Cooperative Institute for Research in Environmental Sciences

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National Snow and Ice Data Center

Supporting Cryospheric Research Since 1976

NSIDC

University of Colorado

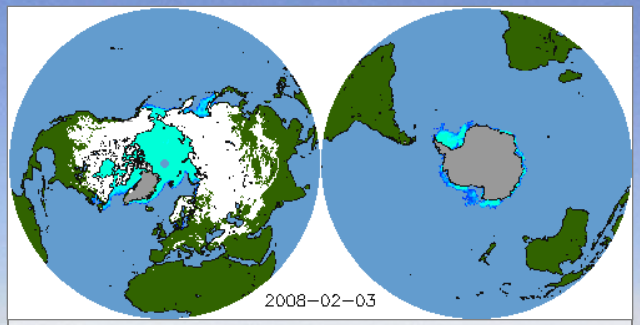
Record Low Arctic Sea Ice Extent in 2012:

An exclamation point on a long-term declining trend

Walt Meier, National Snow and Ice Data Center

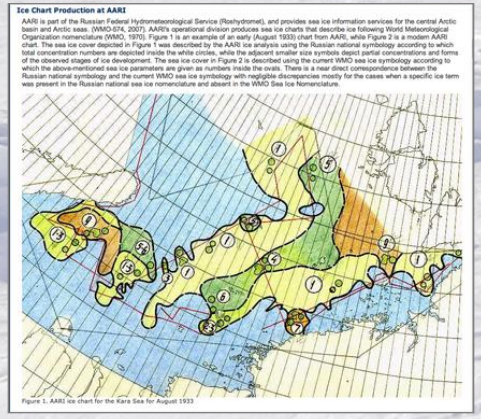
12 September 2012

The National Snow and Ice Data Center…

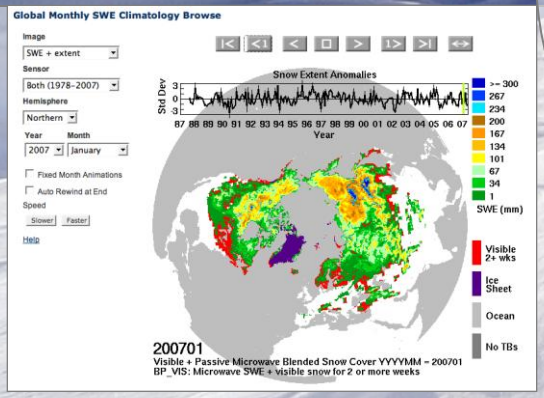


Manages and distributes scientific data

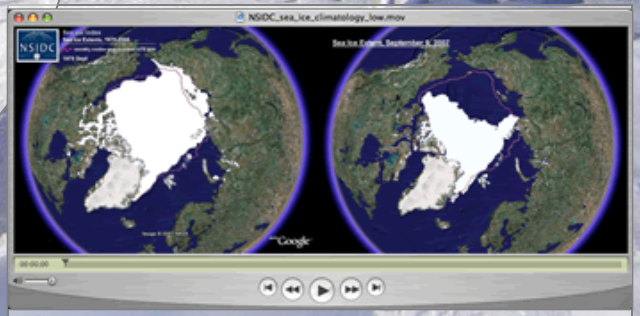
Performs scientific research



Supports data users



Creates tools for data access



Educates the public about the cryosphere

NSIDC affiliations and sponsorship

Cooperative Institute for Research in Environmental Sciences

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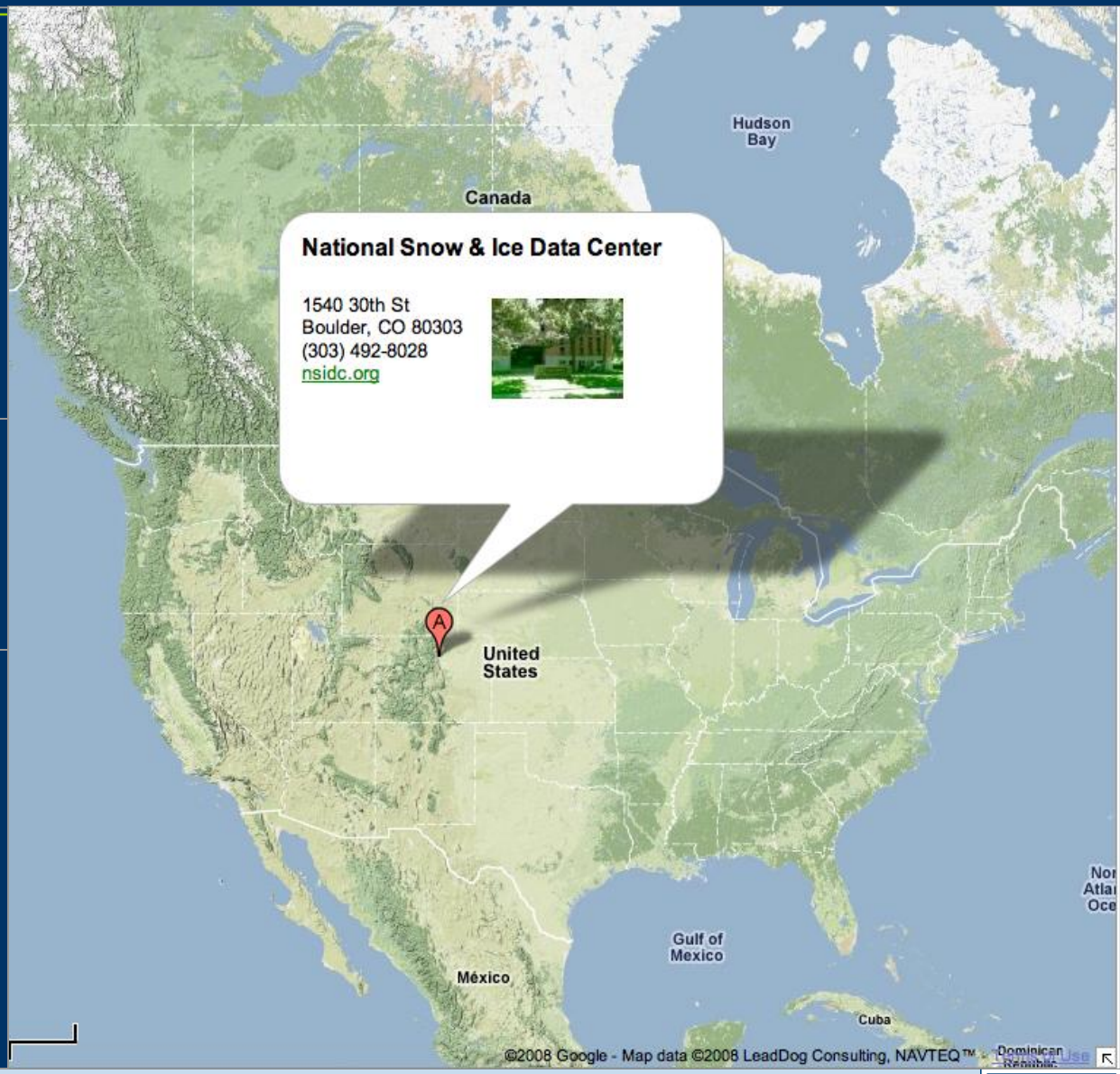
University of Colorado Boulder

University of Colorado Boulder

Main sponsors:

NASA NOAA NSF



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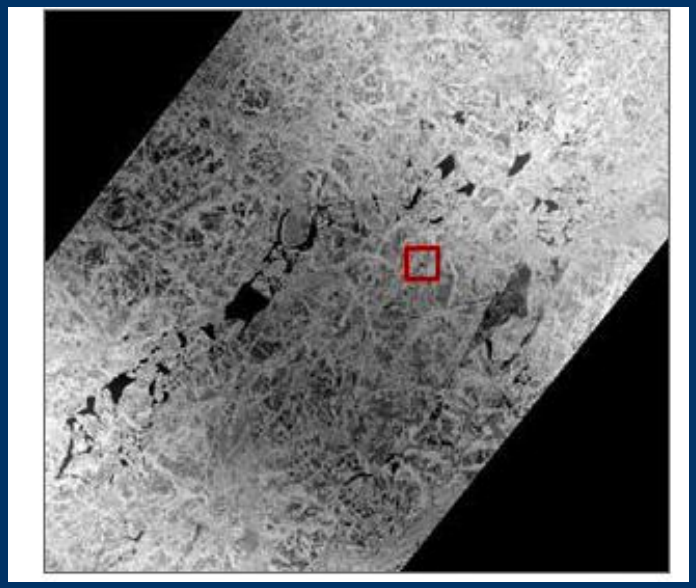
NOAA@NSIDC

Emphasis on

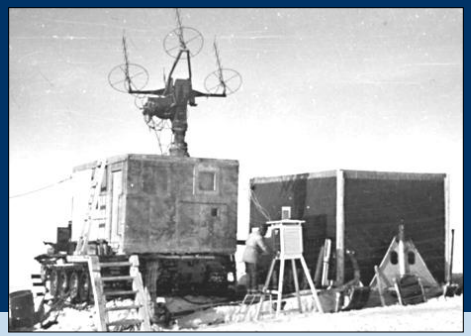
- in situ data sets,
- data rescue
- products from the operational community,
- outreach products: Google Earth data sets, **Sea Ice Index**



SHEBA exp ship. 1m NTM imagery.

Products in cooperation with operational communities:

- National Ice Center Arctic Sea Ice Charts and Climatologies in Gridded Format *[Navy/NOAA/Coast Guard National Ice Center]*
- Arctic Sea Ice Melt Pond Statistics and Maps, 1999, 2000, and 2001 *[USGS/Reconnaissance imagery]*
- Joint US-Russian Env. Working Group Arctic Atlases on CD-ROM *[Medea Project and others]*
- Snow Data Assimilation System (SNODAS) *[National Weather Service]*
- IMS Daily Northern Hemisphere Snow and Ice Analysis at 4 km and 24 km Resolution *[NOAA and NIC]*



Instrumentation on one of the Russian "North Pole" drifting stations. (1937 - 1991)

ULS data with ASL, UW.

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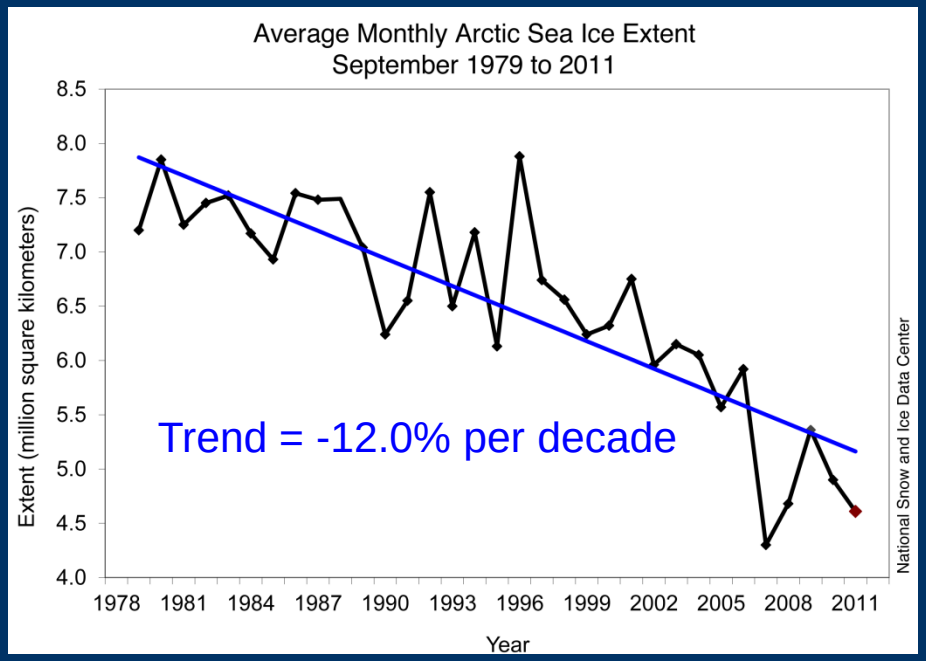
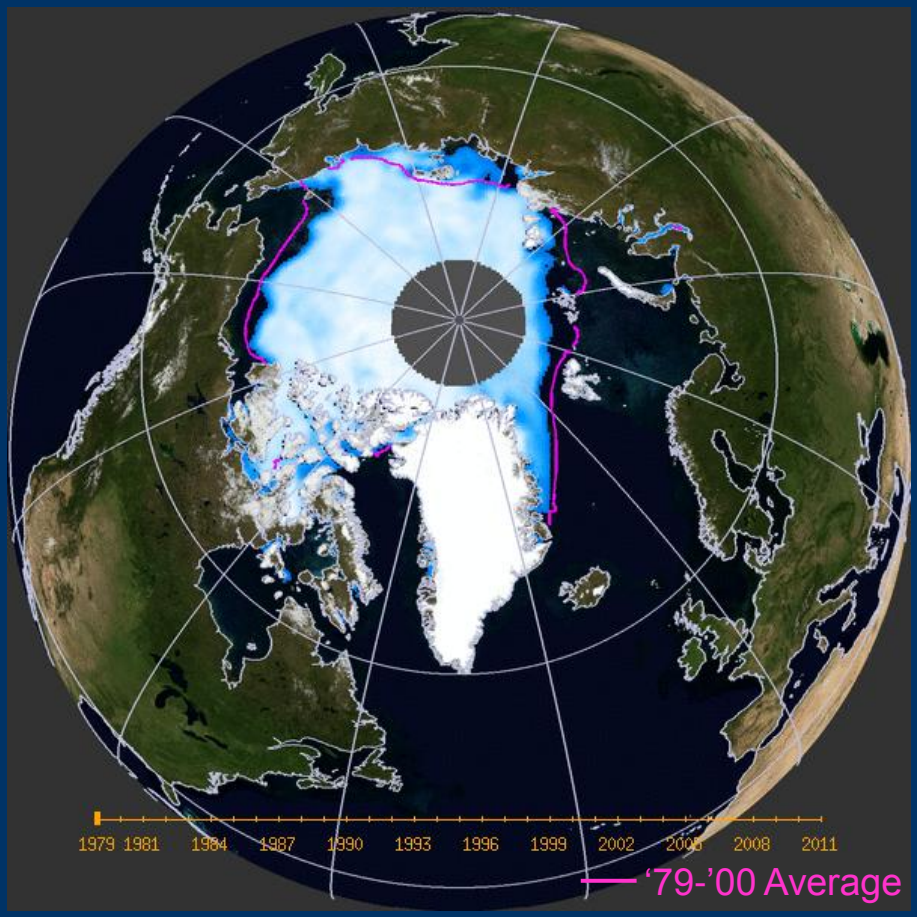
Long-term sea ice decline, 1979-2011

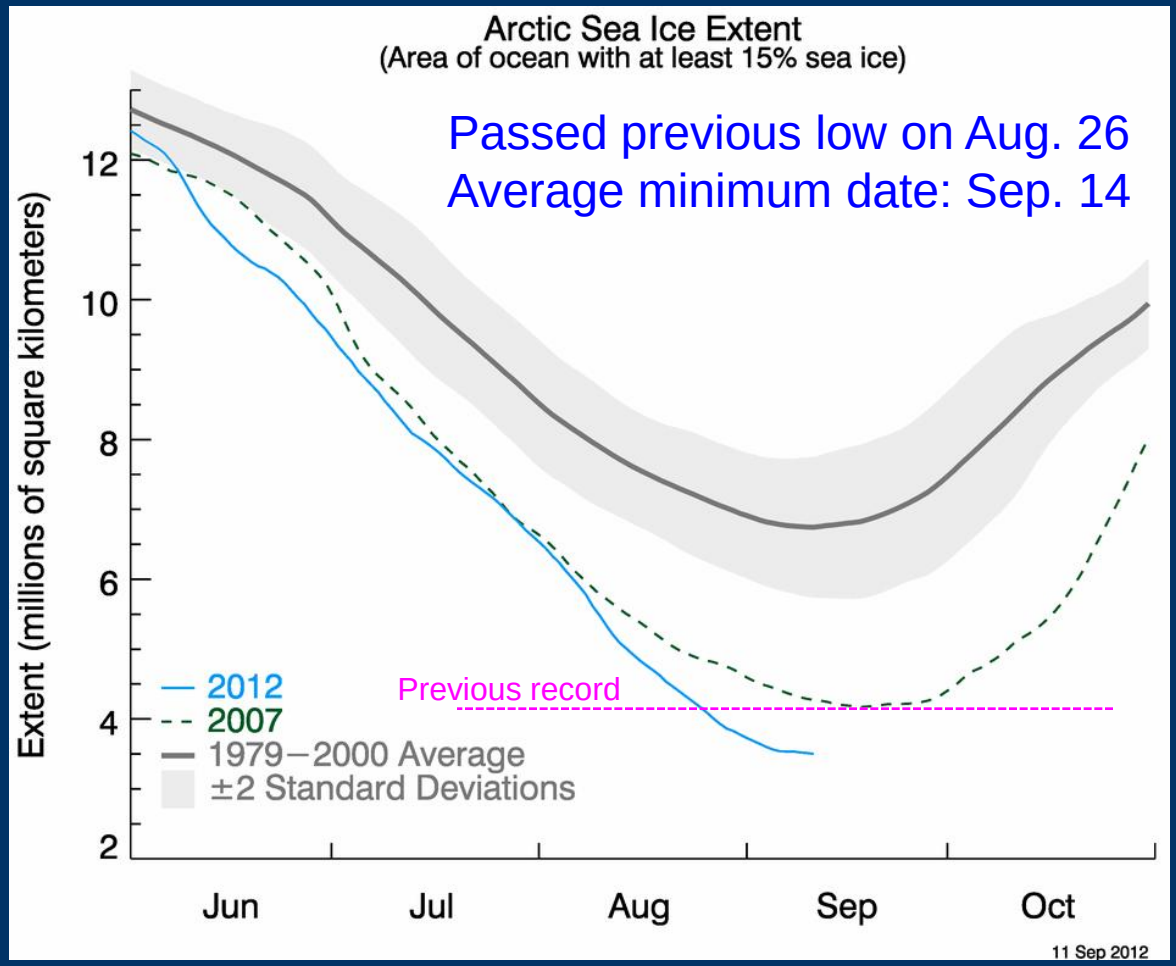
Arctic sea ice reaches its seasonal minimum in September



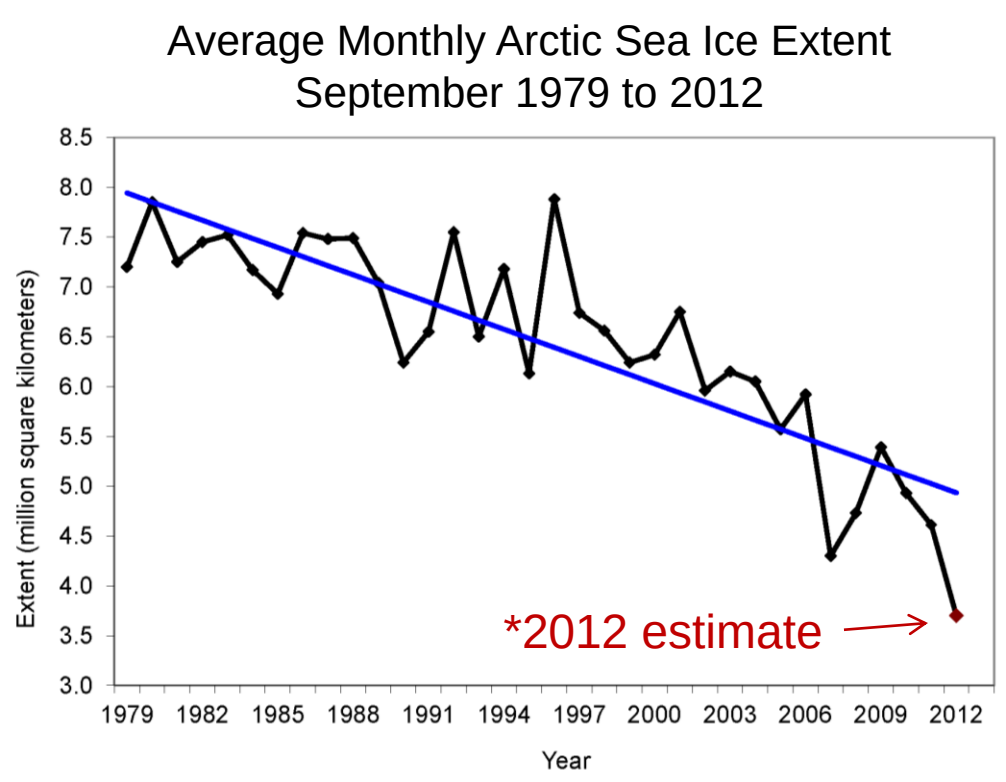


Then came the summer of 2012:

September 7, 2012



September extent trend is accelerating



- Overall, the Arctic has lost ~50% of its summer ice cover
- The last six Septembers are the lowest in our satellite records (beginning in 1979)

Years	Trend (km^2 yr^{-1})	% $decade^{-1}$ relative to 79-00 avg.
79-01	-45900	-6.5
79-02	-51000	-7.3
79-03	-52800	-7.5
79-04	-54600	-7.8
79-05	-59400	-8.4
79-06	-60200	-8.6
79-07	-71600	-10.2
79-08	-78100	-11.1
79-09	-78700	-11.2
79-10	-81400	-11.6
79-11	-84700	-12.0
79-12*	-91200	-13.0

State of Indiana = 92,900 km^2

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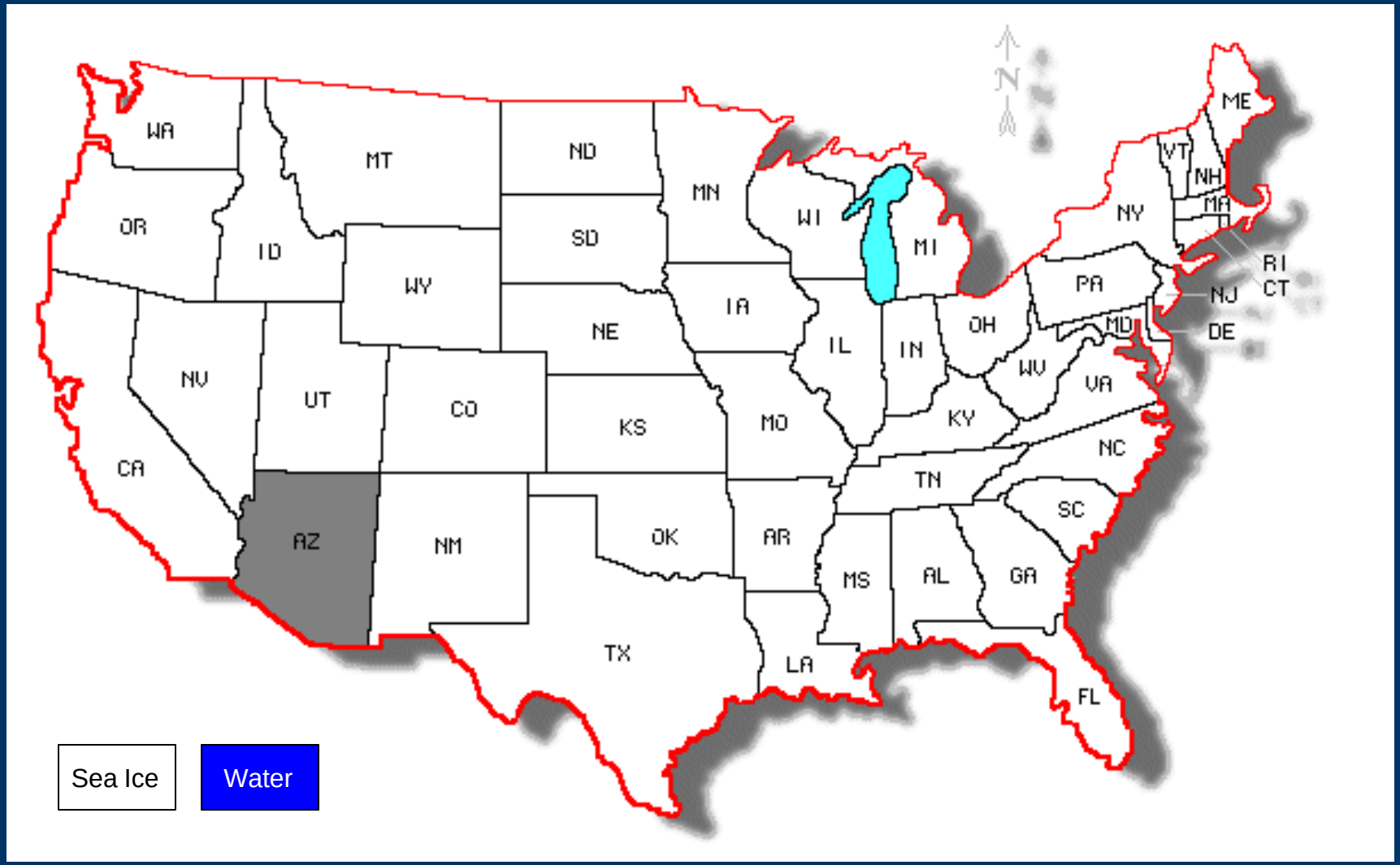
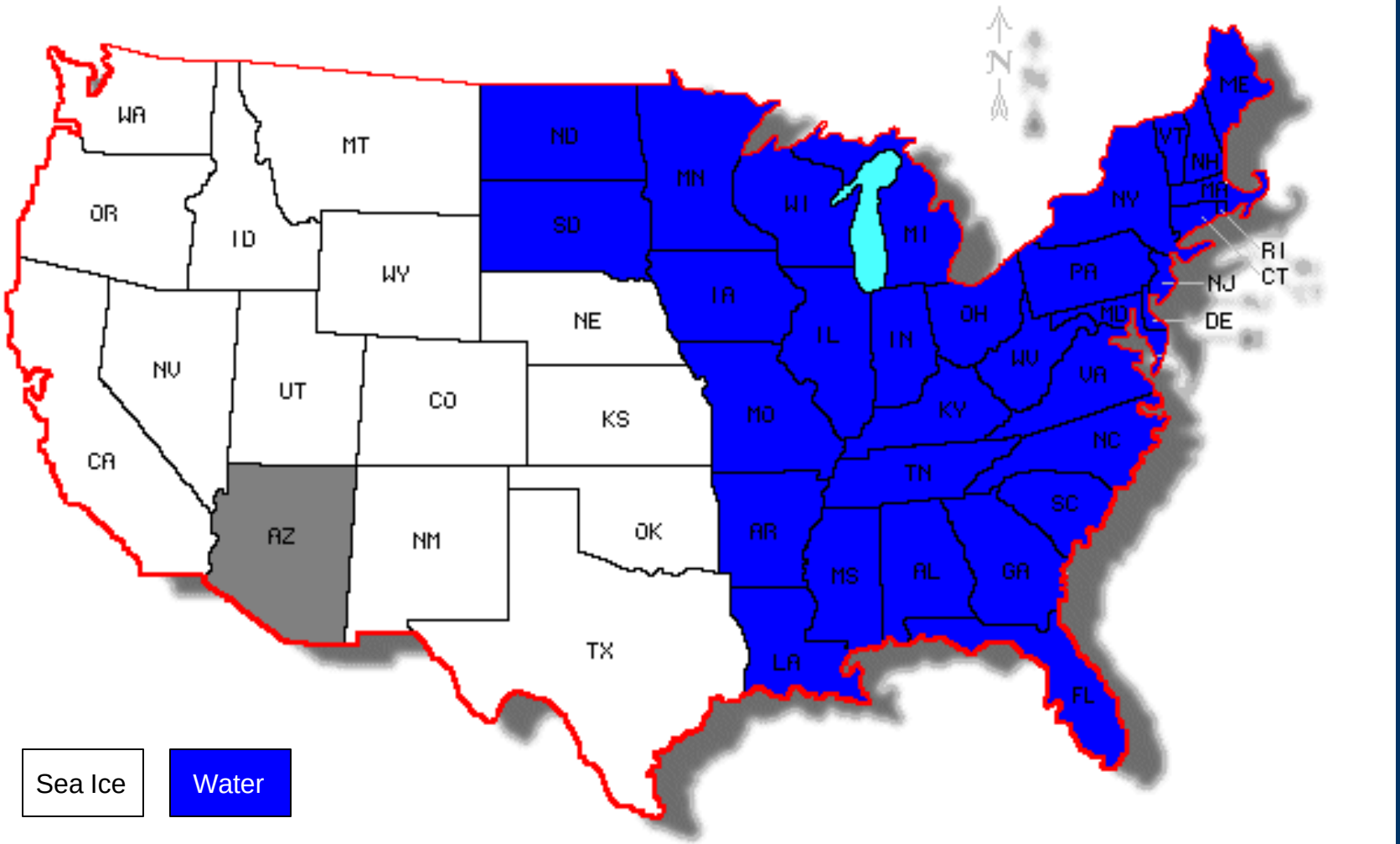
How big of a change is that?



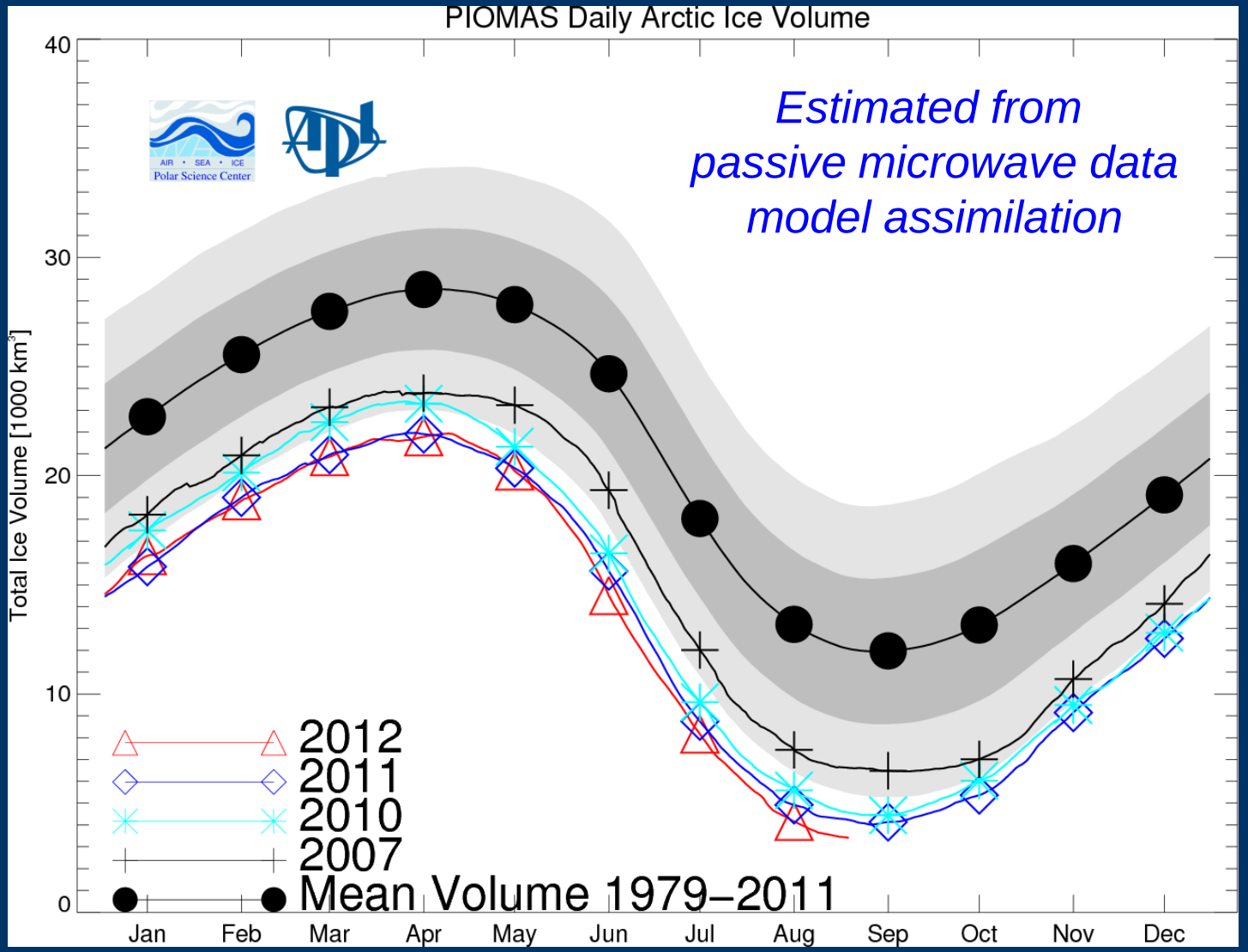
Map courtesy: http://diymaps.net/us_12.htm

How big of a change is that?

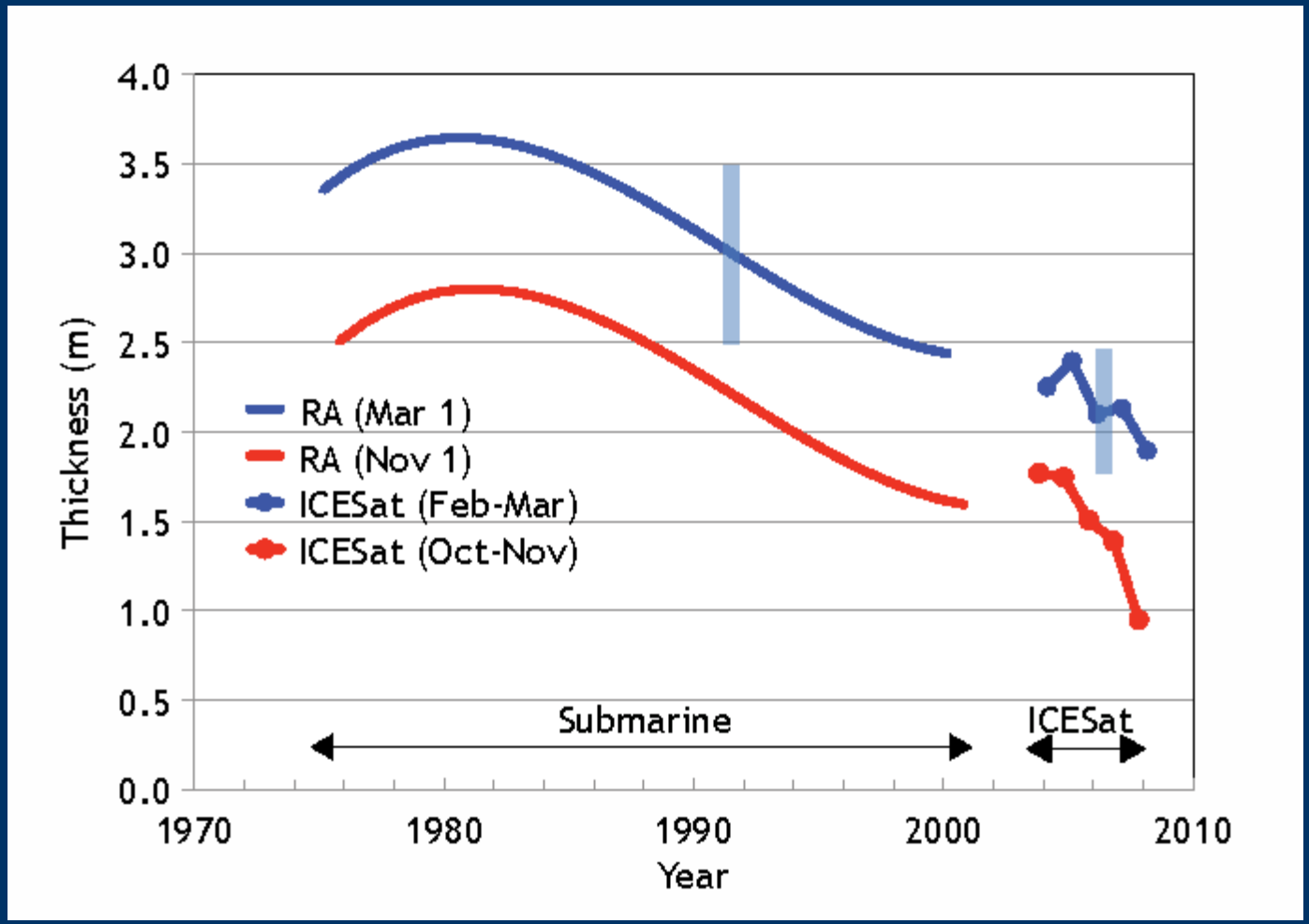


Map courtesy: http://diymaps.net/us_12.htm

Sea ice volume decreasing



Submarine and ICESat ice thickness



From Kwok and Rothrock, 2009

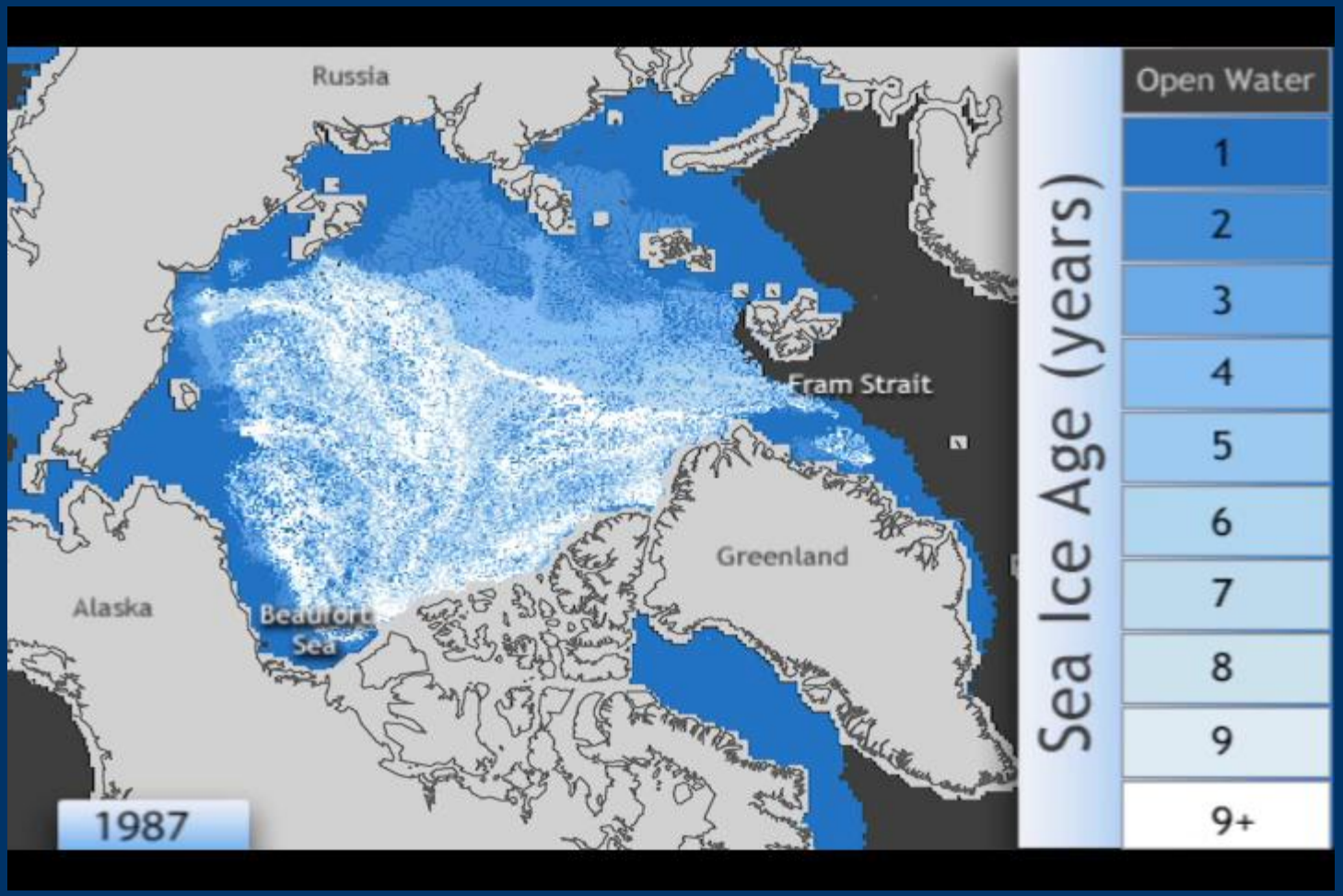
Inferred thickness from sea ice age data

Age can be used as a proxy to estimate sea ice thickness

Other things being equal:

Older ice = Thicker ice

Loss of old ice



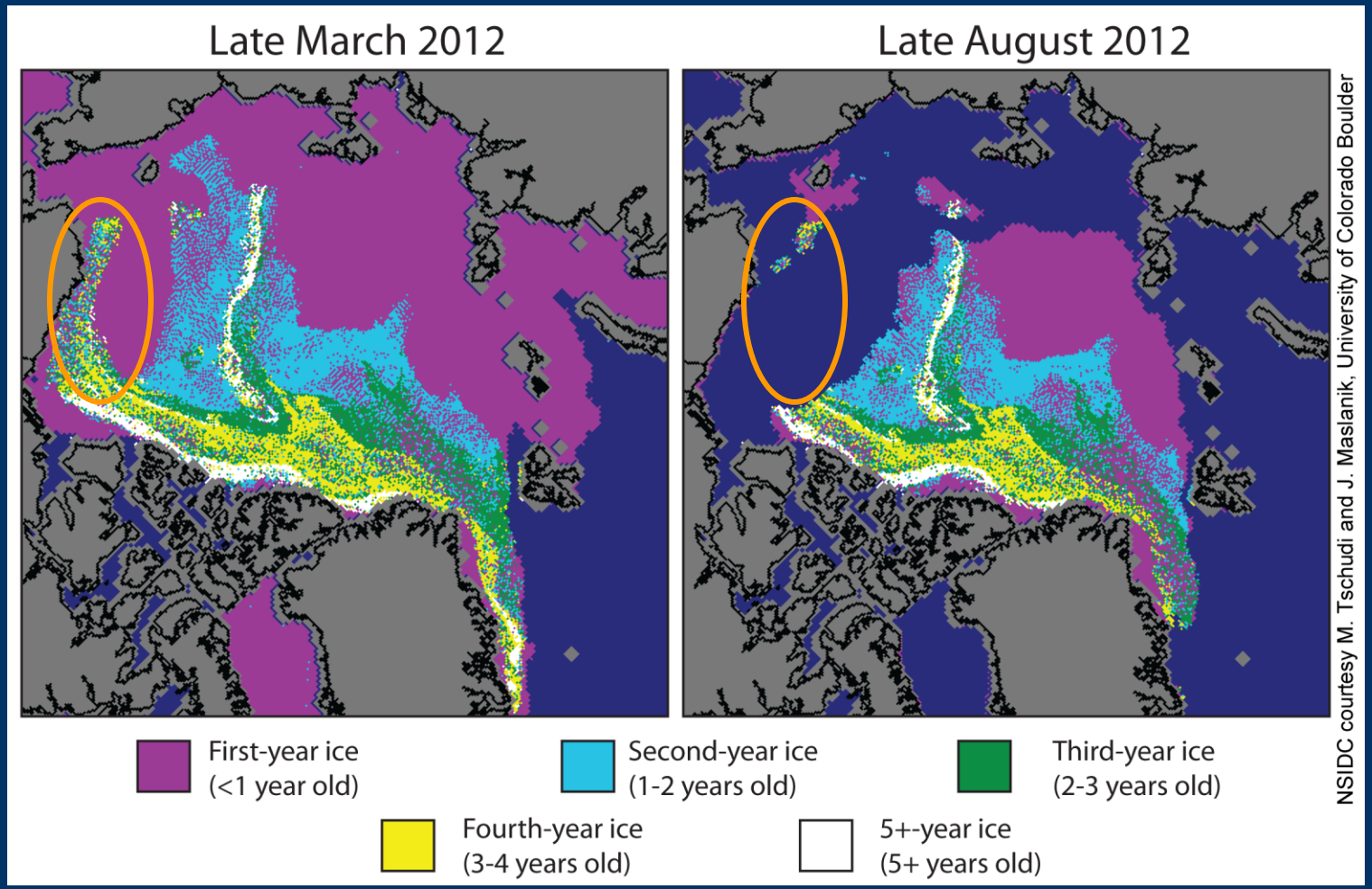
Thinner (~1-2 m)

Thicker (~3-4 m)

Images are at weekly intervals

Data from J. Maslanik, C. Fowler, and M. Tschudi, University of Colorado
Animation by NOAA Climate Watch, http://www.climatewatch.noaa.gov/videos

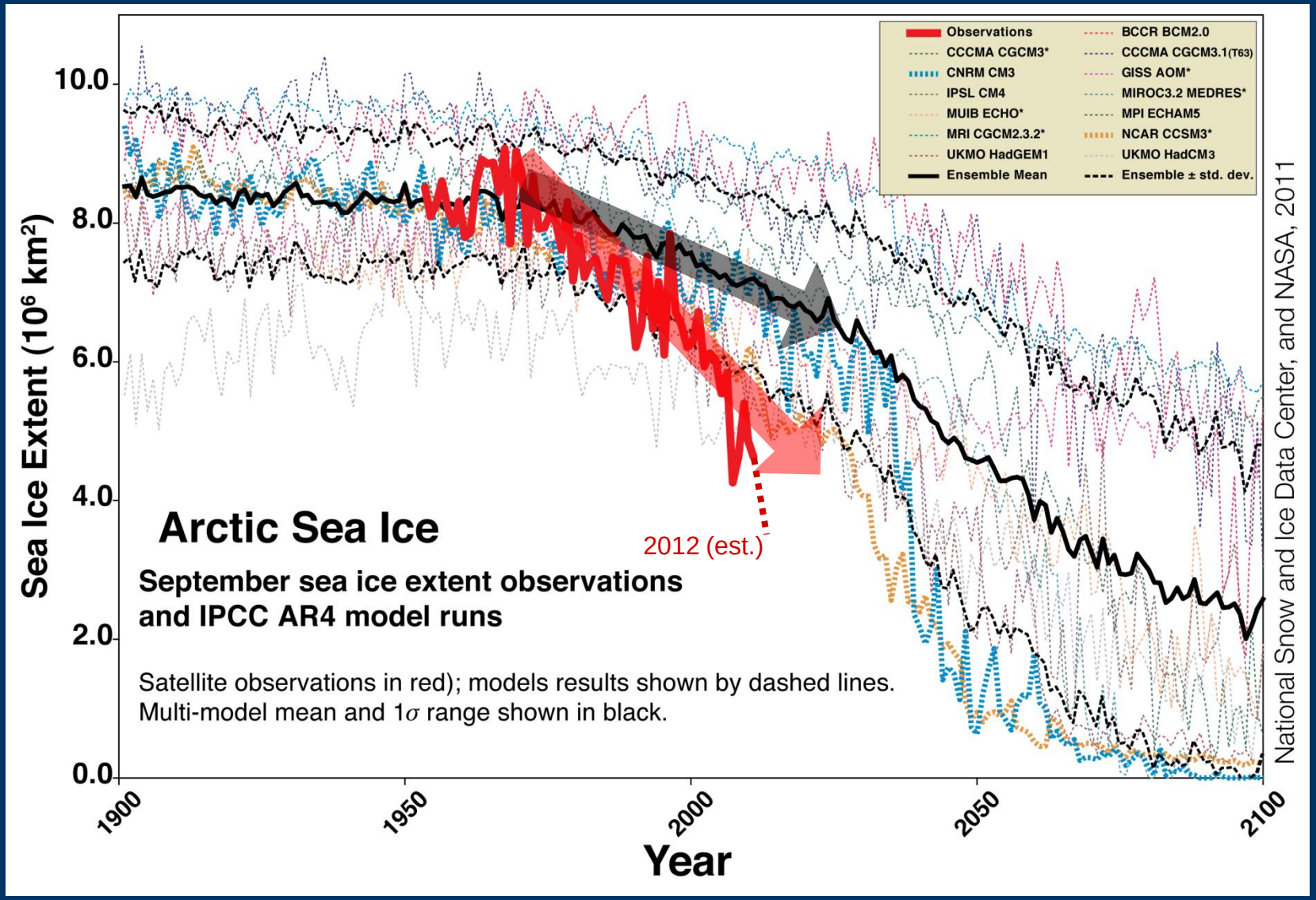
Melt of old ice during summer 2012



Projections of future sea ice changes

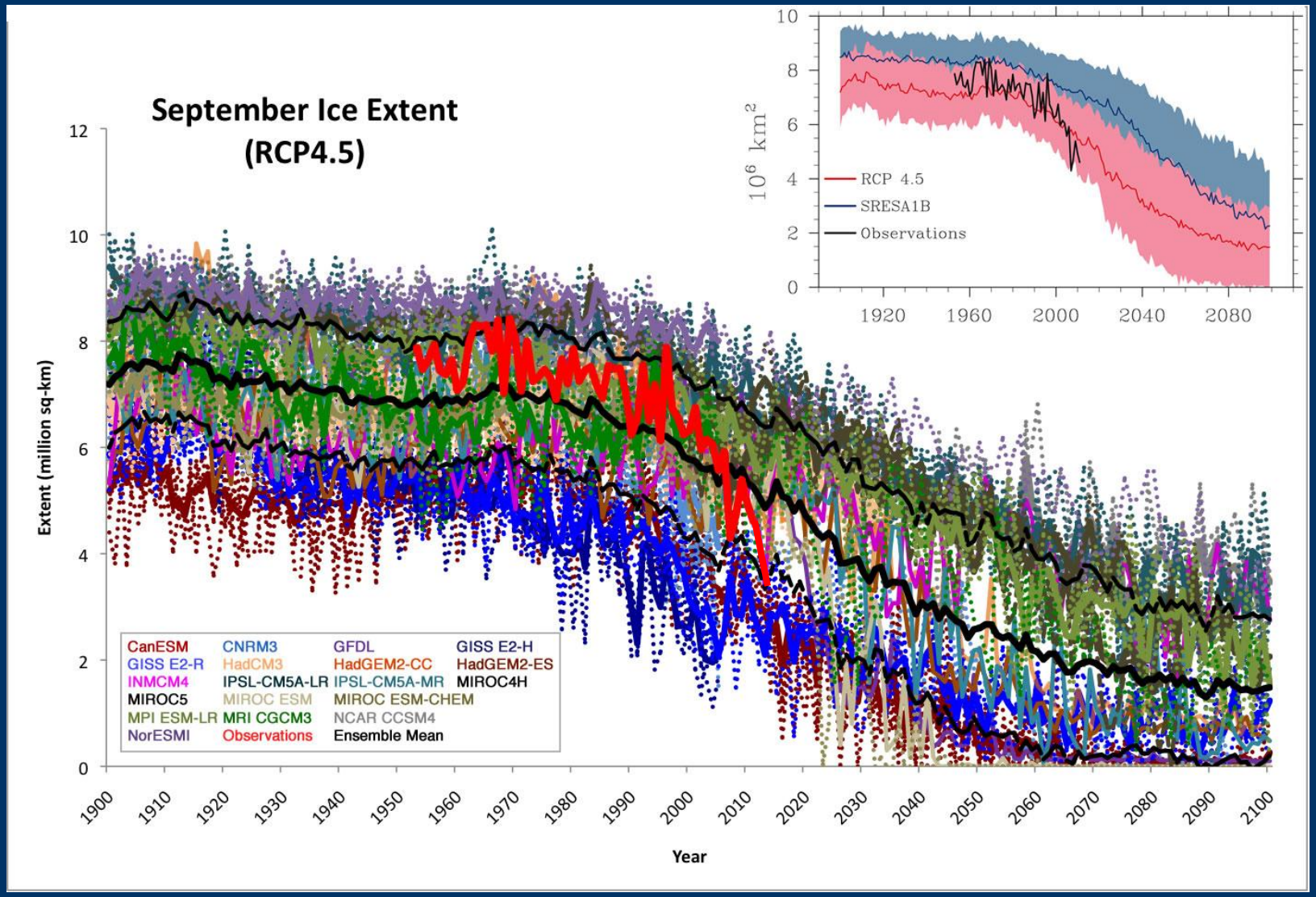
There is much interest to improve predictability of sea ice on century, decadal, and seasonal scales

Decline is faster than forecast, old IPCC models



Updated from Stroeve et al., Geophysical Research Letters, 2007

Decline is faster than forecast, new IPCC models



Stroeve et al., Geophysical Research Letters, 2012

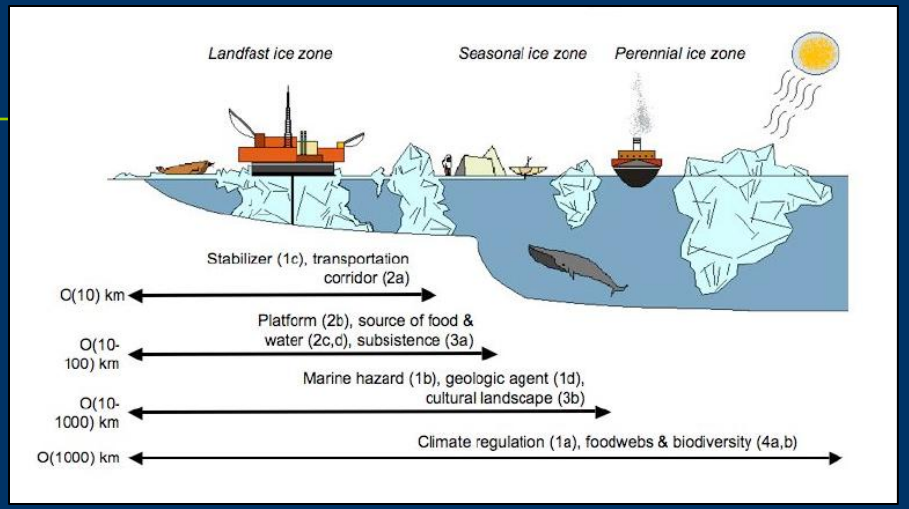
Impacts of a changing Arctic sea ice cover

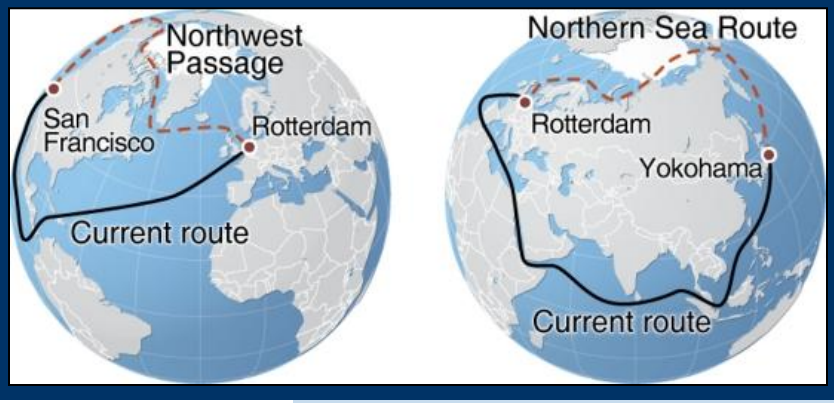
Sea ice plays a key role the Arctic environment, human activities in the Arctic, and in regional and global climate

Photo by Mike Webber, U.S. Fish & Wildlife Service

Human impacts

- Local communities
- Shipping and navigation
- Resource extraction
- Tourism
- National sovereignty and defense issues
- Global climate impacts





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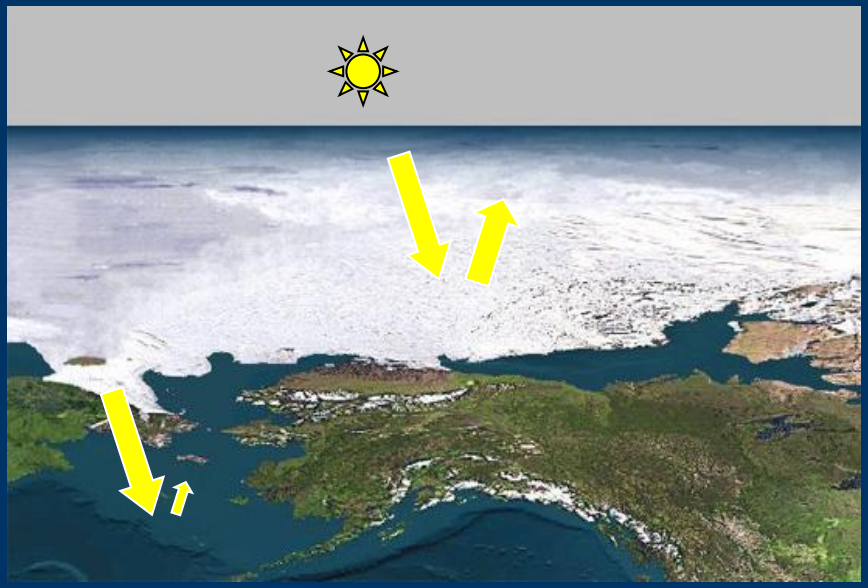
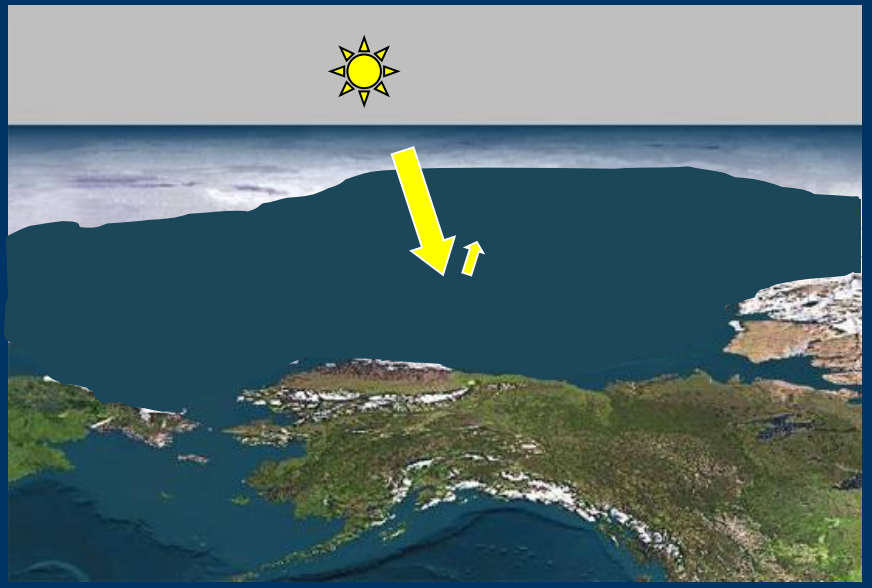
Effects of sea ice change on global climate

Winter sea ice; image from NASA

Loss of summer sea ice decreases albedo



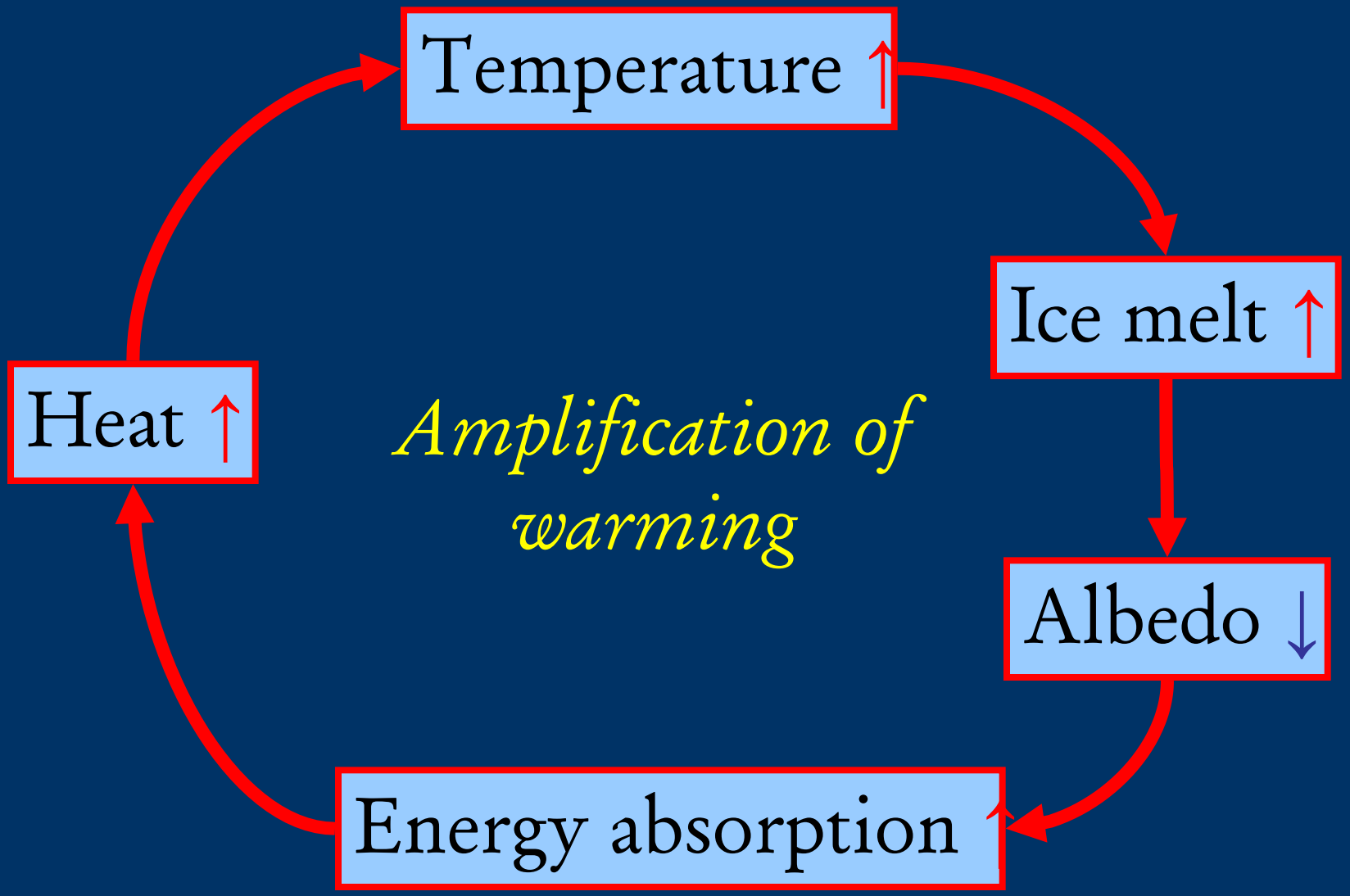
With sea ice: α **≥ 60%**



Without sea ice: α **≤ 10%**

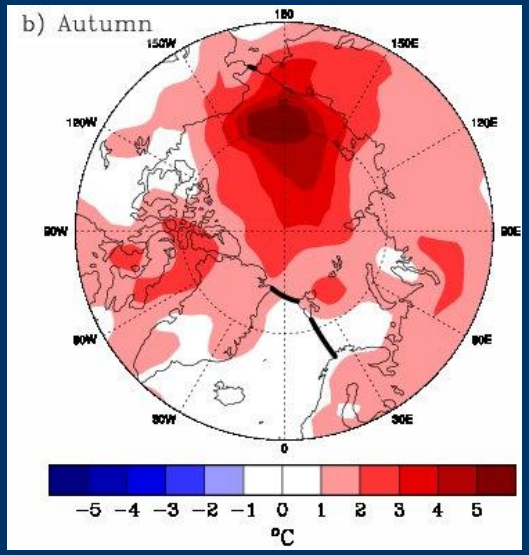
The change from sea ice to ice-free ocean is the largest surface contrast on earth as far as solar energy is concerned

Sea Ice – Albedo Feedback

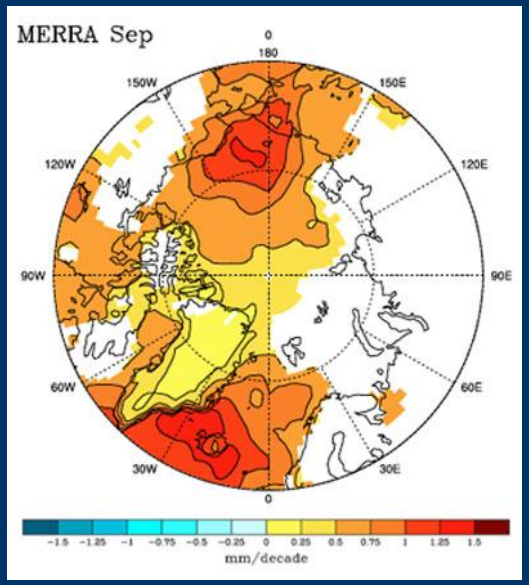


Arctic Amplification: a warmer, wetter Arctic

- Temperatures:
  - Ocean absorbs more of sun's energy during summer than sea ice
  - Ocean heat keeps atmosphere warm into the fall
  - "Arctic Amplification"
- Water vapor:
  - Less sea ice means more transfer of moister to the atmosphere
  - More water vapor during the autumm



Autumn air temperature anomalies, (2003-2007) minus (1979-2007)

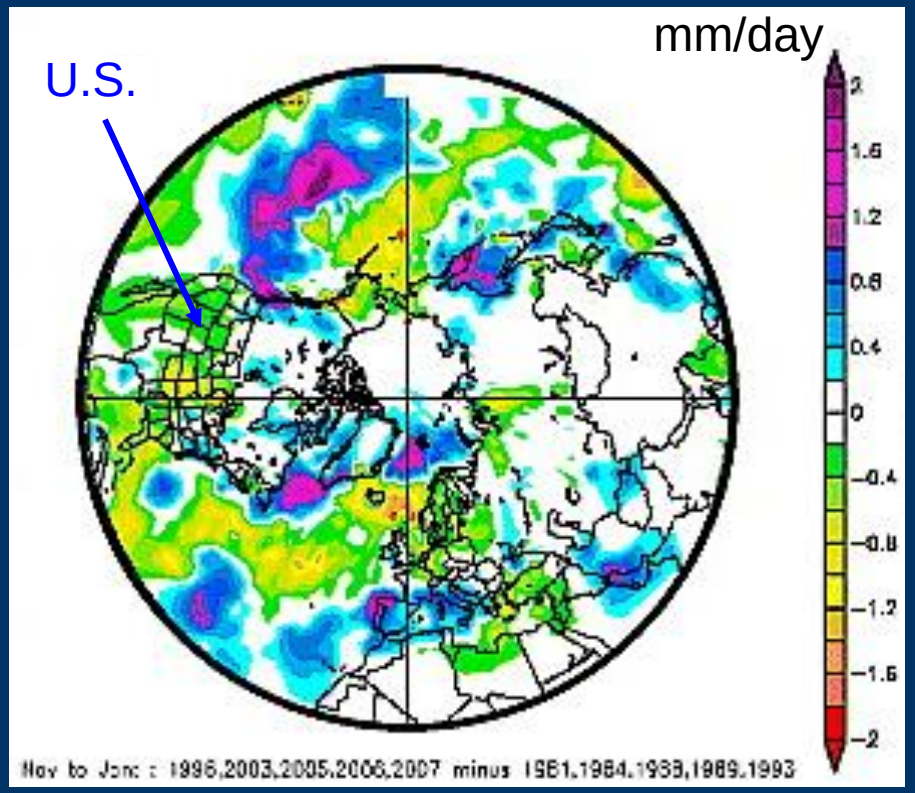


September water vapor anomalies, (2003-2007) minus (1979-2007)

Serreze, et al., 2008 and Serreze et al., 2012
Data from NOAA NCEP (top) and NASA MERRA (bottom)

Changes in Arctic sea ice affecting global climate?

- Storm tracks change
- Precipitation patterns change
- Most of U.S. becomes drier with less summer sea ice?
- Changes expected in Europe and Asia as well



Precipitation change:
Low ice years minus high ice years
1981-2007

J. Francis, Rutgers Univ.; Francis et al., Geophys. Res. Letters, 2009
Francis and Vavrus, Geophys. Res. Letters, 2012

Summary

- Arctic sea ice is changing faster than expected
  - Extent is decreasing
  - Ice is thinning
  - Multiyear ice is being lost
- Impacts in the Arctic are being seen
  - Native communities
  - Coastal erosion
  - Wildlife
  - Resource exploitation
- There are already indications of possible impacts on global climate

Sea Ice News: http://nsidc.org/arcticseaicenews/
Sea Ice Data: http:/nsidc.org/data/seaice_index/
Education Resources: http:/nsidc.org/cryosphere/