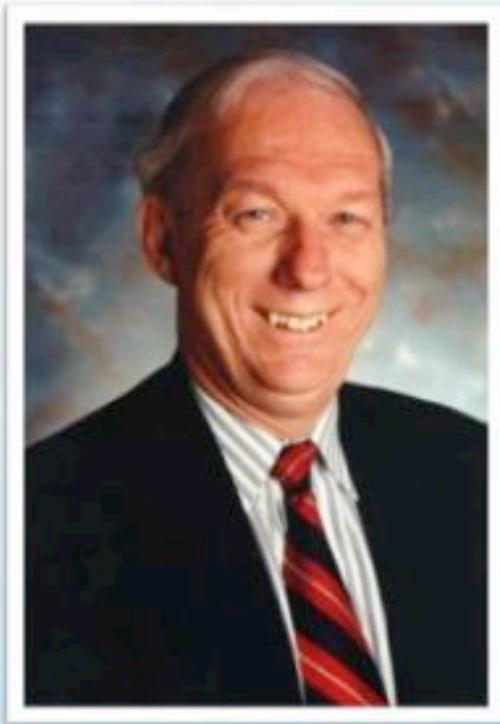




STATE OF THE ARCTIC

16 - 19 March 2010 • Hyatt Regency Miami



ROBERT W. CORELL

The Arctic Climate Impact
Assessment

The Climate Action Initiative
Global Environment and
Technology Foundation



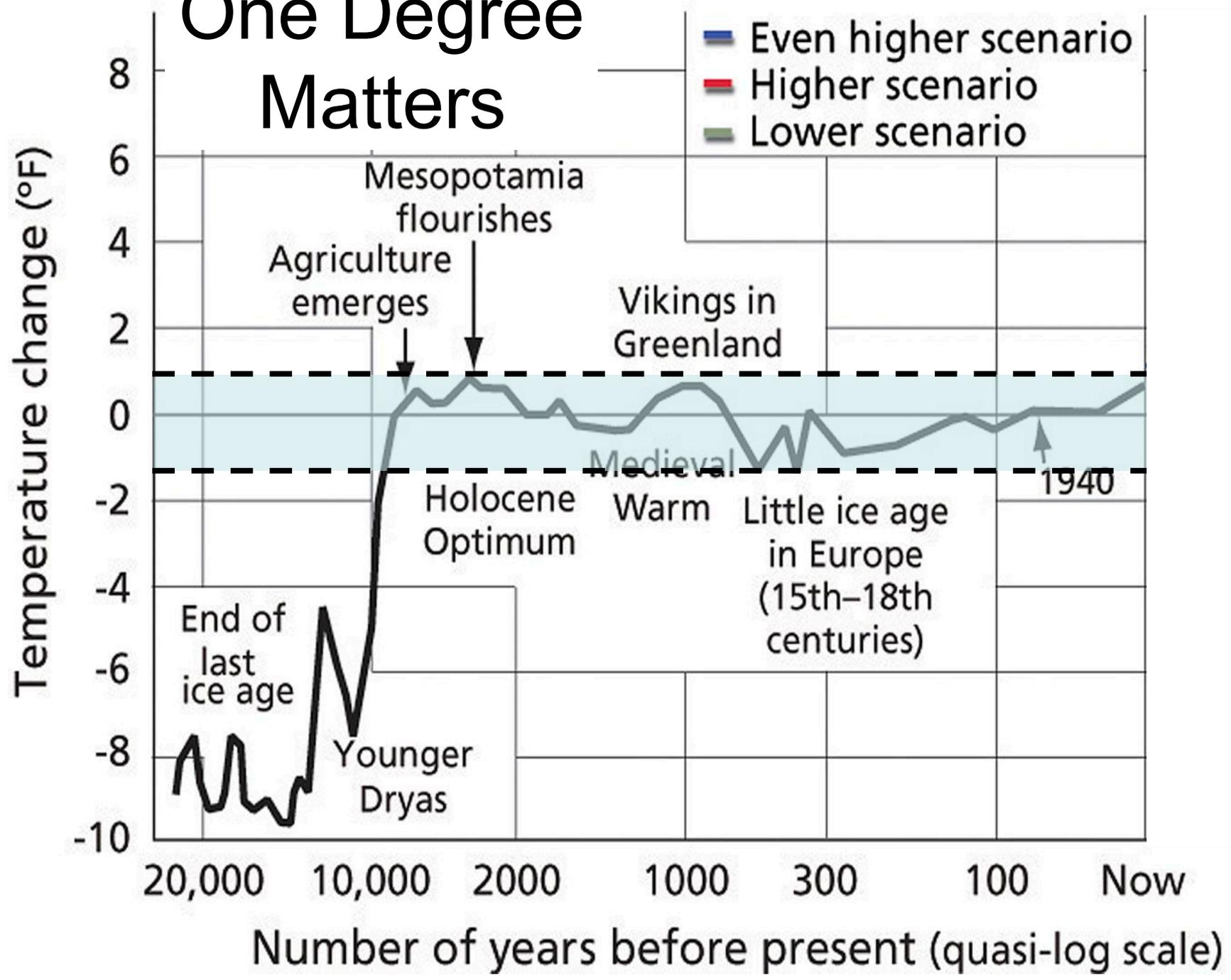
**Arctic Change: Turning
Science Into Policy and Action**
State of the Arctic Conference
March 18th 2010



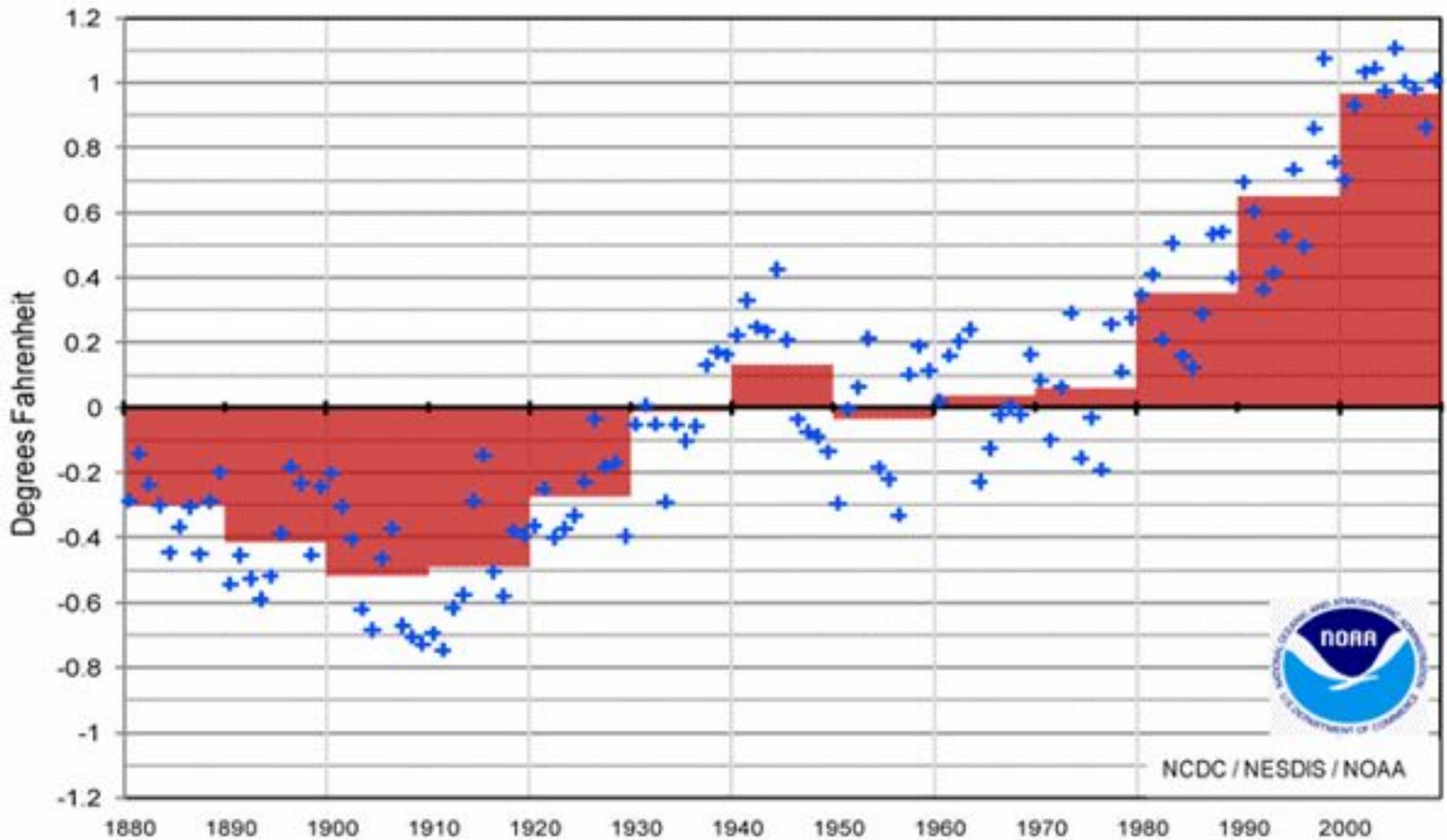
Arctic Change: Turning Science Into Policy and Action

Robert W. Corell Chair, *The Arctic Climate Impact Assessment*; *University Professor II*,
University of the Arctic's Institute for Circumpolar Reindeer Husbandry with Saami University
College and University of Tromso (Norway)

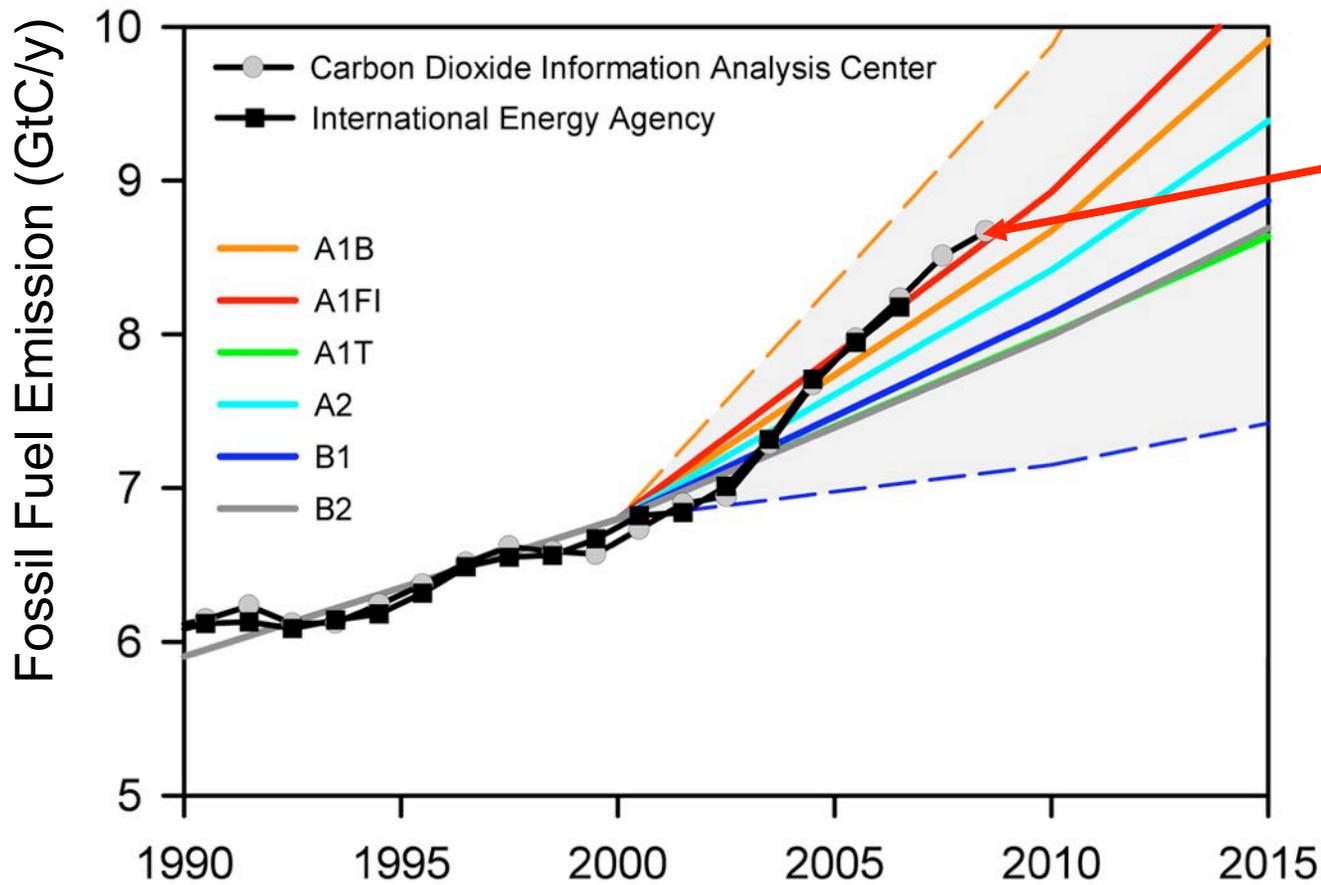
One Degree Matters



Annual Global (Land & Ocean) Temperature Anomaly relative to 1901-2000 base period



Fossil Fuel Emissions: Actual vs. IPCC Scenarios



2008 “Actual” Emissions as reported by the GCP based on an analysis of IEA data, EIA and other major sources of fossil fuel emissions worldwide

Atmospheric CO₂ Concentration

**Year 2008
Atmospheric CO₂
Concentration:**

387 ppm

~ 40% above pre-industrial

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

Growth in Atmospheric CO₂ 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

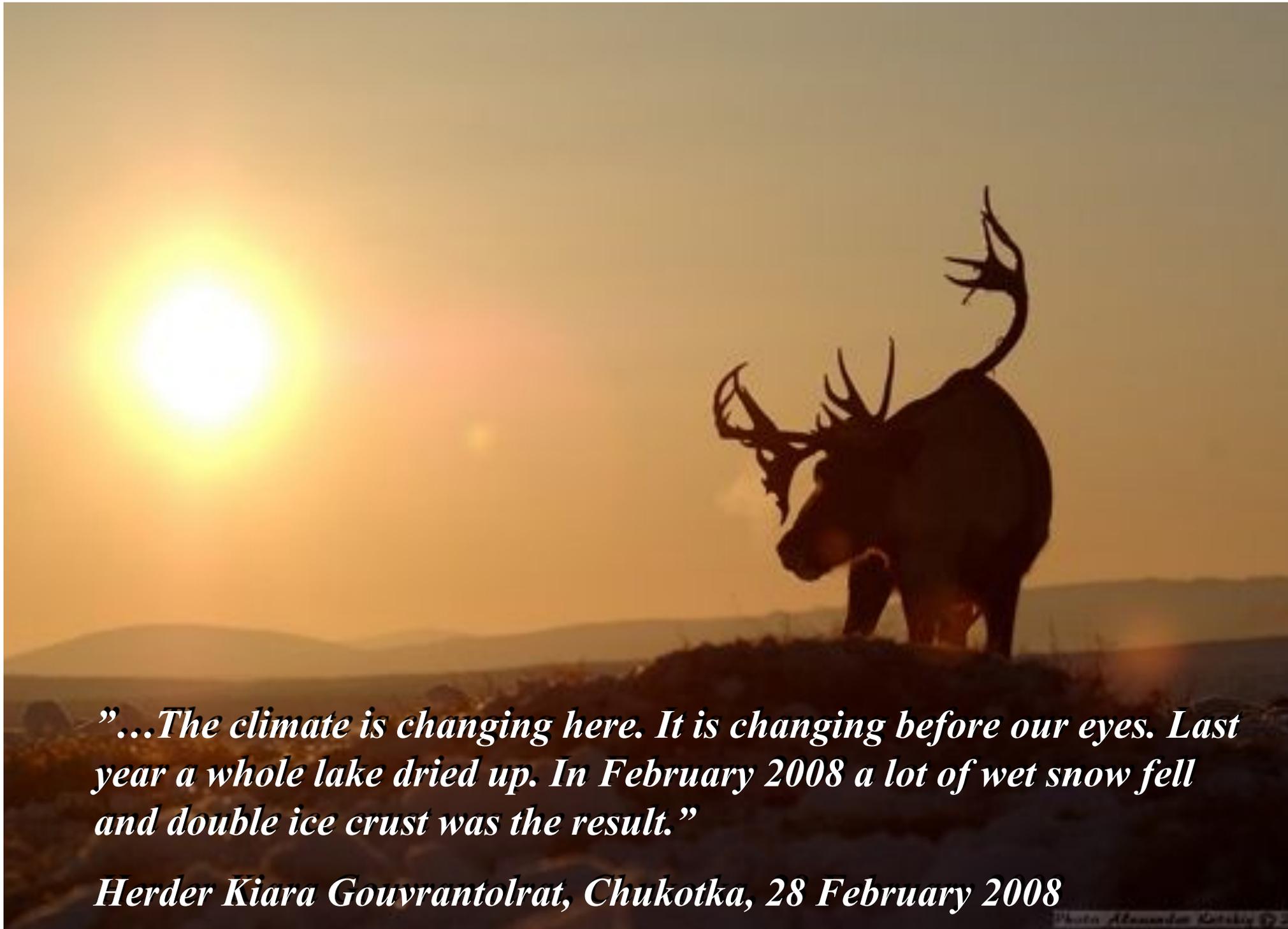
2007: 2.2 ppm/year

2008: 2.3 ppm/year

Accelerating

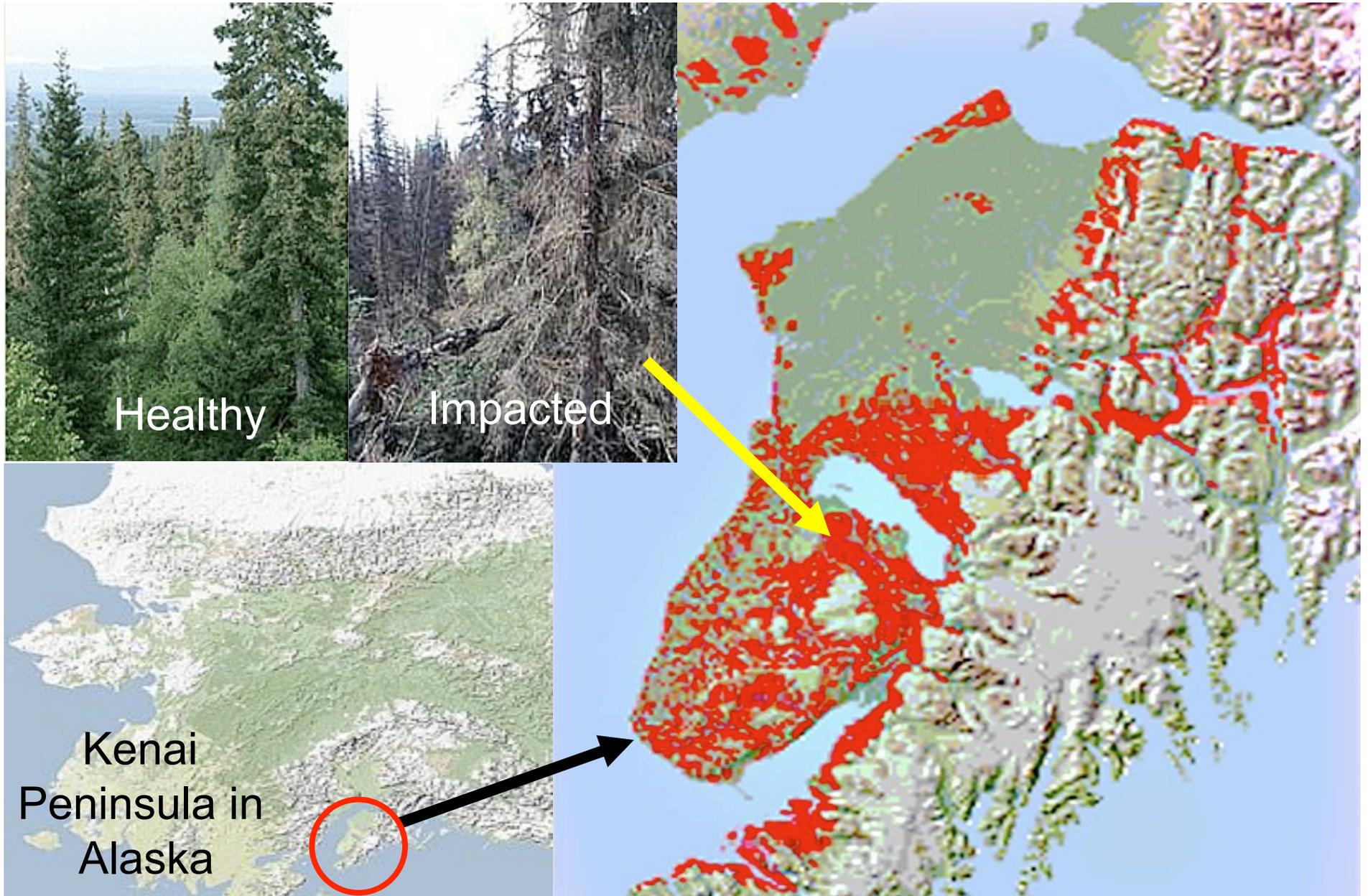


The Arctic is the Climate Change Bellwether for the rest of the planet. Changes here precede those to come at lower latitudes by a generation or so. What is happening to the Sea Ice and the Greenland Ice sheet?



”...The climate is changing here. It is changing before our eyes. Last year a whole lake dried up. In February 2008 a lot of wet snow fell and double ice crust was the result.”

Herder Kiara Gouvrantolrat, Chukotka, 28 February 2008



Spruce bark beetle dramatically changes the forest, the landscape, and ecological systems.



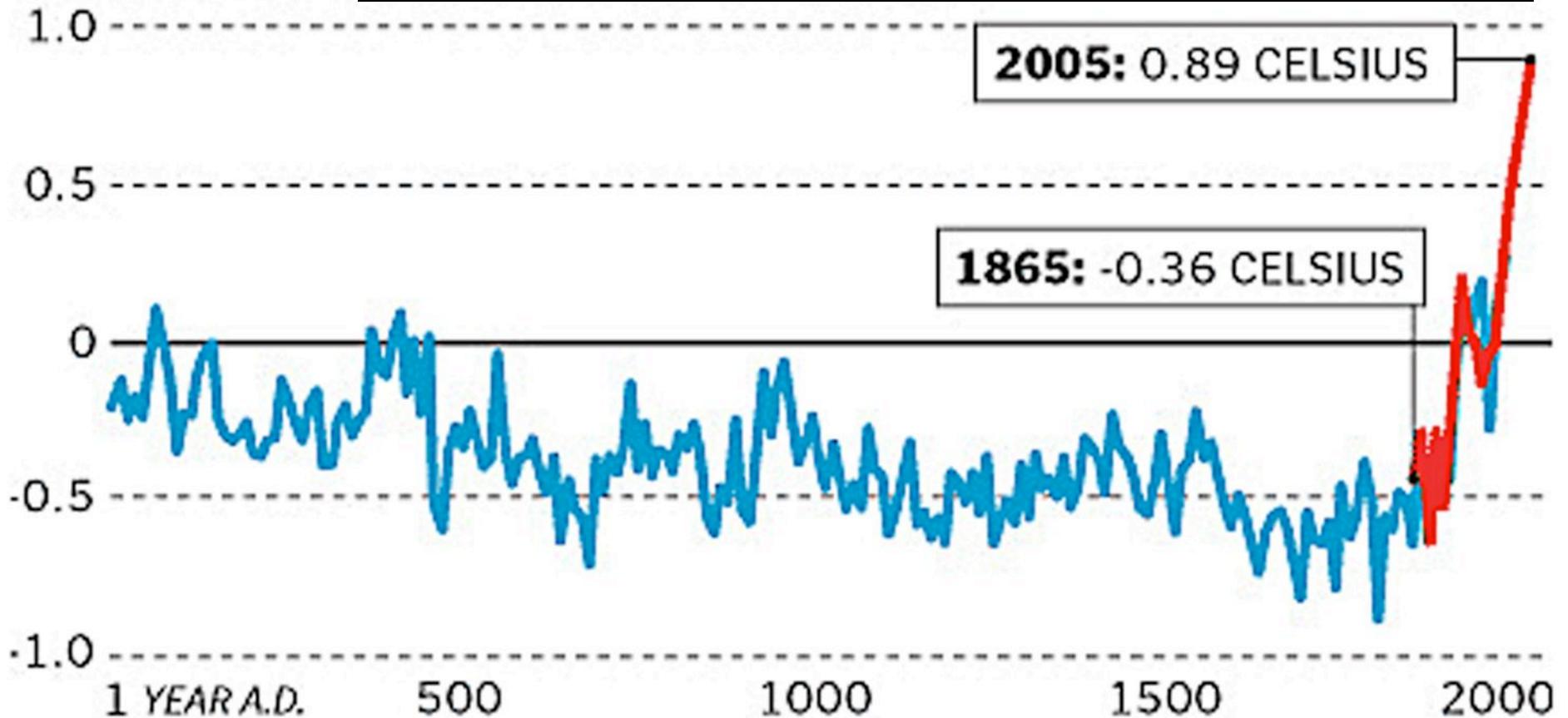
Adaptation Issues Arising from a Changing Climate

UArctic International Centre for Reindeer Husbandry
 Sami University College
 Kautokeino, Norway
 February 2010

Arctic temperature anomalies over past 2,000 years

DEGREES CELSIUS

140 Years = An Increase of 1.25 °C or 2.25 °F

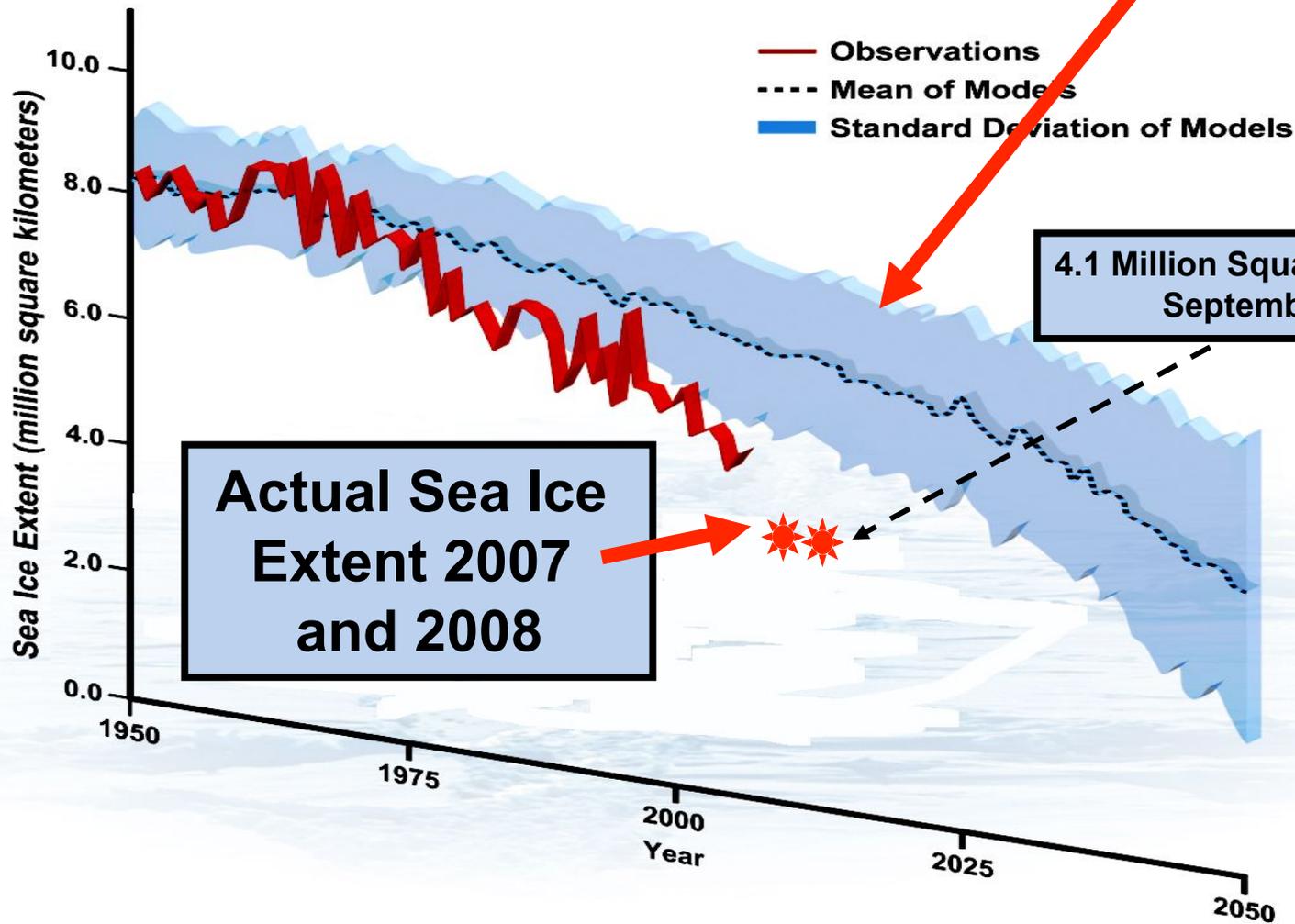


Source: Kaufman, et al *Science* Sept. 2009

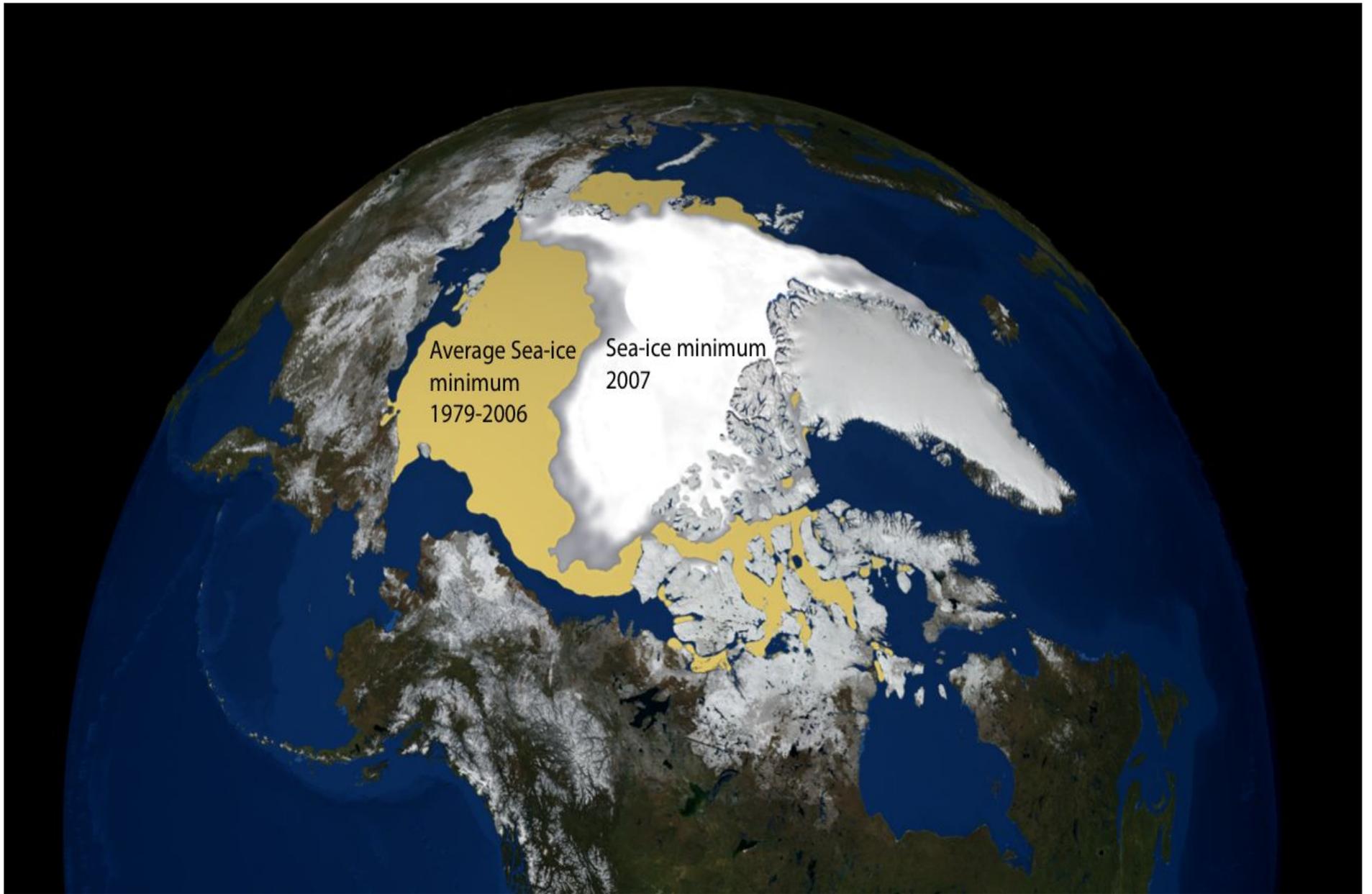
Recent Findings:

Arctic September Sea Ice Extent: Observations and Model Runs

ACIA Model Projections in 2004



NSIDC data/UCAR image



Minimum Arctic Sea-ice Extent from 1979 to 2007

Projections of Sea Ice Extent for Mid-September

These open waters dramatically change the balance of reflected radiation from about 85 reflected to about 85 absorbed by both the open water ocean and the non-snow covered land, a major change in the radiation feedback mechanisms, accelerating warming and major changes in weather patterns.





**Arctic Change: Turning
Science Into Policy and Action**
State of the Arctic Conference
March 18th 2010

There is a growing recognition that rapid change in the Arctic is producing new challenges for governance in the Arctic region:

- ***Access:*** Issues of access and rights of passage through sea routes including the Northern Sea Route (Russia) and the Northwest Passage (Canada).
- ***Maritime Claims and Boundary Issues:*** Issues involving claims to jurisdiction over areas beyond the territorial sea within the Arctic oceanic basin (including claims under the provisions of UNCLOS Art. 76 to continental shelves extending beyond the limits of Exclusive Economic Zones) and the resolution of offshore boundary disputes.
- ***Commercial Shipping and Oil and Gas Development:*** Issues regarding the development of effective codes of conduct for shipping under Arctic conditions and for the conduct of offshore oil and gas drilling and production.
- ***Arctic Fisheries:*** Issues concerning the management of northward moving commercial fisheries that takes into account the principles of ecosystem-based management.
- ***Land Claims:*** Issues arising from longstanding use and occupancy and the still unresolved claims of a number of indigenous peoples as they relate to the governance of human-environment interactions in the Arctic.
- ***Conservation of Arctic Ecosystems:*** Issues regarding the protection of marine and terrestrial ecosystems in the Arctic under pressure from human actions as well as biophysical changes.
- ***Regional Governance:*** Issues relating to multi-level governance and collaboration among regional, national, and international bodies in guiding northern development toward mutually desirable ends.



Greenland Ice Sheet Melt Zone Change



Ilulissat Region of Greenland

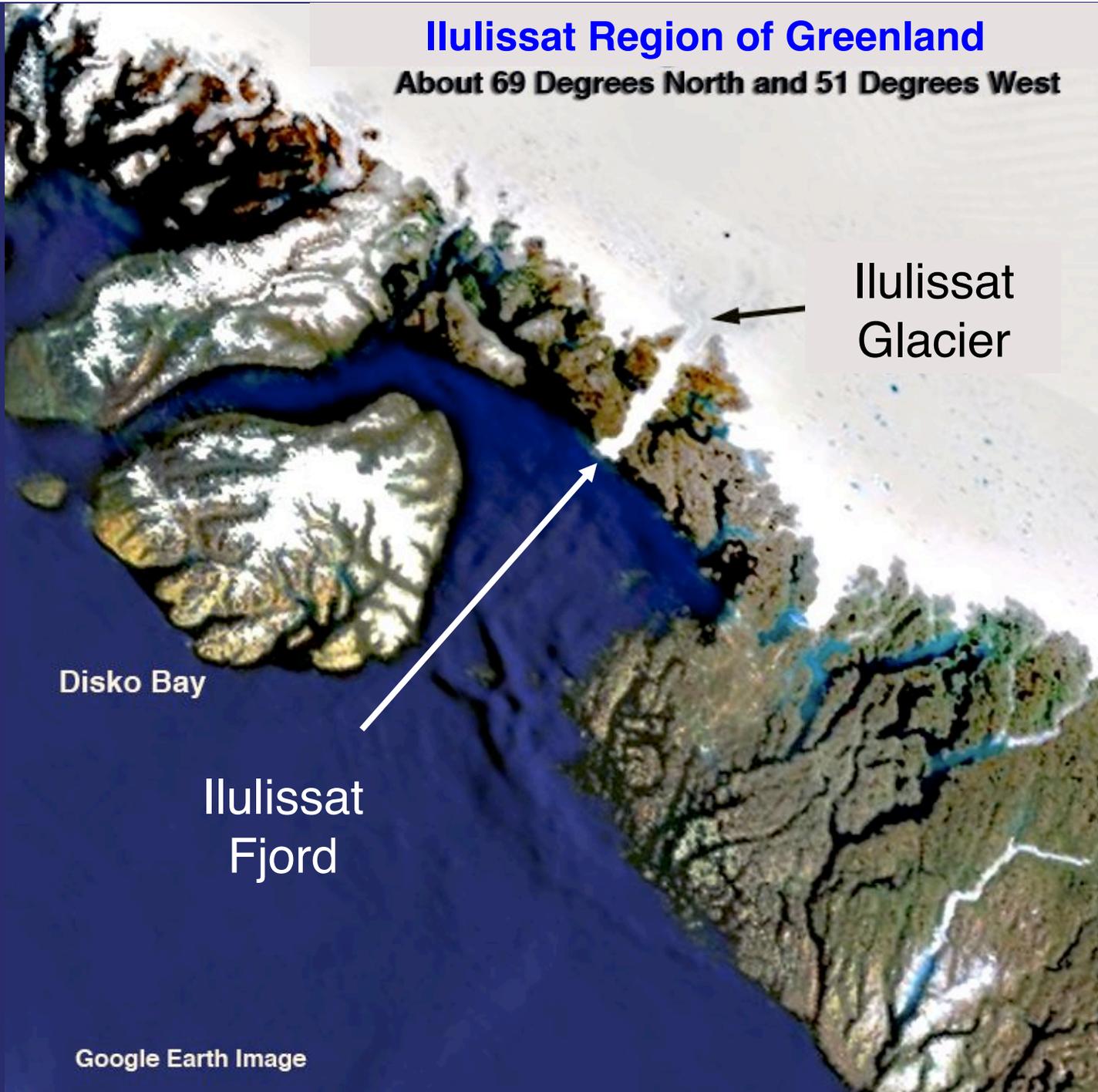
About 69 Degrees North and 51 Degrees West

Ilulissat
Glacier

Disko Bay

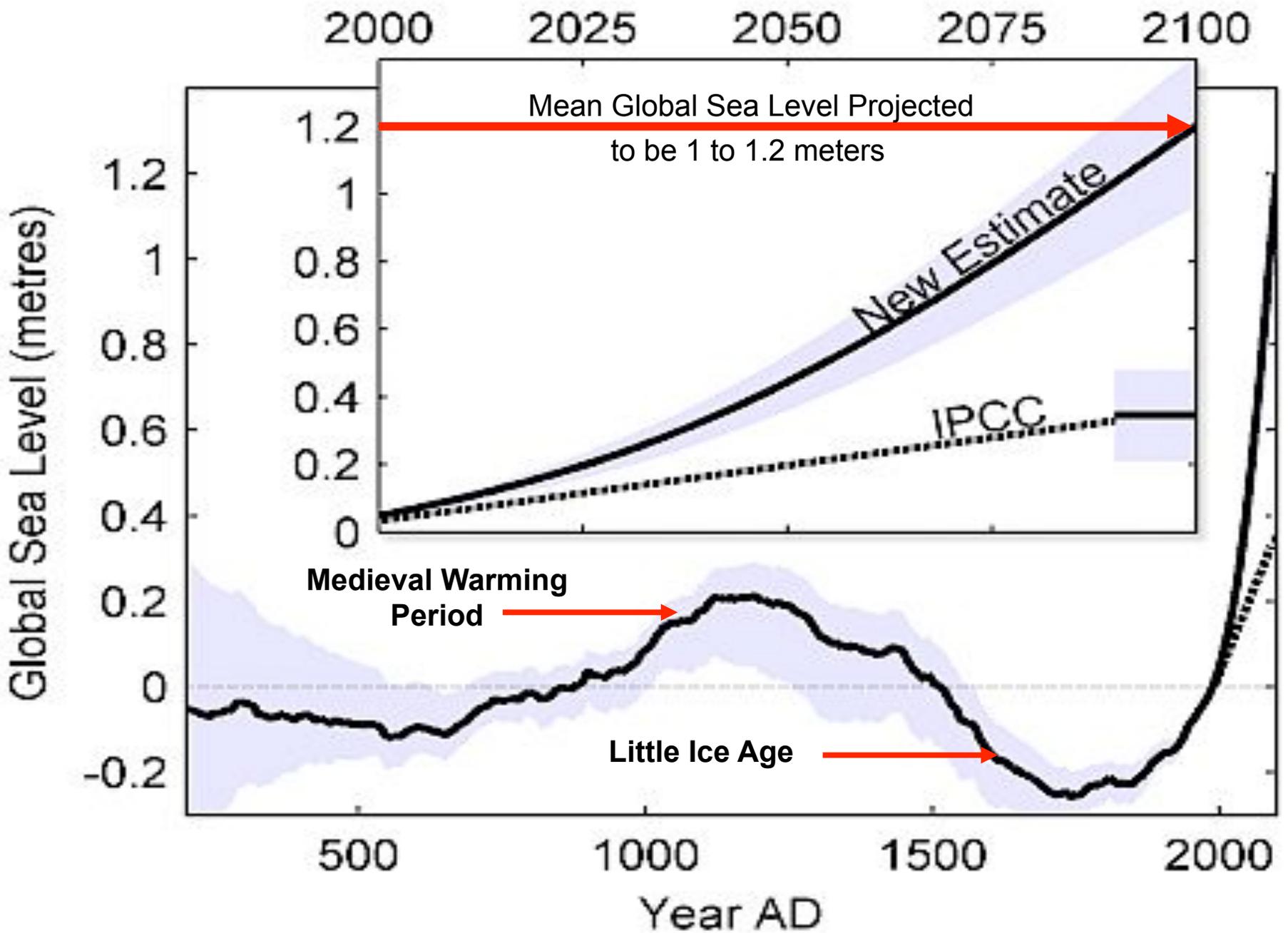
Ilulissat
Fjord

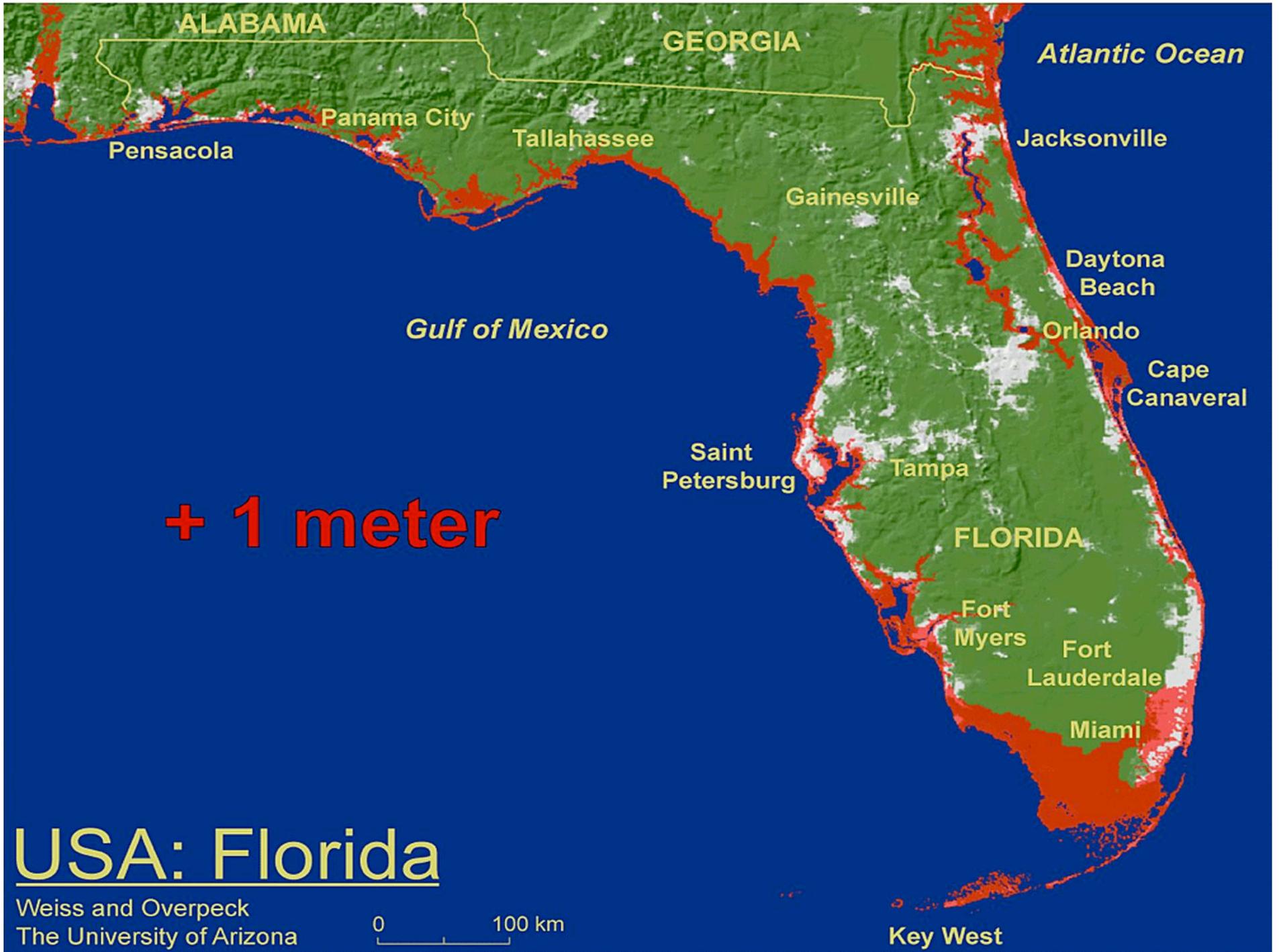
Google Earth Image



Scale is over kilometer across the face and about 900 meters high









Arctic Change: Turning Science Into Policy and Action

State of the Arctic Conference

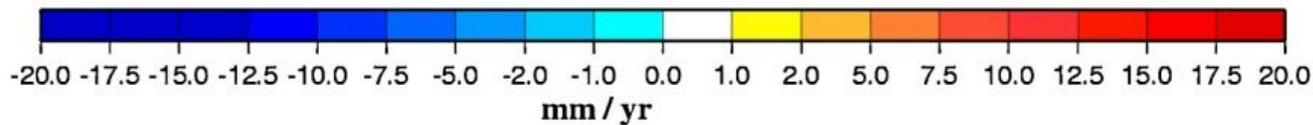
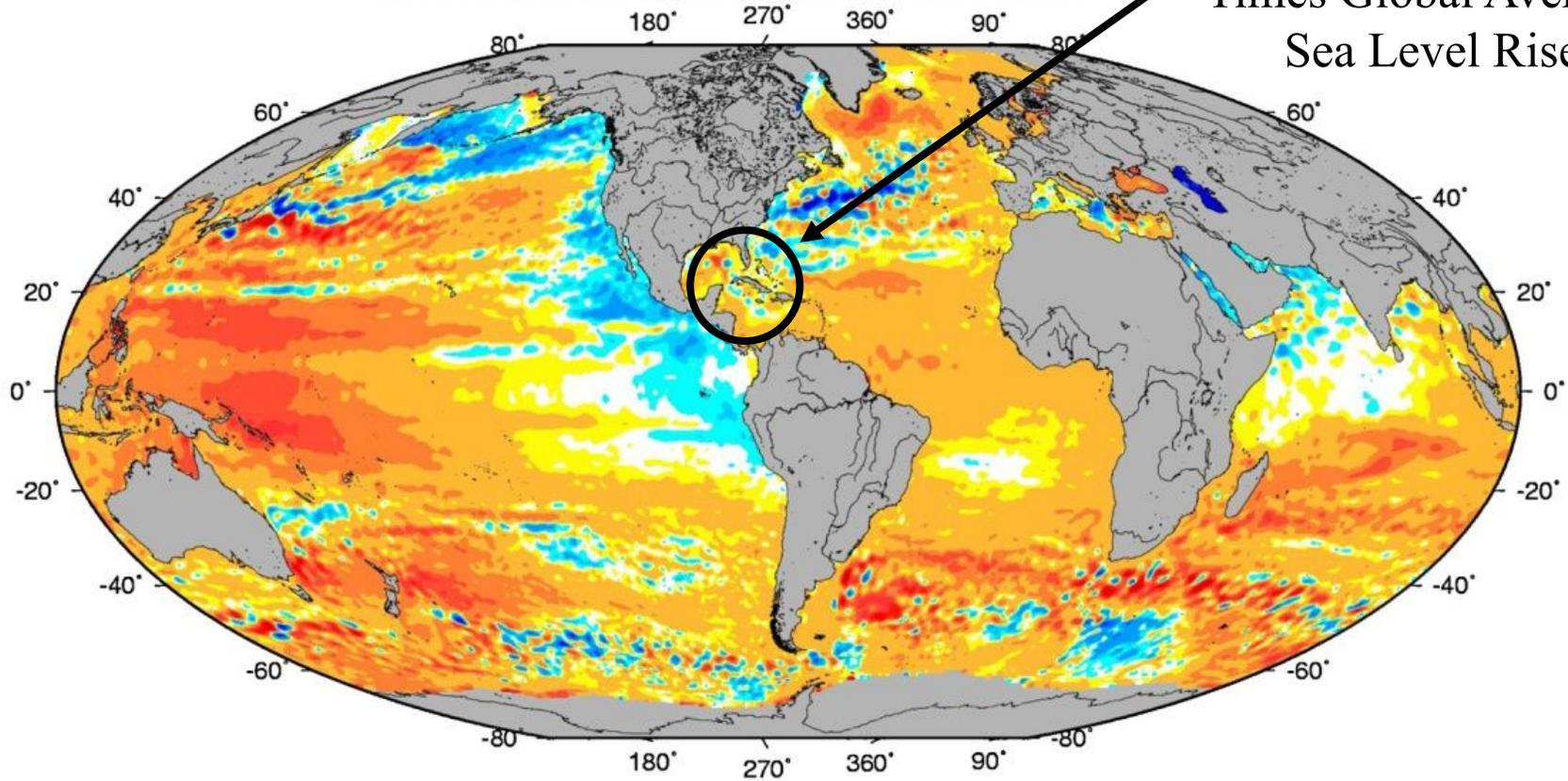
March 18th 2010



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

Amplified by 1.3 to 1.5
Times Global Average
Sea Level Rise

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





**Arctic Change: Turning
Science Into Policy and Action**
State of the Arctic Conference
March 18th 2010



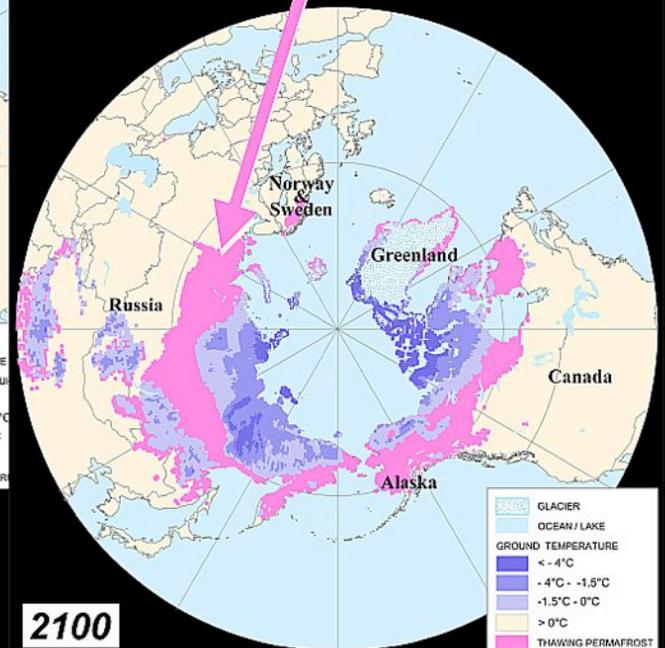
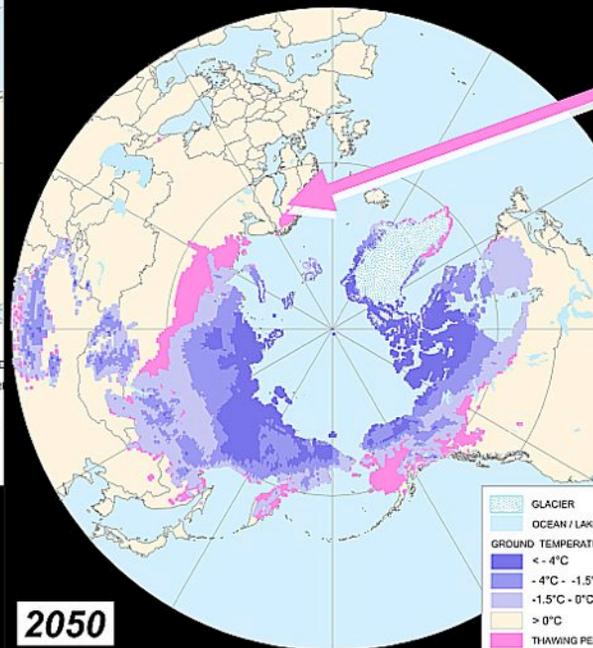
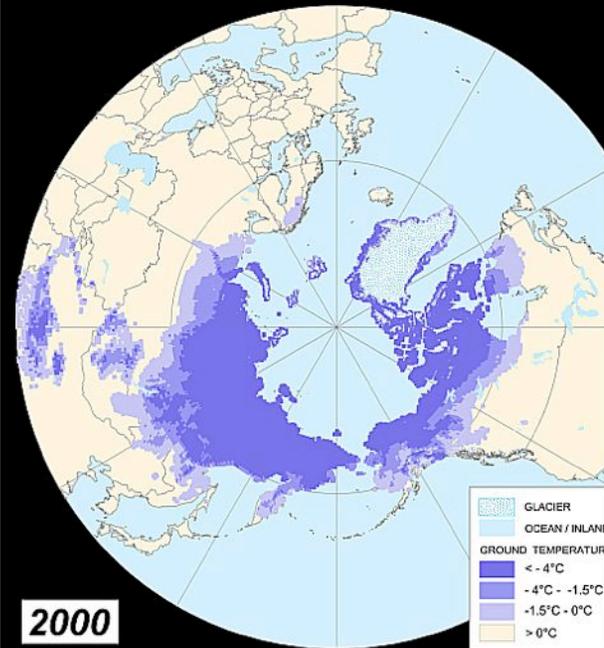
Methane Bogs in Siberia





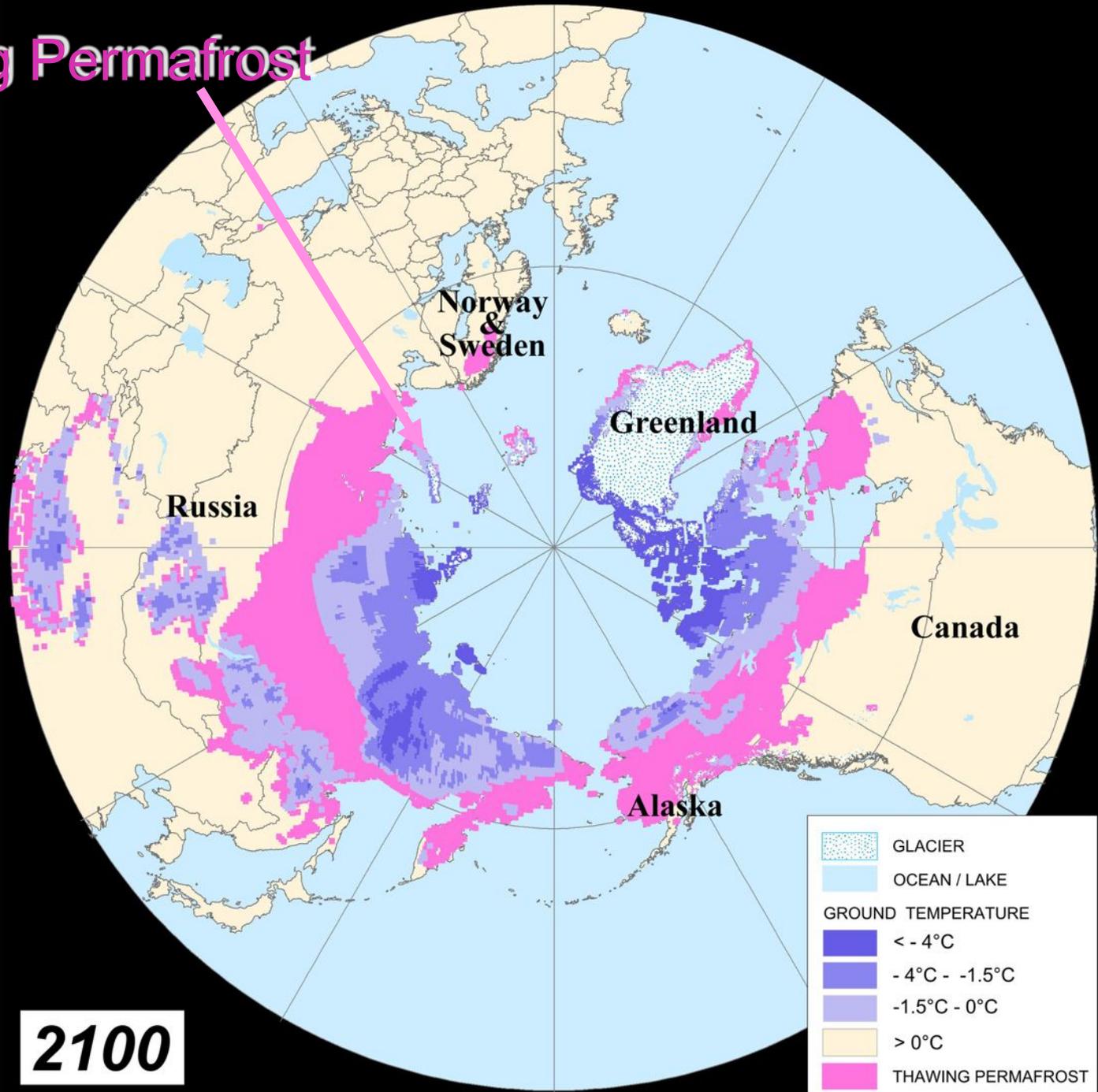
Adaptation Issues Arising from a Changing Climate

UArctic International Centre for Reindeer Husbandry
Sami University College
Kautokeino, Norway
February 2010



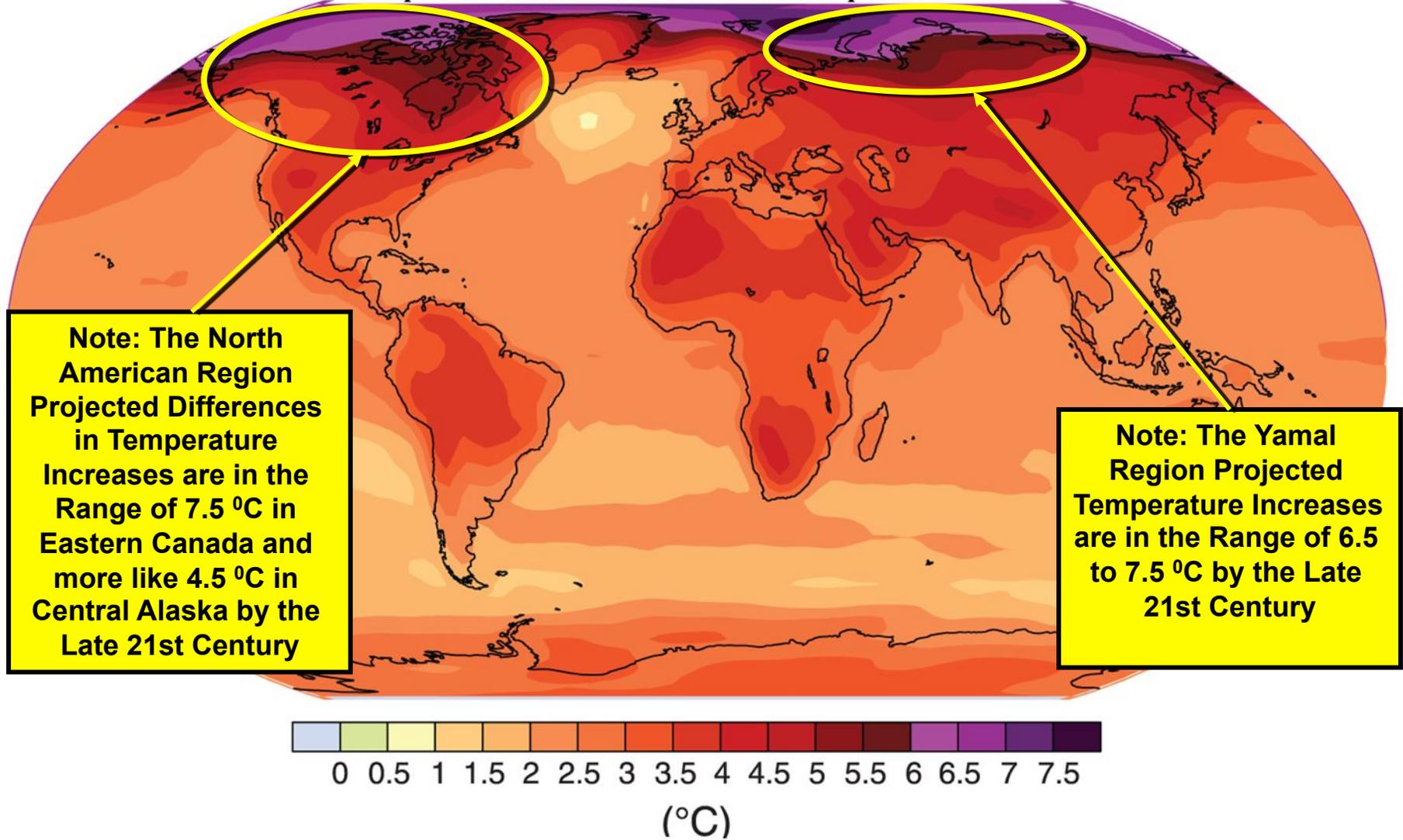
Thawing Permafrost

Thawing Permafrost

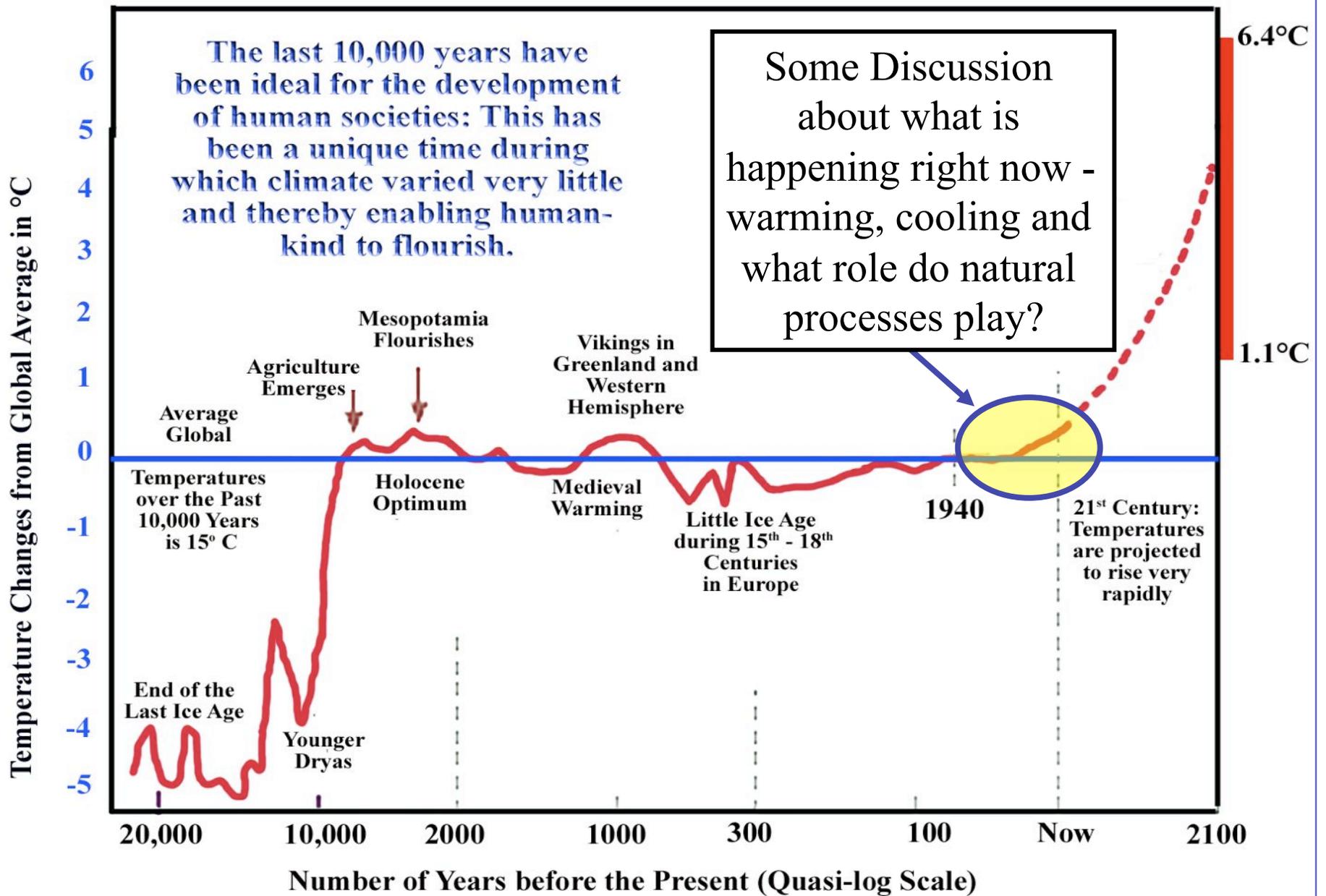


Projected Surface Temperature Changes for the late 21st Century (2090-2099).

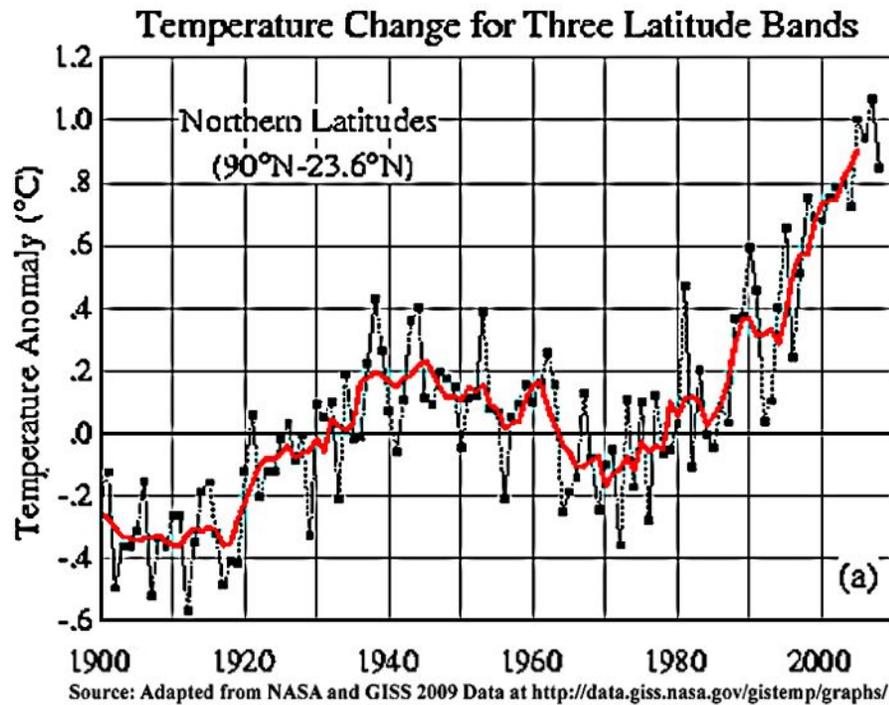
Temperatures Increases are relative to the period 1980-1999.



Source: IPCC Ensemble Average Projections based on the A1B Upper Mid-Range IPCC Scenario

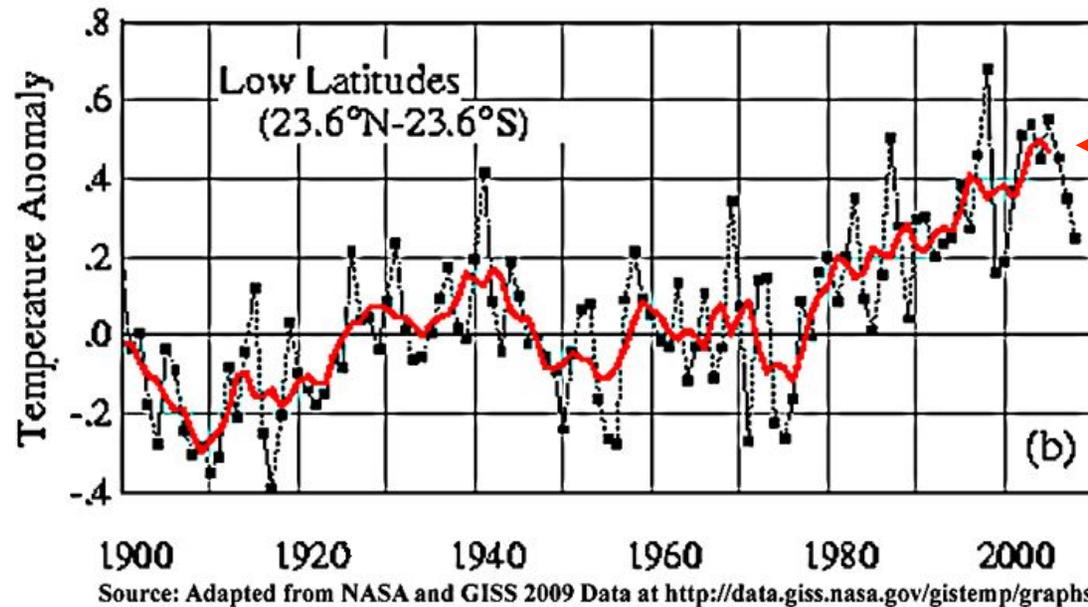
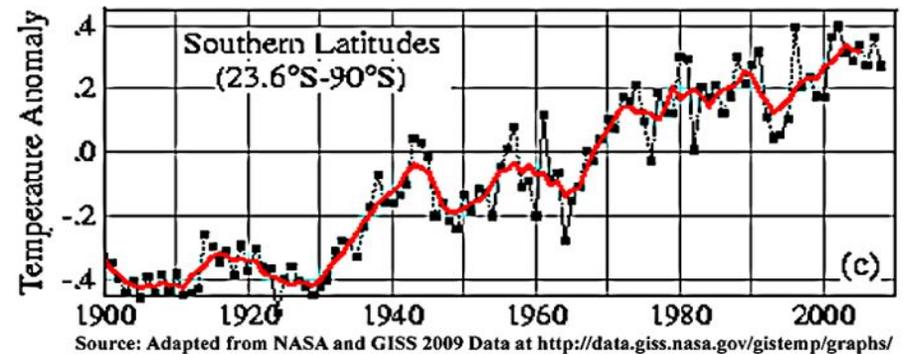


Source: Adapted from "Climate change and human health - risks and responses" published by WHO in collaboration with UNEP and WMO 2003 and more recent data from IPCC 2007.



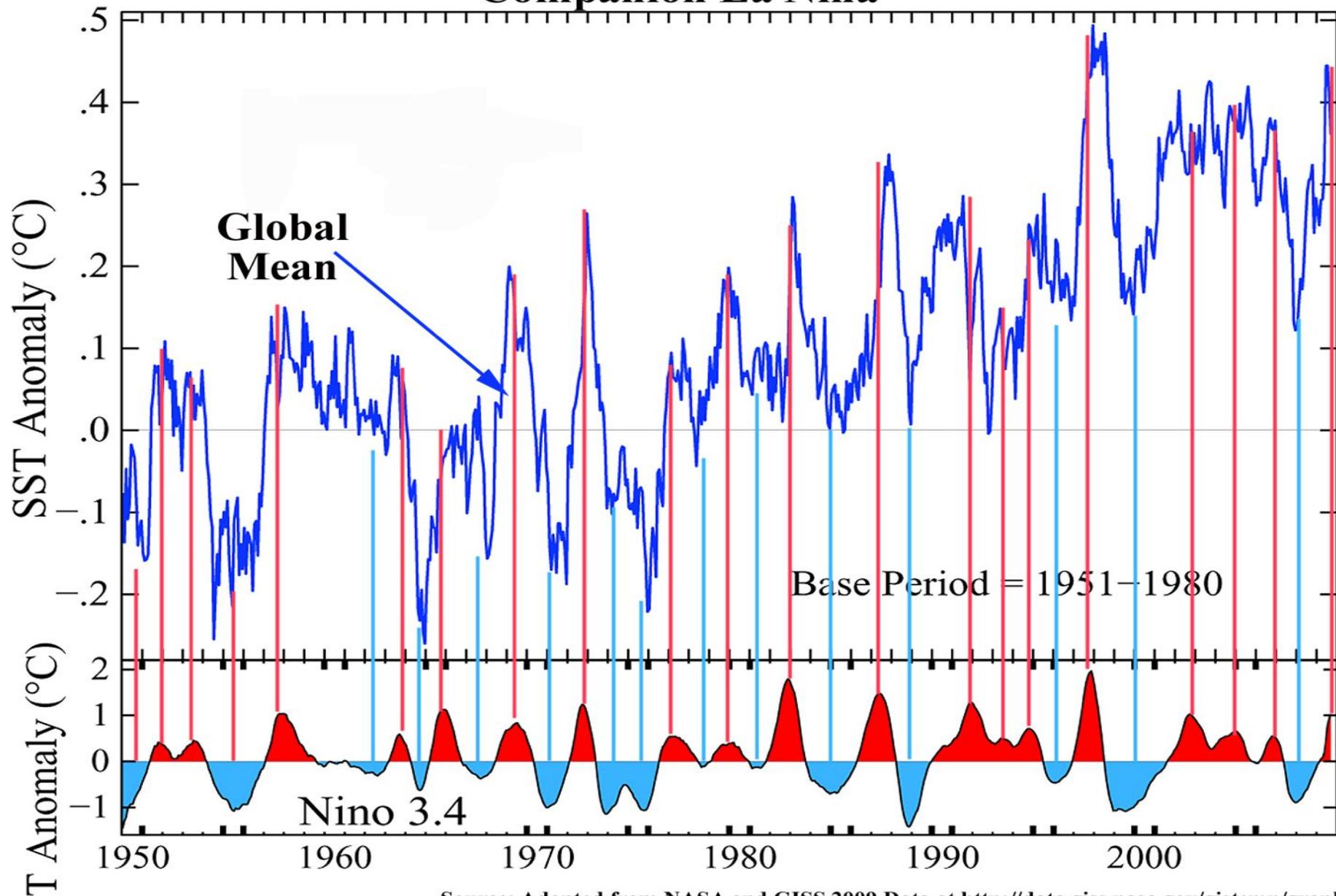
The Patterns of Warming

Note: The Warming in the North is Substantially Greater than in the Southern Hemisphere



Relative Cooling is here and likely due to La Nina

Phase Correlation between Monthly-Mean Sea Surface Temperatures and the El Niño-Southern Oscillation and the Companion La Niña



Source: Adapted from NASA and GISS 2009 Data at <http://data.giss.nasa.gov/gistemp/graphs/>

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.*



What can we say
about the future?



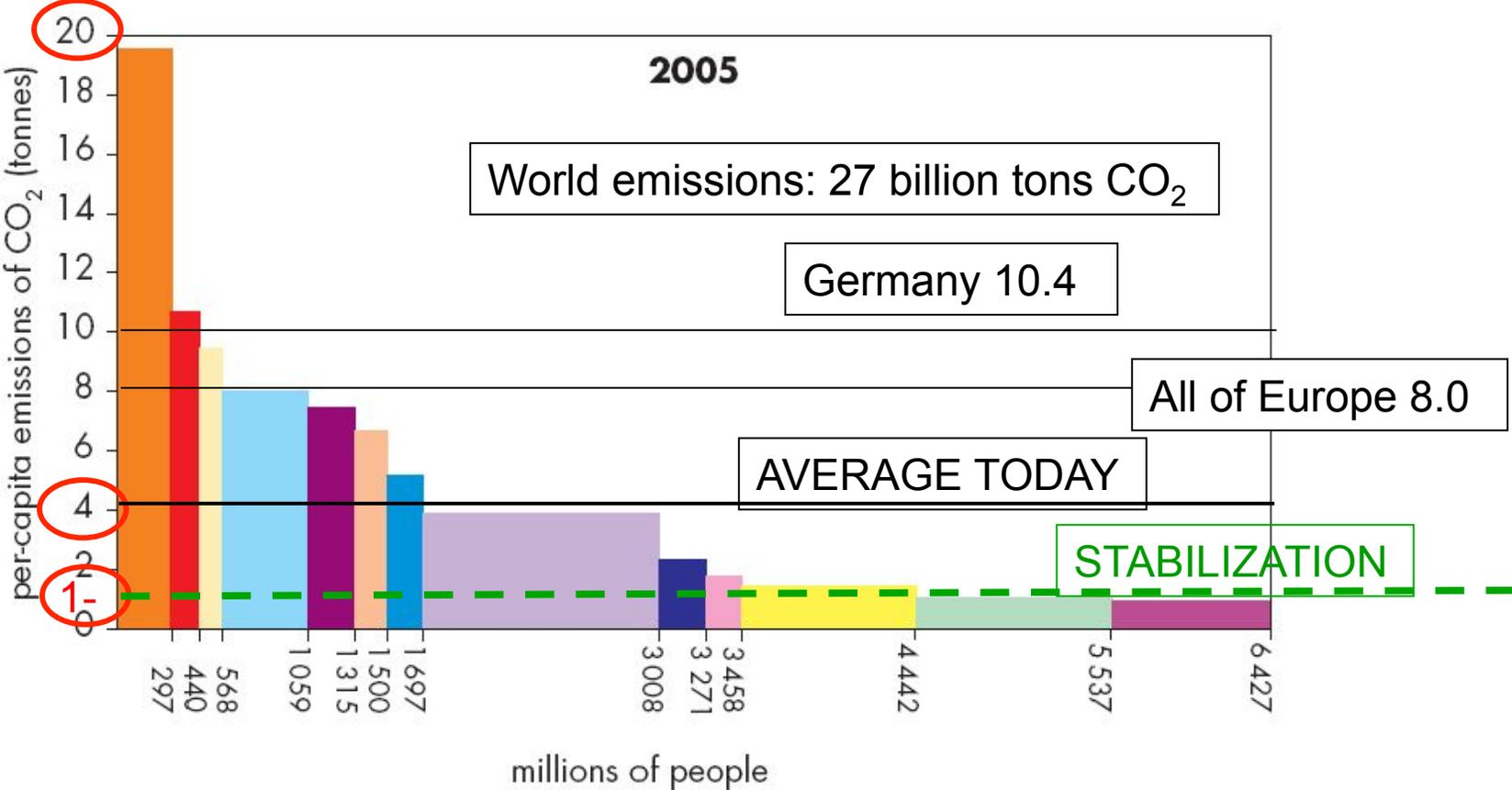
The most significant recent climate change findings, prepared for the Copenhagen UNFCCC Summit are:

- **Recent global temperatures demonstrate human-induced warming:** *Over the past 25 years temperatures have increased at a rate of 0.19 C per decade, in very good agreement with predictions based on greenhouse gas increases. Even over the past ten years, despite a decrease in solar forcing, the trend continues to be one of warming. Natural, short-term fluctuations are occurring as usual, but there have been no significant changes in the underlying warming trend.*
- **Acceleration of melting of ice-sheets, glaciers and ice-caps:** *A wide array of satellite and ice measurements now demonstrate beyond doubt that both the Greenland and Antarctic ice-sheets are losing mass at an increasing rate.*
- **Rapid Arctic sea-ice decline:** *Summer-time melting of Arctic sea-ice has accelerated far beyond the expectations of climate models. The area of sea-ice melt during 2007-2009 was about 40% greater than the average prediction from 2007 IPCC climate models.*



- **Current sea-level rise underestimated:** *Satellites show recent global average sea-level rise to be about 80% above past IPCC predictions. This acceleration in sea-level rise is very likely from melting of glaciers, ice caps, and the Greenland and West-Antarctic ice-sheets and if emissions are not reduced, sea level rise may well exceed 1 meter with an upper limit of about 2 meters by 2100. Sea level will continue to rise for centuries after global temperatures have been stabilized, and several meters of sea level rise must be expected over the next few centuries.*
- **Surging greenhouse gas emissions:** *Global carbon dioxide emissions from fossil fuels in 2008 were nearly 40% higher than those in 1990. Even if global emission rates are stabilized at present-day levels, just 20 more years of emissions would give a 25% probability that warming exceeds 2-C, even with zero emissions after 2030. Every year of delayed action increases the chances of exceeding 2-C warming.*

Per-capita Fossil-Fuel CO₂ Emissions, 2005



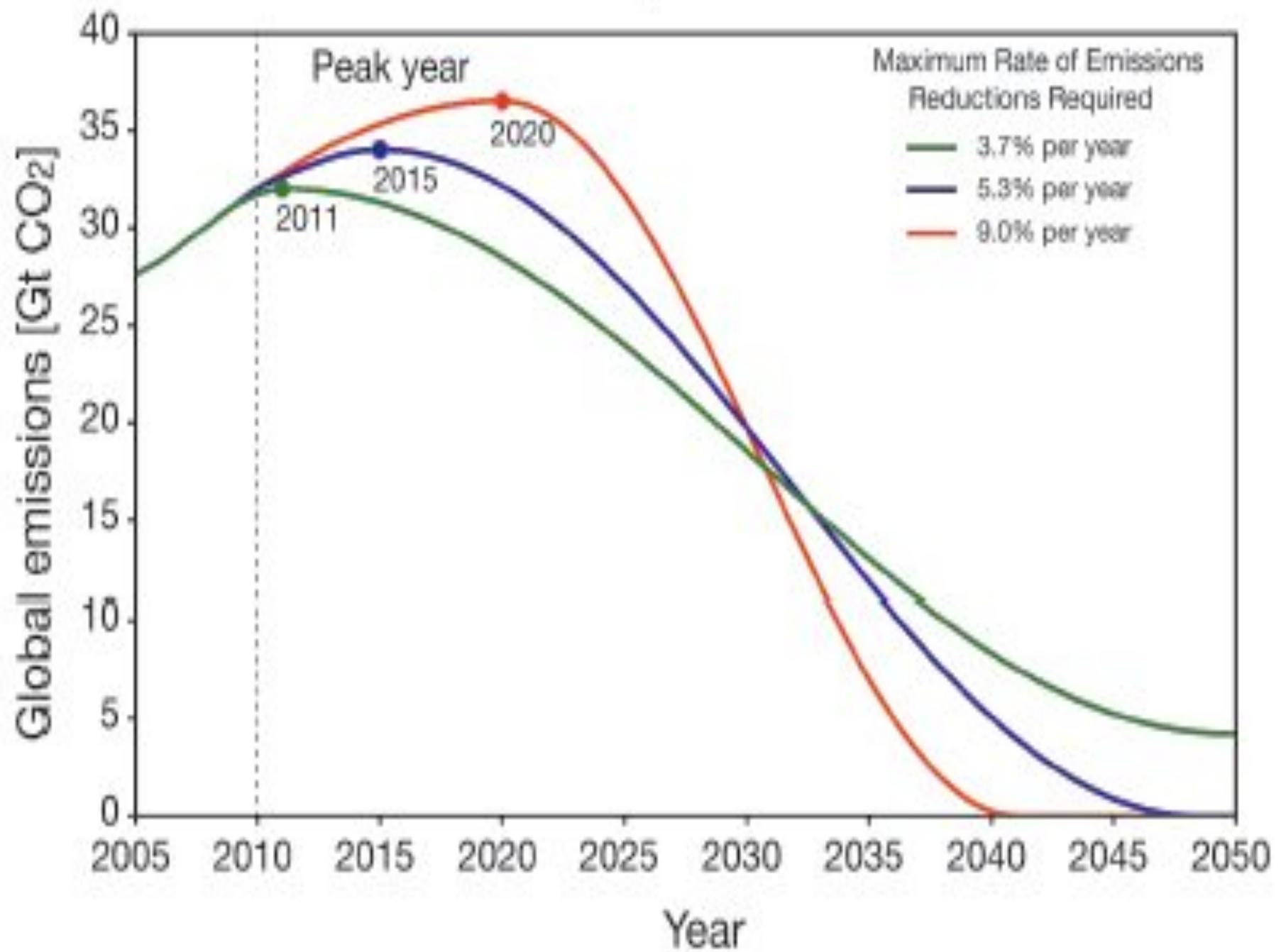
- US
- Russia
- Japan
- EU
- Other OECD
- Middle East
- Other transition economies
- China
- Other Latin America
- Brazil
- Rest of Asia
- India
- Africa

Source: IEA WEO 2007

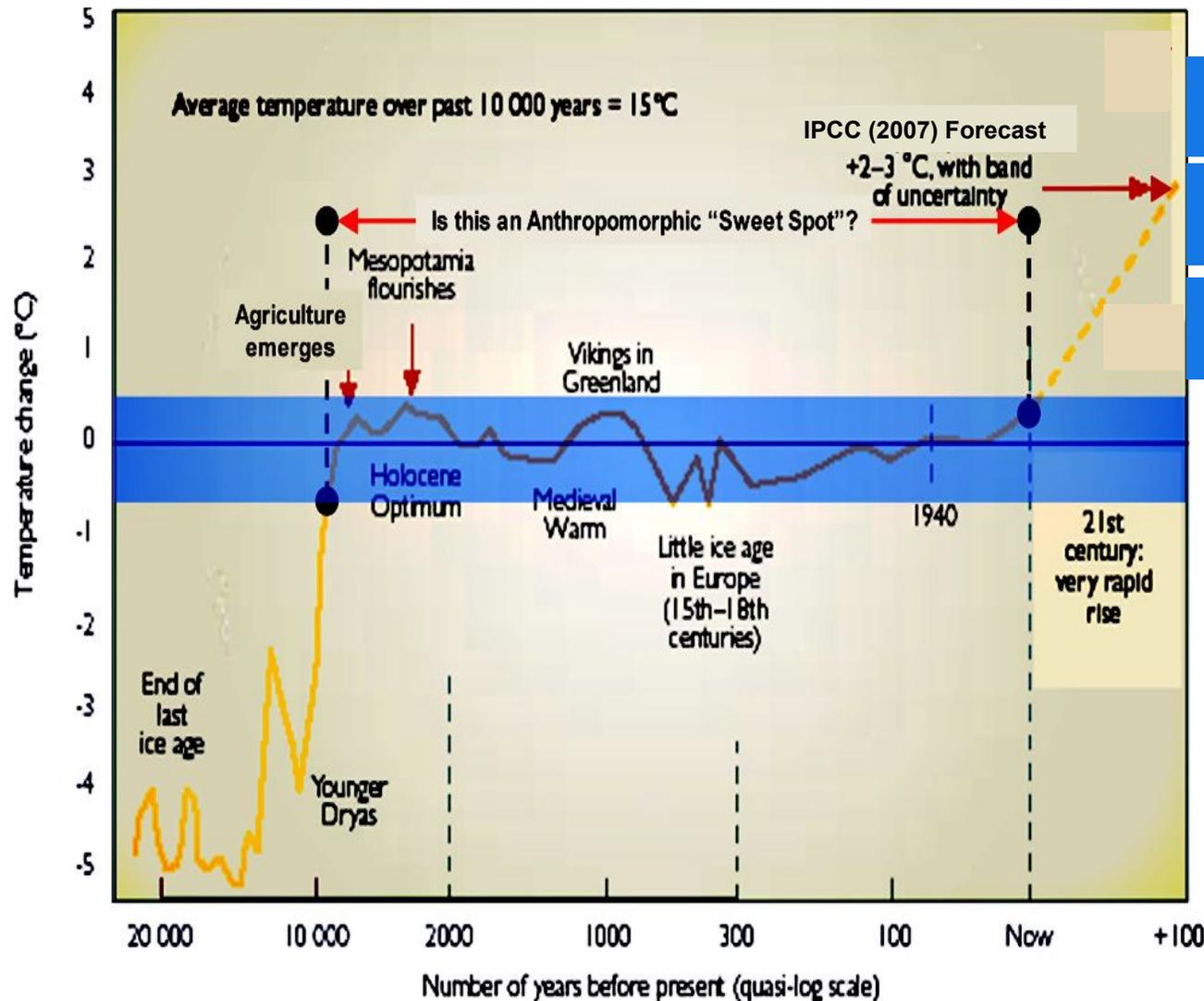


- **Delay in action risks irreversible damage:** *Several vulnerable elements in the climate system (e.g. continental ice-sheets, Amazon rainforest, West African monsoon and others) could be pushed towards abrupt or irreversible change if warming continues as business-as-usual throughout this century. Thus waiting for higher levels of scientific certainty could mean that some tipping points will be crossed before they are recognized.*
- **The turning point must come soon:** *If global warming is to be limited to a maximum of 2 °C above pre-industrial values, global emissions need to peak between 2015 and 2020 and then decline rapidly. More specifically, the average annual per-capita emissions will have to shrink to well under 1 metric ton CO₂ by 2050. This is 80-95% below the per-capita emissions in developed nations in 2000.*

What does this mean?



The question is: At what temperature will we stabilize?



770 ppm ~ 3.9 °C

550 ppm ~ 3 °C

450 ppm ~ 2 °C

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

US Arctic Policy

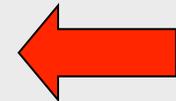
Issued as a

National Security Presidential Directive and Homeland Security Presidential Directive January 2009

Excerpts from Document Available at: <http://www.whitehouse.gov/news/releases/2009/01/20090112-3.html>

It is now the policy of the United States to:

- **Meet national security and homeland security needs relevant to the Arctic region;**
- **Protect the Arctic environment and conserve its biological resources;**
- **Ensure that natural resource management and economic development in the region are environmentally sustainable;**
- **Strengthen institutions for cooperation among the eight Arctic nations (the United States, Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, and Sweden);**
- **Involve the Arctic's indigenous communities in decisions that affect them; and**
- **Enhance scientific monitoring and research into local, regional, and global environmental issues.**



US Arctic Policy

Issued as a

National Security Presidential Directive and Homeland Security Presidential Directive January 2009

Excerpts from Document Available at: <http://www.whitehouse.gov/news/releases/2009/01/20090112-3.html>

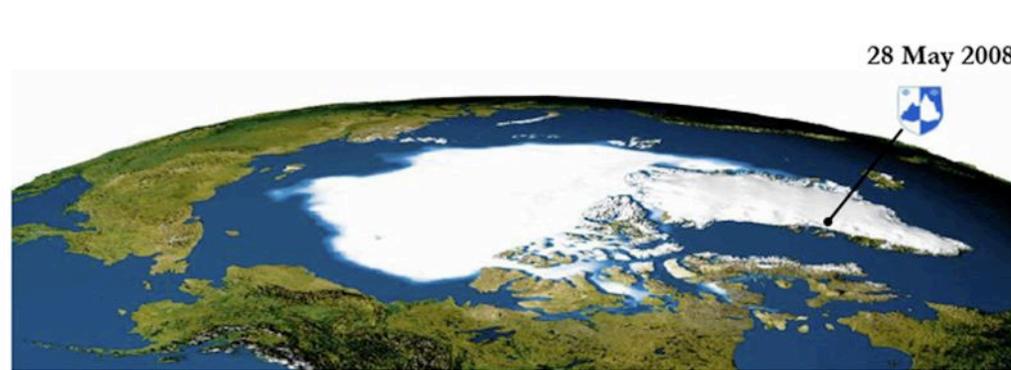
It is the policy of the United States to concerning international governance, the U.S. government shall:

- **Develop greater capabilities and capacity, as necessary, to protect United States air, land, and sea borders in the Arctic region;**
- **Increase Arctic maritime domain awareness in order to protect maritime commerce, critical infrastructure, and key resources;**
- **Preserve the global mobility of United States military and civilian vessels and aircraft throughout the Arctic region;**
- **Project a sovereign United States maritime presence in the Arctic in support of essential United States interests; and**
- **Encourage the peaceful resolution of disputes in the Arctic region.**

The European Union and the Arctic Policies and Actions

A Summary of the EU Policy Perspectives on the Arctic 2008:

To gain a rightful “place in the midnight sun” without appearing to be in competition for it, the EU might wish to concentrate on the issue of the protection of the Arctic environment, for which it has many credentials, including its constant leadership in combating climate change. To this effect, it would need to establish, intensify and possibly formalize international cooperation with Arctic regional bodies and Arctic partners, as well as within multilateral fora – with sustainable development as the overarching guiding principle. Greater attention to the human element – social and cultural aspects of life in the Arctic – would contribute to the EU establishing itself as a respected and well-appreciated actor on the Arctic scene.



THE ILULISSAT DECLARATION

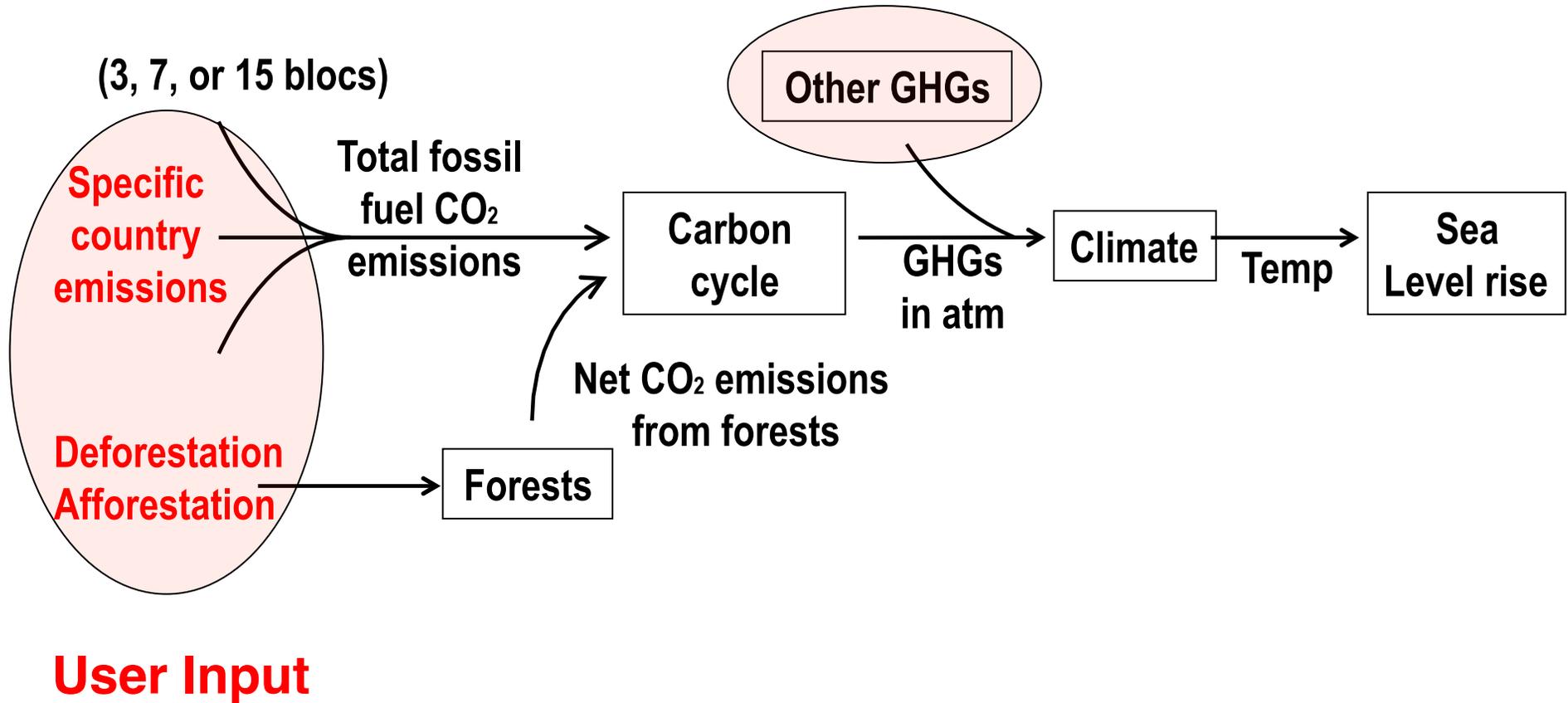
ARCTIC OCEAN CONFERENCE
ILULISSAT, GREENLAND, 27 – 29 MAY 2008

The Arctic Ocean is a unique ecosystem, which the five coastal states have a stewardship role in protecting. We will take steps in accordance with international law both nationally and in cooperation among the five states and other interested parties to ensure the protection and preservation of the fragile marine environment of the Arctic Ocean.

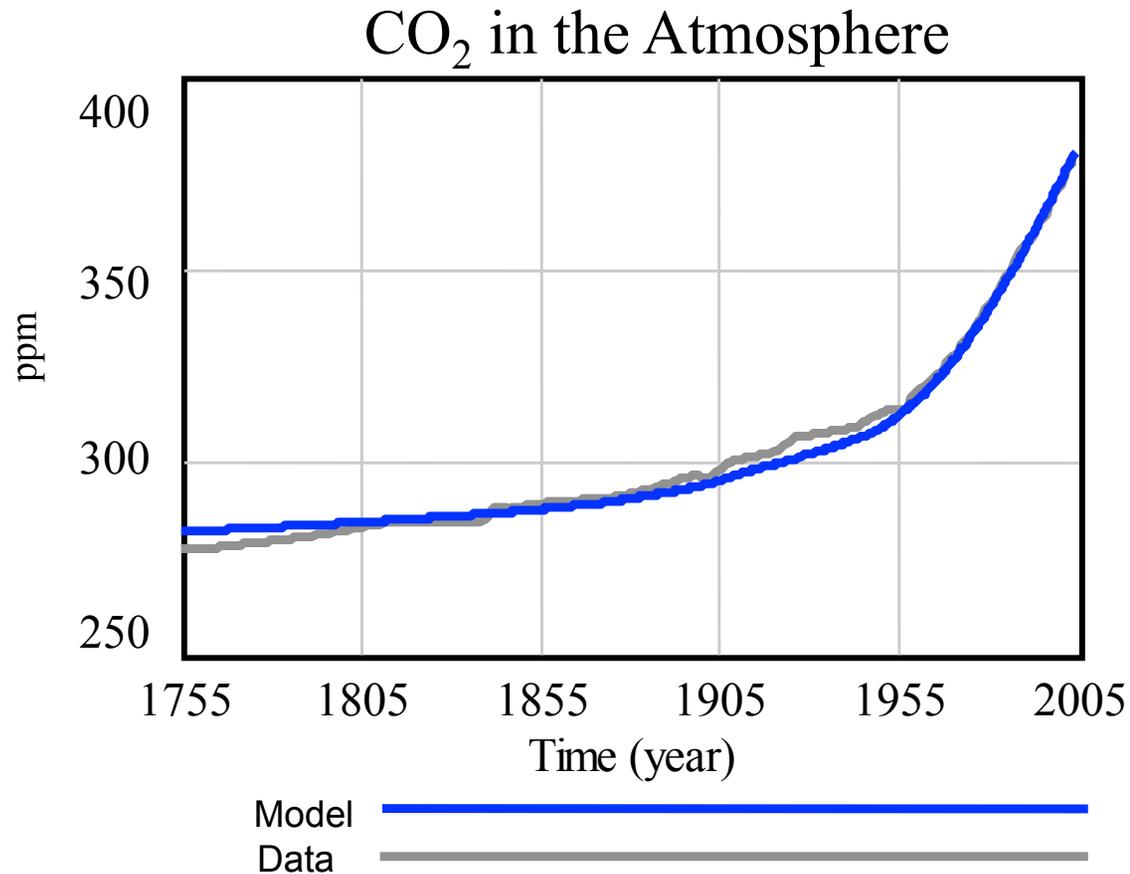
We see no need to develop a new comprehensive international legal regime to govern the Arctic Ocean. We will keep abreast of the developments in the Arctic Ocean and continue to implement appropriate measures.

C-ROADS Global Climate Model

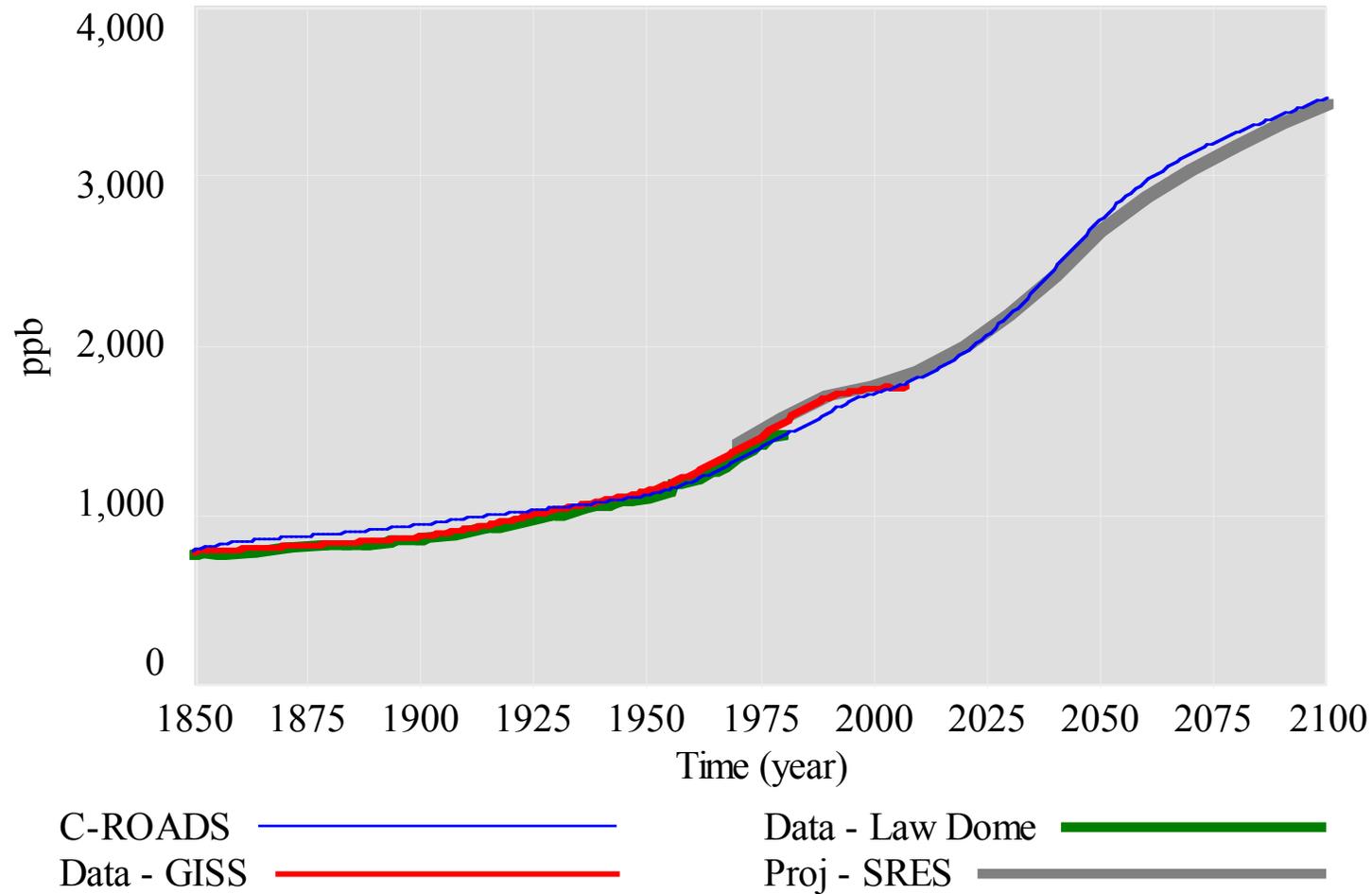
User Input



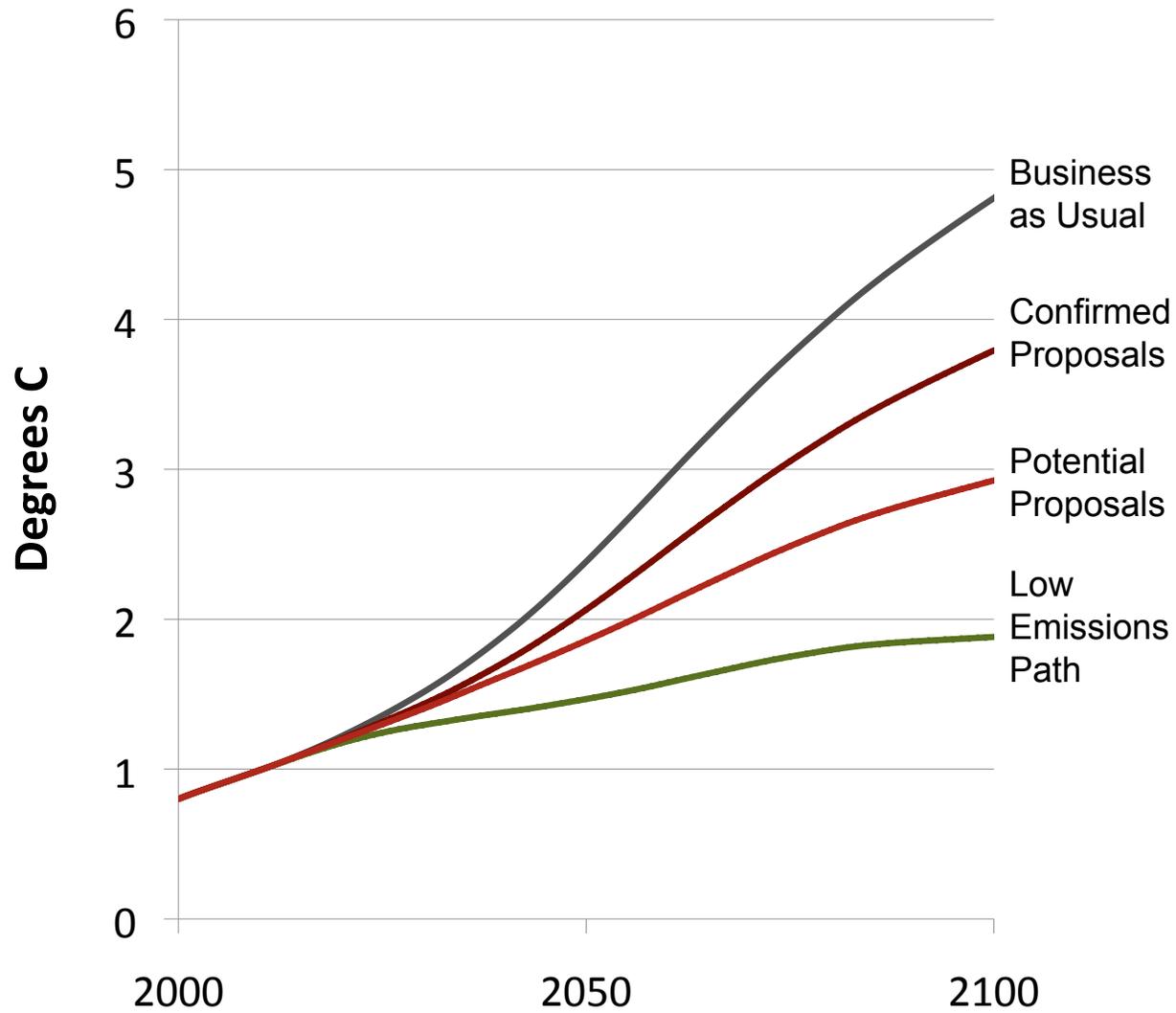
We Compare Our Modeled CO₂ Concentrations to Historical Data



C-ROADS Produces Methane Concentration Results Consistent with History and SRES Forecasts



Temperature Change Over Pre-Industrial

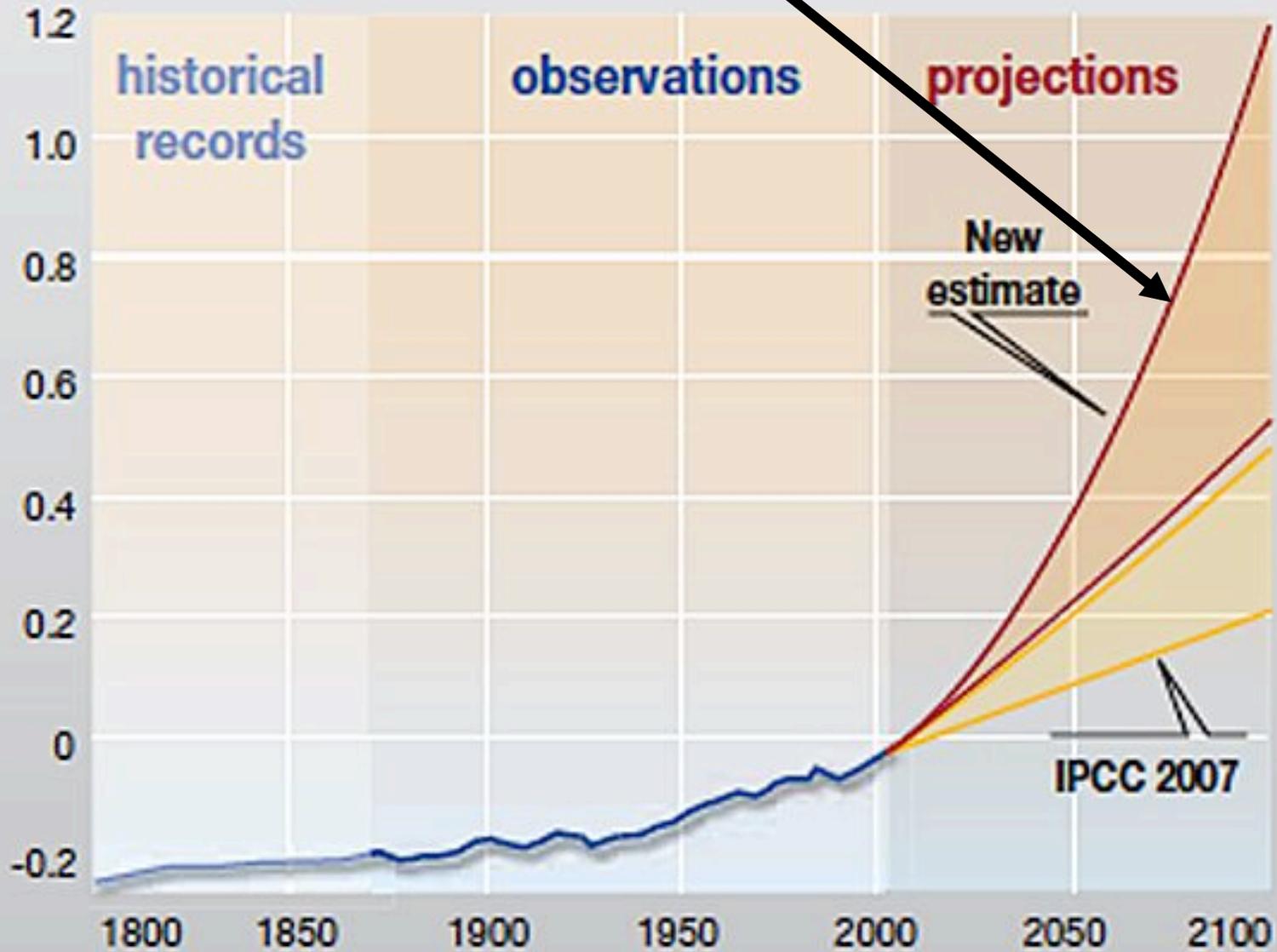


C-ROADS Model Run for CoP 15 Negotiations

Global sea-level rise

Metres

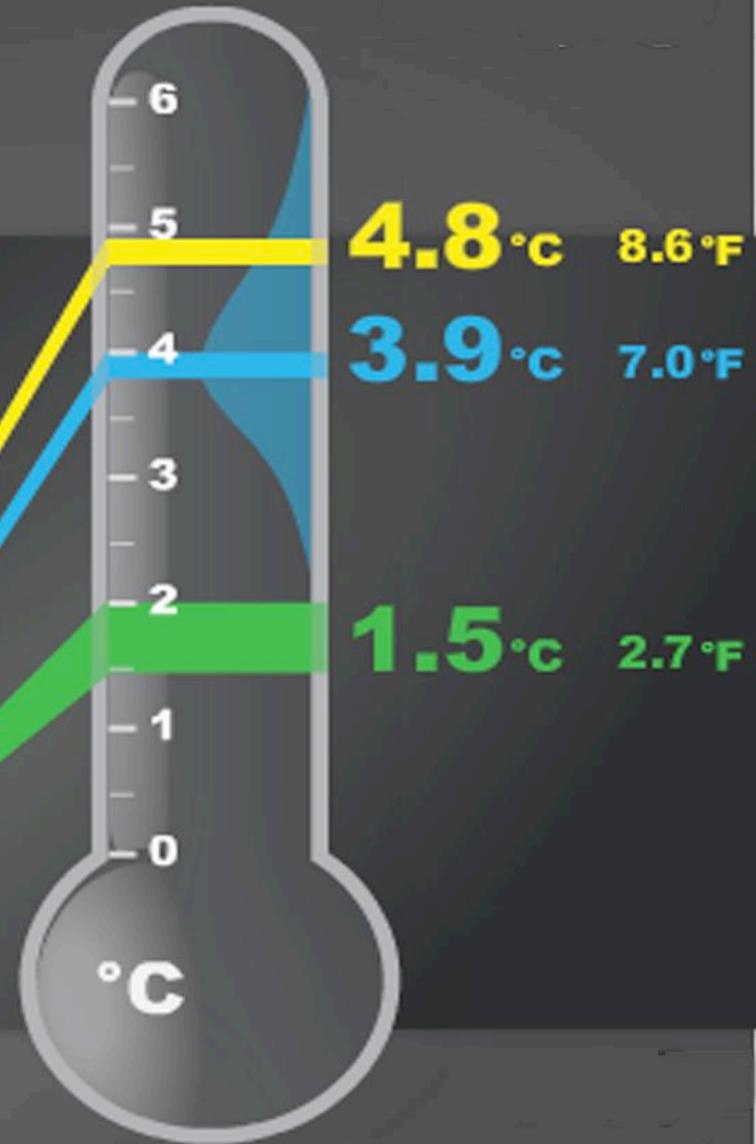
This is about 1 foot every 20 to 25 years around the entire globe



Increase in Global Temperature by 2100

Where will proposals from the climate negotiations lead?

business as usual
Dec 5 **proposals**
goals



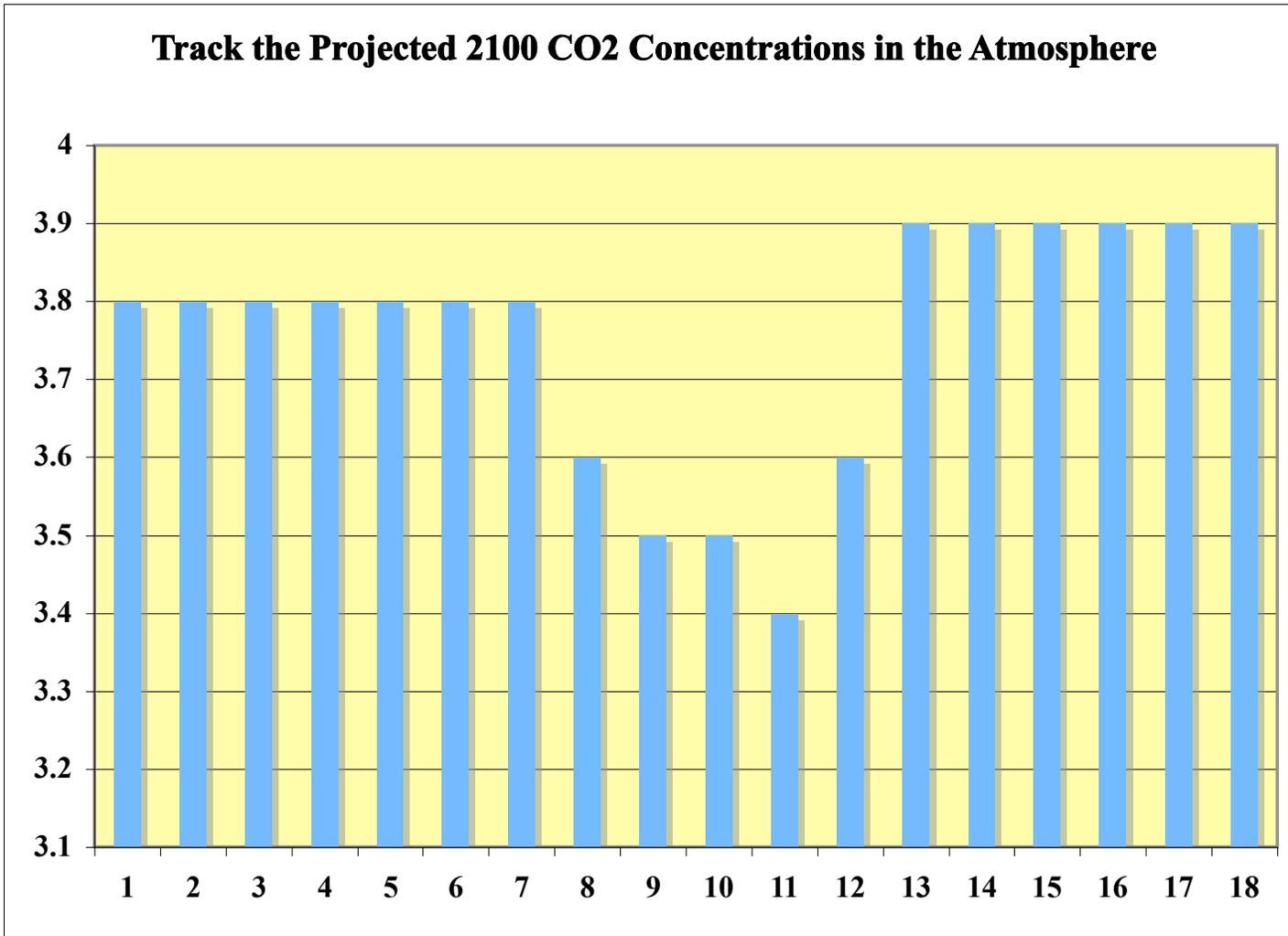


**Arctic Change: Turning
Science Into Policy and Action**
State of the Arctic Conference
March 18th 2010



**C-ROADS Model Projection of Global Mean
CO2 Concentrations in the Atmosphere in PPM**

Track the Projected 2100 CO2 Concentrations in the Atmosphere



December Date during the CoP 15 Meeting



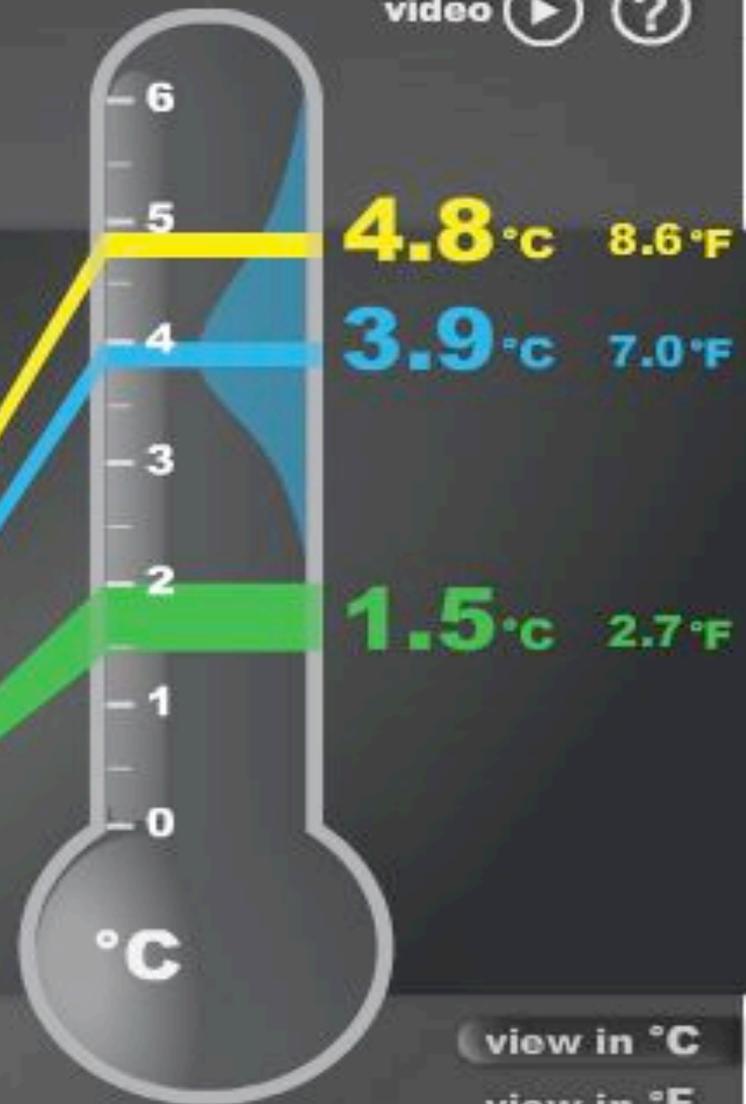
Key Issues that were Barriers to the Development of a Copenhagen Protocol

- Monitoring, Recording and Verification (MRV)
- \$100 Billion/Annum Fund for Developing Countries to Help them Meet their Targets for Emissions Reduction -- Text to weak
- Adequate Institutional Enablement to Assure Implementation and would not Challenge National Sovereignty
- Continuing Doubts about the Urgency of the Issue
- Inability for individual Nations to return with a Perceived “Win”

Increase in Global Temperature by 2100

Where will proposals from the climate negotiations lead?

business as usual
Mar 16 **proposals**
goals



view in °C

view in °F

by 2020 **Brazil:** Amazon deforestation rate 70% below 2009 level

“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

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.



Thank You !