Integrated Hydrodynamic and Ecological Models for Assessment of Climate-Change Impacts on Apalachicola Bay Ecosystem

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Major Effects of Climate Change (IPCC, 2007)

- Drought
- Flood
- Storms
- Hurricanes

ACF Basin and Apalachicola Bay

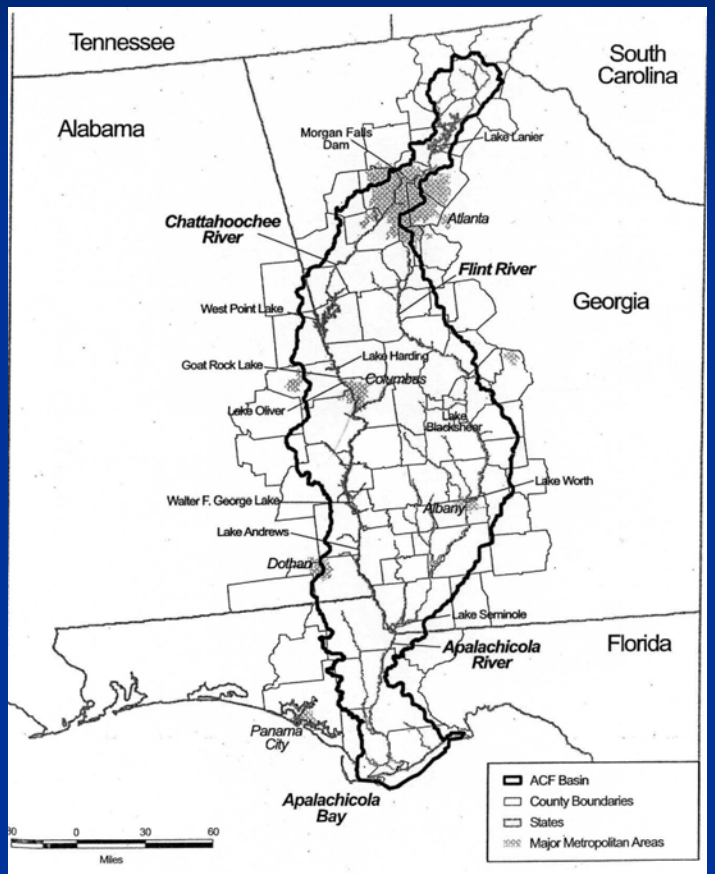
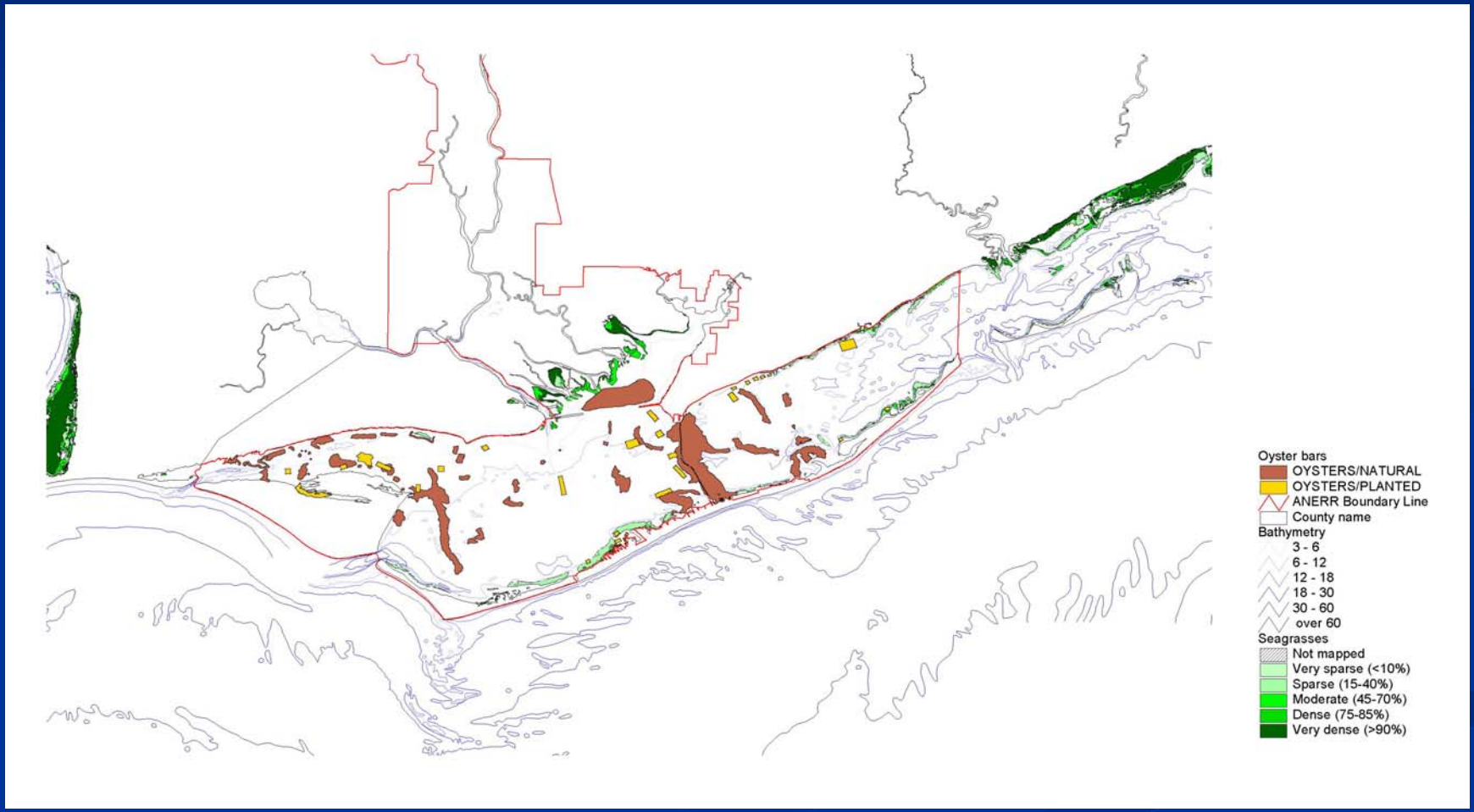


Figure 1. Study area: The Apalachicola River basin

- Competing water usage among states of Alabama, Georgia, and Florida.
- Apalachicola Bay been has been designated as a National a National Estuarine Research Reserve.

Apalachicola Bay produces about 90% of Florida's oyster



Oysters, Shrimps, and clams

Neural network for flow forecasting in Apalachicola River (Huang et al, 2004)

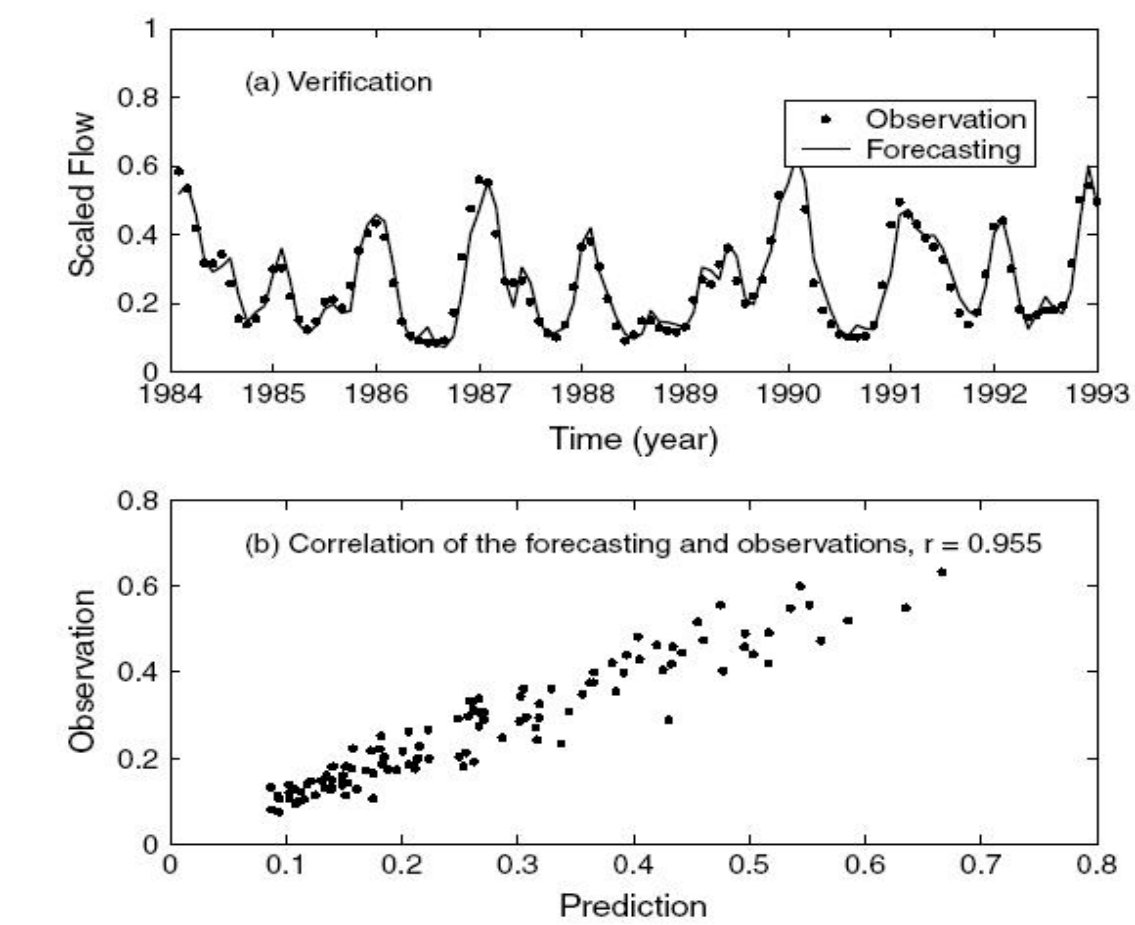


Figure 8. ANN verification for monthly flow forecasting

Neural network for flow forecasting - model training

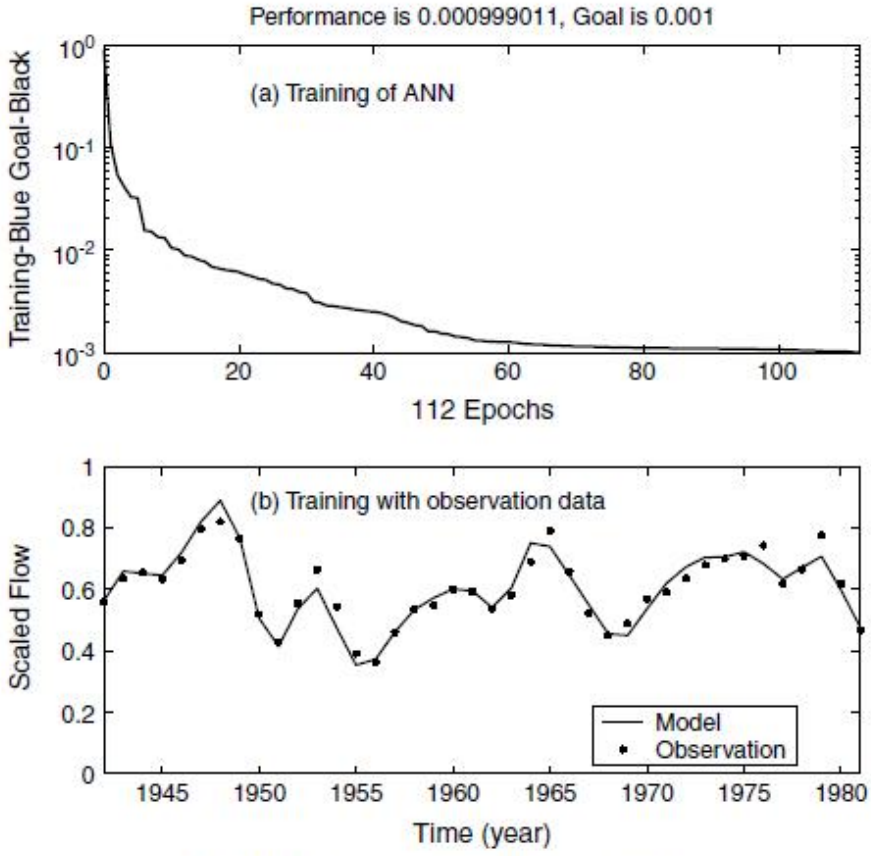
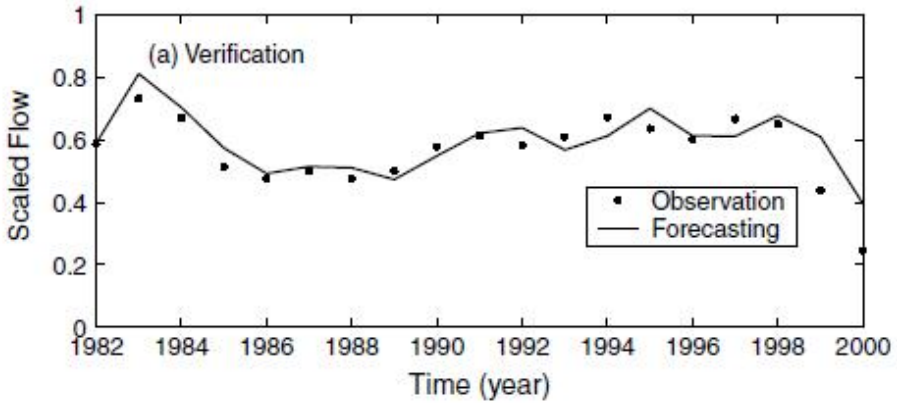


Figure 13. ANN training for yearly flow forecasting

Neural network for flow forecasting – model verification/testing



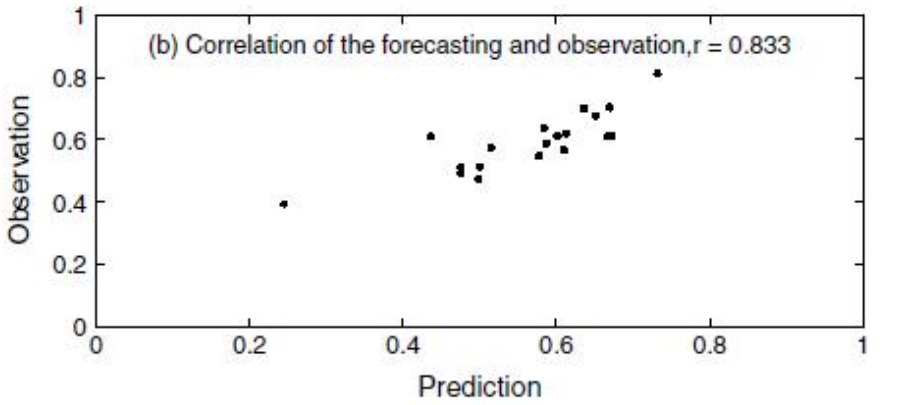
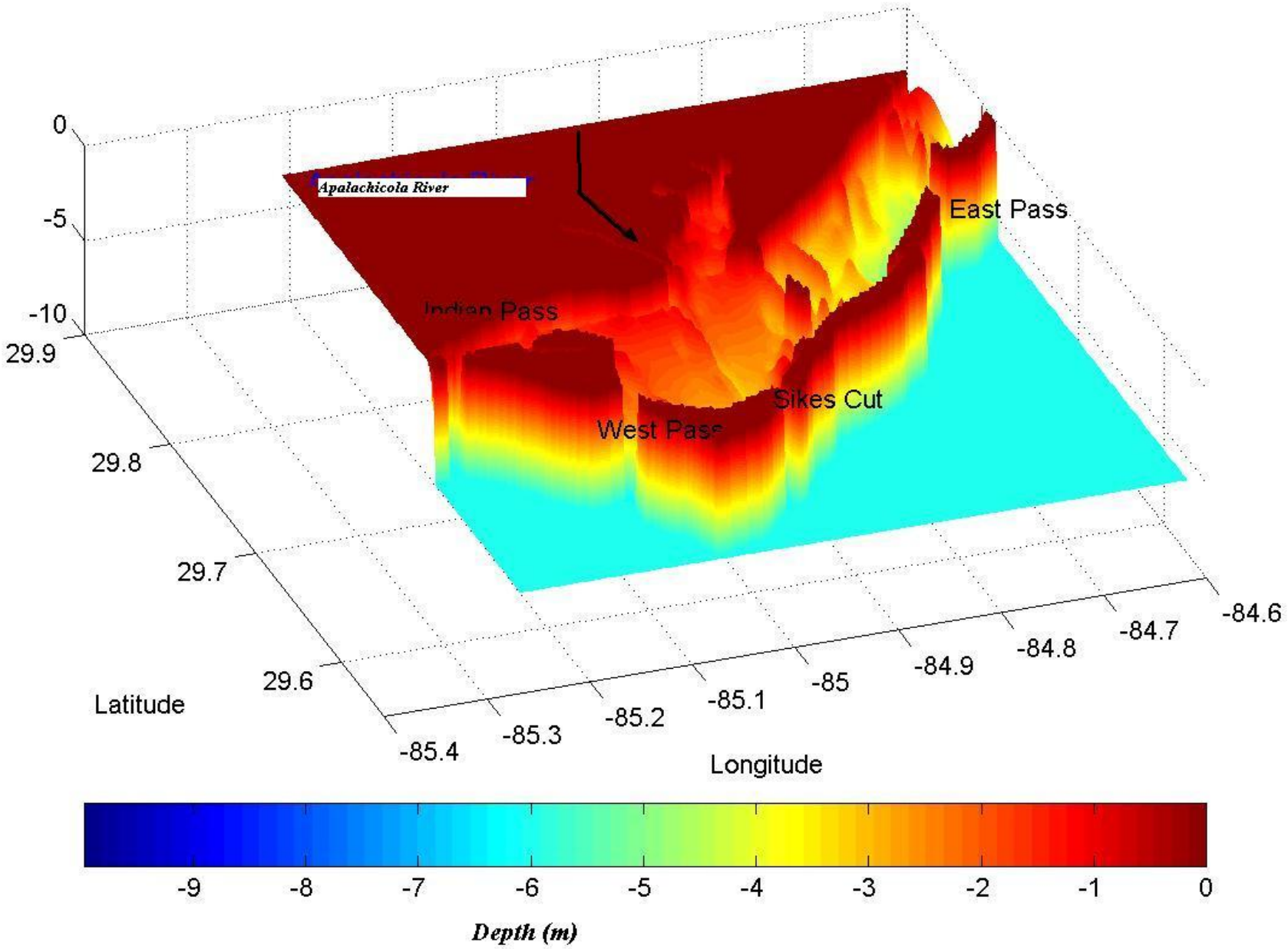


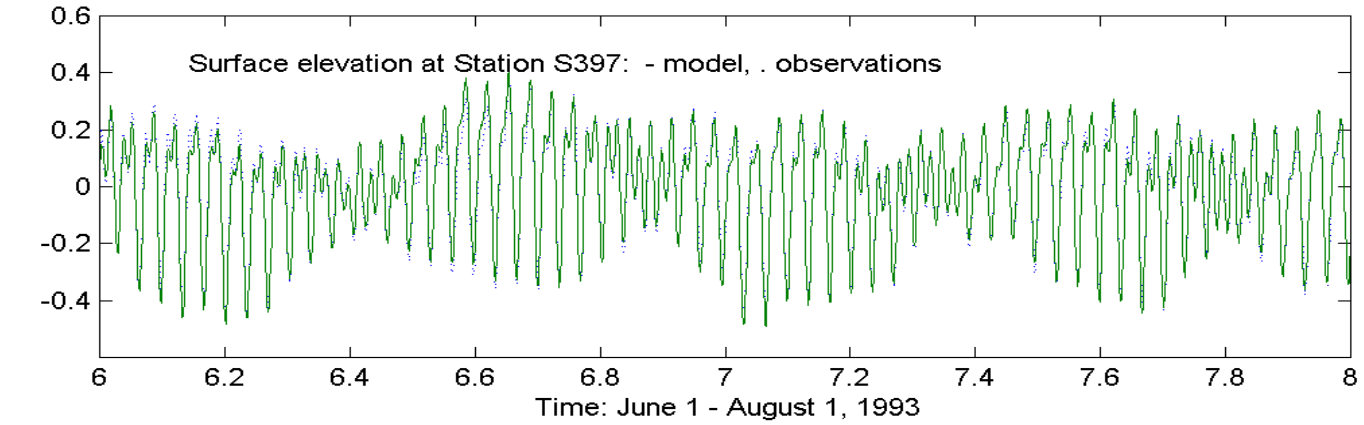
Figure 14. ANN verification for yearly forecasting

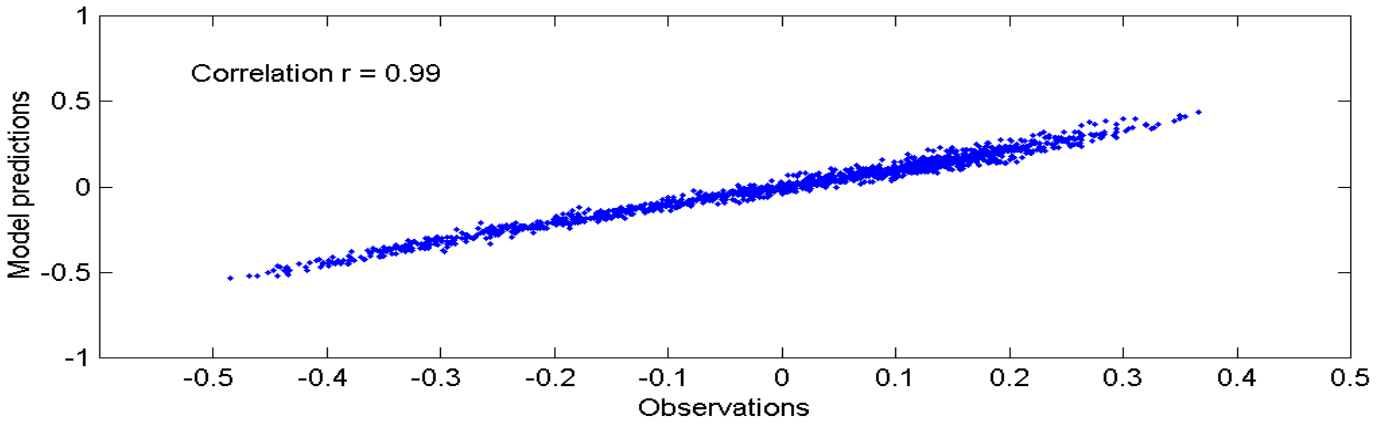
Hydrodynamic and water quality Models

- POM model improved by Huang (2000, 2002) in turbulent model and sigma coordinate schemes
- The model is able to predict temporal and spatial distributions of water levels, currents, and salinity in the bay.
- EFDC Model-coupled hydrodynamics and water quality models


0
-5
-10
29.9
29.8
29.7
29.6
Latitude
-85.4
-85.3
-85.2
-85.1
-85
-84.9
-84.8
-84.7
-84.6
Longitude
Apalachicola River
East Pass
Indian Pass
Sikes Cut
West Pass
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
Depth (m)

Surface elevation at observation station





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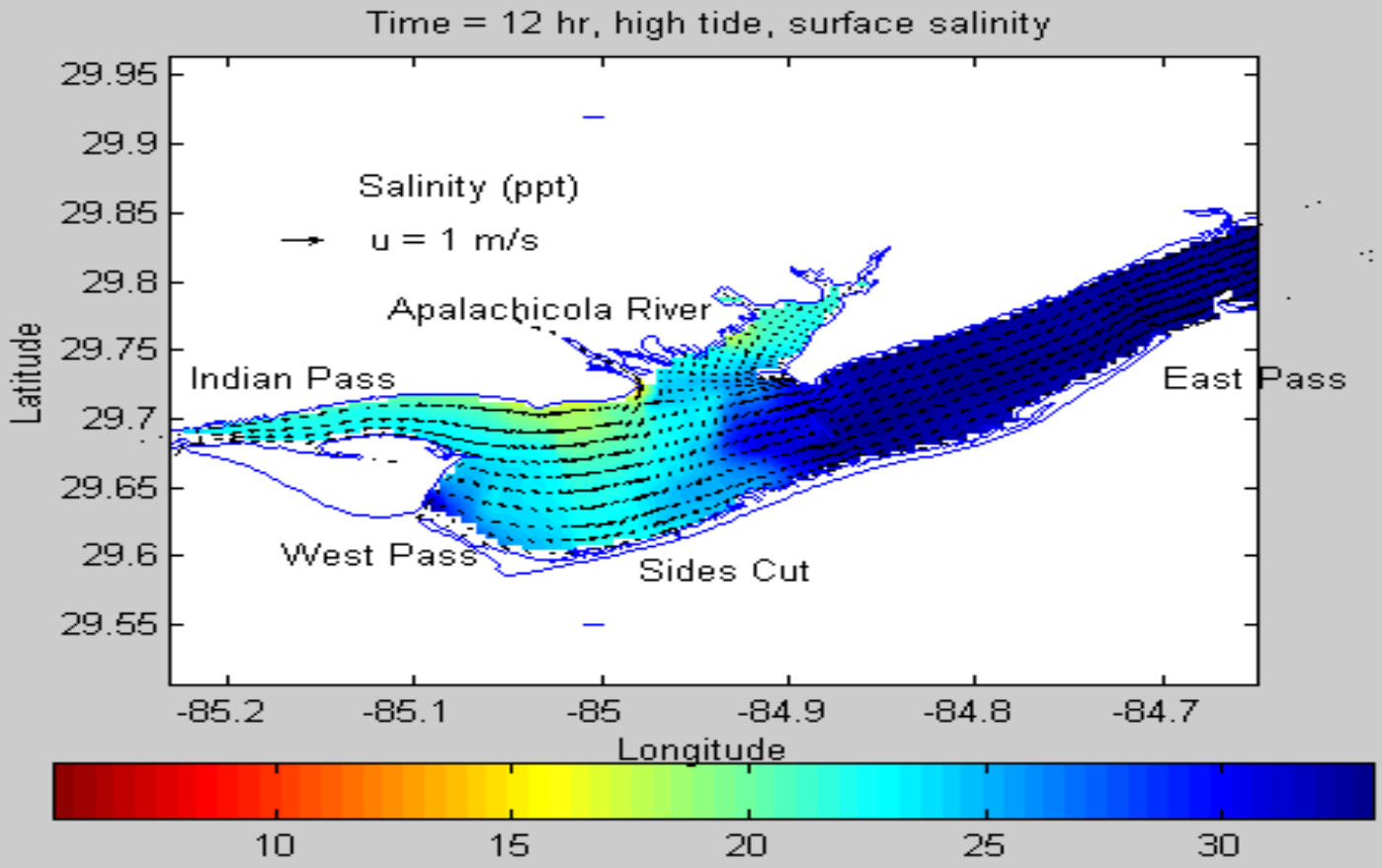
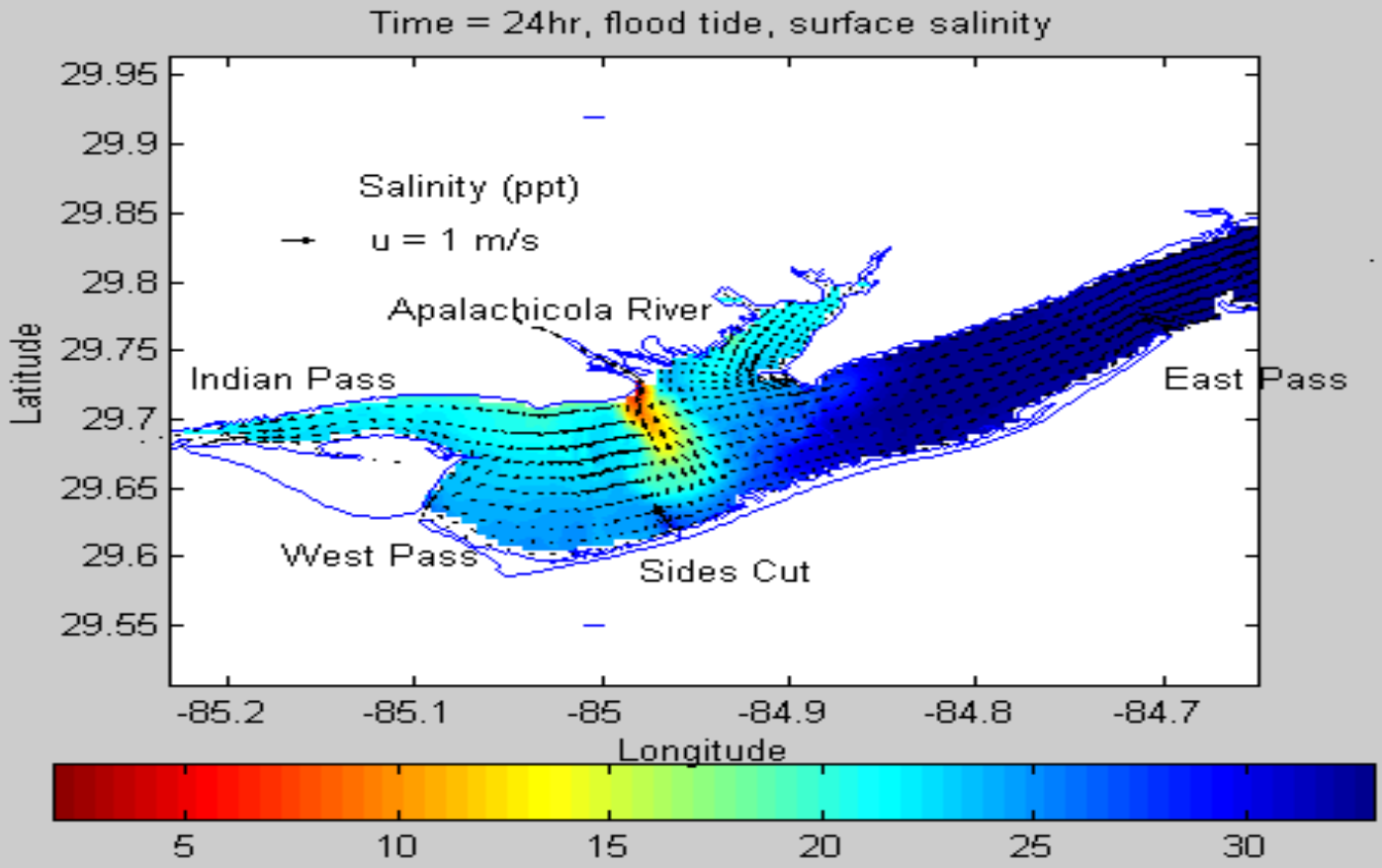
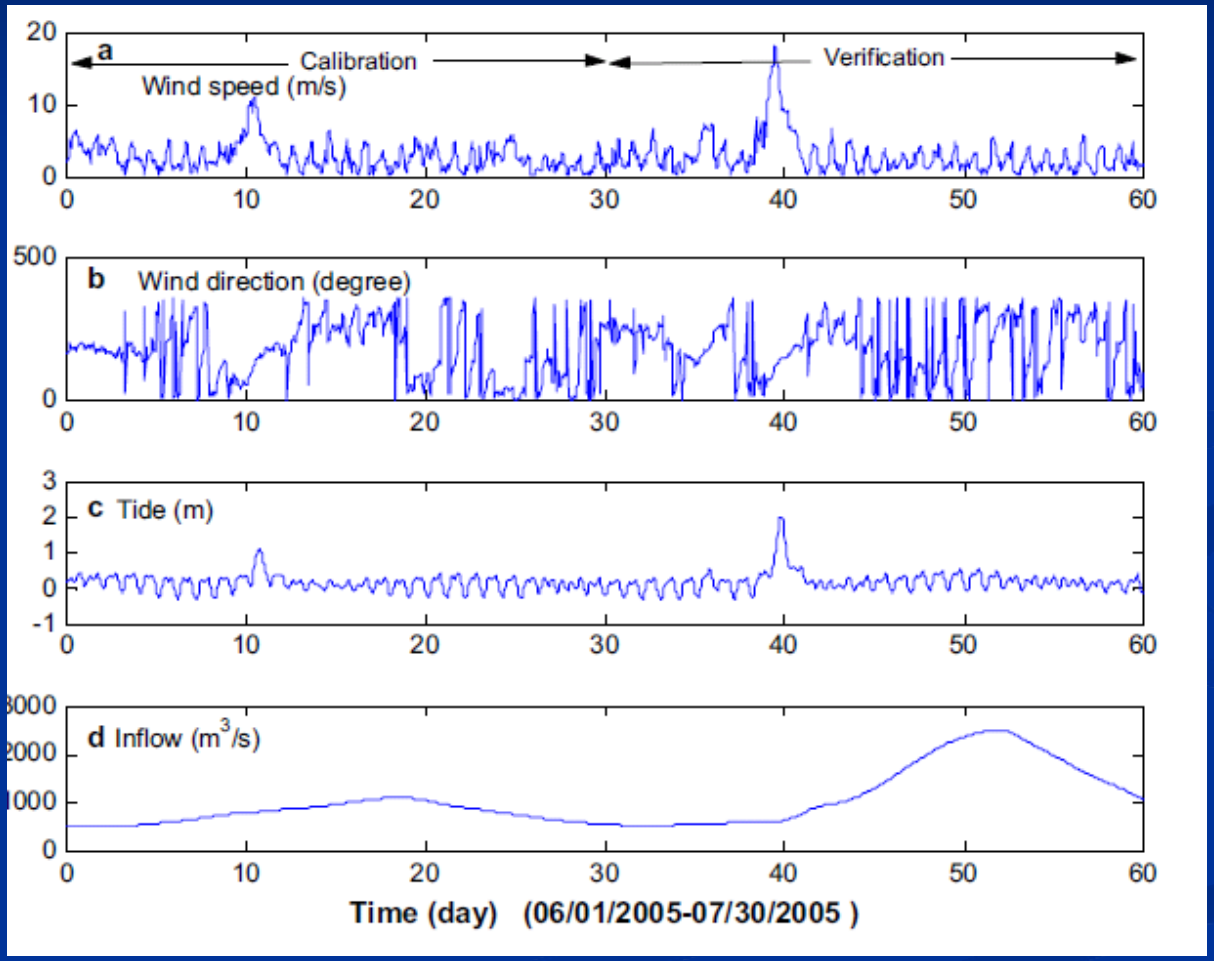
Horizontal salinity variation




Time = 24hr, flood tide, surface salinity
Salinity (ppt)
u = 1 m/s
Apalachicola River
Indian Pass
East Pass
West Pass
Sides Cut
Latitude
Longitude
29.95
29.9
29.85
29.8
29.75
29.7
29.65
29.6
29.55
-85.2
-85.1
-85
-84.9
-84.8
-84.7
5
10
15
20
25
30

Suspended sediment Modeling (Liu and Huang, 2009)-Boundary conditions



Suspended sediment Modeling (Liu and Huang, 2009)- Model calibration

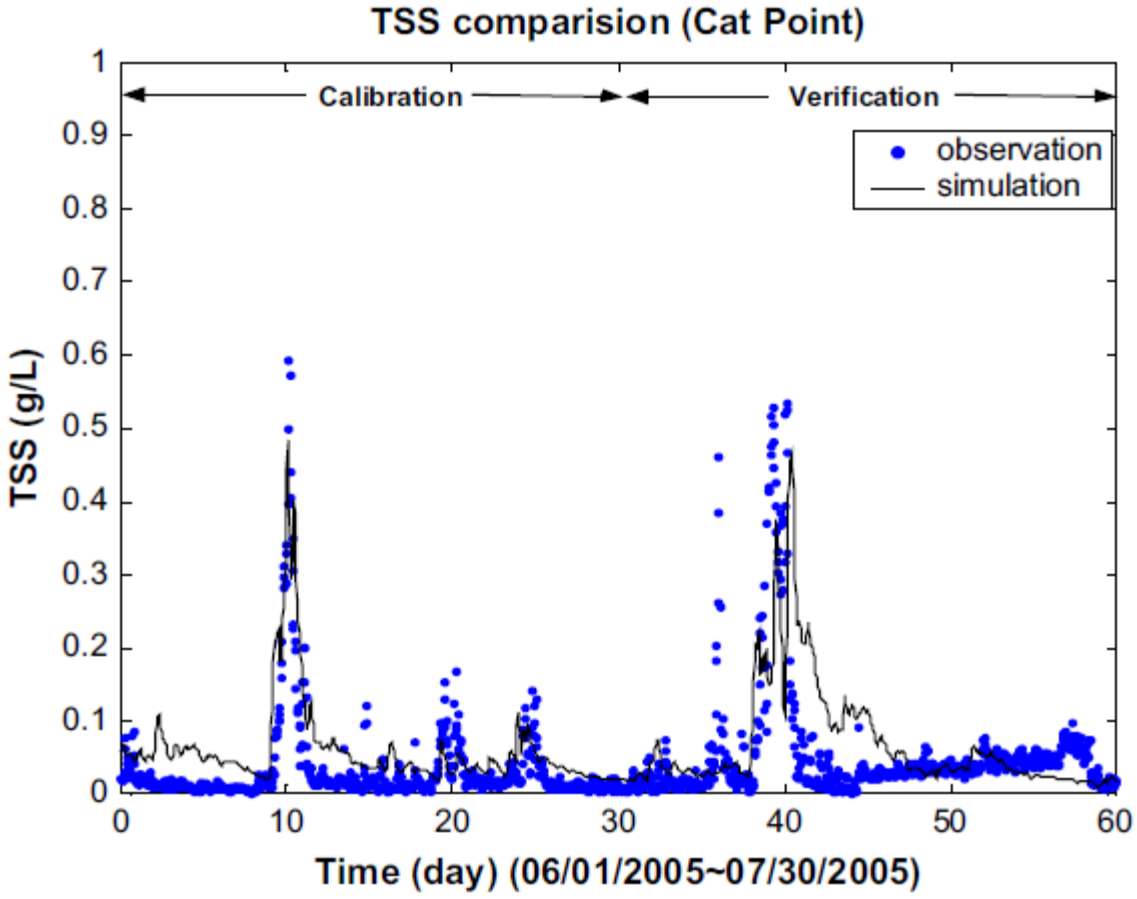
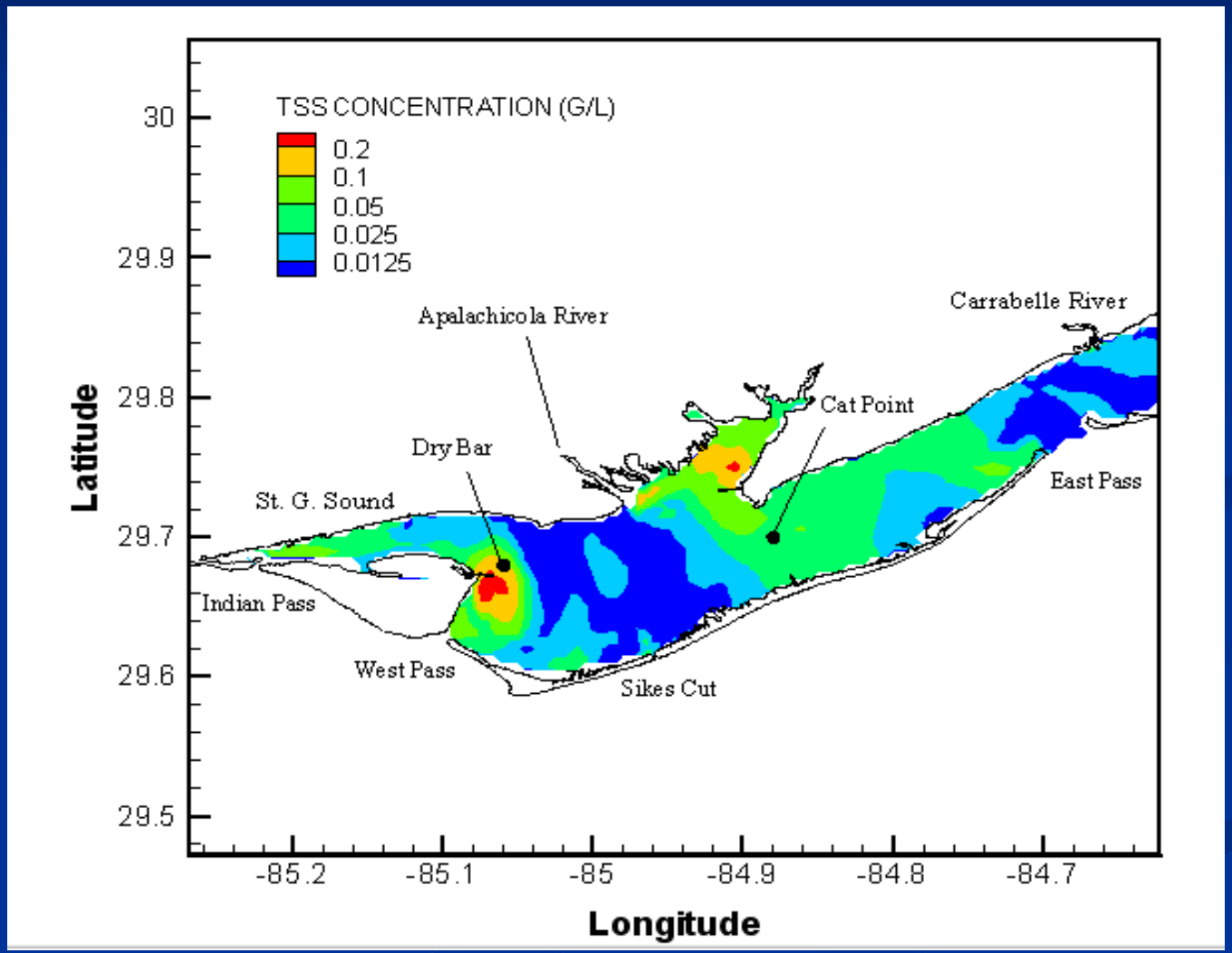


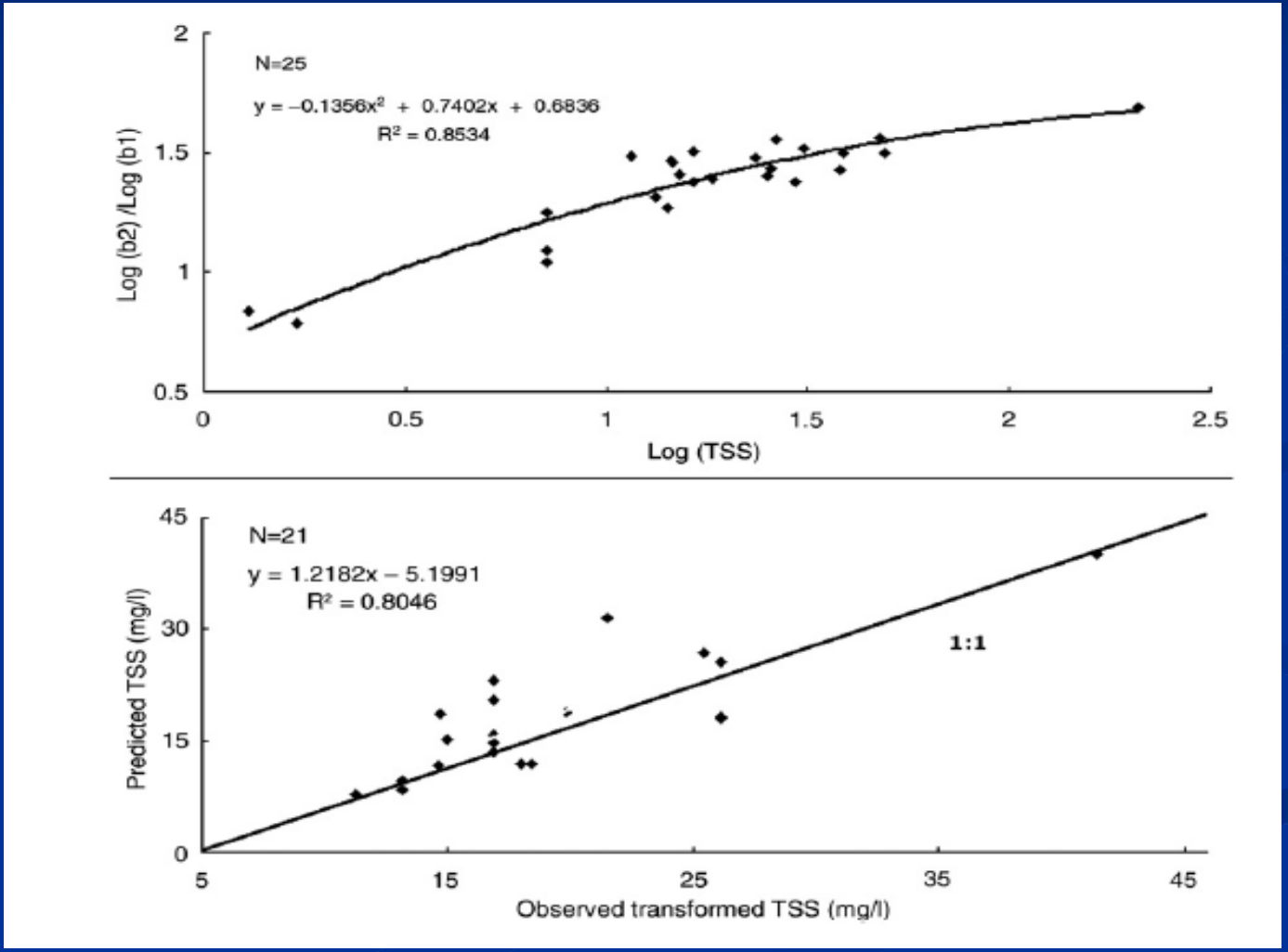
Fig. 9. Comparison of observation and simulation of TSS at Station Cat Point.

Suspended sediment Modeling (Liu and Huang, 2009)- model simulations



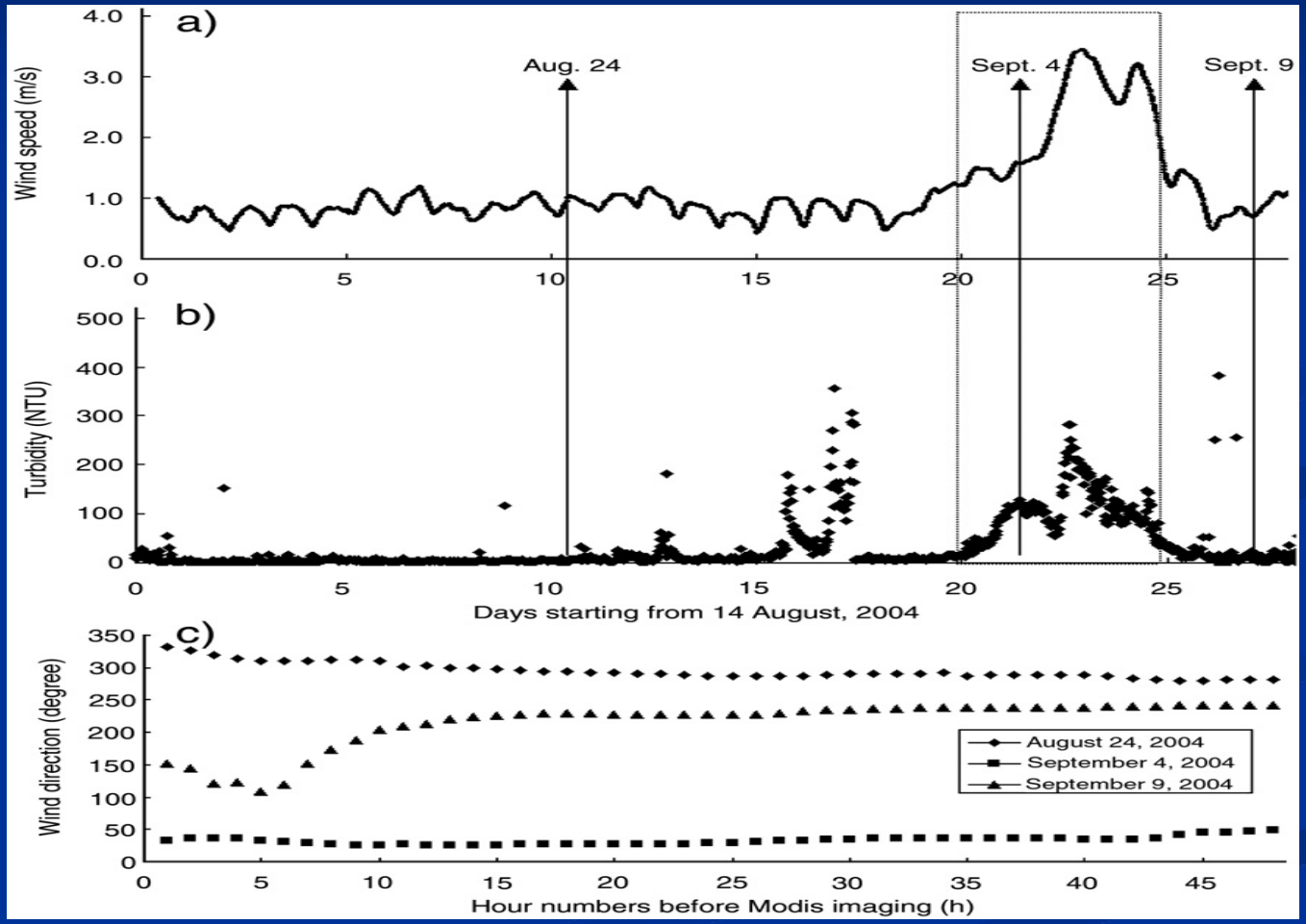
Detecting hurricane-induced sediment by remote sensing

Remote-Sensing Regression Model (MODIS 250m)

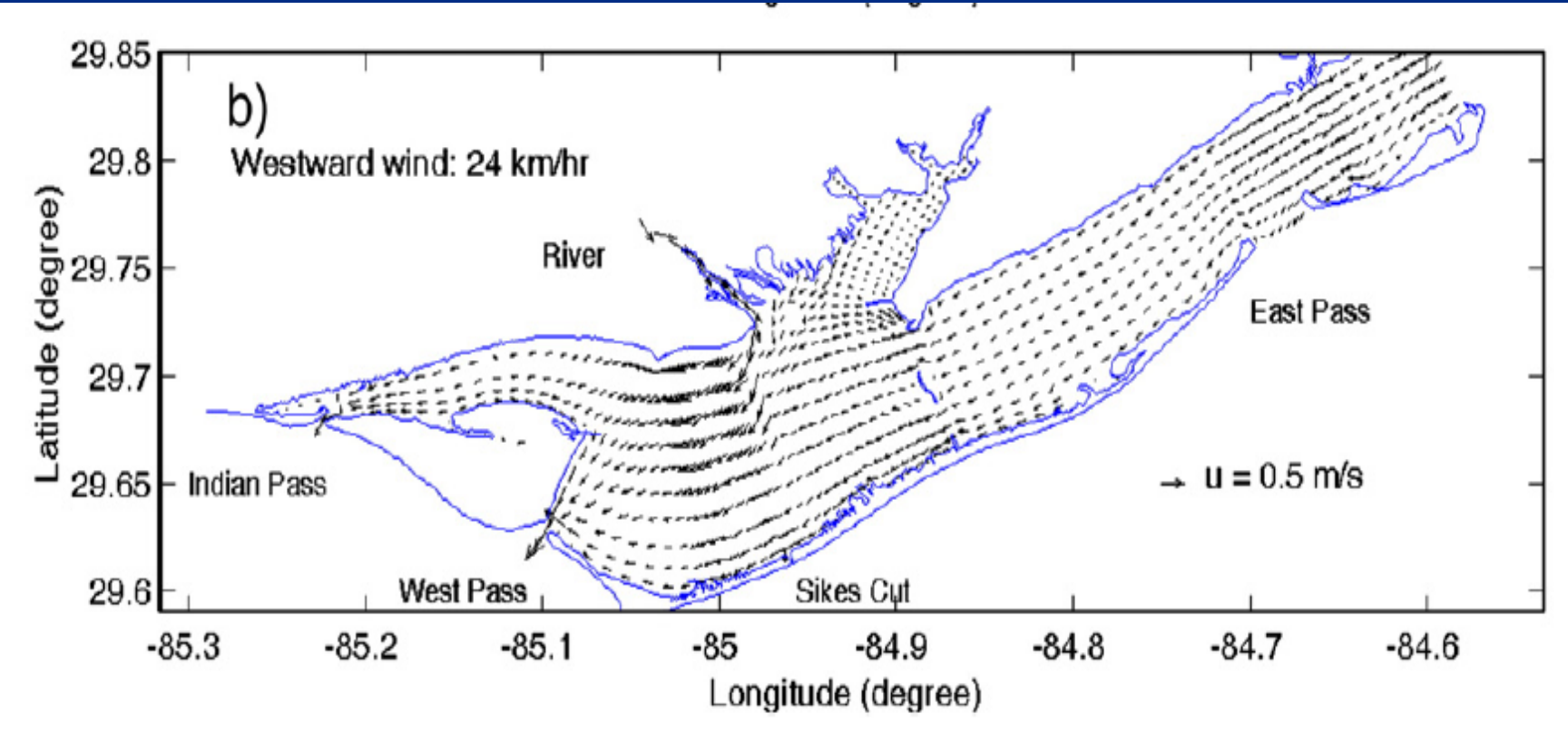


Path of Hurricane Frances and Apalachicola Bay area, 9/4/2004

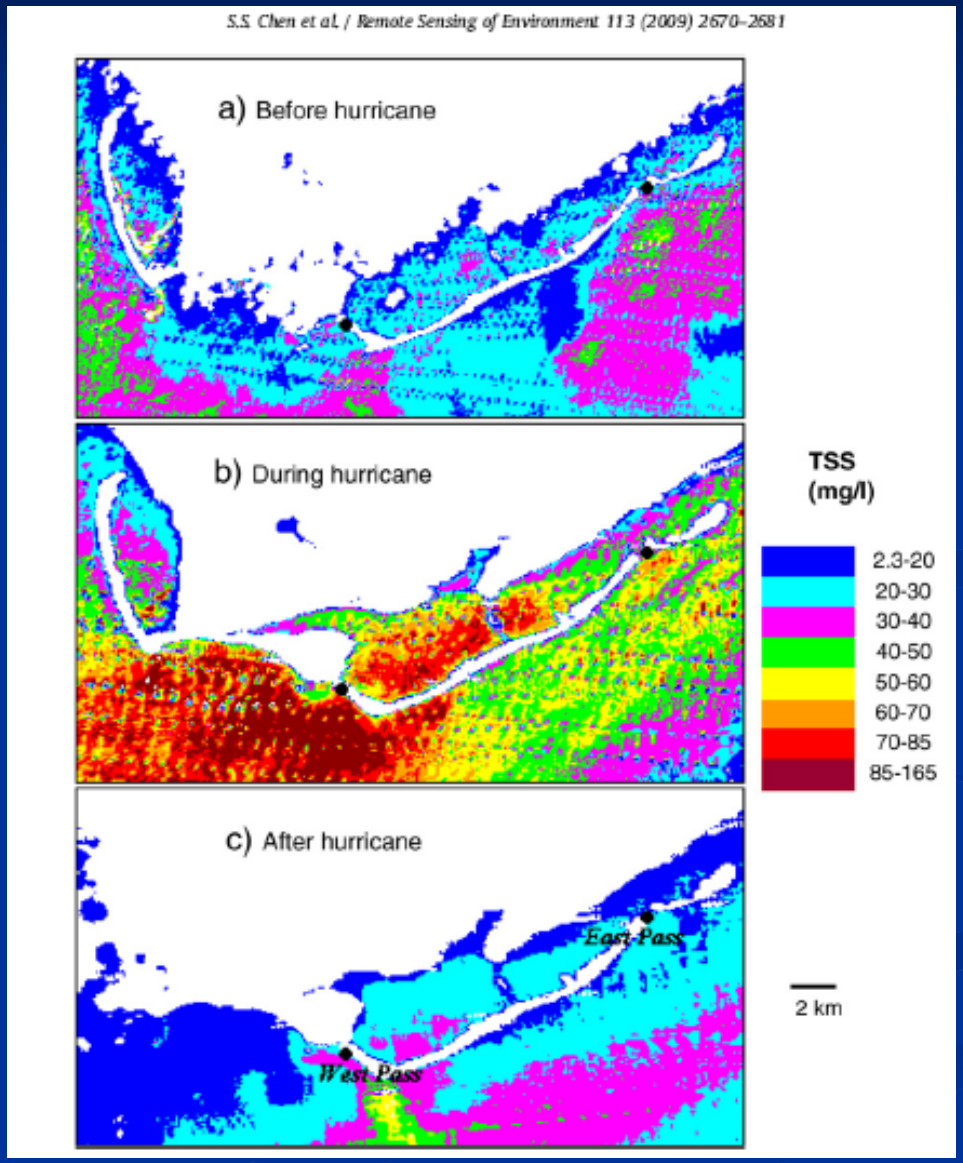
Wind speed and direction



Hydrodynamic modeling analysis



Hurricane effects on suspended sediment



Reference

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Remote sensing assessment of sediment re-suspension during Hurricane Frances in Apalachicola Bay, USA

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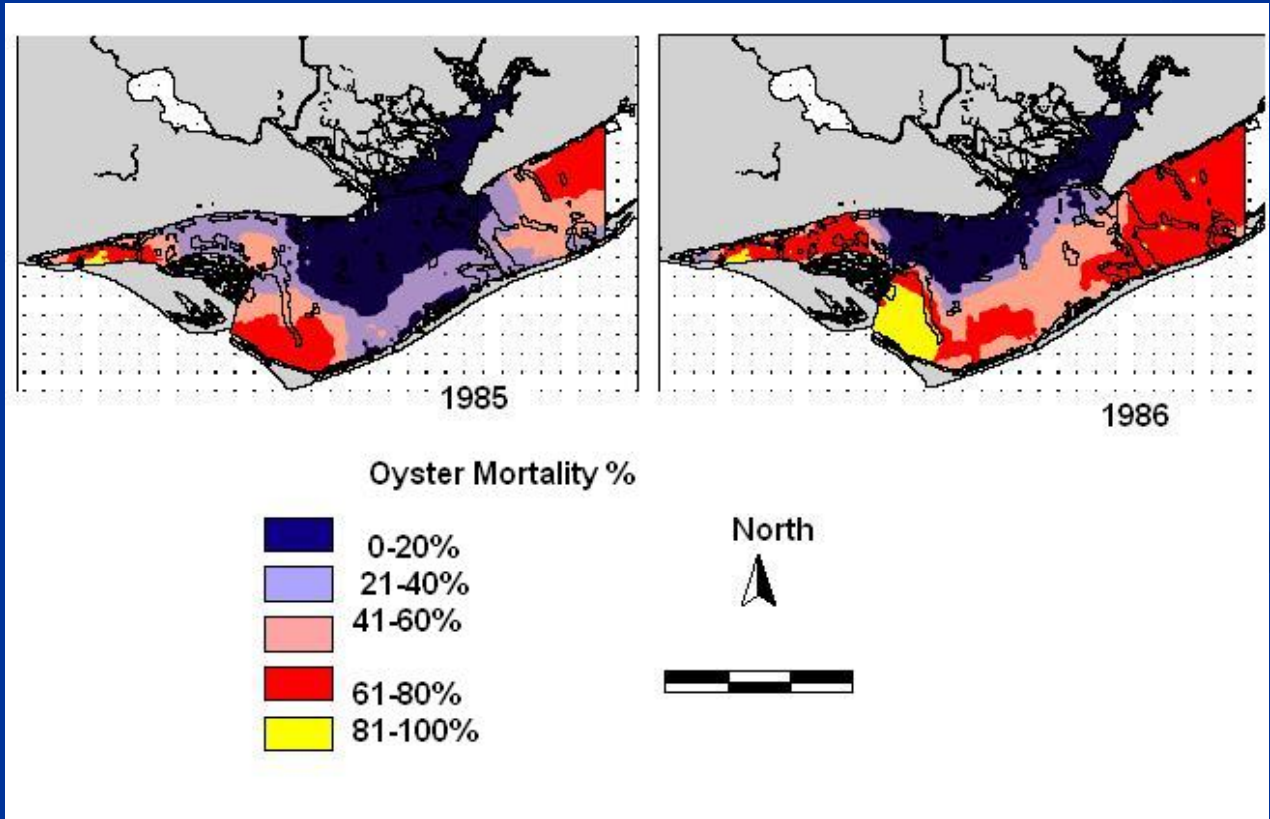
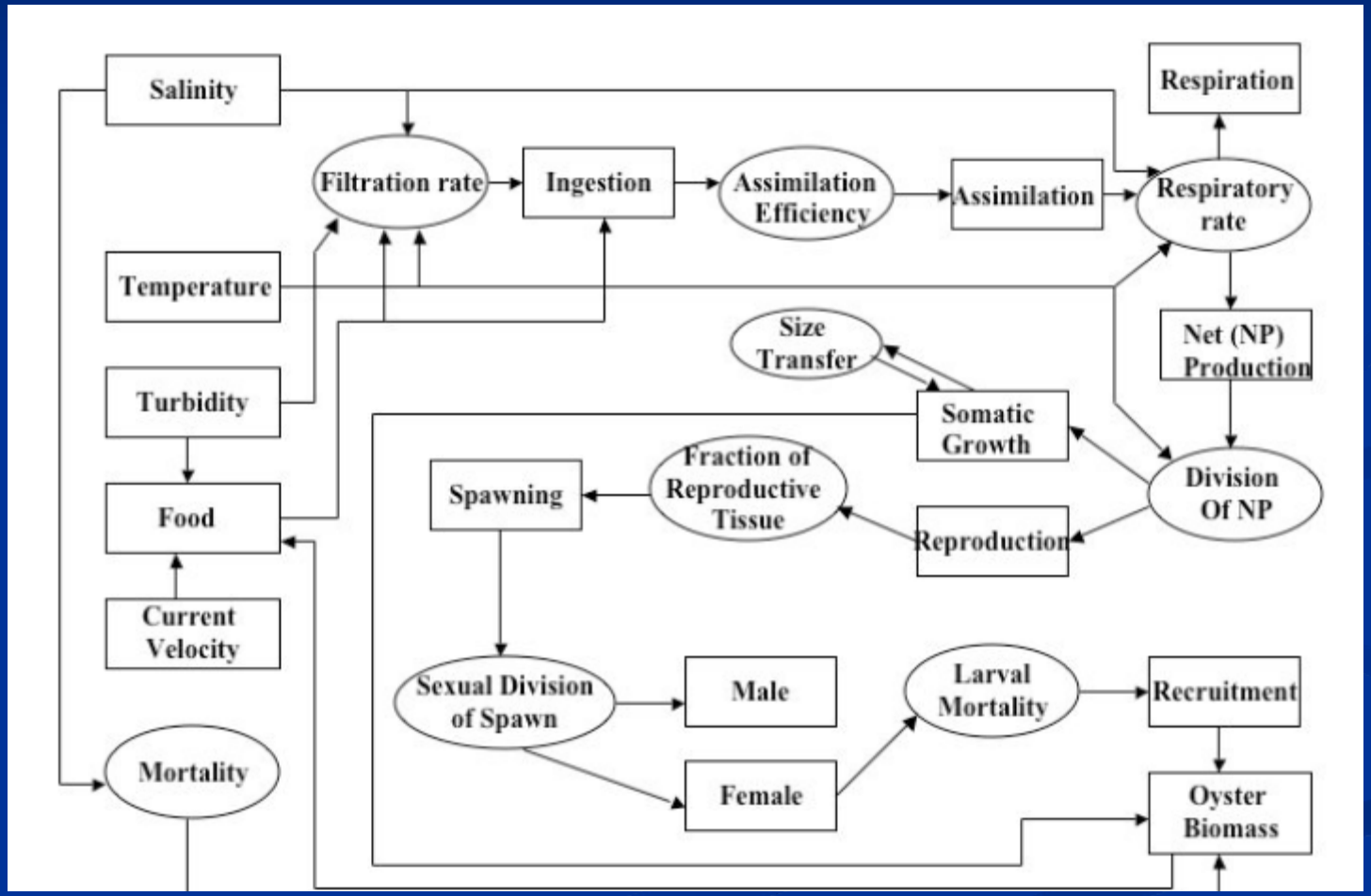
Oyster statistical model

Modelling Oyster Population Response to Variation in Freshwater Input

R. J. Livingston[a], F. G. Lewis[b], G. C. Woodsum[a], X.-F. Niu[c], B. Galperin[d], W. Huang[e], J. D. Christensen[f], M. E. Monaco[f], T. A. Battista[f], C. J. Klein[f], R. L. Howell IV[a] and G. L. Ray[g]



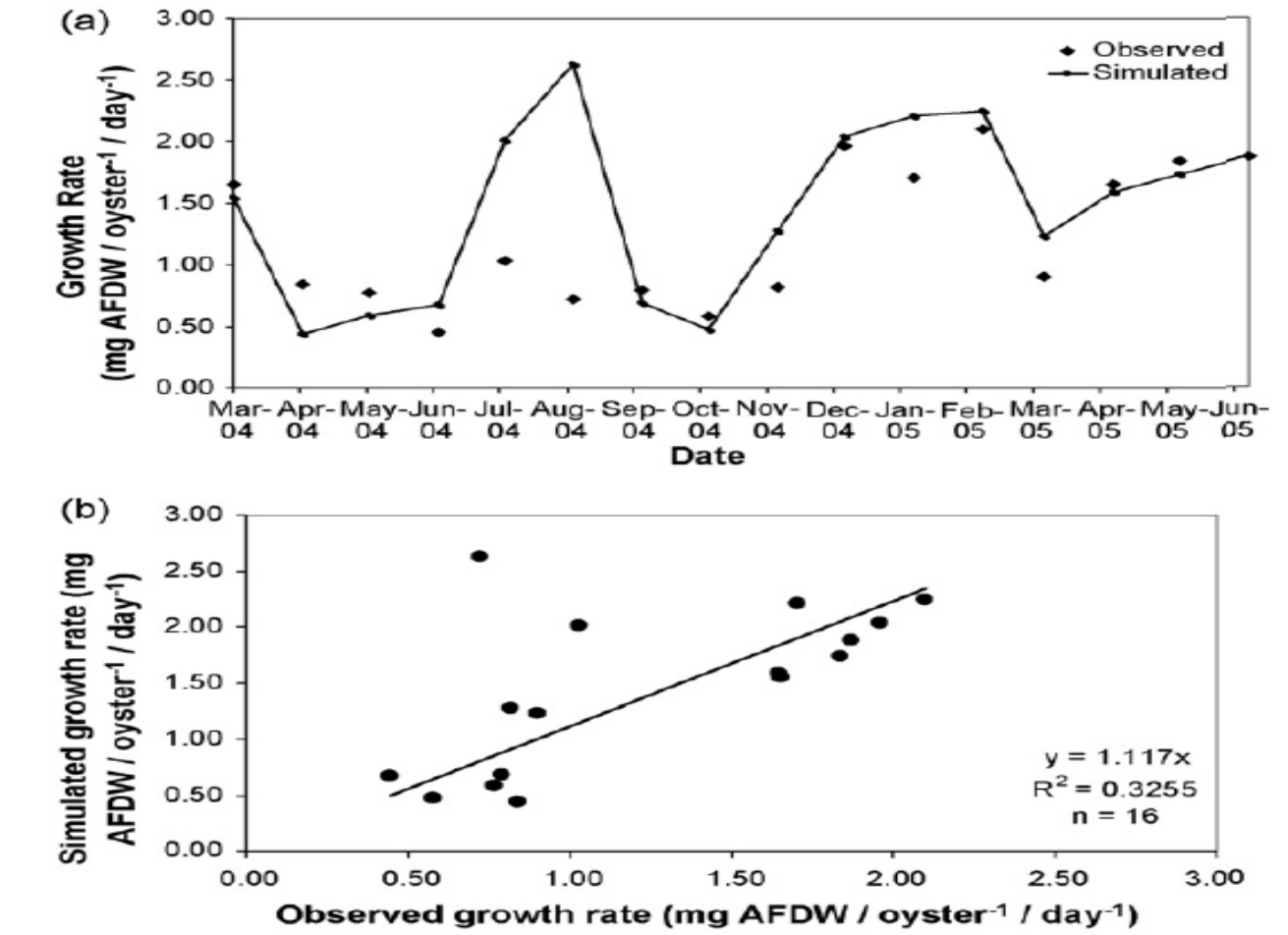
Oyster Dynamic Model (Wang, Huang, et al., 2008)



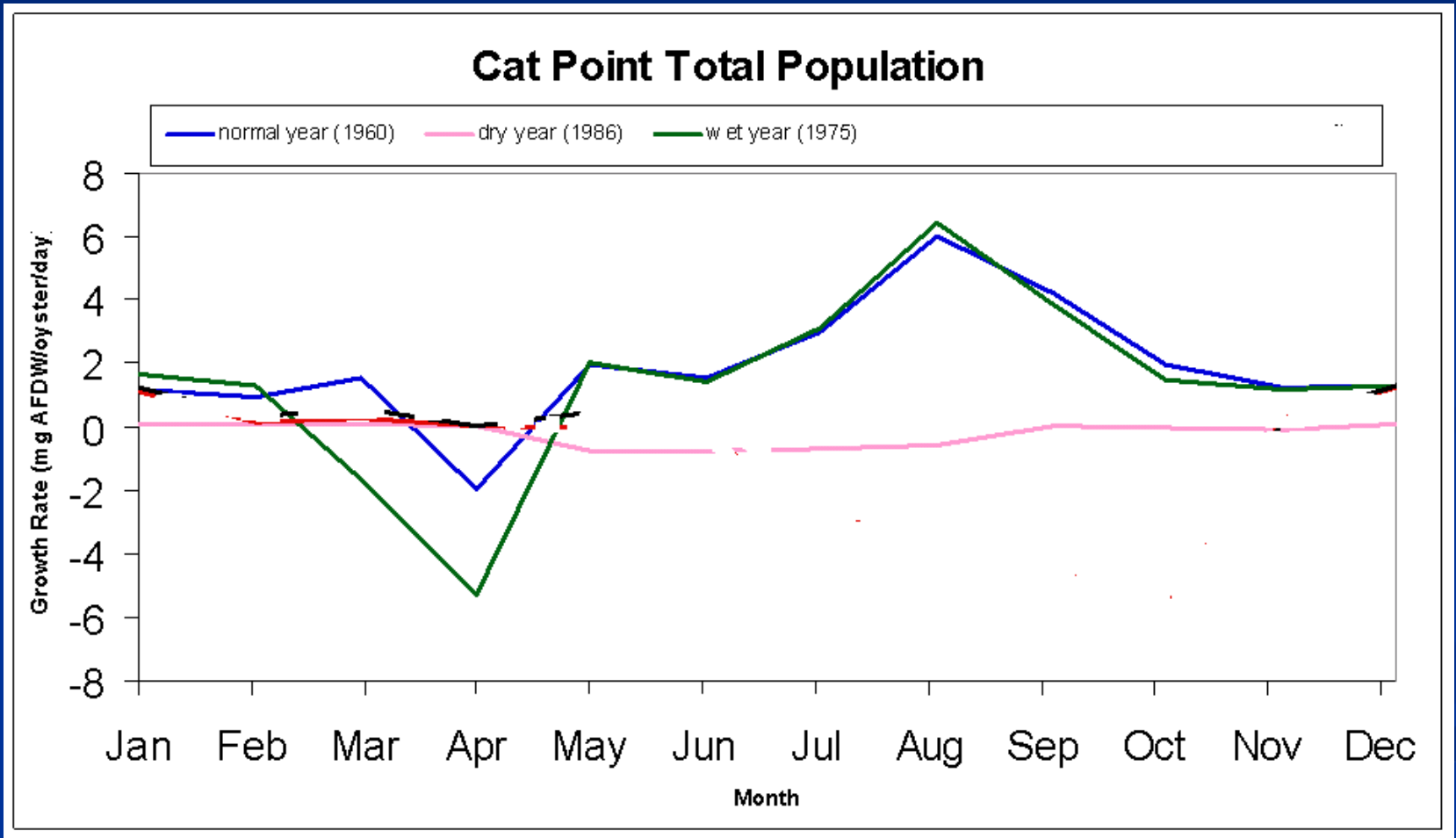
Integrated hydrodynamic model and oyster ecological Model

- Hydrodynamic model predicts circulation and salinity in the bay in response to river flow from proposed water management alternatives
- Ecological model predicts the effects on aquatic ecosystem.

Comparison between model predictions and observations (Wang, Huang, etc, 2010)



Model application examples



Ongoing research to predict climate-change impacts by integrating hydrodynamic and oyster ecological models

Changes in environmental stressors:

- Drought
- Flood
- Storms/hurricanes
- Sea level rising

ACKNOWLEDGEMENT

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