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National Convective Weather Forecast (NCWF) Product Demonstration Final Report

William Benner
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16. Abstract

This report describes the Demonstration of the National Convective Weather Forecast (NCWF) Product conducted by ACT-320 at Delta, Atlantic Coast, and Northwest Airlines' dispatch centers from June 22 through October 19, 1998.

The web-based NCWF, developed by scientists from the National Center for Atmospheric Research (NCAR), provides graphical information regarding the current (detection) and forecast locations of thunderstorms both nationally and regionally. The algorithm produces a 60-minute forecast.

The Demonstration was conducted from a Human Factors perspective and was essentially a usability study assessing the utility, performance, and user-computer interface aspects of the NCWF Product. Job-task benefits to the airline dispatcher community were also assessed. Dispatchers who participated in the study provided data via the use of questionnaires, on-line logs, and individual structured interviews.

Overall, the product was positively rated. However, some changes and improvements may make the NCWF more useful for airline dispatchers. This document describes Demonstration activities, reports results from the data collection effort, and identifies areas needing improvement.

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EXECUTIVE SUMMARY

This report describes the Demonstration of the National Convective Weather Forecast (NCWF) Product conducted by ACT-320 at Delta, Atlantic Coast, and Northwest Airlines' dispatch offices. The Demonstration was conducted between June 20 and October 19, 1998. Specific results, conclusions, and recommendations for the Demonstration are detailed within the report.

The NCWF Product, developed by the National Center for Atmospheric Research (NCAR), is a web-based graphical representation of current and forecast (to 1 hour) convectively active regions, both nationally and regionally. The first iteration of the NCWF, formerly named the Automated Convective SIGMET Forecast (ACSF) Product, was demonstrated in 1997 to the Aviation Weather Center's (AWC) Convective SIGMET Forecasters. Although the Product had merit, findings indicated it may be better suited to nonmeteorological aviation weather users, specifically airline dispatchers.

Participants in the NCWF Demonstration consisted of dispatchers from two major airlines, Delta and Northwest; and one regional airline, Atlantic Coast. Demonstrations were conducted on-site at each of the airline's operational dispatch centers. Objectives of the Demonstration were to evaluate the extent the NCWF benefited dispatchers in performing job tasks when convective weather effectively impacted the airline's flight routes. Human-computer interface aspects of the Product, as well as performance and utility, were also assessed. Data collection metrics employed included on-line user logs, questionnaires, and individual structured interview sessions.

Overall findings from all airlines were generally consistent. With few exceptions, the NCWF was rated positively. However, issues concerning the NCWF's performance, as well as improvements, were also identified. These included:

1. The forecast component was sometimes inaccurate, especially during airmass type storms.

2. A user-selected zoom capability would be preferable to the static national and regional map views.

3. A longer forecast duration would help meet dispatch flight planning requirements. Usually flight plans are issued 1 to 1 1/2 hours prior to departure.

4. Display animation would contribute more information on weather trends.

5. A growth and decay component would give a better general picture of weather dissipation as well as intensity for dispatch planning purposes.

6. User-selected overlays such as major cities, airports, VORs, and jet routes would help narrow the focus in determining locations of the weather.

Despite issues and desired improvements, results from the Demonstration indicate the NCWF Product has merit for airline dispatch use and should be considered for future development and evaluation.

1. INTRODUCTION.

Thunderstorms, or convection, account for nearly half of national airspace delays during the summer season. Thunderstorm phenomena such as lightning, turbulence, hail, rain, icing, and poor visibility require airspace users to provide a wide margin of separation between these phenomena and aircraft operations. In order to help circumvent these phenomena as safely and expeditiously as possible, reliable detection and forecasts of thunderstorms and convective activity are required.

In response to this requirement, prototype convective weather detection and forecast products are being developed and evaluated. Under the Federal Aviation Administration's (FAA) Aviation Weather Research (AWR) Program, the following organizations: Massachusetts Institute of Technology's Lincoln Laboratory (MIT/LL); the National Severe Storms Laboratory (NSSL); National Weather Service (NWS); Aviation Weather Center (AWC); and the National Center for Atmospheric Research (NCAR) are collaborating on developing automated techniques for short-term (0-3 hours) forecasts of convection for the aviation community. As part of this collaborative effort, the National Convective Weather Forecast (NCWF) Product, a 0–1 hour forecast product developed by NCAR, was evaluated by the FAA to ascertain whether or not it meets the aviation community's requirements for a graphical, convective, forecast and detection product. The web-based NCWF Product provides graphical information regarding the current (detection) and forecast locations of thunderstorms both nationally and regionally. The algorithm produces a 60-minute forecast.

The NCWF Product was first assessed during a demonstration at the AWC during the summer of 1997 as the Automated Convective SIGMET Forecast (ACSF) Product. During this demonstration, Convective SIGMET forecasters used the forecast and detection product as a tool to aid in creating Convective SIGMETs. The assessment was conducted by personnel from the FAA William J. Hughes Technical Center and NCAR. The demonstration revealed that some components of the Product had merit; however, specific improvements would be required in order to make it useful for AWC Convective SIGMET generation. Results from this demonstration are documented in the Technical Center's Automated Convective SIGMET Forecast Product Demonstration Final Report, December 1997.

Using feedback from Convective SIGMET forecasters, NCAR developers modified the Product display and worked on improving the Product algorithms. For the revised NCWF Product, NCAR placed an increased emphasis on other potential aviation users, particularly airline dispatchers. To address the needs of both small and large airlines, regional and major airlines were asked to participate in the demonstration.

To assess the perceived performance and value of the NCWF Product for airline dispatch use, the Technical Center and NCAR conducted an NCWF Product demonstration throughout the summer and early fall of 1998. Two major and one regional airline participated in this demonstration. These included (1) Northwest Airlines, (2) Delta Airlines, and (3) Atlantic Coast Airlines. Demonstrations were conducted at each airline's dispatch operations' center located in Minneapolis, MN; Atlanta, GA; and Dulles, VA; respectively.

1.1 PURPOSE OF REPORT.

The purpose of this report is to document feedback and data collected as well as discussions and conclusions addressing the extent to which the NCWF Product met stated demonstration objectives.

1.2 SCOPE OF REPORT.

The NCWF Demonstration Report will summarize demonstration conduct and results regarding Product utility, user interface, and overall perceived benefit of the NCWF Product for airline dispatchers. A separate report, prepared by NCAR, will address the scientific and meteorological aspects of the NCWF Demonstration.

2. REFERENCE DOCUMENTS.

FAA-STD-024B U. S Department of Transportation, Federal Aviation Administration Standard, Content and Format Requirements for the Preparation of Test and Evaluation Documentation.

Acquisition Management System, Test and Evaluation Process Guidelines, February 1999.

National Convective Weather Forecast (NCWF) Product Demonstration Plan and Procedures, June 1998.

Automated Convective SIGMET Forecast (ACSF) Product Demonstration Final Report, December 1997.

3. SYSTEM DESCRIPTION.

The NCWF Product determines the locations of thunderstorm hazards from the integration of lightning and radar data. The lightning data is mapped to a Cartesian grid by assigning each lightning strike a circle radius of two grids covering a 16 kilometer (km) diameter circle. Lightning rate is calculated over a 5-minute period. National Scale Vertically Integrated Liquid (VIL) is compared to corresponding EchoTop data and removed if the echo top value is less than 17,000 feet. This technique removes the majority of Anomalous Propagation (AP). The VIL and lightning rate fields are then combined to create the detection field.

The VIL data field is also used in the forecast. This field is filtered using a scale separation filter that eliminates small-scale features (those perishable within an hour) providing a more accurate forecast of long lived linear storm systems. The Thunderstorm Identification Tracking and Nowcasting (TITAN) software is used both to determine storm motion from the filtered data field and to identify storms in the detection field. Storms that have a projected area of 520 km^2 and are over 22,000 feet in altitude are extrapolated. Using values from the extrapolated storm field, a storm motion vector is assigned to each of the detected storms.

The data sources used for the NCWF algorithm are the WSI WSR88D VIL, Echo Tops Mosaics, and National Lightning Detection Network (NDLN) data from Global, Inc., via Kavouras. The lightning fields are 4 km in resolution and updated automatically every 10 minutes. Figure 1 (AWC Algorithms) schematically depicts all the processes (algorithms) and data used in creating the NCWF Product output. Meteorological Data Volume (MDV) indicates gridded data whereas SYMPROD database (SPDB) represents text files. MDV and SPDB are both acronyms used internally by NCAR.

3.1 NCWF PRODUCT COMPONENTS.

Figure 2 illustrates one of the regional views (Great Lakes) of the NCWF Product. Various components of the NCWF Product and display are defined below.

3.1.1 Initial Detection Field.

The initial detection field (figure 2, item 1) displays current convective activity, and is depicted by a 6-level intensity color scale with highest intensity levels (5-6) as red and lowest intensity levels (1-2) as green. When convective detection criteria are met, the colored field will be displayed, indicating areas most likely to contain convective activity. Although Kavouras provided radar is one of the components of the Initial Detection Field data ingests, this product should not be confused with commercial radar output because lightning data and filtering of low echo top regions are used in its creation. Additionally, VIL radar output is not commonly used in aviation centers.

3.1.2 Convective Intensity Color Scale.

The convective intensity color scale, (figure 2, item 2) located on the right of the display, indicates intensity levels of convective activity in a similar manner commonly seen on radar displays, i.e., red indicating the highest intensity and green the lowest.

3.1.3 Detection Field Colors.

Detection field colors (figure 2, item 1) are the 6-level intensity colors indicated by the color intensity scale.

3.1.4 Forecast Contours.

Forecast contours (figure 2, item 3) are cyan colored polygons indicating areas where convective activity may occur in 1 hour. The forecast option may be toggled on or off by selecting the forecast on/off button on the bottom left of the planview display.

3.1.5 Storm Height Information.

Storm height information (figure 2, item 4) is numerically annotated in hundreds of feet and located over the displayed detection and forecast convective areas.

3.1.6 Echo Speed Values.

Echo speed values (figure 2, item 5) are numerically annotated in knots per hour along with storm height information.

3.1.7 Forecast Direction Lines.

Forecast direction lines (figure 2, item 6) are displayed as white lines or vectors, indicating the direction of storm movement.

3.1.8 Views.

Geographical areas of interest are divided by "views." Users may select a national view to observe the contiguous United States, or smaller views such as the Eastern United States, Southwest, or a specific Air Route Traffic Control Center (ARTCC) area. An example of the Great Lakes regional view is shown in figure 2.

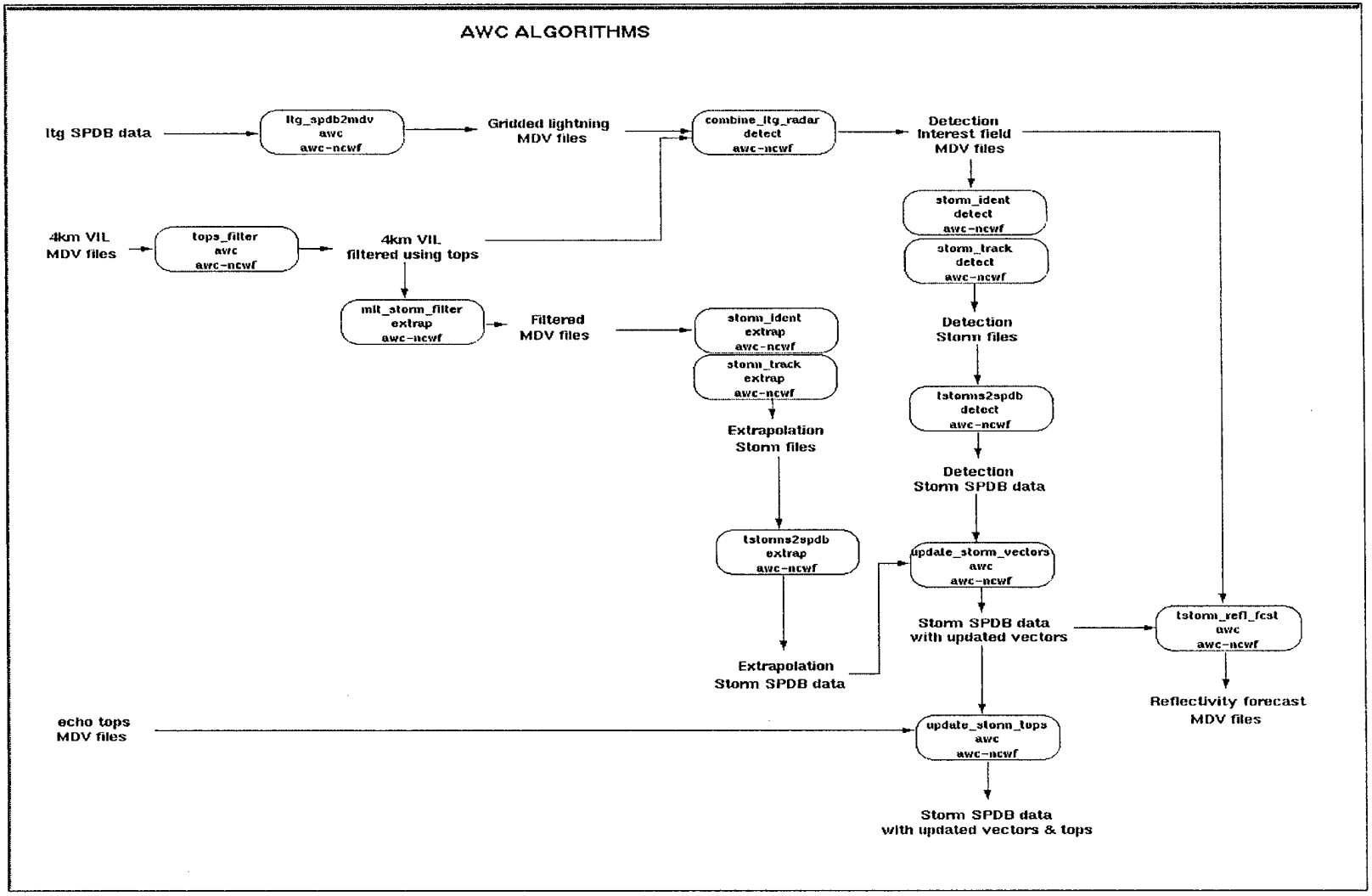

FIGURE 1. AWC ALGORITHMS

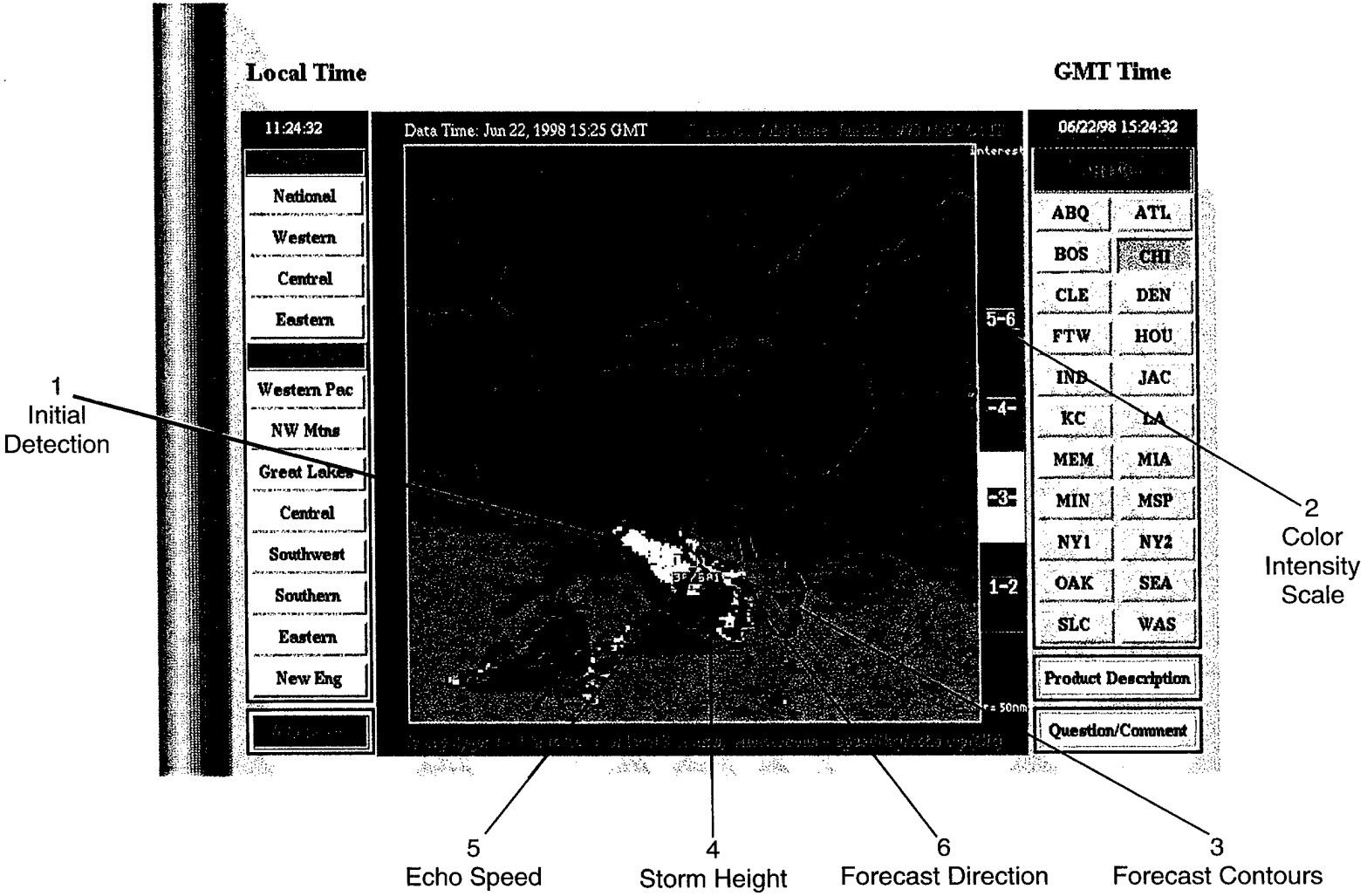

FIGURE 2. NATIONAL CONVECTIVE WEATHER FORECAST PRODUCT

4. DEMONSTRATION DESCRIPTION.

4.1 DEMONSTRATION SCHEDULE AND LOCATIONS.

The NCWF operational demonstration took place at the following airline dispatch operations centers:

a. Delta Airlines Operations Center, Atlanta, GA;

b. Northwest Airlines Systems Operations Center (SOC), Minneapolis, MN; and

c. Atlantic Coast Airlines Dispatch Operations, Sterling, VA (Washington-Dulles Airport).

The demonstration schedule for each airline was as follows:

a. Delta Airlines: June 22 through July 28, 1998;

b. Northwest Airlines: June 22 through October 19, 1998. (Note: The Northwest demonstration phase was extended to accommodate the pilot strike and month-long interruption in operations.);

c. Atlantic Coast Airlines: July 20 through September 7, 1998.

4.2 PARTICIPANTS.

Demonstration participants at each airline consisted of the following:

a. Delta Airlines: flight superintendents (dispatchers) and dispatch Air Traffic Control (ATC) liaisons;

b. Northwest Airlines: dispatchers, dispatch supervisors, and dispatch liaisons;

c. Atlantic Coast Airlines: dispatchers, dispatch team leads, and dispatch supervisors.

Because all categories of dispatchers are involved in dispatch operations and the overall participant response was relatively small, all participants have been categorized as "dispatchers."

4.3 DEMONSTRATION AND SPECIALIZED EQUIPMENT.

No specialized equipment was required. Since NCWF is a web-based product, Internet capability on computer display monitors were the only requirements for Product access.

4.4 DEMONSTRATION OBJECTIVES/CRITERIA.

The objectives of the NCWF Product Demonstration were to determine the following:

a. Does the NCWF Product add value to identifying and forecasting areas of convective weather activity?

b. Does the NCWF Product benefit tasks and decisions affected by convective weather activity?

c. How well does the Product perform? Under what situations does the Product perform well or not perform well?

d. How can the Product be enhanced? What improvements or changes would this necessitate?

e. Is a 1-hour forecast Product adequate for airline dispatchers' needs?

f. Are the NCWF Product interfaces and characteristics operationally acceptable?

The extent to which these objectives have been met is discussed in sections 5 and 6 of this report.

4.5 DEMONSTRATION DESCRIPTIONS.

The NCWF Demonstration was conducted in two phases. Activities during phase 1 consisted of airline coordination, demonstration planning, initial Product concept feedback, and training. Phase 2 included actual demonstration conduct where dispatchers were asked to look at and/or use the Product operationally and provide feedback in the form of daily logs, questionnaires, and structured interviews. Each of these phases is discussed in detail in subsequent paragraphs.

4.5.1 Phase 1 Demonstration Activities.

4.5.1.1 Product Concept Development.

Three potential NCWF Product options were informally briefed to dispatchers in order to obtain feedback on a preferred Product presentation; i.e., placement of locators, incorporation of range rings, and VOR overlays. Based on these responses, NCAR created a final Product concept for demonstration purposes. Figure 1 illustrates the final NCWF Product.

4.5.1.2 Training.

Training was conducted at each of the airlines' operational dispatch environments. Training, provided by NCAR and monitored by ACT-320 test personnel, was hands-on, individual, and interactive. A one-page quick reference guide was provided to all trainees explaining Product components, limitations, and contacts for troubleshooting. Due to time and resource constraints, all dispatchers were not trained. However, airlines agreed to allow previously

trained dispatchers to familiarize other dispatchers on their shifts. Since Product use is fairly intuitive; the interface is fundamentally simple; and displayed data is understandable; extensive training was not considered an issue.

4.5.2 Phase 2 Demonstration Activities.

4.5.2.3 Questionnaires.

At the end of the demonstration phase, ACT-320 test personnel distributed questionnaires to all dispatchers at each of the three airlines. The questionnaire contained two sections.

4.5.2.3.1 Section 1.

In section 1, dispatchers were asked to rate the NCWF Product and components on the dimensions of utility, reliability, confidence, and readability using a 5-point Likert scale. Product components and functions were rated on all or a subset of these dimensions. Items rated included:

a. Initial Detection Fields
b. Convective Intensity Color Scale
c. Detection Field Colors
d. Forecast Contours
e. Forecast Direction Lines
f. 50 nautical miles (nmi) Range Rings
g. Storm Height Information
h. Echo Speed Values
i. ARTCC Boundary Overlays
j. ARTCC Map
k. Views: National, Eastern, Southern, et al
l. Regional Views: Northeast, Great Lakes, et al
m. Navigation Between Views
n. Product Update Rate

Rating anchors included the following:

a. Largely Acceptable – This response indicates the Product/component being assessed consistently enhances your ability to meet the requirements of your job; likely to lead to enhanced job performance.

b. Acceptable – This response indicates the Product/component being assessed frequently enhances your ability to meet the requirements of your job; may lead to enhanced job performance.

c. Borderline – This response indicates that, although the Product/component being assessed is adequate, minor improvements would make it more helpful in identifying and forecasting convective weather and does not degrade or improve job performance.

d. Unacceptable – This response indicates the Product/component being assessed frequently impedes your ability to meet the requirements of your job; may lead to degradation of job performance.

e. Largely Unacceptable – This response indicates the Product/component being assessed consistently impedes your ability to meet the requirements of your job; likely to lead to degradation of job performance.

4.5.2.3.2 Section 2.

The second section assessed Product usefulness in relation to operational tasking. Tasks were identified during the first phase of the demonstration and verified by dispatch management. Again, a 5-point Likert scale was used and Product usefulness was measured against specific tasks. Questions relating Product usefulness to dispatcher tasking included the following:

a. Preparing flight plans
b. Planning fuel quantity
c. Planning flight route
d. Avoidance of severe convective weather
e. Selecting an alternate airport
f. Selecting altitude
g. Monitoring flight conditions
h. Rerouting flights
i. Advising pilots enroute of severe convective weather
j. Anticipating ground delays
k. Anticipating ATC actions (i.e., rerouting, closing runways, changing arrival gates)

Rating anchors ranged from 1, "Of Considerable Use" to 5, "Not at all Useful." A rating of 3 indicated the Product had little to no effect either positively or negatively, on decisions and activities related to the performance of the task. Rating anchors included the following:

a. Of Considerable Use. This response indicates the NCWF Product had a significant positive effect on decisions and activities related to the performance of this task.

b. Somewhat Useful. This response indicates the NCWF Product had a positive effect on decisions and activities related to the performance of the task.

c. Borderline. This response indicates the NCWF Product had little to no effect on decisions and activities related to the performance of the task.

d. Of Little Use. This response indicates the NCWF had a negative effect on decisions and activities related to the performance of the task.

e. Not at all Useful. This response indicates the NCWF Product had a significant negative effect on decisions and activities related to the performance of the task.

The questionnaire also included two open-ended questions soliciting suggestions for improvement and additional capabilities/components. The questionnaire is located in appendix A and a compilation of questionnaire comments from the open-ended questions are located in appendix B.

4.5.2.4 Structured Interviews.

Concurrent with questionnaire administration, structured interviews were conducted individually within the dispatch area by ACT-320 test personnel. The intent of the interview was to solicit information that may not be ratable within the questionnaire format and to provide more detail. These included the extent of Product use, how it compared to other convective weather sources, value added to operations, instances where the Product performed well or poorly, and requirements for forecast times. Structured interview questions and summaries are located in appendices C and D.

4.5.2.5 Daily User Log.

Throughout the demonstration, dispatchers were also asked to provide daily comments on the user feedback form linked to the NCWF Product web page. Users were encouraged to note any negative or positive performance aspects of the Product during day-to-day use. A sample of the user log form is located in appendix E.

4.6 DATA COLLECTION AND ANALYSIS METHOD.

Descriptive statistics were used for data analysis. Rating scores were not normally distributed and data was ordinal, therefore, the median was used as a measure of central tendency. One half of the observations fall above and below the median value. When there is an even number of observations, no unique center value exists, so the mean of the two middle observations is taken as the median value. Percentage values of rating scale responses were also calculated. Responses from questionnaire comments, and structured interview questions were summarized.

4.6.1 Factors Affecting Results.

a. Small Sample Size – The number of questionnaire responses from all participating airlines was poor. At Delta, for example, only 16 questionnaires were completed (out of the 145 distributed to all dispatchers). At Northwest, nine questionnaires were returned and Atlantic Coast Airlines completed three. Whether these samples are representative of Delta, Northwest, and Atlantic Coast Airlines; or airline dispatchers in general, is questionable.

b. Lack of Operationally Significant Convective Weather – Operationally significant convective weather activity was not prevalent throughout the demonstration period. Although there were some occurrences, the Product may not have had a chance to be fully utilized.

c. Training/Familiarization Constraints - Training was conducted individually in the operational environment at each participating airline. With a dispatch population of over 140 at both Delta and Northwest Airlines, resources and time to train each dispatcher were unavailable. Although those who missed training were to be trained by other trained dispatchers, this was not always the case. Consequently, many dispatchers were unaware the NCWF existed or were too unfamiliar with the Product to use it.

d. Product Inaccessibility – The ability of dispatchers to use the NCWF Product at Atlantic Coast Airlines was limited since the Product was only displayed at one workstation and not viewable from other workstations. In order to view the display, most dispatchers had to walk across the room and around the workstation. This was both time consuming and disruptive, accounting for limited operational use of the Product.

e. Northwest Airlines Pilot Strike – The pilot strike occurred during the middle of the demonstration period. Until its resolution, all flight operations ceased for approximately 1 month. Although the NCWF demonstration continued from that point, the interruption may have compromised user motivation in using the Product and providing feedback.

5. RESULTS.

5.1 QUESTIONNAIRE RESULTS.

Overall results from questionnaire rating and comment questions for all airline dispatcher participants are discussed below. Additionally, individual results will be discussed based on participant responses from each of the three airline dispatch groups.

5.1.1 Overall Results.

5.1.1.1 Product Components and Interfaces.

Overall median scores from data from all participating airline dispatchers were derived. Table 1 represents overall acceptability ratings from the first section of the questionnaire (questions 1 – 14) regarding the human interface/ Product component questions.

In the first section of the questionnaire, all Product components and interfaces were rated positively, receiving an overall rating of 2 (acceptable) on all dimensions rated including utility, reliability, readability, and confidence. (Note: Not all interfaces and components were rated on all dimensions.)

5.1.1.2 Product Improvements.

Product improvement questionnaire comments are addressed under individual airline headings. An overall summary of improvements is listed in appendix B.

5.1.1.3 Product Usefulness.

Median rating scores from the second part of the questionnaire (questions 17 – 27) assessing Product usefulness were also positive overall. NCWF usefulness was rated highest (1 – of considerable use) for avoiding convective weather and advising pilots of convective weather activity. Product usefulness for flight monitoring and planning flight routes also received positive ratings with a median score of 1.5. A median score of 2 was obtained for fuel planning, rerouting, and anticipating ATC decisions, indicating the NCWF Product was useful. Product usefulness for selecting altitude, anticipating ground delays, and anticipating ATC actions received a borderline rating of 3, indicating the NCWF Product had little to no effect on decisions and activities related to the performance of the tasks. See table 2 for overall Product usefulness ratings.

TABLE 1. OVERALL ACCEPTABILITY MEDIAN RATINGS AND PERCENTAGES OF PRODUCT COMPONENTS AND INTERFACES FOR DELTA, NORTHWEST, AND ATLANTIC COAST AIRLINES

COMPONENT/FEATURE		Largely Acceptable	Acceptable	Borderline	Unacceptable	Largely Unacceptable	
		1	2	3	4	5	
	Total N	N %	N %	N %	N %	N %	*Mdn*
1. Initial Detection Fields							
a. Utility	27	6 22.2	17 63	4 14.8	0 0	0 0	2
b. Reliability	27	7 30.4	12 52.2	3 13	1 4.3	0 0	2
c. Readability	27	6 22.2	19 70.4	2 7.4	0 0	0 0	2
d. Confidence	27	6 22.2	15 55.6	5 18.5	1 3.7	0 0	2
2. Convective Intensity Color Scale							
a. Utility	28	12 42.9	14 50.0	2 7.1	0 0	0 0	2
b. Reliability	26	10 38.5	13 50	2 7.7	1 3.8	0 0	2
c. Readability	28	11 39.3	15 53.6	2 7.1	0 0	0 0	2
3. Detection Field colors							
a. Utility	27	9 32.1	15 53.6	2 7.1	0 0	1 3.7	2
b. Readability	27	9 33.3	16 59.3	1 3.7	0 0	1 3.7	2
4. Forecast Contours							
a. Utility	28	9 32.1	17 60.7	2 7.1	0 0	0 0	2
b. Reliability	27	8 29.6	15 55.6	3 11.1	1 3.7	0 0	2
c. Readability	28	7 25	19 67.9	2 7.1	0 0	0 0	2
d. Confidence	28	8 28.6	12 42.9	7 25	1 3.6	0 0	2
5. Forecast Direction Lines							
a. Utility	26	7 26.9	14 53.8	5 19.2	0 0	0 0	2
b. Reliability	25	6 24	15 60	2 8	1 4	1 4	2
c. Readability	26	4 15.4	18 69.2	4 14.3	0 0	0 0	2
d. Confidence	26	3 11.5	16 61.5	7 26.9	0 0	0 0	2

TABLE 1. OVERALL ACCEPTABILITY MEDIAN RATINGS AND PERCENTAGES OF PRODUCT COMPONENTS AND INTERFACES FOR DELTA, NORTHWEST, AND ATLANTIC COAST AIRLINES (CONTINUED)

COMPONENT/FEATURE		Largely Acceptable	Acceptable	Borderline	Unacceptable	Largely Unacceptable	
		1	2	3	4	5	
	Total N	N %	N %	N %	N %	N %	*Mdn*
6. 50 nm Range Rings							
a. Utility	23	10 43.5	12 52.2	1 4.3	0 0	0 0	2
b. Readability	22	11 47.8	12 52.2	0 0	0 0	0 0	2
7. Storm Height Information							
a. Utility	28	9 32.1	16 57.1	3 10.7	0 0	0 0	2
b. Reliability	26	7 26.9	16 61.5	2 7.7	1 3.8	0 0	2
c. Readability	27	9 33.3	12 44.4	6 22.2	0 0	0 0	2
d. Confidence	28	5 17.9	19 67.9	3 10.7	1 3.6	0 0	2
8. Echo Speed Values							
a. Utility	28	6 21.4	20 71.4	2 7.1	0 0	0 0	2
b. Reliability	26	6 23.1	17 65.4	2 7.7	1 3.8	0 0	2
c. Readability	18	5 17.9	19 67.9	4 14.3	0 0	0 0	2
d. Confidence	28	5 17.9	19 67.9	3 10.7	1 3.6	0 0	2
9. ARTCC Boundary Overlays							
a. Utility	26	12 46.2	12 46.2	1 3.8	1 3.8	0 0	2
b. Readability	25	12 48	12 48	0 0	1 4	0 0	2
10. ARTCC Map							
a. Utility	26	12 46.2	12 46.2	1 3.8	0 0	1 3.8	2
b. Readability	26	12 46.2	13 50	0 0	1 3.8	0 0	2
11. Views (National, Eastern, et al)							
a. Utility	28	6 21.4	18 64.3	3 10.7	0 0	1 3.6	2
b. Readability	28	9 32.1	14 50	5 17.9	0 0	0 0	2

TABLE 1. OVERALL ACCEPTABILITY MEDIAN RATINGS AND PERCENTAGES OF PRODUCT COMPONENTS AND INTERFACES FOR DELTA, NORTHWEST, AND ATLANTIC COAST AIRLINES (CONTINUED)

COMPONENT/FEATURE		Largely Acceptable	Acceptable	Borderline	Unacceptable	Largely Unacceptable	
		1	2	3	4	5	
	Total N	N %	N %	N %	N %	N %	*Mdn*
12. Regional views							
a. Utility	28	6 21.4	18 64.3	3 10.7	0 0	1 3.6	2
b. Readability	28	7 25	17 60.7	3 10.7	1 3.6	0 0	2
13. Navigation Between Views	26	5 19.2	14 53.8	5 19.2	1 3.8	1 3.8	2
14. Product Update Rate	27	9 33.3	10 37	6 22.2	1 3.7	1 3.7	2
15 and 16: See Product Improvement summaries in Appendix B							

TABLE 2. OVERALL USEFULNESS MEDIAN RATINGS AND PERCENTAGES FOR DISPATCHER TASKING FOR DELTA, NORTHWEST AND ATLANTIC COAST AIRLINES

TASK		Of Considerable Use	Somewhat Useful	Borderline	Of Little Use	Not at all Useful	
		1	2	3	4	5	
	Total N	N %	N %	N %	N %	N %	*Mdn*
17. Preparing Flight Plans	28	9 32.1	14 50	3 10.7	2 7.1	0 0	2
18. Planning Fuel Quantity	27	5 18.5	13 48.1	6 22.2	3 11.1	0 0	2
19. Planning Flight Route	28	14 50	10 35.7	2 7.1	2 7.1	0 0	1.5
20. Avoidance of Severe Convective Weather	28	16 57.1	10 35.7	2 7.1	0 0	0 0	1
21. Selecting an Alternate Airport	28	6 21.4	10 35.7	9 32.1	3 10.7	0 0	2
22. Selecting Altitude	28	1 3.6	12 42.9	7 25	8 28.6	0 0	3
23. Monitoring Flight Conditions	28	15 53.6	9 32.1	3 10.7	1 3.6	0 0	1
24. Re-routing Flights	28	14 50	11 39.3	3 10.7	0 0	0 0	1.5
25. Advising Pilots Enroute of Severe Convective Weather	27	17 63	7 25	2 7.1	1 3.7	0 0	1
26. Anticipating Ground Delays	26	5 17.9	7 25	9 32.1	4 14.3	1 3.6	3
27. Anticipating ATC Actions	28	1 3.6	12 42.9	7 25	8 28.6	0 0	3

5.1.2 Delta Airlines Questionnaire Results.

5.1.2.1 Product Components and Interfaces.

Questionnaire results from Delta airline dispatchers were similar to overall results. In the first section of the questionnaire (questions 1 – 14), all Product interface components of the NCWF were rated positively. Product components rated via a combination or subset of utility, reliability, readability, and confidence received rating scores of 2 (acceptable) or higher. Utility of the 50-nmi range rings and Product Update Rate was rated highest with an overall rating score of 1 (largely acceptable). Table 3 illustrates overall questionnaire results per airline.

5.1.2.1 Product Improvements.

Generally, respondent comments on Product improvements or suggestions (see questions 15 and 16 on questionnaire) focused on user defined zoom capability, animation or looping capability (to see trending), and longer forecast durations (2 to 6 hours).

Criticism centered on difficulty reading tops and echo speed annotations, and a lack of adequate cities and airport overlays for easier identification – especially for those airports or cities that serve as hubs (Atlanta, Dallas/Ft. Worth, Cincinnati) and destinations.

Delta questionnaire comment summaries from questions 15 and 16 are located in appendix B.

5.1.2.2 Product Usefulness.

In the Product usefulness section of the questionnaire, relating the Product to tasking, overall rating scores were positive. With the exception of the "Selecting altitude" task, which received an overall borderline score of 3, all other categories received overall ratings of 2.5 and above. Rating scores on "Avoidance of severe weather" and "Advising pilots enroute of severe convective weather" received an overall rating score of 1 ("Of Considerable Use"). A bar chart depicting Delta's Product usefulness ratings along with Northwest's and Atlantic Coast Airline's are provided in figure 3.

TABLE 3. MEDIAN RANKINGS ON UTILITY, READABILITY, RELIABILITY, AND CONFIDENCE PER COMPONENT/FEATURE BY INDIVIDUAL AIRLINE DISPATCHERS

Product/Component	Delta Airlines (N=16)	Northwest Airlines (N=9)	Atlantic Coast Airlines (N=3)
1. Initial Detection Field			
a. Utility	2	2	2
b. Reliability	2	2	2
c. Readability	2	2	2
d. Confidence	2	2	2
2. Convective Intensity Color Scale			
a. Utility	2	2	1
b. Reliability	2	2	1.5
c. Readability	2	2	1
3. Detection Field Colors			
a. Utility	2	2	1
b. Readability	2	2	2
4. Forecast Contours			
a. Utility	2	2	1
b. Reliability	2	2	1.5
c. Readability	2	2	2
d. Confidence	2	2	2
5. Forecast Direction Lines			
a. Utility	2	2	1
b. Reliability	2	2	1.5
c. Readability	2	2	2
d. Confidence	2	2	2
6. 50 nm Range Rings			
a. Utility	2	1.5	1.5
b. Readability	1	1.5	2
7. Storm Height Information			
a. Utility	2	2	2
b. Reliability	2	2	2
c. Readability	2	2	2
d. Confidence	2	2	2
8. Echo Speed Values			
a. Utility	2	2	2
b. Reliability	2	2	2
c. Readability	2	2	2
d. Confidence	2	2	2
9. ARTCC Boundary Overlays			
a. Utility	2	2	1
b. Readability	2	1	1
10. ARTCC Map			
a. Utility	2	2	1
b. Readability	2	1	1

TABLE 3. MEDIAN RANKINGS ON UTILITY, READABILITY, RELIABILITY, AND CONFIDENCE PER COMPONENT/FEATURE BY INDIVIDUAL AIRLINE DISPATCHERS (CONTINUED)

Component/Feature	Delta Airlines (N=16)	Northwest Airlines (N=9)	Atlantic Coast Airlines (N=3)
11. Views (National, Eastern, et al)			
a. Utility	2	2	3
b. Readability	2	2	3
12. Regional Views			
a. Utility	2	2	2
b. Readability	2	2	2
13. Navigation Between Views	2	2	3
14. Product Update Rate	2	3	2

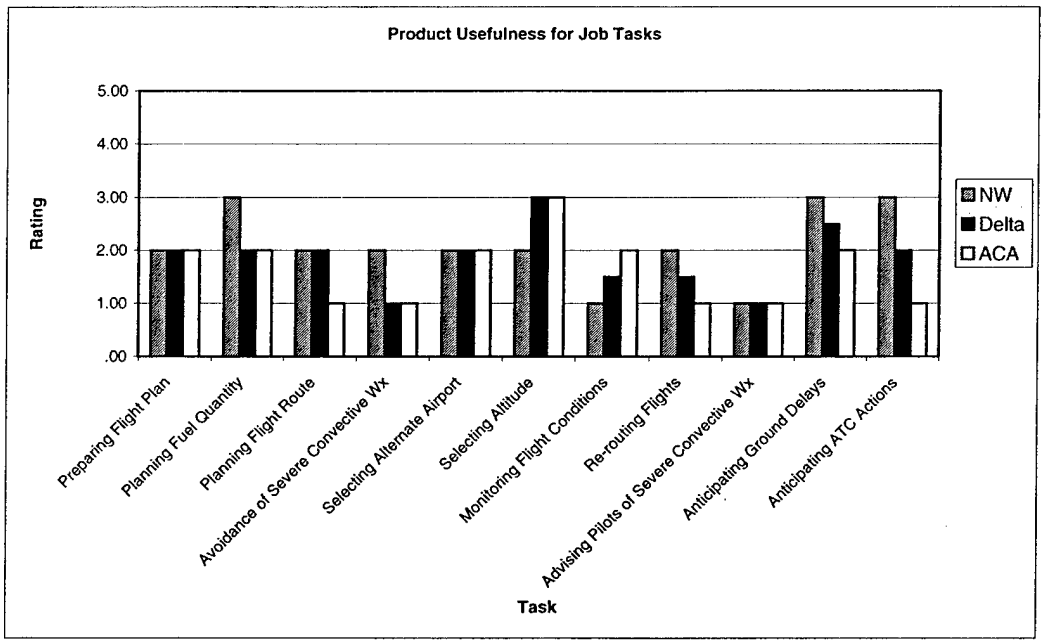

FIGURE 3. PRODUCT USEFULNESS FOR JOB TASKS

5.1.3 Northwest Airlines Questionnaire Results.

Results from the Northwest questionnaire were similar to Delta's. In the first section, almost all Product interface components of the NCWF were rated positively receiving rating scores of 2 (acceptable) or higher. Utility and readability of the 50-nmi range rings received the highest positive rating score of 1.5. Acceptability of the NCWF Product update rate, however, received an overall borderline rating of 3.

5.1.3.1 Product Improvements.

Most comments addressed the need for additional display identifiers and overlays for jet routes, navigational aids (navaids), fixes, cities, VORs, and other geographical features such as roads and rail lines. One suggested overlaying the NCWF Product on the current Aircraft Situation Display (ASD) which already provides this information.

User selected zoom and animation capabilities were also suggested as well as the need for a longer forecast time – up to 4 hours for flight planning purposes. The capability to filter out selected levels on the 6-level color intensity scale; i.e., allowing the user to filter out convective levels of 1 - 3 and displaying levels 4 - 6, was also suggested.

Northwest questionnaire comment summaries on Product improvements are located in appendix B.

5.1.3.2 Product Usefulness.

Product usefulness was rated highest (1) for two tasks:

a. Monitoring flight conditions, and
b. Advising pilots enroute of severe convective weather

Five other task areas received positive usefulness ratings (somewhat useful) and include:

a. Planning flight routes
b. Rerouting flights
c. Avoidance of severe convective weather
d. Selecting alternate airports, and
e. Selecting altitudes

Three task areas, however, received borderline usefulness ratings, indicating the Product had neither a positive nor negative effect on the task. These included:

a. Planning fuel quantity
b. Anticipating ground delays, and
c. Anticipating ATC actions

A bar chart depicting Northwest Airlines Product usefulness ratings along with Delta's and Atlantic Coast's are provided in figure 3.

5.1.4 Atlantic Coast Airlines Questionnaire Results.

Results from the Atlantic Coast Airlines (ACA) questionnaire were mostly positive. However, given the small sample size (N = 3), results cannot be considered significant.

In the first section, almost all Product components and interfaces received positive rating scores of 2 (acceptable) or higher. Approximately 40 percent of these were rated largely acceptable on all Product component dimensions scoring 1.5 and above. Dimensions of the components rated highest included:

a. Utility and readability of the convective intensity color scale
b. Utility of the forecast contours, and
c. Utility and readability of the ARTCC maps

Utility and readability of the main views; i.e., National, Eastern, and Southern received borderline ratings. Acceptability of Product navigation was also considered borderline.

5.1.4.1 Product Improvements.

Overall, easier navigation between Product views was suggested. Need for a longer forecast duration, 2 to 4 hours, was also noted. Product improvement summaries are located in appendix B.

5.1.4.2 Product Usefulness.

Product usefulness was rated highest in five of the identified task areas. These are listed below.

a. Planning flight routes
b. Avoidance of severe convective weather
c. Rerouting flights
d. Advising pilots enroute of severe convective weather
e. Anticipating ATC actions.

With the exception of the borderline rating for the "selecting altitude" task, all other tasks received positive usefulness ratings (2). A bar chart depicting Atlantic Coast Airlines Product usefulness ratings along with Delta's and Northwest's are provided in figure 3.

5.2 STRUCTURED INTERVIEW RESULTS.

Structured interview questions focused on Product use; comparisons to other convective weather information sources; perceived value added to operations effected by convective weather; usefulness of Product components; and scenarios where the Product did or did not perform well. Comments on Product enhancements concerning forecast time requirements and animation capabilities were also solicited. Additional comments on Product improvements are also included in these summaries and may be referenced in appendix C.

5.2.1 Delta Airline Interview Results.

ACT-320 conducted 17 individual interviews at Delta's Operational Control Center in the operational dispatch area. Results are summarized according to interview question.

1. Did you use the NCWF Product?

Most respondents (15) had used the NCWF Product to some extent. Factors affecting why the Product was not used extensively included comparatively few instances of severe convective weather and little or no awareness of the Product itself.

2. How did the NCWF compare to other convective weather products?

Many users (7) compared the Product to the current Weather Information Dissemination Service (WIDS) display. Although Product update times were viewed favorably, the Product's inability to zoom and provide animation was noted. At least six respondents compared the NCWF Product favorably to other convective weather sources. One noted that it provided a better definition of convective areas than Convective SIGMETs.

3. Did the NCWF Product add value?

Most dispatchers (13) indicated the Product did add value in performance of duties affected by convective weather adding the graphical projection was useful information. Three indicated the Product added no value due to insufficient forecast duration (a 1-hour forecast was considered inadequate for planning purposes) and lack of confidence in Product accuracy.

4. Did Product use save time?

Several dispatchers (8) stated that NCWF Product use did not save them time. However, they felt that timesaving was not as important as information accuracy.

5. What NCWF Product components were most useful?

Components found most useful included the 1-hour forecast capability and echo speed information.

6. Describe typical situations, if any, where the NCWF Product and/or its components performed well.

At least eight dispatchers could not recall instances where the NCWF Product did or did not perform well. One positive Product scenario involved a pilot holding over a fix due to severe convective weather activity. By using the NCWF, the dispatcher reported seeing a "window of opportunity" and could see the storm was moving off. The aircraft successfully flew through without diverting and refueling. Another scenario, received over the Product comment daily log, reported that "the algorithm nailed the progress (thunderstorms) perfectly and its guidance allowed me to make the correct decision with regard to the operational control of my flight."

7. Describe typical situations, if any, where the NCWF Product and/or its components performed poorly.

Again, most interviewed could not recall specific Product performance scenarios. One respondent cited an instance where a storm was forecast to move south, but actually moved east. Another reported a line moving south to Chattanooga was not detected at all. It was also noted the Product performed well in clearly defined frontal situations but not with air mass thunderstorms.

8. Would Product animation add more value? Would a longer forecast time be preferable?

All dispatchers agreed that animation and longer forecast durations would be beneficial. All were aware that given a longer forecast duration, degradation in accuracy may be an issue. Although difficult to measure, many agreed that degradation over 50 percent would not be acceptable.

9. Additional Suggestions for Improvement

a. Provide individual zoom capability at a user selected area.
b. Include animation for trending.
c. Include annotated speed of the storm tops.
d. Integrate the forecast component with the ASD display for a bigger picture, thereby negating the need for mentally overlaying geographic identifiers, radar locations, and aircraft positions.

Delta Interview comment summaries may be referenced in appendix C.

5.2.2 Northwest Airlines Interview Results.

Seven users, including dispatchers and dispatch coordinators were interviewed. Interviews took place in the dispatch operations area. A brief summary is discussed after each interview question in italics below.

1. Did you use the NCWF Product?

Most dispatchers (5) reported using the Product minimally, or looking at it nonoperationally. Generally, this was attributed to a lack of significant convective weather and lack of confidence in the Product's accuracy. Two dispatch coordinators, however, reported extensive operational NCWF Product use for tasks involving Collaborative Decision Making (CDM), fuel planning, and rerouting.

2. How did the NCWF Product compare to other convective weather products?

Comparisons to other weather Products were divided. NCWF was compared mostly to the ASD, which contains location identifiers, aircraft positions, and current animated radar information. Suggestions for combining the two were often noted. One dispatcher noted that he had been mentally drawing the forecast lines for years and found the NCWF Product very effective. Conversely, another dispatcher stated the Product was worthless and compares poorly to current radars, Airline Dispatch Federation (ADF) website information, and composite radar and satellite displays.

3. Did the NCWF Product add value?

Most dispatchers (5) agreed the NCWF Product had value – or could potentially add value to current dispatch operations. One dispatcher indicated the Product would not add value and another could not comment on this question.

4. Did Product use save time?

Three dispatchers reported the Product has the potential to save time although they did not experience any timesaving. One dispatcher noted it would not save time, whereas the remaining dispatchers (3) felt they could not respond to this question.

5. What NCWF Product components were most useful?

Overall, the forecast component was found most useful.

6. Describe typical situations, if any, where the NCWF Product and/or its components performed well.

Two dispatchers reported specific instances where the Product performed well. In one instance thunderstorms had developed along a route from Minneapolis to Sioux Falls and was tracking northward. By using the information from the NCWF forecast polygons, the dispatcher could effect shortcuts by routing flights south of Sioux Falls. The forecast was accurate, and aircraft were able to get through. In another scenario, a dispatch coordinator reported thunderstorms were impacting the Western routes from Minneapolis. By using the NCWF, he was able to anticipate ATC actions and plan reroutes.

7. Describe typical situations, if any, where the NCWF Product and/or its components performed poorly.

One dispatcher commented that in some instances, cell development was not displayed even though significant convective activity was present. Two dispatchers indicated that lack of growth and decay capability was a serious limitation to the Product.

8. Would Product animation add more value?

All dispatchers interviewed reported that animation would be beneficial in order to see trending.

9. Would a longer forecast time be preferable?

All dispatchers interviewed agreed that a longer forecast time would be preferable with a minimum duration of 2 hours. Degradation in accuracy would be acceptable if the degree of accuracy were known.

10. Additional Suggestions for Improvement

a. Prediction of thunderstorm movement with a high degree of probability.
b. Longer forecasts – up to 3 hours.
c. Addition of a growth and decay component.
d. Provide user selected zoom capability.
e. Overlay aviation identifiers such as, navigational aids (NAVAIDS), aircraft position and jetways as well as geographical locators as displayed on the ASD. Allow user to toggle overlays on and off.
f. Overlay the Product forecast component on the existing ASD.
g. Provide consistent symbology with other weather systems.
h. Display instability and weather fronts.
i. Ensure Product annotations (speed and tops) do not obscure weather depictions.

Northwest interview summaries are located in appendix C.

5.2.3 Atlantic Coast Airlines Interview Results.

Six dispatchers were interviewed at the Atlantic Coast Airlines dispatch operations center. Comments are summarized below under each corresponding question. See appendix C for all interview question responses.

1. Did you use the NCWF Product?

All six dispatchers reported using the NCWF Product operationally. It was noted, however, that Product inaccessibility was an issue. One dispatcher reported using the NCWF for short haul flights, especially in the Northeast corridor, where it helped to see where convective weather would be impacting in an hour.

2. How did the NCWF compare to other convective weather products?

Most dispatchers viewed the forecast component of the NCWF Product as another convective weather information source used in conjunction with available weather sources such as terminal aerodrome forecasts (TAF), radar, and National Weather Service (NWS) briefings. Some reported the forecast helped with the guesswork and allowed them to see a bigger weather picture.

3. Did the NCWF Product add value?

All dispatchers interviewed agreed the NCWF Product had value – or could potentially add value to current dispatch operations. Potential value areas included safety, planning, and increased revenues.

4. Did Product use save time?

Two dispatchers reported the Product had saved time operationally. One stated it had the potential to save time after extended use. Another noted that when NCWF Product confidence increases, so will timesavings. Two dispatchers did not comment on this question.

5. What NCWF Product components were most useful?

Overall, the forecast component was found most useful.

6. Describe typical situations, if any, where the NCWF Product and/or its components performed well.

One dispatcher noted the NCWF seemed to work best when there was a solid line of thunderstorms. In one scenario, storms from Canada to North Carolina were cutting off the Northern routes. The NCWF displayed gaps in the lines large enough for aircraft to fly through. This information was also useful for coordination activities with the Air Traffic Control System Command Center (ATCSCC). Planning was more proactive (5 minutes versus 1 hour ahead). Another dispatcher reported thunderstorms developing Northwest from Cleveland through the Pittsburgh area and moving south. Although the radar animation helped gauge storm movement, the NCWF was more specific in identifying locations and helped in making better routing decisions.

7. Describe typical situations, if any, where the NCWF Product and/or its components performed poorly.

Although specific instances were not recalled, some noted the algorithm did not pick up isolated cells and missed smaller storms identified by the ASD.

8. Would NCWF Product animation add more value?

All dispatchers interviewed reported that animation would be beneficial in order to see trending.

9. Would a longer forecast time be preferable?

All dispatchers interviewed agreed that a longer forecast time would be preferable with a minimum duration of 2 hours. Degradation in accuracy of 30 – 40 percent would be acceptable for a 4- to 6-hour forecast.

10. Additional Suggestions for Improvement

The following suggestions for improvement were mentioned during the course of the interview and noted below:

a. Overlay the NCWF forecast component on the ASD,
b. Provide annotated cloud heights information,
c. Provide 1- to 2-hour animations for trending,
d. Allow user selected zoom capability,
e. Incorporate lightning data as a separate component.

6. CONCLUSIONS.

With few exceptions, overall feedback from participating dispatchers was positive and overall ratings between airlines were consistent. A summary of results from the 1998 National Convective Weather Forecast (NCWF) Summer Demonstration, corresponding to each of the stated Demonstration objectives (*in italics*), are discussed below.

1. Does the NCWF Product add value to identifying and forecasting areas of convective weather activity?

When asked directly about Product value, most dispatchers agreed the NCWF Product had the potential to add value in identifying and forecasting areas of convective weather activity. The tendency to state "potential value" as opposed to "actual value" was based on infrequency of use and confidence in the accuracy of the detections and forecast. Until confidence is gained, dispatchers are generally reluctant to rely on information from an experimental source.

Additionally, most reports on positive NCWF Product performance indicated the Product enabled the dispatcher, on some occasions, to see breaks within a line of thunderstorms, enabling them to fly planes through instead of rerouting. This is also indicated via the high usefulness ratings in tasks involving (1) advising pilots enroute of severe convective weather, and (2) flight monitoring.

2. Does the NCWF Product benefit tasks and decisions affected by convective weather activity?

Based on questionnaire data relating Product usefulness to job task performance overall, the Product received positive to very positive ratings. Product usefulness was rated highest (of considerable use) in 5 of the 11 task areas:

a. Advising pilots enroute of severe convective weather,
b. Avoidance of severe convective weather,
c. Routing flights,
d. Planning the flight route,
e. Monitoring flight conditions.

Conversely, NCWF Product usefulness was rated borderline overall in three task areas:

a. Selecting alternate airports,
b. Anticipating ground delays,
c. Anticipating air traffic control (ATC) actions.

The borderline rating indicates the NCWF Product had neither a positive nor negative effect in the performance of these tasks.

The remaining four task areas received positive usefulness ratings and included:

a. Preparing flight plans,
b. Planning fuel quantity,
c. Selecting altitude,
d. Anticipating ATC actions.

Again, results indicate the NCWF Product is useful in performing these tasks.

3. How well does the Product perform? Under what situations does the Product perform well or not perform well?

Most dispatchers reported the Product performed well. This was particularly true during well-defined frontal situations. Positive Product performance was also indicated by the positive confidence ratings from questionnaire data on Product components such as initial detection and forecast contours.

Reports of poor Product performance centered on the NCWF's occasional inability to detect and track some storms such as air mass thunderstorms and incorrectly display storm movement. Absence of a growth and decay component and longer forecast durations were also considered Product limitations.

4. How can the Product be enhanced? What improvements or changes would this necessitate?

Although many suggestions for improvements or changes were suggested, the following represent items reported most often:

a. Animation – The capability to loop images from 1 to 2 hours to see weather trends was expressed by almost all dispatchers in both interview and questionnaire responses.

b. User selected zoom function – Most dispatchers indicated the need for better zoom capability and considered available Product views too limited. This was reported in both open-ended questionnaire responses and during interview sessions.

c. Longer forecast duration – Most dispatchers considered the 1-hour forecast insufficient. Flight plans must be issued to the pilot at least 1 hour or more prior to takeoff. A 1-hour forecast, therefore, is inadequate for flight planning considerations. However, based on questionnaire responses, the Product did receive overall positive usefulness ratings for preparing flight plans and planning flight routes.

d. Growth and decay component – Since offset and onset of weather is of particular interest to dispatchers for flight planning, this would augment and enhance overall perceived performance of the NCWF. Some dispatchers noted that offset of weather was of particular value for dispatcher planning purposes. Knowing when and where a storm will dissipate was viewed as more critical than knowing where it will develop.

e. Overlays – The NCWF was often compared to the aircraft situation display (ASD), which is used extensively for flight monitoring and identifying current weather. The ASD overlays consist of geographical locators and identifiers such as airports, very high frequency omni-range radars (VOR), arrival/departure gates, and airplane locations. These types of overlays, if user selected, would obviate the need for dispatchers to mentally overlay identifiers.

5. Is a 1-hour forecast Product adequate for airline users' needs?

As noted above, the 1- hour forecast is not adequate for dispatcher planning purposes. Degradation in forecast accuracy was acceptable as long as it did not exceed 50 percent and accuracy constraints were understood; i.e., the user is aware of lower accuracy thresholds as the forecast is extended. A 3-6 hour forecast was preferred overall.

6. Are Product interfaces and characteristics operationally acceptable?

Based on questionnaire rating data, overall Product interfaces such as: readability and utility of color scales; detection fields; forecast contours; overlays; views; navigation; and update rates were rated positively (acceptable to largely acceptable). However, some comments from open ended questionnaire questions and interview questions indicated that navigation between views could be simplified, additional overlays and information are needed, and care should be taken not to obscure weather data with echo speed and height information. Update rates were also criticized as being too long. Although Product views were rated positively, many reported the Air Route Traffic Control Center (ARTCC) and Regional views were inadequate for monitoring and planning flights, indicating the need for a user selected zoom capability.

7. RECOMMENDATIONS.

a. Ensure training is consistent and across the board by employing "train the trainer" methodologies to reach a larger population. Although use of the National Convective Weather Forecast (NCWF) Product was intuitive, knowledge of its capabilities and limitations may have increased Product use overall.

b. Emphasis should be placed on future Product improvements based on suggestions reported and discussed in section 6. These include:

1. Animation,
2. User selected zoom function,
3. Longer forecast durations (3-6 hours),
4. Growth and decay component,
5. Additional overlays and geographical identifiers.

Additions of any or all of these components may enhance the Product's overall usefulness in meeting dispatch requirements for an automated, graphical, convective, forecast and detection tool.

c. Additional research is recommended to increase performance under certain conditions; particularly when storms are not well defined or when air mass thunderstorms are present.

d. Given the total number of dispatchers (approximately 300) at the three participating airlines, overall response was poor. Methods for increasing participation of users should be researched.

8. ACRONYMS.

ACA	-	Atlantic Coast Airlines
ACSF	-	Automated Convective SIGMET Forecast
ADF	-	Aviation Dispatch Federation
AP	-	Anomalous Propagation
ASD	-	Aircraft Situation Display
ARTCC	-	Air Route Traffic Control Center
ATC	-	Air Traffic Control
ATCSCC	-	Air Traffic Control System Command Center
AWC	-	Aviation Weather Center
AWR	-	Aviation Weather Research
CDM	-	Collaborative Decision Making
MDV	-	Meteorological Data Volume (NCAR internal)
MIT/LL	-	Massachusetts Institute of Technology/Lincoln Labs
NAVAIDS	-	navigational aids
NCAR	-	National Center for Atmospheric Research
NCWF	-	National Convective Weather Forecast
NLDN	-	National Lightning Detection Network
nmi	-	nautical miles
NSSL	-	National Severe Storms Laboratory
NWS	-	National Weather Service
SPDB	-	SYMPROD database (NCAR internal)
TAF	-	Terminal Aerodrome Forecast
WIDS	-	Weather Information Dissemination Service
VIL	-	Vertically Integrated Liquid
VOR	-	Very High Frequency Omni-Range

APPENDIX A

DISPATCHER QUESTIONNAIRE

1998 NATIONAL CONVECTIVE WEATHER FORECAST DEMONSTRATION

DISPATCHER QUESTIONNAIRE

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Please provide the following information:

Airline:_____ Title:_____

Please check or indicate the dispatch area you cover

Long Haul____ Short Haul____ Other_____

Instructions

The purpose of this questionnaire is to obtain feedback from airline dispatchers regarding the National Convective Weather Forecast (NCWF) Product. The demonstration of the NCWF Product is being conducted by the National Center for Atmospheric Research (NCAR) with the assistance of the FAA's William J. Hughes Technical Center.

Feedback from dispatchers is a very important component of the demonstration, and your responses to this questionnaire will provide important information for use in future iterations of the NCWF Product. Please respond to all questions as honestly and thoroughly as possible.

All responses will remain ANONYMOUS and CONFIDENTIAL. A report will be written on the results of this questionnaire, summarizing respondent's comments; however, no one will be identified or associated with any specific comment. **Please return the questionnaire to the FAA's Technical Center Evaluator.**

Rating Scale Definitions

The five-point scale below should be used to rate the National Convective Weather Forecast Product. The following definitions are provided for use when assessing the Product. Please refer to these definitions when responding. Feel free to tear out this page and keep it as a reference when answering questions. Also, for your reference, a color print of the NCWF Product display has been provided to aid in relating specific questions to the components of the display.

(1) Largely Acceptable - This response indicates the Product/component being assessed consistently enhances your ability to meet the requirements of your job; likely to lead to enhanced job performance.

(2) Acceptable - This response indicates the Product/component being assessed frequently enhances your ability to meet the requirements of your job; may lead to enhanced job performance.

(3) Borderline - This response indicates that, although the Product/component being assessed is adequate, minor improvements would make it more helpful in identifying and forecasting convective weather and does not degrade or improve job performance.

(4) Unacceptable - This response indicates the Product/component being assessed frequently impedes your ability to meet the requirements of your job: may lead to degradation of job performance.

(5) Largely Unacceptable - This response indicates the Product/component being assessed consistently impedes your ability to meet the requirements of your job; likely to lead to degradation of job performance.

NA - you have never used the Product/component in question.

Other Definitions

You will be asked to rate the Product and its components according to their Utility, Reliability, Readability, and Confidence. The following definitions should be considered when answering questions.

(1) Utility - The Product/ component is useful, meets job requirements and responsibilities, and aids in identifying and forecasting areas of convective weather;

(2) Reliability – The Product/components are consistently working without problems. Data is provided consistently;

(3) Readability - This refers to how readable or legible the Product or feature is (i.e. display clutter, font size, color-coding).

(4) Confidence – This refers to the degree of user confidence based on the Product's ability to detect and forecast convective weather areas.

Instructions: Please rate the National Convective Weather Forecast Product and its components by circling the appropriate number.

National Convective Weather Forecast Product	Largely Acceptable		Borderline		Largely Unacceptable	
1. Initial Detection Fields						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
c. Readability	1	2	3	4	5	NA
d. Confidence	1	2	3	4	5	NA
2. Convective Intensity Color Scale						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
c. Readability	1	2	3	4	5	NA
3. Detection Field Colors						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
4. Forecast Contours						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
c. Readability	1	2	3	4	5	NA
d. Confidence	1	2	3	4	5	NA
5. Forecast Direction Lines						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
c. Readability	1	2	3	4	5	NA
d. Confidence	1	2	3	4	5	NA
6. 50 nm Range Rings						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
7. Storm Height Information						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
c. Readability	1	2	3	4	5	NA
d. Confidence	1	2	3	4	5	NA

National Convective Weather Forecast Product	Largely Acceptable		Borderline Acceptable		Largely Unacceptable	
8. Echo Speed Values						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
c. Readability	1	2	3	4	5	NA
d. Confidence	1	2	3	4	5	NA
9. ARTCC Boundary Overlays						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
10. ARTCC Map						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
11. Views (National, Eastern, et al)						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
12. Regional Views						
a. Utility	1	2	3	4	5	NA
b. Reliability	1	2	3	4	5	NA
13. Navigation Between Views	1	2	3	4	5	NA
14. Product Update Rate	1	2	3	4	5	NA

15. List suggestions for improving any of the above Products, functions or displayed items. Please be sure to include the item name in the suggestion(s).

_____

_____

_____

_____

16. List other attributes or components that you think should be added to the National Convective Weather Forecast Product.

_____

_____

_____

_____

Product Usefulness for Job Tasks

Instructions: The five point scale below should be used to rank the usefulness of the National Convective Weather Forecast Product as related to convective weather, on each of the tasks listed. Please refer to these definitions when responding.

Rating Scale Definitions

1 – **Of Considerable Use**. This response indicates the NCWF Product had a significant positive effect on decisions and activities related to the performance of this task.

2 – **Somewhat Useful.** This response indicates the NCWF Product had a positive effect on decisions and activities related to the performance of the task.

3 – **Borderline**. This response indicates the NCWF Product had little to no effect on decisions and activities related to the performance of the task.

4 – **Of Little Use**. This response indicates the NCWF had a negative effect on decisions and activities related to the performance of the task.

5. –**Not at all Useful**. This response indicates the NCWF Product had a significant negative effect on decisions and activities related to the performance of the task.

NA – You have never used the Product in performing this task.

National Convective Weather Forecast Product	Of Considerable Use	Somewhat Useful	Borderline	Of Little Use	Not at all Useful	
17. Preparing flight plans.	1	2	3	4	5	NA
18. Planning fuel quantity.	1	2	3	4	5	NA
19. Planning flight route.	1	2	3	4	5	NA
20. Avoidance of severe convective weather.	1	2	3	4	5	NA
21. Selecting an alternate airport.	1	2	3	4	5	NA
22. Selecting altitude.	1	2	3	4	5	NA
23. Monitoring flight conditions.	1	2	3	4	5	NA
24. Re-routing flights.	1	2	3	4	5	NA
25. Advising pilots enroute of severe convective weather.	1	2	3	4	5	NA
26. Anticipating ground delays.	1	2	3	4	5	NA
27. Anticipating ATC actions (i.e. rerouting, closing runways, changing arrival gates)	1	2	3	4	5	NA
28. Other_____	1	2	3	4	5	NA

Thank you for your time and cooperation. Please mail completed questionnaires to:

Cynthia Fidalgo
Raytheon Systems Co.
500 Scarborough Drive #304
Egg Harbor Township, NJ 08405

APPENDIX B

QUESTIONNAIRE COMMENT RESULTS

Northwest, Delta, and Atlantic Coast Airlines (ACA) Questionnaire Responses - # 15 and 16

15. List suggestions for improving any of the above Products, functions or displayed items.

Airline	Response
Nortwest	State borders are nice but in trying to provide location information to pilots we speak in terms of jet routes, or distance from airport or navaid. Would like to be able to zoom to a specific location vs. a pre-set area or region.
Nortwest	Detection should include direction and speed of thunderstorm area. Echo tops should also be included.
Nortwest	Click and zoom function, buttons are cumbersome and increase update time. Nav data overlays need to be added (cities, VORs, jet airways).
Nortwest	ARTCC boundaries and maps need a more applicable basemap including navaids, fixes, airways, sectors as well as ARTCC boundaries and airports. Also the ability to select the above elements on/off would help.
Nortwest	Update rate needs to be improved greatly.
Nortwest	Timely to use in our present version that was available to me.
Nortwest	One hour forecasts are relatively of little value. Average NWA segment is 1:15. Average release is sent 2+ hours in advance. We need 3 hour forecast!
ACA	The viewer interface was difficult to use and made it hard to navigate to the information needed. Need to be able to zoom into selected areas for viewing.
ACA	Navigation between views could be simplified or defined better.
ACA	Maybe provide projections 2-4 hours in advance.
Delta	Would like to lightning detection separate so you can see them or overlay with + or - marks. 14. Need to be able to project movement of TRW -2/3/4 hrs.
Delta	Display very useful 8/9/98. Color change on display for forecast contours and speed/tops data made speed/tops unreadable.
Delta	Blank
Delta	Be able to zoom and loop images. Also, 1hr. is not acceptable for a forecasting tool. We need 4-6 hrs.
Delta	Font size could be larger. Direction arrows longer.
Delta	I would like to further enlarge areas of convective activity. There should be additional airport zooms CX NYC area, ATC, DCA area.
Delta	We should be able to zoom in and out.
Delta	Extend forecast range on separate view to 2 or 3 hours.
Delta	When it updates, I do not like the way it updates the US map and displays it, then it goes to whatever you have selected and updates that map.
Delta	Loop current returns and project out 4 to 6 hrs. To help with long haul planning. Show areas diminishing as they do.
Delta	The display of storm height information and echo speed values does not conform to convential displays normally used with this information. This is initially confusing. Perhaps adding the identifiers "MT xxx" and "xxkts" would make the nature of these val
Delta	Need looping to re-enforce the confidence level in the forecast. ie time lapse.

16. List other attributes or components that you think should be added to the NCWF Product

Airline	Response
Nortwest	The NCWF components should be incorporated into the existing ASD data provided in-house. Use ASD as the foundation and NCWF as an overlay.
Nortwest	Capability of filtering out selected levels at the 6-level intensity scale. ARTCC boundaries should be in a different color than the base-map for readability. ARTCC's should be labeled with their respective identifiers. Note: Overall, this forecast Product has the potential to improve aircraft route selection, reduce fuel usage, and improve ETAs.
Nortwest	Growth and decay logic. Quicker display time. 20 mins for algorithm to forecast new level 3 is a long time. Forecast lines should go past 60 minutes.
Nortwest	Additional time frames: 0 – 30 or 0 – 1:30 would help. Also an animated sequence of say every ½ hour from 1:30 thru + 1:30. The same could be done with the use of different colored lines for past and forecast conditions.
Nortwest	Ability to overlay surface maps (roads, rail, geographical features, etc.)
ACA	Distance and azimuth tool.
Delta	I would like radar improvement to GFF because I want radar in relation to aircraft.
Delta	Expand geographic area to SE/NE/NW/SW would like to see zoom feature on all displays. Would like additional cities available for display with ability to tailor display if additional cities unable to be accommodated on current screen.
Delta	Possible zoom feature all views.
Delta	I would like to see additional cities on base MAP views CX BDL - PWM - HAR - RIC Etc.
Delta	User defined areas, winter weather format.
Delta	3 Hr. forecast position, Looping option, zoom capability and /or customize area. Integration with out graphic flight following.
Delta	Add icing/frzlvl from data in NCARs sys, i.e.: Boundary the area in a different color and put a number indicating frzlvl and top of frz area add more airport zooms.
Delta	Great Product - thanks! I have been very impressed with how well the algorithm handles air mass convection.
Delta	Just an idea – incorporating PIREPS and forecast turbulence outside of the immediately vicinity of the TSTMS. Example - light scalloped area indicating area most likely to contain turbulence associated with cirrus blow off. Useful for best deviations.

APPENDIX C

STRUCTURED INTERVIEW QUESTIONS

Interview Questions for the National Convective Weather Forecast Product Demonstration

1. Did you use the Product for identification and forecasting of convective weather areas? Please explain why or why not.

2. How did the NCWF information compare to other convective weather information sources?

3. Did the Product add value in performance of your duties effected by convective weather?

4. Did Product use save time?

5. What Product components, if any, did you find most useful? Why?

6. Describe typical situations, if any, where the Product and/or its components performed well.

7. Describe typical situations, if any, where the Product and/or its components performed poorly.

8. Would Product animation add more value?

9. Would a longer forecast time be preferable?

    - For your needs, what would be the ideal forecast time?

10. What degree of accuracy is required for a 2 or more hour forecast Product? i.e.: would a 2 hour forecast have to be as accurate as a 1 hour forecast?

    - What amount of degradation in forecast accuracy would be acceptable for the following forecast times?

    2 hour forecast - 10%___ 20%____ 30% ____ 40%____ 50%___

    4 hour forecast - 10%___ 20%____ 30% ____ 40%____ 50%___

    6 hour forecast - 10%___ 20%____ 30% ____ 40%____ 50%___

APPENDIX D

STRUCTURED INTERVIEW SUMMARIES

INTERVIEW RESPONSES – NORTHWEST, DELTA AND ATLANTIC COAST AIRLINES (ACA)

1. Did you use the product for identification and forecasting of convective weather areas? Please explain why or why not.

Airline	Response
Delta	Have not looked at it yet.
Delta	Not used - knew it was here, but did not use. Wanted to wait until it was fine tuned. Would be nice to filter out level 1 and 2.
Delta	Used it. - but data was 4 hours old. Did not use much after that. A few times.
Delta	Uses it - Almost always up.
Delta	Use when convective wx present - use quite often.
Delta	Yes. 3 or 4 days used forecast contours.
Delta	Yes - Occasionally used once - mostly looked at.
Delta	Use everyday - like looking ahead.
Delta	Used occasionally - sometimes looks at.
Delta	Used often - generally up.
Delta	Used for 1 Week.
Delta	Used 5x - Used to see projections for TSs - 1hr ahead.
Delta	Used quite a bit - Make font bigger.
Delta	Uses all the time - helps with holding, anticipating holding - wx at fixes anticipated ATS action. Would like to see: Customize picture, zoom on cities, include zoom box. Can see breaks in relation to position for pilot. Better than pilot's radar.
Delta	Uses product all the time. Problem: Need zoom - area I am interested in. Box to zoom in on. Can customize zoom. Can't see picture of all Ts activity. Need to manipulate display too much. Need to use slider. Would like full view of display. Save f
Delta	Use every day - Helps in planning has become dependent on it. Aids in decision making.
Delta	Used it - Almost everyday when had wx is present.
ACA	Used but not as much as the ASD display. Did use during diverse weather to see where its forecasting storms to be.
ACA	Used to see where weather will be for flights, however, not used that much.
ACA	Used operationally to get a better feel for convective activity, I.e. cells impacting NYC, Newark. However product was not easily accessible.
ACA	Used quite a bit - operationally. Since flights are generally short it helps to see where the weather will be in an hour - especially the Northeast corridor. The forecast seems accurate based on overlaying printouts of the product over radar one hour la
ACA	Used it mostly for identification of convective weather. Would be more useful if overlaid on the ASD display. Like to see big picture.
ACA	Used quite a bit - whenever there was convective activity. Its one tool I reference.
Northwest	Looked at it but not used operationally. Did not see it until the end of the convective season for 4 or 5 days. Used other information sources.
Northwest	Used very little. Uses weather animation via Northwest's intranet. Meteorologists at Northwest make adjustments and can see movement on product.
Northwest	Used as ATC coordinator but not in operations as a dispatcher. Also analyzed as a dispatcher (not operationally).

1. Did you use the product for identification and forecasting of convective weather areas? Please explain why or why not.

Airline	Response
Northwest	Used a lot operationally for coordinating routes, CDM, and in conjunction with ASD.
Northwest	Didn't use much.
Northwest	Used occassionally - great product and good start for a convective product. Problem: needs to predict thunderstoem movement with a high degree of probability. Need 2-3 hour forecast with high degree of accuracy. If less accurate, then product won't be
Northwest	Used operationally to suggest routes to ATC out of Minneapolis and Detroit. Also used on severe weather telecons and the Command Denter. Sent information to other dispatchers for rerouting and added fuel planning.

2. How did the NCWF information compare to other convective weather information sources?

Airline	Response
Delta	Not exceptional - on a par.
Delta	NA - does not zoom - wants ind-zoom. Does not zoom in on Atlanta Airport. Delta really needs that kind of zoom.
Delta	No conclusion - 1 hour legs on flights. Uses WSI w/loop, likes Tops information (5).
Delta	Likes Timelines, Accuracy and Forecast Plot.
Delta	Viable tool as far as convective product - better definition than SIGMET. Not easily accessible. Will click bookmark. Once bookmark mastered, got it made.
Delta	Uses WIDs too - 1 hour prod more reliable. NCWF always updates, however, can't get big picture to look for hole. WIDs opens up more to see where you can get through.
Delta	Another input device WIDs has bigger picture. Can blow up WIDs to area I am looking at.
Delta	Can also loop for trend on WIDs but w/ looping you can't tell when it will grow or dissipate. Upper air charts lifted index but likes how NCWF draws where position will be Delta met dept.
Delta	Prefers WIDs because of animation and zoom. Met chart. NCWF limited showing where wx is. Would like to point and click. Would like to zoom in and out. Not used enough to check on reliability.
Delta	Doesn't trend - no loop.
Delta	More current than WIDs. - Likes tops and speed.
Delta	Likes WDDs better - look is better - darker background - uses more often. Would like lightning data, zoom feature. Would like GFF to have better radar.
Delta	Like forecast area - good indication - pretty accurate.
Delta	More up to date - updates faster. Better more accurate, delineates storm better. Other data old. Intellicast not as clear cut as NCWF but easier to read. Chicago clear W and E needed to click between views to see whole picture.
Delta	No comparison - Great - Likes heights and movement. Would like simple extrapolation based on 15 min. animated increments.
Delta	Resolution not as good as WDDs - but not as important.
Delta	Likes Centers.
ACA	The forecast is the biggest asset. Composite and NEXRAD radar are used but I can't see all the factors. The NCWF allows that and I can get a real world picture - not just the radar. Used with all other tools for the big picture.
ACA	NCWF was used for the forecast. Used composite and NEXRAD radars for detection.
ACA	Takes one step further. Can see looping on the radar screens. NCWF does the guessing for me.
ACA	Nothing else projects. Can actually see where weather will be in 1 hour. The TAF doesn't show convection.
ACA	SIGMETs are text only and difficult to visualize. If availbe it would be used more than other products like the NWS briefings and SIGMETs. Good tool to have for a quick look and in addition to information sources already there.
ACA	Only tool we have that forecasts thunerstorm movement. Sometimes use the ATA website and CDM products. These seemed accurate.
Northwest	Other products are more accessible and easier to use. Like to use the ASD display the most which has locator identifiers making it easier to describe locations to the crew, I.e. cells are 131 miles west of Abalene and 130 miles east of Abalene. With ASD
Northwest	Likes Northwests product weather animation for trending.
Northwest	Nothing compares to it (except ITWS). A unique product. Have been mentally drawing cyan forecast lines for years. A pre-tactical

2. How did the NCWF information compare to other convective weather information sources?

Airline	Response
	event horizon tool. Helps dispatcher to know beyond the radar on an airplane - ideal for dispatch. Most effective for sho
Northwest	Totally different (except for ITWS). Nice visual tool.
Northwest	Found it worthlesss. Operationally it was not worth while. Current radars are best for short hauls. Uses the ADF website for weather information. What is needed is knowing where thunderstorms will be given a block of clean air. Also use composite rad
Northwest	Graphical display and forecast. Best in long haul area.Needs airway overlays - should be consistent in symbology with other products like TDWR. Shared consistency would support shared situational awareness - understand what AT is looking at. Also needs
Northwest	Would compare to the ASD and check forecast thunderstorm activity. Would mentally overlay on ASD. Internet problems were an issue as was accessibility.

3. Did the product add value in performance of your duties effected by convective weather?

Airline	Response
Delta	Has value - did not use.
Delta	Would add value if accurate and had longer forecast - not useful now for planning.
Delta	Did not add value.
Delta	Yes.
Delta	Yes. - gives close idea of where Wx will be. Same as WIDs - Loops w/ WIDS. Basic idea of what is going but no time frame.
Delta	Yes. Added value. Very informational. All information at once ie: tops, look at 1 picture to get information.
Delta	Yes - Added value - worked together with everything else. Liked tops and movement (not on WIDs) if under 20,000 ft. not a factor if over 50, - yes. W/air mass TS's, product can't keep up with them. More useful with frontal line.
Delta	Forecast doesn't help much on long haul.
Delta	Looks to see if it agrees with what is happening. Cross check - one prod validates another.
Delta	Does add value - esp. terminal environment. Plot within 5-10 min before landing.
Delta	Yes. Projection is helpful.
Delta	Somewhat
Delta	Definitely.
Delta	Yes.
Delta	Very usable, added value, speed and tops are hard to read.
Delta	Added value.
Delta	Adds value.
ACA	Adds value
ACA	Yes, even if it only helped once. As we continue to use it, it will add more value.
ACA	Helped to some degree. Better than radar picture.
ACA	Yes, adds value.
ACA	Yes it will. Can add value to safety and airline economics.
ACA	Yes, for decision making, go or no go. Another tool with radar summary and live radar.
Northwest	The product has value and is a good visual display. Would like to see the forecast projections overlaid on the ASD.
Northwest	Adds value for route planning and back-up information.
Northwest	The forecast adds the greatest value. Growth and decay is still an issue.
Northwest	There is added value. Better than a static display. Will compare to ASD to see if the route was impacted.
Northwest	No
Northwest	Yes

4. Did product use save time?

Airline	Response
Delta	No - Another tool
Delta	Time saving not important - What is important is more accurate data. Need accurate information for planning part of bigger picture.
Delta	No.
Delta	
Delta	Did not make any difference. Except did not have to decipher conv. sigmet did not need to plot. This product (NCWF) updates more readily.
Delta	Yes.
Delta	Yes - saved time. Liked tops, already, didn't have to look somewhere else.
Delta	
Delta	Yes - gives me progression of wx.
Delta	No.
Delta	Not really.
Delta	No.
Delta	Questionable - More important to get better information to crews.
Delta	Quick resource probably does save time - quick look.
Delta	No - but it gives me information I want. Integrated w/tops - Don't have to go to another product.
Delta	Did not save time but validated what I am looking at.
Delta	Time not issue - more correct information - better info to pilots. Would like to zoom - user selected.
ACA	N/A
ACA	Not now - maybe after I've used it longer and forecasts are longer.
ACA	N/A
ACA	Yes. Radar summary is "now". The product helps plan ahead. Pilots have been commenting on the excellent routing.
ACA	Yes, most definetely. This product alerts us to what's going on.
ACA	Could save time if I knew I could rely on it.
Northwest	N/A
Northwest	Potential to save time.
Northwest	
Northwest	Theoretically especially for an airport being effected - faster diversion recovery. Most helpful for decisions on avoidance.
Northwest	No
Northwest	Theoretically, yes

5. What product components, if any, did you find most useful? Why?

Airline	Response
Delta	Forecast - where web will be.
Delta	1 hour forecast (but not long enough) need animation.
Delta	Wind Speed.
Delta	
Delta	
Delta	Forecast contour tops.
Delta	Tops - need to use more updates good.
Delta	
Delta	Cyan forecast useful - stands out - away from wx. Can see. Wants to see Tops speed. (good info) annotation not covering wx. background color good.
Delta	Likes to compare to looping. Will trend continue.
Delta	User selected zooms overview - big picture.
Delta	For projection.
Delta	Forecast tops and speed and motion.
Delta	
Delta	Used RUC 12hr. convective outlook product - WSI up all of the time.
Delta	1 hour forecast tops not that important, like speed. Would like to see color change if switch in direction or speed.
Delta	50 nm min forecast. Likes integration of information. Doesn't like whole US to update - loses screen - would not mind if area he is looking at. Only forecast I have graphically others are verbal. Prefer not to look at different screens. WDDs picture
ACA	N/A
ACA	Forecast
ACA	User friendly. Tops information was not helpful, but it gave a feel for intensity.
ACA	Components the product has now are good. Could enhance it with animation and cloud heights information.
ACA	Forecast contours. Would like to correlate the Convective SIGMETs with the product, I.e. by number.
ACA	All current components are valuable. It could use user selected options and zoom capability.
Northwest	It anticipated the cell location in the forecast - nothing else.
Northwest	likes color differentiation, forecast capability, intensity and ability to hone in on smaller weather areas.
Northwest	Forecast component is most useful. Has no strong opinion on other product components.
Northwest	Forecast. All other components can be duplicated. Good pictorial view with timely, continuous updates. Ease of use an issues. Would like zoom capability like ITWS, ability to toggle lighting and navaids on and off, jet structure, fix structure and overlay
Northwest	The forecast component is something.
Northwest	Forecast component - but still need greater accuracy.
Northwest	Graphic presentation and forecast - also ability of stating one step ahead of thunderstorms for planning. Reliability in-house was the biggest problem.

6. Describe typical situations, if any, where the product and/or its components performed well.

Airline	Response
Delta	NA - Usually use WSI didn't want to bring it up a lot of clicking not easily accessible - not user friendly.
Delta	NA
Delta	No - Not looked at much.
Delta	Projected move West well. Gets severe stuff can see it plot along. Look at movement and tops.
Delta	No - Can't think of any.
Delta	Flight NY to Dallas. Wx was further back from line. Contours showed where wx would be in an hour. Could fly around it. Accurate portrayal of where it would be.
Delta	Can't answer since using both WIDs and it at same time when used, it was accurate.
Delta	
Delta	Not used enough.
Delta	Useful - 2 days ago. 4 flts no alternate. Useful to reroute - if moving would make a difference - was able to reroute given information. 3 flights went below. 1 went thru center.
Delta	Not really.
Delta	Transcon flight - an idea where to deviate.
Delta	In Atlanta. - Met report forecast T's. However, not on display. Confidence in getting planes in time.
Delta	Storms over field checked movement pilot holding over fix saw window of opportunity. Could tell them storm moving off. Did not need to divert and refuel.
Delta	Key hubstations for Atlanta, Birmingham, Montgomery and Chattanooga. Chicago - Denver Gulf area.
Delta	Helpful in frontal situation - Chicago - wave after wave of Ts. Not as helpful with air mass Ts
Delta	N/A
ACA	Best when there's a line of storms, I.e. storms from Canada to North Carolina were cutting off the northern routes. The NCWF forecast showed gaps to get planes through. Also helped in confirmation with the Command Center. I could plan 1 hour in advance
ACA	In Cleveland there was a solid line of thunderstorms through Ohio. Could see some gaps north and south. Got some planes through instead of cancelling flights.
ACA	Forecast was accurate - showed thunderstorm activity over the NY area and Eastern PA.
ACA	Was able to reroute planes through line of thunderstorms in NY state.
ACA	N/A
ACA	Convective weather developed northwest out of Cleveland through the Pittsburgh area. The line moved south. Looking at the radar trend was ok, but NCWF was more specific and I could make better routing decisions.
Northwest	N/A
Northwest	N/A
Northwest	N/A
Northwest	Good for field planning, I.e. knowing speed and direction of weather and whether extra gas is required. ASD used extensively to see where planes can get through - NCWF was limited in this capacity. Feel more comfortable using ASD with overlaid routes.

6. Describe typical situations, if any, where the product and/or its components performed well.

Airline	Response
Northwest	N/A
Northwest	Flight from Minneapolis to Sioux Falls - thunderstorms from Fargo to Aberdeen. The storm was tracking northward. Wutg the NCWF polygons, could effect short cuts by routing south of Sioux Falls. The polygons were right on. Other flights started following
Northwest	Thunderstorms were effecting the Western routes from Minneapolis, could plan ATC actions and able to plan reroutes. Have gotten positive feedback from dispatchers with information from NCWF.

7. Describe typical situations, if any, where the product and/or its components performed poorly.

Airline	Response
Delta	NA - Haven't seen.
Delta	NA
Delta	4 hours old of data.
Delta	No, never saw that. Prefer better zoom capabilities.
Delta	No - usually pretty accurate. Draws line around existing wx and move it mostly accurate - wind speed.
Delta	No problems.
Delta	No.
Delta	Prod was 90% off. Forecast south and went East. 1 hour to correct.
Delta	
Delta	Connected to 90% error (see previous).
Delta	No.
Delta	No.
Delta	No - Can't recall it not being accurate.
Delta	No. Line moving south to Chattanooga. Did not pick up all. But than it dissipated.
Delta	
Delta	
Delta	N/A
ACA	It only covers storms that cover a certain area. It doesn't pick up isoloated cells and misses smaller storms - which are picked up on the ASD.
ACA	N/A
ACA	Sometimes area of note is larger than radar detection - although product seemed accurate.
ACA	No.
ACA	N/A
ACA	Sometimes the product doesn't correspond to the radar depiction, even when weather is intense.
Northwest	N/A
Northwest	N/A
Northwest	N/A
Northwest	When used it seemed accurate enough for field planning - it took out a lot of clutter (level 3 and above) and helped unobscure weather. Internet reliability was a problem. Lack of growth and decay capability is a limitation. Sometimes it would appear
Northwest	N/A
Northwest	In some instances, no development was shown. Growth and decay is essential. Without it, degree of confidence is low.
Northwest	No

8. Would product animation add more value?

Airline	Response
Delta	Yes - Animation would be a necessity for history and trend.
Delta	Yes!! Without looping, useless, would like zooming.
Delta	Perhaps
Delta	Yes - but since it is forecasting, doesn't really need to. Would be nice.
Delta	Yes - works better, if could move blue forecast line would help.
Delta	Animation - Yes!!
Delta	Yes. How we get movement now - even if forecasting can relate to where forecasting to - could be used with frontal activity.
Delta	
Delta	
Delta	Yes.
Delta	Yes - helpful - give more idea of dir. may be redundant with projection.
Delta	Yes.
Delta	Yes - 3 hours back.
Delta	Yes - Takes a step further of where wx will go.
Delta	Yes. Would like ATC to use. Shared situational awareness.
Delta	Maybe confusing - don't know
Delta	Yes - animation - at least option - like to see building.
ACA	Yes, where it came from and where its going.
ACA	Yes, would be easier to see the direction and history - trending aspect.
ACA	Yes, would help.
ACA	Animation would be helpful - show trending.
ACA	Yes, would help show trends in the forecast.
ACA	Yes, would enhance visualization, especially if it could be toggled on and off.
Northwest	Yes, would also like to see zoom, jet routes, navaids, and an indication of how long before weather impacts an area. Future products should be 3 dimensional
Northwest	Yes, for trending.
Northwest	Yes with animation loops of 30 minutes, 1 hr and 1 1/2 hrs.
Northwest	Yes with 1/2 hour to hour loops.
Northwest	Animation would be helpful.
Northwest	Animation would be helpful for trend analysis.
Northwest	Yes, animation would be helpful.

9. Would a longer forecast time be preferable? - For your needs, what would be the ideal forecast time?

Airline	Response
Delta	Yes - 3 hours.
Delta	Yes - 6 hours
Delta	Yes possibly. - Could be useful - Maybe 2 hours.
Delta	Maybe OK for 1 hour - if hold together for 1 hour all you need.
Delta	Would like to see storms dissipating 2 hours.
Delta	Yes - 2 or 3 hours max.
Delta	For short haul, no (maybe 2 hours), For long - 4 hours.
Delta	Yes. 4, 5 or 6 hours. Effects routing. If not there could lighten load. Would like to know what will develop or what may develop for planning.
Delta	2-3 hours.
Delta	8 hours. Actually 4 hours would be good.
Delta	2 hours with same accuracy 4-6 understood not as accurate.
Delta	Up to 4 hours.
Delta	Yes - At least 2 hauls. Forecasts in different colors, ie. 2 hour in green and 4 hour red, etc..
Delta	May want longer forecast on separate page - not to compromise accuracy of 1 hour product. 3 hours or less.
Delta	Need 2 or 3 hour forecast, 5 would be preferable of areas airplanes can't get through.
Delta	2-3 hour forecast wants growth. - At least 2, more better.
Delta	3 hours.
ACA	Yes, a 4 hour graphical outlook would be better.
ACA	Forecast of 2 to 3 hours.
ACA	2 - 3 hours.
ACA	2 hours would be ideal. 1 hour is ok since we deal with hour block times. 2 hours would project into ground time.
ACA	Yes, 4-6 hours and planning and validation (comparing forecast to actual weather)
ACA	Yes, 2-3 hours.
Northwest	1 hour in inadequate. Forecast should go out to 6 hours given known degradation in accuracy.
Northwest	Longer forecast would be better with an estimated accuracy determinant.
Northwest	Forecast should be out to 2 hours. 2 or more hours would be good for stragetic decision making.
Northwest	2-3 hr. forecast would be ideal (most flights are 1 hr. 15 minutes.)
Northwest	Would be useful is the algorithm could predict risk factors, I.e. risk of convection in Fla. - can we get planes into Miami. Should provide a standard forecast so that everyone is thinking the same way.
Northwest	If we can see 2-3 hours out of NY it can make a huge difference. Can prepare for worst case scenarios.
Northwest	Yes, 2 hours.

10. What degree of accuracy is required for a 2 or more hour forecast product? What amount of forecast degradation would be acceptable for 2, 4, and a 6 hour forecast?

Airline	Response
Delta	Does not have to be accurate - just tell us what you are thinking. 2-30% 4-40% 6 - No more than 40%
Delta	2 - 20% 4 - 30% 6 - 40% no further.
Delta	2 - 10% 4 - 20% 6 - 30%
Delta	ATC is problem.
Delta	2 - 20% 4 - 20% 6 - 20%
Delta	Just use for idea, can't give % will accept accuracy will degrade. Really likes it!!
Delta	2 - 50% 4 - 25% 6 - NA - does not do long haul.
Delta	WIDS animation. Exceeds 1 hour on NCWF. Would like more g and d.
Delta	No more than 20% for 2 hour, 30% for 4 and for 6 "wary". Can already project an hour with trending.
Delta	Prefers 1 hour on short term with dead accuracy. Would like growth and decay.
Delta	10-15% degradation would be acceptable. Uses it with everything else.
Delta	20% - 2 20% - 4 20% - 6
Delta	Best you can do will accept.
Delta	25% - 2 hour 50% - 3 hour then 25% increments.
Delta	As long as updating, not an issue.
Delta	Loss of accuracy understood as long as it updates every hour whatever is better than what I have as long as there is a graphic
Delta	
ACA	If it matched with the radar loop, would use it to forecast along with the 4 hour outlook. Would like 50 - 55% accuracy for a 4 hour forecast.
ACA	2-3 hrs with 20% accuracy.

10. What degree of accuracy is required for a 2 or more hour forecast product? What amount of forecast degradation would be acceptable for 2, 4, and a 6 hour forecast?

Airline	Response
ACA	for 3-6 hours, 30 - 40% accuracy.
ACA	For 2 hours, 30%. 4 hours, 40%.
ACA	4-6 hours, 20 - 30%
ACA	10% degradation for every 1/2 hour forecast out.
Northwest	If known, degradation in accuracy out to 6 hours could be accepted. Allow the user to select the forecast range.
Northwest	
Northwest	
Northwest	Accuracy degradation is a known, but is better to have some basis for planning
Northwest	Anything for a convective outlook is valuable. Would like 4 hours out with 100% accuracy. Would also like a 3-D display.
Northwest	
Northwest	

APPENDIX E

DAILY USER LOG

Email Form

Questions and Comments

Use this page to send questions or comments to the **Development Group**. If applicable, please describe situations where the Product did or did not perform well.