

METEOROLOGICAL AND DEPOSITION CHEMISTRY MONITORING

- 1992 -

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COOPERATORS

UVM Proctor Maple Research Center (PMRC), VT Dept. of Environmental Conservation (DEC), WCAX-TV staff at Mt. Mansfield transmitter station, National Atmospheric Deposition Program (NADP), US Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), University of Michigan Air Quality Laboratory, Lake Champlain Research Consortium (LCRC), National Weather Service (NWS), and the Electric Power Research Institute (EPRI).

ABSTRACT:

Continuous monitoring of meteorology and wet and dry deposition chemistry has been conducted at the VMC Mansfield site. This work is a fundamental component of the monitoring and research activities there, providing basic information on the physical and chemical environment. Several projects are underway, including (a) basic meteorology at four locations, (b) four precipitation chemistry monitoring programs, and (c) a dry deposition monitoring program. Continuous hourly meteorology data from PMRC (400 m elevation) are available from 1988 to present, and daily temperature and precipitation data from the summit of Mt. Mansfield (1205 m) are available from 1954 to present. Data from the Vermont Acid Precipitation Monitoring Program consist of daily precipitation pH since 1980 (Mt. Mansfield summit) and 1983 (PMRC). The National Atmospheric Deposition Program, operating at PMRC since 1984, provides weekly analysis of major ions in precipitation, while the Atmospheric Integrated Research Monitoring Network, established at the very end of 1992, provides similar data on a daily basis. In cooperation with the University of Michigan Air Quality Laboratory, atmospheric mercury monitoring in precipitation, gaseous and aerosol phases was also established at the end of 1992. Finally the Dry Deposition Inferential Measurement system, started mid year in 1992, provides weekly data on dry deposition of nitrogen (HNO_3 vapor) and sulfur (SO_2) compounds.

No detailed assessment of patterns or trends in the data from these projects has been performed at this time, but the data are available from the VMC in various forms, including as Voyager files. Included in this report are representative data tables and Voyager views of the data. Also discussed here are plans for the future of these projects.

OBJECTIVES:

Continuous monitoring of meteorological variables and precipitation and dry deposition chemistry at several locations at the VMC Mansfield site.

METHODS:

Several monitoring stations and programs were operated at the VMC Mansfield site in Underhill in 1992:

1. Basic meteorology (continuous temperature, dew point, wind speed and direction, standard deviation of wind direction, and precipitation amount) is monitored at the air quality monitoring station at the VMC Mansfield site at the Proctor Maple Research Center (PMRC) at 400 m. elevation. This station has remote (modem) access and has been in continuous operation since June 1988. Data are updated continuously and are stored electronically and as hard copy. Data are available from the VMC as spreadsheets (Lotus, Excel) and in 1993 will be available in Voyager format. Station supervision is by Tim Scherbatskoy and operation is now by Joanne Cummings and Carl Waite. Cooperators are Sumner Williams and Mel Tyree at PMRC. Additional meteorological data were collected at the forest research tower site and in Underhill State Park; these are described in other reports.

2. The National Weather Service (NWS) under NOAA supervises a second weather station at the WCAX-TV transmitter station near the nose of Mt. Mansfield (1205 m), one of 45 NWS cooperative weather stations currently operating in Vermont. This station has monitored temperature (daily minimum, maximum and temperature at time of observation) and precipitation amount (daily rainfall, snowfall and snow depth on the ground) since 1954. Data are collected and stored by the National Climatic Data Center. The VMC does not directly support this station, but has access to the data for this station and all others in Vermont through the NWS. Efforts in 1992 were aimed at formatting these data for Voyager and developing a system for obtaining data updates through the Vermont State Climatologist. Data are now available from the VMC in Voyager format for the period 1954-1991. Funding for this station comes from the National Weather Service and the cooperation of the WCAX-TV transmitter facility.

3. VAPMP (Vermont Acid Precipitation Monitoring Program) collects bulk precipitation samples on an event basis for analysis of amount and pH. Samples are collected at the air quality monitoring station at PMRC (400 m) and near the WCAX-TV transmitter station near the nose of Mt. Mansfield (1205 m), and at 10 other sites around Vermont. These stations have been in continuous operation since 1983 (PMRC) and 1980 (Mt. Mansfield summit). Data are collected and stored by VT DEC Water Quality Division where the program supervisor is Jim Kellogg. Data are available from the VMC in Voyager format or in other forms from the program supervisor. The site operators are Joanne Cummings with cooperation from Sumner Williams at PMRC, and the staff at the WCAX-TV transmitter facility on Mt. Mansfield. Funding to support these stations comes from the VT Department of Environmental Conservation.

4. NADP/NTN (National Atmospheric Deposition Program/National Trends Network) maintains a site at the air quality monitoring station at PMRC (400 m) for the weekly collection of precipitation for chemical analysis. Precipitation amount, pH and conductivity are measured locally, and the

sample is then shipped to the NADP Central Analytical Laboratory in Illinois for analysis of pH, conductivity, Ca, K, Mg, Na, NH₄, NO₃, Cl, SO₄ and PO₄. This station has been operational since 1984, and is part of a national network of over 200 stations including one other in Vermont at Bennington. Data are available from the VMC in Voyager format or in other forms from the NADP Central Analytical Laboratory. The site supervisor is Tim Scherbatskoy, and the site operator is now Joanne Cummings with cooperation from Sumner Williams at PMRC.

5. DDIM (Dry Deposition Inferential Measurement) program was started in August 1992 at the forest research tower at the PMRC. This monitoring program uses filterpack technology to collect continuous weekly samples of dry deposition of sulfur (SO₂) and nitrogen (HNO₃ vapor), and also continuous meteorology including temperature, relative humidity, wind speed and direction, surface wetness and precipitation amount. The goal of this program is to measure atmospheric concentrations of these species and model their deposition rates. This station is one of 10 stations in the NOAA network in the eastern US; the data collected are comparable to other dry deposition monitoring programs in the US operated by the EPA. This equipment is located above the forest canopy at 22 m. on the forest research tower. Station operation is by Joanne Cummings with supervision by Tim Scherbatskoy. Filterpack and data analysis are conducted by NOAA, with data returned to the VMC quarterly.

6. AIRMoN (Atmospheric Integrated Research Monitoring Network) is a daily precipitation monitoring program established at the end of 1992 to provide high-resolution data on precipitation chemistry to support regional modeling efforts. There are 7 sites in the network, located in the northeastern US. Except for being a daily sampling program, it follows the protocol and measures the variables of the NADP/NTN described in (4) above; the sampler is located at the Air Quality site at PMRC (400 m). Station operation is by Joanne Cummings with supervision by Tim Scherbatskoy. The AIRMoN station was installed in December, 1992; the station is scheduled to begin monitoring in January 1993, when data will become available quarterly.

7. Atmospheric mercury is being monitored at the VMC Air Quality site in Underhill. This project was started in December, 1992 in cooperation with the University of Michigan Air Quality Laboratory and the Lake Champlain Research Consortium. This is part of a larger research project to understand the behavior and sources of atmospheric mercury and other chemicals in the Lake Champlain Basin. Daily wet-only precipitation and twice-weekly 24 hour air samples are collected and sent to UMAQL for analysis of mercury in precipitation, gaseous and aerosol phases. Precipitation is collected using a MIC Co. automated trace metal quality precipitation collector, while the air samples are collected on gold sand traps (gas phase) and quartz filters (aerosol phase). Station operation is by Joanne Cummings with supervision by Tim Scherbatskoy. Analysis is conducted at the UMAQL in Ann Arbor under the direction of Dr. Jerry Keeler.

SIGNIFICANT FINDINGS:

No major analyses of trends and relationships in these projects have been completed at this time. However, data are maintained as up-to-date as possible, and are generally available from the VMC in various forms. A major effort is underway to also make these data available as Voyager files (see the Data Integration Project). In addition, periodic reports are made available by the major sponsor of each program (e.g., NADP annual statistical summaries).

1. Basic meteorology.

Consolidation of the basic meteorology data from the VMC Mansfield site is completed, and consists of annual daily and hourly data for all variables. In 1993, monthly data summaries will be produced routinely. These data are available in ASCII text files, spreadsheets, and Voyager workbooks. Representative data, showing variables and time resolution of the raw data being collected, are presented in Table 1.

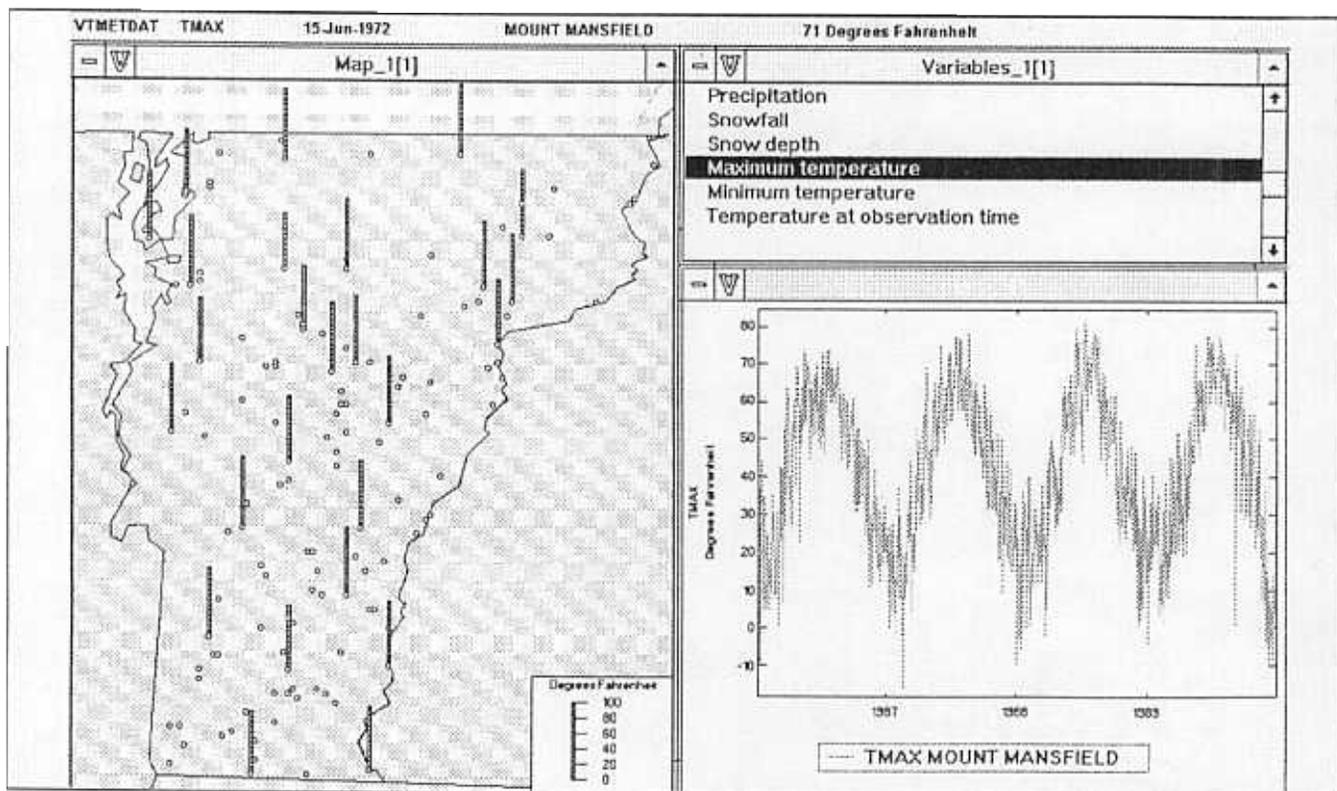
Table 1: Basic Meteorology at PMRC: portion of raw data file as logged hourly at the weather station.

date	time hr	precip cm	wdr deg	wsp mph	temp deg F	bp in	dp deg F	sd-wd deg
9/18/92	1:00	0.00	110	2.0	67.3	28.43	56.2	31.7
9/18/92	2:00	0.00	98	2.5	67.0	28.43	56.4	17.7
9/18/92	3:00	0.00	91	2.1	66.0	28.43	56.4	16.4
9/18/92	4:00	0.00	102	2.7	65.7	28.43	56.4	19.2
9/18/92	5:00	0.00	104	2.5	65.5	28.43	56.3	18.8
9/18/92	6:00	0.00	117	2.2	65.7	28.43	55.9	39.6
9/18/92	7:00	0.00	113	2.7	66.4	28.43	55.9	33.9
9/18/92	8:00	0.00	109	2.6	66.3	28.43	56.2	32.5
9/18/92	9:00	0.00	115	2.3	67.2	28.43	57.0	38.6
9/18/92	10:00	0.00	171	3.6	69.1	28.43	57.5	46.3
9/18/92	11:00	0.00	198	5.1	70.9	28.41	57.9	29.0
9/18/92	12:00	0.00	203	5.9	73.3	28.39	58.3	20.8
9/18/92	13:00	0.00	199	7.1	75.7	28.35	56.6	23.5
9/18/92	14:00	0.00	200	7.7	77.3	28.32	55.4	21.0
9/18/92	15:00	0.00	199	8.6	77.7	28.29	56.1	24.8
9/18/92	16:00	0.00	198	8.3	77.7	28.26	56.6	21.9
9/18/92	17:00	0.00	193	7.6	76.2	28.25	56.1	24.4
9/18/92	18:00	0.00	180	5.6	73.6	28.22	55.8	47.1

2. National Weather Service data.

Due to the time lag in obtaining data from the National Climatic Data Center, the 1992 data from the Mt. Mansfield weather station will not be available until May 1993. Current data is complete through 1991. Representative data, as a Voyager view, are shown in Figure 1.

Figure 1: NWS Cooperating stations in Vermont: Voyager view showing the Vermont map view and a time view for the Mt. Mansfield summit weather station.



3. Vermont Acid Precitation Monitoring Program.

The database for VAPMP is up-to-date, but no data interpretation is planned for individual stations or the program until 1993; the last program report (from the VT Water Quality Division) was in 1986. Representative data, as a Voyager view, are shown in Figure 2. These data are available from the VMC as Voyager workbooks (see the Data Integration Project).

Figure 2: VAPMP stations in Vermont: Voyager view showing the Vermont map view and a time view for the VMC-operated station in Underhill.

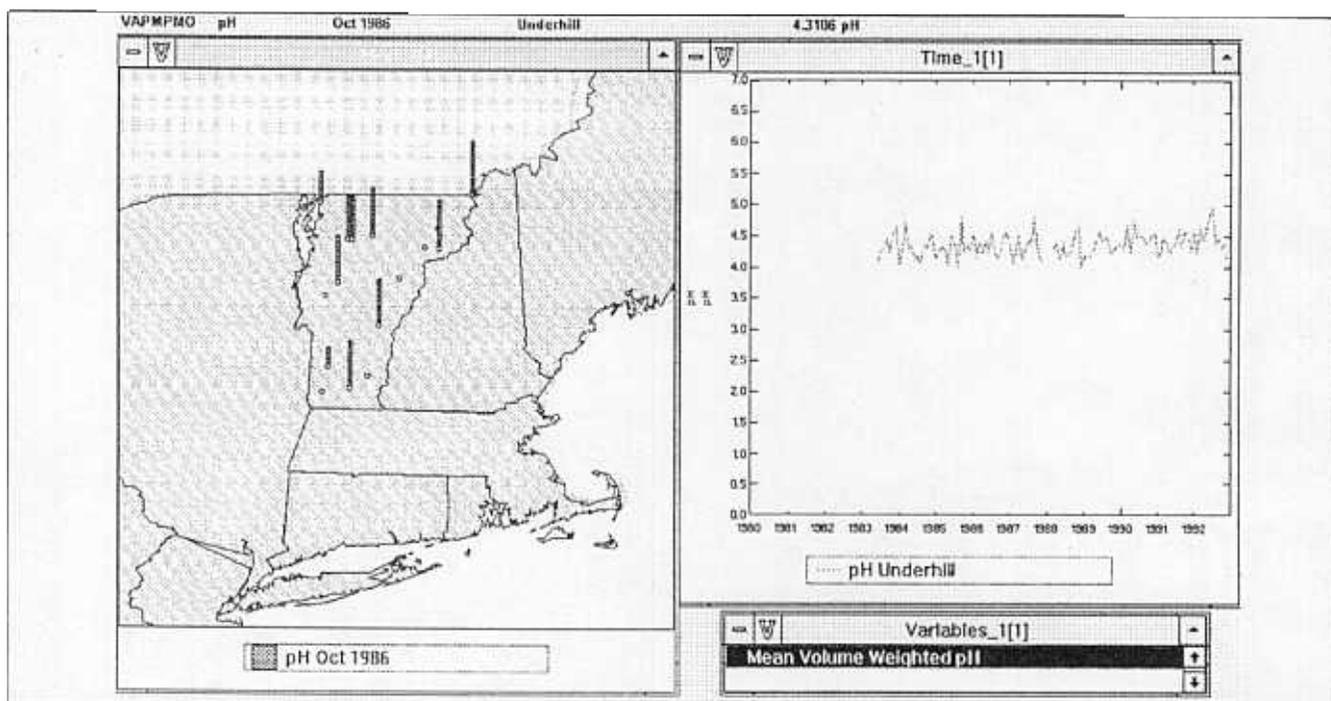


Table 2: VAPMP data: portion of raw data file for VMC station in Underhill showing daily precipitation chemistry data.

id	yr	mo	da	pH	precip (in), form	vol wtd H+
11	92	10	1	4.76	0.03 M	5.213E-07
11	92	10	12	4.81	0.72 R	1.115E-05
11	92	10	13	4.32	0.15 R	7.179E-06
	92	10	16	3.74	0.05 R	9.099E-06
11	92	10	20	4.22	0.25 M	1.506E-05
11	92	10	27	4.26	1.46 M	8.023E-05
11	92	11	3	4.75	0.63 R	1.12E-05
11	92	11	12	4.37	0.79 R	3.37E-05
11	92	11	14	4.86	0.23 M	3.175E-06

4. National Atmospheric Deposition/National Trends Network.

Data from the NADP station are available for each 2-month period from the site supervisor, and are available for the entire network annually from NADP; the last annual data summary from NADP is for 1991. Representative data, as a Voyager view, are shown in Figure 3 and as bi-monthly data table in Table 3.

Figure 3: NADP program data: Voyager view showing map view for the eastern United States and a time view of data for the VMC station in Underhill.

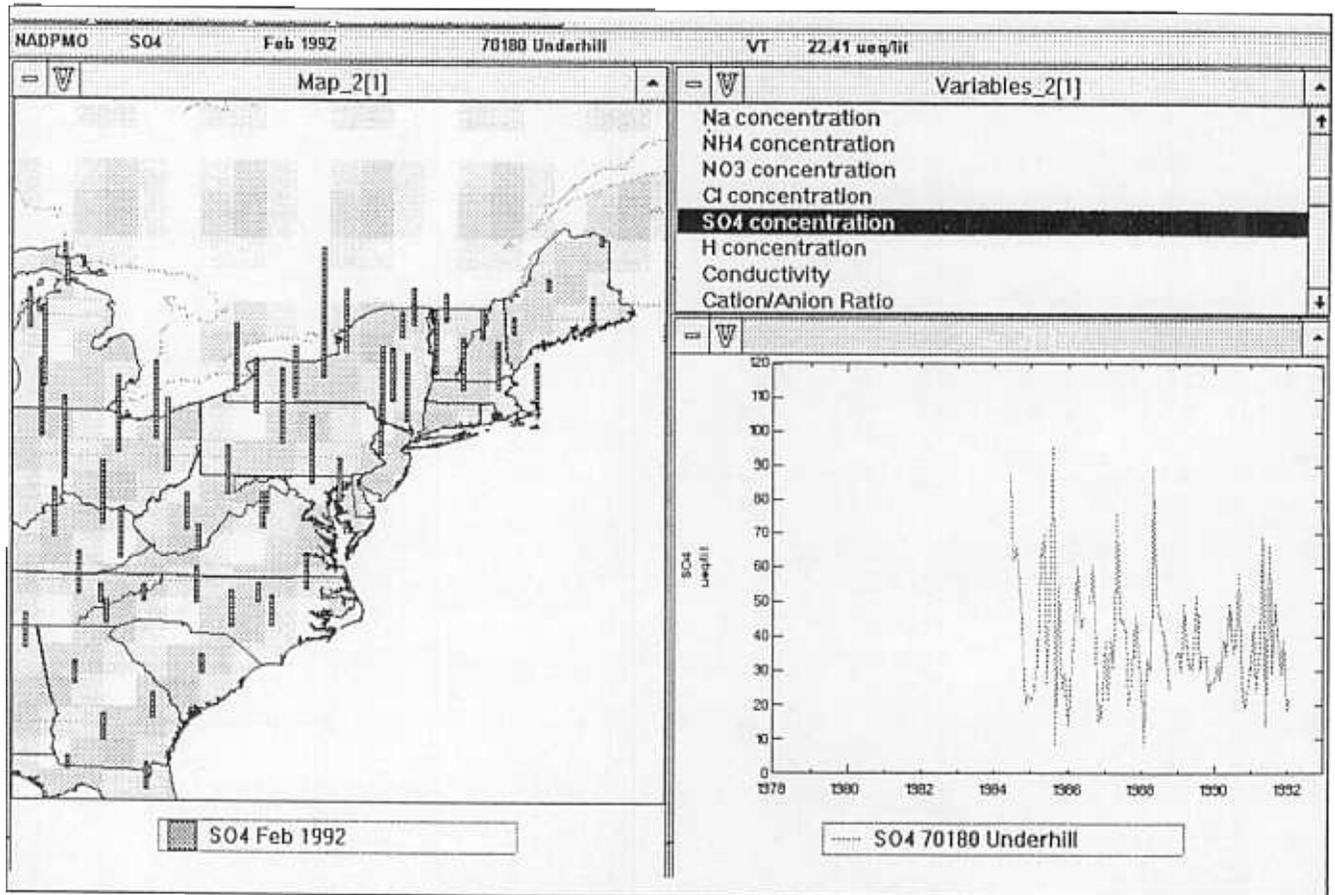


Table 3: NADP/NTN data: field and laboratory data for November, 1992 from bi-monthly data reports.

NADP/NTN CENTRAL ANALYTICAL LABORATORY - ILLINOIS STATE WATER SURVEY

FIELD PRINTOUT
PRINTOUT DATE: 11/12/1992

PLEASE NOTE - DATA WITH A SAMPLE ID LESS THAN NL14010W (MARKED WITH AN ASTERISK) HAS BEEN REVIEWED BY THE CAL FOR THIS REPORT

SAMPLE ID	LAB TYPE	DATE ON	TIME ON	DATE OFF	TIME OFF	TIME ZONE	PH		CONDUCTIVITY		SAMPLE VOLUME (ML)	SAMPLE DEPTH (IN.)	PRECIP. DEPTH (IN.) LEAKAGE	
							LAB	FLD	LAB	FLD				
*NL10730WVT99	W	072892	1032	080492	0815	LT	4.21	4.35	33.3	34.0	2837.6	1.65	1.60	NONE
*NL13160WVT99	W	080492	0815	081192	0900	LT	4.20	4.32	34.3	34.5	1663.7	.96	.98	NONE
NL14050WVT99	W	081192	0900	081892	0952	LT	4.49	4.29	18.5	21.0	887.6	.51	.31	NONE
NL17100WVT99	W	081892	0952	082592	0815	LT	3.92	3.83	66.8	85.0	121.5	.07	.08	NONE
NL17860WVT99	W	082592	0815	090192	0630	LT	4.18	4.16	37.1	38.0	2258.5	1.31	1.34	NONE
NL19950WVT99	W	090192	0630	090892	1120	LT	4.40	4.35	20.6	22.5	761.5	.44	.44	NONE
NL22620WVT99	W	090892	1120	091592	0745	LT	4.45	4.38	19.0	22.0	2456.5	1.42	1.41	NONE

PRELIMINARY PRINTOUT
DATE: 11/12/92

NADP/NTN CENTRAL ANALYTICAL LABORATORY ILLINOIS STATE WATER SURVEY

PLEASE NOTE - DATA WITH A SAMPLE ID LESS THAN NL14010W (MARKED WITH AN ASTERISK) HAS BEEN REVIEWED BY THE CAL FOR THIS REPORT

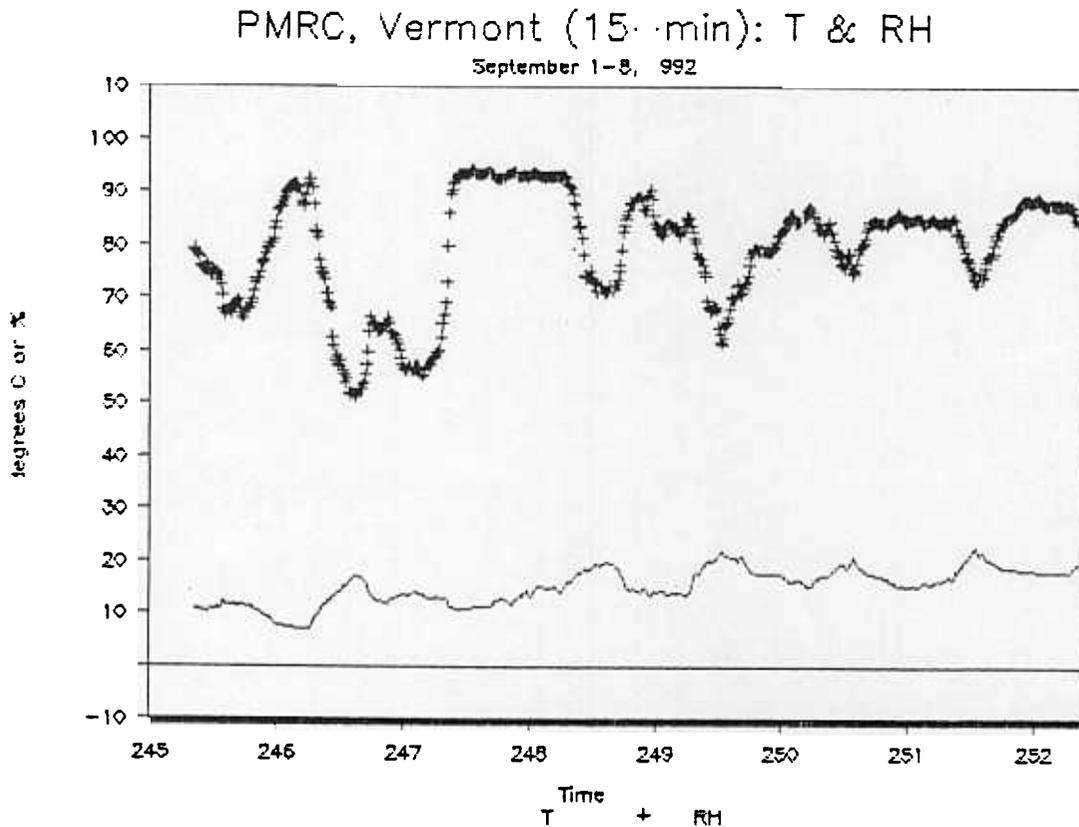
SAMPLE ID	LAB TYPE	DATE ON	TIME ON	DATE OFF	TIME OFF	CONCENTRATIONS (MG/L)										FIELD LAB FIELD LAB			
						CA	MG	K	NA	NH4	NO3	CL	SO4	PO4	COND. (MICROMHOS/CM)	COND.	PH	PH	
*NL10730WVT99	W	072892	1032	080492	0815	.135	.017	.041	.042	.23	1.85	.06	3.09	<.020	34.0	33.3	4.35	4.21	
*NL13160WVT99	W	080492	0815	081192	0900	.043	.008	.008	.010	.32	1.51	.07	3.46	<.020	34.5	34.3	4.32	4.20	
NL14050WVT99	W	081192	0900	081892	0952	.045	.010	<.003	.009	.06	.99	.03	1.92	<.020	21.0	18.5	4.29	4.49	
NL17100WVT99	W	081892	0952	082592	0815	.131	.034	.016	.050	.51	3.96	.21	7.84	<.020	85.0	66.8	3.83	3.92	
NL17860WVT99	W	082592	0815	090192	0630	.182	.028	.025	.046	.61	1.65	.09	4.28	<.020	38.0	37.1	4.16	4.18	
NL19950WVT99	W	090192	0630	090892	1120	.076	.022	.135	.026	<.02	1.24	.08	1.67	<.020	22.5	20.6	4.35	4.40	
NL22620WVT99	W	090892	1120	091592	0745	.087	.016	.008	.043	.25	1.08	.05	2.37	<.020	22.0	19.0	4.38	4.45	

SAMPLE	LAB	DEPOSITION(MILLIGRAMS/SQUARE METER)							SAMPLE H	MEAS VOL(ML)	MEAS ANIONS (MICROEQUIV/L)			MEAS CATIONS		
		CA	MG	K	NA	NH4	NO3	CL			SO4	PO4				
NL10730WVT99	W	5.64	.71	1.71	1.76	9.61	77.33	2.51	129.16	<.84	2.60	2837.6			96.2	85.4
NL13160WVT99	W	1.05	.20	.20	.25	7.84	37.01	1.72	84.79	<.49	1.56	1663.7			98.7	84.3
NL14050WVT99	W	.59	.13	<.04	.12	.78	12.94	.39	25.10	<.26	.43	887.6			57.1	39.2
NL17100WVT99	W	.23	.06	.03	.09	.91	7.09	.38	14.03	<.04	.22	121.5			233.4	160.4
NL17860WVT99	W	6.05	.93	.83	1.53	20.29	54.89	2.99	142.39	<.67	2.22	2258.5			118.6	113.9
NL19950WVT99	W	.85	.25	1.51	.29	<.22	13.91	.90	18.73	<.22	.45	761.5			57.4	50.6
NL22620WVT99	W	3.15	.58	.29	1.56	9.05	39.08	1.81	85.76	<.72	1.29	2456.5			68.5	57.1

5. Dry Deposition Inferential Measurement System.

At this time, no chemical data from the DDIM project have been returned to the VMC due to the time lag in chemical analysis. Meteorological data in graphical form, but not as data files, have been received. We anticipate receiving copies of both the chemical and meteorological data as computer data files quarterly in 1993. Representative meteorological data, as a graph provided by NOAA, are shown in Figure 4.

Figure 4. DDIM station representative meteorological data: 15-min temperature and relative humidity for September 1-8, 1992.



FUNDING:

1. Basic meteorology: The weather station is maintained with funds from the VMC base budget, the University of Vermont, and the VT Dept. of Environmental Conservation (DEC); this amounts to approximately \$2,500 for utilities, maintenance and data management. During its first two years this station was funded and operated by EPRI as part of the Operational Evaluation Network.

2. National Weather Service: Data collection and station operations are supported by the NOAA National Weather Service and WCAX-TV. VMC activity and funding was used for initial acquisition of the data (approximately \$600) and data processing (approximately \$1,500). Involvement of university students seeking research experience has reduced costs of data management.

3. VAPMP: This program is operated and funded by the Water Quality Division of the VT DEC. The VMC contributes directly to sample collection and analysis at the Air Quality site in Underhill through partial support of the research field technician position there and maintenance of the site and equipment (about \$500 per year).

4. NADP/NTN: The overall program is funded by several federal agencies; operation of the VMC station is supported by the US Geological Survey (\$3,700). Chemical analysis and data management are supported independently by the USGS, at a cost of about \$5,000 per year.

5. DDIM: The overall program as well as the VMC station at the forest research tower is supported by the National Oceanic and Atmospheric Administration (NOAA), with additional support from the VT DEC. Site operations here cost about \$1,000 per year; data management, sampling equipment and chemical analysis are paid for by NOAA at a cost of \$9,000 per year.

6. AIRMoN: This program is also supported by NOAA, with additional support from the VT DEC. Anticipated annual costs for the VMC station in this network are about \$10,000 for operation, chemical analysis and data management.

7. Atmospheric mercury: This program is also supported primarily by NOAA, with additional support from the VT DEC and the Lake Champlain Research Consortium. Annual costs for the VMC station are about \$65,000 for operation, chemical analysis and data management.

FUTURE PLANS:

All of these stations will continue to operate in 1993. Updates for the Mt. Mansfield weather station (as well as all other National Weather Service Vermont stations) will be obtained annually.

The two projects begun at the end of the year (AIRMoN and the mercury program) will operate for their first full year in 1993. The AIRMoN program is envisioned as a long-term effort and may be incorporated into the program management of the NADP. The mercury program is planned to continue for at least two full years to establish reliable information on temporal and spatial patterns; long term plans will be made for this program in 1994.

We have received a grant from the VT DEC to develop a monitoring program for solar ultraviolet radiation (UV-B). Plans included a detailed assessment of the state of the science of UV-B monitoring, and deployment of a broad-band UV-B monitoring instrument at the Mt. Mansfield site.