

RAPID STEPS OF SEA LEVEL RISE: An Ominous View Into the Future

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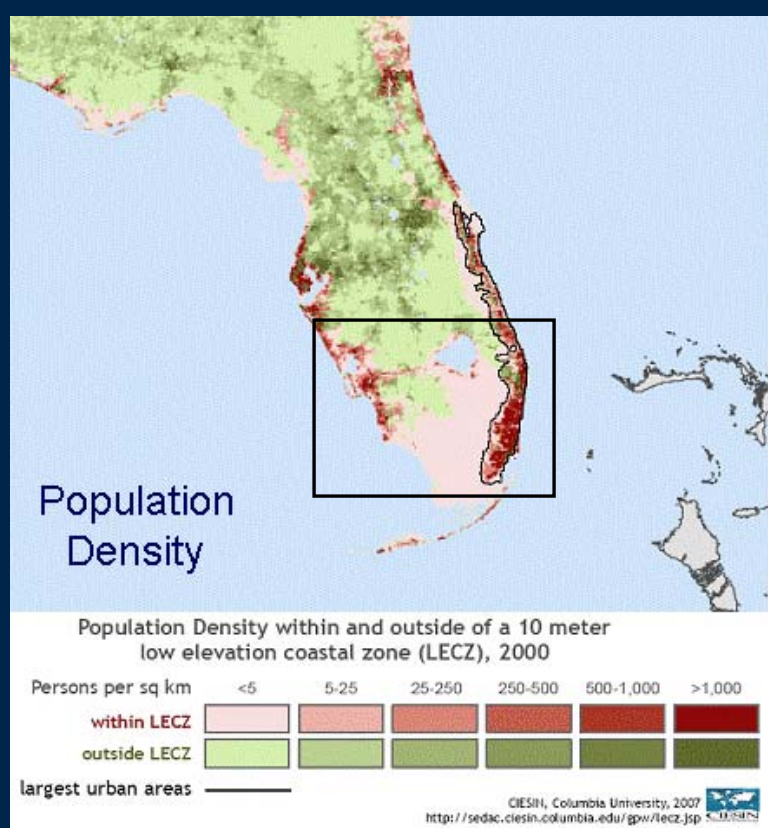
University of Miami

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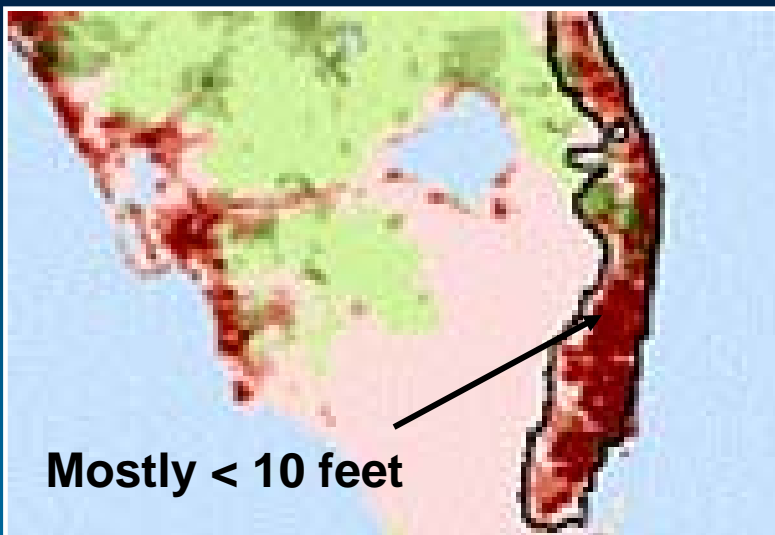
Society of Environmental
Journalists

Plenary Luncheon

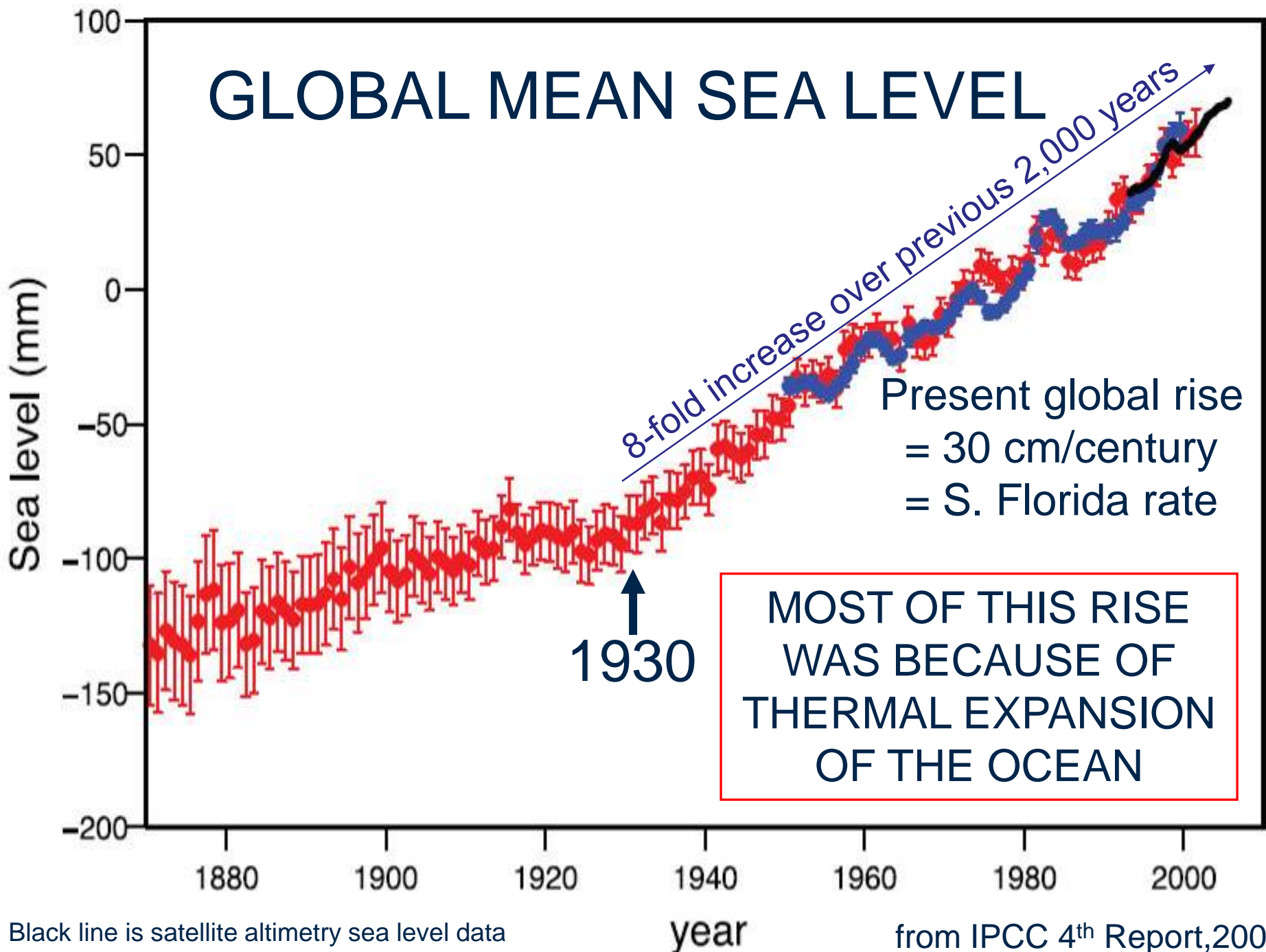
October 22, 2011

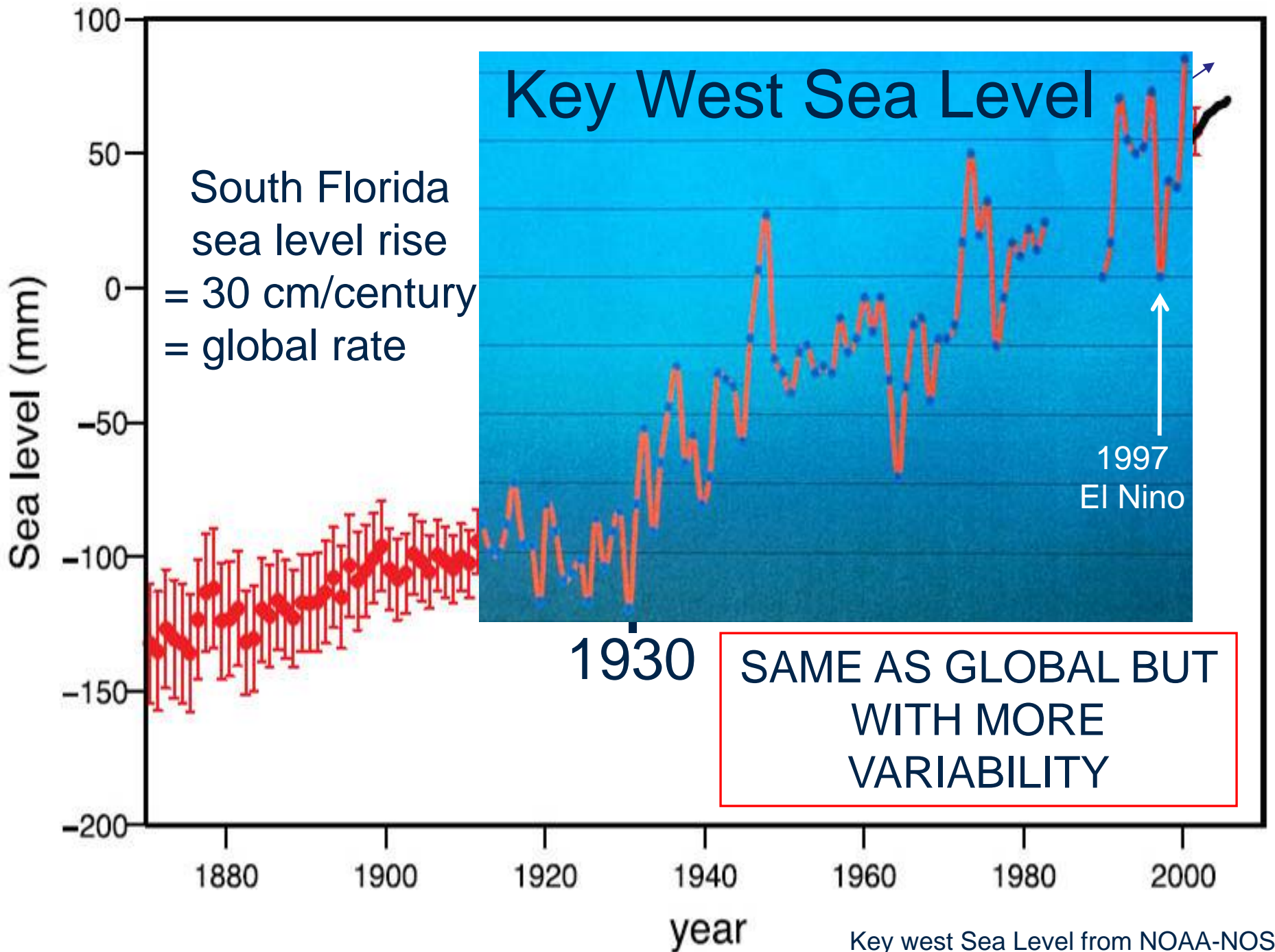


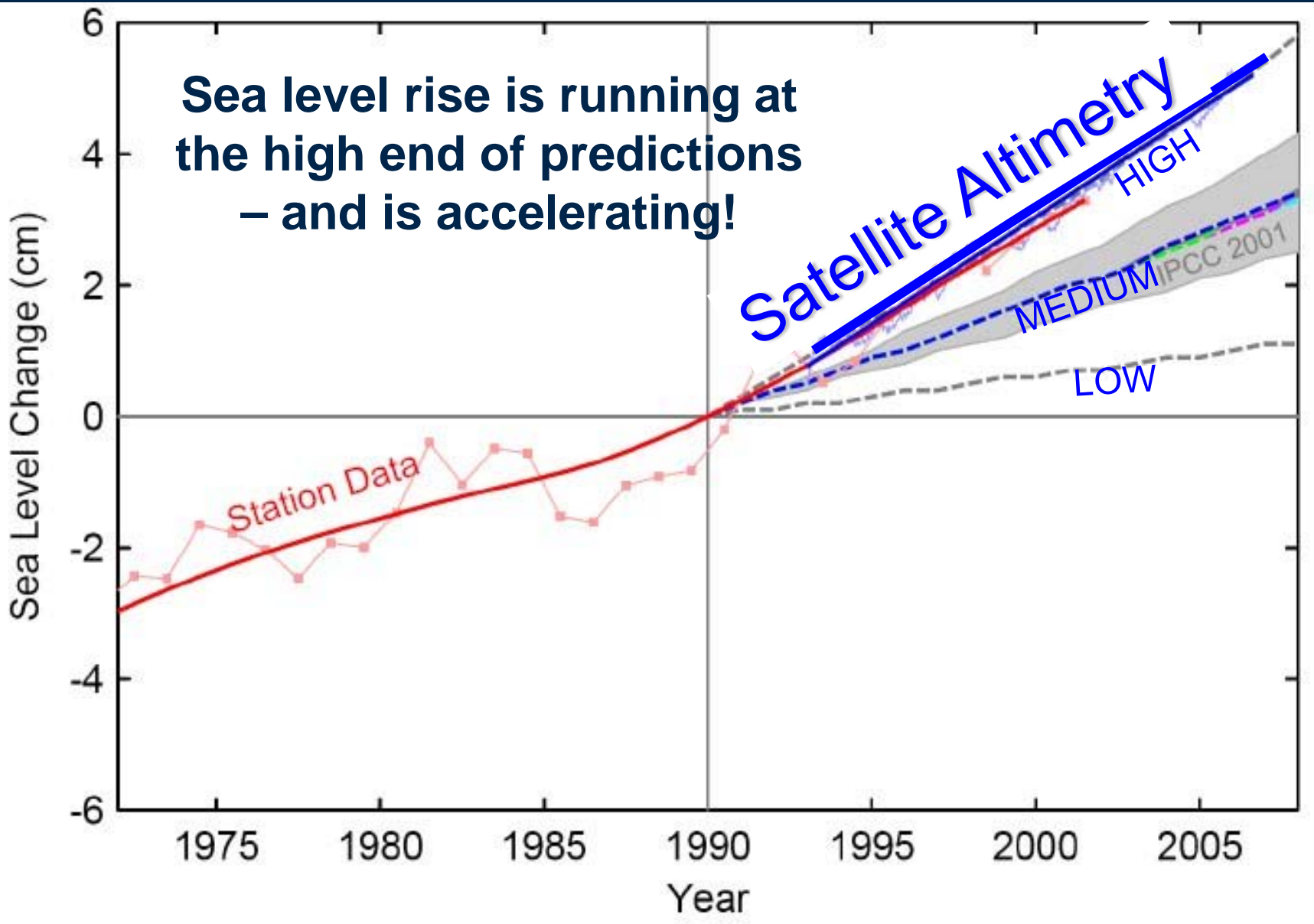
<http://sedac.ciesin.columbia.edu/gpw/lec2.jsp>



GLOBAL MEAN SEA LEVEL







Global sea level rise (based on tide gauge and satellite data) has been following the highest end of the 2001 IPCC sea level projection.

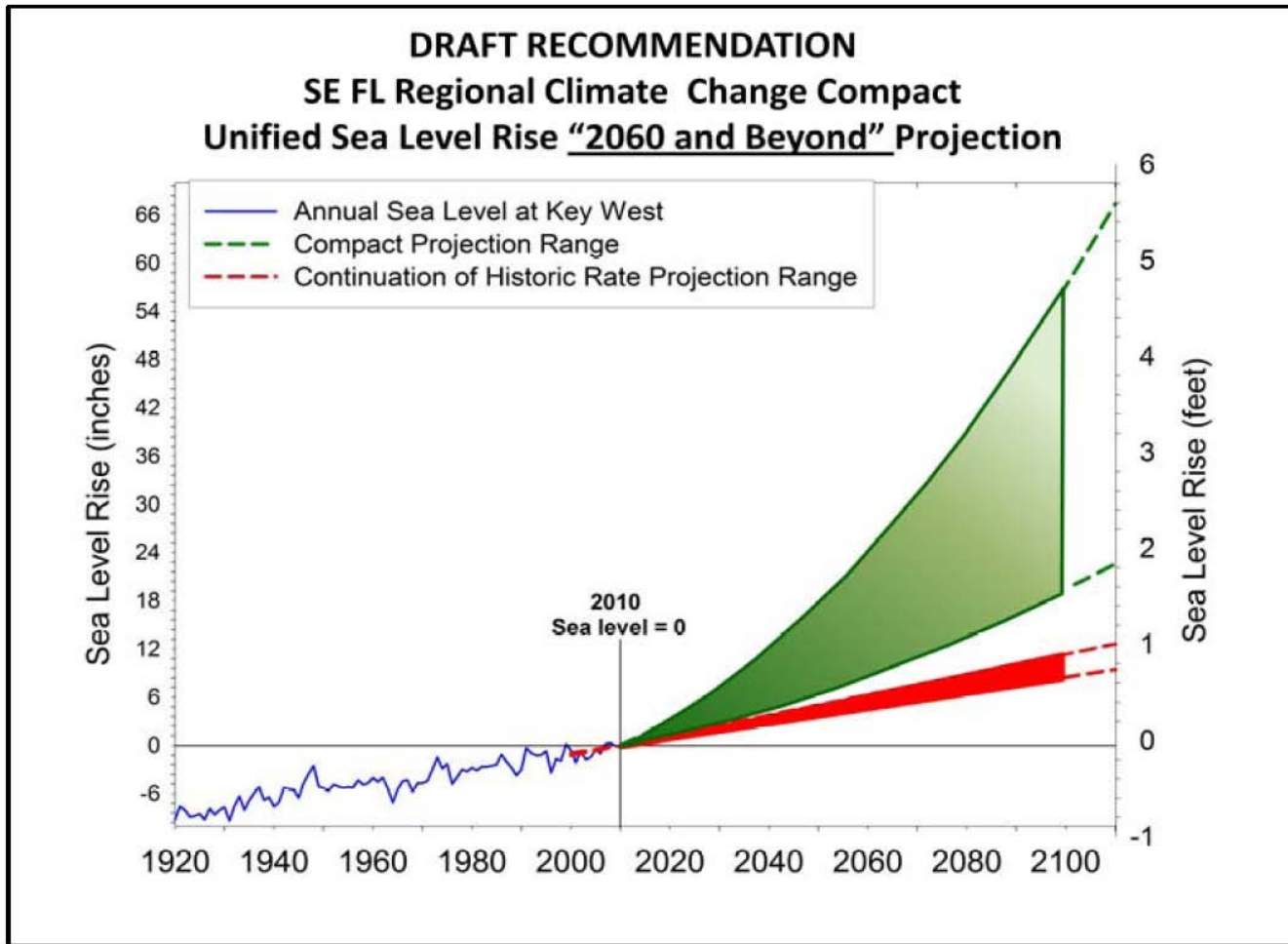
Scientists on the Miami-Dade County Climate Change Advisory Task Force:

- “With what is happening in the Arctic and Greenland, [there will be] a likely sea level rise of at least 1.5 feet in the coming 50 years and a total of **at least 3-5 feet by the end of the century**, possibly significantly more. Spring high tides would be at +7 to +9 feet.
- “This does not take into account the **possibility of a catastrophically rapid melt of land-bound ice from Greenland**, and it makes no assumptions about Antarctica.”
- “The projected **rises will just be the beginning** because of further significant releases from Greenland and possibly Antarctica.”

(September 20, 2007)

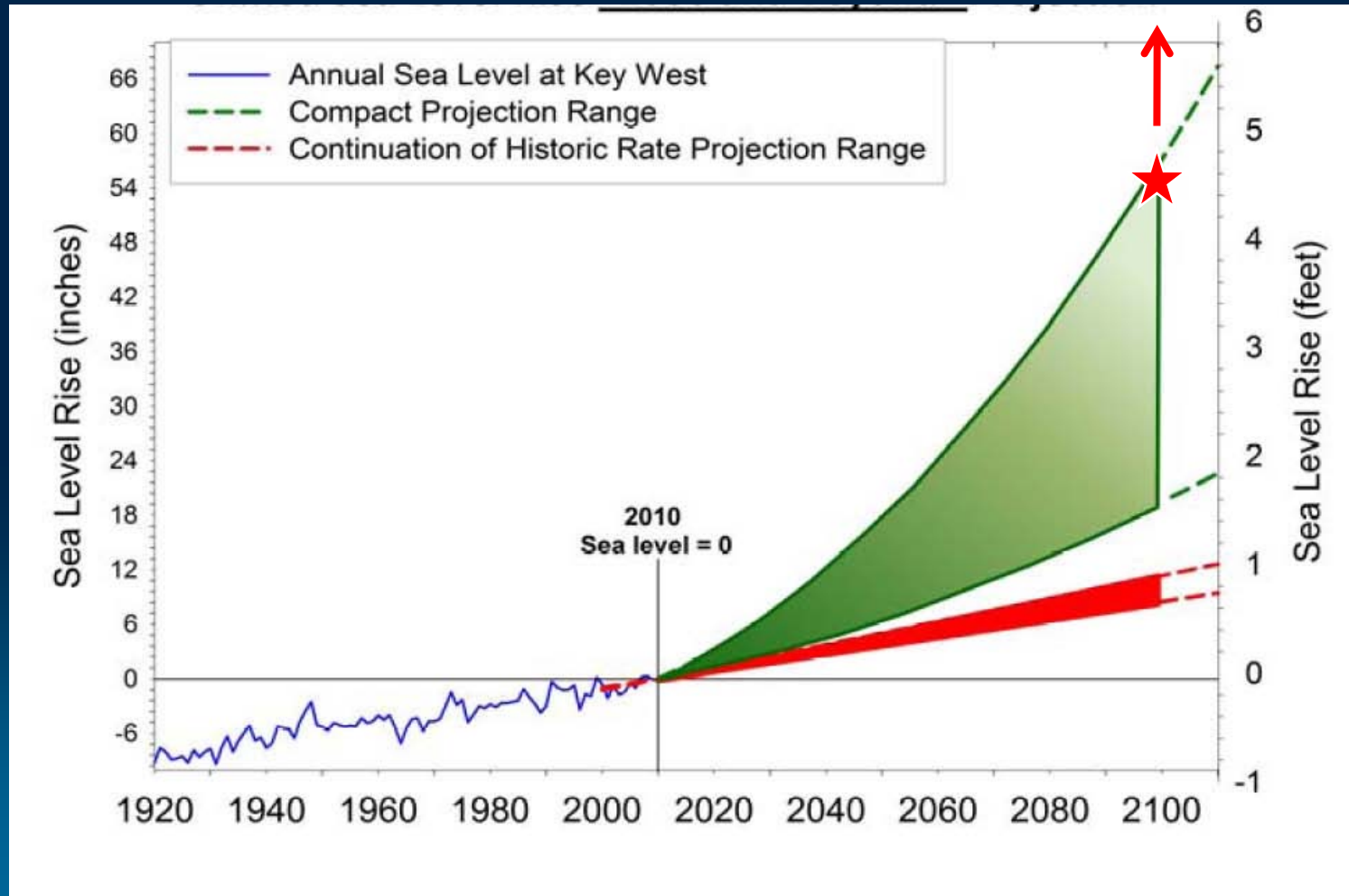
The U.S. Army Corps of Engineers (*) is now required to incorporate likely sea level rise into all civil works planning.

This projection is also used by the Southeast Florida Regional Planning Council

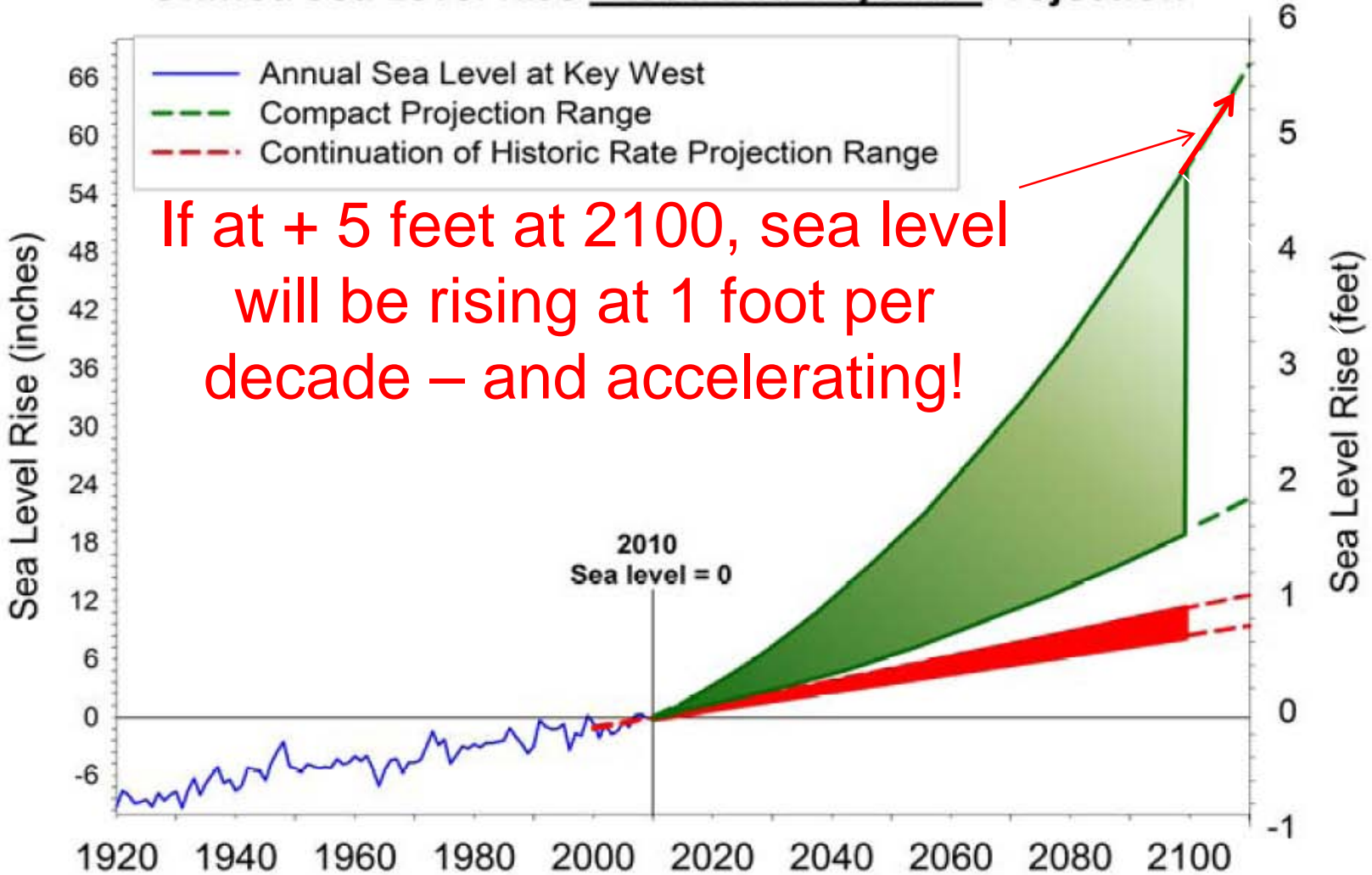


* Department of the Army, U.S. Army Corps of Engineers, Circular No. 1165-2-211. 1 July 2009

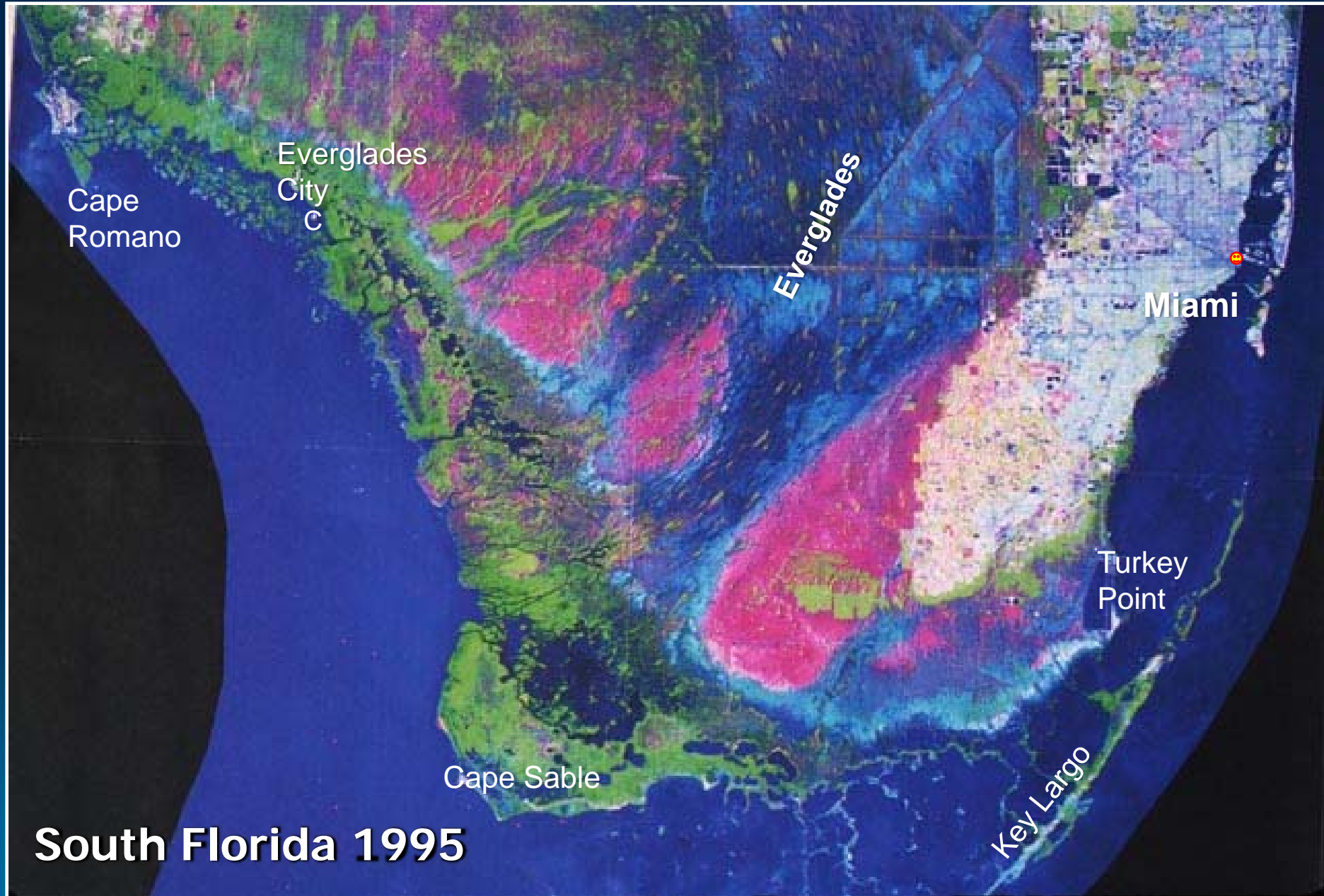
With continued melt from the Ice Sheets at the current acceleration, a conservative but realistic projection for sea level rise will be at least 4.5 feet (★) by the end of the century – likely much more.



SE FL Regional Climate Change Compact Unified Sea Level Rise "2060 and Beyond" Projection

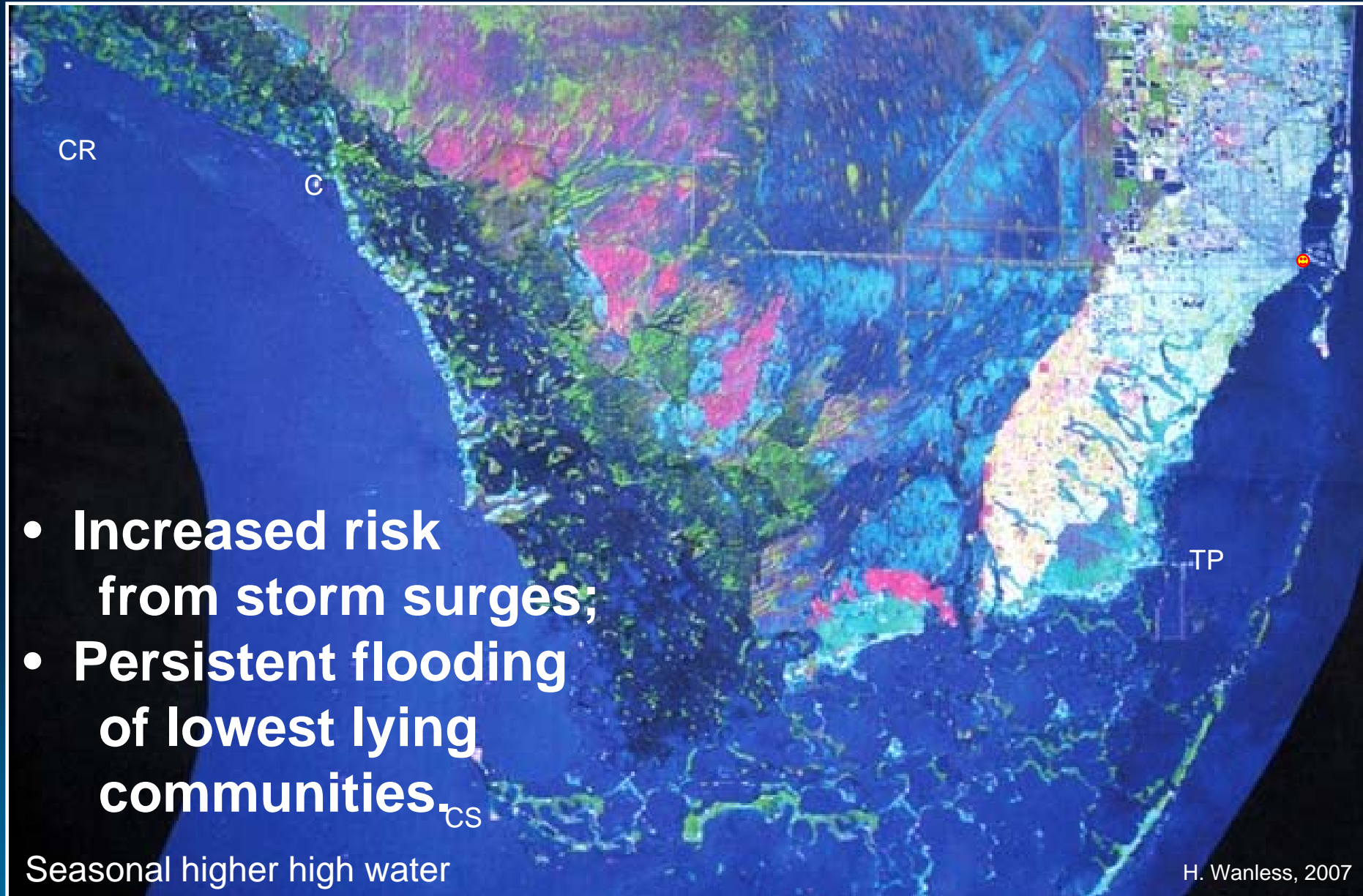


South Florida is very vulnerable to even a small amount of sea level rise.



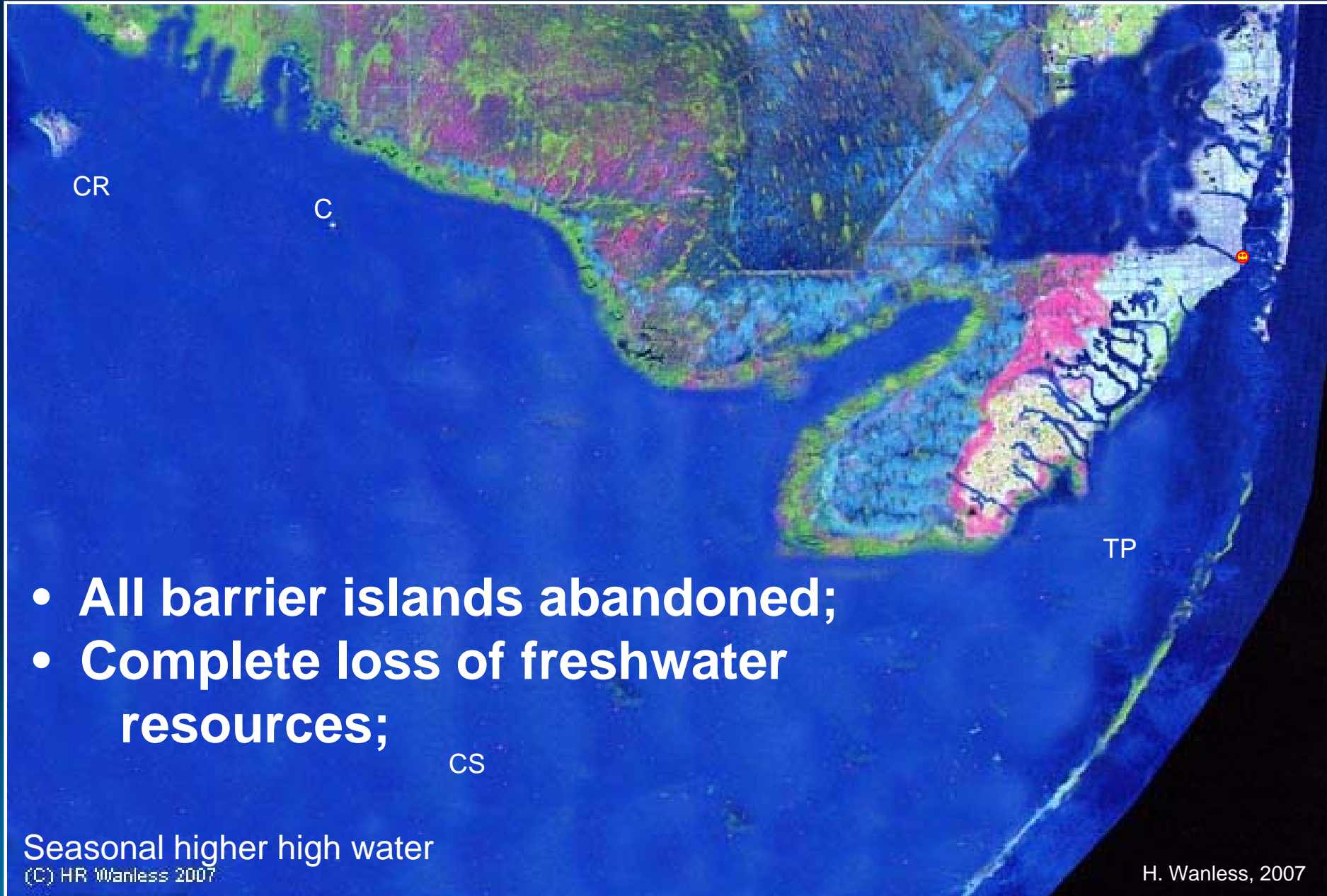
+2 foot rise (shhw = +4.5' above 1929 MSL)

South Florida 2100



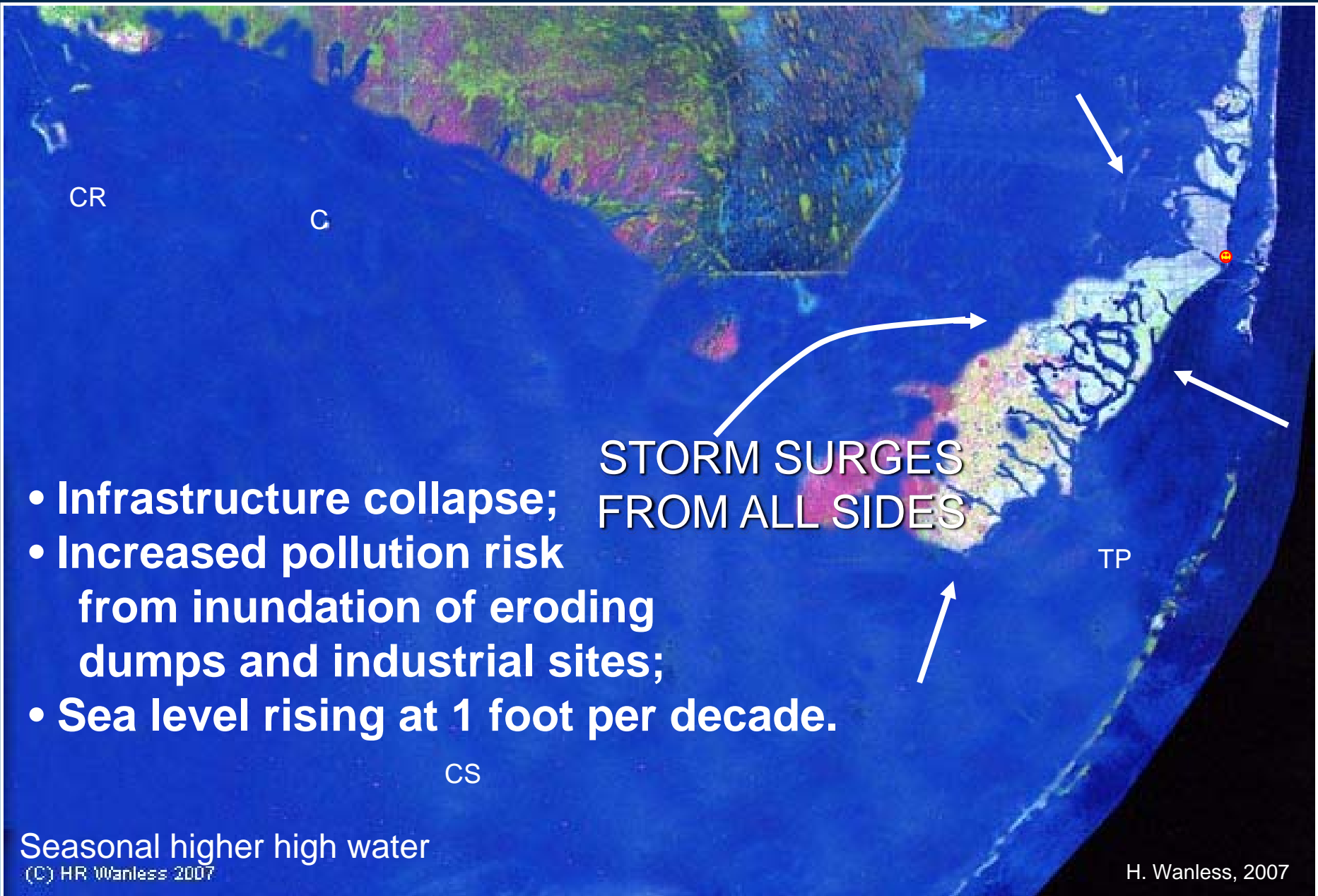
+4 foot rise (shhw = +6.5' above 1929 MSL)

South Florida 2100



+5 foot rise (shhw = +7.5' above 1929 MSL)

South Florida 2100



- **Infrastructure collapse;**
- **Increased pollution risk from inundation of eroding dumps and industrial sites;**
- **Sea level rising at 1 foot per decade.**

STORM SURGES FROM ALL SIDES

Seasonal higher high water

(C) HR Wanless 2007

H. Wanless, 2007

+6 foot rise (shhw = +8.5' above 1929 MSL)

South Florida 2100

CR

C

- **Miami-Dade, Broward, and Monroe counties diminished and risky place to live - including all of the Florida Keys**

TP

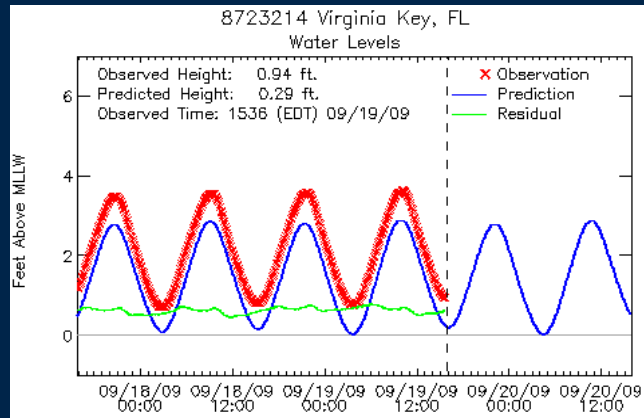
CS

Seasonal higher high water

(C) HR Wanless 2007

H. Wanless, 2007

ON TOP OF THIS SEA LEVEL RISE WILL BE HIGHER TIDE EVENTS –



This is high tide in the 1700 block of North Bayshore Dr., Miami FL. Unfortunately, this flooding is not associated with storm surge or any other exceptional tidal or weather event. It has become the regular twice a day occurrence of the tide.

from Tim O. Walker

– AND STORM SURGES



Bolivar Peninsula, Texas
Hurricane Ike, Category 2, September 2008

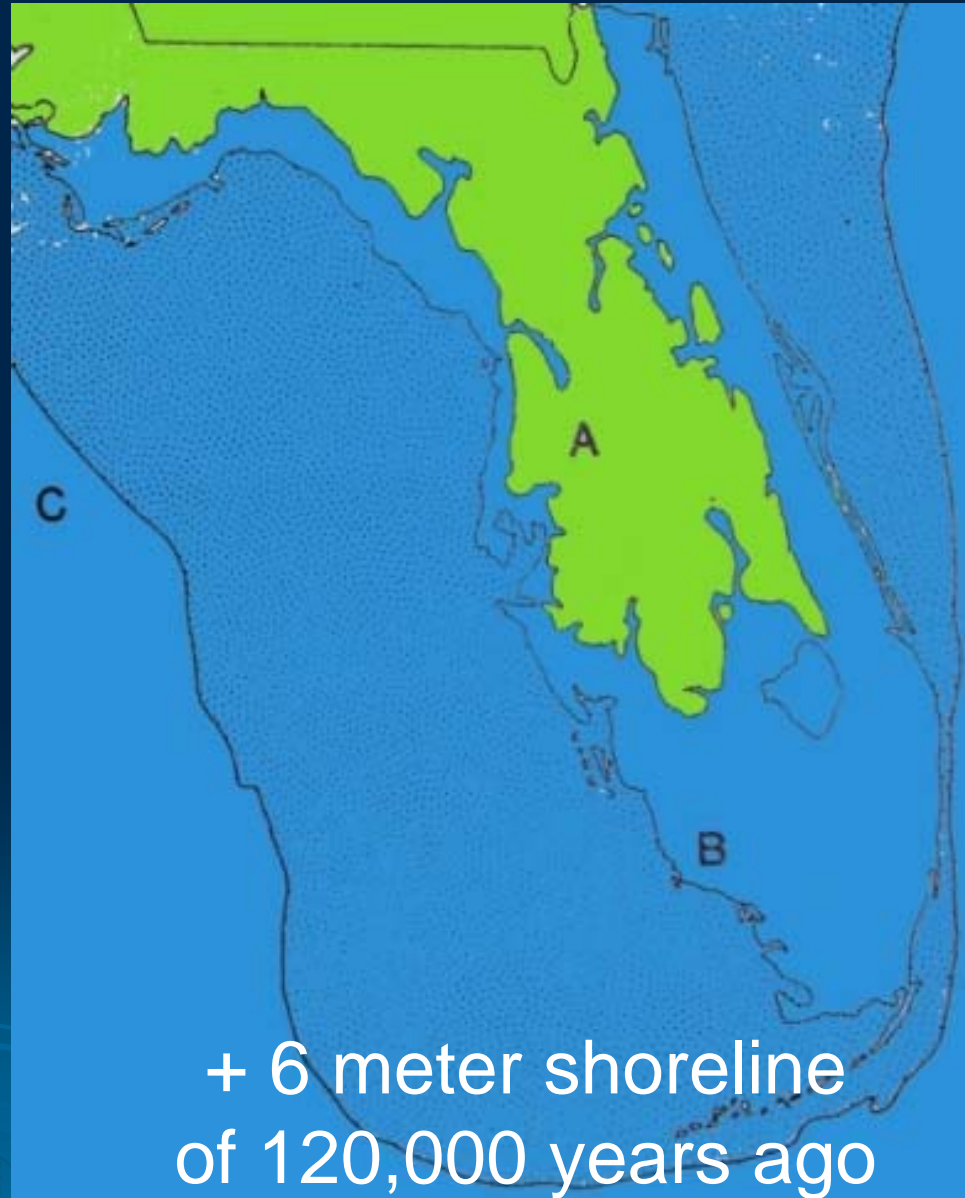
Now the bad news -

“The warming we're on track to do now is more than enough to commit us to last-interglacial levels of sea-level rise.”

(Kopp, Nature, 2009)

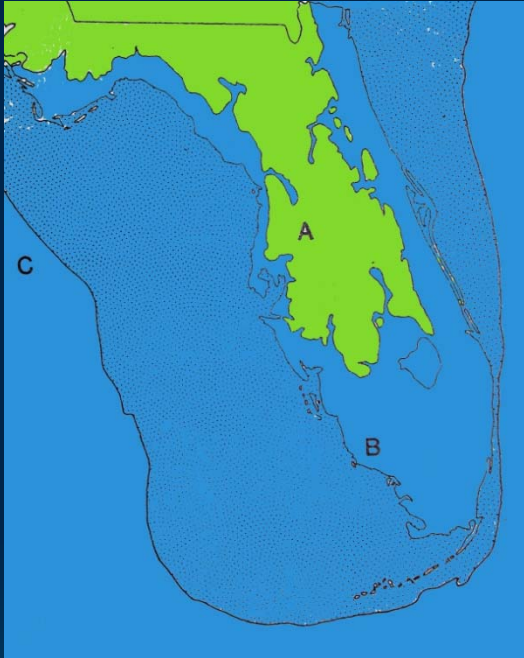
“It may happen much faster than we are anticipating.”

(Wanless, SEJ, 2011)



+ 6 meter shoreline
of 120,000 years ago

FLORIDA THROUGH TIME



120,000 years ago

+ 6 meters (+20')

~ 1/2 from Greenland

~ 1/2 from Antarctica

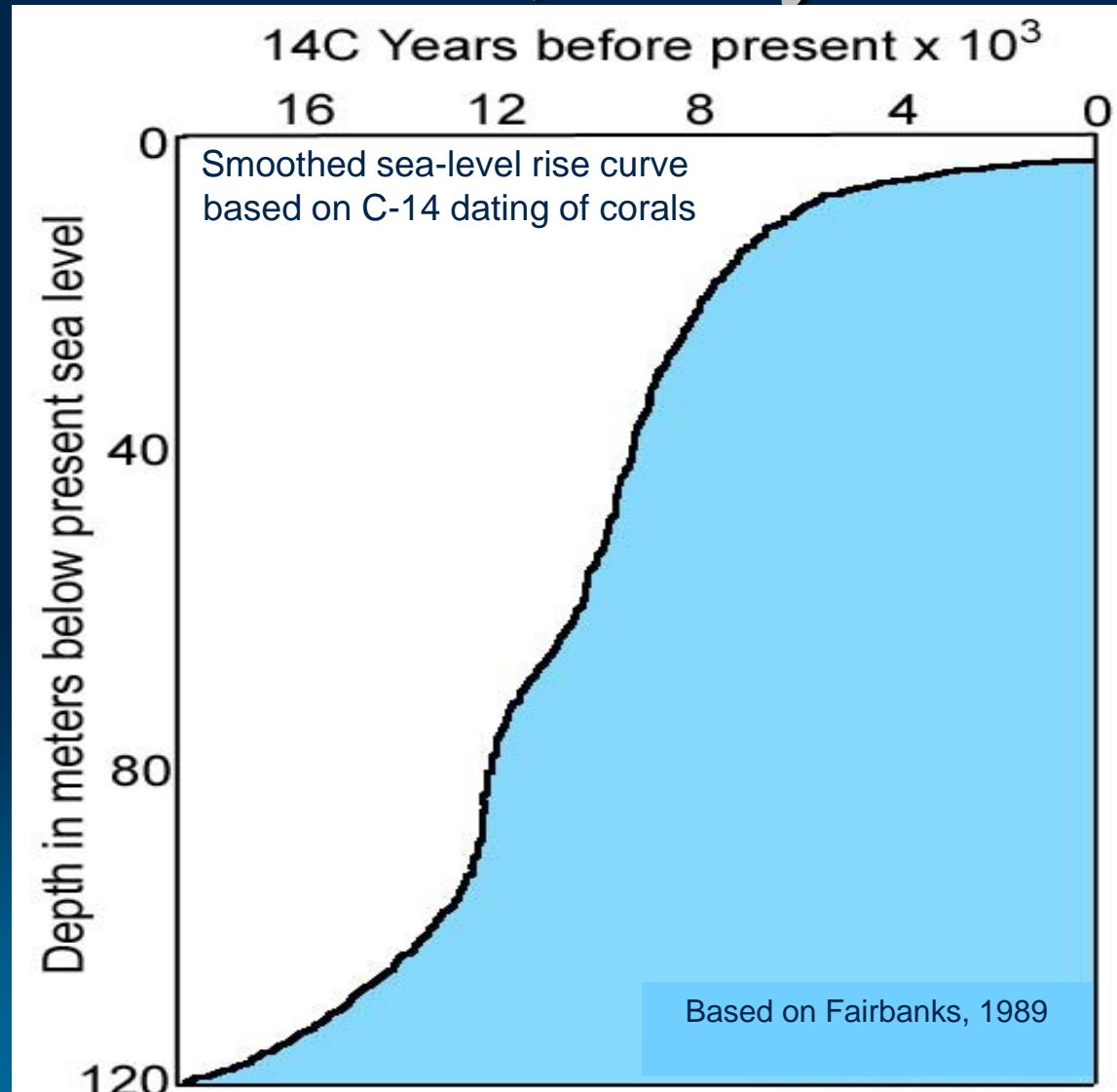
18,000 years ago

- 120 meters (-420')

Today

**How did this
sea level rise
occur?**

Sea Level rise since last glacial maximum 18,000 years ago.



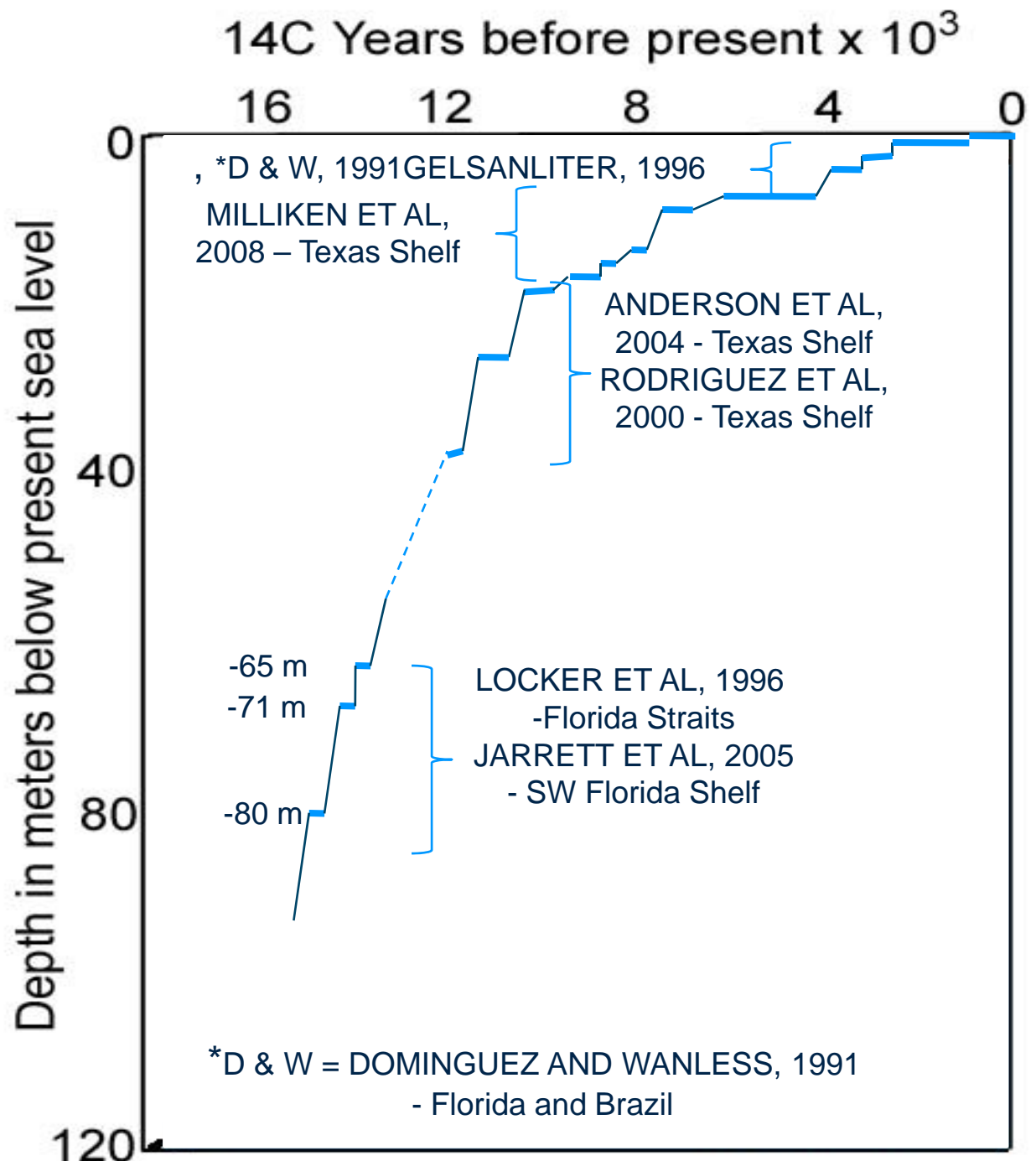
BUT SEA LEVEL RISE RATES
DID NOT GRADUALLY
INCREASE AND DECREASE
LIKE THIS.

RATHER, THERE WERE
REPEATED STILL STANDS
AND THEN RAPID PULSES
OF SEA LEVEL RISE.

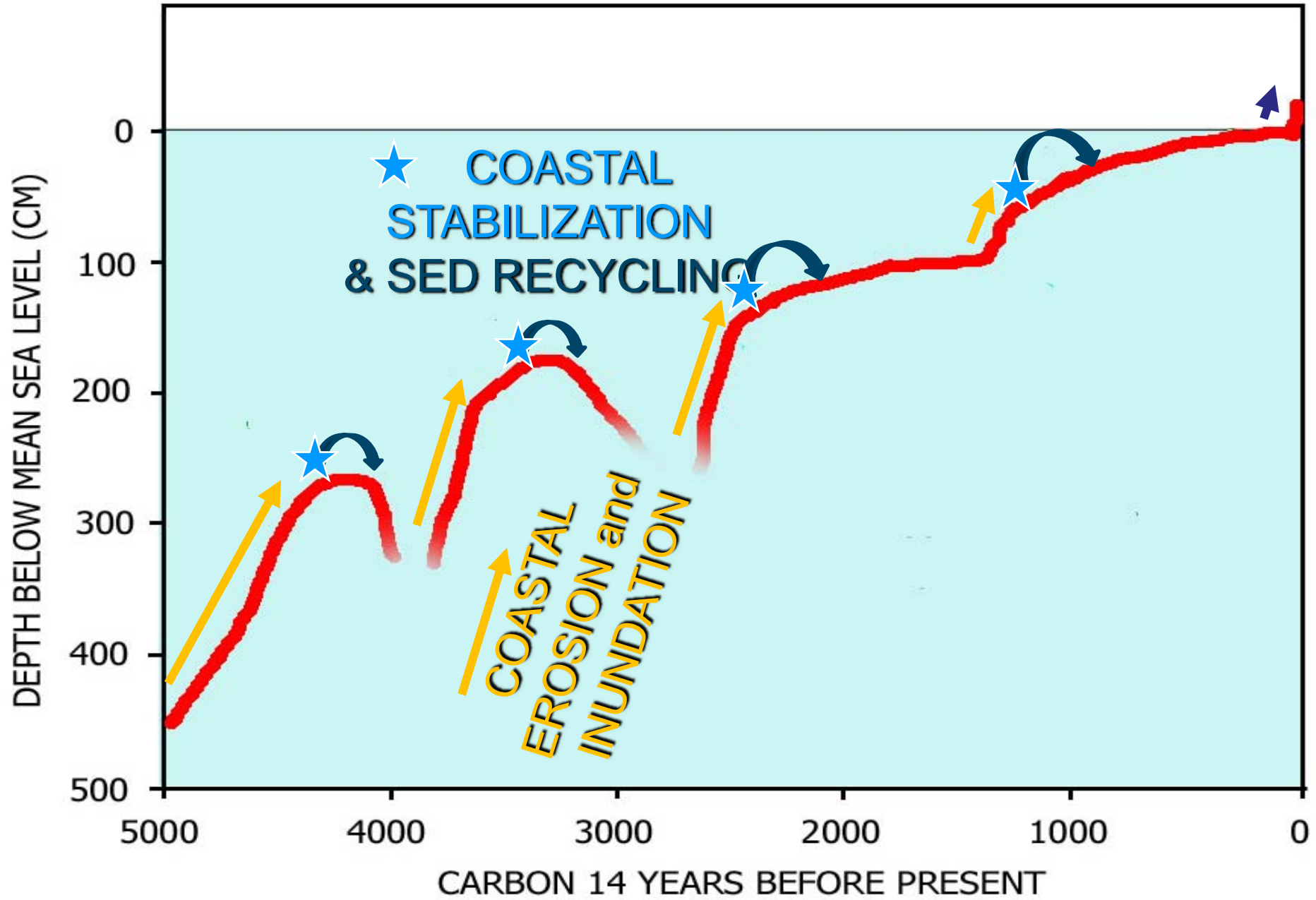
SEA LEVEL STILL STANDS AND RAPID RISES.

Recorded by preserved drowned barrier islands, tidal inlet sand deltas, and reefs on the shelf.

Rapid rises from 1-10 meters.



RELATIVE SEA LEVEL HISTORY FOR SOUTH FLORIDA



**WILL THERE BE SIGNIFICANT
RAPID
SEA LEVEL PULSES IN THE
FUTURE?**

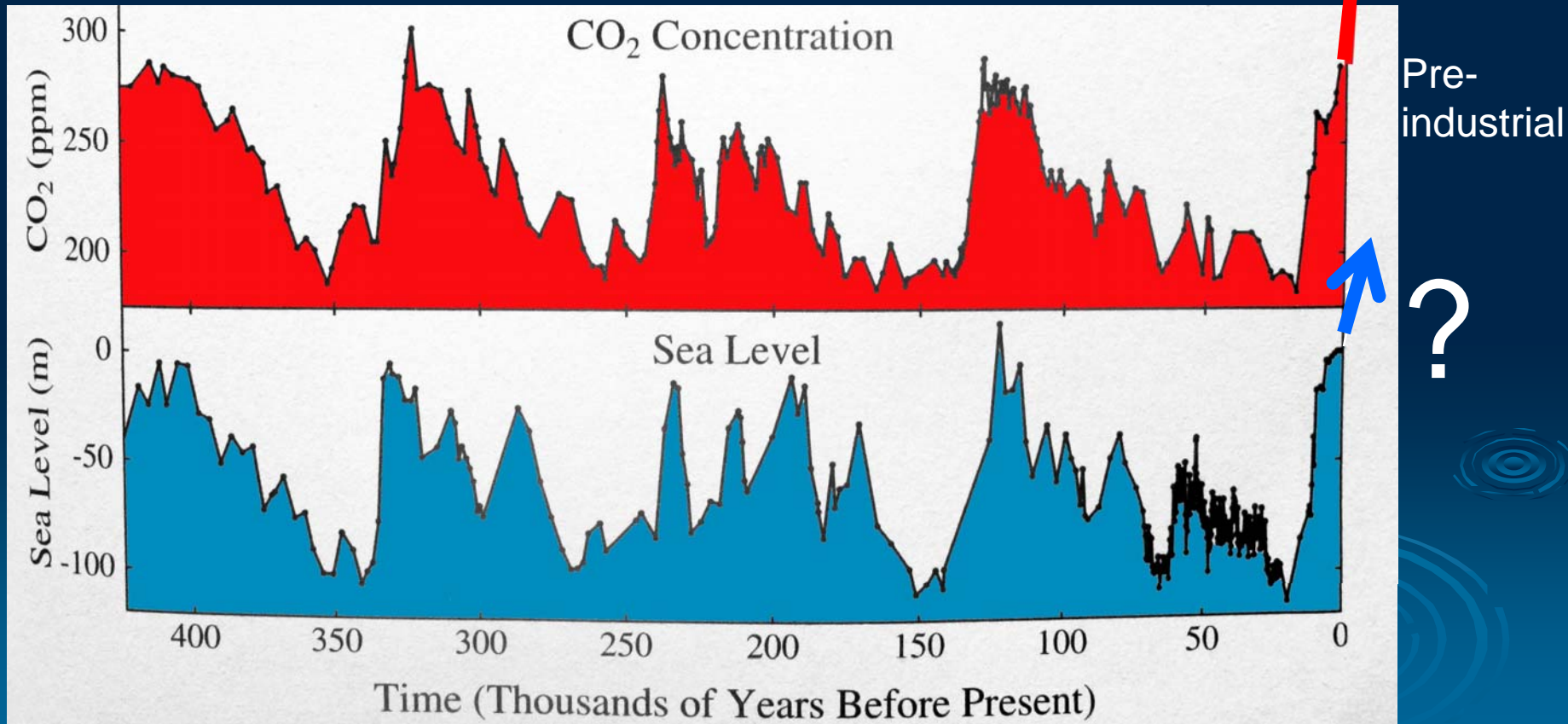
YES.

**AND WE MAY BE SEEING THE
BEGINNING NOW --**



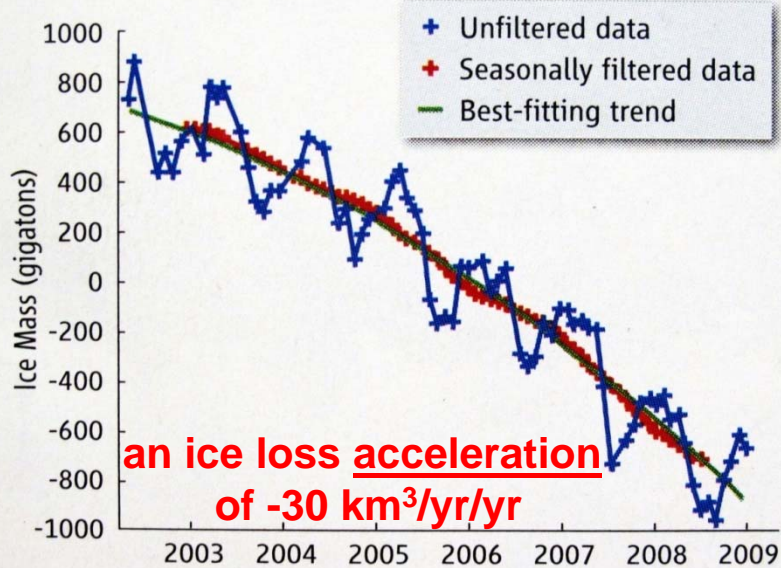
We have seriously increased the warming stressors.

We must expect a serious ice melt and sea level response – as it has in the past.



ACCELERATING ICE MASS LOSS ON GREENLAND AND ANTARCTICA FROM THE GRACE SATELLITES

GREENLAND ICE MASS



Bending down. The trend line of Greenland ice mass (green) curves downward with time, suggesting that losses have been accelerating.

Science, October 6, 2009, p.217.

Antarctica Ice Loss

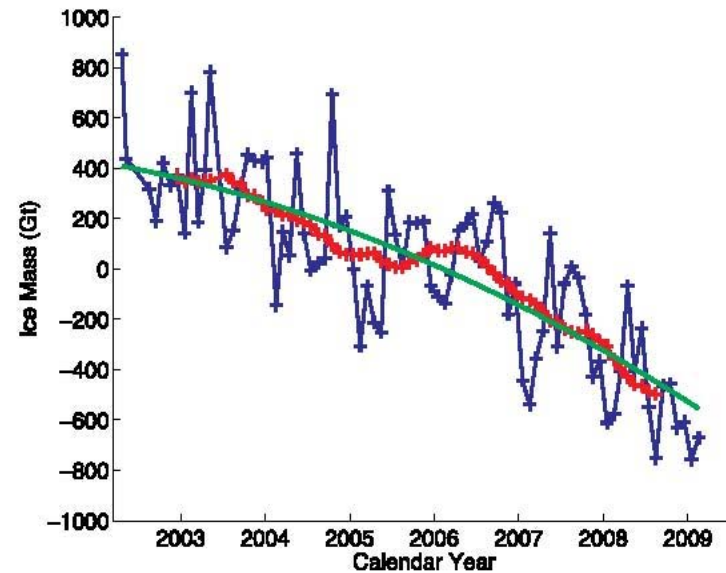


Figure 2. Time series of ice mass changes for the Antarctic ice sheet estimated from GRACE monthly mass solutions for the period from April 2002 to February 2009.

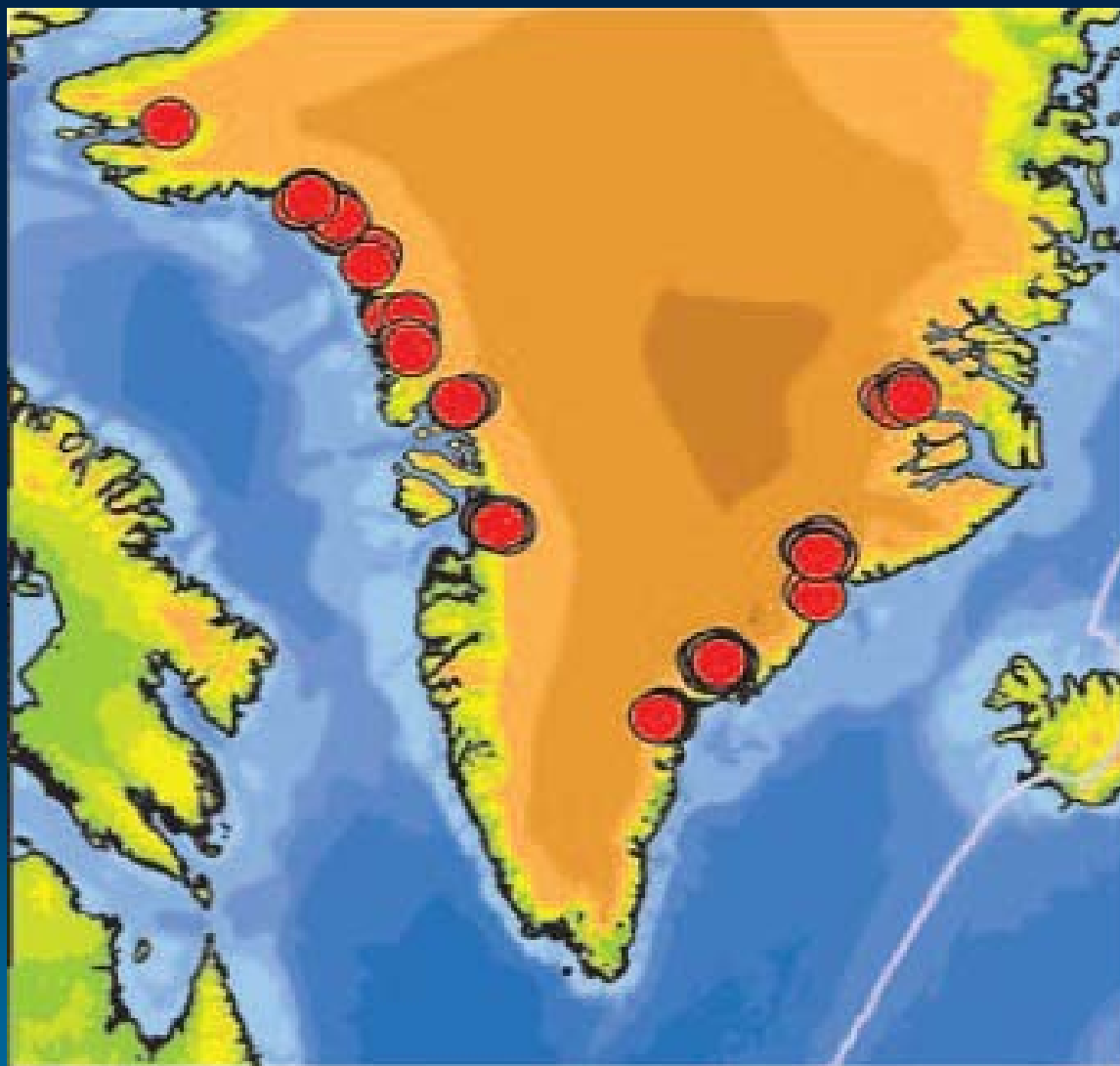
Velicogna, 2009.

Geophysical Research Letters

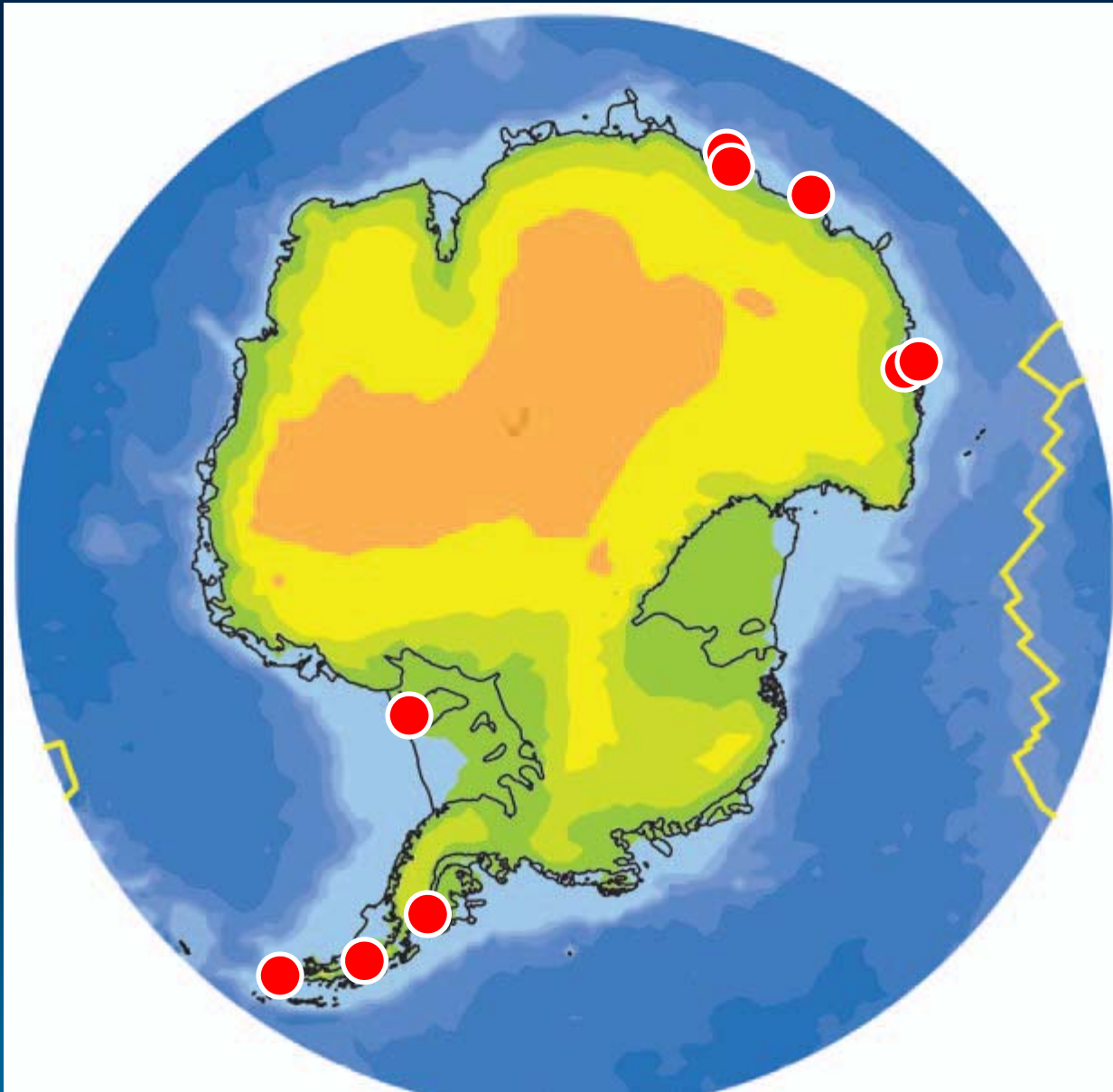
➤ Rate of mass loss more than doubled on both Greenland and Antarctica between 2002 and 2009.

➤ Is now an annual 17% acceleration in melt rate and a 5% acceleration in the contribution to rise in sea level.

Map of Greenland showing locations of 184 glacial earthquakes for the period 1993–2005. Note the tight clustering of earthquake epicenters near major outlet glaciers.



Antarctic teleseismic detections that are likely to correspond to glacial earthquakes.



Collapsing front
of glacial
outlets produce
seismic events.



Helheim Glacier,
Greenland



- ICE DISCHARGE THROUGH OUTLET GLACIERS HAS DRAMATICALLY INCREASED – BECAUSE OF WARM OCEAN WATERS MOVING IN BELOW
- The Jakobshavn Isbreen in western Greenland (5 km wide and 1.5 km deep) is now moving at more 15km a year into the sea, although in surges it moves even faster.

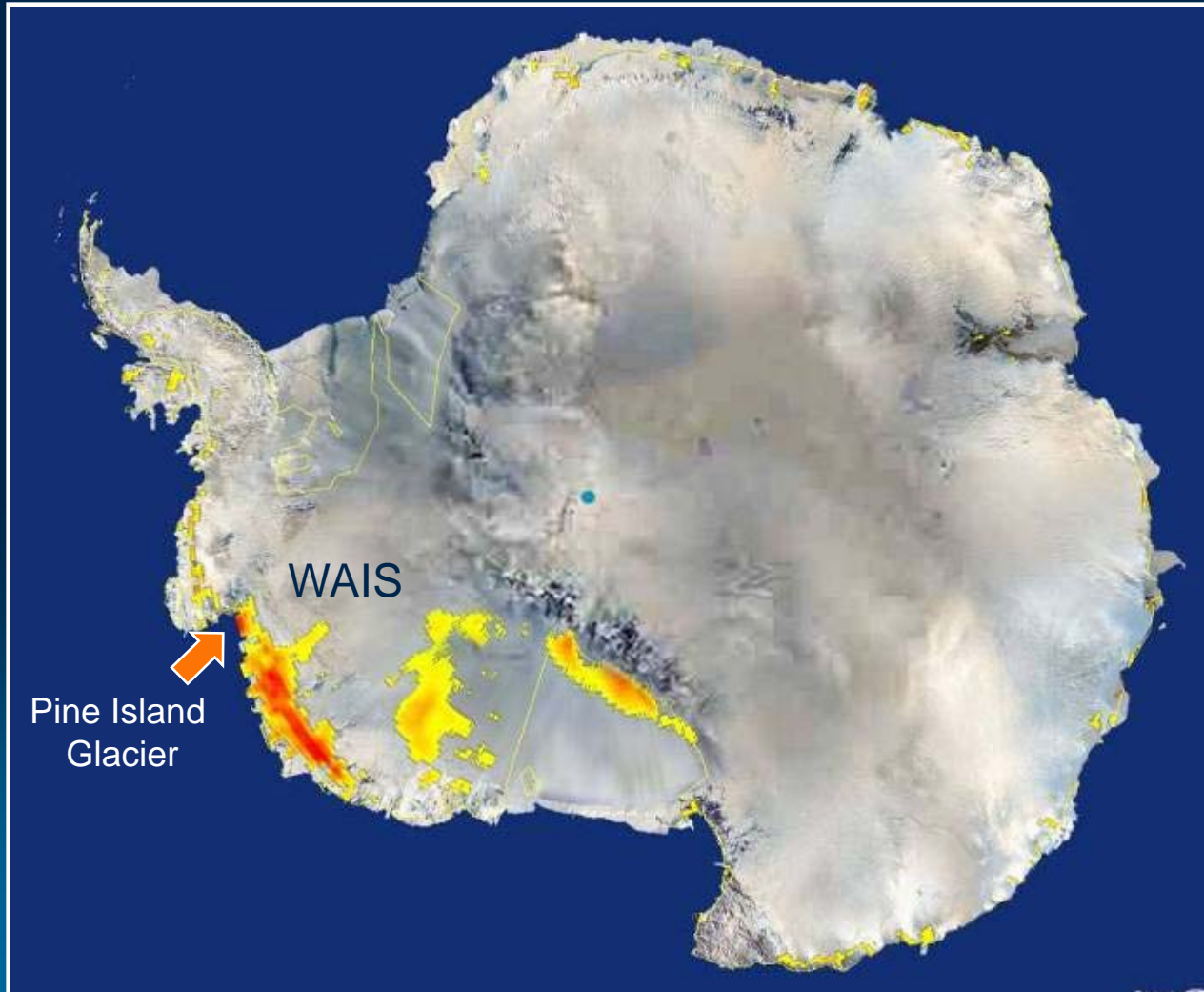
We now know that warm waters moving under the outlets are driving the accelerated melt.



Jacobshavn Isbreen I in Ilulissat, Vestgrønland (Greenland); Photograph by Dirk Jenrich

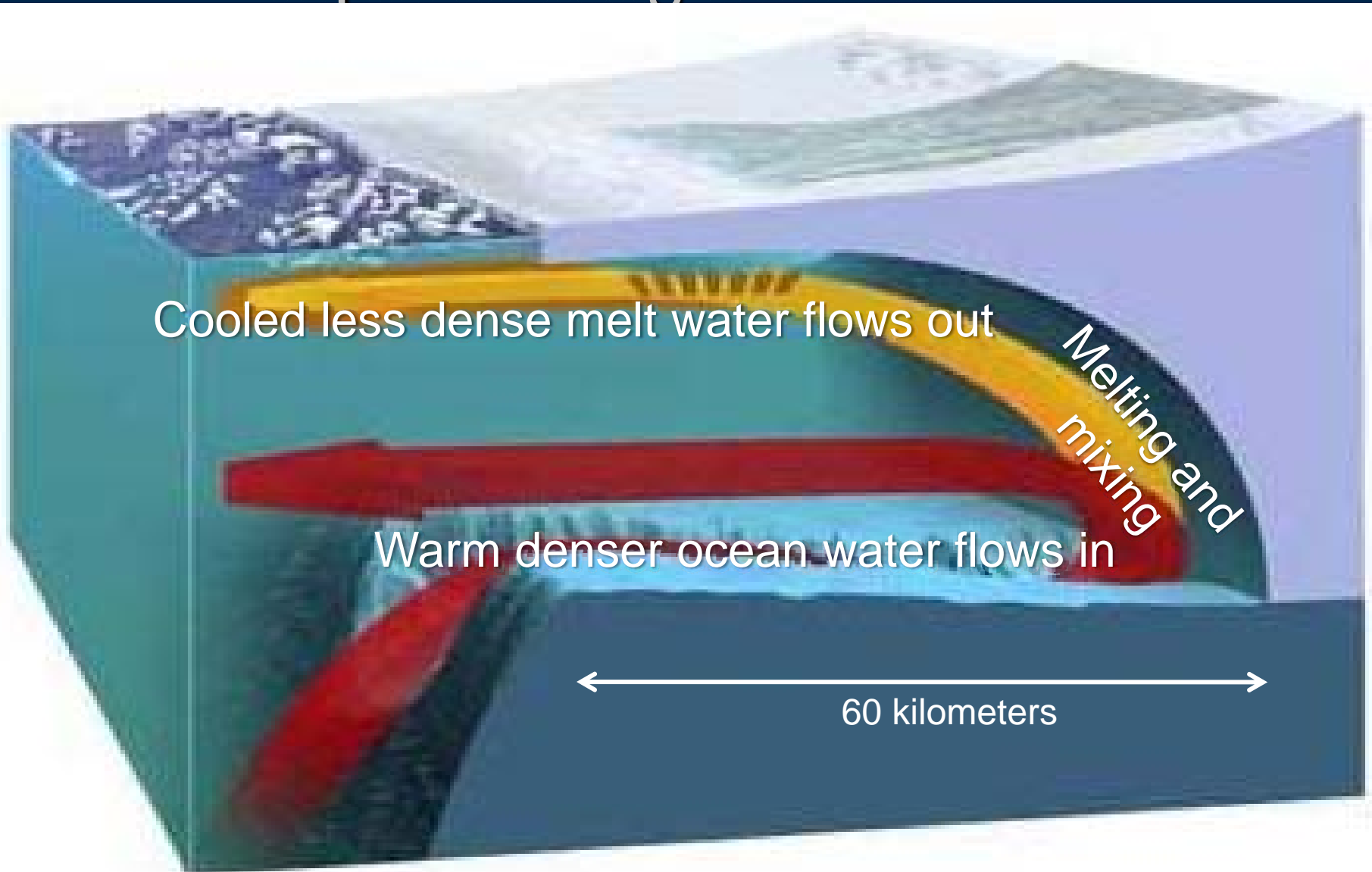
2009- Pine Island Glacier, a major outlet for the West Antarctic Ice Sheet (WAIS), is melting at a rate 4 times faster than just a decade ago – because of warming waters.

It is thinning at 16 m per year – 90 m in the past decade.

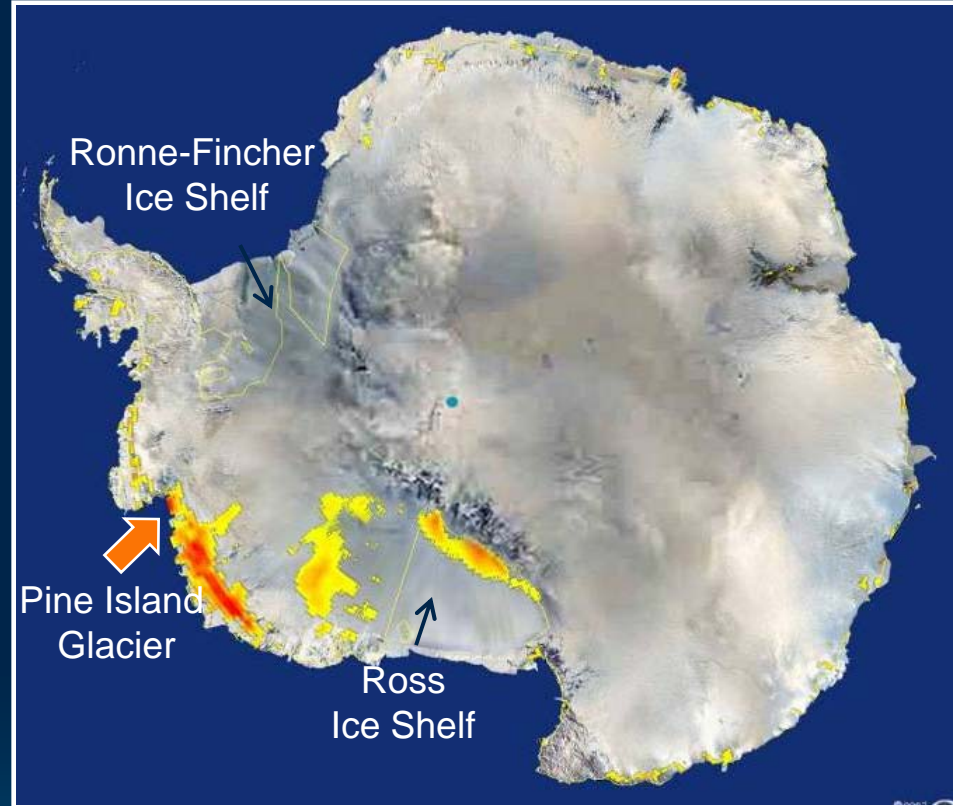
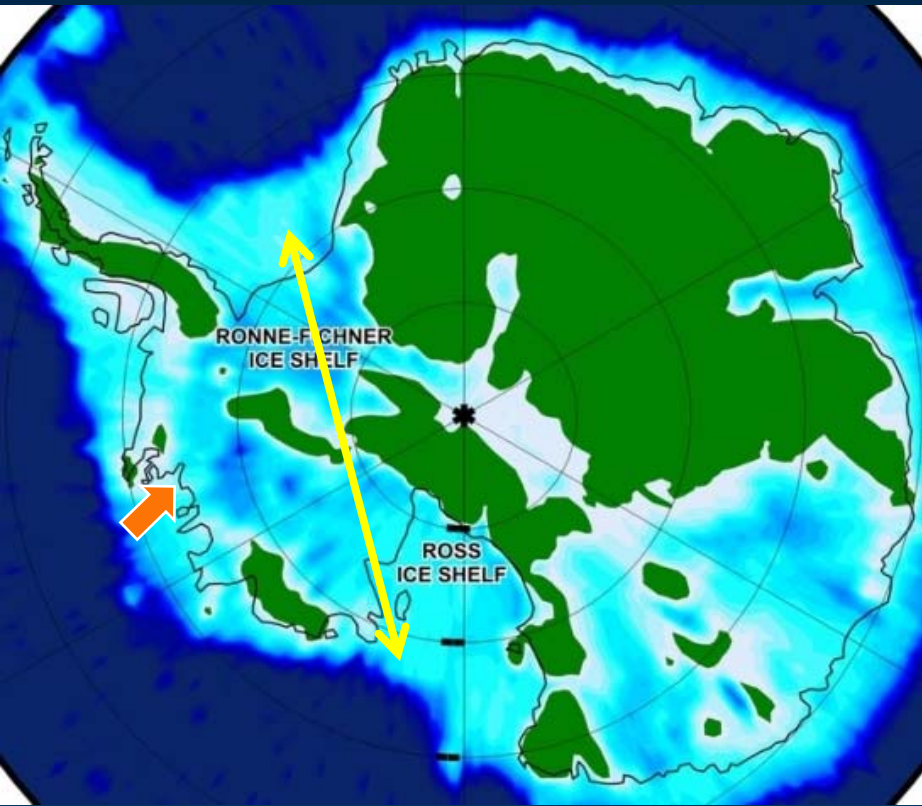


A. Shepard,
University of
Leeds,
August 2009.


Estuarine circulation now promoting rapid melting beneath ice.



Can melt much of the West Antarctic Ice Sheet from below – and have in the past.

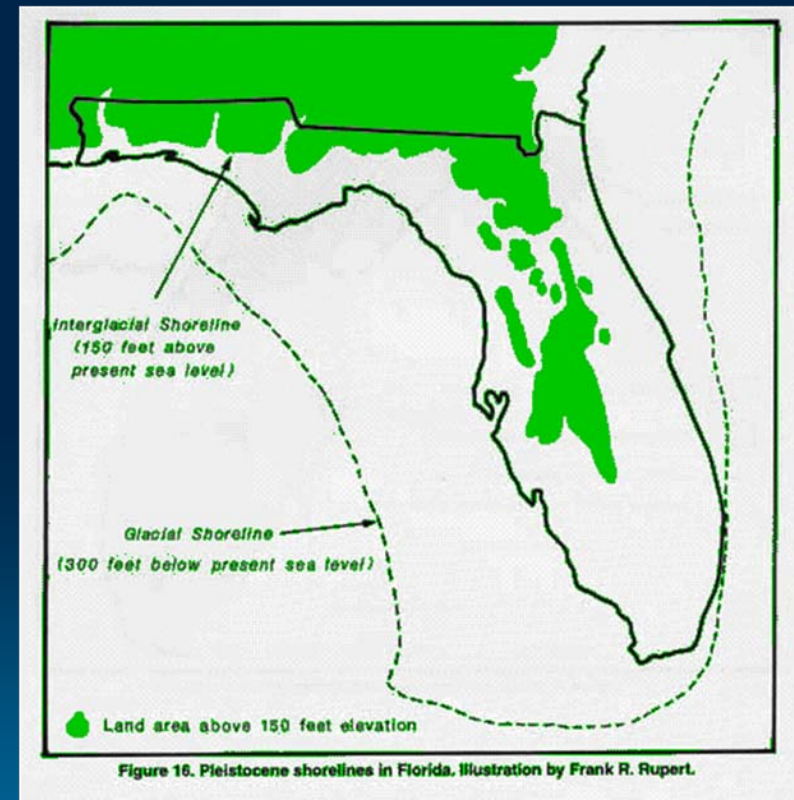


 = Pine Island glacier outlet of West Antarctic Ice Sheet

 = was open seaway during last interglacial (when sea level was 20' higher than today)

It is time to recognize the likelihood of having pulses of rapid sea level rise in the 1-10 meter range in the near future.

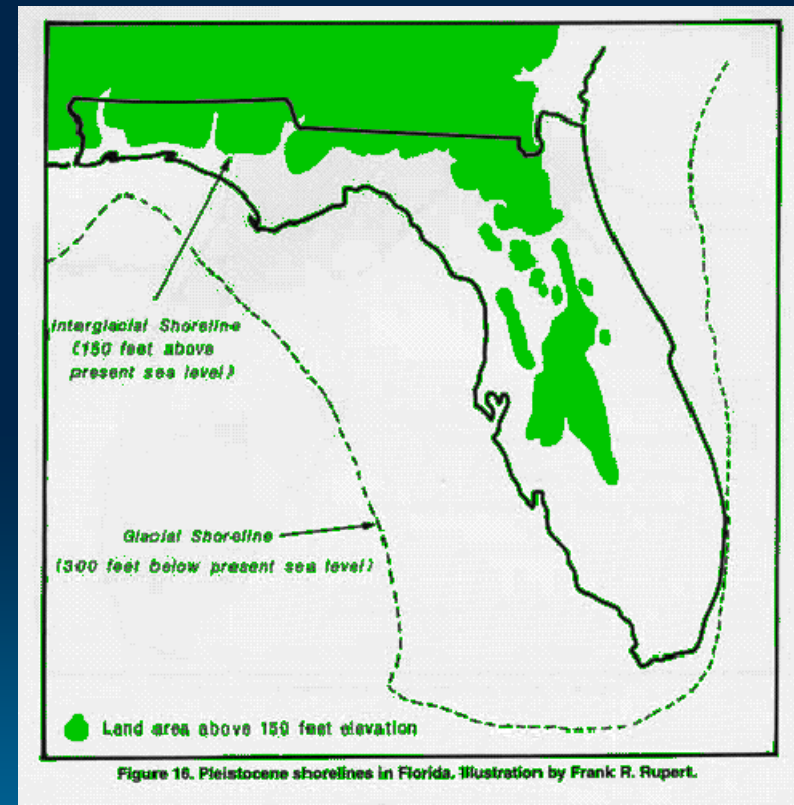
- Leading to a 10-30 m (33-100 ft) sea level rise from multiple rise pulses.



Elevations greater than 150'

Recommend quick planning and implementation for putting things too important to lose (seed banks; National archives and libraries, unique coherent cultural hubs) and too valuable to be disrupted (nuclear power and waste disposal sites, critical military and transportation centers, agricultural centers) -

- At greater than 165 feet (>50 meters) elevation and
- In areas that will not be in the chaos of rapid relocation.



Elevations greater than 150'

MIAMI-DADE COUNTY LiDAR MAPS

Elevations from Mean High Water Level

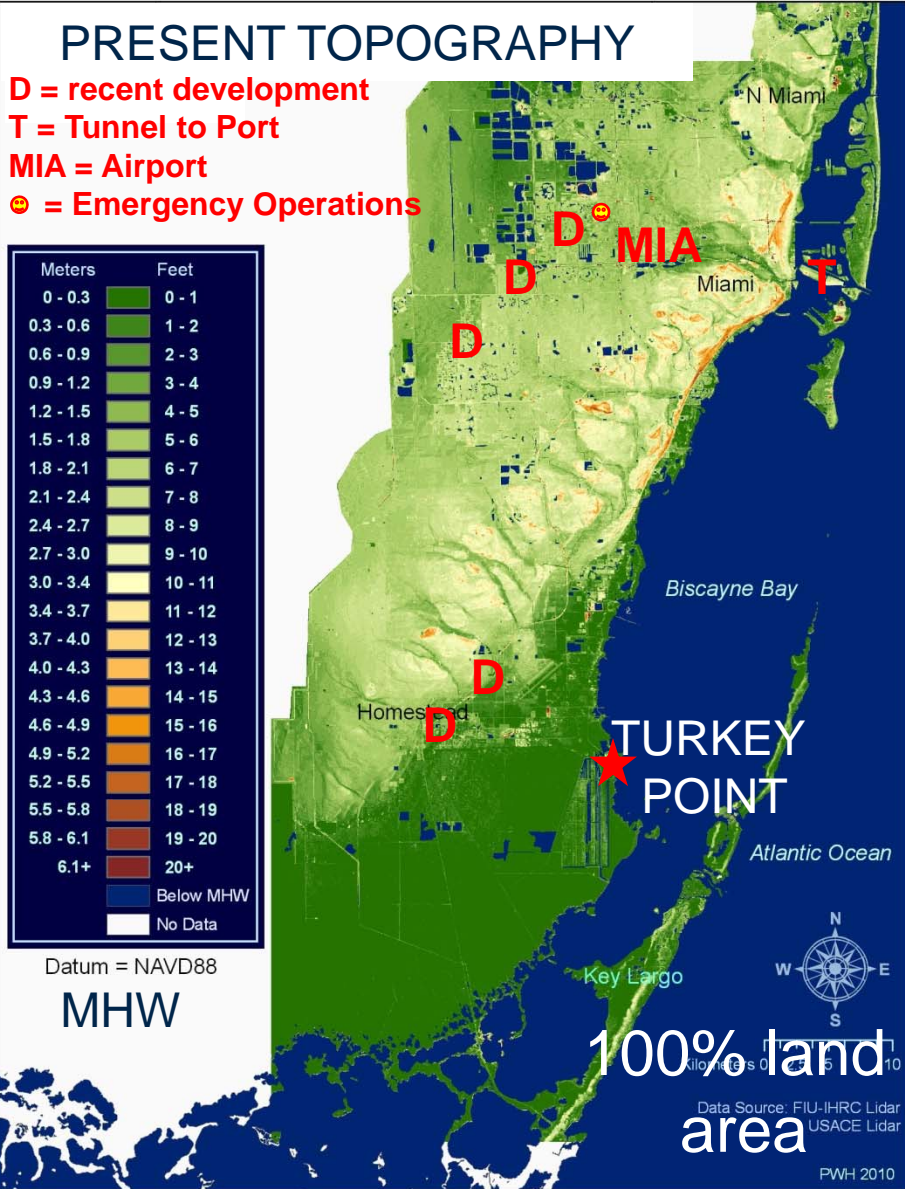
from Peter Harlem, SERC, FIU, 2010

PRESENT TOPOGRAPHY

- D** = recent development
- T** = Tunnel to Port
- MIA** = Airport
- ☉** = Emergency Operations

Meters	Feet
0 - 0.3	0 - 1
0.3 - 0.6	1 - 2
0.6 - 0.9	2 - 3
0.9 - 1.2	3 - 4
1.2 - 1.5	4 - 5
1.5 - 1.8	5 - 6
1.8 - 2.1	6 - 7
2.1 - 2.4	7 - 8
2.4 - 2.7	8 - 9
2.7 - 3.0	9 - 10
3.0 - 3.4	10 - 11
3.4 - 3.7	11 - 12
3.7 - 4.0	12 - 13
4.0 - 4.3	13 - 14
4.3 - 4.6	14 - 15
4.6 - 4.9	15 - 16
4.9 - 5.2	16 - 17
5.2 - 5.5	17 - 18
5.5 - 5.8	18 - 19
5.8 - 6.1	19 - 20
6.1+	20+
Below MHW	
No Data	

Datum = NAVD88
MHW



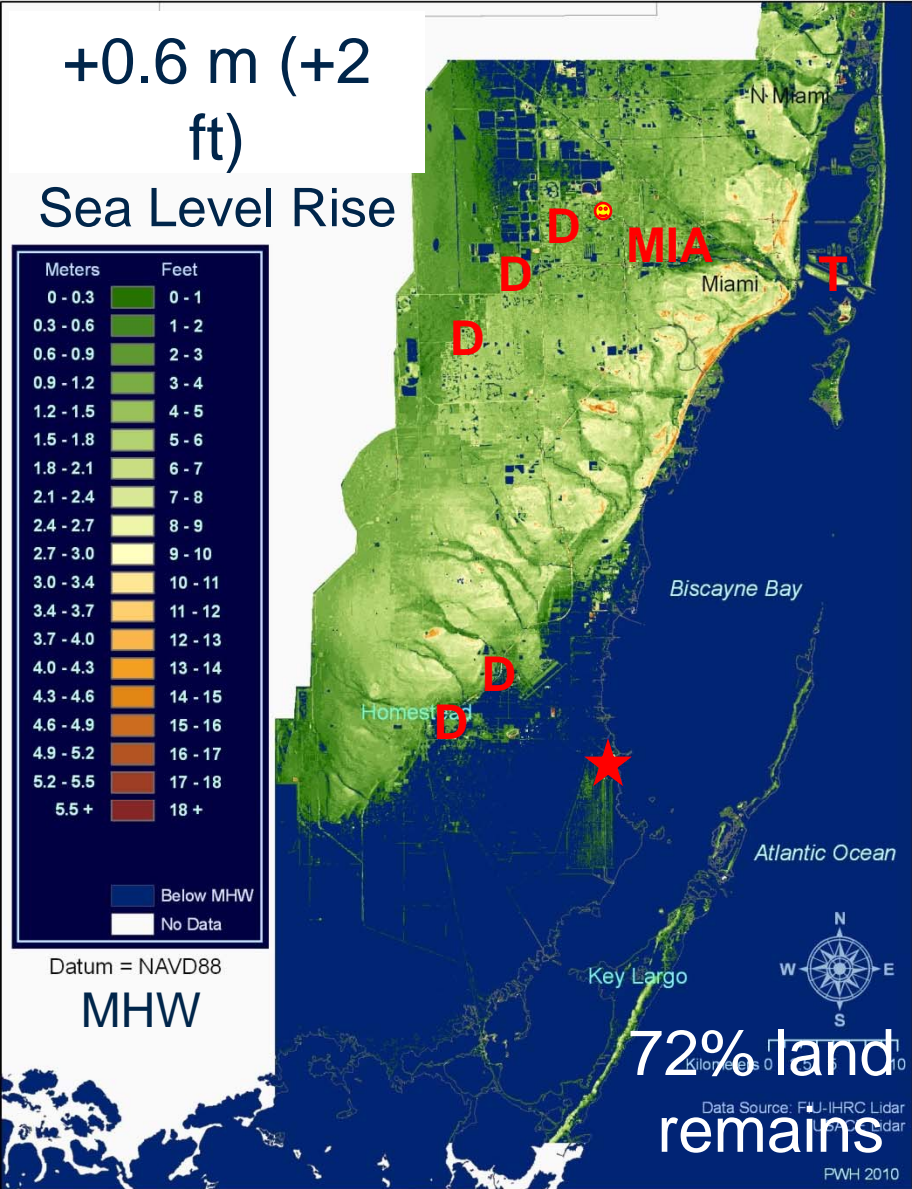
100% land area

Data Source: FIU-IHRC Lidar
USACE Lidar
PWH 2010

+0.6 m (+2 ft) Sea Level Rise

Meters	Feet
0 - 0.3	0 - 1
0.3 - 0.6	1 - 2
0.6 - 0.9	2 - 3
0.9 - 1.2	3 - 4
1.2 - 1.5	4 - 5
1.5 - 1.8	5 - 6
1.8 - 2.1	6 - 7
2.1 - 2.4	7 - 8
2.4 - 2.7	8 - 9
2.7 - 3.0	9 - 10
3.0 - 3.4	10 - 11
3.4 - 3.7	11 - 12
3.7 - 4.0	12 - 13
4.0 - 4.3	13 - 14
4.3 - 4.6	14 - 15
4.6 - 4.9	15 - 16
4.9 - 5.2	16 - 17
5.2 - 5.5	17 - 18
5.5 +	18 +
Below MHW	
No Data	

Datum = NAVD88
MHW



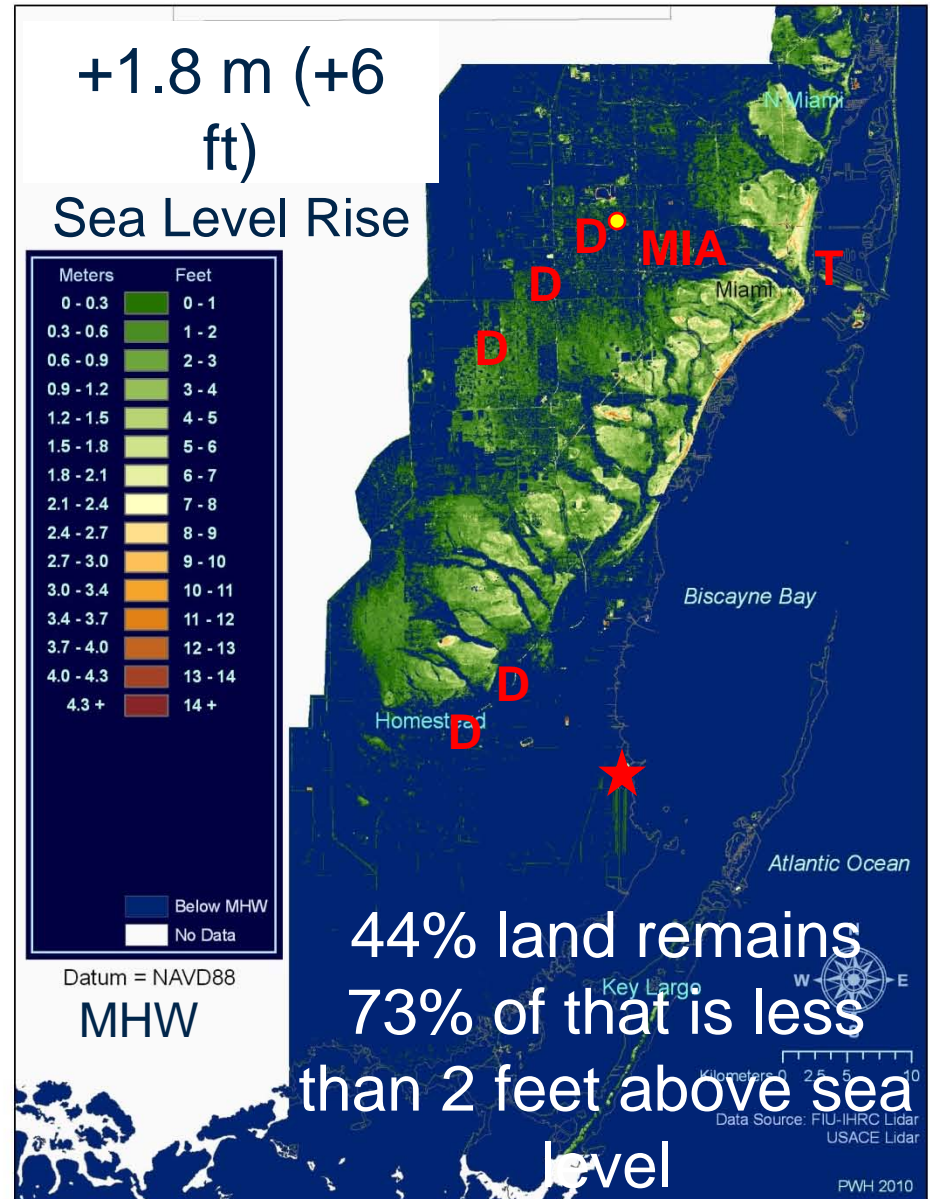
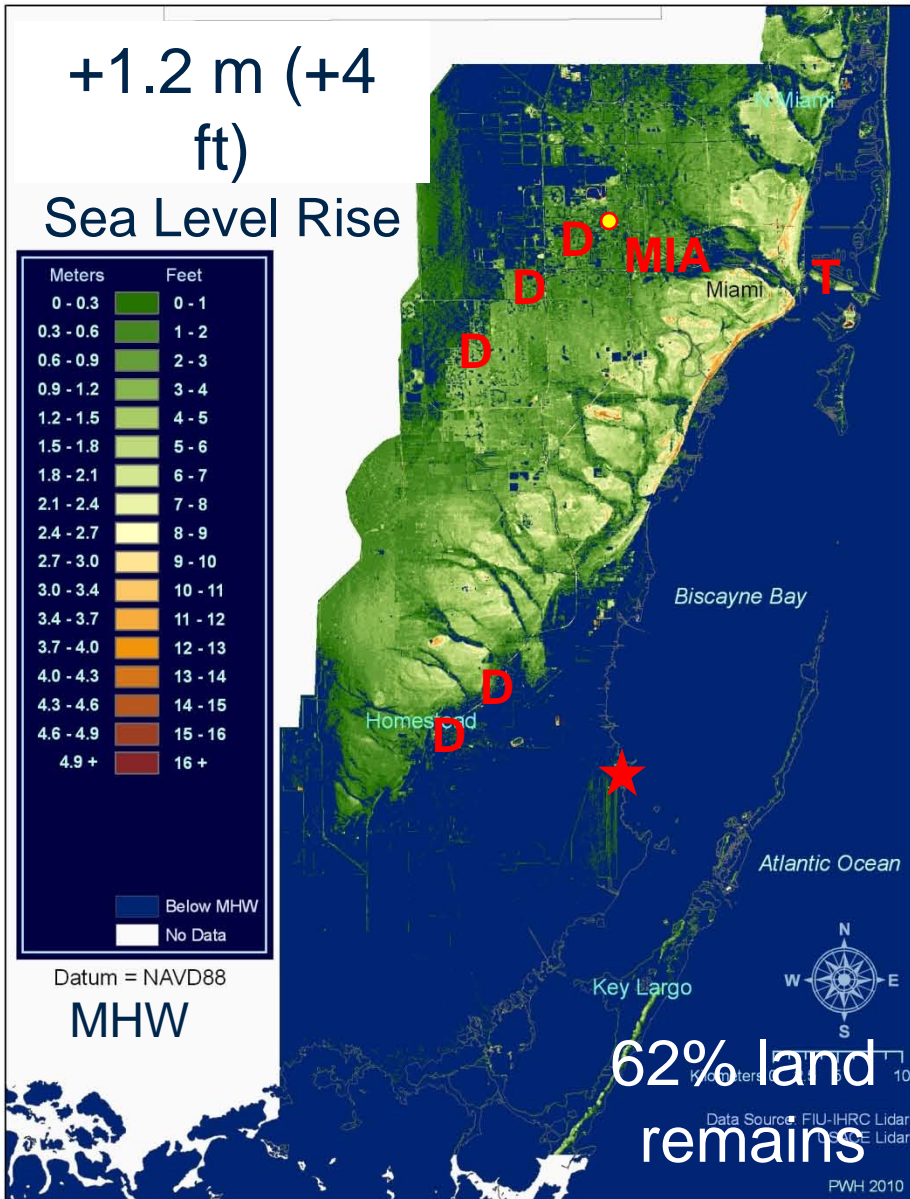
72% land remains

Data Source: FIU-IHRC Lidar
USACE Lidar
PWH 2010

MIAMI-DADE COUNTY LiDAR MAPS

Elevations from Mean High Water Level

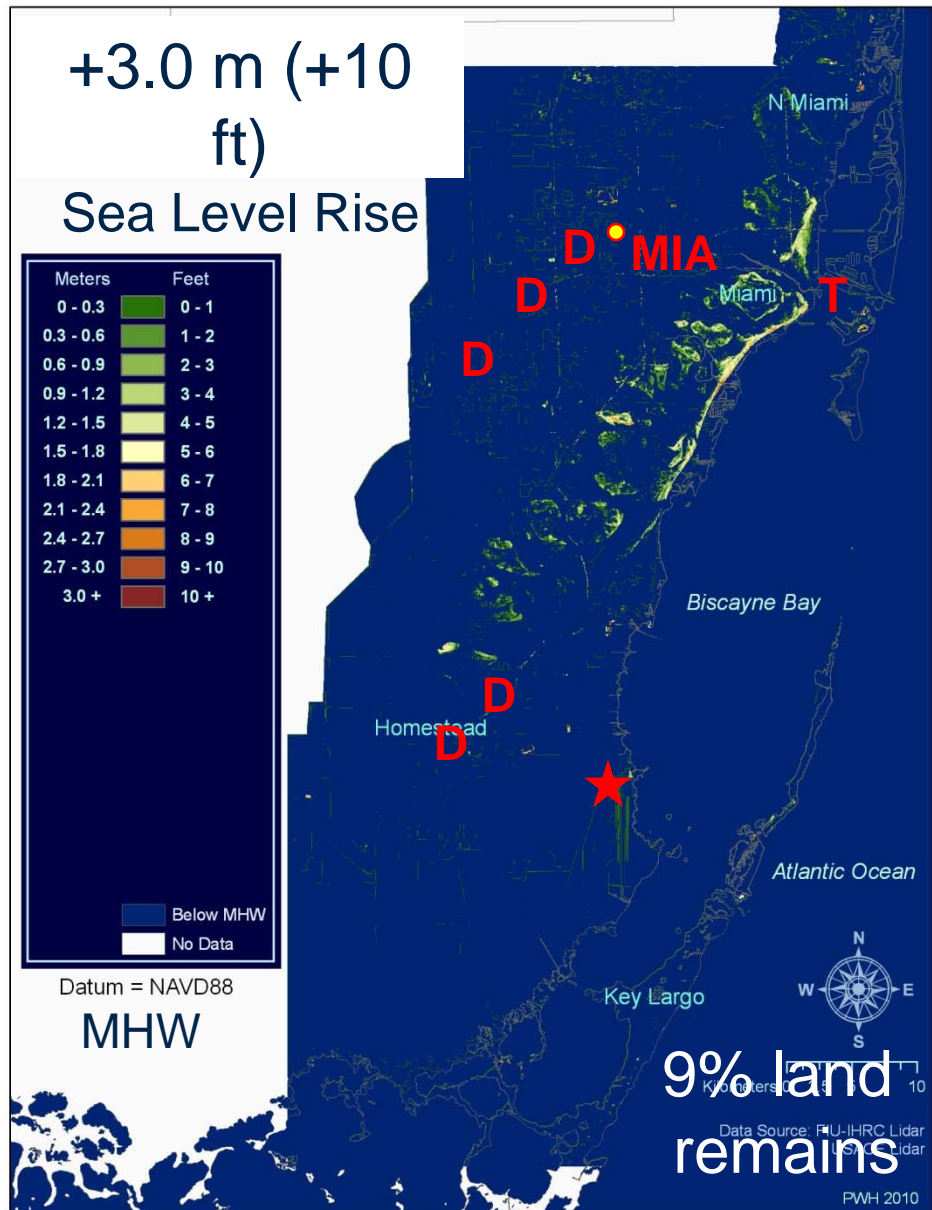
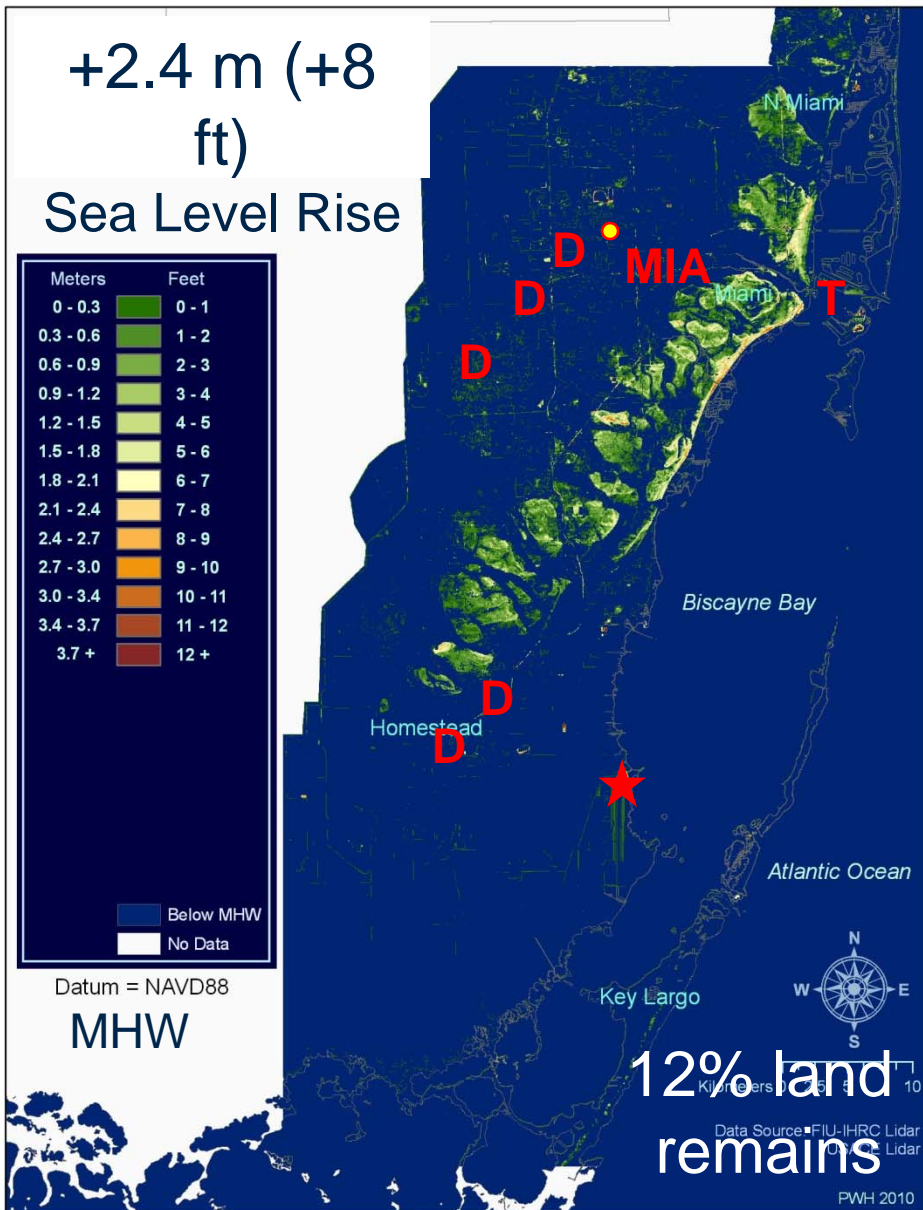
from Peter Harlem, SERC, FIU, 2010



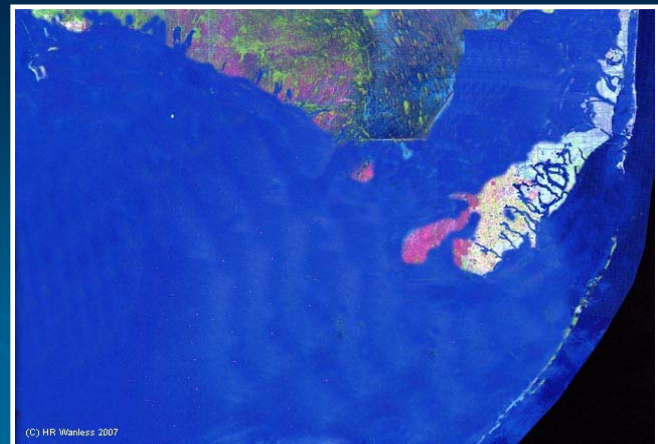
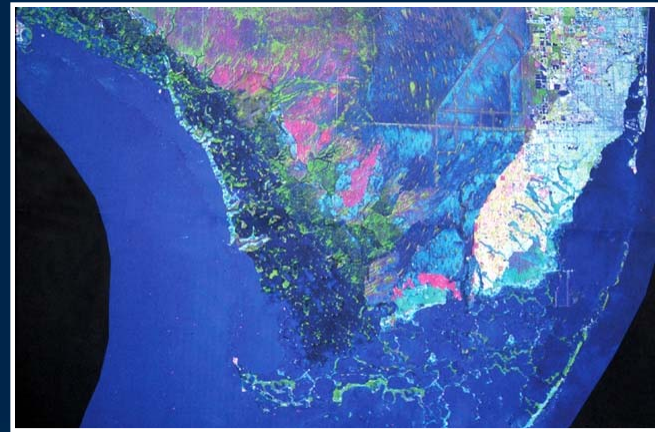
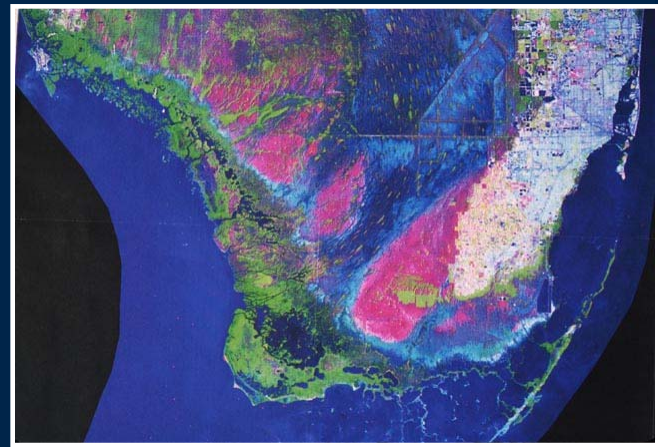
MIAMI-DADE COUNTY LiDAR MAPS

Elevations from Mean High Water Level

from Peter Harlem, SERC, FIU, 2010



Earth has a close to catastrophic evolution of its coastal and low-lying environments, habitats, infrastructure and resources underway.



What level of uncertainty accompanies the models, predictions and empirical measurements upon which these estimates are based?

- Minimum is quite certain and should be accelerating.
- Consensus that there will be accelerating SLR well beyond end of century.
- **Not certain when there will be rapid pulses of ice release and melt and sea level rise –BUT IT WILL HAPPEN.**

It is curiously inconvenient and a bit comic now –
but not when you visualize the remainder of the
century and beyond .



Venice, Italy

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