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WINTER STORM VERIFICATION IN EASTERN REGION

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SUMMARY OF REVISIONS: This supplement supercedes Regional Operations Manual Letter (ROML) E-01-01, "Winter Storm and High Wind Verification," filed with WSOM Chapters C-42, C-44, and C-75, dated November 20, 2001. This supplement more precisely defines terms and adds the concept of Percent of Events with Zero Lead Time. Wind warning verification is now addressed in a separate supplement.

< signed > 01-09-04

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Winter Storm Verification

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1. Purpose. The purpose of Winter Storm Watch/Warning verification is to assess NWS winter storm forecast performance and identify areas for service improvement.

2. Background. Verification of winter storm watches and warnings can be done many ways. This supplement provides standardized guidelines so annual verification statistics can be compared.

3. Responsibility. All Eastern Region (ER) Weather Forecast Offices (WFOs) are responsible for following these verification guidelines. ER Headquarters is responsible for compiling and posting summaries of seasonal statistics for WFO viewing.

4. Guidelines.

4.1 Verification Area. Verification for winter storm watches and warnings is based on individual public zones. Thus, a Winter Storm Warning (WSW) product covering three zones counts as three separate warnings.

4.2 Winter Storm Verification. NWSI 10-513 discusses the multi-tiered concept for winter storm outlooks, watches, warnings and advisories. The only ER winter storm verification requirements are for watches and warnings. Winter Storm Watches will be verified on whether WARNING criteria were met, not advisory criteria. This maintains a one to one correspondence between watch and warning verification statistics.

4.3 Issuance Trigger. Winter Storm Watches and Warnings for snow/ice accumulations are triggered when the **mid-point** of the forecast range is expected to meet or exceed the warning threshold. For watch issuance, a 50% or greater chance of reaching the threshold must exist; for warning issuance, 80% or greater.

Watches and warnings may, on occasion, be triggered when significant public impact is expected, even though quantitative thresholds are not likely to be met. For watch issuance, a 50% or greater chance of significant public impact must exist; for warning issuance, 80% or greater.

4.4 Event Definition. A winter storm event has occurred when the average* snow / ice accumulation across a zone equals or exceeds the warning threshold. The only exception is for localized, mesoscale events (mainly lake effect snow bands), where the average of representative observations within the band will be used to determine if the warning threshold was met and an event occurred.

Public impact from a storm can also be used to determine if an event has occurred. For example, the first snowstorm of the season may be counted as an event if costly transportation impacts occur. Similarly, a late season storm causing widespread power outages from heavy, wet snow breaking leaf bearing tree branches onto power lines would count as an event because of the adverse public impact.

4.5 Warned Event (Hit). An event has been warned for when it occurs in a warned zone during the valid period of the warning. Watch hits are defined the same way.

4.6 Warning without an event (False Alarm). A warning without an event occurs when an event fails to materialize within the warned zone during the valid period of the warning. Watch false alarms are defined the same way.

4.7 Missed Events. Missed events occur when:

a. the average* snow / ice accumulation found in a zone meets or exceeds the warning threshold when no warning was in effect, or

b. significant public impact occurs in a zone that would justify a warning when none was in effect,

c. warnings are downgraded to advisories, then warning criteria are subsequently
met or exceeded during that storm, or

d. weather events continue beyond the end time of a warning, resulting in warning criteria being met once again (see Attachment B for an example).

4.8 Lead Time. Compute a lead time for each zone that experiences an event. Subtract the time of watch / warning issuance from the time when the event first met warning criteria in the zone. Set negative values to zero. If a zone experiences an event with no warning in effect, assign that event a lead time of zero. Compute average lead time from all the lead times listed in the event database, including zeros.

4.9 Percent of Events with Zero Lead Time. Compute the percent of events with zero lead time by dividing the number of events with no lead time by the total number of events. Events with zero lead time include all missed events, plus warned events with
no lead time.

4.10 Expansion/Extension Rules. Expansion of watches/warnings into new areas (zones) count as new watches/warnings, with lead times computed from the new issuance time in accordance with section 4.8. Extensions in time for any of the zones in the initial warning will not be verified as separate warnings. The lead time will be computed from the initial watch/warning issuance time.

4.11 Combined Events. When winter storm and high wind events occur simultaneously, both phenomena should be mentioned within the WSW product. However, only the precipitation-related phenomena (observed amounts or public impact) will be used to verify the winter storm watch/warning.

4.12 Storm Episode. A storm episode is defined as any storm system that produces phenomena reaching or exceeding warning criteria in one or more zones. Individual storm episodes may be generated by a single synoptic scale system, a series of waves along a slow moving frontal zone (frontal system counts as one episode), or a mesoscale event such as lake-effect snow.

4.13 Verification Equations. Equations for computing Probability of Detection (POD), False Alarm Ratio (FAR), Critical Success Index (CSI), Lead Time (LT) and Percent of Events with Zero LT (% 0 LT) are listed below:

$$POD = \frac{\text{\# of warned events}}{\text{total \# of events}}$$

$$FAR = \frac{\text{\# of warnings without an event}}{\text{total \# of warnings}}$$

$$CSI = \frac{\text{\# of warned events}}{(\text{\# of warnings without an event}) + (\text{total \# of events})}$$

LT = (initial time criteria is reached) - (issuance time of warning)

$$\%\ 0\ LT = \frac{(\text{\# of missed events}) + (\text{\# warned events with no lead time})}{\text{total \# of events}} \times 100$$

These equations are applicable to watch verification statistics as well.

4.14 Reporting Procedures. Events occurring from October 1 through December 31 of any calendar year will be tallied for the entire CWA and reported to ERH MSD no later than the following January 31. A cumulative tally encompassing the period from October 1 to March 31 will be reported no later than April 30. Isolated late season storms between March 31 and May 31 must be reported no later than June 30. Any storms occurring the remainder of the fiscal year (through September 30) must be reported no later than October 15.

Use Attachment A to summarize and report verification numbers to ERH.

4.15 Verification Records. Annual verification statistics should be kept on a zone by zone basis at each WFO to document and improve services on spatial scales smaller than the entire CWA.

ERH will keep summaries of winter storm verification statistics for the entire region and make this information freely available for all Weather Forecast Offices to review.

* Average snow accumulation is computed using the arithmetic mean of all reports available within a zone. Sleet accumulation is considered the same as snow accumulation for verification purposes. Ice accumulation within a zone is computed using an arithmetic mean as well, however public impact is frequently used to determine the magnitude of an icing event, due to the difficulty of measuring ice accumulation.

Attachment A - Winter Storm Warning Verification Summary Sheet

WFO _____ Fiscal Year _____

Winter Storm Watches	OCT-DEC	OCT-MAR	OCT-SEP
Number of Watches Issued			
Watches with an event			
Watches without an event			
Probability of Detection			
False Alarm Ratio			
Critical Success Index			
Average (Event-based) Lead Time			
% 0 LT			

Winter Storm Warnings

Number of Warnings Issued			
Warnings with an event			
Warnings without an event			
Probability of Detection			
False Alarm Ratio			
Critical Success Index			
Average (Event-based) Lead Time			
% 0 LT			

Winter Storm Event Summary

Number of Events			
Events Watches Only			
Events Warnings Only			
Events Neither			
Events Both			
Total # of Storm Episodes			

$$\text{POD} = \frac{\text{\# of warned events}}{\text{total \# of events}} \qquad \text{FAR} = \frac{\text{\# of warnings without an event}}{\text{total \# of warnings}}$$

$$\text{CSI} = \frac{\text{\# of warned events}}{(\text{\# of warnings without an event}) + (\text{total \# of events})}$$

LT = (initial time criteria is reached) - (issuance time of warning)

$$\%\ 0\ \text{LT} = \frac{(\text{\# of missed events}) + (\text{\# of warned events with no lead time})}{\text{total \# of events}} \times 100$$

Attachment B - Verification Examples

Example 1 - reference section 4.7.c - Missed Events.

The mid-shift issues a winter storm warning for Franklin County valid from 6 PM to 6 AM. At 3 PM, the day-shift decides to downgrade the warning to an advisory. Then at 3 AM, 3 inches of snow accumulates, meeting warning criteria. This scenario is tallied as both a missed event and a false alarm. The double penalty is designed to encourage forecasters to be conservative about downgrading warnings.

Example 2 - reference section 4.7.d - Missed Events.

A foot of lake-effect snow has fallen in Franklin County, but the warning covering this event is allowed to expire at 5 PM, as the snow band is forecast to drift south of the county. The band does drift south, but more slowly than expected. An additional, criteria-meeting 7 inches of snow falls after 5 PM. This is counted as a missed event, because the warning threshold was re-met outside of the warning time window.

Example 3 - reference section 4.12 - Watch-based rather than event-based Lead Time

Event-based lead times are computed using all values, including zeros. This is the standard way of computing and reporting all lead times. However, there may be instances where watch-based lead times are desired. Watch-based lead times are computed for just those zones where watches were issued - i.e. zero lead times due to missed events are excluded. Watch-based lead times can be reconstructed from the event-based LT and the proportion of missed events as follows:

$$\text{Watch-based LT} = \frac{\text{Event-Based LT}}{\text{Watch POD}}$$

Example 4 - reference section 4.12 - Seasonal Lead Time computation.

Seasonal lead time computations must use a weighted average of each storm's lead time rather than a simple average. Thus, an office with two storms will have:

((20 zones x 12 hr) + (36 zones x 16 hr)) / 56 zones, yielding the correct LT of 14.57 hours, rather than a simple average of (12 hr + 16 hr) / 2, which gives an incorrect LT of 14 hours.

Alternatively, each individual event lead time through the whole season can be used to compute the average lead time.