

## **Documentation and Metadata for the NESAs Weather Station 1986–2008**

This document serves as a final report describing the construction, configuration, modifications, and history of the weather station operated by the University of Kansas Field Station and Ecological Reserves (KSR) from 1986–2008. The weather station was located on a KSR tract known as the Nelson Environmental Study Area and is referred to as the “NESAs Weather Station”. Included in this document is a section describing the Standard Operating Procedures in place at the time that the station was decommissioned and replaced on 31 December 2008. There are seven Appendices that document the sensors used at the site, the datalogger input storage locations, old data parameter files used for archiving data, data format keys, a list of data gaps, a synopsis of significant configuration changes, and a description of the physical station and its data archive. Galen L. Pittman, who was responsible for operating and maintaining the station from 1986–2008, prepared this document.

### **Section I: History of the changes to the NESAs Weather Station**

Prior to early 1987, there was very little weather data collected at the Nelson Environmental Study Area (NESAs). Between 1974 and 1986, there were some hygrothermograph (model H311) charts that were recorded in a Stephenson Screen near the current Armitage Education Center. In addition, in the mid 1980s, some rainfall data was collected from “unofficial” rain gauges mounted on gateposts at the NESAs entrance. Neither the data from the charts or gauges was considered of sufficient quality or value to merit archival.

Between December 1986 and March 1987, two KU Civil Engineering Professors (Dennis Lane and Glen Marotz) and several graduate students (primarily Mark Thomas and Steve Mauch) installed some research equipment and several recording weather instruments at the present site of the NESAs weather station. These engineers were interested in collecting data relating to dry deposition of various compounds that were known to contribute to atmospheric pollution. They collected atmospheric and weather data at NESAs, starting about 18 June 1987 and also in a similar project, later in 1987 and 1988, from a tower erected on the northwest corner of the Fitch Natural History Reservation. At the start, the weather data that was collected at NESAs was used to support the dry deposition research projects. By 31 May 1988 the engineers turned over data downloading and collection duties for the weather station to KSR staff (Galen Pittman). At that time there were electronic data files transferred (through May 1988) to the Experimental and Applied Ecology Program (EAEP; forerunner of KSR) at KU. From that point on, the weather station was incorporated into the NESAs Field Station infrastructure, and the station operated “officially” by the EAEP program.

By November 1988 the sensors, equipment, and type of weather parameters that were being recorded were reconfigured and the station had undergone various improvements. The weather data was not being collected specifically for the dry deposition project but was evolving to become baseline monitoring data to support the research mission of the EAEP program and the Field Station.

Throughout 1989, some of the weather sensors and the types of data that were being collected continued to be evaluated. The station was again reconfigured and

several changes were made to the structure of the weather station data file. A new permanent triangular tower and several new sensors were purchased and a new datalogger program written by Mark Thomas was installed.

The tipping rain bucket was replaced by a weighing can because it was discovered in 1988 that the tipping bucket would sometimes generate “false trips” caused by strong winds shaking the whole bucket when there was no true rain event. An effort was made to “correct” the rainfall amounts that appear in the rainfall data files for 1988 and part of 1989. Some entries during that period are marked with an “\*” to indicate that those data were “error corrected”. All of the tipping bucket data was examined and compared with the weekly standard can measurements. Also the relative humidity and wind speed data were checked whenever the tipping bucket was triggered and indicated a rain event. Virtually all of the false trips of the tipping bucket could readily be detected and eliminated from the data set. Daily precipitation amounts were reconciled to match the weekly standard can measurements in much the same way that daily amounts were reconciled when the weighing can was being used from 1989 onward.

The replacement of the tipping rain bucket with a weighing rain bucket necessitated re-configuring the data logger. The Campbell 21 datalogger had nine channels, 7 were switch excitation (voltage) channels, one was a slow pulse channel, and one was a fast pulse channel. The tipping rain bucket was on the slow pulse channel and the wind speed sensor was on the fast pulse channel. The three temperature probes, the relative humidity probe, wind direction sensor, and pyranometer were on the 6 good voltage channels (with one voltage channel bad from the beginning). The weighing rain bucket had to be on one of the voltage channels and without the tipping bucket the slow pulse channel was unused. Therefore, the voltage channels had to be reallocated to some extent. The high temperature probe was replaced with the weighing bucket input and the middle temperature probe was replaced with the soil temperature probe input (soil temperature had previously not been monitored because no channel was available). The remaining four voltage channels were not changed. These changes in input channels also affected the output generated by the datalogger (basic structure data file). (In addition, the nature of the precipitation output changed. Previously, the tipping bucket generated data in discrete pulses (each trip = 0.01 inch), now the weighing bucket generates data in a fashion similar to the temperature probe as a most current value. This change necessitated that the raw rainfall data had to be manipulated, after the fact, to generate daily event precipitation summaries.) These changes took effect on 1 November 1989. At this time (and from the start) the weather parameters were recorded every ten minutes during each hour and 24 hours a day.

During 1990, the station set up and configuration continued to be evaluated. New sensors and equipment were purchased and the station was completely revamped, reprogrammed, and reconfigured. Starting on May 1, 1990 we began adding approximately 2cc of mineral oil to the standard can during non-freezing weather to decrease evaporation loss. By 19 October 1990 the “new configuration” was installed. The top two sections of the 30-foot instrument tower were removed and the wind speed and direction sensors were mounted at the top of the tower at 10 feet above ground level. A new Quantum sensor, soil temperature probe, air temp/RH sensor, new Stephenson Screen, datalogger enclosure, and new Campbell Scientific 21X datalogger were installed. The new configuration included a change from recording weather parameters every 10 minutes to recording data once an hour that was a calculated mean of each parameter values that were sampled up to every 5 seconds. In addition to the 24- hour

“hourly” measurements, several daily minimum and maximum values and the battery voltage were recorded once a day at midnight.

The datalogger programming was “debugged”, tweaked, and a new solid state data storage module purchased and installed for downloading data. By 28 November 1990, the format was finalized and essentially the configuration of the instruments and the type and frequency of the data collection was settled on and the station began to record data in a consistent matter. See Appendix A for a compilation of data field keys for all the raw data formats used during the entire history of the NESA weather station.

Problems with switching and charging Gel cell batteries continued to be tweaked and one final format change was instituted on 17 November 1992 to switch the wind direction parameter to a more meaningful wind vector value. That was essentially the last significant change to the data parameters. Various sensors were replaced as needed. One major wind event on 7 September 2001 destroyed the Stephenson Screen and interrupted data collection for four different sensors. By 9 October 2001 all the sensors were either replaced or repaired and a new instrument shelter installed. The soil temperature sensor failed and was replaced in September 2006. The station operated more or less normally after November 1992. See Appendix B for a list of the most significant data gaps that occurred during the stations operational history.

In the fall of 2008, a completely new NRCS SCAN weather station (Natural Resources Conservation Service - Soil and Climate Analysis Network) was installed with real time Internet data access. The old NESA weather station ceased “normal” data collection as of 31 December 2008. The old sensors, shelters, datalogger, and instrument tower was decommissioned and dismantled in mid- year 2009. At the beginning of 2009, the standard rain can was removed and re-installed just south of the Armitage Education Center where “daily” precipitation reading will be continued and submitted online by KSR staff to the Community Collaborative Rain, Hail, and Snow (CoCoRHS) volunteer network.

A synopsis of the most significant changes and events to the NESA weather station can be found in Appendix C. Appendix D contains a physical description of the NESA station. Appendix E contains a description of the station’s archival data set that has been placed on the KSR Website.

## Section II: Standard Operating Procedure for the NESAs Weather Station

[The following materials (Section II) represent the procedures used for the operation and maintenance of the KSR Weather Station until 31 December 2008, the time at which it was decommissioned.]

### Part IIA: Weekly Operation and Data Retrieval

#### Objective:

Describe the weekly data retrieval from the Campbell micrologger and the servicing of the precipitation cans and analog recorders from the KSR weather station at NESAs. See Appendix F for a list of sensors and other equipment that is currently being utilized at the KSR weather station.

#### Procedure:

1.) At approximately the same time on Tuesday each week, obtain the SM4M storage module, replacement strip charts for the hygrothermograph and weighing can, the weather data logs (all in a red three ring binder), and standard can measuring stick and any other precipitation measuring equipment that is needed (see steps 5a, 5b, 6a, and 6b) and take them to the KSR weather site. (This procedure can be done at any time of day except for "on the top of the hour" when the micrologger is logging data.) Observe the general weather conditions at the site. If there is frozen precipitation on the ground measure its depth to the nearest whole centimeter at the designated location in the southwest corner of the adjacent mowed area. Record this measurement in the weather observation log as well as a qualitative assessment as to the type and condition of the precipitation (snow, sleet, hail, ice, etc.) Also, record any noteworthy observations of the current or just past weather conditions as general notes in the log.

2.) Record the date, time, and your name on the logs and strip chart headers. Take the SM4M to the micrologger enclosure, open the enclosure and place the module on the wooden shelf next to the Gel/Cell battery. Insert the 9 pin-D connector cable that is attached to the 21X Campbell datalogger into the SM4M data port. Under normal operating conditions the LED display on the 21X micrologger should read ": LOG 1". If the display has any other message refer to page 3-13 in the 21X manual.

Key in "\* 9". The display will read "09:00". Key in "30", which will replace the two zeros. This is a code for this particular storage module. Key in "A" (advance command). The display will read "01:XXXX", where the X's stand for the start of dump location. Make sure that the start location (key in if necessary) is the same number recorded in the end box of the final storage location from the data collection log for the last recorded data dump. This number will replace the location number on the 21X display. Record this number in the start box of the current log entry. Key in "A". The display will read "02:XXXX", where the X's stand for the end of dump location (which is the location of the last data sent to final storage, since the last data dump). Record this number in the "end" box of the current log entry. Key in "A". The display will read "03:00". To initiate the dump, key in any number then "A". Keying in "B" will allow one to go backwards through the locations to check that they are correct. Sometimes the logger is processing data when the dump command is given and will not respond for up to a minute. The procedure can be repeated (the location address for the start position

(01) may have advanced and be the same for both the start and end position, in which case the start address would need to be re-entered to dump the correct set of data).

While dumping, "09" will be displayed in the ID field and the location number in the data field. The location number will increment as the data transfers and stop when the dump is complete. The transfer of data can be verified by watching the light diodes on the front of the SM4M. The storage module light should flash synchronously with the incrementing of the 21X display and is so fast that it may appear to be lit continuously during the transfer). [See section 4.2 of the 21X manual for additional information on using the \* 9 mode]

After the transfer of data is complete, key in "\* 0". The display should read: "LOG 1", which indicates the program instructions are being executed and is the mode the micrologger should be left in between dumps. Disconnect the SM4M from the 9-pin cable and remove the module to where the data will be processed.

3.) Check the current battery voltage and various sensor readouts, for "normal" values, by viewing Input Storage (\* 6). [See section 1.3 of the 21X manual for \* 6 mode commands.] Key in "\* 6". The display should read "06:0000". Key in "A". This will advance through the nine Input Storage locations, incrementing one location each time "A" is keyed. The number to the left of the colon is the location (01-09) and the number to the right of the colon is the current sensor value which is updated every five seconds. You can go backwards through the locations, one at a time, by keying in "B". (See Appendix G for a key to the contents of the storage locations.)

Normal values for each parameter are as follows:

01 - Air temperature:  $-20^{\circ}\text{C} = -4.0^{\circ}\text{F}$ ,  $10^{\circ}\text{C} = 50^{\circ}\text{F}$ ,  $40^{\circ}\text{C} = 104^{\circ}\text{F}$

02 - Relative humidity: compare to hygromograph (RH below 20% would be very unusual)

03 - Soil temperature: warms up and cools off more slowly than the air (will not drop significantly below freezing (perhaps  $-1.0^{\circ}\text{C}$ ))

04 - Wind speed: 2 mph = 0.9 mps, 10 mph = 4.5 mps, 20 mph = 8.9 mps, 30 mph = 13.4 mps

05 - Wind direction: East =  $90^{\circ}$  with the wind vane counter weight pointing toward the U.S. Weather Bureau Instrument Shelter

06 - Quantum sensor: varies from approximately 2800+ on a bright sunny summer day at midday to approximately 200 on a gray overcast winter day at midday

07 - Precipitation gauge: compare to analog strip chart and standard can measurement (micrologger output will read between - 0.5 and 1.5 when empty!)

08 - Battery voltage: a fully charged battery may output as high as 13.0 + DC volts and if allowed to drop below 11.0 volts can cause micrologger shut down and memory loss!

WARNING: Be conservative when changing the Gel/Cell battery! A fully charged battery usually loses its charge gradually until the voltage drops to 11.0 volts or less (it should take approx. 4-6 weeks to reach this level). Then, the loss accelerates and the micrologger "shut down" can occur in a very short time span. When battery voltage drops below 12.0 volts be prepared to switch the micrologger to the fully charged "spare" before the drained battery's voltage can drop to 11.0 or lower

09 - Pyranometer sensor: varies from approximately 0.95 on a bright sunny day at midday to approximately 0.15 on a gray overcast day at midday. Visually inspect the

instrument tower; the micrologger enclosure, and the wind sensor mounted on the top of the tower for general sturdiness, damage, and/or corrosion.

4.) Proceed to the white louvered Instrument Shelter and unlock it with the small key inside the datalogger enclosure. Open the shelter door and remove the hygrothermograph to the top of the datalogger enclosure, unlatch the hygrothermograph cover by pressing in on the button on the lower left hand side and lifting the cover up out of the way to the right. Gently pull the lever behind the two pen arms towards you until it lifts the points off of the chart paper. Remove the spring clip that holds the chart to the drum and remove the chart. Fill in the "ending" date and time and initial it on the header portion of the chart and file it with the other used charts in the program office. Locate the clock drive key on the top of the drum and wind the key approximately ten half-turns in a clockwise direction. **CAUTION: DO NOT OVER TIGHTEN THE SPRING!** Ten half-turns is sufficient for a normal one-week interval and is the maximum length of time the clock drive will run. Install the new strip chart by wrapping it around the drum with the blank end underneath and the crease of the folded-under header on top. Line up the crease with the right hand edge of the notch where the spring clip fits so the spring clip just covers the free end of the paper. Rotate the drum clockwise by hand until the desired time line is a little to the left of the pen, then counterclockwise to the proper time setting. Always make the final time setting by turning the drum counterclockwise as this removes the effect of any backlash in the drive gearing. Lower the pen points down onto the paper by pushing the lever away from you. Close the hygrothermograph cover and return it to the Instrument Shelter, lock it and return the key to the logger enclosure and visually inspect it and the two insolation sensors mounted on the roof for any damage or deterioration.

**[If it is the season of above freezing air temperatures, the procedures found in step 5a should be followed to measure the precipitation in the standard can. If it is the season of below freezing air temperatures, then proceed to step 5b.]**

**5a. NON-FREEZING TEMPERATURE PROCEDURES)** Open the gate in the wind screen surrounding the standard can and remove the funnel shaped top of the can. If there has been a rain event since last week, insert the measuring stick into the center of the 3-inch tube. Be careful to avoid the sides of the tube and make sure the stick is firmly resting on the bottom. Hold the stick, without any agitation, in the water column for several seconds to allow the water to properly "wet" the stick. The stick is printed on both sides -- one metric (each gradation equal to 0.20 mm) and the other English (each gradation equal to 0.01 inch). Record the English and units and fill in the "standard can" column on the collection log. Record the precipitation to the nearest 0.01-inch. If there has not been any overflow (less than or = 2.00 inches) of the small tube into the 8-inch can, simply dump the water out and allow it to drain for several seconds. Place the small tube inside the 8-inch can in the center, add approx. 2.0 cc of mineral oil if needed, replace the funnel top, and close the wind screen gate. The measuring stick may need to be dried and/or washed with soap and water between uses to remove mineral oil so the precipitation will "wet" the stick.

If there has been overflow (greater than 2.00 inches) into the 8-inch can, measure and record the water in the "full" tube and then pour it out and drain as before. Now, carefully pour the "overflow" water from the 8-inch can into the 3-inch tube and use the plastic funnel provided to avoid spillage. Measure and record the second aliquot. Repeat

the procedure as needed. **[Note: if you think the week's precipitation may have exceeded the capacity of two small tubes (greater than 4.00 inches) be especially careful, when transferring water, not to overfill the small tube and thus lose part of the week's precipitation]** Simply sum all the aliquots and record the grand total in the log. Inspect the standard can, windscreen, and their supports for general sturdiness and/or signs of corrosion.

**5b. FREEZING TEMPERATURE PROCEDURES)** When air temperatures are regularly below freezing (late November through March) the 8-inch standard can should be set up to collect sleet and snow. This "winter" set up requires that the small 3-inch tube and funnel top be removed to expose the 8 inch orifice directly to the elements and that no mineral oil be added. When winter precipitation has been collected in the 8-inch can and, at the time of measurement, is not frozen; the water can simply be poured into the 3-inch tube and measured and recorded in the standard way as outlined in the step 5a. When winter precipitation has been collected in the 8-inch can and, at the time of measurement, is frozen; the ice must be first melted and then measured and recorded in the standard way as outlined above. To melt the ice in the 8-inch can, obtain a 5 gal plastic bucket in the KSR field office and fill it about 1/3 full with hot tap water and bring it out to the weather site. Immerse the bottom of the 8-inch can in the hot water in the black can. It should take only a few minutes to melt the ice.

**[If it is the season of above freezing air temperatures, the procedures found in step 6a should be followed to change the weighing can chart and dump the accumulated precipitation. If it is the season of below freezing air temperatures, then proceed to step 6b.]**

**6a. NON-FREEZING TEMPERATURE PROCEDURES)** Proceed to the weighing can (transmitting/recording precipitation gauge) and open the gate in the windscreen. Open the access cover at the bottom of the can by pushing the latch button, on the upper left, to the right. When the cover is up all the way, push the latch button to the left to secure it in the up position. Gently pull the pen arm shifter lever to the right until the chart pens are lifted off of the chart paper. Remove the spring clip that holds the chart to the drum and remove the chart. Check the chart to confirm that the batteries have not prematurely lost their charge and fill in the "check clock" column of the data collection log. Fill in the "ending" date and time and initial it on the header portion of the chart and file it with the other "used" charts in the KSR field office. Install the new strip chart by wrapping it around the drum so that the header end is underneath and on the right. Be sure to start the wrap so that the beginning of the chart is at or just beyond the right hand side of the flange slot and the spring clip covers the free end of the paper. Rotate the drum clockwise by hand until the desired time line is a little to the left of the pen, then counterclockwise to the proper time setting. Always make the final time setting by turning the drum counterclockwise as this removes the effect of any backlash in the drive gearing.

If there has been a rain event since last week, remove the top of the weighing can by first rotating it to the left and then lifting it straight up. Remove the galvanized bucket from the weighing platform and dump the water out. Allow the bucket to drain for a few seconds and "pat" it dry with a towel. Gently replace the bucket onto the weighing platform with the overflow tube inserted into the opening provided for it, and replace the top by reversing the motions described before. Pull the pen arm shifter lever to the left

and lower the pen points onto the paper. Close the access cover and visually inspect the weighing can, windscreen, and their supports for general sturdiness and/or signs of corrosion. Fill in the appropriate columns of the data collection log.

**6b. FREEZING TEMPERATURE PROCEDURES)** When air temperatures are regularly below freezing (late November through March) the weighing can should be set up to collect sleet and snow. This "winter" set up requires that the funnel mounted under the 8-inch orifice be removed and thus expose the collection bucket directly to the elements. When winter precipitation has been collected in the weighing can and, at the time of measurement, is not frozen; the procedures outlined in step 6a should be followed. When winter precipitation has been collected in the weighing can and, at the time of measurement, is frozen; the procedures to follow are the same as before with the exception that the ice in the galvanized bucket may need to be melted slightly to be removed. If the ice holds fast, simply pour some of the hot tap water used in step 5b into the bucket and proceed.

**7.)** At the time when the normal weekly servicing of the weather station is performed (as described in steps 1-6 above), but at less frequent intervals, spot checks of several separate sensor readings should be performed. Once every two weeks check the air temperature by using the dry-bulb thermometer in the sling psychrometer that is stored in the louvered instrument shelter and compare it to the air temperature from the CS500 probe (input storage location # 1) and the HI-Q 5023 Hygrothermograph. Once every four weeks calculate the relative humidity using the same psychrometer. Refer to specific instructions for operating the sling psychrometer in the back pocket of the data logger three ring binder. Compare this value with the value generated by the CS 500 probe (Input Storage location # 2) and the Hygrothermograph. Once every six months, or as needed, the Quantum sensor (location # 6) and the Pyranometer (location # 9) can be checked by borrowing a portable hand held pyranometer and quantum sensor that is location in Dr. Craig Martin's lab at 8020 Haworth Hall on the main KU campus. Record each of these values in the appropriate spaces on the sensor spot check log, as well as the date and observer.

**8.)** Return the weather data log notebook and all the precipitation servicing equipment to the KSR field office and store them in their appropriate place.

## Part IIB: Data Archiving

### Objective:

Describe the transfer, translation, and storage of raw weather data from the NESAs weather station to the KSR Meteorological Archive via the Campbell Scientific PC208W software.

### Procedure:

#### **1.) Transfer of the data from the field and the generation of weekly raw data files for archiving**

Take the SM4M storage module, after the weekly data dump at the weather station site has been accomplished to the location of KSR program computer (currently in room 110 Station Headquarters at NESAs). Turn on the computer (which has the PC208W software installed) and double click on the Campbell Scientific PC208W icon on the desktop. Click on the storage module button on the Datalogger Support Software toolbar. Make sure that the window that opens has the tab labeled “SM4M/SM16M” selected. With that tab open make sure that the “comma separated” button under File Format and the “new name for each file” button under File Naming Options are both selected. Insert the 9 pin-D end of the SC209 ribbon cable (that is connected to the SC532 peripheral interface that is connected to the computer) into the port on the front of the SM4M storage module. Click the tab labeled “Get New”. The new window that opens will show a file name that was the last one previously used, e.g. = “08176183.dat”. These file names have eight characters with a “dat” extension that corresponds to the date the data was retrieved at the weather site (the last two digits of the year and the beginning and ending Julian day). In this example, the start and end dates are a week apart and correspond to a data file that was retrieved (the previous week) on 1 July 2008 (data from 24 June – 1 July 2008). For a download for the next week (8 July 2008), the file name would need to be changed to 08183190.dat to correspond to the download dates of 1 July- 8 July 2008. See the front pocket of the datalogger binder for a Julian Day (JD) conversion calendar. Once the correct file name is entered then the “save” button is clicked to initiate the transfer. A status bar in the lower right hand corner will flash until the transfer is complete. To double check the data file just created and transferred to the PC click on the MS Notepad icon on the desktop to open the file and check it. When the Notepad window opens click on “file” and then “open”. At the top of the window will be a box labeled “look in” that should have the location of the last weather data file saved. Make sure it is set to look in file location D:/PC208W/rawdata /2008 which contains the 2008 weather data. Also make sure the “files of type” is set to “all files”. Scroll through the files in the 2008 folder and confirm the file that you just transferred is there and open it to check to see if the data is all there and looks normal. If a hard copy is needed, a copy can be printed from the Notepad window. The latest weather station raw data file is now saved on the hard drive of the KSR program PC. Periodic backup copies of the data should be copied to whichever electronic media is desired, including floppy disks, CDs, or flash drives. Store the one copy of the weather data in the appropriate place at NESAs and deposit a second copy of the data in room 145 in Higuchi Hall. Unplug the SM4M Storage Module and store it until the next weather station data retrieval. The “week” files that are created with the procedures outlined above are the basic weather data files that are maintained in the KSR Meteorological Database. A key to all the data output formats

from July 1987 through December 2008 is contained in Appendix A. These raw data files are also appended together into calendar month files and are labeled with the format: NESAxxyy.dat, with xx = the last two digits of the year and yy = the numerical value of the month, e.g., July 2008 = NESA0807.data. These month files are usually filed together in folders labeled with the year of the data. These raw data files were previously stored on duplicate 3 1/2 inch high density floppy disks, with one copy in Higuchi Hall on KU's West Campus and a second in the field laboratory at NESAs. Rawdata file copies are also saved and stored on compact disk, as well as some printed paper copies at NESAs.

## **2.) Procedure for appending weekly raw data files into month files**

Click on the MS Notepad icon on the desktop and use this program to cut and paste the various "week files" into month files that begin and end with precisely the correct hour and day of the first and last day of each month. You will need a Julian Day Calendar (see datalogger binder) to interpret the start and end of each month file constructed since the raw weekly data files use Julian Days. Don't forget that 1988, 1992, 1996, 2000, 2004, and 2008 were leap years and have an extra day (29 February = JD 060 while JD 60 = 1 March in non-leap year years. Currently the raw data files have a code in the first space that identifies the hourly and daily data (110 = hourly and 118 = daily. The second space is the year, the third is the JD, and the fourth is the hour (24 hour military time). The month of July 2008 would start with a line that begins "110, 2008, 183, 100" while the last line in that month would begin with "118, 2008, 213, 2400". Make sure that the last day of each month actually ends with the "daily" line for that final day that is recorded every day at 2400 hours.

When the Notepad window opens click on "file" and then "open". At the top of the window will be a box labeled "look in" that should have the location of the weather data files saved from the procedure above. Make sure it is set to look in the correct location for the files to be appended, e.g., D:/PC208W/rawdata /2008 (which contains the 2008 weather data). Also make sure the "files of type" is set to "all files" (has to be reset every time that window opens!) Scroll through the files in the 2008 folder and find a "week" file that contains the Julian Day that you need. Cut and paste the correct lines, rename the files as appropriate and save the appended files that you have constructed as month files. Use the file labeling convention described above and save the month files in the rawdata folder with the weekly files for that calendar year. Since the weekly rawdata files are "dumped" at different hours of the day make sure that each appended month file doesn't have "gaps" between weeks (unless there is an actual gap in the data collected). See the documentation section for a table of significant data gaps in the historic NESAs weather data set. See the KSR weather station description for more details about the availability of the NESAs weather data archive including formats and summary content.

## **3.) Procedures for generating hourly weighting can printouts that are needed to generate daily precipitation summaries from the weekly raw data files**

Once the rawdata is appended into month files (using MS Notepad), go to the computer, which has the PC208W software installed. Double click on the Campbell Scientific PC208W icon on the desktop. Click on the "Report" button on the Datalogger Support Software toolbar. In the window that opens (labeled: Split Version 1.6) click on the "file" button and select the program called D:\PC208\HRLYWC.par. Make sure the "Input file" tab is selected and click the browse button to select the input data file that you are interested in running this "PAR" program with. For example select d:\pc208w\rawdata\

2008\Nesa0808 for the appended month file containing the July 2008 data. Click the OK button. That selection should appear in the input file box. Select the Output File tab. The output file name is not important since you are going to select “printer” under Report and “field” under File Format. On the top of the page toolbar click on “Run” and then click on “Go”. The “PAR” program should compile and print out a hard copy of the report. There will be a window left open that has a status report of the compiled program. Click on the “close” tab in the lower left. Repeat this procedure for as many different raw data files as you want to run this “PAR” program on. Generally as one or two months of data are collected, throughout the year, this procedure can be repeated whenever there is a need to “generate” weighing can data printouts. With these printouts, weekly standard can data can be compared to the hourly weighing can data and daily precipitation totals can be generated. The hourly changes in the weighing can output indicates if a rain or snow event took place and in what amount, during each 24-hour period ending at midnight. The weighing can usually captures somewhat less precipitation than the standard can, therefore the combined daily totals for each week are made to equal the weekly standard can total. These corrections are prorated according to the proportion of the weekly precipitation that occurred during each 24 hour period and are used to compile the amount and frequency of the precipitation recorded at the NESAs weather station on a daily basis. (This means the daily totals from the standard can and those summed from the raw data for each day could be slightly different).

#### **4.) Procedures to generate “hard copy” summary reports or excel format reports**

Each month, after the weekly raw data files have been appended into month files. Parameter files DAILY.PAR and HOURLY.PAR can be run with the PC208W spilt program to generate hard copies of the latest monthly raw data in a labeled column format. See Appendix H for descriptions of several “old” parameter files that were previously used to on older versions of the NESAs weather rawdata files. These hard copy printouts are a much more easily read format than the comma-delineated strings that are produced by the CR21X datalogger. Some research users actually prefer these hard copy printouts. The raw weather data can also be generated as monthly files in MS excel format. When the “DAILY.PAR” and “HOURLY.PAR” are run in the PC208W-REPORT/SPILT program, the results can be saved and the data files appended into MS excel format files and saved as such. Most other research users prefer data presented in “MS excel” format.

PC 208W parameter files can be written and saved that will sort or analyze raw data and/or select any subset of the data for any specific time period. The results can be simply printed out or saved to named files. Currently, the scope of the KSR weather data management is to simply collect, archive, and make the raw data accessible to persons conducting research at KSR. Occasionally some data has been provided to researchers in sorted formats by special request. All of the old weather data has been archived and is available on the KSR website: <http://www.ksr.ku.edu/libres/assets/climate.htm>

## Appendix A: Data Formats

### A1: Key to the raw data fields from July 1987–31 October 1989

Ten-minute data line (Code 1)

Column	Type	Contents
1	Integer	1 - Code for 10 minute record
2	Integer	Julian Day
3	Integer	Time - military time without leading zeros
4	Real	Temperature - high probe - degrees Celsius
5	Real	Temperature - middle probe - degrees Celsius
6	Real	Temperature - shelter - degrees Celsius
7	Real	Relative humidity - percent
8	Real	Wind - mean speed - meters/second
9	Real	Wind - vector magnitude - meters/second
10	Real	Wind - vector direction - degrees
11	Real	Wind - standard deviation of vector direction - degrees
12	Real	Precipitation- total for 10-minute interval - millimeters

Hourly summary line (Code 2)

Column	Type	Contents
1	Integer	2 - Code for hourly summary record
2	Real	Precipitation - total for hour - millimeters
3	Real	Temperature - Soil - degrees Celsius
4	Real	Insolation - total for hour - Langleys

Daily summary line (Code 3)

Column	Type	Contents
1	Integer	3 - Code for daily summary line
2	Real	Battery voltage
3	Real	Temperature - maximum for day - degrees Celsius
4	Integer	Time of maximum temperature - military time
5	Real	Temperature - minimum for day - degrees Celsius
6	Integer	Time of minimum temperature - military time
7	Real	Wind - peak gust for day - meters/second
8	Integer	Wind - time of peak gust - military time
9	Real	Precipitation - total for day - millimeters
10	Real	Insolation - total for day - Langleys

#### Data blocks and files

Hour block =

6 ten-minute data lines  
Hourly summary line

Day block =

24 Hour blocks  
Daily summary line

**A2: Key to the raw data fields from 1 November 1989–19 October 1990**

Ten-minute data line

Column	Type	Contents
1	Integer	1 - code for 10 minute record
2	Integer	Julian Day
3	Integer	Time - military time without leading zeros
4	Real	Temperature - soil - degrees Celsius
5	Real	Temperature - shelter - degrees Celsius
6	Real	Relative humidity - percent
7	Real	Wind - mean speed - meters/second
8	Real	Wind - vector magnitude - meters/second
9	Real	Wind - vector direction - degrees
10	Real	Wind - standard deviation of vector direction - degrees
11	Real	Precipitation - current value - millimeters

Hourly summary line

Column	Type	Contents
1	Integer	2 - code for hourly summary record
2	Real	Precipitation - current value - millimeters
3	Real	Temperature - soil - degrees Celsius
4	Real	Insolation - total for hour - Langleys

Daily summary line

Column	Type	Contents
1	Integer	3 - code for daily summary record
2	Real	Battery voltage
3	Real	Temperature - maximum for day - degrees Celsius
4	Integer	Time of max temp - military time
5	Real	Temperature - minimum for day - degrees Celsius
6	Integer	Temperature - time of min temp - military time
7	Real	Wind - peak gust for day - meters/second
8	Integer	Wind - time of peak gust - military time
9	Real	Insolation - total for day - Langleys

### A3: Key to the raw data fields from 19 October 1990-28 February 1991

The data from 19 - 31 October is contained in the file labeled 90292304.DAT.

From 19 October 1990 (date of the station overhaul) till 28 November 1990 the CR21X's program was being "debugged" and refined and thus the output format went through several changes until the present format was finalized. In addition, there was a battery crash that occurred on 3 December and there is a gap in the data set from Julian day 337 - 1200 hours to day 338 - 1400 hours. However, from 1400 hours on day 338 (4 Dec) to the present there are no gaps and no format changes.

From day 292 - 1600 hours (19 Oct) to day 306 - 1100 hours (2 Nov) the raw data set has the following format. Column 9 (PAR Insolation) on the hourly data line had an incorrect "multiplier and offset" and column 14 (Total Quantum Radiation) on the daily data line is a nonsense value.

#### Hourly data line

Column	Type	Contents
1	Integer	108 - code for hourly record
2	Integer	Calendar year
3	Integer	Julian Day
4	Real	Air Temperature - degrees Celsius
5	Real	Relative humidity - percent
6	Real	Soil Temperature - degrees Celsius
7	Real	Wind - mean speed - meters per second
8	Real	Wind - mean direction - degrees
9	Real	Insolation - mean PAR flux density - in Einsteins
10	Real	Precipitation - current value - millimeters
11	Real	Wind - standard deviation of the wind direction

#### Daily summary line

Column	Type	Contents
1	Integer	113 - code for daily summary record
2	Integer	Calendar year
3	Integer	Julian Day
4	Real	Air Temperature - daily maximum - degrees Celsius
5	Integer	Air Temperature - time of max temperature
6	Real	Air Temperature - daily minimum - degrees Celsius
7	Integer	Air Temperature - time of min temperature
8	Real	Soil Temperature - daily maximum - degrees Celsius
9	Integer	Soil Temperature - time of max temperature
10	Real	Soil Temperature - daily minimum - degrees Celsius
11	Integer	Soil Temperature - time of min temperature
12	Real	Wind - peak gust for day - in meters per second
13	Integer	Wind - time of peak gust
14	Real	Totalized Quantum Radiation

Starting with day 306 - 1200 hours (2 Nov) the weighing rain can's "multiplier and offset" calibration had been performed and an "hour" field added to both the hourly and daily data lines. In addition, a battery voltage reading was added to the daily data line.

From day 306 - 1200 hours (2 Nov) to day 317 - 1200 hours (13 Nov) the raw data set has the following format: Column 10 on the hourly line (PAR Insolation) and column 15 on the daily line (Total Quantum Radiation) have the same problem as before.

#### Hourly data line

Column	Type	Contents
1	Integer	109 - code for hourly record
2	Integer	Calendar year
3	Integer	Julian Day
4	Integer	Time - military time without leading zeros
5	Real	Air temperature - degrees Celsius
6	Real	Relative humidity - percent
7	Real	Soil temperature - degrees Celsius
8	Real	Wind - mean speed -meters per second
9	Real	Wind - mean direction - degrees
10	Real	Insolation - mean PAR flux density - in Einsteins
11	Real	Precipitation - current value - millimeters
12	Real	Wind - standard deviation of the wind direction

#### Daily summary line

Column	Type	Contents
1	Integer	115 - code for daily summary record
2	Integer	Calendar year
3	Integer	Julian Day
4	Integer	Time - military time without leading zeros
5	Real	Air temperature - daily maximum - degrees Celsius
6	Integer	Air temperature - time of max temperature
7	Real	Air temperature - daily minimum - degrees Celsius
8	Integer	Air temperature - time of min temperature
9	Real	Soil temperature - daily maximum - degrees Celsius
10	Integer	Soil temperature - time of max temperature
11	Real	Soil temperature - daily minimum - degrees Celsius
12	Integer	Soil temperature - time of min temperature
13	Real	Wind - peak gust for day - meters per second
14	Integer	Wind - time of peak gust
15	Real	Totalized Quantum Radiation
16	Real	Battery voltage

Starting with day 317 - 1700 hours (13 Nov) the Pyranometer sensor (back from its factory calibration) was added to the station sensor array and the daily data line gained a total global radiation field even though it was as nonsensical as the total Quantum radiation field already there! As before, the Quantum sensor still has the incorrect "multiplier and offset".

From day 317 - 1700 hours (13 Nov) to day 332 - 1600 hours (28 Nov) the raw data set has the following format and the time for the midnight hour, which previously read 0 for the following day, reads 2400 hours for the same day starting with midnight on day 320 (16 Nov).

Hourly data line		
Column	Type	Contents
1	Integer	110 - code for hourly record
2	Integer	Calendar year
3	Integer	Julian Day
4	Integer	Time - military time without leading zeros
5	Real	Air Temperature - degrees Celsius
6	Real	Relative humidity - percent
7	Real	Soil Temperature - degrees Celsius
8	Real	Wind - mean speed - meters per second
9	Real	Wind - mean direction - degrees
10	Real	Insolation - mean PAR flux density - in Einsteins
11	Real	Insolation - mean global radiation - kilowatts per meter <sup>2</sup>
12	Real	Precipitation - current value - millimeters
13	Real	Wind - standard deviation of the wind direction

Daily summary line		
Column	Type	Contents
1	Integer	117 - code for daily summary record
2	Integer	Calendar year
3	Integer	Julian Day
4	Integer	Time - military time without leading zeros
5	Real	Air Temperature - daily maximum - degrees Celsius
6	Integer	Air Temperature - time of max temperature
7	Real	Air Temperature - daily minimum - degrees Celsius
8	Integer	Air Temperature - time of min temperature
9	Real	Soil Temperature - daily maximum - degrees Celsius
10	Integer	Soil Temperature - time of max temperature
11	Real	Soil Temperature - daily minimum - degrees Celsius
12	Integer	Soil Temperature - time of min temperature
13	Real	Wind - peak gust for day - meters per second
14	Integer	Wind - time of peak gust
15	Real	Totalized Quantum Radiation
16	Real	Totalized Global Radiation
17	Real	Battery voltage

Starting on day 332 - 1700 hours (28 Nov) the Quantum sensor has the correct "multiplier and offset" and the two totalized radiation fields on the daily data line were removed!

From day 332 - 1700 hours (28 Nov) to the present, the raw data set has the following format.

#### Hourly data line

Column	Type	Contents
1	Integer	110 - code for hourly record
2	Integer	Calendar year
3	Integer	Julian Day
4	Integer	Time - military time without leading zeros
5	Real	Air Temperature - degrees Celsius
6	Real	Relative humidity - percent
7	Real	Soil Temperature - degrees Celsius
8	Real	Wind - mean speed - meters per second
9	Real	Wind - mean direction - degrees
10	Real	Insolation - mean PAR flux density - in Einsteins
11	Real	Insolation - mean global radiation - in kilowatts per meter <sup>2</sup>
12	Real	Precipitation - current value - millimeters
13	Real	Wind - standard deviation of the wind direction

#### Daily summary line

Column	Type	Contents
1	Integer	117 - code for daily summary record
2	Integer	Calendar year
3	Integer	Julian Day
4	Integer	Time - military time without leading zeros
5	Real	Air Temperature - daily maximum - degrees Celsius
6	Integer	Air Temperature - time of max temperature
7	Real	Air Temperature - daily minimum - degrees Celsius
8	Integer	Air Temperature - time of min temperature
9	Real	Soil Temperature - daily maximum - degrees Celsius
10	Integer	Soil Temperature - time of max temperature
11	Real	Soil Temperature - daily minimum - degrees Celsius
12	Integer	Soil Temperature - time of min temperature
13	Real	Wind - peak gust for day - meters per second
14	Integer	Wind - time of peak gust
15	Real	Battery voltage

**A4: Key to the raw data fields from 17 November 1992–31 Dec 2008**

Starting at 1700 hours on 17 November 1992 (day 322) the raw data output format was slightly rearranged and a new, more meaningful, set of wind parameters were programmed (via the Campbell 21X Micrologger output instruction # "76 wind vector" ((see page 11-4 of the 21X manual)) to be output. Previously, the wind parameters were output as simply mean wind speed and direction and the standard deviation of the direction. Now, output instruction # 76 generates: 1.) Mean wind speed 2.) Mean wind vector magnitude 3.) Mean wind vector direction 4.) Standard deviation of the wind direction. The current raw data set has the following format.

## Hourly data line

Column	Type	Contents
1	Integer	110 - code for hourly record
2	Integer	Calendar year
3	Integer	Julian Day
4	Integer	Time - military time without leading zeros
5	Real	Air Temperature - in degrees Celsius
6	Real	Relative humidity - percent
7	Real	Soil Temperature - in degrees Celsius
8	Real	Insolation - mean PAR flux density - in microEinsteins
9	Real	Insolation - mean global radiation - in kilowatts per meter <sup>2</sup>
10	Real	Precipitation - current value - in millimeters
11	Real	Wind - mean speed - meters per second
12	Real	Wind - mean vector magnitude - meters per second
13	Real	Wind - mean vector direction - in degrees
14	Real	Wind - standard deviation of the wind direction

## Daily summary line

Column	Type	Contents
1	Integer	118 - code for daily summary record
2	Integer	Calendar year
3	Integer	Julian Day
4	Integer	Time - military time without leading zeros
5	Real	Air Temperature - maximum for day - in degrees Celsius
6	Integer	Air Temperature - time of max temperature
7	Real	Air Temperature - minimum for day - in degrees Celsius
8	Integer	Air Temperature - time of min temperature
9	Real	Soil Temperature - maximum for day - in degrees Celsius
10	Integer	Soil Temperature - time of max temperature
11	Real	Soil Temperature - minimum for day - in degrees Celsius
12	Integer	Soil Temperature - time of min temperature
13	Real	Wind - peak gust for day - in meters per second
14	Integer	Wind - time of peak gust
15	Real	Battery voltage

## Appendix B: Data Gaps

KSR Weather station significant data gaps (JD = Julian Day)

**01 July 2006 (approx.)**, (JD = 182) – **05 Sept 2006**, (JD = 248) (**66 days**) (soil temp sensor bad)

**07 Sept 2001**, 20:00 CST (JD = 250) – **12 Sept 2001**, 17:00 CST (JD = 255) (**5 days**) (four bad sensors)

**30 Dec 1998**, 15:00 CST (JD = 356) – **05 Jan 1999**, 17:00 CST (JD = 005) (**7 days**) (battery crash)

**01 Dec 1998**, 16:00 CST (JD = 335) – **08 Dec 1998**, 17:00 CST (JD = 342) (**7 days**) (battery crash)

**13 Oct 1998**, 11:00 CST (JD = 286) – **20 Oct 1998**, 16:00 CST (JD = 293) (**7 days**) (battery crash)

**24 Jan 1992**, 8:00 CST (JD = 024) – **28 Jan 1992**, 11:00 CST (JD = 028) (**4 days**) (battery problem)

**26 Nov 1991**, 13:00 CST (JD = 330) – **03 Dec 1991**, 13:00 CST (JD = 337) (**7 days**) (battery crash)

**14 Sept 1991**, 19:00 CST (JD = 257) – **24 Sept 1991**, 16:00 CST (JD = 267) (**10 days**) (wind speed bad)

**16 July 1991**, 10:00 CST (JD = 197) – **19 July 1991**, 16:00 CST (JD = 200) (**6 hours**) (battery short)

**03 Dec 1990**, 13:00 CST (JD = 337) – **4 Dec 1990**, 13:00 CST (JD = 338) (**1 day**) (battery problem)

**13 Nov 1990**, 13:00 CST (JD = 317) – **13 Nov 1990**, 16:00 CST (**3 hours**) (reconfigure)

**19 Oct 1990**, 12:40 CST (JD = 292) – **19 Oct 1990**, 16:00 CST (**4 hours**) (reconfigure)

**20 Mar 1990**, 10:30 CST (JD = 079) – **27 Mar 1990**, 12:50 CST (JD = 086) (**7 days**) (battery crash)

**11 Apr 1988**, 11:40 CST (JD = 100) – **13 Apr 1988**, 08:20 CST (JD = 102) (**2 days**)

*(continued on next page)*

**23 Mar 1988**, 17:10 CST (JD = 081) – **25 Mar 1988**, 10:50 CST (JD = 083)  
(2 days)

**30 Nov 1987**, 17:00 CST (JD = 334) – **08 Jan 1988**, 14:50 CST (JD = 008)  
(40 days)

**09 Oct 1987**, 11:30 CST (JD = 282) – **13 Nov 1987**, 10:50 CST (JD = 317)  
(25 days)

**Appendix C: Synopsis of significant historic events and changes to the NESAs weather station.**

- December 1986 – January 1987: Poured building and instrument footings
- February – March 1987: KU F.O. installing electrical power to site and erecting weather tower and finishing instrument installation.
- 6 April 1987: First weekly Standard Can reading with wind screen installed.
- 18 June 1987: Start up data collection for weather data monitoring.
- August – November 1988: Install new triangular Rohn tower and reconfigured data collection to address issues of long term monitoring instead of the specific needs of the dry deposition project.
- 31 January 1989: Installed windscreen around tipping bucket.
- 14 July 1989: tipping bucket replaced by weighing can, data not automatically logged till 1 November 1989).
- October – November 1989. Station configuration was re-evaluated and reconfigured culminating in new format, as of 1 November 1989. (See details in the text above.)
- 19 October 1990: Second major reconfiguration and re-programming of sensors with the addition of a new datalogger and several new replacement sensors. (See details in the text above)
- 28 November 1990: Datalogger programming was debugged and “tweaked” with the data collection format more or less finalized for the future.
- 24 December 1991: New computer and software resources purchased, culminating in a routine weather data retrieval and archive procedure.
- 17 November 1992: Datalogger program altered to record wind direction and speed as a wind vector value. This was essentially the last data parameter change to present.
- 23 August 2000: New integrated wind monitor (Young model 5103) sensor installed.
- 28 August 2001: New Quantum light sensor (LI-190SB) installed.
- 7 September 2001: Windstorm damages Stephenson Screen and several sensors.

*(continued on next page)*

- 4-9 October 2001: New pyranometer light sensor, new Stephenson screen, repaired Quantum sensor, and new CS500 temperature/RH probe installed.
- 5 September 2006: New 107 soil temperature sensor installed.
- 18-19 August 2008: NRCS - SCAN site installed and start-up of data collection.
- 31 December 2008: NESA weather station decommissioned with “official” data collection ending.
- January 2009: Standard can moved and re-installed near the KSR Headquarters building to start “daily” precipitation measurements reported to the CoCoRaHs website.
- July 2009: Final disassembly and removal of all old sensors, mounting brackets, and support structures.

## Appendix D: Weather station physical description

### Description of the KSR Weather Station at NESAs

The KSR Weather station is located at 95° 11' 30" W and 39° 03' 00" N in the extreme southeastern corner of Jefferson County, KS. The weather station site is on a flat ridge at 1088 feet elevation surrounded by an established brome grass stand. A buffer zone of approximately 100 feet, centered on the instrument tower and shelter, is maintained as a no disturbance area and is mowed 4 inches high once a year in late summer.

The KSR weather station at the Nelson Environmental Study Area sampled eight atmospheric parameters 24 hours a day, 7 days a week. It utilized a battery powered Campbell Scientific 21X datalogger that was manually downloaded to a PC once a week. The datalogger sampled these eight parameters every 5 seconds and, on the hour, and stored a mean value of the previous hours measurements. In addition to these hourly means, the datalogger recorded daily (24 hour) minimum and maximum air and soil temperature and the time when they occurred. It also recorded the daily peak wind speed and the time at which it occurred. The datalogger utilized Central Standard Time, year round. The eight semi-automated recorded parameters were as follows:

Air Temperature (degrees Celsius)

Soil Temperature (degrees Celsius - probe 20 cm below the surface)

Relative Humidity (%)

Wind Speed (meters per second)

Wind Direction (vector direction in degrees)

Total Global Radiation (mean instantaneous solar radiation in kilowatts per meter<sup>2</sup>)

PAR Radiation (mean instantaneous flux density in microEinsteins)

Precipitation \* (current amount in weighing bucket in millimeters)

\* Note: weekly standard can measures are also recorded and total daily precipitation is provided in separate summaries.

In August 2008, a new NRCS SCAN network weather station was installed next to the current KSR weather station site. The old KSR weather station was decommissioned on 31 December 2008. Weather data for the SCAN site is available in real time on an Internet website maintained by NRCS. This data is available to the public. All requests for NESAs weather data starting in 2009 will be referred to the NRCS SCAN website:

<http://www.wcc.nrcs.usda.gov/scan/Kansas/kansas.html>

January 2009, Galen L. Pittman (configuration at the time of replacement by the NRCS SCAN network station).

## Appendix E: Description of the NESAs Weather Data Archive

Access to the NESAs raw weather data is available on the KSR Website: <http://www.ksr.ku.edu/libres/assets/climate.htm>. Questions can be directed to Galen L. Pittman, KSR Station Manager/Biologist, email: [gpittman@ku.edu](mailto:gpittman@ku.edu)).

The raw weather data (both daily and hourly) is currently available in MS excel format for the period 1990 through 2008. The data are organized as month files and are labeled as follows:

NESA0208.xls = hourly raw data for the month of August 2002.

24HR0507.xls = daily raw data for the month of July 2005.

The entire data set of rawdata (1987–2008) has been archived in text files in comma-delimited strings. Interpreting this data requires a key to the specific data fields and is available upon request, and is not available on the KSR website. The data is organized in month files, labeled as follows:

\*NESA9105.dat = text file for all rawdata for the month of May 1991.

\* Note: the oldest data was recorded every 10 minutes with different hourly and daily summaries.

The precipitation data is available in MS excel format in two tabulations. One tabulation is of **daily** precipitation (1988 – 2008) and is organized in month files, labeled as follows:

2006\_daily\_prec.xls = the daily precipitation for the calendar year 2006.

The second precipitation tabulation consists of a table of **monthly** precipitation totals (1988 - 2008), labeled as follows:

NESA\_ppt\_1988-2008.xls

In addition, there is a tabulation of the **weekly** standard rain can readings that were recorded from 16 February 1987 – 2 January 2009. This data is available in MS excel format in one large file and includes precipitation amounts in inches and the calendar and Julian date, labeled as follows:

stand\_can.2-87\_12-08.xls

Finally, there is a summary of mean air temperature that is available in MS excel format. This tabulation includes a mean, a minimum (min), and maximum (max) temperature for each month, and an annual mean with an overall annual max and min temperature. These data are tabulated for the period from 1989 – 2008, labeled as follows:

monthly\_temp.89\_08.xls

## Appendix F: Sensor and Equipment List

- 1.) 21X Micrologger - The 21X has self-checking/diagnostic software that automatically displays error messages. See micrologger manual for start up diagnostic (section 1.5.1, page 1-6), and error codes (section 3.10, page 3-13 and 14 and back page of 21X prompt sheet).
- 2.) SM4M Storage Module
- 3.) 5915R Transmitting/Recording 8 inch Precipitation Gauge: The pen point can be recharged with ink (from the small bottle and the hypodermic syringe inside the logger enclosure), and will require filling about once a month or as needed. The two 1-1/2 volt C size batteries, that power the chart drive, should be replaced about every six months or as needed.
- 4.) CS 500 - L Air Temperature and Relative Humidity Probe
- 5.) 107L Soil Temperature Probe
- 6.) LI-200X -L Pyranometer Sensor
- 7.) LI-190SB Quantum Sensor
- 8.) 5103 R.M. Young Wind Monitor
- 9.) HI-Q 5023 Hygrothermograph (H311): The pen points can be recharged with ink (from the small bottle and the hypodermic syringe inside the logger enclosure), and will require filling about once a month or as needed.
- 10.) 6310 Standard 8 inch Rain Can
- 12.) U.S. Weather Bureau Small Instrument Shelter
- 13.) 021 Micrologger Enclosure
- 14.) Rohn 25G Instrument Tower
- 15.) Weksler sling psychrometer
- 16.) PS-1270 12 V, 7.0 am.hr. Gel/Cell Battery (2): The spare Gel/Cell battery should be stored (when not in use) fully charged. It should not be exposed to extreme heat or allowed to discharge completely. A full discharge shortens the life of the battery and may affect the battery's capacity to take and maintain a full charge again. When in use (powering the 21X Micrologger), the battery voltage should not be allowed to drop below approximately 11.0 volts or the 21X could shut down and display a "08" error code (see section A, step 2 of this SOP for error code details). If the 21X shuts down, the program instructions will be lost and have to re-entered! Also the final memory is a ring memory that writes over the oldest stored data when full (equal to about 60 days at its current configuration). If the 21X shuts down it loses all of the ring memory and doesn't continue to log data. Since the data is downloaded once a week there should be copies of all of the old data except for the last 7 days since the previous download. Therefore a battery voltage crash tends to result in only the lost of about one week's worth of data, once the logger program is re-entered and the ring memory logs data again. The current datalogger program samples and records battery voltage at midnight, every day.

**Appendix G: Key to contents of Input Storage Locations**

## Location

01 = Air Temperature in degrees Celsius ( $^{\circ}$  C)

02 = Relative Humidity in %

03 = Soil Temperature in degrees Celsius ( $^{\circ}$  C)

04 = Wind Speed in meters per second (mps)

05 = Wind Direction in degrees (East =  $90^{\circ}$ )

06 = Quantum Sensor - Average Photosynthetically Active Radiation (PAR) flux density  
in microEinsteins (micromoles of photons per second per meter<sup>2</sup>)

07 = Precipitation Gauge in millimeters (mm) - current value

08 = Gel/Cell Battery Voltage in DC volts

09 = Pyranometer - Average global solar radiation in kilowatts per meter<sup>2</sup> (1000 joules  
per second per meter<sup>2</sup>)

**Appendix H: Description of old PC208 parameter files for the KSR weather station.**

DAY-COLM.PAR - Generates the raw daily summary data in a column format with descriptive headings and a title. This file also prints out the date in a month/day format in addition to the Julian day. This file is only for use with data from 28 November 1990 at 1700 hours through 1600 hours on 17 November 1992.

DYCOLNEW.PAR - Generates the raw daily summary data exactly like DAY-COLM.PAR except it is for data starting at 1700 hours on 17 November 1992 to the present.

HR-COLMN.PAR - Generates the raw hourly weather data but in a column format with descriptive headings and a title. This file also prints out the date in a month/day format in addition to the Julian day. This file is only for use with data from 28 November 1990 at 1700 hours through 1600 hours on 17 November 1992.

HRCOLNEW.PAR - Generates the raw hourly weather data exactly like HR-COLMN.PAR, except it is for data starting at 1700 hours on 17 November 1992 to the present.

HRLY-WC.PAR - Generates hourly weighing can precipitation data (rounded to the nearest tenth of a millimeter) plus the hourly relative humidity reading in column format with descriptive headings. It also prints out the minimum and maximum precipitation value for each 24 hour period. This file is only for use with data from 28 November 1990 at 1700 hours through 1600 hours on 17 November 1992.

HRWCNEW.PAR - Generates exactly the same data as HRLY-WC.PAR, except it is for data starting at 1700 hours on 17 November 1992 to 31 December 2008.