

SEA LEVEL RISE & FLOODING 101



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Brian McNoldy

Senior Research Associate
University of Miami

Tropical Weather Expert
Capital Weather Gang

Science Advisor
Coastal Risk Consulting



ROSENSTIEL
SCHOOL of MARINE &
ATMOSPHERIC SCIENCE

The Washington Post



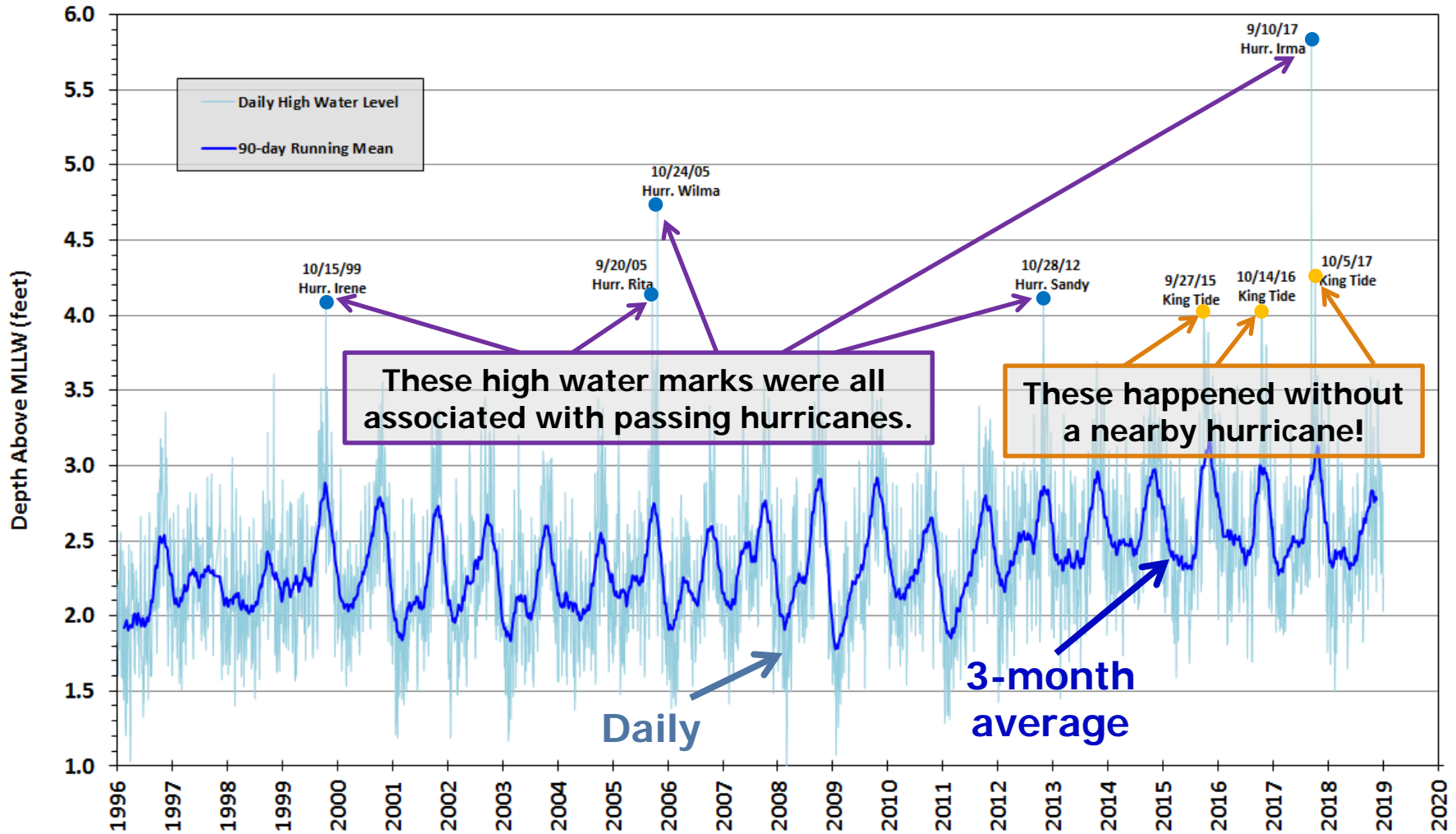
COASTAL RISK CONSULTING

OVERVIEW

- Understand normal changes in sea level first
 - There are large natural variations throughout the year and even across multiple years to decades
 - Sea level rise = long-term background trend of mean sea level after accounting for known cycles & variations
- Flooding takes many forms
 - Flood = standing or flowing water over land that is normally dry (can be fresh or salt water)
 - Can last minutes to days
 - Impacts range from nuisance to catastrophic
 - Never perfectly predictable or preventable
- There is no debate: sea level IS rising
 - Sea level rise is increasing the baseline for floods
 - A higher baseline makes every type of flood more common and more severe

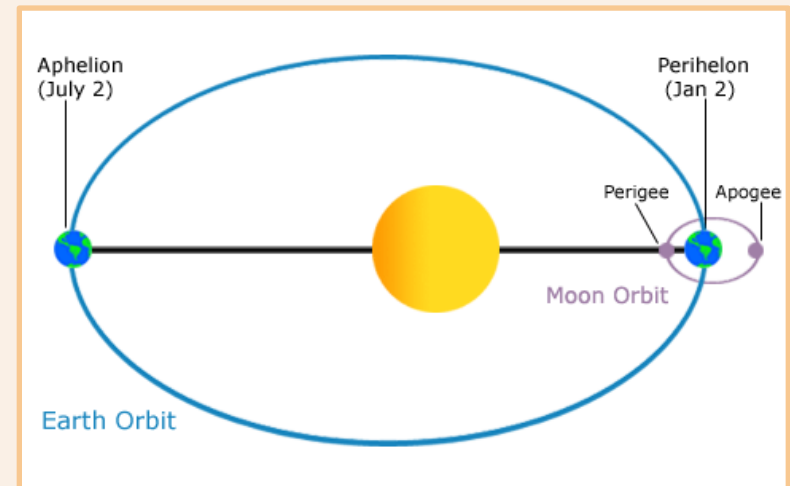
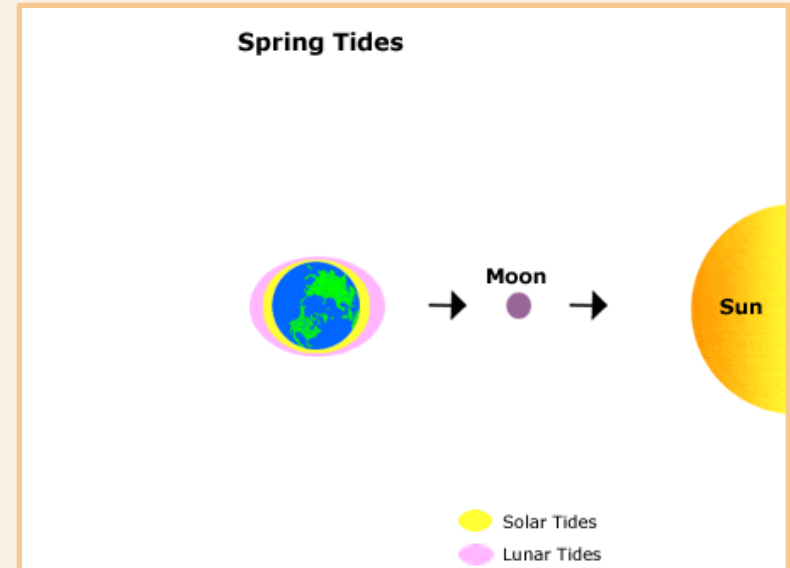
23 YEARS OF SEA LEVEL MEASUREMENTS

Verified High Water Levels at Virginia Key, FL



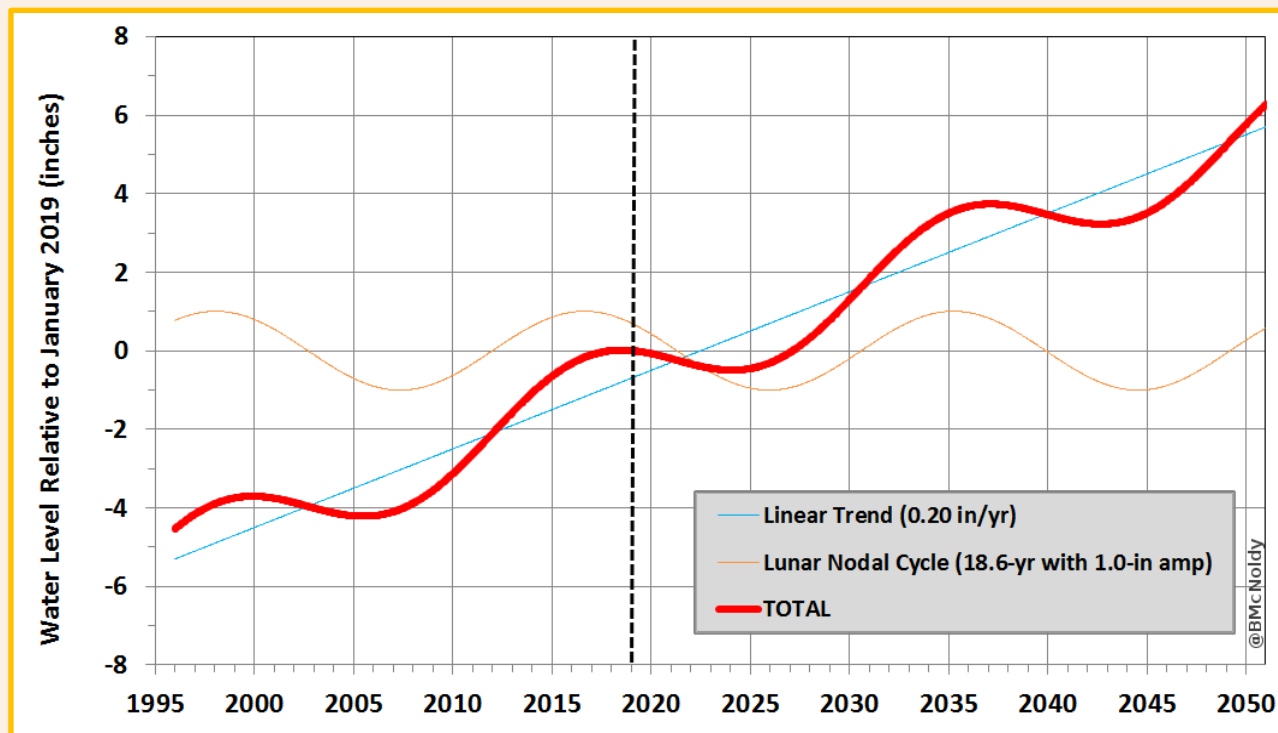
WHAT FACTORS INFLUENCE SEA LEVEL?

- Phase of the moon
 - Full and new moons exert greater tidal pull on oceans
- Earth's proximity to the moon
 - Moon's elliptical orbit means once/month it's closer to Earth, producing greater tidal forces
- Earth's proximity to the sun
 - Earth's elliptical orbit means once/year (January) it's closer to the sun, producing greater tidal forces



WHAT FACTORS INFLUENCE SEA LEVEL?

- Lunar Nodal Cycle
 - Precession in the moon's orbital plane causes an 18.6-year cycle in mean sea level. Locally, peak rate due to LNC roughly matches recent rate of SLR.

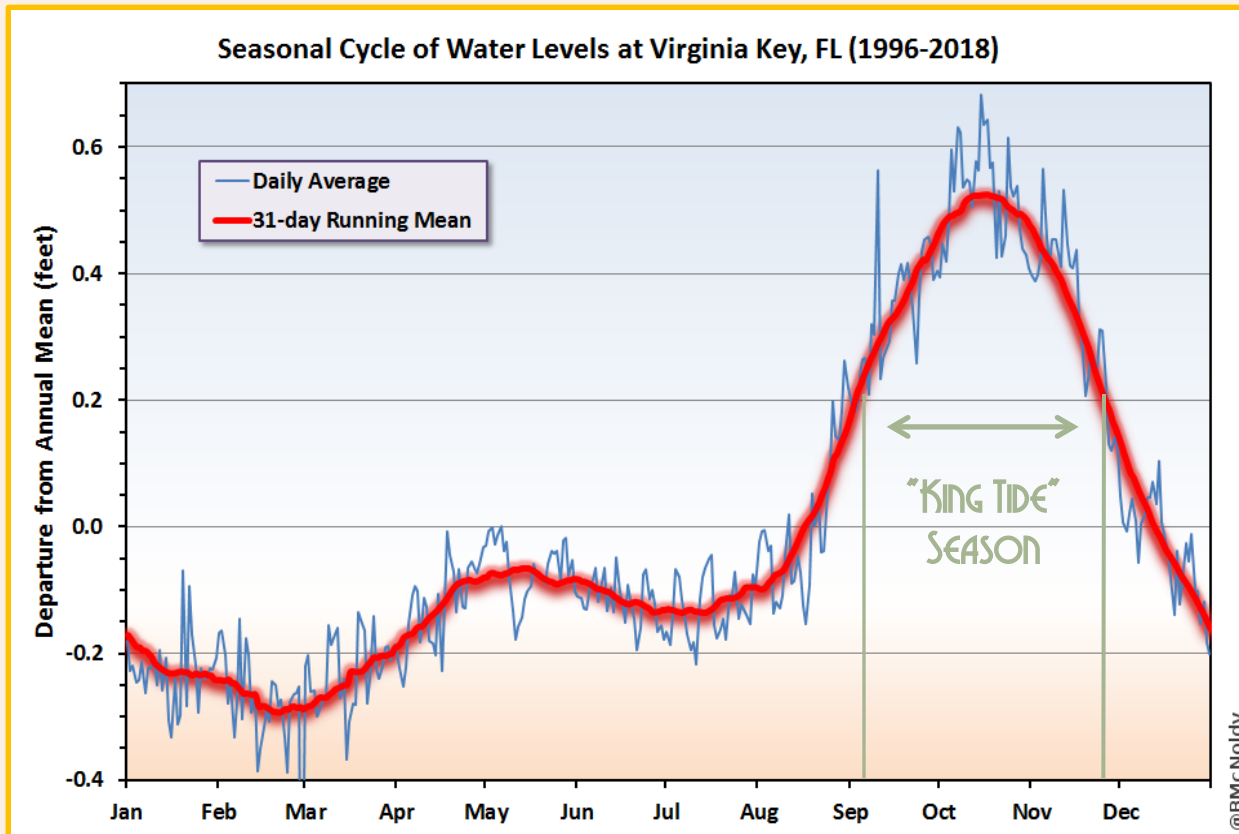


WHAT FACTORS INFLUENCE SEA LEVEL?

- Persistent wind direction
 - Strong onshore winds push water onto land
- Ocean temperature
 - Warm water expands more than cooler water
- Atmospheric pressure
 - Low pressure allows sea level to bulge up (rise)
- Locally, the strength of the Gulf Stream (and Florida Current) plays a role
 - Reduced transport allows water to pile up along U.S. east coast

AVERAGE SEASONAL CYCLE OF SEA LEVEL IN SOUTHEAST FLORIDA

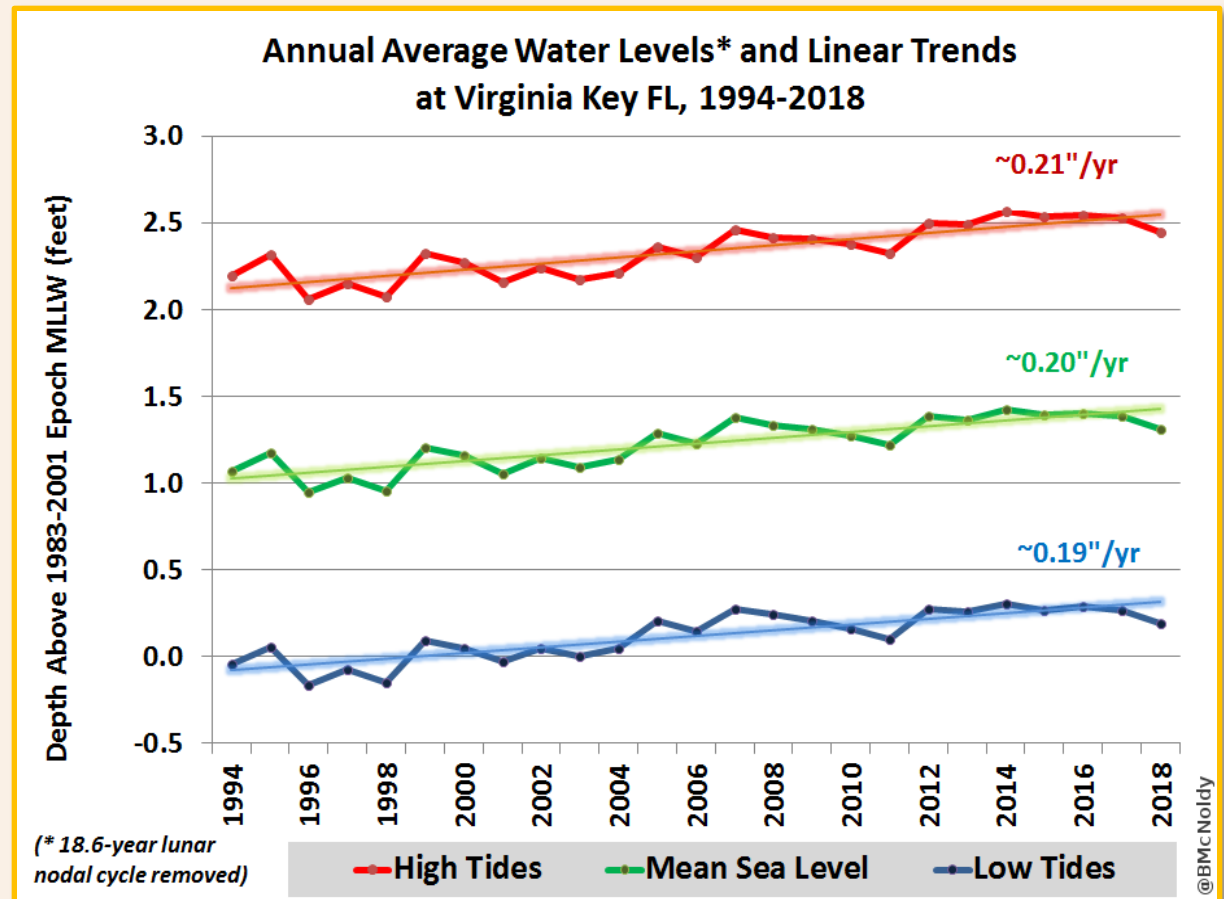
- For reasons just outlined, water levels are naturally lowest in Jan-Feb-Mar and highest in Sep-Oct-Nov here



~10”

MOVING ON TO SEA LEVEL RISE

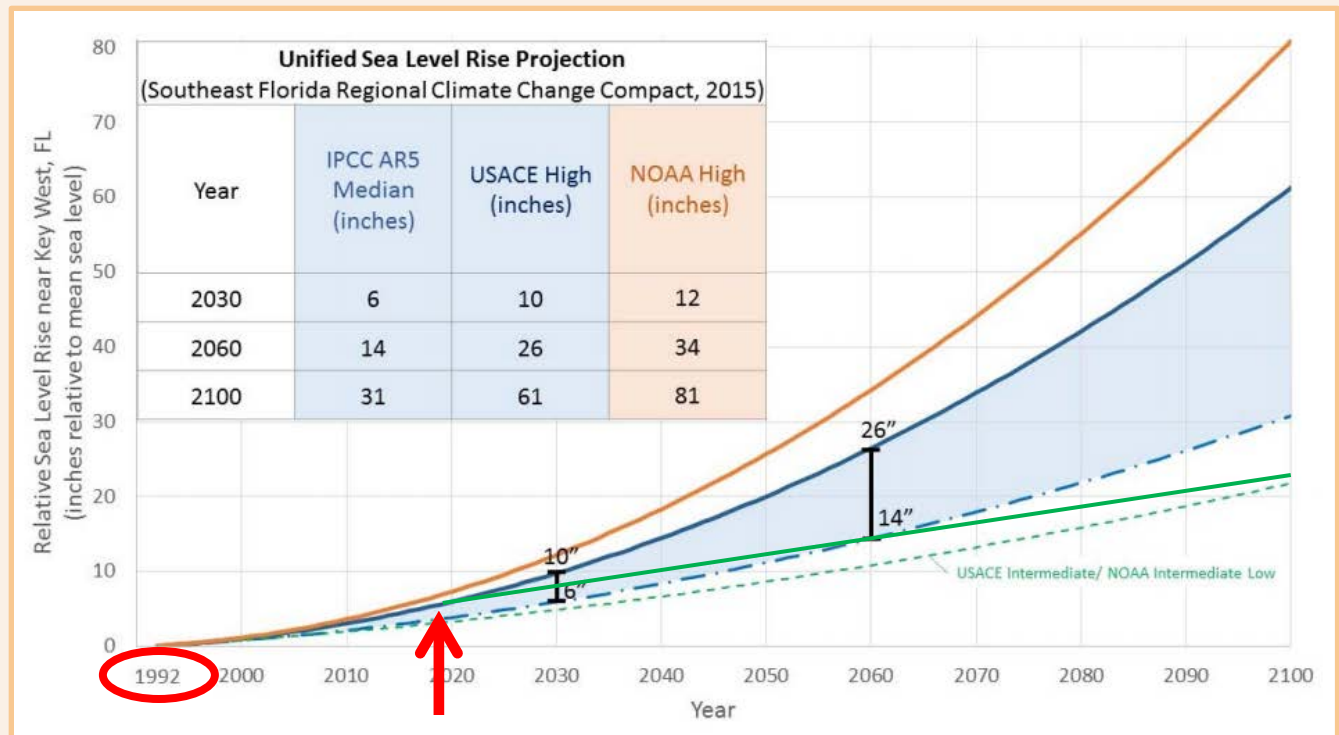
- Now that we understand some of the natural variations, we can remove the major known cycles and look at the remaining trend
- There are ups & downs in the annual averages, but overall trend is definitely UP
- (Similar values come from trends of daily data with seasonal cycle and lunar nodal cycle removed)



SEA LEVEL RISE PROJECTIONS FROM 2019 LEVELS

	2030	2050	2070	2100
Constant 0.2"/year	2.2"	6.2"	10.2"	16.2"
IPCC AR5 Median	0.5"	5"	12"	25"
USACE High	4.5"	15"	27"	55"
NOAA High	6.5"	20"	39"	75"

** Using 0.2"/yr trend, sea level has risen ~5½" since 1992, which is the baseline year for values in this chart (from 2015 SFRCCC)*



SEA LEVEL RISE AS A THREAT

- The gradual increase of mean sea level in coming decades and centuries will have a significant impact on coastal areas around the world -- it already is in some places!
- By 2050, sea level could be 5-20 inches higher
- By 2100, sea level could be 2-6 feet higher
- SLR by itself isn't a flood, but it increases the baseline for floods of any kind
- SLR is a slow-motion crisis that will be crippling to coastal cities if ignored now

RELEVANT TYPES OF FLOODING

- **RAINFALL**

- Associated with strong or slow-moving thunderstorms, rain (fresh water) falls at rate too high for drainage systems to handle
- Timescale: minutes to hours
- Heavy rain in a short period of time creates flash floods
- Predictable minutes to hours in advance
- Can be dangerous and destructive

- **TIDAL**

- Associated with regular tides, sea water rises high enough to be above ground level
- Timescale: hours (now)... will last longer in the future
- Most noticeable at the highest tides of the year in the lowest areas
- Predictable days to months in advance
- Mostly a nuisance to people, but can be destructive to property

- **STORM SURGE**

- Associated with hurricanes, sea water pushed ashore by strong winds
- Timescale: hours to a couple days
- Could be as little as a few inches to over 15 FEET
- Predictable 1-3 days in advance
- Can be deadly and catastrophically destructive

MIAMI & MIAMI BEACH FLOODING EXAMPLES

RAINFALL

AUGUST 1, 2017



Josh Baumgard



Carl Juste

TIDAL

OCTOBER 5, 2017



Brian McNoldy



Julie Guy



Tomas Kennedy

STORM SURGE

SEPTEMBER 10, 2017



Tony Semaan



Derek Van Dam



Derek Van Dam