

WINTER HIGH WIND TORNADO & FLASH FLOOD VERIFICATION PROCEDURES

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1. Introduction. The purpose of the verification programs for winter storms, high winds, tornadoes and flash floods is to assess National Weather Service (NWS) warning performance and identify areas for improvement in service to NWS customers.

This supplement will specify additional instructions which Central Region Weather Forecast Offices (WFOs) will follow for winter storm, high wind, tornado, and flash flood warning verification. In each of these verification types, preliminary statistics are produced to cover the period of time prior to Storm Data processing at NWS Headquarters (NWSH). In this supplement, statistics using the Storm Data will be referred to as ‘quasi final’ since subsequent entries made into the Storm Data after the original processing, though rare, can change these statistics. Quasi final statistics will come from the Stats on Demand web site.

WFOs should quality control their Stats on Demand preliminary verification event databases to provide the best preliminary statistics possible. These preliminary statistics are used by Central Region Headquarters (CRH) and NWSH to answer high official’s questions on NWS recent performance.

2. Winter Storm Warnings. Unless otherwise stated in this supplement, WFOs will follow instructions in NWSI 10-1601, section 1.5 for verification of winter storm warnings. Winter storm warnings used here are defined in NWS Instruction (NWSI) 10-1601, section 1.5.1, table 2. Stats on Demand is set up to generate either event specific or generic winter storm verification statistics as discussed in NWSI 10-1601, section 1.5. Central Region will use the generic version of winter storm verification to create both preliminary and the quasi final winter storm statistics. For preliminary statistics, CRH will run verification statistics for winter storm warnings. WFOs may verify outlooks, watches, and advisories, as well as wind chill warnings if they desire.

Central Region WFOs will enter the following winter storm statistics via the Central Region Intranet:

- Number of winter storm warnings;
- Number of winter storm warnings verified;

- Number of winter storm events;
- Total lead time for all winter storm events in hours.

CRH will use the Intranet to calculate the following parameters for each WFO and for the entire Central Region:

- Number of winter storm warnings not verified;
- Number of winter storm events warned. (In winter storm verification, the number of winter storm events warned is the same as the number of winter storm warnings verified.)
- Number of winter storm events not warned
- Average lead time;
- Probability of Detection (POD);
- False Alarm Ratio (FAR);
- Critical Success Index (CSI).

WFOs may compute these statistics for their own use.

The quasi final winter storm statistics will be run by National Weather Service Headquarters (NWSH) using the winter storm warning data base and Storm Data, filed 60 days after the end of the month. Central Region WFOs will follow NWSI 10-1605 for entering winter storm events in Storm Data.

For both preliminary and quasi final winter storm statistics, NWSI 10-1601, table 1, and NWSI 10-1605, sections 7.3, 7.22, 7.26, 7.28, 7.36, 7.47 and 7.48 provide guidance for determining winter events. Note that wind chill warnings are not included in the winter storm verification statistics. NWSI 10-1601 section 1.5, subjective judgment, common sense, and integrity will be used as guiding factors in determining winter storm events and lead times. Some points WFOs should consider when deciding whether or not a warning verified:

WFO criteria for winter storm warning thresholds are locally determined and posted on the Central Region Intranet. Any changes to these criteria must be approved by the Chief of Integrated Services and must blend well with surrounding WFOs.

- a. WFOs in Colorado and Wyoming, as well as Jackson, Kentucky, will consider elevation. Criteria for mountain zones in Colorado and Wyoming are posted on the Central Region

Intranet. Any changes to these criteria must be approved by the Chief of Integrated Services and must blend well with surround WFOs.

- b. WFOs should verify winter storm warnings using quality assessed surface observations and reports from Local Climatological Data (LCD) site observers (see NWSI 10-1311 for guidance) or cooperative observers (see NWSI 10-1307 for guidance). Other types of snow depth observations or ice accumulation observations may be used if the WFO staff judges these to be an accurate estimation of what precipitation fell.
- c. If a warned zone has no snow or ice accumulation reports or observations, and the WFO suspects this zone did reach warning criteria, WFOs may estimate snowfall amounts or ice accumulation using information from radar data, satellite precipitation estimates, as well as surface observations and reports from nearby zones to verify this zone's warning.
- d. WFOs are free to consider, whether or not, the combination of elements, such as snowfall, ice accumulation, blowing snow, wind chill, etc., created a life-threatening hazard even though no single element by itself met warning criteria. Forecasting this life-threatening situation is the mission of the winter storm warning program as indicated in NWSI 10-513, section 6.1.
- e. Events, beginning after a warning has been downgraded to an advisory, are missed events.
- f. Events, beginning after the warning expires or is cancelled, are missed events.
- g. Events, ending before the warning is issued, are missed events.
- h. For a warning issued after an event begins, but before the event ends, the warning is verified, but the lead time is zero.
- i. Written instructions cannot address every situation. The final determination will reside with the WFO Meteorologist in Charge (MIC) as to, whether or not, an event occurred and, whether or not, an event should in Storm Data to be used in Stats on Demand's quasi final statistics.
- j. For local application and to build a suitable archive of a WFO's verification efforts, WFOs should complete a very brief account of the observations or data which verified each zone.
- k. To avoid a "last minute" rush to complete winter storm verification, WFOs should perform verification soon after each storm.

Preliminary winter storm verification statistics for each month will be due at CRH by close of business the 15th day of the following month. If the 15th of the month falls on a weekend, winter storm verification statistics will be due at CRH by close of business the next business day.

Like all verification statistics, if new information becomes available, numbers may be amended. For example, a WFO enters its statistics on November 15. Newspaper articles, verifying a winter storm in October for five previously unverified counties, arrive at the WFO November 22. The Warning Coordination Meteorologist enters this data November 25. The data becomes part of the preliminary October monthly statistics upon entry.

3. High Wind Warnings. Unless otherwise stated in this supplement, Central Region WFOs will follow instructions in NWSI 10-1601, section 1.6 for verification of high wind warnings. This is valid for both preliminary and the quasi final high wind statistics.

Preliminary statistics will be necessary for high wind events and warnings to cover the time prior to the storm data generated statistics at NWSH. For preliminary high wind statistics, CRH will run statistics for high wind warnings. WFOs may verify outlooks, watches, and advisories, as well as dust storm, excessive heat, or freeze warnings.

For preliminary statistics, Central Region WFOs will enter the following high wind statistics via the Central Region Intranet:

- Number of high wind warnings;
- Number of high wind warnings verified;
- Number of high wind events;
- Total lead time for all high wind events.

CRH will calculate the following parameters via the Intranet for each WFO and the entire Central Region:

- Number of high wind warnings not verified;
- Number of high wind events warned. (In high wind verification, the number of high wind events warned is the same as the number of high wind warnings verified.);
- Number of high wind events not warned;
- Average lead time;
- POD;
- FAR;
- CSI.

WFOs may compute these statistics for their own use.

The quasi final high wind statistics will be run by NWSH using the high wind warning database and Storm Data, filed 60 days after the end of the month. Central Region WFOs will follow NWSI 10-1605 for entering high wind events in Storm Data.

For both preliminary and quasi final high wind verification, NWSI 10-1601, table 1, and NWSI 10-1605, sections 7.24 and 7.38 provide guidance for determining high wind events. NWSI 10-1601 section 1.6, subjective judgment, common sense, and integrity will be the guiding factors in determining high wind events and lead times. Some points WFOs should consider when deciding whether or not a high wind warning verified:

- a. WFO criteria for high wind warning thresholds are locally determined and are posted on the Central Region Intranet. Any changes to these criteria must be approved by the Chief of Integrated Services and must blend well with surrounding WFOs.
- b. WFOs in Colorado and Wyoming will consider elevation. Criteria for mountain zones in Colorado and Wyoming are posted on the Central Region Intranet. Any changes to these criteria must be approved by the Chief of Integrated Services and must blend well with surrounding WFOs.
- c. WFOs should verify high wind warnings using quality assessed surface observations from Automated Surface Observing Systems (ASOS), Automated Weather Observing Systems (AWOS), or mesoscale networks meeting NWS standards (see NWSI 10-1302 for guidance). Other types of wind observations may be used if the WFO staff judges these to be an accurate estimation of what actually occurred.
- d. For zones with insufficient surface observations, WFOs may estimate winds using surface observations from nearby zones.
- e. WFOs are free to consider, whether or not, the combination of other elements with wind, created a life-threatening hazard even though no single element by itself met warning criteria.. Forecasting this life-threatening situation is the mission of the high wind-warning program as indicated in NWSI 10-515, section 6.1.
- f. Events, beginning after a warning has been downgraded to an advisory, are missed events.
- g. Events, beginning after the warning expires or is cancelled, are missed events.
- h. Events, ending before the warning is issued, are missed events.
- i. For a warning issued after an event begins, but before the event ends, the warning is verified but the lead time is zero.
- j. Written instructions cannot address every situation. The final determination will reside with the WFO Meteorologist in Charge as to, whether or not, an event occurred and,

whether or not, an event should be in Storm Data to be used in the Stats on Demand's quasi final statistics.

- k. For local application and to build a suitable archive of a WFO's verification efforts, WFOs should complete a very brief account of the observations or data which verified each zone.
- l. To avoid a "last minute" rush to complete high wind verification, WFOs should perform verification soon after each storm.

Preliminary high wind verification statistics will be due at CRH by close of business the 15th day of the following month. If the 15th of the month falls on a weekend, high wind verification statistics will be due at CRH by close of business the next business day.

Like all verification statistics, if new information becomes available, numbers may be amended. For example, a WFO enters its statistics on November 15. Newspaper articles verifying a high wind event in October for three previously unverified counties arrive at the WFO November 21. The Warning Coordination Meteorologist enters this data November 23. The data becomes part of the October preliminary monthly statistics upon entry.

4. Tornado Warnings. For verification of tornado warnings, Central Region WFOs will follow instructions in NWSI 10-1601, section 2.2, except for the following.

Central Region will use Stats on Demand to produce preliminary verification statistics for tornadoes. CRH will run Stats on Demand for the entire region shortly after the first of the month. CRH will post Central Region tornado statistics on the Central Region Intranet.

Tornado warnings are automatically entered into the verification database.

WFOs will enter Storm Data as per NWSI 10-1605. NWSI 10-1605 section 7.40 provides guidance for entering tornado information in Storm Data. Storm data is run at NWSH around 60 days after the end of the month. After the Storm Data has been run for any given time period, WFOs will no longer need to update the preliminary, or local storm report (LSR), Stats on Demand.

Some points to remember when verifying tornado data are:

- a. Tornado warnings are only verified with a tornado report, not a hail or damaging wind report.
- b. Lead time, in this context, is event lead time.
- c. All reported tornado events have a lead time.
- d. A tornado warning may be used to calculate lead time for more than one tornado event.

- e. For a warning issued after an event begins, but before the event ends, the warning is verified, but the lead time is zero.
- f. For preliminary tornado statistics using the LSR event database, WFOs may add events to the database, based on damage surveys, which verify previously unverified tornado polygon warnings. These events should be the time the damage survey indicates the tornado entered the polygon. Central Region Headquarters will not require WFOs to do this.

5. Flash Flood Warning. For verification of flash flood warnings, Central Region WFOs will follow instructions in NWSI 10-1601, except for the following

Central Region will use Stats on Demand to produce preliminary verification statistics for flash floods. CRH will run Stats on Demand for the entire region shortly after the first of the month. CRH will post Central Region flash flood statistics on the Central Region Intranet.

Flash Flood Warnings are automatically entered into the verification database.

WFOs will enter Storm Data as per NWSI 10-1605, section 3. NWSI 10-1605 section 7.14 provides guidance for entering flash flood events in Storm Data. Storm data is run at NWSH around 60 days after the end of the month. After the Storm Data has been run for any given time period, WFOs will no longer need to update the preliminary, or LSR, Stats on Demand.

Some points to remember are:

- a. Lead time, in this context, is event lead time.
- b. For a warning issued after an event begins, but before the event ends, the warning is verified, but the lead time is zero.
- c. Flash Flood is defined in NWSI 10-950, section 2.
- d. For warning operations, a "flash flood" definition may be restricted to a beginning time frame of less than six hours of the flash flood event's cause depending on local warning criteria.
- e. In an effort to estimate flash flood warning lead times objectively and consistently, WFOs in Central Region should use the following methods and information. Although some subjectivity will remain, these actions should reduce ambiguity in determining when a flash flood began, or when a low-impact flood became life threatening. This, in turn, should facilitate better consistency in reports between offices and reporting periods.
 - 1) Use information provided by spotters, dispatch personnel, media, and other public officials; ask specific questions, such as those listed in NWSI 10-1605, section 7.14.3.

- 2) Additional actions which can be performed to determine when low-impact flooding became life threatening include:
 - a) Use flash flood emergency 911 Natural Disaster Information Cards. Provide spotters with information cards and guidelines.
 - b) Use E-spotter or a similar application to obtain reports.
 - c) Train spotters to report the depth of water, whether or not the water is moving, the water's impact, and timing issues, if known.
- 3) Perform storm surveys for flash flood events; interview people and ask for locations of hot spots, specific water impacts, and other information; this effort will help refine lead times.

Where spotter, public or media information is lacking, use radar data, Flash Flood Monitoring and Prediction (FFMP), or other precipitation estimates, such as Mountain Mapper or satellite-derived precipitation estimates, to approximate the time period of intense rainfall. Then, estimate the lag time from the time of intense rainfall to the flash flood.

- 4) Urban areas will have a nearly instantaneous response (near zero lag time); flooding is likely during the period of heaviest rainfall; in general, a rainfall rate of about one inch or more per hour may result in some degree of urban flooding. Use current guidelines for flash flood guidance (FFG) in impervious locations.
- 5) In non-urban areas, a modest lag time may occur between the time of heaviest rainfall and the time creeks and streams rise over bank full, especially in relatively flat terrain.
- 6) Compare FFG values to radar estimates and other quantitative precipitation estimates (QPE) to approximate the beginning time of low-impact flooding (i.e., when QPE exceeds FFG).
- 7) Consider limitations to accurate radar estimates (e.g., high storm precipitation efficiency, hail contamination, etc.).
- 8) Based on terrain, basin characteristics, ongoing heavy rainfall, or the degree to which QPE exceeds FFG (e.g., by 0.5-1.0 inch or more); estimate the time of impact flooding, and then compare this to the warning dissemination time.
- 9) In burn scarred areas, use the appropriate guidelines from the River Forecast Center (RFC) and partner agencies such as the United States Geological Survey (USGS).