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ABSTRACT

An extensive, 33 year (1964-1996), climatic database has been developed for three climate stations on the Reynolds Creek Experimental Watershed (RCEW) located near the north end of the Owyhee Mountains in southwest Idaho. The longest records (1964-1996) are for daily maximum and minimum temperature. The length of record for other weather elements that include relative humidity, solar radiation, wind speed and direction, daily Class A pan evaporation and barometric pressure varies, but in general is from 1974-1996. Weather sensors have varied from hygrothermographs with spring-driven clocks and charts to electronic sensors with the data telemetered daily to the Northwest Watershed Research Center (NWRC) office in Boise, Idaho. Most of the data, since the early 1980's, were measured and stored electronically, therefore, hourly data are available for most climatic elements between the early 1980's and 1996. These data can be accessed from the USDA-ARS Northwest Watershed Research Center database through the anonymous ftp site: *ftp.nwrc.ars.usda.gov*.

Key Words: Climate, meteorology, air temperature, relative humidity, solar radiation, wind speed, wind direction, evaporation, hydrology, watershed

1. INTRODUCTION

Weather elements, such as air temperature and solar radiation, and their spatial and seasonal variations, are basic to all hydrologic and natural resource studies. The U. S. Department of Agriculture-Agricultural Research Service (ARS), Northwest Watershed Research Center (NWRC) operates a climate network as an integral part of the hydrologic studies on the Reynolds Creek Experimental Watershed (RCEW) (Figure 1). The experimental area is a 239-km^2 watershed located in the Owyhee Mountains of southwest Idaho [*Johnson et al.*, 1982; *Johnson et al.*, 1987; *Robins et al.*, 1965; *Stephenson,* 1977]. The lowest elevation on the watershed is 1101 m; the eastern boundary rises to about 1525 m; the western to 830 m; and southern to a peak of 2241 m. Reynolds Creek is a north-flowing tributary of the Snake River.

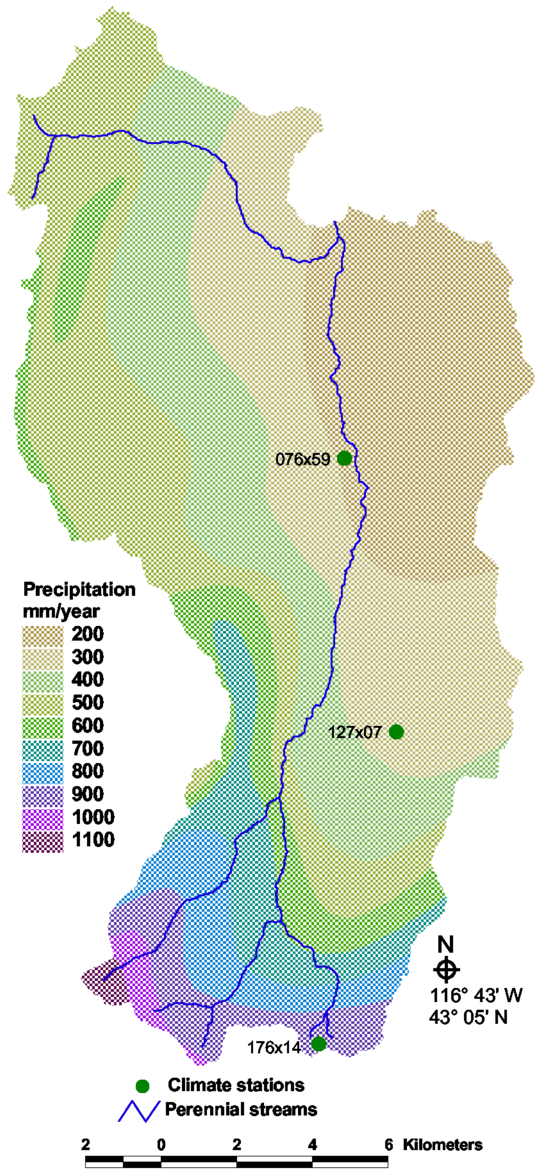

Figure 1. Location of the three climate stations on the Reynolds Creek Experimental Watershed located in southwest Idaho, USA.

An extensive, 33 year (1964-1996) climatic database has been developed for three climate stations on the RCEW (Table 1). Climate station locations on the watershed are referenced to a grid as described by *Seyfried et al.* [2000]. The longest records (1964-1996) are for daily maximum and minimum air temperature at station 076x59. Daily maximum and minimum air temperatures are available from 1967 through 1996 for the other two climate stations. The length of record for other climate elements that include relative humidity, dew-point temperature, solar radiation, wind speed and direction, daily Class A pan evaporation and barometric pressure vary, but in general is from 1974 through1996.

Table 1. Location, elevation and annual summary of air temperature, wind speed and Class A pan evaporation of the three weather stations on the Reynolds Creek Experimental Watershed

	Location		Elevation		Mean Annual Daily Air Temperature			Mean Wind	Mean Seasonal
Weather Station	Easting (m)	Northing (m)	GPS (m)	DEM (m)	Maximum (°C)	Minimum (°C)	Mean (°C)	Speed (m/s)	Evaporation (mm)
076X59	520,367	4,783,418	1207	1202	15.6	2.1	8.9	1.80	1,255
127X07	521,742	4,776,189	1652	1653	12.1	3.7	7.9	3.05	1,082
176X14	519,693	4,767,923	2097	2097	8.8	0.7	4.7	3.81	795

2. REYNOLDS CREEK EXPERIMENTAL WATERSHED CLIMATE NETWORK

2.1. Air Temperature

2.1.1 Measurements and Database

The NWRC database contains maximum and minimum daily air temperatures that were obtained from recording hygrothermographs housed in a National Weather Service medium-sized weather shelter [*Brakensiek et al.,* 1979*; Finklin and Fischer,* 1990*; U. S. Dept. of Commerce,* 1989] located at each of the three climate stations. These records were hand listed from the hygrothermograph charts with each day ending at 2400 Mountain Standard Time (MST). These data started in 1964 at weather station 076x59 as shown in Table 2 and continued through the early 1980's. After the early 1980's, hourly and daily maximum and minimum air temperatures were measured and recorded electronically at the three climate stations (Table 2). Hourly data are the average temperature of the hour prior to the time that the temperature values were recorded.

The electronic sensors were located in an aspirated shield at stations 076x59 and 176x14 and in a Gill type shield [*Finklin and Fischer,* 1990] at climate station 127x07. The electronic sensor at 076x59 was located at 1 m above the ground between 1981 and September 30, 1996. To keep the sensors above the snow and to help prevent vandalism, the electronic sensors were located at 3 m at climate stations 127x07 and 176x14.

Table 2. Sensor height above ground and starting date of climate record for the three weather stations on the Reynolds Creek Experimental Watershed; all records end September 30, 1996.

	HOURLY DATA				DAILY DATA		
	Wind Speed (m/s), Wind Direction (degrees)		Air Temperature (°C), Dew Point (°C), Relative Humidity (%), Vapor Pressure (kPa), Solar Radiation (w/m^2)		Max/Min Air Temperature (°C)		Class A Pan Evaporation (mm)
Weather Station	Sensor Height (m)	Record Begins	Sensor Height (m)	Record Begins	Sensor Height (m)	Record Begins	Record Begins
076X59	2.0	05/15/1986	1.0	06/18/1981	1.5	01/01/1964	03/22/1974
	9.1	08/23/1985					
127X07	2.0	12/05/1984	3.0	12/05/1984	1.5	01/01/1967	04/21/1977
176X14	3.0	02/24/1983	3.0	02/24/1983	1.5	01/01/1967	06/14/1974

Prior to the electronic temperature records, missing daily maximum and minimum air temperature values were estimated using regression equations that were developed from temperature records from all available climate stations located on the RCEW. Temperature records from only three of these climate stations are included in this dataset. Hygrothermograph data were used to estimate most of the missing electronic records and regression equations were used when hygrothermograph data were not available.

2.1.2 Example Analyses

As shown in Table 1, the mean annual temperature at the three climate stations, 076x59, 127x07 and 176x14 was 8.9, 7.9 and 4.7 °C, respectively. These temperature values indicate that there is a mean annual temperature gradient of 0.22 °C per 100 m between the low and mid elevation stations and a gradient of 0.72 °C per 100 m between the mid and high elevation stations. This difference in temperature gradient is due to the warmer minimum temperatures at the mid elevation climate station caused by cold-air drainage into the valley below.

The mean maximum and minimum temperatures by month for each of the three climate stations are shown in Figure 2. As would be expected, the mean maximum temperature for each month is the warmest at the low elevation station (076x59) and the coldest at the highest station (176x14). These differences vary from 4 °C in the winter to 7 °C in the summer.

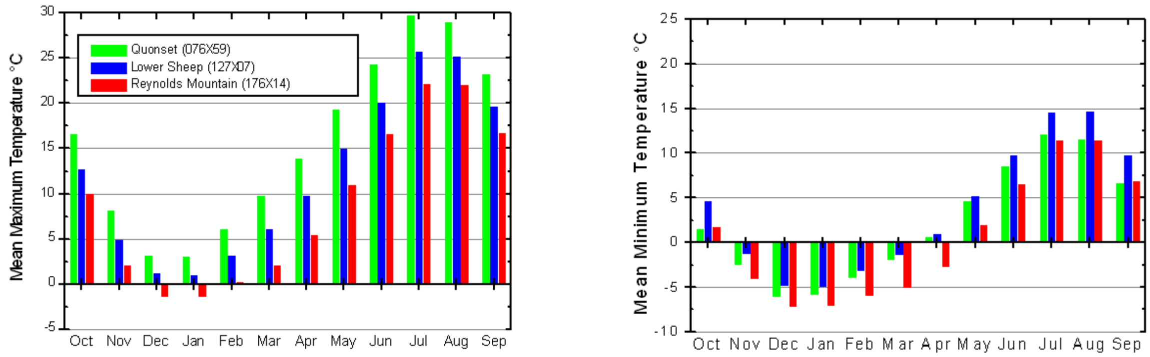

Figure 2. Mean monthly maximum and minimum temperature of the three climate stations on the Reynolds Creek Experimental Watershed, Idaho.

The mean minimum temperature was the warmest at the mid elevation station and in general the coldest at the high elevation station. The mean monthly minimum temperature of the low and high elevation stations was about the same during September and October. This mean minimum temperature regime in conjunction with the normal snow cover on the RCEW generally results in a shallower frozen soil layer at the mid than the lower elevation climate station.

2.2 Relative Humidity, Dew-Point Temperature and Vapor Pressure

2.2.1 Measurements and Database

Hourly average relative humidity from December 5, 1984 through September 30, 1996 was measured and recorded electronically at 127x07. The sensor was in a Gill type shield mounted 3 m above the ground. At 176x14, hourly relative humidity was measured electronically in an aspirated shield mounted 3 m above the ground from February 24, 1983 through September 30, 1996.

Hourly dew-point temperatures at climate station 076x59 are available for June 18, 1981 through September 30, 1996. These data were measured by a lithium chloride dew-cell that was housed in an aspirated shield mounted 1 m above the ground.

Climate variables, relative humidity, dew-point temperature and vapor pressure, are listed as available in Table 2 but only relative humidity or dew-point was measured at a climate station. The other two weather variables were calculated using the measured data and standard conversion equations [*Marks et al.*, 1999].

Missing hourly relative humidity and dew-point temperature values were estimated from regression relationships that have been developed between climate stations used in this database and data from other climate stations located on RCEW that are not available in this database.

2.3. Solar Radiation

2.3.1 Measurements and Database

At each of the climate stations, hemispherical short-wave radiation was measured with Eppley precision pyranometers sensitive to wavelengths from 0.285 to 2.8 µm. Hourly solar radiation is available in the database from June 18, 1981, December 14, 1984, and February 24, 1983 through September 30, 1996 for climate stations 076x59, 127x07 and 176x14, respectively.

Hourly radiation data were checked for outliers using clear-sky radiation calculated using a version of the Lowtran-7 radiation transfer model [*Kneizys, et al.*, 1988] that was corrected for solar geometry and terrain effects [*Dubayah*, 1994*; Dubayah, et al.*, 1990]. Missing hourly radiation at each site was then estimated using data from either of the other sites that were in operation, and the simulated clear-sky value.

2.4. Wind Speed and Direction

2.4.1 Measurements and Database

As shown in Table 2, average hourly wind speed in meters per second was recorded at the three climate stations from the mid 1980's through September 30, 1996. Anemometers were mounted 2 and 9.1 m above the ground at climate station 076x59, 2 m at climate station 127x07, and 3 m at climate station 176x14. The anemometer was mounted higher at climate station 176x14 so that it was at least 2 m above the snow pack during the winter months.

Various types of 3-cup anemometers were used at each of the three climate stations depending on what equipment was available and the type of recording units that were being used to record and transmit the hourly data. The various anemometers had threshold wind speeds from 0.5 to 1 m/sec. The wind speed data have not been adjusted for threshold values.

Wind vanes were used at each of the three climate stations to indicate the hourly, instantaneous wind-direction in degrees from north. The wind vanes were mounted 9.1, 2 and 3 m above the ground at climate stations 076x59, 127x07 and 176x14, respectively.

There are missing records in both of the hourly wind speed and wind direction datasets from each of the three weather stations. Some of the missing records in both the speed and direction datasets were estimated by interpolation for periods of less than 5 hours.

2.4.2 Example Analyses

The mean annual, hourly wind speed at climate station 076x59 was 1.80 m/sec (Table 1). This station is located at the lower end of the valley so it is protected by mountains from the extreme winds associated with climate station 176x14. Climate station 176x14 is located on an exposed site on the southern ridge of the watershed and thus is subject to extreme wind conditions especially during winter storms.

2.5. Class A Pan Evaporation

2.5.1 Measurement and Database

Class A pans [*Brakensiek et al.*, 1979; *Finklin and Fischer*, 1990; *U. S. Dept. of Commerce*, 1989] were used to measure evaporation at each of the three climate stations on the RCEW each summer starting in the mid 1970's through 1996 (Table 2). The level of water in the pans was maintained between 5.1 cm and 7.6 cm below the rim of the pans by automatically filling them from stored water [*Hanson and Burgess,* 1997]. The pans were equipped with stilling wells and float driven recorders to measure the depth of water in the pans until the depth of water measurements were converted to electronic transducers in 1993.

The transducers were located in stilling wells at 0.6 m below the ground surface. This was done to minimize the effects of wind induced waves in the pans that affected transducer output. It was also done to minimize changes in transducer output due to air temperature variations.

Missing records were estimated using regression equations that had been developed for total daily pan evaporation between climate stations or from equations developed by *Hanson* [1989]. Each daily Class A pan evaporation record ends at 2400 Mountain Standard Time.

2.5.2 Example Analyses

As shown in Table 1, *Hanson* [1989] found that the mean seasonal Class A pan evaporation was 1,255, 1,082 and 795 mm for climate stations 076x59,127x07 and 176x14, respectively. The seasonal, daily evaporation rates were very nearly the same at the two lower elevation climate stations 076x59 and 127x07, so the longer season at climate station 076x59 was the reason for greater total seasonal pan evaporation at that site. At climate station 176x14, the mean daily pan evaporation rate was less than at the other two sites and the season was shorter at this highest elevation site, resulting in less mean seasonal pan evaporation.

2.6. Barometric Pressure

2.6.1 Measurement and Database

Hourly values of barometric pressure have been measured at climate station 076x59 using a Vaisala PTA 427 series barometric pressure transmitter and the data stored electronically in the NWRC database from February 12, 1987 through September 30, 1996. These data have been checked for outliers, but missing records could not be estimated.

3. DATA AVAILABILITY

Data from the three climate stations are available from the anonymous ftp site *ftp.nwrc.ars.usda.gov* maintained by the USDA Agricultural Research Service, Northwest Watershed Research Center in Boise, Idaho, USA. Data are located in the directory *publicdatabase/climate*, in ASCII files that have been compressed using a "zip" utility. Each file has a <26>-line ascii header providing brief information on file contents, location (Easting and Northing, UTM zone 11), both the GPS elevation and the DEM elevation (see Seyfried et al., 2000), time format, period of record, column contents and units, missing data key, contact, citation and disclaimer information. An ASCII README file in the same directory gives a detailed description of the file format and contents. Both the daily and hourly climate data are stored in three separate files (one for each climate station) identified by the data type and station ID (eg.: "daily076x59climate.txt" or "hourly076x59climate.txt"). Each record in the daily files consists of a line containing month, day, year, minimum air temperature (°C), maximum air temperature (°C), and Class A pan evaporation (mm). Each record in the hourly files consists of a line containing month, day, year, hour, minute, air temperature (°C), relative humidity (decimal %), vapor pressure (kPa), dew-point temperature (°C), solar radiation (w/m^2), wind speed (m/s), wind direction (degrees from north), and, at site 076x59, atmospheric pressure (kPa).

Any publications which are generated from these data should cite this publication, and acknowledge the USDA-ARS Northwest Watershed Research Center as the source. In addition, we request that you notify NWRC of all publications, including theses and dissertations, which use or refer to these data. Citations may be sent by email to: *publicdatabase@nwrc.ars.usda.gov* or by mail to: USDA-ARS Northwest Watershed Research Center, 800 Park Blvd., Suite 105, Boise, ID 83712-7716. Your cooperation in this matter will promote further research and cooperation, help to validate the usefulness of the ARS experimental watersheds and data collection activities, and influence agency policy regarding future data collection.

4. SUMMARY

An unique 33 year (January 1964 through September 1996) climate database has been developed and made available on the web for the for the Reynolds Creek Experimental Watershed located in the Owyhee Mountains in southwest Idaho. This mountainous watershed represents much of the climate and vegetation conditions associated with rangelands in the interior Pacific Northwest and is operated by the USDA-Agricultural Research Service. This database includes daily and hourly air temperature, solar radiation, relative humidity, dew-point temperature, vapor pressure, Class A pan evaporation, and wind speed and direction for three climate stations on the watershed. Not all of records are available for all climate elements for the full 33 year series but in general hourly data are available between the early 1980's and September 30,1996.

These data can be accessed from the USDA-ARS Northwest Watershed Research Center database through the anonymous ftp site: *ftp.nwrc.ars.usda.gov*.

5. DISCLAIMER

The mention of trade names or commercial products does not constitute endorsement or recommendation for use. The Agricultural Research Service (ARS) is a research organization. There are no legal mandates for the agency to collect or to distribute data collected for specific research projects. These data are being made available to the research community to promote the general knowledge of the processes relating to our country's natural resources.

6. ACKNOWLEDGMENTS

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