INTEGRATED ICING FORECAST ALGORITHM ASSESSMENT

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1. INTRODUCTION

The Federal Aviation Administration (FAA) Aviation Weather Research Program (AWRP) has sponsored research and development activities aimed at providing timely and accurate in-flight icing detection and forecasting. As a result of these efforts, the Research Applications Program at the National Center for Atmospheric Research (NCAR/RAP) has developed the Integrated Icing Forecast Algorithm (IIFA). The IIFA combines several techniques that were used for diagnosing in-flight icing conditions and mimics them in a model-based forecast. The forecasts produce three-dimensional grids of Icing Potential, and Supercooled Large Drop (SLD) Potential.

In support of IIFA's development in 2002, the FAA William J. Hughes Technical Center Weather Processors and Sensors Group (ACB-630) performed a user assessment of the IIFA. The assessment examined the utility and benefit of IIFA to regional airline dispatchers and pilots. Two regional airlines participated in the study, Air Wisconsin supplied dispatchers from their Flight Operations Center and Sky West provided pilots. A usability study evaluated the extent to which the IIFA was used, valued, and supported pilot briefings and dispatch operations. Specific aspects of the study focused on: ease of use, ease of data display interpretation, value-added benefit, perceived mental workload, and perceptions of IIFA's accuracy and performance in detecting and forecasting icing. As part of the assessment, ACB-630 meteorologists reviewed IIFA on a daily basis to identify trends in model output and performance. In addition, user feedback provided indications of conditions where IIFA did and did not perform well. Any trends identified were further examined in regard to the underlying meteorological conditions. Assessment results will be used to identify potential enhancements to IIFA.

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2. PRODUCT DESCRIPTION

IIFA uses Rapid Update Cycle (RUC) predicted temperature, relative humidity, precipitation, and supercooled liquid water from the RUC microphysics package to identify areas of expected in-flight icing. The IIFA is completely model based and attempts to mimic the inputs of the Integrated Icing Diagnosis Algorithm (McDonough and Bernstein, 1999). Cloud top temperature is estimated for each grid point by finding the temperature at the highest altitude where relative humidity is 70% or higher. Cloud Base is estimated identifying the lowest altitude above the boundary layer where relative humidity is 80% or greater. Precipitation type is determined with a scheme used in the Eta model (Baldwin, et. al 1994).

IIFA output is displayed as horizontal plan views of Icing Potential and SLD Potential at flight levels ranging from 3,000 to 30,000 feet at 3,000-foot intervals, as well as a composite picture shown in Figure 1. Plan views are also available for the tops and bases of Icing Potential, SLD Potential, and clouds. IIFA output is available for 3-, 6-, 9-, and 12-hour forecasts. IIFA outputs are listed in Table 1.

Table 1. IIFA Outputs

1. 3-D grids of Icing Potential
2. 3-D grids of SLD Potential
3. 2-D grids of Cloud Bases and Tops
4. 2-D grids of Icing Bases and Tops
5. 2-D grids of SLD Bases and Tops

Figure 1: Sample of IIFA Composite

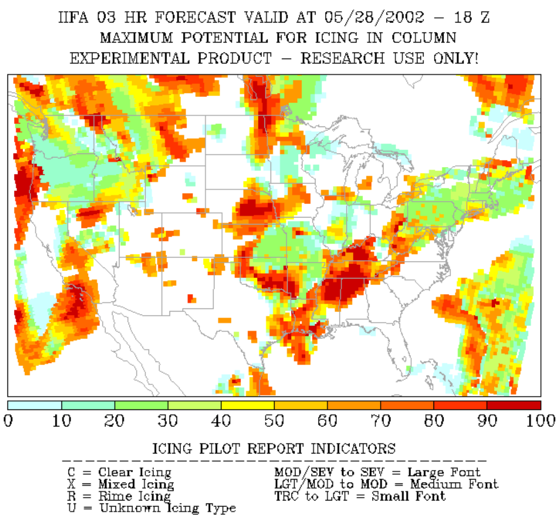
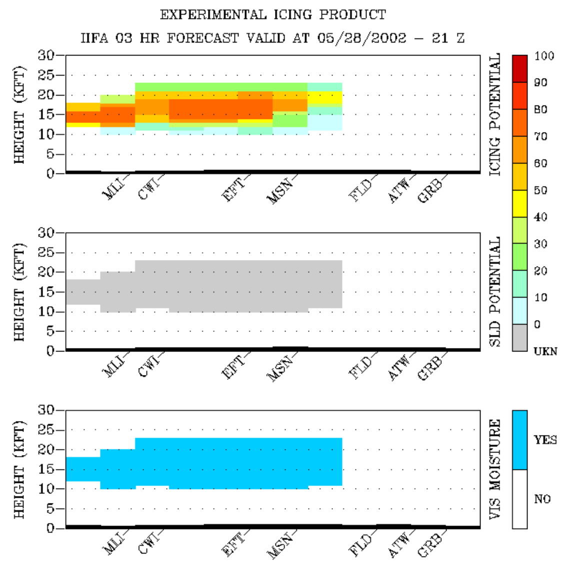


Figure 2: Sample of IIFA Cross-Section



The IIFA output is scaled to match the standard RUC data grid (40 kilometers in the horizontal), with the output produced on an hourly basis. The primary output grids were Icing Potential and SLD Potential, both of which are scaled from 0 (no icing or SLD) to 100 (icing or SLD very likely).

Cross-sections are also available for specific routes flown by the study's participating airlines. These cross-sections take a segment of the three-dimensional grid between two points. The cross-sections show icing within approximately 60km of a straight-line route. A sample of the cross section is shown in Figure 2. IIFA output is produced every three hours at NCAR/RAP and placed on the NCAR web server accessed via the Internet.

3. METHODOLOGY

The IIFA Assessment was conducted using questionnaires, structured interviews, and telephone interviews. ACB-630 meteorologists monitored IIFA on a daily basis identifying trends in model output and performance, to assist ACB-630 human factors specialists in determining icing conditions. In addition to the user feedback, ACB-630 personnel subjectively examined IIFA meteorological performance. User feedback identified times when IIFA tended to perform well or not. These times will be further analyzed in regard to the meteorological environment. The assessment period was February – April 2002.

3.1 Participants

To gain a broader prospective on the utility of IIFA, two different types of users were solicited. Each gave a different perspective based on their experience and their perceived utility of the product. Two regional airlines participated. One set of participants consisted of dispatchers from Air Wisconsin, whose flights are primarily based out of Denver. Specific objectives for dispatch participants were to assess IIFA for such things as: flight planning task benefit, value compared to existing icing information sources, utility for dispatcher operations, reliability, user perceptions of accuracy and performance, user confidence in the product, acceptability of it's interface, potential integration into the dispatcher's work environment, and perceived operator mental workload.

The other set of participants include pilots from regional airline, Sky West. Objectives for this user were to assess IIFA for such things as: icing forecasting task benefit, value compared to existing icing information sources, utility for meteorological operations, reliability and perceived accuracy, user perceptions of performance; user confidence in the product, acceptability of the user interface, the integration into a pilot's preparations capabilities, and perceived mental workload.

3.2 Questionnaires.

Questionnaires were administered to dispatchers and pilots and a 5-point rating scale was used to rate IIFA. Users answered questions about utility, potential benefit, and perceived accuracy. In addition, the questionnaires addressed user interface issues, such as interpretability of data, color-coding, and navigation. The questionnaires included a number of open-ended questions soliciting suggestions for enhancements and other comments. Questionnaires were administered twice during the assessment; at a mid-way point and at the end of the assessment.

3.3 Structured Interviews.

ACB-630 personnel conducted structured interviews of the dispatchers and pilots. The interviews were conducted on-site at Air Wisconsin, and at airports with SkyWest pilots in conjunction with the administration of the questionnaires. The intent of the structured interviews was to solicit information that may not be ratable within the questionnaire format and to obtain more detailed information, clarification on problems or benefits, and other pertinent comments.

3.4 Telephone Interviews.

The intent of the phone interviews was to assess daily use and performance of IIFA. Daily interviews occurred during normal business hours, when practicable, from Monday through Friday. The dispatchers from Air Wisconsin were asked a series of short questions concerning their use of IIFA and how well the algorithm performed for the given day. The interview took no more than 5-10 minutes. Dispatchers were contacted and rotated in order to ensure a representative sample.

4. RESULTS

At the current time, data analysis and results are being completed. Complete results will be presented at the 19th Conference on Weather Analysis and Forecasting. Complete evaluation results including procedures, results, conclusions, and recommendations will be documented in an ACB-630 report available from the FAA William J. Hughes Technical Center.

5. CONCLUSIONS AND RECOMMENDATIONS

Feedback of the results will be presented to the Icing Product Development Team (PDT) for the improvement of IIFA. Final results of all work will be documented in an ACB-630 report. Conclusions and recommendations will be presented at the 19th Conference on Weather Analysis and Forecasting.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

McDonough, F. and B.C. Bernstein, 1999:Combining satellite, radar, and surface observations with model data to create a better aircraft icing diagnosis. Preprints, 8th Conf. on Aviation, Range and Aerospace Meteorology, Dallas TX, Amer. Meteor. Soc., Boston, pp. 467-471.

Baldwin, M., R. Treadon and S. Coturno, 1994: Precipitation type prediction using a decision tree approach with NMC's mesoscale eta model. Preprints, 10th Conf. on Numerical Weather Prediction, Portland OR, Amer. Meteor. Soc., Boston, pp. 30-31.