

Current data holdings of historical *in situ* snow cover observations

Contributors

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NOAA: Taneil Uttal and Sandy Starkweather



NCAR's Research Data Archive

- 600+ distinct datasets for climate and weather research
- Free and open access
- 10,000+ unique users in FY2014
- Collection Summary
 - Historical observations (ISPD, ICOADS, NCDC ISD, Upper Air Database)
 - Reanalyses: 20CR, ECMWF ERA, JRA-55, NCEP CSFR, ...)
 - *Byrd Polar Research Center, Arctic System Reanalysis*
 - Operational (NCEP observations, analyses, & forecasts)
 - Climate/regional models (CMIP5, NRCM, ...)
 - Remote sensing
- Each collection managed by a RDA data specialist

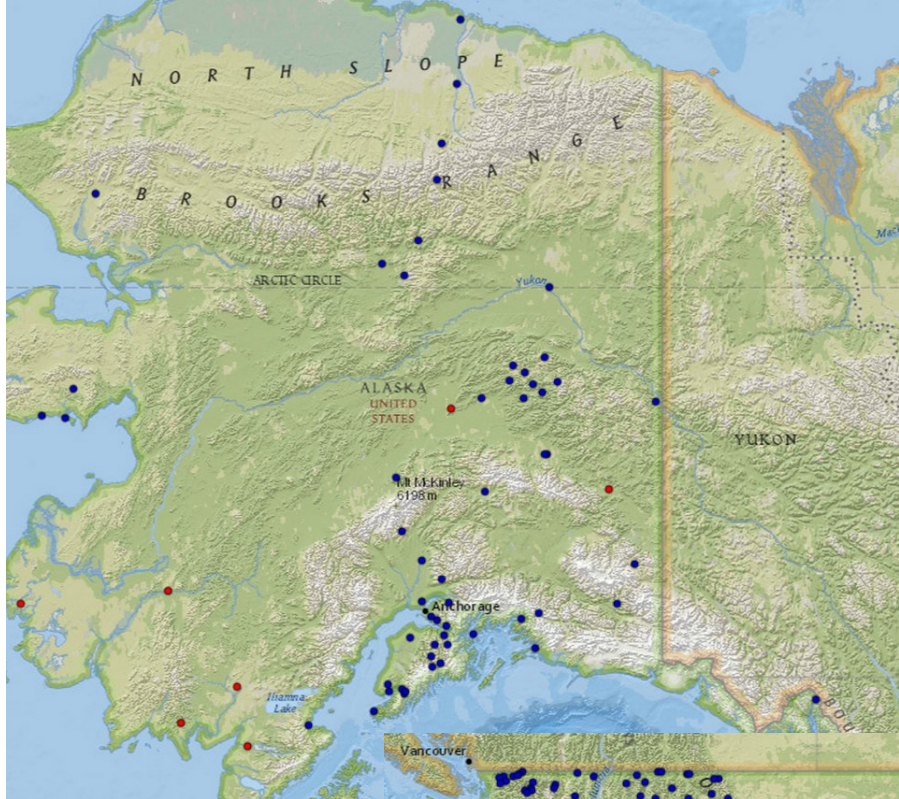
At NCAR-RDA, from US Department of Agriculture (USDA) Natural Resources Conservation Service

SNOTEL, SNOWpack TELEmetry, Stations

- U.S. Western States (mountain snowpack and precipitation)
- Daily data are part of GHCN-D at NCDC
- Parameters : Snow Water Equivalent, Snow Depth, All Phase Precipitation, Air Temperature
- Beginning 1963- ongoing, [hourly](#) data
- Nominally, 831 stations

SNOLite Stations

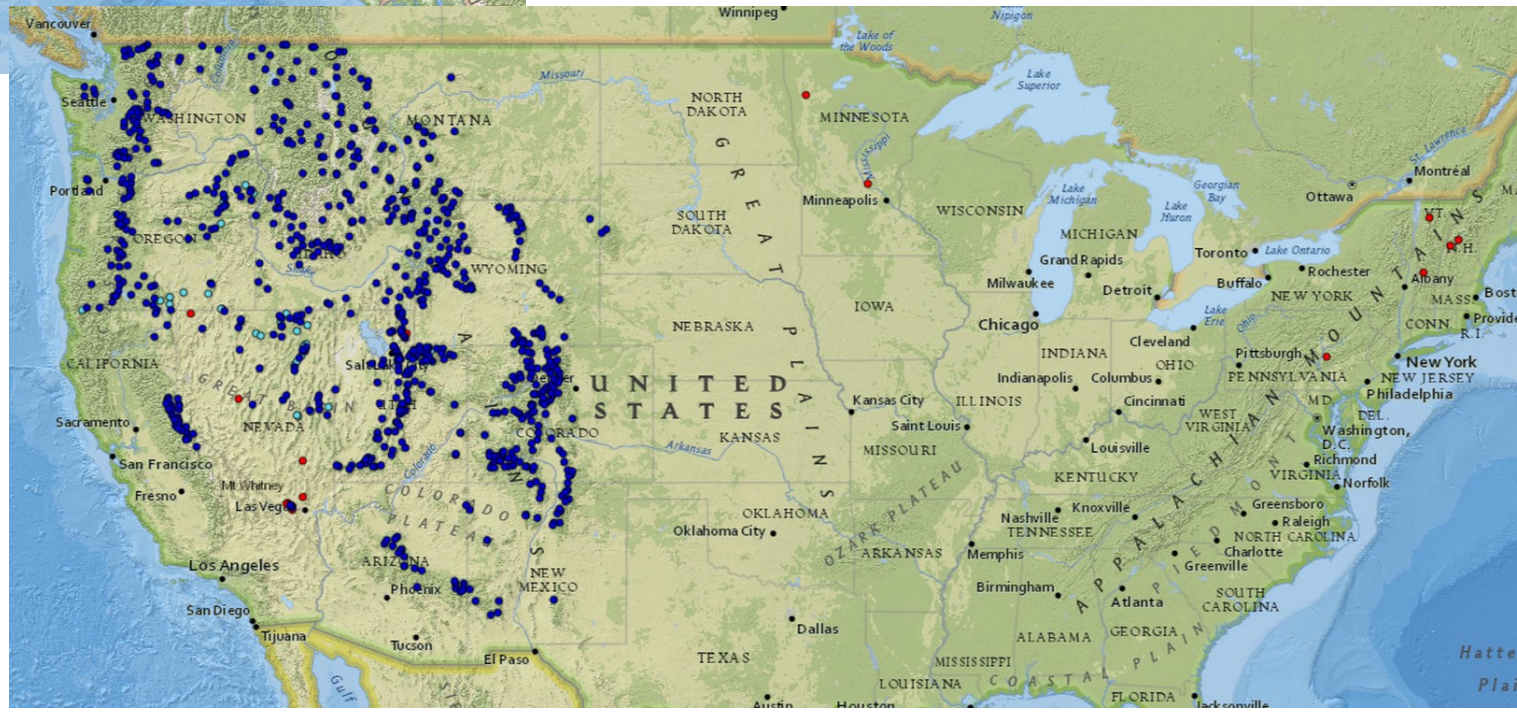
- SNOTEL stations without full parameter set
 - Have SWE, snow depth, and air temperature
- 2013-ongoing, [hourly](#) sampling
- 29 Stations



USDA-NRCS Real-Time Networks

- ✓ ■ SNOTEL (835)
- ✓ ■ SCAN (23)
- ✓ ■ SNOLITE (29)
- ✓ ■ Other NRCS Hydromet (0)

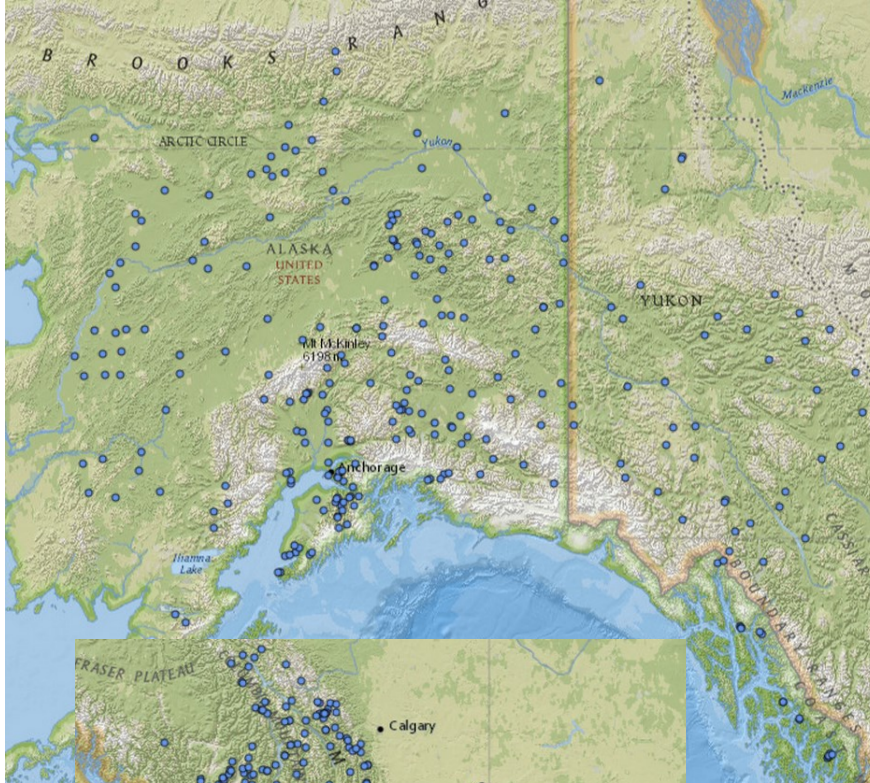
USDA Interface => 835 SNOTEL and 29 SNOLITE stations with snow depth or SWE



At NCAR, from US Department of Agriculture (USDA) Natural Resources Conservation Service

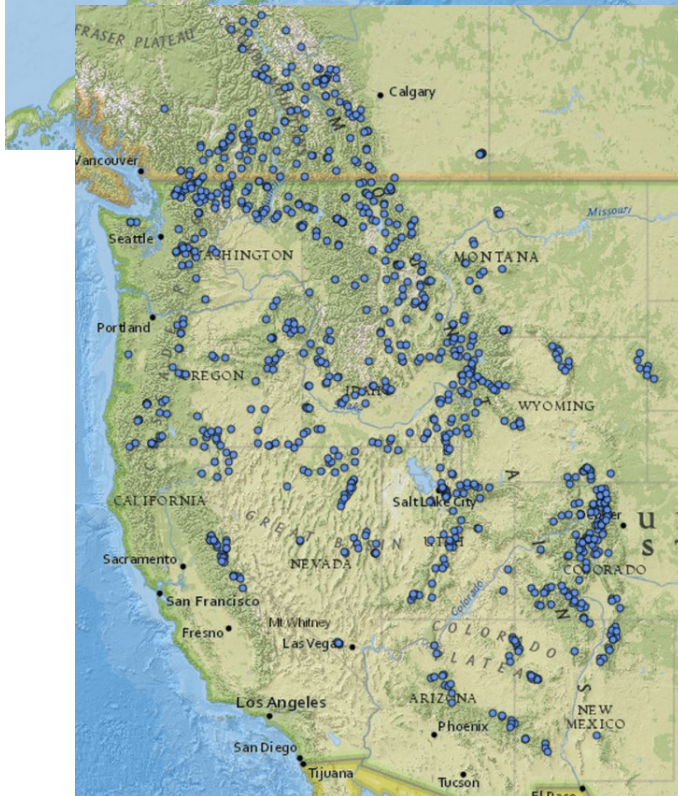
Snow Course

- Manual measurements, generally, [monthly](#) during snow season
- Beginning 1910 and ongoing
- 956 stations



USDA-NRCS Non-Real-Time Networks

- ✓ Snow Course/Aerial Marker (1121)
- ✓ Manual SNOTEL (2)
- ✓ Manual Precipitation (0)

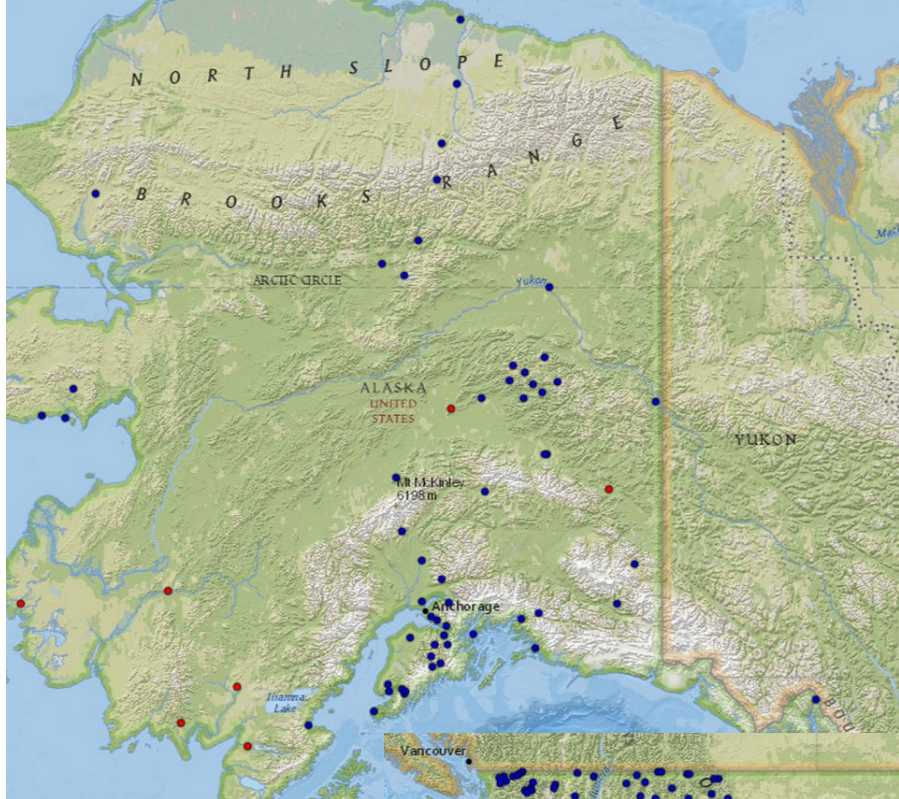


USDA interface => 1121 stations with snow depth or SWE

At NCAR, from US Department of Agriculture (USDA) Natural Resources Conservation Service

SCAN - Soil Climate Analysis Network

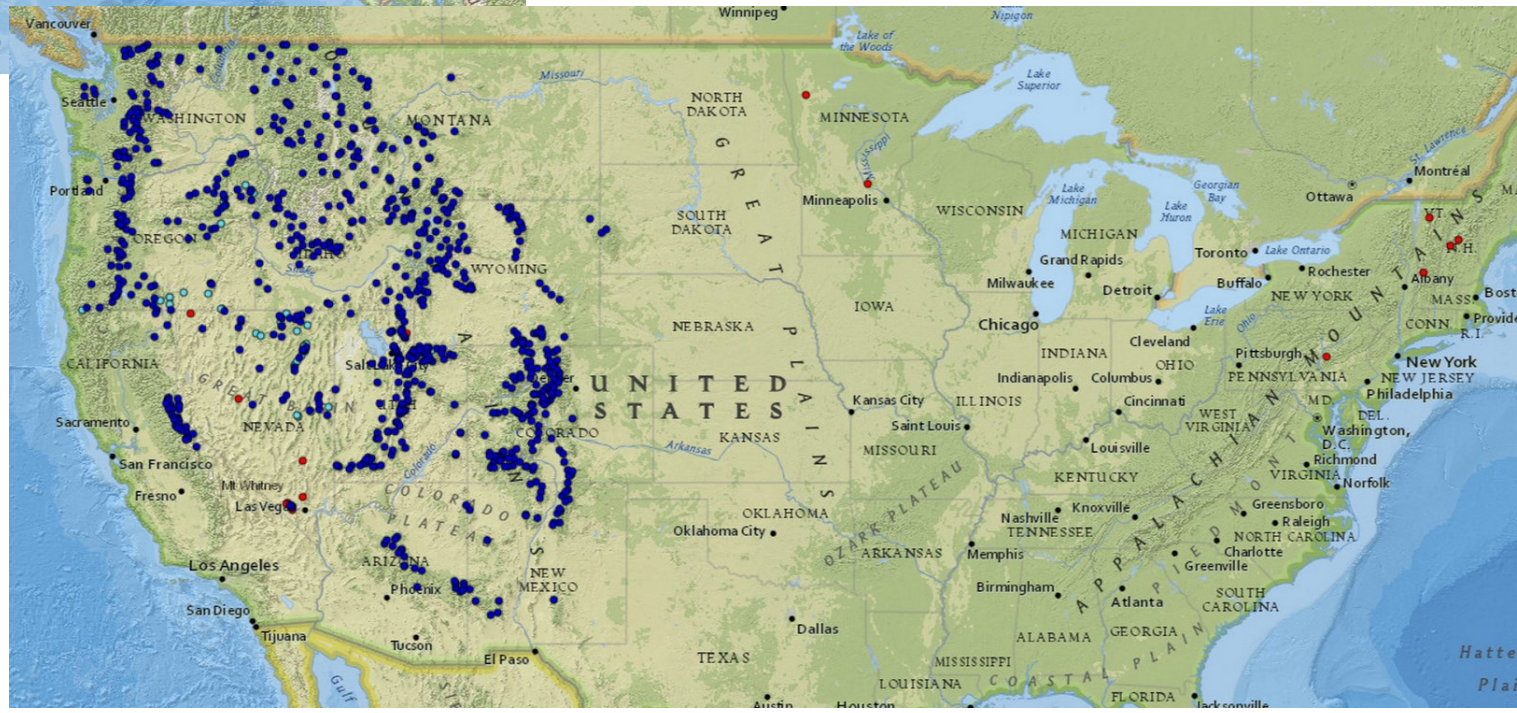
- Primarily for Agriculture soil moisture
- 1986 – ongoing, [6-hourly](#) going to [hourly](#)
- 24 Stations with SWE and snow depth
 - Eastern and Western U.S.



USDA-NRCS Real-Time Networks

- ✓ ■ SNOTEL (835)
- ✓ ■ SCAN (23)
- ✓ ■ SNOLITE (29)
- ✓ ■ Other NRCS Hydromet (0)

USDA Interface => 23 SCAN stations with snow depth or SWE



At NCAR, from U.S. Geological Survey, Bureau of Land Management, U.S. Fish and Wildlife Service

Alaska National Petroleum Reserve and Arctic National Wildlife Refuge

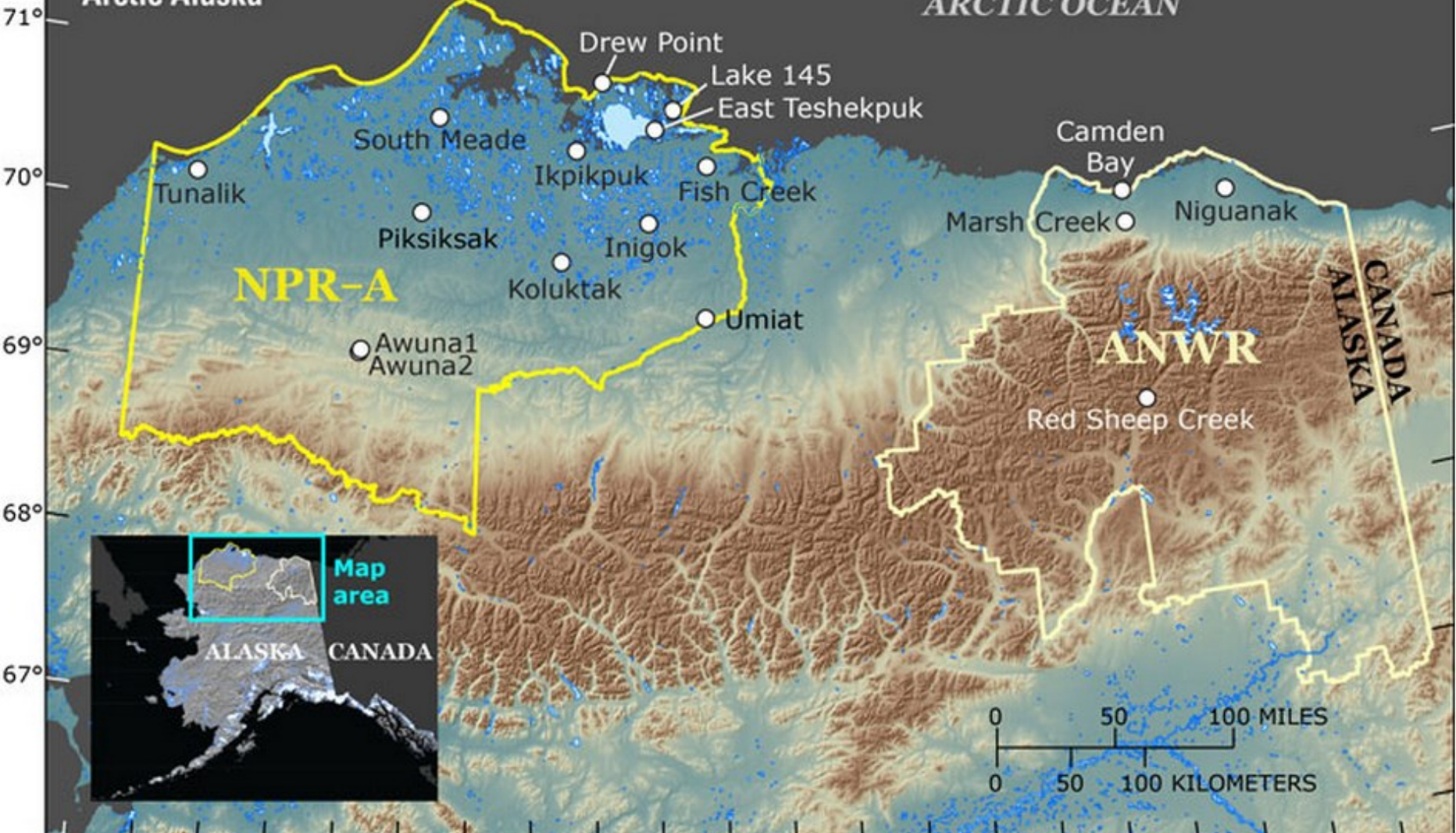
- Northern Alaska
- Beginning 1998, [hourly](#) data
 - 1998-2011 at NCAR, sampling is ongoing
- Very complete parameter set
 - air temperature, wind speed and direction, ground temperature and soil moisture, **snow depth**, rainfall, up- and downwelling shortwave radiation, and atmospheric pressure
 - Full metadata for all station instrumentation
 - E.g. CSI model SR50 ultrasonic distance sensor for snow depth
- 17 Stations

160° 155° 150° 145° 140°

USGS Permafrost and Climate-Monitoring Networks

Arctic Alaska

ARCTIC OCEAN

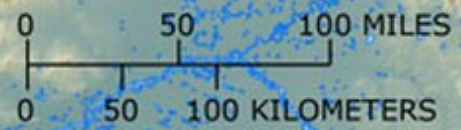


NPR-A

ANWR

CANADA
ALASKA

71°
70°
69°
68°
67°



At NCAR-RDA

NCDC Integrated Surface Data (ISD)

- 1943-2011
- Hourly observations from many global sources

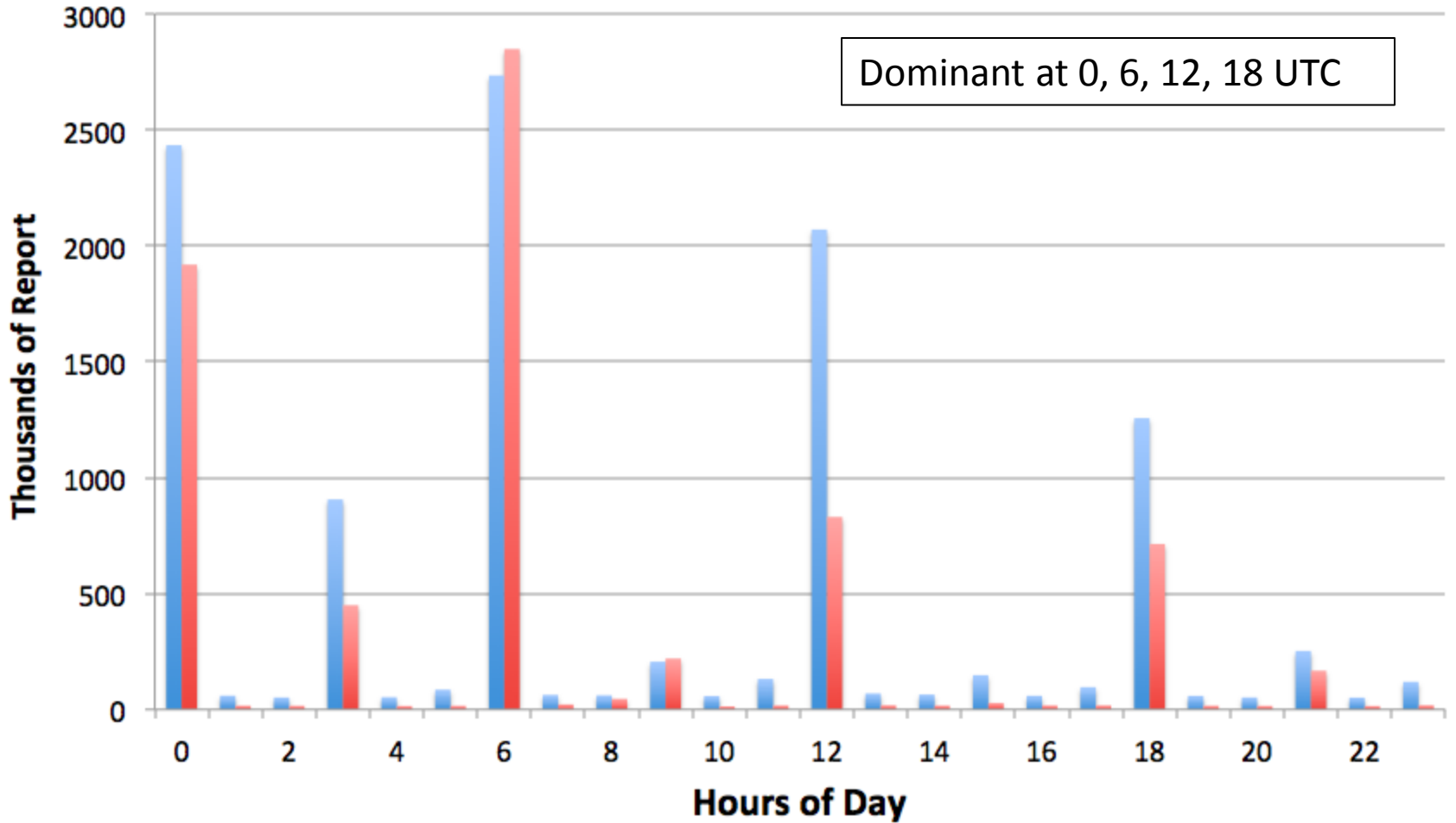
Reports	# Non-Zero Obs.	# Zero Obs.
Total	11142578	7591409
Number of Stations	10731	8896

- National Climatic Data Center (NCDC)

ISD Snow Depth Observations by Hour

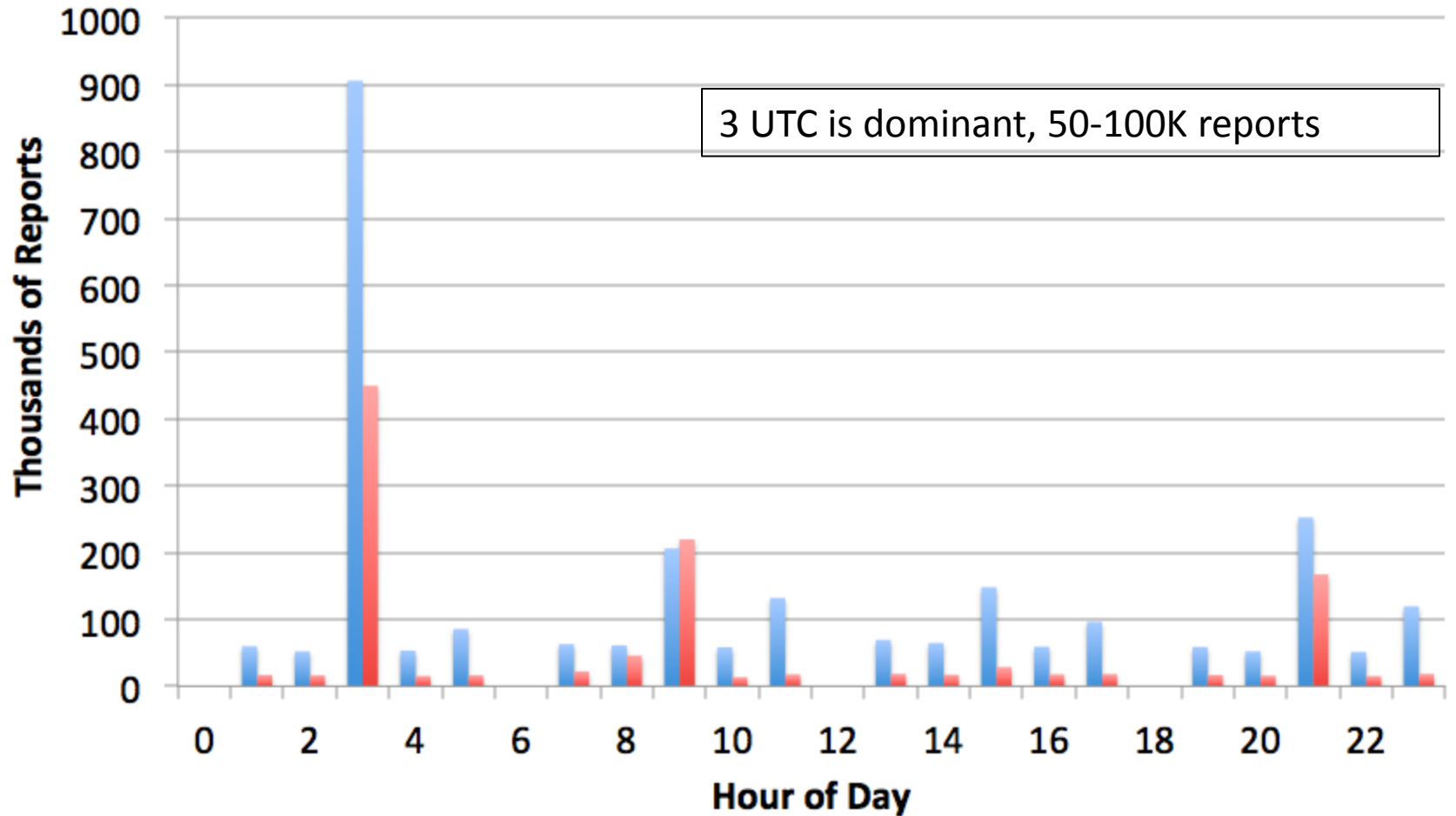
■ Non-zero obs. ■ Zero obs.

Dominant at 0, 6, 12, 18 UTC



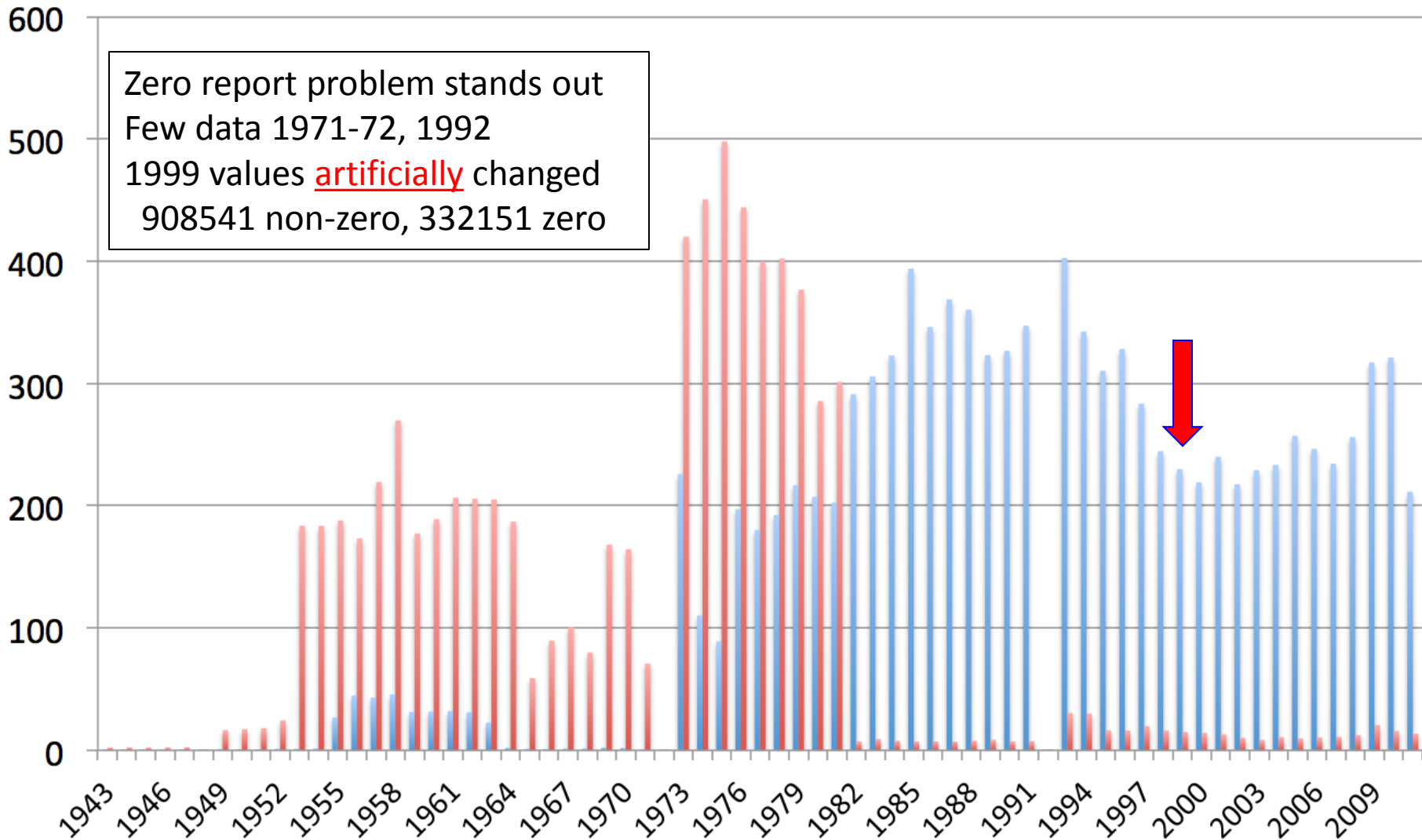
ISD Snow Depth Observations, Off Synoptic Hours

■ Non-zero obs. ■ Zero obs.



ISD Snow Depth Observations by Year

■ Non-zero obs. ■ Zero obs.



Report Type	# Non-Zero Obs.	# Zero Obs.
SYNOP Report of land surface observation	6957358	6138880
METAR Aviation routine weather report	881768	280697
Synoptic and METAR merged report	897732	181833
SPECI Aviation special Wx report	55197	17322
Synoptic and airways merged report	1789676	806273
Synoptic and aero merged report	42	235
Aerological report	511	0
Airways report	543213	52696
Report from an automatic station	257	0
Supplementary airways station report	170	26
Airways special report	8413	193
SHIP Report of surface observation	8079	96
BUOY Report of a buoy observation	80	6
missing	82	0

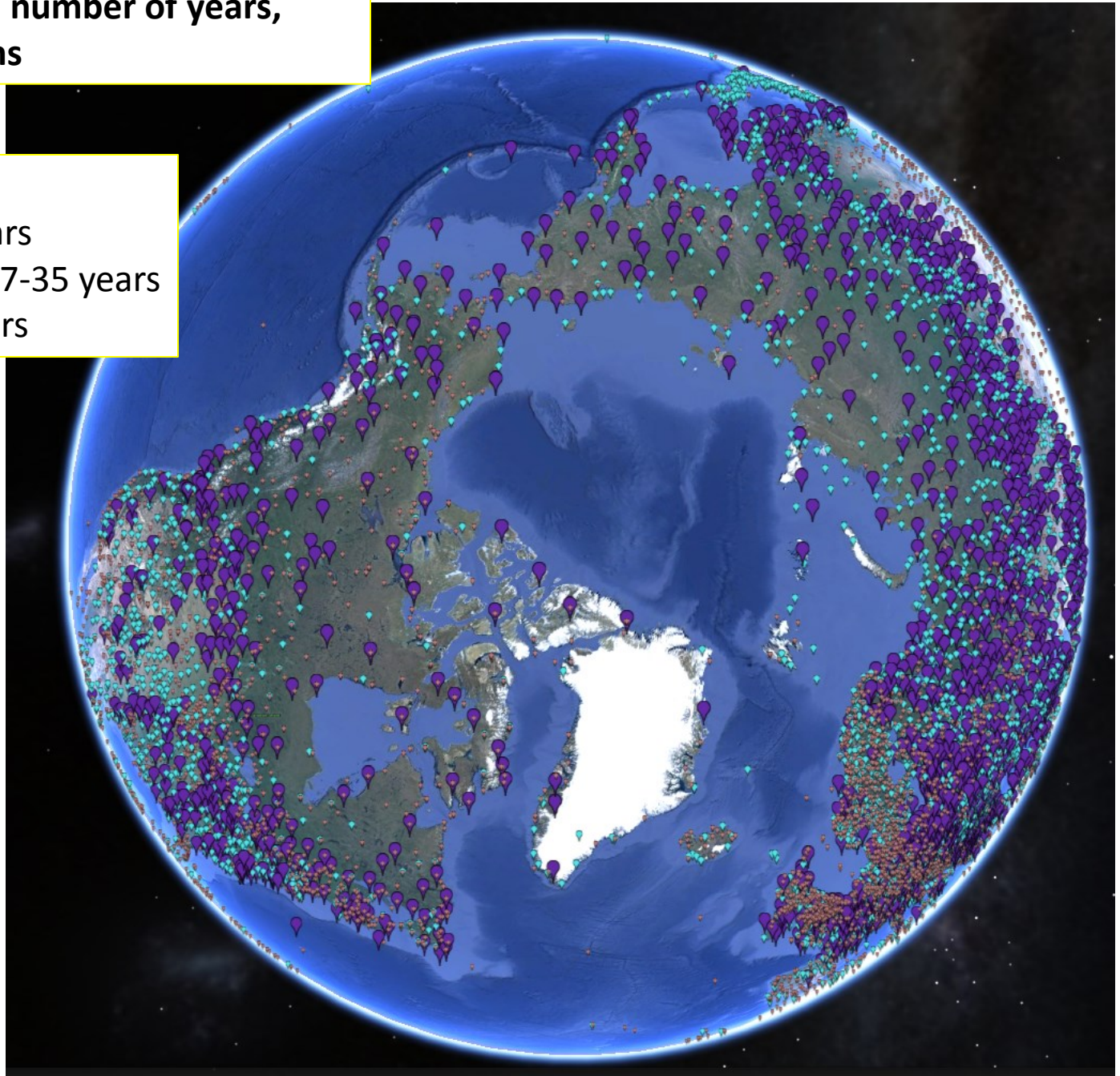
**ISD station locations, number of years,
non-zero observations**

Legend for pins:

small/brown < 17 years

medium/bluegreen 17-35 years

large/purple > 35 years



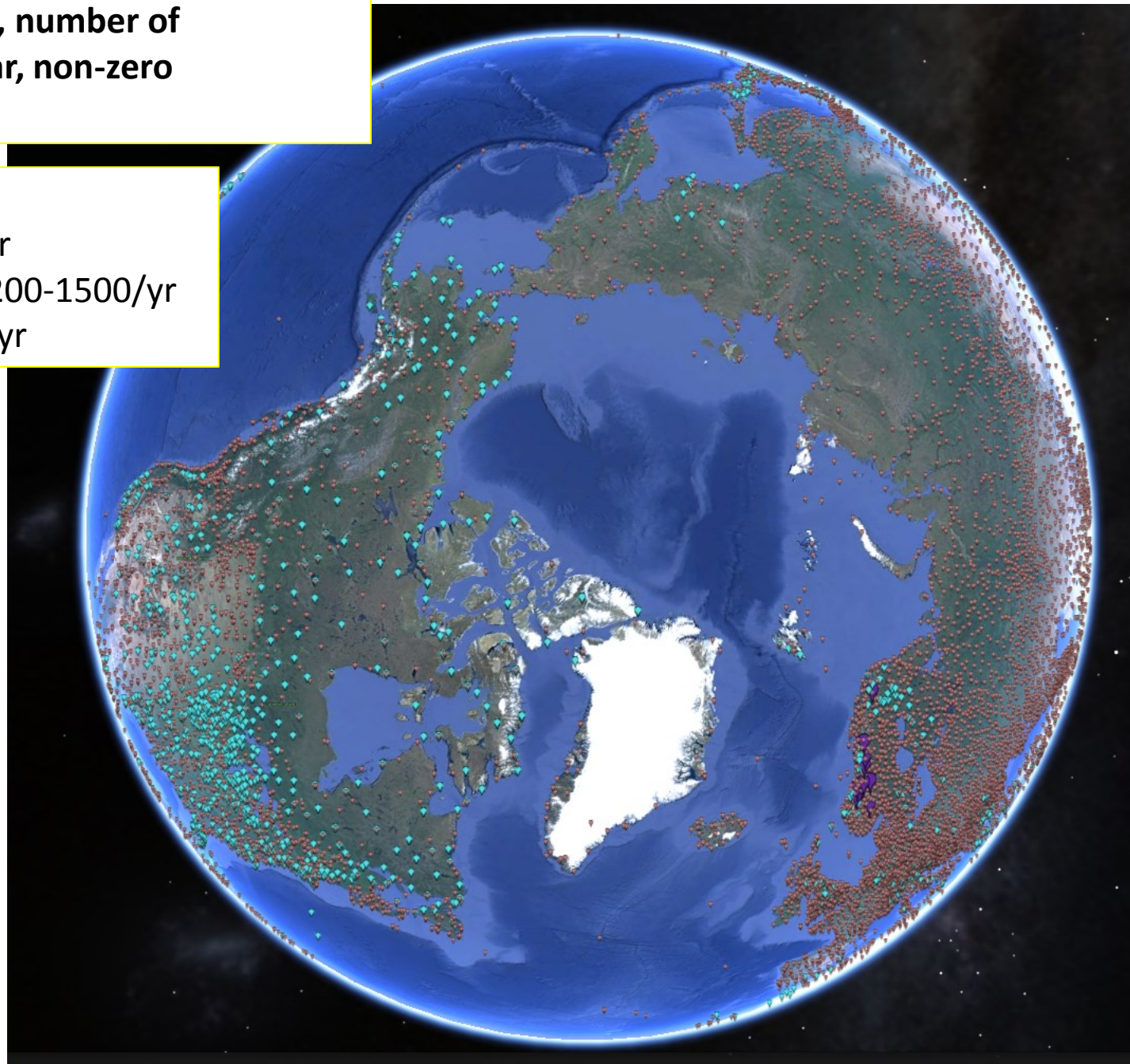
ISD station locations, number of observations per year, non-zero observations

Legend for pins:

small/brown < 200/yr

medium/bluegreen 200-1500/yr

large/purple > 1500/yr



At NCAR RDA

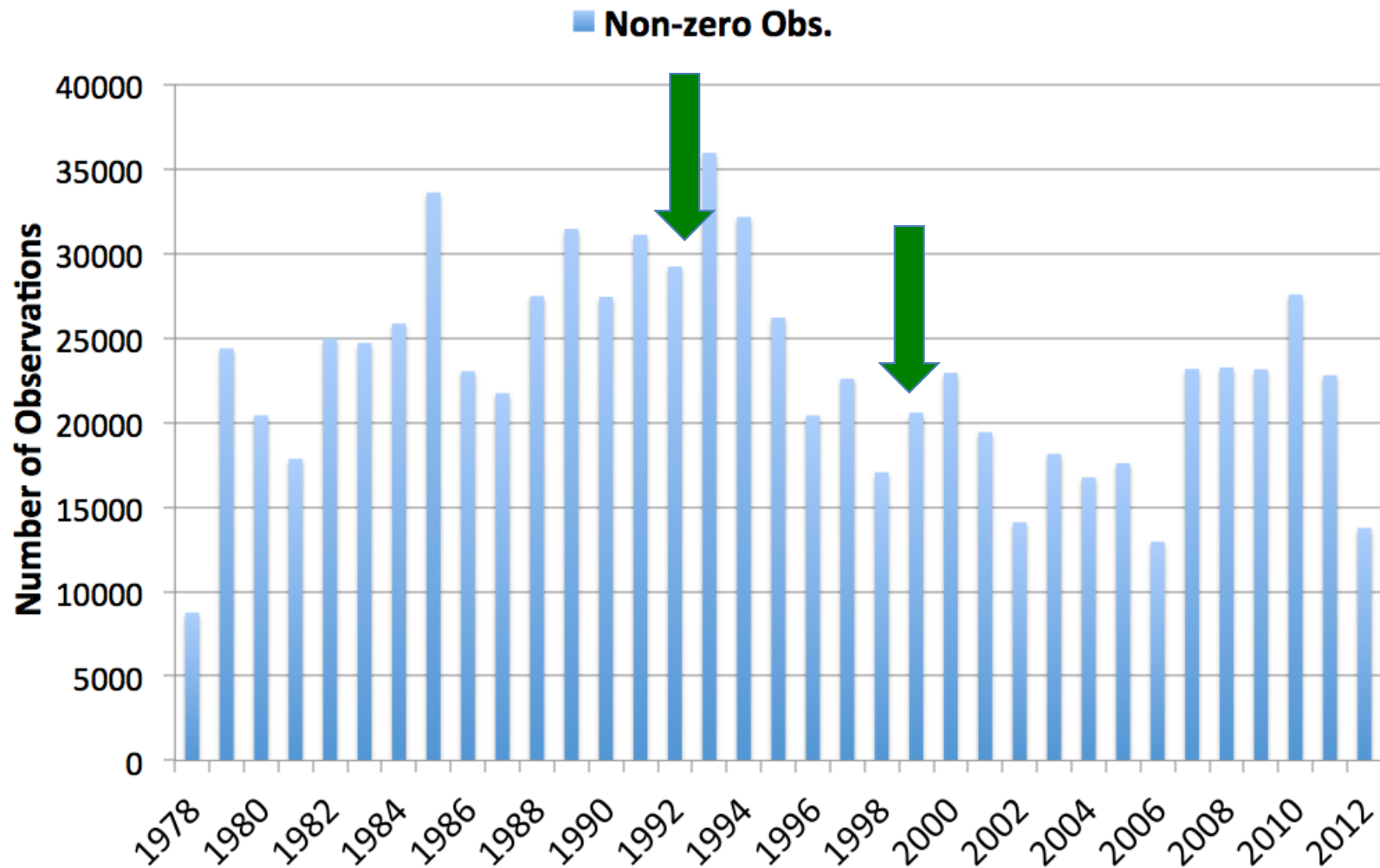
U.S. and Canada Surface Hourly Observations ([for U.S. only here](#))

- 1978 - 2012
- 250-450 Stations
 - SYNOP and METAR reports
- 6-hrly snow fall and snow depth
- Meteorological Development Laboratory, US NWS NOAA

Useful to address some ISD anomalies

- Fill the US portion of the data void in 1992 – only 500 reports in ISD, 30000 here
- Help decipher and correct the 1999 high anomaly, e.g. does this match the U.S. contribution in ISD?

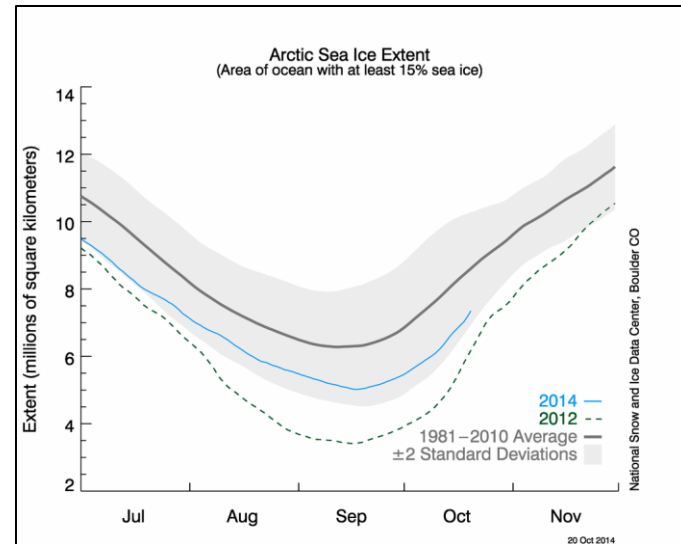
MDL, US Snow Depth Observations



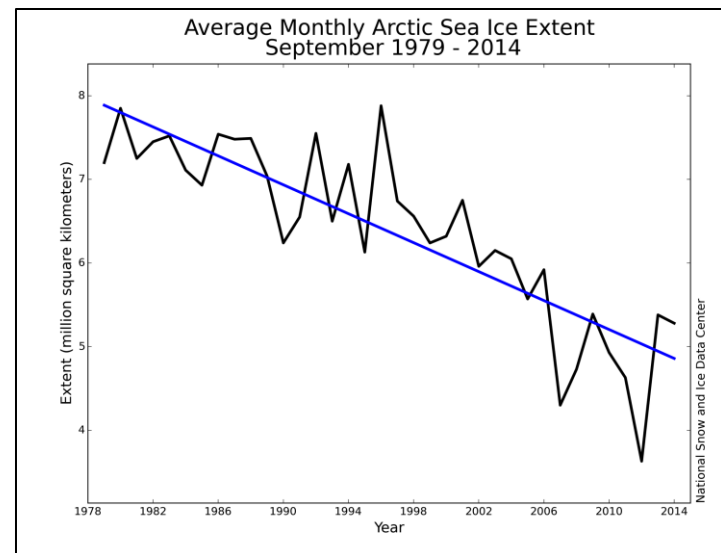
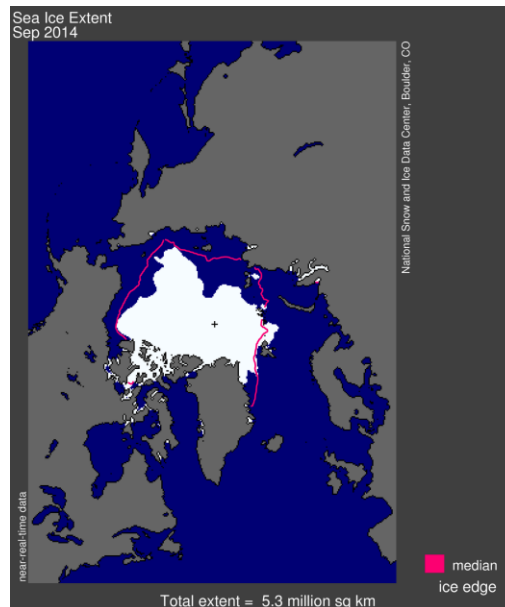
At National Snow and Ice Data Center (NSIDC), Boulder Colorado, USA

Overview

- NASA DAAC, with smaller support from NOAA and NSF
- Strong on satellite-based products
- Historical in situ observations collections



Fetterer, F., K. Knowles, W. Meier, and M. Savoie. 2002, updated daily. Sea Ice Index. Boulder, Colorado USA: National Snow and Ice Data Center.
<http://dx.doi.org/10.7265/N5QJ7F7W>.



At NSIDC, Multi-station Networks

Estonian Mean Snow Depth and Duration

- 1891-1990
- 255 Stations
- Three 10-day snow depth mean values per month, October through May
- Contributed to NSIDC by Jaak Jaagus, University of Tartu, Estonia

Jaagus, J. 2000. Estonian Mean Snow Depth and Duration (1891-1994). Boulder, Colorado USA: National Snow and Ice Data Center.

<http://dx.doi.org/10.7265/N5X63JTN>.

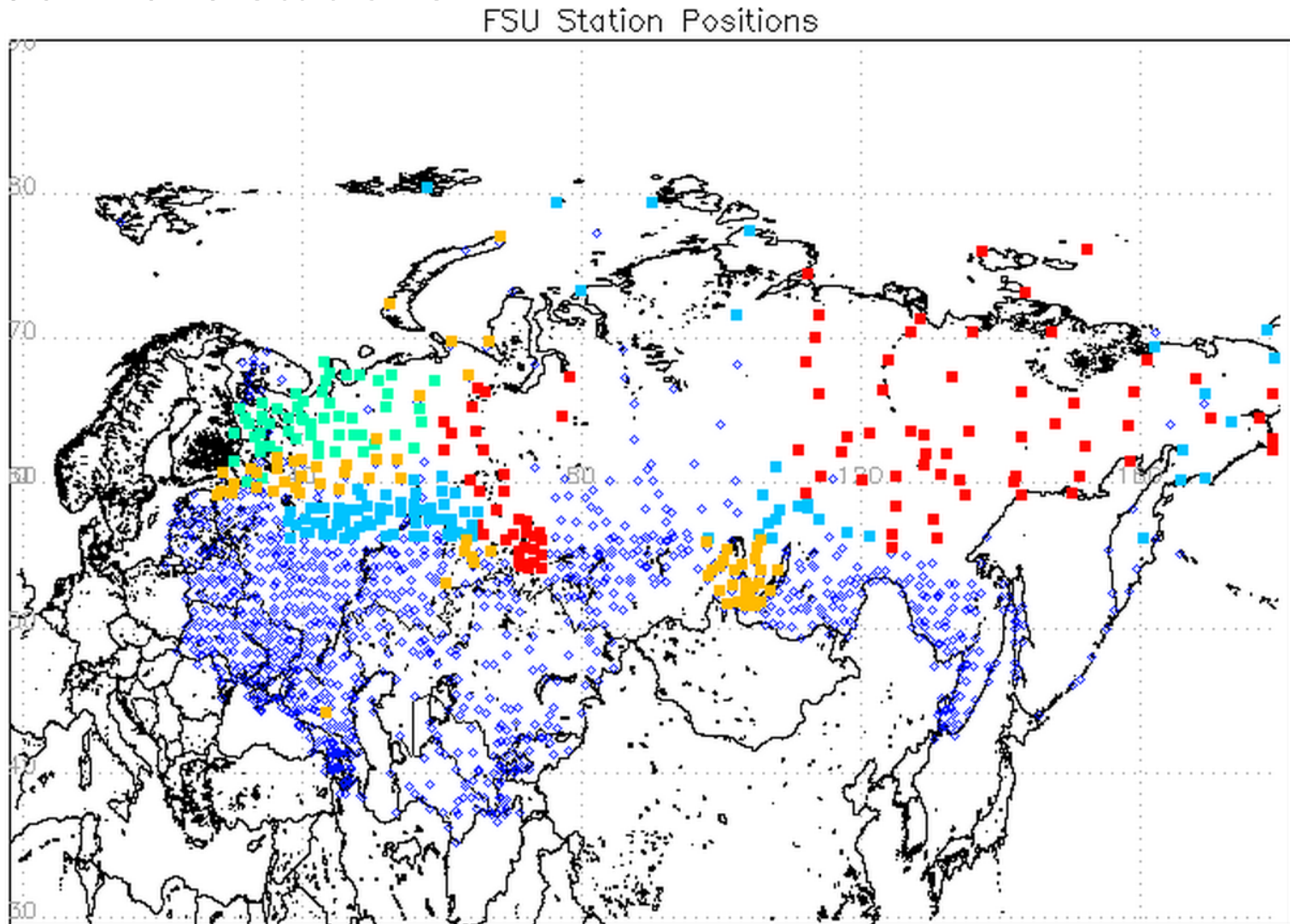
At NSIDC, Multi-station Networks

Former Soviet Union Hydrological Snow Surveys

- 1966-1996
 - 1345 sites, over 200 sites between 1991-1996
- Three data groups
- Synoptic: Daily mean, minimum, maximum snow depth along transects
 - Station: Three 10-day snow depth mean values per month
 - Transect: Mean transect data for 10th, 20th, and last day of the month
- Contributed to NSIDC by Professor Alexander Krenke, Russian Academy of Sciences

Krenke, A. Edited by National Snow and Ice Data Center. 1998, updated 2004. Former Soviet Union Hydrological Snow Surveys, 1966-1996. Boulder, Colorado USA: National Snow and Ice Data Center. <http://dx.doi.org/10.7265/N58C9T60>.

Former Soviet Union Hydrological Snow Surveys, 1966-1996. 1345 stations.



Colors denote dates when the station data were updated at the NSIDC archive

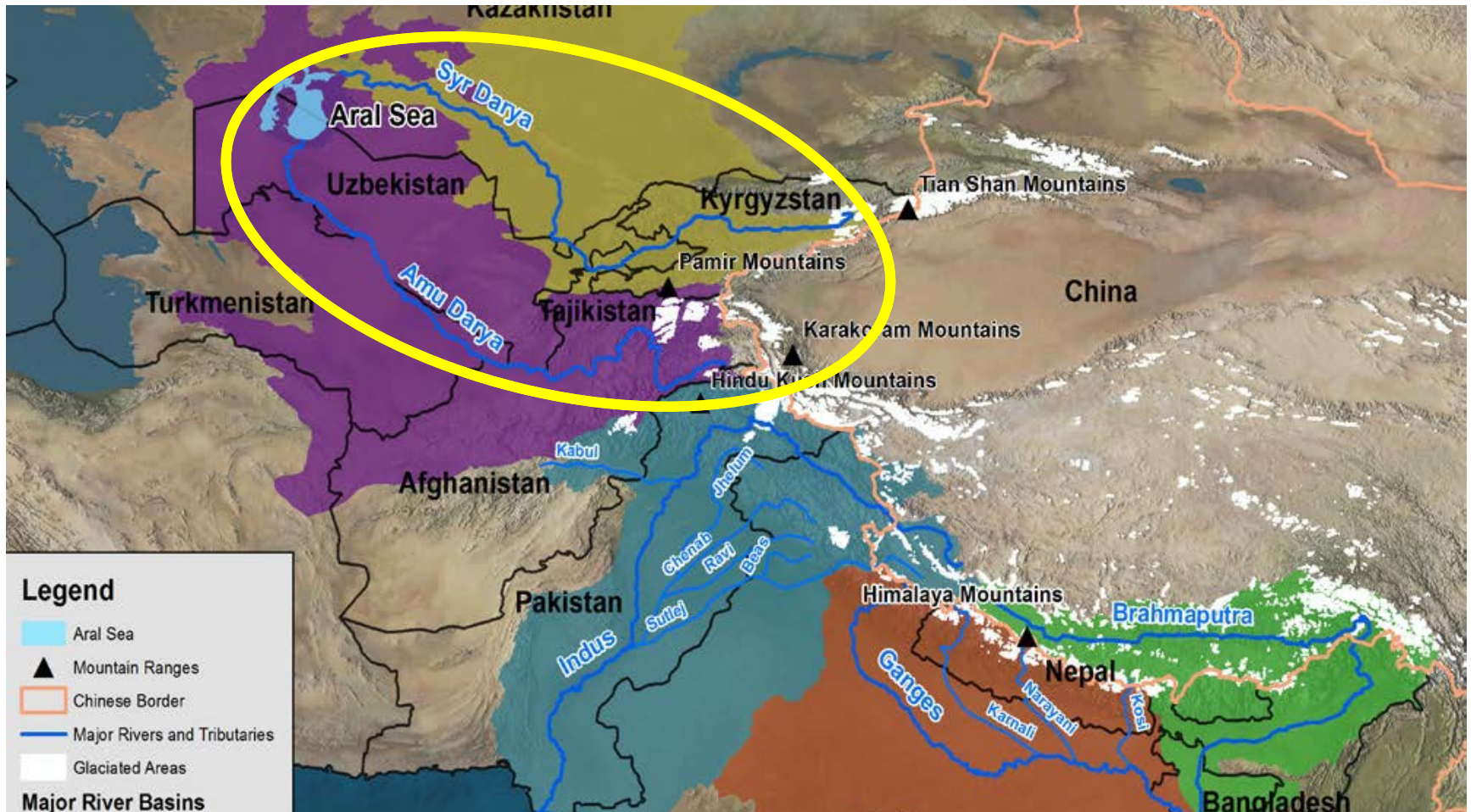
At NSIDC, Multi-station Networks

Central Asian Snow Cover from Hydrometeorological Surveys

- 1932-1990
- Three river basins: Amu Darya, Sir Darya, Naryn
- Snow depth, SWE, snow density
- Manual **monthly** measurements, additional measurements by helicopter
- 50-100's ground stations, 100's + helicopter stations
- State Hydrometeorological Service in Tashkent, Uzbekistan

Bedford, D. and B. Tsarev. 2001. Central Asian Snow Cover from Hydrometeorological Surveys. Boulder, Colorado USA: National Snow and Ice Data Center. <http://dx.doi.org/10.7265/N51Z4291>.

Amu Darya, Syr Darya, Naryn River Basins



At NSIDC, Multi-station Networks

Snowfall and Snow Depth for Canada 1943-1982

- 1943-1982
- **Monthly** snow depth and total snow fall
- 140 stations with at least 20-year record
- Sources: Canadian Climate Center and NCDC
- Compiled by J.E. Walsh

Walsh, J. E. 1996. Snowfall and Snow Depth for Canada 1943-1982. Boulder, Colorado USA: National Snow and Ice Data Center.
<http://dx.doi.org/10.7265/N5TD9V75>.

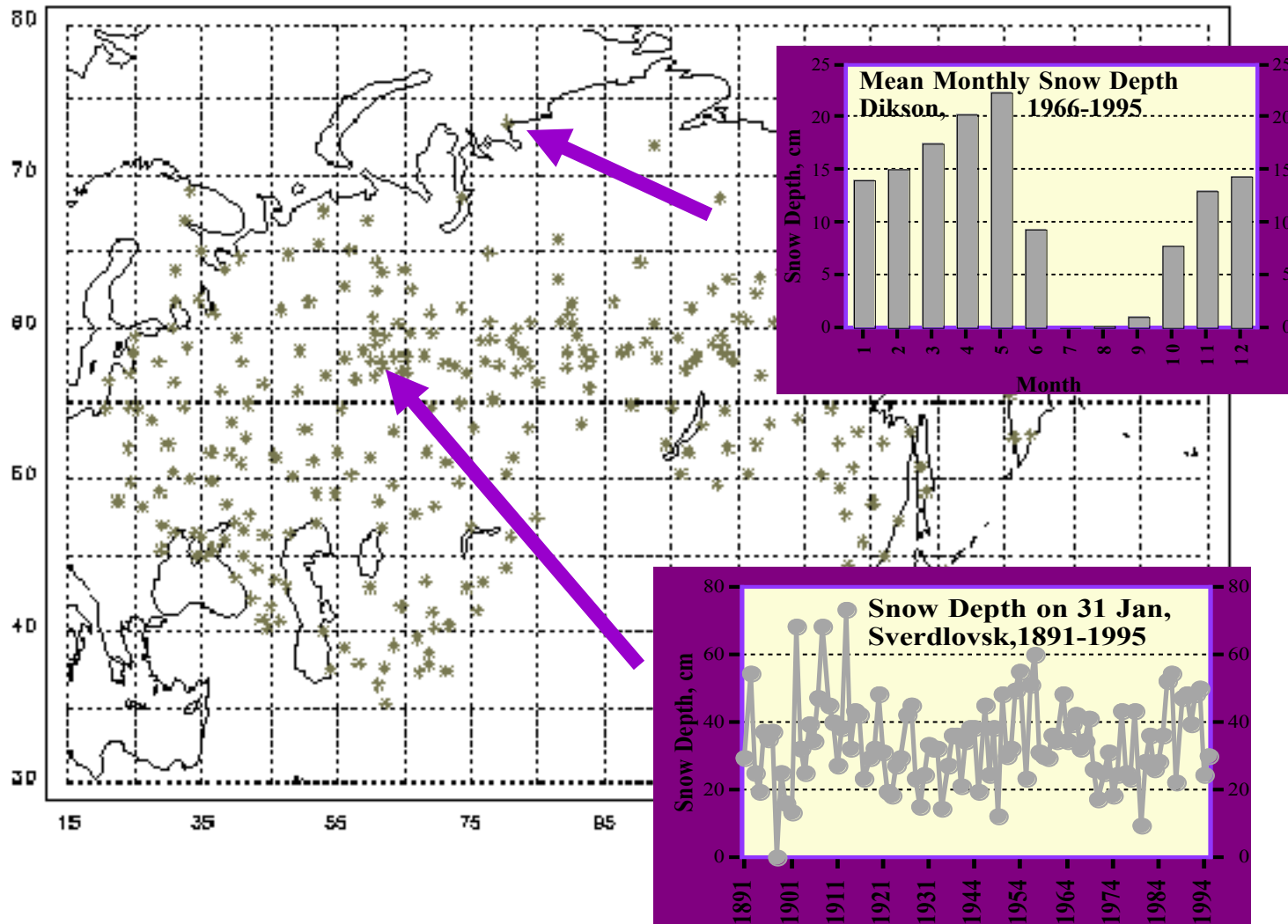
At NSIDC, Multi-station Networks

Historical Soviet Daily Snow Depth (HSDSD), Version 2

- 1881-1995
- Products
 - **Synoptic** data 1966-1995
 - **Daily** data 1881-1995
 - Monthly and Seasonal Summary, Monthly Climatology
- 284 stations, Russia and FSU
- Other parameters snow cover %, snow characteristics, QC
- Source: State Hydrometeorological Service in Obninsk
- Acquired through US-USSR data exchange program

Armstrong, R. 1999. Historical Soviet Daily Snow Depth (HSDSD). Version 2. Boulder, Colorado USA: National Snow and Ice Data Center. <http://dx.doi.org/10.7265/N5JW8BS3>.

Historical Soviet Daily Snow Depth



At NSIDC, Multi-station Networks

Western Italian Alps Monthly Snowfall and Snow Cover Duration

- 1877-1996
- **Monthly** snowfall amount, snow cover duration
- **Daily** snow depth at 8am local time
- 18 stations at 565-2720m elevation

Mercalli, L. and C. Castellano. 1999. Western Italian Alps Monthly Snowfall and Snow Cover Duration. Boulder, Colorado USA: National Snow and Ice Data Center. <http://dx.doi.org/10.7265/N5NP22C0>.

At NSIDC, Multi-station Networks

Morphometric Characteristics of Ice and Snow in the Arctic Basin: Aircraft Landing Observations from the Former Soviet Union

- 1928-1989
- Data collected in support of High-latitude Airborne Annual Expeditions and North Pole Drifting Station programs
- Snow depth and coverage, characteristics, and density
- One **synoptic** observation per landing
- Up to 200 landings per year
- Aside: sea ice thickness are included

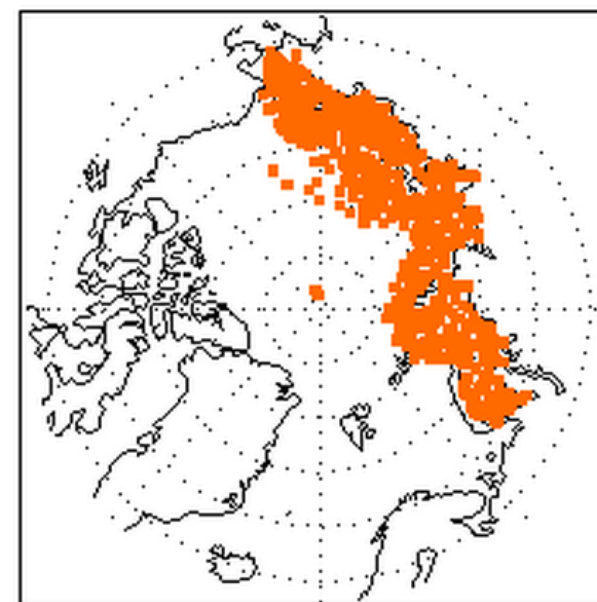
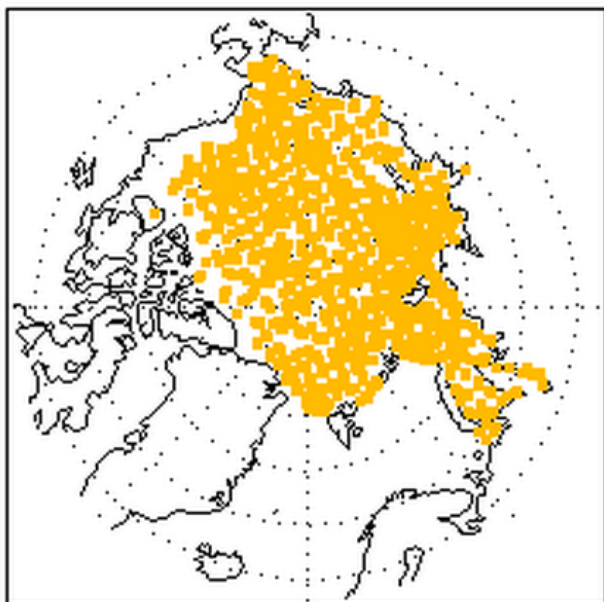
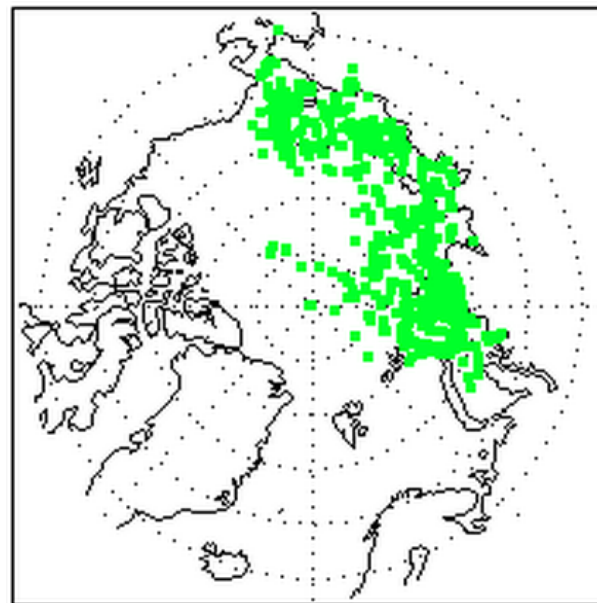
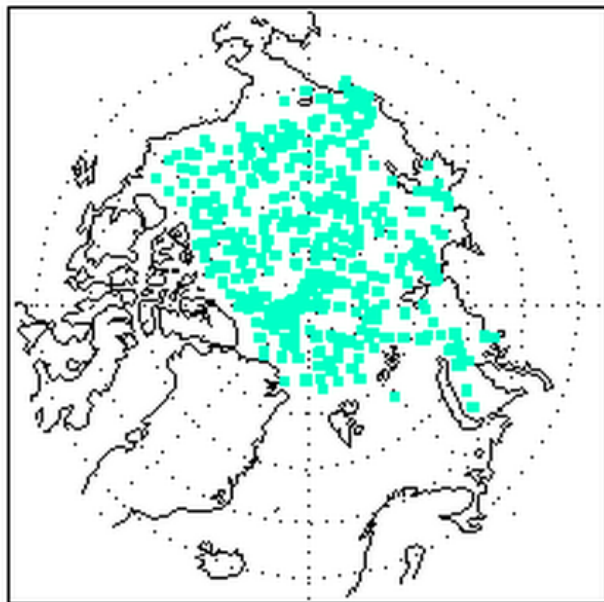
I. P. Romanov. 2004. Morphometric Characteristics of Ice and Snow in the Arctic Basin: Aircraft Landing Observations from the Former Soviet Union, 1928-1989. Boulder, Colorado USA: National Snow and Ice Data Center. <http://dx.doi.org/10.7265/N5B8562T>

High-latitude expedition Sever base on Zhokhov Island (photo taken by Sergey Kessel and used with permission)



Фото 58. База ВВЭ «Север» на о. Жохова

Landing Site Locations, by Decade, 1950s, 1960s, 1970s, 1980s



At NSIDC, Multi-station Networks

- **ClimoBase: Rouse Canadian Surface Observations of Weather, Climate, and Hydrological Variables**
- 1984-1998
- Surface meteorological and land surface measurements, including precipitation and snowfall accumulation, up to 177 parameters
- Sampling range, **15 minutes to daily**
- 24 sites with different land surface characteristics, surround three focus locations (Provinces: Manitoba, Northwest Territories), collected by Wayne Rouse

National Snow and Ice Data Center. 2014. ClimoBase: Rouse Canadian Surface Observations of Weather, Climate, and Hydrological Variables, 1984-1998. Boulder, Colorado USA: National Snow and Ice Data Center. <http://dx.doi.org/10.7265/N5FX77CH>.



INTERNATIONAL ARCTIC SYSTEMS FOR OBSERVING THE ATMOSPHERE

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International Arctic Systems for Observing the Atmosphere (IASOA)



<http://www.esrl.noaa.gov/psd/iasoa/>

IASOA



1. Ultrasonic Snow Depth and IR Ground Temperature Sensor
2. Gauge measurements are also made

IASOA

Snow Depth Data

- Tiksi
 - Met. Obs., 1932-2009, [daily](#), served by AARI (*currently not online*)
 - Tower Obs., 2010-2014, [minute](#) snow depth, served by NOAA, online
- Eureka, 2007-2014, [minute](#) snow depth
- Cherskii, 2008-2014, [30-minute](#) snow depth

All stations are known to have extensive manual and instrumental measurements.

These and other resources are being organized by the WMO Global Cryosphere Watch under two sub-programs called CyroNet (for surface observations) and Snow Watch (for satellite data)

- <http://globalcryospherewatch.org/projects/>
- Benefit: QC, best practices, and standardization

Questions

- Research Data Archive at NCAR

<http://rda.ucar.edu/>

- National Snow and Ice Data Center's NOAA program

<http://nsidc.org/noaa>

- International Arctic Systems for Observing the Atmosphere

<http://www.esrl.noaa.gov/psd/iasoa/>

Supplementary Slides

At NCAR, from US Department of Agriculture (USDA) Natural Resources Conservation Service

Contacts:

- <http://www.wcc.nrcs.usda.gov/snow/>
- Tony Tolsdorf, tony.tolsdorf@por.usda.gov

Format, CSV file, text

SNOTEL

Snow Course

SNOLite

SCAN

NCAR Access

Dataset in Research Data Archive file download

Update plan - TBD

At NCAR, from U.S. Geological Survey, Bureau of Land Management, U.S. Fish and Wildlife Service

Contact

- Frank Urban, furban@usgs.gov
- <http://pubs.usgs.gov/ds/812/introduction.html>

Format, ASCII text table

NCAR Access

Dataset in Research Data Archive file download

Update plan - TBD

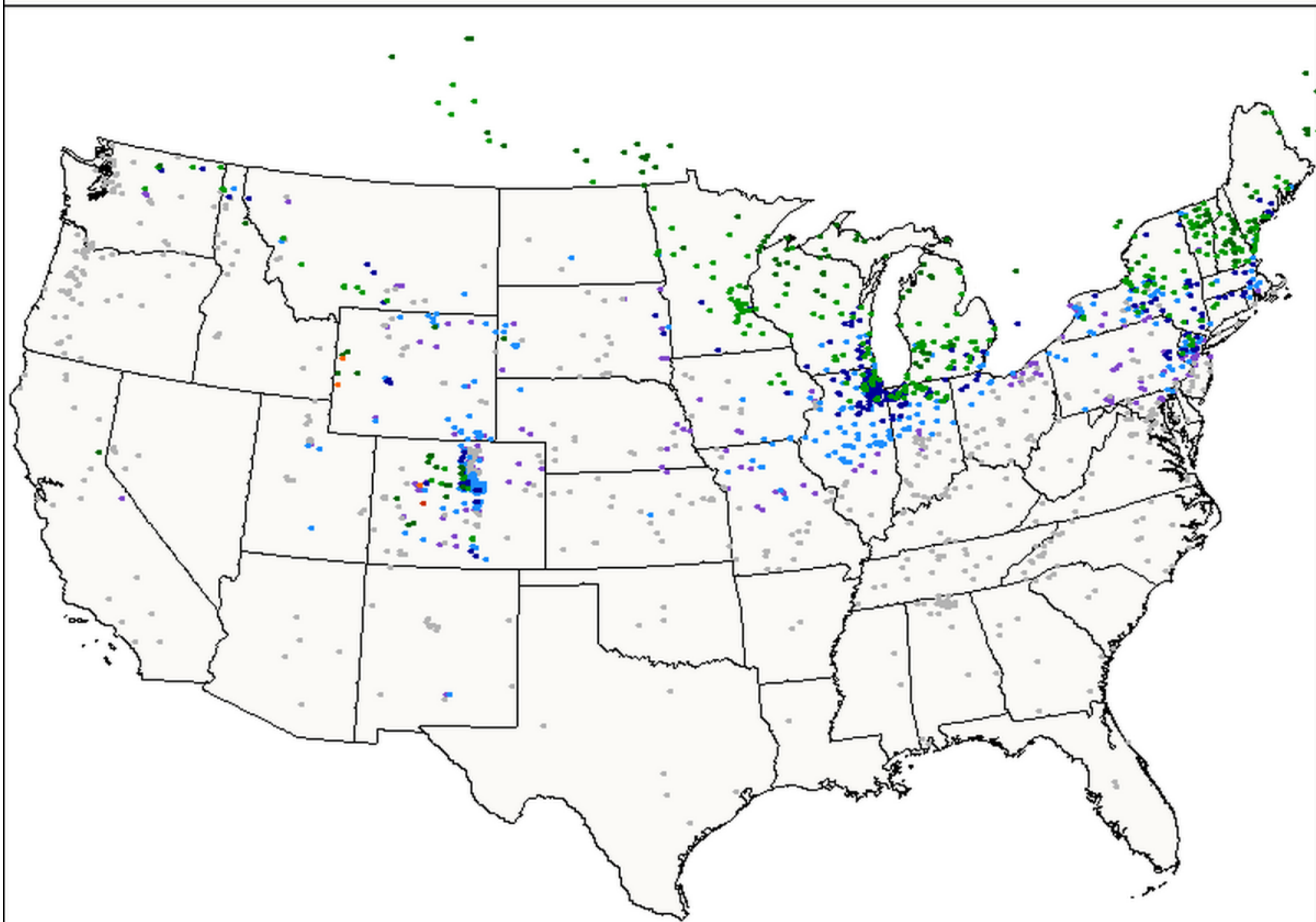
Community Collaborative Rain, Hail & Snow Network CoCoRaHS

- **NCDC ingests this into GHCN-D (check starting date with Matt Menne)**
- Volunteers working together to measure precipitation
- Originated at CSU in 1998
- Sponsored by NOAA and NSF, private donations
- Training videos and slide shows
- 16 years, growing coverage over time
- Sampling time: daily at 7 am Local time – needs adjustment
- Contact: Nolan Doesken, Colorado State Climatologist

Total Snow Depth (inches x.x)

USA 3/12/2014

0.0 Trace 0.0 - 3.6 3.7 - 7.2 7.3 - 18.0 18.1 - 43.2 43.3 - 64.8 64.9 - 72.0



comments

Taneil Uttal – NOAA, 303,497,6409, taneil.uttal@noaa.gov

Like to see IASOA data be use an compatible with reanalyses. Sandy Starkweather is upgrading the IASOA portal with more metadata now and more snow depth data should appear. Acutally, all the stations should have extensive records that need standardization and exposure.

If CORE-CLIMAX made a request for the information it would help move the development forward.

See global cryosphere watch

http://globalcryospherewatch.org/reference/documents/files/gcw_portal_handout.pdf

<http://globalcryospherewatch.org/cryonet/>

Need for standards for snow climate variables

<http://www.ipysnow.net/>

15-min. data at barrow

Snow depth data for Canada

- <https://www.ccin.ca/home/ccw/snow/links>
- Contact: Brown.Ross@ouranos.ca
 - Gridded North American Monthly Snow Depth and Snow Water Equivalent for GCM Evaluation, Brown, Brasnett, and Robinson 2003, Atmosphere-Ocean 41 (1) 2003, pp. 1-14.
- Email sent to Ross, 26 Sept. 2014
- CD's
 - daily, monthly, and climate normal
 - Period 1785-2000
 - 4285 stations

IASOA

Snow Depth Data

- Tiksi
 - Met. Obs., 1932-2009, [daily](#), served by AARI (*currently not online*)
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Contacts: taneil.uttal@noaa.gov & sandy.starkweather@noaa.gov

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