Coastal Cities-Coastal Impacts: 'The Tides They Are A-Changin'

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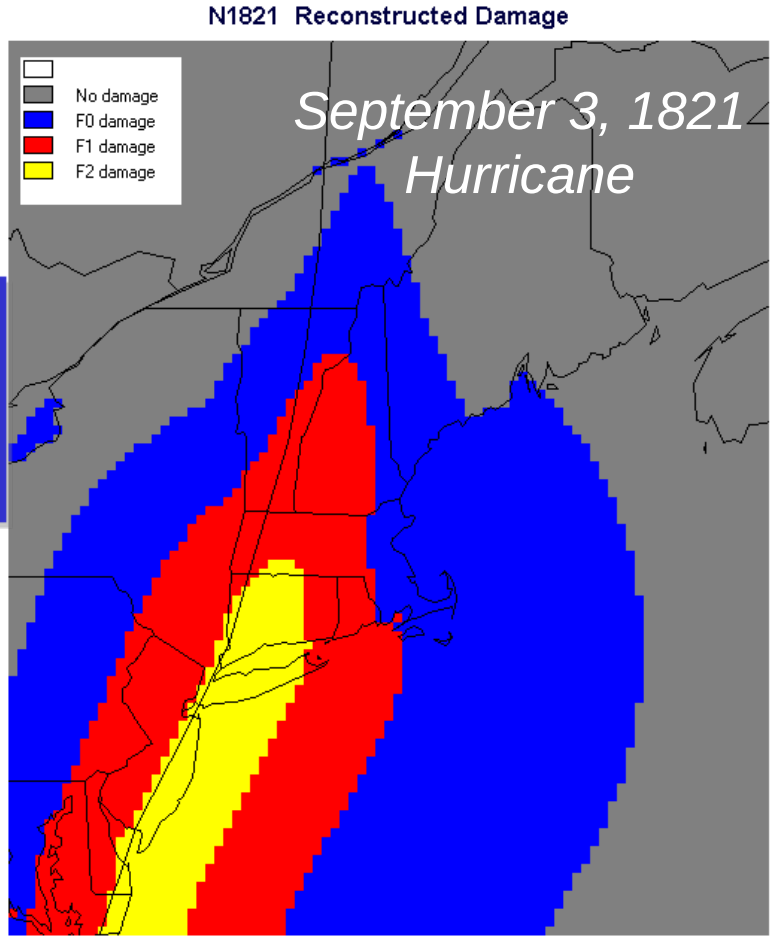
Thanks to: Jeff Donnelly, Chris Reddy, Porter Hoagland, Jim Price, Dennis McGillicuddy, Scott Doney, Kirk Waters, Don Anderson, Robert Weller, Margaret Davidson, Lonny Lippsett

AMS, January 2008

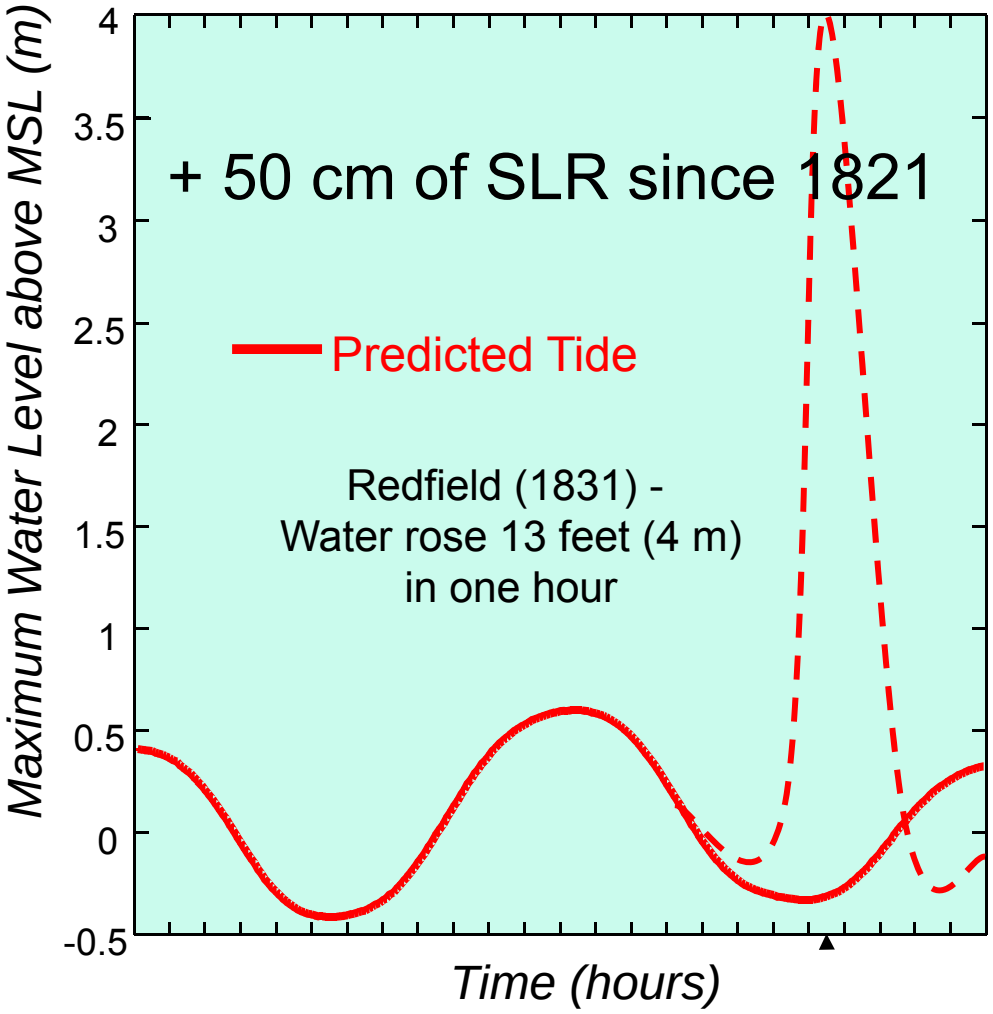
Historical storms: Northeastern US Vulnerability

moving at about 50 mph
the storm took less than
8 hours
to get from NC to NY

from
Boose et al.
2004



September 3, 1821 Storm Surge: New York City



Courtesy Jeff Donnelly, WHOI

Population and wealth have substantially increased in the areas impacted by the 1821 Hurricane

Coastal population in MD, DE, NJ, NY, and CT now exceeds 31 million

Insured coastal property is over 1 trillion dollars


Rockaway Beach, NY

Difficulty evacuating people


Photo: Atlantic City Convention & Visitors Authority


Ocean City, Maryland

THE CROWDED COAST: POPULATION TRENDS, 1970-2000

From 1970 to 2000, population continued to grow in coastal counties. Although population increase and coastal development give rise to numerous economic benefits, they also may result in the loss of critical habitat, green space, and biodiversity. Public policymakers and coastal managers are confronted with the daily task of finding a balance between benefiting from economic growth and mitigating the effects of this growth on coastal environments. This task is becoming ever more challenging as the coastal population continues to grow in a limited space.

County Population Change: 1970 - 2000

FACTS

In 2000, of the 281 million people that lived in the U.S., more than 148 million people lived in coastal counties.

Coastal counties contain 53% of the nation's population, yet, excluding Alaska, only account for 17% of U.S. land area.

From 2000 to 2015, coastal county population is expected to increase by 17 million people.

22 of the 25 most densely populated counties are coastal.

Coastal counties average 291 persons per square mile (not including Alaska), over five times greater than the population density of noncoastal counties.

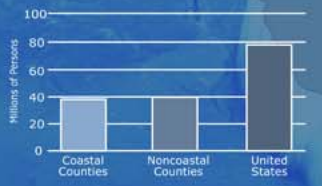
Thousands of Persons

Coastal Counties

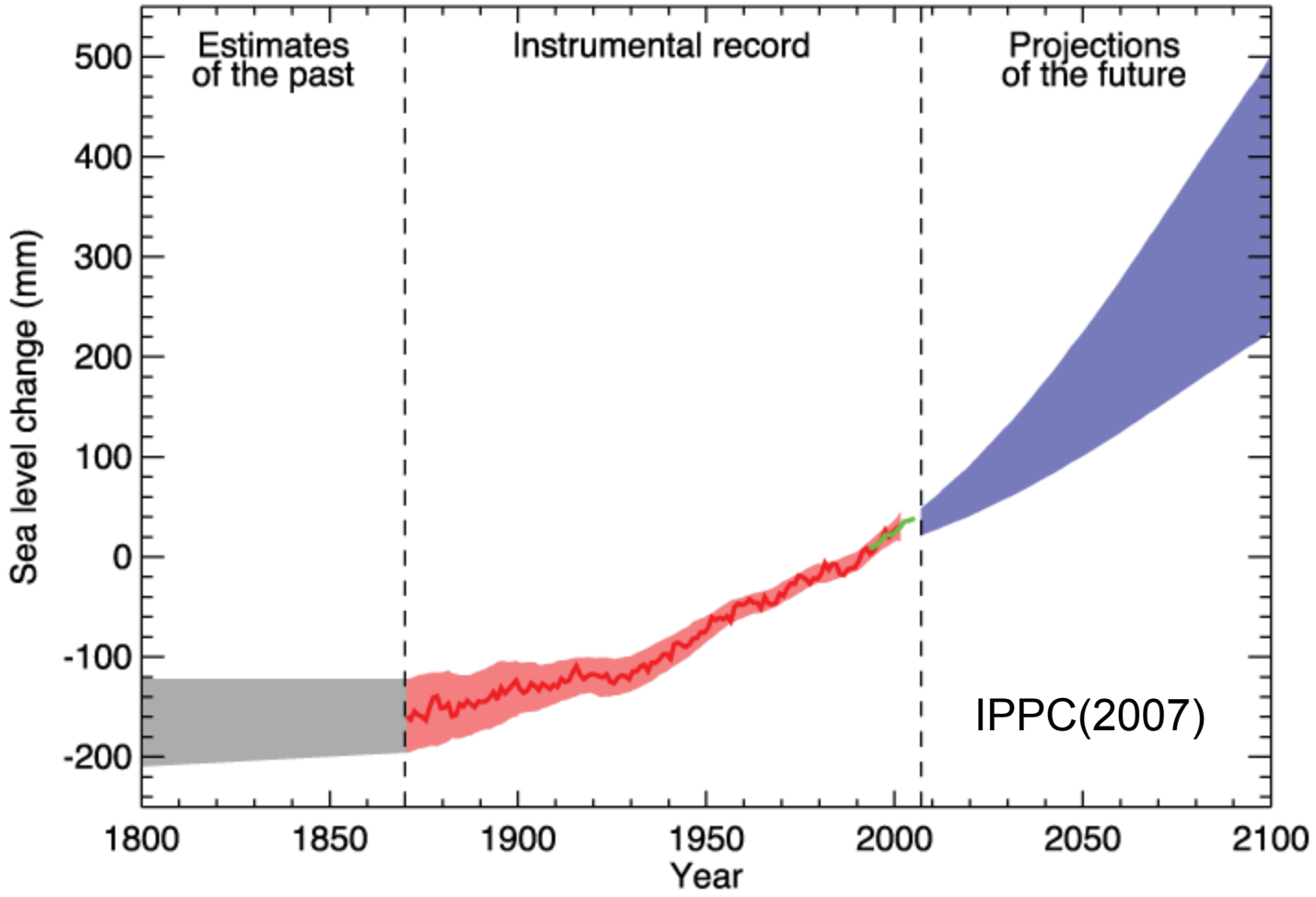
Noncoastal Counties

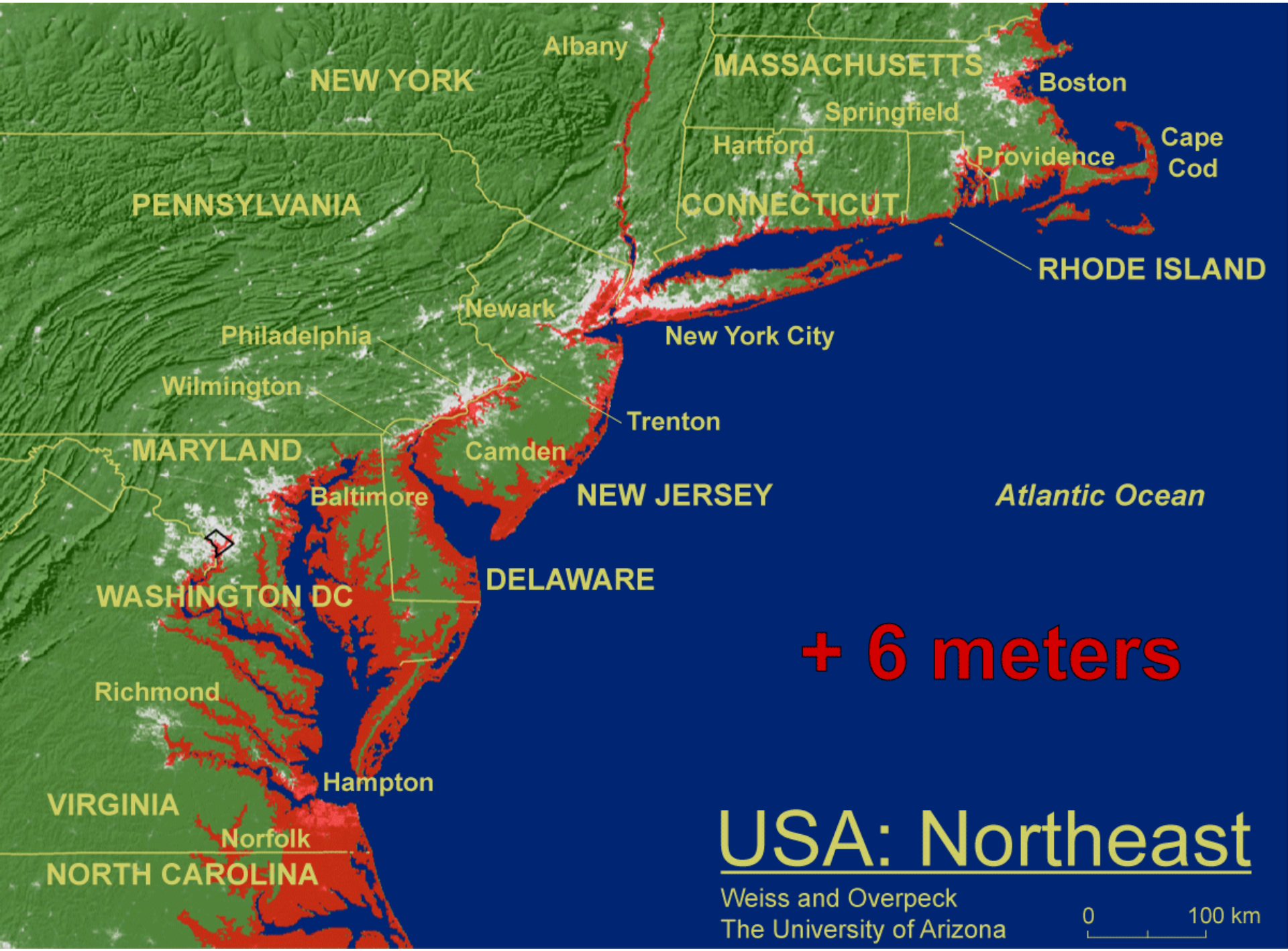
< -100
-100 - 0
0 - 200
200 - 500
> 500
Insufficient Data

Population Change: 1970-2000



Sea level rise is probably greatest climate change threat to coastal urban environments




Albany
NEW YORK
MASSACHUSETTS
Boston
Springfield
Hartford
Providence
Cape Cod
PENNSYLVANIA
CONNECTICUT
RHODE ISLAND
Newark
Philadelphia
New York City
Wilmington
Trenton
MARYLAND
Camden
Baltimore
NEW JERSEY
Atlantic Ocean
DELAWARE
WASHINGTON DC
+ 6 meters
Richmond
Hampton
VIRGINIA
Norfolk
NORTH CAROLINA
USA: Northeast
Weiss and Overpeck
The University of Arizona
0
100 km

Associated inundation from shallow coastal flooding and sea level rise (Charleston)

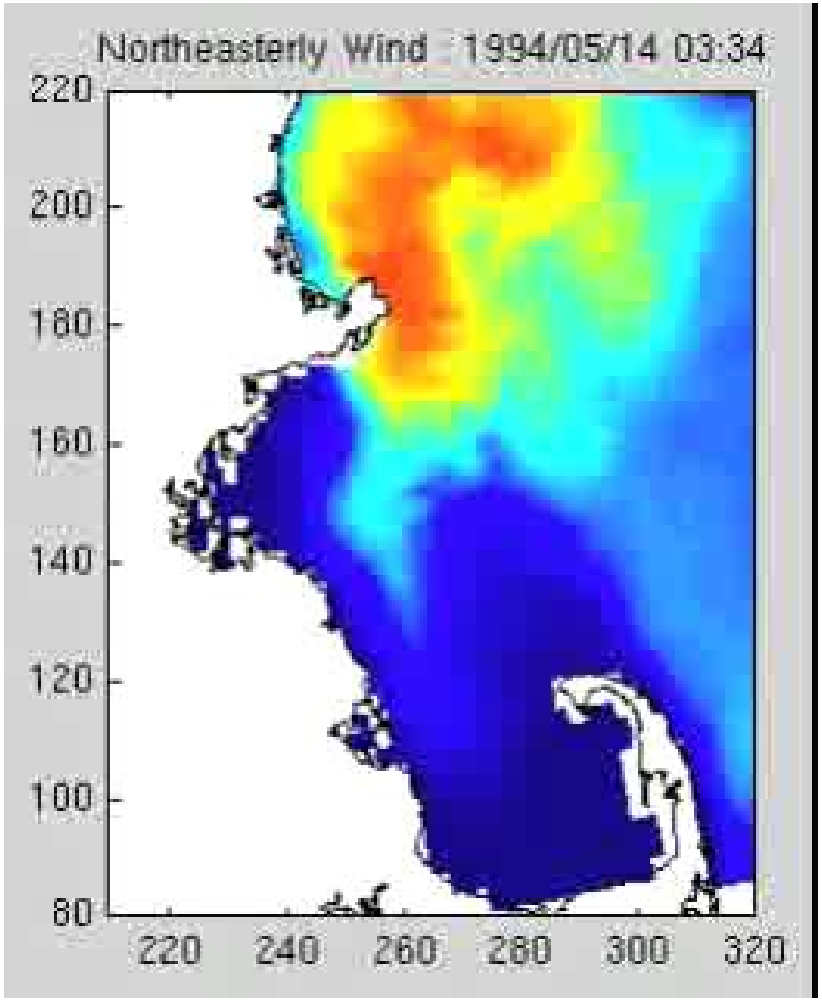
Courtesy Billy Brooks, Tara Miller, Lynne Dingerson, and Kirk Waters, NOAA

Coastal cities also impacted by local human practices and land use

Compared to 30 years ago, we have

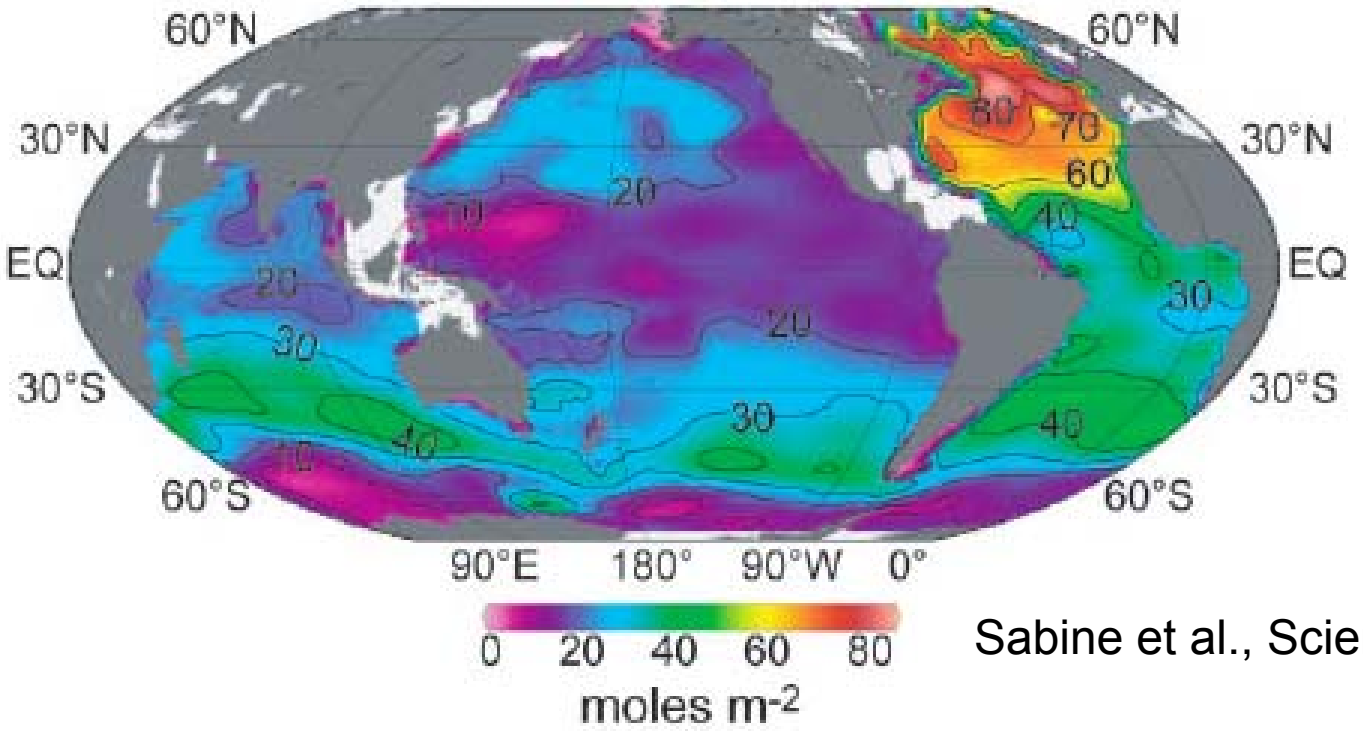
- Greater populations leading to more pollution
- Greater pressure on resources
- Loss of coastal barriers and marshes
- More toxic and invasive species

Red tide in the Gulf of Maine, Spring 2005



Courtesy of Don Anderson (WHOI) and R. Signell (USGS)

Ocean chemistry changes affecting global waters



Sabine et al., Science, 2004

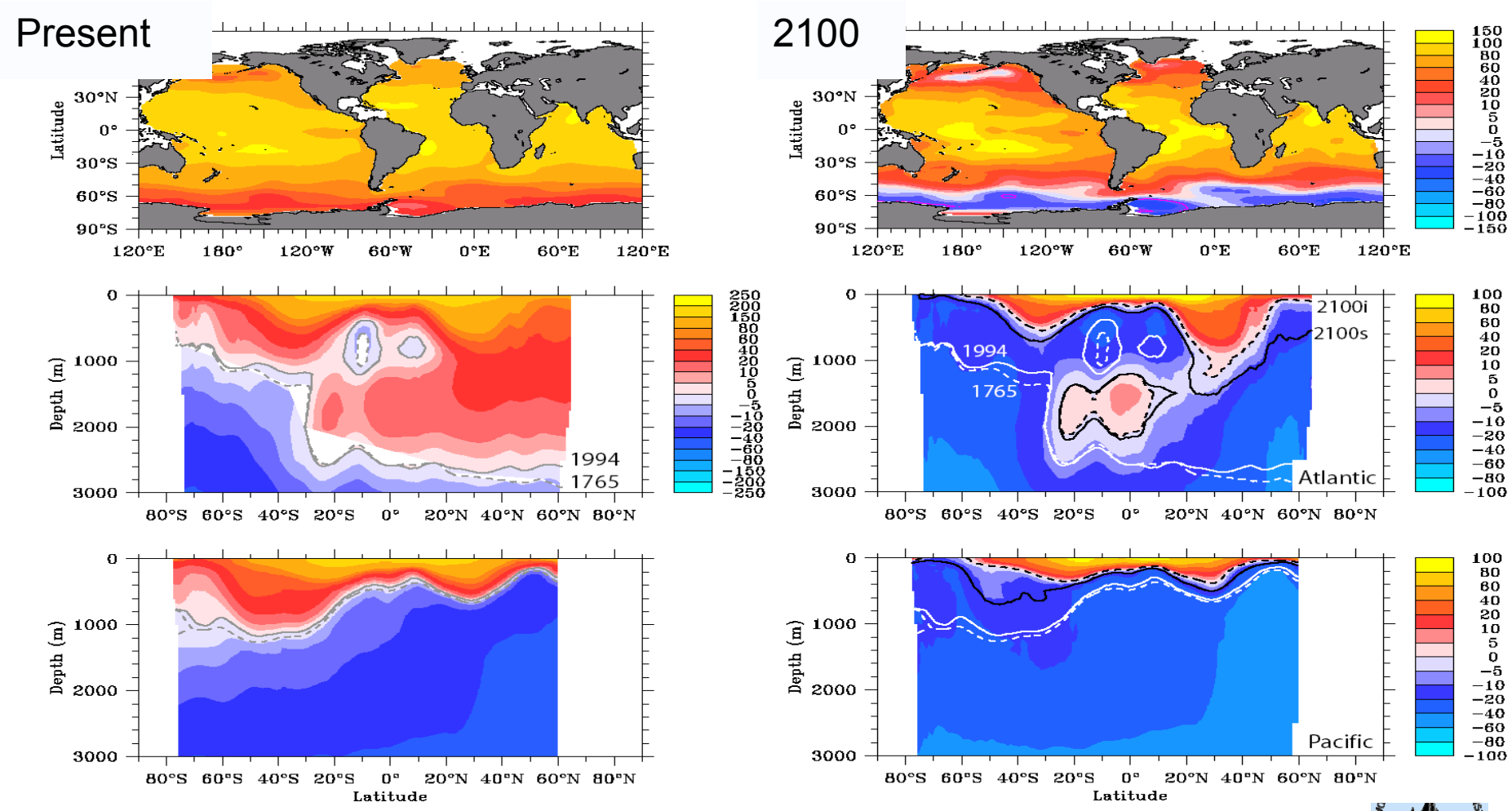
Fig. 1. Column inventory of anthropogenic CO_2 in the ocean (mol m^{-2}). High inventories are associated with deep water formation in the North Atlantic and intermediate and mode water formation between 30° and 50°S. Total inventory of shaded regions is 106 ± 17 Pg C.

CO_2 Effects on $CaCO_3$ Saturation Ω (aragonite)

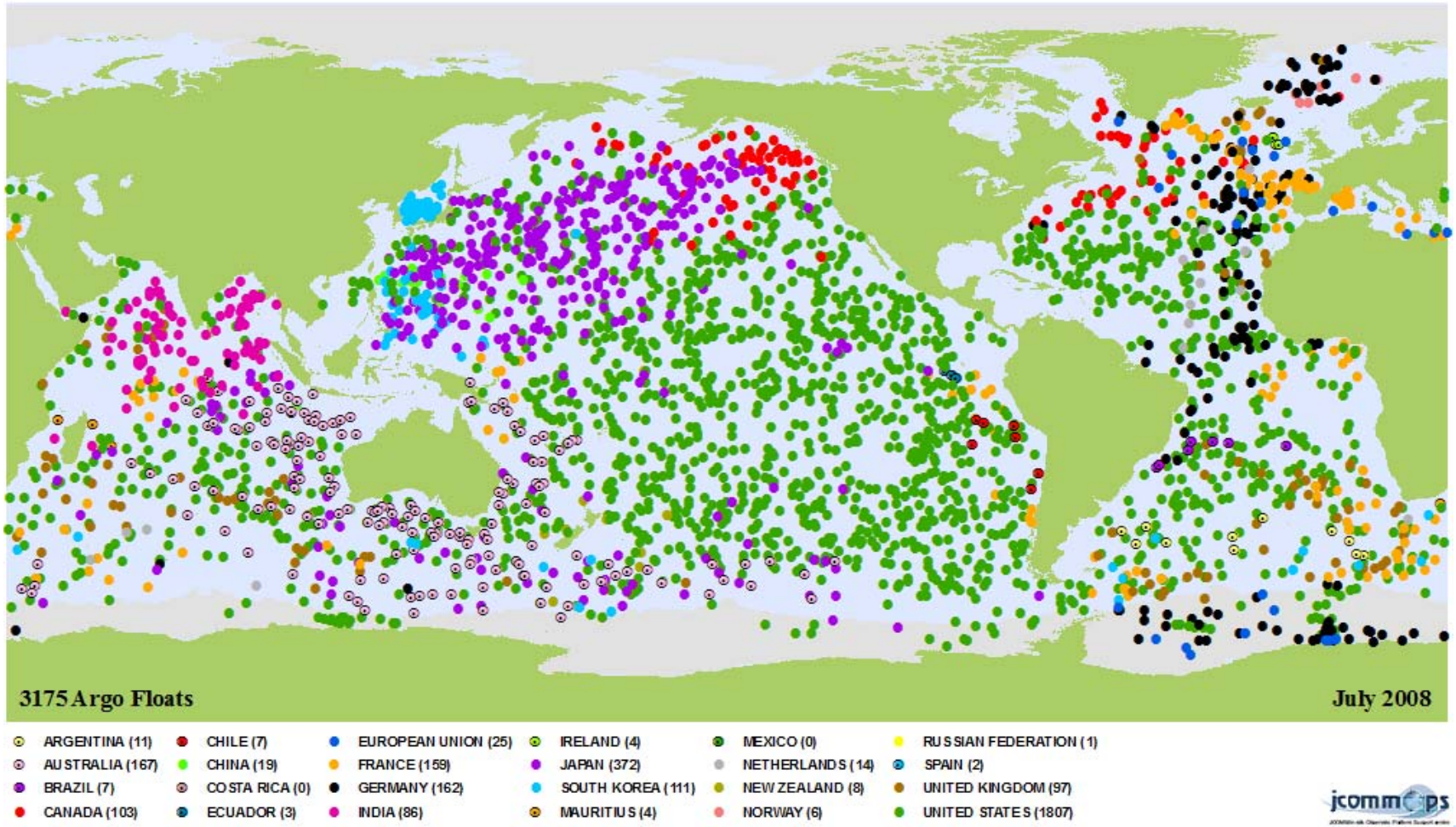
$\Omega = [Ca^{2+}][CO_3^{2-}] / K_{sp}$

$\Delta[CO_3^{2-}] = [CO_3^{2-}]_{obs} - [CO_3^{2-}]_{sat}$

Orr et al. Nature (2005)

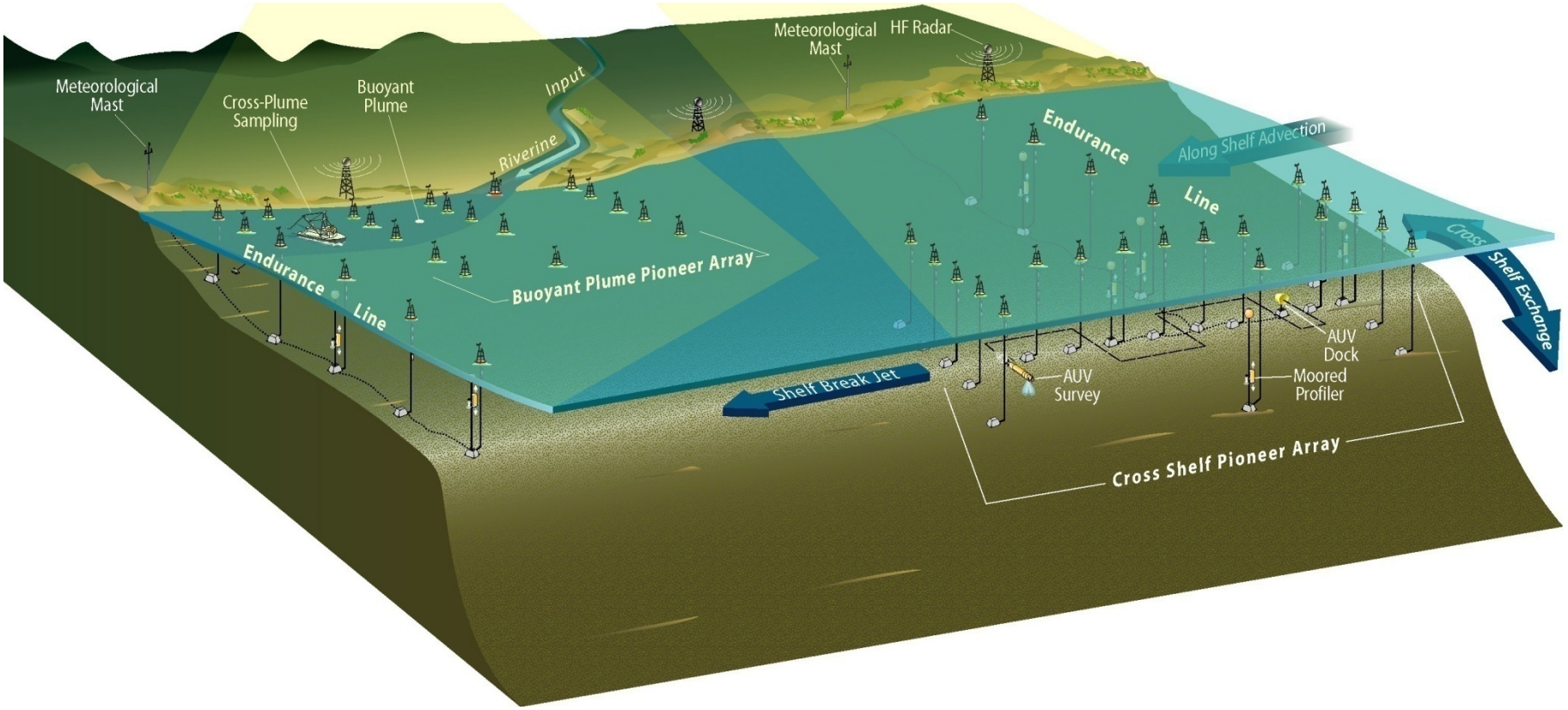


Argo profiling float array: the radiosonde of the ocean

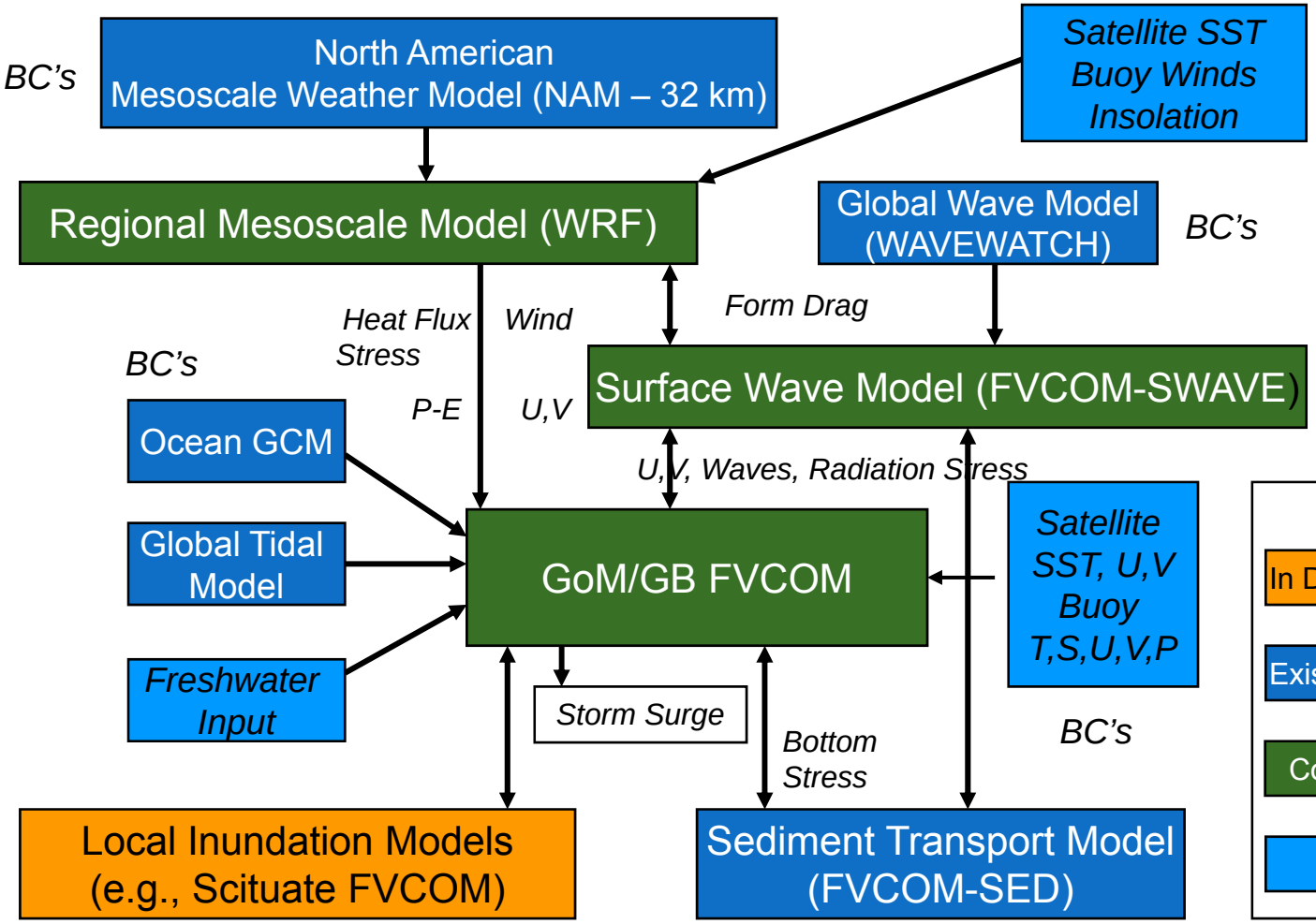


Courtesy Mike Johnson, NOAA

New ocean observatories are coming on line



Northeast Coastal Ocean Forecast System:
Simplified for storm surge and inundation prediction



Courtesy of Bob Beardsley, WHOI, Changsheng Chen, UMass Dartmouth, and NOAA

Coastal cities have increased their vulnerability but also can be part of solution

- Strategies for containing costs of short term disasters will be equally helpful for addressing long term sea level rise and other climate change impacts
- Investments in public infrastructure tied to resilient citing and design
- Strategic and aggressive approach towards coastal habitat acquisition, restoration, remediation and creation
- LEEDS-type standards for resilient structures (and tax credits)
- Integrated regional coastal zone management plans
- Energy saving and fossil fuel reduction technologies
- Influencing changes in life style behavior
- Relocation

The science agenda must…

- Develop systems approach to modeling and observing coastal regions and cities (atmosphere, ocean, land; social infrastructure and human practices)
- Enhance integrated observing systems (both coastal and global)
- Work within city frameworks to provide science into decision-making processes
- Coordinate and develop sustained international partnerships
- Pursue adaptation focus: Energy – Mitigation; Water-Adaptation