


PAME Protection of the Arctic Marine Environment

AOR ARCTIC OCEAN REVIEW PROJECT 2009 - 2013

ARCTIC COUNCIL

Arctic Ocean Review Expert Workshop

Washington D.C., USA September 13-14, 2010


A Changing Arctic: Turning Science into Policy and Action

A Set of Opening Thoughts by Robert W. Corell

Principal, Global Environment and Technology Foundation

PAME Workshop for the AOR Project
September 13-14, 2010

Hosted at the Consortium for Ocean Leadership

1201 New York Ave, NW, 4th Floor, Washington, DC


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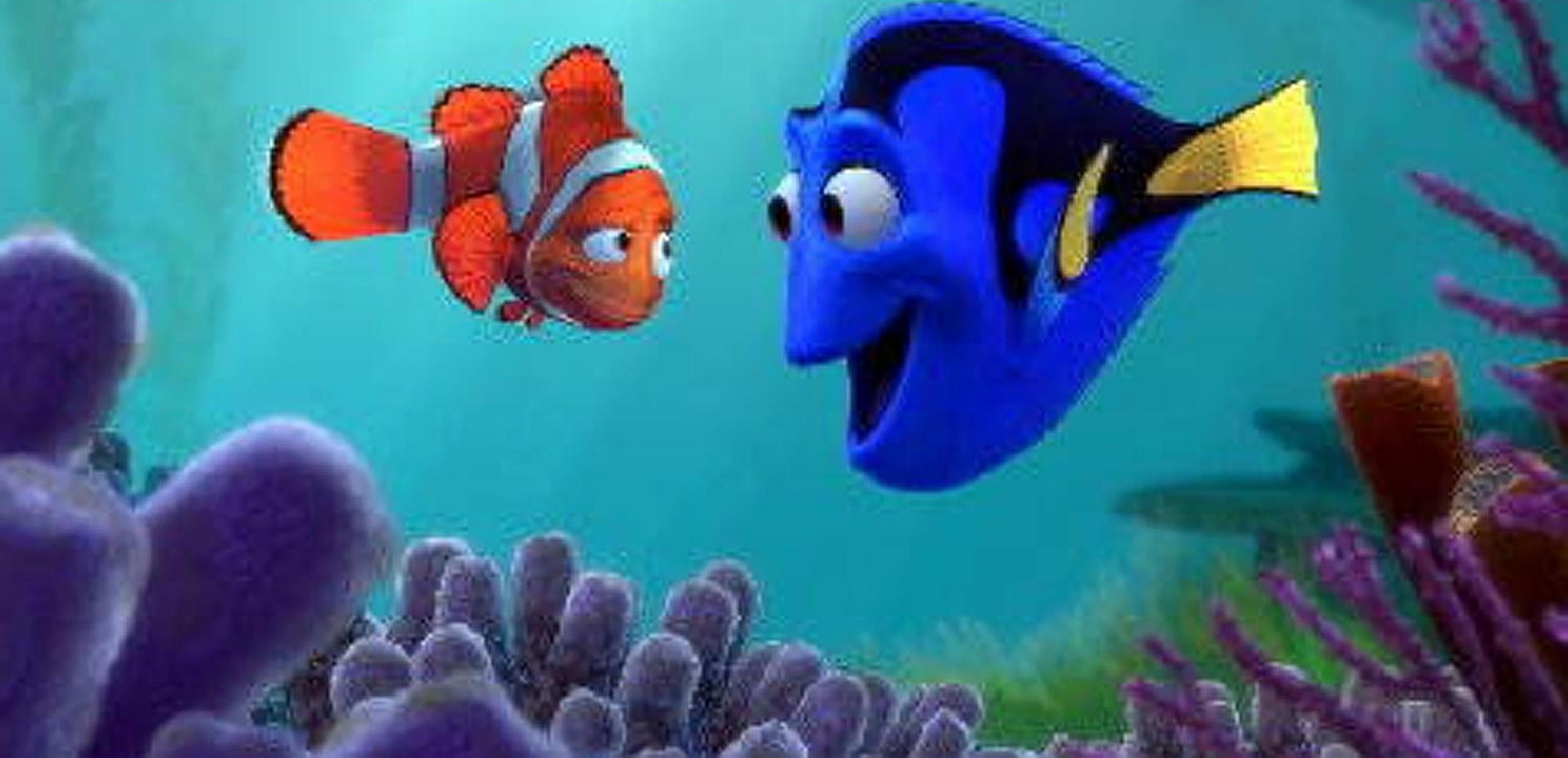
Nemo, Let’s get started, protecting these oceans is really a *BIG* Challenge!



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Objectives for the PAME AOR Project Workshop

Your Workshop seeks to:

- **Compile information on global and regional measures** that are relevant to the conservation and sustainable use of the Arctic marine environment;
- **Survey the status and trends in the Arctic marine environment** in cooperation with other working groups of the Arctic Council;
- **Disseminate compiled information through communication products/tools**, and conduct outreach to both communicate efforts and obtain input;
- **Prepare a compilation document** that will review global and regional measures that are relevant to the conservation and sustainable use of the Arctic marine environment and identify and highlight potential weaknesses; and,
- **Develop a status report** for Arctic Council Ministers.

A Central Purpose of the Workshop

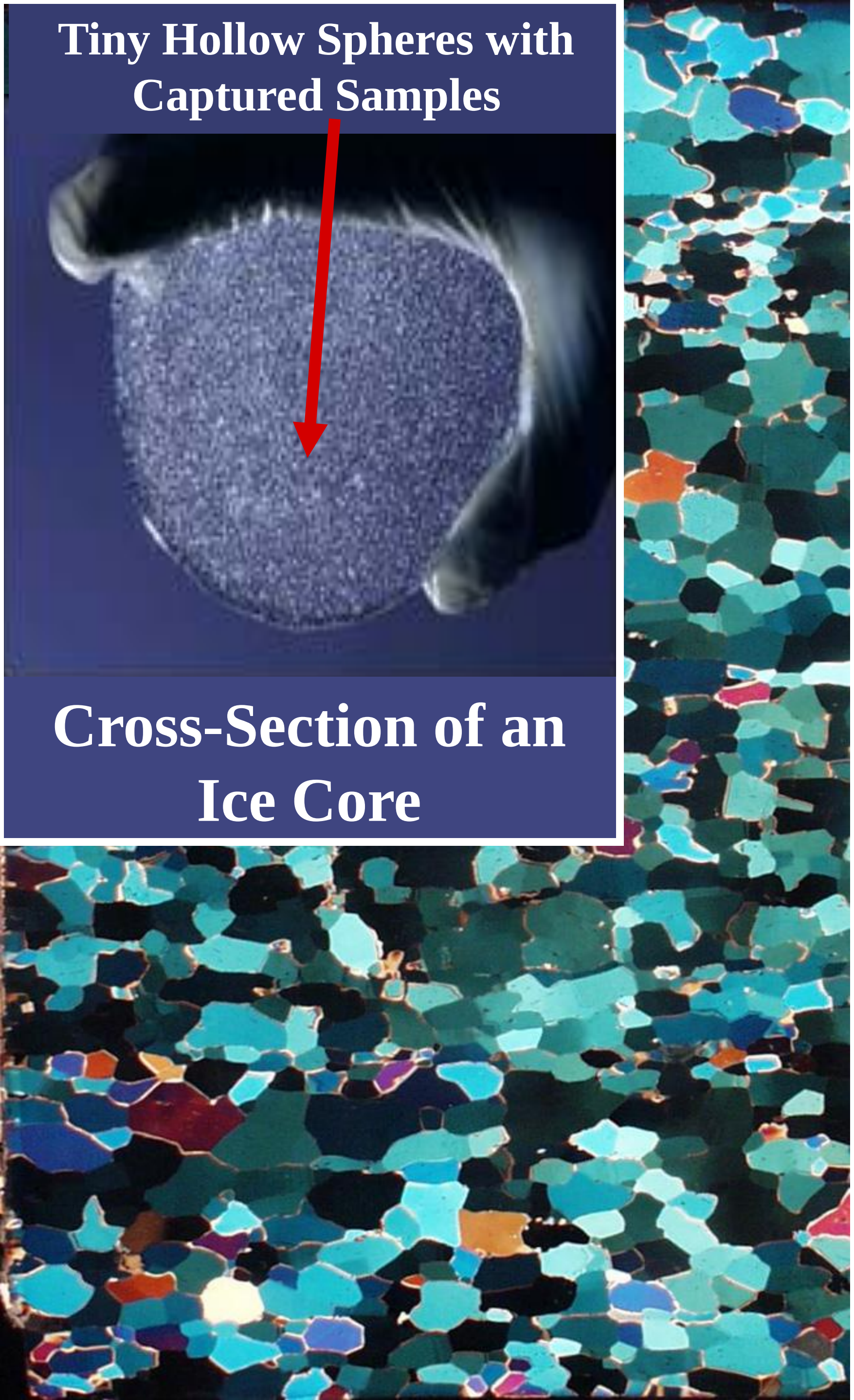
Let's Look at the Changing Arctic: ***A set of Thoughts on Turning Science into Policy and Action by Reviewing:***

1. Advancing Science: *Knowing and Framing the Future by Enhanced Understandings,*
2. Adaptation and Coping Strategies: *Understanding the Consequences of the Change,*
3. Mitigation and Taking Action: *Identifying and Address the Root Causes of the Changes, and*
4. Diffusion of Knowledge: *The Communication Challenges to Build Resilience in Our Societies*

1. **Knowing and Framing the Future:** The *Science* of Our Changing Planet.

This pale blue dot is planet Earth taken from Saturn by NASA's Cassini spacecraft looking back toward the Earth on Sept. 27, 2006. Saturn is about 800 million miles from the Earth.

I'd like to begin by building scientific perspectives on global scales, first on millennial time scales and then to the past 10,000 years. What do we know, is it credible, and why is it important?

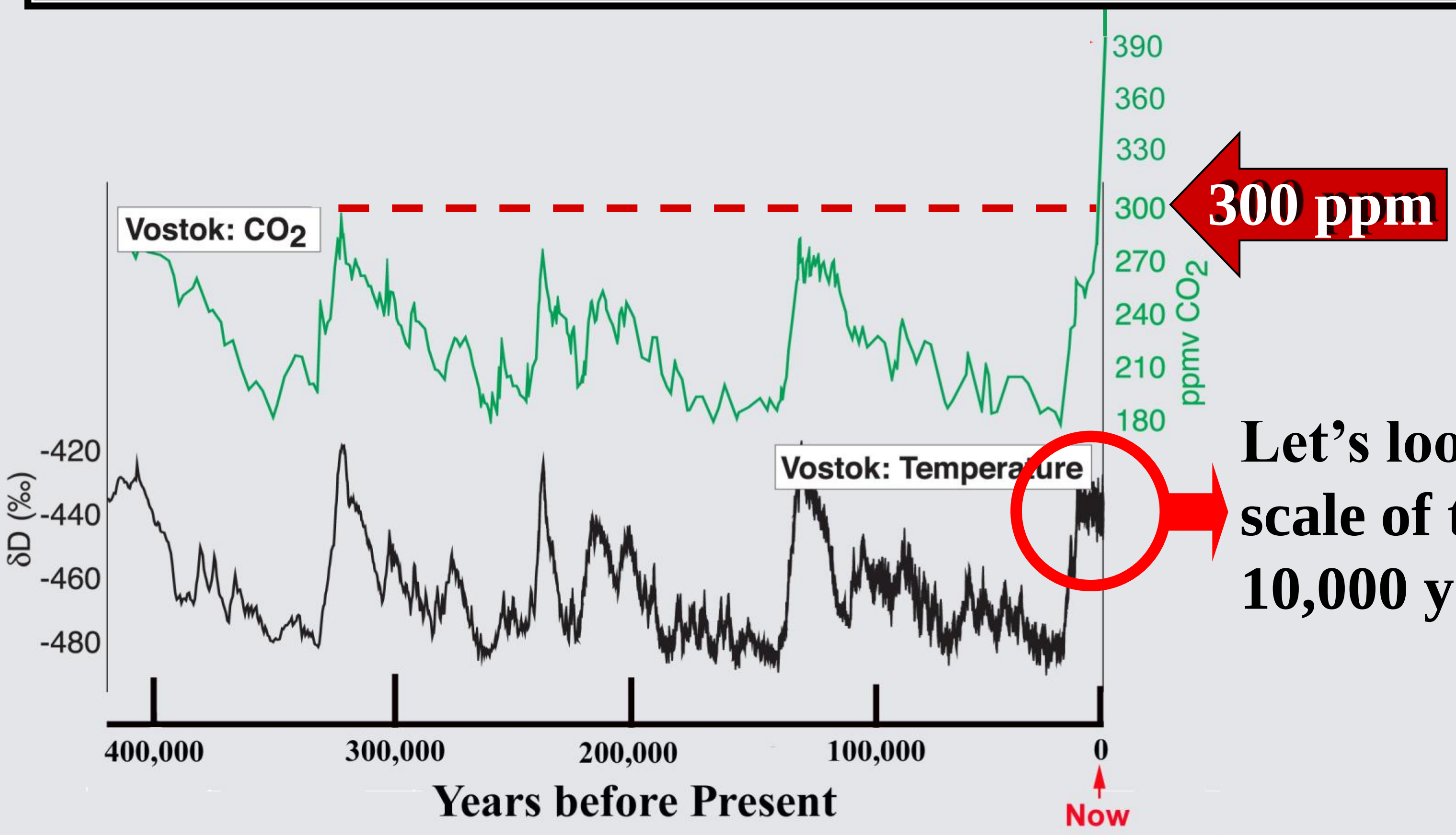


Ice Core data
A shopping list

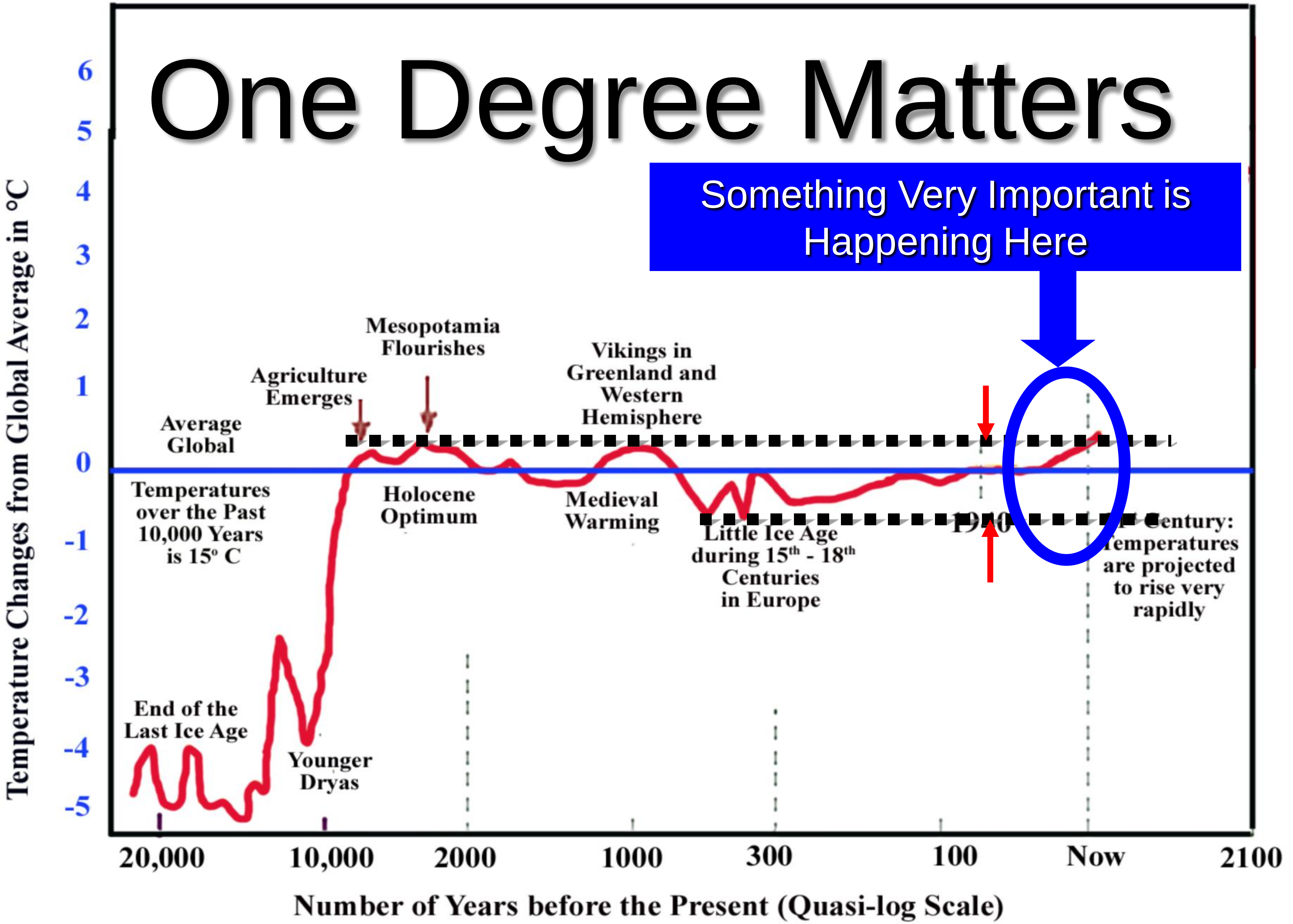
- The ice: ^{18}O , ^{17}O , ^{16}O, ^{1}H og ^{2}D
- Continental dust, volcanic ash, micro metheorites and biological material
- Ions: Cl^-, NO_3^-, SO_4^{2-}, F^-, H^+, Na^+, K^+, NH_4^+, Mg^{2+}, Ca^{2+}
- Gas in air bubbles: CO_2, CH_4, O_2, N_2, SF_6.
- Radioactive isotopes: ^{10}Be, ^{36}Cl, ^{210}Pb, ^{32}Si, ^{14}C, ^{137}Cs, ^{90}Sr.
- DNA
- Ice Properties
- Bore hole logging: temperature, geometry

Natural ice through polarized light
(sample size : 4 x 10 cm)

CO_2 is the critical gas in the atmosphere that controls the greenhouse warming effect we are observing now, it has never exceeded 300 ppm for over 800,000 years until the beginning of the industrial period and the extensive use of fossil fuels when it began to rise until now it is 390 ppm or 30% higher than it has been in almost one million years!



Let's look at this scale of time, the past 10,000 years or so.



Source: Adapted from "Climate change and human health - risks and responses" published by WHO in collaboration with UNEP and WMO 2003 and more recent data from IPCC 2007.

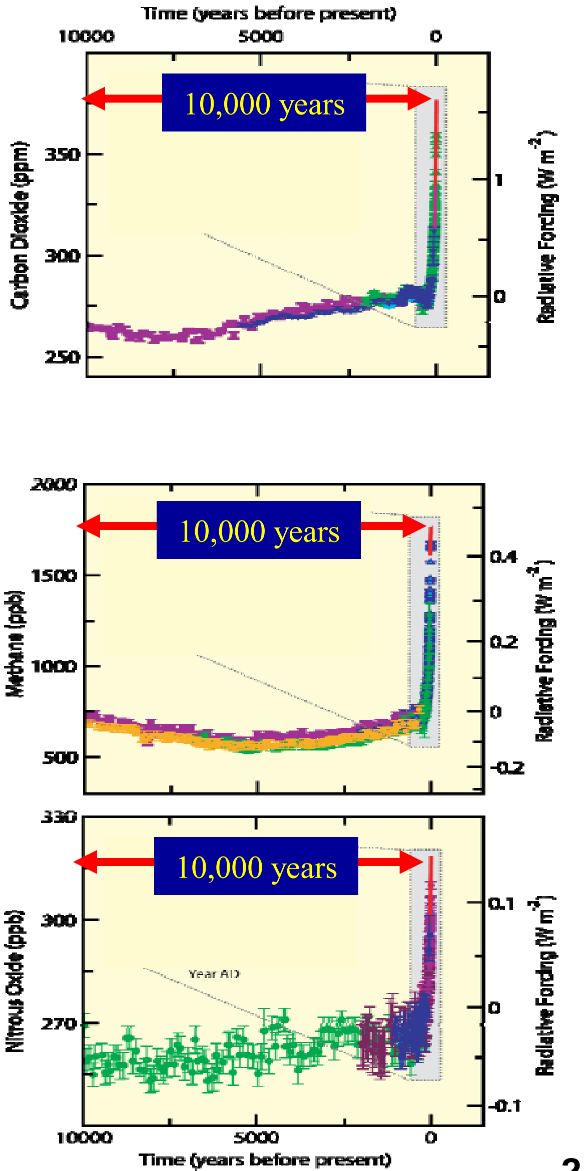
IPCC WG I (2007):

- "The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land-use change,while those of methane and nitrous oxide are primarily due to agriculture."

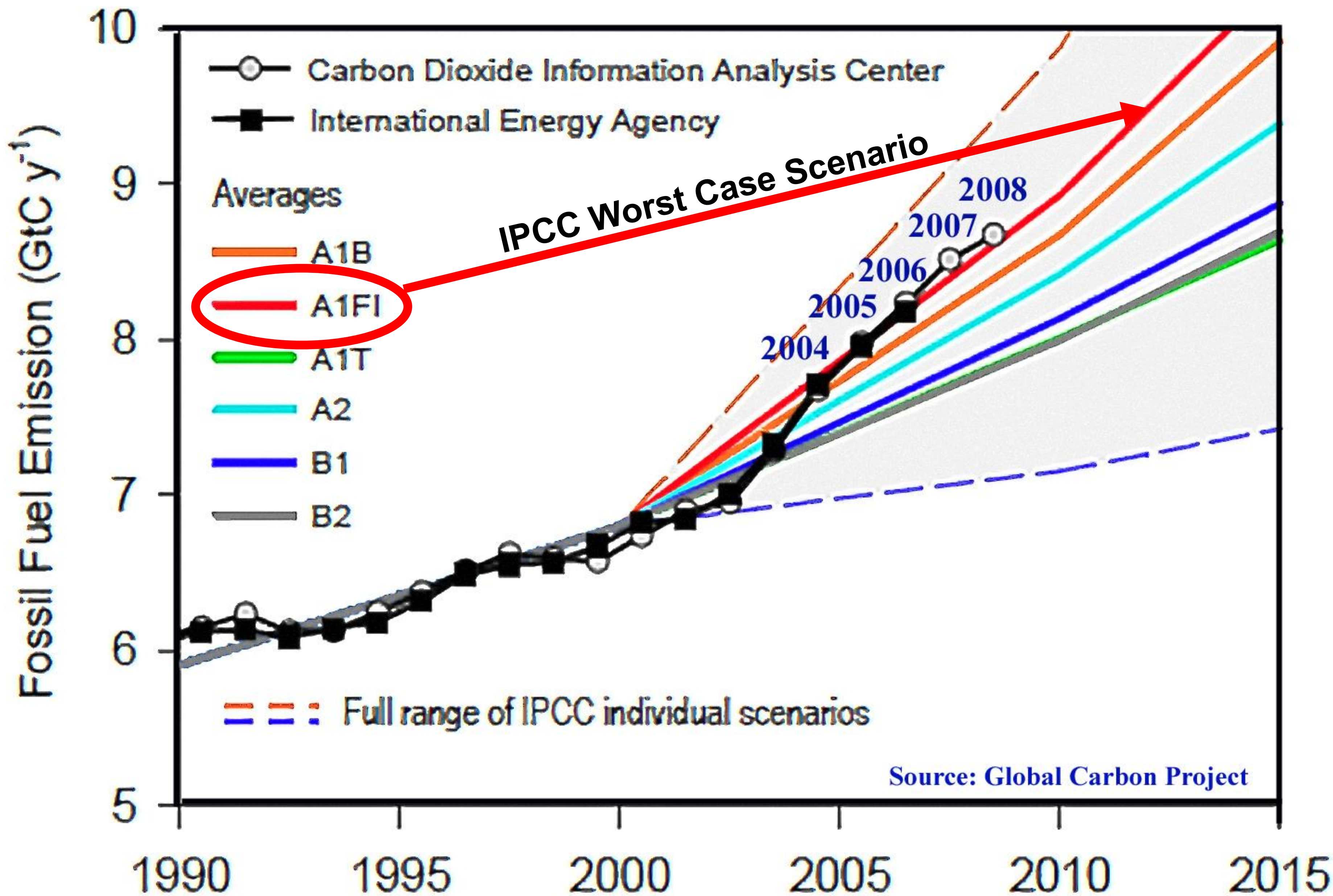
Carbon Dioxide

Methane

Nitrous Oxide



Fossil Fuel Emissions: Actual vs. IPCC Scenarios



Atmospheric CO_2 Concentration

Year 2010

Atmospheric CO_2

Concentration:

390 ppm

~ 40% above pre-industrial

At this accelerating rate we will be at 500 ppm by 2050

Growth in Atmospheric CO_2 Concentrations/Year

1970 - 1979: 1.3 ppm/year

1980 - 1989: 1.6 ppm/year

1990 - 1999: 1.5 ppm/year

2000 - 2007: 2.0 ppm/year

2007: 2.2 ppm/year

2008: 2.3 ppm/year

2009: 2.1 ppm/year

Accelerating

Data Source: Pieter Tans and Thomas Conway, NOAA/ESRL

Fate of Anthropogenic CO_2 Emissions (2000-2007)

~ 15%

+

~ 85%

Atmosphere

~ 46%

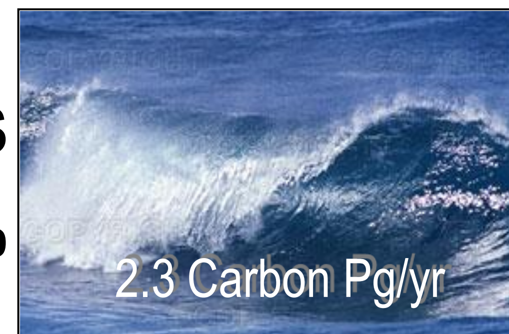
Must Go Up !

Land

~ 28%

Oceans

~ 26%



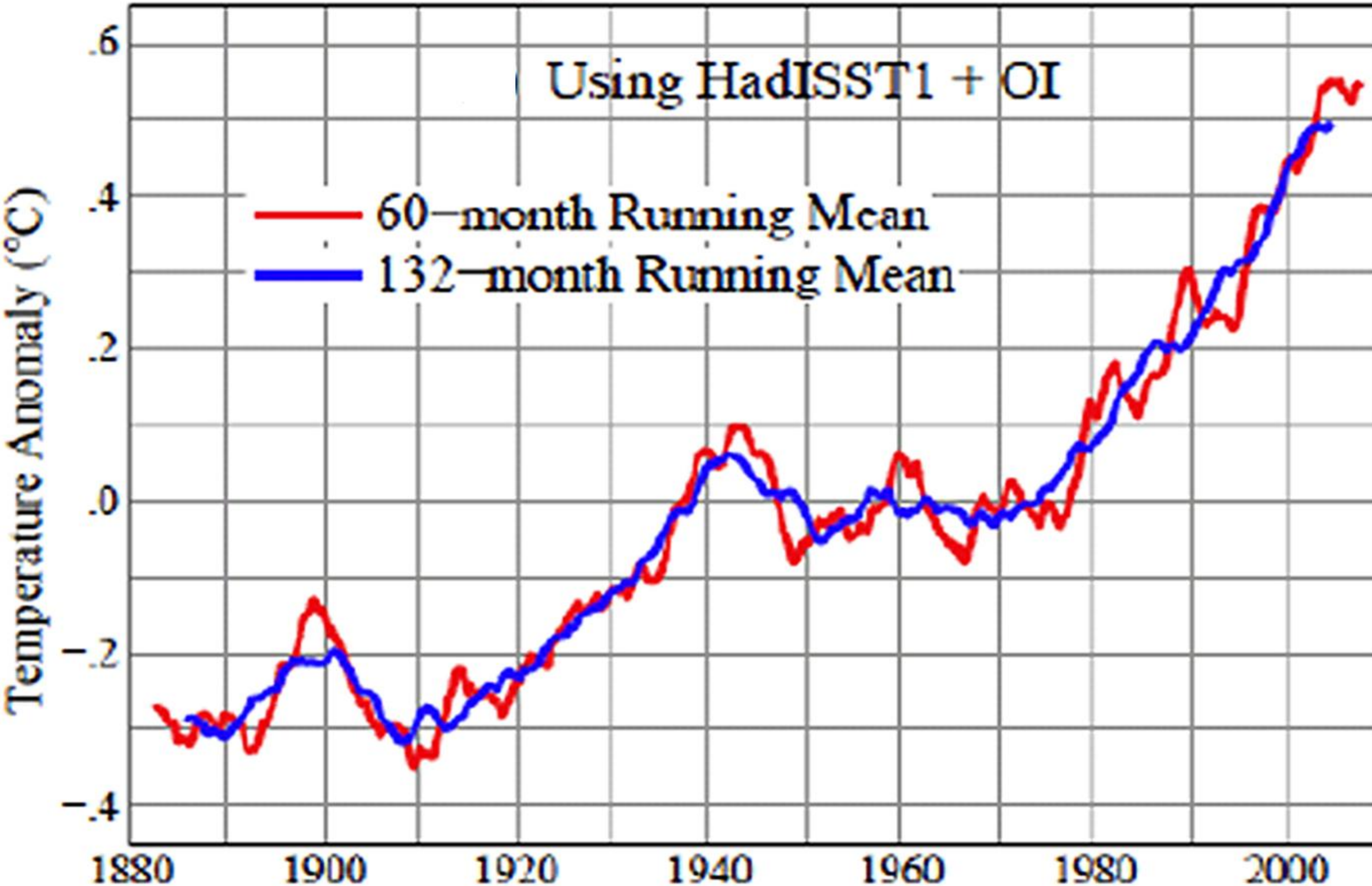
Down by 5%

Down ~ 5%

Canadell et al. 2007, PNAS (updated)

Global Mean Surface Temperatures

Analysis as of March 2010



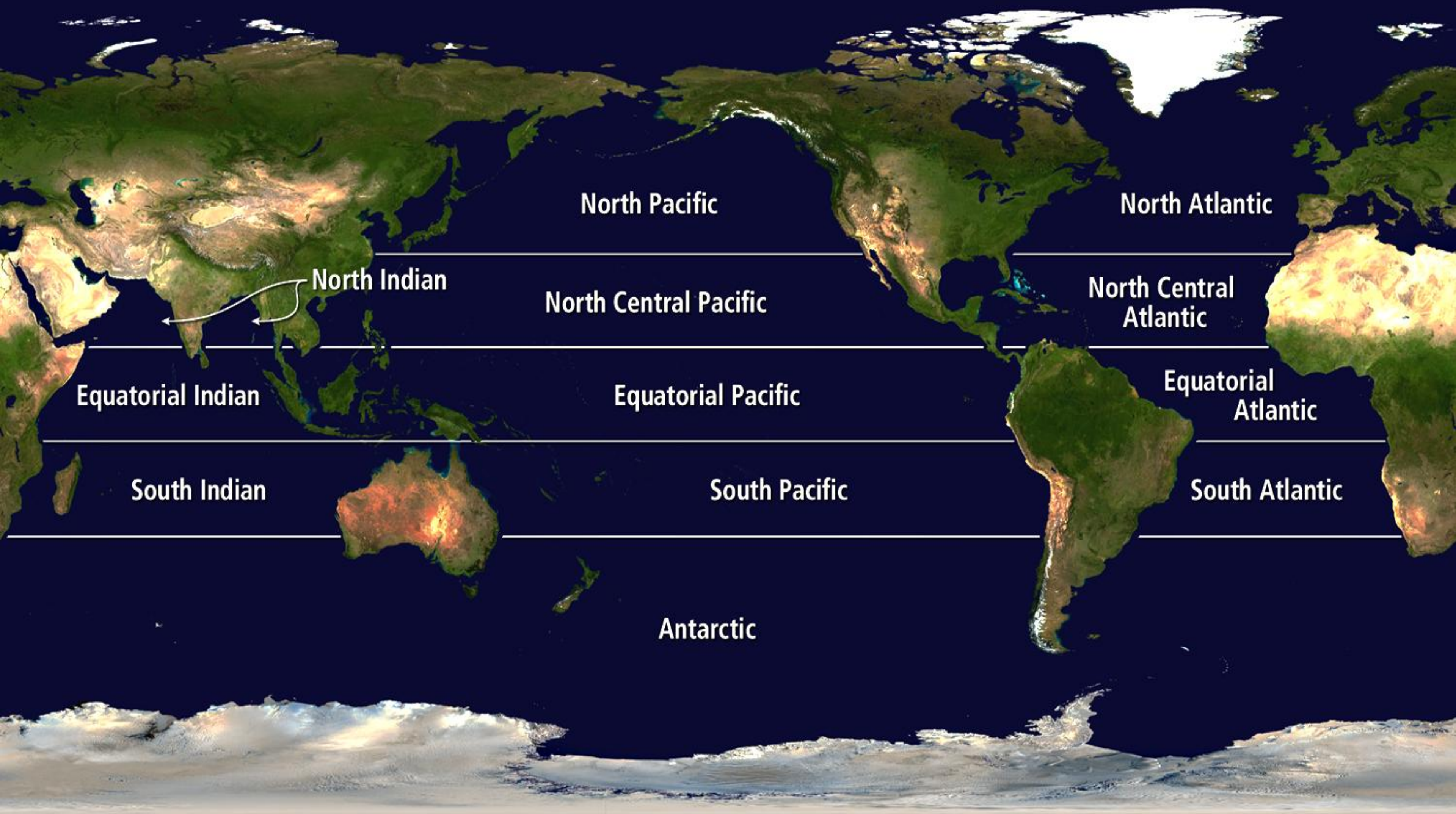
Source: Current GISS Global Surface Temperature Analysis by GISS at Columbia University by J. Hansen, et al, 2010

New Data

Global Carbon Project October 2008 Report

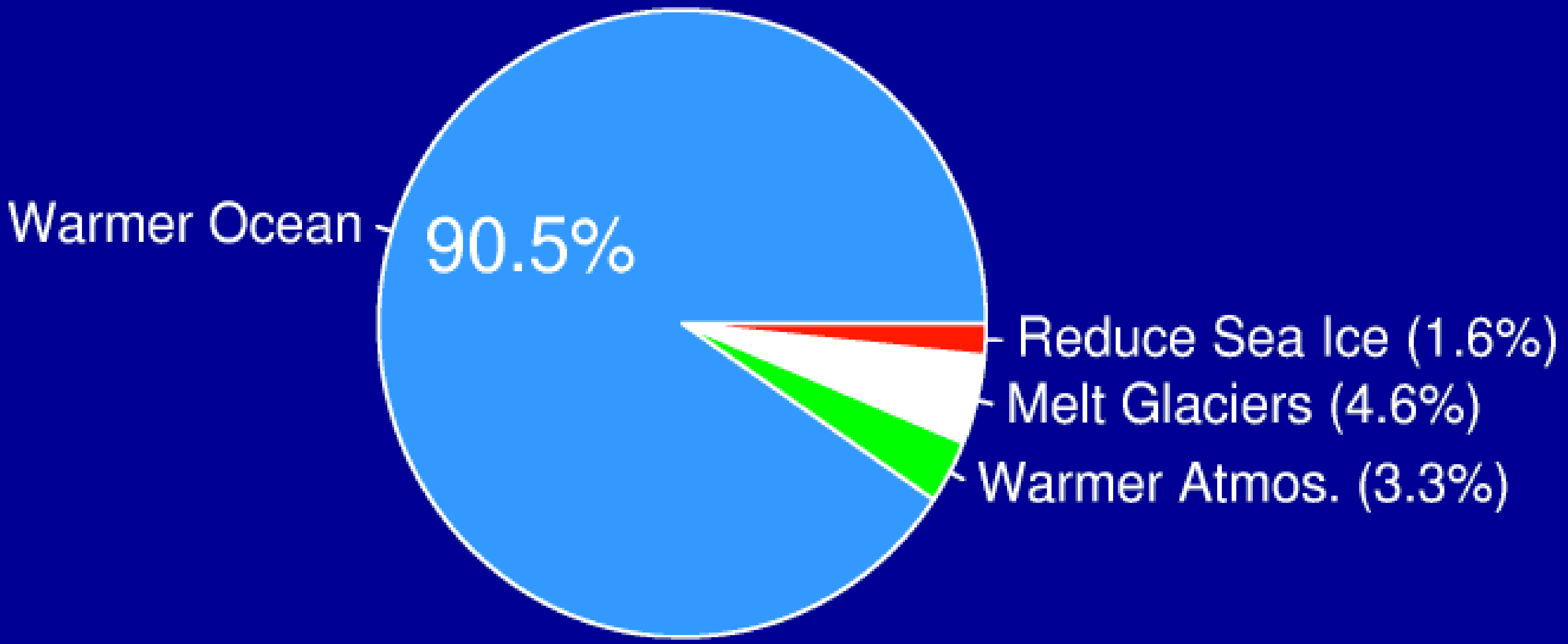
- Since 2000, CO_2 emissions derived from human sources have been growing x4 faster than in the 1990s and are now above the worst case emission scenario of the Intergovernmental Panel on Climate Change.
- Despite 15 years of intense international climate negotiations, concentrations of CO_2 in the atmospheric have been growing 33% faster during the last 8 years than in the 1990s.
- These drivers of climate change are accelerating.

Let's look at the role the oceans play in the dynamics of climate change.



Why are the oceans Important?

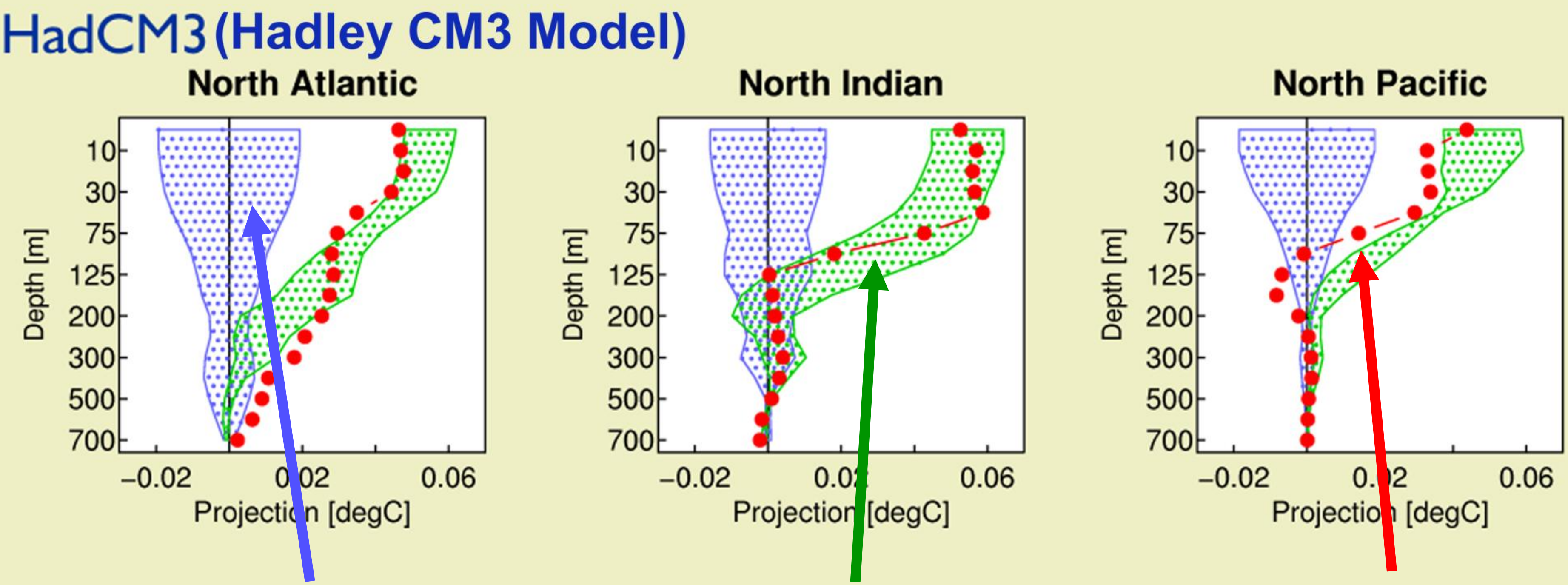
Because, that is where the heat goes !



Data from Levitus et al, *Science*, 2001

Warming of the World’s Oceans

(An Analysis of the past 40 Years)



No Anthropogenic Forcing (Blue)

With Anthropogenic Forcing (Green)

Observational Data (Red Dots)

Source: T.P. Barnett, et al 2005

The ocean pH changes will persist for thousands of years. Because the fossil fuel CO_2 rise is faster than natural CO_2 increases in the past, the ocean will be acidified to a much greater extent than has occurred naturally in the past [Caldeira and Wicket, 2003].

Corals

Calcareous plankton

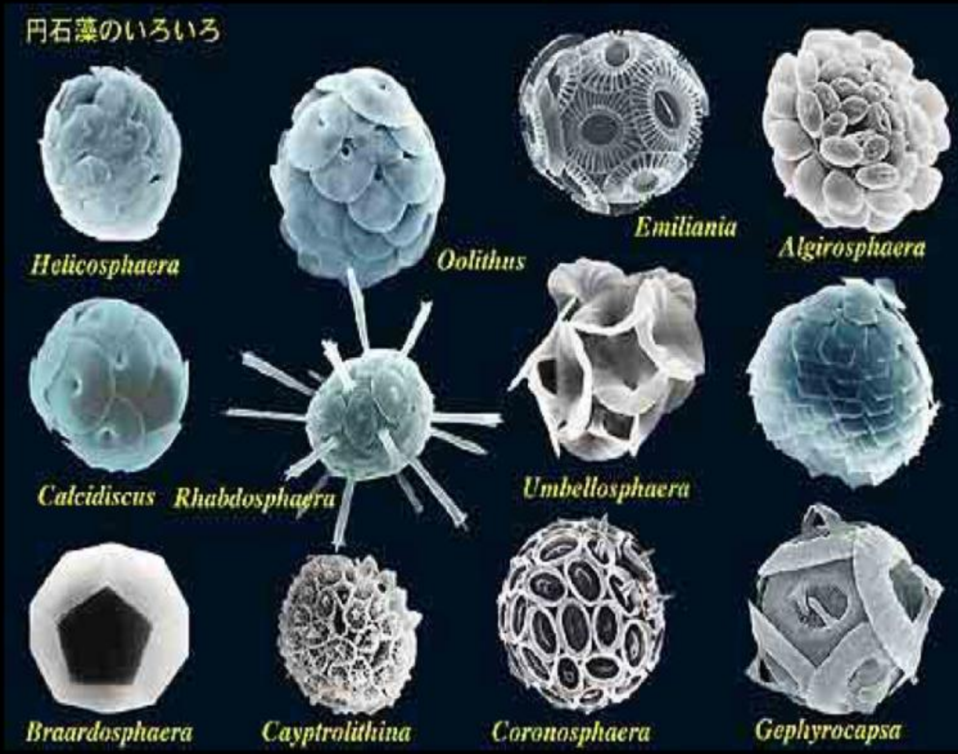
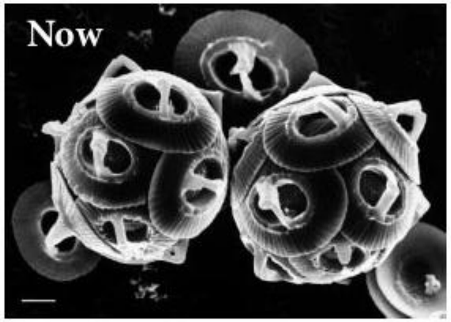


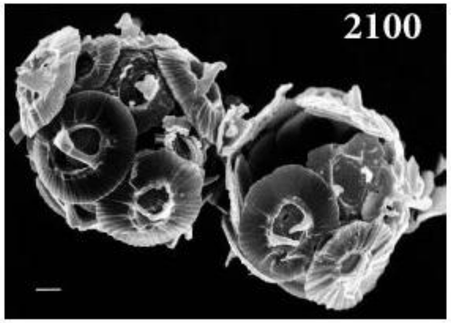
Photo: Missouri Botanical Gardens

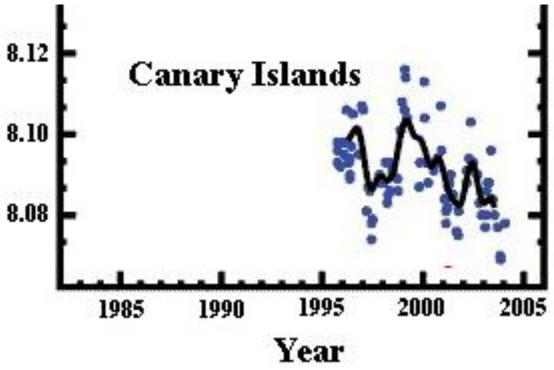
http://www.biol.tsukuba.ac.jp/~inouye

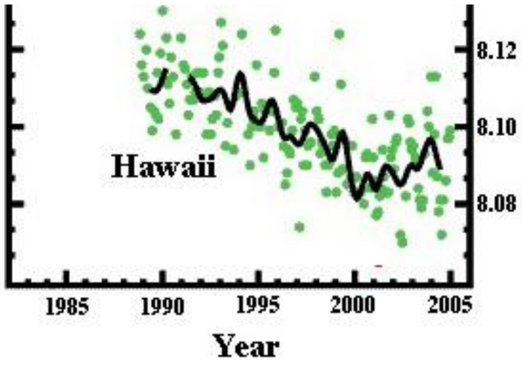
Ocean Acidification is

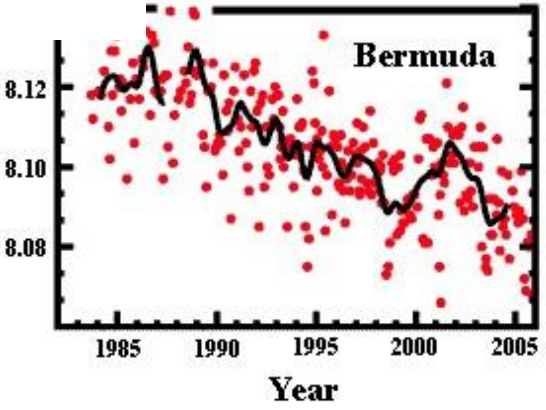
A recently published analysis projects that changes in the acidification of the deep ocean may exceed anything seen in the past 65 million years. **Andy Ridgwell, et al *Nature Geoscience*, 14 February 2010**







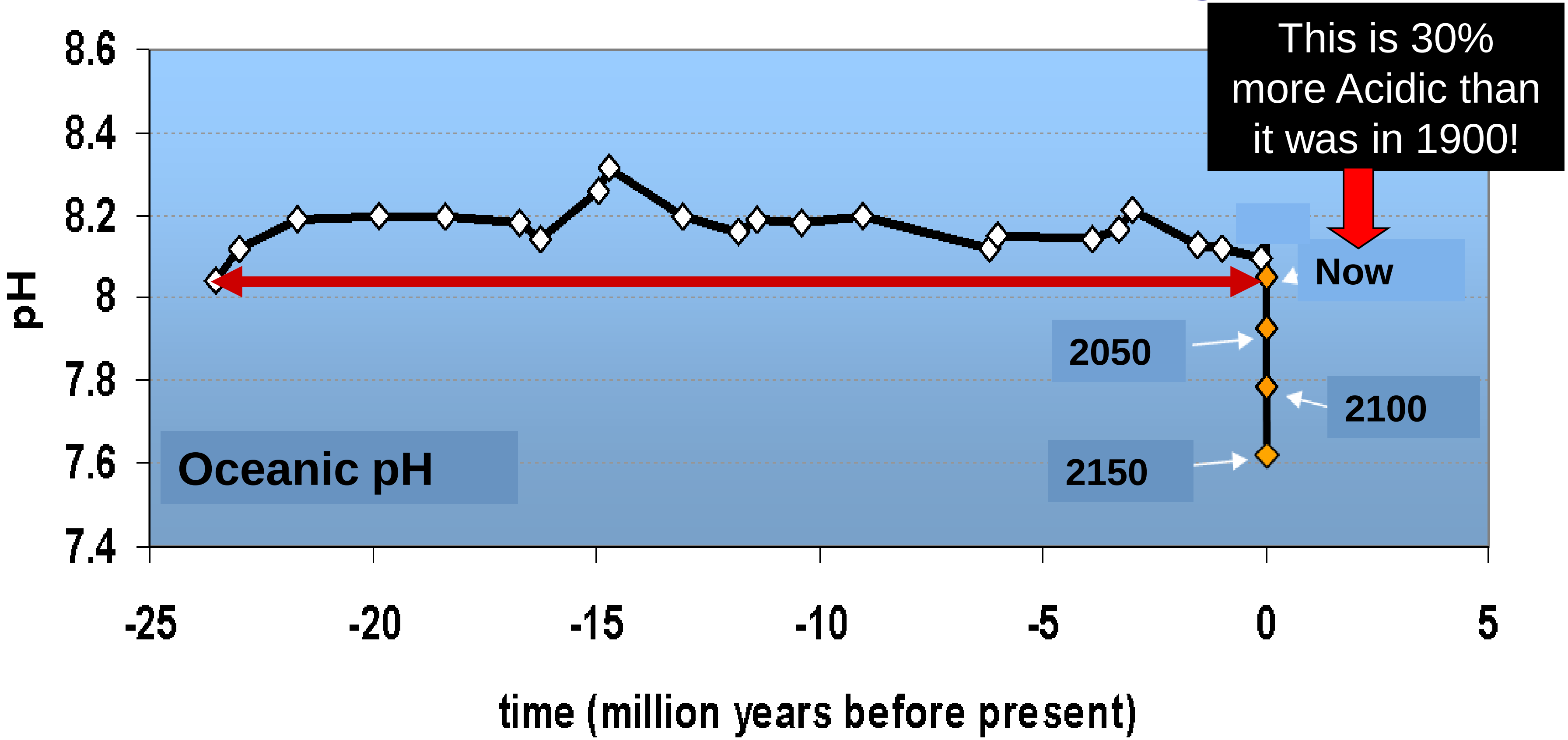




Trends over the Past Decade in Three Locations

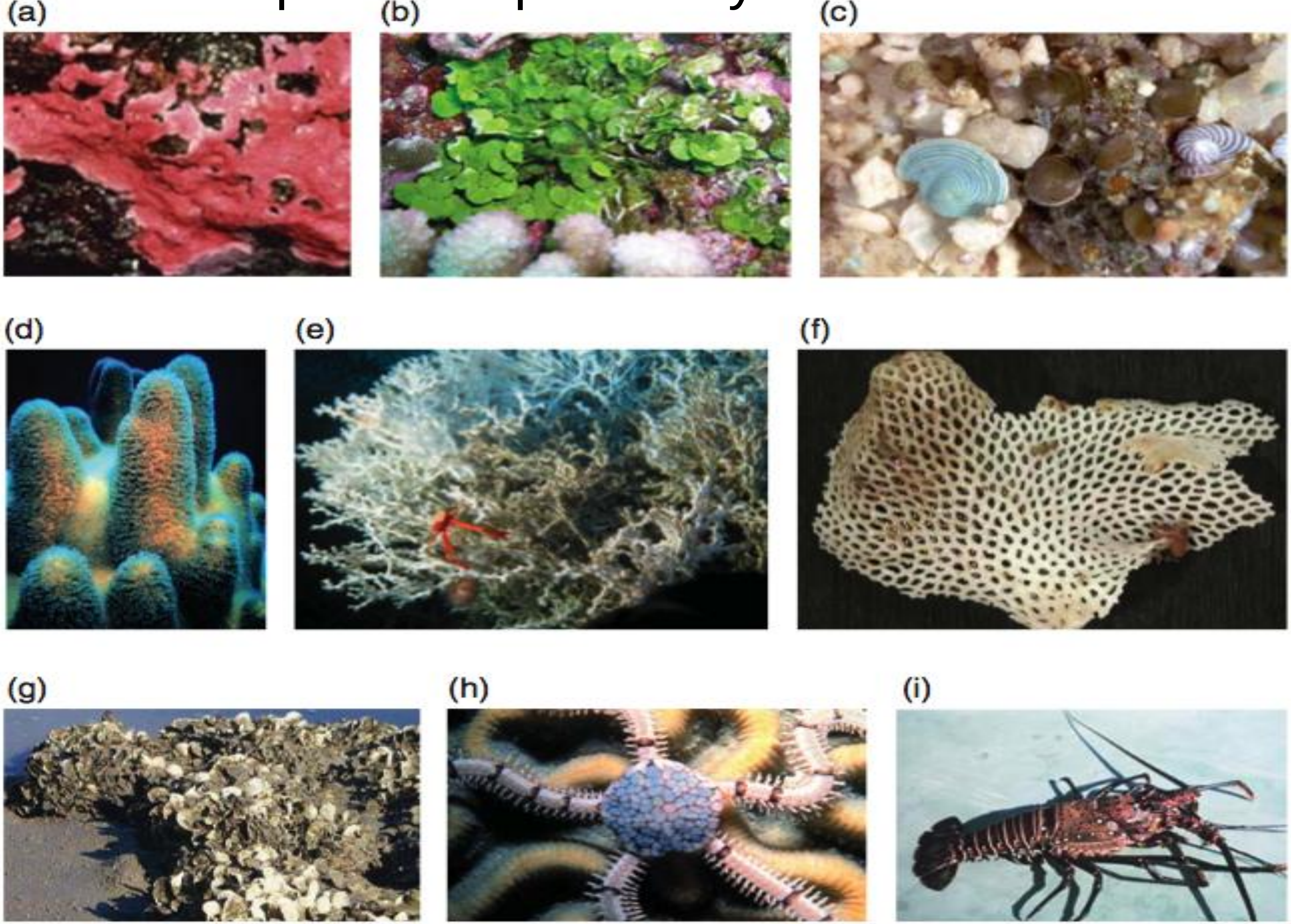
Ocean Acidification

What are the prospects for the coming decades?

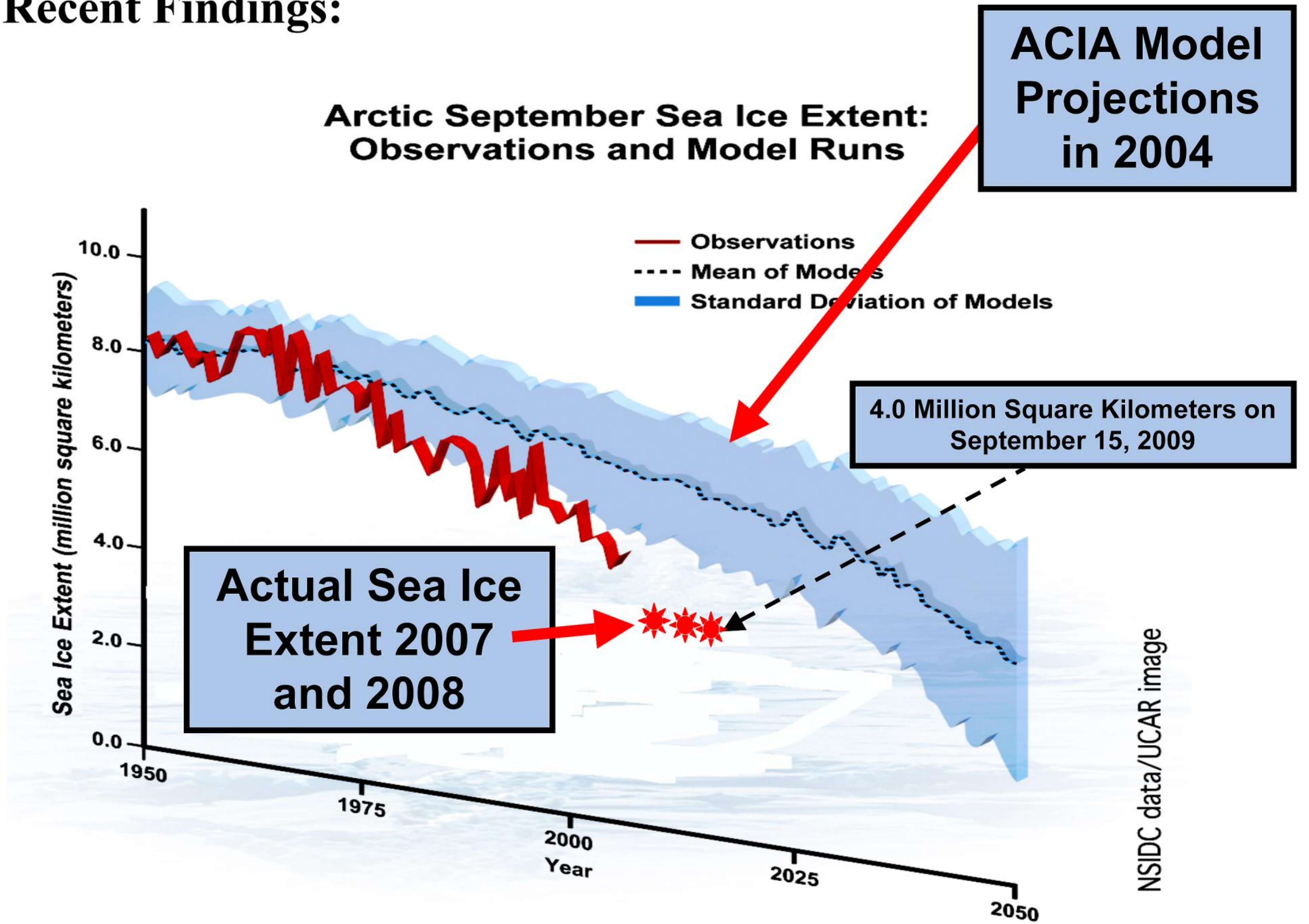


Avoiding Dangerous Climate Change (Turley et al 2006)

Marine Species Impacted by Ocean Acidification



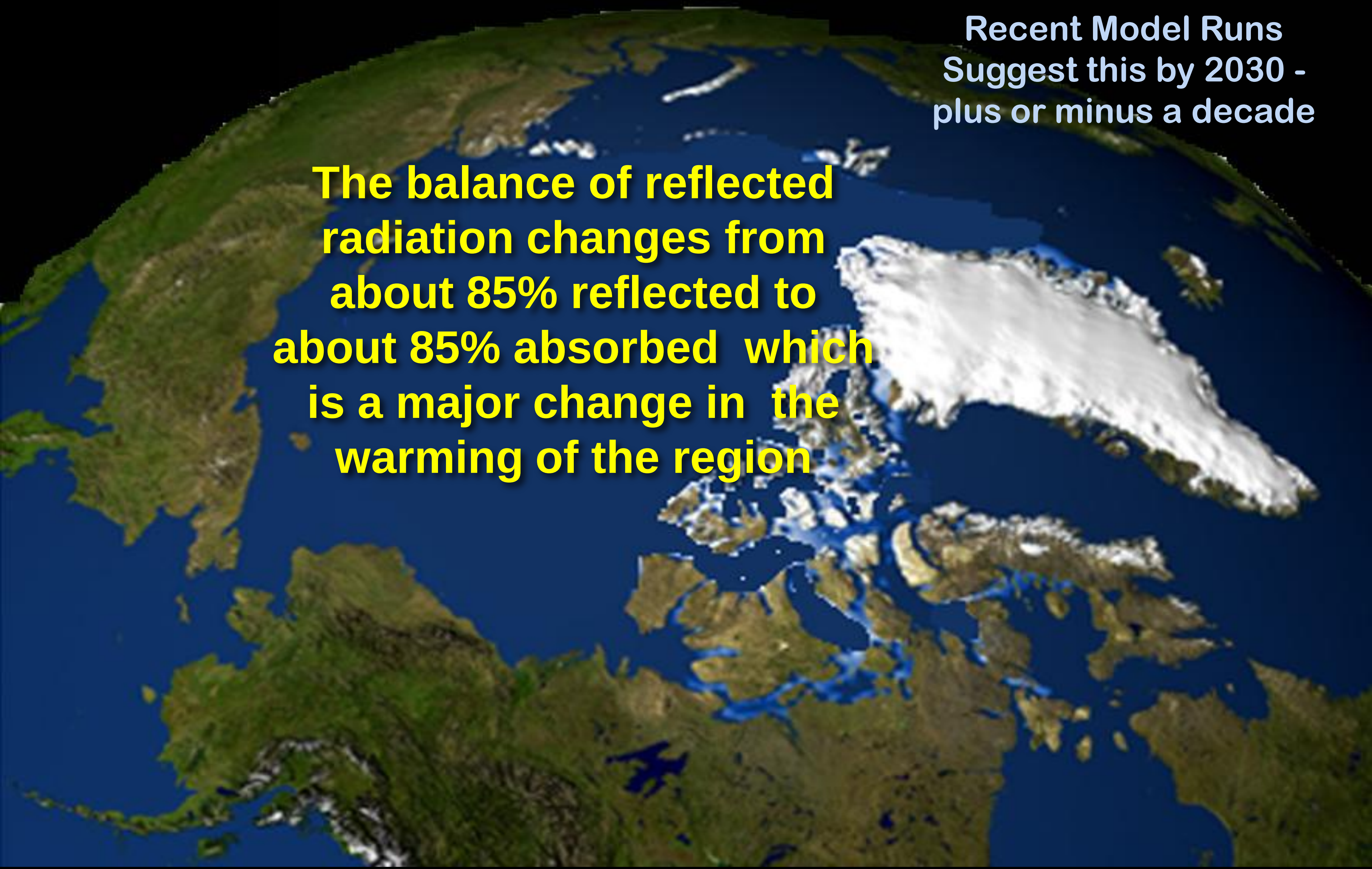
Recent Findings:



Sept 11th 2009

Models Project Sea Ice Extent

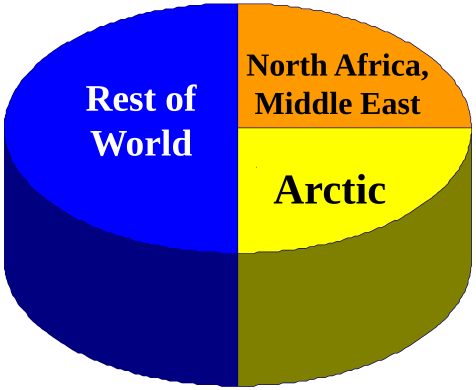
for Mid-September



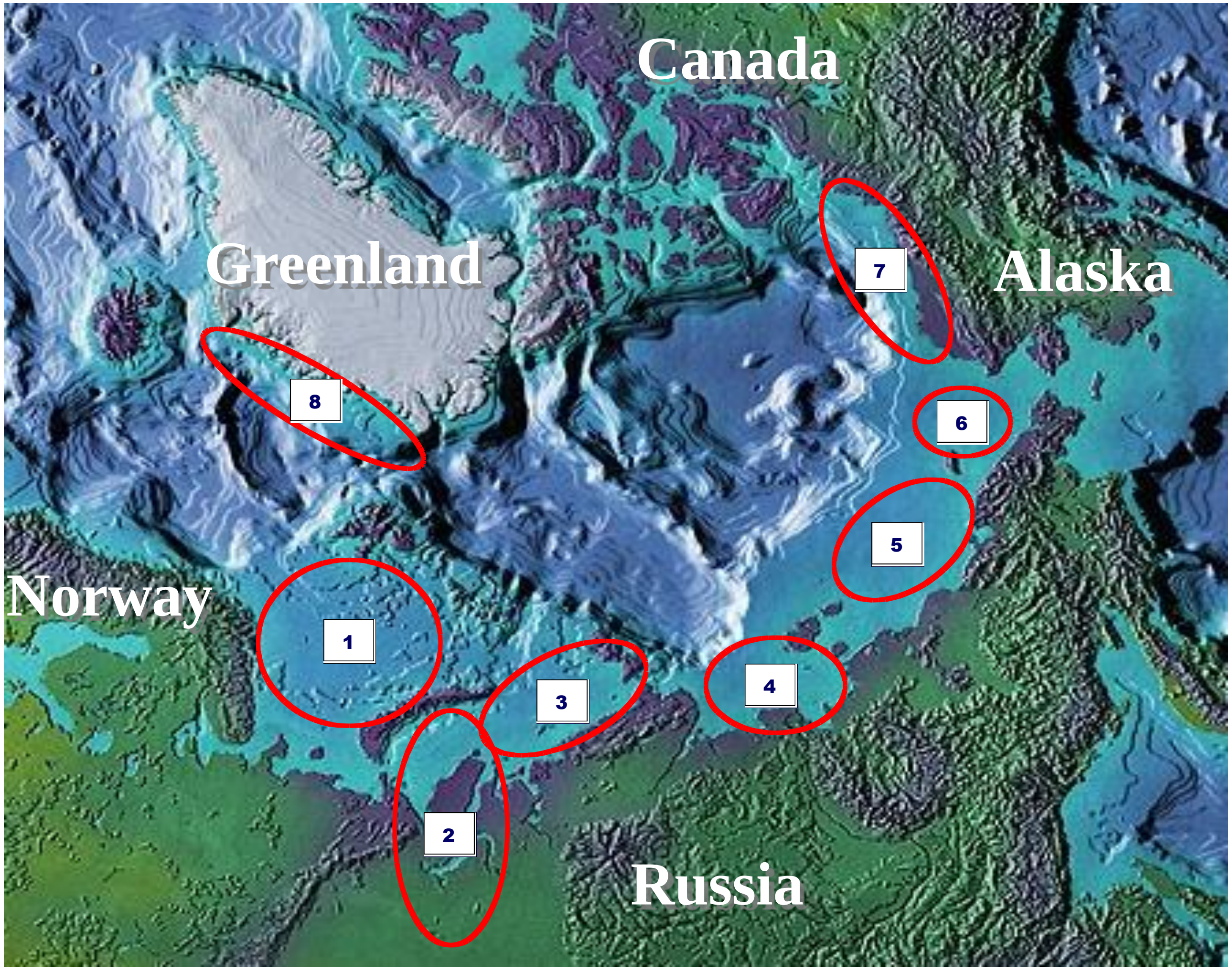
Recent Model Runs
Suggest this by 2030 -
plus or minus a decade

The balance of reflected radiation changes from about 85% reflected to about 85% absorbed which is a major change in the warming of the region

World’s Petroleum Potential

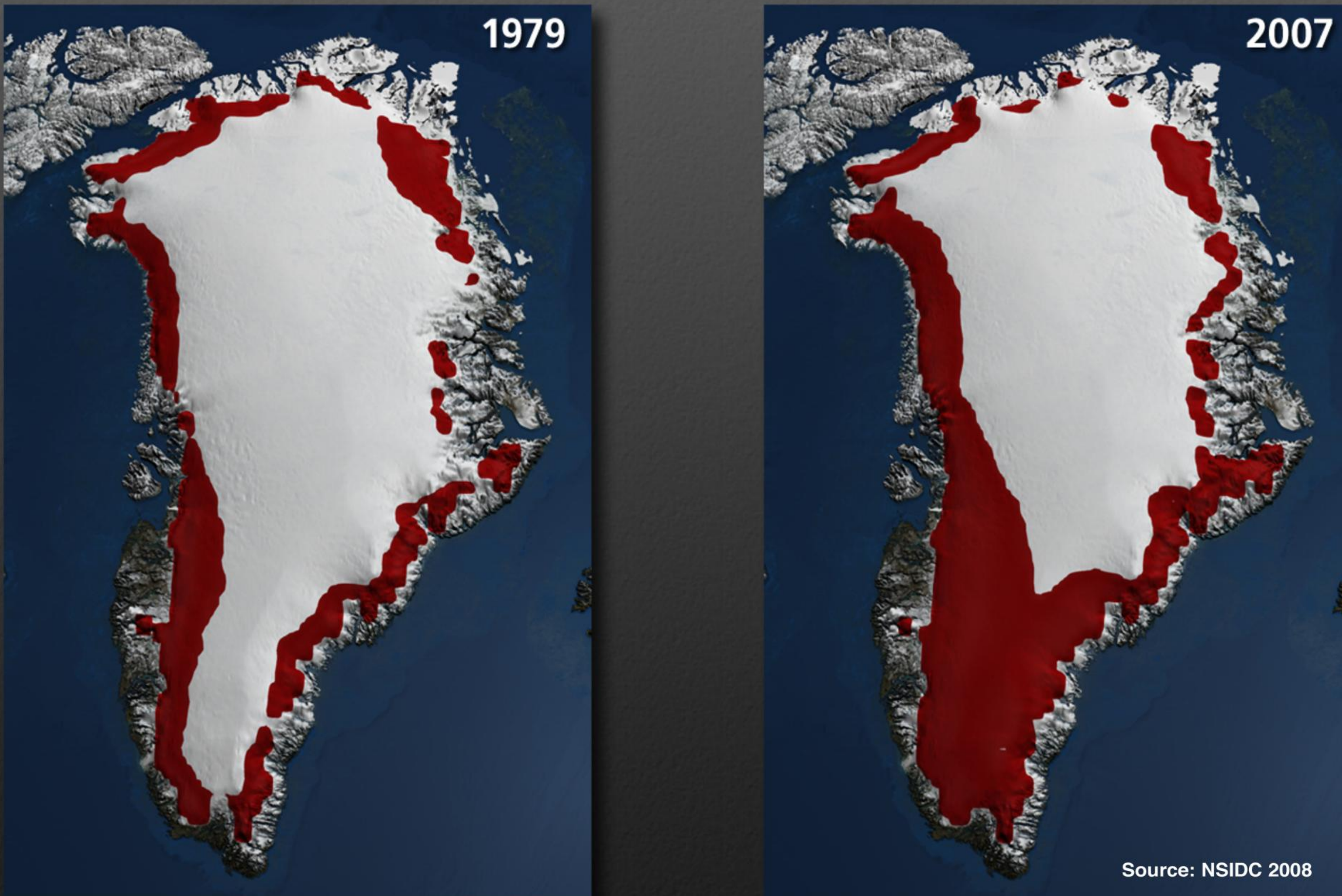


1. Barents Sea
2. Southern Kara Sea and Western Siberia
3. Northern Kara Sea
4. Laptev Sea
5. East Siberian Sea
6. Chukchi Sea
7. Alaska North Slope
8. East Greenland

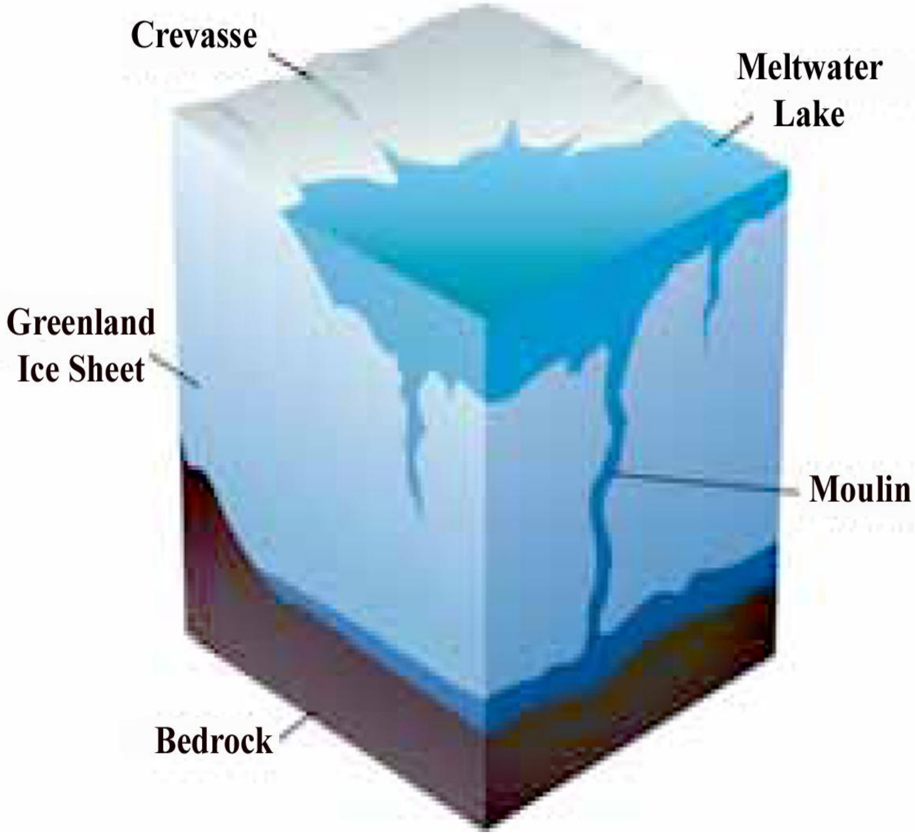


Polar Front
Cold polar water
Mixed cold water
Warm water of the Irminger Current and the North Atlantic Drift
Mixed cool water

Greenland Ice Sheet Melt Zone Change

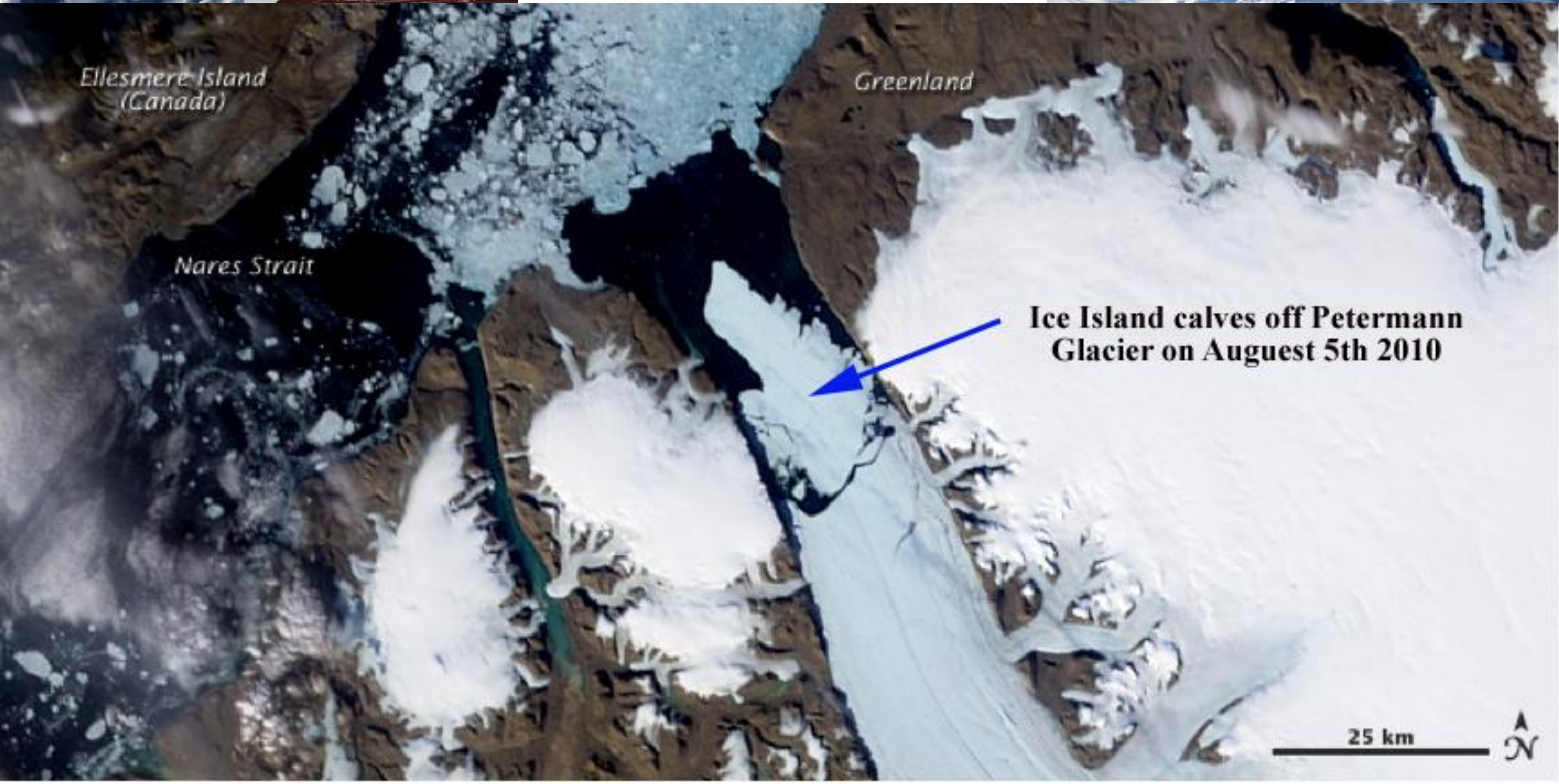


A Moulin drains the surface meltwater through crevasse to the base of the glacier, which in turn "lubricates" the base of the ice sheet.

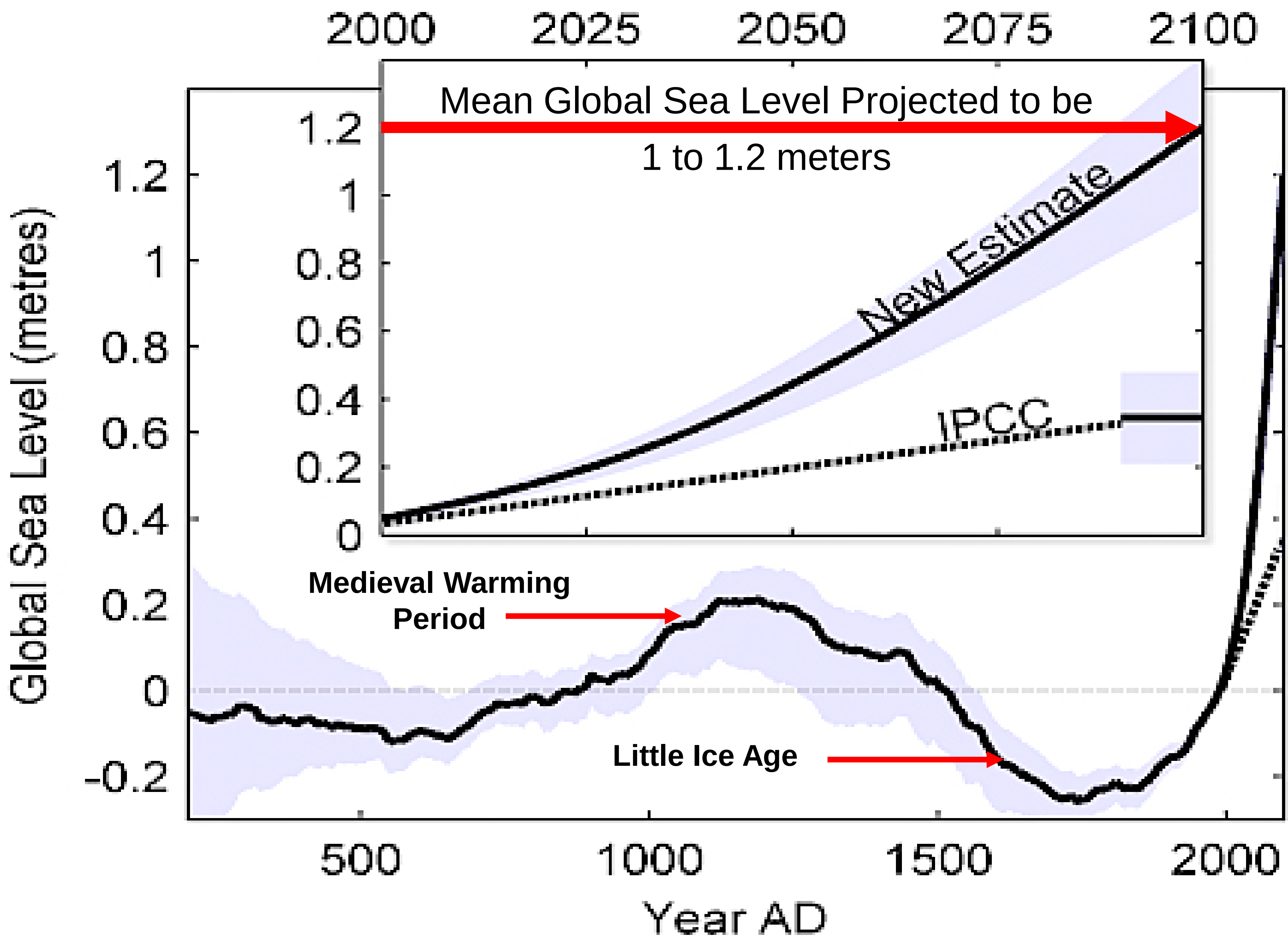



Svalbard
Fram Strait
Ellesmere Island
Greenland Sea
Baffin Bay
Jan Mayen
Baffin Island
GREENLAND
Disko Bay
Denmark Strait
ICELAND
FAROE ISLANDS
Davis Strait
Ammassalik
Cape Farewell
Labrador
Atlantic Ocean
Polar Front
Cold polar water
Mixed cold water
Warm water of the Irminger Current and the North Atlantic Drift
Mixed cool water

Illulissat Glacier: Increased Rates of Calving



The Petermann Glacier Issue: ***A new Ice Island (a flat surfaced Iceberg) with an area of 100 square miles which is about four times the size of Manhattan broke off the Petermann Glacier in northern Greenland on Aug. 5th 2010. It is located at 81 degrees N latitude and 61 degrees W longitude, about 620 miles [1,000 km] south of the North Pole.***



A. Grindsted, Climate Dynamics, 2009

The recent *Nature* article suggesting that projections of sea level rise do to melting of glaciers in Greenland, Antarctic and Alaska/Yukon may be overestimated. Sea level rise relative to the land masses is composed of:

- **Thermal Expansion of oceanic waters**
- **Melting of land-fast glaciers and icesheets, and**
- **Adjustments for the post-ice age isostatic rebound of the earth because of the massively reduced ice masses over continental areas. The Wu paper suggests:**

Wu Paper Analysis

Region	Mass gain all data (GIA estimated) Gt yr^{-1}	Mass gain GRACE only (GIA corrected) Gt yr^{-1}
Greenland	-104 ± 23	-161 ± 35
Alaska/Yukon	-101 ± 23	-68 ± 28
West Antarctica	-64 ± 32	-99 ± 59
East Antarctica	-23 ± 29	16 ± 54
Remaining land	14 ± 76	-74 ± 148
Oceans	236 ± 81	341 ± 137

30% Deduction Compared to GRACE only

CReSIS
Haskell Indian Nations University
The Netherlands
Inundated Area
0 50 100 150 200 250 Miles
0 75 150 225 300 375 Kilometers
1 Meter Inundation


Jackson
LOUISIANA
Alexandria
MISSISSIPPI
TEXAS
Hattiesburg
Baton Rouge
Hammond
Lake Charles
Beaumont
Slidell
Lafayette
New Orleans
Houma
+ 1 meter
USA: Louisiana
Gulf of Mexico
Weiss and Overpeck
0
100 km

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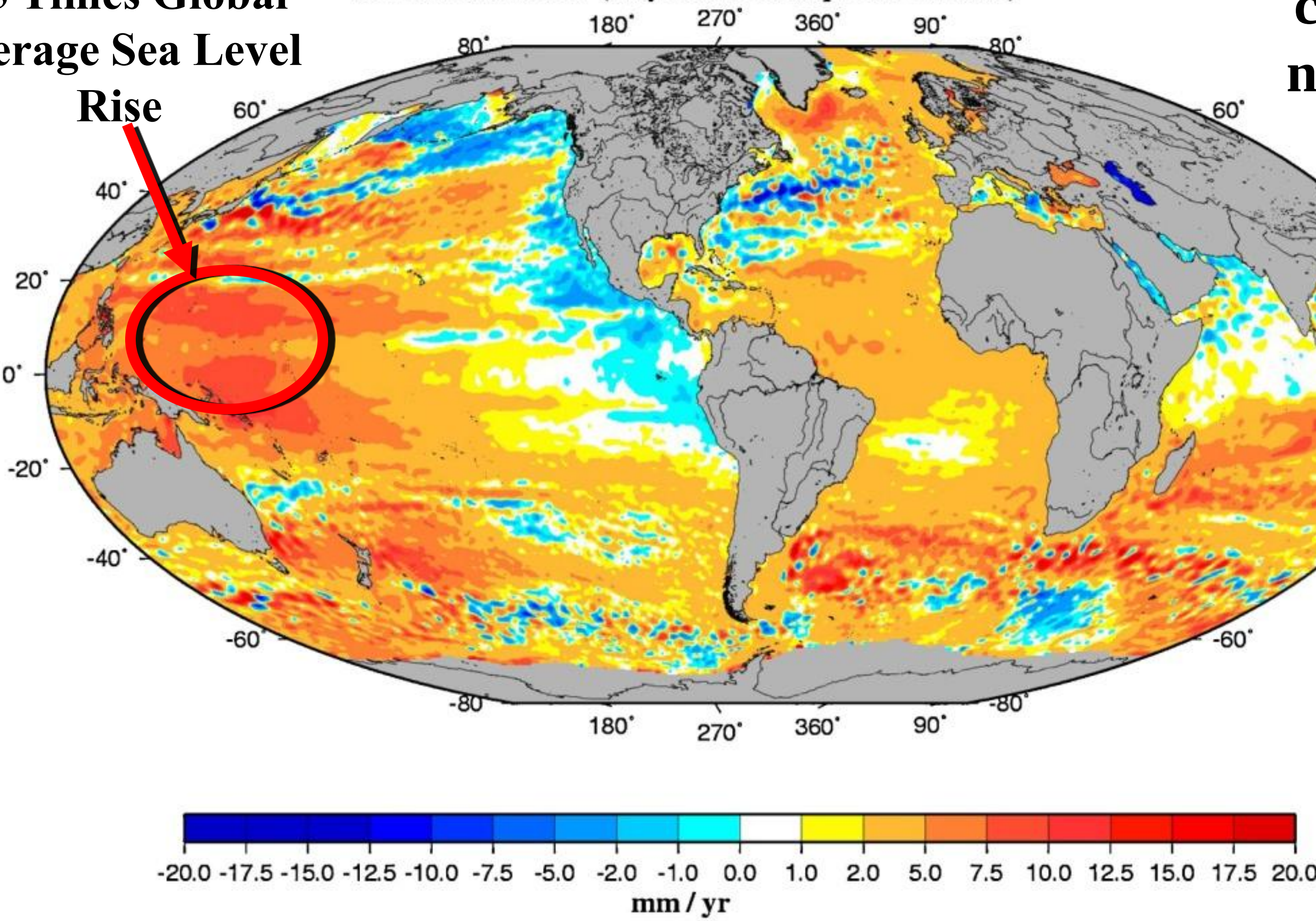
Amplified by about 3.5 Times Global Average Sea Level Rise

Sea level trends from satellite altimetry (Oct.92-Jan.08)

LEGOS/CNES/CLS (May. 2008 netcdf qd CLS 22.05.08)



Sea level changes are not uniform over the planet

In Summary:

- ***Warming of the climate system is unequivocal*, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.**
- ***There is now higher confidence in projected patterns of warming* and other regional-scale features, including changes in wind patterns, precipitation and some aspects of extremes and of ice.**
- ***Anthropogenic warming and sea level rise will continue for centuries* due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.**



2. **Adaptation and Coping Strategies:** ***Understanding the Consequences of the Change.***

"Over the past 50 years, humans have changed marine and terrestrial ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber, and fuel."

Source: The Main Findings of the Millennium Ecosystem Assessment (2005)

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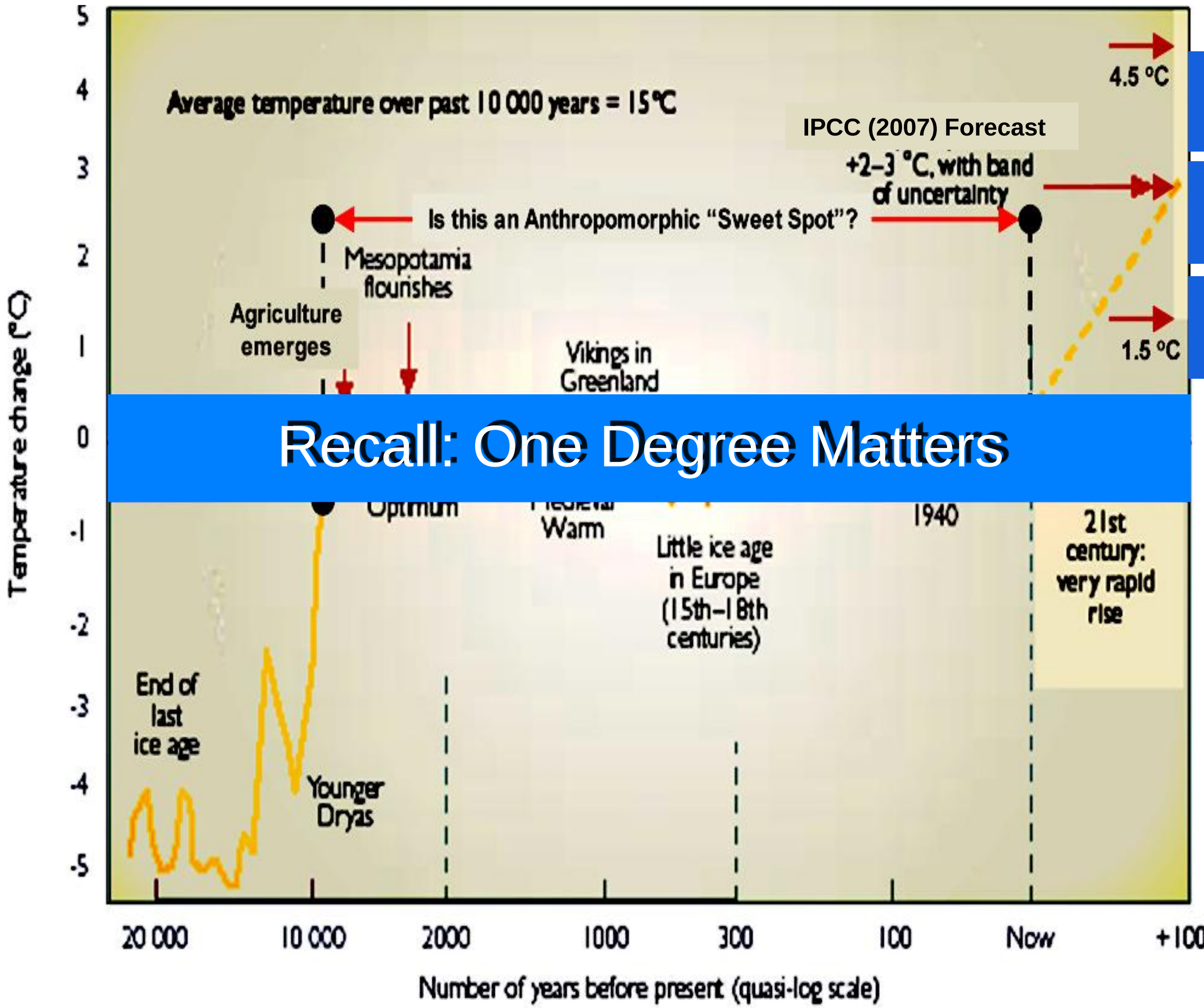
Recall: One Degree Matters

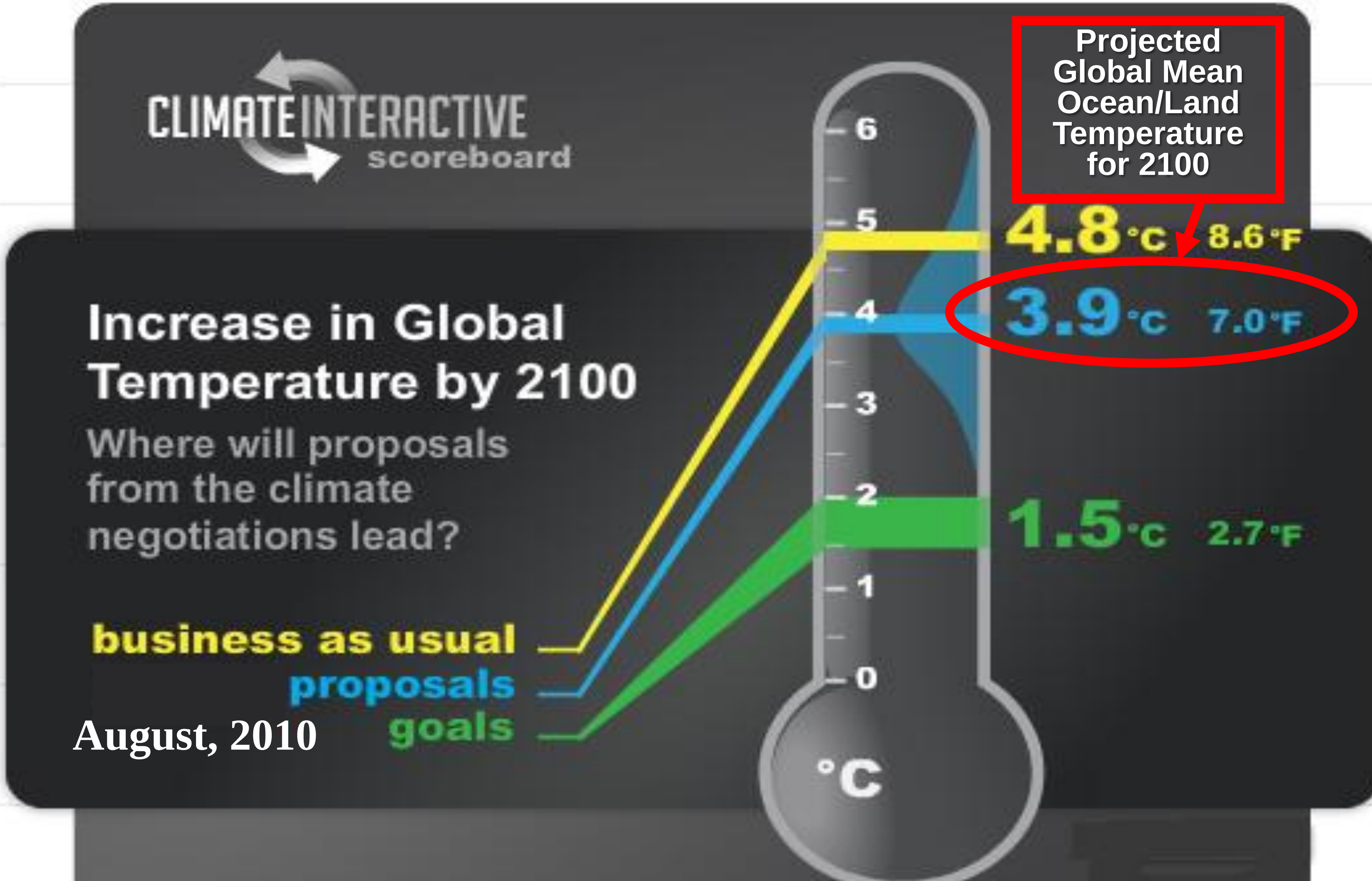


750 ppm ~ 4.3 ^{0}C

550 ppm ~ 3 ^{0}C

450 ppm ~ 2 ^{0}C

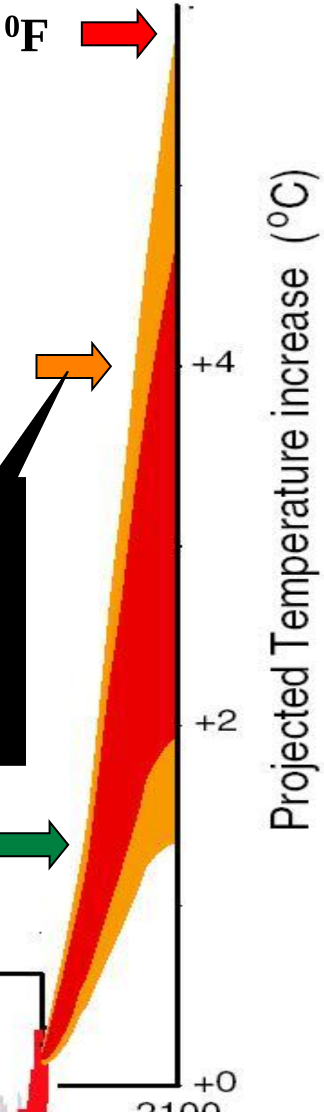
There is the potential that the climate is likely, as projected by the IPCC, to take humankind where it has never been

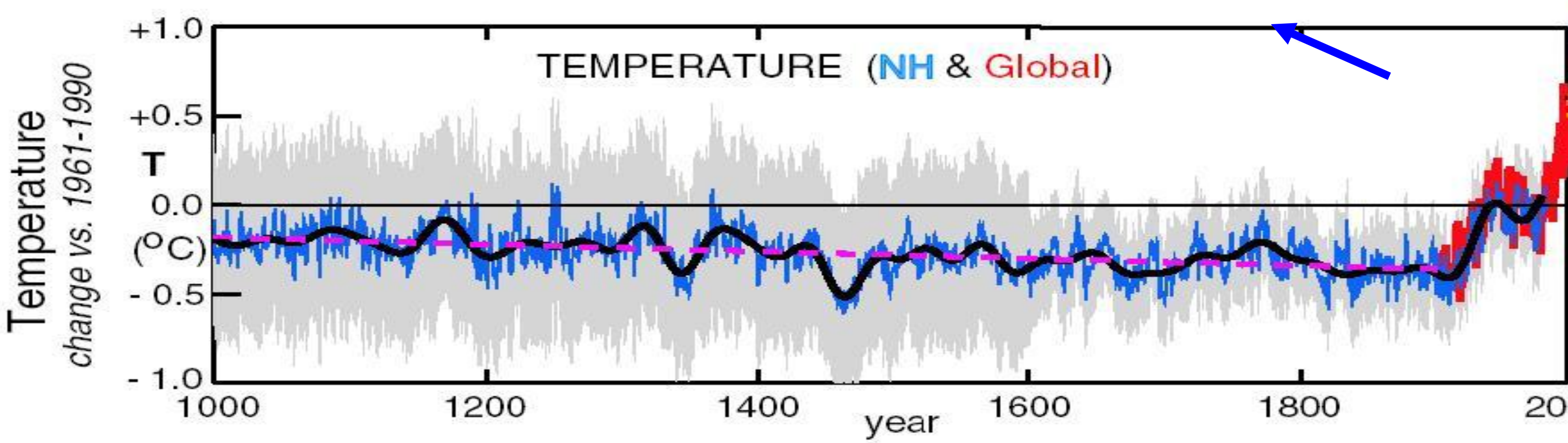


Projections based on publically available emission targets of 193 nations UNFCCC, including the Copenhagen Accord Commitments

Climate change is like to continue to confront humanity in the 21st century and beyond

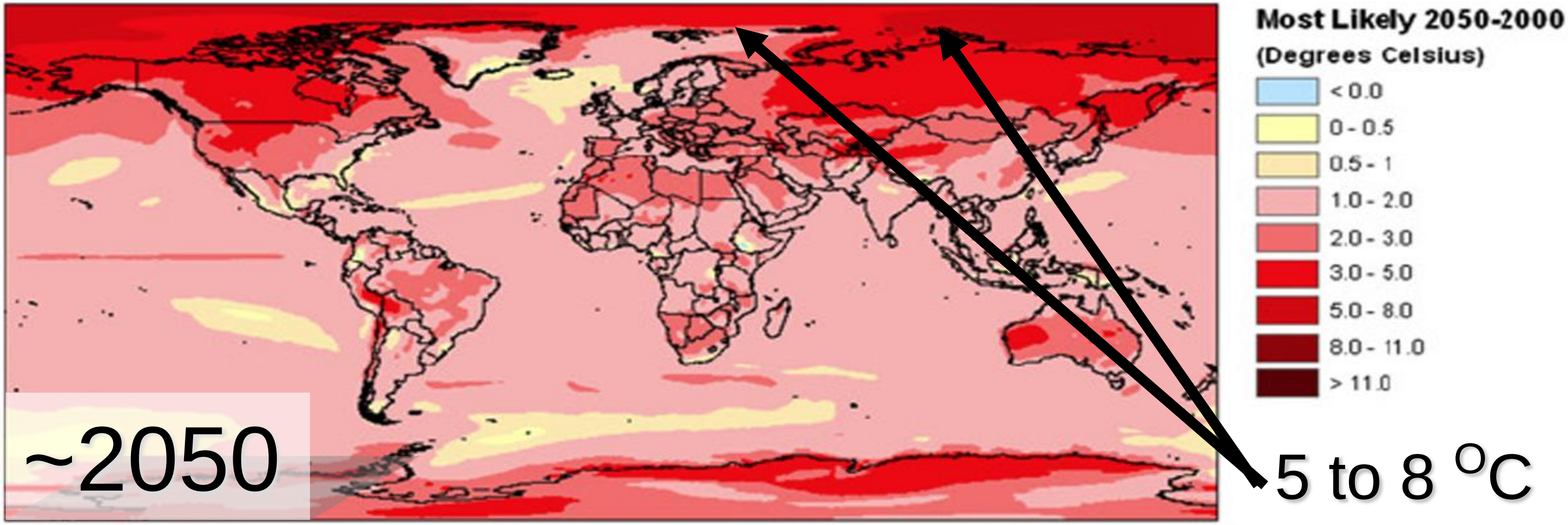
Projected Range of Temperatures based on the Current Proposal of the 193 UNFCCC Treaty Nations

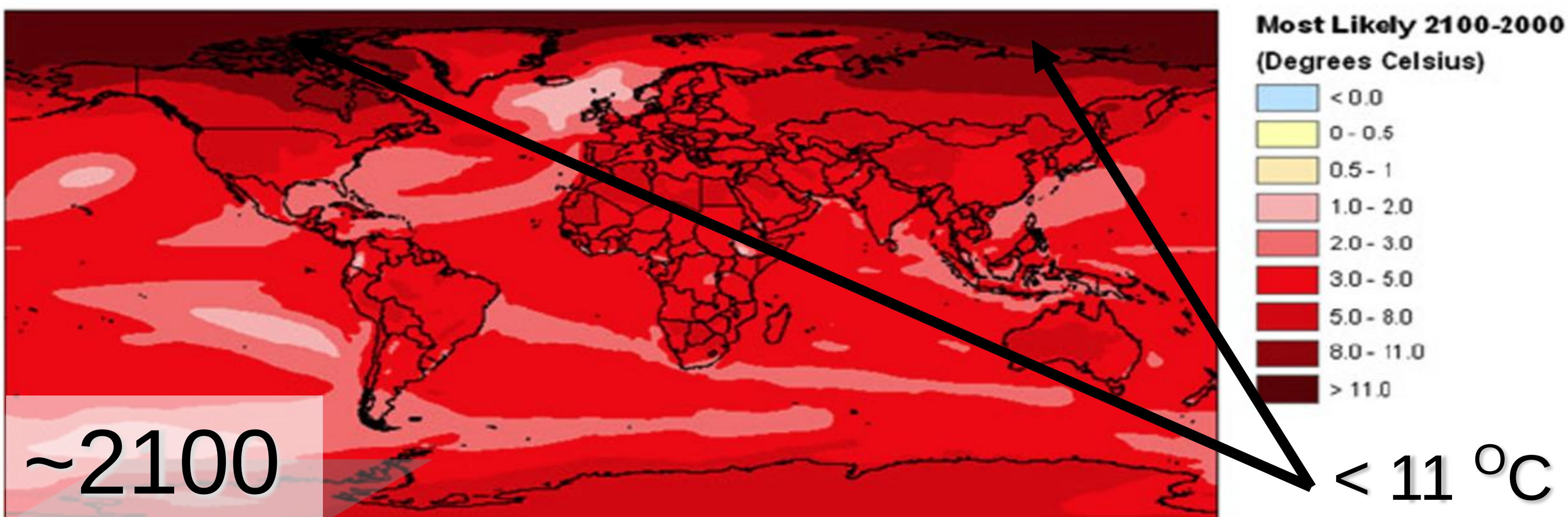




Offset to correct for increases to 2000 in global average temperatures since beginning of the industrial ear.

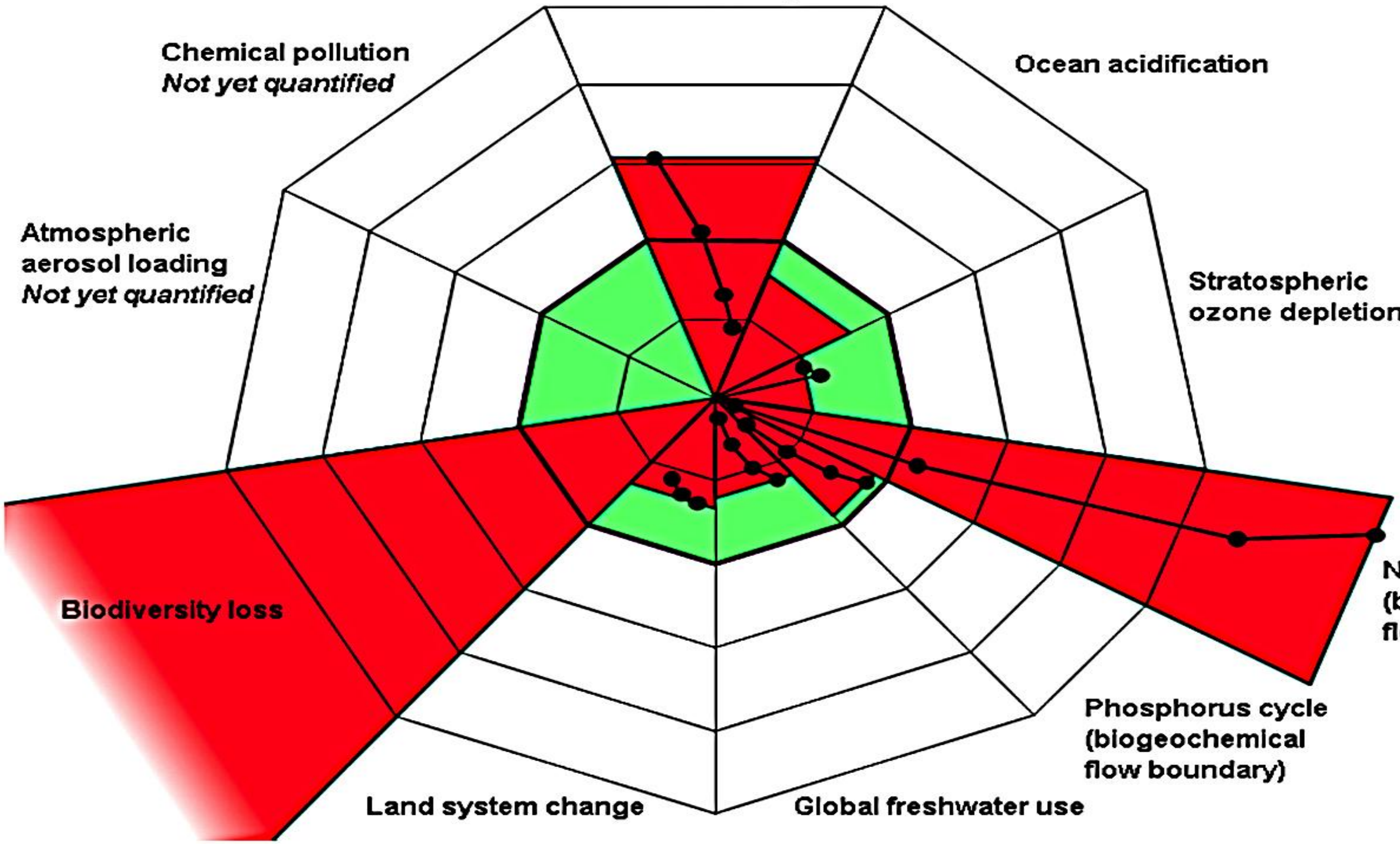
Projections of Surface Temperatures for the Most Likely (the statistical mean) for A1FI Projections as computed on CCSM 3.0. (www.ccsm.ucar.edu/)





Source: www.pnas.org/content/106/37/15555.full.pdf+html

Projections of Planetary Boundaries



Source: Ecology and Society 14(2): 32 (http://www.ecologyandsociety.org/vol14/iss2/art32/)

A Fundamental Construct

Adaptation and coping implementations are largely at scales consistent with the impacts and consequences and, that it will require methodologies that implement action based in a long-term planning activity.

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Local of Place-Based (Local)

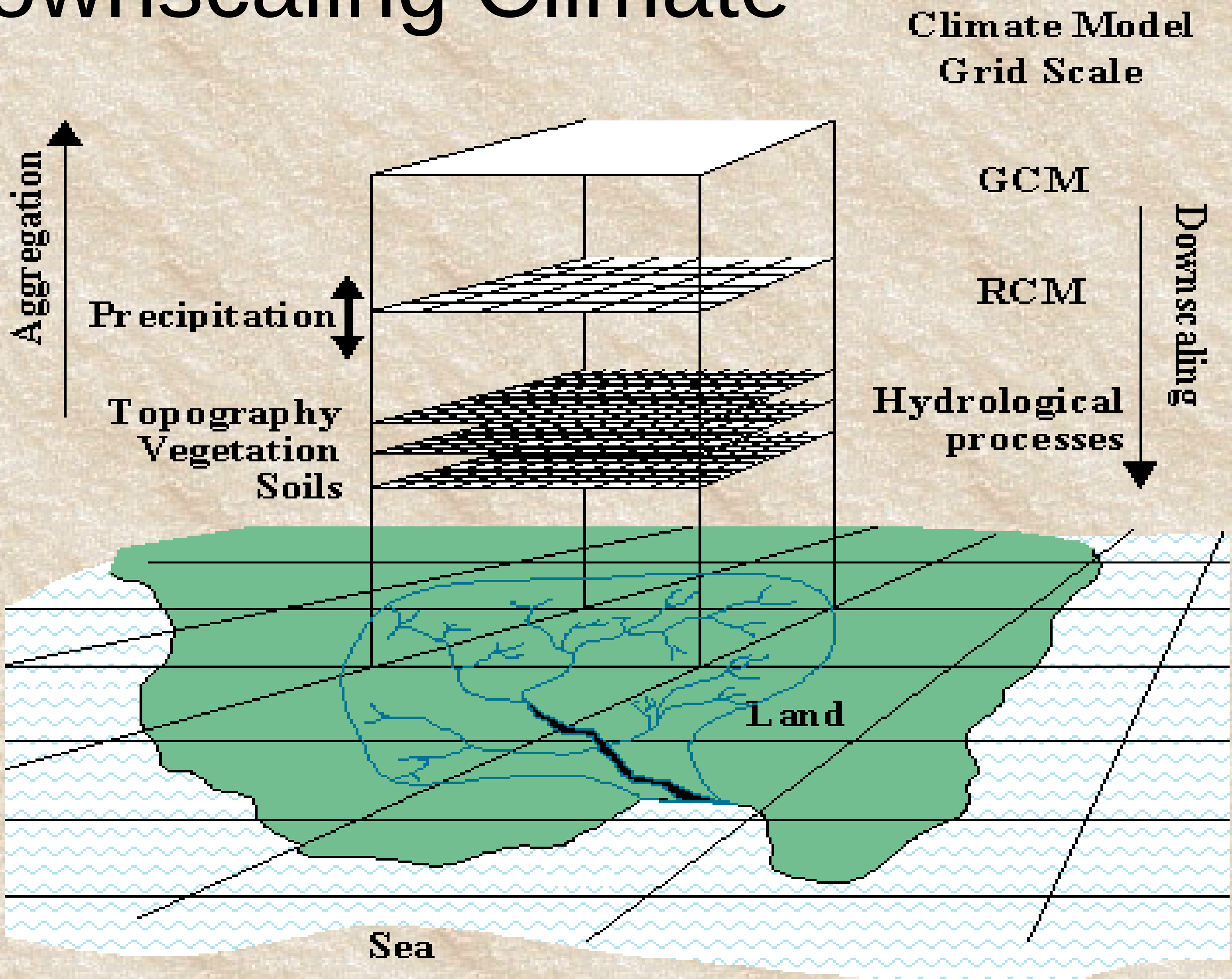
Local or Place-Based (Local)

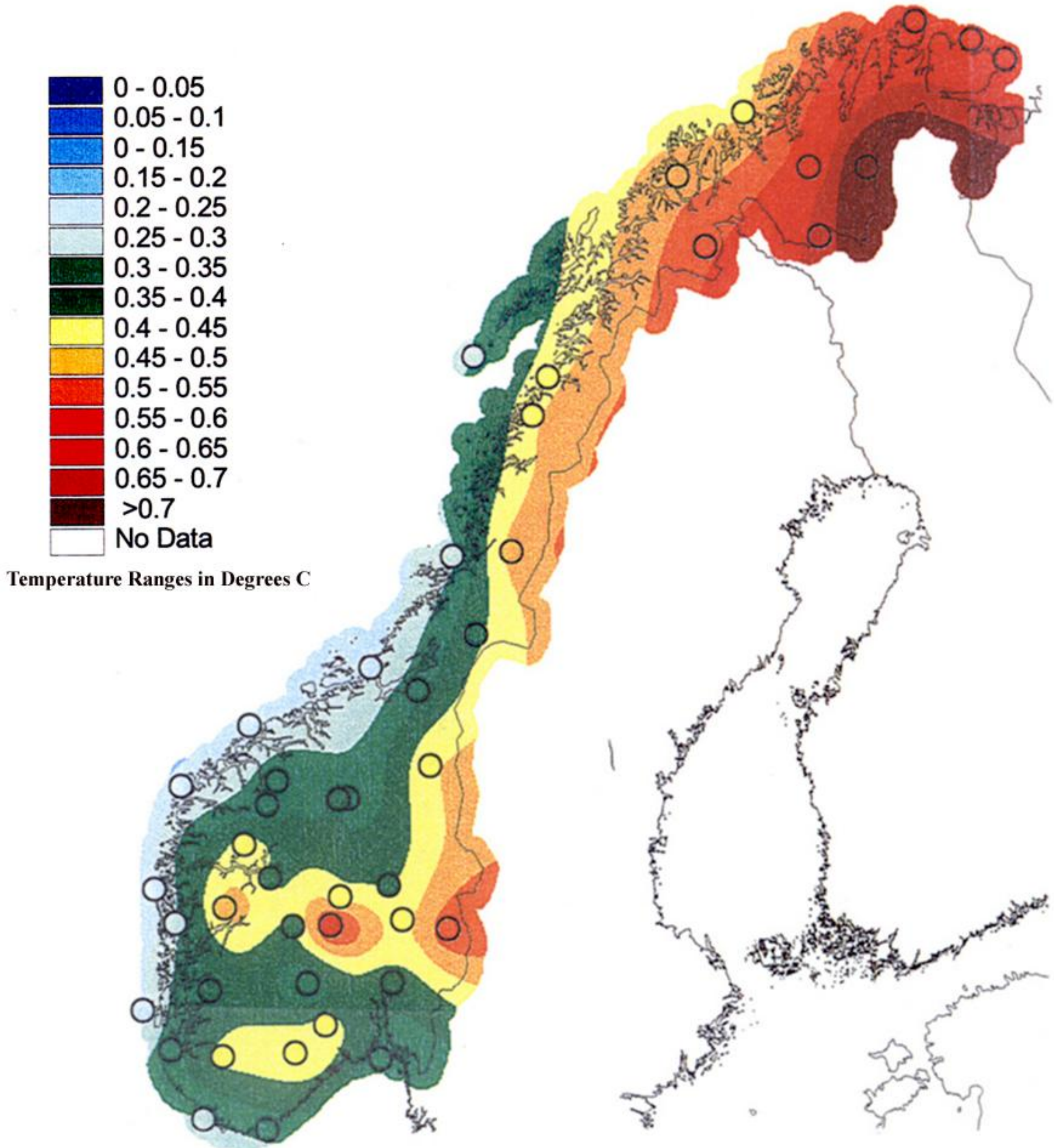
Local or Place-Based (Local)

Vulnerability = Impacts - Adaptive Capacity

Clearly, coping/adaptation is at local scales and the strategies should be about building resilience at those scales !

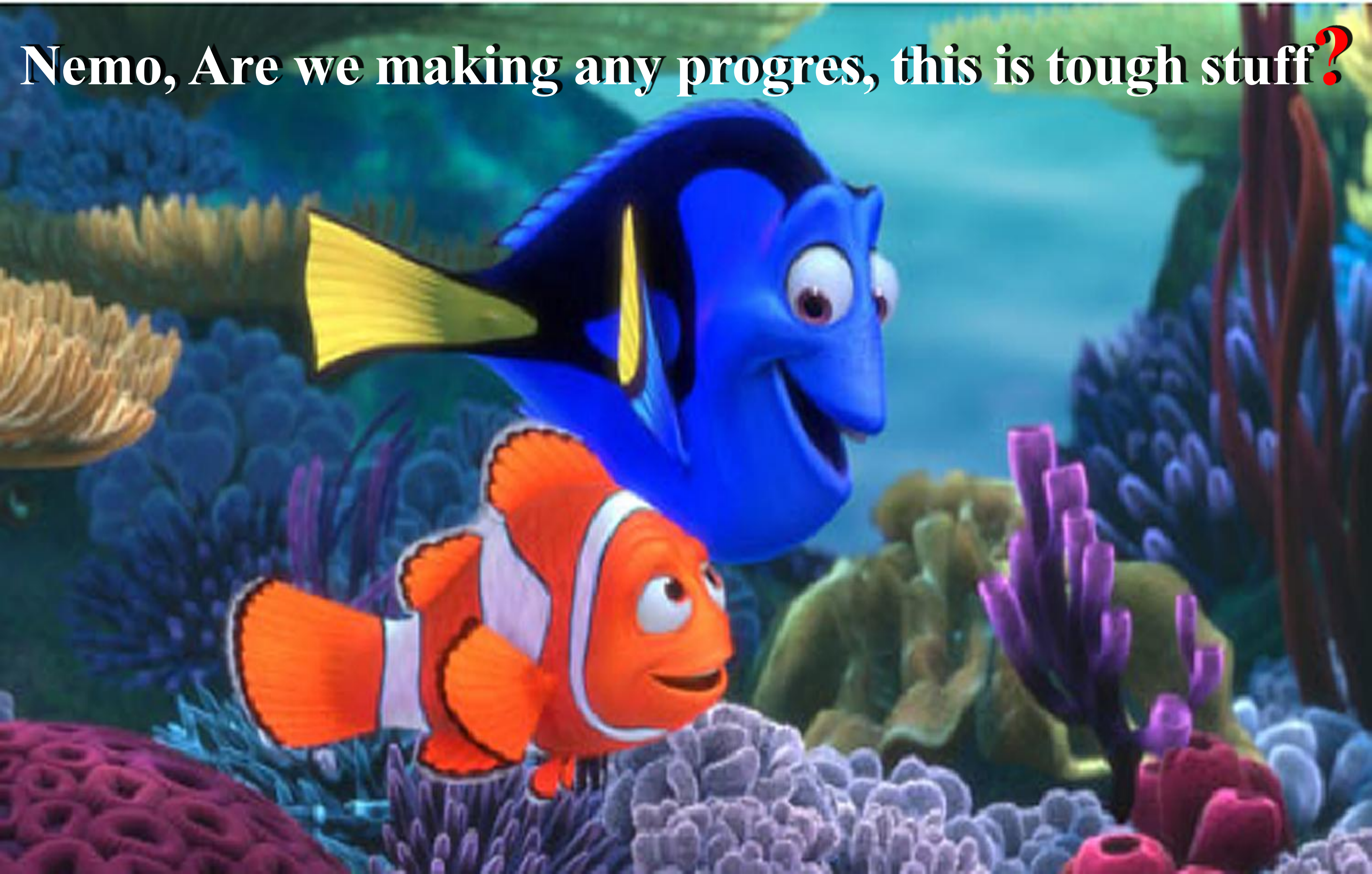
Downscaling Climate





Increases in Norwegianwinter temperatures per dedcade from the period of 1961-1990 to the period 2020-2049

Nemo, Are we making any progres, this is tough stuff?



3. Mitigation and Taking Action: *Identifying and Address the Root Causes of the Changes*

- More efficient use of energy and energy conservation;
- Using lower carbon energy sources (alternative non-carbon energy);
- Capturing CO2 (CCS) and limiting other greenhouse gases;
- Reducing emission of Non-CO2 gases from industrial and agricultural sources; and
- Fixing CO2 in vegetation by reducing deforestation, forestation degradation, and protecting peat lands, and planning new forest.

The global community seeks to address this through the Global Energy Assessment

The GEA seeks to challenge conventional thinking on energy policy, such as:

- **Ensuring Sustain Energy Service:** The need to sustain affordable, available energy services as a precursor to healthy economic growth;
- **Securing Supplies of Energy:** The requirement for continued, secure supplies of energy;
- **Achieving Equity of Supply to all Peoples:** The challenge of achieving equity and ensuring that we meet the needs of the two billion or so people who currently lack access to affordable modern forms of energy;
- **Addressing the Mitigation Challenge:** The need to address climate change mitigation in a timely fashion;
- **Resolving the other Energy-Environmental Challenges:** To adequately resolve the many other environmental challenges posed by energy production, transport,processing and use, including indoor and urban air pollution, the "*Asian Brown Cloud*" phenomenon and acidification of the oceans; and
- **Containing the Risks posed by Operating Energy Systems:** The need to contain ancillary risks posed by operating energy systems, such as ensuring security and peace through addressing nuclear proliferation, nuclear waste security, and reducing the potential for acts of terrorism.

The Global Energy Assessment (GEA) Addresses these Four Major Areas

- **Cluster I: Major Global Issues and Energy**
  Framing the global energy landscape and assessing the energy/climate change challenges.
- **Cluster II: Energy Resources and Technological Options**
  Assessing of the supply-side components available to build future energy systems.
- **Cluster III: Describing Possible Sustainable Futures**
  Assessing how to combine the demand-side components to create energy systems that address the challenges and using scenarios to project into the future.
- **Cluster IV: Realizing Energy for Sustainable Development**
  Assessment a range of policy pathways that address the challenges and realize the energy systems across the globe.

4. Building Resilience in Our Societies: *Educating, Enhancing Public Understanding, and Implementing Polices and Sustainable Practices.*

IPCC 2007 Key Finding:

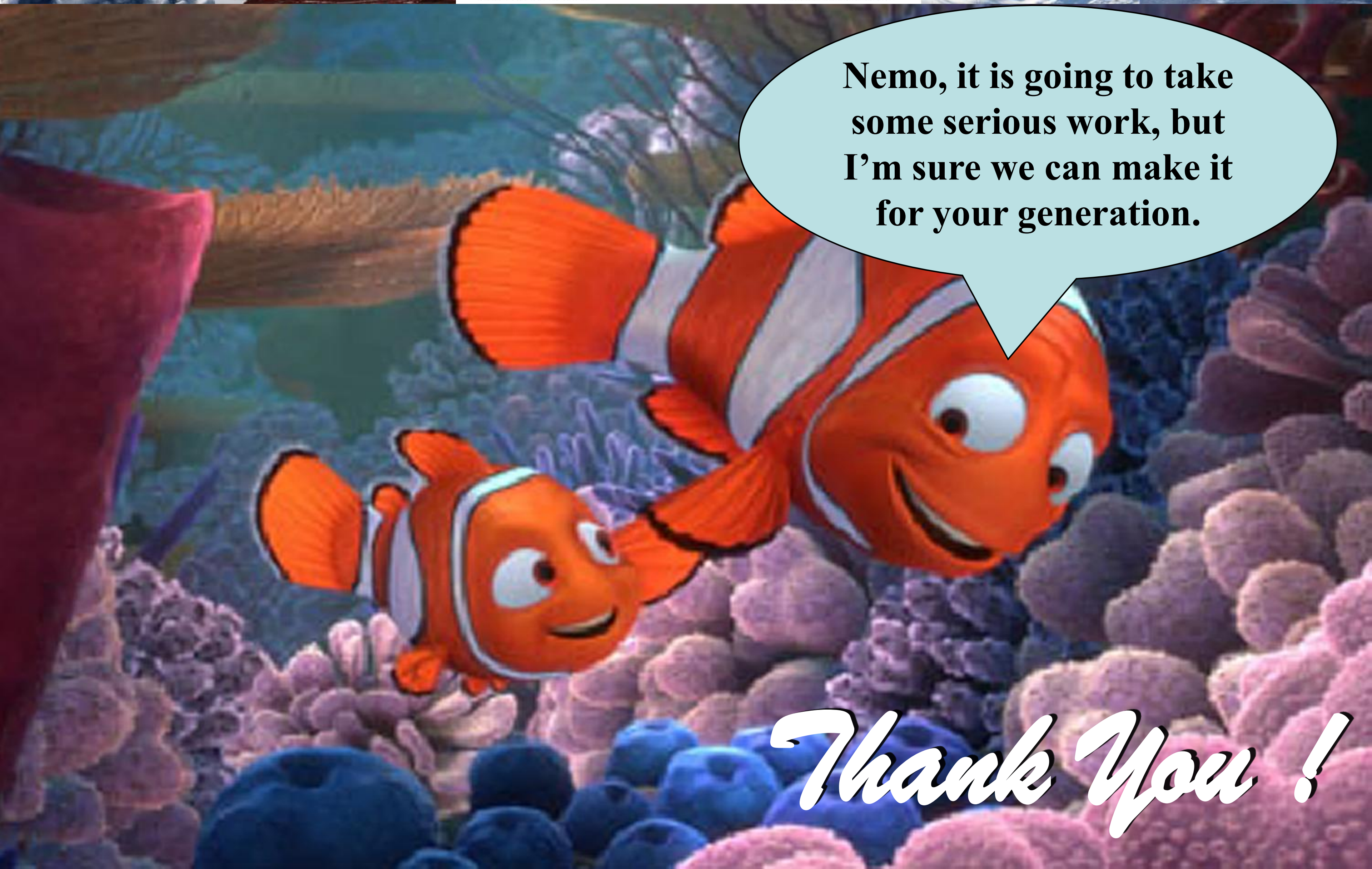
Warming of the climate system is *unequivocal*. Most of the observed increase in global average temperatures since the mid-20th century with a *greater than 90% confidence* that such is due to the observed increase in anthropogenic GHG concentrations. Further, continued GHG emissions (CO2, methane, nitrous oxide, etc.) at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would be larger than those observed during the 20th century, with a similar *confidence level of greater than 90%.*

This is our collective challenge, you all for the Arctic Oceans and we all together for the Planet!

"The stakes are high. Climate change has profound implications for virtually all aspects of human well being, from jobs and health to food security and peace within and among nations. Yet too often climate change is seen as an environmental problem when it should be part of the broader development and economic agenda. Until we acknowledge the all-encompassing nature of the threat, our response will fall short."

Kofi Anan. Former Secretary General of the United Nations




Nemo, it is going to take some serious work, but I'm sure we can make it for your generation.
Thank You !