

Talking Points for "Applying the Ten Principles of Climate Monitoring in NWS Field Operations"

1) This presentation is being made by instructors from the National Weather Service's Climate Services Division and the National Environmental Satellite, Data, and Information Service's (NESDIS's) National Climatic Data Center (NCDC) in order to assure that the perspectives of both line offices support the National Oceanic and Atmospheric Administration (NOAA) federal lead to provide quality climate information.

Welcome to this presentation of Professional Competency Unit (PCU) 6, Unit 1, "Applying the Ten Principles of Climate Monitoring to NWS Observing Systems" PCU6 is a training lesson under the NWS Professional Development (PDS) in climate services: The development of PCU6 was ordered by Jack Kelly, the Director of the National Weather Service, in 2003 because of feedback he was receiving from customers regarding the need for increased attention to the collection and dissemination of timely, quality climate data.

The goal of PCU6 is to equip you with the knowledge needed to produce the most timely, accurate, and consistent climate observations possible. The specific goal of this unit is to equip you to Apply the Ten Principles of Climate Monitoring in NWS Management of the nation's Observing Systems. We will do this over the next hour. In particular, it relates to the management and operation of the surface observing networks. Upper air is targeted to a lesser degree.

Some of the subjects taught here are contained in "Cooperative Network Operations" course taught at the NWS Training Facility by instructor Mike Wyatt. Others are in handbooks.

2) In this presentation, we will provide background for the ten principles of climate monitoring, then we will list and discuss each principle. I will introduce each principle.

3) As part of the background information, I would like to provide you with several examples that illustrate the need for the ten principles of climate monitoring. This is the first of several. Climate observations must be made with great care in order to have confidence in trends that are evaluated to the nearest tenth of a degree Fahrenheit. For example, 2003 (based on preliminary data) ranks as one of the top 20 warmest years on record for the U.S. with temperatures near 53.6°F (12.0°C). We must be able to express a high degree of confidence in these numbers, as they are relied upon by the public and decision makers alike.

4) This is another example of an important of the ten principles. This is a product that relies on accurate weather/climate information. Erroneous data can cause risk assessments to be faulty, which can be a critical problem for many users.

Remember, multi-million dollar decisions are routinely made on NWS weather/climate observations. For example, drought declarations and presidential disaster declarations are frequently based on COOP data. Billions of dollars of weather risk management contracts each year are now determined by ASOS temperatures. Applications of our climate data are covered in more detail in Units 3 and 4 of PCU6.

- 5) Each degree change equals \$1 B in heating/cooling costs
- \$10 B Yearly in Weather Risk Contracts
 - 2 deg. shift at a MD rooftop COOP resulted in \$2 M difference in a weather risk contract.
 - 0.10 inch COOP precipitation error in 1988 almost cost a farmer \$70 K in drought insurance.
 - Global warming...changes of just tenths of degrees equate to \$100's B in policy costs.

We (NWS) operate the maintain the nation's weather and climate observing systems. Yes, our systems and data support not only our primary mission of the protection of life and property but climate as well. We are also responsible for first level of quality control for the preliminary data, and its dissemination to our customers. Customers and climate demand accurate, consistent observations for many applications, ranging from climate change to business.

NWSH is responsible for developing climate services and observation policy. Regional Headquarters implement and ensure that policy are adhered to. Local WFOs and RCCs are where the rubber meets the road.

- 6) The session provides National Weather Service field personnel who manage NOAA's climate observing systems with a better understanding of best practices for managing weather/climate observing systems to meet both weather and climate sciences needs.

The National Research Council (NRC 1999) recommended that the following ten climate monitoring principles proposed by Karl et al. (1995), should be applied to all weather/climate monitoring systems.

- 7) The example here addresses the impact of observing time changes. Such changes can be dealt with using statistical techniques; in fact, the time of observation bias is removed from monthly data sets at NCDC using such a technique.

- 8) This is Principle 1: Management of Network Change. If you evaluate trends in the NWS COOP network, the percentage of observers making evening observations has steadily decreased while the percentage of morning observers has increased in recent decades. This was largely a direct result of NWS requesting observers to change their reporting times to better support NWS hydrologic services.

This change introduced a bias into the climate record. As morning observers tend to amplify daily minimum temperature across multiple days, this change has led to a decreasing bias across much of the U.S. In the mid 1980's, NCDC implemented a time-of-observation bias correction, which is dependent, in part, on accurate station metadata. Keep in mind that the corrections NCDC makes cannot be applied at the daily level. Only monthly average temperatures can be corrected.

- 9) Coordinate proposed observing time changes in published climate stations (a stations) **before** implementation with your CSPM and the River Forecast Center. The CSPM will in turn, coordinate with NCDC. Remember, changing the 24-hour observation clock introduces a temperature bias for the climate record.

If observing time change is necessary, encourage 24-hour observation as close to midnight as possible. This reduces the discontinuity (bias) with the standard 24 hour midnight-to-midnight climatological calendar day.

NWS Observing Handbook No.6; Cooperative Program Operations; Section 3, contains more on the time of observation issue. This handbook is being now under revision (OS7) and will be replaced in the future by a NWS Policy Manual.

10) This flow chart illustrates the one of two paths you can follow to work with our climate community partners to solve problems and insure adequate communication. The climate community partners are NWS, including WFOs, and RFCs, the regional Headquarters, including Climate Services Program Managers, the the State Climatologists (AASC), the National Climatic Data Center (NCDC).

Climate record related issues, those that affect the integrity and/or continuity of the climate record, are best handled through channels depicted by the flow of the red arrows. Depending on the scope of the issue, the communication may or may not reach NWSH. Basically, NWS field offices, both WFOs and RFCs, coordinate a climate integrity issue with the Regional Climate Services Program Manager. The RCSPM in turn will contact the SC, RCC, NCDC, and/or NWSH Climate Services Division as appropriate. NWSH gets involved if national level policy and resource issues are in question.

11) same

12) Operate the old system simultaneously with the replacement system over a sufficiently long time period to observe the behavior of the two systems over the full range of variation of the climate variable observed.

This testing should allow the derivation of a transfer function to convert between climatic data taken before and after the change.

When the observing system is of sufficient scope and importance, the results of parallel testing should be documented in peer-reviewed literature.

13) Here's another example of the importance of parallel testing. Parallel testing is absolutely critical to be able to determine transfer functions between different instruments. In this example, the responsiveness in time and overall catch of frozen precipitation is evaluated for proposed automated instrumentation.

Knowledge of the different responses of different instruments to the environment allows NCDC to develop transfer functions and homogeneous data sets.

14) Principle 2, parallel testing, requires that you take the parallel observations between old and new systems, or station relocations when possible if an HCN is involved. For new systems, parallel testing plans will be made available via a NWS data continuity plan. NWSH Climate Observations Division has the lead on these plans.

For HCN site changes, contact your Climate Services Program Manager. They will, in turn, coordinate with NCDC and/or the SC, RCC and/or NWSH CSD.

In the case of national network-wide changes such as those required for COOP modernization, a data continuity plan will be provided to you. You may be a part of developing such plans.

Refer to the new NWS Policy Directive 10-21 for details on parallel observation for climate data continuity. The web url is shown.

15) Metadata is an essential part of climate information. This ‘data about data’ covers simple things like units of temperature to more complicated descriptions of site characteristics. Objective measures of any conditions that can bias instrument measurements must be consistently and readily made and reported.

16) In this example, metadata about siting helps explain the regular occurrence of extreme maximum daily temperatures at the COOP site atop Baltimore’s Custom House. Compared to nearby street-level instruments and nearby airports, it is clear that a warm bias exists at the rooftop location.

Minimum temperatures are also elevated in the summer. The number of 80 plus mins during the one-year of data overlap was 13 on the roof and zero at all three surrounding LCD airports, the ground-based inner harbor site, and all 10 COOPs in the same north-central MD climate zone. 80 degree mins are an extremely rare occurrence in the mid-Atlantic region at standard ground-based stations.

The non-standard rooftop exposure results in a shift of the apparent climate of Baltimore about 500 miles south in the summer for ground-based temperatures.

17) The U.S. Climate Reference Network, America’s first observational network dedicated to measuring the long-term climate signal, is being deployed using an extensive set of selection criteria based on collected metadata.

The most desirable local surrounding landscape is a relatively large and flat open area with low local vegetation in order that the sky view is unobstructed in all directions except at the lower angles of altitude above the horizon. No significant obstruction within 300 meters of the instrument tower.

Obviously, there will be many sites that are less than ideal. Selecting a site is a series of compromises. The CRN use an objective classification scheme to document the “meteorological measurements representativity” at each site. This scheme, described by Michel Leroy (1998), is being used by Meteo-France to classify their network of approximately 550 stations.

Example:

Local Site Representativity Evaluation (Classification Scheme)

Classification for Temperature and Humidity

Class 1: Flat and horizontal ground surrounded by a clear surface with a slope below 1/3 (<19 degrees). Grass/low vegetation ground cover <10 cm high. Sensors located at least 100

meters (m) from artificial heating or reflecting surfaces, such as buildings, concrete surfaces, and

parking lots. Far from large bodies of water, except if it is representative of the area, and then

located at least 100 meters away. No shading when the sun elevation >3 degrees.

Class 2: Same as Class 1 with the following differences. Surrounding Vegetation <25 cm. Artificial heating sources within 30m. No shading for a sun elevation >5 degrees.
Class 3 (error 1 C): Same as Class 2, except no artificial heating sources within 10m.
Class 4 (error ≥ 2 C): Artificial heating sources <10m.
Class 5 (error ≥ 5 C): Temperature sensor located next to/above an artificial heating source, such a building, roof top, parking lot, or concrete surface.

18) Principle 3, metadata is a critical one for NWS personnel. Remember that we are the source for metadata and it is only as accurate and complete as we make it.

Think about the importance of knowing when a new thermometer was installed and what kind it was for understanding why a temperature discontinuity occurred in the long-term record.

Document changes in instruments, environment, algorithms, time of observations. This is a history of the station including observing methodologies.

Document environmental changes within 300 feet of the site. Example: forest removal, new buildings, change in land use, expanded driveways, etc.

Read the Cooperative Station Service Accountability (CSSA) Manual

Complete accurate histories of the station are essential if we are to understand the data and changes in it.

19) Routine data quality assessments are significant because they help identify problems in the instrument record quickly before erroneous data is made public and used for quality assurance of other data.

Extreme events are an important indicator of climate variability and change and they are being monitored carefully by many in the climate community.

20) Network performance can be assessed manually or automatically. In this case, NCDC has a web-based statistical package in its 'Health of the Network' program (<http://www.ncdc.noaa.gov/oa/hofn/index.html>) that allows users to evaluate the impact of either recorded or unrecorded station characteristics changes.

In this example, the statistical technique identifies two changes in station characteristics based on the maximum monthly mean temperature. These changes were found to correspond to ASOS instrumentation introduction in 1994 and siting changes in 2000 at Phoenix Sky Harbor Airport.

21) Not only can statistical techniques identify discontinuities, but they can do so when the causes are not well-known. This provides researchers with the ability to focus on specific time intervals for analysis using metadata and nearby information as evidence.

Even though statistical techniques can identify when a discontinuity, accurate, thorough metadata allows to understand why the change occurred.

22) There are several actions you need to consider in complying with Principle 4. -Routinely be a part of the data quality control process. We are the source for the data and responsible for data quality! We are working with NCDC to reduce the number of data edits they make and increase the amount of responsibility at our end. Adopt the

attitude that the best data is that which is QC'd as much as possible before it ever leaves the site. See (NWS Policy Instruction 10-1305; Observational Quality Control & the new to-be-updated NWS Policy Directive 10-1004 Climate Record)

Remember that the 5 horizontal mile, 100 vertical feet change rule for station re-numbering is only a guideline, not a firm rule. For example, you should establish a new station identification if a station relocation results in changed topographic setting which likely introduces a temperature discontinuity into the record.

Keeping the same number implies climatological compatibility with the new site. You are encouraged to consult with your RCSPM, and/or the RCC and SC to make a determination on how to proceed with determining whether a new number is needed or not.

Establish new station identification if station relocation results in changed topographic setting.

If you have an extreme event occur, request National Climate Extremes Committee activation if national record is in question: Visit the NCEC web site to identify what types of records are under their charter. Understand that the Committee is there to relieve you of the burden of making a call on a record on the fly and ensure NOAA extreme events archive is accurate. Contact your RCSPM for details on how to proceed if appropriate.

23) Anticipate the use of data in the development of environmental assessments, particularly those pertaining to climate variability and change, as a part of a climate observing system's strategic plan.

National climate assessments and international assessments (e.g., international ozone or IPCC) are critical to evaluating and maintaining overall consistency of climate data sets.

A system's participation in an integrated environmental monitoring program can also be quite beneficial for maintaining climate relevancy.

Time series of data achieve value only with regular scientific analysis.

24) This slide is an example of using data for an assessment. Observations and data are the foundation for scientific understanding. Such understanding, in turn, can allow climate conditions to be placed in proper perspective. An application like the Palmer Drought Index is important to constituents like agribusiness and engineering.

I want to reiterate that almost all the climate data used by NCDC comes from NWS weather/climate observing systems that you maintain.

25) Although no direct action is required by you to ensure compliance with Principle 5, you do need to understand that you are becoming an integrated member of the climate community. As such, the big picture is important for your understanding of the need to collect accurate, consistent, and timely climate data.

NWS weather and climate observations are used for a multitude of applications outside the immediate needs for support short term forecast and warning services. These applications are covered in greater detail in Units 3 and 4 of PCU6 (knowledge of NOAA and non-NOAA applications of data).

26) The importance of homogeneous observations could not be more important in an era of rapid land cover changes throughout the United States. Many COOP sites, while sited in less-than-ideal circumstances, have a period of record in a single location that goes back many decades. The significance of maintaining long-term sites is particularly important and is a major consideration in NWS COOP modernization plans.

27) 99.6% of HCN sites are COOP sites as well.

28) Principle 6, Historical significance, is an important commandment for NWS field personnel. Stations with more historical significance require special attention as the value of climate data increases with age.

Know which stations in your area of responsibility are HCN sites. Treat them with lots of TLC. They are the most valuable sites for the climate record. Insure that HCN sites receive high priority for maintenance, stability, and continued operation.

If an HCN site is in jeopardy of changing or closing, contact your RCSPM to discuss options.

RCSPM will coordinate issue with SC, RCC, and NCDC's Data Operations Division and provide guidance.

29) Data conversion activities have made, for the first time, many pre-1948 data records available in digital form. The NWS field, in collaboration with NCDC, Regional Climate Centers, State Climate Offices, and other archives, must work together to assure that paper records are properly cataloged, imaged, and digitized. This will lengthen records, fill in many missing periods, and improve the confidence in 19th and early 20th Century climate assessments.

30) NCDC's Climate Data Modernization Program (CDMP) has worked diligently over the past 2 years to digitize the pre-1948 record for many COOP sites. This work continues, and is paying rich dividends to NWS field locations that are using the historic data to populate local databases like XMClimate.

31) Principle 7, complementary data, has important implications for NWS field personnel. Remember that public law requires that all original NWS weather and climate data records are public property and must be sent to NCDC for archiving.

Ensure that COOP modernization supports spacing plan guidelines. Guidelines will be issued before modernization begins. The network spacing design includes climate, agricultural and forecasting needs. The design basically calls for one station every 20 x 20 mile grid in flat terrain with even gradients and denser spacing allowed in areas with steeper gradients such as mountains, lake-ocean-land boundaries, and large urban metropolitan areas.

32) This commandment is an FYI for NWS field personnel. With the implementation of new networks, like ASOS and U.S. CRN, requirements for instrument performance shape engineering design of networks. Communication capabilities are rapidly

advancing, increasingly allowing the design of networks that can provide high-quality, near-real-time data access.

33) Discuss the importance of the slide. Human induced biases can dwarf the natural climate variability and change signals.

34) Principle 8 translates into a climate network being planned out. Instrumentation accuracy is understood.

Non-approved instrumentation can degrade the accuracy and continuity of the climate record. Some data is better than no data is not always true (i.e., “garbage in...garbage out”). This may be true for some forecast and warning services but it is not true for climate applications.

Identify non-approved instrumented sites and either plan to upgrade them through COOP modernization or eliminate them from publication. Coordinate with your CSPM for further guidance.

Install only approved equipment into operation at published climate stations. Some non-approved instrumentation has crept into our networks and in some cases, the sites are being published because the metadata does not accurately describe the instrumentation being used. Sites with non-approved instrumentation for the climate record should not be published in NCDC's Climatological Data publication.

Read NWS Observing Handbook No. 6: Cooperative Program Operations; Section 17.1 Criteria for Publishing Cooperative Stations for details.

35) The successful deployment of operational weather and climate networks requires solid research. The continued vitality of such networks requires careful assessment of data and information by researchers and by NWS field personnel – a team effort is necessary!

36) U. S. Benchmark Network for temperature and precipitation
Ten Climate Monitoring Principles
NRC Report “Adequacy of Climate
Observing Systems” (1999)
Satisfies the requirements of GCOS/UNFCCC/SBSTA
Anchor points for Cooperative U. S. Historical Climate
Network (USHCN)
Strong Climate Science & Research Component

Long-Term Stability of Observing Site (50+ years)
Minimal impact from local changes
Sensors Calibrated to Traceable Standards
Network Performance Monitoring - Hourly and Daily

37) As the NWS regional and local climate services plan is implemented nationally, we will continue strengthening our climate partnerships to improve the accuracy and continuity of the climate record. Don't lose sight of the climate purpose....the data gets

only more valuable as it ages...maintain a stable, long-term commitment to collecting quality observations.

Be proud of the essential function you provide to this nation and its citizenry. You are the nation's stewards for the collection and dissemination of the fundamental building blocks of the science of climate and weather.

38) Data access is a must as user groups require more rapid and sophisticated access to climate information.

39) You can use several tools to improve the access of customers to data. XMClimate is one. Another is CSSA. NWSH is evaluating customer requests to allow access to parts of the metadata. You will be informed as soon as decisions are made.

Remember, you are the keeper of the metadata. It is only as good as the information you enter into the database. Be diligent and remember the importance of accurate metadata in understanding changes in long-term climate record.

Public access to CSSA is under consideration today by the Observations Services Division of OCWWS. Customers are demanding access to metadata so they can understand the data better. Of course, some parts of CSSA cannot be made public (for example, COOP phone numbers).

40) You can learn more about access to NCDC data and metadata by accessing the NCDC web site. Understand that all data which NCDC makes available are free to NWS employees but this free data is not for redistribution to customers.

Utilize the NCDC web site [<http://cdo.ncdc.noaa.gov>] for accessing data sets. Utilize XMClimate and CSSA for on-station responses to simple media inquiries, etc. Ensure preliminary F-6's are available via the web for all LCD sites.

Make referrals to climate services partners when state or regional expertise are warranted.

Refer all data certification requests to NCDC.

41) 1) NWS has adopted the "ten principles of climate monitoring" for use in our day-to-day management of the nation's climate/weather observing systems. Doing so better serves NOAA's role as the federal climate lead and improves the integrity of the nation's climate record.. Complying with the ten climate monitoring principles in NWS field operations is, to a large degree, common sense. Many of the principles are already discussed in existing NWS documents. We basically just need to place more emphasis on them.

2) Although NWS's primary mission is short term weather forecasts and warnings and the protection of life and property, our observing systems serve a dual purpose. They are also the the nation's climate observing systems. You are the stewards for the collection of accurate weather and climate data. Be proud of your essential role. Without your efforts, there is no science of weather and climate. There are no accurate forecasts and warnings. There is no clue as to how climate varies or changes. Accurate science is based on accurate observations and data. Your activity forms the basic building blocks for the NOAA's mission to describe, monitor, and assess climate and its variability and change.

3) In becoming the best steward's we can be, we must build and strengthen our relationship with our climate community partners. Coordinate, coordinate, coordinate. Communicate regularly with your RCSPMs, SCs, RCCs, and NCDC. Don't hesitate to ask questions or request guidance....this is an ongoing learning process.