# Hypoxia in Estuarine and Coastal Waters

by

Y. Peter Sheng, Taeyun Kim, and Kijin Park
Civil & Coastal Engineering Department
University of Florida

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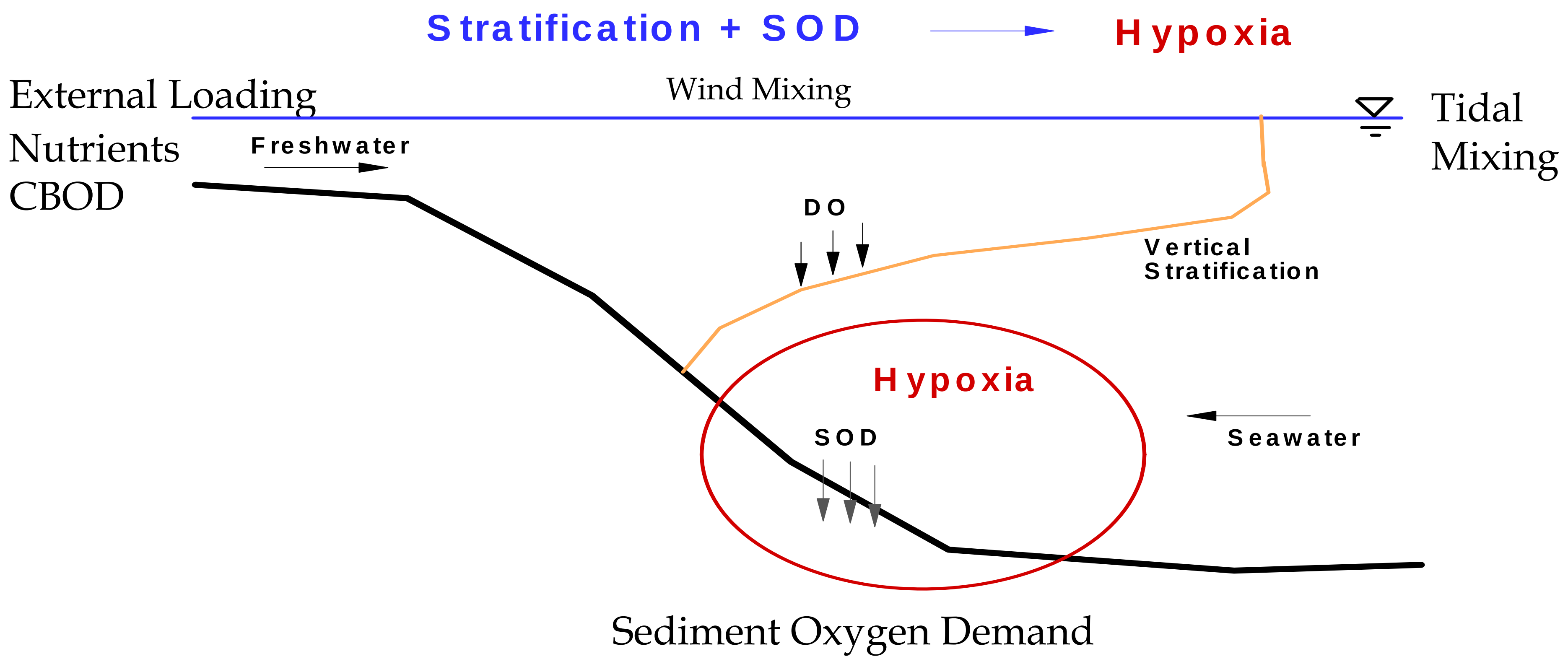
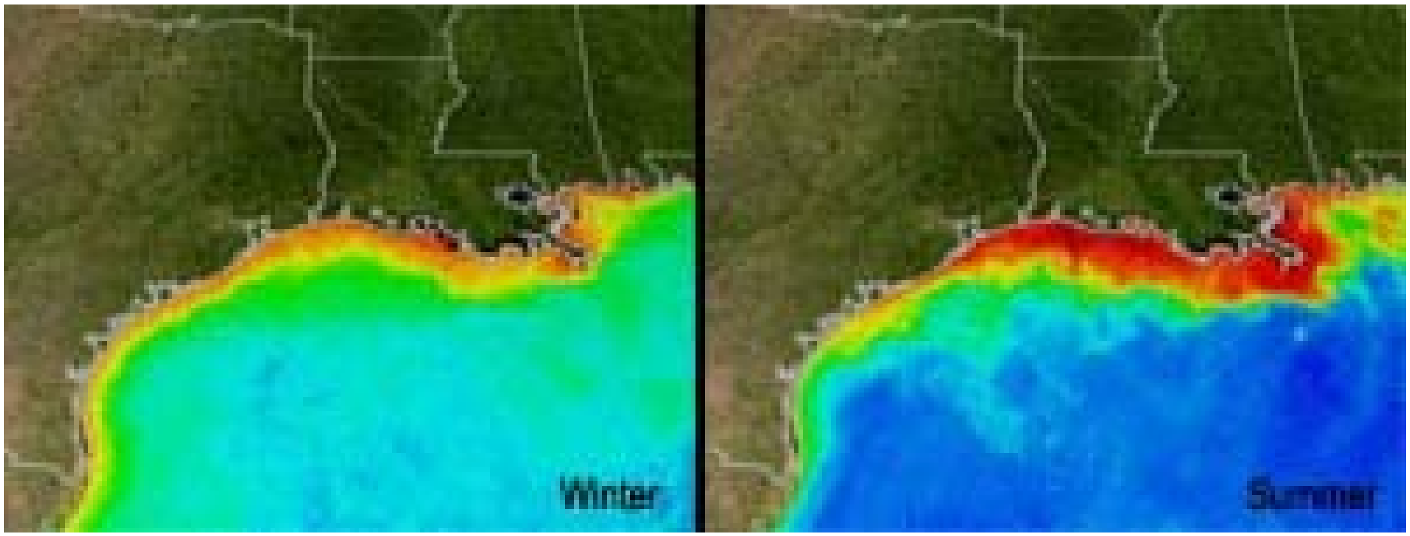
- What Cause Hypoxia?
- Hypoxia in Gulf of Mexico & Chesapeake Bay
- Hypoxia in Florida
- Simulation of Hypoxia in Florida
- How do External Loading and Climate Change Affect Hypoxia?

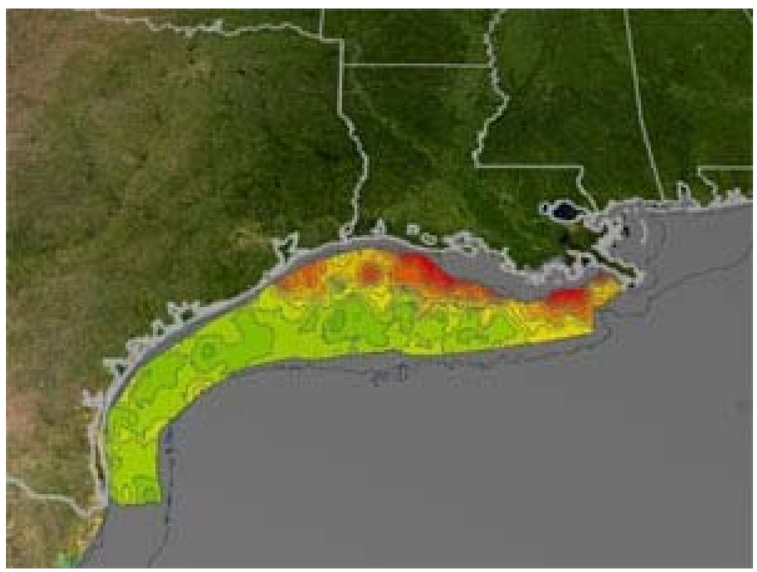
# What Cause Hypoxia?



# Mississippi Dead Zone
# 4500-7000 sq mi

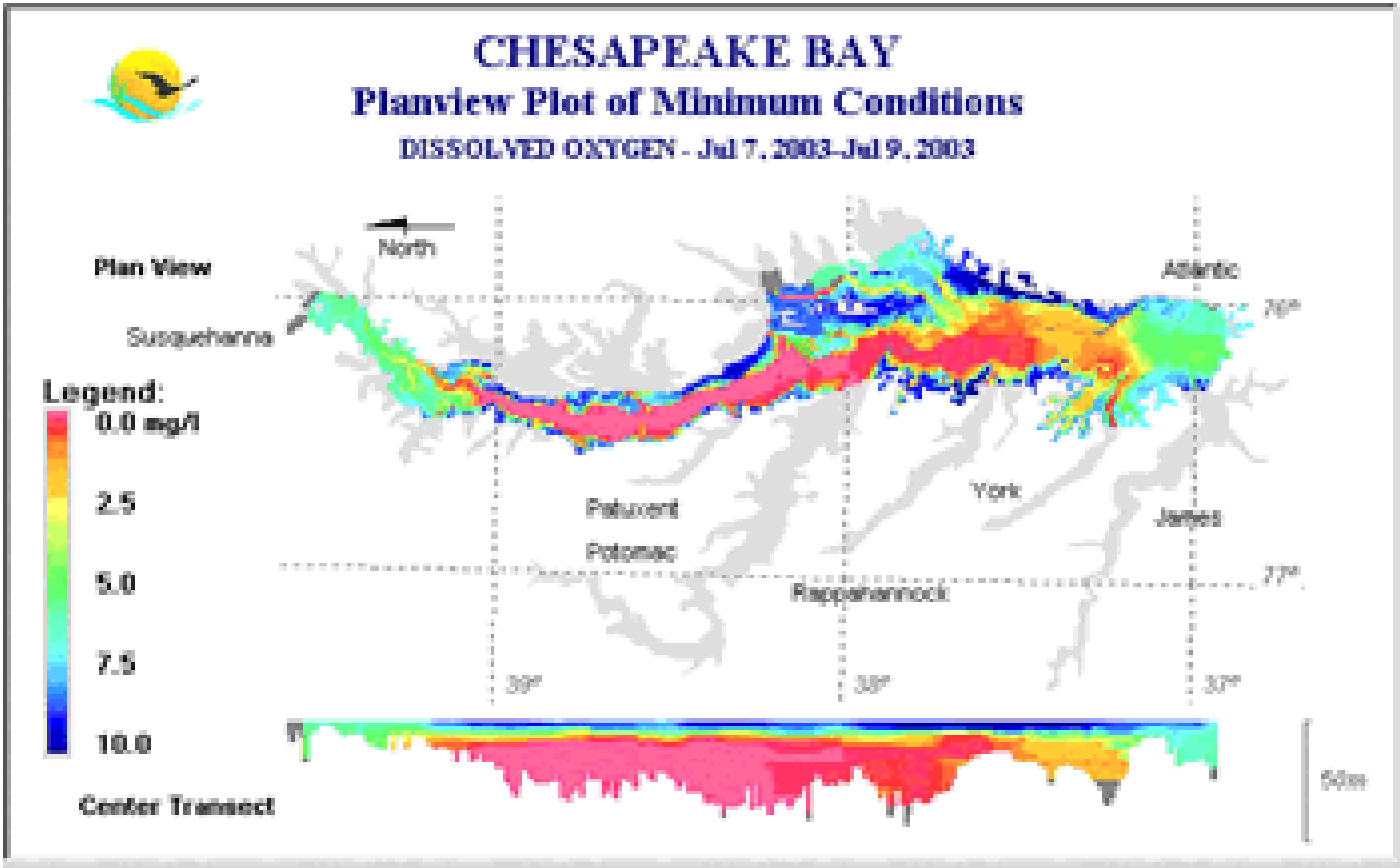



NASA Satellite Imagery

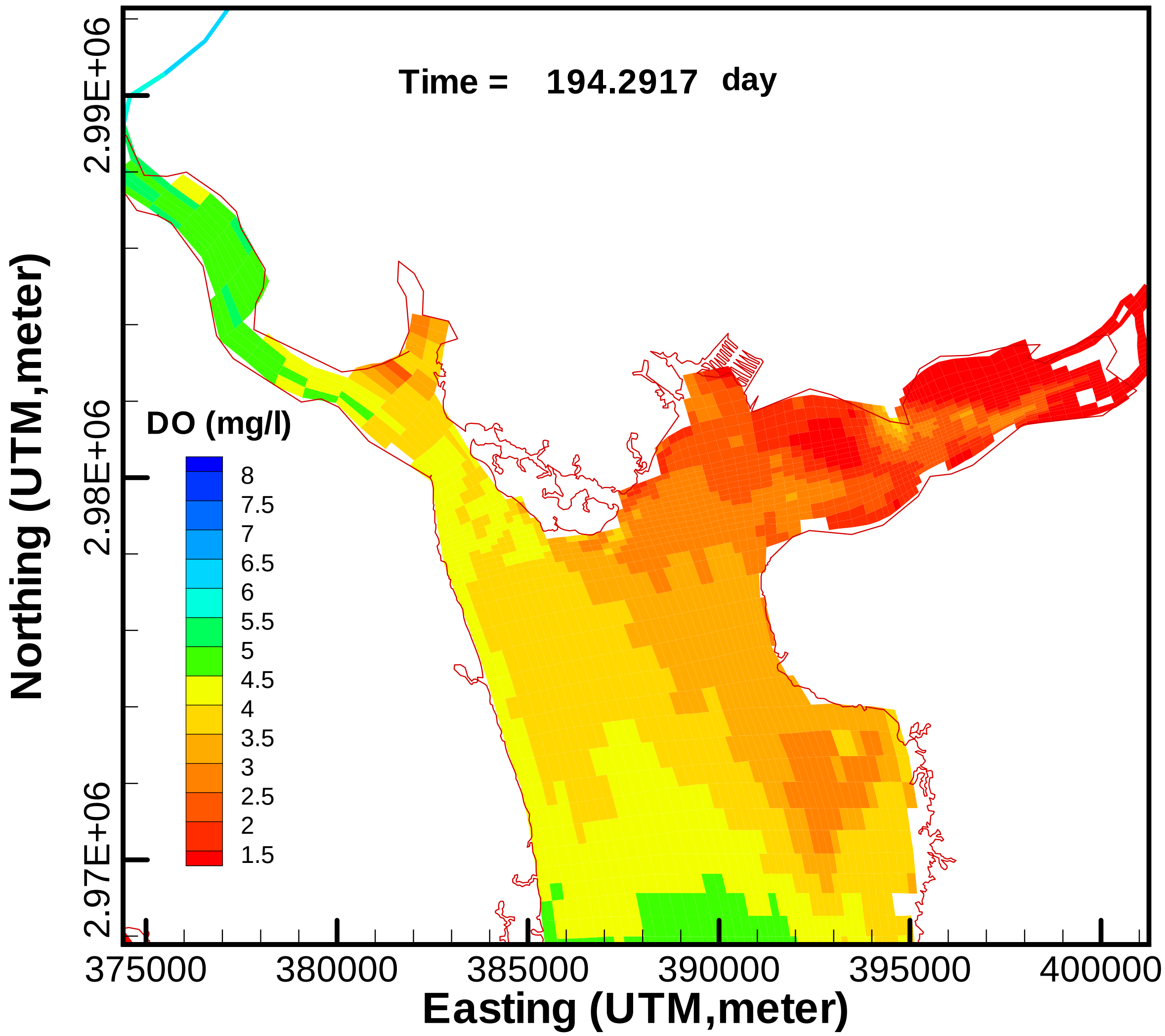


NOAA Ship Survey

# Chesapeake Bay Dead Zone



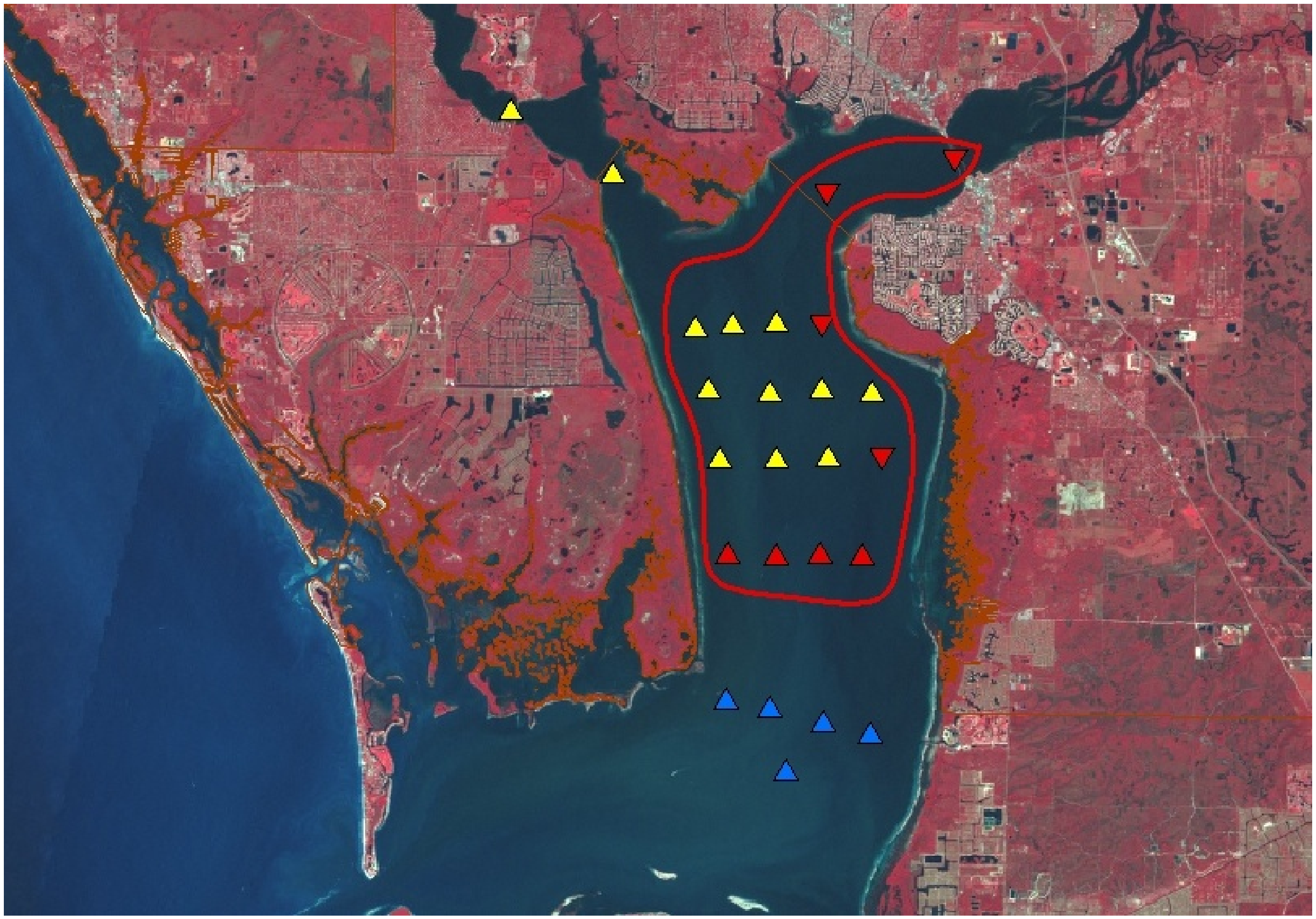
# Bottom-water Hypoxia in Charlotte Harbor, FL

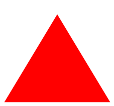



July 2000

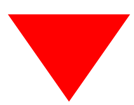
# Hypoxia in Charlotte Harbor After Charley (8/13/2004)

D. Tomasko





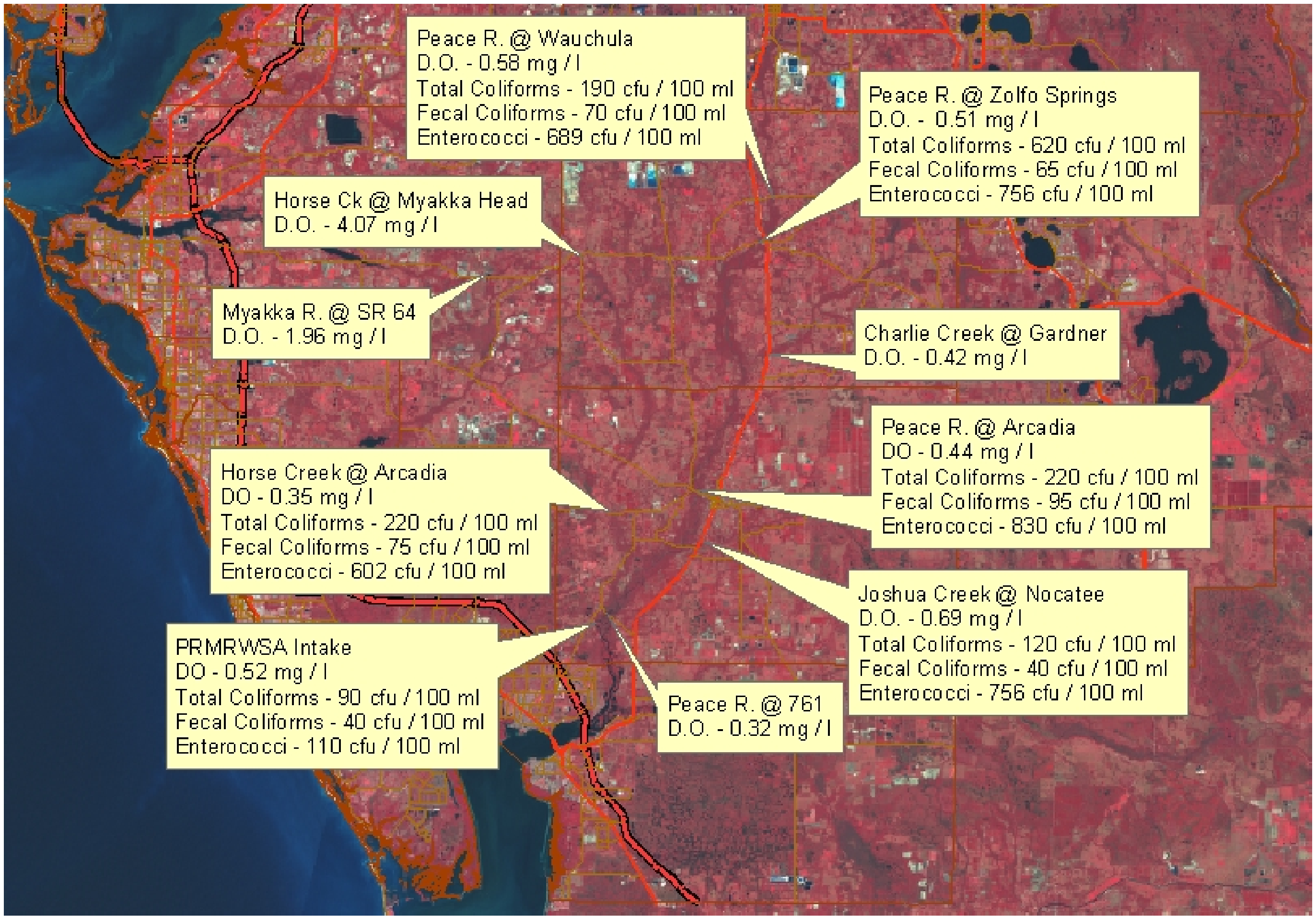
Bottom hypoxia



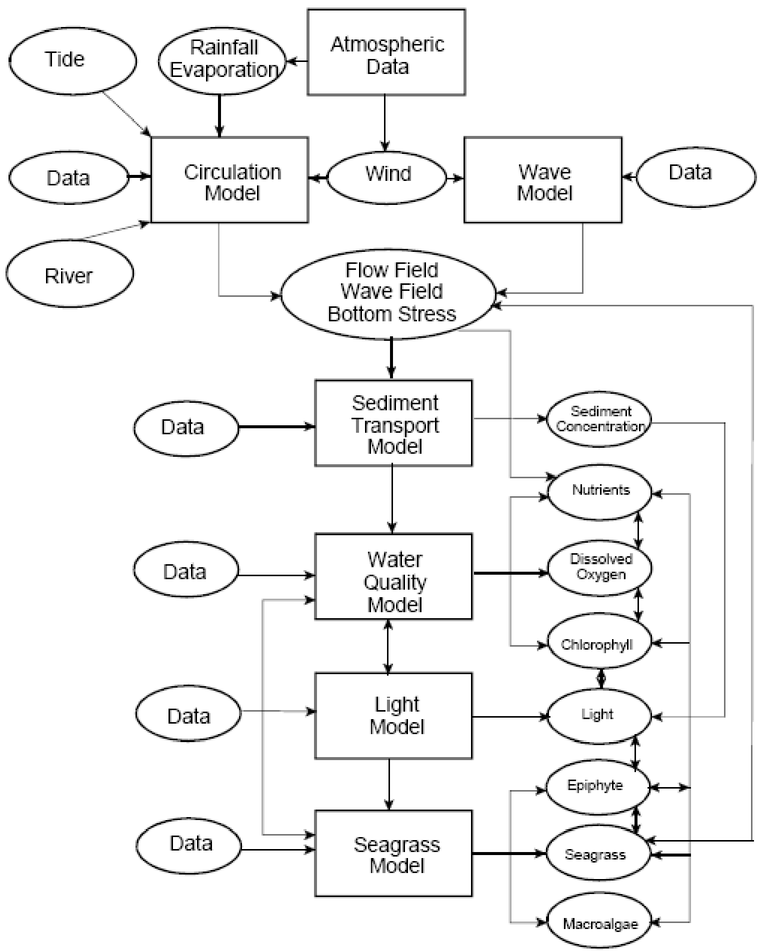
Surface+Bottom hypoxia

**~38 sq mi on 8/27/04**

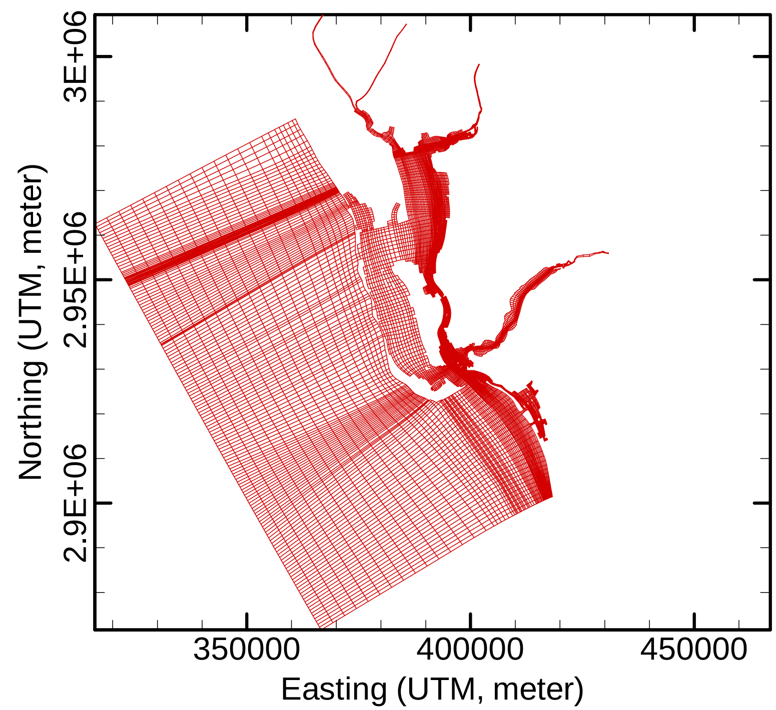
# Hypoxia in Peace River Watershed 8/21/2004



# Simulation of Hypoxia Using an Integrated Modeling System for Estuarine and Coastal Ecosystems

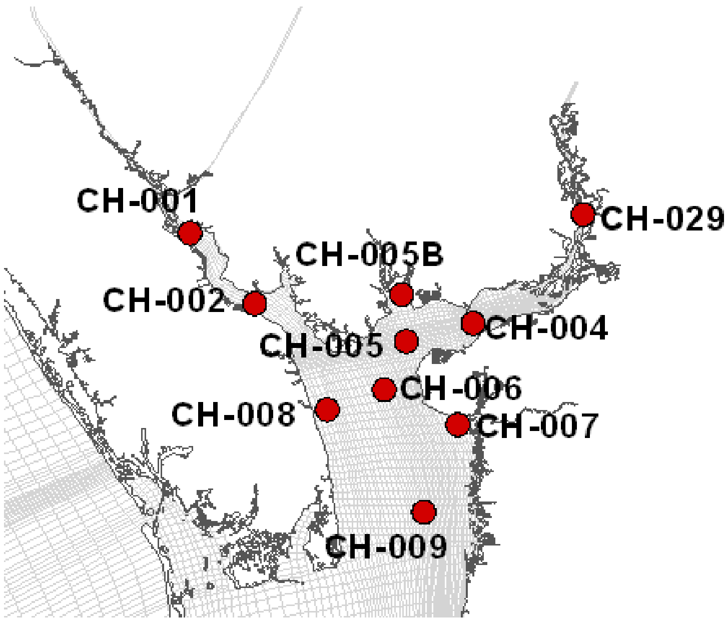


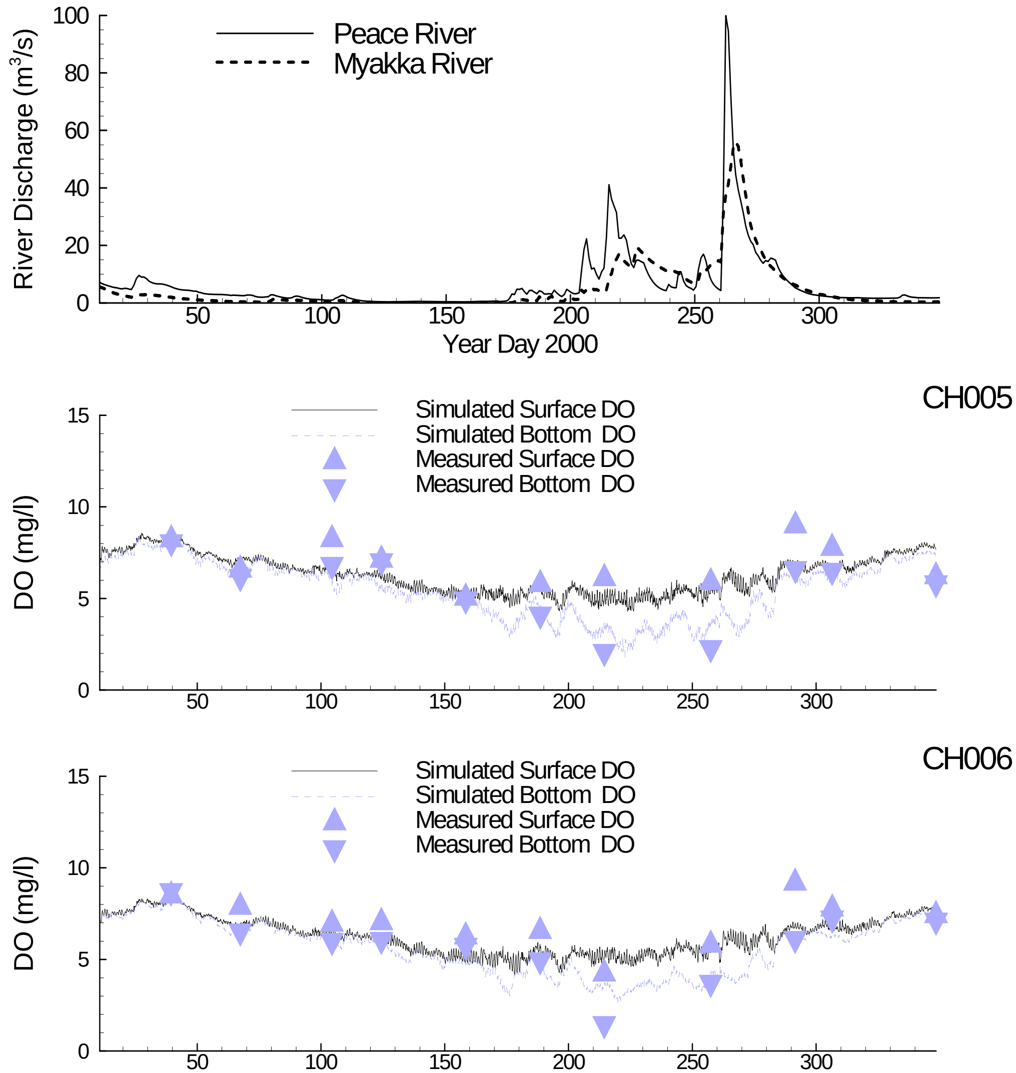

**CH3D-IMS (Sheng et al. 2002)**




Model Grid

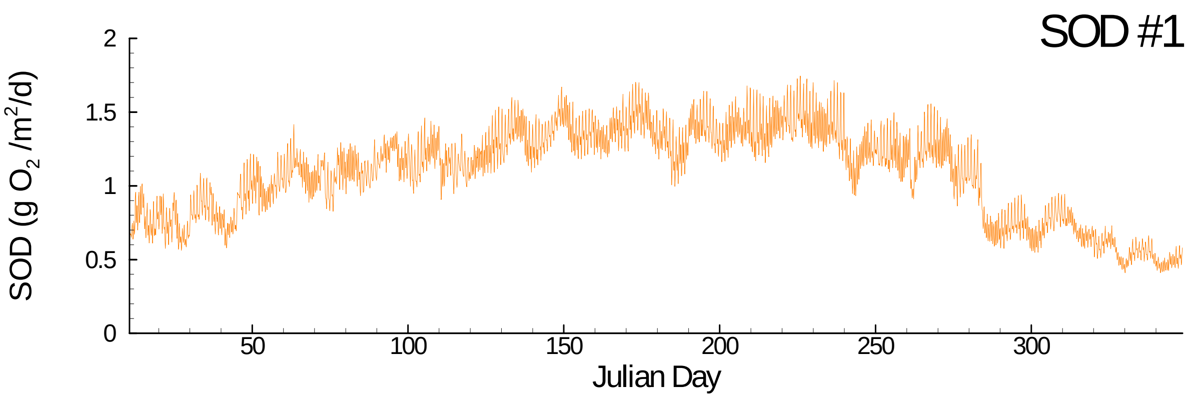
# Hypoxia in Charlotte Harbor during 2000

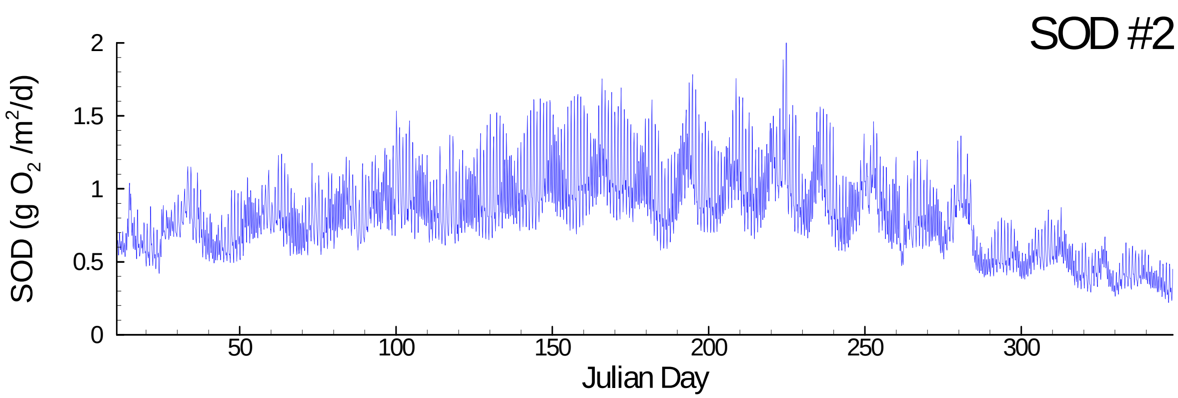


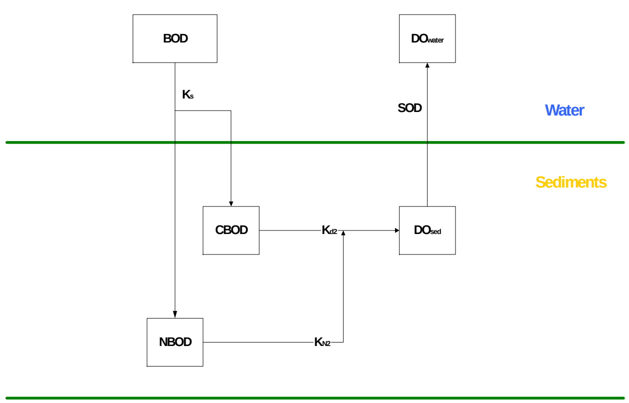



# Sediment Oxygen Demand

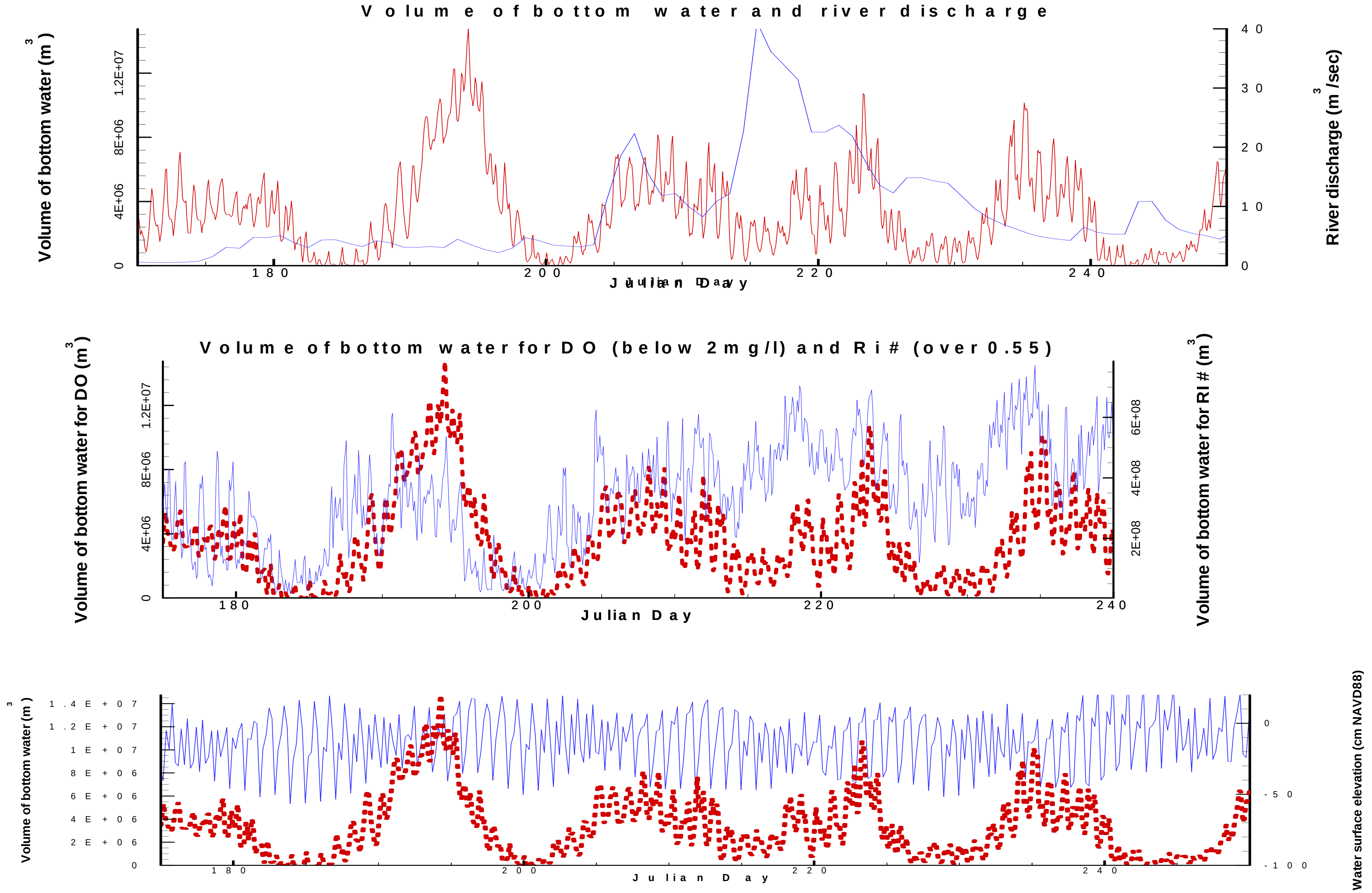
| Station | Latitude | Longitude | Measured Value (March 1984) | Measured Value (Sep. 1984) |
|---|---|---|---|---|
| SOD #1 | 26º 55' 00" | 82º 06' 18" | 1.49 | 1.03 |
| SOD #2 | 26º 48' 18" | 82º 06' 30" | N/A | 1.39 |



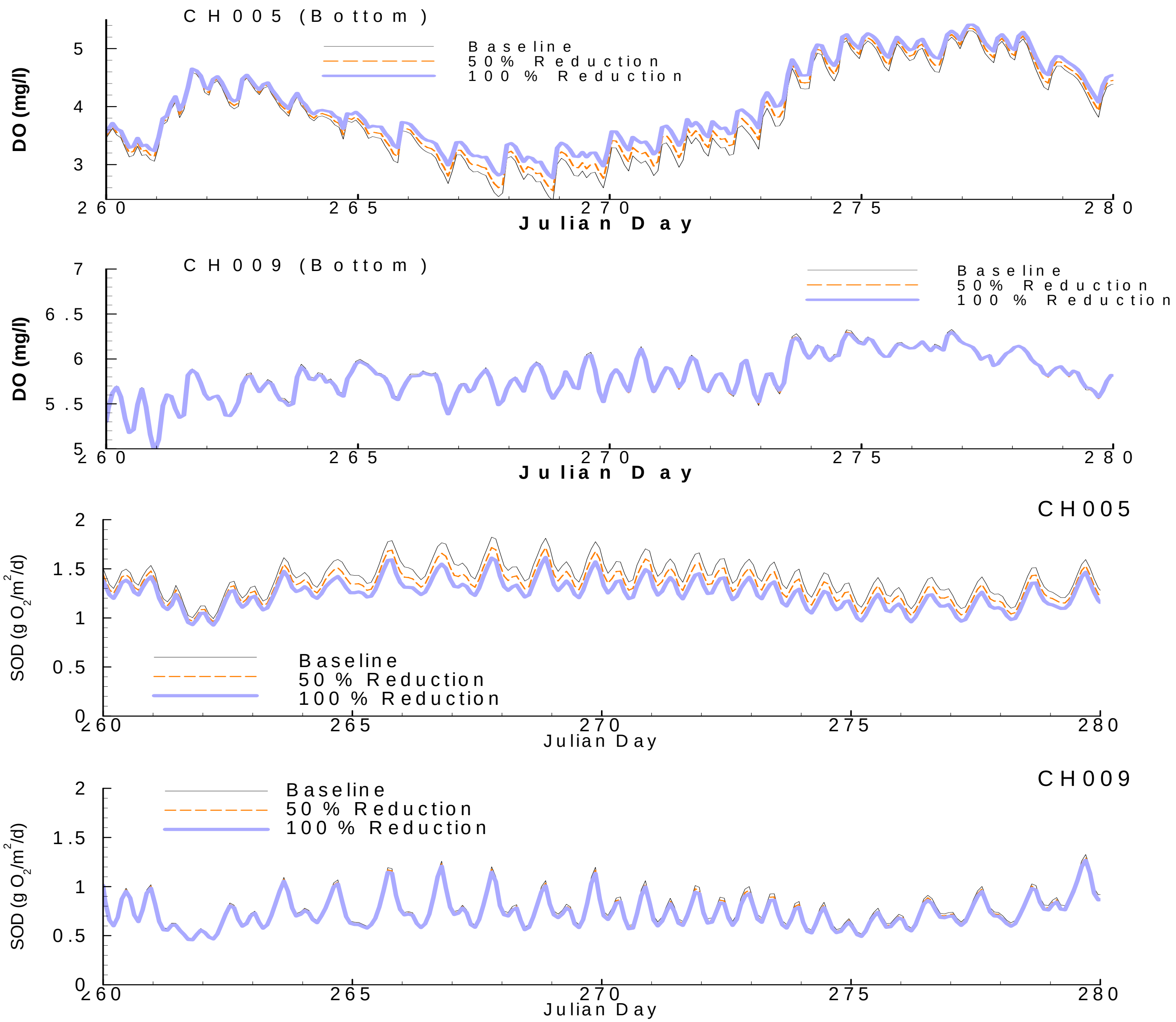
# Volume of Bottom Hypoxic Water is Related to River Discharge, Ri, and Tide



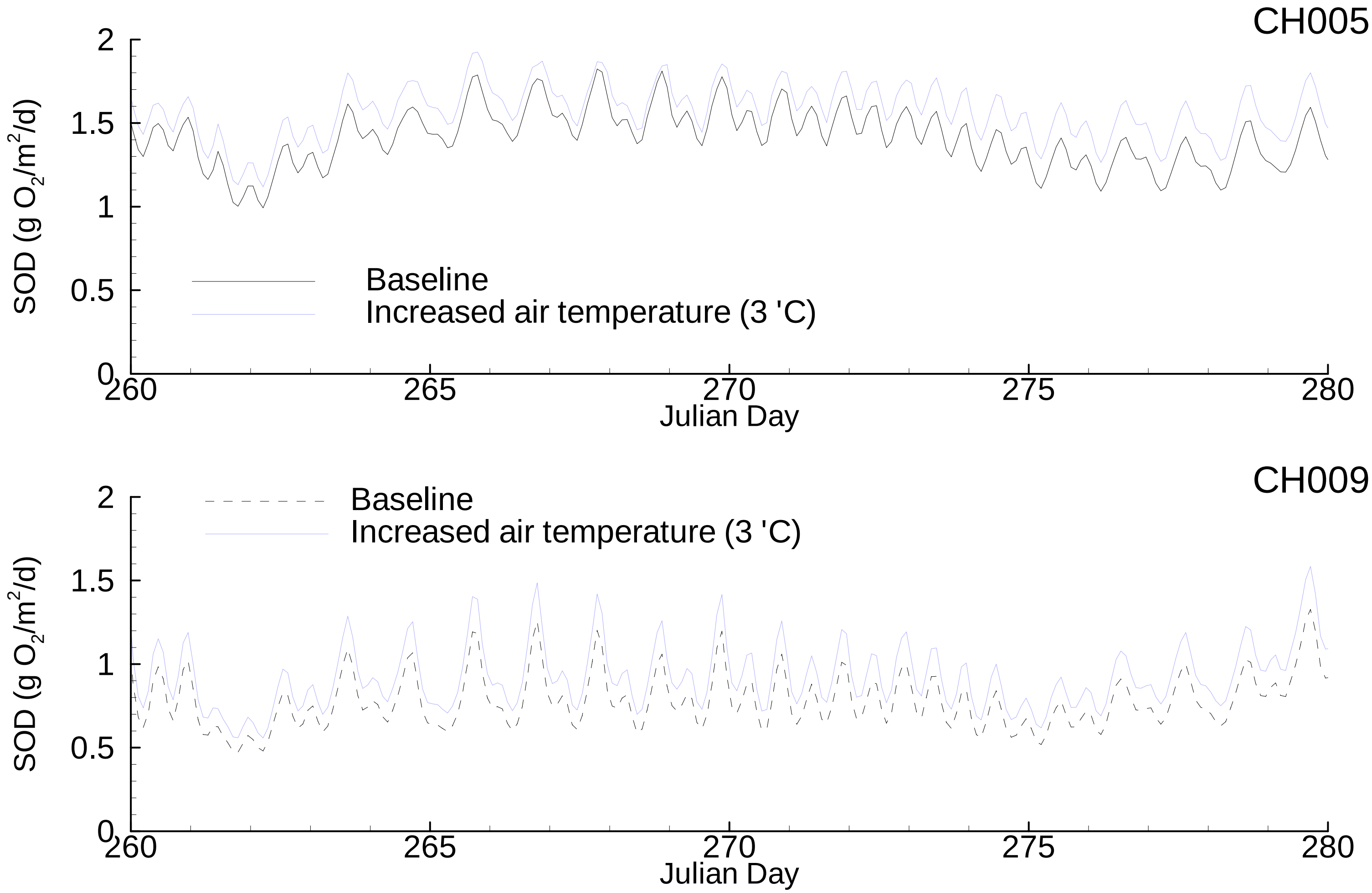
# Can we control Hypoxia?

- **Sediment Oxygen Demand (SOD) is due to the oxidation of organic matter in bottom sediments.**
- **The main sources of organic matter in bottom sediments are from river loading, waste discharge, and dead algae following major bloom.**
- **SOD can be a large fraction of oxygen consumption in surface water bodies.**

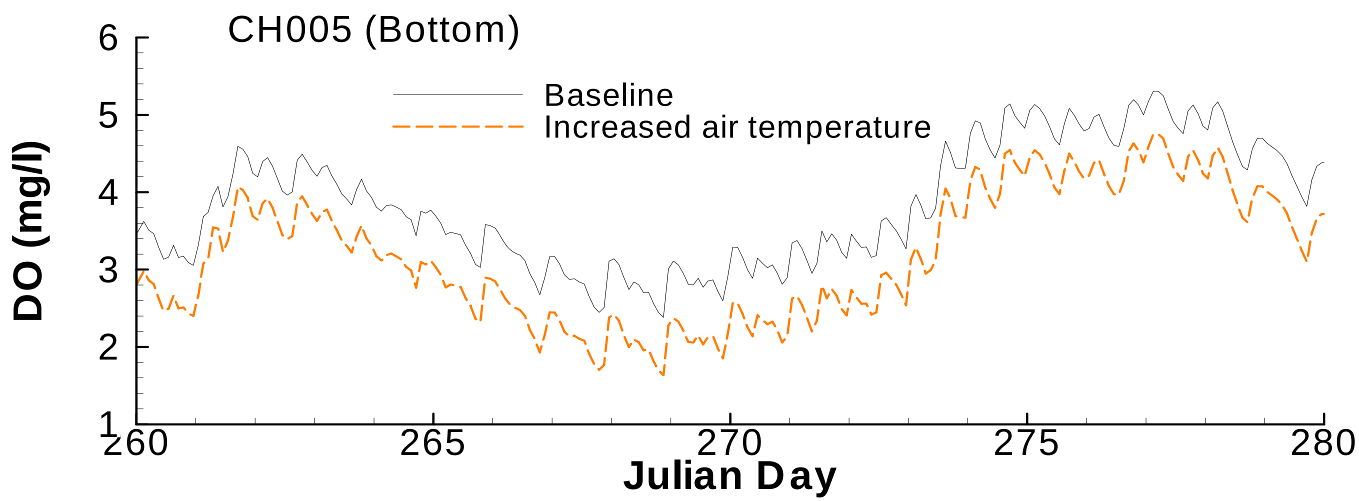
# DO and SOD with reduced nutrient/CBOD loading

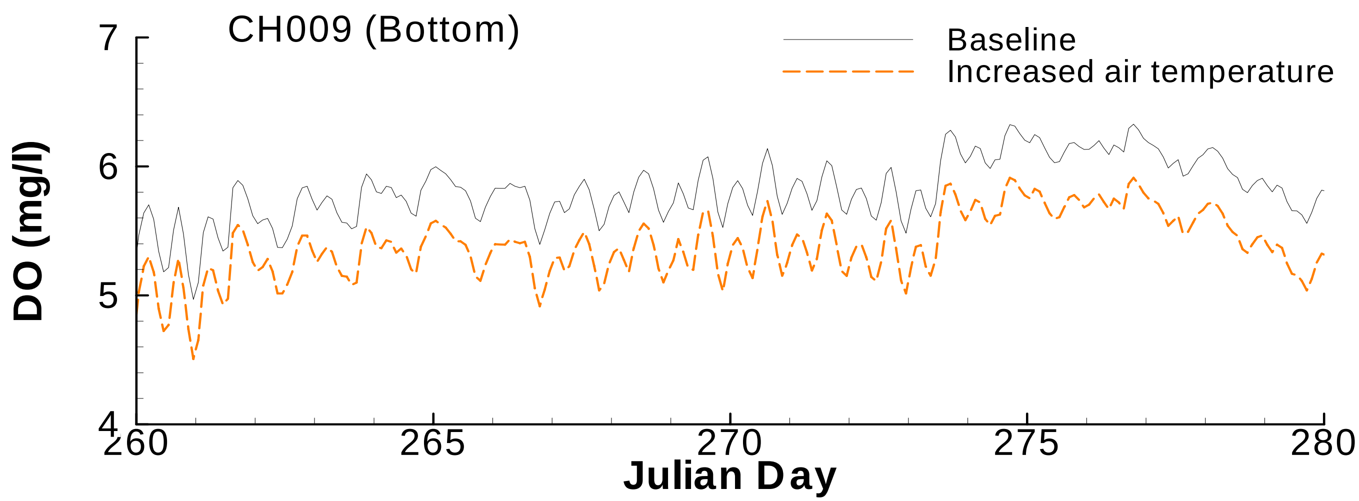


# SOD in the Upper Charlotte Harbor (Increased air temperature of 3°)

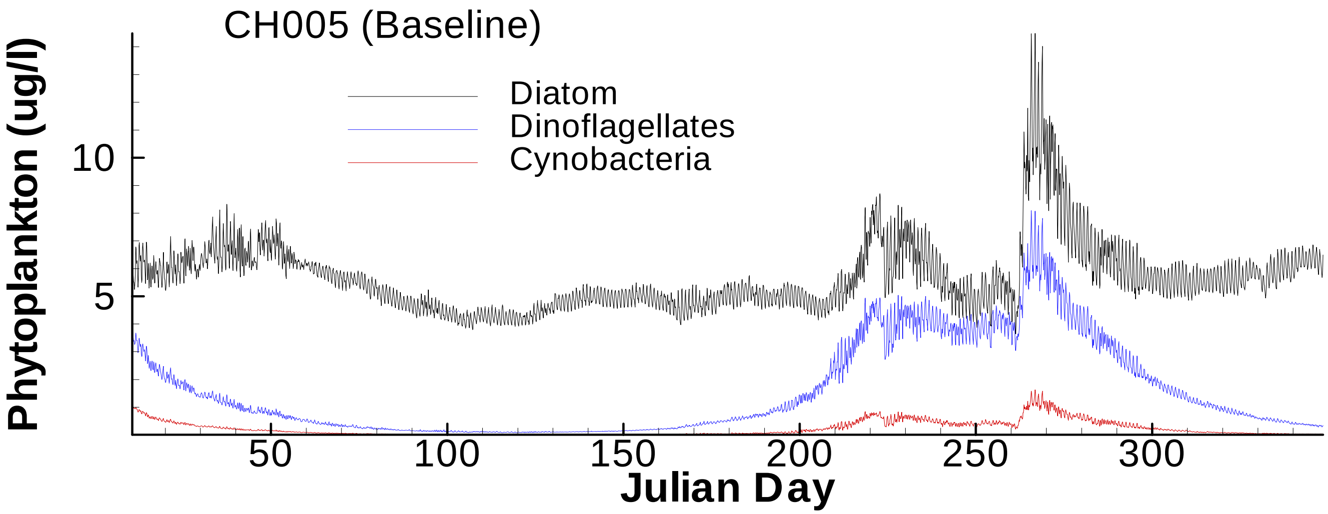


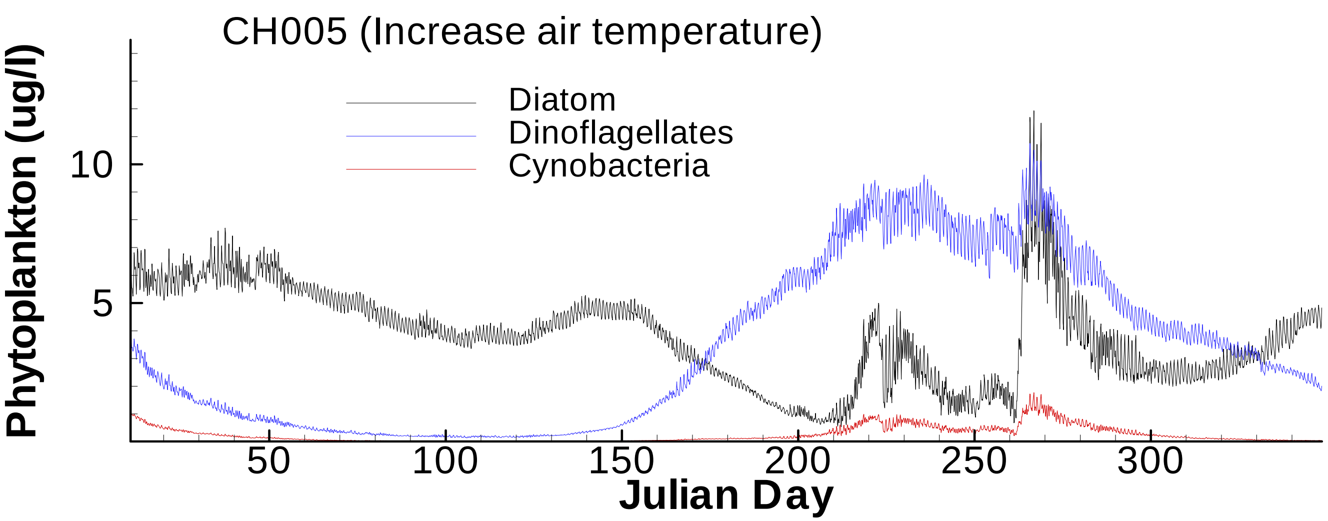
# DO in the Upper Charlotte Harbor
# (Increased air temperature of 3°)



# Phytoplankton in the Upper Charlotte Harbor (Increased air temperature of 3°)



# Conclusion

- Hypoxia exists in Gulf of Mexico, Chesapeake Bay, and Florida.
- Hypoxia in Charlotte Harbor is governed by river flow induced stratification and Sediment Oxygen Demand.
- Bottom hypoxic water decreases when
  - stratification decreases (low river flow, high wind, high tide)
  - external loading (nutrients/CBOD) decreases
- Peak hypoxic water volume is reduced by 5-10% with 50-100% load reduction
- Climate change will lead to increase in SOD and decrease in DO, and changes in phytoplankton species

$$\frac{\partial DO}{\partial t} = \frac{K_{ak}}{\Delta z}(DO_s - DO) \text{ (Reaeration)}$$

$$- K_D \frac{DO}{H_{CBOD} + DO} * CBOD \text{ (Oxidation)}$$

$$- \frac{64}{14} K_{Nt} \frac{DO}{H_{NIT} + DO} * NH_4 \text{ (Nitrification)}$$

$$- \frac{SOD}{H} \text{ (Sediment oxygen demand)}$$

$$+ [(1.3 - 0.3 * P_N) * \mu_a - Kaw - Kar] * Aoc * PHYTO \text{ (photosynthesis)}$$

$$\frac{SOD}{H} = \frac{1}{H} * 1.11 * v_s * CBOD_{bw} * ST * \theta^{T-20} * \frac{DO}{K_{SOD} + DO}$$