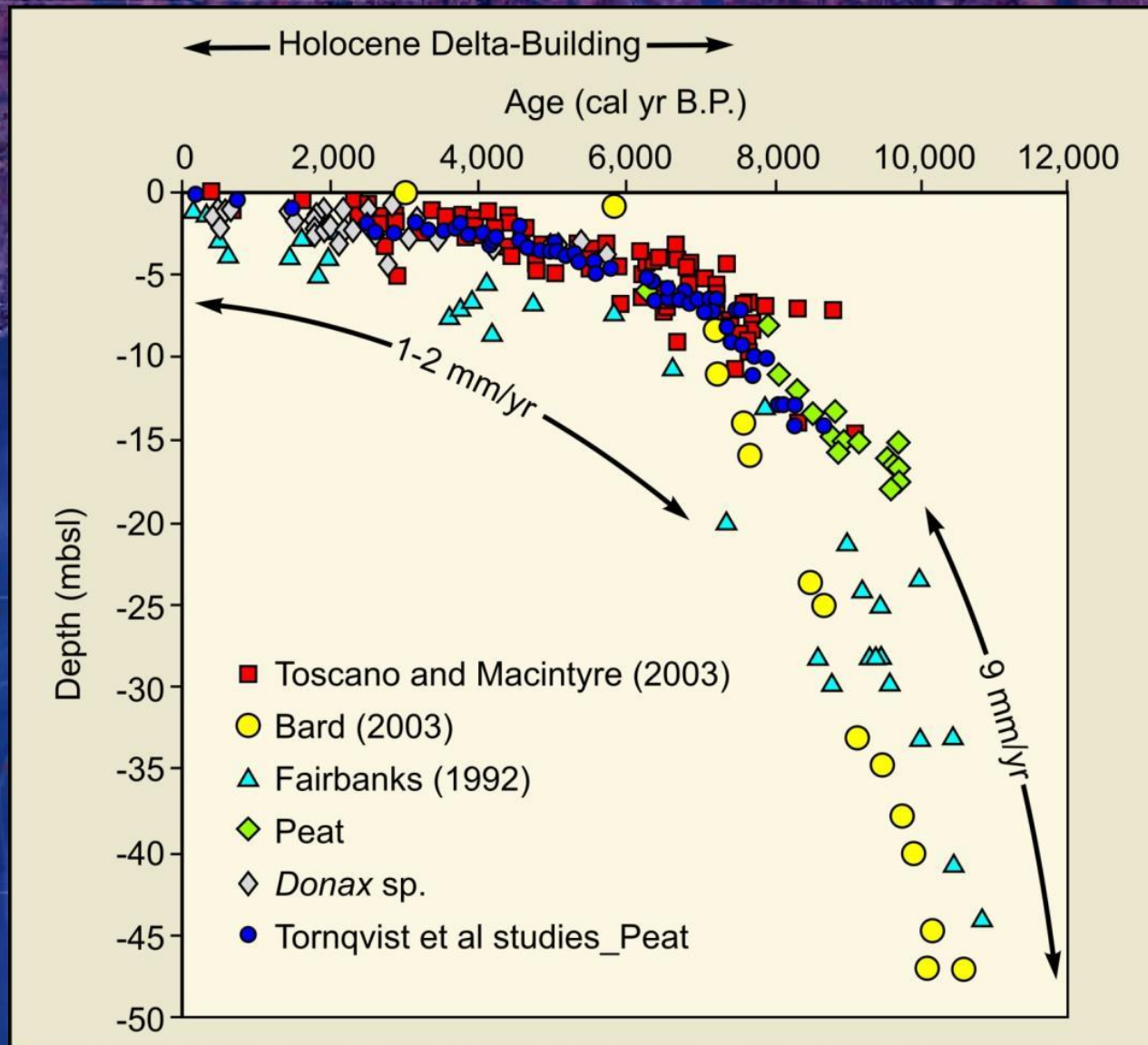
Sediment Fill of the Incised Alluvial Valley



Sea Level History

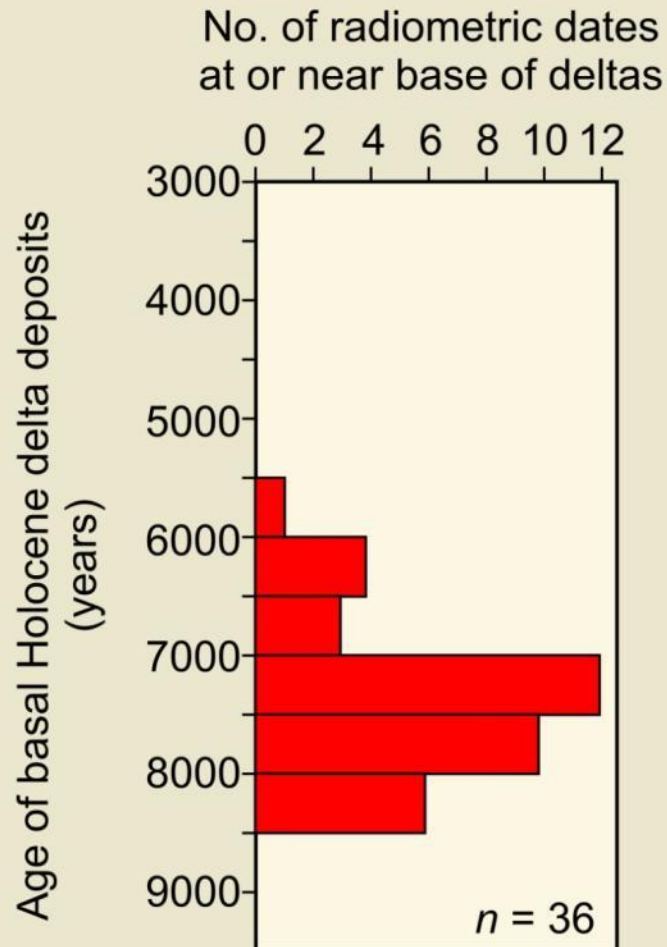


Holocene Sea Level



Initiation of Holocene World Deltas

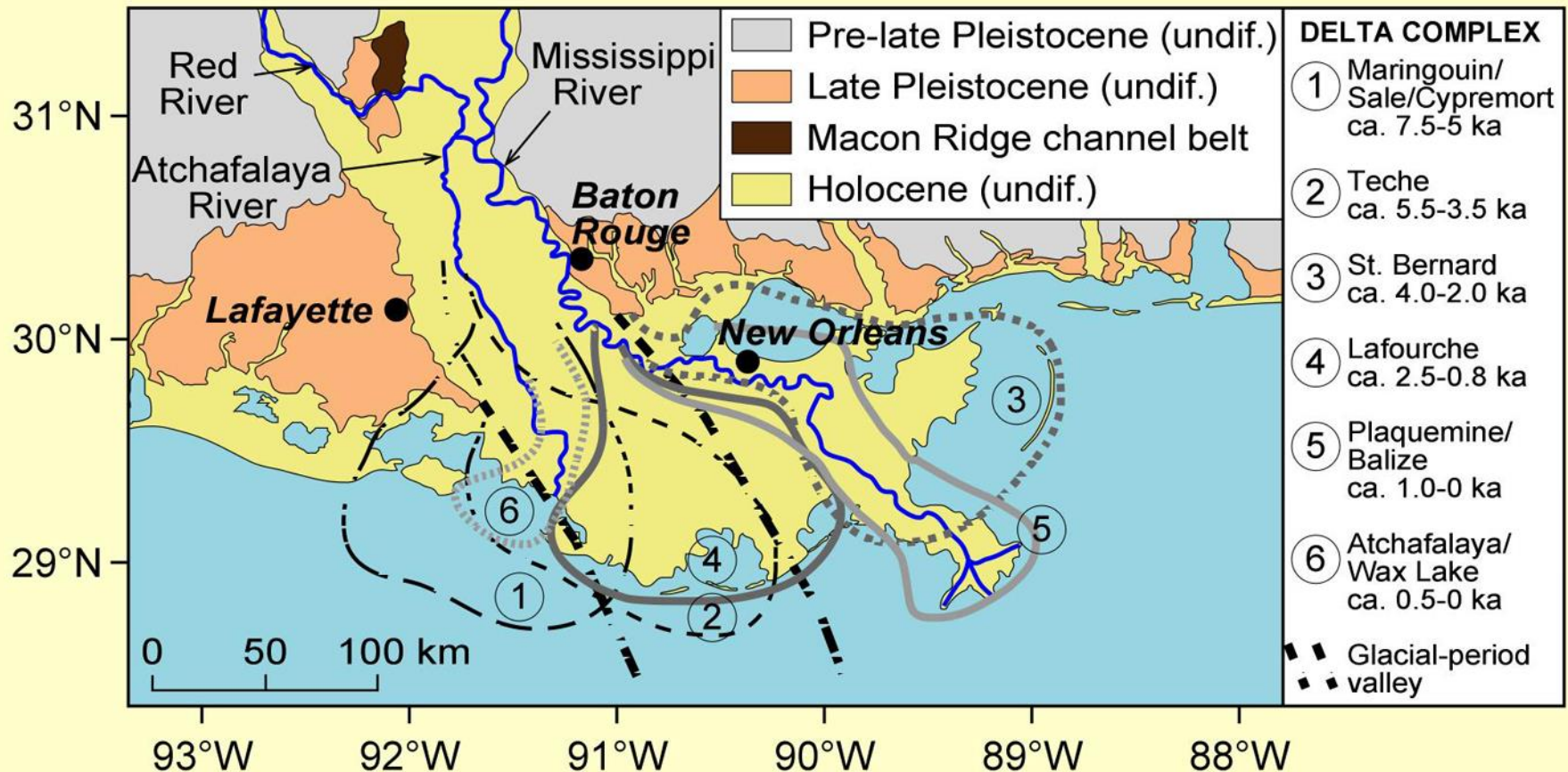
RECENT WORLD DELTAS



Stanley and Warne (1994)

Mississippi River Delta

Holocene History of Delta Growth



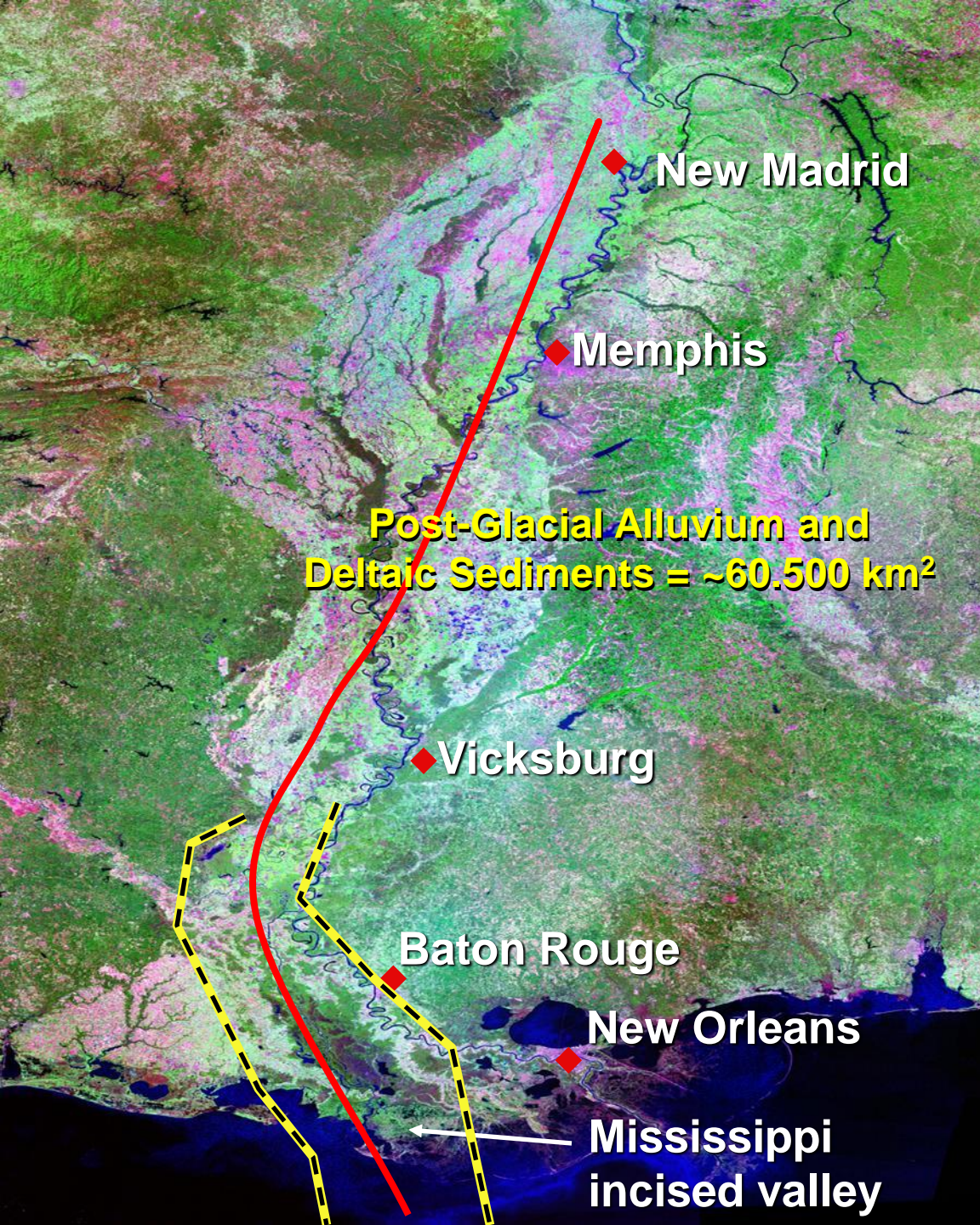
from Roberts (1997)

- 6 major coupled channel belts and delta complexes
- like most major deltas, growth occurred after ca. 7000 yrs BP

Sediment Storage in the System Before Human Intervention

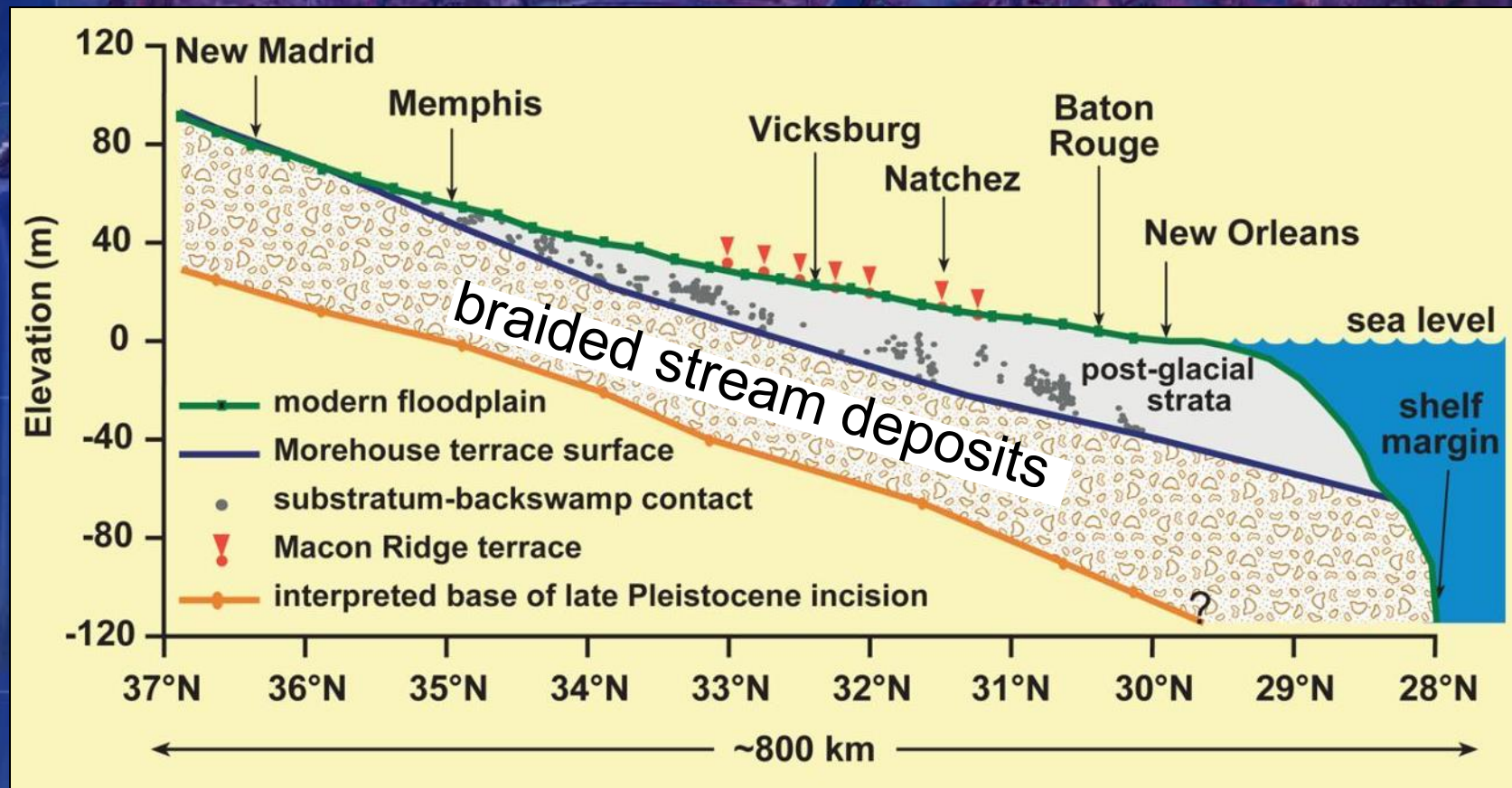
The Lower Mississippi River and Delta

- Glacial-period braided streams within incised valley
- Holocene valley filling and delta construction
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Longitudinal Profile of the Lower Mississippi Valley and Delta

Tracing Late Pleistocene Braided Streams into the Subsurface Using Base of Backswamp Deposits

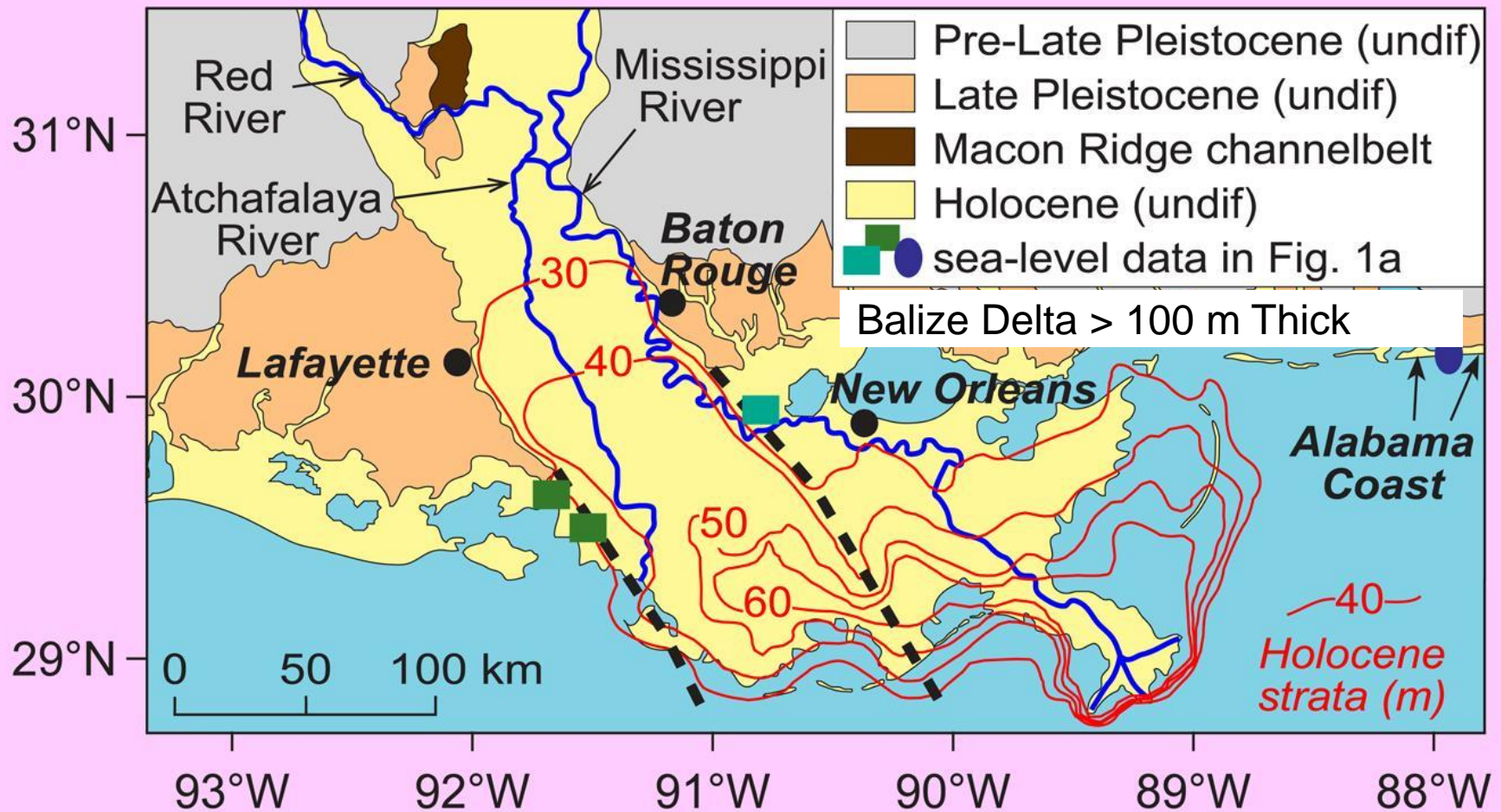


Based on 325 USACE boreholes

from Blum et al. (2008)

Lower Mississippi Valley and Delta

Magnitude of Post-Glacial Deposition



Total storage = 1860-2300 km³ or 2790-3450 BT of sediment

Storage rate = ~230-290 MT/yr over 12,000 yr post-glacial period

sediment isopachs adapted from Kulp (2000)



Mississippi River Discharges and Sediment Storage

Pre-Dam

Sediment Load*: ~400 – 500 MT/yr

Mean Sediment Storage**:
230 – 290 MT/yr

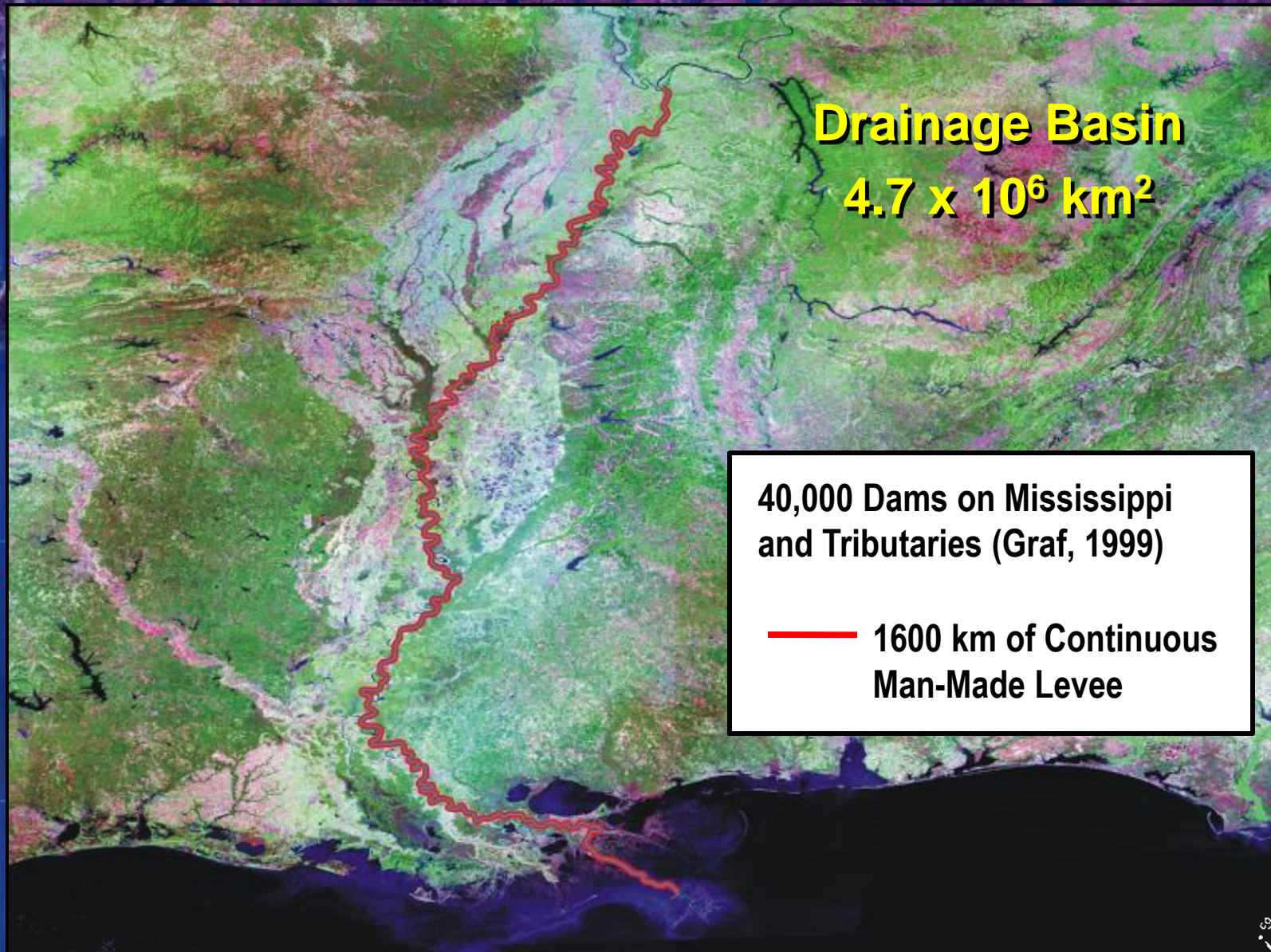
1976-2006

Mississippi & Atchafalaya Sediment
Load: ~205 MT/yr

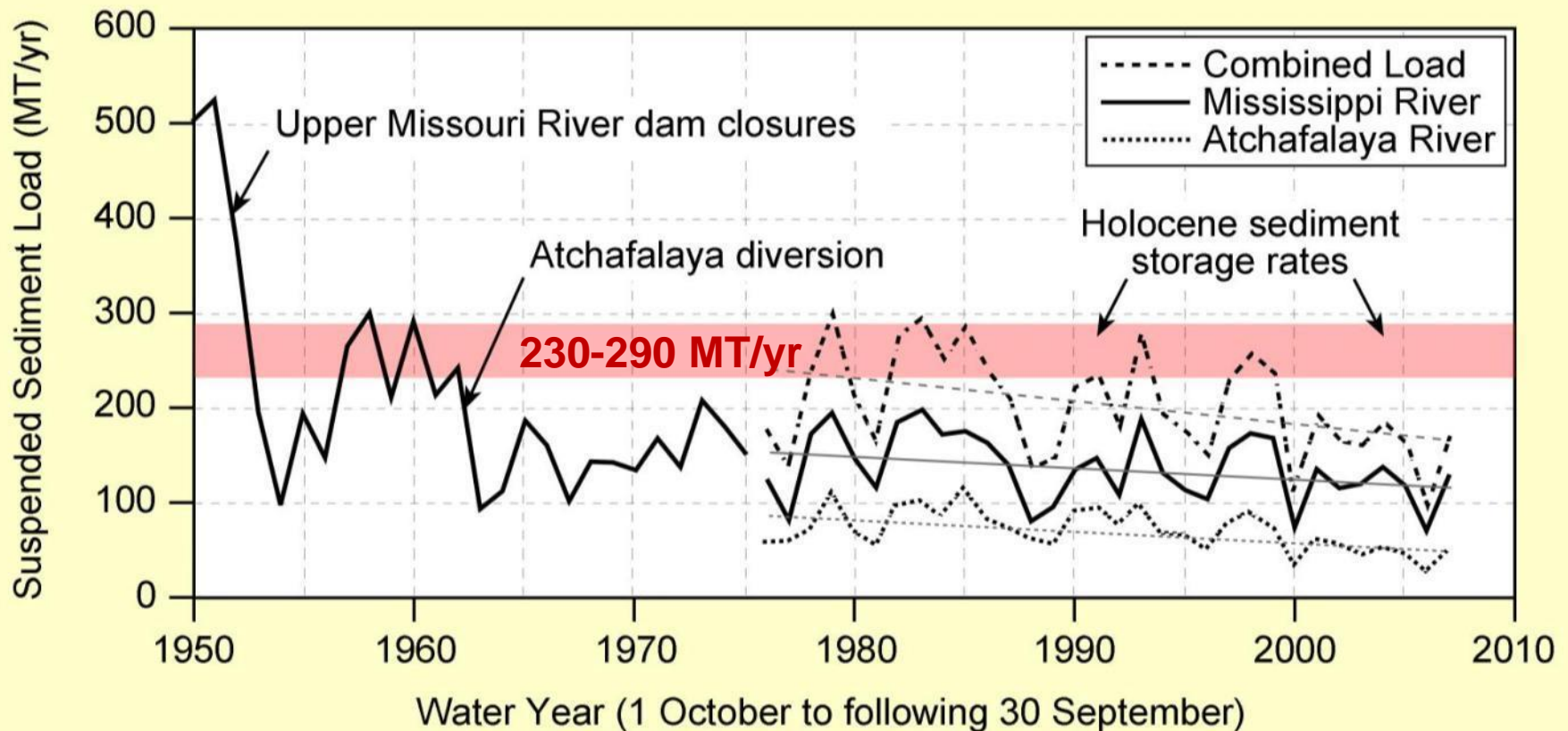
*Suspended Sediment Load Meade et al. (1990);
Kesel et al. (1992)

**Avg. over 12 kyrs

Mississippi River Alluvial Valley



Lower Mississippi River Sediment Load Pre- and Post-Dam Loads



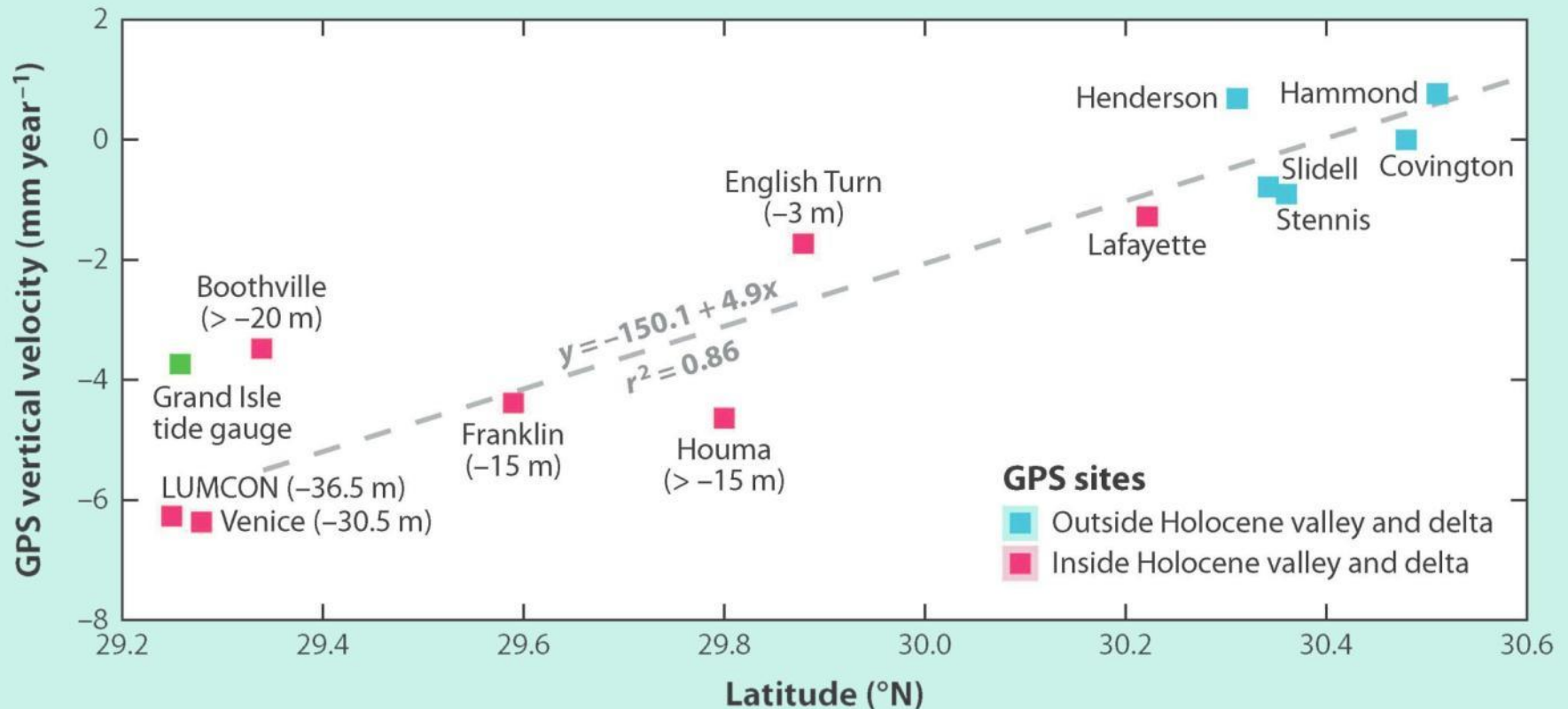
Data courtesy of USGS Baton Rouge

Modern post-dam sediment loads are ~65% of the long-term mean storage component alone

Today's Problem: Increasing Accommodation

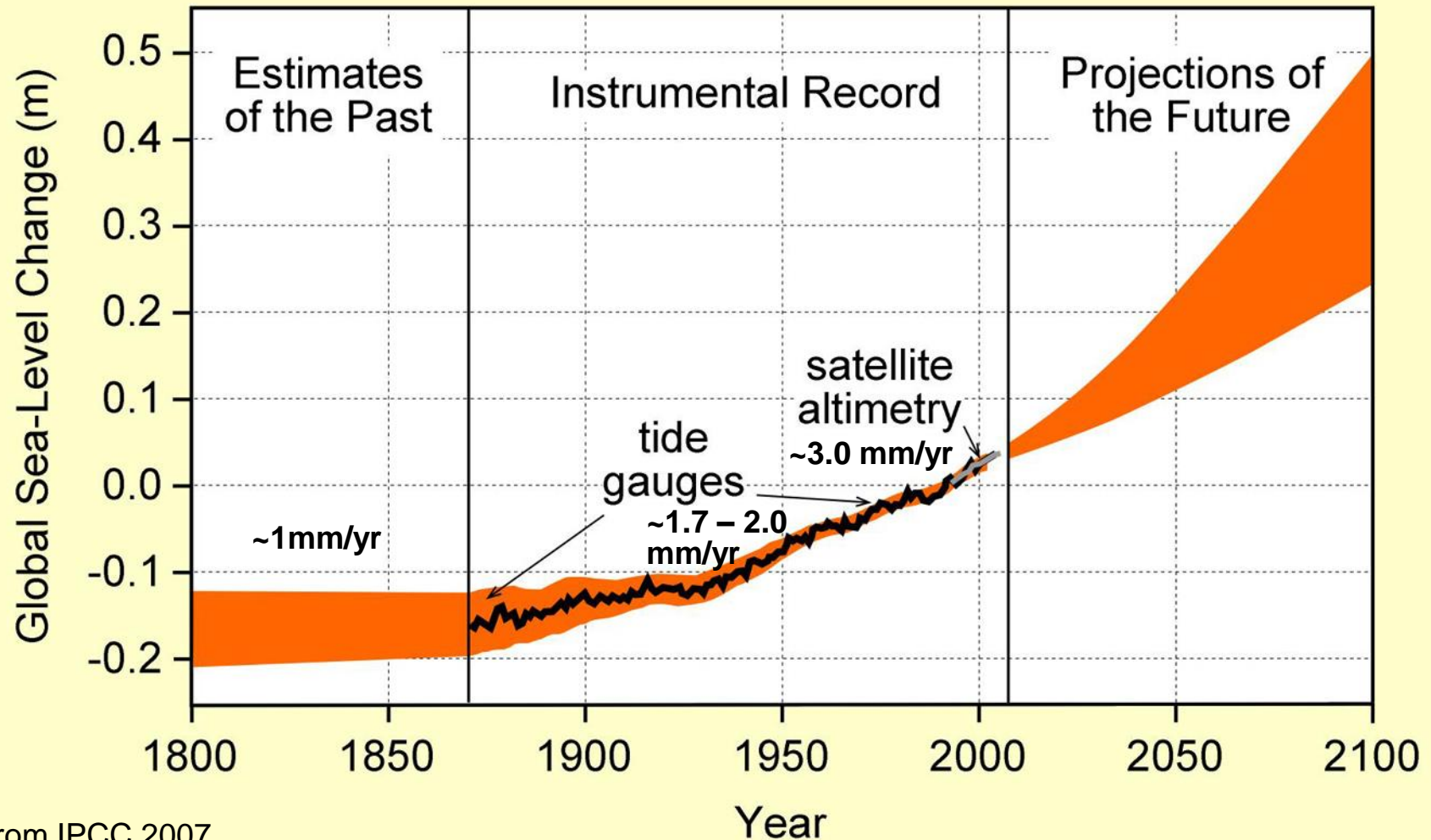
- Combined Processes of Subsidence
- Increasing Rate of SL Rise

Coastal Plain GPS Vertical Velocities



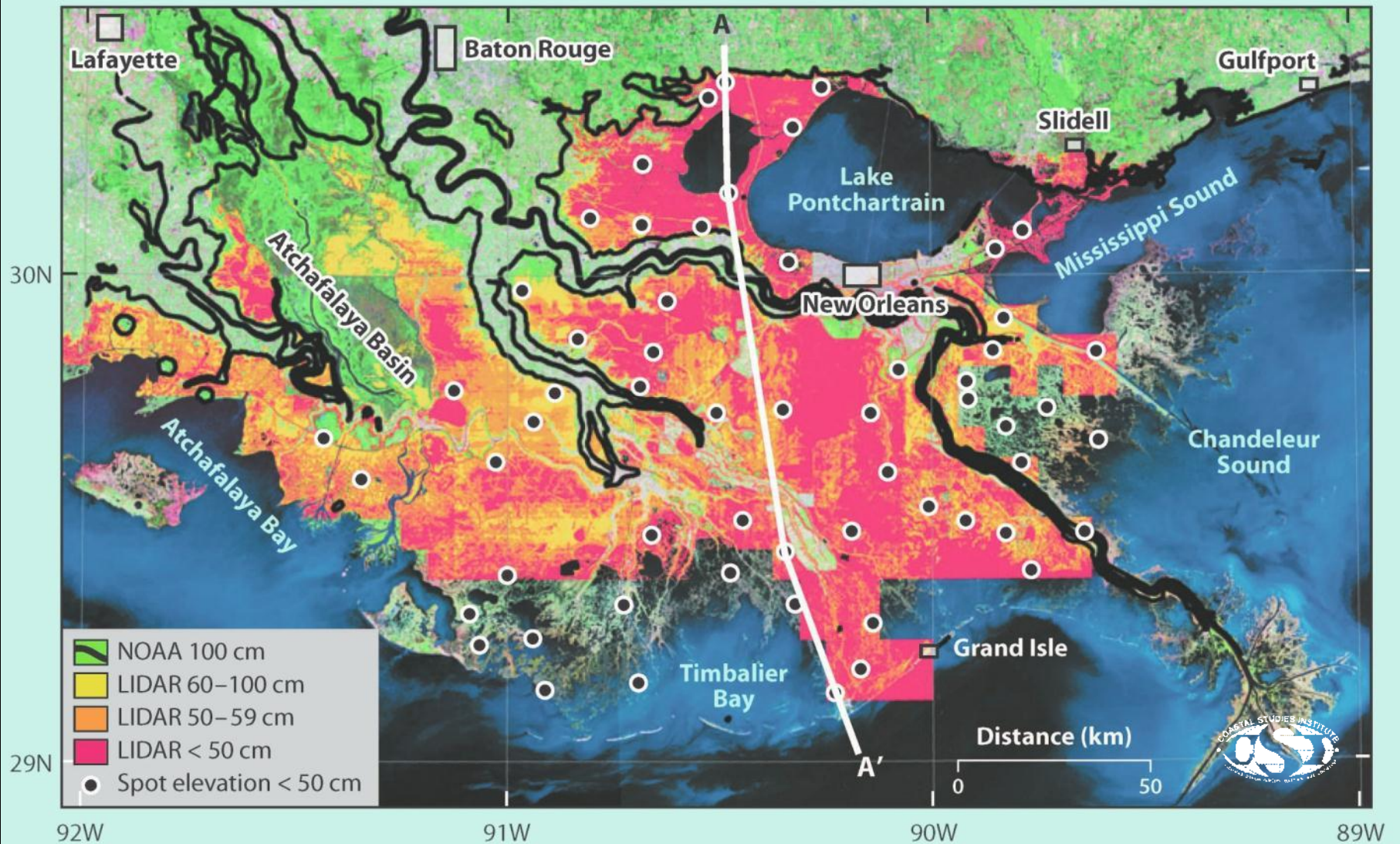
Global Sea-Level Rise

Sea-Level Change Data and Projections

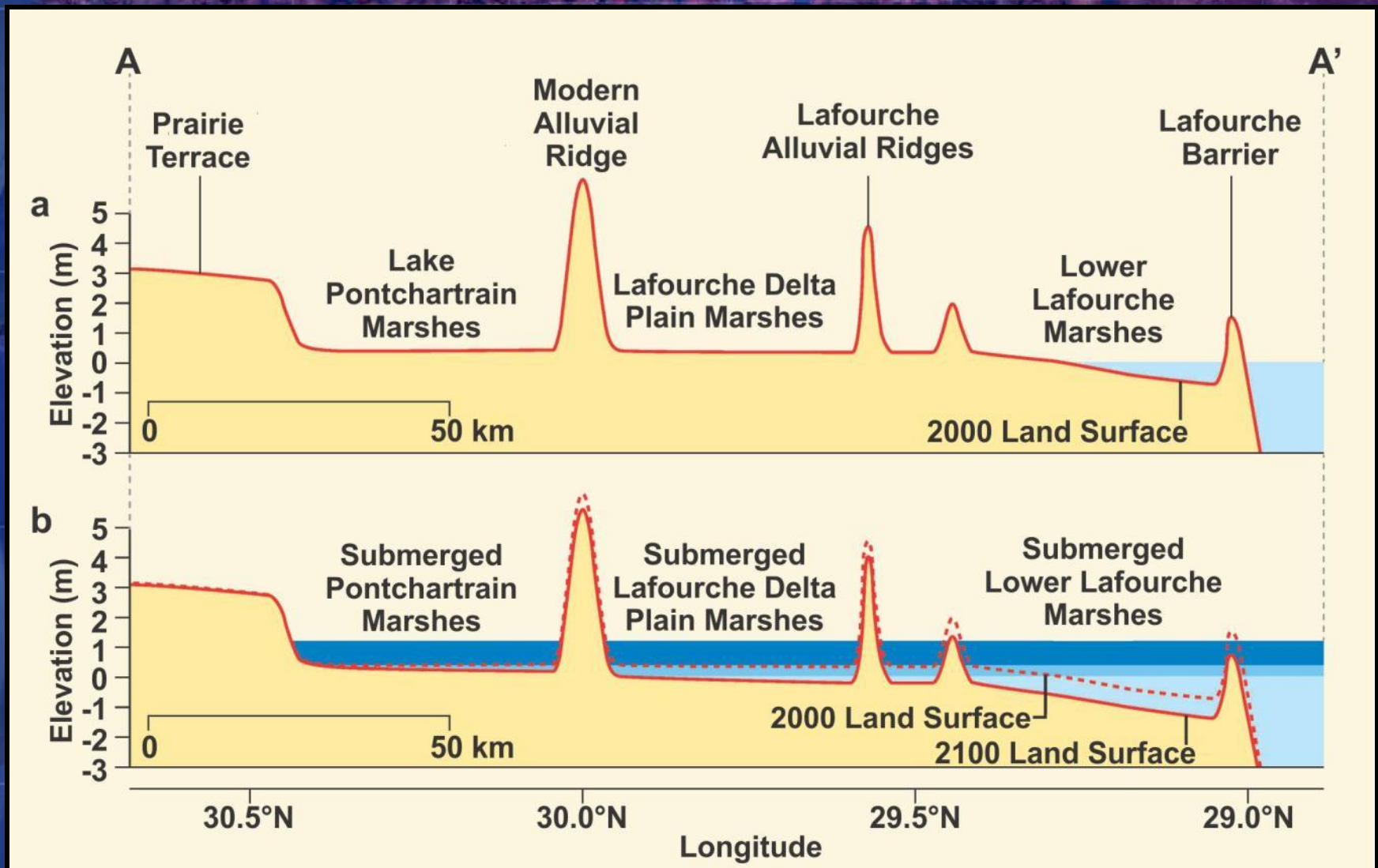


from IPCC 2007

Coastal Plain Elevations



Projected Submergence: 2000 vs 2100





River Diversions: Best Hope for Off-Setting Coastal Land Loss

THE LOUISIANA COAST IN 2000



A satellite map of the Louisiana coast in 2000. The map shows the Mississippi River delta and the Gulf of Mexico. The land is primarily green, indicating vegetation, with some areas of pink and purple, possibly representing urban or developed areas. The coastline is irregular, with many small inlets and bays. Three locations are marked with white hexagons and labeled: Lafayette, Baton Rouge, and New Orleans. The Gulf of Mexico is shown in dark blue at the bottom of the map.

Lafayette

Baton Rouge

New Orleans

THE LOUISIANA COAST IN 2100?



A map of the Louisiana coastline showing projected future land loss. The map uses a color-coded system: green for land, blue for water, and pink/magenta for areas of projected loss. The Mississippi River is shown as a prominent blue line winding through the landscape. Three locations are marked with white hexagons and labeled: Lafayette, Baton Rouge, and New Orleans. The projected land loss is most significant in the coastal areas, particularly around New Orleans and the delta region.

Lafayette

Baton Rouge

New Orleans

Projected future land loss of **10,500-13,500 km²**

The Louisiana Coast in 2100?

Mass balance considerations present tough choices for diversion scenarios

Lafayette

Baton Rouge

New Orleans

Projected future land loss of 10,500-13,500 km²

1400-1800 km²
with 50% of
Sediment load

An aerial photograph of a coastal plain, likely in the Southeastern United States, showing a complex network of rivers and wetlands. The land is colored in shades of brown and tan, while the water bodies are dark blue. Numerous small red dots are scattered across the land, particularly along the river channels, indicating areas of sediment retention. The text is overlaid in a large, bold, yellow font with a black outline.

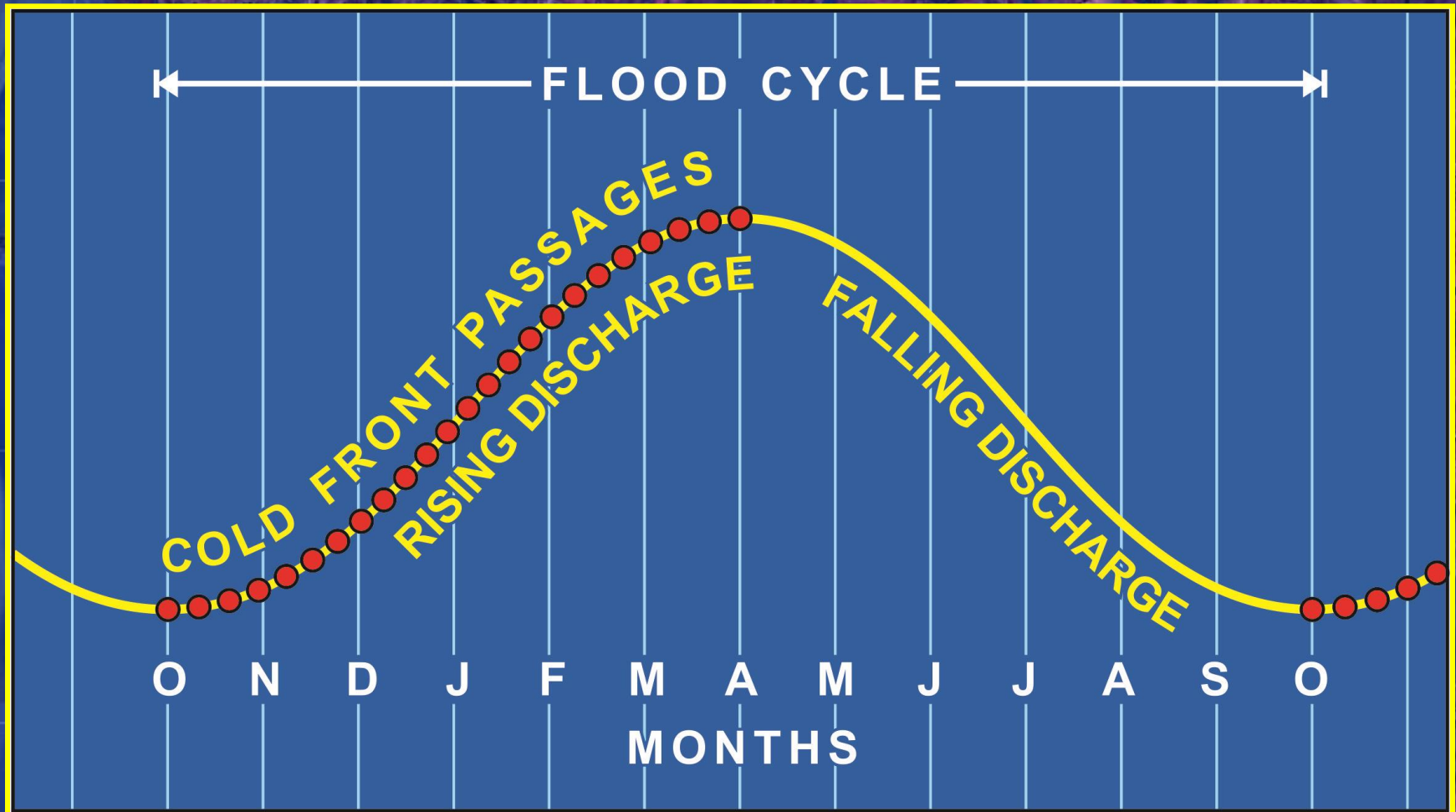
A Goal of River Diversions: Maximize Retention of Sediment Within the Coastal Plain

Fundamental Questions: River Diversions

- How are the sediments partitioned within the coastal-shelf system?
- What is the sediment retention capability in the delta and adjacent marshland?
- What are the important processes linked to sediment transport to the delta-marsh-offshore?

Physical Processes of Sediment Delivery

Rising Flood and Cold Fronts Form Synergistic Sediment Delivery Processes



Important Positive Impacts of Tropical Storms and Cold Fronts

Cold Front Modulation of Sediment Transport

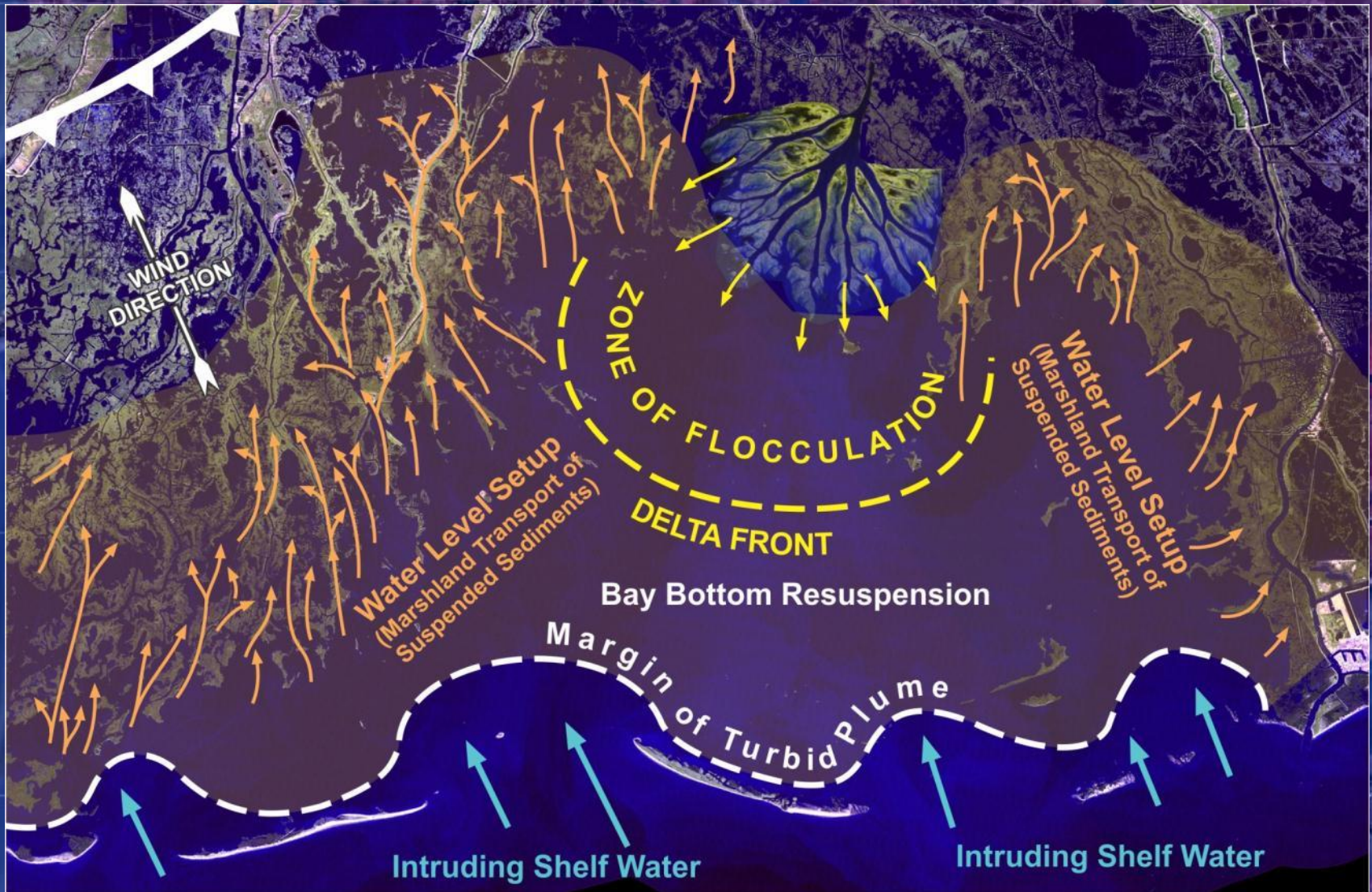
- **Prefrontal:**

- Onshore Winds
- Water Level Set-Up
- Onshore Sediment Transport

- **Postfrontal:**

- Offshore Winds
- Water Level Set-Down
- Offshore Sediment Transport

Prefrontal Conditions



RESULT: Marshward Transport of Sediment (20-30 times/year)

An aerial photograph of a river delta, likely the Mississippi River Delta, showing a complex network of distributaries and intertributary basins. The image is overlaid with a light blue grid. A solid red horizontal line is positioned near the top of the frame. The text is centered over the image in a large, bold, white font with a black outline.

**Placement of River Diversions in Landward
Parts of Intertributary Basins Will
Maximize Sediment Retention Through
Landward Suspended Sediment Transport
by Cold-Front-Related Processes.**