COMES THE SEA

ACCELERATING SEA LEVEL RISE WILL DRAMATICALLY CHANGE LIFE ON EARTH AS THE CENTURY PROGRESSES.

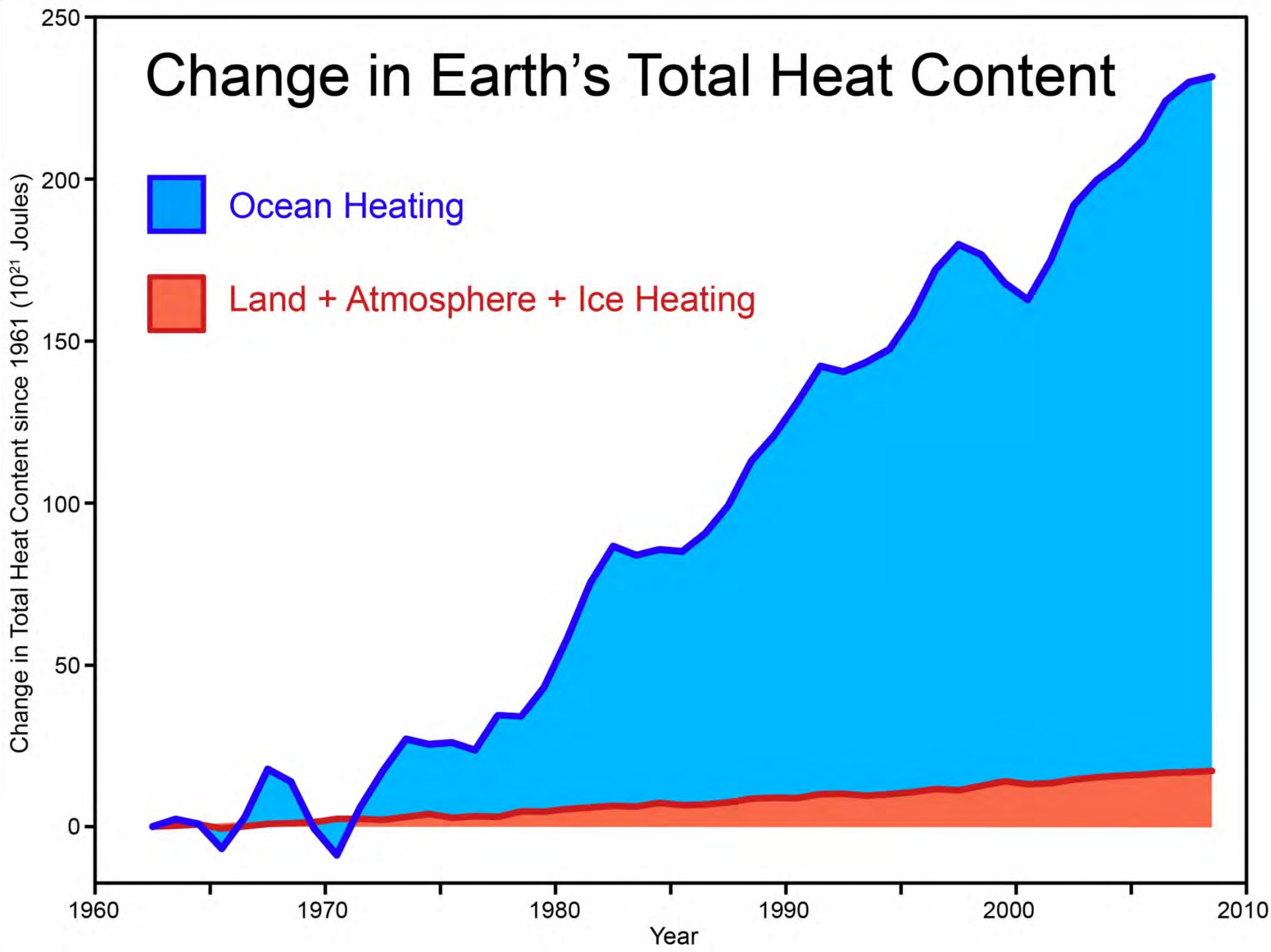
Inez, 1966, Key Biscayne

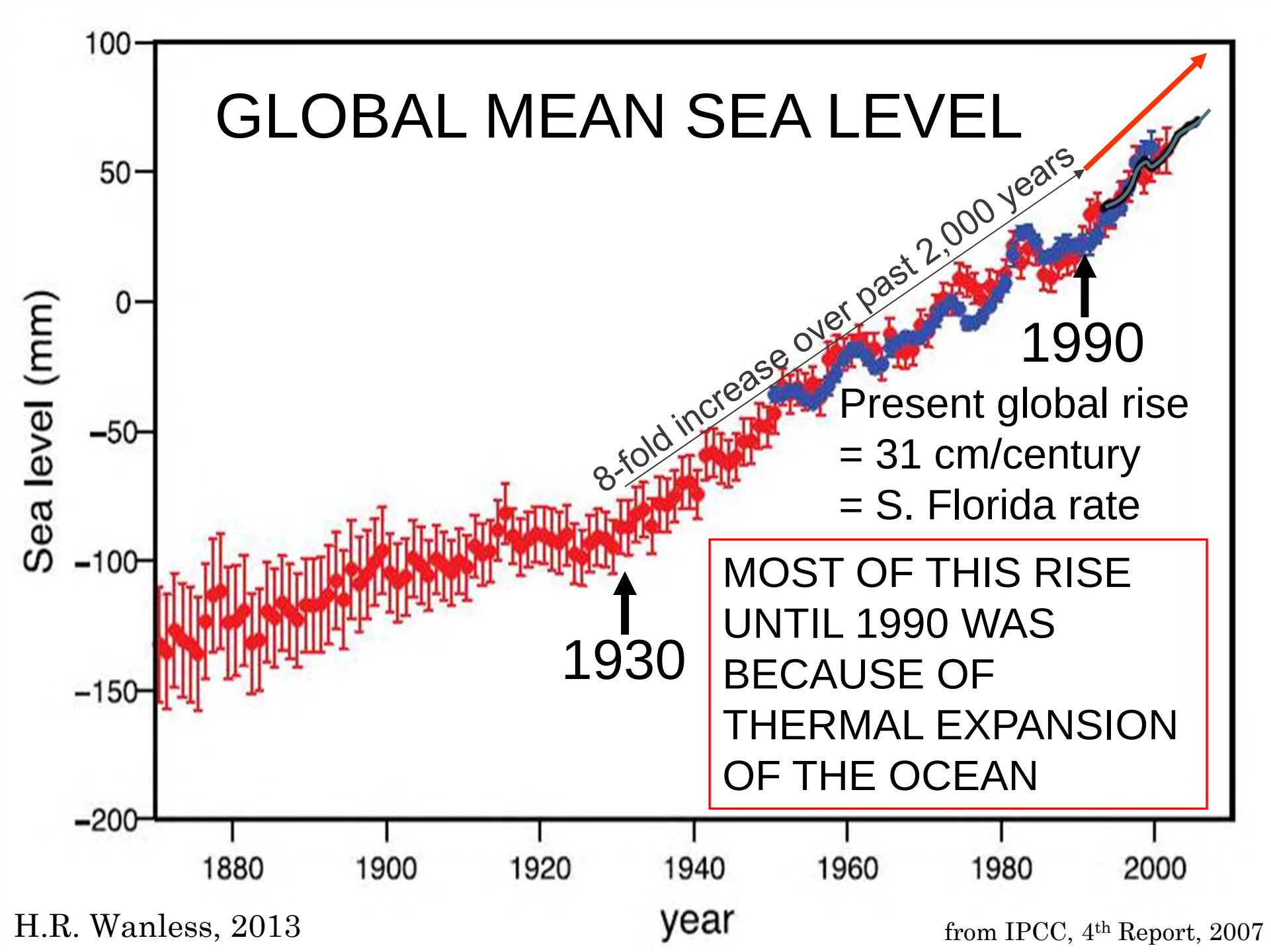
HAROLD R. WANLESS
hwanless@miami.edu

for

Biscayne Bay Regional Restoration Coordination Team
NOAA Marine Fisheries, Miami

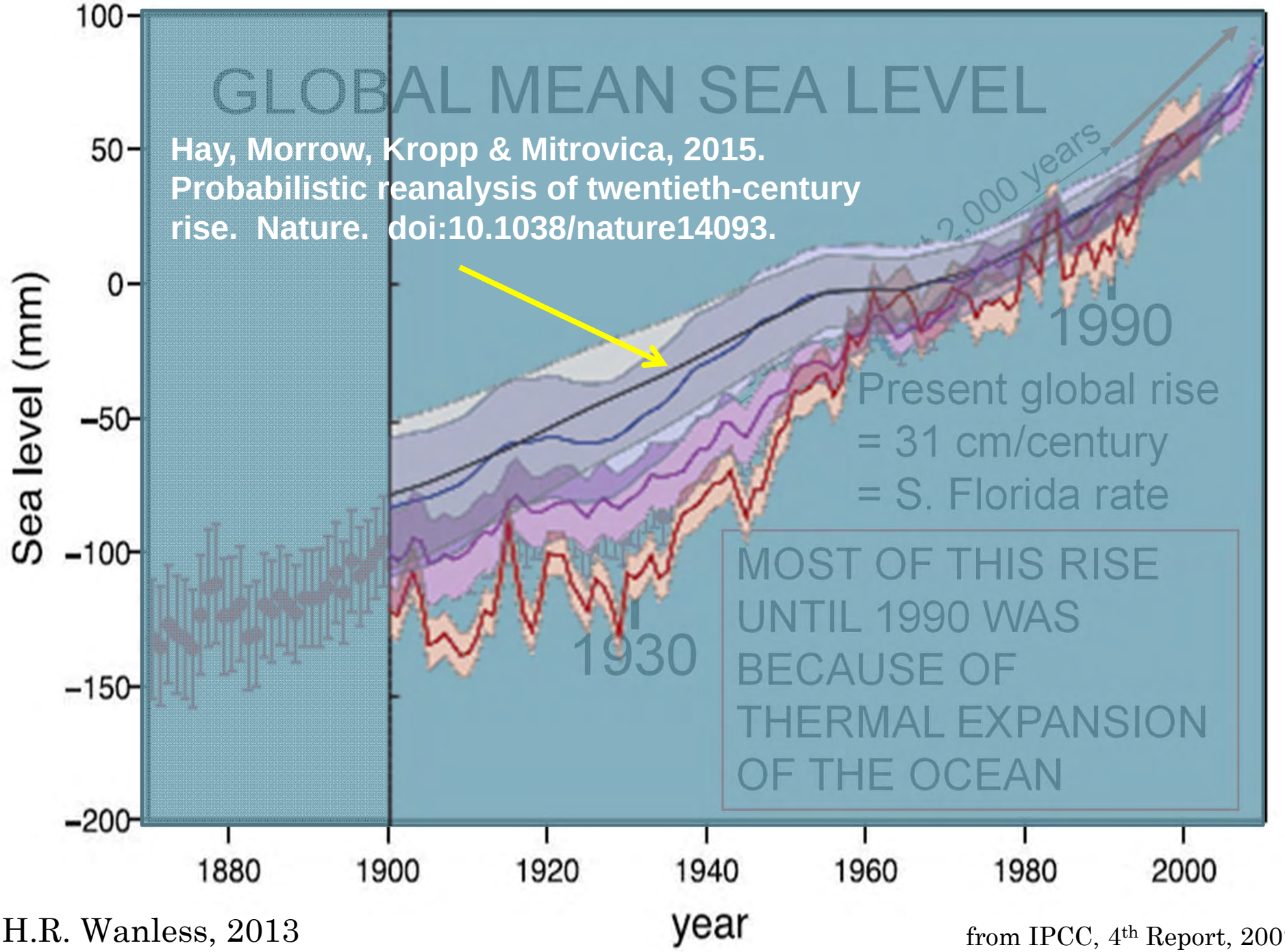
January 14, 2015


Change in Earth's Total Heat Content
Ocean Heating
Land + Atmosphere + Ice Heating
Change in Total Heat Content since 1961 (10^{21} Joules)
250
200
150
100
50
0
1960
1970
1980
1990
2000
2010
Year



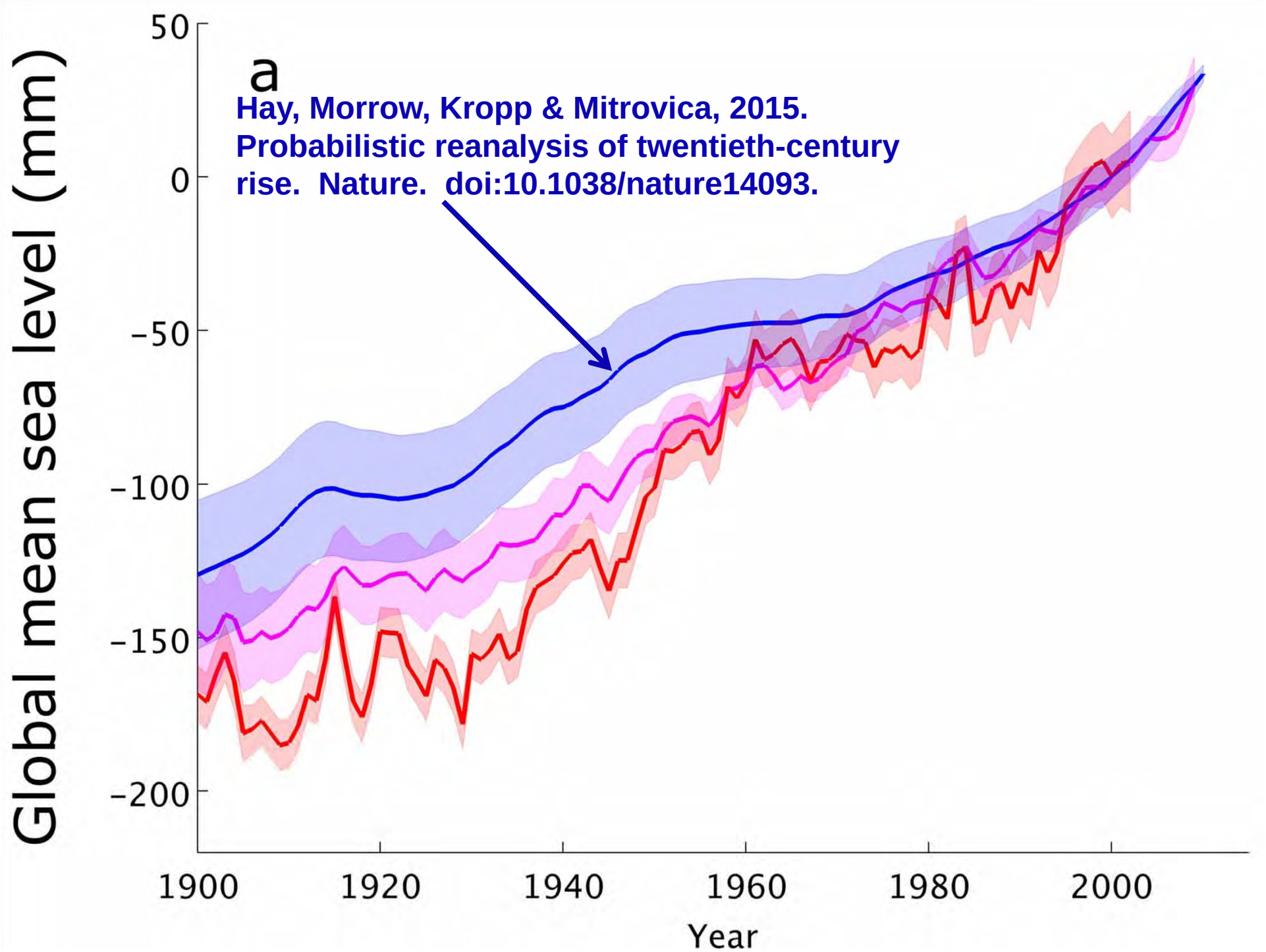
H.R. Wanless, 2013

from IPCC, 4th Report, 2007

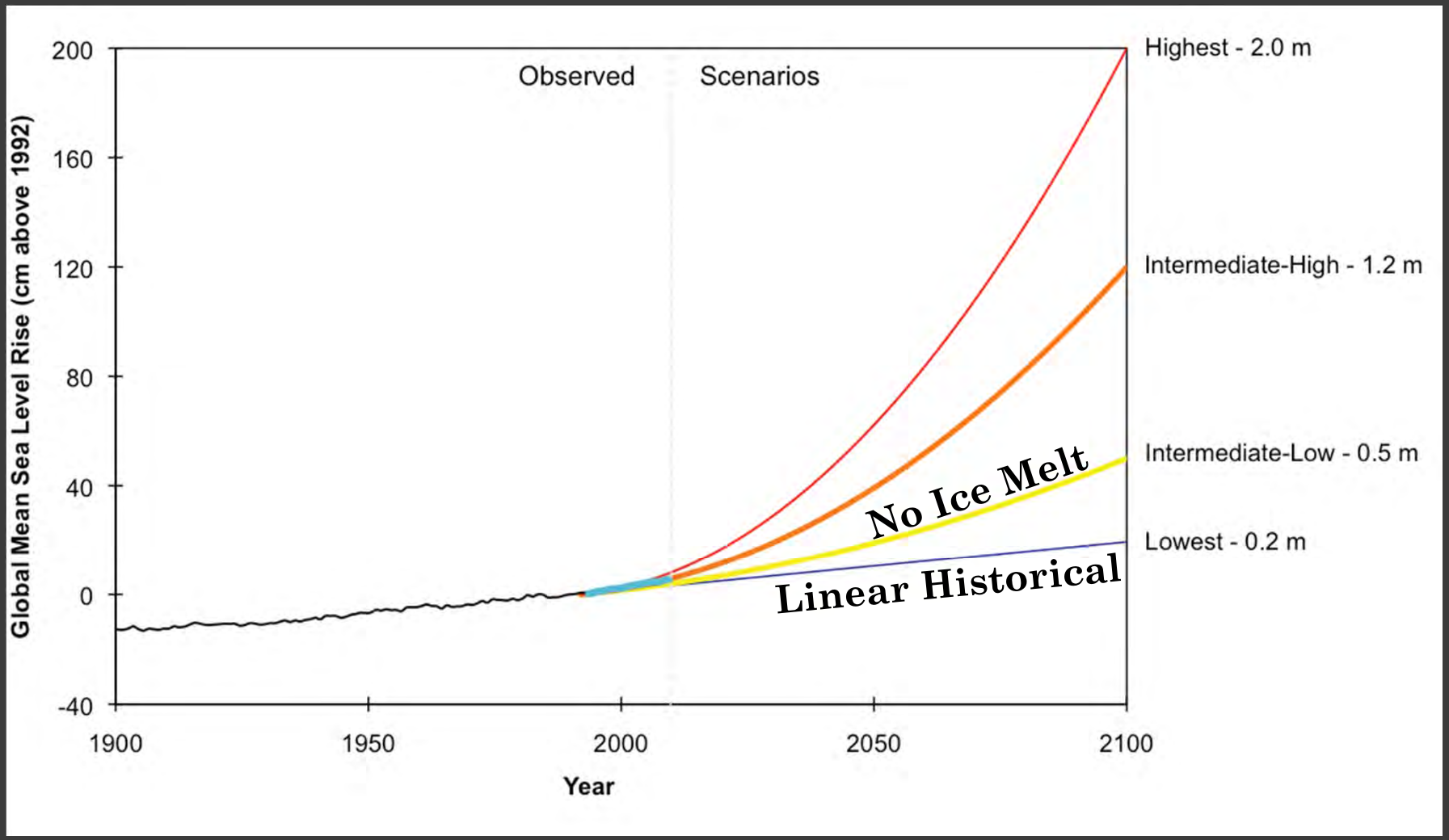


H.R. Wanless, 2013

from IPCC, 4th Report, 2007


a
Hay, Morrow, Kropp & Mitrovica, 2015.
Probabilistic reanalysis of twentieth-century
rise. Nature. doi:10.1038/nature14093.
Global mean sea level (mm)
50
0
−50
−100
−150
−200
1900
1920
1940
1960
1980
2000
Year

MOST RECENT GOVERNMENT PROJECTIONS

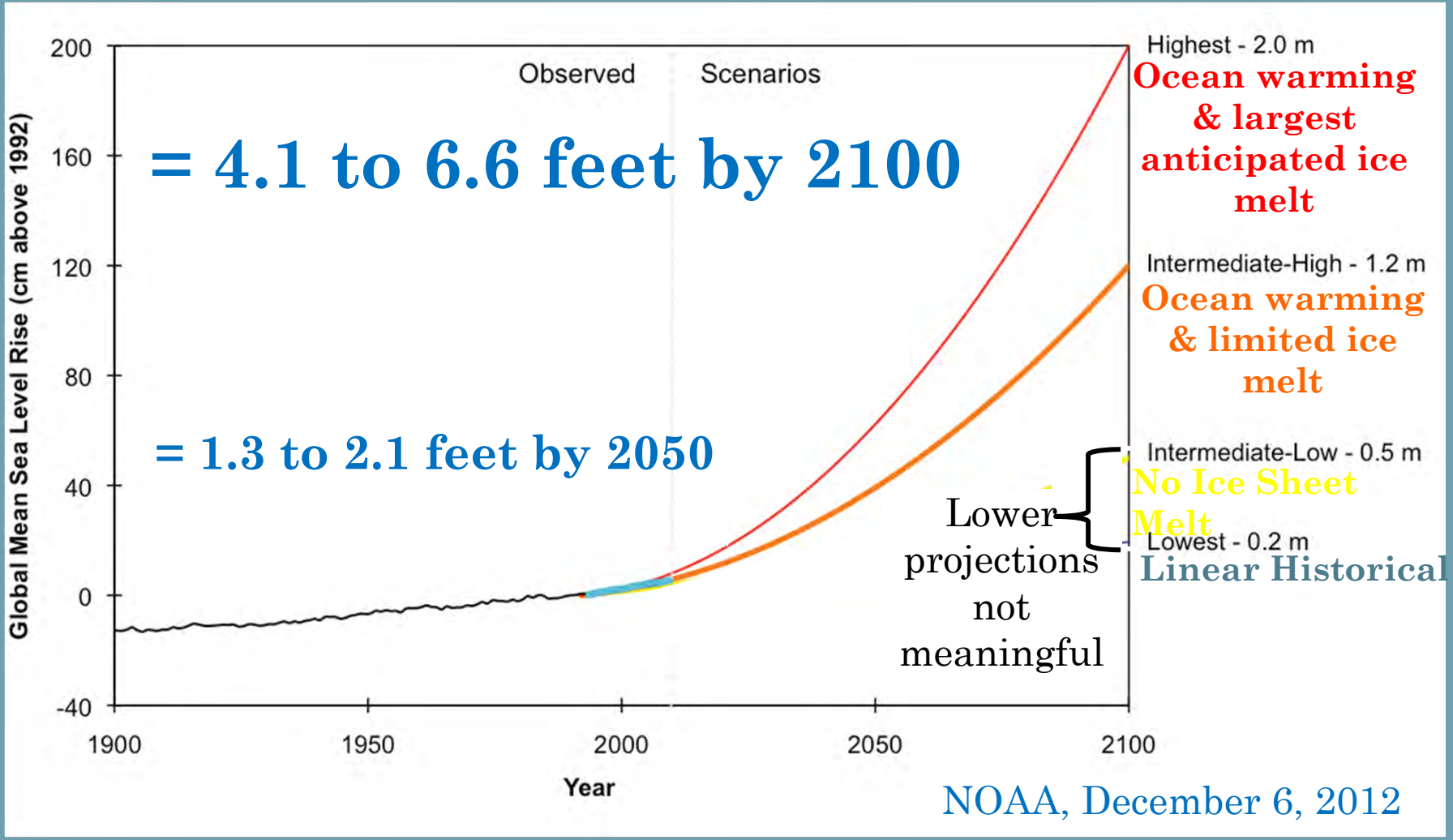


NOAA, December 6, 2012

In: "Global Sea Level Rise Scenarios for the United States National Climate

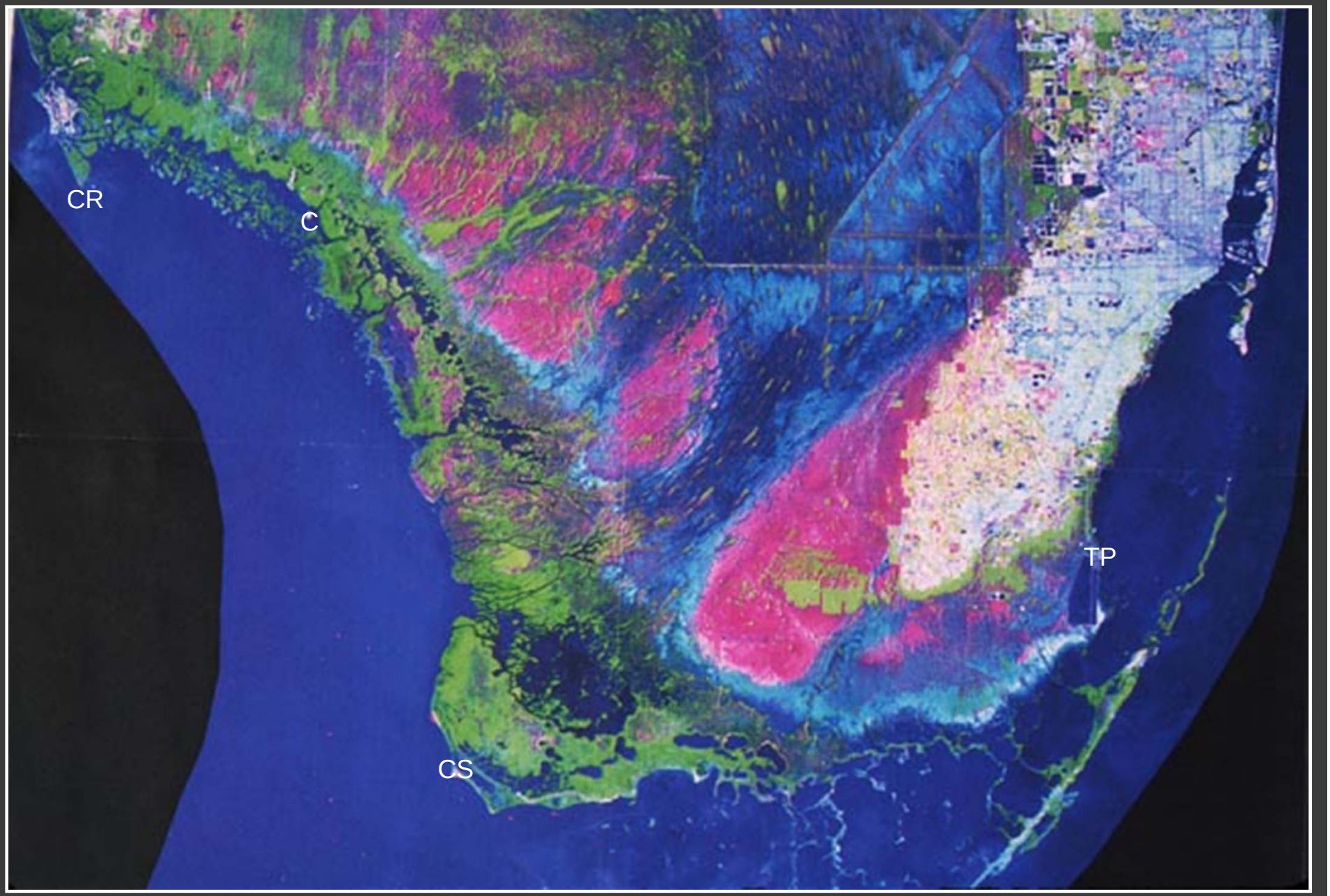
MOST RECENT U.S. GOVERNMENT PROJECTIONS

BY NOAA, UNITED STATES GEOLOGICAL SURVEY, DEPARTMENT OF DEFENSE, ENVIRONMENTAL PROTECTION AGENCY, DEPARTMENT OF ENERGY, AND THE US ARMY CORPS OF ENGINEERS

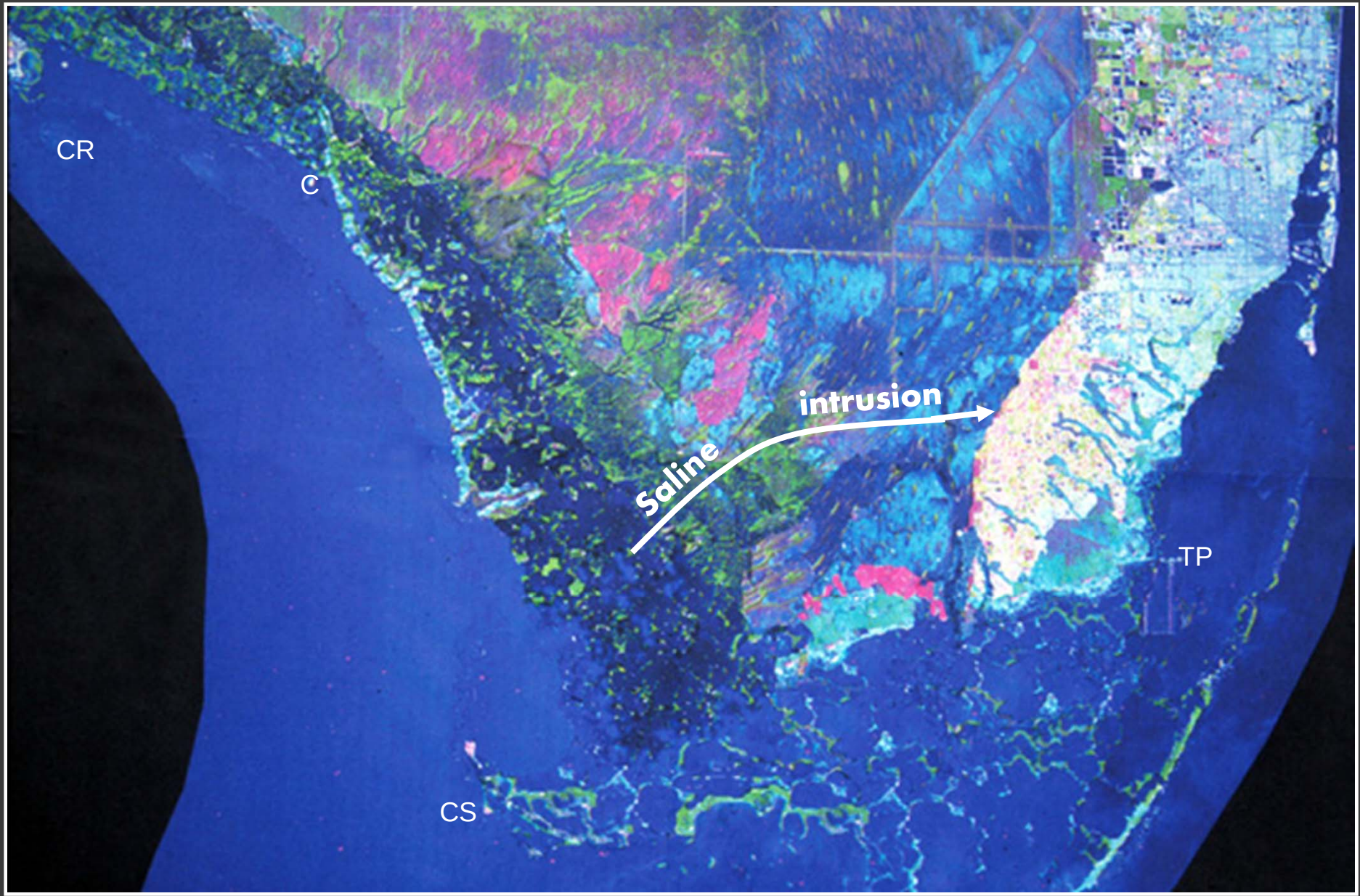


H.R. Wanless, 2013

South Florida 1995



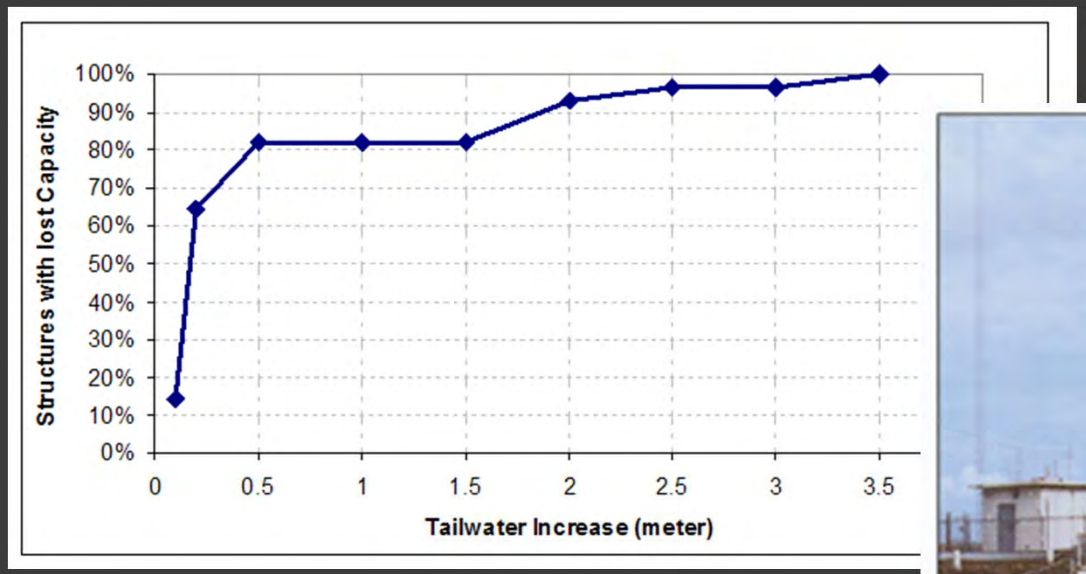
+2 foot rise (mhhw = +4.5’ above 1929 MSL) **South Florida ~2060**



1-2' VERSUS 3-5' – ALL THE DIFFERENCE

- A 1-2 foot rise this century –
  - Miami, barrier islands and upper Keys are still sort of inhabitable;
  - probably worth throwing up extensive defenses;
  - and just maybe will get hold of global warming problem before all is lost.

EVERY COUNTY AND CITY URGENTLY NEEDS ACCURATE AND DETAILED ELEVATION MAPS FROM WHICH TO ASSESS FUTURE DRAINAGE AND INFRASTRUCTURE RISK.



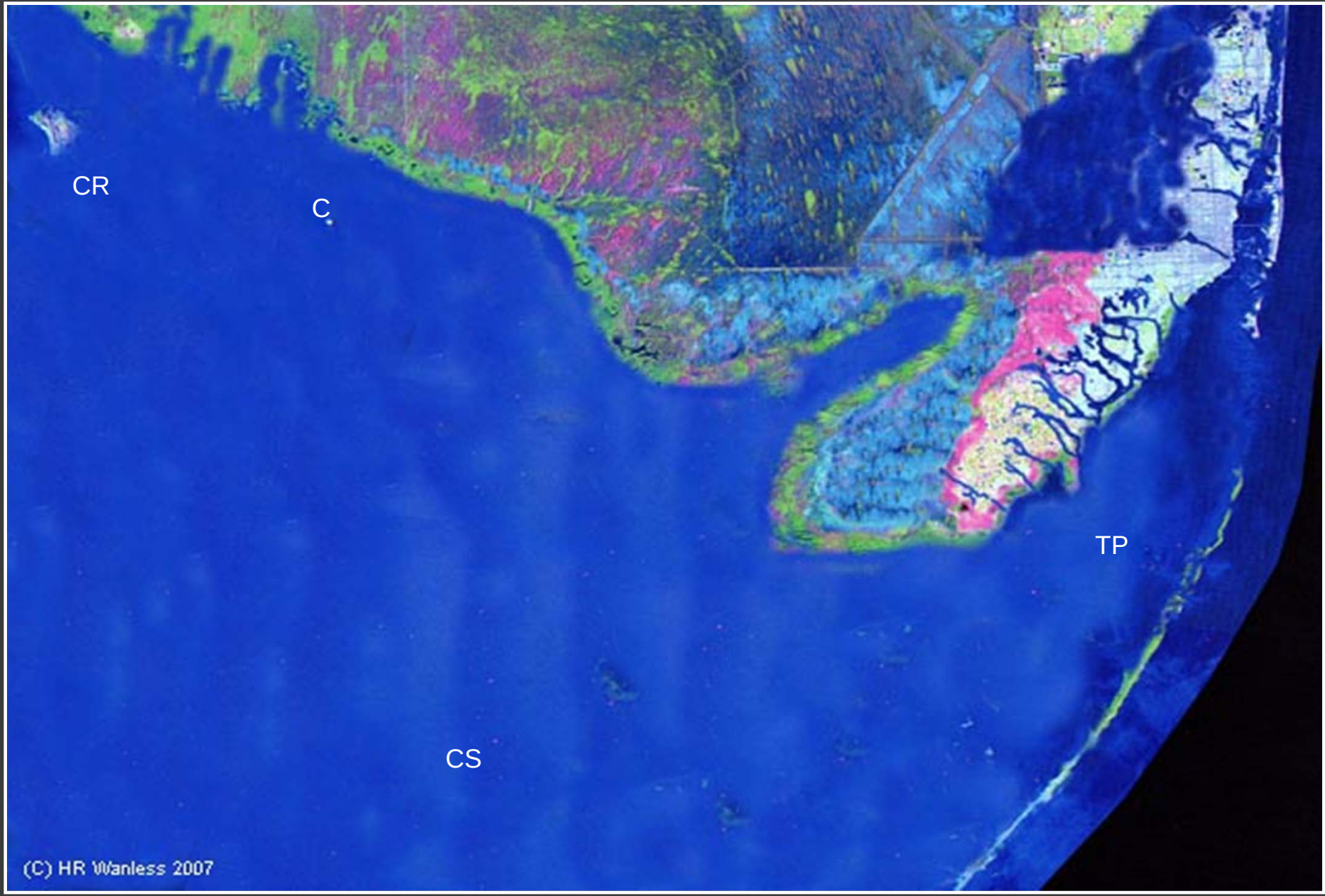
Sherwood and others, 1973

In SE Florida, a 50 cm (20 inch) sea level rise will make 80% of our coastal water control structures useless.

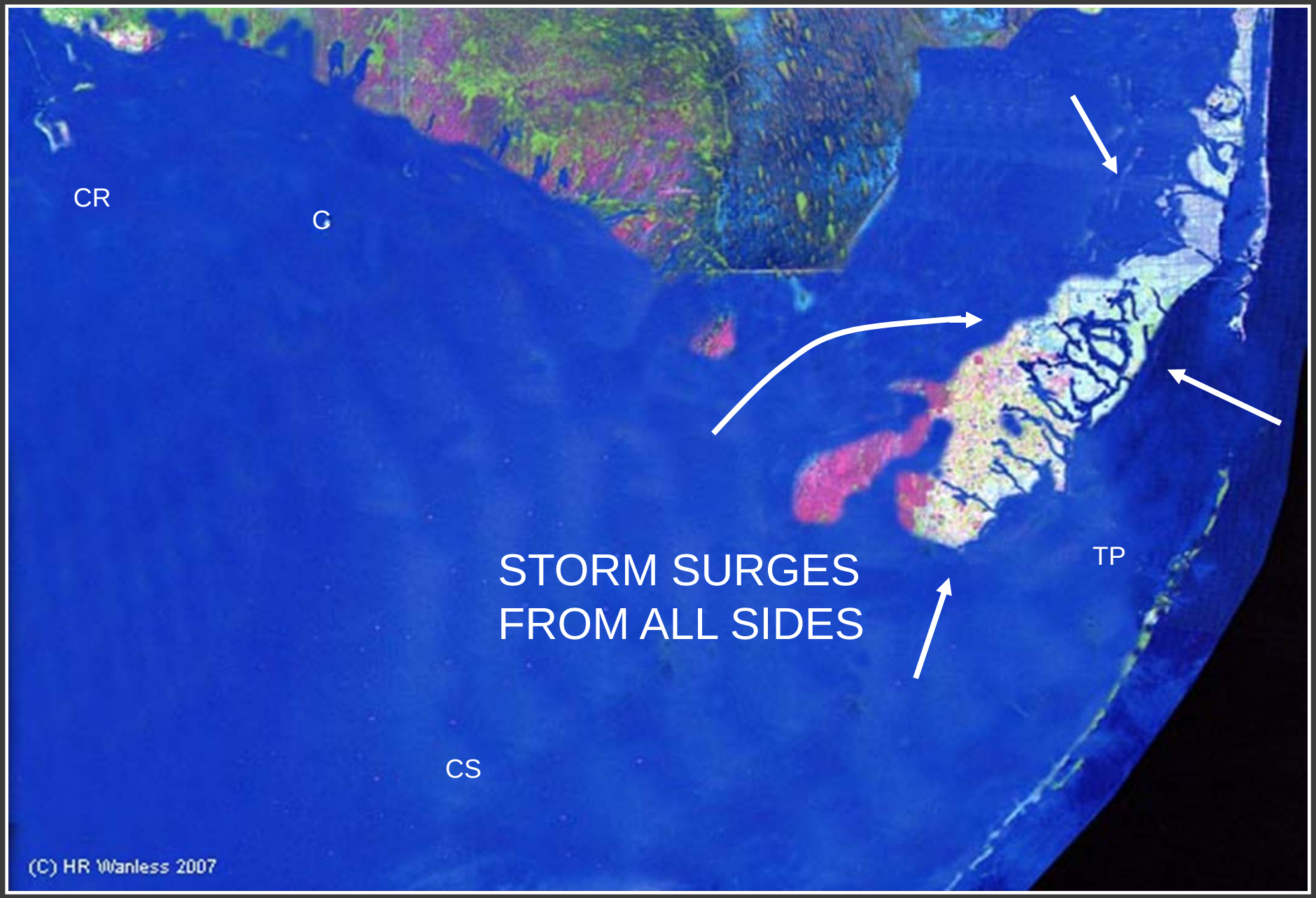
1-2’ VERSUS 3-5’ – ALL THE DIFFERENCE

- 3-5 foot rise this century –
  - All barrier islands abandoned;
  - Miami-Dade & Broward diminished and risky place to live - including all of the Florida Keys;
  - increased pollution risk from eroding dumps;
  - sea level rising at 0.6 to1 foot per decade.

+4 foot rise (mhhw = +6.5’ above 1929 MSL) **South Florida ~2085**



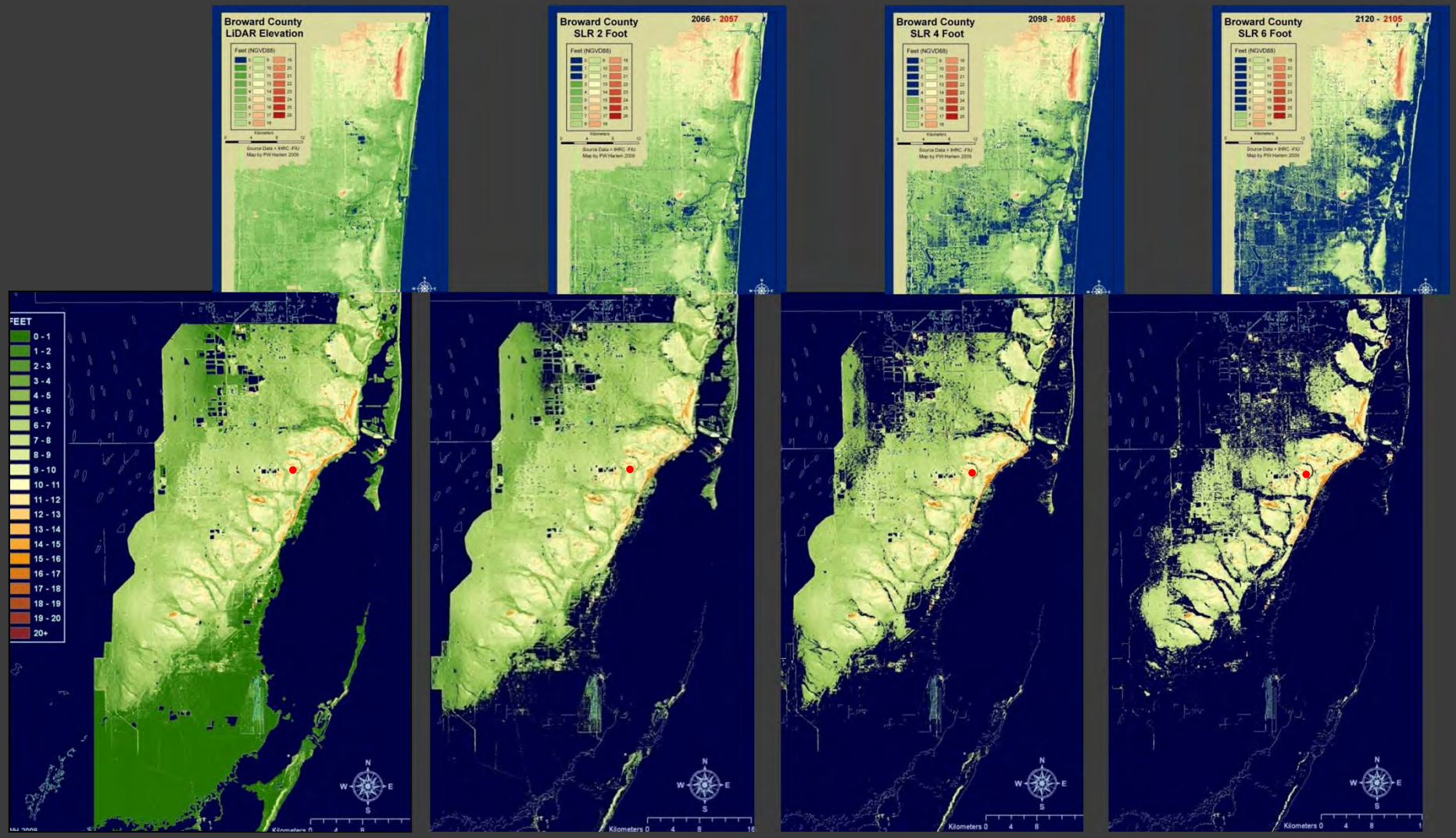
+5 foot rise (mhhw = +7.5' above 1929 MSL) **South Florida ~2102**



+6 foot rise (mhhw = +8.5' above 1929 MSL) **South Florida ~2112**

Monroe, Miami-Dade, Broward and Palm Beach Counties are greatly diminished and largely Uninhabitable.

MIAMI-DADE AND BROWARD COUNTIES THIS CENTURY



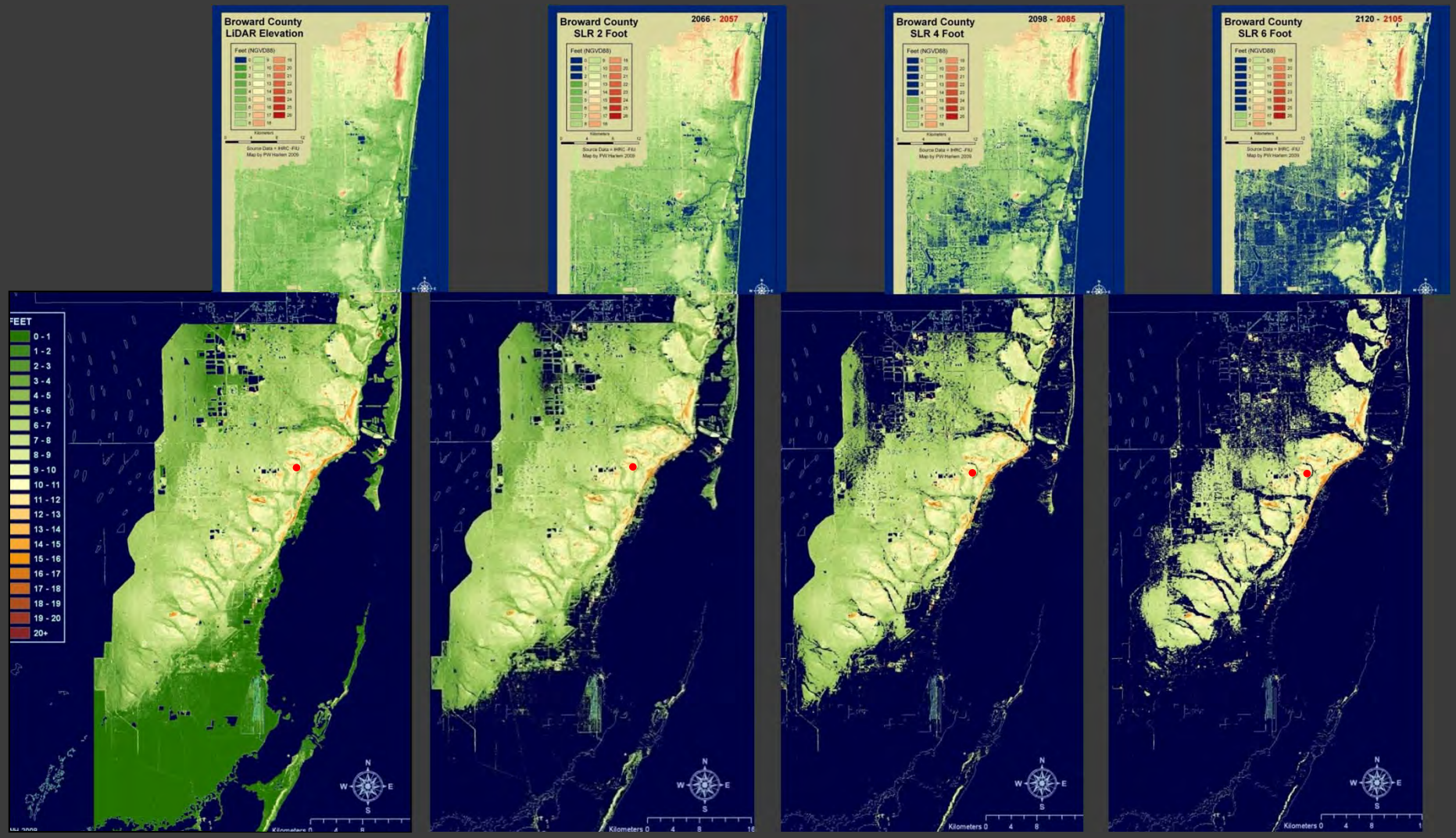
Present topography

+2 FEET
(2048-2066)
72 % remains
60 % inhabitable

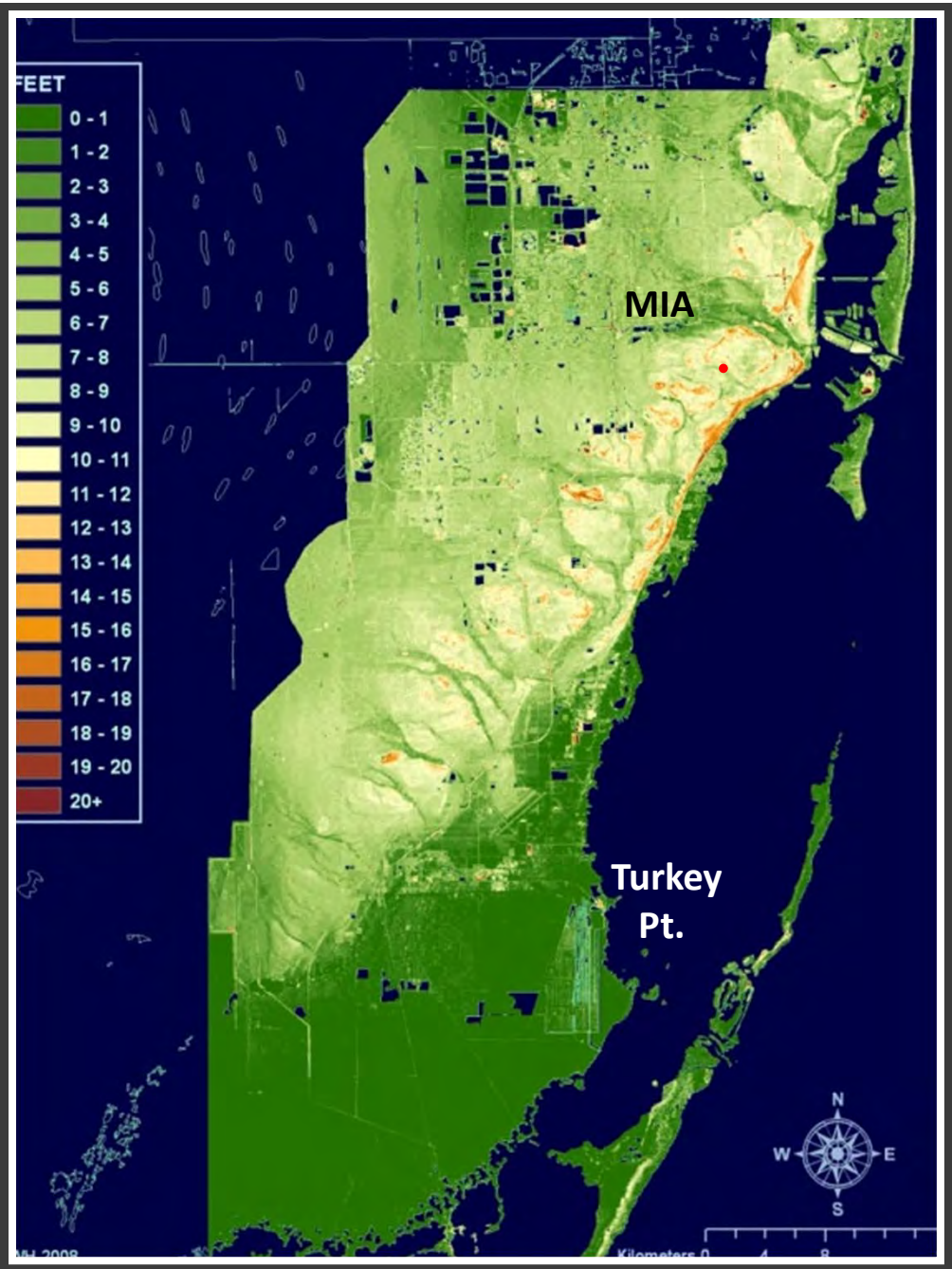
+4 FEET
(2074-2099)
62% remains
40% inhabitable

+6 FEET
(2093-2121)
44% remains
11% inhabitable

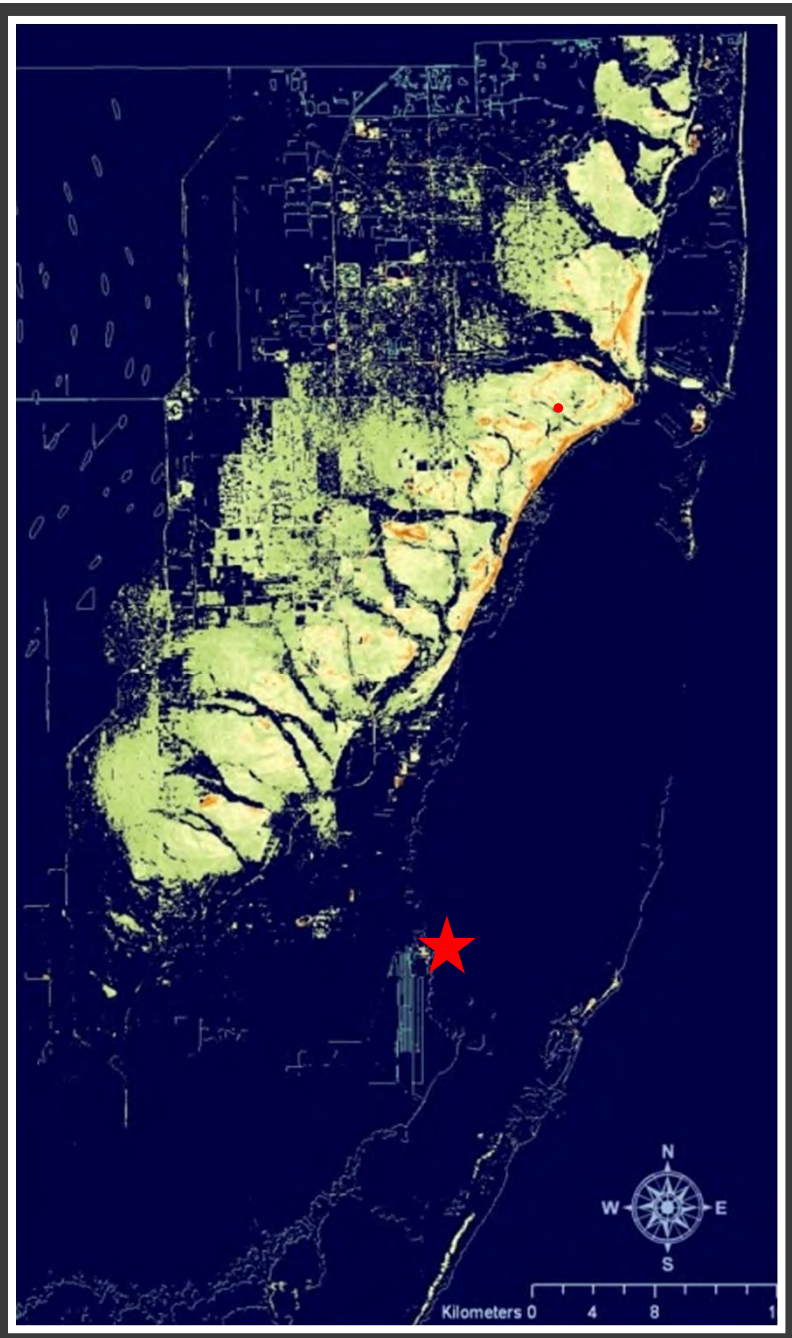
MIAMI-DADE AND BROWARD COUNTIES THIS CENTURY



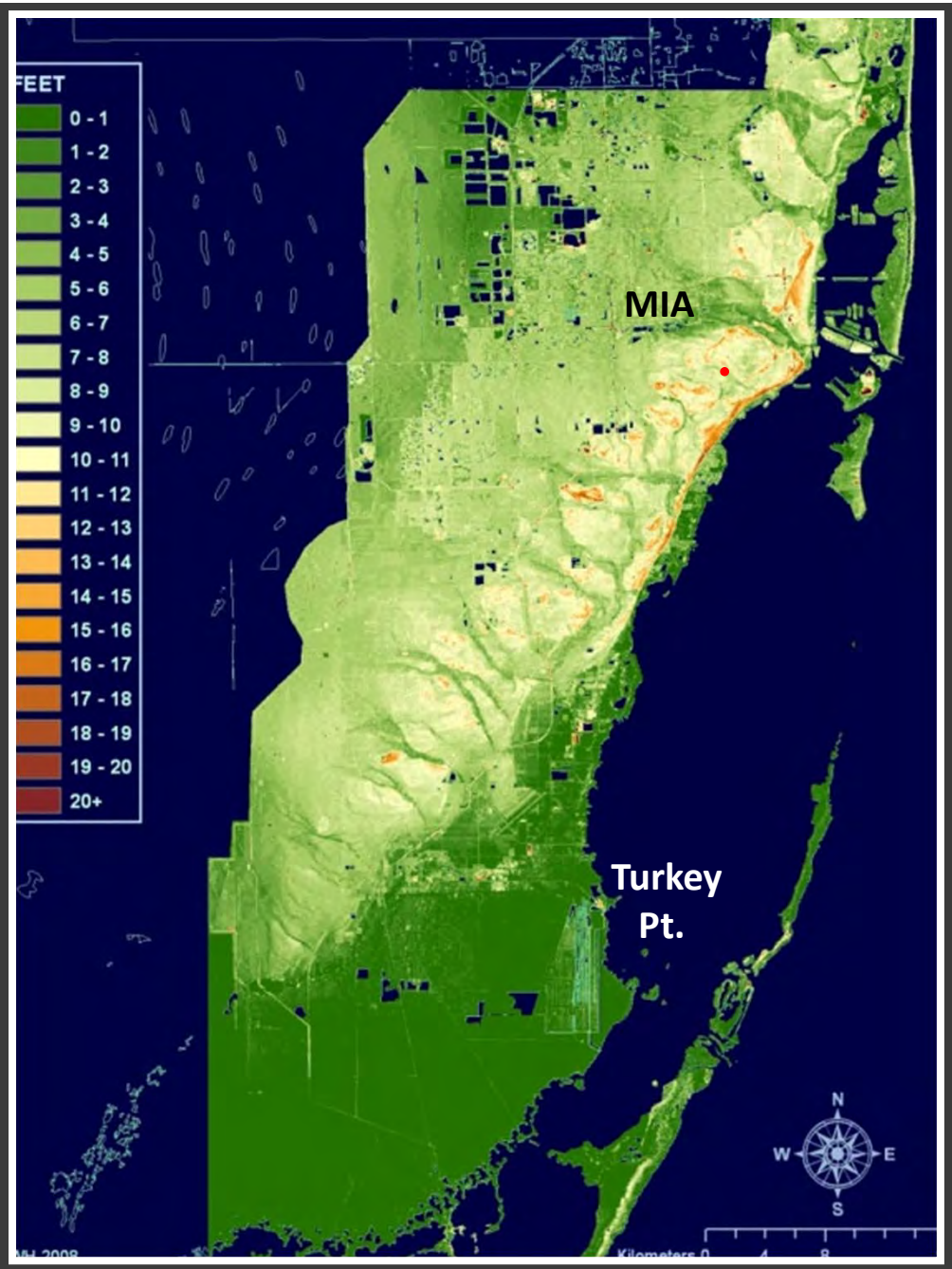
Present topography	+2 FEET	+4 FEET	+6 FEET
	(2048-2066)	(2074-2099)	(2093-2121)
WHAT WE WILL LOSE	Freshwater Resource	Airports	Storm Protection
	Sewage Plants	Road connectivity	Tax Base



Present topography



+6 FEET (2093-2121)



Present topography

+6 FEET (2093-2121)

Inundation projections using LiDAR elevation data

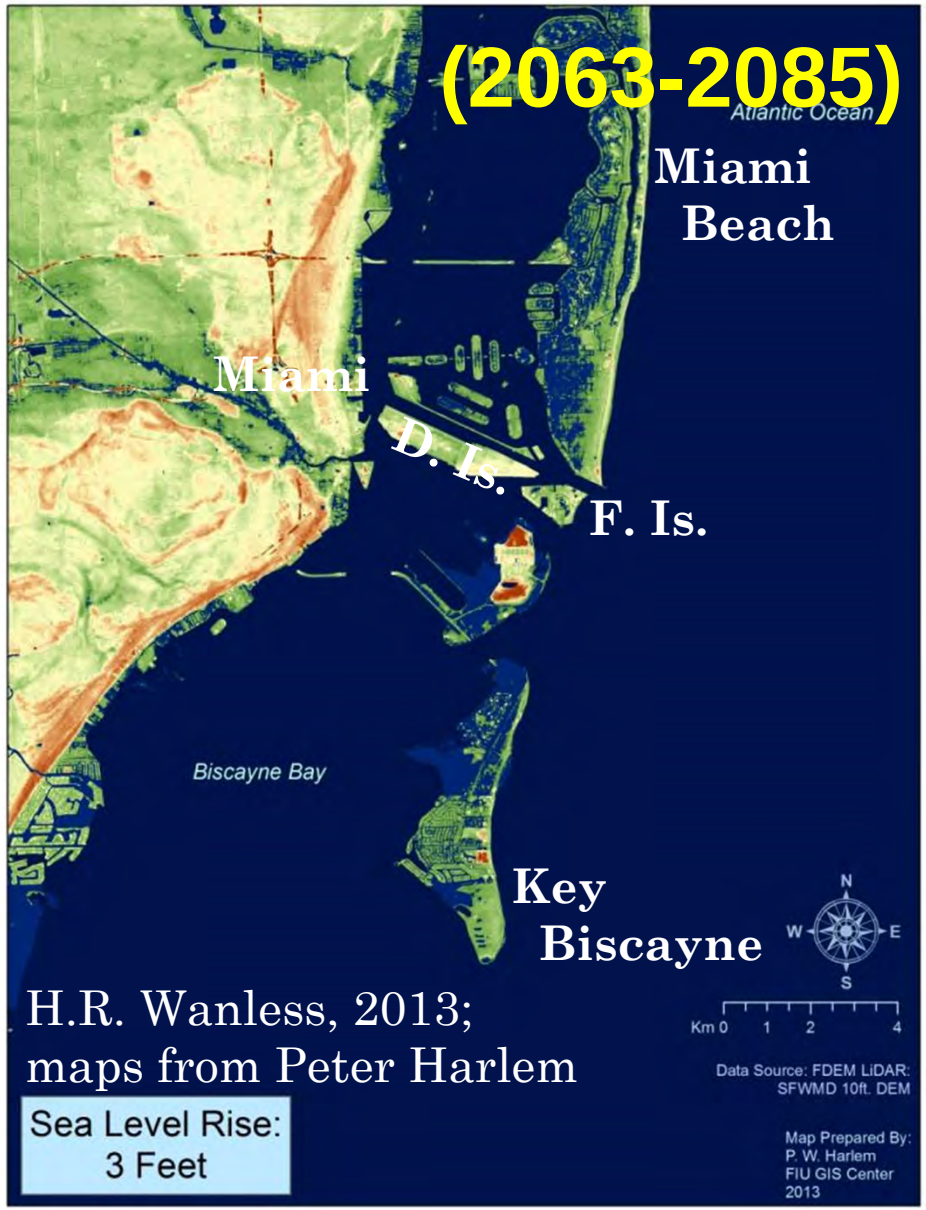
Present topography

H.R. Wanless, 2013;
maps from Peter Harlem, FIU

2 Feet Sea Level Rise (2048-2066)

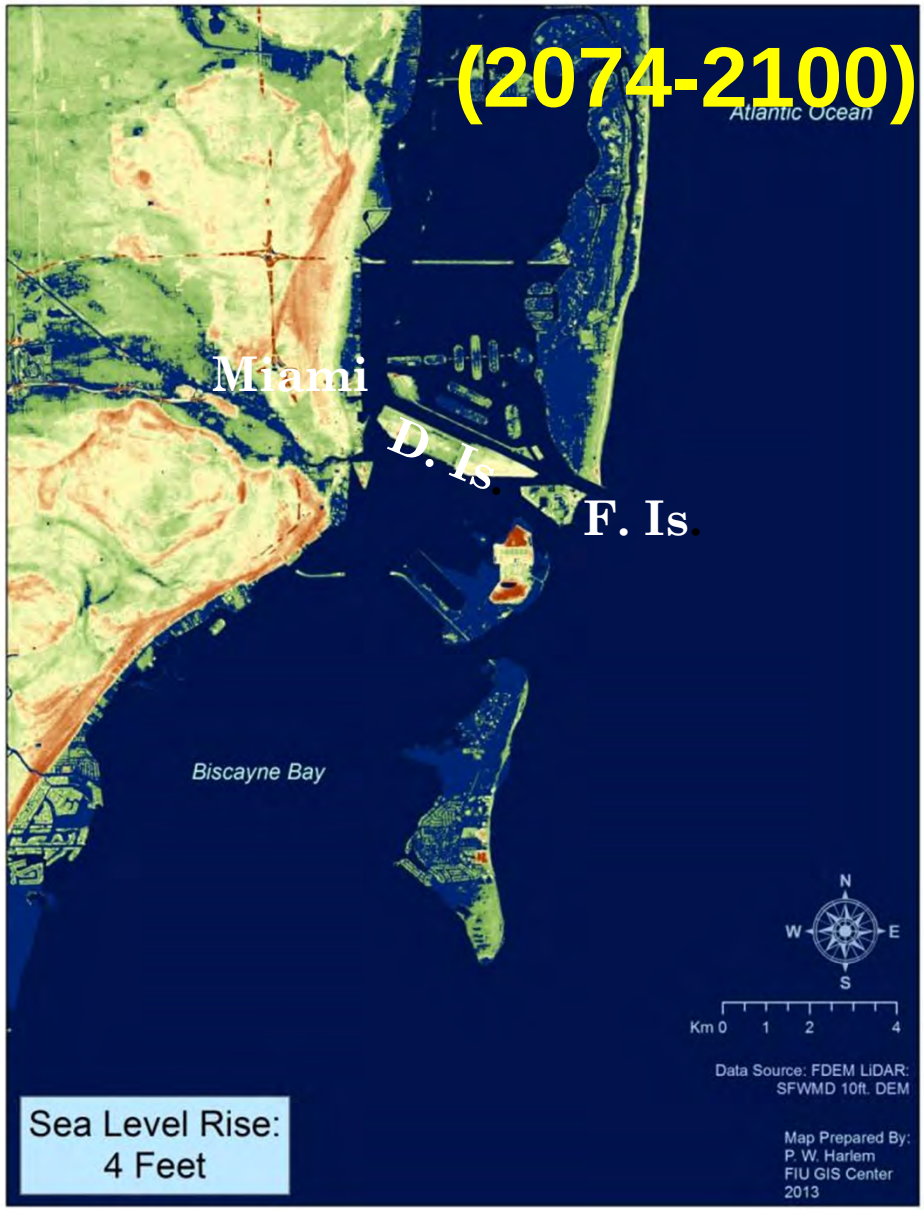
Inundation projections using LiDAR elevation data

3 Feet Sea Level Rise



H.R. Wanless, 2013;
maps from Peter Harlem

4 Feet Sea Level Rise

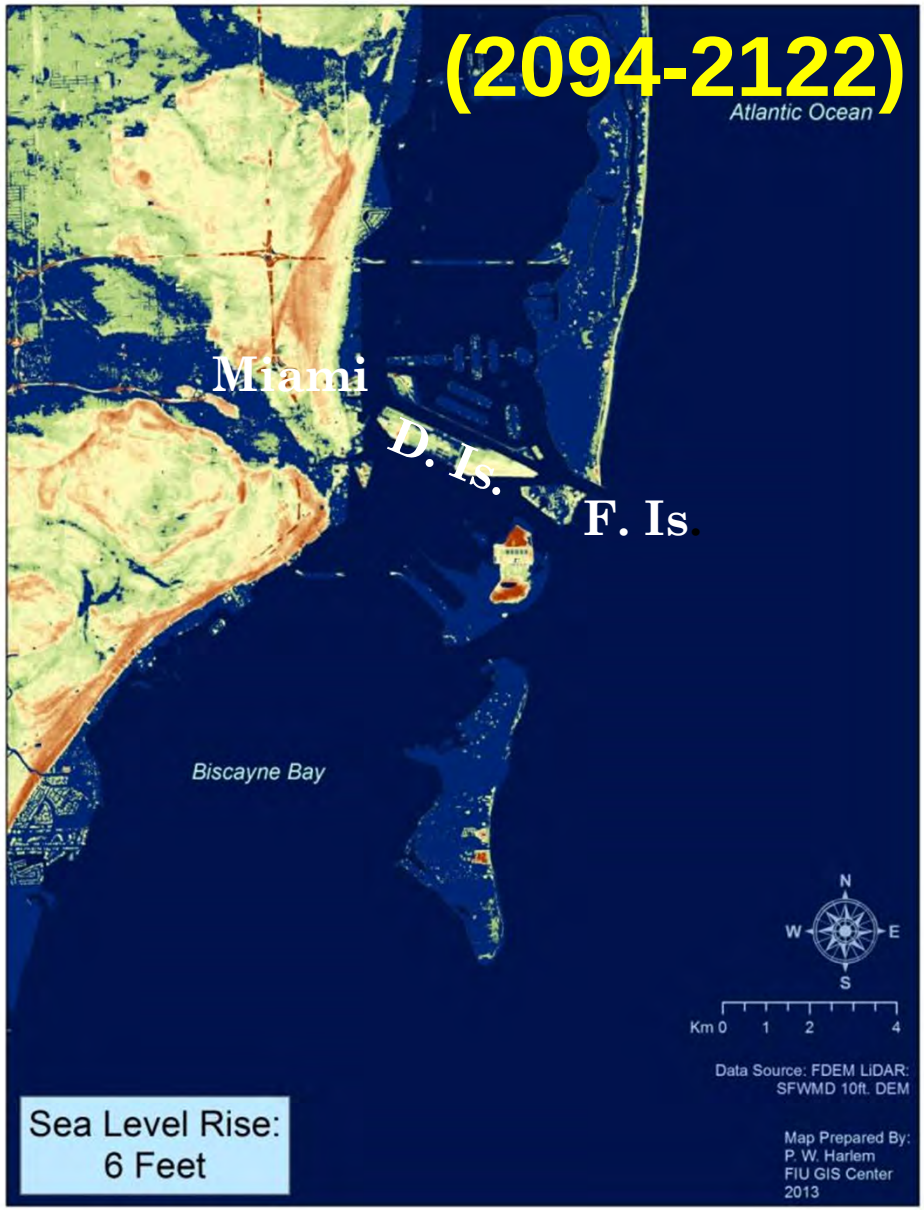


Inundation projections using LiDAR elevation data

5 Feet Sea Level Rise

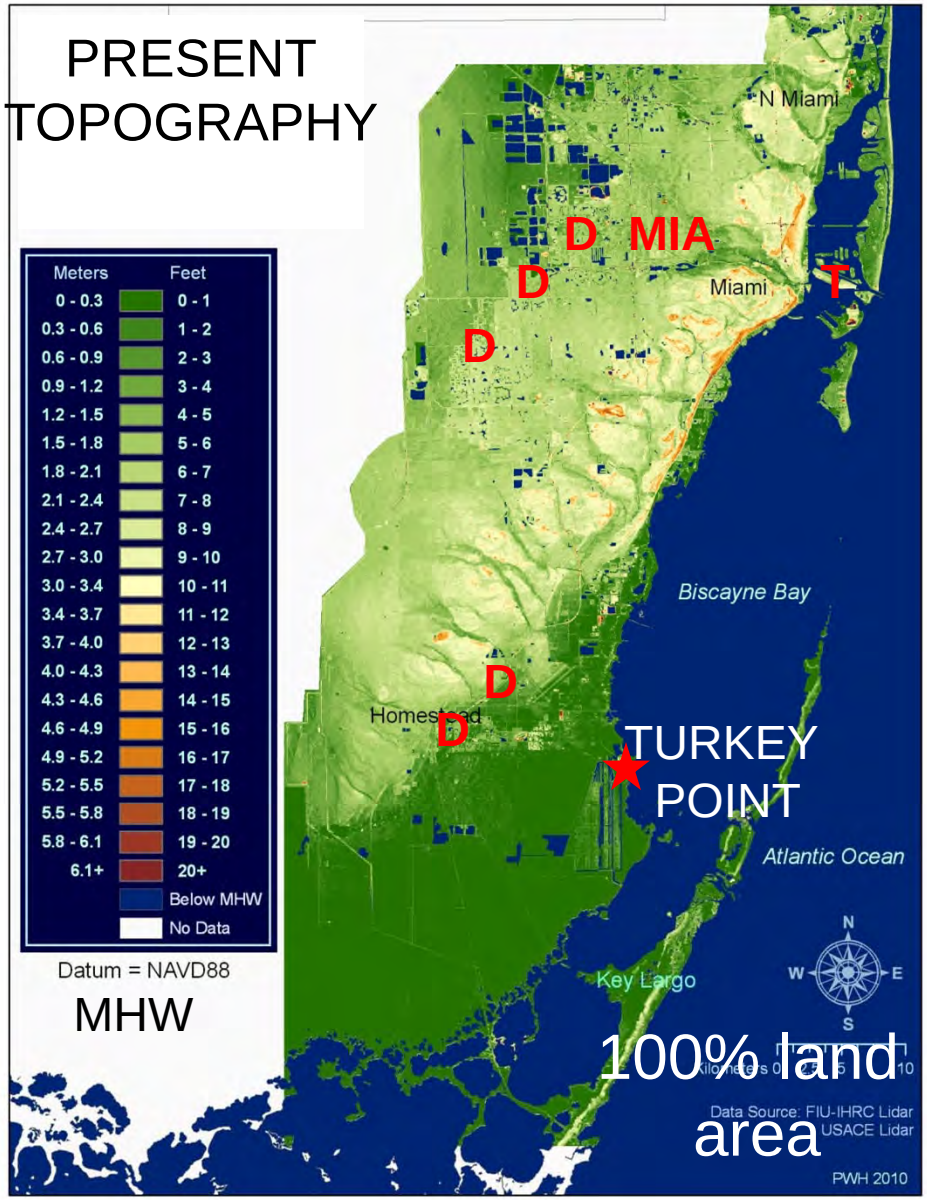
H.R. Wanless, 2013;
maps from Peter Harlem

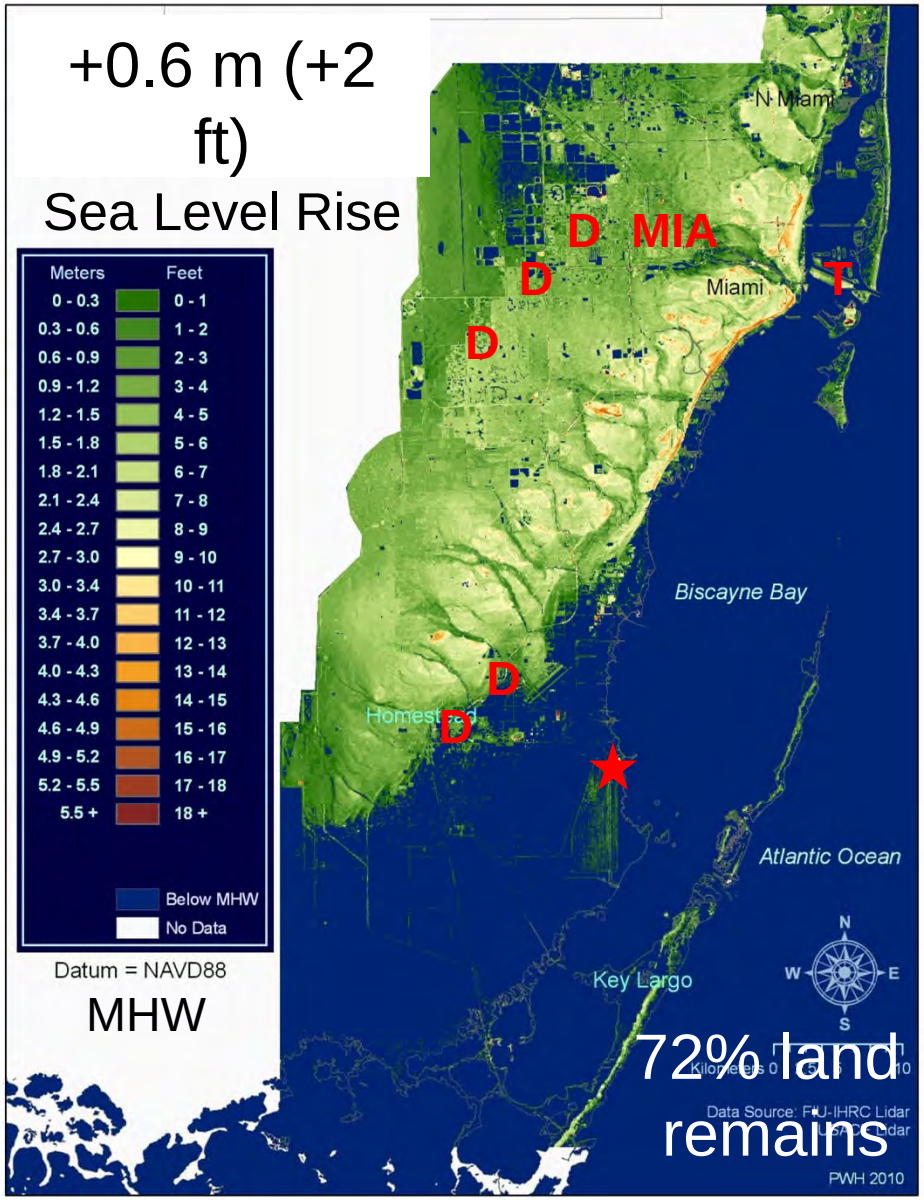
6 Feet Sea Level Rise



MIAMI-DADE COUNTY LIDAR MAPS

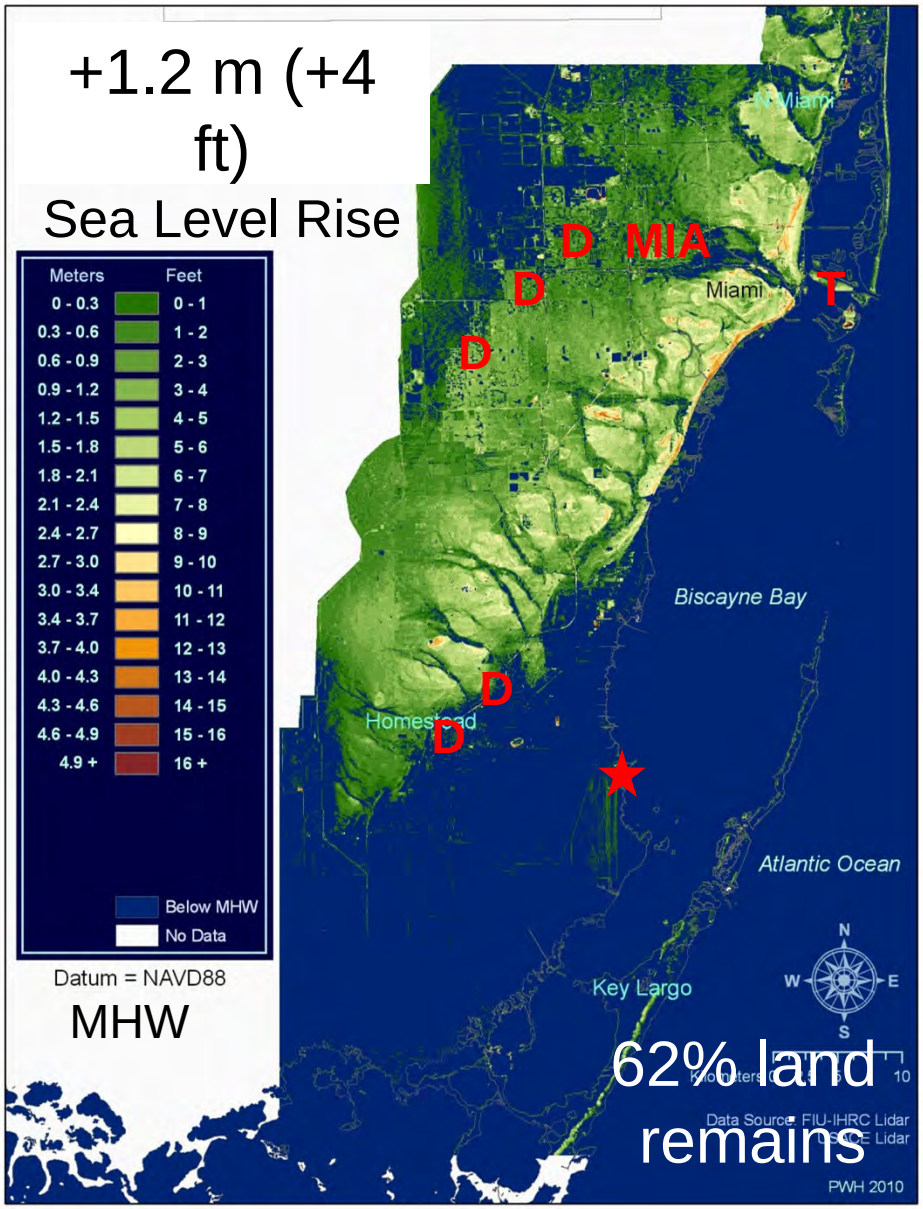
from P. Harlem, 2010

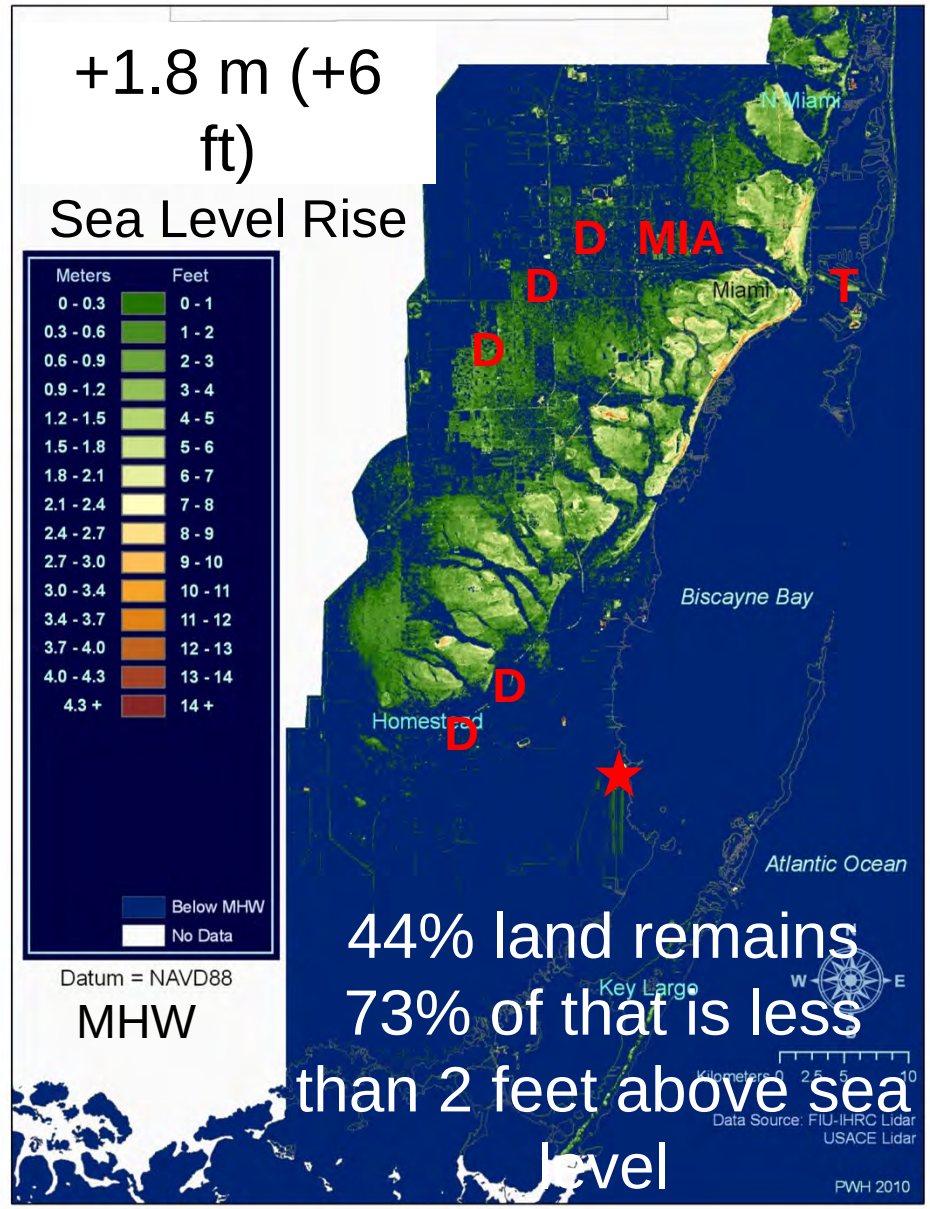




MIAMI-DADE COUNTY LiDAR MAPS

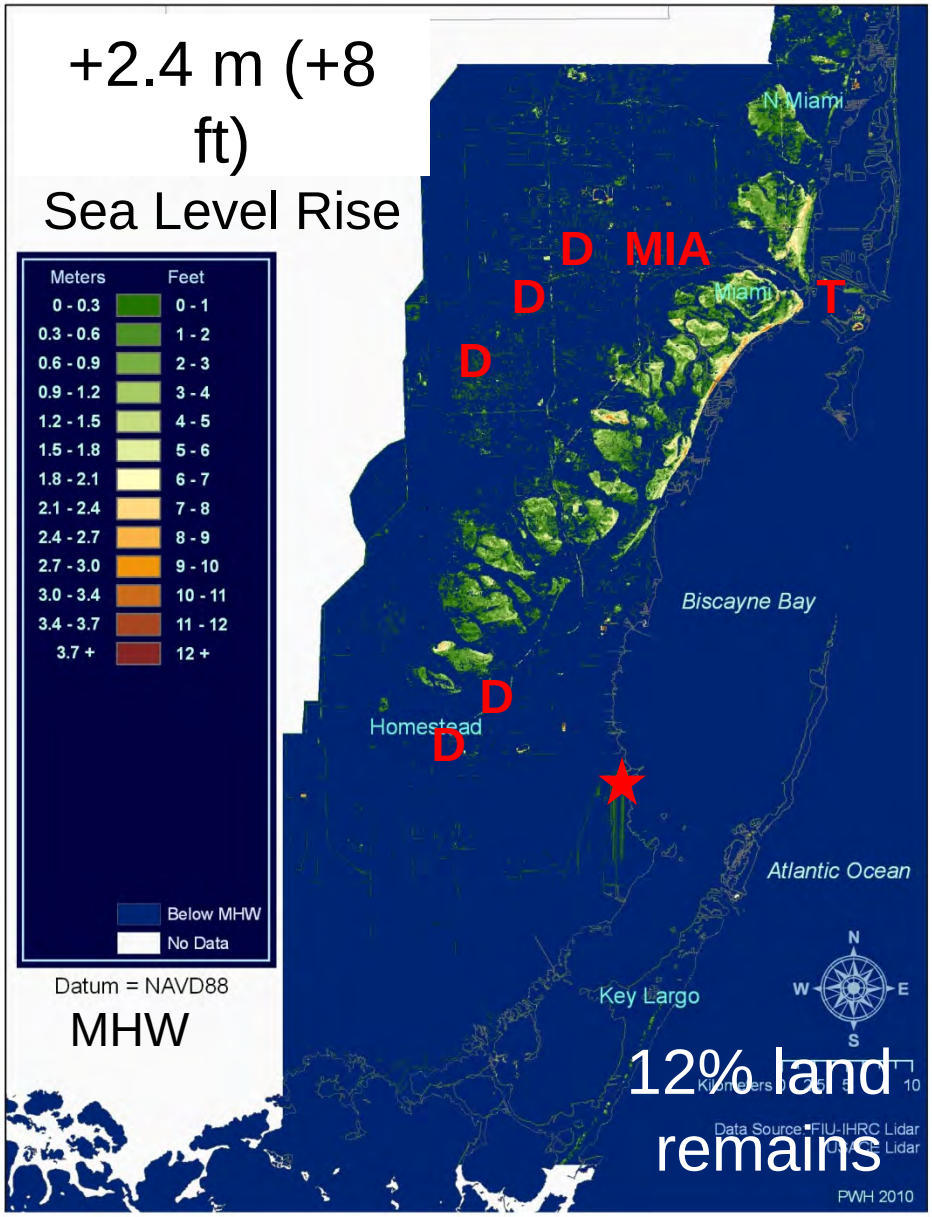
from P. Harlem, 2010

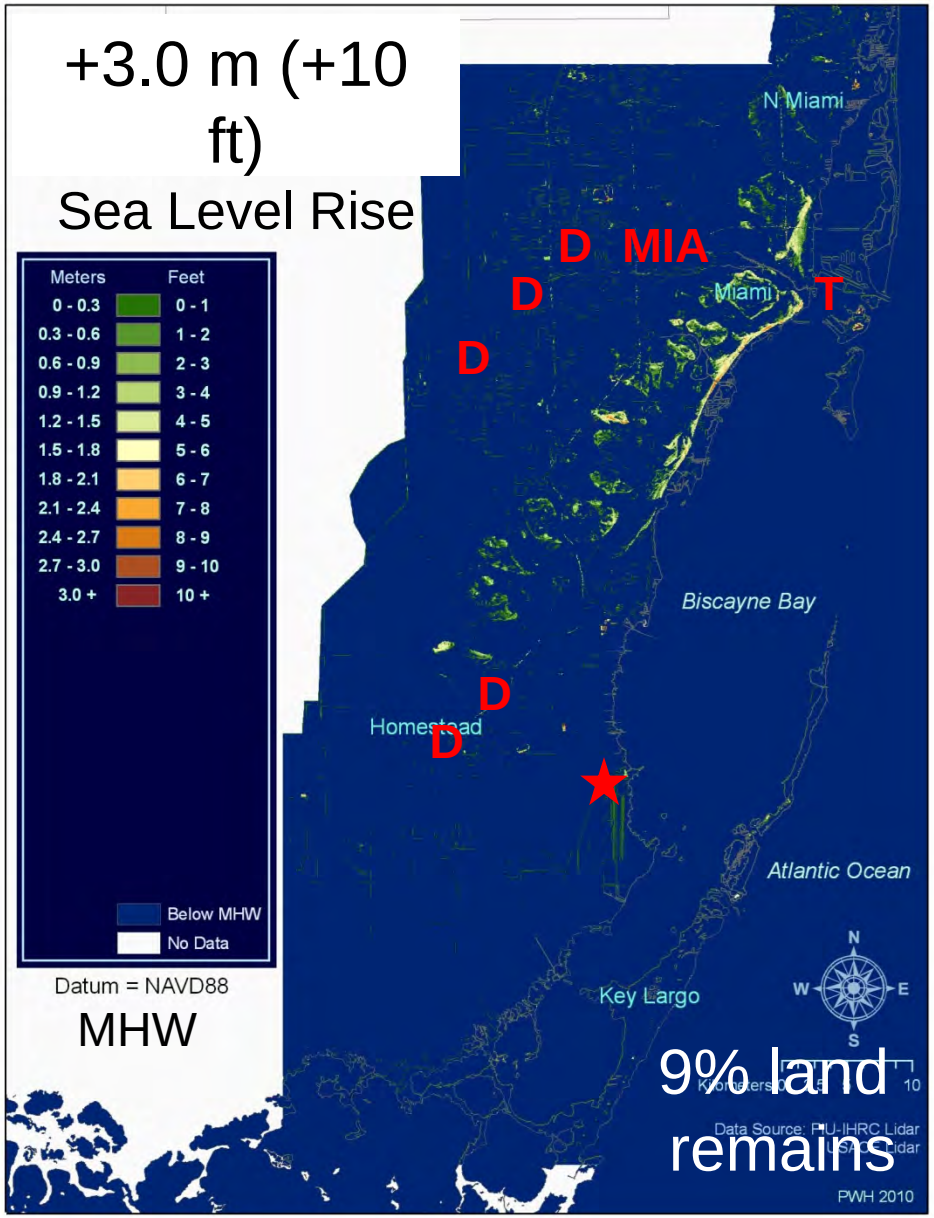




MIAMI-DADE COUNTY LiDAR MAPS

from P. Harlem, 2010





ON TOP OF THESE PROJECTIONS ARE HIGHER SEASONAL TIDES

Miami Beach tidal flooding at 10th and Alton, (aka. the corner of climate change and clean energy.). Photo is 2 ½ hours after high tide. No rain. No water main break. No hurricane. Just a twice daily high tide.

H.R. Wanless, 2013

Photo by Jon Ullman

STORM SURGES, ACTING AT HIGHER SEA LEVELS, WILL CAUSING MORE FREQUENT AND EXPONENTIALLY MORE SEVERE AND EXPENSIVE DAMAGE.

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

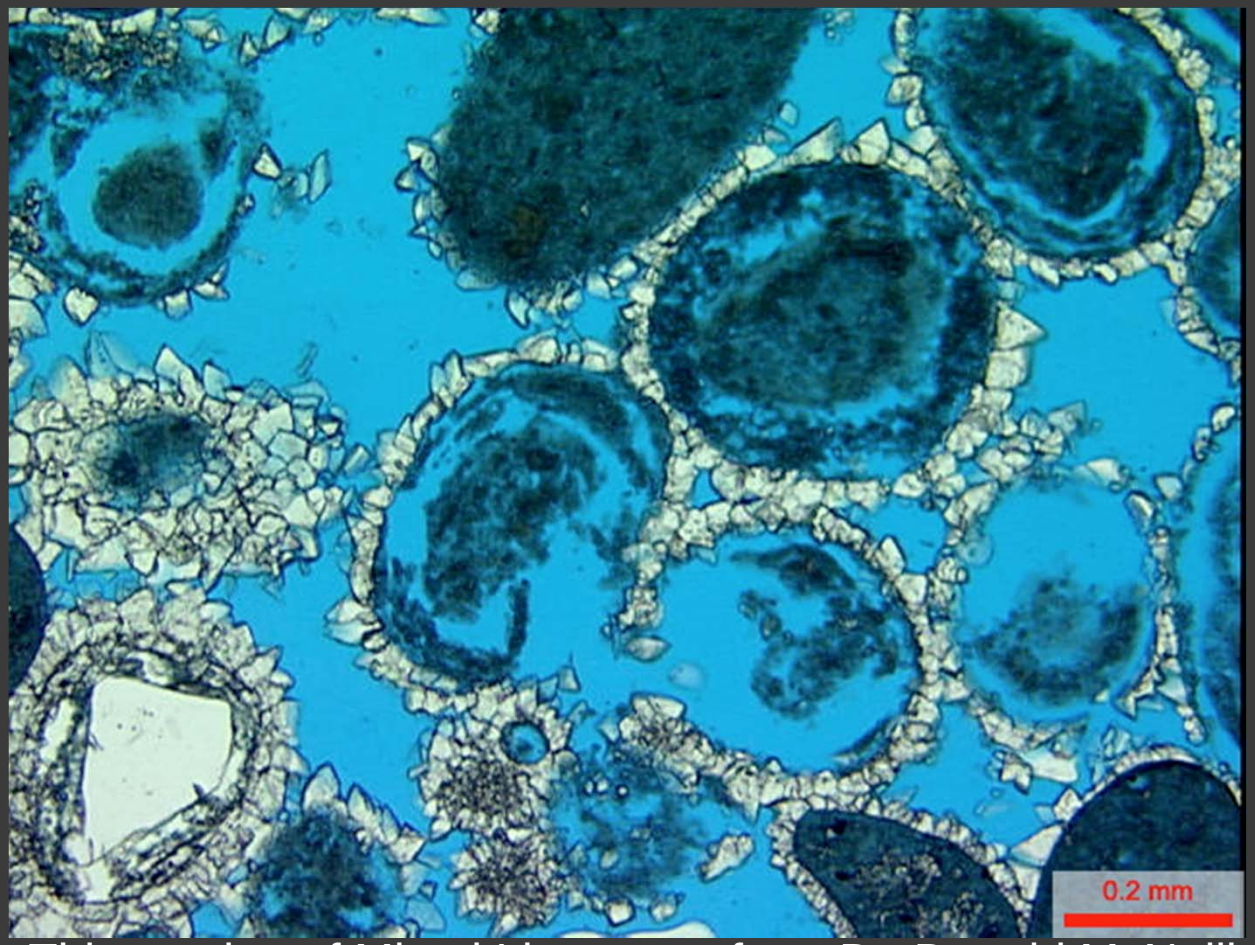
H.R. Wanless, 2013

from PPT by William B Potter

IMPORTANTLY, FLORIDA IS UNDERLAIN BY VERY POROUS LIMESTONE AND SAND

We cannot build dikes to keep out rising water.

BLUE IS POROSITY



Thin section of Miami Limestone from Dr. Donald McNeill

“Sea ice decline is decades ahead of when models predicted.

“Melting of polar ice sheets may occur more rapidly than previously predicted.

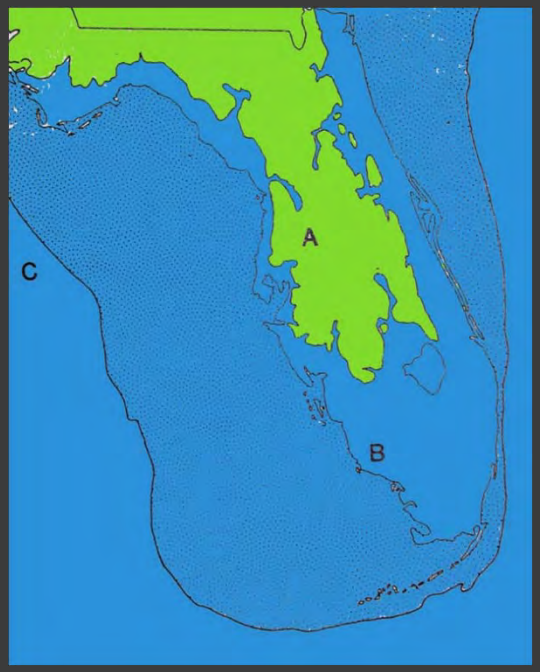
“We could see disastrous consequences of climate change far sooner than expected.”

Dr. Michael Mann,
Director Earth System Science Center,
Pennsylvania State University
October, 2012

REINFORCING FEEDBACKS
MAKE FUTURE
RAPIDLY ACCELERATING
ICE MELT
AND ACCELERATING
SEA LEVEL RISE
INEVITABLE AND UNSTOPPABLE AND

FASTER THAN ANTICIPATED.

FLORIDA THROUGH TIME



120,000 years ago

+ 6 meters

~ ½ from Greenland

~ ½ from Antarctica

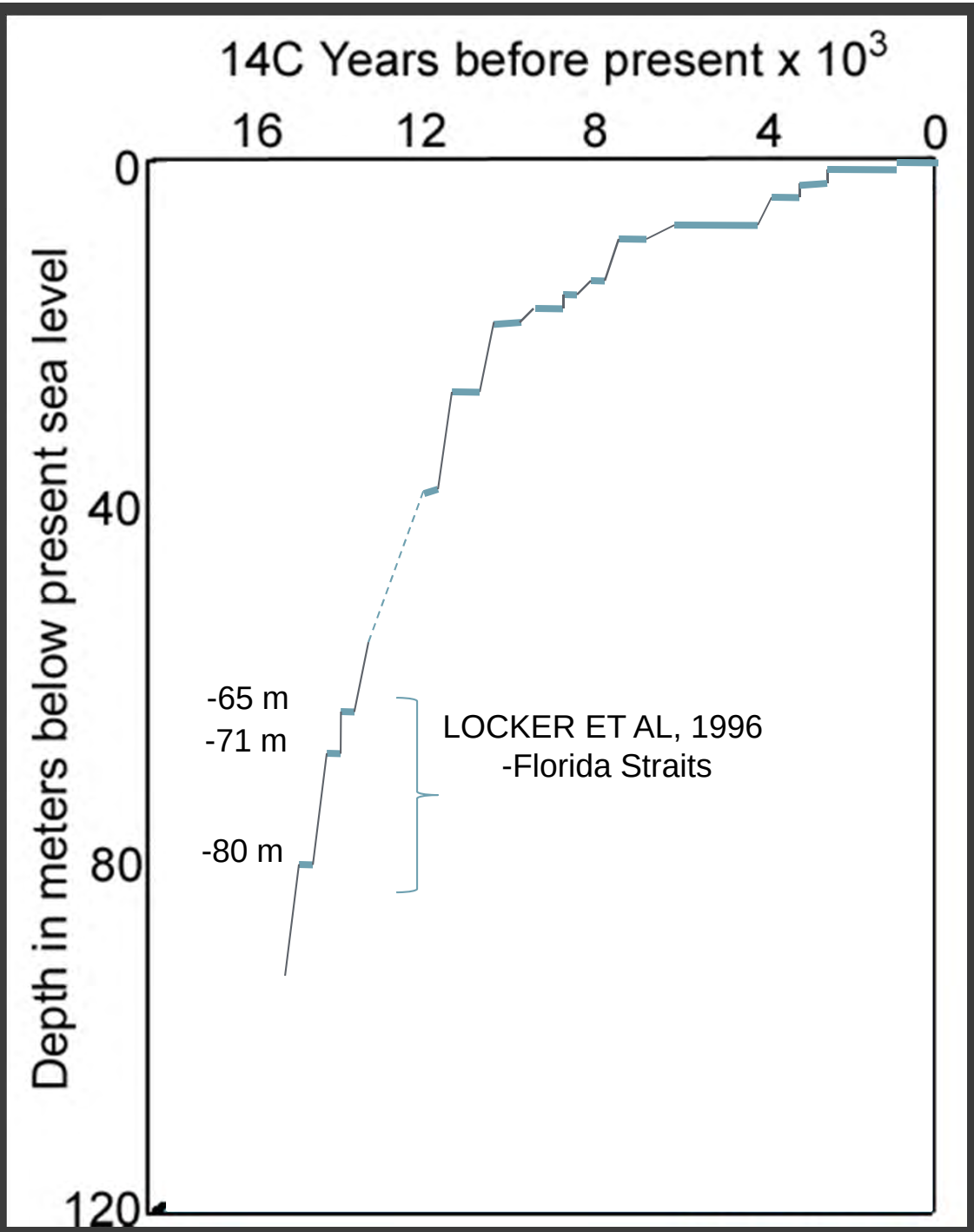
18,000 years ago

- 120 meters

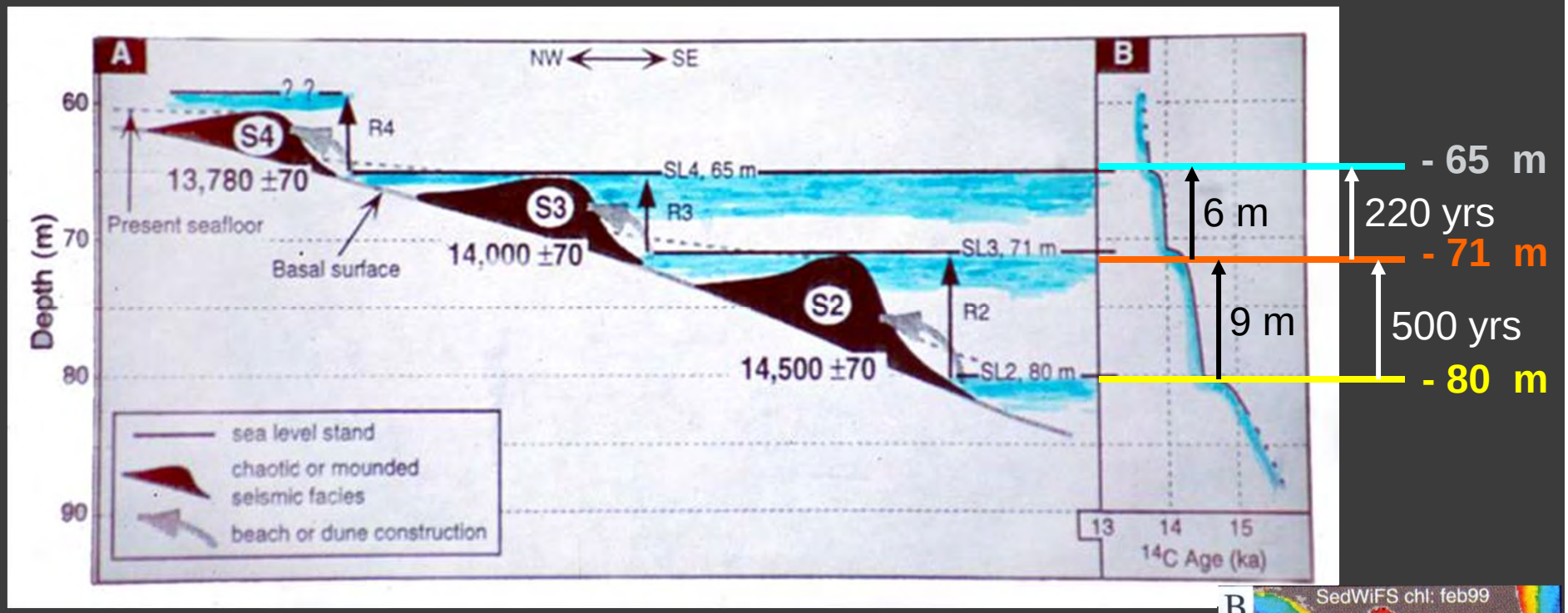
Today

How did this sea level rise occur?

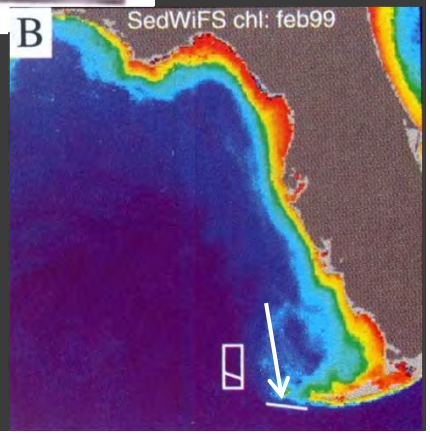
SEA LEVEL
STILL STANDS
AND
RAPID RISES



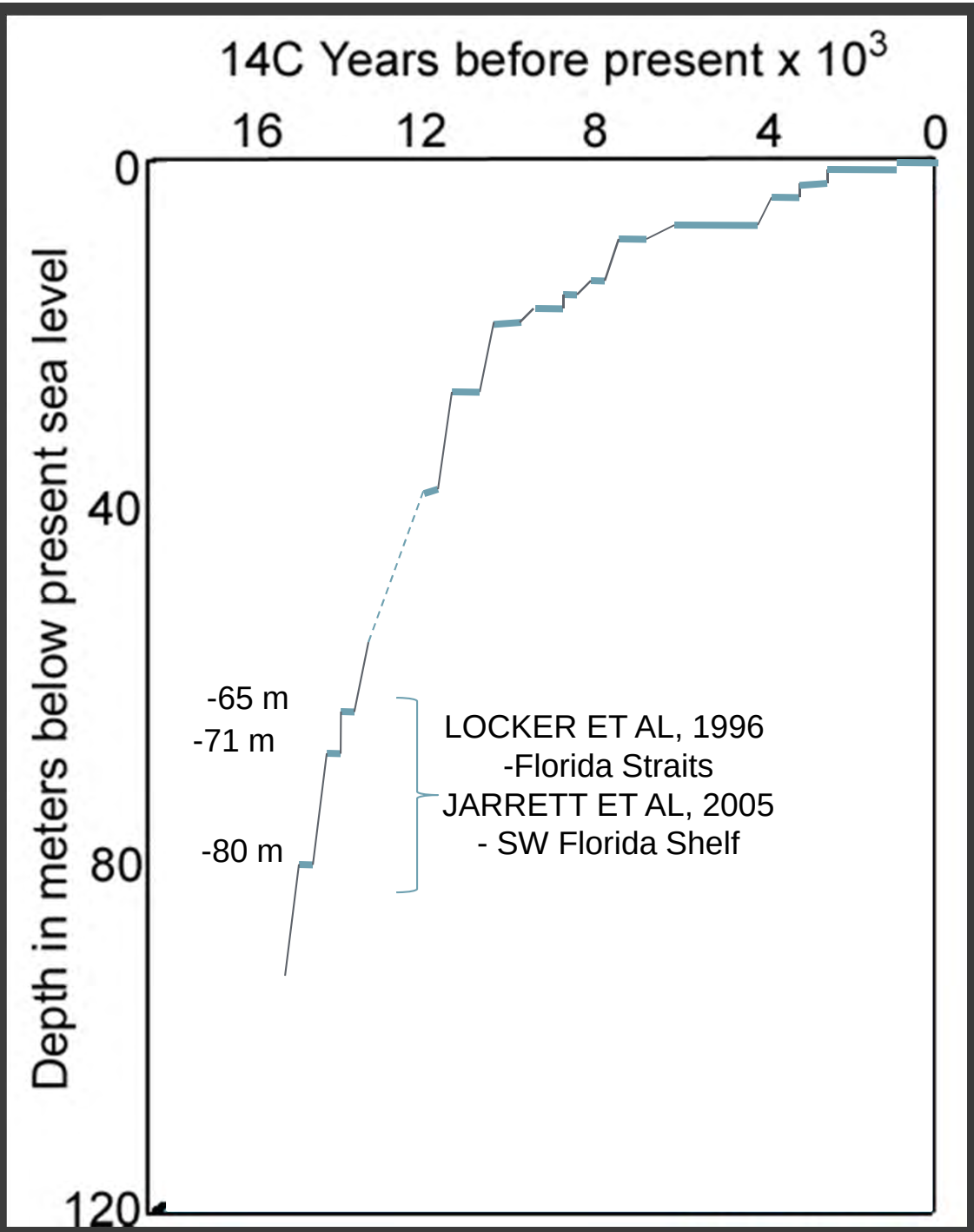
Recent research shows that relative sea level rise is not a simple curve but one with significant stalls and rapid rises.



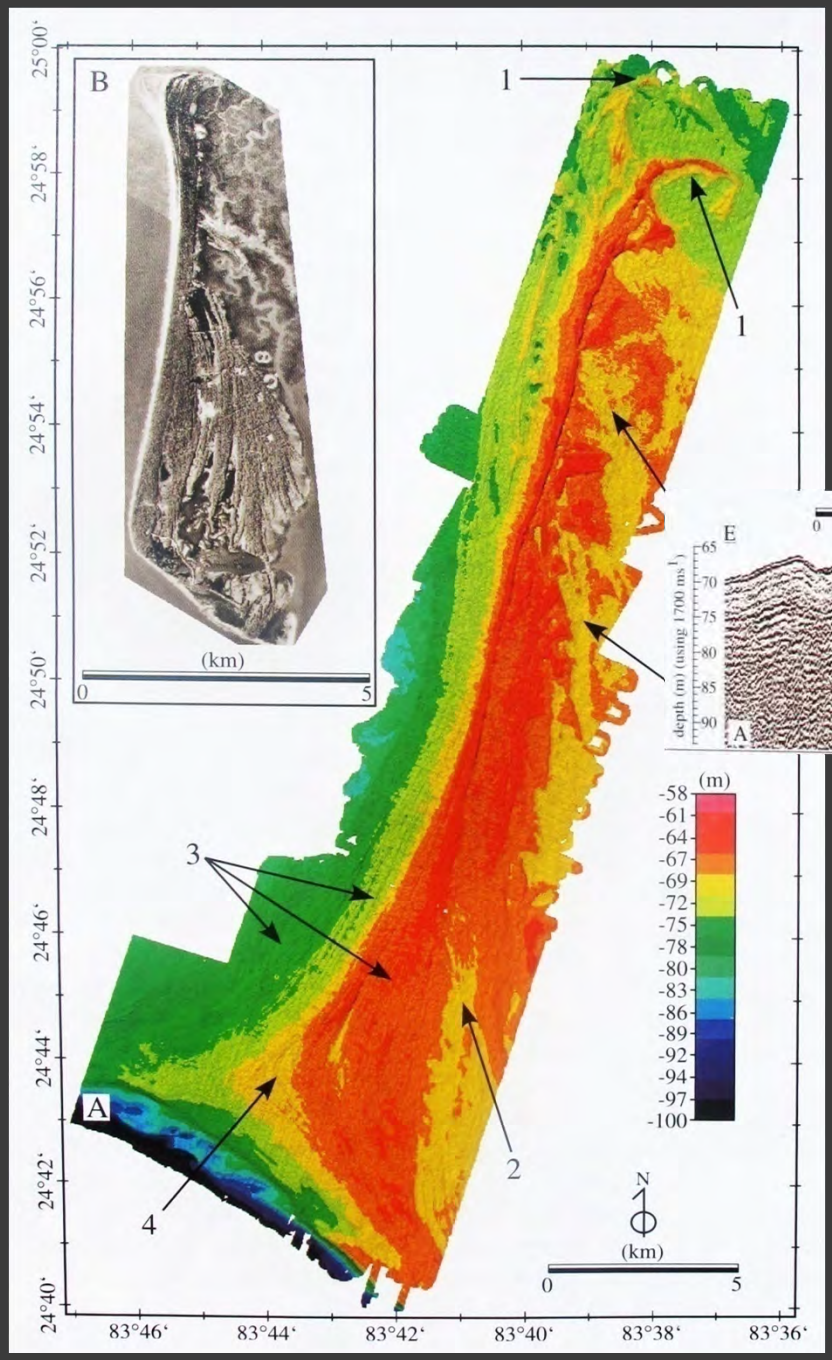
As sea level was first advancing out of the last ice age, it rose in 6-10 meter steps 200-500 years apart, each still stand leaving a distinct, cemented, oolitic sand beach ridge.

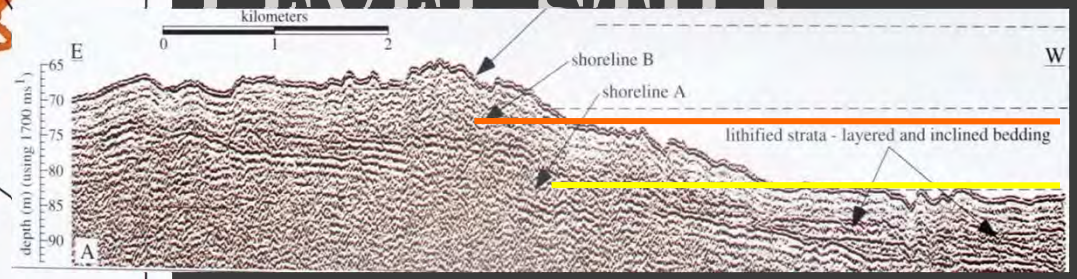


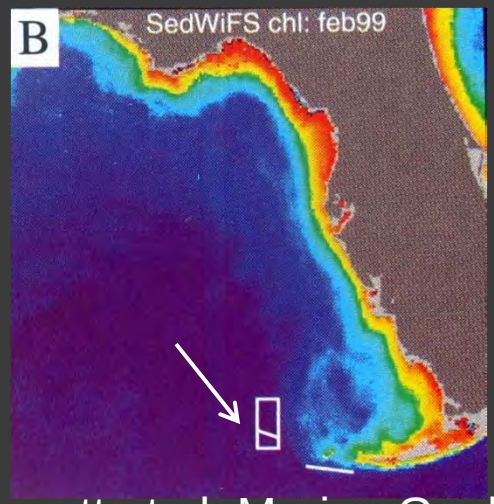
SEA LEVEL STILL STANDS AND RAPID RISES



DEEP CORAL REEF CAPPING A DROWNED BARRIER ISLAND FORMED DURING TWO SEA LEVEL STILL

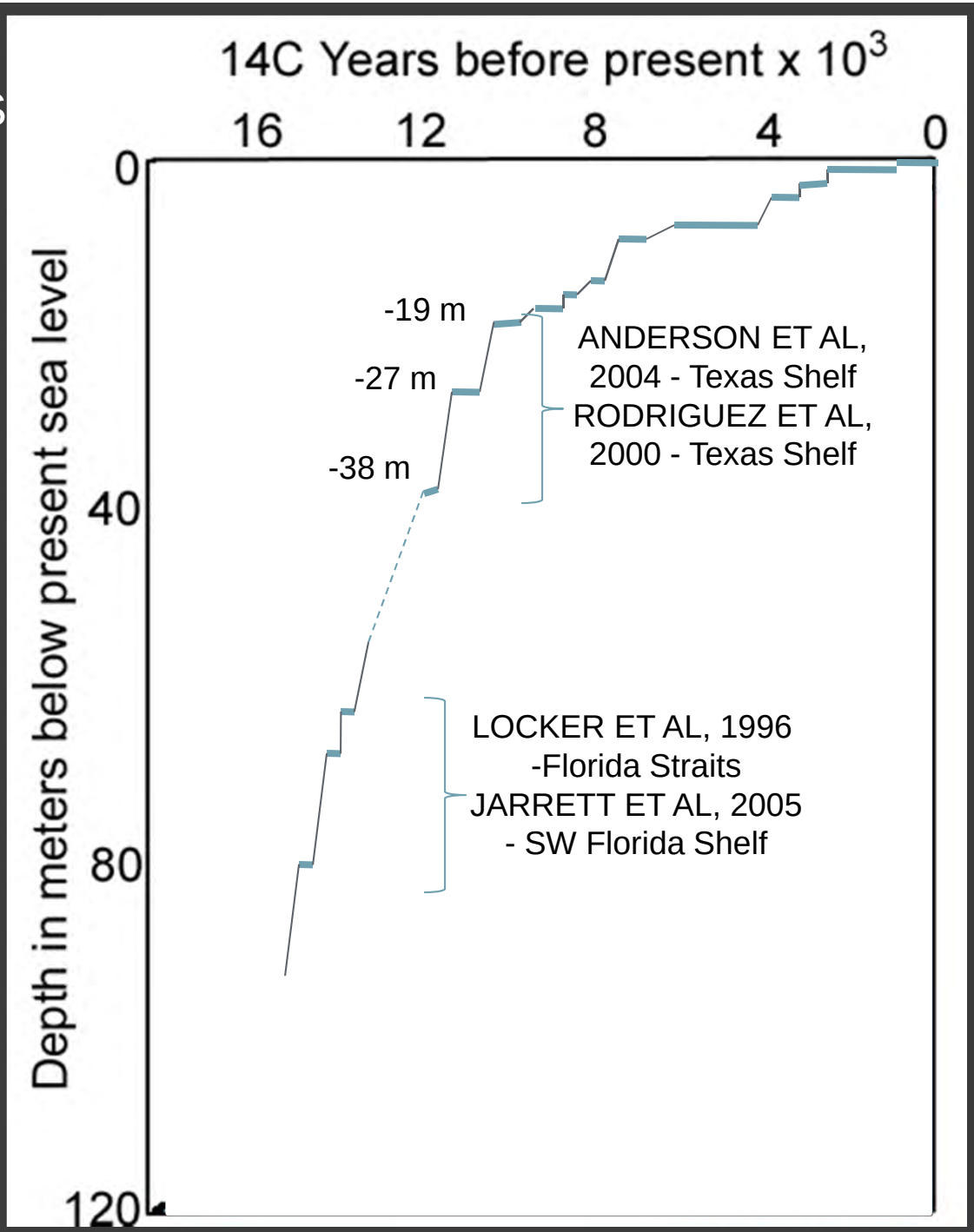






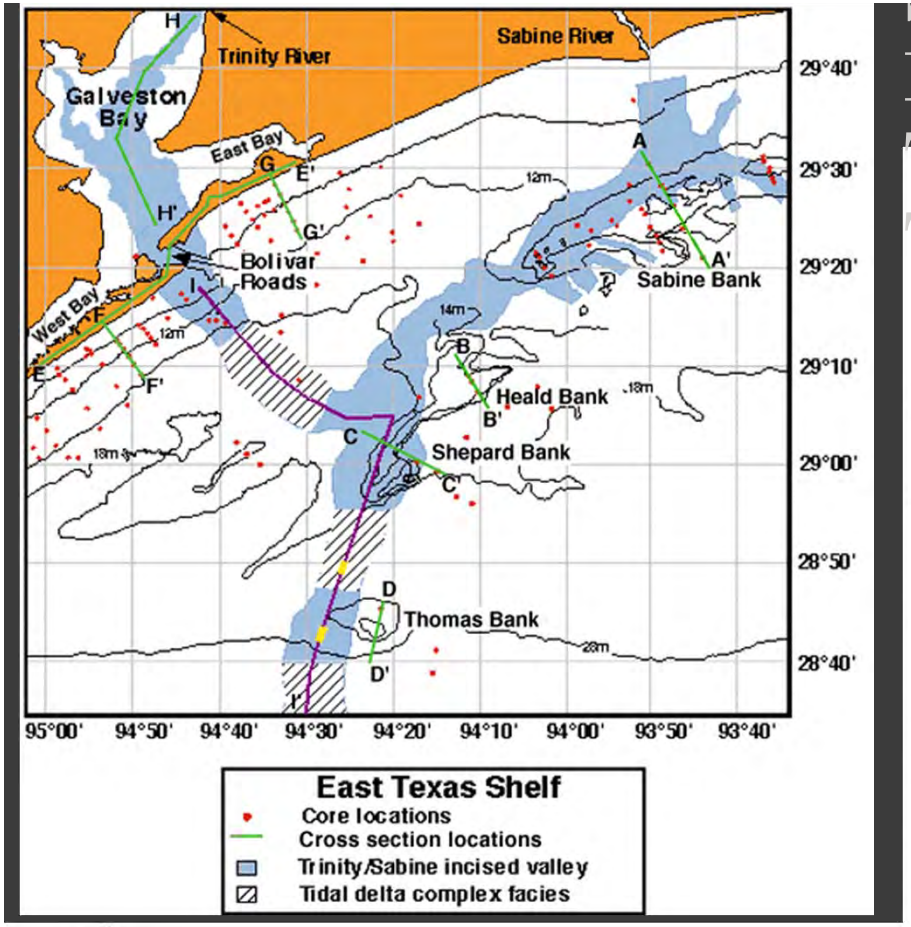
From: Jarrett et al, Marine Geology, 2005

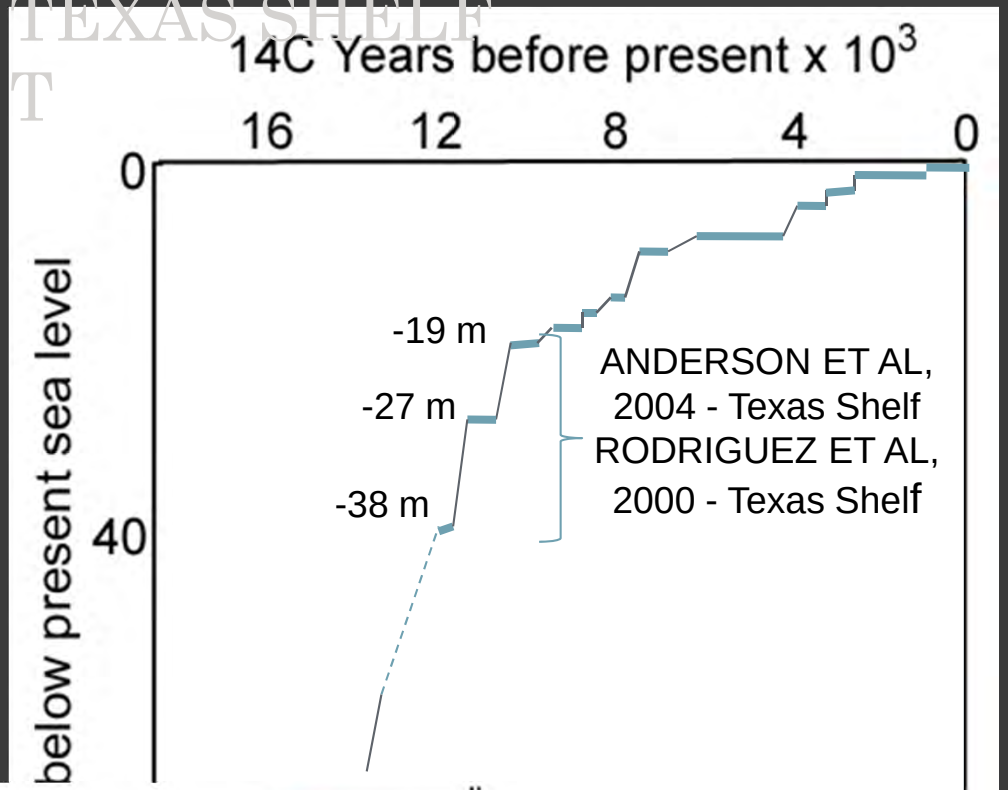
SEA LEVEL STILL STANDS AND RAPID RISES

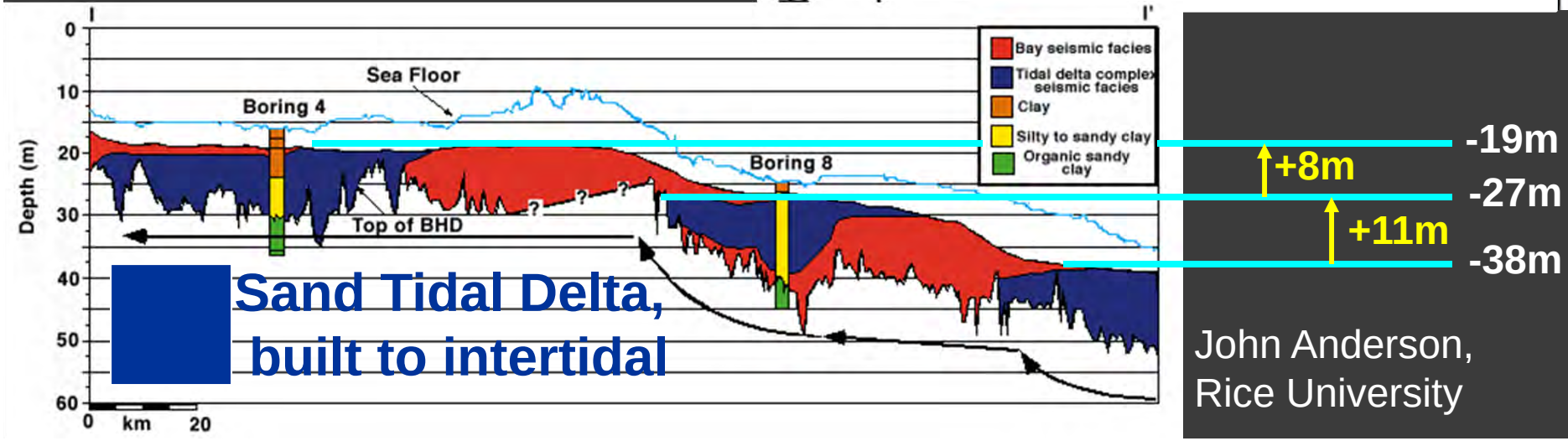


STEPS OF RAPID SEA LEVEL RISE

TEXAS SHELF

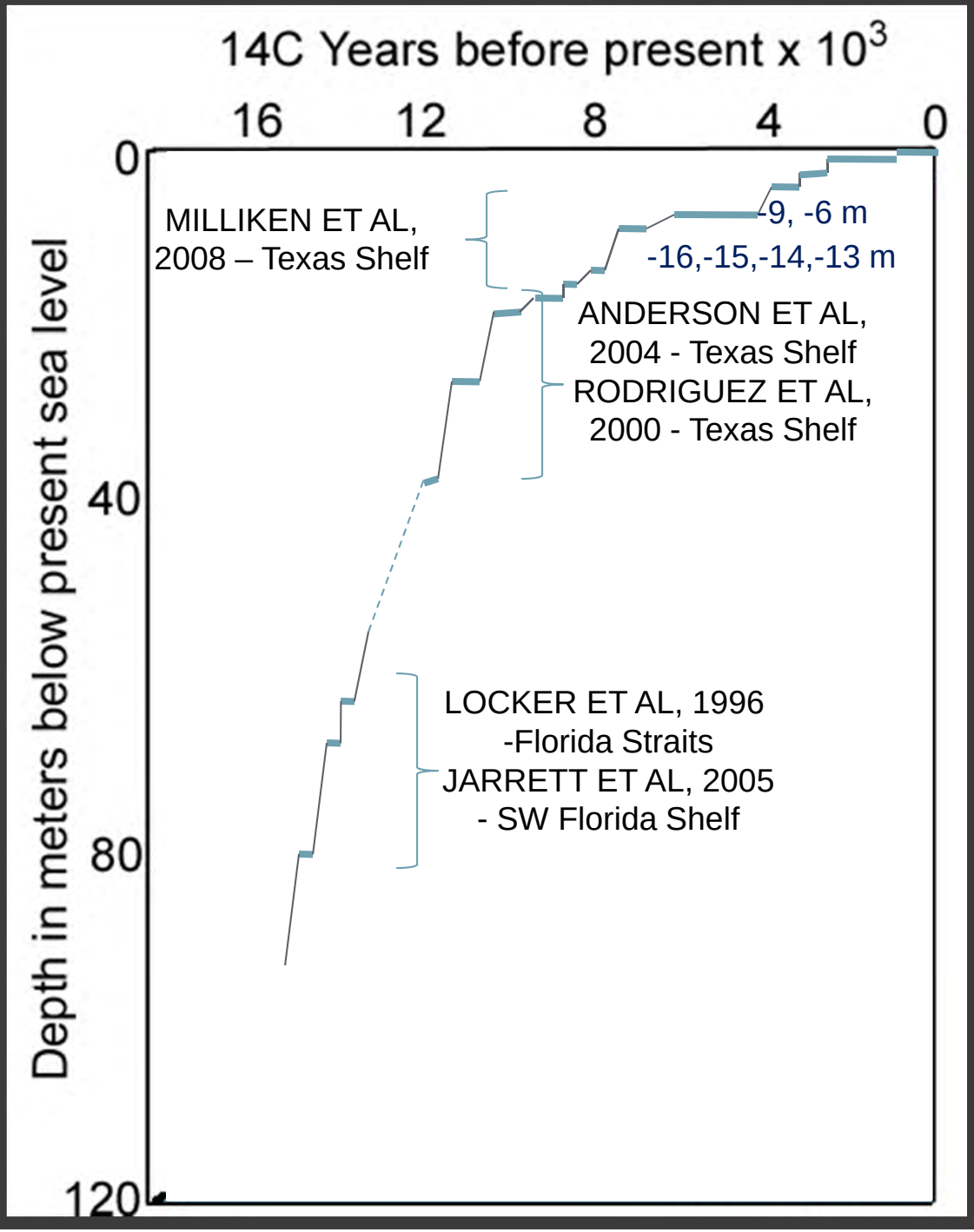




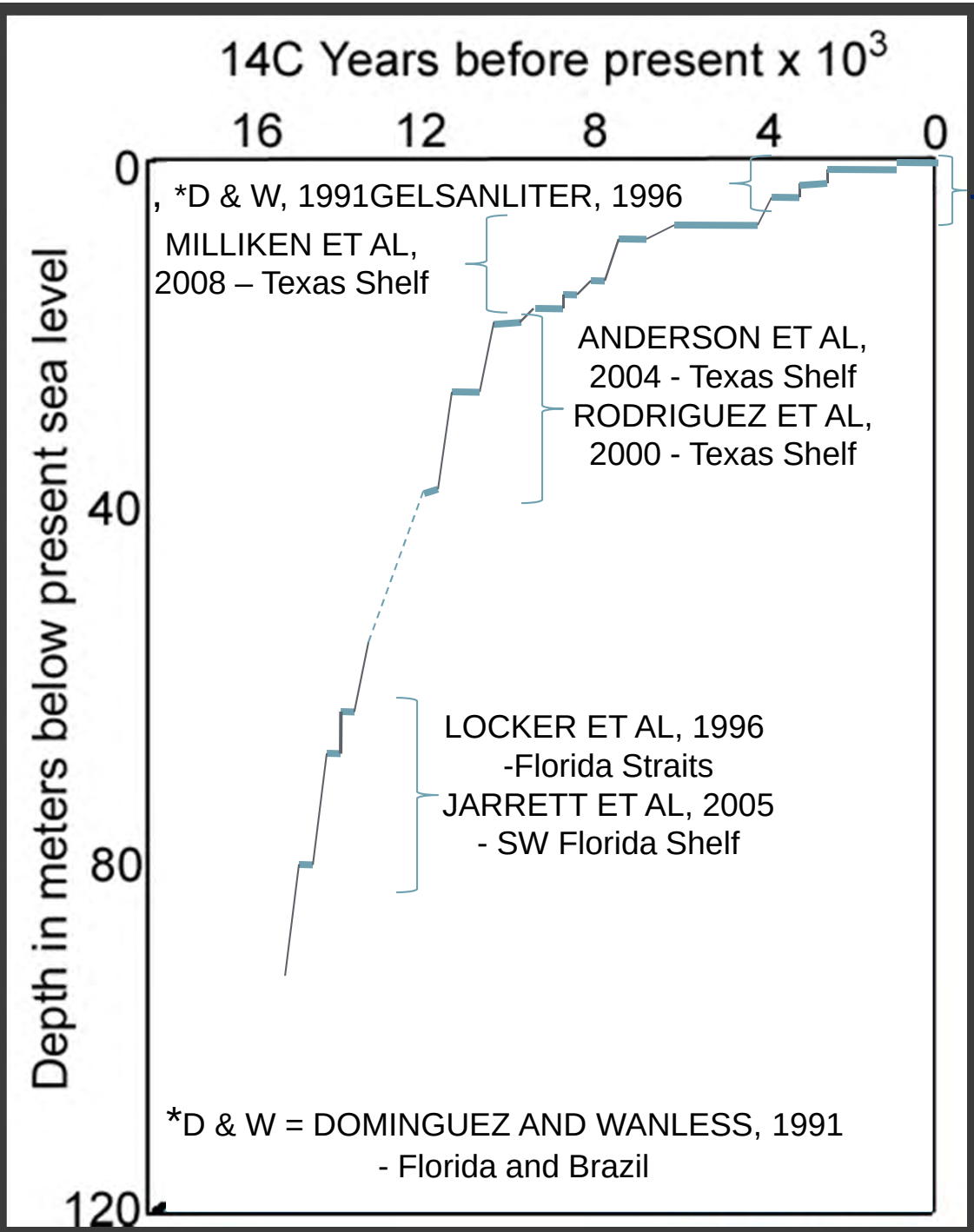


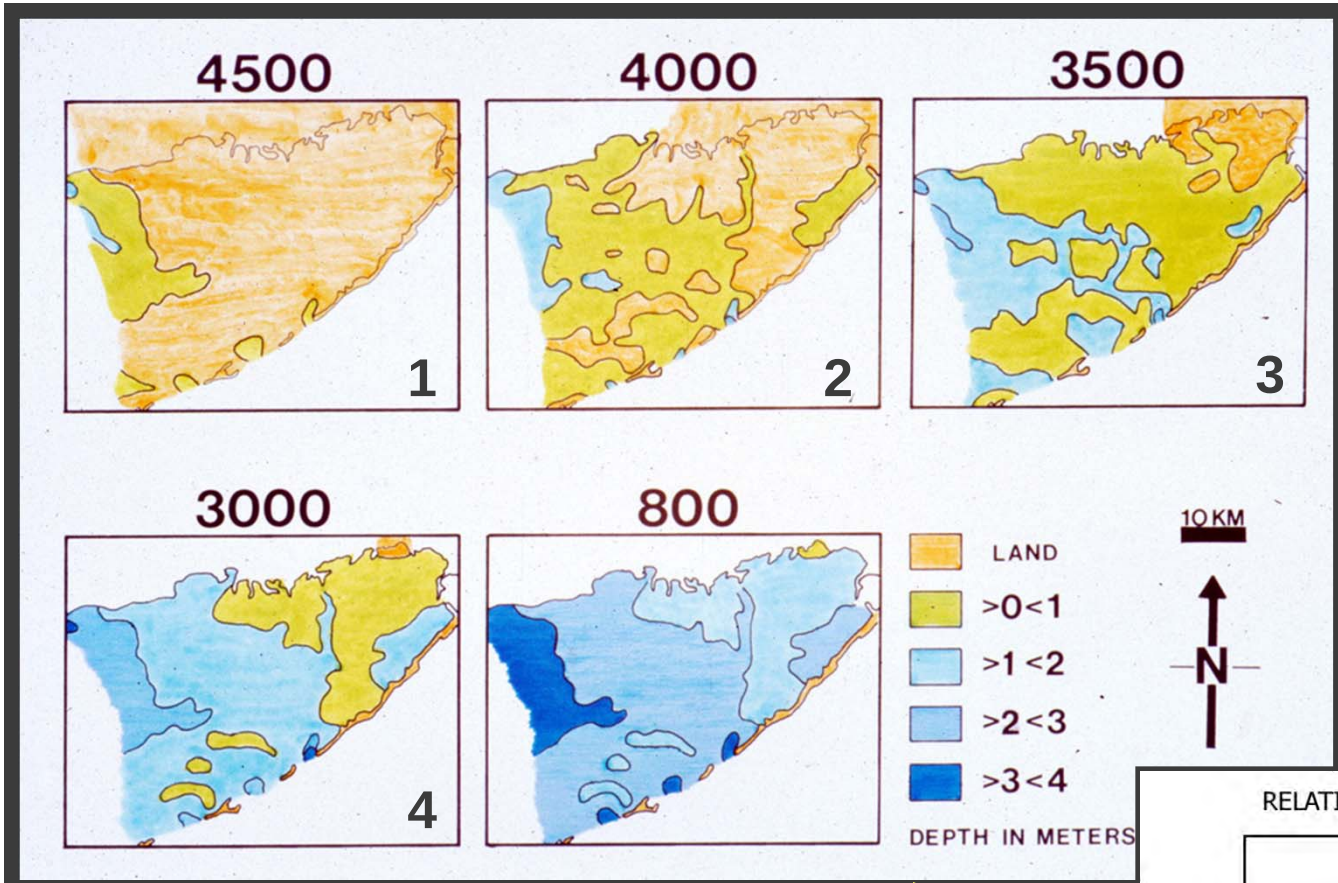
John Anderson, Rice University

SEA LEVEL STILL STANDS AND RAPID RISES

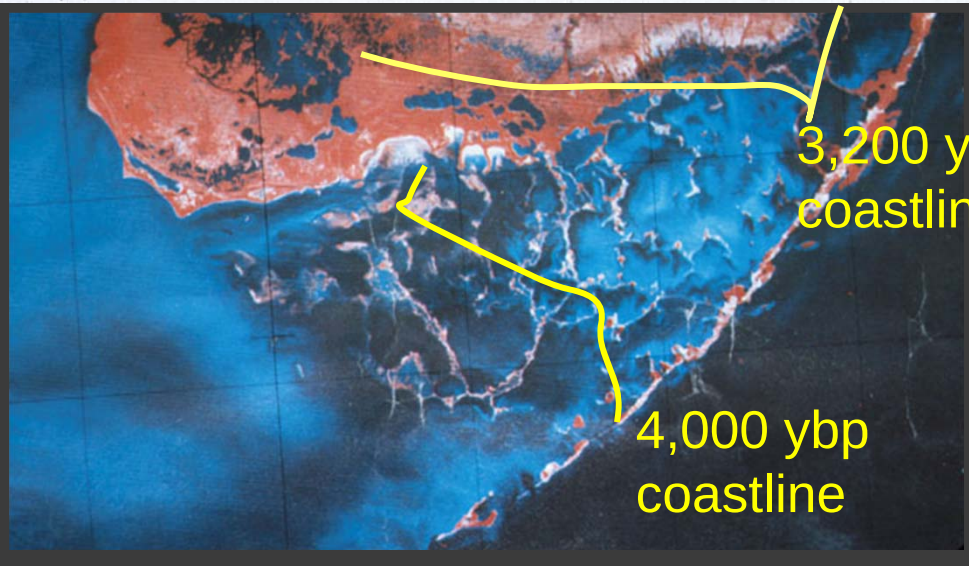


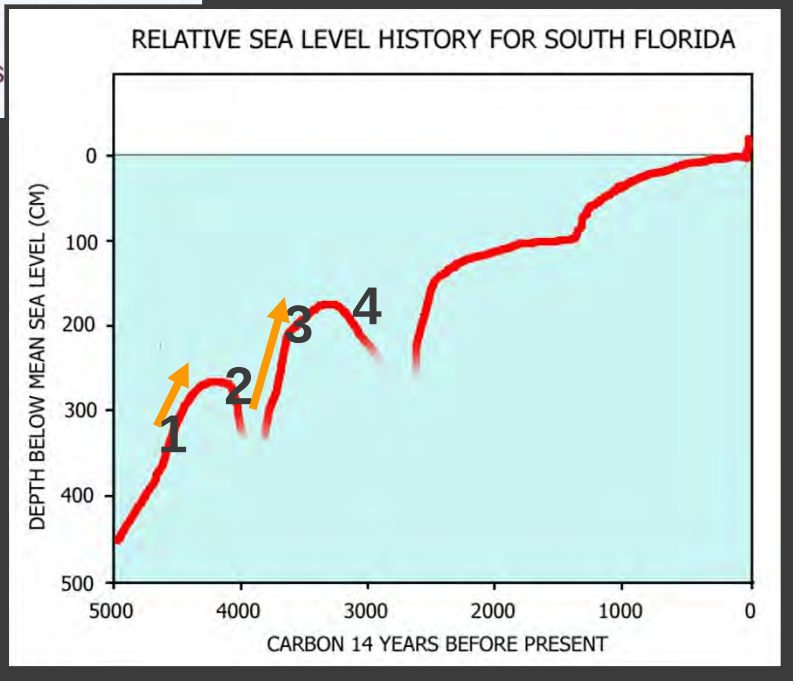
SEA LEVEL STILL STANDS AND RAPID RISES

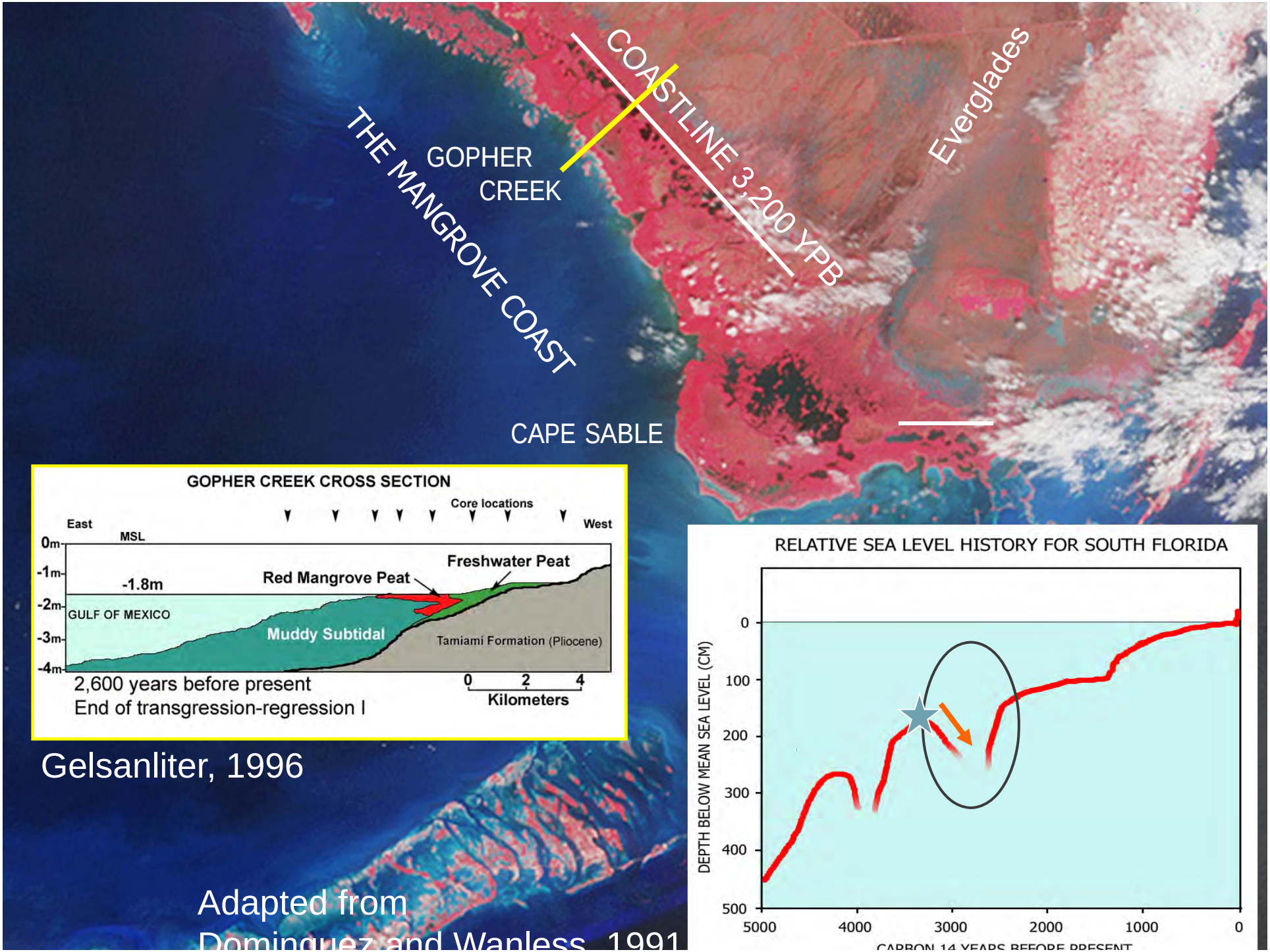




Florida Bay was inundated during two pulses of sea level rise between 4,500 and 3,200 ybp.



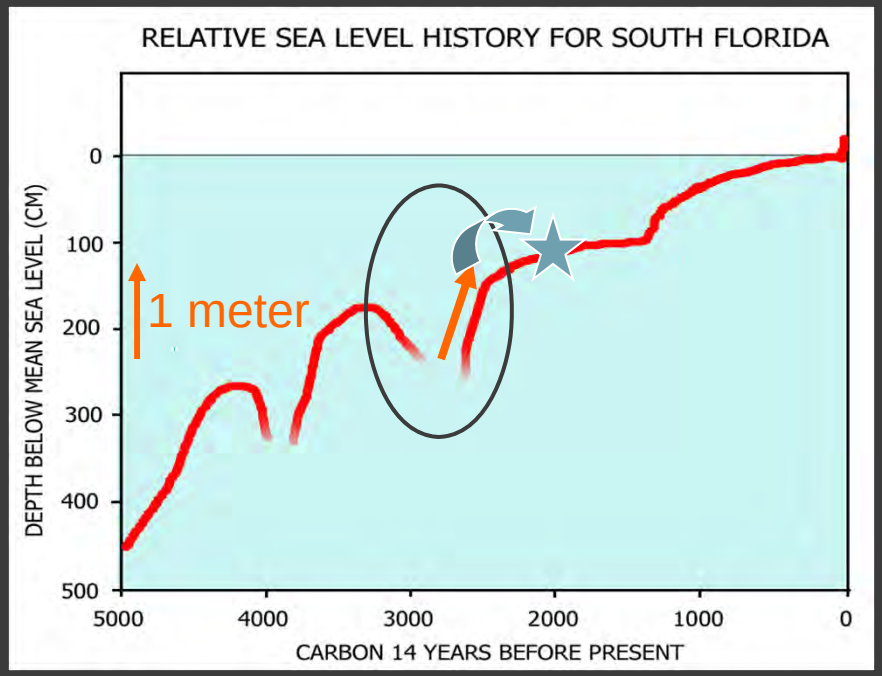


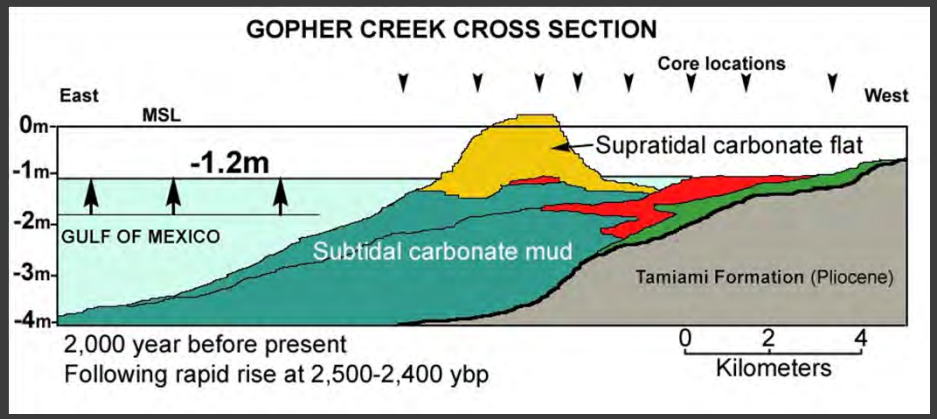


Gelsanliter, 1996

Adapted from Dominguez and Wanless, 1991

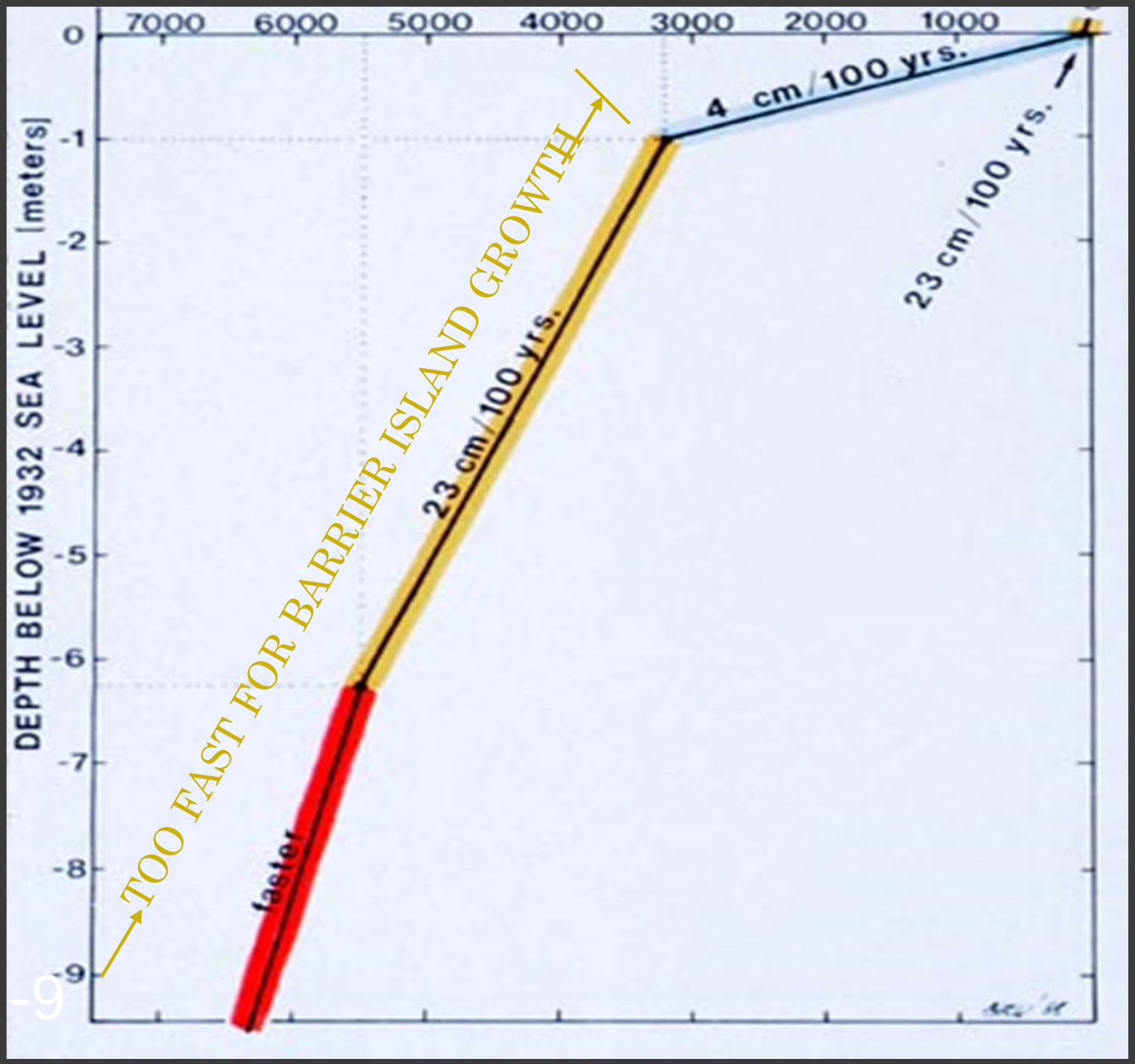
A small, rapid rise 2,500-2,400 ybp; then a 400 year period of intensive sediment erosion and recycling.





Gelsanliter, 1996

RELATIVE SEA LEVEL HISTORY FOR SOUTH FLORIDA

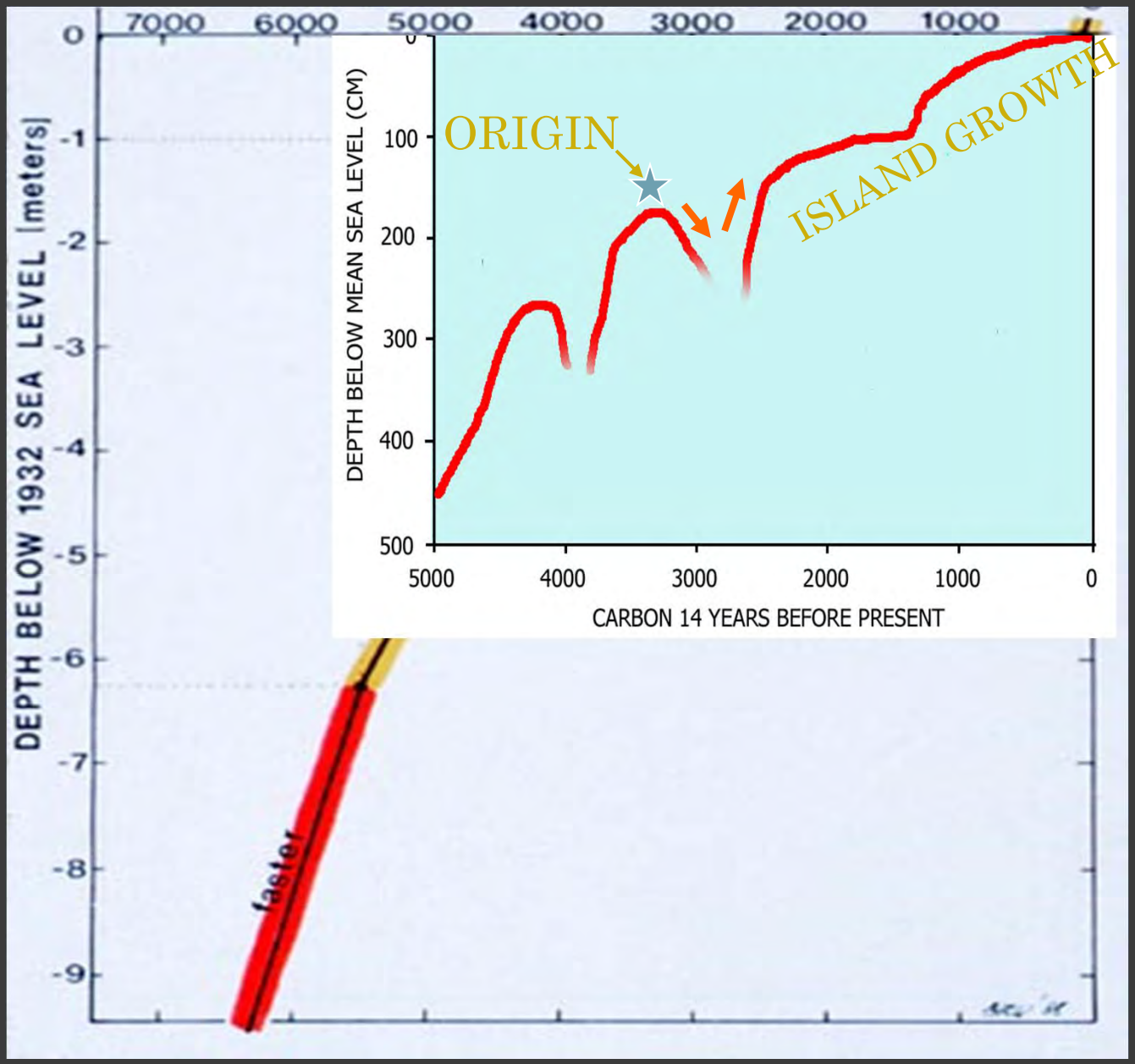


Graph of last 7,000 years of south Florida sea level rise

Gradually decreasing rate of sea level rise

Too fast a rise until about 3,200 years ago

RELATIVE SEA LEVEL HISTORY FOR SOUTH FLORIDA



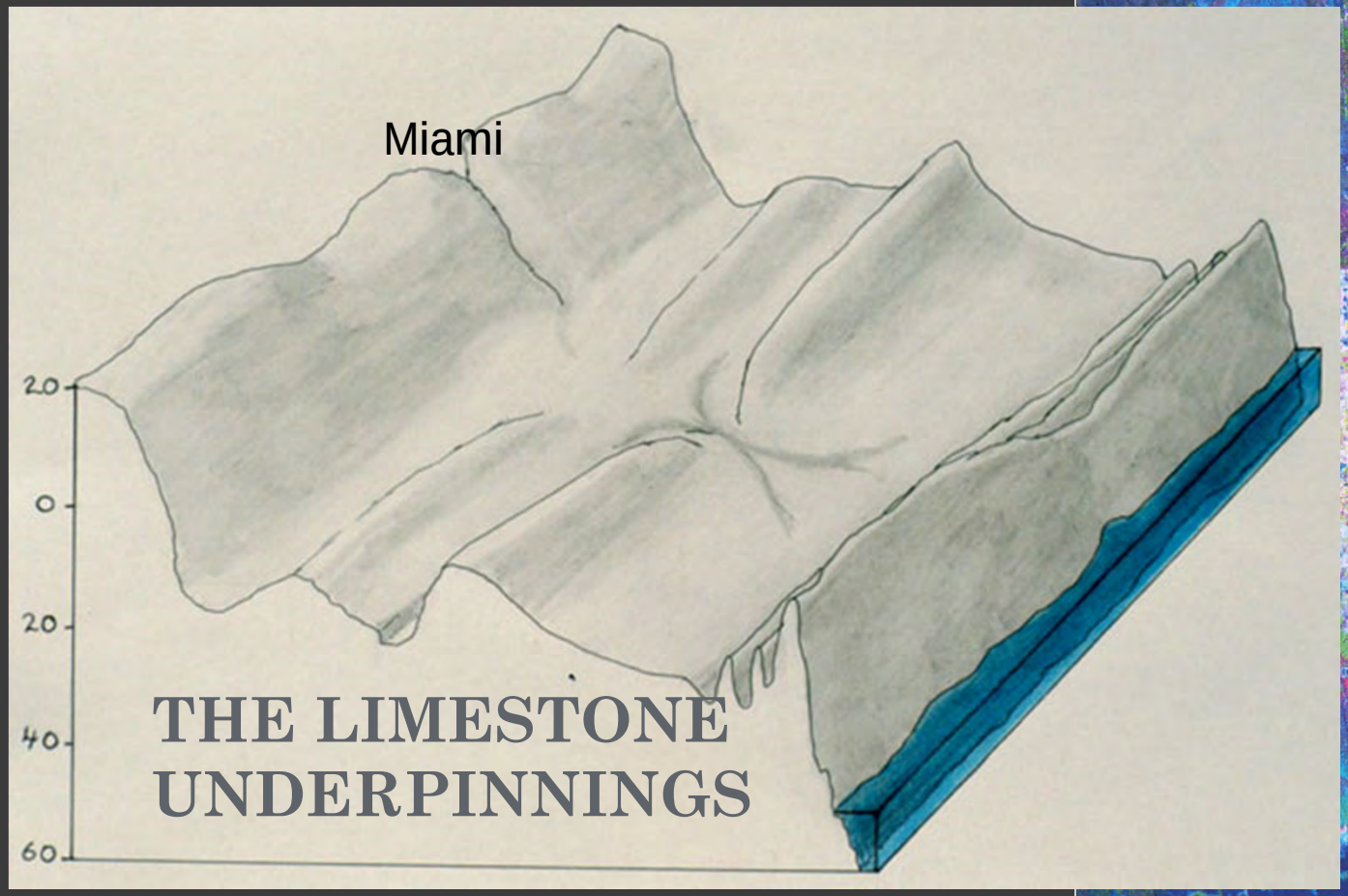
More detailed look at last 5,000 years.

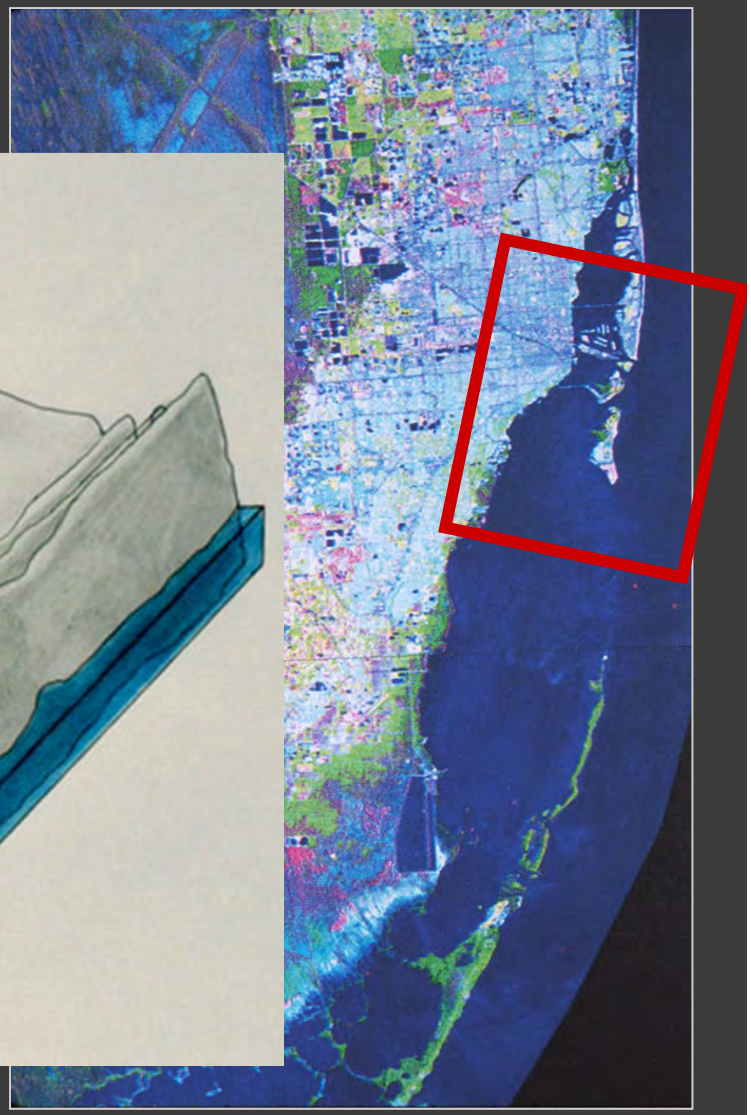
Key Biscayne was initiated during a pause in sea level rise about 3,200 years ago.

Most of island growth was over past 2,300 years.

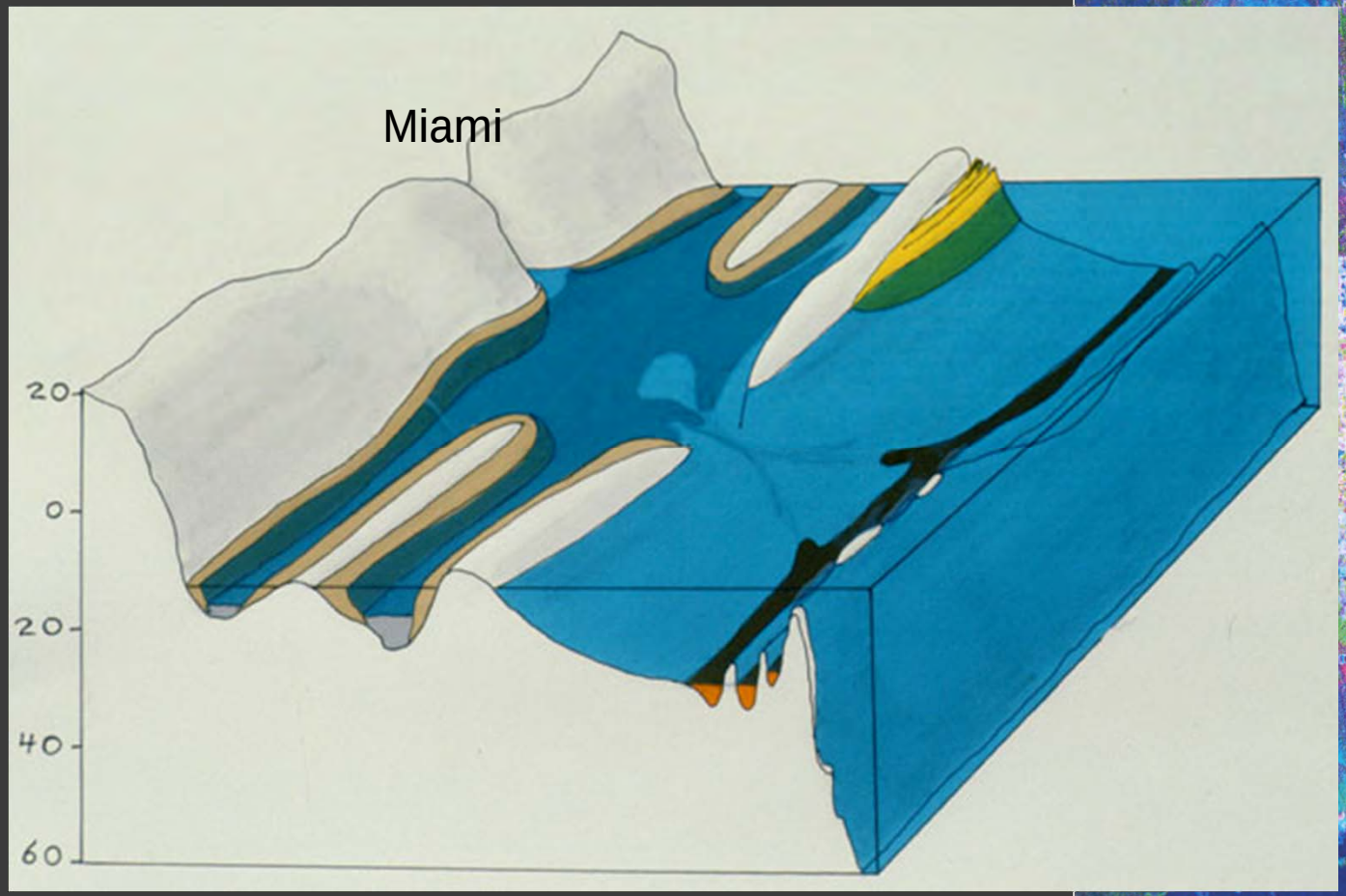
A BLOCK DIAGRAM OF THE AREA NEAR MIAMI ABOUT 7,500 YEARS AGO

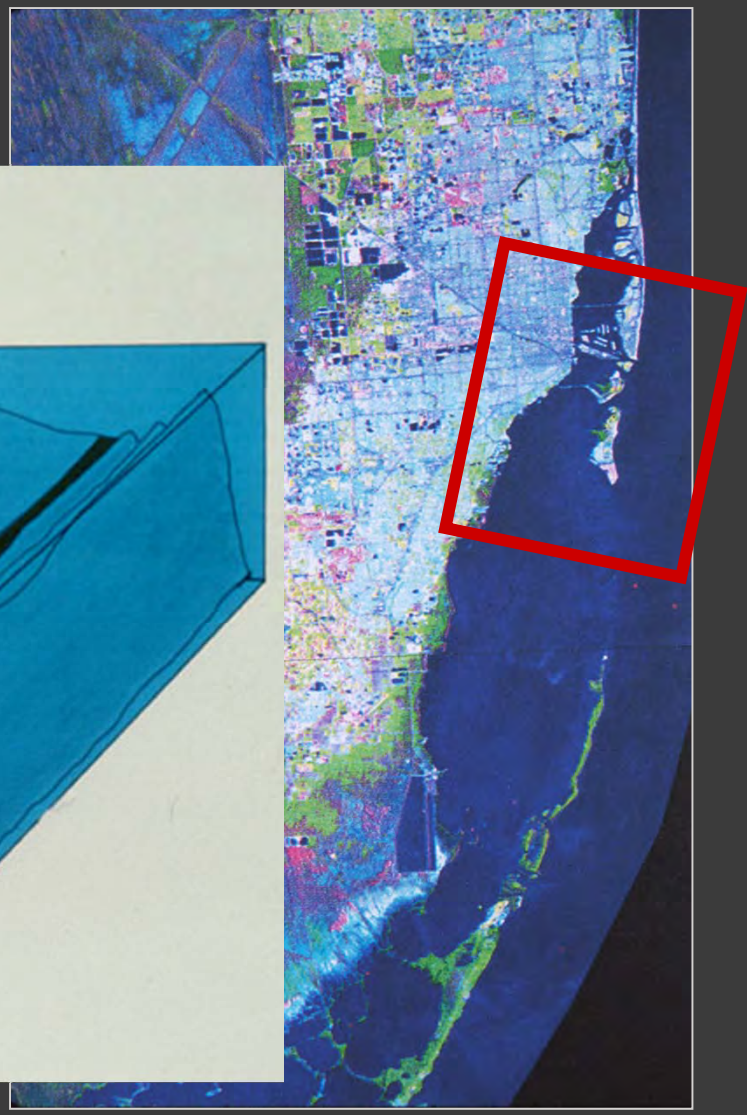
-



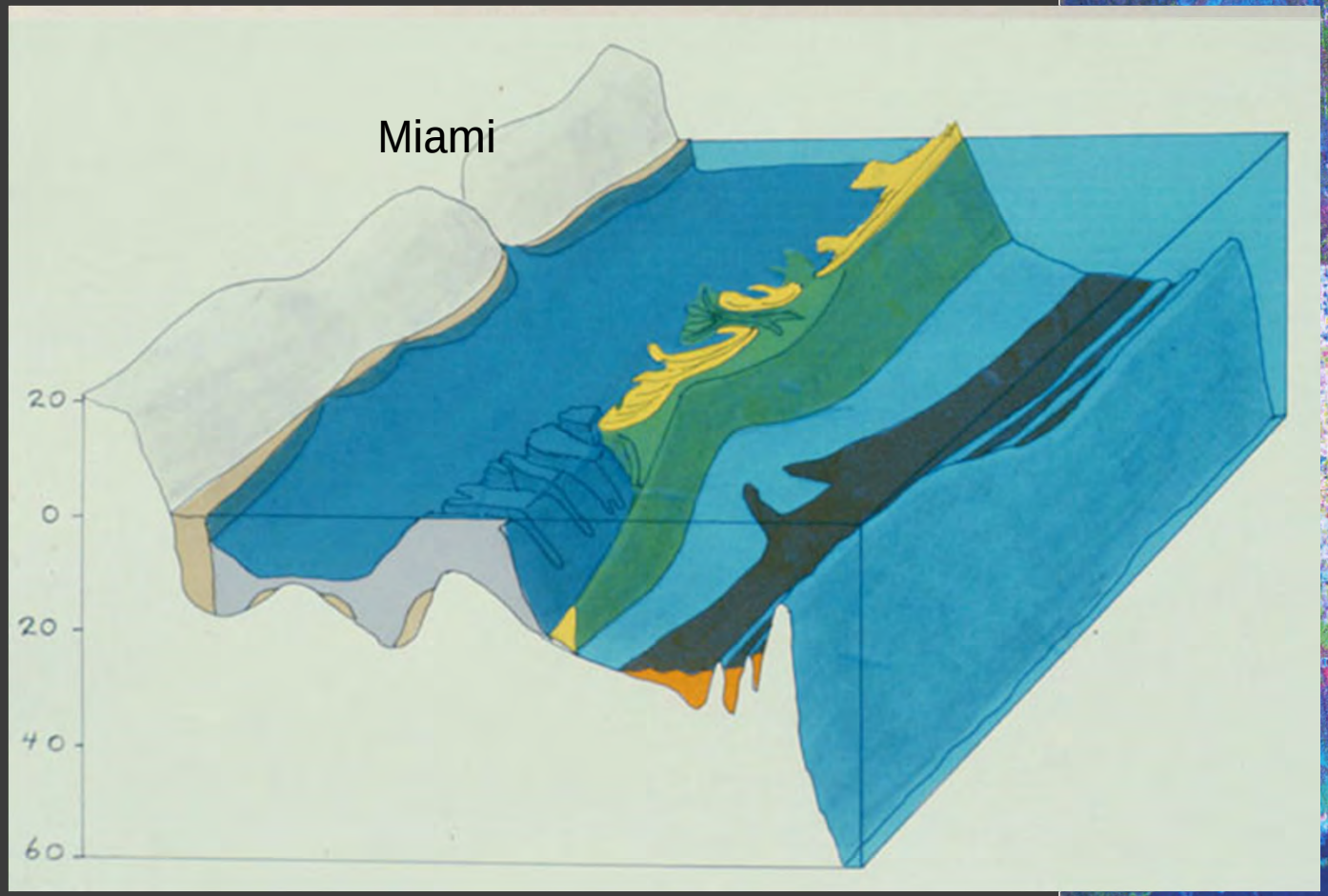


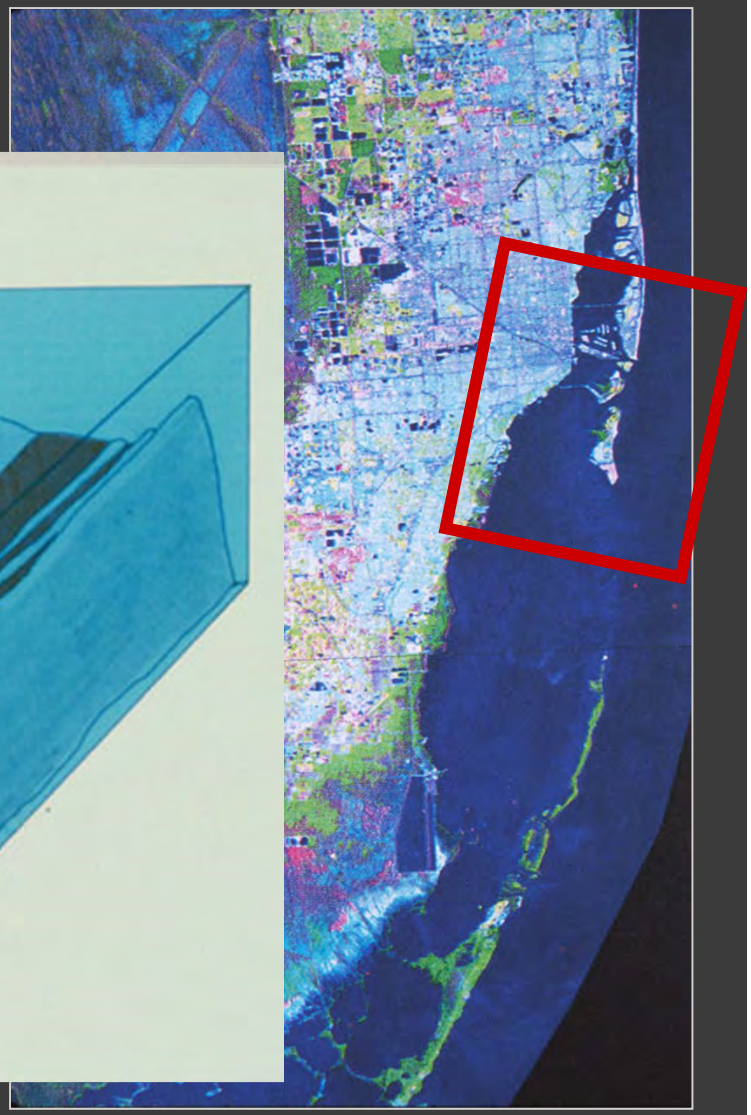
- ABOUT 4,000 YEARS AGO AS THE SEA WAS INVADING BISCAYNE BAY.

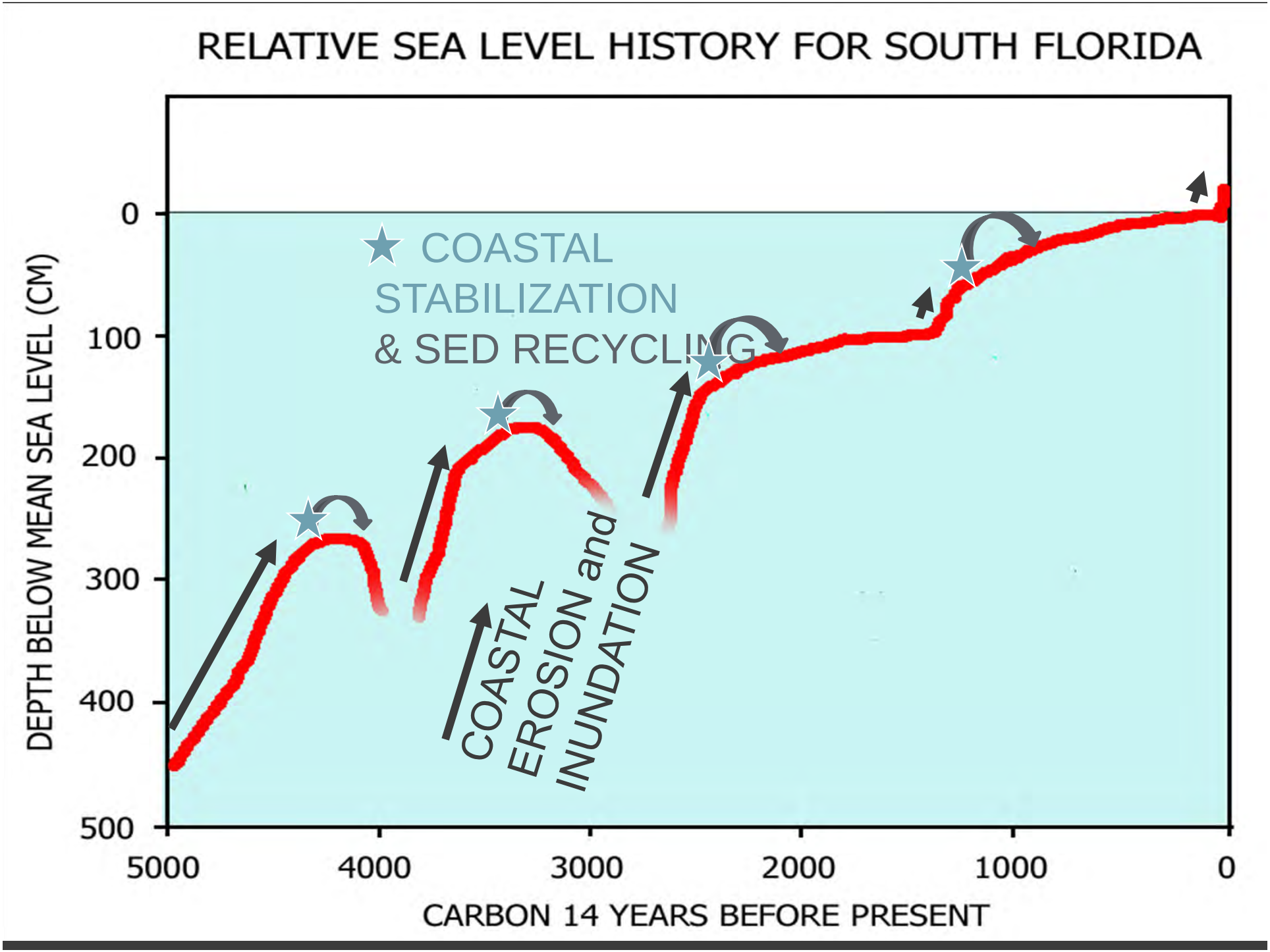




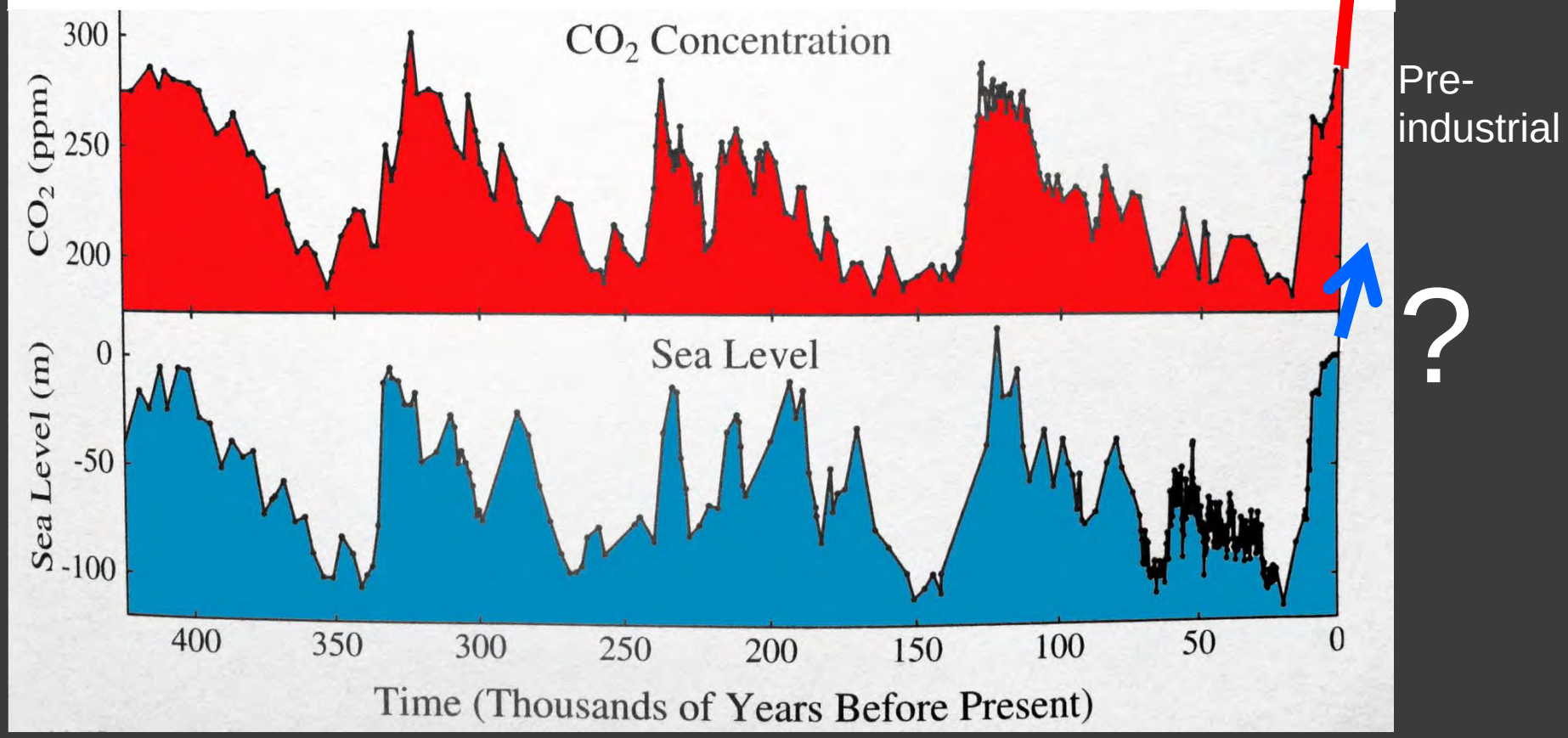
- AND TODAY.






RELATIVE SEA LEVEL HISTORY FOR SOUTH FLORIDA
COASTAL STABILIZATION & SED RECYCLING
COASTAL EROSION and INUNDATION
DEPTH BELOW MEAN SEA LEVEL (CM)
0
100
200
300
400
500
5000
4000
3000
2000
1000
0
CARBON 14 YEARS BEFORE PRESENT

WE HAVE SERIOUSLY INCREASED THE WARMING STRESSORS. WE MUST EXPECT ICE MELT AND SEA LEVEL TO RESPOND AS IT HAS IN THE PAST.



From Hansen, 2009, p. 153

“Sea ice decline is decades ahead of when models predicted.

“Melting of polar ice sheets may occur more rapidly than previously predicted.

“We could see disastrous consequences of climate change far sooner than expected.”

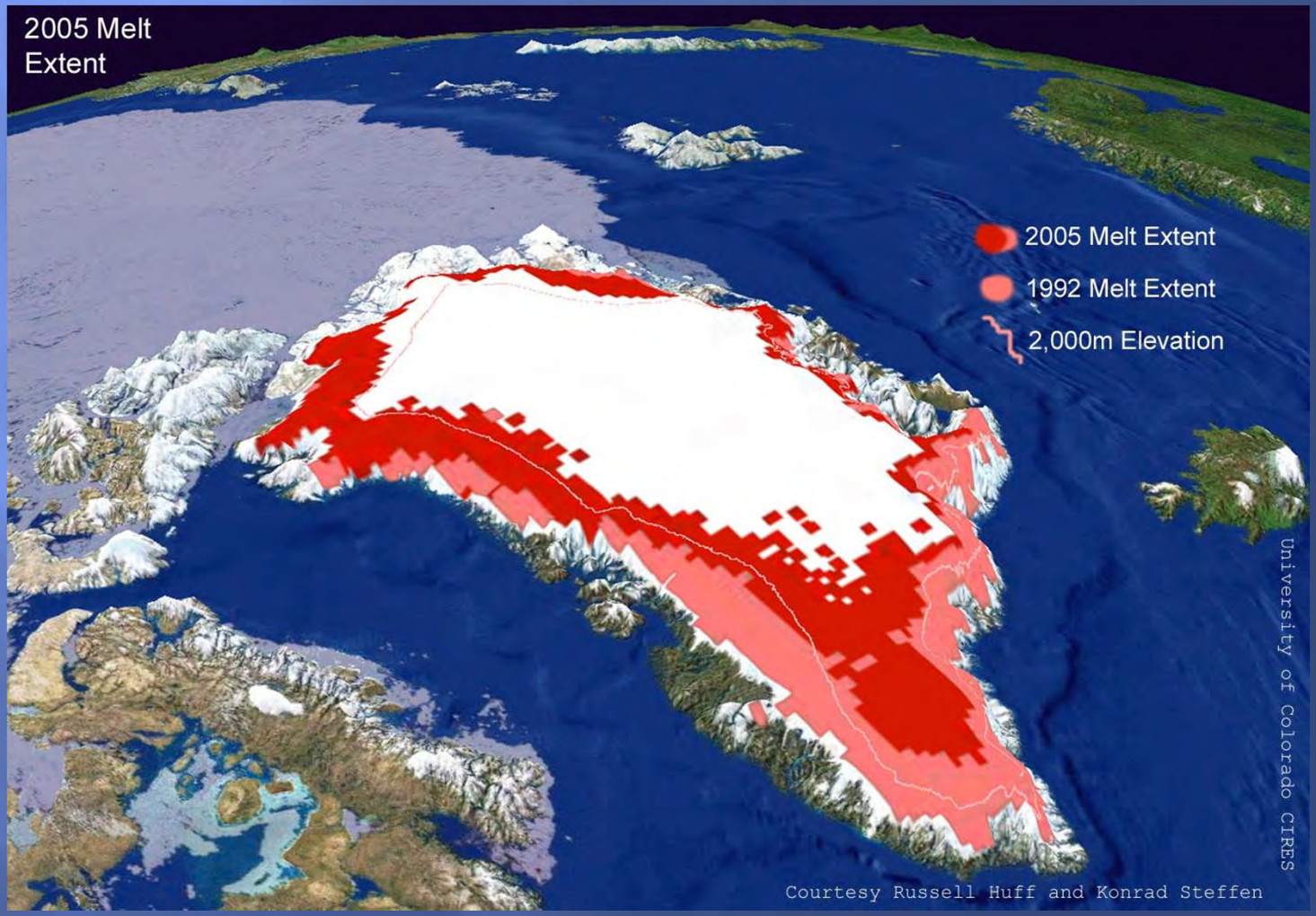
Dr. Michael Mann,
Director Earth System Science Center,
Pennsylvania State University
October, 2012

We are now seeing:

- Continued warming of the world's oceans (= expansion and huge heat reservoir).
- Accelerating ice melt of alpine glaciers.
- ★ Rapidly accelerating ice melt of Greenland Ice Sheet and West Antarctic Ice Sheet.
- ★ Rapidly diminishing Arctic Pack Ice cover in summer.

- Rapidly accelerating ice melt of Greenland Ice Sheet by a warmed atmosphere.

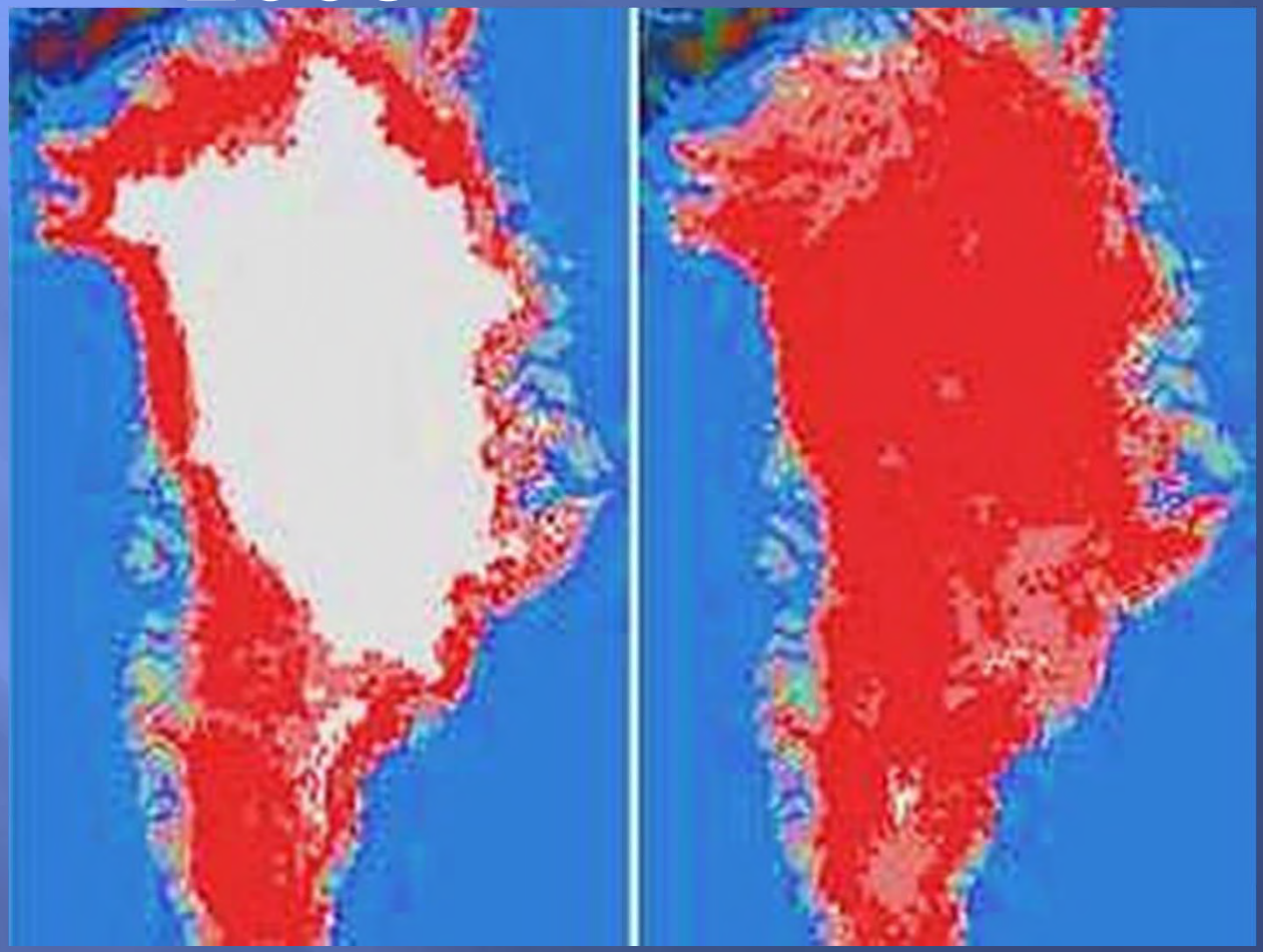
= 1.5 feet or much greater per century rise.



Enough ice to raise sea level ~23 feet

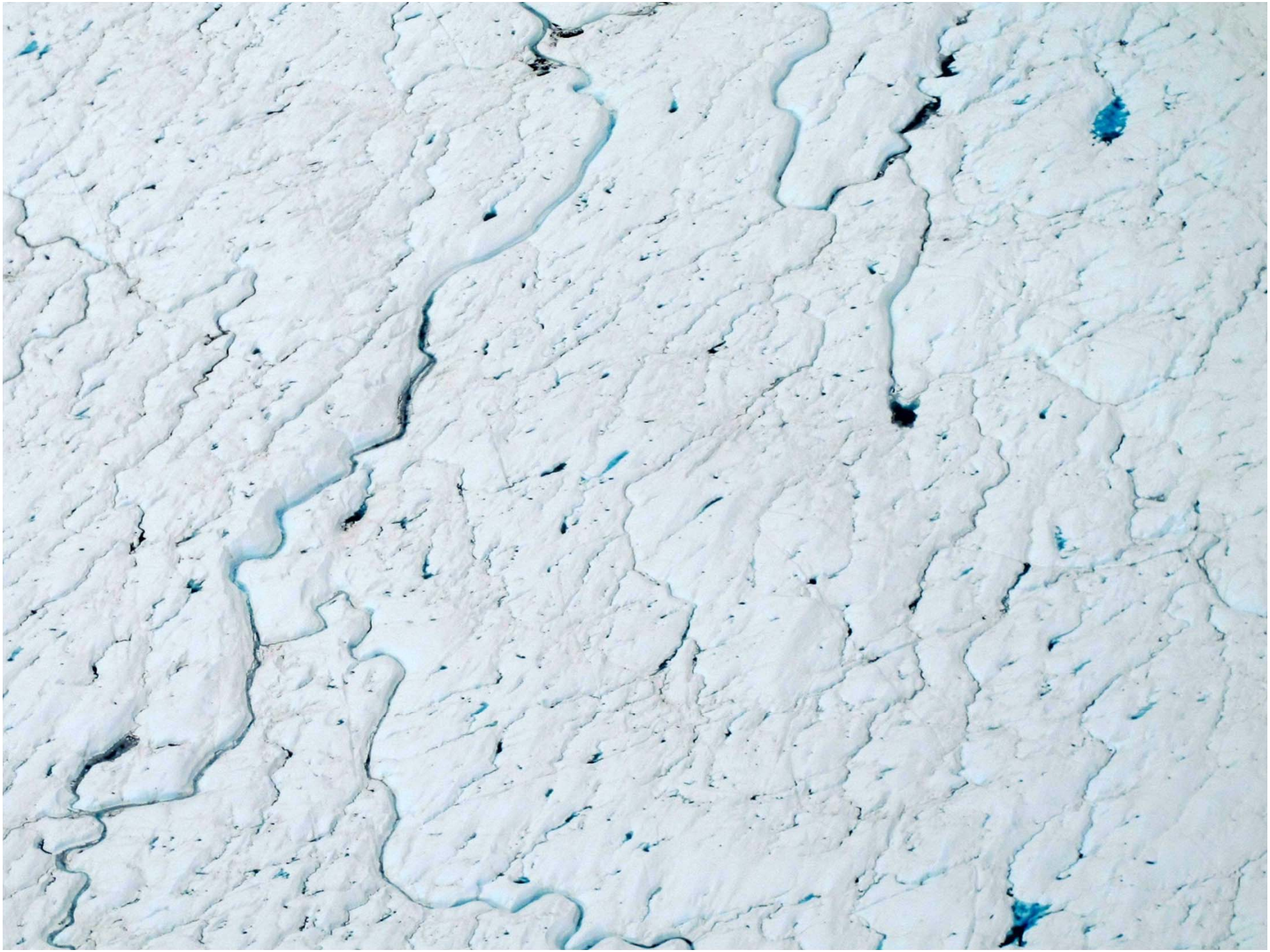
Atmospheric warming is dramatically increasing extent of summer melt

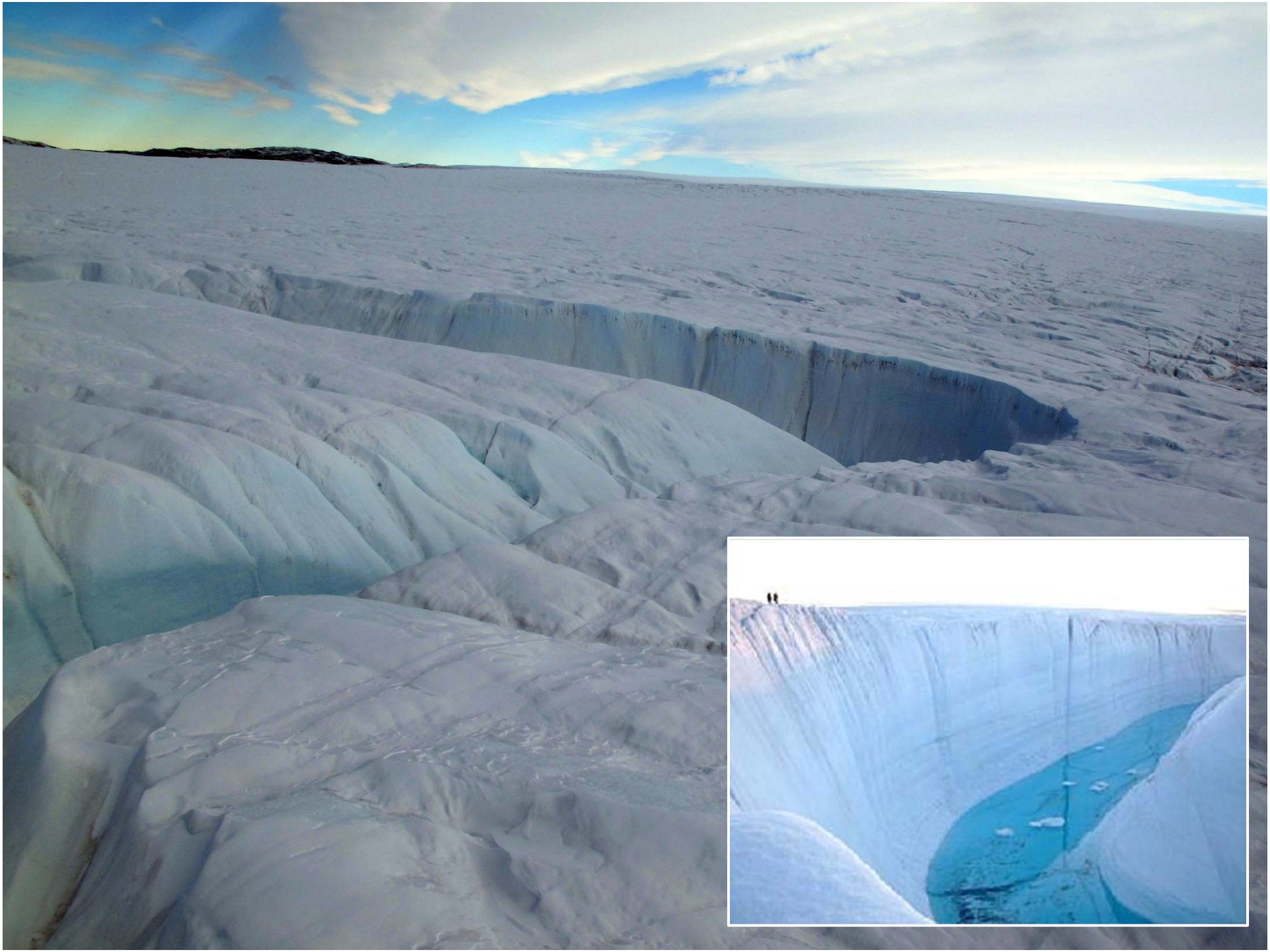
2005 2012

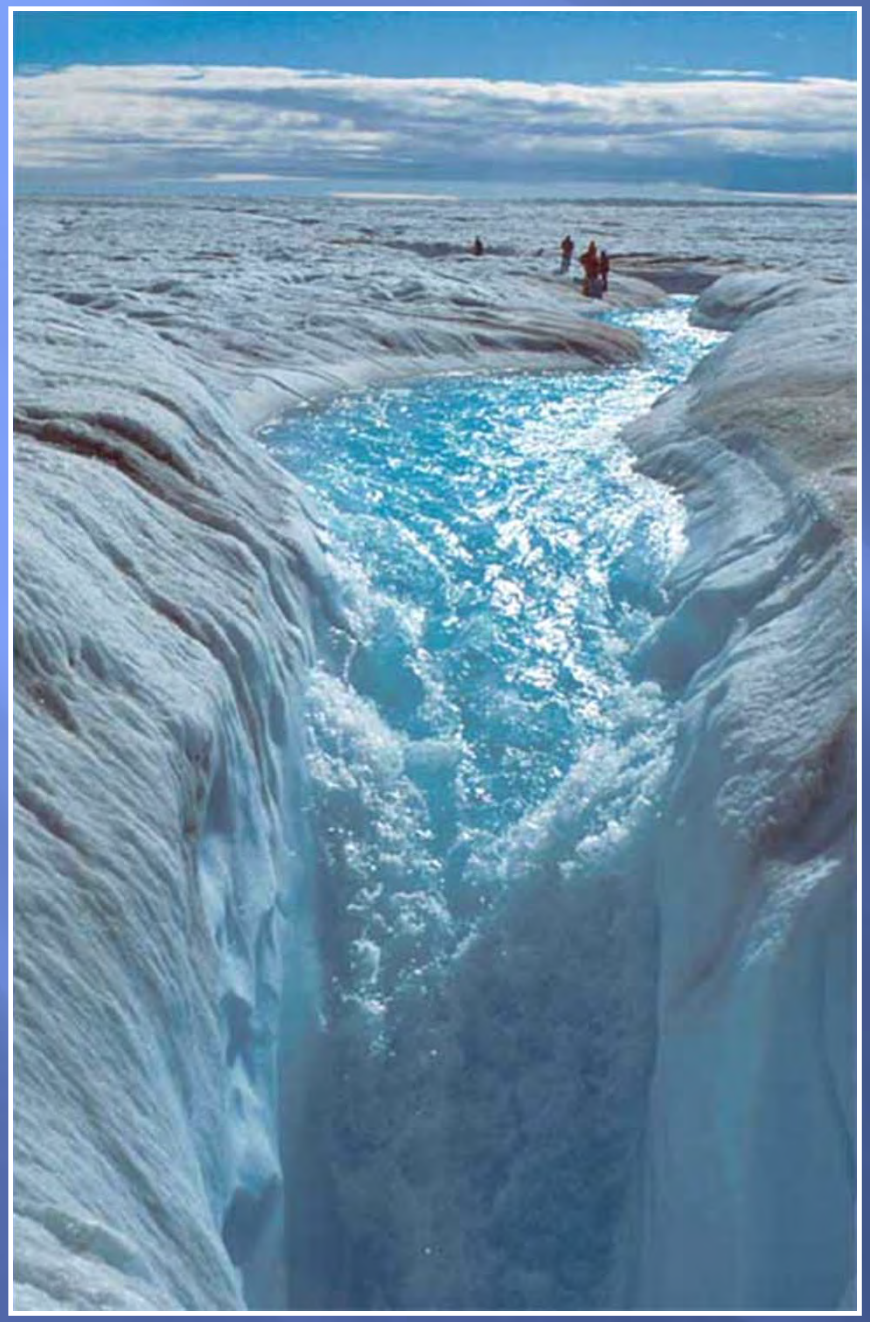


but biggest concern is the warming ocean water.

OY-HGY

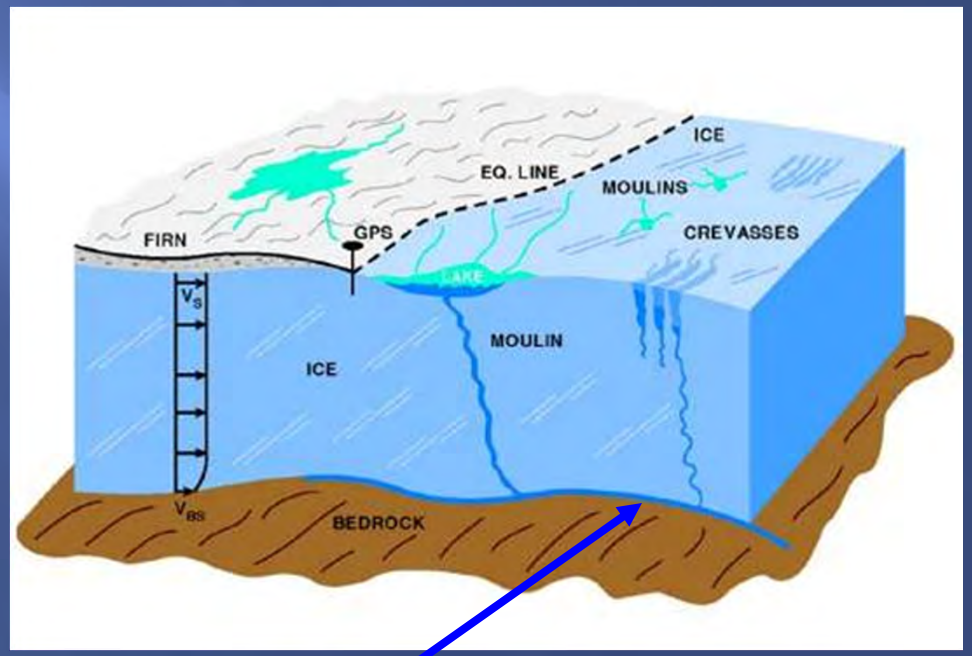






MOULINS

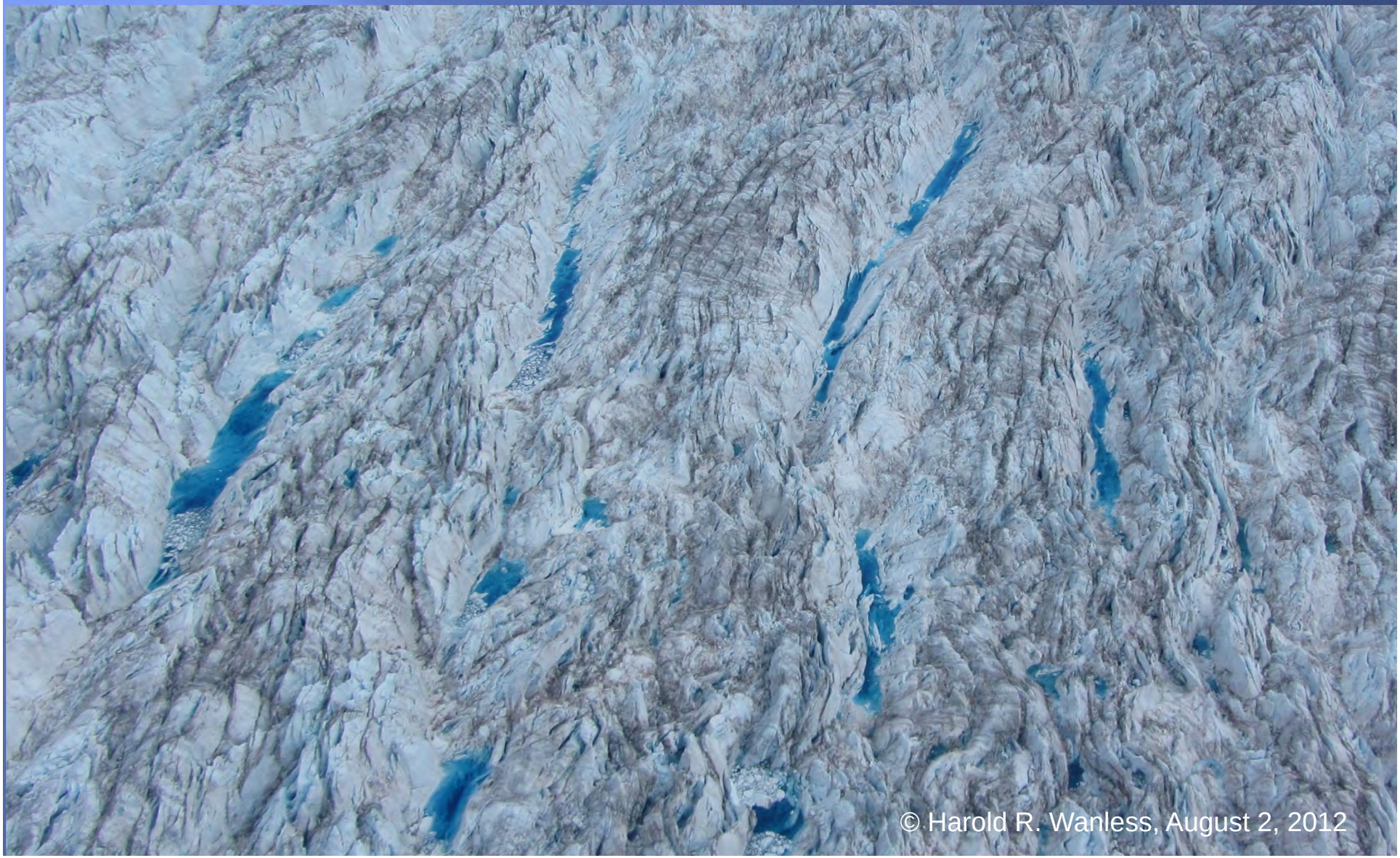
Like karst in limestones



Water lubricates base of ice sheet and results in sliding, fracturing and weakening of the ice sheet.

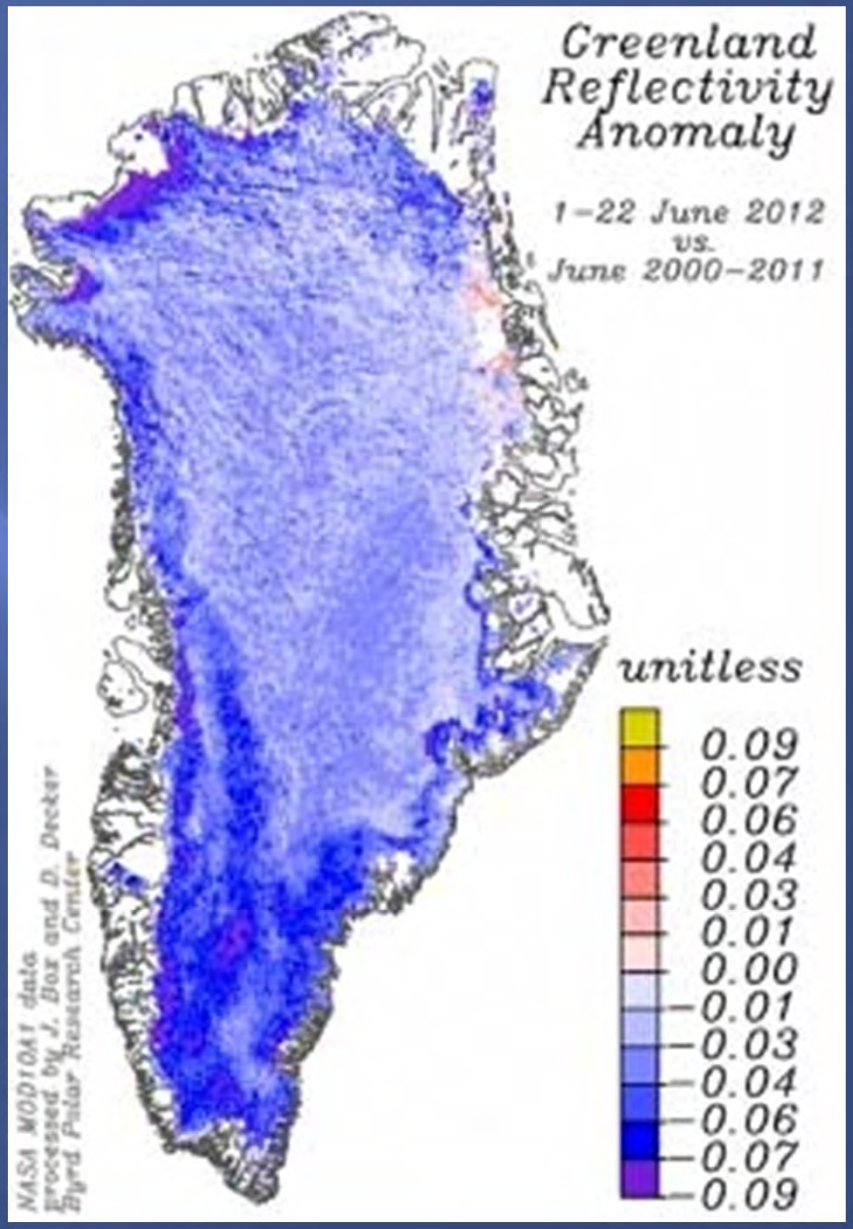
08/02/2012 10:39
© Harold R. Wanless, August 2, 2012

severely fractured and rapidly melting



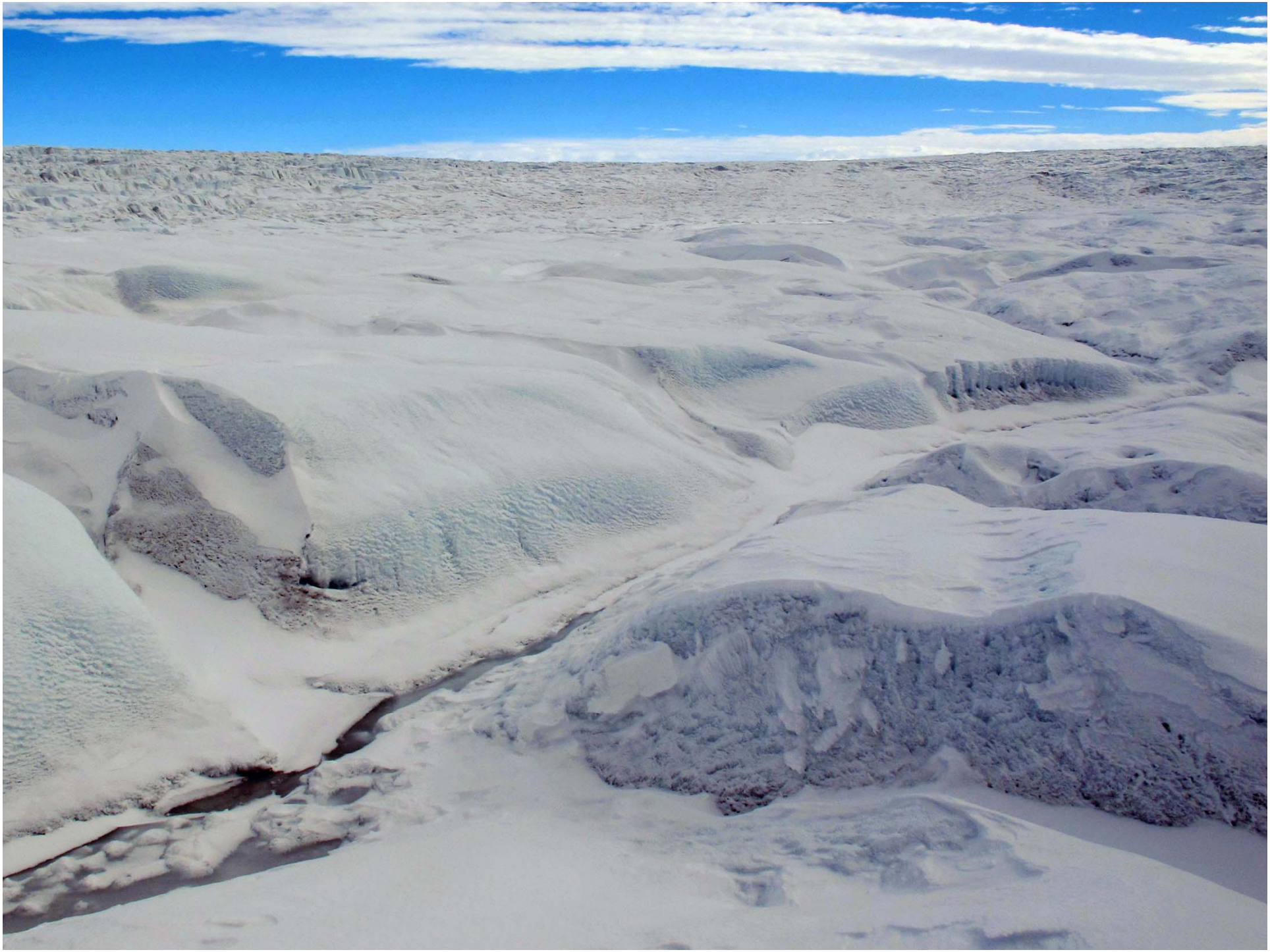
and accumulating dark dust and soot on the surface – further accelerating ice melt.

http://www.arctic.noaa.gov/future/images/Press_Photo_10.jpg



OY-HGY
air greenland

air greenland



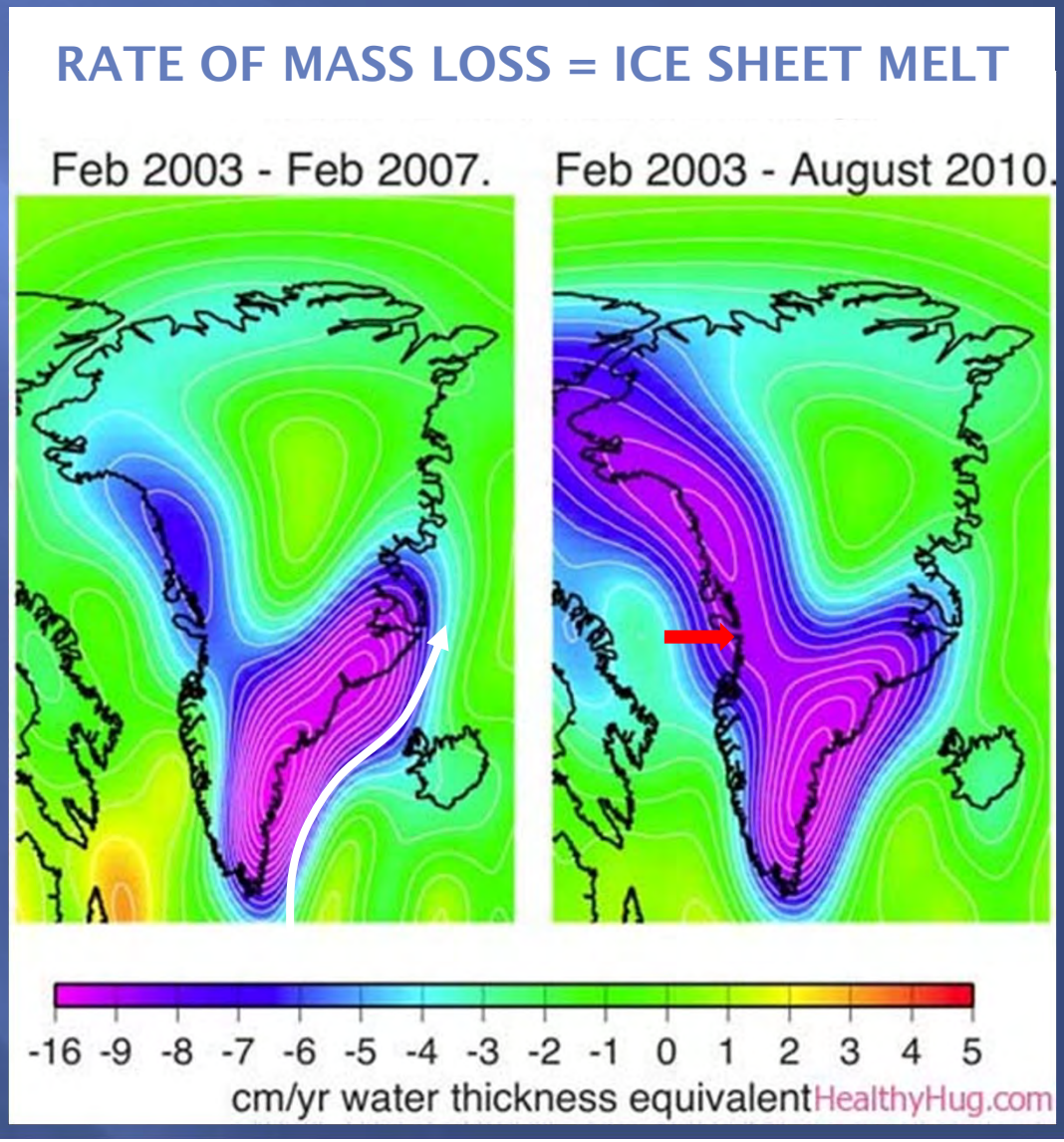
- Rapidly accelerating ice melt of Greenland Ice Sheet by warmed sea water.

  = 1.5 foot or much greater per century rise.

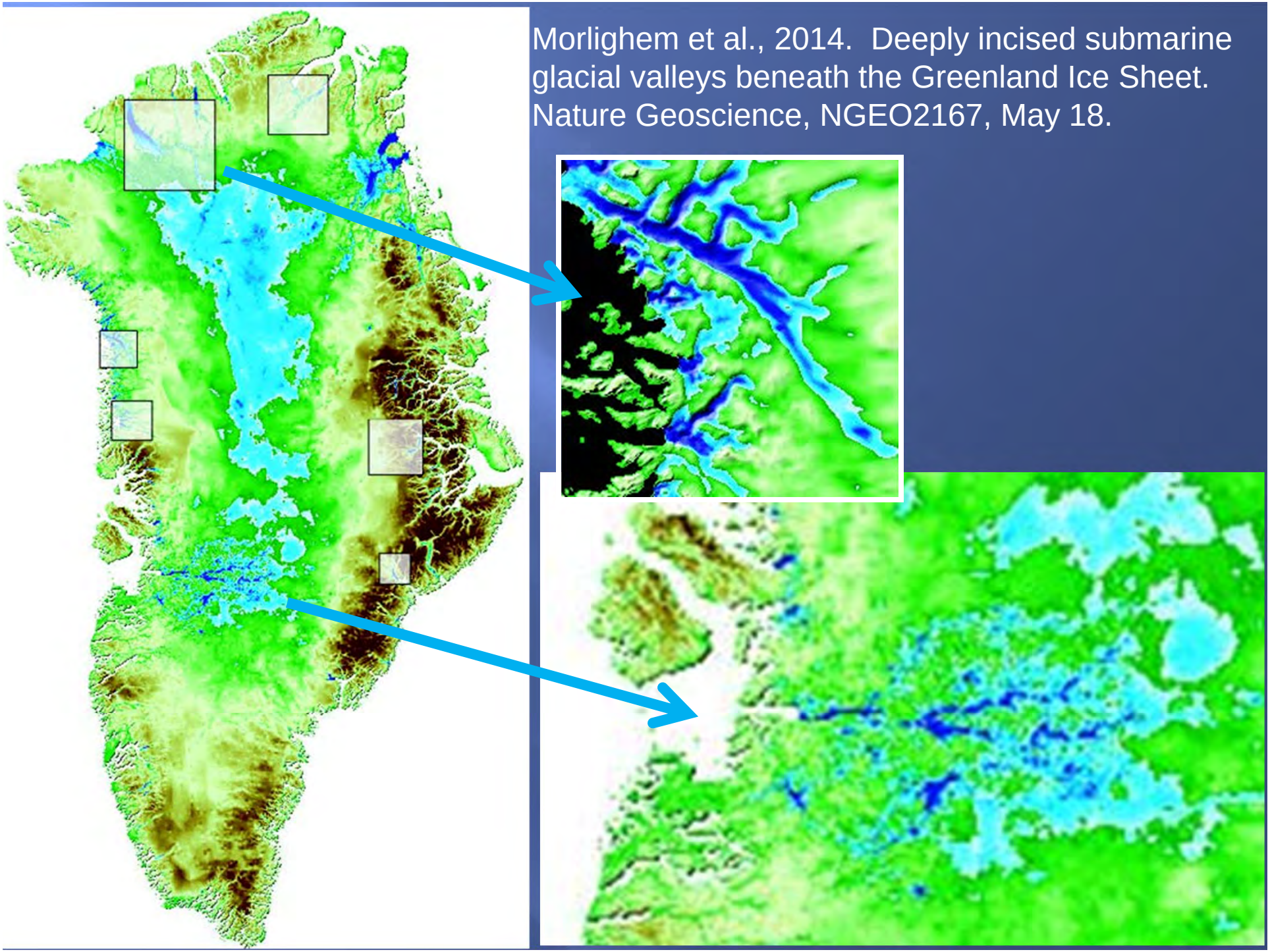
Warm North Atlantic Ocean water moving up the east side of Greenland through 2007, then up the west side after.

This warm ocean water is moving into the deep fjords of outlet glaciers and powerfully accelerating melt far into the Greenland Ice Sheet.

Jacobshaven Icefjord is at the arrow ➡ .



Morlighem et al., 2014. Deeply incised submarine glacial valleys beneath the Greenland Ice Sheet. Nature Geoscience, NGEO2167, May 18.



JACOBSHAVEN ICE FJORD

- MELTING BECAUSE OF WARM OCEAN WATERS MOVING IN ALONG BOTTOM
- ICE SHEET NOW MOVING TOWARDS FJORD AT 10-20 MILES PER YEAR.
- MELT NOW REACHES > 80 MILES IN UNDER ICE SHEET.

Trim line – where the ice sheet recently was.

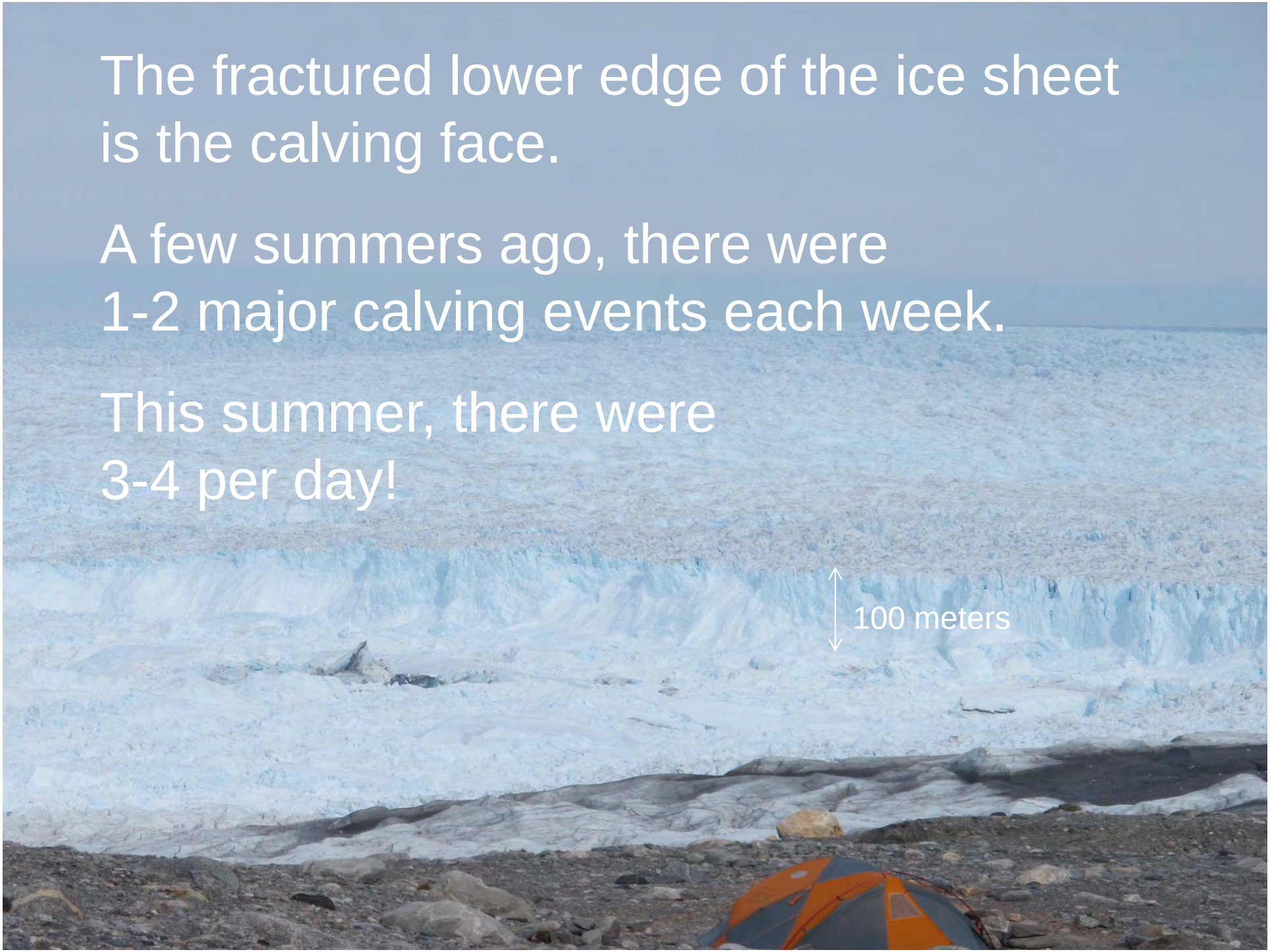
"Warmed ocean water is causing rapid retreat of the ice front (claving face), greatly accelerated fracturing of the marginal ice sheet, and accelerated frequency of calving."

The trim line along interior north margin of Jacobshaven Icefjord,
the 100 meter high calving front,
and the Greenland Ice Sheet beyond.

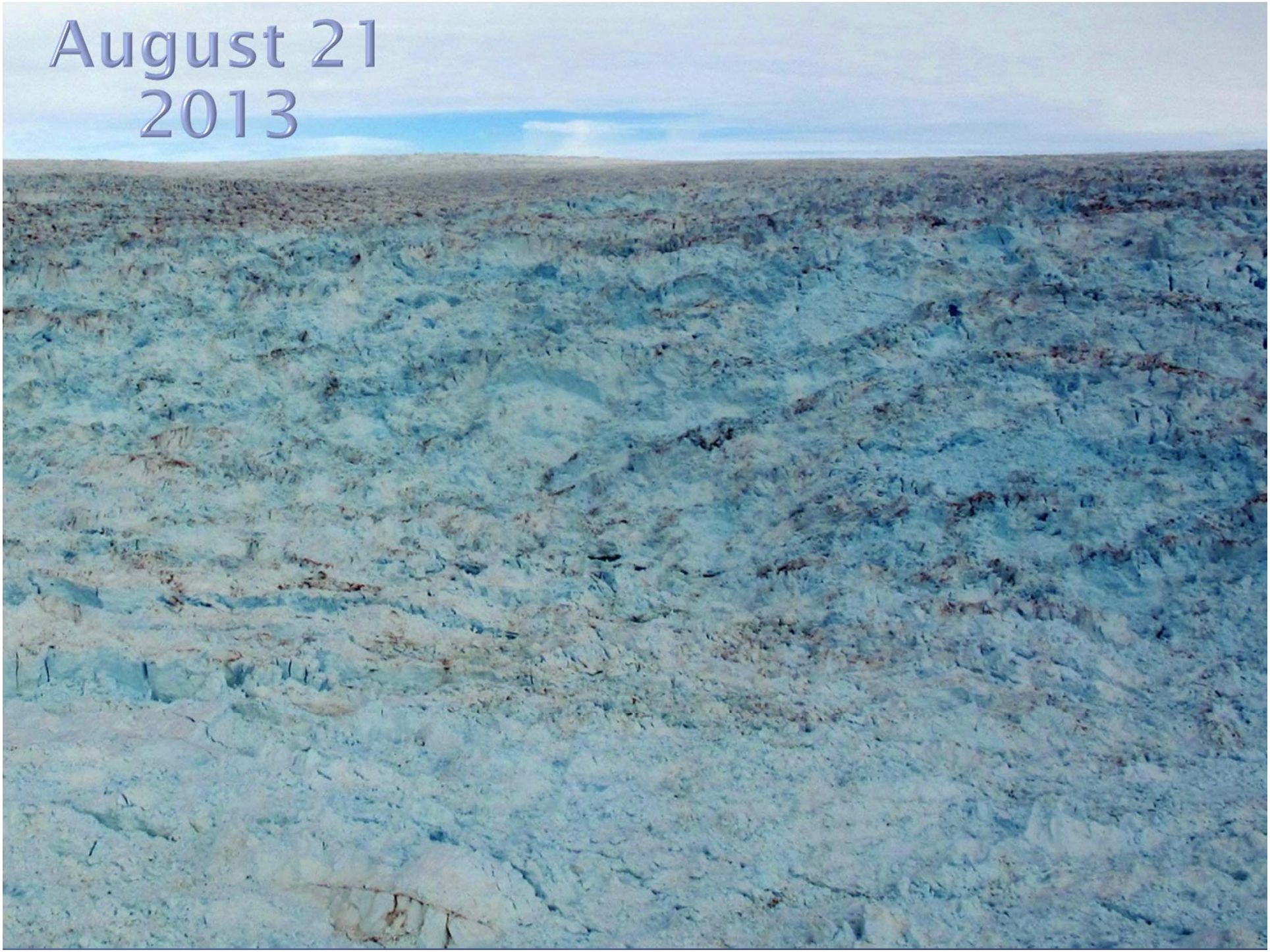
East of Ilulissat, Greenland – August 5, 2012 – © H. R. Wanless

National Science Foundation Camp

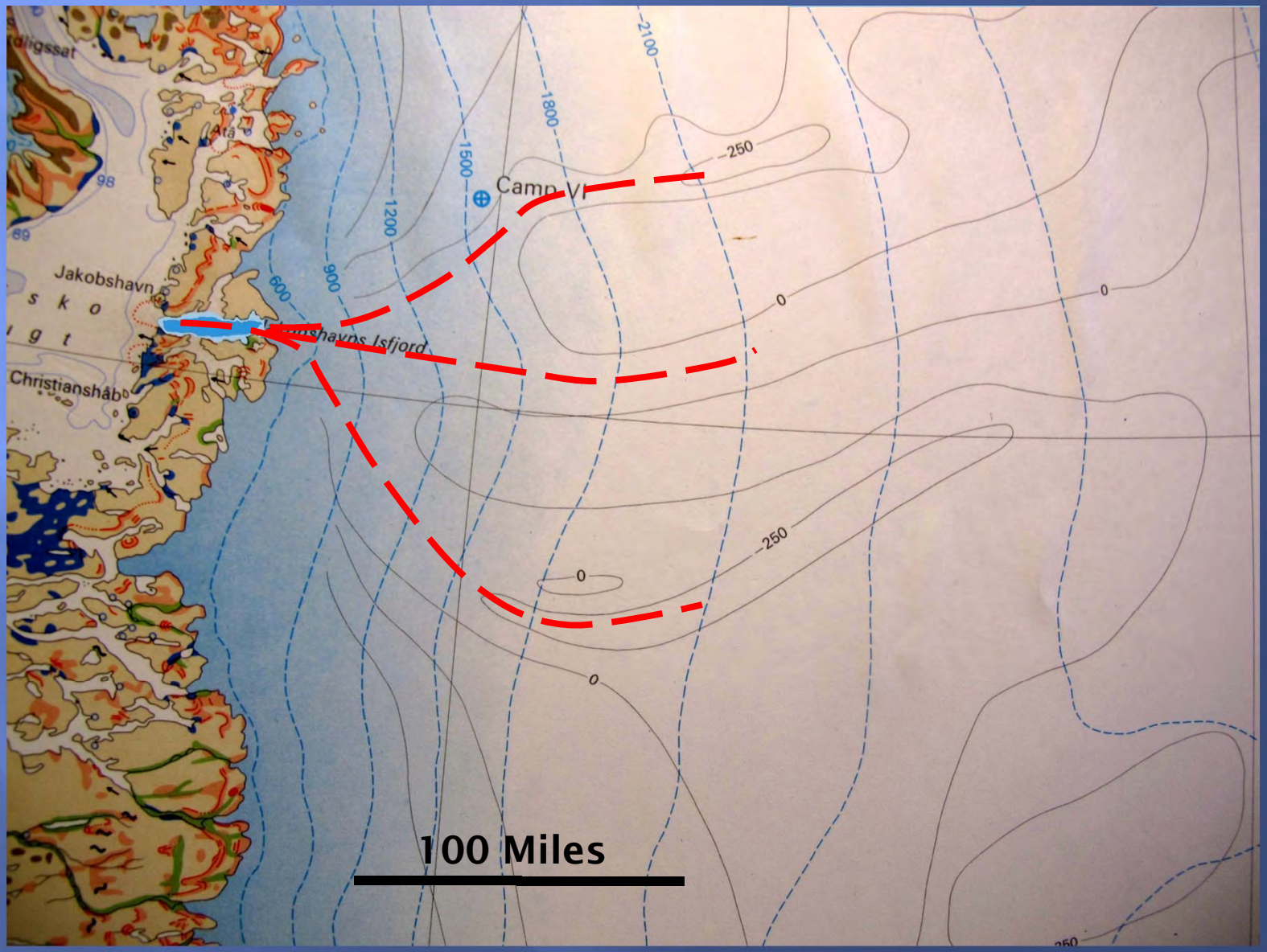
Calving front of Ice Sheet
08/04/2012 15:23


The fractured lower edge of the ice sheet is the calving face.
A few summers ago, there were 1-2 major calving events each week.
This summer, there were 3-4 per day!
100 meters

August 12
2012


August 21
2013

This warm ocean water is penetrating far in from the Icefjord beneath the Ice Sheet.



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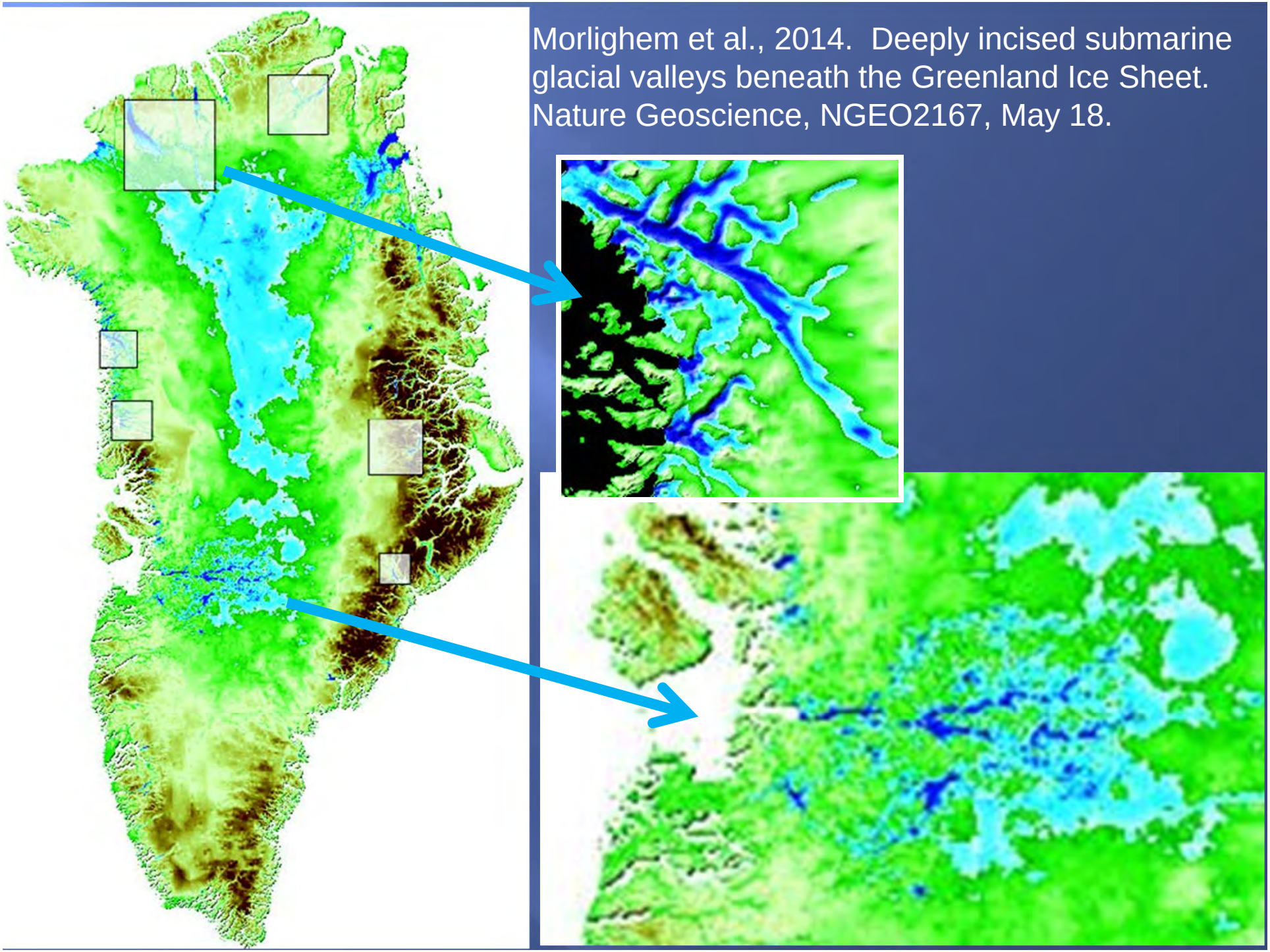

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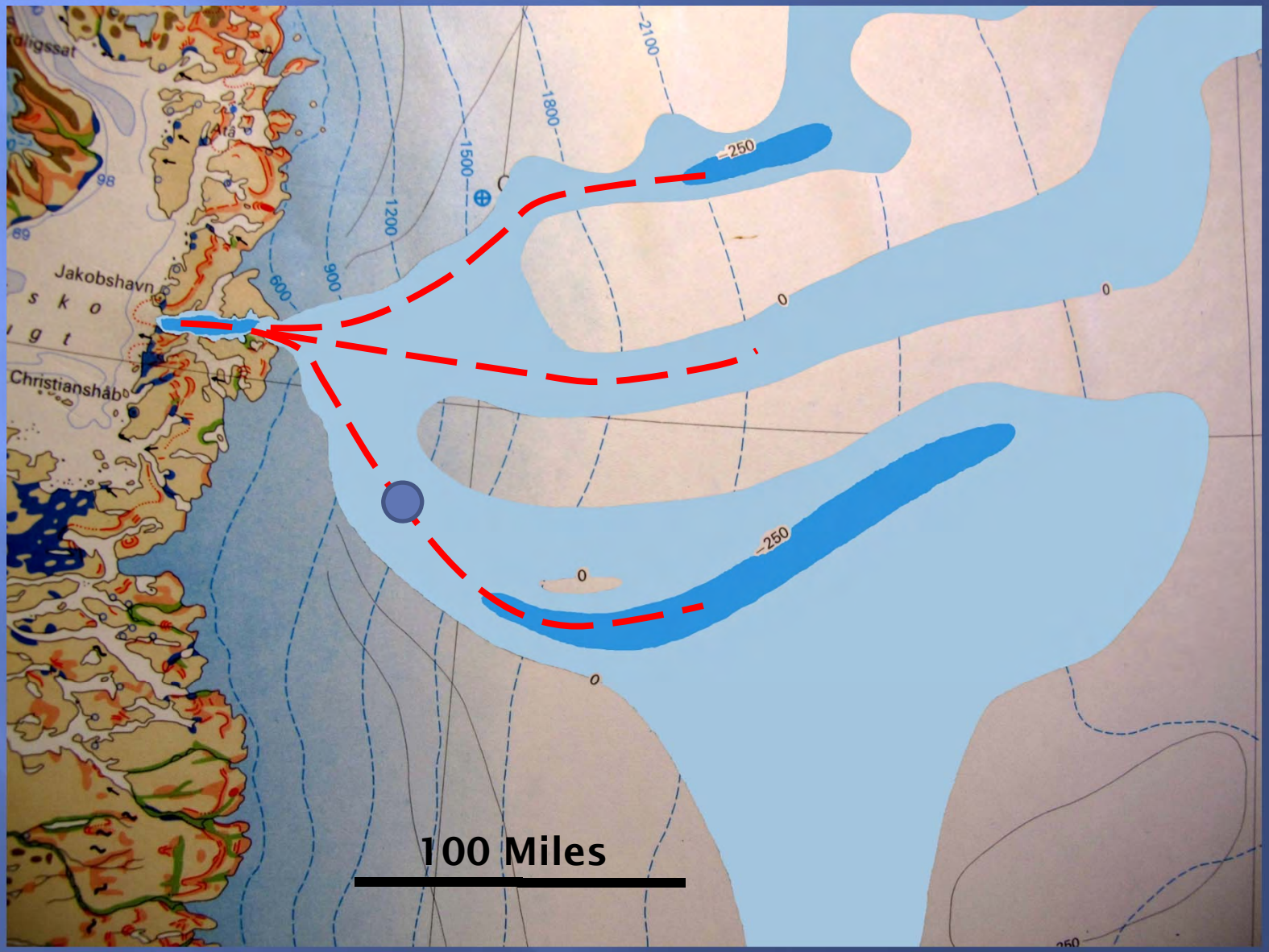
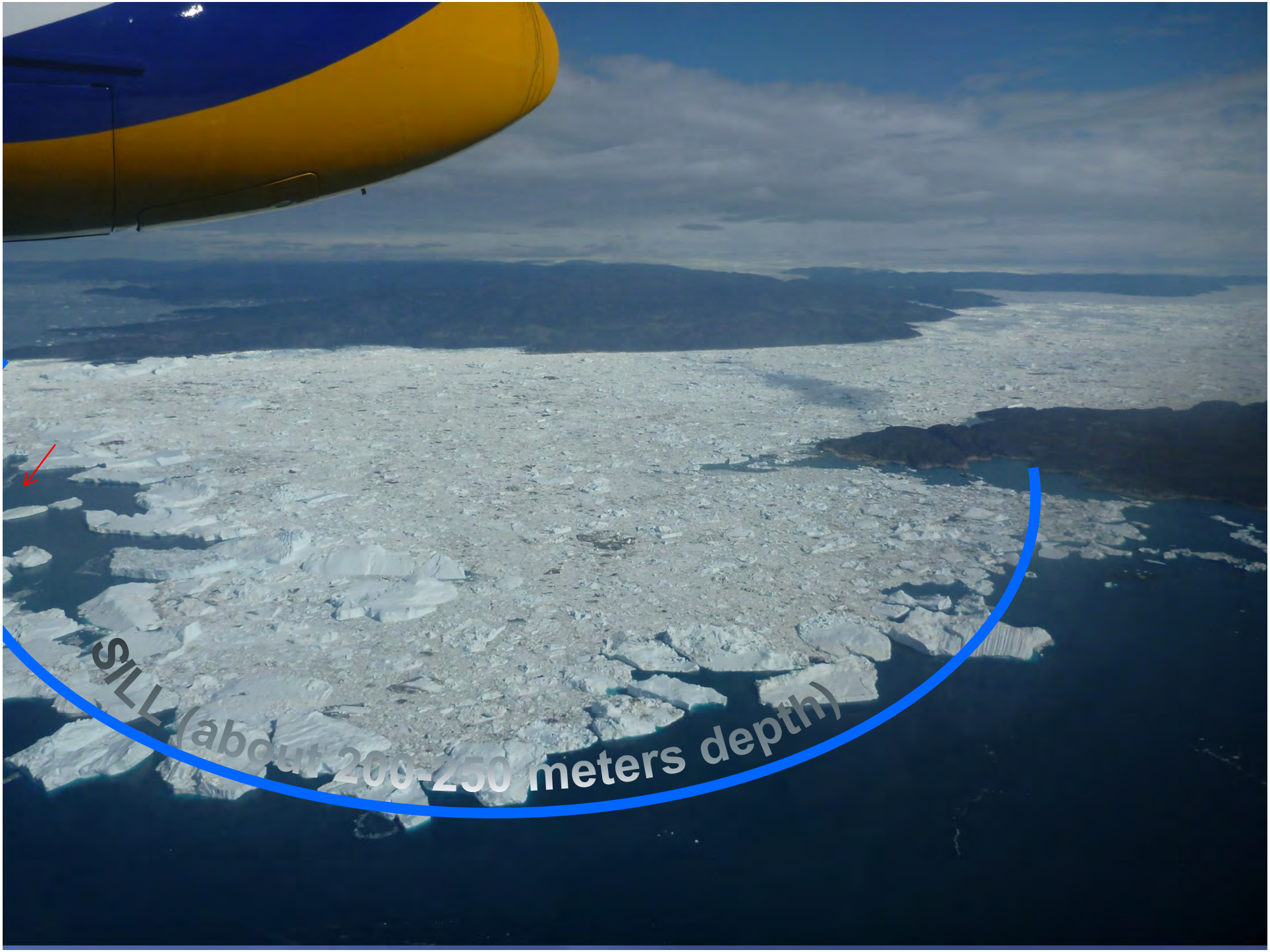
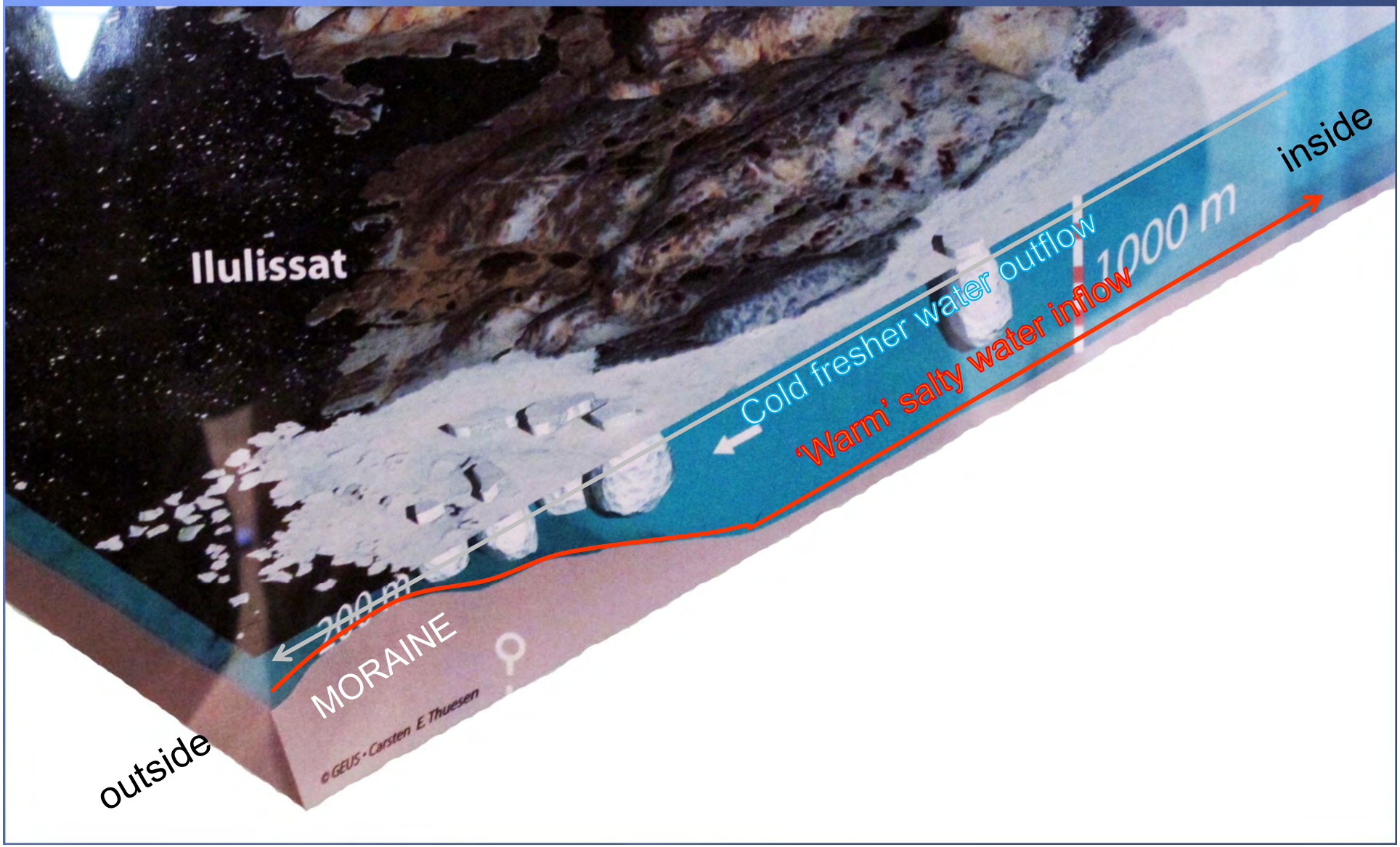
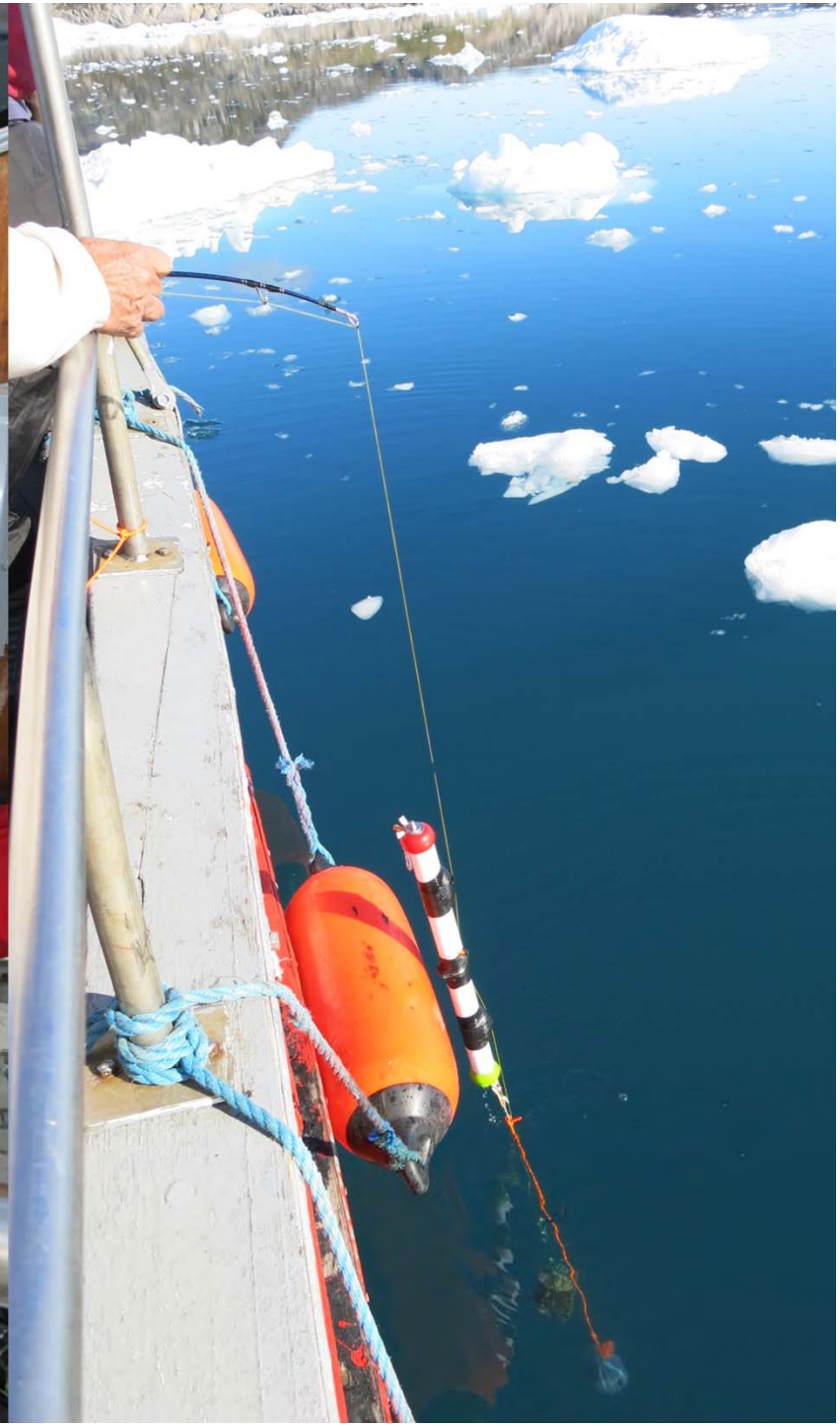



SILL (about 200-250 meters depth)

Estuarine circulation now promoting rapid melting beneath ice.

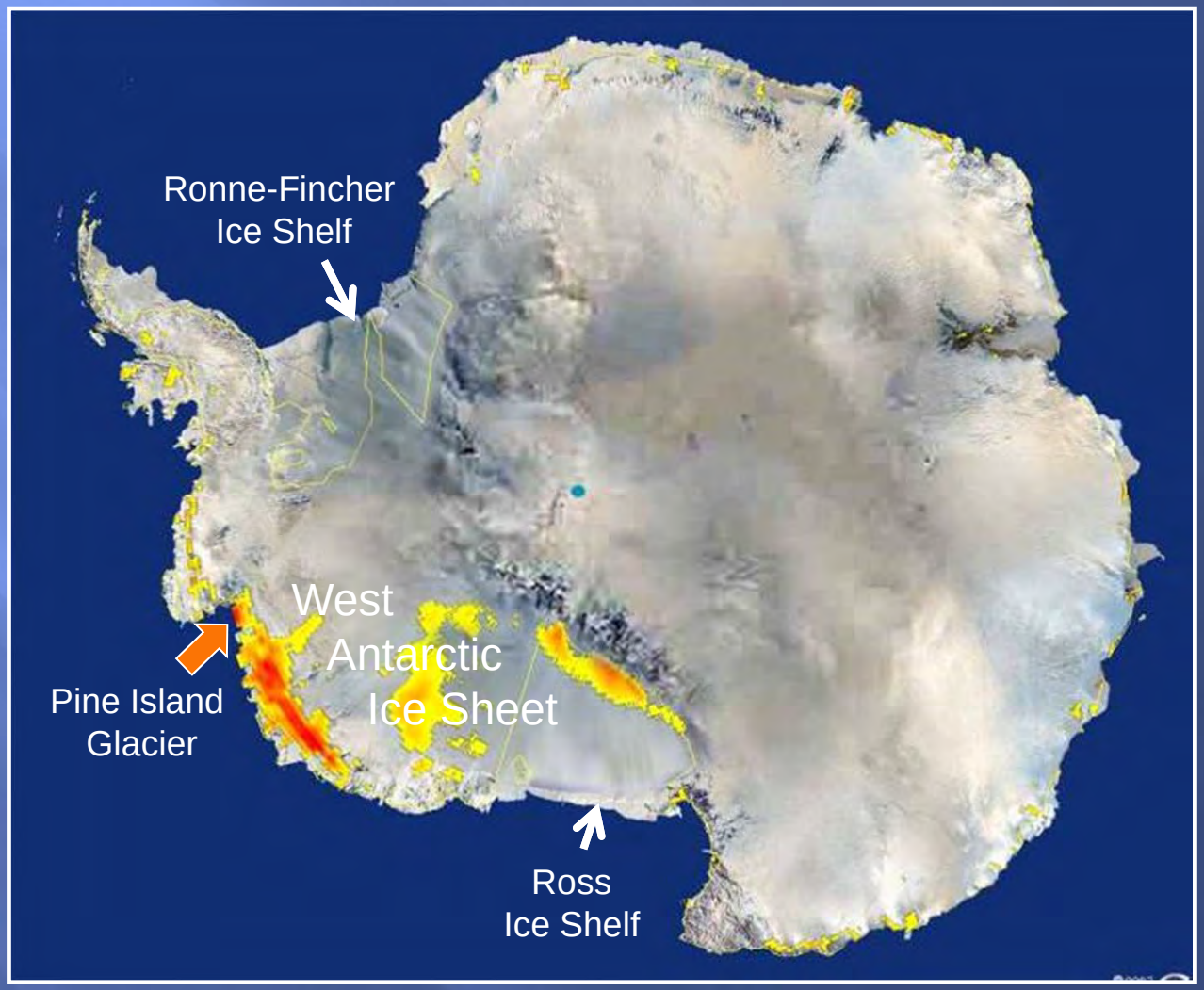


GR-12-208



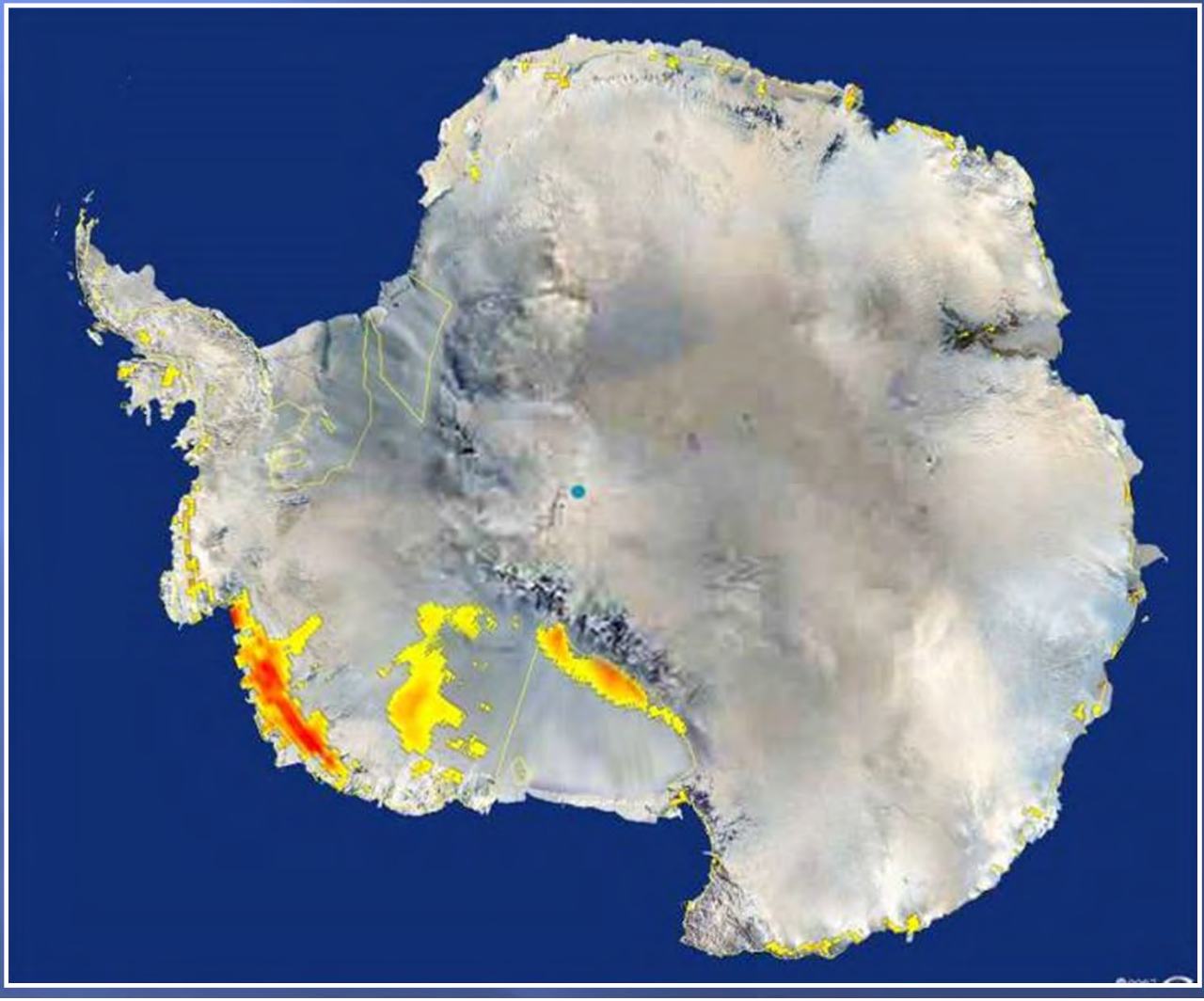
Thermometers we were using to 850 ft.

4. Rapidly accelerating melt of outlet glaciers to the West Antarctic Ice sheet by warmed sea water.



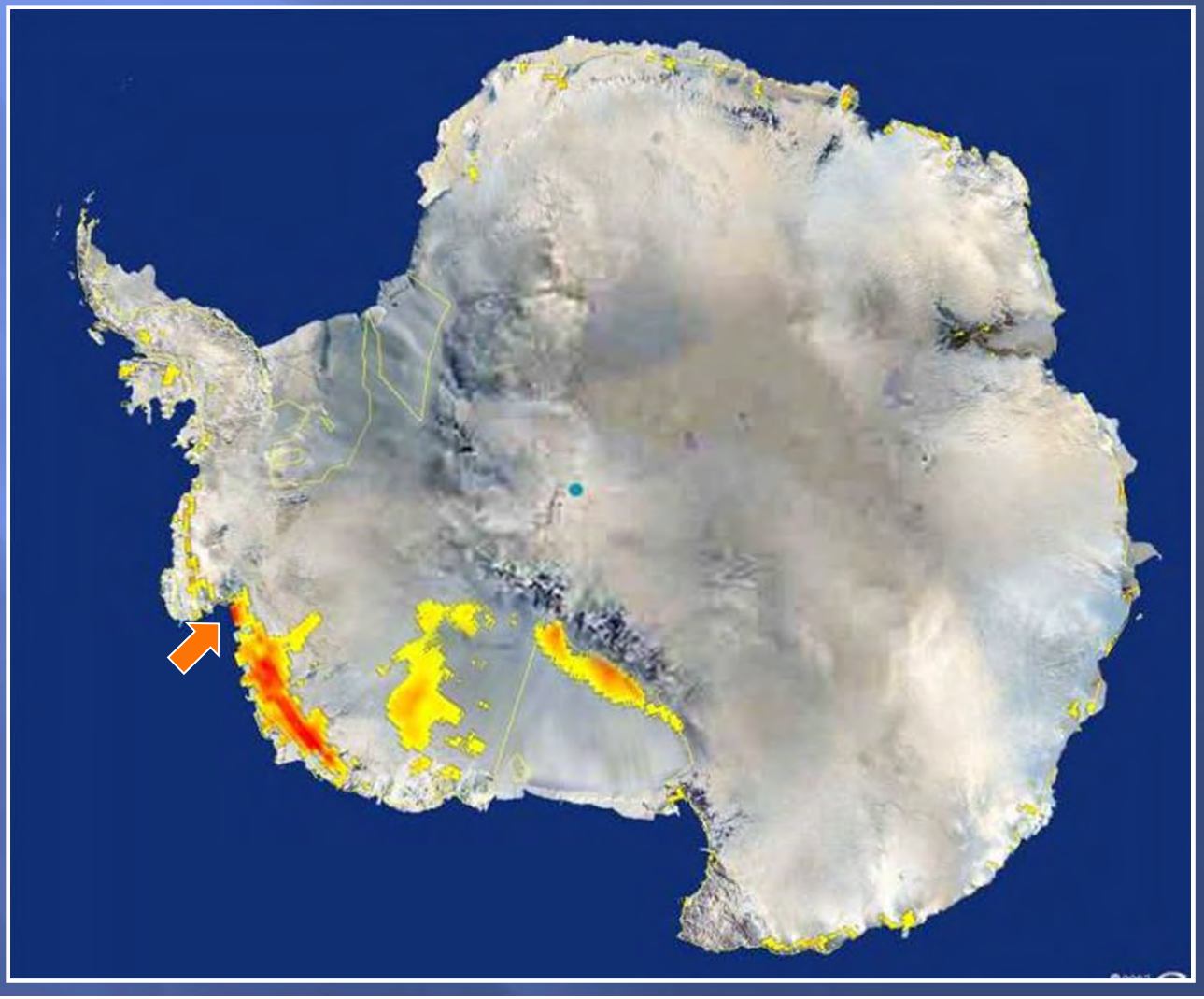
If the West Antarctic Ice Sheet melts, sea level will rise ~25'.

Scientists are just now recognizing that Antarctica is also rapidly melting, and has been for some time. This is because of increased wind shear, which has increased upwelling and melting under the ice shelves – and --



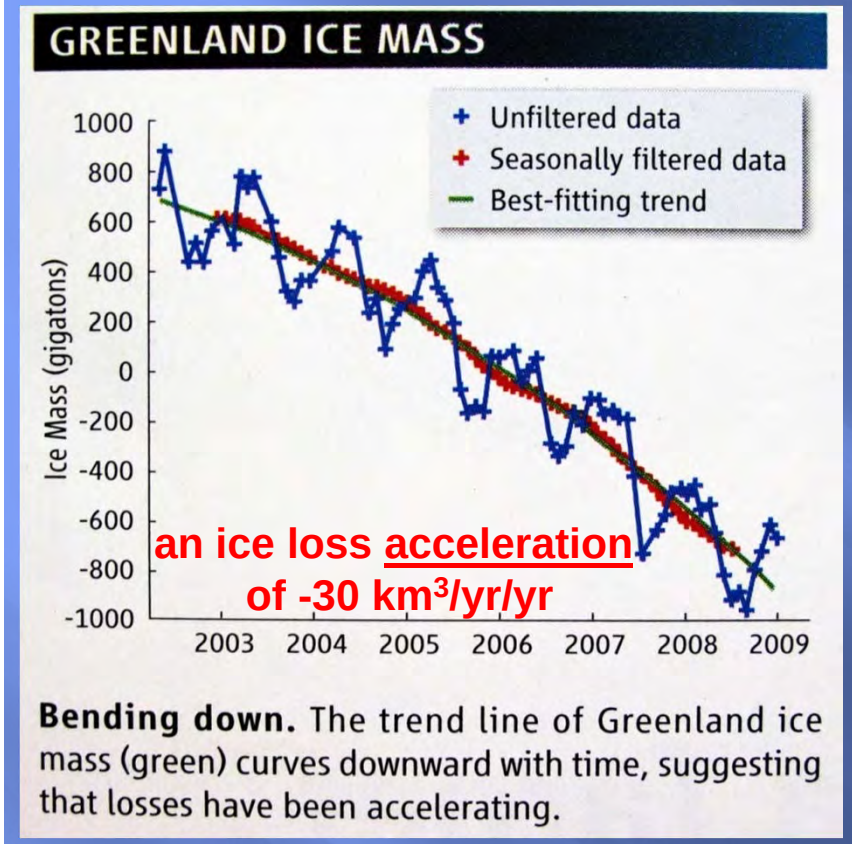
2009 - Pine Island Glacier, the largest in West Antarctica, is melting at a rate 4 times faster than just a decade ago – because of warming waters.

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

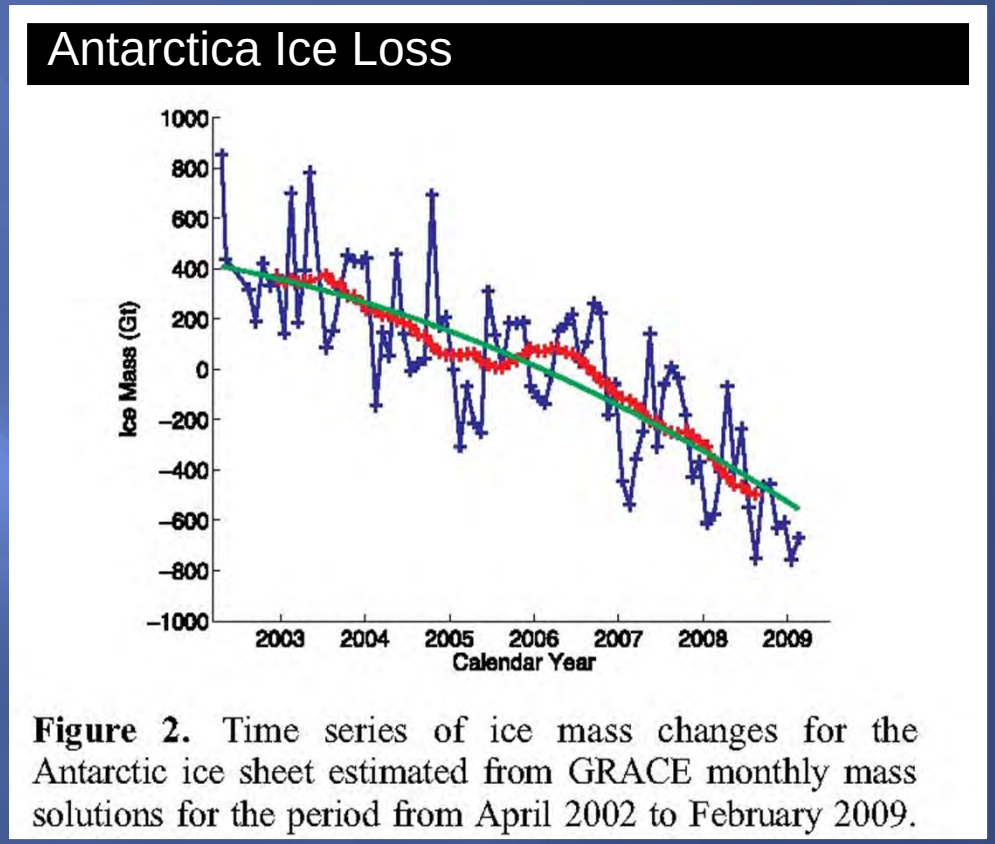


A. Shepard, University of Leeds, August 2009.

RECENT DATA FROM THE GRACE SATELLITES



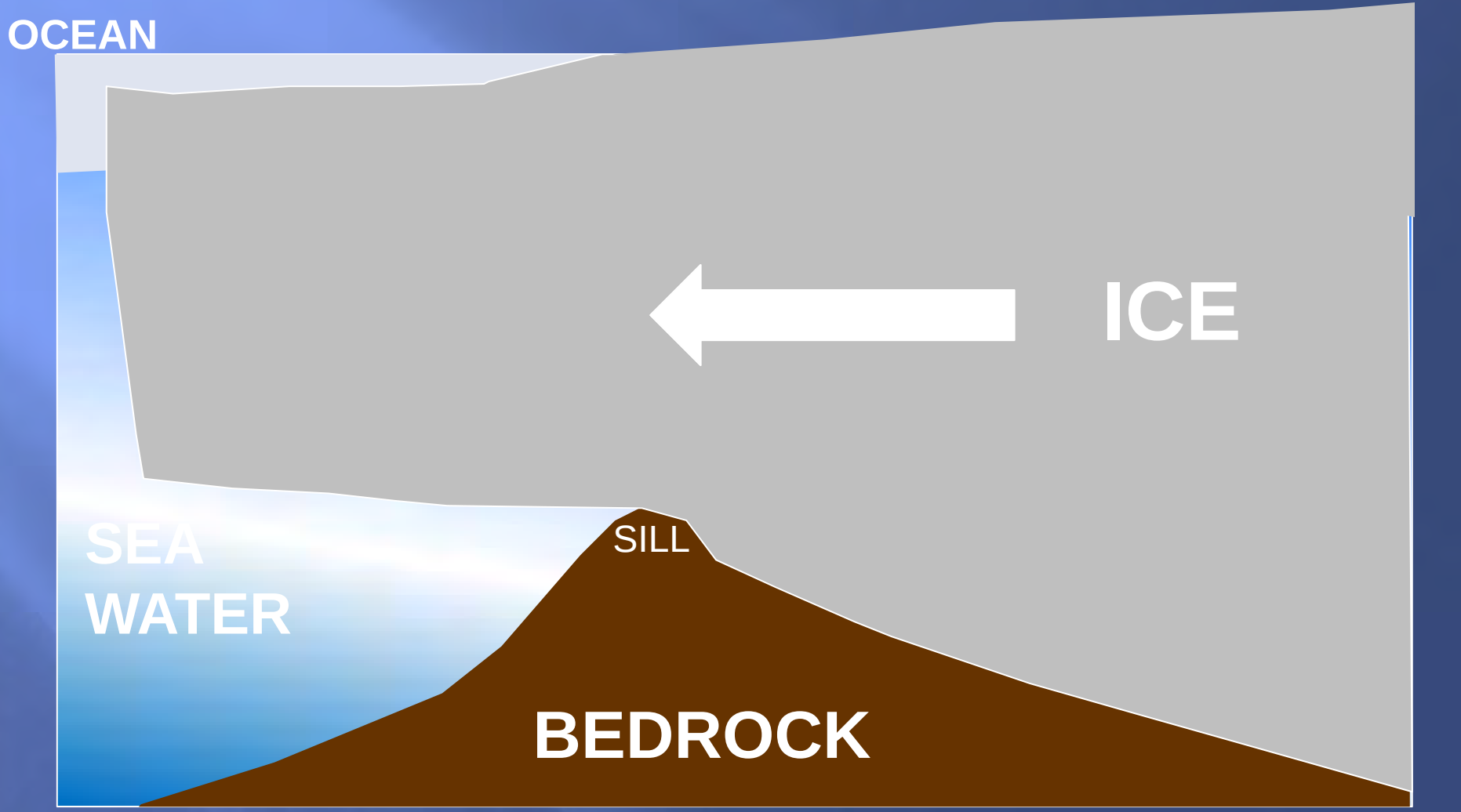
Science, October 6, 2009, p.217.



Velicogna, 2009.
Geophysical Research Letters

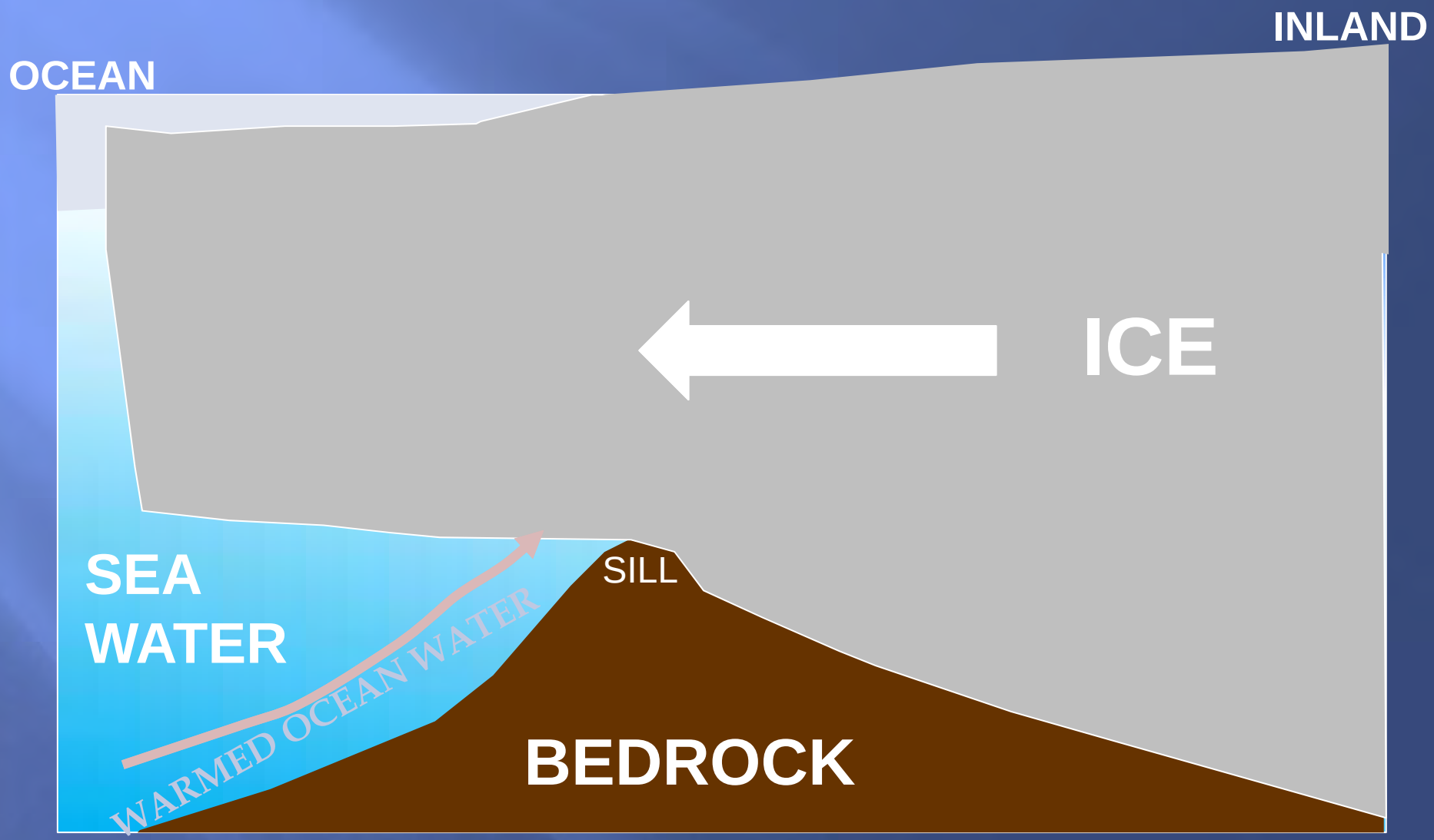
- Rate of mass loss has more than doubled over past 7 years on both Greenland and Antarctica.
- Is now an annual 17% acceleration in melt rate and a 5% acceleration in the contribution to rise in sea level.

Cold Sea Water. Ice Sheet margin buttressed against sill.



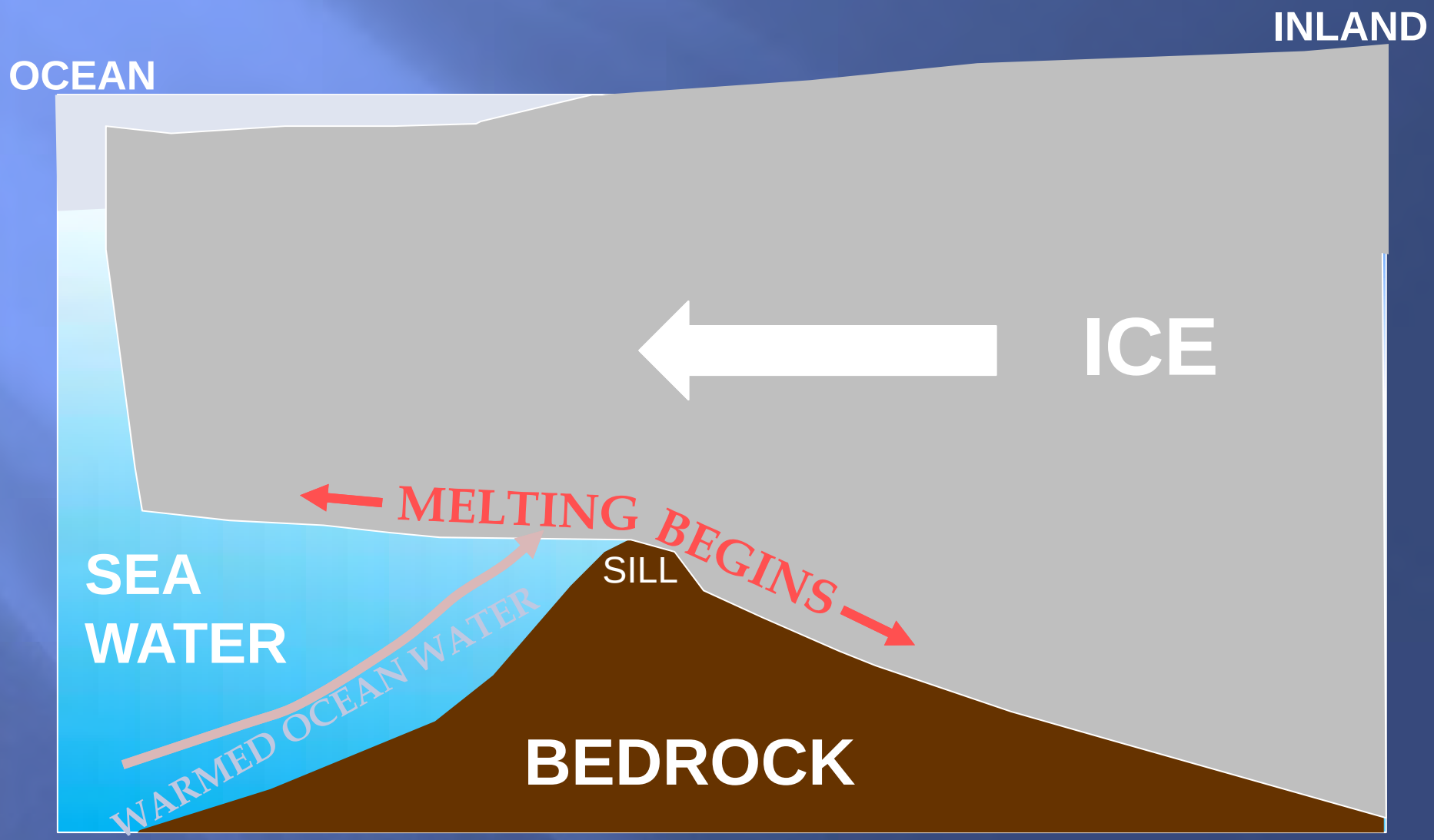
CROSS SECTION OF PINE ISLAND OUTLET GLACIER, WEST ANTARCTICA

Upwelling of warm ocean water



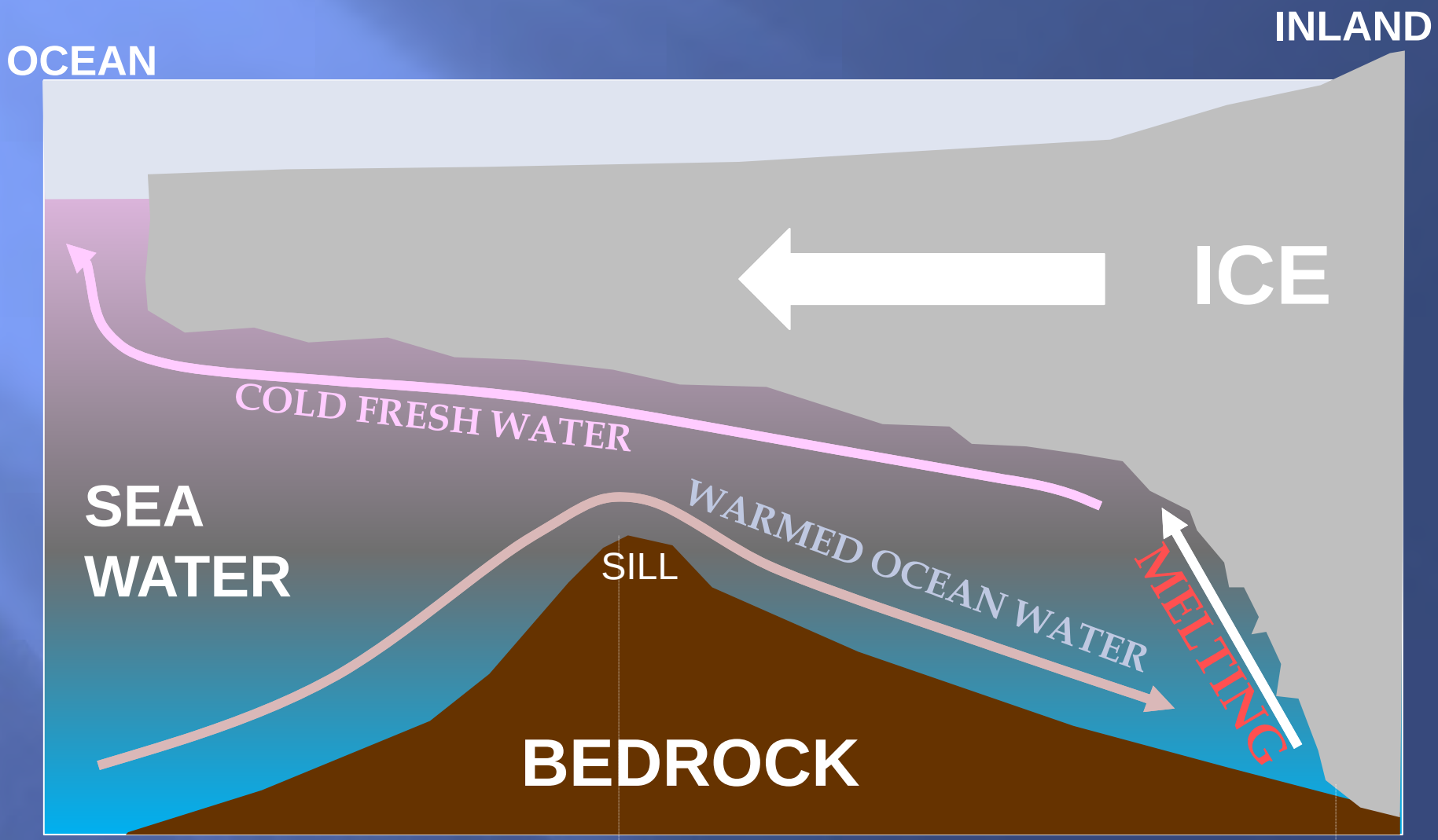
CROSS SECTION OF PINE ISLAND OUTLET GLACIER, WEST ANTARCTICA

Basal melting outpaces ice flow



CROSS SECTION OF PINE ISLAND OUTLET GLACIER, WEST ANTARCTICA

Ice outflow is no longer buttressed by sill, and warm sea water is penetrating deep beneath ice.



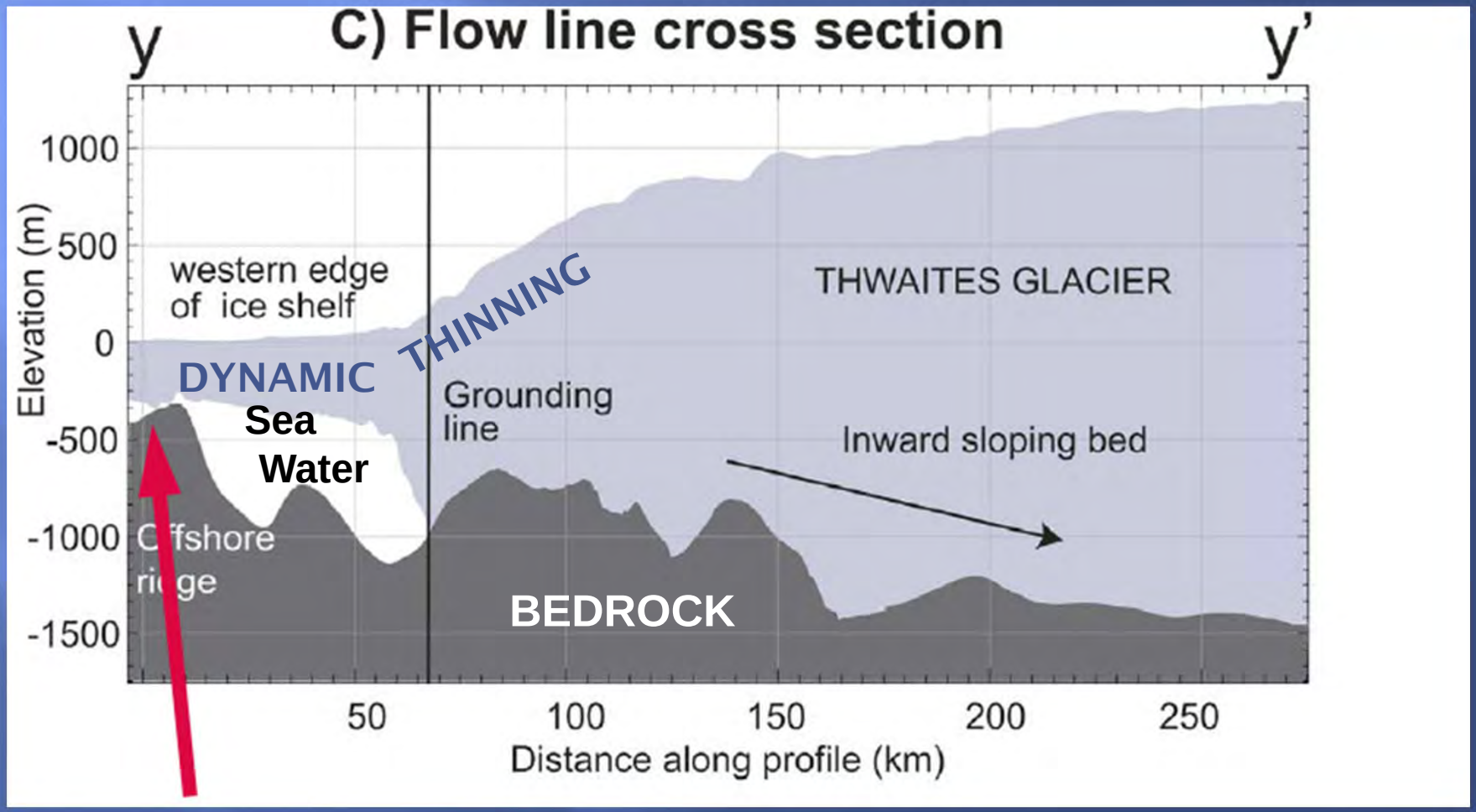
40 Kilometers (25 miles) by 2009

(Jenkins, Nature Geoscience, 2010)

Many of the outlet glaciers for the West Antarctic Ice Sheet show this rapid thinning.

OCEAN

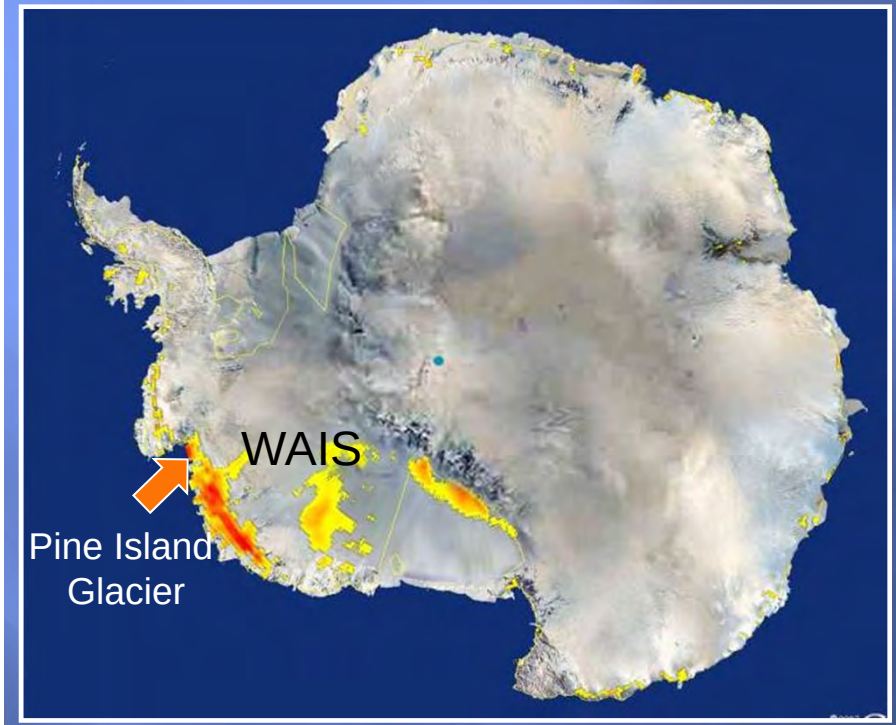
INLAND



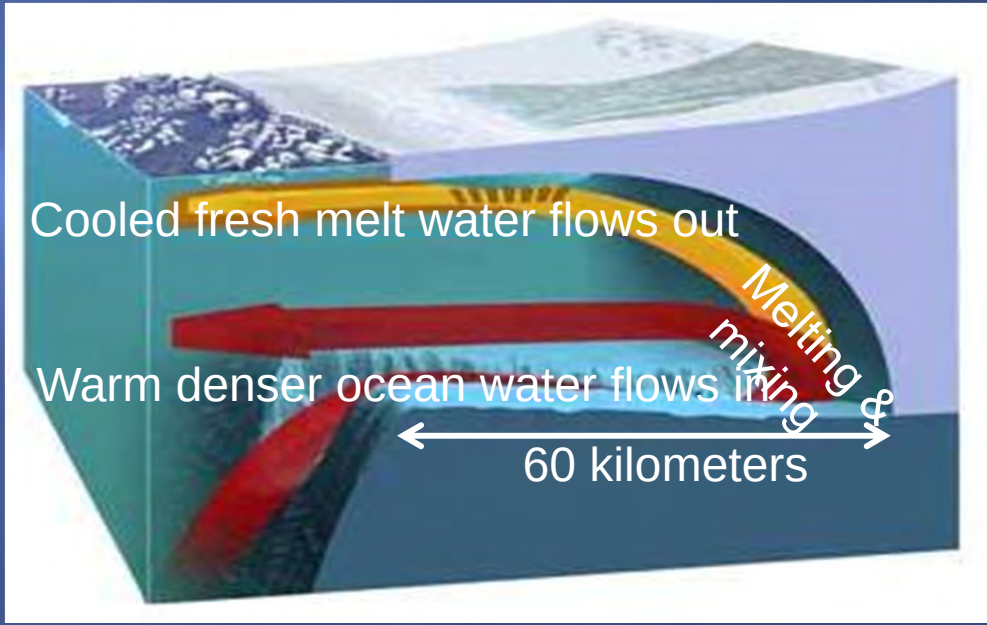
From: http://glacierchange.wordpress.com/2012/10/08/thwaites-glacier-tongue-major-calving-event-antarctica/

- Rapidly accelerating melt of outlet glaciers to the West Antarctic Ice sheet by warmed sea water.

  = 1.5 feet or much, much greater per century rise.



Estuarine circulation is now promoting rapid melting beneath ice.

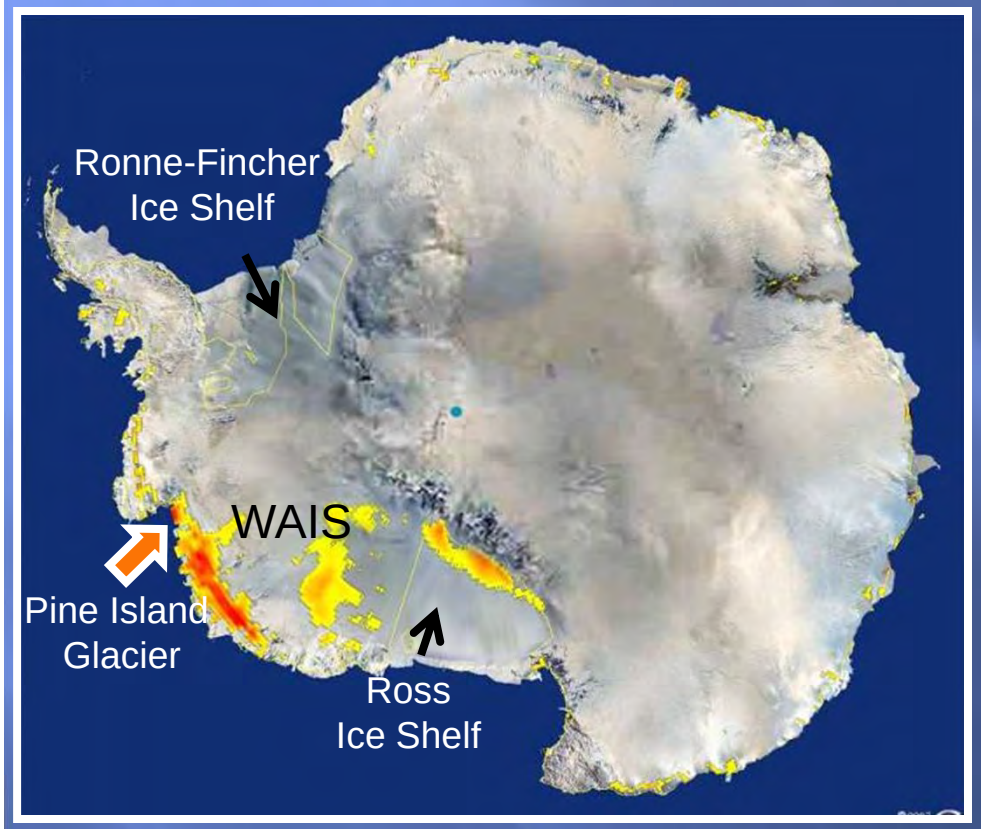


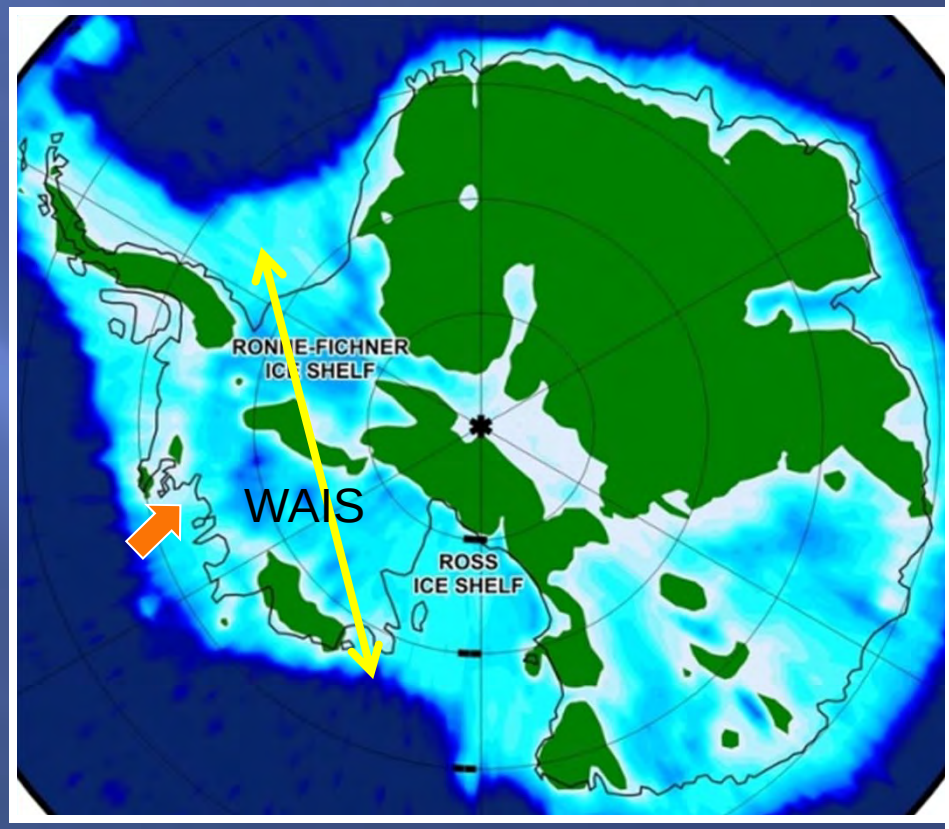
If the West Antarctic Ice Sheet melts, sea level will rise ~25'.

By 2009 the Pine Island Glacier, a major outlet for the West Antarctic Ice Sheet (WAIS), was melting at a rate 4 times faster than just a decade ago – because of the influence of warming ocean waters. It has thinned 90 m in the past decade.

A. Shepard, ,2009.

Much of the West Antarctic Ice Sheet is below sea level. Can melt it from below – and have in the past.

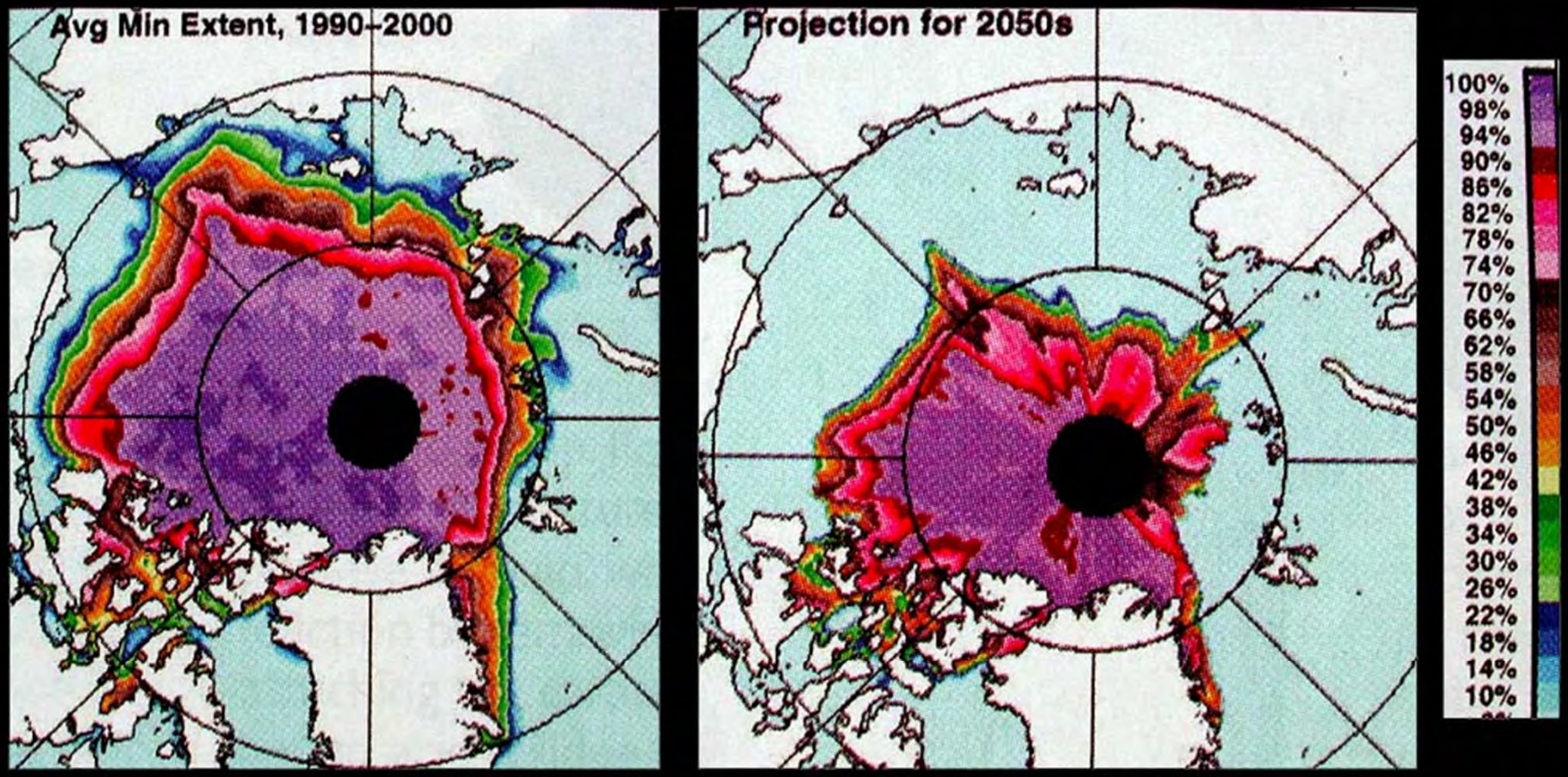




= Pine Island glacier outlet of West Antarctic Ice Sheet

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

IN 2002 THIS WAS THE ANTICIPATED LOSS OF ARCTIC OCEAN ICE IN 2050. WE ARE ALREADY THERE!



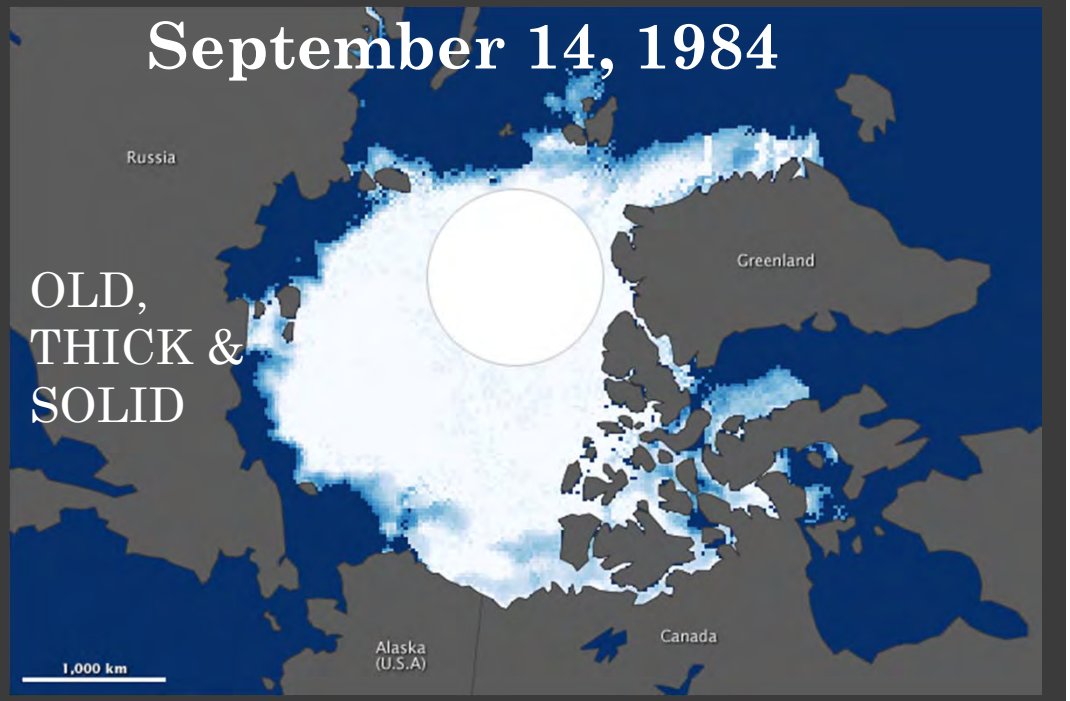
Average minimum extent 1990-2000 Projection for 2050

ARCTIC OCEAN ICE CONCENTRATION

Science v.298, p.1301 - from Geophys. Res. Lett. v.29, p.1956, 2002

LOSS OF ARCTIC SUMMER PACK ICE SINCE 1984

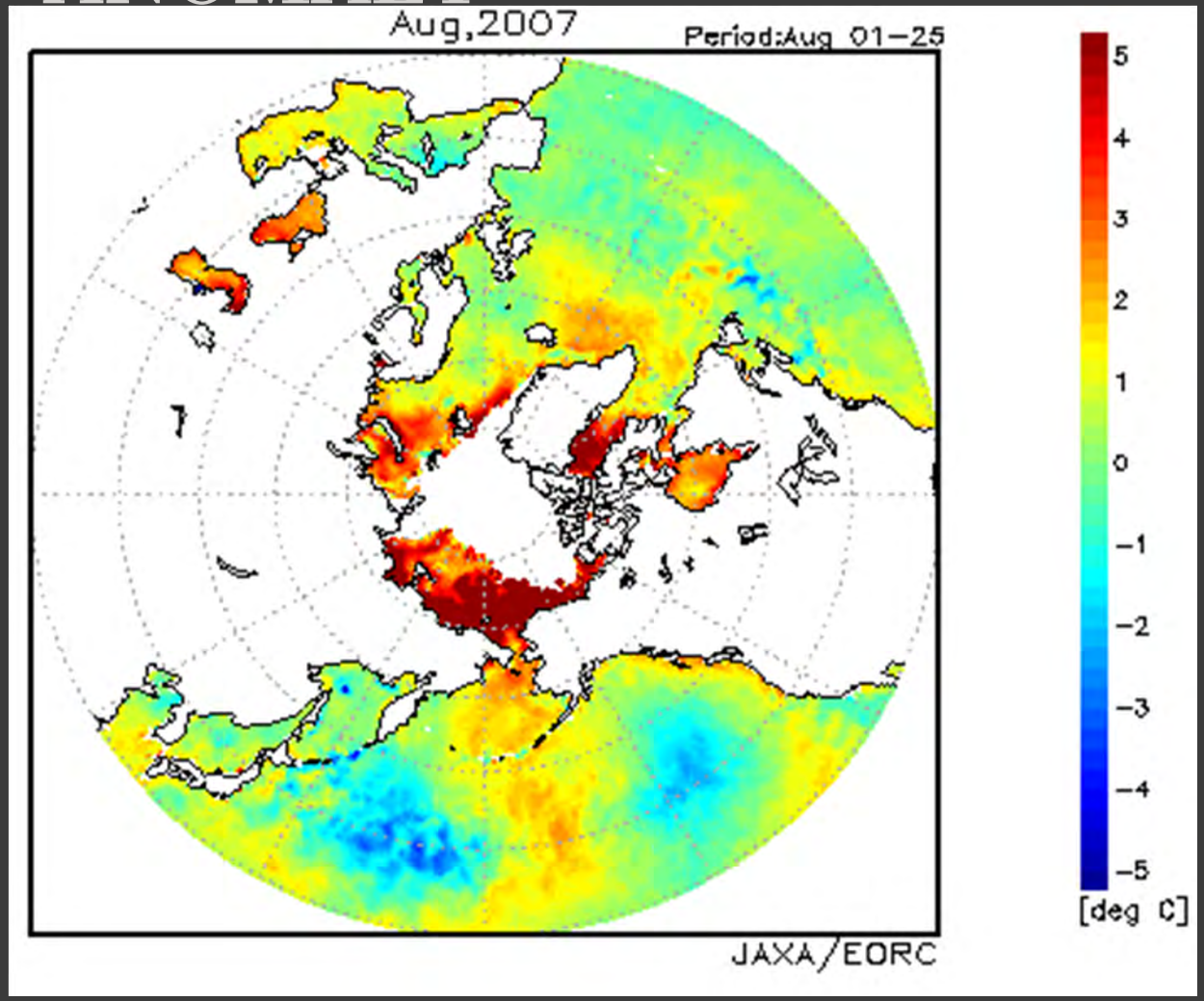
- Warming Greenland
- =>> Ice Sheet melt
- Melting methane hydrates = >> CH_4
- Melting Permafrost =>> CO_2



NORTH POLE WEB CAM – AUGUST 25, 2007

Ice reflects nearly all incoming solar radiation back into the air and space. Open water absorbs over 90% of incoming solar radiation

ARCTIC SEA SURFACE TEMPERATURE ANOMALY

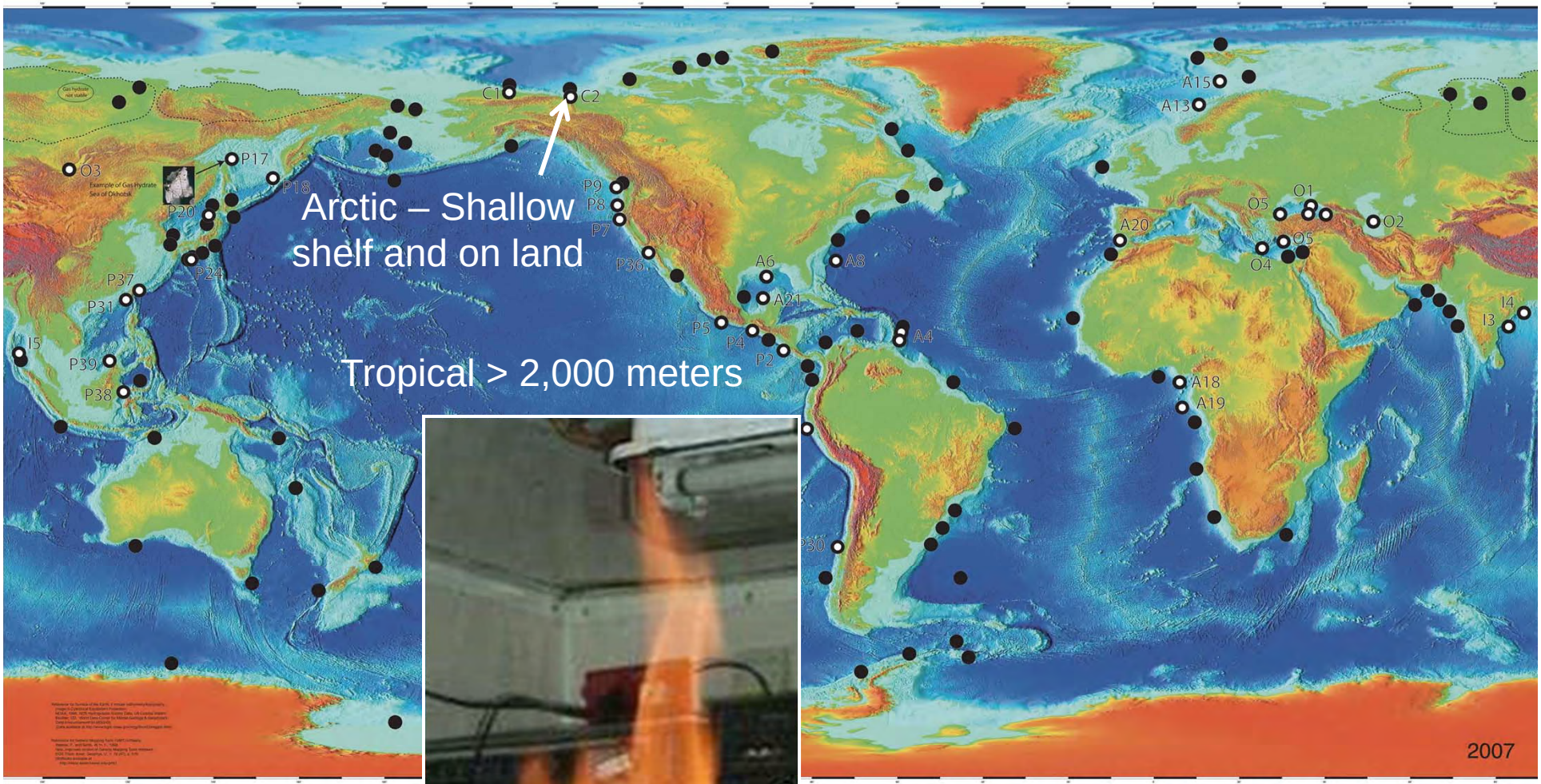


REINFORCING FEEDBACKS ARE ACCELERATING ARCTIC AND GREENLAND TRENDS

Five years ago the Arctic was projected to lose summer pack ice by 2070. Today scientists project the summer Arctic ma y be ice free within a decade!

Earth Observation Research Center, Japan Aerospace Exploration Agency

Global Inventory of Natural Gas Hydrate Occurrence

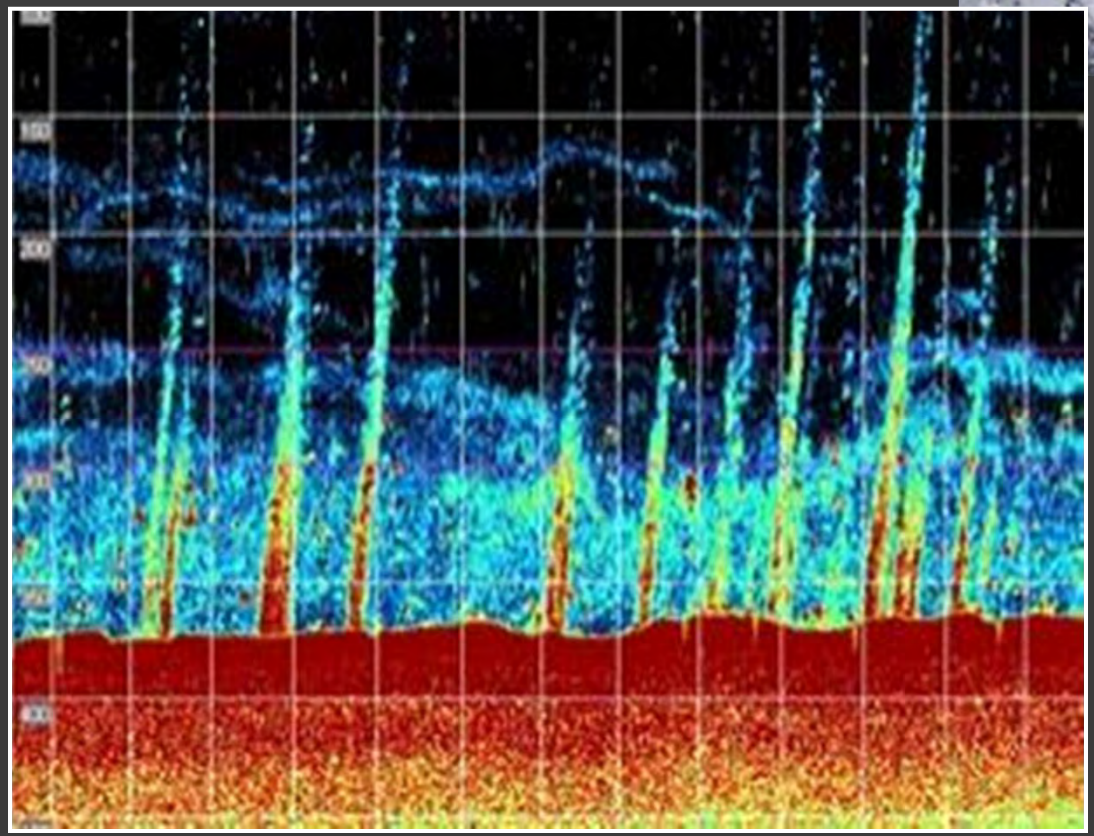


Thomas D. Lorenson and Keith A. Kvenvolden

Methane Hydrates

MELTING OF METHANE HYDRATES ON ARCTIC OCEAN SHELF

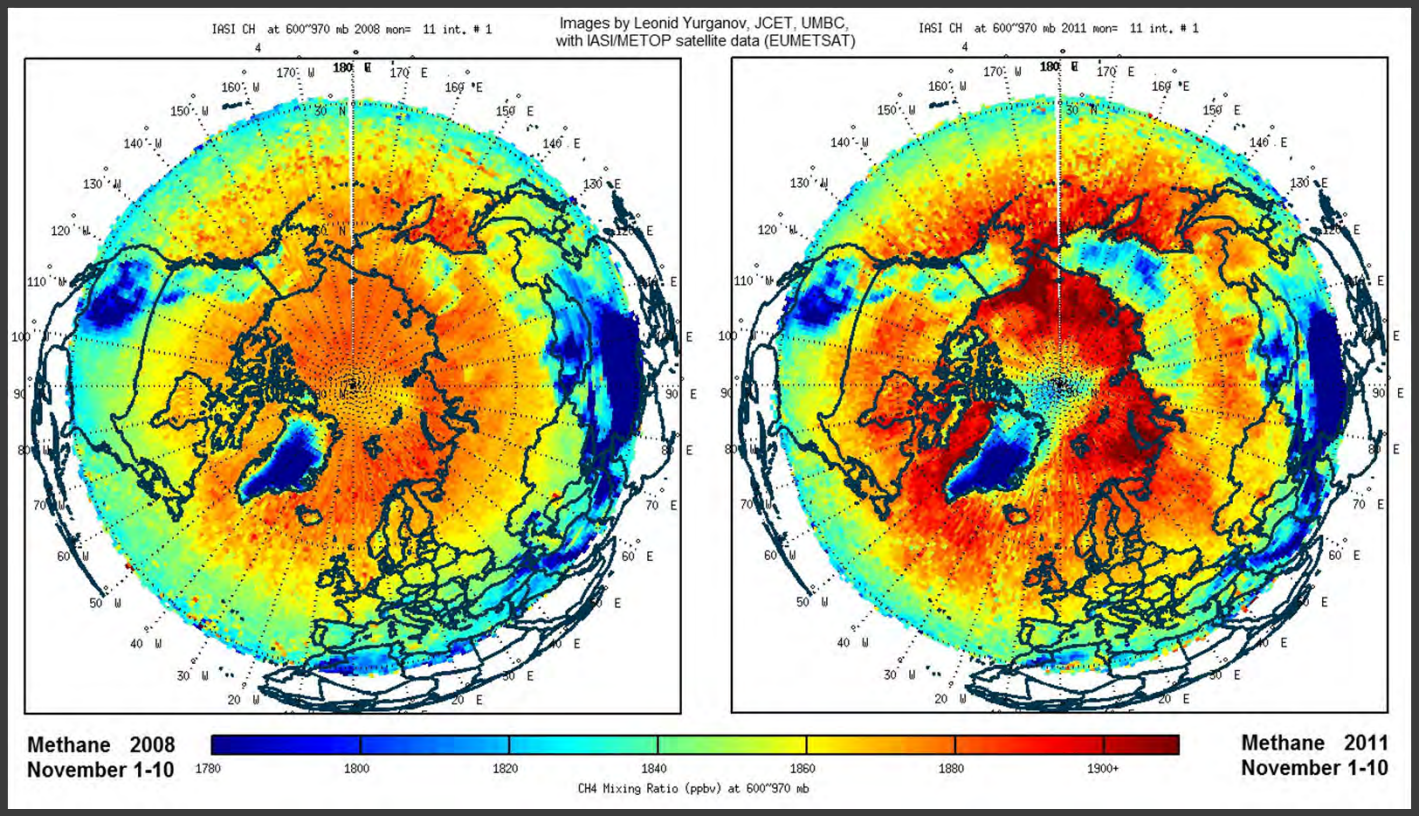
METHANE BUBBLIN
TO ARCTIC OCEAN
SURFACE



METHANE
VENTING
THROUGH THE
OCEAN TO THE
ATMOSPHERE ON
THE ARCTIC

SHELF RELEASE OF METHANE

From melting methane hydrates (NOVEMBER)



2008 2011

IASI AIRS CH4 at 600^^970 mb in NOVEMBER (CH4 Mixing Ratio in ppvb)

Yurganov, 2012

Permafrost rims the Arctic Ocean

- Permafrost is frozen ground 150-2,000 feet thick.
- Huge amounts of organics are frozen in the permafrost.
- 20% of tundra has been lost since the 1980s.
- 3-5 meters of permafrost are expected to melt in the coming 100 years (Ted Schuur, University of Florida).
- Organic decay from melting the upper 3 meters of permafrost will release as much CO2 as is presently in the atmosphere.

MELTING PERMAFROST

WEST OF GOOSE BAY, LABRADOR JULY, 2012

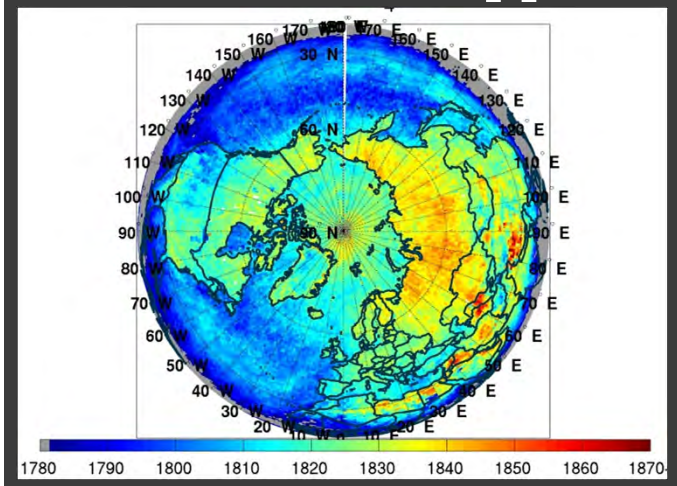
Decayed organics in melted permafrost release carbon dioxide and methane:

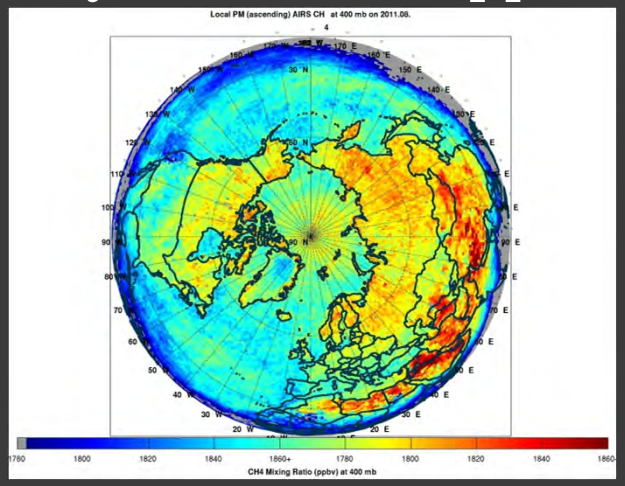
Release as methane if ground is wet;

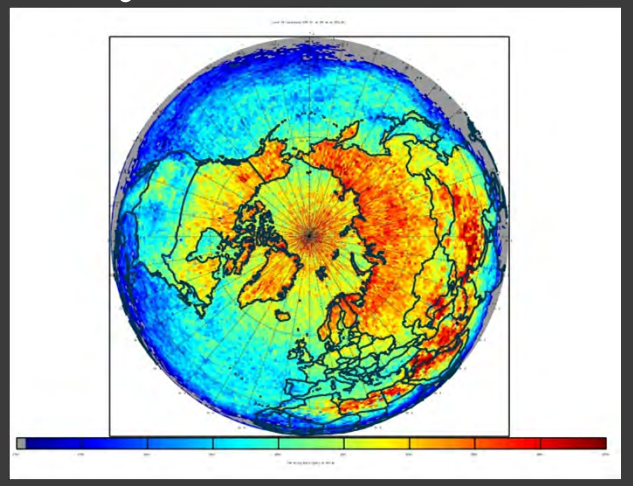
Release as carbon dioxide if ground is dry.

PERMAFROST RELEASE OF METHANE (AUGUST)

+ 10 ppvb in 8 years **+ 10 ppvb in 1 year !!**







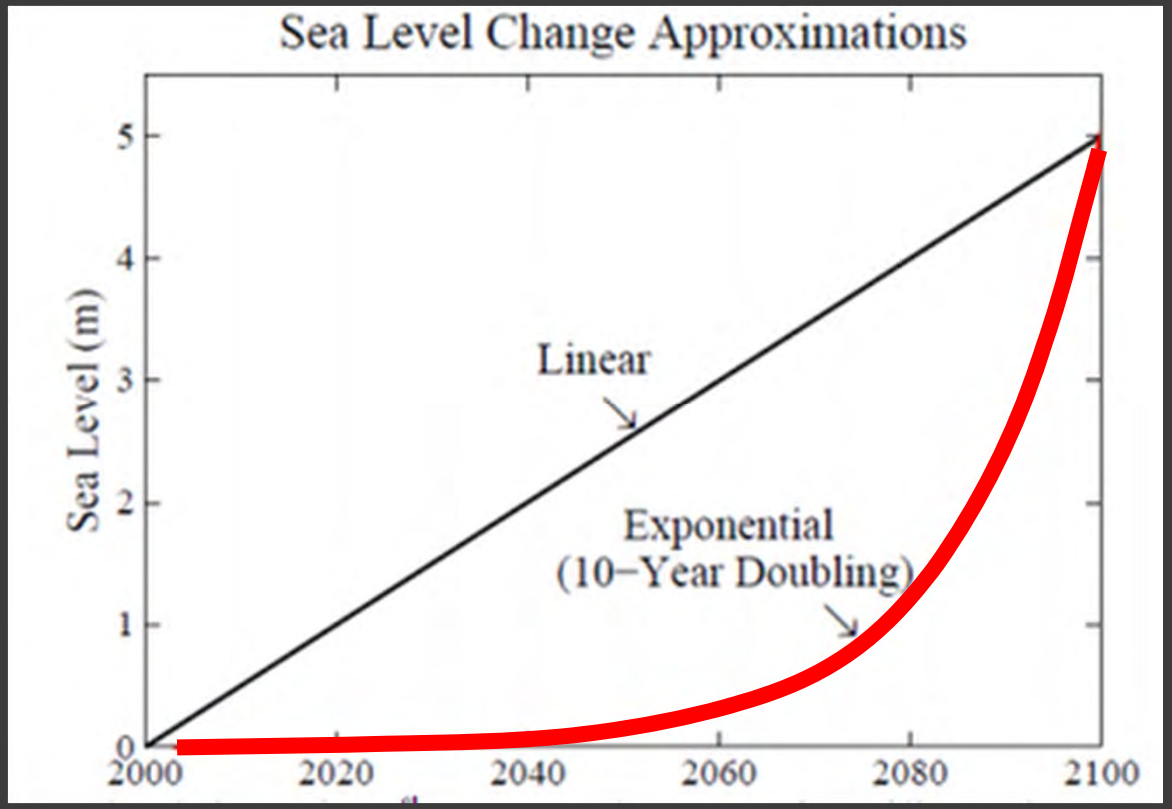
2003 2011 2012

Local PM (ascending) AIRS CH4 at 400 mb in August (CH4 Mixing Ratio in ppvb)

University of Maryland, 2012

Leading Climatologist, James Hansen

has suggested a sea level rise of 5 meters (16 feet) by 2100



Amplifying feedbacks make ice sheet disintegration necessarily highly non-linear.

A 10-year doubling time for sea level rise is plausible, and such a doubling time, from a 1 mm per year ice sheet contribution to sea level in the decade 2005-2015, would lead to a cumulative 5 m sea level rise by 2095.

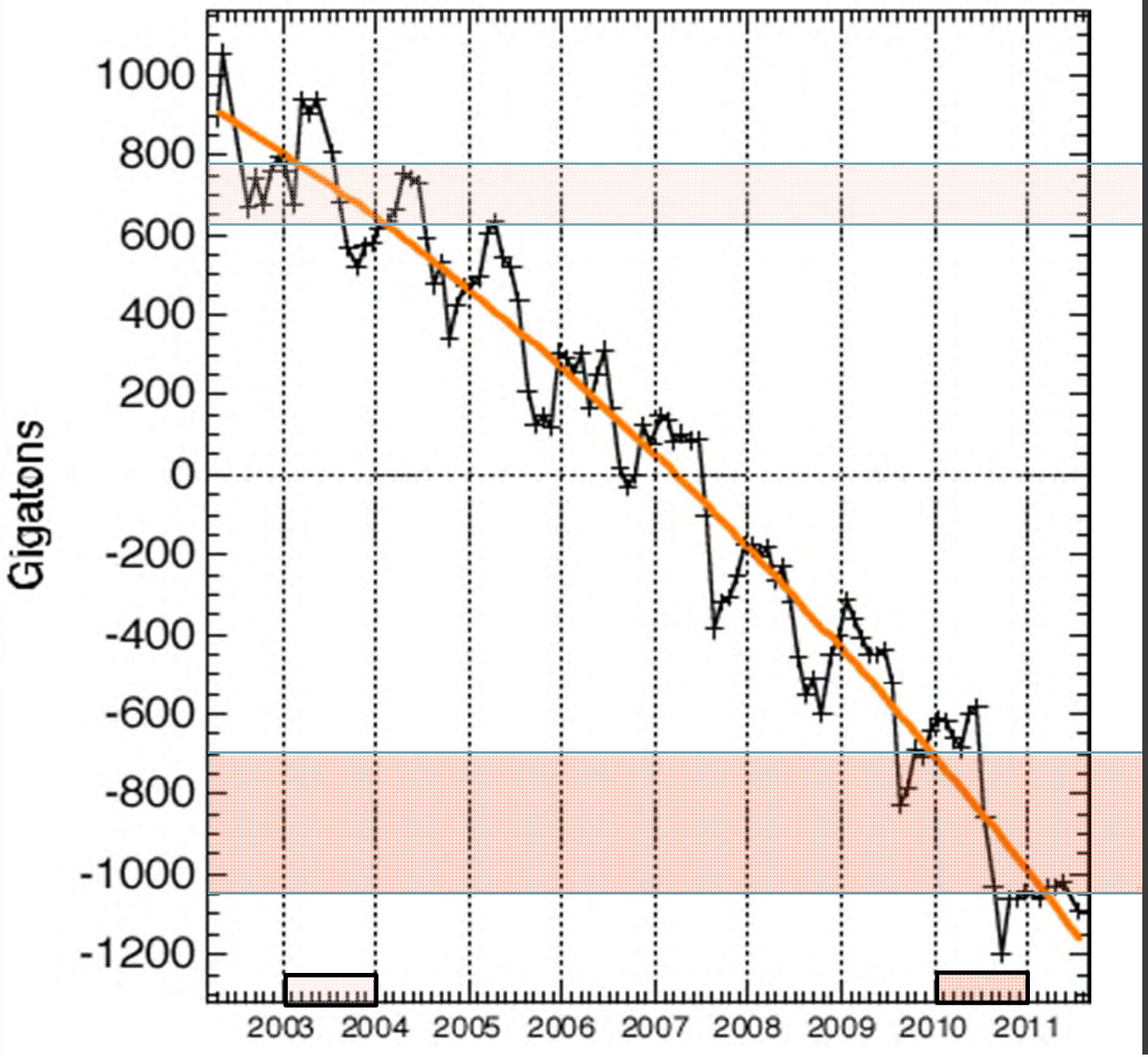
James Hansen (2007) and James Hansen and Miki Sato (2012)

WE ARE RUNNING WELL AHEAD OF HANSEN’S PREDICTION

-

LOOKING JUST AT GREENLAND.

Greenland Ice Mass

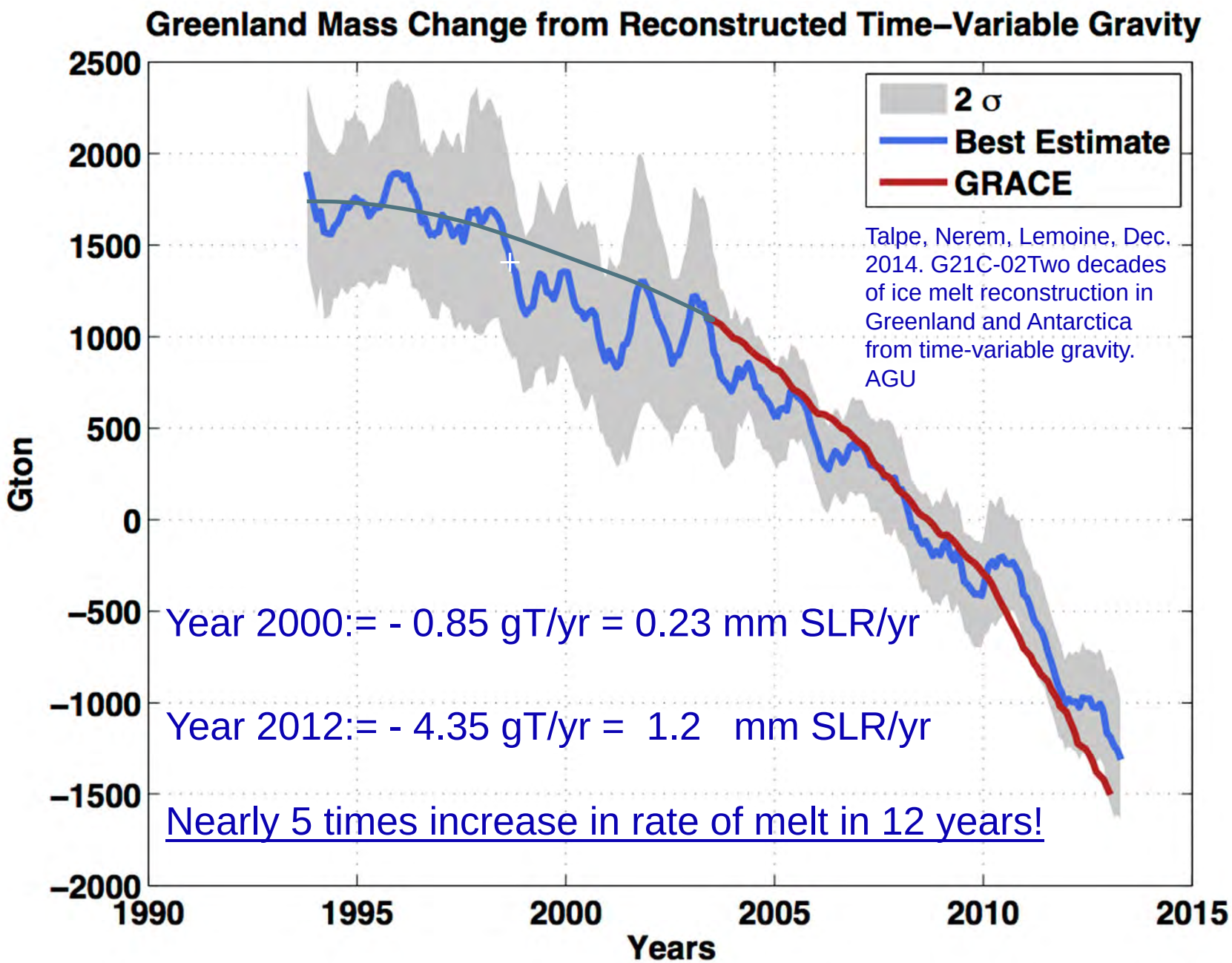


RAPIDLY ACCELERATING LOSS

-150 gigatons/yr
=0.41 mm/yr

7 Years

-350 gigatons/yr
= 0.97 mm/yr


Greenland Mass Change from Reconstructed Time–Variable Gravity
2 σ
Best Estimate
GRACE
Talpe, Nerem, Lemoine, Dec. 2014. G21C-02Two decades of ice melt reconstruction in Greenland and Antarctica from time-variable gravity. AGU
Gton
Years
2500
2000
1500
1000
500
0
–500
–1000
–1500
–2000
1990
1995
2000
2005
2010
2015
Year 2000:= - 0.85 gT/yr = 0.23 mm SLR/yr
Year 2012:= - 4.35 gT/yr = 1.2 mm SLR/yr
Nearly 5 times increase in rate of melt in 12 years!

In January 2013,glaciologist Jason Box said that "Humans have already set in motion 69 feet (20 meters) of sea level rise".

20 meters (69 feet) sea level rise

In a 2012 National Science Foundation report, paleo-climatologist Kenneth Miller of Rutgers University said: "The natural state of the Earth with present carbon dioxide levels is one with sea levels about 70 feet higher than now."

The problem is that these rises will occur as a series of rapid pulses -

IT IS TIME TO BEGIN THE CONSIDERATION THAT PULSES OF RAPID SEA LEVEL RISE IN THE 1-10 METER RANGE AREA A REAL POSSIBILITY DURING THIS CENTURY.

LEADING TO 10-30 M (33-100 FT) SEA LEVEL RISE FROM MULTIPLE PULSES OF SEA LEVEL RISE.

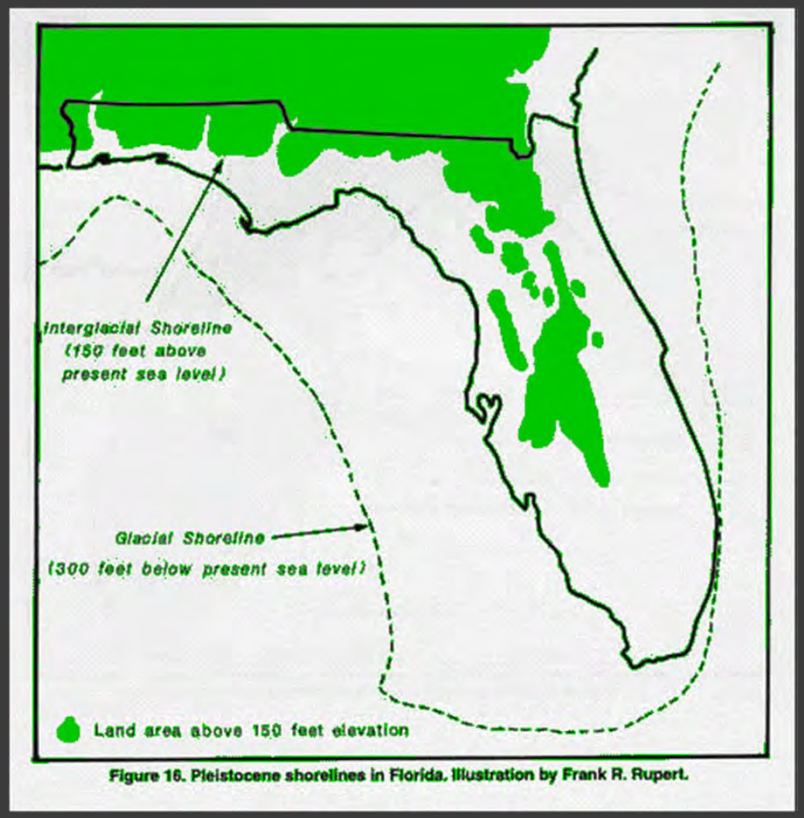


Figure 16. Pleistocene shorelines in Florida. Illustration by Frank R. Rupert.

Elevations greater than 150’

I recommend quick planning and implementation for putting things too important to lose and too valuable to be disrupted

At greater than 165 feet (>50 meters) elevation and

in areas that will not be in the chaos of rapid relocatio

Such as:
National Archives, Museums, & Gallerys
Mints, Critical Military Bases, Legal Archives
Global Seed Banks, Computer Data Centers
National Health & Disease Control Centers
Water supply/storage, disposal, energy systems
Planning for rapid resettlement of large population groups,
Maintaining agricultural functionality and distribution (most deltas compromised with less than 6 feet rise).

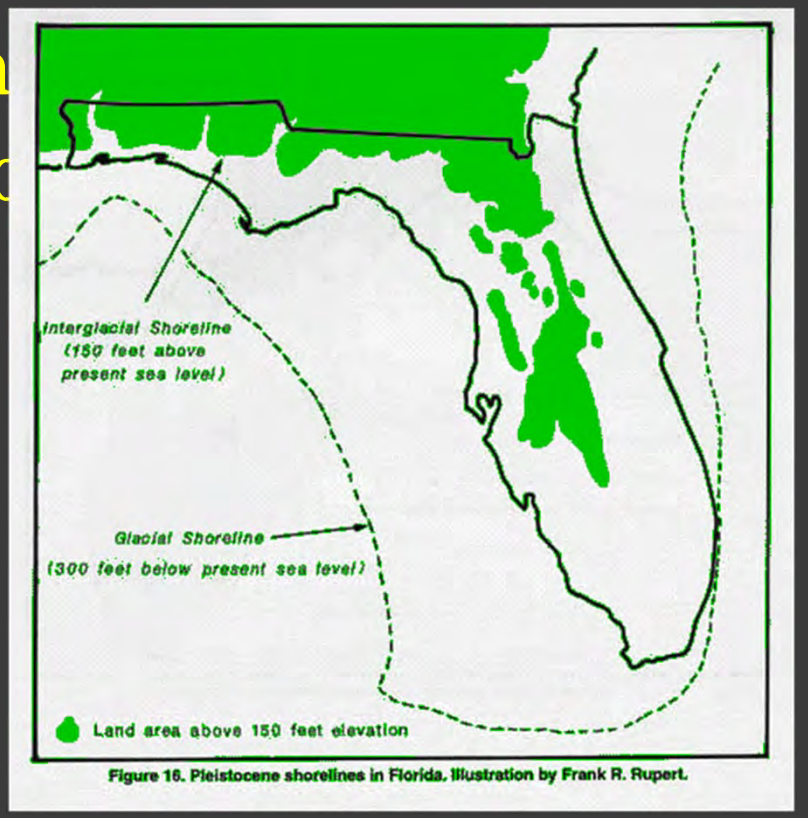


Figure 16. Pleistocene shorelines in Florida. Illustration by Frank R. Rupert.

Elevations greater than 150’

DELTAS ARE THE FOUNDATION FOR FOOD SUPPLY WORLDWIDE.

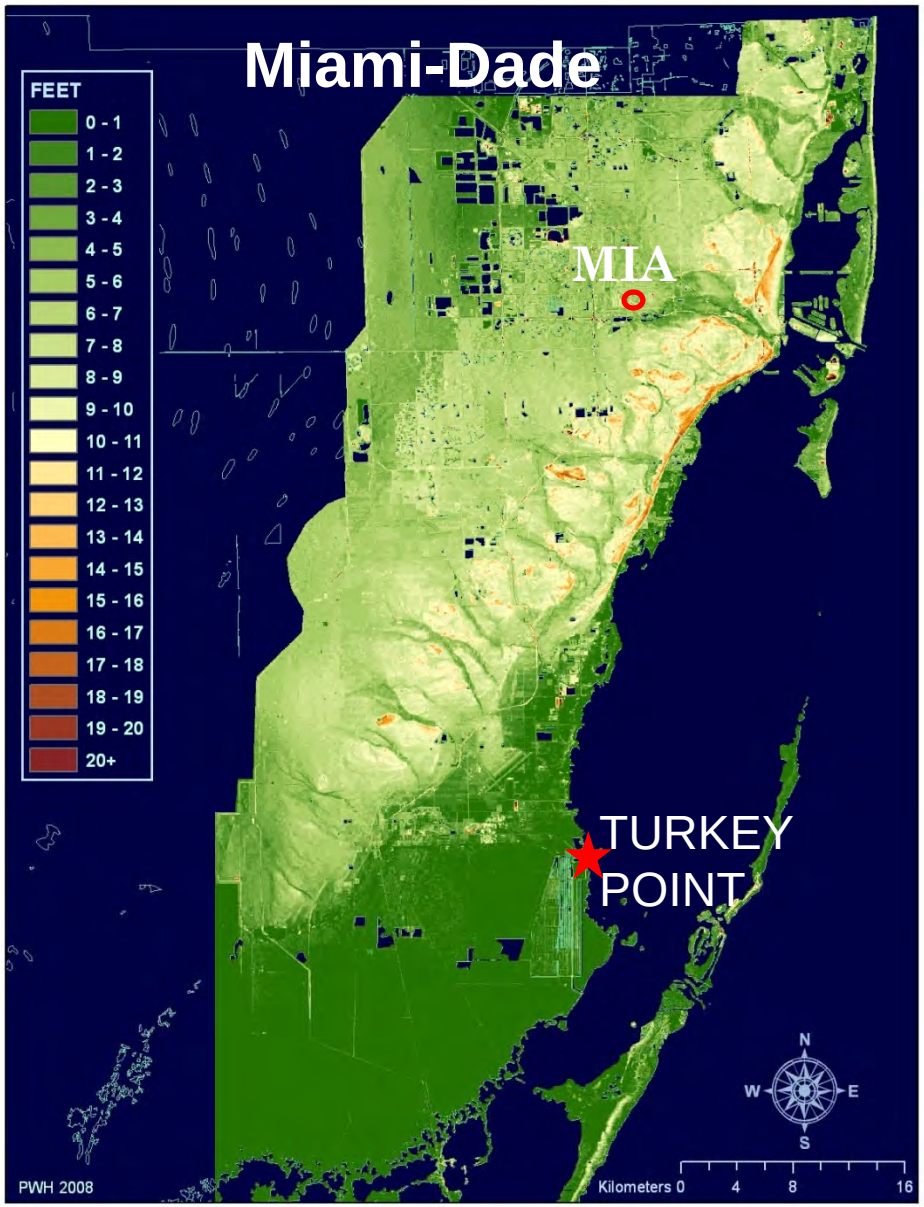
A 2 meter (6.5 foot) rise will inundate them.

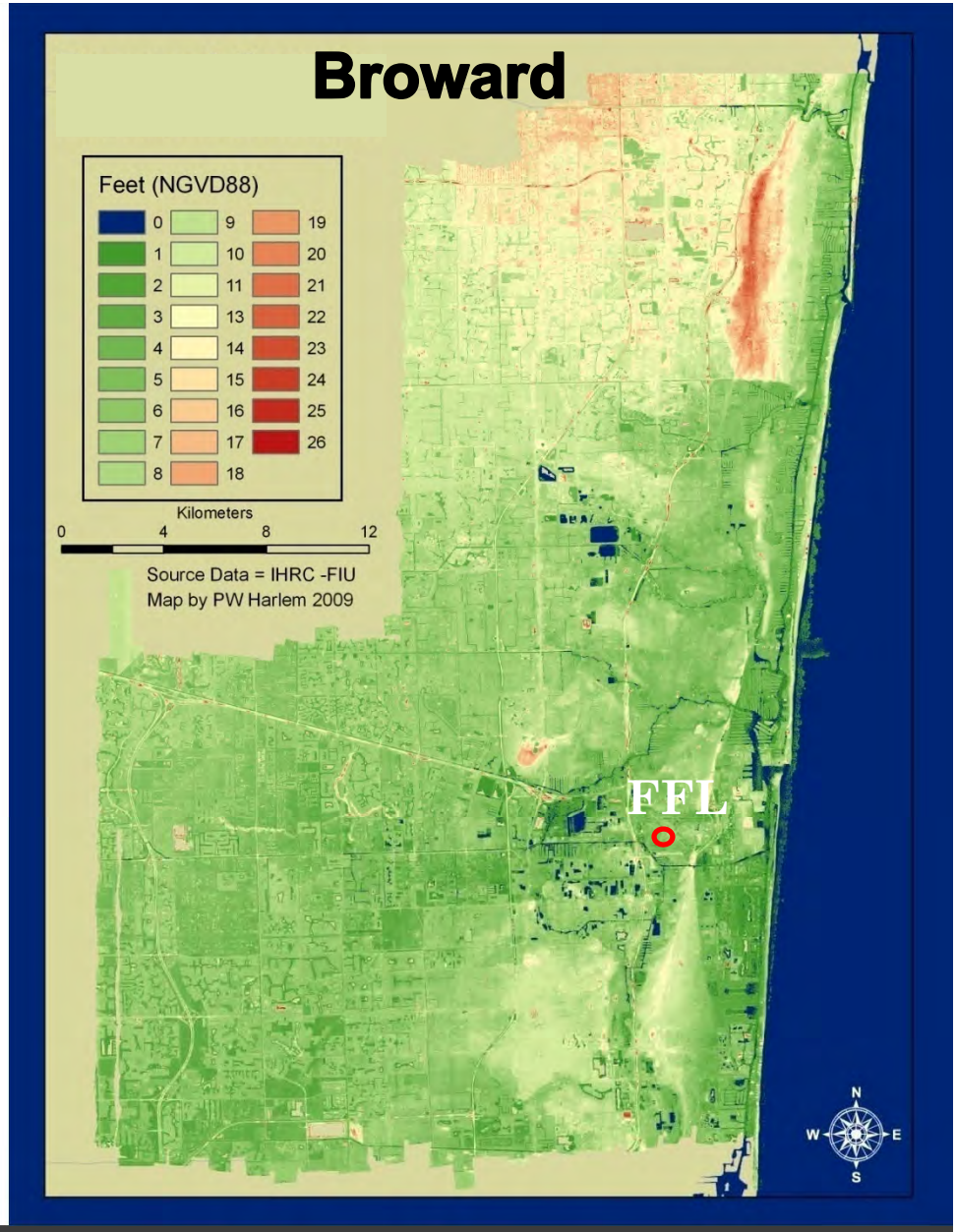
Godavari River Delta, India

© Harold R. Wanless, August 18 , 2012

LOOK HOW VULNERABLE SOUTHEAST FLORIDA IS TO RISING SEA LEVEL –

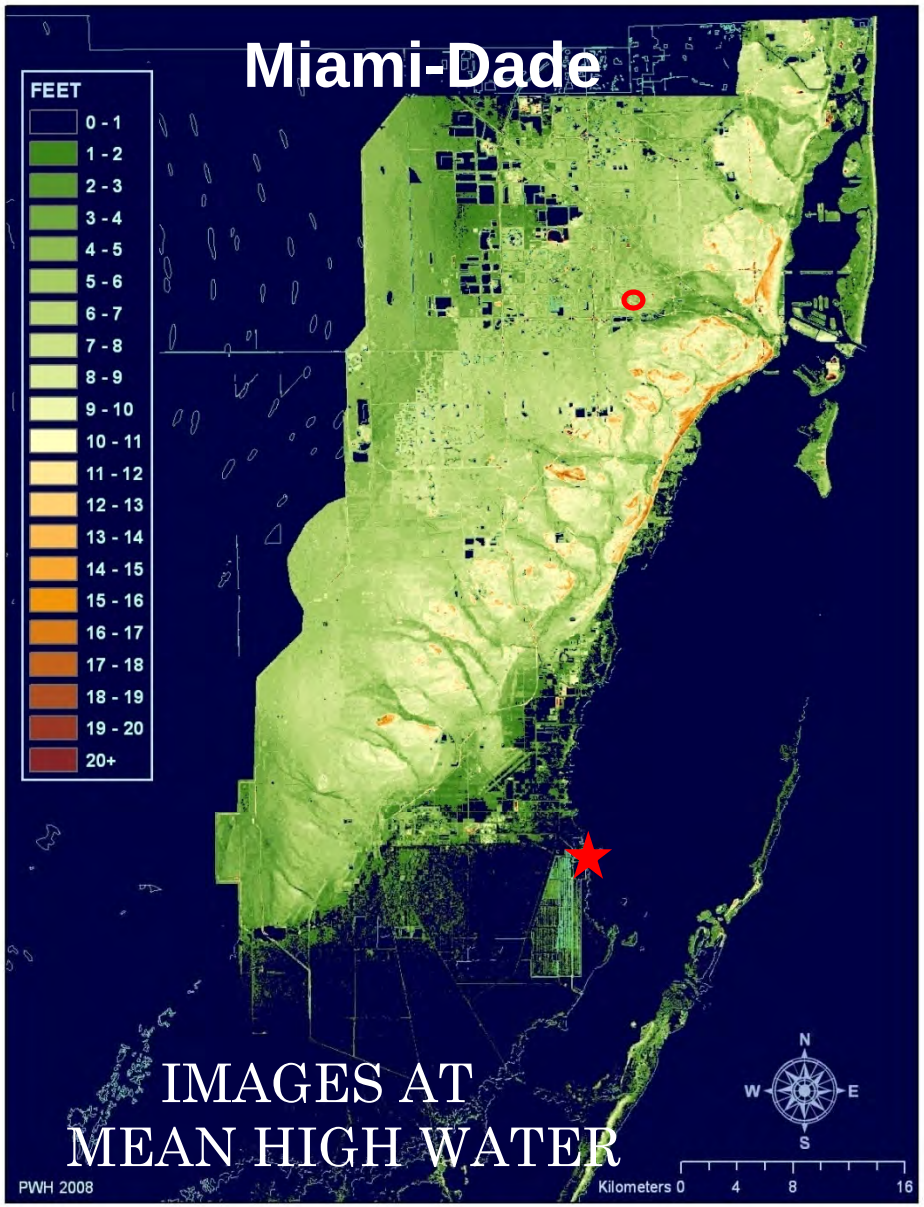
BARRIER ISLANDS AND MAINLAND:

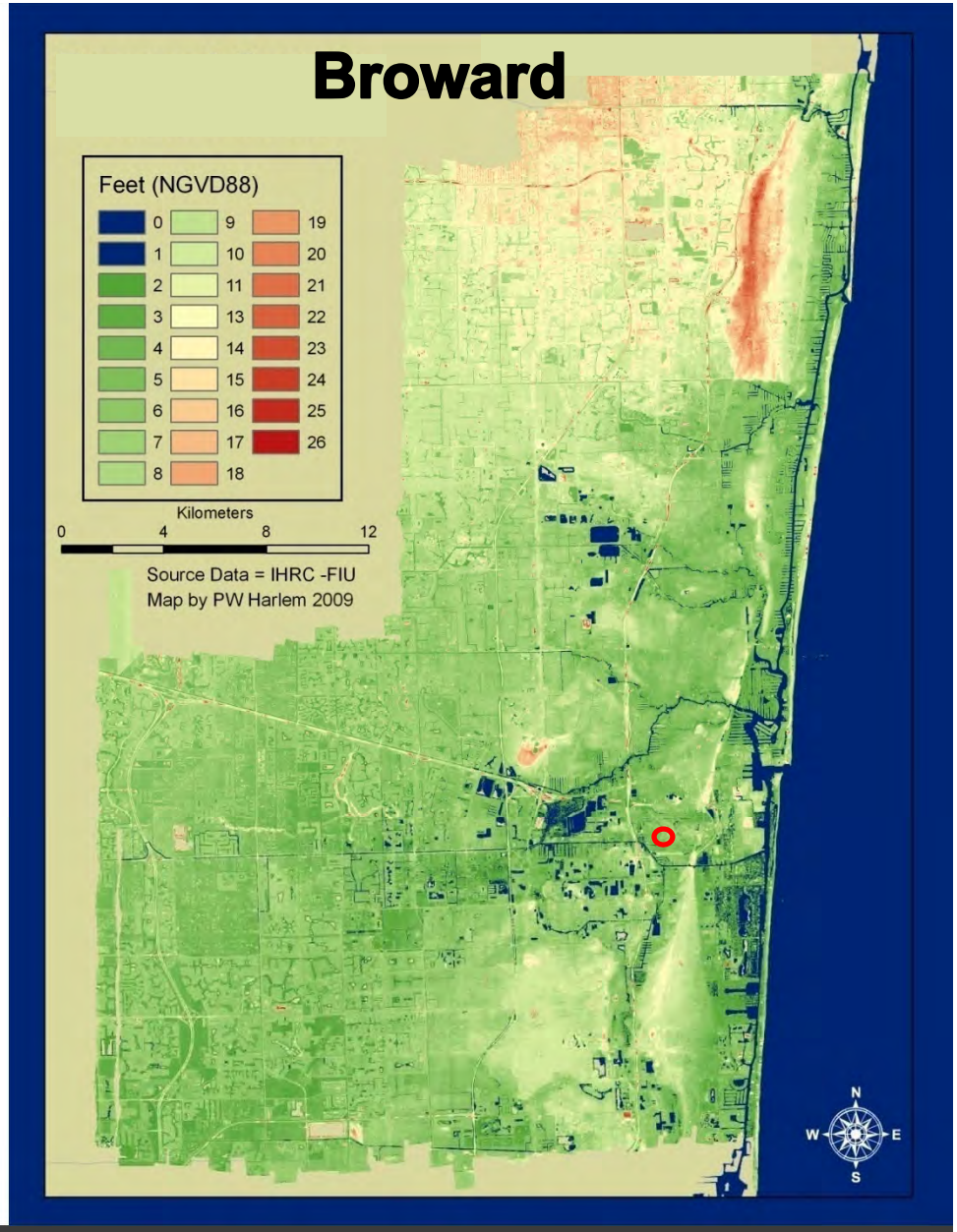




Present topography as shown with LiDAR elevation data

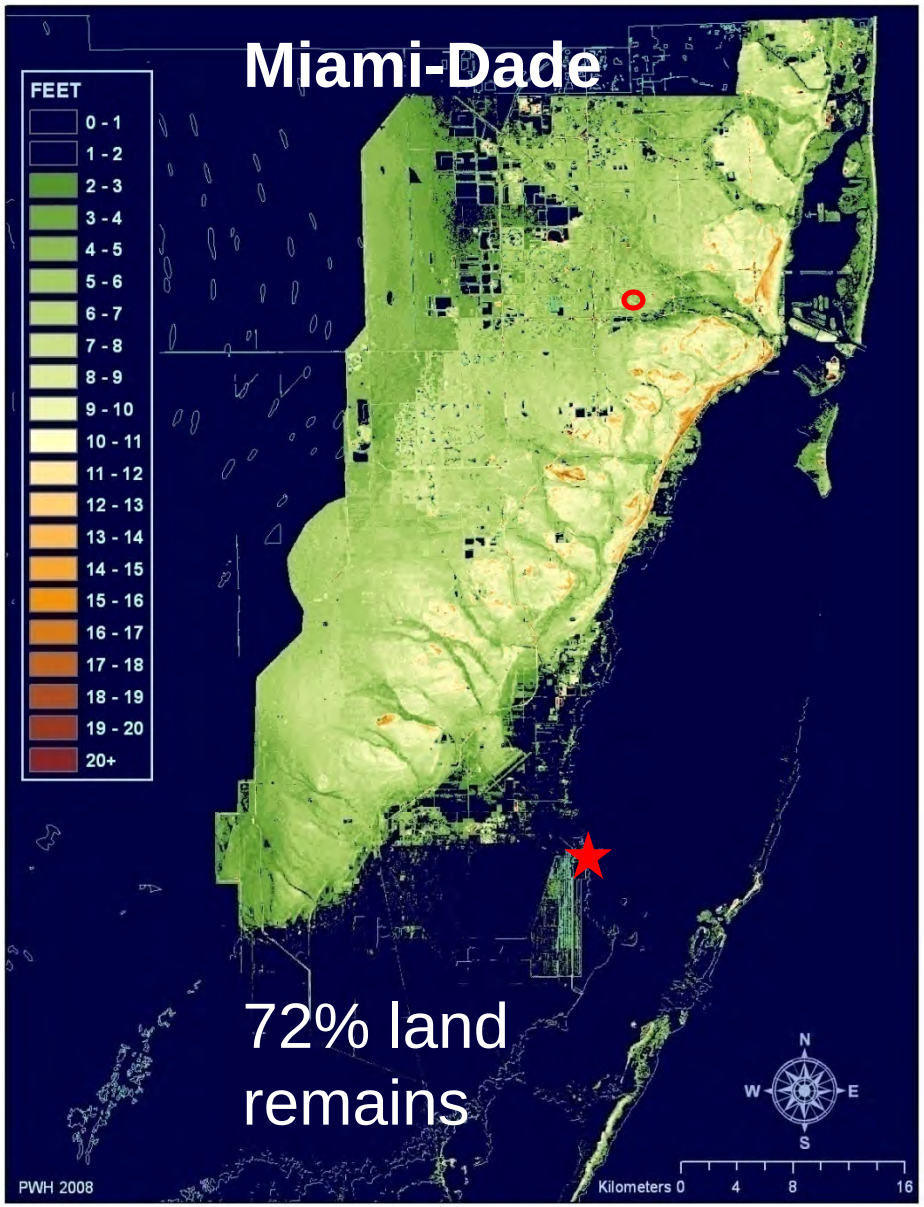
from P. Harlem, 2011

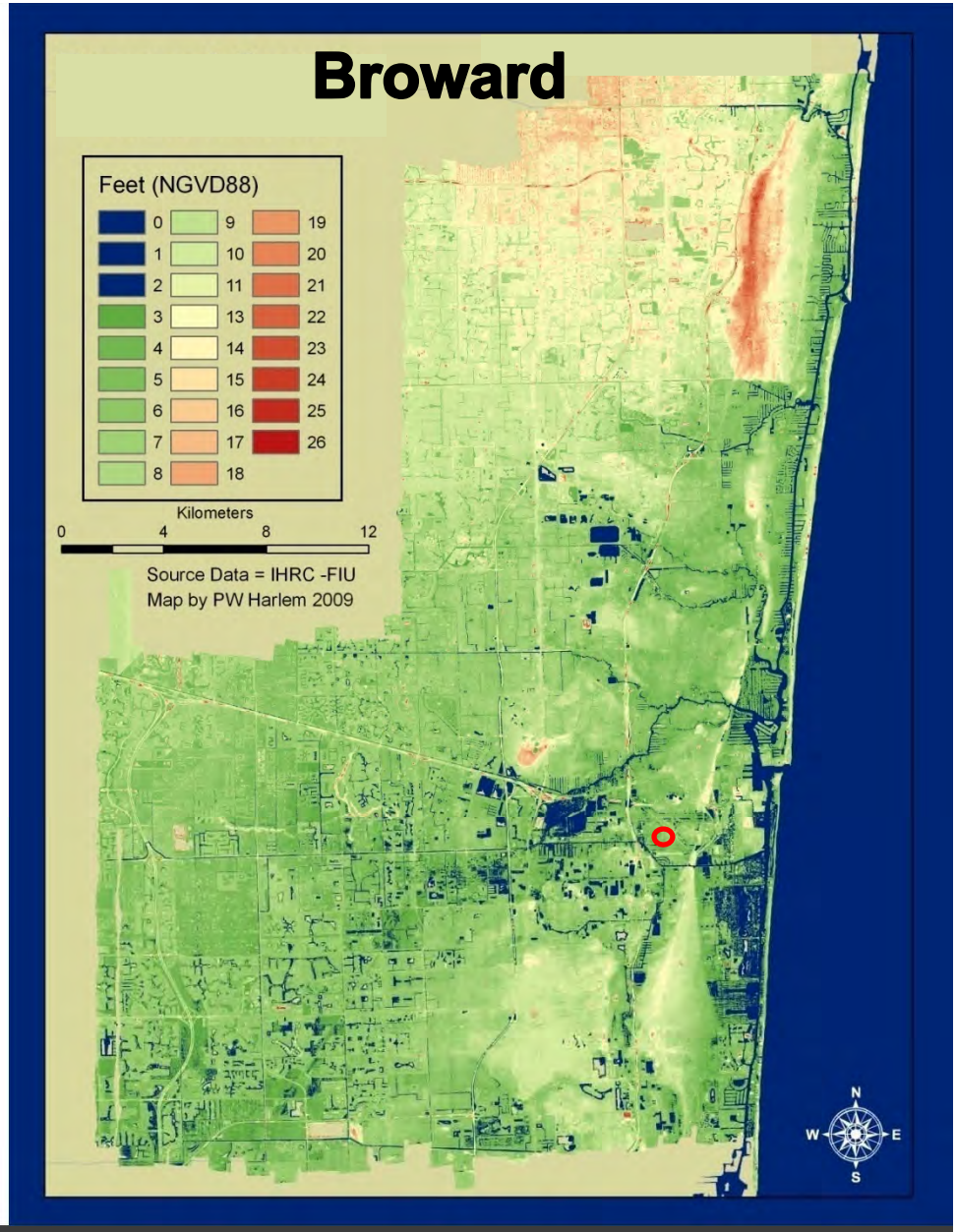




Inundation from 1 ft. Sea Level Rise (2030-2042)

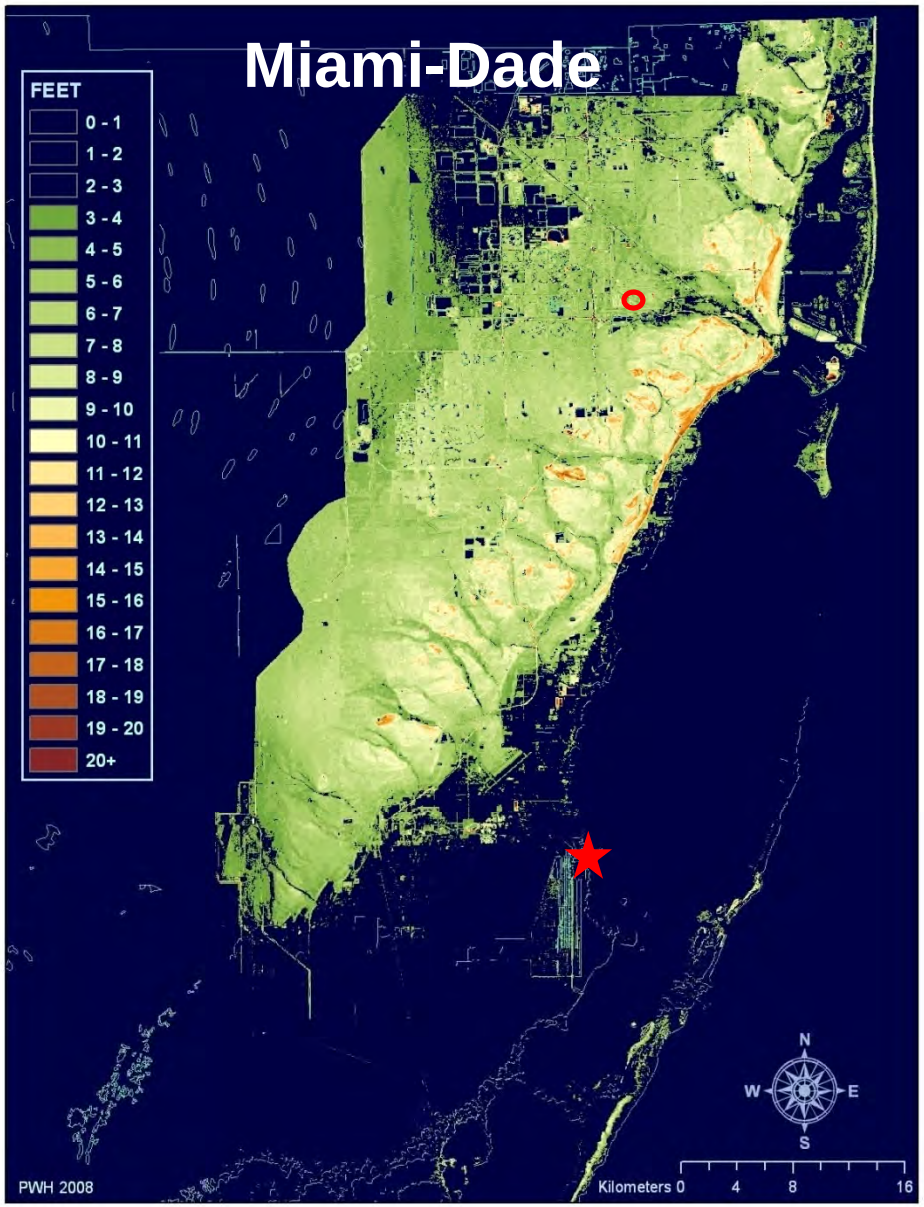
from P. Harlem, 2011

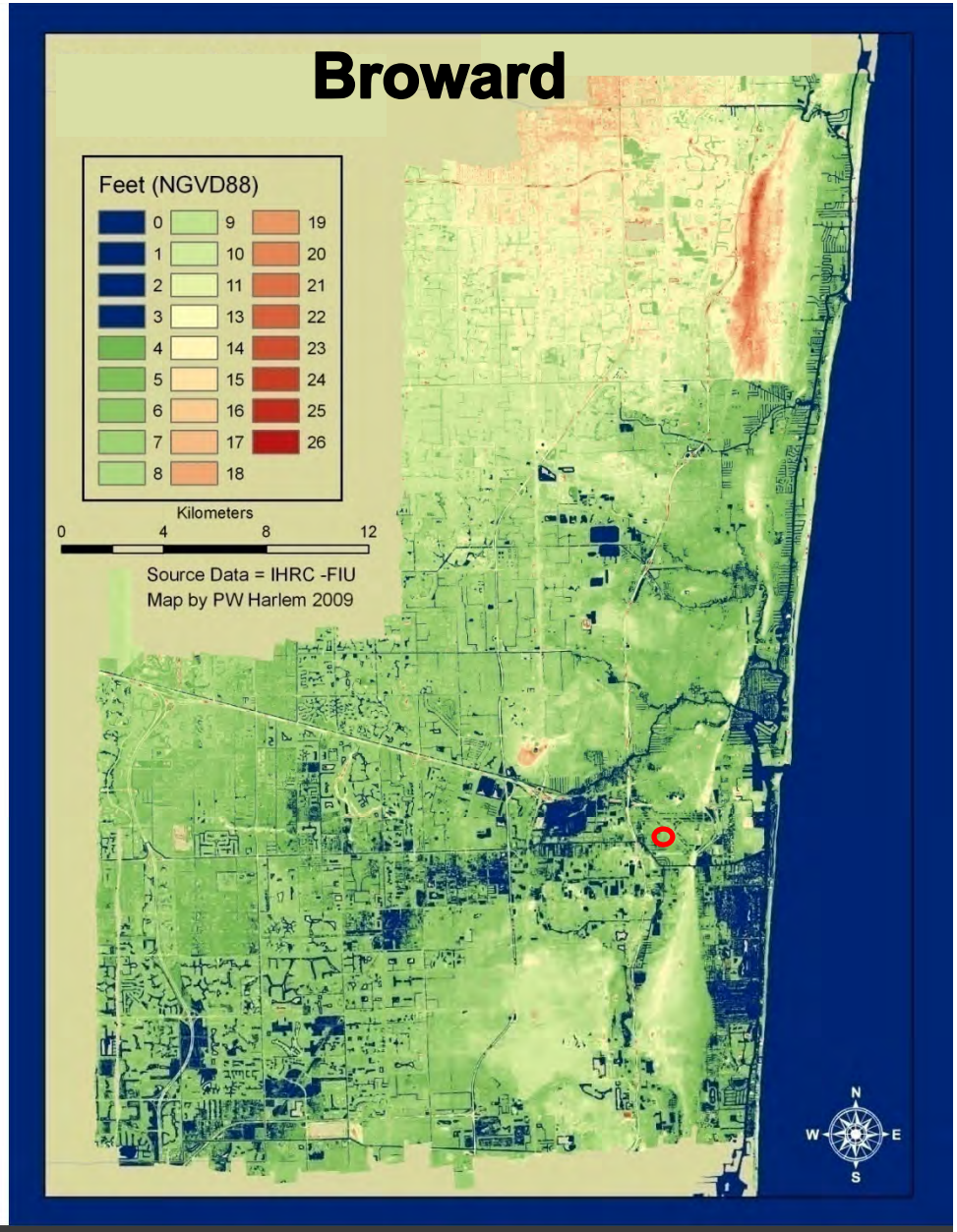




Inundation from 2 ft. Sea Level Rise (2048-2066)

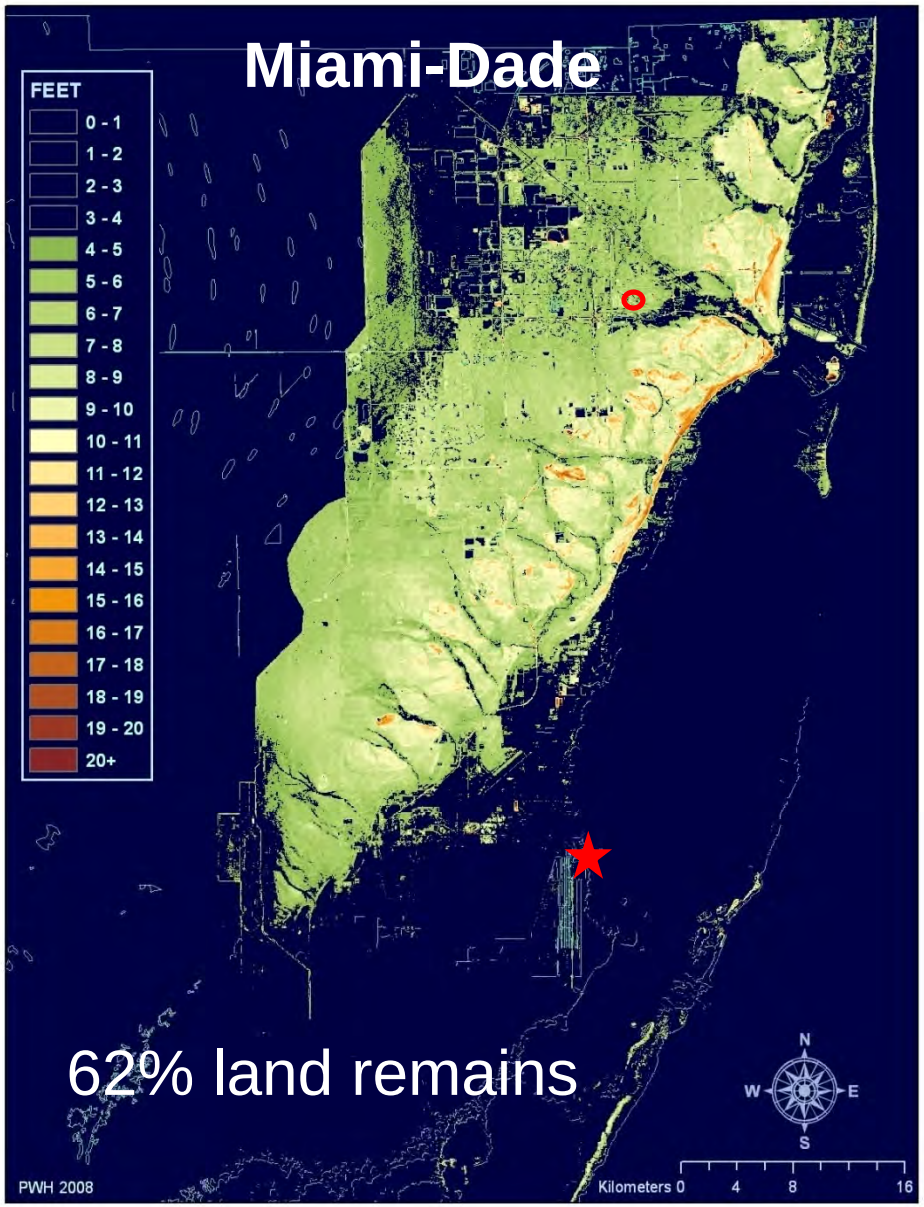
from P. Harlem, 2011

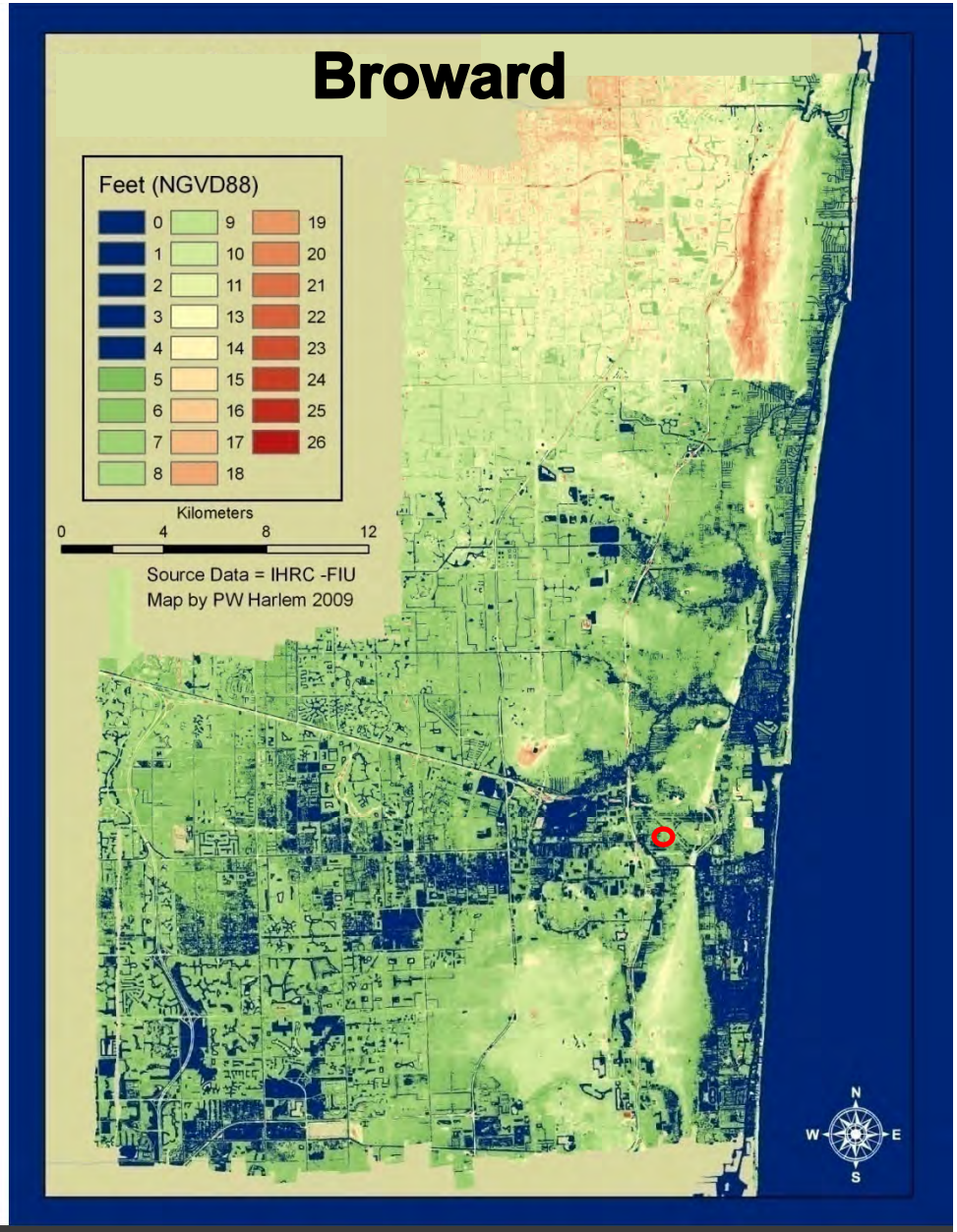




Inundation from 3 ft. Sea Level Rise (2063-2084)

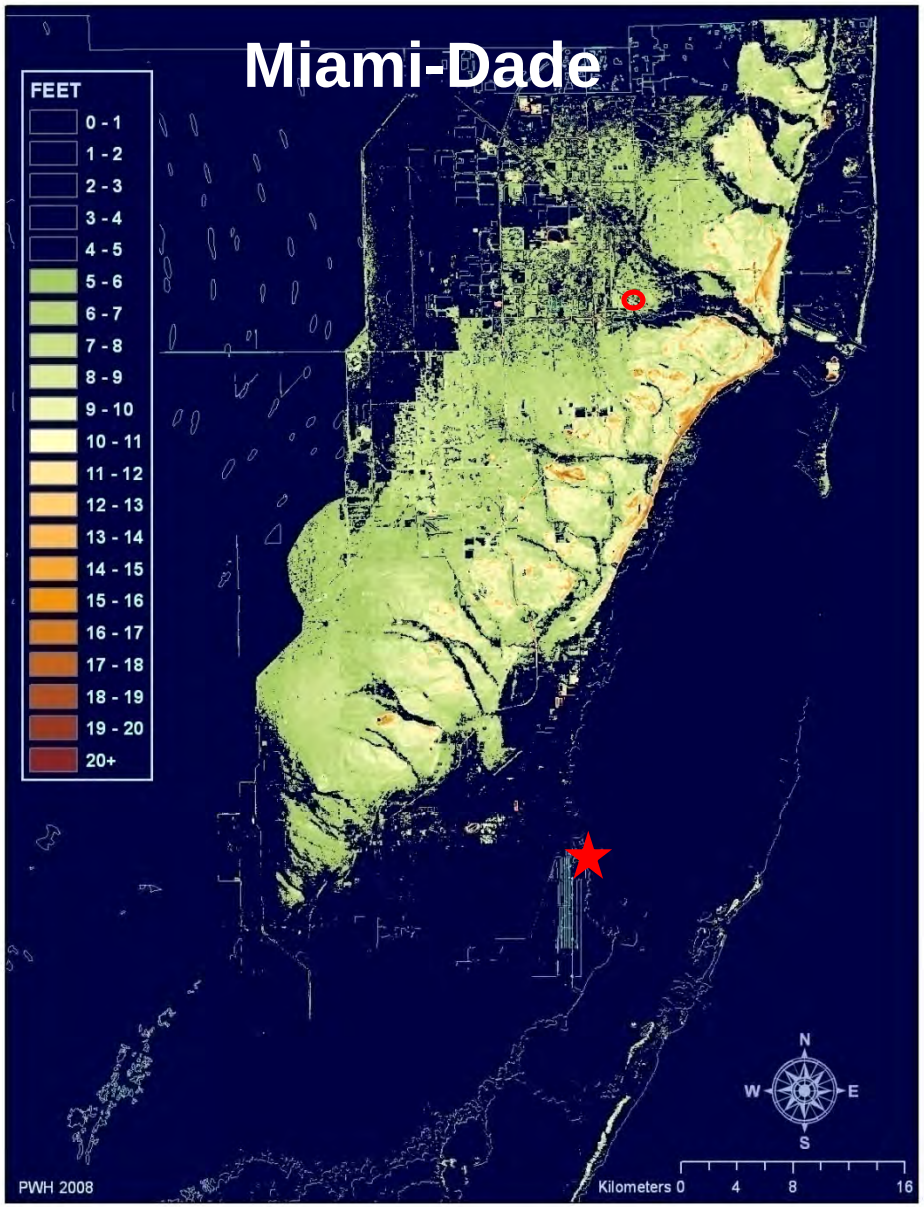
from P. Harlem, 2011

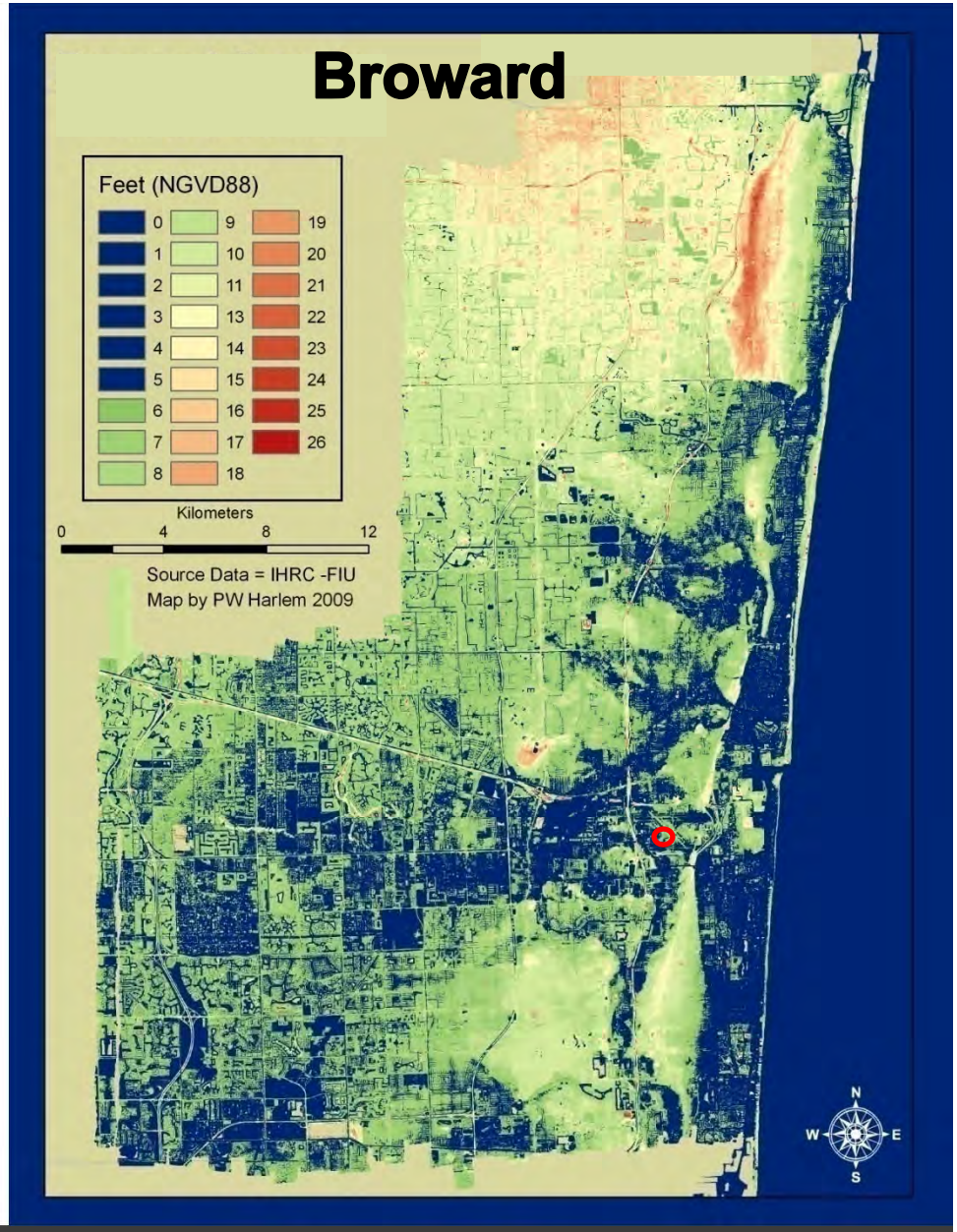




Inundation from 4 ft. Sea Level Rise (2074-2099)

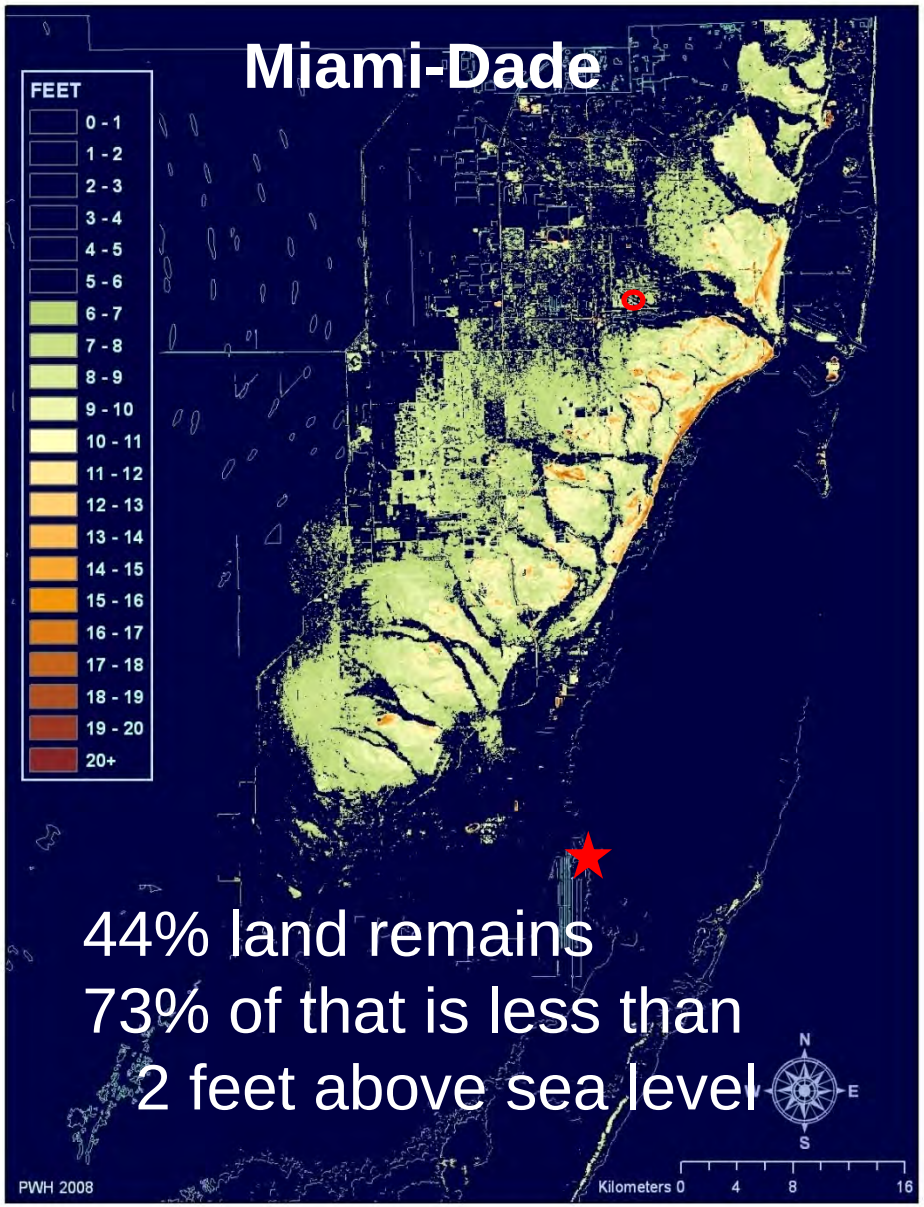
from P. Harlem, 2011

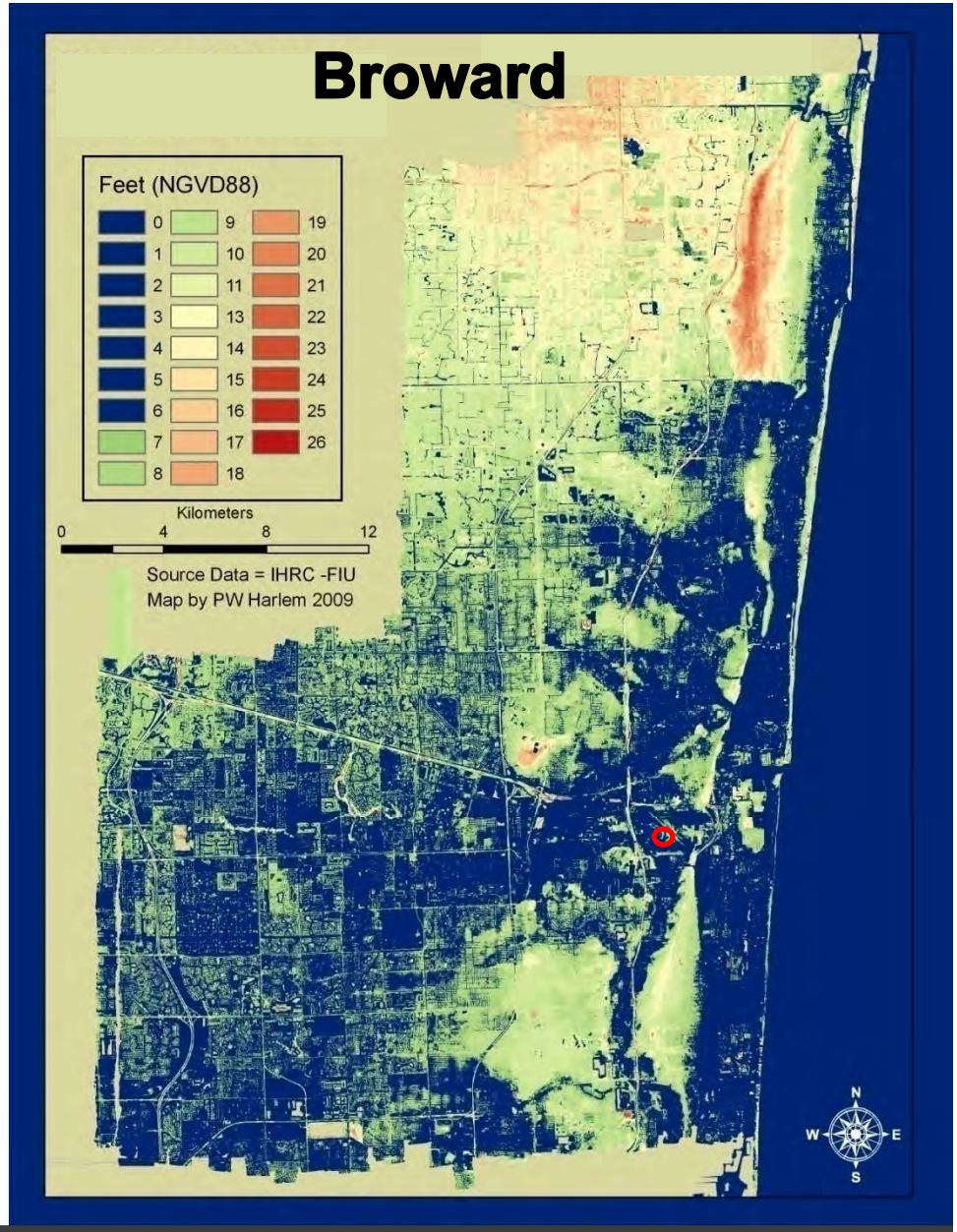




Inundation from 5 ft. Sea Level Rise (2084-2112)

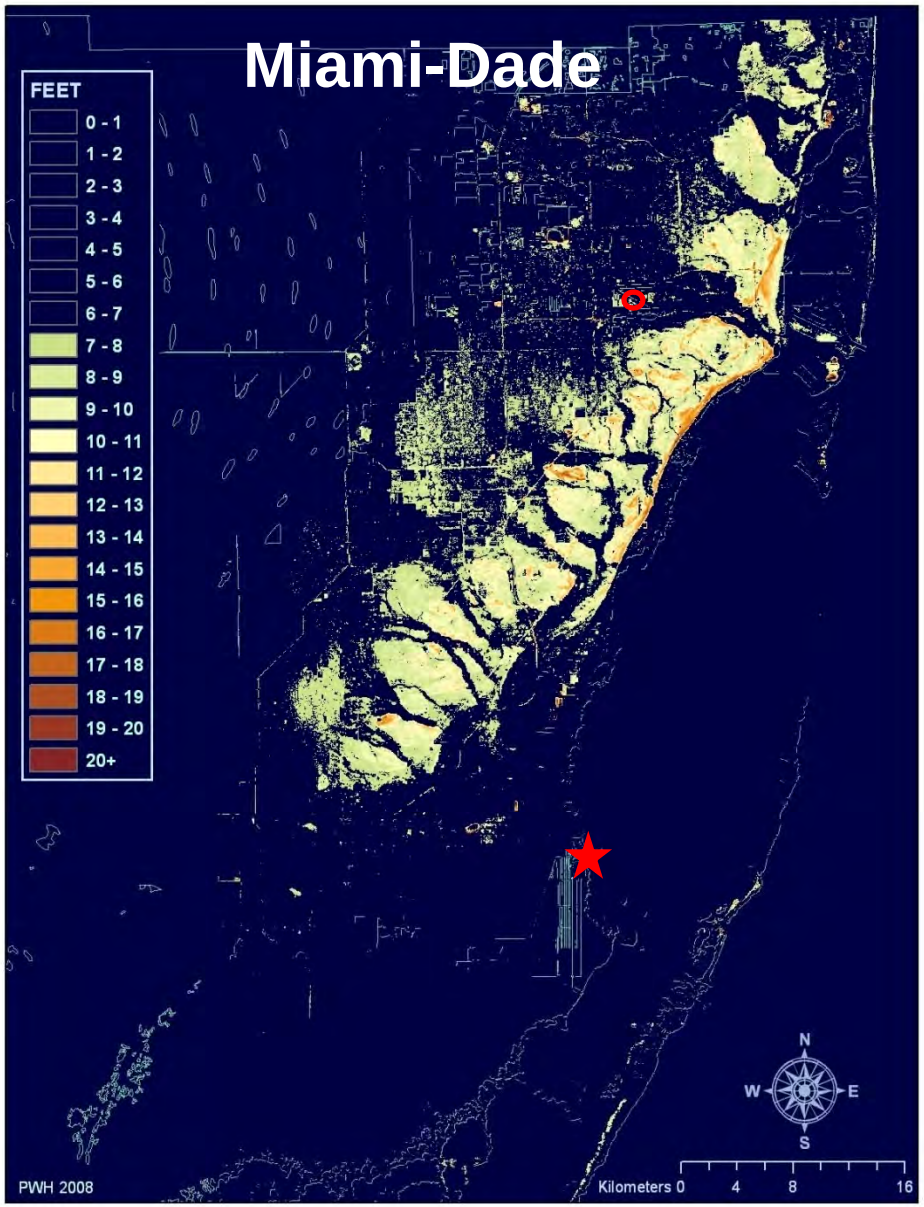
from P. Harlem, 2011

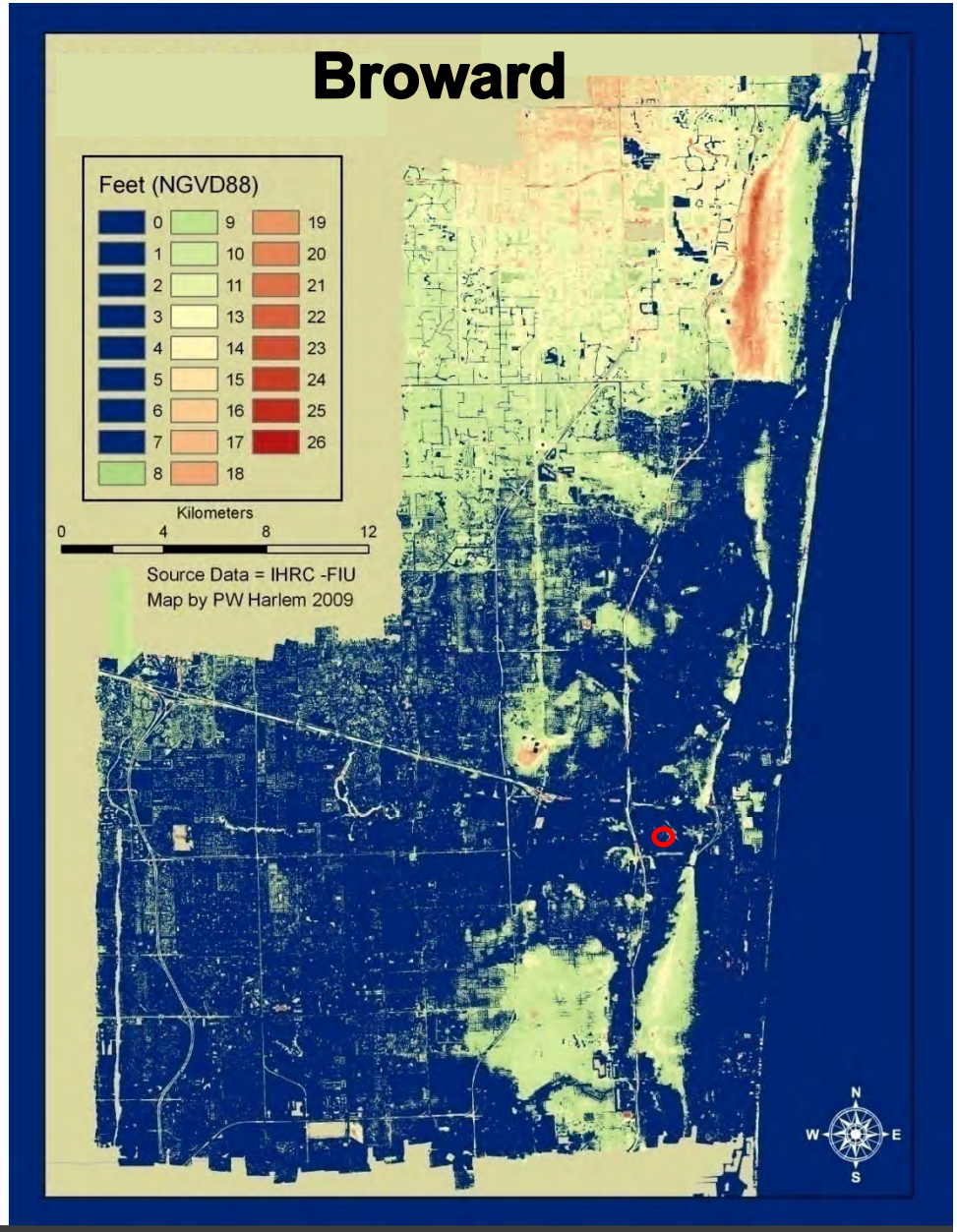




Inundation from 6 ft. Sea Level Rise (2093-2121)

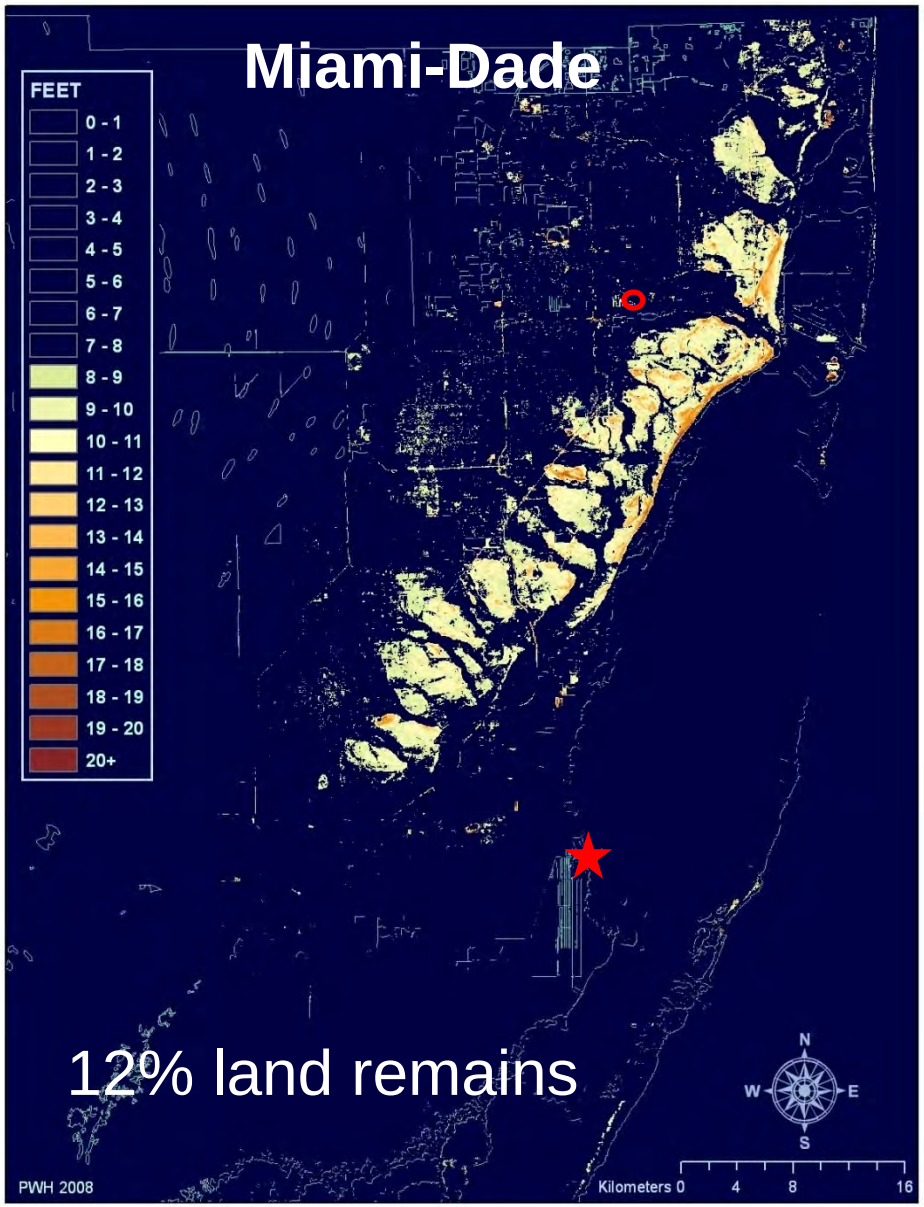
from P. Harlem, 2011

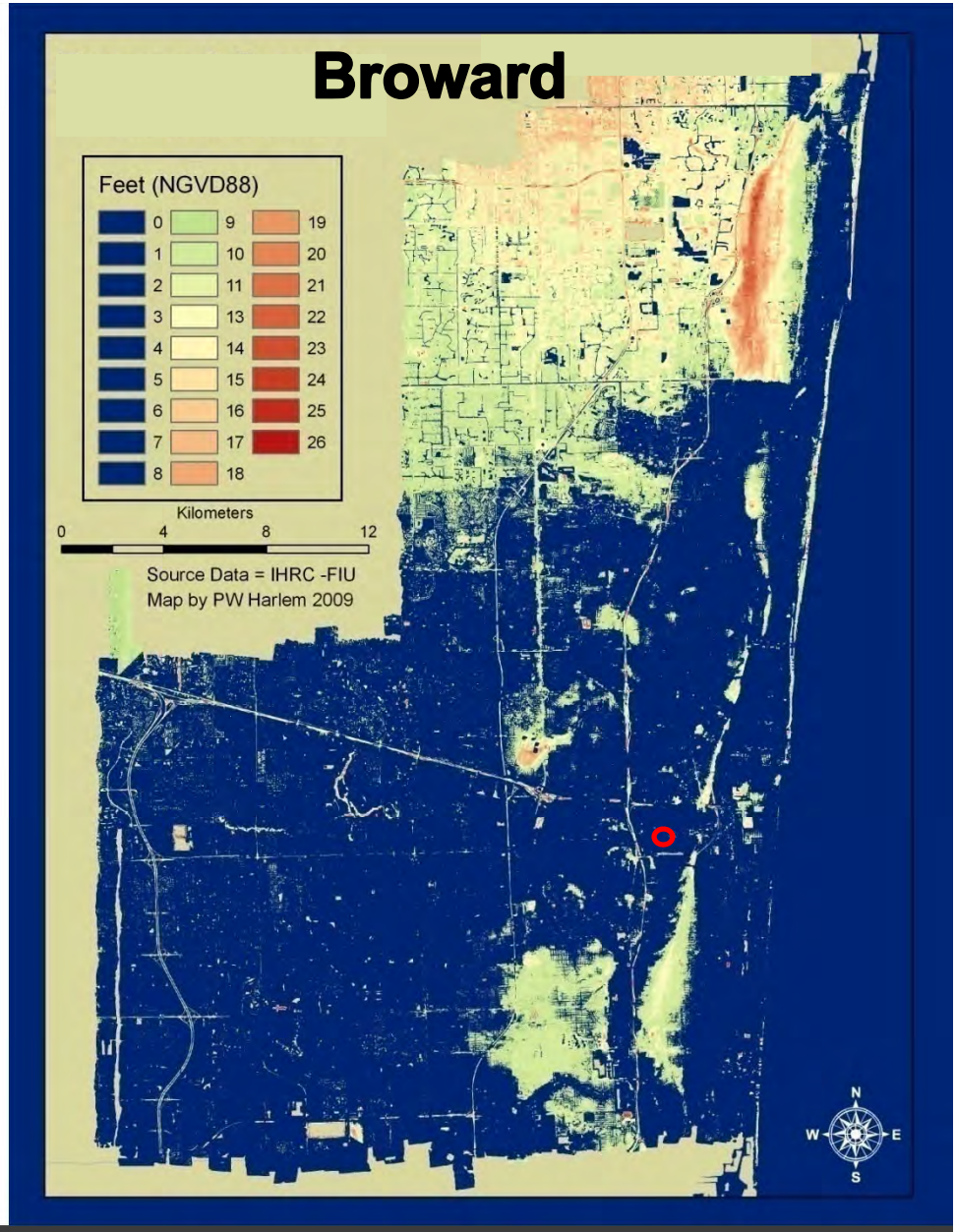




Inundation from 7 ft. Sea Level Rise

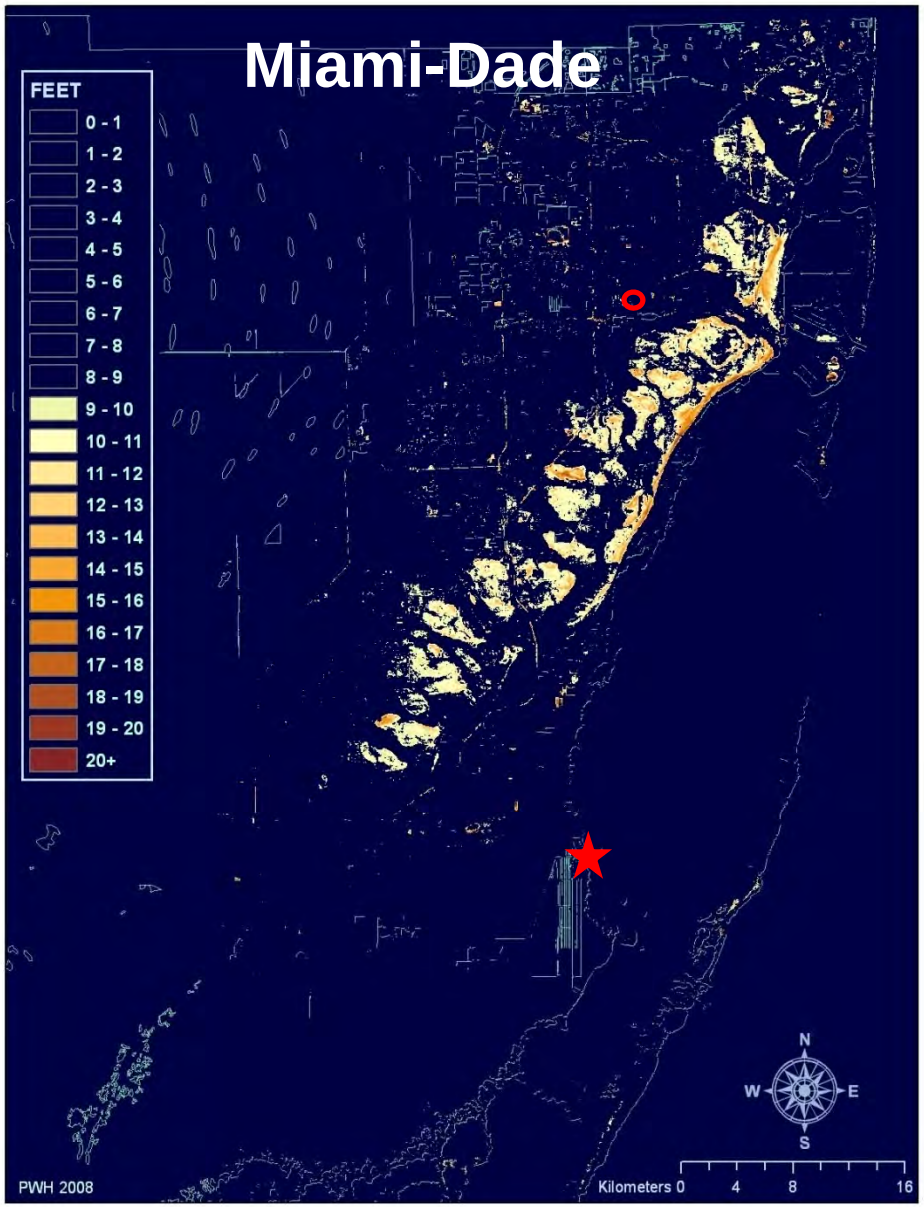
from P. Harlem, 2011

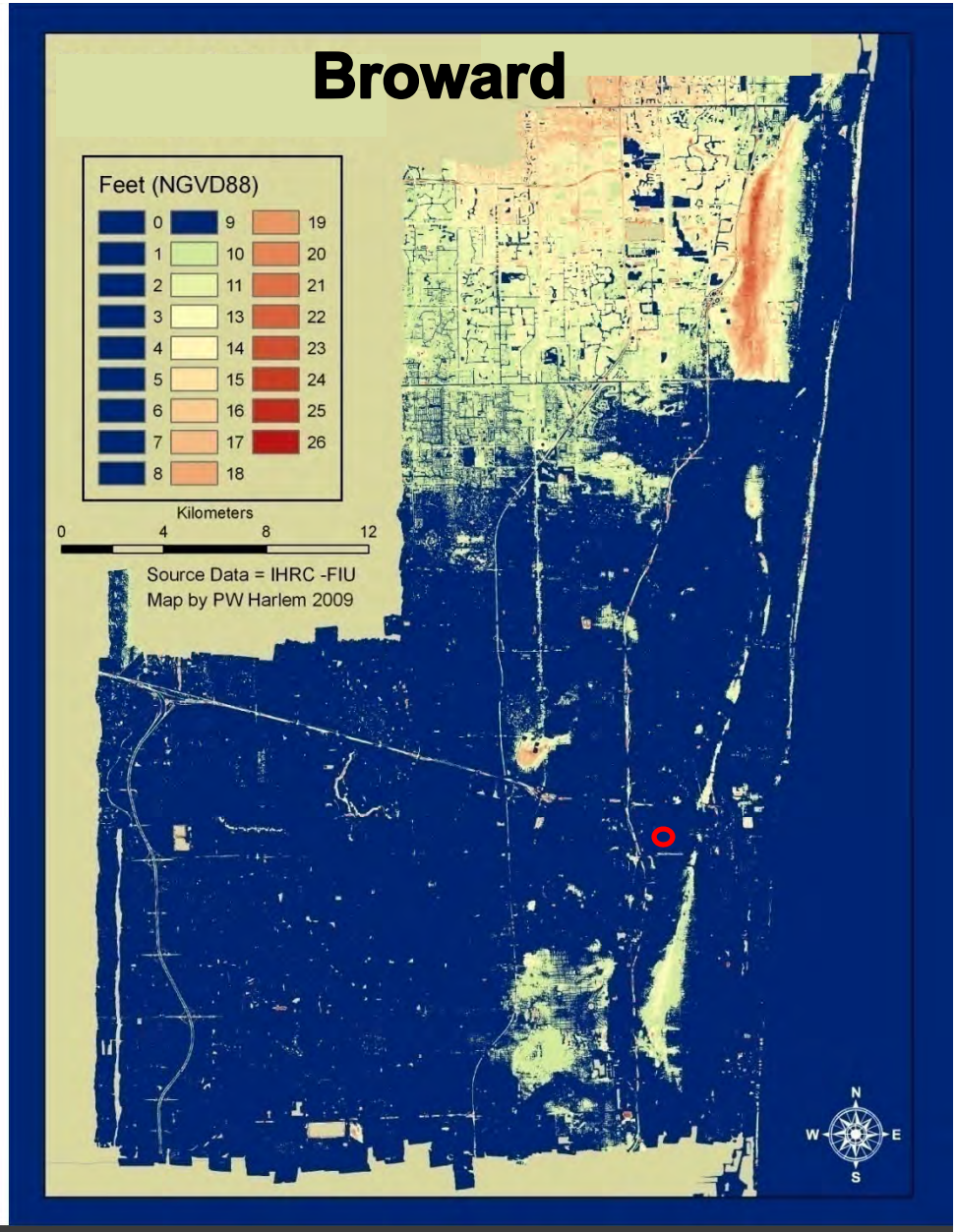




Inundation from 8 ft. Sea Level Rise

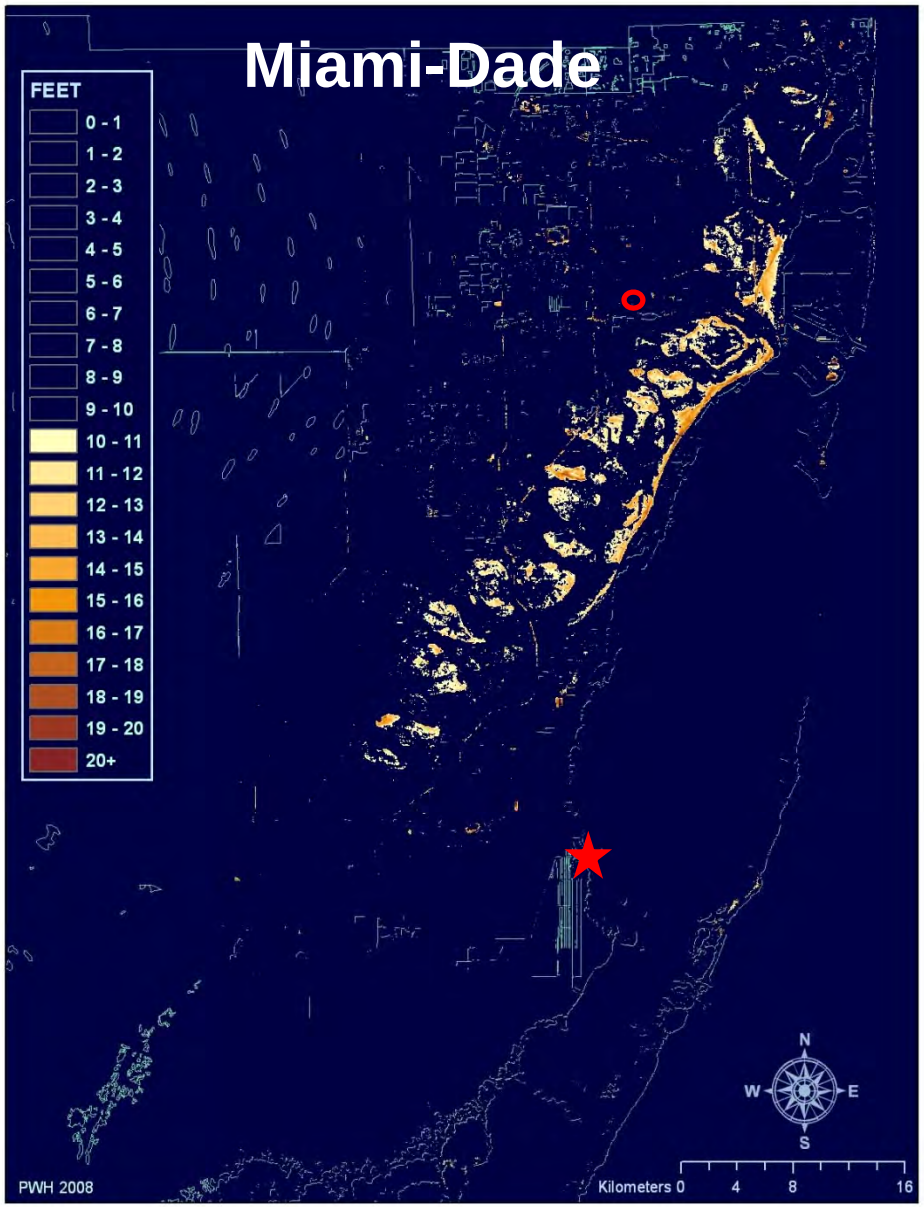
from P. Harlem, 2011

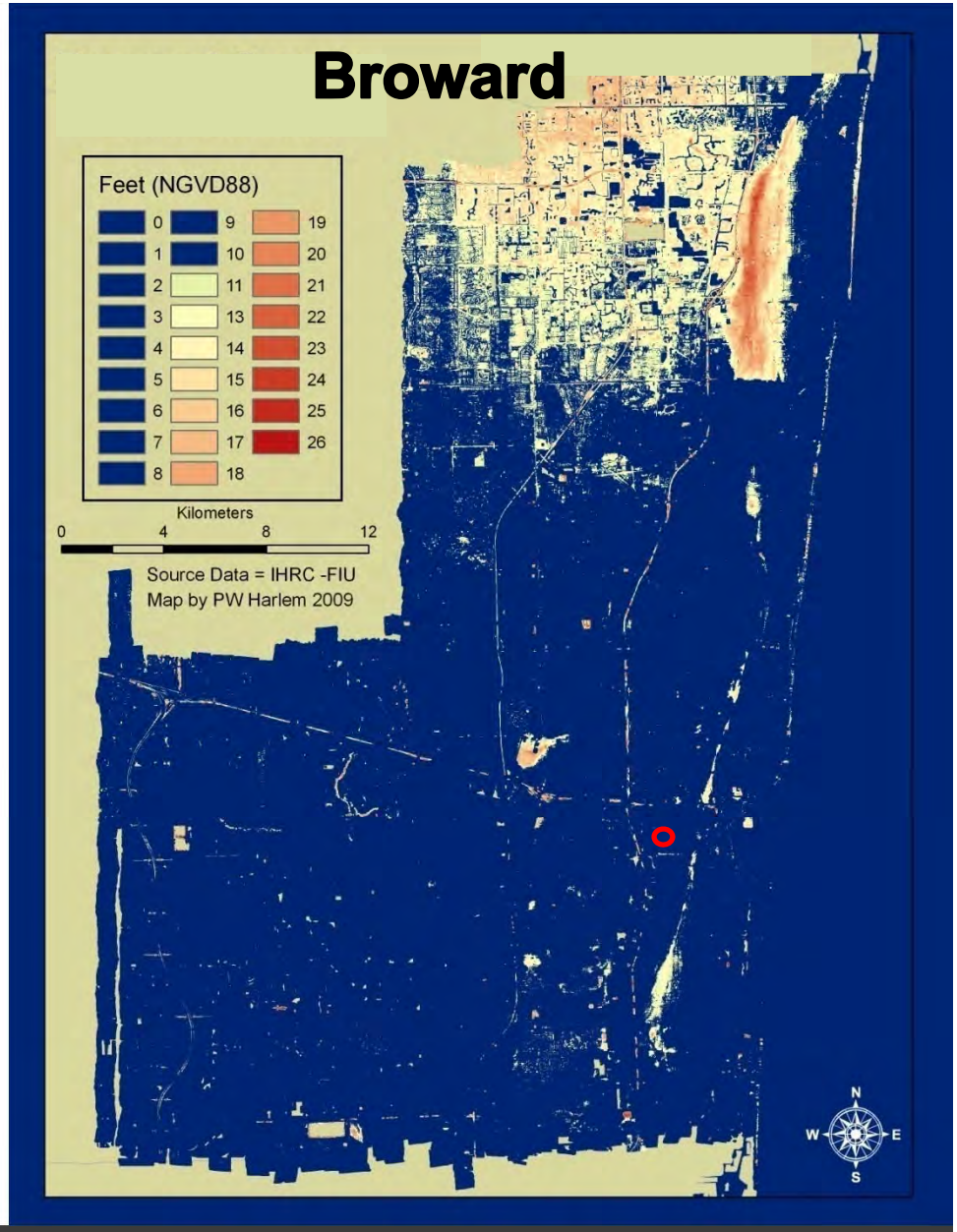




Inundation from 9 ft. Sea Level Rise

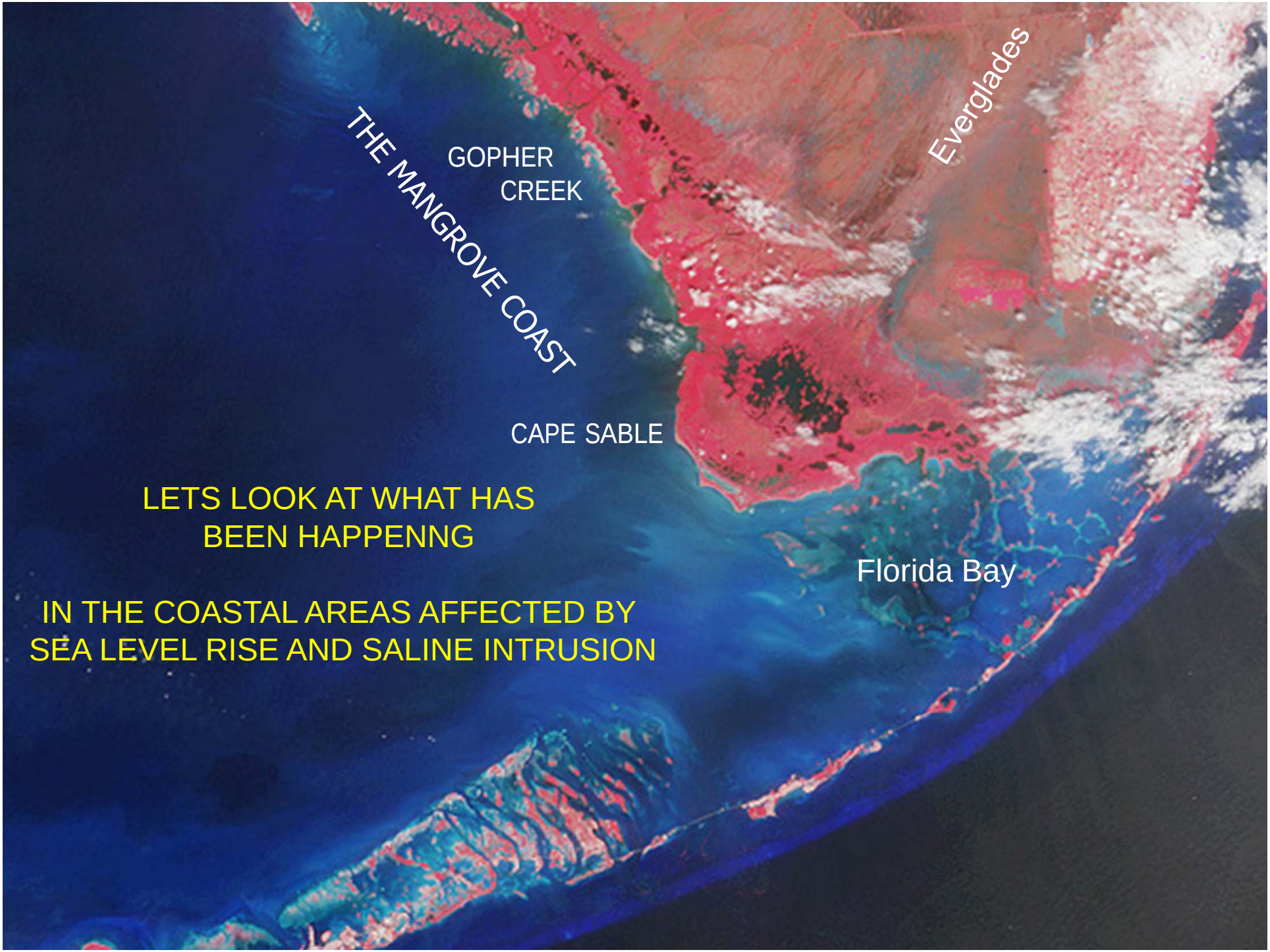
from P. Harlem, 2011





Inundation from 10 ft. Sea Level Rise

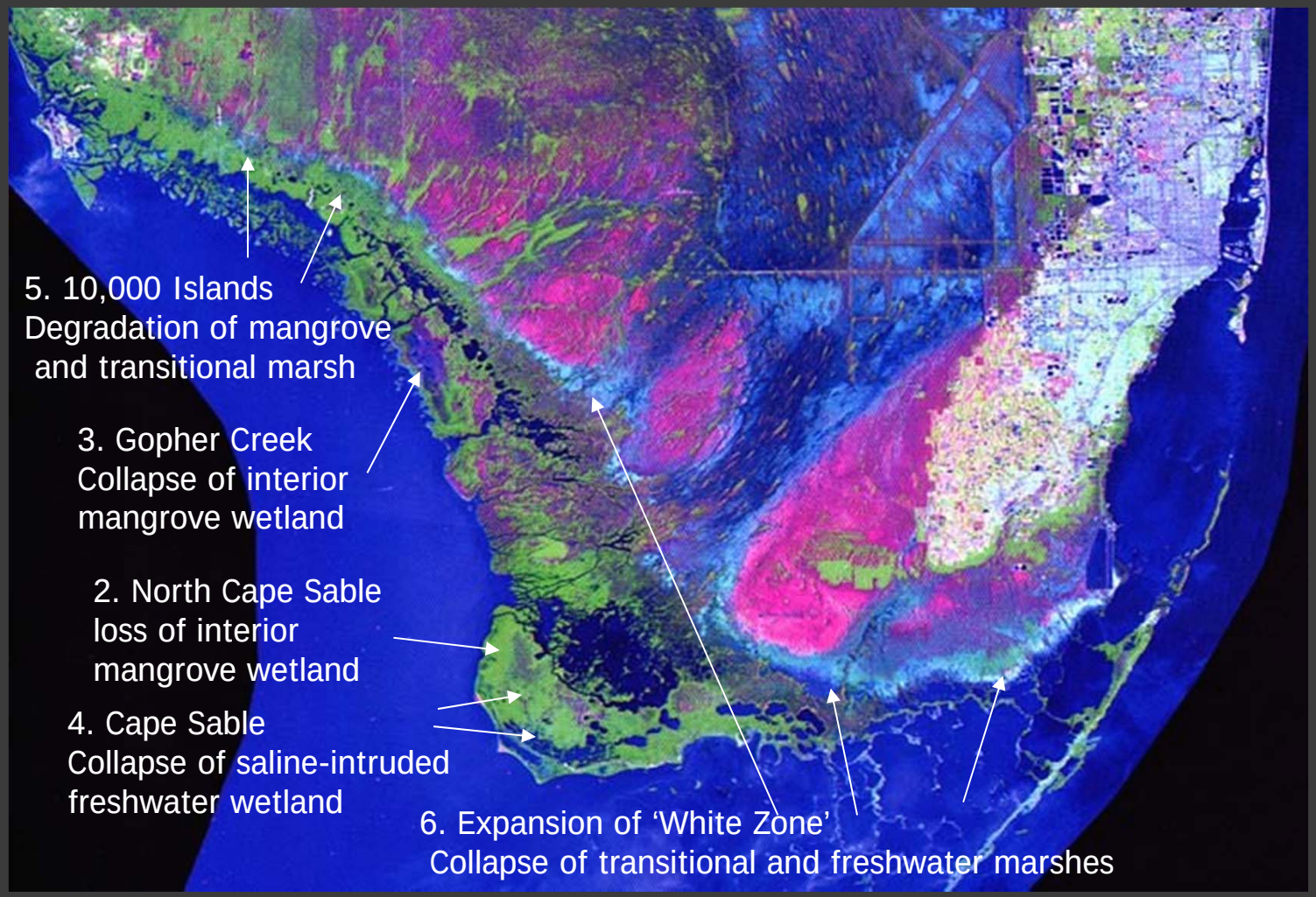
from P. Harlem, 2011

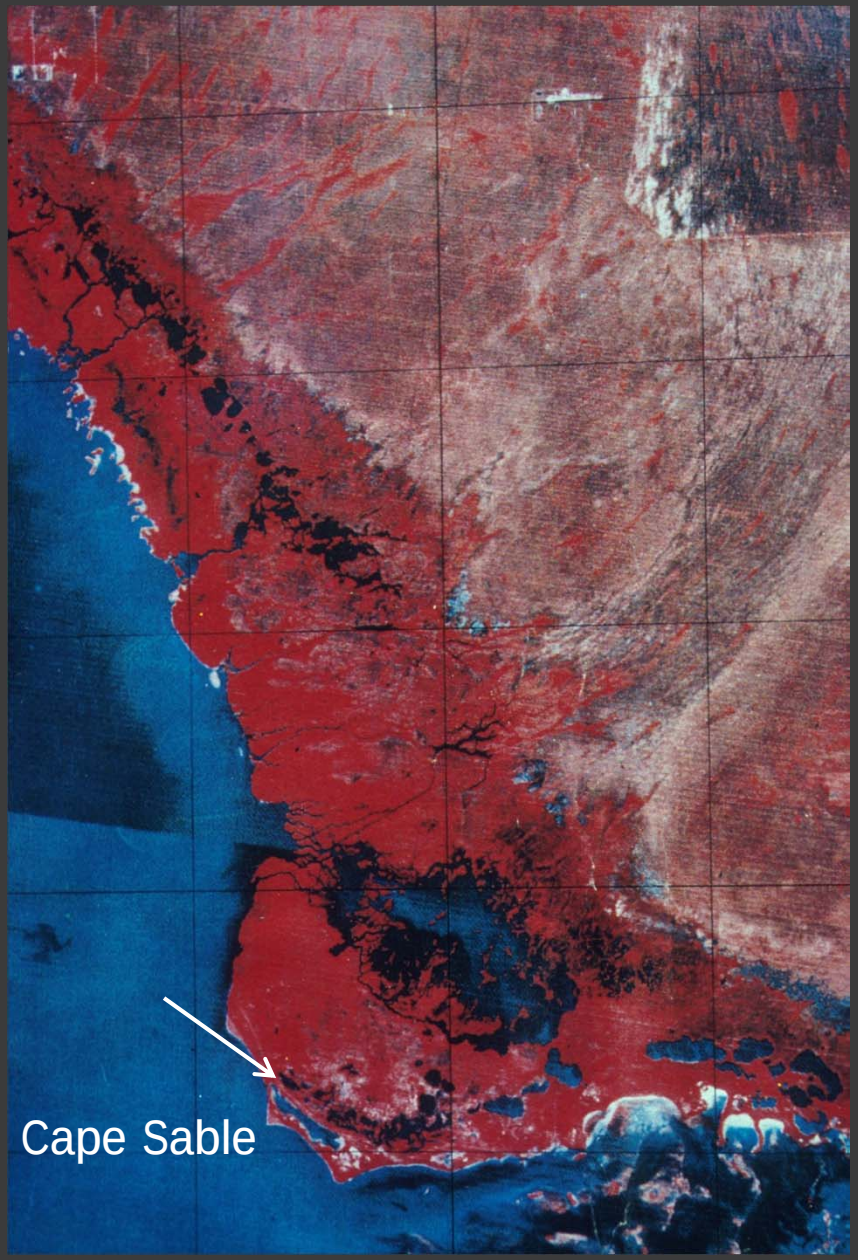


LETS LOOK AT WHAT HAS
BEEN HAPPENNG

IN THE COASTAL AREAS AFFECTED BY
SEA LEVEL RISE AND SALINE INTRUSION

RAPID LOSS OF SALINE AND FRESHWATER WETLANDS IS OCCURRING THROUGHOUT SOUTH FLORIDA'S COASTAL COMPLEX IN RESPONSE TO SEA LEVEL RISE AND SALINE INTRUSION.





- In 1917 the marl ridge of Cape Sable was advertised as the finest agriculture soil.
- Roads and houses were built.
- The freshwater marsh behind was drained for grazing and sugar cane.

BULLETIN of CAPE SABLE, FLORIDA

You are always strongly impressed with statements made by persons whose only object is to tell of interesting people, or countries, or places, which have appealed to them with an extraordinary and peculiar attraction, and in which they have no interest for gain, but only the wish to have their knowledge be of assistance to others.

The articles herein are copied from publications of the highest standing in the State and throughout the South.

The "Florida Grower" is the official organ of the Fruit and Vegetable Growers of Florida. They maintain a department of investigation for the purpose of ascertaining true facts before advising inquirers.

The "Manufacturers' Record" is the leading industrial publication in the U. S. south of the Ohio River. Communications must be from reliable sources to receive consideration.

Other sources of information are equally trustworthy.

IF, AFTER READING THESE PAGES YOUR INTEREST IS AWAKENED TO ONE OF THE GREATEST OPPORTUNITIES IN OUR COUNTRY, WE SHOULD BE PLEASED TO HEAR FROM YOU, AND GO INTO THE MATTER MORE FULLY AS TO THE POSSIBILITIES FOR YOURSELF.

KEEP IN MIND THAT CAPE SABLE WILL PRODUCE ANY CROPS GROWN IN THE SOUTH OR IN CUBA. THAT FLORIDA WILL SOME DAY GROW ALL THE CANE NECESSARY TO SUPPLY THE UNITED STATES WITH SUGAR. PERFECTION OF SUGAR CANE SOIL IS ON CAPE SABLE.

Remarkable Rosources of a Section Practically Unknown

By Lindley Heimburger, B. S. in Agriculture, M. S. Agricultur
iency Engineer, Tampa, Fla.

(Manufacturers Record) August 6th

The South as a whole, especially we Floridians, do not realize the crisis the nation is experiencing, due to the worl wide shortage of foodstuffs, and espe cially now that we are an active party in the great war which involves fully 90 per cent. of both the peoples and resources of the entire world.

The true seriousness of this food shortage situation was most forcibly impressed upon me a few weeks ago when I was called to the nation's active hub, New York City, in the capacity of an experienced Southern agricultural engineer, to give testimony as to ways and means of meeting this shortage issue, and especially the possibilities the South today offers in the immediate production of large supplies of foodstuffs.

It is probably true that Florida at the present time is the most misrepresented and least understood State in the Union. Though the first State to be discovered geographically, Florida is the last of the States to receive serious economic development. . . . .

About the middle of April, 1917, the writer, in the capacity of an agricultural engineer, had occasion to investigate lands in the Cape Sable country for some Chicago financiers who were contemplating making investments in that part of Florida.

Though this Cape Sable territory will in the very near future be but two days' distance from New York, due to isolation it is today one of the least known spots in the United States. Though the writer has had over 25 years of exten-

Southern sco he hookworm disease. Th ry is one of the few sa where soil con- sical nature as the hookworm

may seem, ry has the spot on cord of g frost prob- mmer outh, hat ds

First— where th Florida sa rock, nor ev glades muck.

Secondly—A acteristic Flor its absence; a rather low, whe present saw pal sent.

Thirdly—Though grass country the wr where the very native a size that they nearly Jersey cow, this section probably the only part South that is naturally fr fever cattle ticks.

Fourthly—Though the m present, both malaria and yello unknown to the few "Conch" fa ing in this Cape Sable land; the applicable to that most dreaded

y recent t seemed to

BULLETIN OF CAPE SABLE, FLORIDA

The Key West Citizen

June 5, 1916.

CAPE SABLE.

UNIQUE CAPE SABLE

(By F. PAGE WILSON.)

The Florida Grower

September 29, 1916.

A CORRECTION AND INFORMATION

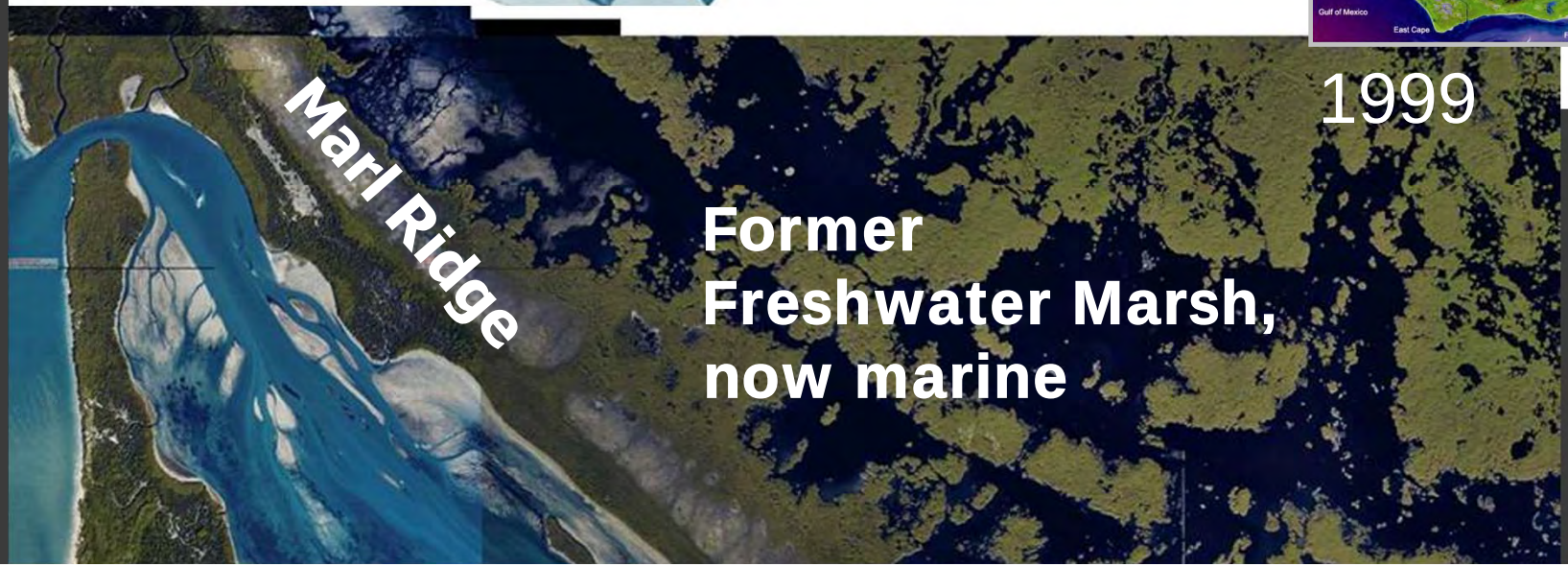
Some Notable People at Cape Sable

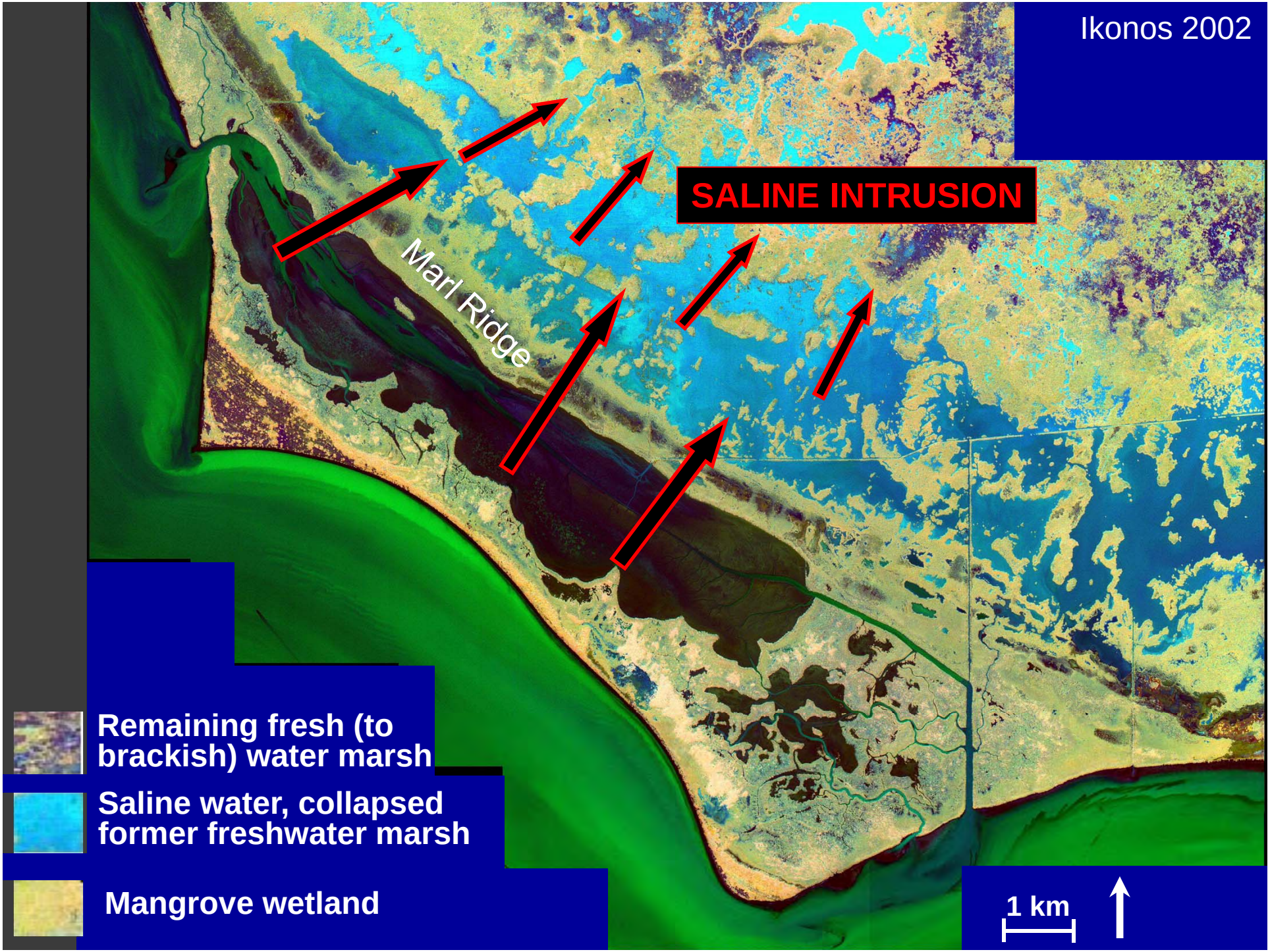
Mr. Bright, Mr. Untermeyer, Mr. Comfort, Mr. Smith and Mr. Burguieres discussing the wonderful possibilities there

Sugar Cane at Cape Sable--One of the Roberts Brothers Cane Fields

Sirup from this cane is made at Cape Sable and finds ready sale at Miami and Key West

THE FRESHWATER MARSH IS NOW A SHALLOW MARINE LAGOON



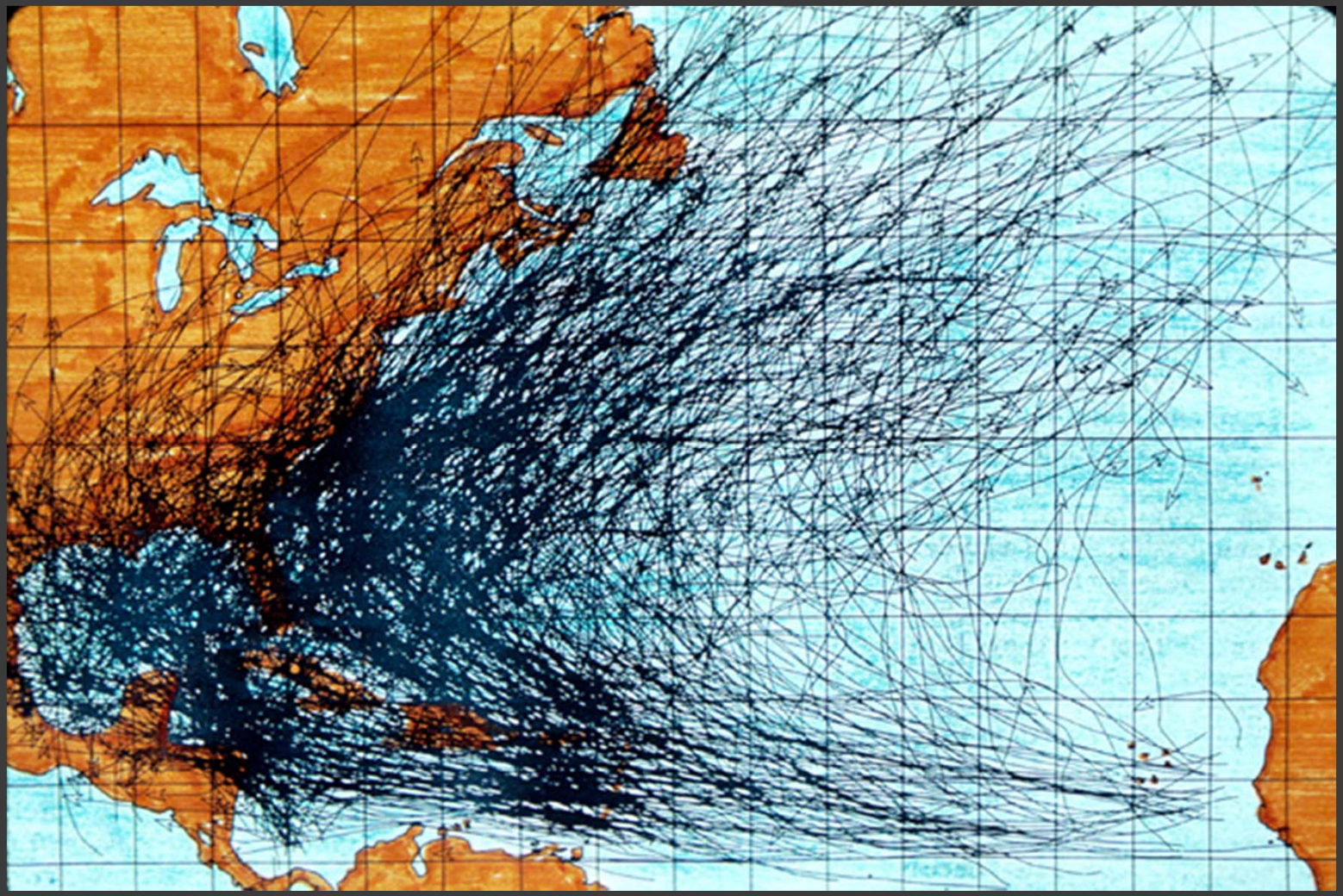

Ikonos 2002
SALINE INTRUSION
Marl Ridge
Remaining fresh (to brackish) water marsh
Saline water, collapsed former freshwater marsh
Mangrove wetland
1 km

THE MARL RIDGE OF CAPE SABLE IS NOW FLOODED
OVER 80 TIMES A YEAR
BY HIGH TIDES FLOWING ACROSS.

WIDESPREAD INUNDATION & COLLAPSE OF FRESWATER WETLANDS – in areas not modified by humans.

AND CONVERSION TO OPEN WATER

Much of the wetland collapse and coastal changes will be caused or initiated by hurricanes

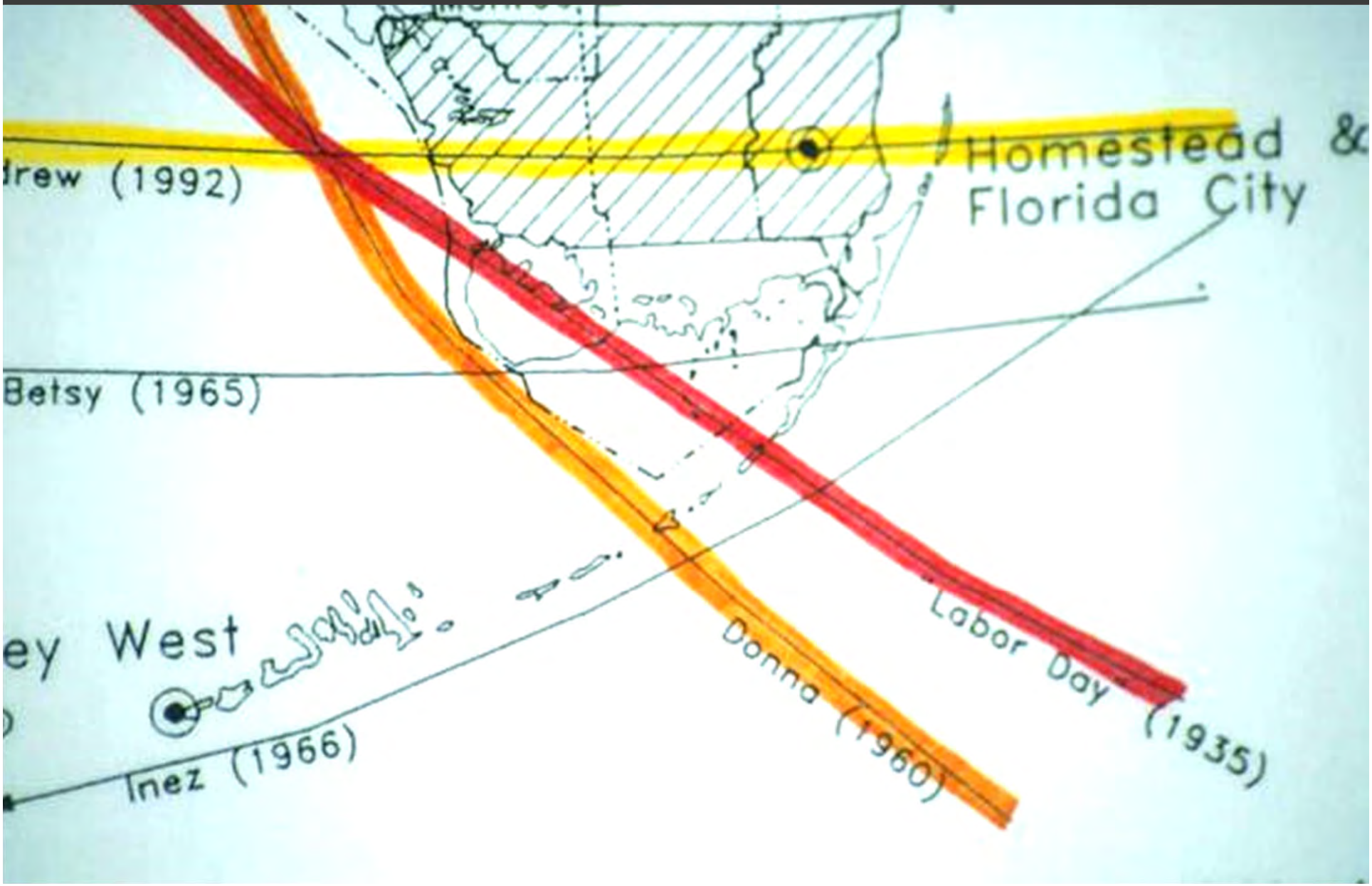


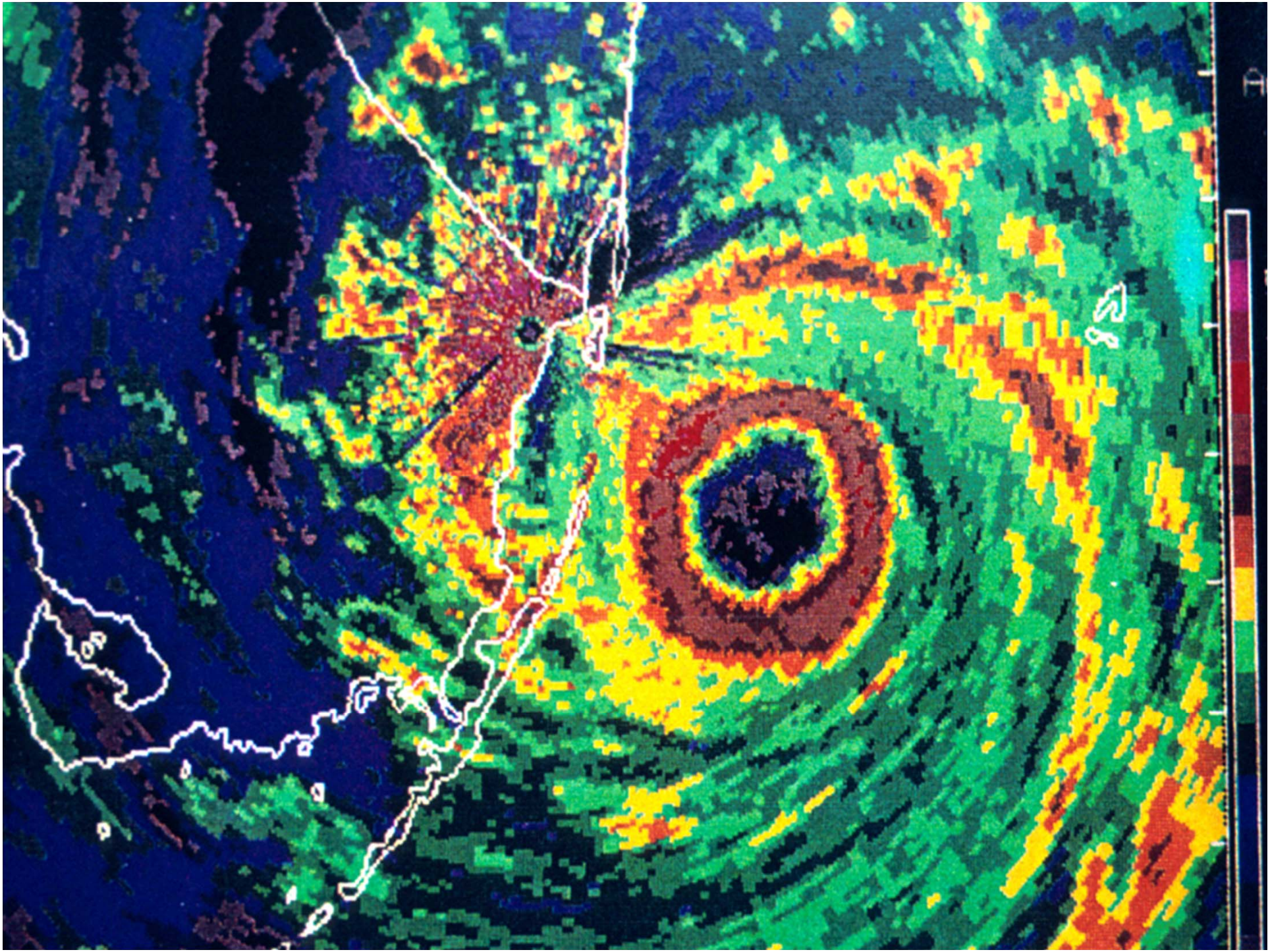
... of which we get plenty.

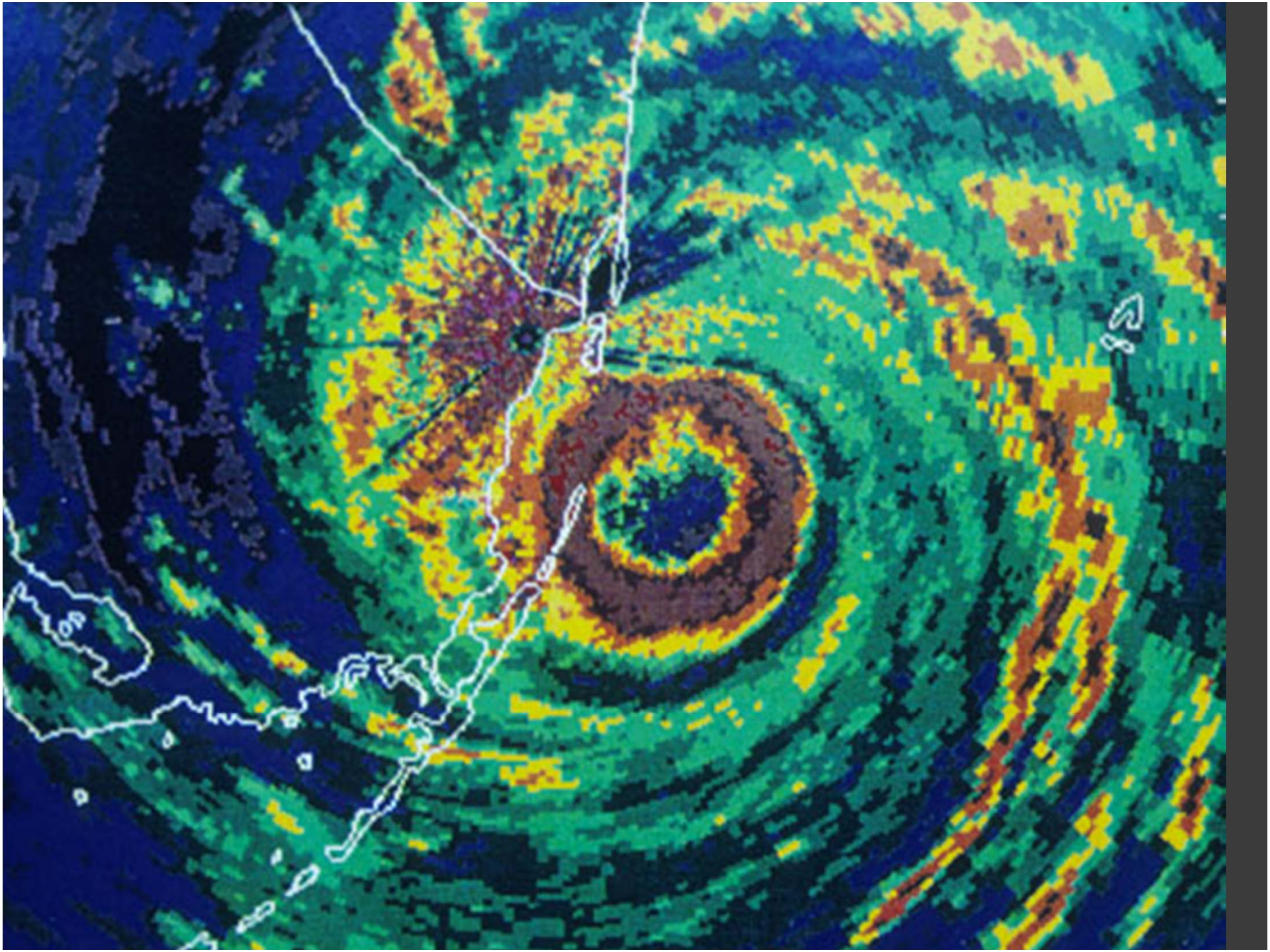
Occurring on an average of once every 5 to 7.5 years,

Any environment in south Florida has had 500-1500 hurricanes over its history.

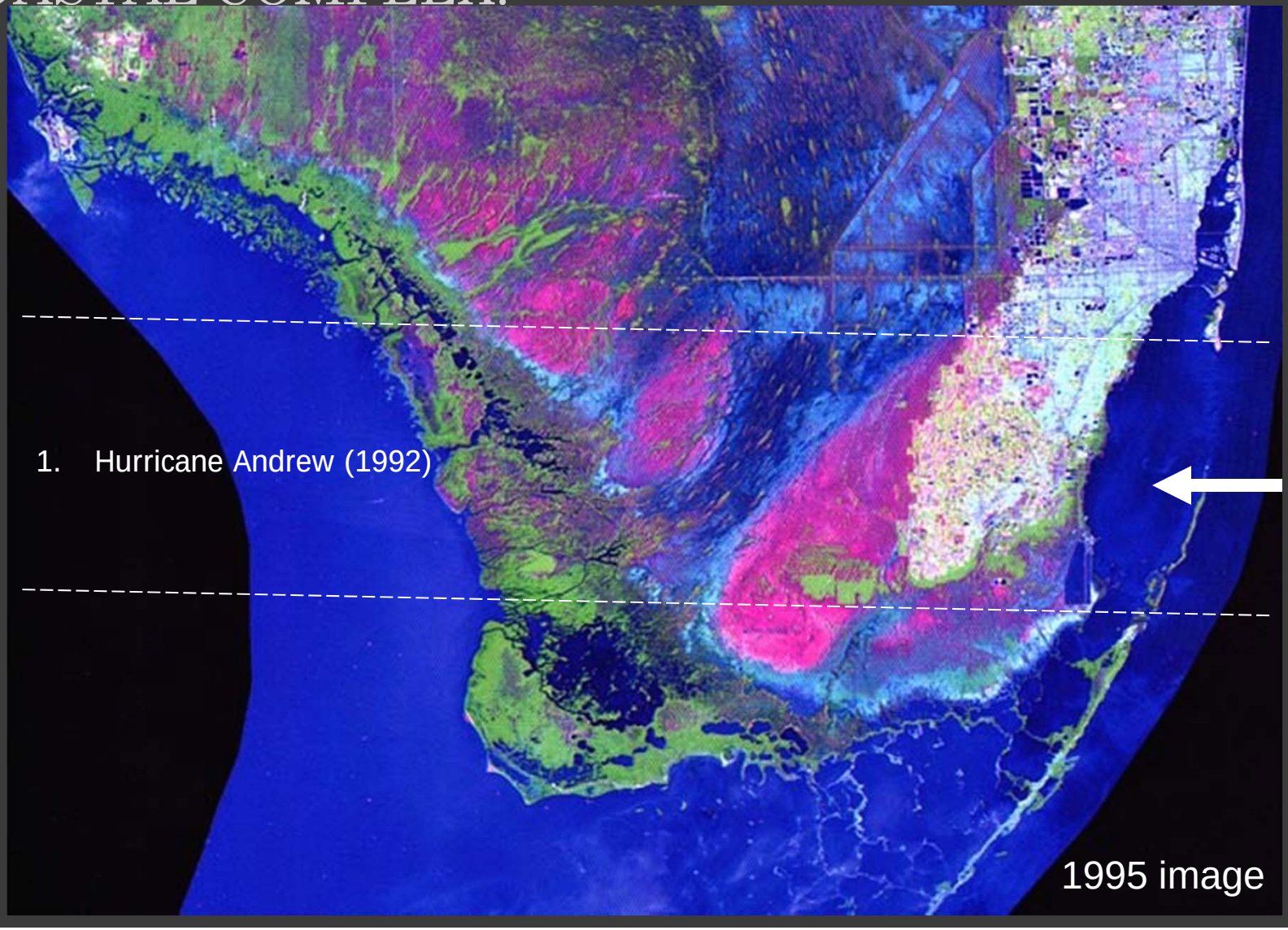
THREE BIG ONES OF THE PAST CENTURY







HURRICANE ANDREW IS THE MOST RECENT OF A SERIES OF CATGORY 4 AND 5 HURRICANES THAT HAVE INITIATED EVOLUTION OF THE COASTAL COMPLEX.



HURRICANES ARE EFFECTORS OF CHANGE IN OUR NATURAL ENVIRONMENTS

Hurricane Andrew, 1992

ON MANGROVE COASTLINES

In the big ones, this ...

ON MANGROVE COASTLINES

In the big ones, this ... Becomes this.

Vast areas of mangrove swamp destroyed by the major hurricanes of 1935, 1960 and 1992 have evolved into shallow bays because –

the rapid subsidence of the root peat prevents recovery as a mangrove community.

Highland Beach and mangroves, Hurricane Andrew

Tom Smith, USGS, Highland Beach

Figure 3-5. Sequential aerial photographs showing the impact of the Great Labor Day Hurricane of 1935 on Big Sable Creek and minimal recovery in the subsequent 18 years. The area was mature black mangrove forest with narrow tidal creeks prior to the storm. See Figures 3-6 to 3-10 for sequential maps.

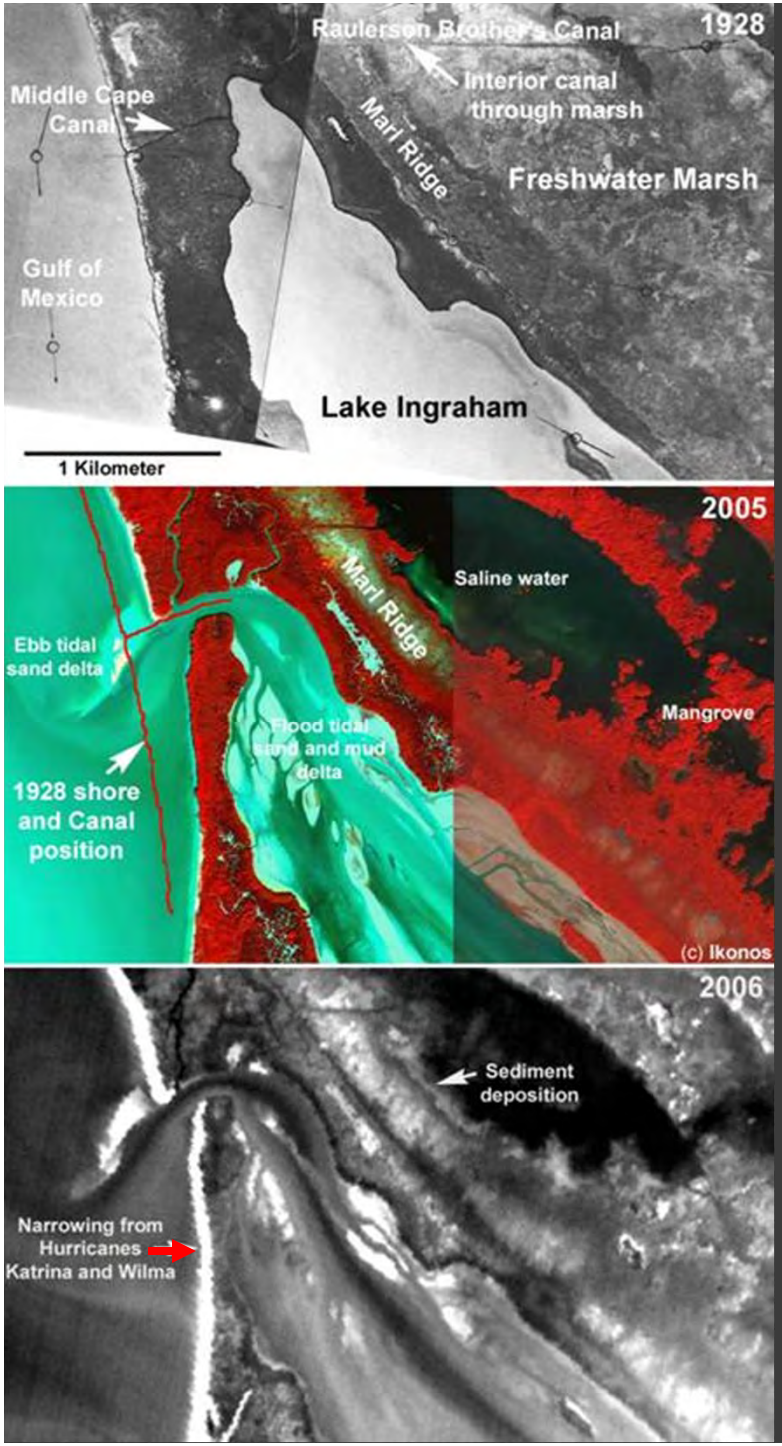
THE GREAT LABOR DAY HURRICANE OF 1935 DECIMATED THE MATURE MANGROVE FOREST OF BIG SABLE CREEK.

1935
1960

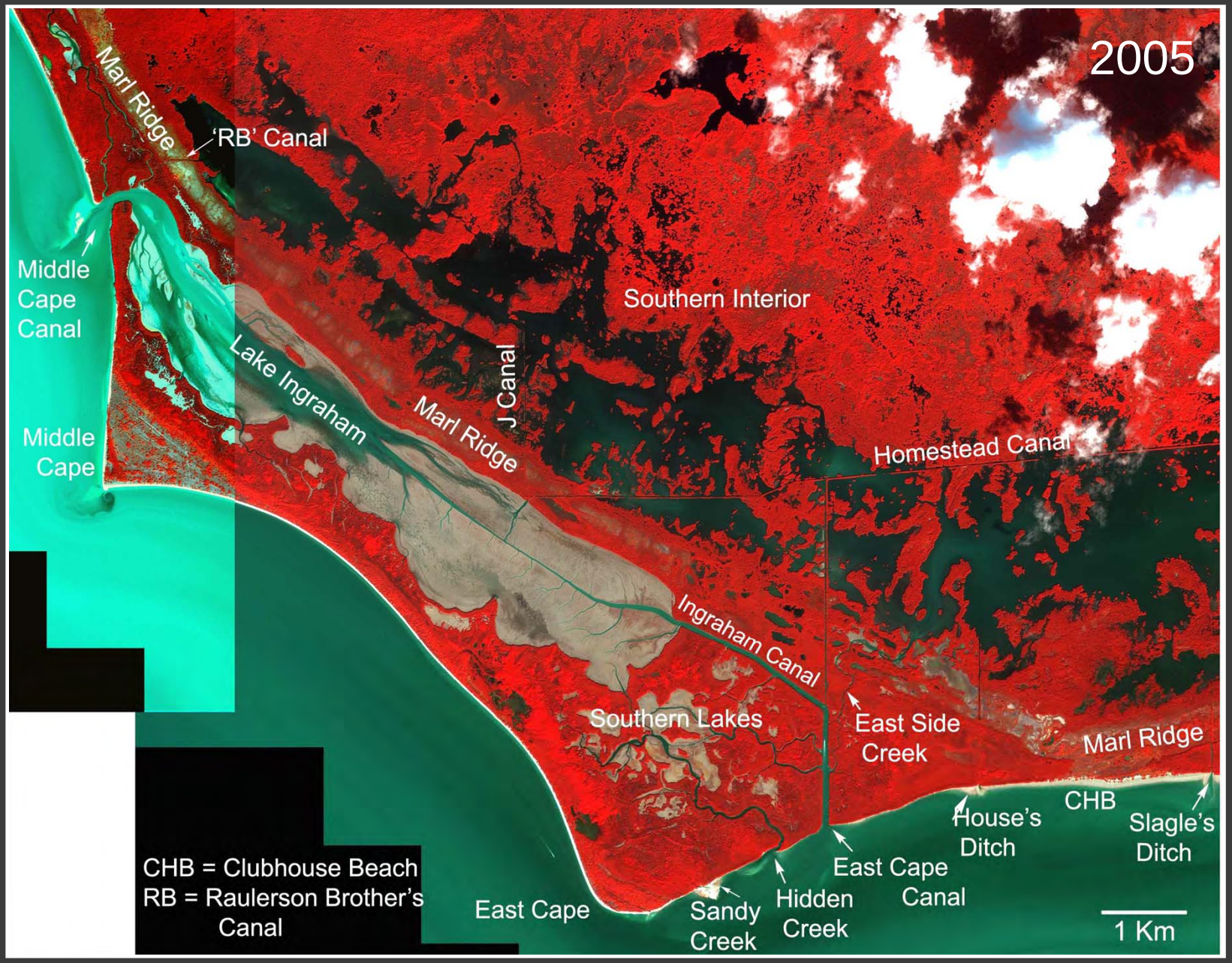
1962

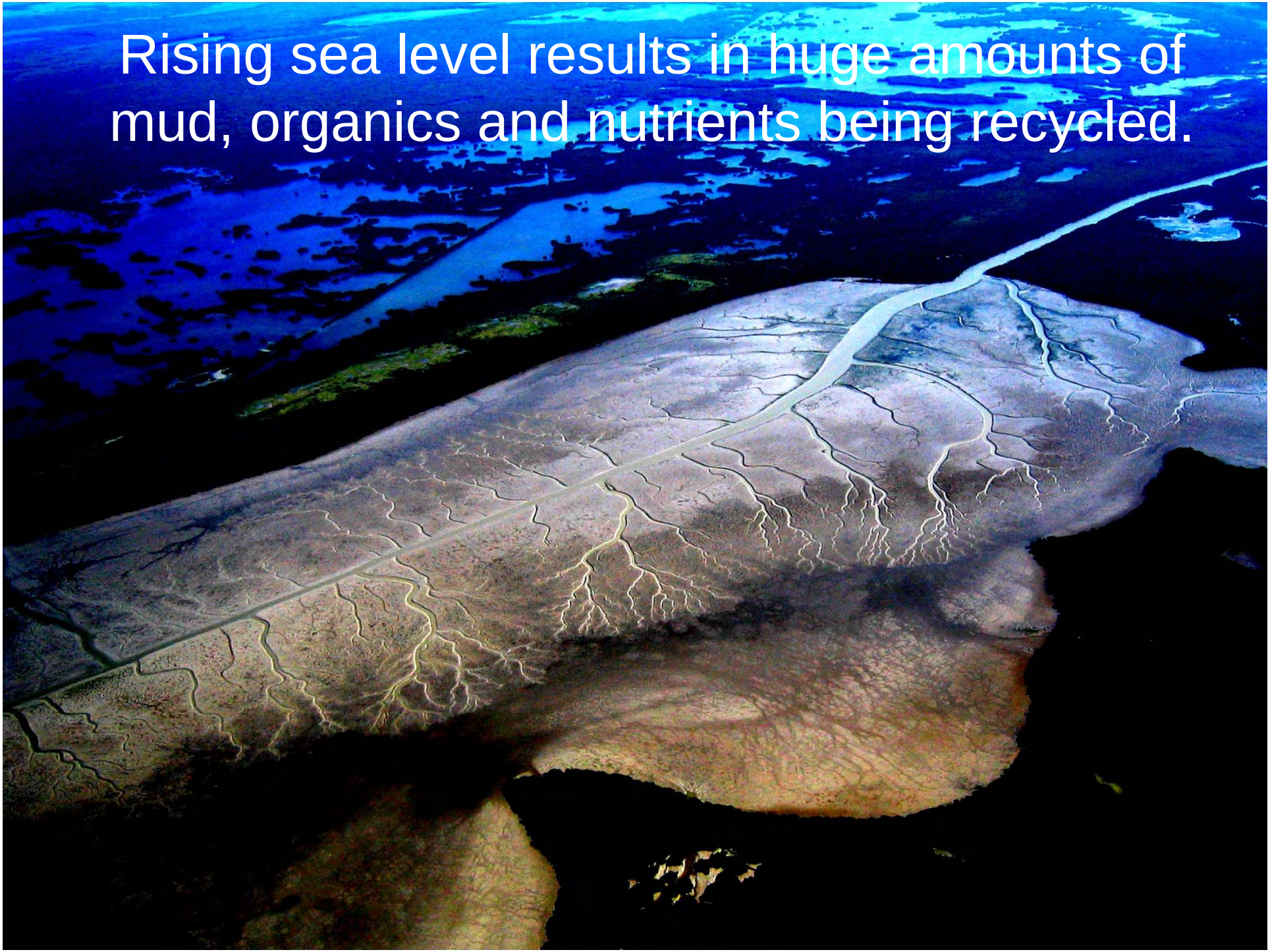
1981

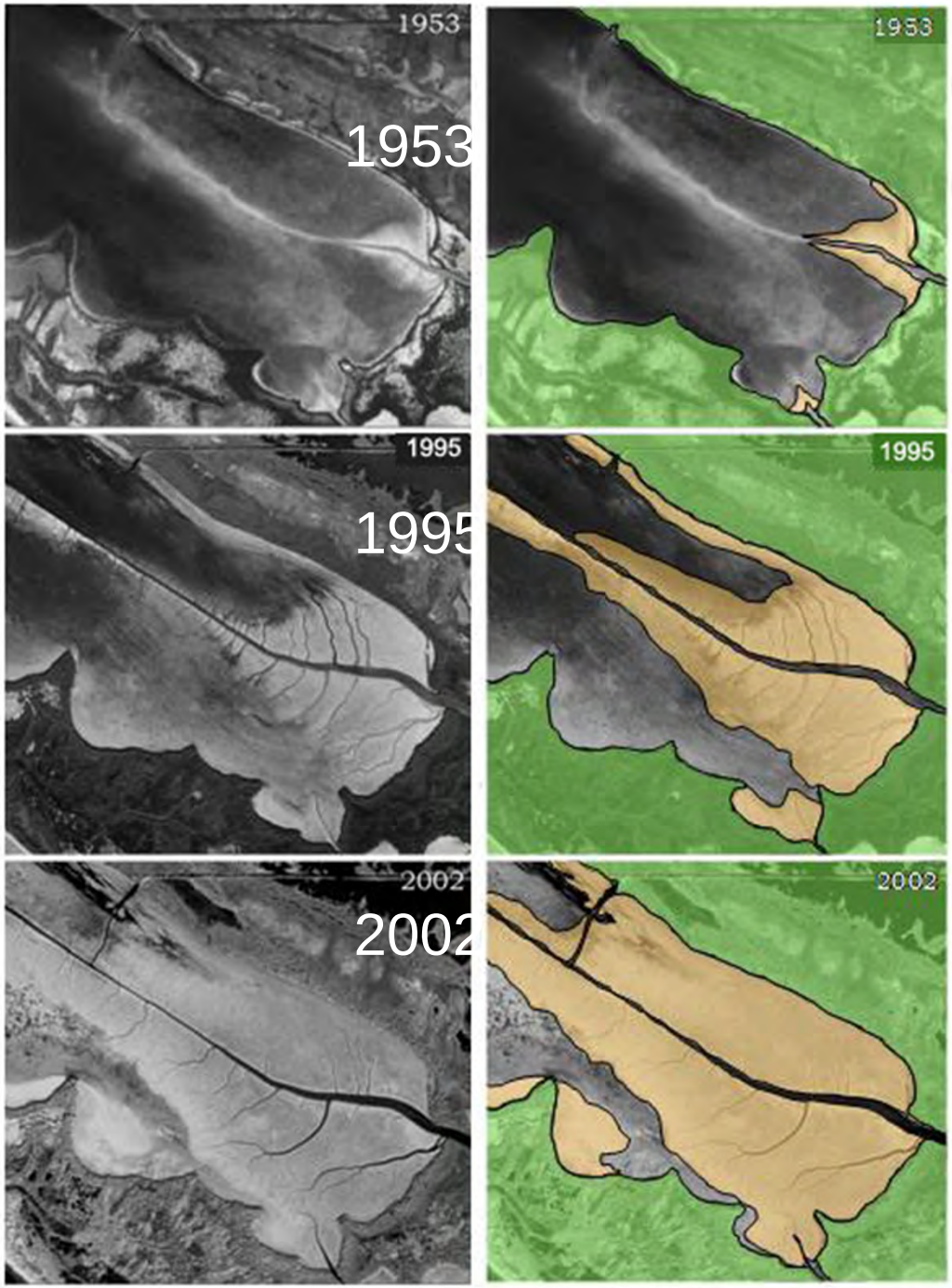
Dead peat surface is now about 3’ (1 m) lower than living mangrove surface – through decay.


1928
Raulerson Brother's Canal
Interior canal through marsh
Middle Cape Canal
Marl Ridge
Freshwater Marsh
Gulf of Mexico
Lake Ingraham
1 Kilometer
2005
Saline water
Marl Ridge
Ebb tidal sand delta
Mangrove
Flood tidal sand and mud delta
1928 shore and Canal position
(c) Ikonos
2006
Sediment deposition
Narrowing from Hurricanes Katrina and Wilma

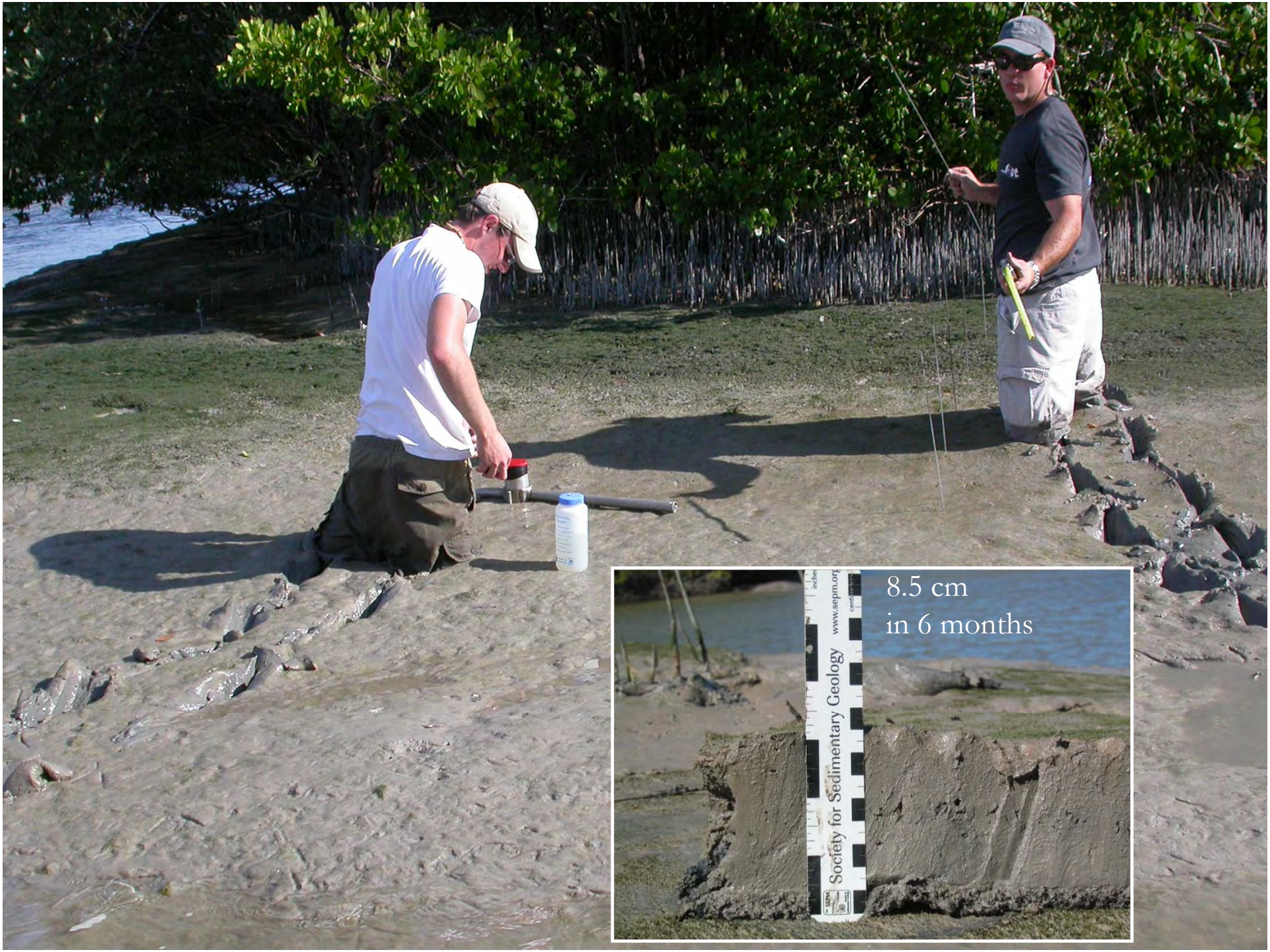
September 26, 2008

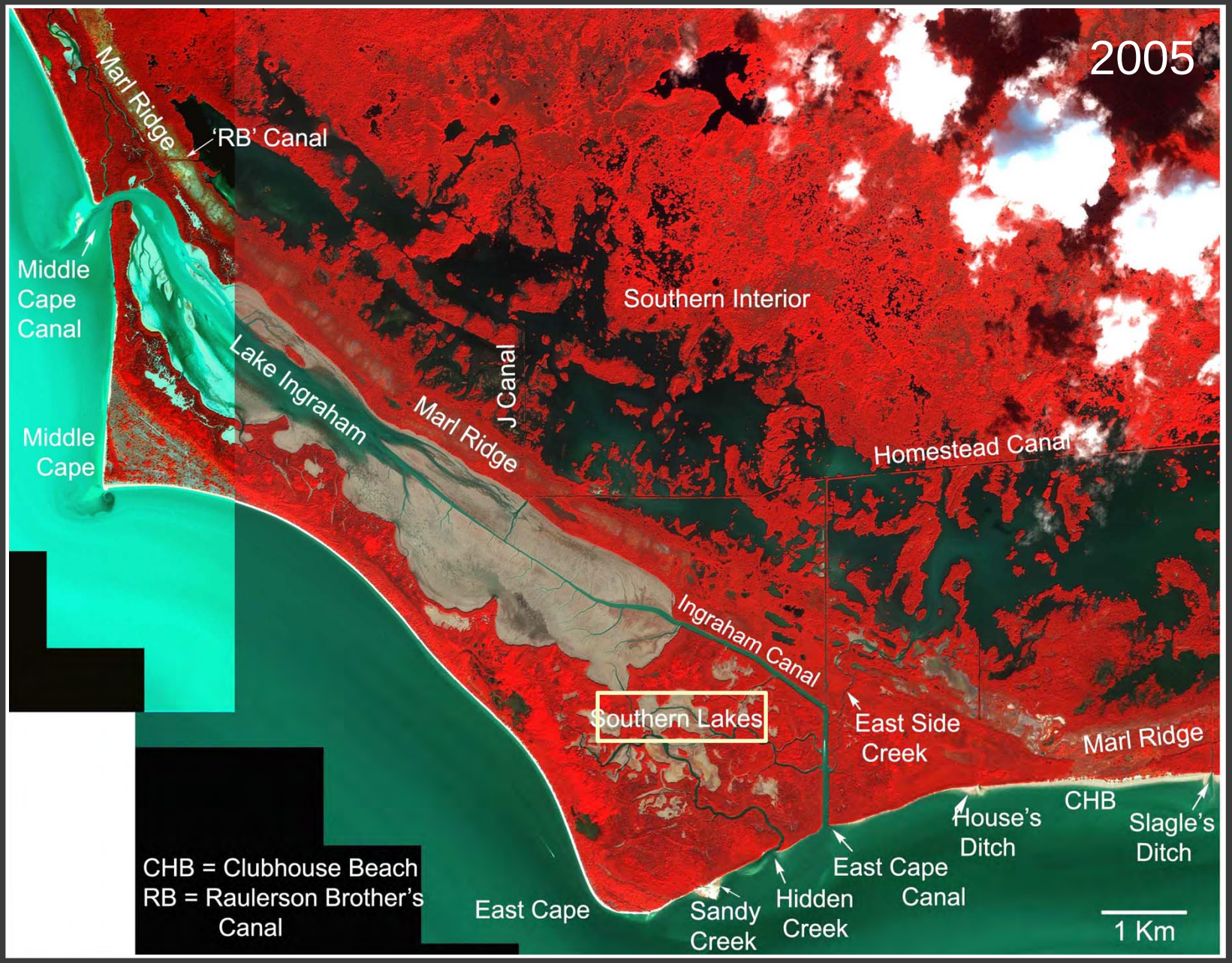

2005
Marl Ridge
'RB' Canal
Middle Cape Canal
Middle Cape
Lake Ingraham
Marl Ridge
J Canal
Southern Interior
Homestead Canal
Ingraham Canal
Southern Lakes
East Side Creek
Marl Ridge
CHB
House's Ditch
Slagle's Ditch
East Cape Canal
Hidden Creek
Sandy Creek
East Cape
CHB = Clubhouse Beach
RB = Raulerson Brother's Canal
1 Km


Rising sea level results in huge amounts of mud, organics and nutrients being recycled.



RAPID EROSION, REDISTRIBUTION AND SEDIMENTATION - SHALLOWING AND CAPPING BY MANGROVES


8.5 cm
in 6 months
Society for Sedimentary Geology
www.sepm.org


2005
Marl Ridge
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Middle Cape
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Marl Ridge
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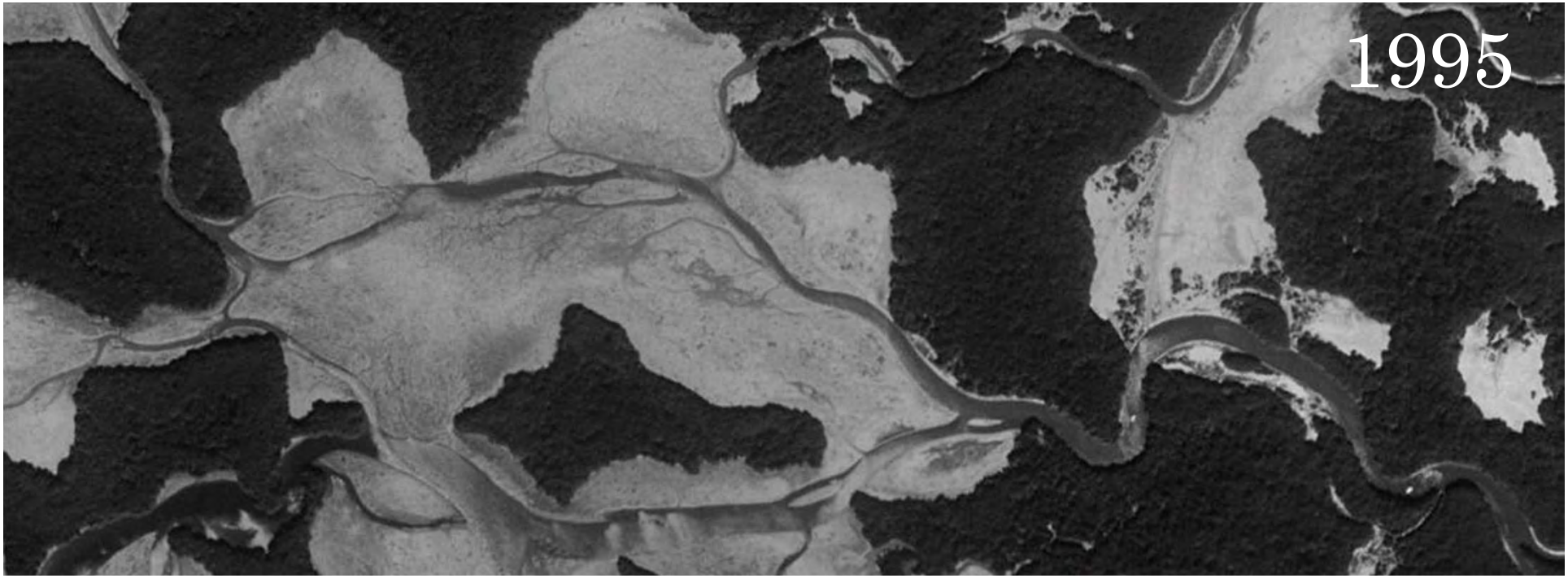
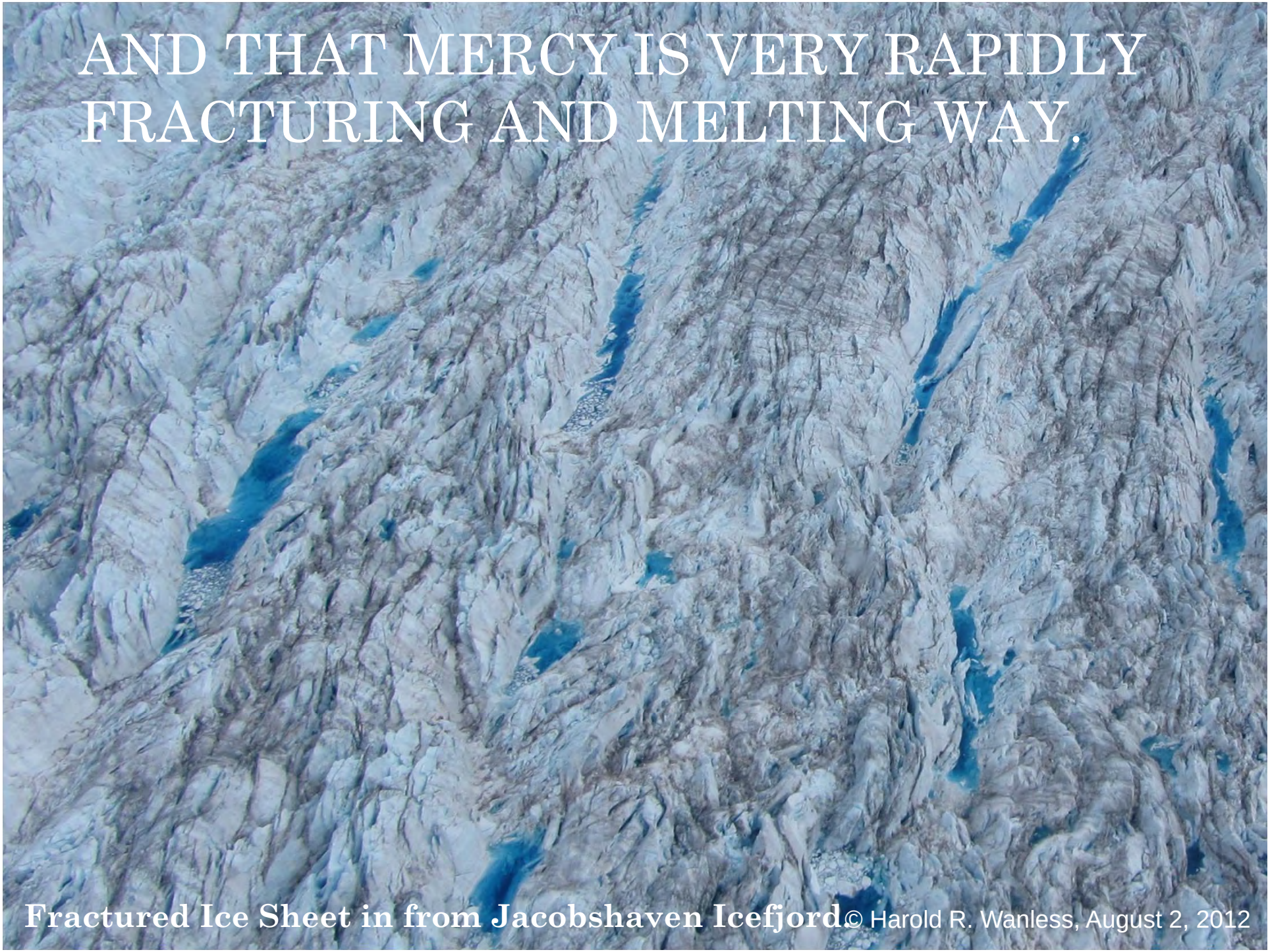

1995

2013

Rising sea level is a time of high nutrients and turbidity

Coastal Florida's future and fate is at the mercy of the dynamics of Polar ice,
H.R. Wanless, 2013
© Harold R. Wanless, August 2, 2012



Fractured Ice Sheet in from Jacobshaven Icefjord. © Harold R. Wanless, August 2, 2012

WE HAVE A CHOICE OF MAKING THIS A PROGRESSIVE ORDERLY PROCESS IN WHICH THERE CAN BE BOTH PLANNING AND HELP TO THE AFFECTED FAMILIES/BUSINESSES/COMMUNITIES AND CLEANING OF THE LAND BEFORE INUNDATION OR - -

– OR RISKING
CATASTROPHIC CHAOS,
CREATION OF LARGE NUMBERS OF DISLOCATED INDIGENTS,
AND
POLLUTED WETLAND AND MARINE ENVIRONMENTS.

THE CHOICE IS OURS.

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