Rising Sea Level: The Crisis on Our Doorstep

John Englander
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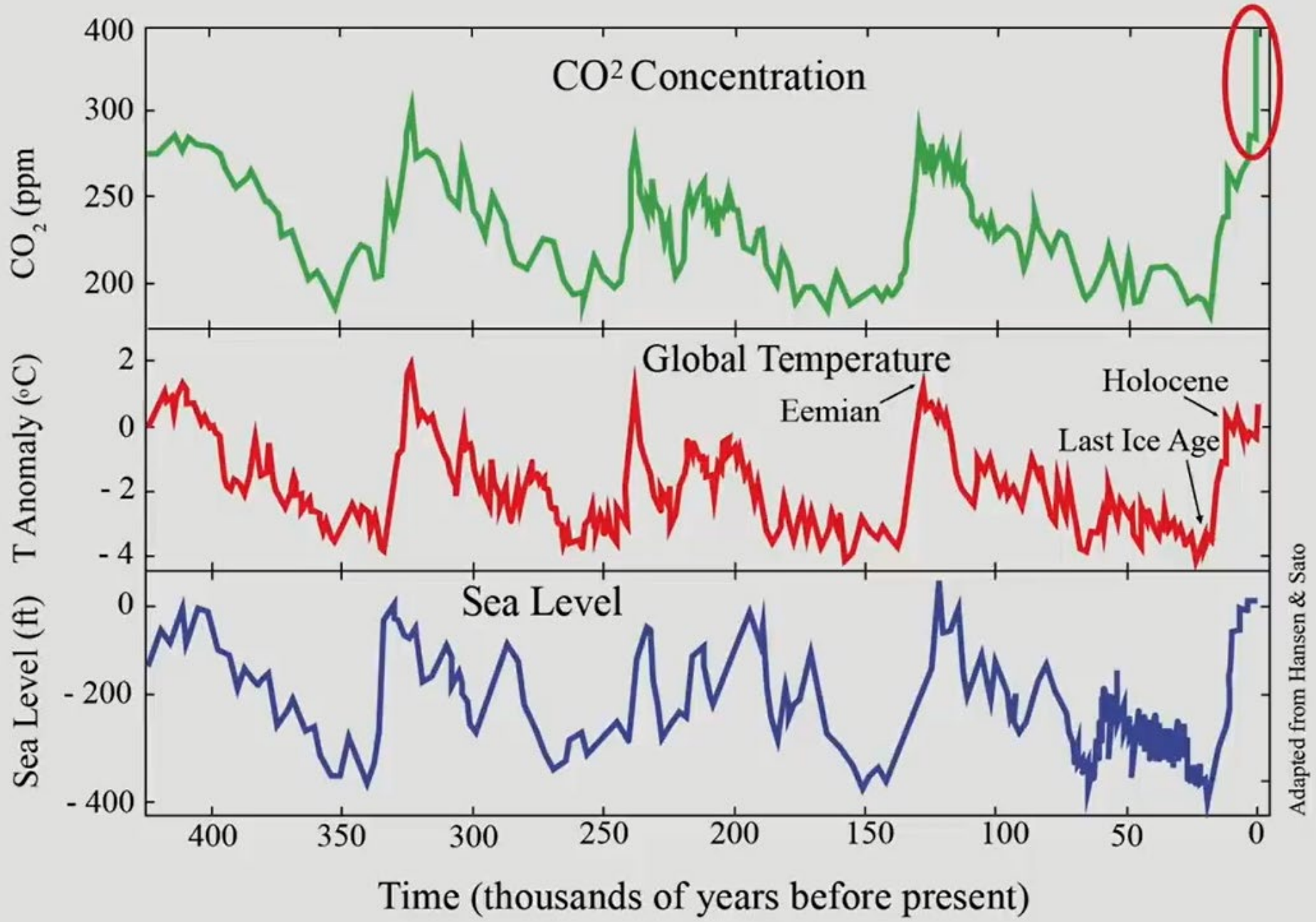
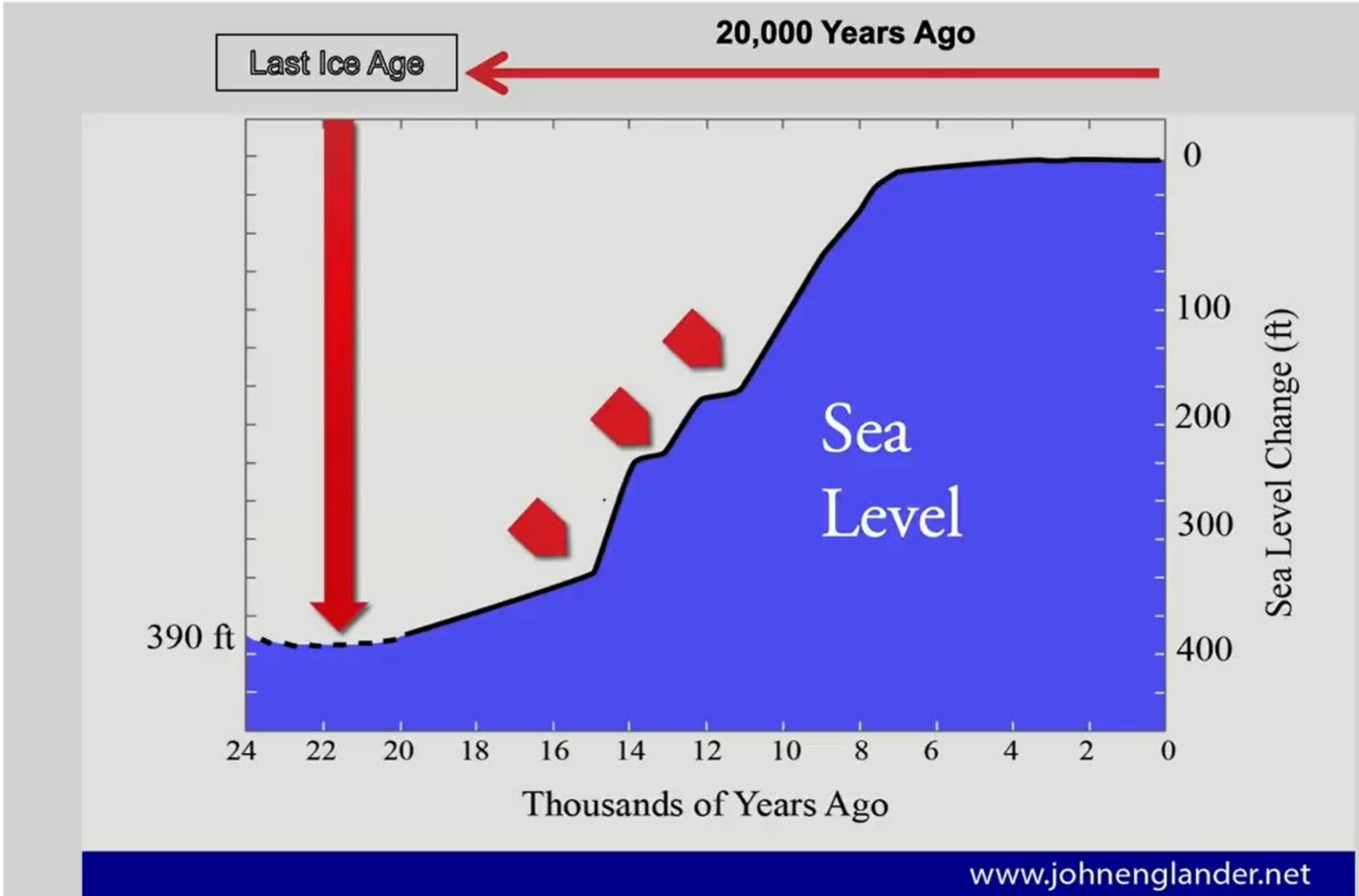
The Royal Institution – London


CO² Concentration
CO2 (ppm
400
300
250
200
Global Temperature
T Anomaly (°C)
2
0
- 2
- 4
Eemian
Holocene
Last Ice Age
Sea Level
Sea Level (ft)
0
- 200
- 400
400
350
300
250
200
150
100
50
0
Time (thousands of years before present)
Adapted from Hansen & Sato


Last Ice Age
20,000 Years Ago
Sea
Level
390 ft
0
100
200
300
400
Sea Level Change (ft)
24
22
20
18
16
14
12
10
8
6
4
2
0
Thousands of Years Ago
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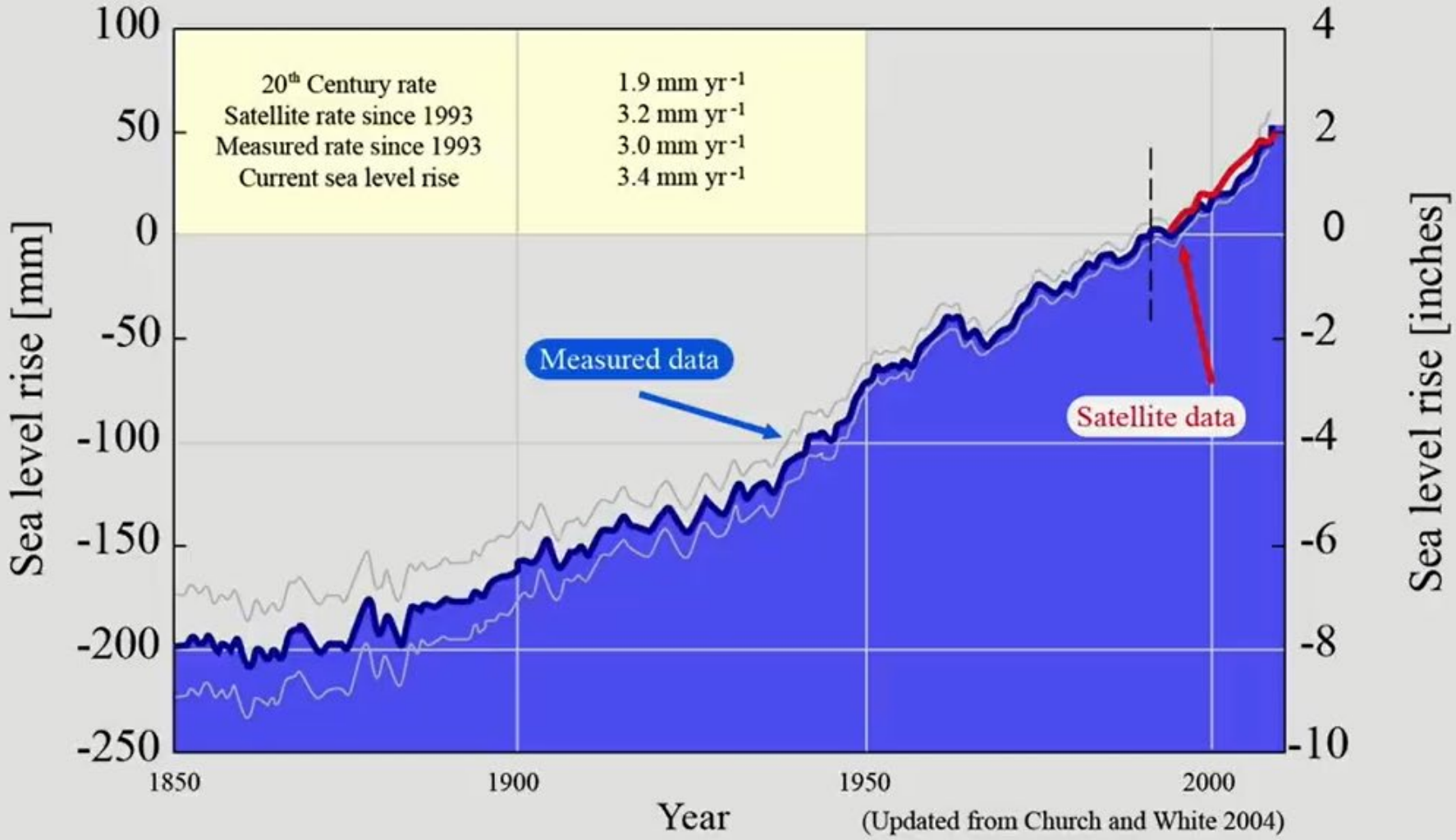
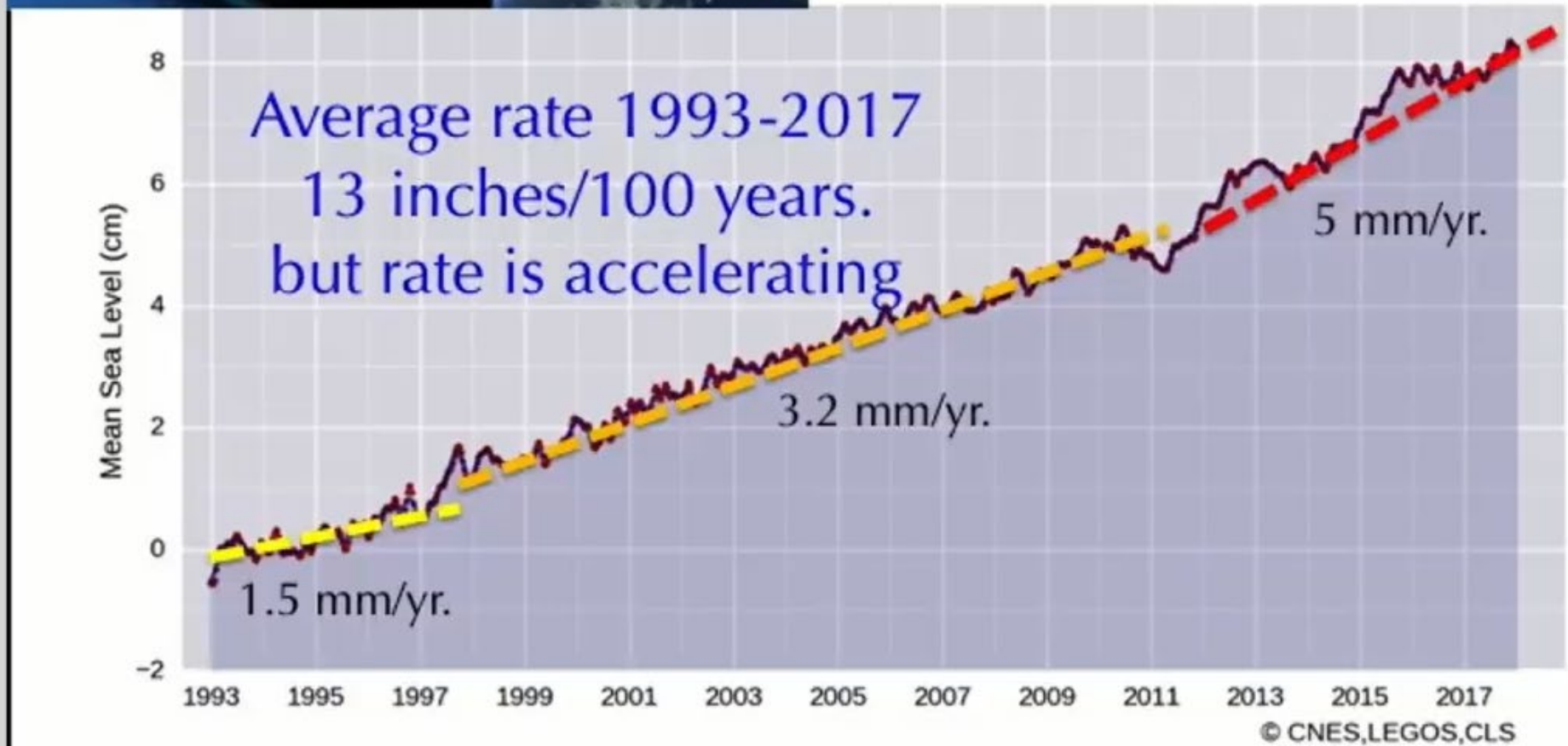
Sea Level Rise: 20th Century



MEASURING SEA LEVEL FROM SATELLITES

+3.31 mm/yr

Reference GMSL - corrected for GIA

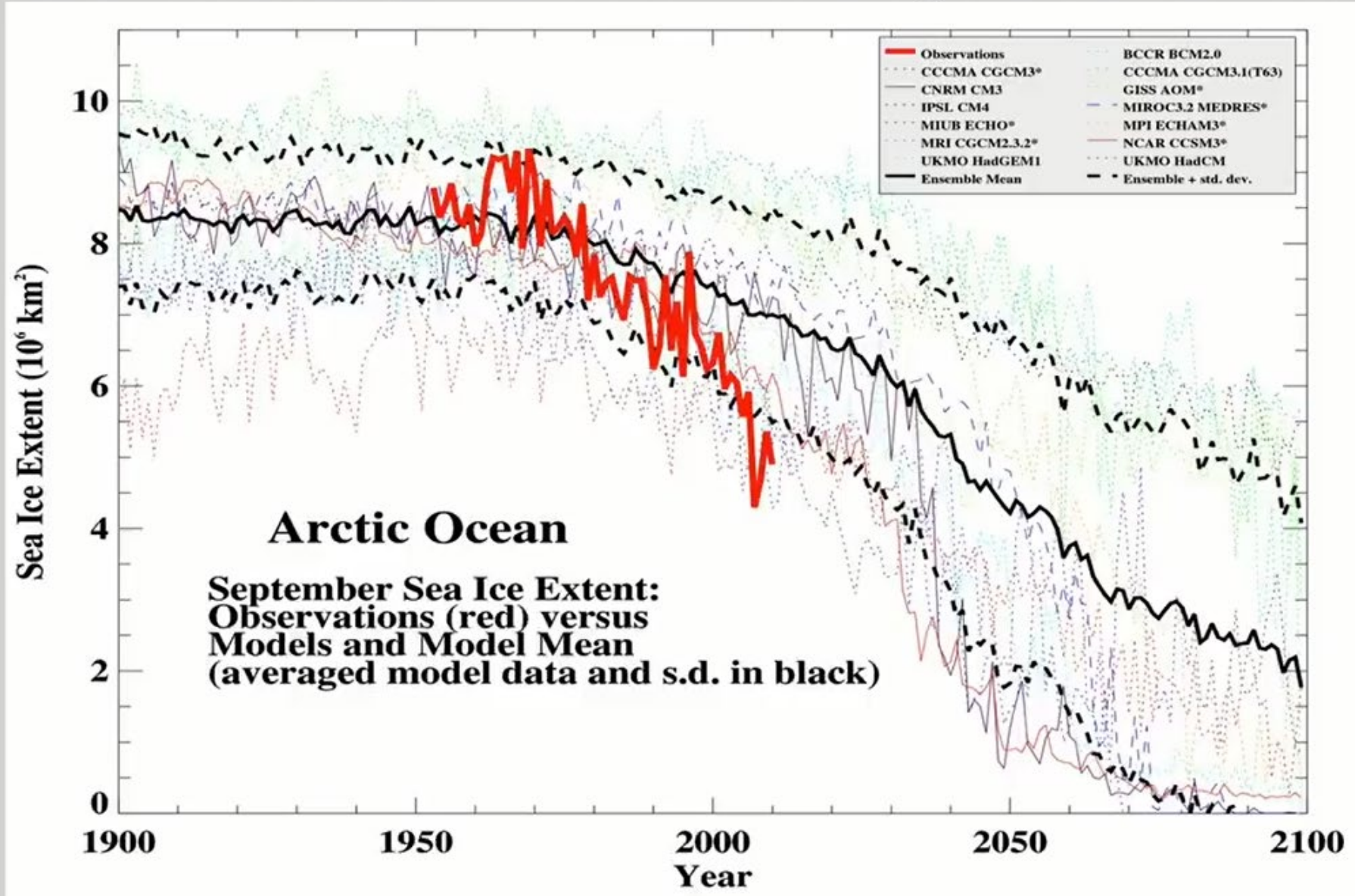


"The greatest shortcoming of the human race is our inability to understand the ***exponential*** *function."*

Albert Allen Bartlett

Exponential Growth is surprising. Starting with a single drop of water, doubling it every minute, how long to fill the stadium?

Arctic sea ice decline has exceed all models indicating models tend to be low

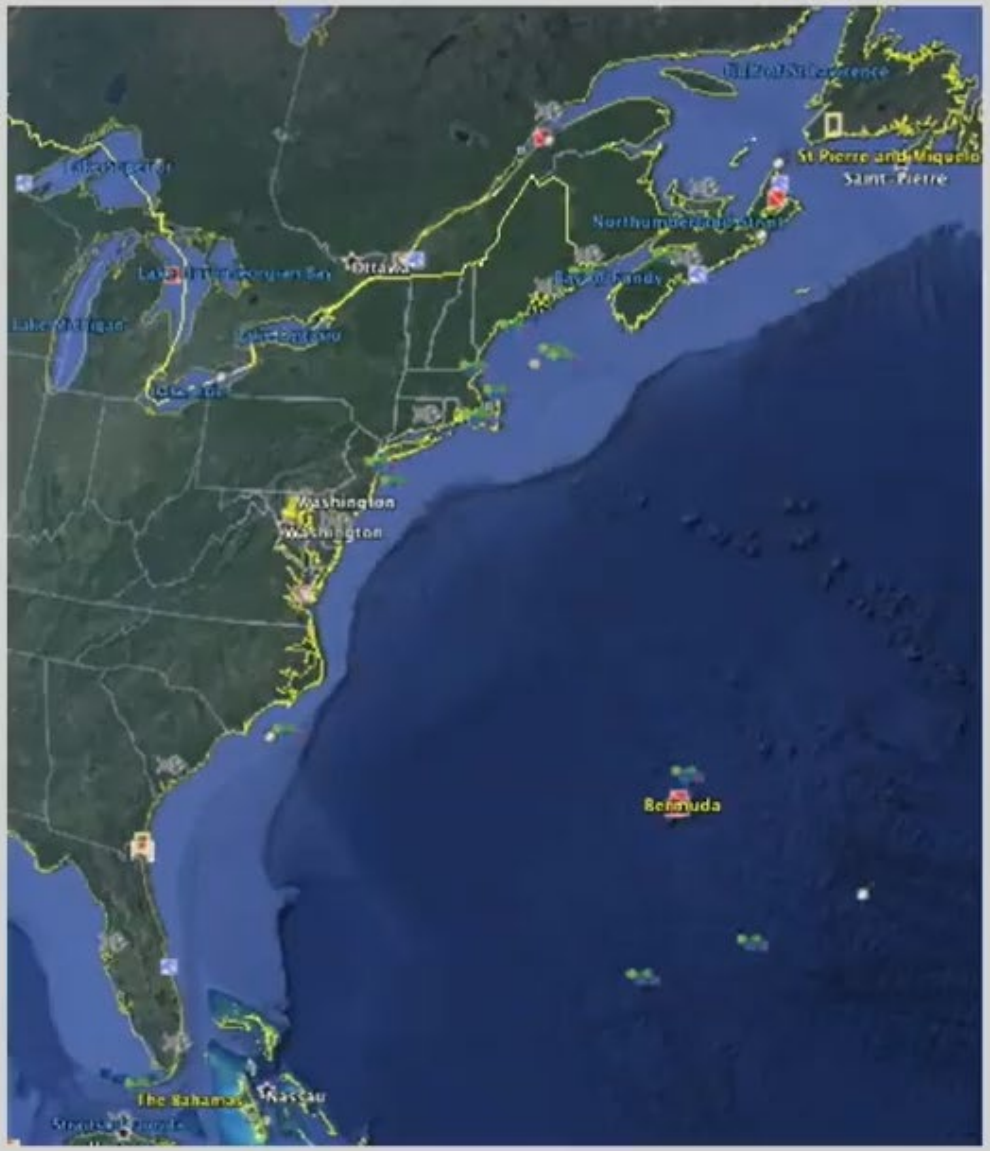


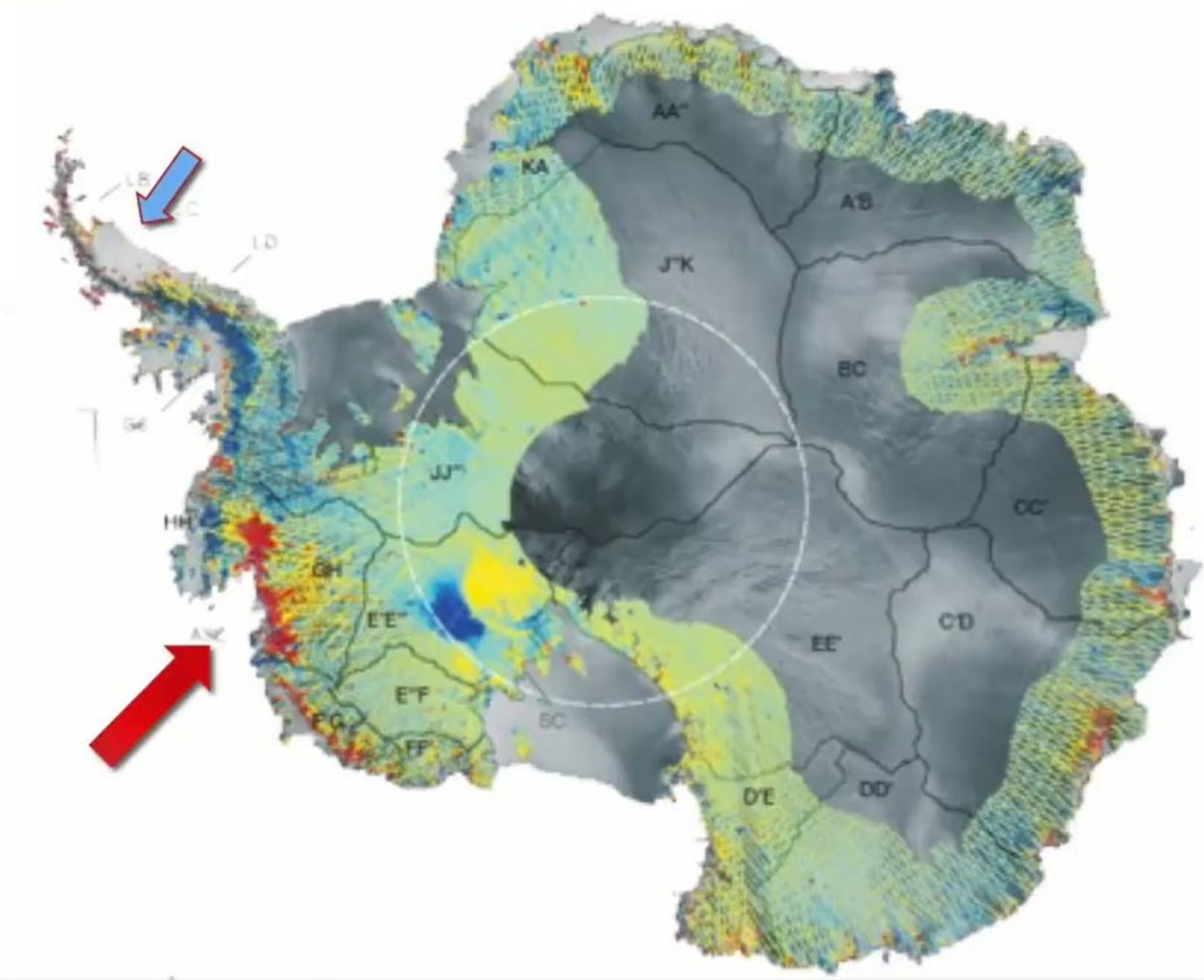
Only two major sources of potential sea level rise (SLR)

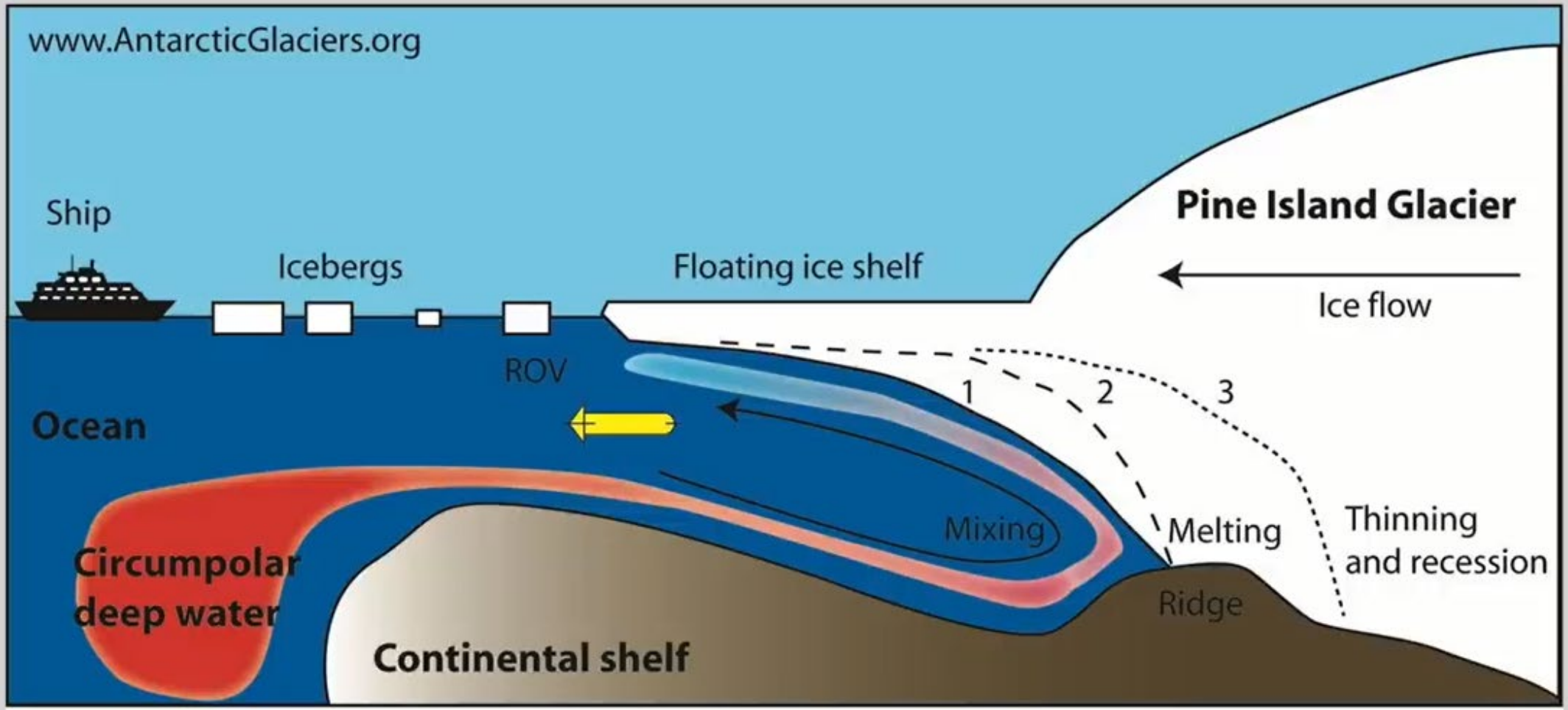
Greenland =
24 feet of SLR

Antarctica =
186 feet of SLR

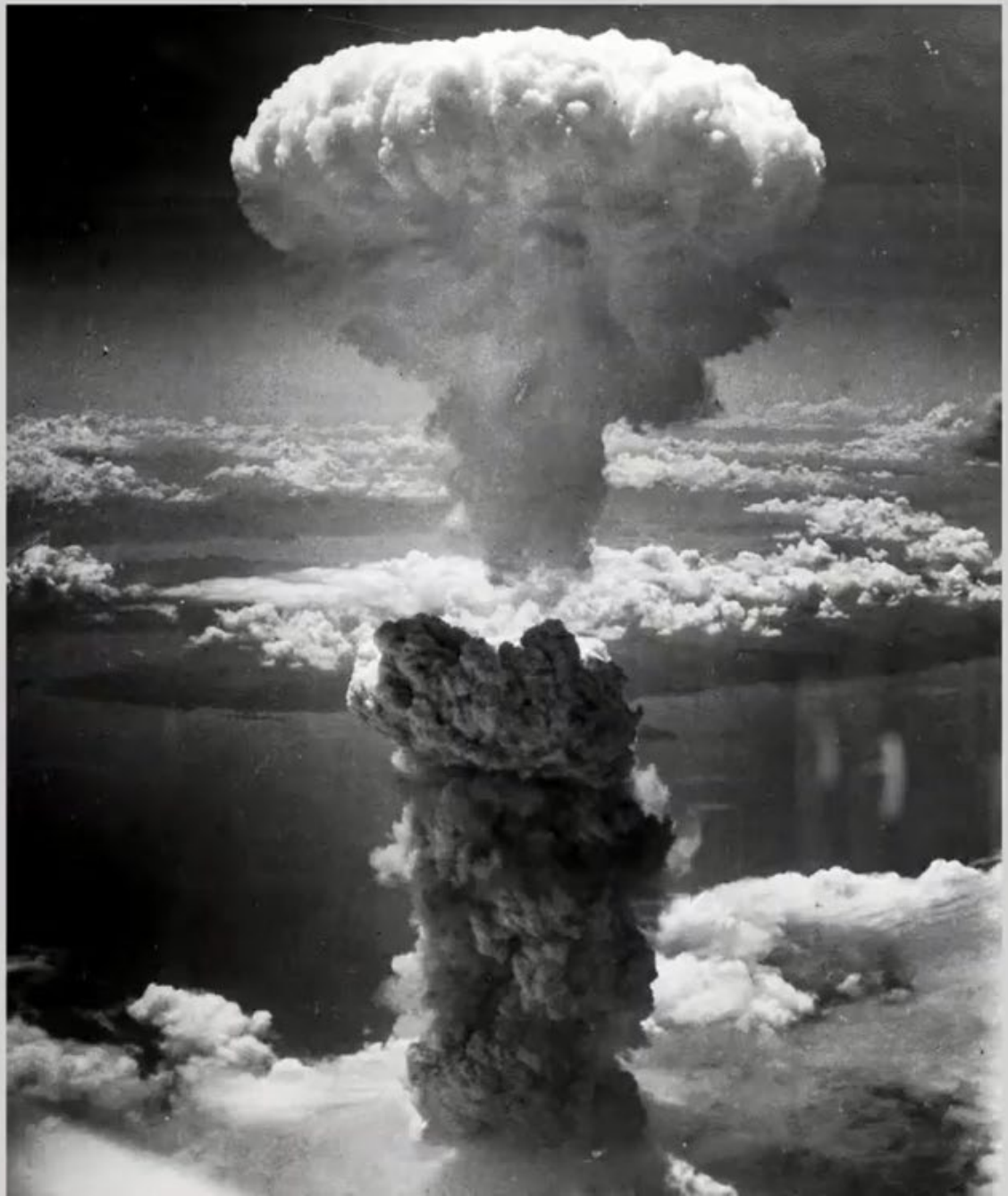
Greenland - Approximate Size Comparison




AA"
KA
A'B
J"K
BC
JJ"
CC"
HH"
GH
E'E"
C'D
EE"
E"F
FF"
D'E
DD"



1. Early 1970s. Pine Island Glacier is grounded at a bedrock ridge.
2. Warm, inflowing Circumpolar Deep Water melts the base of the glacier. The glacier steepens and accelerates.
3. Present day, observed by a remotely operated vehicle (ROV). Glacier is thinning and receding.



GHG Traps Excess

Heat equal to 500,000

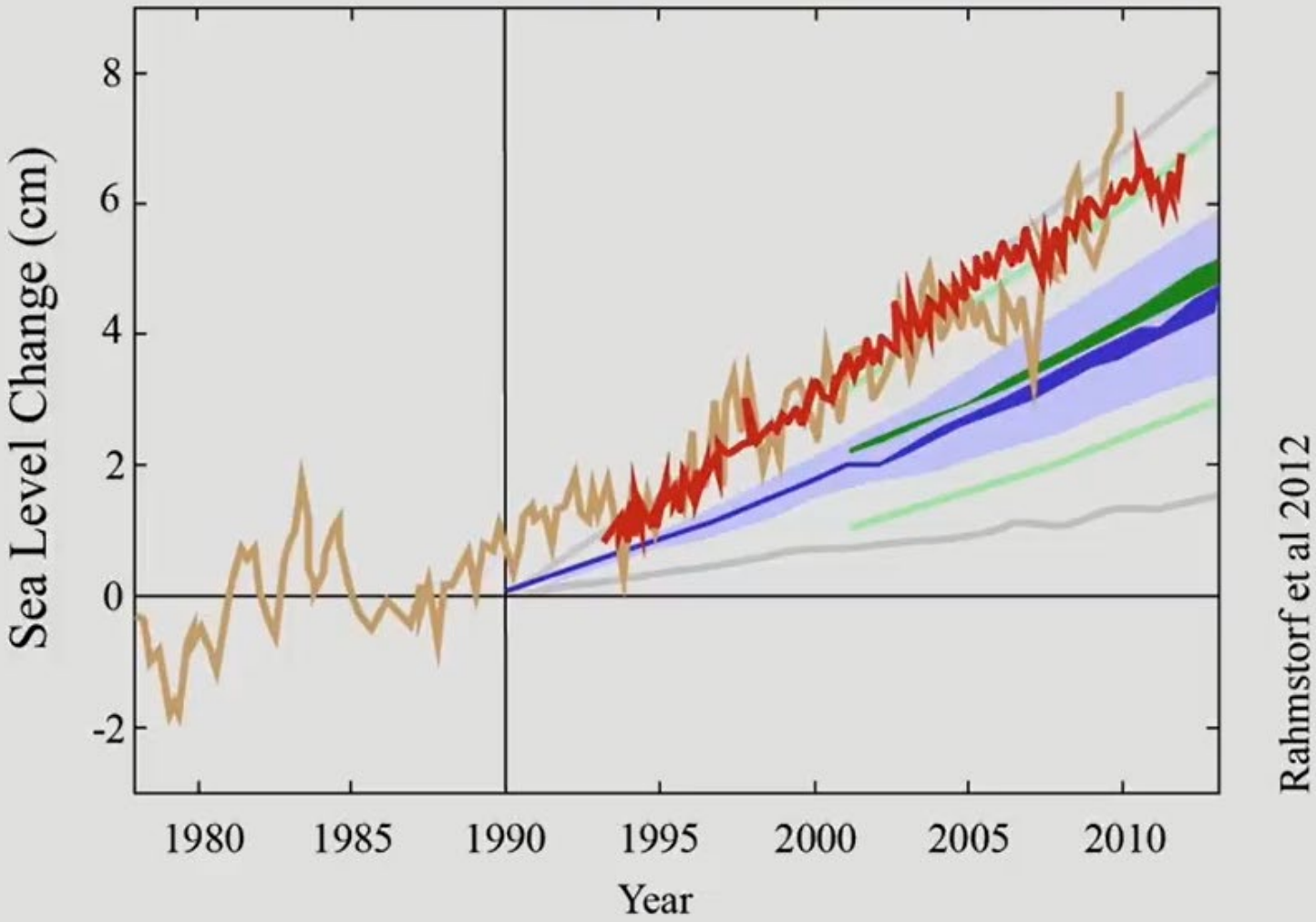
atomic bombs a day.

5 every second, 24 / 7

93% of the heat is

stored in the ocean.

Actual SL Exceeding Projections

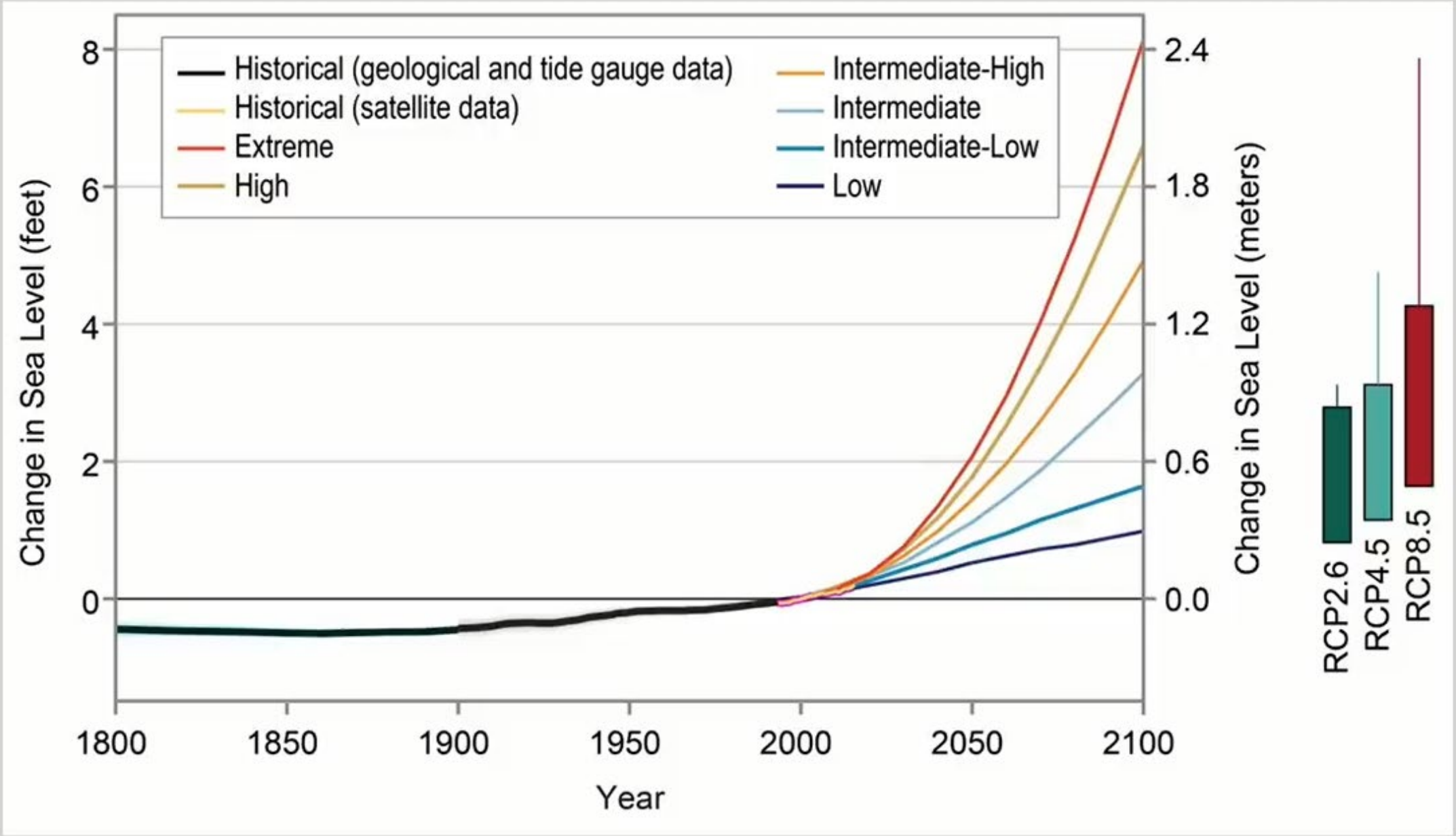


Blue – 1990 Projections

Green – 2002 Projections

Gold – Actual Sea level

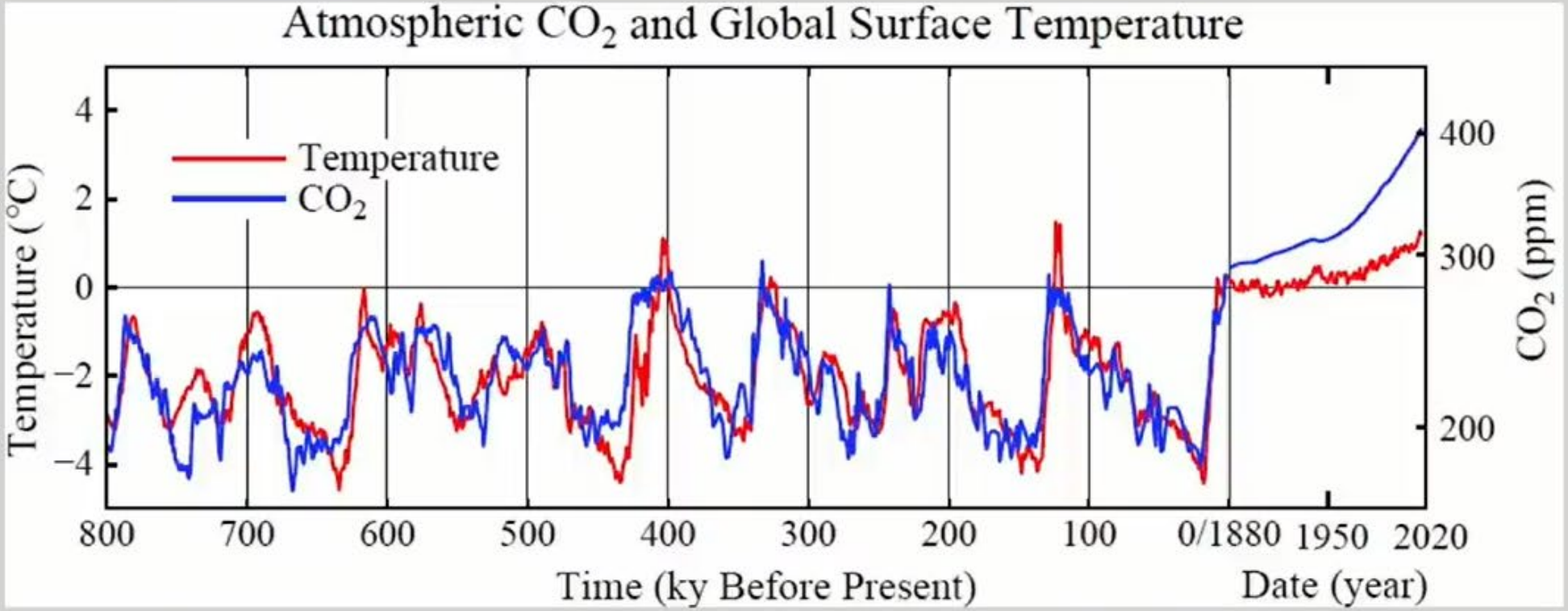
Red - SL with trend line smoothing


Historical (geological and tide gauge data)
Historical (satellite data)
Extreme
High
Intermediate-High
Intermediate
Intermediate-Low
Low
Change in Sea Level (feet)
Change in Sea Level (meters)
Year
8
6
4
2
0
2.4
1.8
1.2
0.6
0.0
1800
1850
1900
1950
2000
2050
2100
RCP2.6
RCP4.5
RCP8.5

Sea level rise varies greatly by location.

Global average sea level has increased 8 inches since 1880. Sea levels along the U.S. East Coast and Gulf of Mexico are rising much faster.

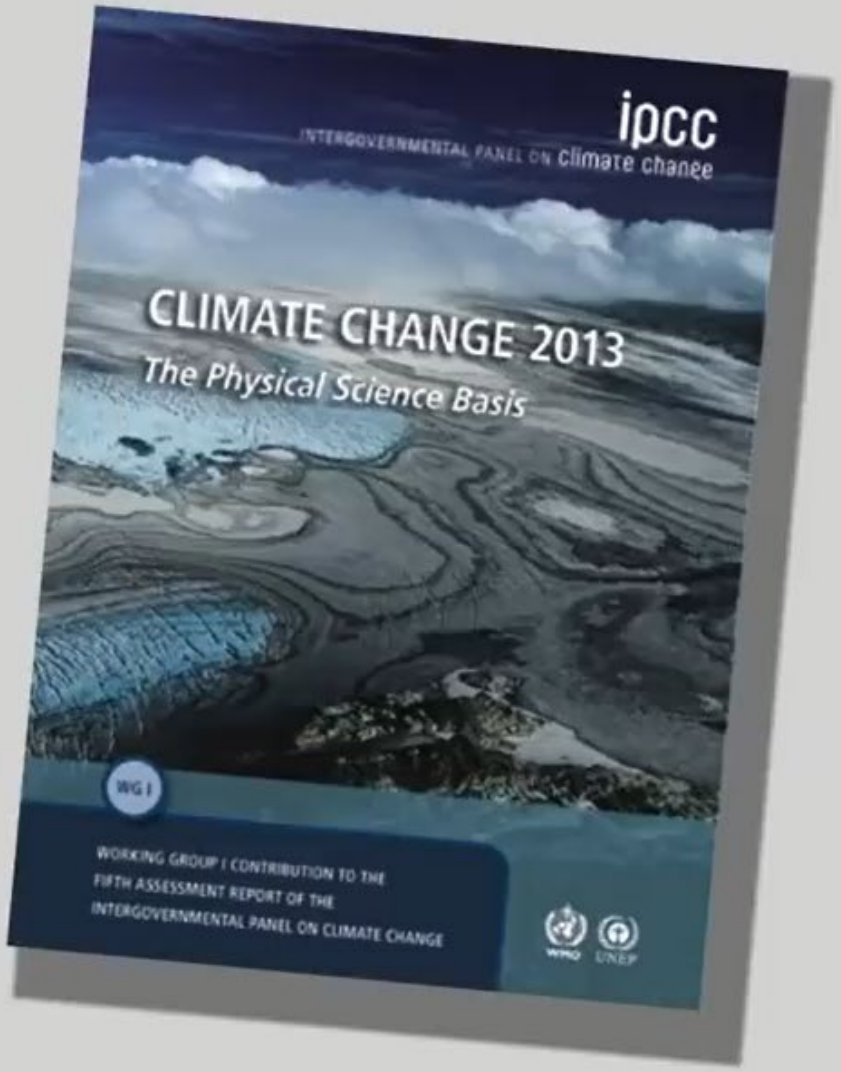
The rate of local sea level rise varies depending on both global and local factors, including currents, ocean floor topography, variations in ocean density, and land uplift or subsidence due to geological reasons or human activities.



Note that the time scale for the past century has been expanded. A logarithmic scale is used for CO_2 because climate forcing and temperature change increase with the logarithm of CO_2.

Paleo global surface temperature change is from ocean core data of Zachos *et al.* (*Nature* 451, 279-283, 2008) via equations of Hansen *et al.* (*Phil. Trans. Roy. Soc. A*, 371, 20120294, 2013).

Intergovernmental Panel on Climate Change is most often cited as reference authority on matters regarding climate change.



Most recent IPCC Projections (2013):

"10 – 32 Inches of SLR by end of century"

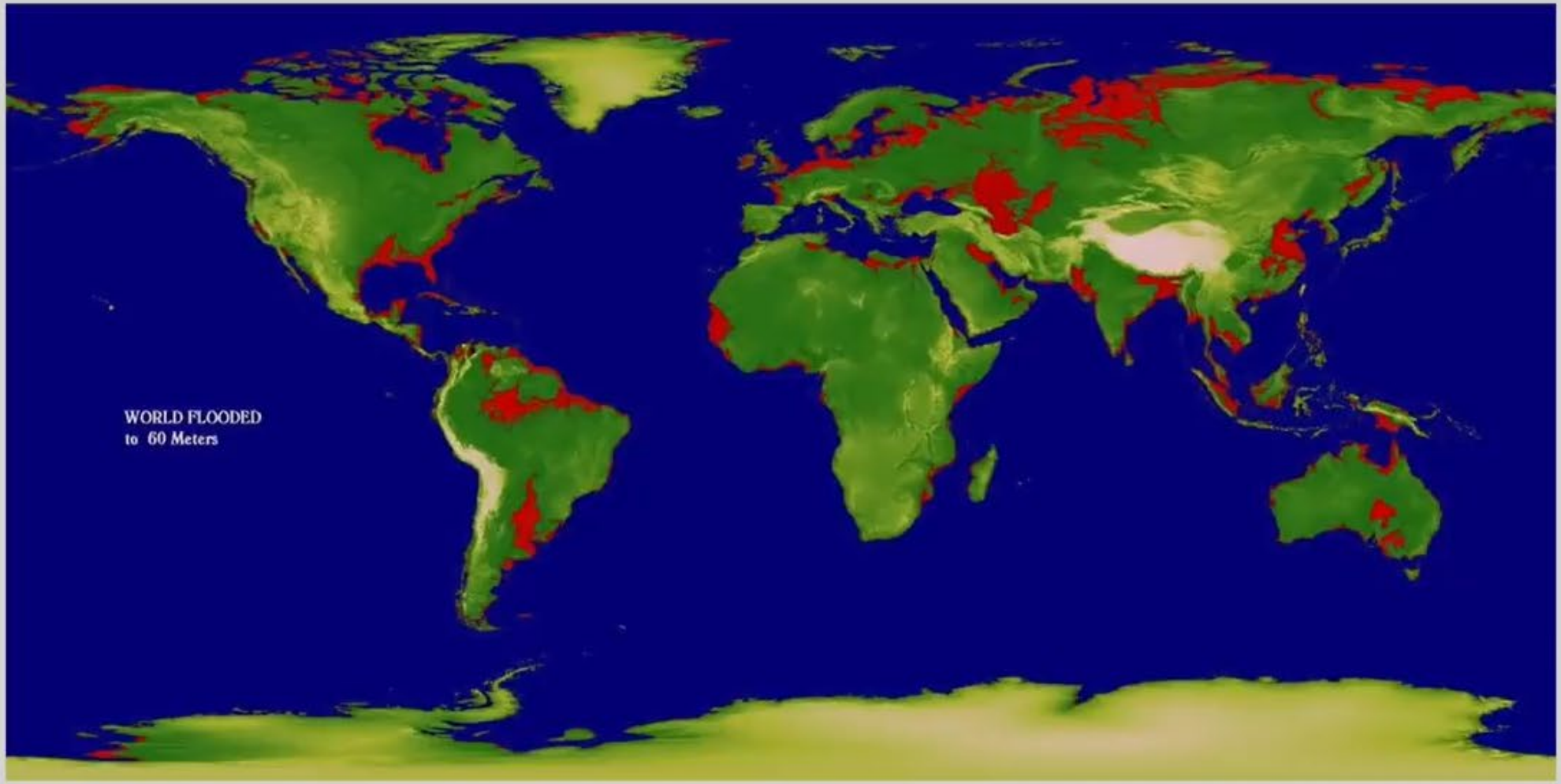
But that does not include "wild card" amplifiers:

- **Methane**
- **West Antarctic glaciers**

Key Points

- Sea Level will continue to rise despite any GHG reduction
- Scientific projections (IPCC) tend to underestimate due to uncertainty of precisely how much will occur by 2100
- The 2 key components are glacier movement/collapse in Greenland and Antarctica – both of which are accelerating
- We are headed back towards situation of 120,000 years ago (“Eemian”) when SL was approx. 25 ft. (7 m) higher
- Planning should begin to invest recognizing rising seas and shifting shorelines (Dutch example of 10 ft. (3m) of SLR established in 2008.)

IF ALL THE ICE MELTS, what goes underwater



Rising Sea Level – Key Points

- Unprecedented. No human experience.
- Can be slowed, but no longer stopped
- Will likely be worse than projections
- Makes other flooding worse
- Invites procrastination, because seems slow
- Severe effects within 50-100 year building useful life

3 Key Takeaways

1. Reducing Emissions is Very Important to slow the warming
2. Regardless, sea level will rise dramatically causing catastrophe globally
3. The sooner we begin to engineer for the future the easier will be the adaptation

INTERNATIONAL SEA LEVEL INSTITUTE

www.sealevelinstitute.org

info@sealevelinstitute.org