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Operations and Services

Surface Observing Program (Land), NWSPD 10-13

OBSERVATIONAL QUALITY CONTROL—GENERAL

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No content changes were made.

Deleted reference to Real-time Observation Monitor and Analysis Network, as the web site no longer exists.

Sign
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09/13/2017
Date

Observational Quality Control – General

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1. Purpose

This instruction defines the role and responsibility of the National Weather Service (NWS) in performing the Quality Control (QC) and Quality Assurance (QA) to ensure a consistent and standardized level of QA and data QC of weather and climate observations.

1. A QA program implies that necessary precautions have been taken to ensure quality output. Weather Forecast Offices (WFOs) and River Forecast Centers (RFCs) can assure quality output by employing preventative measures to ensure quality observations, such as defining observing standards, staff and observer training, station visitation and internal data checking.
2. A QC program consists of the corrective actions by WFOs and RFCs to ensure high quality data in real-time through post processing.

2. General

The NWS has the responsibility of collecting and providing weather and climate observation data. Hydrometeorological analyses and forecasts are dependent on the quality of observational data. The accuracy of climatological records is also dependent on the quality of observations. The observations need to conform to standards to ensure high quality data. These demands can be met in part by a thorough and effective QC/QA program. Today, with the ever increasing use of observational data by the research community, the media, private industry, the general public, it is of the utmost importance to accurately and consistently apply QC/QA at all field offices.

Local observational data collected at WFOs and RFCs are subjected to manual and automated QC routines. These data include, but are not limited to, reports from the Automated Surface Observing System (ASOS); Automated Weather Observing System (AWOS); manual aviation routine weather reports (METAR) observing stations; manual land synoptic stations; cooperative observing stations; local mesonet data providers in accordance with NWS Instruction (NWSI) 1-1201; hydrological observation stations; marine reporting stations; upper air stations; and radar stations. These stations and systems employ a variety of sensor technologies, siting criteria, and observing practices. This diversity introduces variability in the quality, accuracy, timeliness, representativeness, and precision of the data being measured and reported. When these differences are excessive, they should be reconciled, and as appropriate, corrected in a timely fashion to the extent allowed by local resources.

In order to ensure the highest quality data and data products, the QC/QA methods discussed in this instruction are highly recommended at each WFO.

The QC of observations is accomplished through a three-tier system:

1. Real-time QC prior to transmission of the observation;
2. Near real-time QC monitoring and review activities within 1 to 2 hours after the observation is transmitted; and
3. National, regional, and local post real-time QC on observations performed centrally two or more hours after data transmission.

3. Responsibility and Organization

The following paragraphs outline the QC responsibilities of NWS Headquarters, National Centers for Environmental Prediction (NCEP), Regional Headquarters (RH) offices, WFOs, and RFCs.

3.1 NWS Headquarters

The Office of Observations (OBS) provides national policy, procedures, and standards for QC of manual and automated observations. OBS coordinates with other NWS offices and federal, state, and local agencies on various QC issues such as observing policy, procedures, monitoring and review, and user education. OBS coordinates internal NWS administration of observer training and certification. OBS coordinates day-to-day activities to monitor observing system operations, perform maintenance, and resolve operational problems. Within the Analyze, Forecast, and Support Office, the Water Resources Services Branch (WRSB) evaluates requirements for hydrometeorological data QC received from the WRSB at RH and field offices.

3.2 National Centers for Environmental Prediction (NCEP)

NCEP has a World Meteorological Organization (WMO) obligation to produce standard monthly reports concerning the quantity and quality of many types of data as well as producing standard measures of NCEP model forecast skill. In addition, NCEP produces reports on data problems as necessary. Besides these reports, NCEP receives similar reports from other international meteorological centers. As a result of this exchange of information with other centers, problem sites can be placed on a reject list, if needed, until the problem is corrected. Meanwhile, problem sites are contacted, missing data problems are resolved and modelers can be notified of significant changes in forecast skill.

The NCEP Central Operations (NCO) and other NCEP Centers in the Washington, DC area maintain a near constant QC operation under the supervision of the Systems Integration Branch supervisor. The NCEP Senior Duty Meteorologist (SDM) is

responsible for guaranteeing that accurate data reports are received in near real time and in sufficient quantity for use in analyses and numerical forecast models. The NCEP SDM is responsible for making the final decision on the quality of individual types of upper air data, including satellite and aircraft data, and generally supervises the QC performed by other centers on various types of surface land and sea data. Quality controlled data are additionally archived for model development and are also sent to the National Centers for Environmental Information (NCEI) for climatological and historical archiving.

The monitoring and reviewing of observational data are accomplished by:

1. NCO upper air data decoders which check and correct data for format errors for both NCEP analyses and models, and for Advanced Weather Interactive Processing System (AWIPS) use.
2. Automated QC programs which weigh, correct, and delete data.
3. Manual QC which can intervene and make the final decision on the quality of data by modifying or deleting the data or by countermanding automated QC decisions.
4. Weekly and monthly reports on individual upper air data sites concerning the quantity, quality and timeliness of data reported, and also on the flight performance of the radiosondes, which are sent to OBS and the RH for their use in the management and assessment of their observational QC programs.
5. NCOs Meteorological Assimilation Data Ingest System (MADIS) supports QC procedures used in hydrologic operations at WFOs and RFCs.

Quality controlled data are also provided to the NCEP's Climate Prediction Center (CPC) where it undergoes some additional manual and automated QC. These data are stored in the Climate Assessment Database (CADB) for use in the support of the DOC\USDA Joint Agricultural Weather Facility (JAWF), climate forecast verification and the development/implementation of statistical climate forecast tools.

3.3 Regional Headquarters Offices (RH)

The RH's are responsible for administering the observational QC program within their region in accordance with policies, procedures, and standards established by OBS, and for unique Regional responsibilities. The RH activities include resolving regional QC issues; conducting periodic inspection visits and administering the observer certification program of NWS stations; and serving as contracting officer technical representative for NWS weather observing contracts. The appropriate regional program managers may provide regional policy, procedures, and standards for QC/QA of manual and automated

observations within their region.

3.4 Weather Forecast Office (WFO)

The Meteorologist-in-Charge (MIC) is responsible for execution of the QC program for observations within the designated County Warning Area (CWA) and Hydrologic Service Area (HSA) of the WFO. The authority to carry out this responsibility may be delegated to the Data Acquisition Program Manager (DAPM), the Observing Program Leader (OPL), or other personnel designated by the MIC. The DAPM or OPL may be the designated data steward for the office. 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.

Duties associated with the QC/QA program include, but are not limited to:

1. Monitoring and reviewing observations.
2. Taking corrective action as appropriate.
3. Station visitations. See NWSI 10-1307, "Cooperative Program Management", and NWSM 10-1401, "Rawinsonde Observations".
4. Observer training as local resources permit. (Other agencies, e.g., the Federal Aviation Administration (FAA), are responsible for their own training activities).
5. Administering observer certification examinations. (See NWSI 10-1301 and NWS Manual (NWSM) 10-1401).

3.5 River Forecast Center (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 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.

When appropriate, the RFCs should participate in the coordination of NWS observational network-related issues, including the design, development, and maintenance of these networks. RFCs rely on hydrometeorological data from networks operated by the NWS and other agencies such as the U.S. Geological Survey, U.S. Army Corps of Engineers, and local cooperators. Data from these networks are simultaneously received at RFCs and WFOs through real-time distribution mechanisms. While WFOs have responsibility for QC of data from both the NWS cooperative network and other hydrometeorological

networks, RFCs also perform QC of data used in their hydrologic modeling and forecast operations.

4. Overall QC Program

The quality of observational data is maintained through observation monitoring and review, program oversight and coordination, and internal observer training and certification. With expanding volumes of data available at NWS offices from automated sensor networks, sophisticated automated QC routines are increasingly essential for ensuring the integrity of the data provided to the user community.

4.1 Observer Training and Certification

Observer training programs need to ensure minimum proficiency standards for providing complete, accurate, and timely observations. The NWS, FAA, and Department of Defense (DoD) conduct Federal observer training programs for their respective agencies that may include formal classroom, computer based instruction, or on-site training. Each agency is responsible for their own weather observer certification.

4.2 Station Visitations

The responsibility for administering NWS station visits and inspection programs for areas in a CWA is shared between the RH and the MIC of the CWA. The responsibility for administering the station visitation program for areas outside of a CWA rests with the RH. Detailed information on the station visitation program is contained in NWSI 10-1301, NWSI 10-1307, NWSM 10-1401, and regional supplements to the NWS Directives System. QC personnel performing station visitations will be knowledgeable of the program they are reviewing.

4.3 Observation Monitoring and Review

The MIC will ensure WFO personnel assigned QC activities monitor and review observational data from all stations within the CWA and HSA.

1. Monitoring includes examining observations and noting problems as well as taking corrective actions (near real time).
 - 1) All operational surface weather reporting stations should accomplish pre-dissemination QC.

- 2) All surface weather reports should be checked for errors after dissemination and prior to the next weather report, if possible.
2. Review includes checking weather records to ensure completeness, correctness, and consistency of transmitted reports. Review also involves responding in a timely and effective manner to QC reports and summary statistics (post real time).
 - 1) Checking weather records to ensure their accuracy prior to forwarding to NCEI is a valuable quality control function. It can also be a valuable training aid if personnel realize why the errors detected were made. Additionally, errors may show where equipment needs improving and where instructions contained in the observing manuals require clarification. An observation that is good in terms of detectable errors but is poor in terms of completely describing existing conditions should not be overlooked.
 - (2) Use WS Form B-14 to record changes to weather records and send a copy to the supervisor of the observing site.

5. Forms and Reports - General

Station inspection forms and reports (for applicable programs), and periodic QC reports and assessments are essential to gauge the health of the observing program. They provide a statistical foundation to assess performance, isolate deficiencies and identify remedies. Station inspection forms and other reports should be objective, factual, and complete. Specific details for what should be contained in these forms and other reports are described in this document and regional supplements.

6. Quality Control of Automated Systems' Observations

Automated self-diagnostics and QC algorithms are built into ASOS as the first step in the QC process. These algorithms look at raw sensor data and prevent questionable data from being transmitted in the METAR/SPECI. More information can be found in the ASOS User's Guide.

Each WFO should have an on-station QC reference source (e.g., binder) with information about each ASOS for which it has QC responsibility. The references may include information on levels of service, phone numbers for points of contact, and other documentation such as user guides, observing handbooks, operations manuals, and description of automated quality control programs, site initialization data, and method of external communication.

6.1 Levels of Service

A list of scheduled hours of operation for the on-site observing staff should be maintained for each ASOS in the WFOs designated CWA. During these hours, the site will be considered an “attended” ASOS; at all other times it should be considered an “unattended” ASOS.

The FAA, NWS, and aviation industry established four levels of detail in weather observations at sites where there is a commissioned ASOS. The service level at each ASOS may be adjusted based on the actual hours of operation. For example, a site designated service level “C” may revert to service level “D” during hours when the facility is closed. A current list of assigned service levels can be found at: <http://www.nws.noaa.gov/om/forms/> “Aviation Service Standards Levels”.

6.2 Points of Contact

A list of phone numbers for points of contact should be maintained at the WFO. This phone list may include:

1. FAA Regional Program Implementation Manager (PIM)
2. Air Traffic Control Tower (ATCT) at the ASOS site
3. Contract Weather Observation (CWO)
4. Non-Federal Observer (NF-OBS)
5. NWS Regional ASOS focal point
6. NWS Regional Contract focal point
7. ASOS Operations and Monitoring Center (AOMC) hotline
8. ASOS voice and data line numbers
9. FAA Operations Control Center phone numbers:

Atlantic Operations Control Center (AOCC): 866-432-2622

Mid-States Operations Control Center (MOCC): 800-322-8879

Pacific Operations Control Center (POCC): 800-269-6665

6.3 ASOS Documentation

The following documents are available for use at the WFO:

1. ASOS User’s Guide. Found at <http://www.nws.noaa.gov/asos>

2. ASOS Ready Reference Guide. Found at:
<https://www.ops1.nws.noaa.gov/Secure/asos/manuals.htm>
3. ASOS Software User's Manual. Found at:
<https://www.ops1.nws.noaa.gov/Secure/asos/manuals.htm>
4. Federal Meteorological Handbook No. 1, "Surface Weather Observations and Reports". Links to this document can be found at
<http://www.weather.gov/om/forms/>
5. FAA Order 7900.5, "Surface Weather Observing". Links to this document can be found at <http://www.weather.gov/om/forms/>.
6. FAA Order 7210.3, "Facility Operation and Administration". Links to this document can be found at <http://www.weather.gov/om/forms/>

6.4 Automated Programs for ASOS/AWOS QC

To increase effectiveness and reduce workload involved in the monitoring and coordination aspects of ASOS/AWOS QC, automated programs are available for use at the WFO via AWIPS. WFOs should consider how these automated programs may be used at the local level.

6.4.1 Near Real-Time QC

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

1. AWIPS Local ASOS Real-time Monitor (ALARM) may be utilized to monitor ASOS/AWOS observations for timeliness and missing elements. This program provides a customizable graphic presentation of the ASOS/AWOS sites within the WFO's CWA. This program is available via the Local Applications Database (LAD).
2. The WFO Hydrologic Forecast System (WHFS) may be utilized with the Alert/Alarm function to monitor ASOS/AWOS observations. Alert/Alarm allows users to compare data values against predefined thresholds. This is baseline AWIPS software.

3. At a minimum of once each hour, WFOs may utilize AWIPS (Spatial QC) (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 as satellite imagery, radar reflectivity and lightning data to check for present weather and precipitation consistency.
4. The Local Area Prediction System (LAPS) is 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.
5. The Graphical Forecast Editor (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.
6. WFOs will use ObsGrid QC Monitor to eliminate erroneous observations from the SFC Obs grids data. This program is available via the LAD.

6.4.2 After-the-Fact QC

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

1. 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 should be quality controlled.

7. Specific Procedures

The WFO staff should, time permitting; routinely check the observations from each ASOS/AWOS in the CWA. The following procedures are minimum guidelines for QC actions, which should be taken consistent with established priorities, when a problem with the ASOS report is detected. Problems are defined as being missing reports, missing elements, erroneous data, or improperly formatted data. The WFO staff as directed by the MIC may take additional action. These procedures are broken down by unattended locations and attended locations.

7.1 Unattended Locations - Missing Reports

When hourly METAR reports are missing from long-line transmission for two hours or more, AOMC will investigate and initiate an appropriate maintenance action. No QC action is required by the WFO.

7.2 Unattended Locations - Missing Elements

Missing elements will usually be noted and an appropriate maintenance action will be initiated by AOMC. However, under certain circumstances, additional missing elements from an ASOS may be temporarily masked from detection by AOMC. In this case, the WFO may inform AOMC of the additional missing element(s).

7.3 Unattended Locations - Erroneous Data

If data are considered marginally or temporarily unrepresentative and the sensor otherwise appears to be operating normally, no action is required by the WFO. However, if data are clearly erroneous due to sensor or equipment failure and the problem appears on two or more consecutive METAR reports, then inform the AOMC or the FAA Operations Control Center, as appropriate, and request that "Report Processing" for the erroneous sensor(s) be turned off.

7.4 Attended Locations - Missing Reports

AOMC routinely monitors ASOS locations for missing reports and will initiate appropriate maintenance action when necessary. However, if it appears that expected backup observations are not provided after two or more consecutive METAR reports, corrective action should be taken. The appropriate FAA shift supervisor (ATCT, CWO, etc.) should be notified and if applicable the on-site observer. Usually, the ATCT shift supervisor will notify FAA and CWO observing personnel. For chronic unresolved problems, the DAPM/OPL will coordinate actions with the NWS regional Observations Program Manager. This may include contact with the associated FAA Regional Air Traffic Division Operations Manager or designee. Do not permit dual observations from the same location at the same time.

7.5 Attended Locations - Missing Elements, Erroneous Data, and Improperly Formatted Data

Notify the appropriate FAA shift supervisor (ATCT, CWO, etc.) if ASOS element(s) are missing, if ASOS data are suspected of being erroneous, or if data are improperly formatted for two or more consecutive METAR reports. Usually, the ATCT shift

supervisor will notify FAA and CWO observing personnel. For chronic unresolved problems, the DAPM/OPL will coordinate actions with the NWS regional Observations Program Manager. This may include contact with the associated FAA Regional Air Traffic Division Operations Manager or designee.

8. Notice to Airmen (NOTAM) Reporting

The aviation observation program needs to be maintained to support aircraft operations. In order that the appropriate NOTAM be issued in accordance with FAA regulatory requirements, the FAA needs to be notified at 1-877-4-US-NTMS (1-877-487-6867) in the event of an ASOS failure when:

1. The entire ASOS observation is missing and no backup observation is available for long-line dissemination;
2. The altimeter setting is missing and is not backed up; or
3. The date/time group is erroneous and has not been corrected.

The WFO responsible for QC of the ASOS site is also responsible for notifying the FAA of the need for NOTAM issuances and cancellations. The WFO will follow these procedures:

1. When one of the three events occurs at a site within the WFO CWA, notify the appropriate FAA facility that the failure/error has occurred.
2. Monitor the event and notify the FAA facility when the conditions have been corrected and the date/information are available/corrected.

9. QC of the Cooperative Network

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 should exist. In order to do this, WFOs should 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.

9.1 Preventative QA

A successful QA program requires that all WFO and RFC staff receive training and are provided necessary tools. WFOs should ensure their preventative QA activities include

observer training, routine station visitations, careful consideration of instruments along with their siting issues (see NWSI 10-1307, Appendix B), and adequate initial and routine refresher training. In addition, WFOs should ensure all station metadata is accurate and timely.

9.2 Real-time QC

Real-time QC can be maximized with a strong QA 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.

The value of the cooperative observing program is degraded significantly without efficient quality control procedures. Some of the best used methods are described below.

1. WxCoder is 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>
2. IV-ROCS is a telephone based system (1-877-266-7627) that provides another method for observers to transmit their observation directly into the NWS dissemination system. This program also has built in QC routines, but they are not as robust as those in WxCoder.
3. Visual inspection of observations, forms, tapes and digital data files. Precipitation reports should be verified and corrected for each day, including past days, based on comparisons with nearby reports or radar estimation.
4. WFOs should utilize CoopQC (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.
5. WHFS may also be utilized. Details on WHFS and how it should be used can be found in Section 6.4.1.b of this instruction.
6. 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.

7. WFOs should use NWSSChat to interact with RFCs and other agencies. This will improve communications in a near real-time basis.

9.3 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 made public.

1. WFOs will review all manually produced COOP Form 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 to be destroyed or otherwise made illegible.
2. 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.
3. NCEI provides a monthly Cooperative Data Quality Assurance Report. This quality assurance report identifies cooperative data observing and recording inconsistencies detected by NCEI. The report lists stations having missing temperature or precipitation data, and temperature inconsistencies at least nine times for the data month listed.

A station identified as having all days of temperature and precipitation missing indicates the B-91 or WxCoder report was not received by NCEI.

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. NCEI receives many B-91s that they cannot match to an active COOP due to metadata errors. Also check WxCoder to ensure the station was properly closed by both the observer and the WFO. Once the nature of the problem is known, take the appropriate action to solve the issue.

4. The Datzilla program is a web based interface which allows select partners (including WFO's) to request changes to the official climate record at the NCEI. Changes to the official, published weather record should be made judiciously. Requests for changes should be submitted by entering a New Report from Datzilla web site: <http://datzilla.srcc.lsu.edu/datzilla/> and clicking the "New" link after login. The appropriate regional focal point should be notified if changes are made regarding office access to Datzilla.

5. NCEI offers online visualization programs to assist in this process, since querying archived data is a crucial part of the post QC process.
 - 1) Image & Publications System (IPS) provides access to COOP weather data forms, and five NCEI 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: <https://www.ncdc.noaa.gov/IPS/>
 - 2) Environmental Document Access and Display System (EDADS). EDADS is a web database developed for displaying document images over the internet. EDADS contains millions of images of original weather records and documents (e.g., B-91s); these are organized in “cabinets” within distinct categories. A username and password is required for access into EDADS. EDADS can be found at the following web site: <Http://www.ncdc.noaa.gov/EdadsV2/>

10. Other Surface Observations

Remote Automated Weather Stations (RAWS), Automated Weather Source Network (AWS), Road Weather Information System (RWIS), and Community Collaborative Rain Hail and Snow Network (CoCoRaHS) are types of observations produced outside of the NWS, although many are used in our products and by our forecasters in developing products. 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 transmitted by a WFO in SHEF coded products, it needs to be quality controlled; if the observation fails QC, it needs to be removed from the product. If the error is noted after transmission, it needs to be corrected using proper SHEF code.

Also, all data used should include a brief description of the source (e.g., NWS spotter, non-NOAA mesonet, etc.). This can be incorporated easily by adding one column to the product. This information can be critical to users. For example, the Department of Homeland Security’s Federal Emergency Management Agency (FEMA) allows published COOP and CoCoRaHS (as long as it has gone through WFO QC first and its being archived at NCEI) precipitation amounts to be used by Governors’ offices when they are requesting for Presidential Disaster Declarations for snowstorms or floods.

1. There should be a disclaimer on products containing non-NWS data stating the data is not from NWS sites and may not reflect the actual conditions due to a lack of quality control. This includes public products that use AWS, RAWS, and RWIS observations that are not SHEF coded. 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 needs to be QC’d.

2. Local Data Acquisition and Dissemination System (LDAD) Quality Control & Monitoring System (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://msas.noaa.gov/qcms.html>
3. The Meteorological Assimilation Data Ingest System (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: <https://madis-data.ncep.noaa.gov/MadisSurface/>
4. The University of Utah maintains the MesoWest 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://mesowest.utah.edu/>

11. 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 are described below.

1. 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.
2. 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 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.
3. 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 needs to 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 the National Operational Hydrologic Remote Sensing Center (NOHRSC) for river and snow modeling.
 4. Snow Depth Water Content (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/om/coop/reference/Snow_Measurement_Guidelines.pdf or Snow Measuring Video provided to all WFOs. Check liquid equivalents to make sure the decimal points are in the correct place.
 5. 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.
 6. 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.

11.1 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 needs to ensure that the information in their data bases is correct, so that our users can obtain and use this quality data.

1. 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 or direct the observer to the same information on the Internet at:
<http://www.cocorahs.org/media/video/measuringsnow/default.aspx>
 - 2) *Snow Measurement Guidelines* is located at:
http://www.nws.noaa.gov/om/coop/reference/Snow_Measurement_Guidelines.pdf. Southern WFOs, where snowfall is infrequent, may want to have their snowfall observers review the information above prior to each snow event.
2. Site Visits offer an opportunity to conduct additional training which will result in better quality snow data from observers, as well as checking the instrumentation at a site. For example, you may review how they should measure snow and where they should place their snow board.

11.2 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 needs to carefully QC snow data.

1. Like other meteorological parameters, spatial QC of snow data is important in looking for outliers. The WFO can use CoopQC (see Section 9.2.d) or WHFS (see Section 6.4.1.b) 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:
 - 1) NCEI Snow Monitoring Web Site. <https://www.ncdc.noaa.gov/snow-and-ice/>
 - 2) Geo Intelligence Division, Office of Water Prediction.
<http://www.nohrsc.noaa.gov>
 - 3) 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.

2. Snow data should be distributed. 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.).

11.3 After-the-Fact QC

1. Review the COOP Form B-91:
 - 1) All 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 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.
2. WFOs will ensure the locations of supplemental snow data observers are properly documented.

12. 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.

12.1 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. The operator should be aware of atmospheric conditions prior to launching by reviewing a number of products, such as LAPS, AMDAR, VAD Wind Data, Wind Profiler Data, etc.

WFOs need to follow the instructions in the RRS software users guide for real time data QC procedures.

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.

12.2 After-the-Fact QC

There are a number of upper air webpages that have sections dedicated to data quality which includes various products from NCEP, NCEI, and the OBS Evaluation Branch. These products will assist in recognizing data quality trends, and problems that may persist from month to month.

The NCEP Data Quality Control includes the latest monthly performance summaries for each NWS station. <https://sites.google.com/a/noaa.gov/nws-radiosonde-observations/>

The NCEI pages include Data Quality Reports, Quality Summary Reports, and Data Error Index Scores. <https://www1.ncdc.noaa.gov/pub/data/ua/reports/>

The OBS Evaluation Branch web page includes Data Quality Graphics, Station Performance Scores, and FAQs. <https://sites.google.com/a/noaa.gov/nws-radiosonde-observations/>

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. After a Rework has been completed, the flight will be re-archived to assure NCEI gets the corrected data.