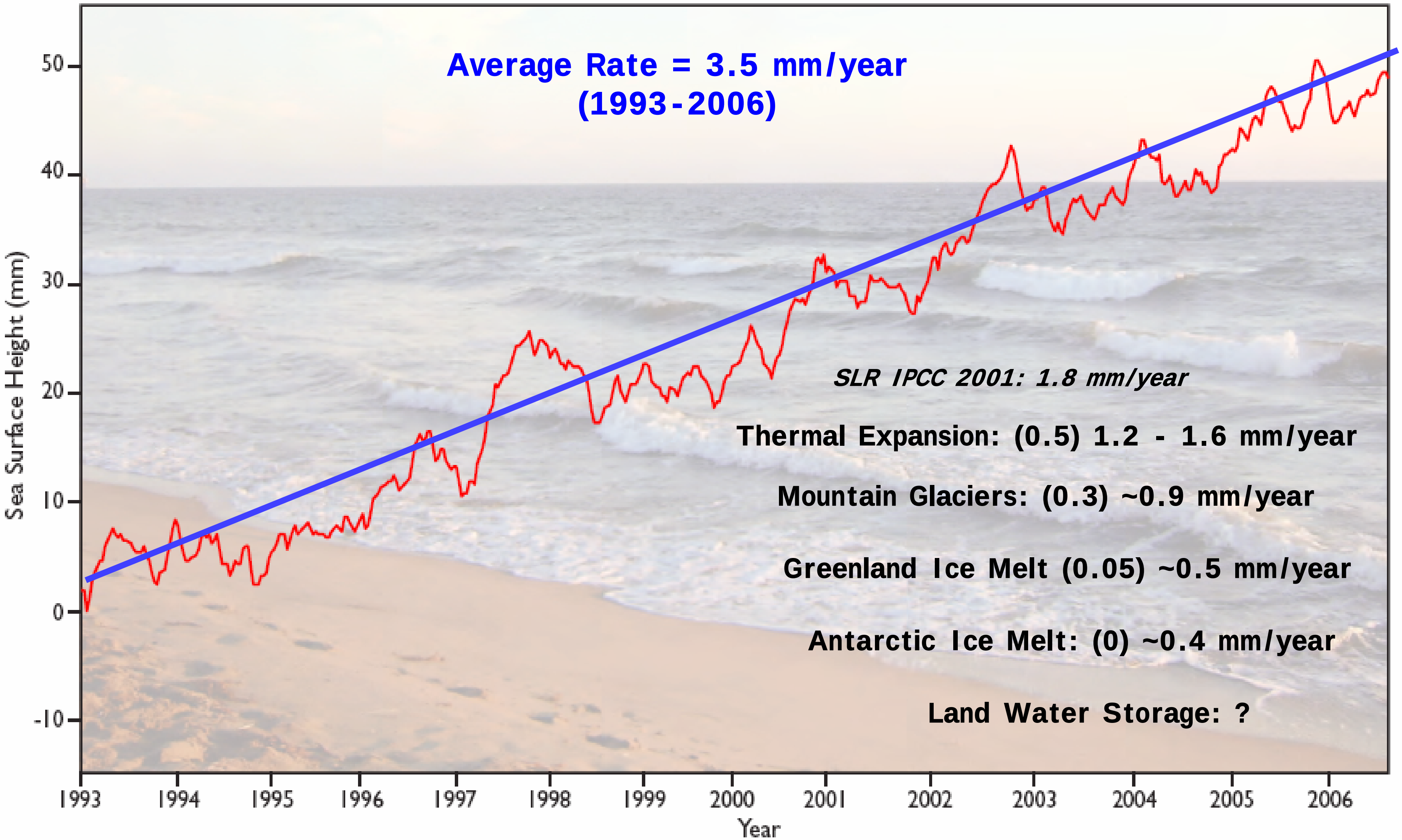
Impacts of Global Change on Coastal Wetlands in the Mississippi River Delta

Karen McKee
National Wetlands Research Center
U.S. Geological Survey

USGS
science for a changing world
Biological Resources
Global Change Program

Global Mean Sea Level from Satellite Altimetry

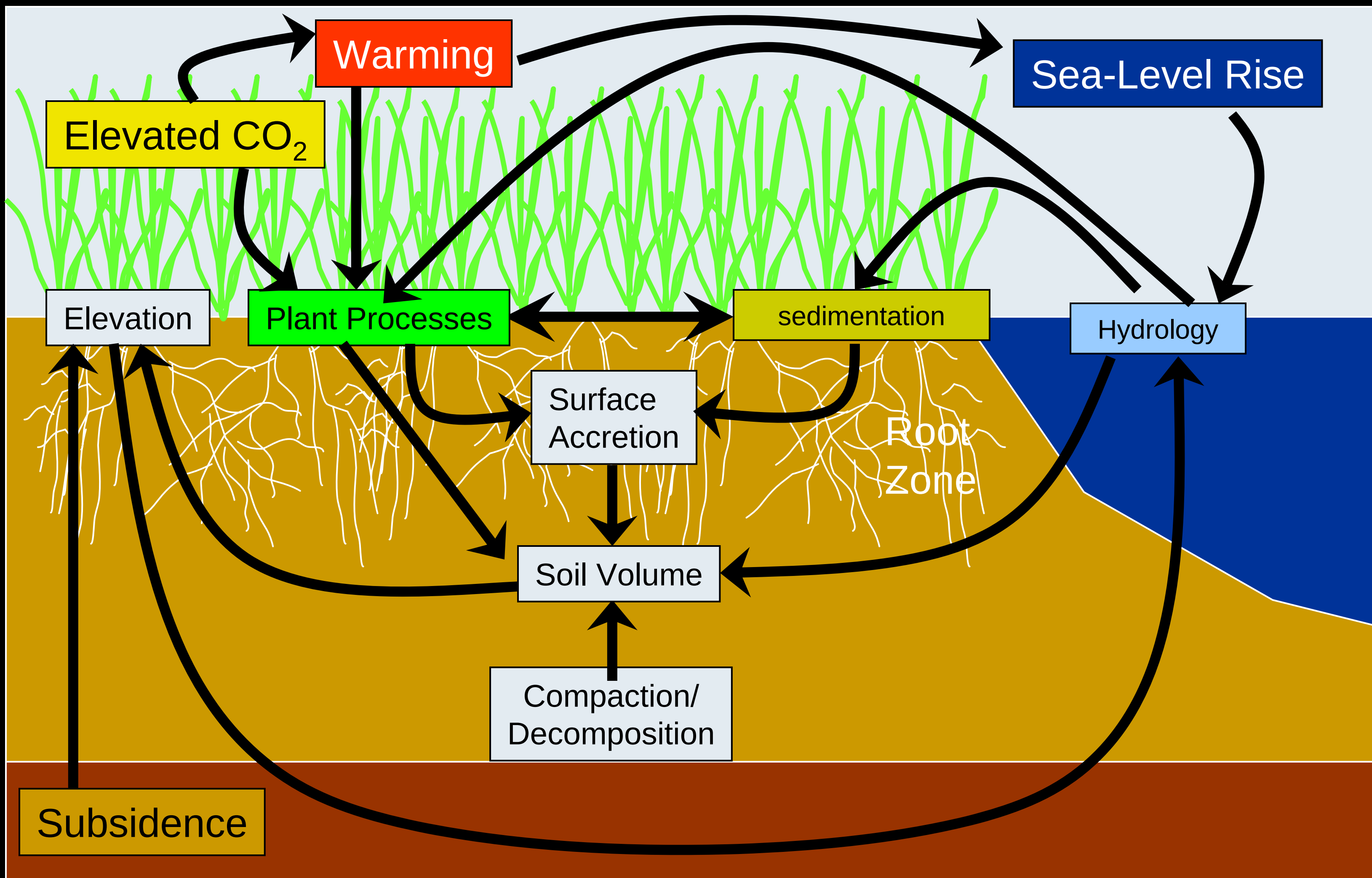


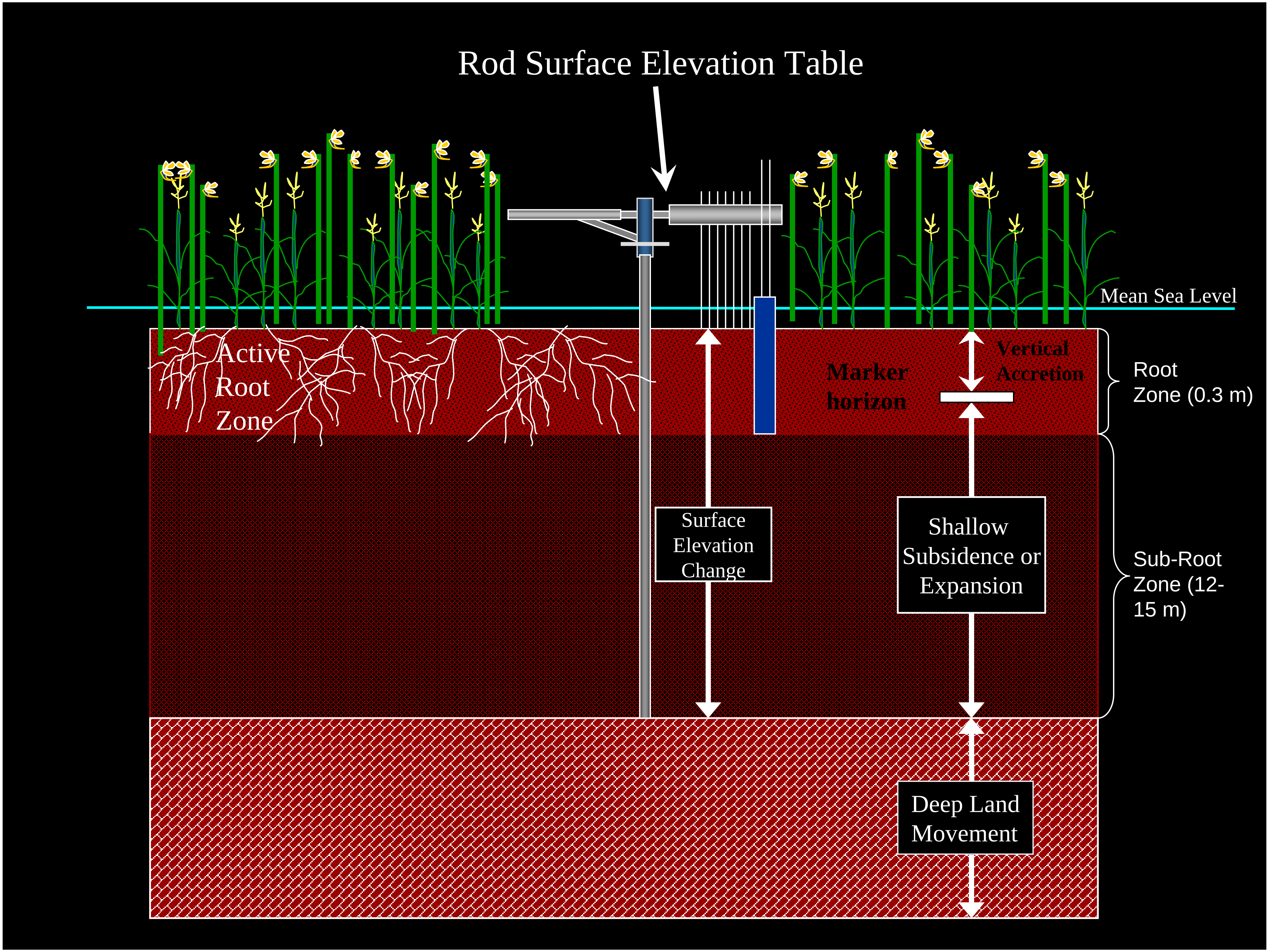
[Mitchum and Nerem, 2007]

As sea-level rises, low-lying coastal areas are prone to more frequent inundation and salt water intrusion

Vulnerability maps are based on physical processes and do not consider potential responses of wetland ecosystems

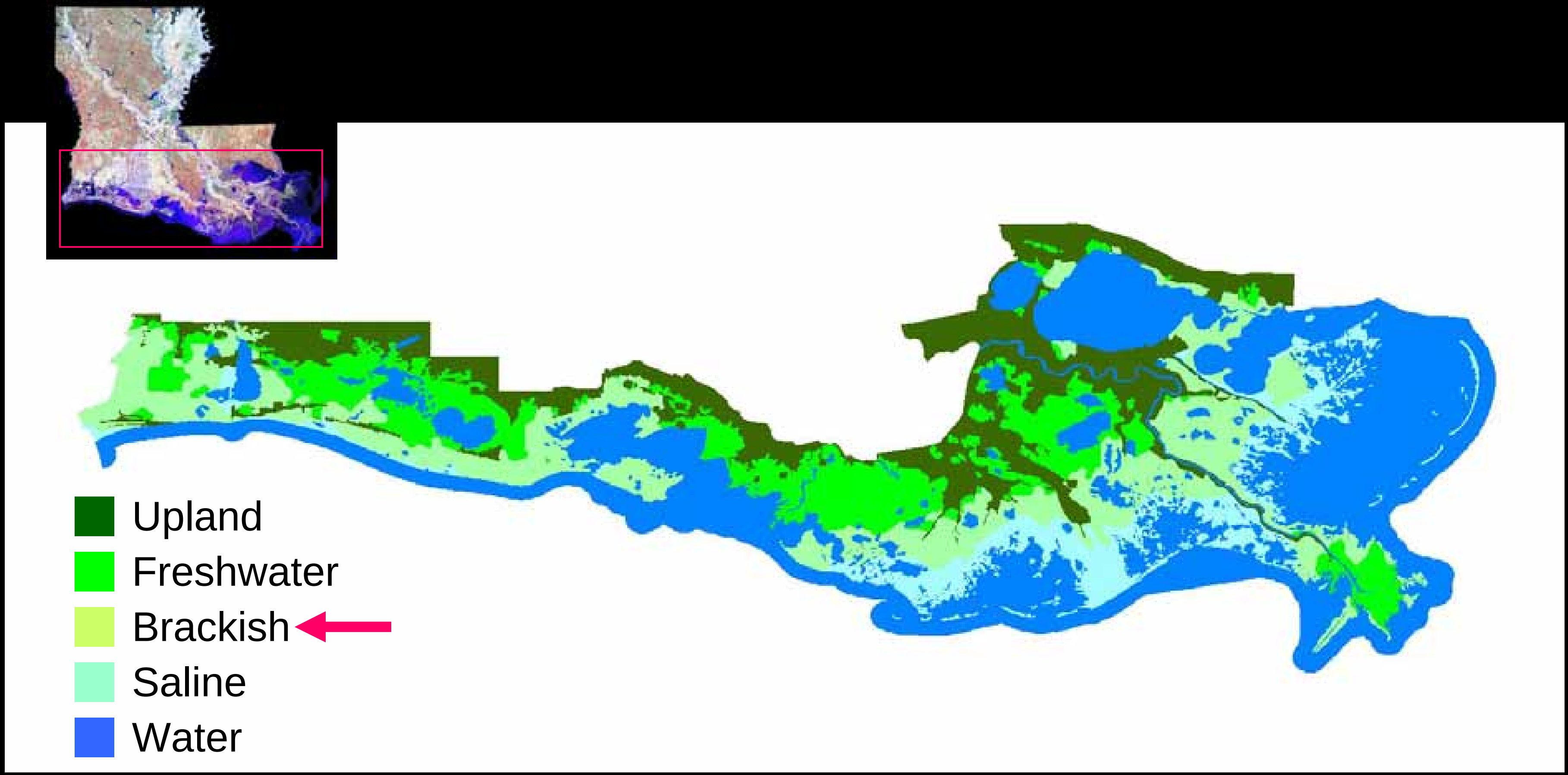
Coastal wetlands maintain soil elevations within the intertidal zone through a combination of physical and biological processes





Rod Surface Elevation Table
Mean Sea Level
Active Root Zone
Marker horizon
Vertical Accretion
Root Zone (0.3 m)
Surface Elevation Change
Shallow Subsidence or Expansion
Sub-Root Zone (12-15 m)
Deep Land Movement

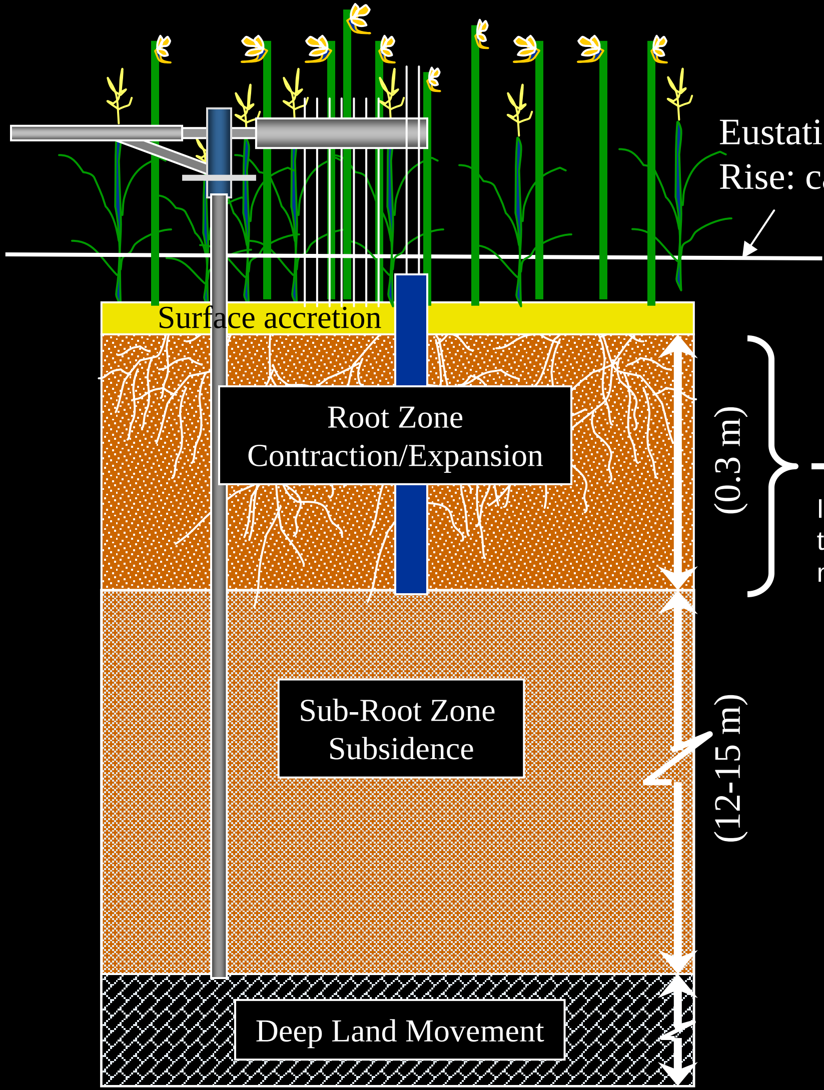
Louisiana's Coastal Wetlands



USGS, 2002

Minimum submergence rate: 1.45 cm yr^{-1}

Brackish Marsh Community

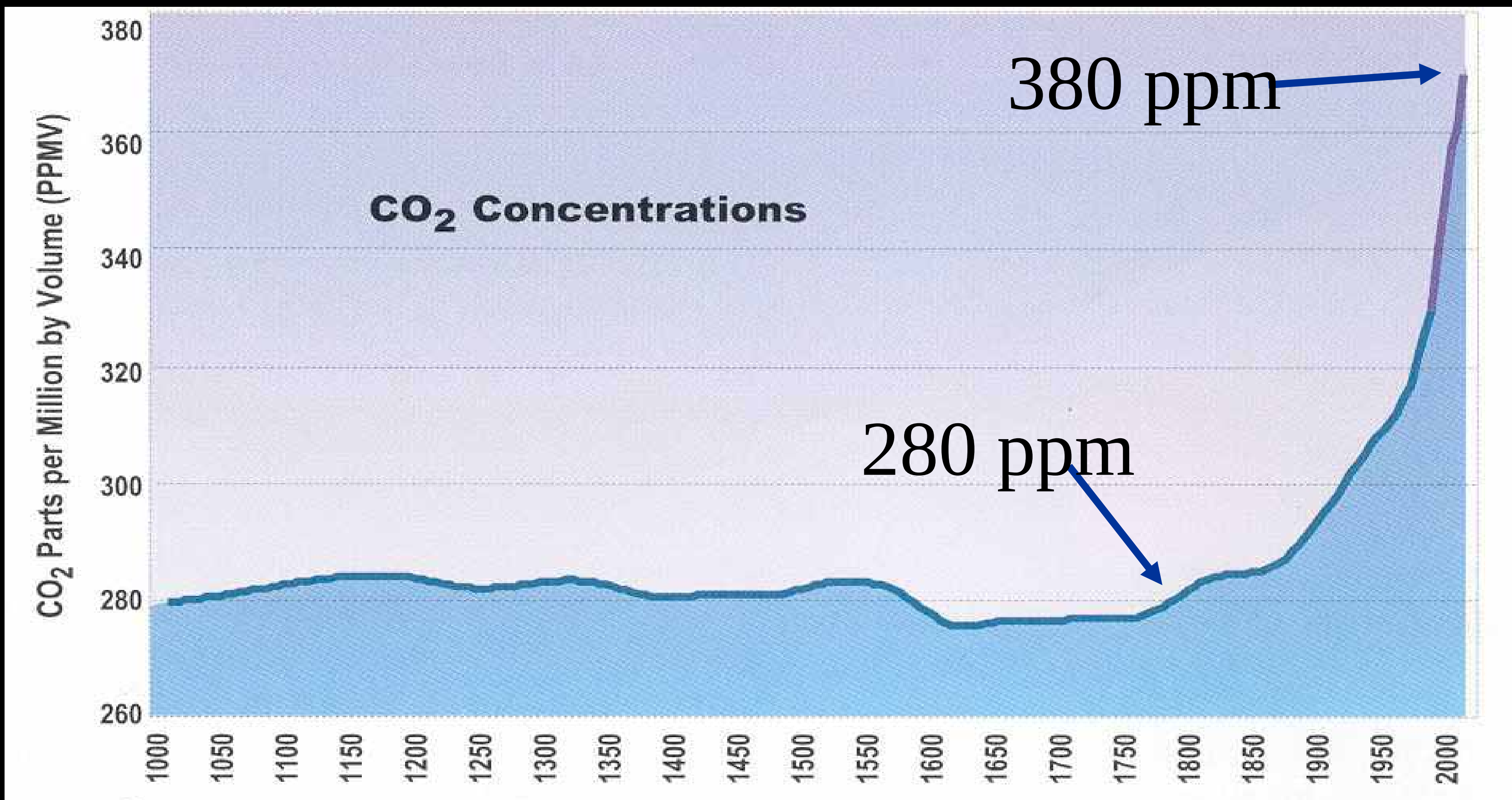


Eustatic Sea-Level Rise: ca. 0.35 cm yr^{-1}

Intact marsh sods transferred to 23 L mesocosms

Wetland Elevated CO_2 Facility
National Wetlands Research Center

Rising CO_2



Year

Interactions of elevated atmospheric CO_2 and soil factors on biological processes influencing wetland elevation

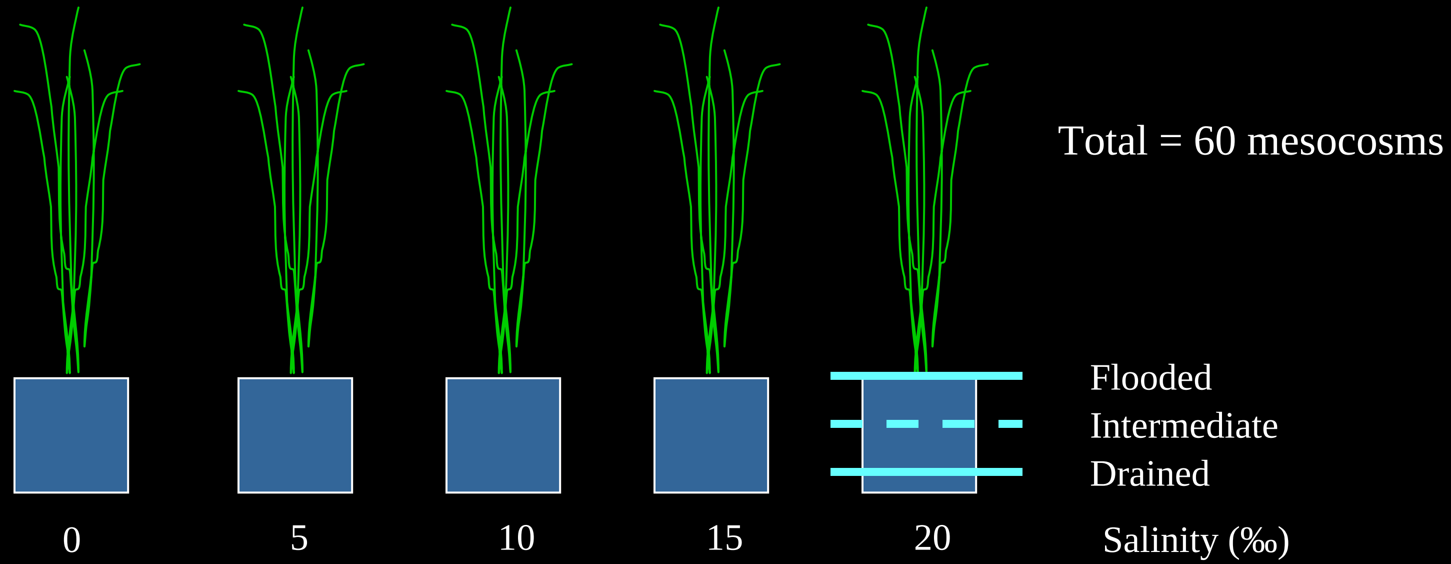
Collaborators:
Julia Cherry, Univ. Alabama
Jim Grace, USGS

Questions

Can elevated atmospheric CO_2 influence vertical marsh building by stimulating organic matter accumulation?

How do salinity and flooding affect root zone responses to CO_2 treatment?

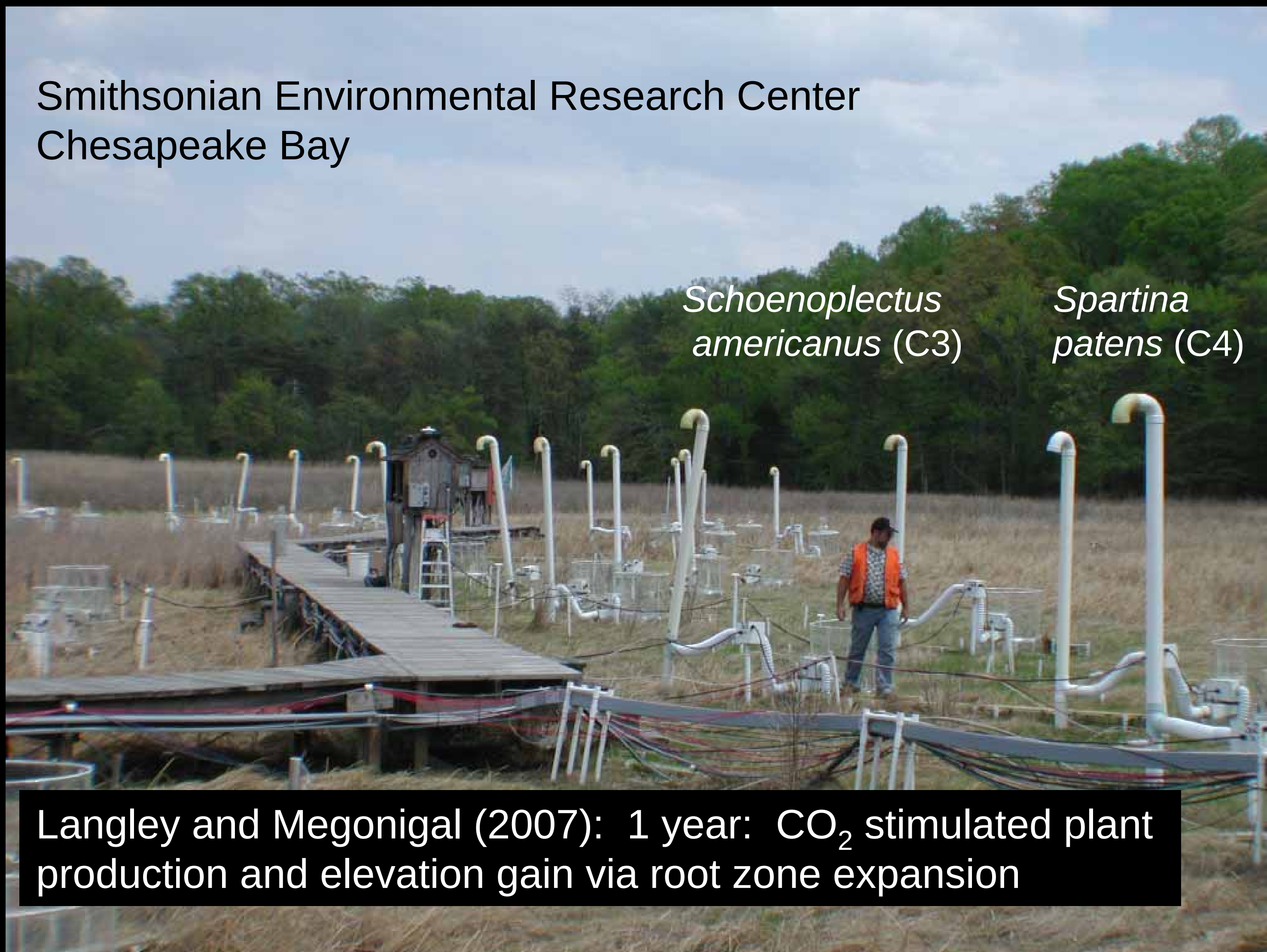
Brackish Marsh Community
Schoenoplectus americanus (C3)
Spartina patens (C4)



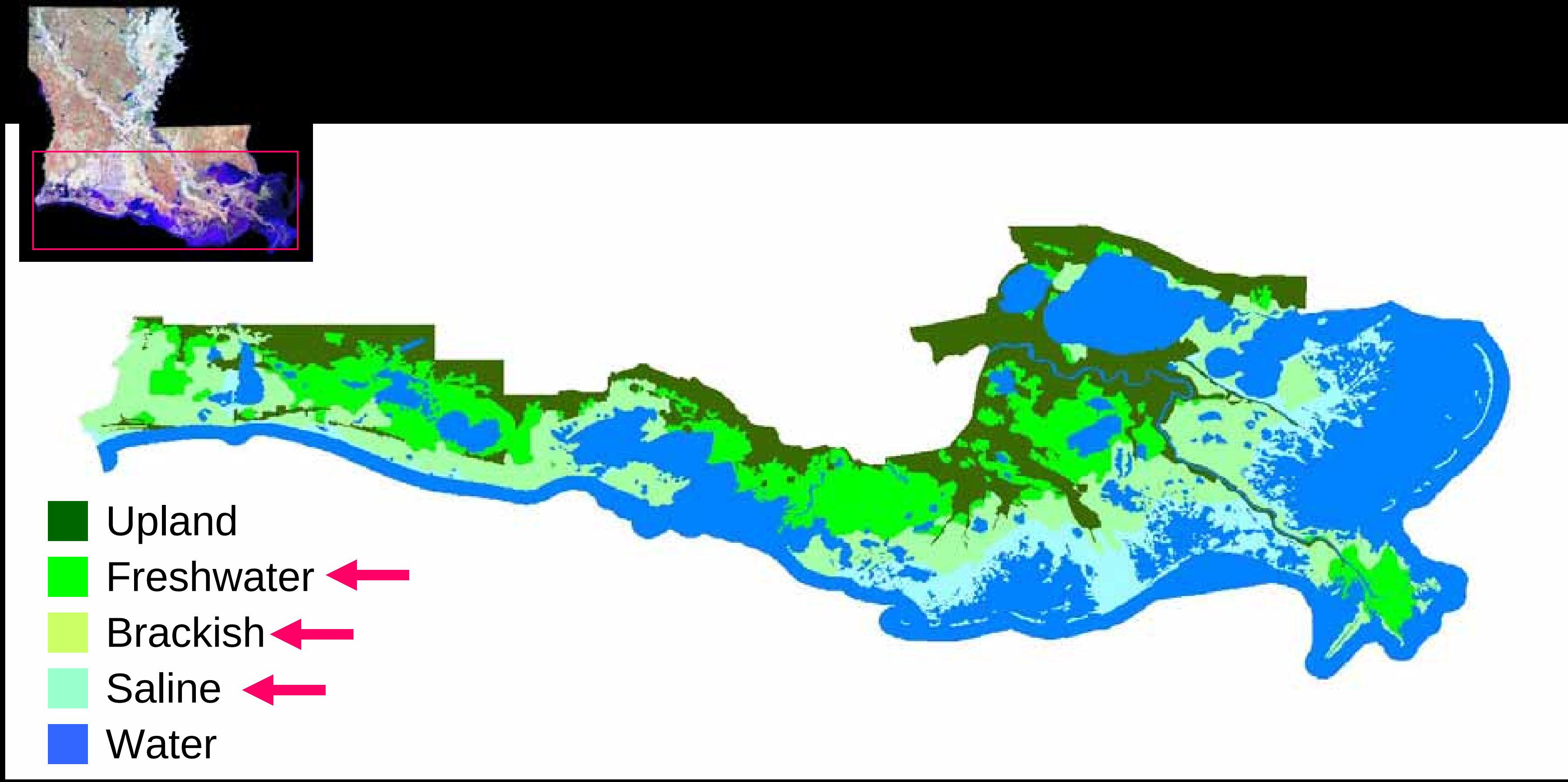
Flooding: 3 levels
Salinity: 5 levels
CO_2: 380 and 720 ppm

Root zone expansion

Field Plot CO_2 Study

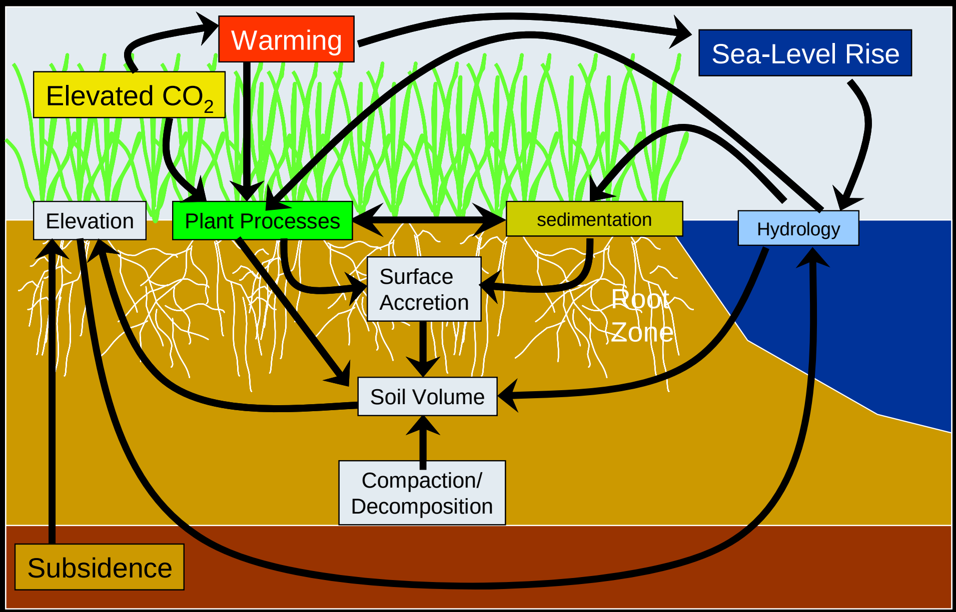


Louisiana's Coastal Wetlands



USGS, 2002

As sea-level rises, biophysical processes and interactions with other global drivers may aid in counterbalancing submergence of some coastal wetlands.



Temperate to Tropical Vegetation Shifts:

WHERE TEMPERATE MEETS TROPICAL:

MULTI-FACTORIAL EFFECTS OF ELEVATED CO_2,

NITROGEN ENRICHMENT, AND COMPETITION ON A

MANGROVE-SALT MARSH COMMUNITY

Karen L. McKee[1,3] and Jill E. Rooth[1,2]

[1]National Wetlands Research Center, U.S. Geological Survey, 700 Cajundome Blvd, Lafayette, LA 70506, USA; [2] Elkhorn Slough National Estuarine Research Reserve, Watsonville, CA 95076, USA; [3]Correspondence: Email: karen_mckee@usgs.gov, Tel: +1 337-266-8500, Fax: +1 337-266-8586

Keywords: Avicennia germinans, plant productivity, biomass partitioning, coastal ecosystem, ecotone, herbivory, nutrients, seedling recruitment, *Spartina alterniflora*, vegetation shift

Temperate to tropical vegetation shifts

Changes in accretion and elevation dynamics?

Global Change Biology (accepted Nov 2007)

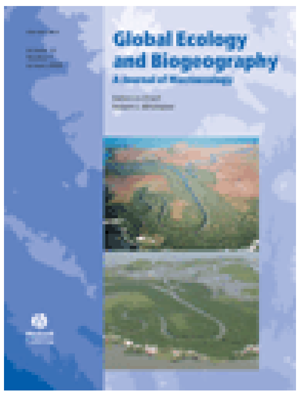
Global Ecology and Biogeography, (*Global Ecol. Biogeogr.*) (2004) **13**, 65–73

RESEARCH PAPER

Acute salt marsh dieback in the Mississippi River deltaic plain: a drought-induced phenomenon?

Karen L. McKee*†, Irving A. Mendelssohn‡ and Michael D. Materne§¶

†US Geological Survey, National Wetlands Research Center, Lafayette, LA 70506, USA, E-mail: karen_mckee@usgs.gov, ‡Wetland Biogeochemistry Institute, Louisiana State University, Baton Rouge, LA 70803, USA, §US Department of Agriculture, Natural Resources Conservation Service, Baton Rouge, LA 70803, USA and ¶Department of Agronomy, Louisiana State University, Baton Rouge, LA 70803, USA



*Corresponding author

ABSTRACT

Aims Extensive dieback of salt marsh dominated by the perennial grass *Spartina alterniflora* occurred throughout the Mississippi River deltaic plain during 2000. More than 100,000 ha were affected, with 43,000 ha severely damaged. The aim of this work was to determine if sudden dieback could have been caused by a coincident drought and to assess the significance of this event with respect to long-term changes in coastal vegetation.

Location Multiple dieback sites and reference sites were established along 150 km of shoreline in coastal Louisiana, USA.

Methods Aerial and ground surveys were conducted from June 2000 to September 2001 to assess soil conditions and plant mortality and recovery.

Results Dieback areas ranged in size from ~300 m^2–5 km^2 in area with 50–100% mortality of plant shoots and rhizomes in affected zones. Co-occurring species such as *Avicennia germinans* (black mangrove) and *Juncus roemerianus* (needlegrass rush) were unaffected. Historical records indicate that precipitation, river discharge, and mean sea level were unusually low during the previous year. Although the cause of dieback is currently unknown, plant and soil characteristics were consistent with temporary soil desiccation that may have reduced water availability, increased soil salinity, and/or caused soil acidification (via pyrite oxidation) and increased uptake of toxic metals such as Fe or Al. Plant recovery 15 months after dieback was variable (0–58% live cover), but recovering plants were vigorous and indicated no long-lasting effects of the dieback agent.

Main conclusions These findings have relevance for global change models of coastal ecosystems that predict vegetation responses based primarily on long-term increases in sea level and submergence of marshes. Our results suggest that large-scale changes in coastal vegetation may occur over a relatively short time span through climatic extremes acting in concert with sea-level fluctuations and pre-existing soil conditions.

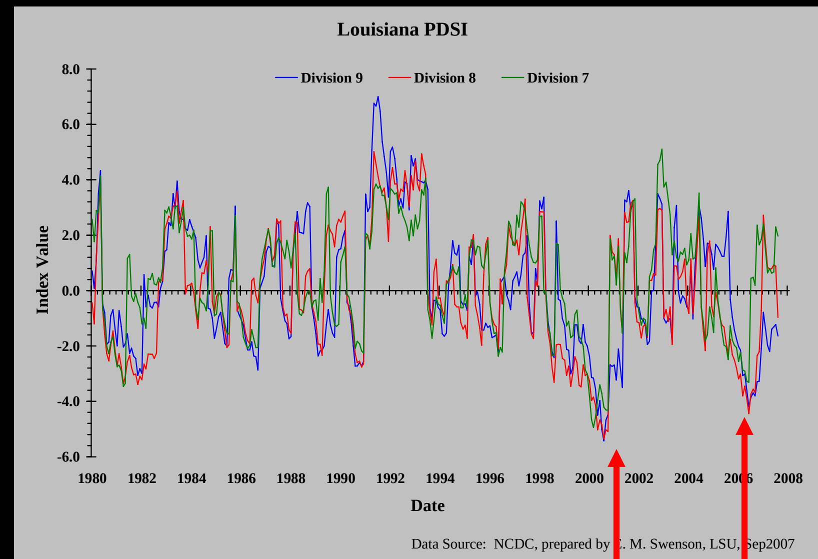
Keywords
Climate change, disturbance, Louisiana, pyrite, salinity, sea-level, soil acidification, *Spartina*, USA, wetland.

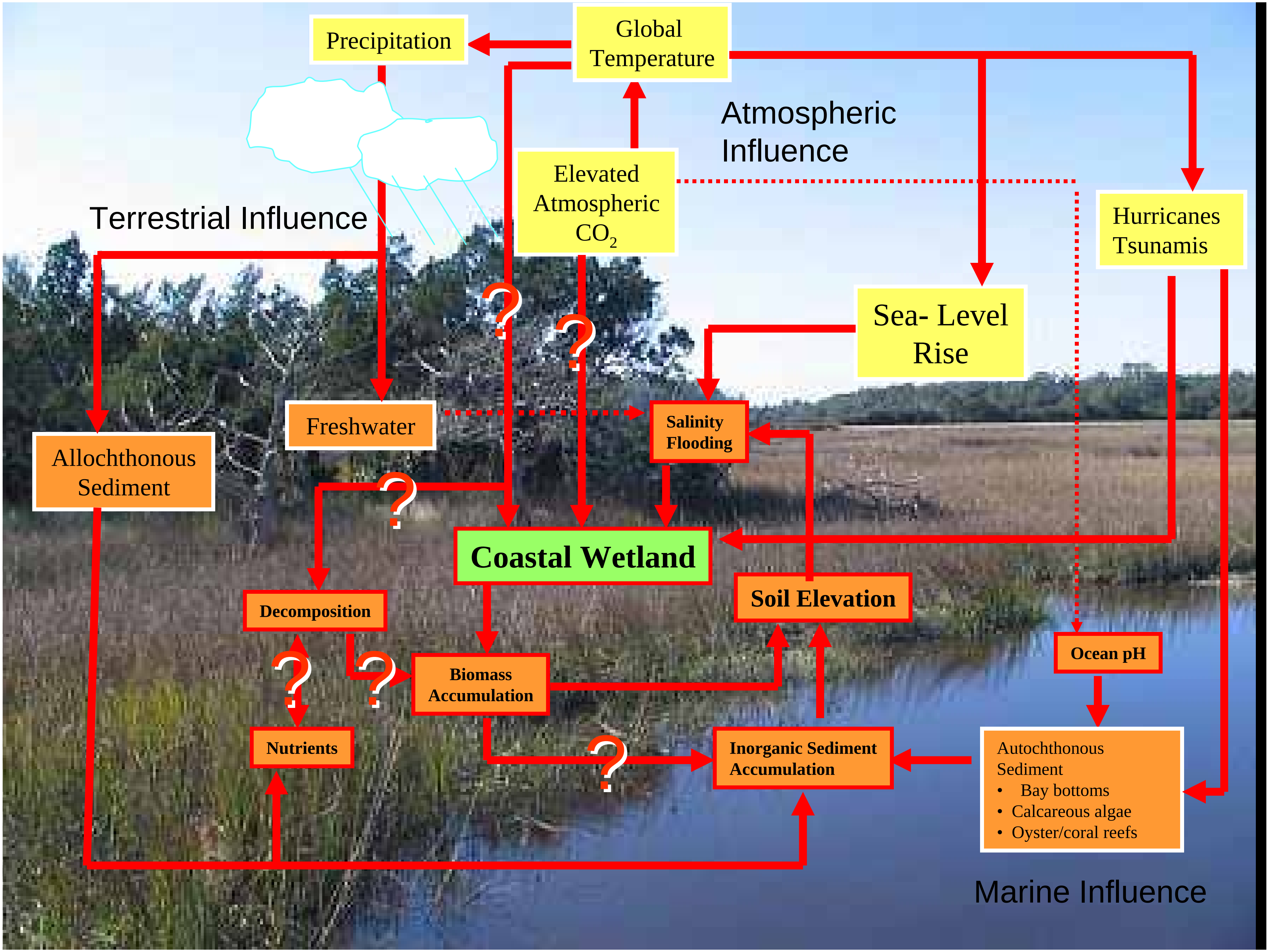
INTRODUCTION

The negative effects of global climate change on coastal wetlands, such as salt marshes and mangroves, are generally linked to increased sea-level rise due to glacial melting and ocean thermal expansion (McCarthy *et al.*, 2001). This scenario predicts that rising water levels will excessively submerge coastal wetlands and accelerate wetland degradation. The mechanisms controlling the impact of sea-level rise on coastal salt marshes are relatively well understood (Mendelssohn *et al.*, 1983; Day *et al.*, 1993). In contrast, climatic extremes, which may also have widespread but more rapid effects on coastal ecosystems, have received little attention.

The perennial marsh grass, *Spartina alterniflora* Loisel. (smooth cordgrass), which dominates regularly flooded salt

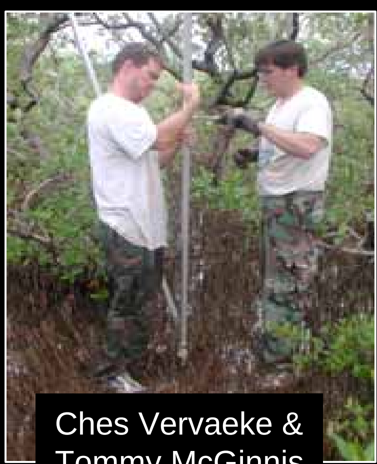
Palmer Drought Severity Index--LA




Global Temperature
Precipitation
Atmospheric Influence
Elevated Atmospheric CO_2
Hurricanes Tsunamis
Terrestrial Influence
Sea- Level Rise
Freshwater
Salinity Flooding
Allochthonous Sediment
Coastal Wetland
Soil Elevation
Decomposition
Ocean pH
Biomass Accumulation
Nutrients
Inorganic Sediment Accumulation
Autochthonous Sediment
• Bay bottoms
• Calcareous algae
• Oyster/coral reefs
Marine Influence

Thanks to Staff and Collaborators!

Ellen Travis



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Tommy McGinnis