

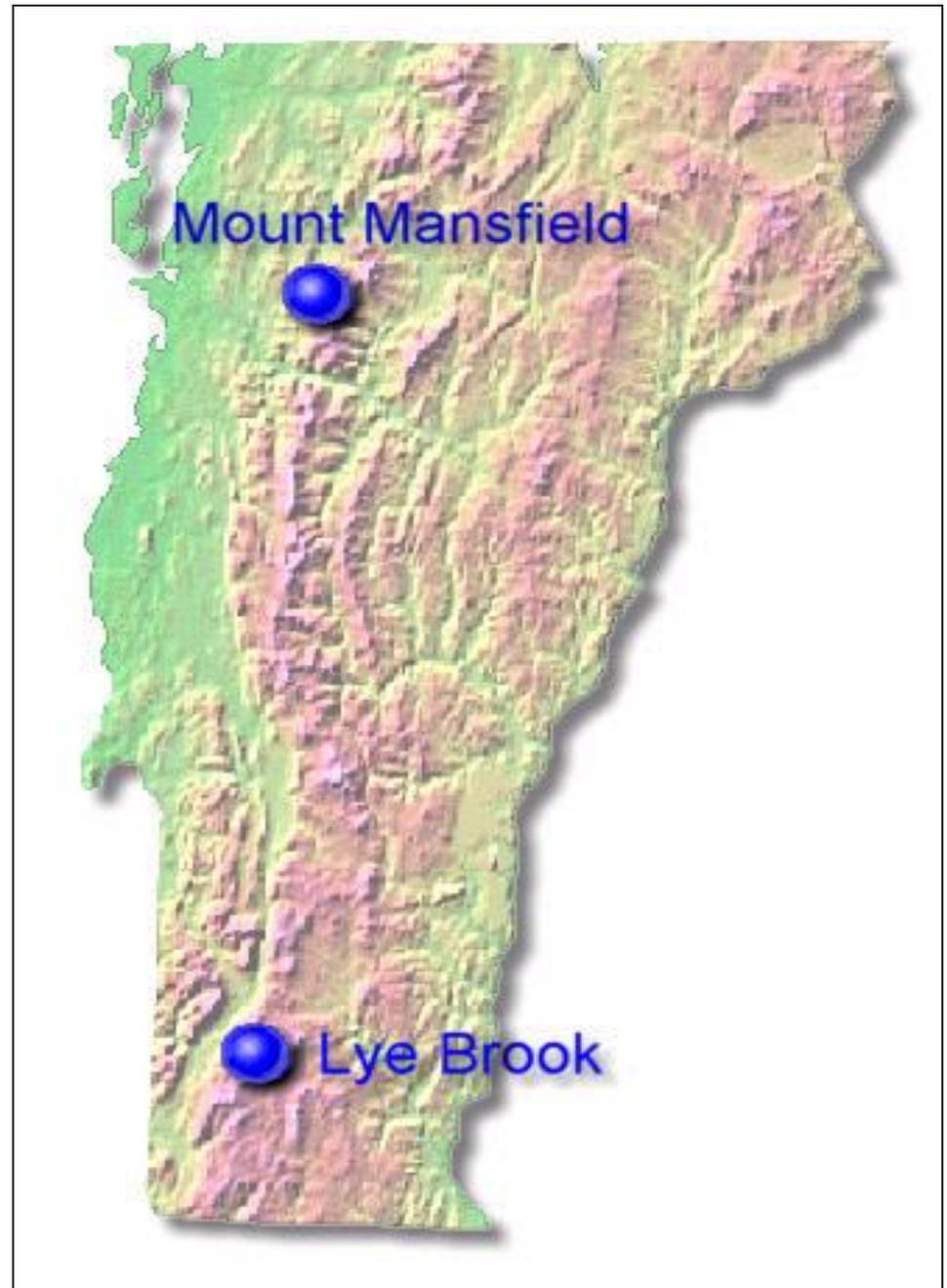
Vermont Soil Climate Analysis Network (SCAN) sites at Lye Brook and Mount Mansfield

13 Years of Soil Temperature and Soil Moisture Data Collection

September 2000 – September 2013



Vermont SCAN
locations – one
at each VMC
research area



What is soil temperature?

- Physical soil property?
- Chemical soil property?
- Biological soil property?

Climate change and soils (from Brevik, 2012)

Major climatic changes that can affect soils:

- Increase in atmospheric concentration of CO₂
- Increase in temperature
- Changes in precipitation amount and pattern
 - How will these affect soil carbon and nitrogen cycles (CO₂, CH₄, N₂O)?
 - Will plant productivity go up or go down?
 - Will soil C levels go up or go down?
 - What will be affected on microbial processes and rates of chemical processes?
 - How will evapotranspiration rates and soil moisture levels be affected?
 - Will soil erosion increase, by both water and wind?

Brevik, E.C. 2012. Soils and Climate Change: Gas Fluxes and Soil Processes. Soil Horizons. doi:10.2136/sh12-04-0012 (<https://www.soils.org/publications/sh/articles/53/4/12>)

**Lye Brook SCAN site - Radio tower with solar panels on left side of image;
MET tower on right side of image behind snow pillow, 2435 ft elevation**



Mount Mansfield SCAN site



2235 ft elevation

OPERATIONS and MAINTENANCE, Current Status

Lye Brook

Management of the Lye Brook site is coordinated through:

- **Jennifer Wright**, Liaison to VMC and Wilderness Coordinator for GMNF, US Forest Service

Mount Mansfield

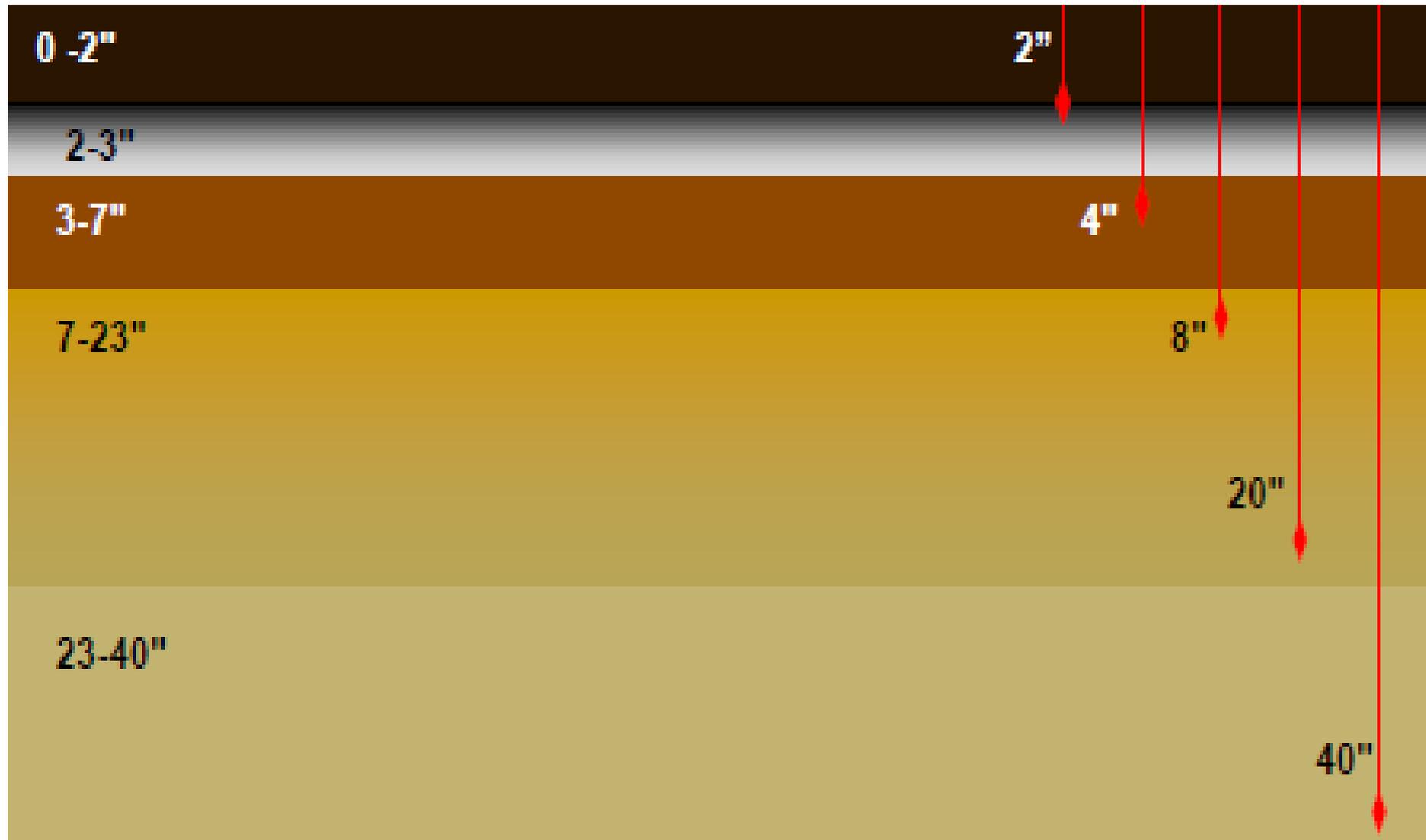
Management of the Mount Mansfield site is coordinated through the Park Manager @ Underhill State Park, and:

- **Thomas Simmons**, Forestry Specialist
Vermont Department of Forests, Parks, and Recreation
Essex Junction, VT

Standard SCAN Site Configuration

Parameter Measured	Description/ Units/Frequency
Precipitation	Tipping Bucket gage, reported as total precipitation for the water year (October 1-September 30). The units in inches of water. Note - gage doesn't collect data on precipitation falling as snow, hail, or sleet.
Air Temperature	Collected by a shielded thermistor in conjunction with Relative Humidity. Units in degrees C.
Relative Humidity	Collected by a thin film capacitance-type sensor. Units are 0-100 percent
Wind Speed and Direction	Collected by a propeller-type anemometer. Units are in miles per hour. Direction is reported as average hourly direction. Units are in degrees true.
Solar Radiation	Collected by a pyranometer. Units in watts/meter ² .
Barometric Pressure	Measured by a silicon capacitive pressure sensor. Units in inches of mercury.
Snow Water Content	Measured using a snow pillow device and a pressure transducer. Units in inches of water. Measurements are taken at sites with snowpack, including both Vermont sites.
Snow Depth	Measurement is done by using a sonic sensor. Units in inches of depth.
Soil Moisture	Collected by a dielectric constant measuring device. Reported as current water volume fraction. Units in percent (saturation is ~ 45 %). Measurements are at 2", 4", 8", 20", and 40".
Soil Temperature	Collected by an encapsulated thermistor. Reported as current temperature. Units in degrees C. Measurements are at 2", 4", 8", 20", and 40".

Typical placement of Hydraprobes in soil profile



Hydraprobe used for collecting soil moisture and temperature data, along with other information. Five hydraprobes are installed in soil profiles at each site at **2, 4, 8, 20 and 40 inches** below the surface.



Soil Temperature

Mean annual soil temperature (at 50cm):

- **7.3° C** at Mount Mansfield open site
- **6.9° C** at the Lye Brook shaded site
- **7.2° C** at the Lye Brook open, less shaded site

Soil Taxonomy soil temperature classification:

- ***frigid*** soil temperature class

Daily summer surface temperature - fluctuations up to 3° C (5.4° F).

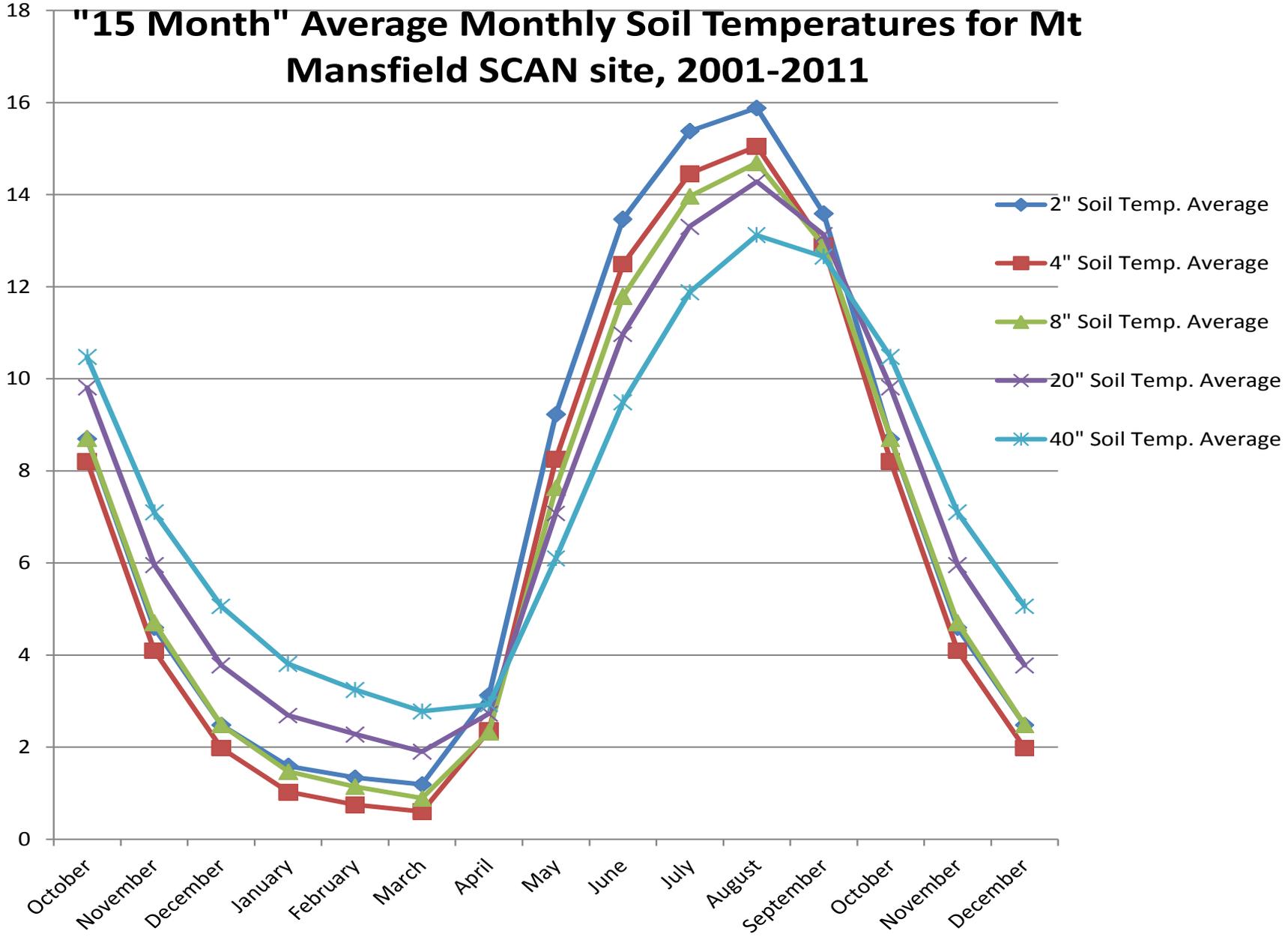
Deeper layers - no daily temperature fluctuations.

Soils are cooler in the shade than in the sun (duh).

Spring and Fall Temperature Turnover

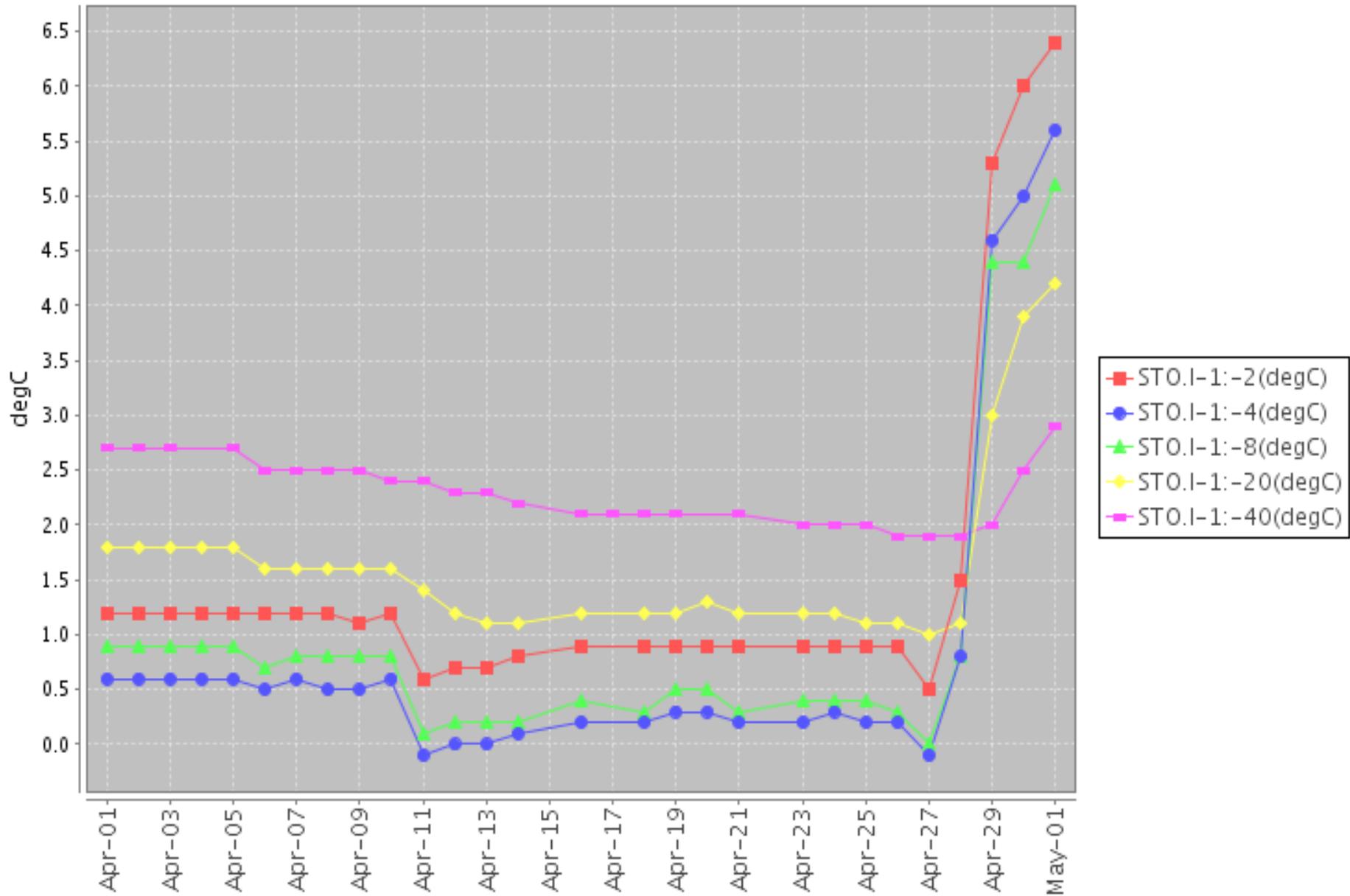
- Soils in northern climates undergo a **spring and fall temperature turnover**, similar to the turnovers that occurs on large northern lakes.
- In the summer, the upper layers of soil are the warmest, and in the winter, the deeper layers are warmest.
- Using SCAN data, a seasonal turnover in soils can be defined ***as the date at which the temperature of the 2 inch sensor crosses over (or under) the temperature of the 40 inch sensor for the season.***
- Useful when looking at a multi-year averages of soil temperature
 - tracking soil warming
 - effects of forest management
 - soil geography
 - other broad environmental issues

"15 Month" Average Monthly Soil Temperatures for Mt Mansfield SCAN site, 2001-2011



2011 Spring Turnover at Lye Brook – April 28th

Station (2041) MONTH=2011-04-01 (Daily) NRCS National Water and Climate Center – Provisional Data – subject to revision Fri May 06 11:54:00 PDT 2011



Average dates of Spring and Fall Turnover for 2000-2010, based on 10 year daily average soil temperature

Ten year average dates for Spring and Fall Turnover at VT SCAN stations

SCAN Station Location	Date of Spring Turnover - 10 Year Average	Date of Fall Turnover - 10 Year Average
Mount Mansfield (in forest opening), 2235 feet elevation	April 14	September 29
Lye Brook (in forest opening), 2435 feet elevation	April 13	September 30
Lye Brook (under forest canopy), 2435 feet elevation	April 19	September 30

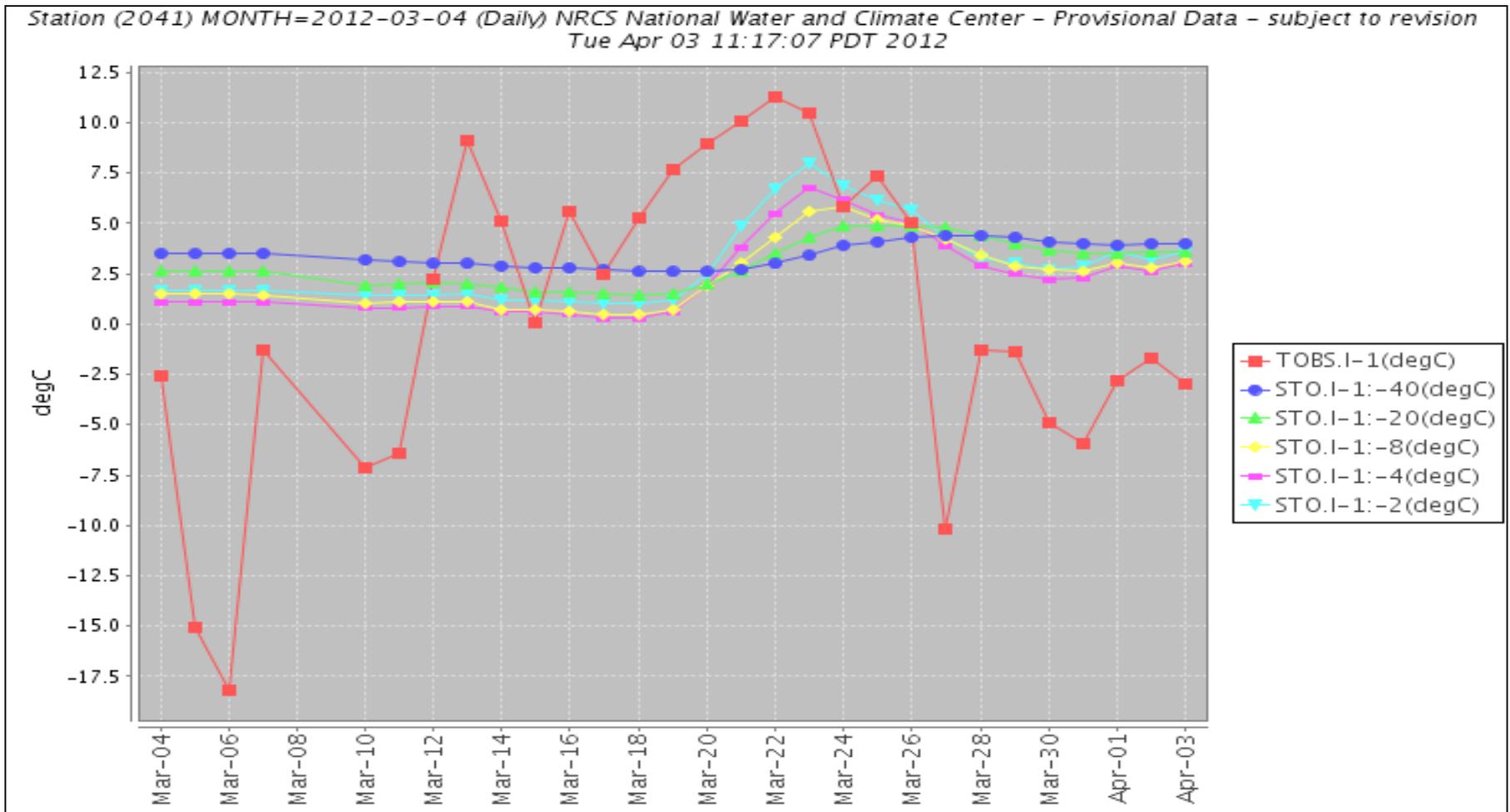
Spring turnover at MM in 2012 – with super warm March temperatures

Average turnover date at MM in spring is April 14th.

The earliest previous spring turnover date was April 4, 2011.

In 2012, turnover first occurred on **March 20th** - 15 days earlier than previous earliest date. Graph is from March 4th to April 3rd.

Soil went back to winter mode as temperatures dropped March 26th.

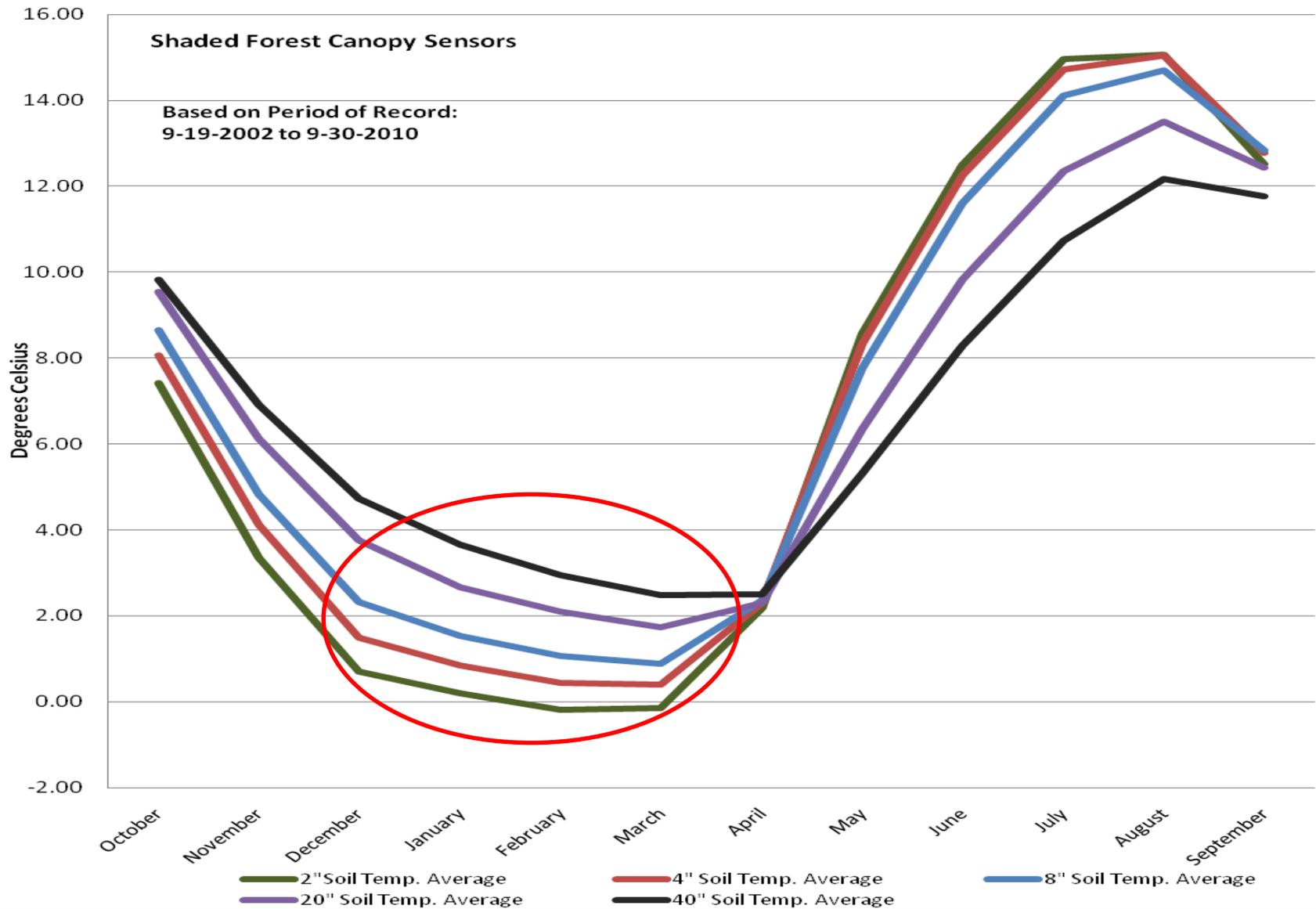


Winter Hibernation

Little change in soil temperature at VT SCAN sites between December and April - soils “hibernate” in the winter.

- Over winter, temperature gradually drops to near 0° C, with deeper layers being warmer than surface layers.
- Coldest daily **soil** temperatures are in late March to early April.
- On average monthly basis, March is the coldest month.
 - Two months later than the coldest average monthly **air** temperature, which occurs in January.
- Few soil temperature readings of below 0° C have been recorded at these forested sites.
- Stability of winter temperatures in the soils
 - a function of sufficient snow depth insulating soil and blocking daily surface temperature swings tied to air temperature and solar radiation.

Lye Brook, VT
Monthly Average Soil Temperature under Forest Canopy
Preliminary Data - Subject to Change



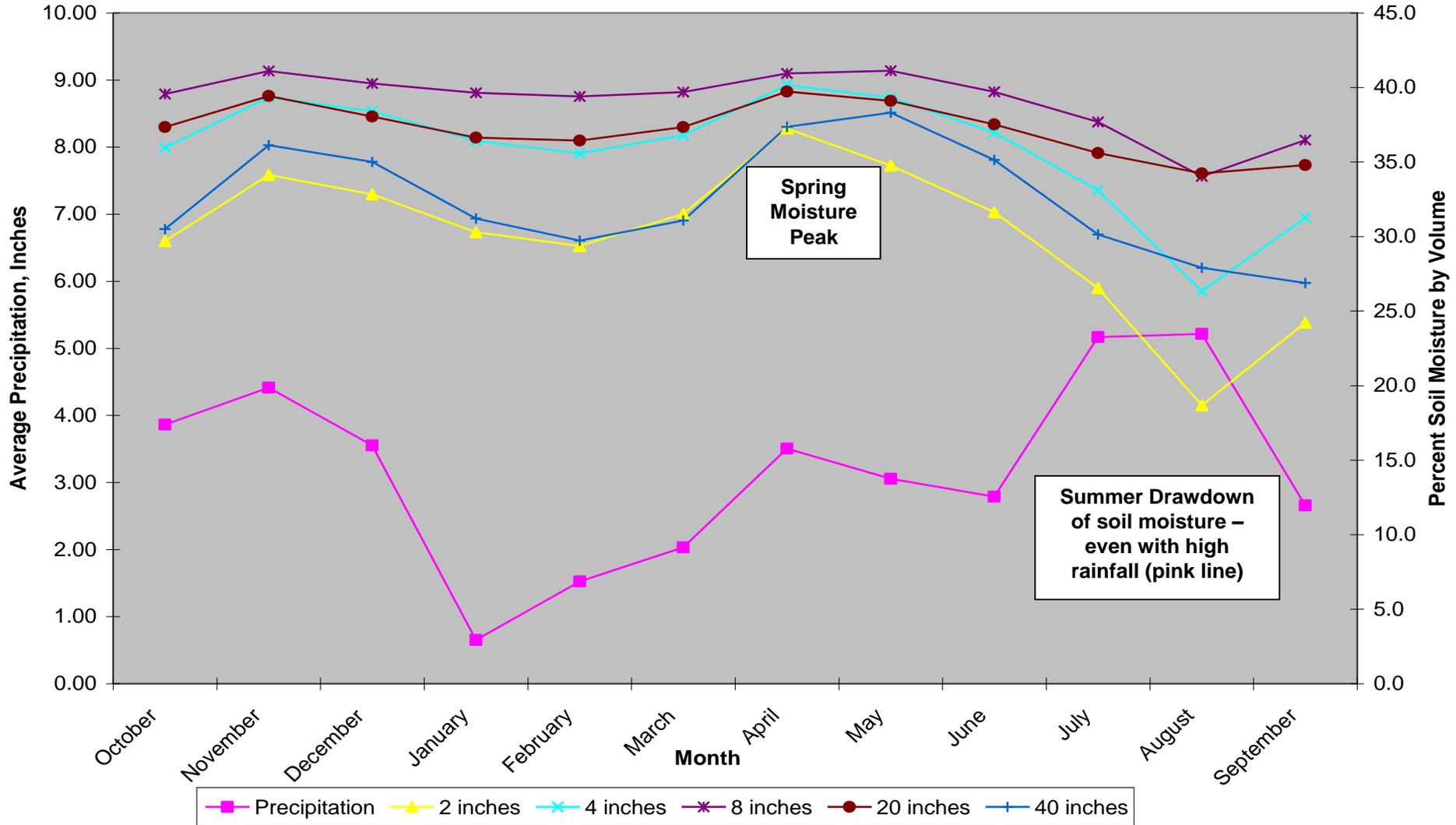
Soil Moisture

- Soils have the highest moisture content in the spring, typically in April.
 - more attributable to snowmelt than increased precipitation.
- Soils dry out in the summer, regardless of precipitation levels.
- The 8 inch soil depth has highest moisture levels – consistent in virtually all months of the year at both sites.
- Smaller moisture peak in the fall as trees start losing their leaves and evapotranspiration rates go down.

Vermont Soil Climate Analysis Network 2001-2005

5 year Average Monthly Precipitation and Soil Moisture, MM

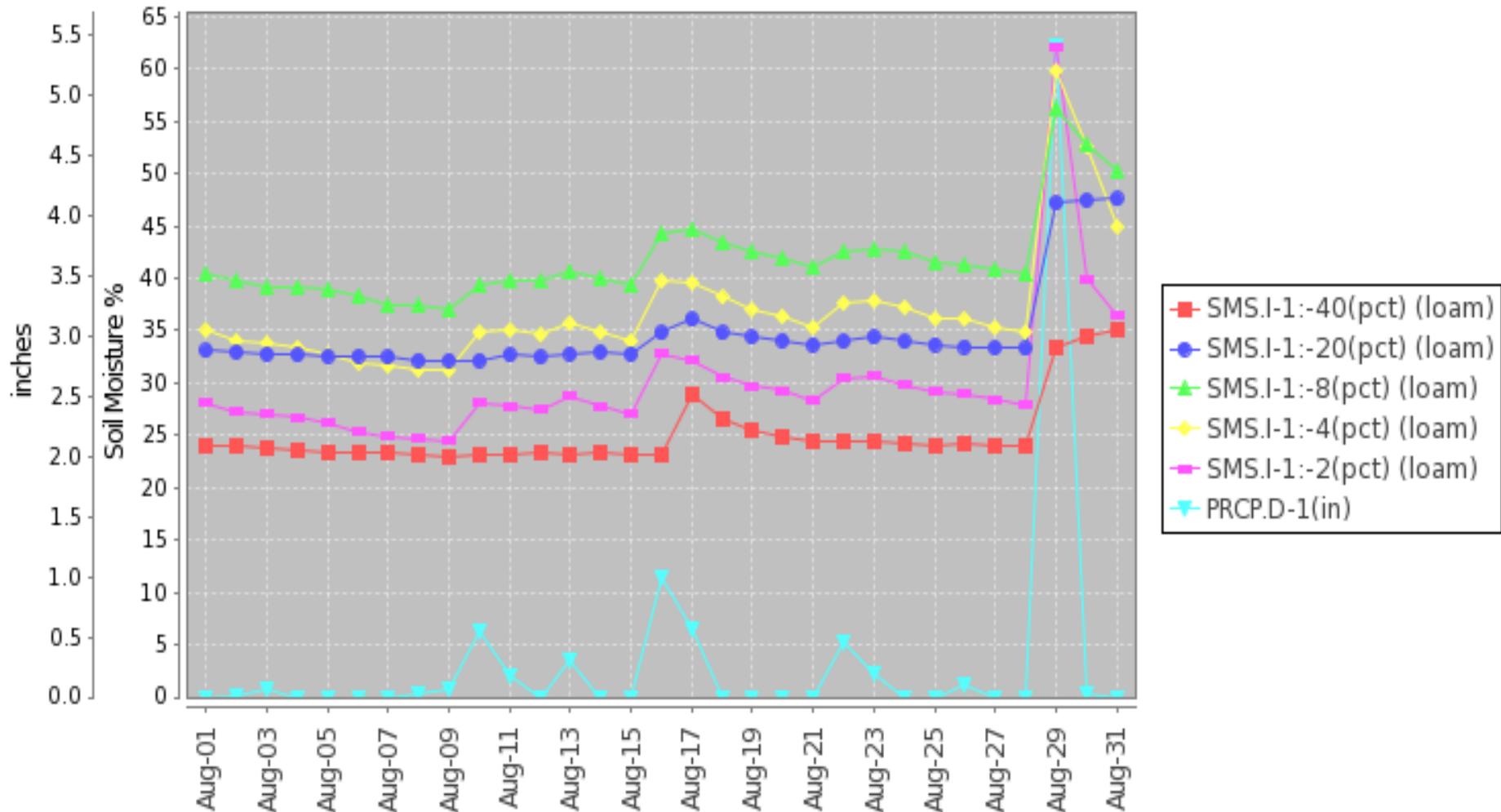
Mount Mansfield, VT
Average Monthly Precipitation and Soil Moisture - 2001-2005
Preliminary Data - Subject to Change



A Memorable Month

Soil Moisture and Precipitation at MM for August 2011

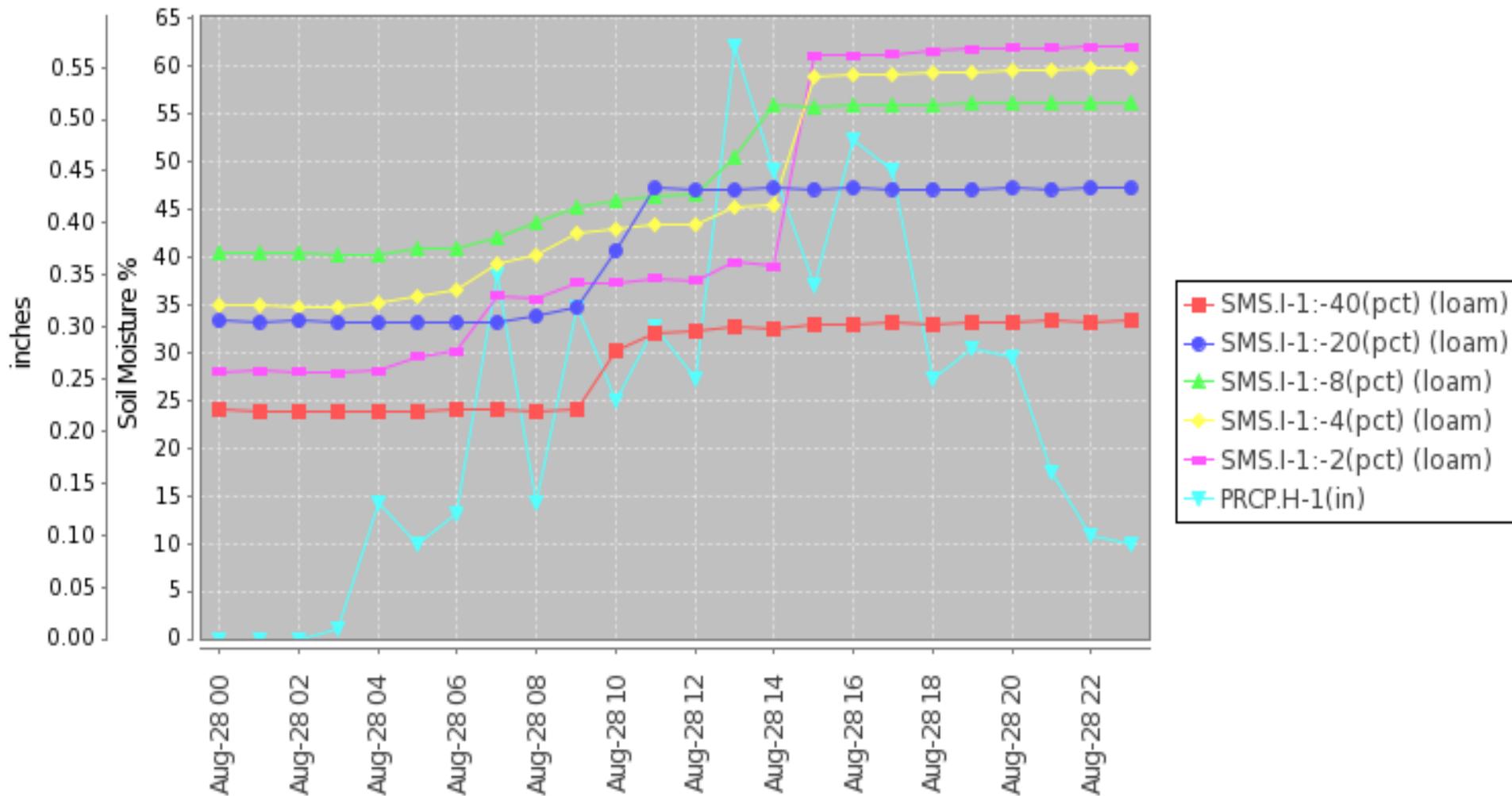
Station (2041) MONTH=2011-08-01 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
Tue Nov 26 09:36:41 PST 2013



Hourly Precipitation and Soil Moisture at MM

August 28, 2011

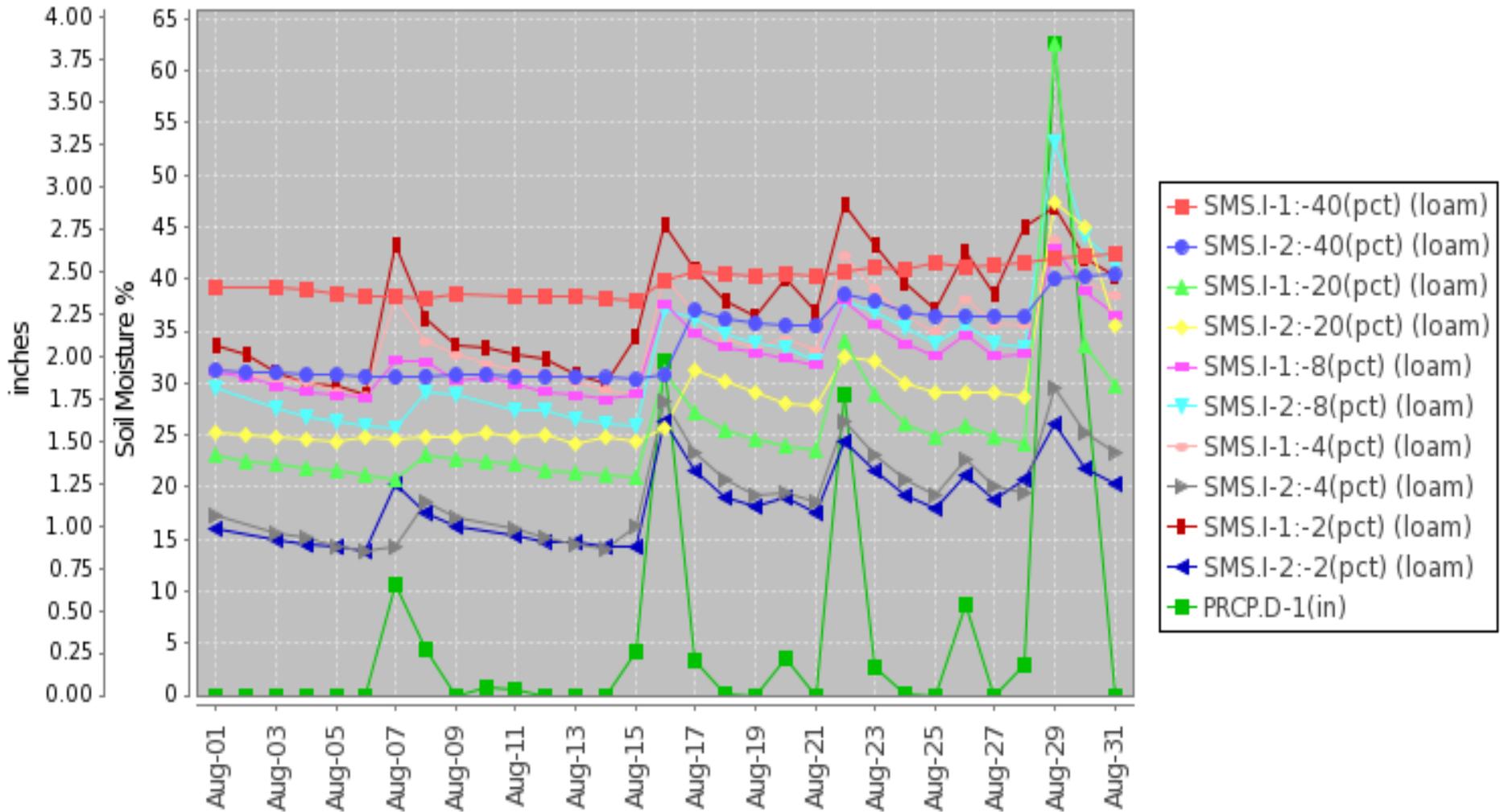
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Tue Nov 26 09:44:50 PST 2013



August 2011

Lye Brook

Station (2042) MONTH=2011-08-01 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
Thu Nov 14 14:18:42 PST 2013

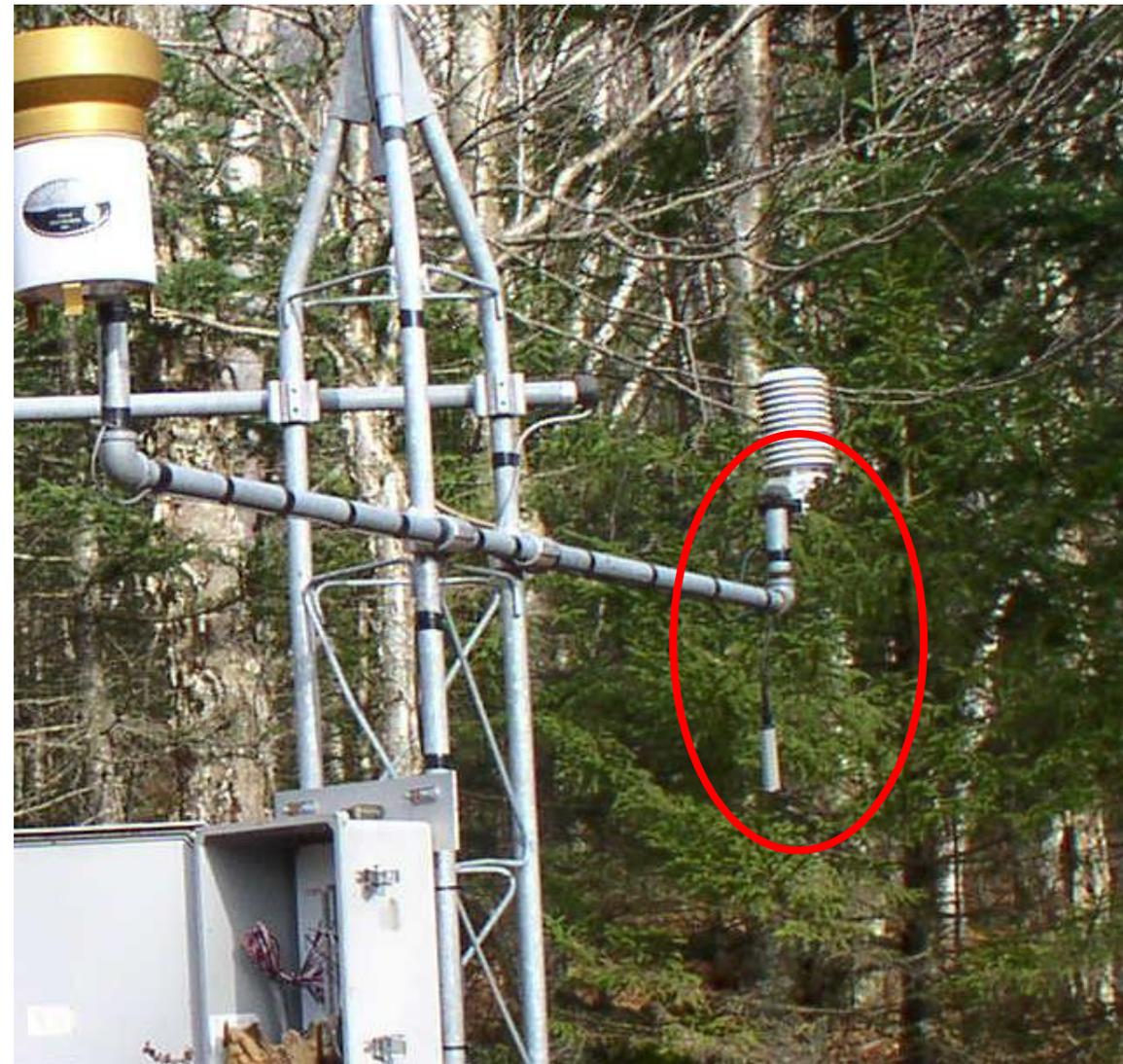


Data is placed on the NRCS National Water and Climate Center SCAN website:

<http://www.wcc.nrcs.usda.gov/scan/>.

- The website contains current and historical data for each SCAN site in the country.

Problem: Moose snagged cable to RH sensor
and broke the sensor



Solution: Make a 'moose guard' for the sensor cable



Problem: Rain gage funnel clogging with small debris; rainfall ponds in funnel
Solution: Put filter fabric over opening



Problem: Cracked Batteries at MM (unknown cause)
Solution: Replace with new ones

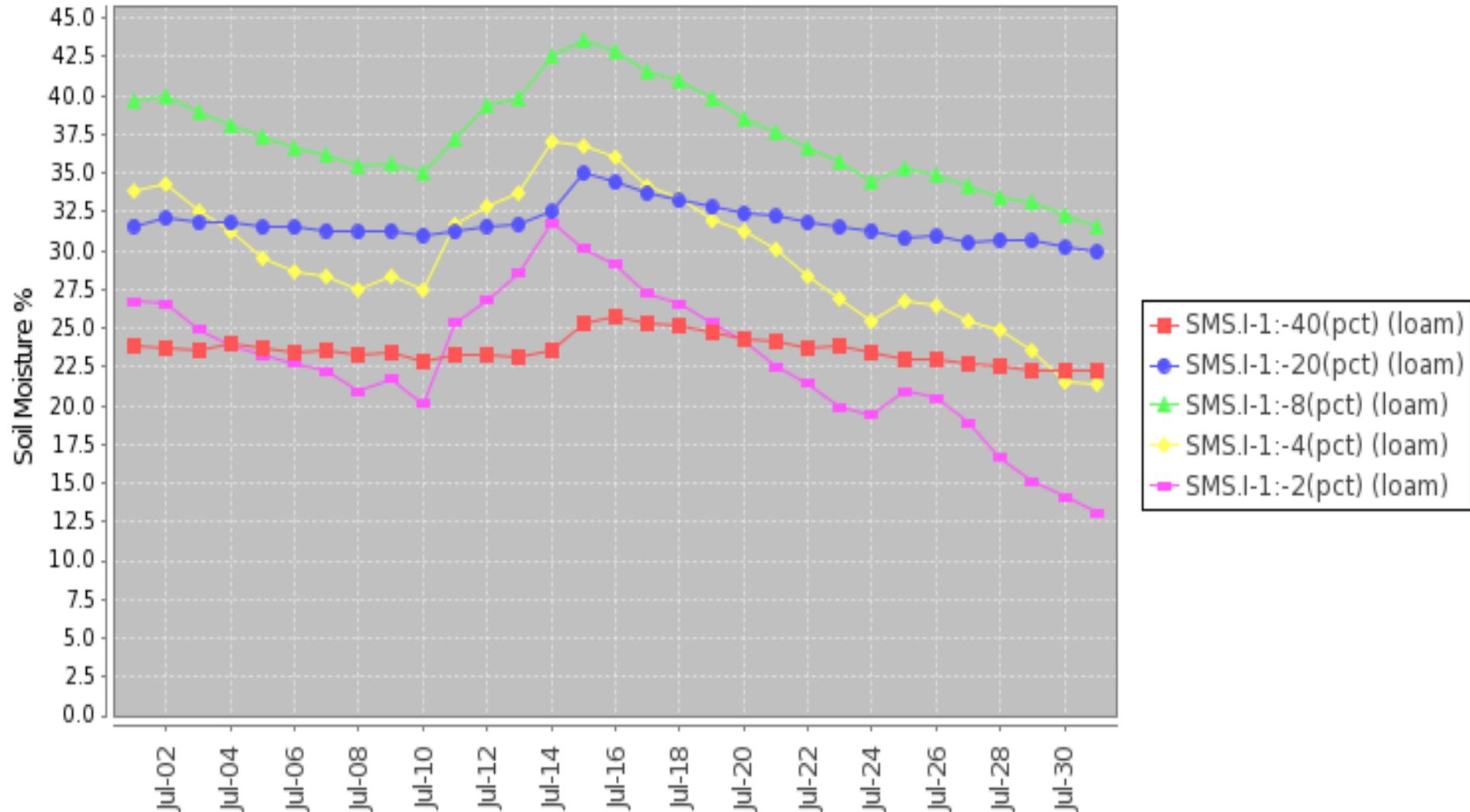


Thank you!

Thomas Villars
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Thomas.villars@vt.usda.gov

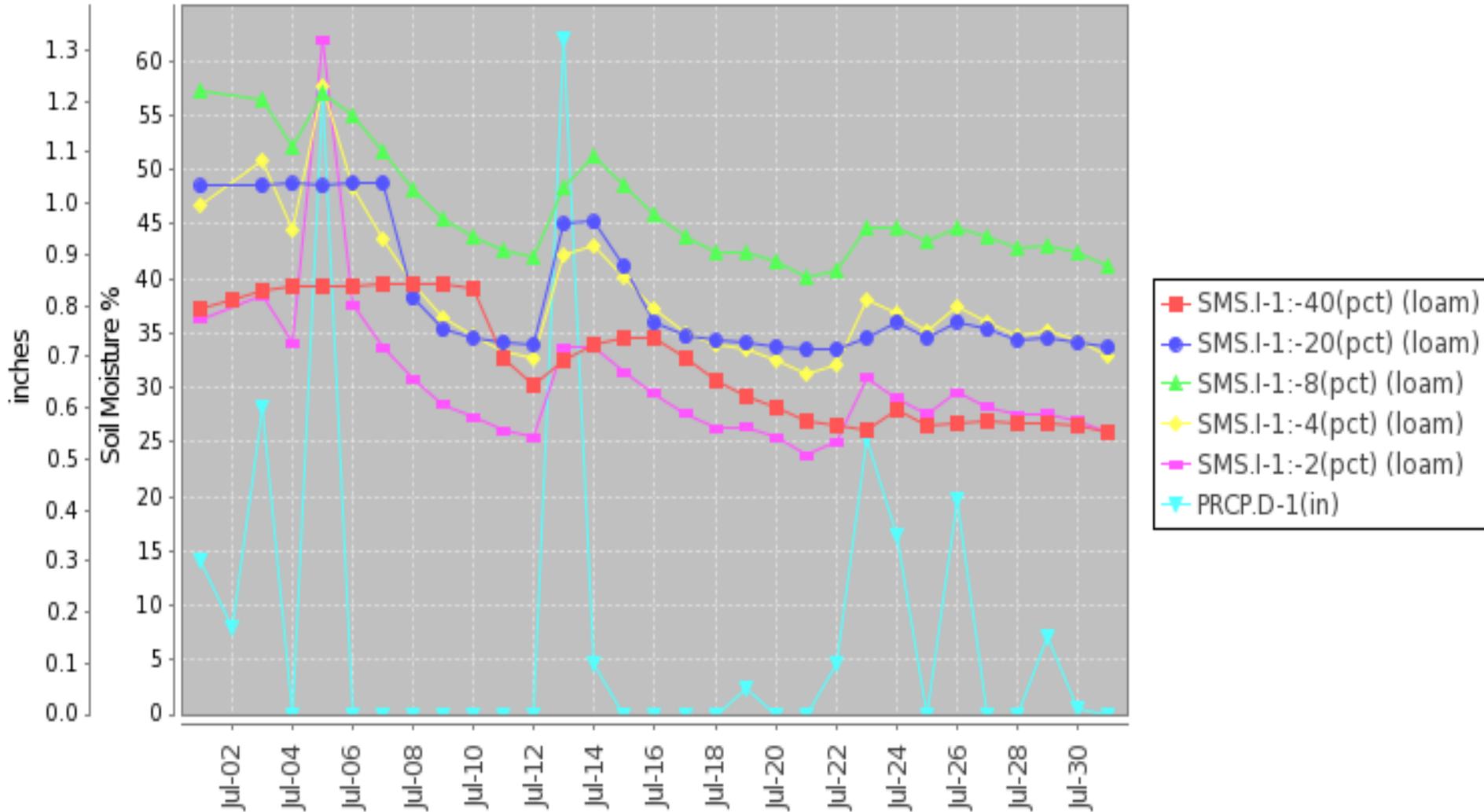
July 2001-sm

Station (2041) MONTH=2001-07-01 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
Wed Nov 27 10:33:58 PST 2013



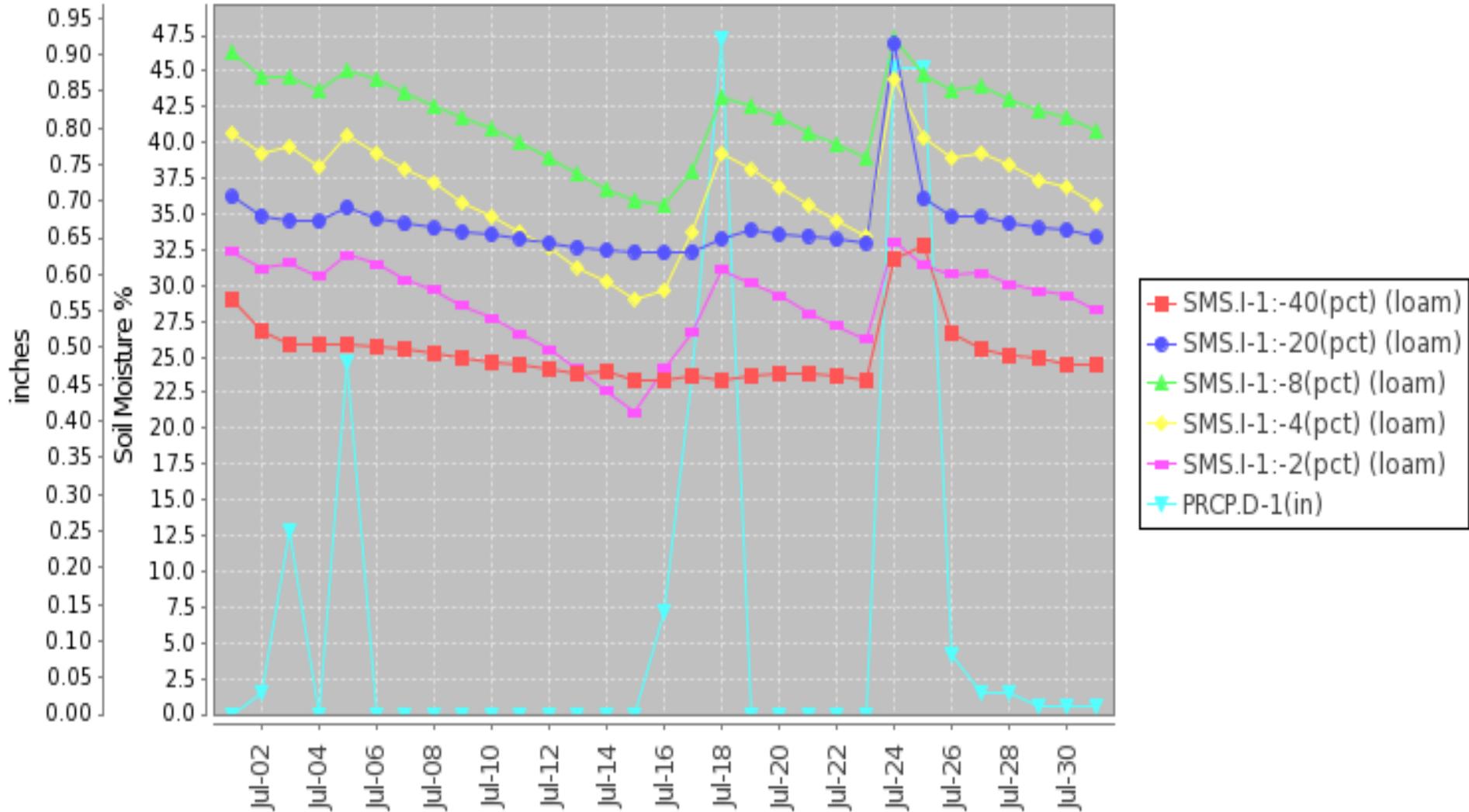
July 2006-sm

Station (2041) MONTH=2006-07-01 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
Wed Nov 27 10:35:41 PST 2013



July 2012-sm

Station (2041) MONTH=2012-07-01 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
Wed Nov 27 10:37:13 PST 2013



Lye Brook Soil/Air Temp, October-November 2013

shows two soils: 1)under forest canopy and 2)in opening

Station (2042) MONTH=2013-10-15 (Hourly) NRCS National Water and Climate Center - Provisional Data - subject to revision Thu Nov 14 12:25:49 PST 2013

