The Arctic on the Fast Track of Change
Dr. Mark Serreze
Senior Research Scientist
National Snow and Ice Data Center

Observed Changes in the Arctic
The Arctic has Warmed Strongly in Recent Decades

In 2005, temperatures were 2-4 deg. C (4-7 °F) above normal.

Arctic temperatures for 2005, relative to the period 1979 to 2005
The Arctic’s floating sea ice cover has declined sharply in the past 25 years, with extreme losses in the past four summers.
Greenland Ice Sheet is Melting

There are indications of accelerated melt of the Greenland Ice Sheet
Melting Fosters Further Melting

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Roger Braithwaite

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Permafrost

Permafrost - perennially frozen ground - underlies most of the Arctic
Permafrost is warming, and in some areas is thawing, altering ecosystems, hydrology and infrastructure.
River Flow to the Arctic Ocean is Increasing

This increase from the major arctic rivers is freshening the Arctic Ocean.
Tundra is Transitioning to Shrub

Changes in Shrub Abundance: Chandler River, AK

Sturm, Racine and Tape: Fifty Years of Change in Arctic Alaskan Shrub Abundance
Satellite-Observed “Greening”

Increased plant production

Longer growing period

Vegetation index

Start of Growing Season
Change per year over 1988-2001

Impacts on Humans and Wildlife

Shrubs → less lichen forage, harder walking
Dr. Charles Vörösmarty

Director, Complex Systems Research Center
University of New Hampshire

Feedbacks and Global Linkages
Arctic Changes Have Global Implications

- Are these changes a collection of independent events or are they linked?
- Are these changes a purely arctic phenomenon?
- Are there tipping points and surprises?
The Arctic has Important Roles in the Larger Earth System
The Arctic Generates Important Planetary Feedbacks

The Ice-Albedo (Reflectivity) Feedback

For every 100 units of incoming sunlight

10 units reflected

85 units reflected

Open Water

Loss of Sea Ice Reinforces Melting

Sea Ice
The Arctic Generates Important Planetary Feedbacks

The Taiga-Tundra Feedback

For every 100 units of incoming sunlight

Expansion of Boreal Forest Melts Snow Earlier Lengthens Ice-Free Period Reinforces Warming
These Feedbacks Amplify and Reinforce Each Other

Physics and Biology Define the System State

Earth system model sensitivity tests...stepwise inclusion of processes

(temperature change relative to common benchmark)

From: Wasson and Claussen 2002
Arctic Freshwater Moves into the Atlantic

Eurasian Arctic Rivers show increasing flow

Hemispheric-Scale freshening of the North Atlantic Measured Changes over 1950s-1990s
Arctic Water Drives Ocean Circulation

Circulation is dependent on freshwater in the Arctic and mixing in high latitude seas.
Arctic Water Drives Ocean Circulation

With increasing freshening... a potential and potentially rapid slowdown could occur with important implications on planetary heat balance.

Consequences of Arctic hydrological change thus could:
- have thresholds
- invoke global footprints
- occur when we have many more billions of people to feed and support
Need for Monitoring

Monitoring of the changing state of the pan-Arctic is far from complete and remains in jeopardy.
Dr. Joshua Schimel
Chair and Professor of Environmental Studies
University of California, Santa Barbara

Challenges and Opportunities
Policy Issues

Change creates both challenges and potential opportunities

How to minimize damage to the U.S., while maximizing our benefits?

*Three types of responses:*

- Minimize change (mitigation)
- Manage change (adaptation)
- Take advantage of opportunities that arise
National to Global

Biggest challenges of warming will be through water:

A more “energetic” water cycle:

- More evaporation- worse droughts & bigger storms
- Loss of the mountain snowpack:
  Increased forest and wildland fire

Higher sea level:

- Coastal storm erosion and storm surge:
  Florida, the Gulf coast, and northern Alaska
Major Changes in the Arctic

Warming means melting:
Loss of sea ice:
- Coastal erosion - loss of coastal communities
- Altered marine conditions & resources

Melting permafrost:
- Infrastructure - buildings, roads, pipelines, etc.
- Exploration - “hard frozen” days are decreasing
Major Changes in the Arctic

• Changing vegetation

• Altered subsistence and game hunting: changing lifestyles
Approaches to Change

Minimizing change: Must be national to international

- The economy is global
- Energy costs will remain high

Thus: the future economy will be driven increasingly by alternative energy, energy efficiency, and “climate friendly” technology.

Investing in developing that future economy is likely to benefit the U.S. regardless of what other nations do and how much the climate changes.
Specific Arctic Policy
(managing and taking advantage)

We must respond to changing:

Ocean conditions:
• Coastal settlements
Specific Arctic Policy (managing and taking advantage)

We must respond to changing:

Ocean conditions:

- Coastal settlements
- Marine resources changing
- Sea lanes opening up
Specific Arctic Policy
(managing and taking advantage)

We must respond to changing:

Land conditions:

• Infrastructure (residential, transportation, industry) is at risk

House destroyed by melting permafrost
Specific Arctic Policy
(managing and taking advantage)

We must respond to changing:

Land conditions:

• Infrastructure (residential, transportation, industry) is at risk
• Natural resource industries changing
• Subsistence resources changing
Example of:
• Good science
• Good planning
• Good engineering
• Good policy

$60 Million per day
The Challenge

What We Know Now

- Changes are here, real, pronounced, and affecting the entire Arctic system
- The changes are rapid and global
- We must deal with the Arctic as a system, and not piecemeal
- Arctic change is already affecting commerce and people

This set of changes are going to require policy, and good policy requires good information
The Challenge

What We Can Offer

• Information about what, when, and how changes are occurring
• The implications of change

It’s urgent that scientists and policy makers talk now
Thank You

Questions?

Thank you to Senator Murkowski’s office