



**SBSTA Session on
Linkages between
Adaptation and
Sustainable Development**



**“The Arctic Climate
Impact Assessment
and Implications on
the Development of
the Region”**



The Scientific Results of the Arctic Climate Impact Assessment and Policy Implications



**United Nations Framework Convention on Climate Change
COP 10
Subsidiary Body for Scientific and Technological Advice
Twenty-First Session
December 8, 2004
Buenos Aires, Argentina**



The Arctic Region
is about 50% Land
and 50% Sea Ice
and Oceans





Ice has shaped the landscape
by repeated glaciations.



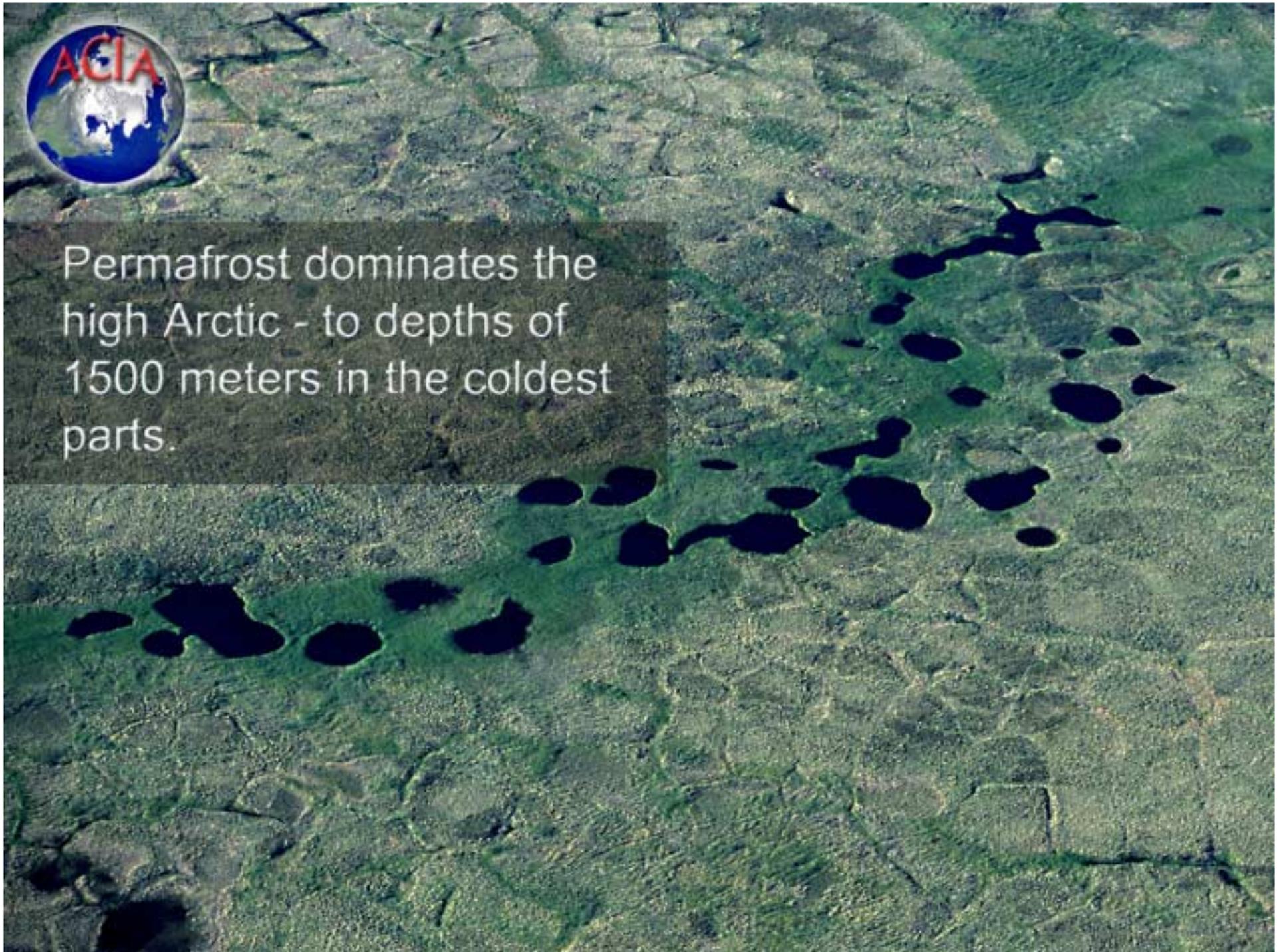


Natural resources are abundant,
fossil fuels, minerals ...

Home to Millions of Indigenous and other
residents of the region.....



Permafrost dominates the high Arctic - to depths of 1500 meters in the coldest parts.





80% to 90% of the freshwater
input to the land occurs during
2 to 3 weeks of snowmelt.



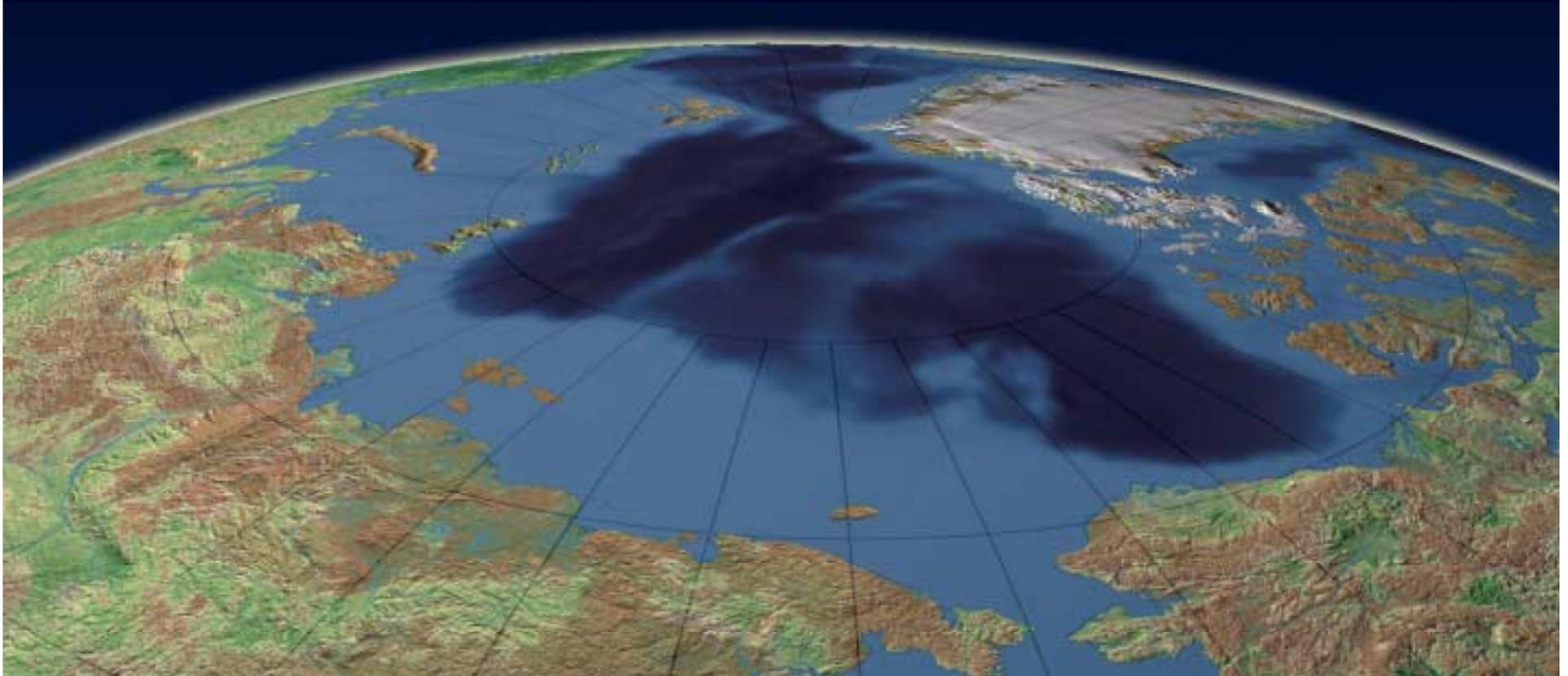


Temperature ranges from 30°C in Summer to -60°C in Winter.

Precipitation varies widely - Northern Greenland is a few inches per year with other locations many times that.



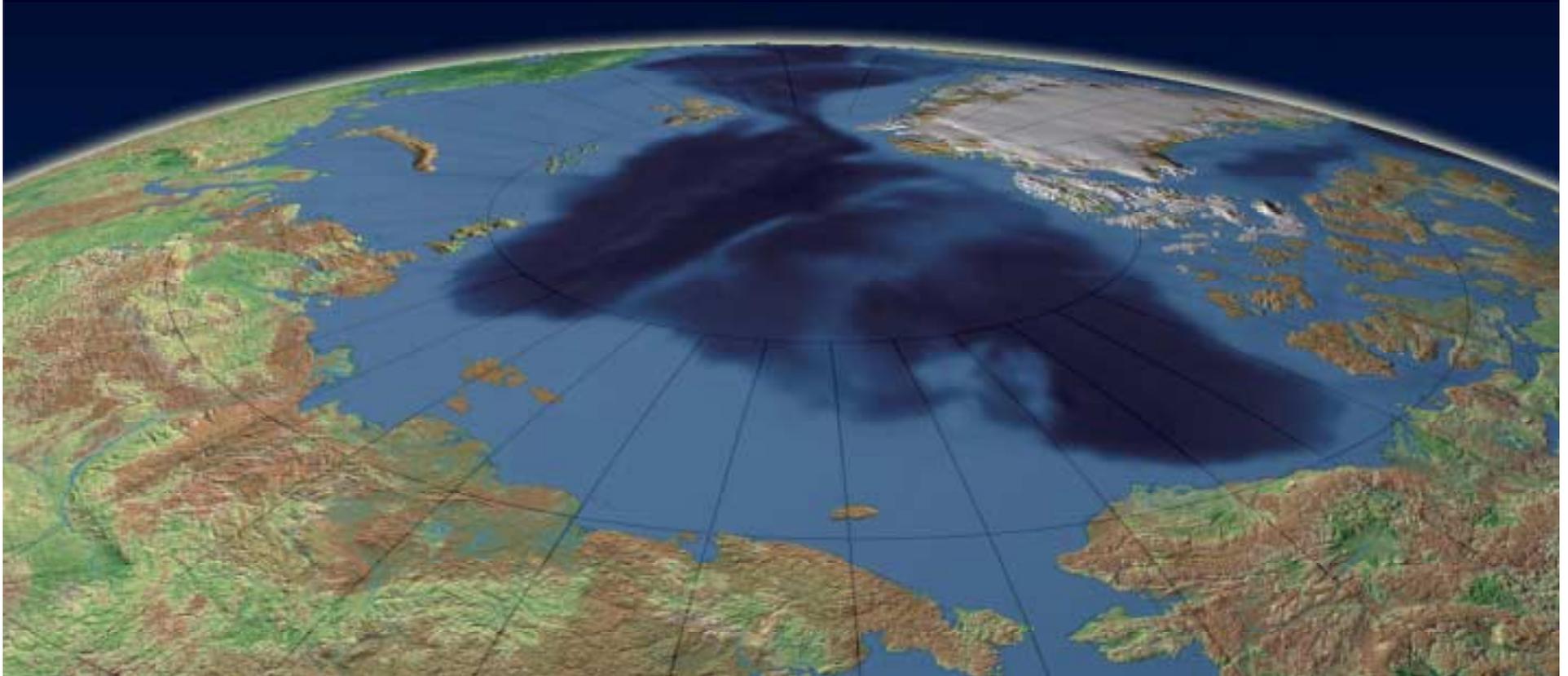
The Arctic region is facing dramatic changes





The Arctic region is facing dramatic changes

- **Substantial Changes in Climate and weather.**





The Arctic region is facing dramatic changes

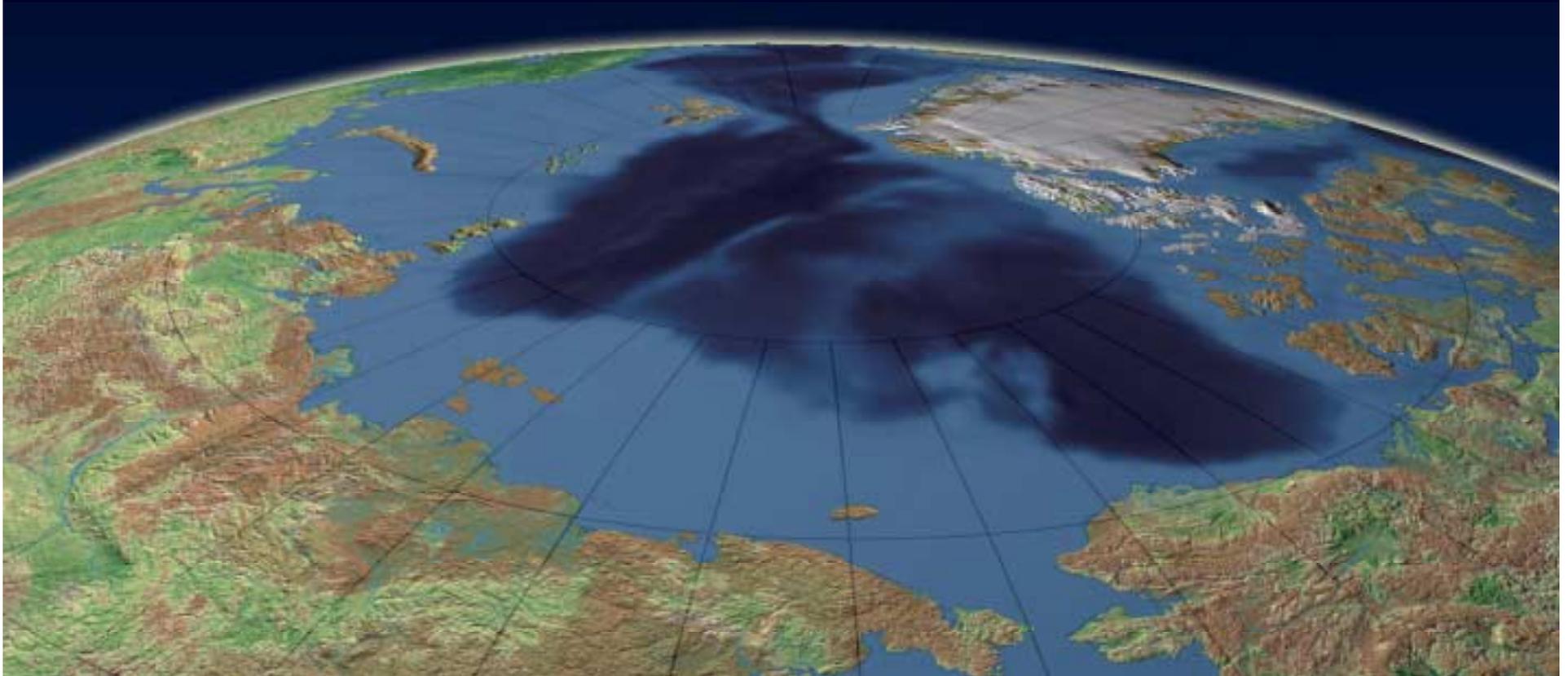
- High Concentrations of Contaminants such as PCBs and mercury.





The Arctic region is facing dramatic changes

- Ozone depletion that leads to UV increases.





The Arctic region is facing dramatic changes

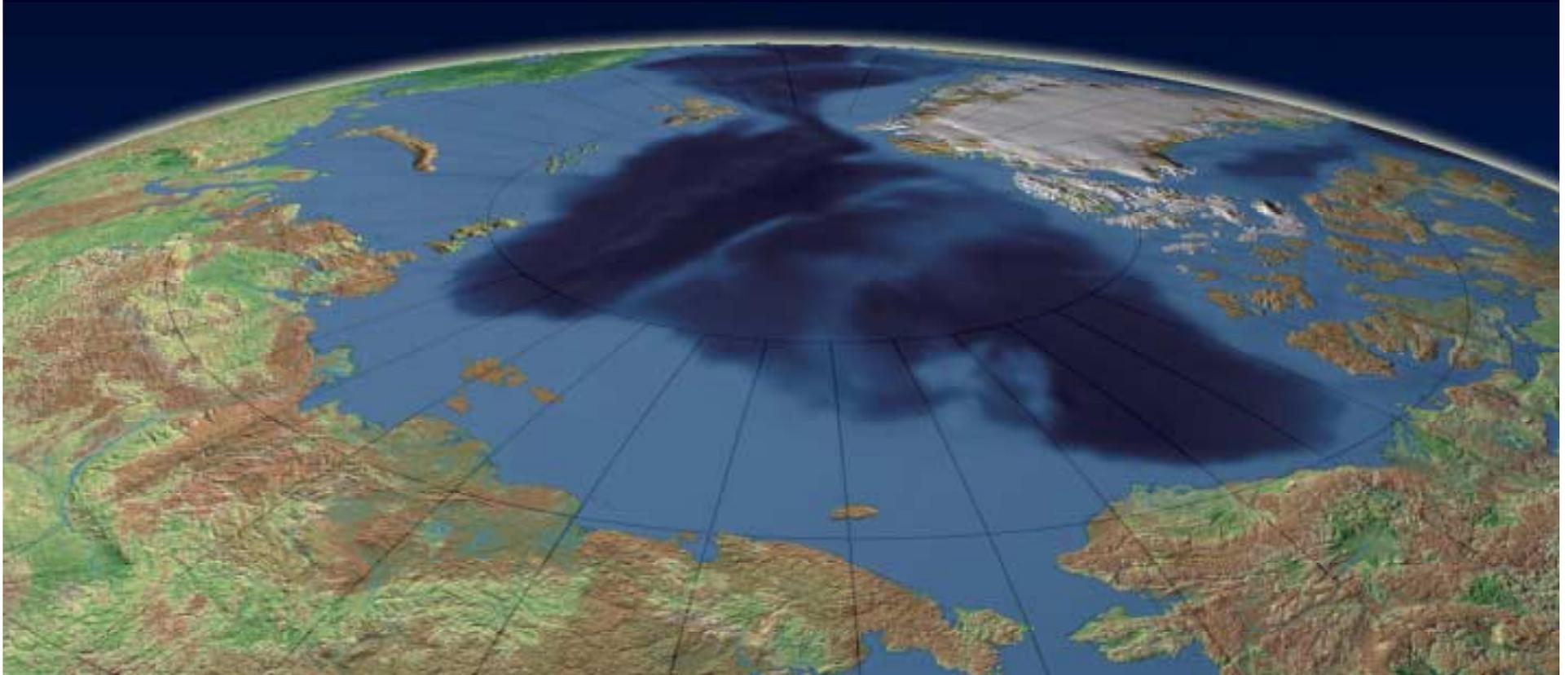
- Globalization such as mixed economies and technological changes.





The Arctic region is facing dramatic changes

- **Rapid cultural and social change**



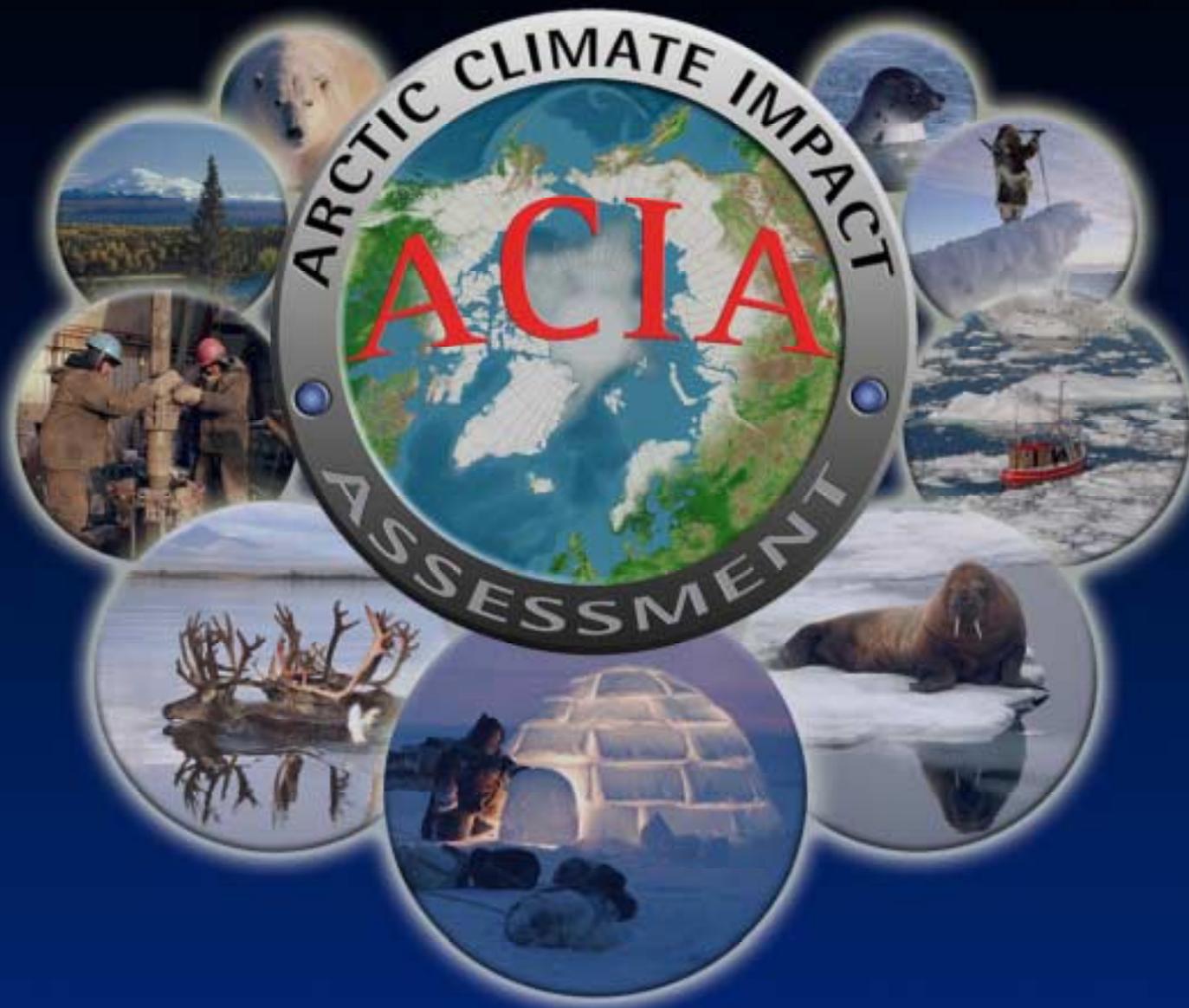


The Arctic region is facing dramatic changes

- **Substantial Changes in Climate and weather.**
- **High Concentrations of Contaminants such as PCBs and mercury.**
- **Ozone depletion and UV increases.**
- **Globalization such technological changes.**
- **Rapid cultural and social change**

Scientific findings are now telling us that together these are dramatically changing the face and character of the entire region

IMPACTS OF A WARMING ARCTIC



The Arctic Council's Barrow Ministerial Meeting in October 2000 charged the Arctic Climate Impact Assessment to:

- *Evaluate and synthesize knowledge on climate change, and*



The Arctic Council's Barrow Ministerial meeting in October 2000 charged the Arctic Climate Impact Assessment to:

- *Evaluate and synthesize knowledge on climate change, and*
- *Provide useful and reliable information to the governments, organizations and peoples of the Arctic region.*



Who Asked for the Assessment and Why ?

Arctic Council*

Barrow Ministerial Declaration

October 13, 2000.

Endorse and adopt the Arctic Climate Impact Assessment (ACIA), a joint project of the Arctic Monitoring and Assessment Programme (AMAP) and the Conservation of Arctic Flora and Fauna (CAFF) Working Group, in cooperation with the International Arctic Science Committee, and

Acknowledge the establishment of the ACIA Steering Committee to coordinate the ACIA, and

Express our appreciation to the United States for financing a substantial portion of the ACIA Secretariat;

Request the ACIA to evaluate and synthesize knowledge on climate variability and change and increased ultraviolet radiation, and support policy-making processes and the work of the Intergovernmental Panel on Climate Change;

Further request that the assessment address environmental, human health, social, cultural and economic impacts and consequences, including policy recommendations; and

Approve the goals and objectives contained in the ACIA Implementation Plan and

Further request that the assessment address environmental, human health, social, cultural and economic impacts and consequences, including policy recommendations; and

Implementation Plan

The assessment will be documented in the following volumes:

- A Scientific Document,
- A Synthesis Document, and
- A Policy Document.

* The Arctic Council consists of eight Arctic countries, Canada, Finland, Iceland, Denmark/Greenland/Faroe Islands, Norway, Russia, Sweden, United States, and six Indigenous Peoples' Organizations of the Arctic region (Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit Circumpolar Conference, Russian Association of Indigenous Peoples of the North, Saami Council), and 38 observers, including France, Germany, the Netherlands, Poland, United Kingdom, NGOs, many scientific and other international bodies.

➔ The Eight Arctic Nations

➔ Six Indigenous Peoples Organizations

➔ Observers (Countries and Organizations)

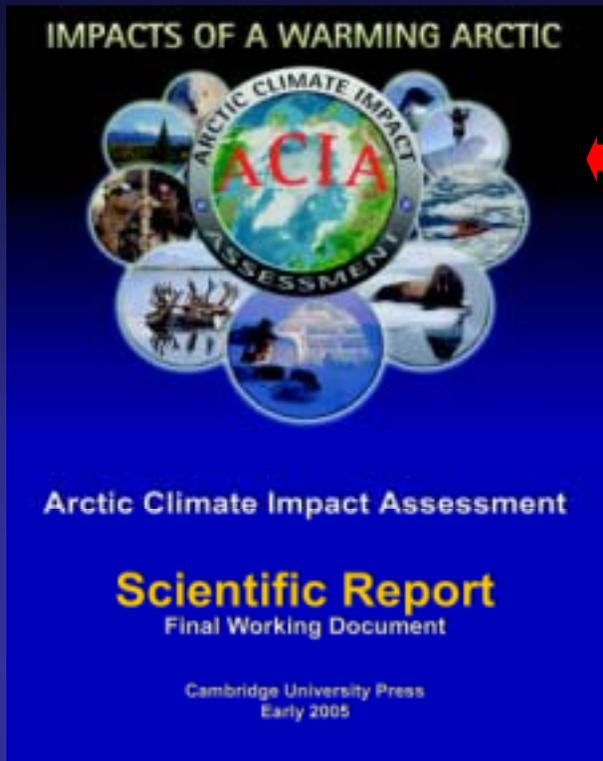
Framework for Implementation

ARCTIC COUNCIL

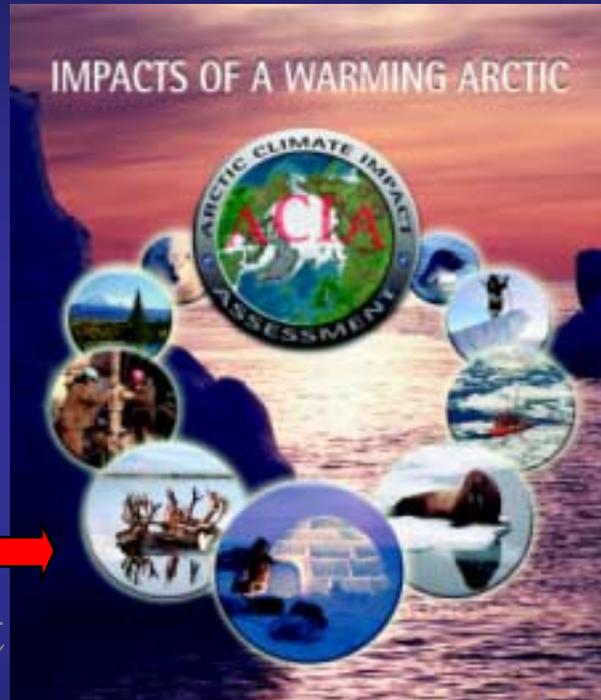
International Arctic Sciences Committee
Composed of Scientist Appointed by the Academies of Science from 18 Countries

ACIA



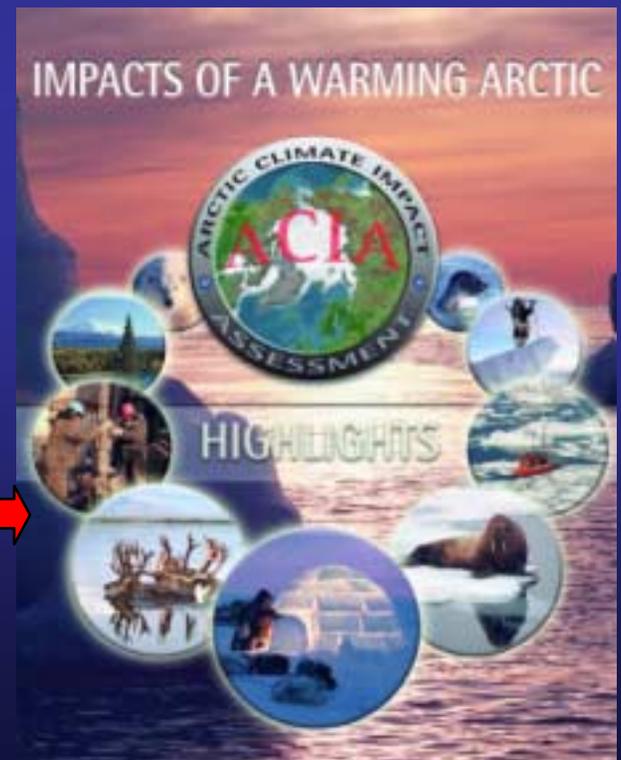


**Detailed Scientific Assessment in
18 Chapters (~ 1200 Pages)**



**Overview
Document that
Details 10 Key
Findings
(140 Pages)**

**Highlights
Document
(18 Pages)**





*What have we
learned ?*

The scientific evidence document in the 2nd and 3rd Assessments of the Intergovernmental Panel on Climate Change (IPCC) concluded with high confidence that:

- *“In the light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations”, and that the*
- *“Climate change in polar regions is expected to be among the largest and most rapid of any regions on the Earth, and will cause major physical, ecological, sociological, and economic impacts, especially in the Arctic, Antarctic Peninsula, and Southern Ocean.”*



ACIA's Unique Approach



Integrating Insights and Knowledge from these Perspectives

Indigenous Communities across the Arctic were Observing

Parameters	Observations
Atmosphere/ Weather/ Winds	More persistent clouds More warm weather Warmer winters in all the regions More extreme weather conditions in last 10-20 years
Rain/ Snow	Less snow than in the past Snow disappears earlier
Ocean/ Sea Ice	There is less sea ice and it is thinner in winter Later freeze-up and earlier break-up
Lakes/ Rivers/	Water levels are lower
Vegetation/ Land	Treeline is moving north into formerly treeless areas bushes and willows are getting bigger and taller

The Approach to the Scientific Assessment

Scientific Document is Organized into 18 Chapters:

Chapter 1: An Introduction to the ACIA

Chapter 2: Arctic Climate: Past and Present

Chapter 3: Indigenous Perspectives

Chapter 4: Future Changes of Arctic Climate

Chapter 5: Ozone and Ultraviolet Radiation

Chapter 6: Cryosphere and Hydrology

Chapter 7: Arctic Tundra and Polar Desert Ecosystems

Chapter 8: Freshwater Arctic Ecosystems

Chapter 9: Marine systems

Chapter 10: Arctic Biodiversity: Principles of Conservation

Chapter 11: Wildlife Management

Chapter 12: Hunting, Herding, and Fishing by Indigenous People

Chapter 13: Fisheries

Chapter 14: Forests, Land Management And Agriculture

Chapter 15: Human Health

Chapter 16: Infrastructure

Chapter 17: Climate Change in a Multiple Stress Context

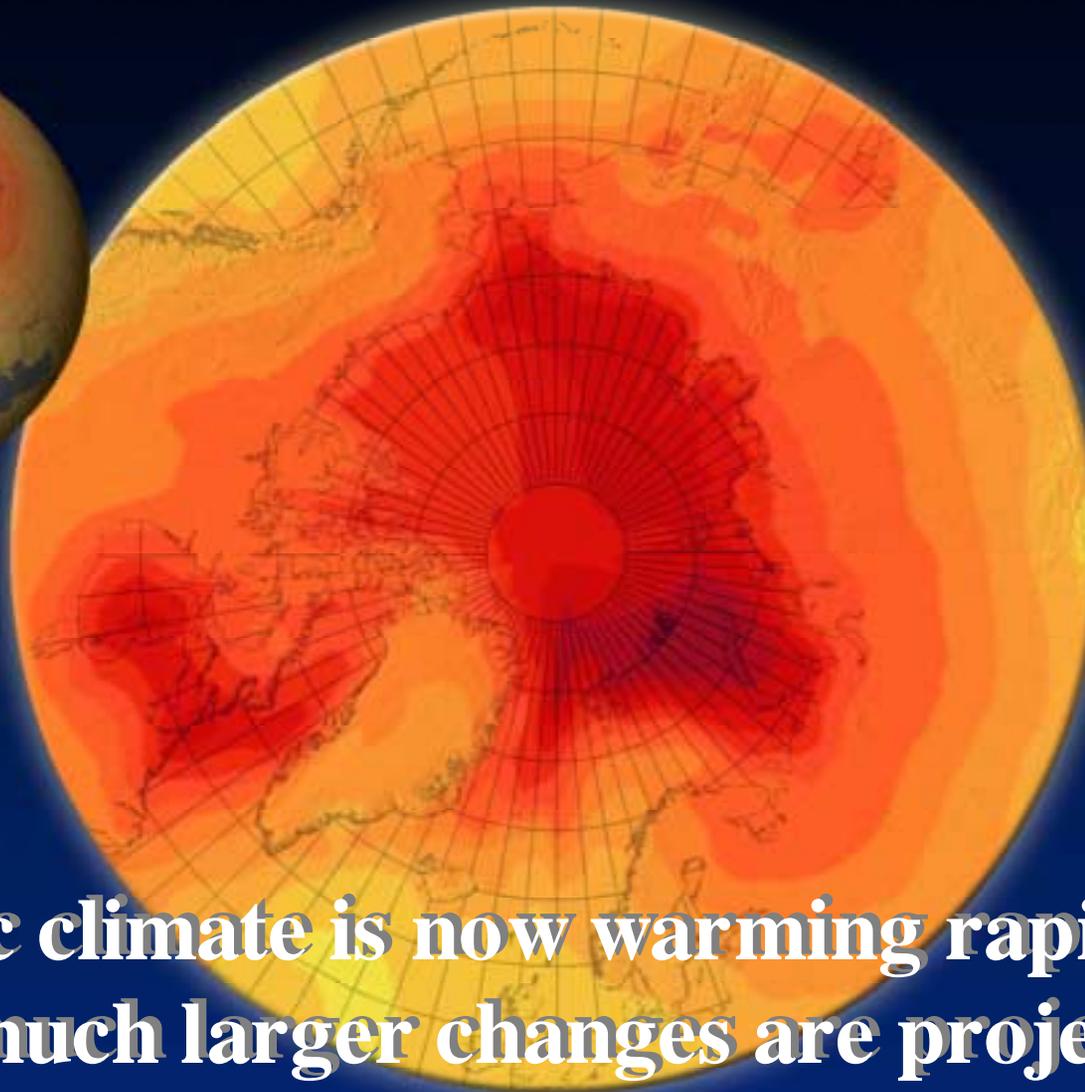
Chapter 18: Summary and Synthesis

Overview Document Organized into Ten Key Findings:

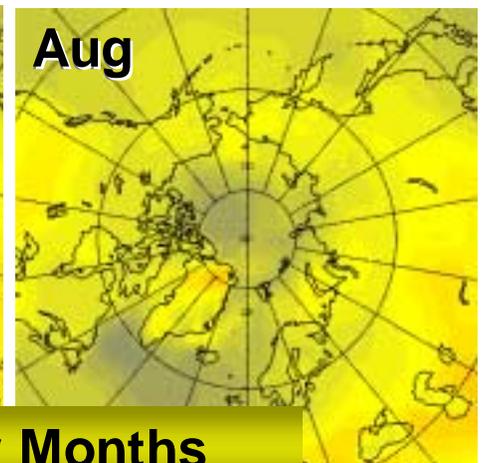
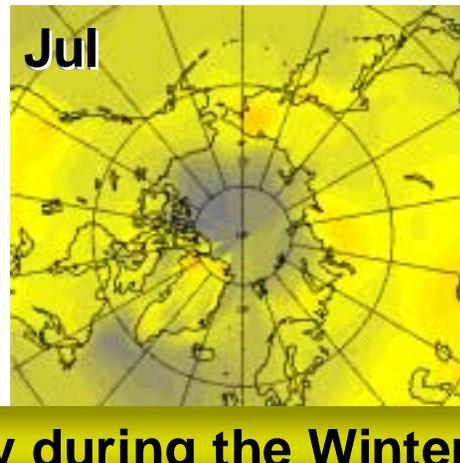
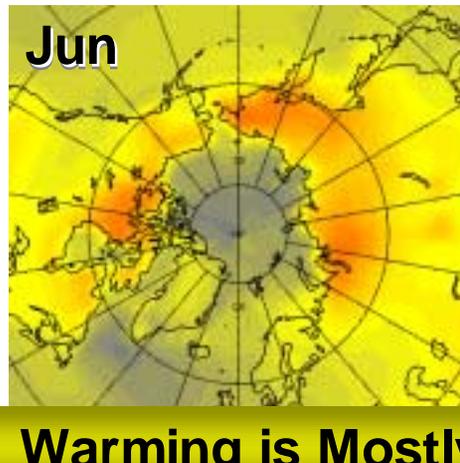
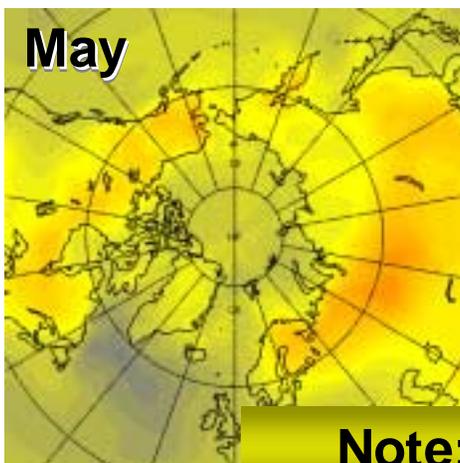
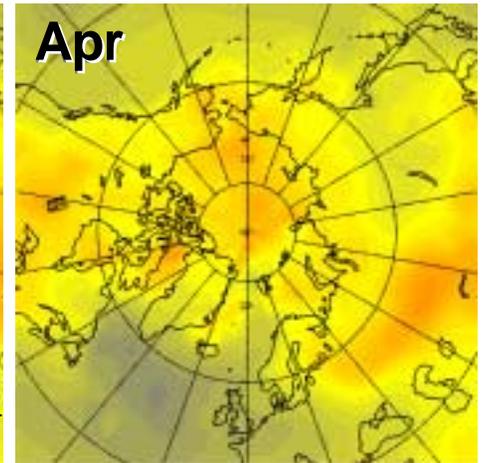
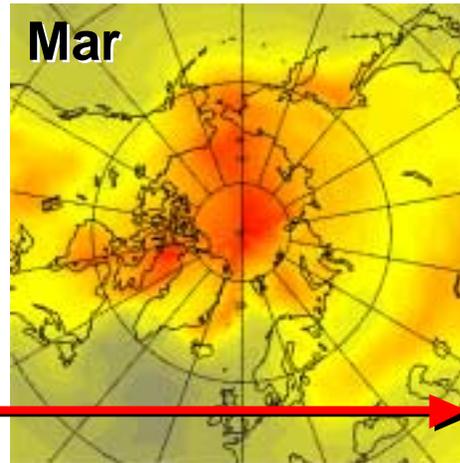
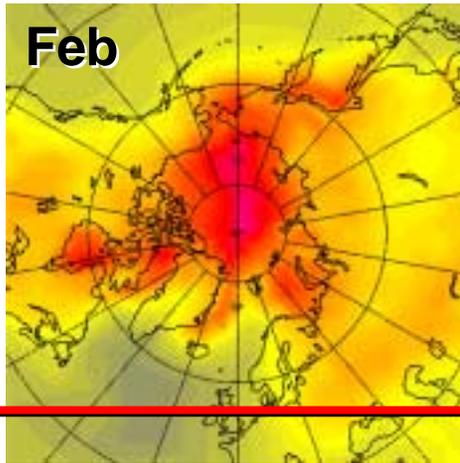
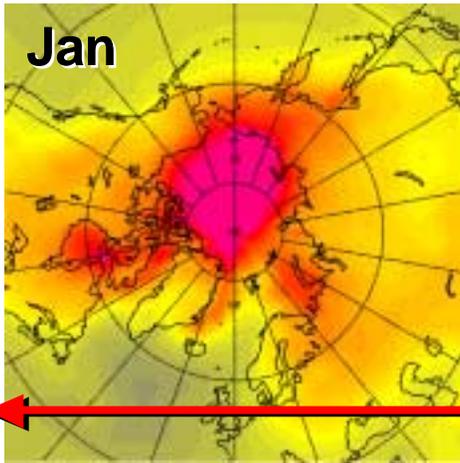


IMPACTS OF A WARMING ARCTIC

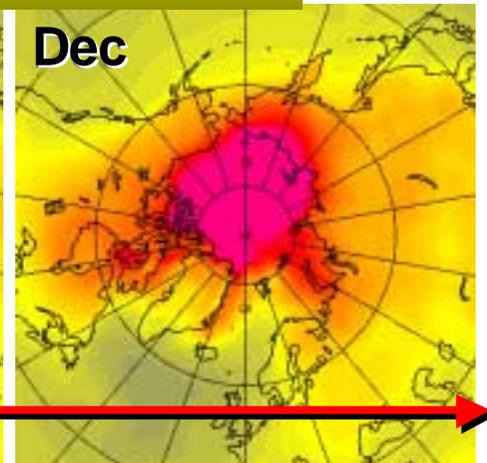
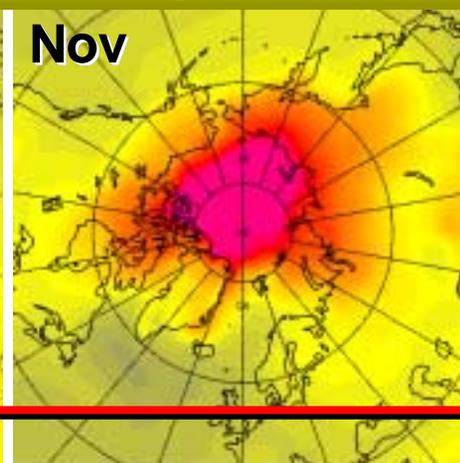
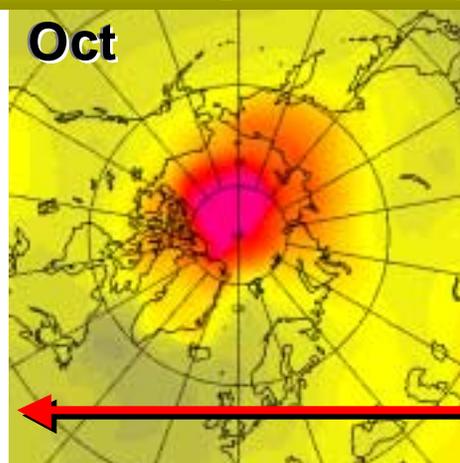
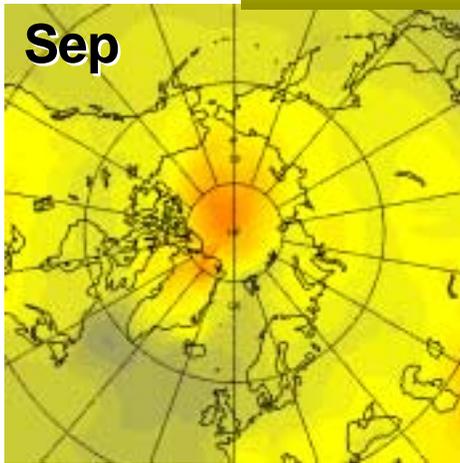
Projected Surface Air Temperature Change:
1990s–2090s (winter Dec–Feb)



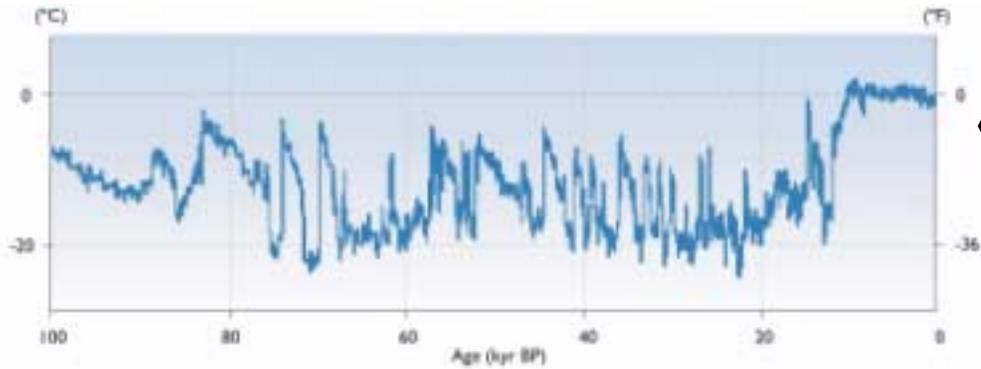
**Arctic climate is now warming rapidly and
much larger changes are projected !**



Note: Warming is Mostly during the Winter Months

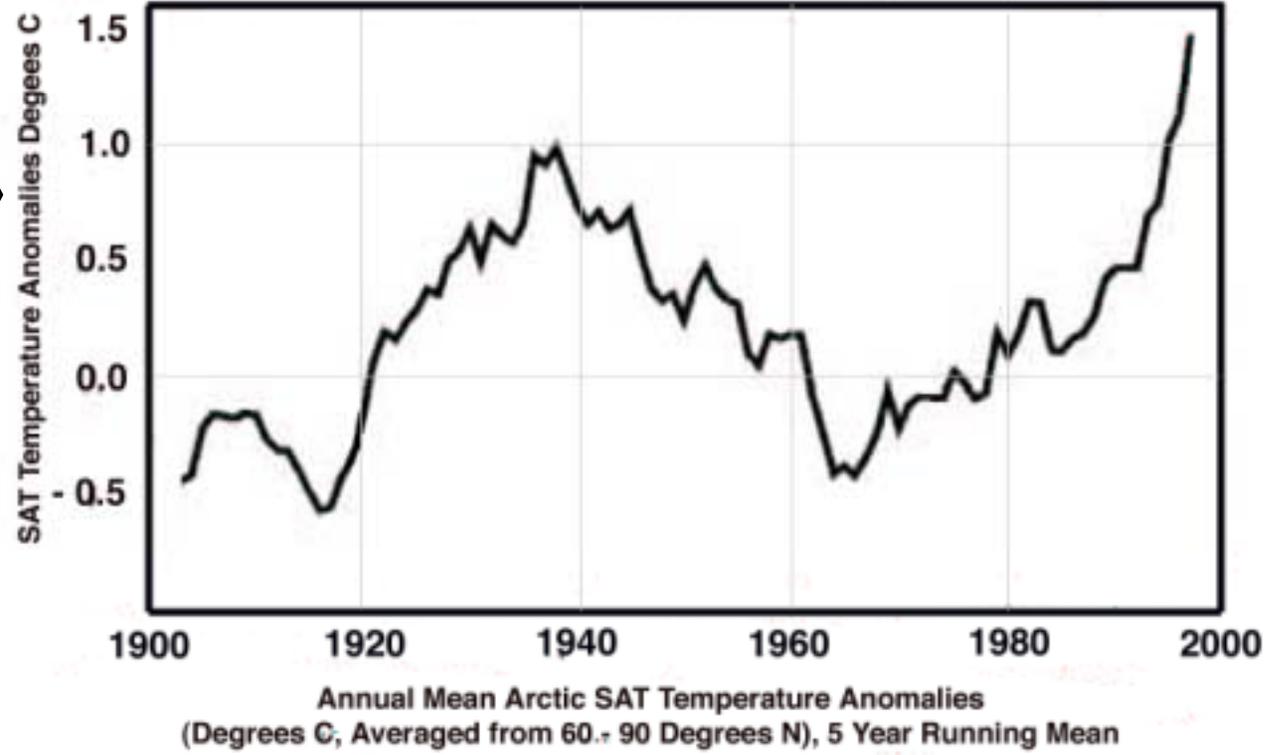


The Temperature Trends for the Past 100,000 Years



The Trends for the Past 100,000 Years in Greenland

The Relative Warming in the 1940's and Recent Trends

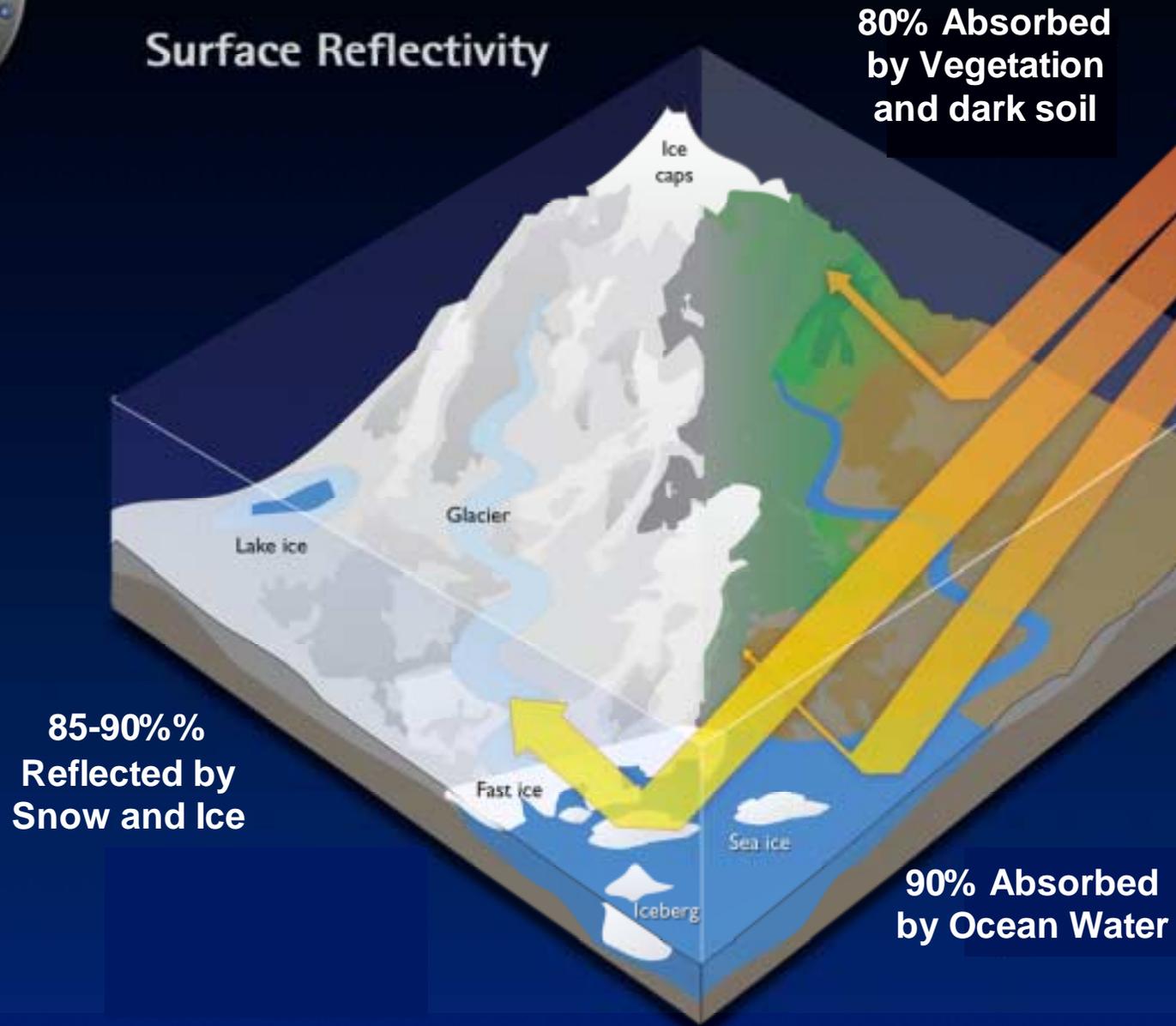


Johannessen et al (2004)



IMPACTS OF A WARMING ARCTIC

Surface Reflectivity



85-90%%
Reflected by
Snow and Ice

80% Absorbed
by Vegetation
and dark soil

90% Absorbed
by Ocean Water



IMPACTS OF A WARMING ARCTIC

What have we learned that is of particular importance to the people and governments of the Arctic region ?

United States of America

Canada

Greenland/
Faroe Islands/
Denmark

Iceland

Russia

Norway

Sweden

Finland





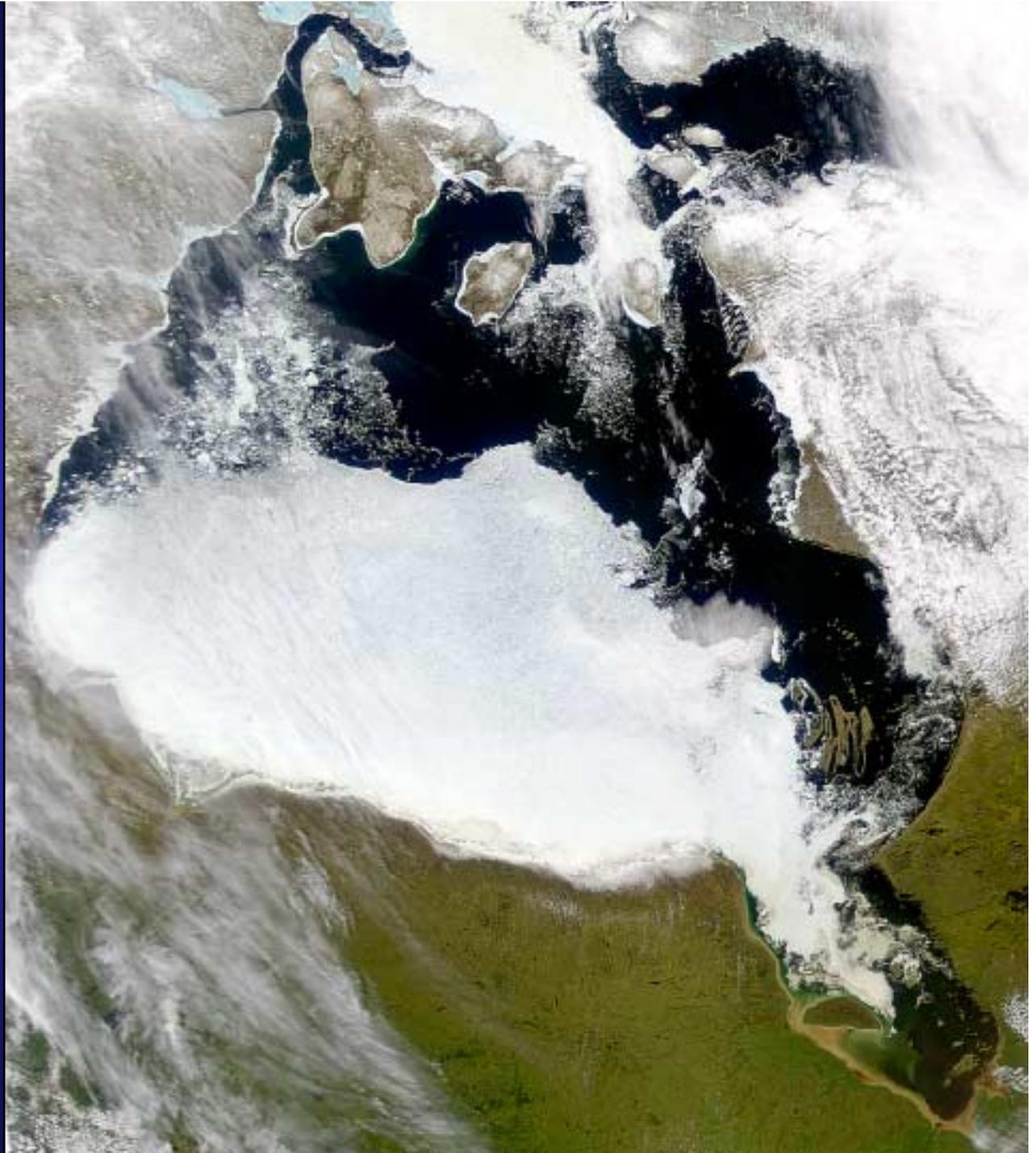
IMPACTS OF A WARMING ARCTIC

Animal species' diversity, ranges, and distribution will change.



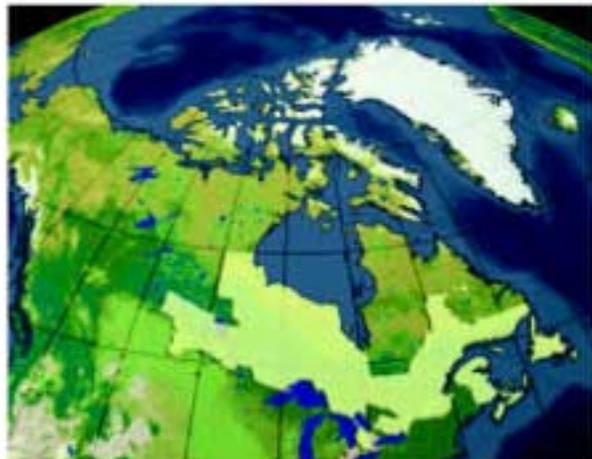
Hudson Bay

An early
indicator of
the changing
climate

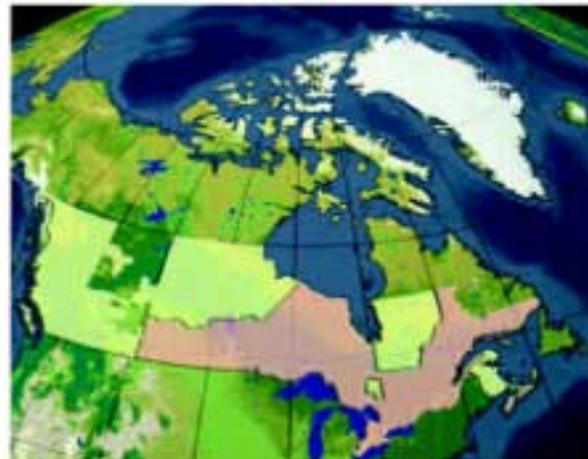




2001



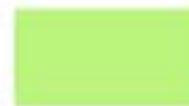
2002



2003



West Nile Virus Changes in Canada



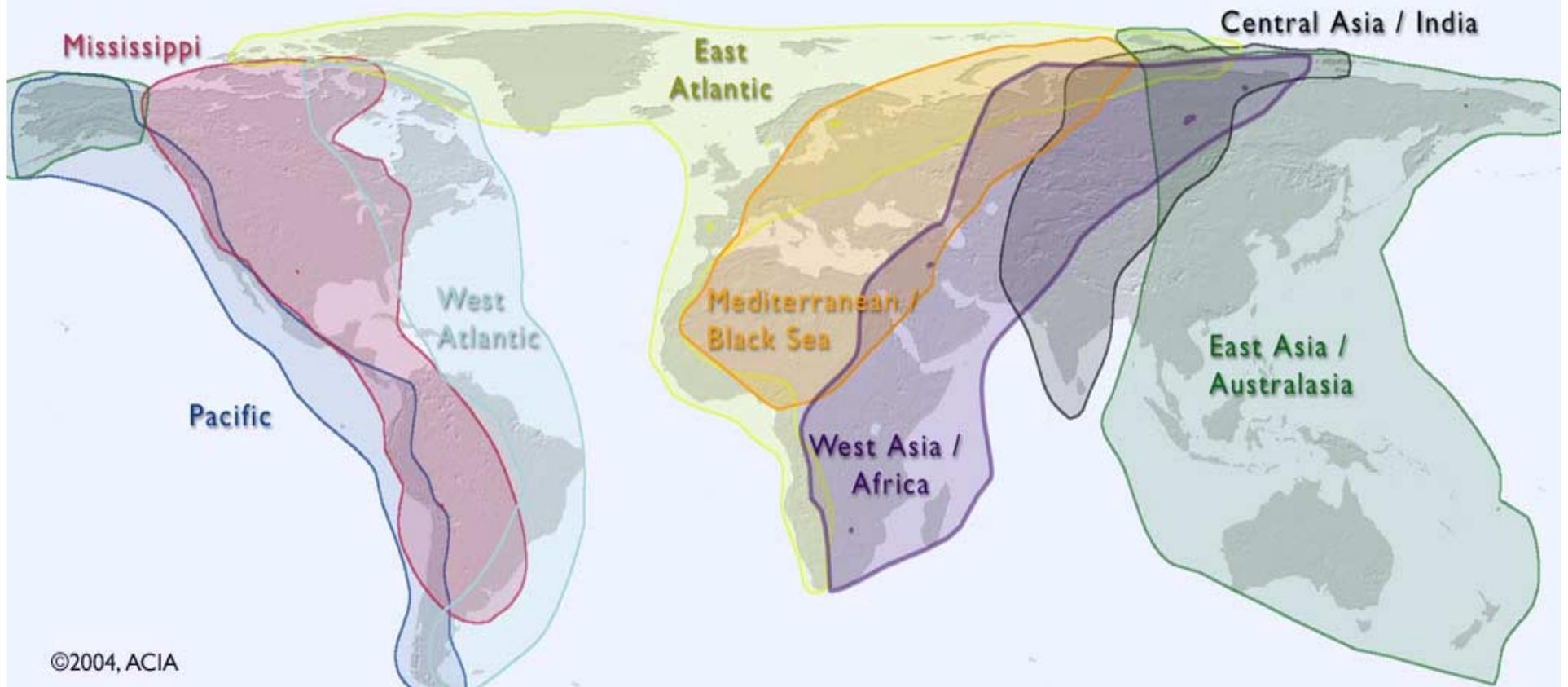
Dead Birds Submitted
for Testing



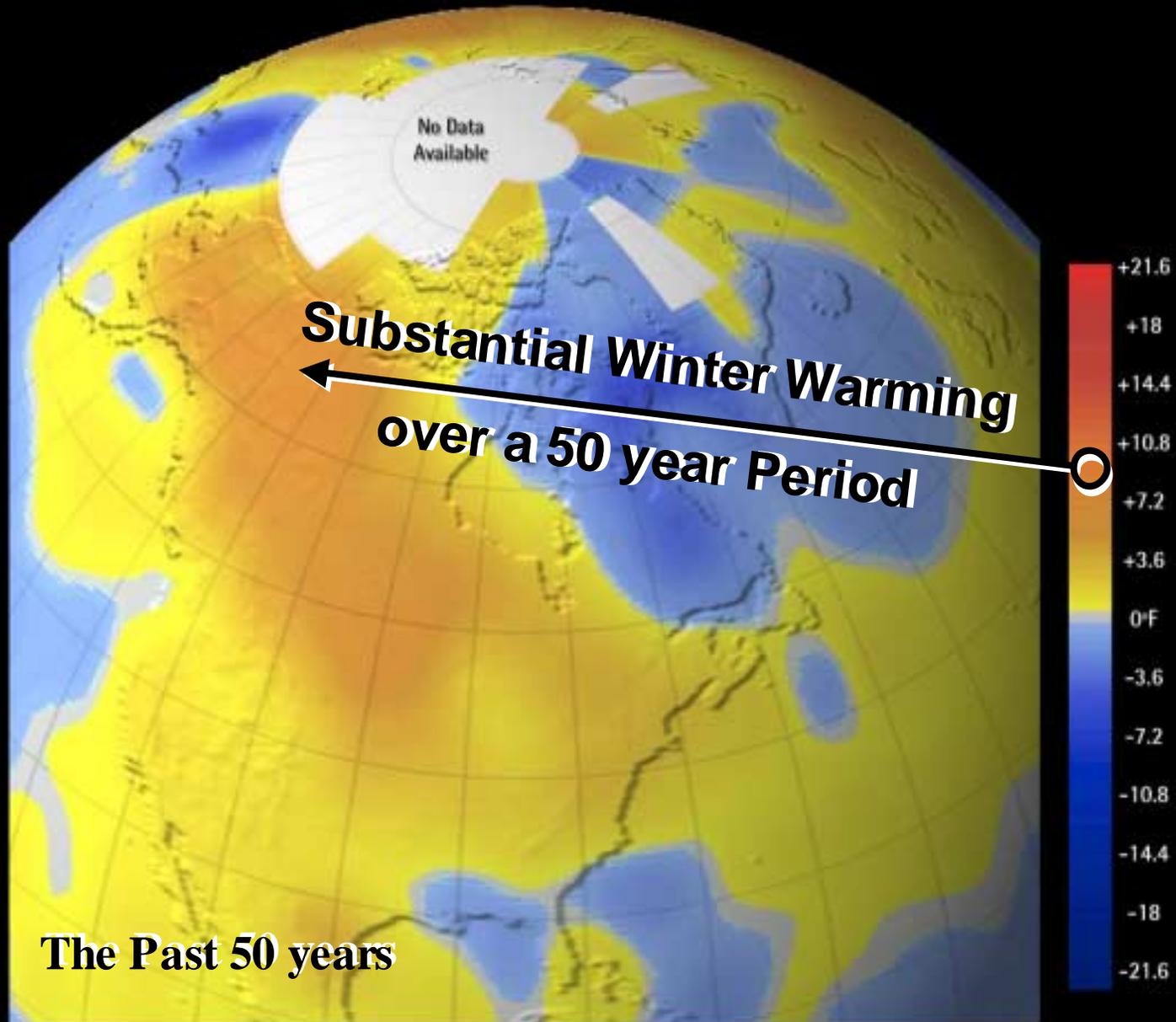
Tested Positive for
West Nile Virus

Wild Fowl Flyways

Annual Migration Routes to the North



Observed Surface Air Temperature Change: 1954 - 2003
(Winter -D,J,F)





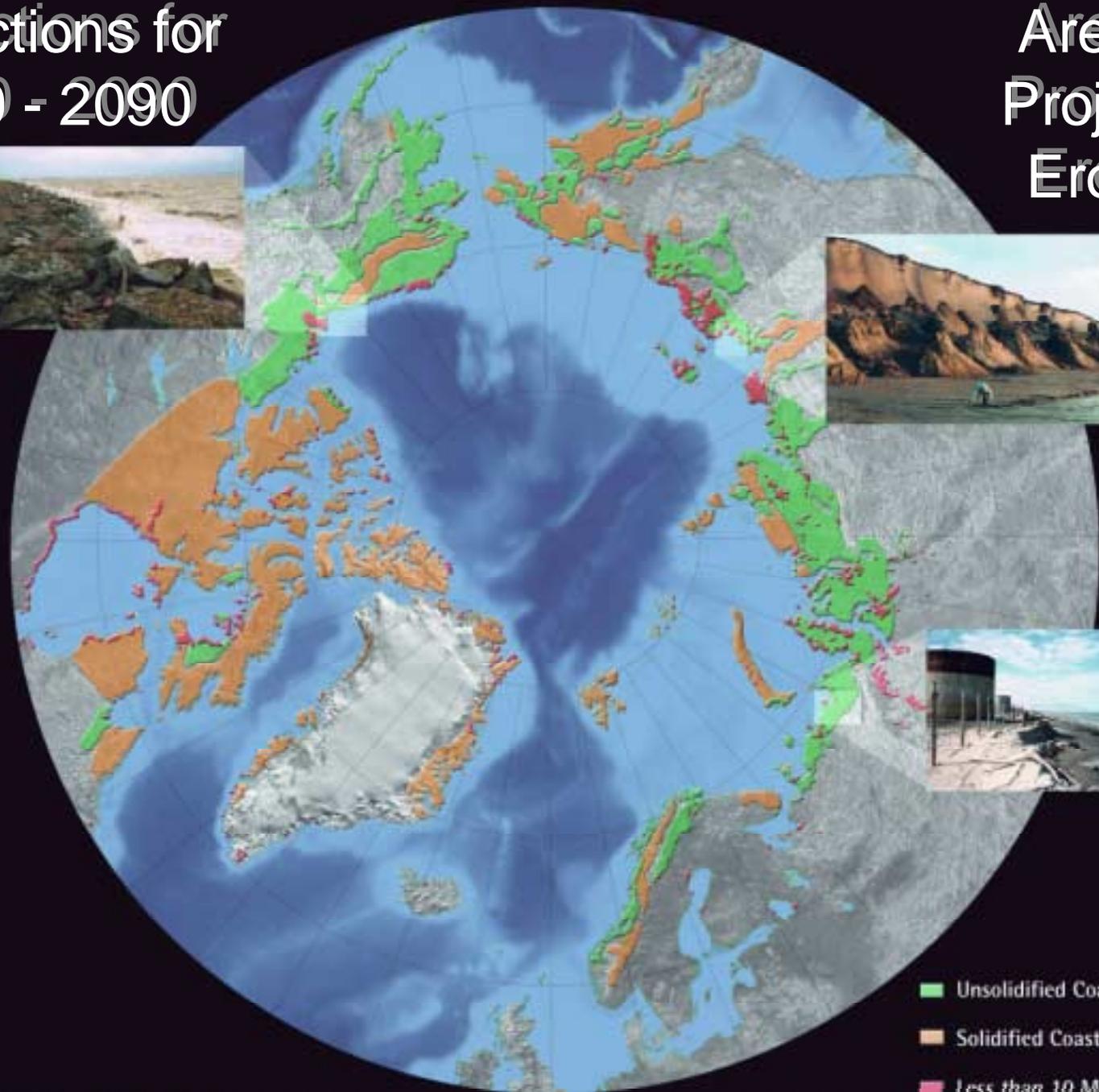
IMPACTS OF A WARMING ARCTIC

Many coastal communities and facilities face increasing exposure to storms.



Projections for 2070 - 2090

Areas of Projected Erosion



- Unsoldified Coasts
- Solidified Coasts
- Less than 10 Meters above average Sea Level



IMPACTS OF A WARMING ARCTIC



Melting of Permafrost is having a marked Impact of Buildings and Ice Roads

The Impacts imposed by a changing climate are really all about:

Ice:



Animals

People



The Climate is Changing NOW and it is Impacting People!



IMPACTS OF A WARMING ARCTIC





IMPACTS OF A WARMING ARCTIC



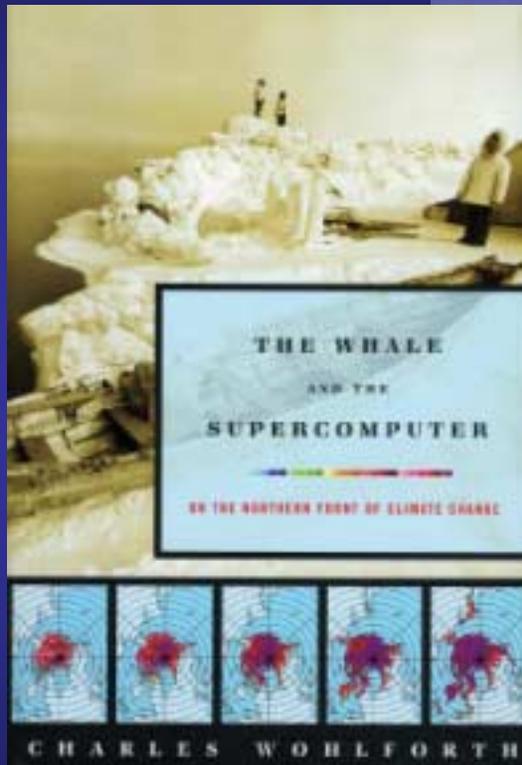


IMPACTS OF A WARMING ARCTIC

Indigenous communities are facing major economic and cultural impacts.



Recent Books of Importance

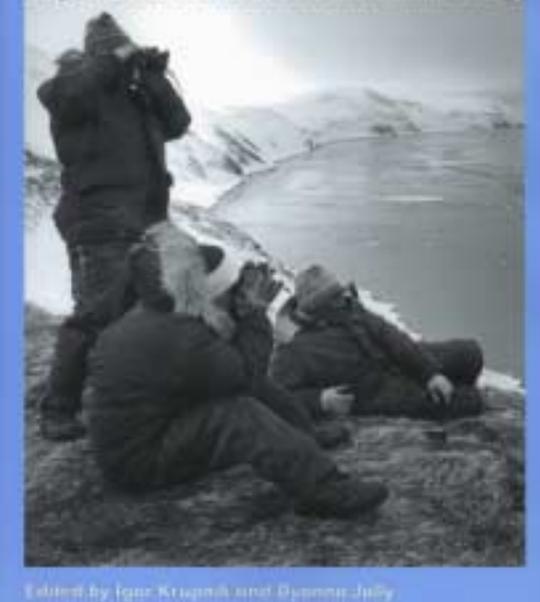


Carisul Oosetu, Chester Nongsook, George Nongsook, Christina Akiva, and Igor Krupnik

Watching Ice and Weather Our Way



The Earth is Faster Now:
Indigenous Observations of Arctic Environmental Change



Climate change isn't an abstraction in the far North. It is a reality that has already altered daily life of Native people who still live largely off the land and sea.

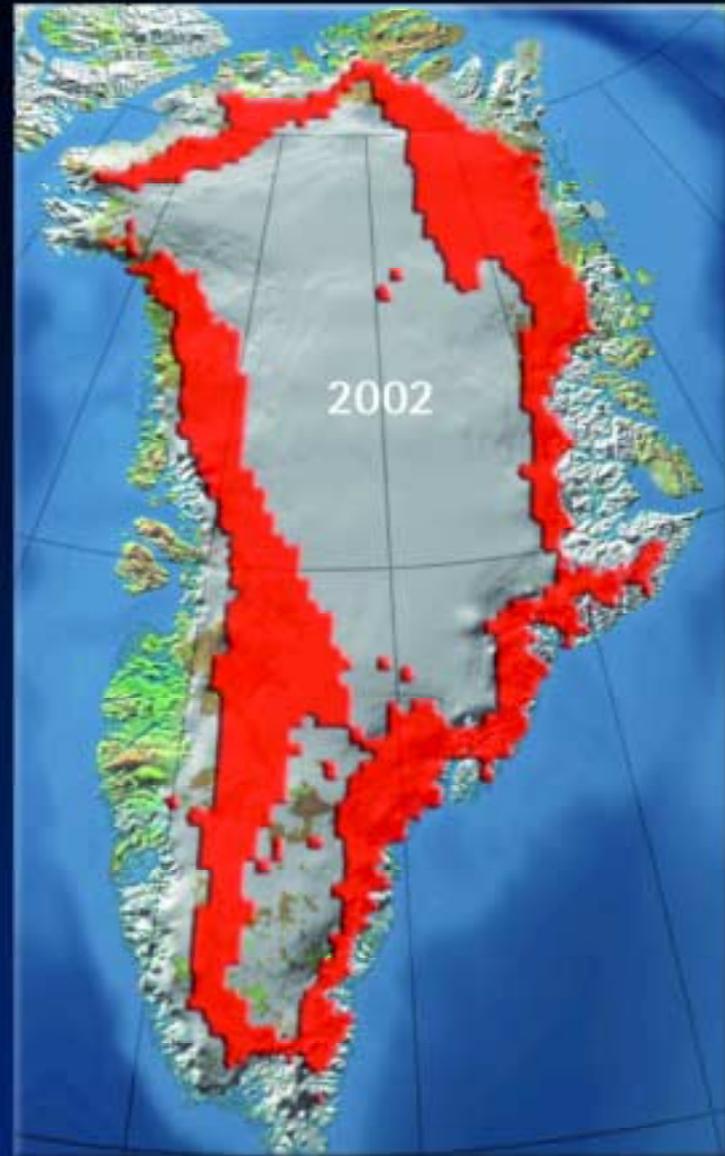


*Why should the rest
of the world care
about climate change
in the Arctic ?*



IMPACTS OF A WARMING ARCTIC

Greenland Ice Sheet Melt Extent



The Greenland Ice Sheet Dominates Land Ice in the Arctic

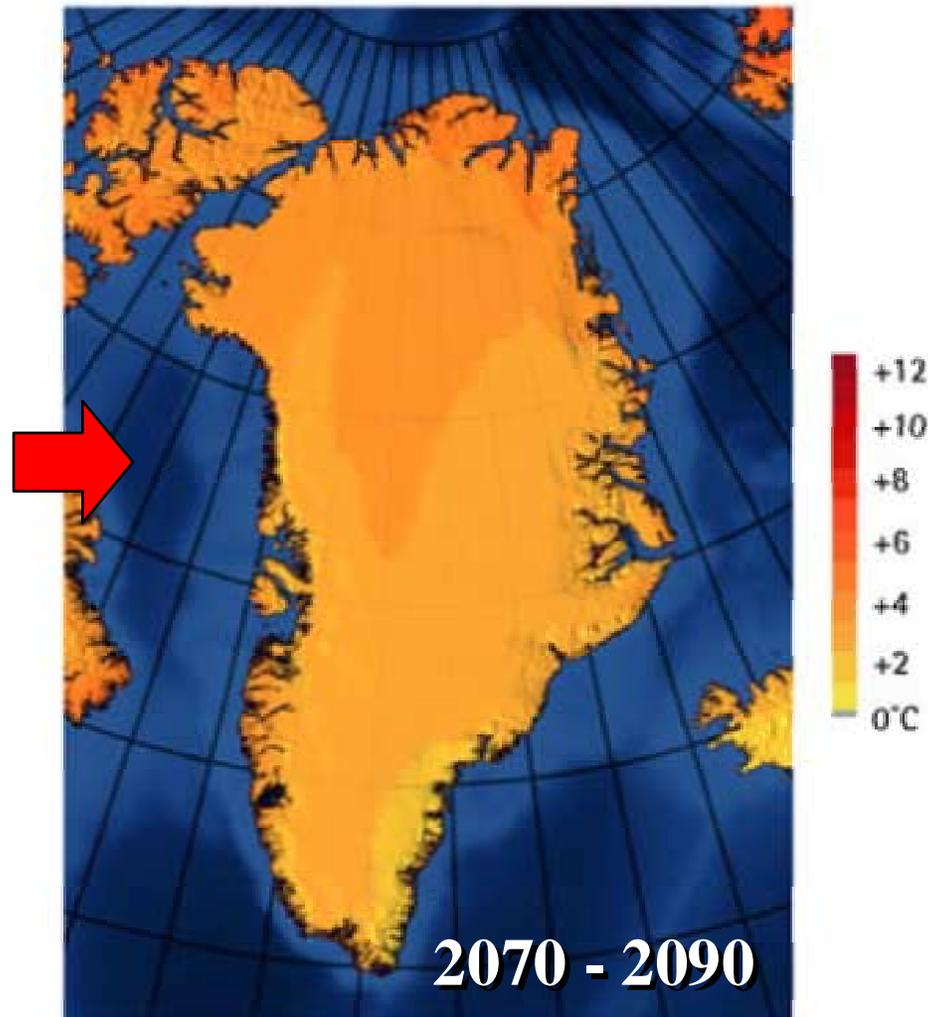
Over the past two decades, the melt area on the Greenland ice sheet has increased on average by about 0.7%/year (or about 16% from 1979 to 2002).



Source: Business Week Aug. 2004

Greenland's Annual Temperatures are Projected to Increase

Projected
to be in the
range of
 $+ 3^{\circ}$ to 6° C



©2004, ACIA / Map ©Clifford Grabhorn

Climate models indicate that the local warming over Greenland is likely to be up to three times the global average.



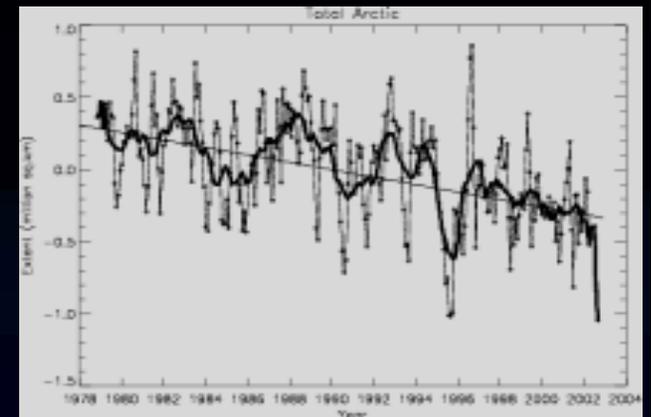
IMPACTS OF A WARMING ARCTIC

Areas in Florida Subject to Inundation
with 100 Centimeter Sea Level Rise





Arctic Climate Impact Assessment



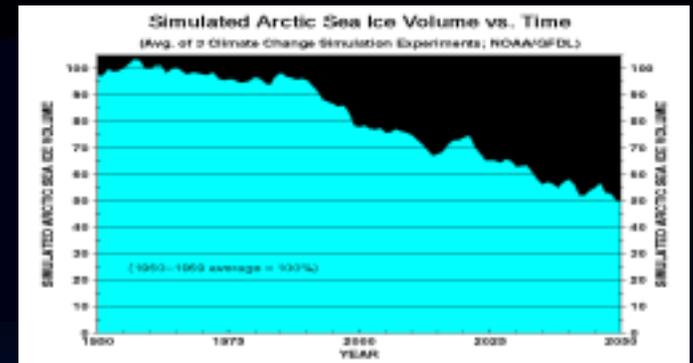
Observed sea ice September 1979

Observed sea ice September 2003





GFDL Simulation Projects 50% Reduction by 2050



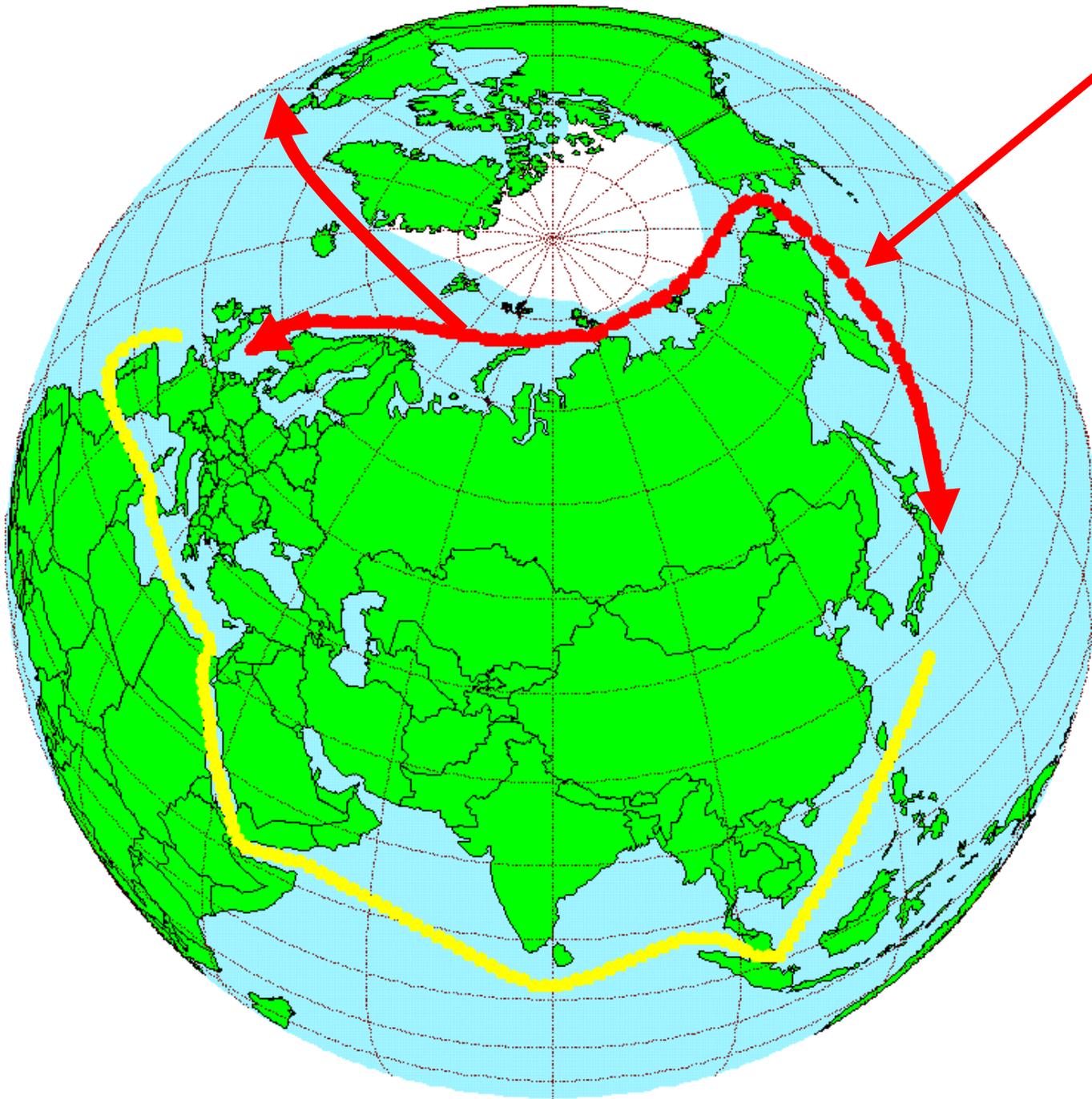
(2010-2030)

(2040 - 2060)

(2070 - 2090)



Projected Sea Ice Extent for Mid-September



**Northern Sea
Route is 45%
Shorter than
through the
Suez Canal**

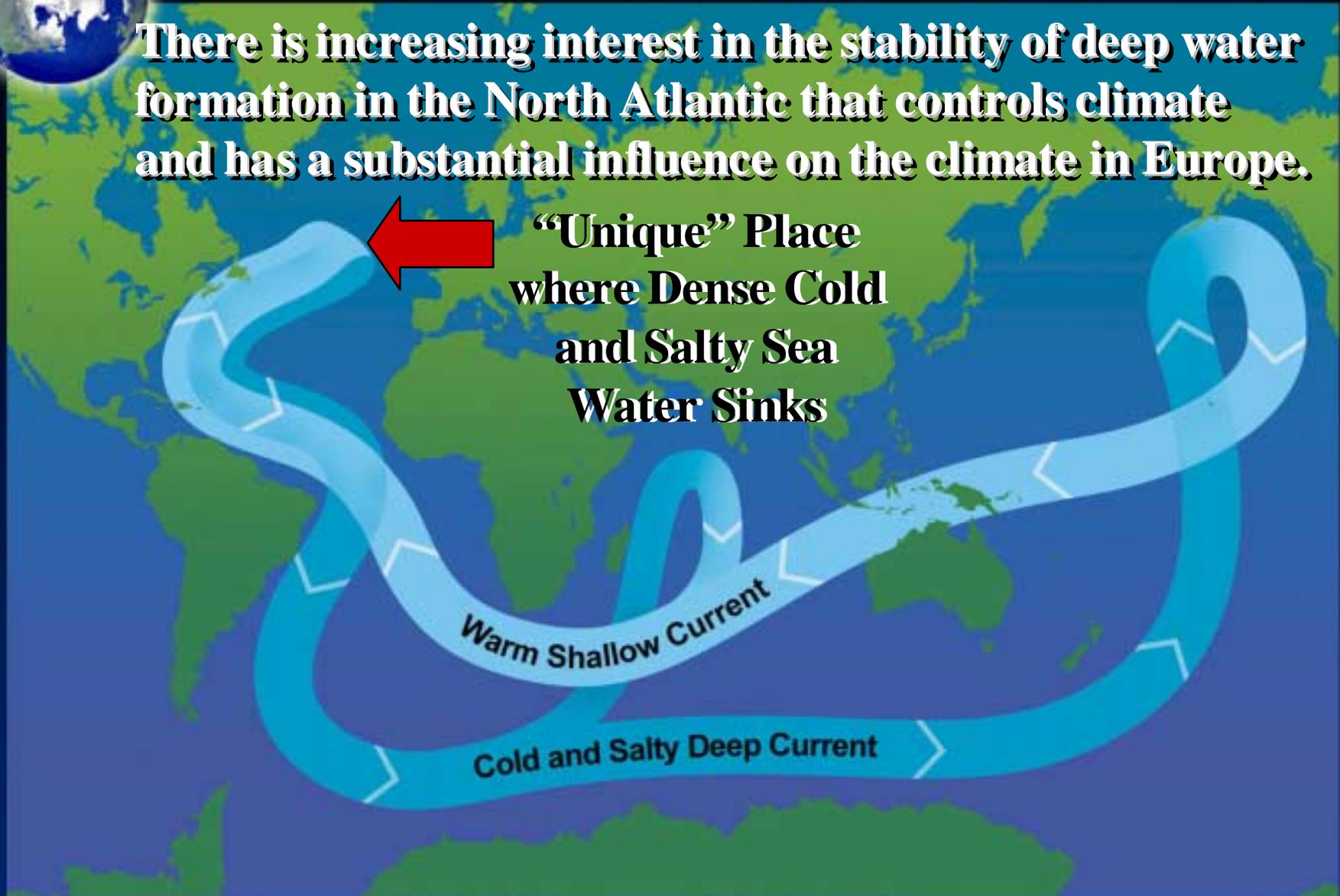
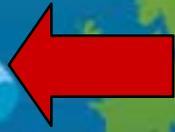
**The ACIA models
projects that the
current navigation
season of 20-30
days per year will
increase to 90-100
days by 2080, with
one model
indicating it is
likely to open to
this degree by
mid-century.**



Great Ocean Conveyor Belt

There is increasing interest in the stability of deep water formation in the North Atlantic that controls climate and has a substantial influence on the climate in Europe.

**“Unique” Place
where Dense Cold
and Salty Sea
Water Sinks**

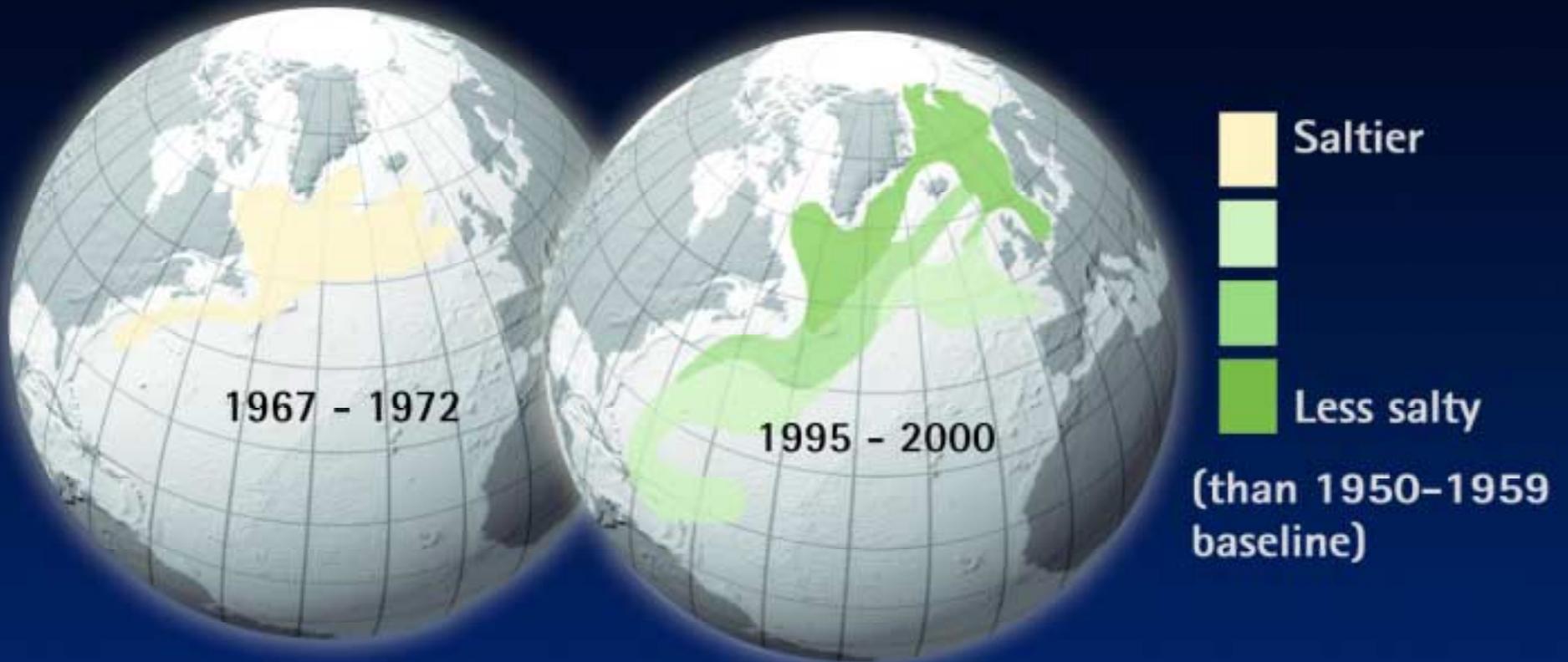


Global Thermohaline Circulation Pattern



IMPACTS OF A WARMING ARCTIC

Reduced Salinity of North Atlantic Waters

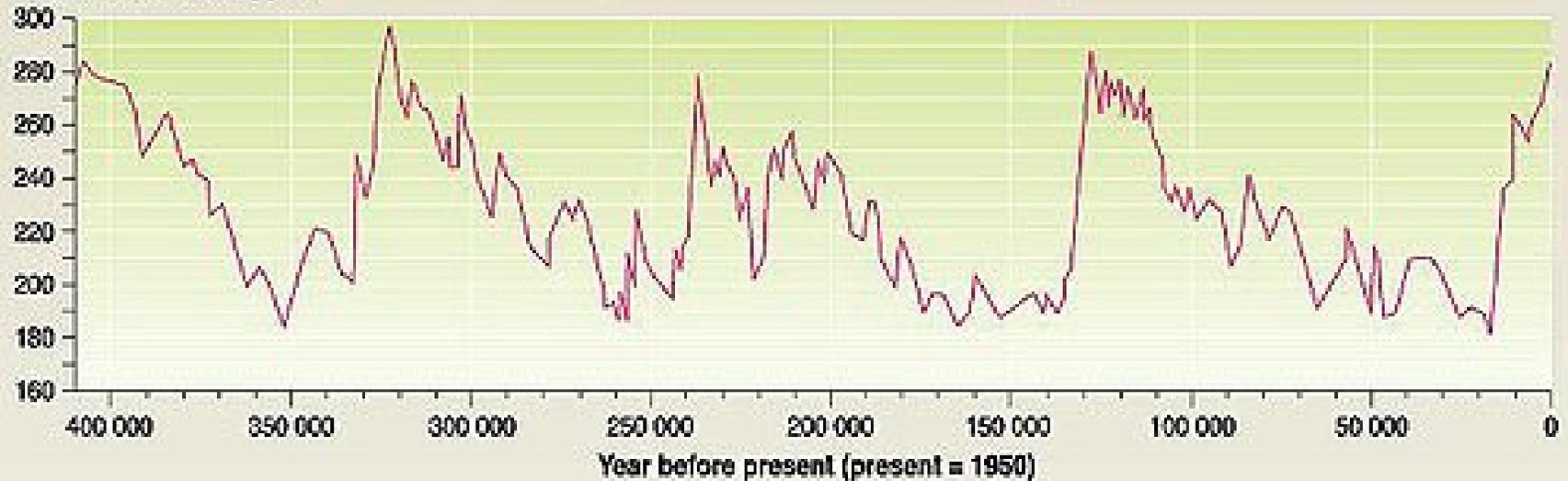




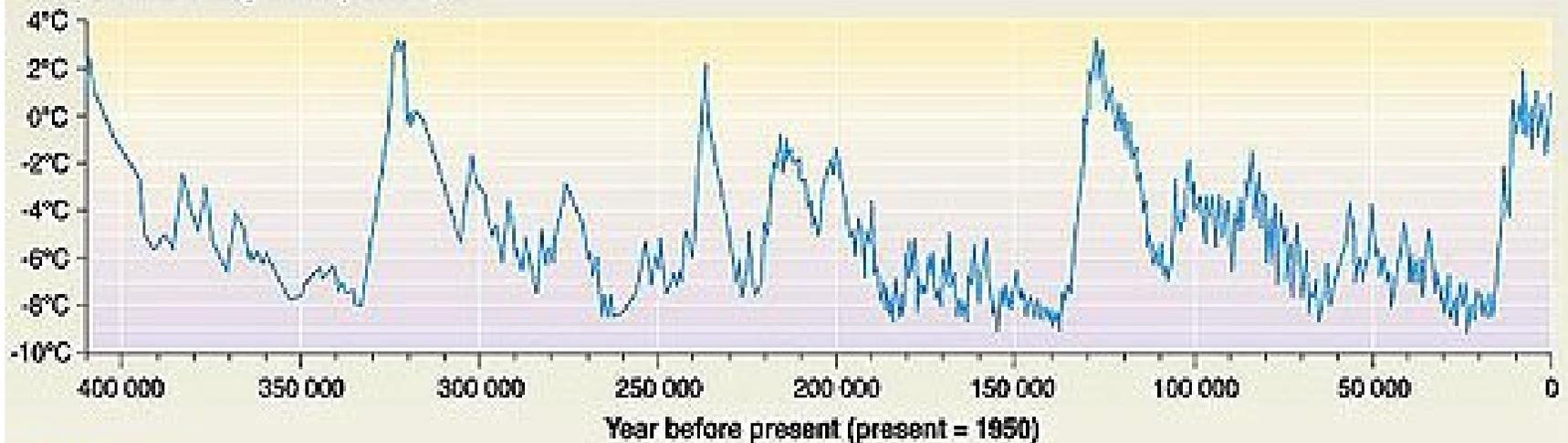
**How can we
project these
changes and what
does it mean ?**

Temperature and CO₂ concentration in the atmosphere over the past 400 000 years (from the Vostok ice core)

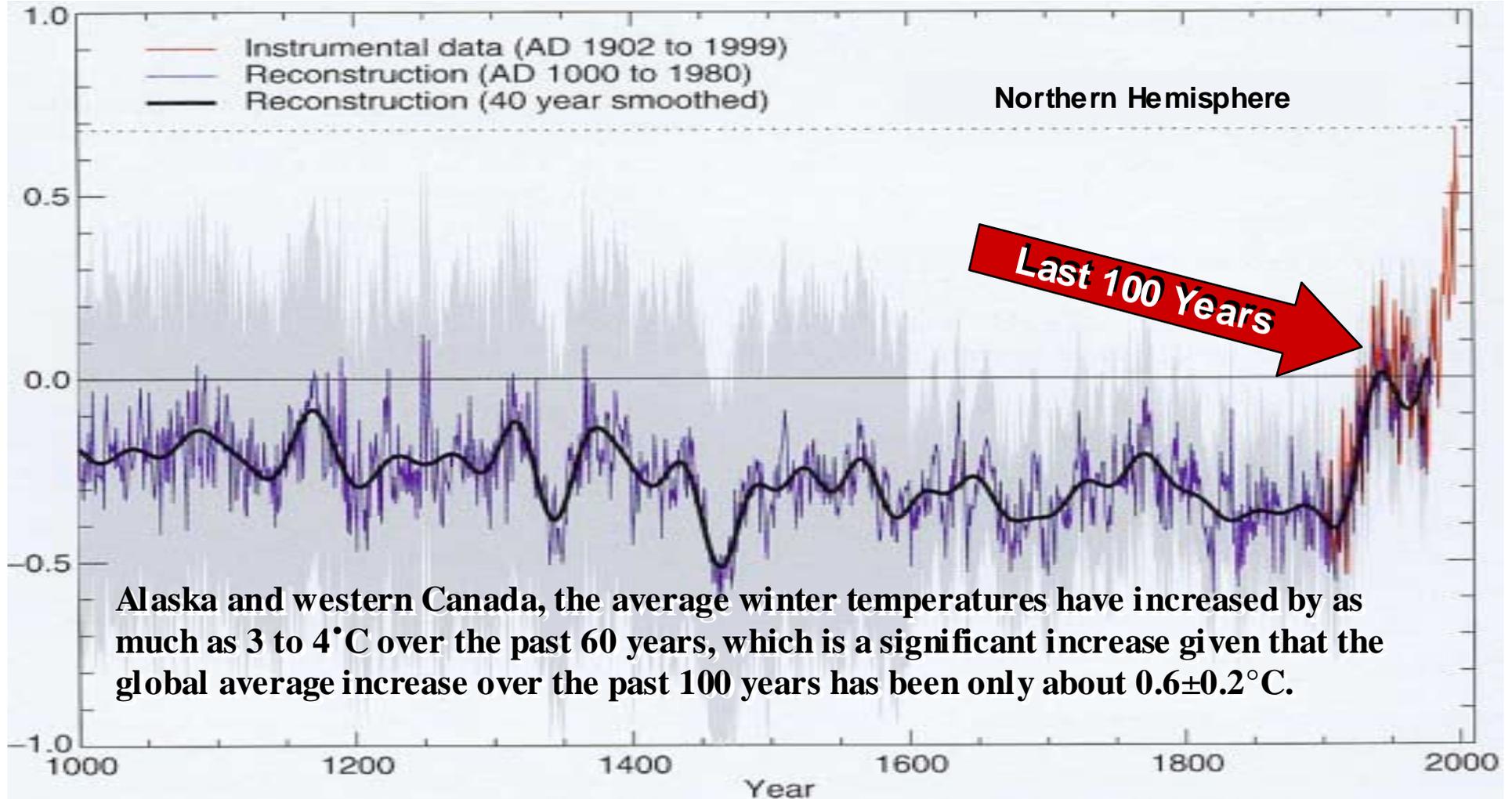
CO₂ concentration, ppmv

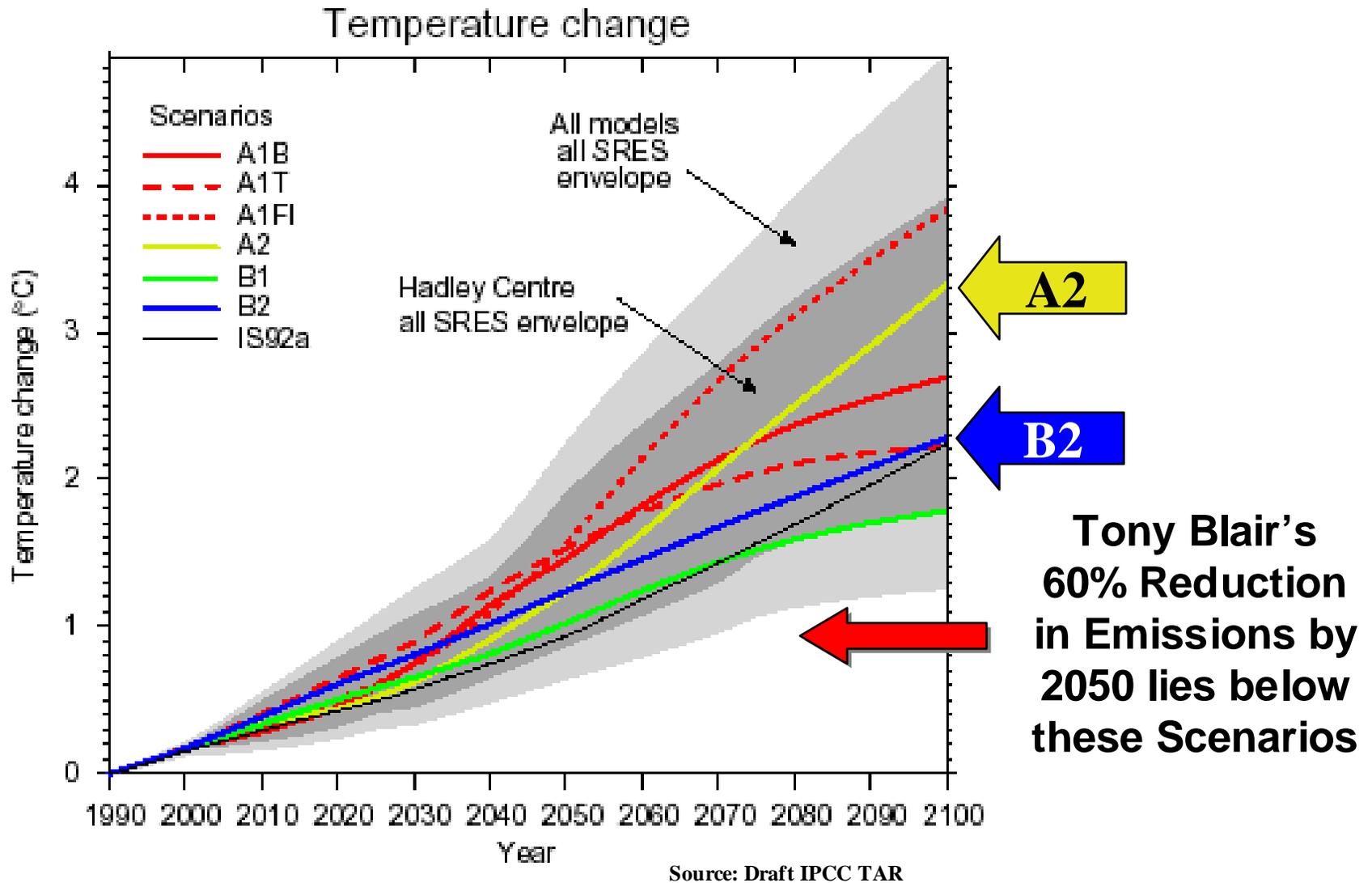


Temperature change from present, °C



Temperature Reconstruction for the Past 1000 Years



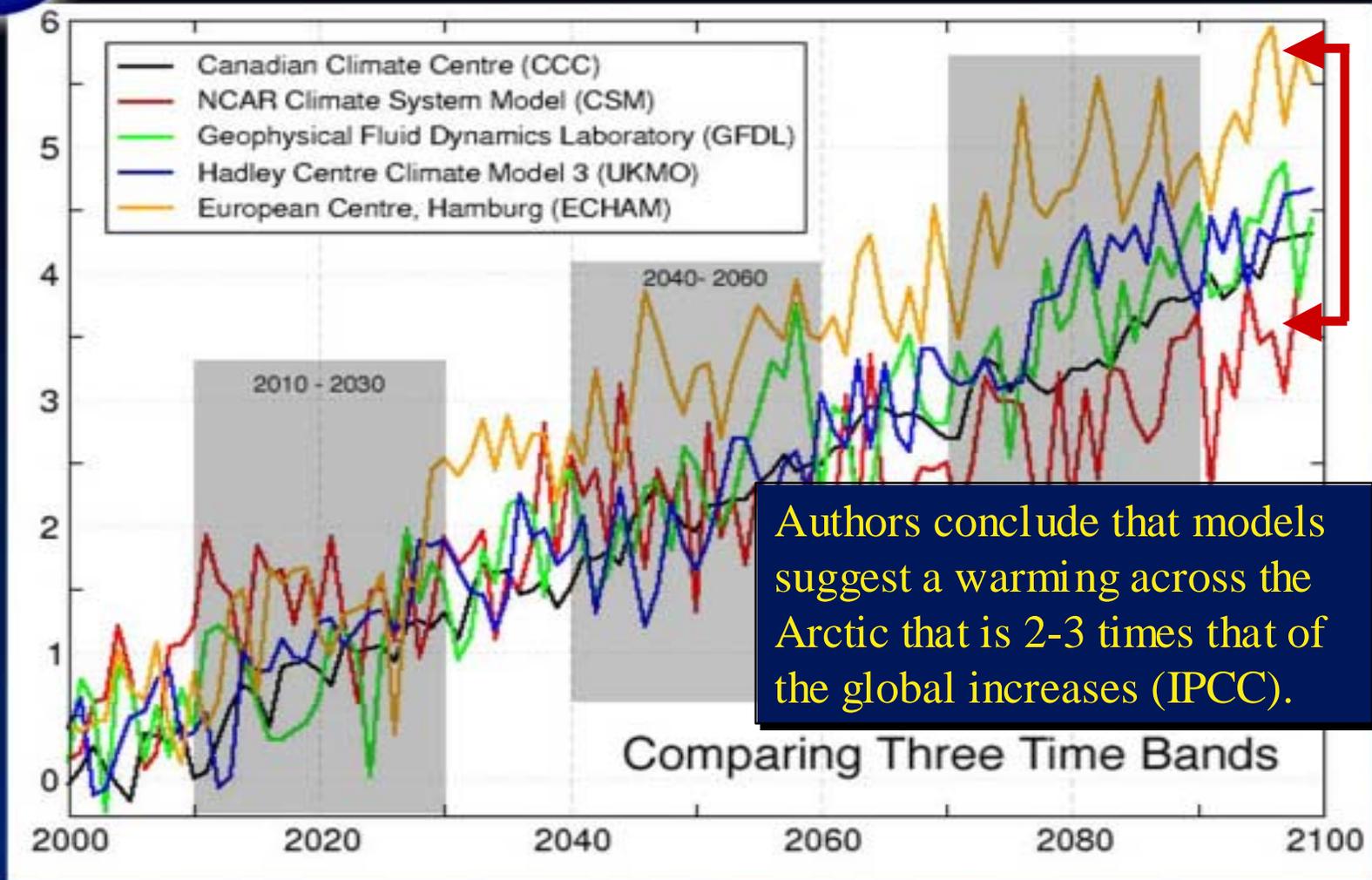


Temperature Projections from B2 Scenario for ACIA



Arctic Surface Air Temperature

60N - Pole: Change from 1990-1999 Average (deg.C)

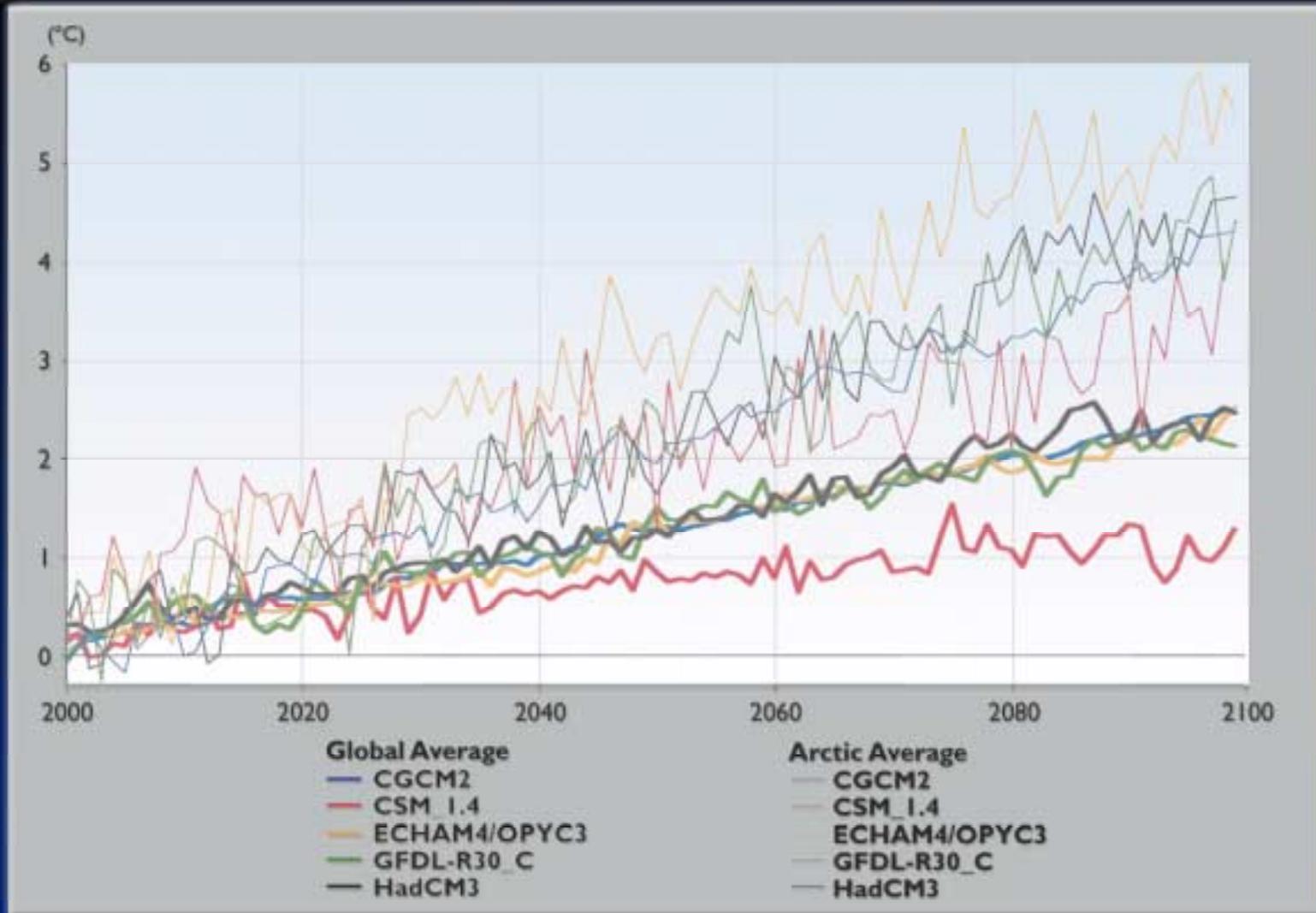


All of the models, regardless of the emissions scenario or computer model selected, project very significant warming for the Arctic over the next 100 years.

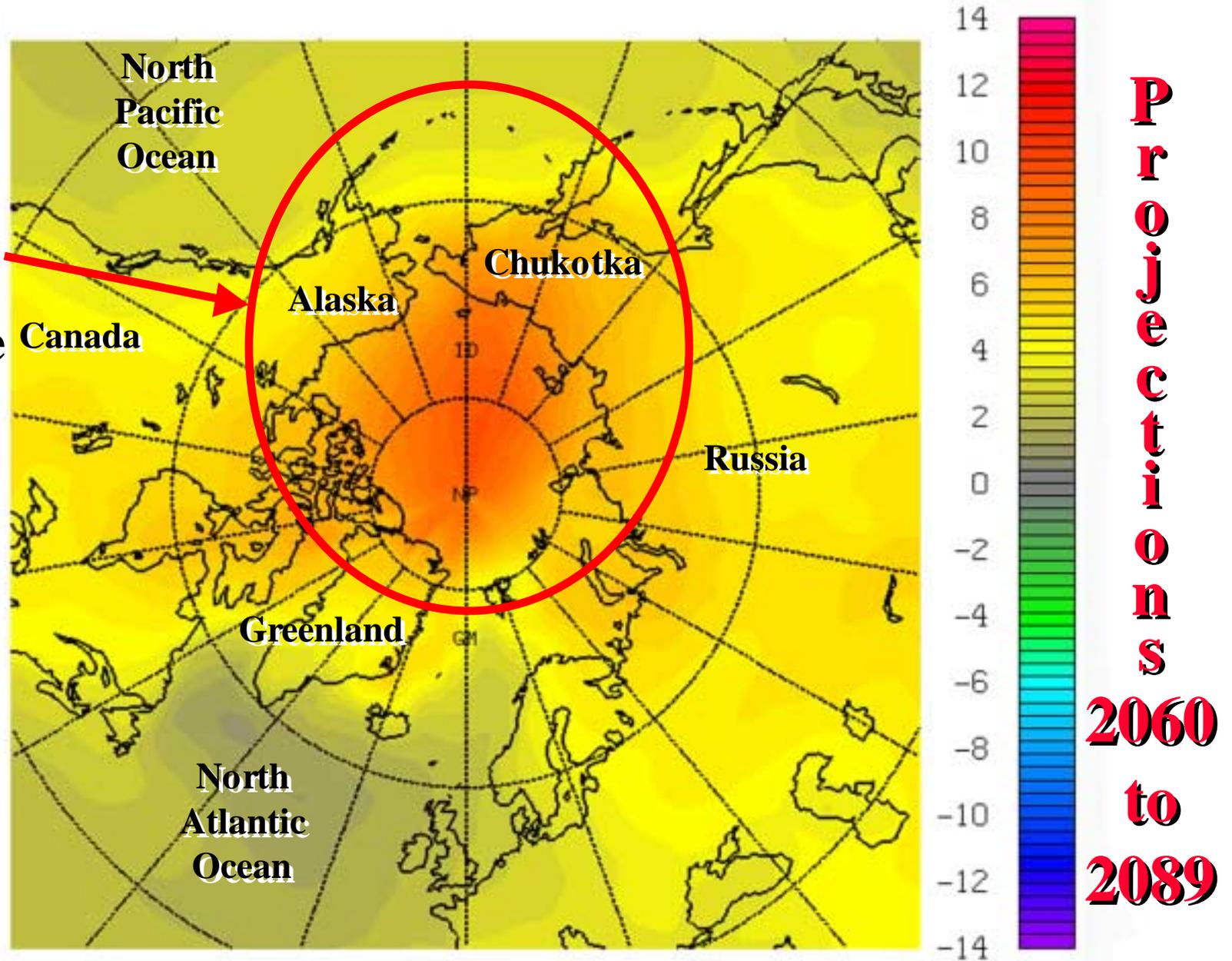


IMPACTS OF A WARMING ARCTIC

Projected Surface Air Temperature Change
(change from 1981-2000 Average)



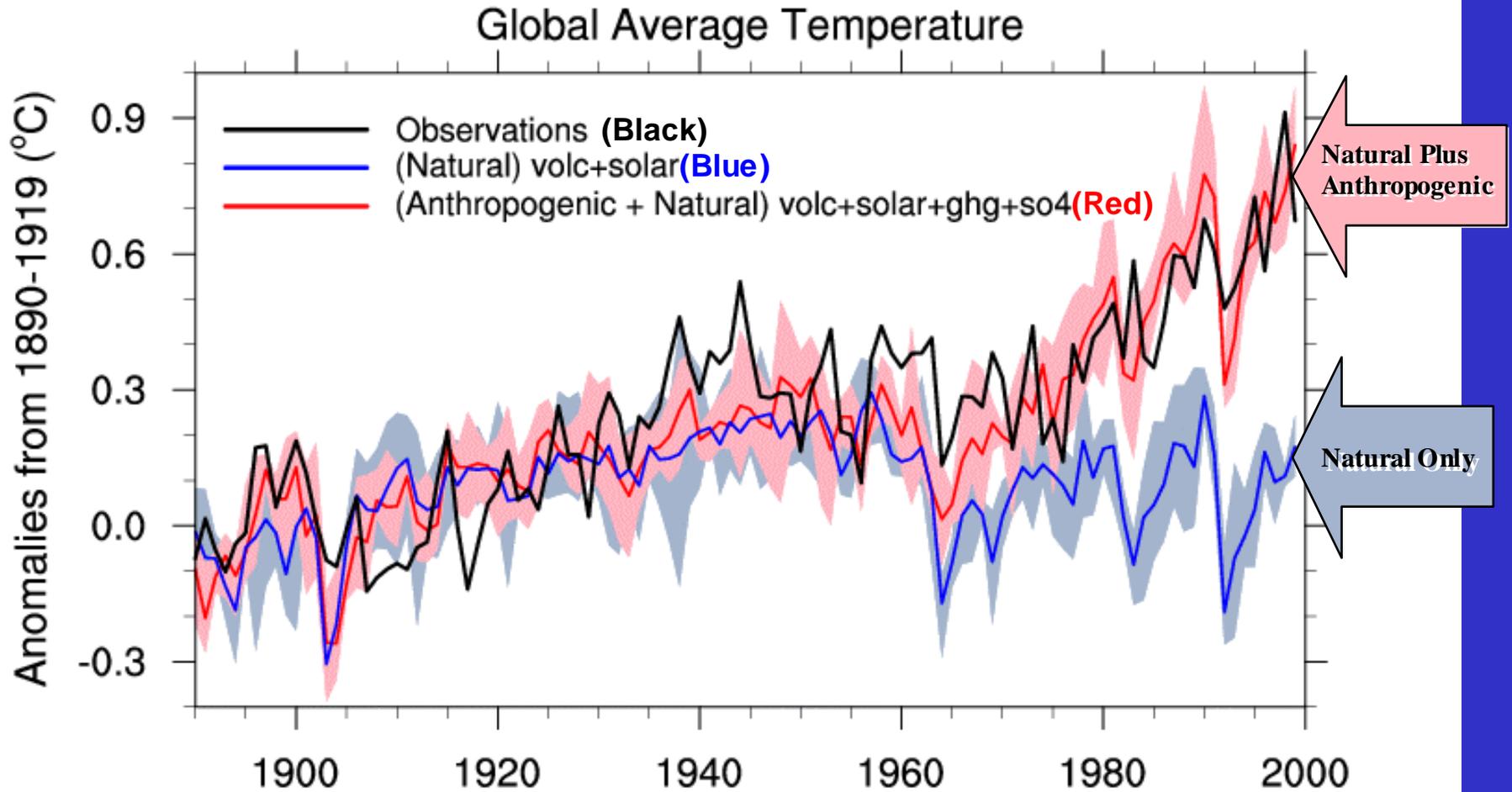
The warming here is in the range of $8^{\circ} - 10^{\circ} \text{C}$



**Surface Temperatures Projected by Five ACIA Models
Annual Differences for the 2060 to 2089**

Base: Average of 1961 - 1990

How well are the models depicting the last 100 years?



CO2 Concentration, Temperature, and Sea Level Continue to Rise Long after Emissions are Reduced

Magnitude of response

Time Taken to Reach Equilibrium

CO2 Emissions Peak Now to 100 Years from

Now

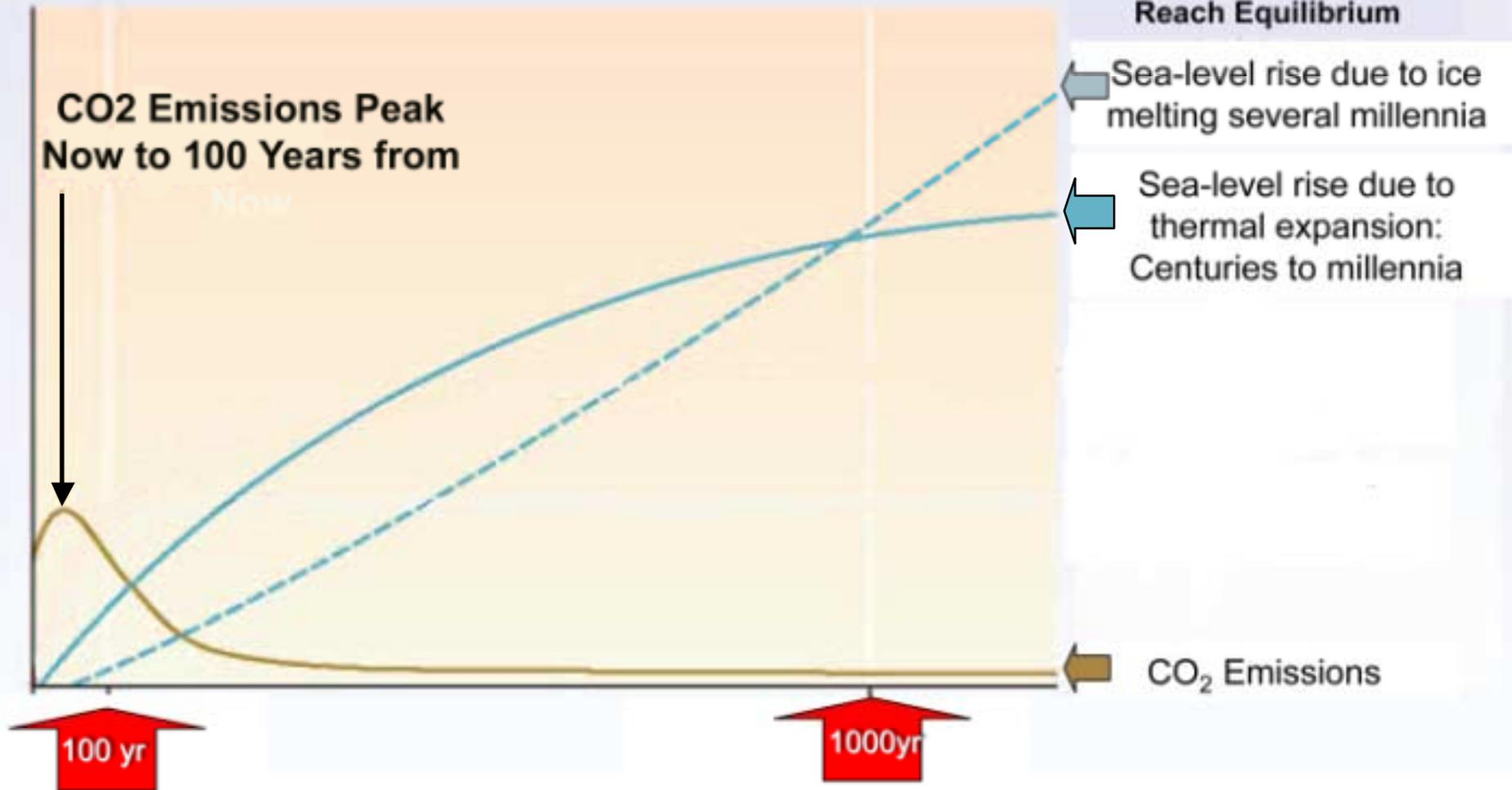
Sea-level rise due to ice melting several millennia

Sea-level rise due to thermal expansion: Centuries to millennia

CO₂ Emissions

100 yr

1000yr





The Arctic is now experiencing some of the most rapid and severe climate change on Earth. Over the next 100 years, climate change is expected to accelerate, contributing to major physical, ecological, social, and economic changes. Changes in the Arctic climate will also affect the rest of the world.

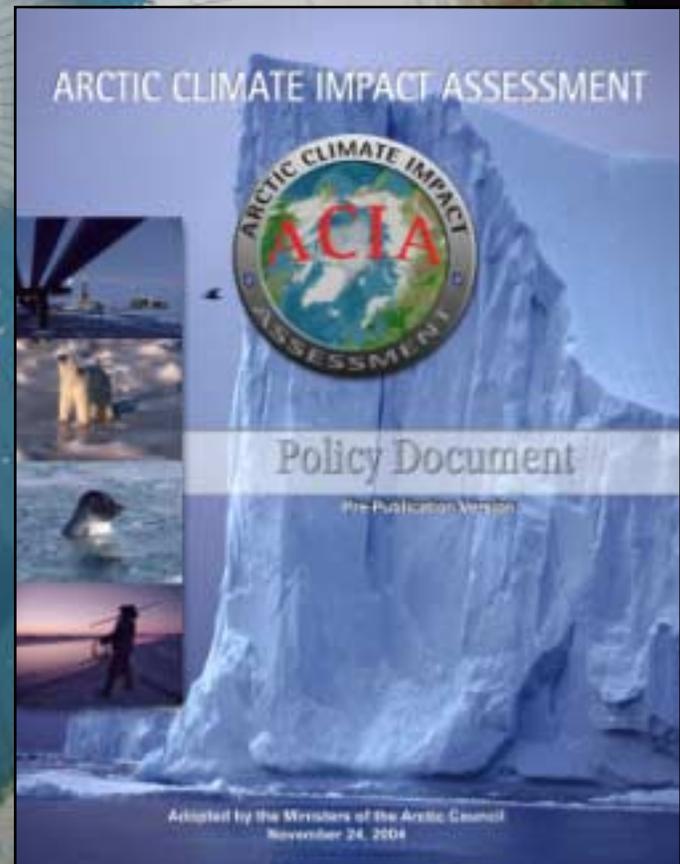
A satellite image of the Arctic region, showing the North Pole and surrounding landmasses. The image is tilted, showing the curvature of the Earth. The Arctic sea ice is visible as a large, white, textured area. The surrounding landmasses are shown in shades of brown and green. The sky is a deep blue.

The Arctic provides a Preview of Earth's Future Climate

**10 Years of Change in
Arctic is a Preview for
the next 25 Years in the
Rest of the world.**



*The Arctic Council
at its Ministerial
Meeting on Nov.
24, 2004 adopted
the Reykjavik
Declaration which
included Policy
Recommendations.*



Reykjavik Declaration:

- **“Recognize** that the Arctic climate is a critical component of the global climate system with worldwide implications,
- **Acknowledges** the need to consider the findings of the ACIA and other relevant studies in implementing their commitments under the UNFCCC and other agreements, including through adoption of climate change mitigation strategies across relevant sectors, and
- **Endorses** the ACIA policy recommendations for mitigation, adaptation, research, monitoring and outreach.”

Reykjavik Declaration further Notes:

Mitigation:

“To address the risks associated with climate change in the Arctic of the magnitude projected by the ACIA and other relevant studies, timely, measured and concerted action is needed to address global emissions.”

Reykjavik Declaration further Notes:

Adaptation:

“While mitigation is necessary to address the risks associated with climate change, the scenarios used by the ACIA and elsewhere project that some climate change is inevitable, indicating that continued adaptation is needed.”

Reykjavik Declaration further Notes:

Research, Observations, Monitoring and Modeling:

“Stress the importance of intensifying natural and social science research on impacts and adaptation, including studies to enhance understanding of fundamental processes and sustainability, procedures for integrating indigenous and local knowledge into scientific studies, and partnerships between indigenous peoples, local communities, and scientists in defining and conducting research and monitoring associated with Arctic climate changes.”

Reykjavik Declaration further Notes:

Outreach:

“Disseminate the ACIA documents within international fora in order to advance co-operation to address the environmental, social, economic and cultural implications of climate change in the Arctic.”

Issues of Adaptation

- ***Integrative*** across the economic growth & stability, human & social well-being, and environmental policies & practices
- ***Increasingly local*** and regionally focused, but set in a global context
- ***Anchored in the goals*** of improving the human condition while conserving earth's life support systems



Some Observation on Societal Adaptive Capacity:

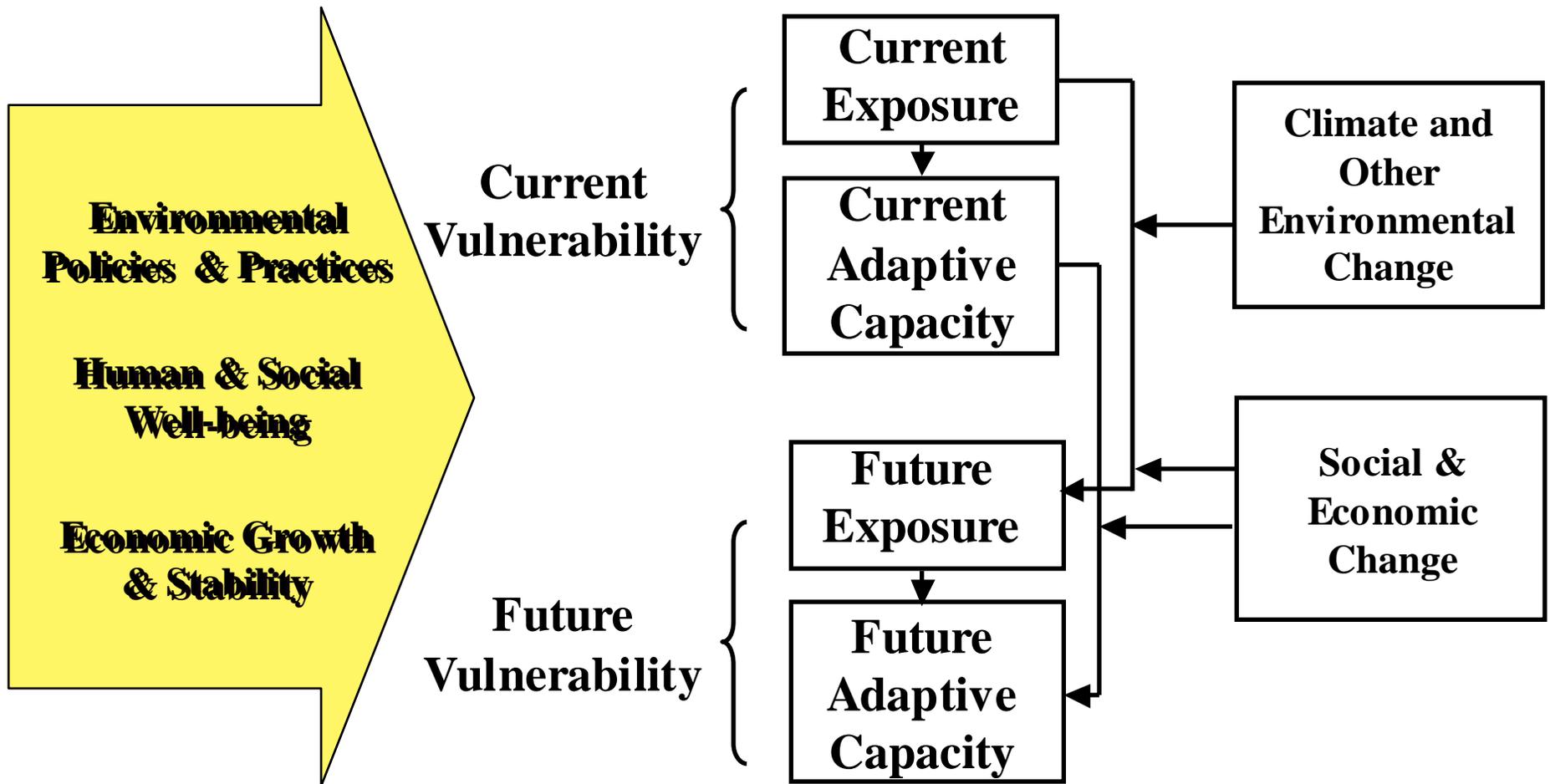
The ability to adapt is highly conditioned by the availability of options. The more 'degrees of freedom' available to a society, the greater their flexibility and the likelihood of finding a successful path of adaptive response.

For example, indigenous peoples of the north used to be highly mobile and migratory; these days they are more 'constrained' by the need for cash and by reliance upon fixed infrastructure like schools and hospitals. Thus the chances for successful adaptation, will require new strategies, strategies that exceed their historic abilities to adapt to major changes in their environment and social condition.

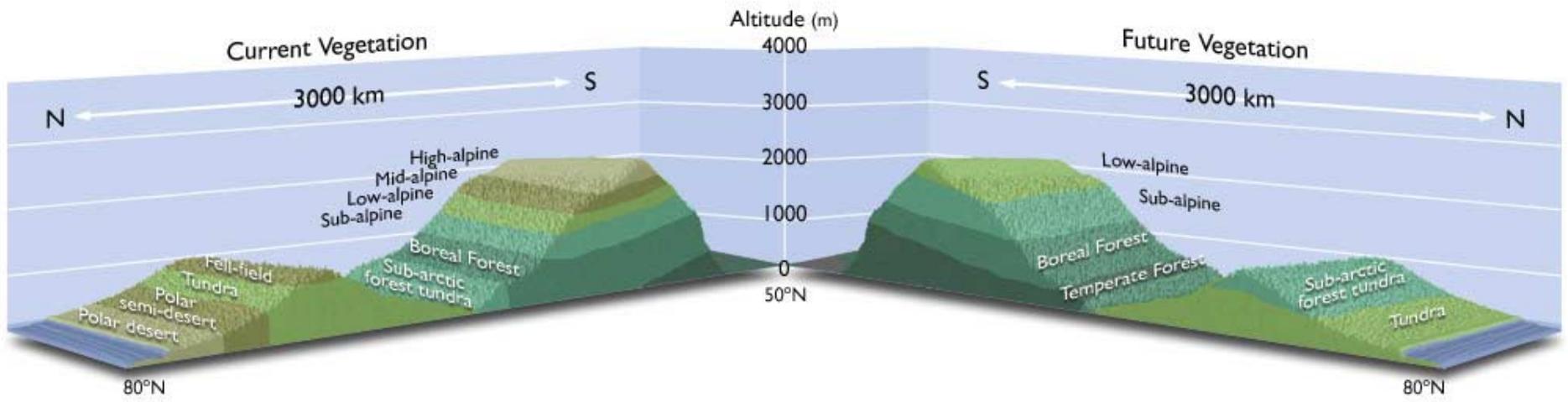
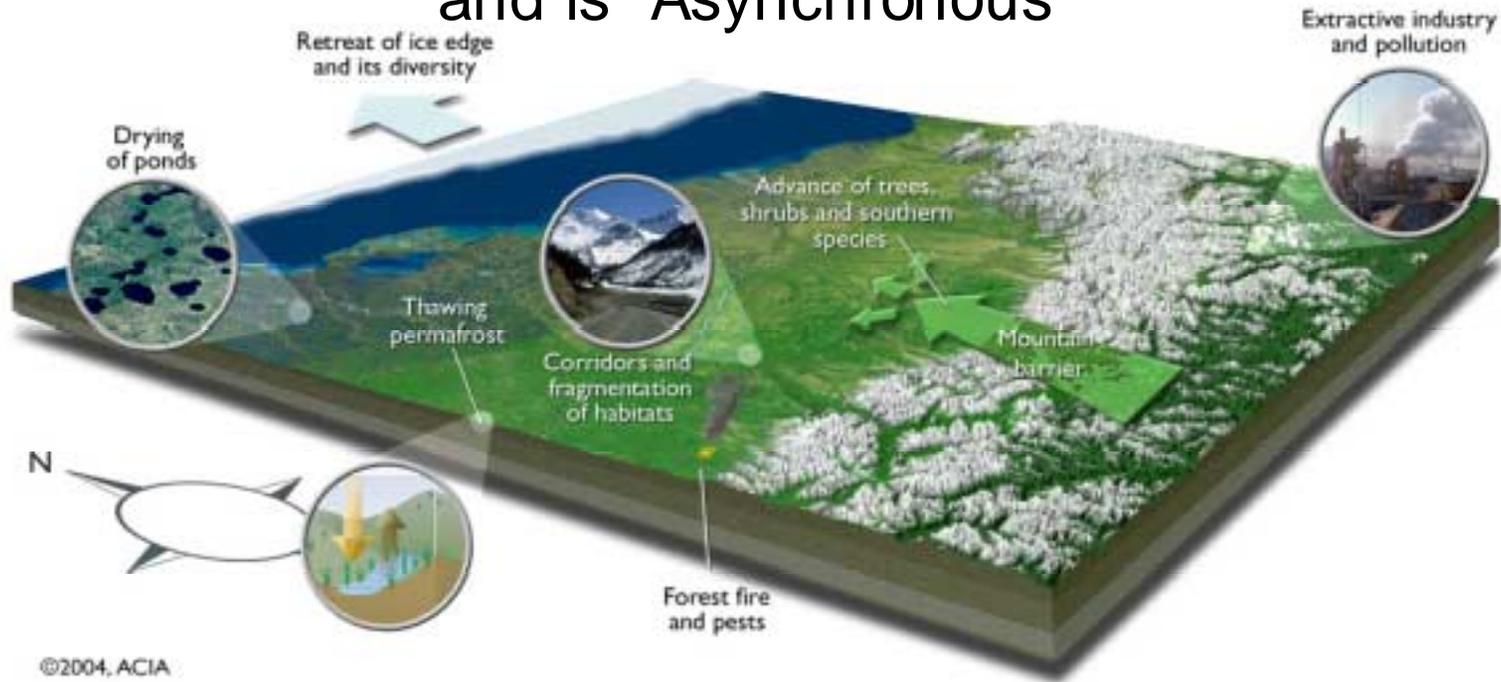
What are some of the questions to address that combine the effects of climate with other stressors to expand adaptive capacity:

- 1) How do social and biophysical conditions of human-environment systems in the Arctic influence the resilience of these systems when they are impacted by climate and other stressors?
- 2) How can the coupled condition of this system be suitably characterized for analysis within a vulnerability framework?
- 3) To what stresses and combinations of stresses is the Arctic coupled human-environment system most vulnerable?
- 4) To what degree can mitigation and enhanced adaptation at local, regional, national and global scales reduce vulnerabilities in the system?

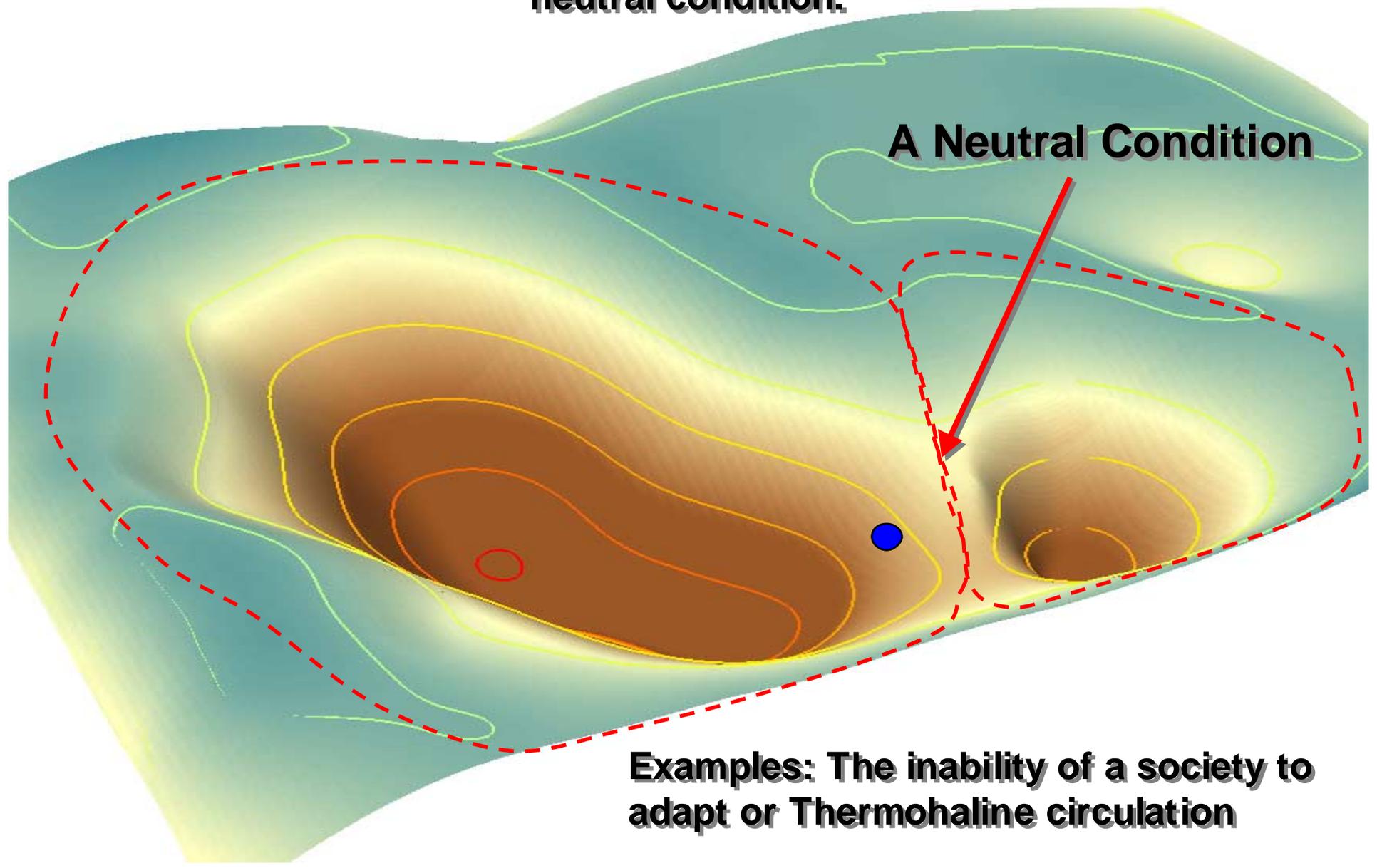
Adaptation in the Context of a Sustainable Future for the Planet and its People



The Adaptive Capacity of Ecosystems is “Rate Limited” and is “Asynchronous”



The Earth's systems (biophysical and societal) have experienced metastable states and can flip with modest changes when close to a neutral condition.

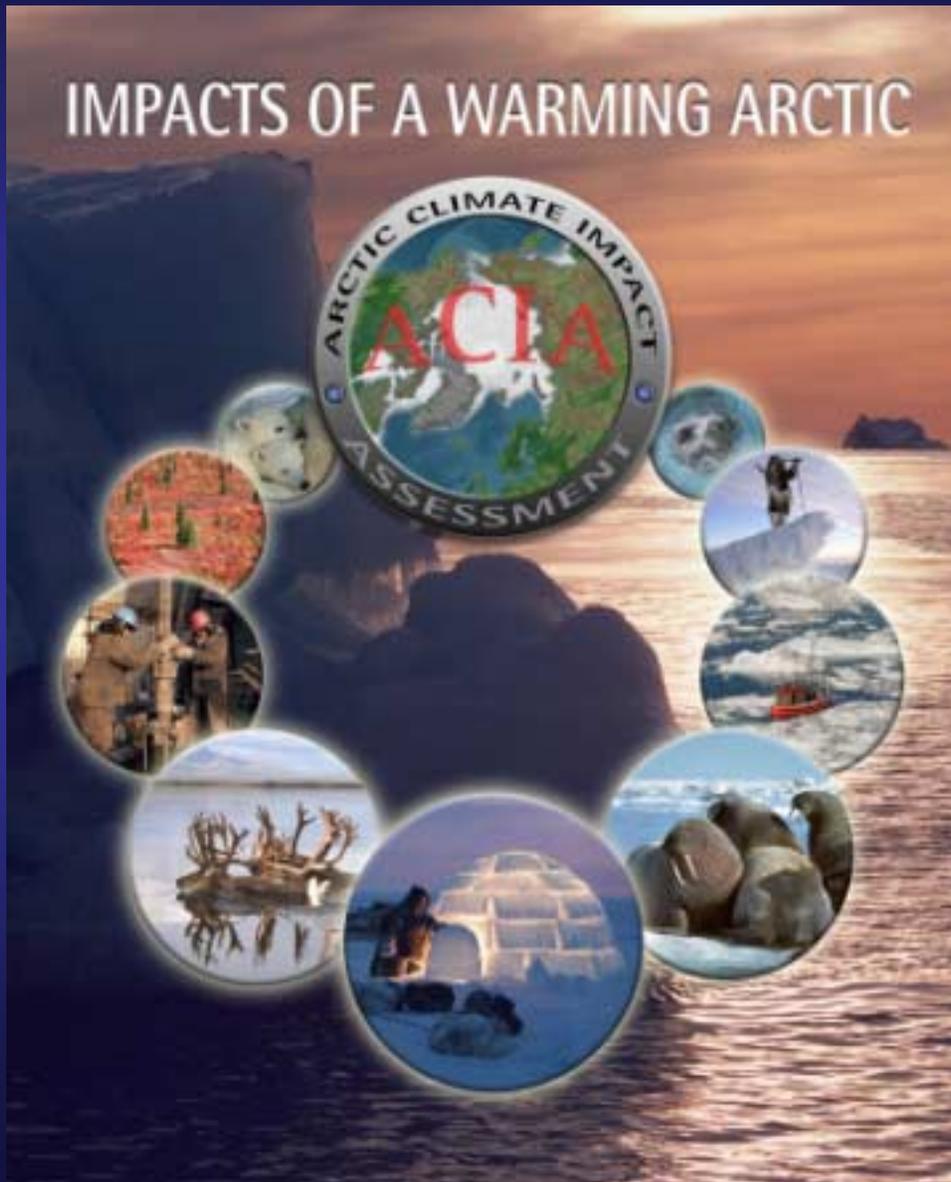


Examples: The inability of a society to adapt or Thermohaline circulation

ACIA

Arctic Climate Impact Assessment

The Arctic: The planet's "Bellwether" for climate change, and hence, is it possible that the Arctic might be the location to expand our efforts to more fully understand societal and ecosystem adaptive capacities?



Action

- UNFCCC
- Action Agreements
- National Action Plans
- Regional Action Plans
- Local Action Plans
- Etc.

Taking Knowledge through Wisdom to Action

- Political Realities
- Moral Judgments
- Economic Realities
- Culture
- Ethics
- Values

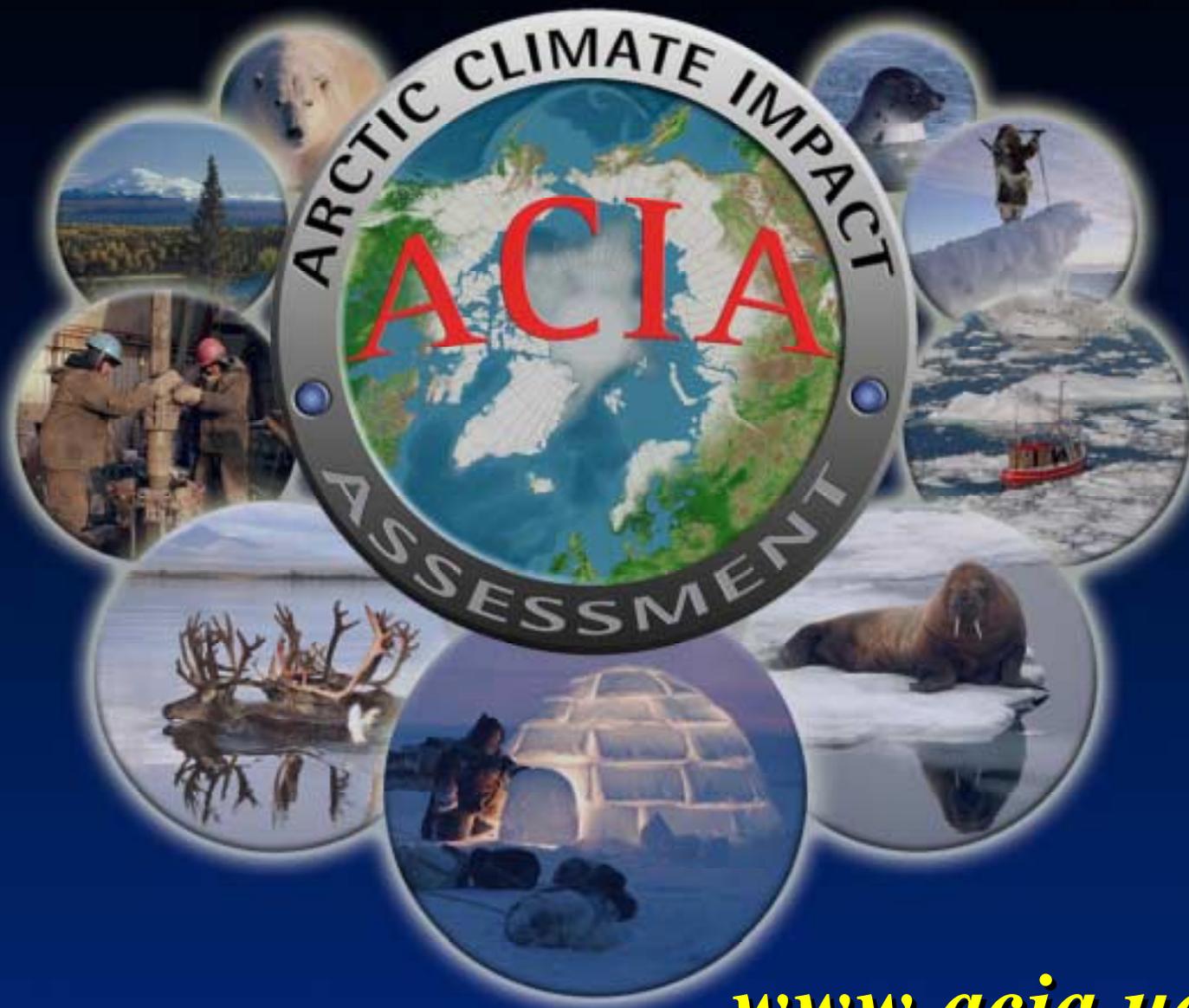
The Challenges of Taking Knowledge to Action

Valley of Indecision and Delay

Focusing Knowledge and Insights

- IPCC
- ACIA, AMAP, MA, etc.
- Country Assessments
- Regional Assessments

IMPACTS OF A WARMING ARCTIC



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