

Meteorologic and Hydrologic Data Sets for the North  
Slope of Alaska along the Kuparuk River Watershed  
1985-2007

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These data are also available, along with the most up to date information, via the Water  
and Environmental Research Center (WERC)- North Slope Hydrology Research Projects'  
home page at:

<http://www.uaf.edu/water/projects/NorthSlope/northslope.html>

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**IMPORTANT NOTE:**

Updates and corrections were made to the data by the investigators, and all of the data  
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## **INTRODUCTION**

Various research projects on the North Slope of Alaska have, since the mid 1980's, resulted in the establishment of several unmanned meteorological and research sites on a north-south transect. For logistical reasons, all of the present sites are located along the Dalton Highway or accessible from roads on the Prudhoe Bay oil field. The catalyst for this data collection program was the Department of Energy's R4D project at Imnavait creek where the first meteorological data sites were established in 1985. One year later in 1987, additional meteorological sites were established at Sagwon and Franklin Bluffs.

In 1992, another meteorological site was installed in conjunction with a wetlands study funded by the U.S. Geological Survey on the west side of the Prudhoe Bay oil field on the banks of the Kuparuk River. In 1993, the Imnavait Basin A site was moved several kilometers, renamed, and re-installed on the Kuparuk River south of the Dalton Highway near Toolik Lake. Finally, in 1994, the first remote meteorological station that transmits via satellite was installed on the Kuparuk River 90 km south of the Arctic Coast in the western most part of the Kuparuk River Basin. No data are reported for either the Upper or West Kuparuk stations in this report.

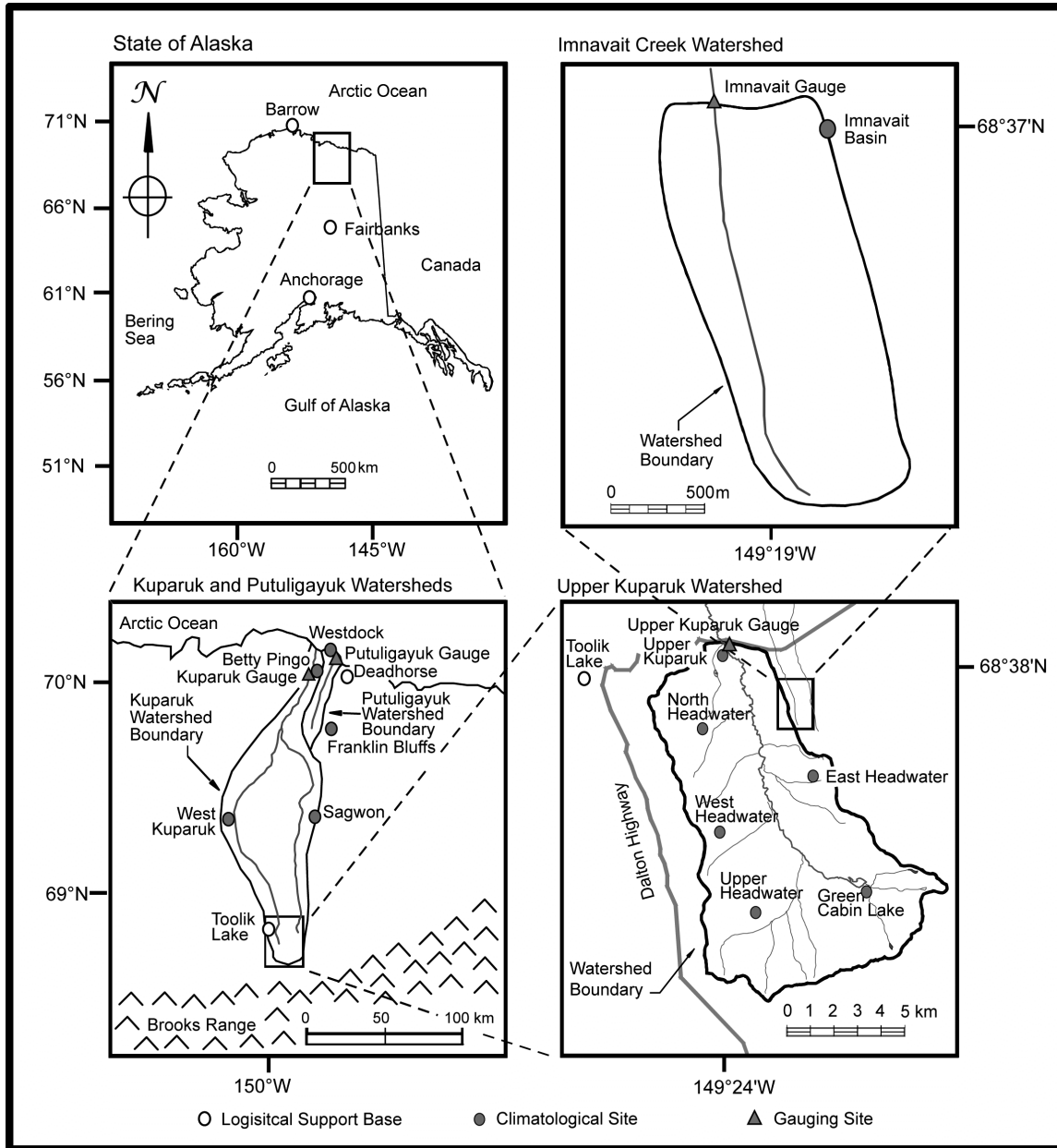
The quality and continuous collection of this data is only possible because of the availability of solid state instrumentation and data loggers. The quality of most data is very good, although some instrumentation does not work well for various environmental conditions. For example, precipitation gages do not work well in windy conditions and radiometers do not work well when coated with rime ice, condensation, dust, etc.. We have tried to identify bad data and remove it, but this is not always possible. Because of poor performance during the winter months, we do not collect data from radiometers and the standard 8 inch (20 cm) orifice precipitation gages from September through mid-April.

The collection of this data set would not be possible without the support of the Department of Energy, U.S. Geological Survey and the National Science Foundation. We would also like to thank the many individuals who assisted us over the years in the collection of this data.

## **SITE DESCRIPTION**

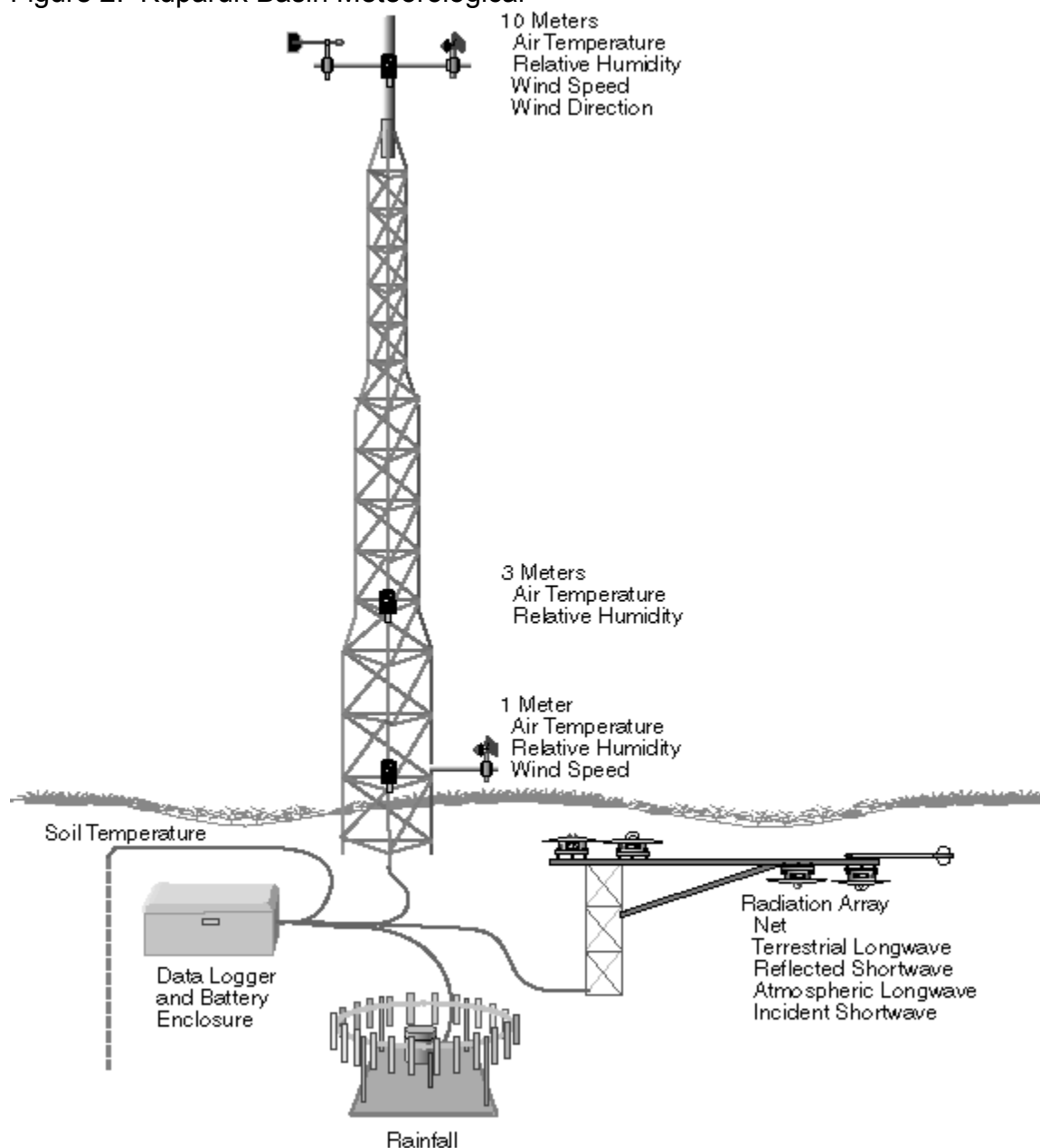
On Alaska's North Slope, starting in 1985, meteorological stations at various research sites were located in a north-south transect along the Dalton Highway (figure 1 -- postscript file FIGURE1.PS). The southernmost site was established in the foothills of the Philip Smith Mountains at the headwaters of Imnavait Creek (latitude 68 degrees, 37 minutes N, longitude 149 degrees, 17 minutes W). This watershed has an average elevation of 910 m and is located 165 km south of Prudhoe Bay and 15 km north of the Brooks Range. The most intense research and data collection have occurred at this location. A typical meteorological station is shown in figure 2.

Figure 1. North Slope Site Locations



Instrumentation for the collection of meteorologic, hydrologic and soil conditions was installed in 1984 and data collection began in the spring of 1985. The hydrology, meteorology and ecology of this watershed have been studied extensively (Everett and Ostendorf, 1988; Hinzman et al., 1991; Hinzman and Kane, 1991; Hinzman et al., 1992; Kane and Hinzman, 1988; Kane et al., 1989; Kane et al., 1990; Kane et al., 1991a; Kane et al., 1991b; Walker et al., 1989).

Figure 2. Kuparuk Basin Meteorological



In the Imnavait Watershed there are two main sites where data collection has taken place. One site, Imnavait A site is located on a 10% west-facing slope, the other site, Imnavait B site is located on a ridge top on the east side of Imnavait Creek Watershed. Meteorologic and soil information were measured at both locations. Near Imnavait A site four runoff plots were constructed in a transect along the slope. These sites were named Imnavait D site (plot 1, upper slope), Imnavait E site (plot 2, upper mid-slope), Imnavait F site (plot 3, lower mid-slope) and Imnavait G site (plot 4, lower slope). Snow and soil temperature profiles were measured adjacent to each runoff plot. Heat flux and precipitation were also measured at Imnavait C site, located midway between Imnavait F and G sites. Imnavait H

site was established near the outlet of the basin to measure stream flow. Imnavait W site, otherwise known as the USDA Soil Conservation Service Toolik River Site, is a Wyoming snow gage located near Imnavait B site. Imnavait S site was established as a snow survey transect paralleling the slope next to Imnavait sites D, E, F and G (runoff plots) and running from the east boundary across the watershed to the west boundary.

The mineral soils in this area are cold, wet, poorly drained silt loams with a high organic content and include many glacial erratics of various sizes. The mineral soils are covered by a peaty layer, and are classified as Histic Pergelic Cryaquepts (Rieger et al., 1979). The vegetation is mostly water tolerant plants such as tussock sedges and mosses, but there are also lichens and shrubs such as willows, alder and dwarf birch. More complete descriptions of tundra vegetation have been published (Brown and Berg, 1980; Walker et al., 1989). The area was glaciated during the Pleistocene and is underlain by continuous permafrost. The maximum thaw depth during the period of study was approximately 120 cm, with typical depths being 40 cm.

In 1986, a second site was established near the Sagwon Bluffs (latitude 69 degrees, 25 minutes N, longitude 148 degrees, 45 minutes W) approximately 100 km south of Prudhoe Bay. This site is located in a transitional zone between costal plain and the foothills at an elevation of 370 m. The vegetation is also characteristic of tussock tundra and the soils are loamy with a peaty surface layer and are poorly drained (Everett, 1980). Instrumentation for measuring soil temperatures and meteorologic conditions as installed near the top of a 10% north-facing slope. Data have been collected for 7 years (1987-1993) at this site.

Also in 1986, a site near Franklin Bluffs (latitude 69 degrees, 50 minutes N, longitude 148 degrees, 45 minutes W) was established on the costal plain 50 km south of Prudhoe Bay. This site is located in the relatively flat area of the Sagavanirktok River flood plain at an elevation of 80 m. The vegetation is comprised of a continuous cover of grasses and sedges rooted in mosses and lichens (Komarkova and Webber, 1980). The soils are poorly drained and generally do not thaw to depths of more than 50 cm. Organic materials of variable thickness overlie silt-loam textured mineral soils (Everett, 1980). Data have been collected for 7 years (1987-1993) at this site.

The northernmost site was established 21 km west of Deadhorse on the banks of the Kuparuk River (latitude 70 degrees, 17 minutes N, longitude 148 degrees, 58 minutes W). This site is located in an area with little topographic relief at an elevation of 50 m. The vegetation consists of wet sedge tundra and forb tundra. The soils are organic overlying layers of fine sand and silts. This site was established in April of 1992.

In March 1994, the North Prudhoe Bay Site (NP, latitude 70 degrees, 21 minutes N, longitude 148 degrees, 31 minutes W) was established at the location of the North Prudhoe Bay State No. 2 pad as part of an EPA revegetation study (Jorgenson et al., 1993). Vegetation was characterized as wet coastal graminoid meadow. The soils are primarily organic with inclusions of sands and silts. This site was replaced by the West

Dock site in July, 1995 and pulled from service in the fall of 1995 due to severe grizzly bear damage. Data were collected for 2 years at this site (1994 to 1995).

## **FILE AND DATA FORMATS**

Data were compiled and tabulated in annual data sets for each site. These data were further subdivided into data sets of various types: meteorological, radiation, soil temperature and heat flux, stream flow and snow surveys. The first two characters in the file name specify the site name, the next four characters identify the year of the record, the final letters describe the general type of data. The codes for the site names, year and data types are shown in Table 1. A full listing of files by site name is given in Tables 2a and 2b. The files are in comma separated ASCII format. Some examples of file names are:

IB1987M.CSV	1987 Imnavait B site meteorological data
SH1992T.CSV	1992 Sagwon soil temperature data
FB1990R.CSV	1990 Franklin Bluffs radiation data
IH1991Q.CSV	1991 Imnavait Creek stream flow
IC1987T.DAT	1987 Imnavait C site heat flux and soil temperatures

Each file begins with several lines identifying the site, year of record and general type of data within the data set. Following this, specific data columns are identified. Data are generally hourly or daily average values. However, some data such as stream flow and snow water equivalent are point values taken at varying time periods. Hourly average values represent the average conditions during the hour preceding the given time. Daily average values represent average conditions for the given day beginning at one minute past midnight and ending at midnight. All dates and times are in Alaska Standard Time.

## **INSTRUMENTATION SPECIFICATIONS**

### **DATA LOGGERS, CABLES AND MOUNTS**

Campbell Scientific 21X data loggers were used to record and process data at all sites. Data recorded on the data loggers were compared to measured conditions to check the sensor calibrations and the data logger during site visits. Cables connecting the sensors to the data logger were shielded to minimize induced voltage caused by auroral activity. Heavy flexible metal conduit was used at some sites to discourage wildlife. Tripod masts (3 m) were used to mount sensors at Imnavait A site, Sagwon and Franklin Bluffs sites. At Imnavait B site, a 10 meter meteorological tower was used to mount the air temperature, relative humidity, wind speed and direction sensors. Radiation sensors were mounted on a separate tripod mount design to suspend these sensor over the tundra and minimize shadows. A 3 meter tower was used to mount the sensors at the Lower Kuparuk site.

Some of the longer outages in the data sets are due to damage caused by wildlife. Bears have been attracted to the sites and caused severe damage. Moose and caribou have damaged cables with their hooves and by rubbing on the towers. Smaller wildlife, rodents and foxes, have also gnawed cables causing outages. The severity of the weather encountered at these sites has also taken its toll on the instrumentation. Lightning and prolonged extreme cold have damaged data loggers and batteries causing outages. As other stations have come online the instrumentation and data loggers have also been updated. As of 2007 there are no longer any older Campbell Scientific CR21X loggers. Current data loggers are primarily the CR10X with extended temperature testing.

**Table 1. File name formats.**

FILE IDENTIFICATION FORMATS

FIRST TWO CHARACTERS		YEAR	FINAL CHARACTER
Site Identification			Data Type(s)
BM	Betty Pingo (replaces LK)	1994-present	
EH	East Headwater	1996-pres	
FB/FR	Franklin Bluffs Site	1986-pres	
GL	Green Cabin Lake Site	1996-pres	
IA	Imnavait A Site	1985-1992	M Meteorological
IB	Imnavait B Site	1986-pres	Q Stream Discharge
IC	Imnavait C Site	1985-1992	R Radiation
ID	Imnavait D Site	1985-1992	S Snow Surveys
IE	Imnavait E Site	1985-1992	T Soil Temperatures
IF	Imnavait F Site	1985-1992	(includes soil heat flux
IG	Imnavait G Site	1985-1992	at Imnavait C site)
IH	Imnavait Flume	1986-pres	
IS	Imnavait Snow Course	1985-1992	
IR	Imnavait Ridge Site	1993-pres	
IV	Imnavait Valley Site	1993-pres	
IW	Imnavait Wyoming snow gauge	1985-1992	
LK	Lower Kuparuk Site	1992-1995	
NH	North Headwater	1996-pres	
NP	North Prudhoe Bay	1994-1995	
PR	Putuligayuk River	1999-pres	
SH	Sagwon site	1986-pres	
SW	Sagwon Wyoming snow gauge	1986-1992	
UH	Upper Headwater	1996-pres	
UK	Upper Kuparuk site	1993-pres	
WD	West Dock (replaces NP)	1995-pres	
WH	West Headwater	1996-pres	
WK	West Kuparuk Site	1995-pres	

## WIND SPEED AND DIRECTION

Wind speed was measured using a Weathertronics anemometer at Imnavait A site from 1985 through 1992. The threshold of the wind measurement is 0.22 m/s and the accuracy is plus/minus 0.07 m/s. Met One model 014A wind speed sensors were employed at



Imnavait B site, Sagwon, Franklin Bluffs and Lower Kuparuk sites. The threshold velocity of this instrument is rated at 0.447 m/s and the reported accuracy is approximately 0.1 m/s. Field calibration tests of the wind speed sensors are difficult to obtain, sensors are regularly replaced and sent to the manufacturer for calibration and replacement of bearings. Wind direction was measured with a model 024a Met One Wind Direction Sensor at all sites. The accuracy, as reported by the manufacturer, is to within plus/minus 5 degrees. The wind direction sensors are calibrated annually by obtaining the full scale return of the resistor and scaling this to the desired 360 degree output. Additionally, the heading of the wind direction sensors are checked periodically each year by pointing the vane at aiming points for four compass points. There are problems of note at these remote sites pertaining to wind speed and direction measurements. The most significant off these are rime ice and freezing precipitation that can at best alter the aerodynamics of these sensors and possibly stop them completely. No attempt was made to identify these periods in the data sets. Prolonged periods of calm with wind speed reporting at the threshold velocity of 0.447 m/s and/or constant wind direction are very rare at these sites and should be considered indicators of these conditions. However, we cannot be sure that a calm period did not occur since the sites were unmanned. Rime ice and freezing precipitation can occur during any season but are most likely during the fall, late winter and early spring. Sensors are cleaned at each site visit, but due to the remoteness of the sites, site visits are generally 1 to 3 months apart. The second problem, specific to the wind sensors, is perching birds. Since these sites are located in treeless tundra, large birds including ravens, rough leg hawks and snowy owls can damage vanes and anemometers by repeatedly perching on them. This rarely caused data loss but may have slightly affected the accuracy of the wind vanes if they were bent.

**Table 2a. Imnavait Research Watershed files.**

Imnavait A Site

Meteorological

IA1985M.DAT

IA1986M.DAT

IA1987M.DAT

IA1988M.DAT

IA1989M.DAT

IA1990M.DAT

IA1991M.DAT

IA1992M.DAT

Continuing through 2001

Radiation

IA1985R.DAT

IA1986R.DAT

IA1987R.DAT

IA1988R.DAT

IA1989R.DAT

IA1990R.DAT

IA1991R.DAT  
IA1992R.DAT  
Continuing through 2001

Imnavait B Site  
Meteorological  
IB1986M.CSV  
IB1987M.CSV  
IB1988M.CSV  
IB1989M.CSV  
IB1990M.CSV  
IB1991M.CSV  
IB1992M.CSV  
Continuing through 2007

Radiation  
IB1986R.CSV  
IB1987R.CSV  
IB1988R.CSV  
IB1989R.CSV  
IB1990R.CSV  
IB1991R.CSV  
IB1992R.CSV  
Continuing through 2007

Soil temperature  
IB1986T.CSV  
IB1987T.CSV  
IB1988T.CSV  
IB1989T.CSV  
IB1990T.CSV  
IB1991T.CSV  
IB1992T.CSV  
Continuing through 2007

Imnavait C Site  
Soil temperature  
and soil heat flux  
IC1985T.DAT  
IC1986T.DAT  
IC1987T.DAT  
IC1988T.DAT  
IC1989T.DAT  
IC1990T.DAT  
IC1991T.DAT  
IC1992T.DAT

Imnavait D Site  
Soil temperature  
ID1985T.DAT  
ID1986T.DAT  
ID1987T.DAT  
ID1988T.DAT  
ID1989T.DAT  
ID1990T.DAT  
ID1991T.DAT  
ID1992T.DAT

Imnavait E Site  
Soil temperature  
IE1985T.DAT  
IE1986T.DAT  
IE1987T.DAT  
IE1988T.DAT  
IE1989T.DAT  
IE1990T.DAT  
IE1991T.DAT  
IE1992T.DAT

Imnavait F Site  
Soil temperature  
IF1985T.DAT  
IF1986T.DAT  
IF1987T.DAT  
IF1988T.DAT  
IF1989T.DAT  
IF1990T.DAT  
IF1991T.DAT  
IF1992T.DAT

Imnavait G Site  
Soil temperature  
IG1985T.DAT  
IG1986T.DAT  
IG1987T.DAT  
IG1988T.DAT  
IG1989T.DAT  
IG1990T.DAT  
IG1991T.DAT  
IG1992T.DAT

Imnavait H Site

Streamflow

IH1985Q.CSV

IH1986Q.CSV

IH1987Q.CSV

IH1988Q.CSV

IH1989Q.CSV

IH1990Q.CSV

IH1991Q.CSV

IH1992Q.CSV

Continuing through 2001

Imnavait S Site

Snow surveys

IS1985S.DAT

IS1986S.DAT

IS1987S.DAT

IS1988S.DAT

IS1989S.DAT

IS1990S.DAT

IS1991S.DAT

IS1992S.DAT

Imnavait W Site

Meteorological

IW1985M.DAT

IW1986M.DAT

IW1987M.DAT

IW1988M.DAT

IW1989M.DAT

IW1990M.DAT

IW1991M.DAT

IW1992M.DAT

**Table 2b. Remote sites files**

Sagwon Hill Site

Meteorological

SH1986M.CSV

SH1987M.CSV

SH1988M.CSV

SH1989M.CSV

SH1990M.CSV

SH1991M.CSV

SH1992M.CSV

Continuing through 2007

Radiation

SH1987R.CSV

SH1988R.CSV

SH1989R.CSV

SH1990R.CSV

SH1991R.CSV

SH1992R.CSV

Continuing through 2007

Soil temperature

SH1986T.CSV

SH1987T.CSV

SH1988T.CSV

SH1989T.CSV

SH1990T.CSV

SH1991T.CSV

SH1992T.CSV

Continuing through 2007

Sagwon Wyoming gage

SW1986M.CSV

SW1987M.CSV

SW1988M.CSV

SW1989M.CSV

SW1990M.CSV

SW1991M.CSV

SW1992M.CSV

Franklin Bluffs Site

Meteorological

FB1986M.CSV

FB1987M.CSV

FB1988M.CSV

FB1989M.CSV

FB1990M.CSV

FB1991M.CSV

FB1992M.CSV

Continuing through 2007

Radiation

FB1987R.CSV

FB1988R.CSV

FB1989R.CSV

FB1990R.CSV

FB1991R.CSV

FB1992R.CSV

Continuing through 2007

Soil temperature

FB1987T.CSV

FB1988T.CSV

FB1989T.CSV

FB1990T.CSV

FB1991T.CSV

FB1992T.CSV

Continuing through 2007

Lower Kugaruk-Site

Meteorological

LK1992M.DAT

Continuing through 1995

Radiation

LK1992R.DAT

Continuing through 1995

Soil temperature

LK1992T.DAT

Continuing through 1995

Upper Kugaruk-Site

Meteorological

UK1994M.CSV through 2007

Radiation

UK1993R.CSV through 2007

Soil Temperature

UK1993T.CSV through 2007

Upper Kugaruk River Site

Discharge

UK1993Q.CSV through 2007

North Headwater Site

Meteorological

NH1996M.CSV through 2007

East Headwater Site

Meteorological

EH1996M.CSV through 2007

West Headwater Site  
Meteorological  
WH1996M.CSV through 2007

Upper Headwater Site  
Meteorological  
UH1996M.CSV through 2007

Green Cabin Lake Site  
Meteorological  
GCL1996M.CSV through 2007

West Kuparuk Site  
Meteorological  
WK1994M.CSV through 2007

Radiation  
WK1994R.CSV through 2007

Soil Temperature  
WK1994T.CSV through 2007

Franklin Bluffs Site  
Meteorological  
FB1987M.CSV through 2007

Radiation  
FB1987R.CSV through 2007

Soil Temperature  
FB1987T.CSV through 2007

Betty Pingo Wetland Site  
Meteorological  
BM1994M.CSV through 2007

Radiation  
BM1994R.CSV through 2007

Soil Temperature  
BM1994TW.CSV through 2007

Betty Pingo Upland Site  
Soil Temperature  
BM1994TU.CSV through 2007

West Dock Site  
Meteorological  
WD1995M.CSV through 2007

Radiation  
WD1995R.CSV through 2007

Putuligayuk River Site  
Discharge  
PR1999Q.CSV through 2007

## **AIR TEMPERATURE AND RELATIVE HUMIDITY**

Originally, Air temperature and relative humidity were measured using a Campbell Scientific Model 207 Temperature and Relative Humidity Probe. The relative humidity component utilizes a Phys-Chemical Research Corporation PCRC humidity transducer. These probes were housed in a self-aspirating radiation shield and are used to measure temperature and relative humidity at all sites. The reported temperature operating range is -33 to +48 degrees C with a worst case accuracy of plus/minus 0.4 degrees C and typically an accuracy of plus/minus 0.2 degrees C, and plus/minus 1 degree C from -33 degrees C to -40 degrees C. The relative humidity operating range is 12 to 100 percent with an accuracy of plus/minus 5 percent. A Campbell Scientific model 105T type T thermocouple was also used at the Innavait B site. This thermocouple's calibrated range is -78 degrees to 50 degrees C, plus/minus 0.2 degrees C. Over time, these sensor have been replaced with Vaisala HMP45C Air Temperature and Relative Humidity probe. The temperature sensor has a range of -40 degree C to +60 degree C with an accuracy of 0.2 degree C at 20 C increasing linearly to 0.5 degree C at the low range and 0.4 degree C at the high range. The relative humidity sensor is accurate to  $\pm 2\%$  0 to 90% relative humidity and  $\pm 3\%$  90 to 100% relative humidity.

As with the wind speed above, rime ice accumulations can affect the air temperature and especially the relative humidity reading obtained. This is caused by insulating the sensors within the radiation shield and isolating them from ambient conditions. Air temperature readings would be affected slightly in the time required to respond to changes in the ambient air temperature. Relative humidity could be greatly affected by being isolated from the ambient conditions. Relative humidities would be related to the vapor pressure of the surface of the rime ice adhering to the radiation shield and wire mesh inner enclosure surrounding the relative humidity sensor and not necessarily indicative of the true ambient conditions.

## **SOIL TEMPERATURE**



Soil temperatures were measured at all sites using YSI model 44007 Thermistors and 100 K ohm precision resistors. These thermistors are rated at plus/minus 0.2 degrees C from 0 to 80 degrees C. The accuracy declines below 0 degrees C to plus/minus 0.3 degrees C at -25 degrees C, plus/minus 0.4 degrees C at -40 degrees C and plus/minus 1.0 degree C at -80 degrees C.

## **RADIATION**

Radiation instruments were installed in the spring usually during March or April and were taken down in the fall (late August or September). Since rime ice, snowfall and freezing precipitation can obscure the sensors in these instruments, values reported during periods of below freezing air temperature should be closely scrutinized. Reported radiation values during winter, early spring and fall should be considered qualitative and not quantitative. The following radiation components were measured: incoming and reflected shortwave radiation, atmospheric and terrestrial longwave radiation, photosynthetically active radiation and net radiation. Radiometer calibrations are checked locally each year by comparison to the output of an instrument of known precision. Every 5 years the radiometers are sent to Eppley Labs for reconditioning and recalibration. All radiometers in use before 1988 were calibrated in March of 1989. All instruments were leveled at each site visit. Although the mounts were made as solid as possible, thawing and refreezing of the active layer soils above the permafrost did cause occasional shifting of the sensors between site visits.

### **Net Radiation**

Net absorbed radiation was measured with a Swissteco model S-1 Net Radiometer at all sites except the Lower Kuparuk site where a REBS Q6 Net Radiometer was used. The operating range of the Swissteco instrument is 0.3 to 60 M; the accuracy is reported as plus/minus 2.5 percent. The Radiation and Energy Balance Systems (REBS) Q6 Net Radiometer's spectral response range is reported by the manufacturer as 0.25 to 60  $\mu$ M, the calibrated accuracy of this instrument was not reported by the manufacturer.

Net radiation components, total hemispheric terrestrial and atmospheric radiation, were also measured using a Weathertronics Pyrradiometer at the Imnavait A site. This sensor produces two outputs, the total incoming and total emitted or reflected radiation, the difference being the net absorbed radiation. The accuracy of this instrument was reported to be within 2 percent.

### **Shortwave Radiation**

Incident and reflected shortwave radiation were measured with a Weathertronics Albedometer at Imnavait A site. The spectral range of this sensor is 0.3 to 3 microns, which excludes the terrestrial longwave component. The accuracy of this sensor is reported to be plus/minus 1 percent and the cosine response is less than 1 percent when the sun angle is within 0 to 70 degrees of perpendicular of the sensor plane.

Incident shortwave radiation was also measured using an Eppley model PSP Precision Spectral Pyranometer at Imnavait A site. This type of instrument was also used to measure incident and reflected shortwave radiation at Franklin Bluffs, Sagwon, and Lower Kuparuk sites. An Eppley Spectral Precision Pyranometer fitted with an RG8 dark red filter was used to measure photosynthetically active radiation between 0.700 and 2.800 microns at the Imnavait A site. This instrument has a reported spectral range of 0.285 to 2.800 microns, and a reported accuracy of plus/minus 1 percent in the range of values encountered. The cosine response of this instrument is plus/minus 1 percent between 0 and 70 degrees and plus/minus 3 percent between 70 degrees and 80 degrees zenith angle.

Eppley model 8-48 Black and White Pyranometers were used to measure incident and reflected solar radiation at the Imnavait B site. This instrument has a reported spectral range of 0.28 to 2.800 microns, and a reported accuracy of plus/minus 1.5 percent in the range of values encountered. Cosine response is reported as plus/minus 2 percent from normalization for angles of 0 degrees to 70 degrees and plus/minus 5 percent.

### **Longwave Radiation**

Eppley model PIR Precision Infrared Pyrgeometers were used to measure longwave radiation, both terrestrial and atmospheric, at all sites. The spectral range of this type of instrument is 4 to 50 M, and the accuracy is reported as plus/minus 1 percent between 0 and 700 W/m<sup>2</sup>.

### **STREAMFLOW**

Stream discharge was estimated from stage data recorded by Leupold Steven's F1 water level recorders within an H type flume. A stage discharge relationship was developed from discharge measurements made with Price AA (Gurley) and Pygmy cup type current meters, and Montedoro Whitney electromagnetic current meters using standard USGS stream cross section techniques to estimate stream discharge from the recorded stage data.

### **SNOWPACK**

Snowpack depth and water equivalent were measured using an Adirondak snow sampler. Each reported value is an average of at least 10 measurements.

**Table 3.****North Slope site status, identity code and location.**

<u>Site Name</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Elevation</u>
Imnavait Trailer (home)	68° 37' 03.6" N	149° 18' 15.1" W	
Imnavait Basin (IB)	68° 36' 58.6" N	149° 18' 13.0" W	937 meters
Imnavait Ridge (IR)	68° 37' 27.9" N	149° 19' 22.3" W	
Imnavait Valley (IV)	68° 37' 02.7" N	149° 19' 02.3" W	
Imnavait Flume (IH)	68° 37' 02.1" N	149° 19' 08.1" W	881 meters
Imnavait Water Track 7 (IT)*			
Imnavait Plot1 (ID)*	68° 36' 36" N	149° 18' 11" W	
Imnavait Plot2 (IE)*	68° 36' 36" N	149° 18' 12" W	
Upper Kuparuk m,r,s (UK)	68° 38' 24.5" N	149° 24' 23.4" W	774 meters
Upper Kuparuk River q (UK)	68° 38' 35" N	149° 24' 15" W	747 meters
North Headwater (NH)	68° 36' 04.8" N	149° 25' 52.8" W	
East Headwater (EH)	68° 34' 7.6" N	149° 18' 32.4" W	
West Headwater (WH)	68° 33' 48.0" N	149° 24' 30.0" W	
Green Cabin Lake (GL)	68° 32' 01.0" N	149° 13' 47.4" W	
Upper Headwater (UH)	68° 31' 19.8" N	149° 20' 18.0" W	
West Kuparuk (WK)	69° 25' 34.3" N	150° 20' 25.3" W	158 meters
Sagwon (SH)	69° 25' 27.5" N	148° 41' 45.1" W	299 meters
Franklin Bluffs (FB/FR)	69° 53' 31.8" N	148° 46' 4.8" W	77.7 meters
Lower Kuparuk (LK)*	70° 17' N	148° 58' W	
[formerly known as Kuparuk Deadhorse (KD)]			
Betty Wetland/Met (BM)	70° 16' 46.3" N	148° 53' 44.5" W	11.6 meters
Betty Upland (BU)	70° 16' 46.9" N	148° 53' 46.5" W	
Betty TDR (BT)	70° 16' 46.7" N	148° 53' 46" W	
North Prudhoe Bay (NP)*	70° 21' N	148° 31' W	
West Dock (WD)	70° 22' 50" N	148° 33' 39" W	7.6 meters
Putligayuk River (PR)	70° 16' N	148° 46' W	

NOTE: Decommissioned or abandoned site designated by \*.  
rg 5/17/01

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## APPENDIX A

### Annual site data description

#### 1985 IMNAVAIT A, C, D, E, F, G, H, S, AND W SITES

##### METEOROLOGICAL DATA

Meteorological data were collected from day 127 through day 365, for air temperature, relative humidity and wind speed and direction. There is missing data from day 148-333 for the air temperature and from day 250-365 for the relative humidity. The wind speed and direction data are missing from day 321-326 and 331-333. Hourly precipitation measurements were recorded day 127 through day 313 with one period of missing data from day 179-214. Daily Wyoming gage precipitation values are complete for the year.

##### RADIATION DATA

In 1985 there were three radiometers in the field at Imnavait A site. A Swissteco net radiometer, an Eppley spectral pyranometer and a Weathertronics albedometer, which measures the incoming and reflected shortwave radiation. Radiation data were collected from day 127 through day 250 and there were no periods of missing data for these instruments.

##### SOIL TEMPERATURES

Data collection of soil temperatures began on day 088 in 1985. There are three above surface probes used to measure snow temperatures at each of four runoff plots in the watershed. These probes are located at 10 cm, 20 cm and 30 cm above ground surface. They are unshielded and therefore temperature data are not reported when there is no snow cover. Soil temperatures were collected at 9 depths at each of the four runoff plots in the watershed. Soil temperatures are measured with thermistors every 5 cm in the active layer, which is approximately 40 cm deep, except at plot 4 where it is only 30 cm.

At Imnavait site D and E, runoff plots 1 and 2, snow temperatures were recorded from day 88-144 and 258-365. There were two periods of missing data, day 110-126 and day 315-333. For the soil temperatures there were three periods of missing data, day 110-126, day 153-157 and day 315-333.

At Imnavait site F and G, runoff plots 3 and 4, snow temperatures were recorded from day 88-143 and day 258-365. There were no periods of missing data for the snow temperatures or the soil temperatures at these two sites.

##### HEAT FLUX AND HOURLY SOIL TEMPERATURES

In 1985 the heat flux plates were installed at site C in the summer and data collection began on day 180. There are three heat flux plates, one measures the heat flux of the surface soils, one measures the heat flux of the organic soils at 10 cm and the other measures the heat flux of the mineral soils at 20 cm. Along with the heat flux, soil temperatures were recorded hourly at 0, 5, 10 and 15 cm. The data records are complete from the onset of collection to the end of the year.

##### SNOWPACK AND STREAM FLOW

In 1985 snowpack water equivalents were measured daily from day 128

through day 150. Stream flow was measured only during snowmelt this year, from day 144-154.

Snowpack water equivalent was determined by taking 40 measurements (10 adjacent to each of the four sites near the runoff plots) and then averaged. The measurements were made with an Adirondak Snow Sampler.

#### 1986 IMNAVAIT A, C, D, E, F, G, H, S, AND W SITES

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year for air temperature, relative humidity and wind speed and direction. The air temperature at 1 meter had two periods of missing data, days 084-087 and 246-283. The 2 meter air temperature has gaps from day 084-139, 207-209, 211-215 and 246-283. Both relative humidity sensors have missing data from day 001-139 and day 246-283. The wind data is only missing from day 084-087. Hourly precipitation was measured from day 001 through day 286 and there were no missing data. Daily Wyoming gage precipitation values are complete for the year.

##### RADIATION DATA

In 1986 a Weathertronics pyrrometer was added to the site. This instrument measures the total incoming and total reflected radiation. The net radiation from the Swissteco and the precision incoming shortwave and incoming and reflected shortwave were all measured. Radiation data were collected from day 088 through day 245 and there were no periods of missing data, except for the precision incoming shortwave which is missing from day 109-130.

##### SOIL TEMPERATURE

At Imnavait site D and E, runoff plots 1 and 2, there was no snow cover from day 150 - 263, therefore no temperatures are reported for the above ground thermistors. There was one period of missing data for all of the snow and soil temperatures from day 085-088 and the 35 cm soil temperatures were missing from day 147-158 for plot 2. The plot 1 20 cm temperatures were not recorded for the entire year.

At Imnavait site F and G, runoff plots 3 and 4, data were missing for day 196 and there were multiple periods of missing data between days 304 and 346 for all depths and day 352-362. The 30 cm temperatures at runoff plot 4 were missing from day 146-365. There were no above ground temperatures recorded between days 151-263 when there was no snow present.

##### HEAT FLUX AND HOURLY SOIL TEMPERATURES

The heat flux and soil temperature data is missing from day 001-156 for all depths. There is also missing data for day 196 and multiple periods of missing data between days 304 and 346 and missing data from day 352-362.

##### SNOWPACK AND STREAM FLOW

In 1986 the snowpack water equivalent was measured daily from day 147 through day 157. The stream flow was measured from day 154-262.

#### 1987 IMNAVAIT A, C, D, E, F, G, H, S, AND W SITES

#### METEOROLOGICAL DATA

In 1987 there were multiple gaps in the records for the air temperature and relative humidity probes at both heights. Missing data occurred on days 170-171, 175-176, 208-212, 220-224, 231-232, 293-299 and other times of less than one day in duration. The wind speed and direction are missing on days 220-224 and 293-299. Hourly precipitation data were collected from day 140 through day 240 with missing data on days 220-224. Daily Wyoming gage precipitation values are complete for the year.

#### RADIATION DATA

Radiation data were collected from day 075 through day 240 in 1987. There was one period of missing data which occurred from day 220-224 for all radiometers. A radiometer to measure the photosynthetically active radiation data was installed on day 147, so the period of record is from day 147-219, and 225-240.

#### SOIL TEMPERATURE

At Imnavait D site, runoff plot 1, there were no snow temperatures recorded between days 130 and 312. The 20 cm temperatures are missing for the entire year. There are several periods when data are missing for all depths; day 175, 209-211, 294-298, and day 315.

At Imnavait E site, runoff plot 2, the 30 cm snow temperatures are missing from day 130-365. For the 20 cm snow temperatures days 131-315 are not recorded or missing and for the 10 cm snow temperatures data are missing or not recorded from day 138-315. All depths are missing data from day 145-175, 209-211, 294-298 and day 315.

At Imnavait site F and G, runoff plots 3 and 4, there are no temperatures for the above ground thermistors between days 137 and 267, when there was no snow on the ground. All the soil temperature files are complete for the year.

#### HEAT FLUX AND HOURLY SOIL TEMPERATURES

In 1987 the surface soil heat flux data is missing from day 001-240. The organic soil heat flux is missing from day 089-240 and the mineral soil heat flux is missing from day 001-130 and 237-240. The surface temperature data is missing day 001-130 and 237-240. For the 5, 10, 15, 20 and 25 cm soil temperatures there is one period of missing data between days 237 and 240.

#### SNOWPACK AND STREAM FLOW

In 1987 snow surveys were conducted daily between days 129 and 144. Stream discharge measurements were made from day 140-256.

#### 1988 IMNAVAIT A, C, D, E, F, G, H, S, AND W SITES

#### METEOROLOGICAL DATA

In 1988 the 1 meter air temperature and humidity are missing on days 209-217 and 220-241. The 2 meter air temperature and relative humidity data are missing on days 209-217, 220-241, and 262-304. The wind speed and direction and precipitation are missing on days 223-241. Hourly precipitation was recorded from day 108 through day 365. Daily Wyoming gage precipitation values are complete for the year.

#### RADIATION DATA

Radiation components measured in 1988 included net absorbed radiation, total incoming and total reflected radiation, precision incoming shortwave, incoming and reflected shortwave radiation and photosynthetically active radiation. Radiation data were collected from day 108 through day 223 with missing data on day 137 for all sensors.

#### SOIL TEMPERATURE

At Imnavait D site, runoff plot 1, there was no snow cover between days 126-263, the snow temperature records are complete for the period of snow cover. The 20 cm probe is missing data from day 001-322 and data for all depths are missing from day 209 - 241 and day 304 - 322. There were also several outages of less than one day during the time of hourly recording (day 108-241). Also the 10, 15, 25, 35 and 40 cm data are missing for days 322-366.

For, Imnavait E site, runoff plot 2, there was no snow cover between days 127-263, the snow temperature records are complete for the 10 and 20 cm probes but the 30 cm snow temperature probe is missing for the entire year.

All depths are missing data from day 209-241 and 304-322. The 40 cm probe is also missing days 322-366. There were also several outages of less than one day during the time of hourly recordings (day 108-241).

Imnavait F site, runoff plot 3, had no snow cover from day 132-263, the snow temperature records are complete for the time of snow cover. All data are missing from day 133-134 and day 303. The 0, 5, 10, 15, 20 and 25 cm probe temperatures are missing from day 135-152.

Imnavait G site, runoff plot 4, had no snow cover from day 133-263. The 21 cm probe was missing data from day 162-303. All depths are missing on day 303.

#### HEAT FLUX AND HOURLY SOIL TEMPERATURES

The heat flux data and soil temperature data are missing for days 132-153 in 1988. The organic soil heat flux plate was also missing days 153-303.

#### SNOWPACK AND STREAM FLOW

Snowpack water equivalents were measured daily from day 129 through day 135. Stream discharge was measured from day 133-243.

#### 1989 IMNAVAIT A, C, D, E, F, G, H, S, AND W SITES

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year for air temperature and relative humidity at heights of 1 and 2 meters and wind speed and direction. Hourly precipitation data were recorded from day 090 through day 299. There was one period of missing data for all instruments, except the Wyoming Gage, from day 226 through 228. Daily Wyoming gage precipitation values are complete for the year.

#### RADIATION DATA

Radiation components measured in 1989 included net absorbed radiation, total incoming and total reflected radiation, precision incoming shortwave, incoming and reflected shortwave radiation and photosynthetically active radiation. Radiation data were collected from day 109 through day 298 with



one period of missing data from day 227-229 for all sensors. The precision incoming shortwave radiation was also missing from day 192 through day 298.

#### SOIL TEMPERATURE

At Imnavait D site, runoff plot 1, there was no snow cover between days 151-272, and therefore no snow temperatures are reported for that period. The temperature records are complete for the snow temperature probes at 10, 20 and 30 cm and for soil temperatures at 0, 5, 10, 15, 25 and 35 cm depths. There were no data for the 20 cm probe and the 30 and 40 cm depths were not recorded from day 307 through day 365.

At Imnavait E site, runoff plot 2, snow temperatures at the 10 cm height were reported from day 001-148 and 272-365. There were no data for the 20 and 30 cm snow temperatures this year. The soil temperature records were complete for all depths.

At Imnavait F site, runoff plot 3, there was no snow cover from day 149-272. All data are missing from days 193-272 and the soil temperatures are missing from days 273-302.

At Imnavait G site, runoff plot 4, there were no snow temperatures recorded from days 150-286. The soil temperatures were all missing from day 193-286.

#### HEAT FLUX AND HOURLY SOIL TEMPERATURES

The heat flux data for the surface and organic soils are missing on days 207- 211, and the mineral soil heat flux data are missing on days 207-208. There are several periods of missing soil temperatures; days 192-193, 200-204, 229-231, 235-238, 244-246 and 271-282.

#### SNOWPACK AND STREAM FLOW

In 1989 the water equivalent of the snowpack was measured daily between days 137 and 150. The stream flow measurements began on day 146 and went through day 257.

#### 1990 IMNAVAIT A, C, D, E, F, G, H, S, AND W SITES

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year, for air temperature, relative humidity and wind speed and direction. There was one period of missing data for the 2 meter air temperature and relative humidity probe from day 134-137. Hourly precipitation was recorded from day 139 through day 251. Daily Wyoming gage precipitation values are complete for the year.

##### RADIATION DATA

###### Radiation components

measured in 1990 included net absorbed radiation, total incoming and total reflected radiation, precision incoming shortwave, incoming and reflected shortwave radiation and photosynthetically active radiation. In 1989 instrumentation was installed to measure the atmospheric and terrestrial longwave components as well. There is a complete record for radiation data this year from day 107 through day 249 for all components except the precision incoming shortwave. For this instrument data were missing from day 221-225 and 240-243 as well as numerous gaps of several hours in the record between days 227 and 239.

#### SOIL TEMPERATURE

Snow and soil temperatures were collected at 12 depths at each of four different locations in the watershed. There was no snow cover between approximately day 136 and day 266, so there are no snow temperatures reported for that time period.

At Imnavait D site, runoff plot 1, the 10, 20 and 30 cm snow temperature records are complete. The 15, 20, 30 and 40 cm soil temperature data are missing as are days 140-186 for the 0, 5, 10, 25 and 35 cm depths.

At Imnavait E site, runoff plot 2, the 10 cm snow temperature record is complete but the 20 cm temperatures are missing from day 1-321 and the 30 cm temperatures are missing completely. The soil temperature records at 0, 5, 10, 15, 20, 25, 30 and 35 cm are complete but the 40 cm depth is missing day 322-365.

At Imnavait F site, runoff plot 3, the snow temperature records at 10, 20 and 30 cm are complete. The soil temperatures are missing data for days 139-221 for 0, 5, 10, 15, 20, 25, 30, 35 and 40 cm.

At Imnavait G site, runoff plot 4, the snow temperature records at 10, 20 and 30 cm are complete. The soil temperatures are missing data for days 139 - 224 for 0, 5, 10, 15, 20, 25, 30, 35 and 40 cm.

#### HEAT FLUX AND HOURLY SOIL TEMPERATURES

In 1990 the heat flux records were missing for the surface heat flux plate from day 260-326 and the mineral soil heat flux plate from day 152-365. The hourly soil temperatures were missing data from day 141-229.

#### SNOWPACK AND STREAM FLOW

The snowpack water equivalent was measured daily from day 129-141. The stream flow was measured from day 135-273.

#### 1991 IMNAVAIT A, C, D, E, F, G, H, S, AND W SITES

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year, for air temperature, relative humidity and wind speed and direction. There was one period of missing data for all sensors from day 205-206. The 2 meter air temperature data is also missing from day 235-237. Hourly precipitation was recorded from day 132 through day 235. Daily Wyoming gage precipitation values are complete for the year.

##### RADIATION DATA

Radiation components measured in 1991 included net absorbed radiation, total incoming and total reflected radiation, incoming and reflected shortwave radiation, photosynthetically active radiation and atmospheric and terrestrial longwave. There is a complete record for radiation data this year from day 110 through day 243 for all components. The precision incoming shortwave data are missing for the entire year.

##### SOIL TEMPERATURE

At Imnavait D site, runoff plot 1, there was no snow cover from day 151-286. Data are missing for all depths from day 090-132. The data for the 10, 15, 25, 35 and 40 cm thermistors are missing for the entire year.

At Imnavait E site, runoff plot 2, there was no snow cover from day 139-286. The 30 cm snow temperatures and the 40 cm soil temperatures are missing for the year.

At Imnavait F site, runoff plot 3, the data were missing for all depths from days 001, 002, 155-212, 221-224 and 236-365. The snow melted from plot 3 on day 126 but the data were missing in the autumn so the time of snowfall can not be determined.

At Imnavait G site, runoff plot 4, there were missing data for all depths from days 001, 002, 045-113, 149, 155-212, 221-224, and 236-365. Also missing were data from the 30 cm snow probe and the 0, 10, 15, 20, 21, 25, 26 and 30 cm soil temperature probes from day 003-044.

#### HEAT FLUX AND HOURLY SOIL TEMPERATURES

The heat flux data for 1991 were bad for most of the year. Data for the surface soil heat flux plate is missing from day 125-135 and 148-365. The organic soil heat flux plate data is missing from day 132-135, 154-365. There is no data for the mineral soil heat flux plate. The soil temperatures are missing from days 154-365 for all depths.

#### SNOWPACK AND STREAM FLOW

In 1991 the snowmelt was early and not many snow surveys were conducted. There are a few data points between days 110 and 135. Stream flow was measured from day 128-235, with a period of missing data from day 195-206.

#### 1992 IMNAVAIT A, C, D, E, F, G, H, S, AND W SITES

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year, for air temperature, relative humidity and wind speed and direction. There was one period of missing data for the 2 meter air temperature probe from day 239-242. Hourly precipitation was recorded from day 158 through day 239. Daily Wyoming gage precipitation values are complete from day 001 through 274.

##### RADIATION DATA

Radiation components measured in 1992 included net absorbed radiation, total incoming and total reflected radiation, precision incoming shortwave, incoming and reflected shortwave radiation, photosynthetically active radiation and atmospheric and terrestrial longwave. There is a complete record for radiation data this year from day 120 through day 244 for all components except the precision incoming shortwave data have numerous gaps of less than one day for the summer.

##### SOIL TEMPERATURE

Imnavait D site, runoff plot 1, had no snow cover from day 165-273. The snow temperature record is complete for the time of snow cover. There were several depths for which no data was collected 10, 15, 25, 35, and 40 cm. The 0, 5 and 20 cm data files are complete.

Imnavait E site, runoff plot 2, had no snow cover from day 165-272. The 30 cm snow record is missing as are the 40 cm soil temperatures for the year. The 20 cm temperatures are missing from day 348-353.

The data logger which recorded soil temperatures at Imnavait sites F and G, runoff plots 3 and 4, had several long outages which resulted in data for only a small portion of the year. Data exists from day 119-166 and 247-248 for plot 3 and 246-248 for plot 4.

#### HEAT FLUX AND HOURLY SOIL TEMPERATURES

The data logger which recorded the heat flux and hourly soil temperatures had several long outages which resulted in data being collected for only a small portion of the year. Data exists from day 119-167, 245-247.

#### SNOWPACK AND STREAM FLOW

In 1992 snow surveys were conducted from day 144-162. Stream flow was measured from day 152 through day 260.

### 1986 IMNAVAIT B SITE

#### METEOROLOGICAL DATA

Meteorological data collection began on day 244 at 15:00 Alaska Standard Time and continued through the end of the year. Data types collected were:

air temperature at 10 meter, 3 meter and 1.5 meter heights, relative humidity, wind speed and wind direction. The 3 meter air temperature is missing from day 283 through day 365 and 10 meter air temperature is accurate to only  $\pm 1$  C from day 283 through day 365.

#### RADIATION DATA

Radiation data were collected from day 245, 15:00 Alaska Standard Time through the end of the year. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave and incident shortwave components. There were no long periods of missing data. However, these data are questionable because the site was unattended and snow and frost probably obscured the sensors much of the time.

#### SOIL AND SNOW TEMPERATURES

Daily average soil and snow temperature data collection began day 245 through the end of the year. These data were missing from day 283 through day 365. One snow temperature was collected at a height of 10 cm. Soil temperatures were collected at surface, 10 cm and 20 cm depths.

### 1987 IMNAVAIT B SITE

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were: air temperature at 10 meter, 3 meter and 1.5 meter heights, relative humidity, wind speed and wind direction. The 3 meter air temperature is missing from day 001 through day 244 and 10 meter air temperature is accurate to only  $\pm 1$  C from day 001 through day 074 and day 241 through day 365. Wind speed measured at 1.5 meters was added to the data set on day 079.

#### RADIATION DATA

Radiation data were collected from day 001 through day 018 and day 074 through day 238. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave and incident shortwave components. There were no long periods of missing data. However, some of these data

collected during winter and spring are questionable because the site was unattended and snow and frost probably obscured the sensors much of the time.

#### SOIL AND SNOW TEMPERATURES

Daily average soil and snow temperature data were collected the entire year. One snow temperature was collected at a height of 10 cm. Soil temperatures were collected at surface for the entire year, soil temperatures were 10 cm and 20 cm depths from day 001 through day 240. Soil temperatures were measured at 40 cm and 60 cm depths from day 241 through the end of year. The 10 cm depth soil temperature was missing from day 001 through day 73 and day 79 through day 80.

#### 1988 IMNAVAIT B SITE

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were: air temperature at 10 meter, 3 meter and 1.5 meter heights, relative humidity, 1.5 meter wind speed, 10 meter wind speed and wind direction. The 10 meter air temperature is accurate to only  $\pm 1$  C from day 001 through day 241.

##### RADIATION DATA

Radiation data were collected from day 001 through day 018 and day 107 through day 239. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave and incident shortwave components. There were no long periods of missing data.

#### SOIL AND SNOW TEMPERATURES

Daily average soil and snow temperature data were collected the entire year. One snow temperature was collected at a height of 10 cm. Soil temperatures were collected at surface, 40 cm and 60 cm depths for the entire year. 10 cm depth soil temperature was missing from day 102 through day 249 and day 362 through day 366.

#### 1989 IMNAVAIT B SITE

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were: air temperature at 10 meter, 2 meter and 1.5 meter or 1 meter heights, relative humidity, 1.5 meter or 1 meter wind speed, 3 meter wind speed, 10 meter wind speed and wind direction. The 3 meter air temperature was missing from day 001 through day 041. The 3 meter air temperature was repaired and reinstalled at the 2 meter height on day 041. The 2 meter air temperature was missing from day 138 through day 152. Wind direction was missing from day 110 through day 132. There were 10 hours of missing data for all sensors on day 153. All data were missing from day 226 through day 228.

##### RADIATION DATA

Radiation data were collected from day 111 through day 299. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave and incident shortwave components. There were 10 hours of missing radiation data on day 153. All radiation data were missing from day 226 through day 228.

#### SOIL AND SNOW TEMPERATURES

Soil and snow temperature data were collected the entire year. Daily average soil temperatures were collected from day 001 through day 110 and day 300 through day 365. Hourly average soil temperatures were collected from day 111 through day 299. One snow temperature was collected at a height of 10 cm and soil temperatures were collected at surface, 40 cm and 60 cm depths for the entire year. Additional soil temperatures were collected from day 111 through day 365 for 10 cm, 15 cm, 20 cm, 30 cm and 50 cm depths. All snow and soil temperatures were missing on day 110 and from day 226 through day 228.

#### 1990 IMNAVAIT B SITE

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were: air temperature at 10 meter, 2 meter, 1 meter heights, relative humidity, 1 meter wind speed, 3 meter wind speed, 10 meter wind speed and wind direction. All data were missing from day 185 through day 186. Data for the 1 meter wind speed were missing from day 215 through day 365.

##### RADIATION DATA

Radiation data were collected from day 106 through day 250. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave and incident shortwave components. All radiation data were missing from day 185 through day 186.

#### SOIL AND SNOW TEMPERATURES

Soil and snow temperature data were collected the entire year. Daily average soil temperatures were collected from day 001 through day 105 and day 250 through day 365. Hourly average soil temperatures were collected from day 106 through day 249. One snow temperature was collected at a height of 10 cm and soil temperature data were collected at the surface, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 50 cm, and 60 cm depths. All snow and soil temperatures were missing from day 185 through day 186.

#### 1991 IMNAVAIT B SITE

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were: air temperature at 10 meter, 2 meter and 1 meter heights, relative humidity, 1 meter wind speed, 3 meter wind speed, 10 meter wind speed and wind direction. All data were missing from day 111 through day 130 and day 150 through day 184. Data for the 2 air temperature were missing from day 111 through day 131. Data from the 1 meter air temperature and relative humidity were missing from day 111 through day 150.

##### RADIATION DATA

Radiation data were collected from day 129 through day 244. Data were collected for terrestrial longwave, reflected shortwave and incident shortwave components. Atmospheric radiation data were not collected in 1991. Terrestrial longwave radiation data were missing from day 129 through day 204. Incident shortwave and reflected shortwave radiation

data were missing from day 150 through day 204.

#### SOIL AND SNOW TEMPERATURES

Soil and snow temperature data were collected the entire year. Daily average soil temperature were collected from day 001 through day 111 and day 205 through day 365. Hourly average soil temperatures were collected from day 112 through day 204. One snow temperature was collected at a height of 10 cm and soil temperature data were collected at the surface, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 50 cm, and 60 cm depths. All snow and soil temperatures were missing from day 111 through day 130, day 139 through day 184, day 309 through day 313, day 317, day 319 through 320, day 326 through day 333, day 336 through 343, day 345 and day 347 through 345.

#### 1992 IMNAVAIT B SITE

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were: air temperature at 10 meter, 2 meter and 1 meter heights, relative humidity, 1 meter wind speed, 3 meter wind speed, 10 meter wind speed and wind direction. The 10 meter air temperature data were intermittent from day 018 through day 045. The 1 meter wind speed data were missing from day 081 through day 086, day 139 through day 141, day 145, day 147 through day 253 day 258 through day 262, day 263, day 277 through day 279 day 314 through day 315 and day 319 through day 322.

##### RADIATION DATA

Radiation data were collected from day 120 through day 244. Data were collected for terrestrial longwave, reflected shortwave and incident shortwave components. Atmospheric radiation data were not collected in 1992. Reflected shortwave data were missing from day 183 through day 184, and portions of days 201 and 202. All data were missing for portions of day 221 and 223.

#### SOIL AND SNOW TEMPERATURES

Daily average soil and snow temperature data were collected the entire year. One snow temperature was collected at a height of 10 cm and soil temperature data were collected at the surface, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 50 cm, and 60 cm depths. All snow and soil temperatures were missing from day 002 through day 010, day 013 through day 017 and day 019 through 045.

#### 1986 SAGWON

##### METEOROLOGICAL DATA

Meteorological data began on day 284 and continued through the end of the year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters and wind direction. The Wyoming gage precipitation data are complete for the year.

##### RADIATION DATA

Radiation data were not collected in 1986.

#### SOIL AND SNOW TEMPERATURES

Soil and snow temperature data were collected from day 284 through the end of year. Soil temperature data were collected at surface, 5 cm, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 55 cm and 70 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. The 30 cm depth was missing from day 284 through day 365.

1987 SAGWON

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at, 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 142 and day 254 through day 365. All data were missing from day 236 through day 254, 1.5 meter wind speed was missing from day from day 236 though day 313. All data were missing for 15 hours during day 352. The Wyoming gage precipitation data are complete for the year.

#### RADIATION DATA

Radiation data were collected from day 108 through day 237. Data were collected for atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. Atmospheric longwave data were missing from day 108 through day 145. Net radiation data were intermittent from day 145 through day 176 missing the peak values due to a programming error.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 55 cm and 70 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. The 30 cm snow temperature was not reported from day 126 through day 254. The 20 cm snow temperature was not reported from day 130 through day 254. The 10 cm depth soil temperatures were missing for the year. All soil and snow temperature data were missing from day 236 through day 254.

1988 SAGWON

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 106 and day 275 through day 366. The Wyoming gage precipitation data are complete for the year.

#### RADIATION DATA

Radiation data were collected from day 195 through day 240. Data were collected for atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. Incident shortwave data were missing from day 195 through day 229. Net radiation data were missing from day 195 through day 229.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were



collected at surface, 5 cm, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 55 cm and 70 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. The 30 cm depth soil temperatures were missing for the year.

1989 SAGWON

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 155 and day 259 through day 365. Air temperature data at the 1.5 meter height was missing from day 057 through day 229. The 3 meter height air temperature and relative humidity data were missing for 12 hours on day 161. All meteorological data were missing from day 290 through day 298. The Wyoming gage precipitation data are complete for the year.

#### RADIATION DATA

Radiation data were collected from day 109 through day 290. Data were collected for atmospheric longwave, reflected shortwave, incident shortwave components and net radiation.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 55 cm and 70 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. The 30 cm depth soil temperatures were missing for the year. All soil and snow temperature data were missing from day 290 through day 297.

1990 SAGWON

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 109 and day 266 through day 365. The wind speed data at 1.5 meters height were missing from day 109 through day 185. The 1.5 meter height temperature and relative humidity data were intermittent from day 146 through day 186. The 3 meter temperature and relative humidity data were missing from day 188 through day 189, day 206 through day 208, day 210 through day 211, day 215 through day 218 and day 230 through day 234. The Wyoming gage precipitation data are complete for the year.

#### RADIATION DATA

Radiation data were collected from day 109 through day 249. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. Atmospheric longwave data were missing from day 109 through day 185.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 55 cm and 70

cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. The 30 cm depth soil temperatures were missing for the year.

1991 SAGWON

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 140 and day 241 through day 365. The 3 meter temperature and relative humidity data were missing for the following periods:

begin day	end day
142	153
155	157
160	168
175	177
181	182
186	187
193	194
201	201
208	210
211	216
223	225
262	265

The 3 meter relative humidity data were missing from day 175 through day 365. The Wyoming gage precipitation data are complete for the year.

#### RADIATION DATA

Radiation data were collected from day 114 through day 240. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. Net radiation data were missing from day 225 through day 240.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 55 cm and 70 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. The 30 cm depth soil temperatures were missing for the year.

1992 SAGWON

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 159 and day 253 through day 365. The 3 meter relative humidity data were missing on from day 001 through day 366. The Wyoming gage data are

reported for day 001 through day 274.

#### RADIATION DATA

Radiation data were collected from day 118 through day 244. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. Reflected shortwave data had intermittent missing values from day 181 through day 186, day 209, day 216 through day 218, day 221 through day 244. Incident shortwave radiation data were missing from day 189 through day 191, day 196 and day 201 through day 202. Net radiation was missing from day 205 through day 244.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 15 cm, 20 cm, 30 cm, 40 cm, 55 cm and 70 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. The 30 cm depth soil temperatures were missing for the year.

### 1986 FRANKLIN BLUFFS

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters and wind direction.

#### RADIATION DATA

No radiation data were collected.

#### SOIL AND SNOW TEMPERATURES

No soil temperature data were collected.

### 1987 FRANKLIN BLUFFS

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 148 and day 274 through day 365. All data were missing from day 241 through day 254. The 3 meter relative humidity data were missing from day 241 through day 313.

#### RADIATION DATA

Radiation data were collected from day 108 through day 242. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. The net radiation data had intermittent missing data from day 164 through day 176.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data began day 176. Soil temperature data were collected at surface, 5 cm, 10 cm, 20 cm, 30 cm, 40 cm, 50 cm, 65 cm and 85 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm

heights. Snow temperatures were reported for the period of snow cover only. All soil and snow temperature data were missing from day 236 through day 315. Surface temperature was missing from day 188, day 189, day 191, day 192 and day 194 through day 316. The 50 cm depth soil temperatures were missing day 345 through day 347, day 359, day 360, day 362 and day 363. The 85 cm depth soil temperature data were missing day 236 through day 365.

1988 FRANKLIN BLUFFS

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 155 and day 262 through day 366. All data were missing from day 126 to day 127 (14 hours). The 3 meter air temperature and relative humidity data were missing from day 140 through day 146 and from day 151 through day 172.

#### RADIATION DATA

Radiation data were collected from day 106 through day 241. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. Radiation data were missing from day 126 to day 127 (14 hours).

#### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 20 cm, 30 cm, 40 cm, 50 cm, 65 cm and 85 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. Soil and snow temperature data were missing on day 125. Surface soil temperatures were missing from day 194 through day 199 and from day 201 through day 203.

1989 FRANKLIN BLUFFS

#### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 152 and day 282 through day 365. All 3 meter wind speed data were missing for the entire year.

#### RADIATION DATA

Radiation data were collected from day 125 through day 298. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 20 cm, 30 cm, 40 cm, 50 cm, 65 cm and 85 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover

only. Soil and snow temperature data were missing on day 125. Surface soil temperatures were missing from day 041 through day 145. The 10 cm snow temperature data were missing from day 014 through day 159. The 30 cm snow temperature data were missing from day 285 through day 365.

#### 1990 FRANKLIN BLUFFS

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 134 and day 267 through day 365. All 3 meter wind speed data were missing for the entire year. The 3 meter temperature and relative humidity were missing from day 247 through day 267 and day 271 through day 282.

##### RADIATION DATA

Radiation data were collected from day 109 through day 249. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation.

##### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 20 cm, 30 cm, 40 cm, 50 cm, 65 cm and 85 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 heights. Snow temperatures were reported for the period of snow cover only. The 10 cm snow temperatures were missing for the entire year. The 20 cm snow temperatures were missing on day 009, day 011 through day 013, day 020 through day 024, day 027 through day 031, day 033 through day 041, day 041 through way 045, day 320 through day 352.

#### 1991 FRANKLIN BLUFFS

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 139 and day 241 through day 365. All 3 meter wind speed data were missing from day 001 through day 114. The 1.5 meter temperature and relative humidity were all or partially missing from day 211 through day 215, day 223 through day 225, day 227 through day 229, day 234 through day 236, day 237 through day 240, day 246 through day 248, day 251 through day 254, day 255 through day 259, day 262 through day 266, day 269 through day 271 and day 277 through day 278.

##### RADIATION DATA

Radiation data were collected from day 114 through day 241. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. Net radiation data were missing from day 114 through day 153, day 174 through day 179, day 181 through day 202 and day 226 through day 241.

##### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were

collected at surface, 5 cm, 10 cm, 20 cm, 30 cm, 40 cm, 50 cm, 65 cm and 85 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. The 10 cm snow temperatures were missing from day 001 through day 171 and day 172 through day 365. The 20 cm snow temperatures were missing from day 045 through day 171. The 30 cm snow temperatures were missing from day 114 through day 171. The Surface soil temperature data were missing from day 114 through day 171 and day 195 through day 329. The 5 cm depth soil temperature data were missing from day 114 through day 180. The 10 cm depth soil temperature data were missing from day 114 through day 171. The 20 cm depth soil temperature data were missing from day 114 through day 180 and day 249 through day 277. The 30 cm depth soil temperature data were missing from day 114 through day 171. The 40 cm depth soil temperature data were missing from day 114 through day 180 and day 247 through day 277. The 50 cm depth soil temperature data were missing from day 114 through day 171. The 65 cm depth soil temperature data were missing from day 114 through day 180. The 5 cm depth soil temperature data were missing from day 114 through day 171.

#### 1992 FRANKLIN BLUFFS

##### METEOROLOGICAL DATA

Meteorological data were collected for the entire year. Data types collected were air temperature at 1.5 and 3 meters, relative humidity at 1.5 and 3 meters, wind speed at 1.5 and 3 meters, wind direction and precipitation. Precipitation data were not collected from day 001 through day 144 and day 244 through day 365. The 1.5 meter relative humidity data were missing from day 001 through day 047.

##### RADIATION DATA

Radiation data were collected from day 118 through day 244. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation. Net radiation data were missing from day 118 through day 244.

##### SOIL AND SNOW TEMPERATURES

Soil temperature data were collected all year. Soil temperature data were collected at surface, 5 cm, 10 cm, 20 cm, 30 cm, 40 cm, 50 cm, 65 cm and 85 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only. The 30 cm snow temperature data were missing from day 340 through day 363. The 10 cm snow temperatures were missing for the entire year. The surface soil temperature data were missing from day 148 through day 168 and day 177 through day 366.

#### 1992 LOWER KUPARUK SITE

##### METEOROLOGICAL DATA

This site was established and meteorological data collection began on day 117. Wind speed data at the 1.5 meter height was missing from day 117 through day 144, day 175 through day 178 and day 181 through day 190. Wind direction was missing from day 117 through day 144. The 3 meter temperature and relative humidity data were missing or intermittent during the following periods:

begin day	end day
140	144
153	155
157	159
183	183
185	186
218	227
229	240
248	253
260	260
266	267
269	273
278	280

#### RADIATION DATA

Radiation data were collected from day 117 through day 244. Data were collected for terrestrial longwave, atmospheric longwave, reflected shortwave, incident shortwave components and net radiation.

#### SOIL AND SNOW TEMPERATURES

Soil temperature data collection began on day 244 and continued through day 366. Soil temperature data were collected at surface, 10 cm, 15 cm, 20 cm, 25 cm, 30 cm, 35 cm, 50 cm, 100 cm and 150 cm depths. Snow temperatures were collected at 30 cm, 20 cm and 10 cm heights. Snow temperatures were reported for the period of snow cover only.

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