ACCURATE PREDICTIONS OF

IN-FLIGHT ICING

Preventing Accidents

Since the 1990s, scientists and engineers in NCAR's Aviation Applications Program have worked to better understand the atmospheric conditions that lead to in-flight icing. Based on that knowledge, pilots and air traffic personnel today have better access to timely diagnoses and accurate forecasts of in-flight icing conditions, and the ability to avoid them.

PINPOINTING ICING CONDITIONS

In-flight icing can be a factor in aircraft accidents and can create significant disruption of flight operations. Avoidance of these events is possible with diagnoses and forecasts of aircraft icing conditions that are improved in their operational availability, resolution, and accuracy. Scientists and engineers at NCAR have developed a gridded depiction of in-flight icing with high temporal and spatial resolution based on integration of operational model output with real-time sensor data.

The Current Icing Product (CIP), developed at NCAR, is an approved operational product run at the National Center for Environmental Prediction's (NCEP) Aviation Weather Center. CIP provides an hourly diagnosis of the potential of encountering airframe icing conditions over the CONUS at 13-km horizontal and 500-ft vertical resolution. Probability, expected severity, and the potential for supercooled large drop conditions (freezing rain and drizzle) are included in the output files and displays.

Benefits & Impacts

- Hourly diagnosis of icing conditions
- Integration of model output with real-time sensor data
- Researching accurate liquid water content and drop size
- Gridded depiction of icing 1-18 hours into the future

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The CIP algorithm combines numerical model output with weather observations – satellite imagery, radar reflectivity, surface observations, and pilot reports – to deduce likely locations for in-flight icing conditions. A fuzzy logic technique, based on physical concepts, as well as forecaster experience, is employed to merge the data sets and produce the final icing product.

CIP's forecast companion, the Forecast Icing Product (FIP) provides forecasts of icing conditions from 1-18 hours into the future. CIP and FIP outputs are available at the National Weather Service's Aviation Weather Center.

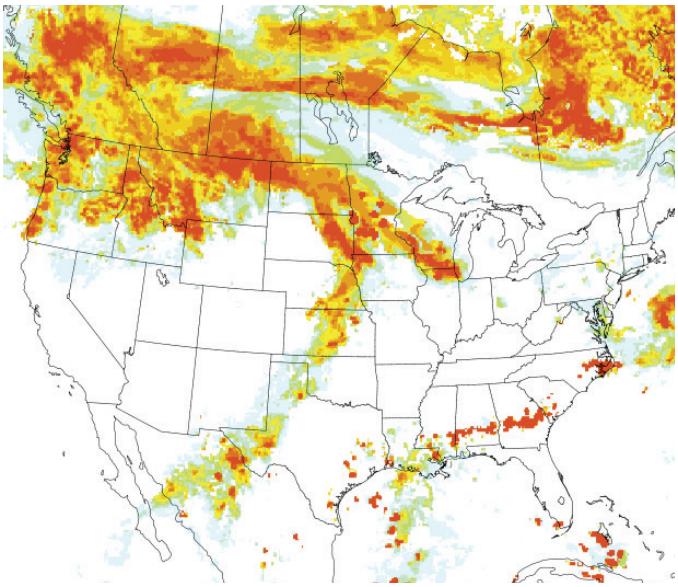
Versions of CIP and FIP are being implemented in locations spanning the globe. NCAR is developing icing diagnosis and forecast algorithms to address the challenging problems faced in Alaska both with different weather situations producing icing and a relative lack of reliable observations. A Taiwan version of CIP and FIP are running operationally. A global version of FIP, covering remote areas used in oceanic aircraft routes, has been developed in partnership with NCEP.

IMPROVING PREDICTIONS

The NCAR in-flight icing program also supports the development of numerical weather model microphysics parameterizations. These models have improved the prediction of supercooled liquid water in clouds, as well as freezing precipitation at the surface. The improved parameterizations were included in the latest NCEP Rapid Update (WRF-RAP) and High-Resolution Rapid Refresh (HRRR) versions of the Weather Research and Forecasting model. Application of this explicit microphysics information for use in icing prediction methods is the subject of current research.

ICING DETECTION BY RADAR

NCAR has been working since 2009 on an algorithm to detect in-flight icing conditions using polarized S-band NEXRAD weather radars. A recent study found that by implementing an NCAR-developed algorithm, operational NEXRADs had a very high icing detection rate over a wide variety of weather and surface precipitation types. NCAR also partnered with NASA on their Icing Remote Sensing System (NIRSS) consisting of a K-band radar, microwave profiling radiometer



Maximum Icing Probability in a Vertical Column

and ceilometer, demonstrating that this suite of instruments had a high success rate in detecting icing conditions. Using lessons learned from working with these technologies, NCAR has developed the Radar Icing Algorithm (RadIA).

RadIA utilizes the polarized moments from the National Weather Service's network of WSR-88D operational radars and the most recent Numerical Weather Prediction model temperature profiles to detect elevated icing hazard regions. The algorithm consists of several internal algorithms for various icing scenario inclusion or non-icing scenario exclusion, the sum of which are combined for a final in-flight icing hazard index.

NEW FRONTIERS

To further support the FAA's mission of safety and efficiency, NCAR researchers are focused on developing a highly resolved depiction and forecast of in-flight icing conditions. Research in numerical modeling, improved observation techniques, and innovative methods for blending this information will result in accurate predictions of liquid water content and drop size. These parameters, along with temperature, may allow for aircraft-specific predictions of severity by being used as input to calculations of ice accretion and resting flight performance degradation, which can be developed by aeronautical engineers.

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