Winter Weather Experiment for 2001-2002

Final Report

by the
National Weather Service's

National Centers
for Environmental Prediction(NCEP)

and

Eastern Region

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1. Introduction

Since the spring of 2000, NCEP's Hydrometeorological Prediction Center (HPC) has worked with the NCEP Director's Office, the NWS Office of Climate, Water, and Weather Services (OCWWS), and Eastern Region Headquarters (ERH) on a proposal to enhance the suite of products and services available from HPC to assist field offices in delivering improved winter weather services to the public. Information gathered from these meetings was used to design a Winter Weather Experiment (WWE), with an experimental design drafted and approved for final dissemination in October 2001. HPC and eventually eight Eastern Region forecast offices participated in this winter weather experiment from November 1, 2001, to May 1, 2002. Table 1 lists the participating offices and the date they began participation.

The experiment in 2001-2002 addressed several key issues. The first was to test NCEP's newly implemented Short Range Ensemble Forecasts (SREF) for their application to winter weather forecasting. The ensembles were evaluated in terms of providing an improved forecast system as well as providing a means to quantify the uncertainty of the forecast. The second key issue was to test HPC's expected new role of collaborating with the WFOs to facilitate a fully coordinated short- and medium-range forecast product suite that over the next two years will transition into the National Digital Forecast Database(NDFD).

This report outlines the products and services provided by HPC during this experiment, summarizes the experimental results, and provides some recommendations for a follow-on experiment during the winter of 2002-2003.

2. Products and Services

Table 2 lists the products and the issuance times of all HPC winter weather products produced this past winter. The products in bold type indicate experimental products developed for the WWE. Products without bold print indicate routine operational products issued by HPC to support all NWS field offices.

2.1 SREF Implementation

The Environmental Modeling Center and NCEP Central Operations placed the SREF into operational production before the start of the WWE. This took a tremendous amount of effort on their part. In addition, the SREF had to be modified to

incorporate the Baldwin winter weather precipitation-type algorithm currently running in the Eta and AVN models. This allowed HPC to generate a consensus gridded precipitation type for each SREF grid point (snow, freezing rain) using the 3-hourly ensemble output. From this, a 40-km grid of consensus precipitation type was created at 6-h increments through 63 h.

2.2 HPC-Generated Snow and Ice Graphics

The grids mentioned in 2.1 were matched with the 1015 UTC /2215 UTC issuance of the HPC 6-h QPFs for day 1 and day 2. From this were generated 12- and 24-h amounts of snow and ice based on the consensus precipitation type at each grid point. These were then bilinearly interpolated to the centroid of each county. The 24-h value at each county centroid was compared to the threshold winter storm watch/warning criteria value provided by ERH (see Appendix A). A color-coded marker was then used to indicate the ratio of the amount of snow or ice to the threshold (i.e., orange .50 to .74 of threshold, green .75 - .99 of threshold, yellow 1.0 - 1.5 of threshold, and red > 1.5 of threshold.) This process was entirely automated. Appendix B shows examples of the day 1 snow guidance graphics issued for the morning and evening chat sessions for January 6, 2002. A similar product was created for icing, again using the county threshold values provided by ERH. A map was produced for the 24-h day 1 and day 2 period for both snow and ice. This product was viewable by the winter weather forecaster approximately five hours after the ensemble initialization (0900 and 2100 UTC).

The forecaster quality controlled these products as necessary and then posted to the chat room for review. Quality control usually consisted of monitoring for changes in QPF areas and amounts based on the newest observations and model guidance and adjusting for changing temperature structure that could impact the assumed 10-to-1 snow-to-liquid ratio or the actual precipitation type. These graphics were posted to a password protected location on the HPC web site by 1130 am/pm EST.

2.3 HPC Expected Tracks Graphic

HPC tested a 0-h through day 3 forecast of expected tracks of major surface lows (Appendix D). The tracks consisted of the lows HPC identified as significant winter weather producers that might impact the WWE forecast area during the 3-day period. In an attempt to identify uncertainty, HPC utilized all available surface low tracks from the various short-range and medium-range models and

ensembles. The “best” track and the position of the low center was indicated at 12-h intervals. The spread of the low positions was encompassed by using stippling to indicate the range of model solutions (uncertainty). This chart also displayed the range of surface pressures associated with the forecast lows as well as the forecaster’s best estimate of the central pressure. This chart was produced twice per day and posted prior to the online chat session.

2.4 Winter Weather Discussion

In addition to the graphics described above a brief write-up was prepared highlighting the meteorological rationale for the graphics posted to the web site. This discussion conveyed the degree of uncertainty associated with the forecast and also highlighted the potential for any major storm development for the next 4-to-7 days.

2.5 SREF Probabilistic Snow and Ice Products

Using output directly from the SREF, HPC also posted to the WWE web site the probabilities of exceeding certain amounts of snow or ice based on the liquid-equivalent QPF (.25, .50, .75, 1.00 inch)from each SREF member. For each grid point in each of the ten members of the ensemble, the consensus precipitation type and 12-hourly QPF was determined. For snow, each member having snow as the type and a QPF equal to or greater than the threshold value was used in the computation of the probability. For example, if 5 of the 10 members had snow for the predominate precipitation type for the 12-h period but only 2 of those 5 members had liquid-equivalent precipitation of .25 inches or greater, the probability of at least 2.5 inches of snow would be 20%. Using this methodology, an individual grid point could have a probability of greater than 0% for snow, ice, and rain based on the individual forecasts from each member. It is important to remember the probabilities calculated in this system are not necessarily totally reliable in the statistical sense. That is, the raw probability distributions have not yet been validated and then calibrated to correct for their bias. Thus these guidance graphics need to be used with caution. Appendix E provides examples of these products for the January 6-7 event. These probability graphics were updated twice per day corresponding to the 0900 and 2100 UTC SREF runs.

2.6 Final Coordinated Winter Weather Watch/Warning Graphic

At the conclusion of the chat session, HPC prepared a

consensus winter weather watch/warning graphic. An example of this graphic is shown on the right side of Appendix B. The preparation of this chart was terminated in mid January 2002 as it was very time consuming to prepare, and in fact may not have represented the final watches and warnings issued by the WFOs. Appendix C shows the 24-h observed snowfall amounts for the January 6-7 event corresponding to the graphics in Appendix B.

3. Overall Results from WWE

The following provides an overview of HPC's impressions of the 2001-2002 WWE. Given the general lack of winter weather for most of the participating offices these results have to be considered preliminary in terms of assessing the implementation of a dedicated winter weather function in the HPC. The conclusions section will suggest a follow-on experiment for 2002-2003 to validate these preliminary results.

3.1 Assessment of SREF in Winter Weather Forecasting

The consensus of HPC forecasters was the SREF does not provide a diverse enough set of predictions that, in most cases, contains the observed solution. The individual perturbations tend to center around the particular model's control run. This basically means the 4 Eta members tend to be centered around the Eta control member and the 4 RSM perturbations tend to center around the RSM control. This leads to much less spread in the ensemble solutions and minimizes the benefits of using an ensemble approach for the 0- to 60-h forecast. On several occasions the WWE forecaster waited for the 12 UTC run of the Eta and AVN models before finalizing the WWE winter weather watch graphic as it more closely matched the forecaster's thinking and, in fact, turned out to be a better solution. It would appear the SREF needs a larger number of members made up of different models or models with different physical parameterizations, not more perturbations of the same two models. Currently EMC is testing the use of the Eta model with the Kain-Fritsch convective parameterization scheme. This would provide 5 additional members to the ensemble to aid in increasing the spread of solutions.

This is not to say there were not some significant benefits from the SREF. A comment from an HPC forecaster is given below:

"Subjectively, my impressions are that early in the

season (before mid-January) you were better off using a blend of the most recent AVN and Eta runs rather than the SREF mean. Frequently the new run's placement of the low was outside of the latest SREF envelope of solutions. During the second half of the winter it was found that the SREF mean for surface low position was the best first guess and frequently the track I would use. The 6th decile (6 of 10 members agreed on this QPF) QPF was great for depicting the area to be affected, but was watered down in the maxes (which is what you would expect). I did find the probabilities that were in 12 hour increments somewhat useful, but less so than if we had the info in 24 hour increments."

In fact, during the second half of the winter, results might have been expected to improve with the incorporation of the latest version of the Eta model into the SREF on January 21 and adjustments to the scaling of perturbations to increase spread.

3.2 Winter Weather Experiment Chat Room

A chat room was established by the HPC for the purpose of facilitating collaboration between HPC and the participating forecast offices. The graphic containing the HPC day 1 and 2 watch guidance graphic for snow and ice accumulation was displayed in chat software (Appendix B). The HPC winter weather forecaster then conducted a chat session twice daily (1145 and 0045 EST) when winter weather watches or warnings were impending inside the WWE domain. The participants in the session included, but were not limited to, forecast offices concerned with issuing winter weather watches or warnings. Appendix F provides two graphs. The first showing the distribution of office participation in the chat room and the second the number of offices participating per chat. Appendix H is a list of all the dates chats were held and offices participating in the chat session.

To expedite the chat session, the HPC winter weather forecaster had previously provided to the participating offices the HPC forecast thinking based on the NCEP operational model runs and short-range ensemble (SREF) output via the discussion and tracks graphic. The consensus opinion among the HPC QPF forecaster, the HPC model diagnostic forecaster, and the WWE forecaster was used in preparing these products. Using this methodology, discussions between HPC and the WFO forecasters concerned spatial and temporal adjustments

to the forecasting of winter storm watches/warnings.

Once all participants became familiar with the idiosyncracies of the software after the initial weeks of the season, the chat sessions flowed rather smoothly from a technological perspective. From the viewpoint of collaboration, most chat sessions were documented as a successful transformation of forecast thinking. However, it took until half way into the winter season for HPC to develop a facilitation procedure to shorten the length of the chat session to a more operationally friendly 20 minutes or less. In fact, the average chat session during the winter lasted 17 min.

On occasion an audio component was introduced to the chat session. The audio capability was well received by HPC and WFO forecasters and highly recommended for future chat endeavors.

3.2.1 w4mserver Review

The chat software used by the HPC to facilitate coordination during the WWE was the w4mserver internet software package. The software was developed by JDH Technologies and is hosted on an NCEP server. The current contractual agreement with JDH allows for up to 10 users to participate in a chat session at a given time. The chat software can be displayed on a PC or Linux machine using the Netscape browser. Both an open forum for displaying images by all conference participants and a structured slide show presentation initiated by the conference host are available. The later option proved to be more stable because the graphics displayed in the whiteboard could not inadvertently be deleted by a conference participant. Audio conferencing capability is also available using PC microphone and sound card hardware.

The annotation tools on the software are fairly intuitive and provide a variety of colors and drawing features for the participant to learn quickly and apply in a chat session. There is also the option to assign a text color to each conference participant.

For graphical display, the HPC forecaster set up a slide show conference to use during the chat session by uploading the forecast snow/ice image from the local PC directory. Setting up a slide show can be a counter-intuitive process and written instruction often needed to be followed by HPC forecasters. During the chat session, only the HPC forecaster (conference host) could manipulate the changing of images, but

each participant could annotate the image. There was the capability for other participants to upload images from their local directories for display to the rest of the chat group. This capability was useful for a field office to share data from a case study containing pertinent information on the impending event or an image from a local model run.

Although not as quality efficient as telephone transmission, the audio capability of the software greatly improved the chat sessions when used. Most offices who could not utilize this feature lacked either the appropriate sound card or PC memory. Once the local microphone was adjusted, the sound clarity in the chat was of good quality. There was a microphone gain tool within the chat software, which helped adjust sound clarity for a specific microphone within the chat session. There were no cases recorded where internet bandwidth interfered with the audio transmission.

One of the more notable benefits of the audio capability was the built-in facilitation. Only one conference participant could hold the microphone at a given time and there was an illuminated menu of request and pass-the-microphone buttons which users clicked to talk then share the microphone with other session members.

The w4mserver software also has both text and conference recording capability. The text from the chat sessions can be saved in a .txt file on the local directory, while a recorded conference gets stored on the server along with slide shows and .gif images. The recorded conferences can be played back in their entirety, including all audio and written chat, as well as graphical annotations on the white board.

3.2.2 Summary of HPC Assessment of Chat Sessions

The consensus among the participants in the WWE was the chat sessions added value to collaboration between the forecasters and improved the coordination process. However, a reliable audio capability is needed to increase efficiency. Sessions must be kept as brief as possible due to the time needed for field offices to prepare their IFPS grids. In addition, the 4mv software licensing restrictions could become an issue if the WWE expands to the CONUS.

The criteria for conducting a chat session and office participation needs to be reviewed. There was some concern regarding offices with impending winter weather in their CWAs not participating in the chat session.

3.3 Winter Weather Discussion

The winter weather discussion focused on the uncertainty in the short-range winter weather forecast and the potential for a winter storm 4-7 days into the future. HPC forecasters and management felt the discussion was redundant with existing HPC products. In fact, almost all the information provided in it was culled from other HPC narratives. It was recommended the winter weather discussion not be done in the future.

3.4 Review of WWE by ERH

ERH asked each of the 8 participating forecast offices in the WWE to provide a list of both the positive and negative aspects of the WWE from their perspective. These comments of this survey are listed below.

Positive comments:

- Having a large-scale perspective from the HPC is very useful.
- HPC contributions were very helpful and positive.
- Snowfall and storm track graphics were very helpful.

Negative comments:

- Collaboration process was too long - keep it under 15 minutes. This is not the only coordination call that takes place.
- WWE draws attention away from other tasks.
- Fearful expanding WWE will only increase collaboration time.

Recommendations:

- Collaboration software needs voice capability.
- White-board graphics that does not require panning but can be enlarged by clicking is needed.
- Storm total snowfall graphic is needed - some events bridge the forecast periods being used.

3.5 Verification

The approach to verification used for this past winter, given reliable time-tagged snow amounts were not available, was to determine the counties indicated by HPC to be included in a watch versus the counties actually included by the WFOs in the official watch. In this way we can see how much consensus was reached through collaboration. Without the snow data we cannot determine whether the POD or lead times were increased but given the lack of storms this winter the sample size probably would be too small to draw significant conclusions.

HPC compared its preliminary winter weather watch product (snow only) and determined every county that was forecast to reach or exceed the warning criteria for day 1. With the assistance of Eastern Region, HPC obtained a listing of all counties that had watches posted based on an issuance time that followed the chat session. Table 3 of Appendix H provides a listing of those events where HPC had at least one county in one of the 8 CWAs of the participating offices that had a ratio of 1 or greater. (Unfortunately it was found out after the fact HPC only archived those counties with a ratio of one or greater.) For those counties where HPC had a ratio of 1 or greater, the WFOs issued watches for approximately two-thirds of them. Table 3 shows, however, the WFOs issued watches for more than 100 more counties then did HPC. Had HPC archived those counties having ratios between .5 and 1, it is believed the numbers in columns 1 and 2 would have been much closer. There are cases, however, where a similar number of counties were identified by both HPC and the WFOs but were not the same counties. January 6-7 illustrates the biggest discrepancy. This case is used by way of example in Appendix B (top two figures).

Included in this report in Appendix H are the HPC 24-h threat scores for 0.5 and 1 inch liquid equivalent for days 1 and 2 for the last 30 years which correspond to the months used in this experiment (November - February). Note that scores for this past winter were the best ever recorded by HPC for the cool season. The four-month threat score of .5 for the day 1 0.5 inch amount equates to HPC correctly forecasting 65% of the area observed to have 0.5 inch or greater. The slope of the trend line plotted for the one inch amount in Appendix H calculates out to a 2.5% improvement per year over the 30 year period. HPC’s threat scores are between 20 and 25% above the best model for the past two winter seasons and even higher in previous years. This improvement translates to an 8 to ten year improvement by the forecaster, or restated, 8 to 10 years of model development will be needed to

match the current skill of the forecaster (2.5% model improvement per year times 8 to 10 years or 20 to 25%). Thus there is a strong case for HPC providing guidance on winter weather given the accuracy in its QPF.

4. Follow-on Winter Weather Experiment

HPC believes a follow-on WWE should be conducted next winter. This past winter did not provide a sufficient number of cases to assess adequately the costs and benefits of having a national center collaborate with field offices on winter weather. Secondly, an NWS team assigned to evaluate the role of HPC in the National Digital Forecast Database (NDFD) era, concluded HPC should act as a facilitator for consensus building to ensure the NDFD is coherent and of high quality. Since winter weather watches/warnings/advisories will be part of the NDFD, this would suggest there is a mandate for HPC to fulfill the role conceived for the WWE. The follow-on experiment will attempt to validate this mandate.

4.1 NCEP - ERH Meeting Results

HPC and ERH met on June 5, 2002. It was agreed a follow-on WWE would take place for the winter of 2002-2003. All Eastern Region offices will participate. Several action items coming out of this meeting will have an impact on next winter's experiment. These include:

- Determine metrics to evaluate the impact of the WWE - a few metrics discussed were: 1) chatroom session length, with target of 15 minutes or less; and 2) verification of WFO preliminary snow depth grids from IFPS versus post-collaboration final snowfall grids to determine whether POD was increased and lead time reduced.

- Identify the software to be used for collaboration in the next WWE. An NWS Team is evaluating this and will be queried as to whether they have made a decision and whether the software they select will be available by the upcoming cool season.

- Contact Central Region to see if they would like to have some offices participate in the WWE. Determine whether Central Region has winter weather criteria based on 12- or 24-hour periods. If different from the Eastern Region, evaluate the impact of this on the design of the next WWE.

- Determine the relationship of the role of HPC in NDFD collaboration with HPC's role in WWE collaboration. Can these be combined on an event-driven basis to reduce the time involved?

- HPC will prepare a draft WWE experimental design by July 15, 2002, for review by all participants.

4.2 Preliminary Design Concept for 2002-2003 WWE (WWE-II)

To support a large number of field offices and to represent better the uncertainty associated with the track and intensity of winter storms, HPC believes it should modify its current probabilistic snow product to use the individual county watch/warning criteria instead of the 2-, 4- or 12-inch amounts currently used. Appendix G provides an example of how this product might look. When HPC transitions to a national scale for winter weather support, it would have to provide a broader-based guidance graphic much like SPC does for its watch areas. (It would not highlight individual counties as was done this year.) This new product would simply be much more relevant to the WFOs included in the watch guidance area because it would be specific to their county watch/warning criteria. HPC would still utilize the same procedures of using the SREF and HPC's QPFs to determine which counties approach or exceed warning criteria. HPC would simply edit these areas as before for changing QPFs and snow ratios before the final area is annotated. The probabilities[1] would be derived based on the ratio of warning criteria. The 50%-to-100% areas would be in the low category, the 100-to-150% moderate, and the greater than 150% in the high category. This would work for both snow and ice. This would provide a more reliable approach to determining probabilities rather than the subjective manner in which it is done now.

Another technique HPC would like to test is the use of streaming video to provide near-real-time video briefings to the impacted forecast offices. HPC believes a tremendous amount of meteorological information can be provided in a 5-6 minute video briefing. This would expedite the collaboration to less than 15 minutes by simply reducing the session to resolving differences in the boundaries of the watch area

[1]It should be noted the HPC graphic products (Appendix B) are *not* fully probabilistic. That is, the intrinsically probabilistic QPF and precipitation type from the SREF are used in conjunction with other model guidance to provide the *single* "best estimate" QPF and consensus precipitation type. The risk would be assessed by determining the ratio of the predicted snow/ice to the county watch/warning criteria.

suggested by HPC.

5. Concluding Remarks

NCEP and eight Eastern Region WFOs participated in a 6-month Winter Weather Experiment during the winter of 2001-2002. The purpose was to improve the timeliness and accuracy of winter weather watches through a collaborative forecast process. The NCEP developed a unique method of combining output from the short-range ensembles (consensus precipitation type) with the HPC 6-h QPFs to create a forecast specifically related to each county's winter weather watch/warning criteria. This product proved quite useful as the basis for a collaborative chat session between the HPC and the WFOs to resolve which counties should be included. Although no verification was performed on quantifying the improvements in lead time and probability of detection, the verification performed did show the HPC and the WFOs agreed about two-thirds of the time as to which counties should be included in a watch. For those cases where there were discrepancies, it was usually because there was rather large uncertainty in the overall forecast.

This experiment highlights the challenges facing both the HPC and the WFOs as the NWS moves into the digital forecast era. With HPC's new role of collaborating with the WFOs to produce a coherent and high-quality NDFD, the WWE served as an excellent test bed for this concept. ER and NCEP believe a follow-on WWE next winter with a larger number of offices participating would greatly aid in validating the decision to have HPC collaborate with the WFOs to improve the quality and coherency of the NDFD, in general, and winter weather forecasting in particular.

Table 1. Forecast Offices Participating in WWE

Office	Date Started
Mt. Holly	11/01/2001
State College	11/01/2001
Sterling	11/01/2001
Wakefield	11/01/2001
Taunton	01/05/2002
Upton	01/05/2002
Caribou	01/13/2002
Gray	01/13/2002

Table 2. WWE Product Suite. Experimental products and services are highlighted in bold. In normal font are listed existing HPC winter weather products and services, which will continue during the winter of 2001-2002.

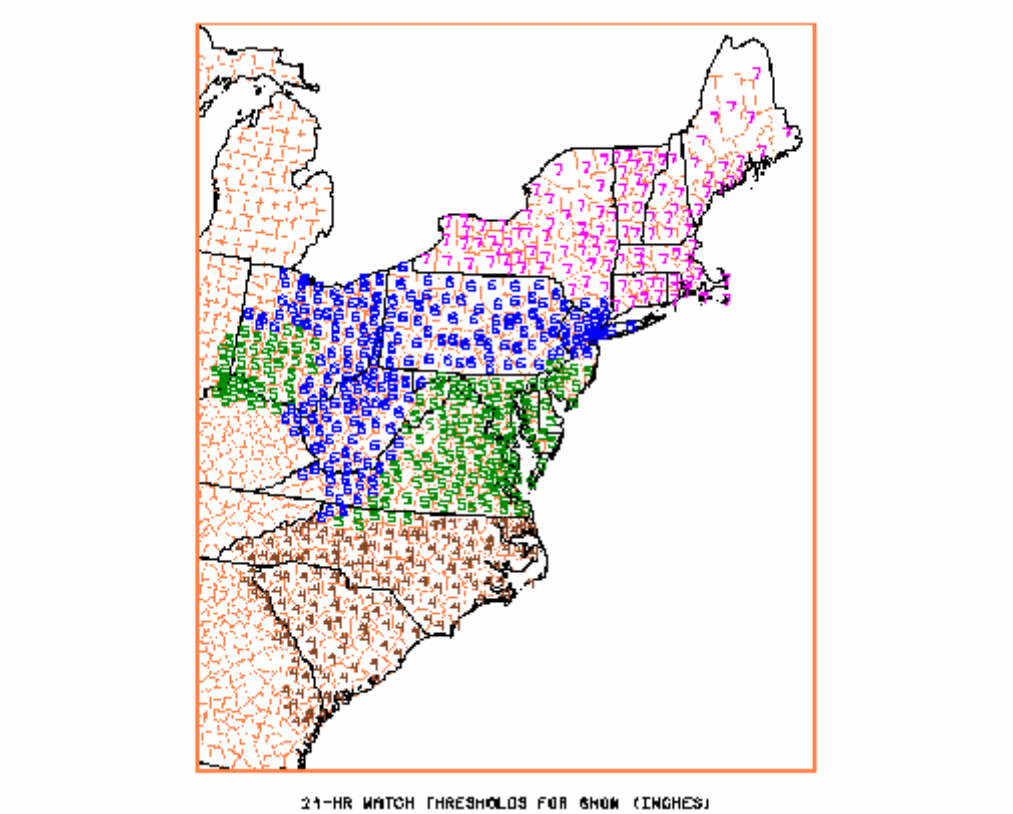
Product/Service	AWIPS ID	Valid Time (UTC)	Issue Time (EST)
Day Shift (6:30 am-4:30 pm EST)			
4-7 day outlook discussion	n/a	0000-0000 day 7	0830
12-h Heavy Snow/ Icing Forecast	93s	1800-0600	0915
12-h Heavy Snow/ Icing Forecast	94s	0600-1800	0915
Heavy Snow/Icing Discussion	HSD	1800-1800	1000
Pre-chat Winter Weather Watch Warning Guidance Graphic Day 1	n/a	0000-0000 day 1	1130
Pre-chat Winter Weather Watch Warning Guidance Graphic Day 2	n/a	0000-0000 day 2	1130
Tracks Forecast with geographical spread of model forecast low positions. 0000 - 1200 UTC DAY 3	n/a	00 hr- 0000 UTC day 3	1130
00 hr - day 3 track discussion	n/a	00 hr- 0000 UTC day 3	1130
Winter Weather Collaborative Chat Session (day 1 and day 2)			1145-1200
Post-chat Winter Weather Watch Warning Guidance Graphic (Day 1)	n/a	0000-0000 day 1	1300
Post-chat Winter Weather Watch Warning Guidance Graphic (Day 2)	n/a	0000-0000 day 2	1300
12-h Heavy Snow/ Icing Forecast	93s	0000-1200	1315

12-h Heavy Snow/ Icing Forecast	94s	1200-0000	1315
12-h Heavy Snow/ Icing Forecast	98s	0000-0000 day 2	1400

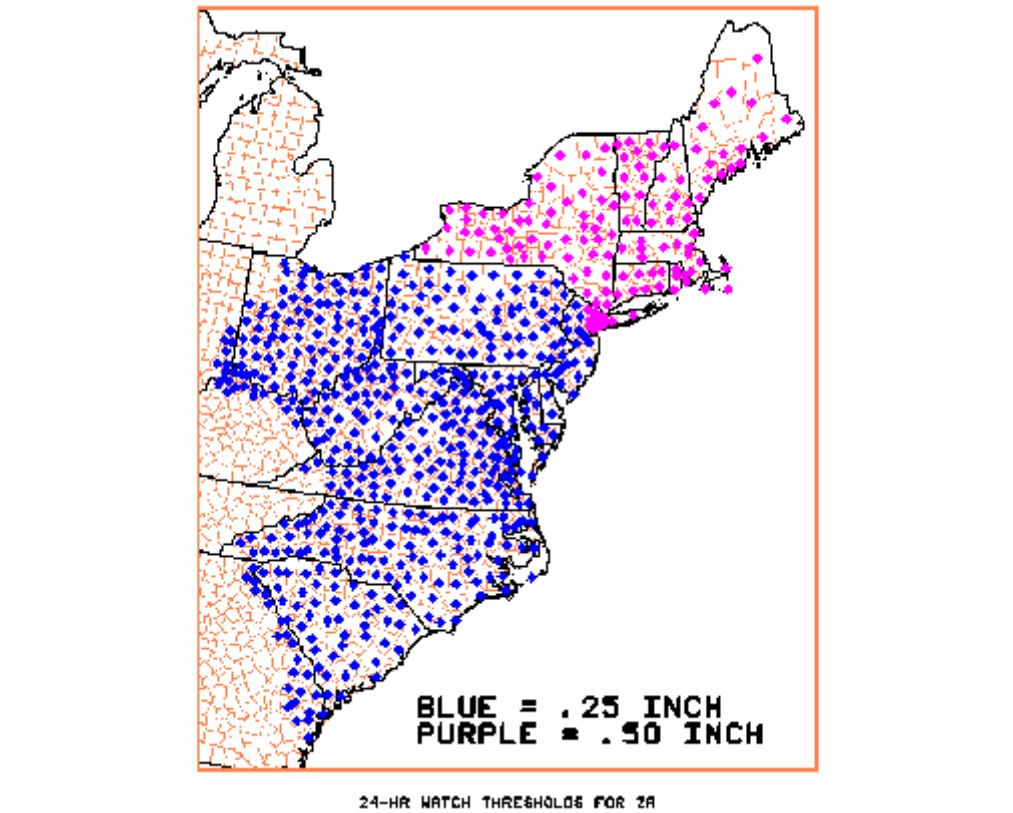
Product/Service	**AWIPS ID**	**Valid Time (UTC)**	**Issue Time (EST)**
Night Shift (6:30 pm-4:30 am EST)			
4-7 day outlook discussion	n/a	1200-1200 day 7	2030
12-h Heavy Snow/ Icing Forecast	93s	0600-1800	2115
12-h Heavy Snow/ Icing Forecast	94s	1800-0600	2115
Heavy Snow/Icing Discussion	HSD	1800-1800	2200
Pre-chat Winter Weather Watch Warning Guidance Graphic Day 1	n/a	1200-1200 day 1	2345
Pre-chat Winter Weather Watch Warning Guidance Graphic Day 2	n/a	1200-1200 day 2	2345
Tracks Forecast with geographical spread of model forecast low positions. 0000 - 1200 UTC DAY 3	n/a	00 hr- 1200 UTC day 3	2330
00 hr - day 3 track discussion	n/a	00 hr- 1200 UTC day 3	2330
Winter Weather Collaborative Chat Session (day 1 and day 2)			0000-0015
Post-chat Winter Weather Watch Warning Guidance Graphic (Day 1)	n/a	1200-1200 day 1	0115
Post-chat Winter Weather Watch Warning Guidance Graphic (Day 2)	n/a	1200-1200 day 2	0115

12-h Heavy Snow/ Icing Forecast	93s	1200-0000	0115
12-h Heavy Snow/ Icing Forecast	94s	0000-1200	0115
12-h Heavy Snow/ Icing Forecast	98s	1200-1200 day 2	0200

Appendix A. County Warning Criteria Used for WWE

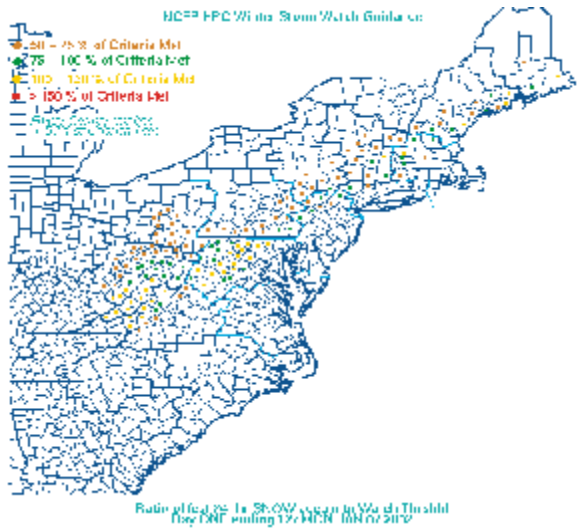


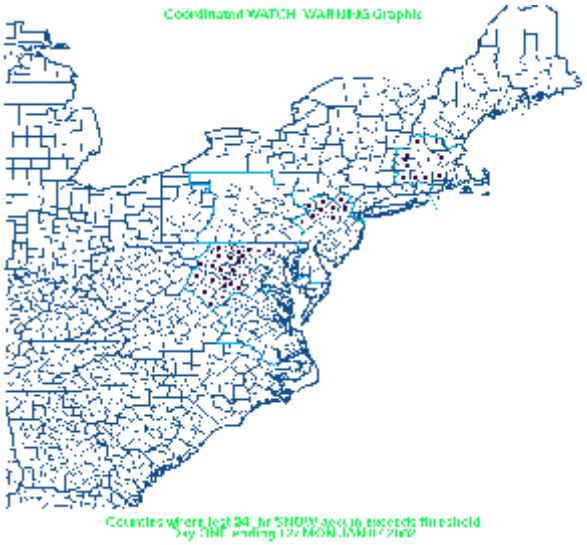
24-HR WATCH THRESHOLDS FOR SNOW (INCHES)

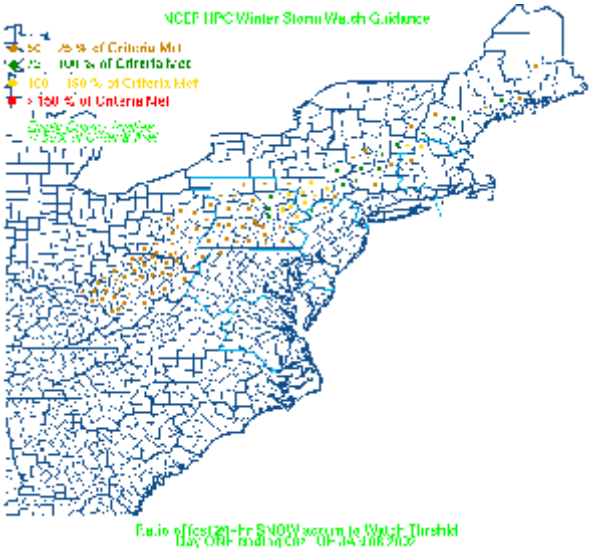


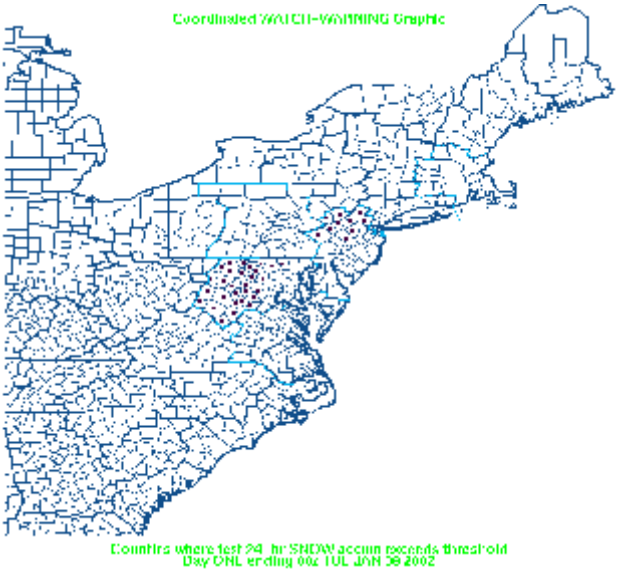
24-HR WATCH THRESHOLDS FOR ZR

Appendix B. Examples of pre-chat graphics (HPC, left) and post-chat graphics (WFO, right)

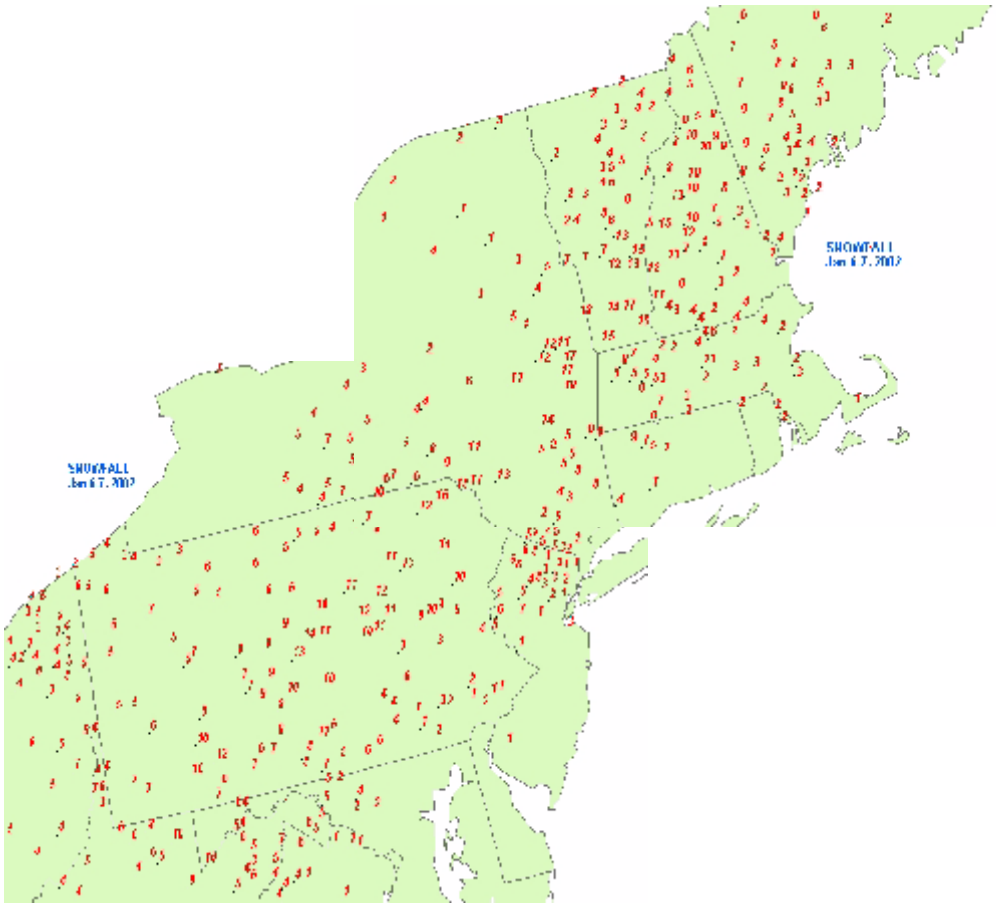




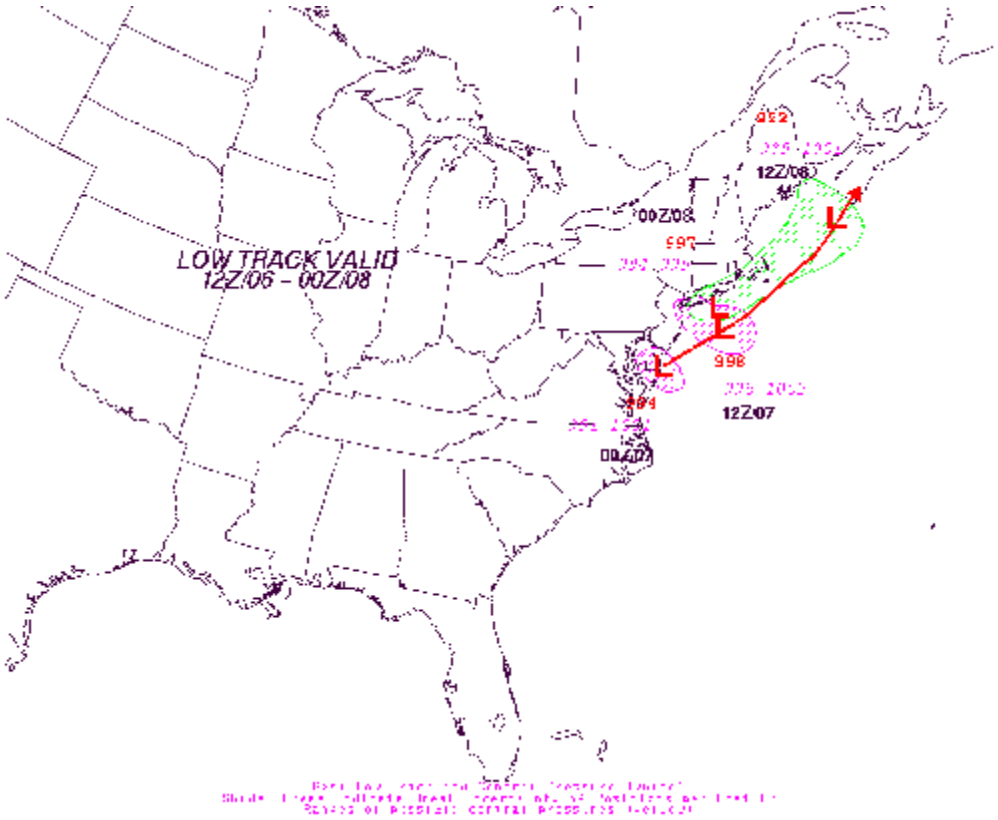




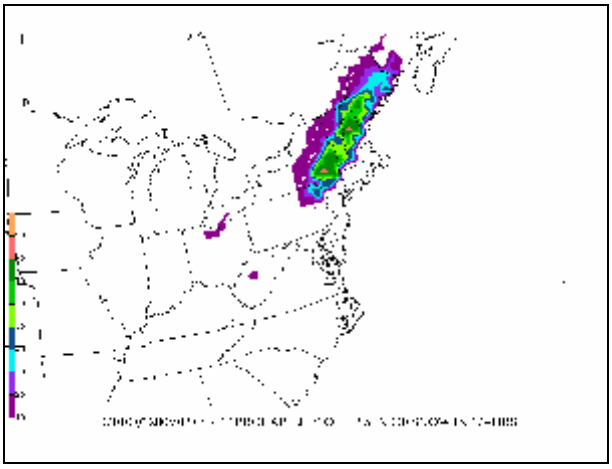
Appendix C. Observed snowfall for January 6-7 event.

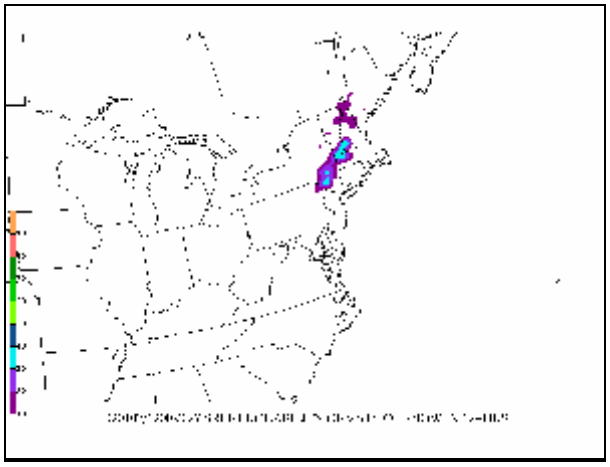


Appendix D. HPC-derived low tracks chart showing best track and spread of solutions.



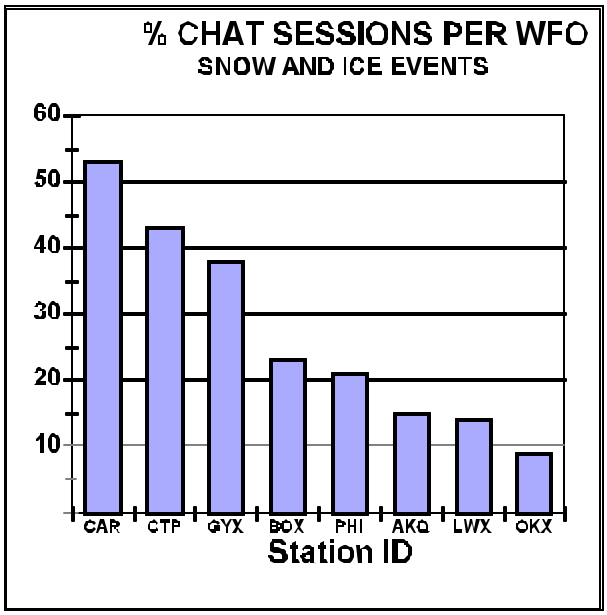
Appendix E. SREF Probability Charts for 2.5 and 5 inches of

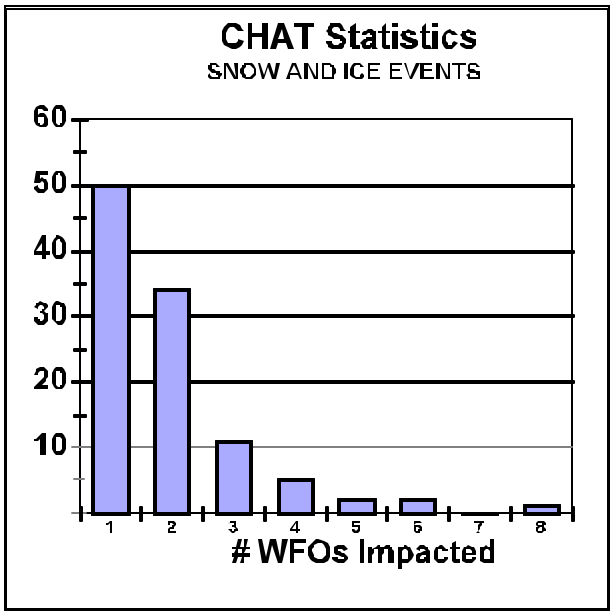




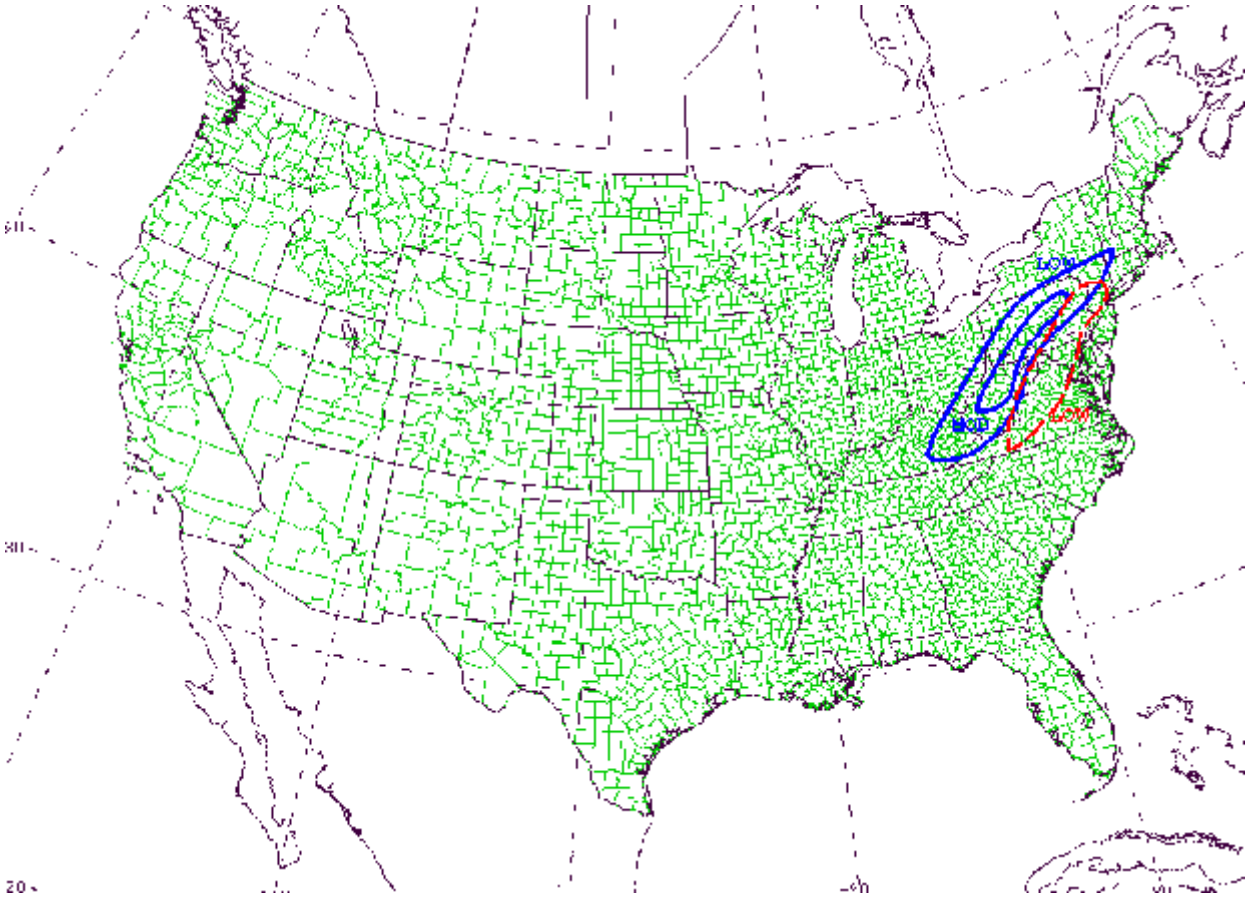
snow in 12 hours.

Appendix F. Chat session participation.





Appendix G. Proposed snow/ice product for the 2002-2003 Winter Weather Experiment. Blue lines denote low and moderate probability of snow exceeding county warning criteria while red dashed line indicates icing accumulation above county warning criteria. LOW - 30% to 39%, MDT - 40% to 70%, HIGH > 70% chance.



APPENDIX H. WWE Chat Sessions Conducted for Winter 2001-2002.

12Z Dec 8-9 Day 2. CTP...PHI

00Z Dec 9-10. Day 1 &2. CTP DAY 1.....CTP/PHI DAY 2 (ICE).

00Z Dec 28-29 Day 1 & 2. CTP DAY 1& 2

00Z Dec 29-30 Day 2. CTP

12Z Dec 28-29 Day 1 CTP

12Z Dec 31-Jan 1 Day 2 CTP

12Z Jan 2-3 Day 1 & 2 AKQ DAY 1 &2

00Z Jan 3-4 Day 1& 2 AKQ DAY 1 &2

12Z Jan 3-4 Day 1 & 2 AKQ DAY 1...AKQ/PHI DAY 2

00Z Jan 4-5 Day 1 & 2 AKQ DAY 1 &2

00Z Jan 6-7 Day 2 CTP

12Z Jan 6-7 Day 1& 2 LWX/CTP/PHI/BOX

00Z Jan 6-7 Day 1 LWX

00Z Jan 7-8 Day 1& 2 LWX/CTP/BOX DAY 1... BOX DAY 2

12Z Jan 7-8 Day 1 LWX/CTP/PHI/BOX

12Z Jan 13-14 Day 1 BOX/GYX/CAR

00Z Jan 14-15 Day 1 CAR

00Z Jan 15-16 Day 1 &2 GYX/CAR DAY 1.....BOX/GYX/CAR DAY 2

12Z Jan 15-16 Day 1 & 2 GYX/CAR DAY 1.....CAR DAY 2

00Z Jan 17-18 Day 1 &2. CTP/PHI DAY 1... CTP DAY 2

00Z Jan 19-20 Day 1 &2. LWX/CTP/AKQ/PHI/OKX DAY 1...LWX/AKQ/PHI DAY 2

12Z Jan 19-20 Day 1&2 LWX/CTP/AKQ/PHI/OKX/BOX Day 1 &2 ICE DAY 1...LWX

12Z Jan 21-22 Day 1 CAR

12Z Jan 24-25 Day 1& 2. GYX DAY 1... CAR DAY 2

00Z Jan 24-25 Day 1 CAR/GYX

12Z Jan 30-31 Day 1&2 CTP (ice)

12Z Jan 31-Feb 1 Day 2. CTP/OKX/BOX/GYX

00Z Feb 1-2 Day 1 GYX/CAR BOX/GYX (ICE)

00Z Feb 4-5 Day 1& 2 GYX/CAR DAY 1....CAR DAY 2

00Z Feb 7-8 Day 1&2 LWX (ICE)

12Z Feb 10 -11 Day 1&2 CAR

00Z Feb 11-12 Day 1& 2 CAR

12Z Feb 17-18 Day 1&2 BOX/GYX DAY 1.....BOX DAY 2

12Z Feb 20-21 Day 2 CAR

00Z Feb 21-22 Day 2 CAR

12Z Feb 21-22 Day 2 CAR

12Z Feb 27-28 Day 1 GYX....CAR

00Z Feb 28- Mar 01 Day 1& 2 GYX...CAR

12Z Mar 8-9 Day 1 CAR

00Z Mar 9-10 Day 1 CAR

00Z Mar 15-16 Day 1&2 GYX...CAR

12Z Mar 15-16 Day 2 GYX...CAR

00Z Mar 16-17 Day 2 CAR

12Z Mar 17-18 Day 1 CTP (ICE)

00Z Mar 18-19 Day 2 CTP

12Z Mar 18-19 Day 1& 2 BOX...GYX

00Z Mar 20-21 Day 2 BOX...GYX

12Z Mar 20-21 Day 1& 2 BOX...GYX...CAR

00Z Mar 21-22 Day 1 GYX...CAR

00Z Mar 22-23 Day 1 GYX...CAR...CTP DAY 2 CAR....CTP

12Z Mar 24-25 Day 1& 2 CTP

12Z Mar 25-26 Day 2 CTP

00Z Mar 25-26 Day 1 CTP...OKX

00Z Mar 26-27 Day 1 CTP (ICE)

12Z Mar 26-27 Day 1&2 GYX...CAR (SNOW & ICE)

00Z Mar 27-28 Day 1&2 GYX...CAR Day 1 GYX (ICE)

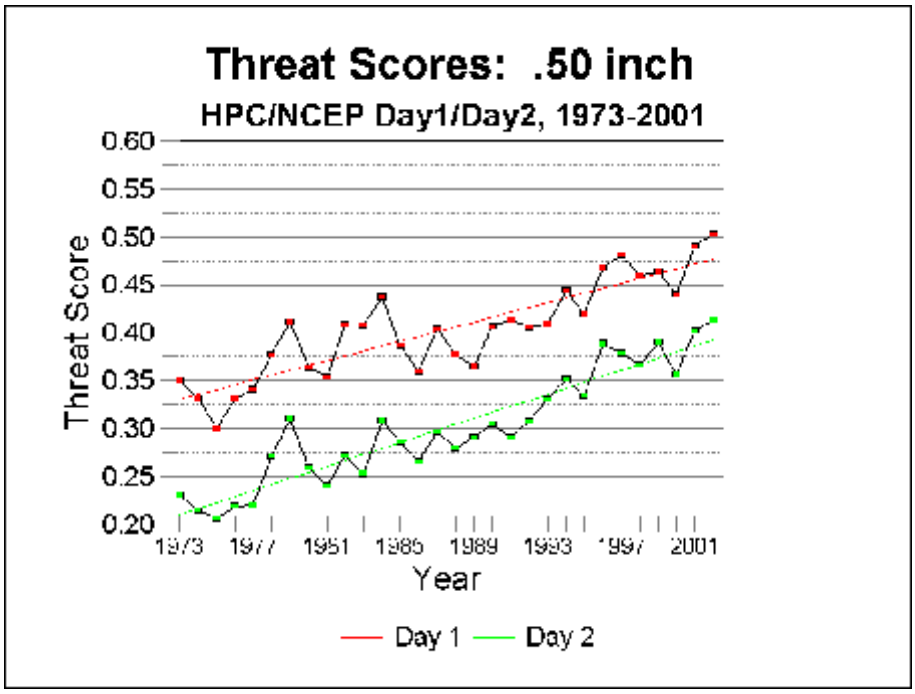
00Z Apr 1-2 Day 1 GYX...CAR

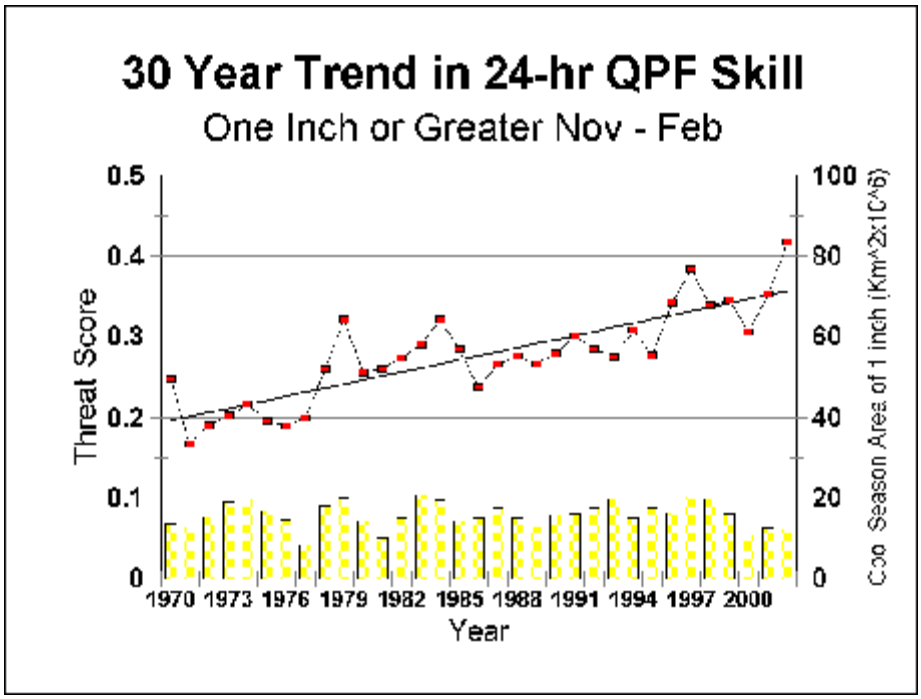
12Z Apr 1-2 Day 1& 2 GYX...CAR

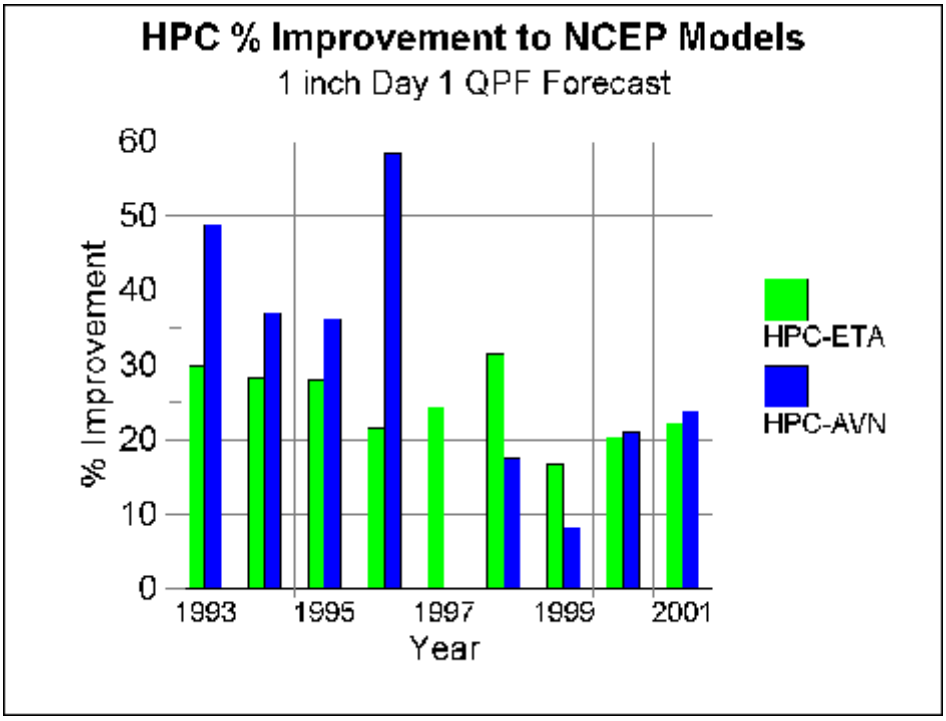
Table 3. Comparison of HPC preliminary and WFO final watches based on 24-h snow criteria.

HPC	WFOS	HPC/WFO Match	%	Date
7	35	7	100	12Z JAN 2-3 2002
32	53	32	100	00Z JAN 3-4 2002
10	32	8	80	12Z JAN 3-4 2001
40	41	13	32.5	12Z JAN 6-7 2002
5	26	5	100	00Z JAN 7-8 2002
53	53	39	73.6	00Z JAN 19-20 2002
33	45	21	63.6	12Z JAN 19-20 2002
8	0	0	0	00Z JAN 25-26 2002
4	4	4	100	00Z JAN 31-FEB 1 2002
2	3	1	50	12Z FEB 3-04 2002
1	0	0	0	12Z FEB 17-18 2002
1	1	0	0	12Z FEB 27-28 2002
2	17	2	100	12Z MAR 25-26 2002
3	0	0	0	12Z MAR 26-27 2002
3	4	3	100	00Z MAR 27-28 2002
3	0	0	0	12Z APRIL 1-2 2002
2	0	0	0	12Z APRIL 25-26 2002
209	314	135	64.6	

Appendix I. HPC Day 1-2 Half-Inch and Day 1 One-Inch Verification Scores for Cool Season.






HPC % Improvement to NCEP Models
1 inch Day 1 QPF Forecast
% Improvement
60
50
40
30
20
10
0
1993
1995
1997
1999
2001
Year
HPC-ETA
HPC-AVN