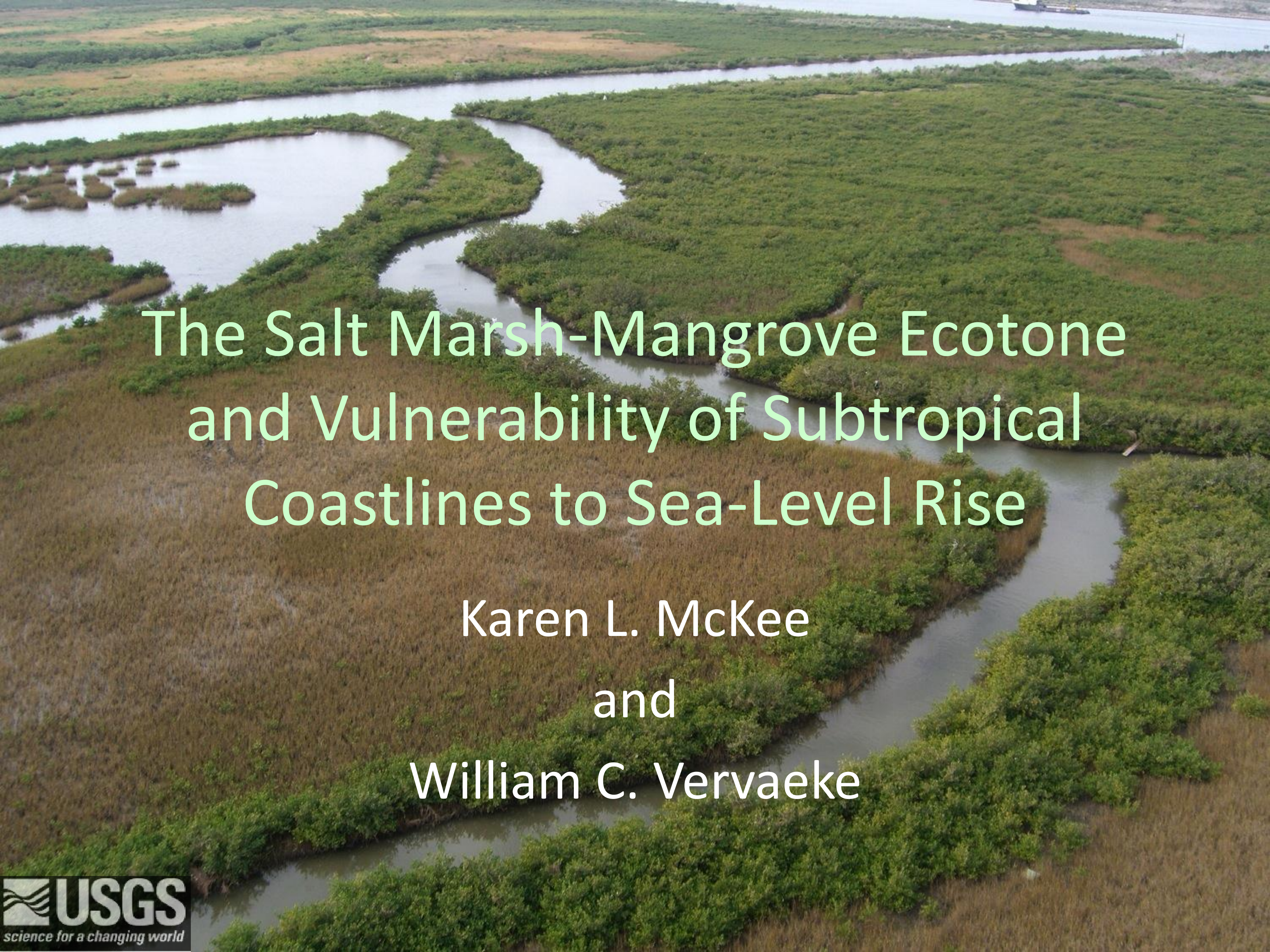
The Salt Marsh-Mangrove Ecotone and Vulnerability of Subtropical Coastlines to Sea-Level Rise

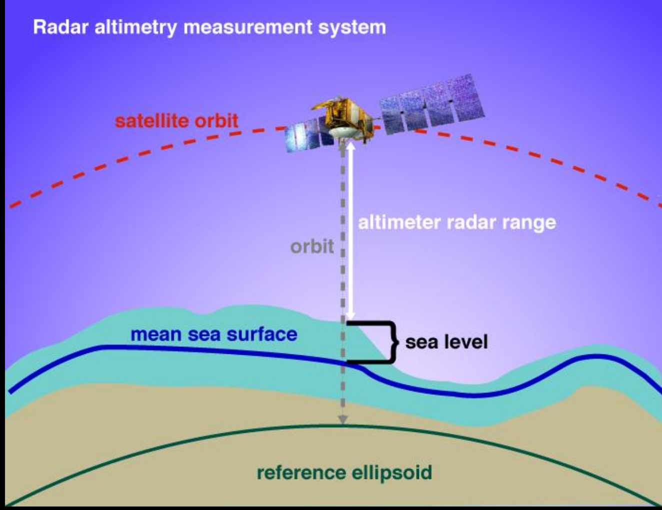
Karen L. McKee

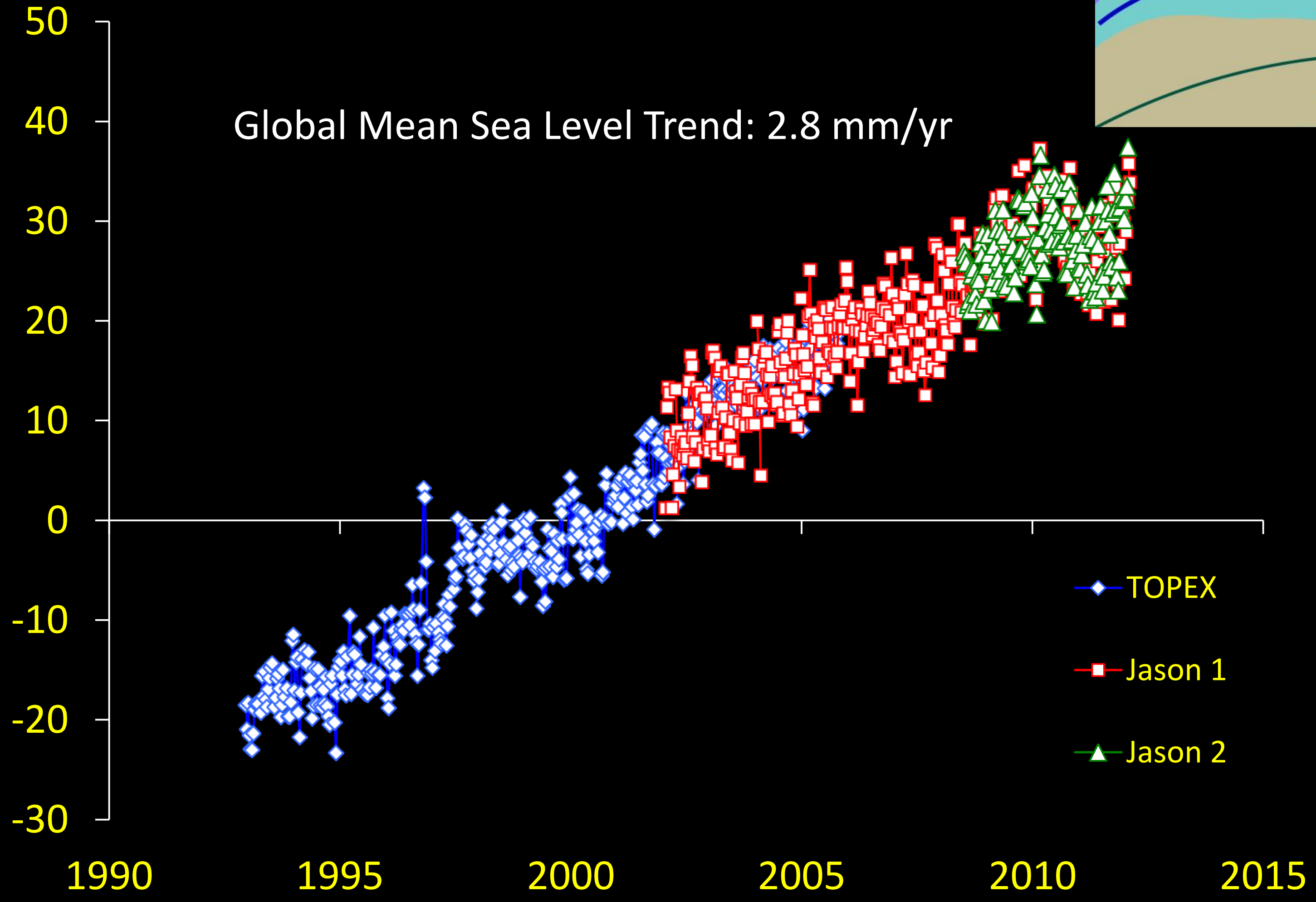
and

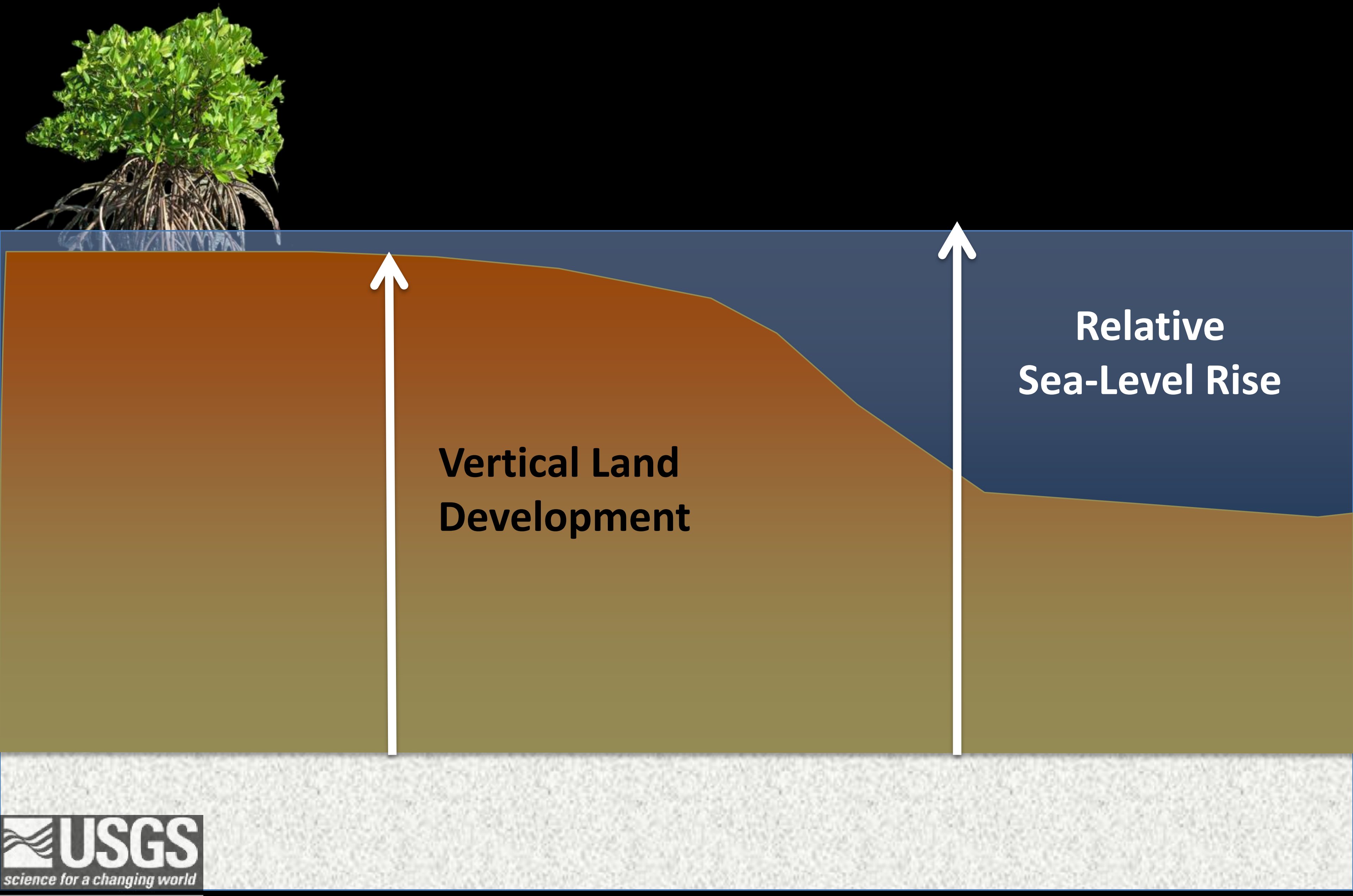
William C. Vervaeke



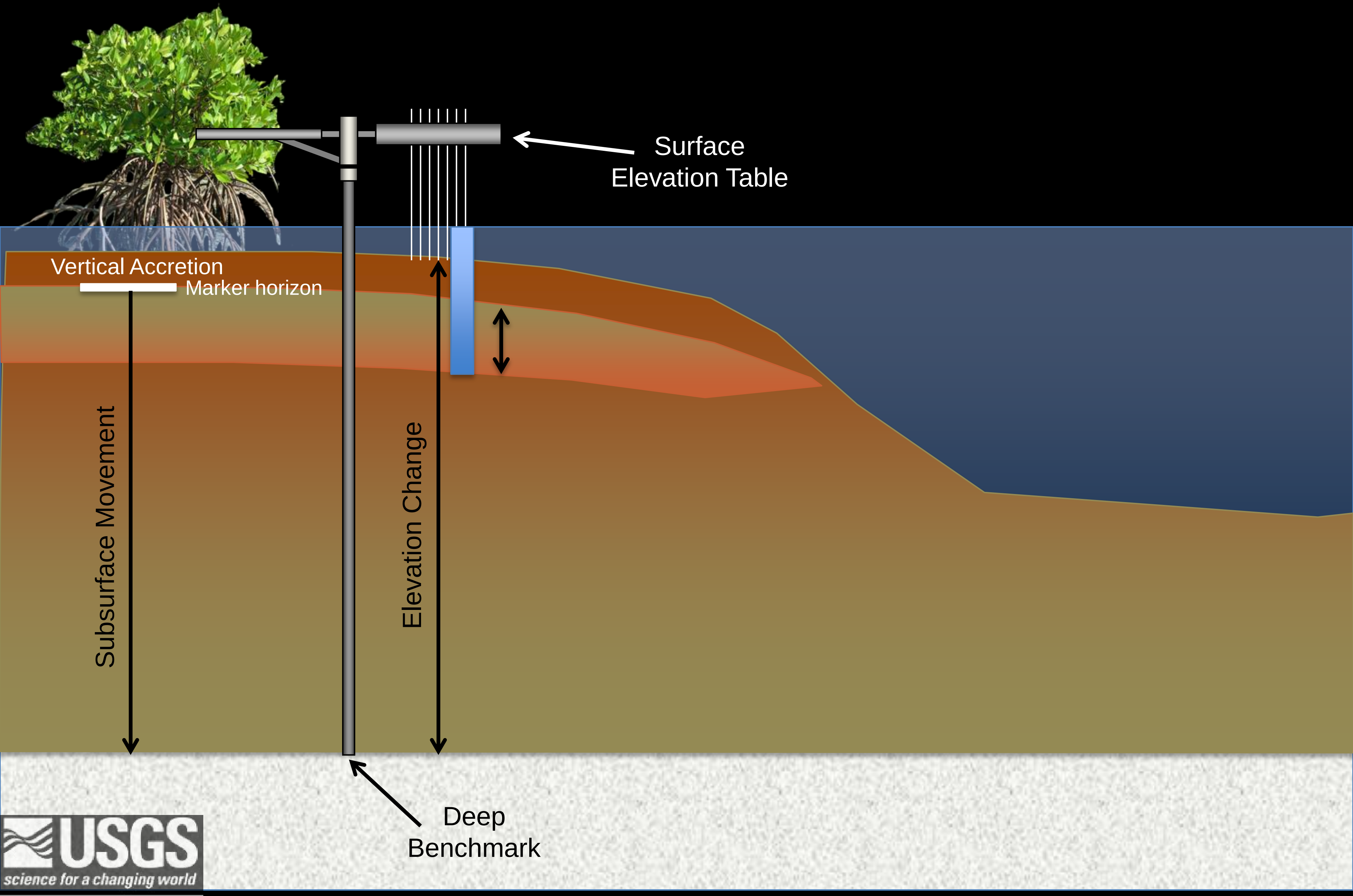
Satellite Altimetry (1992-present)

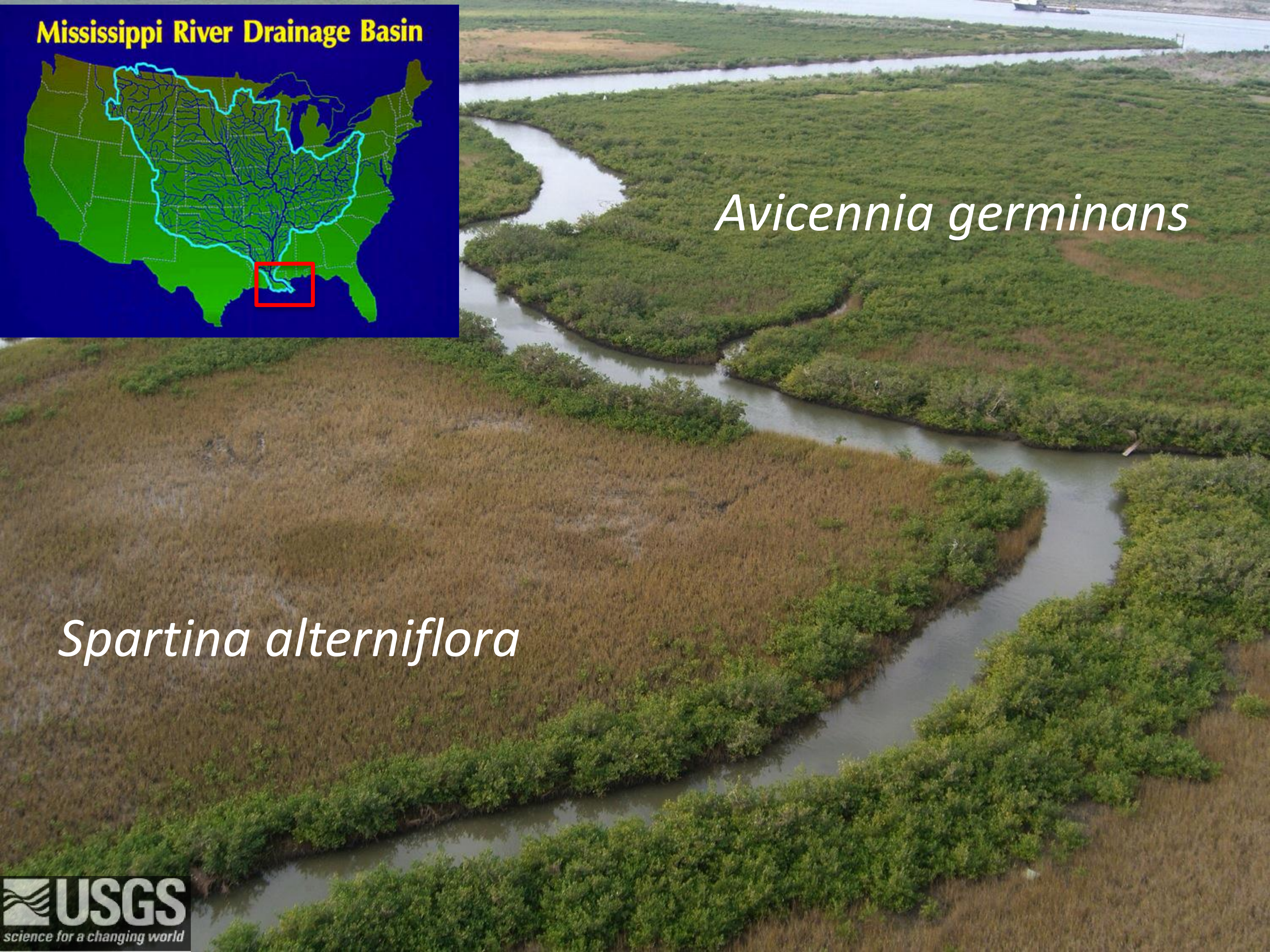





Relative
Sea-Level Rise
Vertical Land
Development
USGS
science for a changing world

Surface Elevation Table-Marker Horizon System




Mississippi River Drainage Basin
Avicennia germinans
Spartina alterniflora
USGS
science for a changing world

Salt Marsh–Wrack Burial


Salt Marsh–Wrack Burial
USGS
science for a changing world

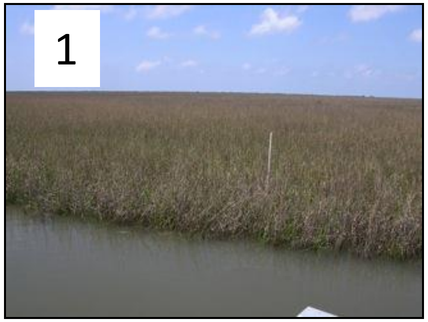

September 2011

September 2011

Mangroves–Freeze Damage

(January 2010)

Marsh-Mangrove Cyclic Succession Driven by Disturbance

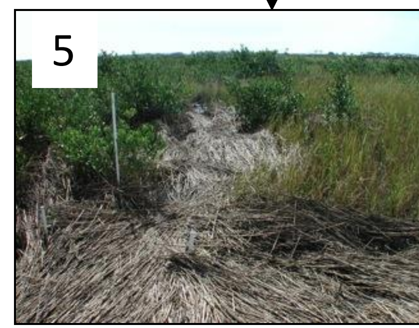


Salt marsh-monospecific stand of *Spartina alterniflora*

Spartina wrack deposited along shoreline in fall

Wrack removed by storm tides; *Avicennia* propagules deposited in bare patches

Mangroves developing in wrack-killed patches



Mangroves trap more wrack.

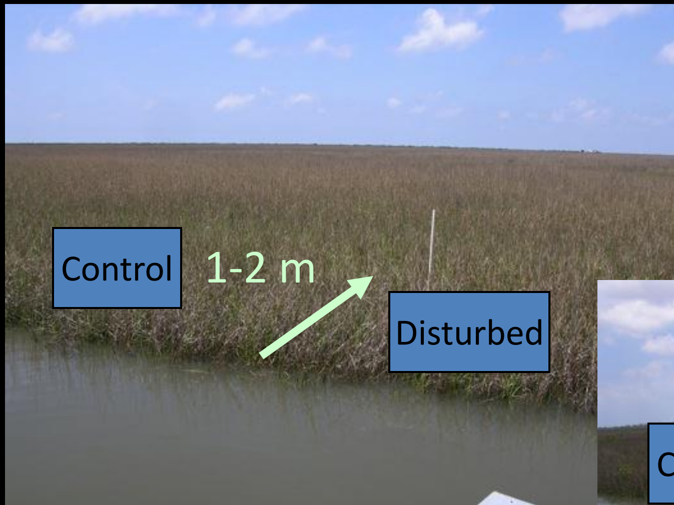
More bare patches are created in the marsh due to wrack trapping

Mangrove patches coalesce to form monospecific stands along the shoreline; marsh in interior

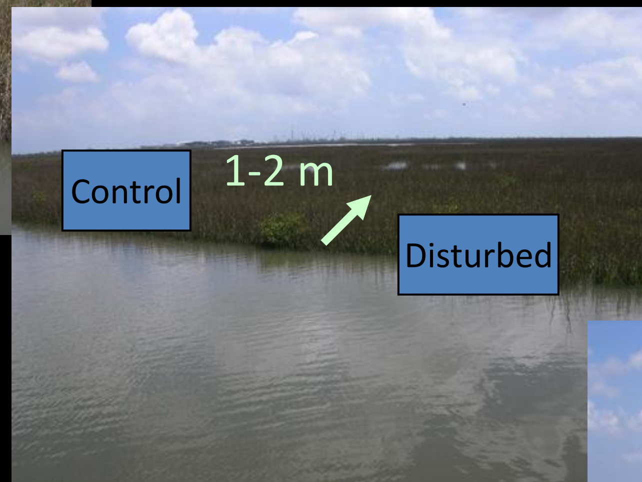
Mangroves damaged or killed by freeze

Do vegetation shifts and small-scale disturbance affect elevation trajectories in the salt marsh-mangrove system?

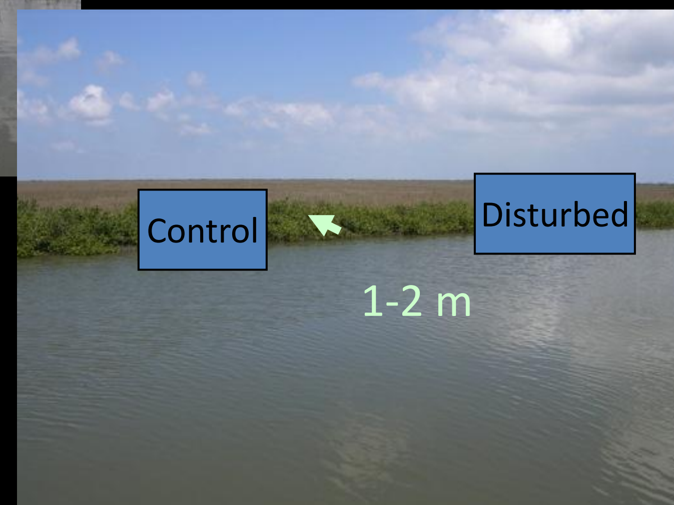
Experimental Design



Spartina



Mixed



Avicenna

3 Assemblages: *Spartina*, Avicennia, Mixed

2 treatments: Control, Disturbed

3 replicates of all combinations (total plots = 18)

USGS
science for a changing world

Instrumented with SETs and marker horizons: May 2006

Disturbance treatments applied: March 2007

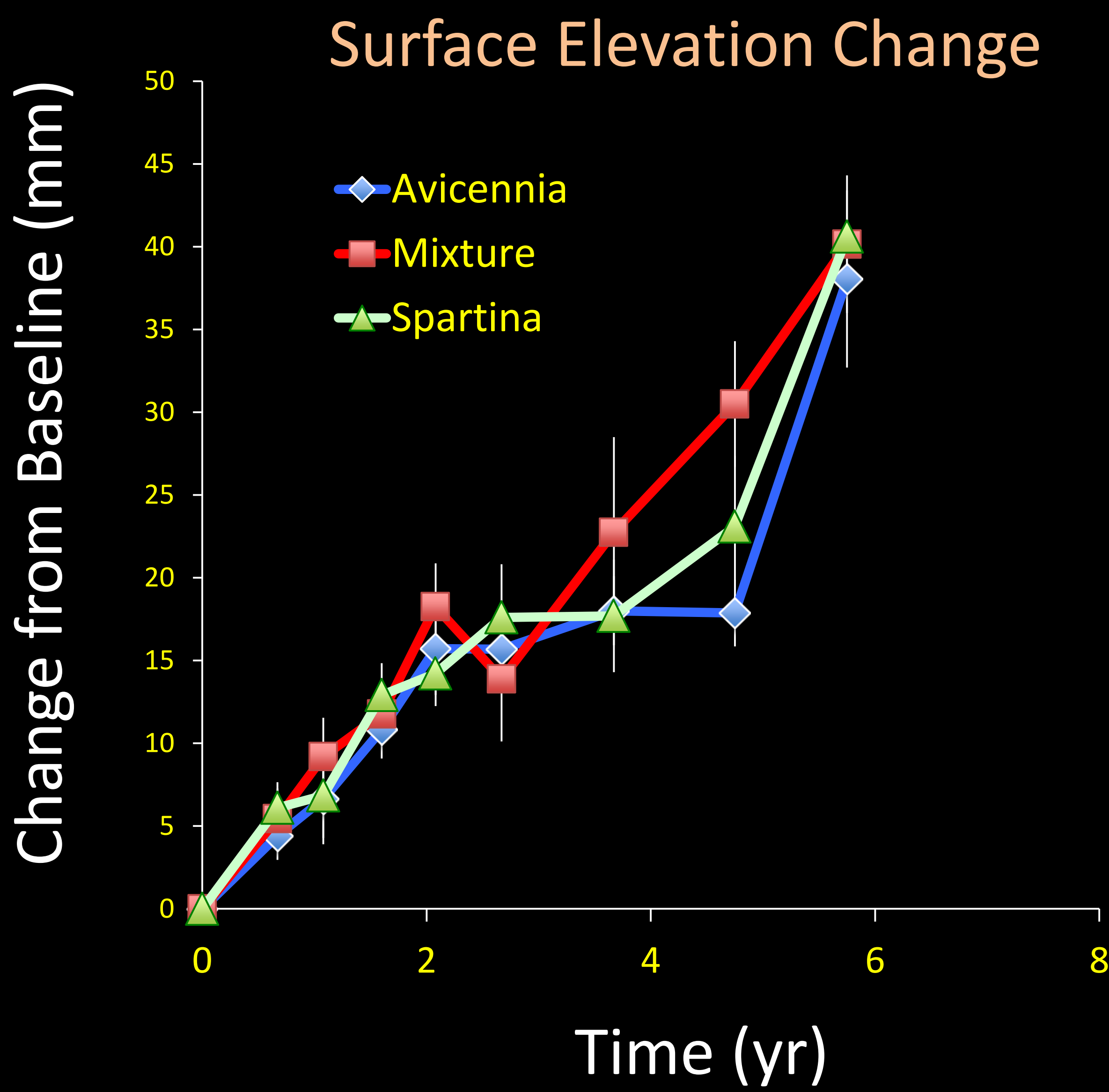
USGS
science for a changing world


USGS
science for a changing world


USGS
science for a changing world

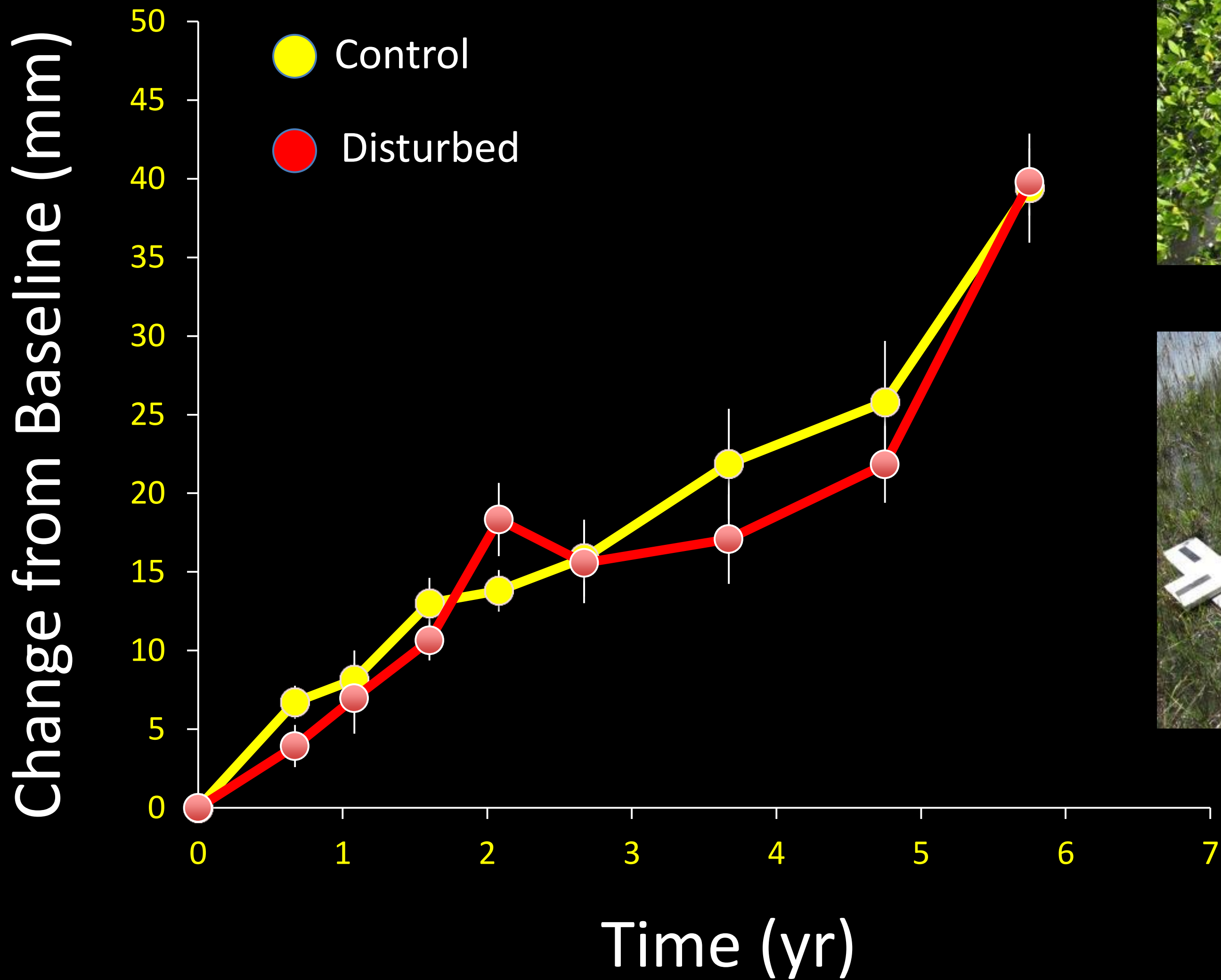

Live Cover:
Control: 71 %
Disturbed: 29%
F-ratio: 42.6, p < 0.0001
USGS
science for a changing world

Results



USGS
science for a changing world

Surface Elevation Change



USGS
science for a changing world

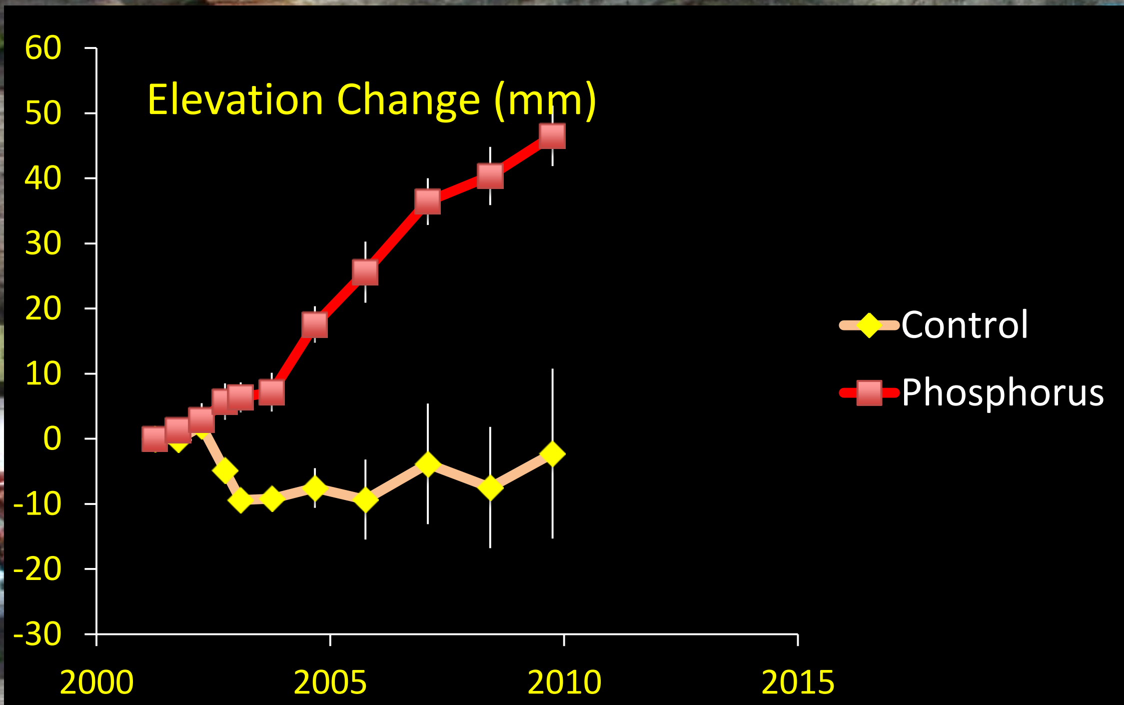
Rates of Change (mm yr^{-1})

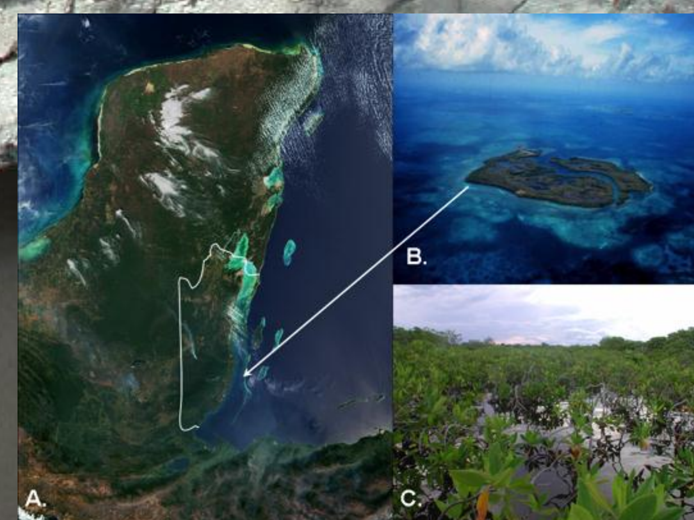
	Elevation Change	Vertical Accretion	Subsidence
Control	5.2 ± 0.9	10.5 ± 0.9	5.3 ± 1.1
Disturbed	4.5 ± 0.6	12.1 ± 1.7	7.7 ± 2.0

	Elevation Change	Vertical Accretion	Subsidence
Avicennia	3.9 ± 0.4	11.7 ± 2.2	7.7 ± 2.1
Spartina	4.6 ± 0.8	10.9 ± 1.2	6.3 ± 1.2
Mixture	6.0 1.3	11.5 ± 1.7	5.5 ± 2.6

ANOVA Source	F-ratio, P value		
Disturbance	0.47, ns	0.53, ns	0.81, ns
Species	1.36, ns	0.05, ns	0.26, ns
Dist x Spec	1.24, ns	0.05, ns	0.11, ns

Peat-Forming Systems (Belize)





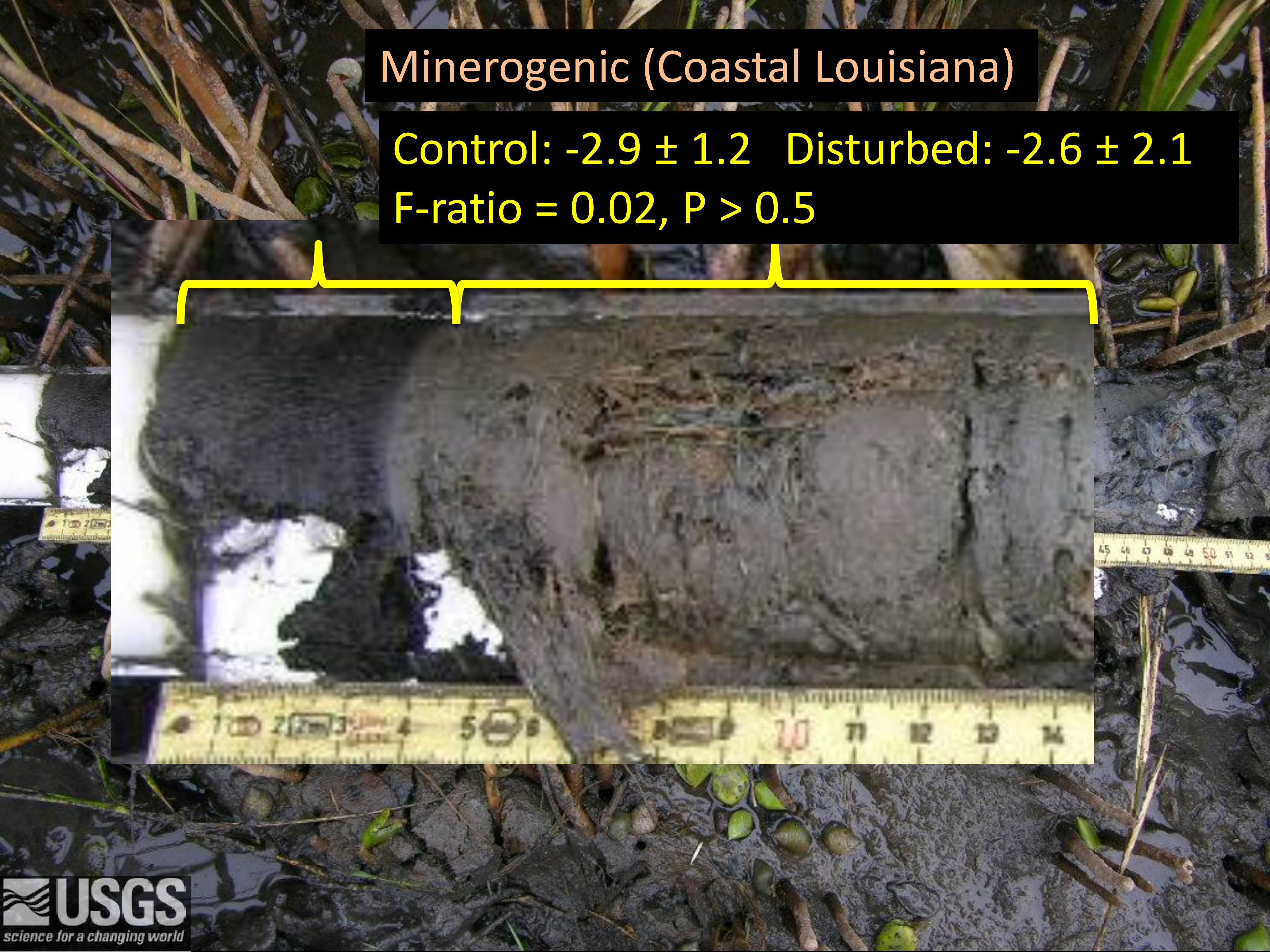
McKee et al. (2007), McKee (2011)

USGS
science for a changing world

Minerogenic (Coastal Louisiana)

Control: -2.9 ± 1.2   Disturbed: -2.6 ± 2.1

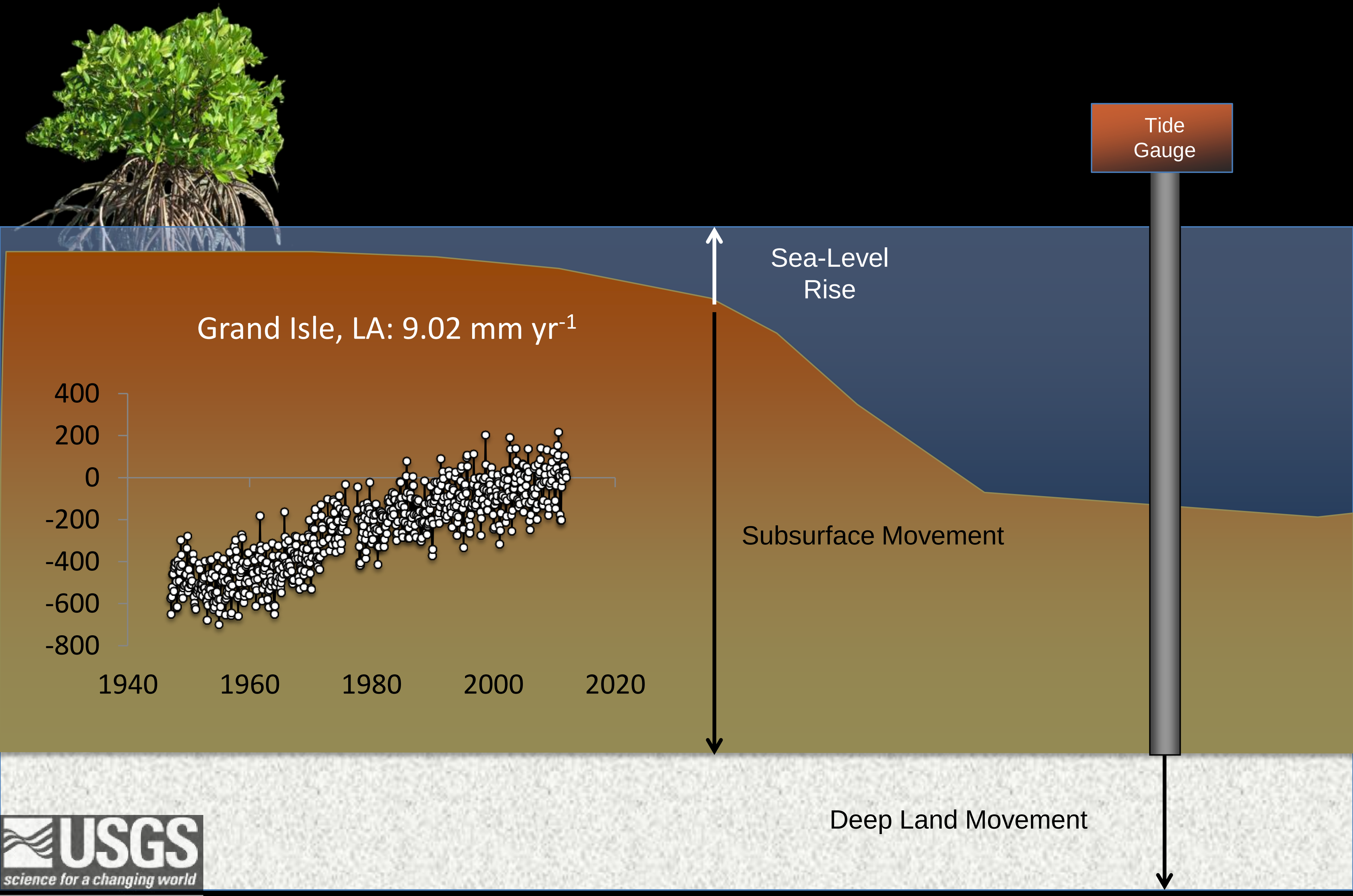
F-ratio = 0.02, P > 0.5



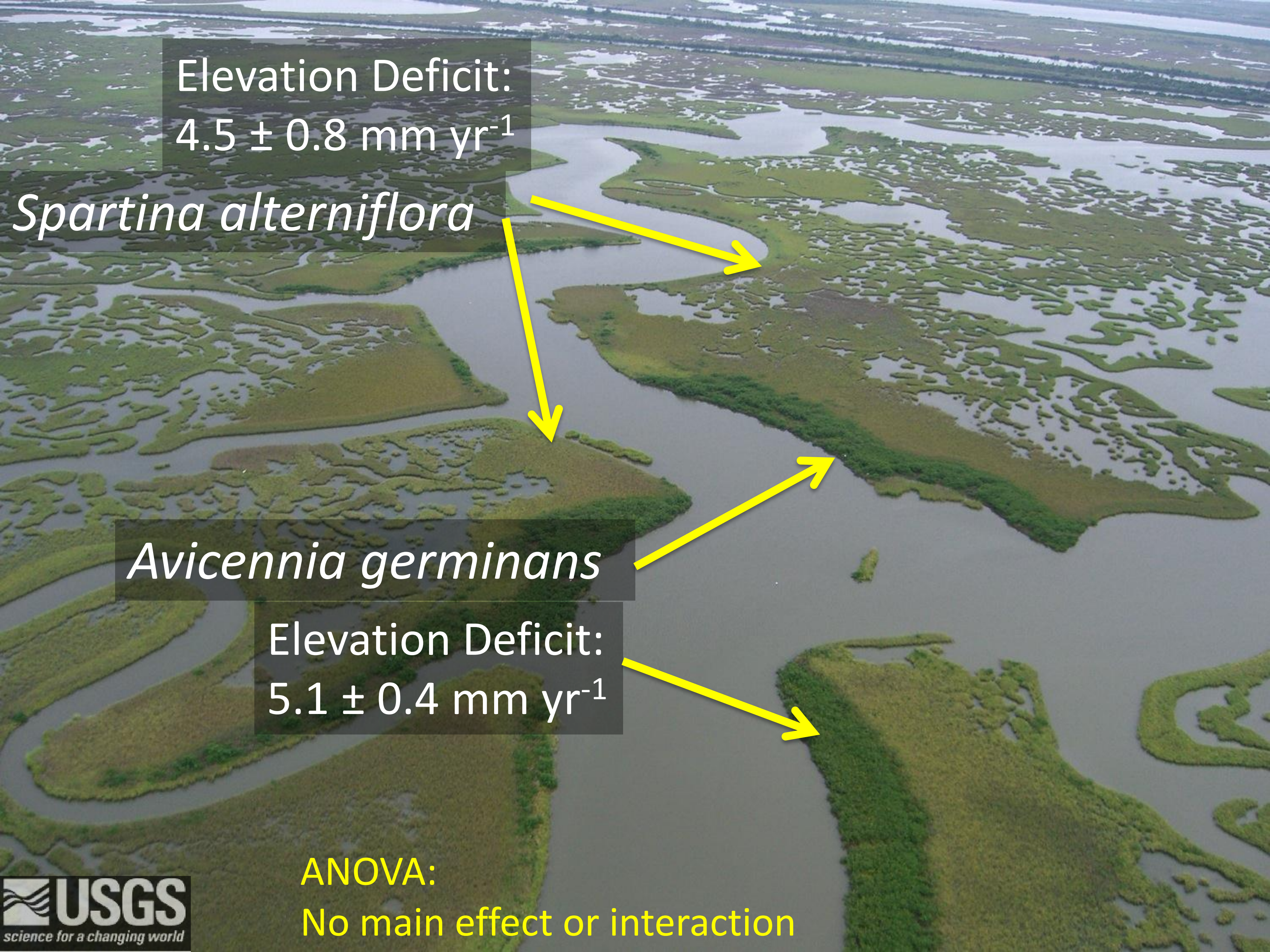
USGS
science for a changing world


Surface accretion
11 mm yr^{-1}
Root zone
-3 mm yr^{-1}
Sub-root zone
-3 mm yr^{-1}
L3A
USGS
science for a changing world

Elevation deficit = Local sea level trend minus elevation change rate



USGS science for a changing world


Elevation Deficit:
4.5 ± 0.8 mm yr-1
Spartina alterniflora
Avicennia germinans
Elevation Deficit:
5.1 ± 0.4 mm yr-1
ANOVA:
No main effect or interaction
USGS
science for a changing world

Control Plots

Elevation Deficit:

3.8 ± 0.9 mm yr^{-1}

Disturbed Plots

Elevation Deficit:

4.6 ± 0.6 mm yr^{-1}

ANOVA: F-ratio = 0.81, ns

Conclusions

1. The salt marsh-mangrove system is not keeping pace with relative sea-level rise

2. However, species shifts due to climate change or disturbance will not likely increase the risk of wetland loss

3. These findings are relevant for understanding vulnerability of subtropical coastlines to rising sea levels.

USGS
science for a changing world