National Climatic Data Center

DATA DOCUMENTATION

FOR

DATA SET 6117 (DSI-6117)
CRN Raw Data

July 29, 2003

National Climatic Data Center
151 Patton Ave.
Asheville, NC 28801-5001 USA

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Table of Contents

1. Abstract: The U.S. Climate Reference Network (USCRN) is a network of
climate stations now being deployed as part of a National Oceanic and
Atmospheric Administration (NOAA) initiative. Its primary goal is to provide
future long-term homogeneous observations of temperature and precipitation
that can be coupled to long-term historical observations for the detection and
attribution of present and future climate change. Data from the USCRN will be
used in operational climate monitoring activities and for placing current
climate anomalies into an historical perspective.

When fully implemented, the CRN will provide observations from approximately
250 locations. Each location will be carefully selected to capture the
representative climate regions of the nation. A communications network will
link each location to the National Climatic Data Center (NCDC), where the
observations will be quality controlled, archived, and made readily available
with their metadata to a worldwide clientele.

The primary CRN measurement parameters are air temperature and precipitation
accumulation. Measurement of these two parameters is essential for the
climate record, and is required at all CRN field sites. Secondary measurement
parameters are wind speed, solar radiation, and ground surface (skin)
temperature. Secondary parameters contribute to improving the confidence in
the observational measurements, and provide insight into the reliability and
performance of the primary sensors.

Every CRN instrument site is being equipped with a standard set of automated
sensors, a data logger, and a satellite communications transmitter attached to a
typical 3 meter (10 feet) instrument tower. The Atmospheric Turbulence and
Diffusion Division (ATDD) of NOAA's Air Resources Laboratory assembles,
calibrates installs and, presently, maintains the sites. The specific system
capabilities and modes of operation have been documented in the CRN Functional
Requirements Document (FRD). Further information is contained in other documents
such as the Site Information Handbook, Instrument Manuals, and Metadata
Management and are available from NCDC's CRN website.

The CRN Program addresses the full spectrum of data management functions, such
as measuring and recording climate related surface environmental parameters,
data processing and quality control, timely access to data and documentation,
data analysis, extensive documentation, long-term life cycle maintenance, and
long-term stewardship (archive). This document is limited to describing
specific data management processes involved in data ingest, data processing,
data quality control and data archive. It also provides information on how to
read the raw, unprocessed CRN data.

2. Element Names and Definitions:

The USCRN data flow begins with the sensors in the field and ends with the
access and archive of this data after it has been processed. Every USCRN
instrument site is being equipped with a standard set of automated sensors, a
data logger, and a satellite communications transmitter attached to a typical
3 meter (10 feet) instrument tower. There are three temperature probes
recording data independently and three measurements of precipitation data from
a three-wire Geonor gauge. Other measured parameters are wind speed, solar
radiation, and ground surface (skin) temperature. (Candidate parameters for
future addition include relative humidity, soil moisture, and soil
temperature.) Precipitation data, recorded every fifteen minutes, temperature
data, and the other hourly observations are collected in a data logger
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attached to the tower. These data are transmitted within a few minutes after each hour via a GOES satellite transmitter for further delivery to NCDC. The data management overview is described in this section, beginning with the acquisition of the data.

At the field sites, a suite of automated instrument sense meteorological parameters. These sensors are sampled frequently as a function of the response time of the instrument. Temperature data, for example, are polled from all three sensors every two seconds. A processing unit, or data logger, creates five-minute averages of the polled values. The twelve five-minute averages are averaged to produce hourly values. Precipitation data are recoded for each of three wires on the rain gauges every fifteen minutes. (Specifics of data acquisition for temperature, precipitation, and for all the other parameters are available on the CRN website). The total processing time for the data logger is about 0.6 seconds. The data stream is sent to a communications device, or data buffer, and transmitted via GOES (see Figure1-1). The message usually takes about 7 seconds to transmit.
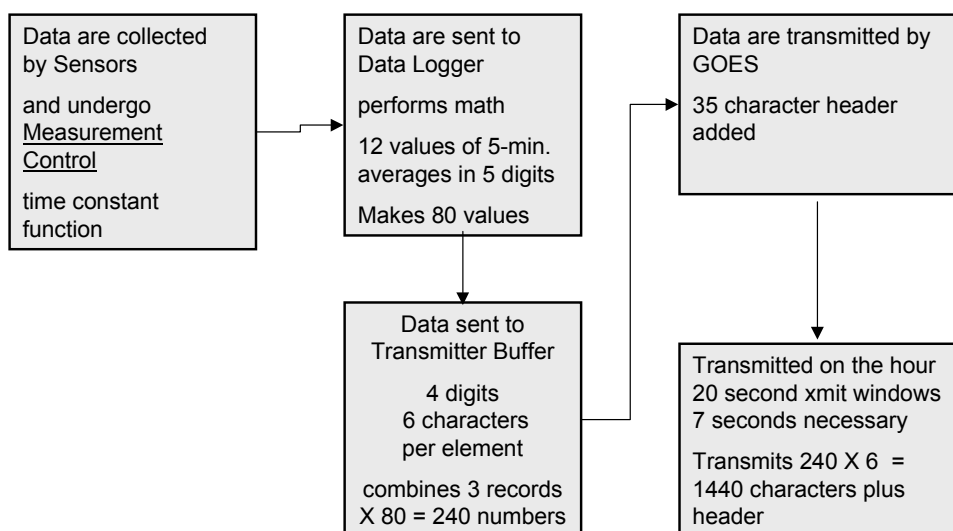
Data are collected by Sensors	Data are sent to Data Logger	Data are transmitted by GOES
and undergo Measurement Control	performs math	35 character header added
time constant function	12 values of 5-min. averages in 5 digits	
	Makes 80 values	

	Data sent to Transmitter Buffer	Transmitted on the hour 20 second xmit windows 7 seconds necessary
	4 digits 6 characters per element	Transmits 240 X 6 = 1440 characters plus header
	combines 3 records X 80 = 240 numbers	

Figure 1-1. Data Acquisition Data Stream

A 20-second transmit window for GOES is open, starting at the top of the hour. A second 20-second window follows the first. If however, the processing of the data is not completed before the opening of the second window, the data are held in the Transmitter Buffer for later transmission. One reason for failure to transmit is a failure to get a lock on the GPS synchronization. The data logger clock is reset every 6 hours to enable synchronization.

If the data have not transmitted for whatever reason, all the data that have not been transmitted are later transmitted, in what is called "data catch up

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mode." Approximately 30 days of data can be stored and transmitted in catch-up mode.

The data stream leaving the data logger has 80 values, each six-characters long, 4 digits, one decimal point, and a (+ or -) sign indicator, making a 480-character length record. The transmit buffer put together the current record and the record from the previous 2 hours, making a record of 1440 characters. The GOES transmission adds a 38 character leader to the data message.

Data are initially sensed by instruments in the field and processed into meteorological values by the Data Logger, then transmitted to NCDC. The USCRN dataflow is schematically shown in Figure 1-2. Data flows from the Field Sites, through the Communications Network, to NCDC, then made available to the User Community.
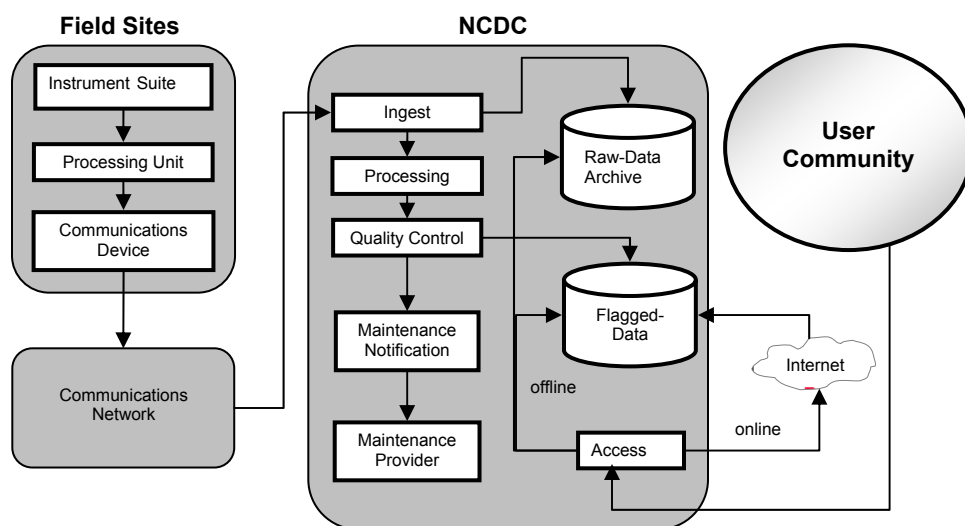

Figure 1-2.   USCRN Data Management Activities

The Data Management activities described in this document are in the NCDC square of the Figure 1-2. They include the processes of data ingest, processing, quality control, archive and access.

The processes that affect the data stream, that is, any source code, script files, or other procedures that affect the way the data is processed are Configuration Items. Changes to Configuration Items are under Configuration Management. The Configuration Management Plan and the Configuration Management Procedures, documented elsewhere, describe the approval process and procedures for changes to Configuration Items.

Once approved, the Data Operations Division handles implementing changes to

the software within the appropriate branch. The processes for data Ingest,
Processing, automated Quality Control, and Archive are maintained by the Data
Processing Branch of NCDC and are described in the CRN Ingest document (see
Appendix A). The Data Access Branch maintains the processes for data display
and web Access. Programming is done with accepted standards - C++, Perl,
Java, etc. and documented to industry standards. Following approval, changes
to the software are initiated by through Change Request forms, sent to the
Network Monitoring Lead and are logged through emails. The appropriate branch
of the Data Operations Division implements the change following the generic
process described in the Change Request document and sketched in the change
request flow diagram (see Figure 1-3).

Figure 1-3. CRN Change Request Flow Diagram
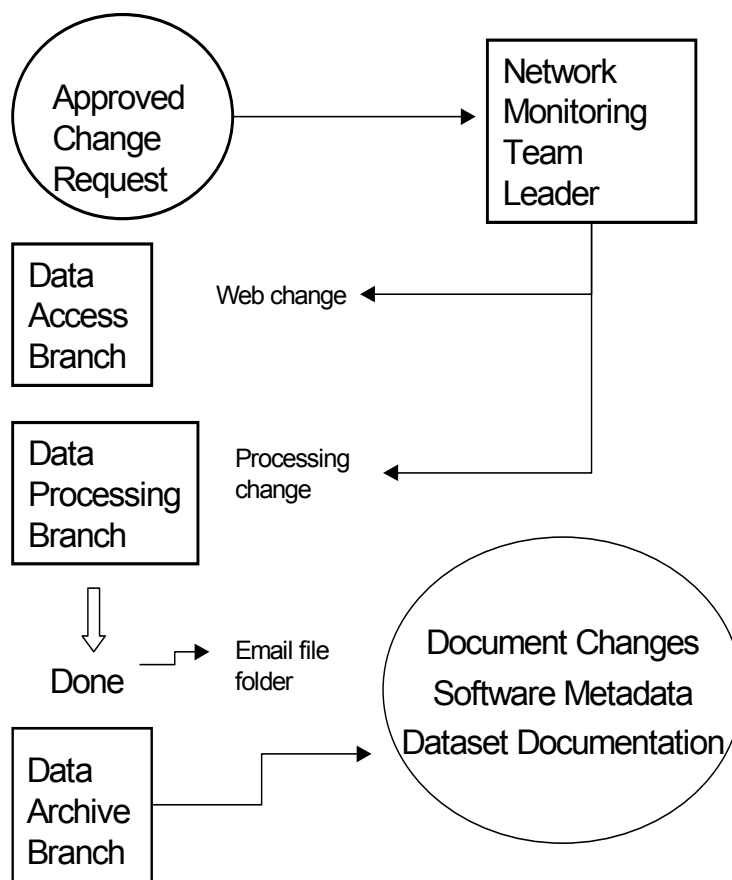
Once the software changes are tested and implemented, the Network Monitoring
Team Lead ensures that the closure to the change request is filed in the email
folder, and registers appropriate metadata documentation with the Data Archive
Branch.

Data Ingest

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After the data stream are acquired at the Field Site and transmitted over the communications network, they are ingested at NCDC. The Data Ingest Process described here begins with acquiring the data from GOES and ends with creating a Raw Data Archive.

Ingest from Transmissions

Data are transmitted over the communications network to the GOES Wallops Virginia facility The Data Ingest allow for multiple access pathways from GOES to NCDC (see figure 2-1) including a direct readout from GOES and NOAA port channel from the National Weather Service Telecommunications Gateway (NWSTG).
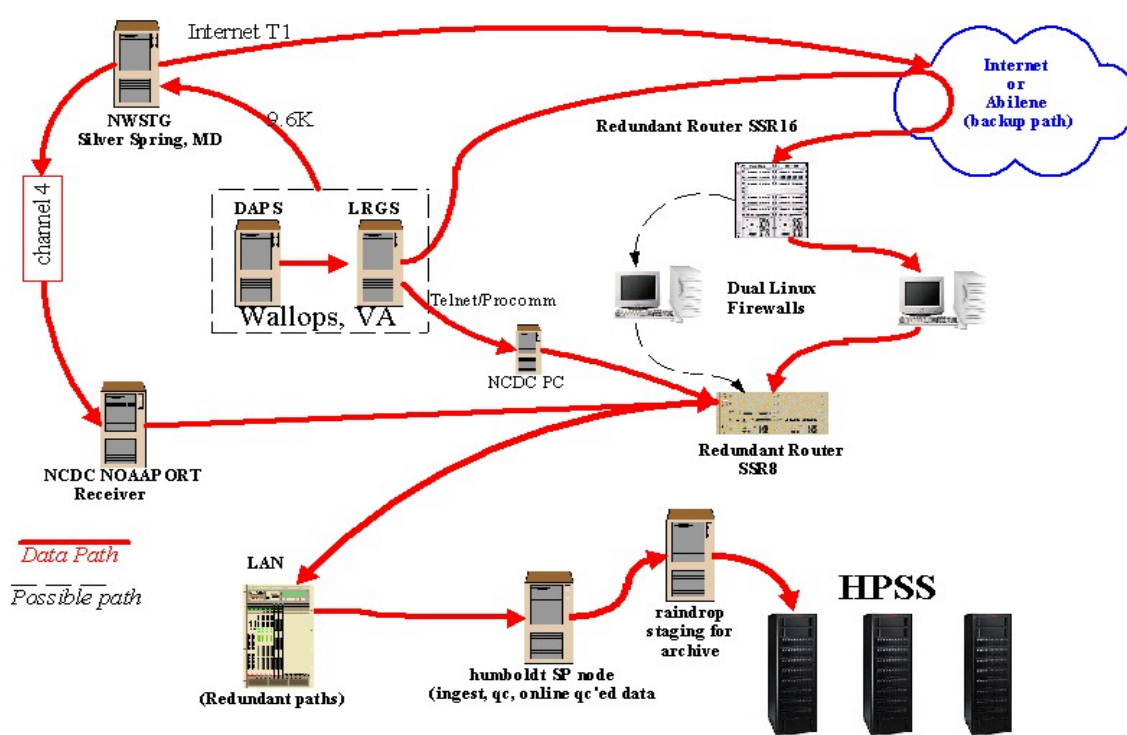
Figure 2-1. Ingest Pathways

The primary data ingest pathway is the GOES Local Read Out Ground Station (LRGS). Through this path, data from the GOES communication are available for ingest at NCDC approximately 5 minutes past each hour.

A data ingest script file process samples two communications ports, primarily, the GOES and secondarily, NOAAPORT. The process, which runs continuously 24 hours a day, 7 days a week is run on a microcomputer called Humboldt. In the event that no data are received from either pathway, a script will automatically be executed which will attempt to retrieve data from alternative avenues, such as from the Reston US Geological Survey (see Figure 2-2).

Figure 2-2. Data Ingest

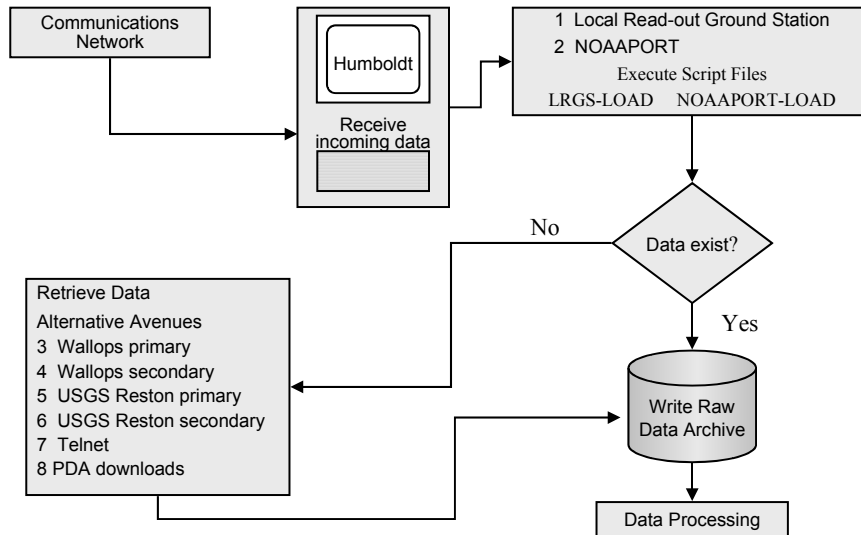As Humboldt receives incoming data streams, it initiates another process that writes a Raw Data Archive on a mass storage device. This archive is an exact replica of the data as ingested, before any sort of data processing or manipulation has occurred. The Raw Data Archive conforms to best practices of NCDC NARA standards, that is, with back-up off-site storage, media migration, and so forth. The Active Archive Branch of NCDC maintains the Dataset documentation for the Raw Data Archive.

Ingest from PDAs

If for some reason data transmission failed, or the data transmitted did not successfully make it through the communications network to the NCDC archives, a Personal Digital Assistant (PDA) can be used to download data from the data logger. Data is retained at each site in the memory of the data logger for approximately five to six months.

A process is run during data ingest to generate time of receipt statistics. At the end of every calendar month, ATDD personnel monitor the Data Availability statistics. Stations that have had less than 97% data availability for the month are flagged and stations missing *any data* in the previous 4 months are examined. An analysis is performed to determine if there is a possibility data may reside on the data logger at the site that can be used to supplement the data received and archived at NCDC. If the analysis indicates there is any possibility data can be retrieved, the site host/contact is notified and a PDA (along with instructions, batteries, return shipping label, etc.) is shipped via overnight mail to the site. (Note: 5 sites currently have laptop PCs with data logger software that allows the retrieval of data onto the laptop, which can then be emailed to ATDD).

When a PDA is returned to ATDD, the data on the PDA is downloaded to the ATDD

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FTP site into the directory: ftp://ftp.atdd.noaa.gov/pub/crn/palm

The data files on the FTP site have a naming convention of: XXXXXXXX_YYYYMMDD,
where:

         XXXXXXXX   - GOES ID of the station (6 to 8 characters, as required)
         YYYY   - Year of last piece of data in file
         MM   - Month of last piece of data in file
         DD   - Day of month of last piece of data in file

At NCDC a cron job checks the ATDD FTP directory on a routine basis, and if it
finds a new file in the directory the file is downloaded to NCDC. An auto-
generated email is sent from NCDC to ATDD to indicate that a file has been
successfully retrieved at NCDC.

If any files from the ATDD FTP site are processed at NCDC, a message is
generated by NCDC that has the following columns:

GOES ID
Year:Mo
#Obs Expected
#Obs Before Recovery
#Obs Recovered
% Recovered
% Complete

Data Processing

Data Ingest Processing

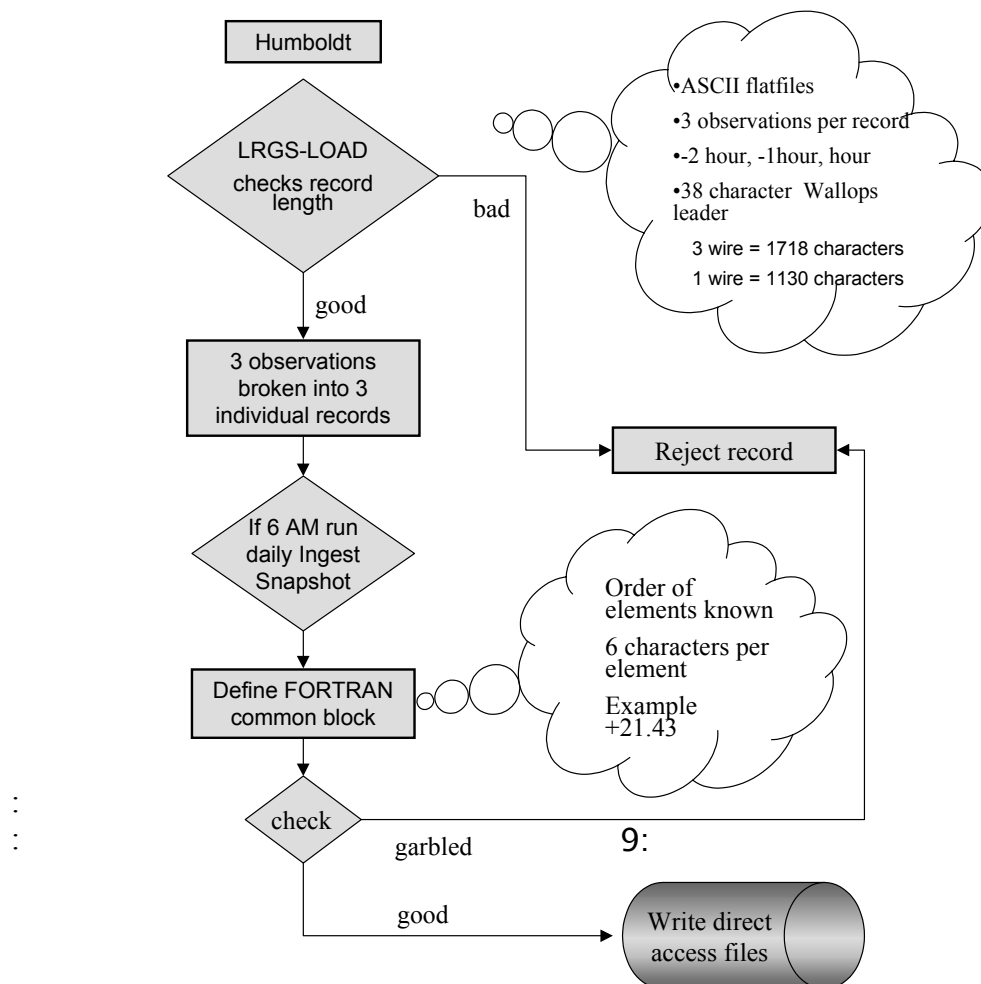Data Ingest Processing involves breaking the raw data file into individual

Figure 3-1. Data Ingest Process

records and writing direct access files. As the Raw Data Archive File is
being written, a Data Load script is simultaneously run on Humboldt. The
script checks the record length, and breaks the data stream, consisting of
three observations, into three individual records (see Figure 3-1). The
process anticipates the record length for each station. The data stream is an
ASCII flat file with three observations per record, the present hour, and the
two previous hours. Most stations have 80 six-character values and some header
information. There can be a variation in the record length if a station is
configured with one or with 3 wires on the Geonor rain gauge, or if a station
records more secondary parameters. Stations with a 3-wire Geonor have longer
record lengths (1718 characters) than stations with a 1-wire Geonor (1130
characters.) If the record length is unacceptable, the record is discarded.
If it is as expected, the data stream is broken into three individual records.

The data stream now contains one record of 80 values, with the values in order
as follows:

    1. Year
    2. Julian Date
    3. Time, 24 hour format with midnight equal to 2400
    4. Latitude
    5. Longitude
    6. Temperature #1 hourly average
    7. Temperature #1 standard deviation
    8. Temperature #2 hourly average
    9. Temperature #2 standard deviation
    10.Temperature #3 hourly average
    11.Temperature #3 standard deviation
    12.CS500 probe Temperature hourly average
    13.CS500 probe Temperature standard deviation
    14.CS500 probe RH hourly average
    15.CS500 probe RH standard deviation
    16.Temperature #1 hour minimum
    17.Temperature #1 hour minimum time of occurrence
    18.Temperature #2 hour minimum
    19.Temperature #2 hour minimum time of occurrence
    20.Temperature #3 hour minimum
    21.Temperature #3 hour minimum time of occurrence
    22.Temperature #1 hour maximum
    23.Temperature #1 hour maximum time of occurrence
    24.Temperature #2 hour maximum
    25.Temperature #2 hour maximum time of occurrence
    26.Temperature #3 hour maximum
    27.Temperature #3 hour maximum time of occurrence
    28.Average Temperature for sensor 1 for minutes 55 to 59
    29.Average Temperature for sensor 2 for minutes 55 to 59
    30.Average Temperature for sensor 3 for minutes 55 to 59
    31.Precipitation for 0 to 15 minutes of hour VW #1
    32.Precipitation for 16 to 30 minutes of hour VW #1
    33.Precipitation for 31 to 45 minutes of hour VW #1
    34.Precipitation for 46 to 60 minutes of hour VW #1
    35.Precipitation total for hour VW #1
    36.Wind Speed average for hour
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37. Wind Speed standard deviation
38. Solar Radiation
39. Solar Radiation standard deviation
40. Surface Temperature
41. Surface Temperature standard deviation
42. Hour rain gage frequency average for VW #1
43. Hour rain gage frequency minimum for VW #1
44. Hour rain gage frequency maximum for VW #1
45. Fan speed output for aspirated shield #1 East
46. Fan speed output for aspirated shield #2 South
47. Fan speed output for aspirated shield #3 West
48. Battery voltage for fan and GOES transmitter battery
49. Battery voltage for fan and GOES transmitter battery under full load
50. Battery voltage for CR23X data logger
51. Time in minutes during the past hour that the enclosure door was open
52. CR23X program version number
53. mm depth at end of 1st 15 minutes for VW #1
54. mm depth at end of 2nd 15 minutes for VW #1
55. mm depth at end of 3rd 15 minutes for VW #1
56. mm depth at end of 4th 15 minutes for VW #1
57. Rainfall for VW #2 1st 15 minutes in mm
58. Rainfall for VW #2 2nd 15 minutes in mm
59. Rainfall for VW #2 3rd 15 minutes in mm
60. Rainfall for VW #2 4th 15 minutes in mm
61. Rainfall total for hour for VW #2
62. mm depth at end of 1st 15 minutes for VW #2
63. mm depth at end of 2nd 15 minutes for VW #2
64. mm depth at end of 3rd 15 minutes for VW #2
65. mm depth at end of 4th 15 minutes for VW #2
66. Hour rain gage frequency average for VW #2
67. Hour rain gage frequency minimum for VW #2
68. Hour rain gage frequency maximum for VW #2
69. Rainfall for VW #3 1st 15 minutes in mm
70. Rainfall for VW #3 2nd 15 minutes in mm
71. Rainfall for VW #3 3rd 15 minutes in mm
72. Rainfall for VW #3 4th 15 minutes in mm
73. Rainfall total for hour for VW #3
74. mm depth at end of 1st 15 minutes for VW #3
75. mm depth at end of 2nd 15 minutes for VW #3
76. mm depth at end of 3rd 15 minutes for VW #3
77. mm depth at end of 4th 15 minutes for VW #3
78. Hour rain gage frequency average for VW #3
79. Hour rain gage frequency minimum for VW #3
80. Hour rain gage frequency maximum for VW #3

Note all temperature measurements are in degrees Celsius. All wind speed measurements are in meters per second. All voltages are in volts.

More detailed information about the USCRN Limits and Ranges can be found in **Appendix A.**

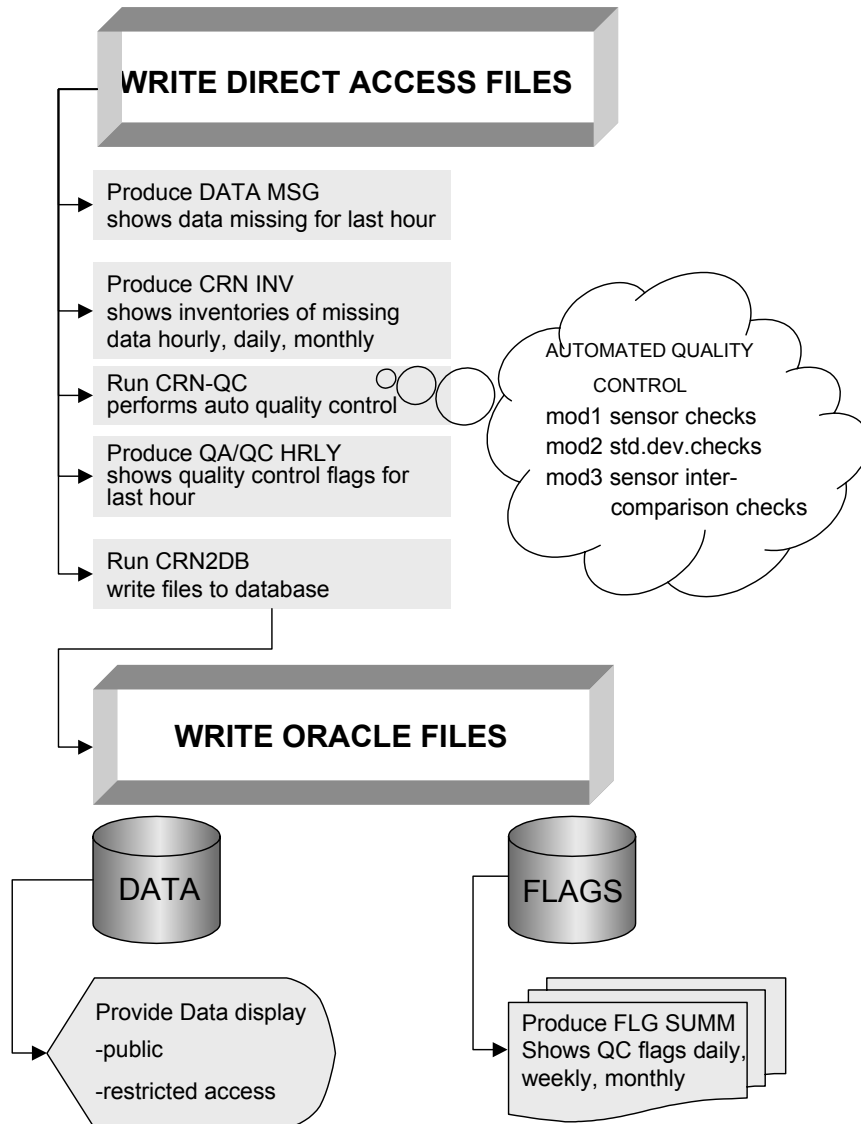Next, a Fortran common block is defined. Knowing the order of the elements in the data stream, the position of signs and decimal points, a check is performed to ensure that expected characters appear in the expected places. If the data are garbled, the record is rejected. Otherwise, the record is accepted. Lastly, a script is run on Humboldt to Write Direct Access Files.

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Data Processing

More data processing occurs after the Humboldt writes the Direct Access Files. Further processing includes automatic procedures to eliminated duplicates, processes to produce data message files, processes to perform automatic quality control checks, and to load data into Oracle Data Tables for on-line access (See Figure 3-2). These processes are outline in the next two sections.

Using direct access files enables easy data access and availability and allows for easy elimination of duplicate observations. As the files are being written, a process checks for and discards duplicate records, (remember, every record could be ingested three times).

WRITE DIRECT ACCESS FILES

Produce DATA MSG
shows data missing for last hour

Produce CRN INV
shows inventories of missing
data hourly, daily, monthly

Run CRN-QC
performs auto quality control

AUTOMATED QUALITY
CONTROL
mod1 sensor checks
mod2 std.dev.checks
mod3 sensor inter-
comparison checks

Produce QA/QC HRLY
shows quality control flags for
last hour

Run CRN2DB
write files to database

WRITE ORACLE FILES

DATA

FLAGS

Provide Data display
-public
-restricted access

Produce FLG SUMM
Shows QC flags daily,
weekly, monthly

Figure 3-2. Data Process

After discarding duplicate messages, every hour the script DATA MSG is run to
identify what data were not received for the hour. A file is produced and
sent via email to the Network Monitoring Team. A sample excerpt from the file
follows:

        DATA MSG FOR LATEST HOUR

        GMT HOUR 09 not found for station Barrow 4 ENE, NOAA (CMDL Observatory)
        on Sun Jun 15 05:55:01 EDT 2003
        LAST KEY IN crn200306.00F0B0 IS 1413H035

        GMT HOUR 09 not found for station Fairbanks 11 NE, NOAA / NESDIS (FCDAS)
        on Sun Jun 15 05:55:01 EDT 2003
        LAST KEY IN crn200306.0102CE IS 1418H313

        NO DATA RECEIVED FOR 0184DA John Day 35 WNW, John Day Fossil Beds Nat.
        Mon for Jun 2003

The process CRN INV produces inventories of the data, showing time periods of
missing data. It is produced daily and monthly. These reports are available
by automated email once daily for the previous day, and once monthly for the
previous month. Summary reports on Data Inventory can also be produced on
demand for any range of stations, for any range of time periods. This command
is available on the restricted access CRN Website
(http://www.ncdc.noaa.gov/oa/climate/uscrn/).

Data Archive

Both raw and processed data are stored in archives. Unprocessed data, the Raw
Data, are written to a mass storage device during data ingest (see Figure 2-
2). The Raw Data Archive is registered in the NESDIS data catalog as TD# 6117.
Processed or flagged data are written to a mass storage device following
quality control (see figure 3-2). The Flagged Data Archive is registered in
the NESDIS data catalogue as TD# 3286. Documentation for both archives resides
with the Archive Branch of the Data Operations Division.

TD# 3286 adheres to full compatibility with NCDC element-structured databases.
Archival CRN data files will adhere to full compatibility with NCDC element-
structured data bases. Hourly, daily, and monthly data will be compatible with

   • TD3280 - Hourly (requiring WBAN numbers),
   • TD3200 - Daily (requiring coop numbers) and
   • TD3220 – Monthly (requiring coop numbers).

The dataset documentation for TD# 3286 includes a description of the data
stream, elements recorded, and units of measurement (go to on-line
documentation and select 3286 here:
http://www4.ncdc.noaa.gov/ol/documentlibrary/datasets.html.)   One page
summaries on each of the sensors, which explain how each parameter (temp,
precip, solar etc) is measured, is also included with the dataset
documentation and can be found on the CRN web site (see
http://www.ncdc.noaa.gov/servlets/crninstrdoc#SENSORS)
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The Archive is done within NARA standards using approved storage media and equipment. Mitigation plans include an automated migration from data on the mass store to higher capacity media. Physical off-site storage with routine back-up procedures exist.   NCDC is developing Continuity of Operations Plan.   With the implementation of the Comprehensive Large Array Stewardship System (CLASS) NCDC will have a mirror site in Washington DC.

3.   **Start Date**: 20011001

4.   **Stop Date**: Ongoing.

5.   **Coverage**: Areal Coverage USA

    a. Southernmost Latitude: 25° S. Latitude
    b. Northernmost Latitude: 50° N. Latitude
    c. Westernmost Longitude: -125° W. Longitude
    d. Easternmost Longitude: -65° E. Longitude

6.   **How to Order Data**:

Ask NCDC's Climate Services about the cost of obtaining this data set.
Phone: 828-271-4800
FAX: 828-271-4876
E-mail: **NCDC.Orders@noaa.gov**

7.   **Archiving Data Center**:

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

8.   **Technical Contact**:

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

9.   **Known Uncorrected Problems**: None.

10.   **Quality Statement**: The process CRN-QC performs automated quality control on the Direct Access Files. Briefly, these processes include the following checks.

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- Modular 1 performs sensor limit checks
- Modular 2 performs standard deviation checks
- Modular 3 performs inter-comparison checks

Next, the CRN2DB script loads data and flags into the Oracle data base Table Files, one for the data and one for the flags.

Hourly, a QA/AC message shows data that have failed some quality control check (see Appendix F for a sample). Script files produce Data Flag Summary reports from the Flag Table. These reports are produced daily, weekly, and monthly. The various data quality flags are displayed in the Monthly Flag Summary report.

Summary reports on Data Flags can also be produced on demand for any range of stations, for any range of time periods. This command is available on the restricted access Website (http://www.ncdc.noaa.gov/oa/climate/uscrn/) for CRN Data Access Module.

In addition, CRN data are included in with separate systems run by the Data Processing Branch of the Data Operations Division. Specifically, CRN temperature data are used in TEMPVAL, an automated quality control process used for validating data from the Cooperative Station Network.

11. **Essential Companion Datasets**: None.

12. **References**: No information provided with original documentation.

Appendix A

El	Flg	Ch	ID	Description	Units	Range Limits	
						Min	**Max**
1		37	Full ID				
2		6	Year	4-digit year		2000	2020
3		6	jday	Julian Date - Day of the year from 1 - 366		+001.0	+366.0
4		6	time	Hour and Minute of observation hour	hours, minutes	+0001.	+2400.
5		6	lat	Latitude of the CRN site	Degrees, tenths	CRN MSL	CRN MSL
6		6	lon	Longitude of the CRN site	Degrees, tenths	CRN MSL	CRN MSL
7	7	6	temp1avg	60 minute average of temp sensor # 1	Degrees C	-60.00	+60.00
8		6	temp1sd	Standard deviation of temp sensor # 1		0.0000	3.0000
9	9	6	temp2avg	60 minute average of temp sensor # 2	Degrees C	-60.00	+60.00
10		6	temp2sd	Standard deviation of temp sensor # 2		0.0000	3.0000
11	11	6	temp3avg	60 minute average of temp sensor # 3	Degrees C	-60.00	+60.00
12		6	temp3sd	Standard deviation of temp sensor # 3		0.0000	3.0000

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13	13	6	cs500tavg	60 minute average of RH temp sensor	Degrees C	-60.00	+60.00
14		6	cs500tsd	Standard deviation of RH temp sensor		0.0000	3.0000
15	15	6	cs500rhav	60 minute average of RH sensor	Percent	+00.00	+100.0
16		6	Cs500rhsd	Standard deviation of RH sensor		0.0000	30.000
17	17	6	tmp1min	Minimum temp recorded by temp sensor #1	Degrees C	-60.00	+60.00
18	18	6	tmp1ntime	Minute of the hour the min temp occurrred	hours, minutes	+0000.	+2359.
19	19	6	tmp2min	Minimum temp recorded by temp sensor #2	Degrees C	-60.00	+60.00
20	20	6	tmp2time	Minute of the hour the min temp occurrred	hours, minutes	+0000.	+2359.
21	21	6	tmp3min	Minimum temp recorded by temp sensor #3	Degrees C	-60.00	+60.00
22	22	6	tmp3time	Minute of the hour the min temp occurrred	hours, minutes	+0000.	+2359.
23	23	6	tmp1max	Maximum temp recorded by temp sensor #1	Degrees C	-60.00	+60.00
24	24	6	tmp1time	Minute of the hour the max temp occurrred	hours, minutes	+0000.	+2359.
25	25	6	tmp2max	Maximum temp recorded by temp sensor #2	Degrees C	-60.00	+60.00
26	26	6	tmp2time	Minute of the hour the max temp occurrred	hours, minutes	+0000.	+2359.
27	27	6	tmp3max	Maximum temp recorded by temp sensor #3	Degrees C	-60.00	+60.00
28	28	6	tmp3time	Minute of the hour the max temp occurrred	hours, minutes	+0000.	+2359.
29	51	6	avt1_5559	Average Temp of Sensor #1 for minutes 55 - 59	Degrees C	-60.00	+60.00
30	52	6	avt2_5559	Average Temp of Sensor #2 for minutes 55 - 59	Degrees C	-60.00	+60.00
31	53	6	avt3_5559	Average Temp of Sensor #3 for minutes 55 - 59	Degrees C	-60.00	+60.00
32	29	6	pcp0-15	Amount of precip recorded during 1st 15 minutes VW#1	millimeters	+0.000	+600.0
33	30	6	pcp16-30	Amount of precip recorded during 2nd 15 minutes VW#1	millimeters	+0.000	+600.0
34	31	6	pcp31-45	Amount of precip recorded during 3rd 15 minutes VW#1	millimeters	+0.000	+600.0
35	32	6	pcp46-60	Amount of precip recorded during 4th 15 minutes VW#1	millimeters	+0.000	+600.0
36	33	6	pcphtot	Amount of precip recorded for the hour VW#1	millimeters	+0.000	+600.0
37	34	6	avgwspd	Average wind speed recorded for the hour	Meters/sec	+00.00	+60.00
38		6	awspdsd	Average wind speed standard deviation		0.0000	20.000
39	36	6	solrad	Amount of solar radiation recorded during past hour	Watts/sq meter	+0000.	+1500.
40		6	solradsd	Solar radiation standard deviation		0.0000	550.00
41	38	6	sfctmp	Temperature of the ground surface	Degrees C	-60.00	+90.00
42		6	sfctmpsd	Surface temp standard deviation		0.0000	6.0000
43	40	6	pcpgavfreq	Average frequency of WRG vibrating wire	Hertz	+0000.	+3000.
44	41	6	pcpgfreqmn	Minimum frequency of WRG vibrating wire	Hertz	+0000.	+1000.
45	42	6	pcpgfreqmx	Maximun frequency of WRG vibrating wire	Hertz	+0000.	+3000.
46	43	6	fanspd1e	The fan speed of the aspirated shield #1 East	Revs/sec	+90.00	+125.0

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47	44	6	fanspd2s	The fan speed of the aspirated shield #2 South	Revs/sec	+90.00	+125.0
48	45	6	fanspd3w	The fan speed of the aspirated shield #3 West	Revs/sec	+90.00	+125.0
49	46	6	battvol	Battery voltage of fan & GOES transmitter	Volts	+12.00	+14.50
50	47	6	battvol_fl	Battery voltage of fan & GOES transmitter, full load	Volts	+11.00	+14.50
51	48	6	battvol_dl	Battery voltage of CR23X datalogger	Volts	+10.00	+14.50
52	49	6	opndoor_tm	# of minutes datalogger door open past hour	hours, minutes	+0001.	+2359.
53	50	6	cr23xver				
	54	6	pcp2_0015				
	55	6	pcp2_1630				
	56	6	pcp2_3145				
	57	6	pcp2_4660				
	58	6	pcp2htot				
54	59	6	gdp1st15_1	Gage Depth Reading 1st 15 minutes VW#1	millimeters	-2.000	+600.0
55	60	6	gdp2nd15_2	Gage Depth Reading 2nd 15 minutes VW#1	millimeters	-2.000	+600.0
56	61	6	gdp3rd15_3	Gage Depth Reading 3rd 15 minutes VW#1	millimeters	-2.000	+600.0
57	62	6	gdp4th15_4	Gage Depth Reading 4th 15 minutes VW#1	millimeters	-2.000	+600.0
58	63	6	pcp1st15_2	Precipitation 1st 15 minutes for VW#2	millimeters	+0.000	+600.0
59	64	6	pcp2nd15_2	Precipitation 2nd 15 minutes for VW#2	millimeters	+0.000	+600.0
60	65	6	pcp3rd15_2	Precipitation 3rd 15 minutes for VW#2	millimeters	+0.000	+600.0
61	66	6	pcp4th15_2	Precipitation 4th 15 minutes for VW#2	millimeters	+0.000	+600.0
62	67	6	pcphrtot_2	Precipitation hour total for VW#2	millimeters	+0.000	+600.0
63	68	6	gdp1st15_2	Gage Depth Reading 1st 15 minutes VW#2	millimeters	-2.000	+600.0
64	69	6	gdp2nd15_2	Gage Depth Reading 2nd 15 minutes VW#2	millimeters	-2.000	+600.0
65	70	6	gdp3rd15_2	Gage Depth Reading 3rd 15 minutes VW#2	millimeters	-2.000	+600.0
66	71	6	gdp4th15_2	Gage Depth Reading 4th 15 minutes VW#2	millimeters	-2.000	+600.0
67	72	6	pcpgavfq_2	Gage Hour Freq Average for VW#2	Hertz	+0000.	+3000.
68	73	6	pcpgmnfq_2	Gage Hour Freq Minimum for VW#2	Hertz	+0000.	+1000.
69	74	6	pcpgmxfq_2	Gage Hour Freq Maximum for VW#2	Hertz	+0000.	+3000.
70	75	6	pcp1st15_3	Precipitation 1st 15 minutes for VW#3	millimeters	+0.000	+600.0
71	76	6	pcp2nd15_3	Precipitation 2nd 15 minutes for VW#3	millimeters	+0.000	+600.0
72	77	6	pcp3rd15_3	Precipitation 3rd 15 minutes for VW#3	millimeters	+0.000	+600.0
73	78	6	pcp4th15_3	Precipitation 4th 15 minutes for VW#3	millimeters	+0.000	+600.0
74	79	6	pcphrtot_3	Precipitation hour total for VW#3	millimeters	+0.000	+600.0

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75	80	6	gdp1st15_3	Gage Depth Reading 1st 15 minute VW#3	millimeters	-2.000	+600.0
76	81	6	gdp2nd15_3	Gage Depth Reading 2nd 15 minute VW#3	millimeters	-2.000	+600.0
77	82	6	gdp3rd15_3	Gage Depth Reading 3rd 15 minute VW#3	millimeters	-2.000	+600.0
78	83	6	gdp4th15_3	Gage Depth Reading 4th 15 minute VW#3	millimeters	-2.000	+600.0
79	84	6	pcpgavfq_3	Gage Hour Freq Avg for VW#3	Hertz	+0000.	+3000.
80	85	6	pcpgmnfq_3	Gage Hour Freq Minimum for VW#3	Hertz	+0000.	+1000.
81	86	6	pcpgmxfq_3	Gage Hour Freq Maximum for VW#3	Hertz	+0000.	+3000.

T   Transmit

* means that this element will be transmitted via the NOAAport in SHEF format

a means that the average of these elements will be transmitted via the NOAAport in SHEF format

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