IceThreat: Using Icing Algorithm Output to Propose AIRMET Regions

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AIRMETs

- Official icing forecasts from the Aviation Weather Center.
- Highlight areas of moderate or greater icing.
- Define a three dimensional space where these conditions are possible for a given amount of time.
- Represented by text (below) or graphically (Fig. 1).

AIRMET ICE…ND SD NE

  States affected by AIRMET (North Dakota, South Dakota, Nebraska)

FROM 50NNE MOT TO 50NNW FSD TO 60SW FSD TO 50SSE ANW TO 40E SNY TO 40ESE CYS TO 50NNW ISN TO 50NNE MOT

  Vertices of the AIRMET polygon (50 nmi north-northeast of Minot, ND)

MOD ICE SFC TO 080. CONDS CONTG BYD 03Z ENDG 03-06Z.

  Vertical boundaries of the AIRMET (Surface to 8000 ft. MSL)
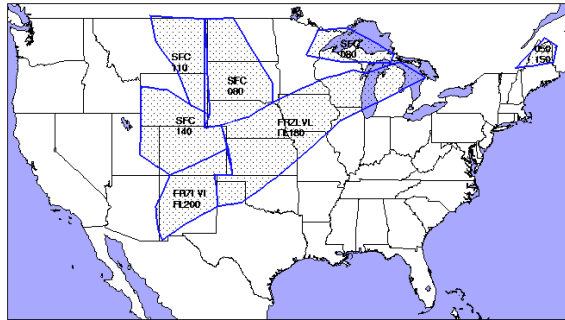

Figure 1. Graphical representation of AIRMETs.

- Graphical AIRMETs (G-AIRMETs) show icing AIRMETs every three hours out to twelve hours.
- These are useful because they show evolution of icing events over a longer forecast period.

Current and Forecast Icing Products (CIP and FIP)

- Developed at NCAR to give automated three-dimensional diagnoses and forecasts of icing conditions over the CONUS.
- Gridded, hourly products showing icing probability and severity (Fig. 2) along with potential for supercooled large drops (SLD)
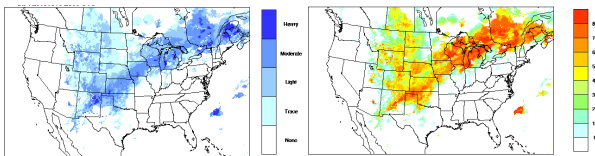- They are supplemental information for pilots.

Figure 2. Icing severity (left) and probability (right) composite images.

Motivation

- Though CIP and FIP differ from AIRMETs in many ways the fields they produce should be useful for recognizing AIRMET conditions.
- The algorithms generally do a good job identifying icing areas that end up in AIRMETs (Fig. 3).
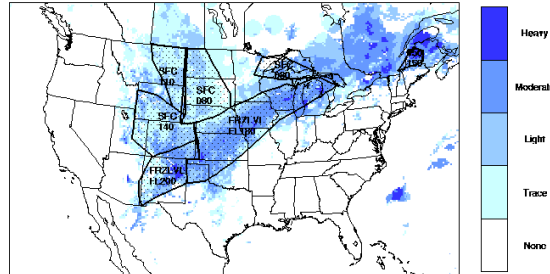

Figure 3. CIP severity composite with AIRMETs overlaid.

Description

- IceThreat uses the icing probability and severity fields to find areas where there is a high likelihood of moderate or greater icing.
- A simple smoothing algorithm is applied to both fields. Currently it averages over 5x5 boxes centered on each point at the current level and 1 level above and below.
- The icing threat is calculated for each point by multiplying the probability and severity values together and taking the square root (Fig. 4).
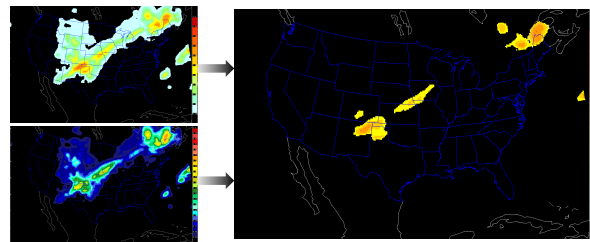

Figure 4. Smoothed icing probability (top left) and raw icing severity (bottom left) and the resultant icing threat (right) at a single level.

- A clumping algorithm finds potential AIRMET regions. These "clumps" are areas with a threat for moderate or greater icing conditions.
- A floor and ceiling are assigned to each "clump" by finding the lowest and highest levels with positive icing threat.
- "Clumps" are combined in horizontal and vertical space based on their proximity and user-defined options. These are the proposed AIRMET regions.

Output

- The algorithm outputs an XML file that defines polygons for all the proposed AIRMETs.
- The file contains the valid time, height of the floor and ceiling, along with latitude and longitude pairs for the center of the shape and each vertex.
- This output can be used to create plots in a variety of packages including NCL and Google Earth.
- Figure 5 shows a comparison between IceThreat run on CIP output and the corresponding AIRMET from 19 March 2010.
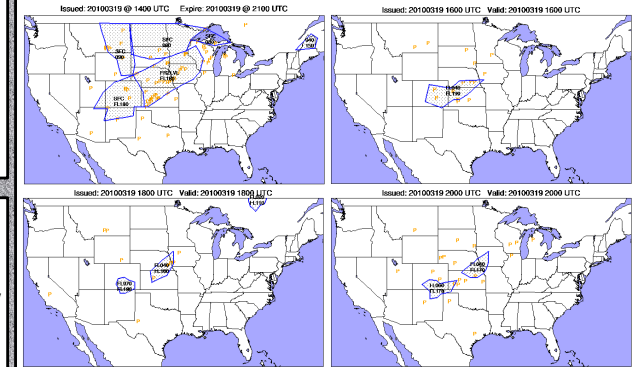

Figure 5. AIRMETs (upper left) and IceThreat output from CIP for three times during its valid period. Positive icing PIREPs from the valid time are in orange.

User Options

- IceThreat was designed to be highly configurable by the user. A parameter file is used to set up the configuration. The options are:
  - icing probability and severity thresholds for defining a threat
  - smoothing window (horizontal and vertical)
  - amount of overlap necessary to combine clumps (can require them to actually overlap, just touch, or even be separated by a certain distance)
  - number of vertices on the proposed AIRMET polygon

Algorithm Use

- The Aviation Weather Testbed at the Aviation Weather Center (AWC) allows new methods, techniques, and software to be tested in a real-time environment and allows for incremental evaluation of products.
- The Interactive Correction in 4 Dimensions (IC4D) software, which is being developed at NOAA and tested at AWC, allows forecasters to edit grids. Proposed AIRMETs from IceThreat could be updated, deleted, or added using this software.
- A webpage has also been set up to compare IceThreat to G-AIRMETs in real-time. http://www.rap.ucar.edu/icing/icethreat