Infrastructure and Flooding

Understanding Storms, Tides & Sea Level Rise

PNWER 2016 - CALGARY

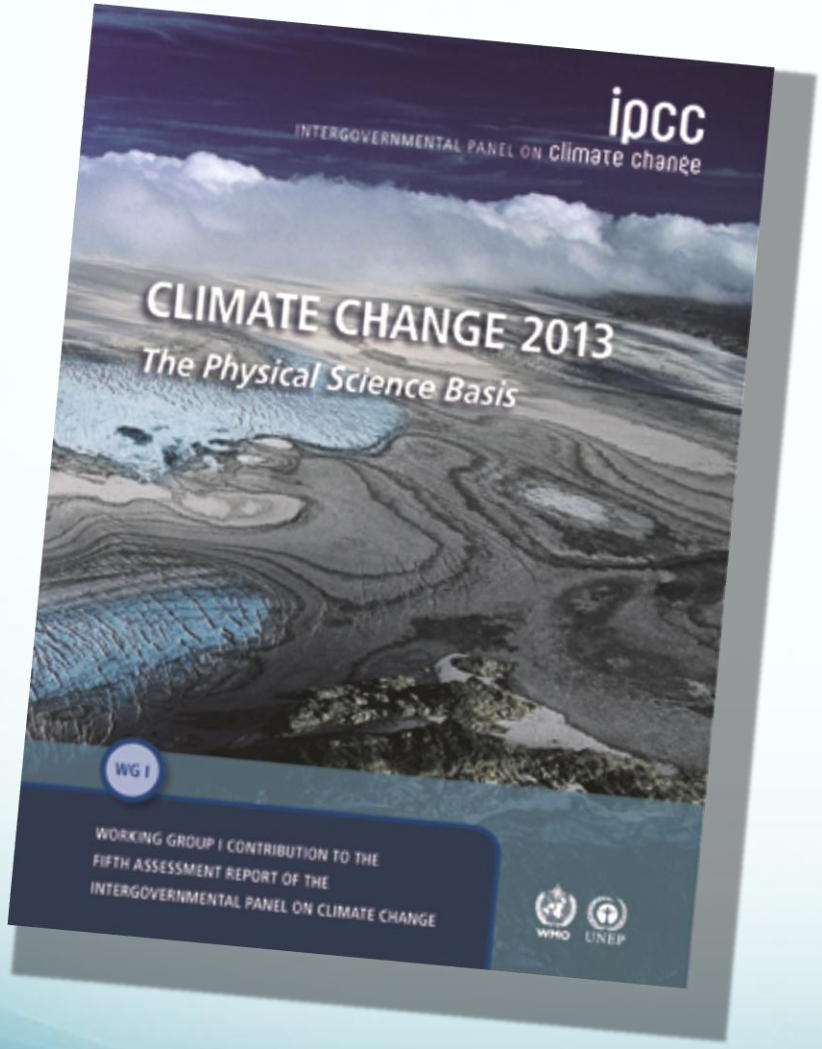
www.johnenglander.net

Types of Flooding

- Sea Level Rise
- Rainfall & Runoff
- Coastal Storm Flooding
- Extreme Tides
- Land Subsidence / Uplift
- Other

Calgary 2013

Seattle 2012



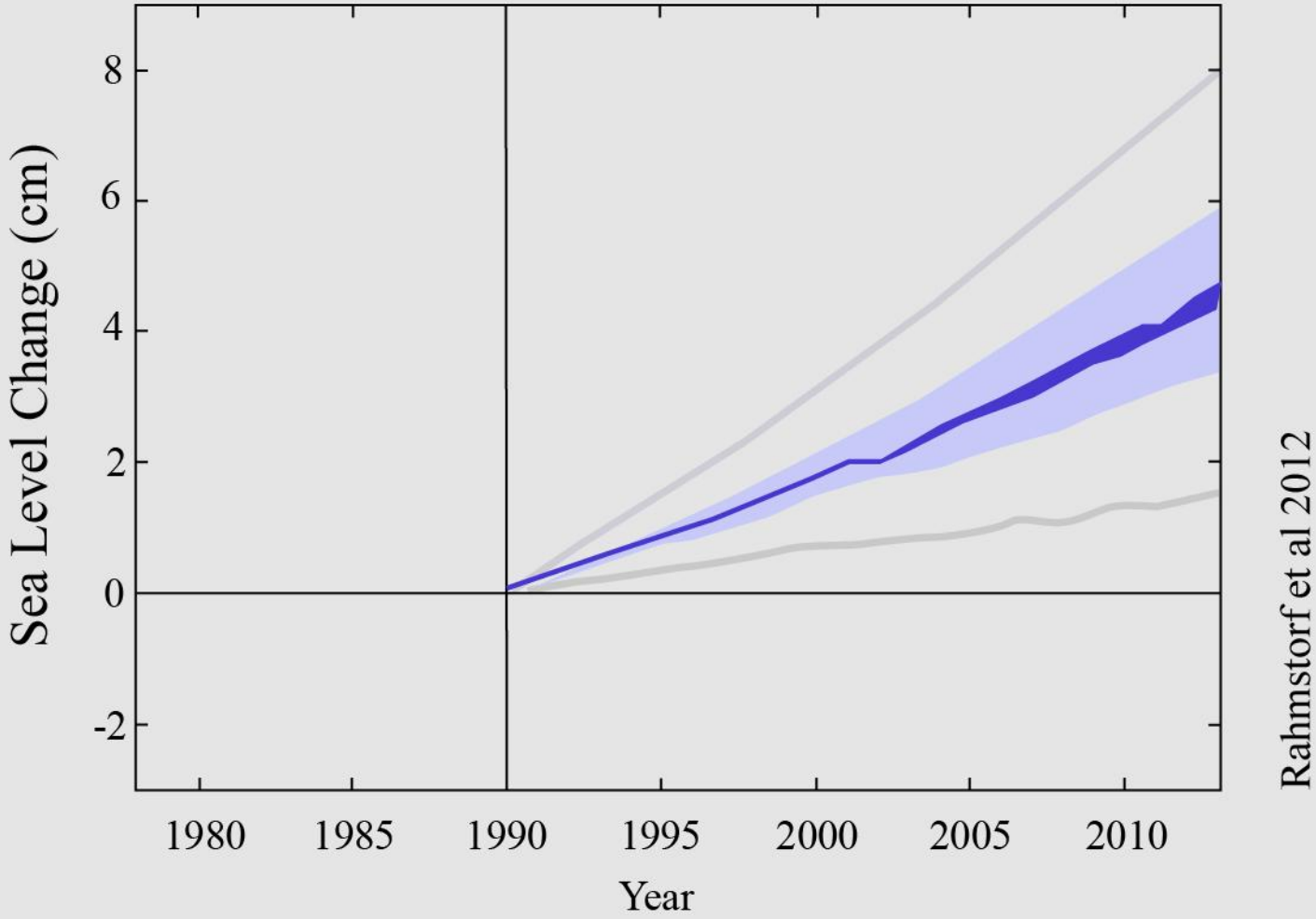
2013 IPCC Projections:

up to 32 in. / 92 cm of sea level rise this century

#'s do not include the "wild card" amplifiers:

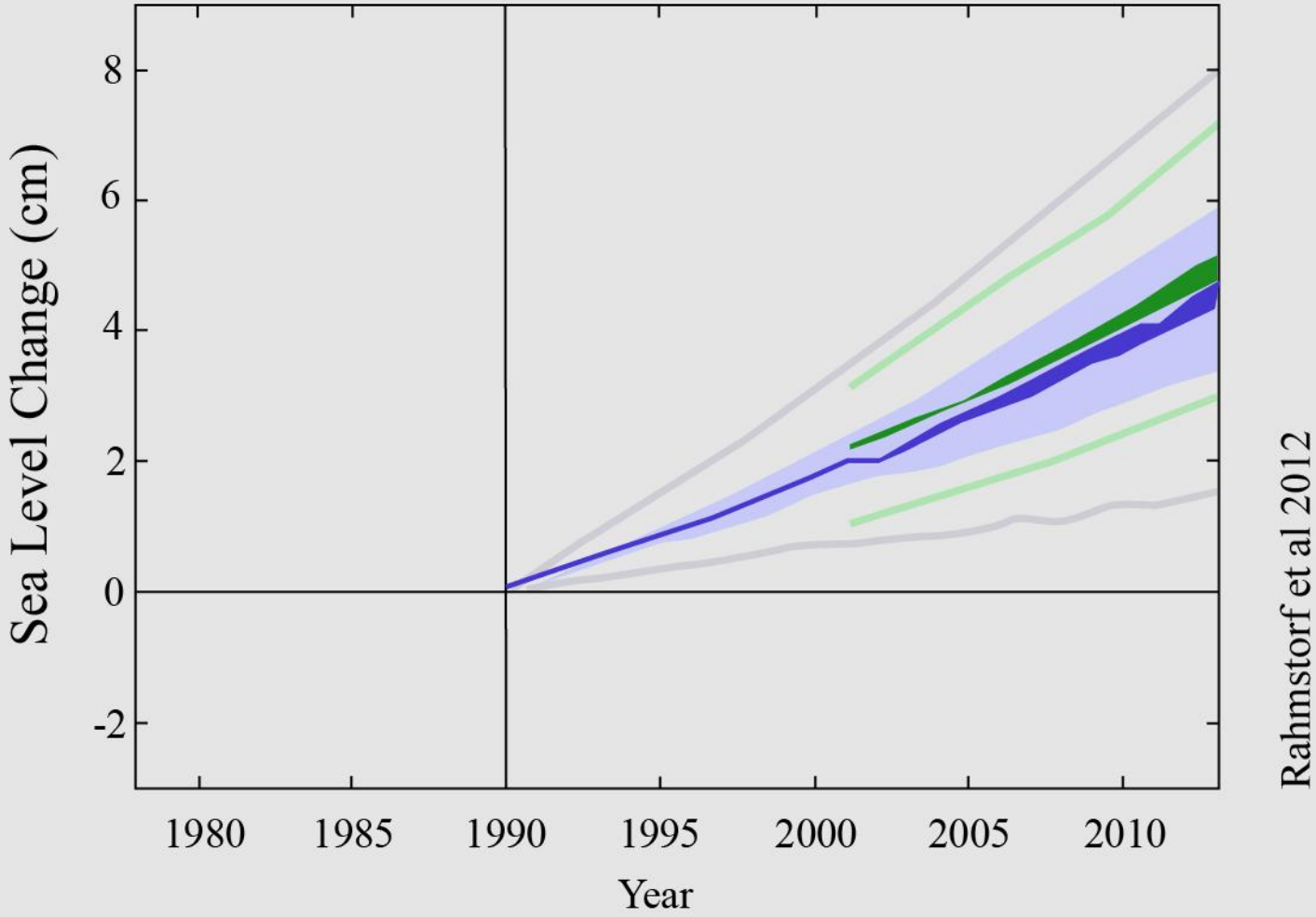
- Methane
- West Antarctic glaciers

Actual SL Exceeding Projections



Blue – 1990 Projections

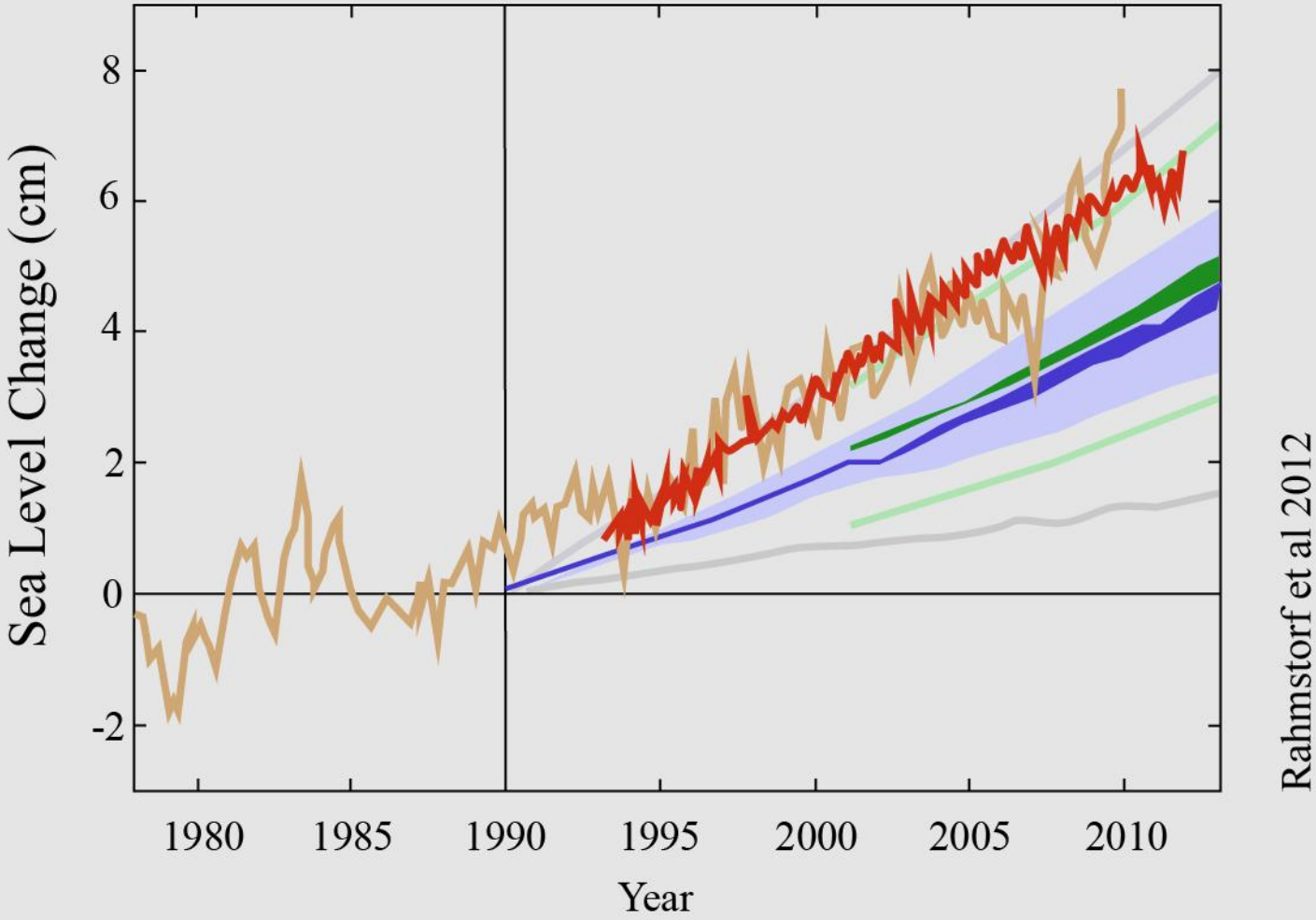
Actual SL Exceeding Projections



Blue – 1990 Projections

Green – 2002 Projections

Actual SL Exceeding Projections



Blue – 1990 Projections

Green – 2002 Projections

Gold – Actual Sea level

Red - SL with trend line smoothing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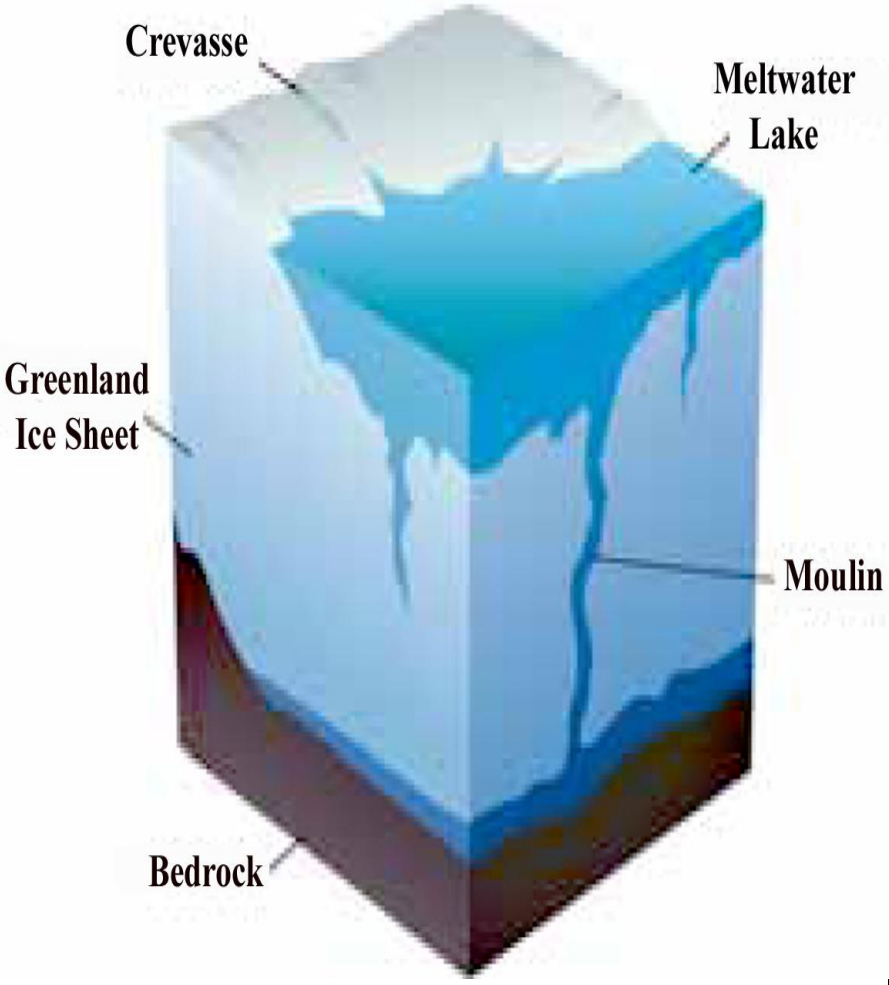
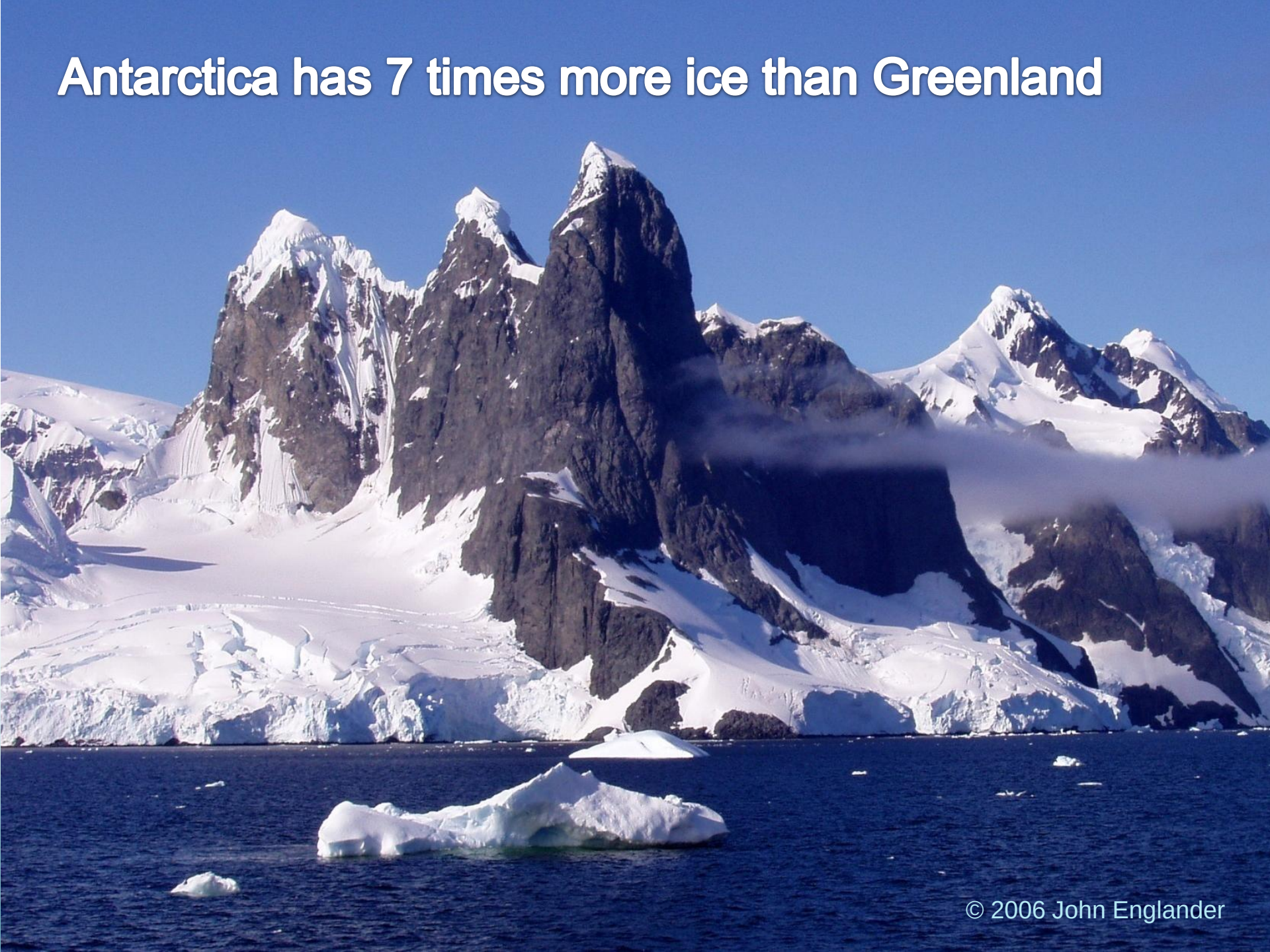
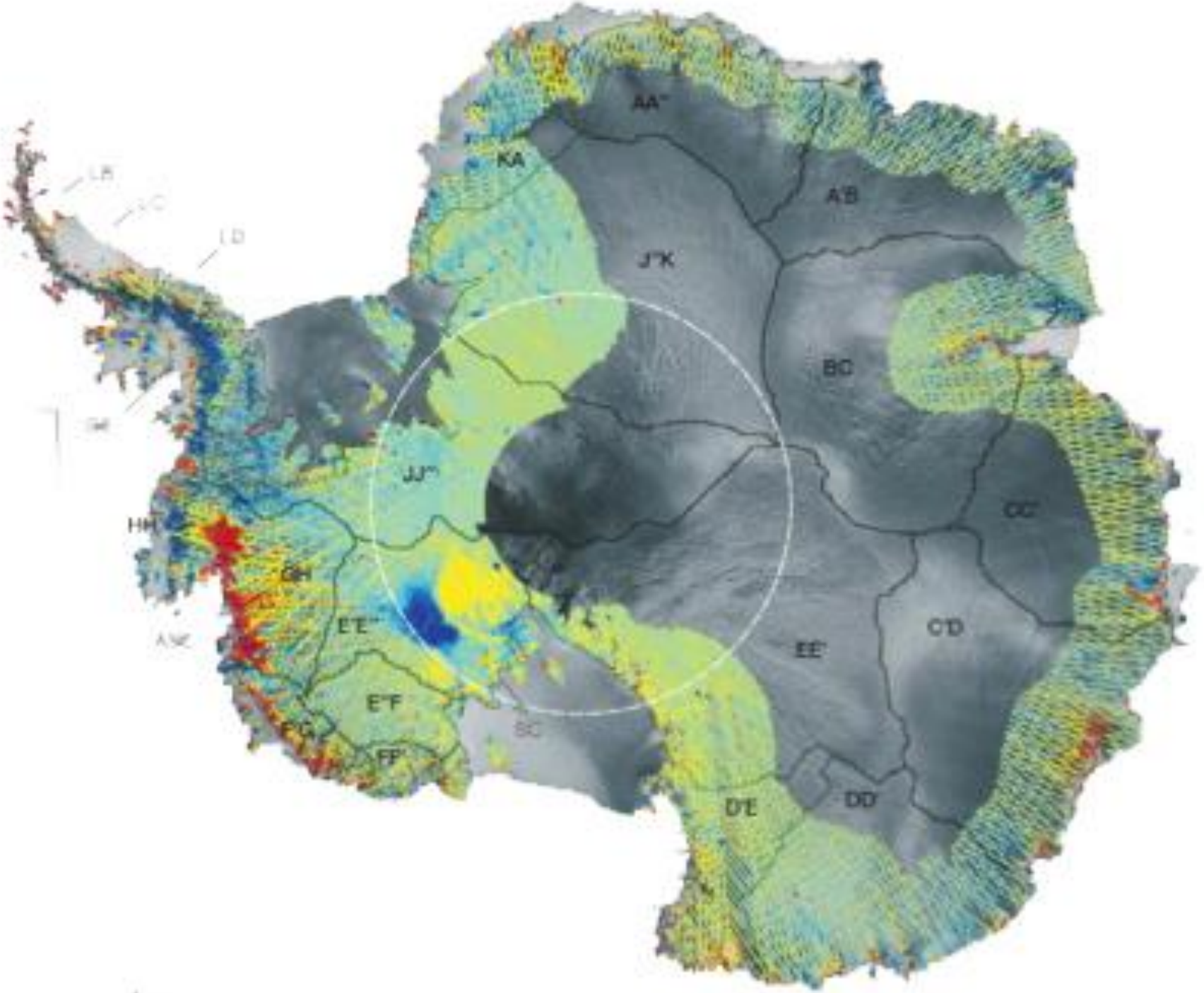
Greenland =
24 feet of SLR

Antarctica =
186 feet of SLR


Crevasse
Meltwater
Lake
Greenland
Ice Sheet
Moulin
Bedrock

Antarctica has 7 times more ice than Greenland




AA
KA
AB
JK
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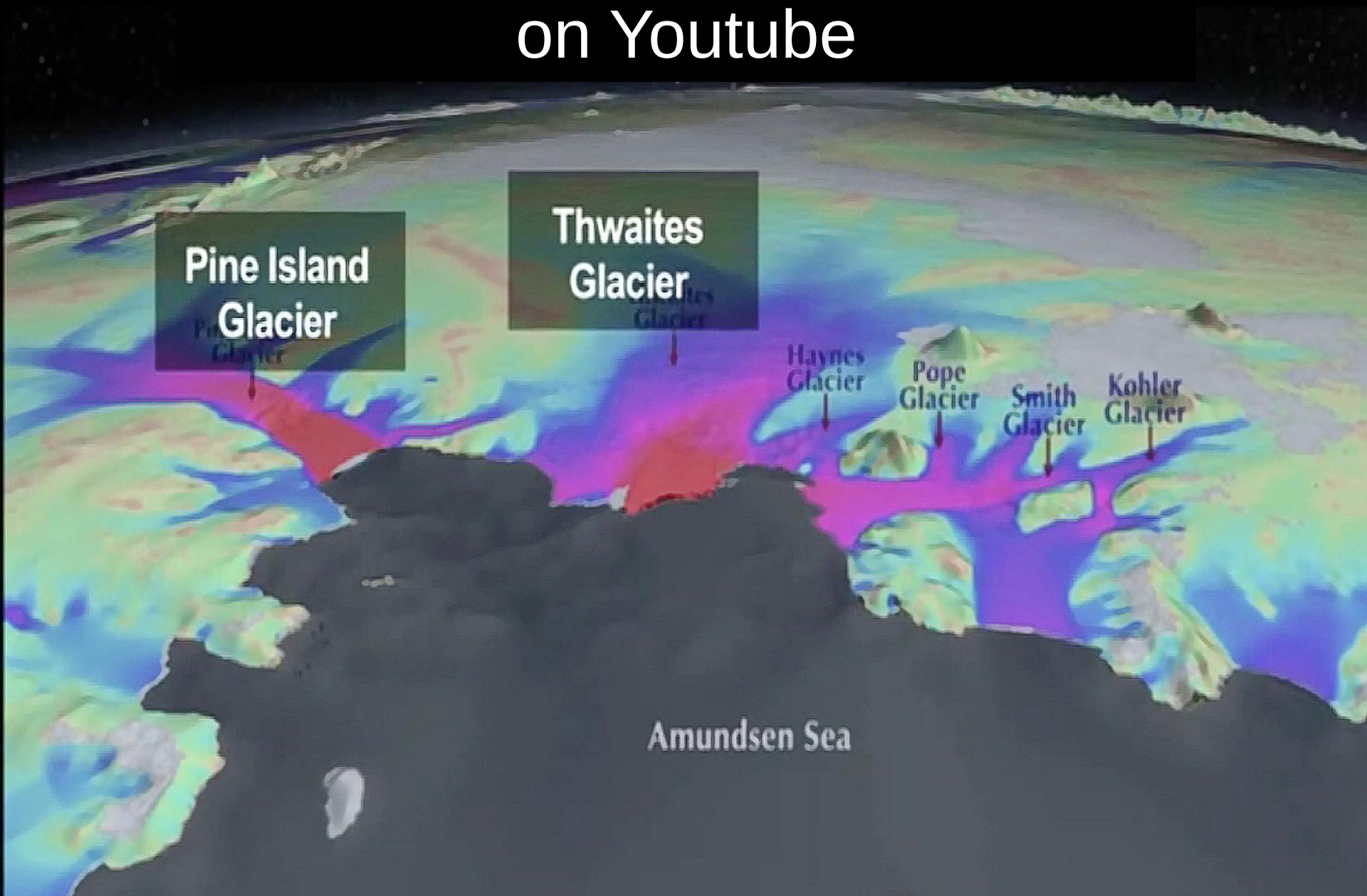
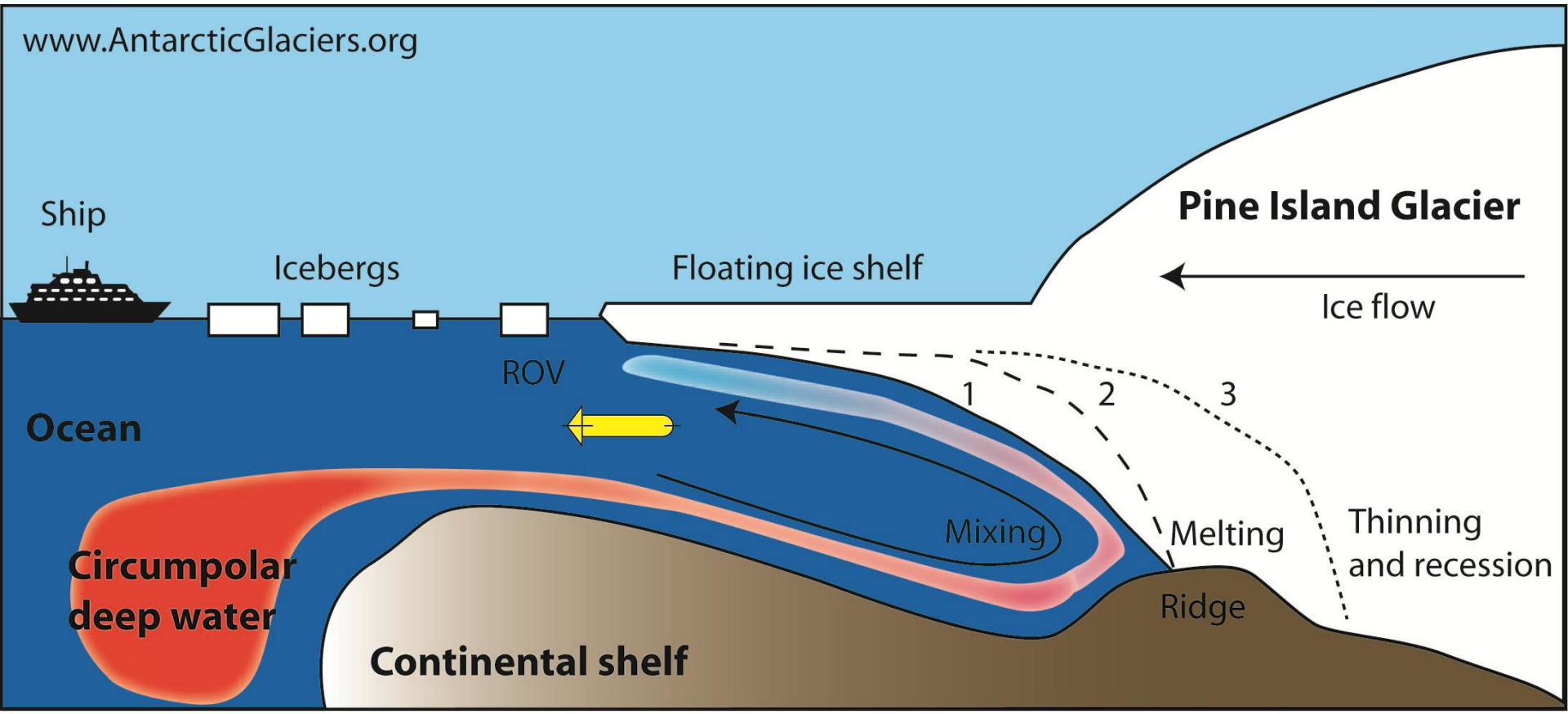
DD

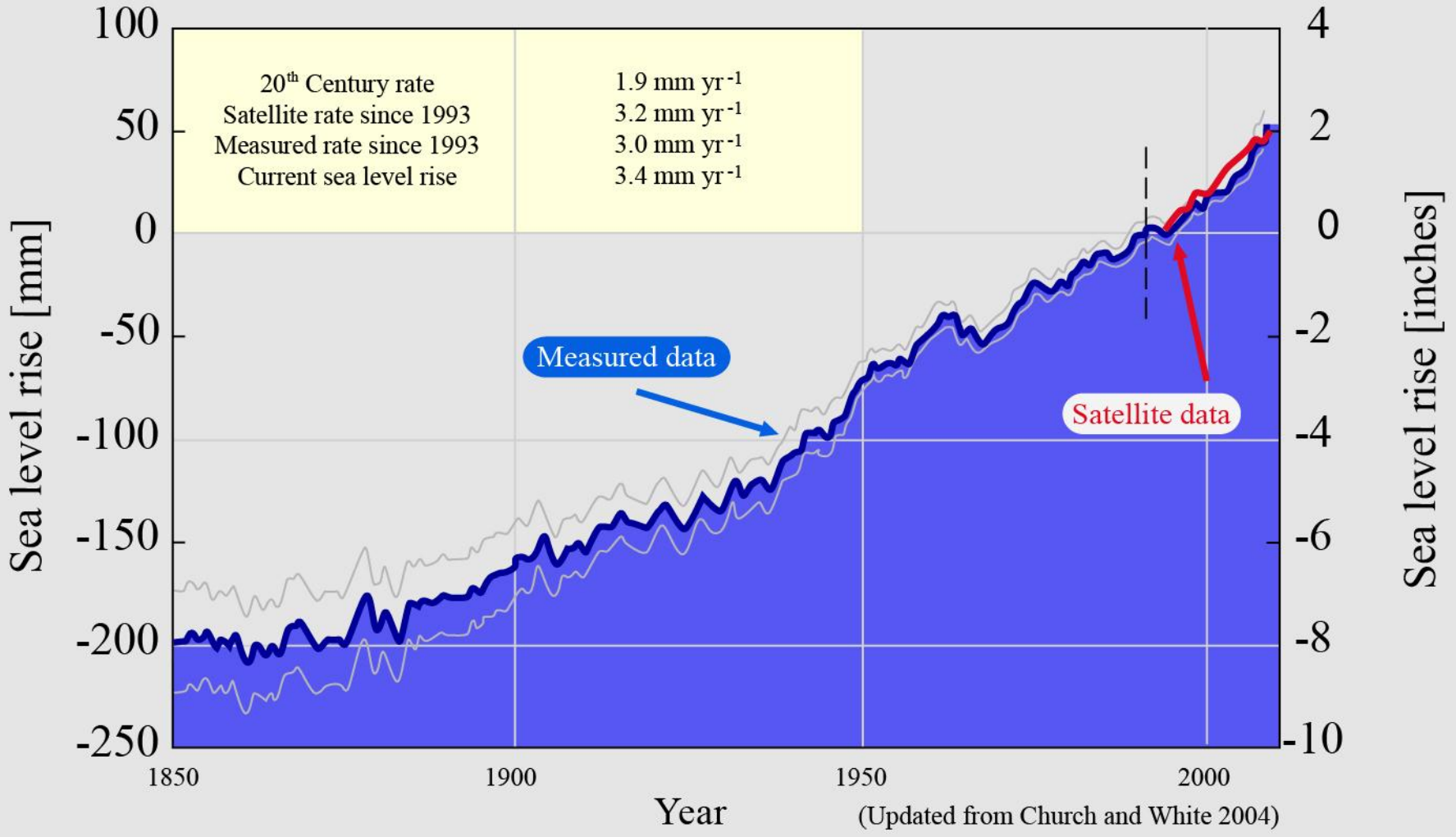
“Meltwater Pulse 2b”
on Youtube



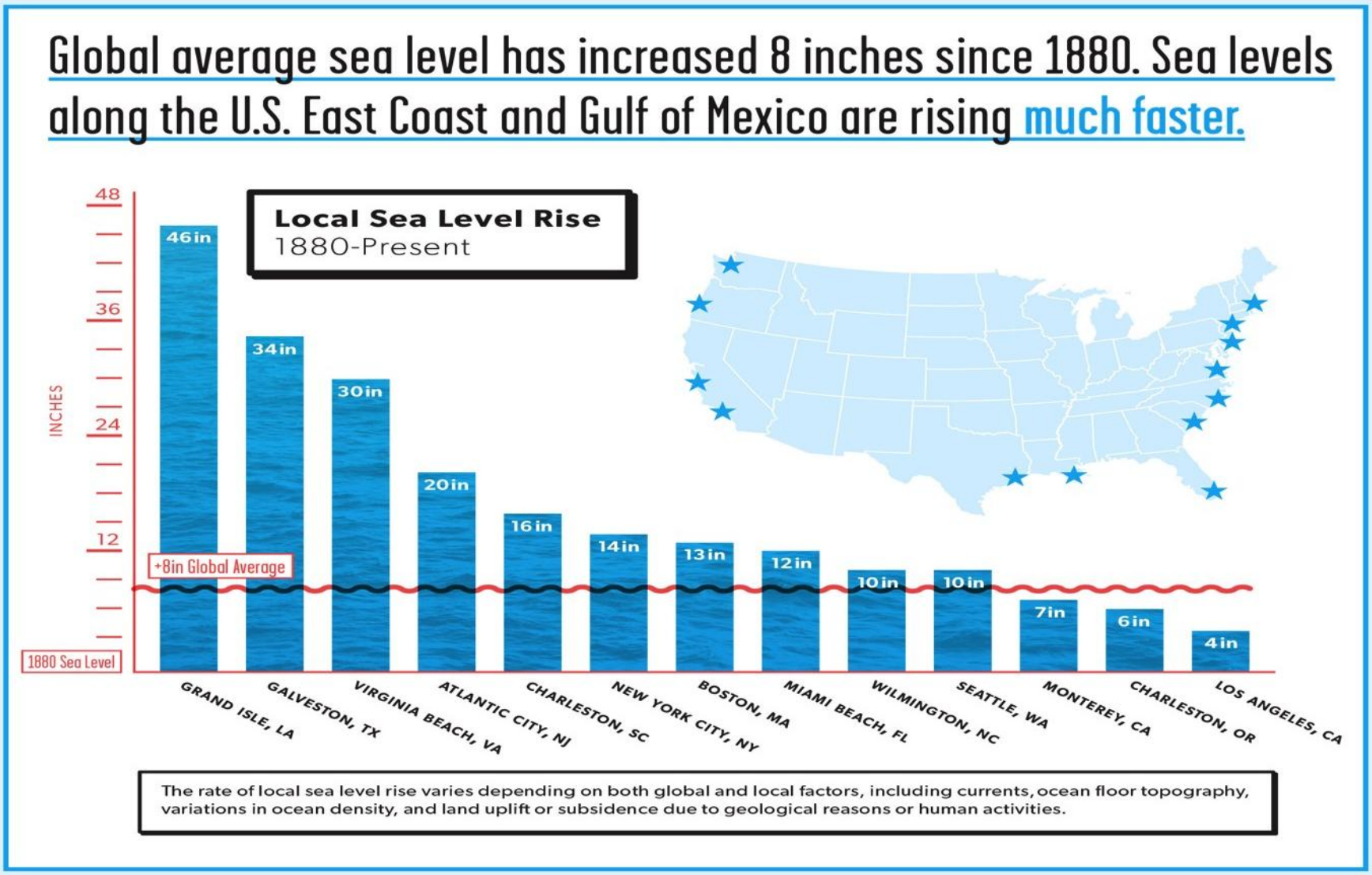


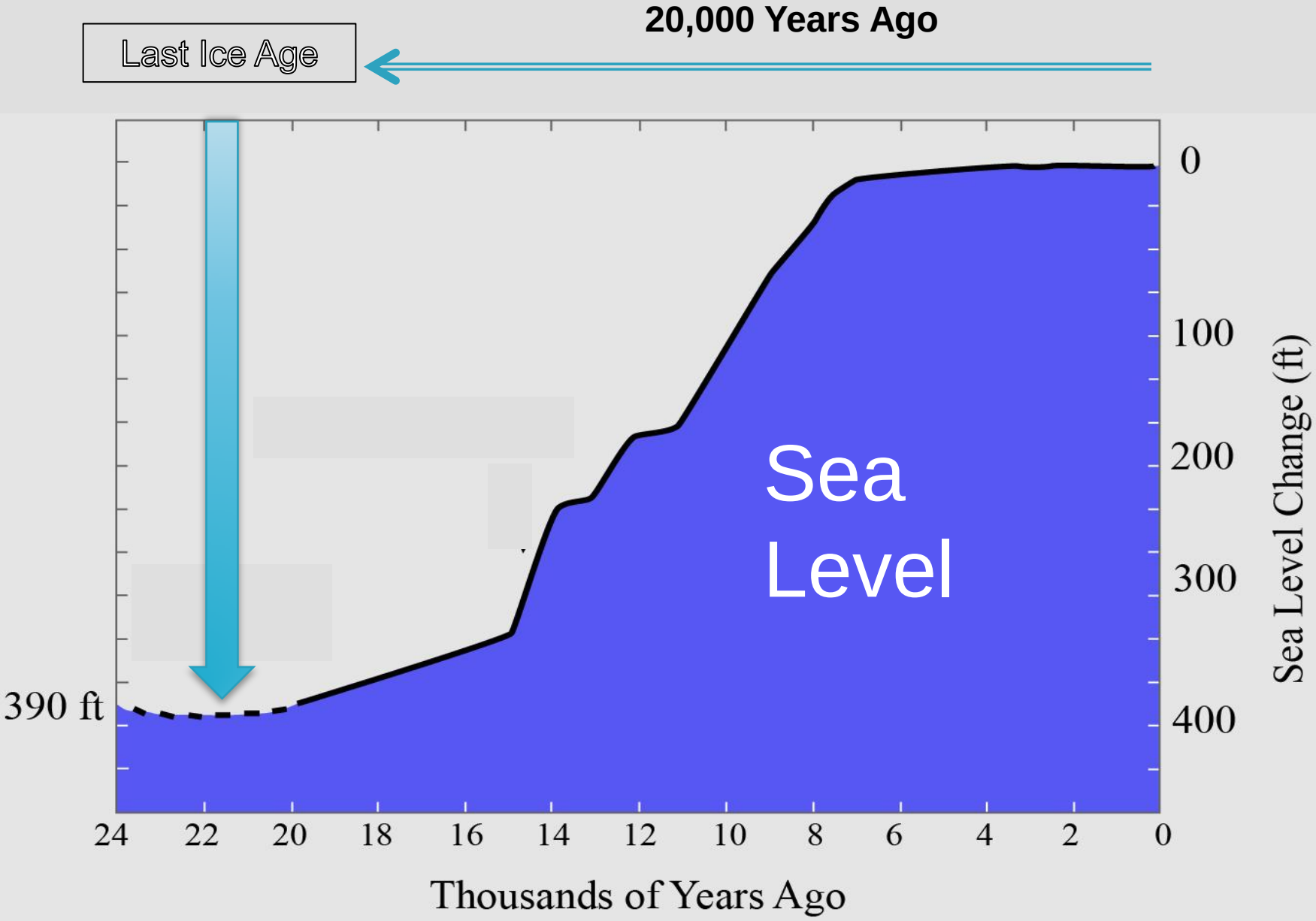
1. Early 1970s. Pine Island Glacier is grounded at a bedrock ridge.
2. Warm, inflowing Circumpolar Deep Water melts the base of the glacier. The glacier steepens and accelerates.
3. Present day, observed by a remotely operated vehicle (ROV). Glacier is thinning and receding.

Sea Level Rise: 20th Century

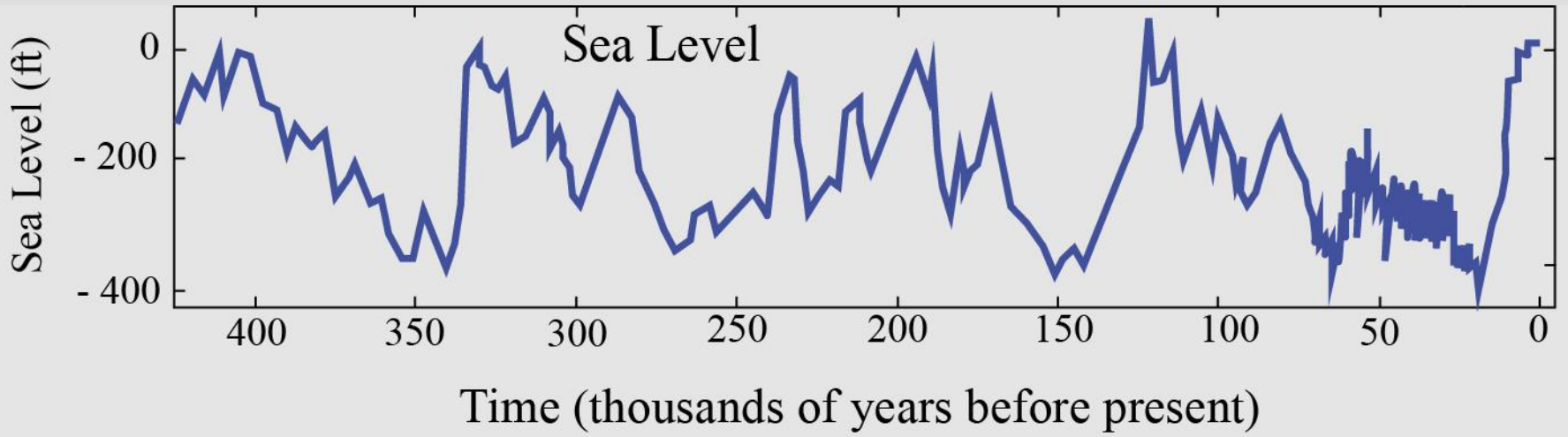


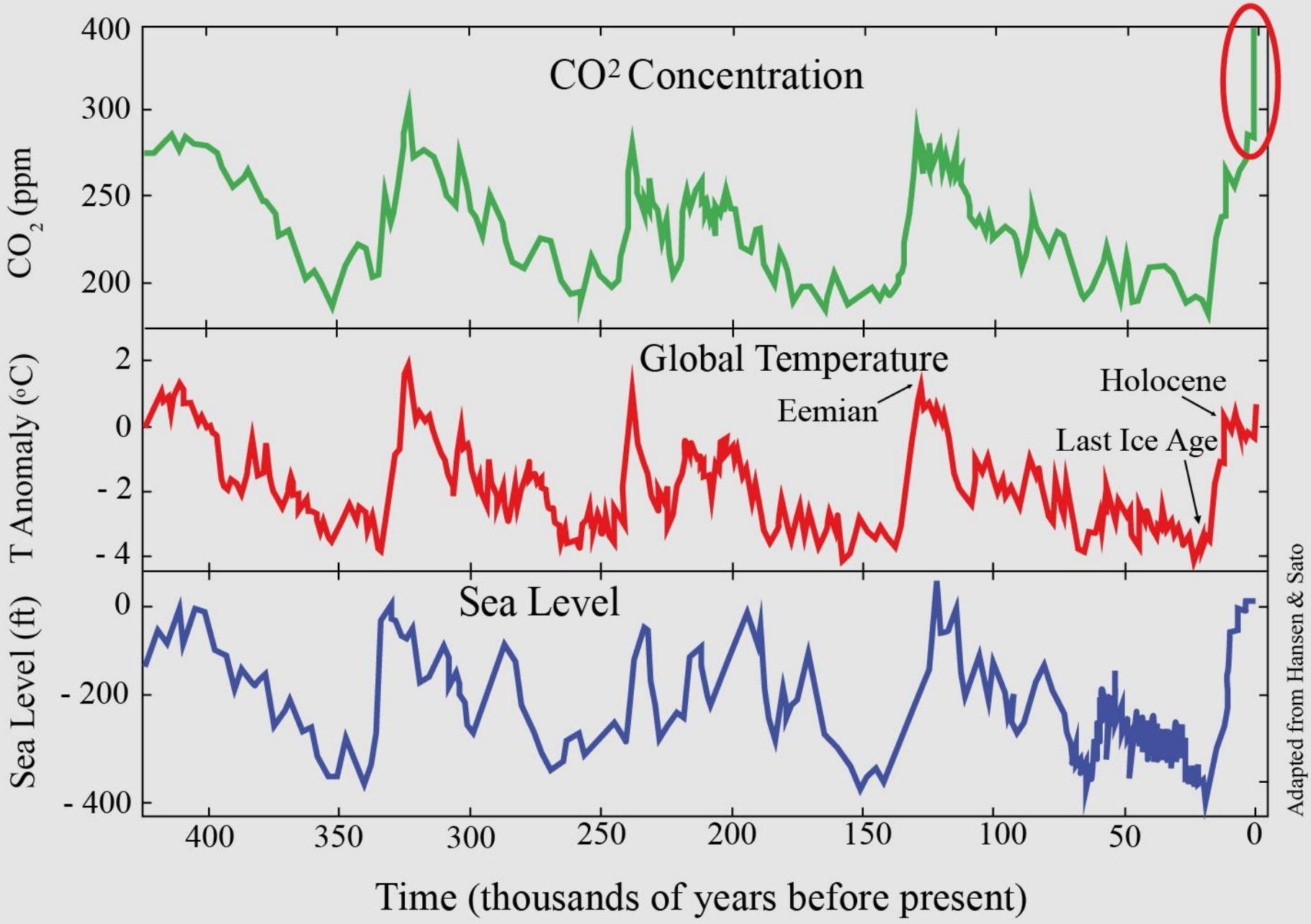
Sea level rise varies greatly by location.

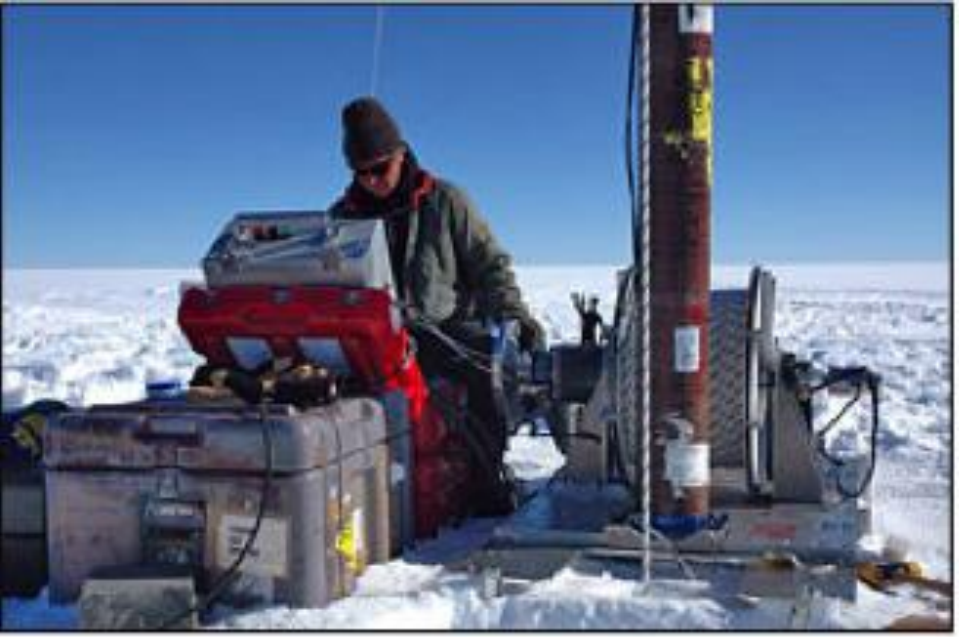


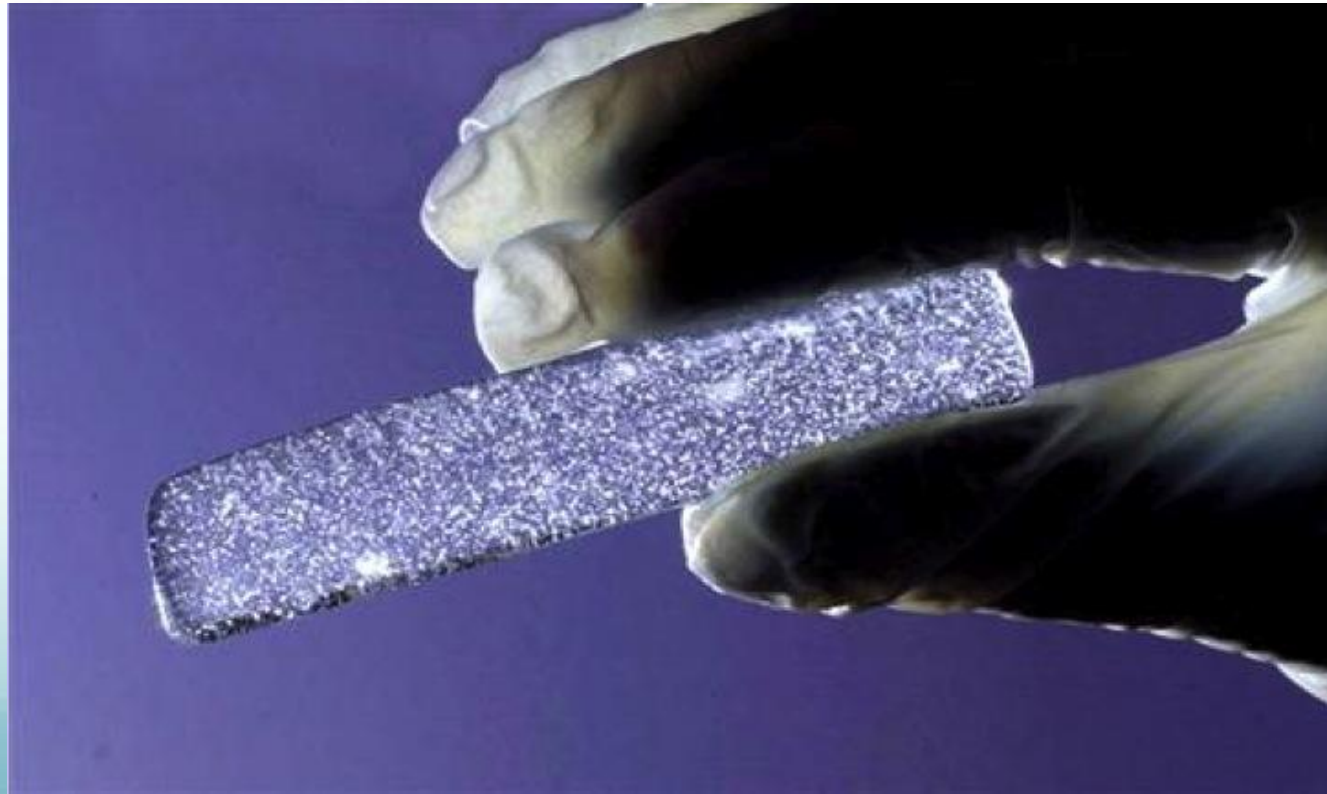

Last Ice Age
20,000 Years Ago
Sea Level
390 ft
0
100
200
300
400
Sea Level Change (ft)
24
22
20
18
16
14
12
10
8
6
4
2
0
Thousands of Years Ago

Sea level change over the last 400,000 years, 4 “ice age” cycles, shows a clear pattern



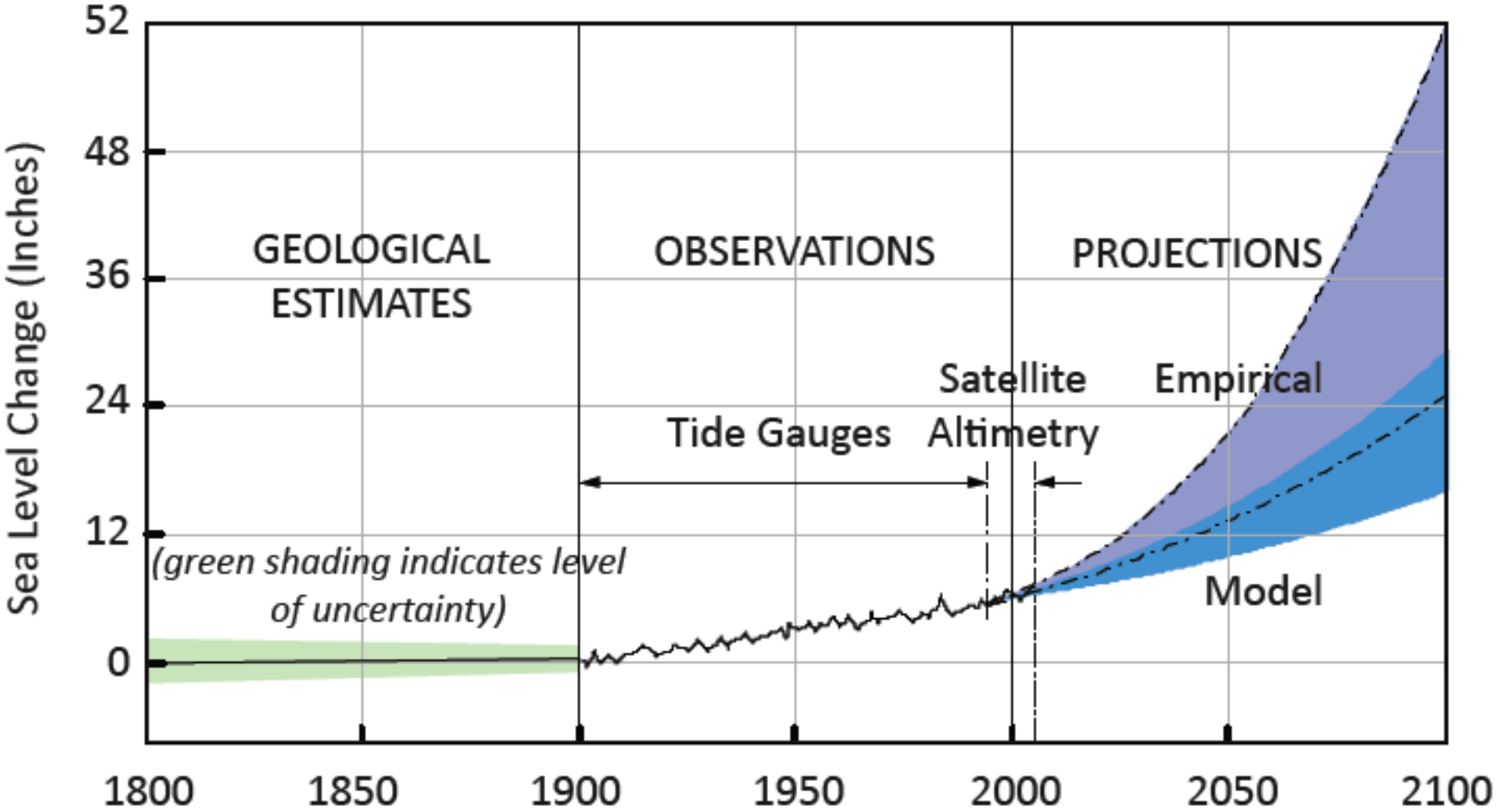

CO² Concentration
CO2 (ppm
400
300
250
200
Global Temperature
T Anomaly (°C)
2
0
- 2
- 4
Eemian
Holocene
Last Ice Age
Sea Level
Sea Level (ft)
0
- 200
- 400
400
350
300
250
200
150
100
50
0
Time (thousands of years before present)
Adapted from Hansen & Sato





Global sea level is rising primarily because land ice is melting and ocean water is expanding as it warms

- 1.7 mm per year over 20th century (from tide gages)
- 3.1 mm per year since 1993 (from satellite altimetry)



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