AVAILABILITY OF SELECTED METEOROLOGICAL DATA IN COMPUTER-BASED FILES OF THE U.S. GEOLOGICAL SURVEY, MONTANA, NORTH DAKOTA, SOUTH DAKOTA, AND WYOMING

by Brenda L. Groskinsky Link and Lawrence E. Cary

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CONVERSION FACTORS

The following factors can be used to convert inch-pound and metric units in this report to the International System of units (SI).

Multiply inch-pound or metric unit	By	To obtain SI unit
	Length	
foot (ft)	0.3048	meter
	0.0000003048	micrometer (micron)
inch	25.40	millimeter
	2.540	centimeter
mile	1.609	kilometer
	Energy	
calorie per square centimeter (langley)	4.184	kilojoule per square meter
	Pressure	
inch of mercury	3.377	kilopascal
millibar	0.1000	kilopascal
millimeter of mercury	0.1333	kilopascal
	Rate	
inch per day	25.40	millimeter per day
mile per hour	1.609	kilometer per hour

Temperature can be converted to degrees Celsius (°C) or degrees Fahrenheit (°F) by the equations:

$$°C = 5/9\ (°F - 32)$$
$$°F = 9/5\ (°C) + 32$$

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

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ABSTRACT

Data from selected meteorological stations in Montana and North Dakota coal regions and adjacent areas including South Dakota and Wyoming have been located, acquired, and stored. Data that were acquired have potential use in small watershed modeling studies as well as other uses. Emphasis was placed on acquiring data collected from 1970 to the present (1984). A map shows the location and type of stations selected. A naration summarizing conventions used in acquiring and storing the meteorological data is provided along with the various retrieval options available. Individual station descriptions are followed by tables listing the meteorological variables collected, period of obtained record, percentage of data recovery, and instruments used and their description.

INTRODUCTION

Meteorological data are being, or have been, acquired in the coal areas of Montana, North Dakota, South Dakota, and Wyoming for various purposes. Some of the purposes include research projects and environmental studies by Federal and State agencies, environmental baseline studies for mining permit applications, and air-quality monitoring.

These data are useful for other purposes, as well. For example, some of the measured meteorologic variables are used as driving variables in hydrologic models, such as the U.S. Geological Survey's precipitation-runoff modeling system.

Purpose and scope

This study was initiated to locate, acquire, and store in computer files all meteorologic data that might have potential use as driving variable data in small watershed models. Owing to various constraints, the study was limited to daily data. Emphasis was placed on stations operated by other Federal agencies, universities, and mining companies. Where several stations are, or have been operated in the same vicinity, only one was selected for inclusion in the study. Many of the air-quality monitoring data, which commonly include meteorological data such as air temperature, are submitted to the appropriate State agency for storage in computer files. These sources were identified, but the data were not acquired because of time constraints and redundancy. Except for sites where incident global solar radiation is measured, meteorological stations operated by, or in cooperation with, the National Weather Service were not included. Such data are already available in published form or on computer tapes.

Many of the data were collected as the result of renewed interest in the development of coal. Because much of this renewed interest occurred after 1970, emphasis was placed on meteorological data acquired from 1970 to the present (1984). Emphasis was placed on acquiring data from the northern Great Plains coal region; however, selected data sets were acquired from nearby locations when such data were readily available.

Acknowledgments

In the course of locating and acquiring these data, many individuals were contacted, in person or by telephone. Although too numerous to identify individually, their assistance is appreciated.

The following organizations provided assistance or data. Their assistance is gratefully acknowledged:

Decker Coal Company
Kiewit Mining and Engineering Company
Montana State University, Agricultural Experiment Station
Montco
North Dakota State University, Agricultural Experiment Station
State of Montana, Department of Health and Environmental Sciences
State of Montana, Department of Natural Resources and Conservation
State of Montana, Department of State Lands
State of North Dakota, Department of Health
State of Wyoming, Department of Environmental Quality
U.S. Department of Agriculture, Agricultural Research Service
U.S. Department of Commerce, National Oceanic and Atmospheric Administration
U.S. Department of the Interior, Bureau of Reclamation
University of Wyoming, Water Resources Center
Western Energy Company
Westmoreland Resources, Inc.

This report was prepared in cooperation with the U.S. Bureau of Land Management.

DATA ACQUISITION

Collected-data sources

Potential data sources were identified by personal visits or telephone contact. A list of stations was compiled, including the station location, station operator, period of available data, meteorologic variables being measured, instruments and methods used, and how and where the data were stored.

Stations were eliminated from the list if the variables being measured were solely for air-quality studies, or if the data were difficult or expensive to acquire. Stations were also eliminated if more than one station was located in the same vicinity, in an effort to obtain a geographic distribution of stations in the time allowed for the study.

The meteorological stations from which data were acquired are shown in figure 1. Although the number of meteorologic variables measured changes from station to station, the symbol used to identify the station is that of a complete weather station. The letter S was appended to the symbol to indicate that radiation is measured at the station. Stations at which wind was measured and data were acquired are indicated by an arrow extending from the symbol.

Off-stream stations are identified according to latitude and longitude, regardless of data source. Where possible, station locations were identified to the nearest second of latitude and longitude, except for National Weather Service solar radiation stations. The National Weather Service identifies their station locations to the nearest minute of latitude and longitude. Their standard was used herein to avoid establishing duplicate identification numbers for the same station. The station identification number consists of 13 digits identifying the latitude and longitude, followed by 2 digits that can be used to identify sequential replicate sampling. Because, in most instances, each meteorologic variable was measured with a single instrument, the sequence number was usually 01. Thus, station number 4516181063808O1 identifies the Prairie Dog Creek meteorological station in southeastern Montana; the station is located at 45 degrees, 16 minutes, 18 seconds north latitude, and 106 degrees, 38 minutes, 08 seconds west longitude, and has a sequence number of 01.

Meteorological variables

The meteorological variables measured at each station depended upon the purpose of the station. The daily simulation mode of the U.S. Geological Survey's precipitation-runoff modeling system requires precipitation, air temperature, and incident global solar radiation or total evaporation as model driving variables. Therefore, emphasis on obtaining data was placed on stations that included these variables. In addition to these variables, wind speed and direction, atmospheric humidity, barometric pressure, and net all-wave radiation were measured at some stations. Some of these variables are required in other models, may be required in future revisions to components of the precipitation-runoff modeling system, or may have uses in addition to modeling. Where available, these data were also acquired.

The frequency and manner in which the data were recorded ranged from hourly values, to daily values, to average or total values that were given for periods longer than a day. Because the emphasis in this study was on daily data summaries, data for periods of 1 day or less were acquired. Three separate frequencies were used by the different stations selected.

1. Maximum, minimum, and mean or total values that were reported daily.
2. Maximum, minimum, and mean or total values that were reported hourly.
3. Maximum, minimum, and mean or total values that were reported at 6-hour intervals.

Data reported for periods of less than 1 day were summarized as daily totals, means, maxima, and minima, as appropriate. The reporting frequencies and period of obtained record for each of the meteorological stations are listed in table 1. If, at a particular station, more than one variable was measured and all the variables had the same reporting frequency, the word "All" was used to describe the variables; otherwise the individual variable name was used. Data for periods of longer than

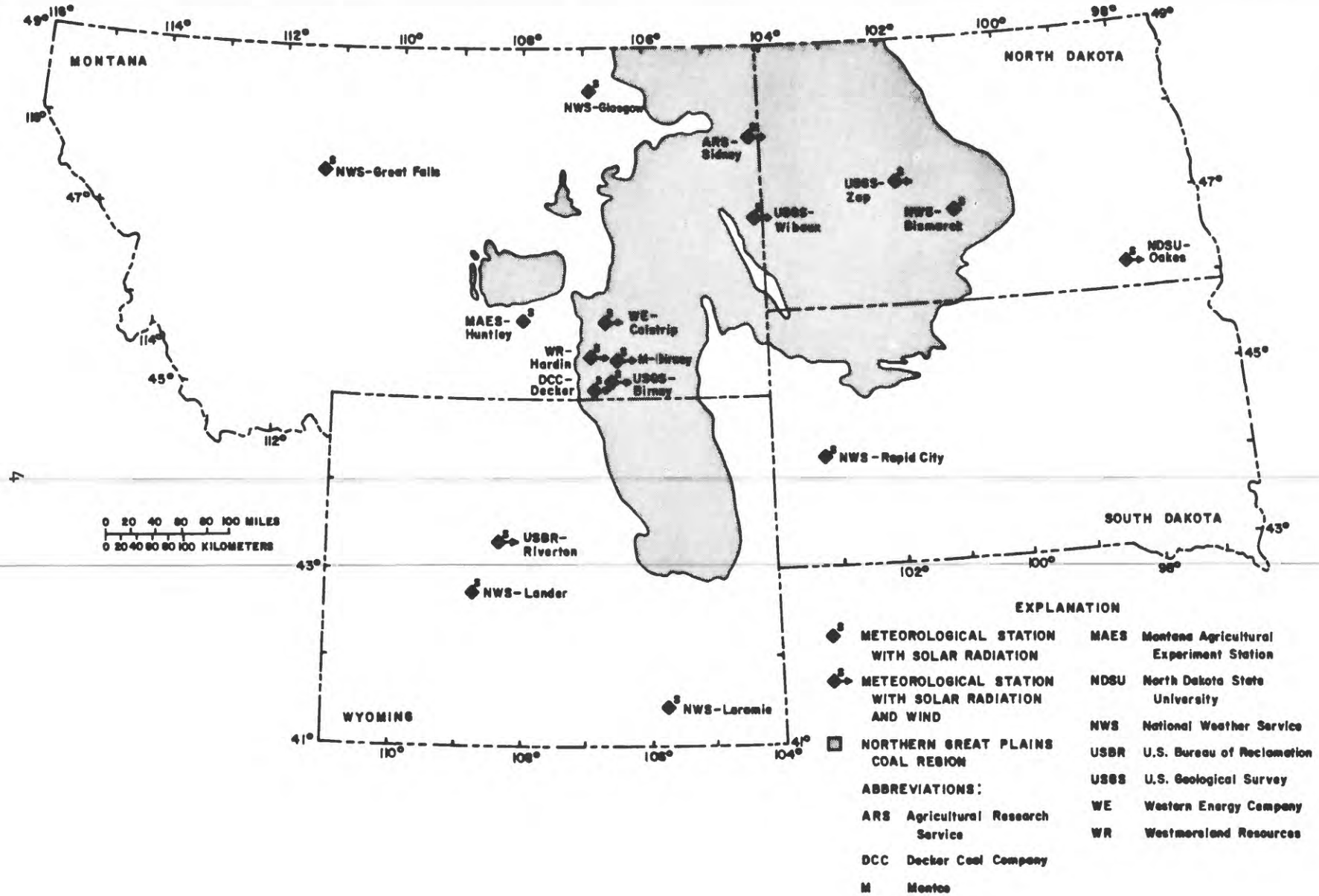

Figure 1.--Location of meteorological stations.

Table 1.--*Meteorological station reporting frequencies*

Station	Period of obtained record	Variable	Reporting frequency
Agricultural Research Service near Sidney, Mont.	1970-83	All	Daily: maximum, minimum, and mean or total
Decker Coal Co. at West Decker Mine near Decker, Mont.	1976-83	All	Daily: maximum, minimum, and mean or total
Montana Agricultural Experiment Station at Huntley, Mont.	1971-83	Incident global solar radiation	Daily: total
Montco at proposed mine site near Birney, Mont.	1979-82	All	Daily: maximum, minimum, and mean or total
National Weather Service at:		Incident global solar radiation	Hourly: total
Bismarck, N. Dak.	1970-83		
Glasgow, Mont.	1970-74		
Great Falls, Mont.	1972-83		
Lander, Wyo.	1970-80		
Laramie, Wyo.	1970-76		
Rapid City, S. Dak.	1970-75		
North Dakota State University near Oakes, N. Dak.	1973-80	All	Daily: maximum, minimum, and mean or total
U.S. Bureau of Reclamation near Riverton, Wyo.	1977-79	All	Daily: maximum, minimum, and mean or total
U.S. Geological Survey at Hay Creek near Wibaux, Mont.	1978-81	All	Hourly: maximum, minimum, and mean or total
U.S. Geological Survey at Prairie Dog Creek near Birney, Mont.	1978-84	All	Hourly: maximum, minimum, and mean or total
U.S. Geological Survey at West Branch Antelope Creek near Zap, N. Dak.	1978-84	All	Hourly: maximum, minimum, and mean or total
Western Energy Company at Rosebud Mine near Colstrip, Mont.	1980-81	All	Daily: maximum and minimum, or total 6-hour readings: mean
--	1981-83	All	6-hour readings: maximum, minimum, and mean or total
Westmoreland Resources at Absaloka Mine east of Hardin, Mont.	1977-82	All	Daily: maximum, minimum, and mean or total

1 day were not acquired. For example, total evaporation data at some stations reported as total or mean evaporation for periods of 2 or more days were excluded.

Generally, missing data were not estimated. When data recorded at intervals of less than 1 day were acquired, a day was considered to be a missing day if more than 2 hourly or 1 or more 6-hourly values were missing. For example, hourly values of solar radiation for 1977-83 for National Weather Service stations were used. If 1 or 2 hours were missing, they were estimated by interpolation. If more than 2 hours were missing, the day was considered to be a day with missing record and was excluded.

Incident global solar radiation at the National Weather Service stations prior to 1977 were acquired, indirectly, from other sources. These data included some estimates for missing data. Time did not permit day-by-day comparison with original records, which would have been necessary to identify the days when estimated values were used. Therefore, these data are reported as received.

When a data set was acquired, it was reviewed. If anomalous values were noted, an attempt was made to isolate the reason for the anomaly. If the reason could be identified (such as a misplaced decimal, or an incorrect conversion), the data were corrected. Otherwise, the anomalous value was deleted.

Instrumentation

The type and quality of the instrumentation varied, depending upon the purpose of the station and budget constraints. Air temperature was measured using bimetallic thermographs, alcohol-mercury minimum-maximum thermometers, thermistors, or thermocouples. Atmospheric humidity was measured using hair hygrographs (technology 50 or more years old), resistance humidity probes, and thermocouple psychrometers. Wind was measured with standard anemometers and wind vanes or with precision microresponse anemometers and wind vanes. Incident global solar radiation was measured with instruments that ranged from bimetallic pyranographs (actinographs), to precison thermopile pyranometers. The accuracy stated for radiation instruments is based on typical errors as indicated in Flowers (1982) and Pogerman and others (1980). Recording methods ranged from simple such as observation and recording on field sheets to more complex such as data acquisition microcomputers. Where possible, the make and model of measuring instrument and recording devices were identified in this report. Identification permits the reader to evaluate the accuracy and reliability of the reported data by reference to the appropriate technical specifications[1].

The accuracy and reliability of the data are dependent upon the measuring instruments used, the methods of recording and reducing the data, and the quality-control methods, including instrument calibration. Except for the review of data discussed earlier in this section, the data are as received. Interested individuals are urged to evaluate the data carefully before use.

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[1]Use of firm or trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Other data sources

In the search for data, several sources were identified and several were probably overlooked. Among the identified sources were some that included incident global solar radiation or other meteorological data that may be usable in small watershed models. These data were not acquired owing to time constraints and to the fact that the data are already stored in computer-based files.

The Montana Department of Natural Resources and Conservation, Energy Planning Division, sponsored a solar radiation availability study during 1979-81. The contractor operated a solar radiation network consisting of 30 continuous-recording stations and 29 manual-recording stations. The stations were operated at selected high schools throughout the State, although not all were operated concurrently. The study is summarized by Fowlkes (1982).

Incident global solar radiation was also measured by the Montana Department of Health and Environmental Sciences, Air Quality Bureau, at eight locations in the State during 1979-82. Of the stations, two were operated for the entire 4 years, two were operated for 2 years, and four were operated for 1 year each. The data are summarized in State computer-based data files.

The Wyoming Water Research Center began the development of a computerized data base (Water Resources Data System) in 1965. The data base currently includes surface-water, ground-water, climatological, and snow-course data. The data were acquired from various Federal and State organizations as well as private sources. The Water Resources Data System (WRDS) provides for several retrieval options, including graphics and statistical analyses. A complete description of the system and its use is provided in the user's guide (Wyoming Water Research Center, 1983).

Air-quality monitoring data are reported periodically to the respective State agencies. These data commonly include air temperature, wind, precipitation, and air quality variables and are generally reported as hourly values. In Montana, these data are reported to the Department of Health and Environmental Sciences, Air Quality Bureau. In North Dakota, the data are reported to the Department of Health, Division of Environmental Engineering. The Wyoming Department of Environmental Quality, Air Quality Division, receives such data for that State.

DATA STORAGE AND RETRIEVAL

Storage-system description

All the data acquired in this study are stored in a Prime 750 super-mini computer located in the Montana District office of the U.S. Geological Survey in Helena, Mont. This computer system is a component of the Distributed Information System (DIS) network of Prime computers within the U.S. Geological Survey. The system allows access to any other Distributed Information System user's computer system. A File Transfer System (FTS) has also been incorporated into the Distributed Information System. Using the File Transfer System, data files from any Distributed Information System user can be transferred to any other Distributed Information System user at will.

The data acquired have been stored on the Prime interactively with the use of Interim ADR Processing System, prepared by Brian D. Gillespie (U.S. Geological

Survey, written commun., 1984). This system is a data processing storage and retrieval system designed to temporarily replace some of the capabilities of the National Water Data Storage and Retrieval System (WATSTORE) of the U.S. Geological Survey until the implementation of the WATSTORE II Distributed Information System. Specifically, the meteorological applications software was used to process most of the data. The ADR software stores all received data with the use of the Multiple Index Data Access System (MIDAS). This system is a specially designed package that permits efficient access and maintenance of keyed data files.

Every data set received was processed and stored using several data management procedures. The first procedure involved reformatting the data, if needed, into a format (ADR card format) compatible with the ADR input programs (fig. 2). This

```
2451618106380801            0002000002                    ENT                82
345161810638080119811001  -3.40  -2.10   1.20  -0.10  -2.00  -6.20  -2.10  -0.40
345161810638080119811002  -2.60  -2.00   4.60   0.80  -4.20  -2.70  -6.40  -5.30
345161810638080119811003  -1.30  -7.10  -4.70  -3.30  -9.00  -9.00 -11.90  -1.30
345161810638080119811004  -0.40  -1.40   0.50  -1.50  -2.90  -4.70  -7.60
345161810638080119811101  -3.20  -3.80  -5.20  -5.80  -4.70  -8.30  -5.60  -4.80,
345161810638080119811102  -8.10  -7.20  -7.90  -7.30  -4.20  -5.40  -9.80  -2.30
345161810638080119811103  -5.50  -1.10  -8.50  -7.50 -10.00  -5.00  -7.50  -6.00
345161810638080119811104 -11.00 -15.00 -16.00 -16.00 -19.00 -14.00
345161810638080119811201 -17.00  -5.00 -13.20 -14.60 -14.60  -7.20  -5.00  -8.20
345161810638080119811202 -11.30  -3.10 -12.30 -15.10 -17.40 -13.80  -9.60 -18.10
345161810638080119811203 -24.00 -27.10 -17.60  -9.30 -14.90 -15.70 -11.60 -17.10
345161810638080119811204 -14.90 -16.20 -19.00 -22.40 -21.50 -19.20 -26.30
345161810638080119820101 -23.30 -27.70 -26.50 -20.80 -23.50 -28.70 -30.90 -18.60
345161810638080119820102 -25.40 -26.00 -19.80 -26.30 -15.80  -4.00 -33.10 -39.70
345161810638080119820103 -12.80 -15.30 -24.80 -28.70 -30.10 -34.40 -34.00 -14.10
345161810638080119820104 -16.70  -9.50 -13.20 -17.60 -17.50 -10.20  -9.90
345161810638080119820201 -14.10 -23.10 -36.20 -38.00 -38.30 -28.00 -20.40 -31.70
345161810638080119820202 -34.80 -31.20 -25.50 -22.70 -14.40  -8.60  -5.80  -7.30
345161810638080119820203  -7.20  -5.80  -2.00  -3.90  -2.60  -3.00 -11.10 -14.90
345161810638080119820204 -13.30  -9.20  -6.00  -5.30
345161810638080119820301  -6.00 -15.30 -11.70 -17.20 -19.30  -6.80  -4.80 -10.50
345161810638080119820302  -5.40  -3.30  -4.70  -3.50  -5.80  -6.10  -2.80  -1.80
345161810638080119820303  -1.80  -1.90  -6.80 -17.10 -22.60 -15.80  -7.00 -10.20
345161810638080119820304 -14.80  -9.70  -2.10  -3.50  -2.10  -1.50  -6.20
345161810638080119820401  -4.00  -5.30  -7.00  -6.60 -10.90  -4.30  -5.00  -7.40
345161810638080119820402  -7.90  -8.60  -4.10   3.60  -1.50  -1.70  -2.90  -6.60
345161810638080119820403  -9.60  -6.10  -2.60  -7.00  -4.00  -7.30  -3.30  -1.50
345161810638080119820404  -0.40  -0.70  -2.40  -5.20  -3.10  -6.10
345161810638080119820501  -3.30   1.20   6.10  -5.40  -8.20  -4.40   0.40   6.20
345161810638080119820502   2.30   1.00   0.10  -2.10  -2.40   8.20   7.20   7.20
345161810638080119820503   3.50   2.40   7.80   5.50   3.30   0.80   1.10  -1.30
345161810638080119820504   3.70  -0.80   3.00   2.00   0.10  -4.40  -6.30
345161810638080119820601   1.20   4.50   2.60   1.20   0.50   1.50  -1.00   0.90
345161810638080119820602  -1.40   2.20   2.60   7.30   8.70   9.10   7.90   6.40
345161810638080119820603   5.80   3.50   3.60   5.90   6.80   7.60  14.50  13.00
345161810638080119820604   8.90  11.30   9.40  14.60  13.40  14.60
345161810638080119820701  12.60   7.80   6.60   9.10   9.50   8.60   4.60   9.70
345161810638080119820702   6.80   7.50   7.60   9.50   9.00  11.80  12.70   5.50
345161810638080119820703   1.20   4.40   9.20  10.80  14.30  15.20  12.10  16.50
345161810638080119820704  16.00  16.90  13.60  12.40  10.70   9.40  11.10
345161810638080119820801  10.90  14.80   9.80   8.80  15.30  13.00  12.00  17.10
345161810638080119820802  13.20  11.70  13.00  13.10   8.30   8.20  15.20  11.60
345161810638080119820803  14.60  14.20  17.20  14.60  13.10  14.60   8.20   3.50
345161810638080119820804   6.60
345161810638080119820901                 1.20   5.50   8.00   2.00   3.80   2.10
345161810638080119820902   3.40   3.10  -1.60  -5.20  -3.40  -6.70  -1.50   1.10
345161810638080119820903  -3.60  -5.80  -4.30  -9.50  -4.10   0.70  -1.60  -3.60
345161810638080119820904   6.60   5.50   5.50   2.70   2.50  -0.20
```

Figure 2.--Example listing of ADR card-formatted data.

format is also compatible with WATSTORE Card Image format. The first digit is the card declaration number. If a 2 is located in the first position, digits 2 through 16 are the station identification number and the following digits are variable identification (parameter and statistic codes). For example, 0004500006 when used as a variable identifier is interpreted as total accumulated rainfall (00045 as rainfall and 00006 as sum). The parameter and statistic codes used in this report are listed in table 2. If a 3 is located in the first position, digits 2 through 16 are the station identification number and the following 6 digits contain the year (4 digits) and the month (2 digits) followed by a card number describing the dates of the succeeding daily values. For example, the card number "01" describes days 1 through 8 and the card number "02" describes days 9 through 16, and so forth. The daily values are placed in right justified, 7-space fields following the card number. Data are also required to be listed in a particular unit of measure. For example, air temperature must be expressed in degrees Celsius. If the units of measure were not as specified by ADR, the data were converted along with the reformation process. If the data were obtained in other than daily values, the data were summarized as appropriate as a primary step to conversion and reformation.

Table 2.--*WATSTORE parameter and statistic codes used in identification of climatologic data in this report*

Parameter code	Description
00014	Wet bulb temperature, in degrees Celsius
00020	Air temperature, in degrees Celsius
00025	Barometric pressure, in millimeters of mercury
00030	Incident global solar radiation, in calories per square centimeter
00035	Wind speed, in miles per hour
00036	Wind direction, in degrees clockwise from true north
00045	Accumulated precipitation, in inches
00050	Total evaporation, in inches per day
00052	Relative humidity, in percent
00196	Wind run, in miles
[2] 46517	Net all-wave radiation, in calories per square centimeter
74207	Soil moisture, in percent of total
81026	Water content of snow, in inches
81027	Soil temperature, in degrees Celsius
81029	Snow temperature, in degrees Celsius
Statistic code	
00001	Maximum
00002	Minimum
00003	Mean
00006	Sum

[2] Temporarily assigned parameter code (used locally).

These procedures were accomplished by a series of self-developed computer programs written in FORTRAN IV and FORTRAN 77. After the summarization, conversion, and reformation processes, the data were input into the ADR system and stored on MIDAS files, making them readily available for retrieval.

Retrieval

The ADR package has the capacity to retrieve the data in several different output formats. An ADR card image format, which is used to input data and has been previously described, is available as a retrieval option. A table formatted retrieval is more readily used as an output option. Each table formatted retrieval has a header that is placed before each annual listing of daily values. The header information contains the identification number, station name, location, altitude, and processing date along with the meteorological variable type and the period of listing. Following the header is a listing of the daily values by month. The monthly statistics for the table are listed below the daily values if that option is chosen. A daily values retrieval in table form can be listed as a calendar year (January-December, fig. 3) or water year (October-September, fig. 4).

Several conventions are used to show missing and nonexistent values. Missing values, usually caused by instrument malfunctions, are expressed as dashes, except in instances where a period of a month or more is missing. These values are left blank. Values for nonexistent days at the end of the month, such as February 31, are listed as dashes. Finally, dashes replace statistical values that have not been calculated because 1 or more days are missing during the respective month (fig. 5).

Three media options are available for transferring or storing retrieved meteorological data. First, the File Transfer System, as mentioned earlier, is available to all Distributed Information System users. Second, retrievals can be copied to a nine-track ASCII/EBDCIC tape with 800 or 1600 BPI. Finally, a hard copy printout is the last means by which a retrieval can be transferred or stored.

METEOROLOGICAL-STATION DESCRIPTIONS

Each station description consists of three parts:

(1) Location--includes a tract description of the station and a brief road log.

(2) Establishment and operation--includes that operation of the station, the period of collection for most meteorological variables, and whether the station is or was operated seasonally.

(3) Description of meteorological station--includes a brief outline of what meteorological variables were measured for the period of data collection. The description includes instrument height and housing specifications along with calibration procedures for each variable listed, except when this information was not available. A summary of data-collection procedures is also given if known. The summary includes the data recording system used and the interval between processing dates.

1980 WY UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

451618106380801 PRAIRIE DOG CR NR BIRNEY MT ME STA (DOG1 PROCESS DATE: 29-MAR-85 08:53 TC
LAT 451618 LONG 1063808 STATE 30 COUNTY 087 DATUM OF GAGE: 3240.00 FT NGVD DRAINAGE AREA:

PROVISIONAL DATA TEMPERATURE, AIR (DEG. C) CALENDAR YEAR JANUARY 1980 TO DECEMBER 1980
MINIMUM VALUES

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-11	-19	-31	-2	3	5	10	16	7	2	-5	-29
2	-10	-10	-20	-1	4	5	14	12	3	-5	-1	-27
3	-12	-9	-13	-5	2	7	13	6	4	0	-6	-15
4	-16	-4	-18	-7	7	10	9	3	-1	-2	-5	-15
5	-18	-8	-22	-6	3	11	9	2	1	4	-2	-16
6	-29	-7	-20	-3	0	9	13	9	5	0	-1	-25
7	-27	-16	-15	-3	-1	8	13	13	9	2	0	-27
8	-26	-20	-14	-10	-3	6	20	15	2	3	2	-27
9	-26	-14	-3	-8	6	8	14	13	-1	-4	-5	-17
10	-23	-15	-8	2	6	11	10	10	6	-6	-3	-19
11	-33	-19	-6	-7	4	13	11	2	11	-9	-1	-6
12	-18	-14	-8	-9	-3	11	12	11	11	-1	-1	-11
13	-6	-16	-11	-9	-3	10	11	12	8	1	-3	-14
14	-8	-19	-7	-5	-3	8	6	9	7	-3	-9	-13
15	-11	-25	-8	-1	2	8	11	15	5	2	-12	-2
16	-10	-31	-13	-2	4	6	8	11	3	-1	-11	1
17	-15	-24	-10	-5	4	7	10	8	7	-4	-15	-3
18	-14	-13	-6	-3	0	9	5	7	3	-4	-11	-15
19	-20	-10	-5	-1	2	11	17	9	4	-2	-12	-18
20	-24	-8	-6	0	7	9	11	9	0	-2	-10	-16
21	-10	-4	-2	1	6	13	6	5	0	2	-10	-13
22	-16	-5	-6	9	7	11	12	8	-3	0	-9	-7
23	1	-7	-9	4	12	11	13	11	4	-6	-15	-18
24	-4	-9	-2	4	9	8	15	9	1	-9	-18	-19
25	-22	-12	-2	-3	5	10	15	10	0	-8	-16	-11
26	-27	-4	-7	-2	2	12	10	9	-2	-3	-13	-4
27	-30	-3	-9	-1	3	15	9	5	-1	-3	-14	-3
28	-33	-8	-5	0	9	9	9	5	2	-8	-10	-5
29	-33	-24	-8	6	7	4	11	12	3	-6	-11	-8
30	-32	---	-4	6	6	15	14	3	1	-4	-6	-3
31	-27	---	-2	---	7	---	13	7	---	-2	---	-3
MEAN	-19	-13	-9	-2	3	9	11	9	3	-2	-8	-13
MAX	1	-3	-2	9	12	15	20	16	11	4	2	1
MIN	-33	-31	-31	-10	-3	4	5	2	-3	-9	-18	-29

CAL YR 1980 MEAN -2 MAX 20 MIN -33
WTR YR 1980 MEAN -2 MAX 20 MIN -33

Figure 3.--Example listing of daily value retrieval using the calendar-year option.

1980 WY UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

451618106380801 PRAIRIE DOG CR NR BIRNEY MT ME STA PDOG1 PROCESS DATE: 29-MAR-85 08:52 LC
LAT 451618 LONG 1063808 STATE 30 COUNTY 087 DATUM OF GAGE: 3240.00 FT NGVD DRAINAGE AREA:

PROVISIONAL DATA TEMPERATURE, AIR (DEG. C) WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
MINIMUM VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-3	-12	-14	-11	-19	-31	-2	3	5	10	16	7
2	-1	-11	-15	-10	-10	-20	-1	4	5	14	12	3
3	-4	-9	-9	-12	-9	-13	-5	2	7	13	6	4
4	-6	-3	-5	-16	-4	-18	-7	7	10	9	3	-1
5	3	-2	-1	-18	-8	-22	-6	3	11	9	2	1
6	0	-4	-1	-29	-7	-20	-3	0	9	13	9	5
7	2	-7	-9	-27	-16	-15	-3	-1	8	13	13	9
8	-3	-7	-11	-26	-20	-14	-10	-3	6	20	15	2
9	-1	-5	-8	-26	-14	-3	-8	6	8	14	13	-1
10	-1	-5	-13	-23	-15	-8	2	6	11	10	10	6
11	4	-7	-21	-33	-19	-6	-7	4	13	11	2	11
12	-1	-9	-17	-18	-14	-8	-9	-3	11	12	11	11
13	-3	-10	-12	-6	-16	-11	-9	-3	10	11	12	8
14	-1	-11	-11	-8	-19	-7	-5	-3	8	6	9	7
15	4	-8	-31	-11	-25	-8	-1	2	8	11	15	5
16	1	-11	-36	-10	-31	-13	-2	4	6	8	11	3
17	-2	-9	-16	-15	-24	-10	-5	4	7	10	8	7
18	1	-5	-12	-14	-13	-6	-3	0	9	5	7	3
19	3	-7	-16	-20	-10	-5	-1	2	11	17	9	4
20	-1	-12	-9	-24	-8	-6	0	7	9	11	9	0
21	-5	-21	-12	-10	-4	-2	1	6	13	6	5	0
22	-7	-19	-13	-16	-5	-6	9	7	11	12	8	-3
23	-4	-19	-15	1	-7	-9	4	12	11	13	11	4
24	1	-3	-15	-4	-9	-2	4	9	8	15	9	1
25	0	-13	-10	-22	-12	-2	-3	5	10	15	10	0
26	-2	-15	-13	-27	-4	-7	-2	2	12	10	9	-2
27	-6	-11	-16	-30	-3	-9	-1	3	15	9	5	-1
28	-2	-20	-14	-33	-8	-5	0	9	9	9	5	2
29	-4	-22	-16	-33	-24	-8	6	7	4	11	12	3
30	-8	-19	-17	-32	---	-4	6	6	15	14	3	1
31	-9	---	-17	-27	---	-2	---	7	---	13	7	---
MEAN	-2	-10	-14	-19	-13	-9	-2	3	9	11	9	3
MAX	4	-2	-1	1	-3	-2	9	12	15	20	16	11
MIN	-9	-22	-36	-33	-31	-31	-10	-3	4	5	2	-3

CAL YR 1979 MEAN -4 MAX 19 MIN -38
WTR YR 1980 MEAN -3 MAX 20 MIN -36

Figure 4.--Example listing of daily value retrieval using the water-year option.

1984 WY UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

451618106380801 PRAIRIE DOG CR NR BIRNEY MT ME STA PDOG1 PROCESS DATE: 29-MAR-85 08:54 LC
LAT 451618 LONG 1063808 STATE 30 COUNTY 087 DATUM OF GAGE: 3240.00 FT NGVD DRAINAGE AREA:

PROVISIONAL DATA TEMPERATURE, AIR (DEG. C) WATER YEAR OCTOBER 1983 TO SEPTEMBER 1984
MINIMUM VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5	-3	---	-19	-7	-4	-2	-6	3	5		
2	4	-1	---	-21	-1	-7	-1	-6	-1	8		
3	5	-1	---	-9	-3	-5	-4	-0	7	9		
4	-1	-1	---	-8	-5	-9	-7	-2	10	8		
5	2	-2	---	-5	-8	-14	-4	-2	6	9		
6	-2	-5	-12	-6	-8	-3	-4	1	4	12		
7	-0	0	-18	-8	-5	-14	-2	-2	6	13		
8	-3	---	-23	-10	-7	-11	-4	-3	6	12		
9	-2	---	-24	-10	-9	-11	-3	4	7	11		
10	4	---	-14	-11	-8	-12	-5	7	8	10		
11	4	---	-18	-7	-9	-5	-0	6	9	10		
12	-1	---	-13	-7	-8	-2	-7	6	6	10		
13	-4	---	-21	-9	-7	-4	-7	3	5	12		
14	4	---	-15	-26	-6	-6	-8	7	8	11		
15	2	---	-16	-28	-10	-7	-9	10	14	10		
16	-1	---	-22	-25	-11	-4	-7	6	12	10		
17	-3	---	-38	-34	-4	-6	-3	-1	10	8		
18	0	---	-41	-35	-10	-3	6	1	11	---		
19	-1	---	-26	-31	-13	-7	6	4	13	---		
20	-4	---	-32	-34	-11	-4	-1	7	13	---		
21	-2	---	-39	-26	-7	-5	-6	6	11	---		
22	-1	---	-40	-17	-8	-3	-7	-1	9	---		
23	3	---	-38	-9	-11	-5	-2	-1	6	---		
24	-4	---	-45	-8	-10	-5	-6	7	6	---		
25	-5	---	-42	-3	-8	-4	-2	0	9	---		
26	-3	---	-24	-6	-5	-4	-5	1	10	---		
27	-3	---	-25	-6	-11	-2	-6	3	9	---		
28	-3	---	-35	-2	-13	-5	-17	-1	8	---		
29	-4	---	-37	-8	-8	-7	-11	2	11	---		
30	-4	---	-22	-9	---	-3	-5	5	8	---		
31	-1	---	-14	-8	---	-3	---	10	---	---		
MEAN	-1	---	---	-14	-8	-6	-4	2	8	---		
MAX	5	---	---	-2	-1	-2	6	10	14	---		
MIN	-5	---	---	-35	-13	-14	-17	-6	-1	---		

Figure 5.--Example listing of daily value retrieval with missing days.

Following each station description is a table listing the meteorological variables collected, the period of obtained record, the percentage of data recovered [3], and the instruments used and their description. Sometimes a variable is listed in the station description as having been measured but pertinent information is not provided in the accompanying table. This means that the description of the instruments used was unavailable, or the data were summarized such that daily values were unobtainable. For example, wind direction commonly was summarized graphically as monthly wind roses; thus, direction on a daily basis was unobtainable. In some instances the instrument formerly used or being used is given but the specifications (accuracy or range) is listed as not available.

National Weather Service stations are described differently than other stations. Stations operated by, or in cooperation with, the National Weather Service were selected for the purpose of collecting added incident global solar radiation data. The remaining meteorological variables measured at these stations are already available. Owing to this fact, these stations are described in a combined narration. Each station's name (including town or city, and state), identification number, and altitude are listed. Information relating to road-log descriptions and establishment and operation procedures is not applicable and therefore is omitted. A brief listing of the sources containing instrument descriptions for the National Weather Service is given in place of station description section. Additional sources can be found in the report of the U.S. Department of Commerce (1983).

A separate table listing periods of collection and the percentages of data recovery is given after the combined station narration. The beginning date for the period of collection for each station is given as January 1, 1970, unless data collection at the station began at a later date or the data included unidentified, estimated missing days. If 1 year, or more, of data was missing, the station is considered to be discontinuous, and new beginning and ending dates are given. Data recovery is calculated for each data-collection period.

Agricultural Research Service near Sidney, Mont.

Station identification number: 474616104144801
Latitude: 47°46'16" Longitude: 104°14'48" Altitude: 2,265 feet

(1) Location--In NE1/4SE1/4SW1/4 sec. 11, T. 23 N., R. 58 E., in Richland County, about 0.25 mile west of State Highway 16 and 5.5 miles northwest of Sidney, Mont. The station is located in an open, flat pasture.

(2) Establishment and operation--The station was established by the Agricultural Research Service in 1970 and has continued to the present (1984). Data collection began for most meteorological variables in May 1970. Data collection for other variables began during the following years as new instruments were added to the system. The station is operated from late spring until late summer. Instrument malfunctions result in some missing data.

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[3] $\text{Data recovery(percent)} = \frac{\text{days of data collected}}{\text{total possible days}} \times 100.$

(3) Description of meteorological station--The meteorological variables being measured at the Agricultural Research Service meteorological station include: air temperature, relative humidity, incident global solar radiation, accumulated precipitation, wind speed, and total evaporation.

Meteorological data were collected, from 1970 until 1979, by a teletype recorded data acquisition system developed by the Electronics Research Laboratory at Montana State University, in Bozeman, and from 1979 until 1983, by a Auto-Data 9 system. The Auto-Data 9 system includes a direct telephone linkage system to a computer, where the data are stored.

The period of collection and the percentage of data recovery along with the instruments being used and their specifications for each meteorological variable are given in table 3. The temperature and relative humidity instruments are housed inside a cotton-region instrument shelter located about 4.5 feet above the ground. The anemometer, which is used to measure wind speed, is located on a pole about 6.5 feet above the ground.

Calibration of the instruments is checked periodically. A backup hygrothermograph is used to obtain maximum and minimum air temperatures on days the maximum/minimum thermometer is not read. The hygrothermograph, along with an Assman psychrometer, is also used to check the wet/dry bulb psychrometer, which is used to measure relative humidity. During equipment failure, solar radiation is obtained from a Kip and Zonen pyranometer located about 7 miles southeast of the station at the Agricultural Research Service office. Both the station and the backup pyranometers are periodically checked with an Epply model PSP precision spectral pyranometer.

Decker Coal Company at West Decker Mine near Decker, Mont.

Station identification number: 450325106491401
Latitude: 45°03'25" Longitude: 106°49'14" Altitude: 3,520 feet

(1) Location--In SE1/4 sec. 10, T. 9 S., R. 40 E., in Big Horn County, at West Decker Mine 330 feet west of Highway 314, 1,320 feet north of loadout area, and 4.5 miles northeast of Decker, Mont.

(2) Establishment and operation--The station was established by the Decker Coal Company in 1976 and has continued to the present (1984). Data collection for most meteorological variables, except for wind speed, began in August 1976. Data collection for wind speed began in January 1983. The station is operated year-round. Instrument malfunctions result in some missing data.

(3) Description of meteorological station--The meteorological variables being measured at West Decker Mine include: air temperature, relative humidity, barometric pressure, incident global solar radiation, accumulated precipitation, wind speed, and wind direction.

The meteorological data are collected by a Weather Measure chart recording system. The period of collection and the percentage of data recovery along with the instruments being used and their specifications for each meteorological variable are given in table 4. Height specifications of the instruments are as follows: The temperature, barometric pressure, and relative humidity instruments are located

Table 3.--*Period of obtained record, data recovery, and instrument description for the Agricultural Research Service meteorological station*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	May 1, 1970-Dec. 31, 1983	99.9	Mercury/alcohol maximum/minimum thermometer acc: ± 0.2 °Fahrenheit r: maximum -38 to +130 °Fahrenheit minimum -50 to +120 °Fahrenheit
Relative humidity	Apr. 11, 1971-June 7, 1983	98.5	Wet/dry bulb thermocouple psychrometer acc: not available r: not available
Incident global solar radiation	Jan. 1, 1970-Dec. 31, 1983	99.3	Pyranometer, (Eppley Laboratory model 8-48) acc: Typically 13 percent or less r: 0.28 to 2.85 micrometers
Accumulated precipitation	Oct. 1, 1976-Nov. 30, 1983	100	Standard 8-inch rain gage with modified Alter windshield (U.S. Weather Bureau) acc: ± 0.01 inch r: not applicable Tipping bucket with modified Alter windshield acc: ± 0.01 inch r: not applicable Digital rain gage with modified Alter windshield (Fischer and Porter Co.) acc: ± 0.10 inch r: 0 to 20 inches
Wind speed	May 1, 1979-Oct. 31, 1983	98.7	Lighweight anemometer (Teledyne-Geotech) acc: not available r: not available
Total evaporation	May 22, 1979-Oct. 5, 1983	96.0	Evaporation pan (Weather Bureau class A) acc: 0.01 inch r: not applicable

Table 4.--*Period of obtained record, data recovery, and instrument description for the Decker Coal Company meteorological station*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	Aug. 16, 1976-Dec. 31, 1983	98.0	Meteorograph (Weather Measure Corp., model M701) acc: ±1.0 percent r: 110 °Fahrenheit (adjustable)
Relative humidity	Aug. 16, 1976-Dec. 31, 1983	96.3	Meteorograph (Weather Measure Corp., model M701) acc: ±1.0 percent between 20 and 80 percent, ±3.0 percent at extremes r: 0 to 100 percent
Barometric pressure	Aug. 16, 1976-Dec. 31, 1983	95.7	Meteorograph (Weather Measure Corp., model M701) acc: ±2 percent of range r: 945 to 1,045 millibars
Incident global solar radiation	Aug. 16, 1976-Dec. 31, 1983	85.1	Mechanical pyranograph (Weather Measure Corp., model R401) acc: typically 28 percent or less r: 0.36 to 2.0 micrometers
Accumulated precipitation	Aug. 16, 1976-Sept. 30, 1982	100	Universal weighing gage with a Wyoming windshield (Belfort Instruments Co., model 5-780) acc: ±0.01 inch r: 0 to 12 inches
Wind speed	Jan. 1, 1983-Feb. 9, 1984	82.6	Anemometer and wind vane (Weather Measure Corp., models W120, W121, WS122, and W123) acc: not available r: not available

about 5 feet above the ground, mounted inside a cotton-region type instrument shelter. The solar radiation monitor is located about 7 feet above the ground, on top of the cotton-region instrument shelter. The precipitation gage is located about 3 feet above the ground. The wind speed and wind direction sensors are located on a mast 33 feet above the ground.

The temperature, relative humidity, and barometric pressure variables are reduced to daily maximum, minimum, and average values. The strip charts (recording wind speed, wind direction, and solar radiation) are interpreted into hourly averages. Precipitation is measured as a 24-hour total, accurate to 0.01 inch.

Calibration procedures are performed annually on most instruments. The air temperature, barometric pressure, and relative humidity meteorograph is returned to the factory at about 1 year intervals for cleaning and calibration. The wind sensors have been replaced 2 or 3 times because of sensor failure. The solar radiation instrument has not been calibrated since 1973. The precipitation gage is checked once a year with calibration weights.

Montana Agricultural Experiment Station at Huntley, Mont.

Station identification number: 455500108150001
Latitude: 45°55'00" Longitude: 108°15'00" Altitude: 3,002 feet

(1) Location--In NE1/4NW1/4SW1/4 sec. 16, T. 2 N., R. 28 E., in Yellowstone County, on the opposite side of the road from the agricultural experiment station, about 200 feet north of Highway 312, and 3.5 miles northeast of Huntley, Mont.

(2) Establishment and operation--The meteorological station was established by the Montana Agricultural Experiment Station, Southern Agricultural Research Center, and is operated in cooperation with the National Weather Service. In addition to the data reported by the National Weather Service, incident global solar radiation data are collected. Collection began in March 1971 and has continued to the present (1984). The station is operated year-round. Instrument malfunctions result in some missing data.

(3) Description of meteorological station--Owing to the fact that the Montana Agricultural Experiment Station meteorological station is operated in cooperation with the National Weather Service, only incident global solar radiation was selected for use in this report.

The solar radiation sensor is mounted on a steel pole near the other meteorological instruments on a platform about 6 feet above the ground. Solar radiation data are obtained from manually digitized chart recordings. The period of obtained record and percentage of data recovery along with the solar radiation instrument being used are given in table 5.

Table 5.--*Period of obtained record, data recovery, and instrument description for the Montana Agricultural Experiment Station meteorological station*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Incident global solar radiation	Mar. 16, 1971-Nov. 30, 1983	95.1	Mechanical pyranograph (Weather Measure Corp., model R401) acc: typically 28 percent or less r: 0.36 to 2.0 micrometers

Montco at proposed mine site near Birney, Mont.

Station identification number: 452553106240801
Latitude: 45°25'53" Longitude: 106°24'08" Altitude: 3,081 feet

(1) Location--In NW1/4 sec. 3, T. 5 S., R. 43 E., Rosebud County, about 0.2 mile west of the Ashland-Birney road, 10 miles northeast of Birney, Mont., and 15 miles south-southwest of Ashland, Mont.

(2) Establishment and operation--The meteorological station was established by Science Application, Inc., for Montco in 1978 and deactivated in 1983. Data collection for most meteorological variables began in June 1978. Collection of the remaining variables began the following year. The station was operated by several consulting firms retained by Montco. From 1979 until 1981, the station was operated by Science Application, Inc., and from 1981 through 1982, by Northern Testing Laboratories with the assistance of a local observer. The station was operated year-round. Instrument malfunctions resulted in some missing data.

(3) Description of meteorological station--The variables measured at the Montco meteorological station include: air temperature, barometric pressure, net all-wave radiation, accumulated precipitation, and wind speed and direction. The instruments used and their specifications are given in table 6. All instruments are located in a remote area free of terrain features that could interfere with instrument exposure. The wind speed and direction sensors are mounted on a pole about 34 and 35 feet, respectively, above the ground. The air temperature sensor is mounted on the same pole about 33 feet above the ground. The solar radiation instrument is located below the air temperature sensor about 7 feet above the ground. The precipitation gage, with a modified Alter windshield, is located near the wind, temperature, and solar radiation instrument mast. Finally, the barometric pressure instrument is housed in a standard instrument shelter.

In April 1980 the Easterline-Angus strip-chart recorders, which were originally used as sole recorders of the meteorological data, were replaced by a Digital Data Acquisition system (model 9300) because of persistent paper jams in the strip-chart recorders. After the installation of the new system, the data were stored on a

Table 6.--*Period of obtained record, data recovery, and instrument description for the Montco meteorological station*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	June 1, 1979-Dec. 31, 1982	96.3	Aspirated temperature sensor (Climet Instruments Inc., model 015-3) acc: ± 0.10 °Celsius r: -30 to +50 °Celsius
Barometric pressure	June 1, 1979-Dec. 31, 1982	94.2	Barometric pressure sensor (Yellow Springs Instruments, Inc., model 2014) acc: ± 0.3 percent of range span r: 19.2 through 32.0 inches of mercury absolute
Net all-wave radiation	Aug. 1, 1980-Dec. 31, 1982	95.3	Net radiometer (Science Associates, Inc., model 622) acc: typically 15 percent or less r: 0.3 to 60 micrometers
Accumulated precipitation	June 1, 1979-Dec. 31, 1982	100	Recording precipitation gage with a modified Alter type windshield (Meteorology Research Inc., model 302) acc: not available r: not available
Wind speed and direction	June 1, 1979-Nov. 28, 1982	76.4	Wind speed sensor (Climet Instrument, Inc., model 011-3) acc: ±1.0 percent or 0.15 mile per hour, whichever is greater r: 0.6 to 90 miles per hour

magnetic tape and the strip-chart recorders were used as a backup system. A local resident was hired by Montco as an onsite technician to perform routine visual inspections at 3-day intervals, and to perform routine maintenance procedures on the equipment as needed. The technician was also required to transfer all meteorological data to the consulting firm for data processing. On August 12, 1980, the wind instruments were sent to the manufacturer for overhaul and calibration procedures. Two of the recorders were also sent to the manufacturer to have chart drive malfunctions corrected. On September 15, 1980, calibration procedures were performed on all the system equipment. The wind speed and wind direction systems were calibrated using an electronic signal generator and a digital voltmeter. The temperature equipment was checked using an accurate thermometer and digital voltmeter. Lastly, the precipitation gage was checked for proper operation by adding a known volume of distilled water and adjusting the response.

National Weather Service at six locations

The following information is provided for the six stations.

Station location	Identification number	Latitude	Longitude	Altitude
Bismarck, N. Dak.	464600100460001	464600	1004600	1,617 feet
Glasgow, Mont.	482300106500001	482300	1065000	2,284 feet
Great Falls, Mont.	472900111220001	472900	1112200	3,663 feet
Lander, Wyo.	424900108440001	424900	1084400	5,574 feet
Laramie, Wyo.[4]	411800105380001	411800	1053800	7,200 feet
Rapid City, S. Dak.	440500103070001	440500	1030700	3,165 feet

A description of the solar radiation instruments and their calibration procedures used by the National Weather Service until about 1977 can be found in three separate manuals prepared by the U.S. Department of Commerce (1978, 1979a, 1979b). These reports contain instrument descriptions and calibration procedures used by the National Weather Service when measuring solar radiation. The period of collection and the percentage of incident global solar radiation data recovery for each National Weather Service station are given in table 7. Only incident global solar radiation data were acquired for these stations, although other radiation measurements are made at some stations.

North Dakota State University near Oakes, N. Dak.

Station identification number: 461000098100001
Latitude: 46°10'00" Longitude: 98°10'00" Altitude: 1,312 feet

(1) Location--In SE1/4SE1/4 sec. 17, T. 130 N., R. 59 W., in Dickey County, 4.5 miles south of Oakes, N. Dak., on State Highway 1.

[4]The Laramie, Wyo. station was operated by the University of Wyoming in cooperation with the National Weather Service.

Table 7.--*Period of obtained record and data recovery for the incident global solar radiation data obtained from the National Weather Service stations*

Station	Period of obtained record	Data recovery (percent)
Bismarck, N. Dak.	Jan. 1, 1970- Dec. 31, 1983	92.8
Glasgow, Mont.	Jan. 1, 1970- Nov. 21, 1974	96.7
Great Falls, Mont.	Sept. 1, 1972- May 20, 1975	97.5
	Jan. 1, 1977- May 31, 1981	91.2
	Feb. 1, 1983- Dec. 31, 1983	89.2
Lander, Wyo.	Jan. 1, 1970- Sept. 30, 1975	93.5
	Jan. 2, 1978- Mar. 31, 1980	77.7
Laramie, Wyo.	Apr. 1, 1970- Aug. 31, 1976	77.6
Rapid City, S. Dak.	Jan. 1, 1970- Mar. 9, 1975	98.6

(2) Establishment and operation--The station was established by the North Dakota State University. Data collection began in May 1973 for all meteorological variables and is still in operation (1984). The station was operated seasonally. Instrument malfunctions resulted in some missing data.

(3) Description of meteorological station--The meteorological variables measured at the North Dakota State University Agro-Climatic station include: air temperature, relative humidity, incident global solar radiation, accumulated precipitation, wind speed, and total evaporation.

The period of collection and the percentage of data recovery along with the instruments being used and their specifications for each meteorological variable are given in table 8. The air temperature thermometers are located 5 feet above the ground in a standard National Weather Service type shelter. The relative humidity instrument is also housed in a standard National Weather Service type

shelter about 3 feet above the ground. The precipitation gage is located on the ground. The evaporation pan is located 15 feet from the precipitation gage. The wind instrument is located above the evaporation pan.

Table 8.--*Period of obtained record, data recovery, and instrument description for the North Dakota State University meteorological station*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	May 1, 1973-Sept. 30, 1980	99.9	Maximum/minimum thermometer (National Weather Service) acc: ±0.2 °Celsius r: maximum -30 to +55 °Celsius minimum -45 to +50 °Celsius
Relative humidity	May 1, 1973-Sept. 30, 1980	100	Hygrothermograph (Bendix, model 594) acc: typically ±4.0 percent r: 0 to 100 percent
Incident global solar radiation	May 1, 1973-Sept. 30, 1980	99.9	unknown
Accumulated precipitation	May 1, 1973-Sept. 30, 1980	100	Universal weighing gage with an 8-day clock and a modified Alter windshield (Belfort Instruments Co., model 5-780) acc: ±0.5 percent r: 0 to 12 inches
Wind speed	May 1, 1973-Sept. 30, 1980	99.9	Anemometer (Science Associates) acc: not available r: not available
Total evaporation	May 1, 1973-Sept. 30, 1980	99.9	Evaporation pan 48-inch diameter acc: not available r: not applicable

U.S. Bureau of Reclamation near Riverton, Wyo.

Station identification number: 431900108340001
Latitude: 43°19'00" Longitude: 108°34'00" Altitude: 4,901.56 feet

(1) Location--In T. 4 N., R. 3 E., in Fremont County, 5 miles north and 6 miles east of Pavillion, Wyo.

(2) Establishment and operation--The station was established by the U.S. Bureau of Reclamation in 1977 and deactivated in 1979. Data collection for most meteorological variables began in April 1977. Collection of remaining data began later that year. The station was operated year-round. Instrument malfunctions resulted in some missing data.

(3) Description of meteorological station--The meteorological variables measured at the U.S. Bureau of Reclamation meteorological station near Riverton, Wyo., include: air temperature, incident global solar radiation, accumulated precipitation, wind speed, and total evaporation.

The air temperature instrument was housed in a cotton-region instrument shelter about 5.5 feet above the ground. The wind speed instrument was located on a pole about 13 feet above the ground. Finally, the solar radiation sensor was located about 5.5 feet above the ground. The period of collection and the percentage of data recovery along with the instruments used and their specifications for each meteorological variable are given in table 9.

U.S. Geological Survey at Hay Creek near Wibaux, Mont.

Station identification number: 470029104063110
Latitude: 47°00'29" Longitude: 104°06'31" Altitude: 2,710 feet

(1) Location--In SE1/4NW1/4SW1/4 sec. 34, T. 15 N., R. 60 E., Wibaux County, 0.25 mile north of farmstead and 4 miles northeast of Wibaux, Mont.

(2) Establishment and operation--The station was established by the North Dakota District, U.S. Geological Survey, in 1978 and deactivated in 1981. Data collection began in August 1978 for most meteorological variables. Collection of the remaining variables began earlier that year. The station was operated year-round. Instrument malfunctions resulted in some missing data.

(3) Description of meteorological station--The meteorological variables measured at Hay Creek include: air temperature, relative humidity, incident global solar radiation, accumulated precipitation, wind speed, and wind direction. Owing to the fact that this station was part of a precipitation-runoff modeling project, other precipitation data as well as periodically measured soil moisture, snow depth, and water content of snow data are available from other locations in the vicinity (Emerson and others, 1983).

Most of the variables were measured by a data acquisition system, which included a group of sensors connected to a data-logging microcomputer. Depending upon the module and sensor, the data logger provided continuous monitoring (wind and solar radiation), interrogation at short time intervals (temperature, every 24 seconds), or recordation when a threshold voltage was exceeded. These values were

Table 9.--*Period of obtained record, data recovery, and instrument description for the U.S. Bureau of Reclamation meteorological station*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	Apr. 11, 1977-Sept. 20, 1979	100	Mercury/alcohol maximum/mimimum thermometer acc: ±0.2 °Fahrenheit r: maximum -38 to +130 °Fahrenheit minimum -50 to +120 °Fahrenheit
Incident global solar radiation	Apr. 11, 1977-Sept. 20, 1979	100	Sol-A-Meter Matrix, Inc. acc: not available r: not available
Accumulated precipitation	Apr. 11, 1977-Sept. 23, 1977	100	Standard 8-inch rain gage with modified Alter windshield (U.S. Weather Bureau) acc: ± 0.01 inch r: not applicable
Wind speed	Apr. 11, 1977-Sept. 20, 1979	100	Totalizing anemometer acc: not available r: not available
Total evaporation	May 3, 1977-Sept. 20, 1979	94.2	Evaporation pan (U.S. Weather Bureau, class A) acc: 0.01 inch r: not applicable

processed into hourly means or sums as indicated. From the microcomputer the data were stored on cassette tapes. Precipitation was cumulatively measured at 5-minute intervals accurate to 0.1 inch. The period of collection and the percentage of data recovery along with the instruments used and their specifications for each meteorological variable are given in table 10. The air temperature instrument was housed in a self-aspirating shelter mounted on an instrument mast about 7 feet above the ground. The relative humidity probe was placed in a cotton-region instrument shelter about 4.5 feet above the ground. A backup hygrothermograph was housed in the shelter about 4 feet above the ground. The wind speed and wind direction instruments were placed on a mast about 10 feet above the ground. The mast was located to prevent obstructions to wind path. Finally, the solar radia-

Table 10.--*Period of obtained record, data recovery, and instrument description for the U.S. Geological Survey meteorological station at Hay Creek*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	Oct. 1, 1977-Nov. 8, 1981	83.7	Linear thermistor (Weathertronics Inc., model 4480) acc: ±0.1 °Celsius r: -50 to +50 °Celsius
Relative humidity	Aug. 15, 1978-Nov. 8, 1981	88.9	Humidity probe (Weathertronics Inc., solid state model 5120) acc: ±1 percent r: 0 to 100 percent
Incident global solar radiation	Aug. 15, 1978-Nov. 8, 1981	86.7	Precision spectral pyranometer, (Eppley Laboratory, model PSP) acc: typically 7 percent or less r: 0.3 to 3.0 micrometers
Accumulated precipitation	Apr. 25, 1978-Nov. 8, 1981	100	Digital weighing rain gage with modified Alter windshield (Fischer and Porter Co., model 35B1559ED14BC2) acc: ±0.1 inch r: 0 to 20 inches
Wind speed	Aug. 16, 1978-Nov. 8, 1981	70.3	Anemometer (Weathertronics Inc., model 2030) acc: ±0.15 mile per hour r: 0.5 to 100 miles per hour
Wind direction	Aug. 16, 1978-Nov. 8, 1981	59.4	Wind vane (Weathertronics Inc., model 2020) acc: ±2 degrees r: 0 to 360 degrees

tion instrument was mounted on a steel pedestal about 5 feet above the ground and away from shadow casting objects.

All instruments were inspected at 2-4 week intervals and calibration procedures were performed as needed. The wind speed instrument was checked against a hand held anemometer. Wind direction was inspected by comparing the vane to various compass points manually. Relative humidity and air temperature were checked with an Assman psychrometer. The humidity probe was calibrated using a constant humidity chamber or an Assman psychrometer and a damp cloth. The latter procedure involved wrapping a damp cloth around the probe and changing the gain and offset on the data logger module after the readings stabilized at 98-100 percent relative humidity. The precipitation gage was calibrated by adding a known weight to the gage and adjusting the response. The pyranometer, used to measure solar radiation, was checked with a constant voltage source every 6 months. The calibration of the pyranometer was checked by the Eppley Laboratory at the end of the project.

U.S. Geological Survey at Prairie Dog Creek near Birney, Mont.

Station identification number: 451618106380801
Latitude: 45°16'18" Longitude: 106°38'08" Altitude: 3,240 feet

(1) Location--In SW1/4 sec. 31, T. 6 S., R. 42 E., Rosebud County, off county road in the mouth of Prairie Dog valley and 7 miles west of Birney, Mont.

(2) Establishment and operation--The station was established by the Montana District, U.S. Geological Survey. Data collection began in October 1978 for all meteorological variables and was deactivated at the end of September 1984. The station was operated year-round. Instrument malfunctions resulted in some missing data.

(3) Description of meteorological station--The meteorological variables measured at Prairie Dog Creek include: air temperature, relative humidity, incident global solar radiation, accumulated precipitation, wind speed and wind direction. Owing to the fact that this station was part of a precipitation-runoff modeling project, other precipitation data as well as periodically measured soil moisture, snow depth, and water content of snow data are available from other locations in the vicinity (Cary and Johnson, 1981, 1982).

Most of the variables were measured by a data-acquisition system that included a group of sensors connected to a data-logging microcomputer. Depending upon the module and sensor, the data logger provided continuous monitoring (wind and solar radiation), interrogation at short time intervals (temperature, every 24 seconds), or recordation when a threshold voltage was exceeded. These values were processed into hourly means or sums as indicated. From the microcomputer the data were stored on cassette tapes. Precipitation was cumulatively measured at 5-minute intervals accurate to 0.1 inch. The period of collection and the percentage of data recovery along with the instruments used and their specifications for each meteorological variable are given in table 11. The air temperature instrument was housed in a self-aspirating shelter mounted on an instrument mast about 7 feet above the ground. The relative humidity probe was placed in a cotton-region instrument shelter about 4.5 feet above the ground. A backup hygrothermograph was housed in the shelter about 4 feet above the ground. The wind speed and wind direction instruments were placed on a mast about 10 feet above the ground. The mast was located to prevent

Table 11.--*Period of obtained record, data recovery, and instrument description for the U.S. Geological Survey meteorological station at Prairie Dog Creek*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	Oct. 1, 1978-July 17, 1984	98.3	Linear thermistor (Weathertronics Inc., model 4480) acc: ±0.1 °Celsius r: -50 to +50 °Celsius
Relative humidity	Oct. 1, 1978-July 17, 1984	96.1	Humidity probe (Weathertronics Inc., solid state model 5120) acc: ±1 percent r: 0 to 100 percent
Incident global solar radiation	Oct. 1, 1978-July 17, 1984	94.8	Precision spectral pyranometer, (Eppley Laboratory, model PSP) acc: typically 7 percent or less r: 0.3 to 3.0 micrometers
Accumulated precipitation	Oct. 1, 1978-Sept. 30, 1982	100	Digital weighing rain gage with modified Alter windshield (Fischer and Porter Co., model 35B1559ED14BC) acc: ±0.10 inch r: 0 to 20 inches
Wind speed	Aug. 16, 1978-Feb. 9, 1984	90.6	Anemometer (Weathertronics Inc., model 2030) acc: ±0.15 mile per hour r: 0.5 to 100 miles per hour
Wind direction	July 7, 1978-July 17, 1984	90.6	Wind vane (Weathertronics Inc., model 2020) acc: ±2 degrees r: 0 to 360 degrees

obstructions to wind path. Finally, the solar radiation instrument was mounted on a steel pedestal about 5 feet above the ground and away from shadow casting objects.

All instruments were inspected and cleaned as indicated. Calibration procedures were performed as needed. The wind speed instrument was checked visually. Wind direction was inspected by comparing the vane to various compass points manually. The relative humidity and air temperature equipment was checked with an Assman psychrometer. The humidity probe was calibrated using a constant humidity chamber or an Assman psychrometer and a damp cloth. The latter procedure involved wrapping a damp cloth around the probe and changing the gain and offset on the data logger module after the readings stabilized at 98-100 percent relative humidity. The pyranometer, used to measure solar radiation, was checked about once a year with a constant voltage source. The calibration of the pyranometer was checked in January 1983 at the National Oceanic and Atmospheric Administration solar radiation facility in Boulder, Colo. No evidence of instrument drift was indicated. The precipitation gage was calibrated by placing a known weight on the gage and adjusting the response.

U.S. Geological Survey at West Branch Antelope Creek near Zap, N. Dak.

Station identification number: 472115101534810
Latitude: 47°21'15" Longitude: 101°53'48" Altitude: 2,160 feet

(1) Location--In SW1/4NW1/4NE1/4 sec. 28, T. 145 N., R. 88 W., Mercer County, about 900 feet southwest of farmstead and 5 miles northeast of Zap, N. Dak.

(2) Establishment and operation--The station was established by the North Dakota District, U.S. Geological Survey, in 1978 and has continued to the present (1984). Data collection began in June 1978 for most meteorological variables. Collection of remaining variables began earlier that year. The station is operated year-round. Instrument malfunctions result in some missing data.

(3) Description of meteorological station. The meteorological variables being measured at the West Branch Antelope Creek station include: air temperature, relative humidity, incident global solar radiation, accumulated precipitation, wind speed, and wind direction. Owing to the fact that this station is part of a modeling project, other precipitation data as well as periodically measured soil moisture, snow depth, and water content of snow data are available from other points in the vicinity (Emerson and others, 1983).

Most of the variables are measured by a data acquisition system that includes a group of sensors connected to a data-logging microcomputer. Depending upon the module and sensor, the data logger provides continuous monitoring (wind and solar radiation), interrogation at short time intervals (temperature, every 24 seconds), or recordation when a threshold voltage is exceeded. These values are processed into hourly means or sums as indicated. From the microcomputer the data are stored on cassette tapes. Precipitation is cumulatively measured at 5-minute intervals accurate to 0.1 inch. The period of collection and the percentages of data recovery along with the instruments being used and their specifications for each meteorological variable are given in table 12. The air temperature instrument is housed in a self-aspirating shelter mounted on an instrument mast about 7 feet above the ground. The relative humidity probe is placed in a cotton-region instrument shelter about 4.5 feet above the ground. A backup hygrothermograph is housed

Table 12.--*Period of obtained record, data recovery, and instrument description for the U.S. Geological Survey meteorological station at West Branch Antelope Creek*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	June 23, 1978-Feb. 9, 1984	90.4	Linear thermistor (Weathertronics Inc., model 4480) acc: ±0.1 °Celsius r: -50 to +50 °Celsius
Relative humidity	June 23, 1978-Feb. 9, 1984	78.8	Humidity probe (Weathertronics, solid state model 5120) acc: ±1 percent r: 0 to 100 percent
Incident global solar radiation	June 24, 1978-Feb. 9, 1984	84.3	Precision spectral pyranometer (Eppley Laboratory, model PSP) acc: typically 7 percent or less r: 0.3 to 3.0 micrometers
Accumulated precipitation	May 7, 1978-Sept. 30, 1982	100	Digital weighing rain gage modified Alter windshield (Fischer and Porter Co., model 35B1559ED14BC) acc: ± 0.1 inch r: 0 to 20 inches
Wind speed	June 24, 1978-Feb. 9, 1984	81.6	Anemometer (Weathertronics Inc., model 2030) acc: ±0.15 mile per hour r: 0.5 to 100 miles per hour
Wind direction	July 7, 1978-Feb. 9, 1984	84.6	Wind vane (Weathertronics Inc., model 2020) acc: ±2 degrees r: 0 to 360 degrees

in the shelter about 4 feet above the ground. The wind speed and wind direction instruments are placed on a mast about 10 feet above the ground. The mast is located to prevent obstructions to wind path. Finally, the solar radiation instrument is mounted on a steel pedestal about 5 feet above the ground and away from shadow casting objects.

All instruments are inspected at 2-4 week intervals and calibration procedures are performed as needed. The wind speed instrument is checked against a hand held anemometer. Wind direction is inspected by comparing the vane to various compass points manually. Relative humidity and air temperature are checked with an Assman psychrometer. The humidity probe is calibrated using a constant humidity chamber or an Assman psychrometer and a damp cloth. The latter procedure involves wrapping a damp cloth around the probe and changing the gain and offset on the data logger module after the readings stabilized at 98-100 percent relative humidity. The precipitation gage is calibrated by adding a known weight to the gage and adjusting the response. The pyranometer, used to measure solar radiation, is checked with a constant voltage source every 6 months. The calibration of the pyranometer was checked by the Eppley Laboratory in early 1985.

Western Energy Company at Rosebud Mine near Colstrip, Mont.

Station identification number: 455204106384501
Latitude: 45°52'04" Longitude: 106°38'45" Altitude: 3,320 feet

(1) Location--In NW1/4 SE1/4, sec. 5, T. 1 N., R. 41 E., in Rosebud County, about 1.5 miles southwest of Colstrip, Mont.

(2) Establishment and operation--The station was established by Western Energy Company in 1980 and has continued to the present (1984). Data collection, for most meteorological variables, began in January 1980. Collection of the remaining variables began later that year. The station is operated year-round. Instrument malfunctions result in some missing data.

(3) Description of meteorological station--The meteorological variables being measured at the Western Energy meteorological station include: air temperature, relative humidity, barometric pressure, incident global solar radiation, accumulated precipitation, and wind speed.

The period of collection and the percentage of data recovery along with the instruments being used and their specifications for each meteorological variable are given in table 13. The air temperature, relative humidity, and barometric pressure instruments are located inside a cotton-region type instrument shelter that stands about 4.5 feet above the ground. The solar radiation sensor is located on a steel pole about 6 feet above the ground. Lastly, the wind instruments are located on a 33-foot tower.

Westmoreland Resources at Absaloka Mine east of Hardin, Mont.

Station identification numbers: 454815107050201 and 454926107071501

Latitude:	45°48'15"	Longitude:	107°05'02"	Altitude:	3,520 feet
	45°49'26"		107°07'15"		3,520 feet

Table 13.--*Period of obtained record, data recovery, and instrument description for the Western Energy Company meteorological station*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	Jan. 1, 1980-Sept. 30, 1983	81.1	Hygrothermograph (Weather Measure Corp., model H311) acc: ±1.0 percent r: 110° Fahrenheit adjustable
Relative humidity	Jan. 1, 1980-Sept. 30, 1983	70.3	Hygrothermograph (Weather Measure Corp., model H311) acc: ±1.0 percent between 20 and 80 percent, ±3.0 percent percent at extremes r: 0 to 100 percent
Barometric pressure	Jan. 1, 1980-Sept. 30, 1983	88.8	Microbarograph (Weather Measure Corp., model B211) acc: ±0.15 percent of range r: 945 to 1,045 millibars
Incident global solar radiation	Mar. 1, 1980-Sept. 30, 1983	67.2	Mechanical pyranograph (Weather Measure Corp., model R401) acc: typically 28 percent or less r: 0.36 to 2.0 micrometers
Accumulated precipitation	Jan. 1, 1980-Sept. 30, 1982	100	Heated snow gage with a modified Alter windshield (Weather Measure Corp., model P511-E) acc: ±0.01 inch r: 0 to 20 inches
Wind speed			Anemometer (Weather Measure Corp., model W200-S) acc: not available r: 0 to 100 miles per hour

(1) Location--In SW1/4 sec. 26, T. 1 N., R. 37 E., and NE1/4 sec. 21, T. 1 N., R. 37 E., Big Horn County, in the Sarpy Creek basin, at the Absaloka Mine, on a small rise of bare ground 100 feet south of the water-treatment building near the coal crushing and storage facility, and 30 miles east of Hardin, Mont.

(2) Establishment and operation--The station was established by Westmoreland Resources, Inc. Data acquired for this study began after installation of new instruments and several modifications to the system in October 1977 and continues to the present (1984). The station is operated year-round. Instrument malfunctions result in some missing data.

(3) Description of meteorological station--The meteorological variables being measured at the Absaloka Mine main station (454815107050201) are: air temperature, relative humidity, barometric pressure, incident global solar radiation, accumulated precipitation, and wind speed. Precipitation is measured at the mine office site (454926107071501).

The period of collection and the percentage of data recovery along with the instruments being used and their specifications for each meteorological variable are listed in table 14. The wind and air temperature sensors are mounted on a pole 33 feet above the ground. Signal conditioners and recorders are housed in a cabinet mounted on the pole below the sensors. A cotton-region type instrument shelter, which stands about 5 feet high, houses the hygrothermograph and the microbarograph recorders. The pyranograph recorder is mounted on top of the instrument shelter. Both precipitation gages at the main meteorological station and at the mine office site are equipped with modified Alter shields. In July 1978, recorders for wind speed, wind direction, and air temperature were replaced with Easterline-Angus A601C strip-chart recorders to improve reliability and accuracy.

The station is operated with weekly maintenance by Westmoreland technicians. From 1977 to 1981 Northern Testing Laboratory was retained as a consulting firm to provide site audits and instrument calibrations, major maintenance and repair work, and data processing procedures, and to instruct the Westmoreland technicians in data retrieval methods. The continuous drum chart variables (precipitation, relative humidity, barometric pressure, solar radiation, and air temperature) were read and processed by Northern Testing Laboratory. The strip-chart parameter (wind speed) was digitized by Envirodata Corporation under subcontract to Northern Testing Laboratory. After January 1982, these duties were conducted by Bison Engineering.

Auditing and calibration of the meteorological instruments are performed semiannually. Wind speed and wind direction are calibrated with an electronic simulator. This process involves providing a known signal to the system and then using a voltmeter to adjust the transmitter to the manufacturer's specifications. Temperature is also calibrated to the manufacturer's specifications using a digital voltmeter. The precipitation gages are calibrated by placing a known weight on the gages and adjusting the response. Lastly, a portable barometer calibrated against National Weather Service instruments is used to calibrate the barometric pressure recorder.

Table 14.--*Period of obtained record, data recovery, and instrument description for the Westmoreland Resources meteorological station*

[Instrument description: acc, accuracy; r, range]

Variable	Period of obtained record	Data recovery (percent)	Instrument description
Air temperature	Oct. 29, 1977-Dec. 31, 1982	95.8	Thermometer (Met One, model 070) acc: typically ±1.0 percent r: -50 to +50 °Celsius
Relative humidity	Oct. 5, 1977-Dec. 31, 1982	64.4	Hygrothermograph (Bendix, model 594) acc: typically ±4.0 percent r: 0 to 100 percent
Barometric pressure	Oct. 5, 1977-Dec. 31, 1982	83.5	Microbarograph (Belfort, model 5-800A) acc: typically less than 1.0 percent r: typically 945 to 1,045 millibars
Incident global solar radiation	Oct. 5, 1977-Dec. 31, 1982	91.2	Mechanical pyranograph (Weather Measure Corp., model R401) acc: typically 28 percent or less r: 0.36 to 2.0 micrometers
Accumulated precipitation	Oct. 5, 1977-Dec. 31, 1982	100	Weighing gage with modified Alter windshield (Belfort Instruments Co.) acc: ±0.5 percent r: 0 to 12 inches
Wind speed	Oct. 29, 1977-Dec. 31, 1982	95.5	Anemometer (Met One, model 011) acc: not available r: not available

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