SDS: DEVELOPMENT OF AN INTEGRATED NORTHERN HEMISPHERE SNOW AND ICE OPERATIONAL CLIMATE DATA RECORD

ARC 1: CONTINUED MONITORING OF GLOBAL SNOW COVER EXTENT AND DEPTH

ARC 2: ONGOING DEVELOPMENT OF SNOW IMPACT SCALES FOR THE U.S.

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NCDC - Asheville
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RUTGERS UNIVERSITY GLOBAL SNOW LAB

SDS: DEVELOPMENT OF AN INTEGRATED NORTHERN HEMISPHERE SNOW AND ICE OPERATIONAL CLIMATE DATA RECORD

Dave Robinson
Rutgers University

Mark Anderson
University of Nebraska

Chuck Fowler & Jim Maslanik
University of Colorado

Sheldon Drobot
National Center for Atmospheric Research

Goals

- Develop mature Northern Hemisphere terrestrial snow and sea ice CDRs with known levels of uncertainty and with community-standard metadata
- Assemble mature Northern Hemisphere terrestrial snow and sea ice data products into an integrated snow and ice CDR
- Provide the snow and ice CDR in multiple grids, on multiple time steps, and in multiple formats for the research community, decision-makers, and stakeholders.

Data

- Sea ice: SDS data product of Walt Meier
- Snow melt on sea ice: Anderson and Drobot algorithm
- Snow extent on land: maps generated by NOAA and “standardized” by Robinson
- Snow depth on land: US and Canadian Coop observations, various Eurasian datasets by Robinson & Mote

Deliverables

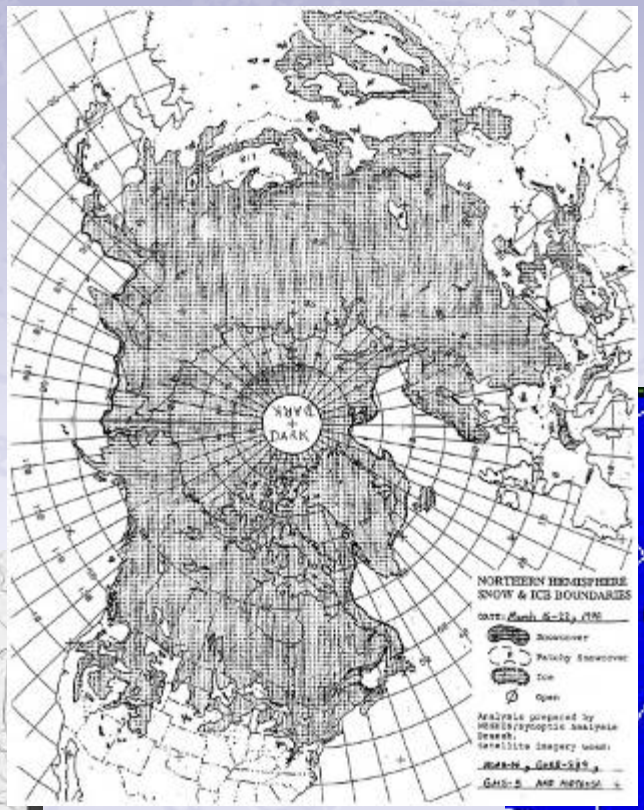
- Datasets or links to datasets
- Integrated CDR on several time steps (daily through annual), in various grids (e.g., Equal-Area Scalable Earth, 1° x 1°), and in various formats (e.g., text, netCDF, flat binary)

User communities

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

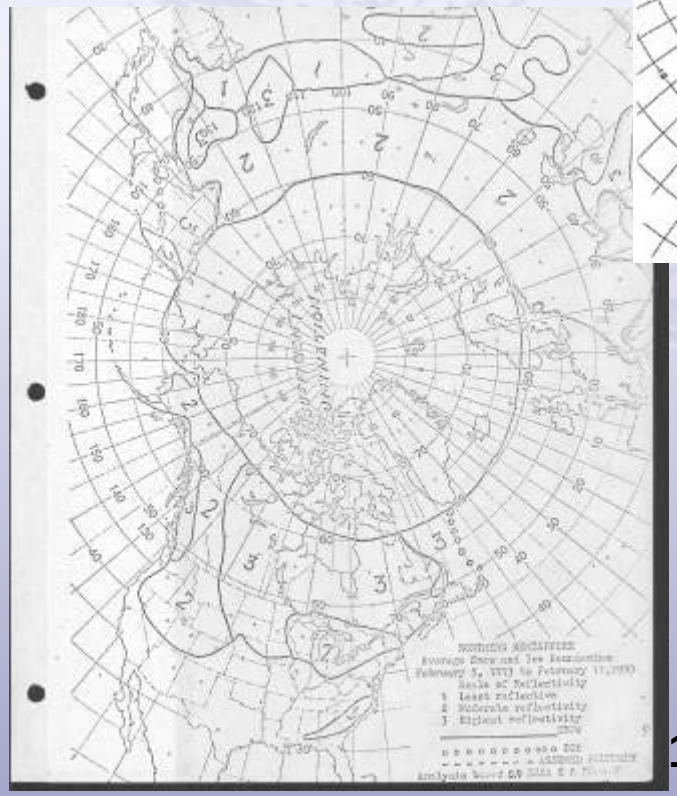
Approach

40 years of visible satellite snow extent mapping by NOAA

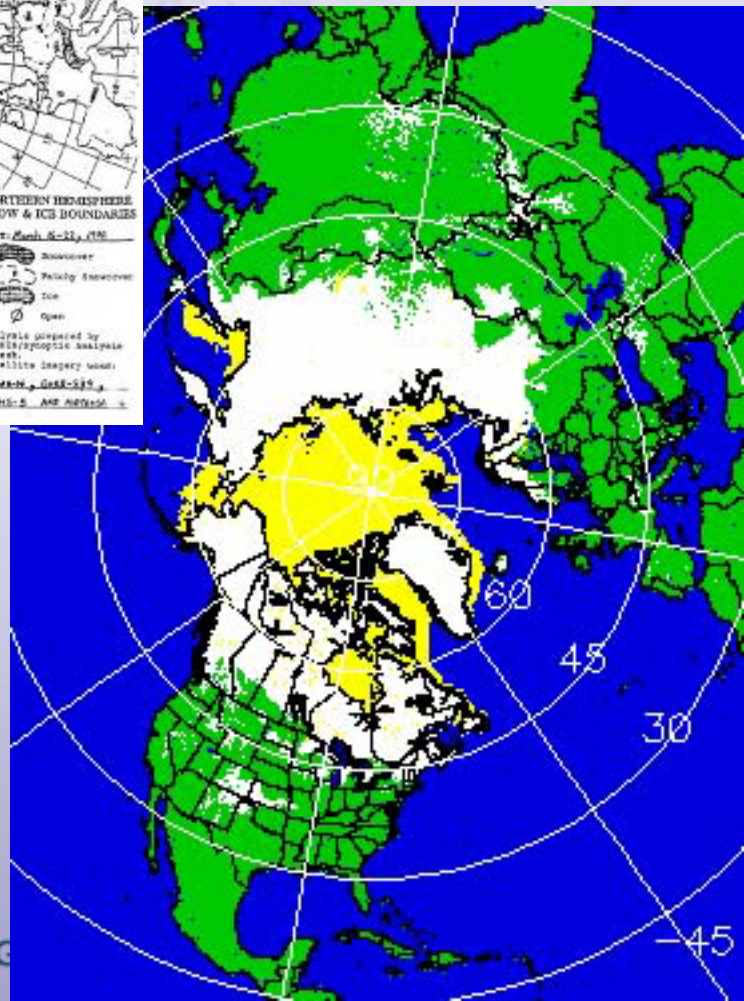


1998

2007



1973



Reanalysis

Match the past mapping to current knowledge and consistency

Correct errors in the past to match what we've learned within the IMS era

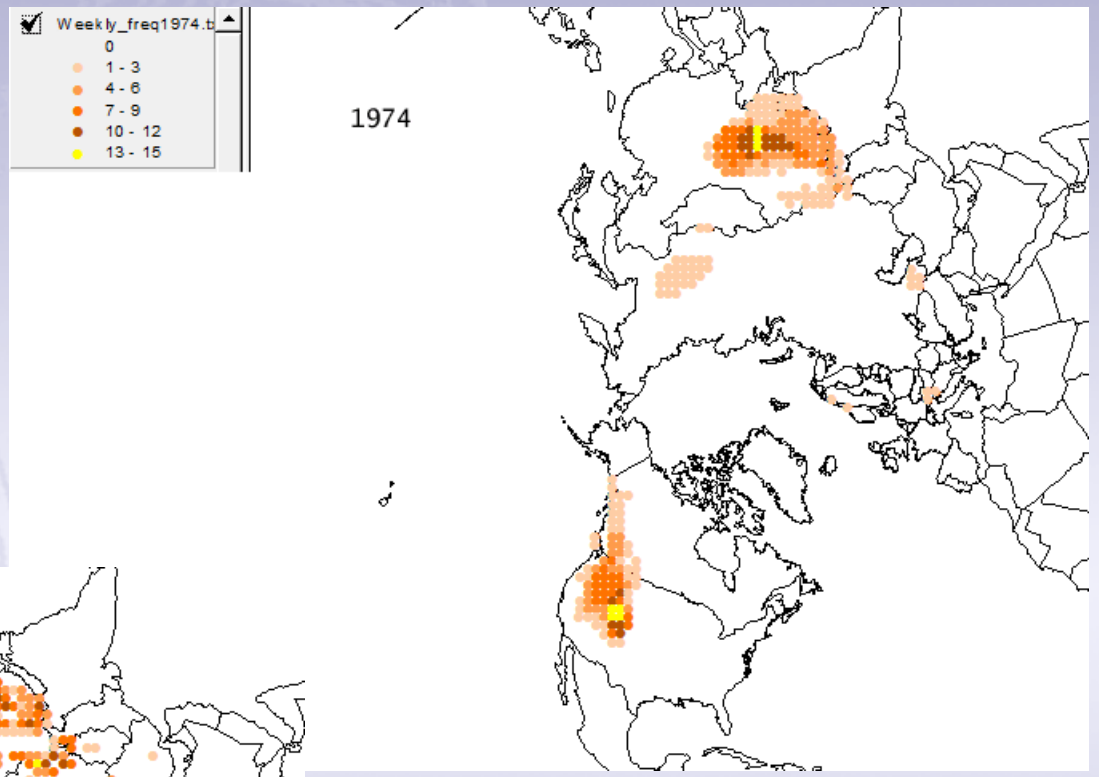
Three steps for each digitized 128x128 NOAA map cell

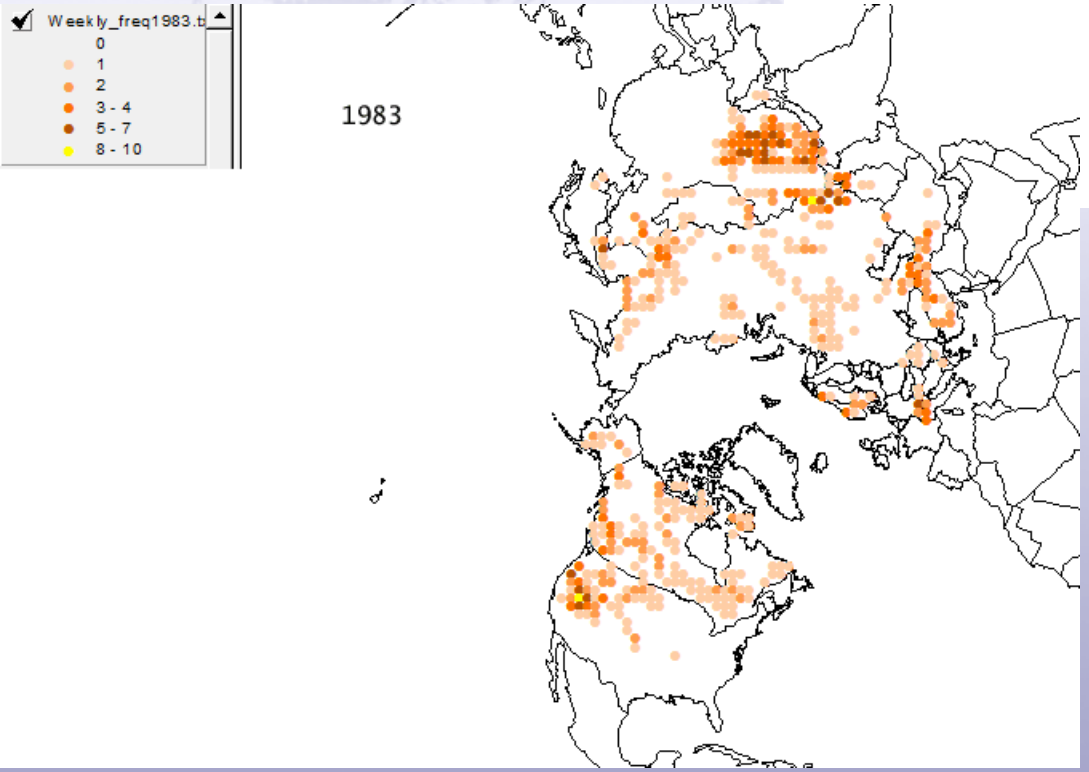
1. Scattered snow reanalysis

2. Compare climatologies

3. Overlap period

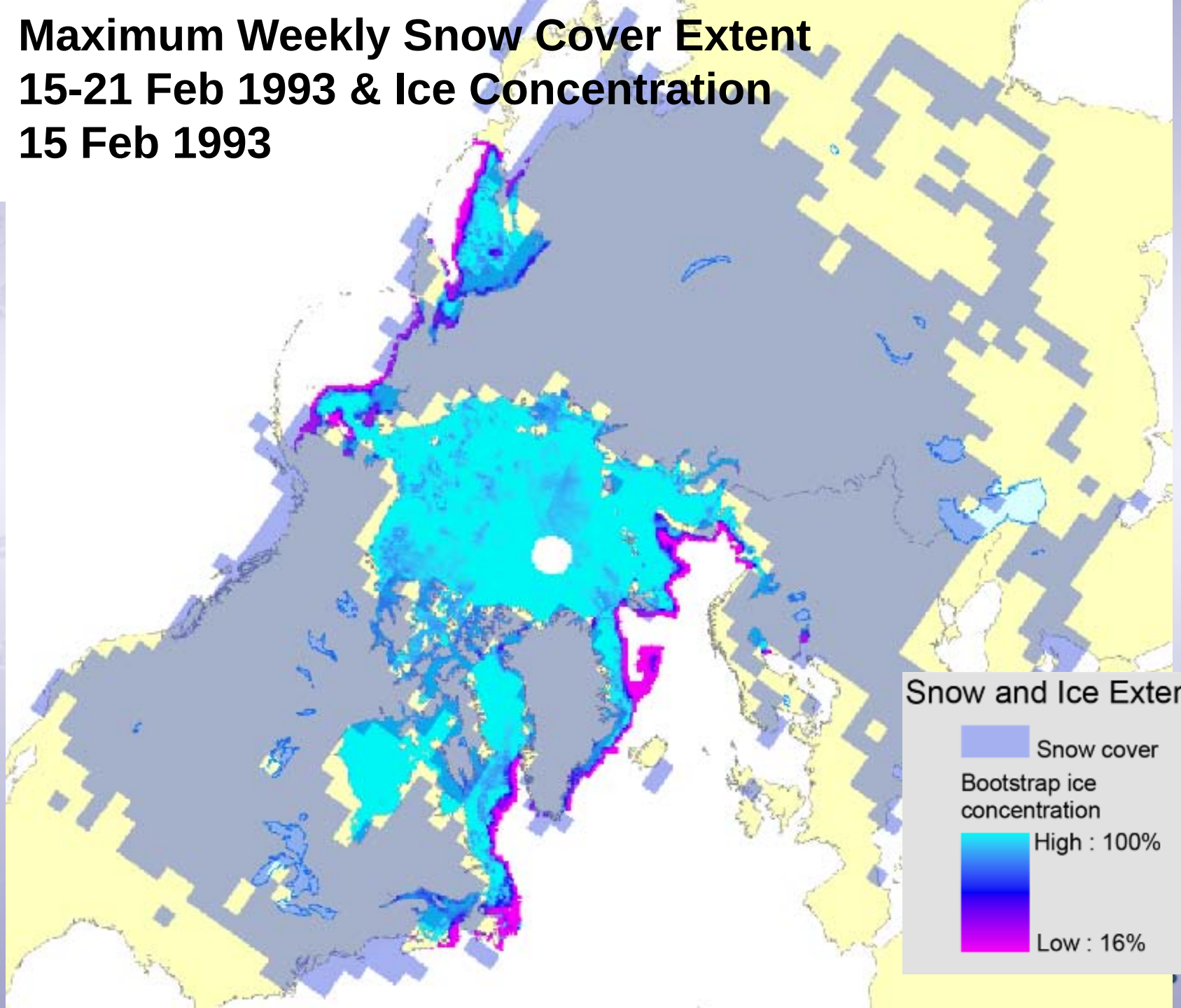
Scattered Snow Reanalysis



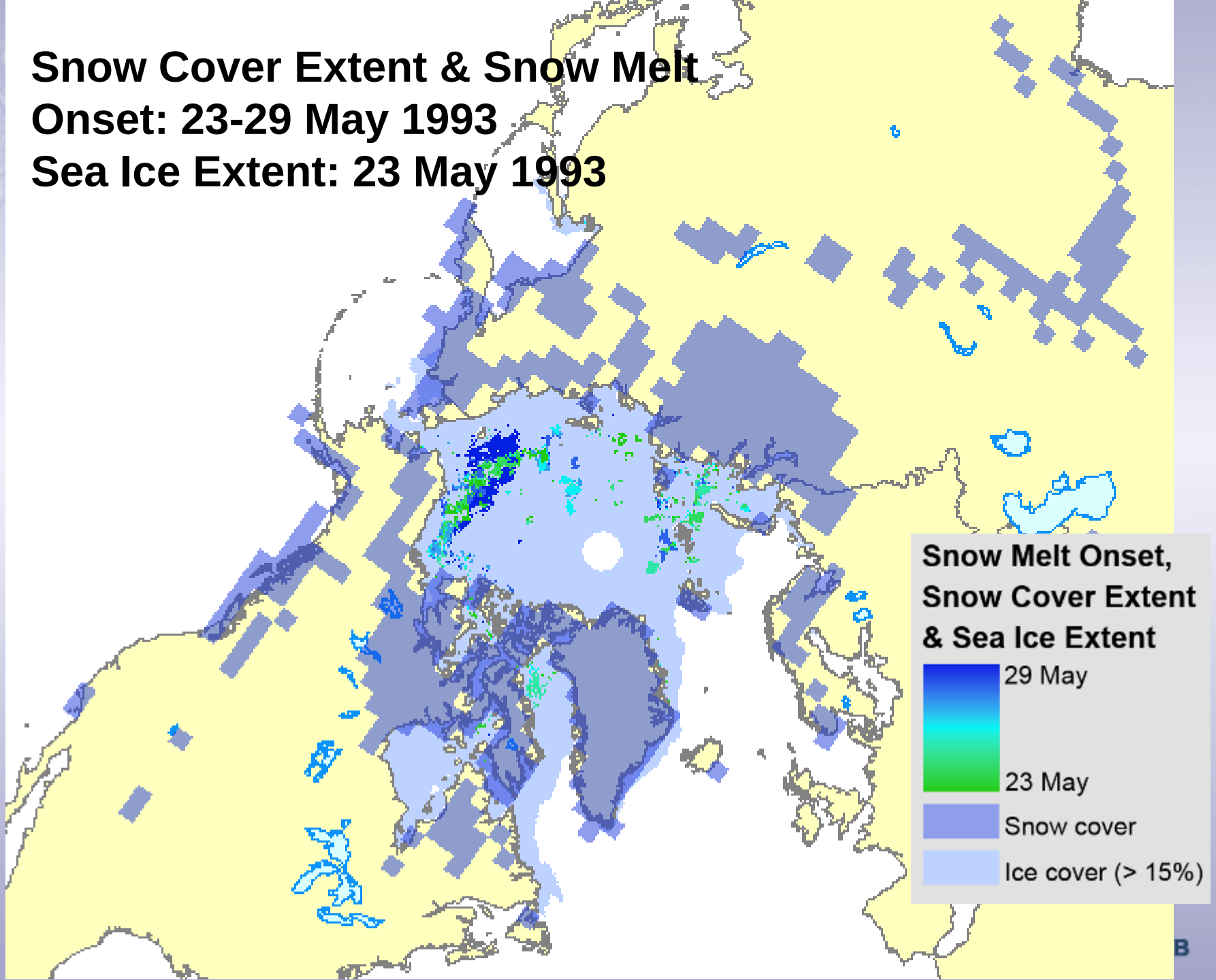


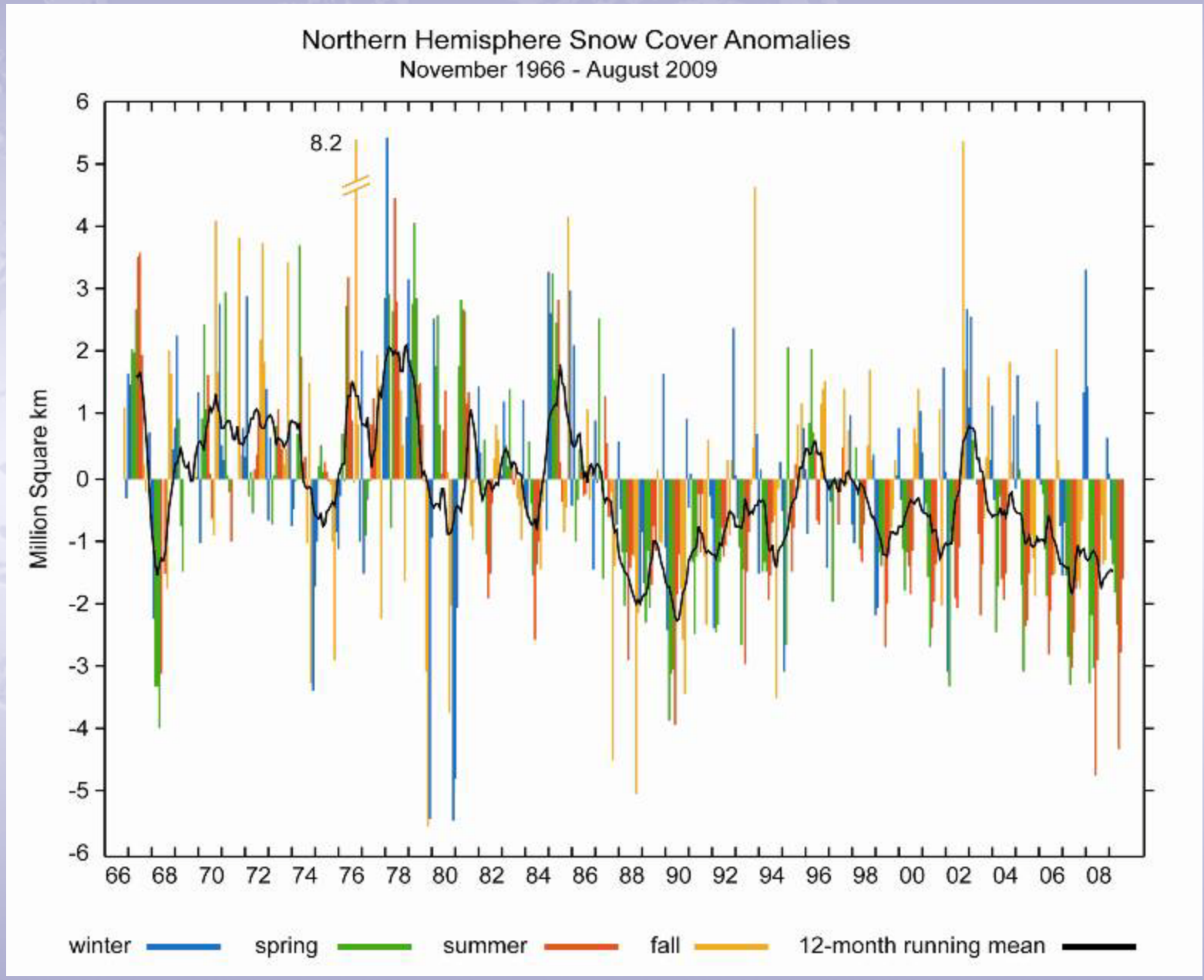
Results/Accomplishments

Maximum Weekly Snow Cover Extent
15-21 Feb 1993 & Ice Concentration
15 Feb 1993



Snow Cover Extent & Snow Melt Onset: 23-29 May 1993 Sea Ice Extent: 23 May 1993




Northern Hemisphere Snow Cover Anomalies
November 1966 - August 2009
Million Square km
8.2
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08
winter
spring
summer
fall
12-month running mean

Validation Strategy

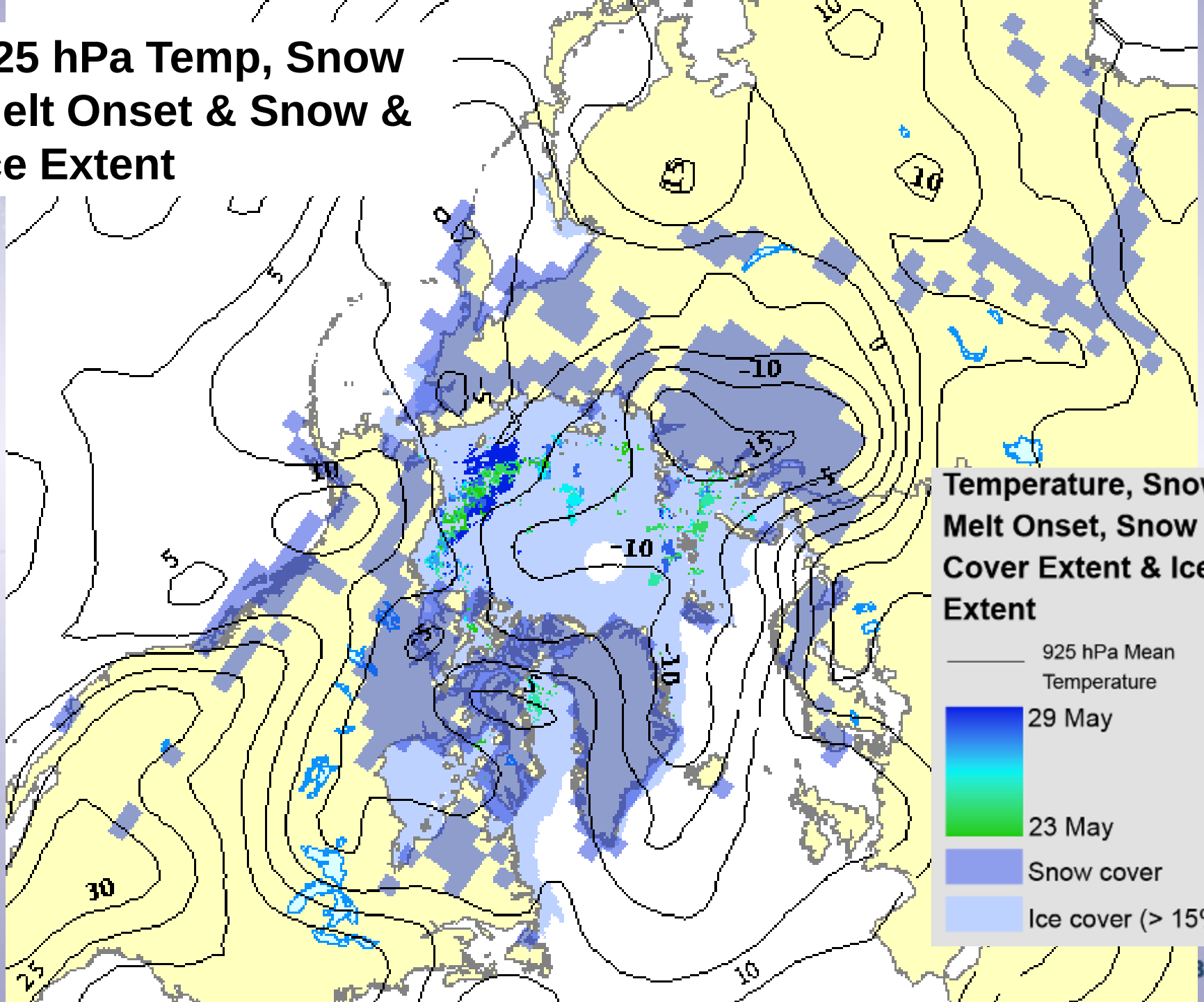
Quantitative estimates of uncertainty

A vexing issue

Continued to be addressed through CDR development effort

Not there yet

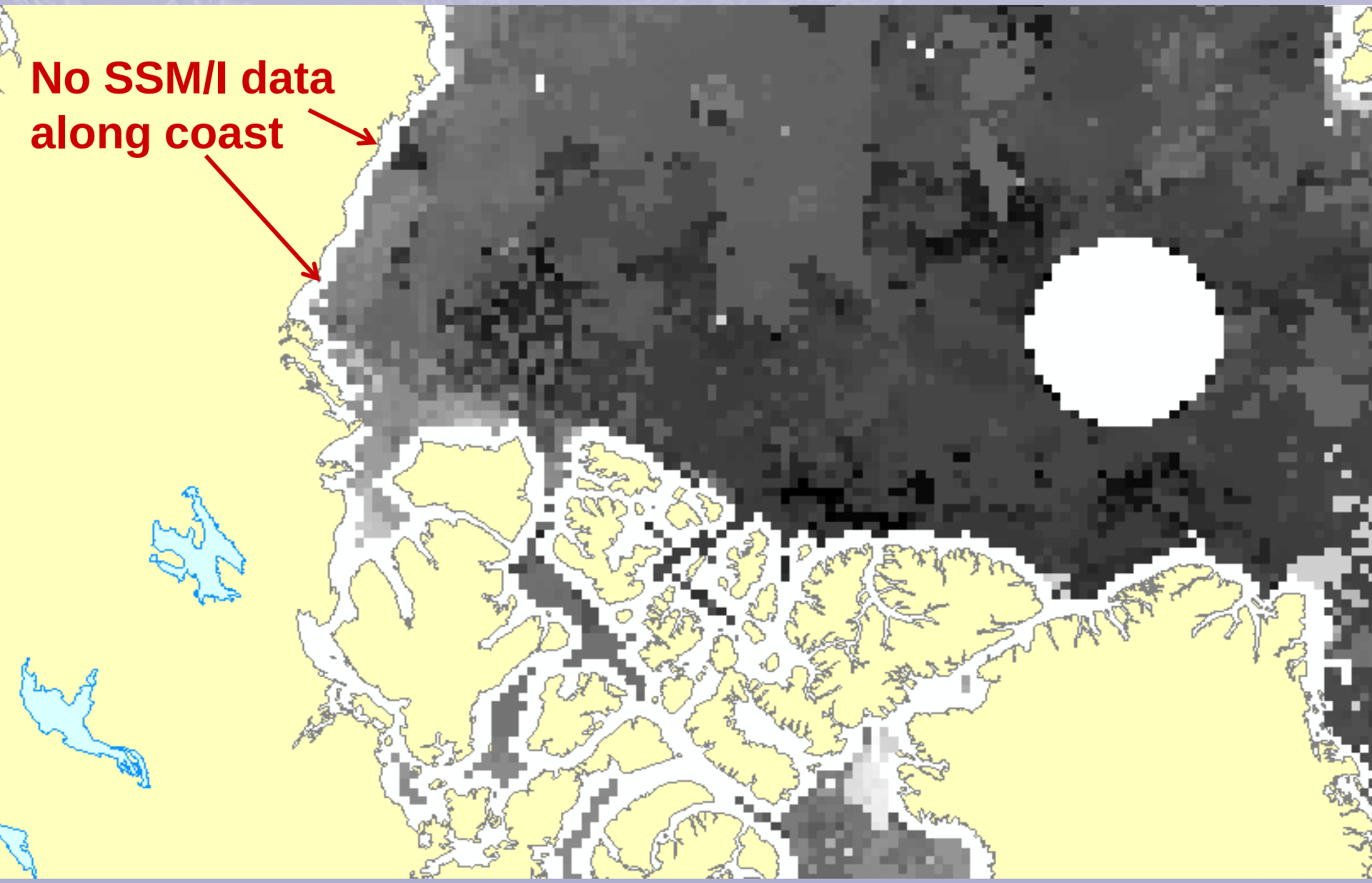
925 hPa Temp, Snow Melt Onset & Snow & Ice Extent

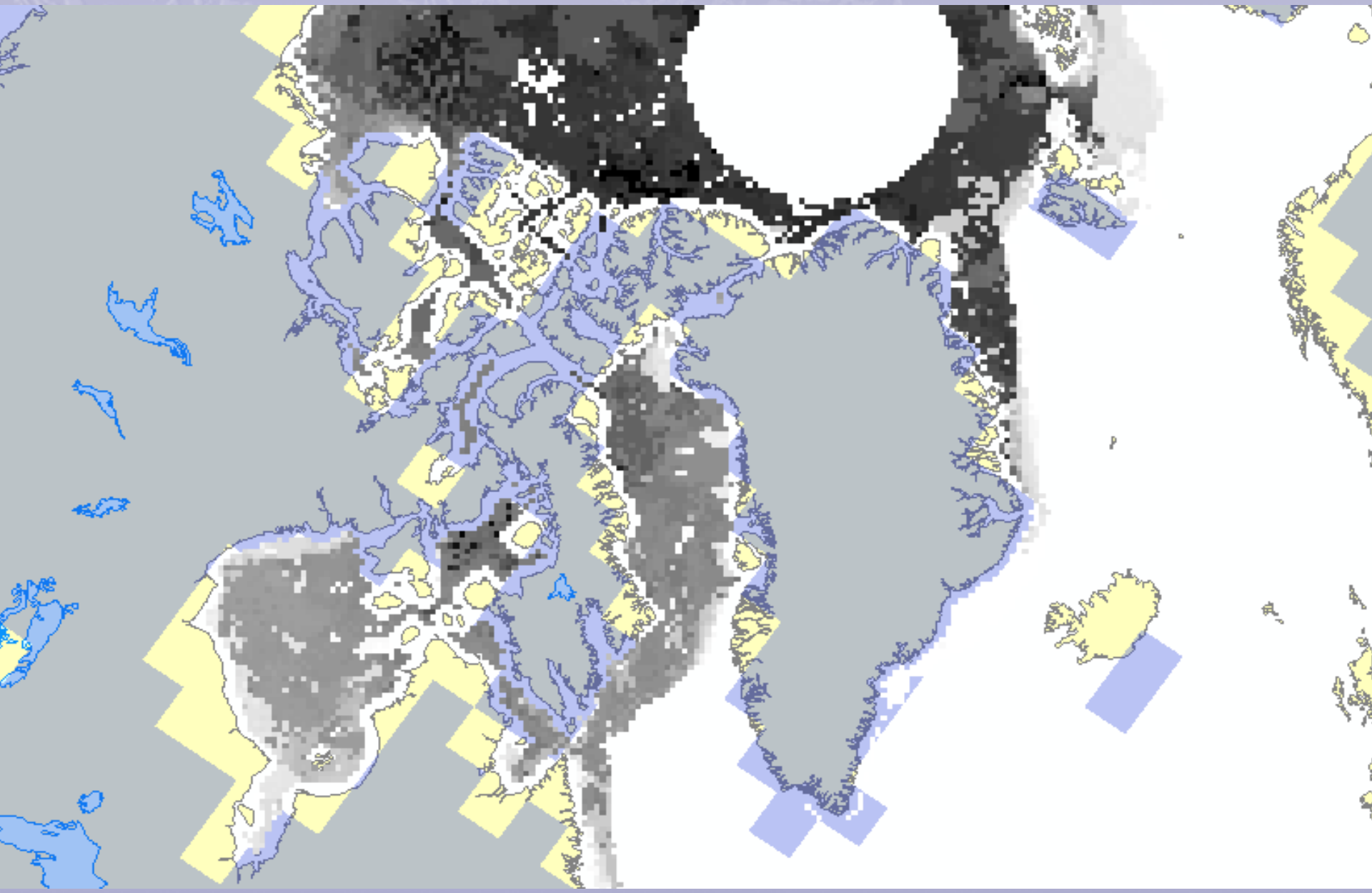


Product Maturity

Product	Algorithm stability	Metadata & QA	Documentation	Validation	Public Release	Science & Applications
Sea Ice (cf. Walt Meier)						
Snow on ice	Minimal changes expected	Research grade	Peer-reviewed algorithm and product description	In progress. Uncertainty estimated over widely distributed times/location..	Data available upon request.	Research community.
Snow extent on land	Minimal changes expected	Research grade	Peer-reviewed publications	In progress. Uncertainty estimated over widely distributed times/location.. .	Data available on web and upon request.	Research community & numerous consumers
Snow depth	NA	Research grade	Under development	In progress. Uncertainty estimated over widely distributed times/location.. .	Data available upon request	Research community

Issues


No SSM/I data
along coast



Schedule

Year 1

- Collect existing snow cover and melt onset data records, including metadata information
- Establish advisory committee and obtain advice on CDR
- Hold town hall at AGU

Year 2

- Obtain and incorporate advisory committee and community feedback on CDRs
- Determine uncertainty in between existing snow and melt onset data records
- Develop integrated snow and melt onset climate data record
- Establish Web-based display containing metadata and data access capabilities
- Begin incorporating sea ice extent CDR into our integrated snow and ice CDR

Year 3

- Generate the portals to release the integrated CDR to appropriate data centers
- Publicize and distribute the integrated CDR
- Produce value added products to accompany the integrated CDR
- Develop procedures for continued updates of the integrated CDR with future data records
- Transfer CDR production to ARC data operations centers

Resources

- Number of personnel employed for project: 8
- Key collaborating projects or personnel
  - Walt Meier: SDS sea ice project
  - Tom Mote (U. Georgia), Dorothy Hall (NASA GSFC) with SDS snow team: NASA MEaSURES project
- Target NOAA Data Center: NCDC, NSIDC

ARC 1: CONTINUED MONITORING OF GLOBAL SNOW COVER EXTENT AND DEPTH

Dave Robinson
Rutgers University

Goals

- Maintaining the long-term daily (formerly weekly) IMS data set of snow maps produced by NOAA.
- In addition, microwave maps of snow cover extent and depth, and station snow depth observations from US and Canadian sources continue to be developed and updated.

Data

- Snow extent on land: maps generated by NOAA and “standardized” by Robinson
- Snow depth on land: US and Canadian Coop observations, various Eurasian datasets

Deliverables

- Daily, weekly, monthly, seasonal and annual continental and hemispheric information.
- Data and interpretive materials for monthly and annual national assessments
- Data and interpretive materials for international assessments.

User communities

- Weather and hydrologic forecasting
- Climate research: various sectors
- Planning and monitoring:
  - Commerce, engineering, travel, agriculture, recreation, wildlife
- In 2008, 15,595 individuals visited the site at least once. There were 11,791 returning visitors over the course of the year. Visits came from 102 countries, with the top ten from greatest to least including the U.S., Russia, United Kingdom, Netherlands, France, Sweden, Canada, Germany, Italy and Spain. 44% of the visitors came directly to the site, suggesting they have it bookmarked. 42% arrived from a referring site, indicating a number of other websites contain a link to our site. The remaining 14% found the site through search engines.

http://climate.rutgers.edu/snowcover

RUTGERS UNIVERSITY :: CLIMATE LAB :: GLOBAL SNOW LAB

SEARCH

gsl RUTGERS UNIVERSITY GLOBAL SNOW LAB

home | publications | data requests | links

PRODUCTS

LATEST SNOW

MONTHLY CHART

Northern Hemisphere

Visible Satellite Charts

- Daily
- Weekly
- Monthly
- Monthly Departure
- Monthly Climatology
- Documentation

Graphs

- Snow Anomalies
- Monthly Anomalies
- Seasonal Extent

Tabular

Area of Snow Extent

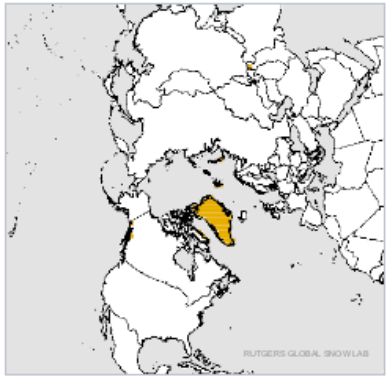
- Weekly
- Monthly
- Rankings
- Download

North America

Blended Snow Charts

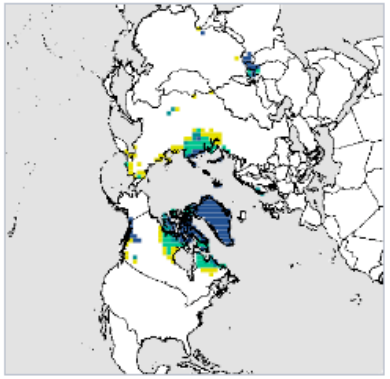
- 3-Way Pentads
- Station Pentads
- Microwave Pentads

July 15, 2009



Yesterday's snow cover extent across Northern Hemisphere lands. For more daily charts, including the departure from satellite-era normal, click the map.

June 2009



Average snow cover extent for the latest month. Based on Rutgers GSL analysis of NOAA daily snow maps. For more results, including the monthly departure from normal for this and other months back to the late 1960s click the map.

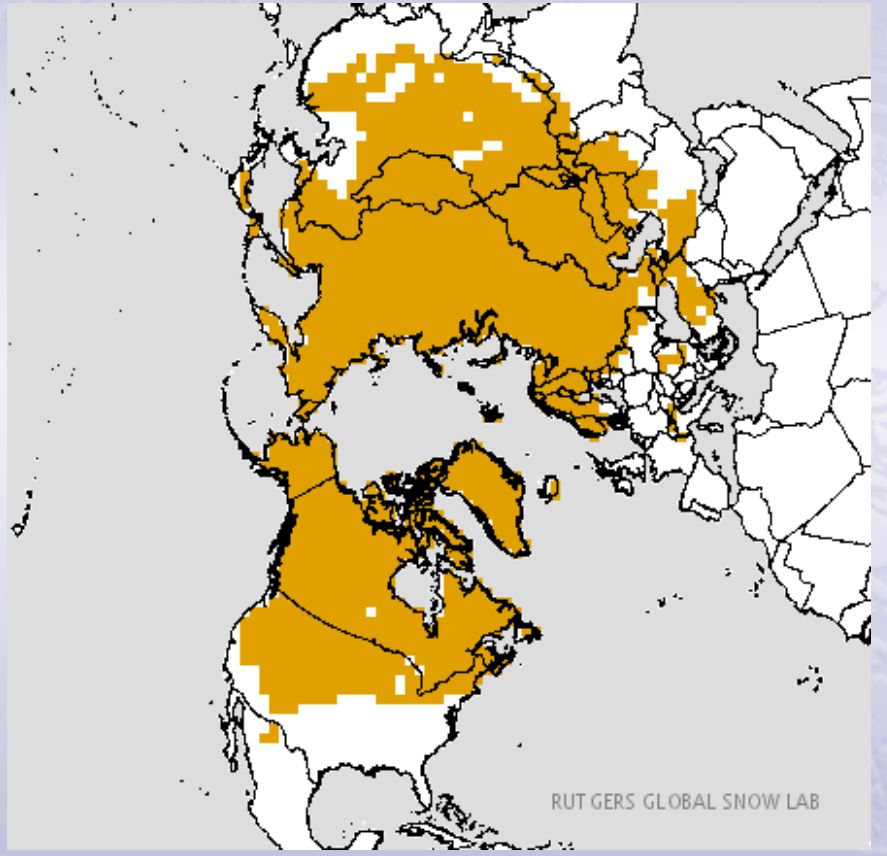
About the GSL

Welcome to the Rutgers University Global Snow Lab. Here you will find various unique products regarding global snow cover. Maps, graphic products and tabular data are available.

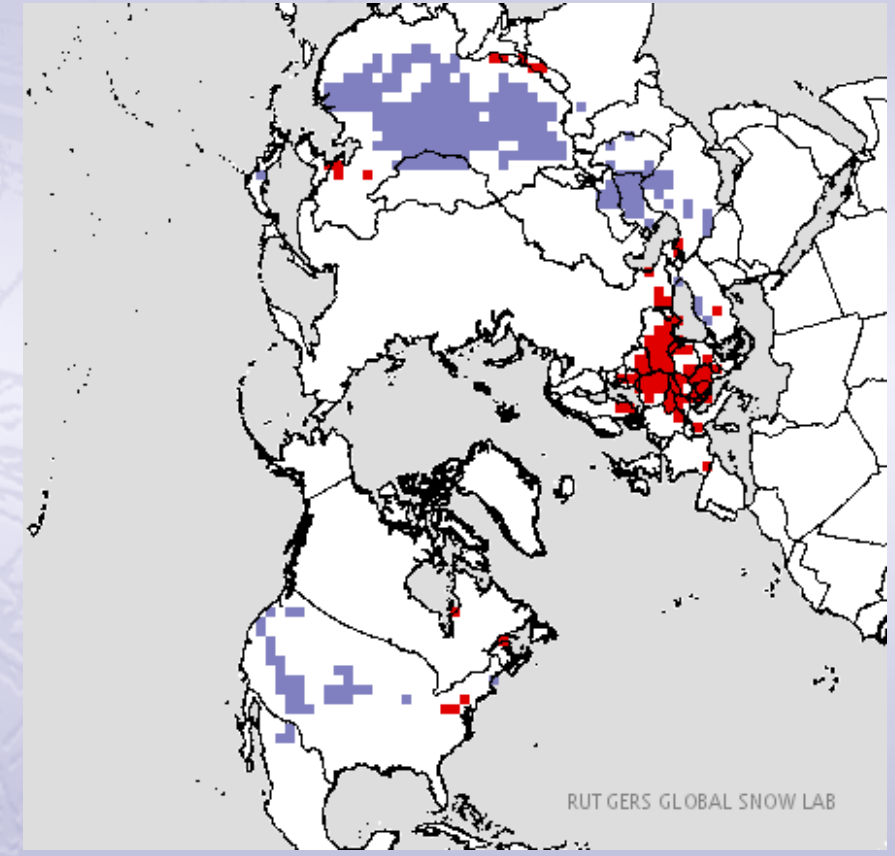
2008 Annual Report

Annual snow cover extent (SCE) over Northern Hemisphere lands averaged 24.4 million square kilometers in 2008. This is 1.1 million sq. km less than the 39-year average and ranks 2008 as having the 4th

Daily snow extent and departure: February 5, 2008

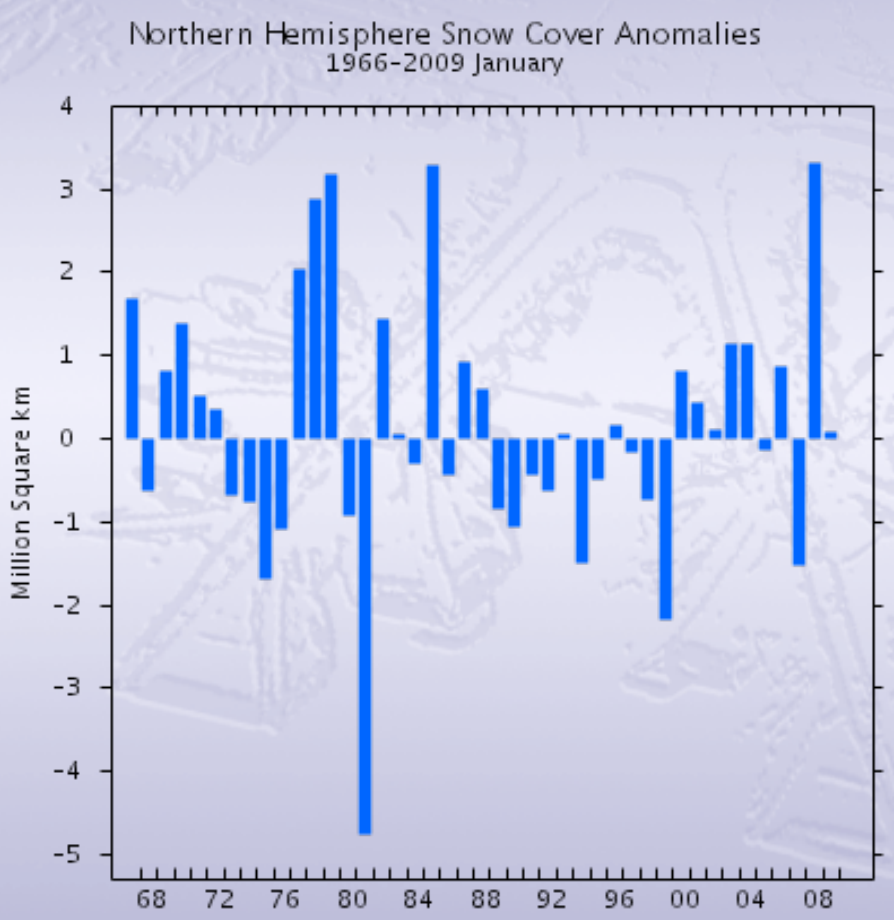


IMS Observed

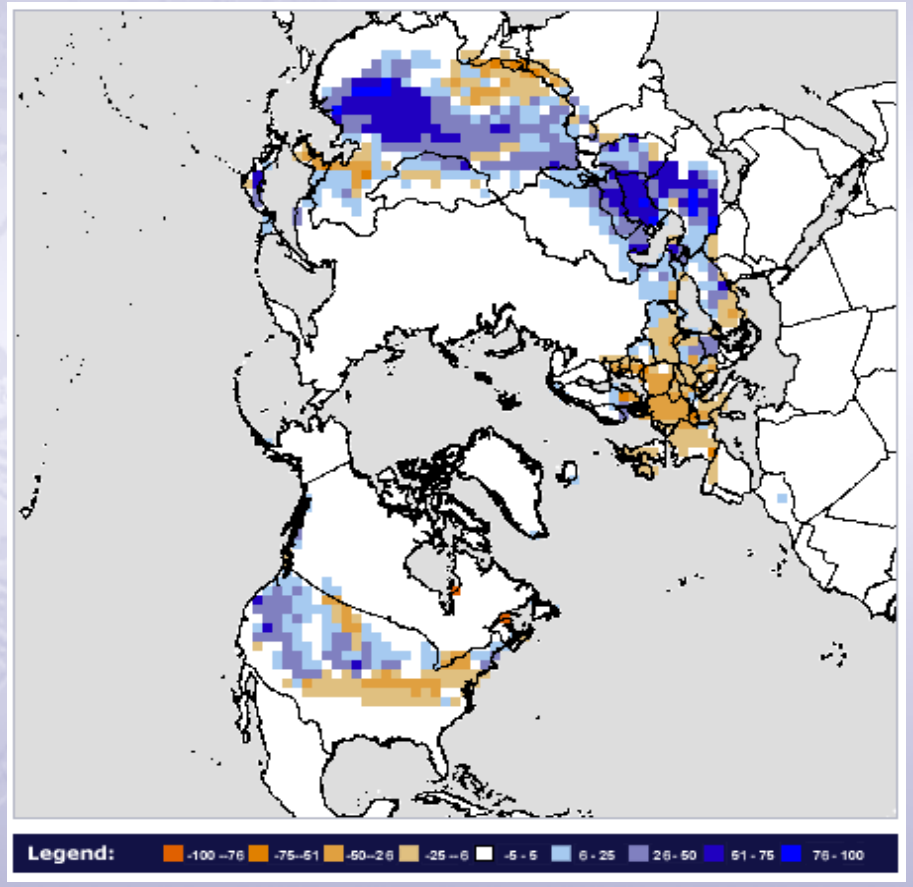


Departure
(red: below, blue: above)

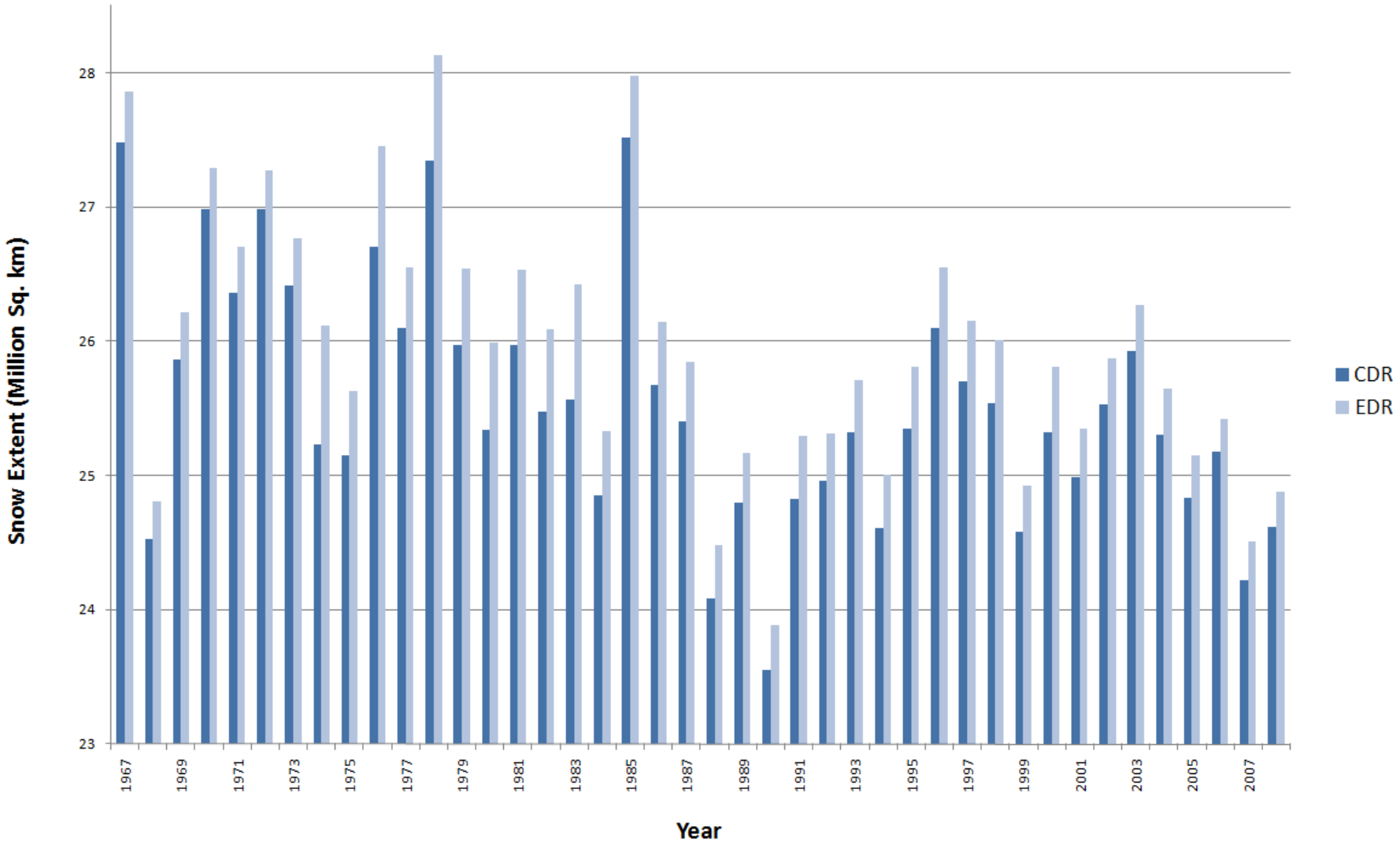
January 2008 Snow Extent



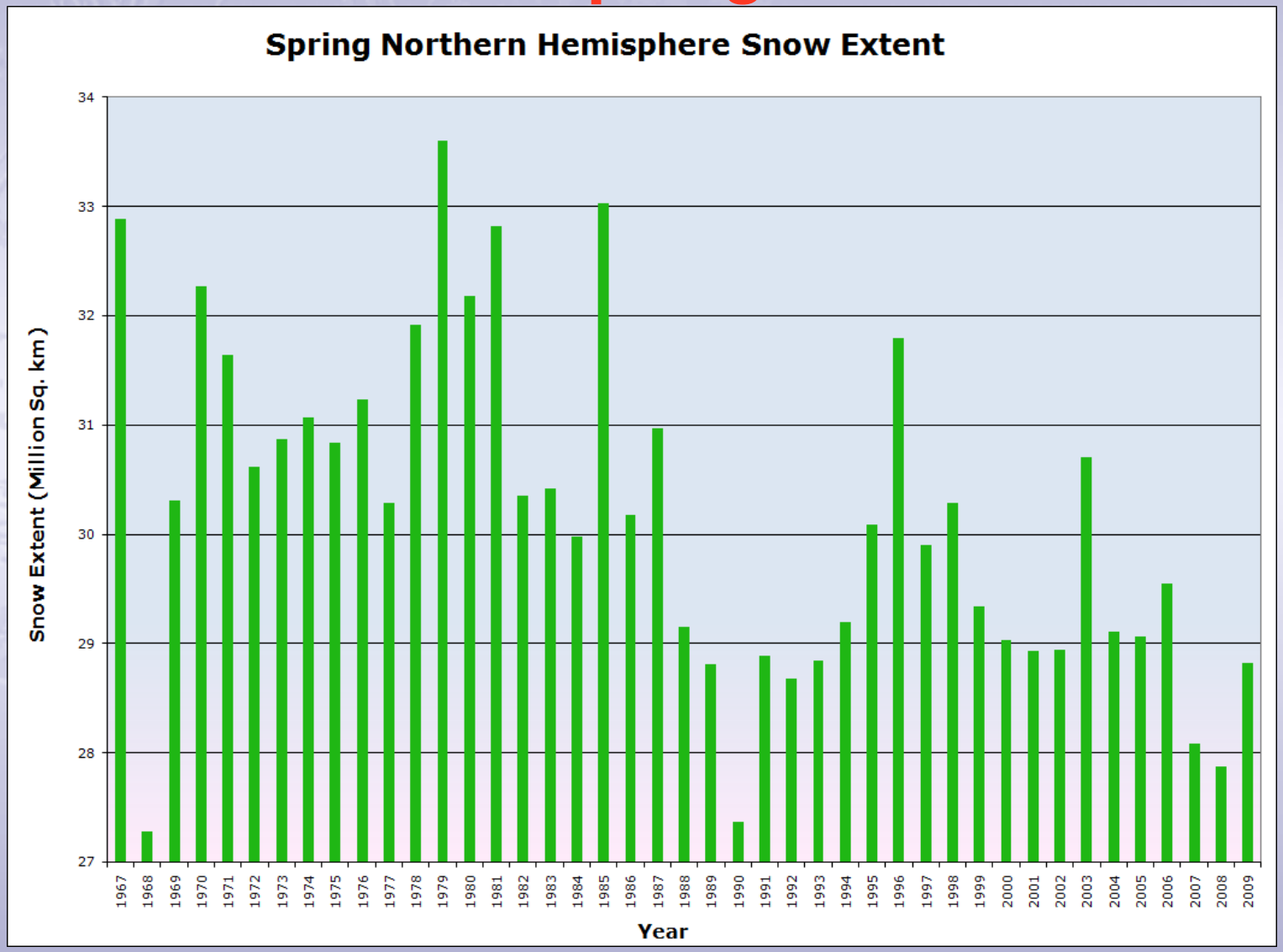
Departures



Annual Mean Northern Hemisphere Snow Extent



Spring


Spring Northern Hemisphere Snow Extent
Snow Extent (Million Sq. km)
34
33
32
31
30
29
28
27
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
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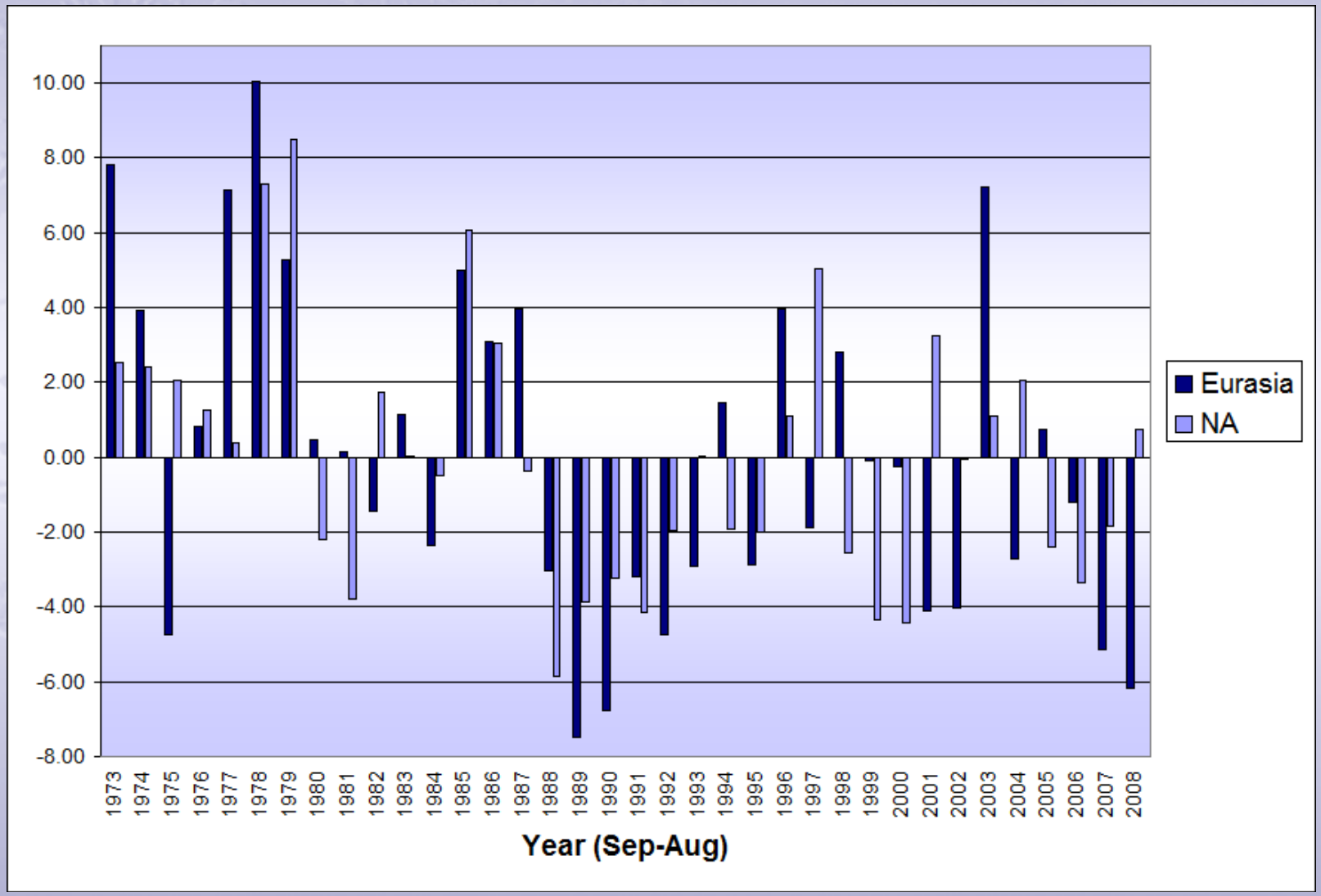
2003
2004
2005
2006
2007
2008
2009
Year

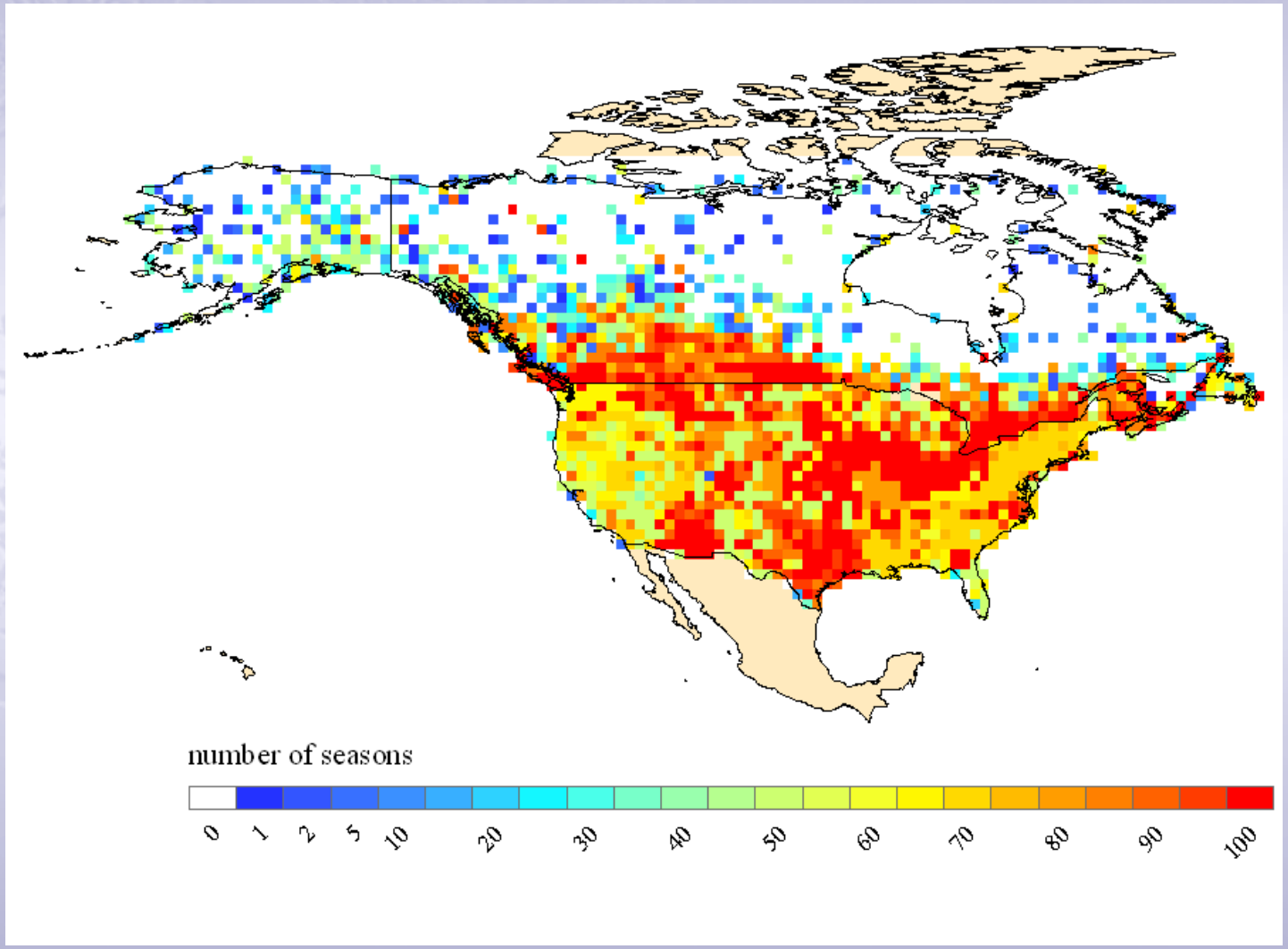
Annual Snow Extent Anomalies



Snow Depth Data

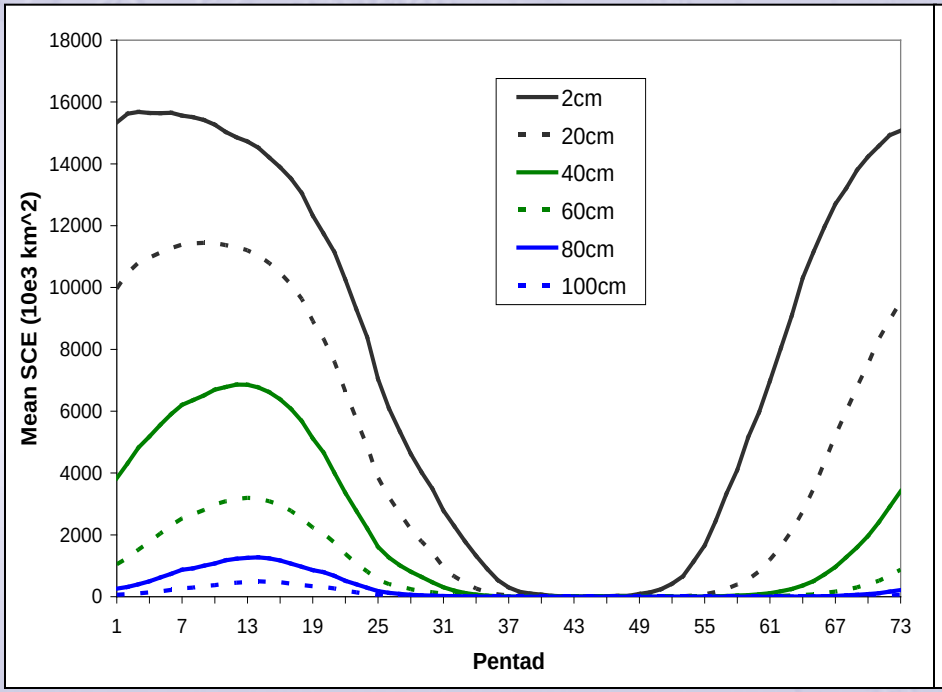
- Combined US and Canadian daily surface snow depth observation network
  - U.S. data: cooperative observer network (USDC, 2003)
  - Canadian data: Meteorological Service of Canada observation network (Brown, 2000; Brown et al., 2003)
- Varying station periods of record and station density over 20th century
- Efforts underway for expansion to Eurasia

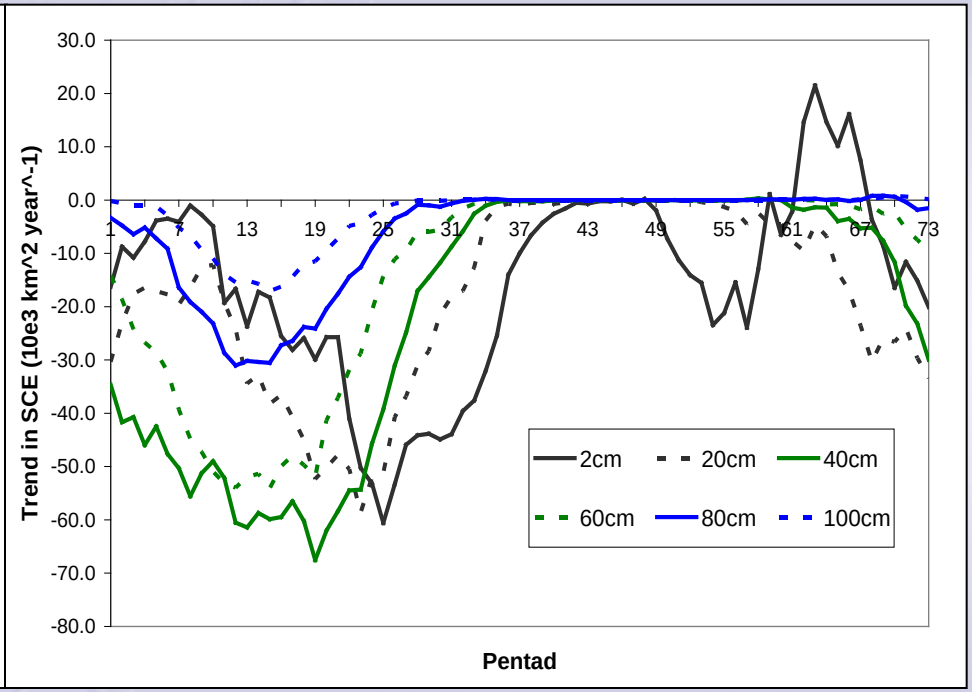
Number of seasons with data



Klewer (2007) using data from Dyer and Mote (2006)

Snow extent for depths exceeding…



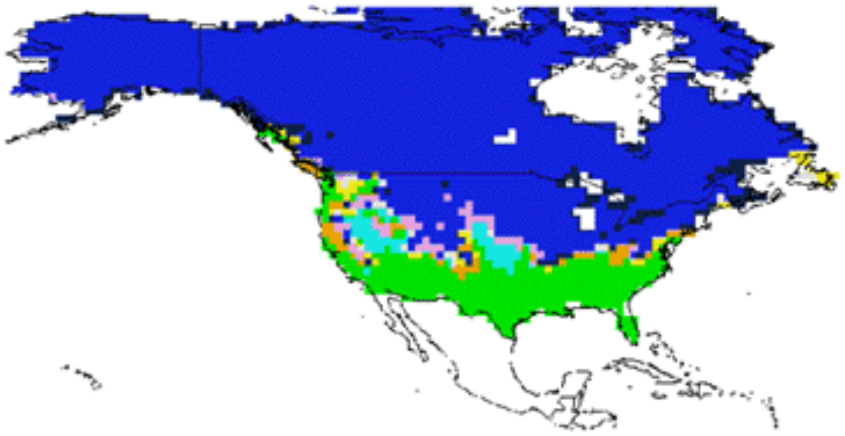


North American snow cover is decreasing in depth at a faster rate than it is decreasing in extent (work of T. Mote)

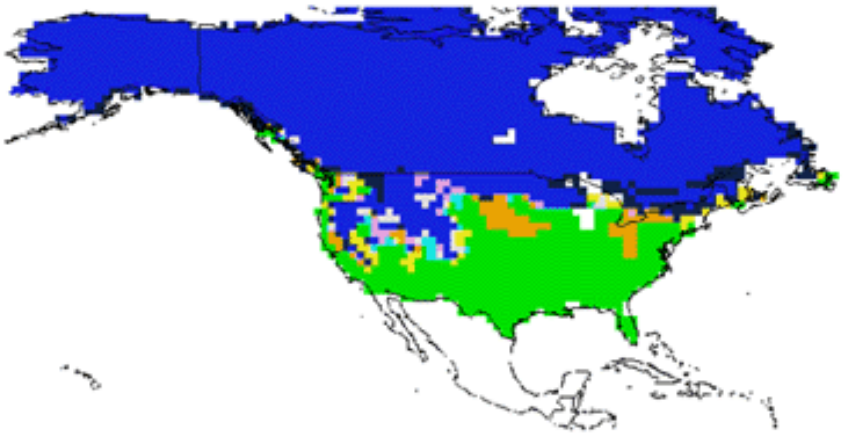
Validation Strategy

North American Snow Cover - Three Product Blending

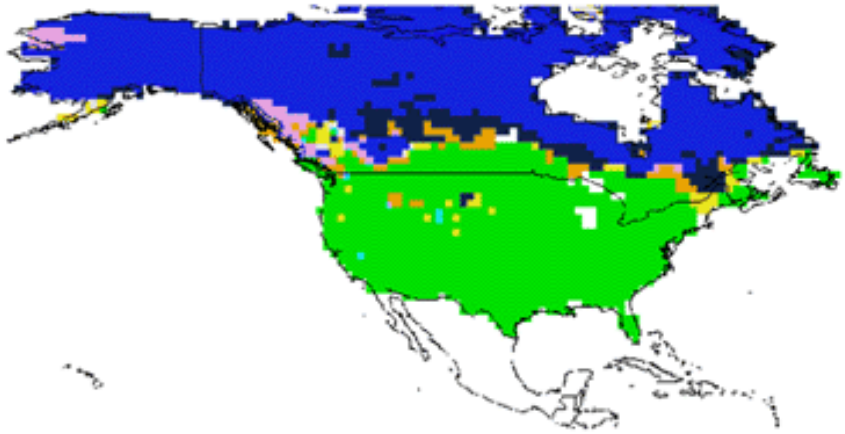
Pentad 1, 1999



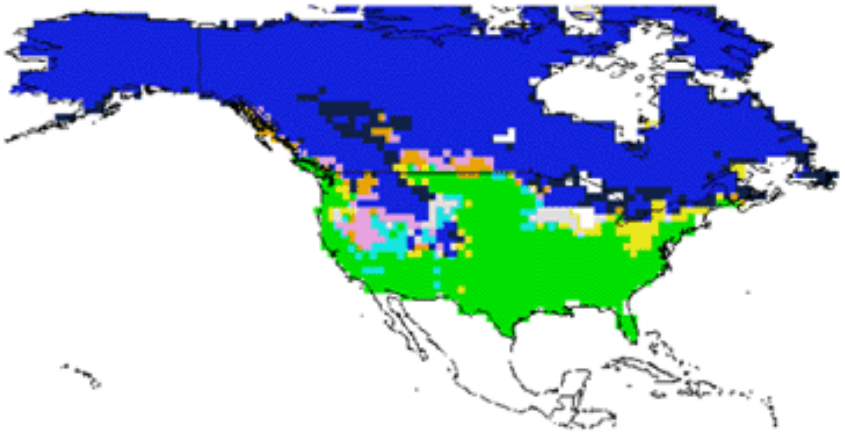
Pentad 10, 1999



Pentad 65, 1999



Pentad 73, 1999



three products snow
no snow indicated
station interpolation only
visible satellite only
SSM/I only
station int. and vis. satellite
SSM/I and visible satellite
SSM/I and station interpolation

ARC 2: ONGOING DEVELOPMENT OF SNOW IMPACT SCALES FOR THE U.S.

Dave Robinson, Mat Gerbush & Tom Estilow
Rutgers University

Jay Lawrimore, Mike Squires & Richard Heim
National Climatic Data Center

Goals

- Extend the Northeast Snowfall Impact Scale, originally developed for the Northeastern US by Kocin and Uccellini, to other regions of the US and to the nation as a whole.

- Operationalize these scales.

Tasks

- Identification of candidate snow storms for regions of the contiguous states from historical data records from the late 1800s to present.
- Collection and quality control of snowfall amount.
- Analysis of each candidate event using the ArcGIS system.
- Calculation of the impact scale values for each historical snowstorm.
- Development of automated GIS scripts for generation of impact scale values within 24 hours of a major snow event.

Data

- US Cooperative Station observations

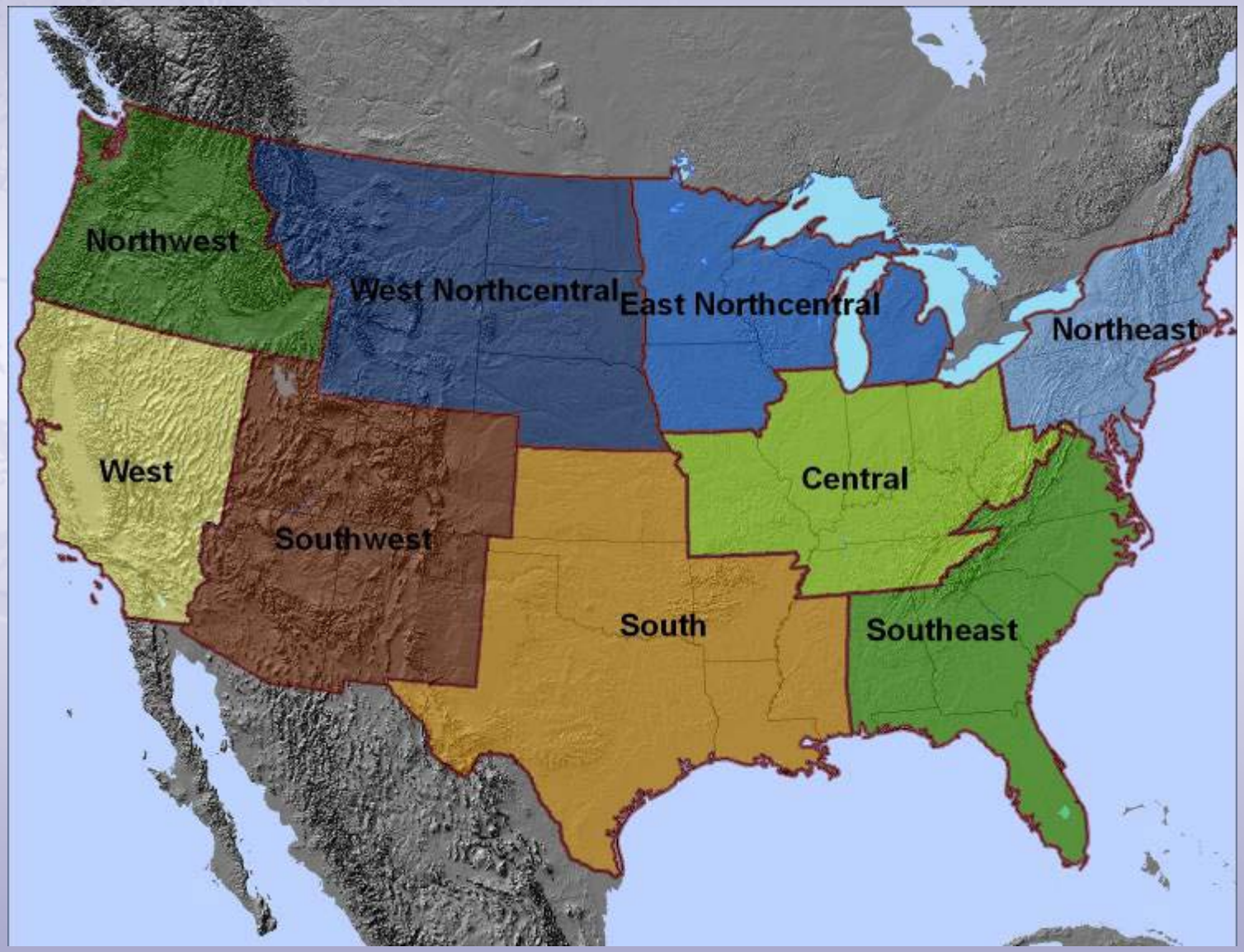
Deliverables

- Impact scale values within 24 hours of a major snow event.

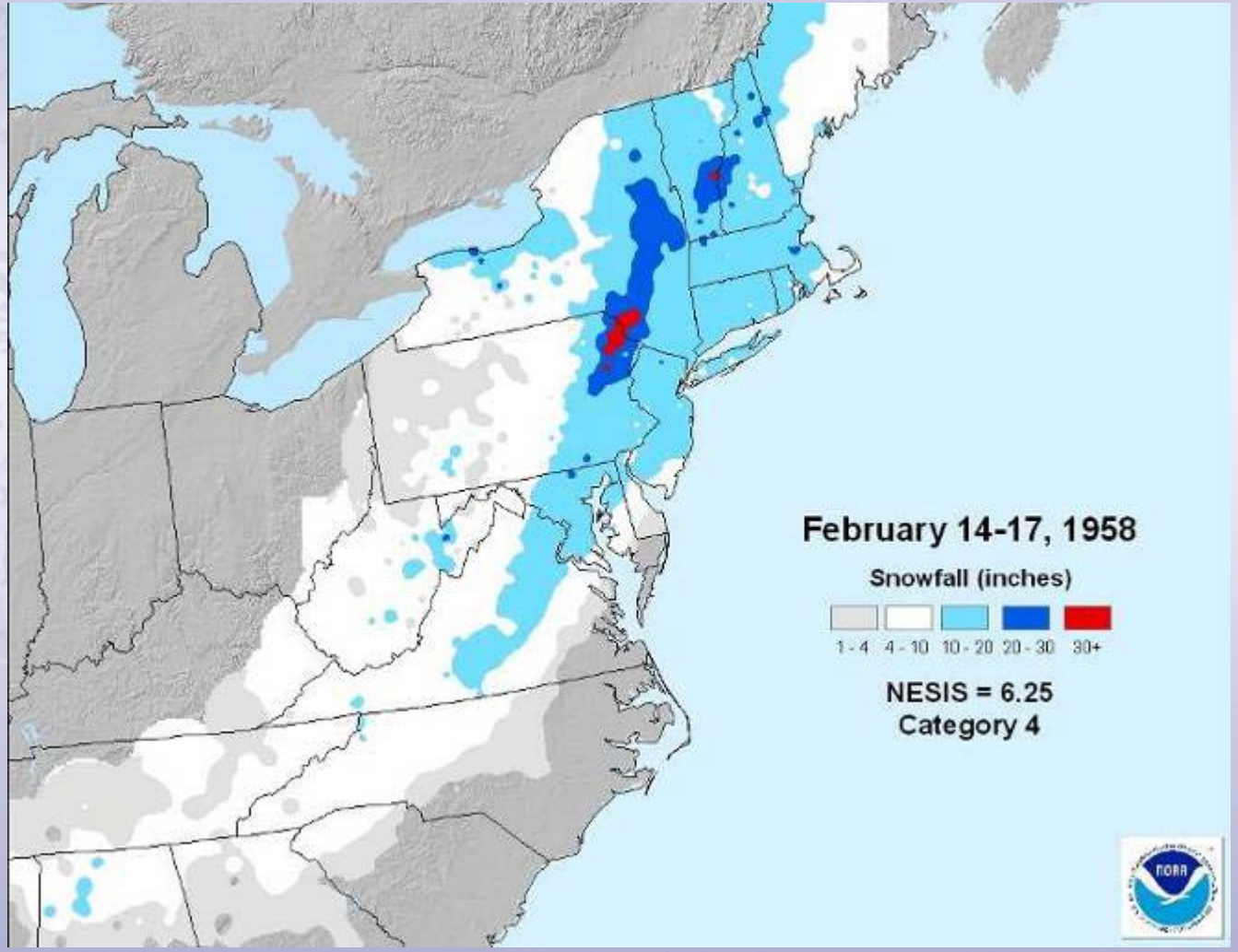
User communities

- Climate research: various sectors
- Planning and monitoring:
  - Commerce, engineering, travel, agriculture, recreation, wildlife
- Potentially: weather forecasters

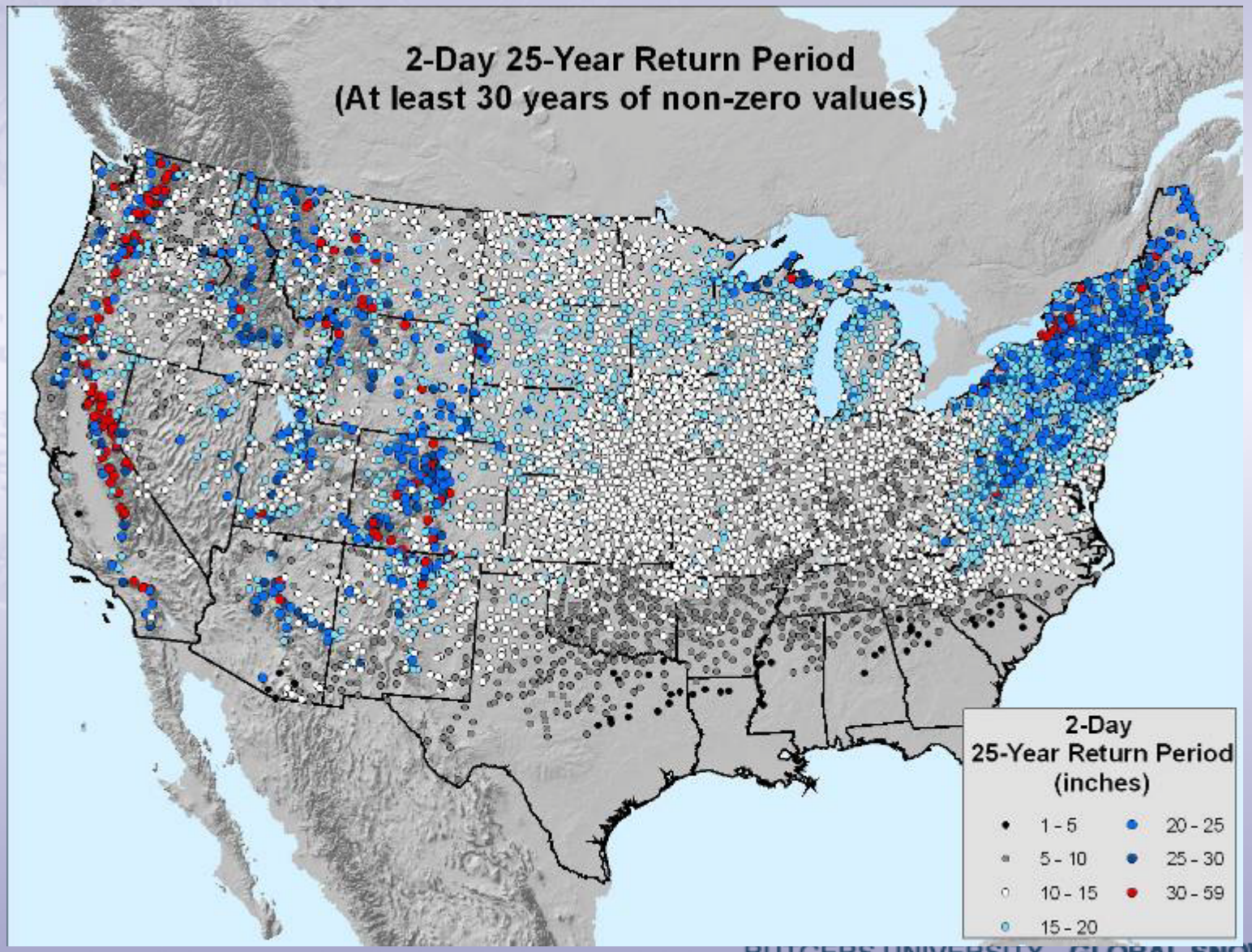
Regional boundaries



Include snowfall and population outside the region?



How to determine thresholds for a region?



Event Selection Process

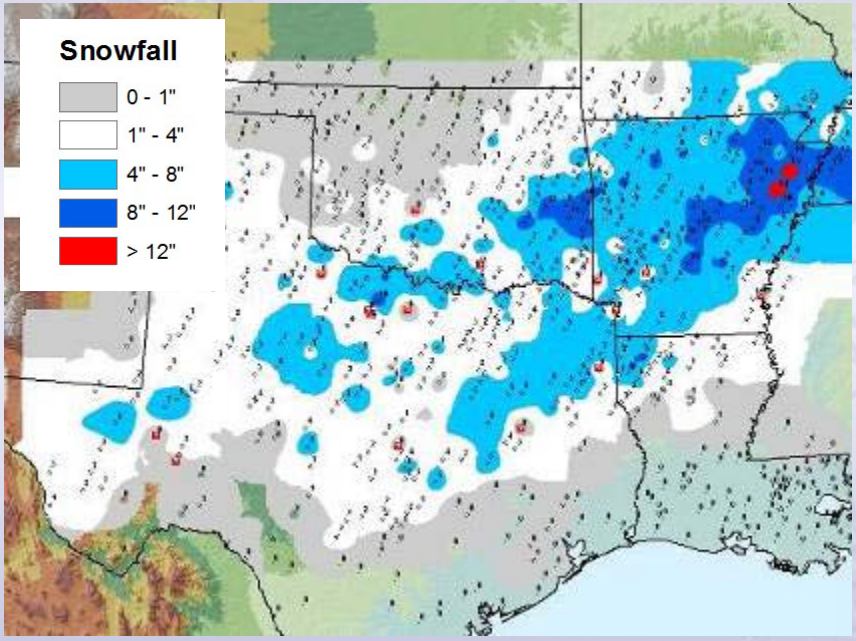
- Determine the largest impact events from Coop database
- 1x1 degree interpolated station snowfall 1900-2005
- 4-day running totals of regional snowfall sum
- Multiplied by gridded 2000 census population data
- For each region, 75 largest impact events selected

Event Data Quality Control

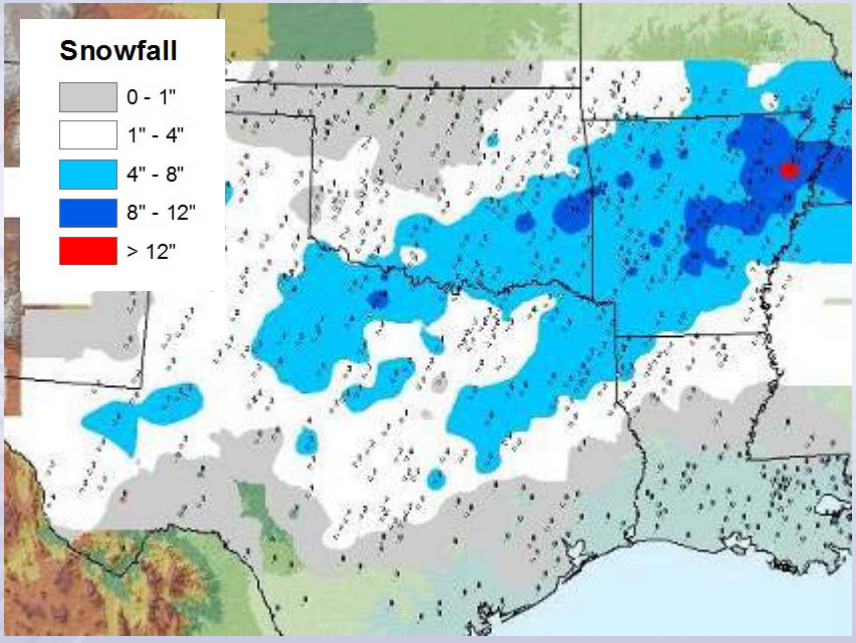
- Mapping the 75 event snow totals in ArcGIS
- Manual removal of missing/bad data points

Event QC

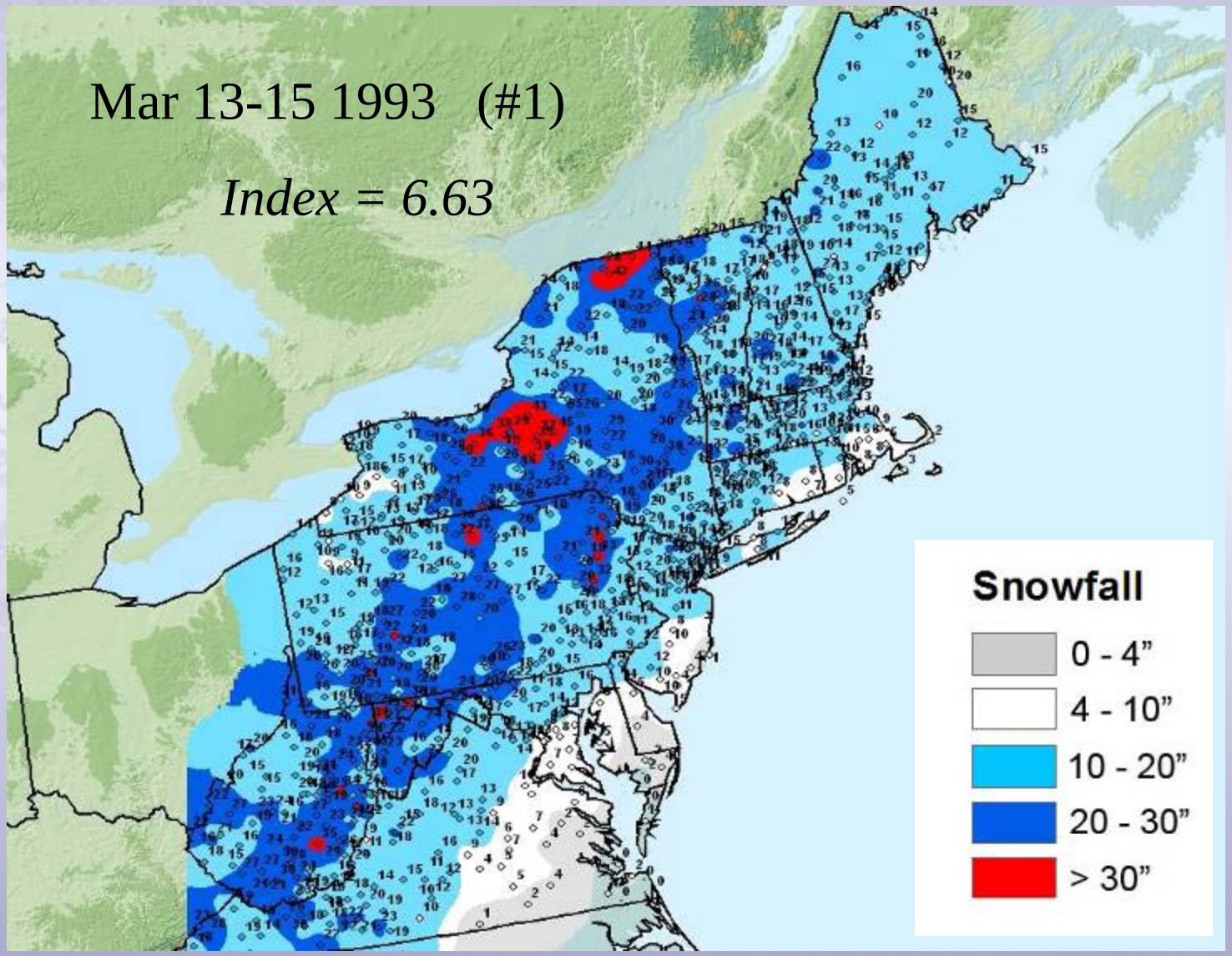
January 31 - February 2, 1985 (pre-QC)



January 31 - February 2, 1985 (post-QC)



Top Northeast storm



What's next?

- Reanalysis with new regions
- Implement operational capability
- Explore the effects of time-dependent population inputs
- Investigate forecast capability
- Create a national index

Resources

- Number of personnel employed for project: 7
- Key collaborating projects or personnel
  - Tom Karl (NCDC), Louis Uccellini (NWS), Paul Kocin (NWS)
- Target NOAA Center: NCDC

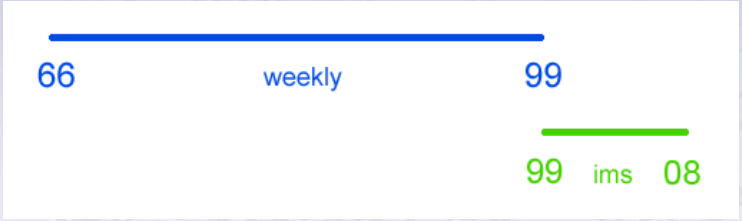
Thanks!

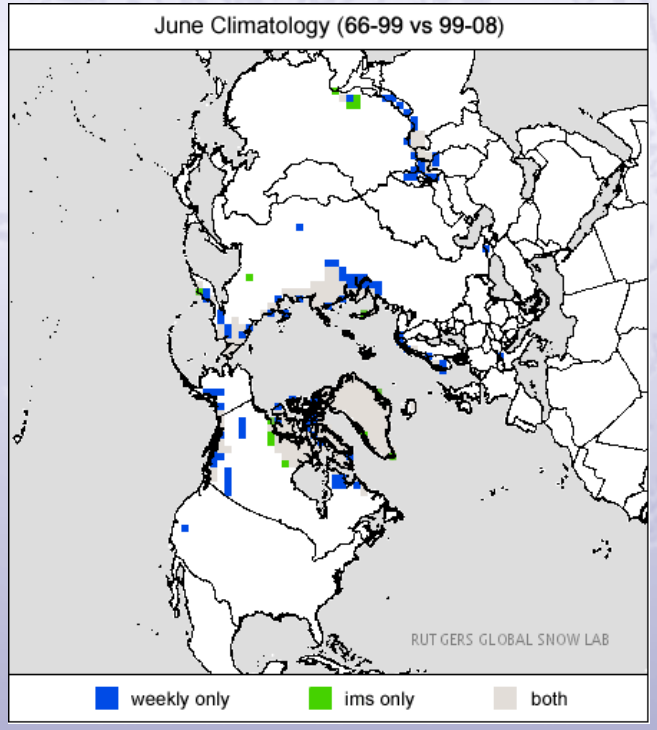
drobins@rci.rutgers.edu

http://climate.rutgers.edu/snowcover

With remaining cells:

Test #1 Compare Monthly Climatologies





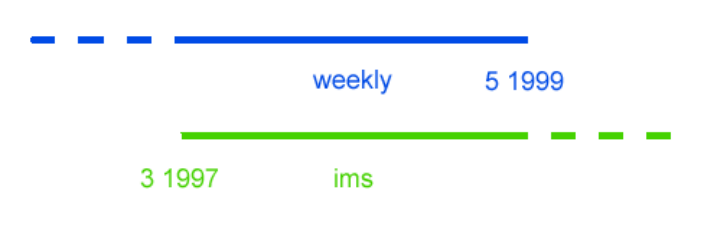
Weekly: 1966-1999

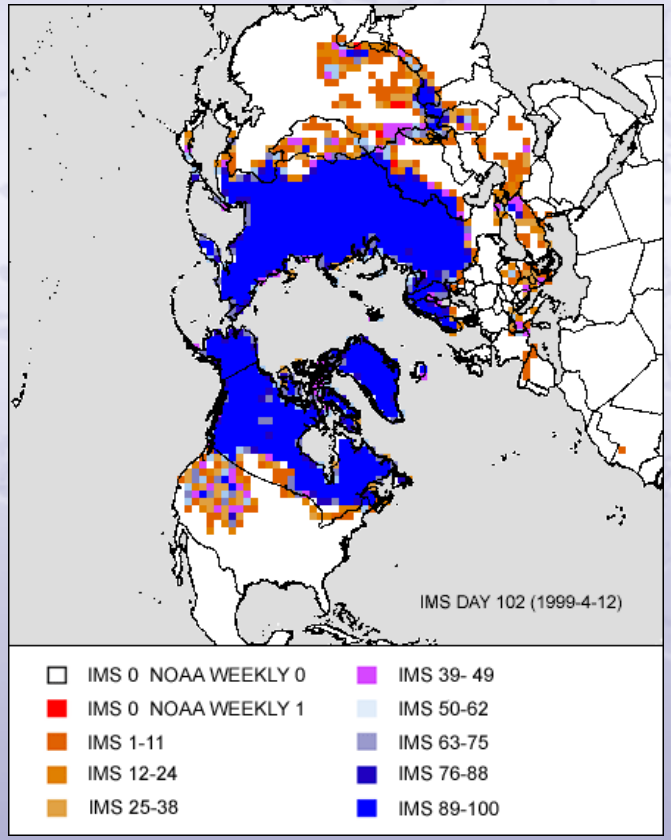
vs.

IMS to weekly conversion: 1999-2008

/	\
Match	**No Match**
|	**|**
No Flag	**Flag**

Test #2 Overlap Period





Direct comparison of

2-year overlap

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Both products produced independently:

Reduce chance of removing

change signal

|

Monthly analysis:

Flag non-matching cells