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Session D

Snow Cover Extent CDR Applications and Societal Benefits

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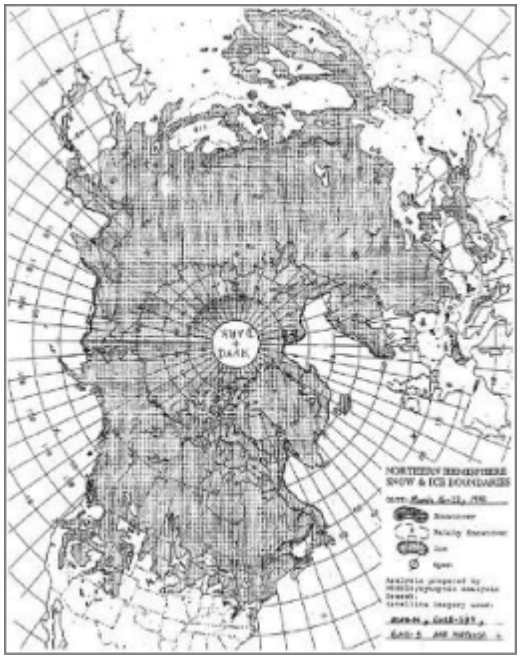
Piscataway, NJ

NOAA Climate Data Record Annual Meeting
Use Cases and Applications Discussion
Asheville, North Carolina | August 5, 2015

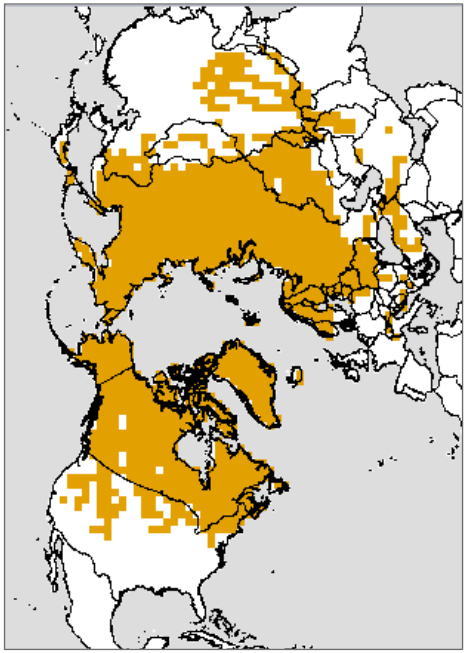
Research supported by
Global Science and Technology, Inc.
at NOAA NCEI

- Almost 50 years of satellite continental snow extent monitoring
- Snow extent variability and trends
  - focus on spring
- Applications and societal benefits
- Future monitoring

NOAA Visible Weekly SCE Climate Data Record



Weekly charts



Digitization

Daily IMS

Nov 1966 | Oct 1972 | May 1975 | 1980-81 | 1988-89 | 1990s May 1999

ESSA, NOAA, GOES Series

Weekly 190 km Digitized

METEOSAT & GMS added

Reanalysis of 1966-71

Feb 1997 | Feb 2004 | Dec 2014

Interactive Multisensor Snow & Ice Mapping System

IMS 24 km | IMS 4 km | IMS 1 km

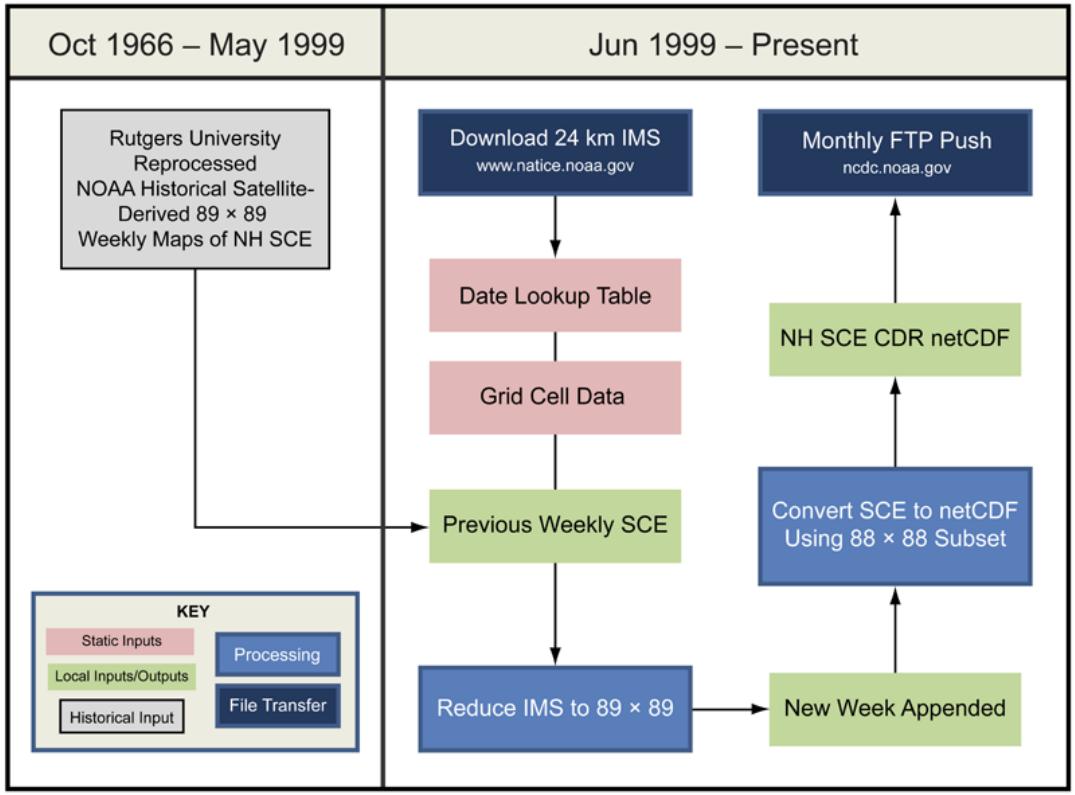
NOAA Visible Weekly SCE Climate Data Record

Specifications

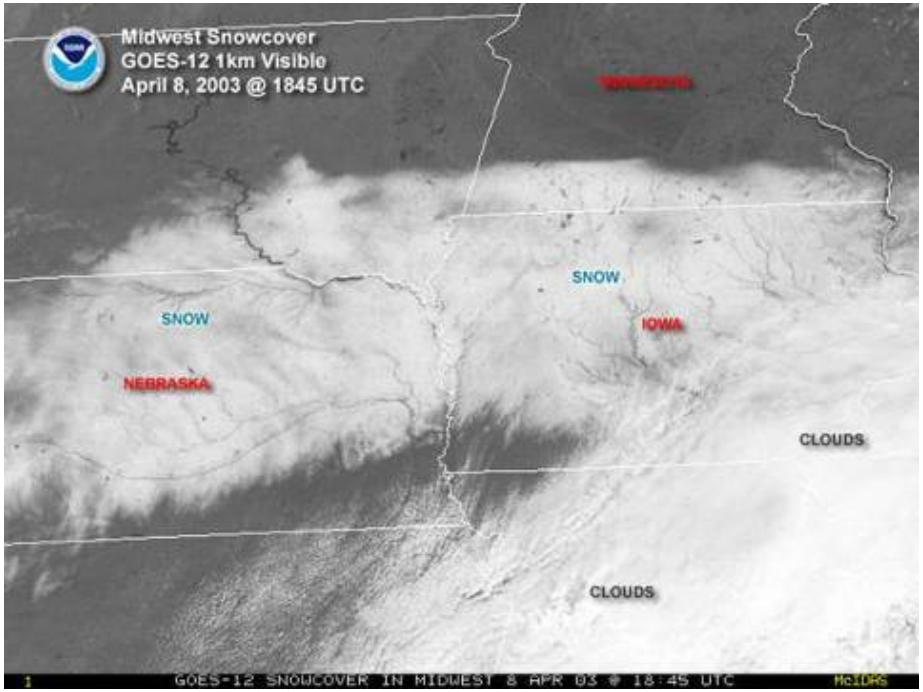
- Binary (snow / no snow) over NH land surface
- 88 × 88 Cartesian grid on polar stereographic projection
- 190.6 km resolution at 60°N
- Weekly temporal resolution
- October 4, 1966–present

Inputs to CDR

- October 1966–May 1999: primarily visible satellite imagery from multiple instruments
- After May 1999: Interactive Multisensor Snow and Ice Mapping System (IMS)
- SCE derived from multiple sources by trained analysts

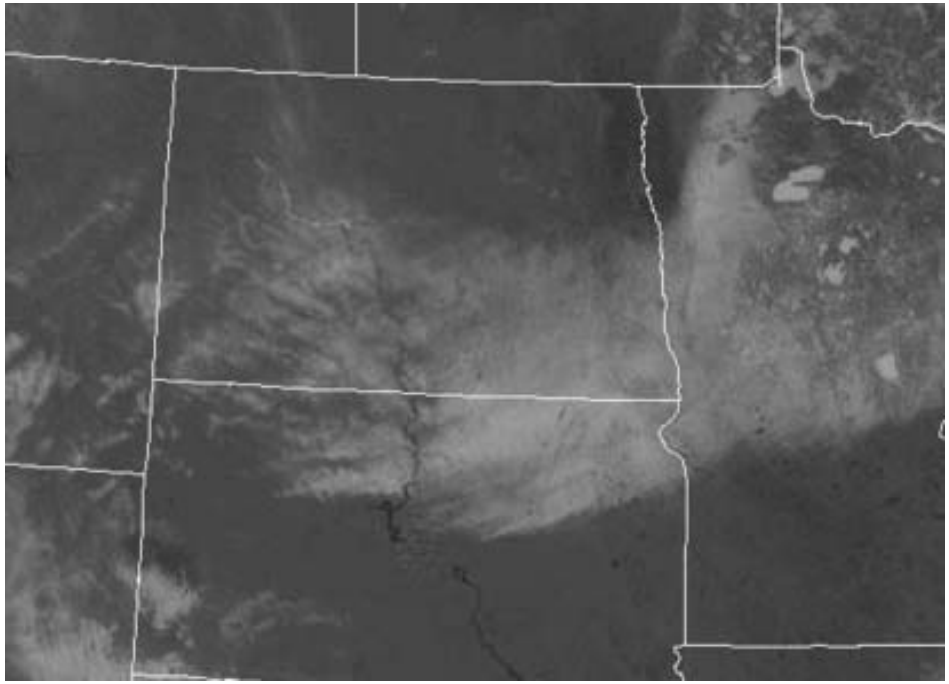


NH SCE CDR simplified processing flow diagram

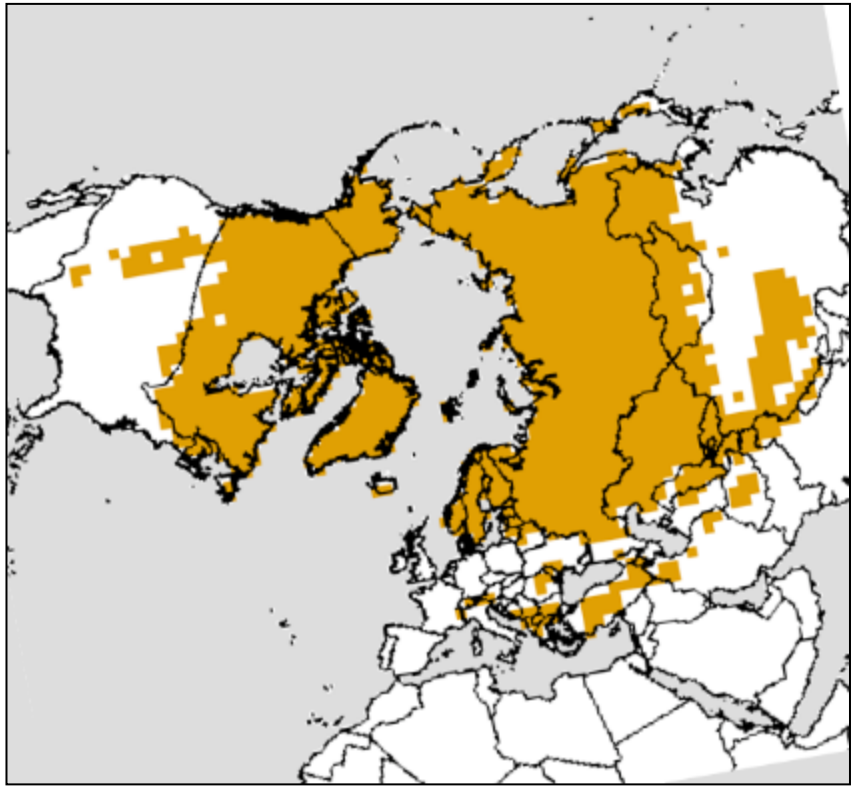


April 8, 2003

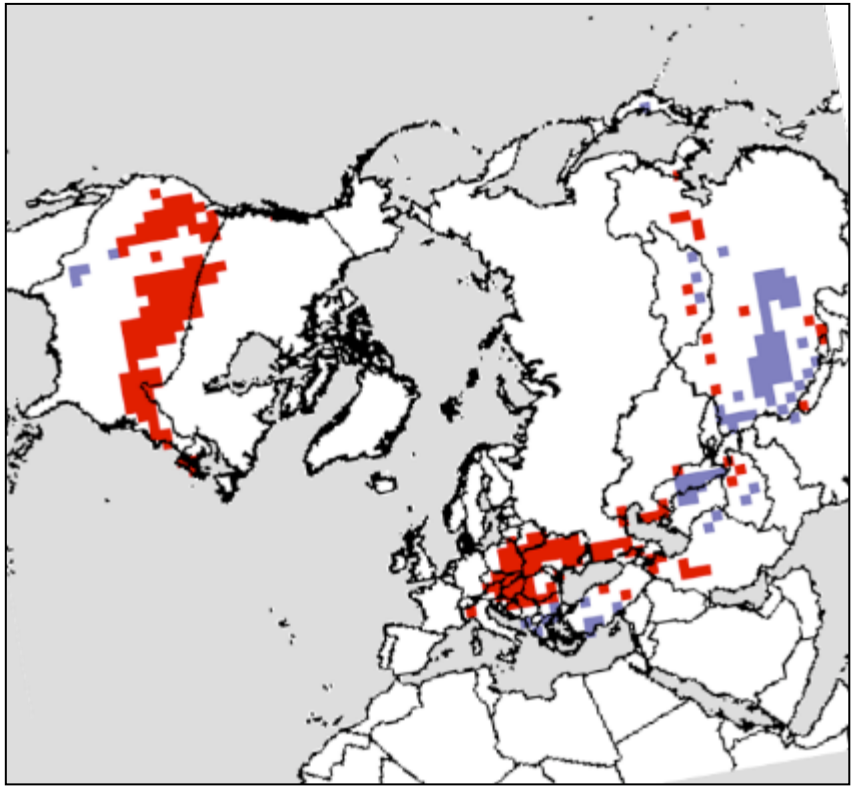
April 8, 2007



Northern Hemisphere Continental Snow Cover
10 January 2012

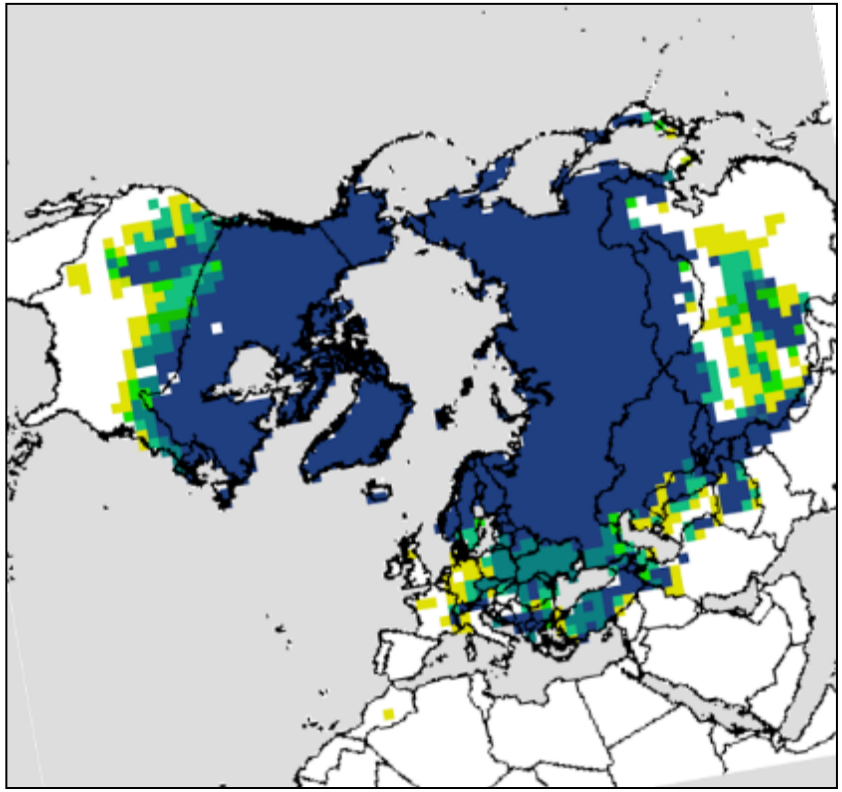


Extent

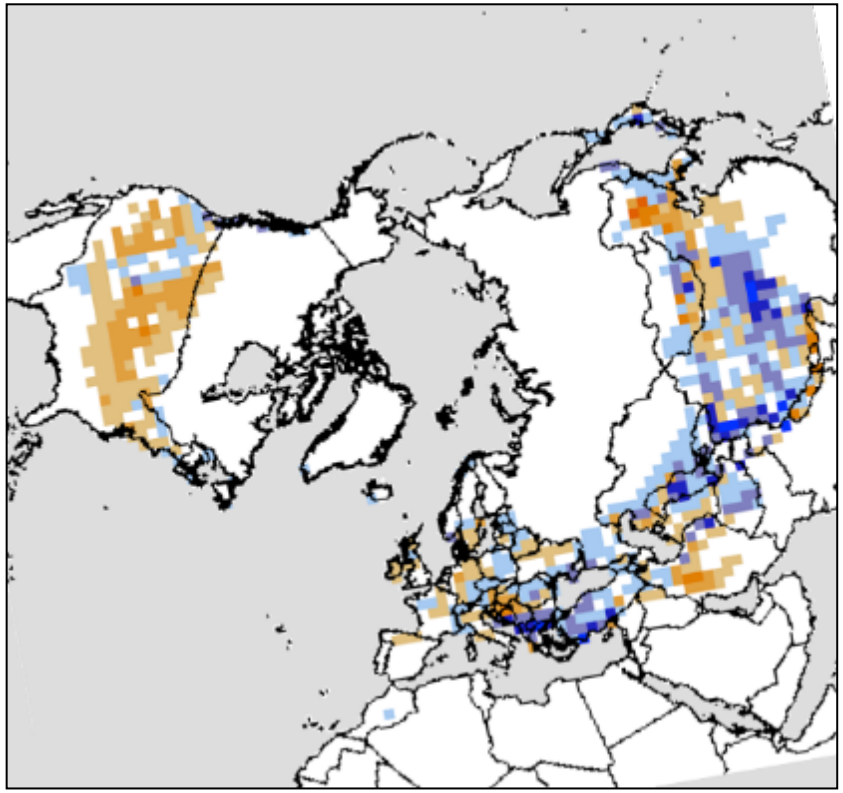


Departure
(blue: positive; red: negative)

Northern Hemisphere Continental Snow Cover January 2012

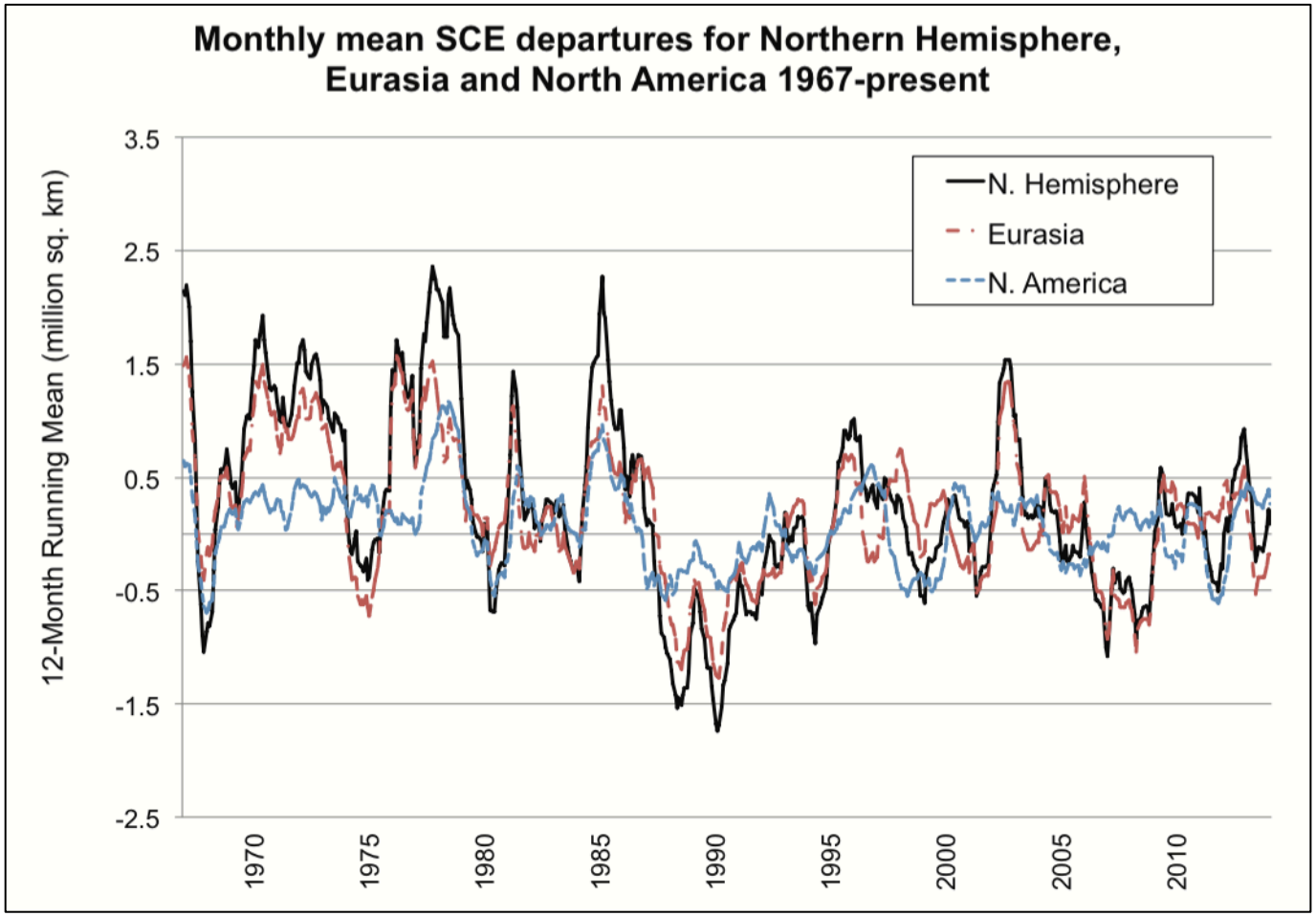


Extent



Departure
(blue: positive; tan: negative)

NH Snow Cover Extent: 1966-2015

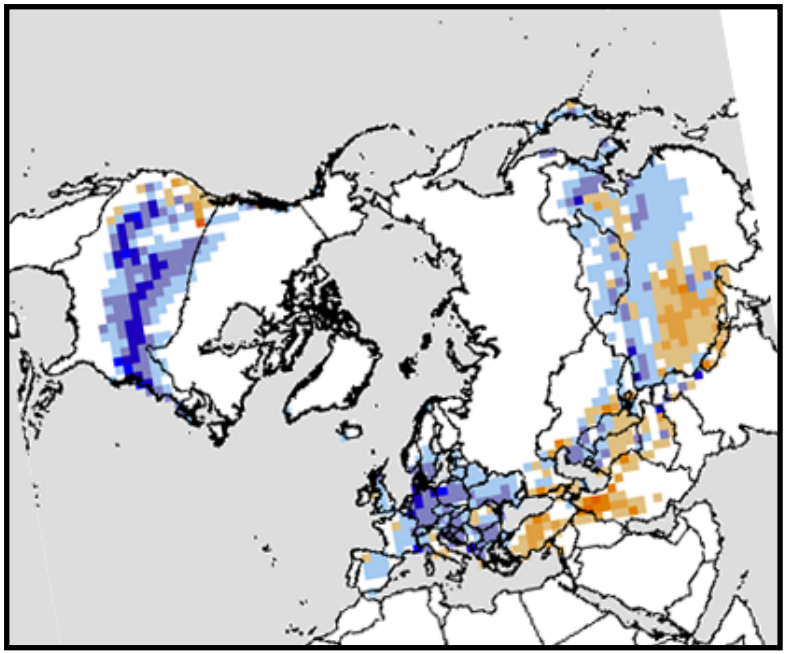


Departures derived from 1981-2010 mean

Swings from most to least extensive SCEs occurring within months

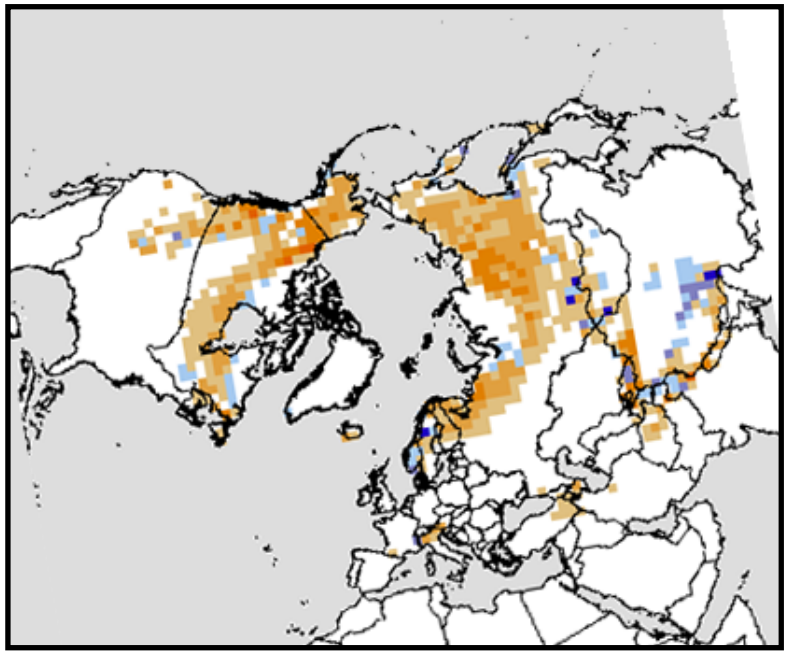
Departures

Feb 2010



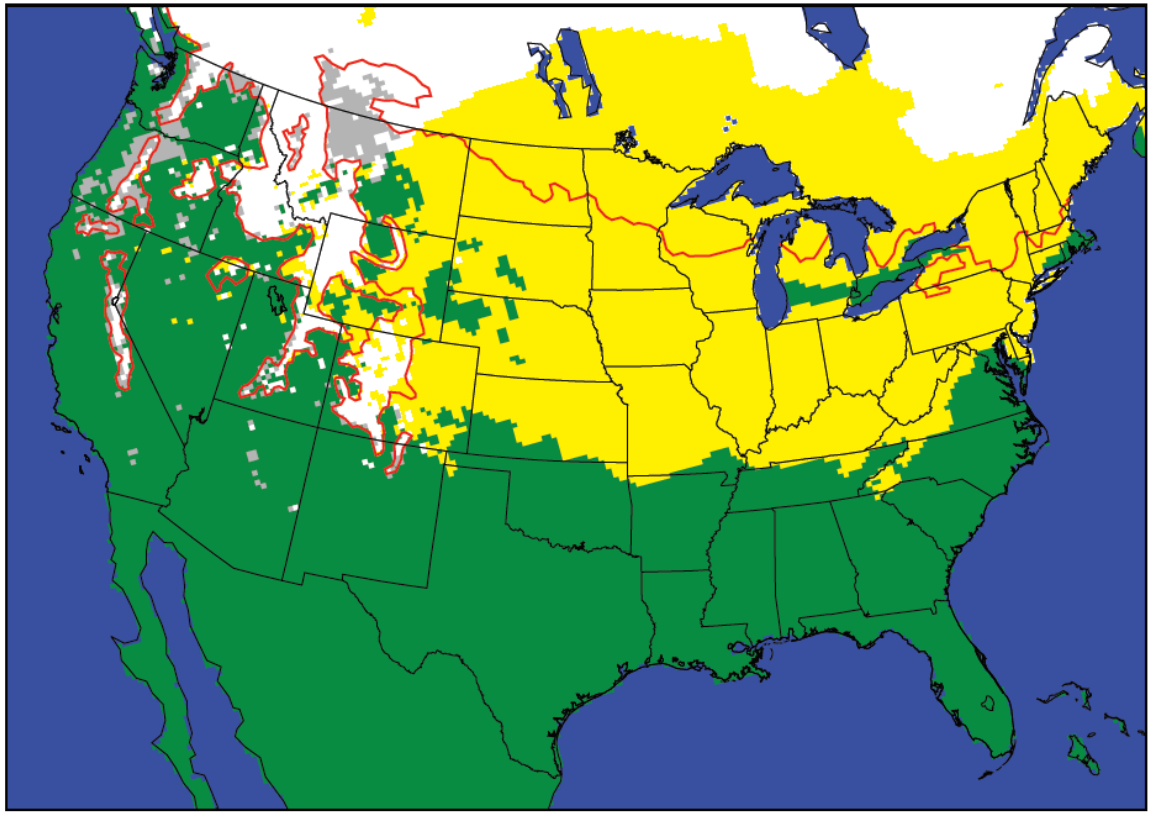
3rd most extensive

May 2010



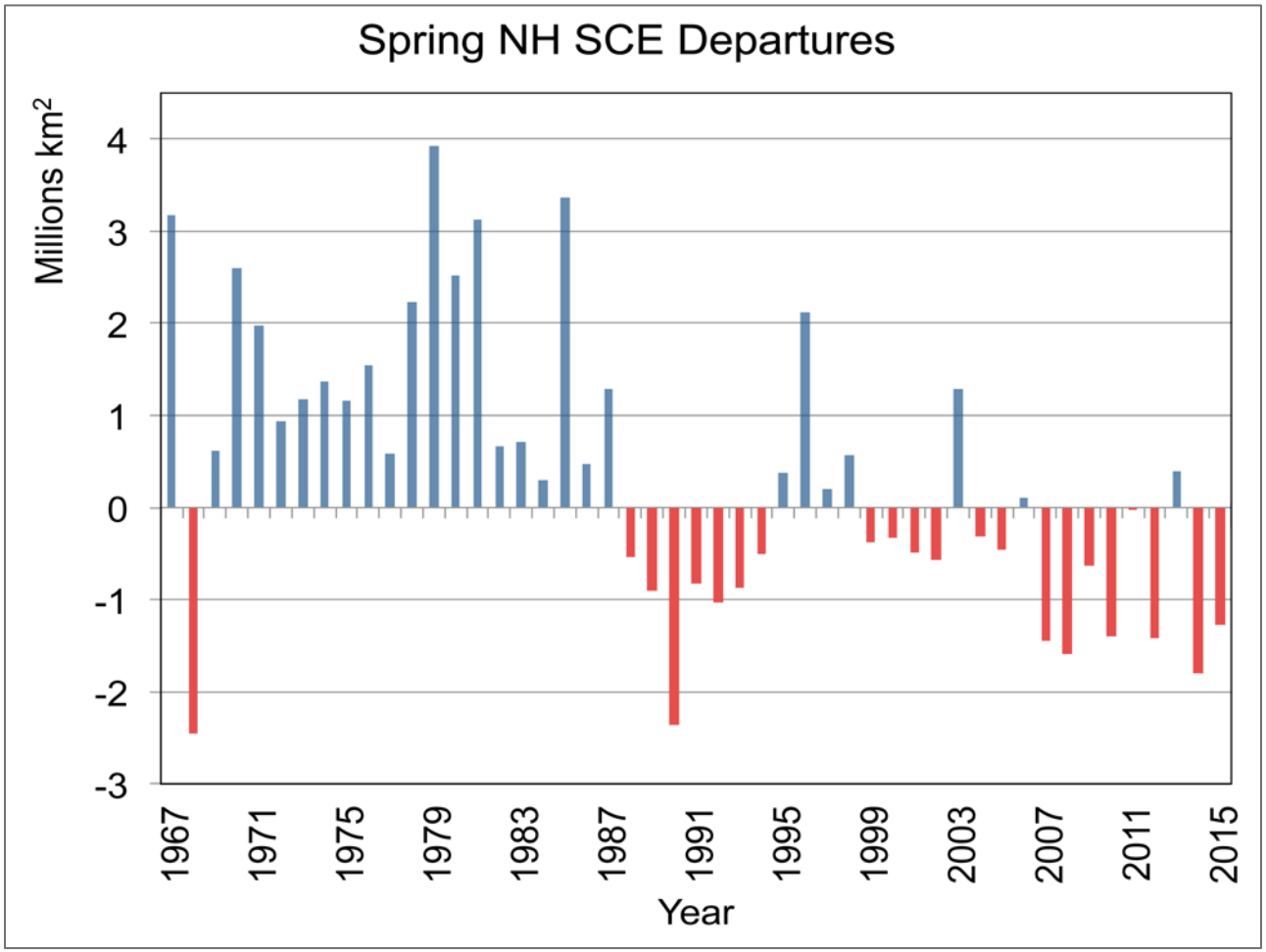
1st least extensive

Interannual variability:
SCE: 25 March 2012 versus 2013



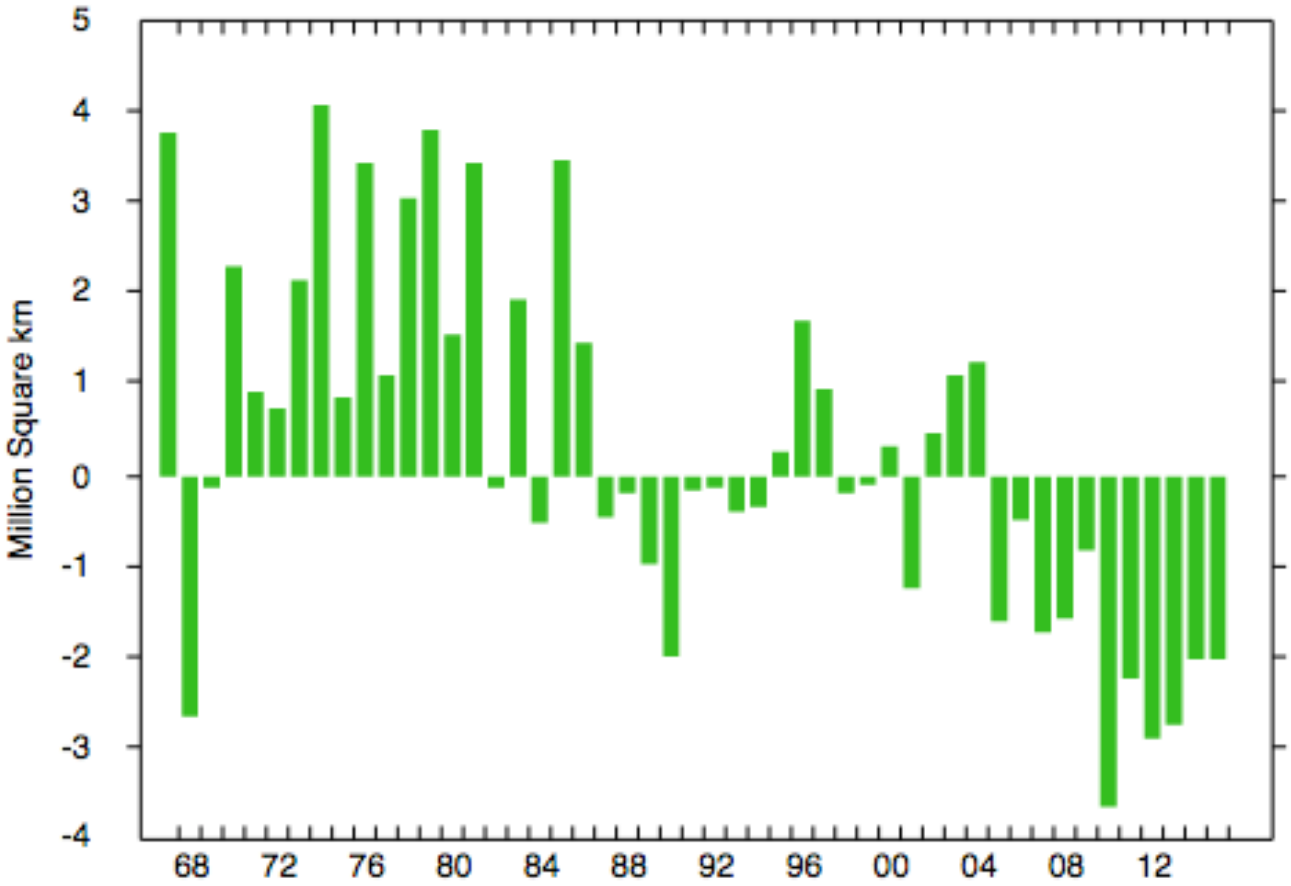
Extent of snow cover across the U.S. and southern Canada on March 25, 2012 and March 25, 2013, showing exceedingly more snow cover on this date in 2012. Areas in white were snow covered on this date in both years. Those in yellow were snow covered in 2012 but not in 2013. Grey areas were snow covered in 2013 but not in 2013. Also shown (red line) is the average extent of snow cover on this date for the period 1999-2013. Data are gleaned from NOAA Interactive Multisensor Snow and Ice Mapping System maps.

NH Spring (MAM) SCE Departures



Departures derived from 1981-2010 mean

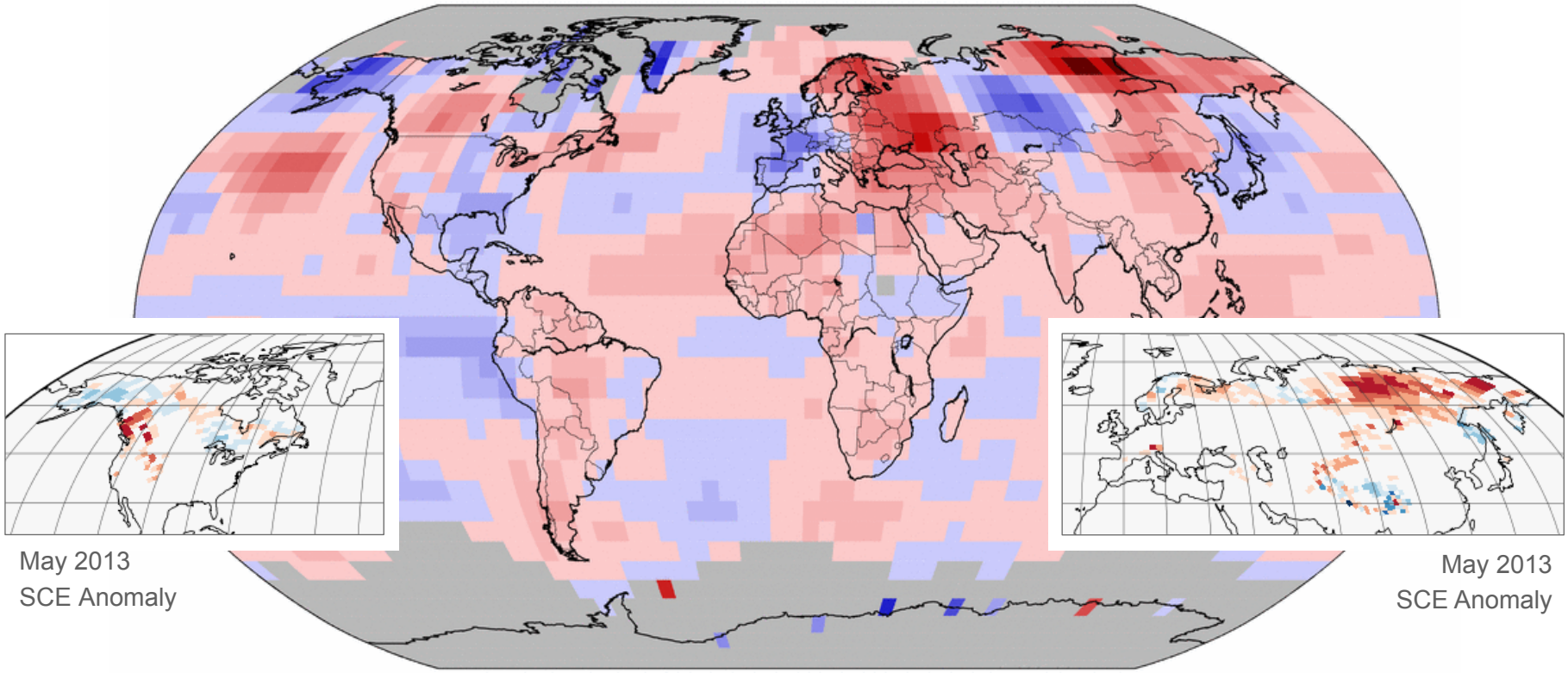
May NH SCE Departures: 1967-2015



Land & Ocean Temperature Anomalies May 2013

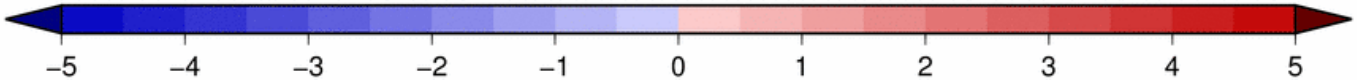
(with respect to a 1981–2010 base period)

Data Source: MLOST version 3.5.3



May 2013
SCE Anomaly

May 2013
SCE Anomaly

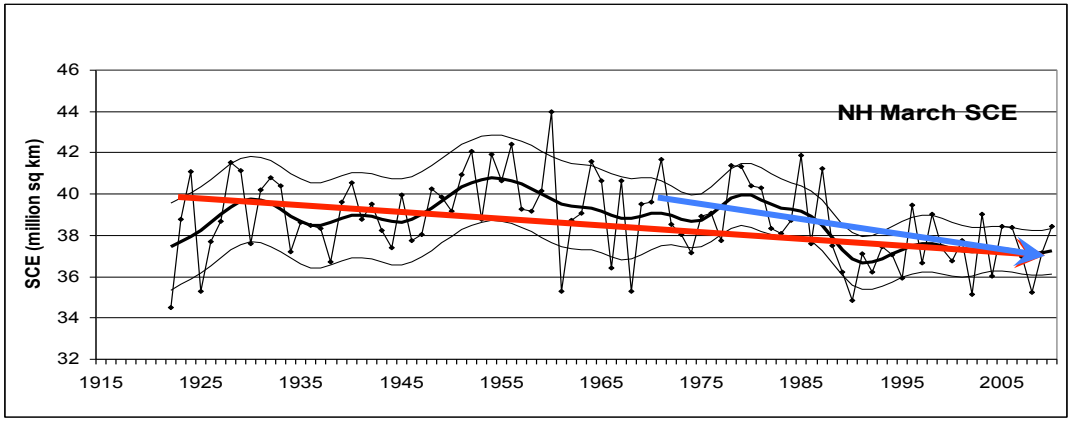


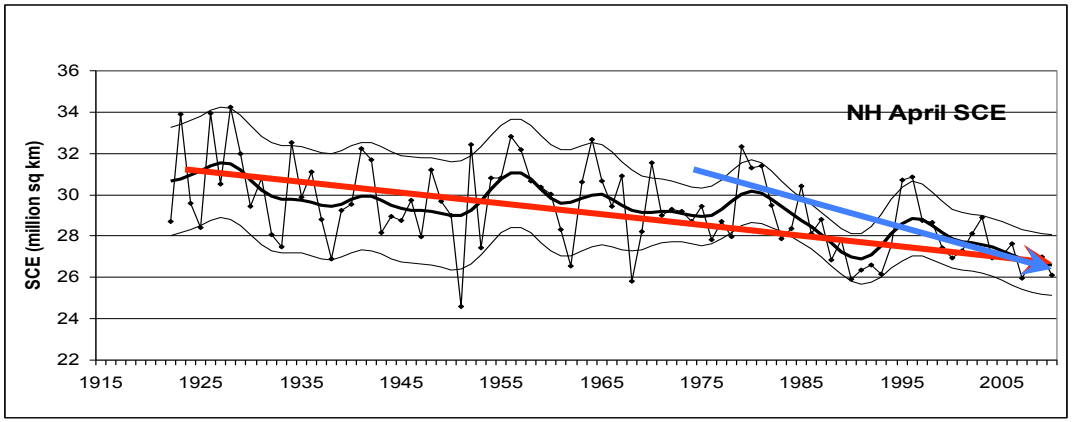
Degrees Celsius

NOAA's National Climatic Data Center
Sun Jun 16 08:26:16 EDT 2013

Please Note: Gray areas represent missing data
Map Projection: Robinson

Spring SCE: 1922-2010





Trends 10^6 km^2 (100 yr)$^{-1}$

March	
1922-2010	-3.24*
1970-2010	-7.26*

* sig at 0.05 level

April	
1922-2010	-4.72*
1970-2010	-8.30*

* sig at 0.05 level

Trend analysis including the annual error estimates showed that NH spring SCE has decreased significantly since 1922 and that the rate of decrease has approximately doubled since 1970 (Brown and Robinson 2011)

SCE CDR: applications and societal benefits

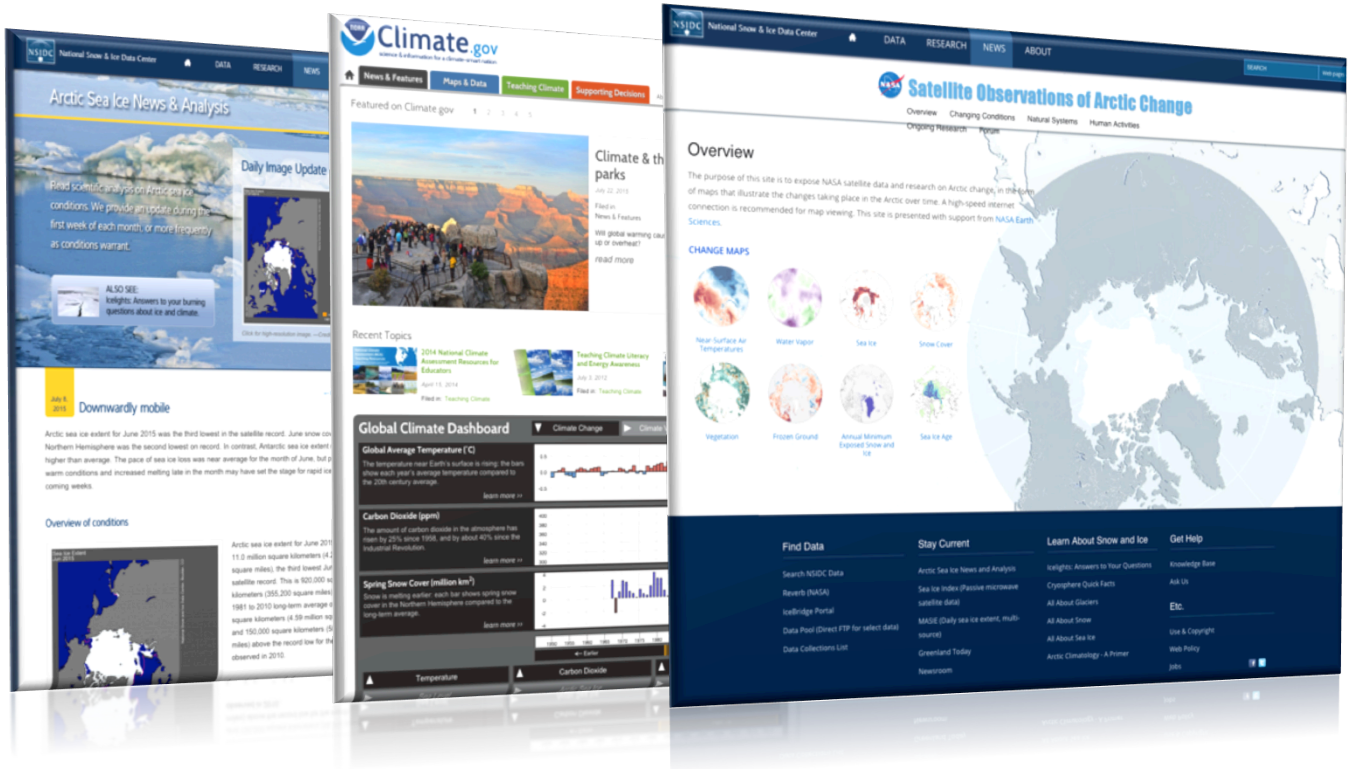
- Weather and hydrologic forecasting
- Climate research: various sectors
- Planning and monitoring:
  - Commerce, engineering, agriculture
  - Travel, recreation, wildlife

Monitoring and Assessment

- U.S. Global Change Research Program (GCRP), *2014 National Climate Assessment*
- Bulletin of the American Meteorological Society (BAMS), *State of the Climate in 2014*
- U.S. Environmental Protection Agency (EPA), *Climate Change Indicators in the United States*

Media and Public Outreach

- NOAA Global Climate Dashboard
- National Snow and Ice Data Center (NSIDC) Satellite Observations of Arctic Change
- NSIDC Arctic Sea Ice News & Analysis
- News media stories



Applied Research:

Snow ablation characteristics and melt–discharge relationships in the Columbia River Basin

- A collaborative effort between colleagues at: Rutgers U., Oregon State U. and U. Georgia

- In cooperation with:

  NCEI, GST, & Columbia Basin stakeholders

Study objectives:

1) Generate a database of SCE, depth, and water equivalent for the Columbia River Basin relying on the NOAA satellite SCE CDR, other satellite products, and *in situ* observations.

2) Utilizing the SCE CDR and other data, evaluate decision tools that have been previously developed to predict streamflow associated with snowmelt within the Columbia Basin using a broad spectrum of scenarios.

3) Make recommendations for additional observations (e.g. frequency and resolution of satellite observations, optimal location of precipitation gauges) to create a network to fully characterize the basin snowpack.

Project deliverables

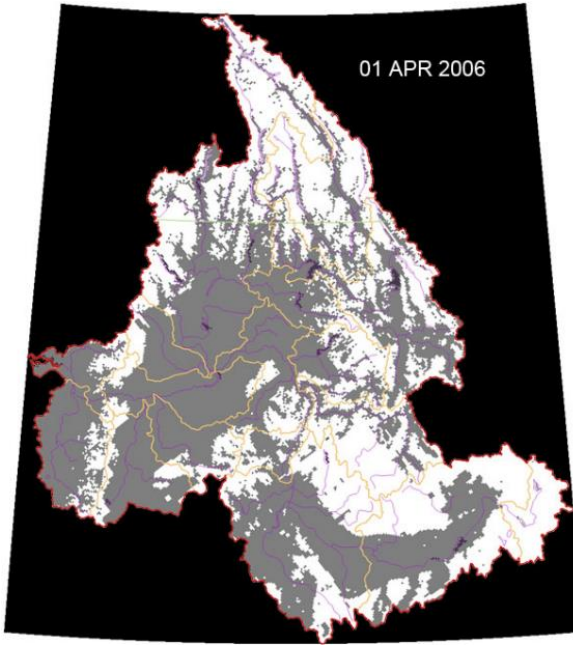
1) Project database.

2) Climatologies: means, extremes, etc. of, for instance, snow extent, depth, water equivalent, river discharge for various locations within the basin.

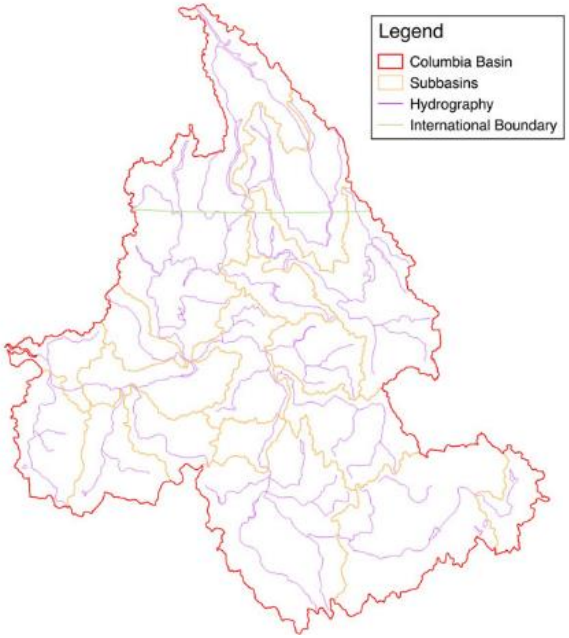
3) Evaluations of pre-existing forecast models with and without SCE CDR input.

4) Decision support tools developed expressly for this project. For instance the probabilities for seasonal discharge based on snow conditions for selected dates (e.g. March 1) and probabilities for timing of discharge based on snow conditions for selected dates (e.g. peak flow mid April).

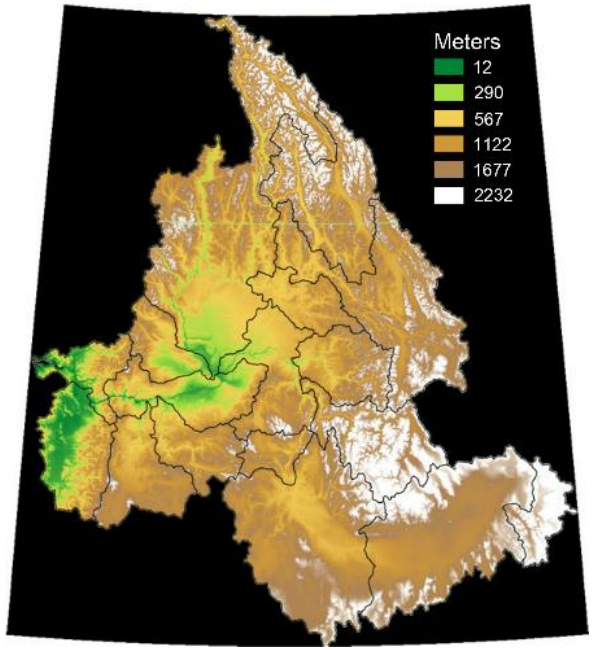
5) Recommendations of optimal observations and their distribution within the basin.



04 km IMS daily



Commission for Environmental Cooperation (CEC)
North American Environmental Atlas

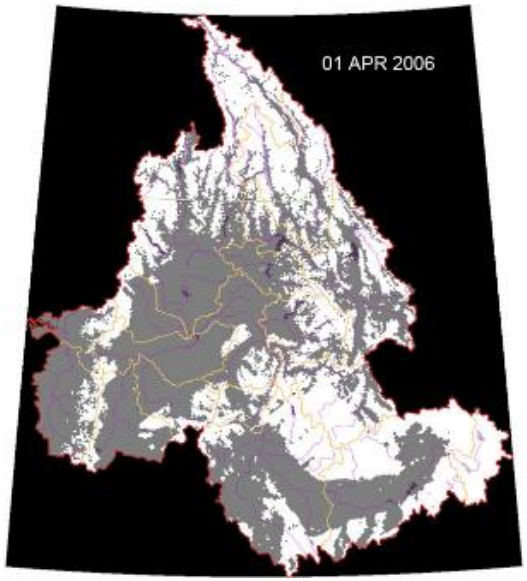


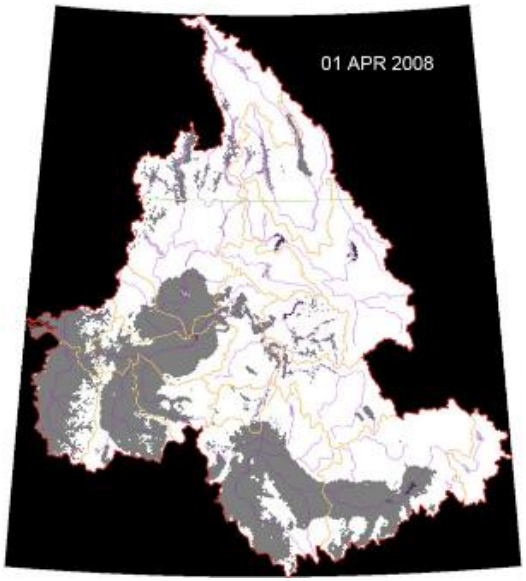
USGS GTOPO30

Basin SCE April 1

Source:
4 km IMS daily

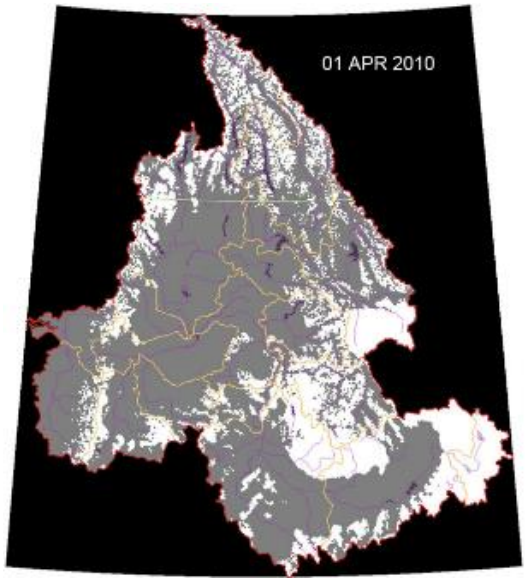
2006

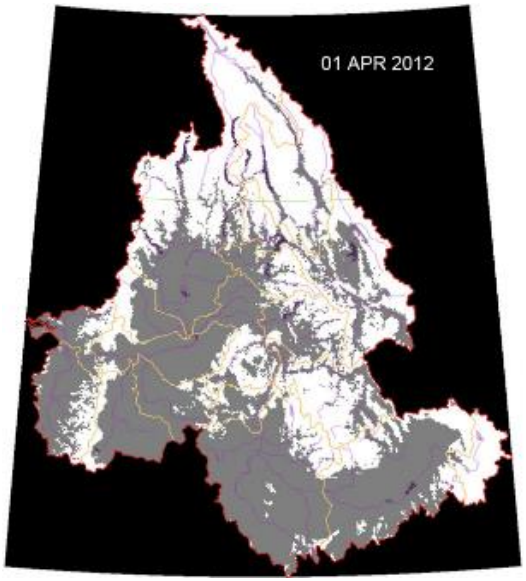




2008

2010





2012

50 years of NH SCE satellite monitoring

- Mark the 50th anniversary of the longest satellite-based record of any environmental variable
- Highlights of plans include redesigned website
- Improved production system for weekly updates

- Change Request (CR) pending to further refine netCDF and bring NH SCE CDR to v01r02

- Ongoing research efforts in house and in cooperation with others for a variety of climatological, hydrological and other purposes

17 years of operational IMS output

- Operational since November 1998
- 24 km resolution at 60°N
- Daily temporal resolution

- Bring IMS SCE output up to CDR standards

Rutgers Global Snow Lab: snowcover.org

Summing up…

- The loss of spring snow cover is similar to the loss of late summer Arctic sea ice extent

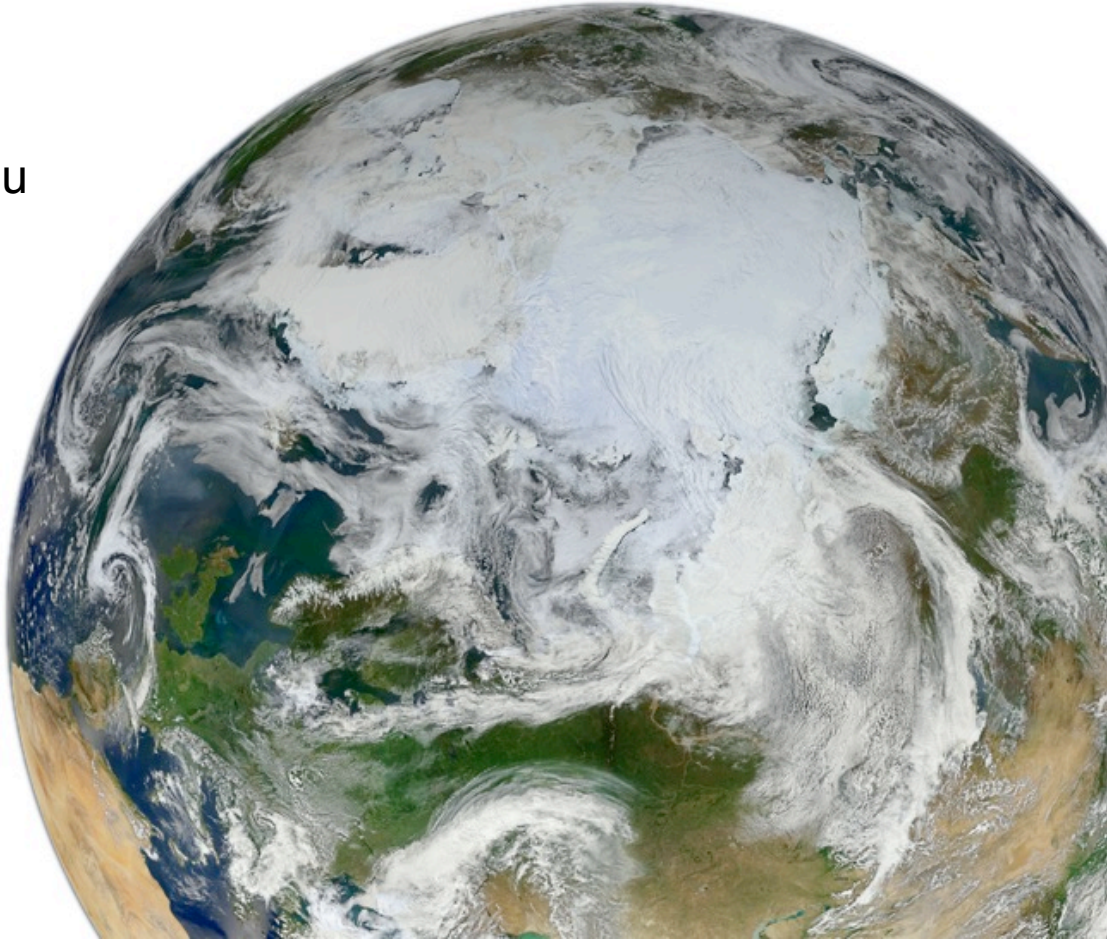
- A soon to be 50-year Northern Hemisphere snow cover climate data record over land continues to be updated
  - Available at NCEI
  - Companion cryosphere CDR includes SCE over land, snow melt onset over Arctic sea ice and snow condition over Greenland. Available at NSIDC. Not being updated beyond 2012.

- Large-scale snow cover information at work
  - Snow cover and hydroclimate studies
  - Snow-atmosphere studies
  - Snow-sea ice studies
  - Seasonal cycle analysis
  - Forced model simulations
  - Model intercomparison/validation
  - Studying long-term climate changes
  - Initializing weather prediction models
  - Estimating snow melt runoff
  - Analyzing surface albedo

Thanks

Dave Robinson

- david.robinson@rutgers.edu
- snowcover.org



NASA/GSFC/Suomi NPP
White Marble
26 May 2012