The Oceans, Their Basins and Circulation Drivers

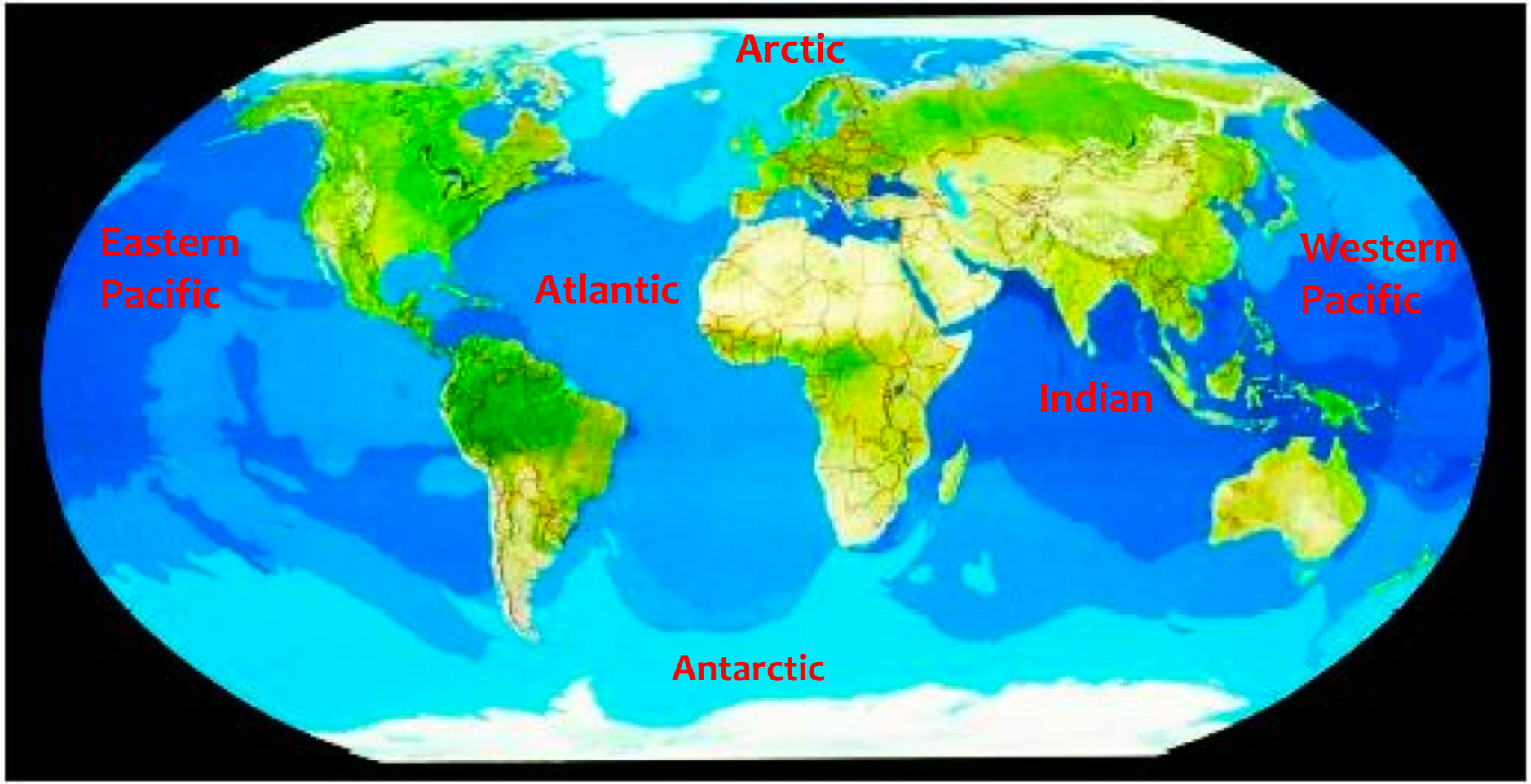
More than you ever want to know about the Oceans and their basins

Oceans Overview

Topics of Discussion

* The Ocean Basins and How They are Connected
* Atmospheric Ocean Circulation Drivers
* Density Current Circulation Drivers
* Tides
* How the Ocean Basins Have Changed Over Time
* Violent Storm Generation and Movement

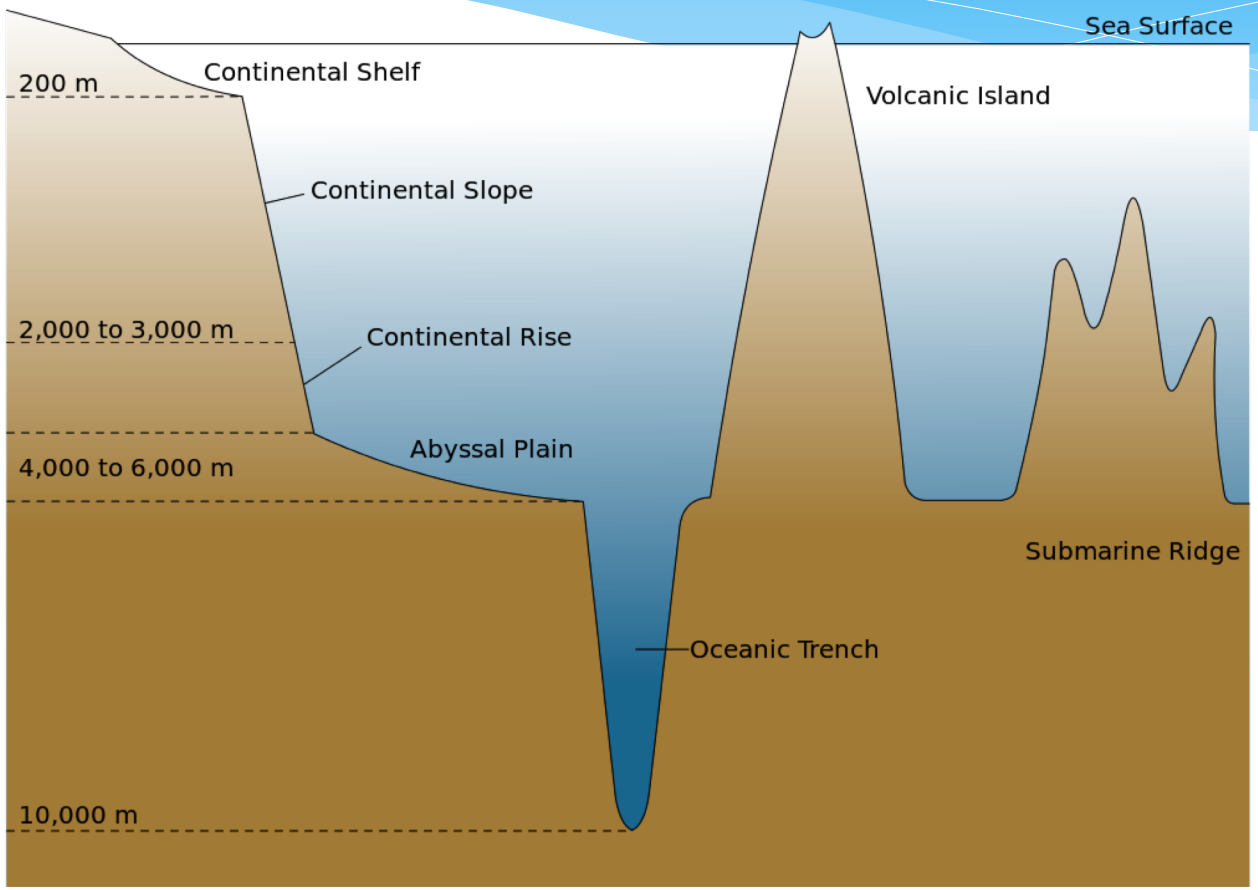
Ocean Basins



Difference Between an Ocean and a Sea

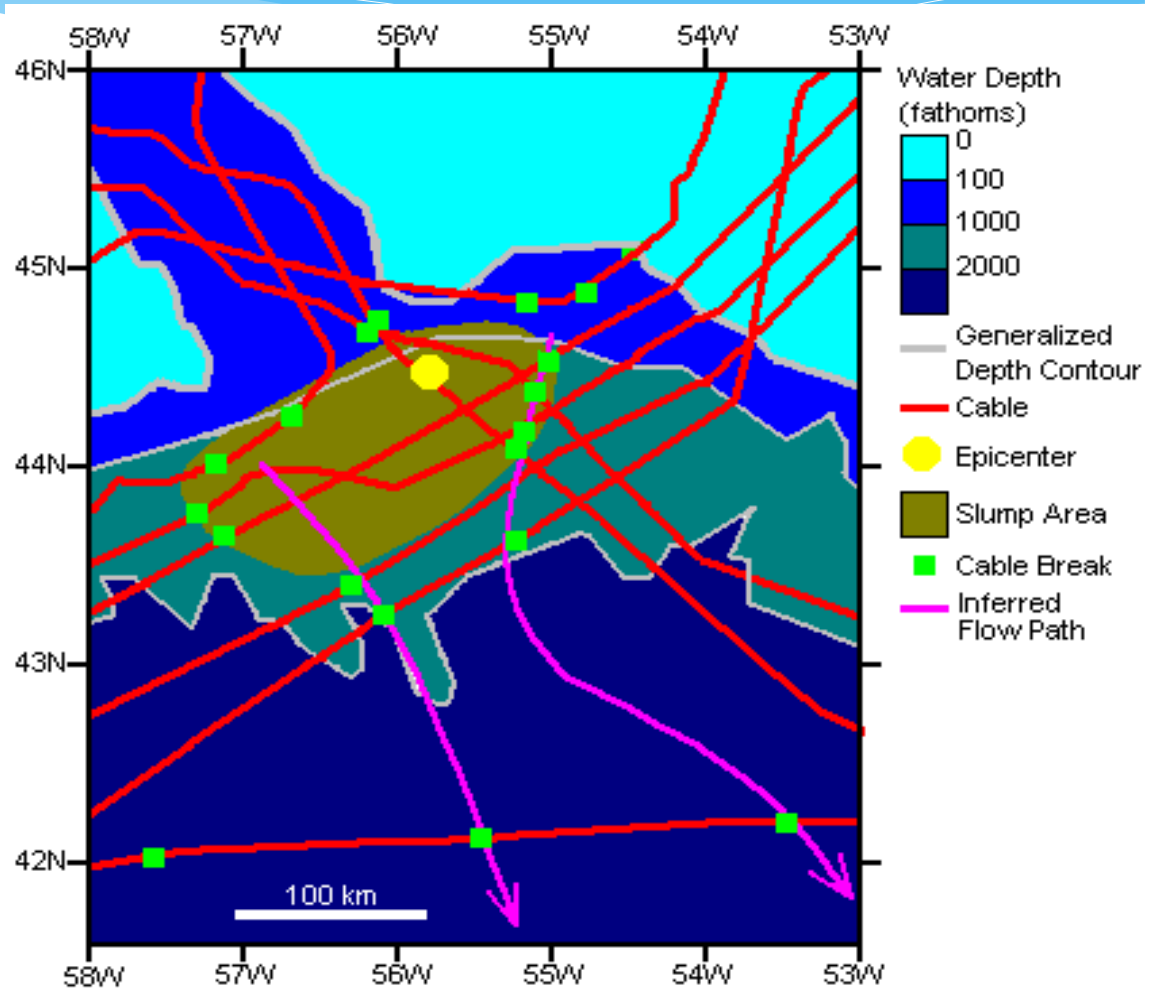
Seas are found on the margins of the ocean and are partially enclosed by Land. Above you can See that the Bering Sea is part of the Pacific Ocean

Ocean Basin Features



Submarine Canyons and Turbidity Currents (Also Known as Density Flows) Sediment Known as Turbidite

* Turbidity Flows – Grand Banks, 1929
* Loss of the Thresher April 10, 1963



How we Map the Bottom

What it Might be Like to Travel Through

Relationship Between The Oceans and the Atmosphere

* The atmosphere affects the oceans and is in turn influenced by them – A Symbiotic Relationship
* Wind creates waves and influences the ocean currents
* Strong winds produce droplets that are absorbed by the atmosphere creating nuclei for the formation of fog and other phenomena
* When water evaporates, heat is removed from the oceans and stored in the atmosphere
* When condensation occurs, this stored heat is released to the atmosphere to develop the mechanical energy of its motion
* The atmosphere obtains nearly half of its energy for circulation from the condensation of evaporated ocean water
* The pattern of atmospheric circulation largely determines the pattern of oceanic surface circulation
* The pattern of atmospheric circulation largely determines the pattern of oceanic surface circulation as well as the location of clouds which influence the temperature of the oceans
* Inorganic Symbiosis at its best

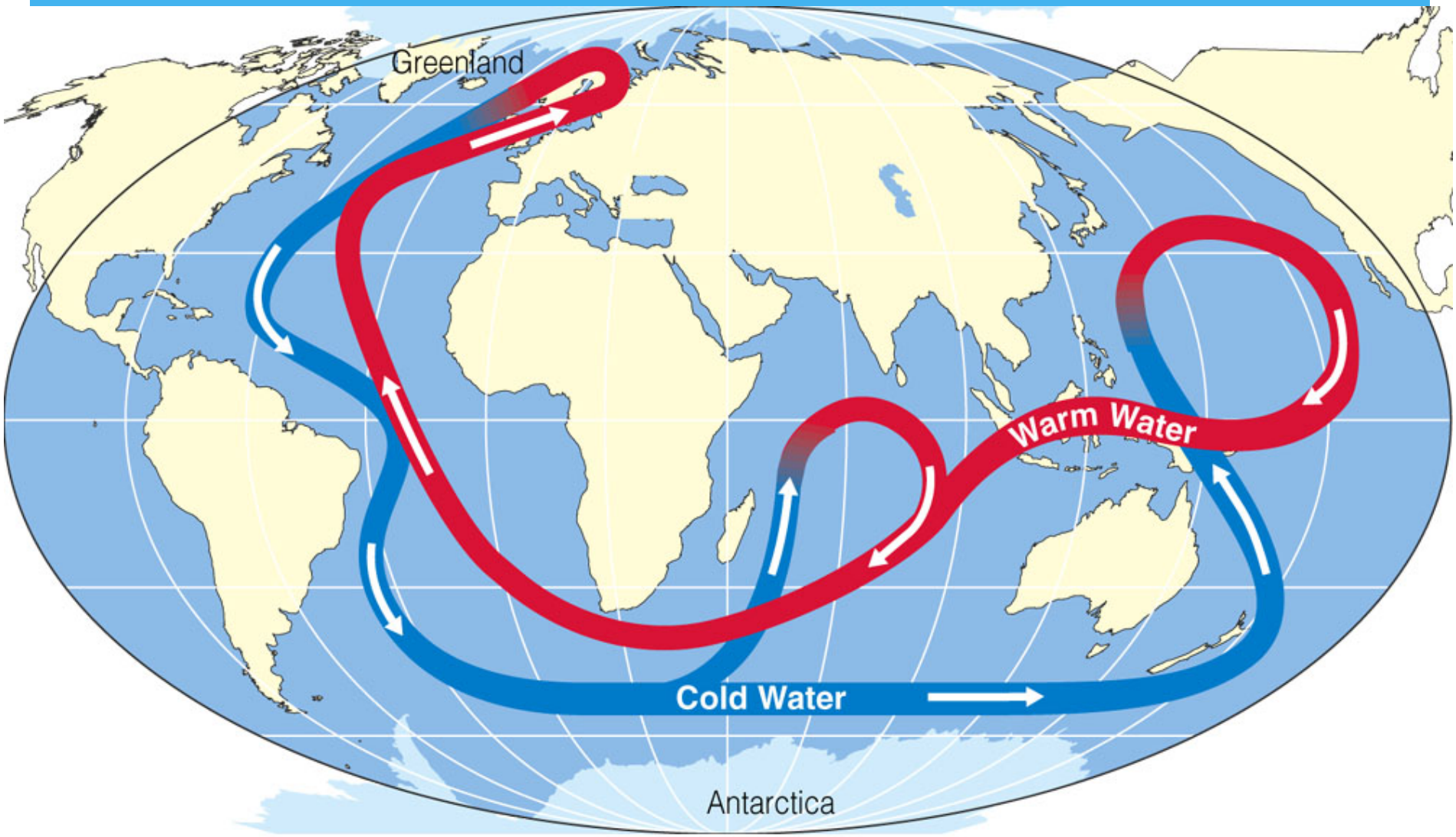
Circulation Drivers Of The Oceans
Or
More Than You Would Ever Want To Know

* Two forces produce the non-tidal ocean currents
  * The wind exerting a stress on the sea surface
  * Fluxes between the ocean and atmosphere that alter the density of the surface water
  * The former induces the wind driven ocean circulation, the latter the thermo-haline circulation (Density Driven)
* Surface water is made denser through the removal of heat and freshwater giving Density driven currents
  * Surface layer descends to deeper depths
  * Can reach the deep sea floor
  * This circulation is called thermo-haline circulation and engages the full volume of the ocean into the climate system
  * Thus ocean water 'meets' and interacts directly with the atmosphere about every 100-1000 years

Circulation Drivers Of The Oceans (Cont.)

* Redistribution of the buoyant surface layer induces Wind Driven
  * Sea level "valleys" in divergent regions
  * And sea level "hills" in convergence regions
  * Hills and valleys amount to only a 1.5 meter in amplitude
  * Induces horizontal pressure gradients which initiate wind driven circulation
* Wind driven circulation is large clock-wise and counter clock-wise flowing gyres (circular pattern) The normal currents
* The Ekman Layer transport (wind stress) is at 90° to the direction of the wind,
  * Right of the wind in the northern hemisphere
  * Left of the wind in the southern hemisphere.
  * Can produce divergence (upwelling) or convergence (sinking) of surface water
* The surface layer is less dense (more buoyant) than deeper layers
  * The Ekman transport field acts to redistribute the buoyant surface water
  * Thins the buoyancy surface layer in divergence regions
  * Thickens the buoyant surface layer in convergence regions
* Thus we have a vertical and horizontal circulation system that is influenced by the position of the continents

Ocean currents "conveyor belt"



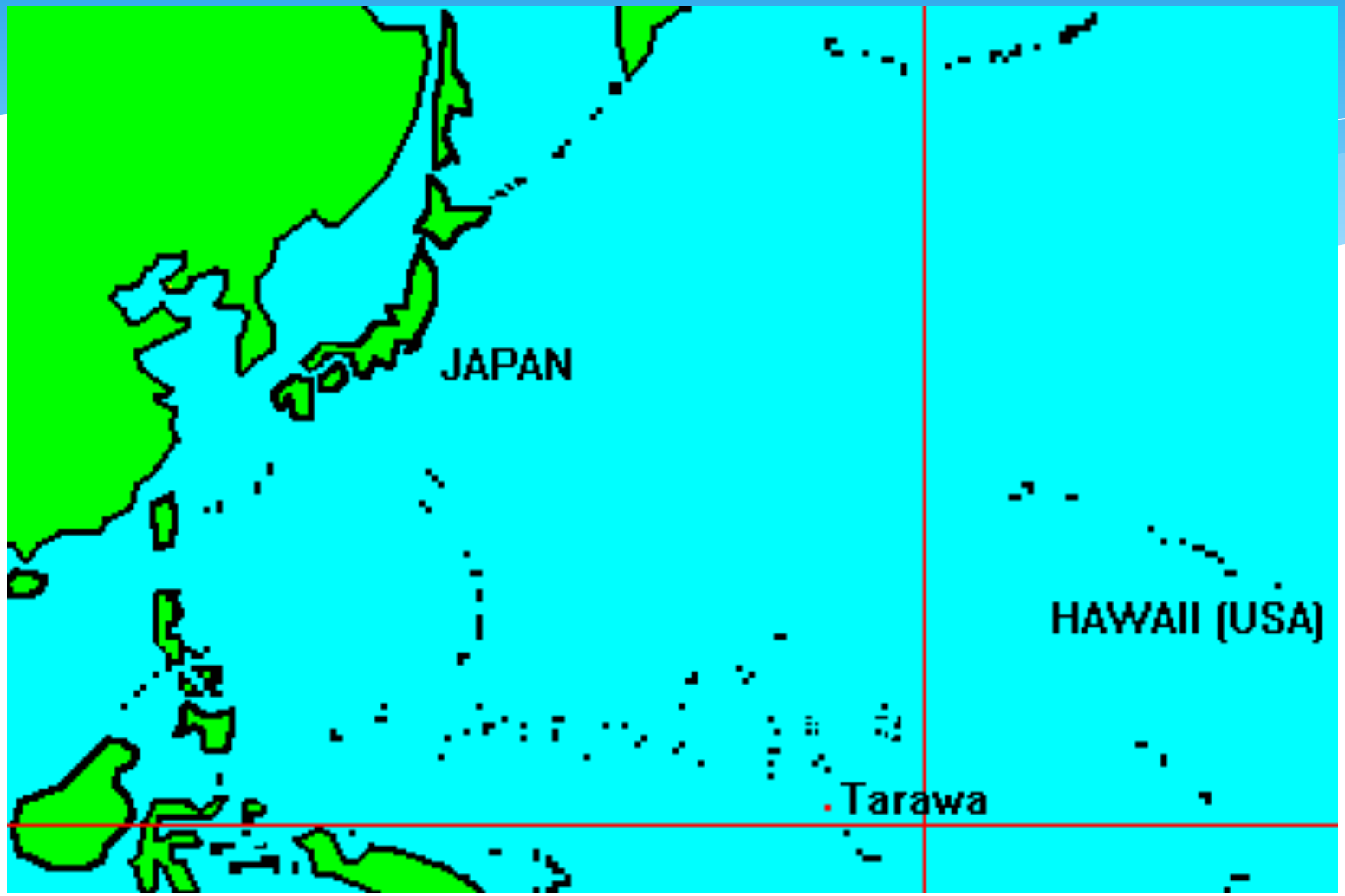
Tides

Tidal Generation

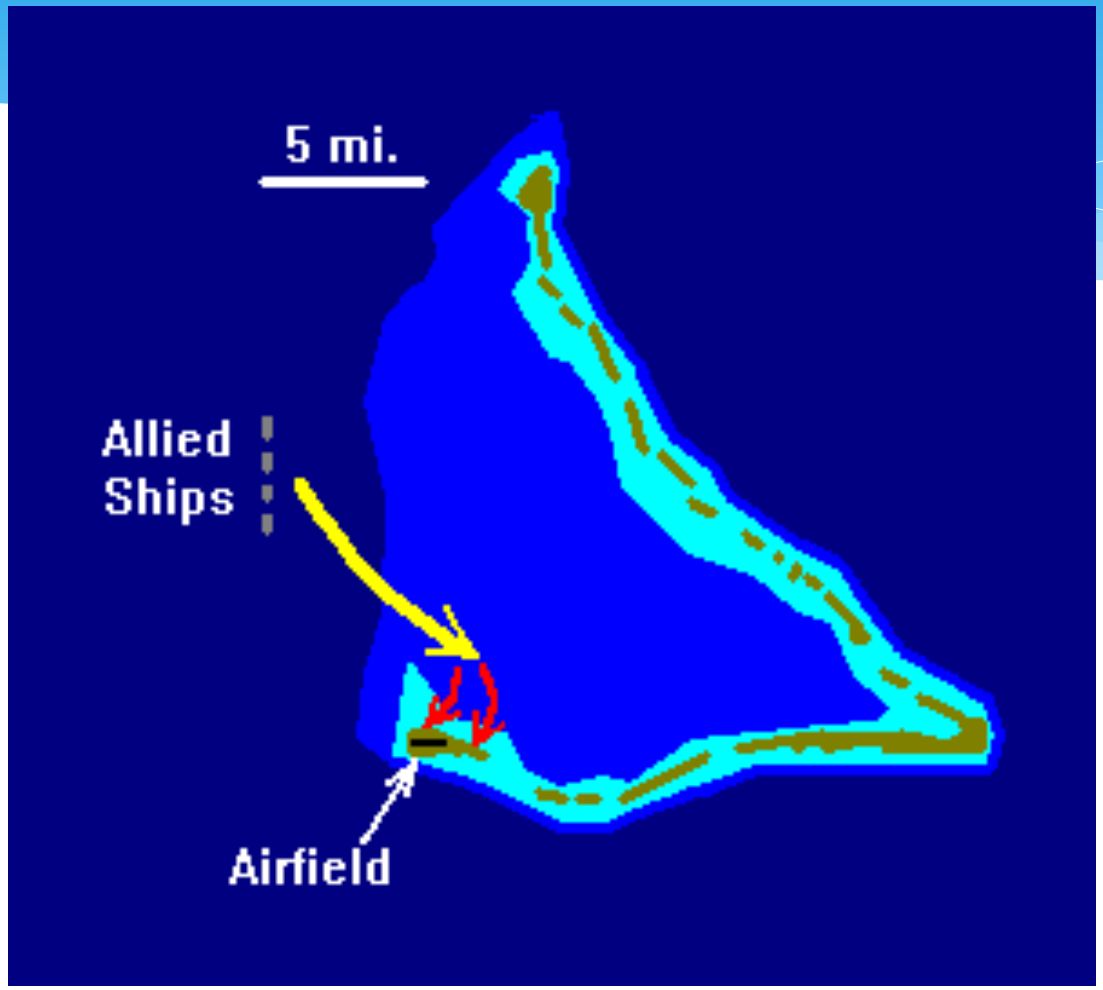
Tides and the Battle of Tarawa, November 20, 1943

* Near Earth's perihelion: strong solar tides
* Near lunar apogee: weak lunar tides
* Near last-quarter moon: neap tide
* Overall effect: unusually small tidal range

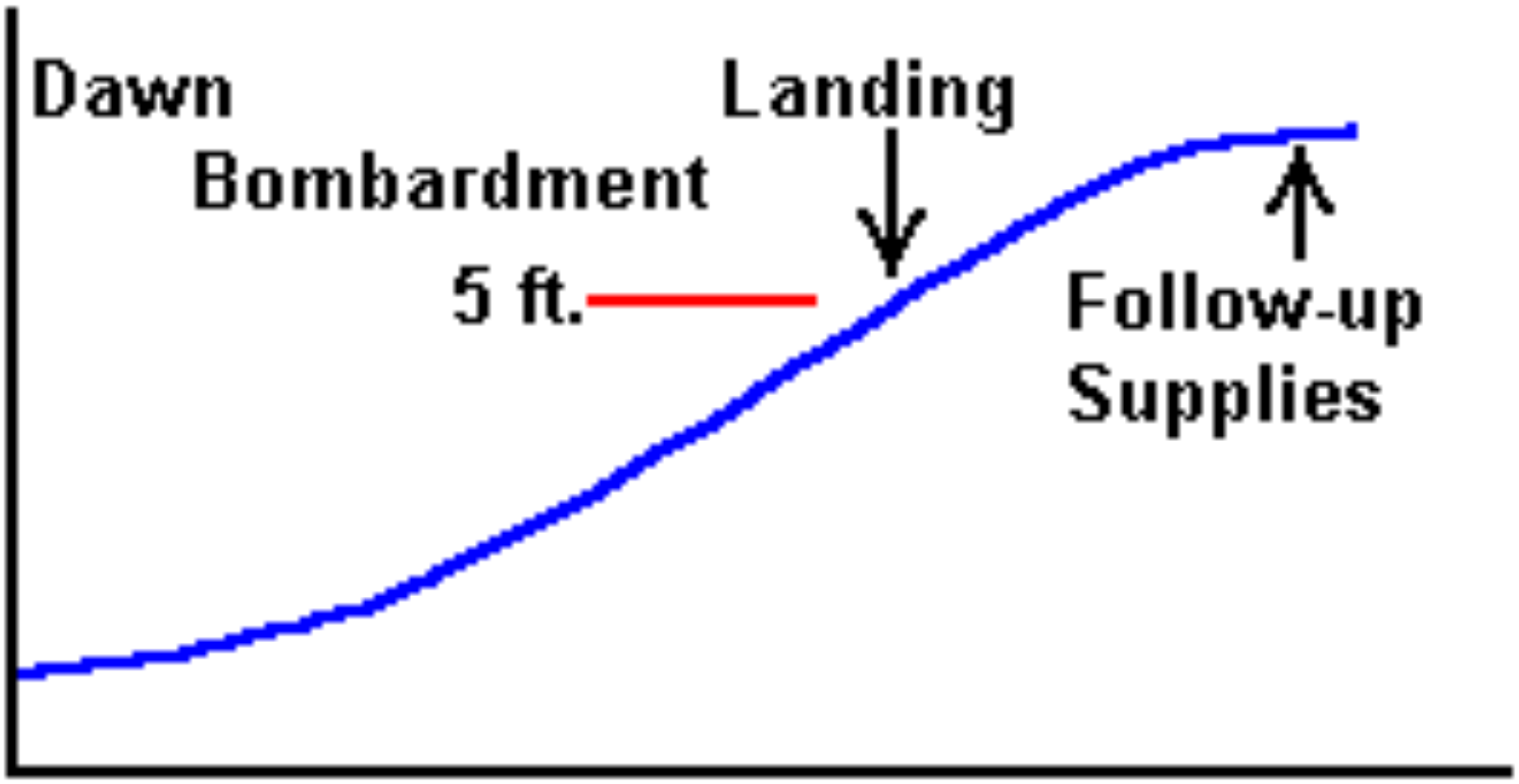
Location of Tarawa



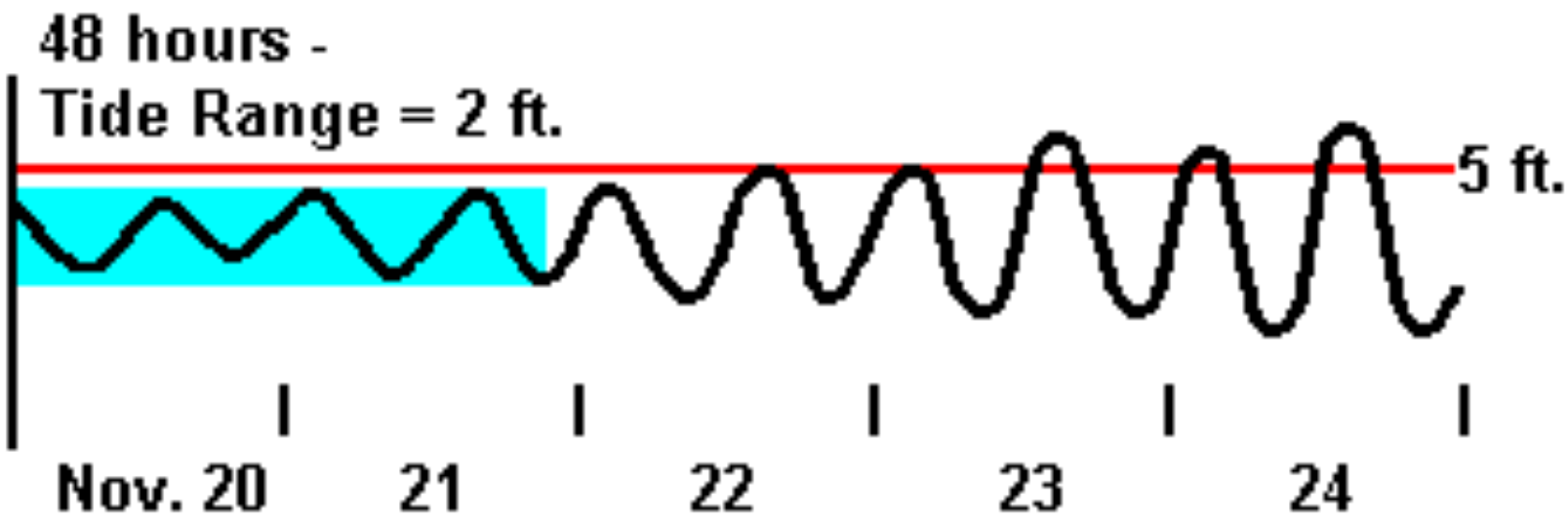
The Attack on Tarawa



Tarawa: What the Planners Wanted

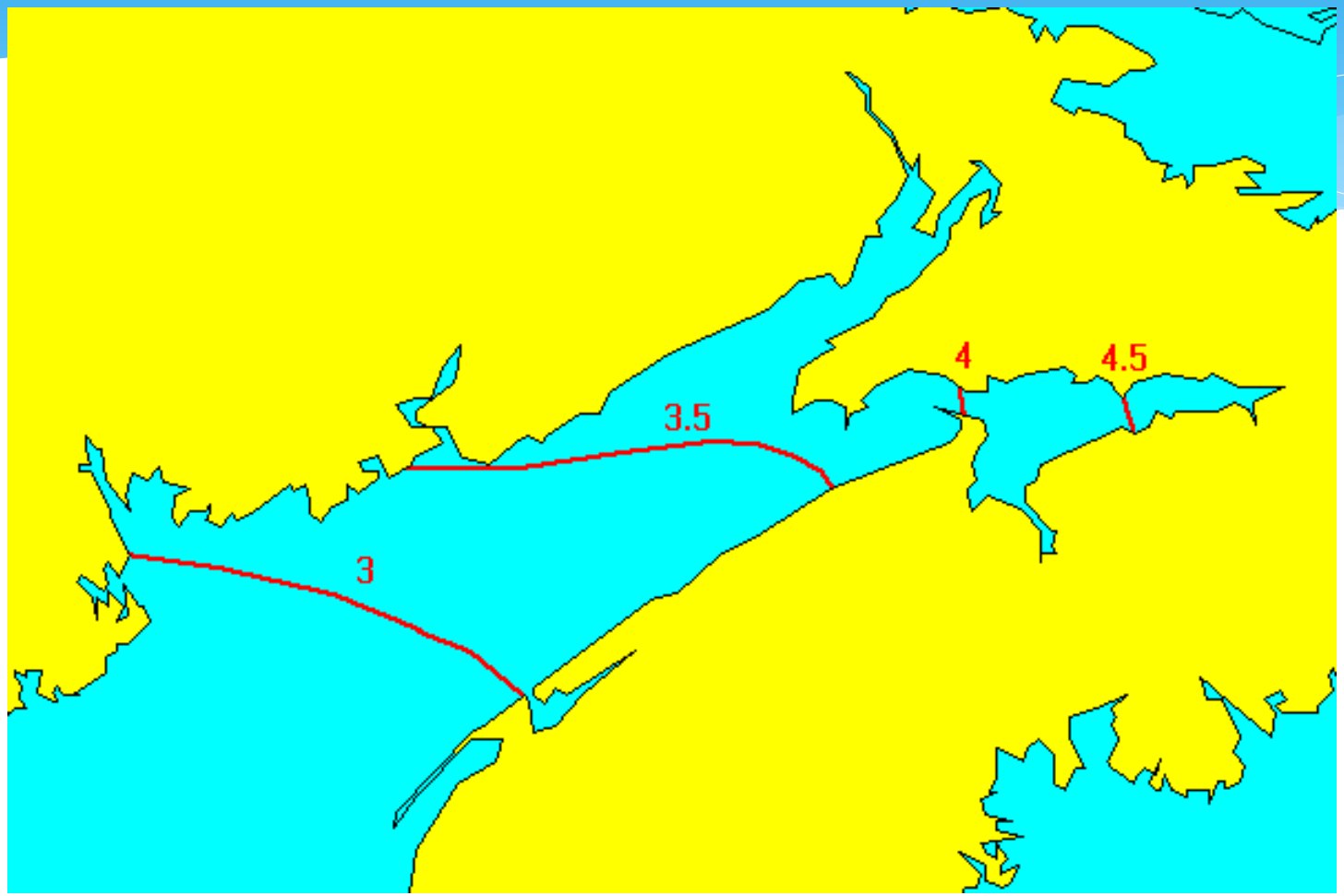


What Actually Happened



1027 Marines killed, 2292 wounded

Tides in Confined Spaces



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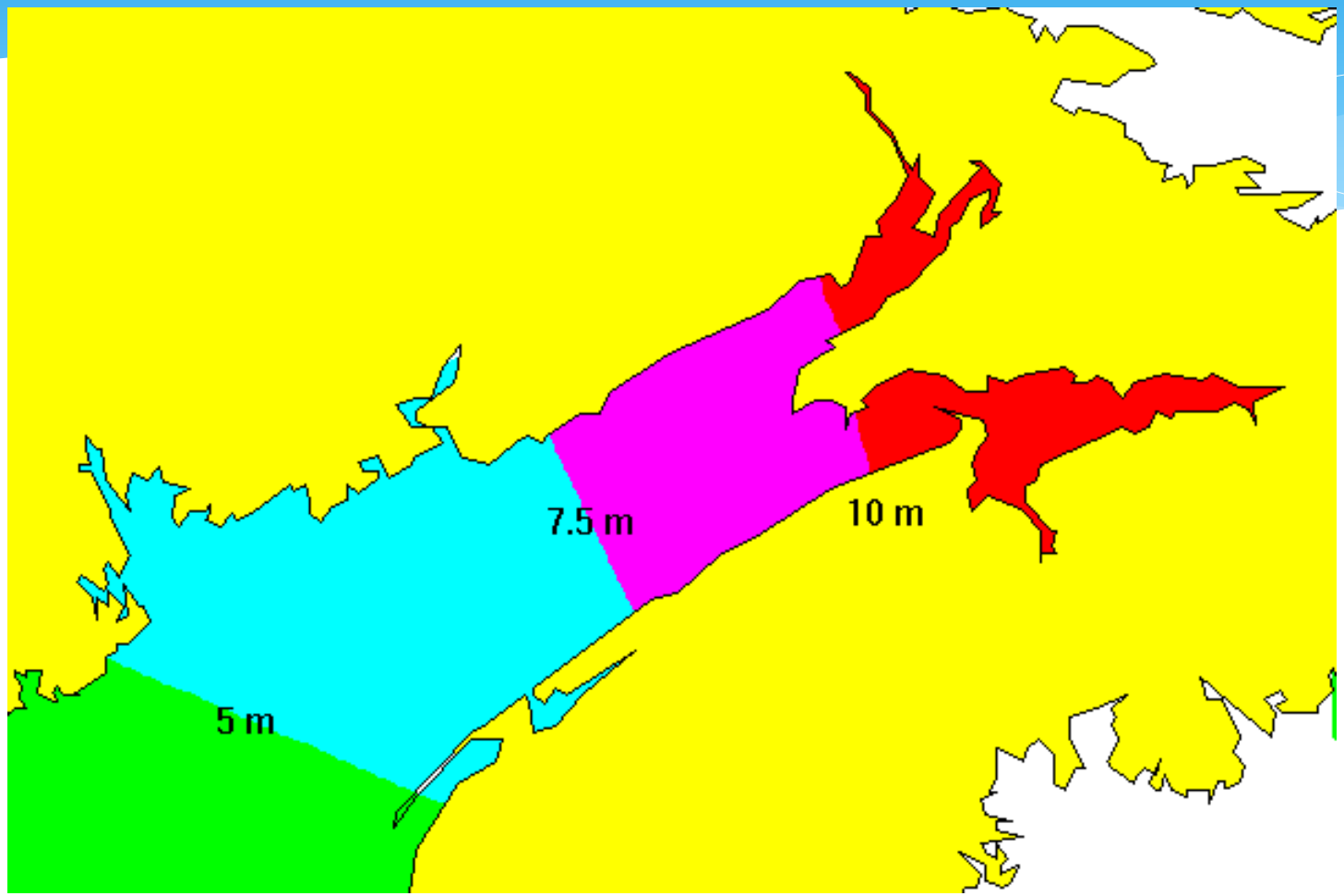
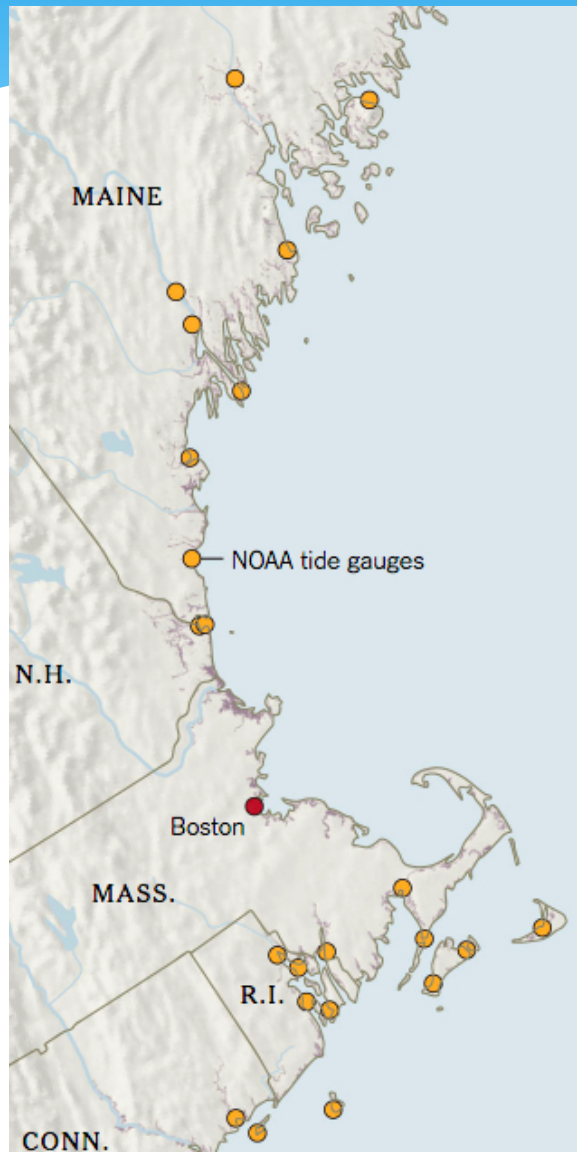


What We Are Already Seeing in the US



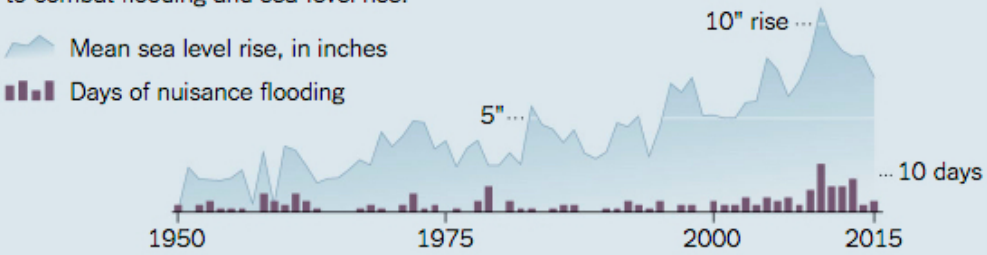
A Sharp Increase In 'Sunny Day' Flooding

By JONATHAN CORUM SEPT. 3, 2016

Global warming and rising seas are increasing the amount of tidal flooding on the Atlantic and Gulf Coasts. Flood levels are different from city to city, but the trends are similar. Related Article

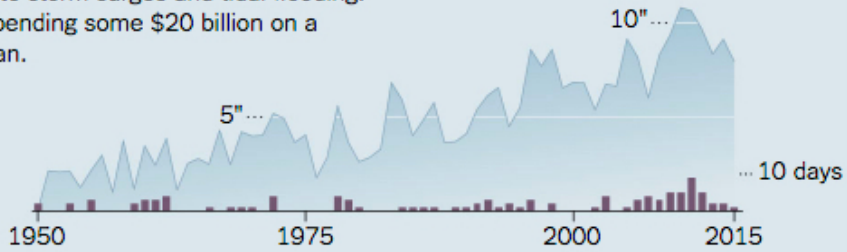
Boston

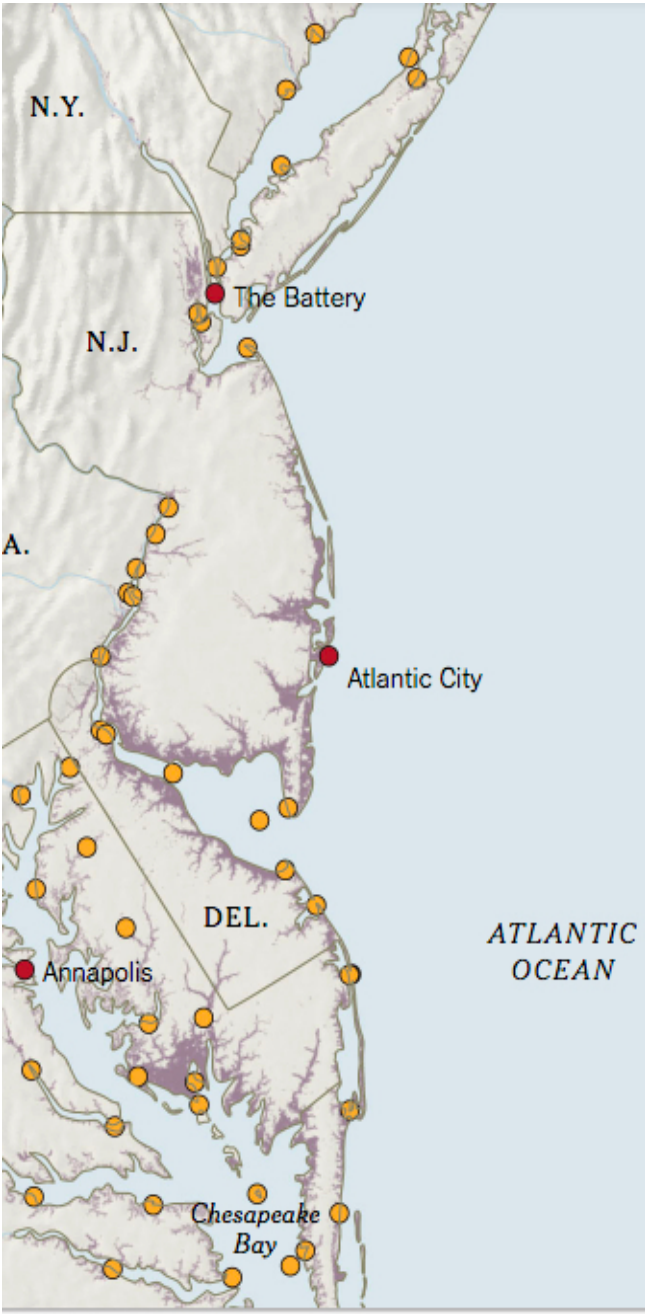
The city has not been hit by tidal flooding as hard as cities farther south, but it is working on a plan to combat flooding and sea-level rise.



The Battery, New York City

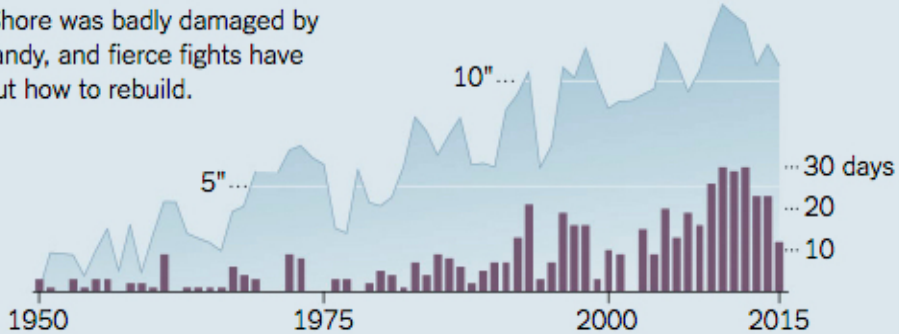
In 2012, Hurricane Sandy laid bare the city's vulnerability to storm surges and tidal flooding. The city is spending some $20 billion on a resilience plan.

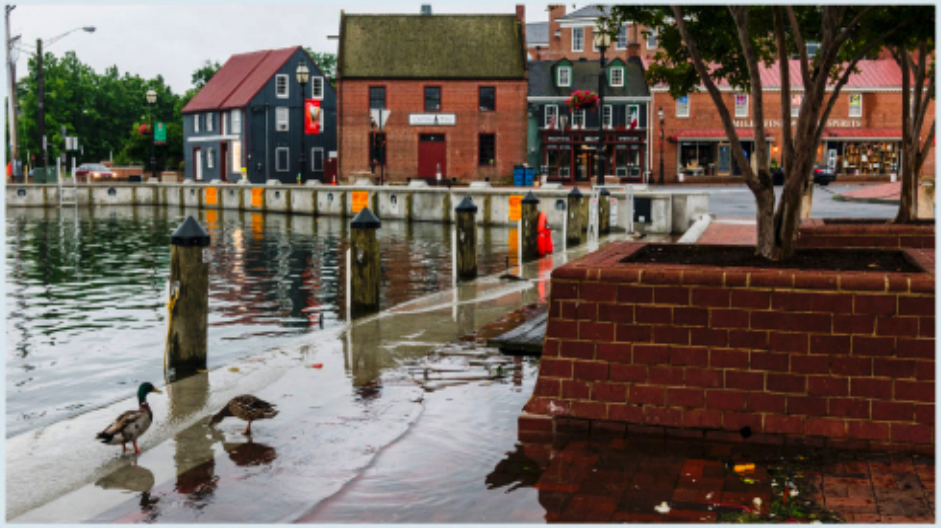




Atlantic City

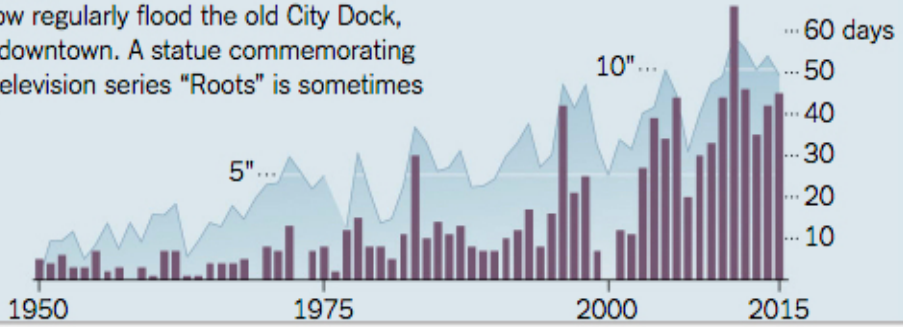
The Jersey Shore was badly damaged by Hurricane Sandy, and fierce fights have erupted about how to rebuild.

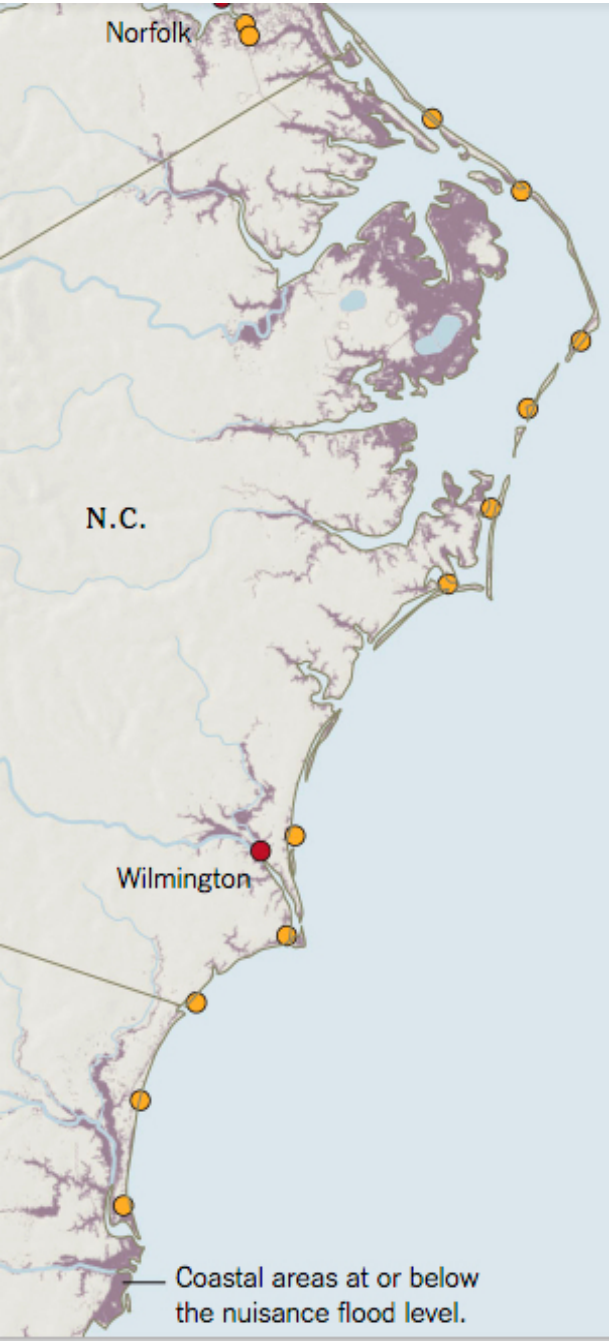




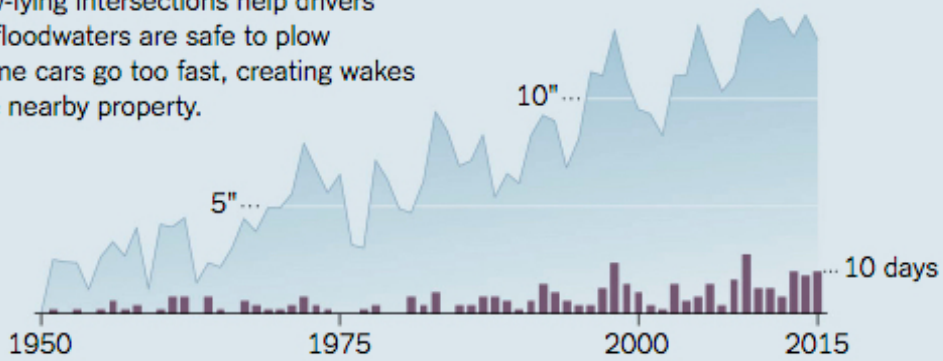
▲ **Annapolis, Md.**

High tides now regularly flood the old City Dock, the heart of downtown. A statue commemorating the historic television series "Roots" is sometimes under water.

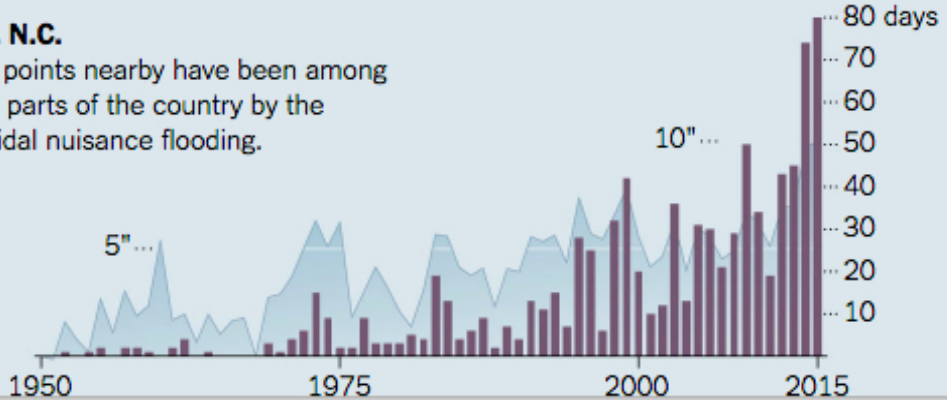


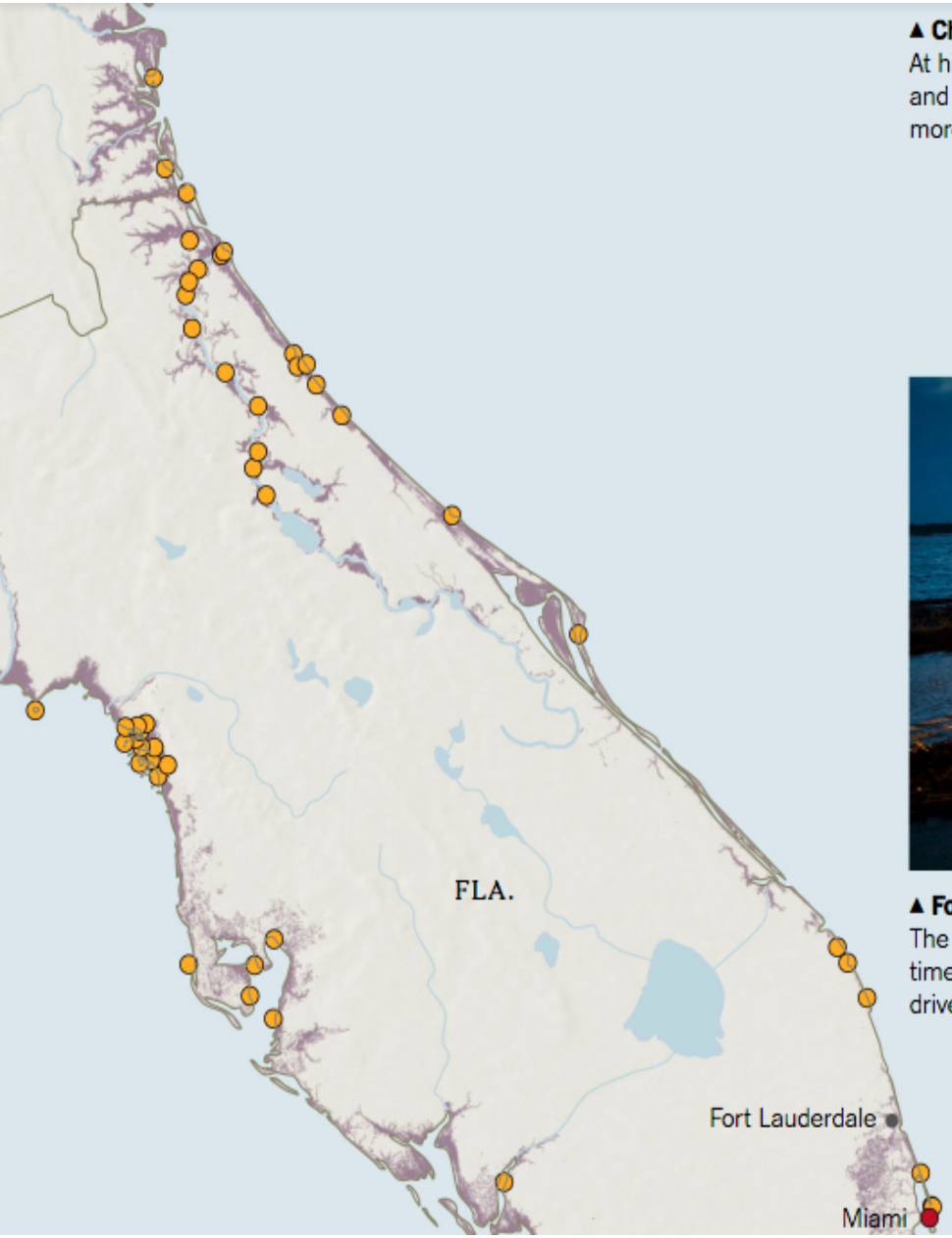


▲ **Norfolk, Va.**
Rulers at low-lying intersections help drivers figure out if floodwaters are safe to plow through. Some cars go too fast, creating wakes that damage nearby property.

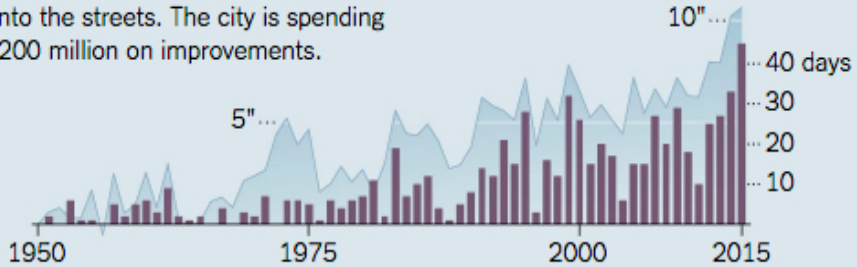


Wilmington, N.C.
The city and points nearby have been among the worst-hit parts of the country by the increase in tidal nuisance flooding.

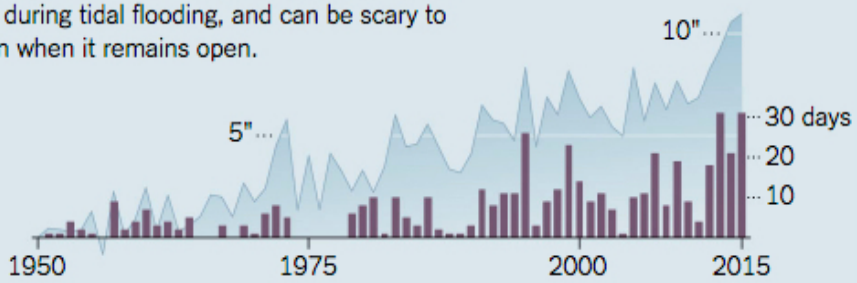


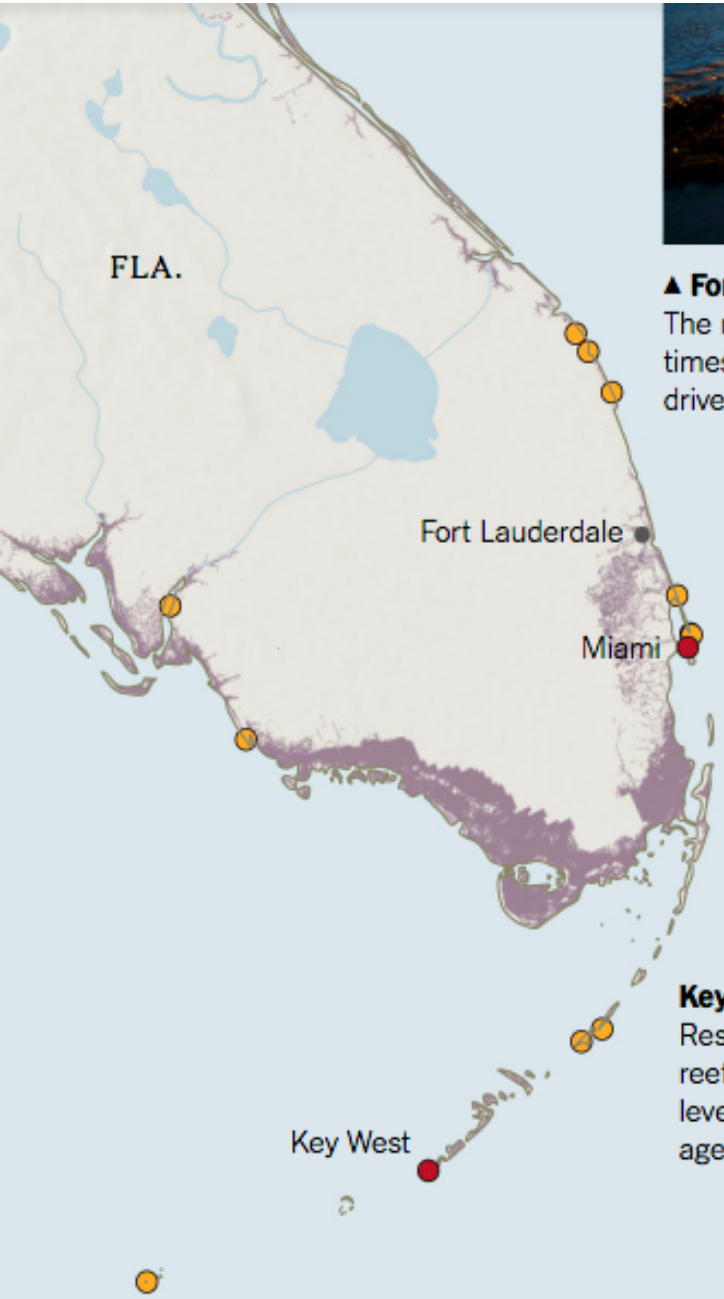


▲ **Charleston, S.C.**
At high tide, water can back up in the old sewers and bubble into the streets. The city is spending more than $200 million on improvements.



▲ **Fort Pulaski, Ga.**
The road to nearby Tybee Island is being closed several times a year during tidal flooding, and can be scary to drive on even when it remains open.





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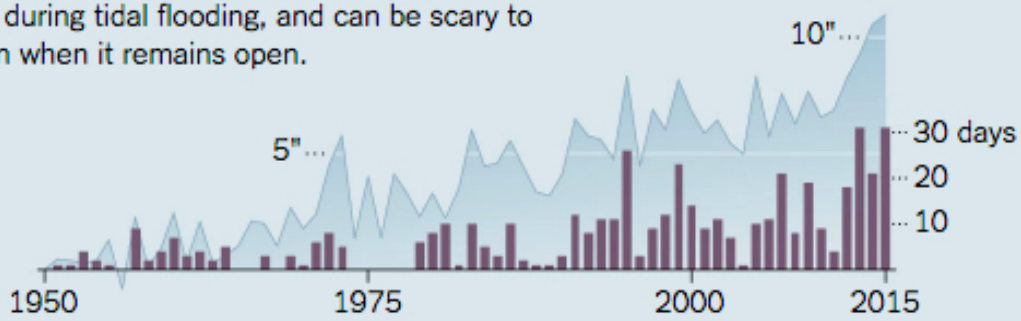
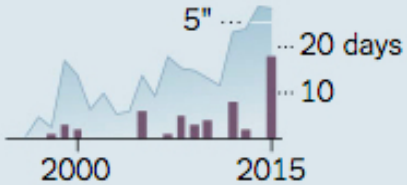
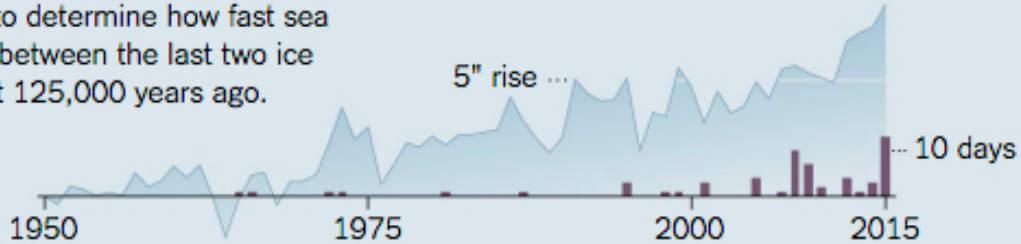


Miami
Miami Beach plans to spend at least $400 million to raise streets, install pumps and elevate seawalls.



Key West, Fla.
Researchers are studying ancient coral reefs here to determine how fast sea levels rose between the last two ice ages, about 125,000 years ago.



Investigating the Sea Floor

* Coring
* Deep-Sea Drilling
* Sonar
* Seismic Refraction
* Gravity Surveys
* Magnetic Surveys

Ocean Basins Over Time – Plate Tectonics

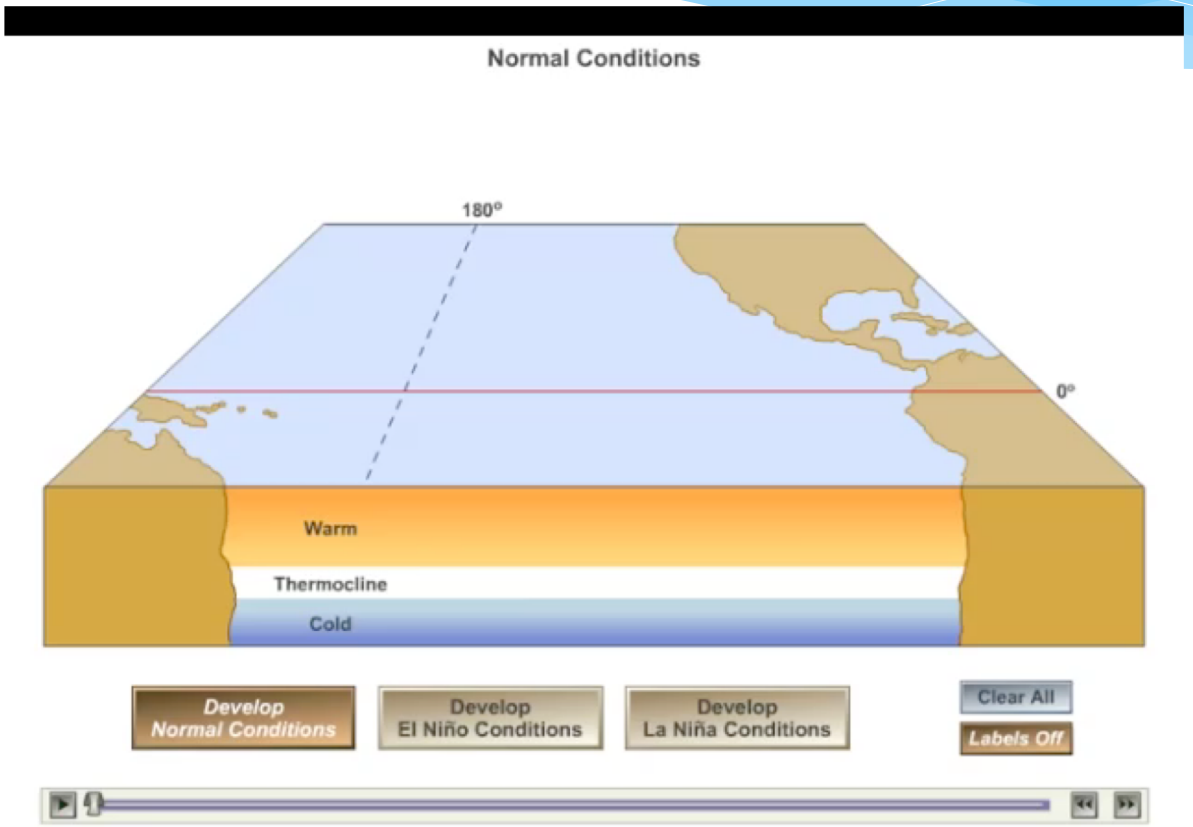
* Plate Tectonics is the now accepted term for the processes of sea floor spreading and continental drift
* Alfred Wegner at the beginning of the 20th Century discovered a remarkable similarity of geologic features, fossils, and continental coastal fits
  * Suggested the continents must have been connected at a past time
  * Suggested that they drifted apart.
  * Problem – no mechanism
* Plate Tectonics to the rescue by identifying the mechanisms that drives the movement of the continents
* A story that must be told in another discussion but here is the short version

Hurricanes

* Tropical storms **occur** in several of the world's oceans, and they are essentially the same type of storm. In the Atlantic Ocean, Gulf of Mexico, and the Eastern Pacific Ocean, they are called **hurricanes**. In the Western Pacific Ocean, they are called typhoons
* Water vapor is the "fuel" for the **hurricanes** because it releases the "latent heat of condensation" when it condenses to form clouds and rain, warming the surrounding air
  * In this way, Hurricanes as well as violent storms are the way that the atmosphere releases some of its stored energy
  * Hurricanes are violent storms which can bring intense winds, heavy rain, a storm surge, floods, coastal erosion, landslides, and also spawn tornadoes
* Tropical Cyclones as these storms are generally named originate over tropical or subtropical waters and rotate clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere.
  * Rotation is due to the Carioles Effect – related to the fact that the Earth is a sphere and the speed of rotation is faster at the equator than at the poles
  * Think of a merry-go-round

Illustration of Thermo-haline Circulation

El Nino – La Nina



Normal Currents

Plate Tectonics

Difference From Tornadoes

Questions?