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OPERATIONS AND SERVICES
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Data Quality Control and Assurance Standards

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OPR: W/CR1x2 Doug Kluck
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Certified by: Mike Looney

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/signed/ April 28, 2008
LYNN P. MAXIMUK Date
DIRECTOR,
CENTRAL REGION

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1. Purpose. This supplement provides guidance for Central Region Weather Forecast Offices (WFOs) and River Forecast Centers (RFCs) to ensure a consistent and standardized level of quality assurance (QA) and data quality control (QC) of manual and automated weather and climate observations.

1.1 A Quality Assurance program implies that necessary precautions have been taken to ensure quality output. WFOs and RFCs can assure quality output by employing preventative measures to ensure quality observations such as defining observing standards, staff and observer training, station inspection, and internal data checking.

1.2 A Quality Control program consists of the corrective actions by WFOs and RFCs to ensure high quality data in real-time through post processing.

2. Introduction. The NWS has the responsibility of collecting and providing weather and climate observation data. However, the methods for the collection, quality control, and delivery of these data vary from office to office. Many of the data quality initiatives between the NWS and NCDC have been uncoordinated. Even with the NWS itself such activities vary greatly between field offices. This situation must change in the interest of efficiency, data record integrity and public use.

Today, with the ever increasing use of observational data by the research community, the media, private industry, and the general public it is of the utmost importance to accurately and consistently apply QC/QA at all field offices. In order to ensure the highest quality data and data products within Central Region, the QC/QA methods discussed in this supplement are highly recommended at each WFO.

3. Responsibilities. The following paragraphs outline the QC/QA responsibilities of Central Region Headquarters (CRH), and their WFOs and RFCs.

3.1 Central Region Headquarters. The Central Region Climate Services Program Manager (CSPM), the Automated Surface Observing System (ASOS) Program Manager, and the Cooperative Program Manager/Upper Air (CPM/UA) Program Manager shall provide regional policy, procedures, and standards for QC/QA of manual and automated observations. They are responsible for administering the observational QC program in accordance with the guidance outlined by the Office of Climate, Water, and Weather Services (OCWWS).

3.2 WFO. The Meteorologist in Charge (MIC) is responsible for execution of the QC/QA program within their designated County Warning Area (CWA). The Data Acquisition Program Manager (DAPM) or Observation Program Leader (OPL) will be the designated data steward for the office. The DAPM/OPL may have someone assist in the development/maintenance of local QC/QA guidance, via a Station Duty Manual (SDM) or QC/QA continuity binder. In addition to the requirements outlined in this supplement, the DAPM/OPL should ensure a random sample of each data product undergoes after-the-fact QC. Finally, the DAPM/OPL should report the health of the office's QC/QA program to the MIC monthly.

3.3 RFC. The Hydrologist in Charge (HIC) is responsible for execution of the QC/QA program for observations within their designated area of responsibility. The HIC should designate a QC/QA steward who will routinely report the health of the office's data program. The RFC shift leader will ensure routine daily QC/QA procedures and coordination are performed by the Hydrometeorological Analysis and Support (HAS) Forecaster or other available staff as appropriate.

4. ASOS/AWOS QC/QA. Continuous monitoring of Automated Surface Observing System (ASOS)/Automated Weather Observing System (AWOS) observations is critical to ensure quality forecasts, as well as quality hydrological, and climatological products. Therefore, at a minimum of once each hour, WFOs will monitor ASOS/AWOS observations for timeliness, missing elements, phantom precipitation, and spatial consistency.

4.1 Real-Time QC. The following programs can aid a WFO's QC of ASOS/AWOS observations.

A. ALARM (Awips Local ASOS Real-time Monitor). WFOs may utilize this program to monitor ASOS/AWOS observations for timeliness and missing elements. This program provides a customizable graphic presentation of the ASOS/AWOS sites within your CWA. Available via the Local Applications Database (LAD).

B. WFO Hydrologic Forecast System (WHFS). WFOs may utilize the Alert/Alarm function of WHFS to monitor ASOS/AWOS observations. Alert/Alarm allows users to compare data values against predefined thresholds. This is baseline AWIPS software.

C. AWIPS (Spatial QC). At a minimum of once each hour, WFOs may utilize AWIPS (or some other mapping program) to map ASOS/AWOS observations within their CWA. Once mapped, data should be visually compared to their neighbors to ensure spatial consistency. In addition, observation plots should be compared against remote sensed data such satellite imagery, radar reflectivity and lightning data to check for present weather and precipitation consistency

D. The Local Area Prediction System (LAPS). A baseline AWIPS program which has excellent QC value. By displaying basic meteorological fields (temperature, dew point, wind, etc.), bad or suspect data show up in the form of "bulls-eyes" in the data fields. This allows the WFO staff to evaluate suspect data further.

E. Graphical Forecast Editor (GFE). GFE is a central part of the Interactive Forecast Preparation System (IFPS) and it can be used as a data QC tool for ASOS and AWOS observations. These observations can be brought into GFE hourly and compared with other observational networks (Road Weather Information System (RWIS), School Net, etc). Since this data is displayed

graphically, one can find discrepancies in temperature, dew point, relative humidity, and wind quickly.

4.2 After-the-Fact QC/QA.

A. Manual Review of F-6. The F-6 will be checked daily for accuracy and continuity of the following elements at a minimum: maximum and minimum temperature, precipitation, snowfall and snow depth.

B. AWOS F-6s. If a WFO places AWOS F-6s online under the "Climate/Local/Local Data/Records" or "Climate/More" links of the standard climate web site, this data shall be quality controlled.

C. NCDC's Health of the ASOS Network (HoN). Available soon from NCDC.

5. COOP QC/QA. With the increased importance of the Cooperative Observer Program (COOP) data in today's society and the speed at which it is transmitted to the public, a strong QC/QA program at the WFO level must exist. In order to do this, WFOs must monitor, review, and take corrective action on any COOP observation that fails to meet the highest standards of quality. This can only be accomplished through preventative, real-time, near real-time, and after-the-fact monitoring of observations.

5.1 Preventative QA. Perhaps the most important element of quality control is the preventative element. A successful QA program requires that all WFO and RFC staff receive training, and are provided necessary tools. Then, If we can ensure the observer has all the necessary tools prior to taking observations, the chances for a successful program are greatly increased. WFOs should ensure their preventative QA activities include observer training, routine station inspections, careful consideration of instrument siting issues, and adequate initial and routine refresher training. In addition, WFOs must ensure all station metadata is accurate and timely.

5.2 Real-time QC Real-time QC can be maximized with a strong Quality Assurance Program combined with use of automated data transmission programs such as Web transmitted Cooperative Observer Data Encoded Report (WXCODER) and the Interactive Voice - Remote Observation Collection System (IV-ROCS). All current COOP observers should be strongly encouraged to use one of these system and any new observers are required to use one of these automated systems.

5.2.1 Best Practices.

A. WXCODER. WxCoder is an internet based and the preferred data entry system. Observers enter their observations directly into the system via a personal computer and an internet connection. Wxcoder has built in QC routines that will catch many common errors before the observation is transmitted. http://wxcoder.org

B. IV-ROCS. IV-ROCS is a telephone (1-877-266-7627) based system that provides another method for observers to transmit their observation directly into the NWS dissemination system. IV-ROCS also has built in QC routines, but they are not as robust as those in WXCODER.

5.3 Near Real-time QC. This type of COOP QC requires monitoring of the data from the time it is first transmitted until 1 to 2 hours afterward. At a minimum, WFOs will develop a near real-time QC/QA program that investigates COOP observations for missing elements, data discrepancies, spatial continuity, and limit checks.

5.3.1 Best Practices.

A. Visual Check of COOP reports. WFOs should perform visual checks for proper coding of COOP reports periodically as they are transmitted by observers or automated programs. Check for collections of reports for multiple days or observer comments regarding multi-day precipitation reports. Precipitation reports should be verified and corrected for each day, including past days, based on comparisons with nearby reports or radar estimation.

B. CoopQC. WFOs should utilize this program (or another similar program) to monitor COOP observations in a near real-time environment. CoopQC allows the user to plot incoming COOP observations providing them with an easy method of performing a visual spatial QC. In addition to mapping the data, CoopQC alerts the user to suspect data through the use of user defined QC thresholds. This program is available via the LAD.

C. WHFS. See **Section 4.1** of this supplement for more details on this software and how it should be used.

D. SHEF Data Qualifier Codes. WFOs should make use of Standard Hydrologic Exchange Format (SHEF) Data Qualifier Codes when reporting questionable data or validating good data that failed a spatial QC check. More information on SHEF Data Qualifier Codes can be found on the CRH Intranet page under the Climate/Data/Correcting section.

5.4 After-the-fact QC. This type of COOP QC occurs anywhere between several hours after data transmission until years, decades, or even centuries after the data are published.

5.4.1 Best Practices.

A. Review of COOP Form B-91. WFOs will review all manually produced B-91s at the end of each month. In addition, WFOs will compare any manually produced B-91 to the transmitted SHEF data. Finally, the WFO should ensure that any corrections made to the data during the month makes it into the final version of the B-91. It is critical that whenever any edits are made to original data, the original data are never be destroyed or otherwise made illegible.

B. NCDC's Health of the COOP Network (HoN). NCDC publishes its HoN data approximately 90 days after the data month. At a minimum, WFOs will review the HoN's Suspect Data Page for any temperature discrepancies of 5 degrees or more and/or precipitation discrepancies of 0.25 inches or more. Some offices divide this responsibility among a data team. In addition to the Suspect Data page, WFOs should review the following information and take action to correct any discrepancies:

1. **Shifted Data.** Identifies those stations suspected of reporting their data on the wrong day. When a station is identified as a data shifter, the WFO should review the B-44 to ensure the observation time is correctly identified. If the B-44 is correct, WFO's should provide the COOP observer with additional training.

2. **Missing Data.** Identifies those COOP sites that have missing data elements.

3. **Missing Stations.** Identifies stations that have missing B-91s. Provides the date the last B-91 was received. More times than not, an entry on the missing stations table indicates a problem with metadata. When a station is identified as missing, the WFO should check the B-44 to ensure its current status, station name, COOP number, etc are correct. NCDC receives many B-91s that they cannot match to an active COOP due to metadata errors. Once the nature of the problem is known, take the appropriate action to solve the issue.

4. **Watch List.** This is a critical element to monitor. It identifies stations showing exhibiting a significant temperature change point (a change in temperature delta's as compared to surrounding stations) without any corresponding metadata that explains the change (close parking lot expansion, new thermometer, station move, etc.). WFO should check this list to ensure stations identified with a change point are not due to undocumented station or equipment moves. Each station on the watch list should be checked to see if something has changed that is not indicated through the metadata. Ideally, every temperature change point at a station should be accompanied by metadata that matches in time. Temperature change points are almost always indication of artificially induced local climate change that NCDC likes to subtract out of the long term climate record. Without matching metadata explanations of why the change point has occurred, they are reluctant to make that critical adjustment.

C. Datzilla. The Datzilla program is a web based interface which allows select partners (including WFO's) request changes to the official climate record at the NCDC. Changes to the official, published weather record should be made judiciously. Requests for change through Datzilla should be confined to discrepancies found in published data (generally data three months or more past

the end of the last calendar month of data received). Requests for changes for preliminary data (unpublished) should be made by sending an email to stations.ncdc@noaa.gov.

The Central Region CSPM should be notified if changes are made regarding office access to Datzilla. Datzilla can be found at the following web site:

http://datzilla.srcc.lsu.edu/datzilla/

For those unfamiliar with how to use this web site, there is a guide ("cookbook") on how to enter data discrepancies in Datzilla on the CR Intranet under "Climate/Data/Correcting" section.

D. Online Visualization Programs. Since querying archived data is a crucial part of the post QC process, NCDC offers online visualization programs to assist in this process.

1. **Image & Publications System (IPS).** IPS provides access to COOP weather data forms, and five NCDC serial publications. Data exists back to the 1800's for some locations, extending forward to near current time, with over 8000 active stations. These are the original (often hand-written) forms from the observers, which are scanned and provided as PDF images. This data can be found at the following web site:

   http://www7.ncdc.noaa.gov/IPS/

   For those unfamiliar with how to use this web site, there is a guide ("cookbook") on the CR Intranet under "Climate/Data/Correcting" section.

2. **Web Search Store Retrieve Display (WSSRD)**. WSSRD is a web database developed for displaying document images over the internet. WSSRD contains almost 40 million images of original weather records and documents (e.g., B-91s); these are organized in "cabinets" within distinct categories. This data can be found at the following web site:

   http://noaa.imcwv.com/

   For those unfamiliar with how to use this web site, there is a guide ("cookbook") on the CR Intranet under "Climate/Data/Correcting" section.

6. Other Surface Observations (Remote Automated Weather Stations (RAWS), Automated Weather Source Network (AWS), RWIS, Community Collaborative

Rain Hail and Snow Network (CoCoRaHS), etc). Although most of these types of observations are produced outside of the NWS, many are used in our products and by our forecasters in developing products. Users view our products as coming from the "neutral broker." As such, our products are assumed to have a high degree of credibility. Thus, it is essential that we apply a level of QC to all observations used in our products, regardless of their source. If RWIS or CoCoRaHS observations are used in the Regional Temperature and Precipitation Table (RTP) or transmitted by a WFO in other SHEF coded products, it must be quality controlled; if the observation fails QC, it must be removed from the RTP. If the error is noted after transmission, it must be corrected using proper SHEF code.

Also, all data used in the RTP should include a brief description of the source. (e.g., published COOP, NWS spotter, non-NOAA mesonet, etc.). This can be incorporated easily by adding one column to the product. This information can be critical to customers. For example, the Department of Homeland Security's Federal Emergency Management Agency (FEMA) only allows published COOP precipitation amounts to be used by Governors' offices when they are requesting for Presidential Disaster Declarations for snowstorms or floods.

6.1 Best Practices.

A. Disclaimer. For those sites which use AWS, RAWS, and RWIS observations in public products that are not SHEF coded, there should be a disclaimer on the product stating they are not NWS sites and may not reflect the actual conditions due to a lack of quality control. This is similar to the disclaimers on the top of the Regional Weather Roundup (RWR) products, regarding AWOS stations ("THESE STATIONS ARE NOT UNDER NWS QUALITY CONTROL."). Any data that is SHEF coded and transmitted in a NWS product must be QC'd.

B. LDAD Quality Control & Monitoring System (QCMS). The LDAD QCMS provides data quality control checking for certain hydrometeorological parameters contained in local meso-networks, ASOS observations, automated METAR observations from non-ASOS sources, manual METAR observations, buoy reports, and the NOAA Profiler network. Further information about the LDAD QCMS is contained at the following web site:

http://www-sdd.fsl.noaa.gov/MSAS/qcms.html

C. The Meteorological Assimilation Data Ingest System (MADIS). MADIS provides ingest, integration, automated QC, and distribution support for both NOAA and non-NOAA observations. This data can be spatially quality controlled through AWIPS. More information can be found here:

http://www-frd.fsl.noaa.gov/mesonet/

D. Iowa Environmental Mesonet. This Iowa State University maintained web site offers a "Sortable Current Conditions" page in which a WFO can combine the

various networks in their CWA. This data can be plotted for spatial QC or searched for obvious discrepancies in tabular format. This site can be found at the following web site:

http://mesonet.agron.iastate.edu/current/

E. MesoWest. The University of Utah maintains this web site. It uses Google Maps to display data from a wide variety of observational networks across the nation. This data can be displayed by region, state, CWA, Fire Weather Zones (FWZ), or up to 300 miles from a specified point. This site can be found at the following web site:

http://www.met.utah.edu/mesowest/

F. Real-time Observation Monitor and Analysis Network (ROMAN). This site is also maintained by the University of Utah. It displays observational data in a tabular format. The quality control of weather information begins with checks that are applied to the data as it is processed. These include "range checks" for all variables as well as a statistical check for several (temperature, relative humidity, and pressure). This site can be found at the following web site:

http://raws.wrh.noaa.gov/roman/

7. Winter Precipitation. Snow is one of the most challenging weather elements to measure accurately and consistently. It often melts as it lands, settles at different rates, and it is easily blown and redistributed**.** In addition, snow is measured in different units; thus, causing confusion with observers. To remedy these problems, the WFO should spend quality time providing refresher training for snow observers prior to each snow season. Some specific highlights to review and keep an eye on with reports include:

A. Snowfall. Check snowfall amounts to make sure they are reported in tenths of an inch. If all snowfall observations end in .0 or .5, contact the observer and make sure they understand that amounts are reported in tenths of an inch, not half-inches. Check that snowfall (SF) reports represent a 24 hour Snowfall, not a weekend total.

B. Snow Depth. Make sure your snow observers are aware of the intricacies of reporting snow depth. For example, snow depth is the amount of snow on the ground at the time of the observation and that it is measured to the nearest inch. When, in their judgment, less than 50 percent of the exposed ground is covered by snow, even though the covered areas may have a significant depth, the snow depth should be recorded as a trace (T). When no snow or ice is on the ground in exposed areas (snow may be present in surrounding forested or otherwise protected areas), record a "0." The zero for snow depth should be carried on the next observation by the observer. This may occur on the day it had melted (for an afternoon reporter) or most likely the next day for morning reporters.

C. Precipitation. During snowfall events ensure that precipitation reports (PP) represent the melted water content of newly fallen snow (SF). WFOs can verify precipitation data based on realistic snow to water ratios and comparisons to radar or nearby reports. Any SHEF coded product transmitted by WFOs or RFCs with precipitation data must be QC'd. During high wind events when gage catch is questionable, observers should not estimate PP by using snowfall to melt water conversion tables. Instead, observers should be instructed to take a core sample of the newly fallen snow. Correct precipitation data is essential for operational users such as RFCs and NOHRSC for river and snow modeling.

D. Snow Water Equivalent. Snow Water Equivalent (SW) represents the liquid water from a melted core sample of the *entire snow pack* on the ground. WFO Staff and COOP reports should follow detailed instructions such as provided in http://www.nws.noaa.gov/os/coop/snowguid.htm or Snow Measuring Video provided to all CR WFOs. Check liquid equivalents to make sure the decimal points are in the correct place.

E. Hail. . Hail accumulation is not entered with snow and ice pellets. Hail accumulation is entered in the **"/remarks/"** section with the amount and diameter (inches and tenths) of the stones. In the rare event that hail mixes with snow, report the entire precipitation event as snowfall.

F. Glaze. Check to make sure glaze accumulations are reported in the a) remarks section, and b), the snow and ice on the ground section. Glaze falls as freezing rain and therefore is reported as liquid precipitation (rainfall), not snowfall.

Even with this periodic additional training, there will still be some questionable snow data that will come into a WFO. This data can be quickly evaluated through the use of spatial QC tools.

7.1 Preventative QA. Consistent and comparable snow data are only possible if standard procedures are established and followed. An important step in ensuring this is by providing our cooperative and supplemental snow observers with training. This is most effective when one starts this training prior to the first snowfall of the season. In addition, the WFO must ensure that the information in their data bases is correct, so that our users can obtain and use this quality data.

7.1.1 Best Practices.

A. Training. Training observers (cooperative and other snow observers) is the best QC tool that a WFO has to improve snow data. A WFO should have them go through the following training tools prior to the start of each snow season.

1. ***Measuring Snow* DVD or VHS Tape.** This is also available on the Internet at:

   http://www.cocorahs.org/media/video/measuringsnow/default.aspx

2. ***Snow Measurement Guidelines*** – This is located on the Cooperative Observer Program section of the Online Data Acquisition and Dissemination web page.

   http://www.nws.noaa.gov/os/coop/snowguid.htm

   For southern WFOs where snowfall is infrequent, they may want to have their snowfall observers review the information above prior to each snow event.

B. Site Visits. Besides checking the instrumentation at a site, visits offer an opportunity to conduct additional training which will result in better quality snow data from observers. For example, you may review how they should measure snow and where they should place their snow board.

7.2 Real-time QC. Even with the best training, the observers will still make an occasional mistake. In addition, mesoscale convective snow bands and mixed precipitation can result in quite variable snow amounts. This is the main reason that a WFO must carefully QC snow data.

A. Best Practices.

1. **Spatial QC.** Like other meteorological parameters, spatial QC of snow data is important in looking for outliers. The WFO can use **CoopQC** (see **Section 5.3.1**) or **WHFS** (see **Section 4.1**) spatial tools to find questionable data. In addition, the following web sites from our partners can help a WFO with its spatial snow QC efforts:

   a. NCDC Snow Monitoring Web Site.

   http://www.ncdc.noaa.gov/oa/climate/research/snow/recent.html

   b. National Operational Hydrologic Remote Sensing Center (NOHRC).

   http://www.nohrsc.nws.gov/interactive/html/map.html

   c. Midwestern Regional Climate Center's Midwest Climate Watch.

http://mcc.sws.uiuc.edu/cliwatch/watch.htm

d. Community Collaborative Rain, Hail, & Snow Network (CoCoRaHS).

http://www.cocorahs.org/

If an outlier is discovered, the WFO should take the time to investigate whether this value is possible. This can be done by calling the observer and validating the observation.

(Moved SW into Winter Precip section with other snow report items.)

2. **Distribution of Snow Data.** Having good quality snow data is only useful when our users and partners can use the data. All snow data which come from Cooperative observers or WFO supplemental snow networks needs to be sent out in SHEF format. All other snow reports that come into a WFO via phone or web should be quality controlled. If the reports look reasonable, they should be sent out in a Public Information Statement (PNS) or Local Storm Report (LSR). All such products should indicate the source of each observation (e.g., published COOP, NWS spotter, non-NOAA network, etc.).

7.3 After-the-Fact QC.

7.3.1 Best Practices.

A. Review of COOP B-91.

1. **Handwritten B-91.** Handwritten B-91 Forms will be checked monthly for the following:

a. Snowfall, snow water equivalent, and snow depth are measured in the correct units.

b. Omitting entries of the total depth of snow on the ground (especially in the days following the snowfall), or reporting this in tenths of inches.

c. Snow depth increases and decreases make meteorological sense.

d. A day(s) with snow/ice cover end with a zero in the "*snow/ice on the ground*" column once the snow has melted off.

e. Days without precipitation have a "zero" entered.

2. **All B-91s.** All B-91s will be checked for the following:

   a. Those observers which consistently use 10 to 1 snow to water ratios.

   b. If snow data is corrected during the month, the WFO should ensure that this data makes it on the final B-91 for the month.

B. F-6. WFOs will include in the remarks section of the F-6 Form the location where their supplemental snow data was obtained by indicating the direction (to the nearest 8 cardinal points of the compass) and distance (to the nearest tenth of a mile) from the primary station. In most cases, this will likely come from the paid snow observer. The calendar date(s) when any backup data are used will also be indicated.

8. Climate Products. Many of the climate products produced by WFOs are dependent on the quality of ASOS, AWOS, and/or COOP observations. A rigorous QC effort of the surface observation data will significantly reduce the errors encountered in climate products. However, even with careful attention to detail occasional errors can be found on many of our climate products. Therefore, it is critical WFOs carefully review the following products.

8.1 Regional Temperature and Precipitation Summary (RTP). Even with a strong ASOS QC program, errors can be found in the RTP due to template problems, missing ASOS observations, and other AWIPS problems. Therefore it is imperative that careful QC is applied to this product prior to and after transmission. The source of each observation should also be included.

8.1.1 Best Practices.

A. Manually dial-up ASOS. Prior to compiling and transmitting the RTP, WFOs should dial-up each of their RTP reporting stations and record maximum and minimum temperatures, and precipitation data for comparison against the computer generated RTP.

B. Visually QC data using HydroView. The baseline AWIPS program HydroView has an option to generate time series in groups up to six panels per screen. Multiple meteorological parameters may be displayed in each individual graphics window. This allows for rapid QC of data such as temperature, precipitation and snowfall. HydroView may also be utilized to plot the data in plan view for spatial comparisons.

C. Use SQL tools to verify totals. Even with properly formatted templates, errors can and do occasionally crop up. Programs such as Snoopy (see **Section 8.2.1** for more information) can quickly accumulate precipitation to verify totals derived by

RiverPro. Offices should utilize such tools to verify that all observations did indeed arrive and are tallied properly.

D. Locally Derived Spreadsheets/Programs. Many offices have developed spreadsheets or programs to aid in their RTP quality control. For example, the SIXHOURLY program, developed by WFO Rapid City, is a script that runs from a "cron" every six hours and extracts the synoptic observations from a list of user-selected METAR sites (typically ASOS sites). The output is a text product that can be easily used to quality control the RTP. This program is available via the LAD.

E. Precipitation Data. In addition to automated procedures WFOs should use situational awareness, radar and nearby station comparisons, and meteorologically feasible snow to water ratios to verify all SHEF coded precipitation data. Questionable data that cannot be verified should be corrected in the RTP.

F. Retransmitted COOP or other network data. All data corrections should be made to the original source product before inclusion in the RTP. Any data retransmitted in the RTP should be coded with the original time stamp.

8.2 CLI/CLM/CF6. As with the RTP, the quality of the CLI/CLM/CF6 products are dependent on the quality of the surface observations for each location a climate product is produced. In addition to the observations, these products are also dependent on the Daily and Monthly Summary Messages (DSM/MSM). Therefore, when troubleshooting problems, the person performing quality control must consider both the DSM/MSM and the associated surface observations.

8.2.1 Best Practices.

A. Missing Data. WFOs will NOT estimate missing data. WFOs should fill in missing ASOS data on the F6 using a nearby predetermined, climatologically compatible backup COOP site (***NWSI 10-1004*** paragraph 4.3.3). Backup COOP sites must be documented on the B-44 and A1/A3. Snowfall and snow depth should be entered from snow paid observations.

B. Snoopy. Snoopy is an interactive GUI based database. This program can be downloaded from LAD.

C. Visually inspect the AWIPS database. Prior to running monthly products, the QA/QC focal point (or designee) should open the AWIPS Climate Program Graphical User Interface (GUI) and visually inspect the normals and means to ensure no database corruption has occurred.

D. Verify the AWIPS data with the CLM. When running the monthly/seasonal CLM, the operator should do a scan of monthly totals in the Climate GUI and

verify them against the published cccCF6xxx product.

8.3 Supplemental Climate Observations (SCD)/Supplemental Data Observation (SDO).

8.3.1 Best Practice

A. SCD/SDO Generator. An interface that allows the user to format SCD's and/or SDO's. Error and quality checks have been built in. This interface will allow local offices to archive and print out observations for up to 60 days.

9. Meta Data. In order to correctly evaluate climatological data, accurate, complete and timely metadata are essential. Therefore, it is of the utmost importance that WFOs fully document each observing system, its operating procedures, and routinely quality control the documentation to ensure accuracy. This is particularly important immediately prior to and following any contemplated change. WFOs will review all metadata documents for their CWA at least annually. This review should include checks for location, equipment, exposure and any undocumented changes.

9.1 B-44/CSSA. The B-44 is the metadata centerpiece for the National Weather Service's COOP. As such, WFOs must ensure the station information is accurate, reliable, and available. WFO's should perform preventative, real-time, and after-the-fact quality control on all B-44s.

9.1.1 Preventative QC Best Practices.

A. Prior to Site Visits.

1. **Review B-44.** Review the latest B-44 for errors, discrepancies, or changes.

2. **Prepare a Station Information Packet.** Provide each COOP observing site a "Station Information Packet". These packets will serve to inform the observer(s) about their duties and responsibilities as a COOP observer. It will also reinforce and enhance their observing and reporting techniques. Lastly, it will provide detailed information on the history of the station as part of the Cooperative observation network. The "Station Information Packet" should include the following.

    a. Latest copy of the station B-44.

    b. Station History file.

    c. Cooperative observation program information (history of program, value of Cooperative weather observations, etc.).

d. Guidance information/instruction of taking of observations (river, temperature, precipitation, snow, etc.). This should be detailed specifically to the site duties assigned.

e. NWS contact information (phone number(s), address, names, etc.).

f. A copy of the NCDC produced poster "*Climate Data are Used in Every Aspect of Our National Economy*." The poster can be printed from the PCU-6 training tutorial at the following url:

http://www.nws.noaa.gov/om/coop/reference/climate%20data%20poster.pdf

9.1.2 Real-time QC Best Practice.

A. Station Visits.

1. During station visits, share and review the details of the B-44 with the observer (and backup observer).

2. Ask the observer(s) to verify the information is correct. Ensure reporting times, station ID, equipment, equipment location, etc. is correct.

3. Inform the observer of the fact that despite the huge growth of other automated near real-time networks, their information still is the only data being officially used to describe the nation's climate record (not bank thermometers, school networks, etc.) and that it is still critical to take their manual observations despite all this other data being more readily available. Also explain that their long period of record is unmatched and cannot be replaced by the newer stations.

B. Prior to Submitting a B-44. Review the B-44 before sending it. Many errors can be caught simply in review. Also, examine the list of ***Top Twelve Most Common B-44 Errors*** prior to submitting a B-44. They are:

1. Station Name Error
2. Observer Name Error
3. Type of Observer Error (i.e., Inst, Individual, Govt.)
4. Changes made are not listed in Remarks field, or only portions of changes are notated. Need to be more complete. (i.e., important changes to station info, observer info, publication of elements)
5. Climate Division incorrect
6. County Name incorrect
7. Lat/Lon errors due to degrees/min/seconds being entered as decimal degrees
8. Reason for Report incorrect (i.e. change, localized move, etc)

9. Rules not followed for Azimuth/distance of equipment
10. Obstructions recorded exceed the 90 degree rule - or the obstructions are not recorded as having equal values for azimuth/distance/angle
11. Serial Number for Required Instruments, enter Unknown if unavailable
12. Reactivations or Re-establishments that involve relocation or Localized Equipment move should have the distance/direction of the move reported in Remarks.

9.1.3 After-the-fact QC Best Practices.

A. Annual Review. Annually review appropriate station description, information and documentation. Most importantly, check to ensure that the required periodic B-44's have been submitted in compliance with national policy. Under no circumstances should a station go longer than 5 years without having a new B-44 submitted.

B. Health of the COOP Network. Problems with B-44s can show up in the Health of the Network's shifted data, missing stations, and watch list. For more information on this see **Section 5.4.1** of this supplement.

10. Upper Air. Upper air quality control is important to ensure quality data is used in generating model data for forecasts and for archive data in the research community. Data can be of the highest quality when enlisting the following practices.

10.1 Real-time and Near Real-time QC. Real time quality control assures that the upper air messages (FZL, MAN, SGL, and ABV) are of the highest quality possible.

10.1.1 Best Practices.

A. Forecast Soundings. Prior to launching, WFOs should review a representative forecast sounding (LAPS) and occasionally compare the ongoing flight to the forecast sounding throughout the entire flight.

B. Flight Comparisons. WFOs should compare their flights with surrounding offices for evaluation and compare against previous flights.

C. ADMNFD. WFOs will review NCEP's ADMNFD bulletin to ensure their office was not identified as having late or erroneous data. Upper air sites should have this product alerted at the appropriate AWIPS workstation.

D. Aircraft Meteorological Data Relay (AMDAR). This program was initiated by the World Meteorological Organization to collect meteorological data worldwide by using commercial aircraft. Data are collected by the aircraft navigation systems and the onboard standard temperature and static pressure probes. The data are then preprocessed before linking them down to the ground either via VHF communication (ACARS) or via satellite link ASDAR. Whenever possible,

AMDAR soundings should be looked at prior to the flight to provide an idea what the radiosonde sounding may look like. In addition, if the flights are close (within an hour) to the actual radiosonde flight, they could be used to help quality control the radiosonde data. The AMDAR soundings can be found at the following web site:

http://amdar.noaa.gov/java/

E. VAD Wind Data. Prior to launching, WFOs should look at the latest WSR-88D VAD Wind Product. This will provide details on how the wind profile should appear.

F. Wind Profiler Data. Prior to launching, WFOs, which are close to wind profilers, should look at this data for details on how the wind profile should appear.

10.2 After-the-Fact QC.

10.2.1 Best Practices.

A. Rework. Reworks of upper air flights are done to correct data after a flight is completed and to perform general QC. When in Rework, observers have the ability to perform many of the same options that are available in live flights. When data is found to be in error, the appropriate corrective actions should be taken. If data were corrected within 6 hours of the observation, RRS users can send the data via Rework. ART users must exit Rework for dissemination and use the Re-transmit Message function. After a Rework has been completed, the flight will be re-archived to assure NCDC gets the corrected data.

B. Upper Air Webpages. The NWS upper air webpage has a section dedicated to data quality which includes various products from NCEP, NCDC, and WSH Observing Systems Branch. These products will assist in recognizing data quality trends, and problems that may persist from month to month.

1. NCEP. Their products include:

a. **Data Quality Reports.** The latest monthly performance summaries for each NWS station, based on data received at NCEP.

http://www.ua.nws.noaa.gov/NCEPdata.htm

2. NCDC. Their products include:

a. **Data Quality Reports.** The latest monthly performance summaries for each NWS station, based on the archive data sent to NCDC.

http://www1.ncdc.noaa.gov/pub/data/ua/reports/

(Note: The reports usually lag behind by a few months.) Check the "Last Modified" Date/Time to ensure report has been updated. Reports are sorted by WMO header.

b. **Upper Air Data Quality Summary Report.** The latest monthly summary of flight performance and data errors detected by NCDC. This product is used to generate the NCDC Error Index scores for each site.

http://www1.ncdc.noaa.gov/pub/data/ua/reports

Click on "summary-<mm>/". (Note: The reports usually lag behind by about 2 months.) After this, click on "UA<yy><mm>.SUM" where "yy" is the 2 digit year and "mm" is the 2 digit month.

c. **Release and Observation Time Report.** The latest monthly report showing stations that had inconsistent observation times and balloon release times, as recorded in the upper air archive and the coded messages (TTAA, TTBB, etc).

http://www1.ncdc.noaa.gov/pub/data/ua/NCDC-GTS/

Click on "NCDC-GTS-<yyyy><mm>.txt <NCDC-GTS-200709.txt>" where "yyyy" is the 4 digit year and "mm" is the 2 digit month.

d. **Data Error Index Scores.** The latest monthly "Data Error Index" scores for each NWS station based on the NCDC Data Quality Reports.

http://www1.ncdc.noaa.gov/pub/data/ua/reports

Click on "summary-<mm>/". (Note: The reports usually lag behind by about 2 months.) After this, click on "MLY_INDEX_<yy><mm>" where "yy" is the 2 digit year and "mm" is the 2 digit month.

e. **Log of NCDC Archive Files.** Occasionally check the FTP Log file to ensure that NCDC has flight data files. These files can be found:

For **RRS Sites**:

http://www1.ncdc.noaa.gov/pub/data/ua/RRS/

Click on current year. The file format is "k<xxx>_<yy><mm>_log.txt" where "xxx" is your station sid, "yy" is the 2 digit year and "mm" is the

2 digit month.

For **ART Sites**:

http://www1.ncdc.noaa.gov/pub/data/ua/

Click on current year. The file format is "inv_<yy><mm>.txt" where "yy" is the 2 digit year and "mm" is the 2 digit month.

3. **WSH Observing Systems Branch.** Their products include:

   a. **Station Reliability Scores.** Helps identify stations with high numbers of missed flights and flights that did not reach 400 MB.

      http://www.ua.nws.noaa.gov/reliability.htm

   b. **Data Quality Graphics.** Histograms for timeliness, height exceedence percentages, rejected temperature and winds and balloon rise rates, generated from reports prepared monthly by NCEP and NCDC.

      http://www.ua.nws.noaa.gov/Graphics.htm

   c. **Station Performance Scores.** NCEP reports used in an equation calculating weighted factors.

      http://www.ua.nws.noaa.gov/stn-rank.htm

   d. **FAQ.** Includes specific information on NCEP and NCDC quality control, as well as real-time data quality checks at the local (WFO) level, and even performance scores.

      http://www.ua.nws.noaa.gov/FAQ-QC.htm