NASA-RIO UCCRN Training Partnership

Sea Level Rise, Urban Heat Island, and Water Quality

SEA LEVEL RISE
Part 1: Basics

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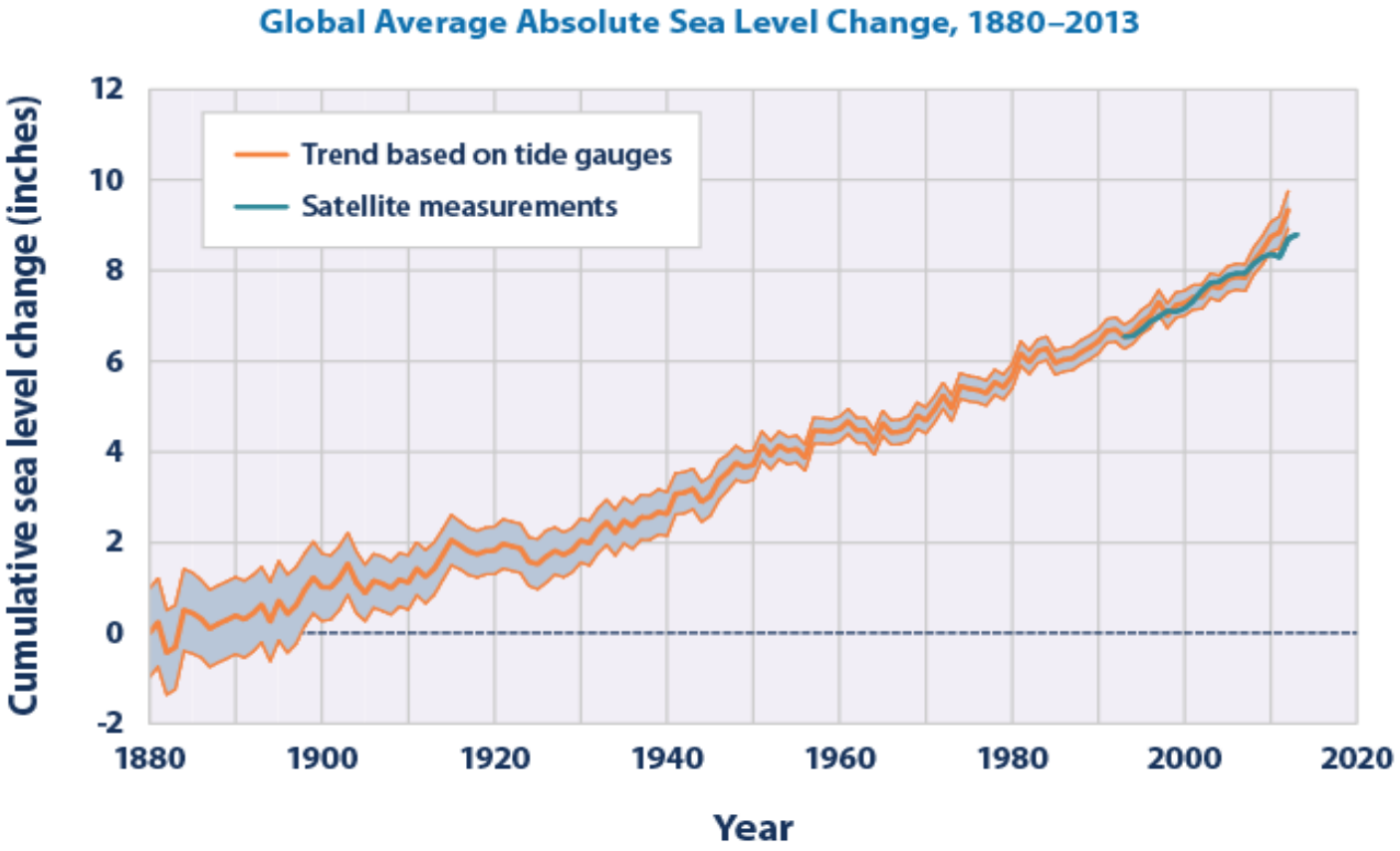
Global Sea Level Change

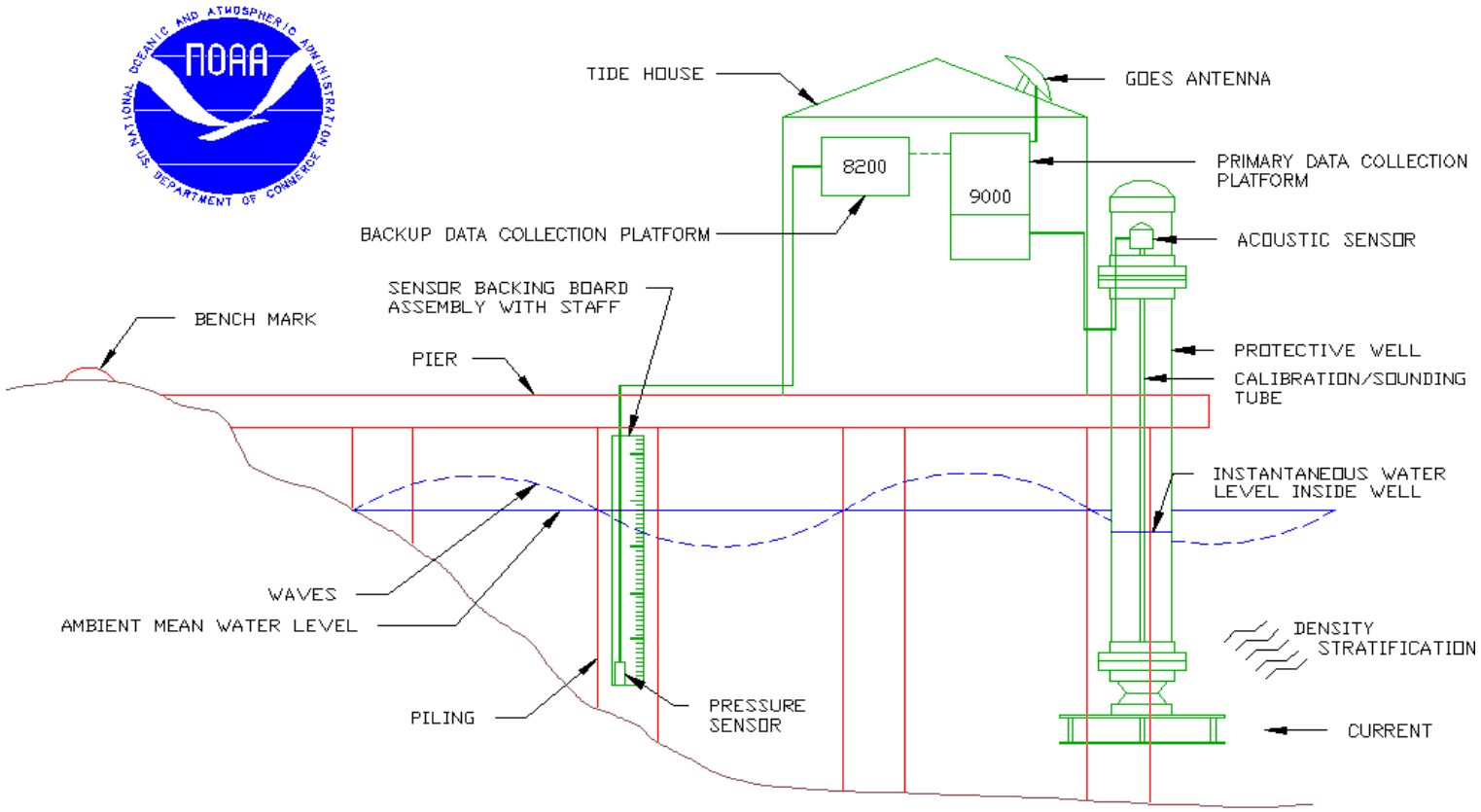


Data sources:

- CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2013 update to data originally published in: Church, J.A., and N.J. White. 2011. Sea-level rise from the late 19th to the early 21st century. Surv. Geophys. 32:585–602.
- NOAA (National Oceanic and Atmospheric Administration). 2014. Laboratory for Satellite Altimetry: Sea level rise. Accessed April 2014. http://ibis.grdl.noaa.gov/SAT/SeaLevelRise/LSA_SLR_timeseries_global.php.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/indicators.

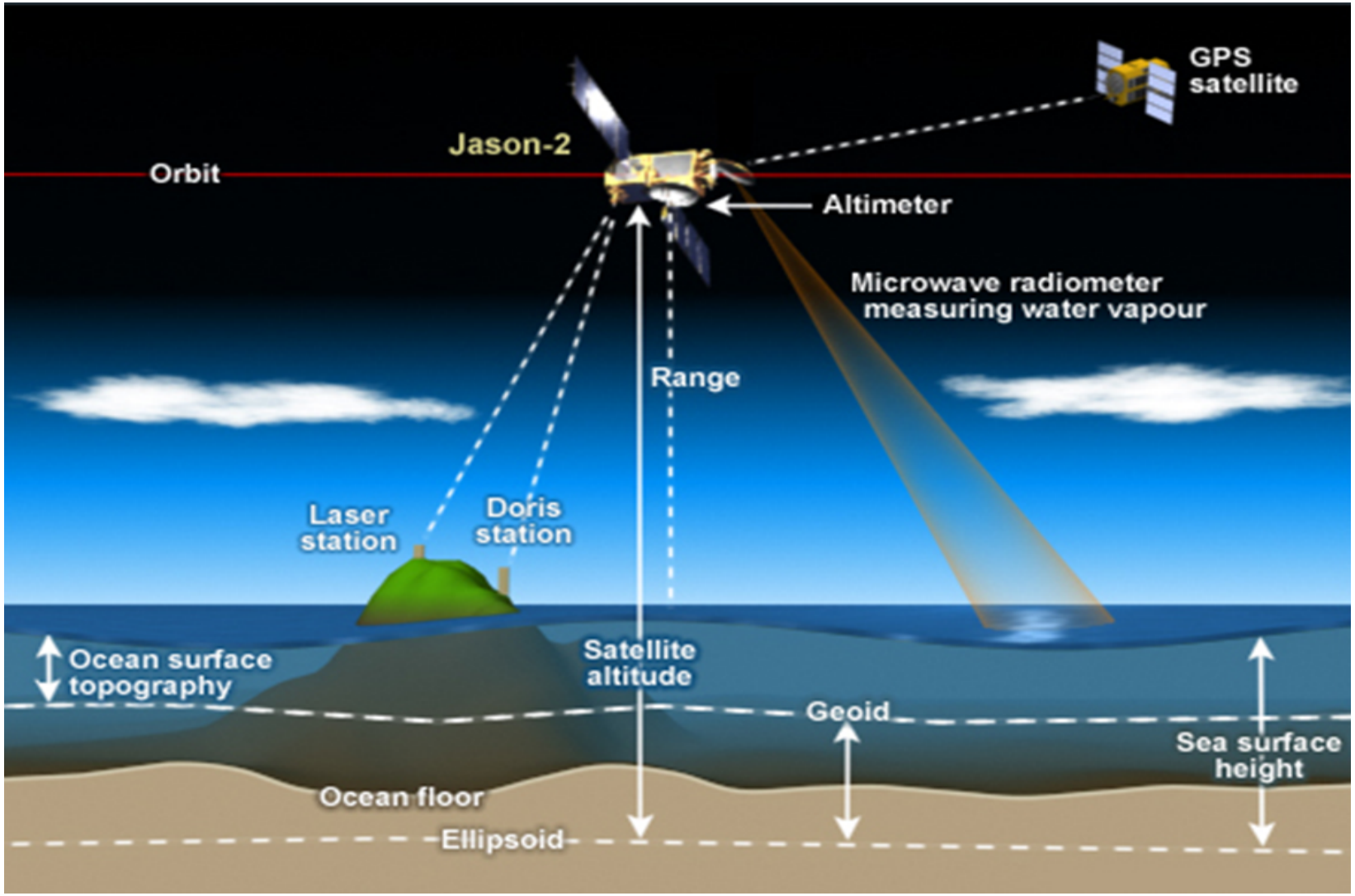
Next Generation Water Level Measurement System
Tide Gauge



NEXT GENERATION WATER LEVEL MEASUREMENT SYSTEM

The Battery Tide Gauge
New York City – Lower Manhattan

The Jason-2 satellite radar altimeter
NASA, Centre National d'Etudes Spatiales (France)



Source: NASA

Causes of Sea Level Change

Land water storage

Groundwater mining, impoundment in reservoirs, urban runoff, deforestation, seepage into aquifers

Vertical land motions

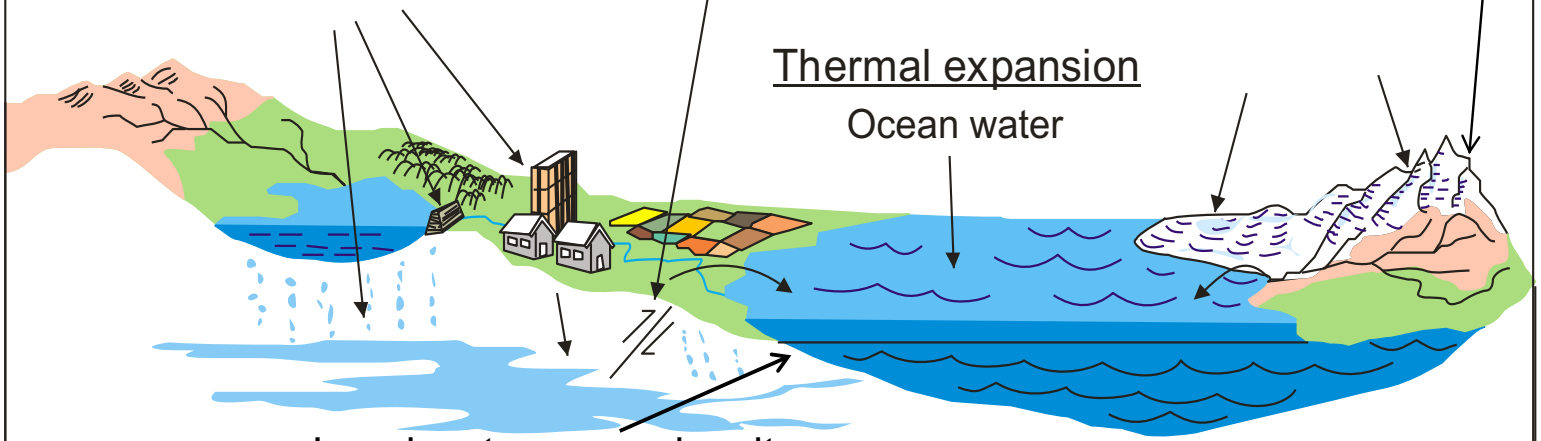
Subsidence/uplift due to glacial isostatic adjustment, tectonics

Fingerprinting

Gravitational, Rotational, Isostatic

Mass changes

Glaciers and ice sheets



Thermal expansion

Ocean water

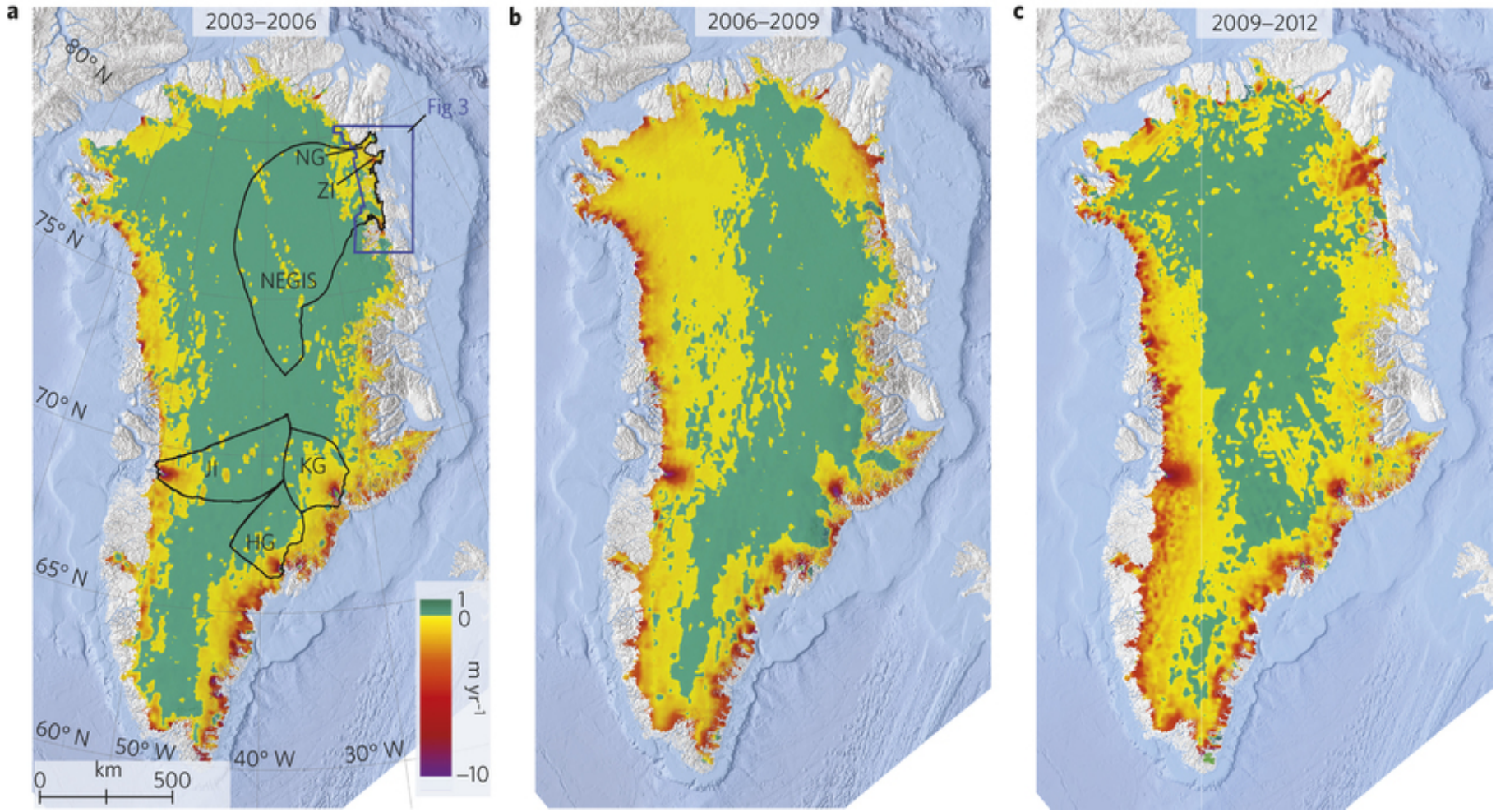
Local water mass density

Temperature, salinity, ocean currents

Muir Inlet, Alaska 1941, USGS

Muir Inlet, Alaska 2004, USGS

Ice losses on Greenland 2003-2012

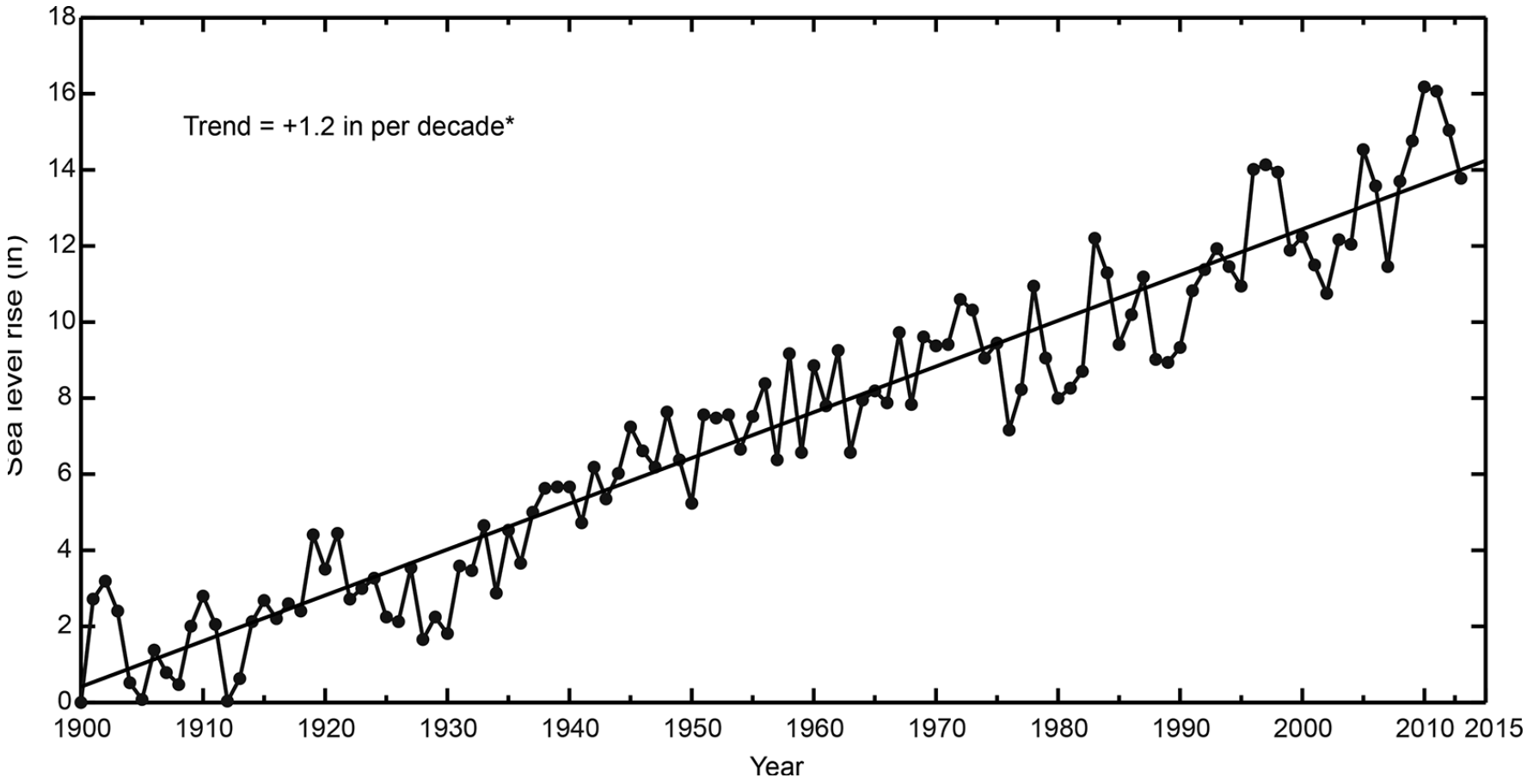


Source: (Khan et al. 2014)

Water cascading down a moulin, Greenland (NASA)

Source: NASA

Historical Sea Level Rise in NYC



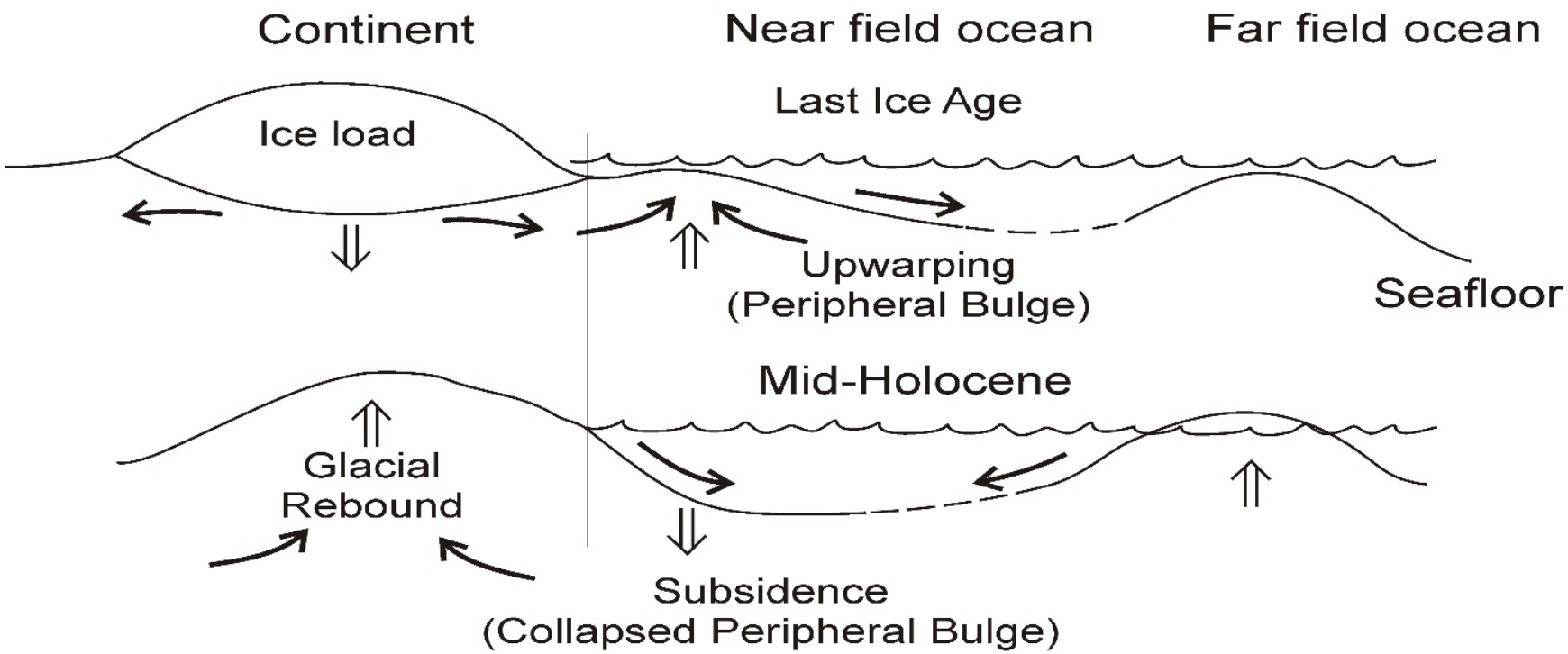
Source: NPCC

RATES OF SEA LEVEL RISE
NEW YORK METROPOLITAN REGION

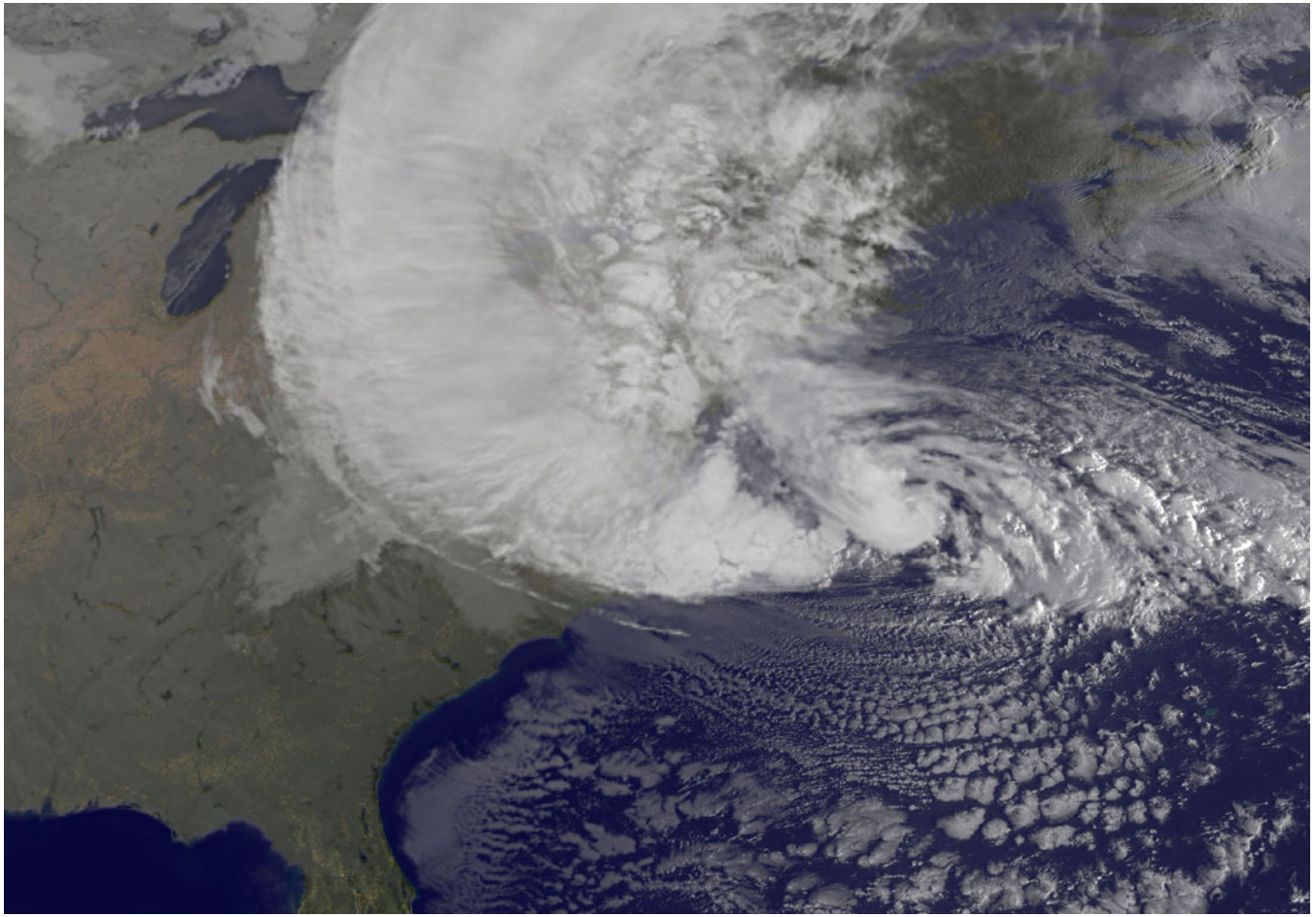
LOCATION	SEA LEVEL RISE mm/year	PERIOD years
Atlantic City	4.07	1911-2015
Sandy Hook, NJ	4.05	1932-2015
NYC, the Battery	2.84	1856-2015
Montauk, NY	3.21	1947-2015
Port Jefferson, NY	2.44	1957-1992
Willets/Kings Point, NY	2.50	1931-2015
Bridgeport, CT	2.81	1964-2015
New London, CT	2.55	1938-2015

Data from NOAA, August, 2016

Glacial isostasy and forebulge collapse



Hurricane Sandy Oct. 29, 2012



Source: NASA

Hurricane Sandy Flooding

a. Waves Crashing Against Shore in Brooklyn

Photo: Henry Zhang

b. Seaside Heights, NJ

c. Water Cascading into WTC Site

d. Hoboken, NJ

Photo: : John Minchillo/Associated Press

TOP 20 COASTAL STORM FLOODS
THE BATTERY, NEW YORK CITY--LAST 77 YEARS

STORM	DATE	WATER LEVEL (NAVD) FT	M
Hurricane Sandy	10/29/2012	11.1	3.38
Hurricane Donna	9/12/60	7.22	2.21
Nor'easter Dec.'92	12/11/92	6.92	2.11
Hurricane Irene	8/28/2011	6.72	2.05
Nor'easter	11/25/50	6.34	1.93
Ash Wednesday storm	3/6-7/62	6.14	1.87
Nor'easter	3/13-14/2010	6.06	1.85
Halloween ("Perfect Storm")	10/31/91	5.95	1.81
Blizzard of '84	3/29/84	5.75	1.75
Nor'easter	1/2/87	5.60	1.70
"Storm of the Century"	3/14/93	5.58	1.70
Nor'easter	11/12/68	5.58	1.70
Nor'easter	4/13/61	5.56	1.69
Nor'easter	2/19/60	5.54	1.68
Nor'easter	3/20/96	5.51	1.68
Nor'easter	10/19/96	5.49	1.67
Hurricane Gloria	9/27/85	5.45	1.66
Long Island Express	9/21/38	5.43	1.65
Hurricane of 1944	9/14/44	5.43	1.65
Nor'Ida	11/13-14/2009	4.79	1.46

Source: NOAA

Consequences of sea level rise

- Increased coastal erosion
- Land submergence
- Saltwater intrusion
- Increased “nuisance” flooding (extreme tides, minor storms)
- Higher surges and waves

Coastal development makes erosion a problem

Figure 20.16

Rising sea level is drowning once vast expanses of wetlands in Blackwater National Wildlife Refuge, Cambridge, Maryland

Source: Chesapeake Bay Foundation

“Ghost” forest, Terrebonne Parish, LA—victim of saltwater intrusion

Source: USGS

Rising sea level makes nuisance flooding, like this in Annapolis, MD, increasingly common

Source: Chesapeake Bay Program

Topics covered in next training session

- **NPCC sea level rise methodology**
- **Changes in storm flood elevations and frequency**
- **Sea level rise risk assessment**
- **Resiliency measures**