Vermont Soil Climate Analysis Network (SCAN) Sites at Lye Brook and Mount Mansfield
5 Year Summary Report
October 2000 – September 2005

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Issued February 2006

This report is a summary of the first 5 years of operation of the Vermont stations of the Soil Climate Analysis Network (SCAN). SCAN is a nationwide project of the USDA Natural Resources Conservation Service. The Vermont stations were installed in September 2000 by a team made up of personnel from the NRCS, USDA Forest Service, and the State of Vermont Agency of Natural Resources, with site coordination and financial assistance provided by the Vermont Monitoring Cooperative.

This report was prepared by Thomas Villars, Soil Resource Specialist, with assistance from the National Water and Climate Center. This project is a part of the NRCS technical soil services program in Vermont.

Judith M. Doerner
NRCS State Conservationist
Colchester, Vermont

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On the cover: *SCAN installation near Kelley Stand and Lye Brook Wilderness in the Green Mountain National Forest. Transmission tower with solar panels on left; meteorological tower on right.*

Introduction

The Soil Climate Analysis Network (SCAN) of the Natural Resources Conservation Service (NRCS) is a cooperative nationwide data collection system designed to support natural resource assessments and conservation activities. It is designed to collect soil moisture, soil temperature, and local climate information on a real-time basis using existing sites and through the establishment of new sites through partnerships with other entities.

In 1999, the Vermont Monitoring Cooperative (VMC), a partnership of the State of Vermont, the University of Vermont, federal agencies such as the Forest Service, and private organizations, partnered with NRCS to develop a long-term soil-monitoring program in Vermont. As part of this program, VMC and NRCS installed SCAN stations at two VMC research and monitoring sites: the first near Lye Brook Wilderness in the Green Mountain National Forest in southern Vermont and the second on state-owned forestland on the west flank of Mount Mansfield in the northwestern part of the state.

VMC granted a sum of $10,000 in 2000 to NRCS to facilitate the installation of the SCAN sites. The NRCS National Water and Climate Center (NWCC) in Portland, Oregon, provided assistance with the installation and oversight by providing the remaining necessary equipment and staffing support. The VMC grant helped cover a portion of NWCC costs for equipment and travel. The two sites were installed in September 2000.

Site criteria for locating the two VMC SCAN stations included: slope less than 5-10 percent in an approximately ¼-acre clearing within a forested area. During the time of installation, the soil at each site was described. Each site was geo-referenced using GPS technology.

The objective of the Vermont SCAN sites are to collect long-term data on weather, soil moisture and soil temperature at the two VMC sites. This will complement measurements of soil physical, chemical, and biological parameters at long-term soil monitoring sites located nearby, in addition to supporting the national objectives of the SCAN program.

NRCS provides administrative and technical oversight for the two sites, with assistance from the State of Vermont and the US Forest Service.

The ability of NRCS and its partners, such as VMC, to make sound resource assessments and watershed decisions has been severely limited by the lack of quality, historic and real-time soil-climate information. SCAN will provide this information to help develop products required to make sound resource management decisions.

Use of SCAN Data

National resource management issues for which long term soil/climate information is needed include:

- Input to global circulation models.
- To predict, monitor and verify droughts.
- To develop new soil moisture accounting and risk assessments.
- To monitor and predict changes in crop, range, and woodland productivity in relation to soil moisture-temperature changes.
- To predict regional shifts in irrigation water requirements which may affect reservoir construction and ground-water levels.
- To predict shifts in wetlands.
- To predict changes in runoff that affects flooding and flood control structures.
- To be able to verify and ground-truth satellite and soil moisture model information.
- To predict the long-term sustainability of cropping systems, and watershed health.

Operations and Maintenance in 2001 - 2005

Lye Brook

Management of the Lye Brook site is coordinated through:

Brian Keel;   bkeel@fs.fed.us
Monitoring and Research Coordinator for GMNF and
VMC Field Coordinator for Lye Brook Wilderness
GMNF Manchester Ranger Station
2538 Depot Street (Vermont Routes 11/30)
Manchester Center, VT 05255
Phone: 802-362-2307
Fax: 802-362-1251

- The Lye Brook site had start-up problems in 2000-2001. In early winter, the battery failed, resulting in a loss of data for about 10 weeks. It was replaced in February 2001.
- October 2001 - basic maintenance visit by NWCC staff.
- September 2002 - the second set of soil probes were installed under the forest canopy (shade) to complement the set in the forest opening (sun).
- October 2002 - basic maintenance visit by NWCC staff.
- October 2003 - radios and dataloggers were maintained by NWCC staff.
- January 2004 - the site was visited for visible signs of damage because of non-transmission of data. No visible signs of damage were noted.
- June 2004 - maintenance was performed on the site. It was noted that trees were blocking the solar panels somewhat.
- October 2004 - basic maintenance visit by NWCC staff.
- February and March 2005 - the batteries and solar panel regulator were replaced.
- July 2005 - all ten soil probes were replaced (5 each for site in opening and site under forest canopy).
- October 2005 - basic maintenance visit by NWCC staff. Pyranometer (sensor for solar radiation) was replaced.

Mount Mansfield

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

Thomas Simmons; thomas.simmons@state.vt.us
Forestry Specialist
Vermont Department of Forests, Parks, and Recreation
111 West Street
Essex Junction, VT 05452-4695
Phone: 802-879-5685
Fax: 802-878-5192

- The Mt. Mansfield site was visited in February 2001 for a review of the systems. There was some inconsistency with the snow depth measurements.
- October 2001 - basic maintenance visit by NWCC staff.
- February 2002 - the battery was replaced.

- September 2002 - site inspection was conducted. Rain gauge bucket was checked for blockage.
- October 2002 - basic maintenance visit by NWCC staff.
- October 2003 - radios and dataloggers were maintained by NWCC staff.
- May 2004 - rain gauge bucket was found plugged and was cleaned out.
- June 2004 - maintenance was performed on the site. Rain gauge bucket was found to be plugged again and was cleaned out.
- July 2005 - maintenance was performed on the site. Air temperature and relative humidity sensor was fixed.
- October 2005 - basic maintenance visit by NWCC staff.

Personnel involved in the maintenance of the sites include those mentioned above and also: Garry Schaefer, Don Huffman, Bill Woolcock and others with the NWCC, Debra Harms with the National Soil Survey Center, Harold Bell with the USDA Forest Service, and Vermont employees of the NRCS.

The sites will continue to require maintenance as part of normal operations. Questions about the functionality of the sites should be sent to the project manager, site coordinators, or the NWCC Liaison. Visitors to the sites are also urged to report any disturbances or damage to the project manager.

Data Summaries

Denice Schilling, Statistical Assistant with the NWCC, provided the summaries for this report.

In Appendix 8, a summary of the average monthly sensor values can be found for both sites. Data is provided for precipitation, air temperature, snow depth, soil temperature, and soil moisture. The data were ingested into Microsoft Excel and the math functions were used to derive the calculated values. Appendix 9 provides graphs of various data for each site.

a. Soil Temperature

The soils at the two SCAN sites have similar temperature characteristics. There are several features that are worth noting (refer also to graphs 1-4 in Appendix 9).

1. Spring and fall turnover – like lakes and other water bodies, the soils have a spring and fall turnover. In the summer, the upper layers of soil are the warmest, but in the winter, the deeper layers are warmest. At some point in the month of April, the soil has virtually the same temperature throughout the 40 inch profile as the upper layers begin to warm up. In September, the same temperature equalization happens as the upper layers begin to cool down.

2. Winter "hibernation" – there is very little change in soil temperature between the months of December and April, with the soils appearing to "sleep" through the winter months. They gradually drop in temperature to near 0 degrees C, with deeper layers being slightly warmer than surface layers. The coldest soil temperatures are in April, although on an average monthly basis, March has the coldest soil temperatures. This is two to three months later than the coldest average monthly air temperature, which occurs in January. Very few soil temperature readings of below 0 C have been recorded, which raises the question of whether these soils actually freeze in winter, as is commonly believed. The data suggests that they do not.

3. Surface layers have daily temperature fluctuations in the summer, while deeper layers do not. Daily temperature fluctuations of up to 3 degrees C occur at the surface, while at 40 inches, daily temperature changes are on the order of about 0.1 degree C or less in July and August.

4. Soils are cooler in the shade than in the sun, based on the limited record of data at Lye Brook. Mean annual soil temperature is 6.8 deg C in the shade and 7.2 deg C in the forest opening. Mean summer soil temperature is 11.8 deg C in the shade and 12.7 deg C, almost one whole degree warmer, in the sunnier forest opening.

b. Soil Moisture

Like soil temperature, the soils at the two SCAN sites also have similar moisture characteristics (refer also to graphs 5 – 8 in Appendix 9).

1. Spring Moisture Peak – all soils have the highest moisture content reading in the spring, typically in April. This seems to be more attributable to snowmelt than increased precipitation. The moisture peaks are more equalized throughout the soil profile in the soils in more sunny forest openings, while the shaded site at Lye Brook has a more diffuse moisture peak, which may be due to a slower rate of snowmelt. However, this site also has the shortest period of record, which may have some influence. It is interesting to note that the Spring Moisture Peak coincides with the Spring Turnover. Perhaps the soil temperature is equalized by the temperature of the soil water throughout the profile.

2. Summer moisture drawdown – all soils exhibit a drying-out in the summer months, irregardless of precipitation levels.

3.The 8 inch depth has the highest moisture levels – this is consistent in virtually all months of the year at both sites.

4. Winter moisture drawdown – although not as distinct as in summer, there is a noticeable drop in soil moisture in winter. At Lye Brook, it is most distinct at the 20 and 40 inch depths. At Mount Mansfield, it is not as pronounced, but also occurs.

5. Effects of storms – the availability of hourly readings makes it possible to track the effect of individual rainfall events. Graph 8 in Appendix 9 portrays the effects of Hurricane Katrina as it passed over the Mount Mansfield station in late August – early September, 2005. It covers a 44 hour period, including before and after the storm came through. Hurricane Katrina was not a hurricane by the time it reached Vermont, but it still dropped enough rainfall to have a noticeable and sudden impact on soil moisture levels.

Soil Taxonomy Soil Temperature Classification

The SCAN site data can be used to verify Soil Taxonomy soil temperature class placement of the soils on the site. Soil temperature classes are used in Keys to Soil Taxonomy (Soil Survey Staff, 2003) as part of the family name in both mineral and organic soils. The Celsius (centigrade) scale is the standard. The control section for the Vermont SCAN site soils is at a depth of 50 centimeters from the soil surface, which is basically the same depth as the 20 inch Hydra probe. Temperature data for that probe was used for these taxonomic determinations.

Soil temperature classes are defined in terms of the mean annual soil temperature and the difference between mean summer and mean winter soil temperatures. Mean summer temperature includes the months of June, July and August. Mean winter temperature includes the months of December, January, and February. The three soil temperature classes recognized in Vermont are:

Mesic – Mean annual soil temperature between 8 and 15 degrees C, with difference of 6 degrees C or more between mean summer and mean winter soil temperature.

Frigid - Mean annual soil temperature lower than 8 degrees C, with difference of 6 degrees C or more between mean summer and mean winter soil temperature.

Cryic - Mean annual soil temperature lower than 8 degrees C, and the mean summer soil temperature is lower than 8 degrees C in soils that have an O horizon and that are not saturated during some part of the summer. (If the soil is saturated with water during some part of the summer, the mean summer soil temperature must be lower than 6 degrees C.)

Soil Taxonomy Soil Temperature Classification Table, 2001-2005 All temperatures Celsius - measured at 50 cm (20 inch) depth Numbers in parentheses indicates years of data for that site				
Location	**Mean Annual Soil Temp.**	**Mean Summer Soil Temp.**	**Mean Winter Soil Temp.**	**Difference between Mean Summer and Mean Winter Soil Temp.**
Lye Brook – in opening Elevation – 2435 ft.	**7.2 (*Frigid*)**	**12.7 (3-5)**	**3.2 (2-3)**	**9.5**
Lye Brook – under canopy Elevation – 2430 ft.	**6.8 (*Frigid*)**	**11.8 (1-3)**	**2.9 (1-2)**	**8.9**
Mount Mansfield – in opening Elevation – 2236 ft.	**7.3 (*Frigid*)**	**12.9 (5)**	**2.8 (5)**	**10.1**

All three of the soil locations, at elevations between 2200 to 2440 feet, classify as having a Frigid soil temperature class based on the 2001-2005 data. This corroborates general thinking about the distribution of soil temperature classes in the state and the specific taxonomic classification of the Mundal and Peru soils located at the sites. The *mesic* soil temperature class zone generally includes warmer, lower elevation areas such as the Champlain Valley and Vermont Valley biophysical regions and the Connecticut River Valley. The *frigid* soil temperature class zone covers almost all of the rest of the state below about 2500 to 3000 feet elevation. The *cryic* soil temperature class zone is limited to the upper slopes and summits of the Green Mountains, Taconic Mountains, and the Northeast Highlands at elevations above 2500 to 3000 feet.

It is worth noting the difference in average temperature between the two Lye Brook sites. The shaded site under the forest canopy has a lower mean annual soil temperature and lower mean summer soil temperature than the sunnier site in the forest opening. Data is limited for the shaded site, however, so this trend will bear further watching.

Data Transmission from Vermont's SCAN sites

SCAN uses *meteor burst telemetry* to obtain remote site information. Meteor burst communication technology utilizes the billions of sand-sized particles that continually enter the earth's atmosphere. As these particles enter the 60 to 80 mile high region, they begin to burn up and leave a highly charged gaseous trail of electrons with some unique properties. When a UHF radio signal hits the gaseous trail, it reflects the radio signal back to the earth. Using meteor burst communication, remote sites such as Vermont's two sites are capable of transmitting information to a master station located within a 1000-mile radius. Each master station can support up to 3,000 remote sites. Currently NRCS owns and operates two master stations, one outside Boise, Idaho and the other near Ogden, Utah. Meteor burst coverage for the eastern U.S. is supported by 3 additional master stations located in Ohio, Missouri, and Mississippi. Once the data arrive at the master station, it is sent via conventional telephone lines to the Central Computer Facility (CCF) in Portland, Oregon, where the data are stored and made available to users.

Remote sites like Vermont's sites are designed to provide near real-time data from a variety of sensors. The above-ground sensors provide the information required for climate analysis and evapotranspiration calculations. The below-ground sensors provide soil temperature and soil moisture at five depths (2 inches, 4 inches, 8 inches, 20 inches, and 40 inches). One set of below-ground sensors are installed at Mount Mansfield (see Appendix 5). Two sets of below-ground sensors are installed at Lye Brook, one set in the forest opening and one set under the forest canopy (see Appendix 4a and 4b). See the section below for more information on the Hydra probe below-ground sensors.

Data Management

Data management is performed in two stages. The first stage is when the data values are initially received at the CCF for processing. For each site and each parameter, a parameter limit and rate of change are determined. The computer automatically checks the incoming value against these limits and flags any values that fall outside these windows before placing the data into the database. A second screening stage is conducted by a statistical assistant who examines any flagged values to determine their accuracy and makes corrections. All parameters are graphed and comparisons are made between sensors to verify that the data are within an acceptable range. All edited values are flagged in the database.

Data Access

Data is placed on the National Water and Climate Center Internet homepage: http://www.wcc.nrcs.usda.gov. The website contains current and historic data for each SCAN site. In addition to data, each site will eventually contain the soil pedon information and site characterization (chemical, physical, and mineralogical) information provided by the National Soil Survey Center.

An Overview of the below-ground Hydra Soil Moisture and Temperature Probe

This section is an edited version of the Hydra Soil Moisture Probe User's Manual, Version 1.2, June 1994 (P/N 92915 Rev A – note: this may not be most current product number) Stevens Vitel, Inc., www.stevenswater.com
See Appendices 4 and 5 for local soil and site information about the soil Hydra probes.

Principles of operation

The Hydra soil moisture probe determines soil moisture and salinity by making a high frequency (50 MHz) complex dielectric constant measurement. A complex dielectric constant measurement resolves the capacitive and conductive parts of a soil's electrical response. The capacitive part of the response is most indicative of soil moisture while the conductive part reflects predominantly soil salinity. Temperature is determined from a calibrated thermistor incorporated into the probe head.

As a soil is wetted, the low dielectric constant component, air, is replaced by water with its much higher dielectric constant. Thus as a soil is wetted, the capacitive response (which depends upon the real dielectric constant) increases steadily. Through the use of appropriate calibration curves, the dielectric constant measurement can be directly related to soil moisture.

Pure water, soil particles, and air all have a very low electrical conductivity. However, natural or man-made salts (fertilizers, for example) present in a soil dissolve into the soil water. These dissolved salts dramatically increase the conductivity of the water and thus the soil. A measurement of soil conductivity combined with the capacitive response can be used to determine soil salinity.

Installation orientation

While the Hydra probe can be installed in any orientation, a horizontal installation is recommended, particularly in locations near the soil surface or where strong soil moisture gradients are encountered. This is because the effective sensing volume is a cylinder approximately 2.5 cm (1 inch) in diameter and 6 cm (2 inches) in length bounded by the three outer tines, the probe head, and the “free” end of the tines. The resulting probe output parameters reflect an average value over this sensing volume. By installing the probe horizontally, the longest dimension of the probe sensing volume will be parallel to the soil surface and perpendicular to the direction of, typically, the strongest soil moisture gradients. This allows the probe to give the best approximation to a "point measurement.”

Soil Moisture - measurement units and accuracy

The output of the data conversion program is water fraction by volume (wfv). For example, a water content of 0.20 wfv means that a one liter soil sample contains 200 ml of water. Full saturation (all the soil pore spaces filled with water) occurs typically between 0.3-0.45 wfv and is quite soil dependent. There are a number of other units used to measure soil moisture. They include % water by weight, % field capacity, % available (to a crop), and tension (or pressure). They are all inter-related in the sense that for a particular soil, knowledge of the soil moisture in any one of these units, allows the soil moisture level in any of the other unit systems to be determined. It is important to remember that the conversion between units can be highly soil dependent.

The unit of water fraction by volume (wfv) was chosen for the Hydra probe for a number of important reasons. First, the physics behind the soil moisture measurement dictates a response that is most closely tied with the wfv content of the soil. Second, without specific knowledge of the soil, one can not convert from wfv to the other unit systems. Third, the unit wfv allows for direct comparison between readings in different soils. A 0.20 wfv clay contains the same amount of water as a 0.20 wfv sand. However, the same thing can not be said about the other measurement units. For example, to use the unit common in tensiometer measurements, a one Bar sand and a one Bar clay will have vastly different water contents.

The wfv unit can also be readily used to estimate the effects of precipitation or irrigation. For example, consider a soil that is initially 0.20 wfv and assume a 5 cm (2 inch) rainfall that is distributed uniformly through the upper one meter of soil. What will the resultant soil moisture in the upper one meter of soil be? Answer: 5 cm is 0.05 of one meter, so the rainfall will increase the soil moisture by 0.05 wfv to result in a 0.25 wfv soil. For other units, this calculation can be much less straightforward, particularly when soil moisture is measured as a tension.

Soil Temperature - measurement units and accuracy

The temperature measurement is in degrees Celsius (or Centigrade). The standard accuracy is +/- 0.6°C throughout the full operating range of -10°C to +65°C. Reproducibility is to +/- 1°C for the standard temperature option

Use of the Hydra probe in freezing soils

The Hydra probe can be left installed in soils subject to freezing. As a soil begins to cools to 0°C, the moisture present in the soil may begin to freeze. However, super cooling to -l°C to -2°C may occur before the water present in a soil begins to freeze. Hence, a simple temperature measurement is not sufficient to determine whether a soil has begun to freeze. In addition, a simple temperature measurement can only detect the beginning of soil freezing and cannot resolve the fraction of the soil moisture that is frozen, since the temperature stays essentially fixed while the soil freezes.

As a soil freezes, the electrical properties of the soil change dramatically. The real dielectric constant of water drops from near 88 to approximately 4 as the water freezes. The real dielectric constant of the soil will also reflect the fall in the real dielectric constant of the water present. For example, a moderately wet soil with a real dielectric constant of 20 will undergo a drop in the real dielectric constant to approximately 3-4 as the soil freezes.

Roughly, the drop in the real dielectric constant is proportional to the fraction of the soil water that is frozen. In the example mentioned earlier, a real dielectric constant of 12 would be indicative of approximately half the water content of the soil being frozen. In addition to the real dielectric constant falling as freezing occurs, the imaginary dielectric constant will also fall.

The marked change in the electrical properties of freezing soil make it relatively simple to distinguish soil freezing from a drop in soil moisture. One should strongly suspect soil freezing is occurring when either 1) the soil temperature is near 0°C or below, or 2) the real dielectric and imaginary dielectric constants both begin to fall.

It should be noted that when freezing occurs in the soil, calculated soil moisture values, temperature corrected real and imaginary dielectric constants, temperature corrected soil conductivity, soil salinity and soil water conductivity will lose their meaning as they are predicated on the water present in the soil being a liquid. The raw electrical parameters such as dielectric constants and soil conductivity, as well as temperature, retain their relevancy. As a practical matter, particularly when the Hydra probe is installed at a depth in excess of 50 cm (20 inches), once freezing commences, the water present in the soil remains fairly fixed. Thus, the last measured soil moisture value obtained before freezing is likely to be a good estimate of the water content of the frozen soil.

References

The author of this report has quoted sections from the following brochures and reports, with minor editing, with permission of Garry Schaefer.

1. **Soil Climate Analysis Network (SCAN) Fact Sheet**
   Garry L. Schaefer
   101 SE Main St., Suite 1600
   Portland, OR 97204
   and
   Ron F. Paetzold
   National Soil Survey Center
   Federal Building, Rm. 152, MS35
   100 Centennial Mall North
   Lincoln, NE 68508-3866

2. **Soil Moisture / Soil Temperature Pilot Project - A National Near-Real Time Monitoring Project**
   Garry L. Schaefer
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   Portland, OR 97204
   and
   Ronald D. Yeck and Ron F. Paetzold
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   Federal Building, Rm. 152, MS35
   100 Centennial Mall North
   Lincoln, NE 68508-3866

Soil Survey Staff. 2003. **Keys to Soil Taxonomy, Ninth Edition, 2003.** United States Department of Agriculture, Natural Resources Conservation Service.

APPENDICES

Appendix 1. 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 are in inches of water.
Air Temperature	Collected by a shielded thermistor in conjunction with Relative Humidity. Reported as current, hourly maximum, minimum, average and 24-hour (midnight to midnight) maximum, minimum, and average. Units are in degrees C.
Relative Humidity	Collected by a thin film capacitance-type sensor. Reported as current, and hourly maximum, and average. Units are 0-100 percent
Wind Speed and Direction	Collected by a propeller type anemometer. Reported as an hourly average and maximum. 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 are in watts/meter^2.
Barometric Pressure	Units are in inches of mercury.
Snow Water Content	Measured using a snow pillow device and a pressure transducer. Units are in inches of water. Measurements are taken at sites with snowpack.
Snow Depth	Measurement is done by using a sonic sensor. Units are in inches of depth. Measurements are not taken at all sites.
Soil Moisture	Collected by a dielectric constant measurement device. Reported as current, water volume fraction. Units are in percent (saturation is ~ 45 %). Typical measurements are at 2”, 4”, 8”, 20”, and 40” where possible. Metadata will specify exact depths.
Soil Temperature	Collected by a thermistor type of device. Reported as current temperature. Units are in degrees C. Typical measurements are at 2”, 4”, 8”, 20”, and 40” where possible. Metadata will specify exact depths.

Appendix 2. Sensor Label Descriptions used for Vermont SCAN stations

Sensor and Element Descriptions for site 2041, Mount Mansfield, Vermont

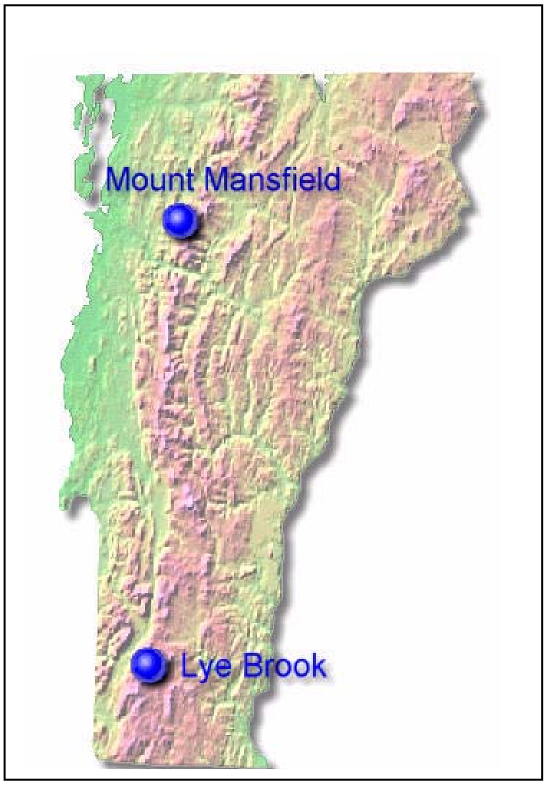
(As of: Wed Feb 08 12:56:09 PST 2006)

Label	Elem Code	Description	Units	Depth
BATCR	BATT	Battery-data logger	volt	0 unitless
PPCTB	PRCP	Incremental Pulse Count Precipitation	in	0 unitless
ATEC	TOBS	Air temperature - sampled 10 minutes	degC	0 unitless
ATEX	TMAX	Air temperature - sampled 10 minutes	degC	0 unitless
ATEN	TMIN	Air temperature - sampled 10 minutes	degC	0 unitless
ATEA	TAVG	Air temperature - sampled 10 minutes	degC	0 unitless
SOLAR	SRADV	Solar radiation average GCCP	watt/m2	0 unitless
WNDSA	WSPDV	Average wind speed - previous hour	mph	0 unitless
WNDDA	WDIRV	Average vector wind direction	degree	0 unitless
WSHX	WSPDX	Maximum wind speed	mph	0 unitless
RHC	RHUM	Relative humidity	pct	0 unitless
RHX	RHUMX	Relative humidity	pct	0 unitless
RHN	RHUMN	Relative humidity	pct	0 unitless
BPC	PRES	Barometric Pressure	inch_Hg	0 unitless
c1smv	SMS	Soil moisture - percent water by volume *	pct	2 inches
c1tmp	STO	Soil temperature	degC	2 inches
c1sal	SAL	Soil salinity	gram/l	2 inches
c1rdc	RDC	Soil real dielectric constant	unitless	2 inches
c2smv	SMS	Soil moisture - percent water by volume *	pct	4 inches
c2tmp	STO	Soil temperature	degC	4 inches
c2sal	SAL	Soil salinity	gram/l	4 inches
c2rdc	RDC	Soil real dielectric constant	unitless	4 inches
c3smv	SMS	Soil moisture - percent water by volume *	pct	8 inches

c3tmp	STO	Soil temperature	degC	8 inches
c3sal	SAL	Soil salinity	gram/l	8 inches
c3rdc	RDC	Soil real dielectric constant	unitless	8 inches
c4smv	SMS	Soil moisture - percent water by volume *	pct	20 inches
c4tmp	STO	Soil temperature	degC	20 inches
c4sal	SAL	Soil salinity	gram/l	20 inches
c4rdc	RDC	Soil real dielectric constant	unitless	20 inches
c5smv	SMS	Soil moisture - percent water by volume *	pct	40 inches
c5tmp	STO	Soil temperature	degC	40 inches
c5sal	SAL	Soil salinity	gram/l	40 inches
c5rdc	RDC	Soil real dielectric constant	unitless	40 inches
AT24X	TMAX	Air temperature - 24 hours	degC	0 unitless
AT24N	TMIN	Air temperature - 24 hours	degC	0 unitless
AT24A	TAVG	Air temperature - 24 hours	degC	0 unitless
WS24A	WSPDV	Wind speed-24 hours	mph	0 unitless
WD24A	WDIRV	Wind direction - previous 24 hours	degree	0 unitless
RHENC	RHUM	Internal Relative Humidity	pct	0 unitless
LBAT	BATT	Lithium battery for data logger backup	volt	0 unitless
PCPDY	PRCP	Incremental Precipitation total - previous day	in	0 unitless
PCPYR	PREC	Cumulative Precipitation total - Y T D	in	0 unitless

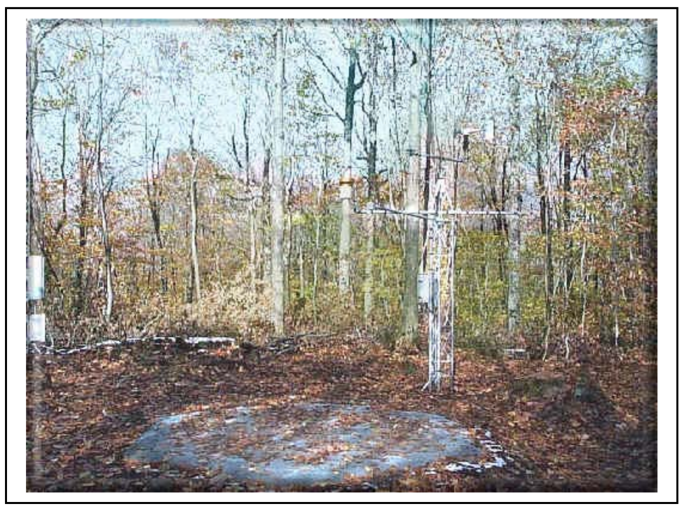
- * - Soil is generally considered to be saturated when the Percent Water by Volume is above 45 percent.
- Lye Brook: soil pit in forest opening is displayed by sensors c1 through c5; soil pit under forest canopy is displayed by sensors c6 through c10.

Appendix 3 . SCAN Web Site Screen Captures - Vermont Pages



State map with locations of SCAN stations

Mount Mansfield



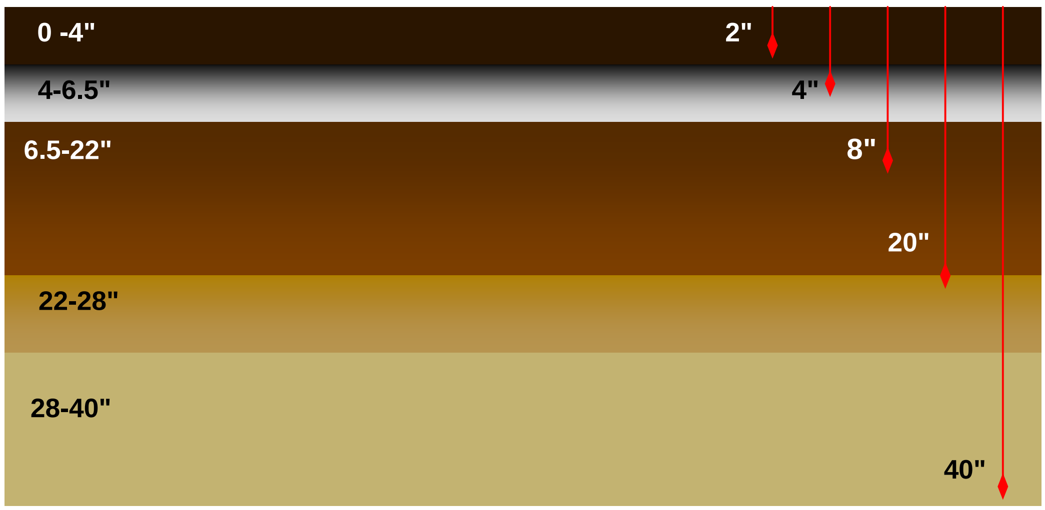
Lye Brook

Appendix 4a. Soil Description at Lye Brook Wilderness (under forest canopy)

Soil type: Mundal — **File No. VT003-02-919-1**
Area: Lye Brook VMC site, Lye Brook Wilderness, near Lye Road Soil Monitoring Plot — **Date**: July 27, 2005
Classification: Coarse-loamy, mixed, frigid Aquic Haplorthods (out of date classification)
Location: SCAN Site 2042 – probes in soil under forest canopy
Vegetation: mostly sugar maple and beech, with striped maple and a few red spruce
Parent Material: Compact Glacial Till
Physiography: Glaciated Upland
Relief : knoll, smooth — **Drainage:** Moderately Well — **Gr. water**: not observed above 40"
Elevation: 2430' — **Slope:** approx 5% — **Aspect:** SW

Additional Notes:

Sketch of Hydra probe placement in the soil profile:



- Hydra probes installed at 2, 4, 8, 20, and 40 inches.
- Soil pit with probes relocated in July 2005: location is 4 feet west of the “stack” (metal post with box), and just south of a large white stone. Stack is about 50 feet southwest of taller antenna tower. Shielded cable runs from tower to stack and a separate shielded 5-cable set runs from stack to sensors, buried about 3 to 5 inches under ground.
- SCAN site is east (upslope) of long-term soil monitoring plot.
- Installation of probes and soil description by Thom Villars, NRCS, White River Junction, VT.
- Soil profile graphic developed by Joe Homer, NRCS, Lancaster, NH.
- Small sample bags taken of Oa and mineral horizons for storage in WRJ office.

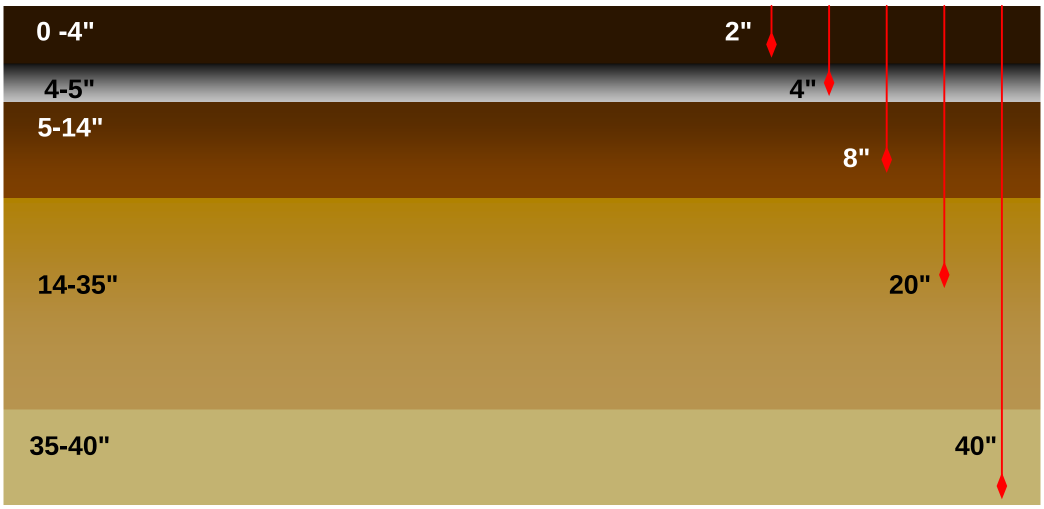
Hori -zon	Depth, inches	Redox Color	Soil Color, Moist	Texture	Structure	Consis-tence	pH	Boun -dary	% Frags	Roots
Oi/e	0-1.5	slightly to moderately decomposed leaves and twigs						as		many vf-co
Oa	1.5-4	black, well decomposed organic materials				vfr		as		many vf-vco
E	4-6.5		5YR 5/2	fsl	2mgr	fr		aw	5	com f-co
Bhs1	6.5-8.5		7.5YR 2.5/2	fsl	2mgr	fr		aw	5	com f-co
Bhs2	8.5-22		7.5YR 3/2	fsl	2msbk	fr		cw	5	com f-co
BC	22-28	c2p 7.5YR 4/6 iron coatings	10YR 5/6	fsl	1mpl to 2msbk	Slightly firm		cw	5	few med
Cd	28-40+		2.5Y 5/4	fsl	1mpl	firm			5	

Appendix 4b. Soil Description at Lye Brook Wilderness (in forest opening)

Soil type: Mundal **File No. VT003-00-914-1**
Area: Lye Brook VMC site, Lye Brook Wilderness, near Lye Road Soil Monitoring Plot **Date**: July 27, 2005
Classification: Coarse-loamy, mixed, frigid Aquic Haplorthods (out of date classification)
Location: SCAN Site 2042 – probes in soil in forest opening
Vegetation: mostly sugar maple, with beech, striped maple, and a few red spruce
Parent Material: Compact Glacial Till
Physiography: Glaciated Upland
Relief : knoll, smooth **Drainage:** Moderately Well **Gr. water**: not observed above 40"
Elevation: 2435' **Slope:** 6% **Aspect:** NNW

Additional Notes:

Sketch of Hydra probe placement in the soil profile:



- Hydra probes installed at 2, 4, 8, 20, and 40 inches.
- Soil pit with probes relocated in July 2005: location is still about 7 feet south-southwest of taller antenna tower. Five unshielded black cables run from tower to sensors.
- SCAN site is east (upslope) of long-term soil monitoring plot.
- Soil described by Thom Villars; installation of probes by TV with Bill Woolcock and Ricky Henderson, National Water and Climate Center.
- Soil profile graphic developed by Joe Homer, Lancaster, NH.

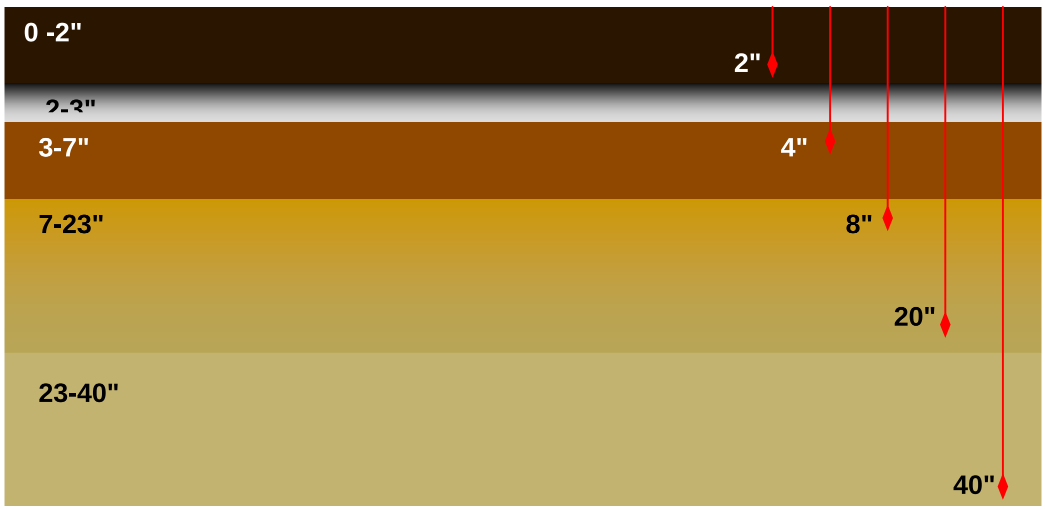
Hori -zon	Depth, inches	Redox Color	Soil Color, Moist	Texture	Structure	Consis- tence	pH	Boun -dary	% Frags	Roots
Oe	0-1	Partially decomposed leaves, needles, & twigs						as		
Oa	1-4	Well decomposed organic materials				vfr		ab		
(A)	(1-4)		7.5YR 2.5/2	fsl	2mgr	vfr	5.2	ab	NA	NA
E	4-5		7.5YR 6/2	fsl	2mgr	fr	5.2	as		
Bhs1	5-6		5YR 2.5/1	fsl, ms	2mgr	fr	4.8	as		
Bhs2	6-14		7.5YR 2.5/2	fsl, ms	1msbk	fr		cs		
Bs	14-29	c3p 7.5YR 3/2 Organic Stains	10YR 4/3	fsl, ws	2msbk	fr		gs		
BC	29-35		10YR 4/4	fsl	2msbk	fr		gs		
Cd	35-40	f2d 2.5Y 5/2	2.5Y 5/4	fsl	massive	fi to fr				

Appendix 5. Soil Description at Mount Mansfield (Underhill State Park)

Soil type: Peru
File No. VT007-00-912-1
Area: Mt. Mansfield VMC site, Underhill State Park, Polka Dot Trail Soil Monitoring Plot
Date: September 12, 2000
Classification: Coarse-loamy, isotic, frigid Aquic Haplorthods
Location: SCAN Site 2041
Vegetation: mostly yellow birch, with beech, balsam fir, striped maple
Parent Material: Compact Glacial Till
Physiography: Glaciated Upland
Relief : toeslope, smooth
Drainage: Moderately Well
Gr. water: not observed above 40"
Elevation: 2236'
Slope: 10-12%
Aspect: South

Additional Notes:

Sketch of Hydra probe placement in the soil profile:



- Hydra probes installed at 2, 4, 8, 20, and 40 inches.
- Soil pit with probes is about 7 feet north and a little east of taller (western) antenna tower. Cable runs from tower to probes.
- SCAN site is south (downslope) of Polka Dot long-term soil monitoring plot.
- Soil described by Thom Villars; installation of probes by Ron Paetzold, National Water and Climate Center.
- Soil profile graphic developed by Joe Homer, Lancaster, NH.

Hori -zon	Depth, inches	Redox Color	Soil Color, Moist	Texture	Structure	Consis- tence	pH	Boun -dary	% Frags	Roots
Oi	1 - 0	Undecomposed leaves, needles, and twigs						as		
Oa	0-1	Moderately decomposed organic materials						as		
A	1-2		5YR 2.5/2	vfsl	1vfgr	vfr	NA	as	NA	NA
E	2-3		7.5YR 4/2	vfsl	1fgr	vfr		as		
Bs1	3-7		7.5YR 4/4	vfsl	2mgr	fr		cs		
Bs2	7-17		10YR 4/4	vfsl	2mgr	fr		cs		
BC	17-23	c2p 5Y 6/2	2.5Y 4/3	fsl	1msbk	fr		cs		
Cd	23-40	similar to BC	similar to BC	fsl	2mpl	firm				

Appendix 6. Vermont Monitoring Cooperative Long-Term Soil Monitoring Plots co-located with SCAN sites					
VMC Long Term Monitoring Plot Name	**Elevation (m)**	**Soil series**	**Taxonomic classification**	**Vegetation type**	**General comments**
Lye Road, Lye Brook Wilderness	739	Mundal	Coarse-loamy, mixed, frigid, Aquic Haplorthods	Beech-sugar maple-yellow birch	Co-located with Lye Brook SCAN site
Polka Dot Site, Underhill State Park, Mt. Mansfield	695	Peru	Coarse-loamy, mixed, frigid, Aquic Haplorthods	Yellow birch-balsam fir	Co-located with Mt. Mansfield SCAN site

Appendix 7. Photographs of Vermont SCAN sites

A. Lye Brook

Left: Lye Brook site under construction in September 2000. Right: Don Huffman of the National Water and Climate Center works on the solar panels on the transmission antenna at Lye Brook.

B. Mt. Mansfield (Underhill State Park)

Staff with Vermont Agency of Natural Resources, USDA Forest Service, and USDA Natural Resources Conservation Service help to install snow pillow at Mt. Mansfield SCAN site.

Detail of meteorological tower.

Snow pillow is filled with non-freezing liquid and is designed to measure weight and depth of snow in order to calculate snow density and water content.

Mt. Mansfield site installation nearing completion in September 2000.

Appendix 8. Monthly Data Summaries

Lye Brook, Vermont, SCAN Monthly Averages for 2001-2005
1. For soil sensors located in forest opening (sunny site)
Precipitation = Inches
ST = Soil Temperature in Degrees Celsius
SM = Volumetric Soil Moisture by Percent (45% = approx. 100% saturation)

Month		Precip.	Air Temp.	Snow Depth	2" Open ST	4" Open ST	8" Open ST	20" Open ST	40" Open ST	2" Open SM	4" Open SM	8" Open SM	20" Open SM	40" Open SM
October	Average	2.84	5.9	3.6	7.9	7.6	8.2	9.2	9.7	36.1	35.4	37.5	30.7	21.8
	Yrs. of Data	5	5	2	4	4	4	4	4	4	4	4	4	4
November	Average	3.91	1.3	2.6	4.1	3.9	4.5	5.8	6.8	36.0	34.9	37.3	30.7	26.6
	Yrs. of Data	5	5	2	4	4	4	4	4	4	4	4	4	4
December	Average	2.43	-5.6	8.2	2.3	2.1	2.8	4.2	5.2	35.0	34.3	36.9	29.9	25.2
	Yrs. of Data	4	4	2	3	3	3	3	3	3	3	3	3	3
January	Average	1.51	-8.7	18.1	1.5	1.2	1.8	2.9	3.9	32.2	32.5	35.6	27.4	19.9
	Yrs. of Data	3	3	1	2	2	2	2	2	2	2	2	2	2
February	Average	2.28	-6.9	42.6	1.4	1.1	1.6	2.5	3.3	32.2	32.4	35.4	27.9	20.8
	Yrs. of Data	3	3	1	3	3	3	3	3	3	3	3	3	3
March	Average	2.62	-2.9	42.6	1.3	0.9	1.3	2.1	2.8	35.7	34.9	37.2	31.4	27.0
	Yrs. of Data	3	3	1	3	3	3	3	3	3	3	3	3	3
April	Average	2.75	4.3	13.2	2.9	2.2	2.4	2.6	2.8	37.9	36.6	38.6	36.3	38.1
	Yrs. of Data	4	4	1	3	3	3	3	3	3	3	3	3	3
May	Average	4.14	9.0	4.9	9.3	8.0	7.6	6.2	5.2	37.7	36.8	38.6	35.2	38.1
	Yrs. of Data	4	4	1	3	3	3	3	3	3	3	3	3	3
June	Average	4.21	15.5	0.0	14.7	13.2	12.6	10.5	8.6	37.0	36.3	38.2	33.6	33.8
	Yrs. of Data	4	4	1	3	3	3	3	3	3	3	3	3	3
July	Average	1.06	16.8	0.0	16.4	15.4	15.0	13.2	11.5	35.2	34.0	34.6	27.3	25.3
	Yrs. of Data	5	5	3	5	5	5	5	5	5	5	5	5	5
August	Average	1.79	17.3	0.0	17.1	16.2	15.8	14.4	12.8	34.5	33.3	34.4	27.7	26.6
	Yrs. of Data	4	5	3	5	5	5	5	5	5	5	5	5	5
September	Average	1.12	12.4	0.0	13.4	13.0	13.1	12.8	12.1	35.3	34.5	35.6	28.5	23.8
	Yrs. of Data	5	5	2	5	5	5	5	5	5	5	5	5	5

Month	Precip.	Air Temp.	Snow Depth	2" Open ST	4" Open ST	8" Open ST	20" Open ST	40" Open ST	2" Open SM	4" Open SM	8" Open SM	20" Open SM	40" Open SM
October	2.84	5.9	3.6	7.9	7.6	8.2	9.2	9.7	36.1	35.4	37.5	30.7	21.8
November	3.91	1.3	2.6	4.1	3.9	4.5	5.8	6.8	36.0	34.9	37.3	30.7	26.6
December	2.43	-5.6	8.2	2.3	2.1	2.8	4.2	5.2	35.0	34.3	36.9	29.9	25.2
January	1.51	-8.7	18.1	1.5	1.2	1.8	2.9	3.9	32.2	32.5	35.6	27.4	19.9
February	2.28	-6.9	42.6	1.4	1.1	1.6	2.5	3.3	32.2	32.4	35.4	27.9	20.8
March	2.62	-2.9	42.6	1.3	0.9	1.3	2.1	2.8	35.7	34.9	37.2	31.4	27.0
April	2.75	4.3	13.2	2.9	2.2	2.4	2.6	2.8	37.9	36.6	38.6	36.3	38.1
May	4.14	9.0	4.9	9.3	8.0	7.6	6.2	5.2	37.7	36.8	38.6	35.2	38.1
June	4.21	15.5	0.0	14.7	13.2	12.6	10.5	8.6	37.0	36.3	38.2	33.6	33.8
July	1.06	16.8	0.0	16.4	15.4	15.0	13.2	11.5	35.2	34.0	34.6	27.3	25.3
August	1.79	17.3	0.0	17.1	16.2	15.8	14.4	12.8	34.5	33.3	34.4	27.7	26.6
September	1.12	12.4	0.0	13.4	13.0	13.1	12.8	12.1	35.3	34.5	35.6	28.5	23.8
Mean Annual Soil Temperature							7.2						

Lye Brook, Vermont, SCAN Monthly Averages for 2001-2005

2. For soil sensors located under the forest canopy (shady site)

ST = Soil Temperature in Degrees Celsius

SM = Volumetric Soil Moisture by Percent (45% = approx. 100% saturation)

Month		2" Canopy ST	4" Canopy ST	8" Canopy ST	20" Canopy ST	40" Canopy ST	2" Canopy SM	4" Canopy SM	8" Canopy SM	20" Canopy SM	40" Canopy SM
October	Average	7.2	7.6	8.0	9.0	9.4	24.4	34.9	39.7	23.8	25.1
	Yrs. of Data	2	2	2	2	2	2	2	2	2	2
November	Average	3.4	3.9	4.4	5.5	6.1	26.6	34.6	39.6	28.8	31.3
	Yrs. of Data	2	2	2	2	2	2	2	2	2	2
December	Average	1.3	1.9	2.4	3.7	4.4	26.4	33.7	39.3	25.9	28.7
	Yrs. of Data	2	2	2	2	2	2	2	2	2	2
January	Average	0.9	1.4	1.8	2.7	3.9	26.9	37.4	40.8	20.5	25.4
	Yrs. of Data	1	1	1	1	1	1	1	1	1	1
February	Average	0.8	1.1	1.5	2.3	3.4	27.2	36.9	40.3	20.2	20.4
	Yrs. of Data	1	1	1	1	1	1	1	1	1	1
March	Average	0.6	0.9	1.2	1.8	2.9	31.8	34.2	39.4	29.2	23.3
	Yrs. of Data	1	1	1	1	1	1	1	1	1	1
April	Average	2.0	1.8	1.9	1.9	2.7	32.3	37.3	40.6	39.3	27.7
	Yrs. of Data	1	1	1	1	1	1	1	1	1	1
May	Average	8.5	7.9	7.5	6.4	5.9	27.5	36.2	40.1	34.3	30.0
	Yrs. of Data	1	1	1	1	1	1	1	1	1	1
June	Average	12.4	11.5	11.0	9.3	8.4	24.4	33.7	39.1	23.9	23.9
	Yrs. of Data	1	1	1	1	1	1	1	1	1	1
July	Average	14.9	14.4	14.0	12.4	11.1	22.1	27.9	34.9	21.8	23.0
	Yrs. of Data	3	3	3	3	3	3	3	3	3	3
August	Average	15.6	15.3	14.9	13.6	12.4	22.5	28.4	35.3	25.4	28.8
	Yrs. of Data	3	3	3	3	3	3	3	3	3	3
September	Average	13.1	13.2	13.2	12.8	12.1	20.0	25.7	34.1	23.1	27.1
	Yrs. of Data	2	2	2	2	2	2	2	2	2	2

Month	2" Canopy ST	4" Canopy ST	8" Canopy ST	20" Canopy ST	40" Canopy ST	2" Canopy SM	4" Canopy SM	8" Canopy SM	20" Canopy SM	40" Canopy SM
October	7.2	7.6	8.0	9.0	9.4	24.2	34.4	39.3	23.5	24.8
November	3.4	3.9	4.4	5.5	6.1	26.6	34.6	39.6	28.8	31.3
December	1.3	1.9	2.4	3.7	4.4	26.4	33.7	39.3	25.9	28.7
January	0.9	1.4	1.8	2.7	3.9	26.9	37.4	40.8	20.5	25.4
February	0.8	1.1	1.5	2.3	3.4	27.2	36.9	40.3	20.2	20.4
March	0.6	0.9	1.2	1.8	2.9	31.8	34.2	39.4	29.2	23.3
April	2.0	1.8	1.9	1.9	2.7	32.3	37.3	40.6	39.3	27.7
May	8.5	7.9	7.5	6.4	5.9	27.5	36.2	40.1	34.3	30.0
June	12.4	11.5	11.0	9.3	8.4	24.4	33.7	39.1	23.9	23.9
July	14.9	14.4	14.0	12.4	11.1	22.1	27.9	34.9	21.8	23.0
August	15.6	15.3	14.9	13.6	12.4	22.5	28.4	35.3	25.4	28.8
September	13.1	13.2	13.2	12.8	12.1	20.0	25.7	34.1	23.1	27.1
Mean Annual Soil Temperature				6.8						

<u>Mount Mansfield, Vermont, SCAN Monthly Averages for 2000-2005</u>

Precipitation = Inches
Temperatures are in degrees Celsius (ST =Soil Temperature)
Soil moisture (SM) = Volumetric Soil Moisture by Percent (45% = approx. 100% saturation)

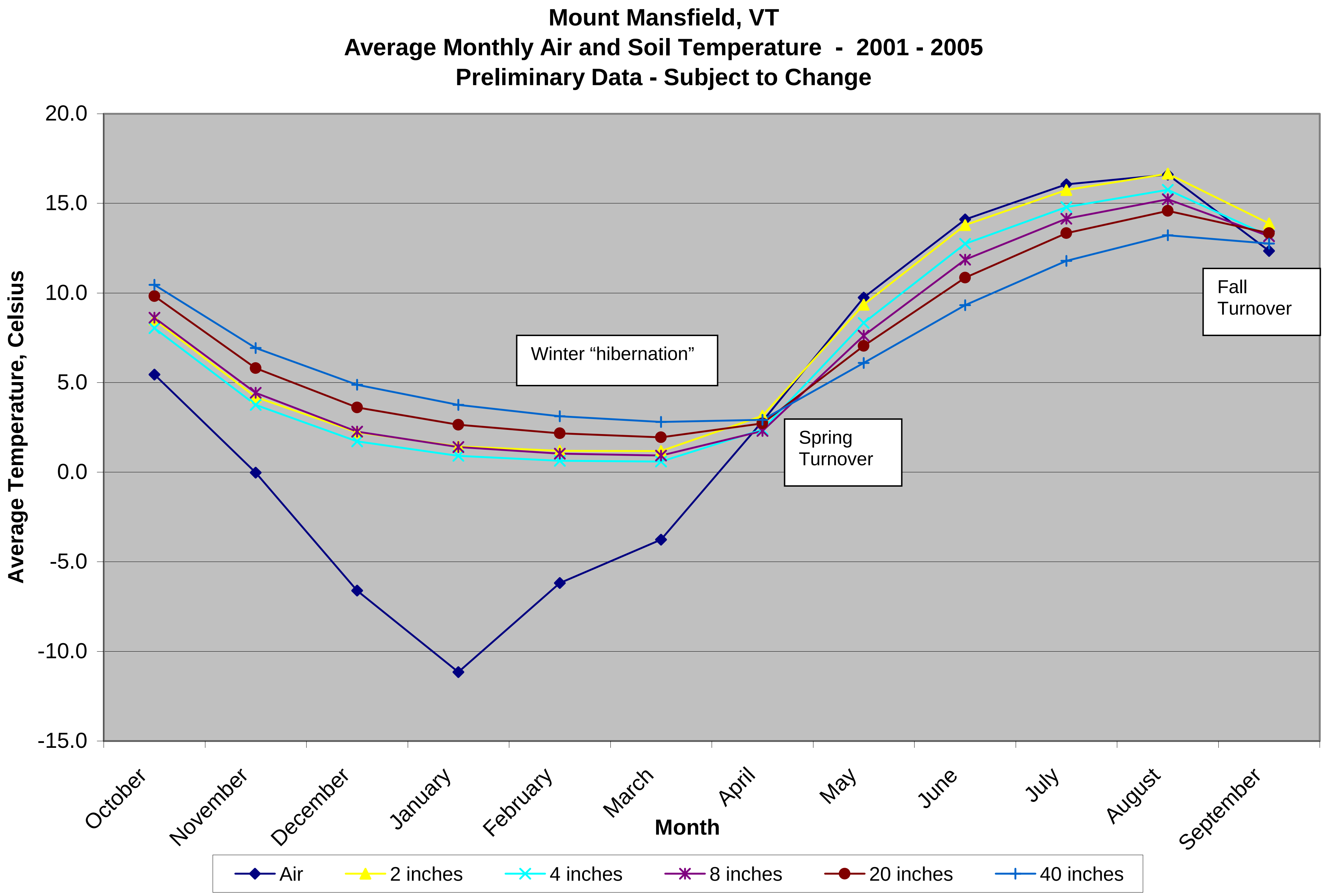
Month		Precipitation	Air Temp.	Snow Depth	2" ST	4" ST	8" ST	20" ST	40" ST	2" SM	4" SM	8" SM	20" SM	40" SM
October	**Average**	3.86	5.5	1.7	8.5	8.0	8.6	9.8	10.5	29.7	36.0	39.6	37.3	30.5
	Yrs. of Data	5	5	4	5	5	5	5	5	5	5	5	5	5
November	**Average**	4.41	0.0	3.6	4.2	3.8	4.4	5.8	6.9	34.1	39.3	41.1	39.4	36.1
	Yrs. of Data	5	5	5	5	5	5	5	5	5	5	5	5	5
December	**Average**	3.55	-6.6	13.3	2.2	1.7	2.3	3.6	4.9	32.8	38.4	40.3	38.0	35.0
	Yrs. of Data	5	5	3	5	5	5	5	5	5	5	5	5	5
January	**Average**	0.65	-11.2	18.6	1.4	0.9	1.4	2.6	3.8	30.3	36.4	39.6	36.6	31.2
	Yrs. of Data	5	5	5	5	5	5	5	5	5	5	5	5	5
February	**Average**	1.52	-6.2	22.2	1.2	0.6	1.0	2.2	3.1	29.4	35.6	39.4	36.4	29.7
	Yrs. of Data	5	5	5	5	5	5	5	5	5	5	5	5	5
March	**Average**	2.03	-3.8	23.4	1.2	0.6	0.9	1.9	2.8	31.5	36.8	39.7	37.3	31.1
	Yrs. of Data	5	4	5	5	5	5	5	5	5	5	5	5	5
April	**Average**	3.50	2.8	4.7	3.1	2.4	2.3	2.7	2.9	37.2	40.2	40.9	39.7	37.4
	Yrs. of Data	5	4	5	5	5	5	5	5	5	5	5	5	5
May	**Average**	3.05	9.7	0.0	9.3	8.3	7.6	7.0	6.1	34.8	39.3	41.1	39.1	38.3
	Yrs. of Data	5	4	4	5	5	5	5	5	5	5	5	5	5
June	**Average**	2.79	14.1	0.0	13.8	12.7	11.9	10.8	9.3	31.6	37.0	39.7	37.5	35.1
	Yrs. of Data	5	4	4	5	5	5	5	5	5	5	5	5	5
July	**Average**	5.17	16.1	0.0	15.7	14.8	14.1	13.3	11.8	26.5	33.1	37.7	35.6	30.1
	Yrs. of Data	5	4	4	5	5	5	5	5	5	5	5	5	5
August	**Average**	5.21	16.6	0.0	16.7	15.8	15.2	14.6	13.2	18.7	26.3	34.0	34.2	27.9
	Yrs. of Data	5	5	4	5	5	5	5	5	5	5	5	5	5
September	**Average**	2.66	12.4	0.0	13.9	13.2	13.2	13.3	12.8	24.2	31.3	36.5	34.8	26.9
	Yrs. of Data*	6	6	4	6	6	6	6	6	6	6	6	6	6

*** - data collection began in September 2000**

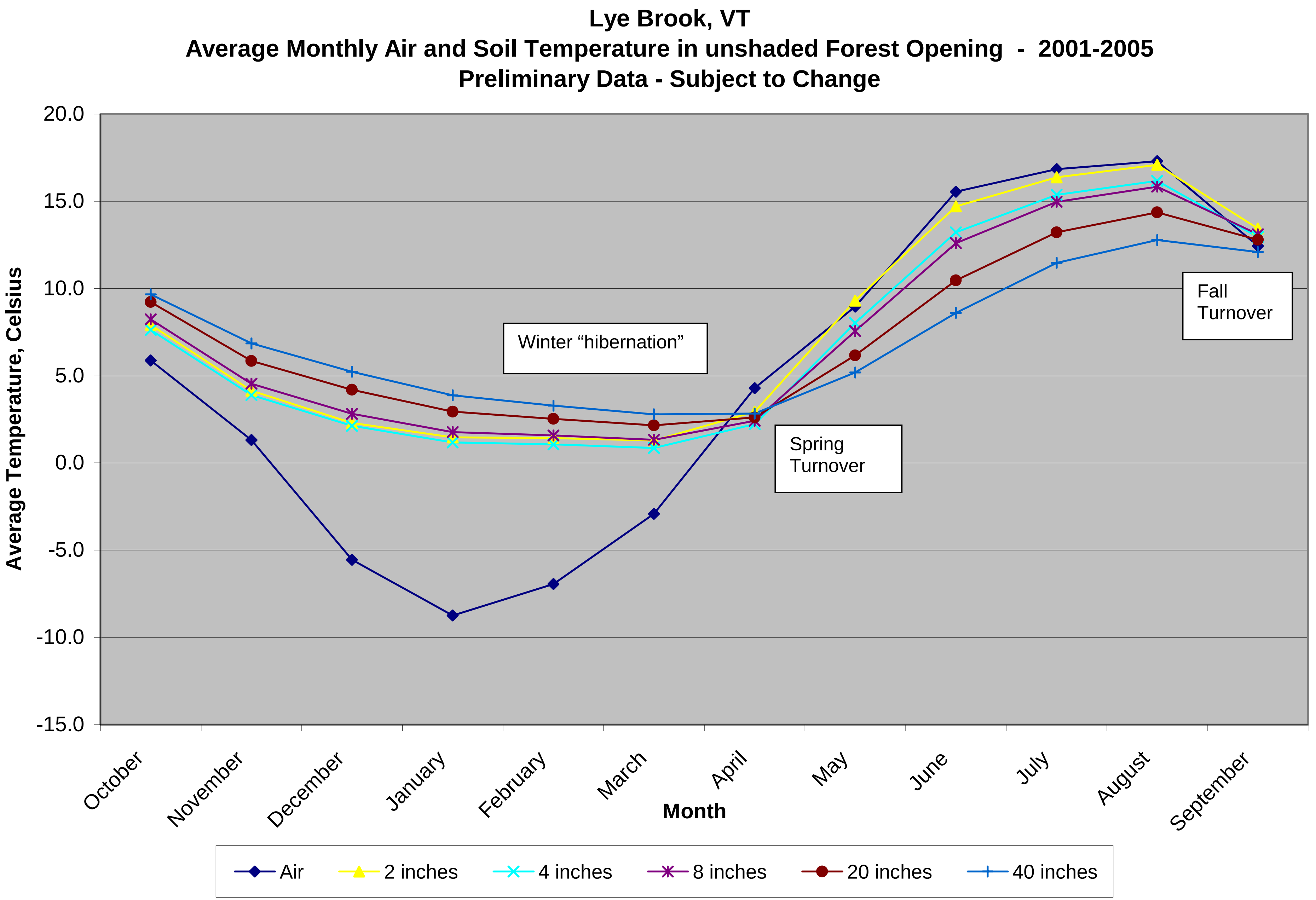
Month	Precipitation	Air Temp.	Snow Depth	2" ST	4" ST	8" ST	20" ST	40" ST	2" SM	4" SM	8" SM	20" SM	40" SM
October	3.86	5.5	1.7	8.5	8.0	8.6	9.8	10.5	29.7	36.0	39.6	37.3	30.5
November	4.41	0.0	3.6	4.2	3.8	4.4	5.8	6.9	34.1	39.3	41.1	39.4	36.1
December	3.55	-6.6	13.3	2.2	1.7	2.3	3.6	4.9	32.8	38.4	40.3	38.0	35.0
January	0.65	-11.2	18.6	1.4	0.9	1.4	2.6	3.8	30.3	36.4	39.6	36.6	31.2
February	1.52	-6.2	22.2	1.2	0.6	1.0	2.2	3.1	29.4	35.6	39.4	36.4	29.7
March	2.03	-3.8	23.4	1.2	0.6	0.9	1.9	2.8	31.5	36.8	39.7	37.3	31.1
April	3.50	2.8	4.7	3.1	2.4	2.3	2.7	2.9	37.2	40.2	40.9	39.7	37.4
May	3.05	9.7	0.0	9.3	8.3	7.6	7.0	6.1	34.8	39.3	41.1	39.1	38.3
June	2.79	14.1	0.0	13.8	12.7	11.9	10.8	9.3	31.6	37.0	39.7	37.5	35.1
July	5.17	16.1	0.0	15.7	14.8	14.1	13.3	11.8	26.5	33.1	37.7	35.6	30.1
August	5.21	16.6	0.0	16.7	15.8	15.2	14.6	13.2	18.7	26.3	34.0	34.2	27.9
September	2.66	12.4	0.0	13.9	13.2	13.2	13.3	12.8	24.2	31.3	36.5	34.8	26.9
Mean Annual Soil Temperature							7.3						

Appendix 9. Graphs of Vermont SCAN Data

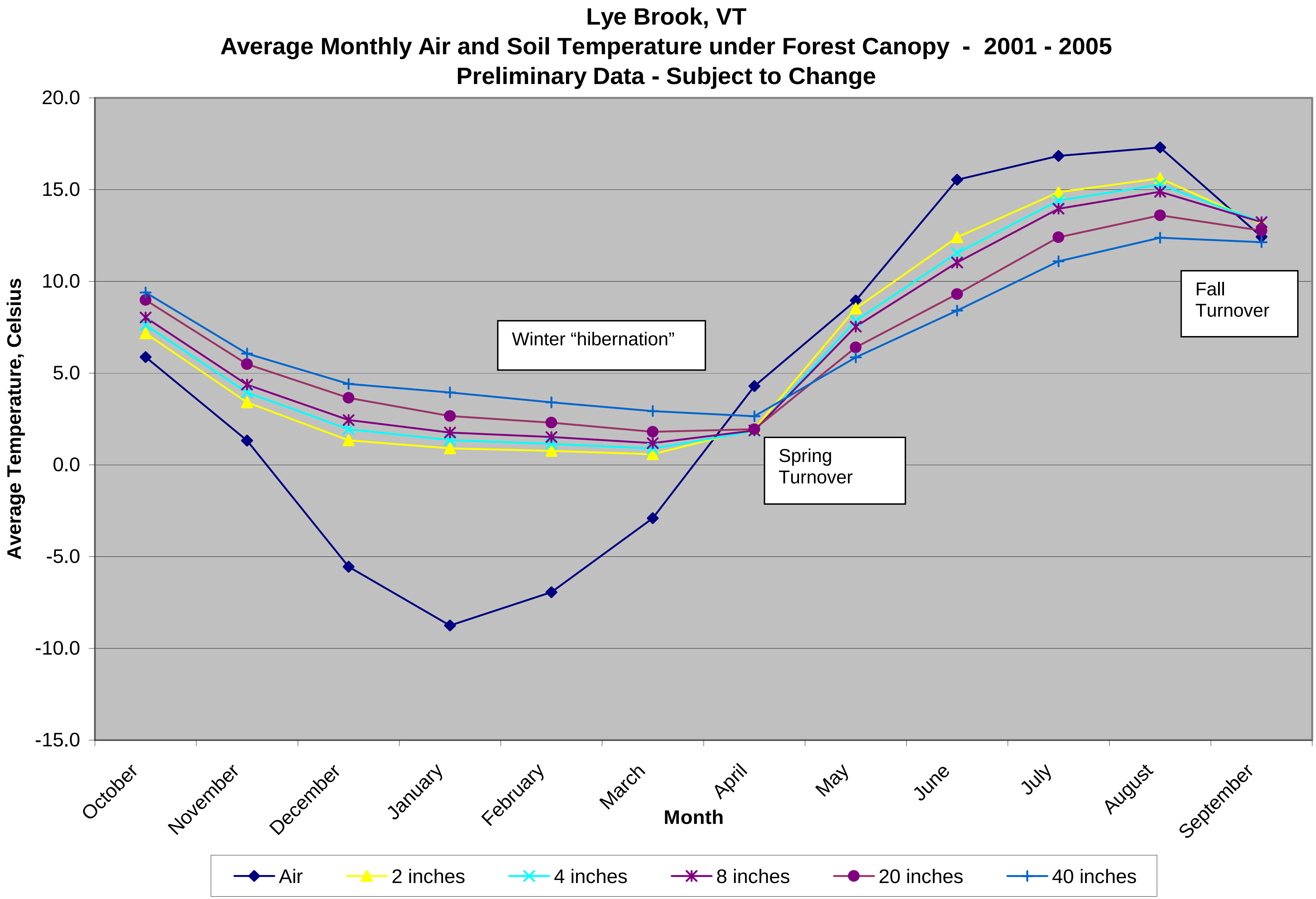
1. Mount Mansfield – Average Monthly Air and Soil Temperature



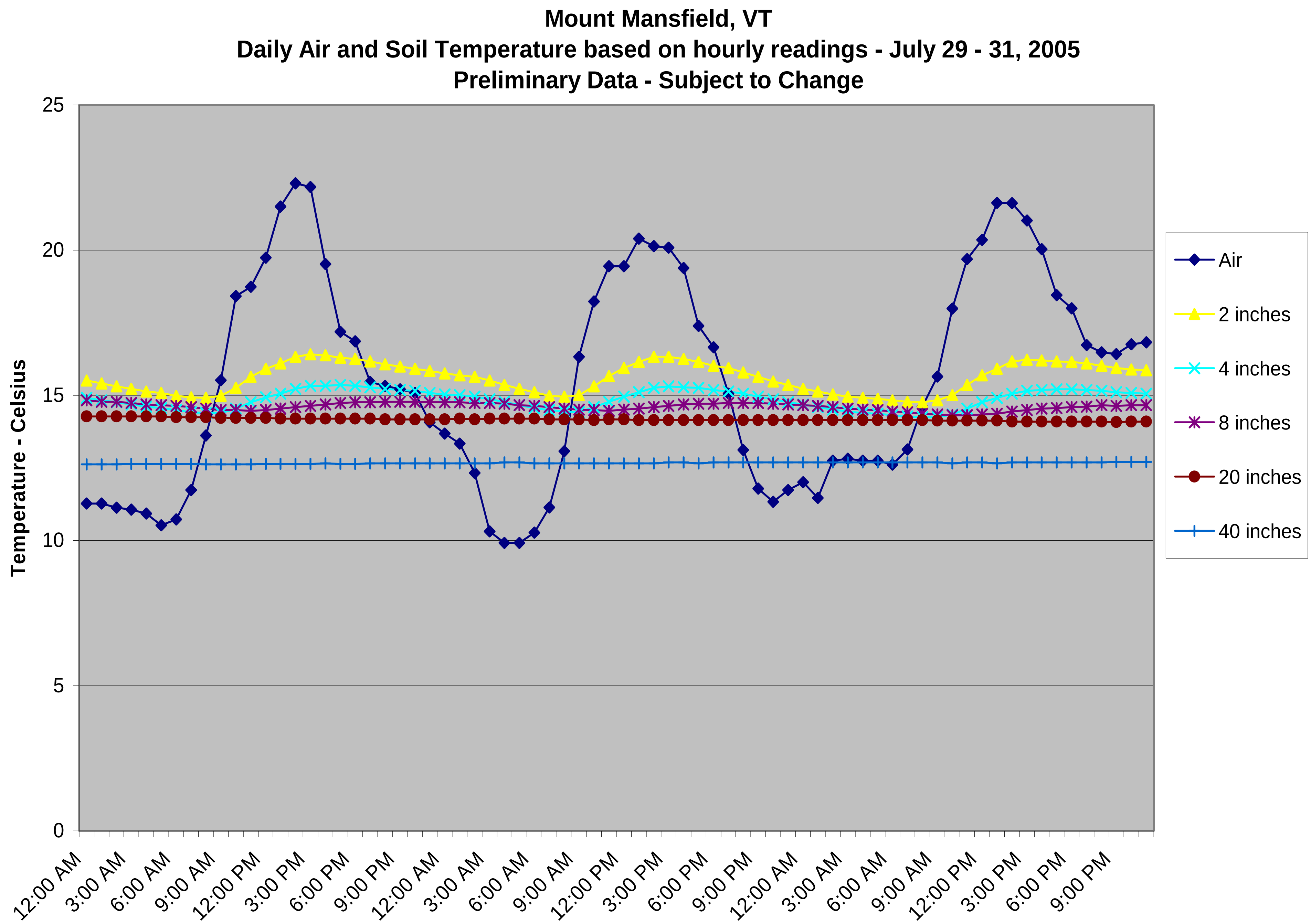
2. Lye Brook – Average Monthly Air and Soil Temperature in forest opening



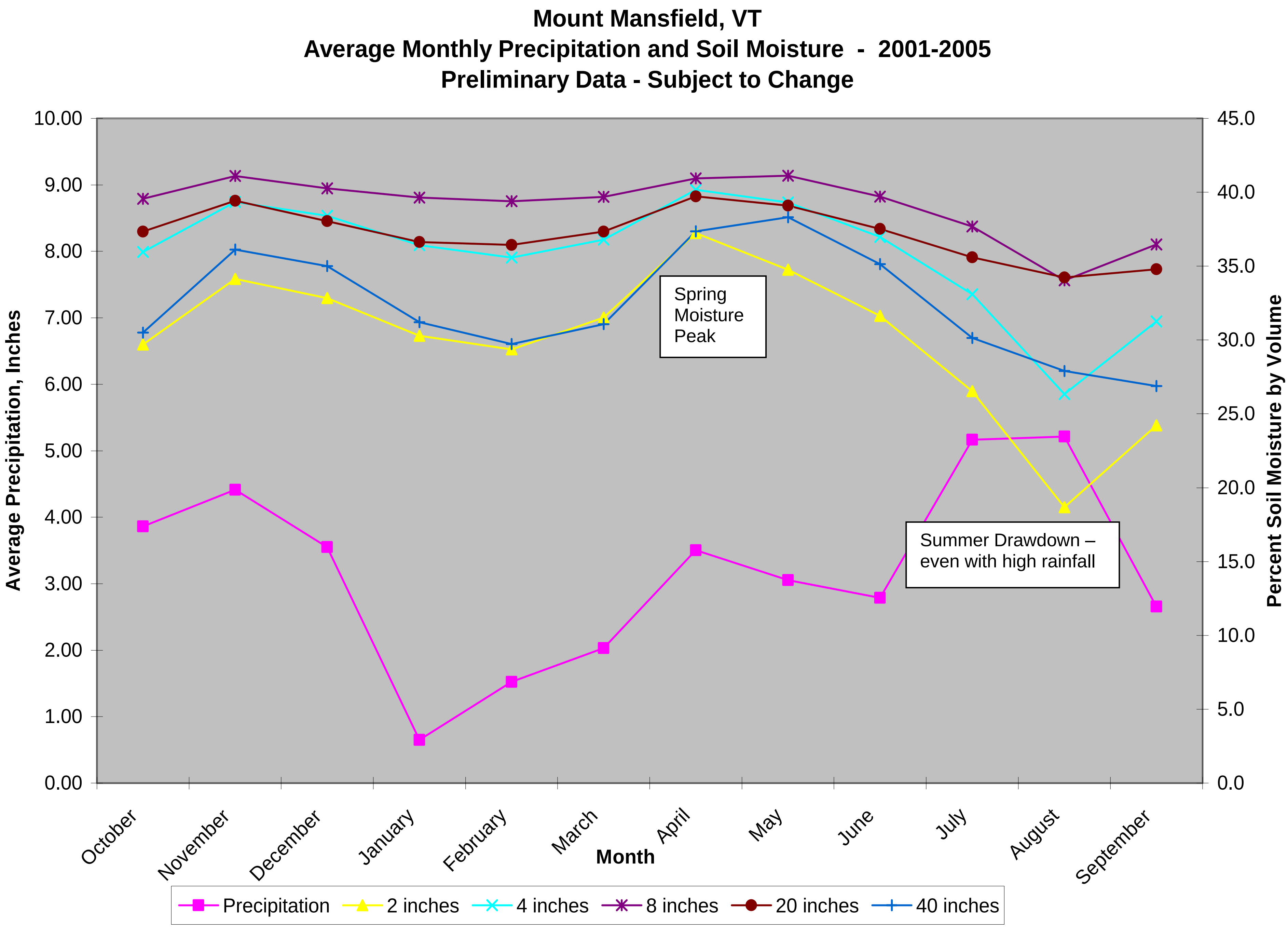
3. Lye Brook – Average Monthly Air and Soil Temperature under forest canopy



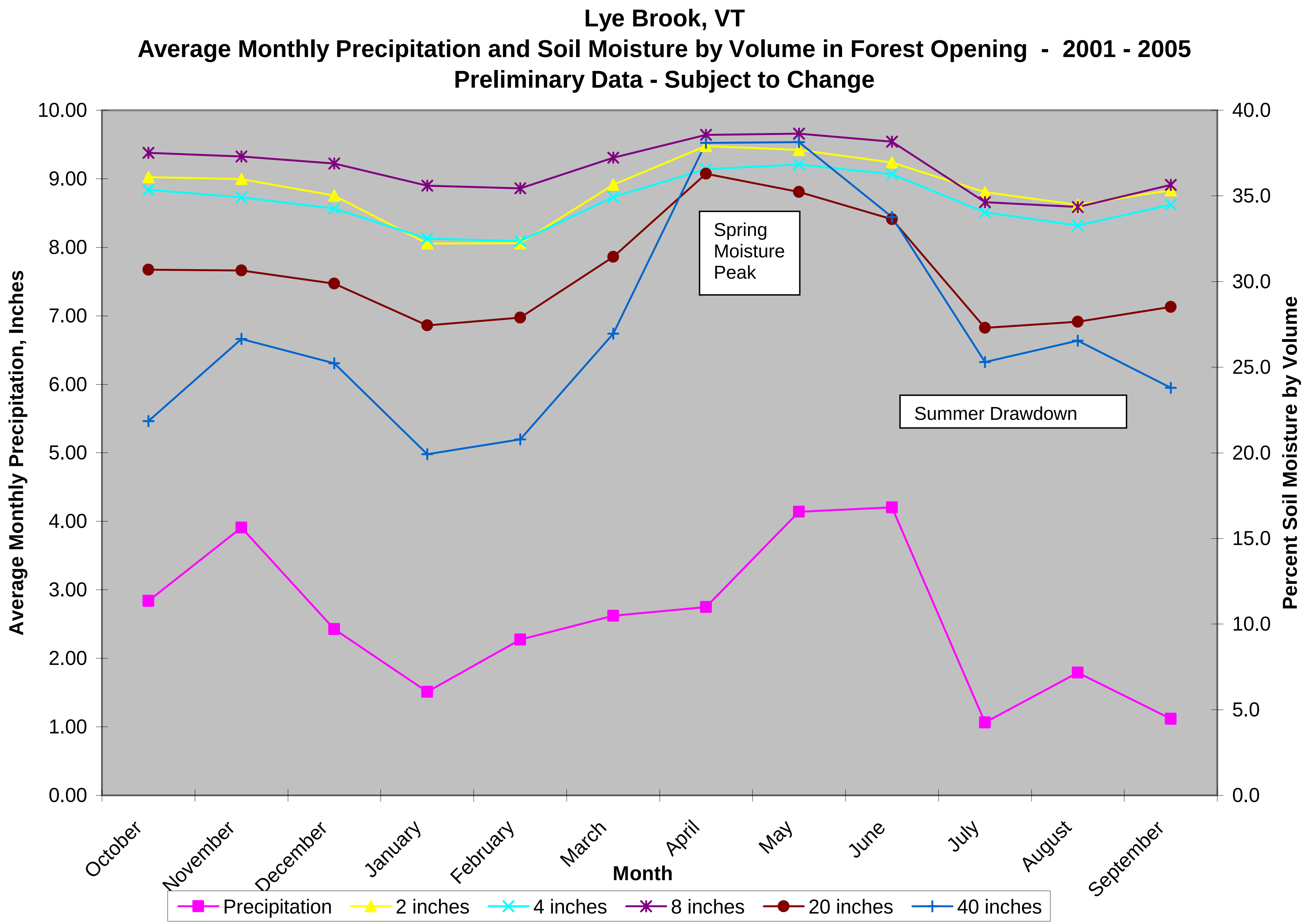
4. Mount Mansfield – Daily Air and Soil Temperature variation based on hourly readings, 12:00am, July 29 – 11:00pm, July 31, 2005



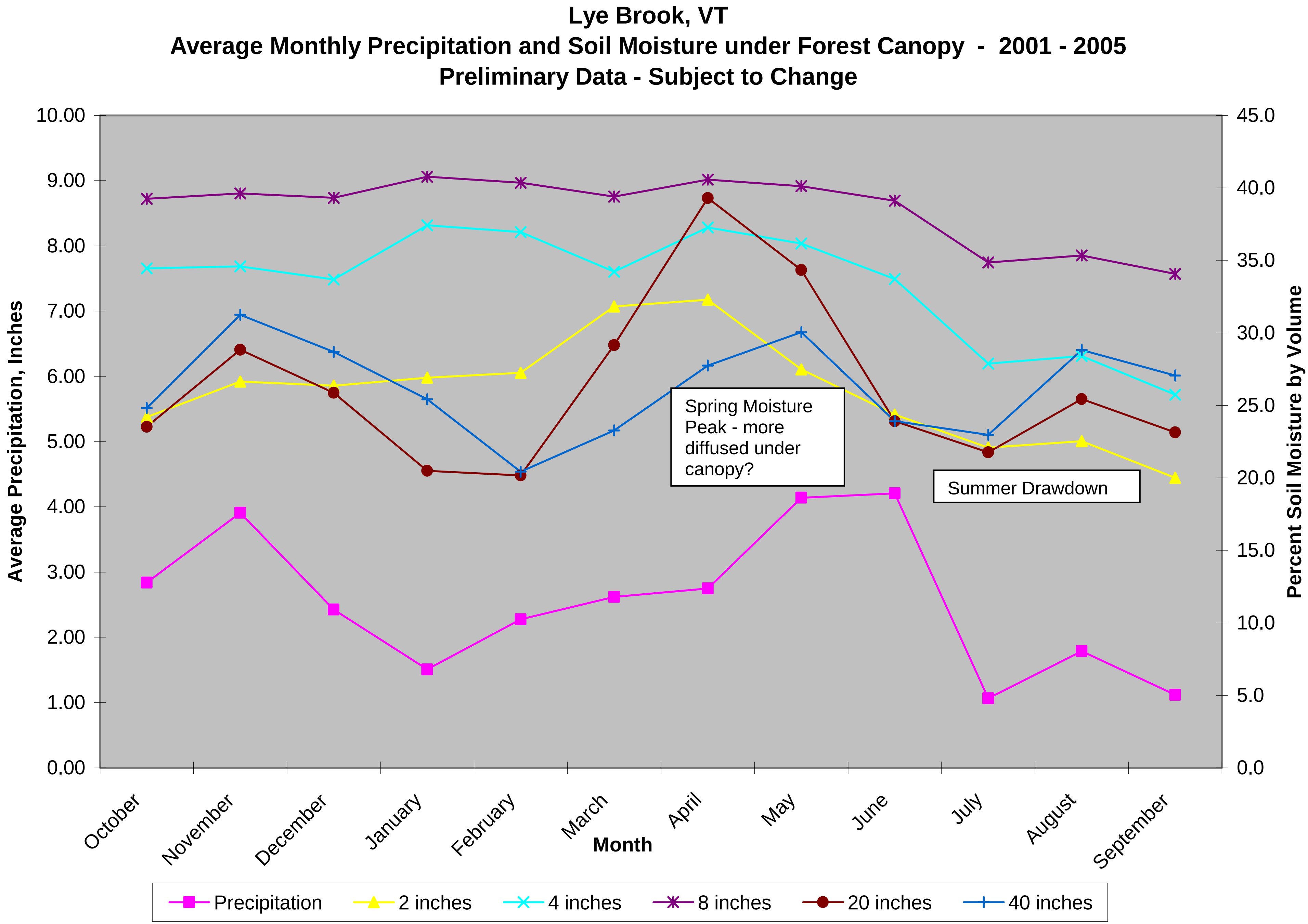
5. Mount Mansfield – Average Monthly Precipitation and Soil Moisture



6. Lye Brook – Average Monthly Precipitation and Soil Moisture in unshaded forest opening



7. Lye Brook – Average Monthly Precipitation and Soil Moisture under forest canopy



8. Mount Mansfield: Hurricane Katrina – Its Effect on Hourly Precipitation and Soil Moisture, August 30 – September 1, 2005