Toxic Tides
Algal blooms reflect disequilibrium in water

California Noctiluca Bloom

Florida Red Tide Bloom of Gymnodinium breve

York River (Chesapeake Bay) Red Tide Bloom of Cochlodinium heterolobatum

Major HAB-related Events in the Coastal U.S.
*Pfiesteria* - The Cell from Hell

*Pfiesteria* in one of its many life forms. This organism produces “exotoxins,” toxic compounds that are released into the water. These toxins cause lesions on fish, in which the dinoflagellates subsequently feed. These injuries ultimately kill fish.

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Ecological Systems and Resilience

Numerous community components play role in Bay health

- Riparian and estuary edge forest
- Emergent fresh and salt marsh vegetation
- Submerged aquatic vegetation
Changes in Systems Compromise Function

- Intensive agriculture
- Coastline development
- Animal production
- Urban sprawl

Extreme Events and the Chesapeake

Hurricane Isabel, September 2003

- Satellite view of Isabel off eastern U.S.
- Cumulative rainfall accompanying Isabel
Storm Surge & Heavy Rainfall
Changes in hydrologic flows alter ecosystem variables

Isabel Alters Water Flux Through Bay
2003 was already a record water year
Water Quality Parameters
Affected by rain and surge

Dilution by rainfall in the Pocomoke

Salinity increase by surge in the Magothy River, MD

Sediments load from runoff in the Magothy River, MD

In addition, Isabel added 459 M lbs of N; typical year is 200 M lbs

Normal Conditions

- Low pressure, easterly winds across Pacific
- Cold water upwelling along S. America
- Strong westward ocean current
- Cycling of air and water
Normal conditions: Temperature profile

- Wet and warm Australia, opposite in South America
- Strong westward ocean current
- Water piles up on Australia
Normal Conditions

- Intertropical Convergence Zone (ITCZ). Low pressure, easterly winds across Pacific
- Large high pressure system in lower Pacific
- Cold water upwelling along S. America
- Wet and warm Australia, opposite in S. America
- Strong westward ocean current
- Cycling of air and water
- Water piles up on Australia

El Niño Conditions

- Weak high pressure system replaces ITCZ
- Winds die and weak westerlies develop
- Ocean current change, water gradient reverses
- Reversal of upwelling and rain
El Niño

- Higher salinity and warmer waters
- Reversal of upwelling and rain
- Cycling slows greatly
El Niño = the little one

- Weak high pressure system replaces ITCZ, which moves out
- Winds die and weak westerlies develop
- Ocean current change, water gradient reverses
- Reversal of upwelling and rain
- Cycling slows greatly
- Higher salinity and warmer waters

Effects of El Niño

- Low nutrient upwelling
- Floods and droughts
- Warming of water and land
- Increased salinity, decreased O₂
- Low fishing productivity
- Hurricanes
- Temperature change