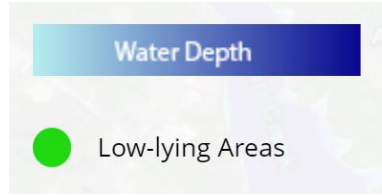




Rising Seas: National and Global Security Challenges

Combined Naval Address on Climate,
Energy & Environment,
26 March 2024
John Englander

10 Feet of Sea Level Rise (SLR)



U.S. Naval Academy



U.S. Naval Postgraduate School



U.S. Naval War College

Different Kinds of Flooding:

- **Storms**
- **Rain / runoff**
- **Tidal “King Tides”**
- **Seismic / tsunamis**
(Coastal Erosion)
- **Sea Level rise**

Different Kinds of Flooding:

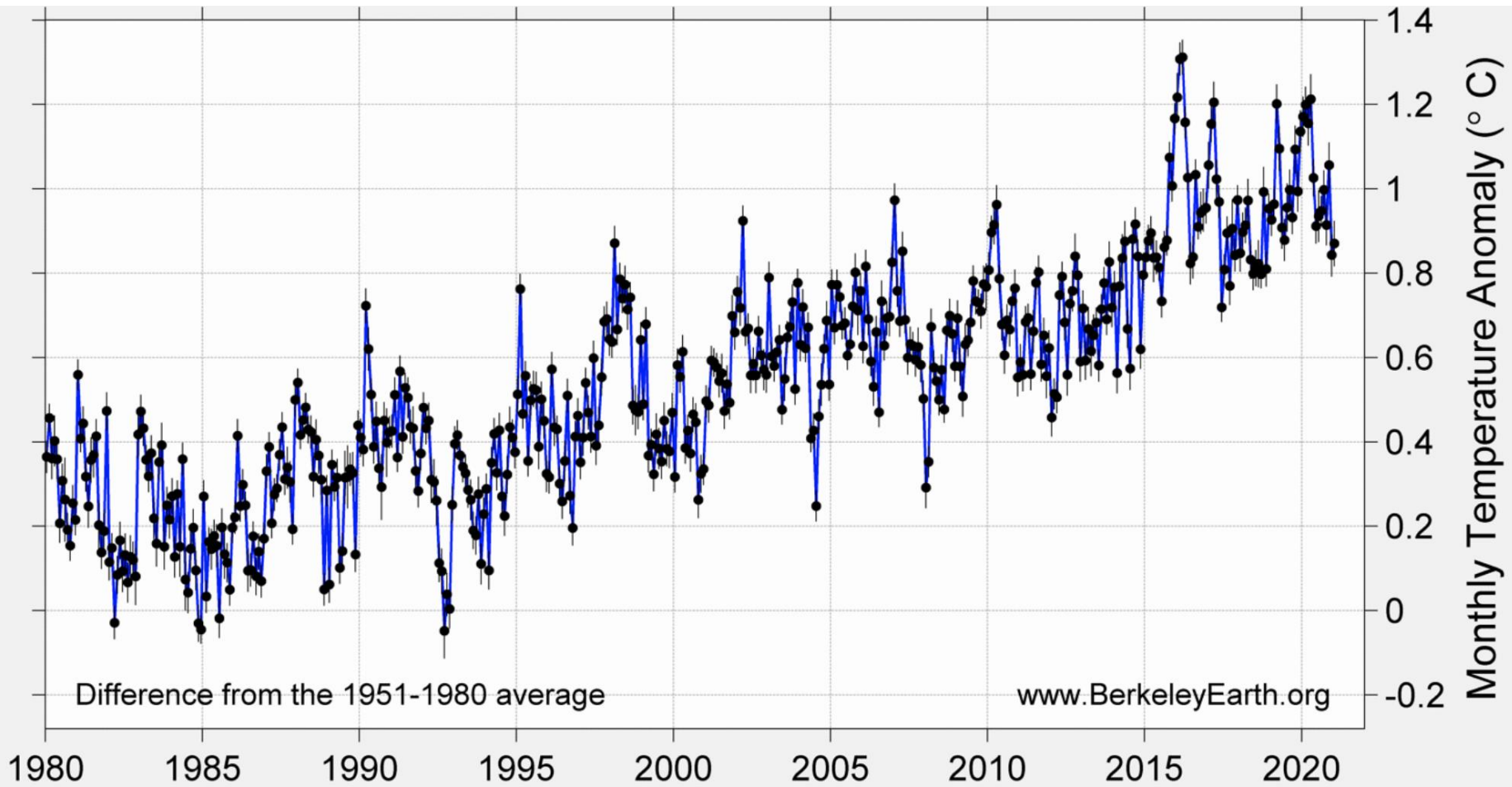
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Rising Seas are Special Challenge:

- **Environmental**
- **Economic**
- **Existential...**

for tens of thousands coastal communities in 140 countries

Global Average Temperature - Warming Each Decade

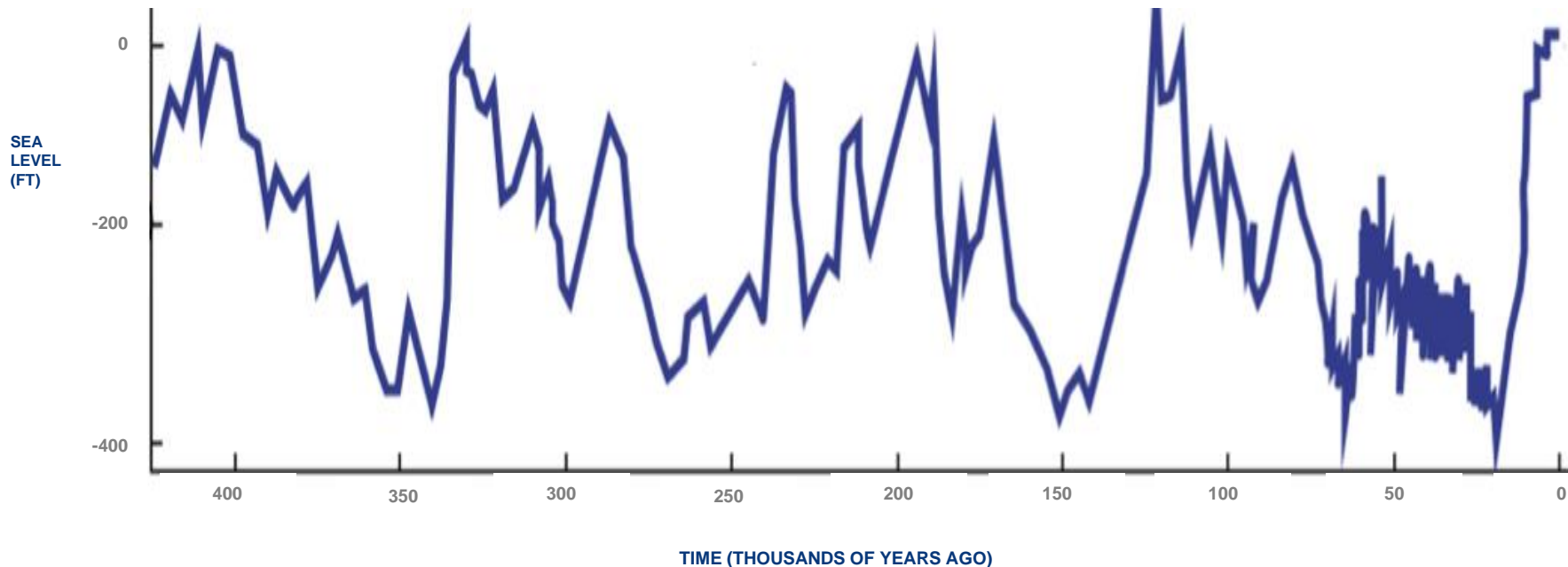


- Earth rapidly approaching 1.5 degrees Celsius danger threshold over pre-industrial temperature levels
- Despite latest global conference (COP28) aimed to stop warming at 2 degrees C, no such plan could be agreed
- Present policies and commitments to reduce *Greenhouse Gas Emissions*, could slow the rate of increase somewhat; by some estimates, 2.7 degrees C above pre-industrial



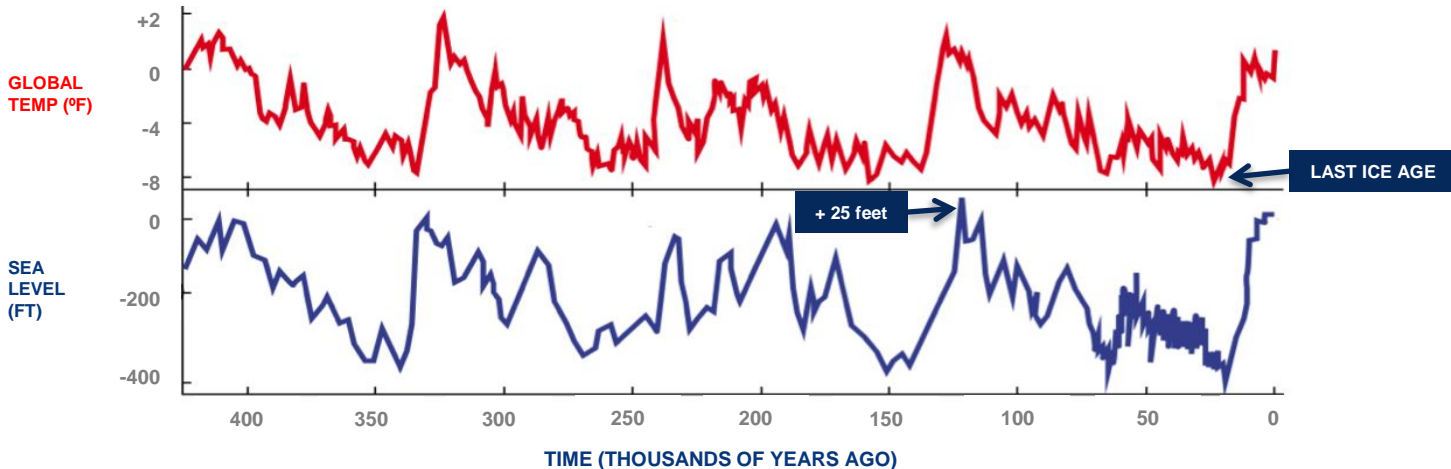
Sea Level has Changed Over Millennia By Nature

400-foot range over 400,000 years shown

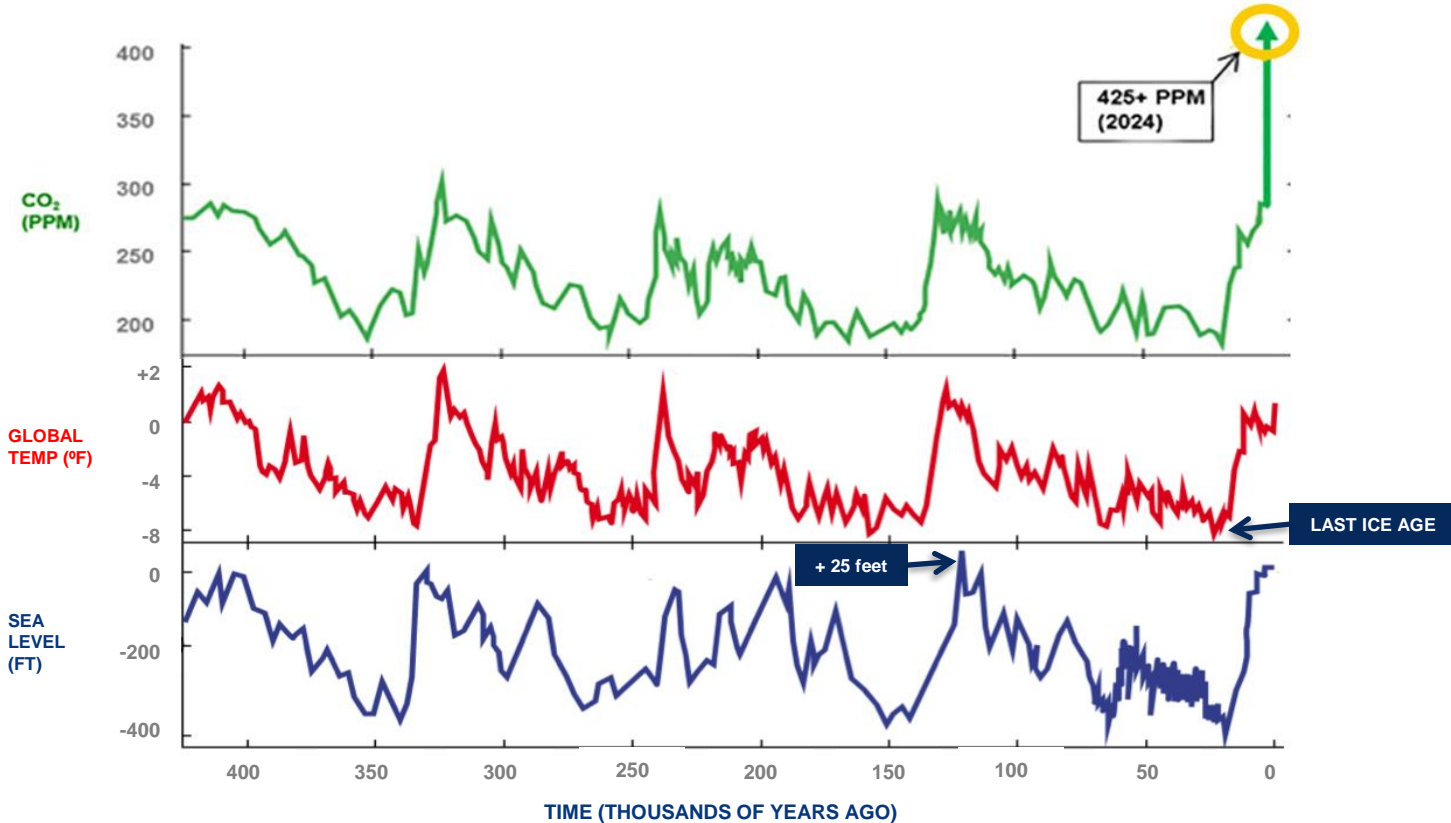


Four “Ice Age Cycles”

Global sea level change is an effect of changing global temperatures. It also provides proof and measurement of long-term change as the amount of ice on land changes over centuries.



CO₂, Temperature, and Sea Level Move Together



Florida Sea Level as an example

TODAY

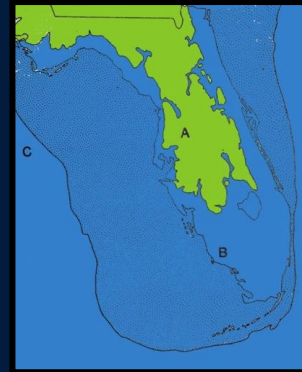


20,000 years ago



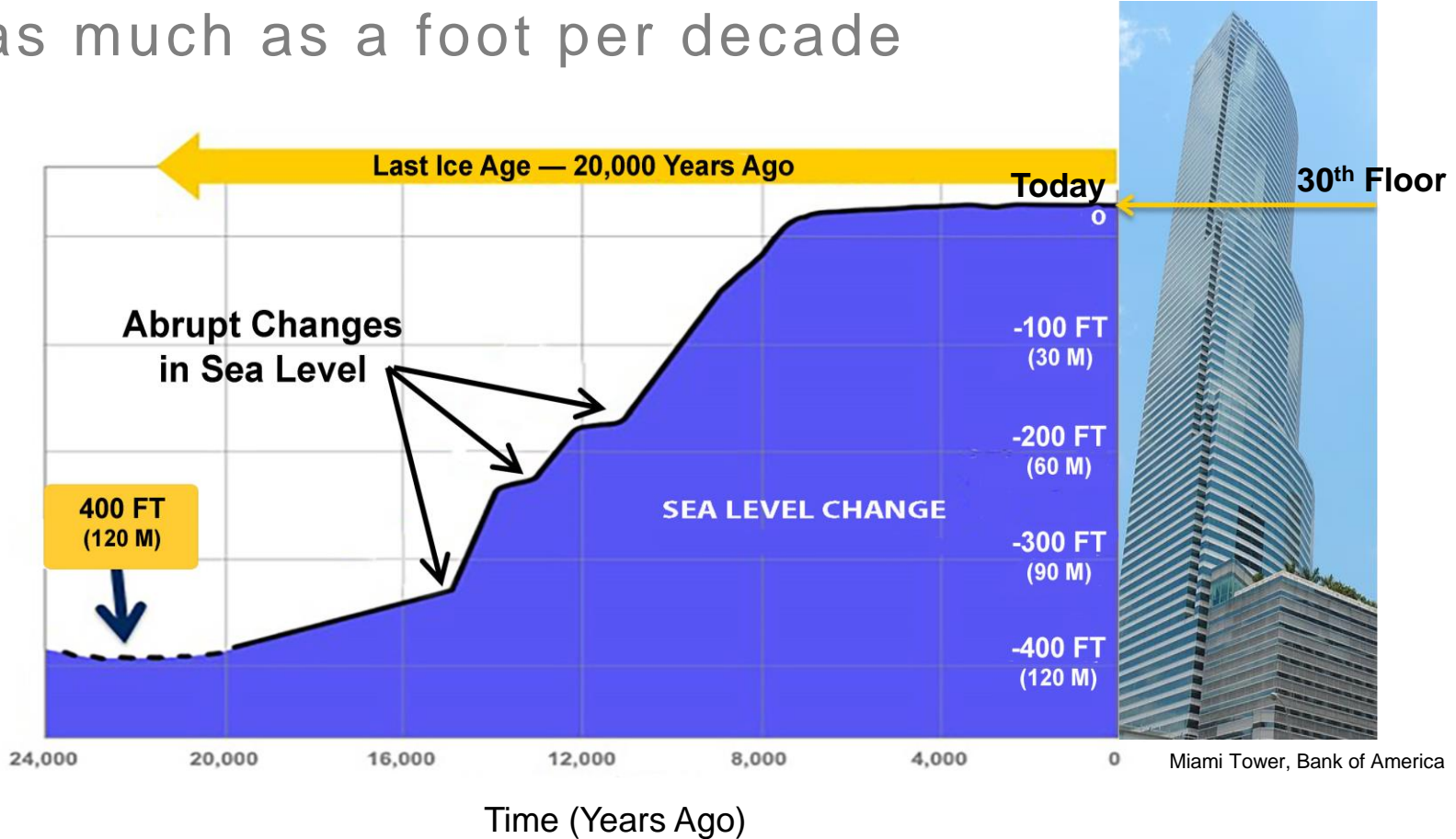
400 feet lower

120,000 years ago



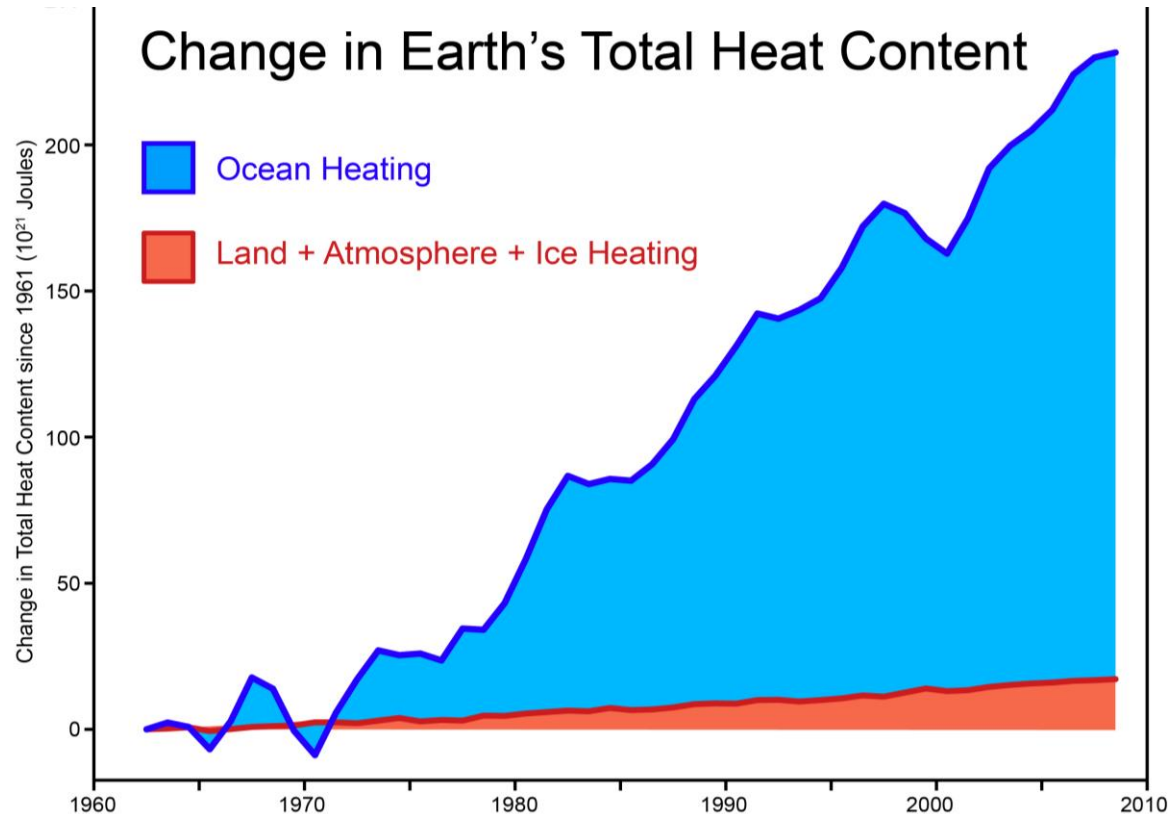
25 feet higher

Sea Level Changed Abruptly in the Past – as much as a foot per decade



Sea Level Rise Will Continue for Centuries

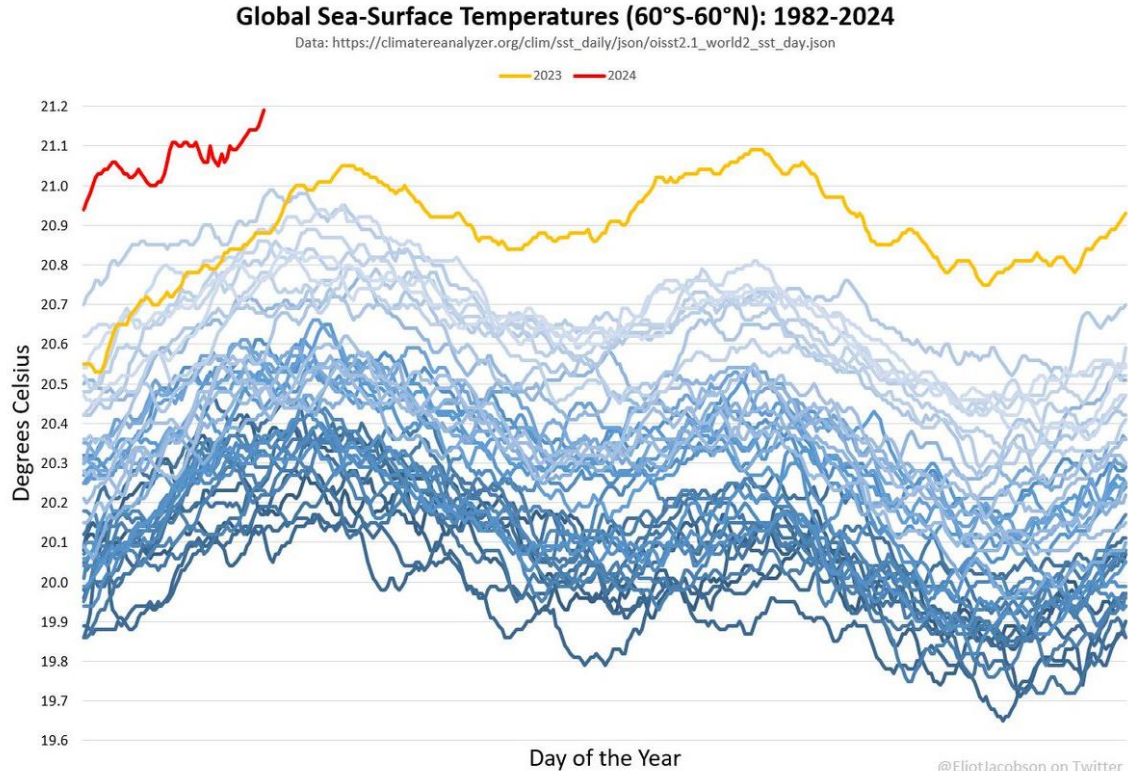
- If we could eliminate all greenhouse gas emissions tomorrow, sea level would continue to rise for centuries
- 93% of the excess heat trapped by greenhouse gases is stored in the ocean, which will continue to melt the ice sheets, locking in meters of future sea level rise



The Oceans are Warming Beyond all Records

Blue lines are 40 years
sea surface temperature
(SST) 1982 - 2022

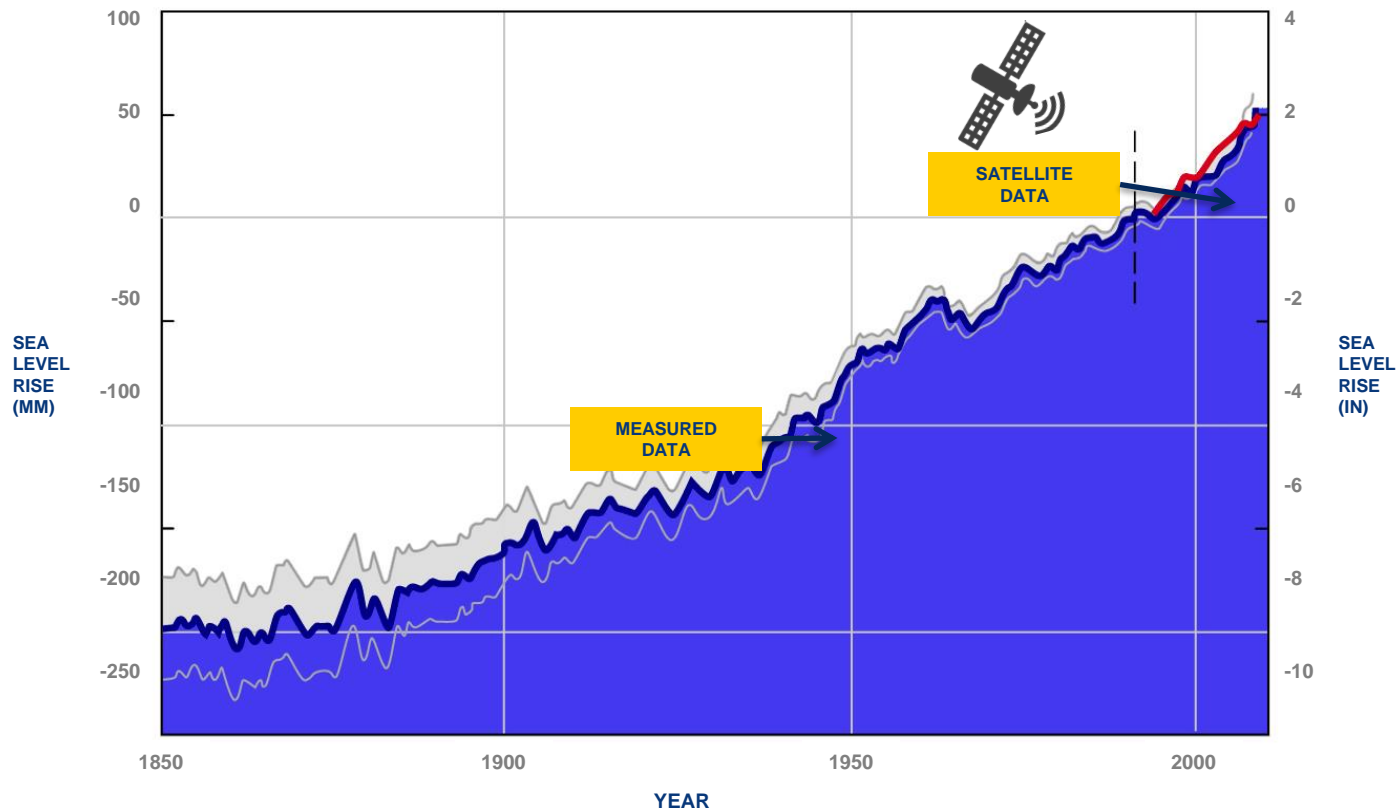
- 2023 (yellow) – new annual record
- 2024 (red) extreme new record as of March 6



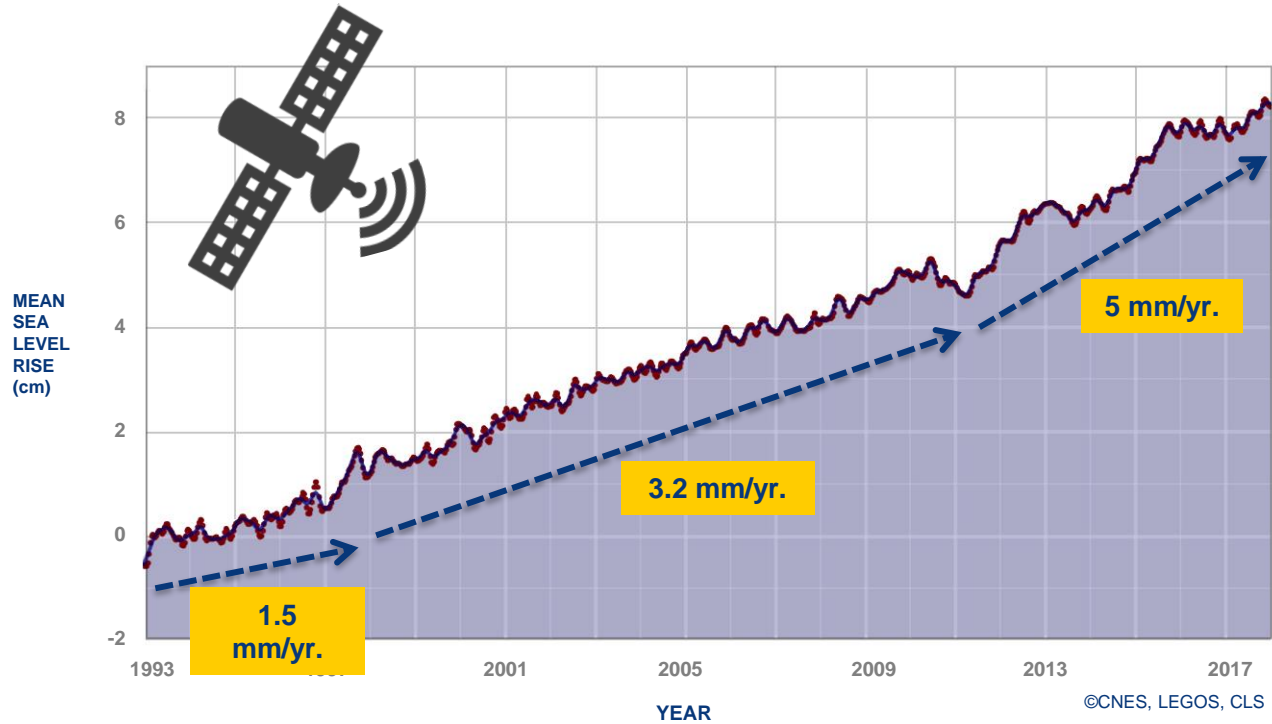
@EliotJacobson on Twitter

Credit: Eliot Jacobson

20TH Century Sea Level Rise



Rate is Accelerating



Key Points from Graphs

- Over decades / centuries as global temperature changes, reducing or adding to the ice sheets, SL changes up/down, ~65 ft (20 m) per degree Celsius, but with a long lag time
- With current 1.5 degrees warming, SLR now committed
- Abrupt change is possible, similar to 11,000 years ago
- Arctic temperatures and global SLR rate has been increasing rapidly for last three decades

Somewhat
surprisingly, as
floating Icebergs
melt, they do not
add to sea level

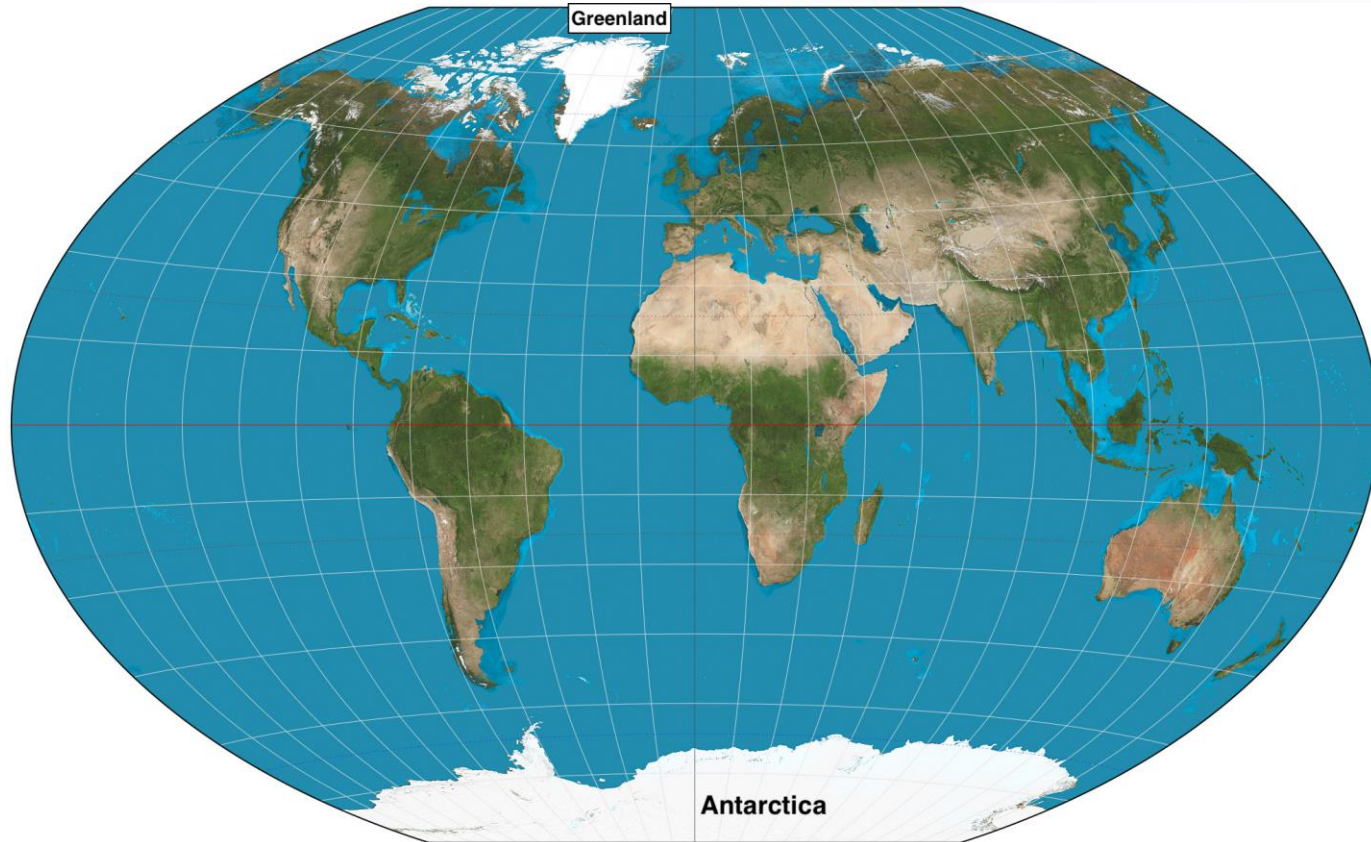


Primary Sources of Sea level Rise

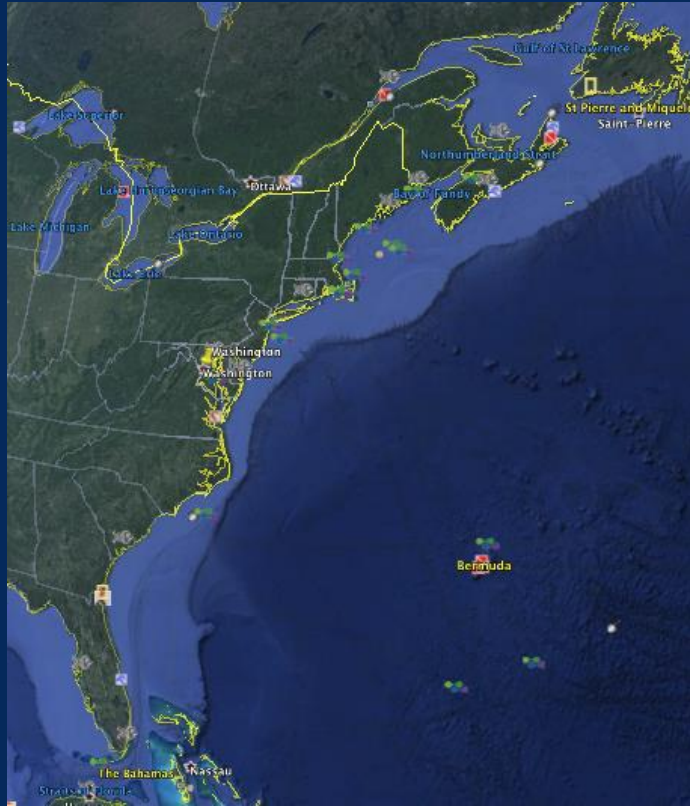
- Glaciers (shown) and ice sheets on land, add meltwater
- Glaciers calving new icebergs, entering the sea
- Thermal expansion of seawater due to warming oceans
- Locally, land subsidence increases sea level; land uplift has an opposite effect



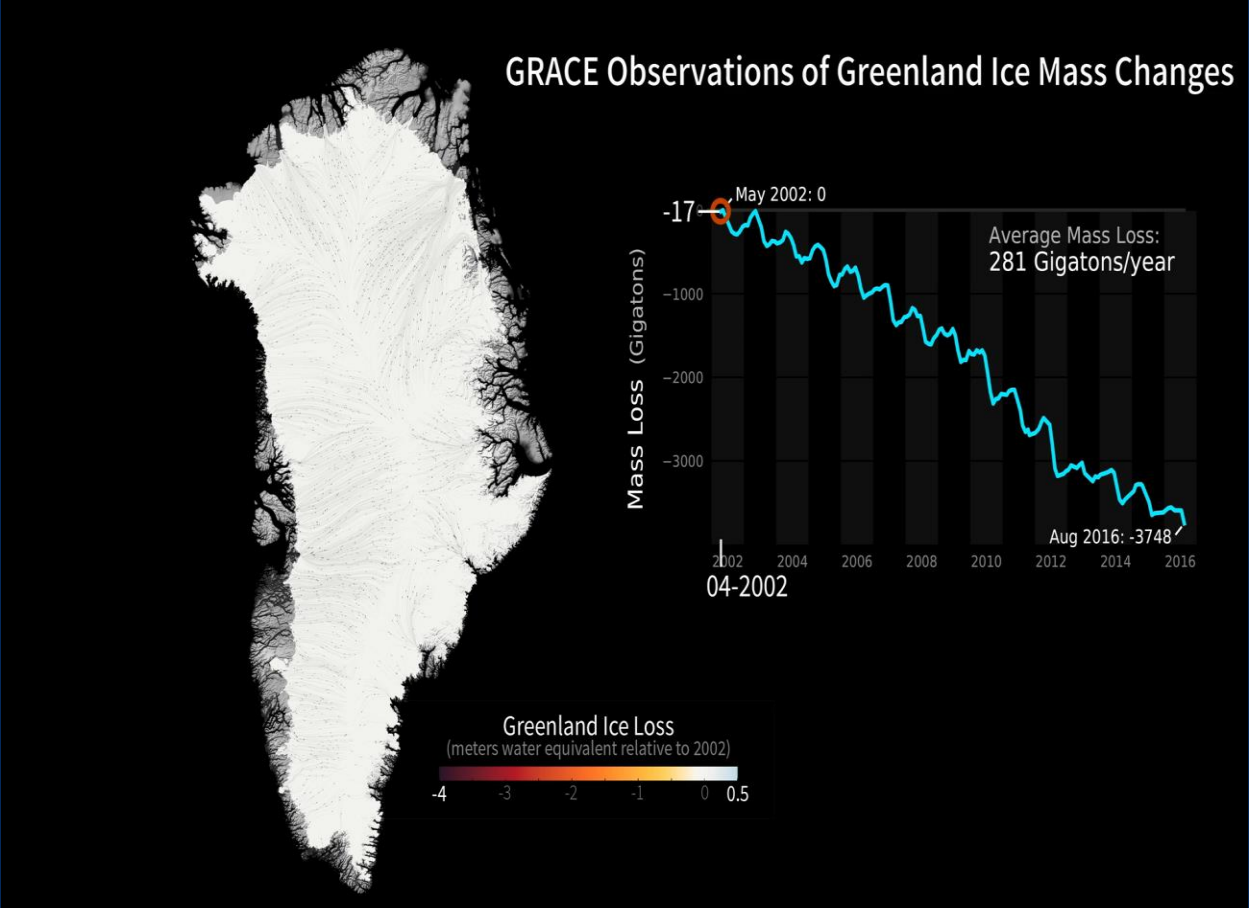
The gigantic ice sheets on Greenland and Antarctica hold 98% of the potential 65 meters (212 feet) of sea level rise.



Greenland - Approximate Size Comparison



Greenland Ice Mass Changes

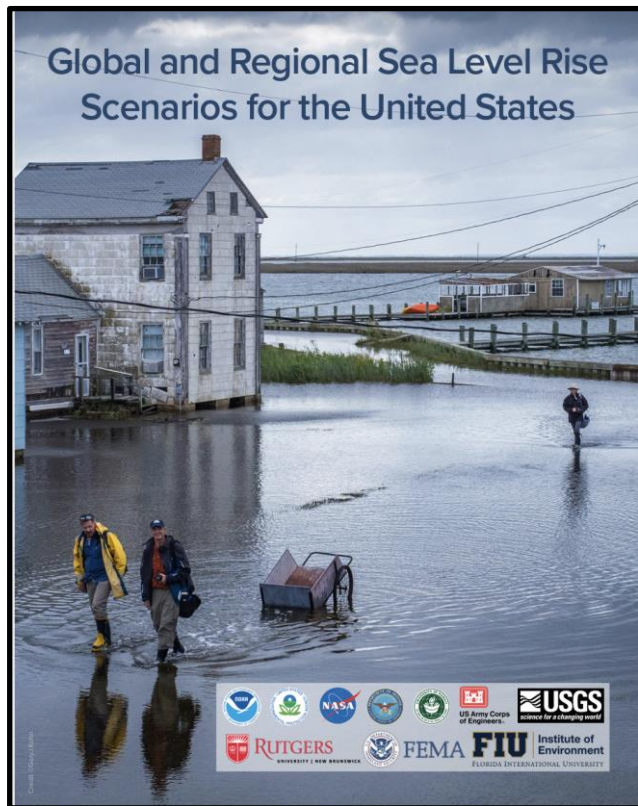


Tipping Points

- Tipping points have the potential to cause abrupt changes in sea level rise
- Dr. Johan Rockström of the Potsdam Institute for Climate Impact Research in Germany, speaking at Davos 2023
- Dr. Rockström discusses how “16 tipping points could push our planet into crisis”



Projected Sea Level Rise



Per Latest NOAA Report
February 2022

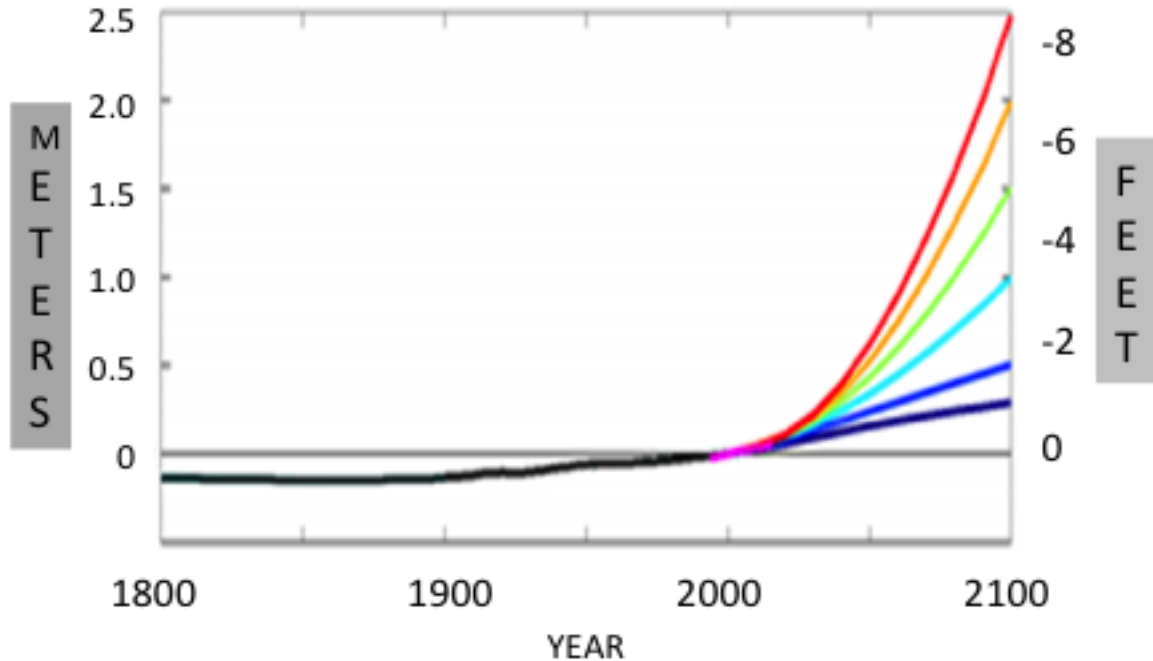
By 2050: 1 foot

By 2100: 2-7 feet...

possibly higher

Typical SLR Projections Show the Huge Uncertainty Prudent Planning: Most Dangerous Course of Action

Six Projections for Rising Sea Level
2017 NOAA Technical Paper 083



How High Will Sea Level Get?

- No one can know how high sea level will rise this century due to
 - Unpredictable emissions rates
 - Unpredictable ice sheet melt / collapse
- Current projections for SLR this century are up to 8 ft (2+ meters)
- Based on the latest data, some experts think it could be more
- Given the unpredictability, 2016 U.S. DoD risk evaluation concluded:
 - “The decision-making paradigm must shift from a predict-then-act approach to a scenario-based approach.”



Recap

- Climate Change – many impacts
- Likely see more disaster flood events (short duration)
- We must slow warming by reducing CO₂ emissions
 - Energy efficiency and renewables very important, and could slow the melting ice and rising sea level
- Plan for resiliency, e.g. floods, fires, droughts, & heat
- Plan for adaptation to rising sea level rise
 - largely unstoppable & unpredictable
 - Infrastructure requires 20-30 year perspective or longer

National Security Challenges

- Military bases and critical infrastructure are at risk
 - 128 U.S. defense facilities are threatened by just 3 feet (1 meter) of higher sea level.
- Challenges capacity of civilian and military forces
- Displacement of domestic populations
- Economic disruption



Global Security Challenges

- Global destabilization
- Mass migration
 - Hundreds of millions could be displaced this century, posing huge challenges of governance
- Competition for resources
- Disruption to global trade systems
- Loss of territory/sovereignty



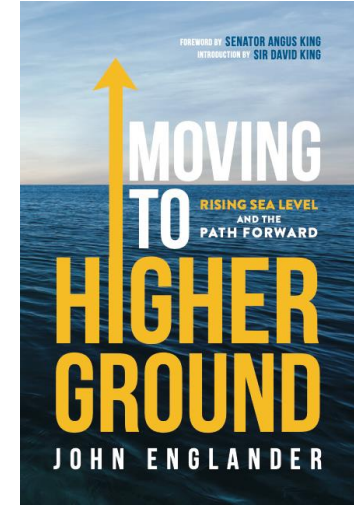
Catastrophe....
or Challenge and
Opportunity

Questions?



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